MINERAL AND ENERGY RESOURCE ASSESSMENT OF THE MCGREGOR RANGE, NEW MEXICO

Prepared for

Program Manager
U.S. Army
McGregor Range Renewal/Fort Bliss
Texas and New Mexico

Geotechnical
Information Center

Prepared through

U.S. Army Corps of Engineers
Fort Worth District Environmental Division
Fort Worth, Texas

Under

Contract No. DACA63-92-D-0011
Delivery Order No. 82

By

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MAI Project 735-82

Geotechnical
Information Center

August 1998

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report assesses the potential of mineral and energy resources on the surface and within the subsurface in the McGregor Range, located in Otero County, New Mexico (refer to Figure ES-1). Resource potential is the likelihood for the occurrence of undiscovered concentrations of metal minerals, nonmetallic minerals (i.e., industrial materials), and energy resources (Goudarzi 1984). The evaluation of mineral resource potential involves a complex process based on geologic analogy of favorable geologic environments with geologic settings that are known to contain economic deposits (geologic models). This assessment will provide land managers with appropriate data to make land use decisions.

This project is required by 43 Code of Federal Regulations Section 2310.3-2(b)(3)(iii) and conforms to mineral assessment guidelines and procedures presented in Goudarzi (1984) and in Section 3060.13 of the Bureau of Land Management manual. Levels of mineral and energy resource potential and certainty of assessment were assigned using the assessment system described in Goudarzi (1984) and shown in Figure ES-2. Pertinent information has been assembled in this mineral and energy assessment report that follows, with some modification, formats and specifications outlined in Goudarzi (1984). This project required the combined efforts of personnel from Fort Bliss, the U.S. Army Corps of Engineers, TRC Mariah Associates Inc., the New Mexico Bureau of Mines and Mineral Resources, New Mexico State University, and various analytical laboratories.

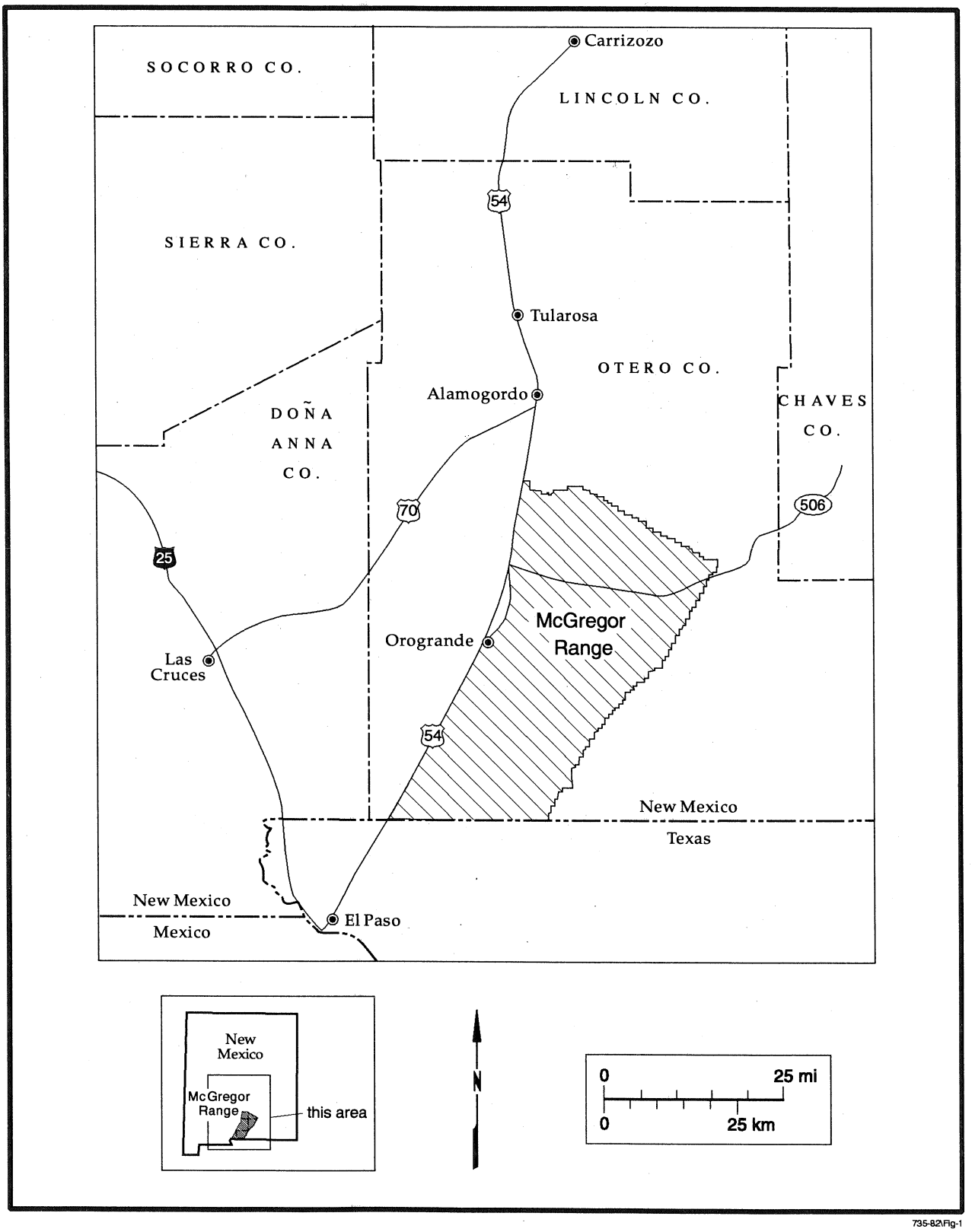

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Figure ES-1 Location of the McGregor Range.

Definitions of Level of Resource Potential

NO (N) mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

LOW (L) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources in unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock, as well as areas with few or no indications of having been mineralized.

MODERATE (M) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH (H) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN (U) mineral resource potential is assigned where information is inadequate to assign low, moderate, or high levels of resource potential.

Definitions of Level of Certainty

A Available information is not adequate for determination of the level of mineral resource potential.

B Available information suggests the level of mineral resource potential.

C Available information gives a good indication of the level of mineral potential.

D Available information clearly defines the level of mineral resource potential.

Relationships Between Levels of Resource Potential and Certainty

Increasing Level of Resource Potential

U/A	H/B High Potential	H/C High Potential	H/D High Potential
	M/B Moderate Potential	M/C Moderate Potential	M/D Moderate Potential
Unknown Potential	L/B Low Potential	L/C Low Potential	L/D Low Potential
			N/D No Potential

Increasing Level of Certainty

[1] Source: Modified from Goudarzi (1984).

Figure ES-2 Definition and Relationship of Resource Potential and Certainty.

2.0 PHYSIOGRAPHIC SETTING

The McGregor Range encompasses approximately 698,000 acres and is located approximately 10 miles south of Alamogordo in southern Otero County, New Mexico (refer to Figure ES-1). The McGregor Range is a military training facility for the U.S. Army at Fort Bliss.

The McGregor Range lies within the Tularosa Valley of the Basin and Range physiographic province. Prominent physiographic features within the McGregor Range include the southern Jarilla Mountains, southern Sacramento Mountains, Otero Platform, and the northern Hueco Mountains (refer to Figure ES-3). There are numerous canyons in the Sacramento and Hueco Mountains, but no major rivers. The Cornudas, Brokeoff, and Guadalupe Mountains lie to the east of the McGregor Range, and the Sacramento Mountains lie to the north. The Jarilla Mountains are along the western boundary. The Franklin and Organ Mountains are to the west of the McGregor Range.

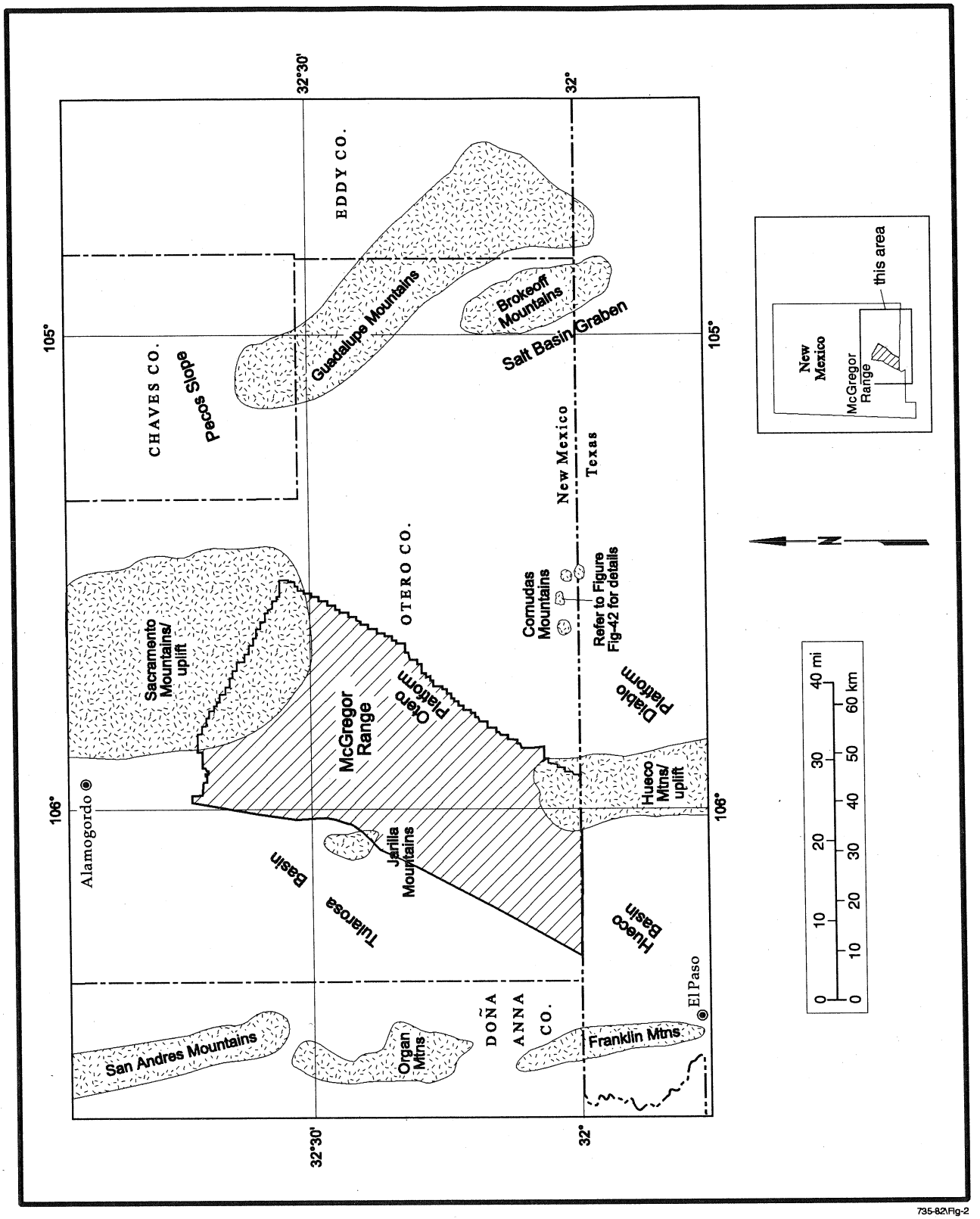

Figure ES-3 Physiographic Features on and Adjacent to the McGregor Range.

3.0 METHOD OF STUDY

The first stage of this resource assessment was the compilation and interpretation of all available published and unpublished geologic, geochemical, geophysical, and production data. Using these data, known mineral occurrences, deposits, mines, and prospects were identified and plotted on base maps. Remote sensing projects were conducted to provide an overview of lineation patterns and to outline areas of spectral response indicative of rock alterations and possible mineralizations. These projects studied geophysical data and Landsat satellite imagery. The National Uranium Resource Evaluation data were also examined and evaluated. Areas of anomalous structural complexity, hydrothermal alteration, and anomalous coloration were delineated and examined during the reconnaissance sampling stage.

A detailed sampling plan was developed based on available background information and data. A total of 385 new geologic samples were collected for this project from within and adjacent to the McGregor Range. The sampling plan identified three general sample types; geochemical characterization samples, stream sediment samples, and mineralized area samples. A total of 136 geochemical characterization samples were collected. These samples were collected and analyzed to determine background chemical and physical characteristics of unaltered rocks on and near the McGregor Range. A total of 211 stream sediment samples were collected, analyzed, and interpreted. The stream sediment sampling program was designed to identify and investigate anomalous areas, as well as provide geochemical data for regional evaluation. A total of 38 mineralized area samples were also collected and analyzed. These samples were collected from existing mines and mineralized or altered areas. "High-grade" ore samples were collected at each sample site; these samples provided information on the type of mineralization present, as well as relationships among trace elements. Some samples were collected from exploration drill hole cores that were archived at the New Mexico Bureau of Mines and Mineral Resources.

Strict sample collection, recordation, and preparation protocols were followed during this phase of the project. All samples were prepared and analyzed for specific parameters utilizing appropriate analytical techniques. Some samples were analyzed for major and trace pathfinder elements, other samples were prepared and examined for mineralogical content, and still other samples were analyzed for industrial commodity parameters and petroleum resource parameters. Because an evaluation and assessment of mineral and energy resource potential relies so heavily on the analytical results obtained from the sample collected within the project area, a quality control and quality assurance program was developed and implemented for this project. The purpose of this program was to ensure that standardized and consistent protocols are followed and accurate data and information were collected during: collection of each sample; documentation of information concerning each sample and the sample locality; and preparation, transportation, and analyses of each sample.

The final evaluation of the mineral and energy resource potential involves integration and interpretation of all available data to identify possible mineral deposits that could occur within the McGregor Range and delineation of areas of potential occurrence. A number of factors were evaluated, including host rock favorability, structural controls, evidence of mineralization, previous mining and production, geochemical and/or geophysical anomalies, regional geologic setting, time of mineralization, alteration, mineralogy and mineral assemblages, processes affecting mineralization since formation, and geologic history. Where appropriate, market conditions and transportation factors were also evaluated as part of the resource potential assessment.

4.0 MINERAL AND ENERGY RESOURCE POTENTIAL

Based on available geologic information and the geologic investigations conducted for this project, mineral and energy resource potentials and certainties have been developed and assigned utilizing the methods described in this report. Resource potentials are discussed below, summarized in Table ES-1, and shown on Figures ES-4 through ES-12.

4.1 METALLIC MINERAL RESOURCES

There are six favorable areas for metallic mineralization present within the McGregor Range as determined from geologic investigations and geochemical sampling. These areas are: the northern Hueco Mountains area, Martin-Hay Meadow Canyons area, central basin area, southern Jarilla Mountains area, southern Otero Platform area, and El Paso-Culp Canyons area (refer to Figure ES-4). A summary of the metallic mineral resource potential is presented in Table ES-1.

4.2 NONMETALLIC MINERAL RESOURCES

Fourteen nonmetallic (i.e., industrial) commodities with potential for development are present on the McGregor Range. However, most industrial resource potentials are rated as low to moderate (refer to Table ES-1). Some industrial commodities areas within the McGregor Range such as construction aggregate, limestone, and gypsum are rated as having a high potential (refer to Table ES-1 and Figures ES-5 through ES-9). Because of the remote nature of the McGregor Range, these ratings are based primarily on transportation and marketing considerations.

4.3 ENERGY RESOURCES

Four energy resources were evaluated as part of this project. This includes: coal, geothermal, petroleum, and uranium. The potentials for all energy resources on the McGregor Range are presented in Table ES-1. Due to the lack of rocks from the Cretaceous period, there is no potential for coal resources on the McGregor Range. Geothermal resource potential ranges from low to high (refer to Table ES-1 and Figure ES-10). The area near the McGregor Base Camp has a high potential, and the western portion of the McGregor Range has a moderate potential. The petroleum resource potential of the McGregor Range varies from low to moderate (refer to Table ES-1 and Figure ES-11). Uranium resource potential is rated as none to low on the McGregor Range (refer to Table ES-1 and Figure ES-12).

Table ES-1 Summary of Mineral and Energy Resource Potential on the McGregor Range.

Resource	Area	Potential	Certainty	Comments
METALLIC MINERAL RESOURCES				
Beryllium	Red Hills area	Low to moderate	B-C	Favorable alkaline host rocks
	Southern Otero Platform area	Low to moderate	C	Similar to topaz-rhyolites
	Martin-Hay Meadow Canyons area	Low	B	None
	Elsewhere on McGregor Range	None	D	None
Copper	Southern Jarilla Mountains area	Low to moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B-C	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Gold	Southern Jarilla Mountains area	Low	C	GPM deposits
	Red Hills area	Low	C	Sedimentary copper, GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Epithermal/mesothermal veins
	Southern Otero Platform area	Low	C	Carbonate-hosted deposits
	El Paso-Culp Canyons area	Low	B	None
	Elsewhere on the McGregor Range	None	D	None
Iron	Entire McGregor Range	Low	C	Favorable host rocks
Lead-zinc	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B-C	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Manganese	Central basin area	Low to moderate	B-C	Geochemical anomalies
	Elsewhere on the McGregor Range	Low	C	None

Table ES-1 (Continued)

Resource	Area	Potential	Certainty	Comments
Molybdenum	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	GPM deposits
	Southern Otero Platform area	Low	C	GPM deposits
	Elsewhere on the McGregor Range	None	D	None
Niobium	Red Hills area	Low	C	Favorable alkaline host rocks
	Elsewhere on the McGregor Range	None	D	None
PGE	Entire McGregor Range	None	C-D	Favorable host rocks
Silver	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Thorium and rare-earth elements	Red Hills area	Low	C	Favorable alkaline host rocks
	Elsewhere on the McGregor Range	None	D	None
Tin	Southern Otero Platform area	Low	C	Similar to topaz-rhyolites
	Elsewhere on McGregor Range	None	D	None
Other metallic resources[1]	Entire McGregor Range	None	D	None
INDUSTRIAL MINERAL RESOURCES				
Barite and Fluorite	All	Low	B-C	None
Borate	All	Low	D	None
Building Stone	All	Low-Moderate	B-D	Dimension stone has dark color, and decorative stone lacks distinctive colors or textures
Clay	All	Low	C	No specialty clay minerals are present
Construction Aggregate	All	None-High	D	Refer to Figures ES-5 through ES-7

Table ES-1 (Continued)

Resource	Area	Potential	Certainty	Comments
Garnet	Hueco and Jarilla Mountains	Low	C	Possible near Tertiary intrusions
	Elsewhere on the McGregor Range	None	D	None
Gypsum	All	None-High	B-C	Refer to Figure ES-8
Halite	All	Low	C	None
Limestone and Dolestone	All	None-High	D	Refer to Figure ES-9, potential for limestone is rated as none to high and dolestone is rated as low
Nepheline Syenite	Red Hills area	Low	C	None
	Elsewhere on the McGregor Range	None	D	None
Silica	All	Low	D	None
Sulfur	All	Low	D	None
ENERGY RESOURCES				
Coal	All	None	D	No Cretaceous rocks
Geothermal	Near McGregor Base Camp	High	D	Refer to Figure ES-10
	Western portion of McGregor Range	Moderate	B	Refer to Figure ES-10
	Elsewhere on the McGregor Range	Low	B	Refer to Figure ES-10
Petroleum	Otero Platform and Hueco Uplift area	Low-Moderate	C	Refer to Figure ES-11
	Sacramento Uplift area	Low	C	Refer to Figure ES-11
	Tularosa Basin area	Moderate	C	Refer to Figure ES-11
Uranium	Hueco Mountains and Martin-Hay Meadows area	Low	C	Refer to Figure ES-12
	Elsewhere on the McGregor Range	None	D	None

[1] Includes: bismuth, cadmium, cobalt, chromium, nickel, tantalum, vanadium, tungsten, and zirconium.

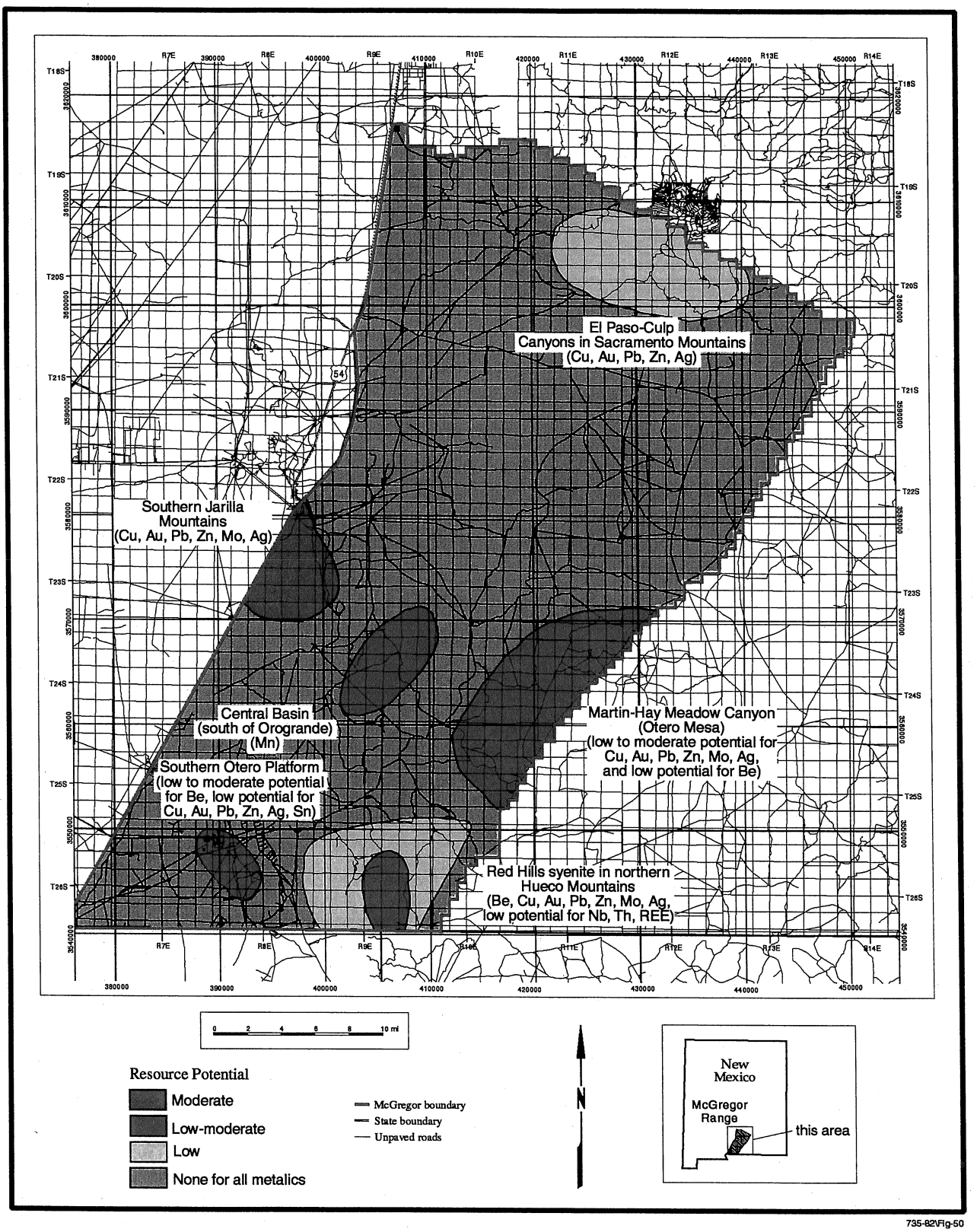

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Figure ES-4 Resource Potential of Metallic Minerals on the McGregor Range

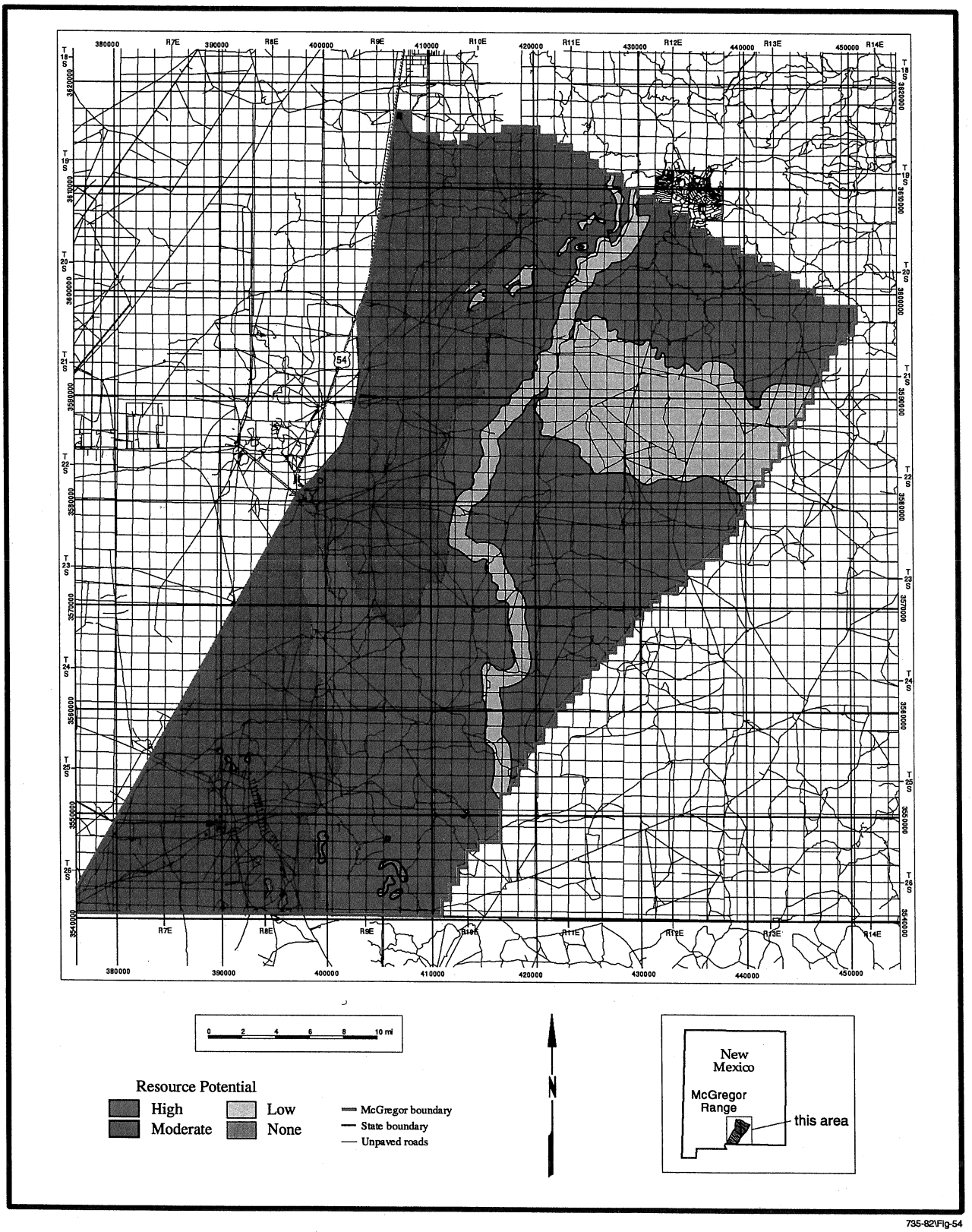

Figure ES-5 Resource Potential for Caliche on the McGregor Range.



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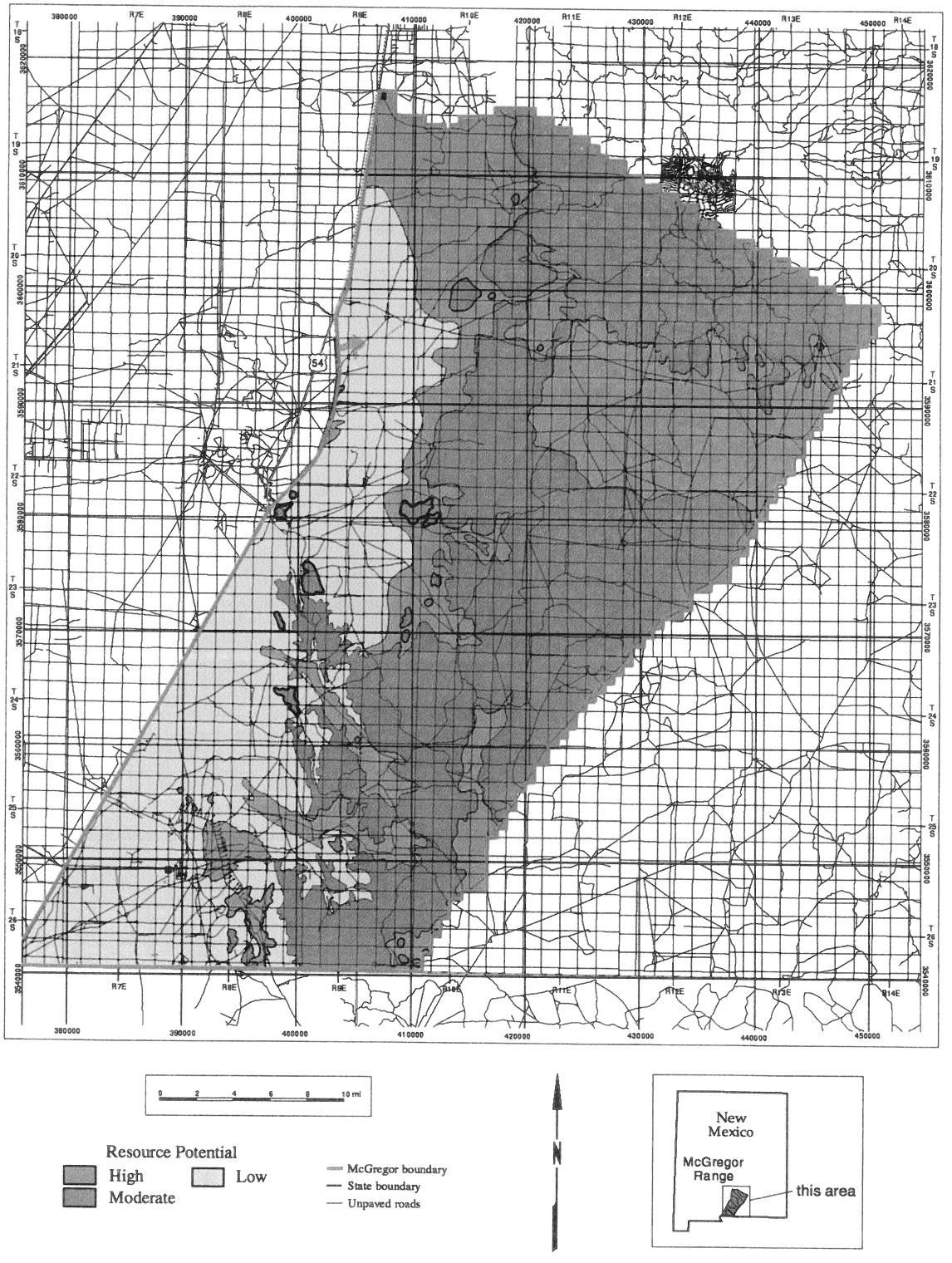
igure ES-6 Resource Potential for Crushed Stone on the McGregor Range.



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ɡure ES-7 Resource Potential for Sand and Gravel on the McGregor Range.

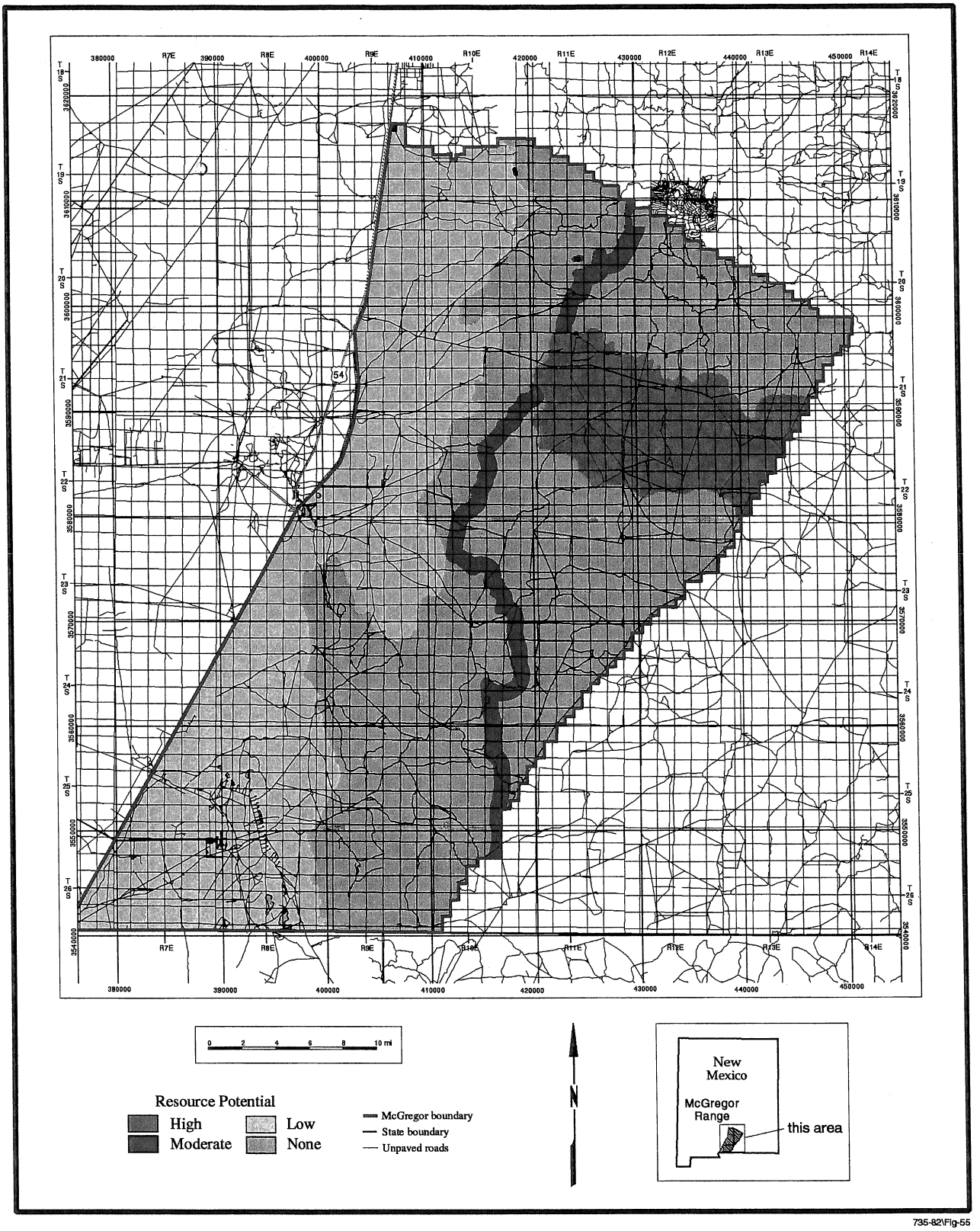

Figure ES-8 Resource Potential for Gypsum on the McGregor Range.

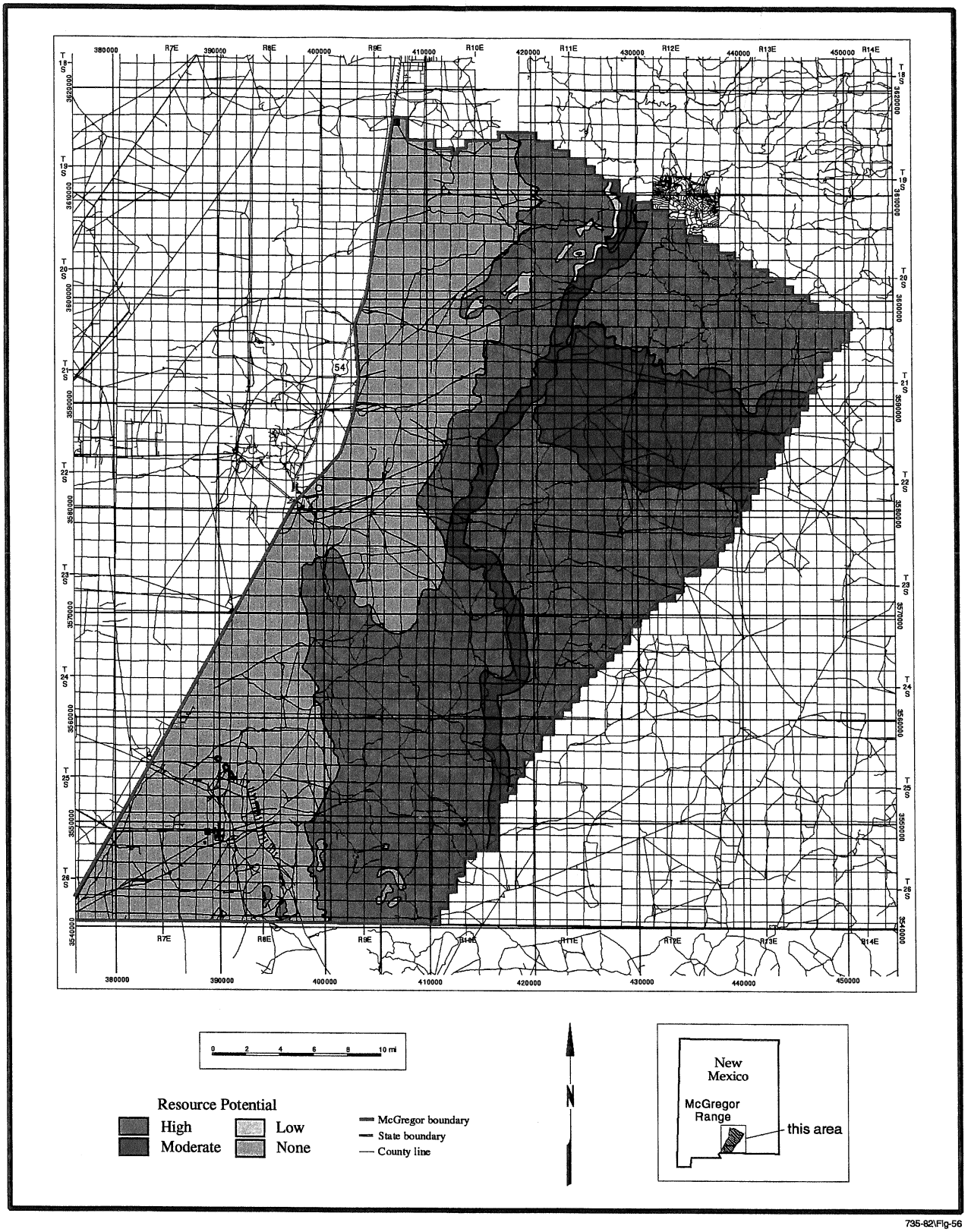

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Figure ES-9 Resource Potential for Limestone on the McGregor Range.

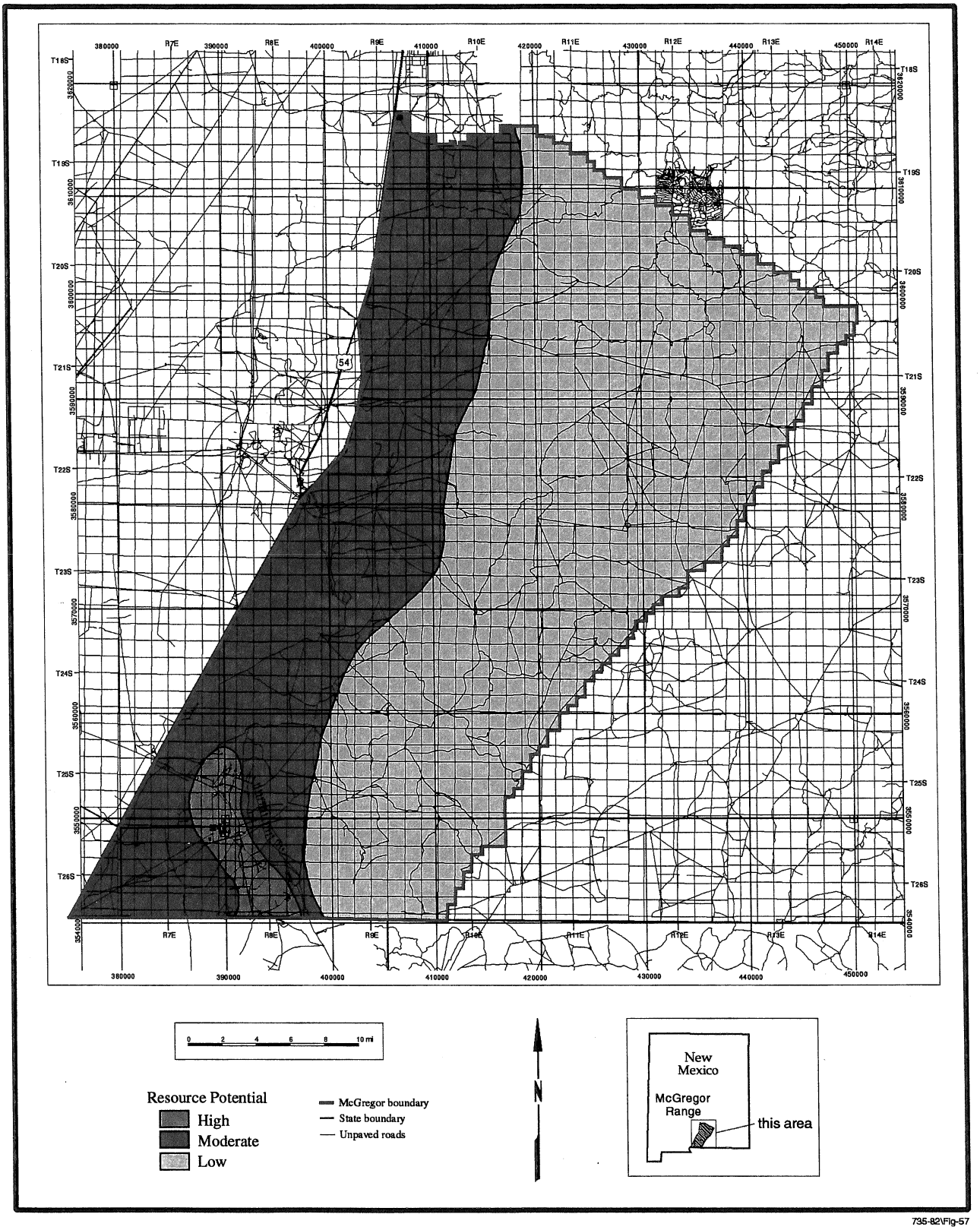

Figure ES-10 Geothermal Resource Potential on the McGregor Range.

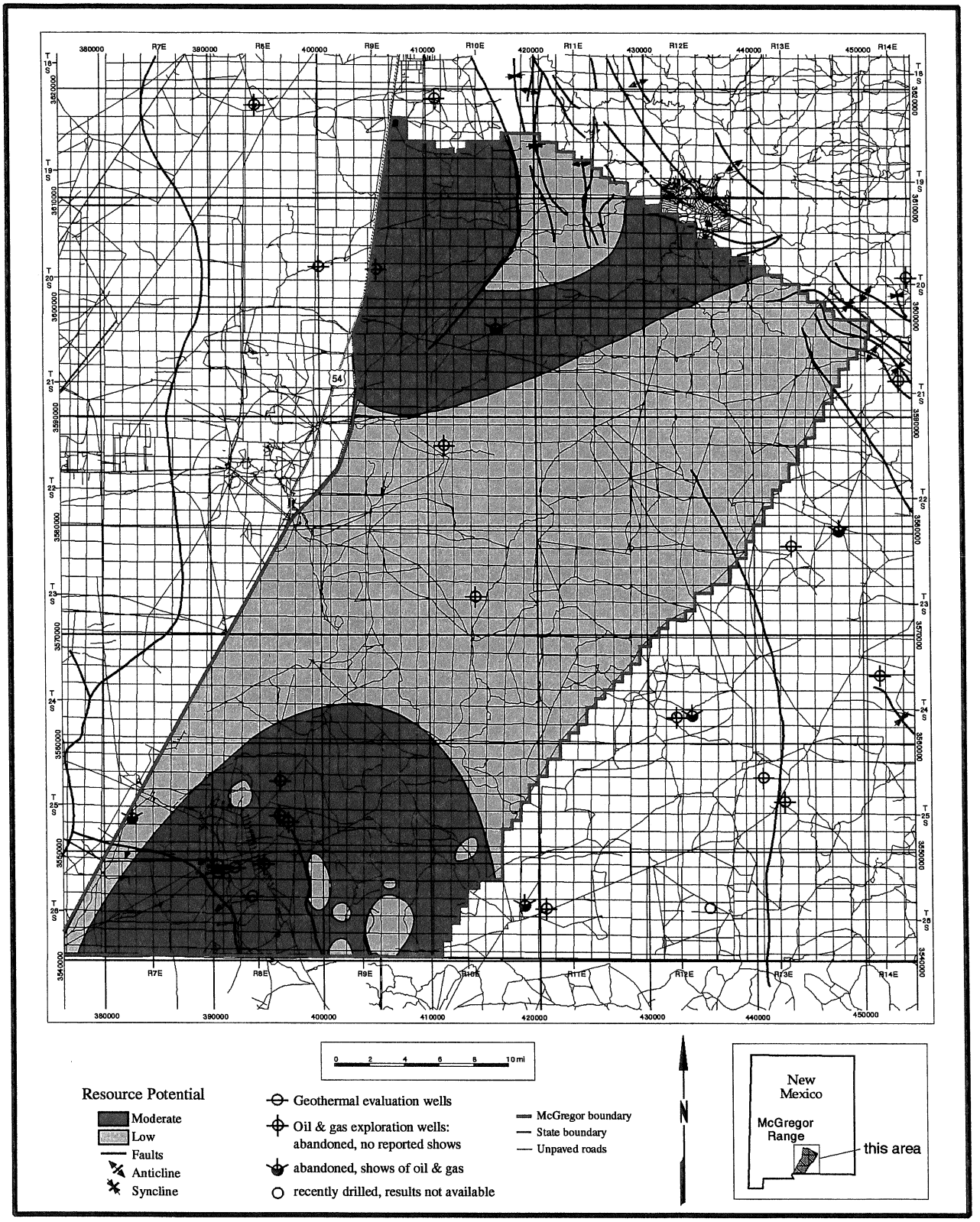

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Figure ES-11 Resource Potential for Petroleum on the McGregor Range.

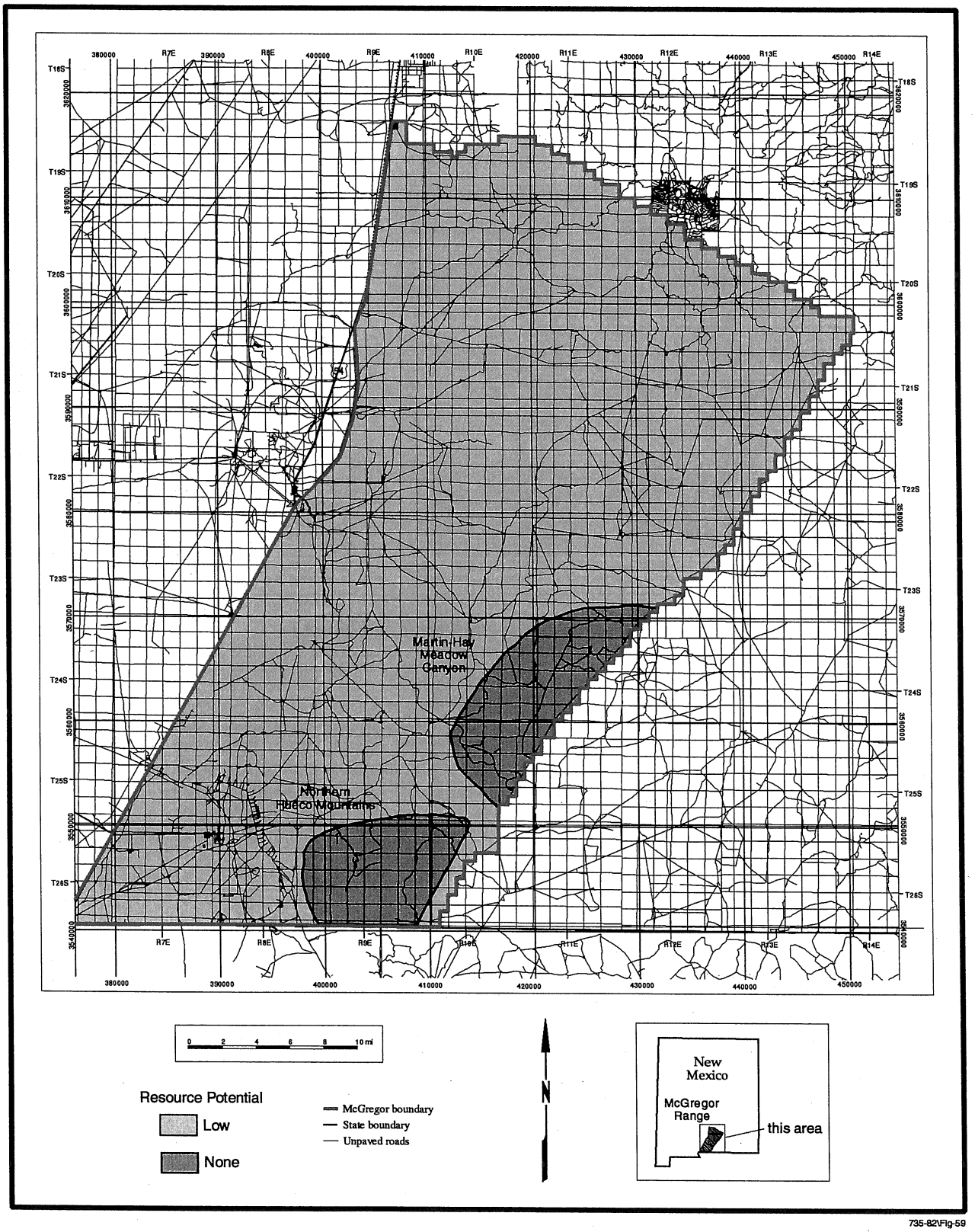

Figure ES-12 Resource Potential for Uranium on the McGregor Range.

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LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society of Testing and Materials
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
DC	Delayed-neutron counting
FOB	Freight-on-board
GPM	Great Plains Margin
GPS	Global positioning system
HDR	Hot dry rock
ICP	Inductively coupled plasma
IM	Industrial mineral
INAA	Instrumental neutron activation analysis
LA	Los Angeles
LOI	Loss on ignition
Ma	Million years before present
MILS	Minerals Industry Location System
MRDS	Mineral Resource Data System
MVT	Mississippi Valley-type
NMBMMR	New Mexico Bureau of Mines and Mineral Resources
NMSU	New Mexico State University
NURE	National Uranium Resource Evaluation
OH	Hydroxyl
PCA	Principle component analyses
PGE	Platinum group elements
ppb	Parts per billion
ppm	Parts per million
QAP	Quartz-alkali feldspar-plagioclase
REE	Rare-earth elements
RGR	Rio Grande Rift
SP	Self-potential
TAI	Thermal Alteration Index
TDS	Total dissolved solids
TM	Thematic Mapper
TOC	Total Organic Carbon
USGS	U.S. Geological Survey
UTEP	University of Texas at El Paso
UV	Ultra-violet
WPG	Within-Plate Granites
VAG	Volcanic Arc Granites
XRAL	XRAL Activation Services Inc.
XRF	X-ray fluorescence

LIST OF ELEMENTS

Ag	silver
Al	aluminum (Al_2O_3)
As	arsenic
Au	gold
B	boron
Ba	barium
Be	beryllium
Bi	bismuth
Br	bromine
Ca	calcium (CaO)
Cd	cadmium
Ce	cerium
Co	cobalt
Cr	chromium
Cs	cesium
Cu	copper
Eu	europium
F	fluorine
Fe	iron (Fe_2O_3 Total, FeO)
Ga	gallium
Ge	germanium
Hg	mercury
Hf	hafnium
Ir	iridium
K	potassium (K_2O)
La	lanthanum
Li	lithium
Lu	lutetium
Mg	magnesium (MgO)
Mn	manganese
Mo	molybdenum
Na	sodium (Na_2O)
Nb	niobium
Nd	neodymium
Ni	nickel
Os	osmium
P	phosphorus (P_2O_5)
Pb	lead
Pd	palladium
Pt	platinum
Rb	rubidium
Re	rhenium
Rh	rhodium
Ru	ruthenium
S	sulfur
Sb	antimony
Sc	scandium
Se	selenium
Si	silica
Sm	samarium
Sn	tin
Sr	strontium
Ta	tantalum
Tb	terbium
Te	tellurium
Th	thorium
Ti	titanium (TiO_2)
U	uranium
V	vanadium
W	tungsten
Y	yttrium
Yb	ytterbium
Zn	zinc
Zr	zircon

GLOSSARY

Bastnasite—A rare-earth, fluorocarbonate mineral that is a major source of rare-earth elements.

DC—Delayed-neutron counting method of geochemical analysis.

Drill stem test—A special test by which formation fluids can be recovered from a known depth interval in a borehole and fluid pressures can be measured from that depth interval by lowering a specialized tool (drill stem test tool) into the wellbore.

GPM—Great Plains Margin deposits, a group of mineral deposits that are related to alkaline rocks.

Granite—A plutonic rock consisting of quartz, K-feldspar, and plagioclase with other accessory minerals.

Hornfels—A medium- or fine-grained granular rock produced by thermal metamorphism.

ICP—Inductively coupled plasma spectrometry method of geochemical analysis.

INAA—Instrumental neutron activation analysis method of geochemical analysis.

Kerogen—High-molecular weight, polymeric, organic material from which oil and natural gas are derived.

Liesegang banding—Secondary rings or bands caused by rhythmic precipitation within a fluid-saturated rock.

LOI—Loss on ignition, total amount of water and volatiles bound up in a sample.

Mine—Any prospect that produced or is currently producing a useful mineral or commodity.

Mineral occurrence—Any locality where a useful mineral or material occurs.

Mineral prospect—Any occurrence that has been developed by underground or aboveground techniques or by subsurface drilling.

Mineral resources—The naturally occurring concentrations of materials (solid, gas, or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions.

Mineral-resource potential—The probability that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions.

MVT—Mississippi Valley-type deposits, lead-zinc deposits that are not associated with igneous activity.

Nepheline syenite—A plutonic rock consisting of alkali feldspar and nepheline with subordinate plagioclase, biotite, pyroxene, amphibole, and other minerals.

NMBMMR—New Mexico Bureau of Mines and Mineral Resources.

NURE—National Uranium Resource Evaluation program of the U. S. Department of Energy, conducted in the 1970s and early 1980s.

PGE—Platinum group elements, specifically platinum (Pt), palladium (Pd), rhodium (Rh), rhenium (Re), ruthenium (Ru), iridium (Ir), and osmium (Os).

RGR—Rio Grande Rift deposits, barite-fluorite-galena deposits that are not associated with igneous activity.

REE—Rare-earth elements, specifically cerium (Ce), dysprosium (Dy), erbium (Er), europium (Eu), gadolinium (Gd), holmium (Ho), lanthanum (La), lutetium (Lu), neodymium (Nd), promethium (Pm), praseodyium (Pr), scandium (Sc), samarium

(Sm), terbium (Tb), thulium (Tm), yttrium (Y), and ytterbium (Yb).

Reservoir (petroleum)—A porous and permeable rock through which petroleum can move and accumulate.

Rhyolite—A volcanic rock consisting of quartz, plagioclase, and K-feldspar and other accessory minerals.

Seal (petroleum)—An impermeable rock, fault, or other geologic barrier that blocks the migration of petroleum in the subsurface.

Sediment—Particles derived from rocks or biological materials that are transported by water, air, or gravity in stream channels.

Syenite—A plutonic rock consisting of alkali feldspar with subordinate plagioclase, biotite, pyroxene, amphibole, and other minerals.

Show (of oil or gas)—A recorded occurrence of oil or gas in a well.

Source rock (petroleum)—A unit of rock that has generated and expelled petroleum in sufficient quantities to form commercial accumulations.

TAI—Thermal Alteration Index, a numerical measure of the color of kerogen in transmitted light which is related to the thermal maturity of a petroleum source rock.

TOC—Total Organic Carbon, the percentage of the weight of a rock that consists of carbon in an organic form.

Trap (petroleum)—The physical arrangement of one or more seals and a reservoir rock that inhibits the migration of petroleum and allows its accumulation.

UTEP—University of Texas at El Paso.

XRF—X-ray fluorescence spectrometry method of geochemical analysis.

1.0 INTRODUCTION

1.1 PURPOSE OF STUDY

This report assesses potentially recoverable mineral and energy resources within the McGregor Range, located in Otero County, New Mexico. Resource potential is the likelihood for the occurrence of undiscovered recoverable concentrations of metals, nonmetals, industrial materials, and energy resources. The evaluation of mineral resource potential involves a complex process based on geologic analogy of favorable geologic environments with geologic settings that contain known economic deposits (geologic models). Such subjective assessments or judgments depend upon available information concerning the area, as well as current knowledge and understanding of known deposits. This assessment will provide land managers with appropriate data to make land use decisions. The project conforms to mineral assessment guidelines and procedures outlined in Goudarzi (1984) and in Section 3060.13 of the Bureau of Land Management (BLM) (1994) manual.

1.2 STUDY AREA

The McGregor Range consists of approximately 698,000 acres and is located approximately 10 mi south of Alamogordo in southern Otero County, New Mexico (refer to Figure 1.1). U.S. Highway 54 approximately marks the western border of the McGregor Range. The McGregor Range is a military training facility for the U.S. Army at Fort Bliss, El Paso, Texas.

The McGregor Range lies within the Tularosa Valley of the Basin and Range physiographic province. Prominent physiographic features within the McGregor Range include the southern Jarilla Mountains, southern Sacramento Mountains, Otero Mesa, and the northern Hueco Mountains (refer to Figure 1.2). There are numerous canyons in the Sacramento and Hueco Mountains, but no major rivers. The Cornudas, Brokeoff, and Guadalupe Mountains lie to the east of the McGregor Range and the Sacramento Mountains lie to the north. The Jarilla Mountains are along the western boundary. The Franklin, Organ, and San Andres Mountains are west of the McGregor Range.

1.3 METHOD OF STUDY

1.3.1 Introduction

Prior to the initiation of this investigation, a detailed sampling plan (U.S. Army 1997) was developed by the project team and approved by the BLM. The first stage of this geologic investigation was the compilation and interpretation of all available published and unpublished geologic, geochemical, geophysical, and production data for the area. Mineral databases were examined, including the Mineral Resource Data System (MRDS) of the U.S. Geological Survey (USGS), the Minerals Industry Location System (MILS) of the U.S. Bureau of Mines (USBM), and unpublished files at the New Mexico Bureau of Mines and Mineral Resources (NMBMMR). Using these data, known mineral occurrences, deposits, mines, and prospects were identified and plotted on base maps. There are no mining claims within the McGregor Range (Kness 1994). National Uranium Resource Evaluation (NURE) data were also examined and evaluated. Areas of anomalous structural complexity, hydrothermal alteration, and anomalous coloration were delineated and examined, where possible, during the reconnaissance sampling stage.

Satellite imagery of the project area was studied, using a variety of image processing techniques employed with Landsat Thematic Mapper (TM) digital datasets to highlight geology, subtle structure patterns,

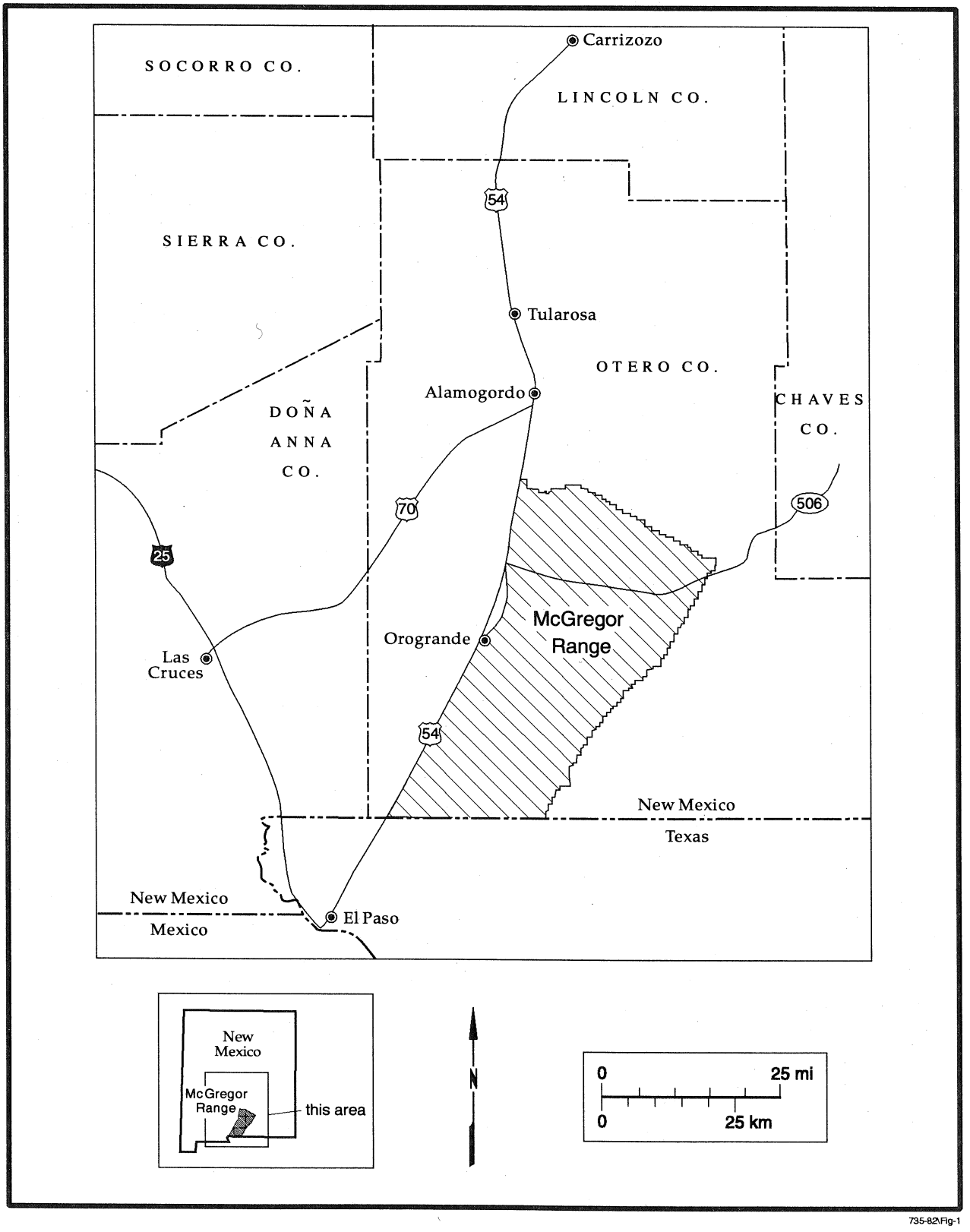

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Figure 1.1 Location of the McGregor Range.

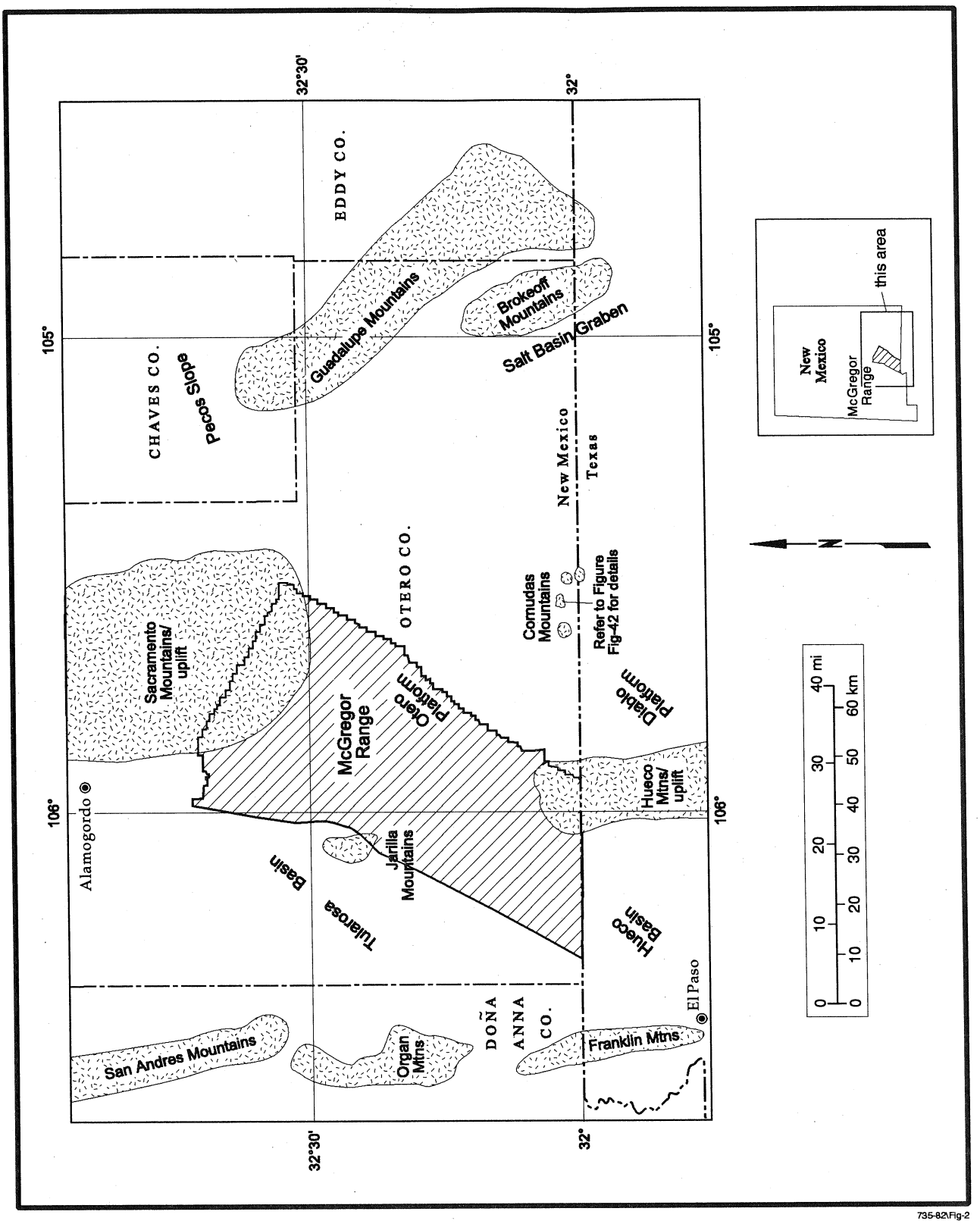

Figure 1.2 Physiographic Features on and Adjacent to the McGregor Range.

hydrothermally altered areas, and potential resource areas. Areas of anomalous structural complexity, anomalous coloration, and possible hydrothermal alteration defined during this phase of the study were examined and sampled during the field examination stage of the project. A more detailed discussion on remote sensing procedures is presented in Section 2.4.

The field portion of this project was divided into three major segments: geochemical characterization sampling, stream sediment sampling, and mineralized area sampling. Most sample sites for these programs were identified prior to field examination, using the procedure discussed above. However, some follow-up samples were collected based on the results of previously collected samples. The geochemical characterization program involved the sampling of the major lithologic units found within or near the McGregor Range for metallic minerals, industrial minerals, and petroleum resources. The results of these samples provided a geochemical baseline of the McGregor Range and were used for comparing the results of the stream sediment and mineralized area sampling. One hundred thirty-six geochemical characterization samples were collected and analyzed. Stream sediment samples were collected to evaluate anomalous areas and to provide geochemical data for regional evaluation. Two hundred eleven stream sediment samples were collected and analyzed. Mineralized area samples were collected from preselected sites within the McGregor Range and provided information on the type of mineralization present and the relationships among trace elements. Thirty-eight mineralized area samples were collected and analyzed. All samples were collected and analyzed during the summer and fall of 1997. A detailed discussion about each sampling program is presented later in this chapter.

The final evaluation of the mineral resource potential involved integration and interpretation of all available data to identify possible mineral deposits that may occur within the McGregor Range and delineation of areas of potential occurrence. A number of factors were evaluated, including host rock favorability, structural controls, evidence of mineralization, previous mining and production, geochemical and/or geophysical anomalies, regional geologic setting, time of mineralization, alteration, mineralogy and mineral assemblages, processes affecting mineralization since formation, and geologic history.

Three hundred eighty-five samples were collected and analyzed for this study and combined with existing data and information. Sample locations are tabulated in Appendix 1 and are shown on Figures 1.3-1.13. From these data, areas of mineral and energy potential were defined and estimates of the types of known and undiscovered resources that may be present within the project area and the favorability of occurrence were made. Levels of mineral resource potential and certainty of assessment (refer to Figure 1.14) were assigned using a modified version of the system described in Goudarzi (1984:23-24). This information has been assembled in this mineral and energy survey report which generally follows, with some modifications, the format outlined by Goudarzi (1984) and the BLM (1994) manual, Section 3060.

1.3.2 Geochemical Characterization Sampling Program

1.3.2.1 Task Summary

A geochemical characterization study which included the collection of various samples from major lithologic units present within the project area was conducted to provide geochemical baselines for the evaluation of the regional, district, and prospect-scale sampling programs. Data collected from this sampling program were utilized to assess metallic mineral, industrial mineral, and petroleum resource potential.

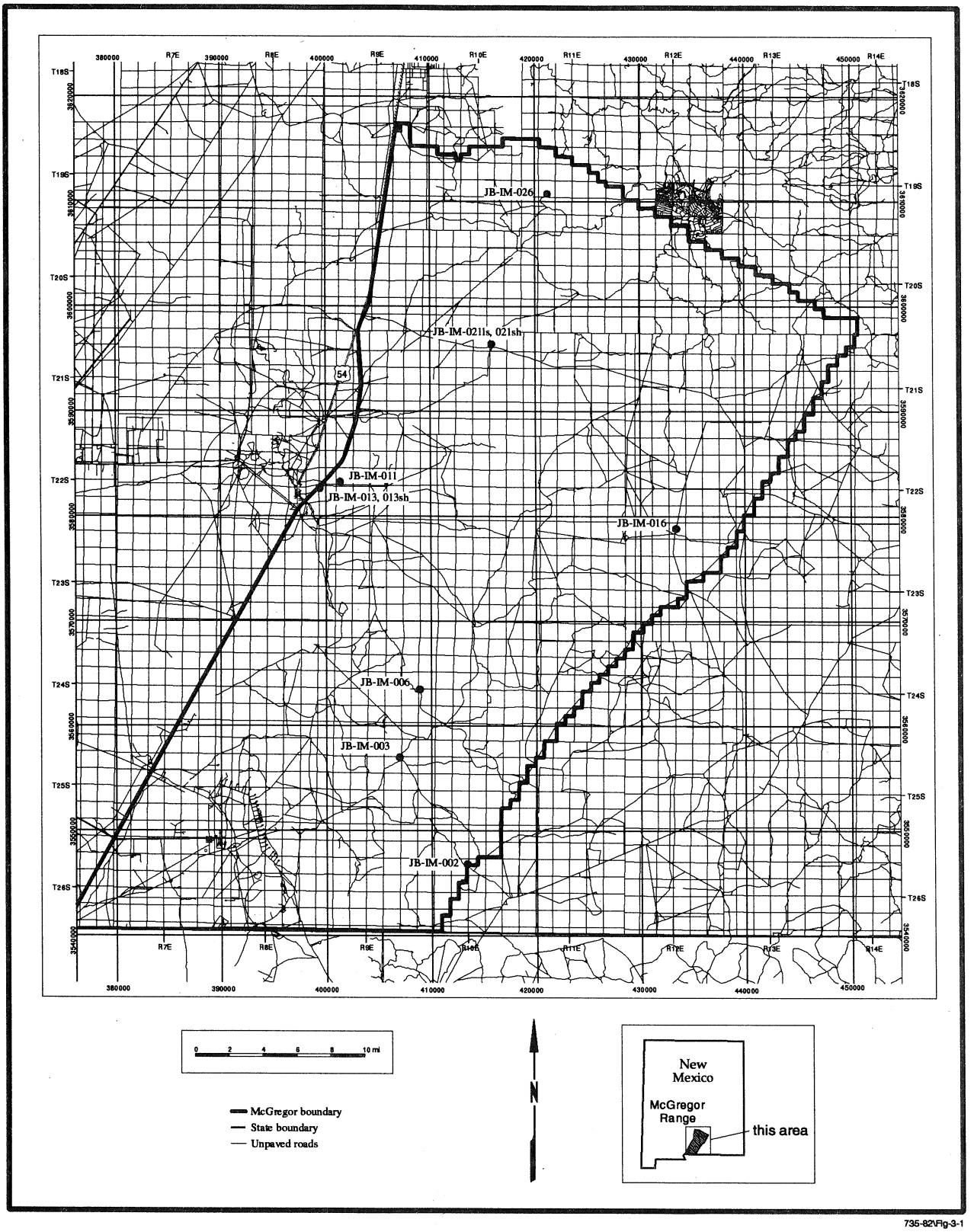

Figure 1.3 Location of Geochemical Characterization Samples (Industrial Minerals).

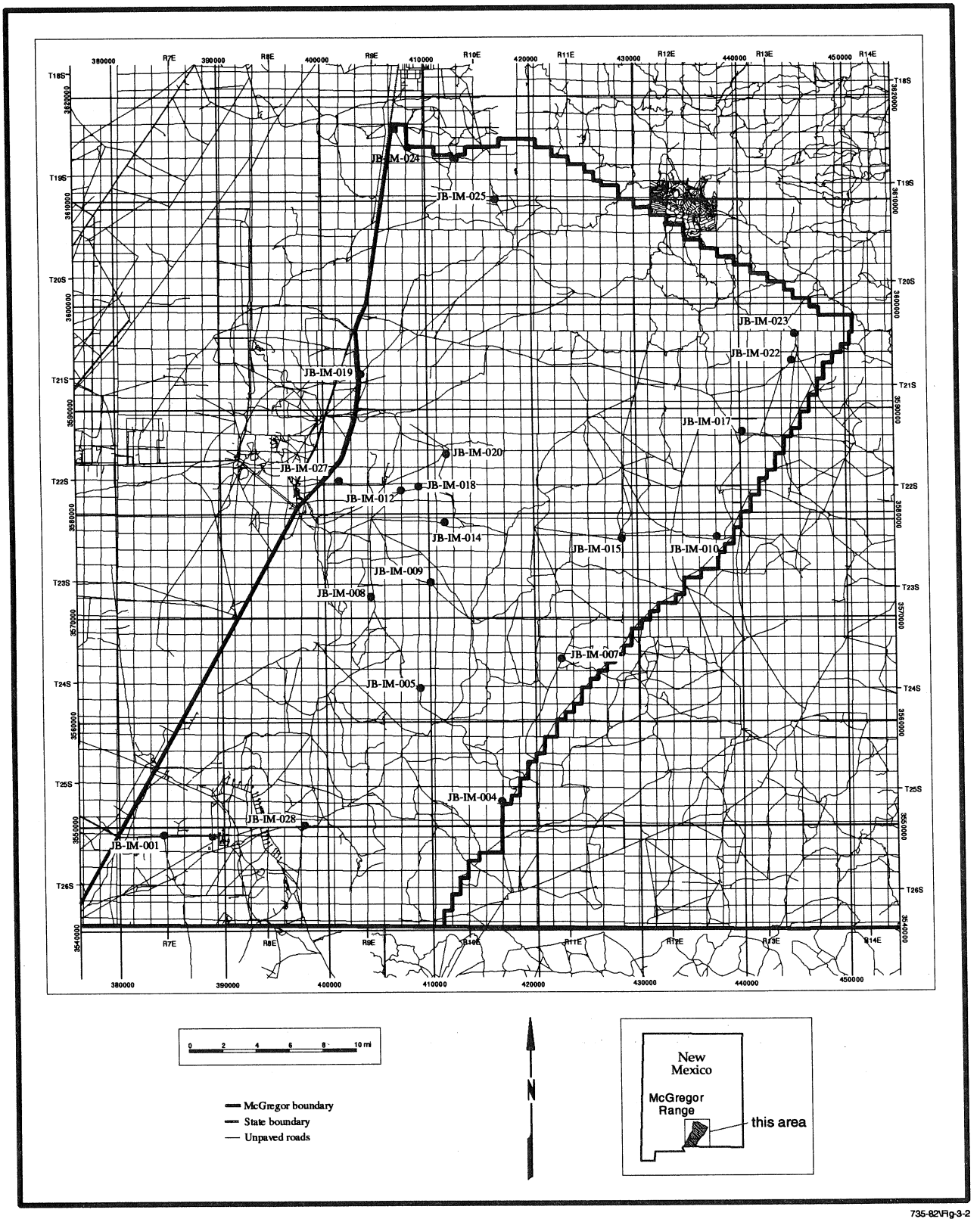

Figure 1.4 Location of Industrial Mineral Samples.

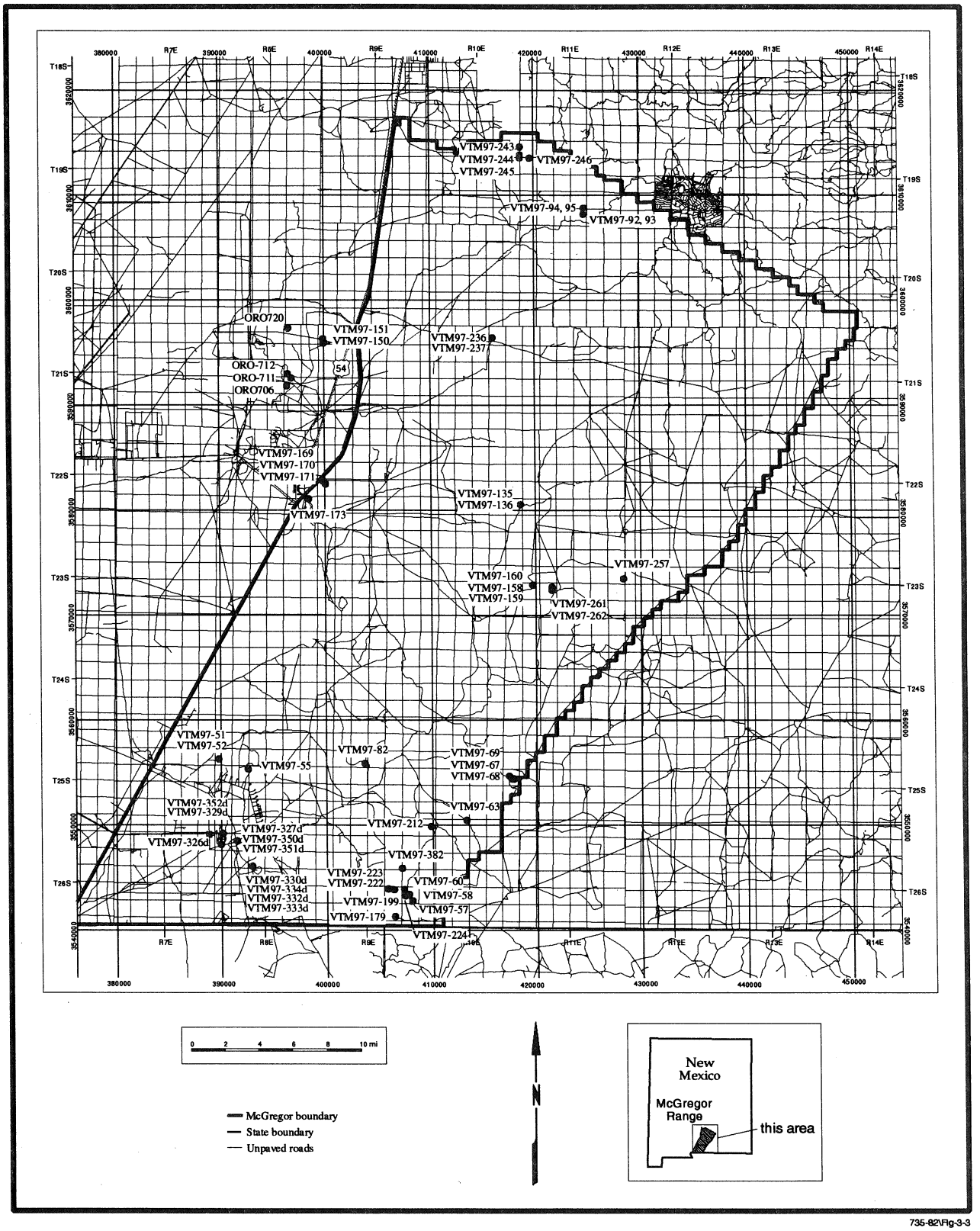

Figure 1.5 Location of Geochemical Characterization Samples (Metallic Minerals).

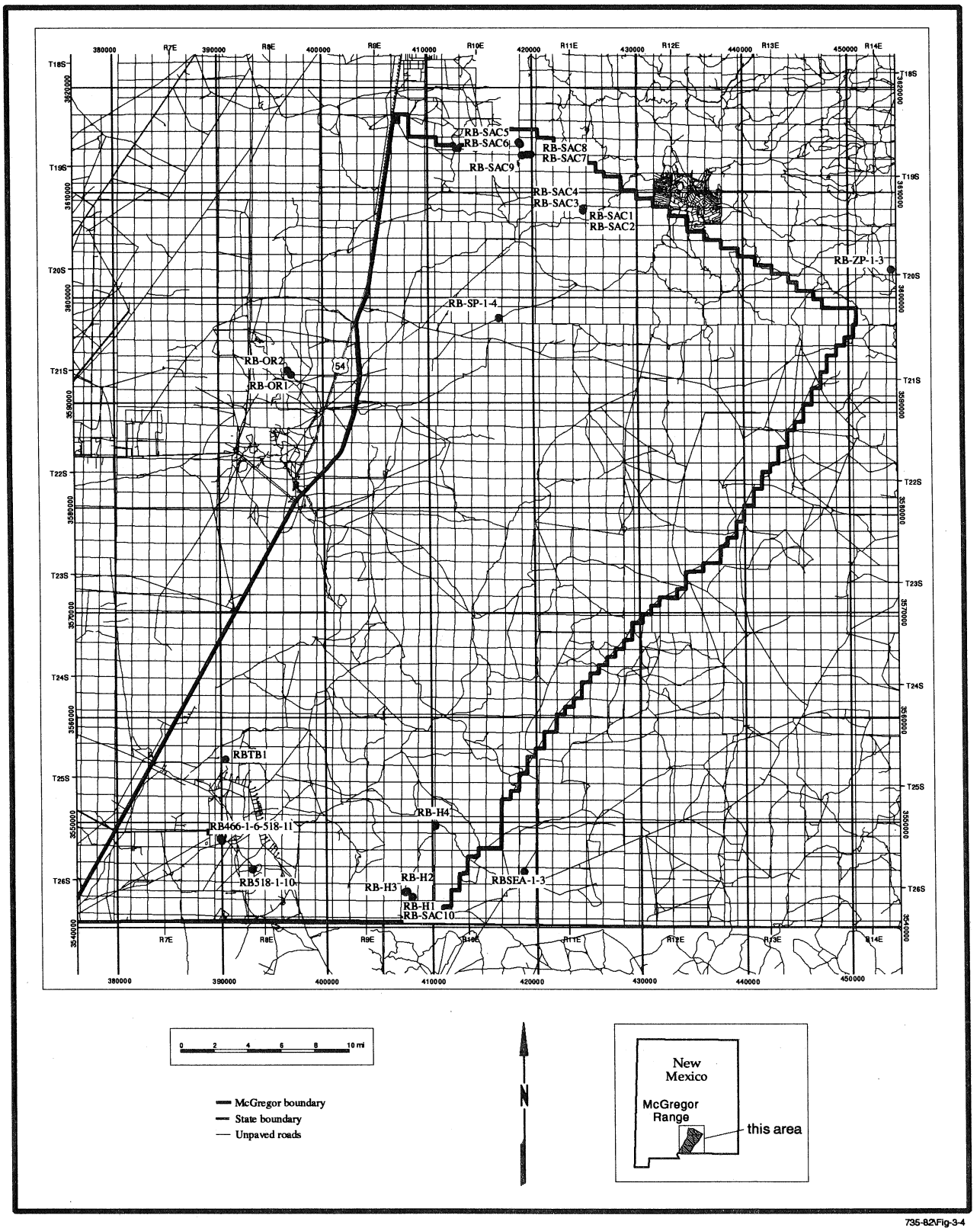

Figure 1.6 Location of Geochemical Characterization Samples (Petroleum Source Rock).

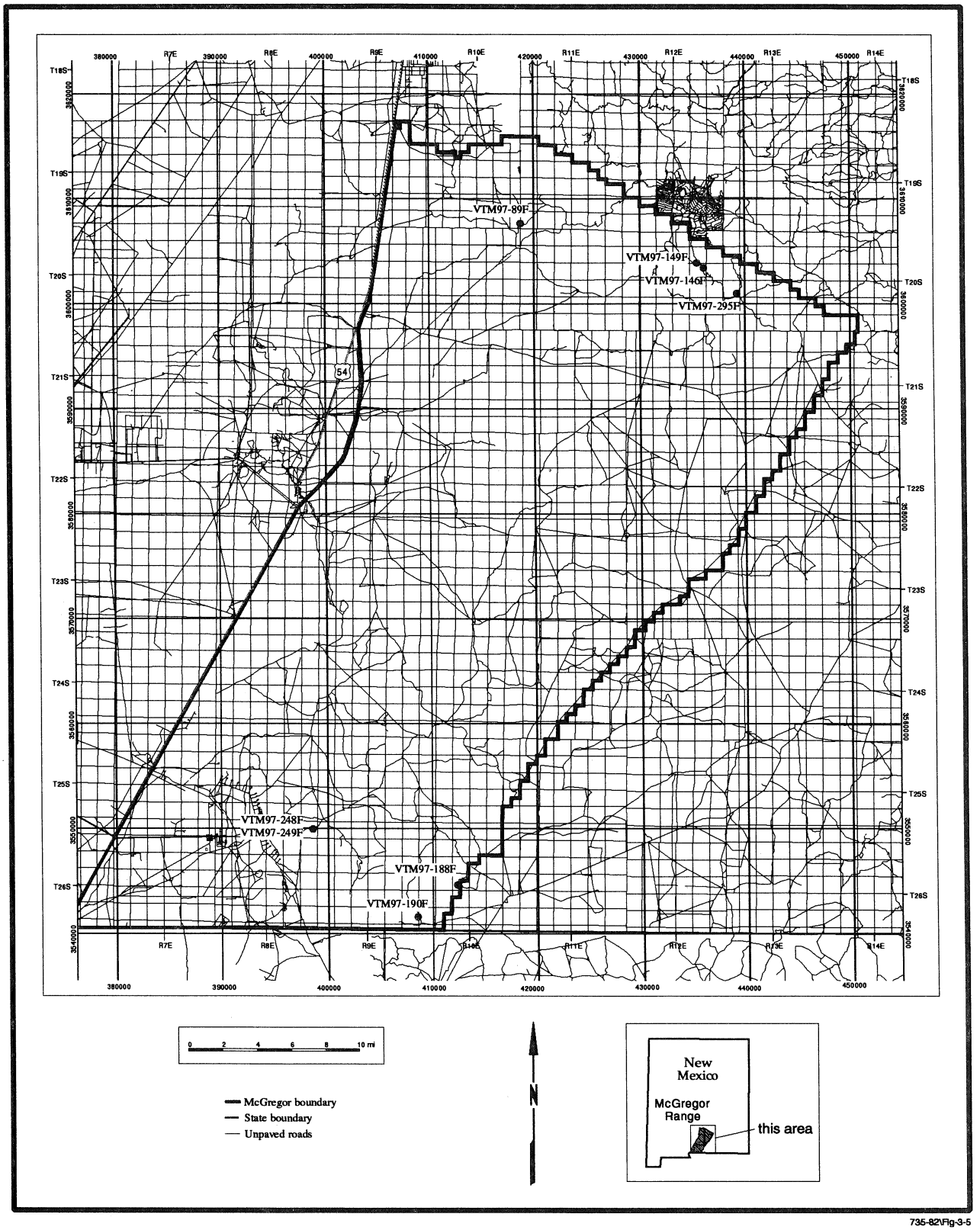

Figure 1.7 Location of Stream Sediment Samples (Float Chip).

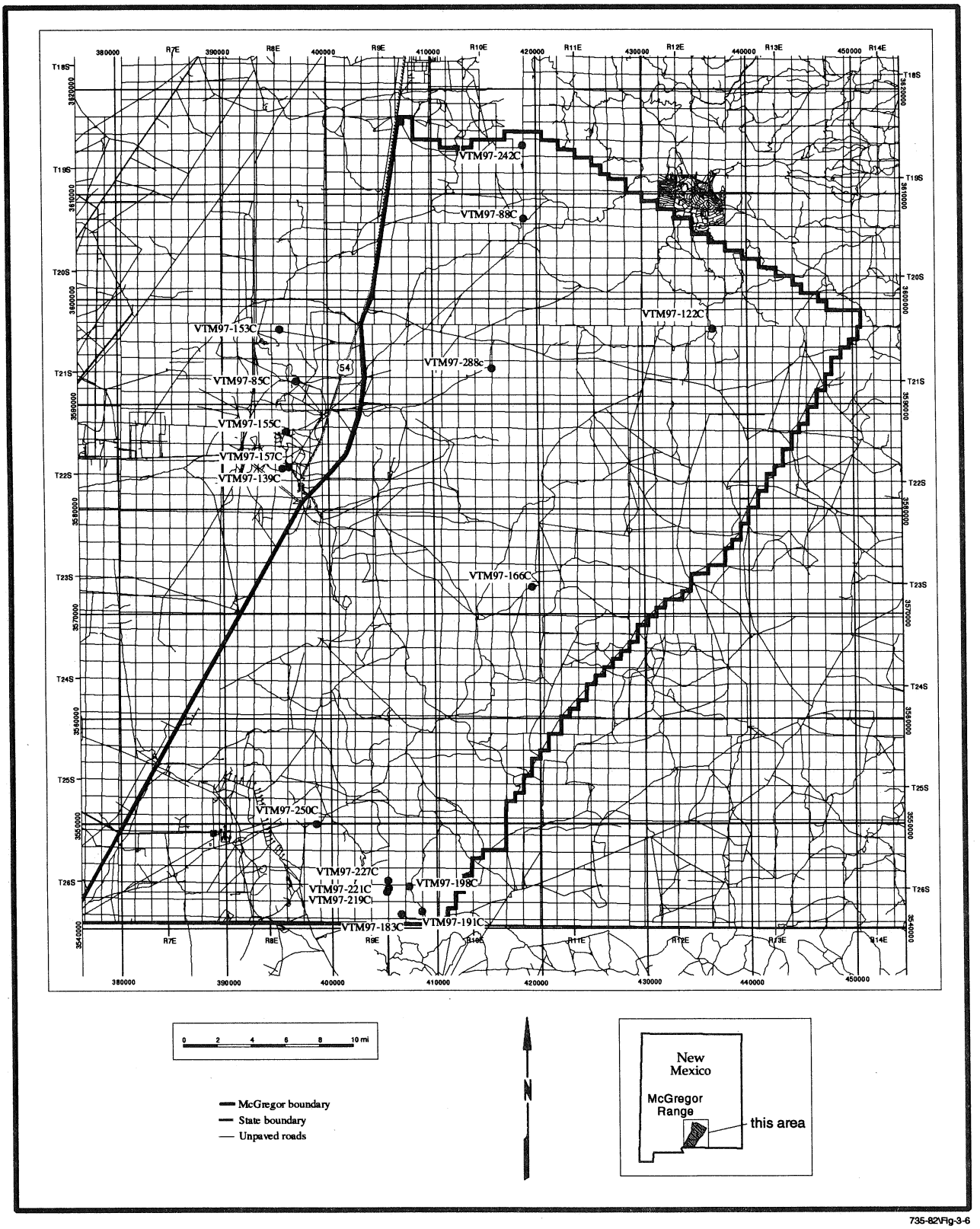

Figure 1.8 Location of Stream Sediment Samples (Heavy Mineral Concentrates).

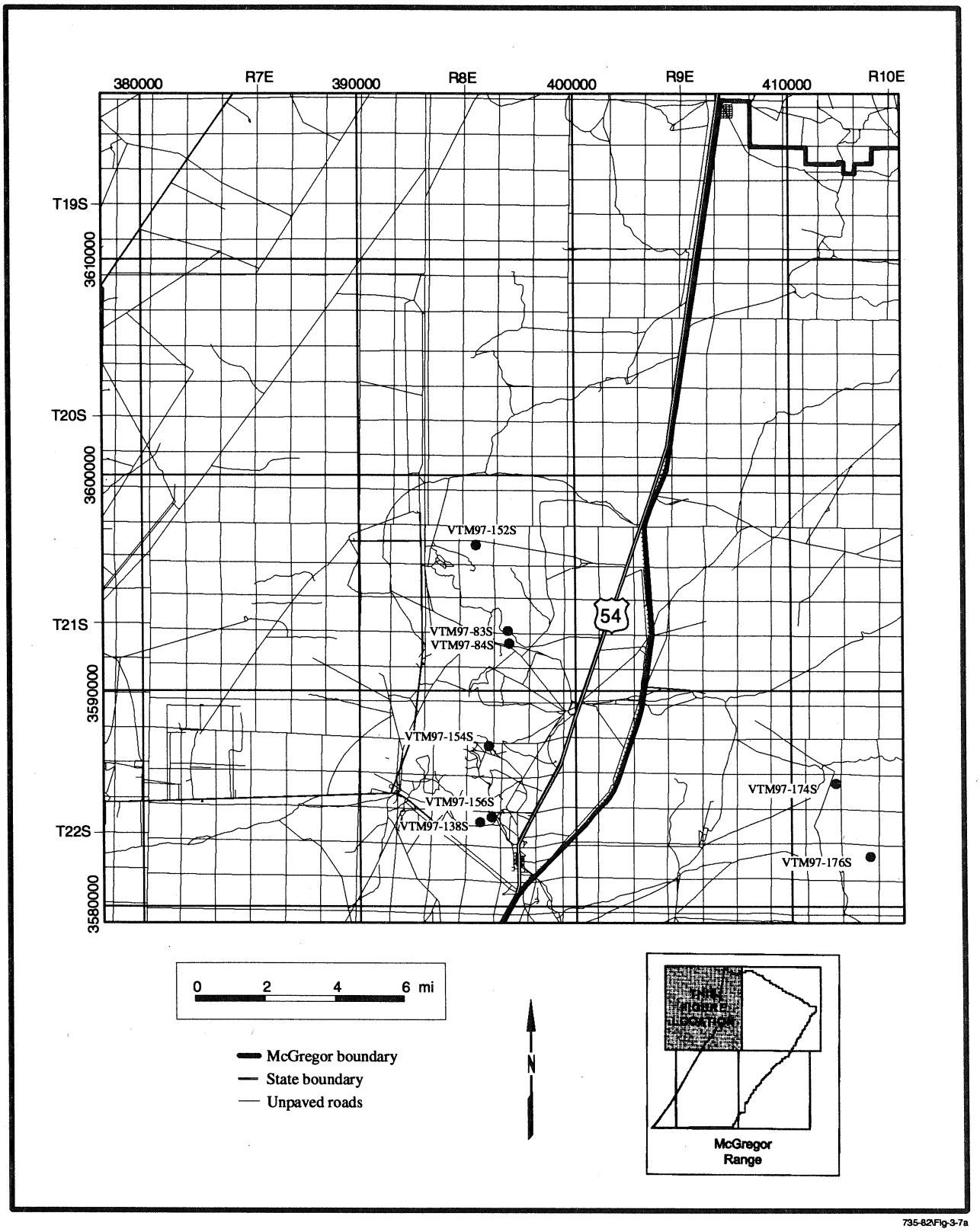

Figure 1.9 Location of Stream Sediment Samples (Sand-Silt), Sheet 1 of 4.

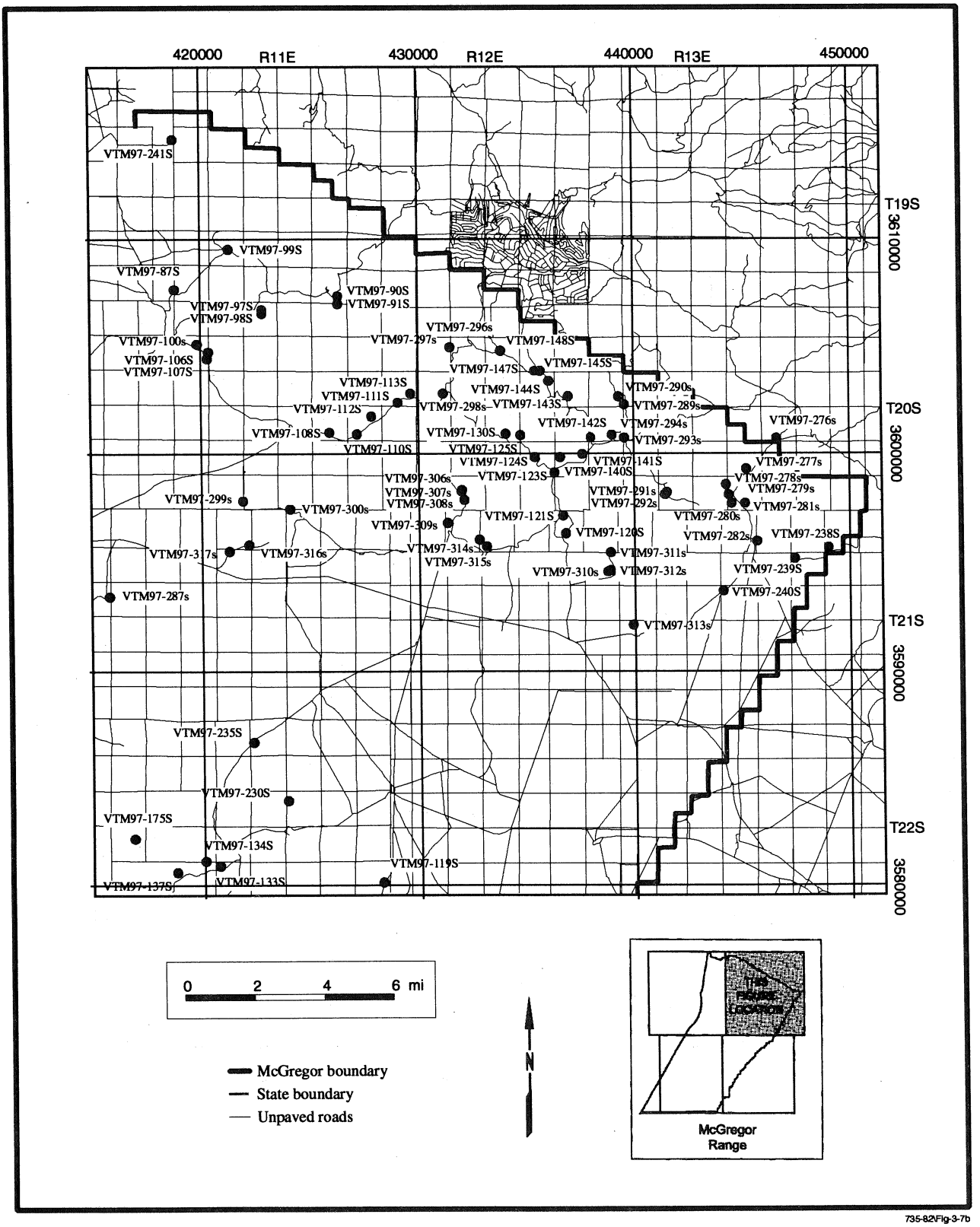

Figure 1.10 Location of Stream Sediment Samples (Sand-Silt), Sheet 2 of 4.

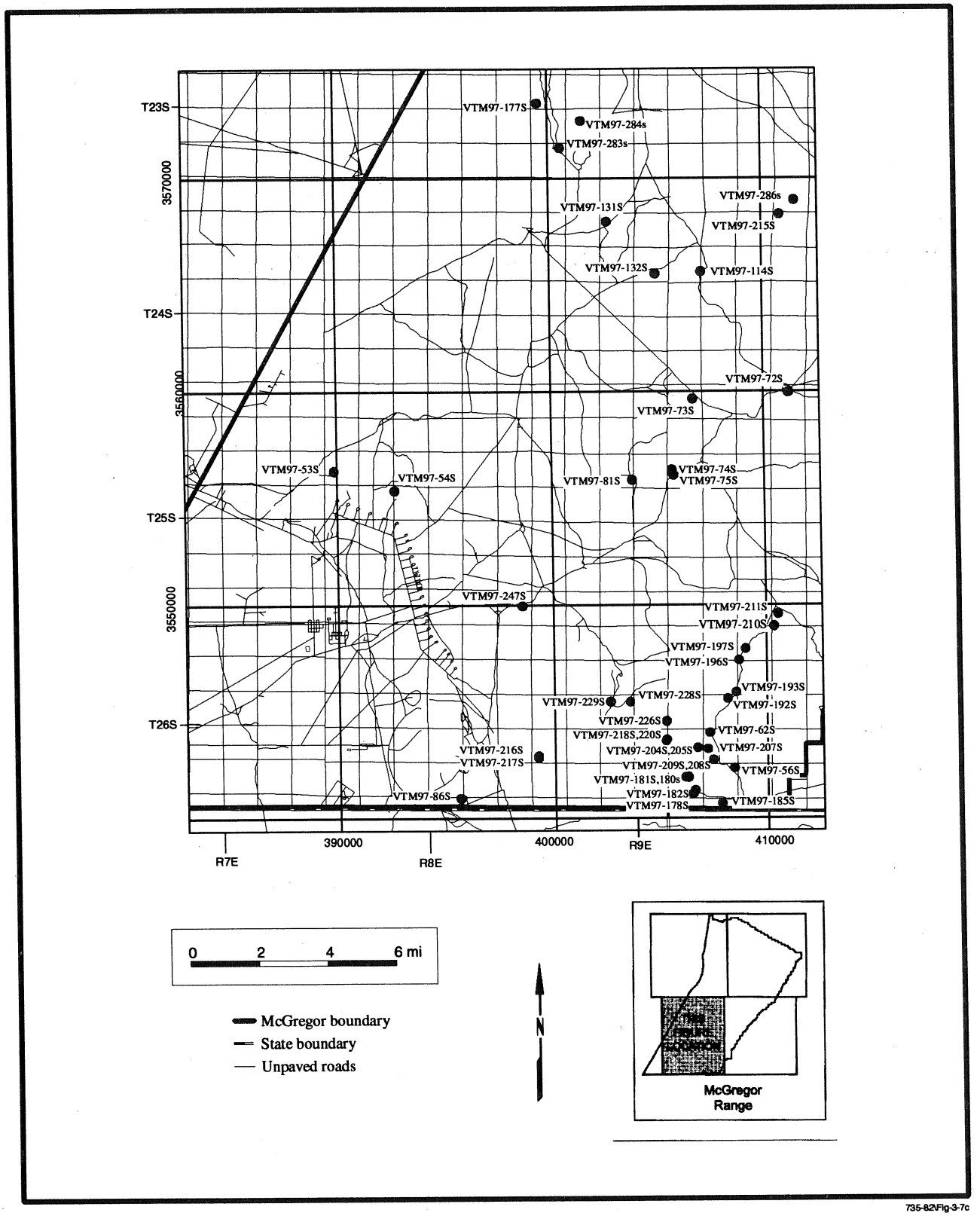

Figure 1.11 Location of Stream Sediment Samples (Sand-Silt), Sheet 3 of 4.

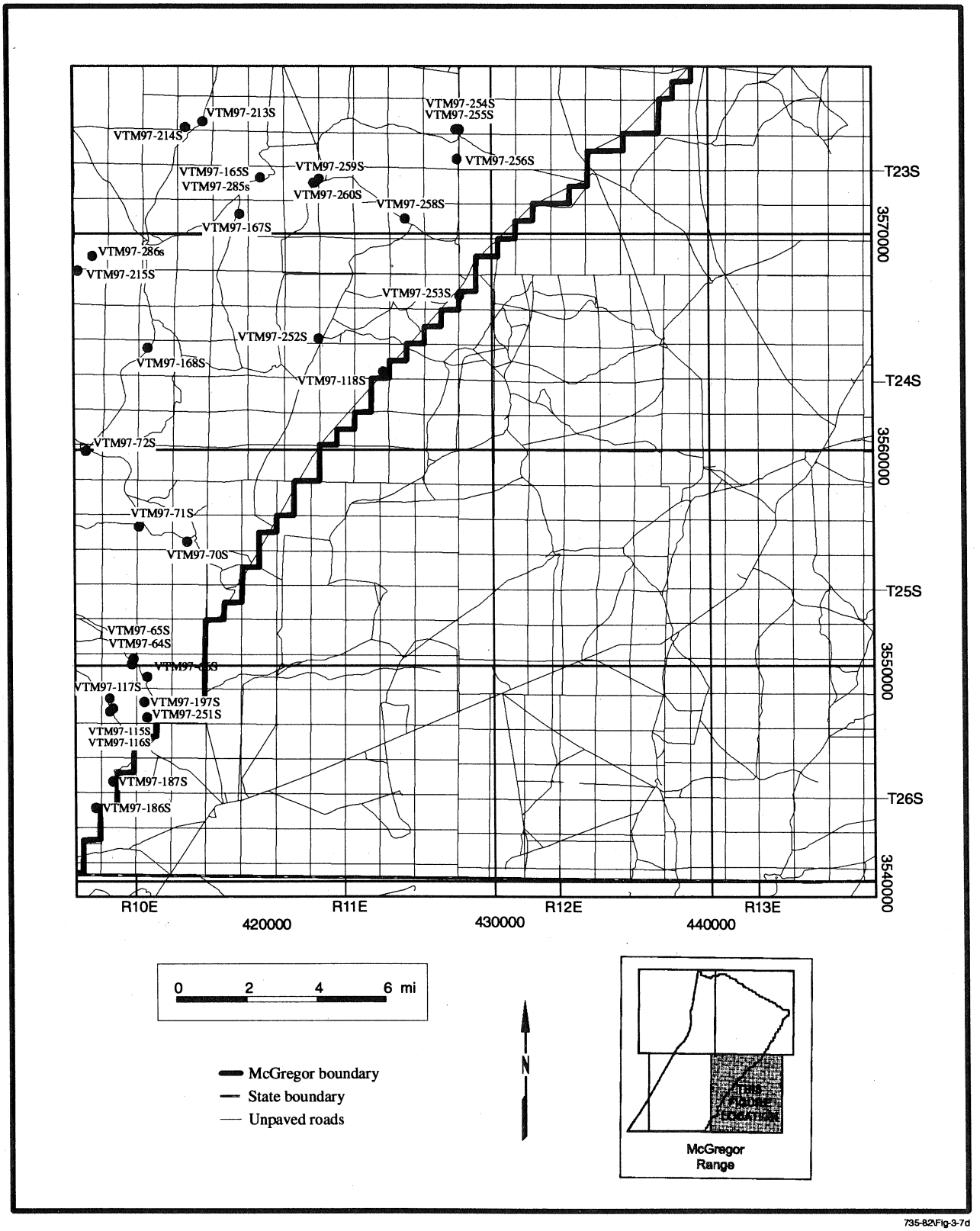

Figure 1.12 Location of Stream Sediment Samples (Sand-Silt), Sheet 4 of 4.

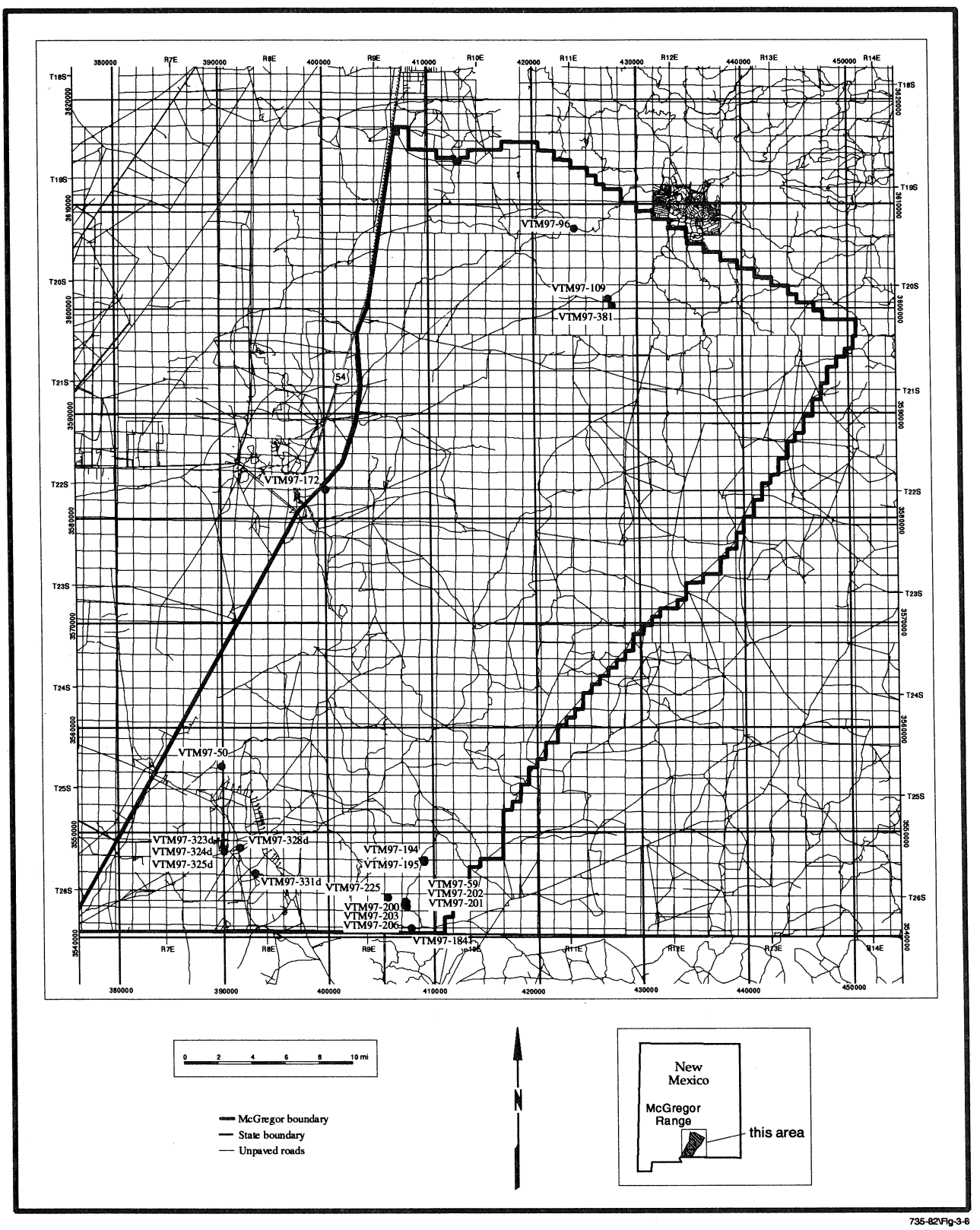

Figure 1.13 Location of Mineralized Area Samples.

Definitions of Level of Resource Potential

NO (N) mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

LOW (L) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources in unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock, as well as areas with few or no indications of having been mineralized.

MODERATE (M) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH (H) mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN (U) mineral resource potential is assigned where information is inadequate to assign low, moderate, or high levels of resource potential.

Definitions of Level of Certainty

A Available information is not adequate for determination of the level of mineral resource potential.

B Available information suggests the level of mineral resource potential.

C Available information gives a good indication of the level of mineral potential.

D Available information clearly defines the level of mineral resource potential.

Relationships Between Levels of Resource Potential and Certainty

Increasing Level of Resource Potential

U/A	H/B High Potential	H/C High Potential	H/D High Potential
	M/B Moderate Potential	M/C Moderate Potential	M/D Moderate Potential
Unknown Potential	L/B	L/C	L/D Low Potential
	Low Potential	Low Potential	N/D No Potential

Increasing Level of Certainty

[1] Source: Modified from Goudarzi (1984).

Figure 1.14 Definition and Relationship of Resource Potential and Certainty.

1.3.2.2 Procedures

All of the major lithologic units that outcrop on the McGregor Range were sampled. Samples were taken from the freshest, least-altered rock available at each locality and were representative of the project area. Altered outcrops were noted on maps and sampled separately as mineralized and/or altered samples. Field geologists with experience in regional stratigraphy and in recognition of altered rocks sampled the various lithologies. At each site, a bulk sample of fresh unweathered rock was collected for petrographic study and geochemical analyses. A hand specimen was also collected for the archive. Each sample was collected in a separate bag, assigned a unique number, and logged on a field description form (refer to Figure 1.15). Tabulation of samples collected from the McGregor Range is presented in Appendix 1. Most sample sites were marked in the field by an aluminum tag and a photograph was taken at selected localities (refer to Appendix 2). Geologic observations were also recorded on the field description form (refer to Figure 1.15), and each site was located on a 7.5' topographic quadrangle. A global positioning system (GPS) reading was also recorded for each sample locality. Descriptive information from all of the samples collected as part of the geochemical characterization sampling program are presented in Appendix 3.

Ten samples from drill cores (McGregor Range Geothermal Project; refer to Section 6.3) were also analyzed. Each drill core sample number includes the letter "d." Thin sections of selected samples were also prepared and examined for mineralogy. Specific analyses were also performed on selected industrial mineral samples, which are discussed in Chapter 5.0. Petrographic descriptions were made for each thin section using the form presented in Figure 1.15; the results are included in Appendix 7. Clay analyses by X-ray diffraction were made where appropriate.

One hundred thirty-six geochemical characterization samples were collected and analyzed for major and trace elements and the results are presented in Appendix 5.

1.3.2.3 Products

The products resulting from the geochemical characterization program are listed below:

- bulk rock samples;
- hand specimens for archive;
- thin sections;
- descriptive information for each sample;
- petrographic descriptions;
- map of each sample location;
- tabulation of sample locations and multi-element geochemical data; and
- photographs of selected sites.

1.3.3 Stream Sediment Sampling Program

1.3.3.1 Task Summary

The stream sediment sampling program involved the collection of stream sediment from preselected sites within the project area. Three types of samples were collected from the active portions of various stream channels: sand-silt, float chip, and heavy mineral sand-silt. The stream sediment sampling program was designed to identify and investigate anomalous areas and to provide geochemical data for regional evaluation.

Example Geochemical Sampling and Characterization Form.

SAMPLE NUMBER:		
PROJECT: McGregor		
COLLECTOR:		
FIELD DATE (mo/day/yr):		
LOCATION:		
QUADRANGLE:	**SCALE**: 1:24,000	
TOWNSHIP:	**RANGE**:	**SECTION**:
LATITUDE:	**LONGITUDE**:	
ROCK UNIT:		
ROCK AGE:		
FIELD OCCURRENCE:		
ROCK DESCRIPTION:		
ROCK STRUCTURES:		
MEASURED SECTION:		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

Petrographic Description Form.

SAMPLE NUMBER:	**FIELD DATE:**
PETROGRAPHER:	
FIELD DESCRIPTION	
LATITUDE:	**LONGITUDE:**
OCCURRENCE:	**QUADRANGLE:**
HAND SPECIMEN DESCRIPTION	
Color:	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary:	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK:	
CLASSIFICATION:	

Figure 1.15 Sample Forms.

Stream Sediment Sample Form.

AREA:	**SAMPLE NUMBER**: VTM97-	
FIELD DATE:	**COLLECTOR**:	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**:	**TOWNSHIP**:
LATITUDE:	**LONGITUDE**:	**RANGE**:
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**:
OTHER:		
SAMPLE DESCRIPTION:		

Mine and Prospect Site Description Form.

PROPERTY NAME:		**DATE OF EXAMINATION:**
ALIASES:		**COUNTY:** Otero
MINERAL COMMODITY(IES):		**MINING DISTRICT:**
TYPE OF DEPOSIT:		**QUADRANGLE:**
SECTION:	**TOWNSHIP:**	**RANGE:**
LATITUDE:		**LONGITUDE:**
PRODUCTION:		
HISTORY:		
DEVELOPMENT:		
ACTIVITY/STATUS:		
GEOLOGY:		
REMARKS:		
REFERENCES:		
EXAMINER:		

Mineralized Area Sample Form.

SAMPLE NUMBER: VTM97-		**COLLECTOR**: VTM
AREA:		**FIELD DATE**:
MINING DISTRICT:		
PROPERTY NAME:		
QUADRANGLE:		**SCALE**: 1:24,000
TOWNSHIP:	**RANGE**:	**SECTION**:
LATITUDE:		**LONGITUDE**:
SAMPLE TYPE:		
ROCK TYPE:		
ALTERATION:		
MINERALIZATION:		
PHOTO NUMBER:		

Figure 1.15 (Continued).

1.3.3.2 Procedures

A sand-silt sample was collected from the stream channel and sieved on-site through a No. 5 mesh (0.157-inch) stainless steel screen. The undersized material was stored in a plastic bag and sealed with wire twist ties. Each sample was collected in a separate bag, assigned a unique number followed by "S," and logged on a field description form (refer to Figure 1.15). Most sample sites were marked in the field by an aluminum tag and a photograph was taken at selected localities (refer to Appendix 2). Geologic observations were recorded on the field description form, each site was located on a 7.5' topographic quadrangle, and a GPS reading was recorded. Two hundred eleven sand-silt sediment samples were collected. Descriptive information collected as part of the stream sediment sampling program is included in Appendix 3. All samples were analyzed for major and trace pathfinder elements, and the results are presented in Appendix 5.

At selected localities, a float chip sample of mineralized or altered float was collected by chipping small fragments from mineralized or altered gravel or larger boulders. Each sample was a composite of material collected over as much as several hundred feet of channel length. Each sample was collected in a separate bag, assigned a unique number followed by "F," and logged on a field description form (refer to Figure 1.15). Most sample sites were marked in the field by an aluminum tag, and a photograph was taken at selected localities (refer to Appendix 2). Each site was located on a 7.5' topographic quadrangle and a GPS reading was recorded. Nine float chip sediment samples were collected. Descriptive information collected from the float chip samples is included in Appendix 3. All samples were analyzed for major and trace pathfinder elements, and the results are presented in Appendix 5.

At selected sites, heavy mineral concentrate samples were collected. At these localities approximately 20 lbs of sand-silt sample were collected from the active portion of the stream and sieved on-site through a No. 5 mesh (0.157-inch) stainless steel screen for processing for heavy mineral concentrates. The undersized material was stored in a plastic bag and sealed with wire twist ties. Each sample was collected in a separate bag, assigned a unique number followed by "C," and logged on a field description form (refer to Figure 1.15). Most sample sites were marked in the field by an aluminum tag, and a photograph was taken at selected localities (refer to Appendix 2). Geologic observations were recorded on the field description form, each site was located on a 7.5' topographic quadrangle, and a GPS reading was recorded.

The heavy mineral fractions were collected, dried, homogenized, weighed, and split. Each heavy mineral concentrate sample was air-dried and rescreened over a No. 10 mesh (1.88-mm) Sweco vibrating screen; the oversized material was discarded after weighing. The undersized fractions were then processed over a Wifley laboratory shaking table. One quarter of each sample was saved for archive and mineralogical examination; the remainder was crushed and submitted for chemical analyses. Twenty heavy mineral sediment samples were collected. Descriptive information of collected heavy mineral samples is included in Appendix 3. All samples were analyzed for major and trace pathfinder elements, and the results are presented in Appendix 5.

1.3.3.3 Products

The products resulting from the stream sediment sampling program are listed below:

- silt-size fractions, mineralized or altered gravel, and heavy mineral concentrate;
- sample splits for archive;
- descriptive information for each sample;

- results of multi-element analyses;
- photographs of selected sites;
- map of each sample location; and
- tabulation of sample locations and geochemical data.

1.3.4 Mineralized Area Sampling Program

1.3.4.1 Task Summary

Mineralized and altered areas within the project area identified during reconnaissance and geochemical characterization sampling were sampled. These areas were examined and described, and accessible workings were examined, sampled, and mapped. "High-grade" ore samples were collected at each site; these samples produced information on the type of mineralization present, as well as relationships among trace elements.

1.3.4.2 Procedures

At each site, a bulk sample of the mineralized or altered rock was collected for petrographic study and geochemical analyses. A hand specimen was also collected for archive. Each sample was collected in a separate bag, assigned a unique number followed by "M," and logged on a field description form (refer to Figure 1.15). Most sample sites were marked in the field by an aluminum tag, and a photograph was taken at most localities. Geologic observations were recorded on the field description form, each site was located on a 7.5' topographic quadrangle, and a GPS reading was recorded. Thirty-eight mineralized area samples were collected. Five of the 38 samples from mineralized zones were from drill cores (McGregor Geothermal Project) and were also analyzed. Each drill core sample number ends with a "d." Descriptive information collected for all mineralized area samples is included in Appendices 3 and 6. All geochemical mineralization samples were analyzed for major and trace elements and the results are presented in Appendix 5. Thin sections of selected samples were prepared and examined for mineralogy and the results are presented in Appendix 7.

1.3.4.3 Products

The products resulting from the mineralized area sampling program are listed below:

- bulk rock samples;
- hand specimens for archive;
- thin sections;
- site descriptions and sample descriptions;
- results of multi-element analyses;
- photographs of selected sites;
- location maps; and
- tabulation of sample locations and multi-element geochemical data.

1.3.4.4 Analytical Procedures

The samples were sent to XRAL Activation Services Inc. (XRAL) and were analyzed for 10 major oxides, loss on ignition (LOI), and 45 trace elements (results are presented in Appendix 5). Analytical methods varied for each element and included X-ray fluorescence (XRF) spectrometry, instrumental neutron

activation analysis (INAA), inductively coupled plasma (ICP) spectrometry, and delayed-neutron counting (DC). Heavy mineral concentrates were analyzed for three major elements and 29 trace elements by INAA. Three stream sediment samples (Samples VTM97-73S, VTM97-238S, and VTM97-239S) were analyzed for platinum group elements (PGE) and gold by NiS fire assay. NMBMMR internal standards and selected samples were also analyzed at the NMBMMR X-ray Laboratory for comparison to results obtained by XRAL.

1.3.5 Quality Control and Quality Assurance Procedures

1.3.5.1 Introduction

An evaluation and assessment of energy and mineral potential for any project area relies heavily on the analytical results obtained from samples collected within the subject property. Therefore, to ensure an adequate level of data quality was obtained from the samples collected on the McGregor Range, a quality control and quality assurance program was established during the planning phase of this project and is summarized in this section. The purpose of these methods and procedures is to ensure that standardized and consistent protocols are followed and accurate data and information are collected during: collection of each sample; documentation of information concerning each sample and the sample locality; and preparation, transportation, and analyses of each sample.

A standardized protocol was followed during the collection of each sample. Field geologists with experience in the specific geotechnical area being evaluated were responsible for the collection of the sample and associated locality information. At each site, a sample was collected according to standardized procedures, as previously discussed. Each sample was collected in a separate bag, assigned a unique number, and logged on a field description form. Most sample sites were marked in the field with an aluminum tag and a photograph was taken at selected localities. Geologic observations were also recorded on the field description form, each site was located on a 7.5' topographic quadrangle, and a GPS reading was recorded for each sample locality.

The number assigned to each sample was utilized during all subsequent phases of the project. Following collection in the field, the samples were transported to NMBMMR facilities, where each sample was prepared for analyses. Samples to be chemically analyzed were initially crushed in jaw crushers and pulverized by tungsten-carbide disc grinders to a grain size of <35 μm. Each sample was homogenized at each crushing step by cone and quarter method. Standardized equipment cleaning procedures were utilized following the preparation of each sample to eliminate cross-sample contamination. Splits of each sample were collected and archived for future reference or study. To avoid lost or misplaced samples, a standard chain of custody form was used when each batch of samples was sent to the commercial laboratories for analyses. Internal standards from NMBMMR, commercial certified standards, and duplicates of selected samples were submitted blind to the commercial laboratories with each batch of samples, not to exceed 25 samples, to document and verify analytical accuracy and precision.

The accuracy of the analytical data is defined as how close the measured value is to the true value. Analysis of certified standards as unknown samples and comparison with known certified values was performed to monitor accuracy for this project. The precision of an analysis, on the other hand, is the repeatability of an analytical measurement. Precision is monitored by multiple analyses of sample duplicates and internal standards. The laboratories selected for this project were known by professional reputation and key project personnel to have sound and reliable quality control and quality assurance programs and standards. The quality control and quality assurance program was designed such that if

significant accuracy or precision problems were detected during the review of the analytical data, appropriate corrective measures would be implemented until the problem was resolved. The results of these efforts would then be documented and included in the project record. The following sections discuss the results of the accuracy and precision measurements collected for this project, along with a summary of the quality control and quality assurance program results.

1.3.5.2 Accuracy and Precision of Geochemical Data

Analyses obtained from XRAL were in agreement with certified values of certified standards, and precision was excellent between multiple analyses (results are presented in Appendix 8). However, some minor differences between certified standards and duplicate pairs did exist.

Three certified samples were submitted to XRAL as unknowns (Samples NIST2709, SO-3, and NIST2711; refer to Appendix 8). The results obtained by XRAL were within the acceptable margin of error of certified sample values for most elements. Nugget effects can account for the variations in silver, gold, and zircon observed in some pairs of samples. A nugget effect occurs when a small grain of native gold or other mineral in one split and not the other split produces a higher concentration value. Another variation between certified values and those provided by XRAL is a result of different analytical techniques. XRAL used ICP spectrometry methods for several elements, including copper, lead, zinc, nickel, cadmium, and vanadium. ICP requires acid digestion and analyses of a liquid base solution. In many cases, not all of the solid rock will be completely digested, which will result in a lower value than that obtained by certified values typically done by XRF or INAA. Samples of NMBMMR internal standards were analyzed for each batch, and the difference between analysis by NMBMMR using XRF and by XRAL using ICP is demonstrated in Figures 1.16, 1.17, and 1.18.

The precision of XRAL analyses was acceptable for most samples (results are presented in Appendix 8). There are numerous reasons why duplicate samples and/or standards do not always agree. Some samples, such as rhyolite and basalt, grind into powder more easily than other samples, such as stream sediment samples and nepheline syenites. Fusion techniques required for XRF analyses vary from lab to lab and may also differ between personnel, which could result in variations between sample pairs. This is demonstrated in Figures 1.17 and 1.18, where both NMBMMR and XRAL used XRF methods for barium and SiO_2. Analytical error is higher for analyses with concentrations close to the detection limit. In addition, stream sediment samples and alluvium, such as the Orogrande standard, are very heterogeneous and difficult to completely homogenize, as shown in the analyses of Samples VTM97-115S and VTM97-77S (included in Appendix 8). Although these samples are split from the same prepared sample, the geochemical results were different. The NMBMMR X-ray Laboratory reanalyzed each of these samples, and the results agreed with the respective results from XRAL (included in Appendix 8). Most variations between duplicate stream sediment samples are probably a result of sample heterogeneities and analytical errors related to low concentrations.

Another problem encountered with stream sediment samples was the variability of sample collection. The sampling team consisted of three people using exact procedures to avoid variations between sample collectors. In addition, two samples were collected at two separate sites to estimate sample collection variability (results are shown in Table A8.2 in Appendix 8). The same person collected Samples VTM97-254S and VTM97-255S; two different people collected Samples VTM97-165S and VTM97-285S. The variability between these two sets of duplicates is within the accepted margin of error for stream sediment samples.

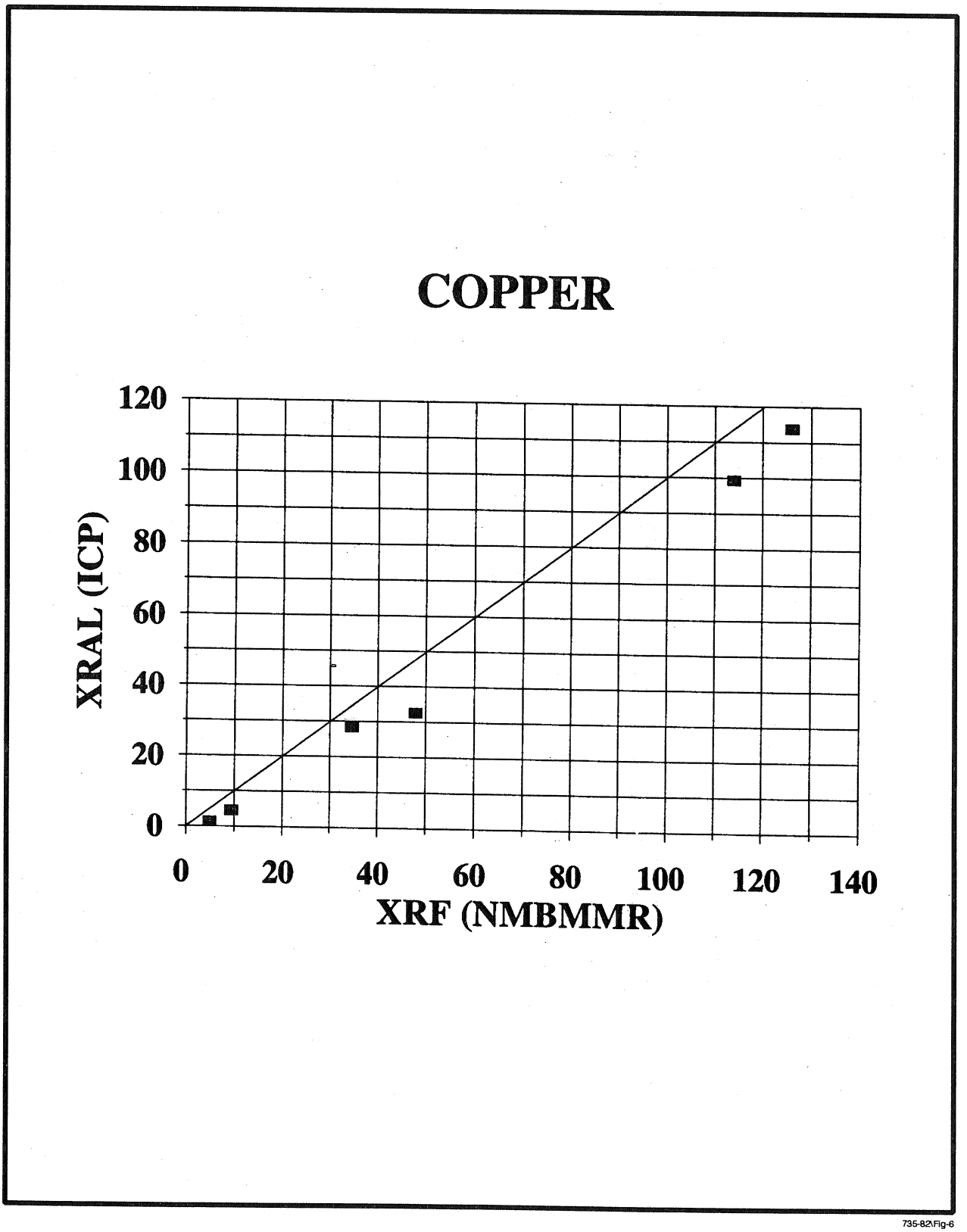

Figure 1.16 Scatter Plot of Copper Analyses Obtained from XRAL and NMBMMR Laboratory.

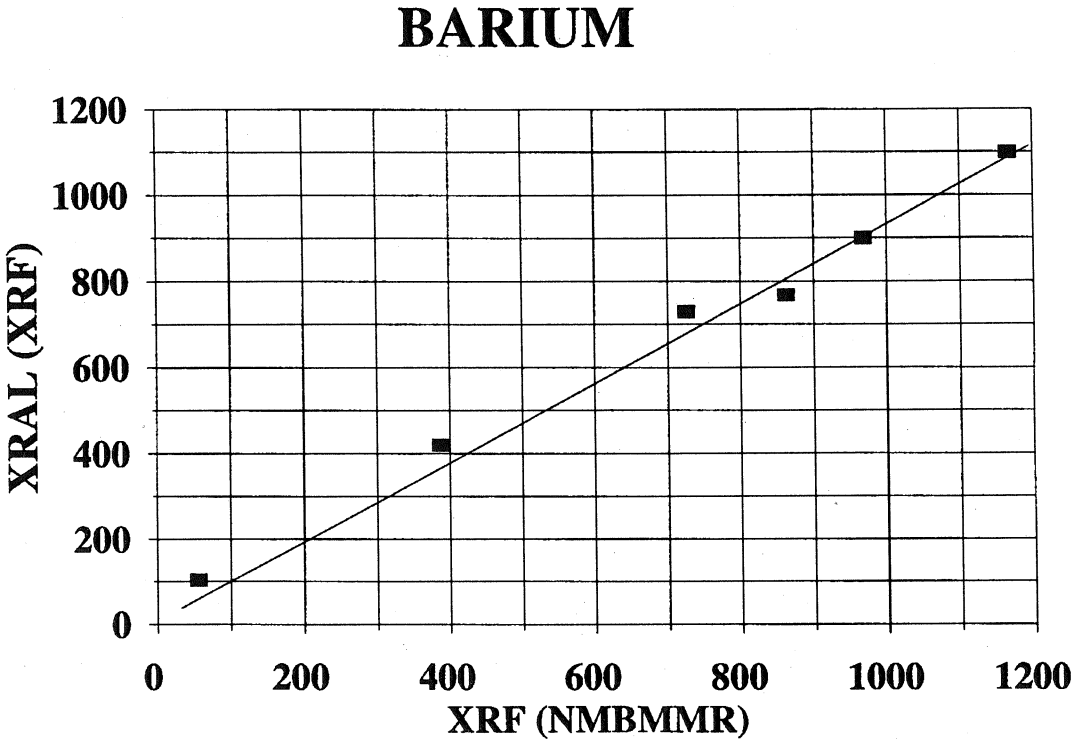

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Figure 1.17 Scatter Plot of Barium Analyses Obtained from XRAL and NMBMMR Laboratory.

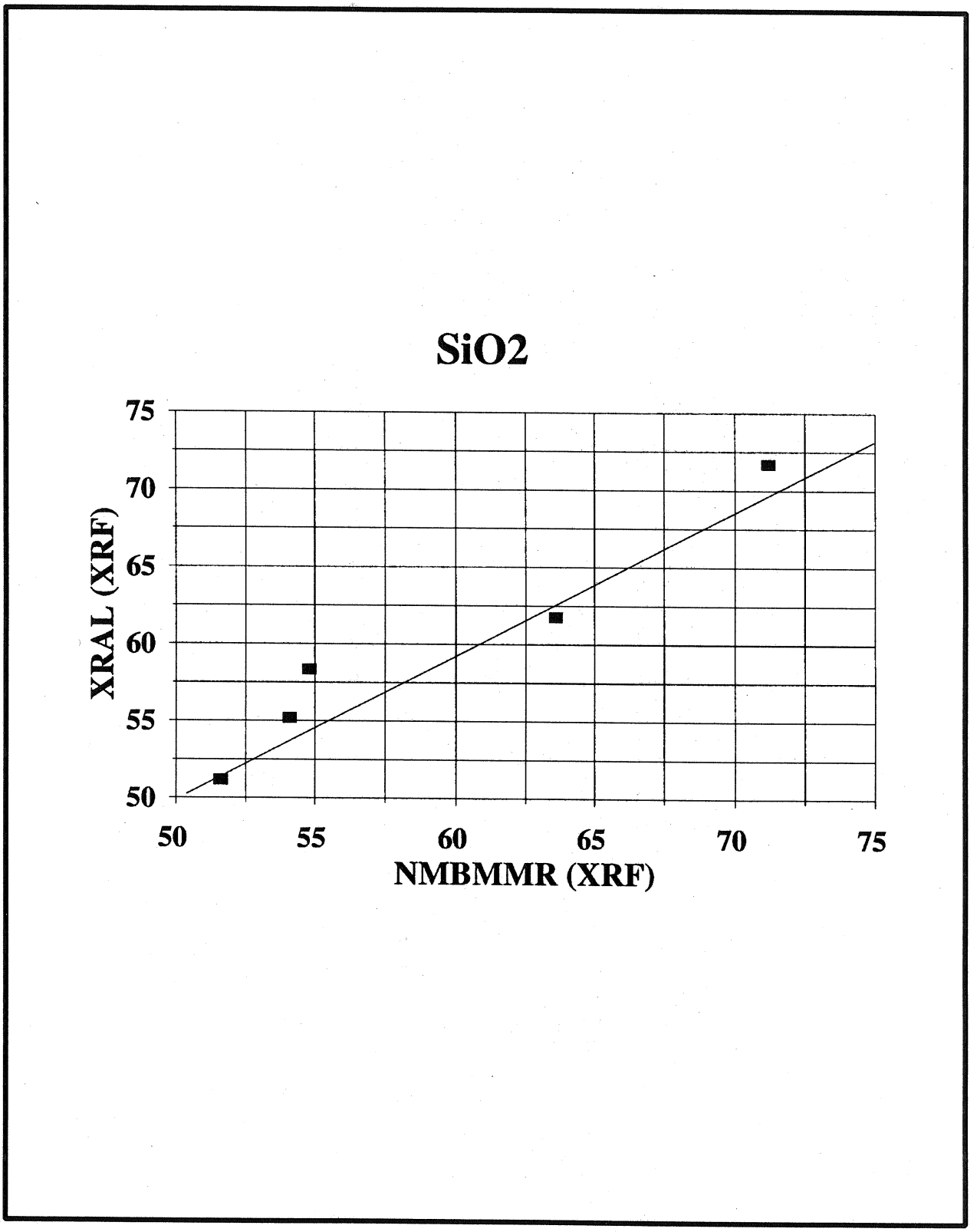

Figure 1.18 Scatter Plot of SiO_2 Analyses Obtained from XRAL and NMBMMR Laboratory.

Three samples of igneous rocks were analyzed for PGE by NiS fire assay methods. Fire assay methods are time-consuming and expensive; therefore, only one reference standard was submitted blind to XRAL (included in Table A8.3 in Appendix 8). The concentrations of the reference standard are higher than the values by XRAL as a result of the nugget effect, but are within the accepted margin of error for the detection of PGE.

1.3.5.3 Accuracy and Precision of Petroleum Source Rock Data

To assess accuracy and precision of petroleum source rock data generated for this phase of the project, two sample standards were submitted blind with each batch of samples submitted to Geochem Laboratories for analyses. Because two sample standards were submitted, each was analyzed twice through the course of the project. One sample standard was collected from the Lower Mancos Shale (Cretaceous) near Carthage, New Mexico. The other sample standard was a limestone collected from the San Andres Formation (Permian) east of Bingham, New Mexico.

In addition to the standards, one duplicate of an outcrop or core sample collected from the McGregor Range was sent for analysis with each set of samples submitted to Geochem Laboratories. Therefore, because two samples of an outcrop or core sample were sent to Geochem Laboratories for analysis, there were two duplicate samples analyzed through the course of the project.

When the sample standards and the duplicate field/core samples are considered, there were four pairs of duplicate samples analyzed through the course of this project (two pairs of standards and two pairs of duplicate outcrop/core samples; refer to Table 1.1). Results of the accuracy and precision evaluation completed on petroleum source rock samples determined that all analyses were within the accepted margin of error for the tests performed. An assessment of data quality is discussed below according to the three types of analyses performed on each sample.

Total Organic Carbon (TOC). The TOC analyses had adequate quality control for petroleum resource assessment. Of the four sets of sample pairs analyzed, the duplicates in all four sets yielded TOC percentages such that the petroleum potential of both samples within each pair were given the same petroleum assessment according to the sample values. Differences in TOC measurement within each pair of duplicates may have been caused by lack of analytical precision, but may also have been be caused by variations in TOC content within the rock. For outcrop samples, these differences could have been accentuated or caused solely by differential weathering not detectable with the naked eye.

Thermal Alteration Index (TAI). The TAI analyses had adequate quality control for petroleum resource assessment. Differences in TAI between samples in each set of duplicates ranged from 0.0 to 0.4. These differences in TAI do not result in significant differences in assessment of thermal maturity.

Visual Estimation of Kerogen Type. The visual estimation of kerogen types had adequate quality control for petroleum resource assessment. Visual estimation of kerogen type resulted in some relatively small differences in the percentages of kerogen types within the duplicate sample pairs. Some of these differences may have been due to lack of analytical precision and some may be explained by natural variations of kerogen populations within the rock samples. However, in each of the four cases of paired (duplicate) samples, the differences were not sufficient to change the type of kerogen (oil-prone, gas-prone, or inertinite) that is dominant within the sample. Therefore, the petroleum resource assessment was similar for both analyses in each of the four paired sets.

Table 1.1 Results of Quality Assurance and Quality Control for Petroleum Source Rock Analyses.

Sample No.	Sample Type	Formation	Lithology	TOC[1] (%)	TAI[2]	Maturity
RB-466-1	Core	Panther Seep	Limestone	1.62	2.9	Mature
RB-518-11	Core	Panther Seep	Limestone	1.52	2.8	Mature
RB-H-1	Outcrop	Panther Seep	Limestone	0.23	2.4	Moderately mature
RB-SAC-10	Outcrop	Panther Seep	Limestone	0.07	2.4	Moderately mature
RB-STD-1	Outcrop	Lower Mancos Shale	Shale	0.50	1.9	Moderately immature
RB-DMY-1	Outcrop	Lower Mancos Shale	Shale	0.63	2.2	Moderately mature
RB-DMY-2	Outcrop	San Andres	Limestone	0.39	2.3	Moderately mature
RB-STD-2	Outcrop	San Andres	Limestone	0.10	2.7	Mature

Sample No.	Algal[3] (%)	Amorphous[3] (%)	Herbaceous[3] (%)	Woody[3] (%)	Inertinite[3] (%)	Comments
RB-466-1	0	40	40	10	10	Same as RB-518-11
RB-518-11	0	23	31	15	31	Same as RB-466-1
RB-H-1	0	43	29	0	29	Same as RB-SAC-10
RB-SAC-10	0	38	50	13	0	Same as RB-H-1
RB-STD-1	0	15	23	31	31	Shale standard
RB-DMY-1	0	20	33	27	20	Shale standard
RB-DMY-2	22	44	22	0	11	Limestone standard
RB-STD-2	0	50	25	13	13	Limestone standard

1 TOC = Total Organic Carbon.
2 TAI = Thermal Alteration Index.
3 Forms of kerogen.

1.3.5.4 Summary of Quality Control and Quality Assurance Results

The various quality control and quality assurance procedures discussed above were implemented and completed. In addition, internal reviews and audits of these procedures and results were completed by key project team members. Appropriate corrective measures were implemented where necessary and are documented in this report. Therefore, based on the results of the internal reviews and audits and the discussions presented above, the quality control and quality assurance results were adequate for the level of accuracy required for this project.

1.4 PREVIOUS GEOLOGIC STUDIES

In the New Mexico portion of the Hueco Mountains, Hardie (1958a, 1958b) and Dane and Bachman (1958, 1965) originally mapped the geology. In the Texas portion of the Hueco Mountains, the first geologic map was prepared by Richardson (1904), followed by King et al. (1945); however, their maps did not extend into New Mexico. Wise (1977) examined the petrography of the igneous rocks in the Texas portion of the Hueco Mountains. The western portion of the McGregor Range covering the eastern Las Cruces 1° by 2° quadrangle was mapped in detail by Seager et al. (1987). Black (1973) mapped the geology of the Otero Platform that covers the northeastern corner of the McGregor Range. Pray (1961) mapped the geology of the Sacramento Mountains, including the northern portion of the McGregor Range. Numerous reports describe the geology and mineral resources of the Orogrande District (Seager 1961; Schmidt 1962; Schmidt and Craddock 1964; Beane et al. 1975; Bloom 1975; Strachan 1976), but none of these reports extend into the McGregor Range.

The geologic map used in this study (refer to Figure 1.19) is from computer data files used to produce the state geologic map (Anderson et al. 1994), with minor corrections and additions. This geologic map was compiled from a variety of sources. In the McGregor Range, the state geologic map was compiled from earlier published geologic maps by Dane and Bachman (1958, 1965) and Seager et al. (1987). Corrections and additions based on field reconnaissance during this study were incorporated into the state geologic map and Figure 9.

Only a few reports described any mineral resources within the McGregor Range. McLemore (1991) briefly described the mineral resources in Otero County, but does not mention any in the McGregor Range. Moore et al. (1989) described the mineral resources in the nearby Brokeoff Mountains. Kness (1994) examined many of the known industrial mineral deposits, but his field reconnaissance was restricted to only 50% of the range. Briggs (1983) described the mineral resources of the West Face Sacramento Mountains Roadless Area that includes the northern part of the McGregor Range. The New Mexico State Highway Department (1972) described the aggregate resources of the range. Kottlowski (1962) described the limestone resources, and Weber and Kottlowski (1959) described the gypsum resources. Five major reports described the oil and gas potential of the area: Black (1973, 1975, 1976), Foster (1978), and King and Harder (1985). Henry and Gluck (1981) and Witcher (1997) describe the geothermal resources in the Hueco Tanks geothermal area of the McGregor Range.

1.5 ACKNOWLEDGMENTS

Listed below in Table 1.2 are the personnel that were involved with the development and execution of this project.

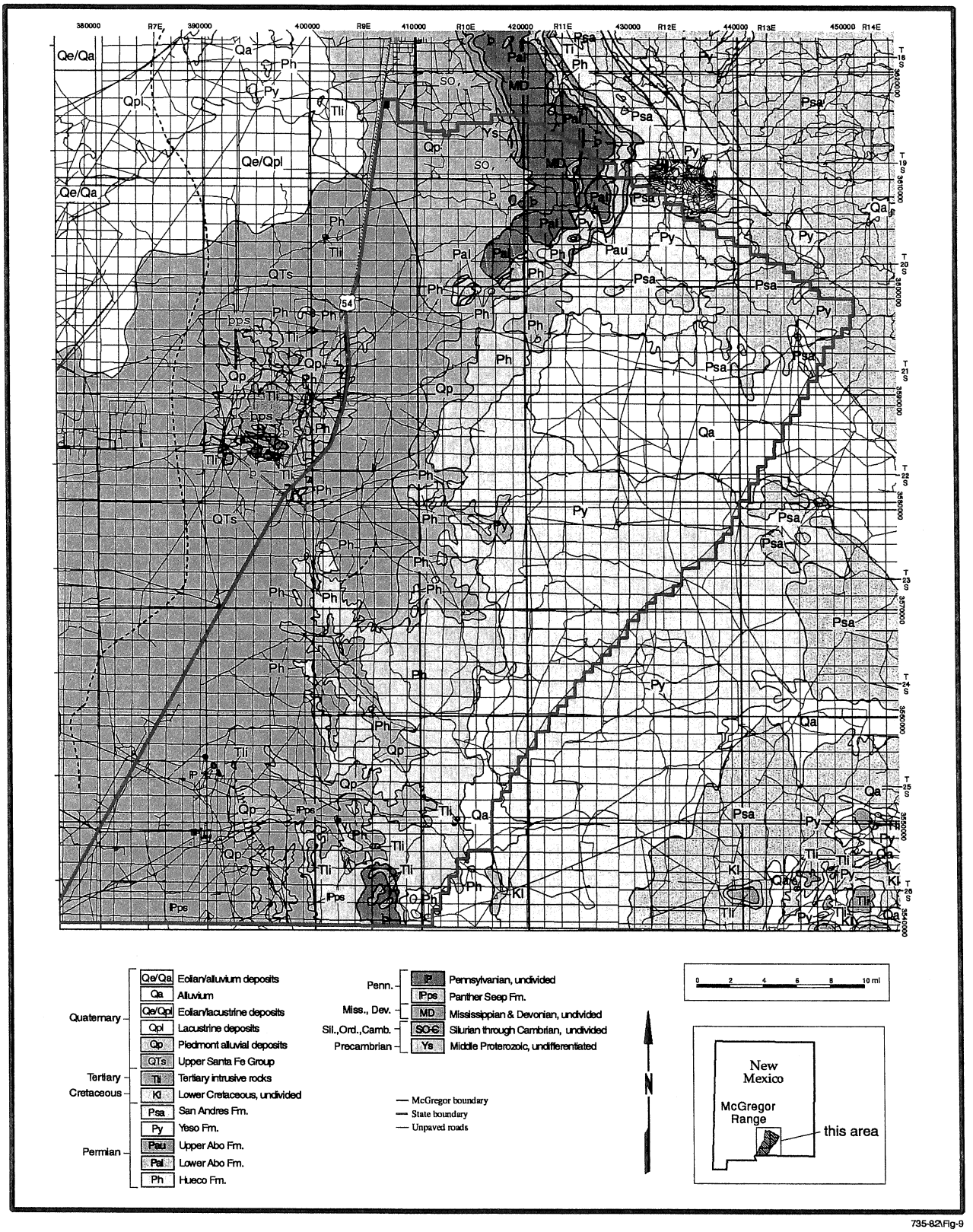

Figure 1.19 Geologic Map of the McGregor Range.

Table 1.2 List of Individuals Involved with this Project.

Technical Specialty	Name	Affiliation
Program Manager - McGregor Land Renewal	A. Vliet	U.S. Army - Fort Bliss
Contracting Officers Technical Representative	A. Marr	U.S. Army Corps of Engineers - Fort Worth
Range Liaison	K. Fischer	U.S. Army - Fort Bliss
Range Liaison	S. Offutt	U.S. Army - Fort Bliss
Project Manager	S. Kamber	TRC Mariah Associates Inc.
Technical Peer Reviewer	J. Tingley	Nevada Bureau of Mines and Geology
Technical Peer Reviewer	C. Chapin	New Mexico Bureau of Mines and Mineral Resources
Principal Investigator	R. Broadhead	New Mexico Bureau of Mines and Mineral Resources
Research Geologist	V. McLemore	New Mexico Bureau of Mines and Mineral Resources
Research Geologist	J. Barker	New Mexico Bureau of Mines and Mineral Resources
Research Geologist	G. Austin	New Mexico Bureau of Mines and Mineral Resources
Research Geologist	J. Witcher	New Mexico State University
CADD Operator	S. Luhr	TRC Mariah Associates Inc.
Cartographer	D. Kleinkopf	U.S. Geological Survey
Cartographer	G. Keller	University of Texas - El Paso
Cartographer	J. Thomas	New Mexico Bureau of Mines and Mineral Resources
Cartographer	K. Degruyter	New Mexico Bureau of Mines and Mineral Resources
Cartographer	M. Ingles	Earth Data Analysis Center
Cartographer	P. Neville	Earth Data Analysis Center
Document Production	C. Hayden	TRC Mariah Associates Inc.
Document Production	K. Heinrich	TRC Mariah Associates Inc.
Document Production	T. Adolf	TRC Mariah Associates Inc.
Document Production Supervisor	G. DeCastro	TRC Mariah Associates Inc.
Document Production/Editor	T. Linse	TRC Mariah Associates Inc.
Document Researcher	L. Hemmingway	New Mexico Bureau of Mines and Mineral Resources
Document Researcher	T. Telles	New Mexico Bureau of Mines and Mineral Resources
Field Assistant	J. McLemore	New Mexico Bureau of Mines and Mineral Resources
Geochemist	M. Wilks	New Mexico Bureau of Mines and Mineral Resources
Geochemist	N. Dunbar	New Mexico Bureau of Mines and Mineral Resources
GIS Specialist	G. Jones	New Mexico Bureau of Mines and Mineral Resources
GIS Specialist	S. Walker	TRC Mariah Associates Inc.
Field Assistant	E. Monroe	New Mexico Bureau of Mines and Mineral Resources
Laboratory Assistant	D. Jones	New Mexico Bureau of Mines and Mineral Resources
Laboratory Assistant	I. Gundiler	New Mexico Bureau of Mines and Mineral Resources
Laboratory Assistant	J. Watrus	New Mexico Bureau of Mines and Mineral Resources
Laboratory Assistant	L. Brandvold	New Mexico Bureau of Mines and Mineral Resources
Laboratory Assistant	V. Ulkert	New Mexico Bureau of Mines and Mineral Resources
Project Administrative Assistant	L. Beougher	TRC Mariah Associates Inc.
Project Administrative Assistant	M. Wickersham	TRC Mariah Associates Inc.
Technical Specialist	R. Thompson	New Mexico Bureau of Mines and Mineral Resources

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2.0 GEOLOGIC SETTING

2.1 REGIONAL STRATIGRAPHY

2.1.1 Proterozoic Rocks

Proterozoic rocks are exposed south of Negro Ed Canyon in the northern portion of the McGregor Range in the southern Sacramento Mountains (refer to Figure 2.1). The poorly exposed rocks consist predominantly of metamorphosed fine-grained sedimentary rocks (quartzites, gneisses, schists) intruded by granitic plutons and gabbro dikes or sills (Pray 1961). The exposed portion of strata is approximately 80 to 100 ft thick.

In the subsurface, the Proterozoic rocks consist of unmetamorphosed to metamorphosed fine-grained clastic sedimentary rocks, carbonates, gabbro/diabase dikes and sills, and minor granitic rocks (refer to Table 2.1; Muehlberger and Denison 1964; Denison and Heatherington 1969; Condie and Budding 1979). Similar rocks are exposed in the San Andres and Franklin Mountains (Muehlberger and Denison 1964; Harbour 1972; Condie and Budding 1979). Metamorphosed carbonates (marble), consisting of calcite, tremolite, garnet, wollastonite, and actinolite, are in the LeFors No. 1 Federal Well (refer to Figure 2.1); these rocks are similar to metamorphosed rocks found in the Franklin Mountains and probably were formed by metamorphism during the Proterozoic. These rocks are part of the Precambrian DeBaca terrain (Condie and Budding 1979).

2.1.2 Paleozoic Rocks

2.1.2.1 Ordovician Rocks

Ordovician strata are divided into three stratigraphic units within the McGregor Range and adjacent areas (Figure 2.2; ascending): Bliss Sandstone, El Paso Group, and Montoya Group. The Bliss Sandstone rests unconformably on Proterozoic rocks. It is 100 to 250 ft thick in the McGregor Range area and consists of tan to light brown, fine- to coarse-grained quartz sandstone and minor light brown dolostone (Figures 2.3-2.6). The contact between the Bliss Sandstone and the overlying El Paso Group is gradational (Pray 1961).

The El Paso Group is 400 to 700 ft thick in the McGregor Range area and consists of thin-bedded, finely crystalline, dark gray dolostones and minor fine- to coarse-grained quartzose sandstones (Figures 2.3-2.6).

The Montoya Group unconformably overlies the El Paso Group in the Sacramento Mountains at the north end of the McGregor Range (Pray 1953). In the subsurface of the McGregor Range and surrounding areas, it is 100 to 500 ft thick. The Montoya Group consists of medium- to thick-bedded, finely crystalline dolostone. Chert nodules are abundant in the upper part (Figures 2.3-2.6).

2.1.2.2 Silurian Rocks

Silurian rocks consist of one stratigraphic unit, the Fusselman Formation. In the Sacramento Mountains, the lower part of the Fusselman has been split out into a separate unit, the Valmont Dolomite, by Pray (1953). However, the Valmont is not recognizable as a distinct stratigraphic entity throughout the McGregor Range and is therefore not discussed as a separate stratigraphic unit in this report. The contact of the Fusselman with the underlying Montoya Group is gradational in most places (Pray 1953, 1961).

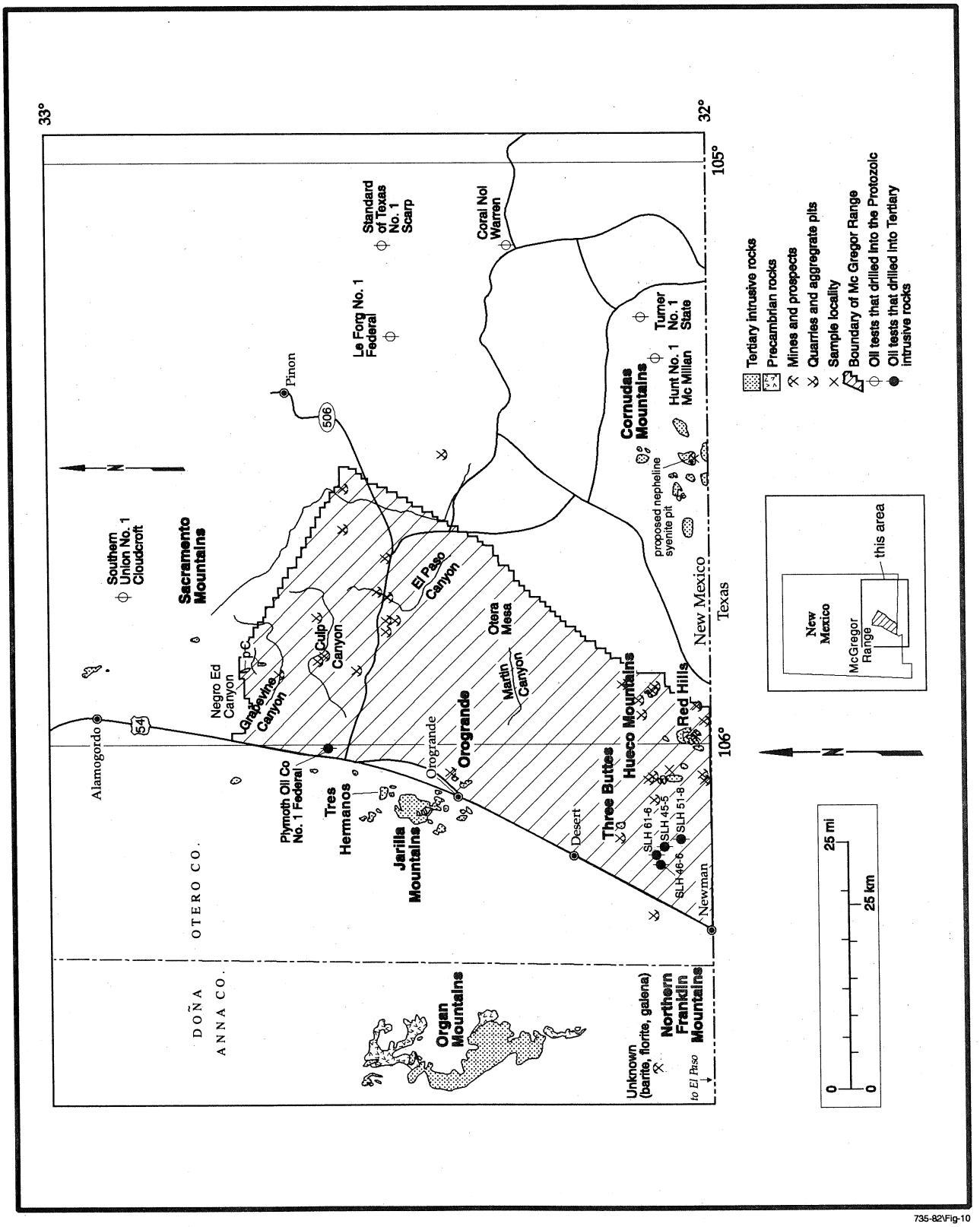

Figure 2.1 Geographic Features, Mines, and Prospects on the McGregor Range Area.

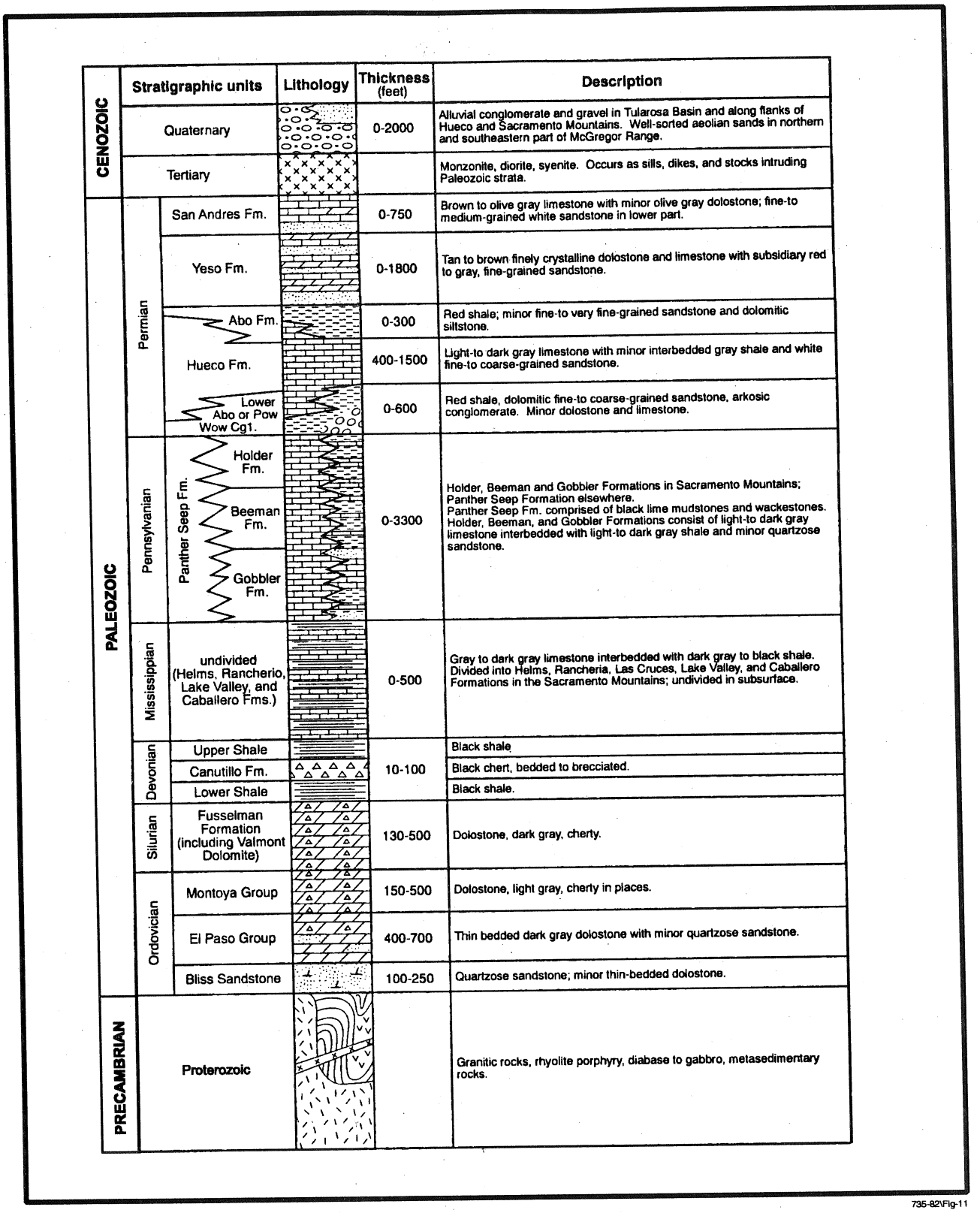

Figure 2.2 Stratigraphic Column of Rocks Within the McGregor Range and Surrounding Areas.

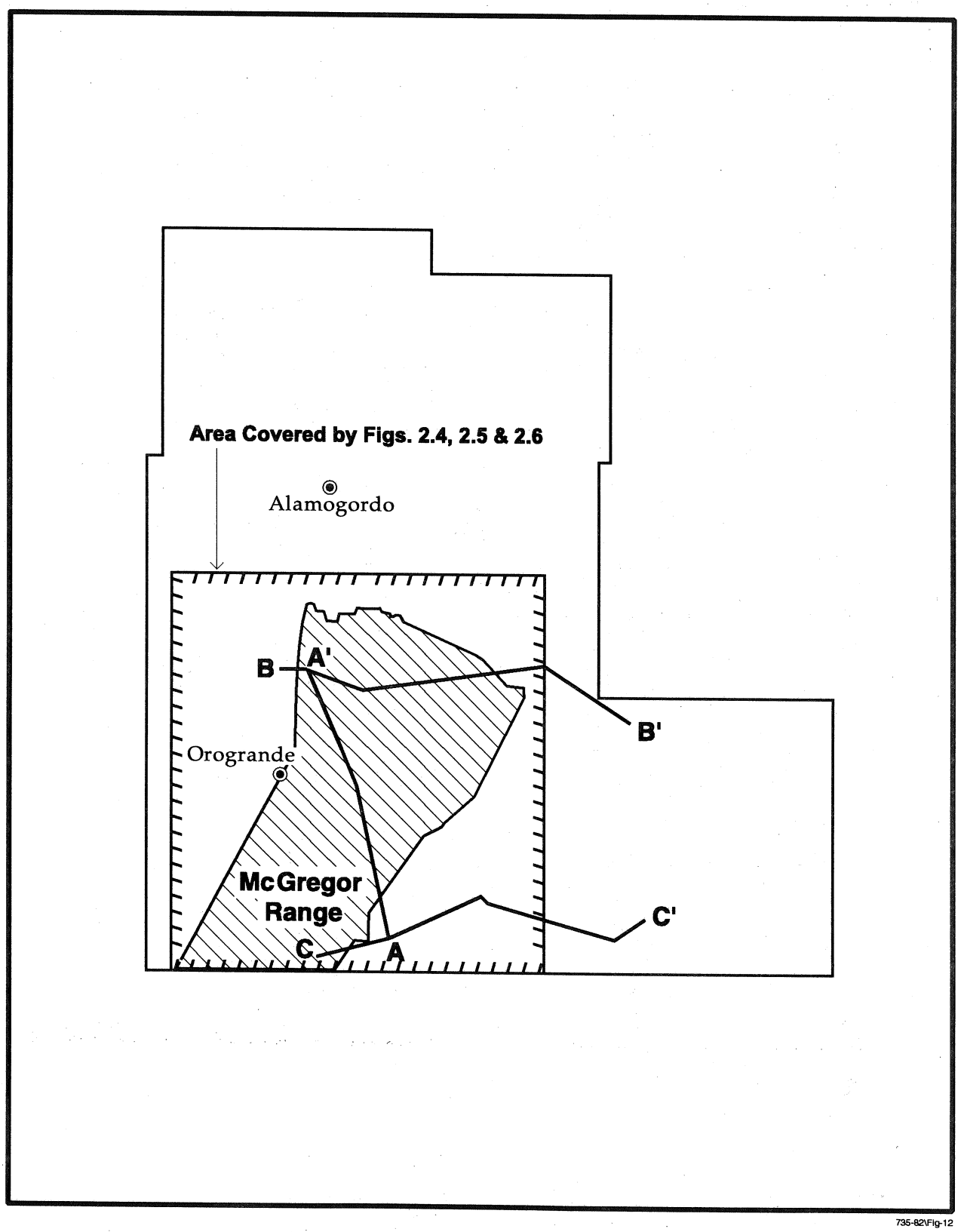

Figure 2.3 Map of Otero County and McGregor Range Showing Cross Sections for Figures 2.4-2.6.

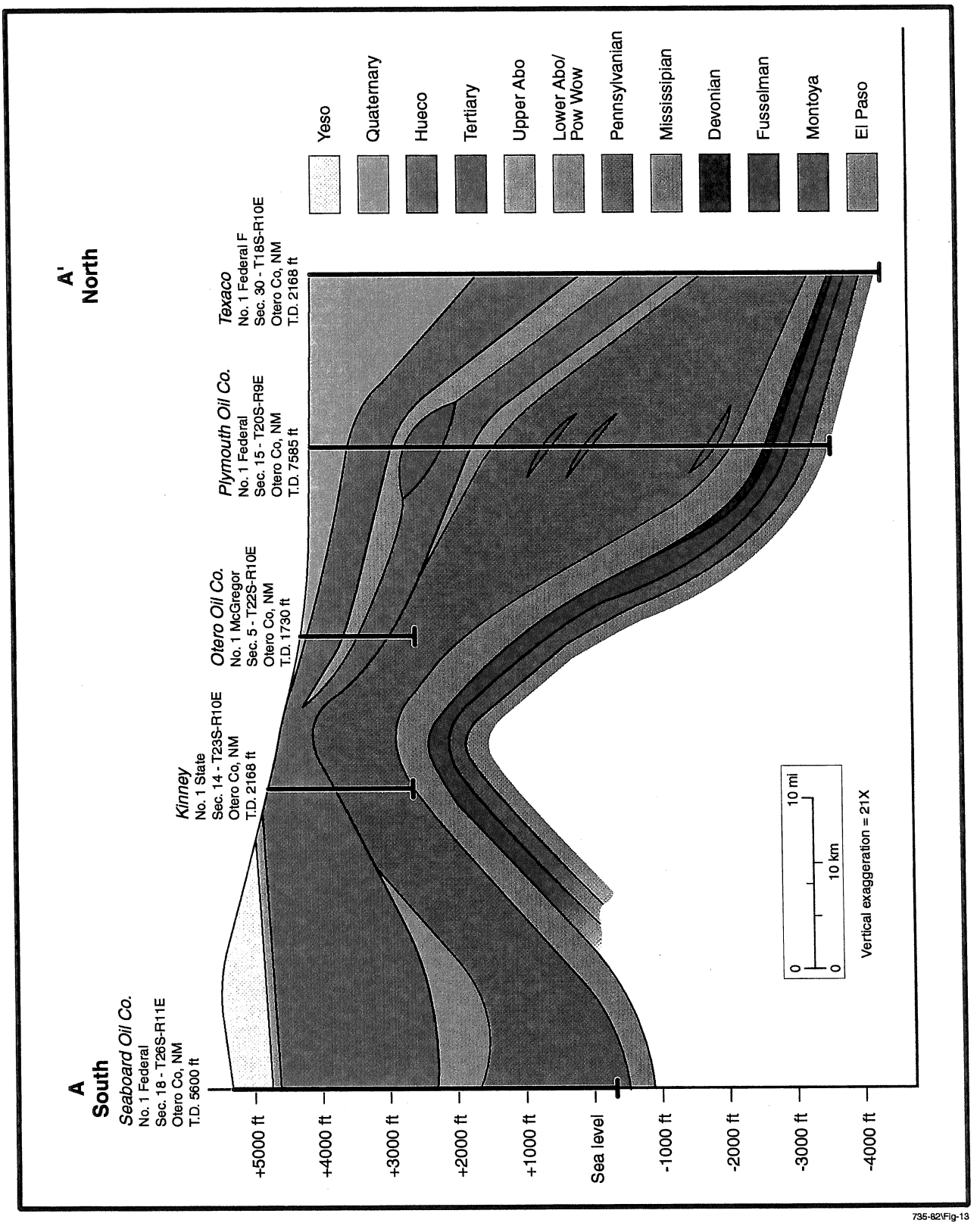

Figure 2.4 West/East Structural Cross Section A-A'.

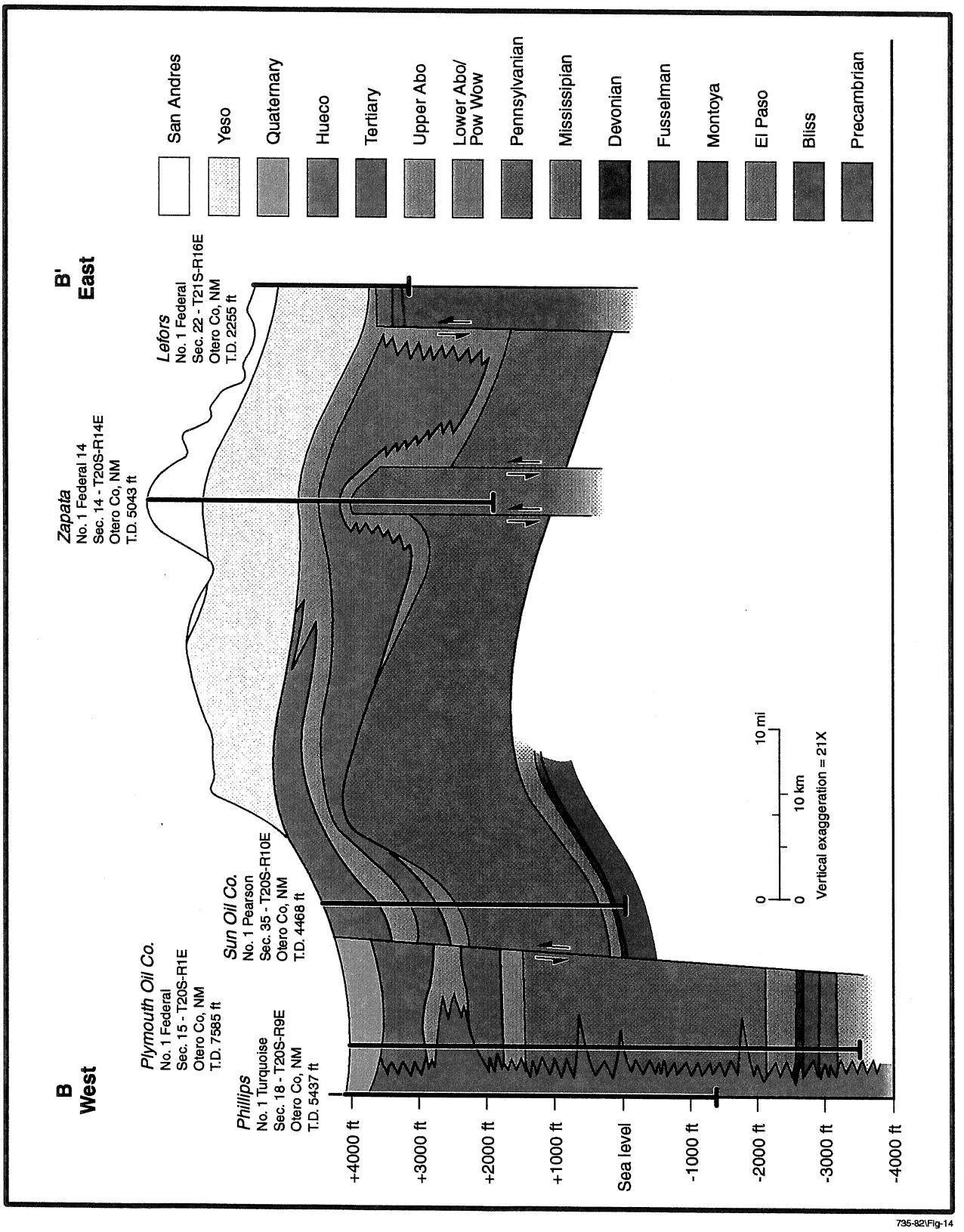

Figure 2.5 West/East Structural Cross Section B-B'.

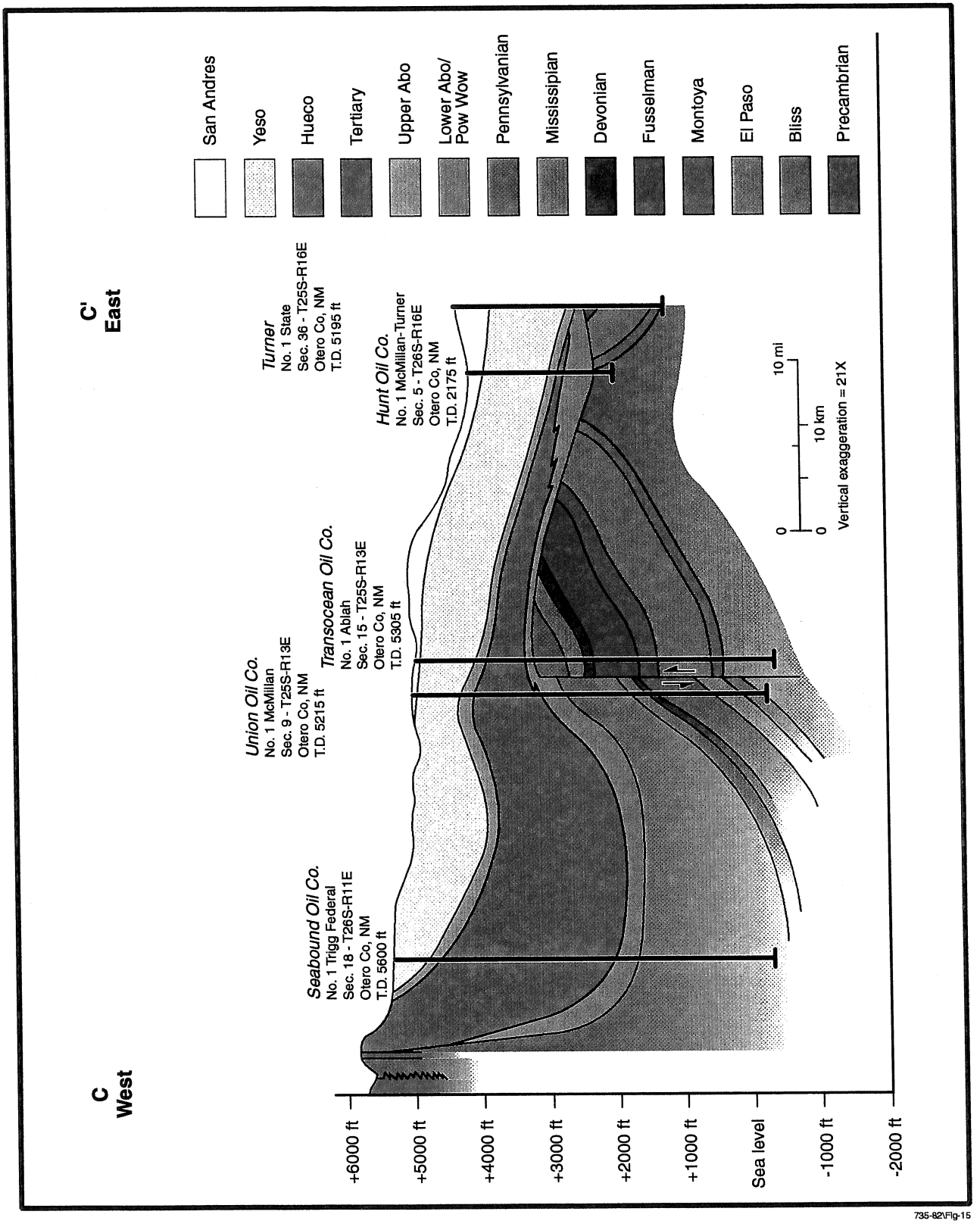

Figure 2.6 West/East Structural Cross Section C-C'.

Table 2.1 Oil Tests Drilled to Proterozoic Rocks Adjacent to the McGregor Range.[1]

Name	Location	Depth to Top (ft)	Elev. (ft)	Lithology
Hunt No. 1 McMillan-Turner	Sec. 5, T26S, R16E	2,175	4,165	Diabase to gabbro, rhyolite porphyry
Standard of Texas No. 1 Scarp	Sec. 18, T21S, R18E	2,578	5,340	Diabase to gabbro
Southern Union No. 1 Cloudcroft	Sec. 5, T17S, R12E	4,701	9,370	Quartzite, argillaceous quartzite, shale cut by diabase to gabbro dikes
Turner No. 1 State	Sec. 36, T25S, R16E	5,195	4,322	Diabase to gabbro, marble, granite
Coral No. 1 Warren	Sec. 19, T23S, R18E	2,155	3,540	Diabase to gabbro
LeFors No. 1 Federal	Sec. 22, T21S, R16E	2,222	5,386	Marble

[1] Foster and Stipp 1961; Denison and Hertherington 1969.

The Fusselman Formation is 130 to 500 ft thick in the McGregor Range area and consists of dark gray, thick-bedded, finely crystalline dolostone (Figures 2.3-2.6).

2.1.2.3 Devonian Rocks

Devonian rocks are 3 to 100 ft thick in the McGregor Range area and consist of a lower unit of interbedded gray and black shale, a middle unit of bedded and brecciated black chert, and an upper unit of black shale (Figures 2.3-2.6). The lower unit may be correlative with the Onate Formation of the Sacramento Mountains (Pray 1961) and the San Andres Mountains (Kottlowski et al. 1956; Sorauf 1984). The middle unit is probably correlative with the Canutillo Formation. The upper unit may be correlative with the Percha Shale of southwest and south-central New Mexico. The lower contact of the Devonian strata with the Fusselman Formation is an unconformity.

2.1.2.4 Mississippian Rocks

Mississippian rocks are 50 to 640 ft thick in the McGregor Range area. They consist of interbedded limestones and dark gray to black shales (Figures 2.3-2.6). The limestones are lime mudstones, wackestones, packstones, and grainstones (see Witcher [1997]). The lower contact with the Devonian is an unconformity. In the Sacramento Mountains, the Mississippian section has been divided into four formations (ascending): Caballero Formation, Lake Valley Formation, Rancheria Formation, and Helms Formation (Pray 1961). In the Hueco Mountains, the Mississippian section has been correlated solely as the Helms Formation (King et al. 1945). Without additional stratigraphic research, subdividing Mississippian rocks throughout the subsurface of the McGregor Range is not feasible.

2.1.2.5 Pennsylvanian Rocks

Pennsylvanian rocks are 0 to 3,300 ft thick in the McGregor Range area (Figures 2.3-2.7). In the Sacramento Mountains, the Pennsylvanian section attains a maximum thickness of 3,300 ft and has been subdivided into three formations (Pray 1961; ascending): Gobbler, Beeman, and Holder Formations. The Gobbler, Beeman, and Holder Formations consist of light to dark gray limestone, light to dark gray shale, and minor quartzose sandstone (Pray 1961). Extensive biothermal buildups are characteristic of the

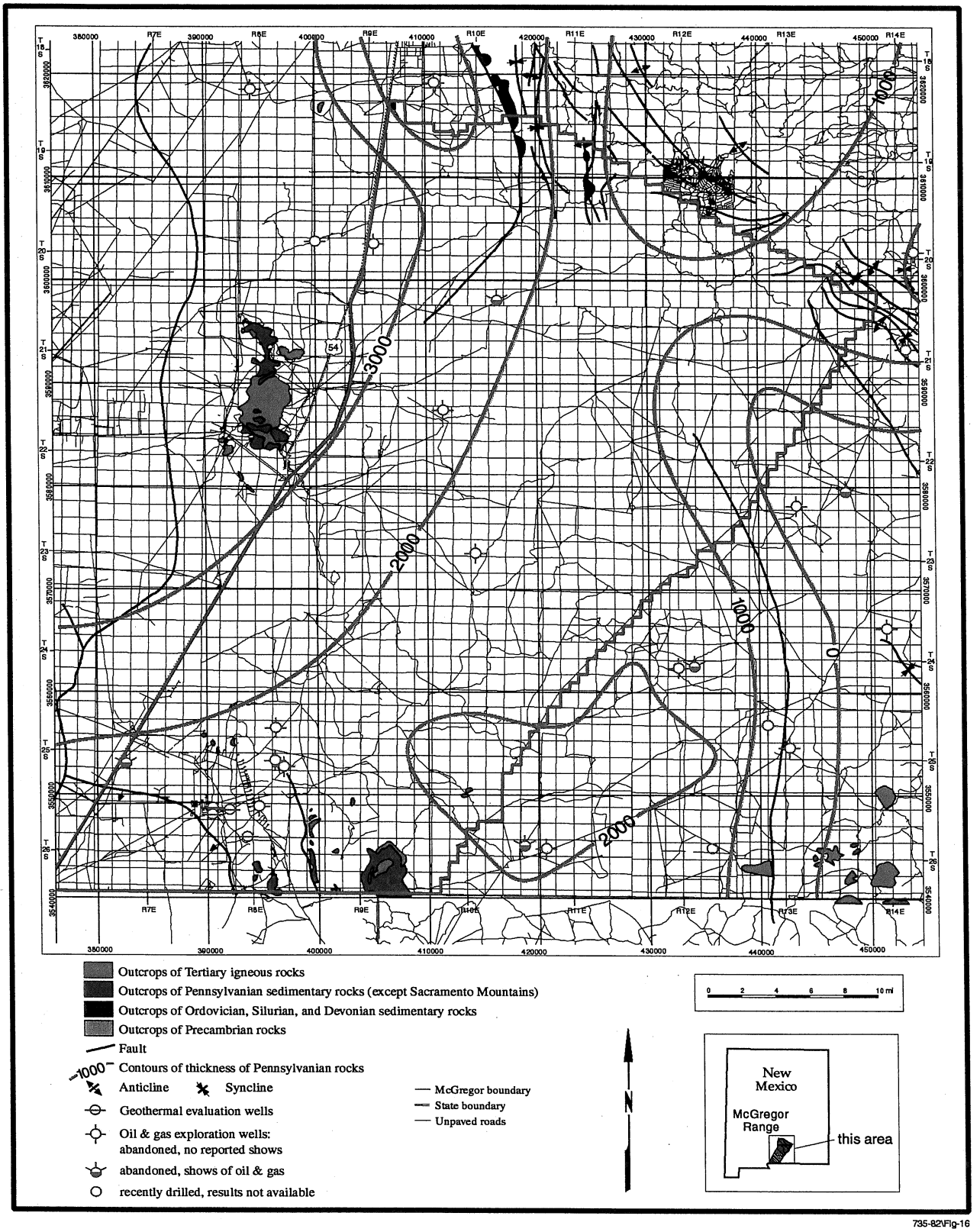

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Figure 2.7 Isopach Map of Pennsylvanian Rocks on McGregor Range and Surrounding Areas.

Gobbler and Holder Formations, which are shelf deposits (Bowsher 1986). In the Hueco Mountains, the Pennsylvanian section is approximately 1,300 ft thick (King et al. 1945; Hardie 1958a, 1958b) and is correlated with the Panther Seep Formation (Kottlowski 1960a). The Panther Seep consists mostly of dark gray to black lime mudstones and lime wackestones and interbedded dark gray to black shales with some limestone pebble conglomerates. The Panther Seep is a basinal facies of the Pennsylvanian and is laterally equivalent to Pennsylvanian shelf sediments of the Sacramento Mountains. The Panther Seep facies appears to constitute the Pennsylvanian section throughout all of the McGregor Range except the northeasternmost part.

2.1.2.6 Permian Rocks

Permian rocks consist of five formations in the McGregor Range area (Figure 2.2; ascending): Pow Wow Conglomerate/lower Abo Formation, Hueco Formation, upper Abo Formation, Yeso Formation, and San Andres Formation. The Pow Wow Conglomerate is present in the Hueco Mountains, where it consists of red shales and limestone pebble conglomerates (King et al. 1945; Kottlowski 1963). The Pow Wow Conglomerate is laterally correlative with the lower part of the Abo Formation, which consists of red shales and dolomitic fine- to coarse-grained sandstones. The Pow Wow/lower Abo section is 0 to 600 ft thick in the McGregor Range area (Figures 2.3-2.6). The lower contact of the Pow Wow Conglomerate with the Panther Seep Formation is an unconformity in the Hueco Mountains (King et al. 1945; Hardie 1958a, 1958b). On the geologic map (Figure 1.19), the Pow Wow and Lower Abo have been included with the Hueco Formation.

The Hueco Formation overlies the Pow Wow/lower Abo section and perhaps also intertongues with it to some extent. The Hueco consists of light to dark gray limestones interbedded with minor gray shales and white fine- to coarse-grained sandstones. It is 400 to 1,500 ft thick in the McGregor Range area (Figures 2.3-2.6). The Hueco is exposed at the surface over much of the western part of the McGregor Range (Figure 1.19).

The upper Abo Formation overlies the Hueco Formation conformably and also laterally intertongues with it. It consists of red shales and red to white fine-grained sandstones and is 0 to 600 ft thick in the McGregor Range area (Figures 2.3-2.6). In the Otero Mesa area, Bachman and Hayes (1958) have named upper Abo strata the Otero Mesa Member of the Yeso Formation, but these red beds are more simply correlated as the upper part of the Abo Formation (Pray 1961).

The Yeso Formation conformably overlies the Abo Formation and is 0 to 1,800 ft thick in the McGregor Range area (Figures 2.3-2.6). The Yeso consists primarily of tan to brown, finely crystalline dolostone and limestone and minor interbedded anhydrite and red to gray fine-grained sandstone within the project area. The Yeso is exposed at the surface over most of Otero Mesa in the eastern part of the McGregor Range and has been removed by erosion over the western part of the range.

The San Andres Formation conformably overlies the Yeso Formation and is 0 to 750 ft thick in the McGregor Range area (Figures 2.3-2.6). It consists of brown to dark gray to olive-gray limestone and minor olive-gray dolostone. Thin beds of fine- to medium-grained quartzose sandstones are locally present in the lowermost 120 ft (Pray 1961). The formation is present only in the easternmost part of the McGregor Range, having been removed by erosion elsewhere.

2.1.3 Mesozoic Rocks

Rocks of Triassic and Jurassic age are not present in the McGregor Range area. Thin erosional remnants of Lower Cretaceous limestones and sandstones were observed in T26S, R10E, 3 mi east of the McGregor Range boundary (Dane and Bachman 1965; Kues and Lucas 1993), and in the Texas part of the Hueco Mountains (King et al. 1945). Cretaceous rocks are not present within the boundaries of the McGregor Range, having been removed by erosion.

2.1.4 Cenozoic Rocks

2.1.4.1 Pliocene (Tertiary) Through Holocene Rocks

Middle Pliocene (Tertiary) through Holocene rocks form the upper basin fill in much of the western part of the McGregor Range and consist of the Pliocene-Early Pleistocene Camp Rice Formation (Seager et al. 1987). The Camp Rice Formation consists of unconsolidated sand and gravel deposited in alluvial fans, fluvial and floodplain systems, and minor lacustrine environments. Holocene (Recent) alluvial fan, terrace, and piedmont slope deposits form the lower foothills of the Hueco Mountains and consist predominantly of limestone boulders, gravel, and sand. Caliche deposits are mixed locally with these alluvial fan deposits (Hardie 1958a, 1958b). Most arroyos and drainages consist of Holocene (Recent) sand to coarse gravel to boulders that are predominantly limestone. Locally, sands, silts, and syenite gravels are found in some arroyos. Recent basin floor deposits of loam, silt, and sand, as well as nonalkaline playa lake deposits, form in the lowest parts of the Tularosa Basin; locally, these units are gypsiferous (Seager et al. 1987). Small dunes and hummocks of windblown sand, locally with minor caliche lenses, cover much of the basin fill throughout the flat-lying areas of the western McGregor Range. Landsat data indicate that these dunes trend northeast to southwest, which is the direction of the prevailing wind. Several sand dunes also overlie Pennsylvanian and Permian sedimentary rocks in the foothills of the southern Sacramento Mountains in the northern part of the McGregor Range.

2.1.4.2 Tertiary Igneous Rocks

The southern McGregor Range is within the northern part of the Trans-Pecos alkaline magmatic province that is the southern extension of the North American Cordilleran alkalic igneous belt. This belt is a diffuse region of Cenozoic igneous rocks that extends along the eastern margin of the North American Cordillera from Alaska and British Columbia southward into Trans-Pecos Texas and eastern Mexico (Figure 2.8) (Barker 1977, 1979, 1987; Mutschler et al. 1985, 1991; Woolley 1987; McLemore 1996a). The widely accepted international nomenclature and classification of igneous rocks is used in this report, where igneous rocks are defined on the basis of mineralogy (mineral mode), unless they are very fine-grained, where they are defined by chemical composition (LeMaitre 1989). Figure 2.9 is a quartz-alkali feldspar-plagioclase (QAP) diagram showing the composition of igneous rocks within the McGregor Range. Mineral compositions are presented in Appendix 4.

In the McGregor Range, Tertiary intrusive rocks are exposed in the hills south of Orogrande (southern Jarilla Mountains), eastern Three Buttes, and in the northern Hueco Mountains (Figure 1.19); drill holes in the Hueco geothermal field south of Three Buttes and Davis Dome went through rhyolite and monzonite. The intrusive rocks south of Orogrande on the McGregor Range are most likely related to the igneous rocks in the Jarilla Mountains. These rocks are associated with skarn and vein deposits found in the Orogrande Mining District. The intrusions in the Hueco Mountains are the northwesternmost igneous activity of the Trans-Pecos alkaline magmatic province (Barker et al. 1977; Barker 1977, 1987).

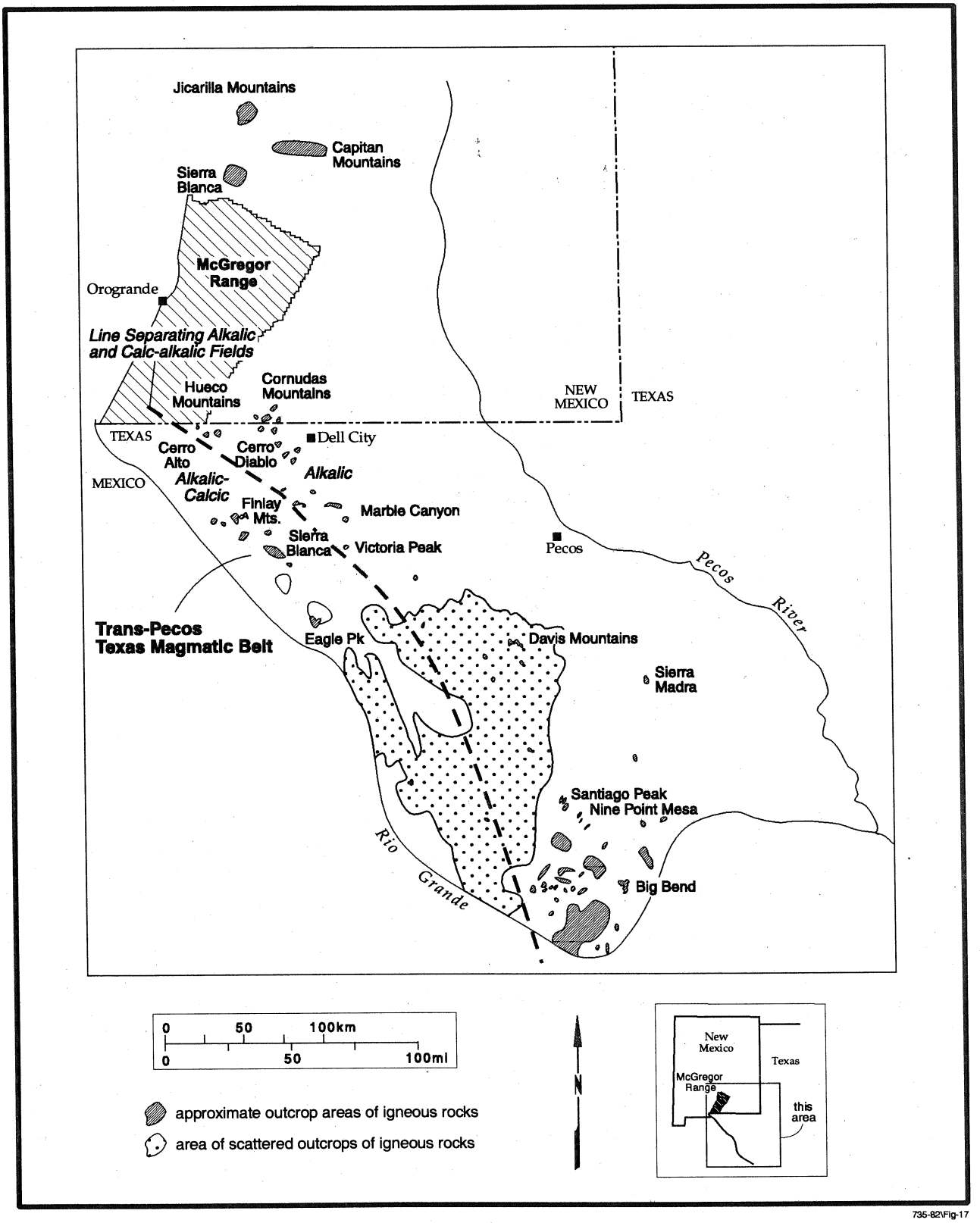
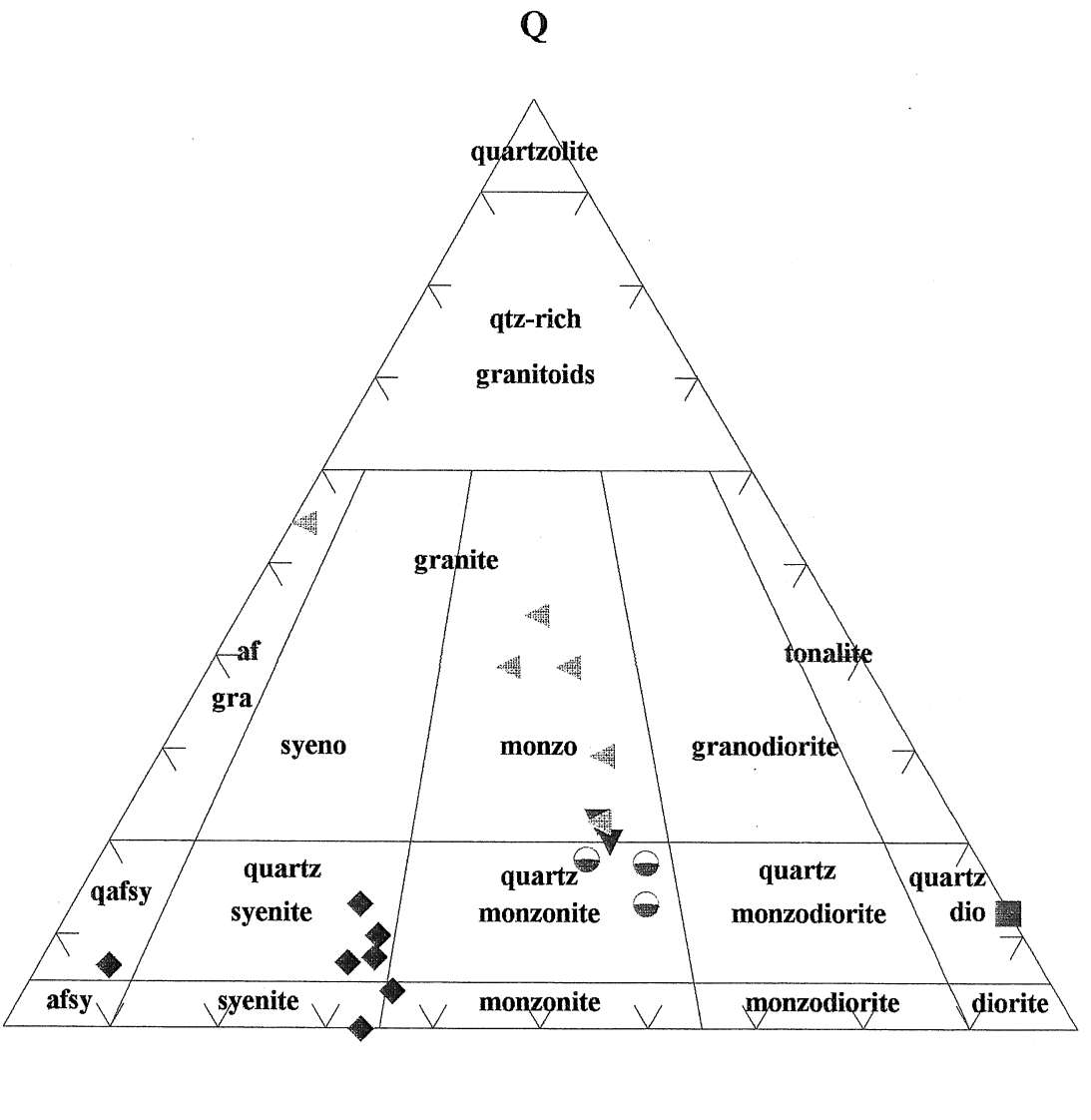


Figure 2.8 Trans-Pecos Magmatic Province, New Mexico and Texas.



Only plutonic rock names are shown on the fields as defined by LeMaitre (1989). **monzo**-monzogranite (volcanic equivalent is rhyolite), **qafsy**-quartz alkali-feldspar syenite (volcanic equivalent is quartz alkali-feldspar trachyte), and **quartzdio**-quartz diorite (volcanic equivalent is quartz gabbro). Volcanic equivalent of syenite is trachyte. Purple triangles represent the quartz monzonites from southern Otero Platform (including drill holes), blue diamonds are syenites and trachytes from the northern Hueco Mountains, gray triangles are rhyolites from the southern Otero Platform (drill holes), blue-green circles are from quartz monzonites near Orogrande in the southern Jarilla Mountains, and the green square is the Proterozoic gabbro from Ed Negro Canyon in the Sacramento Mountains. Mineralogy is in Appendix 7.

Figure 2.9 QAP Diagram of Igneous Rocks Collected from the McGregor Range.

The Jarilla Mountains west of the McGregor Range consist of a core of granodiorite surrounded by monzonite (Seager 1961; Schmidt and Craddock 1964; Beane et al. 1975; Bloom 1975). The granodiorite is dark gray, massive, and fine- to medium-grained. It consists of plagioclase (50-75%), orthoclase (10-30%), biotite (5-15%), hornblende (4-8%), quartz (5-20%), and augite (1-2%) (Beane et al. 1975). The monzonite is gray, typically porphyritic, and variable in composition. Monzonite in the southern part of the range consists of plagioclase (30-40%), orthoclase (35-40%), hornblende (as much as 10%), quartz (5-10%), and accessory biotite, apatite, titanite, and zircon (Beane et al. 1975). Other outcrops of monzonite contain more quartz and orthoclase.

In the southern part of the Jarilla Mountains, the monzonite crosscuts a quartz latite (Beane et al. 1975). The quartz latite is white to pink and aphanitic and consists of plagioclase, K-feldspar, and quartz. A large number of granodiorite, monzonite, andesite, and diabase dikes and sills cut the larger intrusions, as well as the surrounding sedimentary rocks. The surrounding sedimentary rocks consist of Pennsylvanian Panther Seep Formation through Permian Hueco Formation (Strachen 1976) that have been metamorphosed to skarns adjacent to the intrusions. Xenoliths and/or roof pendants are common within the granodiorite and are also metamorphosed. Marble is common.

The easternmost hill of the Three Buttes consists of gray-brown quartz monzonite stock (refer to Sample VTM97-55 in Appendix 4). The stock is fine-grained and porphyritic and consists of quartz (10%), plagioclase (25%), K-feldspar (20%), biotite (2%), aegirine (2%), calcite (5%), magnetite (5%), sericite and clay (30%), and apatite (1%). The phenocrysts are as much as 5 mm long. The stock is surrounded by alluvium; no intrusive contacts or xenoliths were found.

The main intrusive rock in the northern Hueco Mountains is the Red Hills syenite (refer to Figure 2.10). It is gray and black and weathers to a dark reddish brown. The syenite is medium-grained and consists of plagioclase phenocrysts (as much as 2 cm long) in a fine-grained ground mass of biotite, plagioclase, K-feldspar, pyroxene, and magnetite. Nepheline or quartz are present in small amounts. Syenite to trachyte dikes intrude the stock (Hardie 1958a, 1958b). These dikes are very fine-grained, are gray to brown, weather reddish brown, and consist of plagioclase, iron oxides, and quartz. Syenite dikes also occur as ring dikes partially surrounding the Red Hills stock (refer to Figure 2.10). These dikes are highly altered with liesegang banding, indicating fluid migration. Syenite sills cut the adjacent limestone. Locally, thin skarns are exposed at or near the contact. Sills or dikes are also exposed in the northwestern part of the Hueco Mountains (Seager et al. 1987), but these sills or dikes are in remote and rugged mountains and were not examined for this study. Mineral compositions are presented in Appendix 4.

A trachyte sill outcrops in the northeastern Hueco Mountains (refer to Sample VTM97-60, Section 24, T26S, R9E, Figure 2.10). The trachyte is green-gray to gray and consists of K-feldspar (65%), augite (5%), magnetite (5%), quartz (5%), microcline (5%), biotite (5%), and hornblende (10%). Calcite and iron oxide veinlets along fractures are common throughout the diorite. It is approximately 25 ft thick and intrudes Panther Seep Limestone. There is no evidence of alteration at the intrusive contact.

In the Texas portion of the Hueco Mountains, igneous intrusions are found at Hueco Tanks, a small hill northwest of Hueco Tanks, Cerro Alto (north of Hueco Tanks), and west of Alcran Mountain (King et al. 1945; Wise 1977). Various lithologies occur, including alkali syenite, syenite, syenodiorite, trachyte, and monzonite. The intrusions are typically fine-grained, light-colored, and porphyritic. Only minor skarns occur, which are less than 30 ft thick. The skarns typically consist of calcite, hematite, silica, and iron oxides and (locally) epidote, garnet, and magnetite (Wise 1977).

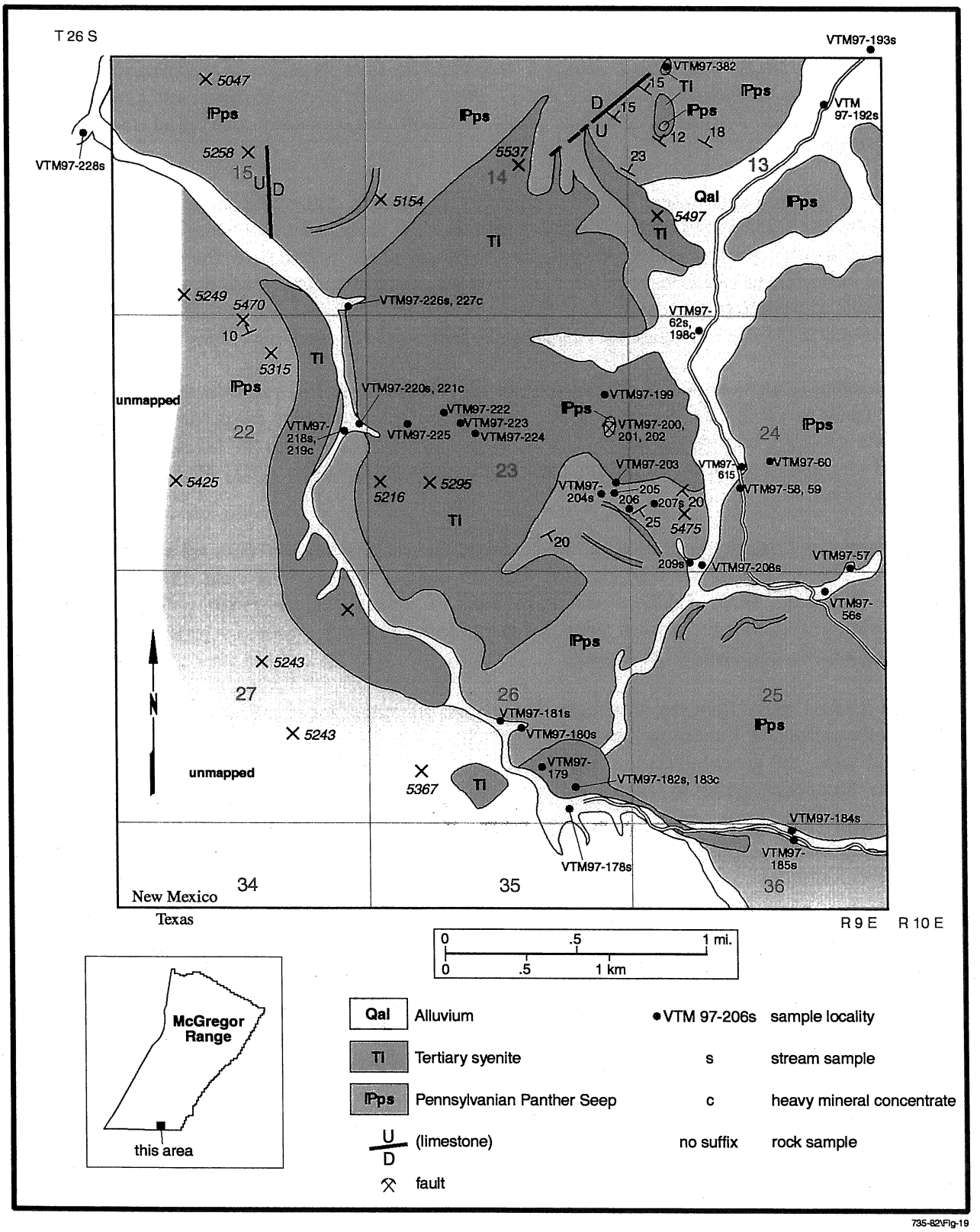


Figure 2.10 Geologic and Sample Location Map of the Red Hills Syenite.

The Cornudas Mountains, east of McGregor Range, consist of 10 larger sills, plugs, and laccoliths and smaller dikes and plugs that intrude relatively flat-lying limestones and other sedimentary rocks of the Hueco Limestone and Bone Spring Limestone (Permian). Intrusive lithologies vary from phonolite and nepheline syenite to syenite and quartz syenite to trachyte (Nutt et al. 1997). Wind Mountain is one of the largest intrusions with an approximate diameter of 1 mi and is mineralogically, texturally, and chemically zoned (McLemore et al. 1994, 1996a, 1996b).

Rhyolite and monzonite intrusions cut the sedimentary sequence in drill core from geothermal test holes in the southern Otero Platform (Table 2.2 and Figure 2.1). The rhyolite intrusions are interpreted to be sills and could possibly represent a buried rhyolite flow dome complex. In Well 61-6, the rhyolite is overlain by Holocene basin fill; in Wells 46-6 and 45-5, the rhyolite intrudes Pennsylvanian limestone and shale. The rhyolite sills are white to pink to brown, fine-grained to very fine-grained, and locally porphyritic and consist of quartz (35-40%), plagioclase (25-30%), K-feldspar (30%), and iron oxides (5%).

The monzonite is also overlain by Tertiary basin fill. These basin fills range in thickness from 139 to 1,272 ft (refer to Table 2.2). A pink to gray-brown, porphyritic monzonite sill occurs in Well 51-8. The monzonite generally consists of quartz (15%), plagioclase (25%), K-feldspar (25%), hornblende (5%), biotite (10%), and iron oxides (5%). Minor recrystallization and hematitic to clay alteration of the adjacent limestone occurred.

Geochemistry of Tertiary Igneous Rocks. Magmas and the resulting igneous rocks are a common source of metals for many types of ore deposits, and different magma compositions yield different types of ore deposits (Lindgren 1933; Guilbert and Park 1986; Cox and Singer 1986). Thus, geochemical characteristics of igneous rocks when compared to known mineralizing igneous systems are a useful tool in evaluating an area for potential ore deposits.

Selected igneous rocks from the McGregor Range were submitted for chemical characterization for this study (refer to Table 2.3 and Appendix 5). The geochemistry of the McGregor Range igneous rocks were compared with the geochemistry of igneous rocks from known mineralizing systems, including the Cornudas Mountains (refer to Tables 2.4 and 2.5; McLemore et al. 1996b; Barker 1987; L.S. Potter

Table 2.2 Oil and Geothermal Tests Drilled Through Tertiary Igneous Rocks Within and Adjacent to the McGregor Range.

Name	Location	Depth to Top (ft)	Thickness (ft)	Lithology
Well 51-8	Sec. 16, T26S, R8E	460	200	Monzonite
Well 46-6	Sec. 6, T26S, R8E	1,145	139	Rhyolite
Well 45-5	Sec. 5, T26S, R8E	433	431	Rhyolite
		1,857	1,272	
Well 61-6	Sec. 6, T26S, R8E	605	825	Rhyolite
Plymouth Oil Co. No. 1 Federal	Sec. 15, T20S, R9E	1,382	404	Diorite or trachyte

Table 2.3 Geochemistry of Igneous Rocks Within the McGregor Range.[1]

Sample No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3[2] (%)	MgO (%)	CaO (%)	K_2O (%)	Na_2O (%)	MnO (%)	P_2O_5 (%)	LOI (%)	Total (%)
VTM97-55[3]	64.0	0.47	15.7	3.81	1.24	3.90	3.63	4.41	0.10	0.19	2.65	100.10
VTM97-60[4]	61.9	0.82	16.1	4.56	0.82	1.85	5.43	5.91	0.13	0.32	1.15	98.99
VTM97-63[5]	61.2	0.85	17.0	4.27	0.92	2.93	5.12	5.62	0.09	0.37	1.45	99.82
VTM97-169[3]	64.0	0.41	15.0	3.73	1.93	2.89	3.59	3.80	0.07	0.18	4.00	99.60
VTM97-173[3]	65.3	0.43	15.5	3.73	1.56	3.26	3.75	4.60	0.06	0.19	1.70	99.99
VTM97-179[5]	65.8	0.69	16.9	2.41	0.30	0.54	5.38	5.86	0.04	0.21	1.15	99.28
VTM97-199[5]	64.0	0.09	17.4	2.77	0.36	1.44	5.81	6.10	0.09	0.16	0.20	98.98
VTM97-212[5]	63.2	0.64	16.4	3.36	0.39	2.46	5.48	4.82	0.17	0.19	3.05	100.17
VTM97-222[5]	60.8	1.16	17.9	3.37	0.82	3.29	4.65	6.39	0.08	0.31	0.55	99.32
VTM97-223[5]	63.0	0.77	18.3	2.21	0.06	0.61	5.14	6.77	<0.01	0.26	1.10	98.22
VTM97-224[5]	65.3	0.55	16.7	2.55	0.38	1.33	5.64	5.72	0.08	0.17	0.40	98.82
VTM97-382	58.7	0.98	17.4	4.03	1.05	2.33	5.85	5.20	0.19	0.35	4.27	100.39
VTM97-326d[6]	76.6	0.07	13.6	0.54	0.19	<0.01	6.82	0.13	0.05	<0.01	2.10	100.10
VTM97-327d[6]	75.2	0.07	13.7	0.68	0.37	0.08	5.23	2.18	0.03	<0.01	2.25	99.79
VTM97-329d[6]	73.4	0.07	13.3	0.79	<0.01	1.34	4.98	3.35	0.10	0.02	1.65	99.00
VTM97-330d[3]	62.3	0.45	15.7	3.75	0.86	3.89	4.53	3.71	0.07	0.18	4.55	99.99
VTM97-350d	68.8	0.21	15.2	1.34	0.16	1.91	4.24	3.96	<0.01	0.09	2.15	98.77
VTM97-351d	68.3	0.23	15.1	2.01	0.36	1.34	3.49	5.78	<0.01	0.08	1.95	98.64
VTM97-352d	74.5	0.06	13.9	0.70	0.10	0.15	4.61	3.42	<0.01	<0.01	1.20	98.64

Sample No.	Ba (ppm)[7]	Cu (ppm)[7]	Pb (ppm)[7]	Rb (ppm)[7]	Sr (ppm)[7]	Zn (ppm)[7]
VTM97-55	1,700	4.0	10	107	800	37
VTM97-60	1,200	<0.5	<2	130	250	37
VTM97-63	1,100	<0.5	3	111	491	65
VTM97-169	1,600	1.6	11	121	704	21
VTM97-173	1,600	<0.5	10	142	839	20
VTM97-179	830	<0.5	4	128	237	7
VTM97-199	570	<0.5	14	163	303	17
VTM97-212	740	<0.5	8	136	142	54
VTM97-222	950	<0.5	7	88	669	39
VTM97-223	1,500	0.8	12	146	372	19
VTM97-224	680	<0.05	16	135	308	77
VTM97-382	1,209	6.0	290	144	406	297
VTM97-326d	1,300	<0.5	34	235	58	35
VTM97-327d	1,600	<0.5	12	171	187	19
VTM97-329d	1,800	6.3	20	138	257	20
VTM97-330d	1,500	4.6	23	156	497	59
VTM97-350d	1,500	1.4	14	127	455	13
VTM97-351d	1,100	0.6	14	102	318	19
VTM97-352d	1,300	2.2	19	162	173	29

1 Complete analyses for these samples are presented in Appendix 5.
2 Fe_2O_3 is total iron calculated as Fe_2O_3.
3 Monzonites.
4 Diorites.
5 Trachytes and syenites.
6 Rholites.
7 ppm = parts per million.

Table 2.4 Chemical Analyses of the Alkaline Rocks in the Cornudas Mountains.[1]

Sample No.[2]	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3[3] (%)	FeO (%)	MgO (%)	CaO (%)	K_2O (%)	Na_2O (%)	MnO (%)	P_2O_5 (%)	LOI (%)	CO_2 (%)	Total (%)
AS-2	54.10	1.81	18.60	3.46	3.28	2.56	5.46	3.67	5.33	0.17	0.81	1.14	0.26	100.39
AS-5	55.15	1.28	18.41	3.24	3.28	1.78	3.75	4.71	5.86	0.17	0.62	0.76	0.22	99.01
CH-1	56.10	0.18	19.57	2.87	1.86	0.13	0.90	4.90	10.77	0.29	0.04	2.42	0.08	100.03
SA-1	56.40	0.21	18.10	4.52	2.03	0.37	1.90	5.27	6.96	0.24	0.16	3.37	0.60	99.53
SA-12	55.20	0.44	17.56	2.01	4.73	0.54	1.75	3.50	7.92	0.27	0.21	4.96	0.03	99.09
WS-1	55.90	0.21	18.10	4.24	2.32	0.45	2.78	5.31	6.22	0.21	0.14	3.10	0.00	98.98
AL-11	58.40	0.21	18.80	2.95	1.60	0.14	0.81	4.98	9.51	0.26	0.07	1.35	0.05	99.08
AL-10	58.10	0.14	18.55	3.64	1.10	0.18	1.09	4.84	8.32	0.24	0.06	2.51	0.21	98.77
CO-1	59.10	0.05	16.60	1.42	1.13	0.81	4.97	5.30	5.99	0.12	0.16	1.04	3.15	97.14
CO-4	63.45	0.05	18.25	2.33	0.92	0.07	1.02	5.30	6.70	0.14	0.18	0.72	0.65	99.76

1 Barker et al. 1977. Analyses from Wind Mountain are in Table 2.5.

2 AS = Augite syenite, CH = Chatfield Mountain, SA = San Antonio Mountain, WS = Washburn Mountain, AL = Alamo Mountain, and CO = Cornudas Mountain.

3 Total iron calculated as Fe_2O_3.

Table 2.5 Whole Rock and Trace Element Chemical Data from the Wind Mountain Nepheline Syenite Laccolith.[1]

Sample No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3[2] (%)	MgO (%)	CaO (%)	K_2O (%)	Na_2O (%)	MnO (%)	P_2O_5 (%)	LOI (%)	Total (%)
CORN 31	60.10	0.18	17.70	5.09	0.24	1.16	5.44	6.83	0.21	0.09	1.02	98.06
CORN 33	59.40	0.18	18.40	5.64	0.48	1.28	5.33	7.72	0.27	0.09	2.06	100.85
CORN 34	58.00	0.08	17.70	4.58	0.19	0.73	5.48	8.04	0.27	0.08	3.35	98.50
TNSP1	58.67	0.19	17.80	5.96	0.44	1.19	5.33	8.12	0.28	0.10	2.20	100.28
TSPfg1	59.00	0.26	18.10	4.75	0.53	1.50	5.20	7.28	0.23	0.12	1.79	98.76
TSPfg2	59.20	0.13	18.50	4.78	0.49	0.94	5.31	7.66	0.26	0.06	3.27	100.60
TSPfg3	59.00	0.24	18.00	4.73	0.46	1.45	5.13	7.00	0.24	0.12	1.67	98.04
TSPfg4	59.50	0.24	18.30	4.65	0.35	1.19	5.27	6.72	0.23	0.11	1.64	98.20

Sample No.	Ba (ppm)[3]	Cr (ppm)[3]	Cs (ppm)[3]	Ga (ppm)[3]	La (ppm)[3]	Nb (ppm)[3]	Pb (ppm)[3]	Rb (ppm)[3]	Sr (ppm)[3]	Th (ppm)[3]	Y (ppm)[3]	Zn (ppm)[3]	Zr (ppm)[3]
CORN 31	182	30	13	27	61	96	15	115	60	8	24	105	744
CORN 33	103	22	18	29	123	214	31	160	64	38	53	184	1,759
CORN 34	89	13	23	32	184	360	55	200	62	77	138	353	2,843
TNSP1	106	28	26	29	116	239	29	157	69	39	65	208	1,994
TSPfg1	442	47	13	23	84	157	22	121	203	22	40	121	1,165
TSPfg2	nd[4]	nd[4]	nd[4]	30	nd[4]	250	38	165	109	46	65	216	2,135
TSPfg3	370	31	18	24	107	178	28	133	130	30	44	132	1,326
TSPfg4	439	36	17	24	84	126	18	122	135	16	36	107	949

1 McLemore et al. 1996a.
2 Total iron calculated as Fe_2O_3.
3 ppm = parts per million.
4 nd = no data.

1996), Cerro Alto in the northern Hueco Mountains (refer to Table 2.6; Barker 1987), Sierra Blanca in Trans-Pecos Texas (refer to Table 2.6; Barker 1980; Rubin et al. 1987), and central Jarilla Mountains (monzonites and quartz latites; Bloom 1975). The geochemistry of the rhyolites in the southern Otero Platform were compared to geochemistry of topaz-rhyolites from Sierra County, New Mexico (Lufkin 1972; Correa 1981; Goerold 1981; Woodard 1982; Duffield and Dalyrymple 1990; Duffield and Ruiz 1992), and Utah (Christiansen et al. 1986).

Three lithologic groups of igneous rocks occur in the McGregor Range: syenite to trachyte, quartz monzonite to diorite, and rhyolite. The three groups are chemically distinctive (refer to Appendix 5). The syenites and trachytes from the Hueco Mountains are alkaline (refer to Figure 2.11) and metaluminous (refer to Figure 2.12). However, they are not as alkaline as the nepheline syenites from the Cornudas Mountains (refer to Figures 2.11 and 2.12). The syenites and trachytes from the McGregor Range and Cornudas Mountains are classified as Within-Plate Granites (WPG) using the classification of Pearce et al. (1984) (refer to Figures 2.13 and 2.14). In accordance with these types of granites, the magma probably originated within the mantle and acquired a significant enrichment in lithophile group elements during its movement through the crust. These data are consistent with either a continental rift or subduction-related back-arc extension settings (McLemore et al. 1996b).

The quartz monzonite rocks are from Three Buttes (refer to Sample VTM97-55), southern Jarilla Mountains (refer to Samples VTM97-169 and VTM97-173), and southern Otero Platform (refer to Sample VTM97-330d). The samples are calc-alkaline and metaluminous and exhibit chemical trends similar to samples from the central Jarilla Mountains (refer to Figures 2.11 and 2.12). They are classified as Volcanic Arc Granites (VAG), using the classification of Pearce et al. (1984) (refer to Figures 2.13 and 2.14). These data are consistent with a subduction-related back-arc extension setting.

The rhyolites are from drill holes in the southern Otero Platform (refer to Samples VTM97-326d, VTM97-327d, VTM97-329d, VTM97-350d, VTM97-351d, and VTM97-352d) and have similar chemical trends as quartz latites from the central Jarilla Mountains and the Sierra Blanca rhyolite; they are calc-alkalic and peraluminous (refer to Figures 2.11 and 2.12). They are classified as VAG using the classification of Pearce et al. (1984) (refer to Figures 2.13 and 2.14). These data are consistent with a subduction-related back-arc extension setting. Although rhyolite domes or volcanic centers are not exposed in the McGregor Range, the rhyolites from the McGregor Range are grossly similar in chemical composition to topaz-bearing rhyolites that are associated with beryllium, flourite, and tin deposits (refer to Figure 2.15; Burt and Sheridan 1986; Burt et al. 1982). However, the McGregor Range rhyolites contain more barium and calcium and less tin, niobium, rubidium, uranium, thorium, molybdenum, and beryllium than most topaz-rhyolites (refer to Figure 2.16; Christiansen et al. 1986; Burt et al. 1982). In addition, the McGregor Range rhyolites have flat rare-earth elements (REE) patterns with slightly depleted europium anomalies (refer to Figure 2.17), whereas most topaz-rhyolites have a larger negative europium anomaly (Burt et al. 1982; Price et al. 1990).

Age of the Tertiary Igneous Rocks. The igneous rocks in and around the McGregor Range are Eocene to Oligocene in age. The oldest rocks are dikes and sills exposed in the Sacramento Mountains and stocks in the Jarilla Mountains (refer to Table 2.7). In the Hueco Mountains, the igneous rocks are younger than those in the Jarilla Mountains and are similar in age to those in the Cornudas Mountains. Apatite cooling ages of rocks in the Sacramento Mountains suggest that this range was uplifted during the Laramide through 35-41 million years before present (Ma); the Sacramento Mountains were not strongly uplifted early in the development of the Rio Grande Rift (RGR) (Kelley and Chapin 1997).

Table 2.6 Whole Rock and Trace Element Chemical Data from Various Topaz-Rhyolites.

Sample No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3[1] (%)	MgO (%)	CaO (%)	K_2O (%)	Na_2O (%)	MnO (%)	P_2O_5 (%)	LOI (%)	Total (%)
1[2]	74.4	0.02	14.1	0.79	0.01	0.45	4.30	5.06	0.05	<0.01	0.33	99.51
2[2]	72.5	0.03	13.7	1.34	0.01	0.08	4.22	6.48	0.08	<0.01	0.13	98.57
3[2]	73.9	0.06	13.1	1.29	0.08	1.27	3.65	4.33	0.06	0.00	3.55	101.29
4[2]	75.0	0.28	13.1	1.13	0.19	0.82	5.51	3.48	0.04	0.02	2.97	102.54
5[2]	76.2	0.07	12.7	0.89	0.05	0.72	4.80	3.74	0.07	0.00	2.84	102.08
6[2]	76.0	0.60	13.0	1.00	0.08	0.60	4.80	4.00	0.06	0.00	0.30	99.76
VTM97-326d[3]	76.6	0.07	13.6	0.54	0.19	<0.01	6.82	0.13	0.05	<0.01	2.10	100.10
VTM97-327d[3]	75.2	0.07	13.7	0.68	0.37	0.08	5.23	2.18	0.03	<0.01	2.25	99.79
VTM97-329d[3]	73.4	0.07	13.3	0.79	<0.01	1.34	4.98	3.35	0.10	0.02	1.65	99.00
VTM97-350d[3]	68.8	0.21	15.2	1.34	0.16	1.91	4.24	3.96	<0.01	0.09	2.15	98.77
VTM97-351d[3]	68.3	0.23	15.1	2.01	0.36	1.34	3.49	5.78	<0.01	0.08	1.95	98.64
VTM97-352d[3]	74.5	0.06	13.9	0.70	0.10	0.15	4.61	3.42	<0.01	<0.01	1.20	98.64

Sample No.	Ba (ppm)[4]	Cu (ppm)[4]	Pb (ppm)[4]	Rb (ppm)[4]	Sr (ppm)[4]	Zn (ppm)[4]
1[2]	16	nd[5]	70	1,090	9	nd[5]
2[2]	8	nd[5]	300	1,900	19	nd[5]
3[2]	63	nd[5]	56	1,060	5	nd[5]
4[2]	41	nd[5]	31	186	83	nd[5]
5[2]	41	nd[5]	31	433	5	nd[5]
6[2]	nd[4]	nd[5]	nd[5]	nd[5]	nd[5]	nd[5]
VTM97-326d[3]	1,300	<0.5	34	235	58	35
VTM97-327d[3]	1,600	<0.5	12	171	187	19
VTM97-329d[3]	1,800	6.3	20	138	257	20
VTM97-350d[3]	1,500	1.4	14	127	455	13
VTM97-351d[3]	1,100	0.6	14	102	318	19
VTM97-352d[3]	1,300	2.2	19	162	173	29

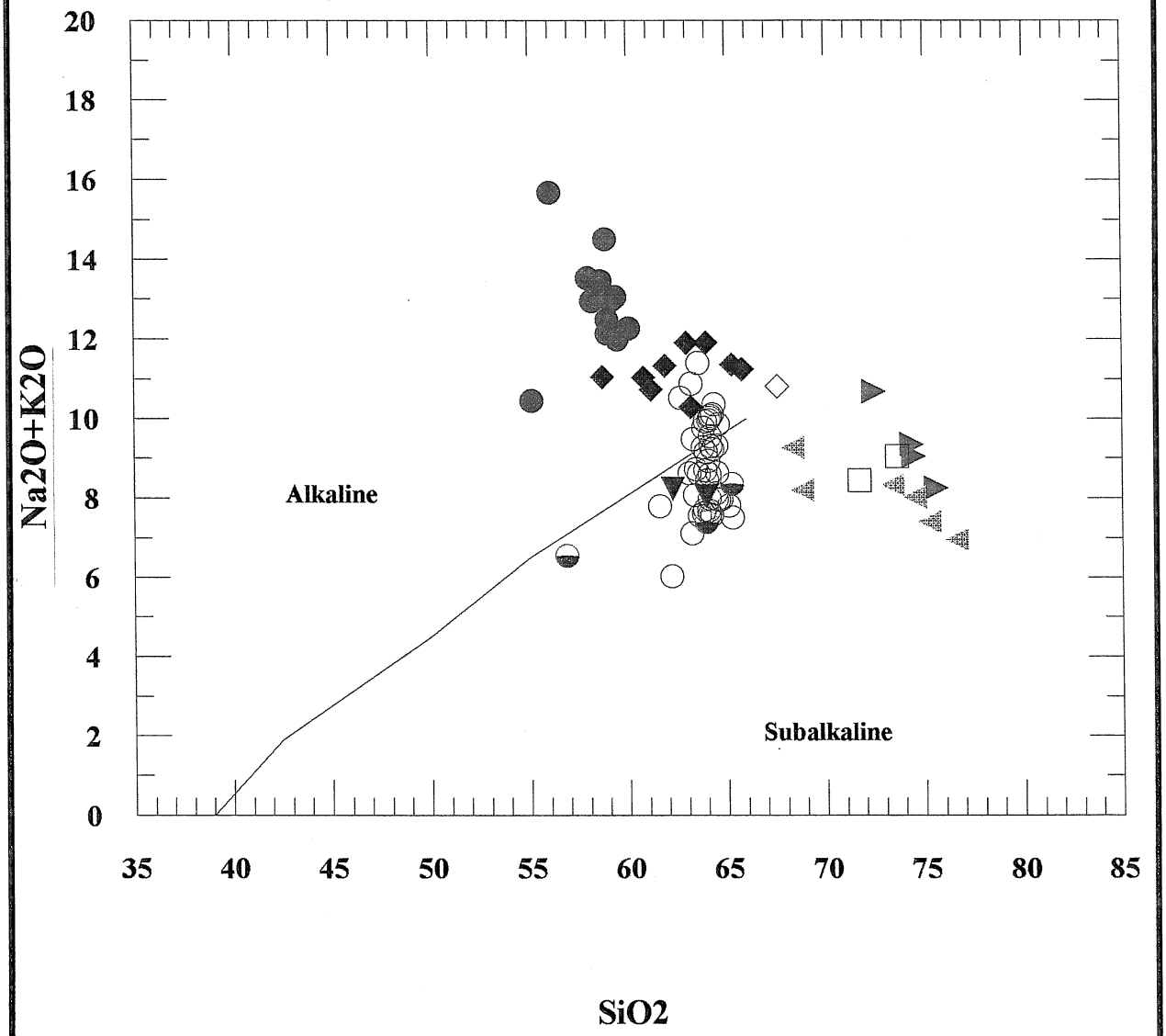
1 Fe_2O_3 is total iron calculated as Fe_2O_3.

2 1 = Sierra Blanca rhyolite (Rubin et al. 1987); 2 = Round Top rhyolite, Sierra Blanca (Price et al. 1990); 3 = SM-35, vitrophyre, Spor Mountain, Utah (Christiansen et al. 1986); 4 and 5 = SM-61a and SM29-206, vitrophyres from Thomas Range, Utah (Christiansen et al. 1986); 6 = average topaz-rhyolite (Christiansen et al. 1986).

3 Complete analyses for these samples are presented in Appendix 5.

4 ppm = parts per million.

5 nd = no data.



The line between alkaline and subalkaline is from Irvine and Baragar (1971). Red circles represent data from Cornudas Mountains, Otero County, blue diamonds from syenites and trachytes from the northern Hueco Mountains (Appendix 5), open red circles from monzonites from the Jarilla Mountains (Bloom 1975), open blue squares from quartz latites from the Jarilla Mountains (Bloom 1975), blue-green circles from quartz monzonites in the southern Jarilla Mountains in the McGregor Range, purple triangles from quartz monzonites from the Otero Platform (including drill holes), gray triangles from rhyolites from the Otero Platform (drill holes), open red diamonds from syenites from southern Hueco Mountains in Texas (Rubin et al. 1987), and green triangles from Sierra Blanca, Texas (Rubin et al. 1987; Price et al. 1990). The syenites and trachytes from the northern Hueco Mountains are similar in major element chemistry as samples from the Cornudas Mountains. The quartz monzonites from the Otero Platform and southern Jarilla Mountains are similar in major element chemistry as samples from the Jarilla Mountains north of the McGregor Range. The rhyolites from the southern Otero Platform are similar in major element chemistry as quartz latites from the Jarilla Mountains north of the McGregor Range and as rhyolites from Sierra Blanca, Texas.

Figure 2.11 A Scatter Plot of Total Alkali Elements ($Na_2O + K_2O$) Versus SiO_2.

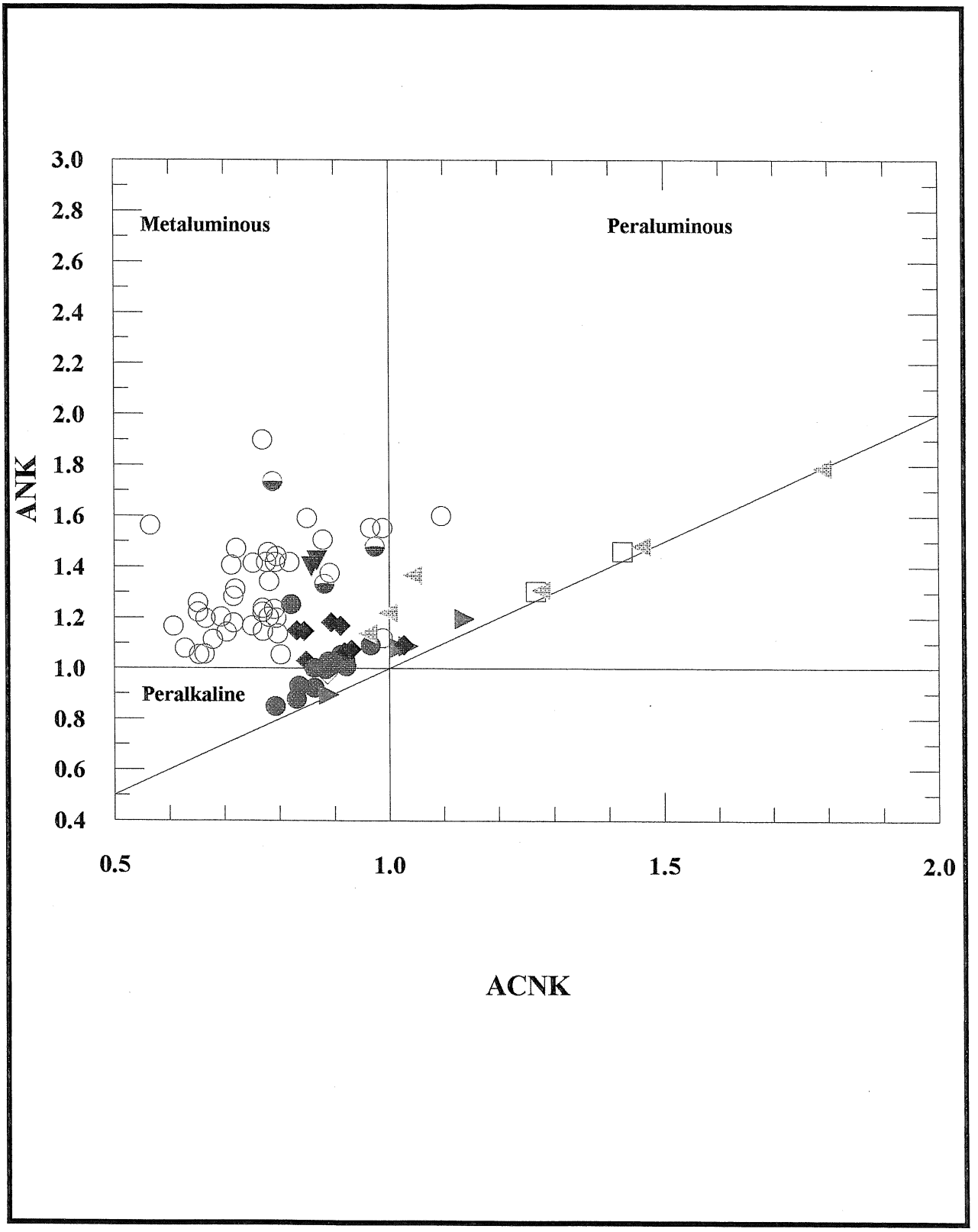


Figure 2.12 A Scatter Plot of ANK Versus ACNK.

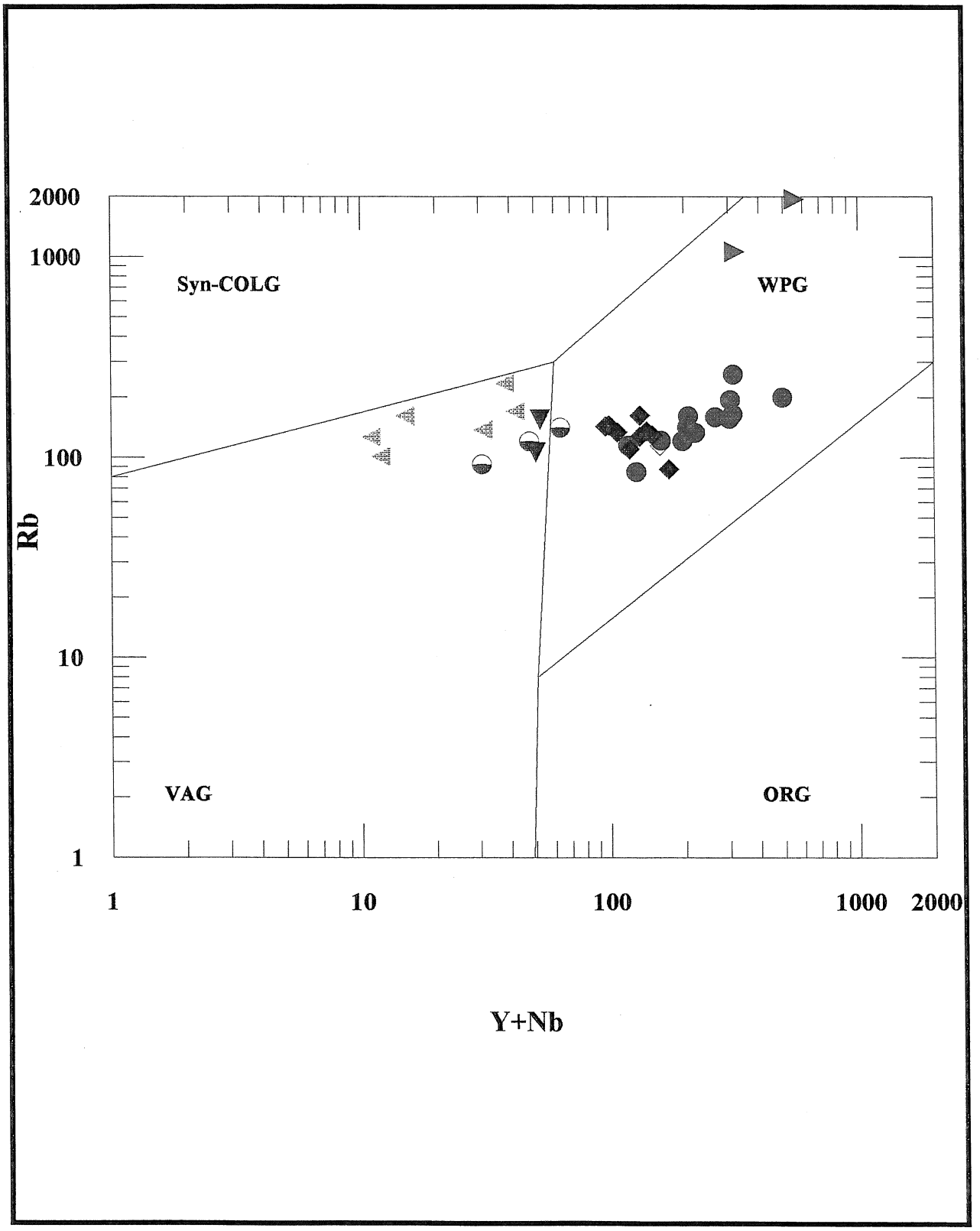


Figure 2.13 A Scatter Plot of Rubidium Versus Yttrium plus Niobium.

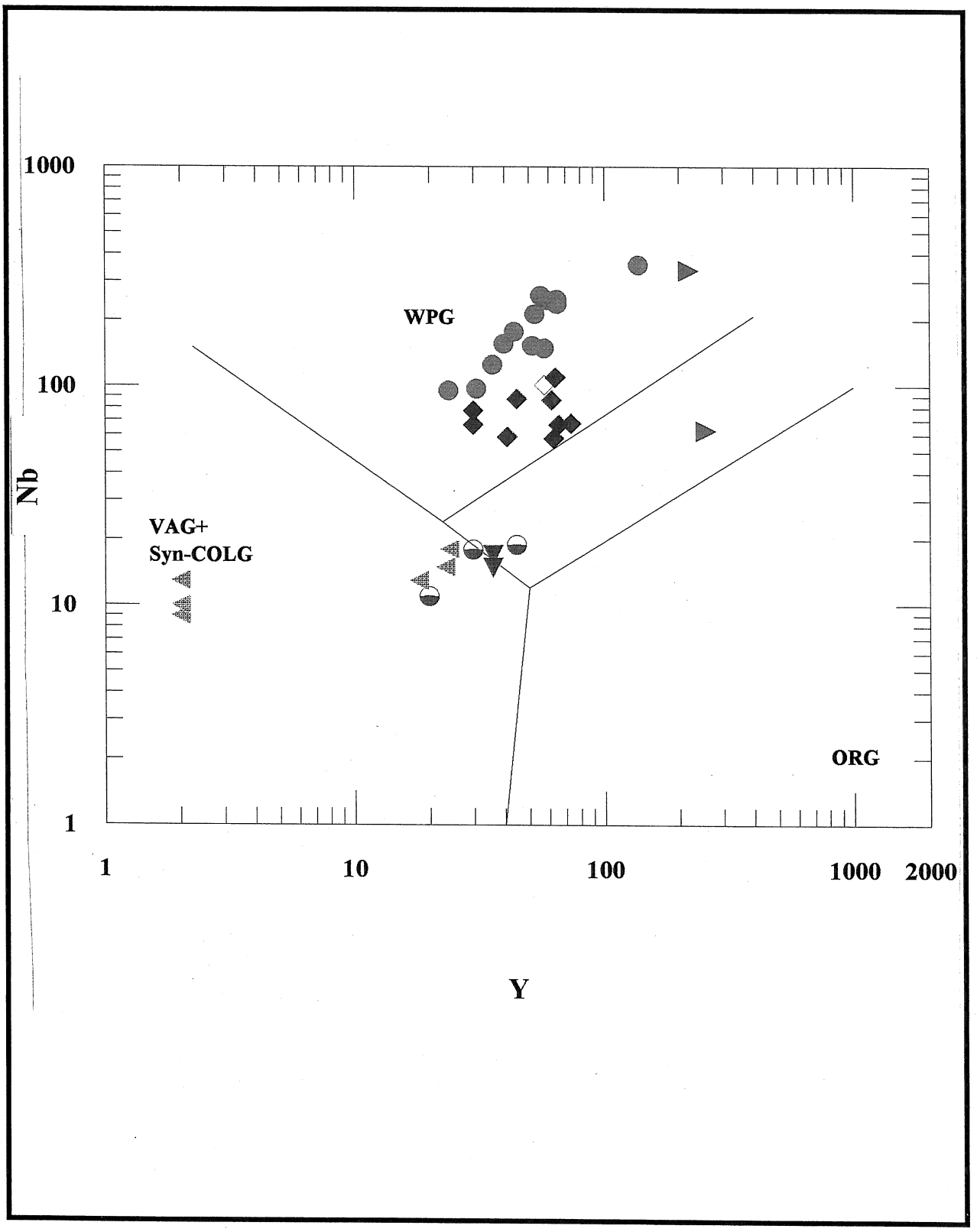
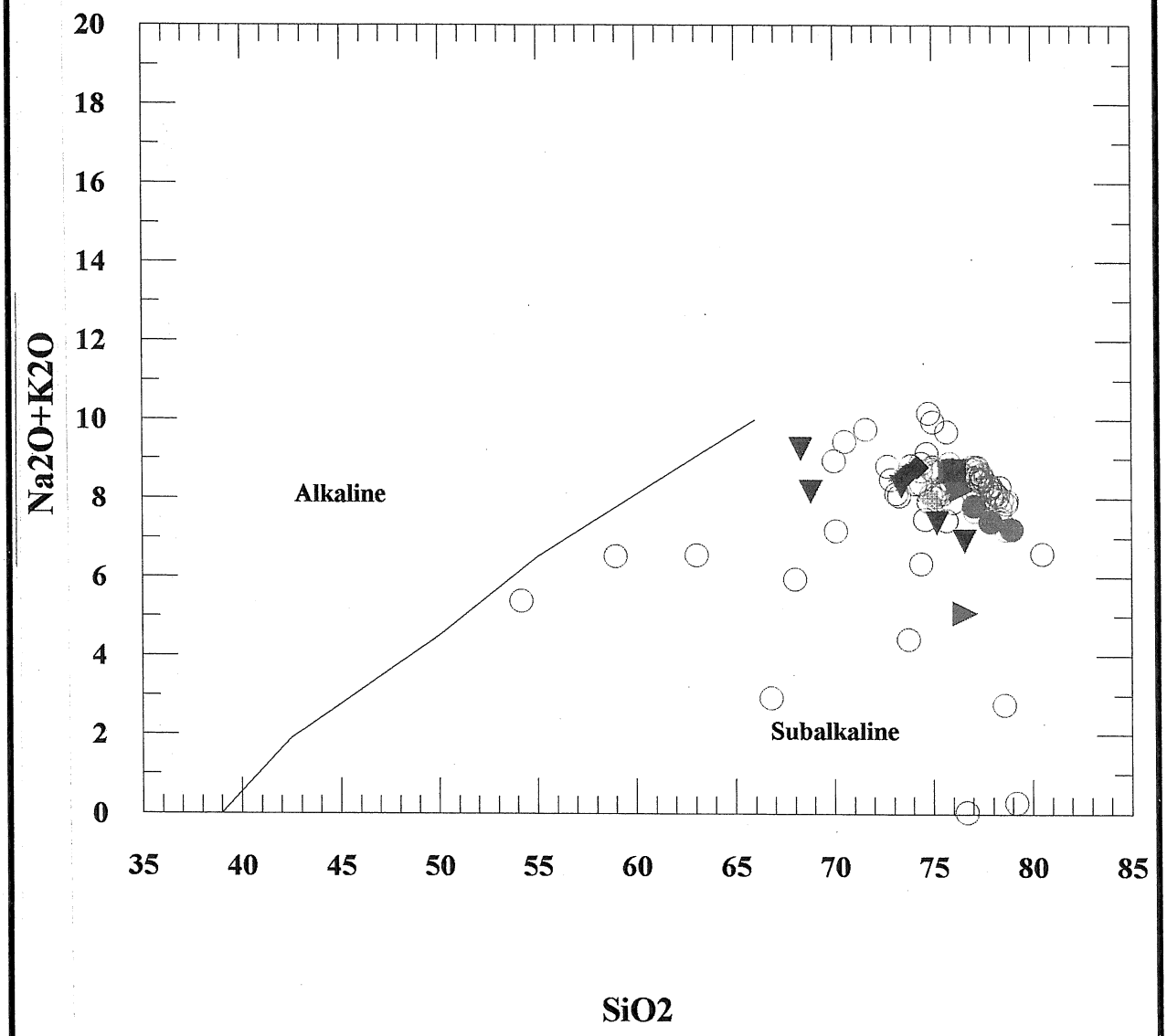
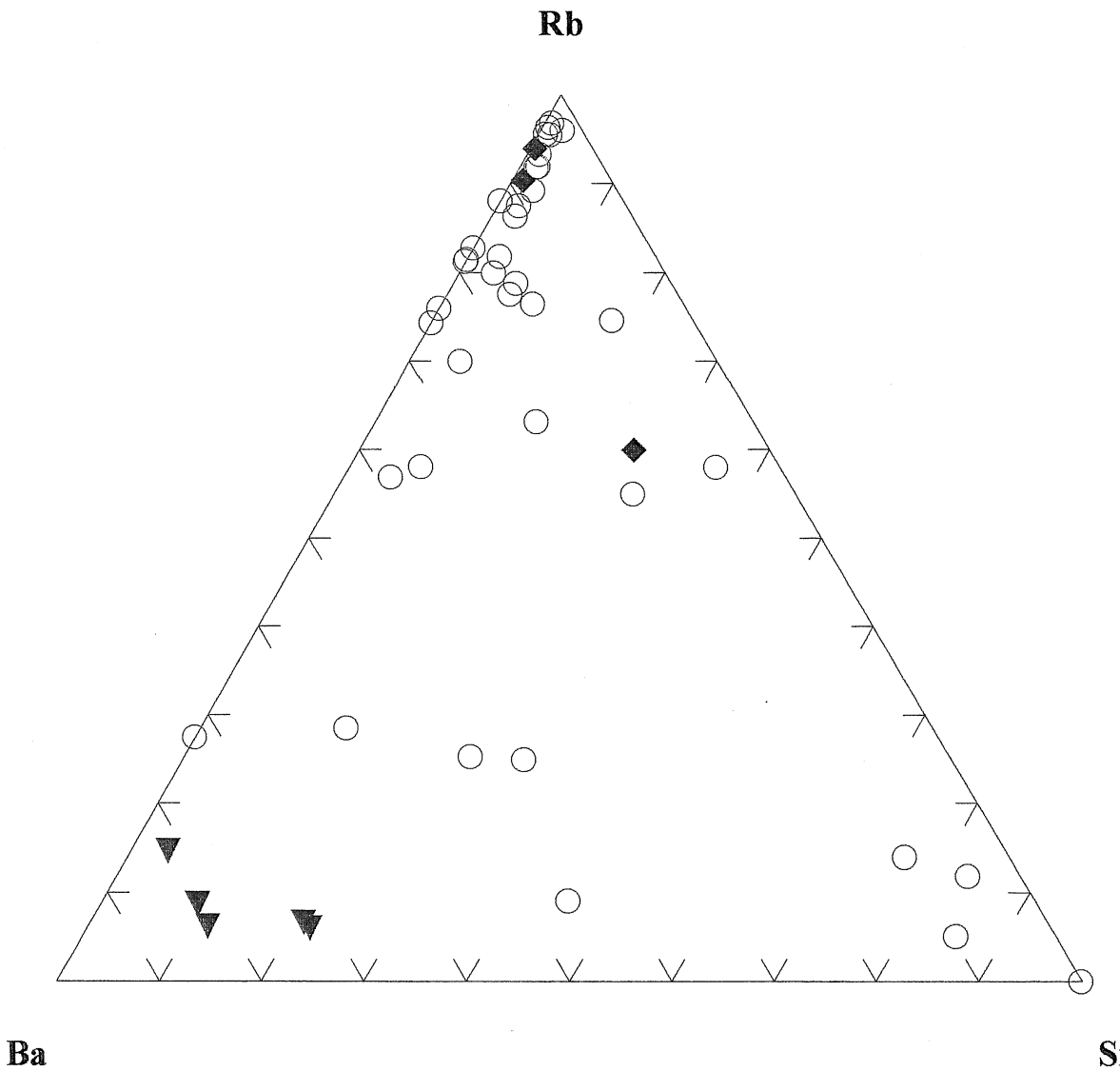


Figure 2.14 A Scatter Plot of Niobium Versus Yttrium.



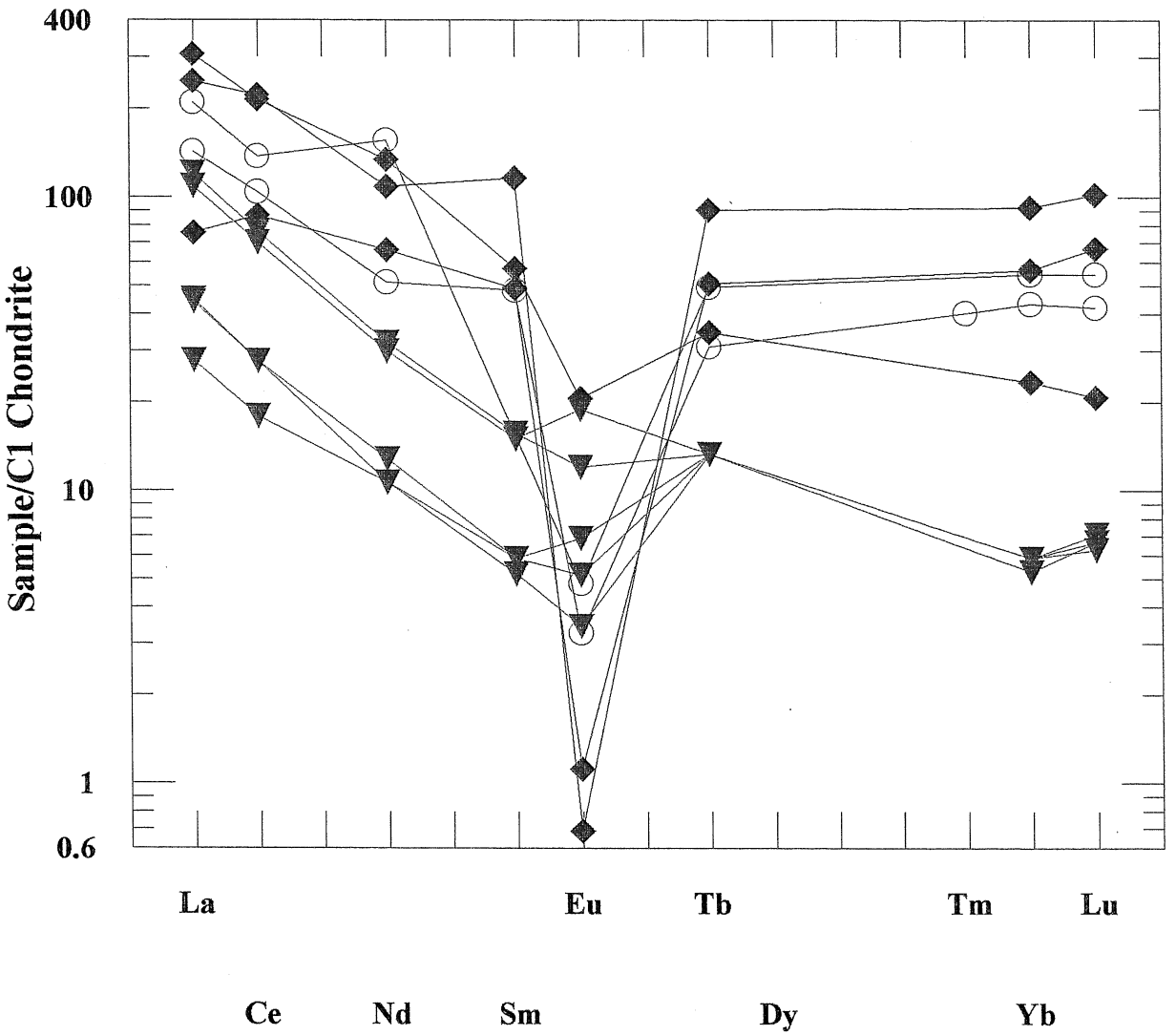
The line between alkaline and subalkaline is from Irvine and Baragar (1971). Red circles represent data from Cuchillo Mountains, Sierra County (Goerold 1981), blue diamonds from Spur Mountain, Utah (Rubin et al. 1987; Price et al. 1990), open red circles from Taylor Creek District, Sierra County (Lufkin 1972; Correa 1981; Duffield and Ruiz 1992; Duffield and Dalyrymple 1990), gray triangles from Iron Mountain, Sierra County (Woodard 1982), green triangles on the side from Thompson Mountain (Christiansen et al. 1986), green squares from Wah Wah Mountains, Utah (Christiansen et al. 1986), and purple triangles from drill holes from southern Otero Platform, McGregor Range (Appendix 5). The rhyolites from the southern Otero Platform (McGregor Range) have similar major element chemistry as topaz-rhyolites from Utah and New Mexico.

Figure 2.15 A Scatter Plot of Total Alkali Elements ($Na_2O + K_2O$) Versus SiO_2 for Various Topaz-Rhyolites.



Purple triangles from drill holes from southern Otero Platform, McGregor Range (Appendix 5), open circles from Taylor Creek District, Sierra County (Lufkin 1972; Correa 1981; Duffield and Ruiz 1992; Duffield and Dalyrymple 1990), and blue diamonds from Spur Mountain, Utah (Christiansen et al. 1984). Note that the McGregor Range rhyolites contain more barium and strontium and less rubidium than topaz-bearing rhyolites.

Figure 2.16 A Rubidium-Barium-Strontium Plot of Various Topaz-Rhyolites.



Open red circles are from Taylor Creek District (Duffield and Dalyrymple 1990), blue diamonds are from Spur Mountain, Utah (Christiansen et al. 1984), and purple triangles are from drill holes from southern Otero Platform, McGregor Range (Appendix 5). Note the depleted europium anomaly found in topaz-rhyolites, whereas the McGregor Range rhyolites do not have as large a europium anomaly.

Figure 2.17 Chondite-Normalized Rare-Earth Element Compositions of Rhyolite from the McGregor Range.

Table 2.7 Age Dates of Igneous Rocks Within and Adjacent to the McGregor Range.

Name	Age Ma[1]	References
Sacramento Mountains		
Oliver Lee camptonite	44.01 ± 0.01 ($^{40}Ar/^{39}Ar$, hornblende)	NMBMMR Geochron Laboratory in this report
Diorite sill	45.3 ± 2.2 (K/Ar)	Asquith (1974)
Jarilla Mountains (Orogrande)		
Granodiorite/quartz diorite	48.3 ± 1.8 (K/Ar, biotite)	Beane et al. (1975)
Latite porphyry (altered)	42.6 ± 2.2 (K/Ar, hornblende)	Kelley and Chapin (1997)
Copper skarn	42.8 ± 1.6 (K/Ar, phlogopite)	Unpublished 1979 report by R.K. Andrews, J.J. Lyons, and M.P. Martineau
Cornudas Mountains		
Alamo Mountain	36.8 ± 0.6 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Cornudas Mountain	34.6 ± 1.5 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Wind Mountain	36.32 ± 0.15 ($^{40}Ar/^{39}Ar$, hornblende)	NMBMMR Geochron Laboratory in this report
Deer Mountain (Little Wind Mountain)	33.0 ± 1.4 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Unnamed hill	36.8 ± 0.6 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Hueco Mountains, Texas		
Cerro Alto	34.3 ± 0.5 (K/Ar on biotite)	Barker et al. (1977)
Hueco Tanks	32.3 (K/Ar, feldspar)	Henry et al. (1986)
Mayfield Valley syenite (Cerro Diablo)	34.9 ± 0.6 to 36.1 ± 0.6 (K/Ar, biotite)	Barker et al. (1977), Henry et al. (1986)
Marble Canyon syenite (Apache Peak)	37.4 ± 1.5	Barker et al. (1977), Henry et al. (1986) Sharp (1979)
Hueco Mountains, New Mexico		
Red Hills syenite	34.48 ± 0.38 ($^{40}Ar/^{39}Ar$, biotite)	NMBMMR Geochron Laboratory in this report
Trachyte sill	34.67 ± 0.21 ($^{40}Ar/^{39}Ar$, biotite, hornblende)	NMBMMR Geochron Laboratory in this report
Eastern Three Buttes	36.7 ± 9.31 ($^{40}Ar/^{39}Ar$, plagioclase)	NMBMMR Geochron Laboratory in this report

[1] Ma = million years before present. All age dates have been corrected using decay constants of Steiger and Jager (1977).

2.2 REGIONAL STRUCTURE

The McGregor Range and adjacent areas lie along the southeastern part of the RGR of the Basin and Range province and encompass six major tectonic elements: the Tularosa Basin, Otero Platform, Sacramento uplift, Hueco uplift, Pedernal uplift, and Orogrande Basin. The steep western escarpment of the Sacramento and Guadalupe Mountains marks the eastern boundary of the RGR in this part of New Mexico (Pray 1961; Chapin 1971; Cordell 1978; Keller and Cather 1994; Nutt et al. 1997). The Tularosa Basin, Otero Platform, Sacramento uplift, and Hueco uplift (refer to Figure 2.18) have geomorphic expression and are principally Tertiary in age. These areas are discussed in detail in the following sections. The Pedernal uplift and Orogrande Basin are buried tectonic elements of late Paleozoic age that have no geomorphic expression in the McGregor Range area. The Pedernal uplift and Orogrande Basin overlap the later Tertiary-age tectonic elements. Paleocene to Eocene Laramide deformation in the region resulted in the formation of west-northwest-trending uplifts and northeast vergent reverse faults (Seager et al. 1986).

2.2.1 Tularosa Basin

The Tularosa Basin is a north/south-trending block of downdropped crust that is present along the western side of the McGregor Range (refer to Figure 2.18; King and Harder 1985). The Tularosa Basin extends southward into Texas where it is referred to as the Hueco Basin. It is formed by asymmetric, west-tilted grabens related to the RGR (Mattick 1967; Seager 1980; Adams and Keller 1994; Collins and Raney 1994). Healy et al. (1978), Woodward et al. (1978), Seager (1980), Henry and Gluck (1981), King and Harder (1985), and Adams and Keller (1994) indicate that the basin is formed by a complex set of north/south-elongated fault blocks whose edges are mostly parallel to the mountain ranges and uplifts that bound the basin on its east and west sides. Numerous step faults and intrabasinal uplifts are present within the basin. The Tularosa Basin is Tertiary in age. Tertiary and Quaternary sands and gravels that fill the basin attain a maximum thickness of 9,000 ft in the deepest parts of the basin (Mattick 1967; Healy et al. 1978).

2.2.2 Otero Platform

The Otero Platform occupies most of the area encompassed by the McGregor Range (refer to Figure 2.18). The Otero Platform is a broad uplifted area bordered on the west by the Tularosa Basin, on the southwest by the Hueco uplift, on the east by the Salt Basin graben, and on the north by the Sacramento uplift. To the south in Texas, the Otero Platform is referred to as the Diablo Platform. On the surface, the Otero Platform appears to have a relatively simple structure. The Permian-age Hueco, Abo, Yeso, and San Andres Formations crop out at the surface or are locally covered by a thin veneer of Holocene sediments. At the surface, the most prominent structural features are north- to northwest-trending anticlines and synclines mapped by Black (1973, 1976) on the part of the Otero Platform east of the McGregor Range. Unmapped folds and minor faults were observed within the McGregor Range during field reconnaissance for this project, but remain unmapped. Geologic mapping on that part of the Otero Platform that is within the eastern part of the McGregor Range is reconnaissance in nature (Dane and Bachman 1958, 1965). The reconnaissance nature of the available maps probably contributes to the simple picture of the geologic structure of this area. Maps of the western part of the Otero Platform are somewhat less generalized (Seager et al. 1987), but are still reconnaissance in nature.

The subsurface of the Otero Platform is known to be more complex than the surface and conceals several large structures. The southern terminus of the north/south-trending late Paleozoic Pedernal uplift is buried

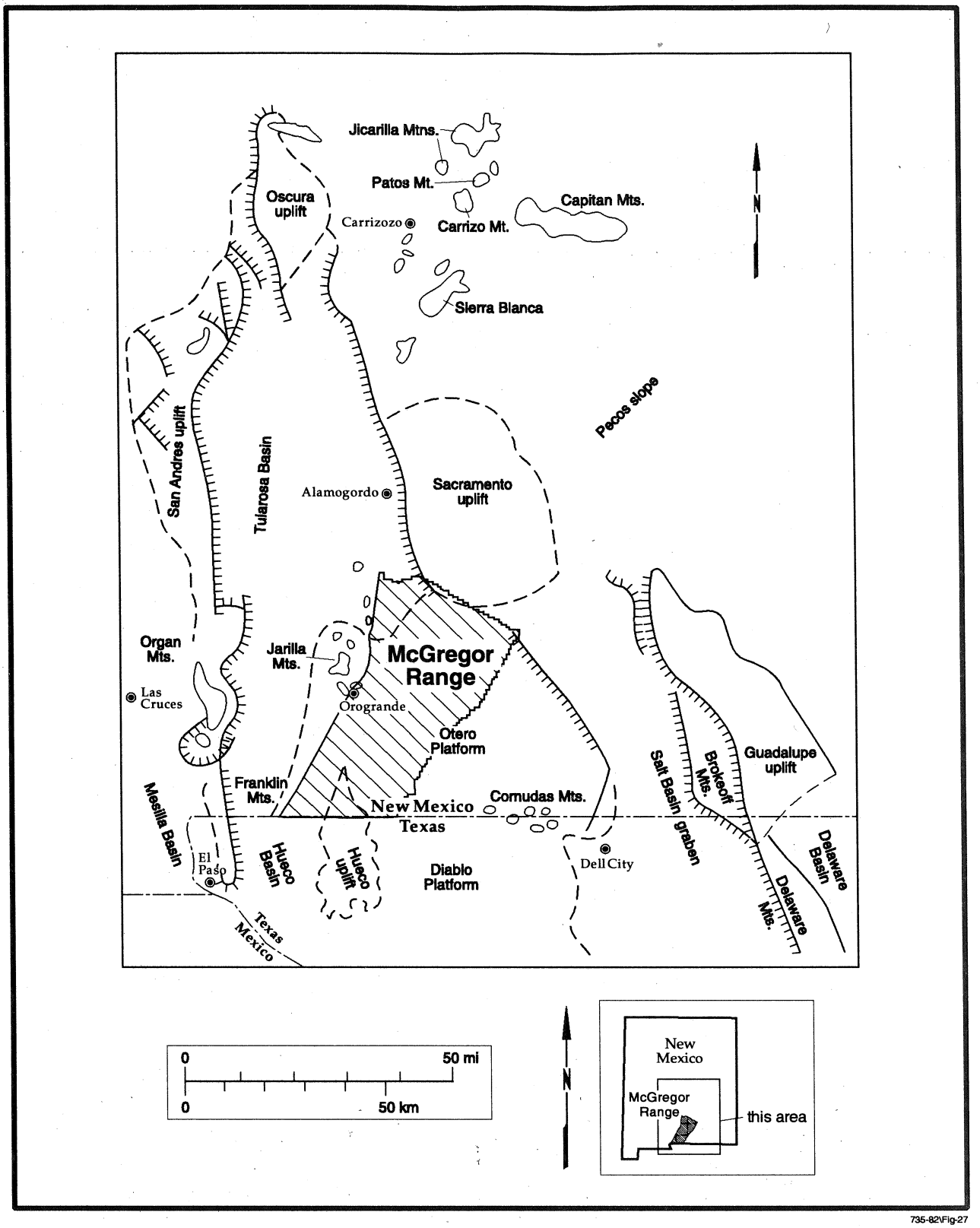


Figure 2.18 Present-day Tectonic Elements on the McGregor Range and Adjacent Areas.

beneath Middle and Upper Permian strata underneath the eastern part of the Otero Platform. The Orogrande Basin was a structurally low area during the late Paleozoic and bordered the Pedernal uplift on the west (Kottlowski 1960b). The Orogrande Basin was the locus of Pennsylvanian and Early Permian deposition.

The Jarilla Mountains are located on the northwestern part of the Otero Platform (refer to Figure 2.18). Igneous intrusions are exposed in the Jarilla Mountains (Bloom 1975; Dane and Bachman 1958; Seager et al. 1987). Paleozoic strata dip away from these intrusions.

2.2.3 Hueco Uplift

The Hueco uplift occupies the southwest part of the McGregor Range and extends south into Texas. It is the present-day site of the Hueco Mountains. It is formed by uplifted Paleozoic strata that have been intruded by Tertiary igneous rocks. Topographic relief relative to adjacent parts of the Otero Platform is approximately 800 ft. Although the present-day Hueco Mountains were formed during the Tertiary, a pronounced angular unconformity between Pennsylvanian and Permian strata indicates that the area was a tectonic uplift during the late Paleozoic as well (King et al. 1945).

2.2.4 Sacramento Uplift

The southern part of the Sacramento uplift is present in the northernmost part of the McGregor Range. It is bounded on the south by the Otero Platform and on the west by the Tularosa Basin. The Sacramento uplift was formed as a discrete structural element primarily during the Tertiary (Pray 1961). Topographic relief relative to the Tularosa Basin to the west is more than 4,500 ft. A pronounced angular unconformity between Pennsylvanian and Permian strata indicate that the area was a tectonic uplift during the late Paleozoic (Pray 1961).

The geologic structure of the McGregor Range and adjacent areas is portrayed by a structure contour map of the top of the Pennsylvanian System (refer to Figure 2.19) and a structure contour map of the top of the Fusselman Formation (refer to Figure 2.20). These structure contour maps were made by combining elevations of formation tops in wells with geological features portrayed on the geologic maps described above and with geophysical features from the regional aeromagnetic map (refer to Figure 2.21), as well as the regional gravity map (refer to Figure 2.22) and the gravity surveys of Healy et al. (1978).

2.3 REGIONAL GEOPHYSICS

2.3.1 Aeromagnetic and Gravity Data

Aeromagnetic and gravity data were evaluated in conjunction with geological, geochemical, and aerial gamma-ray data to assess the mineral resource potential of the McGregor Range. Aeromagnetic and gravity data can define margins of near-subsurface intrusions and major fault systems beneath sedimentary cover that may be related to areas of mineralization and/or hydrothermal alteration. Magnetic anomalies are typically caused by small differences in magnetic susceptibility (relative magnetite content) of mostly igneous rocks or by differences in depth to crystalline basement. Gravity anomalies reflect differences in density contrast among igneous, sedimentary, and metamorphic rocks. These data are reconnaissance in nature and are useful to define only regional features.

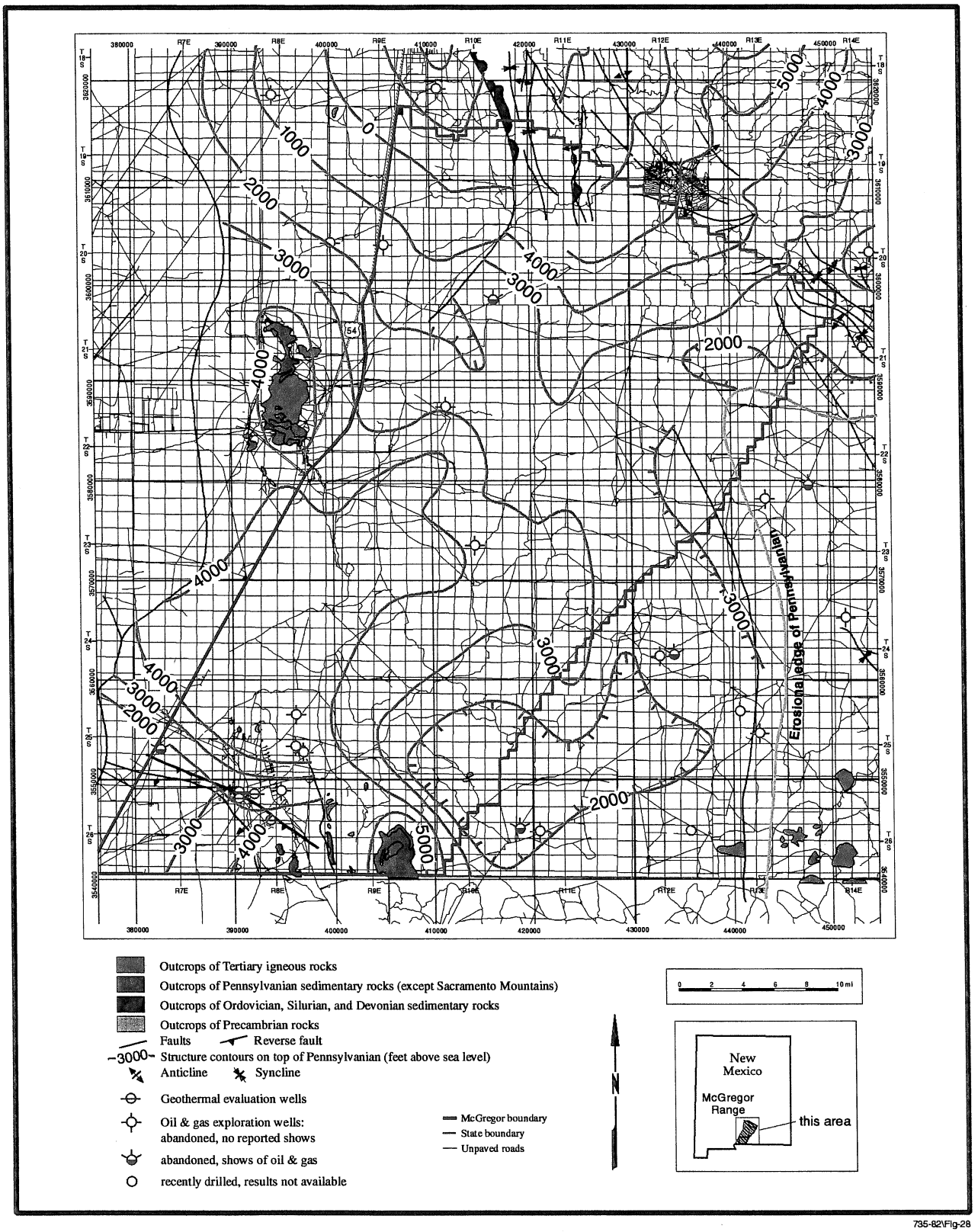


Figure 2.19 Structure Contours on Top of Pennsylvanian Rocks on McGregor Range and Adjacent Areas.

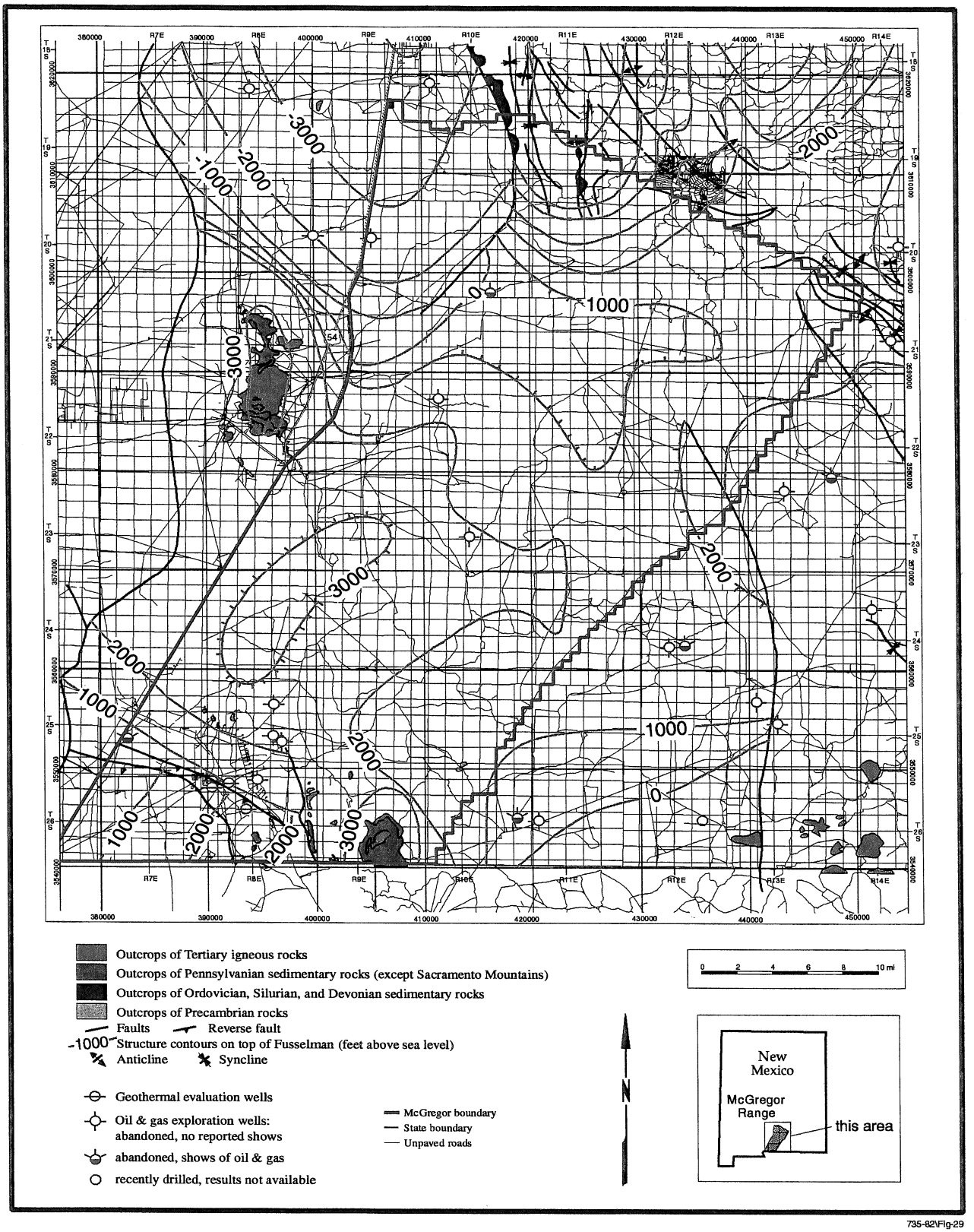


Figure 2.20 Structure Contours on Top of Fusselman Formation (Silurian) on the McGregor Range and Adjacent Areas.

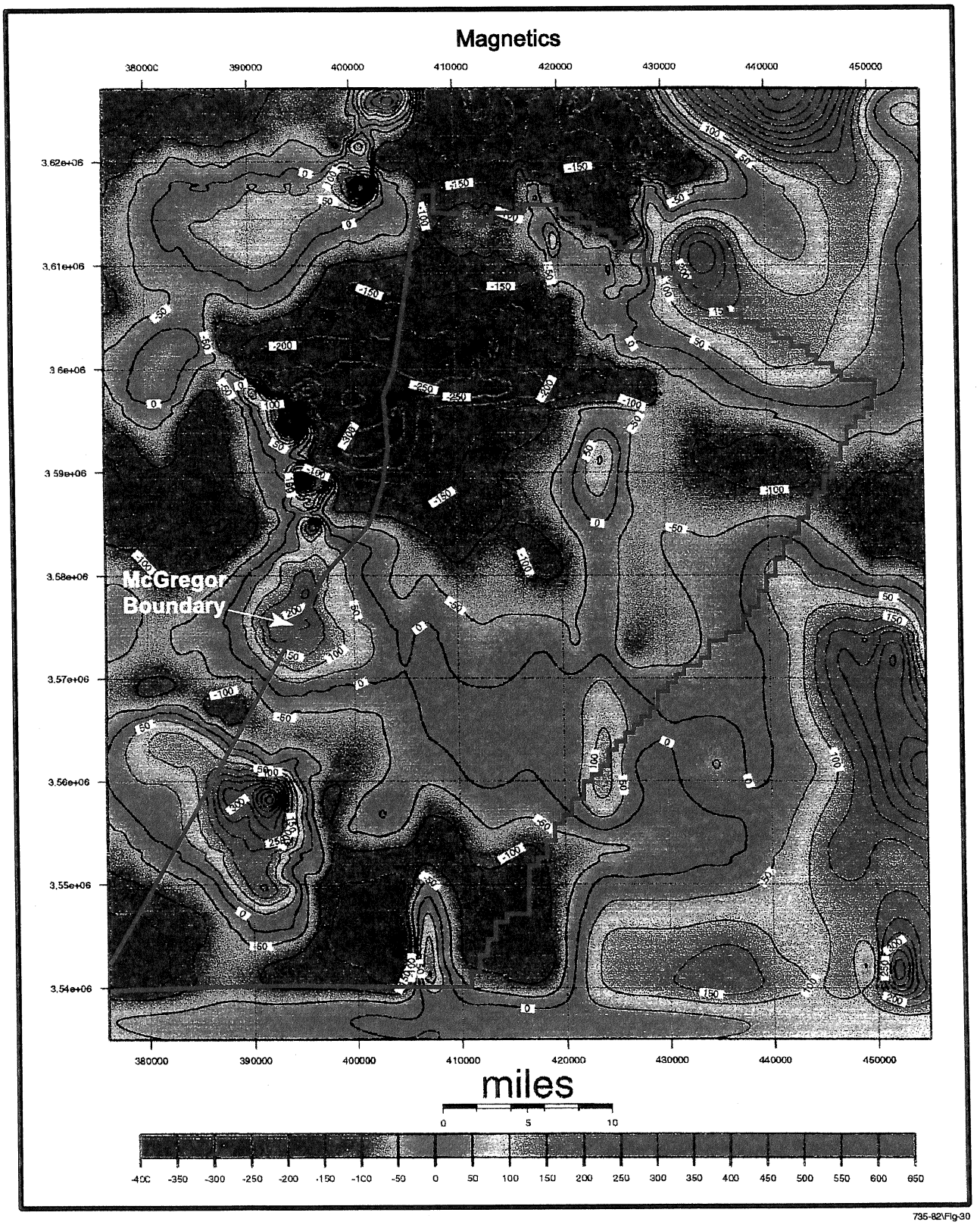


Figure 2.21 Aeromagnetic Map of the McGregor Range.

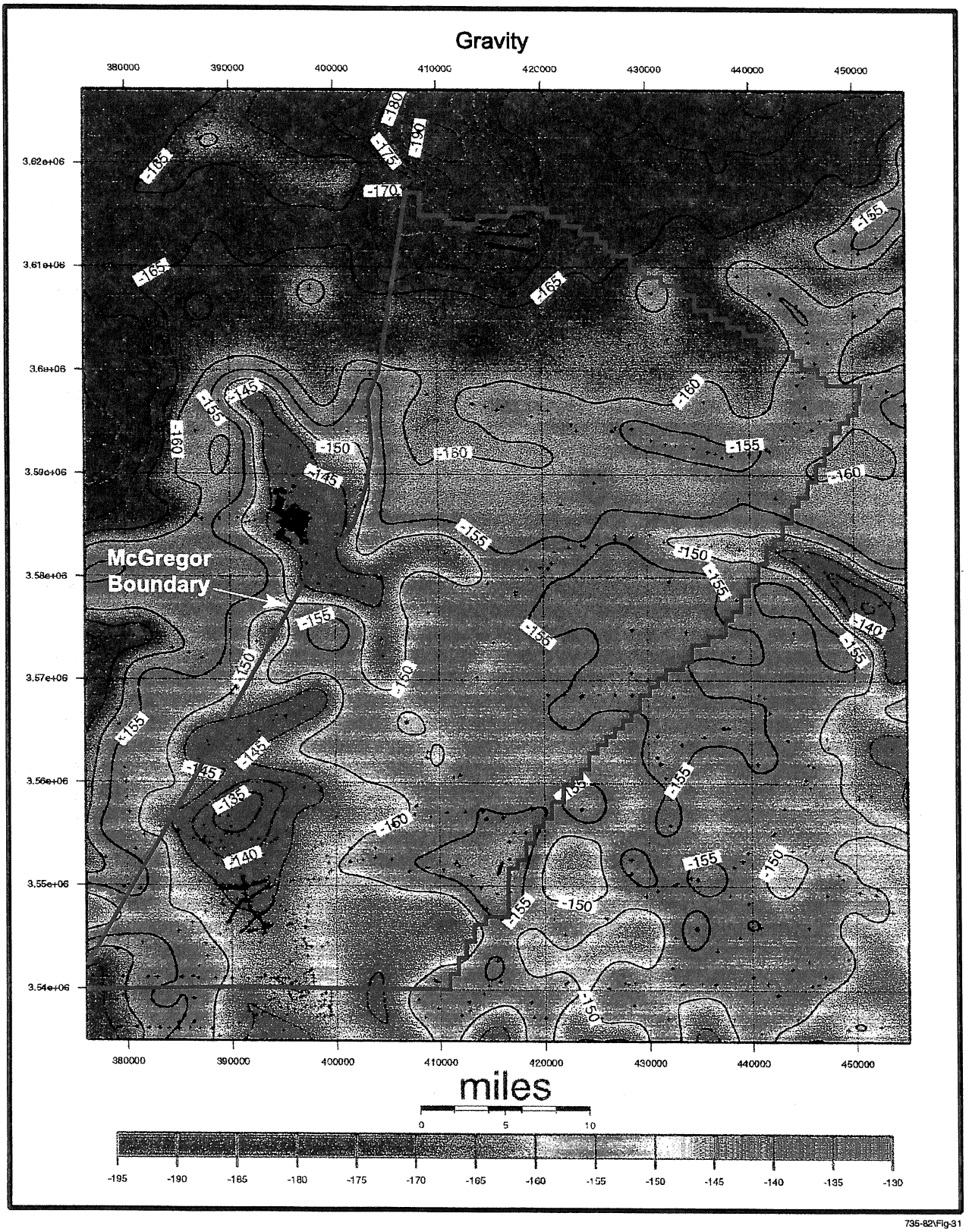


Figure 2.22 Gravity Map of the McGregor Range.

The gravity and aeromagnetic data used in this study are a result of a long-standing cooperative effort between USGS and the University of Texas at El Paso (UTEP). The aeromagnetic data are from Cordell (1984). The original data are from surveys that were flown at a variety of elevations. Cordell (1984) combined these data to produce the highest resolution possible. The aeromagnetic data that were gathered as part of the NURE program were used where more detailed data were not available. The combined data were then gridded using the minimum curvature technique and released to the public through the National Geophysical Data Center. Since no newer data have been collected in the study area, the grid produced by Cordell (1984) was contoured to produce the maps presented in Figures 2.21 and 2.22. The index of data sources and methods of combining surveys is included in Cordell (1984).

Gravity anomalies are calculated to predict the value of the gravity field at a particular place on the earth. The difference between the predicted and observed values is called an anomaly. This procedure yields anomalies that are primarily due to density variations in the rocks that make up the upper crust. The UTEP group has collected new gravity measurements in the study area. These data were added to the database complied by Keller and Cordell (1984) and were also gridded using the minimum curvature technique (refer to Figure 2.22). The gravity data reductions were standardized for the production of Bouguer anomaly values and were documented by Cordell et al. (1982). A sea datum and a Bouguer reduction density of 2.67 gm/cc were employed. The maps presented in this study were produced using a public domain software package called Generic Mapping Tools (Wessel and Smith 1991).

The predominant feature in the McGregor Range is a large oblong gravity and magnetic high that trends north/south along the western margin of the McGregor Range and corresponds to the Tularosa Basin boundary (refer to Figure 2.18). This zone may reflect a zone of crustal weakness that accommodated igneous intrusions. To the north, these geophysical anomalies coincide with outcrops of Tertiary intrusions in the Jarilla Mountains that are related to mineralization in the Orogrande District. The gravity and magnetic anomalies define a greater subsurface extent of the igneous intrusions beyond mapped exposures in the McGregor Range (refer to Figures 2.21 and 2.22). The gravity and magnetic anomalies at Orogrande are typical for igneous intrusions, which in this case are mineralized. The southern Hueco Mountains are also probably underlain by more extensive igneous intrusions as evidenced by slight gravity and magnetic highs. Two magnetic anomalies occur along the eastern border of the McGregor Range and are consistent with a buried igneous intrusion, but not enough information is available to be certain. There are other igneous intrusions in the Tularosa Basin and on the Otero Platform, but the lack of significant gravity and magnetic anomalies in the study area east of Orogrande suggest that no large intrusions are present at shallow enough depths for them to be economic targets for mineral exploration.

When looking at the Tularosa Basin and Otero Platform in a regional context, the gravity and magnetic anomalies indicate the presence of a structurally high block (horst) which extends along most of the central part of the basin. Thus, the Tularosa Basin is deepest west of the study area (refer to Figure 2.18). The Otero Platform has a structural high near its western edge (the Orogrande structure) and has a relatively shallow eastern section that is terminated by the Hueco and Sacramento Mountains. There is also a series of gravity and magnetic highs extending along the eastern edge of the maps, east of the McGregor Range outside the study area. The highs correlate with a structural high where Precambrian basement rocks are shallow (Otero-Diablo Platform; refer to Figure 2.18) and coincide with a zone of outcropping igneous intrusions in the Cornudas Mountains (Nutt et al. 1997).

2.3.2 Aerial Gamma-Ray Data

Aerial gamma-ray data can delineate zones of hydrothermal alteration and define major fault systems. Aerial gamma-ray data were evaluated in conjunction with geological, geochemical, and other geophysical data for the mineral resource potential of the McGregor Range. These data were acquired as part of the NURE program from surveys flown at 400 ft above ground level at flight lines spaced 2-6 mi apart with north/south tie lines spaced 12-15 mi apart. The NURE gamma-ray surveys included measurements of the gamma-ray flux produced by the radioactive decay of K^{40} and by members of the radioactive decay series of U^{238} and Th^{232}. Published maps by Duval (1988) and U.S. Department of Energy (1981a, 1981b) were used for this report. Only the eastern portion of the McGregor Range covered by the Carlsbad 1° by 2° quadrangle was flown. The western portion of the range covered by the Las Cruces 1° by 2° quadrangle was not flown (U.S. Department of Energy 1981a, 1981b); no data are available for this area.

The most radioactive rocks in the Carlsbad portion of the McGregor Range are Tertiary igneous rocks in the Hueco Mountains (approximately 2 ppm eU). Sedimentary rocks of the Abo tongue (Hueco Formation) in the Martin Canyon area and Quaternary alluvial deposits derived from these units also are slightly radioactive (approximately 1-5 ppm eU) (U.S. Department of Energy 1981a, 1981b; Duvall 1988). However, both of these areas contain less radioactive rocks as compared to igneous rocks in the Cornudas Mountains to the east (approximately 4 ppm eU).

2.4 REGIONAL REMOTE SENSING

Remote sensing data are based on bulk physical and chemical properties of exposed rocks, soils, and vegetation and can define differences in vegetation cover, major lineaments, tectonic structural features, regional lithology or soil types, and intersections of major fault systems. Remote sensing data can also define major lithologic boundaries and areas of hydrothermal alteration, including iron staining, clay alteration, and silicification. Landsat TM imagery data for the McGregor Range were evaluated in conjunction with geological, geochemical, and geophysical data to provide regional definition of structural lineations, areas of hydrothermal alteration, and possible mineral resource areas. These data were presented in TM images and were obtained from Earth Data Analysis Center in Albuquerque, New Mexico. Seven wavelength bands were available: Band 1 corresponds to visible blue, band 2 corresponds to visible green, band 3 corresponds to visible red, band 4 corresponds to near infrared, bands 5 and 7 correspond to mid-infrared, and band 6 corresponds to the thermal variation. Bands 3, 4, 5, and 7 are typically related to geological features. Computer enhancements, statistical calculations, and various combinations of different wavelength bands were employed to provide anomalies that may be related to geologic features.

Several TM images were compiled for this project. The plot combining bands 4, 6, and 7 emphasizes burned areas (bright colors) and the blue coloration represents mesquite. The Abo red beds are shown in bright red to maroon. The plot combining bands 4, 5, and 6 emphasizes vegetation. The plot combining bands 2, 4, and 5 emphasizes the natural color; local linear features are visible on this plot. TM data can be statistically enhanced using principle component analyses (PCA) statistics. The resulting PCA map enhances the clay and iron alteration and sand dunes. The Abo red beds are emphasized. The hydrothermal alteration in the center of the Orogrande map is represented by a green-blue. These maps, at 1:100,000 scale, are available for review at NMBMMR.

From all of these various plots, an interpretative map was produced (refer to Figure 2.23). The sandy soils covering the basin floor in much of the McGregor Range are represented by the purple color. Higher

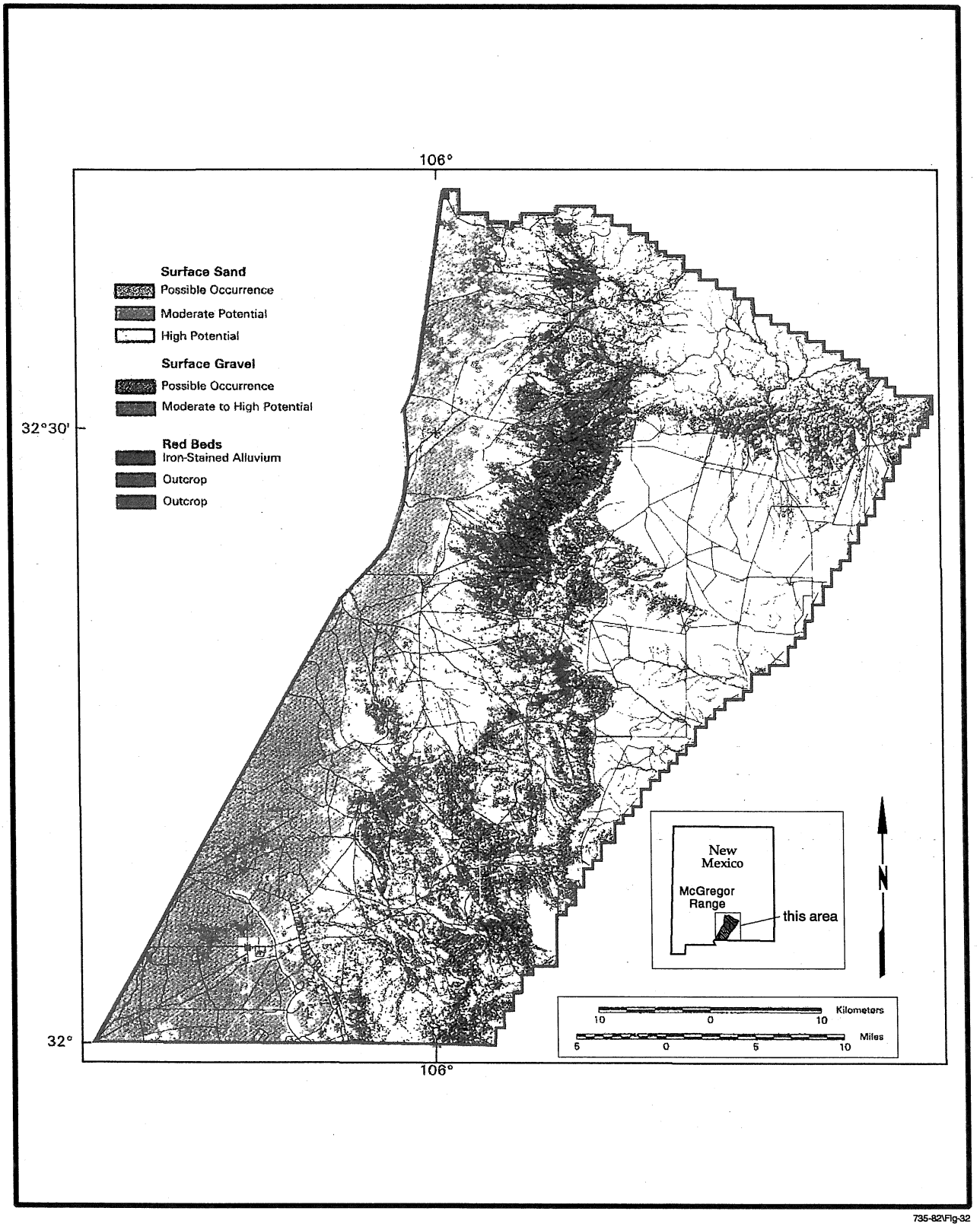


Figure 2.23 Interpretive Map from Landsat TM Image Data for the McGregor Range.

reflective areas form brown to bright areas surrounded by the purple representing the sandy soils. The gray is predominantly limestone gravel, whereas the orange-brown is primarily mixed gravels. The lower Abo red beds are represented in bright red, and the upper Abo and Yeso units are represented by lighter red. The Abo red beds are host rocks for sedimentary copper deposits in the Sacramento Mining District.

2.5 REGIONAL GEOCHEMISTRY

2.5.1 Anomaly Definition

The purpose of a regional geochemical sampling program is to detect areas of abnormal chemical patterns, or geochemical anomalies. An empirical, rather than a statistical, approach was used to define anomalous element concentrations. Cumulative frequency plots were constructed for selected elements of economic interest to show the general distribution and range of the data. Thresholds (Sinclair 1991) for anomalous concentrations in the data were chosen from these plots where gaps or breaks in slopes occurred. The threshold values were then compared to concentrations of lithologic characterization rocks and to terrestrial abundances (Greenwood and Earnshaw 1986) and adjusted if necessary. Single point anomalies are difficult to interpret geologically because they could represent analytical error, sample inhomogenities, or contamination of a particular site. Therefore, only groups of closely spaced anomalous samples were interpreted.

A strong anomaly may be interpreted as: 1) a large area of low-grade mineralization, 2) swarms of small deposits of high-grade material, 3) small deposits of weakly mineralized, but highly fractured, rock that is easily eroded and leached, 4) one or more large mineral deposits, or 5) rocks enriched in certain elements. Furthermore, the absence of an anomaly does not completely exclude the possibility that a mineral deposit may be present within a drainage. The inability to identify an anomaly may be due to nonexposure and/or erosion of the mineralized material, dilution of the eroded mineralized material once it is released in the drainage, or chemical or physical precipitation of the mineralized material elsewhere in the drainage.

2.5.2 Geochemical Characterization Sampling Program

The purpose of the geochemical characterization sampling program was to establish baseline geochemical data to evaluate the regional geochemical data. Samples of the major lithologic units were collected and analyzed for major and trace elements. The geochemical analyses are presented in Appendix 5 and summarized in Table 2.8, and sample locations are shown in Figures 1.3-1.13. Mineralogy of selected samples is included in Appendix 4, and petrographic descriptions are presented in Appendix 7. Average terrestrial abundances from Greenwood and Earnshaw (1986) are included for comparison to values obtained from samples collected from the McGregor Range.

Most of the rocks collected from the McGregor Range were similar in concentration to average terrestrial abundance, with a few exceptions (refer to Table 2.8). Average lithologies from the McGregor Range were higher in concentration than average terrestrial abundance in tungsten, arsenic, and boron (except for limestone and rhyolite). Barium concentrations in syenite, rhyolite, and quartz monzonite were higher than average terrestrial abundance. Samples from the McGregor Range were lower in concentration in cobalt, chromium, copper, nickel, and vanadium than average terrestrial abundance. Most of the arkosic sandstones from the Sacramento District (sedimentary copper deposits) in the Sacramento Mountains north of the McGregor Range (Wilhelm 1983) contained more sodium, barium, and lead than the sandstones in the McGregor Range.

Table 2.8 Summary of the Geochemical Characterization Data of Samples Collected from the McGregor Range.[1]

Elements	Mean Chert (3)[2]	Mean Limestone[3] (17)[2]	Mean Shale (14)[2]	Mean Sandstone (7)[2]	Mean Syenite (9)[2]	Mean Rhyolite (6)[2]	Mean Quartz Monzonite (5)[2]	Mean of All Samples[4] (61)[2]	Terrestrial Abundance
Major (%)									
SiO_2	76.37	6.00	48.8	51.9	62.6	72.8	62.5	68.0	58.3
Al_2O_3	0.85	0.45	11.1	5.3	17.1	14.1	15.5	8.4	15.7
CaO	7.99	46.7	11.6	15.8	1.86	0.96	4.00	18.8	8.7
MgO	4.09	4.57	4.69	4.7	0.6	0.24	1.58	3.4	4.6
Na_2O	0.03	0.10	0.41	0.2	5.8	3.14	4.02	2.0	3.1
K_2O	0.26	0.07	2.85	1.6	5.3	4.9	3.69	2.5	2.2
Fe_2O_3[5]	0.42	0.41	3.97	1.9	3.2	1.01	4.35	2.5	8.9
MnO	0.01	0.03	0.04	0.02	0.1	0.06	0.08	0.06	0.1
TiO_2	0.05	0.03	0.62	0.3	0.8	0.12	0.5	0.42	1.1
P_2O_5	0.11	0.07	0.16	0.05	0.3	0.03	0.21	0.16	0.3
LOI	10.1	41.6	15.9	18.6	1.5	2	3.36	17.7	--
S	0.19	0.03	0.35	0.03	0.01	0.03	0.01	0.1	0.03
Trace (ppm)									
Ag	<0.5	<0.5	<0.5-0.6	<0.5	<0.5-2.2	<0.5	<0.5	<0.5	0.08
As	4	2	8	10	4	8	2	6	1.8
Au	3	5	4	2	3	9	3	4	4
B	20	<10	94	48	20	<10	10	64	9
Ba	50	<50-520	224	287	975	1,433	1,560	617	390
Be	<1	<1	3	<1	6	2	3	3	2
Bi	<3	<3	<3-6	<5	6	<5	<5	<5	0.008
Br	3	3	4	4	2	1	2	3	2.5
Ce	23	12	55	26	154	25	76	54	66
Co	14	3	10	7	9	26	15	12	29
Cr	18	9	79	23	11	3	17	31	122
Cs	2	1	10	2	1	2	3	6	2.6
Cu	2	1	22	30	3	3	5	17	68
Eu	0.3	0.3	0.9	0.7	2	0.6	1	0.9	2.1
Hf	1	<1	5	5	15	4	7	7	2.8
La	5.2	4	28	13	79	16	39	23	35
Lu	0.12	0.1	0.3	0.2	0.6	0.2	0.3	0.3	--
Mo	2	3	7	3	2	2	3	3	1.2
Nb	10	19	18	15	76	13	16	25	20
Nd	10	10	25	13	61	9	29	26	40
Ni	8	3	36	9	4	4	4	20	99
Pb	5	<2-15	17.5	8	44	19	16	19	13
Rb	19	<10-38	124	45	131	156	124	88	78
Sb	0.4	<0.2-0.7	1	0.5	0.3	1	1	0.8	0.2
Sc	1.7	<0.5-1.9	10.6	3	3	1	6	6	25
Sm	0.8	0.7	5	3	11	1	5	4	7
Sr	45	733	279	147	353	241	788	413	384
Ta	<1	<1	<1-1	<1	5	1	1	2	1.7
Tb	<0.5	<0.5	0.8	0.7	1	<0.5	0.4	1	1.2
Th	1	<1-1	9	3	17	7	11	8	8.1
U	2	3	6	2	4	4	3	4	2.3
V	10	<10-10	113	27	23	<10	74	68	136
W	142	13	16	39	74	182	111	61	1.2
Y	10	16	31	19	53	17	33	27	31
Yb	0.7	0.49	2	1	4	1	2	2	3.1
Zn	28	13	80	20	68	23	39	45	76
Zr	60	14	158	151	590	105	210	223	162

1 Analyses of major elements are in percent (%) and trace elements are in parts per million (ppm) with the exception of Au, which is in parts per billion (ppb). Terrestrial abundance is from Greenwood and Earnshaw (1986) for comparison. A list of chemical symbols and their definitions is presented at the beginning of this document.

2 ( ) = Number of samples.

3 Sample JB-IMO26 was not included in this summary.

4 Five samples, JB-IMO26, JB-IMO21, IS, ORO720, and High 10, were not included in this summary.

5 Fe_2O_3 is total iron calculated as Fe_2O_3.

2.5.3 National Uranium Resource Evaluation (NURE) Data

Geochemical data collected as part of the NURE program for detailed uranium exploration were examined for this study (Union Carbide Corp. 1981a, 1981b). Data were primarily for stream sediment samples collected within the Carlsbad and Las Cruces 1° by 2° quadrangles.

Approximately 300 stream sediment samples were collected within the McGregor Range. Less than 50 water samples from or adjacent to the McGregor Range were collected and analyzed for the NURE project. Only stream sediment data were evaluated for this project. The stream sediment samples were analyzed by Oak Ridge National Laboratory by plasma source emission spectrometry using partial extraction techniques (Arendt et al. 1979). Since the focus of the NURE program was to assess potential uranium resources, samples were not routinely analyzed for most pathfinder elements required for precious and base metals exploration. Therefore, the NURE data have limited value in the McGregor Range mineral and energy resource assessment.

The NURE data are presented in Appendix 9 and summarized in Table 2.9, and sample locations are shown on Figure 2.24. None of the NURE samples collected within the McGregor Range contained detectable silver or molybdenum. Also note that copper, cobalt, chromium, beryllium, yttrium, zircon, and nickel concentrations of sediments from the McGregor Range are below average terrestrial abundance.

2.5.4 Stream Sediment Sampling Program

The geochemical analyses of the stream sediment samples collected from the McGregor Range are presented in Appendix 5, summarized in Table 2.10, and the locations are shown on Figures 1.3-1.13. Note that all stream sediment samples from the McGregor Range were lower in concentration in cobalt, chromium, nickel, and vanadium than average terrestrial abundance (refer to Table 2.10).

Anomalous lead concentrations were found near U.S. Highway 54 that could be a result of automobile exhaust fumes. Anomalous copper concentrations are found south of Orogrande that could be related to the abandoned copper smelter at Orogrande. Anomalous lead, thorium, niobium, calcium, lithium, cerium, manganese, tungsten, barium, vanadium, zinc, SiO_2, yttrium, and nickel concentrations were found in stream sediments from the Martin-Hay Meadow Canyons area of Otero Mesa. Anomalous lead, cerium, lanthanum, iron, copper, calcium, tungsten, barium, vanadium, zinc, arsenic, SiO_2, and yttrium concentrations were found in stream sediments from the Hueco Mountains. Anomalous thorium, niobium, cerium, iron, copper, manganese, tungsten, barium, vanadium, zinc, arsenic, SiO_2, yttrium, and nickel concentrations were found in stream sediments south of Orogrande. Anomalous nickel concentrations were found in Negro Ed Canyon in the Sacramento Mountains that is probably related to Proterozoic gabbro.

2.5.5 Interpretation of the Stream Sediment Surveys

The NURE dataset cannot be combined with the McGregor Range dataset because of different size fractions analyzed and different analytical techniques used in the two surveys. However, each element from each dataset was plotted on the same element maps, using different colors for the NURE and McGregor Range data. Anomaly threshold areas were determined from each dataset separately as described in Section 2.5.1 using threshold values shown on Tables 2.9 and 2.10 and were differentiated on the various element maps (e.g., Figure 2.25).

Table 2.9 Summary of the NURE Geochemical Data.[1]

Trace Element (ppm)	Maximum	Minimum	Mean	Standard Deviation	Anomaly Threshold	Terrestrial Abundance
Ag	<2	<2	nc[2]	nc[2]	na[3]	0.08
Al	61,900	13,800	43,292	6,950	na[3]	8,300
B	56	<10	15	9	na[3]	9
Ba	932	242	506	82	610	390
Be	2	<1	1	nc[2]	na[3]	2
Ca	159,500	3,400	38,073	27,700	na[3]	46,600
Ce	100	11	41	10	60	66
Co	16	<4	3	2	7	29
Cr	45	6	22	5	32	122
Cu	66	3	14	7	25	68
Fe	81,500	6,800	17,774	6,200	25,000	62,000
Hf	58	<15	nc[2]	nc[2]	na[3]	2.8
K	22,700	7,300	14,504	2,780	na[3]	18,400
La	40	6	19	4	27	35
Li	43	5	20	5	31	18
Mg	21,600	1,400	5,511	2,980	na[3]	27,640
Mn	1,050	98	284	90	450	1,060
Mo	<4	<4	nc[2]	nc[2]	na[3]	1.2
Na	13,900	2,200	7,761	2,030	na[3]	22,700
Nb	40	<4	10	3	15	20
Ni	32	3	11	4	17	99
P	751	78	287	135	na[3]	1,120
Pb	169	<10	13	14	45	13
Sc	7	1	4	0.9	na[3]	25
Sr	785	108	194	63	na[3]	384
Th	14	<2	5	3	12	8.1
Ti	12,271	676	2,444	883	4,000	6,320
U	4.5	0	2.3	0.5	3	2.3
V	211	14	45	17	80	136
Y	17	4	10	2	13	31
Zn	131	13	43	12	65	76
Zr	124	13	58	12	na[3]	162

[1] Source (Union Carbide Corp. 1981a, 1981b). Terrestrial abundance is from Greenwood and Earnshaw (1986) for comparison. Anomaly threshold values are determined for selected elements of economic interest. Number of samples used to calculate the statistics was 334.

[2] nc = not calculated.

[3] na = not available.

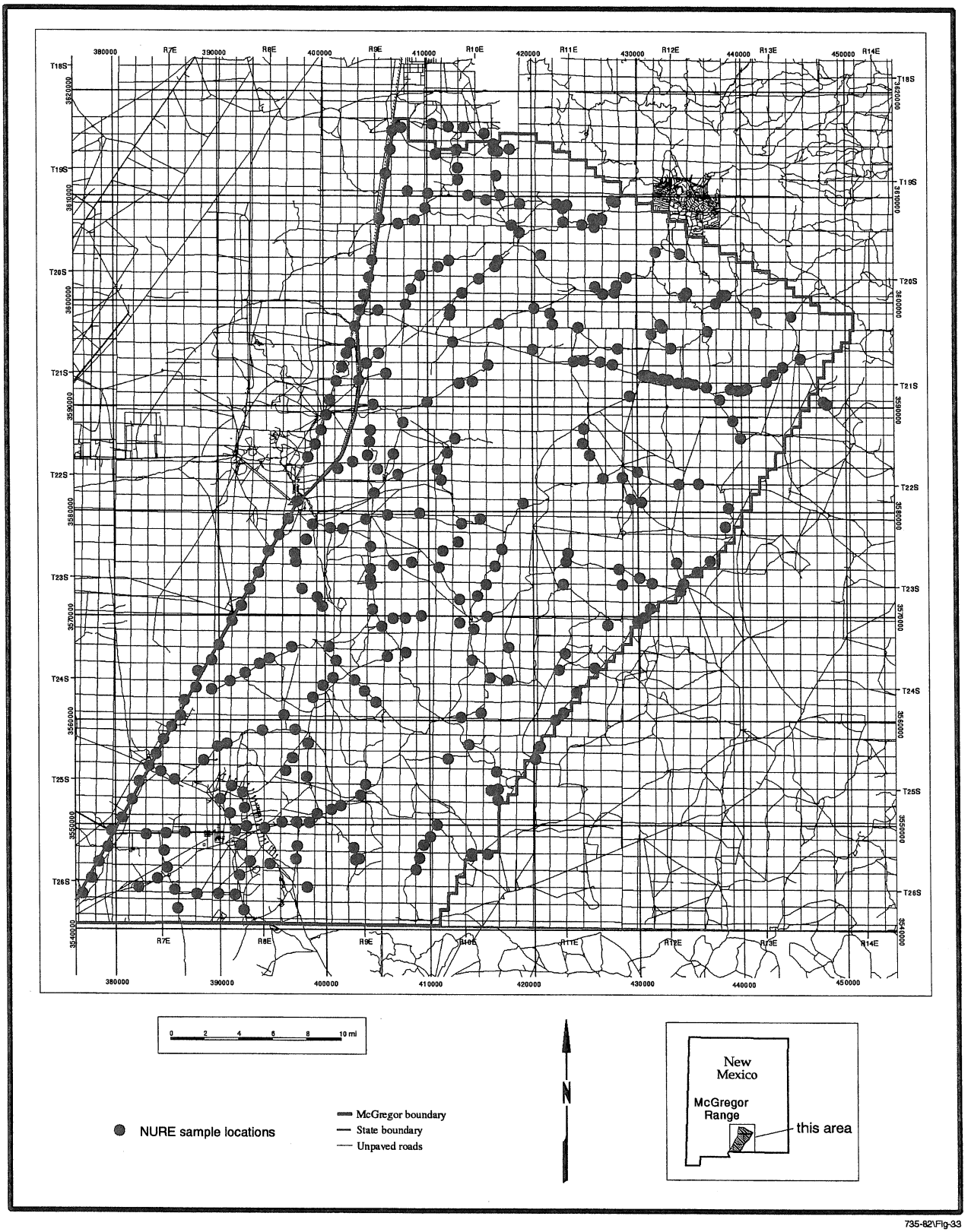


Figure 2.24 Map of NURE Sample Locations on the McGregor Range.

Table 2.10 Summary of the Geochemical Data of Stream Sediment Samples Collected from the McGregor Range.[1]

Major (%)	Maximum	Minimum	Mean	Standard Deviation	Anomaly Threshold	Terrestrial Abundance
SiO_2	80.6	8.14	33.24	16	45.0	58.3
Al_2O_3	14.0	0.83	5.05	3	na[4]	15.7
CaO	50.3	1.79	29.84	12	32.0	8.7
MgO	5.96	0.26	1.54	1	na[4]	4.6
Na_2O	3.70	<0.01	0.66	0.7	na[4]	3.1
K_2O	3.37	0.11	1.26	0.8	na[4]	2.2
Fe_2O_3[2]	10.4	0.33	2.17	1.5	4.0	8.9
MnO	1.00	<0.01	0.06	0.1	0.1	0.1
TiO_2	0.90	<0.01	0.29	0.2	0.4	1.1
P_2O_5	0.24	<0.01	0.08	0.01	na[4]	0.3
LOI	40.0	3.25	25.93	9	na[4]	na[4]
S	0.07	<0.01	0.03	0.01	na[4]	0.03
Trace (ppm)						
Ag	1	<1	nc[3]	nc[3]	na[4]	0.08
As	100	<1	6	9	8	1.8
Au	26	<1	11	6	na[4]	4
B	70	<10	nc[3]	nc[3]	na[4]	9
Ba	961	20	306	222	600	390
Be	4	<1	1	0.7	na[4]	2
Bi	6	<5	nc[3]	nc[3]	na[4]	0.008
Br	16	1	6	2	na[4]	2.5
Cd	1	<1	nc[3]	nc[3]	na[4]	0.16
Ce	98	12	38	18	70	66
Co	20	1	6	3	na[4]	29
Cr	65	11	36	21	na[4]	122
Cs	7	<1	2	1	na[4]	2.6
Cu	234	<0.5	12	22	20	68
Eu	1.6	<0.2	0.7	0.3	na[4]	2.1
Hg	2	<1	nc[3]	nc[3]	na[4]	0.08
Hf	13	<1	5	3	na[4]	2.8
La	60	6.6	20.8	10	40	35
Lu	12	0.06	0.30	1	na[4]	nc[4]
Mo	6	<1	3	1	na[4]	1.2
Nb	350	<10	22	30	20	20
Nd	41	6	17	7	na[4]	40
Ni	23	3	8	4	15	99
Pb	52	<2	13	9	25	13
Pd	14	<1	nc[3]	nc[3]	na[4]	15
Pt	50	<10	nc[3]	nc[3]	na[4]	10
Rb	115	3	40	28	na[4]	78
Sb	10	<0.2	0.7	1	na[4]	0.2
Sc	11.3	0.7	3.4	2	na[4]	25
Sm	7.8	0.1	3.0	1	na[4]	7
Sr	1,060	150	395	179	na[4]	384

Table 2.10 (Continued)

Major (%)	Maximum	Minimum	Mean	Standard Deviation	Anomaly Threshold	Terrestrial Abundance
Ta	3	<1	1	0.4	na[4]	1.7
Tb	1.1	<0.5	0.9	0.2	na[4]	1.2
Th	12	1	5	3	8	8.1
U	6.7	0.9	2.6	0.7	3.5	2.3
V	90	<10	30	19	60	136
W	76	4	23	13	50	1.2
Y	50	8	23	8	34	31
Yb	0.4	4.1	1.4	0.7	na[4]	3.1
Zn	81	9.2	30	16	40	76
Zr	431	9	146	110	na[4]	162

[1] Analyses of major elements are in percent (%) and trace elements are in parts per million (ppm) with the exception of Au, Pt, and Pd, which are in parts per billion (ppb). Terrestrial abundance is from Greenwood and Earnshaw (1986) for comparison. Anomaly threshold values are determined for selected elements of economic interest. A list of chemical symbols and their definitions is presented at the beginning of this document. Number of samples used to calculate the statistics was 150.

[2] Fe_2O_3 is total iron calculated as Fe_2O_3.

[3] nc = not calculated.

[4] na = not available.

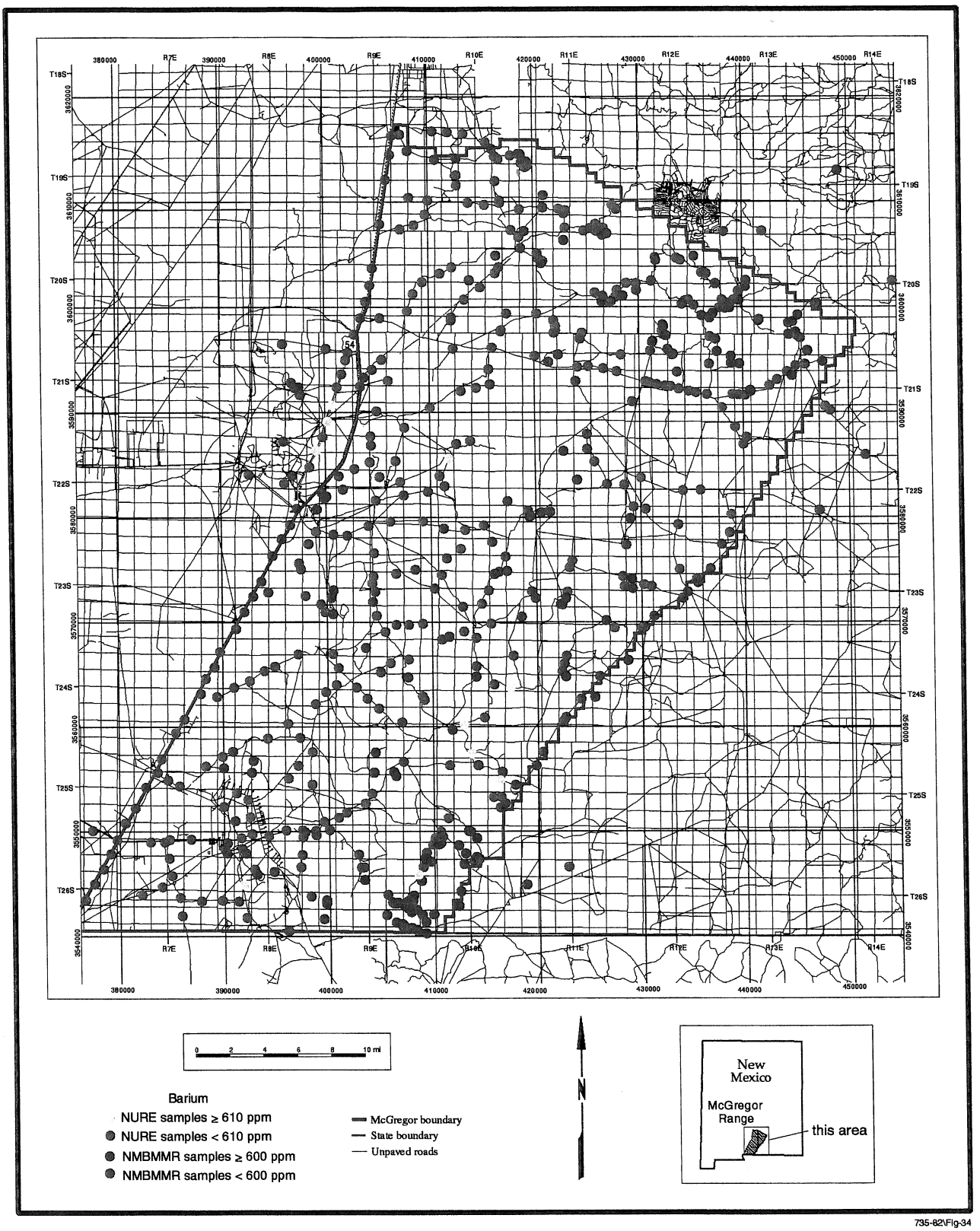


Figure 2.25 Geochemical Anomaly Map of Barium.

Stream sediment samples were collected in the Orogrande District to characterize the copper-gold skarns and stockwork vein deposits and to compare with areas in the McGregor Range. The stream sediment samples contained higher concentrations of copper, lead, zinc, arsenic, tungsten, thorium, niobium, lanthanum, cerium, iron, manganese, barium, vanadium, SiO_2, yttrium, and nickel than most samples from the McGregor Range (refer to Appendix 5). Stream sediment samples from this district contained the highest gold (26 ppb), copper (234 ppm), and tungsten (76 ppm) when compared to the other samples collected from the McGregor Range. Copper concentrations ranged from <6.5 to 234 ppm, gold from <1 to 26 ppb, arsenic from <1 to 100 ppm, tungsten from 4 to 76 ppm, lead from <2 to 52 ppm, and zinc from 9.2 to 81 ppm.

Two stream sediment samples were collected from the Sacramento (High Rolls) District, north of the McGregor Range (Samples VTM97-319S and VTM97-321S; refer to Appendix 5) and one from the Northern Franklin Mountains District (refer to Figure 2.26), west of the McGregor Range (Sample VTM97-268S) to characterize the mineralization in these two districts. Both districts are described in more detail in Section 3.3. The Sacramento District contains sedimentary copper deposits that also have produced significant amounts of lead. The stream sediment samples contained slightly higher concentrations of SiO_2, Fe_2O_3, TiO_2, beryllium, nickel, rubidium, thorium, yttrium, tungsten, zinc, lanthanum, and cerium and lower CaO than most samples collected from the McGregor Range. One stream sediment sample contained anomalously high barium (910 ppm), and the other sample contained anomalously high copper (49.4 ppm) compared to other samples from the McGregor Range (Appendix 5). The Northern Franklin Mountains District contains RGR barite-fluorite-galena deposits. The stream sediment sample from below the mine and prospects in the Northern Franklin Mountains District contained anomalously high concentrations of SiO_2, arsenic, barium, antimony, and zinc and low Fe_2O_3, CaO, and MnO compared to most stream sediment samples collected from the McGregor Range. In addition, this sample contained the highest concentrations of lead (52 ppm) and molybdenum (6 ppm) of all the stream sediment samples collected for this report.

Interpretation of the stream sediment data from the NURE survey and this project has identified distribution patterns of selected elements on a regional scale that may be related to locally anomalous areas of mineralization or to possible underlying structures that could serve as conduits for metal-bearing fluids. Seven areas within the McGregor Range have one or more geochemical anomalies: Red Hills area in the northern Hueco Mountains; Martin-Hay Meadow Canyons area of Otero Mesa; El Paso-Culp Canyons area of the Sacramento Mountains; Negro Ed Canyon area in the Sacramento Mountains; the southwestern McGregor Range area located along U.S. Highway 54 in the southwestern corner of the McGregor Range; central basin area south of Orogrande; and the Orogrande area southeast of Orogrande (refer to Figure 2.27).

Stream sediment samples from the Red Hills in the northern Hueco Mountains contained anomalous concentrations of lead, thorium, niobium, cerium, lanthanum, iron, copper, manganese, tungsten, barium, yttrium, vanadium, zinc, arsenic, and SiO_2. Stream sediment samples from the Martin-Hay Meadow Canyons area of the Otero Mesa contained anomalous concentrations of lead, thorium, niobium, calcium, lithium, cerium, iron, copper, manganese, tungsten, barium, vanadium, zinc, arsenic, SiO_2, yttrium, and nickel. One or more stream sediment samples from the El Paso-Culp Canyons area of the southern Sacramento Mountains contained anomalous concentrations of zinc, arsenic, calcium, tungsten, niobium, barium, and lithium. Stream sediment samples from Negro Ed Canyon in the Sacramento Mountains near the Proterozoic outcrops contained anomalous concentrations of nickel, yttrium, lithium, and calcium. Stream sediment samples from the central basin area south of Orogrande contained anomalous concentrations of manganese.

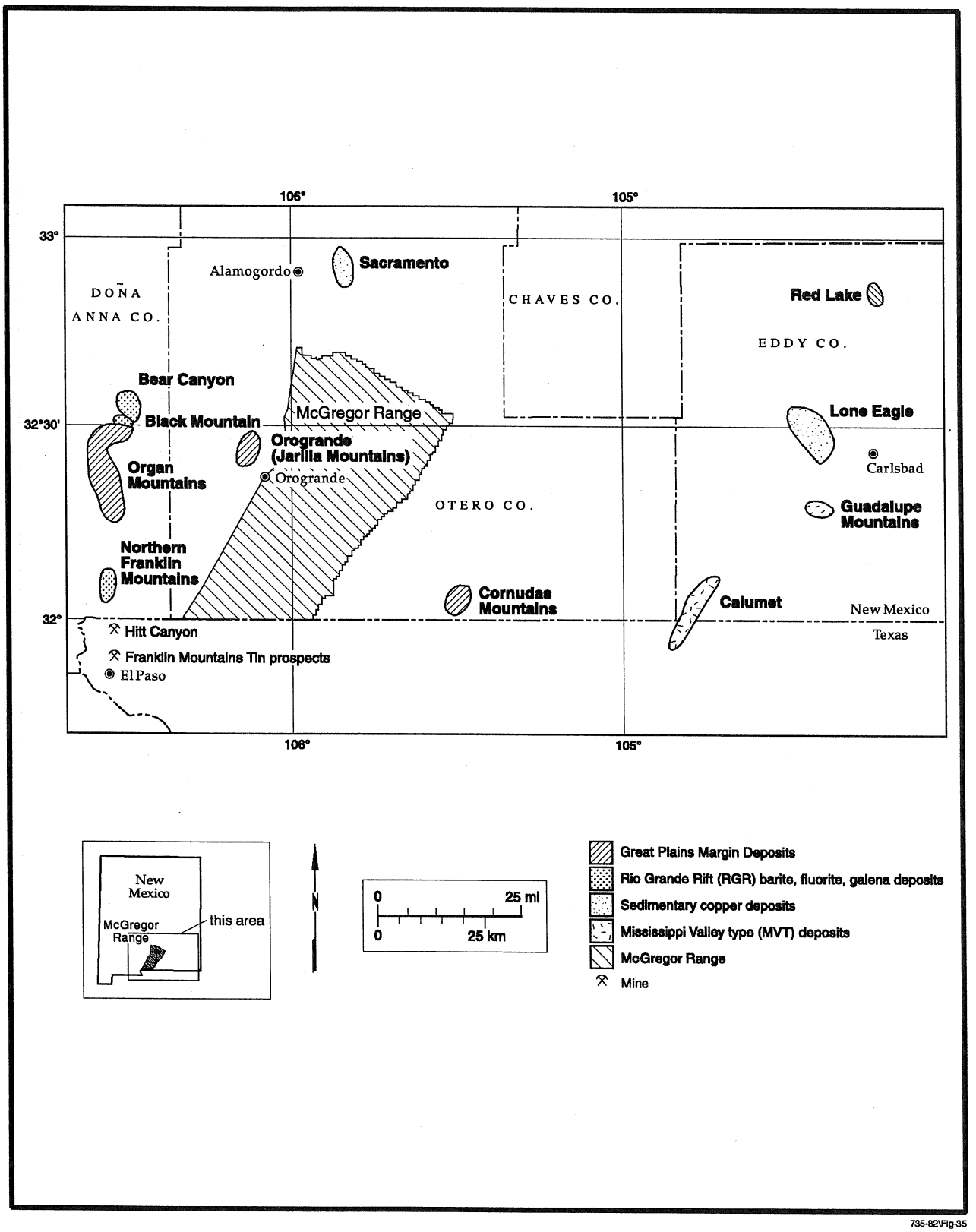


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Figure 2.26 Mining Districts Adjacent to the McGregor Range.

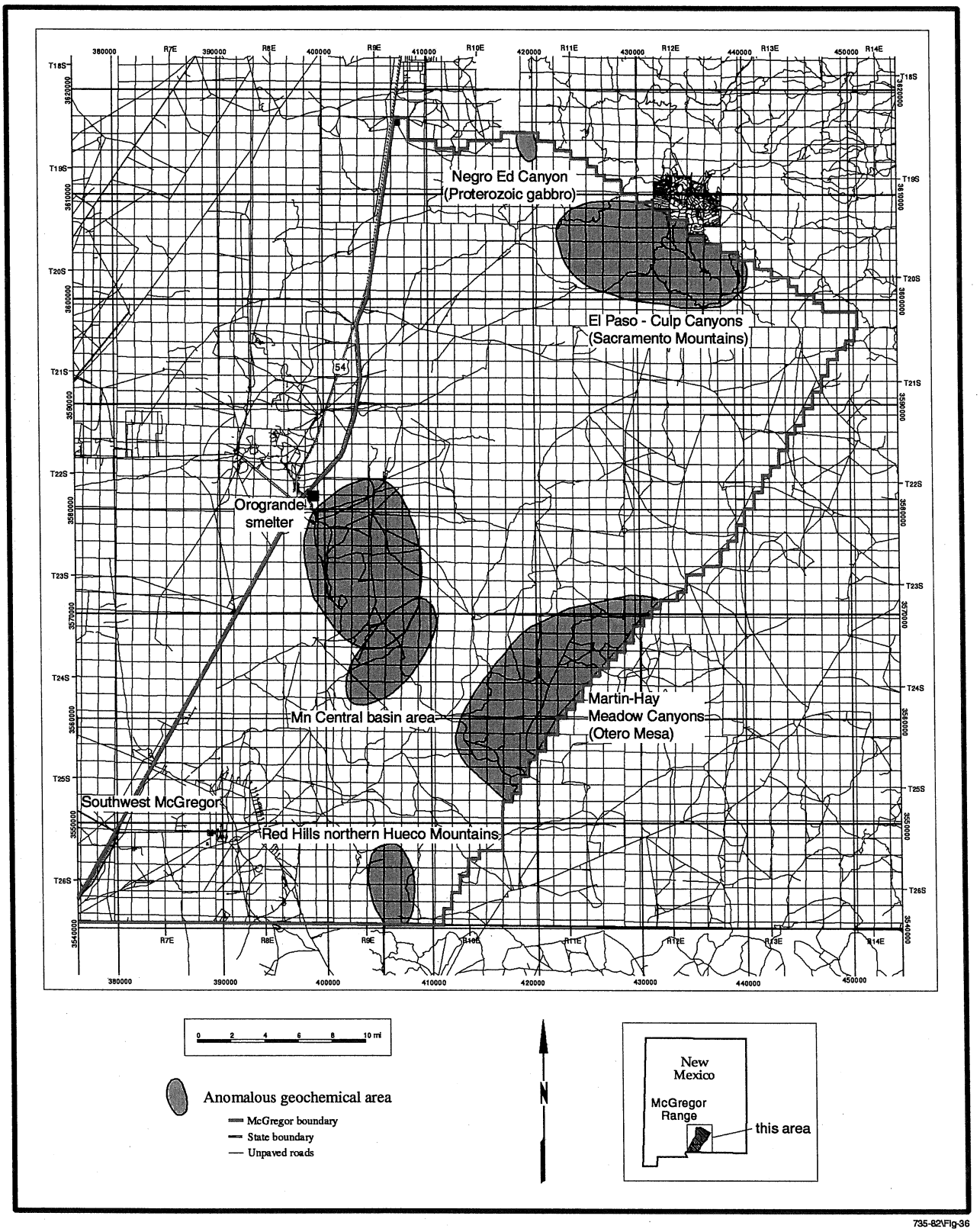

Figure 2.27 Areas on the McGregor Range with Anomalous Geochemical Samples.

Anomalous lead concentrations are found along U.S. Highway 54 southwest of the McGregor Range that could be a result of automobile fumes. There is no known geologic model that would account for anomalous lead concentrations in dune sands found in this area.

The Orogrande area within the McGregor Range exhibits anomalous copper concentrations in the stream sediment samples (refer to Figure 2.28). No other geochemical anomalies are observed in the characterization samples or stream sediment samples from this area. The most likely source for this copper anomaly is probably the abandoned copper smelter located in the northern part of the town of Orogrande. The prevailing wind in this area is from the west to northwest and would account for these geochemical anomalies. Another possibility for this copper anomaly would be contamination by the military, since this has been a historical ordnance impact area. This possibility is discounted because the anomaly extends near U.S. Highway 54, outside of the impact area, and other elements should be anomalously high if it were due to impact of military ordnance.

2.5.6 Heavy Mineral Concentrate Survey

Heavy mineral concentrate samples provide an enhancement of local geochemical anomalies. The heavy mineral concentrate samples generally represent less than 7% by weight of the total stream sediment sample (refer to Table 2.11). Most samples contained magnetite, hematite, quartz, calcite, and feldspar (refer to Table 2.12). Heavy mineral concentrate samples were analyzed by INAA in a separate batch from the corresponding stream sediment samples taken at the same localities.

There were no significant silver, cobalt, nickel, selenium, thorium, uranium, zinc, or REE anomalies in heavy mineral concentrate samples on the McGregor Range or adjacent areas (refer to Table 2.13 and Appendix 5). The only detectable gold values are from two samples collected within the Orogrande District; these two samples also exhibit high copper, molybdenum, and tungsten concentrations (refer to Samples VTM97-155C and VTM97-157C in Table 2.13). The sample collected from the Northern Franklin Mountains (Sample VTM97-269C) exhibited high barium, arsenic, molybdenum, and antimony values. Sample VTM97-322C collected from the Sacramento Mountains District exhibited high barium and copper concentrations.

With the exception of six samples, samples collected from the McGregor Range exhibited no significant geochemical anomalies. One heavy mineral concentrate sample from Culp Canyon in the southern Sacramento Mountains (Sample VTM97-88C in Table 2.13) contained high concentrations of arsenic, chromium, copper, and antimony and also contained the highest levels of arsenic, chromium, hafnium, antimony, scandium, thorium, uranium, and REE of all heavy mineral concentrate samples collected for this project. The stream sediment sample from this locality (Sample VTM97-87S; Appendix 5) contained high concentrations of SiO_2 and antimony and the highest arsenic of all stream sediment samples collected for this report. A float chip sample from the same locality contained elevated concentrations of arsenic, barium, antimony, and tungsten. Together these samples indicate potential jasperoids, possibly related to precious and/or base metals mineralization in the area.

A sample each from El Paso/Culp Canyons area, southern Sacramento Mountains (Sample VTM97-122C), and Tres Hermanos area (Sample VTM97-153C) west of the McGregor Range (refer to Figures 1.3-1.13) contained slightly elevated tungsten concentrations. The sample from the Tres Hermanos area contained a slightly anomalous copper value. The stream sediment sample from the same locality as Sample VTM97-122C contained a high concentration of CaO (Sample VTM97-121S). The

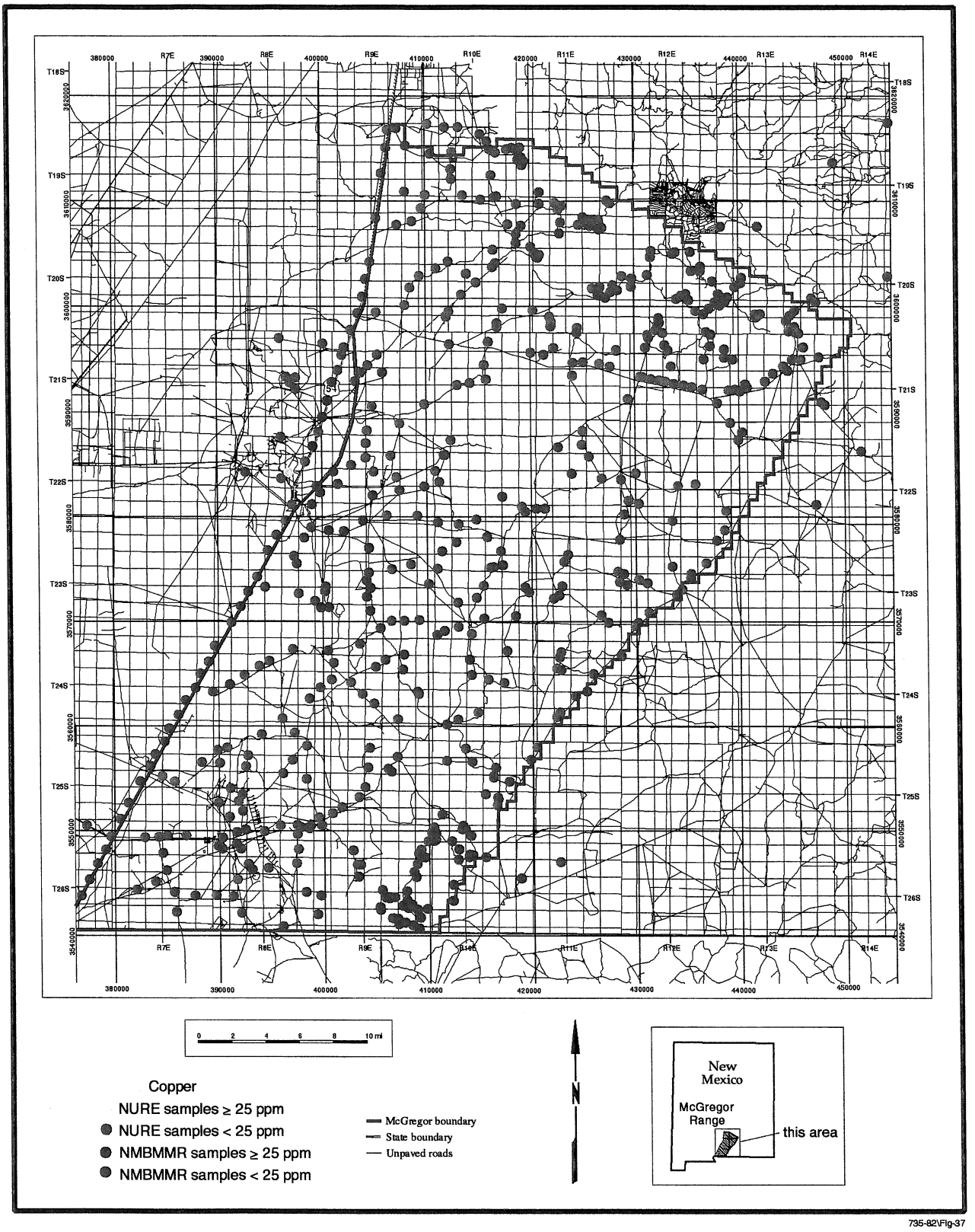

Figure 2.28 Geochemical Anomaly Map of Copper.

Table 2.11 Percent of Heavy Mineral Concentrate of Sand-Silt Samples.

Sample No.	Oversize (g, 1.88-4 mm)	Undersize (g, <1.88 mm)	Heavy Concentrate (g)	Heavy Mineral Concentrate (%)
VTM97-85C	1,541	1,973	226.2	6.4
VTM97-88C	1,444	4,488	136.6	2.3
VTM97-122C	2,416	2,636	80.3	1.6
VTM97-139C	834	4,216	268.8	5.3
VTM97-153C	2,168	2,642	89.8	1.9
VTM97-155C	1,297	3,192	300.4	6.7
VTM97-157C	1,823	3,320	307.3	6.0
VTM97-166C	1,910	1,854	25.3	0.7
VTM97-166C	4,265	4,522	197.9	2.2
VTM97-183C	2,738	3,390	186.7	3.0
VTM97-191C	3,155	1,880	111.3	2.2
VTM97-198C	2,744	3,356	147.7	2.4
VTM97-219C	3,224	2,954	269.6	4.4
VTM97-221C	3,237	3,311	182.7	2.8
VTM97-227C	3,085	2,582	131.2	2.3
VTM97-242C	3,560	3,094	102.7	1.5
VTM97-250C	2,237	3,360	352.8	5.9
VTM97-269C	777	3,760	150.4	3.2
VTM97-288C	660	4,385	254.4	4.8
VTM97-320C	1,962	5,145	388.3	5.2
VTM97-322C	1,836	7,010	416.9	4.5

sample from the same locality as Sample VTM97-153C contained high concentrations of SiO_2, Fe_2O_3, arsenic, and tungsten and 2 ppb gold (Sample VTM97-152S).

This suggests that mineralization similar to that at Orogrande could extend northward into the Tres Hermanos area.

Another sample from the Hueco Mountains (Sample VTM97-191C) contained high barium and molybdenum concentrations. The stream sediment sample from this locality contained high concentrations of CaO, niobium, and zinc (Sample VTM97-189S). The high calcium concentration suggests that these anomalies may be related to unknown RGR or carbonate-hosted lead-zinc deposits. One sample from the Hueco Mountains contained slightly anomalous concentration of copper (Sample VTM97-221C). An additional sample from Martin/Hay Meadow Canyons area contained anomalous concentrations of copper (Sample VTM97-166C) and could be indicative of sedimentary copper deposits.

Each mineral resource is discussed in more detail in Chapter 4.0.

Table 2.12 Mineralogy of Heavy Mineral Concentrate Samples.[1]

Sample No.	Major Minerals	Minor Minerals
VTM97-85C	Magnetite, hematite	Quartz, calcite, albite, K-feldspar, rock fragments
VTM97-88C	Magnetite, hematite, garnet	Quartz, rock fragments
VTM97-122C	Magnetite, garnet	Quartz, calcite, K-feldspar, rock fragments
VTM97-139C	Magnetite, andradite	Quartz, calcite, albite, microcline, rock fragments
VTM97-153C	Magnetite, garnet	Quartz, calcite, cuprite, K-feldspar, rock fragments
VTM97-155C	Magnetite, andradite, biotite	Quartz, albite, rock fragments
VTM97-157C	Magnetite, andradite	Quartz, albite
VTM97-166C	Magnetite, hematite	Quartz, calcite, plagioclase, K-feldspar, dolomite, rock fragments
VTM97-183C	Magnetite, hematite, garnet	Quartz, rock fragments K-feldspar, calcite
VTM97-191C	Magnetite	Calcite, quartz, K-feldspar, rock fragments
VTM97-198C	Magnetite, garnet	Quartz, calcite, albite, rock fragments
VTM97-219C	Magnetite, hematite, garnet	Quartz, calcite, K-feldspar
VTM97-221C	Magnetite, diopside, clinopyroxene, hematite, biotite	Quartz, calcite, albite, muscovite, K-feldspar, rock fragments
VTM97-227C	Magnetite, hematite	Quartz, calcite, albite, K-feldspar, cuprite
VTM97-242C	Magnetite, hematite, zircon	Quartz, calcite, K-feldspar, rock fragments
VTM97-250C	Magnetite, hematite, enstatite, garnet, biotite	Quartz, calcite, K-feldspar, muscovite
VTM97-269C	Magnetite, hematite, garnet	Quartz, calcite, K-feldspar, rock fragments, dolomite
VTM97-288C	Magnetite, hematite, garnet, enstatite	Quartz, calcite, rock fragments
VTM97-320C	Magnetite, hematite	Quartz, calcite, K-feldspar, rock fragments, dolomite
VTM97-322C	Magnetite, hematite	Quartz, calcite, K-feldspar, rock fragments, albite

[1] Analysis by x-ray diffraction and microscope examination.

Table 2.13 Chemical Analyses of Heavy Mineral Concentrate Samples.[1]

Sample No.	As (ppm)	Au (ppb)	Ba (ppm)	Ca (%)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Eu (ppm)	Fe (%)	Hf (ppm)	La (ppm)
Anomaly threshold	150	30	3,000	na[2]	120	40	80	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]
Method	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	ICP	INAA	INAA	INAA	INAA
Detection limit	5	10	200	1	3	5	10	2	0.5	0.2	0.02	1	1
Orogrande District													
VTM97-85C	77	<10	800	2	65	35	20	<2	15.5	1.1	7.07	8	34
VTM97-139C	31	<10	300	13	144	32	100	3	58.9	1.7	16.80	79	82
VTM97-155C	27	50	300	14	128	46	40	2	146.0	3.3	21.20	13	73
VTM97-157C	40	30	300	11	87	49	30	<2	213.0	2.0	21.30	16	49
North Franklin Mountains District													
VTM97-269C	150	<10	5,300	13	103	20	100	2	14.7	1.3	7.55	61	53
Sacramento District													
VTM97-320C	<5	<10	2,700	12	52	15	20	<2	8.2	0.6	1.82	11	26
VTM97-322C	7	<10	1,300	6	73	19	30	3	113.0	1.4	3.73	20	36
Various Locations within the McGregor Range													
VTM97-88C	250	<10	400	3	166	24	130	2	12.6	1.4	11.50	110	86
VTM97-122C	<5	<10	400	4	76	16	60	<2	3.7	0.7	3.28	55	39
VTM97-153C	39	<10	300	9	132	34	70	3	16.6	1.5	12.40	52	67
VTM97-166C	8	<10	500	14	31	12	20	<2	10.8	0.5	1.91	15	16
VTM97-183C	14	<10	400	18	67	16	40	2	9.6	1.4	4.42	14	35
VTM97-191C	30	<10	1,000	22	52	11	40	<2	4.0	0.7	6.93	27	28
VTM97-198C	29	<10	200	11	115	27	70	<2	8.7	2.0	13.80	36	59
VTM97-219C	30	<10	400	14	79	18	30	<2	8.2	1.1	6.72	15	41
VTM97-221C	24	<10	300	8	141	34	50	<2	10.4	2.1	22.50	78	71
VTM97-227C	21	<10	600	9	65	14	20	<2	8.7	1.2	3.24	7	34
VTM97-242C	22	<10	600	17	35	15	30	<2	14.4	0.6	3.95	15	19
VTM97-250C	21	<10	400	16	73	18	40	<2	6.8	1.3	6.77	25	39
VTM97-288C	<5	<10	300	20	60	9	40	<2	4.6	0.7	2.16	29	32
Maximum	250	50	5,300	22	166	49	130	3	213.0	3.3	22.50	110	86
Minimum	<5	<10	200	2	31	9	20	<2	3.7	0.5	1.82	7	16

Table 2.13 (Continued)

Sample No.	Lu (ppm)	Na (ppm)	Sb (ppm)	Mo (ppm)	Nd (ppm)	Sc (ppm)	Sm (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	W (ppm)	Yb (ppm)	Zn (ppm)
Anomaly threshold	na[2]	na[2]	12	34	na[2]	na[2]	na[2]	na[2]	20	12	110	na[2]	300
Method	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA
Detection limit	0.1	500	0.2	20	10	0.1	0.1	1	0.5	0.5	10	0.2	200
Orogrande District													
VTM97-85C	0.3	8,500	2.5	<20	20	3.8	4.1	<1	7.2	3.5	50	2.1	<200
VTM97-139C	1.3	2,400	1.2	<20	50	6.8	9.1	3	21.0	10.7	90	7.2	<200
VTM97-155C	0.5	2,600	0.4	<20	40	3.1	6.6	<1	6.5	12.2	110	2.7	<200
VTM97-157C	0.4	3,100	4.0	20	30	2.7	4.7	1	8.1	7.4	160	2.4	<200
North Franklin Mountains District													
VTM97-269C	1.2	3,200	14.0	60	40	8.0	7.3	<1	14.0	8.6	50	6.7	300
Sacramento District													
VTM97-320C	0.5	8,200	0.5	<20	20	3.5	4.8	<1	8.4	2.9	80	3.5	<200
VTM97-322C	0.9	8,300	0.7	<20	30	9.7	7.1	2	13.0	5.0	50	6.0	<200
Various Locations within the McGregor Range													
VTM97-88C	1.9	3,200	24.0	<20	60	10.8	11.0	4	24.0	14.5	50	11.3	200
VTM97-122C	0.9	3,900	0.9	<20	30	4.8	5.5	2	12.0	5.4	80	5.2	<200
VTM97-153C	1.1	3,600	2.2	<20	50	8.1	9.3	3	16.0	10.3	90	6.4	<200
VTM97-166C	0.3	3,000	0.8	<20	10	2.8	2.5	<1	4.3	3.1	50	1.7	<200
VTM97-183C	0.5	6,600	1.4	<20	30	5.7	4.9	2	6.7	4.6	20	2.7	<200
VTM97-191C	0.5	2,000	2.4	20	20	3.0	3.7	1	8.0	4.5	30	2.9	400
VTM97-198C	0.9	3,200	1.9	<20	50	8.8	9.0	9	12.0	6.3	70	5.7	<200
VTM97-219C	0.5	6,700	2.0	<20	30	5.4	5.5	3	13.0	5.1	40	3.0	<200
VTM97-221C	1.2	5,700	1.3	<20	60	7.9	10.9	19	21.0	7.7	30	7.2	400
VTM97-227C	0.3	21,000	1.4	<20	20	3.3	3.6	<1	7.1	3.1	30	1.8	<200
VTM97-242C	0.3	2,300	2.4	<20	20	3.3	2.9	<1	4.5	4.6	60	2.1	<200
VTM97-250C	0.6	8,500	1.3	<20	30	4.8	5.1	66	8.6	4.6	40	3.4	<200
VTM97-288C	0.5	3,500	0.6	<20	30	3.9	4.7	1	8.5	4.0	30	3.3	<200
Maximum	1.9	21,000	24.0	60	60	10.8	11.0	66	24.0	14.5	160	11.3	400
Minimum	0.3	2,000	0.4	<20	10	2.7	2.5	<1	4.3	2.9	20	1.7	<200

[1] For all samples: Ag <5 ppm, Br <5 ppm, Ni <200 ppm, Se <20 ppm, Tb <2 ppm, Ir <50 ppb, and Hg <5 ppm. Refer to Appendix 5 for complete analyses of these samples.

[2] na = not available.

3.0 DESCRIPTION OF KNOWN MINERAL RESOURCES

3.1 TYPES OF METALLIC MINERAL DEPOSITS

3.1.1 Introduction

Numerous classifications have been applied to mineral deposits to aid in evaluation of mineral resources (Eckstrand 1984; Guilbert and Park 1986; Cox and Singer 1986; Roberts and Sheahan 1988; Sheahan and Cherry 1993). Early classifications were based on the form of the deposit or a combination of form and perceived chemical conditions of formation, such as Lindgren's (1933) classification of mineral deposits associated with igneous rocks into epithermal, mesothermal, and hydrothermal. In the 1960s and 1970s, wide acceptance of plate tectonic theories led to the recognition that similar mineral deposits occur in areas of similar environments and resulted in classifications of mineral deposits according to tectonic settings (Sillitoe 1972, 1981; Guilbert and Park 1986). In the 1980s, mineral deposit models became popular which incorporated tectonic setting and physical and chemical characteristics of the deposits (Cox and Singer 1986; Roberts and Sheahan 1988; Sheahan and Cherry 1993).

In New Mexico, North and McLemore (1986, 1988) and McLemore (in press) expanded on previous classifications of deposits in New Mexico by incorporating plate tectonic theories with known age relationships and conditions of chemical deposition (fluid inclusion data). This information classified the metal deposits of New Mexico, in order of importance, according to age of deposition, tectonic setting, genetic processes, mineral assemblages and metal associations, host rocks, and form of the deposits. This classification, with a few modifications and additions, is retained in this report and is compatible with other, more recent classifications (Cox and Singer 1986; Guilbert and Park 1986; Roberts and Sheahan 1988; Sheahan and Cherry 1993). Some of the deposit types are described in more detail elsewhere (e.g., placers [McLemore 1994b], volcanic-epithermal vein deposits [McLemore 1994c, 1996c], Great Plains Margin (GPM) deposits [McLemore 1996a], copper porphyry [McLemore 1996b], and carbonate-hosted deposits [carbonate-hosted lead-zinc replacement, carbonate-hosted silver replacement, Laramide skarn, RGR, and MVT deposits; McLemore and Lueth in press]). Fifteen types of mineral deposits could occur within the McGregor Range (refer to Table 3.1) based on geologic criteria presented in North and McLemore (1986, 1988); McLemore (in press); and Cox and Singer (1986). These mineral deposits are discussed below in more detail.

3.1.2 Great Plains Margin (GPM) Deposits

Some of New Mexico's largest gold deposits occur along a north/south belt roughly coinciding with the Great Plains physiographic margin with the RGR Basin and Range and Rocky Mountains physiographic province (McLemore 1996a). These deposits have similar characteristics that, when compared with their tectonic setting, define a class of ore deposits referred to as GPM deposits by North and McLemore (1986, 1988). These deposits are classified as a variety of deposit types by different authors. They are known as alkalic-gold or alkaline-igneous-related gold deposits (Fulp and Woodward 1991; Thompson 1991, 1992; Bonham 1988; Mutschler et al. 1985, 1991), but not all of the GPM deposits occur in alkaline igneous rocks. Some scientists have called these deposits porphyry-gold deposits, but not all GPM deposits are associated with porphyritic rocks. The term Rocky Mountain gold province does not adequately encompass all of the deposits in New Mexico.

The GPM deposits contain both precious and base metals, with concentrations of precious metals, especially gold, are typically high compared to other metal deposits in the state. These deposits consist of six associated deposit types: 1) placer gold; 2) porphyry copper-gold (± molybdenum) and gold; 3) gold-silver and polymetallic veins and breccia deposits; 4) copper, lead/zinc, and/or gold skarns or carbonate-hosted replacement deposits; 5) iron skarns and replacement bodies; and 6) thorium-REE-fluorite epithermal veins and breccias. Alkaline igneous rocks are found in most districts, but mineralization is usually associated with silica-saturated (monzonite) or oversaturated (quartz monzonite) rocks (Segerstrom and Ryberg 1974; McLemore and North 1987; McLemore et al. 1991; Thompson 1991). The deposits are typically associated with Oligocene intrusive rocks (stocks, laccoliths, sills), although deposits in the Orogrande District are associated with Eocene intrusive rocks (North and McLemore 1988). Lamprophyre dikes or sills are common to most districts, but the association to mineralization is unknown. The veins have high gold-base metal ratios and typically low silver-gold ratios (McLemore 1996a) in contrast with other high silver-gold deposits in western New Mexico.

Table 3.1 Types of Mineral Deposits that May Occur Within the McGregor Range.

NMBMMR Classification	USGS Classification	USGS Model No.
GPM Deposits		
• Placer gold deposits	Gold placers	39a
• Copper-molybdenum-gold porphyry deposits	Copper porphyry, molybdenum porphyry	20c, 21a,
• Alkaline-related gold-silver and polymetallic veins and breccia deposits	Alkaline Au-Te veins, polymetallic veins	21b
• Copper, lead-zinc, and gold skarns or carbonate-hosted deposits	Copper skarns	22b, c
• Iron contact-metasomatic and skarn deposits	Iron skarns	18a, b, c
• Thorium-REE-fluorite and niobium vein deposits	Thorium-REE vein deposits	18d
	None	11c, d
		None
Beryllium contact-metasomatic and skarn deposits	None	None
Carbonate-hosted Pb-Zn and Ag (Mn) replacement deposits	Polymetallic carbonate-hosted	19a, b
Rhyolite-hosted tin deposits	Rhyolite-hosted tin deposits	25h
RGR barite-fluorite-galena deposits	None (analogous to MVT deposits)	None
MVT deposits	MVT	32a, b
Sedimentary copper deposits	Sediment-hosted copper	30b
Veins and replacements in Proterozoic rocks	Polymetallic veins, fluorite veins	22b, c, 26b
Gabbro/syenite-hosted Cu-Ag-PGE deposits	None	None
Replacement manganese deposits	Replacement manganese	19b

3.1.2.1 Placer Gold Deposits

Placer gold deposits are low-grade disseminated deposits consisting of small-sized gold deposits, locally, with silver as a byproduct. In New Mexico, they generally occur in Late Tertiary to Recent alluvial fans, bench or terrace gravels, river bars, and stream deposits, or as residual placers formed directly on top of lode deposits typically derived from Proterozoic, Cretaceous, and Tertiary source rocks (McLemore 1994b). They are typically close to the lode deposits. During fluvial events, large volumes of sediment containing free gold and other particles are transported and deposited in relatively poorly sorted alluvial and stream deposits. Thus, placer gold deposits are controlled by ancient and modern stream patterns. The gold concentrates by gravity in incised stream valleys and alluvial fans in deeply weathered highlands. Some placer deposits are richer in gold than the original lode deposits. Native gold and electrum occurs with quartz, magnetite, ilmenite, amphiboles, pyroxenes, pyrite, zircon, garnet, rutile, and a variety of other minerals. The best ore zones typically occur as narrow pay streaks or layers of fine-grained disseminated gold, locally on top of basement rock or clay or caliche lenses within gravel deposits. The best gold values occur near the base of the gravel deposits where the gold is trapped by natural processes such as riffles in the river bottom, fractures within the bedrock, along bedding or foliation planes, and/or structures that are transverse to the river flow. Gold also concentrates above cemented gravels and clay layers within the gravel deposits, which constrain downward migration of gold particles. Most deposits in New Mexico are thin, less than 45 ft below the surface (Lindgren et al. 1910; Johnson 1972), and contain less than 0.05 oz/yd^3 (McLemore 1994b). The gold is greater than 900 fine. Placer gold deposits in New Mexico are similar in occurrence, size, and grades to placer gold deposits worldwide (Cox and Singer 1986).

3.1.2.2 Copper-Molybdenum-Gold Porphyry Deposits

Copper-gold and/or gold porphyries locally, with significant quantities of molybdenum, are found in some GPM deposits in New Mexico (Cerrillos, Orogrande, and Organ Mountains) (McLemore 1996a). Copper minerals and gold and molybdenite occur as disseminations and stockwork veinlets in and adjacent to porphyritic intrusives that have been hydrothermally altered (Giles 1991; Maynard et al. 1989, 1990). Disseminated molybdenum and copper minerals occur in the Rialto stock in Lincoln County, but the low grades and proximity to a wilderness area have hampered development (Thompson 1968). Extensive alteration is distributed irregularly around most deposits with inner zones of argillic alteration and silicification (Thompson 1973; Wargo 1964). At the Mudpuppy-Waterdog prospect in the Nogal-Bonito District, a copper-gold porphyry deposit is hosted by a syenite to monzonite stock that is concentrically zoned from outer propylitic to argillic to inner phyllic alteration to a core of silicified and oxidized breccia (T.B. Thompson 1983; Fulp and Woodward 1991). A copper-molybdenum porphyry deposit has been encountered in drill holes in the Organ Mountains northwest of the McGregor Range, where the altered quartz monzonite consists of stockwork veining and averages 0.25% copper and 0.1% molybdenum (Newcomer and Giordano 1986). In most porphyry deposits in GPM districts in New Mexico, gold/silver ratios are typically greater than 1:1. Bulk tonnage mining methods would need to be employed because of low grades and disseminated nature of the deposit.

3.1.2.3 Alkaline-Related Gold-Silver and Polymetallic Veins and Breccia Deposits

Polymetallic veins are common to most GPM deposits in New Mexico and production has been locally significant (McLemore 1996a). Native gold and a variety of silver minerals are found in veins in most districts, along with chalcopyrite, galena, and sphalerite. Pyrite, calcite, quartz, iron, and manganese oxides and clay minerals are common gangue minerals. Veins occur in both Tertiary intrusives and surrounding sedimentary rocks. Veins are typically thin, less than a 3 ft wide, have steep dips, and occur along faults. Wall rock alteration is typically weak propylitic to argillic (Douglas and Campbell 1995; Phillips et al. 1991; McLemore and Phillips 1991). Silver to

gold ratios are typically low, below 5:1 (McLemore 1996a). In contrast, most precious metal deposits in New Mexico have high silver/gold ratios (15:50). GPM deposits also have high gold/base metal ratios.

Many polymetallic veins are associated with gold-bearing breccia deposits and quartz veins in many GPM districts (McLemore 1996a). The gold-bearing breccia deposits are typically the target of most recent exploration programs because of the potentially large gold concentrations amenable to bulk mining techniques. Breccia deposits occur as pipes or conical bodies and vary in size. The Vera Cruz deposit (Nogal District, Lincoln County) is approximately 600 ft long and 180 ft wide (Ryberg 1991). The Cunningham Hill (Old Placers District, Santa Fe County) deposit was approximately 620 ft long and 360 ft wide (Wright 1983). Quartz, pyrite, electrum, and native gold with little or no additional sulfides are found in these deposits, typically as veins, replacements, and breccia cement. The Carache Canyon breccia deposit (Old Placers District, Santa Fe County) is approximately 1,650 ft long and 900 ft wide (Maynard et al. 1989, 1990).

Molybdenum breccia pipes are found in some districts. At Cave Peak, Sierra Diablo, Texas, three molybdenum breccia pipes are associated with the Sierra Diablo syenite to rhyolite to quartz monzonite intrusions (Sharp 1979). The largest pipe is 2,500 ft in diameter and consists of up to three zones of mineralization. Molybdenum occurs as discrete concentrations of veinlets and disseminated molybdenite with quartz, fluorite, biotite, chalcopyrite, hubnerite, cassiterite, sphalerite, marcasite, arsenopyrite, magnetite, ilmenite, rutile, and columbite (Sharp 1979). Grades as high as 0.10-0.25% MoS_2, 0.20-1.64% copper, 500 ppm WO_3, 125-540 ppm tin, and 1.3-3.1% fluorite are reported (Sharp 1979). In the Nogal District, Lincoln County, New Mexico, eight molybdenum breccia pipes are associated with the Rialto stock (Thompson 1968). The Rialto stock is a hornblende-biotite monzonite. Molybdenite and other sulphides occur as thin coating along fractures and thin quartz veins. Grades as high as 0.181% MoS_2 and 0.22% copper are reported (Thompson 1968).

Breccia deposits occur in a variety of brecciated igneous and sedimentary rocks. Breccia fragments are typically highly altered and vary in size, ranging from large blocks tens of feet in diameter to clay-sized particles. The origin of these breccia deposits is controversial. Some current theories include: 1) solution collapse (Maynard 1989; Maynard et al. 1989, 1990), 2) pheatic eruptions, 3) boiling of magmas causing pressure release of volatiles forming hydrothermal brecciation, and 4) volcanic eruption (Perhac 1970; Woodward and Fulp 1991). Flooding of hydrothermal fluids has resulted in cementation of the breccia fragments and quartz veins, subsequently followed brecciation.

Many polymetallic veins, breccia deposits, and quartz veins have textures typical of epithermal deposits, such as multiple banding, hydrothermal brecciation, bladed calcite and/or quartz, vuggy textures, and drusy quartz. Recent studies at the Helen Rae Mine in the Nogal District indicate fluid inclusion temperatures of 200°C, salinity of 16 eq. wt% NaCl, and delta ^{18}O of 6.0-24.2%, all of which are higher than typical epithermal deposits (Campbell et al. 1991; Douglas and Campbell 1995). Fluid inclusion and isotope studies have not been made for most GPM deposits in New Mexico. Available data are consistent with observations of Campbell et al. (1991) that GPM deposits have medium to high temperatures of formation and formed by high-salinity fluids (McLemore 1996a). These data confirm that the GPM deposits are epithermal to mesothermal.

3.1.2.4 Copper, Lead-Zinc, and Gold Skarns or Carbonate-Hosted Replacements

Numerous GPM districts host copper, lead-zinc, and gold skarn deposits in New Mexico. Most skarns are copper skarns, but they contain considerable gold concentrations, especially compared to other copper and lead-zinc skarns in southwestern New Mexico (McLemore et al. 1996c). Gold skarns are defined as carbonate-hosted deposits containing at least 1 ppm gold and exhibiting a distinctive skarn mineralogy (Theodore et al. 1991). Many skarns in the GPM districts contained sufficient gold to be classified as gold skarns; most also

contained significant copper. Skarns containing only gold have not been reported in New Mexico. Well-developed copper and local lead-zinc skarns containing gold and silver occur in Ordovician to Mississippian limestones and dolomites in the Orogrande District in Otero County (Strachan 1976, 1991; Bloom 1975; North 1982; Schmidt and Craddock 1964; Korzeb and Kness 1994). A tabular skarn containing 305,000 metric tons grading 0.7% copper and 1.7 ppm gold has been encountered in drill holes at a depth of 80 ft (Strachan 1991). The Cerrillos District also contains numerous copper skarns containing gold and silver in Pennsylvanian and Permian limestones (J.L. White 1991; Giles 1991). The skarns typically occur in metasomatized limestone adjacent to or in the vicinity of an intrusive contact with stocks, dikes, and/or sills. Calc-silicate minerals such as garnet, tremolite, and diopside occur with magnetite, epidote, cordierite, scapolite, and chlorite. The Lukas Canyon skarn in the Old Placers District is a copper-gold skarn with as much as 1 ppm gold (Maynard 1989). Iron contact-metasomatic and skarn deposits are also common in most districts containing copper, lead-zinc, and gold skarns (McLemore 1996a).

3.1.2.5 Iron Contact-Metasomatic and Skarn Deposits

Numerous iron contact-metasomatic and skarn deposits occur throughout the New Mexico GPM alkaline igneous rock belt. Most deposits are small and insignificant (Griswold 1959; Kelley 1949), and none are economic gold deposits. However, selected high-grade samples from some iron contact-metasomatic and skarn deposits locally carry anomalous gold. The largest iron deposit, Capitan, contained more than 1 million tons of ore grading 45.6% iron with local trace amounts of gold (Kelley 1949). A sample of the Chupadera Mesa iron skarn in Torrance County contained 0.7 ppm gold, but several additional samples contained no gold. Twenty samples collected from the Jones Camp iron deposits ranged from 3 to 23 ppb gold and 5 to 7 ppm silver (Gibbons 1981). Samples from the iron deposits in the Tecolote District contained as much as 22 ppb gold (Korzeb and Kness 1992).

These iron deposits consist of hematite and magnetite and occur as lenses or irregular bodies in limestone and as veins filling fractures, faults, and along bedding planes adjacent to Tertiary intrusions. Calc-silicate minerals are rare and typically occur only in the larger deposits (i.e., Jones Camp, Capitan Mountains). Fluid inclusions in garnet from the Capitan iron deposit are high-salinity inclusions, as indicated by the presence of one or more daughter minerals, and are similar to fluid inclusions from the REE-fluorite veins, suggesting a similar magmatic-hydrothermal origin (McLemore and Phillips 1991; Phillips et al. 1991).

3.1.2.6 Thorium-Rare Earth Elements (REE)-Fluorite and Niobium Vein Deposits

Thorium-REE-fluorite epithermal veins and breccias may contain potential economic concentrations of thorium, REE, niobium, fluorine, beryllium, barium, and lead, and occur throughout the GPM area (McLemore 1996a). Known deposits in New Mexico typically occur as tabular bodies, narrow lenses, and breccia zones along fractures, faults, and shear zones. These deposits vary from less than 3 ft to over 900 ft long and from less than 1 inch to 10 ft wide (Staatz 1985, 1986; Perhac 1970; McLemore and Phillips 1991; McLemore and Guilinger 1993; Schreiner 1991, 1993). The deposits are typically spotty, discontinuous, of variable grade, and contain local concentrations of REE, yttrium, thorium, uranium, niobium, and gold (McLemore et al. 1988a, 1988b). The larger deposits are in the Laughlin Peak-Chico Hills, Capitan Mountains, and Gallinas Districts (McLemore 1996a). Total REE content ranges from 100 to 30,000 ppm in the Laughlin Peak-Chico Hills District (Staatz 1985). Bastnaesite was produced from the Gallinas District (Griswold 1959). Uranium was produced from the Capitan Mountains (McLemore and Phillips 1991).

3.1.3 Beryllium Contact-Metasomatic Replacement and Skarn Deposits

Beryllium is widespread in contact metasomatic-replacement deposits at the contact zones between rhyolite and Cretaceous limestones and shales at Sierra Blanca, Texas (W.N. McAnulty 1980), and Aguachile, Coahuila, Mexico (Levinson 1962; McAnulty et al. 1963). The mineralized zones are found at the contact zone between Tertiary rhyolite and Cretaceous limestones and shales at both deposits. The intrusive rhyolite is peraluminous and calc-alkaline (determined from chemical analyses by Barker [1980]) and typically contains elevated concentrations of beryllium, fluorite, and uranium and locally tin, REE, and zinc. Recrystallized limestone and jasperoids are common near the mineralized deposits in both areas. The contacts between mineralized and barren limestone are sharp and crosscut stratigraphic features.

Five shallow rhyolite laccoliths intruded Cretaceous limestones near Sierra Blanca, Texas (Rubin et al. 1987). At the Sierra Blanca fluorspar-beryllium deposit, as much as 12,000 ppm beryllium is reported from the contact zone and as much as 4,100 ppm beryllium is reported from the rhyolite breccias (W.N. McAnulty 1980). Cyprus Minerals Inc. announced resources totaling 2.5 million lbs of BeO grading better than 2% BeO (Price et al. 1990; Henry 1992). The mineralized zones contain silica, fluorite, gearksutite, ralstonite, thomsenolite, cryolite, and bertrandite (W.N. McAnulty 1980). These zones also contain elevated uranium (3-485 ppm), tin (70-1,000 ppm), and zinc (85-1,000 ppm). There has been no beryllium production from this deposit. The rhyolites are high-silica and peraluminous and enriched in lithium, beryllium, flourine, zinc, yttrium, niobium, REE, and other elements (Rubin et al. 1987). They are grossly similar in chemistry to topaz-rhyolites that are associated with tin deposits, but they contain cryolite and are enriched in heavy REE, unlike most topaz-rhyolites (Rubin et al. 1987; Price et al. 1990). The main rhyolite laccolith has an age date of 36.2 ± 0.6 Ma (biotite, potassium-argon) (Henry et al. 1986).

At Aguachile, the mineralized zones are less than 20 ft wide and several hundred feet long and contain fluorite, silica, and bertrandite. The ore averages 5% BeO (McAnulty et al. 1963). Deposits at Aguachile has been mined for fluorite ever since the mid-1950s; no beryllium has ever been recovered. Underground stopping, block caving, and open-pit mining methods are being employed.

3.1.4 Carbonate-Hosted Lead-Zinc and Silver (Manganese) Replacement Deposits

Carbonate-hosted lead-zinc and silver (manganese) replacement deposits occur in southwestern New Mexico and were formed between approximately 50 and 20 Ma (North and McLemore 1986, 1988; McLemore in press; McLemore and Lueth in press). The deposits include replacements in carbonate rocks with little or no calc-silicate minerals, minor skarns with calc-silicate minerals, and minor veins in carbonate rocks and adjacent intrusive and sedimentary rocks. Two types of deposits occur. One type is typically lead/zinc dominant, with by-product copper, silver, and gold. Galena and sphalerite are the predominant ore minerals with lesser amounts of chalcopyrite. The other type of deposit contains predominantly silver and manganese oxides; over 20 million ounces of silver have been recovered from deposits of this type (North and McLemore 1986). Recognizable silver and gold minerals are rare. The oxidized zones have typically been the most productive.

The deposits are hosted by Paleozoic limestones and dolomitic limestones, typically the Fusselman Dolomite (Silurian) and Lake Valley Formation (Mississippian). The Percha Shale commonly acts as the uppermost, impermeable cap on mineralization in the Fusselman Dolomite. Jasperoids are common to most deposits and also act as impermeable caps to mineralization. Many deposits are structurally controlled along fault, fracture, and contact zones. The localization of some deposits is also stratigraphically controlled.

The deposits vary in size and grade, ranging from a few thousands of tons to a few hundreds of thousands of tons and typically grading 5-30% combined lead and zinc; the amount of silver varies and gold is rare (McLemore and Lueth in press). In most carbonate-hosted replacement districts in New Mexico, lead is the predominant metal, followed by zinc and copper. Manganese, locally with silver, occurs as replacements and epithermal veins peripheral to many carbonate-hosted lead-zinc replacement deposits (McLemore et al. 1996b). Skarns are poorly developed and rarely exhibit any mineral zonation. Fluid inclusion data from five deposits indicate temperatures of formation between 147 and 367°C and low to moderate salinities (<10 eq. wt.% NaCl) (McLemore and Lueth in press).

The association between carbonate-hosted lead-zinc replacement deposits and igneous activity is uncertain. Tertiary intrusive rocks, ranging in age from 50 to 20 Ma, outcrop in all districts except the Big Hatchet Mountains. In many districts, polymetallic veins and/or disseminations of sulfides occur in the adjacent intrusive rocks. Higher temperatures of formation and higher salinities are consistent, but not conclusive, for formation (entirely or in part) from magmatic fluids. Drilling in the Macho District in Sierra County encountered carbonate-hosted lead/zinc replacement deposits in the Fusselman Dolomite 3,000 ft below the volcanic-epithermal veins. This suggests that the carbonate-hosted deposits and the distal epithermal deposits may have been deposited by the same hydrothermal system. The carbonate-hosted lead/zinc replacement deposits are similar in form, mineralogy, texture, age, and temperature to the chimney, manto, and pod carbonate-hosted silver-lead-zinc (copper) deposits in northern Mexico (Megaw et al. 1988). Geochemical, fluid inclusion, and stable-isotope data suggest that the Mexican deposits were formed by mixing of variable amounts of magmatic and meteoric fluids (Megaw et al. 1988), and a similar origin is reasonable for the New Mexico deposits.

3.1.5 Rhyolite-Hosted Tin Deposits

Rhyolite-hosted tin deposits consist of discontinuous veins and veinlets in rhyolite domes and volcanic centers (Cox and Singer 1986; Christiansen et al. 1986). The tin deposits occur in the fractured and brecciated outer parts of flow-dome complexes and are hosted by high-silica (>75%) peraluminous rhyolites and/or pyroclastic deposits. Hematitic and argillic alteration is commonly associated with the tin deposits. The deposits are typically small (less than several hundred thousand tons of ore) and low grade (<2% tin) (Cox and Singer 1986). Four types of tin deposits are found in the altered Oligocene-Miocene rhyolite domes and tuffs in the Taylor Creek District, New Mexico (Maxwell et al. 1986; Eggleston and Norman 1986): miarolitic cavities within rhyolite, thin veins and veinlets cutting rhyolite, disseminations in rhyolite, and placer deposits in streams and alluvial deposits adjacent to rhyolite domes and flows.

3.1.6 Rio Grande Rift (RGR) Barite-Fluorite-Galena Deposits

RGR deposits, formerly called sedimentary-hydrothermal barite-fluorite-galena (± silver) deposits (North and McLemore 1986, 1988) and MVT deposits (Putnam et al. 1983), are found within or near continental basins along the RGR in central New Mexico (McLemore and Barker 1985; Van Alstine 1976; North and McLemore 1985; Hill 1994; McLemore and Lueth in press). These deposits are low-temperature, open-space fillings with little or no replacement of host rocks, and they are not obviously associated with any magmatic or volcanic activity. They consist predominantly of barite, fluorite, and galena (locally argentiferous), with minor amounts of chalcopyrite and sphalerite locally. Silicification and dolomitization are locally common. The largest deposits of this type in New Mexico are in the Hansonburg District (McLemore and Lueth in press).

The deposits are typically hosted by Paleozoic carbonate rocks as veins, breccia cement, and cavity fillings adjacent to or within Basin and Range-related faults (e.g., Smith 1981; McLemore 1994a). Locally, RGR deposits occur along faults, fractures, contact zones, shear zones, bedding planes, and solution cavities in Precambrian, Paleozoic, and Tertiary rocks of varying lithologies (North and McLemore 1986).

Most RGR deposits in New Mexico are small, typically less than a few thousand tons of ore. Some deposits can be traced along strike for several thousand feet. The Hansonburg deposits are larger and consist of equal amounts of barite, fluorite, and galena; but the lead and zinc grades are much lower than skarn and carbonate-hosted lead-zinc replacement deposits in the state (McLemore and Lueth in press). Locally, some deposits in New Mexico contain pockets or zones of high-grade barite, fluorite, or lead-silver ore that were mined selectively in the past. No significant barite-fluorite-galena deposits occur north of the Placitas District in north-central New Mexico. This absence corresponds to a lack of evaporites in the stratigraphic section, which could provide sulfur needed to form these barite-rich deposits (McLemore and North 1984; McLemore and Barker 1985). Most of the RGR deposits are too small to be economically productive today.

Fluid inclusion and geochemical data indicate that the mineralizing fluids at Hansonburg were low temperature (less than 210°C), moderate salinity (10–18 eq. wt.% NaCl), and acidic (pH of 4.3-5.1) and were emplaced under low pressures at shallow depths (Putnam et al. 1983; Norman et al. 1985). Analysis of gases in fluid inclusions from samples from the Hansonburg District indicate that the predominant volatile is water; whereas the predominant gases are CO_2, C_nH_n, and N_2, consistent with formation from basin brines (Norman et al. 1985). Conodont geothermometry indicates that the sediments were heated to between 110 and 140°C (Cook 1986). Similar low-temperature, moderate-salinity fluids formed the deposits at El Cuervo Butte (North and McLemore 1985) and elsewhere along the RGR in central New Mexico (North and Tuff 1986b; Hill 1994; McLemore and Lueth in press).

Evidence suggests that RGR deposits are Tertiary in age; all RGR deposits are within or along the flanks of Tertiary rift basins (McLemore and Lueth in press). Stratigraphic evidence in the Tonuco Mountain and Rincon Districts indicates that these deposits are Miocene or younger (Seager et al. 1971; Seager and Hawley 1973). The Gonzales deposit in the Chupadera District, Socorro County, may be as young as 8 Ma according to fission track cooling ages of the host rock (Kelley et al. 1992). New $^{40}Ar/^{39}Ar$ age determinations of jarosite from the Copiapo jarosite deposit, Northern Franklin Mountains District, indicate an age of 4.6-5.0 Ma; jarosite from Hansonburg is 5.98-6.36 Ma (Lueth and Goodell 1996; Lueth and Heizler 1997).

The RGR deposits in New Mexico were formed by low-temperature formation waters or basinal fluids that accumulated in sedimentary basins and were heated by high-heat flow, magmatic activity, or radiogenetic heat from Precambrian plutons. The warm convecting waters leached barium, sulfate, lead, silver, and other ions from source rocks such as arkosic sediments, evaporites, Precambrian rocks, and mineral deposits. Fluorine may be derived from magmatic fluids. The mineralized waters were injected along open spaces such as bedding planes, unconformities, faults, and fractures as a result of gravity-driven flow from topographic highs, compaction of basin sediments, and/or density-driven flow produced by thermal contrasts along the basin flanks (Person and Garven 1994). Precipitation occurred as a result of cooling of the fluids, decrease in pressure, change in water chemistry, and/or mixing of the mineralized fluids with subsurface brines or meteoric water. This process could occur at any time during development of the basin and results in deposits of varying age.

3.1.7 Mississippi Valley-type (MVT) Deposits

MVT deposits are low-temperature lead/zinc deposits generally in carbonate rocks near the margins of marine sedimentary basins without any associated volcanic or intrusive activity. Three districts are adjacent to the marine Permian Basin in southeastern New Mexico (Red Lake, Guadalupe Mountains, and Calumet) and may contain oxidized MVT deposits (North and McLemore 1986, 1988; Hill 1993, 1996; McLemore in press). This type of deposit differs from RGR barite-fluorite-galena deposits by association with a marine basin, in contrast to the association of RGR deposits in New Mexico with continental basins along the RGR. The MVT deposits in New Mexico consist of open-space fillings in breccia zones with minor replacement. The deposits are small and highly oxidized and contain minor amounts of lead, silver, and zinc. Gold is extremely rare in these deposits. Geochemical and stable-isotope data suggest basin brines, possibly related to migration of oil and gas deeper within the basin during the Oligocene-Miocene uplift of the Delaware Basin (N. McAnulty 1980; Hill 1996) formed these deposits. These deposits are similar to barite deposits at Seven Heart Gap in Culberson County, Texas, where a similar origin by basin brines is envisioned (N. McAnulty 1980).

3.1.8 Sedimentary Copper Deposits

Stratabound sedimentary copper deposits containing copper and silver and (locally) gold, lead, zinc, uranium, vanadium, and molybdenum occur throughout New Mexico (North and McLemore 1986). These deposits have also been called "red-bed" or "sandstone" copper deposits by previous authors (Soulé 1956; Phillips 1960; Cox and Singer 1986). They are stratigraphically controlled and occur in bleached gray, pink, green, or tan sandstones, siltstones, shales, and limestones within or marginal to typical thick red-bed sequences of red, brown, purple, or yellow sedimentary rocks deposited in fluvial, deltaic, or marginal marine environments of Pennsylvanian, Permian, or Triassic age. The majority of sedimentary copper deposits in New Mexico occur at or near the base of these formations; some deposits such as those in the Zuni Mountains and Nacimiento Districts are in sedimentary rocks that unconformably overlie mineralized Proterozoic granitic rocks.

The mineralized bodies typically occur as lenses or blankets of disseminated and/or fractured coatings of copper minerals, predominantly chalcopyrite, chalcocite, malachite, and azurite, along with numerous other copper minerals. The deposits in New Mexico range in size from 3 to 60 ft thick and up to several thousand feet long. Copper mineralization is dominant, with some deposits containing up to 40-50% copper. Silver averages approximately 0.5 oz/ton (17 ppm) and typically increases with increasing copper concentrations. Gold is rare in these deposits.

The sedimentary copper deposits are typically associated with organic debris and other carbonaceous material. Local sedimentary features such as bedding, crossbedding, paleochannels, and intraformational slumping appear to control mineralization. Local structures in some areas are also important mineralization controls.

Ore bodies in New Mexico range from small occurrences containing less than a ton of ore to large deposits containing several hundred thousand tons of ore. Most deposits have been mined by open pit methods, although underground methods have been employed in many districts. In situ leaching of the copper deposits was proposed and initiated at the Nacimiento Mine, but the operation was not successful.

Copper and other metals were probably transported in low-temperature solutions through permeable sediments and along bedding planes and faults shortly after burial. Replacement textures and diagenic

features of the organic material indicate mineralization occurred during or after diagenesis. Oxidizing waters could leach copper and other metals from: 1) Proterozoic rocks enriched in these metals, 2) Proterozoic base metal deposits, and 3) clay minerals and detrital grains within the red-bed sequences (LaPoint 1976, 1979; Brown 1984). Chloride and carbonate form soluble cuprous-chloride or cuprous-carbonate and other metal complexes (Rose 1976), sources which occur in older Paleozoic evaporite and carbonate sequences. Transport of metal-bearing waters occurred laterally through the aquifers from Proterozoic highlands or, in some cases, by circulating ascending fluids (Brown 1984). Geologic, mineralogic, and isotopic studies of similar deposits elsewhere in the U.S. suggest that these waters are in approximate chemical equilibrium with quartz, feldspar, hematite, and mica at temperatures less than 75°C (Rose 1976). Precipitation occurred at favorable oxidation-reduction interfaces in the presence of organic material or H_2S-rich waters. Subsequent groundwater, igneous intrusive rocks (such as at Sacramento), and structural events may modify, alter, or even destroy some deposits (LaPoint 1979).

3.1.9 Veins and Replacements in Proterozoic Rocks

Vein and replacement deposits containing precious and base metals occur sporadically throughout most of the Proterozoic terranes in New Mexico (North and McLemore 1986). However, production of gold and silver from most districts has been limited. Evidence suggests that Proterozoic deposits may be a significant source for younger deposits (LaPoint 1976, 1979; Fulp and Woodward 1990). Cox and Singer (1986) classified these deposits as polymetallic veins (#22c), fluorite veins (#26b), or gold-silver-telluride veins (#22b). Most of the precious and base metals deposits in Proterozoic terranes are small and low grade.

Several types of deposits occur in Proterozoic terranes in New Mexico. Gold, silver, and copper occur in lenticular quartz veins along shear zones in Proterozoic greenstones in the Hell Canyon and Tijeras Canyon Districts. Silver, with some gold and copper, occurs in quartz veins along shear zones in Proterozoic granitic and metamorphic rocks in the Zuni Mountains District (McLemore 1989). Free gold occurs with quartz in several other districts. Copper minerals with gold and silver concentrations occur in shear zones and as disseminations in granitic and mafic rocks in many districts (North and McLemore 1986). Veins and small replacement bodies containing copper, gold, silver, tungsten, and bismuth occur along faults, fractures, shear zones, and contact zones within Proterozoic granitic and metamorphic rocks in the Grandview-Sulfur Canyons District in Sierra County (McLemore 1994a).

The age of mineralization is uncertain in most districts. Many of these deposits are structurally controlled by schistosity or shear zones of Proterozoic age and are, therefore, syn- or post-metamorphic (McLemore 1989, 1994a). Some of these deposits show evidence of metamorphism (Williams 1982; Williams and Bauer 1995). A syn- to late-metamorphic age of the Copper Hill deposits in the Picuris District in Taos County is indicated by crosscutting relationships, local replacements of kyanite and staurolite by sulfide minerals, and evidence for post-mineralization anealing of vein quartz and quartzite (Williams and Bauer 1995). In most districts, there is no evidence of Tertiary intrusive activity, and a Proterozoic age is presumed. Many vein and replacement deposits in Proterozoic rocks are associated with quartz veins, also presumed to be Proterozoic in age. In many districts, there is a strong spatial association of precious metal veins with diabase or mafic dikes of uncertain age (Dunham 1935; McLemore 1994a; McLemore et al. 1996c).

3.1.10 Gabbro/Syenite-Hosted Copper-Silver-PGE Deposits

PGE deposits typically occur in economic concentrations in ultramafic and associated mafic rocks (Macdonald 1988; Eckstrand 1984; Cox and Singer 1986). Many of the PGE deposits in the world are in Archean rocks. PGE includes platinum, palladium, osmium, ruthenium, iridium, and rhodium. The average concentration of platinum in unmineralized mafic and ultramafic rocks is approximately 10 ppb, ranging from 0.1 to 500 ppb (Macdonald 1988). Combined PGE content of most ore deposits ranges from 1 to 20 g/ton (Eckstrand 1984). Typical host rocks include diorite, peridotite, pyroxenite, anorthosite, gabbro, norite, and syenite (Macdonald 1988; Eckstrand 1984; Cox and Singer 1986; Mutschler et al. 1985). PGE ore occurs as conformable layers or lenses near the base of layered ultramafic and mafic complexes, thin stratiform layers within ultramafic and mafic intrusions, and irregular pipe-like bodies with ultramafic and mafic intrusions.

The Stillwater Mine in the Beartooth Mountains, Montana, accounts for nearly all of the PGE produced in the U.S. (Reese 1996; Hilliard 1997a). PGE deposits occur in stratiform ore bodies in Archean layered mafic and ultramafic rocks. Reported values are as high as 8 ppm platinum, 11 ppm palladium, 1.7 ppm rhodium, 0.5 ppm iridium, 1.0 ppm ruthenium, and 0.1 ppm gold (Page et al. 1976); in 1992, the ore averaged 0.8 oz/ton PGE. The ore averages 8 ft thick and 4 ft wide. PGE deposits are mined at Stillwater by underground methods and smelted at the mine site, and the resulting concentrate is shipped to Belgium for refining. In 1996, the mine produced 1,840 kg of platinum and 6,100 kg of palladium (Hilliard 1997a).

3.1.11 Replacement Manganese Deposits

Numerous replacement manganese deposits occur in carbonate rocks throughout New Mexico (Farnham 1961; McLemore et al. 1996c). Manganese oxide minerals occur in veins, breccia cement, replacements, or cavity fillings in limestone and dolomite and form tabular or pod-shaped deposits. Most deposits in New Mexico are typically less than a few feet thick and less than a few hundred feet long, but some ore shoots have been larger (Farnham 1961; McLemore et al. 1996c). Most deposits in New Mexico are typically low grade (<50% manganese), small, and uneconomical to produce.

3.2 MINES, PROSPECTS, MINERAL OCCURRENCES, AND MINERALIZED AREAS ON THE MCGREGOR RANGE

There is no reported mining or prospecting for metallic minerals or solid energy resources on the McGregor Range. However, four prospect pits and 27 aggregate quarries or pits were found on the McGregor Range during the reconnaissance sampling phase of this project (refer to Figure 2.1, Table 3.2, and Appendix 6). The aggregate quarries typically are in Quaternary alluvium or Permian limestone, and the material was quarried, sized, and probably used locally for road surfacing. Based on available information, there are no identified mineral or energy resources on the McGregor Range.

3.2.1 Existing Prospect Pits

The Three Buttes prospect pit is 264 ft long and 42-89 ft wide (refer to Figures 2.1 and 3.1). The highwall is 3-35 ft high. The pit is entirely within the Pennsylvanian Panther Seep Formation that consists of gray fine-grained limestone with interbedded lenses of black chert. The beds are nearly horizontal. White to reddish brown calcite and iron oxide veins with local brecciation occur in several areas of the pit; the veins are less than 2-3 inches wide and less than 10 ft long. A sample of the vein contained 6 ppb gold, 2.1 ppm

Table 3.2 Prospect Pits and Aggregate Quarries Within the McGregor Range.

Name	Latitude	Longitude	Sample No.	Possible Commodities
Three Buttes prospect pit	32° 8' 32"	106° 9' 57"	VTM97-50M,VTM97-51, VTM97-52,VTM97-53S	Limestone
Orogrande prospect pit	32° 22' 33"	106° 3' 54"	JB-IM-013, VTM97-172	Limestone, quartz monzonite
Red Hills prospect pit	32° 1' 39"	105° 58' 52"	VTM97-200, VTM97-201, VTM97-202	Cu, Au?, Ag?
Unknown prospect pit	32° 6' 18"	106° 33' 1"	VTM97-263M, VTM97-264M, VTM97-265M, VTM97-266M, VTM97-267M, VTM97-268S, VTM97-269C	Ba, F, Ag
USBM #285, NMSH #285	32° 35' 27"	105° 52' 0"	na[1]	Aggregate
USBM #286, NMSH #286	32° 35' 10"	105° 51' 0"	na[1]	Aggregate
USBM #287, NMSH #287	32° 33' 5"	105° 47' 0"	na[1]	Aggregate
USBM #294, NMSH #294	32° 39' 5"	105° 53' 30"	na[1]	Aggregate
USBM #451, NMSH #451	32° 0' 45"	106° 4' 0"	na[1]	Aggregate
USBM #450, USBM #450	32° 5' 17"	106° 5' 1"	na[1]	Aggregate
USBM #289, NMSH #289	32° 33' 20"	105° 38' 40"	na[1]	Aggregate
USBM #290, NMSH #290	32° 30' 15"	105° 44' 0"	na[1]	Aggregate
USBM #444, NMSH #444	32° 6' 3"	105° 56' 25"	na[1]	Aggregate
USBM #445, NMSH #445	32° 1' 7"	105° 57' 20"	na[1]	Aggregate
NMSH #446, NMSH #446	32° 0' 25"	106° 58' 40"	na[1]	Aggregate
NMSH #452	32° 5' 15"	106° 18' 0"	na[1]	Aggregate
Unknown quarry	32° 29' 22"	105° 49' 55"	na[1]	Aggregate
Unknown quarry	32° 29' 22"	105° 48' 35"	na[1]	Aggregate
NMSH #436	32° 24' 55"	105° 30' 55"	na[1]	Aggregate
USBM #433, NMSH #433	32° 28' 40"	105° 48' 33"	na[1]	Aggregate
USBM #434, NMSH #434	32° 29' 0"	105° 45' 0"	na[1]	Aggregate
USBM #435, NMSH #435	32° 29' 35"	105° 40' 27"	na[1]	Aggregate
USBM #284, NMSH #284	32° 32' 5"	105° 52' 50"	na[1]	Aggregate
USBM #291, NMSH #291	32° 32' 47"	105° 34' 0"	na[1]	Aggregate
Unknown quarry	32°30'22.1"	105°53'41.7"	JB-IM-021 IS	Aggregate
Unknown quarry	32°22'59.6"	106° 2' 50.2"	JB-IM-011	Aggregate
Training Pit	32° 5' 17.5"	106° 4' 34.7"	na[1]	Aggregate
Training Pit	32° 6' 00.1"	105°56'21.9"	na[1]	Aggregate
Training Pit	32° 7' 56"	105° 52' 43"	na[1]	Aggregate
Training Pit	32° 5' 1"	105° 54' 49"	na[1]	Aggregate
Training Pit	32° 4' 49"	105° 54' 44"	na[1]	Aggregate

[1] na = not available.

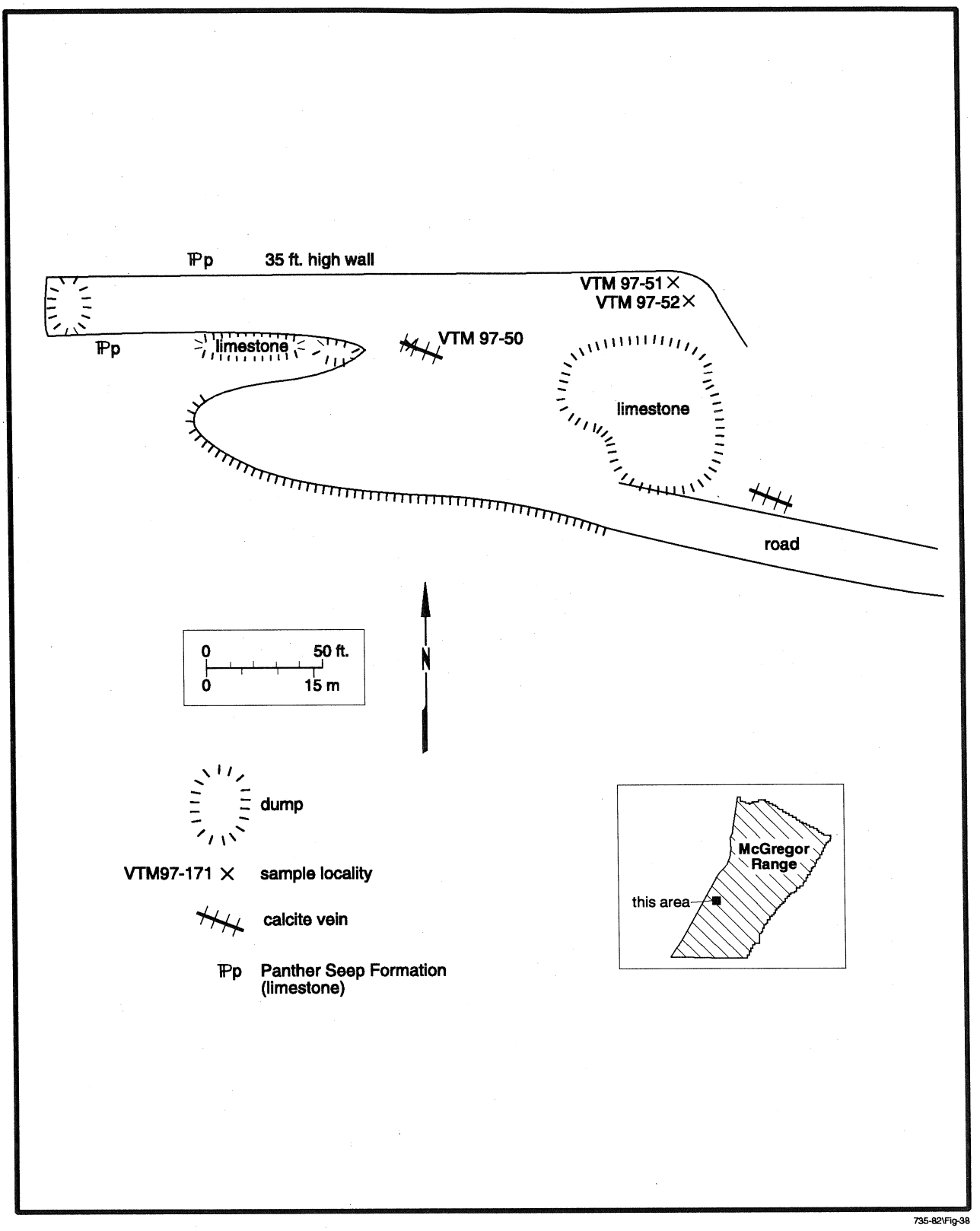

Figure 3.1 Sketch Map of Three Buttes Prospect Pit, McGregor Range, Otero County.

copper, <2 ppm lead, and 74 ppm zinc (refer to Sample VTM97-50M in Appendix 5). An unknown amount of limestone was mined from the pit for road material.

The Orogrande prospect pit is 352 ft long and 21-40 ft wide (refer to Figures 2.1 and 3.2). The highwall is 10-30 ft high. The pit exposes the steeply dipping intrusive contact between Tertiary quartz monzonite and Permian Hueco Formation. The Permian Hueco Formation consists of interbedded brown to gray shale and gray fine-grained limestone. The sedimentary rocks strike N5°W and dip 35°E. The shale along the contact is iron-stained and altered and consists of mixed illite/smectite, illite, kaolinite, smectite, calcite, and quartz (refer to Appendix 4). A sample of this zone contained 1 ppb gold, 14.7 ppm copper, 20 ppm lead, and 25 ppm zinc (refer to Sample VTM97-172 in Appendix 5). An unknown amount of limestone was mined from this pit. Crushed and sized limestone gravel is piled east of the pit for use as road surfacing material. Some quartz monzonite was blasted and stockpiled, but it is unsuitable for road material because it crumbles when blasted.

The Red Hills prospect pit is 10 ft long, up to 10 ft deep, and 6 ft wide (refer to Figures 2.1 and 3.3). The pit exposes a hornfels and magnetite-hematite replacement body within a limestone xenolith of Pennsylvanian Panther Seep Formation in the Tertiary nepheline syenite. The hornfels is green to green-gray and consists of iron oxides, calcite, quartz, epidote, chlorite, and a trace of pyrite (refer to Sample VTM97-201 in Appendix 5). The magnetite-hematite replacement body is brown to black and consists of magnetite, hematite, iron oxides, quartz, calcite, and a trace of pyrite and bornite (refer to Sample VTM97-200 in Appendix 5). Samples of white to gray silicified limestone from the waste dump contained calcite, quartz, iron oxides and a trace of pyrite and malachite (refer to Sample VTM97-202 in Appendix 5).

Chemical analyses of samples taken from prospect pits and aggregate quarries are presented in Table 3.3 and Appendix 5.

3.2.2 Mineral Occurrences

Silicified and recrystallized limestone beds of the Pennsylvanian Panther Seep Formation are found locally within several hundred to 1,000 ft of the intrusive contact with the nepheline syenite (refer to Figure 2.10). The altered zones are typically less than 1 ft thick and consist of quartz, calcite, iron oxides, and trace amounts of pyrite (refer to Samples VTM97-203M and VTM97-206M in Appendix 5); chemical analyses are presented in Table 3.3 and Appendix 5. Kness (1994) also reports low values of geochemical analyses from these zones (refer to Samples 93, 94, and 95 in Table 3.3).

A large undeveloped jasperoid body is exposed along a hillside northeast of the Red Hills syenite in Sections 6 and 7, T26S, R9E (refer to Figures 2.10 and 3.4). The jasperoid is approximately 100 ft long and up to 40 ft wide. It consists of jasper, iron oxides, quartz, and unmineralized limestone. The unmineralized limestone is cut by iron oxide and jasper veins. Two samples of the jasperoid contained 85% and 92.3% SiO_2 and 30 and 27 ppm beryllium (refer to Samples VTM97-194 and VTM97-195 in Table 3.2 and Appendix 5).

Four float chip samples were collected from four streams in the northern Hueco Mountains (refer to Table 3.3 and Appendix 5). Three of the samples contain high concentrations of Fe_2O_3, arsenic, barium, molybdenum, and lead. The geochemistry suggests that jasperoids may occur upstream.

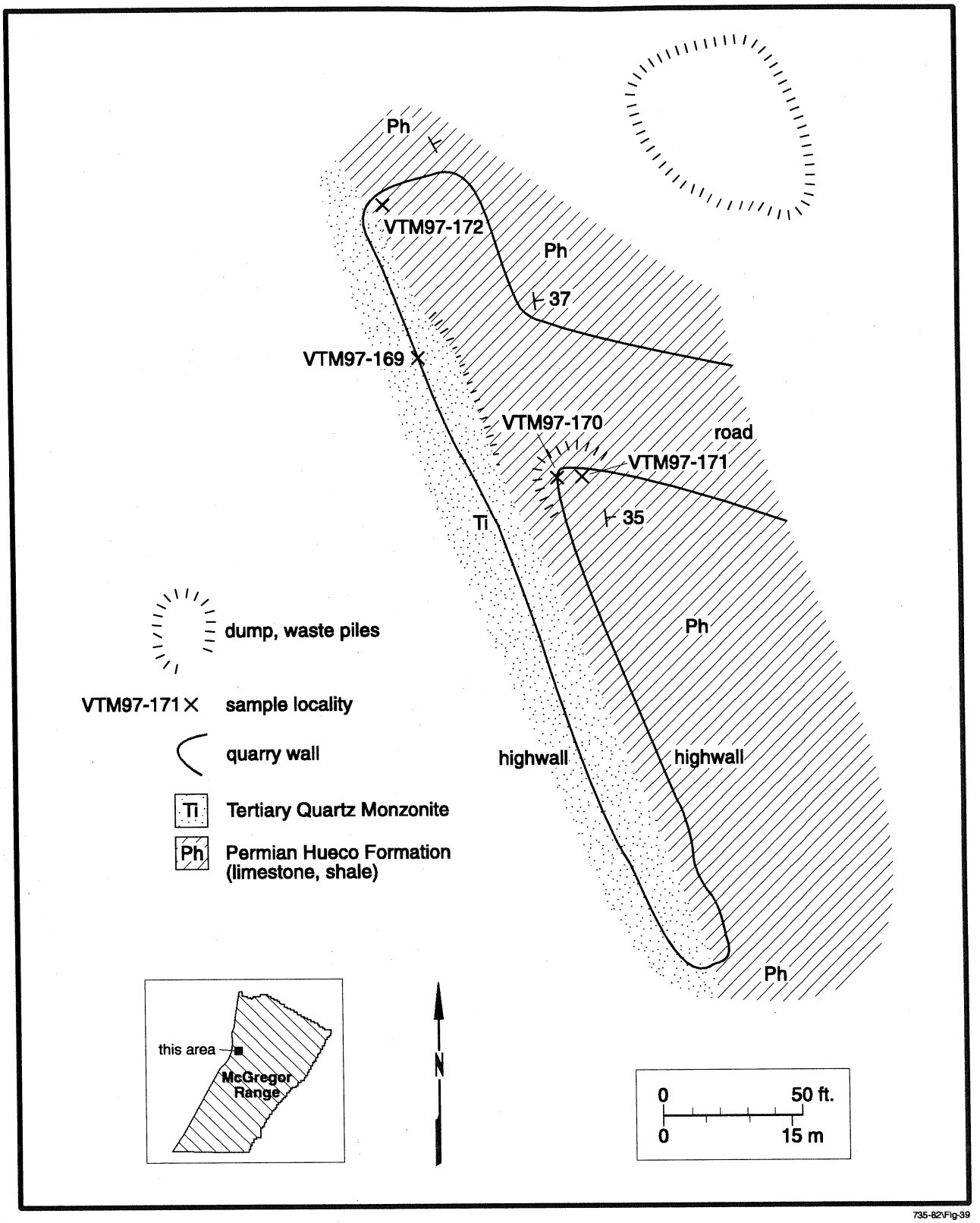

Figure 3.2 Sketch Map of Orogrande Rock Quarry, McGregor Range, Otero County.

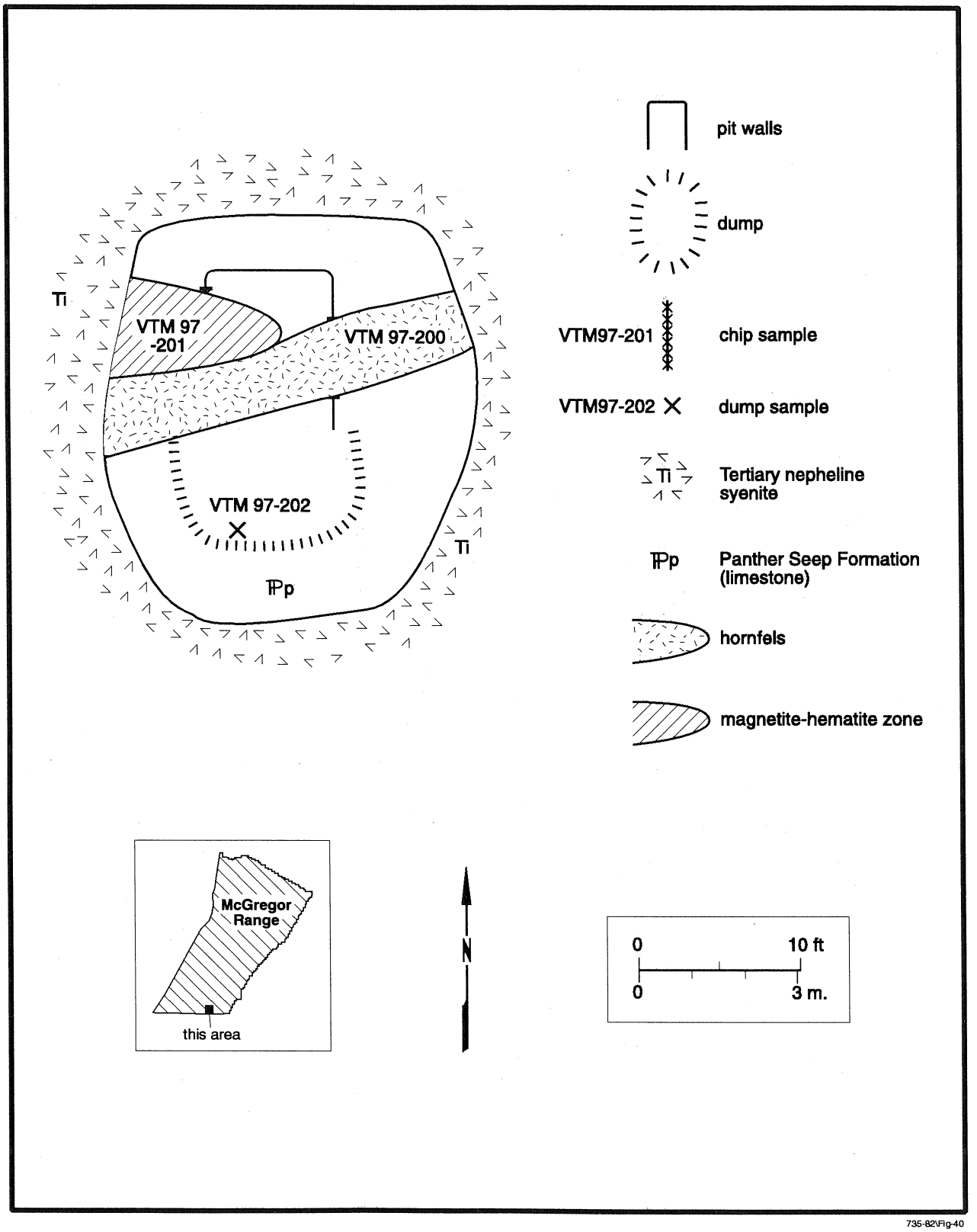

Figure 3.3 Sketch Map of Red Hills Prospect Pit, Hueco Mountains, McGregor Range.

Table 3.3 Selected Geochemical Analyses of Mineralized and Altered Samples from the Hueco Mountains Area, McGregor Range.[1]

Sample No.	Fe_2O_3[2] (%)	Ag (ppm)	As (ppm)	Au (ppb)	Ba (ppm)	Cu (ppm)	La (ppm)	Mo (ppm)	Nb (ppm)	Pb (ppm)	Sb (ppm)	Th (ppm)	U (ppm)	W (ppm)	Zn (ppm)
Method	XRF	ICP	INAA	DC	XRF	ICP	INAA	ICP	XRF	ICP	INAA	INAA	INAA	INAA	ICP
Detection limit	0.01	0.5	1	1	20	0.5	0.5	2	2	2	0.2	1	0.5	3	0.5
93[3]	5.15	<5	6	<5	na[4]	na[4]	31.0	<2	na[4]	na[4]	0.9	9	2.5	<2	<200
94[3]	5.01	<5	23	<5	na[4]	na[4]	41.0	4	na[4]	na[4]	2.7	9	7.4	<2	1,600.0
97[3]	2.72	<5	9	<5	na[4]	na[4]	29.0	41	na[4]	na[4]	2.0	8	2.5	11	<200
VTM97-59M	3.21	<0.5	9	<1	70	2.4	6.0	1	12	<2	0.5	<1	1.4	38	12.0
VTM97-184M	3.04	<0.5	3	<1	2,100	<0.5	8.3	5	16	9	0.5	1	3.0	24	13.0
VTM97-188F	13.00	<0.5	510	<1	60	3.6	6.0	9	<10	5	7.8	<1	1.4	38	12.0
VTM97-190F	19.00	1.4	73	2	800	4.9	15.1	73	<10	130	8.1	<1	10.3	78	2,400.0
VTM97-194M	4.34	<0.5	74	<1	70	2.7	1.4	5	3	8	1.9	<1	1.2	180	68.0
VTM97-195M	2.75	<0.5	21	<1	90	2.8	2.0	3	4	6	4.2	<1	1.6	270	37.0
VTM97-200M	9.51	0.5	40	<1	450	7.5	93.3	7	17	100	2.8	7	10.9	74	500.0
VTM97-201M	5.15	<0.5	51	1	510	25.2	66.3	5	17	190	2.2	8	6.4	60	1,100.0
VTM97-202M	4.34	<0.5	9	1	330	36.6	55.7	2	19	22	1.0	9	7.0	54	100.0
VTM97-203M	3.30	<0.5	5	11	1,200	2.6	48.8	3	27	13	0.9	11	6.5	120	37.0
VTM97-206M	4.74	<0.5	9	<1	340	16.9	34.2	2	15	24	0.8	9	2.7	84	87.0
VTM97-225M	2.32	<0.5	6	<1	90	8.6	22.9	3	13	5	0.2	4	6.1	22	33.0
VTM97-248F	10.00	<0.5	100	<1	990	6.8	49.6	13	86	32	15.0	23	6.5	130	250.0
VTM97-289F	1.49	<0.5	3	<1	490	9.1	26.5	10	39	16	0.6	13	2.8	120	59.0

1 Sample locations are shown on Figures 2.10 and 3.4. The remaining samples are described in Appendix 3, and complete analyses are presented in Appendix 5.

2 Iron is reported as total iron (Fe_2O_3).

3 Denotes analyses by Kness (1994) of mineralized limestone near the Red Hills syenite (exact locations are not available).

4 na = not available.

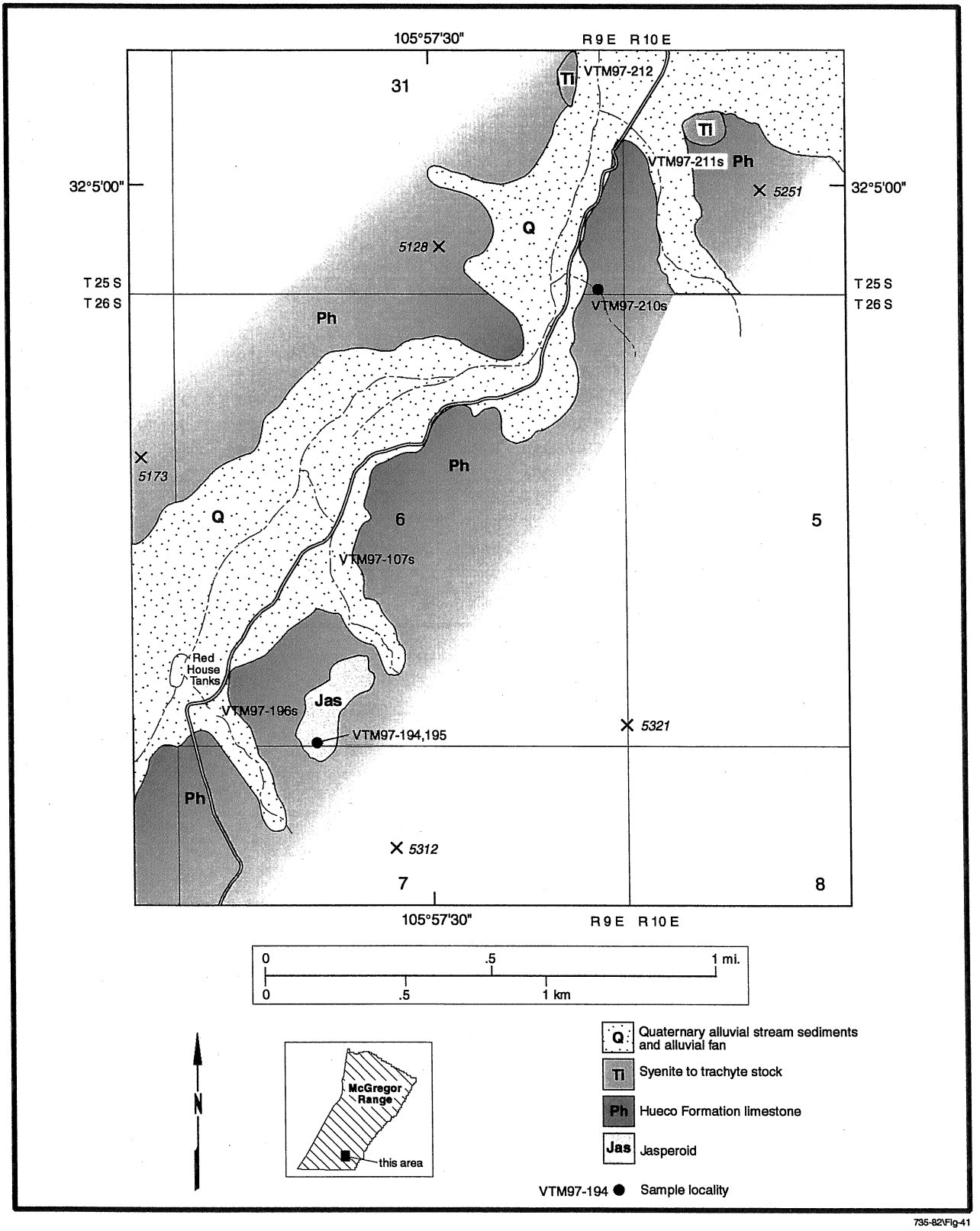

Figure 3.4 Geologic and Sample Location Map of the Jasperoid Body.

Five float chip samples were collected from El Paso/Culp Canyons in the Sacramento Mountains (refer to Appendix 5). These samples contained high concentrations of Fe_2O_3, arsenic, barium, molybdenum, beryllium, and lead. One sample (Sample VTM97-89F) contained the highest concentrations of arsenic of any sample collected from the McGregor Range. The geochemistry suggests that jasperoids may occur upstream. One drainage was examined in September 1997; the remaining drainages should be examined in the future. Upstream of Culp Canyon, Sample VTM97-89F was examined. Similar jasperoid material was found throughout the gravel terrace deposits in the area. No outcrops of jasperoid could be found. This suggests that jasperoid may have been eroded and redeposited in the terrace gravel deposits.

Additional mineralized or altered sampled were collected from elsewhere in the McGregor Range (refer to Samples VTM97-50M, VTM97-96M, VTM97-109M, VTM97-172M, VTM97-323dM, VTM97-324dM, VTM97-328dM, VTM97-331dM, and VTM97-381M in Appendix 5). None of these samples contain anomalous concentrations of any commodities.

3.3 MINES, PROSPECTS, MINERAL OCCURRENCES, AND MINERALIZED AREAS ADJACENT TO THE MCGREGOR RANGE

Numerous mining districts are located in south-central New Mexico and west Texas near the McGregor Range (refer to Figure 2.26 and Table 3.4). The Orogrande Mining District and Northern Franklin Mountains Mining District are located immediately adjacent to the McGregor Range and were examined as part of this project. In addition, mines and prospects in the Cornudas and Guadalupe Mountains area and in the Sacramento Mountains (refer to Figure 2.26), were also examined as part of this report, because similar deposits may occur on the McGregor Range.

Numerous mineralized and altered samples were collected from throughout the McGregor Range and adjacent mining districts to provide comparisons between known mineralized deposits and samples collected from McGregor Range. Table 3.5 presents a summary of the geochemical statistics from mineralized and altered samples collected adjacent to the McGregor Range. Each mining district is discussed in detail below, along with a comparison of geochemical results. These mining districts provided the assessment team with background information on various mineral deposits that could potentially occur on the McGregor Range.

3.3.1 Bear Canyon District

The Bear Canyon District, also known as the Stevens or San Augustin District, is in the southern San Andres Mountains (refer to Figure 2.26), northwest of the McGregor Range. The district extends from Bear Canyon (north of Black Mountain) northward to Little San Nicolas Canyon (north of Goat Mountain) in Doña Ana County. Shafts, adits, and prospect pits occur along the foothills (lower contact deposits) and near the crest (upper contact deposits) (McLemore et al. 1996c). J. Bennett discovered the district in 1883. In 1906, W.J. Stevens and J.G. Stewart owned most of the district. Production occurred a few years later. Less than 10,000 lbs of copper, less than 100 oz of silver, and some lead have been produced from the district (Dunham 1935; McLemore 1994a). In 1932, 50 tons of barite were produced from the Stevens Mine (Williams 1966). The district lies entirely within the White Sands Missile Range and is withdrawn from mineral entry.

The Bear Canyon District consists of westward-dipping Cambrian through Mississippian sedimentary rocks in either fault or unconformable contact with Proterozoic granitic and metamorphic rocks (Dunham

Table 3.4 Summary Information on Mining Districts Adjacent to the McGregor Range.

District Name (Aliases)	Year of Discovery	Production Years	Historically Produced Commodities	Estimated Cumulative Value[2] ($K)	Type of Mineral Deposit
Bear Canyon (Stevens, San Augustin)	1883	Early 1900s	Copper, silver, lead, barite	<5	RGR
Black Mountain (Kent, Organ, Gold Camp)	1883	1883-1900s	Copper, gold, silver, fluorite, lead	<78	RGR
Calumet	1900s	1914-1927	Copper, silver	0	Sedimentary copper
Cornudas Mountains	1950s	1995	Nepheline syenite	0	GPM
Franklin Mountains Tin Deposits	1900s	1900s	Tin	<5	Tin vein
Guadalupe Mountains (Two Ladies)	1930s	None	None	<1	MVT
Hitt Canyon	Unknown	None	None	0	Copper, lead, zinc skarn or carbonate-hosted deposits, iron contact-metasomatic and skarn
Lone Eagle (Golden Eagle, Lucky Strike, Great Eagle, Annon)	1905	1905-1956	Copper	8	Sedimentary copper
Northern Franklin Mountains	1914	1925-1928	Lead, silver, gypsum, jarosite, galena	<1	RGR deposits, sedimentary
Organ Mountains (Mineral Hill, Bishops Cap, Organ Gold Camp, Modoc, South Canyon, Soledad Canyon, Texas Canyon)	1830s, perhaps as early as 1797	1849-1961	Copper, lead, gold, silver, barite, fluorite, uranium, vanadium, zinc, bismuth	4,000	Carbonate-hosted lead-zinc replacement, skarn, pegmatites, epithermal/ mesothermal veins, porphyry-copper-molybdenum(?), copper breccia, RGR
Orogrande (Jarilla, Brice, Silver Hill)	1890	1890-1966	Copper, gold, lead, silver, iron, tungsten, turquoise	2,000	GPM, placer gold
Red Lake	Unknown	1900s	Copper, silver	<1	MVT
Sacramento (High Rolls)	1900	1904-1962	Copper, lead, gold, silver, zinc	100	Sedimentary copper

[1] Refer to Figure 2.26 for approximate locations.
[2] Value of production in original dollars.

Table 3.5 Summary of Statistics of Mineralized and Altered Samples Adjacent to the McGregor Range.[1]

Parameter	Average	Standard Deviation	Maximum	Minimum
Oxide (%)				
SiO_2	45.2	25.2	92.3	3.19
Al_2O_3	5.93	5.4	15.3	0.17
CaO	22.06	16.8	53.4	0.25
MgO	1.21	1.1	3.91	0.05
Na_2O	0.86	1.01	3.06	0.03
K_2O	1.62	2.1	7.55	0.03
Fe_2O_3[2]	5.42	5.6	19.0	0.12
MnO	0.29	0.6	2.81	0.01
TiO_2	0.37	0.58	2.9	0.01
P_2O_5	0.13	0.1	0.53	0.02
LOI	16.75	13.8	42.4	1.8
S	0.47	1.6	8.06	0.02
Trace (ppm)				
Ag	1	0.06	1.4	<0.5
As	112	261	1,300	1
Au[3]	4	3	11	<1
B	51	54	150	<10
Ba	869	921	3,300	<20
Be	9	15	64	<1
Bi	10	1	11	<5
Br	2	2	11	<1
Co	12	6	28	<1
Cr	47	62	310	<2
Cs	5	6	21	<1
Cu	9	10	36.6	<0.5
Hf	5	4	17	<1
Mo	10	15	73	<1
Nb	20	16	86	<10
Ni	21	19	70	<1
Pb	43	56	190	<2
Rb	84	83	283	<10
Sb	12	21	86	<0.2
Sc	6	5	15.3	<0.2
Sr	505	482	2,120	25
Ta	2	1	6	<1
Th	8	5	23	<1
U	5	2	10.9	1
V	63	39	170	<10
W	73	66	270	4
Y	24	13	53	6
Zn	221	487	2,400	12
Zr	125	95	430	19
La	24	24	93.3	0.9
Ce	47	36	130	<3
Nd	21	10	34	<5
Sm	2	2	6.4	0.1
Eu	0.8	0.5	6.4	<0.2
Tb	0.7	0.1	0.9	<0.5
Yb	2	1	5.1	<0.2
Lu	0.3	0.2	0.83	<0.05

1 Geochemical analyses are presented in Appendix 5. Total number of samples used to calculate the statistics is 27.
2 Iron is reported as total iron Fe_2O_3.
3 In ppb.

1935; Bachman and Myers 1963, 1969). Locally mineralized low-angle thrust faults in the southern portion of the range have placed Proterozoic rocks over Ordovician and Cambrian sedimentary rocks (Dunham 1935; Bachman and Myers 1969). Younger sedimentary rocks of Pennsylvanian through Tertiary age overlie the older rocks west of the district. A series of sills or dikes of presumably Tertiary age intrude the sedimentary rocks south of Bear Canyon on Quartzite Mountain (Bachman and Myers 1969; Seager 1981). These sills are sericitized, quartz-feldspar porphyry. Basaltic and dioritic dikes intrude the sedimentary rocks north of Bear Mountain and are highly altered and weathered (Bachman and Myers 1969). Normal faults are common in the southern portion of the district and locally are mineralized.

RGR barite-fluorite-galena deposits are found scattered throughout the area and are found in limestones and dolomites along the low-angle fault between the Ordovician El Paso Group and Proterozoic granite in the foothills (lower contact deposits) and within the Silurian Fusselman Dolomites beneath the Percha Shale (Devonian) along the crest (upper contact deposits) (Dunham 1935; Williams et al. 1964; Bachman and Myers 1969; Smith 1981; McLemore 1994a). The deposits consist predominantly of veins, breccia cement, cavity-fillings, and minor irregular replacement deposits along faults, fractures, unconformities, and bedding planes in dolomitic limestone. The ore bodies are 20-100 ft wide and up to several hundred feet long. Lead and barite predominate along the upper and lower contacts, and copper is abundant in a zone between the two. Malachite and azurite occur as fracture-fillings along the diorite dike. The Percha Shale and Proterozoic granitic and metamorphic rocks acted as an impermeable cap for upward migrating mineralizing fluids. Jasperiods are common. Barite, fluorite, calcite, and quartz are predominant minerals in these deposits. Locally, galena, malachite, vanadinite, and wulfenite are found. Assays as high as 2.6 oz/ton (89 ppm) silver, 12.2% copper, and 34.8% lead have been reported. Samples have assayed as high as 5.4 ppm silver, 3,600 ppm copper, 10,000 ppm lead, and 180 ppm zinc (McLemore et al. 1996c). The deposits along the upper contact near the crest are remote and inaccessible and have low mineral resource potential. The deposits along the lower contact are small and low grade and also have low mineral resource potential.

On the slope of North Quartzite Mountain, a shaft and several prospect pits expose fissure veins and replacements of barite, quartz, and iron oxides; malachite occurs along fractures at one locality. Jasperiods and brecciated zones are common. The host rock is the Fusselman Dolomite.

3.3.2 Black Mountain District

The Black Mountain District lies north of the Organ Mountains District in the southern San Andres Mountains in Doña Ana County (refer to Figure 2.26). The district, also known as Kent, Organ, or Gold Camp Districts, was discovered in 1883 by Pat Breen. The Mountain Chief and Black Mountain Mines were the only productive mines in the district (McLemore et al. 1996c) and produced less than $12,000 of copper (<10,000 lbs), gold (600 oz), silver (<1,000 oz), fluorite (1,100 tons), and some lead (Dunham 1935; Williams 1966; McAnulty 1978; McLemore 1994a; McLemore et al. 1996c). The Black Mountain District lies on the White Sands Missile Range and is closed to public access.

RGR barite-fluorite-galena deposits are found scattered throughout the Black Mountain area. These deposits are hosted by Ordovician dolomites and limestones of the El Paso Group which are in fault contact with Proterozoic granite and metamorphic rocks (Dunham 1935; Seager 1981). North- and west-trending faults cut the rocks.

The Mountain Chief Mine, the largest mine in the district (NW1/4 of Section 11, T21S, R4E), is located on the south side of Black Mountain and consists of a 60-ft shaft and prospect pits. It is an irregular

replacement body in Fusselman Dolomite and consists of gold, quartz, calcite, limonite, pyrite, and chlorite (Dunham 1935). The Percha Shale has acted as an impermeable cap to mineralization. The relatively large amount of gold production reported is unusual for these types of deposits; unfortunately, the deposits are remote and inaccessible and were not examined during this study. Two additional, but minor, prospects are found in the district. The Bighorn deposit in Section 12, T21S, R4E consists of a 500-ft adit in Paleozoic dolomite. Irregular replacement bodies of galena were developed along a vein trending N50°W. A small barite-galena deposit occurs at the summit of Black Mountain in Section 1, T21S, R4E (Dunham 1935) and is exposed by an 80-ft shaft. Percha Shale forms a cap on the deposit. Small local barite replacement deposits occur along the Fusselman-Percha contact. None of these deposits are economic.

3.3.3 Calumet District

Possible oxidized MVT deposits are found in the Calumet District, in the western Guadalupe Mountains in southeastern Eddy County, New Mexico, and northern Culberson County, Texas (refer to Figure 2.26). Carlsbad Caverns National Park lies to the northeast. The district also includes numerous small mines that lie within the Guadalupe National Park in Texas. Minor prospecting has occurred in the district since the early 1900s (J.R. Thompson 1983; Hayes et al. 1983). The only known production is from the Calumet Mines in Texas where, in 1914 and 1926-1927, approximately 66 tons of ore containing 5,256 lbs of copper and 3 oz of silver were mined (Lasky and Wootton 1933; J.R. Thompson 1983).

The Guadalupe Mountains are a gently folded and tilted fault block of predominantly Pennsylvanian and Permian sedimentary rocks that is bounded by north-trending range-bounding faults of Tertiary age. Fractures and joints are associated with anticlines and synclines in the area, which increased permeability and allowed fluids, both mineralizing and barren, to migrate through the host rocks. Many caves were formed along these channels.

The largest deposits in the district are at the Calumet Mines in Texas, where lead, zinc, copper, and iron oxide minerals occur along joints, fractures, and bedding planes in dolomites of the Seven Rivers Formation. The thin mineralized zones occur along spurs of a large graben formed by the Dog Canyon fault. Samples assayed no gold or silver, 0.01-11.6% copper, 0.001-0.004% molybdenum, 0.01-4.8% lead, and 0.5->5% zinc (J.R. Thompson 1983). Similar deposits are found at the Copper Queen Mine, Guadalupe Ridge area, Fir Canyon, Mc-Th-Pi prospect, and Devil's Den prospect in New Mexico (J.R. Thompson 1983; Corbetta 1987).

At the Queen of the Guadalupe Mine, azurite, malachite, bornite, and abundant iron oxides occur in small irregular deposits in sandstone and limestone of the Seven Rivers Formation. The shaft intersects a nearly vertical limestone cave. Samples assayed as much as 0.006 oz/ton gold, 0.004-0.01% copper, 0.001-0.02% molybdenum, 0.02-0.05% lead, and 0.1% zinc (J.R. Thompson 1983). A jasperoid sample from near the contact between the Seven Rivers and Yates Formations in the Lonesome Ridge area, south of the Queen of the Guadalupe Mine, contained 0.06 ppm silver, 5 ppb gold, 0.365% zinc, and 170 ppm lead (Corbetta 1987).

Two samples were collected from the district and assayed for this report (refer to Samples VTM97-9RM and VTM97-11RM in Appendix 5). The samples contained no silver or barium, 80-84 ppm arsenic, 10-1,300 ppm lead, and 100-4,600 ppm zinc. One sample contained 9 ppb gold. These concentrations are uneconomic.

Rock and stream sediment samples from the Guadalupe Escarpment area are enriched in zinc, cadmium, arsenic, lead, and molybdenum (Light and Domenico 1983; Light et al. 1985; Hayes et al. 1983; Corbetta 1987). These geochemical anomalies are found near the limestone-dolomite interface in algal reef deposits at or near the contact between the Seven Rivers and Yates Formations and are similar to geochemical associations found in some MVT deposits (Hayes et al. 1983).

3.3.4 Cornudas Mountains District

The Cornudas Mountains are east of the McGregor Range in southern Otero County, New Mexico, and northern Hudspeth County, Texas (refer to Figures 2.26 and 3.5). Cornudas is Spanish for the horns, suggested by the rugged rock formations. They form the northern extent of the Trans-Pecos alkaline magmatic province (refer to Figure 2.8). The Cornudas Mountains have been examined for potential deposits of uranium, beryllium, REE, niobium, gold, and silver (McLemore and Guilinger 1993; Schreiner 1994); but there has been no production except for test shipments in 1995 of nepheline syenite for use as sand-blasting material.

In the 1950s, prospectors located several areas of anomalously high radioactivity in the Cornudas Mountains and attributed it to the presence of uranium. Shallow prospect pits were dug on many of the claims in the area, but assay results were very low and the claims were later dropped with no production (refer to Figure 3.5) (Collins 1958; Warner et al. 1959; Holser 1959; Zapp 1941; McLemore 1983; Schreiner 1994). In 1956, the U.S. Atomic Energy Commission examined the area to evaluate the potential for uranium (Collins 1958), and no further work was recommended. Beryllium was first reported from the Cornudas Mountains during the 1940s (Warner et al. 1959). Alkaline igneous rocks are known to contain high concentrations of REE, niobium, zirconium, and titanium. Economically producable deposits are rare, but do occur associated with alkaline igneous complexes (Woolley 1987). A few companies have examined the Cornudas Mountains unsuccessfully for similar deposits. In 1984, Leonard Minerals Company, in conjunction with U.S. Borax Corporation, conducted an exploration program for REE, niobium, and zirconium. Mapping, sampling, and drilling northeast of Wind Mountain failed to discover any significant mineralized zones.

Addwest Minerals, Inc. began exploration and development of the Wind Mountain nepheline syenite in the Cornudas Mountains in 1991-1995 for use in manufacturing amber-colored beverage containers, flatware, and ceramics and for use as an abrasive and as roofing granules (McLemore et al. 1996a). Several small shipments of nepheline syenite were sent for testing for use as sand-blasting material. The company is presently for sale, and the future of mining at Wind Mountain is unknown.

The Cornudas Mountains consist of 10 larger sills, plugs, and laccoliths (refer to Figure 3.5 and Table 3.6) and smaller dikes and plugs that intrude relatively flat-lying limestones and other sedimentary rocks of the Hueco Limestone and Bone Spring Limestone (Permian). Mineralogy is presented in Table 3.7, and chemical analyses of the igneous rocks are presented in Table 2.5. Other dikes, sills, and plugs are buried by sedimentary cover as indicated by subsurface drilling (King and Harder 1985), geophysical surveys, and structural anomalies (i.e., folds, synclines, faults) in the overlying sedimentary rocks. Wind Mountain is one of the largest intrusives, with an approximate diameter of 1 mi, and it is mineralogically, texturally, and chemically zoned (McLemore et al. 1996a, 1996b).

The Wind Mountain laccolith consists of six mineralogical and textural zones (refer to Table 3.7 and Figures 3.6 and 3.7) (McLemore et al. 1996a, 1996b; McLemore and Guilinger 1996). The laccolith is typically gray to cream-colored and weathers to darker colors. Accessory minerals form dark-colored aggregates dispersed throughout the rock. The margin of the laccolith is foliated. The foliation dips steeply away from the center of the intrusive body. Chemical variations among the individual map units within the laccolith cannot be readily

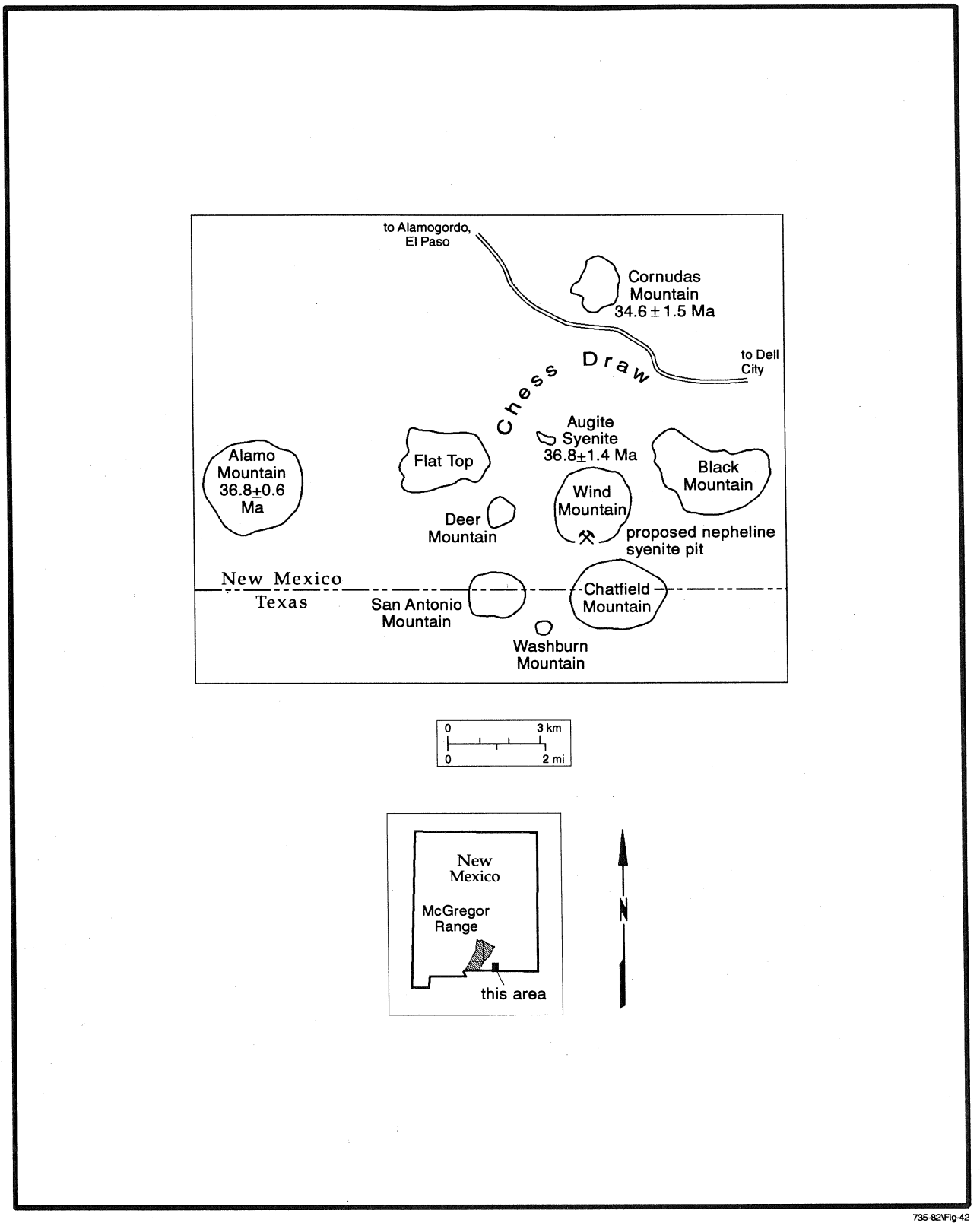

Figure 3.5 Location Map of Cornudas Mountains.

Table 3.6 Description of Igneous Intrusive Bodies Within the Cornudas Mountains.

Name	Form	Predominant Lithology	Age Ma[1]	References
Alamo Mountain	Phonolite, foliated porphyritic nepheline syenite	Discordant sheet or sill	36.8 ± 0.6 (K/Ar on biotite)	Barker et al. (1977), Clabaugh (1941), Henry et al. (1986)
Flat Top Mountain	Phonolite, augite syenite dike	Sill	na[2]	Barker et al. (1977), Clabaugh (1941)
Cornudas Mountain	Quartz-bearing syenite, syenite, trachyte	Plug or laccolith	34.6 ± 1.5 (K/Ar on biotite)	Barker et al. (1977), Zapp (1941), Henry et al. (1986)
Wind Mountain	Nepheline syenite, phonolite, porphyritic nepheline syenite	Laccolith or plug	36.32 ± 0.15 ($^{40}Ar/^{39}Ar$, hornblende; NMBMMR Argon Laboratory)	Barker et al. (1977), Warner et al. (1959), McLemore and Guilinger (1993), Nutt et al. (1997)
San Antonio Mountain	Nepheline syenite	Laccolith	na[2]	Timm (1941), Barker et al. (1977)
Deer Mountain (Little Wind Mountain)	Nepheline syenite	Plug or laccolith	33.0 ± 1.4 (K/Ar on biotite)	Barker et al. (1977), Clabaugh (1941, 1950), Henry et al. (1986)
Chatfield Mountain	Phonolite	Sill	na[2]	Timm (1941), Barker et al. (1977)
Black Mountain	Porphyritic nepheline syenite	Sill	na[2]	Barker et al. (1977)
Washburn Mountain	Porphyritic nepheline syenite	Sill	na[2]	Timm (1941), Barker et al. (1977)
Unnamed hill	Nepheline-bearing augite syenite	Plug	36.8 ± 0.6 (K/Ar on biotite)	Barker et al. (1977), Clabaugh (1941), Henry et al. (1986)

[1] Ma = million years before present.
[2] na = not available.

Table 3.7 Mineralogical Analyses of the Wind Mountain Nepheline Syenite.[1]

Unit	$TNSP_3$	Pit 2 $TNSP_2$	Coarse $TNSP_1$	Upper $TSPfg_4$	Upper $TSPfg_3$	Top $TSPfg_1$
Albite	50	64	42	65	55	60
K-feldspar	32	15	30	18	20	20
Nepheline	6	10	8	<1	<1	<1
Amphibole	8	2	2	3	4	3
Pyroxene	2	4	6	7	5	5
Zeolite	1	2	10	2	14	6
Magnetite	2	2	2	3	3	4
Mica	<1	1	<1	1	1	2
Feo and clay	11	8	7	12	12	4

[1] In percent. McLemore and Guilinger 1993.

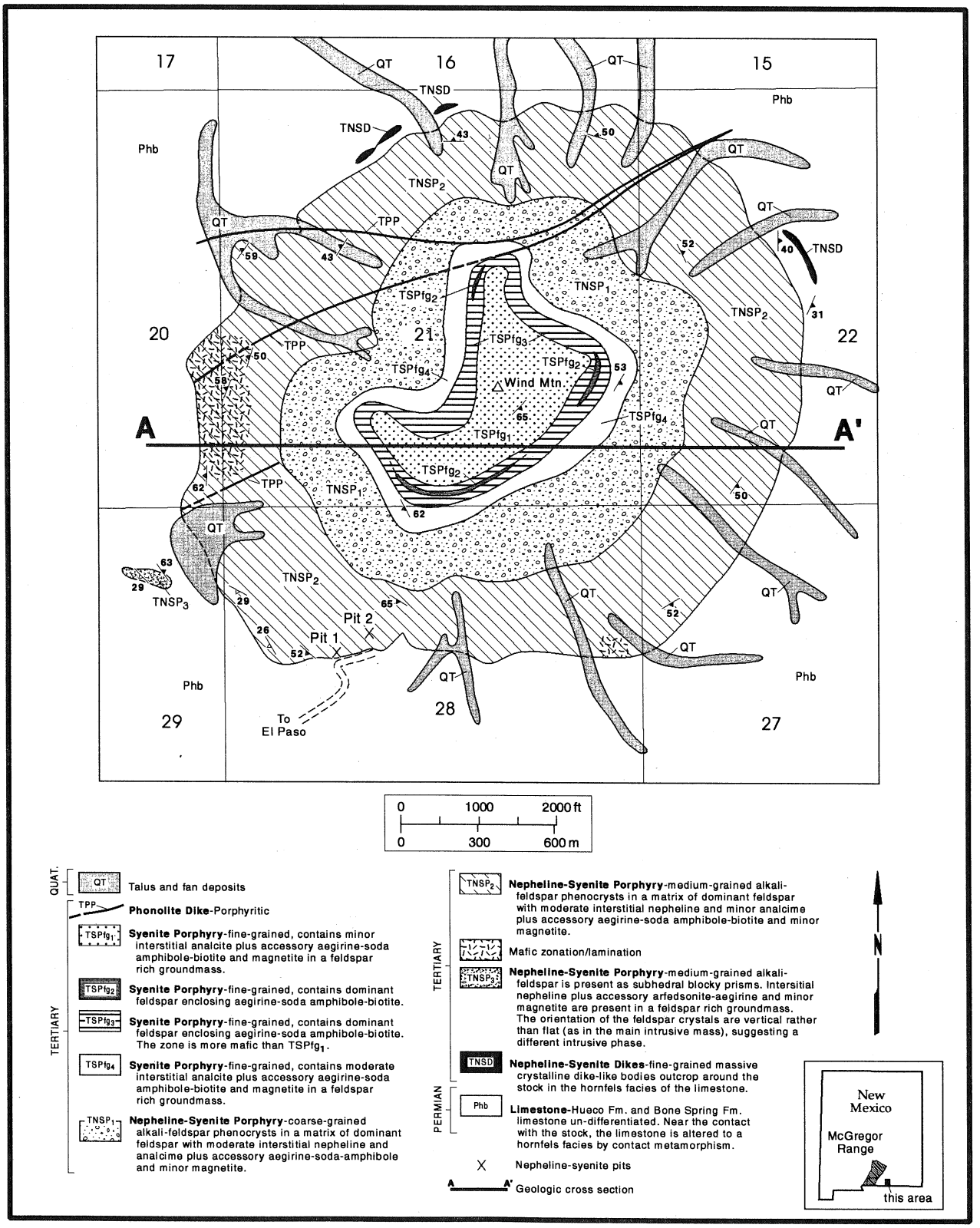

Figure 3.6 Geologic Map of Wind Mountain.

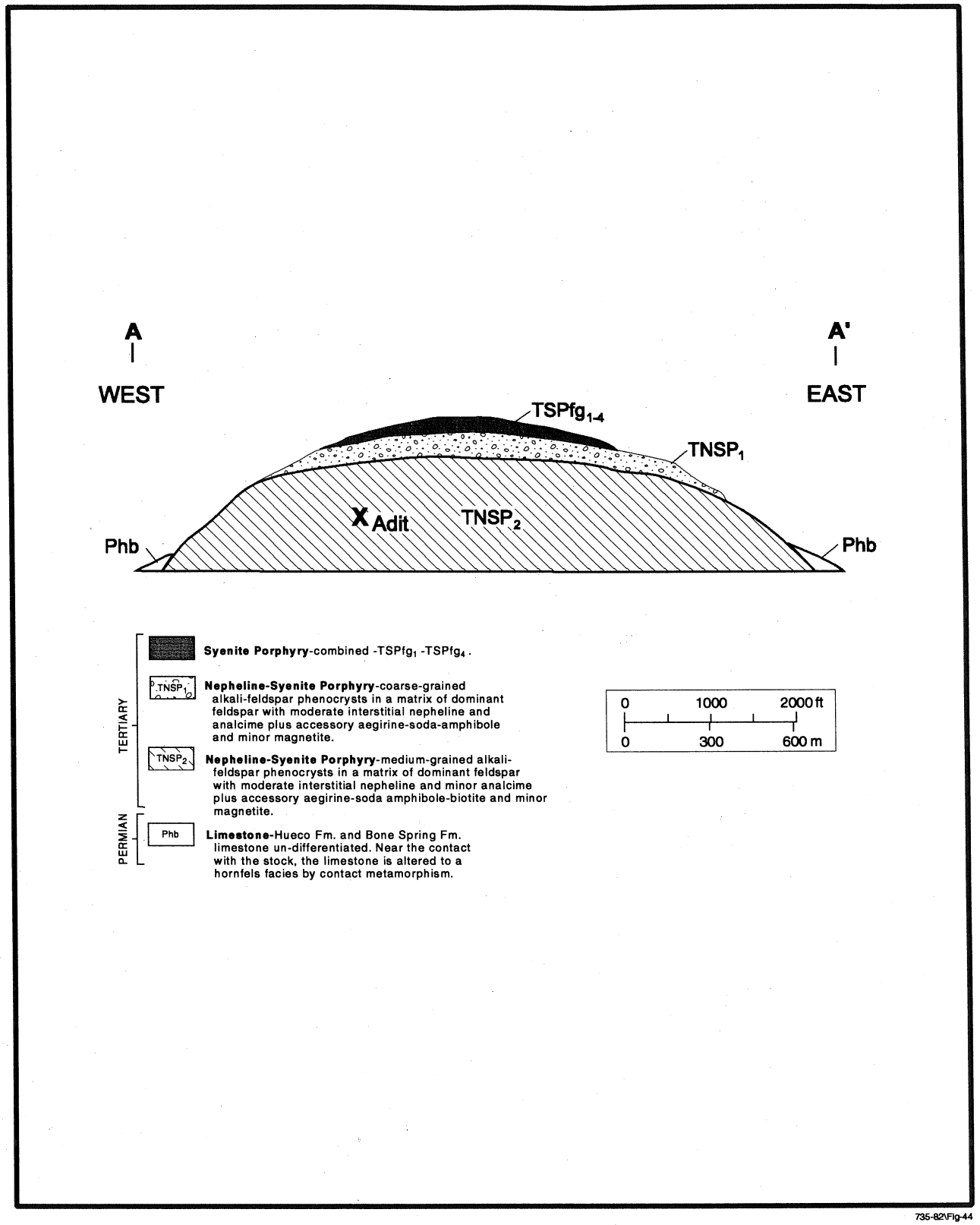

Figure 3.7 Idealized Geologic Cross Section of Wind Mountain.

discerned by utilizing major element analyses (refer to Table 3.8) (McLemore et al. 1996a, 1996b). However, significant chemical differences in barium and strontium between the nepheline syenite and syenite units are observed. The syenites contain more barium and strontium than the nepheline syenites (McLemore et al. 1996a, 1996b). These chemical analyses of the Wind Mountain laccolith suggest that the zonation appears to be controlled by crystal fractionation, volatile separation, and cooling history, not different pulses of magma (McLemore et al. 1996b). Feldspar crystallization under initially subsolvus conditions can account for most of the variations in the zones. The feldspar-rich solid forms at or migrates towards the top of the magma chamber and forms a capping syenite. Differential cooling of the magma has resulted in the textural variations at Wind Mountain. The outer zone (refer to Sample $TNSP_2$ in Table 3.7) is most suitable for use in manufacturing amber-colored beverage containers, flatware, and ceramics.

Past exploration for uranium and thorium has been unsuccessful. Uranium and thorium occur disseminated within the dikes and intrusions, but not in economic concentrations. Assays ranged from 0 to 0.8% U_3O_8 (Collins 1958) and 13-351 ppm thorium (Schreiner 1994). Aerial gamma-ray data indicate a strong positive uranium, thorium, and potassium anomaly over the Cornudas Mountains, indicating that these igneous rocks are anomalously radioactive (U.S. Department of Energy 1981b).

Past exploration for beryllium in the Cornudas Mountains was inconclusive. A few samples assayed as much as 0.2% BeO (Warner et al. 1959). Beryllium occurs in feldspar, nepheline, aegirine, and eudialite within dikes, sills, and laccoliths in the Cornudas Mountains; no beryllium minerals have been identified. North of Wind Mountain, one sample contained 150 ppm beryllium, whereas the remaining samples from that area contained less than 100 ppm beryllium (personal communication, January 1986, with U.S. Borax; Schreiner 1994).

The abundant rare mineralogies in the Cornudas Mountains (refer to Table 3.8 and Figure 3.6) suggest the area has potential for undiscovered deposits of REE, niobium, and zirconium. U.S. Borax sampled and drilled northwest of Wind Mountain, but their assays were low (up to 0.06% total rare earth oxides, 10-1,400 ppm niobium, 10-3,000 ppm zircon, 230-13,000 ppm flourine). An analysis of a dike reported by McLemore et al. (1988a, 1988b) contained 1,235 ppm cerium, 700 ppm lanthanum, 270 ppm neodymium, and 242 ppm yttrium (Sample 7368). Analyses reported by Schreiner (1994) are also low and not economically feasible, with as much as 3,790 ppm total REE, 2,332 ppm niobium, 92 ppm beryllium, and 3,137 ppm flourine. Zirconium silicates are common in the area, and assays as high as 9,919 ppm zirconium are reported (Schreiner 1994).

Eight samples of altered areas northwest of Wind Mountain in Chess Draw (refer to Figure 3.5) were assayed for gold and silver (refer to Table 3.9; McLemore and Guilinger 1993). One sample contained a trace of gold (<0.02 oz/ton) and 0.78 oz/ton silver. U.S. Borax also sampled and drilled in the area and assayed for gold and silver, but their samples contained only trace amounts. Schreiner (1994) collected and assayed 35 samples, which ranged from <5 to 20 ppb gold and <0.2 to 5.2 ppm silver. Additional sampling and drilling is required to locate any potential gold-silver deposits. However, there is little evidence for a major hydrothermal system around the intrusions that would concentrate gold and silver. Skarn deposits are possible, but those near Wind Mountain are small and barren of sulfides.

The outer zone of the Wind Mountain nepheline syenite (refer to Sample $TNSP_2$ in Table 3.7) in the Cornudas Mountains is currently being developed for use as a constituent in glass, ceramics, and flatware and for use as an abrasive. The mineral will be mined by underground room-and-pillar methods. Processing will involve crushing, grinding, magnetic separation, and screening. At full production, Wind Mountain is expected to process 3 ,000 tons per day or 700,000 tons per year. Current proven, probable, and inferred reserves total

Table 3.8 Selected Minerals and Their Occurrence Reported from the Cornudas Mountains.

Mineral	Occurrence	Reference
Anaclime	Replaces nepheline, lines vugs, vesicles and miarolitic cavities	Barker and Hodges (1977), Boggs (1985)
Natrolite	Replaces nepheline and feldspars	Barker and Hodges (1977)
Olivine	Mineral aggregates of ferromagnesian minerals and magnetite	Barker and Hodges (1977)
Aenigmatite	In nepheline syenite	Barker and Hodges (1977)
Eudialyte[1]	In dikes, sills, and laccoliths and in miarolitic cavities	Barker and Hodges (1977), Clabaugh (1950), Boggs (1985, 1987)
Catapleiite[2]	Miarolitic cavities	Boggs (1985)
Georgechaoite[3]	Miarolitic cavities	Boggs (1985), Boggs and Ghose (1985), Ghose and Thakur (1985)
Aegirine (acmite)	Miarolitic cavities	Boggs (1985, 1987)
Monazite	Miarolitic cavities	Boggs (1985)
Thomosonite	Miarolitic cavities	Zapp (1941), Boggs (1985)
Chabazite	Miarolitic cavities	Boggs (1985)
Parakeldyshite[4]	Nepheline syenite, Wind Mountain	McLemore et al. (1996a)
Pyrite	Mineral aggregates of ferromagnesian minerals	McLemore et al. (1996a)
Fluorite	Breccia	Barker et al. (1977)

1 Chemical formula of rare species: $Na_4(Ca, Ce)_2(Fe^{2+}, Mn^{2+})\ YZrSi_8O_{22}(OH,Cl)_2$.
2 Chemical formula of rare species: $Na_2ZrSi_3O_9 \cdot 2H_2O$.
3 Chemical formula of rare species: $NaKZrSi_3O_9 \cdot 2H_2O$.
4 Chemical formula of rare species: $Na_2ZrSi_2O_7$.

Table 3.9 Chemical Analyses of Samples from Chess Draw Area.[1]

Sample No.	Location	Ag (oz/ton)	Au (oz/ton)	Cu (ppm)	Hg (ppm)	Pb (ppm)	Zn (ppm)
7368	Sec. 18, T26S, R14E	0.78	tr (<0.02)	—	—	—	—
CORN 16	Sec. 18, T26S, R14E	0.00	0.00	10	0.05	15	62
CORN 17	Sec. 18, T26S, R14E	0.00	0.00	122	0.17	195	122
CORN 19	Sec. 18, T26S, R14E	0.00	0.00	27	0.02	22	34
USBM 4	NE, Sec. 18, T26S. R14E	<0.006	0.0003	9	0.02	6	43
USBM 19	SE, Sec. 20, T26S, R14E	0.15	0.0005	30	0.02	118	278
USBM 20	SE, Sec. 20, T26S, R14E	0.05	0.0006	23	<0.01	185	732
USBM 22	SE, Sec. 20, T26S ,R14E	0.15	<0.00001	42	<0.01	86	114

[1] McLemore and Guilinger 1993; Schreiner 1994.

200 million tons, for a mine life of more than 100 years (Industrial Minerals 1995). At the present, the company is for sale and the future of the project is uncertain.

3.3.5 Franklin Mountains Tin Deposits, Texas

The Franklin Mountain tin deposits are on the east side of the mountains in the Proterozoic Red Bluff Granite (refer to Figure 2.1). Geochemical evidence presented by Norman et al. (1987) suggests that the Red Bluff granites were formed by fractional crystallization of mantle-derived basalts. Approximately 8 tons of tin were mined in the early 1900s from six veins (Harbour 1972; Goodell 1976). The veins strike N70°W to west with a vertical dip and consist of quartz and cassiterite, with minor amounts of fluorite, topaz, tourmaline, wolframite, and pyrite (Goodell 1976). They are as much as 6 ft thick and pinch and swell along strike. Samples assayed as much as 62.94% tin; one sample contained 11.65% tin, 0.03% antimony, 0.04% lead, and 0.23% copper (Goodell 1976). These deposits were probably formed by late- or post-magmatic fluids, similar to the Cornwall tin deposits in England (Norman et al. 1987; London and Manning 1995).

3.3.6 Guadalupe Mountains District

Possible oxidized MVT deposits are found in the Guadalupe Mountains (Two Ladies) District in the eastern Guadalupe Mountains, southeastern Eddy County (refer to Figure 2.1). Carlsbad Caverns National Park lies north and Guadalupe National Park lies southwest of the district. Minor prospecting has occurred in the district since the early 1930s. There is no known production from the district.

The Guadalupe Mountains are a gently folded and tilted fault block of predominantly Pennsylvanian and Permian sedimentary rocks that are bounded by north-trending faults of Tertiary age. Faults, fractures, and

joints associated with anticlines and synclines in the area increased permeability and allowed fluids, both mineralizing and barren, to migrate through the host rocks. Many caves were formed along these channels.

Possible oxidized MVT deposits occur in brecciated dolomite. Only three deposits are known: the Jurnigan gossan (Hill 1996), Wallace Smith, and Two Ladies prospects (North and McLemore 1986). The largest deposit is the Two Ladies prospect, where a pod-shaped deposit, approximately 100 ft long, replaces brecciated limestone. The deposit consists of iron oxides, calcite, and quartz and trace galena, smithsonite, and hemimorphite. Samples contained 0.32-2.34 oz/ton silver and 27% zinc (personal communication, 1993, with Robert North). The other two deposits are smaller than the Two Ladies and consist of primarily iron oxides, calcite, and quartz.

Two samples were collected from this district and assayed for this report (refer to Samples VTM97-8RM and VTM97-10RM in Appendix 5). The samples contained no silver, 62-80 ppm arsenic, 10-3,400 ppm lead, and 100-3,100 ppm zinc. These concentrations are uneconomic.

3.3.7 Hitt Canyon, Franklin Mountains, Texas

Copper is found in Proterozoic Castner Marble near the contact with Proterozoic granite in Hitt Canyon in the Franklin Mountains, just south of the New Mexico-Texas state line (refer to Figure 2.1) (Harbour 1972; Deen 1976; Goodell 1976). Small discontinuous contact-metasomatic deposits at Hitt Canyon consist of bornite, pyrite, covellite, chalcopyrite, marcasite, and pyrrhotite (Deen 1976; Goodell 1976). A sample assayed 5.84% copper, 0.016% lead, and 0.81% zinc (Goodell 1976). Shallow prospect pits have exposed the deposits. In addition, iron deposits have replaced the Castner Limestone (Proterozoic), where the limestone has been intruded by granite, approximately 1.8 mi south of the state line. Iron occurs as siderite and rarely exceeds 40% iron (Harbour 1972). Similar deposits may occur in Proterozoic rocks that occur beneath the northern Franklin Mountains in New Mexico. Similar deposits may occur in the subsurface, since two petroleum tests, Turner No. 1 State and LeFors No. 1 Federal, encountered marble at depth (refer to Table 2.1).

3.3.8 Lone Eagle District

The Lone Eagle Mining District is named after the Lone Eagle Mine that is also known as Lucky Strike, Golden Eagle, Great Eagle, and Ammon property and is northwest of Carlsbad, New Mexico (refer to Figure 2.1). The Lone Eagle deposit was discovered in the early 1900s, and in April 1929, it was sold by H. and Ola Davidson to the Carlsbad Copper Company (Hill 1996). Numerous additional small brecciated zones contain iron oxides and may represent small oxidized MVT deposits. Small uraniferous limestone and sandstone occurrences are also found throughout the district (McLemore 1983).

The Lone Eagle Mine is the largest of the sedimentary copper deposits in the district and occurs in sandstones of the Yates Formation. Malachite, azurite, and chalcocite are disseminated throughout the sandstone as cement and replacements of grains and also coat fracture surfaces. The mine is along an anticline (Motts 1962). The deposit consists of predominantly copper (as much as 2.51% copper) (Hill 1996), with minor concentrations of lead (2,590 ppm) (Hill 1996) and uranium (0.004% U_3O_8) (McLemore 1983).

Numerous small brecciated zones in limestones and dolomites of the Yates and Seven Rivers Formations contain iron oxides and may represent small oxidized MVT deposits. These deposits consist of iron oxides, calcite, marcasite (locally), and possibly smithsonite in brecciated and altered limestones and dolomites.

Two samples were collected from the district and assayed for this report (refer to Samples VTM97-12RM and VTM97-18RM in Appendix 5). The samples contained <0.5-1.4 ppm silver, 6-10 ppm lead, 31.5-13,300 ppm copper, and 13-170 ppm zinc. These concentrations are uneconomic.

3.3.9 Northern Franklin Mountains District

The Northern Franklin Mountains District, discovered in 1914, is in the New Mexico portion of the northern Franklin Mountains which extend southward into Texas (refer to Figures 2.1 and 3.8). Small amounts of lead and silver were produced in 1914 from an RGR deposit. This deposit lies within a portion of the McGregor Range not included in this report. Jarosite and gypsum also have been produced from the area.

The northern Franklin Mountains consist of Ordovician through Permian carbonates and shales (Harbour 1972; Kelley and Matheny 1983). These rocks have been folded, possibly during the Laramide compressional event. North-trending low-angle and high-angle normal faults cut the Paleozoic rocks in places (Kelley and Matheny 1983). Quaternary piedmont and alluvial deposits form the lower foothills, covering the older rocks.

RGR deposits, consisting of veins and small replacement pods of galena, barite, fluorite, calcite, iron oxides, and quartz, occur along a fault in dolomitic limestones of the Silurian Fusselman Dolomite and Devonian Sly Gap Formation (refer to Figure 3.9). Dunham (1935) reports an assay of 4 oz/ton silver from one vein in the SE¼ of Section 32, T25S, R4E, and states that small shipments of argentiferous galena were made. Assays of samples collected by McLemore et al. (1996c) and for this report are presented in Table 3.10 and Figure 3.9. The largest vein is steeply dipping, less than 3 ft wide, and several hundred feet long. Brecciation and jasperoids are common in the canyon.

The Copiapo Jarosite Mine is located in the northern Franklin Mountains at Webb Gap south of the McGregor Range (refer to Figure 3.8; NE¼ of Section 8, T26S, R4E). Development consists of a 200-ft inclined shaft with four levels and six prospect pits (McLemore et al. 1996c). Several hundred tons of material were mined in 1925-28 by F. Schneider Co. for use as pigment in paints.

The deposit occurs along a north-trending, low-angle fault zone (N10°E 40-50°E) within the Bishop Cap Member of the Magdalena Group (Pennsylvanian) (Kelley and Matheny 1983; McLemore et al. 1996c). At the shaft, the deposit is 10-15 ft wide for an approximate length of 100-200 ft. The deposit pinches out to the north; a drift at the 100-ft level is 20 ft long to the north and 100 ft long to the south (Dunham 1935). The deposit thins to the south (<10 ft wide) for approximately 1,000 ft. The host limestone strikes N13°W and dips 40°W.

The deposit consists of veins and replacement bodies along the fault zone and contains jarosite (red to yellow to orange), limonite, hematite (red to black to brown), fluorite (white), gypsum, calcite, and aragonite. Malachite stains are reported coating fractures at the bottom of the shaft (Dunham 1935). Jarosite occurs only within the upper 100 ft. A crude zonation is present. The zone adjacent to the footwall consists of black to dark brown hematite and limonite and is approximately 1-2 ft wide. Dump material from this zone had greater assay values of copper, zinc, iron, and molybdenum than the other zones (McLemore et al. 1996c). Jarosite, limonite, and hematite of various colors form the central zone, which ranges in thickness from 2 to 10 ft. Assays of selected samples from this zone range from 0.04 to 3.14 oz/ton silver, 10 to 16 ppm copper, 27 to 61 ppm lead, 120 to 240 ppm zinc, and 2 to 29% iron (McLemore et al. 1996c). The outer zone, adjacent to the hanging wall, consists of white calcareous to

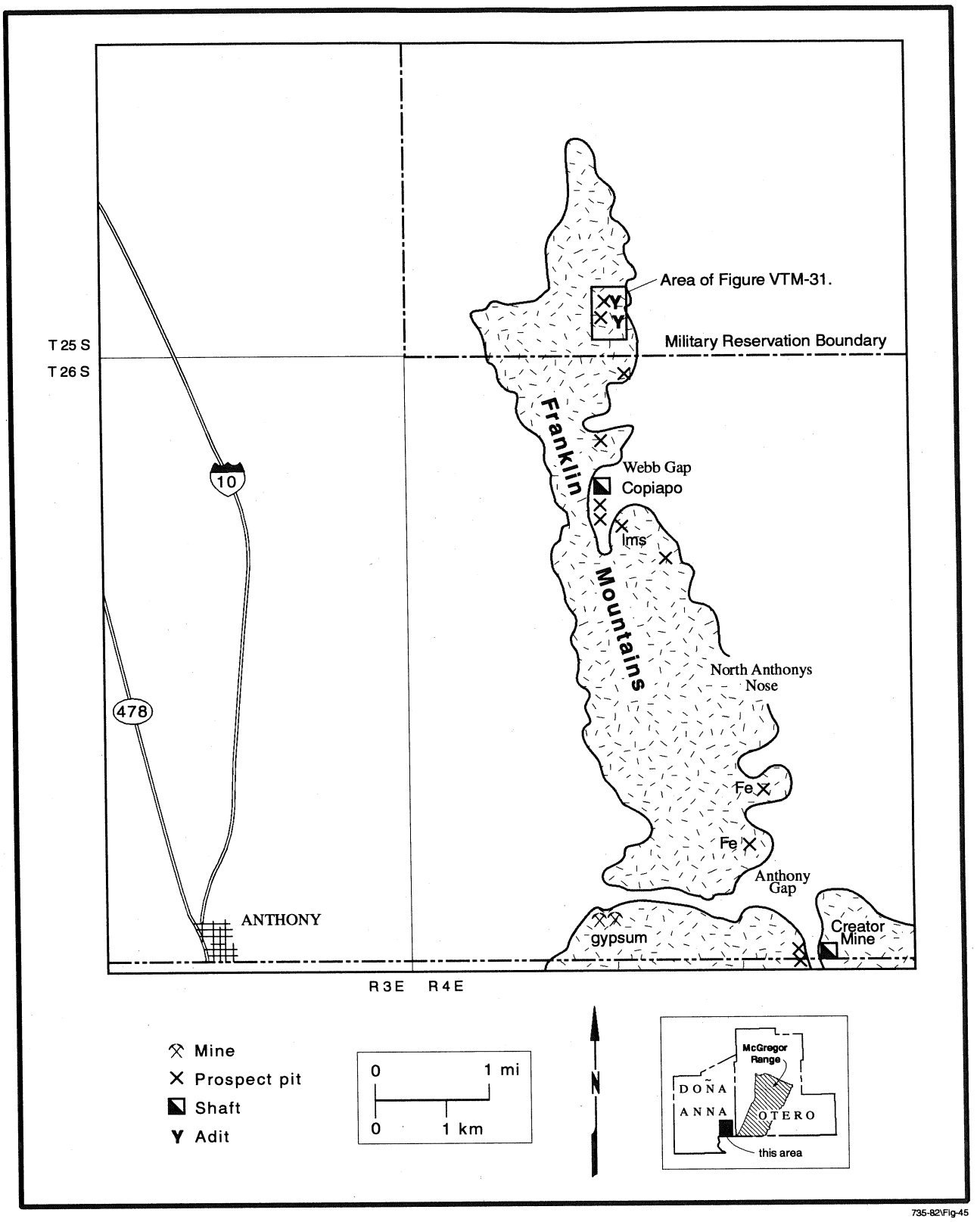

Figure 3.8 Mines and Prospects in the Northern Franklin Mountains Mining District.

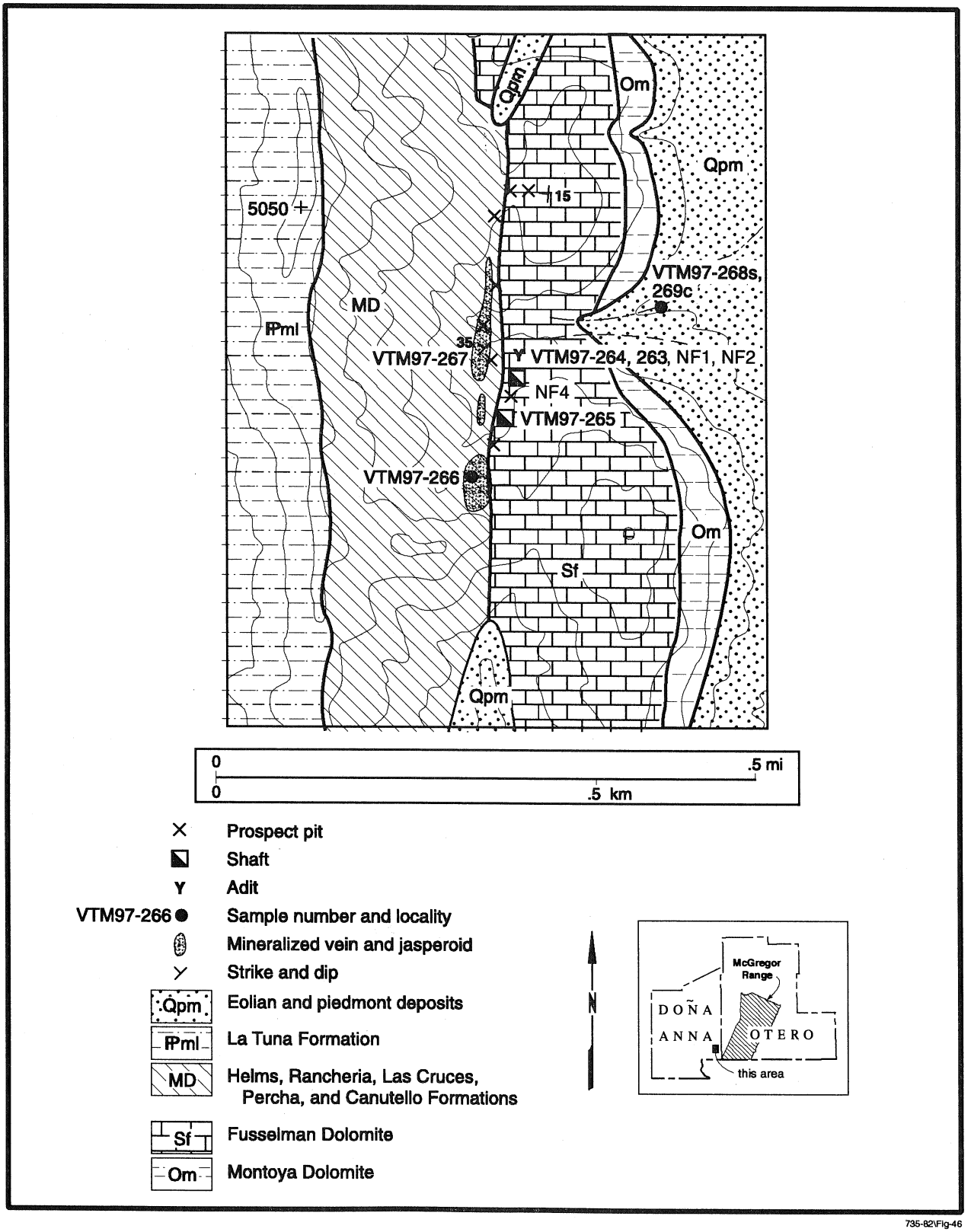

Figure 3.9 Rio Grande Rift Barite-Fluorite-Galena Deposits in the Northern Franklin Mountains.

Table 3.10 Selected Chemical Analyses of Samples Collected from the Northern Franklin Mountains District.[1]

Field No.	Lab No.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ba (ppm)	Description
NF1	579	BD	BD	54	93	190	BD	4-ft chip sample along face at end of adit
NF2	580	BD	BD	<50	7,500	5,400	BD	Select sample of dump at adit
NF4	581	BD	BD	<50	18,000	86	BD	Grab sample of dump of 50-ft shaft
VTM97-263	--	<1	11	15.3	9,500	7,700	300,000	4-ft chip sample across vein, 40 ft in adit
VTM97-264	--	<1	5.9	4.8	1,200	12,000	210,000	Select dump at adit
VTM97-265	--	<1	20	3.4	2,200	260	270,000	Select dump at shaft
VTM97-266	--	7	0.7	5.4	29	15	890	25-ft chip sample across jasperoid
VTM97-267	--	3	1.2	7	28	460	12,000	Select sample of dump at pit

[1] SE of Section 32, T25S, R4E. Analyses of NF1, NF2, and NF4 from McLemore et al. (1996c) by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by fire assay after aqua regia digestion). Other analyses by XRAL for this report (Appendix 5). BD = below detection limit (0.02 oz/ton). Sample locations are shown in Figure 3.9.

clayey material with zones of hematite and jarosite cutting it. A channel sample across this zone had the least amounts of metals (McLemore et al. 1996c). Fluorite occurs in the bottom of the shaft (personal communication, November 1996, with V. Lueth). An $^{40}Ar/^{39}Ar$ age date on jarosite from the deposit is 4.96-5.98 Ma (Lueth and Goodell 1996).

The origin of the deposit is speculative; the minerals are poorly crystalline to very-fine grained, which is consistent with an origin similar to that of RGR deposits. The mineralogy and crude zonation are also suggestive of a basin dewatering (RGR deposits) or a supergene origin. The age of the jarosite is consistent with either origin. Sulfur isotope analyses are required to confirm a supergene origin. It is possible that this deposit overlies epithermal base or precious metal deposits, but drilling would be required to confirm their presence. The economic potential for future use as paint pigment is probably low because of the small size and the distance from paint manufacturers.

Additional small isolated occurrences of jarosite, limonite, and hematite occur throughout the limestones in Sections 22 and 27, T26S, R4E. These occurrences are predominantly fracture coatings and are uneconomical to produce.

3.3.10 Organ Mountains District

The Organ Mountains District is northwest of the McGregor Range in Doña Ana County (refer to Figure 2.1) and includes the Mineral Hill, Bishops Cap, Organ Gold Camp, Modoc, South Canyon, Soledad Canyon, and Texas Canyon subdistricts. Mineralization was discovered in the 1830s and perhaps

as early as 1797 (Dunham 1935). Metal production from the district amounts to $2.7 million worth of copper, lead, zinc, silver, and gold (McLemore et al. 1996c). Other production from the Organ Mountains District amounts to 600 tons of barite; 1,650 tons of fluorite; 14 lbs of uranium; and 9 lbs of vanadium (McLemore et al. 1996c). Bismuth occurs locally; a small amount was produced from the Texas Canyon Mine (Dasch 1965), and other ore shipments were penalized for bismuth at the smelter. Uranium and barite were produced from the Bishops Cap area (Williams et al. 1964; McLemore 1983; McLemore et al. 1996c). In addition, local occurrences of iron, manganese, molybdenum, tin, tellurium, and tungsten are reported. Numerous mines and prospects occur in the district (McLemore et al. 1996c).

In the 1960s through the early 1980s, several companies examined the Organ Mountains for potential copper-molybdenum porphyry deposits. Kerr-McGee Mining Corporation drilled 18 holes in 1963. AMAX Inc. drilled six holes in 1969, followed by six more holes in 1970 by Bear Creek Mining Company. Conoco, Inc. drilled 14 holes between 1972 and 1976. More than 60 drill holes have been drilled northeast of Organ Mountains, ranging in depth from 195 to 3,100 ft (Newcomer and Giordano 1986). Lithology, alteration assemblages, mineral zoning, and stockwork veining suggest that a porphyry-copper and/or porphyry-copper-molybdenum deposit(s) may occur in the Organ Mountains District. Drilling has not delineated any ore bodies, but assays range from 0.001% to 0.065% copper and as high as 0.15% molybdenum (Newcomer 1984; Newcomer and Giordano 1986).

The Organ Mountains form a west-tilted block exposing rocks ranging in age from Proterozoic through Quaternary. The oldest rocks in the area are Proterozoic granitic rocks which are overlain by as much as 8,500 ft of Paleozoic sedimentary rocks, mostly of marine origin (Seager 1981). These rocks were deformed during the Laramide compressional event. In the Oligocene, the Organ batholith and volcanic rocks associated with the Organ caldera were emplaced (Seager 1981; Newcomer and Giordano 1986; Seager and McCurry 1988). The Organ batholith is a complex pluton made up of multiple intrusions (Seager 1981; Seager and McCurry 1988); three major phases are the granite of Granite Peak, Sugarloaf Peak quartz monzonite, and Organ Needle quartz syenite. The Sugarloaf Peak quartz monzonite has been dated at 34.4±0.3 Ma ($^{40}Ar/^{39}Ar$, hornblende; McLemore et al. 1995). All three phases are related to mineral deposits. Rhyolite dikes have intruded the Organ batholith locally and also are related to mineralization. Uplift and erosion produced younger sedimentary deposits and the rugged topography characteristic of the Organ Mountains.

Six types of mineral deposits are found in the Organ Mountains District (Dunham 1935; Seager 1981; Seager and McCurry 1988; McLemore et al. 1996c). Different types of classifications have been used to describe the deposits in the Organ Mountains. For the purposes of this report, the deposits are grouped as disseminated and veinlets of copper-molybdenum mineralization, copper breccia deposits, carbonate-hosted lead-zinc replacement and skarn deposits, epithermal/mesothermal gold-silver veins, pegmatites, and fluorite deposits (McLemore et al. 1996c). Major mines and/or prospects of each type of deposit are described below, based on field observations, published descriptions, and unpublished accounts.

The deposits form five metal zones (refer to Figure 3.10). Disseminated and veinlets of copper-molybdenum mineralization form a core, surrounded by zinc-lead, lead-zinc, gold-silver, and outer fluorite-barite zones (refer to Figure 3.10). This district-wide zoning is best preserved in the northern Organ Mountains where disseminated copper and molybdenum mineralization has been encountered in drill holes northwest of Organ Mountains and may represent a faulted portion of a porphyry-copper and/or copper-molybdenum deposit (refer to Figure 3.10) (Newcomer and Giordano 1986). A zone of disseminated and veined pyrite occurs to the east at San Augustin Pass in the Sugarloaf Peak quartz monzonite, the last and most volatile-rich phase of the Organ batholith, that forms the center of the northern

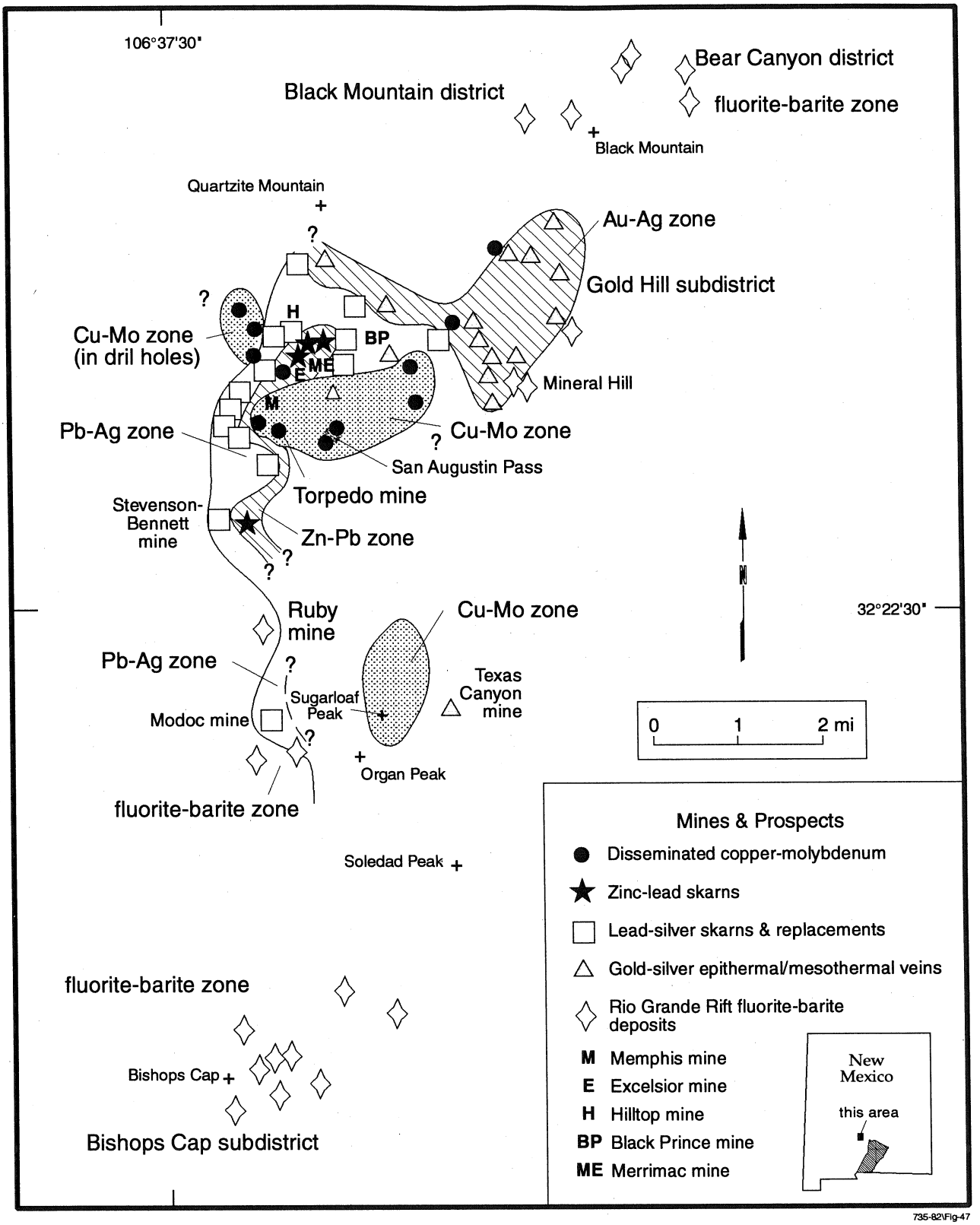

Figure 3.10 District Zoning in the Organ Mountains.

part of the district. Silver-bearing pegmatites, dated at 30.8±0.1 Ma ($^{40}Ar/^{39}Ar$, K-feldspar), occur near San Augustin Pass in the Sugarloaf Peak quartz monzonite (Dunham 1935; McLemore et al. 1995). Copper-breccia deposits occur west of the Sugarloaf Peak quartz monzonite at the Torpedo and Memphis Mines. A transition from disseminated copper and molybdenum to copper skarns and breccias to zinc-lead skarns and replacement deposits occurs in carbonates northwest of the Memphis Mine and near the Excelsior Mine in the northern portion of the district (Lueth 1988). The Homestake and Memphis deposits are zinc-lead skarns. The Merrimac Mine is predominantly zinc replacements; lead with silver becomes more dominant to the east. The Hilltop and Black Prince Mines are predominantly carbonate-hosted lead-silver deposits. The Stephenson-Bennett Mine is a carbonate-hosted lead-silver and zinc-lead replacement deposit (polymetallic replacement). Gold and silver epithermal/mesothermal veins occur in the Proterozoic rocks in the Gold Hill area, east of the Sugarloaf Peak quartz monzonite (refer to Figure 3.10) (McLemore et al. 1996c). Silver decreases to the north and barite becomes dominant. The Modoc and Orejon deposits along the west side of the Organ Mountains are lead-zinc skarn and replacement deposits and may be related to a third copper-molybdenum zone in the central Organ Mountains near Organ Peak (refer to Figure 3.10). An outer zone, surrounding the Organ Mountains batholith, consists of RGR barite-fluorite deposits, locally with copper, lead, silver, uranium, and vanadium. Examples include the Bishops Cap (refer to Figure 3.10) and Ruby Mines.

Carbonate-hosted lead-zinc replacement and skarn deposits are the most economically important types of deposits in the Organ Mountains. They typically consist of malachite, galena, sphalerite, and galena in a gangue of calcite, quartz, pyrite and locally garnet and epidote. The epithermal/mesothermal gold-silver veins at Mineral Hill consist of banded, vuggy quartz, massive calcite, and vugs shaped as cubes, indicating the former presence of pyrite. Locally, quartz is bladed after calcite, indicating boiling occurred. Argillic alteration is common with local epidote present. Locally, pyrite, hematite, malachite, chalocpyrite, bornite, galena, sphalerite, and acanthite are present in the veins. Some of the largest fluorite deposits are RGR veins and replacements at Bishops Cap in the southwestern portion of New Mexico. These deposits consist of narrow veins along faults and bedding planes and irregular replacement deposits in the Fusselman Dolomite, Canutillo, Rancheria, and La Tuna Formations. Fluorite with uranium minerals, barite, quartz, calcite, and trace amounts of galena occurs in limestone. Production has amounted to 150 tons of fluorite. Veins and replacement bodies are 20-40 ft long and up to 2 ft thick. A sample assayed 6.8% $BaSO_4$ and 40.1% CaF_2. Jasperiods are common.

Brucite and magnesite also occur in the southern Organ Mountains as xenoliths within the Organ batholith (Dunham 1935). Some of the xenoliths are up to 1,000 ft long and 500 ft wide. Pits have exposed portions of the magnesite. The area is west of the McGregor Range and has restricted access because of unexploded ordnance, thus it was not examined for this study. Magnesite is also reported to occur in the northern Organ Mountains, where magnesite has replaced Montoya and Fusselman Dolomite.

Marble occurs sporadically along the intrusive contact between the limestone and rhyolite and quartz monzonite porphyry north of Organ (Dunham 1935; Seager 1981). The marble is typically white and locally contains disseminations of pyrite, garnet, and epidote. One of the largest deposits is at the Hilltop Mine, where the adit penetrates approximately 300 ft of white marble interbedded with unaltered limestone. The economic potential of these marble deposits is probably low because of small size, distance to potential markets, and location within the White Sands Missile Range.

Alteration, mineralization, and drilling indicate that at least three copper-molybdenum porphyry systems probably occur in the Organ Mountains, but the potential for an economic deposit is low (Luddington et al. 1988). The potential for copper breccia, skarn, carbonate-hosted lead-zinc, epithermal/mesothermal

gold-silver vein, and fluorite deposits in the Organ Mountains is moderate (Luddington et al. 1988). Other metals occur in the district, such as bismuth (Dasch 1965), tungsten, tellurium, tin, and manganese. The Torpedo Mine contains an estimated 600,000 tons of 4-5% copper in reserves (Soulé 1951). The Stephenson-Bennett Mine contains an estimated 35,000 tons of ore grading 2.9 oz/ton silver, 10.55% lead, and 13% zinc (Jeske 1987). The Ruby Mine contains an estimated 230,000 tons of 18% CaF_2 (Jeske 1987). Similar deposits probably do not occur on the east McGregor Range because of the absence of intrusive quartz monzonites similar to the Organ Mountains batholith. In addition, there are no geologic indications that a caldera similar to the Organ caldera exists in the east McGregor Range.

3.3.11 Orogrande District

The Orogrande District, also known as Jarilla, Brice, and Silver Hill Districts, is located south of Alamogordo and west of the small community of Orogrande (refer to Figure 3.11). Orogrande is Spanish for "big gold." Turquoise was probably first mined from the district by Native Americans before the 1880s. In 1891, 50 kg of turquoise stones were produced from the district (Weber 1979). The first patented claim was the Grizzly Bear in 1890; soon 33 additional patents followed. Between 1898 and 1921, two mining camps, Brice and Ohaysi, were established (Heylmun 1985). A railroad spur was built between the town of Orogrande and the mines.

In 1905, the Southwest Smelting and Refining Co. consolidated many of the mining claims and built a 250-ton copper matte smelter in Orogrande in 1907, but it closed in 1908 (Kelley 1949; Anderson 1957). The smelter was sold to Orogrande Smelting Co. in 1909 and resumed operation until 1910. The smelter is north of the town of Orogrande in the SE¼ of Section 14, T22S, R8E.

In later years, copper production was shipped to the ASARCO smelter in El Paso. The iron deposits were extensively mined until about 1913. The railroad was later extended from Ohaysi to the Cinco de Mayo Mine, where iron was produced until 1921. Less than 259,000 tons of iron ore worth approximately $500,000 were produced during that time (Kelley 1949; Harrer and Kelly 1963). A jigging plant operated until 1921. Total production from the district from 1879 to 1966 is estimated as 16,500 oz gold, 50,000 oz silver, 5.7 million lbs copper, and 158,000 lbs lead. In 1916, 6,656 tons of tungsten ore were produced from the district (Finley 1922). Total iron ore production was approximately 260,000 tons.

Bear Creek Mining Co. drilled in the district in 1976. In 1979, Anaconda Copper Co. discovered a low-grade porphyry molybdenum deposit averaging 0.03% molybdenum. Later drilling resulted in the discovery of tabular skarn deposits that contain 335,500 tons of ore grading 0.05 oz/ton gold and 0.7% copper at depths up to 80 ft (Strachan 1991).

The Jarilla Mountains (refer to Figure 2.1) consist of a core of granodiorite surrounded by monzonite (Seager 1961; Schmidt and Craddock 1964; Beane et al. 1975; Bloom 1975). The granodiorite exposed in the Jarilla Mountains has been dated at 47.1±1.8 Ma (potassium-argon, biotite) (Beane et al. 1975). Phlogopite from a copper skarn has been dated at 42.8±1.6 Ma (potassium-argon). In the southern part of the Jarilla Mountains, the monzonite crosscuts a quartz latite (Beane et al. 1975). A large number of granodiorite, monzonite, andesite, and diabase dikes and sills cut the larger intrusions, as well as the surrounding sedimentary rocks.

The surrounding sedimentary rocks consist of Pennsylvanian Panther Seep Formation through Permian Hueco Formation (Strachan 1976). The limestones and shales adjacent to parts of the intrusions have been metamorphosed to three types of skarns: pyroxene-scapolite-garnet adjacent to granodiorite,

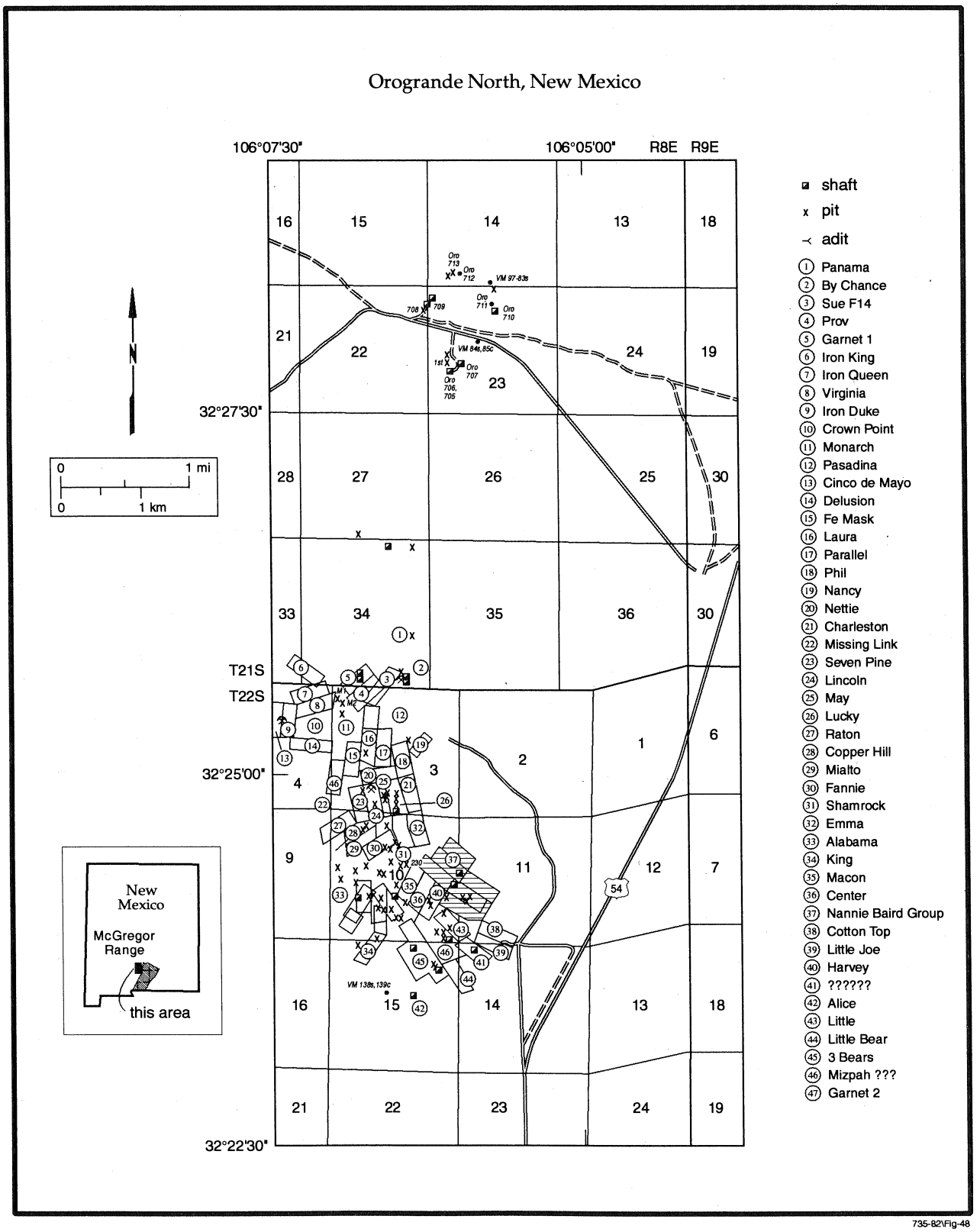

Figure 3.11 Mining Claims, Mines, and Prospects in the Orogrande District.

epidote-garnet-calcite adjacent to monzonite porphyry, and pyroxene-scapolite-garnet-epidote-calcite adjacent to dikes and granodiorite (Beane et al. 1975). Xenoliths and/or roof pendants are common within the granodiorite and are also metamorphosed.

North and McLemore (1986, 1988) and McLemore (in press) classified the deposits in the Orogrande Mining District as GPM deposits. There are four types of deposits in the district: contact-metasomatic and replacement iron, placer gold, copper and copper-lead skarns and replacement, and vein deposits. In addition, alteration and mineralization have suggested to many geologists that a copper-molybdenum porphyry or copper-gold porphyry may occur at depth.

Distribution of mineralization and alteration led Beane et al. (1975) to suggest that a porphyry copper-molybdenum deposit may lie at depth. Potassic alteration occurs near the Cinco de Mayo Mine, where intensely fractured monzonite is cut by quartz and K-feldspar veinlets; fractures are typically coated with secondary copper minerals. Phyllic alteration locally overlaps the potassic alteration and is characterized by quartz-sericite replacements and veinlets; mafic minerals are typically altered beyond recognition.

Copper and copper-lead skarns and replacement deposits have been the most productive of the base metal deposits in the district. Pyrite and chalcopyrite occur in the garnet-scapolite skarns adjacent to the monzonite, with abundant magnetite occurring locally. The Garnet (No. 1) Mine (refer to Figure 3.11) is one of many copper and copper-lead skarns and replacement deposits in the district and is located in Section 34, T21S, R8E. Historical production from 1905 to 1939 from the mine includes 19,525 tons of ore grading 0.12 oz/ton gold, 0.47 oz/ton silver, and 3.22% copper worth $15,000. A garnet skarn is exposed at the lower level workings which is 43 ft long, 22 ft wide, and a minimum of 23 ft thick. The skarn consists predominantly of garnet, with lesser amounts of malachite, pyrite, chalcopyrite, calcite, and chert.

The Three Bears Mine (refer to Figure 3.11), also known as Grizzly Bear, Cinnamon Bear, and Little Bear, is developed by a shaft 525 ft deep with five levels and extensive underground workings. The shaft was driven along a copper-garnet skarn, which is also exposed along the western hillside. The skarn along the western hillside is approximately 60 ft wide.

A spectacular exposure of a skarn is seen at the Cinco de Mayo-Iron Duke (refer to Figure 3.11) open cut and adits in the NE of Section 4, T22S, R8E. Alternating beds 3-15 ft thick of black magnetite-hematite, white marble, and green garnet occur in a thickness of approximately 50-130 ft. Iron was produced from the mine, although chalcopyrite and malachite are also common. The garnet zones also contain as much as 50% calcite, iron oxides, pyrite, actinolite, quartz, chalcopyrite, and malachite. The magnetite-hematite layers also contain garnet, pyrite, actinolite, calcite, fluorite, and chalcopyrite. Ore shipments contained 54.35% iron, 0.056% phosphorus, 10.55% SiO_2, 0.31% manganese, 0.66% Al_2O_3, 4.51% lime, 0.58% magnesium, 1.08% sulfur, and 0.11% copper (Kelley 1949).

Placer gold deposits have been worked along several arroyos and the southeastern slopes of the Jarilla Mountains. Alluvial fans and pediment surfaces border the steep rugged hills forming the Jarilla Mountains. Many of these alluvial fans and resulting drainages contained or may contain placer gold. The gravels are reported to assay $1/yd^3 (Anderson 1957) or approximately 0.05-0.2 oz/yd^3 (Heylmun 1985). Placer gold is reported as 940 fine (Jones 1904; Anderson 1957). The largest gold nugget reported from the district was collected in 1904, weighed 6.5 oz, and was valued at $123 (Jones 1904). The best gold values are found in red- to brown-stained stream gravels lying directly on bedrock or caliche hardpan (Heylmun 1985). Most streams in the Jarilla Mountains carry some placer gold, but the higher grade

deposits are downstream of rich lode deposits. Some trenches are as much as 15 ft deep, which is probably the average thickness of the gold-bearing alluvial deposits.

Most iron skarn and replacement deposits also contain trace amounts of copper. The iron deposits are similar to the copper and copper-lead skarns and replacement deposits described above. They are found in garnet-diopside skarns adjacent to the monzonite; the largest are in Ohaysi Valley. The average geochemical analyses of iron ore produced from the Orogrande District until 1949 was 55.8% iron, 0.051% phosphorus, 9.8% SiO_2, 0.23% manganese, 0.50% Al_2O_3, 3.81% CaO, 0.51% MgO, 0.91% sulfur, and 0.09% copper (Kelley 1949).

Vein deposits are variable in extent and composition. Calcite veins containing chalcopyrite and gold occur along faults such as the Nannie Baird Mine (refer to Figure 3.11). Mineralized, fractured, and brecciated zones of veinlets, fracture coatings, and disseminations of chalcopyrite, malachite, azurite, and pyrite occur within altered monzonite.

Garnet skarns are common throughout the district and are similar to the copper and copper-lead skarns described above. Most garnet skarns contain trace to major amounts of chalcopyrite and/or magnetite. Garnet contents vary as high as 80%. Garnet is typically fine-grained and occurs in irregular tabular zones that pinch and swell. Most industrial uses of garnet require coarse-grained garnet that breaks up easily without blasting. Only a few areas in the Orogrande District consist of this grade of garnet. However, many of the dumps can be reprocessed for garnet.

Turquoise is found in over 50 localities in the district. The turquoise is associated with kaolin and other clay minerals in altered quartz monzonite or monzonite and is typically within 25 ft of the surface.

3.3.12 Red Lake District

The Red Lake (Caprock Escarpment) District, east of Artesia in Eddy County (refer to Figure 2.26), consists of oxidized MVT deposits. Several pits, an open cut, and two 20- and 30-ft deep shafts, are found in Section 29, T17S, R28E. Total production is unknown, but the district is reported to have produced small amounts of copper, silver, and possibly some lead and zinc (Anderson 1957).

Small replacement pods and fracture fillings occur in breccias within the Permian Rustler and Salado Formations. These deposits consist of chrysocolla, malachite, wulfenite, bornite, hemimorphite, anglesite, and descloizite in a gangue of quartz, calcite, dolomite, kaolinite, barite, goethite, and iron oxides (North and Tuff 1986a). Small pods of minor copper minerals are also disseminated throughout the adjacent sandstone. The deposits are less than 2-4 ft thick and less than 50 ft long.

Seven samples were collected and assayed for this report (refer to Samples VTM97-1RM through VTM97-7RM in Appendix 5). The samples contained <0.5-100 ppm silver, 27-250 ppm arsenic, 7-110 ppb gold, 140-64,000 lead, and 530->10,000 ppm zinc.

3.3.13 Sacramento District

The Sacramento or High Rolls Mining District is in the central Sacramento Mountains, east of Alamogordo (refer to Figures 2.26 and 3.12). The district was discovered in 1881. Sedimentary copper deposits occur in the upper Permian Abo Formation. Estimated total production from 1904 to 1962 amounts to 318,200 lbs copper, 2,170,200 lbs lead, 1,300 oz silver, and 10 oz gold (McLemore in preparation). A

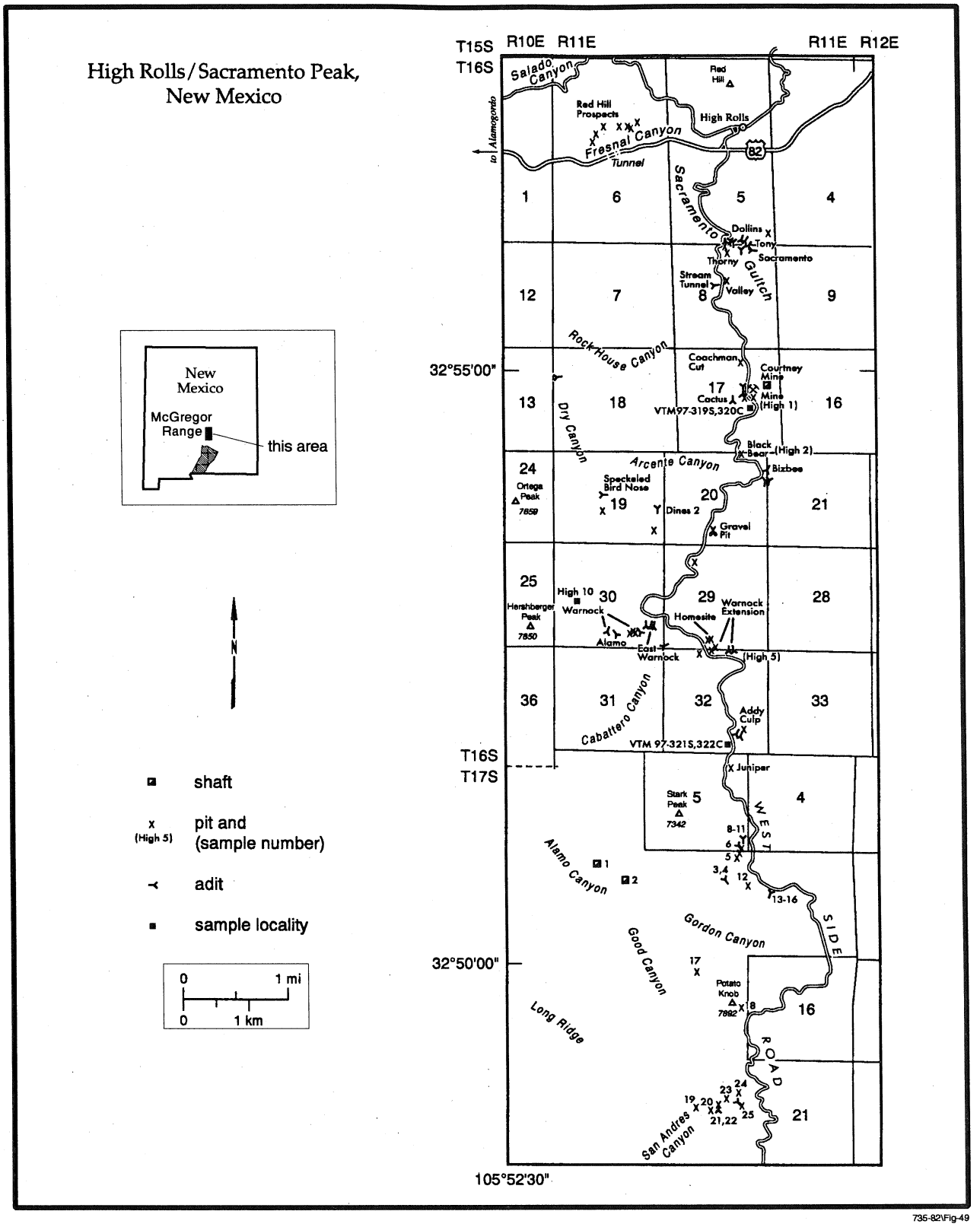

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Figure 3.12 Mines and Prospects in the Sacramento Mining District.

small possible carbonate-hosted lead-zinc deposit is found in Dog Canyon at Oliver Lee State Park. A small iron-replacement deposit (Danley) is found in the southern Sacramento Mountains.

The sedimentary rocks in the Sacramento Mountains range in age from Proterozoic through Permian (Jerome et al. 1965; Pray 1961). Tertiary andesite to camptonite sills and dikes locally intrude the sedimentary rocks throughout the mountain range. A camptonite sill in Dog Canyon has been dated at 44.01 ± 0.15 Ma by $^{40}Ar/^{39}Ar$ methods (hornblende at the New Mexico Geochron Laboratory in April 1996). The sedimentary copper deposits are found in the Permian Abo Formation, which consists of a basal limestone or conglomerate; a middle arkose, siltstone, and shale sequence; and an upper shale. The middle arkose, siltstone, and shale sequence pinches out to shale to the south (Pray 1961). Most of the Abo rocks are a distinctive brick-red color. In the district, the Abo Formation ranges in thickness from 200 to 700 ft (Jerome et al. 1965). The Abo Formation unconformably overlies folded and faulted older sedimentary rocks and is, in turn, overlain conformably by the Permian Yeso Formation. Arkosic sandstones from throughout the district range in concentration from <5 to 114,000 ppm lead and 40 to 73,000 ppm barium (Wilhelm 1983).

The sedimentary copper deposits consist of disseminations, replacements, and thin veinlets of copper and lead minerals in Abo sandstones, shales, and siltstones. Malachite and chalcocite commonly coat fractures and bedding planes within the sandstone, siltstone, and shale bed. The mineral deposits show no relationship to the variation in thickness of the Abo Formation; the Warnock and Speckled Bird deposits are in thicker basin deposits, whereas the Addy, Dollins, Tony, and Courtney deposits are in thinner sections of the Abo Formation (Jerome et al. 1965). The copper ore typically averages 2-7% copper, whereas the lead ore averages 5-15% lead (Jerome et al. 1965). Silver assays are typically less than 0.1 oz/ton (Jerome et al. 1965), but values as high as 4.4 oz/ton silver have been common (Briggs 1983). Most of the copper ore was produced from the Courtney Mine, and most of the lead was produced from the Warnock Mine. Copper ore deposits are typically less than several thousand tons, occur in red to gray arkose, siltstone, and shale, and consist of malachite, azurite, chalcocite, tennorite, cuprite, bornite, covellite, digenite, native copper, and chalcopyrite (Phillips 1960; Jerome et al. 1965). Lead ore bodies have been as large as 25,000 tons in a light gray to yellowish cream arkose bed that has a range of 7-29% lead and contains galena, cerussite, and anglesite (Jerome et al. 1965). Other minerals found in the district include smithsonite, pyrite, marcasite, and vanadinite. Copper deposits are more extensive than the lead deposits and are found locally above or below the lead deposits. Locally, copper minerals also occur with lead minerals. Albitization of the feldspars occurred prior to copper and lead mineralization (Wilhelm 1983). Lead isotope studies on two samples of galena from the Warnock and Courtney Mines indicate a model uranium/lead age of about 120 Ma, suggesting a modern lead source (Slawson and Austin 1962; Ewing 1979). The sedimentary copper deposits in the Sacramento Mining District contain higher grades and tonnages of lead than any other sedimentary copper district in New Mexico (McLemore 1996b).

Carbonate-hosted lead-zinc replacement deposits also occur in the Sacramento District. On the steep north side of Dog Canyon above the picnic area and in the canyon bottom at Oliver Lee Memorial State Park, a shallow shaft, 15 ft deep, and four prospect pits were dug into the Montoya and upper El Paso rocks. The shaft was driven along an altered fracture zone to find hidden mineral deposits. Yellowish brown clay and dolomite forms a talus from the workings. Only calcite, dolomite, and iron oxides are found (Kottlowski 1981). However, samples assayed trace-0.4 oz/ton silver, 0.01-0.03% lead, and <0.01-3.5% zinc (Briggs 1983) and are suggestive of carbonate-hosted lead-zinc replacement deposits.

4.0 ASSESSMENT OF METALLIC MINERAL RESOURCE POTENTIAL

4.1 FAVORABLE AREAS FOR MINERALIZATION ON THE MCGREGOR RANGE

There are six favorable areas for metals mineralization within the McGregor Range as determined from geologic investigations and geochemical sampling. These areas are the Red Hills in the northern Hueco Mountains, Martin-Hay Meadow Canyons area of Otero Mesa, southern Jarilla Mountains, southern Otero Platform, central basin area south of Orogrande, and El Paso-Culp Canyons area of the Sacramento Mountains (refer to Figure 4.1).

4.1.1 Red Hills Area

The Red Hills area in the northern Hueco Mountains contains syenite and nepheline syenite stocks, plugs, sills, and dikes. Tectonic setting, lithology, and geophysical and geochemical anomalies suggest that there is potential for the occurrence of GPM-associated deposits in the Red Hills area of the Hueco Mountains. The boundary of the Red Hills area in the Hueco Mountains is defined by geophysical, geochemical, and geological criteria (refer to Figure 4.1). The more favorable area is defined by the outcrop exposure of the nepheline syenite. The surrounding less favorable area is defined by geophysical anomalies indicating the subsurface extent of the favorable intrusive rocks.

4.1.2 Martin-Hay Meadow Canyons Area

The Martin-Hay Meadow Canyons area of the Otero Mesa contains Permian sedimentary rocks. A thick section of Abo sandstones, shales, and siltstones outcrops in the area (refer to Figure 2.23). This section thins to the north and south. Subsurface data indicates that a Pennsylvanian high exists to the west which was probably an uplift that shed sediments into the Martin-Hay Meadow Canyons area during Permian times (refer to Figure 2.6). The lithology of these sediments may account for some of the geochemical anomalies observed in the area (lead, thorium, niobium, calcium, lithium, cerium, iron, copper, manganese, tungsten, beryllium, vanadium, zinc, arsenic, SiO_2, yttrium, and nickel). However, there is also a magnetic anomaly to the east (refer to Figure 2.21) that could indicate an igneous intrusion. The igneous intrusion most likely would be rhyolite or monzonite, similar to that found in the Jarilla Mountains and Otero Platform. If an igneous intrusion exists in the subsurface, then this area could have similar metals potential as the Red Hills or Orogrande areas. The geochemical anomalies (lead, thorium, niobium, calcium, lithium, cerium, iron, copper, manganese, tungsten, beryllium, vanadium, zinc, arsenic, SiO_2, yttrium, and nickel) are consistent with an igneous source. Geochemical, subsurface, Landsat, surface geologic, and geophysical data define the boundary of this area (refer to Figure 4.1).

4.1.3 Southern Jarilla Mountains Area

The southern Jarilla Mountains area is the southern extent of the Jarilla Mountains, where copper-gold skarns and stockwork veins have been mined in the Orogrande District. Small hills southeast of Orogrande containing monzonite and limestone are included in this area. The igneous rocks are of similar chemistry as those in Orogrande (refer to Figures 2.11-2.14), and this suggests that the district extends into the McGregor Range. The geophysical data (refer to Figures 2.21 and 2.22) are consistent with this interpretation. The boundary of the south Orogrande area is defined by the magnetic anomaly. Geochemical anomalies are absent because the favorable terrane is in the subsurface.

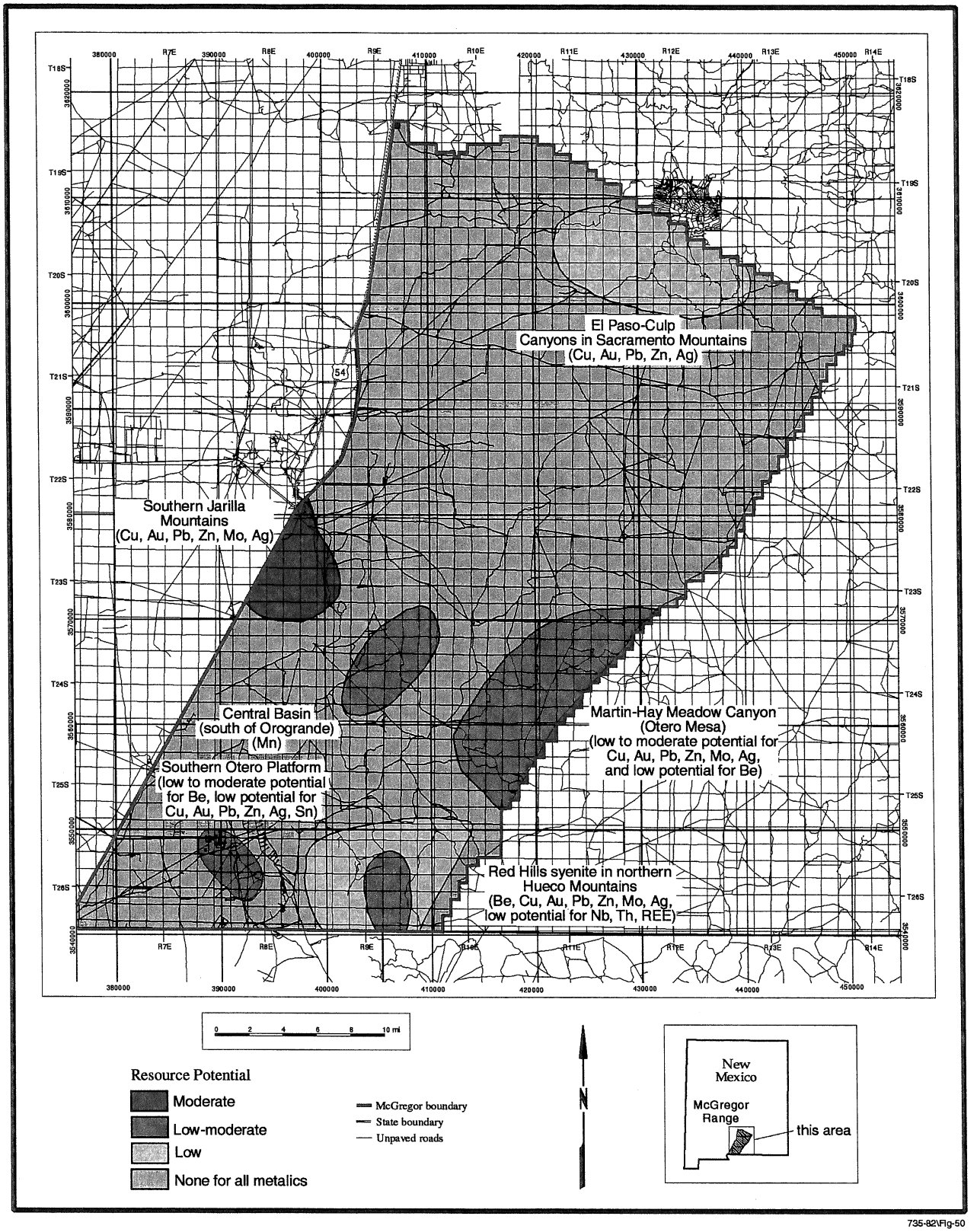

Figure 4.1 Resource Potential of Metallic Minerals on the McGregor Range.

4.1.4 El Paso-Culp Canyons Area

The El Paso-Culp Canyons area in the Sacramento Mountains contains mostly Permian limestones. However, geochemical data strongly suggest the presence of widely scattered jasperoids that could indicate carbonate-hosted metals deposit. The boundary of this area is defined by scattered geochemical anomalies (refer to Figure 4.1).

4.1.5 Southern Otero Platform

The southern Otero Platform area is an area of hot water along fractures and is considered favorable for geothermal resources. Drill holes encountered rhyolites that have similar major-element geochemistry as topaz-rhyolites. Monzonite sills that have similar compositions as the monzonites in the Jarilla Mountains are also found in the drill holes (refer to Figures 2.9 and 2.11-2.14). The drill holes are on the edge of gravity and magnetic anomalies (refer to Figures 2.21 and 2.22). The boundary of this area is defined by geophysical, geothermal, and subsurface data (refer to Figure 4.1).

4.1.6 Central Basin Area

The Central Basin area is south of Orogrande and is defined by anomalous concentrations of manganese found in stream sediment samples (refer to Figure 4.1) that could be representative of carbonate-hosted manganese deposits.

4.2 METALLIC MINERALS

Metallic mineral resources have been evaluated based on a regional and site-specific level utilizing geochemical data obtained from the geochemical characterization sampling program, the stream sediment sampling program, and the mineralized area sampling program. These data were used to identify potentially anomalous areas, which were evaluated utilizing the resource potential and certainty system described in Chapter 1.0 (refer to Figure 1.14). Individual metallic mineral resources identified on the McGregor Range are described and evaluated below. A summary of the metallic mineral resources potential for the McGregor Range is presented in Table 4.1 and shown on Figure 4.1.

4.2.1 Beryllium

4.2.1.1 General Information

Beryllium is a high-strength, lightweight metal used as an alloy, oxide, and metal in electronic components, aerospace and defense applications, appliances, and computers. Only one mine in the U.S., Spar Mountain in Utah, produces beryllium. At Spar Mountain, bertrandite, a beryllium mineral, replaces dolomite fragments in a tuffaceous surge deposit associated with topaz-rhyolite flows and domes (Burt et al. 1982; Burt and Sheridan 1987). Beryllium deposits are also found elsewhere in skarns, contact-metasomatic deposits, greisen-bordered veins, and pegmatites (Burt et al. 1982). Associated igneous rocks include topaz-bearing rhyolites (Burt et al. 1982) and high-silica rhyolites (Levinson 1962; McAnulty et al. 1963; W.N. McAnulty 1980). Combined reserves of bertrandite at Spar Mountain and Sierra Blanca in Texas are estimated as 20,000 tons. In 1995, production amounted to 222.2 tons beryllium metal from the U.S. (Kramer 1995). Current production meets or exceeds estimated consumption in the U.S. Beryllium is also found associated with alkaline plutonic rocks (Warner et al. 1959; Holser 1959; Mutschler et al. 1985, 1991).

Table 4.1 Summary of Metallic Mineral Resources in the McGregor Range.

Metal	Area	Potential	Certainty	Comments[1]
Beryllium	Red Hills area	Low to moderate	B-C	Favorable alkaline host rocks
	Southern Otero Platform area	Low to moderate	C	Similar to topaz-rhyolites
	Martin-Hay Meadow Canyons area	Low	B	None
	Elsewhere on McGregor Range	None	D	None
Copper	Southern Jarilla Mountains area	Low to moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B-C	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Gold	Southern Jarilla Mountains area	Low	C	GPM deposits
	Red Hills area	Low	C	Sedimentary copper, GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Epithermal/mesothermal veins
	Southern Otero Platform area	Low	C	Carbonate-hosted deposits
	El Paso-Culp Canyons area	Low	B	None
	Elsewhere on the McGregor Range	None	D	None
Iron	Entire McGregor Range	Low	C	Favorable host rocks
Lead-zinc	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B-C	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Manganese	Central basin area	Low to moderate	B-C	Geochemical anomalies
	Elsewhere on the McGregor Range	Low	C	None
Molybdenum	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	GPM deposits
	Southern Otero Platform area	Low	C	GPM deposits
	Elsewhere on the McGregor Range	None	D	None

Table 4.1 (Continued)

Metal	Area	Potential	Certainty	Comments[1]
Niobium	Red Hills area	Low	C	Favorable alkaline host rocks
	Elsewhere on the McGregor Range	None	D	None
PGE	Entire McGregor Range	None	C-D	Favorable host rocks
Silver	Southern Jarilla Mountains area	Moderate	C	GPM deposits
	Red Hills area	Low to moderate	C	GPM deposits
	Martin-Hay Meadow Canyons area	Low to moderate	B	Sedimentary copper, GPM deposits
	Southern Otero Platform area	Low	C	Epithermal/mesothermal veins
	El Paso-Culp Canyons area	Low	B	Carbonate-hosted deposits
	Elsewhere on the McGregor Range	None	D	None
Thorium and rare-earth elements	Red Hills area	Low	C	Favorable alkaline host rocks
	Elsewhere on the McGregor Range	None	D	None
Tin	Southern Otero Platform area	Low	C	Similar to topaz-rhyolites
	Elsewhere on McGregor Range	None	D	None
Other metallic resources[2]	Entire McGregor Range	None	D	None

[1] GPM = Great Plains Margin.
[2] Includes bismuth, cadmium, cobalt, chromium, nickel, tantalum, vanadium, tungsten, and zirconium.

4.2.1.2 Beryllium Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, three beryllium anomaly areas were identified: the Red Hills area, the southern Otero Platform area, and the Martin-Hay Meadow Canyons area (refer to Figure 4.1).

Red Hills Area. Syenite stocks and sills occur in the Hueco Mountains; the largest is the Red Hills area in the southern portion of the McGregor Range (refer to Figure 4.1). Skarn and/or contact-metasomatic beryllium deposits may occur near intrusive contacts. A sample of the Red Hills syenite contained 11 ppm beryllium (refer to Sample VTM97-224 in Appendix 5), indicating that elevated concentrations of beryllium occur in the syenite, thereby providing a potential source of beryllium. Samples from the nearby Cornudas Mountains contained 92 ppm to 0.2% beryllium (Schreiner 1994; Warner et al. 1959). Six stream sediment samples from the eastern part of the Red Hills syenite in the Hueco Mountains contained 3-4 ppm beryllium (Samples VTM97-197S, VTM97-204S, VTM97-205S, VTM97-207S, VTM97-208S, and VTM97-209S), the highest concentrations of beryllium in stream sediment samples from the McGregor Range. Many of the remaining stream sediment samples from that area contained 1-2 ppm beryllium. The

large jasperoid northeast of the Red Hills area contained 27-30 ppm beryllium (refer to Figure 3.4 and Samples VTM97-194 and VTM97-195 in Appendix 5). A stream sediment sample nearby contained 4 ppm beryllium (refer to Sample VTM97-197S in Appendix 5). A float chip sample of altered limestone in the eastern Hueco Mountains at Mountain Tank contained 64 ppm beryllium (refer to Sample VTM97-188F in Appendix 5) and indicates that another jasperoid probably occurs in that area. The intrusions in the Hueco Mountains are associated with only minor areas of brecciation, and alkali metasomatism is absent. Unfortunately, there are few data concerning the lithology and geochemistry of the sills mapped by Dane and Bachman (1965) in the northwestern part of the Hueco Mountains (refer to Figure 1.19) because this area is remote, rugged, and inaccessible. However, these sills are likely to be similar in composition to the Red Hills syenite, and by geologic analogy, the mineral resource potential is similar. The resource potential for the occurrence of beryllium in contact-metasomatic replacement and skarn deposits is rated as low to moderate near the Red Hills area in the Hueco Mountains and low elsewhere in the northern part of the Hueco Mountains. The level of geologic certainty is rated as C near the Red Hills syenite and B elsewhere in the northern Hueco Mountains. However, it is unlikely that undiscovered deposits in the Hueco Mountains would be economic, because the area is remote and rugged and would not be competitive with known deposits in Utah and Texas.

Southern Otero Platform Area. Although rhyolite domes and volcanic centers are not presently exposed in the McGregor Range, rhyolite sills are found in drill holes in the southern Otero Platform. The rhyolites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). However, the McGregor Range rhyolites contain more barium and calcium and less tin, niobium, rubidium, uranium, thorium, molybdenum, and beryllium than most topaz-rhyolites (refer to Figure 2.16) (Christiansen et al. 1986; Burt et al. 1982). In addition, the McGregor Range rhyolites have flat REE patterns with slightly depleted europium anomalies (refer to Figure 2.17), whereas most topaz-rhyolites have a larger negative europium anomaly (Burt et al. 1982; Price et al. 1990). An altered drill core sample contained 10 ppm beryllium (refer to Sample VTM97-324d in Appendix 5). Rhyolites from the Sierra Blanca area in Texas contained 4-170 ppm beryllium (Rubin et al. 1987). Current water temperatures at the geothermal field range from 80° to 110°C and the waters contain 1,100 to 12, 500 mg/L dissolved solids which is sufficient to form GPM deposits (Henry and Gluck 1981). The resource potential for beryllium near the rhyolite sills in the southern Otero Platform area is rated as low to moderate with a C level of certainty.

Martin-Hay Meadow Canyons Area. A thick sequence of lower Abo Formation overlain by Hueco limestone occurs in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figures 1.19 and 2.23). The lower Abo beds thin to the north and south. In the subsurface, drill hole data indicate that there is a Pennsylvanian high to the northwest (refer to Figure 2.6). This high could have provided sediment during Abo deposition. A magnetic high occurs east of the Martin-Hay Meadow Canyons area. In the Martin-Hay Meadow Canyons area, numerous geochemical anomalies occur that are consistent with igneous intrusions. It is possible that these geophysical and geochemical anomalies could be indicative of a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin fill deposits. If a rhyolite or monzonite intrusion exists, it is possible that tin and/or beryllium could occur in this area as well.

It is also possible that the geochemical anomalies may coincide with Abo rocks or potential sedimentary copper deposits. Two stream sediment samples from the Sacramento (High Rolls) District contained 3-4 ppm beryllium (refer to Samples VTM97-319S and VTM97-321S in Appendix 5) and suggest that beryllium may be anonymously high in these sedimentary copper deposits. One stream sediment sample

from the Martin-Hay Meadow Canyons area contains 3 ppm beryllium (refer to Sample VTM97-213 in Appendix 5); two nearby samples contained 2 ppm beryllium (refer to Samples VTM97-214S and VTM-167S in Appendix 5). The Abo sandstone crops out in both areas. Two explanations could account for these anomalies. Beryllium in the Sacramento District could be related to the nearby igneous rocks, whereas beryllium in the Martin-Hay Meadow Canyons area could be related to a buried intrusion. Alternatively, beryllium could be associated with sedimentary copper deposits in both areas. Therefore, based on the discussion presented above, the resource potential for beryllium in the Martin-Hay Meadow Canyons area is rated as low with a B level of certainty.

Elsewhere on the McGregor Range. Elsewhere in the McGregor Range, there are no geologic indications of any economic concentrations of beryllium. Therefore, there is no resource potential for beryllium elsewhere in the McGregor Range with a D level of certainty.

4.2.2 Copper

4.2.2.1 General Information

Copper is a major component in structural and electrical use in building construction, electrical products, machinery and equipment, and consumer general products (Edelstein 1997). The U.S. is the second largest producer of copper, and much of that production comes from Arizona and New Mexico. Two copper smelters are located in New Mexico at Hurley and Playas (operated by Phelps Dodge Corporation), and ASARCO operates another smelter at El Paso, Texas. Copper occurs in a variety of deposits in New Mexico (McLemore 1994c), but current production comes from porphyry-copper mines near Silver City, New Mexico.

4.2.2.2 Copper Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, five copper anomaly areas are identified: the southern Jarilla Mountains area, the Red Hills area, the Martin-Hay Meadow Canyons area, the southern Otero Platform area, and the El Paso-Culp Canyons area (refer to Figure 4.1).

Southern Jarilla Mountains Area. The mineral resource potential for copper in GPM-type deposits is moderate in the southern Jarilla Mountains with a C level of certainty (refer to Figure 4.1). This evaluation is based on several criteria. Known copper skarn and stockwork vein deposits occur in the Orogrande District in the Jarilla Mountains and could exist in the subsurface in the McGregor Range. The area within the McGregor Range is along the same magnetic and gravity anomalies that define the Jarilla Mountains (refer to Figure 2.21 and 2.22). Similar monzonites crop out in the McGregor Range portion of the southern Jarilla Mountains as in the Orogrande District (refer to Figures 2.11-2.14). Limestones surround the monzonites in both areas and offer excellent host rocks for skarn and carbonate-hosted replacement deposits. Geophysical and alteration data suggest that a copper-molybdenum-gold porphyry deposit could be buried in the southern Jarilla Mountains and could extend into the McGregor Range. Geochemical anomalies are absent in the McGregor Range, because the suspected deposits would be buried.

Red Hills Area. There are three possible types of copper deposits in the Red Hills area of the northern Hueco Mountains. Each type of deposit is discussed and evaluated below.

The mineral resource potential for alkaline-related copper, lead-zinc, and gold skarn or carbonate-hosted replacement deposits in the Red Hills area is rated low to moderate with a C level of certainty. This assessment is based on the mineralized roof pendent indicating minor fluid migration (refer to Figure 3.3) and abundance of limestone host rocks in the Hueco Mountains. The lack of evidence for widespread fluid or vapor phases and lack of silica-saturated igneous rocks results in the low to moderate rating. Mineralized skarn and replacement deposits are smaller mineral deposits and are more likely to occur in the area than copper-molybdenum-gold porphyry and gold-silver and polymetallic veins and breccia deposits; this accounts for a slightly higher rating (low to moderate). The mineral resource potential for alkaline-related copper, lead-zinc, and gold skarns or carbonate-hosted replacements elsewhere in the northern Hueco Mountains is also rated as low with a C level of certainty.

The mineral resource potential for copper-molybdenum-gold porphyry deposits in the Red Hills area is low with a C level of certainty. This assessment is based on: 1) the mineralized roof pendent indicating minor fluid migration, 2) the lack of significantly altered and mineralized rocks in the Hueco Mountains, 3) the lack of evidence for widespread fluid or vapor phases, and 4) the lack of silica-saturated igneous rocks. The mineral resource potential for copper-molybdenum-gold porphyry deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

The mineral resource potential for copper in alkaline-related gold-silver and polymetallic veins and breccia deposits in the Red Hills area is low with a C level of certainty. This assessment is based on the same criteria discussed above and the lack of significant faults and breccia zones within sedimentary rocks to serve as ore controls. The mineral resource potential for copper in alkaline-related gold-silver and polymetallic veins and breccia deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

Therefore, the overall potential for copper deposits in the Red Hills area is rated low to moderate with a C level of certainty (refer to Figure 4.1).

Martin-Hay Meadow Canyons Area. There are two possible types of copper deposits in the Martin-Hay Meadow Canyons area. Each type of deposit is discussed and evaluated below.

The geochemical anomalies found in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figures 1.19 and 2.23) may be related to a buried intrusion to the east as suggested by a magnetic high east of the Martin-Hay Meadow Canyons area. In the Martin-Hay Meadow Canyons area, numerous geochemical anomalies occur that are consistent with igneous intrusions. These geophysical and geochemical anomalies may indicate a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin-fill deposits. If a rhyolite or monzonite intrusion exists, it is possible that GPM deposits could occur in this area as well. The resource potential for copper in the Martin-Hay Meadow Canyons area is rated as low to moderate with a B level of certainty near this magnetic high.

There are no known sedimentary copper deposits in the McGregor Range. However, sedimentary copper deposits are found in the Sacramento District, north of McGregor Range, and in Eddy County, east of the McGregor Range. There are also favorable red-bed sedimentary rocks in the Martin-Hay Meadow Canyons area of Otero Mesa, and there are geochemical anomalies that are consistent with sedimentary copper deposits. However, the red beds in Otero Mesa are quartz-calcite sandstones (refer to Appendix 4), whereas the sandstones in the Sacramento District are arkosic sandstones (Wilhelm 1983). The arkosic sandstones containing feldspars may be more favorable for sedimentary copper deposits than quartz-calcite sandstones of the Otero Mesa area. Furthermore, the copper concentrations are low and do not indicate

any economic sedimentary copper deposits in that area. The mineral resource potential for sedimentary copper deposits in the Martin-Hay Meadow Canyons area of the Otero Mesa is rated as low with a C level.

Therefore, the overall potential for copper deposits in the Martin-Hay Meadow Canyons area is rated as low to moderate with a B-C level of certainty (refer to Figure 4.1).

Southern Otero Platform Area. Rhyolite and monzonite sills are found in drill holes in the southern Otero Platform area. The rhyolites and monzonites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). The monzonite in these drill holes is similar in composition to the monzonite exposed in the Jarilla Mountains that is associated with GPM deposits found in the Orogrande District (refer to Figures 2.9, 2.11, and 2.12). Current water temperatures at the geothermal field range from 80° to 110°C, and the waters contain 1,100 to 12,500 mg/L dissolved solids (Henry and Gluck 1981), which is sufficient to form GPM deposits. The mineral resource potential for copper (GPM copper deposits) near the monzonite is rated as low in the southern Otero Platform area with a C level of certainty (refer to Figure 4.1).

El Paso-Culp Canyons Area. The mineral resource potential for copper is low in the El Paso-Culp Canyons of the Sacramento Mountains with a B level of certainty (refer to Figure 4.1). Widely scattered geochemical anomalies, including the presence of jasperoid float, suggest that jasperoids may be widely scattered throughout the El Paso-Culp Canyons area. These jasperoids may indicate buried carbonate-hosted replacement deposits or they may be barren jasperoids. The jasperoids also could be remnants of eroded jasperoids. Additional geologic mapping and sampling would be required to determine the extent of these possible anomalies.

Elsewhere on the McGregor Range. Elsewhere in the McGregor Range, there are no geologic indications of economic concentrations of copper. Copper concentrations in stream sediments from the McGregor Range are lower than average terrestrial abundance (refer to Tables 2.9 and 2.10 and Appendix 5). Therefore, there is no resource potential for copper elsewhere in the McGregor Range with a D level of certainty.

4.2.3 Gold

4.2.3.1 General Information

Gold is a precious metal that is used in bullion, jewelry, electrical/electronics circuits, and dental work (Sehnke 1997). Gold production in the U.S. is second in the world; South Africa produces more gold than the U.S. (Sehnke 1997). Gold occurs in a variety of deposits in New Mexico (North and McLemore 1986, 1988; McLemore in press).

4.2.3.2 Gold Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, five gold anomaly areas were identified: southern Jarilla Mountains area, the Red Hills area, the Martin-Hay Meadow Canyons area, the southern Otero Platform area, and the El Paso-Culp Canyons area (refer to Figure 4.1).

Southern Jarilla Mountains Area. There are two possible types of gold deposits in the southern Jarilla Mountains area. Each type of deposit is discussed and evaluated below.

The mineral resource potential for gold in GPM-type deposits is moderate in the southern Jarilla Mountains with a C level of certainty (refer to Figure 4.1). This evaluation is based on several criteria. Known copper skarn and stockwork vein deposits containing gold occur in the Orogrande District in the Jarilla Mountains and could exist in the subsurface in the McGregor Range. The area within the McGregor Range is along the same magnetic and gravity anomalies that define the Jarilla Mountains. Similar monzonites crop out in the McGregor Range portion of the southern Jarilla Mountains as in the Jarilla Mountains (refer to Figures 2.11-2.14). Limestones surround the monzonites in both areas and offer excellent host rocks for skarn and carbonate-hosted replacement deposits. Geophysical and alteration data suggest that a copper-molybdenum-gold porphyry deposit could be buried in the Jarilla Mountains and could include the area within the McGregor Range. Geochemical anomalies are absent in the McGregor Range, because the suspected deposits would be buried.

There are no known placer gold deposits in the McGregor Range, and there are only a few local anomalies of gold (<1-26 ppb) in the stream sediment samples collected from the McGregor Range (refer to Appendix 5). Placer gold deposits are found in the Orogrande District, where they are derived from the gold-bearing skarn and replacement deposits. Gold anomalies are found in the NURE stream sediment samples from this district (Union Carbide Corporation 1981a, 1981b), as well as in the heavy mineral concentrate samples collected for this study (Samples VTM97-139c and VTM97-157c in Table 2.13). The known and prospective placer gold deposits in the Orogrande District appear to be restricted to the foothills of the Jarilla Mountains, outside of the McGregor Range boundaries. None of the heavy mineral concentrate samples from the McGregor Range contained any detectable gold (refer to Table 2.13). Therefore, the mineral resource potential for placer gold deposits in the southern Jarilla Mountains is rated as low with a C level of certainty (refer to Figure 4.1).

Therefore, based on the discussion presented above, the overall resource potential for gold in the southern Jarilla Mountain area is rated as low to moderate with a C level of certainty.

Red Hills Area. There are three possible types of gold deposits in the Red Hills area. Each type of deposit is discussed and evaluated below.

The mineral resource potential for alkaline-related gold skarns or carbonate-hosted replacements in the Red Hills area of the northern Hueco Mountains is rated as low to moderate with a C level of certainty (refer to Figure 4.1). This assessment is based on the mineralized roof pendent indicating minor fluid migration (refer to Figure 3.3) and abundance of limestone host rocks in the Hueco Mountains. The lack of evidence for widespread fluid or vapor phases and lack of silica-saturated igneous rocks results in the low to moderate rating. Mineralized skarn and replacement deposits are smaller mineral deposits and are more likely to occur in the area than copper-molybdenum-gold porphyry and gold-silver and polymetallic veins and breccia deposits; this accounts for a slightly higher rating (low to moderate). The mineral resource potential for alkaline-related gold skarns or carbonate-hosted replacement deposits elsewhere in the northern Hueco Mountains is low with a C level of certainty.

The mineral resource potential for gold in copper-molybdenum-gold porphyry deposits in the Red Hills area is rated as low with a C level of certainty. This assessment is based on: 1) the mineralized roof pendent indicating minor fluid migration, 2) the lack of significantly altered and mineralized rocks in the Hueco Mountains, 3) the lack of evidence for widespread fluid or vapor phases, and 4) the lack of silica-saturated

igneous rocks. The mineral resource potential for gold in copper-molybdenum-gold porphyry deposits in the surrounding area in the northern Hueco Mountains is low with a C level of certainty.

The mineral resource potential for gold in alkaline-related gold-silver and polymetallic veins and breccia deposits in the Red Hills area in the northern Hueco Mountains is low with a C level of certainty. This assessment is based on the criteria discussed above and the lack of significant faults and breccia zones within sedimentary rocks to serve as ore controls. The mineral resource potential for gold in alkaline-related gold-silver and polymetallic veins and breccia deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

Therefore, based on the discussion presented above, the resource potential for gold in the Red Hills area is rated as low with a C level of certainty (refer to Figure 4.1).

Martin-Hay Meadow Canyons Area. The geochemical anomalies found in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figure 2.23) may be related to a buried intrusion to the east. A magnetic high occurs east of the Martin-Hay Meadow Canyons area (refer to Figure 2.21). In the Martin-Hay Meadow Canyons area, numerous geochemical anomalies occur that are consistent with igneous intrusions. These geophysical and geochemical anomalies may indicate a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin-fill deposits. If a rhyolite or monzonite intrusion exists, GPM deposits may occur in this area as well. The resource potential for gold is low to moderate with a B level of certainty near this magnetic high (refer to Figure 4.1).

Southern Otero Platform Area. Rhyolite and monzonite sills are found in drill holes in the southern Otero Platform. The rhyolites and monzonites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). Gold and silver vein deposits are associated locally with topaz-rhyolites (Burt and Sheridan 1986). The monzonite in these drill holes is similar in composition to the monzonite exposed in the Jarilla Mountains that is associated with GPM deposits found in the Orogrande District (refer to Figures 2.9, 2.11, and 2.12 and Appendix 5). Current water temperatures at the geothermal field range from 80° to 110°C, and the waters contain 1,100 to 12,500 mg/L dissolved solids (Henry and Gluck 1981), which is sufficient to form GPM deposits. The mineral resource potential for gold near the monzonite is low in the southern Otero Platform with a C level of certainty (refer to Figure 4.1).

El Paso-Culp Canyons Area. The mineral resource potential for gold is low in the El Paso-Culp Canyons of the Sacramento Mountains with a B level of certainty (refer to Figure 4.1). Widely scattered geochemical anomalies, including the presence of jasperoid float, suggest that jasperoids may be dispersed throughout the El Paso-Culp Canyons area of the Sacramento Mountains. These jasperoids could indicate buried carbonate-hosted replacement deposits or they could be barren jasperoids. The jasperoids could also be remnants of eroded jasperoids. Additional geologic mapping and sampling would be required to determine the extent of these anomalies.

Elsewhere on the McGregor Range. Elsewhere in the McGregor Range, there are no geologic indications of any economic concentrations of gold. Therefore, there is no resource potential for gold elsewhere in the McGregor Range with a D level of certainty.

4.2.4 Iron

4.2.4.1 General Information

Iron ore is essential to the economy of the U.S. because it is the primary metal used in steel. In 1996, domestic iron ore production reached its highest level since 1981, with 62.5 million tons produced (Kirk 1997). Nearly all domestic production comes from mines in Minnesota. Iron oxide materials are also produced for yellow, red, brown, and black pigments and ochres in construction materials and coatings (M. Potter 1996). In 1995, production of finished natural iron oxide pigments was 76,200 tons (M. Potter 1996). In New Mexico, iron ore occurs predominantly in small- to medium-sized skarns and carbonate-hosted replacement deposits which are uneconomic (Kelley 1949; Harrer and Kelly 1963).

4.2.4.2 Iron Resources on the McGregor Range

On the McGregor Range, iron occurs in jasperoids where the silica content is too high to be economic for iron. Most of the high iron anomalies in the NURE and McGregor stream sediment samples are associated with areas high in other elements. No areas are considered potential for economic iron ore deposits. Therefore, the mineral resource potential for iron on the McGregor Range is low with a C level of certainty.

4.2.5 Lead and Zinc

4.2.5.1 General Information

Lead is used in automotive batteries, solders, seals, bearings, electronic/electrical applications, television glass, shielding, ammunition, and a variety of other uses. Lead is processed at two smelter-refineries in Missouri, a smelter in Montana, and a refinery in Nebraska (Smith 1997). Most lead produced in the U.S. comes from mines in Alaska and Missouri.

Zinc is used to produce brass, bronze, alloys, chemicals, zinc oxide, and zinc slab (Plachy 1997). There are three smelters operating in the U.S. in Illinois, Tennessee, and Pennsylvania. The Red Dog Mine in Alaska is the largest zinc producing mine in the U.S.

4.2.5.2 Lead and Zinc Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, five lead or zinc anomaly areas were identified: the southern Jarilla Mountains area, the Red Hills area, the Martin-Hay Meadow Canyons area, the southern Otero Platform area, and the El Paso-Culp Canyons area (refer to Figure 4.1).

Southern Jarilla Mountains Area. The mineral resource potential for lead and zinc in GPM type deposits is moderate in the southern Jarilla Mountains area with a C level of certainty. This evaluation is based on several criteria. Known copper skarn and stockwork vein deposits containing lead and zinc locally occur in the Orogrande District in the Jarilla Mountains and could exist in the subsurface in the McGregor Range. The area within the McGregor Range is along the same magnetic and gravity anomalies that define the Jarilla Mountains. Similar monzonites crop out in the southern Jarilla Mountains in the McGregor Range (refer to Figures 2.11-2.14). Limestones surround the monzonites in both areas and offer excellent host rocks for skarn and carbonate-hosted replacement deposits. Geochemical anomalies are absent in the McGregor Range, because the suspected deposits would be buried.

Red Hills Area. There are two possible types of lead-zinc deposits in the Red Hills area. Each type of deposit is discussed and evaluated below.

The mineral resource potential for alkaline-related lead-zinc skarns or carbonate-hosted replacement deposits in the Red Hills area of the northern Hueco Mountains is low to moderate with a C level of certainty. This assessment is based on the mineralized roof pendent indicating minor fluid migration (refer to Figure 3.3) and the abundance of limestone host rocks in the Hueco Mountains. The lack of evidence for widespread fluid or vapor phases and the lack of silica-saturated igneous rocks result in the low to moderate rating. The mineral resource potential for alkaline-related lead-zinc skarns or carbonate-hosted replacements elsewhere in the northern Hueco Mountains is rated as low with a C level of certainty.

The mineral resource potential for lead and zinc in alkaline-related polymetallic veins and breccia deposits in the Red Hills syenite in the northern Hueco Mountains is low with a C level of certainty. This assessment is based on: 1) the mineralized roof pendent indicating minor fluid migration, 2) the lack of altered, brecciated, and mineralized rocks in the Hueco Mountains, 3) the lack of evidence for widespread fluid or vapor phases, 4) the lack of silica-saturated igneous rocks, and 5) the lack of significant faults and breccia zones within sedimentary rocks to serve as ore controls. The mineral resource potential for lead and zinc in alkaline-related polymetallic veins and breccia deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

Therefore, based on the discussion presented above, the resource potential for lead-zinc deposits in the Red Hills area is rated as low to moderate with a C level of certainty (refer to Figure 4.1).

Martin-Hay Meadow Canyons Area. The geochemical anomalies found in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figures 1.19 and 2.23) may be related to a buried intrusion to the east. A magnetic high occurs east of the Martin-Hay Meadow Canyons area. In this area, numerous geochemical anomalies occur that are consistent with igneous intrusions. These geophysical and geochemical anomalies may indicate a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin fill deposits. If a rhyolite or monzonite intrusion exists, GPM deposits could occur in this area as well. The resource potential for lead and zinc is rated as low to moderate with a B level of certainty near this magnetic high.

Southern Otero Platform Area. Rhyolite and monzonite sills are found in drill holes in the southern Otero Platform. The rhyolites and monzonites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). The monzonite in these drill holes is similar in composition to the monzonite exposed in the Jarilla Mountains that is associated with GPM deposits found in the Orogrande District (refer to Figures 2.9, 2.11, and 2.12 and Appendix 5). Current water temperatures at the geothermal field range from 80° to 110°C, and the waters contain 1,100 to 12,500 mg/L dissolved solids (Henry and Gluck 1981), which is sufficient to form GPM deposits. The mineral resource potential for lead and zinc near the monzonite is low in the southern Otero Platform with a C level of certainty (refer to Figure 4.1).

El Paso-Culp Canyons Area. There are two possible types of lead-zinc deposits in the El Paso-Culp Canyons area. Each type of deposit is discussed and evaluated below.

Carbonate-hosted lead-zinc and silver (manganese) replacement deposits may occur in the Sacramento Mountains. Widely scattered geochemical anomalies, including the presence of jasperoid float, suggest that

jasperoids may be widely scattered throughout the El Paso-Culp Canyons area of the Sacramento Mountains. These jasperoids could indicate buried carbonate-hosted replacement deposits or they could be barren jasperoids. The jasperoids could also be remnants of eroded jasperoids. Additional geologic mapping and sampling would be required to determine the extent of these anomalies. Therefore, the mineral resource potential for carbonate-hosted lead-zinc and silver manganese replacement deposits in the El Paso-Culp Canyons area is rated as low with a B level of certainty.

There are no known RGR barite-fluorite-galena deposits in the McGregor Range. The nearest RGR barite-fluorite-galena deposit to the McGregor Range is in the west McGregor Range in the northern Franklin Mountains (refer to Figure 3.9), where barite, fluorite, zinc, and lead concentrations are low (refer to Table 3.9 and Appendix 5). RGR deposits are also found in the Organ Mountains (Seager 1981; McLemore et al. 1996c). All of these deposits are small and uneconomic. Although there are favorable limestone host rocks in the McGregor Range, the presence of fresh water in drill holes in the east McGregor Range (see Section 6.4), suggests that basin brines required to form RGR deposits may have been flushed out of the Otero Platform and Hueco Mountains areas to the west. There is a low mineral resource potential with a C level of certainty for lead and zinc in RGR deposits on the McGregor Range.

Therefore, based on the discussion presented above, the overall resource potential for lead or zinc in the El Paso-Culp Canyons area is rated as low with a B-C level of certainty (refer to Figure 4.1).

Elsewhere on the McGregor Range. Elsewhere in the McGregor Range, there are no geologic indications of any economic concentrations of lead or zinc. The highest lead concentration from stream sediment samples collected from the McGregor Range was 169 ppm and the highest zinc concentration was 131 ppm (refer to Tables 2.9 and 2.10 and Appendix 5). Therefore, there is no resource potential for lead and zinc elsewhere in the McGregor Range with a D level of certainty.

4.2.6 Manganese

4.2.6.1 General Information

Manganese is an essential ingredient in iron and steel production because of its sulfur-fixing, deoxidizing, and alloying properties (Jones 1997). It is also used in a variety of additional applications, including aluminum alloys, dry cell batteries, and coloration of bricks. Minor amounts of manganese have been recovered and sold from stockpiles at Deming, New Mexico. Manganese has not been produced from mines in New Mexico for many years.

4.2.6.2 Manganese Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, only the central basin was identified as a potential manganese anomaly area (refer to Figure 4.1).

Central Basin Area. In the McGregor Range, anomalous concentrations of manganese are found in several stream sediment samples from the central basin area south of Orogrande that could be representative of carbonate-hosted manganese deposits. The mineral resource potential for manganese in carbonate rocks is rated as low to moderate with a B-C level of certainty in this area (refer to Figure 4.1).

Elsewhere on the McGregor Range. Manganese also occurs in jasperoids, but the silica content is too high to be economic for manganese. Most of the high manganese anomalies in the NURE and McGregor stream

sediment samples are associated with areas high in other elements. There are no other areas that would be considered potential for manganese ore deposits. Therefore, the mineral resource potential for manganese in the McGregor Range is rated as low with a C level of certainty.

4.2.7 Molybdenum

4.2.7.1 General Information

Molybdenum is used in various industrial processes and equipment. Only one mine in New Mexico currently produces molybdenum, Unocal's Questa Mine in Taos County. The U.S. contains most of the world's molybdenum resources.

4.2.7.2 Molybdenum Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, four molybdenum anomaly areas were identified: the southern Jarilla Mountains area, the Red Hills area, the Martin-Hay Meadows Canyons area, and the southern Otero Platform area (refer to Figure 4.1). Each area is discussed and evaluated below.

Southern Jarilla Mountains Area. The mineral resource potential for molybdenum in GPM-type deposits is moderate in the southern Jarilla Mountains area with a C level of certainty (refer to Figure 4.1). This evaluation is based on several criteria. Known copper skarn and stockwork vein deposits containing molybdenum occur in the Orogrande district in the Jarilla Mountains and could exist in the subsurface of the McGregor Range. The area within the McGregor Range is along the same magnetic and gravity anomalies that define the Jarilla Mountains. Similar monzonites crop out in the McGregor portion of the southern Jarilla Mountains as in the Jarilla Mountains (refer to Figures 2.11-2.14). Limestones surround the monzonites in both areas and offer excellent host rocks for skarn and carbonate-hosted replacement deposits. Geophysical and alteration data suggest that a copper-molybdenum-gold porphyry deposit could be buried in the Jarilla Mountains and could include the area within the McGregor Range. Geochemical anomalies are absent in the McGregor Range, because the suspected deposits would be buried.

Red Hills Area. There are three possible types of molybdenum deposits in the Red Hills area. Each type of deposit is discussed and evaluated below.

This assessment is based on the mineralized roof pendent indicating minor fluid migration (refer to Figure 3.3) and abundance of limestone host rocks in the Hueco Mountains. The lack of evidence for widespread fluid or vapor phases and lack of silica-saturated igneous rocks results in the low to moderate rating. Mineralized skarn and replacement deposits are smaller mineral deposits and are more likely to occur in the area than copper-molybdenum-gold porphyry and gold-silver and polymetallic veins and breccia deposits; this accounts for a slightly higher rating (low to moderate). The mineral resource potential for molybdenum in alkaline-related copper, lead-zinc, and gold skarns or carbonate-hosted replacement deposits elsewhere in the northern Hueco Mountains is low with a C level of certainty.

The mineral resource potential for copper-molybdenum-gold porphyry deposits in the Red Hills area of the northern Hueco Mountains is low with C level of certainty. This assessment is based on: 1) the mineralized roof pendent indicating minor fluid migration, 2) the lack of significantly altered and mineralized rocks in the Hueco Mountains, 3) the lack of evidence for widespread fluid or vapor phases, and 4) the lack of silica-saturated igneous rocks. The mineral resource potential for

copper-molybdenum-gold porphyry deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

The mineral resource potential for molybdenum in alkaline-related polymetallic veins and breccia deposits in the Red Hills syenite in the northern Hueco Mountains is low with C level of certainty. This assessment is based upon the criteria listed above and the lack of significant faults and breccia zones within sedimentary rocks to serve as ore controls. The mineral resource potential for molybdenum in alkaline-related polymetallic veins and breccia deposits in the surrounding area in the northern Hueco Mountains is also low with a C level of certainty.

Therefore, based on the discussion presented above, the overall resource potential for molybdenum in the Red Hills area is rated as low with a C level of certainty (refer to Figure 4.1).

Martin-Hay Meadow Canyons Area. The geochemical anomalies found in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figures 1.19 and 2.23) may be related to a buried intrusion to the east. A magnetic high occurs east of the Martin-Hay Meadow Canyons area. In the Martin-Hay Meadow Canyons area, numerous geochemical anomalies occur that are consistent with igneous intrusions. These geophysical and geochemical anomalies may indicate a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin fill deposits. If a rhyolite or monzonite intrusion exists, it is possible that GPM deposits could occur in this area as well. The resource potential for molybdenum in the Martin-Hay Meadow Canyons area is rated as low to moderate with a B level of certainty near this magnetic high (refer to Figure 4.1).

Southern Otero Platform Area. Rhyolite and monzonite sills are found in drill holes in the southern Otero Platform area. The rhyolites and monzonites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). Topaz-rhyolites also may be associated with porphyry molybdenum deposits (Burt et al. 1982; Burt and Sheridan 1986). The monzonite in these drill holes is similar in composition to the monzonite exposed in the Jarilla Mountains that is associated with GPM deposits found in the Orogrande District (refer to Figures 4.1, 2.11, and 2.12 and Appendix 5). Current water temperatures at the geothermal field range from 80° to 110°C, and the waters contain 1,100 to 12,500 mg/L dissolved solids (Henry and Gluck 1981), which is sufficient to form GPM deposits. The mineral resource potential for molybdenum near the monzonite is rated as low in the southern Otero Platform area with a C level of certainty (refer to Figure 4.1).

Elsewhere on the McGregor Range. Elsewhere on the McGregor Range, there are no geologic indications of any economic concentrations of molybdenum. The highest molybdenum concentration from stream sediment samples collected from the McGregor Range was 6 ppm (refer to Tables 2.9 and 2.10 and Appendix 5). Therefore, there is no resource potential for molybdenum elsewhere in the McGregor Range, with a D level of certainty.

4.2.8 Niobium

4.2.8.1 General Information

Niobium (columbium) is a critical metal used as an alloy in steels and superalloys. Domestic deposits are low-grade and uneconomic. Most niobium is imported from Canada and Nigeria (Cunningham 1996).

Niobium is found in alkaline rocks and is associated with areas of brecciation and alkali metasomatism (Mutschler et al. 1985, 1991).

4.2.8.2 Niobium Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, only the Red Hills area was identified as a possible niobium anomaly area (refer to Figure 4.1).

Red Hills Area. The only alkaline rocks found in the McGregor Range are syenites and nepheline syenites in the Red Hills area in the Hueco Mountains. Niobium concentrations range from 58 to 110 ppm in the syenites (refer to Appendix 5). Stream sediment samples from the Hueco Mountains are also anomalous in niobium. However, none of these concentrations are economic. Furthermore, the intrusions in the Hueco Mountains are associated with only minor areas of brecciation and alkali metasomatism is absent. Therefore, the mineral resource potential for niobium in the Red Hills area is rated as low with a C level of certainty (refer to Figure 4.1).

Elsewhere on the McGregor Range. Elsewhere on the McGregor Range, there are no geologic indications of any economic concentrations of niobium. Therefore, there is no potential for niobium deposits with a D level of certainty.

4.2.9 Platinum Group Elements (PGE)

4.2.9.1 General Information

PGE are used mostly as catalysts; the largest use is in catalytic converters for automobiles to control emissions. Only one mine in the U.S., the Stillwater Mine in Montana, produces PGE. There, PGE occur in stratiform ore bodies in Archean layered mafic and ultramafic rocks. Reported values from the mine are as high as 8 ppm platinum, 11 ppm palladium, 1.7 ppm rhodium, 0.5 ppm iridium, 1.0 ppm ruthenium, and 0.1 ppm gold (Page et al. 1976). Combined PGE contents of most ore deposits range from 1 to 20 ppm (Eckstrand 1984).

No PGE deposits that contain concentrations rich enough and/or large enough deposits to be mined economically are currently known in New Mexico(McLemore et al. 1989). However, several Proterozoic terranes in New Mexico, including the McGregor Range, contain mafic and rarely ultramafic rocks that could have limited potential for occurrence of PGE. PGE values also have been obtained from sulfide ores associated with alkalic rocks (Finch et al. 1983; Mutschler et al. 1985) and similar rocks do occur in the McGregor Range.

4.2.9.2 PGE Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, no possible PGE deposit or anomaly areas were identified. However, available PGE information from the McGregor Range is discussed below.

Two stream sediment samples from Chatfield Canyon in the Sacramento Mountains contained <10 ppb platinum and 10 ppb palladium and 50 ppb platinum and 14 ppb palladium, respectively, by DC methods (Samples VTM97-238S and VTM97-239S in Appendix 5). These samples were taken from drainages containing limestone and a trace of sandstone gravel (refer to Appendix 3); there are no other indications

that these rocks represent an economic PGE deposit. There are no geologic models that account for these anomalies. Splits of these anomalous PGE samples were reanalyzed and found to contain low levels of PGE. These values are uneconomic, and the area has no mineral resource potential for PGE in the Chatfield Canyon with a C level of certainty.

Proterozoic mafic rocks from the Sacramento Mountains in the northern McGregor Range contain 1 ppb platinum and 66 ppb palladium (refer to Table 4.2). Similar Proterozoic mafic rocks from the Caballo Mountains contain 1-3 ppb platinum and 1-2 ppb palladium. The average concentration of platinum in typical unmineralized mafic and ultramafic rocks is approximately 10 ppb, ranging from 0.1 to 500 ppb (Macdonald 1988). Thus, values for the abovementioned area are too low to constitute an economic PGE deposit, and there is no mineral resource potential for PGE in Proterozoic mafic rocks in the McGregor Range with a C-D level of certainty.

Samples from the Red Hills area contain 1-4 ppb platinum and 9-66 ppb palladium (refer to Table 4.3). These values are below crustal abundance and are uneconomic; there are no other indications that these rocks may contain an economic PGE deposit. Therefore, there is no mineral resource potential for PGE in alkaline rocks from the Red Hills area with a D level of certainty.

A stream sediment sample from the northern Jarilla Mountains contained 20 ppb platinum and 4 ppb palladium (refer to Sample VTM97-84S in Appendix 5). This sample was taken from the Monte Largo Gap area and may represent anomalous trace PGE associated with the Orogrande mineralization, previously unreported. Other samples from the Jarilla Mountains are at or below detection limits for platinum and palladium. These values are uneconomic, and there are no other indications that these rocks would contain an economic PGE deposit. Therefore, there is no mineral resource potential for PGE in the Jarilla Mountains with a C-D level of certainty.

The remaining samples from the McGregor Range are low in PGE, containing <1-10 ppb platinum, 1-14 ppb palladium, and <10-10 ppb iridium. Most of these values are below crustal abundance and uneconomic. A few stream sediment samples from the McGregor Range contained trace amounts of PGE; however, most of these values are near the detection limit for platinum and palladium and are probably meaningless as anomalies.

Therefore, based on the discussion presented above, there is no mineral resource potential for PGE deposits elsewhere on the McGregor Range with a C-D level of certainty.

4.2.10 Silver

4.2.10.1 General Information

Silver is a precious metal that is used in photographic products, electrical and electronic and electroplated components, sterlingware, and jewelry. Approximately 3.61 million lbs of silver were produced from 83 mines in the U.S. in 1995; production from New Mexico in 1995 was 43,800 lbs (Reese 1997). Silver occurs in a variety of deposits in New Mexico (North and McLemore 1986, 1988; McLemore in press). The Chino Mine in Grant County (porphyry copper deposit) is the largest silver-producing mine in New Mexico and ranked 24th in the U.S. in 1996 for production (Hilliard 1997b).

Table 4.2 Platinum Group Elements Analyses of Three Samples from the McGregor Range and a Standard.[1]

		Element							
Sample No.	Lithology	Au (ppb)	Ir (ppb)	Os (ppb)	Pd (ppb)	Pt (ppb)	Re (ppb)	Rh (ppb)	Ru (ppb)
VMT97-244	Proterozoic gabbro	7	<0.2	<3	66	1	<1	<1	<1
VMT97-179	Red Hills syenite	10	0.2	<3	19	4	<1	<1	1
VMT97-199	Red Hills syenite	7	<0.2	<3	9	1	<1	<1	<1
VMT97-275	Standard	150	19	7	330	550	11	45	9
Certified standard	—	182 (±0.4)	na	na	792 (±2)	586 (±0.5)	na	82	na

[1] Analyses by NiS Fusion Fire Assay. Sample VTM97-275 is a split of the Canadian Standard Reference Material B, Nickel-Copper Matte Standard (McAdam et al. 1971); na = not available.

Table 4.3 Re-analyses of Three Stream Sediment Samples from the McGregor Range and a Standard for Platinum Group Elements.[1]

	Element							
Sample No.	Au (ppb)	Ir (ppb)	Os (ppb)	Pd (ppb)	Pt (ppb)	Re (ppb)	Rh (ppb)	Ru (ppb)
VMT97-73S	<1	<0.2	<3	3	<1	<1	<1	<1
VMT97-238S	<1	<0.2	<3	2	<1	<1	<1	<1
VMT97-239S	<1	<0.2	<3	4	<1	<1	<1	<1
VMT97-356	55	64	22	28	2,800	<1	13	3
Certified standard	182 (±0.4)	na	na	792 (±2)	586 (±0.5)	na	82	na

[1] Analyses by NiS Fusion Fire Assay. Sample VTM97-356 is a split of the Canadian Standard Reference Material B, Nickel Copper Matte Standard (McAdam et al. 1971); na = not available.

4.2.10.2 Silver Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, five silver anomaly areas were identified: the southern Jarilla Mountains area, the Red Hills area, the Martin-Hay Meadow Canyons area, the southern Otero Platform area, and the El Paso-Culp Canyons area (refer to Figure 4.1).

Southern Jarilla Mountains Area. The mineral resource potential for silver in GPM type deposits is moderate in the southern Jarilla Mountains area with a C level of certainty (refer to Figure 4.1). This evaluation is based on several criteria. Known copper skarn and stockwork vein deposits containing silver occur in the Orogrande District in the Jarilla Mountains and could exist in the subsurface in the McGregor Range. The area within the McGregor Range is along the same magnetic and gravity anomalies that define the Jarilla Mountains. Similar monzonites crop out in the McGregor Range portion of the southern Jarilla Mountains as in the Jarilla Mountains (refer to Figures 2.11-2.14). Limestones surround the monzonites in both areas and offer excellent host rocks for skarn and carbonate-hosted replacement deposits. Geophysical and alteration data suggest that a copper-molybdenum-gold porphyry deposit, possibly containing silver, could be buried in the Jarilla Mountains and could include the area within the McGregor Range. Geochemical anomalies are absent in the McGregor Range, because the suspected deposits would be buried.

Red Hills Area. There are three possible types of silver deposits in the Red Hills area. Each type of deposit is discussed and evaluated below.

This assessment is based on the mineralized roof pendent indicating minor fluid migration (refer to Figure 3.3) and abundance of limestone host rocks in the Hueco Mountains. The lack of evidence for widespread fluid or vapor phases and lack of silica-saturated igneous rocks results in the low to moderate rating. Mineralized skarn and replacement deposits are smaller mineral deposits and more likely to occur in the area than copper-molybdenum-gold porphyry and gold-silver and polymetallic veins and breccia deposits, which accounts for a slightly higher rating (low to moderate). The mineral resource potential for silver in alkaline-related copper, lead-zinc, and gold skarns or carbonate-hosted replacements elsewhere in the northern Hueco Mountains is low with a C level of certainty.

The mineral resource potential for silver in copper-molybdenum-gold porphyry deposits in the Red Hills area is low with a C level of certainty. This assessment is based on: 1) the mineralized roof pendent indicating minor fluid migration, 2) the lack of significantly altered and mineralized rocks in the Hueco Mountains, 3) the lack of evidence for widespread fluid or vapor phases, and 4) the lack of silica-saturated igneous rocks. The mineral resource potential for silver in copper-molybdenum-gold porphyry deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

The mineral resource potential for silver in alkaline-related gold-silver and polymetallic veins and breccia deposits in the Red Hills syenite in the northern Hueco Mountains is rated as low with a C level of certainty. This assessment is based on the criteria discussed above and the lack of significant faults and breccia zones within sedimentary rocks to serve as ore controls. The mineral resource potential for silver in alkaline-related gold-silver and polymetallic veins and breccia deposits in the surrounding area in the northern Hueco Mountains is also rated as low with a C level of certainty.

Therefore, based on the discussion presented above, the overall resource potential for silver in the Red Hills area is rated as low to moderate with a C level of certainty (refer to Figure 4.1).

Martin-Hay Meadow Canyons Area. The geochemical anomalies found in the Martin-Hay Meadow Canyons area of Otero Mesa (refer to Figures1.19 and 2.23) may be related to a buried intrusion to the east. A magnetic high occurs east of the Martin-Hay Meadow Canyons area. In the Martin-Hay Meadow Canyons area, numerous geochemical anomalies occur that are consistent with igneous intrusions. These geophysical and geochemical anomalies could indicate a buried rhyolite or monzonite intrusion that may have been exposed before deposition of Holocene basin fill deposits. If a rhyolite or monzonite intrusion exists, GPM deposits could occur in this area as well. The resource potential for silver is low to moderate with a B level of certainty near this magnetic high (refer to Figure 4.1).

Southern Otero Platform Area. Rhyolite and monzonite sills are found in drill holes in the southern Otero Platform. The rhyolites and monzonites coincide with the edge of a magnetic high (refer to Figure 2.21). The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and 2.16 and Table 2.6) (Christiansen et al. 1986). Gold and silver vein deposits are associated locally with topaz-rhyolites (Burt and Sheridan 1986). The monzonite in these drill holes is similar in composition to the monzonite exposed in the Jarilla Mountains that is associated with GPM deposits found in the Orogrande District (refer to Figures 2.9, 2.11, and 2.12 and Appendix 5). Current water temperatures at the geothermal field range from 80° to 110°C, and the waters contain 1,100 to 12,500 mg/L dissolved solids (Henry and Gluck 1981), which is sufficient to form GPM deposits. The mineral resource potential for silver near the monzonite is rated as low in the southern Otero Platform area with a C level of certainty (refer to Figure 4.1).

El Paso-Culp Canyons Area. The mineral resource potential for silver is low in the El Paso-Culp Canyons of the Sacramento Mountains with a B level of certainty (refer to Figure 4.1). Widely scattered geochemical anomalies, including the presence of jasperoid float, suggest that jasperoids may be widely scattered throughout the El Paso-Culp Canyons area of the Sacramento Mountains. These jasperoids could indicate buried carbonate-hosted replacement deposits or they could be barren jasperoids. The jasperoids could also be remnants of eroded jasperoids. Additional geologic mapping and sampling would be required to determine the extent of these anomalies.

Elsewhere on the McGregor Range. Elsewhere on the McGregor Range, there are no geologic indications of any economic concentrations of silver. The highest silver concentration from stream sediment samples collected from the McGregor Range was 1 ppm (refer to Table 2.10 and Appendix 5). Therefore, there is no resource potential for silver elsewhere in the McGregor Range with a D level of certainty.

4.2.11 Thorium and Rare-Earth Elements

4.2.11.1 General Information

Thorium is a soft, ductile, silvery-white, radioactive metal that is used in the manufacture of high-strength, high-temperature alloys and refractory ceramics (Hedrick 1996). Most of the thorium production in the U.S. is a by-product of monzonite that is mined for REE. Most of the thorium produced is discarded in waste piles, because production exceeds demand. REE are related elements that are used in a variety of applications, including automotive catalytic converters, permanent magnets, and rechargeable rare-earth-nickel hydride batteries (Hedrick 1997). In 1995, 24,420 tons of rare earth oxides were produced in the U.S. from one mine in California, where bastnaesite is mined by open-pit methods from the Mountain Pass carbonatite. In New Mexico, thorium and REE occur predominantly in Precambrian pegmatites and Tertiary veins and breccia deposits associated with alkaline intrusions (i.e., GPM deposits)

(McLemore et al. 1988a, 1988b). Widespread alkali metasomatism is common surrounding known deposits.

4.2.11.2 Thorium and Rare-Earth Elements Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, only the Red Hills area was identified as a possible thorium and REE anomaly area (refer to Figure 4.1).

Red Hills Area. The only alkaline rocks found in the McGregor Range are syenites and trachytes in the Red Hills area in the Hueco Mountains. Thorium and REE concentrations range from 10 to 38 ppm thorium and less than 400 ppm total REE (refer to Appendix 5). Stream sediment samples from the Hueco Mountains are also anomalous in thorium and REE. However, none of these concentrations are economic. Furthermore, the intrusions in the Hueco Mountains are associated with only minor areas of brecciation, and alkali metasomatism is absent. Therefore, the mineral resource potential for thorium and REE in the Red Hills area of the Hueco Mountains is low with a C level of certainty (refer to Figure 4.1).

Elsewhere on the McGregor Range. Elsewhere on the McGregor Range, there are no geologic indications of any economic concentrations of thorium or REE. The highest thorium concentration from stream sediment samples collected from the McGregor Range was 14 ppm and the highest cerium value was 100 ppm (refer to Tables 2.9 and 2.10 and Appendix 5). Therefore, there is no resource potential for thorium and REE elsewhere in the McGregor Range with a D level of certainty.

4.2.12 Tin

4.2.12.1 General Information

Tin as a metal is used in containers, electrical applications, construction, transportation, and other minor uses. Tin has not been produced from mines in the U.S. since 1993, when a few small tin mines were in production. Approximately one-fifth of the tin used in the U.S. comes from recycling; the remaining tin consumed in the U.S. is imported (Carlin 1997). World tin reserves are estimated as 7 million tons and are more than adequate to meet current demand. Tin is found associated with high-silica rhyolites in New Mexico and Proterozoic granitic rocks in the Franklin Mountains, Texas. Both deposits have yielded minor production in the past.

4.2.12.2 Tin Resources on the McGregor Range

Based on available background information and geologic surveys conducted for this study, only the southern Otero Platform area was identified as a possible tin anomaly area (refer to Figure 4.1).

Southern Otero Platform Area. The presence of tin in Proterozoic granite in the Franklin Mountains suggests that tin may exist locally in the Precambrian crust in the McGregor Range. Similar Proterozoic rocks are too deep in the McGregor Range to have any resource potential for tin. However, tin in the Precambrian crust could be available for redistribution in Tertiary intrusive rocks. Furthermore, the presence of beryllium associated with high-silica rhyolites in the drill holes in the southern Otero Platform suggests that rhyolite-hosted tin deposits may also exist in that region. Although rhyolite domes and volcanic centers are not presently exposed in the McGregor Range, rhyolite sills are found in drill holes in the southern Otero Platform. The rhyolites in these drill holes are grossly similar in chemical composition to topaz-rhyolites that are typically associated with beryllium and tin deposits (refer to Figures 2.15 and

2.16 and Table 2.6; Christiansen et al. 1986). However, the McGregor Range rhyolites contain more barium and calcium and less tin, niobium, rubidium, uranium, thorium, molybdenum, and beryllium than most topaz-rhyolites (refer to Figure 2.16; Christiansen et al. 1986; Burt et al. 1982). In addition, the McGregor rhyolites have flat REE patterns with slightly depleted europium anomalies (refer to Figure 2.16), whereas most topaz-rhyolites have a larger negative europium anomaly (Burt et al. 1982; Price et al. 1990). None of the samples collected from the McGregor Range contained any detectable tin (<10 ppm tin, refer to Appendix 5). Therefore, the mineral resource potential for rhyolite-hosted tin deposits in the southern Otero Platform area is low with a C level of certainty (refer to Figure 4.1).

Elsewhere on the McGregor Range. Elsewhere on the McGregor Range, there are no geologic indications of any economic concentrations of tin. Therefore, there is no potential for tin deposits with a D level of certainty.

4.2.13 Other Metallic Resources

There is no potential for other metallic resources in the McGregor Range with a D level of certainty. Concentrations of bismuth, cadmium, cobalt, chromium, nickel, tantalum, vanadium, tungsten, and zirconium in samples collected from the McGregor Range are below economic grades (refer to Appendix 5). Vanadium sometimes occurs in sedimentary copper deposits, but the concentrations from the Sacramento District and the McGregor Range are below recoverable limits. The geology of the McGregor Range is unfavorable for the occurrence of economic deposits of bismuth, cadmium, cobalt, chromium, nickel, tantalum, vanadium, tungsten, and zirconium (Cox and Singer 1986; Sheahan and Cherry 1993; Roberts and Sheahan 1988).

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5.0 ASSESSMENT OF NONMETALLIC MINERAL RESOURCES

5.1 INTRODUCTION

A nonmetallic (industrial) mineral is defined as "any rock, mineral or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels, and gemstones; one of the nonmetallics" (Bates and Jackson 1987). In recent years, the term "industrial mineral" has been applied to such manufactured products as cement and lime, as well as brines, both natural and manmade. Because of the wide-ranging nature of recent usage, the term "industrial minerals" will be used for all nonmetallic minerals, rocks, and commodities discussed hereafter.

Resource assessment potential for industrial minerals is slightly different from that of metallic minerals. For most industrial mineral commodities, ore deposit models do not have the same importance as they do for the metallic commodities. Assessment of industrial mineral resource potential must take into account the following factors: geology (exploration, development), production (mining, milling), transportation, and marketing (specifications, end user). Additional factors besides geology will have a profound impact on the resource potential of any industrial mineral venture and especially so for the high-bulk low-value commodities (e.g., building materials) most common on the McGregor Range. In general, it is more difficult to find an end user willing to buy a commodity than it is to find a deposit of a given commodity. This relationship is further complicated by the need to mine, mill, and transport the material to the end user at a competitive price. To provide a complete picture of the industrial mineral potential on the McGregor Range, all of the factors described above have been included and evaluated as part of this assessment.

As with the other mineral and energy resource assessments completed for this project, existing information and data were reviewed and selected geologic samples were collected and analyzed to fully assess industrial mineral resource potential on the McGregor Range.

The locations of industrial mineral samples collected for this evaluation are presented in Appendix 1 and descriptions are presented in Appendix 3. Sample locations and descriptions of samples taken by the USBM and the New Mexico Highway Department are listed in Appendix 11. The location of all samples used in this assessment are shown on Figure 5.1.

5.2 INDUSTRIAL MINERALS

Individual industrial mineral resources identified on the McGregor Range are described and evaluated below. A summary of the industrial mineral resource potential is presented in Table 5.1 and shown on Figures 5.2-5.6.

5.2.1 Barite and Fluorite

5.2.1.1 General Information

Barite is used primarily as a weighting agent in petroleum well fluids; minor uses include use as an ingredient in paint, rubber, glass, and barium chemicals. Fluorite is used to manufacture a variety of products such as aluminum, insulating foams, refrigerants, steel, and uranium fuel (Miller 1997a). In 1995, the last fluorspar mine operating in the U.S. closed after 158 years of fluorspar production in the country. Fluorspar is imported from China, South Africa, and Mexico (Miller 1997a). Barite and fluorite

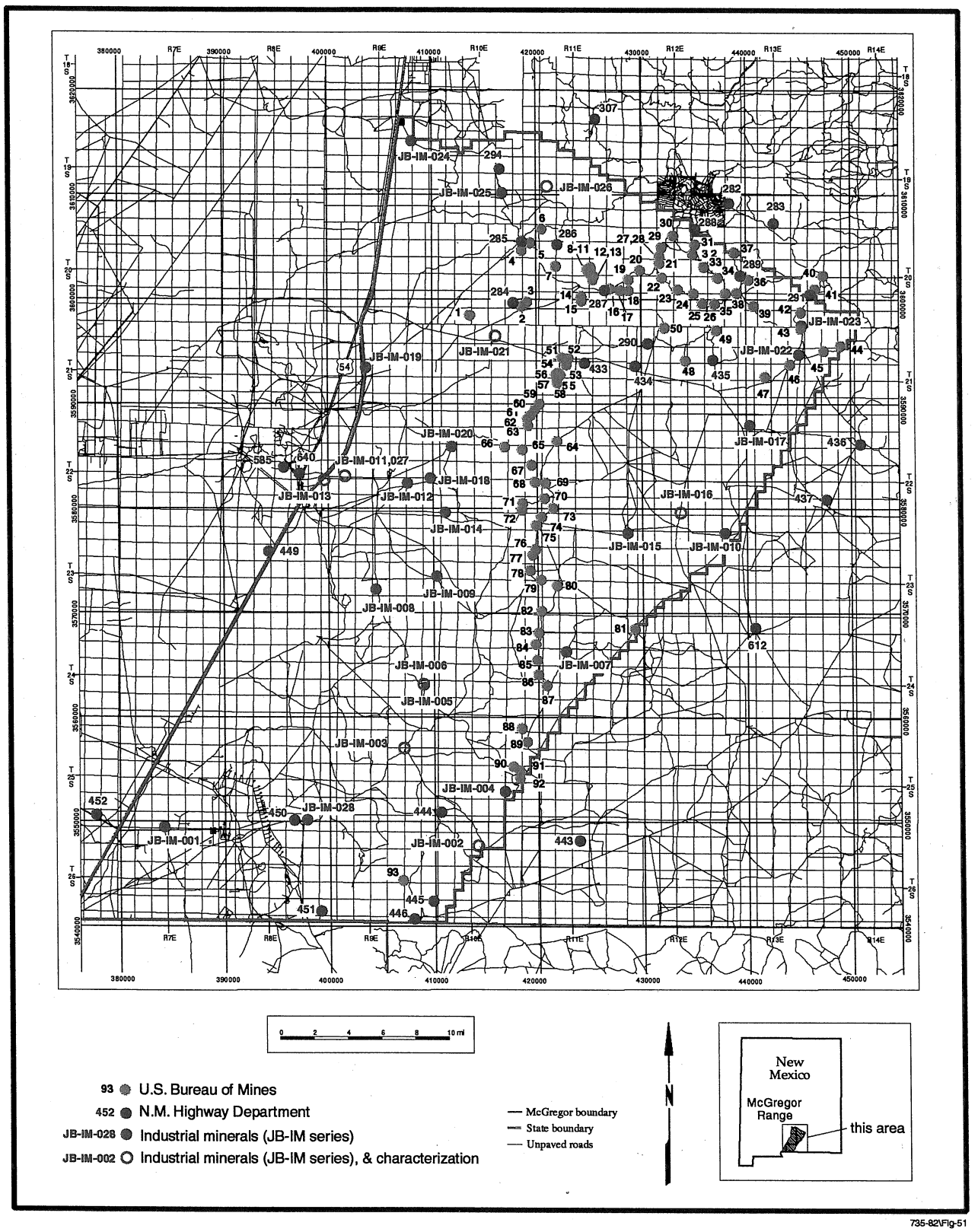

Figure 5.1 Sample Locations Used in the Assessment of Industrial Minerals.

Table 5.1 Resource Potential for Industrial Minerals on the McGregor Range.

Resource	Area	Potential	Certainty	Comments
Barite and Fluorite	All	Low	B-C	None
Borate	All	Low	D	None
Building Stone	All	Low-Moderate	B-D	Dimension stone has dark color, and decorative stone lacks distinctive colors or textures
Clay	All	Low	C	No specialty clay minerals are present
Construction Aggregate	All	None-High	D	Refer to Figures 5.2-5.4
Garnet	Hueco and Jarilla Mountains	Low	C	Possible near Tertiary intrusions
	Elsewhere on the McGregor Range	None	D	None
Gypsum	All	None-High	B-C	Refer to Figure 5.5
Halite	All	Low	C	None
Limestone and Dolestone	All	None-High	D	Refer to Figure 5.6; potential for limestone is rated as none to high and dolestone is rated as low
Nepheline Syenite	Red Hills area	Low	C	None
	Elsewhere on the McGregor Range	None	D	None
Silica	All	Low	D	None
Sulfur	All	Low	D	None

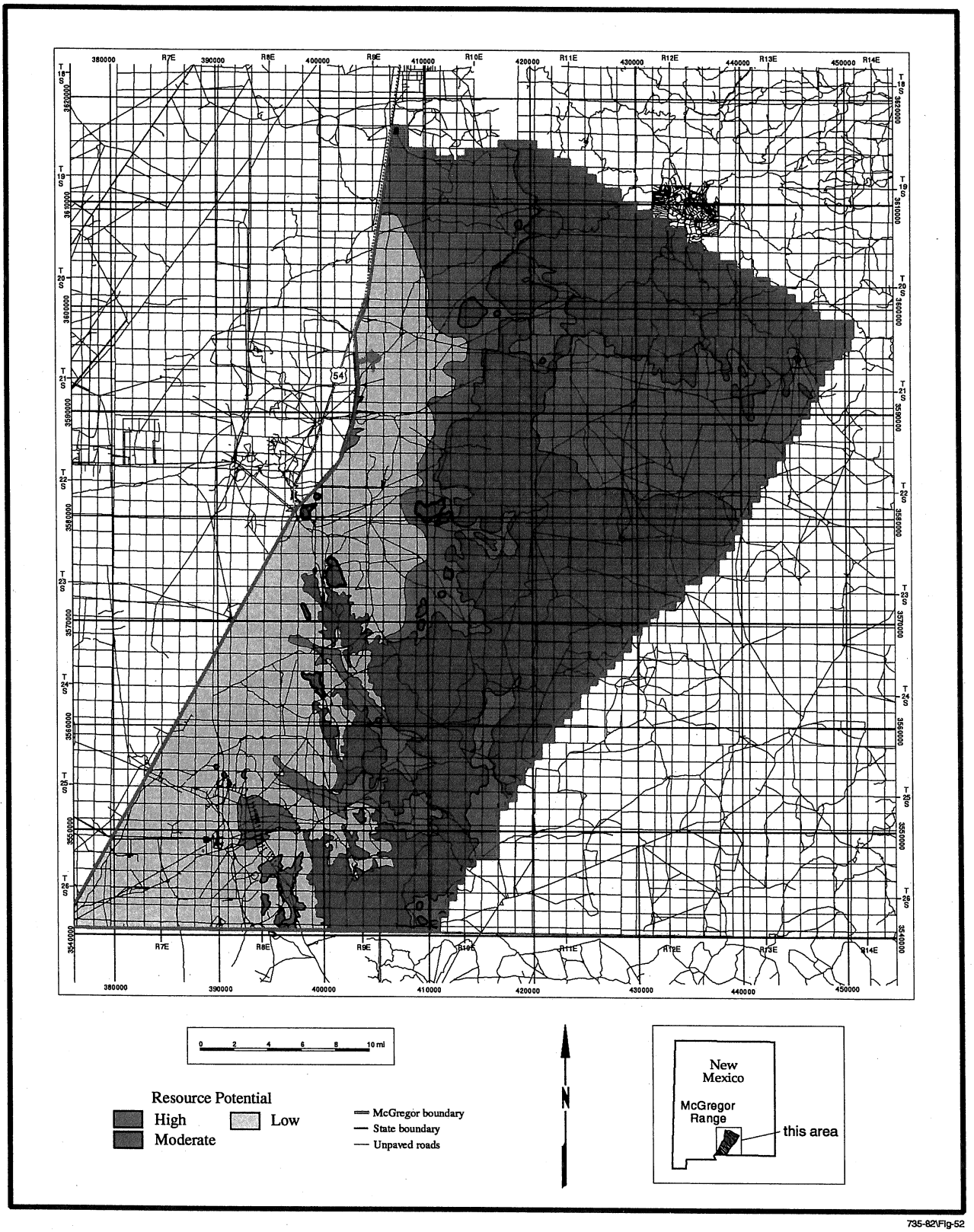

Figure 5.2 Resource Potential for Sand and Gravel on the McGregor Range.

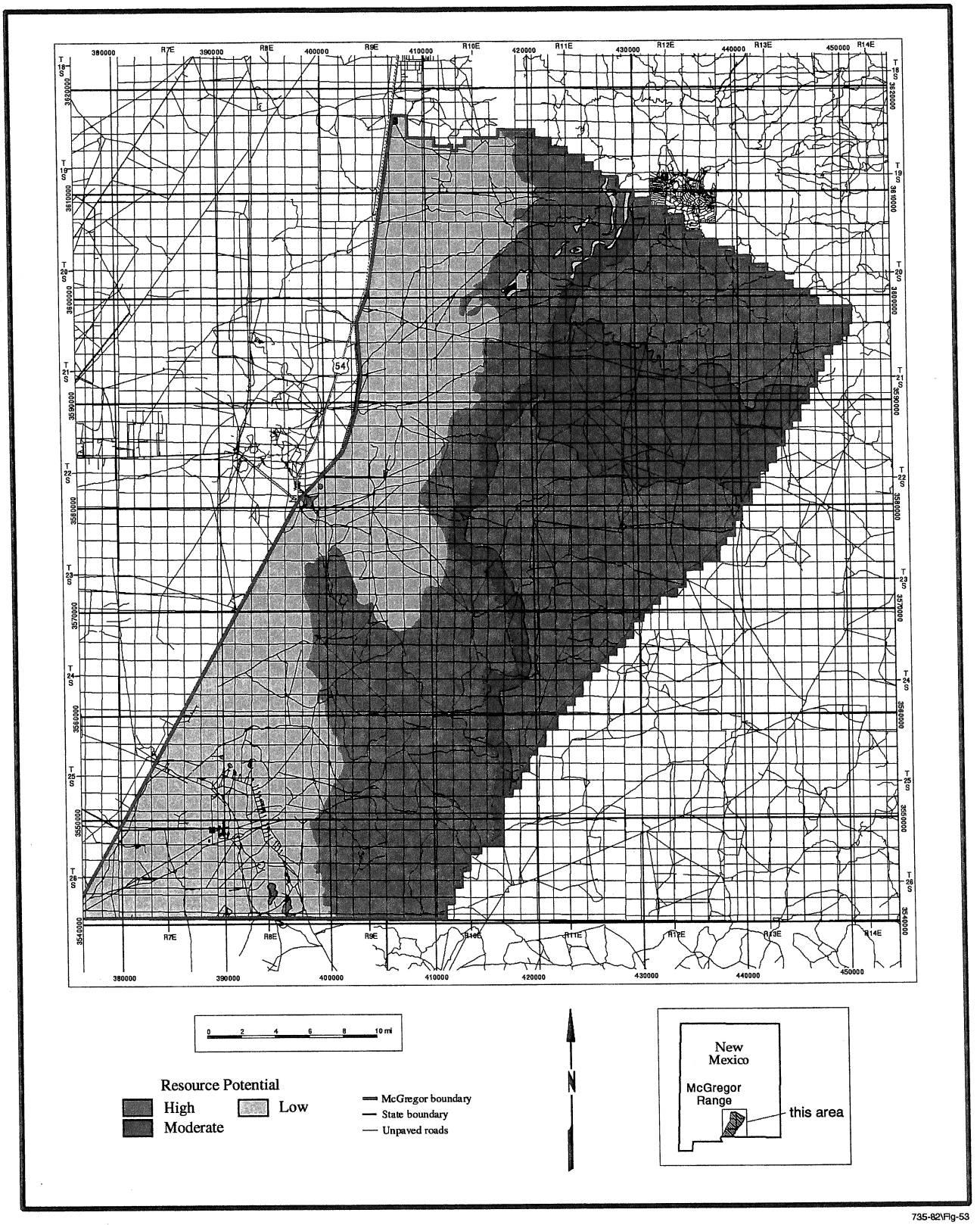

Figure 5.3 Resource Potential for Crushed Stone on the McGregor Range.

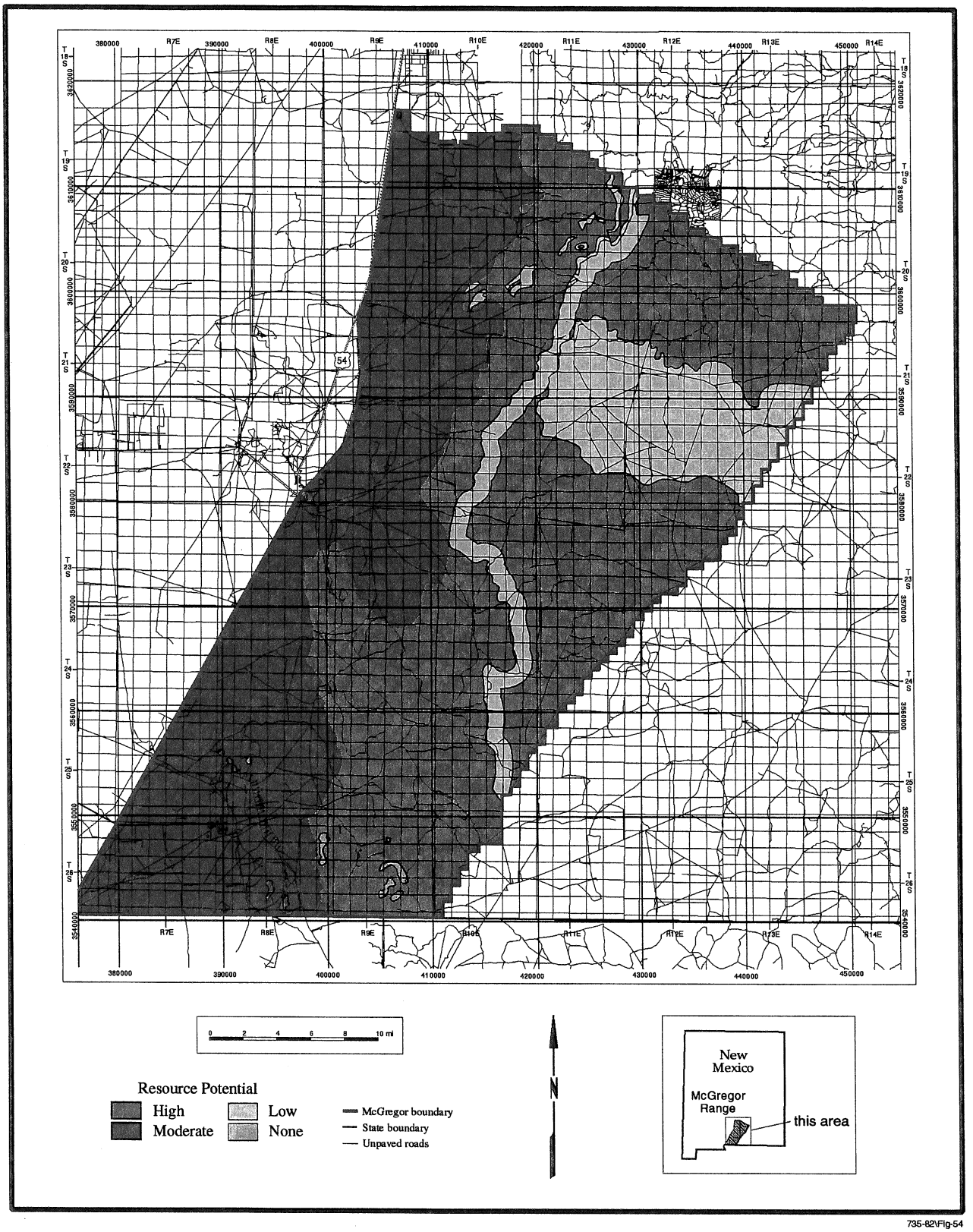

Figure 5.4 Resource Potential for Caliche on the McGregor Range.

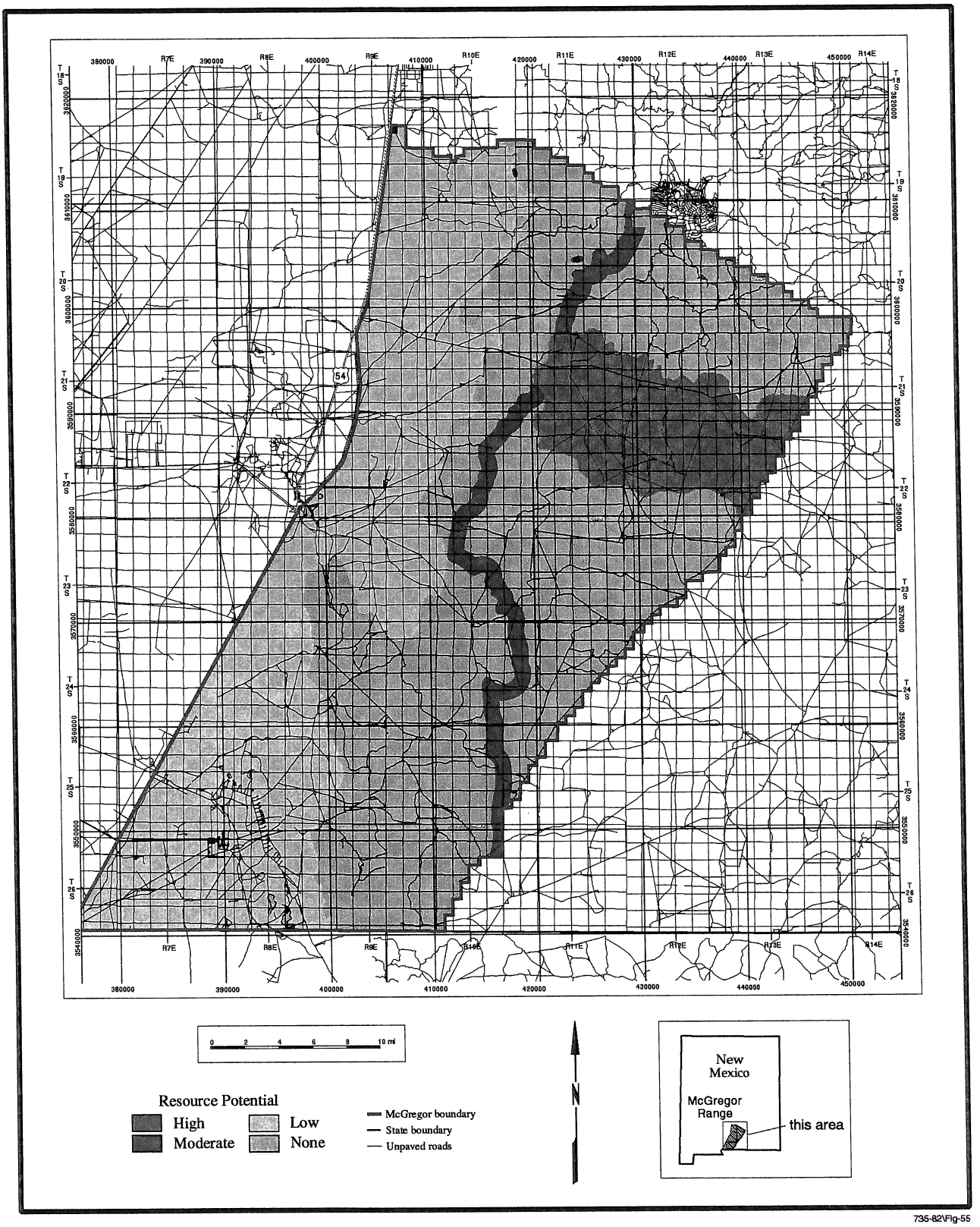

Figure 5.5 Resource Potential for Gypsum on the McGregor Range.

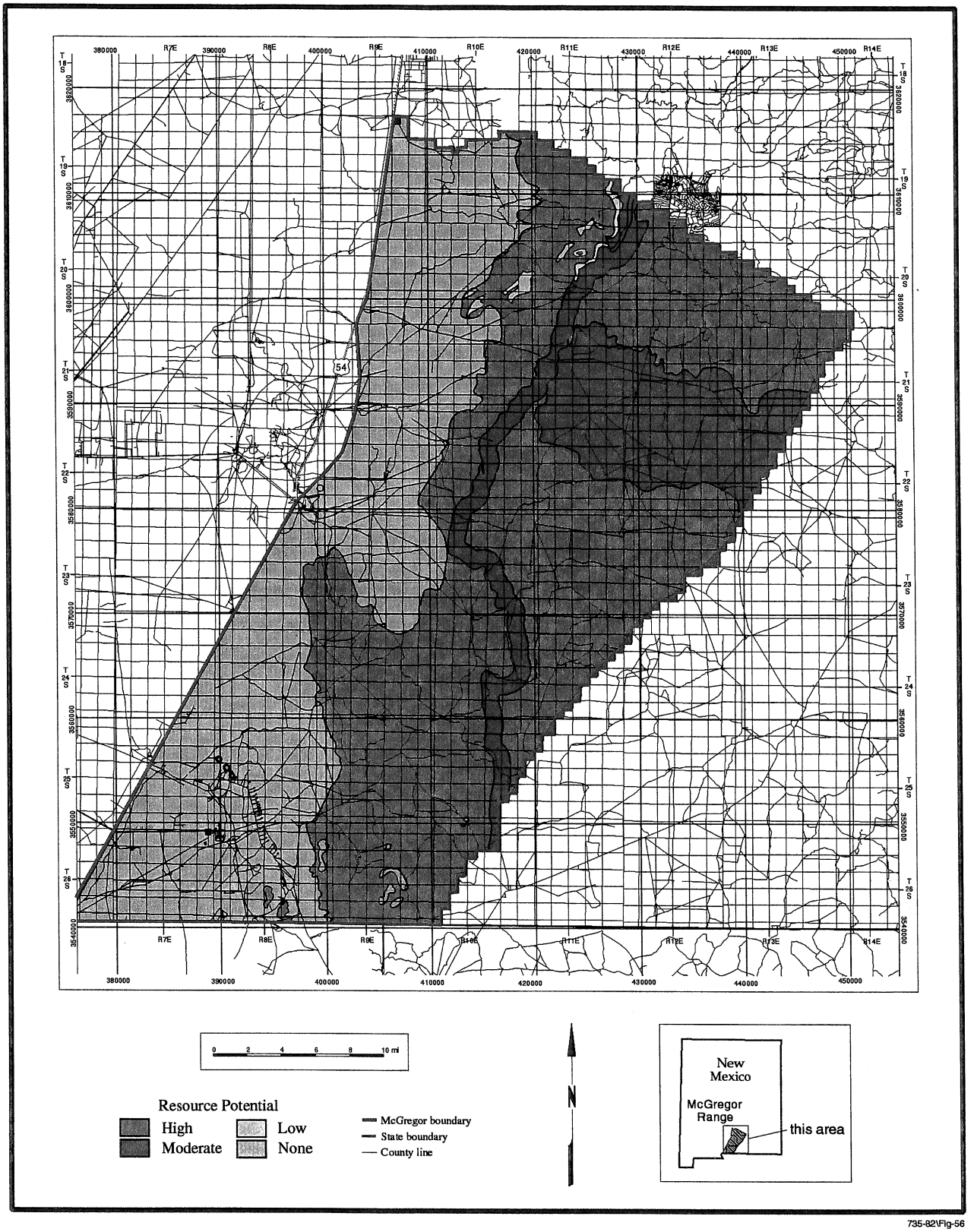

Figure 5.6 Resource Potential for Limestone on the McGregor Range.

deposits in New Mexico are described by Williams (1966), McAnulty (1978), McLemore and Barker (1985), and Rothrock et al. (1946).

Barite and fluorite occur in RGR deposits throughout New Mexico. There are no known RGR barite-fluorite-galena deposits on the McGregor Range. The RGR barite-fluorite-galena deposit nearest to the McGregor Range is west of McGregor Range in the northern Franklin Mountains (refer to Figure 2.26), where barite, fluorite, and lead concentrations are low (refer to Samples VTM97-263 to VTM97-267 in Appendix 5). RGR deposits are also found in the Organ Mountains (Seager 1981; McLemore et al. 1996c) (Figure 2.26). All of these deposits are small and uneconomical to produce. Although there are favorable limestone host rocks in the McGregor Range, the presence of fresh water in drill holes in the east McGregor Range suggests that basin brines required to form RGR deposits may have been flushed out of the Otero Platform and Hueco Mountains area to the west.

5.2.1.2 Barite and Fluorite Resources on the McGregor Range

Epithermal barite and fluorite deposits are locally associated with topaz-rhyolites and alkaline rocks (Burt and Sheridan 1986; Wooley 1987). Therefore, the rhyolites in drill holes in the Otero Platform and the syenites and trachytes in the Hueco Mountains are favorable for vein-type barite and fluorite deposits. However, there was no visible barite and fluorite observed in either area. Fluorine was not analyzed as part of this project. The lack of alteration and brecciation in the Otero Platform and Hueco Mountains suggests that barite and fluorite deposits in these areas are unlikely.

Therefore, based on the discussion presented above, there is a low mineral resource potential with a B-C level of certainty for barite and fluorite on the McGregor Range.

5.2.2 Borate

5.2.2.1 General Information

Boric oxide revenue in the U.S. was $462 million on production of about 600,000 metric tons (Lyday 1996). Boron compounds in the U.S. are used for glass products (56%), agriculture (7%), fire retardants (6%), soaps and detergents (5%), and other uses (26%) (Lyday 1997), including nuclear shielding, metallurgy, advanced composites, refractories and abrasives, fuels, medicine, tanning, chemicals, and electronics (Lyday 1985).

Traces of borax (4%) have been reported in the Tularosa Basin at Lake Lucero and surrounding small lakes and alkali flats (Alto and Fulton 1965:304) several miles west of White Sands National Monument Visitor Center. Such an occurrence in an arid-climate shallow lake with interior drainage is not unusual. The regional rocks are mainly marine in origin. Marine illite is enriched with boron (Walker 1963) that is released by weathering, but boron also can be supplied by other rocks. The presence of small amounts of borate in a region does not imply that potential deposits exist; many other factors must be considered (Barker and Barker 1985). Large-scale borate deposition is primarily related to the location of subduction zones and associated volcanism. In the western U.S., the primary borate-producing areas are eastern California and western Nevada (Barker and LeFond 1985).

5.2.2.2 Borate Resources on the McGregor Range

Results of samples collected from the McGregor Range, along with the discussion presented above, do not indicate any evidence of possible commercial borate deposits. Therefore, the resource potential for borate on the McGregor Range is rated as low with a D level of certainty.

5.2.3 Building Stone

5.2.3.1 General Information

Introduction. Building stone is mainly used in the construction of buildings, monuments, and civil structures, and in landscaping. However, classification of building stone by end use does not eliminate overlap between dimension stone and decorative stone. Most stone can serve several purposes when byproducts or coproducts are considered. Building stone may be quarried in large blocks that are later cut for final finishing, or it may be sold in natural or broken pieces that remain unfinished. In general, commercial building stone comes from production of deposits of durable rock that contains few fractures.

The use of rock as building stone is principally governed by a combination of unique physical properties and aesthetic appeal rather than purely physical parameters. Aesthetic appeal has always been difficult to define and quantify and may change with building and decorating fashions. The "name" of a stone is very important in marketing. Stone from new quarries is often ignored until it is established as having a consistent supply and color over a number of years. Physical properties, if carefully defined by technical specifications and standards, form the basis for selection of natural stone in a variety of construction applications. Personal tastes have moved toward natural materials and finishes, which has stimulated domestic and international markets for building stone. New fabrication techniques allow production of finished stone as unitized tiles and panels, which are thinner and lighter. These panels may even be a composite with concrete or honeycomb backing and they now represent the main growth area in domestic stone production (Lemons 1997). Much of the industry is now automated to lower production costs and make finished stone feasible for use in a greater number of construction projects.

The U.S. market for building stone experienced strong growth during the more affluent latter half of the 1980s, but slowed in some sectors during the early 1990s as a reflection of a slowing in economic growth. The total stone production in the U.S. in 1995 was about 1.33 million metric tons, with a value of $173 per metric ton, a tonnage increase of 15% since 1990 (Lemons 1997). Imports (usually subsidized by the government of the producing country) were about double in value compared to domestic production and were about nine times the tonnage of exports. Despite short-term fluctuations, the long-term market outlook is for continuing growth.

Dimension Stone. Dimension stone is rock that is sold in finished and sized (dimensioned) shapes for specific uses (Power 1994). Most dimension stone is fabricated into panels, slabs, or shapes from granite, marble, limestone, sandstone, or slate. Dimension stone is cut using water jets, flame gas jets, diamond saws, or other abrasives and includes all building stone that is cut or broken to specific dimensions, often on all sides. Dimension stone can take many forms. Surfaces may be textured, smoothed, or polished to meet specifications. Tile and facing sheets are made from thin panels of stone that often have some form of finished surface. Large finished blocks of dimension stone are prepared as monumental stone, which includes grave markers and statuary. Stone shaped into regular pieces along natural fractures can be used for wall construction and roof slate. Large blocks of rough-hewn stone are used in retaining walls,

seawalls, and bridges. Power (1994) provides more thorough description of categories and uses of building stone.

Decorative Stone. Decorative stone is any stone used in construction primarily for its color, texture, or appearance rather than its strength and durability (Barker and Austin 1994). Decorative stone often serves a secondary structural purpose. It is not load-bearing, allowing weak or costly stones to be used solely because they are attractive. Independent statistics are not kept for decorative stone. The basic types of decorative stone are aggregate, rough stone, and cut or dressed stone. Aggregate, either natural or crushed, comprises the bulk of decorative stone production.

Rough stone is used as it is found naturally with limited hand processing. It includes fieldstone and flagstone. Fieldstone, loose rock collected with simple tools, includes nearly every durable rock type set by hand. A variety common in New Mexico is moss rock, which is fieldstone partially covered by moss, algae, fungi, and lichen. Flagstone (flagging) consists of thin irregular slabs used for paving or wall veneers.

Cut or dressed decorative stone has one or more uniform sides but is not made to specific dimensions. This category includes statuary and *objets d'art*, fireplace and hearth stones, ashlar, monuments and memorials, tiles and paving blocks, and veneers or wall cladding.

5.2.3.2 Building Stone Resources on the McGregor Range.

No dimension stones with distinctive color or texture suitable for regional or other markets occur on the McGregor Range. Marble occurs within limestone units surrounding the Tertiary Red Hills syenite. The marble zones are small and of poor quality and do not represent an economic resource. Limestones found on the McGregor Range are dark, while current and past markets indicate a preference for light or neutral colors.

Decorative stone resources on the McGregor Range are minimal. The beauty of decorative stone is an individual perception. Decorative stone on the McGregor Range tends to be gray limestone, which is not unique. The McGregor Range is on the edge of the regional stone market area so that a resource would need to be of exceptional beauty, and hence value, to allow its development relatively far from markets. Some formations, such as the Yeso or Abo, are red or yellow but contain largely poorly indurated fine-grained rocks with scattered occurrences of more durable stone. The amount of waste per ton of usable stone precludes development. Some of the alluvial fan deposits are well-rounded "river rock" that could be marketed but these are on the northeast side of the McGregor Range near New Mexico State Highway 506 which is too far from markets.

The overall potential for all dimension stone resources on the McGregor Range is rated as low with a B level of certainty. The overall potential for decorative stone on the McGregor Range is rated as moderate with a C to D level of certainty. Therefore, the overall building stone resource potential is rated as low to moderate with a B to D level of certainty.

5.2.4 Clay

5.2.4.1 General Information

Clay is a natural, very fine-grained material composed mostly of one or more groups of crystalline minerals known collectively as the clay minerals. Clay minerals are hydrous silicates composed of mainly silica, alumina, and water. Some clay minerals contain significant amounts of the alkali metals, alkaline earths, and iron. As mineral commodities, clay can be classified into several distinct groups. Clay commodities are subdivided into common clay and specialty clays, such as bentonite, kaolin, and hormites (Murray 1994a). If the clay minerals are deposited in water or by moving air, the resulting rock is called shale. Claystone is a rock containing more than 50% clay-sized (<2 μm) materials. Shale commonly has less than 50% clay-sized materials, but the principal feature of shale is breakage along parallel planes or fissility due to orientation of clay minerals. If the rock contains a large amount of clay- and silt-sized particles but does not have the fissility of shale, it is called a mudstone.

Clay is one of the most important domestic industrial minerals in terms of value and volume of production. Production in the U.S. in 1995 was 46.6 million metric tons with a value of $1.8 billion (Virta 1996). Over the last 10 years, annual domestic clay production has been relatively stable at around 40 million metric tons.

Common clay is mainly used in construction products such as bricks, roofing tiles, and portland cement and is also used in pottery and as filler in paint. The term common clay encompasses a variety of naturally occurring mixtures of clay minerals, including illite, kaolinite, and smectite. Common clay is mined in every state in the U.S. except Alaska and Rhode Island (Murray 1994b) and is mined at several locations in New Mexico and west Texas. The largest operations extract clay for the production of brick. The brick plant nearest to the McGregor Range is just west of the Rio Grande and just north of the Mexican border near Sunland Park, New Mexico.

5.2.4.2 Clay Resources on the McGregor Range

Only common clay is available on the McGregor Range. No high-purity clay mineral concentrations are present, but several formations have thin shaly units that contain a mixture of clay minerals (refer to Appendix 12). This common clay may be suitable for brick, tile, pottery, stoneware, and similar products. Other sources in and near the large population areas of El Paso, Las Cruces, and Alamogordo supply the present market. It appears unlikely that additional sources of common clay will be needed regionally in the foreseeable future. Thus, the common clay resources of the McGregor Range would not be developed even if large quantities were available. Therefore, the potential for clay resources on the McGregor Range is rated as low with a C level of certainty.

5.2.5 Construction Aggregate

5.2.5.1 General Information

Construction aggregate consists of a variety of natural or crushed stone, usually screened to specified size ranges. It is used to provide bulk and strength in portland cement concrete, asphalt concrete, fill, road base, loose road surfacing, railroad ballast, concrete block, and stucco. Mined natural materials provide most of the construction aggregate used in the U.S., although recycled materials such as crushed glass and smelter slag are used, as well as manufactured lightweight aggregate such as expanded shale. Sand and

gravel and crushed stone, including caliche and volcanic cinders, are mined materials that are currently used for construction aggregate in New Mexico.

Sand and gravel are natural aggregates mined from unconsolidated stream channel, floodplain, terrace, alluvial fan, river, and beach deposits. In New Mexico along the Rio Grande corridor, almost all sand and gravel production is from river and alluvial fan deposits, with minor production from active stream channels. Sand and gravel that is ideally suited for most construction aggregate is composed of clean, uncoated, properly shaped and sized fragments that are sound and durable. Individual sand and gravel particles must be resistant to physical stress and to chemical and physical changes. Sand and gravel that contains excessive amounts of clay, organic matter, soluble minerals, or weak particles generally makes poor aggregate, although some deleterious materials may be removed by screening and washing. Sand and gravel deposits that contain more than a minor amount of reactive rock types, mainly siliceous rocks such as chert, may not be suitable for use in portland cement concrete without special treatment (Goldman 1994).

Many different rock types are used as crushed stone, a manmade aggregate. The types used are determined mainly by availability and rock quality. Rock types must meet the same, or more stringent, soundness and durability requirements as those for sand and gravel and therefore should not contain reactive minerals or other weaknesses. However, extremely hard or abrasive rock types are generally not used in crushed stone because of high crushing and screening costs. For most uses, it is important that the rock break into more-or-less equant fragments when crushed. Platy rocks such as slate generally make poor aggregate. Certain mineral components, such as mica in some schists, are deleterious in aggregate because they cause structural weakness. Some types of crushed stone are particularly desirable for specific uses. For example, fine-grained basalt is commonly used in asphalt concrete, and crushed pumice is used in lightweight portland cement concrete and in concrete (cinder) blocks. As is the case with sand and gravel, certain reactive siliceous rocks and minerals are unsuitable for aggregate used in portland cement concrete. They should not be used without special care because of the alkali-silica reactivity of certain silicene materials (Malisch 1978).

Caliche is calcium carbonate in the soils of the arid southwestern U.S. The calcium carbonate accumulates from dust and calcium ions in precipitation. The thickness of caliche deposits increase with time on stable structures. Caliche varies greatly in durability, but generally makes a poor aggregate only suitable for building unimproved dirt roads. Caliche is generally a poor construction material and is used only as a last resort.

On the basis of data from Tepordei (1993a, 1993b), the annual domestic production of construction aggregate has been over 1.5 billion tons for more than 25 years, except during the recession years of 1981 through 1983. The annual amount used averaged 1.84 billion metric tons between 1970 and 1990 (Langer and Glanzman 1993) and reached a maximum of 2.21 billion metric tons during 1996 (Nelson 1997). Import-export activity was minor. The value of domestic crushed stone and sand and gravel, which was estimated to be more than $10 billion in 1994 (Tepordei 1995), reached $11.3 billion in 1996 (Nelson 1997). This total value exceeds the value of any other mineral commodity produced in the U.S. and is expected to grow about 3% in 1997.

5.2.5.2 Construction Aggregate Resources on the McGregor Range

Construction aggregate (i.e., sand, gravel, crushed stone, and caliche) produced on the McGregor Range is used locally by the military. If produced commercially, it would compete on the open regional market.

This market is comprised mainly of El Paso, Las Cruces, and Alamogordo; virtually no aggregate crosses the international border. These cities and the surrounding areas are rapidly growing, have large nearby government facilities, and contain abundant local building stone resources. Companies typically bid competitively on a contract-by-contract basis. The low bidder then supplies building stone according to the contract specifications. The supplier may use their own sources or may trade or purchase the necessary material from a competitor or landowner better located to supply the material efficiently. Some pits are not operated by building material suppliers but are opened to suppliers on a fee basis by the landowner only when a contract is active. This competitive-cooperative system makes it difficult to compete solely on location but also would allow the somewhat remote building stone resources of the McGregor Range to compete in the local market to a modest degree.

As is typical nationwide, the region, and especially El Paso, is divided into zones with standard rates based grossly on tonnage/distance for each zone. Load sizes tend to be 5, 12.5, or 23 tons. The 23-ton truck access is restricted in central El Paso and the 5-ton trucks are inefficient for long hauls. In the summer of 1997, typical rates for 23-ton loads of concrete sand from the southwestern corner of McGregor Range (near Newman, New Mexico) were $120 (Las Cruces), $100 (Alamogordo), and $38 to $58 (El Paso). Other materials would have similar delivered costs from the McGregor Range area. Freight-on-board (FOB) mine prices in the region are about $4 to $15 per ton depending on the material, with additional costs of transportation added accordingly. Caliche typically sells for $0.25 to $0.50 per cubic yard in the region.

The Los Angeles (LA) Wear test is the most widely specified test used to measure resistance to abrasion and impact in aggregate (Marek 1991). It is reported as percent wear according to the American Society for Testing and Materials (ASTM) C 131-89 standard and is used for aggregate smaller than 1.5 inches; C 535-89 is used for aggregate coarser than 0.75 inch. The percent passing specified sieves (1/2 and 3/8 inch for Grading B) is the percent wear or percent loss. These data allow comparisons only between similar materials. Aggregate having a percent wear less than 40 is considered a tough and abrasion-resistant aggregate, although values up to 50 are often accepted (T.D. White 1991). All of the aggregate on and near the McGregor Range tested below 50 and most below 40 (refer to Appendices 13 and 14). The New Mexico Highway and Transportation Department publishes *Standard Specifications for Highway and Bridge Construction* (New Mexico Highway and Transportation Department 1994) that lists all "quality acceptance of aggregate" values. These specifications rely primarily on LA Wear and soundness tests. Local availability of aggregate is the deciding factor, and material out of specification may be used if it is the best available and design corrections are made.

Caliche deposits are widespread on the McGregor Range, but the quality (refer to Appendices 13 and 14) is generally poor to good when compared to good to excellent limestone.

The potential for construction aggregate resources is rated as none to high with a D level of certainty (refer to Figures 5.2-5.6).

5.2.6 Garnet

5.2.6.1 General Information

Garnets are a group of silicate minerals common to skarns and igneous rocks used as an abrasive and in sand-blasting media, water filtration, and waterjet cutting. The U.S. produces approximately one-third of

the world's garnets; in 1996, six companies produced 68,200 tons of crude garnet from mines in the U.S. (Balazik 1997a).

5.2.6.2 Garnet Resources on the McGregor Range

Garnet occurs within thin skarns (less than 3 ft thick) and along bedding planes adjacent to the Red Hills syenite. The zones are small and low grade and do not represent an economic resource. Larger zones of garnet may occur in the subsurface, but garnet, like many industrial minerals, is typically mined at the surface by open-pit methods. Small amounts of garnet are found in metamorphosed Proterozoic carbonates in the subsurface. However, the Proterozoic rocks are too deep to be considered an economic source for garnet.

Therefore, garnet has a low mineral resource potential with a C level of certainty near Tertiary intrusions in the Hueco and Jarilla Mountains of the McGregor Range (refer to Figure 4.1). Elsewhere on the McGregor Range, there is no mineral resource potential for garnet with a D level of certainty.

5.2.7 Gypsum

5.2.7.1 General Information

Gypsum ($CaSO_4 \cdot 2H_2O$) and its nonhydrated counterpart, anhydrite ($CaSO_4$), are mined in large amounts mainly for use in wallboard, portland cement, and agriculture. Over 17 million metric tons of crude gypsum and anhydrite were mined in the U.S. in 1996 (Sharpe 1997). The average price for crude gypsum in 1996 was $7.50 per metric ton. This is based mainly on prices for internal company sales because most gypsum is used in wallboard manufactured by the company that mines it.

Gypsum is used in construction (80%), industrial (12%), and agricultural (8%) industries. Wallboard is used in the building and construction industries and accounts for use of 86% of gypsum production (Balazik 1997b). Molding plasters, Keenes cement (building plaster), and portland cement retarder are industrial uses. Agricultural applications include use as soil conditioner and use in animal feed.

Gypsum is marketed in uncalcined or calcined forms. Uncalcined gypsum is crushed or ground. Calcining reduces gypsum ($CaSO_4 \cdot 2H_2O$) to a hemihydrate ($CaSO_4 \cdot 1/2H_2O$). Pure gypsum, which contains 20.93% H_2O, begins to lose water of crystallization at 110-120°F (43-49°C) when heated in calcining kettles or rotary kilns. About 300°-330°F (149-165°C), it contains 5-6% combined water, a 75% water loss. The resulting hemihydrate (calcined gypsum or plaster of Paris), when mixed with water, will set or harden as the calcium sulfate returns to the dihydrate form.

Uncalcined gypsum is used as a retarder for portland cement. The SO_3 content for this use is a minimum of 46% (ASTM 1980). Finished cement contains about 5% by weight of gypsum. High-purity, finely ground raw gypsum (terra alba) is used as a diluent and a calcium source. When used in pharmaceuticals, bread, and bakery products, a terra alba is 97% pure.

Calcined gypsum for industrial uses requires gypsum of more than 78.4% purity; some uses require high-purity (>95%) gypsum. The percent purity is determined by dividing percentage combined water by 20.93 and multiplying by 100.

Industry standards for gypsum are published by the ASTM, from which the following 1980 standards are summarized. Gypsum must have a minimum purity of 70% (14.65% combined water). Calcined gypsum products, such as concrete, plaster, and pre-cast reinforced slabs, require a purity of 78.3% or higher. Calcined casting and molding plasters are made from high-purity (>95%) gypsum. ASTM lists no wallboard purity standards; however, according to Roger Patterson (personal communication, 1991, with Centex American Gypsum), purity should be 90% or higher.

Domestic crude gypsum production in 1996 was 17.2 million metric tons, and 9.3 million metric tons was imported, mainly from Canada (Sharpe 1997). This total of 26.5 million metric tons includes about 1.5 million metric tons of gypsum produced as a by-product of flue gas desulfurization (Balazik 1997b). About 77% of the total was calcined for prefabricated products and 23% was uncalcined (Balazik 1997c).

New Mexico produced an undocumented amount of gypsum in 1996, mostly from a single captive mine owned by Centex American Gypsum in the San Ysidro area. Most of this gypsum supplies the Centex American wallboard plant in Bernalillo, although a small amount is used as a hardening retarder by the Rio Grande Portland Cement plant at Tijeras, east of Albuquerque. A small deposit, called the Keystone #1, is located south of the White Sands National Monument. It is operated intermittently by Schneider Welding of Anthony, New Mexico, at a capacity of 600 to 800 metric tons per year, but the final use of the gypsum is not known. A small pit is operated by Coogler Gypsum Company in the same area (Hatton et al. 1995).

5.2.7.2 Gypsum Resources on the McGregor Range

Most of the significant gypsum deposits on the McGregor Range occur in the basal Yeso Formation. Pray (1961:107-111) measured a stratigraphic section in the Yeso "red beds" just west of the Range (SE1/4 of Section 30, T19S, R12E in the Lincoln National Forest) that contained four gypsum beds ranging from 4 to 54 ft in thickness. Gypsum represents only 7% to 9% of the section at the northern edge of the McGregor Range. The Yeso "red beds" are actually pinkish and mainly in the lowermost Yeso on the McGregor Range. Pray reports that the Yeso is "composed of a large number of rock types" with poor outcrops and that "carbonate rocks become increasingly abundant" to the south. Gypsum correspondingly decreases southward on the southern McGregor Range. The lower contact is gradational into the Abo Formation over a few feet.

The New Mexico Highway Department (1972) geologic map shows the lower to middle Yeso Formation extensively exposed in the northeastern portion of the Range and at Otero Mesa southward to the state line. Several poorly exposed, 10- to 20-ft thick gypsum beds within the Yeso Formation crop out along the base of the Otero Mesa escarpment (Weber and Kottlowski 1959:45) in the central McGregor Range. This gypsum, which is lenticular with thin interbeds and laminae of siltstone and dolomitic limestone, is largely covered by gypsite and dips eastward under Otero Mesa. The area along New Mexico State Highway 506 from the base of Otero Mesa eastward is the prime area of gypsum resource potential. The erosion along this major drainage has exposed the Yeso gypsum in a series of west-facing/east-dipping cuestas. The gypsum is widespread in this area (refer to Figure 5.5). Hardie (1958a:6-7) found a 25- to 75-ft thick gypsum bed in Pennsylvanian rocks near the western end of the Hueco Mountains, but found no gypsum near Red Hill. This agrees with Weber and Kottlowski (1959:plate 1) who show the last gypsum outcrops about 6 to 7 mi north of the southern boundary of McGregor Range and northeast of Red Hill. Gypsum also occurs in the upper Abo Formation near the contact with the Yeso. This unit is poorly exposed and impure (Weber and Kottlowski 1959).

All gypsum samples collected by the USBM were from the Yeso Formation. Gypsum outcrops less than 1 mi northeast of Culp Canyon (refer to Samples USBM-9, USBM-10, and USBM-12 in Appendix 15). Four gypsum beds range from 3 to 12 ft thick. A 6-ft thick gypsum bed (refer to Sample USBM-12) is traceable for about 40 ft. Gypsum (refer to Samples USBM-56 to USBM-58 in Appendix 15) in the Yeso Formation is poorly exposed for about 3 mi along the base of Otero Mesa escarpment. This gypsum bed is at least 25 ft thick and gently dips to the east. Gypsum may be traced visually from the escarpment southward along the base of the cliffs to beneath the location of Sample USBM-61.

USBM analytical data (refer to Appendix 16) show that no samples meet the SO_3 specification of 46% for gypsum to be used in the manufacture of cement. The samples ranged in SO_3 from 39.1% (84.1% gypsum) to 44.1% (94.8% gypsum). Appendix 17 shows that all USBM samples exceed the 78.3% purity that is necessary for gypsum to be used for terra alba. These purity levels indicate all of the samples are suitable for plasters, most are suitable for wallboard, and some are of high purity, suitable for casting and molding plasters; however, the purity varies laterally within and vertically between gypsum beds in the same formation.

Cement and wallboard plants have regional spacing among them that affords each plant an unofficial "market area" or "radius" with as little overlap as possible. Cement and wallboard needs in southern New Mexico and west Texas are well covered by existing plants. In fact, the region is extremely competitive owing to plants built nearby in Mexico that tend to ignore the "market areas" concept common in the U.S. Finally, gypsum is a low-priced ($3-$11 per metric ton FOB mill) (Jorgensen 1994), high-place-value commodity that affords little room for processing or transport. However, the McGregor Range deposits are well positioned for El Paso because they are the nearest gypsum outcrops (Weber and Kottlowski 1959:Plate 1).

More detailed evaluation of gypsum resources on the McGregor Range cannot be completed without an extensive mapping and drilling program; however, based on available information these resources are large. The depth of overburden, lateral extent of exposed beds, and uniformity are unknown, but are locally acceptable. It is unlikely gypsum resources in the McGregor Range will be developed on a large scale owing to economic and market factors, rather than geological factors. Gypsum resource potential is, therefore, rated none to high, with a B-C level of certainty (refer to Figure 5.5).

5.2.8 Halite (Salt)

5.2.8.1 General Information

Domestic halite (salt) revenue was $960 million for production of about 44 million metric tons (Kostick 1996). About 39% of salt is used in chemicals, primarily as brine. Additional uses include highway salt (35%), food (6%), water treatment (1%), and others (13%).

5.2.8.2 Halite Resources on the McGregor Range

Minor halite is present in the Yeso Formation (Pray 1961). Halite interbedded with various sedimentary rocks was present over a 2,000-ft interval in an oil test (Section 33, T26S, R9E) in Lincoln County (Alto and Fulton 1965), suggesting that some halite may occur at depth under the McGregor Range. Economic deposits, which must be large and pure, are unlikely. Therefore, the resource potential for halite on the McGregor Range is rated low with a C level of certainty.

5.2.9 Limestone and Dolostone

5.2.9.1 General Information

Limestone and dolostone are almost 15% of all near-surface sedimentary rocks available for exploitation and are the most useful and widely utilized of all the industrial minerals and rocks. Limestone is a sedimentary carbonate rock composed of 50% or more calcite or aragonite (both $CaCO_3$). Dolostone is a similar rock composed mainly of the mineral dolomite, $CaMg(CO_3)_2$. Variable mixtures of $CaCO_3$, dolomite, and other carbonate minerals occur in many formations, and most limestone and dolostone contain impurities, most commonly clay, chert, and organic matter. The purity of a deposit of carbonate rock, its size, and its lithological and compositional consistency depend on the environment of deposition and its mineralogical and tectonic history. Limestone and dolostone recrystallized by heat and pressure are called marble.

Geological assessment of the industrial potential of limestone and dolostone are based initially on bulk chemical composition, carbonate mineral content, and the amounts of clay, silica, and other contaminant materials. Physical attributes of the rock may also be important. For example, high-calcium lime is generally produced from very fine-grained limestone because most coarsely crystallized carbonate rock decrepitates during calcination. Mineral, chemical, and physical attributes of carbonate rocks can generally be related to their depositional and tectonic history. Many classification systems for carbonate rocks allow for interpretation of these factors and, combined with models for deposition and tectonic history, allow some predictability in the location and selection of carbonate rocks for industrial applications. Beyond the utilization of carbonate rock for the production of construction aggregate and building stone (refer to Section 5.2.3), five major areas of application are portland cement, lime, refractories, fillers and extenders, and agriculture.

In 1996, about 950 million metric tons of limestone and dolostone were produced in the U.S. (Miller 1997b). Of that amount, 855 million metric tons was limestone and 95 million metric tons was dolostone. Limestone is the dominant ingredient in cement, so cement plants generally are located close to this resource. Acceptable cement limestone has a $CaCO_3$ content greater than 70% to 75%. Numerous deposits of limestone are mined in the southwestern U.S., most supplying the cement and lime industries, especially in populous Texas and, to a lesser extent, in Nevada, Arizona, and New Mexico.

In 1996, domestic plants shipped 77.8 million metric tons of clinker and cement (MacFadyen 1997). Imports of cement accounted for another 12.3 million metric tons. California leads the country in cement production, mainly from plants in southern California. In 1995, the average price for portland cement was $66.89 per metric ton for portland cement, $85.64 per metric ton for masonry cement, and $174.66 per metric ton for white portland cement.

The sole cement producer in New Mexico is Rio Grande Portland Cement Company, supplying about 500,000 metric tons per year of cement from its Tijeras plant near Albuquerque to markets in New Mexico and southern Colorado. Limestone raw material for this operation is the Mississippian Madera Limestone that is mined nearby. There is no cement production in El Paso, but Cementos de Chihuahua has two plants in the Juarez area supplying cement to the El Paso market. The older Juarez plant is capable of producing about 500,000 metric tons annually. The newer Samalayuca plant is rated at 1.2 million metric tons per year. Cementos de Chihuahua is also the parent company of Rio Grande Portland Cement Company. Southdown, Inc. operates a cement plant at Odessa, Texas, about 250 mi east of El Paso, which

has a capacity of about 750,000 metric tons per year. These four cement plants produce almost all the cement needed in the New Mexico-west Texas area.

The long-term demand for limestone and dolostone is expected to grow at an annual rate of about 2.0% to 2.5% (Carr et al. 1994). Demand for limestone and lime could be stimulated by the need for flue gas desulfurization based on the 1990 Clean Air Act Amendment. The long-term outlook for cement consumption is one of steady but moderate growth. The domestic portland cement industry grew 5.6% in 1996 (production and imports), on top of the 11% increase in 1994–1995 (MacFadyen 1997) and prices continued to rise. Over 90% of production was Types I and II gray portland cement. Demand and prices should be firm through 1997–1998, although capacity increases planned over the next 2 to 4 years could soften them (MacFadyen 1997).

Prices for limestone, dolostone, lime products, and cement depend substantially on the grade of limestone and dolostone, or lime, or the specific product requirements. Crushed limestone for aggregate uses and agricultural applications is generally priced at $4 to $10 per metric ton (Harben 1995). The prices for fillers range from $40 per metric ton for coarse filler to $292 per metric ton for ultrafine fillers (Harben 1995). Grades for cement powder also may vary considerably, but Solomon (1995) gives an average domestic price for portland cement in 1994 of about $60 per metric ton. The average price in 1995 was $66.89 per metric ton for portland cement, $85.64 per metric ton for masonry cement, and $174.66 per metric ton for white portland cement (MacFadyen 1997). Regional price differences are evident across the U.S.

5.2.9.2 Limestone and Dolostone Resources on the McGregor Range

According to Kness (1994), Kottlowski (1962:56) stated that high-calcium-limestone beds occur within the Hueco Limestone in the Hueco Mountains. Two Hueco limestone samples were collected, and spectrographic analysis showed the limestone contained 97% and 99.88% $CaCO_3$ (Kottlowski 1962:10). All samples (refer to Samples USBM-2, USBM-3, and USBM-7 in Appendix 18) of the Hueco limestone tested by the USBM exceed 3% SiO_2. One silicified limestone sample (Sample USBM-93) taken near the Red Hill intrusive contained 43.14% $CaCO_3$ and 41.53% SiO_2.

Most carbonate rock samples taken by the USBM (66 samples) were from the Yeso Formation (refer to Appendix 11). Analytical data from the samples (refer to Appendix 18) show that six samples are ultra-high-calcium limestone, nine are high-calcium limestone, and five are high-magnesium dolostone and dolostone. The remaining samples (46) are lower quality limestone and dolostones. Forty samples are high-purity carbonate rock containing less than 3% SiO_2. High-quality dolostone beds crop out along Culp Canyon (refer to Samples USBM-27 and USBM-28 in Appendix 18) and at the intersection of El Paso and West McAfee Canyons (refer to Samples USBM-23 to USBM-25 in Appendix 18).

The remaining 16 carbonate rocks taken by the USBM are from the San Andres and Gobbler Formations. Of the 12 samples taken from the San Andres Formation, analytical data (refer to Appendix 18) show that two samples are ultra-high-calcium limestone, six are high-calcium limestone, and one is high-purity dolostone. Eleven samples from the San Andres Formation show the presence of high-purity carbonate rock containing less than 3% SiO_2. Silica content is low (<3%) except for Sample USBM-35 (5.83%). Of four samples (refer to Samples USBM-1 and USBM-4 to USBM-6 in Appendix 18) from the Gobbler Formation, two are high-quality limestone and three qualify as high-purity carbonate rock.

Many of the carbonate rocks from the McGregor Range are suitable for lime and cement manufacture (refer to Appendix 19). High-quality limestone and dolostone beds are found in the above formations. Quality varies laterally within and vertically between beds in the same formation. The best quality of carbonate rock occurs in beds within the San Andres Formation. Carbonate rock resources in the central and eastern part of the McGregor Range are very large.

Therefore, based on the discussion above, the potential for limestone resources on the McGregor Range is rated as none to high with a D level of certainty (refer to Figure 5.6). Dolostone is uncommon and the potential is rated as low with a D level of certainty.

5.2.10 Nepheline Syenite

5.2.10.1 General Information

Nepheline syenite is a constituent in manufacturing glass, ceramics, and flatware (Allen and Charsley 1968; Guillet 1994; Bourne 1994; O'Driscoll 1990; Potter 1997). More than 20 industrial minerals and rocks are utilized in the manufacture of various forms of glass (O'Driscoll 1990), and nepheline syenite is an inexpensive source of essential alumina, soda, and potash. Nepheline syenite also improves the workability of the glass batch by lowering the viscosity, and it imparts a unique quality of toughness to the glass which makes it more resistant to breakage. Nepheline syenite is also used for extender pigments, fillers, roofing granules, dimension stone, abrasive, and aggregate (Allen and Charsley 1968; Guillet 1994; McLemore and Guilinger 1993, 1996; McLemore et al. 1996a). Nepheline syenite is desired in pigments and fillers because it has a high brightness, inertness, and easy wetting and dispersion in parent formulations. The ultraviolet (UV) attenuation characteristics and resistance to weathering makes nepheline syenite a desirable component in roofing materials. The lack of quartz or free silica and relative hardness also enables use of nepheline syenite as a silica-free abrasive. Nepheline syenites also have been examined as potential sources of alumina and alkalis (Allen and Charsley 1968). Other uses include fertilizers, ingredients in refractory cement, and paper (Allen and Charsley 1968). Nepheline syenite is currently produced in Canada and Norway (Potter 1997). Feldspar can be substituted for most uses of nepheline syenite.

The outer zone of the Wind Mountain nepheline syenite in the Cornudas Mountains is currently being developed for use as a constituent in glass, ceramics, and flatware and for use as an abrasive. The nepheline syenite contains high iron (refer to Tables 2.5 and 5.2) compared to other commercial sources of nepheline syenite. However, when the Wind Mountain nepheline syenite is crushed and passed through a specialized rare earth magnet, the resulting product is similar in composition to Grade B product specified by Unimin Canada Ltd. (refer to Table 5.3) and has been certified by Coors Inc. as being suitable for amber-colored glass and ceramics. The lack of free silica (i.e., no quartz) and a Mho's hardness scale greater than 6 enables use of the Wind Mountain nepheline syenite as a silica-free abrasive (McLemore et al. 1996a, 1996b; McLemore and Guilinger 1996). Physical and chemical test results of Wind Mountain nepheline syenite meet or exceed standards for use as roofing granules, dimension stone, aggregate, and abrasives (McLemore and Guilinger 1996).

5.2.10.2 Nepheline Syenite Resources on the McGregor Range

Although lower in iron, the Red Hills area syenite and trachyte intrusions in the Hueco Mountains contain too much silica and not enough alkalis or nepheline compared to nepheline syenites to be economic for glassware (refer to Tables 2.3, 2.5, and 5.2 and Figure 2.11) (Kness 1994). Iron oxide is evenly distributed throughout the Red Hills area syenite, and iron minerals would be difficult to separate. Iron minerals in the

Table 5.2 Chemical Composition of Unprocessed, Raw Nepheline Syenite.[1]

Element	Average Wind Mountain ($TNSP_2$)[2]	Red Hill Syenite (Sample VTM97-199, Appendix 5)	Deer Mountain[3]	Blue Mountain, Ontario[4]	French River, Ontario[4]	Rutter, Ontario[4]
SiO_2	59.84	64.00	57.3	59.18	56.35	59.03
TiO_2	0.12	0.65	0.48	0.06	0.16	0.03
Al_2O_3	18.84	17.4	19.6	23.06	20.31	21.81
Fe_2O_3[5]	4.90	2.77	6.85	2.15	7.19	3.82
MgO	0.73	0.36	0.44	0.17	0.11	0.06
CaO	1.23	1.44	1.52	0.76	1.69	0.53
K_2O	5.35	5.81	5.46	3.94	4.86	4.36
Na_2O	7.82	6.10	7.03	10.48	8.31	10.78
MnO	0.27	0.09	0.38	na[6]	0.18	0.03
P_2O_5	0.11	0.16	0.13	0.02	0.04	0.02
LOI	2.24	0.20	2.62	0.40	1.36	0.15
Total	101.45	98.98	101.81	100.22	100.56	100.62

1 In percent. From the Hueco and Cornudas Mountains, New Mexico, and from Blue Mountain, French River, and Rutter, Ontario, Canada, which have been used for manufacturing glass.
2 From McLemore and Guilinger (1993) and McLemore et al. (1994, 1996a, 1996b) unaltered surface and drill core samples (n=5).
3 Average from Barker et al. (1977; n=4) and Schreiner (1994; n=2).
4 From Guillet (1994).
5 Total iron calculated as Fe_2O_3.
6 na = not available.

Table 5.3 Chemical Analyses of Nepheline Syenite.[1]

Element	Wind Mountain $TNSP_2$ Pit 1[2]	Wind Mountain $TNSP_2$ Pit 2[2]	Unimin Canada Ltd. A Grade[3]	Unimin Canada Ltd. B Grade[3]	Elkenm Neflin, North Cape, Norway[3]
SiO_2	64.70	63.80	60.20	60.10	55.90
Al_2O_3	20.50	20.90	23.50	23.40	24.20
Fe_2O_3[4]	0.52	0.40	0.08	0.35	0.10
Na_20	7.62	8.23	10.60	10.50	7.90
K_2O	6.74	6.73	5.10	4.90	9.00
CaO	0.23	0.20	0.30	0.30	1.30
MgO	<0.05	<0.05	trace	trace	trace
TiO_2	<0.01	<0.01	na[5]	na[5]	na[5]
ZrO_2	<0.01	<0.01	na[5]	na[5]	na[5]
P_2O_3	<0.05	<0.05	na[5]	na[5]	0.10
LOI	na[5]	na[5]	0.40	0.30	1.00
Total	100.31	100.26	100.18	99.85	99.50

1 In percent. After magnetic separation from Wind Mountain, New Mexico, compared to raw composition of typical glass grade compositions of Blue Mountain and Elkenm Neflin nepheline syenites.
2 McLemore et al. (1996b).
3 Guillet (1994).
4 Total iron calculated as Fe_2O_3.
5 na = not available.

Wind Mountain nepheline syenite are in aggregates and are easily separated by REE magnets (McLemore et al. 1996a, 1996b). It is also unlikely that the Red Hills syenite could be mined economically for dimension stone or other uses described above for the Wind Mountain nepheline syenite, because of remoteness and inaccessibility to the market. In addition, the Wind Mountain nepheline syenite has more tonnage, is more readily accessible, and is more economic for dimension stone and other uses than the Red Hills area syenite. The mineral resource potential for nepheline syenite in the Red Hills area of the Hueco Mountains is low with a C level of certainty (refer to Figure 4.1). There is no mineral resource potential with a D level of certainty of assurance for nepheline syenite elsewhere in the McGregor Range, because nepheline syenite does not outcrop anywhere else within the McGregor Range.

5.2.11 Silica

5.2.11.1 General Information

Few other industrial minerals have more diversified uses than silica (sand). Most silica is used for the manufacture of glass or as foundry sand in casting iron-, aluminum-, and copper-based alloys (Bolen 1992). Silica and sandstone (lithified varieties of silica) are used in refractory sands and abrasives, for metallurgical applications, and for filtration and oil well fracturing. Ground silica is used in fillers and extenders. Cryptocrystalline silica is mined primarily in minor amounts for abrasive applications such as whetstones and for grinding media in pebble mills. Quartz veins are now mined in small amounts for optical and electronic quartz, but in the past, large quartz vein deposits were mined for metallurgical and refractory silica.

Prices for western U.S. silica sand, FOB plant, range between $14 and $25 per ton, depending on use and quality (Zdunczyk and Linkous 1994). Prices for silica gravel used to make silicon and ferrosilicon range between $10 and $11 per ton, and high-quality silica for specialty abrasive uses brings as much as $60 per ton (Alsobrook 1994). The average value for domestic silica sand, FOB plant, is about $17 per metric ton, but ground silica used in fillers is sold for about $95 per metric ton (Bolen 1992, 1994). Arkansas whetstone rock sells for nearly $4/kg, and grinding pebbles for as much as $2/kg (Zdunczyk and Linkous 1994). Quartzite and quartz pebble used in silicon and ferrosilicon production sells for about $10 per metric ton (Alsobrook 1994).

Most domestic silica comes from deposits of sand or sandstone in the eastern and midwestern U.S. (Zdunczyk and Linkous 1994). In the western U.S., most production is from Tertiary formations. High-silica sandstones in New Mexico are poorly studied and records of past production are not available. Silica production in New Mexico was mainly from the Phelps Dodge operation in Hidalgo County and from Royal Minerals and Southwest Silica Flux near Silver City in Grant County. In the San Pedro Mountains east of Albuquerque, silica sand was mined from the Permian Glorietta Sandstone in open pits by Oro Mountain Mining Company. Other units of potential interest in New Mexico are the Chuska sandstone and portions of the Bliss Formation.

5.2.11.2 Silica Resources on the McGregor Range

Silica is a very common mineral in surface rocks and, thus, is widespread but disseminated on the McGregor Range. Silica specifications are among the most stringent of any industrial mineral group and vary depending on the application and the user; however, they generally require SiO_2 content in the 95% to 99% range with low iron. Thus, only about 70 stratigraphic units in the country are known to have potential for economic silica production (Bolen 1992) even though silica is extremely common.

Commercial silica deposits must be very high quality and easy to mine. No deposits on McGregor Range fit these basic requirements. Therefore, the resource potential for silica on the McGregor Range is low with a D level of certainty.

5.2.12 Sulfur

5.2.12.1 General Information

Elemental sulfur and combined sulfur are together one of the most important industrial commodities in the world. Production in the U.S. was 10.3 million metric tons of elemental sulfur, which was about 65% of production of sulfur in all forms valued at about $500 million. About 90% of sulfur is used to make sulfuric acid, about 67% of which is used to make fertilizer (Ober 1996). Other uses include chemicals (8%), mining (6%), and petroleum (5%). The remaining 14% is spread over literally thousands of uses.

5.2.12.2 Sulfur Resources on the McGregor Range

Sulfur is formed a variety of ways (Wessel 1994) but the four main modes are related to metals (pyrite), volcanism (fumarole gases), petroleum (sour gas), or biogenesis (H_2S + gypsum/anhydrite). The latter is the only possibility on the McGregor Range because sour gas from deep petroleum could migrate into the gypsum deposits under portions of the McGregor Range. Such an occurrence requires extensive "plumbing" in the form of faults and fractures plus a seal to keep reactants mixed. The gypsum is shallow and any significant reaction with H_2S would have some surface manifestation. No sulfur has been reported and the gypsum and limestone appear to be unaltered. Therefore, the resource potential for sulfur on the McGregor Range is rated as low with a D certainty level.

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6.0 ASSESSMENT OF ENERGY RESOURCE POTENTIAL

6.1 INTRODUCTION

Energy resources likely present on the McGregor Range include leasable minerals and energy resources such as petroleum, geothermal, coal, and locatable minerals such as uranium. These resources have been evaluated utilizing the methodology described in Chapter 1.0 of this report and Goudarzi (1984). Because petroleum and geothermal resources on the McGregor Range are more difficult to evaluate than other locatable or saleable mineral resources, additional background information has been prepared and included in the appropriate sections of this chapter. The potential for energy resources on the McGregor Range is summarized in Table 6.1 and shown on Figures 6.1, 6.2, and 6.3.

6.2 COAL

6.2.1 General Information

Coal is mined in the San Juan Basin in northwestern New Mexico and Raton Basin in northeastern New Mexico from Cretaceous-age rocks (Hoffman 1996). Power plants in the San Juan Basin burn coal to generate electricity. Coal from Raton is shipped to other power plants and has been used in steel furnaces as flux.

6.2.2 Coal Resources on the McGregor Range

There are no coal-bearing rocks in the McGregor Range. The nearest coal field to the McGregor Range is the Sierra Blanca coal field, which is north of Alamogordo and 50 mi north of the McGregor Range. The coal is hosted by Cretaceous rocks which do not crop out in the McGregor Range (Hoffman 1996). The Sierra Blanca field is part of a synclinal basin that does not extend into the McGregor Range. There is no resource potential for coal on the McGregor Range with a D level of certainty.

Table 6.1 Energy Resource Potential on the McGregor Range.

Resource	Area	Potential	Certainty	Comments
Coal	All	None	D	No Cretaceous rocks
Geothermal	Near McGregor Base Camp	High	D	Refer to Figure 6.1
	Western portion of McGregor Range	Moderate	B	Refer to Figure 6.1
	Elsewhere on the McGregor Range	Low	B	Refer to Figure 6.1
Petroleum	Otero Platform and Hueco Uplift area	Low-Moderate	C	Refer to Figure 6.2
	Sacramento Uplift area	Low	C	Refer to Figure 6.2
	Tularosa Basin area	Moderate	C	Refer to Figure 6.2
Uranium	Hueco Mountains and Martin-Hay Meadow Canyons area	Low	C	Refer to Figure 6.3
	Elsewhere on the McGregor Range	None	D	None

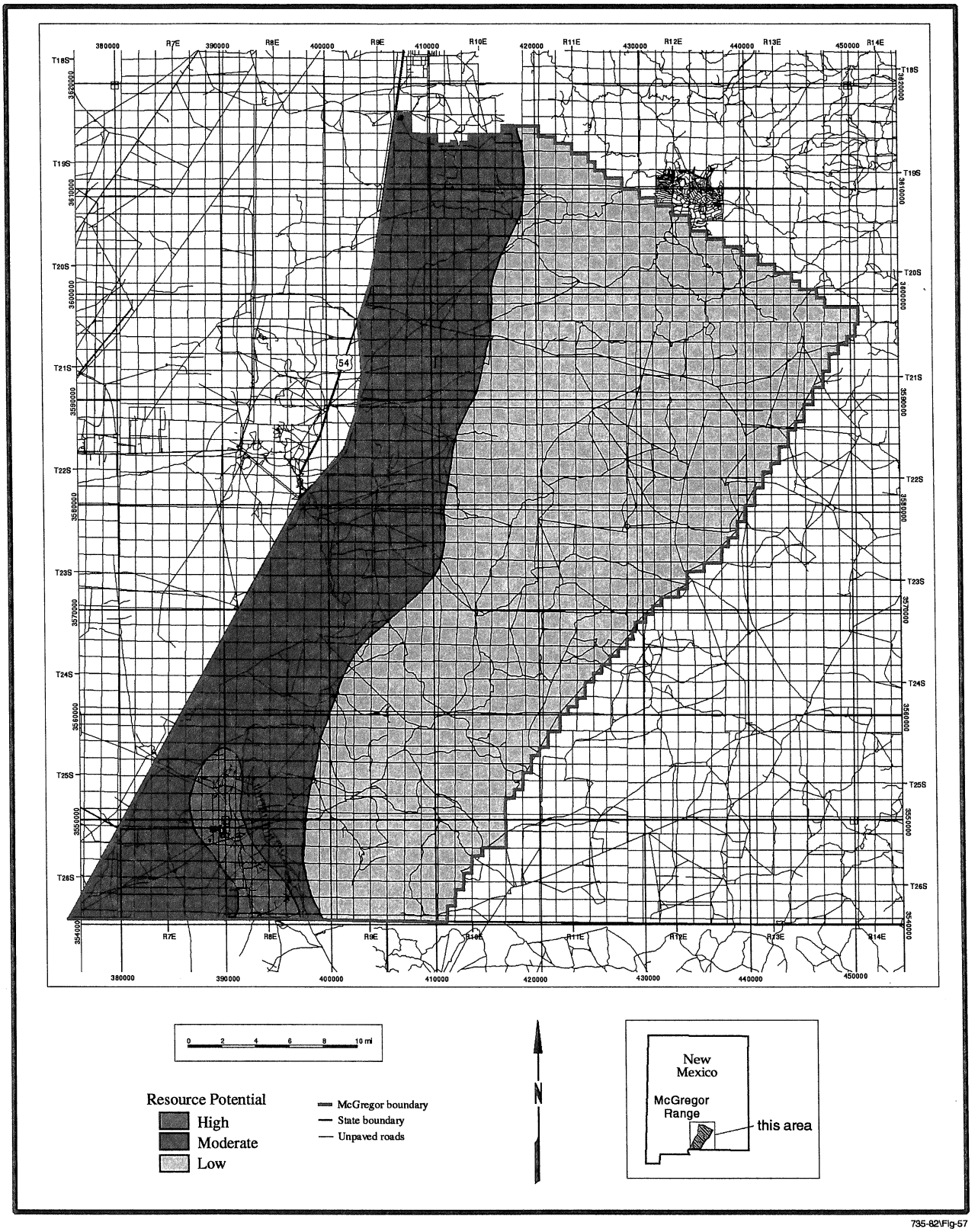


Figure 6.1 Geothermal Resource Potential on the McGregor Range.

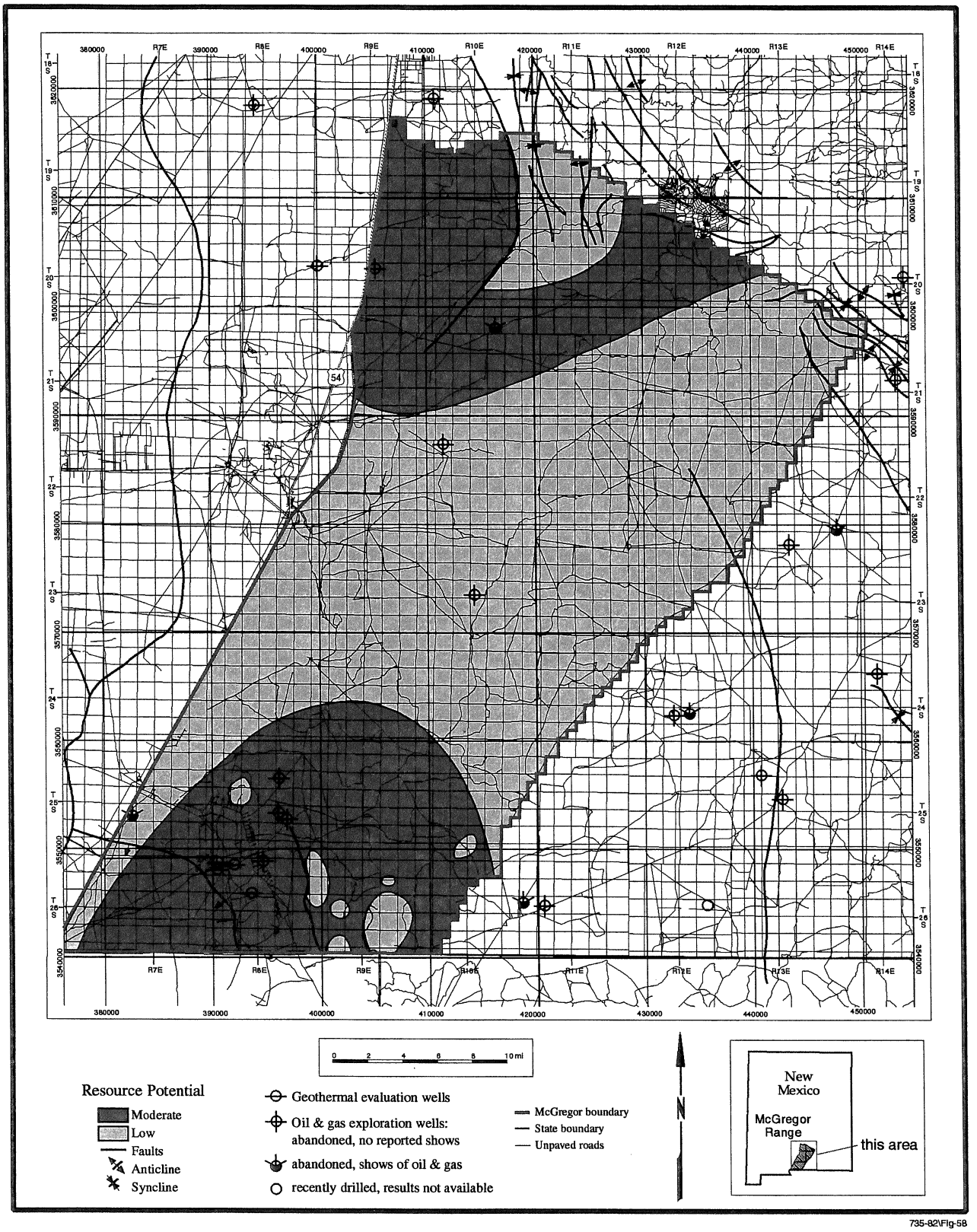


Figure 6.2 Resource Potential for Petroleum on the McGregor Range.

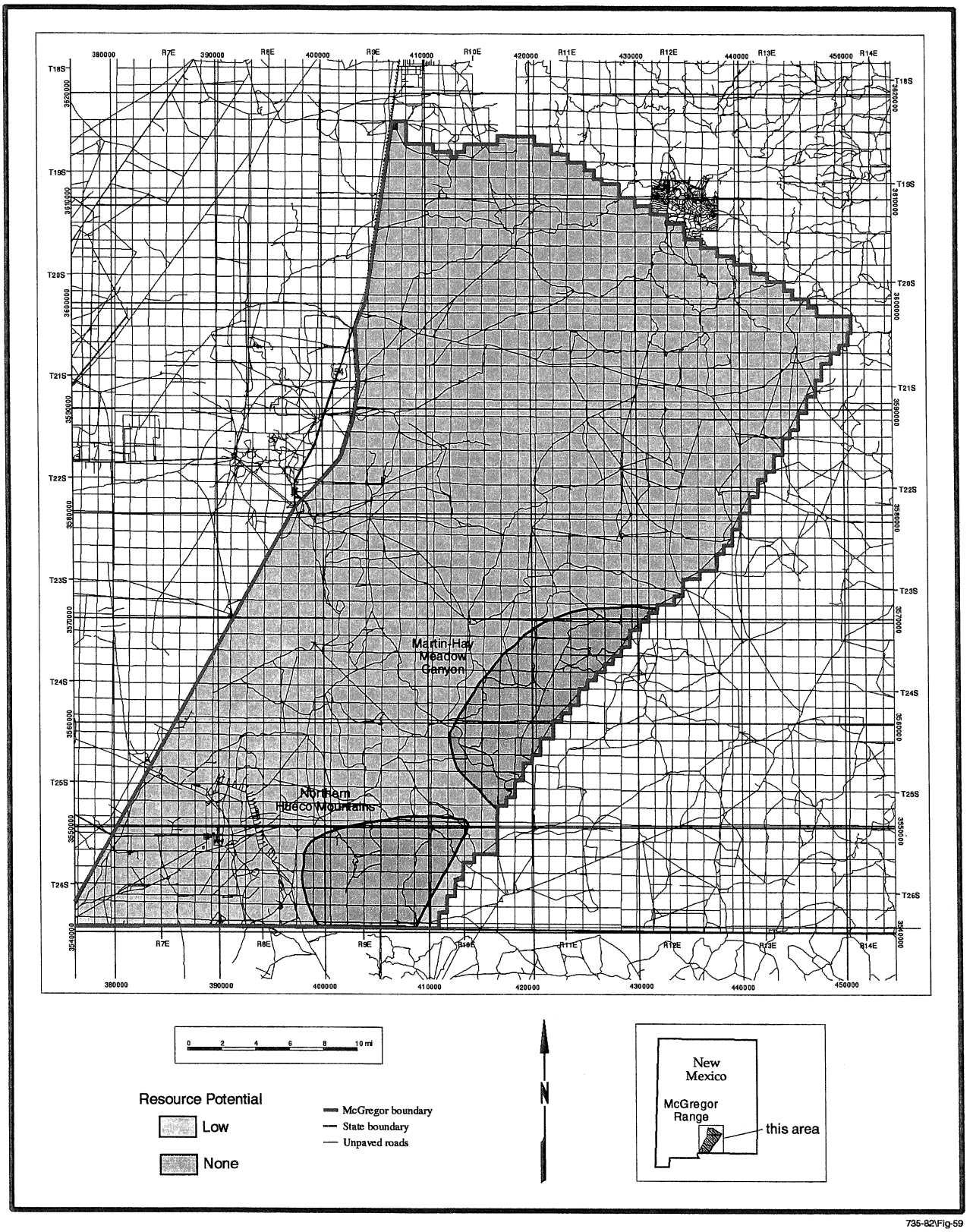


Figure 6.3 Resource Potential for Uranium on the McGregor Range.

6.3 GEOTHERMAL

6.3.1 Previous Studies

A variety of geophysical and geochemical surveys have been performed over the years to delineate geothermal resources in the McGregor Range area. These surveys provided a framework to select the sites for geothermal test drilling. Some of the most recent studies include three shallow seismic reflection profiles by UTEP (personal communication, 1997, with Steve Harder, UTEP). Geologic mapping, a radon soil-gas survey, a soil mercury survey, and a shallow temperature-gradient and heat-flow survey by New Mexico State University (NMSU) have delineated the near-surface thermal regime and probable upflow zones and identified a previously unmapped Pleistocene fault (Witcher 1997). Also, a detailed self-potential (SP) geophysical survey by NMSU and the University of Utah provided additional information to assess the dynamics of the geothermal system (Ross and Witcher 1995). Published groundwater and geothermal surveys provide important, but poorly constrained, information on water levels, temperature gradients, fluid chemistry, and reservoir geothermometry (Henry and Gluck 1981; Hoffer 1978, 1979; Taylor et al. 1980; Taylor 1981). Regional gravity and aeromagnetic maps provide supplemental subsurface structural information. These surveys have provided a framework to select the sites for geothermal test drilling. Four slim-hole continuous-wireline core holes have provided deep subsurface information on the nature of the McGregor Range geothermal system (Witcher et al. 1997; Finger and Jacobson 1997).

6.3.2 Structure and Subsurface Geology

6.3.2.1 Structural Setting

The McGregor Range geothermal system is located along the eastern hinge or flexural margin of a major RGR half-graben complex, the Tularosa-Hueco Basin (Woodward et al. 1978). The Tularosa-Hueco half graben is rotated downward to the west along an east-facing boundary fault margin, the East Franklin Mountains fault system (Collins and Raney 1994; Seager 1980; Machette 1987) (refer to Figure 6.4). Seismic and gravity survey interpretations suggest that nearly 9,000 ft of basin-fill sediments fill the half graben at maximum structural relief, a few miles east of the surface expression of the East Franklin Mountains boundary fault.

The East Franklin Mountains fault is a segment of a much larger fault system which extends from El Paso northward into New Mexico along the Franklin, Organ, and San Andres Mountains for about 120 mi (Machette 1987). This extended fault system shows significant Pleistocene to Recent movement and represents one of the larger Quaternary fault systems in the interior of the U.S. (Machette 1987; Collins and Raney 1994; Gile 1987, 1994). Seager (1980) discussed a 16-mi wide zone of related intragraben faults which cut basin-fill sediments and Quaternary surfaces with between 10 and 92 ft of offset. These faults exhibit anastomizing patterns and are generally between 7 and 16 mi long with synthetic and antithetic relationships to the East Franklin Mountains fault.

An echelon series of northwest-trending intrabasin faults and basin floor flexures is mapped by Seager (1980) and Seager et al. (1987) to extend across the half graben from the southern Organ Mountains southeastward to the area of the McGregor Range Camp. The southeastern terminus of the intrabasin faults approximates the location of the northern end of the McGregor Range geothermal system (refer to Figures 6.5 and 6.6). In general, the intrabasin fault system is antithetic to the East Franklin Mountains boundary fault system.

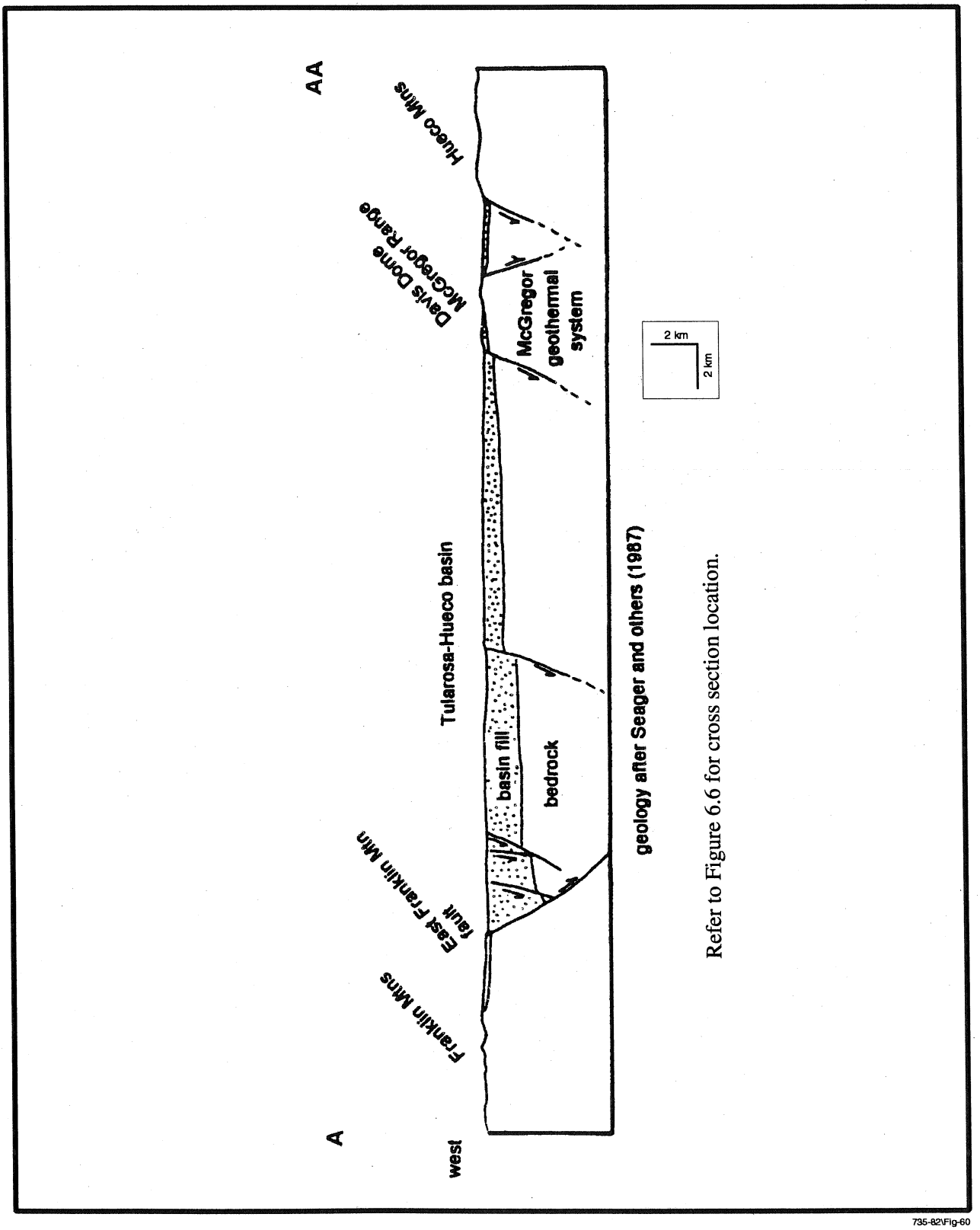


Figure 6.4 Generalized Geologic Cross Section of the Tularosa-Hueco Basin.

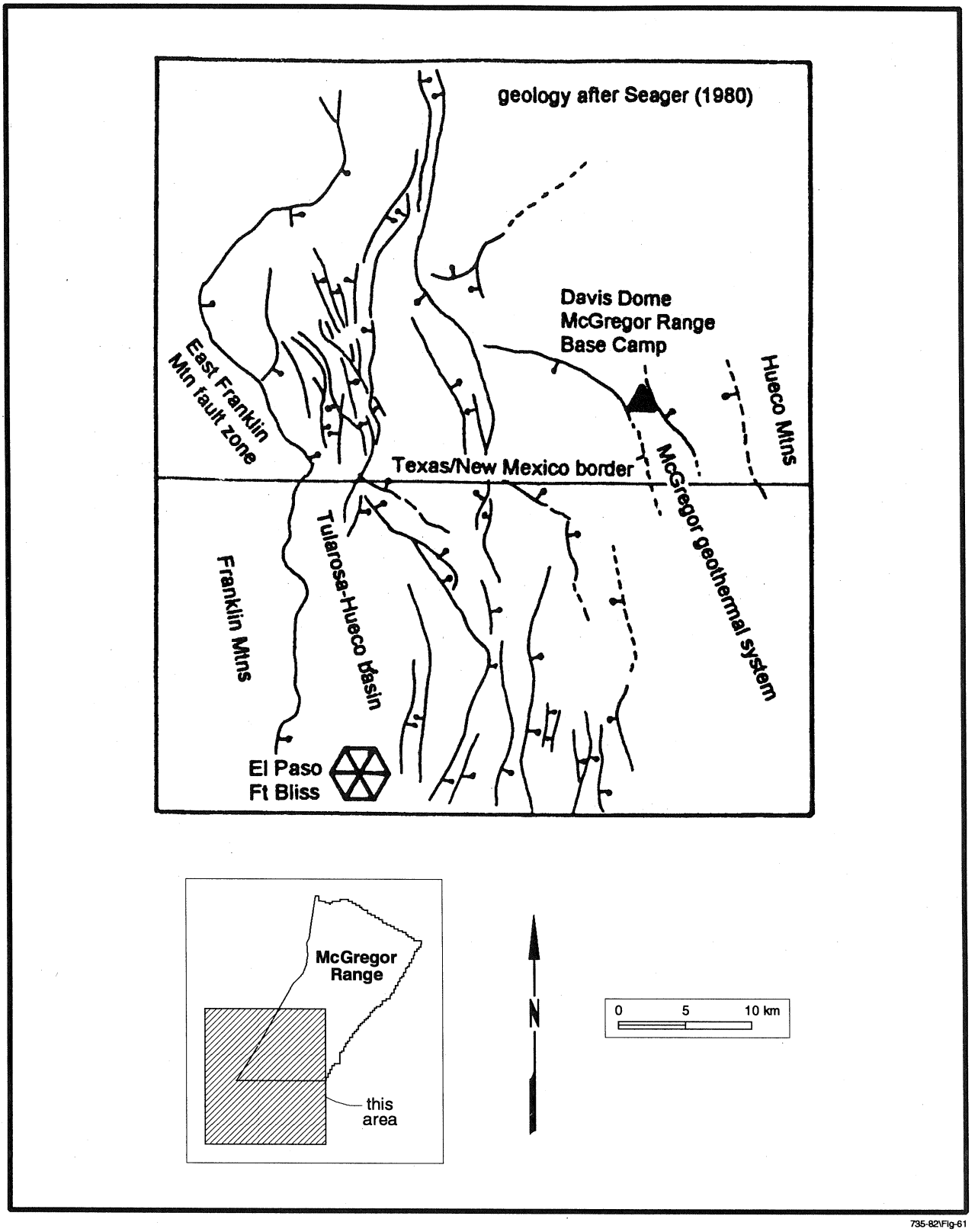


Figure 6.5 Regional Map of the McGregor Range Camp Area.

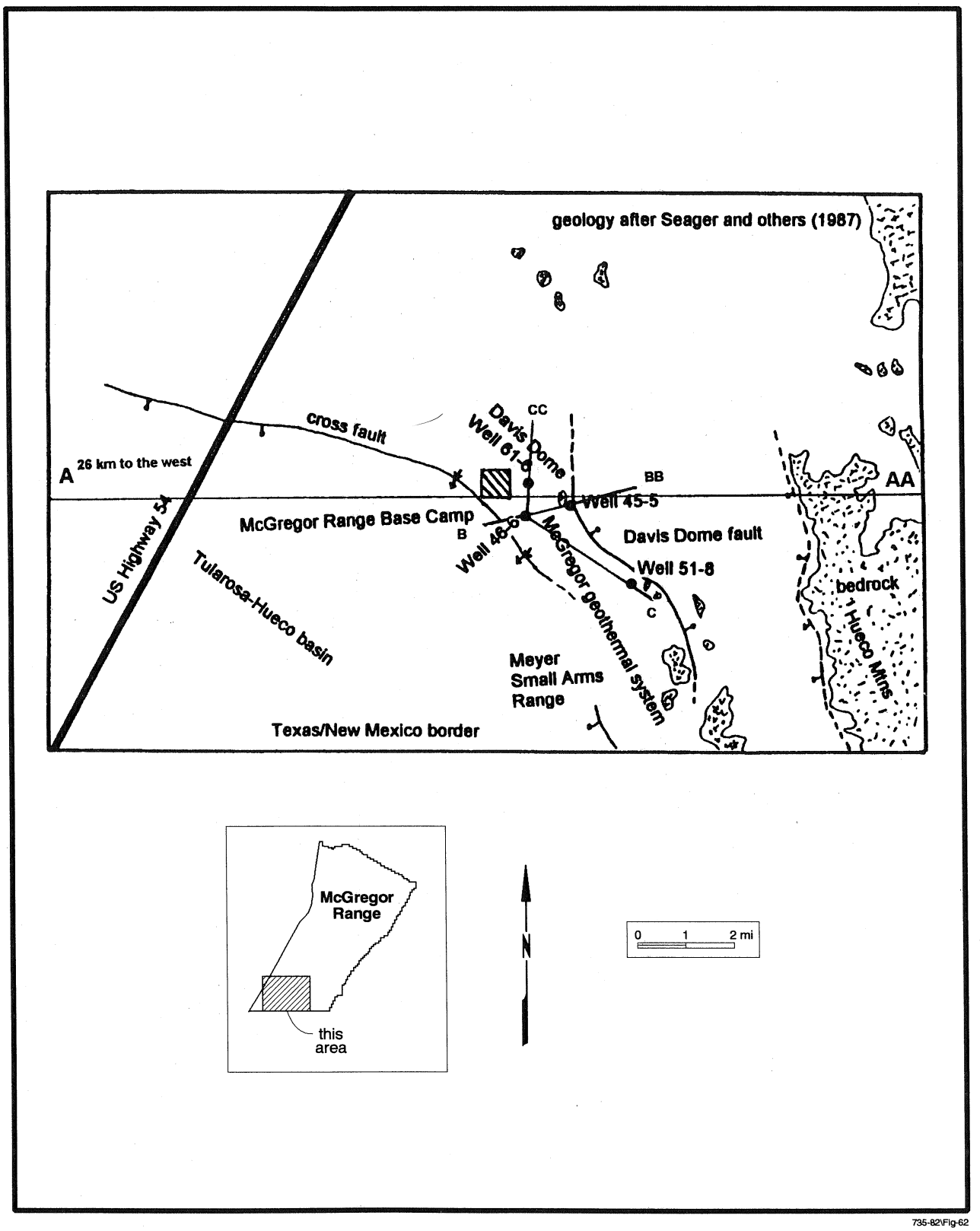


Figure 6.6 Generalized Map of the McGregor Range Camp Area.

An additional Pleistocene intrabasin fault was recently identified just east of Davis Dome (Witcher 1997) (refer to Figure 6.5). The La Mesa surface caliche (stage IV to V) (Monger 1993) is displaced 16 to 49 ft along this fault zone (Witcher 1997). This fault is synthetic to the East Franklin Mountains boundary fault and appears to mark the east margin of a minor intrabasin horst within the half-graben flexural margin. This minor intrabasin horst appears to host the McGregor Range geothermal system upflow and outflow plume (Witcher 1997). The horst or uplift is partially buried by basin fill with bedrock outcrops at Davis Dome and in the vicinity of the Meyer Small Arms Range near the New Mexico-Texas line.

Within the rift nomenclature of Morley et al. (1990), the McGregor Range geothermal area represents a divergent-conjugate accommodation zone. The intrabasin fault system extending northwest from this region may represent yet another rift transfer zone. From a regional perspective, the intrabasin fault system may mark the beginning of the transition to the Trans-Pecos or Big Bend segment of the RGR. This segment of the rift in western Texas is characterized by en echelon grabens that step to the left along the so-called Texas Lineament (Dickerson and Muehlberger 1994).

6.3.2.2 Subsurface Geology

Information about the subsurface geology for the McGregor Range geothermal system is derived from four deep slim-hole continuous-wireline core holes (Witcher et al. 1997) (refer to Figure 6.7). Depth-to-bedrock is highly variable over the partially buried horst block. Basin fill thickness ranges from 710 ft in Well 46-6 to about 30 ft in Well 45-5 (refer to Figure 6.7). Basin fill consists of variably indurated pebbly sand, sand, silt, and clay. Highly indurated caliche (La Mesa surface) about 10 ft in maximum thickness caps the basin-fill sequence. Windblown sand forms a thin surficial veneer over the caliche cap.

Paleozoic limestone and dolomite and Tertiary felsite intrusives are the major bedrock units cored. Paleozoic rocks units include: 1) Ordovician and Silurian dolomite, cherty dolomite, and chert of the Montoya Group and Fusselman Formation; 2) Devonian (?) and Mississippian black argillaceous limestone and calcareous shale and dark fossiliferous and sometimes cherty limestones of the Las Cruces, Rancheria, and Helms Formations; and 3) Pennsylvanian gray to dark gray cherty, fossiliferous limestones of the Magdalena Group. Tertiary felsite intrusives show concordant contacts and are generally interpreted as sills. Well 45-5 cored a small felsite laccolith. Limestone above the felsite laccolith shows moderate dips; however, the intrusion is floored by flat-lying limestone. Formation tops and thickness drilled in each well are presented in Appendix 20.

A "blind" thrust fault was cored in Well 51-8. The thrust fault juxtaposes gently dipping Silurian dolomite over steeply dipping and overturned Mississippian black limestone and shale. Units on the hanging wall and footwall of the fault are pervasively fractured and deformed. This hidden structure may have important regional tectonic significance. Steeply dipping and overturned beds in the footwall point toward a basement-involved fold that is locally thrust-faulted. This style of deformation is typical of classic Laramide (Late Cretaceous-early Tertiary) Rocky Mountain basement-cored uplift margins. Several Laramide uplifts are well-documented in the southern RGR (Seager 1983).

A deeply penetrating structure with fracture permeability in basement (Precambrian) rocks may be required to create the geothermal system at McGregor Range. Schmidt et al. (1993) present a generalized descriptive classification of the geometric features found in Laramide reverse fault and fold structures. In their study of basement deformation in Laramide structures across the Rocky Mountain region, Schmidt et al. (1993) observed that the major deformation of basement rocks occurs in the "forelimb domain." The style of deformation is largely dependent on the fabric of basement rocks. For instance, foliated rocks,

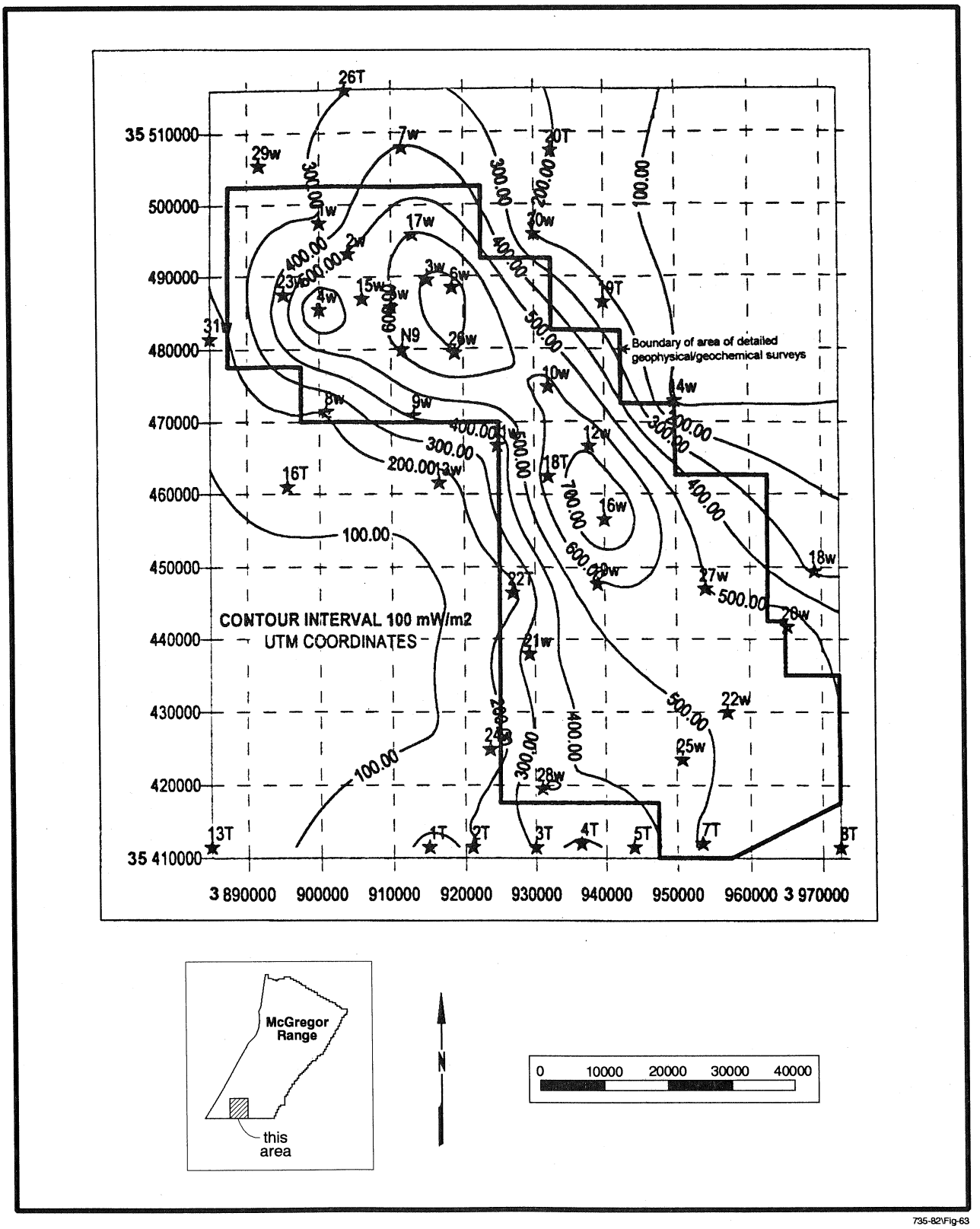


Figure 6.7 Heat-Flow Map of the McGregor Range Geothermal System.

such as schist, show distributed shear or shear on close-spaced faults; while isotropic rocks, such as granite, may be pervasively broken at all scales. Shattered-rock domains will provide the best potential reservoir hosts. In any case, the fault enhances the potential for deeply circulating regional groundwater flows through basement rocks and may help explain the McGregor Range geothermal system.

6.3.3 Hydrogeology

Paleozoic rock units can act as aquitards or aquifers. Regional geologic information indicates that the El Paso and Montoya Groups (Ordovician) and the Fusselman Dolomite (Silurian) may have excellent reservoir potential. As noted by Lucia (1988), these units frequently contain extensively-fractured and brecciated terrain in the Franklin Mountains, Caballo, and southern Hueco Mountains. The breccias formed by collapse of dissolution features and large caverns (Carlsbad Caverns magnitude) which were created during the El Paso-Montoya and the Fusselman-Canutillo unconformities (Lucia 1988). The most extensive caverns were formed in the El Paso Group and collapse of the El Paso caverns produced subsequent fracturing, dissolution, and collapse of the overlying Montoya Group and Fusselman Dolomite. It is believed that tabular, laterally extensive caverns formed in close proximity to paleo water tables. In addition, fracture-controlled dissolution formed vertically oriented caverns and solution cavities. Lucia (1988) presented evidence that most of the collapse occurred during and after Fusselman deposition.

Preservation or enhancement of permeability and porosity associated with the breccias and dolomitization has important implications for geothermal resources in the McGregor Range subsurface because Ordovician and Silurian units are the deepest seated potential Paleozoic reservoir hosts.

Coring performed on the McGregor Range in 1997 indicated that nearly all Paleozoic units show some fracture permeability; however, the black Mississippian limestone and shale units tend to exhibit less fracture permeability. As predicted by regional geology, important vuggy solution porosity and permeability is prominent in the Ordovician and Silurian dolomitic units.

Major solution permeability is found in Wells 45-5 and 46-6 and is especially dramatic in Pennsylvanian limestones near the static water level, above and below intrusive contacts, and near the bedrock-basin fill unconformity. Cavernous intervals were encountered in Well 45-5 in Pennsylvanian rocks. Also, stylolites, when present in the Pennsylvanian units, frequently have important solution permeability.

Tertiary felsite sills and laccoliths also show intervals with important fracture permeability in the core holes. Plugs or dikes feeding the sills and laccoliths may provide hydrogeologic windows for outflow of deep-seated geothermal fluids into fractured Paleozoic reservoir hosts. Tertiary basin-fill units are not hosts for geothermal resources on McGregor Range. On the other hand, these units do confine or provide leaky caps over the geothermal systems due to their fine-grained (silty and clayey) nature.

Static water level information for the area indicates that geothermal fluids in the carbonate reservoir have hydraulic heads about 100 ft less than levels observed in nonthermal and thermal (conductively heated) water in the basin fill deposits. Static level of the carbonate geothermal reservoir ranges between 3,640 and 3,670 ft elevation with a gradient to the southeast.

6.3.4 Thermal Regime

6.3.4.1 Heat Flow

In general, the background thermal regime of the McGregor Range is typical of the southern RGR and ranges from 85 to 123 mW/m^2. Measured heat values reported by Reiter et al. (1975, 1978, 1986) and Decker and Smithson (1975) are from sites around Orogrande on the west and Cornudas on the east of McGregor Range. Temperature gradient and heat-flow studies by Taylor (1981) and Taylor et al. (1980) are combined with 31 temperature gradient measurements by NMSU to produce a detailed heat flow map of the only known geothermal system on McGregor Range (Witcher 1997) (refer to Figure 6.7). This heat flow anomaly is more than 19 mi^2 and extends southward beyond McGregor Range into west Texas near Hueco Tanks. Anomalies of radon soil gas, soil mercury, surface self-potential (SP) data, and temperature gradients point toward a broadly distributed upflow zone that roughly coincides with the heat-flow closure west of Davis Dome. The southeast elongation of the anomaly probably represents lateral outflow. Variations in heat flow are due to topography of the Tertiary basin-fill/Pennsylvanian limestone contact where this contact extends below the water table. The silty and clayey basin-fill confines the flow to solution and fracture zones in the limestone below the contact. Total heat loss for the system exceeds 15,000 kJ/s.

6.3.4.2 Shallow Reservoir Temperatures

Measured reservoir temperatures in the shallow reservoir (less than 3,000 ft) are shown on Figure 6.8. The main upflow zone for the system lies in the vicinity of Well 46-6. The main outflow extends southeastward from Well 46-6 to Well 51-8. A relatively intense, but thin, outflow extends eastward toward Well 45-5 at shallow depth in solution permeability in Pennsylvanian limestone. A planned dipole-dipole resistivity survey by NMSU and the University of Utah will provide more detail on the reservoir flow regimes.

6.3.4.3 Heat Content

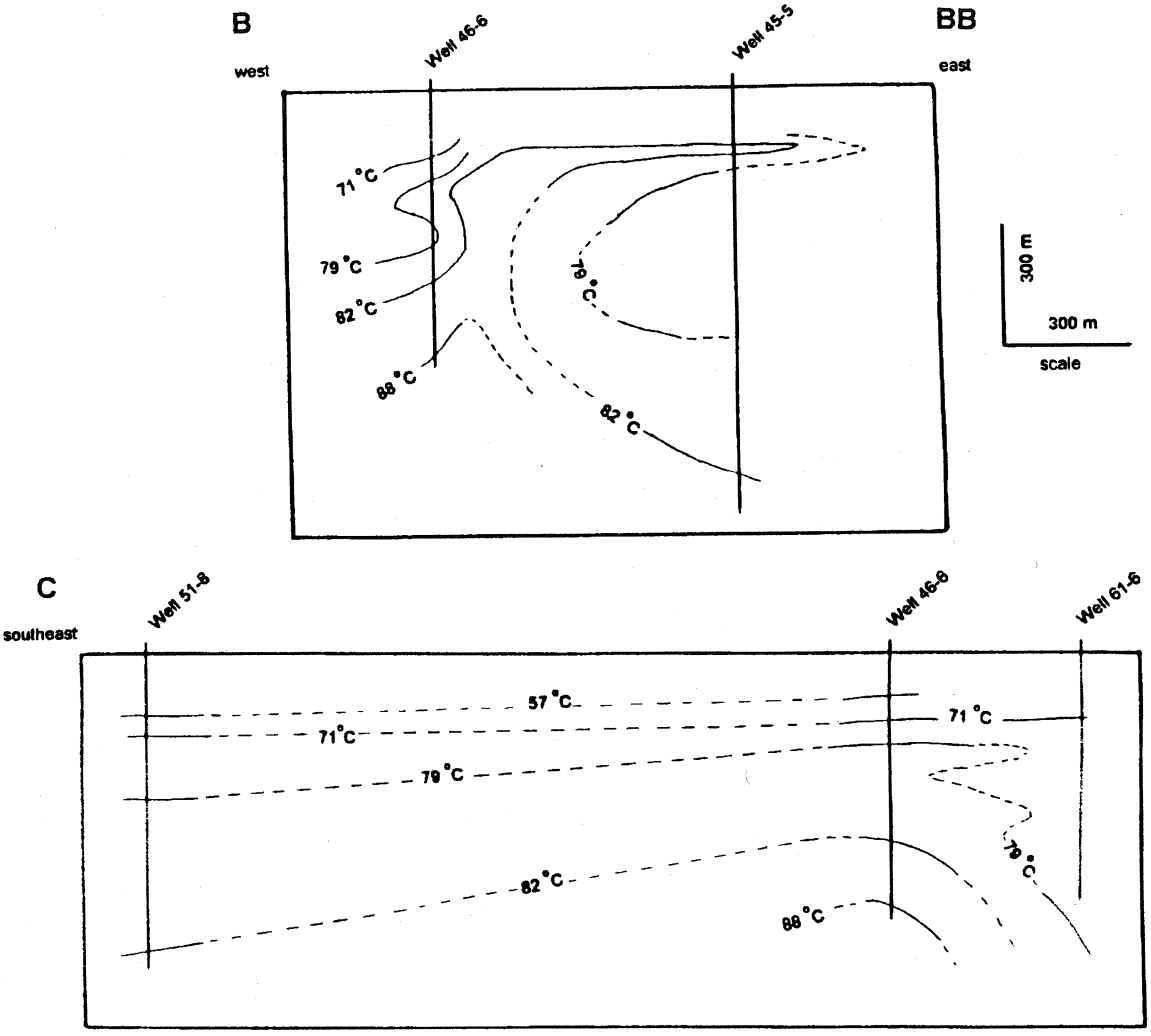
The amount of economically available heat is the geothermal resource base. Less than 10% of the heat contained in the reservoir is contained in the fluid; most of the heat is stored in the rock (Muffler and Cataldi 1978). The economically accessible geothermal resource (geothermal reserves) at McGregor Range will be determined by the end use. No commercial direct-use geothermal operation in New Mexico uses wells deeper than 985 ft depth. However, with binary power production or desalination, deep wells may be economic. Determination of the useful resource base employed the volume method of Muffler and Cataldi (1978).

The reservoir volume is based on the area that circumscribes the 500 mW/m^2 heat-flow contour and a depth interval of 1,000 m:

$$Q_r = (1-\phi)(c_r)(p_r)(V_r)(Tave - Tmat) + (\phi)(c_w)(p_w)(V_r)(Tave - Tmat)$$

where:

	Q_r	=	total heat content (geothermal resource base) (J)
	ϕ	=	porosity (0.10 m^3/m^3)
	c_r	=	specific heat of rock (limestone at 85°C) (950 J/kg°K) (Robertson 1988)



Refer to Figure 6.6 for cross section locations.

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Figure 6.8 Subsurface Temperatures of the Shallow Reservoir.

p_r	=	density of rock (2,700 kg/m^3)
V_r	=	volume of reservoir (1,000 m x 2,500 m x 6,000 m)
Tave	=	geothermometer (85°C)
T_{mat}	=	mean annual temperature (18°C)
c_w	=	specific heat of fluid (4,184 J/kg °K)
p_w	=	density of fluid (1,000 kg/m^3)

The total amount of heat available in the reservoir was estimated at 2.7 x 10^{21} J. The amount of resource that is recoverable for use is much less.

The geothermal reserves are related to the resource base by a recoverability factor:

$$Q_u = (Q_r)(R_f)$$

where:			
	Q_u	=	geothermal reserves (J)
	Q_r	=	total heat content (geothermal resource base) (J)
	R_f	=	recoverability factor (0.15)

The recoverability factor (R_f) is a somewhat subjective number. The recoverability factor depends on the length of time the resource is exploited, reservoir porosity, method of geothermal extraction, and natural convective and conductive recharge. Muffler and Cataldi (1978) indicate that recoverability could range up to 25% for some hot-water reservoirs. A factor of 15% is used in this analysis. Recoverable geothermal resources (geothermal reserves) on McGregor Range are estimated at 4.1 x 10^{20} J.

6.3.5 Geochemistry

Geothermal fluids from the McGregor Range geothermal system are currently poorly characterized. A sampling program of the deep slim-hole core tests was planned for late 1997. However, limited data reported by Henry and Gluck (1981) provide some useful information. Overall, the fluids are sodium chloride composition with total dissolved solids (TDS) ranging from 445 mg/L to 6,590 mg/L. Figure 6.9 is a silica versus chloride plot that may indicate a mixing of thermal and nonthermal water. However, only three data points constrain this possibility. Also, the lower TDS water may simply represent shallow groundwater that has been heated conductively by geothermal waters confined below the sample depth. The chemistry of Well M-11 is typical of nonthermal groundwater.

Of more importance, the silica geothermometers predict that the maximum reservoir temperature is 109°C using the quartz (no steam loss-conductive) geothermometer (Fournier 1977). The quartz geothermometer is best used where reservoir temperatures are probably much greater than 100°C. This is because the kinetics of a quartz-dissolved silica system are extremely slow at temperatures below 150°C (Rimstidt and Barnes 1980). Experience shows that New Mexico low-temperature geothermal waters are usually best characterized by the chalcedony geothermometer (Swanberg 1983). The chalcedony geothermometer indicates a maximum reservoir temperature of 80°C. Common cation geothermometers, such as the sodium/potassium/calcium and sodium/potassium, were not calculated, as these geothermometers are empirically derived from cation ratios of known high-temperature geothermal systems (Fournier and Truesdell 1973). Also, since the main reservoirs are carbonate rocks and gypsum may exist along system flow paths, calcium may be controlled by nontemperature chemical equilibria. Basic assumptions that are required for geothermometer use are discussed in Fournier et al. (1974).

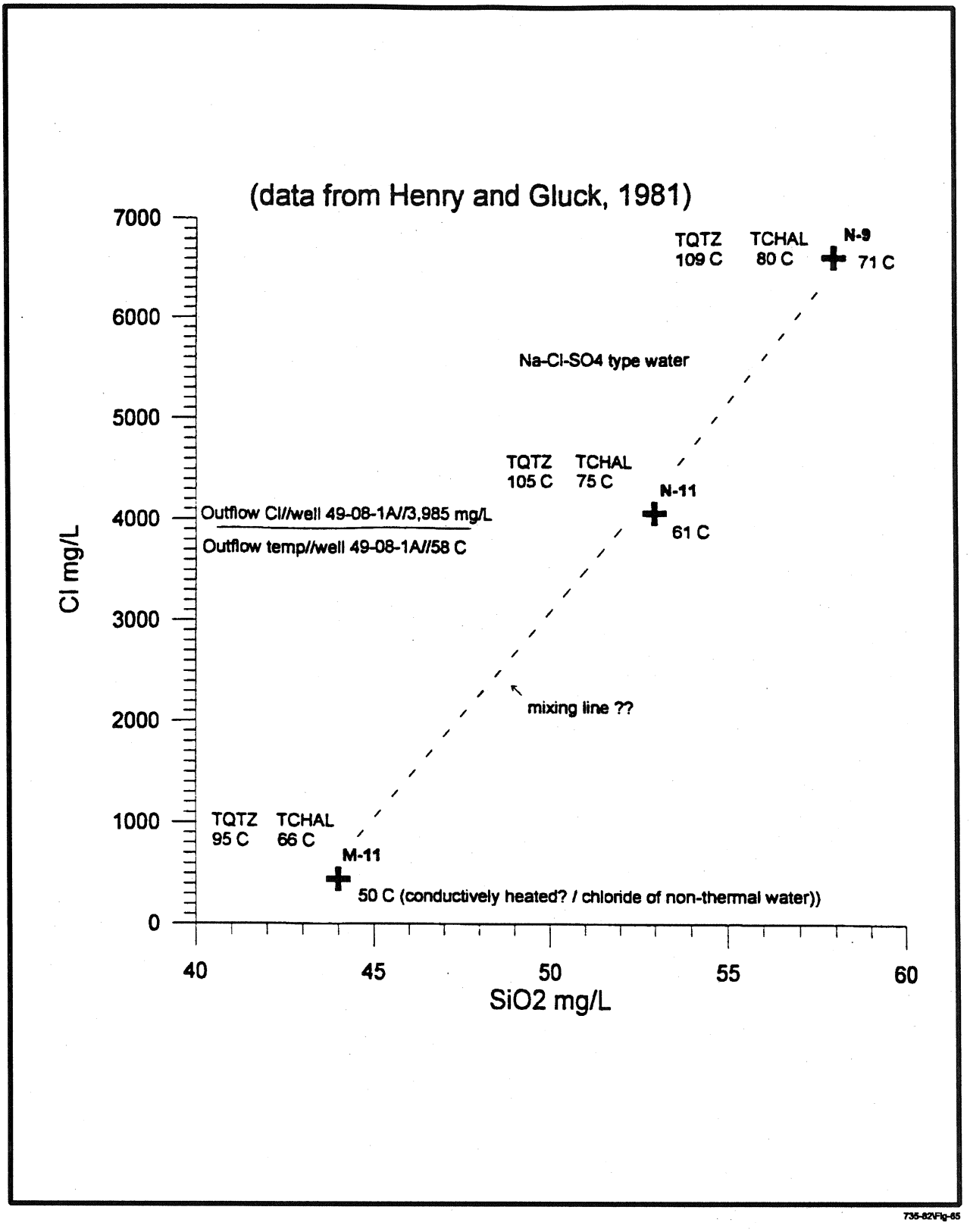

Figure 6.9 Silica Versus Chloride Concentrations for the McGregor Hot Wells.

A low- to moderate-temperature reservoir (<110°C) is also indicated by the lack of quartz or jasperoidal hydrothermal phases in the carbonate reservoir rocks. Also, fracture fillings were almost entirely calcite, dolomite, minor pyrite, or hematitic clay and clay. However, some quartz with pyrite was observed in Well 45-5, overprinting "saddle" dolomite crystals in vugs at 3,150 to 3,153 ft depth in the Silurian Fusselman Formation.

Cherty dolomite in the Fusselman Formation and Montoya Group units was usually accompanied by alteration rims of very finely crystalline talc and calcite on chert.

This alteration may be described as follows:

dolomite + water + silica = calcite + talc + carbon dioxide

or

$$3CaMg(CO_3)_2 + H_20 + 4SiO_2 = 3CaCO_3 + Mg_3SiO_{10}(OH)_2 + 3CO_2$$

This reaction may also buffer dissolved silica concentrations, making quartz geothermometry invalid. Alteration observed in Tertiary intrusive rocks is believed to be coeval with intrusive activity. Further geochemical study is needed on the fluids and rocks to confidently understand deep subsurface reservoir conditions. Available evidence points to a low- to moderate-temperature (80 to 110°C) reservoir.

6.3.6 Synthesis

Hydrothermal resources occur in regions where heat flow from the Earth's interior is elevated. The RGR provides a thermally enhanced regional setting (Decker and Smithson 1975; Reiter et al. 1978, 1986). To localize and concentrate heat, several geologic conditions are required. First, water must circulate past the heat source. A suitable heat source may be concentrated as a "point source" in the shallow crust (magma chamber) or the heat source may be diffuse and deep-seated (high conductive regional heat flow in the crust). Hydrothermal circulation requires a permeable framework or favorable "plumbing" that allows recharge flow, fluid storage, and discharge flow from the system. A variety of structural and stratigraphic elements must work in concert to host a hydrothermal system. Favorable stratigraphy is required to provide deep-seated and laterally extensive aquifers (reservoirs) and to provide confining aquitards (reservoir caps). Recharge may have a dominant structural or stratigraphic control or both. Generally, structure provides vertical permeability for discharge. Vertical permeability, whether it is for recharge or discharge, is most efficient at geohydrologic windows. Witcher (1988) defines geohydrologic windows as "outcrop and subcrop terranes underlain by permeable rock where confining aquitards have been erosionally or tectonically stripped away." A geohydrologic window may have structural and stratigraphic attributes.

More importantly, a geohydrologic window allows the most rapid upward movement of fluids with the least heat loss. While vertical cross formational flow across aquitards is capable of creating enhanced heat flow and subsurface temperatures (see Harder et al. [1980]; Morgan et al. [1981]), the mass and energy flux observed with geothermal systems requires high vertical permeability. In fact, all geothermal wells studied in the RGR are observed to discharge at the surface or into the shallow subsurface at geohydrologic windows (Witcher 1988). Transfer or accommodation zones are favored sites for geothermal systems in the southern RGR (Chapin et al. 1978). These zones generally have enhanced fracture permeability and are relatively high structurally. Both factors favor the creation of geohydrologic windows.

With an average conductive 90 mW/m^2 heat flow, the amount of heat energy leaving a square kilometer is 90 kJ/s. If 10% of conductive heat is captured or swept up by groundwater flow, a recharge area of at least 2,000 km^2 is required to balance conductive heat loss over the McGregor Range geothermal system discharge. The required recharge area has the same order of magnitude as the area of McGregor Range, indicating that the probable recharge for the system is higher elevation terrane north, northeast, and east of the extent of the mapped geothermal system. In other words, geothermal potential elsewhere on McGregor Range is unlikely because the region acts as a recharge zone for the system near Davis Dome. An exception may be the narrow region between U.S. Highway 54 and the Hueco-Otero Mesa "range front" northward to Orogrande and on to Alamogordo. This region, at relatively low elevation, may contain favorable structurally high or intrusive hydrogeologic windows such as observed near Davis Dome. However, insufficient data are available to quantify the potential in this narrow strip on the western portions of McGregor Range.

6.3.7 Possible Uses of Geothermal Energy

Three potential uses are identified for the known geothermal resources at McGregor Range. These uses fall into two major geothermal technologies, direct use and electrical power production.

Direct-use applications use heat directly without conversion to electricity and are suitable for low-temperature geothermal fluids (<100°C). Direct use geothermal technology has potential applicability for space heating, heating domestic hot water (showers and mess hall), and for swimming pool heating at McGregor Range Camp. Another direct-use technology that may have potential is geothermal desalination where the geothermal heat is used in a cascaded, vacuum-distilling process. Currently, potable water is piped uphill to McGregor Base Camp over a distance of more than 20 mi.

Generally, geothermal electrical power is only commercially competitive at temperatures above 175°C for conventional flash steam technology and above 130°C for binary power technology (DiPippo 1987). However, binary power technology has been applied with geothermal fluids with temperatures between 85 and 130°C to produce 50 kW to 1 MW of electrical power (DiPippo 1987; Bronicki 1995). Binary power plants use a secondary working fluid which is heated by the geothermal fluid in a heat exchanger. The secondary working fluid consists of organic media, such as isobutane, which vaporizes at lower temperatures than water. The working fluid vapor turns the turbine and is condensed prior to reheating at the heat exchanger to form a closed-loop working cycle. The geothermal fluids are injected into the reservoir after heating the working fluid in the heat exchanger.

The economic and engineering feasibility of uses at McGregor Range is not known and is beyond the scope of this report. However, there are several mitigating factors such as the high pumping head (greater than 460 ft) of the geothermal reservoir and the sporadic nature of heat demand at the McGregor Range Camp. For electrical power, very large well production rates (and injection) would be required because the reservoir temperatures are marginal with current binary power technology. However, small-scale power production, coupled with desalination and cascaded direct-use heating, may be feasible.

6.3.8 Geothermal Energy Resources on the McGregor Range

Based on the information presented above, the geothermal energy potential for the McGregor Range has been evaluated and is summarized below. There is high resource potential, certainty level D, for the area immediately near the McGregor Base Camp (refer to Figure 6.1). Available information indicates that

heated water (75-85°C) exists less than 3,000 ft below the surface in this area, and there are potential near-term users of this resource (e.g., the U.S. Army).

There is also an area of moderate potential, certainty level B located on the western portion of the McGregor Range (refer to Figure 6.1). Geology in this area is similar to the Davis Dome/ McGregor Base Camp area discussed above. However, this area has not been explored as thoroughly as the Davis Dome/McGregor Base Camp area.

The remaining portion of the McGregor Range is rated as low potential, certainty level B (refer to Figure 6.1). The area does have an elevated regional heat flow as indicated by its proximity with the RGR, and the area may have resource potential in the next century with improvements in hot dry rock (HDR) technologies. Limitations on geothermal resources in this area are related to the lack of local energy users and the lack of probable shallow connective resources as indicated from available data.

6.4 PETROLEUM

6.4.1 Introduction and Methodology

Evaluation of the petroleum (oil and natural gas) resource potential of an area involves consideration and analysis of seven major factors.

- Overview of previous evaluations of petroleum resource potential.
- Previous drilling results. Has previous exploratory drilling in the area resulted in discovery of oil or gas in commercial quantities? If not, have there been noncommercial shows of oil or gas in wells drilled within the area?
- Petroleum source rocks. Has petroleum been generated in the area or in adjacent parts of the basin spacing? If so, is the petroleum oil, gas, or a combination of the two?
- Petroleum preservation. Has the generated petroleum been preserved or has it been heated to temperatures in excess of its thermal preservation limit?
- Petroleum reservoir analysis. Are reservoir rocks present of sufficient volume, porosity, and permeability to store and produce petroleum in commercial quantities?
- Petroleum traps. Are traps present that could have blocked the movement of petroleum after it has migrated out of the source rock and into the reservoir rocks, thereby forming petroleum accumulations?
- Trap integrity. Has the integrity of the traps been maintained throughout geologic time or has post-entrapment structural movement breached the seals, resulting in leakage of petroleum from the traps?

Analysis and discussion of these seven factors is presented in the following sections. Should analysis of all of the above factors be favorable, then the petroleum resource potential of an area is high. Conversely, if analysis of all of the factors is unfavorable, then the petroleum resource potential of an area is low.

The following sections present analyses and assessment of petroleum potential on the McGregor Range. Where appropriate, comparisons are made between strata in the McGregor Range and chronologically equivalent productive strata in the Permian Basin, 60 mi to the east. Because the Permian Basin is one of the world's most productive petroleum basins, with 18% of U.S. annual oil production and 8% of U.S. annual gas production (data from Energy Information Administration [1995]), such comparisons shed light on the petroleum potential on the McGregor Range and are essential to assessment of petroleum potential.

6.4.2 Previous Evaluations of Petroleum Resources

There is no established oil and gas production within the McGregor Range. The nearest established oil and gas production is 60 mi east in the Permian Basin of southeast New Mexico and west Texas (refer to Figure 6.10). Those parts of New Mexico and west Texas within and adjacent to the McGregor Range can be considered a frontier for petroleum exploration. Density of exploratory drilling is low in this area, significantly less than one well per township.

There have been three major published evaluations of petroleum resource potential on the McGregor Range. Black (1973, 1975) mapped the geology of the Otero Platform east of the McGregor Range and evaluated its oil and gas potential. Foster (1978) evaluated the oil and gas resource potential of tracts of New Mexico State Trust Land within the White Sands Missile Range located west of the McGregor Range. King and Harder (1985) evaluated the oil and gas potential of south-central New Mexico and neighboring areas of Texas, including the Tularosa Basin, Otero Platform, and Salt Basin graben (refer to Figure 2.18). The methodology and major conclusions of each of these investigations is summarized below.

Black (1973, 1975) used outcrop field mapping, aerial photographs, and aerial reconnaissance to map that part of Otero Mesa east of the McGregor Range. These reports contain detailed geologic and tectonic maps of the area and also examine records of oil and gas exploration wells drilled within the study area to evaluate lateral facies changes within stratigraphic units. Black concludes that the western part of the Otero platform may contain possible petroleum source rocks in the lower Paleozoic section. Black envisions a hydrocarbon system in which oil and gas generated in these strata would have migrated updip to the east. Entrapment would occur in lower Paleozoic and Pennsylvanian strata which are erosionally truncated by Lower Permian strata on the western flank of the buried Pedernal uplift. A similar trapping mechanism occurs in lower Paleozoic strata along the flanks of the Central Basin platform in Lea County, New Mexico, and adjoining areas of west Texas (Black 1975; see Speer [1993a, 1993b], Bebout and Garrett [1989], and Garrett [1983] for examples). Black (1975) assumes that Lower Permian strata would seal the truncated reservoirs. Because these truncated strata lie chiefly east of the McGregor Range (refer to Figure 2.5), Black's prospective area is outside the boundary of the McGregor Range.

Foster (1978) evaluated the oil and gas potential of tracts of New Mexico State Trust Land within the White Sands Missile Range and the Fort Bliss Military Reservation, including the McGregor Range. The purpose of Foster's project was to assess the value of these lands for the State of New Mexico in light of condemnation by the Department of Defense. None of the land tracts are within the McGregor Range; all are within the boundaries of the White Sands Missile Range. However, some aspects of Foster's study can be used to gain insight into the oil and gas potential on the McGregor Range.

Foster's evaluation was based mostly on subsurface data from petroleum exploration wells drilled within and around the study area, as well as published and unpublished reports of the geology of the region. Foster (1978) created numerous subsurface stratigraphic maps as part of his evaluation. Leasing of lands in the area is used as a direct indicator of exploratory interest by oil companies and, therefore, as an indirect indicator of oil and gas potential. Although petroleum source rocks were assumed to be present, they were neither analyzed nor assessed in a rigorous manner for this report.

Foster's subsurface mapping and stratigraphic analysis indicated that high-quality reservoirs are present in dolostones of the El Paso and Montoya Groups (Ordovician) and Fusselman Formation (Silurian) (refer to Figure 2.2) (Foster 1978). Mississippian limestones and Pennsylvanian limestones and sandstones are considered to have excellent reservoir potential. Structural traps may be present beneath anticlines that

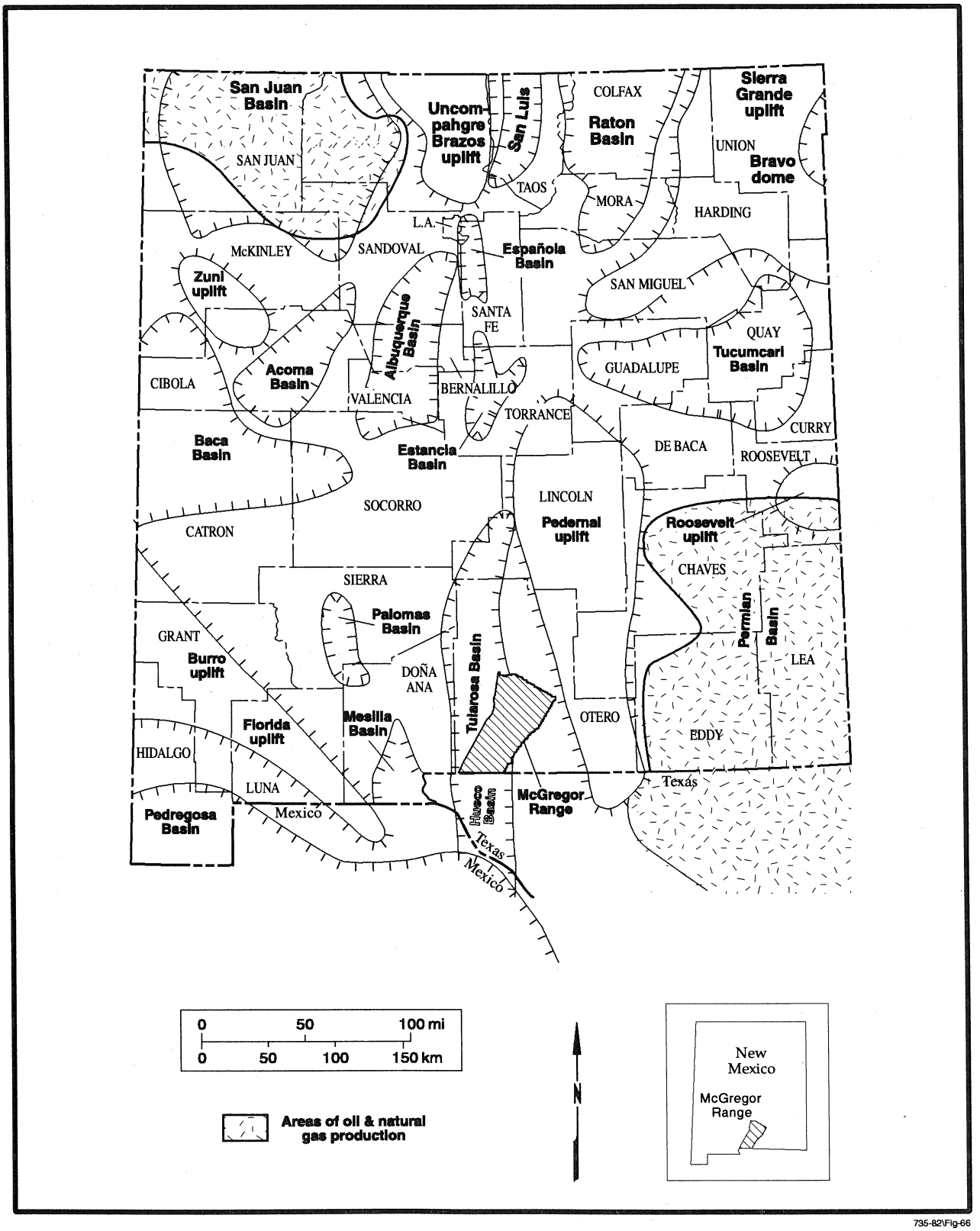

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Figure 6.10 Map of Major Geologic Elements in New Mexico, with Location of McGregor Range and Major Oil- and Gas-Producing Areas.

have been mapped at the surface. Stratigraphic traps are considered highly probable, especially in the Pennsylvanian section, where the depositional setting resulted in the formation of both permeable carbonate buildups ("reefs") and porous deltaic sandstones encased in shales. Foster concludes that Laramide- and Tertiary-age faulting in the region might have created fault-bounded traps. But Foster also concluded that the Laramide and Tertiary faults may have breached pre-existing traps. Inflow of meteoric (fresh) water could have flushed the petroleum out of these traps. Evaluation of previously drilled petroleum exploration wells revealed the presence of brackish and fresh waters in the eastern part of the Tularosa Basin; that is, in areas of the basin that underlie and are adjacent to the McGregor Range (refer to Figure 6.10). The presence of fresh and brackish waters indicates that reservoirs in these areas have been flushed by influent meteoric waters. Unflushed areas lie west and north of the McGregor Range, where waters remain saline.

The closest land tracts to the McGregor Range that were evaluated by Foster (1978) are located in T19S, R6E, and T19S, R9E. This area is located in the Tularosa Basin approximately 14 mi west of the McGregor Range. Oil and gas potential of the tracts was considered good based on the presence of numerous potentially good reservoirs in rocks of Ordovician through Permian age and the absence of flushing of these reservoirs by meteoric waters in the area. However, Foster (1978) noted that areas farther east (closer to the McGregor Range) appeared to have been flushed by fresh meteoric waters. Therefore, these more easterly lands would have diminished petroleum potential.

King and Harder (1985) evaluated the oil and gas resource potential of the Tularosa Basin, the Otero Platform, and the Salt Basin graben in south-central New Mexico and neighboring areas of Texas (Figure 2.18). This study relied mostly on subsurface stratigraphic mapping and analysis of drill stem tests of oil and gas exploration wells drilled in the area. The presence or absence of petroleum source rocks was inferred from records of oil and gas shows in these wells and not from geochemical analyses of potential source rocks.

King and Harder (1985) concluded that source rocks and reservoir rocks are widespread within the Tularosa Basin. Primary reservoir targets are thought to be within Pennsylvanian and Permian strata. King and Harder believed that both structural and stratigraphic traps are present within the basin. Structural traps may be formed by both anticlines and faults. Because of the thick cover of relatively undeformed Tertiary and Quaternary sediments over most of the basin, King and Harder concluded that seismic reflection surveys are needed to identify possible trap forming structures; the sedimentary cover makes it impossible to map these features on the surface. Stratigraphic traps are thought to be probable because stratigraphic studies indicated reefing in carbonate rocks and depositional pinchout of reservoirs in both carbonate and clastic settings. King and Harder also thought that traps below angular unconformities are probable and agreed with Foster that many of the potential oil and gas reservoirs along the eastern margin of the basin have been flushed by fresh water. Thus, areas of high oil and gas potential are confined to the central or western parts of the Tularosa Basin and not to the eastern margin which underlie the McGregor Range.

King and Harder (1985) concluded that the oil and gas potential of the Otero platform is not very high. King and Harder agreed with Black (1975) that pre-Permian strata are truncated by Permian strata beneath the angular unconformity at the base of the Permian. However, King and Harder discussed differences between the Otero Platform and Black's (1975) central basin platform analogy that lessen the chances for oil and gas accumulations on the Otero Platform. First, Hills (1984) noted that the primary seals within the Permian section on the central basin platform are thick widespread evaporites. Widespread evaporites are not present within the Permian section on the Otero Platform. Instead, the Permian section on the Otero Platform consists mostly of carbonate rocks which are easily fractured. Although shales that could act as

seals are present, the only widespread ones are thin and occur within the Pow Wow/lower Abo and upper Abo sections (King and Harder 1985). Second, Paleozoic strata under the Otero Platform have been flushed by fresh groundwaters whose most likely source is the Paleozoic outcrops in the Sacramento Mountains. This diminishes the chance for hydrocarbon accumulations west of the Pedernal uplift (Figure 6.11).

6.4.3 Results of Previous Exploratory Drilling on the McGregor Range and Adjacent Areas

Forty-one petroleum exploration wells have been drilled within and adjacent to the McGregor Range (refer to Table 6.2 and Figure 6.12). Nine of those 41 wells have been drilled within the boundaries of the McGregor Range. None of the wells resulted in discovery of commercial quantities of oil or natural gas.

"Shows of oil and gas" were reported in only two of the nine wells drilled within the McGregor Range: the R.H. Ernest No. 1 Located Land well, located along the eastern edge of the Tularosa Basin in the southwestern part of the McGregor Range, and the Sun Oil Co. No. 1 T.J. Pearson well, located in the north-central part of the McGregor Range (refer to Table 6.3 and Figure 6.12). A "show" can be regarded as a recorded occurrence of oil and/or gas in a well. The volume of oil or gas represented by a "show" may be either commercial or noncommercial.

In the R.H. Ernest well, "shows of oil and gas" were reported from three depth intervals within the Tertiary-aged basin-fill and from at least four depth intervals within the Pennsylvanian section. Unfortunately, documentation of these shows are just simple reports of "show of oil" or "show of gas" and do not record the nature of the show (e.g., oil or gas recovered on a drill stem test for a well drilled with rotary tools, oil recovered in a mud bailer for a well drilled with cable tools). These simple reports of "show of oil" or "show of gas" without documentation of the nature of the show may be just an unsubstantiated guess or they may be bonified shows. Therefore, they must be regarded only as possible occurrences of oil or gas in the well.

Four additional exploratory wells were drilled within the southern part of the McGregor Range: the George Muldery No. 1 State, the Holland Page Jr. No. 1 J.A. Maris State, the Bechtel Brothers No. 1 J.A. Maris State, and the W.G. Wilmoth No. 1 Wilmoth Federal (refer to Tables 6.2 and 6.3 and Figure 6.12). None of those four wells had reported shows of oil or gas; however, none were drilled to a total depth of more than 1,000 ft, and two did not even reach a depth of 300 ft. Because depth to the Precambrian basement in the southern part of the McGregor Range varies from 2,700 ft to more than 7,500 ft, these wells represent incomplete tests of the Paleozoic section and should not be used to infer the presence or absence of petroleum.

Two petroleum exploration wells have been drilled on the Otero Platform in the central part of the McGregor Range: the Kinney Oil & Gas No. 1 State and the Otero Oil Company No. 1 McGregor (refer to Tables 6.2 and 6.3 and Figure 6.12). The Otero Oil Company No. 1 McGregor, was drilled to a total depth of 1,730 ft in Pennsylvanian strata. The Kinney Oil & Gas No. 1 State was drilled to a total depth of 2,168 ft in lowermost Pennsylvanian or uppermost Mississippian strata. Therefore, these wells tested only the Permian and Pennsylvanian sections and did not test the Mississippian or lower Paleozoic sections. The Otero Oil Company well had no reported "shows of oil or gas" and did not have any reported recoveries of fluids from strata that it penetrated (refer to Table 6.3). The Kinney well also did not have any reported "shows of oil or gas." However, fresh water was reportedly encountered from Pennsylvanian limestones at depths of 1,138 ft, 1,310 ft, and 2,151 ft (refer to Table 6.3). Although chemical analyses of salinity are

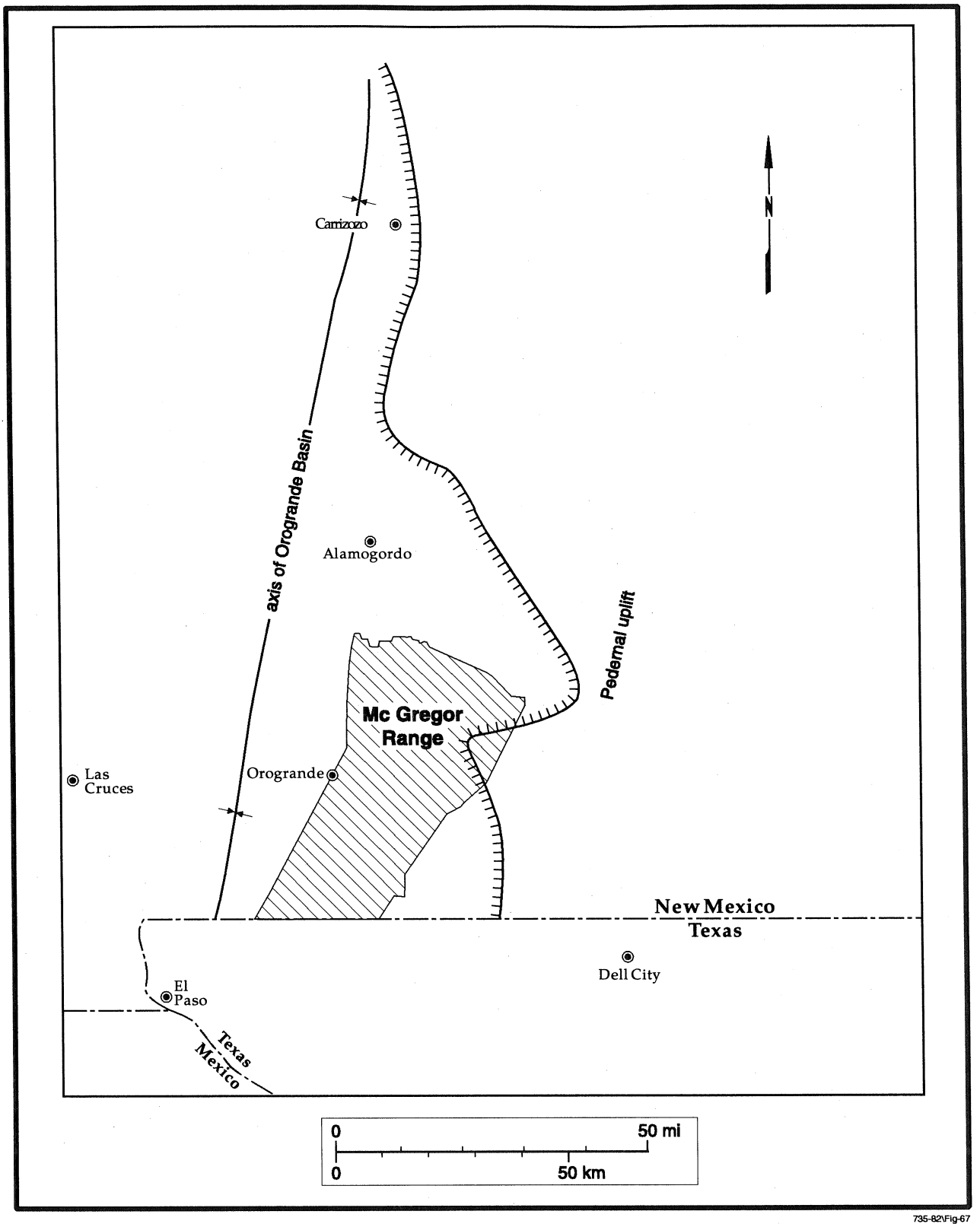

Figure 6.11 Late Paleozoic Tectonic Elements on the McGregor Range and Adjacent Areas.

Table 6.2 Summary Data of Oil and Gas Exploration Wells Drilled on the McGregor Range and Adjacent Areas.

Operator	Well Number and Name	Location (Footage From Section Lines)	Surface Elevation (ft Above Sea Level)	Total Depth (ft)	Completion Date
Atlantic Refining Co.	No. 1 State AV	Section 16, T20S, R15E, 990 FSL 1,650 FEL	6,289	4,027	Jul-63
Bechtel Brothers	No. 1 J.A. Maris State	Section 23, T25S, R8E, 1,980 FSL 660 FWL	4,192	986	May-50
Coral Oil & Gas Co.	No. 1 Leonard Federal	Section 17, T22S, R16E, 330 FSL 1,650 FWL	4,740	65	Aug-61
Coral Oil & Gas Co.	No. 1 Ann Spanel	Section 9, T24S, R14E, 660 FNL 660 FEL	4,560	1,873	Aug-61
E.P Campbell	No. 1 Hurley	Section 30, T22S, R14E, 660 FSL 660 FWL	4,605	2,433	Jul-60
E.P. Campbell	No. 1 Liberman State	Section 7, T23S, R15E, 660 FNL 1,908 FWL	4,350	2,700	Jan-61
E.P. Campbell	No. 1 Lois Spanel	Section 7, T23S, R16E, 990 FSL 483 FEL	4,620	2,683	Jul-60
Flynn, Welch & Yates	No. 1 Donahue	Section 28, T24S, R15E, 660 FNL 1,980 FEL	4,275	1,692	Jul-35
Fred Turner Jr.	No. 1 E.V. Everett	Section 34, T22S, R13E, 660 FSL 660 FEL	4,745	3,945	Aug-38
Fred Turner Jr.	No. 1 State	Section 36, T25S, R16E, 1,980 FNL 1,980 FWL	4,322	5,195	Jan-60
Fred Turner Jr.	No. 1 Fee	Section 23, T26S, R16E, 990 FNL 2,310 FWL	4,090	150	Feb-42
George Muldery	No. 1 State	Section 11, T25S, R8E,250 FSL 300 FWL	4,165	263	Jul-37
Harvey E. Yates	No. 1 Y Bennett Ranch Unit	Section 14, T26S, R12E, 990 FNL, 2,005 FEL	5,100	8,400	Not completed by report date
Holland Page Jr.	No. 1 J.A. Maris State	Section 23, T25S, R8E, 330 FSL 2,310 FWL	4,217	731	Oct-49
Hunt Oil Co.	No. 1 McMillan Turner	Section 5, T26S, R16E, 660 FSL 1,980 FEL	4,165	2,175	Apr-43
John Eisner	No. 1 Federal	Section 21, T24S, R12E, 1,880 FSL 1,999 FEL	4,911	1,855	Mar-57
Kinney Oil & Gas	No.1 State	Section 14, T23S, R10E, 1,120 FWL 1,520 FSL	4,768	2,168	Jan-98
Lefors Petroleum Co.	No. 1 Federal	Section 22, T21S, R16E, 330 FNL 1,650 FWL	5,386	2,255	Nov-62
Marathon	No. 1 Mesa Verde Ranch	Section 35, T18S, R14E, 1,880 FNL 1,730 FEL	7,021	7,011	Mar-82
Otero Oil Co.	No. 1 McGregor	Section 5, T22S, R10E, 1,980 FSL 1,980 FWL	4,230	1,730	Feb-43
Pasotero	No. 1 H. Evans	Section 22, T24S, R12E, 2,270 FSL 330 FWL	5,014	3,763	Jul-98
Phillips	No. 1 Turquoise	Section 18, T20S, R9E, 661 FNL 661 FEL	4,059	5,437	Feb-61
Plymouth Oil Co.	No. 1 Federal	Section 15, T20S, R9E, 660 FNL 660 FWL	4,044	7,585	Nov-54

Table 6.2 (Continued)

Operator	Well Number and Name	Location (Footage From Section Lines)	Surface Elevation (ft Above Sea Level)	Total Depth (ft)	Completion Date
R.H. Ernest	No. 1 Located Land	Section 20, T25S, R7E,330 FSL 330 FEL	4,099	3,941	Jan-42
Samuel Butler et al.	No. 1 E.A. Wingo Permit	Section 17, T26S, R11E, 1,756 FSL 2,440 FWL	5,255	450	Aug-98
Seaboard Oil Co.	No. 1 Blanche Trigg Federal	Section 18, T26S, R11E, 1,980 FNL 1,980 FWL	5,302	5,600	May-55
Southern Production Co.	No. 1 Cloudcroft Unit	Section 5, T17S, R12E, 2,310 FNL 1,980 FEL	9,370	4,701	Jun-53
Stanolind Oil & Gas	No. 1 Thorn Unit	Section 15, T21S, R14E, 1,980 FNL 660 FEL	6,280	4,646	Sep-53
Sun Oil Co.	No. 1 T.J. Pearson	Section 35, T20S, R10E, 800 FSL 800 FEL	4,408	4,468	Dec-54
Texaco	No. 1 Federal E	Section 10, T18S, R8E, 660 FSL 660 FWL	3,999	7,785	Feb-70
Texaco	No. 1 Federal G	Section 33, T18S, R8E, 1,552 FNL 1,934 FEL	4,186	7,660	Sep-70
Texaco	No. 1 Federal F	Section 30, T18S, R10E, 1,980 FSL 1,980 FEL	4,042	8,288	Nov-70
Transocean Oil Co.	No. 1 George J. Ablah	Section 15, T25S, R13E, 1,900 FSL 1,900 FWL	4,951	5,305	Oct-78
U.S. Army	Ft. Bliss core 45-5	Section 5, T26S, R8E, 2,530 FSL 2,250 FWL	4,107	3,961	Apr-97
U.S. Army	Ft. Bliss core 46-6	Section 6, T26S, R8E, 1,380 FSL 2,500 FWL	4,105	2,258	Apr-97
U.S. Army	Ft. Bliss core 61-6	Section 6, T26S, R8E, 5,030 FSL 3,300 FWL	4,115	2,018	Apr-97
U.S. Army	Ft. Bliss core 51-8	Section 16, T26S, R8E, 5,260 FSL 2,800 FWL	4,110	2,573	Apr-97
Union Oil Co.	No. 1 McMillan	Section 9, T25S, R13E, 660 FNL 660 FWL	4,995	5,215	Sep-46
W.G. Wilmoth	No. 1 Wilmoth Federal	Section 3, T26S, R8E, 990 FNL 500 FWL	4,130	206	Sep-49
Yates Petroleum	No. 1 Dog Canyon YF Federal	Section 15, T18S, R15E, 1,785 FSL 1,980 FWL	6,386	8,430	Jul-84
Zapata Petroleum Corp.	No. 1 Federal 14	Section 14, T20S, R14E, 660 FSL 660 FWL	6,918	5,043	Mar-58

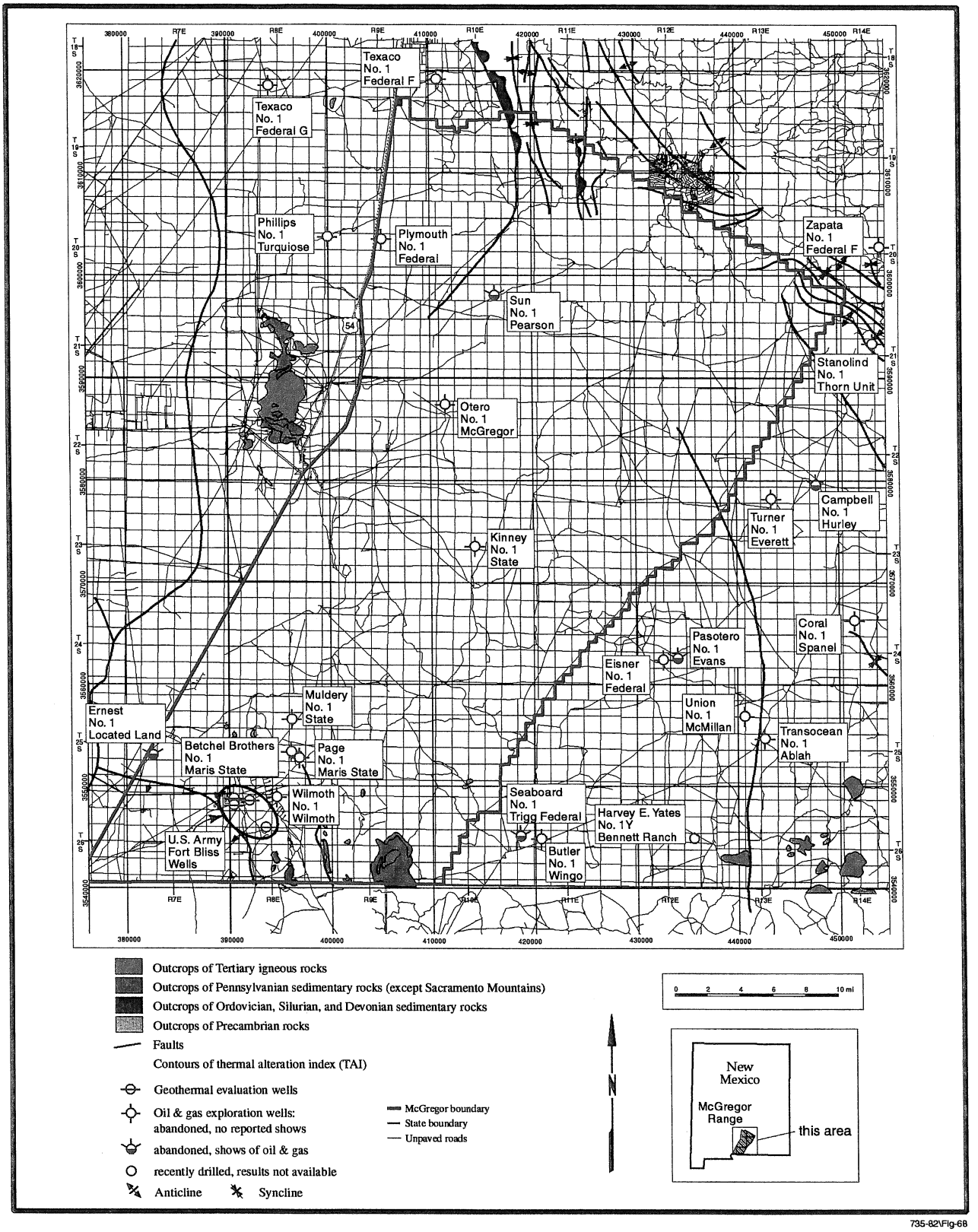

Figure 6.12 Oil and Gas Exploration Wells and Geothermal Evaluation Wells Drilled on McGregor Range and Adjacent Areas and Boundaries of the McGregor Range.

Table 6.3 Drill Stem Tests, Production Tests, and Other Fluid Recovery from Oil and Gas Exploration Wells Drilled on the McGregor Range and Adjacent Areas.

Operator	Well Number and Name	Location	Drill-Stem Tests	Completion Tests	Other Fluid Recovery
Atlantic Refining Co.	No. 1 State AV	Section 16, T20S, R15E	DST #1 2,407-2,472 ft (Hueco), rec 61 ft mud. DST #2 3,089-3,124 ft (Pennsylvanian), rec 240 ft water-cut mud. DST #3 3,160-3,238 ft (Pennsylvanian), rec 30 ft drilling mud.		Lost circulation at 1,220 and 1,230 ft (Yeso) and at 3,995 ft (Pennsylvanian).
Bechtel Brothers	No. 1 J.A. Maris State	Section 23, T25S, R8E			
Coral Oil & Gas Co.	No. 1 Leonard Federal	Section 17, T22S, R16E			
Coral Oil & Gas Co.	No. 1 Ann Spanel	Section 9, T24S, R14E			Fresh water at 1,660-1,670 ft (Abo?).
E.P. Campbell	No. 1 Hurley	Section 30, T22S, R14E	DST #1 2,002-2,056 ft (Hueco), tool plugged, rec 65 ft mud. DST #2 2,086-2,104 ft (Mississippian), rec 1,080 ft fresh water.		Show oil at 2,191 ft (Fusselman) in mud bailer. Small gas show at top of Devonian.
E.P. Campbell	No. 1 Liberman State	Section 7, T23S, R15E	DST #1 depths unknown (Abo), rec sulfur water.		Show oil at 2,370 ft (Hueco). Sulfur water entered hole in Hueco, depth unknown.
E.P. Campbell	No. 1 Lois Spanel	Section 7, T23S, R16E	DST #1 2,600-26,82 ft (Fusselman), rec 1,080 ft fresh water. DST #2 2,600-2,640 ft (Fusselman), rec 800 ft mud + 120 ft fresh water.		Water at 940-950 ft (Yeso). Small gas show at top of Devonian.
Flynn, Welch & Yates	No. 1 Donahue	Section 28, T24S, R15E			60 ft of water in hole from 932 ft.
Fred Turner Jr.	No. 1 E.V. Everett	Section 34, T22S, R13E			Hole full of water at 1,300 ft (Hueco).
Fred Turner Jr.	No. 1 State	Section 36, T25S, R16E	DST #1 4,205-4,300 ft (Precambrian), rec 920 ft drilling mud. DST #2 2,980-3,085 ft (Bliss), no recovery. DST #3 2,040-2,145 ft (Montoya), no recovery.		
Fred Turner Jr.	No. 1 Fee	Section 23, T26S, R16E			
George Muldery	No. 1 State	Section 11, T25S, R8E			
Holland Page Jr.	No. 1 J.A. Maris State	Section 23, T25S, R8E			
Hunt Oil Co.	No. 1 McMillan Turner	Section 5, T26S, R16E			Fresh water at 747 ft (Abo). Fresh water at 1,300 ft, 1,395-1,492 ft (Hueco). Fresh water at 2,113-2,136 ft (Precambrian) flowed 20 gallons per hour. Converted to water well.
John Eisner	No. 1 Federal	Section 21, T24S, R12E			
Kinney Oil & Gas	No. 1 State	Section 14, T23S, R10E			Fresh water at 1,138 ft, 1,310 ft, and 2,151 ft (Pennsylvanian).
Lefors Petroleum Co.	No. 1 Federal	Section 22, T21S, R16E	DST #1 1,990-2,156 ft (Bliss), misrun. DST #2 2,000-2,156 ft (Bliss), rec 606 ft fresh water.		Fresh water at 1,729 ft (El Paso).
Marathon	No. 1 Mesa Verde Ranch	Section 35, T18S,R14E	DST #1 3,795-3,852 ft (Hueco), rec 30 ft mud. DST #2 3,247-3259 ft (Hueco), rec 30 ft mud. DST #3 3,247-3,259 ft (Hueco), rec 10 ft water; 0.256 cu ft gas + 1,600 cc acid-cut water in sample chamber.		
Otero Oil Co.	No. 1 McGregor	Section 5, T22S, R10E			

Table 6.3 (Continued)

Operator	Well Number and Name	Location	Drill-Stem Tests	Completion Tests	Other Fluid Recovery
Pasotero Petroleum Corp.	No. 1 H. Evans	Section 22, T24S, R12E			Show gas at 353 ft and 410 ft (Yeso) and 1,086 ft (Pennsylvanian?). 600 ft salt water in hole 1,180-1,210 ft (Pennsylvanian?). Fresh water at 1,210-1,225 ft (Pennsylvanian?), exhausted. Salt and sulfur water at 1,450 ft (Pennsylvanian?) flowed 5 gallons per hour. Water at 1,575-1,580 ft (Pennsylvanian?) flowed 5 bbls per hour. Show oil at 1,709 ft (Mississippian?). Salt water at 1,951 ft (Fusselman?). Fresh water at 3,562-3,566 ft (El Paso?).
Phillips Petroleum	No. 1 Turquoise	Section 18, T20S, R9E			
Plymouth Oil Co.	No. 1 Federal	Section 15, T20S, R9E	DST #1 6,996-7,045 ft (Montoya), rec 110 ft mud + 540 ft mud-cut salt water + 4,875 ft salt water. DST #2 7,202-7267 ft (Montoya), rec 3,300 ft salt water-cut mud + 3,400 ft salt water (13,000 ppm chlorides). DST #3 7,385-7,585 ft (El Paso), rec 1,320 ft salt water-cut mud + 4,865 ft salt water.		
R.H. Ernest	No. 1 Located Land	Section 20, T25S, R7E			Water at 465 ft (Quaternary) flowed 1 bbl per hour. Show oil & gas at 1788 ft (Quaternary). Show oil at 1,954 ft (Quaternary). Salt water at 2,35-2,037 ft (Quaternary). Show oil at 2,089-2,093 ft (Quaternary). Show oil and salt water at 2,343 ft (Pennsylvanian). Show oil at 3,276 ft (Pennsylvanian). Show oil & gas at 3,940 ft (Pennsylvanian). Salt water in hole at total depth of 3,941 ft (Pennsylvanian).
Samuel Butler et al.	No. 1 E.A. Wingo Permit	Section 17, T26S, R11E			
Seaboard Oil Co.	No. 1 Blanche Trigg Federal	Section 18, T26S, R11E	DST #1 2,410-2,474 ft (Hueco), rec 550 ft fresh water.		400 ft water in hole at 1981 ft (Hueco). Mudlog has gas kick at 2,590-2,642 ft (Hueco). Limestone has fluorescence and cut at 2,628-2,630 ft, 2,684-2,686 ft, 2,690-3,400 ft, and 3,662-3,714 ft (Hueco). Limestone has fluorescence and cut at 3,662-3,714 ft, 4,352-4,354 ft, 5,284-5,250 ft (Pennsylvanian). Calcite fracture filling with bleeding oil at 4,050-4,058 ft (Pennsylvanian). Calcite fracture filling with fluorescence and cut at 4,082-4,084 ft, 4,673-4,682 ft, and 5,388-5,394 ft (Pennsylvanian). Sandstone has fluorescence and cut at 4,744-4,756 ft, 4,902-4,924 ft, and 5,396-5,400 ft (Pennsylvanian). Dolostone with intercrystalline porosity has fluorescence at 4,760-4,776 ft (Pennsylvanian). Anhydrite has fluorescence and cut at 5,424-5,434 (Pennsylvanian). Mudlog has gas kick in black shale at 5,080-5,100 ft and 5,224-5,278 ft (Pennsylvanian).

Table 6.3 (Continued)

Operator	Well Number and Name	Location	Drill-Stem Tests	Completion Tests	Other Fluid Recovery
Southern Production Co.	No. 1 Cloudcroft Unit	Section 5, T17S, R12E	DST #1 2,464-2,492 ft (Pennsylvanian), rec 25 ft slight oil- and gas-cut mud. DST #2 3,530-3,558 ft (Fusselman), rec 15 ft mud. DST #3 3,596-3,637 ft (Fusselman), rec 10 ft mud.		Lost circulation at 3,886 ft (El Paso). Lost circulation at 3,902 ft (El Paso).
Stanolind Oil & Gas	No. 1 Thorn Unit	Section 15, T21S, R14E			
Sun Oil Co.	No. 1 T.J. Pearson	Section 35, T20S, R10E	DST #1 4,452-4,468 ft (Fusselman), rec 3,600 ft slightly salty water.		Lost circulation at total depth of 4,468 ft (Fusselman), unable to regain circulation and hole abandoned. Fluorescence in limestone cuttings 260-300 ft, 716-722 ft (Hueco).Mudlog has gas kick in shale section at 2,236-2,246 ft (Pennsylvanian).
Texaco	No. 1 Federal E	Section 10, T18S, R8E	DST #1 204-290 ft (San Andres), packer failed. DST #2 7,043-7,250 ft (Fusselman), rec 478 ft drilling mud + 4,880 ft salt water. DST #3 7,260-7,369 ft (Montoya), packer failed. DST #4 7,259-7,371 ft (Montoya), rec 188 ft drilling mud + 1,692 ft salt water. DST #5 7,534-7,683 ft (El Paso), rec 185 ft drilling mud + 5,067 ft salt water.		
Texaco	No. 1 Federal G	Section 33, T18S, R8E	DST #1 3,495-3,565 ft (Pennsylvanian), rec 5 ft drilling fluid. DST #2 7,055-7,115 ft (Fusselman), rec 180 ft drilling mud + 360 ft salt water-cut drilling mud + 210 ft salt water. DST #3 7,115-7,228 ft (Fusselman), rec 450 ft drilling mud + 1,030 ft salt water. DST #4 7,505-7,660 ft (Montoya-El Paso), rec 400 ft drilling mud + 575 ft salt water-cut drilling mud + 5,845 ft salt water.	Perforated 5,835-5,854 ft (Pennsylvanian), swabbed 100% salt water.	
Texaco	No. 1 Federal F	Section 30, T18S, R10E	DST #1 5,252-5,523 ft (Hueco), packer failed. DST #2 5,245-5,523 ft (Hueco), rec 450 ft drilling mud + 2,139 ft mud-cut formation water + 884 ft formation water. DST #3 6,762-6,946 ft (Pennsylvanian), rec 450 ft drilling mud + 3,586 ft slightly salty water. DST #4 7,366-7,410 ft (Mississippian), rec 90 ft drilling mud + 125 ft water-cut mud + 270 ft brackish water. DST #5 7,675-8,000 ft (Fusselman-Montoya), rec 837 ft drilling mud + 217 ft brackish water.		
Transocean Oil Co.	No. 1 George Ablah	Section 15, T25S, R13E			Plugged back to 1,960 ft (Pennsylvanian) and converted to water supply well.
U.S. Army	Ft. Bliss core 45-5	Section 5, T26S, R8E			Thermal waters entered borehole; rose to depth of 466 ft.
U.S. Army	Ft. Bliss core 46-6	Section 6, T26S, R8E			Thermal waters entered borehole; rose to depth of 451 ft.
U.S. Army	Ft. Bliss core 61-6	Section 6, T26S, R8E			Thermal waters entered borehole; rose to depth of 463 ft.
U.S. Army	Ft. Bliss core 51-8	Section 16, T26S, R8E			Thermal waters entered borehole; rose to depth of 473 ft.
Union Oil Co.	No. 1 McMillan	Section 9, T25S, R13E			Water at 3,375 ft (Mississippian).
W.G. Wilmoth	No. 1 Wilmoth Federal	Section 3, T26S, R8E			

Table 6.3 (Continued)

Operator	Well Number and Name	Location	Drill-Stem Tests	Completion Tests	Other Fluid Recovery
Yates Petroleum	No. 1 Dog Canyon YF Federal	Section 15, T18S, R15E	DST #1 5,712-5,800 ft (Pennsylvanian), rec 5 ft mud. DST #2 6,160-6,220 ft (Pennsylvanian), rec 20 ft fluid. DST #3 6,265-6,450 ft (Pennsylvanian), rec 280 ft salt water-cut mud.	Perforated 1,538-1,547 ft (Yeso), swabbed with no show. Perforated 1,800-1,808 ft (Yeso), swabbed with no show. Perforated 1,201-1,210 ft (Yeso), swabbed water with no show.	
Zapata Petroleum Corp.	No. 1 Federal 14	Section 14, T20S, R14E			

not available and were probably never performed, the reports of "fresh water" suggest that at least some of the reservoirs in the Pennsylvanian section in this area were flushed by fresh, nonsaline waters.

Two petroleum exploration wells have been drilled within the northern part of the McGregor range: the Sun Oil Company, No. 1 T.J. Pearson and the Plymouth Oil Company No. 1 Federal (refer to Table 6.2 and Figure 6.12). The Sun Oil Company No. 1 T.J. Pearson was drilled on the Otero platform to a total depth of 4,468 ft in the Fusselman Formation (Silurian). A drill stem test from 4,452 to 4,468 ft in the Fusselman recovered water described as slightly salty (refer to Table 6.3). Again, chemical analyses of salinity are not available, but the description "slightly salty waters" indicates at least some flushing of the Fusselman reservoirs by influent fresh waters. During drilling of the well, circulation of drilling fluids was lost at the total depth of 4,468 ft, causing the well to be abandoned. The lost circulation indicates the presence of either a highly permeable Fusselman reservoir or fractures. Two intervals of limestone in the Hueco Formation (Permian) are reported to have exhibited hydrocarbon fluorescence on the mudlog but were not tested further (refer to Table 6.3). There was also a slight gas kick on the mudlog from 2,236 to 2,246 ft in a Pennsylvanian shale that was not tested, but the presence of slight, noncommercial "gas shows" in shales ("shale gas") is not unusual.

The Plymouth Oil Company No. 1 Federal well was drilled in the easternmost part of the Tularosa Basin (refer to Table 6.3 and Figure 6.12). The well was drilled to a total depth of 7,585 ft in the El Paso Group (Ordovician). Drill stem tests in the Montoya and El Paso Groups recovered salt water, with salinity of Montoya water measured at 13,000 ppm chlorides. This is not as saline as Ordovician waters in the Permian Basin, where typical brines have salinities that range from 120,000 to 126,000 ppm chlorides (NMBMMR 1993). This salinity indicates that the lower Paleozoic section in the Tularosa Basin part of the McGregor Range has been at least partially flushed by fresh water, a conclusion supported by both Foster (1978) and King and Harder (1985).

Several petroleum exploration wells have been drilled east of the McGregor Range in central and eastern Otero County (refer to Tables 6.2 and 6.3 and Figure 6.12). These wells variously reached total depth in the Hueco Formation (Permian), Pennsylvanian strata, Mississippian strata, Ordovician strata, or in Precambrian basement. Most of these wells were drilled on surface anticlines (Black 1973). "Oil or gas shows" were reported in only five of these wells: the Campbell No. 1 Hurley well; the Campbell No. 1 Liberman State well; the Campbell No. 1 Lois Spanel well; the Pasotero Petroleum Corporation No. 1 Evans well; and the Seaboard Oil Company No. 1 Blanche Trigg Federal well. In the Campbell No. 1 Hurley and Campbell No. 1 Spanel wells, small "gas shows" were reported at the top of the Devonian section. In the Campbell No. 1 Liberman State well, a "show of oil" was reported in the Hueco Formation (Permian). In the Pasotero No. 1 Evans well, undocumented "gas shows" were reported in the Yeso Formation (Permian) and undocumented "oil shows" were reported from Pennsylvanian and Mississippian strata. In these wells and in other wells drilled east of the McGregor Range, drill stem tests and other fluid recoveries encountered water generally described as either fresh water or as sulfur water, indicating that at least some of the reservoirs have been flushed by influent meteoric waters. In the Seaboard Oil Company No. 1 Blanche Trigg Federal well, drilled 3 mi east of the McGregor Range boundary, several intervals of limestone in the Hueco Formation (Permian) and several intervals of limestone, dolostone, and sandstone in the Pennsylvanian section were reported to have had blue to yellow hydrocarbon fluorescence and hydrocarbon cut on the mudlog (refer to Table 6.3); these intervals were not subjected to additional testing. Some of these intervals also exhibited hydrocarbon fluorescence in calcite fracture fillings. The mudlog also indicates the presence of oil bleeding from a calcite fracture filling at a depth of 4,050 ft in the Pennsylvanian. Furthermore, the mudlog indicates gas kicks in two intervals of black shales in the Pennsylvanian (refer to Table 6.3). These "shows" document the presence of hydrocarbons in the Pennsylvanian section near the southeastern part of the McGregor Range.

Fresh water is common, but salt water appears to be rare in Paleozoic reservoirs east of the McGregor Range, indicating significant flushing of reservoirs by fresh surface waters in the past. Two petroleum exploration wells, the Transocean Oil Company No. 1 George Ablah (located in Section 15, T25S, R13E) and the Hunt Oil Company No. 1 McMillan Turner (located in Section 5, T26S, R16E) (9 mi east of the map area of Figure 6.12), were converted to water supply wells; water was apparently obtained from the Pennsylvanian in the Transocean well and from the Abo Formation (Permian), Bliss sandstone (Ordovician), and fractured Precambrian basement in the Hunt well. In the Seaboard Oil Company No. 1 Trigg Federal well, fresh water entered the drill hole at a depth of 1,981 ft in the Hueco Formation, and a drill-stem test from 2,410 to 2,474 ft in the Hueco Formation recovered fresh water.

Several petroleum exploration wells have also been drilled north and northeast of the McGregor Range (refer to Tables 6.2 and 6.3). In the Southern Production Company No. 1 Cloudcroft Unit well located in Section 5, T17S, R12E on the eastern slopes of the Sacramento Mountains (8 mi north of the map area of Figure 6.12), a drill stem test in Pennsylvanian strata recovered oil- and gas-cut mud (refer to Table 6.3). In that well, circulation was lost twice in carbonates of the El Paso Group (Ordovician), indicating the presence of permeable reservoirs. In the Marathon No. 1 Mesa Verde Ranch well, located in Section 35, T18S, R14E (0.5 mi east of the map area of Figure 6.12), a drill stem test in the Hueco Formation (Permian) recovered water and gas in the sample chamber. In the Yates Petroleum Corporation No. 1 Dog Canyon YF Federal well, located in Section 15, T18S, R15E (5 mi east of the mapped area shown on Figure 6.12), a drill stem test in the Pennsylvanian recovered salt water-cut mud, indicating that the Pennsylvanian section may not have been flushed with fresh water in this area. Three attempts to complete the well with perforated casing in the Yeso Formation yielded no oil or gas, and the well was unsuccessful. In the Atlantic Refining Company No. 1 State AV well, located in Section 16, T20S, R15E (5 mi east of the map area of Figure 6.12), drill stem tests of Hueco (Permian) and Pennsylvanian strata recovered either

drilling mud or water-cut drilling mud, with no shows of oil or gas. During drilling operations, circulation was lost at two intervals in the Yeso Formation (Permian) and at one interval in the Pennsylvanian section in the State AV well, indicating the presence of permeable reservoirs and/or fractured zones.

Texaco drilled three petroleum exploration wells in the Tularosa basin northwest of the McGregor Range during 1970. In the Texaco No. 1 Federal E well located in Section 10, T18S, R8E (1 mi north of the mapped area shown on Figure 6.12) and in the Texaco No. 1 Federal G well located in Section 33, T18S, R8E, drill stem tests of dolostones in the Fusselman Formation (Silurian) and Montoya and El Paso Groups (Ordovician) recovered salt water, indicating that these reservoirs have not been flushed by fresh water in this area. A completion attempt in the Pennsylvanian in the Texaco No. 1 Federal G well also resulted in recovery of salt water. However, in the Texaco No. 1 Federal F well located east of the other Texaco wells, drill stem tests in Mississippian strata and in the Fusselman Formation and Montoya Groups recovered water described as brackish. If the description of brackish waters is accurate, then at least partial flushing of reservoir zones by fresh water is indicated. King and Harder (1985) indicated that waters in the deep central part of the Tularosa Basin west of the map in Figure 2.18 are extremely saline. Because the Federal F well is the easternmost of the three Texaco wells, it is possible that fresh water has entered the Tularosa Basin through the fault system that forms the eastern boundary of the basin and separates the basin from the Sacramento uplift and Otero Platform.

The Harvey E. Yates, No 1Y Bennet Ranch well was drilled to a total depth of 8,400 ft in Section 14, T26S, R12E during August 1997. Results of drilling were confidential at the time this report was written and were not released by either the operator or the BLM. Therefore, data from the well could not be used to evaluate petroleum resources for this report.

6.4.4 Petroleum Source Rock Analysis

To assess the first factor listed at the beginning of Section 6.4.1, petroleum source rock analyses were run on 48 samples from the McGregor Range and adjacent areas (refer to Table 6.4 and Appendix 5). Samples were obtained from outcrops within and near the McGregor Range, from cores of geothermal evaluation wells drilled in the southern part of the McGregor Range, and from cuttings of petroleum exploration wells that have been drilled within and near the McGregor Range. Analytical results from an additional 69 source rock samples collected from wells adjacent to the McGregor Range that were publicly available were also utilized for this assessment. Information on these samples is presented in Table 6.5.

In general, the pre-existing source rock analyses were not considered as reliable as those run for this project. This is primarily because the pre-existing analyses were performed on drill cuttings of petroleum exploration wells. Although source rock analyses performed on drill cuttings can be quite reliable and valuable if the cuttings are sorted to exclude cavings and nonsource lithologies, it is not known if this step was performed for the pre-existing analyses. This type of sorting was performed for samples of well cuttings analyzed as part of this project. Unsorted cuttings are particularly vulnerable to errors in Total Organic Carbon (TOC) measurements and estimates of the types of kerogens that constitute the organic fraction of the rock. In wells where samples are seriously contaminated by cavings from overlying rocks, TOC measurements will bear no relation to actual TOC in the interval that is analyzed unless cavings are excluded by physically sorting them under a microscope.

When assessing petroleum source rocks, three questions must be asked to determine if petroleum has been generated.

Table 6.4 Petroleum Source Rock Analyses Performed for this Project.[1]

Sample No.	Sample Type	Location	Latitude; Longitude	Well Name or Outcrop Area
RB-466-1	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-466-2	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-466-3	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-466-4	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-466-5	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-466-6	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-518-1	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-2	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-3	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-4	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-5	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-6	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-7	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-8	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-9	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-10	Core	Sec. 16 T26S R8E	N 32 3' 2"; W 106 7' 58"	U.S. Army Ft. Bliss core 51-8
RB-518-11	Core	Sec. 6 T26S R8E	N 32 4' 8"; W 106 9' 52"	U.S. Army Ft. Bliss core 46-6
RB-H-1	Outcrop	Sec. 24 T26S R9E	N 32 01' 20.2"; W 105 58' 21.6"	Hueco Mountains
RB-H-2	Outcrop	Sec. 24 T26S R9E	N 32 01' 36.9"; W 105 58' 40.5"	Hueco Mountains
RB-H-3	Outcrop	Sec. 24 T26S R9E	N 32 01' 47.5"; W 105 58' 47.6"	Hueco Mountains
RB-H-4	Outcrop	Sec. 24 T26S R9E	N 32 05' 02.3"; W 105 57' 4.8"	Hueco Mountains
RB-OR-1	Outcrop	Sec. 23 T21S R8E	N 32 28' 13.4"; W 106 05' 43.7"	Jarilla Mountains
RB-OR-2	Outcrop	Sec. 14 T21S R8E	N 32 28' 26.4"; W 106 05' 57.0"	Jarilla Mountains
RB-SAC-1	Outcrop	Sec. 34 T19S R11E	N 32 36' 48"; W 105 47' 51"	Sacramento Mountains
RB-SAC-2	Outcrop	Sec. 34 T19S R11E	N 32 36' 48"; W 105 47' 51"	Sacramento Mountains
RB-SAC-3	Outcrop	Sec. 34 T19S R11E	N 32 36' 34"; W 105 47' 41"	Sacramento Mountains
RB-SAC-4	Outcrop	Sec. 34 T19S R11E	N 32 36' 34"; W 105 47' 41"	Sacramento Mountains
RB-SAC-5	Outcrop	Sec. 12 T19S R10E	N 32 40' 18.8"; W 105 51' 59.8"	Sacramento Mountains
RB-SAC-6	Outcrop	Sec. 7 T19S R11E	N 32 40' 17.5"; W 105 52' 03.9"	Sacramento Mountains
RB-SAC-7	Outcrop	Sec. 18 T19S R11E	N 32 39' 47.9"; W 105 51' 54.4"	Sacramento Mountains
RB-SAC-8	Outcrop	Sec. 18 T19S R11E	N 32 39' 46.4"; W 105 51' 40.4"	Sacramento Mountains
RB-SAC-9	Outcrop	Sec. 18 T19S R11E	N 32 39' 51.2"; W 105 51' 39.0"	Sacramento Mountains
RB-SAC-10	Outcrop	Sec. 24 T26S R9E	N 32 01' 20.2"; W 105 58' 21.6"	Hueco Mountains
RB-SEA-1	Cuttings	Sec. 18 T26S R11E	N 32 02' 41"; W 105 51' 35"	Seaboard Oil Co. No. 1, Trigg well
RB-SEA-2	Cuttings	Sec. 18 T26S R11E	N 32 02' 41"; W 105 51' 35"	Seaboard Oil Co. No. 1, Trigg well
RB-SEA-3	Cuttings	Sec. 18 T26S R11E	N 32 02' 41"; W 105 51' 35"	Seaboard Oil Co. No. 1, Trigg well
RB-SP-1	Cuttings	Sec. 35 T20S R10E	N 32 31' 14"; W 105 53' 09"	Sun Oil No. 1, T.J. Pearson
RB-SP-2	Cuttings	Sec. 35 T20S R10E	N 32 31' 14"; W 105 53' 09"	Sun Oil No. 1, T.J. Pearson
RB-SP-3	Cuttings	Sec. 35 T20S R10E	N 32 31' 14"; W 105 53' 09"	Sun Oil No. 1, T.J. Pearson
RB-SP-4	Cuttings	Sec. 35 T20S R10E	N 32 31' 14"; W 105 53' 09"	Sun Oil No. 1, T.J. Pearson
RB-STD-1	Outcrop	Sec. 9 T5S R2E	N 33 53' 33.6"; W 106 43' 55.3"	Carthage area
RB-STD-2	Outcrop	Sec. 8 T6S R7E	N 33 53' 06.9; W 106 24' 49.6"	Bingham area
RB-TB-1	Outcrop	Sec. 7 T25S R8E	N 32 08' 38.2"; W 105 10' 9.6"	Three Buttes
RB-ZP-1	Cuttings	Sec. 14 T20S R14E	N 32 33' 51"; W 105 29' 17"	Zapata Petroleum No. 1, Federal 14
RB-ZP-2	Cuttings	Sec. 14 T20S R14E	N 32 33' 51"; W 105 29' 17"	Zapata Petroleum No. 1, Federal 14
RB-ZP-3	Cuttings	Sec. 14 T20S R14E	N 32 33' 51"; W 105 29' 17"	Zapata Petroleum No. 1, Federal 14
RB-DMY-1	Outcrop	Sec. 9 T5S R2E	N 33 53' 33.6"; W 106 43' 55.3"	Carthage area
RB-DMY-2	Outcrop	Sec. 8 T6S R7E	N 33 53' 06.9; W 106 24' 49.6"	Bingham area

Table 6.4 (Continued)

Sample No.	Depth (ft)	Formation	Lithology	TOC [2] (%)	TAI[2]	Maturity
RB-466-1	947	Panther Seep	Limestone	1.62	2.90	Mature
RB-466-2	1,403	Panther Seep	Limestone	0.46	2.10	Moderately immature
RB-466-3	1,500	Panther Seep	Limestone	0.48	2.20	Moderately mature
RB-466-4	1,630	Panther Seep	Shale	0.78	2.1 (3.9)	Moderately immature (very mature)
RB-466-5	1,823	Mississippian	Limestone	0.66	2.1 (4.2)	Moderately immature (severely altered)
RB-466-6	2,144	Mississippian	Limestone	2.63	2.10	Moderately immature
RB-518-1	1,151	Mississippian	Limestone	1.94	3.10	Mature
RB-518-2	1,325	Mississippian	Limestone	2.61	3.00	Mature
RB-518-3	1,417	Devonian	Shale	3.67	2.0 (4.1)	Moderately immature (very mature)
RB-518-4	1,466	Devonian	Chert	1.17	2.2 (4.1)	Moderately mature (very mature)
RB-518-5	1,500	Devonian	Shale	3.68	3.40	Mature
RB-518-6	1,512	Fusselman	Dolostone	0.18	3.00	Mature
RB-518-7	2,092	El Paso	Dolostone	0.24	2.10	Moderately immature
RB-518-8	2,261	Mississippian	Shale	2.92	3.00	Mature
RB-518-9	2,353	Mississippian	Limestone	0.69	2.4 (4.2)	Moderately mature (severely altered)
RB-518-10	2,569	Panther Seep	Limestone	0.66	2.70	Mature
RB-518-11	947	Panther Seep	Limestone	1.52	2.80	Mature
RB-H-1	Surface	Panther Seep	Limestone	0.23	2.40	Moderately mature
RB-H-2	Surface	Panther Seep	Limestone	0.07	3.80	Very mature
RB-H-3	Surface	Panther Seep	Shale	0.18	2.90	Mature
RB-H-4	Surface	Hueco	Limestone	0.33	3.30	Mature
RB-OR-1	Surface	Panther Seep	Limestone	0.16	1.90	Moderately immature
RB-OR-2	Surface	Hueco	Limestone	0.18	2.00	Moderately immature
RB-SAC-1	Surface	Mississippian	Shale	0.45	2.50	Moderately mature
RB-SAC-2	Surface	Mississippian	Limestone	0.22	2.20	Moderately mature
RB-SAC-3	Surface	Devonian	Chert	0.18	1.50	Immature
RB-SAC-4	Surface	Fusselman	Dolostone	0.12	1.60	Immature
RB-SAC-5	Surface	Montoya	Dolostone	0.02	2.20	Moderately mature
RB-SAC-6	Surface	Valmont Dolomite	Dolostone	0.09	2.20	Moderately mature
RB-SAC-7	Surface	El Paso	Dolostone	0.01	2.60	Mature
RB-SAC-8	Surface	Lake Valley	Limestone	0.14	2.10	Moderately immature
RB-SAC-9	Surface	Devonian	Shale	0.72	2.40	Moderately mature
RB-SAC-10	Surface	Panther Seep	Limestone	0.07	2.40	Moderately mature
RB-SEA-1	3,300-3,400	Hueco	Shale	0.71	2.50	Moderately mature
RB-SEA-2	4,000-4,200	Panther Seep	Shale	0.62	2.10	Moderately immature
RB-SEA-3	5,050-5,360	Panther Seep	Limestone	0.75	2.40	Moderately mature
RB-SP-1	1,350-1,450	Hueco	Limestone	0.50	2.00	Moderately immature
RB-SP-2	2,350-2,550	Panther Seep	Limestone	0.44	2.20	Moderately immature
RB-SP-3	3,500-3,700	Panther Seep	Limestone	0.60	2.60	Mature
RB-SP-4	4,200-4,270	Mississippian	Limestone	1.01	2.30	Moderately mature
RB-STD-1	Surface	Lower Mancos Shale	Shale	0.50	1.90	Moderately immature
RB-STD-2	Surface	San Andres	Limestone	0.10	2.70	Mature
RB-TB-1	Surface	Panther Seep	Limestone	0.22	2.50	Moderately mature
RB-ZP-1	2,500-2,600	Hueco	Limestone	0.66	2.00	Moderately immature
RB-ZP-2	3,464-3,500	Panther Seep	Shale	0.57	2.40	Moderately mature
RB-ZP-3	4,800-4,900	Panther Seep	Shale	1.66	2.00	Moderately immature
RB-DMY-1	Surface	Mancos	Shale	0.63	2.20	Moderately mature
RB-DMY-2	Surface	San Andres	Limestone	0.39	2.30	Moderately mature

Table 6.4 (Continued)

Sample No.	% Algal[2]	% Amorphous[2]	% Herbaceous[2]	% Woody[2]	% Inertinite[2]	Comments
RB-466-1	0	40	40	10	10	
RB-466-2	0	50	30	0	13	
RB-466-3	0	30	30	20	20	
RB-466-4	0 (0)	9 (0)	18 (0)	36 (50)	36 (50)	
RB-466-5	0 (0)	9 (0)	18 (0)	36 (50)	36 (50)	
RB-466-6	0	33	25	8	33	
RB-518-1	18	36	36	0	9	
RB-518-2	10	40	40	0	10	
RB-518-3	0 (0)	23 (0)	31 (33)	15 (0)	31 (67)	
RB-518-4	0 (0)	31 (0)	23 (33)	15 (0)	31 (67)	
RB-518-5	0	36	27	0	36	
RB-518-6	20	40	20	0	20	
RB-518-7	22	33	22	0	22	
RB-518-8	13	50	13	0	25	
RB-518-9	0 (0)	15 (0)	23 (0)	31 (50)	31 (50)	
RB-518-10	8	31	15	23	23	
RB-518-11	0	23	31	15	31	Duplicate, same as sample RB-466-1
RB-H-1	0	43	29	0	29	
RB-H-2	0	50	25	13	13	
RB-H-3	0	50	25	0	25	
RB-H-4	0	44	33	11	11	
RB-OR-1	0	57	43	0	0	
RB-OR-2	0	27	36	18	18	
RB-SAC-1	0	15	23	31	31	
RB-SAC-2	0	67	33	0	0	
RB-SAC-3	0	25	63	13	0	
RB-SAC-4	0	50	25	0	25	
RB-SAC-5	0	67	33	0	0	
RB-SAC-6	0	13	50	25	13	
RB-SAC-7	0	50	25	13	13	
RB-SAC-8	0	50	38	0	13	
RB-SAC-9	0	38	50	13	0	
RB-SAC-10	0	38	50	13	0	Duplicate, same as RB-H-1
RB-SEA-1	0	0	27	36	36	
RB-SEA-2	0	15	23	31	31	
RB-SEA-3	0	40	40	10	10	
RB-SP-1	0	8	25	33	33	
RB-SP-2	8	25	33	33	0	
RB-SP-3	0	17	17	33	33	
RB-SP-4	0	8	33	33	25	
RB-STD-1	0	15	23	31	31	Standard, Lower Mancos Shale
RB-STD-2	0	50	25	13	13	Standard, San Andres Formation
RB-TB-1	0	50	38	13	0	
RB-ZP-1	0	0	50	25	25	
RB-ZP-2	0	36	27	18	18	
RB-ZP-3	0	8	25	33	33	
RB-DMY-1	0	20	33	27	20	Standard Lower Mancos Shale
RB-DMY-2	22	44	22	0	11	Standard San Andres Formation

[1] Performed by Geochem Laboratories Inc.

[2] TOC = Total Organic Carbon; TAI = Thermal Alteration Index; Algal, Amorphous, Herbaceous, Woody, and Inertinite = forms of kerogens; ( ) = reworked second kerogen population.

Table 6.5 Other Petroleum Source Rock Analyses.

Sample No.	Sample Type	Location	Well Name	Depth (ft)	Formation	% TOC[2]	TAI[2]	TMAX[2]	Maturity
84012-6	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	2,400	Hueco	0.15			
84012-7	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	2,450	Pennsylvanian	0.32			
84012-8	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,130	Pennsylvanian	0.60			
84012-9	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,150	Pennsylvanian	0.45			
84012-10	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,450	Devonian	0.15			
84012-11	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,470	Devonian	0.16			
84012-12	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,500	Devonian	0.43			
84012-13	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	4,154	El Paso	0.12			
84012-14	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	4,400	El Paso	0.13			
84012-15	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	1,448	Yeso	0.30			
84012-16	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	2,011	Yeso	1.08			
84012-17	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	5,395	Pennsylvanian	1.74			
84012-18	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	5,600	Mississippian	0.30			
84012-19	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	5,806	Devonian	0.51			
84012-20	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	5,900	Fusselman	1.01			
84012-21	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	6,031	Montoya	1.28			
84012-22	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	6,118	Montoya	0.20			
84012-28	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	1,482	Yeso	0.30			
84012-29	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	3,530	Hueco	0.51	2.9?		Mature
84012-30	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	3,810	Hueco	0.73	2.9?		Mature
84012-31	Cuttings	Sec. 35 T18S R14E	Marathon No. 1 Mesa Verde Ranch	4,519	Pennsylvanian	0.36	2.9?		Mature
84012-32	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,565	Fusselman	0.09			
84012-33	Cuttings	Sec. 5 T17S R12E	Southern Production No. 1 Cloudcroft	3,894	El Paso	1.15		507	Severely altered
934-001	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	600-650	Yeso	0.49			
934-002	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	1,200-1,300	Abo	0.80			
934-003	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	1,900-2,000	Hueco	0.96			
934-004	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	2,200-2,300	Hueco	0.75			
934-005	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	2,600-2,700	Pennsylvanian	0.91			
934-006	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	2,800-2,900	Pennsylvanian	0.96			
934-007	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,100-3,200	Pennsylvanian	0.98			
934-008	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,240-3,300	Pennsylvanian	1.20			
934-009	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,300-3,400	Pennsylvanian	0.82			
934-010	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,500-3,600	Pennsylvanian	0.94			
934-011	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,600-3,700	Pennsylvanian	1.21			
934-012	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,700-3,800	Pennsylvanian	0.93			
934-013	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,800-3,850	Pennsylvanian	1.93			
934-014	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,850-3,900	Pennsylvanian	1.28			
934-015	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,900-3,950	Pennsylvanian	1.50	3.60		Very mature
934-016	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	3,950-4,020	Pennsylvanian	2.40			
934-017	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,020-4,100	Pennsylvanian	1.34			
934-018	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,100-4,150	Pennsylvanian	1.39			
934-019	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,150-4,200	Pennsylvanian	1.76	3.70		Very mature
934-020	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,200-4,250	Pennsylvanian	1.23			
934-021	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,260-4,320	Pennsylvanian	1.55			
934-022	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,320-4,370	Pennsylvanian	1.54			
934-023	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,400-4,460	Pennsylvanian	1.92			
934-024	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,460-4,520	Pennsylvanian	2.09			
934-025	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,520-4,600	Pennsylvanian	1.92			
934-026	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,600-4,700	Pennsylvanian	1.59	3.70		Very mature
934-027	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,700-4,800	Pennsylvanian	1.53			
934-028	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,800-4,900	Pennsylvanian	1.82			
934-029	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	4,900-5,000	Pennsylvanian	1.76			
934-030	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,000-5,040	Pennsylvanian	1.02			
934-031	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,040-5,100	Pennsylvanian	1.84			
934-032	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,100-5,200	Pennsylvanian	1.58			
934-033	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,200-5,260	Pennsylvanian	1.31	3.70		Very mature

Table 6.5 (Continued)

Sample No.	Sample Type	Location	Well Name	Depth (ft)	Formation	% TOC[2]	TAI[2]	TMAX[2]	Maturity
934-034	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,260-5,300	Pennsylvanian	1.25			
934-035	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,300-5,400	Pennsylvanian	1.19			
934-036	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,400-5,500	Pennsylvanian	0.97			
934-037	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,500-5,600	Pennsylvanian	1.10			
934-038	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,600-5,700	Pennsylvanian	1.17			
934-039	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,710-5,800	Pennsylvanian	0.91			
934-040	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	5,800-5,860	Pennsylvanian	0.87			
934-041	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,000-6,070	Pennsylvanian	1.03			
934-042	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,150-6,170	Pennsylvanian	0.95			
934-043	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,350-6,300	Pennsylvanian	0.73			
934-044	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,400-6,500	Pennsylvanian	0.79			
934-045	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,560-6,590	Pennsylvanian	0.32			
934-046	Cuttings	Sec. 15 T20S R9E	Plymouth Oil Co. No. 1 Federal	6,700-6,800	Devonian	2.05	3.8-3.9		Very mature

[1] Obtained from Jacobsen et al. (1984a, 1984b).
[2] TOC = Total Organic Carbon. TAI = Thermal Alteration Index. TMAX = Maximum Temperature Pyrolsis S2 Peak.

- Does the rock have sufficient organic matter to have generated petroleum in commercial quantities? This question is answered by analyzing appropriate sedimentary rocks for TOC content. Rocks that have insufficient TOC can beruled out as possible source rocks. Jarvie (1991) recently proposed a modified TOC rating system for screening potential source rocks (refer to Table 6.6). According to Jarvie's system, any rock with more than 0.5% TOC is a possible source rock that must be evaluated further to determine thermal maturity and organic matter type. For this project, representative rock samples from all stratigraphic units throughout the McGregor Range area were analyzed for TOC content (refer to Table 6.4).

- Is the organic matter (kerogen) in the rock oil-prone, gas-prone, or is it incapable of generating oil or gas? The type of organic matter, if present in sufficient quantity, will determine if a source rock will generate principally oil or principally gas upon maturation (refer to Table 6.7). For this project, identification of organic matter type was based on petrographic analysis of kerogen concentrate of all samples submitted for source rock analysis. Algal, herbaceous, and many amorphous kerogens (kerogen types I and II) will generate oil and associated gas upon maturation (Hunt 1979; Brooks et al. 1987 Tyson 1987). Woody kerogen (kerogen type III) and some amorphous kerogens (kerogen types I and II) will generate gas and possibly some gas condensate upon maturation (Hunt 1979; Brooks et al. 1987; Tyson 1987). Inertinites are type IV kerogens that have extremely low hydrogen contents and are incapable of generating significant amounts of hydrocarbons.

- Is the thermal maturity of the possible source rock sufficient for hydrocarbon generation? For this project, the level of thermal maturity was evaluated using visual kerogen analysis. The color of a kerogen concentrate from a potential source rock is examined; the kerogen color changes from yellow to orange to brown to black with increasing maturation (Staplin 1969). Based on calibrated color charts, the sample is assigned a numerical value (Thermal Alteration Index [TAI]). TAI ranges from 1.0 for thermally immature rocks to 5.0 for thermally overmature, metamorphosed rocks (refer to Table 6.8).

Table 6.6 Qualitative Evaluation of Source Rock Potential as a Function of Total Organic Carbon (TOC) Content.[1]

Source Rock Rating	Total Organic Carbon (TOC) (%)
Inadequate	0 - 0.5
Marginal	0.5 - 1.0
Adequate	> 1.0

[1] Jarvie (1991).

Table 6.7 Kerogen Types and Petroleum Products Produced on Thermal Maturation.

General Kerogen Type	Kerogen Type	Petrographic Form	Coal Maceral Group	Hydrocarbons Generated
Sapropelic (oil prone)	I	Algal	Exinite or liptinite	Oil, gas
		Amorphous		
	II	Herbaceous		
Humic (gas prone)	III	Woody	Vitrinite or huminite	Gas, possibly minor oil
	IV	Coaly (inertinite)	Inertinite	None

[1] Based on summary works of Merrill (1991) and Tyson (1987).

Table 6.8 Correlation of Maturation Parameters Used in This Report with Zones of Hydrocarbon Generation.[1]

Maturation Level	Products Generated	Visual Kerogen Thermal Alteration Index (TAI)
Immature	Biogenic gas	1.0 - 1.7
Moderately immature	Biogenic gas and immature oil	1.8 - 2.1
Moderately mature	Immature heavy oil	2.2 - 2.5
Mature	Mature oil, condensate	2.6 - 3.5
Very mature	Condensate, wet gas, petrogenic dry gas	3.6 - 4.1
Severely altered	Petrogenic methane	4.2 - 4.9
Metamorphosed		5.0

[1] Based on Geochem Laboratories, Inc. (1980) and Sentfle and Landis (1991).

The three questions concerning source rock analyses are answered for the major stratigraphic intervals as summarized below.

The Ordovician and Silurian dolostones are poor petroleum source rocks. They have insufficient TOC for petroleum generation (refer to Tables 6.4 and 6.5). Only one sample from the El Paso Group (Ordovician) had a TOC exceeding 0.5% and that was from a depth of 3,894 ft in the Southern Production Company No. 1 Cloudcroft well. As discussed above, it is unknown if the TOC measurements in this well are reliable. In all other samples, TOC of the El Paso Group varied from 0.01 to 0.24%.

The Montoya Group (Ordovician) also has insufficient TOC to be considered a source rock. Montoya TOC was less than 0.20% in two of the three available samples. It was reported to be 1.28% in the sample from a depth of 6,031 ft in the Marathon No. 1 Mesa Verde Ranch well (refer to Table 6.5), but it is unknown if this result was reliable. If the reported TOC is correct, then the Montoya may have sufficient TOC to be considered a source rock in the area northeast of the McGregor Range.

The Fusselman Formation (Silurian) also appears to have insufficient TOC to be considered a petroleum source rock. Fusselman TOC was less than 0.20% in three of the four available samples. Only in the Marathon No. 1 Mesa Verde Ranch well located northeast of the McGregor Range did Fusselman Formation TOC exceed 0.5%; and in that well it was reported as 1.01%.

Devonian strata are thermally mature oil-prone source rocks in the McGregor Range area. They have sufficient TOC to be considered source rocks. In the southern part of the McGregor Range in the U.S. Army Fort Bliss core hole 51-8, Devonian shales have 3.67 to 3.68% TOC (refer to Table 6.4). The upper shale in that hole was thermally immature with a TAI of 2.0. A second, reworked population of kerogen from the upper shale had a TAI of 4.1; presumably the extra level of maturation was obtained from incorporation and burial in a pre-existing sedimentary rock and does not apply to the existing shale. The lower shale in U.S. Army Fort Bliss core hole 51-8 was thermally mature, with a TAI of 3.4. Furthermore, kerogen in the lower shale was dominantly amorphous and herbaceous, so it is capable of generating oil and associated gas.

The outcrop sample from the lower shale in the Sacramento Mountains had a TOC of 0.72%, sufficient for hydrocarbon generation. The kerogens were predominantly amorphous and herbaceous oil-prone types. The sample was moderately mature with a TAI of 2.4, so perhaps it generated some heavier oils along with gas. In the southernmost Sacramento Mountains in Grapevine Canyon, the Devonian section was thin and consisted of approximately 3 ft of the middle chert unit. This chert was thermally immature with a TAI of only 1.5, suggesting that the area was a middle Paleozoic structural high that has never been buried very deeply.

Mississippian strata are thermally mature, oil-prone source rocks in the McGregor Range area. TOC is more than sufficient for petroleum generation, ranging from 0.22% to 2.92% and exceeding 1.0% in five of the nine analyzed samples (refer to Table 6.4). Kerogens were predominantly algal, amorphous, and herbaceous oil-prone types. Mississippian rocks are thermally mature in the southern parts of the McGregor Range with TAIs in the 2.4 to 3.1 range. In the northern part of the McGregor Range, the Mississippian section is moderately mature, with TAIs in the 2.2 to 2.5 range.

Pennsylvanian strata are mature oil-prone source rocks in the northern and southern parts of the McGregor Range. For this project, source rock analyses were performed on 18 samples from the basinal Panther

Seep Formation (refer to Table 6.4); most of those samples were dark gray to black lime mudstones. Nine of those samples had more than 0.5% TOC and, therefore, have sufficient kerogen to be considered petroleum source rocks. Three of the 18 samples had more than 1.5% TOC. Kerogen types were mixed, but were dominantly oil-prone amorphous and herbaceous types in most samples.

The Pennsylvanian section is thermally mature in the southern part of the McGregor Range (refer to Figure 6.13 and Tables 6.4 and 6.5). It has also reached thermal maturity in the northern part of the McGregor Range in the Sun Oil Company No. 1 Pearson well (refer to Table 6.4). In these areas, thermal maturity ranges from moderately immature to very mature. Data suggest that proximity to intrusive igneous rocks, as well as burial depth, exerts control on maturation, with rocks within several miles of large intrusive bodies being the most mature. In the Tularosa Basin in the Plymouth Oil Company No. 1 Federal well, the entire Pennsylvanian section was very mature with TAI values ranging from 3.6 to 3.7 (refer to Figure 6.13 and Table 6.5). This higher level of maturation is probably the result of deeper burial within the Tularosa Basin as compared to the Otero Platform.

Permian strata are poor source rocks for oil and gas within the McGregor Range. In the Hueco Formation, TOC measurements at first appeared adequate in places for petroleum generation, ranging from 0.15 to 0.96% (refer to Tables 6.4 and 6.5). However, kerogens are mixed amorphous, herbaceous, woody, and algal types, and the inertinite fraction of the kerogen varies from 11% to 36%. When the inertinite fraction is factored in, none of the samples from the Hueco Formation have sufficient TOC to be considered source rock. Furthermore, the Hueco Formation appears to be thermally immature throughout most of the area covered by this report. The Hueco Formation has matured to the stage of oil generation only near intrusive igneous rocks in the Hueco Mountains (refer to Sample RB-H-4 in Table 6.4). The Hueco Formation is mature in the Tularosa Basin in the Plymouth Oil Company No. 1 Federal well (refer to Table 6.5).

Samples from Permian strata shallower than the Hueco Formation were not subjected to source rock analysis for this project. Within the McGregor Range, these shallower units have either been eroded or are present at the surface and not at any great depth.

6.4.5 Petroleum Preservation

An analysis of source rock samples can determine if oil and gas generated within the McGregor Range has been preserved or has been heated to temperatures in excess of specific thermal preservation limits. If oil has been trapped in a reservoir and subsequent heating due to either burial or local intrusion of an igneous body has elevated the TAI above 3.5, then the oil will be thermally cracked into condensate, wet gas, and dry gas (refer to Table 6.8). Gas in a reservoir will not be altered when maturation passes above a TAI value of 3.5. At TAI values in excess of 4.1, however, condensate and wet gas are thermally cracked to methane (dry gas).

Throughout most of the McGregor Range area, values of TAI in all Paleozoic strata are less than 3.5. Therefore, any oil and gas that has been trapped within most of the McGregor Range has been preserved rather than thermally degraded.

The only places where the preservation limit of oil has been exceeded are areas in close proximity to intrusive bodies in the southern part of the McGregor Range and in the deeply buried Pennsylvanian and Devonian sections as seen in Plymouth Oil Company, No. 1 Federal well in the Tularosa Basin (refer to Tables 6.4 and 6.5). Even in these areas, however, TAI is less than 4.1 and condensate and wet gas, as well as dry gas, could be preserved if they had accumulated in these strata.

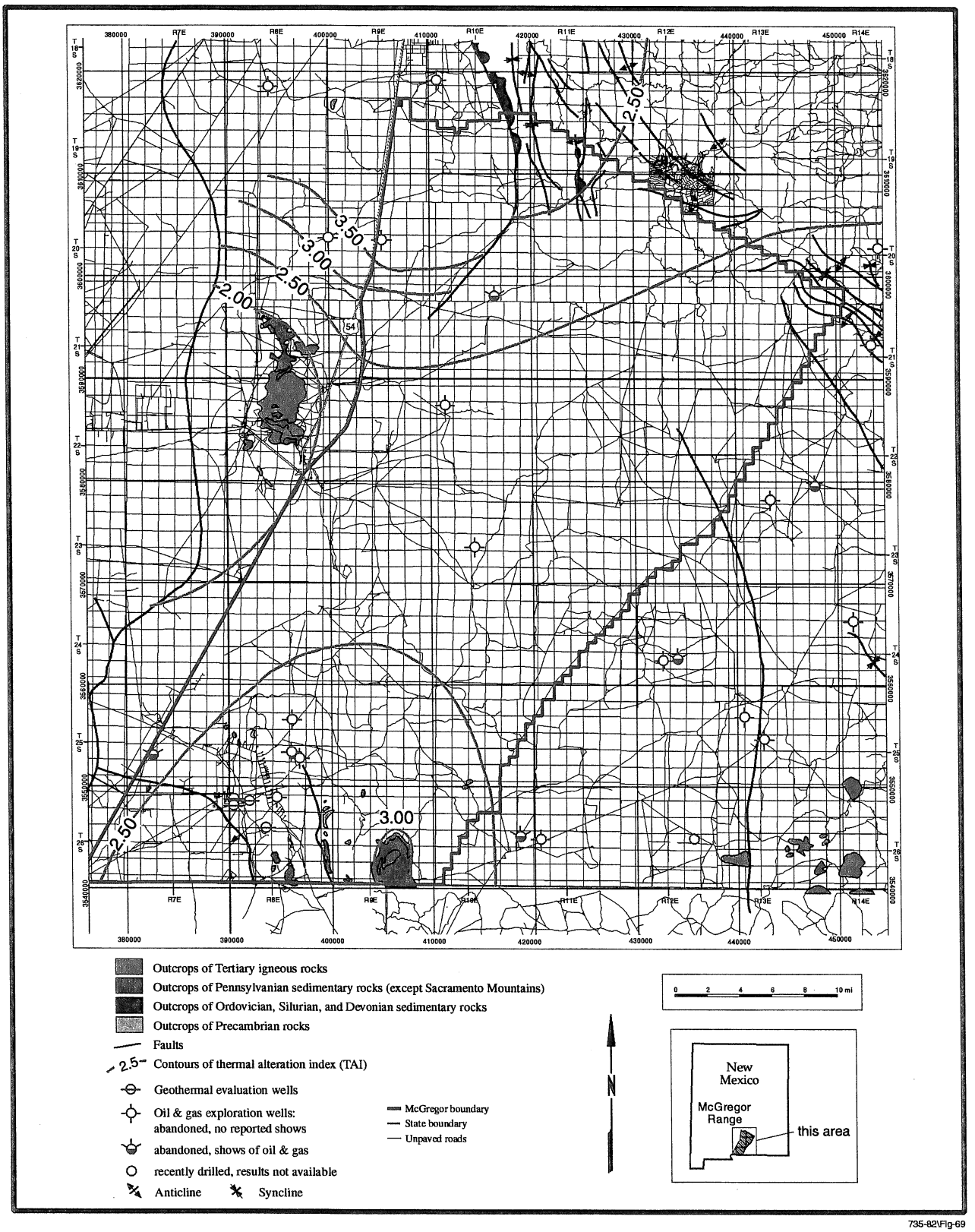

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Figure 6.13 Contours of Thermal Alteration Index (TAI) of Pennsylvania-Age Rocks on the McGregor Range and Adjacent Areas.

6.4.6 Petroleum Reservoir Analysis

6.4.6.1 Introduction

Assessment of the petroleum resource potential of an area requires a determination of the reservoir engineering characteristics of possible petroleum reservoirs to determine if they have sufficient porosity and permeability to function as economically viable petroleum reservoirs. For this project, the approach to this evaluation involved the analysis of five types of information and three major eras with petroleum potential.

- Examination of drilling records of petroleum exploration wells (including mudlogs, when available) for indications of fluid recovery from drill-stem tests. Recovery of large volumes of formation fluids (whether water or hydrocarbons) indicates the presence of permeable rocks that are able to transmit large volumes of fluid within a short period of time. Permeability detected in this manner may be associated with matrix porosity or with fractures.
- Examination of drilling records of exploration wells to determine if water or other formation fluids entered the borehole while the well was being drilled. These data generally are associated with older wells drilled with a cable tool rig instead of more modern wells drilled with rotary tools. The entry of large amounts of fluid into the borehole indicates the presence of a permeable zone.
- Examination of drilling records for zones of lost circulation. Drilling fluids are lost in a modern well drilled with rotary tools when a permeable, low-pressure zone is drilled. Permeability detected in this manner may be associated with matrix porosity or it may be associated with fractures.
- Examination of descriptions of cores and cuttings for descriptions of porosity. These descriptions not only reveal the presence of porous reservoir zones within a well, but can also give an indication of what type of porosity is present. Is the porosity intergranular or vuggy? Is it capable of storing large volumes of oil or gas? Or is the porosity present only as fractures that have high permeability but low storage volume?
- Comparison of stratigraphic units in the McGregor Range area with equivalent, productive stratigraphic units in the Permian Basin 60 mi to the east. These comparisons with productive strata were made to determine if rocks in the McGregor Range are lithologically and depositionally similar to those in the Permian Basin in order to draw inferences about reservoir characteristics.

6.4.6.2 Lower and Middle Paleozoic Era

Dolostones of the lower Paleozoic El Paso and Montoya Groups (Ordovician) and the Fusselman Formation (Silurian) contain good oil and gas reservoirs. In the Tularosa Basin, the Texaco wells and the Plymouth Oil Company No. 1 Federal well recovered large volumes of formation waters on drill-stem tests (refer to Table 6.2), indicating that these stratigraphic units contain permeable zones capable of transmitting relatively large volumes of fluid in a short time. A similar situation exists on the Otero Platform, with large volumes of formation waters recovered on drill-stem tests in the Fusselman Formation in the Sun Oil Company No. 1 T.J. Pearson well and in the E.P. Campbell No. 1 Lois Spanel well (refer to Table 6.2). In the Sun No. 1 Pearson, the well was abandoned at a total depth of 4,468 ft in the Fusselman Formation because the well lost circulation and circulation could not be regained; in this case, it is unknown whether the permeability in the lost circulation zone was caused by high-storage volume matrix porosity or low-storage-volume fracture porosity. However, descriptions of cuttings and cores for wells

drilled in the area indicate that the Ordovician and Fusselman dolostones are characterized by zones of vugular porosity (refer to Figure 6.14). Similar porosity systems produce commercial volumes of oil and gas from Ordovician and Silurian dolostones in the Permian Basin (Speer 1993a, 1993b). Therefore, it appears that the lower Paleozoic dolostones within the McGregor Range are suitable petroleum reservoirs.

Devonian strata within the McGregor Range consist of shales and bedded, brecciated cherts. These rocks do not have appreciable permeability unless fractured; therefore, most are poor petroleum reservoir rocks. The Devonian section is fractured in the core from the U.S. Army Fort Bliss Well 51-8, but the fractures have been filled with carbonate cement, rendering the Devonian rocks impermeable.

Mississippian strata within the McGregor Range consist of interbedded shales and limestones. The shales have no appreciable permeability and are poor petroleum reservoirs unless fractured. Mississippian limestones, on the other hand, may be good reservoirs. In the Tularosa Basin, a drill-stem test of the Mississippian section in the Texaco No. 1 Federal F well recovered formation water (refer to Table 6.2). On the Otero Platform, a drill-stem test of the Mississippian section in the E.P. Campbell No. 1 Hurley well recovered relatively large volumes of fresh formation water. It would, therefore, appear that at least some Mississippian limestones are porous and permeable and are capable of transmitting relatively large volumes of fluid in a short period of time. However, the fluids are probably transmitted primarily through fractures. Greenwood et al. (1977) concluded that Mississippian strata in the Orogrande Basin area (equivalent to the area covered by this study) are impervious, poor reservoirs and that Mississippian bioherms are too small to be major drilling objectives. Mississippian strata are relatively minor reservoirs of oil and gas in the Permian Basin, having produced only 2 million barrels of oil and 19 billion ft^3 gas in the New Mexico part of the basin (Broadhead and Speer 1995); this is less than 0.1% of the oil and gas produced in the New Mexico part of the basin. This would appear to diminish the potential for major reservoirs within the Mississippian section in the McGregor Range.

6.4.6.3 Upper Paleozoic Era

Pennsylvanian carbonate rocks are major reservoirs for oil and gas in the Permian Basin. In the New Mexico part of the basin, Pennsylvanian carbonates have produced a cumulative total of 445 million barrels of oil and 6.8 trillion ft^3 gas, 10% of the oil and 34% of the gas produced in the New Mexico part of the basin. Most of the gas produced from the Pennsylvanian section in southeastern New Mexico is obtained from fine-grained, "tight" sandstones in the Morrow and Atoka (Lower Pennsylvanian). Analogous gas reservoirs are not present to any major extent in the McGregor Range area, where sandstones are a minor component of the Lower Pennsylvanian (Connelly and Stanton 1986). However, most of the oil produced from the Pennsylvanian section in the Permian Basin is obtained from carbonate reservoirs in the Upper Pennsylvanian (Speer 1993c; Broadhead and Speer 1995). In southeastern New Mexico, these reservoirs were deposited on a wide, shallow carbonate shelf. Oil and gas fields are associated principally with carbonate buildups (bioherms) that grew on the shallow shelves (Speer 1993c; Broadhead in press). Published lithofacies maps of the McGregor Range area indicate that the Pennsylvanian section, as a whole, consists predominantly of limestones with relatively minor shales and sandstones (Meyer 1966; Kottlowski 1969; McKee and Crosby 1975).

In the northernmost portion of the McGregor Range area, the Pennsylvanian section was deposited principally on a shallow shelf in the Sacramento Mountains, where it is comprised of three formations (ascending): Gobbler, Beeman, and Holder Formations (Pray 1961; Bowsher 1986). The Gobbler and Holder Formations are shelf deposits and the Beeman Formation appears to be a basinal deposit throughout



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Figure 6.14 Nonfracture-Related Vugular Porosity in Fusselman Dolostone (Silurian), U.S. Army Fort Bliss Core 51-8, Depth 1,549 ft.

the Sacramento Mountains (Bowsher 1986). Bowsher (1986) documented occurrences of numerous bioherms in the Sacramento Mountains.

The Pennsylvanian section appears to consist primarily of basinal deposits throughout most of the rest of the McGregor Range, limiting the shelf facies principally to the Sacramento Mountains area. These basinal strata are correlated with the Panther Seep Formation and outcrop in the Hueco Mountains (Hardie 1958a, 1958b; Kottlowski 1960b) and in the Jarilla Mountains near Orogrande, as well as in the Three Buttes area of the southwestern part of the McGregor Range. Van Wagoner (1977) concluded from sedimentologic and stratigraphic studies that the black, fine-grained Lower Pennsylvanian limestones in the center of the Orogrande Basin represent the start of deposition in a deep euxinic basin; Connelly and Stanton (1986) disagreed and believed that the area was covered by a shallow sea during the Early Pennsylvanian and that rapid subsidence and deep-water sedimentation did not begin until later in the Pennsylvanian. The Pennsylvanian section in the Sun No. 1 Pearson well consists mostly of dark-colored, fine-grained limestones and minor arkosic sandstones of the Panther Seep Formation, although beds in the middle Pennsylvanian from 3,030 to 3,790 ft may be roughly correlative to the Bug Scuffle Limestone Member of the Gobbler Formation (Kottlowski 1960b). In spite of the controversy about the exact timing of major subsidence and the start of deep basin deposition during the Pennsylvanian, it appears that fine-grained basinal limestones dominate most of the Pennsylvanian section in this area. The shelf edge lies northeast of the Sun No. 1 Pearson well, although it may have migrated to the southwest for brief periods.

Kottlowski (1960a) concluded that these basinal deposits extend eastward into the vicinity of the Zapata No. 1 Federal 14 well in Section 14, T20S, R14E and the Stanolind No. 1 Thorn Unit well in Section 15, T21S, R14E. The Pennsylvanian section in this area consists mostly of black to dark gray shales. Further to the southeast, the Pennsylvanian has been eroded from the west flank of the Pedernal Uplift. It is probable that the north-trending fault in T24S to T26S, R13E (refer to Figure 2.19) delineated the shelf edge and that Pennsylvanian strata west of this fault should be dominated by the basinal Panther Seep facies. Therefore, the Pennsylvanian section throughout all but the northeasternmost part of the McGregor Range should be a basinal facies with reservoirs unlike those that produce most of the Pennsylvanian oil from southeastern New Mexico in the Permian Basin. Some shallow water sediments may be present around the old Paleozoic uplift in the Hueco Mountains (Kottlowski 1969), but field observation indicate that these rocks are mostly a quiet water basinal facies in which fine-grained rocks with poor reservoir quality are deposited.

Common rock types in the basinal Pennsylvanian facies are lime mudstones and angular intraformational limestone conglomerates. The limestone conglomerates consist of angular clasts of mixed limestone lithologies suspended in a lime mud matrix. They were probably deposited as debris flows derived from shelf edge and slope carbonates. In lower Permian carbonates adjacent to the shelf edge in the Permian Basin, similar debris flows form prolific oil reservoirs (Hobson et al. 1985, Loucks et al. 1985). The most likely places for these to occur in the McGregor Range are immediately basinward (west) of the shelf margin in the northeastern and southeastern parts of the McGregor Range and around the late Paleozoic Hueco uplift in the southern part of the McGregor Range. Elsewhere, the basinal deposits will be distant from the shelf edge and will most likely be devoid of significant depositional porosity.

The Southern Production Company No. 1 Cloudcroft Unit well, located north of the McGregor Range in Section 5, T17S, R12E, ran a drill-stem test in Pennsylvanian shelf deposits. Slight oil- and gas-cut drilling muds were recovered on that drill-stem test. East of that well, the Yates Petroleum No. 1 Dog Canyon YF well recovered salt water-cut drilling mud on a drill-stem test of the Pennsylvanian basinal facies, indicating the presence of permeable reservoirs. In the same area, the Atlantic Refining Company

No. 1 State AV well recovered salt water-cut drilling mud on a drill-stem test of the Pennsylvanian, also indicating the presence of a permeable zone.

Just east of the southern part of the McGregor Range, the Pasotero Petroleum Corporation No. 1 Evans well, which was drilled with a cable-tool rig, encountered several intervals in the Pennsylvanian which yielded water. The same was true in the R.H. Ernest No. 1 Located Land well drilled in the southwestern part of the McGregor Range (refer to Table 6.2). These two wells indicate the presence of permeable Pennsylvanian reservoirs throughout a large part of the McGregor Range.

In the four deep geothermal test holes drilled in the southwestern part of the McGregor Range (refer to Figure 6.12 and Table 6.2), the Pennsylvanian section is the primary aquifer (personal communication, 1997 with Jim Witcher, NMSU). Permeable zones are principally formed by fractures adjacent to the fault zones and by fractured igneous sills of Tertiary age. In places, porosity and permeability have been enhanced by dissolution of limestones along the fractures (refer to Figure 6.15). Permeable zones may also be associated with strata containing secondary vuggy porosity that have no association with faults or fractures, but the cores from the geothermal wells indicate that most vuggy porosity in the Panther Seep Formation is developed along fractures. Core data are limited to the southwestern part of the McGregor Range and may not be representative of the entire McGregor Range, but suggest that the most permeable parts of the Panther Seep are related to fractures rather than matrix porosity.

Wolfcampian (Lower Permian) carbonate rocks are major reservoirs for oil and gas in the Permian Basin, where they have produced 124 million barrels of oil and 341 billion ft^3 of gas (Broadhead and Speer 1995). Equivalent strata in the McGregor Range belong to the Hueco Formation. In the Texaco No. 1 Federal F well in the Tularosa Basin, a drill-stem test of the Hueco recovered a significant amount of formation water (refer to Table 6.3), indicating the presence of permeable zones. Northeast of the McGregor Range in the Marathon No. 1 Mesa Verde Ranch well, a drill-stem test of the Hueco recovered water and minor gas, also indicating the presence of reservoir zones. East of the southern part of the McGregor Range, a drill-stem test of the Hueco in the Seaboard Oil Company No. 1 Blanche Trigg well recovered fresh water from the Hueco; fresh water also entered the drill hole in the Hueco while the well was being drilled (refer to Table 6.2). Fresh water also entered the drill hole in the Hueco section in the Hunt Oil Company No. 1 McMillan Turner well (refer to Table 6.2 and Figure 2.5), which is located 9 mi east of the map boundary of Figure 6.12.

Most other Permian strata are poor reservoirs for oil and gas. The Abo Formation consists mostly of red shales and shaly fine-grained sandstones that are better suited as seals than as reservoir rocks. Conglomerates in the Pow Wow/lower Abo section may make good reservoirs; they are best developed as local deposits along the flanks of late Paleozoic uplifts such as the Hueco uplift and the area east of the McGregor Range along the west flank of the Pedernal uplift. The Yeso Formation contains sandstones that may be suitable reservoirs, but the Yeso has been eroded from the western half of the McGregor Range and crops out over most of the eastern half of the McGregor Range, limiting its potential as a petroleum reservoir. Only thin remnants of the San Andres Formation remain in the easternmost part of the McGregor Range, so the San Andres Formation is not a potential petroleum reservoir.

6.4.6.4 Post-Paleozoic Era

Relatively small bodies of intrusive volcanic rocks occur in the subsurface throughout a large part of the McGregor Range. They intrude Mississippian, Pennsylvanian, and Permian petroleum source rocks. Although these rocks have no matrix porosity, they are fractured where penetrated in the geothermal test



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Figure 6.15 Fractures Enhanced by Dissolution of Carbonate Rock. U.S. Army Fort Bliss Core 46-6, Depth 856 ft.

evaluation wells in the southwestern part of the McGregor Range. Where these fractured volcanic rocks have intruded impermeable Paleozoic source rocks, they could form petroleum reservoirs, similar to the Dineh-Bi-Keyah oil field of northeastern Arizona (Danie 1978).

Tertiary through Holocene sands and gravels that form the basin fill in the Tularosa Basin are poorly compacted and therefore have relatively high porosity and permeability. It is unlikely that sufficient seals are present within the section, rendering these sediments of little interest as petroleum reservoirs. The unconsolidated Quaternary eolian and alluvial sands on the Otero platform are thin surficial deposits that are of no interest as petroleum reservoirs.

6.4.7 Petroleum Traps

After oil and gas are generated within a source rock, it will migrate out of the source rock into reservoir beds or along faults and fractures. Because most rocks in the subsurface are saturated with water, buoyant forces will cause the oil and gas to migrate upward through the pore system of the rock matrix or through fractures until the upward movement is arrested by a seal. A seal can be defined as an impermeable rock or fault that blocks the movement of oil and gas. The physical arrangement of one or more seals and a reservoir rock that inhibits further upward migration of petroleum is called a trap. If a trap has been charged with oil or gas, it is called an oil or gas field.

Most traps fall into one of two broad categories, structural and stratigraphic (North 1985). Structural traps may be formed by folding of the reservoir rock and an overlying seal into an anticline or dome. They may also be formed by tilting of a reservoir and overlying seal in a fault block; in this case, the fault usually cuts the reservoir stratum and acts as a lateral seal for the accumulation. Stratigraphic traps do not depend on structure; they are formed by a lateral transition of a porous and permeable reservoir rock into an impermeable rock (seal). This lateral transition may be caused by depositional variations and/or diagenetic variations in the reservoir stratum.

Active flow of water through a reservoir (hydrodynamics) can also affect accumulations of oil and gas. Although it is possible that oil and gas can be trapped by hydrodynamic processes alone, more often hydrodynamics act to modify a pre-existing structural or stratigraphic trap by tilting the hydrocarbon-water contact within the trap or by flushing hydrocarbons out of the trap altogether (North 1985; Dahlberg 1995).

Both structural and stratigraphic traps are undoubtedly present within the McGregor Range. Numerous possibilities exist for structural traps within the McGregor Range area. Black (1973) mapped several north/south-trending anticlines on Otero Mesa east of the boundary of the McGregor Range. Had Black extended his mapping into the McGregor Range, he undoubtedly would have found similar structures. In the western part of the McGregor Range, Seager et al. (1987) and Healy et al. (1978) mapped anticlines and faults that could conceivably form traps. The map of Seager et al. (1987), although regional in nature, also shows areas of structural reversals that could be explained by either faulting or folding; these structural reversals could form traps. Structures may act to trap petroleum in Ordovician, Silurian, Mississippian, Pennsylvanian, and lowermost Permian reservoirs. In general, geologic mapping within the boundaries of the McGregor Range is insufficiently detailed to define surface structures that could form traps.

Most wells drilled in Otero County east of the McGregor Range were drilled on anticlines, which have been mapped by Black (1973). These anticlines are of Laramide age (Black 1973). The exploratory wells

drilled on these anticlines failed to find accumulations of petroleum, but did encounter reservoirs charged with moveable fresh water. Four possible explanations exist for the failure of these wells: 1) the reservoirs in the anticlines were never charged with oil and gas; 2) the anticlines had been charged with oil and gas at one time but the seals have subsequently been breached allowing for leakage of petroleum and inflow of fresh water; 3) the wells were not placed on the apex of the structures and structurally controlled accumulations of oil and gas exist updip; or 4) the anticlines at one time trapped petroleum and the seals remain intact, but influent fresh waters have flushed hydrocarbons out of the trap.

Opportunities for traps appear to be more limited stratigraphically than opportunities for structural traps. Although they are not extensively studied for reservoir characteristics, the Ordovician and Silurian dolostones do not appear to exhibit significant lateral variation in lithology or porosity, diminishing the possibilities for stratigraphic traps in these units. Stratigraphic traps may be present, however, in Mississippian, Pennsylvanian, and lowermost Permian (Hueco) strata. Reefs and bioherms that may form traps are known to exist and are well documented in Mississippian, Pennsylvanian, and Permian strata that were deposited on a carbonate shelf in the Sacramento Mountains (Bowsher 1986; Toomey et al. 1977; Greenwood et al. 1977; Wilson 1989). In general, Mississippian strata in the area appear to be tight and impervious, and Mississippian bioherms are too small to be major subsurface objectives (Greenwood et al. 1977). Pennsylvanian reefs and bioherms appear to be somewhat larger and are good exploration targets. In the McGregor Range, however, major bioherm development is confined to areas of shelf deposition in the northernmost parts of the McGregor Range.

As previously discussed, Pennsylvanian strata are basinal deposits throughout most of the McGregor Range. Because most basinal strata are deposited in quiescent relatively deep-water conditions, they usually have poor porosity and form poor reservoirs. An exception to this may be debris flow and carbonate turbidite deposits. In the Permian Basin, Pennsylvanian and Permian carbonate debris flow and turbidite deposits form lenticular and channelform stratigraphic traps just basinward of the shelf margin (see Hobson et al. [1985]; Loucks et al. [1985]). If present, this type of trap would most likely occur within a few miles of the shelf edge in the northern part of the McGregor Range or perhaps off of the margins of the late Paleozoic Hueco uplift, where limestone pebble conglomerates occur in beds up to 34 ft thick (Hardie 1958a, 1958b). Although the possibilities for stratigraphic entrapment of petroleum in Pennsylvanian strata are diminished in the more depositionally distal central and southern parts of the McGregor Range, stratal zones of vuggy porosity may be present in this area; seals would be formed by layers of impervious, nonvuggy lime mudstones. Hardie (1958a, 1958b) described shale beds up to 60 ft thick in the Pennsylvanian section of the Hueco Mountains. Meyers' (1966) lithofacies maps also indicate the presence of significant amounts of shale in this area. These shales could act as seals for limestones with vuggy porosity or for porous limestone pebble conglomerates deposited by debris flows. Shales do not appear to be as abundant in the northern parts of the McGregor Range or in the eastern parts of the McGregor Range, limiting the seals in these areas to impermeable carbonates.

6.4.8 Trap Integrity

Destruction of traps by post-entrapment faulting or fracturing of seals is quite probable in the McGregor Range area. Field reconnaissance studies performed as part of this project and examination of cores of geothermal evaluation wells reveal that the Paleozoic section has been intensely fractured throughout much of the McGregor Range. The presence of fresh water in reservoir rocks throughout the stratigraphic section on the Otero Platform also suggests a dense fracture network that has allowed surface water to invade these reservoirs throughout the region. These fractures were probably formed during Laramide compressional deformation and during post-Laramide extensional deformation of the region.

Post-Laramide extension acted to open fractures rather than seal them. The breached seals allowed the escape of previously trapped hydrocarbons, as well as an influx of fresh water. The limited amount of data available from cores indicate that post-fracture diagenesis enhanced fracture permeability by dissolution of the carbonates along many of the fractures (refer to Figure 6.15). In other places, diagenetic precipitation of cements in fractures may have acted to seal them (refer to Figure 6.16). Therefore, some of the fractures remain open to fluid flow and others have been closed to fluid flow. Thick shale seals in the southern part of the McGregor Range will be more ductile than the fine-grained carbonate seals found elsewhere in the McGregor Range (Downey 1984); therefore, trap integrity will be somewhat greater on the southern portion of the McGregor Range.

6.4.9 Petroleum Resources on the McGregor Range

Estimates of undiscovered petroleum resources are very subjective. The seven factors evaluated specifically for this report (overview of previous evaluations of oil and gas potential, results of previous drilling, petroleum source rocks, petroleum preservation, petroleum reservoir analysis, petroleum traps, trap integrity) are commonly considered when assessing petroleum potential. Identification of these factors and their evaluation as separate variables lends rigor to the assessment process.

The petroleum resource potential of the McGregor Range varies from low to moderate with certainty level C (refer to Figure 6.2). A summary of the factors to assess petroleum resource potential on the McGregor Range is presented in Table 6.9. Areas of moderate potential occur in the northern and southern parts of the McGregor Range. Areas of low potential are located in the central and northernmost parts of the McGregor Range. Isolated areas of low potential are also present in the southern part of the McGregor Range.

Otero Platform and Hueco Uplift Area. That part of the McGregor Range covered by the Otero Platform and the Hueco uplift has a low to moderate petroleum potential with certainty level C (refer to Figure 6.2). Discussion of petroleum potential of this region is subdivided according to three areas: 1) the northern part of the McGregor Range, which has a moderate petroleum potential; 2) the central part of the McGregor Range, which has a low petroleum potential; and 3) the southern part of the McGregor Range, which has a moderate to low petroleum potential.

The northern part of the Otero Platform has a moderate potential with a certainty level C. Factors favoring petroleum accumulations in this area are the presence of source rocks and reservoir rocks and the possibility that both stratigraphic and structural traps are present. Mature oil-prone source rocks are present in the Pennsylvanian section in this area. Although data are not available because of a lack of penetration by exploratory wells, it is almost certain that the more deeply buried Devonian shales are also thermally mature and could be sources of oil for the Silurian and Ordovician reservoirs they overlie. Drill-stem tests reveal that these reservoirs are permeable in this area. The area overlies the Pennsylvanian shelf edge. Stratigraphic traps may be present in the Pennsylvanian section as bioherms on the shelf in the northeastern part of the area and as debris flow deposits in that part of the Panther Seep basinal facies adjacent to the shelf edge. Anticlines, which have been mapped in the area, may form traps for Ordovician and Silurian reservoirs, as well as for Pennsylvanian reservoirs. "Shows of oil and gas" in both the upper and lower Paleozoic sections are also favorable indicators.

Factors unfavorable to petroleum accumulation in this area are the presence of brackish or slightly salty water in the Paleozoic section and the proximity of the area to Paleozoic outcrops in the Sacramento Mountains. The brackish or slightly salty water indicates at least partial flushing of reservoirs, and

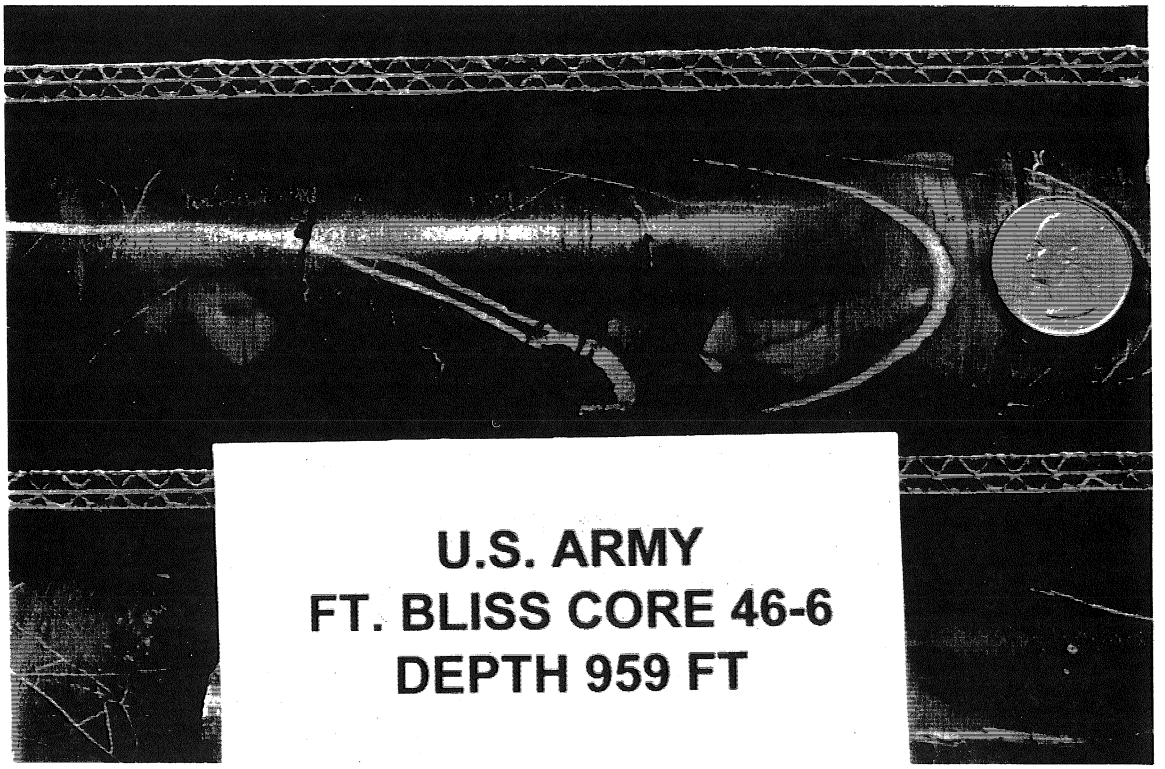

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Figure 6.16 Fractures in Limestone Filled with Calcite Cement, Panther Seep Formation (Pennsylvanian), U.S. Army Fort Bliss Core 46-6, Depth 959 ft.

Table 6.9 Summary of Factors Used to Assess Petroleum Resource Potential of the McGregor Range.

Area	Previous Drilling Results	Petroleum Source Rocks	Petroleum Preservation	Petroleum Reservoir Analysis
Otero Platform and Hueco uplift, central and southern parts of McGregor Range	Oil and gas shows in Devonian, Pennsylvanian, and Permian strata; fresh water ubiquitous	Mature oil-prone source rocks on north 1/3 and south 1/3 of Otero Platform and on Hueco uplift; immature to marginally mature elsewhere	Immature to mature; crude oil preserved	Ordovician and Silurian dolostones are good reservoirs; fractured and vuggy porosity in basinal Pennsylvanian limestones may make good, but limited, reservoirs
Sacramento uplift, northernmost part of McGregor Range	No previous drilling	Immature source rocks	Immature; crude oil preserved;	Ordovician and Silurian dolostones may be good reservoirs; bioherms in Pennsylvanian may be reservoirs
Tularosa Basin, northwestern part of McGregor Range	Recovered salty water with 13,000 ppm chlorides	Mature oil-prone source rocks	In condensate/ wet gas window; oil not preserved	Ordovician and Silurian dolostones are good reservoirs

Area	Petroleum Traps	Trap Integrity	Petroleum Potential And Certainty
Otero Platform and Hueco uplift, central and southern parts of McGregor Range	Anticlinal traps possible in Ordovician and Silurian dolostones; basinal debris flow deposits may form stratigraphic traps in Pennsylvanian limestones in basin adjacent to Pennsylvanian shelf edge and Hueco uplift	Trap integrity compromised by extensive fracturing of brittle Paleozoic carbonates and introduction of fresh water into Paleozoic reservoirs; shale seals in Pennsylvanian in the southern part of this area may not be as susceptible to fracturing	Low to moderate potential Certainty level C Refer to Figure 6.2
Sacramento uplift, northernmost part of McGregor Range	Pennsylvanian bioherms are potential targets; anticlines on east flank of Sacramento Mountains possible targets	Traps unlikely to be preserved; faulting and fracturing has destroyed seal integrity; exposure of strata in mountains has made Paleozoic section susceptible to fresh water flushing and updip leakage of petroleum	Low potential Certainty level C Refer to Figure 6.2
Tularosa Basin, northwestern part of McGregor Range	Structural traps possible in Ordovician and Silurian dolostones; opportunities for stratigraphic traps in Pennsylvanian limestones limited to debris flow deposits on east flank of basin	Partial flushing by fresh water may have displaced petroleum from traps, but not necessarily	Moderate potential Certainty level C Refer to Figure 6.2

possibly traps, by influent fresh water. Fresh water could have entered reservoir strata through outcrops in the Sacramento Mountains or could have migrated vertically downward from the surface through fractures and faults in the area.

The central part of the McGregor Range covers the Otero Platform and has a low petroleum resource potential with a certainty level C. Most evaluated factors are unfavorable for petroleum resources. In this area, potential source rocks in the Pennsylvanian are immature (TAI = 1.9) to moderately mature (TAI <2.5). Underlying possible source rocks in the Mississippian and Devonian are buried less than 1,000 ft more deeply than the Pennsylvanian, so it is unlikely that they are fully mature. The moderately mature source rocks in this area may have generated some heavier oils and accompanying gas, but peak generation of hydrocarbons has not been reached. Laramide and Tertiary tectonic movement has placed source rocks in this area structurally downdip from stratigraphically equivalent mature source rocks to the north and south (refer to Figures 2.19 and 2.20). The two petroleum exploration wells that have been drilled in this area have penetrated only Permian and Pennsylvanian strata and did not test pre-Pennsylvanian strata. Nevertheless, the results of these wells were not encouraging; neither well had reported "shows of oil or gas." One well, the Kinney Oil & Gas No. 1 State encountered fresh water in the Pennsylvanian section, indicating the Pennsylvanian may be flushed by fresh water. The Otero Oil Company No. 1 McGregor well did not report encounters with any fluids (oil, gas, or water), suggesting that permeable zones were not encountered. The best reservoirs in this area are probably limited to the dolostones in the lower Paleozoic section; during the Pennsylvanian, the area was the site of deposition of fine-grained lime muds and was distant from the shelf edge, where permeable, porous strata would have been deposited.

The southern part of the McGregor Range covers the Otero Platform and the Hueco uplift. Most of this area has a moderate petroleum potential with certainty level C. There are small islands of low potential within this area. Factors favoring oil and gas accumulations are mature oil-prone source rocks in the Pennsylvanian, Mississippian, and Devonian sections, the presence of reservoirs in the Pennsylvanian, Silurian, Ordovician, and possibly Mississippian sections, and shows of oil and gas from petroleum exploration wells drilled in this area; and the presence of shale seals within the Pennsylvanian and Mississippian section. The source rocks are within the oil window and have reached the stage of peak hydrocarbon generation. The extensive suite of hydrocarbon shows encountered by the Seaboard No. 1 Trigg Federal well supports the conclusion that mature source rocks are present and have generated hydrocarbons in this area. The best reservoirs are in vuggy zones in the Ordovician and Silurian dolostones and in the Pennsylvanian limestones. The basinal and mostly distal nature of the Pennsylvanian strata suggests that reservoirs may be limited to zones of secondary dissolution porosity; there are unlikely to be large bodies of rock with significant primary porosity in the Pennsylvanian section. The main factor unfavorable to petroleum accumulation is again the widespread presence of fresh water in the subsurface. Not only may traps have been flushed, but extensive fracturing which allowed entrance of fresh water may have breached seals in the brittle Pennsylvanian carbonates. However, the thick Pennsylvanian shales present around the Hueco uplift would be less prone to fracturing than the carbonates and may have maintained their integrity as hydrocarbon seals. Tertiary igneous sills that have intruded Pennsylvanian and Mississippian source rocks developed fractures upon cooling (personal communication, 1997, with Jim Witcher) and are possible traps, where not exposed at the surface.

In the southern part of the McGregor Range, petroleum potential is rated as low with a certainty level C in the immediate vicinity of intrusive igneous rocks that are exposed at the surface. The intrusive rocks have breached any traps that may have existed in these areas and fractures within the igneous rocks have provided conduits for migration and escape of hydrocarbons to the surface.

In areas where intrusive rocks have not reached the surface, petroleum potential is moderate in the southern part of the McGregor Range. Structural traps could be present in strata that have been arched into domes or anticlines above the intrusive bodies. Additionally, cooling fractures within the intrusive rocks could form petroleum reservoirs, but traps would occur only if the Paleozoic strata in which the intrusives are encased remain unfractured.

Sacramento Uplift Area. The northernmost part of the McGregor Range lies on the Sacramento uplift and has a low petroleum potential with certainty level C (refer to Figure 6.2). Exposure of the entire Paleozoic section along the western front of the Sacramento Mountains and in fault blocks within the Sacramento Mountains has made reservoirs susceptible to flushing by fresh water. Because most tectonic uplift in the mountains occurred relatively late, during the Tertiary Period, most seals have been breached by faults, allowing the upward migration and escape of petroleum.

Tularosa Basin Area. The northwesternmost part of the McGregor Range extends into the Tularosa Basin. This area has moderate petroleum potential with certainty level C (refer to Figure 6.2). Source rocks are present, but the Paleozoic section is somewhat overmature. Both source rocks and reservoirs are in the wet gas/condensate window, so any hydrocarbons that are present would be either wet gas, condensate, or dry gas. The presence of brackish or slightly salty water in reservoirs along the eastern side of the basin indicates that the reservoirs have been partially flushed by fresh waters that have entered the basin through the faults that form its eastern boundary. Therefore, these faults are leaky and probably cannot trap petroleum. Any traps must be formed by anticlines or by stratigraphic pinchouts of porous and permeable zones. Furthermore, fresh water may have flushed oil and gas out of any traps that remained intact after faulting. However, significant hydrocarbon accumulations can exist in the presence of fresh water, as demonstrated by the Dagger Draw field of Eddy County, New Mexico. The Dagger Draw field, with less than 400 producing wells, is the most productive oil field in New Mexico and accounts for 14% of the state's oil production; the other 86% of the state's production is obtained from the other 2,057 oil and gas fields in the state (Broadhead in press). Yet, the oil field waters in the Dagger Draw reservoir are relatively fresh, with a salinity of only 4,000 ppm chlorides (Murphy 1977a, 1977b). Influent meteoric waters have not flushed oil from the trap at Dagger Draw.

6.5 URANIUM

6.5.1 General Information

Uranium is an important energy source for electricity in nuclear power plants and for production of nuclear weapons. Production of uranium in New Mexico has been significant in the past (McLemore and Chenoweth 1989), but the decline in demand forced all convention uranium mines in the state to close in the early 1980s. Currently, the only uranium produced in New Mexico is from mine water recovery at Ambrosia Lake. However, several companies are exploring for uranium in sandstones in the Grants Uranium District (northwestern New Mexico) for possible in situ leaching. Most uranium was produced from sandstone-uranium deposits of Jurassic age (McLemore and Chenoweth 1989); similar sandstone-uranium deposits do not occur in the McGregor Range. Other types of uranium deposits have been mined in the past (McLemore and Chenoweth 1989).

6.5.2 Uranium Resources on the McGregor Range

There are no known uranium deposits in the McGregor Range (McLemore 1983; McLemore and Chenoweth 1989). Minor amounts of uranium occur in the sedimentary copper deposits in the Sacramento

District (refer to Figure 3.12; McLemore 1983), but there has been no uranium production. Uranium occurs with copper minerals locally within the sandstones, shales, and siltstones of the Abo Formation. Uranium also occurs in alkaline rocks. In the 1950s, shallow prospect pits were dug on radioactive anomalies in the Cornudas Mountains; but assay results were very low and the claims were later dropped with no production (refer to Figure 3.5) (Collins 1958).

The most radioactive rocks in the eastern portion of the McGregor Range, according to the aerial gamma-ray data, are Tertiary igneous rocks in the Hueco Mountains (approximately 2.00 ppm eU) and sedimentary rocks of the Abo tongue of the Hueco Formation south of the Martin-Hay Meadow Canyons area, including Quaternary alluvial deposits derived from these units (approximately 1-5 ppm eU) (U.S. Department of Energy 1981a, 1981b; Duval 1988). Both of these areas are less radioactive than similar areas in the Cornudas and Sacramento Mountains. Therefore, the mineral resource potential for uranium in the Hueco Mountains and Martin-Hay Meadow Canyons area is low with a C level of certainty (refer to Figure 6.3).

The highest value in the NURE stream sediment data is 4.5 ppm, approximately twice the terrestrial abundance (refer to Table 2.9). The highest value in stream sediment samples collected for this report from the McGregor Range is 6.7 ppm (refer to Table 2.10). These values are too low and too widely distributed for the favorability of occurrence of economic uranium deposits. Therefore, there is no uranium resource potential elsewhere in the McGregor Range with a D level of certainty.

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APPENDIX 1:

LOCATION OF SAMPLES COLLECTED FROM MCGREGOR RANGE

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Sample Type/No.	Latitude	Longitude	Location
Geochemical Characterization Samples (Industrial Minerals)			
JB-IM001	32° 04' 42"	106° 13' 36"	Sec.3 T26S R7E
JB-IM002	32° 3' 55.6"	105° 54' 35.9"	Sec.10 T26S R10E
JB-IM003	32° 8' 58.7"	105° 59' 7.3"	Sec.11 T25S R9E
JB-IM004	32° 06' 48"	105° 53' 00"	Sec.23 T25S R10E
JB-IM005	32° 12' 13"	105° 57' 54"	Sec.19 T24S R10E
JB-IM006	32° 12' 18.4"	105° 57' 55.7"	Sec.19 T24S R10E
JB-IM007	32° 14' 07"	105° 49' 18"	Sec.9 T24S R11E
JB-IM008	32° 17' 11"	106° 00' 59"	Sec.22 T23S R9E
JB-IM009	32° 17' 56"	105° 57' 16"	Sec.18 T23S R10E
JB-IM010	32° 20' 18"	105° 39' 41"	Sec.1 T23S R12E
JB-IM011	32° 22' 59.6"	106° 2' 50.2"	Sec.17 T22S R9E
JB-IM012	32° 22' 42"	105° 59' 03"	Sec.23 T22S R9E
JB-IM013	32° 22' 49.1"	106° 4' 5.4"	Sec.19 T22S R9E
JB-IM013Sh	32° 22' 49.1"	106° 4' 5.4"	Sec.19 T22S R9E
JB-IM014	32° 21' 07"	105° 56' 44"	Sec.32 T22S R10E
JB-IM015	32° 20' 15"	105° 45' 35"	Sec.1 T23S R11E
JB-IM016	32° 21' 16"	105° 42' 24.2"	Sec.34 T22S R12E
JB-IM017	32° 25' 50"	105° 38' 08"	Sec.32 T21S R13E
JB-IM018	32° 22' 57"	105° 57' 34"	Sec.19 T22S R10E
JB-IM019	32° 28' 43"	106° 01' 29"	Sec.16 T21S R9E
JB-IM020	32° 24' 36"	105° 56' 18"	Sec.8 T22S R10E
JB-IM021	32° 30' 22"	105° 53' 42"	Sec.2 T21S R10E
JB-IM021lS	32° 30' 22.1"	105° 53' 41.7"	Sec.2 T21S R10E
JB-IM021Sh	32° 30' 22.1"	105° 53' 41.7"	Sec.2 T21S R10E
JB-IM022	32° 29' 33"	105° 35' 08"	Sec.11 T21S R13E
JB-IM023	32° 30' 59"	105° 34' 57"	Sec.2 T21S R13E
JB-IM024	32° 40' 30"	105° 58' 48"	Sec.11 T19S R9E
JB-IM025	32° 37' 50"	105° 53' 18"	Sec.26 T19S R10E
JB-IM026	32° 38' 5.4"	105° 50' 35.5"	Sec.29 T19S R11E
JB-IM027	32° 23' 00"	106° 02' 50"	Sec.17 T22S R9E
JB-IM028	32° 05' 17"	106° 05' 01"	Sec.36 T25S R8E
Geochemical Characterization Samples (Metallic Mineral)			
High 10	32° 52' 50"	105° 51' 50"	Sec.30 T16S R11E
ORO706	32° 28' 13"	106° 5' 44"	Sec.23 T21S R8E
ORO-711	32° 28' 13"	106° 5' 44"	Sec.23 T21S R8E
ORO-712	32° 28' 26"	106° 5' 57"	Sec.14 T21S R8E
ORO-713	32° 28' 26"	106° 5' 58"	Sec.14 T21S R8E
ORO-720	32° 28' 26"	106° 5' 57"	Sec.3 T21S R8E
VTM97-135	32° 21' 44"	105° 51' 23"	Sec.30 T22S R11E
VTM97-136	32° 21' 44"	105° 51' 23"	Sec.30 T22S R11E
VTM97-150	32° 30' 15"	106° 3' 50"	Sec.6 T21S R9E
VTM97-151	32° 30' 15"	106° 3' 50"	Sec.6 T21S R9E
VTM97-158	32° 17' 30"	105° 51' 5"	Sec.19 T23S R11E
VTM97-159	32° 17' 30"	105° 51' 5"	Sec.19 T23S R11E
VTM97-160	32° 17' 30"	105° 51' 5"	Sec.19 T23S R11E

Sample Type/No.	Latitude	Longitude	Location
VTM97-169	32° 22' 33"	106° 3' 54"	Sec.19 T22S R9E
VTM97-170	32° 22' 32"	106° 3' 53"	Sec.19 T22S R9E
VTM97-171	32° 22' 32"	106° 3' 53"	Sec.19 T22S R9E
VTM97-173	32° 21' 54"	106° 4' 22"	Sec.25 T22S R8E
VTM97-179	32° 00' 31"	105° 59' 10"	Sec.26 T26S R9E
VTM97-199	32° 1' 46"	105° 58' 52"	Sec.23 T26S R9E
VTM97-212	32° 5' 3"	105° 56' 53"	Sec.32 T25S R10E
VTM97-222	32° 1' 36"	105° 59' 39"	Sec.23 T26S R9E
VTM97-223	32° 1' 36"	105° 59' 34"	Sec.23 T26S R9E
VTM97-224	32° 1' 38"	105° 59' 29"	Sec.23 T26S R9E
VTM97-236	32° 30' 22"	105° 53' 42"	Sec.2 T21S R10E
VTM97-237	32° 30' 22"	105° 53' 42"	Sec.2 T21S R10E
VTM97-243	32° 40' 13"	105° 51' 59"	Sec.7 T19S R11E
VTM97-244	32° 39' 37"	105° 51' 37"	Sec.18 T19S R11E
VTM97-245	32° 39' 40"	105° 51' 35"	Sec.18 T19S R11E
VTM97-246	32° 39' 51"	105° 51' 39"	Sec.18 T19S R11E
VTM97-257	32° 18' 00"	105° 45' 13"	Sec.13 T23S R11E
VTM97-261	32° 17' 14"	105° 49' 31"	Sec.20 T23S R11E
VTM97-262	32° 17' 15"	105° 49' 31"	Sec.20 T23S R11E
VTM97-326d	32° 4' 12"	106° 9' 55"	Sec.6 T26S R8E
VTM97-327d	32° 4' 23"	106° 8' 54"	Sec.5 T26S R8E
VTM97-329d	32° 4' 42"	106° 9' 55"	Sec.6 T26S R8E
VTM97-330d	32° 3' 2"	106° 7' 58"	Sec.16 T26S R8E
VTM97-332d	32° 3' 2"	106° 7' 58"	Sec.16 T26S R8E
VTM97-333d	32° 3' 2"	106° 7' 58"	Sec.16 T26S R8E
VTM97-334d	32° 3' 2"	106° 7' 58"	Sec.16 T26S R8E
VTM97-350d	32° 4' 23"	106° 8' 54"	Sec.5 T26S R8E
VTM97-351d	32° 4' 23"	106° 8' 54"	Sec.5 T26S R8E
VTM97-352d	32° 4' 42"	106° 9' 55"	Sec.6 T26S R8E
VTM97-382	32° 3' 4"	105° 59' 00"	Sec.13 T26S R9E
VTM97-51	32° 8' 32"	106° 9' 58"	Sec.7 T25S R8E
VTM97-52	32° 8' 32"	106° 9' 58"	Sec.7 T25S R8E
VTM97-55	32° 8' 22"	106° 8' 20""	Sec.16 T25S R8E
VTM97-57	32° 1' 20"	105° 58' 21"	Sec.24 T26S R9E
VTM97-58	32° 1' 48"	105° 58' 48"	Sec.24 T26S R9E
VTM97-60	32° 1' 39"	105° 58' 37"	Sec.24 T26S R9E
VTM97-63	32° 5' 20"	105° 55' 5"	Sec.33 T25S R10E
VTM97-67	32° 7' 43"	105° 52' 20"	Sec.13 T25S R10E
VTM97-68	32° 7' 43"	105° 52' 19"	Sec.13 T25S R10E
VTM97-69	32° 7' 44"	105° 52' 21"	Sec.13 T25S R10E
VTM97-82	32° 8' 23"	106° 00' 55"	Sec.9 T25S R9E
VTM97-92	32° 36' 47"	105° 47' 52"	Sec.34 T19S R11E
VTM97-93	32° 36' 47"	105° 47' 52"	Sec.34 T19S R11E
VTM97-94	32° 36' 34"	105° 47' 41"	Sec.34 T19S R11E
VTM97-95	32° 36' 34"	105° 47' 41"	Sec.34 T19S R11E

Sample Type/No.	Latitude	Longitude	Location
Geochemical Characterization Samples (Petroleum Source Rock)			
RB-466-1	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-466-2	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-466-3	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-466-4	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-466-5	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-466-6	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-518-1	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-2	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-3	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-4	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-5	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-6	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-7	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-8	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-9	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-10	32° 3' 2"	106° 7' 58"	Sec. 16 T26S R8E
RB-518-11	32° 4' 8"	106° 9' 52"	Sec. 6 T26S R8E
RB-H-1	32° 01' 20.2"	105° 58' 21.6"	Sec. 24 T26S R9E
RB-H-2	32° 01' 36.9"	105° 58' 40.5"	Sec. 24 T26S R9E
RB-H-3	32° 01' 35"	105° 58' 47.6"	Sec. 24 T26S R9E
RB-H-4	32° 05' 00"	105° 57' 00"	Sec. 32 T25S R10E
RB-OR-1	32° 28' 13.4"	106° 05' 43.7"	Sec. 23 T21S R8E
RB-OR-2	32° 28' 26.4"	106° 05' 57.0"	Sec. 14 T21S R8E
RB-SAC-1	32° 36' 48"	105° 48' 01"	Sec. 34 T19S R11E
RB-SAC-2	32° 36' 48"	105° 48' 01"	Sec. 34 T19S R11E
RB-SAC-3	32° 36' 55"	105° 48' 00"	Sec. 34 T19S R11E
RB-SAC-4	32° 36' 55"	105° 48' 00"	Sec. 34 T19S R11E
RB-SAC-5	32° 40' 15"	105° 51' 55"	Sec. 12 T19S R10E
RB-SAC-6	32° 40' 14"	105° 51' 54"	Sec. 7 T19S R11E
RB-SAC-7	32° 39' 37"	105° 51' 45"	Sec. 18 T19S R11E
RB-SAC-8	32° 39' 40"	105° 51' 18"	Sec. 18 T19S R11E
RB-SAC-9	32° 39' 40"	105° 51' 20"	Sec. 18 T19S R11E
RB-SAC-10	32° 01' 20.2"	105° 58' 21.6"	Sec. 24 T26S R9E
RB-SEA-1	32° 02' 41"	105° 51' 35"	Sec. 18 T26S R11E
RB-SEA-2	32° 02' 41"	105° 51' 35"	Sec. 18 T26S R11E
RB-SEA-3	32° 02' 41"	105° 51' 35"	Sec. 18 T26S R11E
RB-SP-1	32° 31' 14"	105° 53' 09"	Sec. 35 T20S R10E
RB-SP-2	32° 31' 14"	105° 53' 09"	Sec. 35 T20S R10E
RB-SP-3	32° 31' 14"	105° 53' 09"	Sec. 35 T20S R10E
RB-SP-4	32° 31' 14"	105° 53' 09"	Sec. 35 T20S R10E
RB-STD-1	33° 53' 33.6"	106° 43' 55.3"	Sec. 9 T5S R2E
RB-STD-2	33° 53' 06.9"	106° 24' 49.6"	Sec. 8 T6S R7E
RB-TB-1	32° 08' 38.2"	105° 10' 9.6"	Sec. 7 T25S R8E
RB-ZP-1	32° 33' 51"	105° 29' 17"	Sec. 14 T20S R14E
RB-ZP-2	32° 33' 51"	105° 29' 17"	Sec. 14 T20S R14E

Sample Type/No.	Latitude	Longitude	Location
RB-ZP-3	32° 33' 51"	105° 29' 17"	Sec. 14 T20S R14E
RB-DMY-1	33° 53' 33.6"	106° 43' 55.3"	Sec. 9 T5S R2E
RB-DMY-2	33° 53' 06.9"	106° 24' 49.6"	Sec. 8 T6S R7E
Stream Sediment Samples (Float Chip)			
VTM97-89F	32° 36' 18"	105° 51' 44"	Sec.36 T19S R10E
VTM97-146F	32° 34' 15	105° 40' 40"	Sec.14 T20S R12E
VTM97-149F	32° 34' 19"	105° 40' 50"	Sec.11 T20S R12E
VTM97-188F	32° 2' 20"	105° 55' 40"	Sec.16 T26S R10E
VTM97-190F	32° 00' 4"	105° 57' 47"	Sec.25 T26S R9E
VTM97-295F	32° 32' 54"	105° 38' 57"	Sec.19 T20S R13E
VTM97-248F	32° 5' 9"	106° 4' 28"	Sec.36 T25S R8E
VTM97-249F	32° 5' 9"	106° 4' 28"	Sec.36 T25S R8E
VTM97-380F	32° 32' 36"	105° 46' 30"	Sec.25 T20S R11E
Stream Sediment Samples - Heavy Mineral Concentrates			
VTM97-85C	32° 27' 50"	106° 5' 25"	Sec.23 T21S R8E
VTM97-88C	32° 36' 18"	105° 51' 44"	Sec.36 T19S R10E
VTM97-122C	32° 30' 52"	105° 40' 2"	Sec.1 T21S R12E
VTM97-139C	32° 23' 14"	106° 6' 22"	Sec.15 T22S R8E
VTM97-153C	32° 30' 28"	106° 6' 26"	Sec.3 T8E R21S
VTM97-155C	32° 25' 25"	106° 6 '25"	Sec.3 T22S R8E
VTM97-157C	32° 23' 41"	106° 5' 55"	Sec.15 T22S R8E
VTM97-166C	32° 17' 45"	105° 51' 24"	Sec.19 T23S R11E
VTM97-183C	32° 00' 22"	105° 59' 2"	Sec.26 T26S R9E
VTM97-191C	32° 00' 4"	105° 57' 47"	Sec.25 T26S R9E
VTM97-198C	32° 1' 58"	105° 58' 31"	Sec.24 T26S R9E
VTM97-219C	32° 1' 4"	106° 00' 10"	Sec.27 T26S R9E
VTM97-221C	32° 1' 2"	106° 00' 9"	Sec.22 T26S R9E
VTM97-227C	32° 2' 3"	106° 00' 3"	Sec.15 T26S R9E
VTM97-242C	32° 40' 15"	105° 51' 59"	Sec.7 T19S R11E
VTM97-250C	32° 5' 9"	106° 4' 28"	Sec.36 T25S R8E
VTM97-269C	32° 5' 7"	106° 32' 37"	Sec.32 T25S R4E
VTM97-288C	32° 28' 25"	105° 53' 50"	Sec.15 T21S R10E
VTM97-320C	32° 54' 40"	105° 50' 00"	Sec.17 T16S R11E
VTM97-322C	32° 52' 00"	105° 50' 5"	Sec.32 T16S R11E
Stream Sediment Samples - Sand-silt			
VTM97-53S	32° 8' 32"	106° 9' 58"	Sec.7 T25S R8E
VTM97-54S	32° 8' 57"	106° 8' 14"	Sec.16 T25S R8E
VTM97-56S	32° 1' 4"	105° 57' 59"	Sec.25 T26S R9E
VTM97-61S	32° 1' 41"	105° 58' 39"	Sec.24 T26S R9E
VTM97-62S	32° 1' 58"	105° 58' 31"	Sec.24 T26S R9E
VTM97-64S	32° 5' 17"	105° 55' 7"	Sec.33 T25S R10E
VTM97-65S	32° 5' 16"	105° 55' 4"	Sec.33 T25S R10E
VTM97-66S	32° 4' 58"	105° 54' 40"	Sec.34 T25S R10E
VTM97-70S	32° 8' 22"	105° 53' 8"	Sec.11 T25S R10E
VTM97-71S	32° 8' 44"	105° 54' 36"	Sec.10 T25S R10E
VTM97-72S	32° 10' 37"	105° 56' 7"	Sec.32 T24S R10E

Sample Type/No.	Latitude	Longitude	Location
VTM97-73S	32° 10' 55"	105° 59' 11"	Sec.35 T24S R9E
VTM97-74S	32° 8' 11"	105° 59' 32"	Sec.11 T25S R9E
VTM97-75S	32° 8' 19"	105° 59' 41"	Sec.11 T25S R9E
VTM97-81S	32° 8' 22"	106° 00' 53"	Sec.9 T25S R9E
VTM97-83S	32° 28' 19"	106° 5' 28"	Sec.23 T21S R8E
VTM97-84S	32° 27' 50"	106° 5' 25"	Sec.23 T21S R8E
VTM97-86S	32° 00' 6"	106° 6' 5"	Sec.34 T26S R8E
VTM97-87S	32° 36' 18"	105° 51' 44"	Sec.36 T19S R10E
VTM97-90S	32° 36' 14"	105° 46' 54"	Sec.35 T19S R11E
VTM97-91S	32° 36' 16"	105° 46' 53"	Sec.35 T19S R11E
VTM97-97S	32° 35' 56"	105° 49' 20"	Sec.4 T20S R11E
VTM97-98S	32° 35' 57"	105° 49' 20"	Sec.4 T20S R11E
VTM97-99S	32° 37' 33"	105° 50' 36"	Sec.29 T19S R11E
VTM97-100S	32° 34' 57"	105° 50' 51"	Sec.7 T20S R11E
VTM97-106S	32° 34' 47"	105° 50' 39"	Sec.7 T20S R11E
VTM97-107S	32° 34' 45"	105° 50' 40"	Sec.7 T20S R11E
VTM97-108S	32° 32' 48"	105° 47' 2"	Sec.23 T20S R11E
VTM97-110S	32° 32' 43"	105° 46' 31"	Sec.23 T20S R11E
VTM97-111S	32° 33' 42"	105° 44' 55"	Sec.18 T20S R12E
VTM97-112S	32° 33' 6"	105° 45' 47"	Sec.24 T20S R11E
VTM97-113S	32° 33' 24"	105° 44' 55"	Sec.18 T20S R12E
VTM97-114S	32° 13¢ 27"	105° 58' 50"	Sec.12 T24S R9E
VTM97-115S	32° 4' 10"	105° 55' 23"	Sec.4 T26S R10E
VTM97-116S	32° 3' 37"	105° 55' 26"	Sec.4 T26S R10E
VTM97-117S	32° 4' 37"	105° 55' 46"	Sec.4 T26S R10E
VTM97-118S	32° 12' 28"	105° 47' 33"	Sec.15 T24S R11E
VTM97-119S	32° 21' 37"	105° 45' 23"	Sec.25 T22S R11E
VTM97-120S	32° 30' 16"	105° 40' 1"	Sec.1 T21S R12E
VTM97-121S	32° 30' 52"	105° 40' 2"	Sec.1 T21S R12E
VTM97-123S	32° 31' 57"	105° 40' 26"	Sec.26 T20S R12E
VTM97-124S	32° 32' 6"	105° 40' 55"	Sec.26 T20S R12E
VTM97-125S	32° 32' 38"	105° 41' 25"	Sec.22 T20S R12E
VTM97-130S	32° 32' 41"	105° 42' 6"	Sec.22 T20S R12E
VTM97-131S	32° 14' 48"	106° 1' 24"	Sec.4 T24S R9E
VTM97-132S	32° 13' 36"	106° 00' 27"	Sec.12 T24S R9E
VTM97-133S	32° 21' 53"	105° 50' 14"	Sec.29 T22S R11E
VTM97-134S	32° 21' 54"	105° 50' 41"	Sec.30 T22S R11E
VTM97-137S	32° 21' 41"	105° 51' 27"	2Sec.5 T22S R10E
VTM97-138S	32° 23' 14"	106° 6' 22"	Sec.15 T22S R8E
VTM97-140S	32° 32' 11"	105° 40' 11"	Sec.25 T20S R12E
VTM97-141S	32° 32' 25"	105° 39' 28"	Sec.25 T20S R12E
VTM97-142S	32° 32' 32"	105° 39' 13"	Sec.30 T20S R13E
VTM97-143S	32° 32' 39"	105° 39' 12"	Sec.30 T20S R13E
VTM97-144S	32° 33' 44"	105° 40' 3"	Sec.13 T20S R12E
VTM97-145S	32° 34' 15"	105° 40' 40"	Sec.14 T20S R12E
VTM97-147S	32° 34' 19"	105° 40' 39"	Sec.14 T20S R12E

Sample Type/No.	Latitude	Longitude	Location
VTM97-148S	32° 34' 19"	105° 40' 50"	Sec.11 T20S R12E
VTM97-152S	32° 30' 28"	106° 6' 26"	Sec.3 T21S R8E
VTM97-154S	32° 25' 25"	106° 6' 25"	Sec.3 T22S R8E
VTM97-156S	32° 23' 41"	106° 5' 53"	Sec.15 T22S R8E
VTM97-165S	32° 17' 45"	105° 51' 24"	Sec.19 T23S R11E
VTM97-167S	32° 16' 26"	105° 52' 00"	Sec.25 T23S R10E
VTM97-168S	32° 13' 13"	105° 54' 40"	Sec.15 T24S R10E
VTM97-174S	32° 24' 32"	105° 55' 39"	Sec.8 T22S R10E
VTM97-175S	32° 22' 31"	105° 52' 46"	Sec.23 T22S R10E
VTM97-176S	32° 32' 50"	105° 55' 5"	Sec.21 T22S R10E
VTM97-177S	32° 17' 43"	106° 3' 26"	Sec.18 T23S R9E
VTM97-178S	32° 00' 21"	105° 59' 6"	Sec.26 T26S R9E
VTM97-180S	32° 00' 35"	105° 59' 13"	Sec.26 T26S R9E
VTM97-181S	32° 00' 37"	105° 59' 24"	Sec.26 T26S R9E
VTM97-182S	32° 00' 22"	105° 59' 2"	Sec.26 T26S R9E
VTM97-185S	32° 00' 15"	105° 58' 17"	Sec.36 T26S R9E
VTM97-186S	32° 1' 31"	105° 55' 44"	Sec.20 T26S R10E
VTM97-187S	32° 2' 20"	105° 55' 40"	Sec.16 T26S R10E
VTM97-189S	32° 00' 4"	105° 57' 47"	Sec.25 T26S R9E
VTM97-192S	32° 2' 43"	105° 58' 00"	Sec.13 T26S R9E
VTM97-193S	32° 3' 53"	105° 57' 44"	Sec.12 T26S R9E
VTM97-196S	32° 3' 49"	105° 57' 40"	Sec.6 T26S R10E
VTM97-197S	32° 4' 40"	105° 56' 55"	Sec.6 T26S R10E
VTM97-204S	32° 1' 26"	105° 58' 56"	Sec.23 T26S R9E
VTM97-205S	32° 1' 27"	105° 58' 55"	Sec.23 T26S R9E
VTM97-207S	32° 1' 22"	105° 58' 42"	Sec.24 T26S R9E
VTM97-208S	32° 1' 13"	105° 58' 35"	Sec.24 T26S R9E
VTM97-209S	32° 1' 13"	105° 58' 34"	Sec.24 T26S R9E
VTM97-210S	32° 4' 41"	105° 56' 50"	Sec.6 T26S R10E
VTM97-211S	32° 5' 00"	105° 56' 50"	Sec.32 T25S R10E
VTM97-213S	32° 18' 54"	105° 52' 48"	Sec.11 T23S R10E
VTM97-214S	32° 18' 45"	105° 53' 35"	Sec.11 T23S R10E
VTM97-215S	32° 15' 15"	105° 56' 45"	Sec.5 T24S R10E
VTM97-216S	32° 1' 44"	106° 3' 48"	Sec.30 T26S R9E
VTM97-217S	32° 1' 46"	106° 3' 48"	Sec.19 T26S R9E
VTM97-218S	32° 1' 4"	106° 00' 10"	Sec.27 T26S R9E
VTM97-220S	32° 1' 2"	106° 00' 9"	Sec.22 T26S R9E
VTM97-226S	32° 2' 3"	106° 00' 3"	Sec.15 T26S R9E
VTM97-228S	32° 2' 43"	106° 00' 49"	Sec.16 T26S R9E
VTM97-229S	32° 2' 44"	106° 1' 28"	Sec.16 T26S R9E
VTM97-230S	32° 23' 39"	105° 48' 34"	Sec.15 T22S R11E
VTM97-235S	32° 25' 7"	105° 49' 24"	Sec.5 T22S R11E
VTM97-238S	32° 29' 43"	105° 32' 36"	Sec.5 T21S R14E
VTM97-239S	32° 29' 44"	105° 33' 31"	Sec.7 T21S R14E
VTM97-240S	32° 29' 00"	105° 35' 21"	Sec.11 T21S R13E
VTM97-241S	32° 40' 15"	105° 51' 59"	Sec.7 T19S R11E

Sample Type/No.	Latitude	Longitude	Location
VTM97-247S	32° 5' 9"	106° 4' 28"	Sec.36 T25S R8E
VTM97-251S	32° 3' 57"	105° 54' 40"	Sec.3 T26S R10E
VTM97-252S	32° 13' 29"	105° 49' 15"	Sec.9 T24S R11E
VTM97-253S	32° 14' 18"	105° 45' 30"	Sec.1 T24S R11E
VTM97-254S	32° 18' 30"	105° 45' 17"	Sec.12 T23S R11E
VTM97-255S	32° 18' 30"	105° 45' 17"	Sec.12 T23S R11E
VTM97-256S	32° 18' 00"	105° 45' 13"	Sec.13 T23S R11E
VTM97-258S	32° 16' 21"	105° 46' 43"	Sec.26 T23S R11E
VTM97-259S	32° 17' 29"	105° 49' 22"	Sec.20,21 T23S R11E
VTM97-260S	32° 17' 13"	105° 49' 30	Sec.20 T23S R11E
VTM97-268S	32° 5' 7"	106° 32' 37"	Sec.32 T25S R4E
VTM97-276S	32° 32' 38"	105° 33' 50"	Sec.25 T20S R13E
VTM97-277S	32° 32' 5"	105° 35' 00"	Sec.26 T20S R13E
VTM97-278S	32° 31' 40"	105° 35' 35"	Sec.35 T20S R13E
VTM97-279S	32° 31' 16"	105° 35' 9"	Sec.35 T20S R13E
VTM97-280S	32° 31' 3"	105° 35' 25"	Sec.35 T20S R13E
VTM97-281S	32° 31' 3"	105° 35' 1"	Sec.35 T20S R13E
VTM97-282S	32° 30' 15"	105° 34' 27"	Sec.1,2 T21S R13E
VTM97-283S	32° 16' 38"	106° 3' 20"	Sec.30 T23S R9E
VTM97-284S	32° 17' 28"	106° 3' 31"	Sec.20 T23S R9E
VTM97-285S	32° 17' 45"	105° 51' 24"	Sec.19 T23S R11E
VTM97-286S	32° 15' 30"	105° 56' 19"	Sec.32 T23S R10E
VTM97-287S	32° 28' 25"	105° 53' 50"	Sec.15 T21S R10E
VTM97-289S	32° 33' 40"	105° 38' 12"	Sec.20 T20S R13E
VTM97-290S	32° 33' 52"	105° 38' 11"	Sec.18 T20S R13E
VTM97-291S	32° 31' 50"	105° 37' 20"	Sec.33 T20S R13E
VTM97-292S	32° 31' 47"	105° 37' 23"	Sec.33 T20S R13E
VTM97-293S	32° 32' 50"	105° 38' 35"	Sec.20 T20S R13E
VTM97-294S	32° 32' 54"	105° 38' 57"	Sec.19 T20S R13E
VTM97-296S	32° 35' 00"	105° 42' 25"	Sec.10 T20S R12E
VTM97-297S	32° 34' 53"	105° 43' 45"	Sec.9 T20S R12E
VTM97-298S	32° 33' 55"	105° 43' 57"	Sec.17 T20S R12E
VTM97-299S	32° 31' 11"	105° 49' 54"	Sec.32 T20S R11E
VTM97-300S	32° 30' 51"	105° 48' 18"	Sec.3 T21S R11E
VTM97-306S	32° 31' 30"	105° 43' 14"	Sec.33 T20S R12E
VTM97-307S	32° 31' 28"	105° 43' 12"	Sec.33 T20S R12E
VTM97-308S	32° 31' 00"	105° 43' 2"	Sec.30 T20S R12E
VTM97-309S	32° 30' 40"	105° 43' 50"	Sec.4 T21S R12E
VTM97-310S	32° 29' 33"	105° 38' 35"	Sec.7 T21S R13E
VTM97-311S	32° 29' 58"	105° 39' 5"	Sec.7 T21S R13E
VTM97-312S	32° 29' 34"	105° 39' 5"	Sec.7 T21S R13E
VTM97-313S	32° 28' 10"	105° 37' 50"	Sec.20 T21S R13E
VTM97-314S	32° 30' 15"	105° 42' 53"	Sec.4 T21S R12E
VTM97-315S	32° 30' 5"	105° 42' 40"	Sec.3 T21S R12E
VTM97-316S	32° 30' 5"	105° 49' 43"	Sec.5 T21S R11E
VTM97-317S	32° 29' 42"	105° 50' 18"	Sec.8 T21S R11E

Sample Type/No.	Latitude	Longitude	Location
VTM97-319S	32° 54' 40"	105° 50' 00"	Sec.17 T16S R11E
VTM97-321S	32° 52' 00"	105° 50' 5"	Sec.32 T16S R11E
Mineralized Area Samples			
VTM97-50M	32° 8' 32"	106° 9' 58"	Sec.7 T25S R8E
VTM97-59M	32° 1' 48"	105° 58' 48"	Sec.24 T26S R9E
VTM97-96M	32° 36' 31"	105° 47' 21"	Sec.36 T19S R11E
VTM97-109M	32° 32' 42"	105° 46' 30"	Sec.25 T20S R11E
VTM97-172M	32° 22' 34"	106° 3' 53"	Sec.19 T22S R9E
VTM97-184M	32° 00' 16"	105° 58' 17"	Sec.36 T26S R9E
VTM97-194M	32° 3' 45"	105° 57' 28"	Sec.6, 7 T26S R9E
VTM97-195M	32° 3' 44"	105° 57' 28"	Sec.7 T26S R9E
VTM97-200M	32° 1' 39"	105° 58' 52"	Sec.23 T26S R9E
VTM97-201M	32° 1' 39"	105° 58' 52"	Sec.23 T26S R9E
VTM97-202M	32° 1' 39"	105° 58' 52"	Sec.23 T26S R9E
VTM97-203M	32° 1' 29"	105° 58' 55"	Sec.23 T26S R9E
VTM97-206M	32° 1' 23"	105° 58' 48"	Sec.24 T26S R9E
VTM97-225M	32° 1' 37"	105° 59' 44"	Sec.23 T26S R9E
VTM97-263M	32° 6' 18"	106° 33' 1"	Sec.32 T25S R4E
VTM97-264M	32° 6' 18"	106° 33' 1"	Sec.32 T25S R4E
VTM97-265M	32° 6' 10"	106° 33' 00"	Sec.32 T25S R4E
VTM97-266M	32° 4' 58"	106° 32' 24"	Sec.32 T25S R4E
VTM97-267M	32° 6' 19"	106° 33' 00"	Sec.32 T25S R4E
VTM97-323dM	32° 4' 12"	106° 9' 55"	Sec.6 T26S R8E
VTM97-324dM	32° 4' 12"	106° 9' 55"	Sec.6 T26S R8E
VTM97-325dM	32° 4' 12"	106° 9' 55"	Sec.6 T26S R8E
VTM97-328dM	32° 4' 23"	106° 8' 54"	Sec.5 T26S R8E
VTM97-331dM	32° 3' 2"	106° 7' 58"	Sec.16 T26S R8E
VTM97-381M	32° 32' 35"	105° 46' 30"	Sec.25 T20S R11E
VTM97-1RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-2RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-3RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-4RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-5RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-6RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-7RM	32° 48' 3"	104° 11' 35"	Sec.29 T17S R28E
VTM97-8RM	32° 2' 17"	104° 46' 50"	Sec.15 T26S R21E
VTM97-9RM	32° 2' 17"	104° 46' 50"	Sec.15 T26S R21E
VTM97-10RM	32° 1' 51"	104° 48' 2"	Sec.15 T26S R21E
VTM97-11RM	32° 1' 51"	104° 48' 2"	Sec.15 T26S R21E
VTM97-12RM	32° 28' 27"	104° 21' 58"	Sec.14 T21S R25E
VTM97-18RM	32° 28' 27"	104° 21' 58"	Sec.32 T23S R 25E

APPENDIX 2:

PHOTOGRAPHS
OF SELECTED SAMPLE SITES

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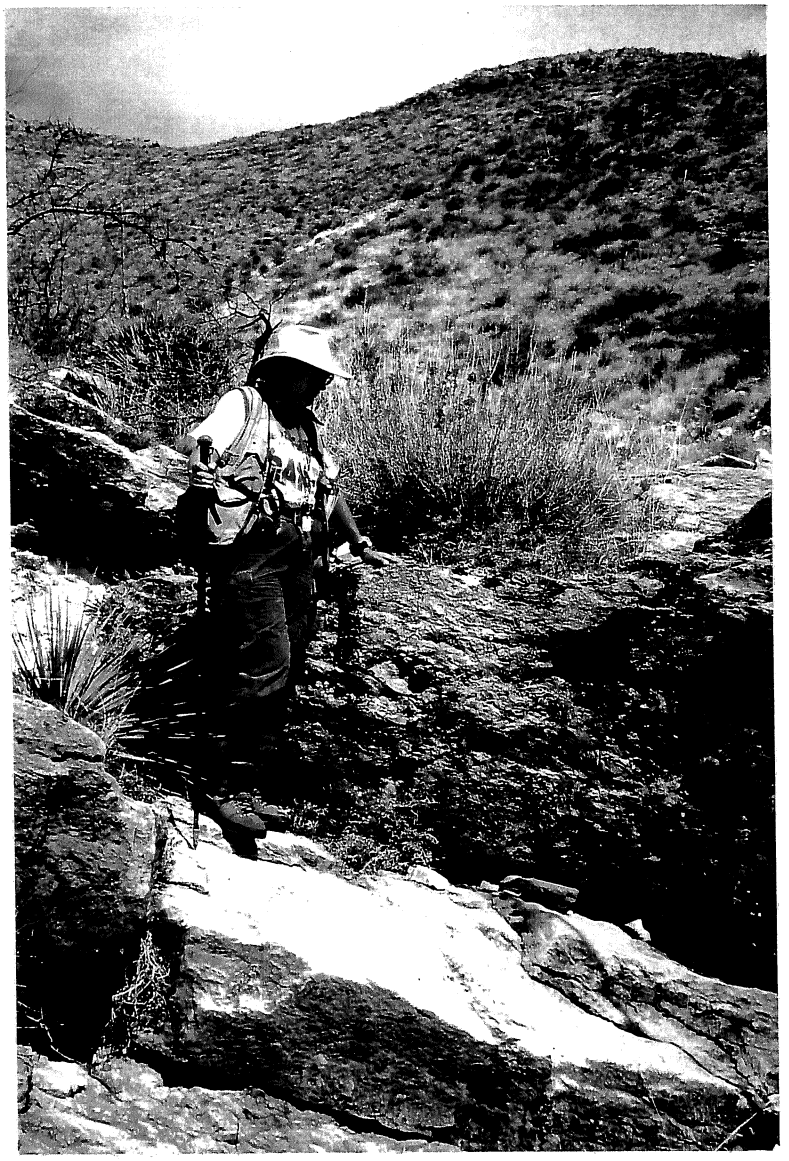

Photo of Sample Site RB-SAC-3 and 4 — Devonian black chert (Samples RB-SAC-3 and VTM97-95) overlying light-gray dolostones of Fusselman Formation (Sample RB-SAC-4) in Grapevine Canyon, Sacramento Mountains.



Photo of Sample Site VTM97-244 — Outcrops of black Proterozoic gabbro south of Negro Ed Canyon, Sacramento Mountains (Sample VTM97-244).



Photo of Sample Site VTM97-245 — Outcrops of orange-brown Bliss sandstone south of Negro Ed Canyon, Sacramento Mountains (Sample VTM97-245).

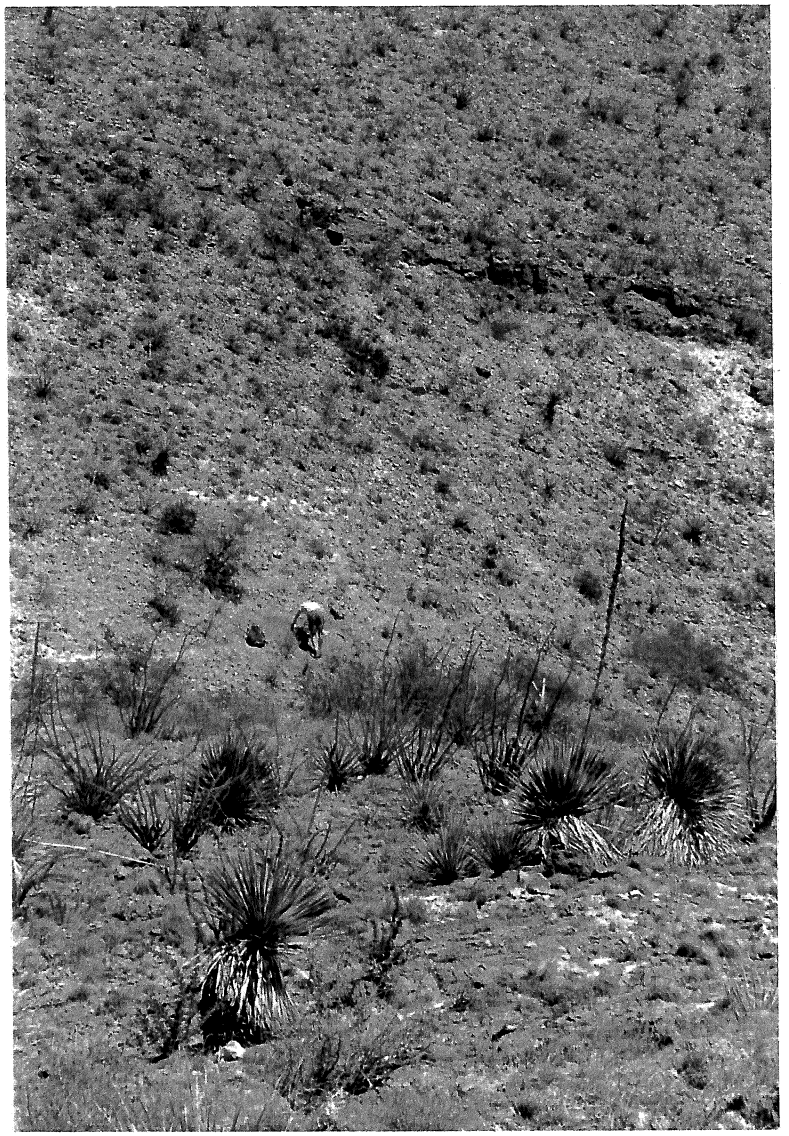

Photo of Sample Site RB-SAC-9 — Eric Munroe sampling Devonian black shale (Samples RB-SAC-9 and VTM97-246), in canyon south of Negro Ed Canyon, Sacramento Mountains. Prominent bed near top of photograph is the black chert at the top of the Devonian section.



Photo of Sample Site VTM97-241S — Collecting stream sediment sample in Negro Ed Canyon, Sacramento Mountains (Sample VTM97-241S). Massive cliffs forming horizon are Hueco limestone.

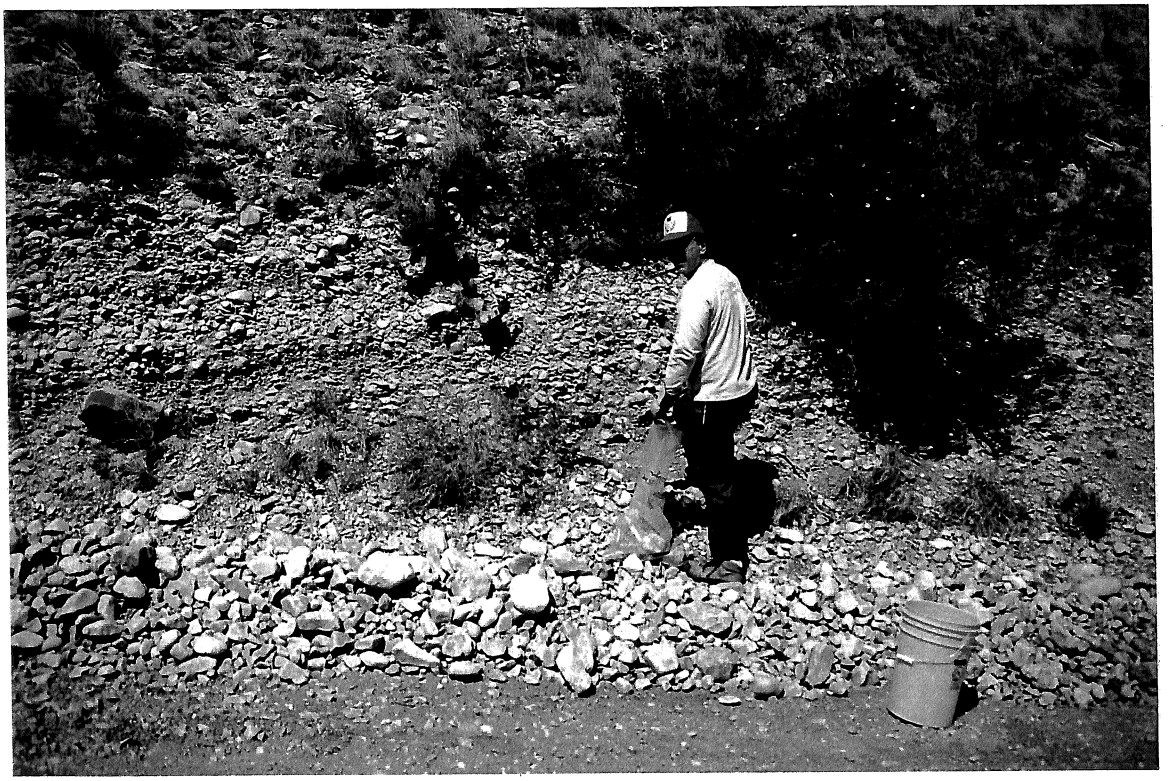

Photo of Sample Site JB-IM023 — Collecting an alluvial fan deposit (Qaf) of cobble conglomerate (Sample JB-IM023) with fine matrix and predominantly rounded limestone clasts. Samples found to have LA Wear rating 19.1% at Grade B.

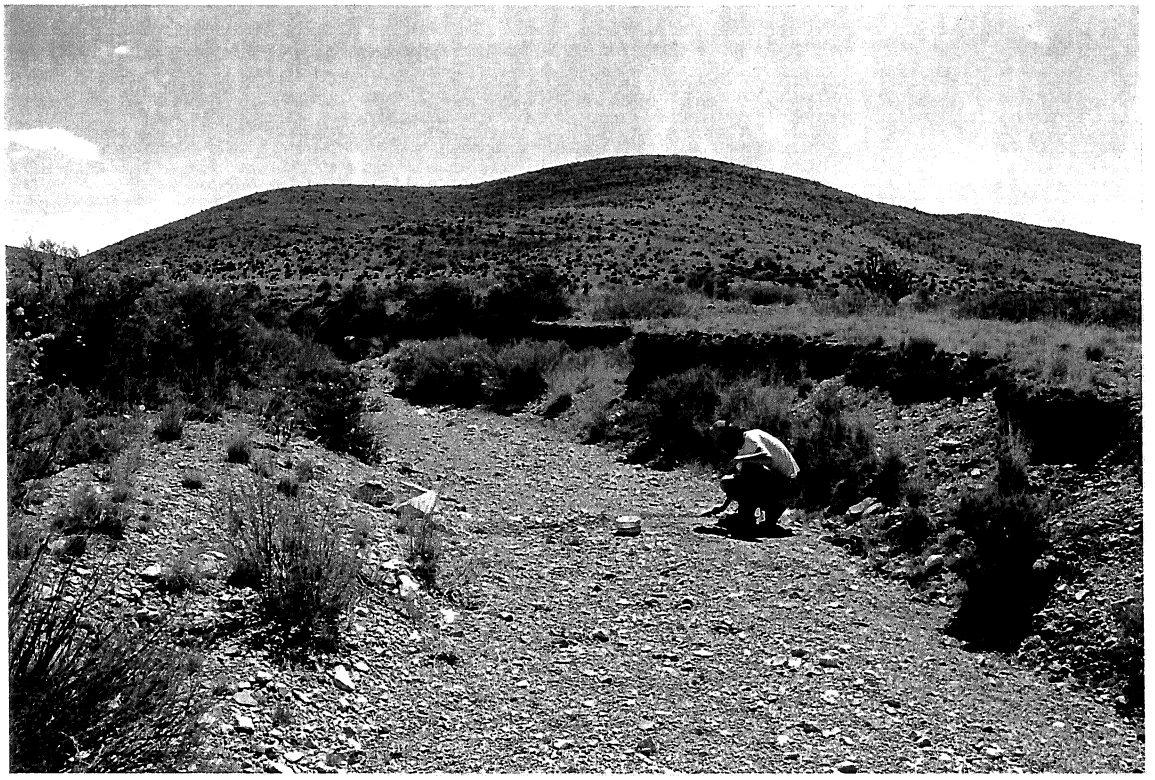

Photo of Sample Site VTM97-121S — Collecting stream sediment sample in El Paso Canyon, Sacramento Mountains (Sample VTM97-121S).

NEAR OROGRANDE, JARILLA MOUNTAINS



Photo of Sample Site VTM97-169a — Contact between Tertiary quartz monzonite porphyry (to left, Sample VTM97-170) and Hueco shale (to right, Sample VTM97-172M) in the rock quarry near Orogrande.



Photo of Sample Site VTM97-169b — Xenolith in quartz monzonite porphyry in the rock quarry near Orogrande.



Photo of Sample Site JB-IM013 — Gray Hueco Limestone with caliche along joints (Sample JB-IM013) and interbedded with thin to thick beds of shale (>2 ft) from active quarry near Orogrande. Samples found to have LA Wear rating 21.7% at Grade B, 50.40% CaO.



Photo of Sample Site VTM97-259S — Collecting stream sediment sample on Otero Mesa near Martin Tank (Sample VTM97-259S).

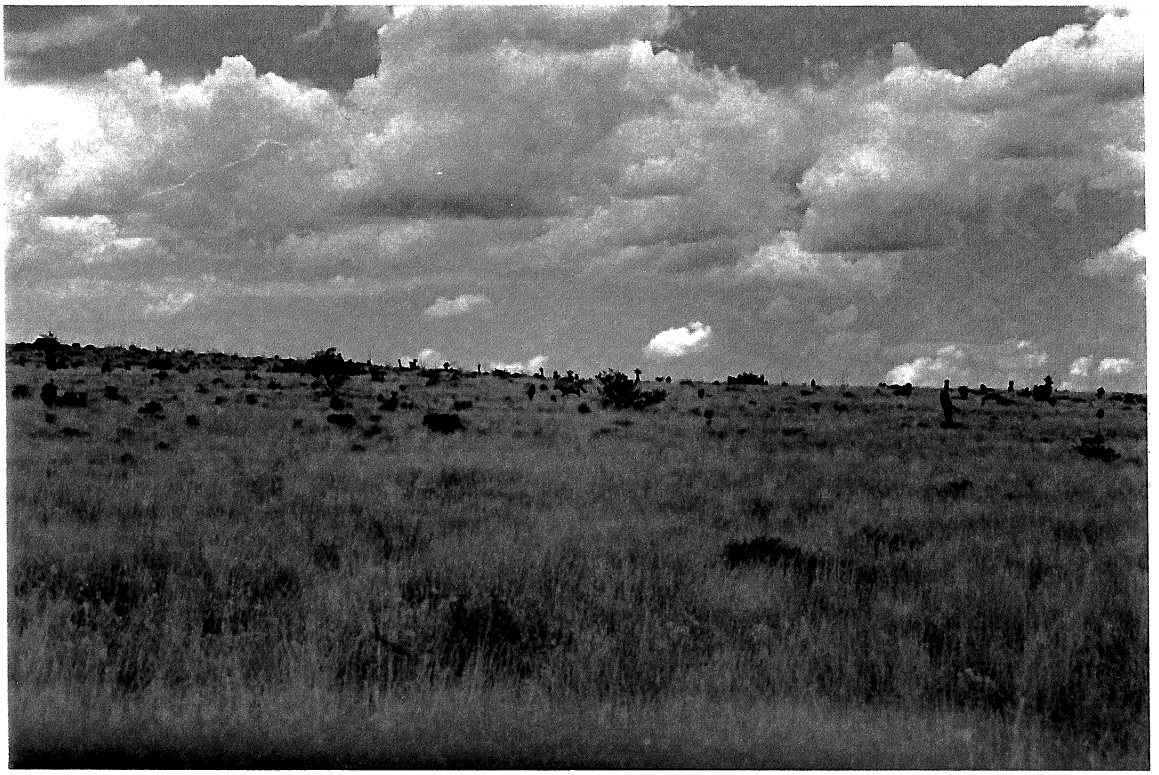

Photo of Sample Site VTM97-174S — Otero Mesa near Sample VTM97-174S.

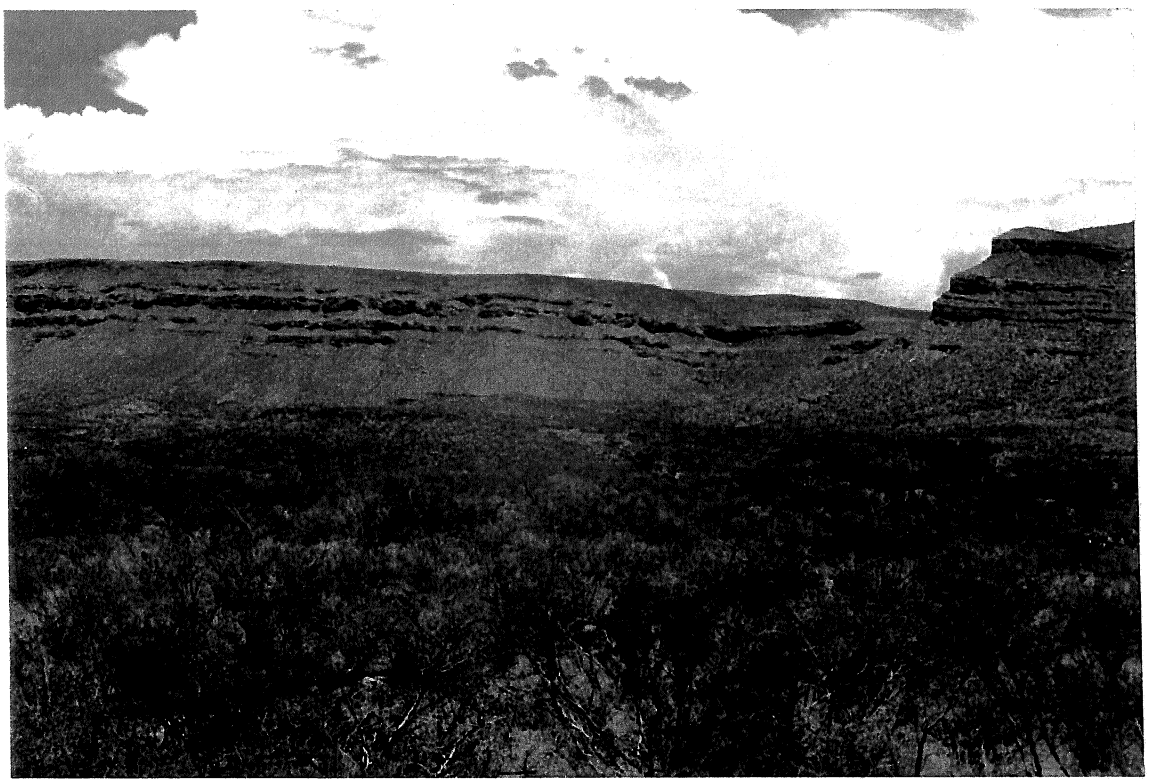

Photo of Sample Site VTM97-176S — Looking at escarpment of Otero Mesa, west of Rough Canyon. Red beds are lower Abo tongue overlain by gray Hueco limestone.



Photo of Sample Site VTM97-67 — Abo tongue (red beds) overlain by gray limestone in Hueco Formation, Hueco Mountains (Sample VTM97-67).



Photo of Sample Site VTM97-194M — Pipe-like zones of silicification are common in the jasperoid body in the Hueco limestone, north of Hueco syenite intrusion (Sample VTM97-194M).

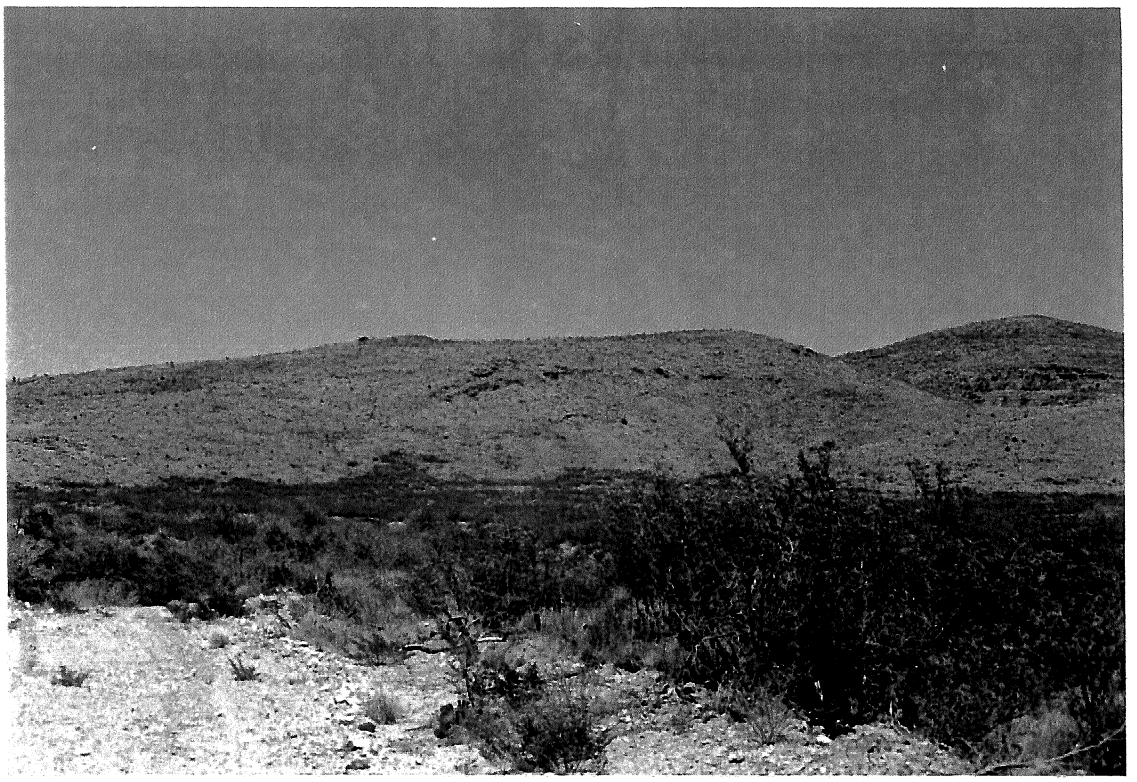

Photo of Sample Site VTM97-194M-195M — View of dark-brown jasperoid body in Hueco limestone, north of Hueco syenite intrusion (Samples VTM97-194M and VTM97-195M).

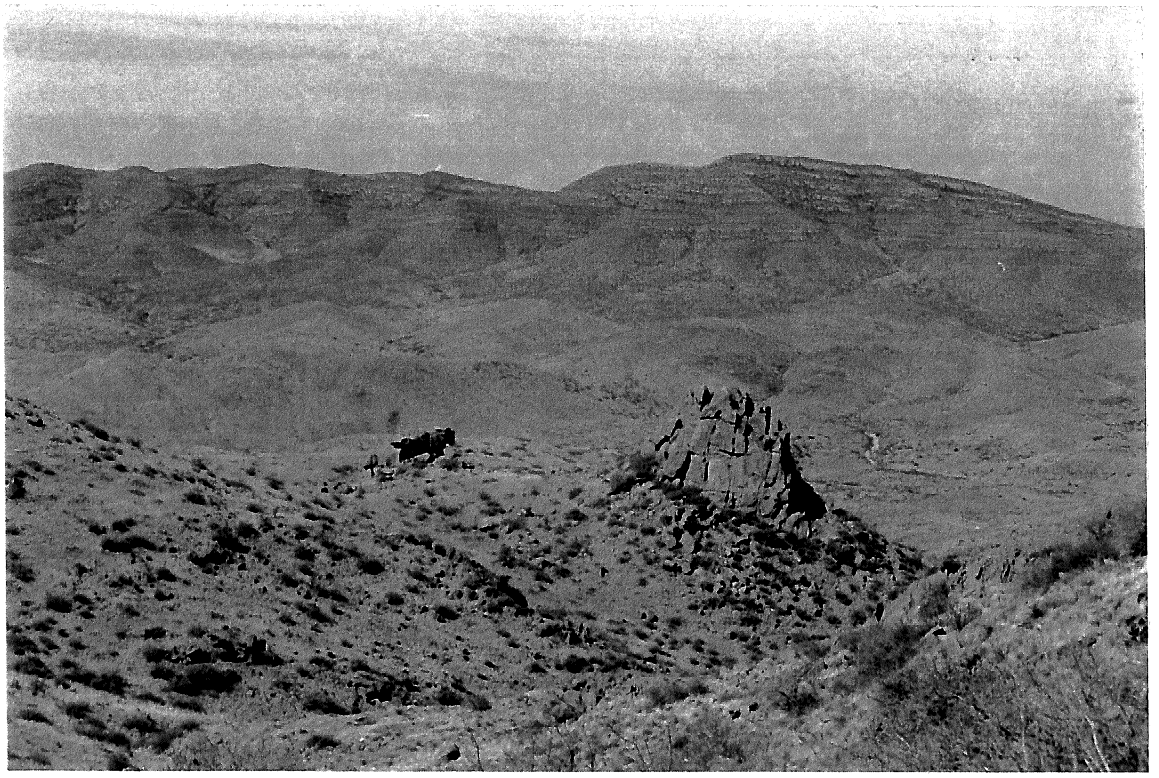

Photo of Sample Site VTM97-200a — View of Hueco syenite with massive cliffs of Hueco limestone in horizon (looking west from Red Hills, Sample VTM97-9RM).



Photo of Sample Site VTM97-200b — Prospect pit in Panther Seep xenolith in Hueco syenite in Red Hills (Sample VTM97-9RM). Dark outcrops are magnetite-hematite zone (to right, Sample VTM97-200M) and lighter outcrops are hornfels (to left, Sample VTM97-201M).

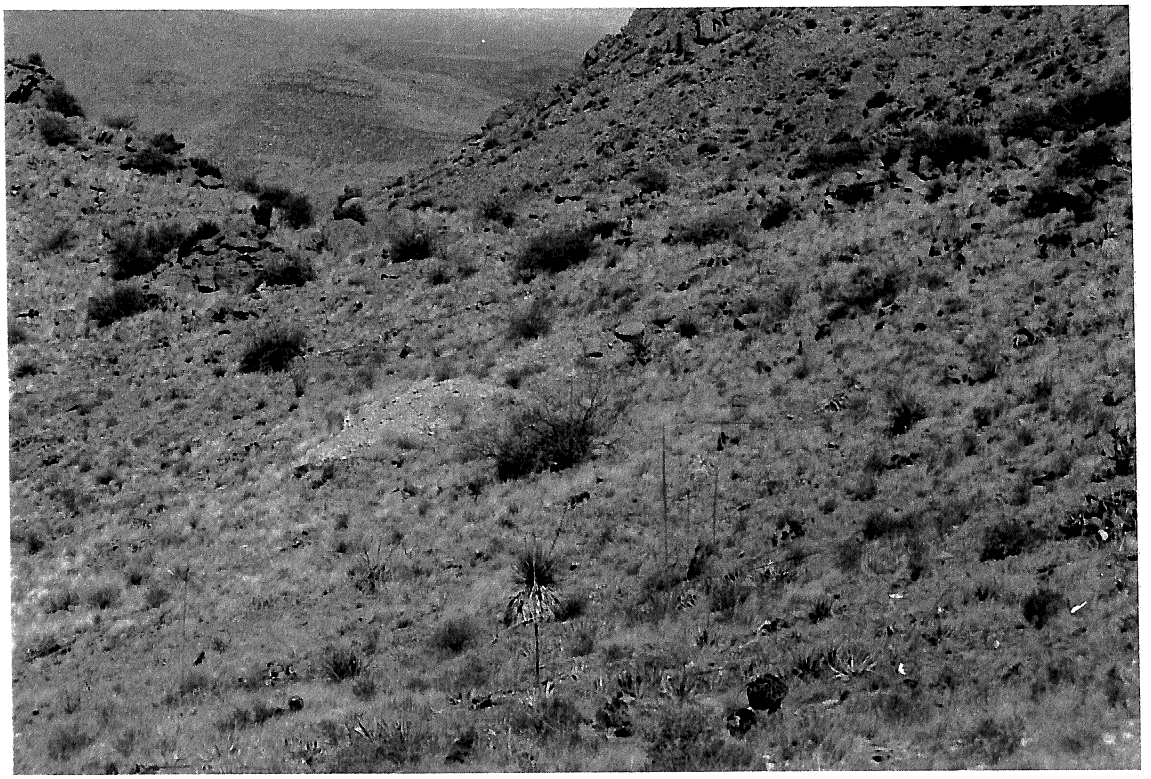

Photo of Sample Site VTM97-200c — Looking west at prospect pit in Red Hills (Sample VTM97-9RM). The hill slopes and outcrops are syenite.



Photo of Sample Site VTM97-225a — Altered zone at contact of syenite (orange-brown at bottom of photo) with overlying bedded, gray limestone, Red Hills (Samples VTM-9RM and VTM97-225M). Sample collected across the zone at the hammer.



Photo of Sample Site VTM97-225b — Banded skarn near contact with syenite, Red Hills (Samples VTM-9RM and VTM97-225M).

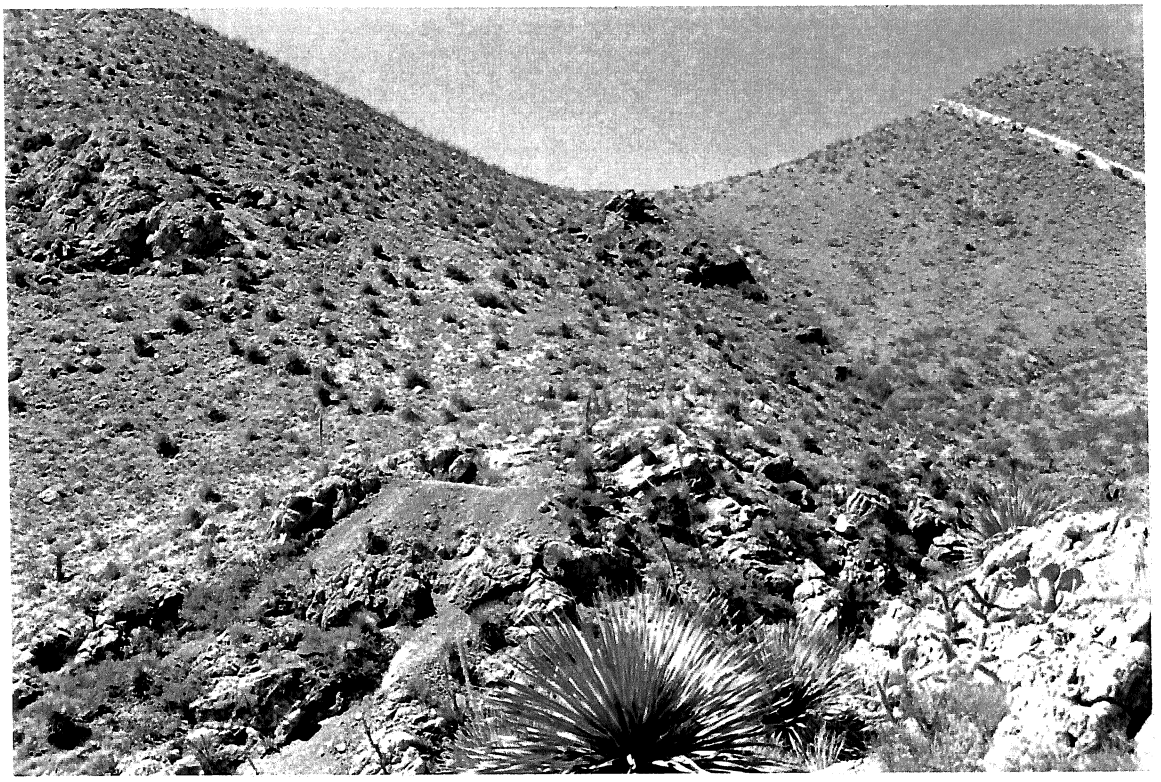

Photo of Sample Site VTM97-266a — View looking south of jasperoid along fault between Mississippian limestones (right) and silicified Fusselman Dolomite (left) (Sample VTM97-266M). Dump in foreground is the location of Sample VTM97-265M.

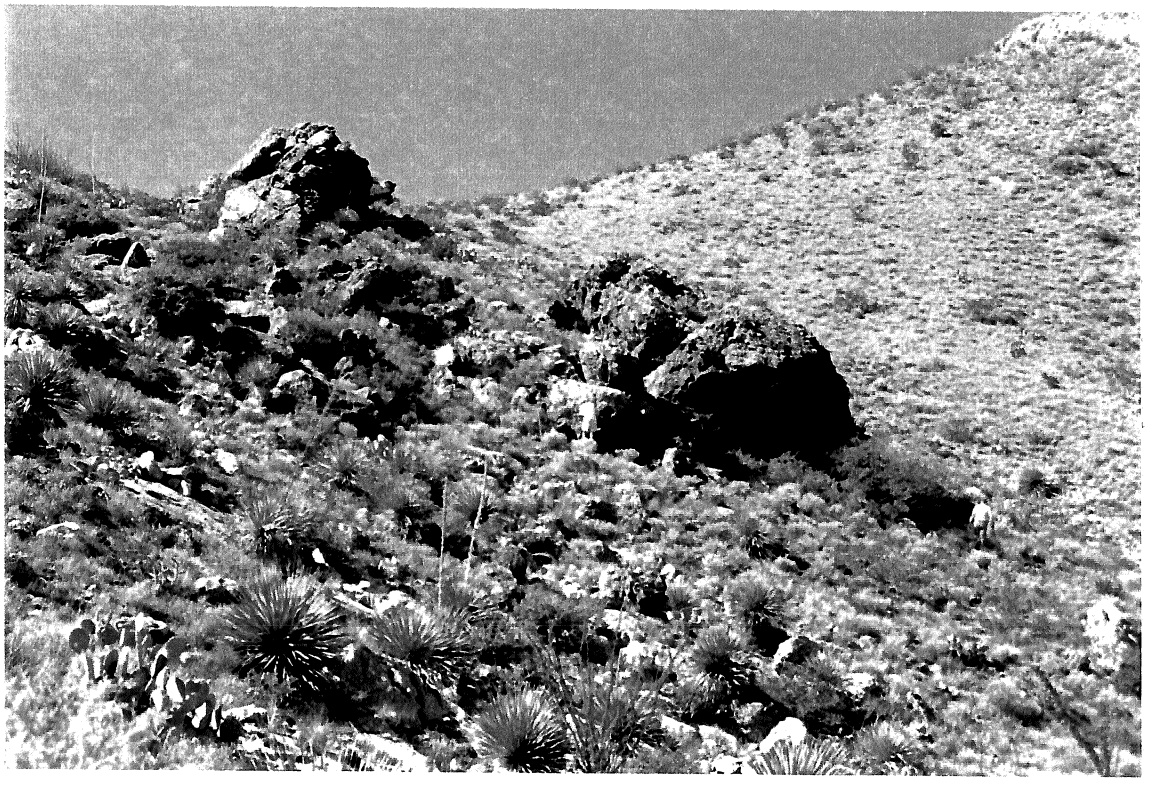

Photo of Sample Site VTM97-266b — View looking south of jasperoid along fault between Mississippian limestones and silicified Fusselman Dolomite (Sample VTM97-266M).

APPENDIX 3:

DESCRIPTION OF SAMPLES
COLLECTED FROM MCGREGOR RANGE

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DESCRIPTION OF SAMPLES COLLECTED FROM MCGREGOR RANGE

This appendix contains locations and sample descriptions of all samples collected for multi-element geochemical analyses, including characterization, mineralization, stream-sediment, heavy-mineral concentrate, float chip, industrial minerals geochemical characterization, and petroleum source rock characterization. The sample descriptions are presented in the order shown on the following list.

High 10	RB-518-3	VTM97-10RM	VTM97-96M	VTM97-150
JB-IM001	RB-518-4	VTM97-11RM	VTM97-97S	VTM97-151
JB-IM002	RB-518-5	VTM97-12RM	VTM97-98S	VTM97-152S
JB-IM003	RB-518-6	VTM97-18RM	VTM97-99S	VTM97-153C
JB-IM004	RB-518-7	VTM97-50M	VTM97-100S	VTM97-154S
JB-IM005	RB-518-8	VTM97-51	VTM97-106S	VTM97-155C
JB-IM006	RB-518-9	VTM97-52	VTM97-107S	VTM97-156S
JB-IM007	RB-518-10	VTM97-53S	VTM97-108S	VTM97-157C
JB-IM008	RB-H-1	VTM97-54S	VTM97-109M	VTM97-158
JB-IM009	RB-H-2	VTM97-55	VTM97-110S	VTM97-159
JB-IM010	RB-H-3	VTM97-56S	VTM97-111S	VTM97-160
JB-IM011	RB-H-4	VTM97-57	VTM97-112S	VTM97-165S
JB-IM012	RB-OR-1	VTM97-58	VTM97-113S	VTM97-166C
JB-IM013	RB-OR-2	VTM97-59M	VTM97-114S	VTM97-167S
JB-IM013Sh	RB-SAC-1	VTM97-60	VTM97-115S	VTM97-168S
JB-IM014	RB-SAC-2	VTM97-61S	VTM97-116S	VTM97-169
JB-IM015	RB-SAC-3	VTM97-62S	VTM97-117S	VTM97-170
JB-IM016	RB-SAC-4	VTM97-63	VTM97-118S	VTM97-171
JB-IM017	RB-SAC-5	VTM97-64S	VTM97-119S	VTM97-172M
JB-IM018	RB-SAC-6	VTM97-65S	VTM97-120S	VTM97-173
JB-IM019	RB-SAC-7	VTM97-66S	VTM97-121S	VTM97-174S
JB-IM020	RB-SAC-8	VTM97-67	VTM97-122C	VTM97-175S
JB-IM021	RB-SAC-9	VTM97-68	VTM97-123S	VTM97-176S
JB-IM021lS	RB-SEA-1	VTM97-69	VTM97-124S	VTM97-177S
JB-IM021Sh	RB-SEA-2	VTM97-70S	VTM97-125S	VTM97-178S
JB-IM022	RB-SEA-3	VTM97-71S	VTM97-130S	VTM97-179
JB-IM023	RB-SP-1	VTM97-72S	VTM97-131S	VTM97-180S
JB-IM024	RB-SP-2	VTM97-73S	VTM97-132S	VTM97-181S
JB-IM025	RB-SP-3	VTM97-74S	VTM97-133S	VTM97-182S
JB-IM026	RB-SP-4	VTM97-75S	VTM97-134S	VTM97-183C
JB-IM027	RB-STD-1	VTM97-81S	VTM97-135	VTM97-184M
JB-IM028	RB-STD-2	VTM97-82	VTM97-136	VTM97-185S
ORO-706	RB-TB-1	VTM97-83S	VTM97-137S	VTM97-186S
ORO-711	RB-ZP-1	VTM97-84S	VTM97-138S	VTM97-187S
ORO-712	RB-ZP-2	VTM97-85C	VTM97-139C	VTM97-188F
ORO-713	RB-ZP-3	VTM97-86S	VTM97-140S	VTM97-189S
ORO-720	VTM97-1RM	VTM97-87S	VTM97-141S	VTM97-190F
RB-466-1	VTM97-2RM	VTM97-88C	VTM97-142S	VTM97-191C
RB-466-2	VTM97-3RM	VTM97-89F(59F)	VTM97-143S	VTM97-192S
RB-466-3	VTM97-4RM	VTM97-90S	VTM97-144S	VTM97-193S
RB-466-4	VTM97-5RM	VTM97-91S	VTM97-145S	VTM97-194M
RB-466-5	VTM97-6RM	VTM97-92	VTM97-146F	VTM97-195M
RB-466-6	VTM97-7RM	VTM97-93	VTM97-147S	VTM97-196S
RB-518-1	VTM97-8RM	VTM97-94	VTM97-148S	VTM97-197S
RB-518-2	VTM97-9RM	VTM97-95	VTM97-149F	VTM97-198C

VTM97-199	VTM97-225M	VTM97-254S	VTM97-285S	VTM97-315S
VTM97-200M	VTM97-226S	VTM97-255S	VTM97-286S	VTM97-316S
VTM97-201M	VTM97-227C	VTM97-256S	VTM97-287S	VTM97-317S
VTM97-202M	VTM97-228S	VTM97-257	VTM97-288C	VTM97-319S
VTM97-203M	VTM97-229S	VTM97-258S	VTM97-289S	VTM97-320C
VTM97-204S	VTM97-230S	VTM97-259S	VTM97-290S	VTM97-321S
VTM97-205S	VTM97-235S	VTM97-260S	VTM97-291S	VTM97-322C
VTM97-206M	VTM97-236	VTM97-261	VTM97-292S	VTM97-323dM
VTM97-207S	VTM97-237	VTM97-262V	VTM97-293S	VTM97-324dM
VTM97-208S	VTM97-238S	VTM97-263M	VTM97-294S	VTM97-325dM
VTM97-209S	VTM97-239S	VTM97-264M	VTM97-295F	VTM97-326d
VTM97-210S	VTM97-240S	TM97-265M	VTM97-296S	VTM97-327d
VTM97-211S	VTM97-241S	VTM97-266M	VTM97-297S	VTM97-328dM
VTM97-212	VTM97-242C	VTM97-267M	VTM97-298S	VTM97-329d
VTM97-213S	VTM97-243	VTM97-268S	VTM97-299S	VTM97-330d
VTM97-214S	VTM97-244	VTM97-269C	VTM97-300S	VTM97-331dM
VTM97-215S	VTM97-245	VTM97-276S	VTM97-306S	VTM97-332d
VTM97-216S	VTM97-246	VTM97-277S	VTM97-307S	VTM97-333d
VTM97-217S	VTM97-247S	VTM97-278S	VTM97-308S	VTM97-334d
VTM97-218S	VTM97-248F	VTM97-279S	VTM97-309S	VTM97-350d
VTM97-219C	VTM97-249F	VTM97-280S	VTM97-310S	VTM97-351d
VTM97-220S	VTM97-250C	VTM97-281S	VTM97-311S	VTM97-352d
VTM97-221C	VTM97-251S	VTM97-282S	VTM97-312S	VTM97-380F
VTM97-222	VTM97-252S	VTM97-283S	VTM97-313S	VTM97-381M
VTM97-223	VTM97-253S	VTM97-284S	VTM97-314S	VTM97-382
VTM97-224				

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM
SAMPLE NUMBER: High 10
PROJECT: McGregor
COLLECTOR: VTM
FIELD DATE (MO/DAY/YR): 10/1/97
LOCATION: Sacramento district
QUADRANGLE: High Rolls **SCALE:** 1:24,000
TOWNSHIP: 16S **RANGE:** 11E **SECTION:** SW 30
LATITUDE: 32" 52' 50" **LONGITUDE:** 105" 51' 50"
ROCK UNIT: Tertiary lampropyhre dike or sill
ROCK AGE: Tertiary
FIELD OCCURRENCE: outcrop of dike trending N20° W
ROCK DESCRIPTION: gray-brown, fine-grained
ROCK STRUCTURES: fractures
MEASURED SECTION: no
PHOTO NUMBER:
REMARKS: poorly exposed, contacts covered
REFERENCES:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM001
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/09/97
5. Location:
   - Quadrangle name: Desert SW
   - Quadrangle scale: 1:24,000
   - Legal description: NW4 sec. 3 T26S, R7E
   - GPS coordinates: 32° 04' 42" 106° 13' 36"
6. Rock unit (formation, member, etc.): Qe
7. Rock age: Quaternary
8. Field occurrence: partly stabilized dune
9. Rock field description: eolian sand, red-brown
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG1001 through 1003
13. Remarks:
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM002		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 10E	**SECTION**: 10
LATITUDE: 35° 3' 55.6"		**LONGITUDE**: 105° 54' 35.9"
ROCK UNIT: Permian Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM003		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION:		
QUADRANGLE: Owl Tank Canyon West		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 9E	**SECTION**: 11
LATITUDE: 32° 8' 58.7"		**LONGITUDE**: 105° 59' 7.3"
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM004
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/14/97
5. Location:
   - Quadrangle name: Mountain Tank
   - Quadrangle scale: 1:24,000
   - Legal description: SE4 sec. 23, T25S R10E
   - GPS coordinates: 32° 06' 48" 105° 53' 00"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence: caliche
9. Rock field description: caliche with sandstone and limestone clasts
10. Rock structures: moderate to well indurated
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3004 through 3006
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM005
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/09/97
5. Location:
   Quadrangle name: Owl Tank Canyon West
   Quadrangle scale: 1:24,000
   Legal description: NW4 sec. 19 T24S, R10E
   GPS coordinates: 32° 12' 13" 105° 57' 54"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence:
9. Rock field description: caliche
10. Rock structures: earthy to well indurated
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG1007 through 1009
13. Remarks:
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM006		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION:		
QUADRANGLE: Owl Tank Canyon West	**SCALE**: 1:24,000	
TOWNSHIP: 24S	**RANGE**: 10E	**SECTION**: 19
LATITUDE: 32° 12' 18.4"	**LONGITUDE**: 105° 57' 55.7"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM007
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/14/97
5. Location:
   - Quadrangle name: Owl Tank Canyon East
   - Quadrangle scale: 1:24,000
   - Legal description: NW4 sec. 9 T24S, R11E
   - GPS coordinates: 32° 14' 07" 105° 49' 18"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence: caliche; regionally extensive on interfluves
9. Rock field description: caliche with Hueco limestone clasts
10. Rock structures: well indurated
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3007 through 3009
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM008
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/09/97
5. Location:
   - Quadrangle name: Orogrande South
   - Quadrangle scale: 1:24,000
   - Legal description: SW4 sec. 22 T23S, R9E
   - GPS coordinates: 32° 17' 11" 106° 00' 59"
6. Rock unit (formation, member, etc.): Qal
7. Rock age: Quaternary
8. Field occurrence: alluvium
9. Rock field description: alluvium with caliche and limestone clasts, very fine to coarse
10. Rock structures: poorly sorted; clasts 6-8 inches maximum diameter
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG1013 through 1015
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM009
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/16/97
5. Location:
   - Quadrangle name: Mack Tanks
   - Quadrangle scale: 1:24,000
   - Legal description: SE4 sec. 18 T23S, R10E
   - GPS coordinates: 32° 17' 56" 105° 57' 16"
6. Rock unit (formation, member, etc.): Qal
7. Rock age: Quaternary
8. Field occurrence: alluvium
9. Rock field description: alluvium with sandstone and limestone clasts, pebbles and cobbles in sand matrix
10. Rock structures: pebbles and cobbles 2 inches maximum diameter
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2028 through 2030
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM010
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/15/97
5. Location:
   - Quadrangle name: Stone Well
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 1 T23S, R12E
   - GPS coordinates: 32° 20' 18" 105° 39' 41"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence: caliche, extensive on interfluves
9. Rock field description: caliche with San Andres limestone clasts
10. Rock structures: 1-3 ft beds exposed
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3022 through 3024
13. Remarks:
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM011		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION: near Jarilla Mountains		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 12E	**SECTION**: 17
LATITUDE: 32° 22' 59.6"		**LONGITUDE**: 106° 2' 50.2"
ROCK UNIT: caliche		
ROCK AGE: Quaternary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: caliche		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM012
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/09/97
5. Location:
   - Quadrangle name: Orogrande North
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 23 T22S, R9E
   - GPS coordinates: 32° 22' 49" 106° 04' 05"
6. Rock unit (formation, member, etc.): Qp
7. Rock age: Quaternary
8. Field occurrence: pediment
9. Rock field description: pediment, thin with lag gravel and caliche clasts
10. Rock structures: poorly sorted; caliche clasts 3-5 inches in diameter
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG1016 through 1018
13. Remarks: underlain by caliche
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM013		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION: Jarilla Mountains		
QUADRANGLE: Orogrande North	**SCALE**: 1:24,000	
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: 19
LATITUDE: 32° 22' 49.1"	**LONGITUDE**: 106° 4' 5.4"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM013Sh		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION: Jarilla Mountains		
QUADRANGLE: Orogrande North	**SCALE**: 1:24,000	
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: 19
LATITUDE: 32° 22' 49.1"	**LONGITUDE**: 106° 4' 5.4"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: shale		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM014
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/16/97
5. Location:
   - Quadrangle name: Mack Tanks
   - Quadrangle scale: 1:24,000
   - Legal description: NW4 sec. 32 T22S, R10E
   - GPS coordinates: 32° 21' 07" 105° 56' 44"
6. Rock unit (formation, member, etc.): Qp
7. Rock age: Quaternary
8. Field occurrence: pediment
9. Rock field description: pediment with limestone clasts in brown fine sand/silt matrix
10. Rock structures: limestone clasts >2in. in diameter
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3031 through 3033
13. Remarks: underlain by caliche
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM015
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/14/97
5. Location:
   - Quadrangle name: Otero Mesa South
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 1 T23S, R11E
   - GPS coordinates: 32° 20' 15" 105° 45' 35"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence: caliche, extensive on interfluves
9. Rock field description: caliche with limestone clasts
10. Rock structures: well indurated; a few feet thick
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3010 through 3012
13. Remarks:
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM016		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION:		
QUADRANGLE: Stone Well		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 12E	**SECTION**: 34
LATITUDE: 32° 21' 16"		**LONGITUDE**: 105° 42' 24.2"
ROCK UNIT: Yeso tongue of the Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM017
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/15/97
5. Location:
   - Quadrangle name: El Paso Draw
   - Quadrangle scale: 1:24,000
   - Legal description: SE4 sec. 32 T21S, R13E
   - GPS coordinates: 32° 25' 50" 105° 38' 08"
6. Rock unit (formation, member, etc.): Qp
7. Rock age: Quaternary
8. Field occurrence: pediment, extensive
9. Rock field description: pediment with v. fine w. few pebbles,
10. Rock structures: pods of limestone conglomerate
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3019 through 3021
13. Remarks: thick caliche cement at top
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM018
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/09/97
5. Location:
   - Quadrangle name: Wilde Tank
   - Quadrangle scale: 1:24,000
   - Legal description: NW4 sec. 19 T22S, R10E
   - GPS coordinates: 32° 22' 57" 105° 57' 34"
6. Rock unit (formation, member, etc.): Qc
7. Rock age: Quaternary
8. Field occurrence: caliche
9. Rock field description: caliche with Hueco limestone clasts
10. Rock structures: thin bedded, several feet thick, large outcrop
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG1013 through 1015
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM019
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/13/97
5. Location:
   - Quadrangle name:
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 16 T21S, R9E
   - GPS coordinates: 32° 28' 43" 106° 01' 29"
6. Rock unit (formation, member, etc.): Qab
7. Rock age: Quaternary
8. Field occurrence: bolson
9. Rock field description: bolson with very fine eolian sand and caliche pebbles
10. Rock structures: thin laminated caliche 1 ft below surface
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2019 through 2021
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM020
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/da/yr): 05/16/97
5. Location:
   - Quadrangle name: Wilde Tank
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 8 T22S, R10E
   - GPS coordinates: 32° 24' 36" 105° 56' 18"
6. Rock unit (formation, member, etc.): Qp
7. Rock age: Quaternary
8. Field occurrence: pediment
9. Rock field description: pediment, conglomeratic, some caliche
10. Rock structures: clasts to 1 ft, few fines, mostly gray limestone
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3034 through 3037
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM021
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/13/97
5. Location:
   - Quadrangle name: Pipeline Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: SW4 sec. 2 T21S, R10E
   - GPS coordinates: 32° 30' 22" 105° 53' 42"
6. Rock unit (formation, member, etc.): Abo Fm.
7. Rock age: Permian
8. Field occurrence: bedded
9. Rock field description: tan limestone (1-2.5 ft), dolomite (?) and shale (up to 3 ft), caliche cap
10. Rock structures: dip 25W
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2010 through 2018
13. Remarks: samples of limestone, shale, and caliche collected here
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM0211S		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION:		
QUADRANGLE: Pipeline Canyon		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 10E	**SECTION**: 2
LATITUDE: 32° 30' 22.1"		**LONGITUDE**: 105° 53' 41.7"
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM021Sh		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5/97		
LOCATION:		
QUADRANGLE: Pipeline Canyon		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 10E	**SECTION**: 2
LATITUDE: 32° 30' 22.1"		**LONGITUDE**: 105° 53' 41.7"
ROCK UNIT: Abo tongue, Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: shale		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM022
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/15/97
5. Location:
   - Quadrangle name: Sixteen Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: SE4 sec. 11 T21S, R13E
   - GPS coordinates: 32° 29' 33" 105° 35' 08"
6. Rock unit (formation, member, etc.): Qaf
7. Rock age: Quaternary
8. Field occurrence: alluvial fan
9. Rock field description: alluvial fan, cobble conglomerate, fine matrix, mainly rounded limestone clasts
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3013 through 3015
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM023
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/16/97
5. Location:
   - Quadrangle name: Surveyors Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: SE4 sec. 2 T21S, R13E
   - GPS coordinates: 32° 30' 59" 105° 34' 57"
6. Rock unit (formation, member, etc.): Qaf
7. Rock age: Quaternary
8. Field occurrence: alluvial fan
9. Rock field description: alluvial fan, cobble conglomerate, fine matrix, mainly rounded limestone clasts
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG3017 through 3018
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM024
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/13/97
5. Location:
   - Quadrangle name: Deadman Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: NE4 sec. 11 T19S, R9E
   - GPS coordinates: 32° 21' 07" 105° 56' 44"
6. Rock unit (formation, member, etc.): Qab
7. Rock age: Quaternary
8. Field occurrence: bolson
9. Rock field description: bolson, v. fine eolian sand w. gypsum
10. Rock structures: not hummocky
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2001 through 2003
13. Remarks:
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM025
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/13/97
5. Location:
   - Quadrangle name: Deadman Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: NW4 sec. 26 T19S, R10E
   - GPS coordinates: 32° 37' 50" 105° 53' 18"
6. Rock unit (formation, member, etc.): Qaf
7. Rock age: Quaternary
8. Field occurrence: alluvial fan; extensive
9. Rock field description: alluvial fan, gravel with fine mudstone and siltstone interbeds;
10. Rock structures: >2 ft thick
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2004 through 2006
13. Remarks:
14. References:

INDUSTRIAL MINERALS GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: JB-IM026		
PROJECT: McGregor		
COLLECTOR: James Barker		
FIELD DATE (mo/day/yr): 5-97		
LOCATION:		
QUADRANGLE: Bug Scuffle Canyon		**SCALE**: 1:24,000
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: 29
LATITUDE: 32° 38' 5.4"		**LONGITUDE**: 105° 50' 35.5"
ROCK UNIT: Gobler Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM027
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/16/97
5. Location:
   Quadrangle name: Orogrande North
   Quadrangle scale: 1:24,000
   Legal description: SW4 sec. 17 T22S, R9E
   GPS coordinates: 32° 23' 00"106° 02' 50"
6. Rock unit (formation, member, etc.): Qal
7. Rock age: Quaternary
8. Field occurrence: alluvium
9. Rock field description: alluvium, red pebbly fine sand, eolian (?);
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: same location as JB-IM011; active pit
14. References:

GEOCHEMICAL CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: JB-IM028
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Barker and Austin
4. Field Date (mo/day/yr): 05/14/97
5. Location:
   Quadrangle name: Desert SE
   Quadrangle scale: 1:24,000
   Legal description: NW4 sec. 36 T25S, R8E
   GPS coordinates: 32° 05' 17" 106° 05' 01"
6. Rock unit (formation, member, etc.): Qal
7. Rock age: Quaternary
8. Field occurrence: alluvium
9. Rock field description: alluvium, mainly gray limestone pebbles
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): McG2022 through 2024
13. Remarks: a former pit now fenced for waste disposal; perhaps some crushing was done
14. References:

JB-IM029, 040-44 for standards and duplicates

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: ORO-706		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/7/97		
LOCATION: Monte Largo Gap, Orogrande district		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 8E	**SECTION**: C N 23
LATITUDE: 32° 28' 13"		**LONGITUDE**: 106° 5' 44"
ROCK UNIT: Tertiary monzonite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: dump select		
ROCK DESCRIPTION: white and black porphyry with quartz, feldspar		
ROCK STRUCTURES: iron oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: ORO-711		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/11/97		
LOCATION: Orogrande, Monte Carlo Gap		
QUADRANGLE: Orogrande North	**SCALE**: 1:24,000	
TOWNSHIP: 21S	**RANGE**: 8E	**SECTION**: C N 23
LATITUDE: 32° 28' 13"	**LONGITUDE**: 106° 5' 44"	
ROCK UNIT: Panther Seep Formation		
ROCK AGE: Pennsylvanian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: black micrite, petrid smell, fossils		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: mine shaft nearby, ORO-710, RB-OR-1		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: ORO-712		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/11/97		
LOCATION: Orogrande, north Monte Carlo Gap		
QUADRANGLE: Orogrande North	**SCALE**: 1:24,000	
TOWNSHIP: 21S	**RANGE**: 8E	**SECTION**: SW SW 14
LATITUDE: 32° 28' 26"	**LONGITUDE**: 106° 5' 57"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: edge of bioherm, lenticular limestone		
ROCK STRUCTURES: fractures		
MEASURED SECTION: no		
PHOTO NUMBER: none		
REMARKS: RB-OR-2		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: ORO-713		**COLLECTOR**: VTM
AREA: Orogrande, north Monte Largo Gap		**FIELD DATE**: 5/11/97
MINING DISTRICT: Orogrande		
PROPERTY NAME: north of Monte Carlo Gap		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 8E	**SECTION**: SW SW 14
LATITUDE: 32° 28' 26"		**LONGITUDE**: 106° 5' 58"
SAMPLE TYPE: grab of dump of iron skarn		
ROCK TYPE: iron skarn in limestone (Hueco Formation) near Tertiary sill		
ALTERATION: iron oxides		
MINERALIZATION: iron oxides, calcite, silica		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: ORO-720		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/7/97		
LOCATION: Tres Hermanos		
QUADRANGLE: Tres Hermanos SE		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 8E	**SECTION**: C N 3
LATITUDE: 32° 30' 51"		**LONGITUDE**: 106° 6' 35"
ROCK UNIT: Tertiary scoria		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: dump select		
ROCK DESCRIPTION: reddish black scoria		
ROCK STRUCTURES: iron oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/5/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 6 T 26S, R 8E
   GPS coordinates: N 32°, 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: core; 947 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Limestone, black, micritic, argillaceous, with thin wavy laminations defined by slight changes in color; lime mudstone
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo numbers: none
13. Remarks: Duplicate sample RB-518-11
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/5/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 6 T 26S, R 8E
   GPS coordinates: N 32° 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: core, 1403 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Limestone, medium to dark grey; micritic to fossiliferous (brachiopods; bioclastic mudstone to wackestone
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/5/97
5. Location:
   - Quadrangle name: Desert SW
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 6 T 26S, R 8E
   - GPS coordinates: N 32° 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: core; 1500 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Limestone, medium grey, micritic; lime mudstone
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-4
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/9/97
5. Location:
   - Quadrangle name: Desert SW
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 6 T 26S, R 8E
   - GPS coordinates: N 32° 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: core; 1630 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Shale, mottled black and green, in bed 2.9 ft thick
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-5
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/9/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 6 T 26S, R 8E
   GPS coordinates: N 32° 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core; 1823 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Limestone, very dark grey, micritic, lime mudstone; with very thinly interbedded light-grey limestone. Light-grey limestone is less than 10% of section.
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-466-6
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/9/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 6 T 26S, R 8E
   GPS coordinates: N 32° 4' 8"; W 106° 9' 52" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core; 2144 ft depth; U.S. Army Ft. Bliss core 46-6
9. Rock field description: Limestone, black, micritic, bioclastic (brachiopods); lime mudstone
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2"; W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core; 1151 ft depth; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Limestone, very dark grey to black, micritic, fossiliferous (brachiopods; lime mudstone; thinly laminated. Occurs in bed approximately 7 ft thick overlain and underlain by medium- to dark-grey limestones that are cherty, thinly laminated, mottled, and(?) burrowed. The medium to dark-grey limestones have red clayey zones of thin to medium thickness , some of which are rubbly and others of which have dissolution voids that appear to result from dissolution of the limestones. Most of the vugs are lined with clear to white dogtooth calcite spar but are not completely infilled with the dogtooth calcite.
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: Core box 77 which contains core from 1199.4 to 1207.5 ft contains fractured limestones - fractures are lined with yellowish and orange-red minerals.
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2"; W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core; 1325 ft depth; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Limestone, very dark grey to black, micritic; lime mudstone
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2"; W 105° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Devonian, upper shale unit
7. Rock age: Devonian
8. Field occurrence: core, 1417 ft. US Army Ft. Bliss core 51-8
9. Rock field description: Shale, black, interbedded with black shales and black mudstone to argillaceous limestone (lime mudstone)
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-4
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32 3' 2", W 106 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Devonian, middle chert unit
7. Rock age: Devonian
8. Field occurrence: core, 1466 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: black chert with thinly interbedded to interlaminated black cherty limstone; chert is laminated; laminae are planar to wavy, many show indications of soft-sedimented deformation
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-5
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Devonian, lower shale unit
7. Rock age: Devonian
8. Field occurrence: core 1500 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: black shale, basal black shale unit in Devonian, about 2 1/2 ft above Fusselman
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-6
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Fusselman Formation
7. Rock age: Silurian
8. Field occurrence: core, 1512 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Dolostone, medium grey, with vugular porosity, microcrystalline
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-7
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): El Paso Formation
7. Rock age: Ordovician
8. Field occurrence: core, 2092 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Dolostone, microcrystalline, medium grey; core is very rubbly in this interval
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Witcher, J.C.

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-8
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/13/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core, 2261.6 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: shale, black; calcareous, numerous horizontal to vertical fractures filled with calcite; this section of the Mississippian consists of interbedded med-dark limestone and black shale beds 2-4 ft thick; stratal dip is about 30-40° in core
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-9
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/13/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: core, 2353.5 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Limestone, very dark grey, micritic; lime mudstone
10. Rock structures: stratal dip of 30-40° in core
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-518-10
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/13/97
5. Location:
   Quadrangle name: Desert SW
   Quadrangle scale: 1:24,000
   Legal description: sec. 16 T 26S, R 8E
   GPS coordinates: N 32° 3' 2", W 106° 7' 58" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian (by Witcher)
8. Field occurrence: core 2569 ft; U.S. Army Ft. Bliss core 51-8
9. Rock field description: Limestone, dark grey, lime mudstone; intensely fractured; fractures filled with calcite; numerous stylolites
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: vertical fractures at approximately 2475 ft. are partially filled with calcite but contain substantial vugular porosity
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-H-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/9/97
5. Location:
   Quadrangle name: Mountain Tank
   Quadrangle scale: 1:24,000
   Legal description: sec. 24, T 26S, R 9E
   GPS coordinates: N 32° 01' 20.2"; W 105° 58' 21.6"
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian (probably Virgilian)
8. Field occurrence: SE dipping slope on hill at SW flank of Hueco Mountains
9. Rock field description: Dark-grey micritic limestone; lime mudstone; approximately 50 ft above break in slope. Bed approximately 1 ft thick; exposures poor but bed appears to have wide lateral continuity. Beds above & below appear to be similar lithologically and are 1 to 3 ft thick. Chert nodules common.
10. Rock structures: uniform gentle dip to SE
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 6 - sample just to right of red flag, center of photo
13. Remarks: Duplicate of sample RB-SAC-10
14. References: Hardie (1958); Kottlowski (1960)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-H-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/9/97
5. Location:
   Quadrangle name: Mountain Tank
   Quadrangle scale: 1:24,000
   Legal description: sec. 24, T 26S, R 9E
   GPS coordinates: N 32° 01' 36.9"; W 105° 58' 40.5"
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian (probably Virgilian)
8. Field occurrence: west side of Arroyo, 10 meters west of road
9. Rock field description: Medium-grey micritic limestone; lime mudstone. Bed 1 1/2 ft thick, interbedded with similar limestones in beds 2 inches to 3 ft thick
10. Rock structures: dip approximately 20° SW
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 7
13. Remarks:
14. References: Hardie (1958); Kottlowski (1960)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-H-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/9/97
5. Location:
   Quadrangle name: Mountain Tank
   Quadrangle scale: 1:24,000
   Legal description: sec. 24, T26S, R 9E
   GPS coordinates: N 32° 1' 35"; W 105° 58' 47.6"
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian (probably Virgilian)
8. Field occurrence: arroyo wall, west side
9. Rock field description: Shale, medium dark grey, weathers light grey to medium greenish grey. Closely spaced fractures with pronounced red iron staining in fractures
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: gypsiferous fine-grained fill in cut to left at top of exposure
14. References: Hardie (1958); Kottlowski (1960)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-H-4
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/9/97
5. Location:
   Quadrangle name: Mountain Tank
   Quadrangle scale: 1:24,000
   Legal description: sec. 32, T 25S, R 10E
   GPS coordinates: N 32° 5'00"; W 105° 57' 00"
6. Rock unit (formation, member, etc.): Hueco Formation
7. Rock age: Permian (Wolfcampian)
8. Field occurrence: small outcrop on NE side of hill, approximately 50 ft from base of hill
9. Rock field description: cherty micritic limestone; lime mudstone; dark grey; in beds approximately 2 ft thick
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Hardie (1958)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-OR-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/11/97
5. Location:
   Quadrangle name: Orogrande North
   Quadrangle scale: 1:24,000
   Legal description: sec. 23, T 21S, R 8E
   GPS coordinates: N 32° 28' 13.4"; W 106° 05' 43.7"
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: east side of hill, poor exposures
9. Rock field description: black micritic limestone; alternating beds 2 to 4 inches thick of finely laminated limestone and limestone with blocky granule- to cobble-size intraclasts of lime mudstone in a lime mudstone matrix
10. Rock structures: gentle dip to north
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Seager et al (1987)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-OR-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/11/97
5. Location:
   Quadrangle name: Orogrande North
   Quadrangle scale: 1:24,000
   Legal description: sec. 14, T 21S, R 8E
   GPS coordinates: N 32° 28' 26.4"; W 106° 05' 57.0"
6. Rock unit (formation, member, etc.): Hueco Formation
7. Rock age: Permian (Wolfcampian)
8. Field occurrence: ledge at top of hill, south facing
9. Rock field description: Limestone - medium-grey wackestone from biohermal buildup; buildup consists of lenticular and wavy beds 1/2 to 2 ft thick of wackestones and packstones. This is probably the flank of the bioherm
10. Rock structures: north-tilting fault block
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 21, photo 22
13. Remarks:
14. References: Seager et al (1987)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/12/97
5. Location:
   - Quadrangle name: Culp Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 34, T 19S, R 11E
   - GPS coordinates: N 32° 36' 48"; W 105° 48' 1"
6. Rock unit (formation, member, etc.): Mississippian
7. Rock age: Mississippian
8. Field occurrence: at bottom of canyon, north side
9. Rock field description: Shale, black; these shales are thinly interbedded with limestones
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/12/97
5. Location:
   - Quadrangle name: Culp Canyon
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 34, T 19S, R 11E
   - GPS coordinates: N 32° 36' 48"; W 105° 48' 1"
6. Rock unit (formation, member, etc.): Mississippian
7. Rock age: Mississippian
8. Field occurrence: near base of Canyon on south wall; located approximately 100 ft downsection from sample RB-SAC1
9. Rock field description: Limestone, medium-grey; limestones are thinly interbedded with dark-grey shales
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 28
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/12/97
5. Location:
    Quadrangle name: Culp Canyon
    Quadrangle scale: 1:24,000
    Legal description: sec. 34, T 19S, R 11E
    GPS coordinates: N 32° 36' 55"; W 105° 48' 00"
6. Rock unit (formation, member, etc.): Canutillo Formation?
7. Rock age: Devonian
8. Field occurrence: ledge forming lower part of canyon wall
9. Rock field description: Black chert, thinly bedded and laminated, brecciated; extremely resistant to erosion
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 31, photo 32
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-4
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/12/97
5. Location:
    Quadrangle name: Culp Canyon
    Quadrangle scale: 1:24,000
    Legal description: sec. 34, T 19S, R 11E
    GPS coordinates: N 32° 36' 55"; W 105° 48' 00"
6. Rock unit (formation, member, etc.): Fusselman Formation
7. Rock age: Silurian
8. Field occurrence: dip slope forms canyon floor
9. Rock field description: Dolostone, medium-grey, finely crystalline
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 31, photo 32
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-5
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/29/97
5. Location:
   Quadrangle name: Bug Scuffle Canyon
   Quadrangle scale: 1:24,000
   Legal description: sec. 12 T 19S, R 10E
   GPS coordinates: N 32° 40' 15"; W 105° 51' 55"
6. Rock unit (formation, member, etc.): Montoya Group
7. Rock age: Ordovician (Upper)
8. Field occurrence: northeast side of hill that forms the south wall of the entrance to Negro Ed Canyon
9. Rock field description: Dolostone, medium grey, microcrystalline. Medium bedded. Similar dolostones above and below are thin to medium bedded. This sample is in the upper third of the Montoya Group.
10. Rock structures: beds dip steeply to east
11. Measured section (yes, no): no
12. Sample locality photo number(s): roll 2, photo 1
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-6
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/29/97
5. Location:
   Quadrangle name: Bug Scuffle Canyon
   Quadrangle scale: 1:24,000
   Legal description: sec. 7 T 19S, R 11E
   GPS coordinates: N 32° 40' 14"; W 105° 51' 54"
6. Rock unit (formation, member, etc.): Valmont Dolomite
7. Rock age: Ordovician (Upper)
8. Field occurrence: on hillside approximately 80 ft above road. Hill forms south wall of entrance to Negro Ed Canyon
9. Rock field description:
10. Rock structures: Beds dip steeply to east
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 2, photo 2, photo 3
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-7
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/29/97
5. Location:
   Quadrangle name: Bug Scuffle Canyon
   Quadrangle scale: 1:24,000
   Legal description: sec. 18 T 19S, R 11E
   GPS coordinates: N 32° 39' 37"; W 105° 51' 45"
6. Rock unit (formation, member, etc.): El Paso Group
7. Rock age: Ordovician (Upper)
8. Field occurrence: ledge outcrop on slope, west side of ridge
9. Rock field description: Dolostone, medium grey, finely macrocrystalline. Thinly bedded.
10. Rock structures: strata dip east
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 2, photo 5
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-8
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/29/97
5. Location:
   Quadrangle name: Bug Scuffle Canyon
   Quadrangle scale: 1:24,000
   Legal description: sec. 18 T 19S, R 11E
   GPS coordinates: N 32° 39' 40"; W 105° 51' 18"
6. Rock unit (formation, member, etc.): Lake Valley Formation
7. Rock age: Mississippian
8. Field occurrence: Hillslope, west edge of ridge near top of ridge
9. Rock field description: Limestone, micritic - lime mudstone, very dark grey to black. Thin bedded. Sample location approximately 5 ft above Mississippian-Devonian contact
10. Rock structures: Strata dip steeply east
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SAC-9
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/29/97
5. Location:
   Quadrangle name: Bug Scuffle Canyon
   Quadrangle scale: 1:24,000
   Legal description: sec. 18 T 19S, R 11E
   GPS coordinates: N 32° 39' 40"; W 105° 51' 20"
6. Rock unit (formation, member, etc.): Sly Gap Formation or Percha Shale
7. Rock age: Devonian
8. Field occurrence: on covered slope, approximately 10 ft above top of Fusselman Formation
9. Rock field description: Shale, very dark grey, weathers to mostly covered slope, in thick bed. Devonian shale appears to be approximately 120 ft thick in this area - consists of interbedded very dark grey to black shale and medium to light grey shale. Beds are thin to thick. Overlain by unit 5 ft thick of interbedded black chert and limestone with limestone prevalent in lower and black chert prevalent in upper part.
10. Rock structures: strata dip steeply east
11. Measured section (yes, no): no
12. Sample locality photo number(s): photo taken from top of ridge to northwest. Erik Munroe taking samples in photo.
13. Remarks:
14. References: Pray (1961)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SEA-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/12/97
5. Location:
   Quadrangle name: Bassett Lake
   Quadrangle scale: 1:62,500
   Legal description: sec. 18 T 26S, R 11E
   GPS coordinates: N 32° 2' 41"; W 105° 51' 35" (determined from topo map)
6. Rock unit (formation, member, etc.): Hueco Formation
7. Rock age: Permian
8. Field occurrence: 3300-3400 ft. depth; cuttings; Seaboard Oil Co. No. 1 Trigg well
9. Rock field description: Shale, light to medium grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SEA-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/12/97
5. Location:
    Quadrangle name: Bassett Lake
    Quadrangle scale: 1:62,500
    Legal description: sec. 18 T 26S, R 11E
    GPS coordinates: N 32° 2' 41"; W 105° 51' 35" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: 4000-4200 ft. depth; cuttings; Seaboard Oil Co. No. 1 Trigg well
9. Rock field description: Shale, light to medium grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SEA-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/13/97
5. Location:
    Quadrangle name: Bassett Lake
    Quadrangle scale: 1:62,500
    Legal description: sec. 18 T 26S, R 11E
    GPS coordinates: N 32° 2' 41"; W 105° 51' 35" (determined from topo map)
6. Rock unit (formation, member, etc.): Fusselman Formation
7. Rock age: Silurian
8. Field occurrence: 5050-5360 ft. depth; cuttings; Seaboard Oil Co. No. 1 Trigg well
9. Rock field description: Dolomite, greenish to dark grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SP-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   Quadrangle name: Escondido Canyon
   Quadrangle scale: 1:62,500
   Legal description: sec. 35 T 20S, R 10E
   GPS coordinates: N 32° 31' 14"; W 105° 53' 9"
6. Rock unit (formation, member, etc.): Hueco Formation
7. Rock age: Permian
8. Field occurrence: 1350-1450 ft. depth; cuttings; Sun Oil No. 1 T.J. Pearson
9. Rock field description: Limestone, light to medium grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SP-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   Quadrangle name: Escondido Canyon
   Quadrangle scale: 1:62,500
   Legal description: sec. 35 T 20S, R 10E
   GPS coordinates: N 32° 31' 14"; W 105° 53' 9" (determined form topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: 2350-2550 ft. depth; cuttings; Sun Oil No. 1 T.J. Pearson
9. Rock field description: Limestone, medium to dark grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SP-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/11/97
5. Location:
   - Quadrangle name: Escondido Canyon
   - Quadrangle scale: 1:62,500
   - Legal description: sec. 35 T 20S, R 10E
   - GPS coordinates: N 32° 31' 14"; W 105° 53' 9" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: 3500-3700 ft. depth; cuttings; Sun Oil No. 1 T.J. Pearson
9. Rock field description: Limestone, medium to dark grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-SP-4
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/11/97
5. Location:
   - Quadrangle name: Escondido Canyon
   - Quadrangle scale: 1:62,500
   - Legal description: sec. 35 T 20S, R 10E
   - GPS coordinates: N 32° 31' 14"; W 105° 53' 9" (determined from topo map)
6. Rock unit (formation, member, etc.): Mississippian (undivided)
7. Rock age: Mississippian
8. Field occurrence: 4200-4270 ft. depth; cuttings; Sun Oil No. 1 T.J. Pearson
9. Rock field description: Limestone, medium to dark grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-STD-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 6/19/97
5. Location:
   - Quadrangle name: Canon Agua Buena
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 9 T5S , R 2E
   - GPS coordinates: N 33° 53' 33.6"; W 106° 43' 55.3"
6. Rock unit (formation, member, etc.): Lower Mancos Shale
7. Rock age: Upper Cretaceous
8. Field occurrence: Minor outcrop at base of hill
9. Rock field description: Shale, black, clayey, with abundant wood fragments
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: Standard sample of black shale for petroleum source rock analysis
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-STD-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/21/97
5. Location:
   - Quadrangle name: Pink Peak
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 8 T 6S, R 7E
   - GPS coordinates: N 33° 53' 06.9"; W 106° 24' 49.6"
6. Rock unit (formation, member, etc.): San Andres Formation
7. Rock age: Permian (Leonardian)
8. Field occurrence: East end of south side of road cut on Highway 380
9. Rock field description: Black micritic limestone - lime mudstone. Thinly bedded.
10. Rock structures: Karsted slumping of San Andres evident in area.
11. Measured section (yes, no): no
12. Sample locality photo number(s): none
13. Remarks: milepost 40 on U.S. Highway 380
14. References: Standard sample of organic-rich micritic limestone for petroleum source rock analysis

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-TB-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Broadhead
4. Field Date (mo/day/yr): 5/9/97
5. Location:
   Quadrangle name: Desert
   Quadrangle scale: 1:24,000
   Legal description: sec. 7, T 25S, R 8E
   GPS coordinates: N 32° 08' 38.2"; W 106° 10' 9.6"
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: base of outcrop in prospect wall; westernmost butte of Three Buttes
9. Rock field description: Limestone, very dark grey, micritic - lime mudstone; bed approximately 2 ft thick; many irregularly shaped chert nodules 6 inches to 2 ft in diameter. Sparse brachiopod fauna (productids?)
10. Rock structures: gentle east dip
11. Measured section (yes, no): no
12. Sample locality photo number(s): Roll 1 - photo 1, photo 2
13. Remarks: cliff composed of limestone in beds 1 to 10 ft thick; limestones are dark-grey to medium-grey in color. Interbedded lighter-grey limestones are mostly wackestones with fauna of crinoid "hashes" and brachiopod and molluscan fragments. Many of the lighter-grey beds have undulatory upper surfaces with 1 to 2 ft of depositional relief. A few pieces of float appear to be pelletal or oolitic grainstones which must have come from inaccessable beds farther up the butte.
14. References: Seager et al (1987)

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-ZP-1
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   Quadrangle name: Pinon
   Quadrangle scale: 1:24,000
   Legal description: sec. 14 T 20S, R 14E
   GPS coordinates: N 32° 33' 51"; W 105° 29' 17" (determined from topo map)
6. Rock unit (formation, member, etc.): Hueco Formation
7. Rock age: Permian
8. Field occurrence: 2500-2600 ft. depth; cuttings; Zapata Petroleum No. 1 Federal 14
9. Rock field description: Limestone, grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-ZP-2
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   - Quadrangle name: Pinon
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 14 T 20S, R 14E
   - GPS coordinates: N 32° 33' 51"; W 105° 29' 17" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: 3464-3500 ft. depth; cuttings; Zapata Petroleum No. 1 Federal 14
9. Rock field description: Shale, black
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

PETROLEUM SOURCE ROCK CHARACTERIZATION AND SAMPLING PROGRAM
Field Description

1. Sample Number: RB-ZP-3
2. Project: McGregor Range Mineral Resource Evaluation
3. Collector: Rone
4. Field Date (mo/day/yr): 6/10/97
5. Location:
   - Quadrangle name: Pinon
   - Quadrangle scale: 1:24,000
   - Legal description: sec. 14 T 20S, R 14E
   - GPS coordinates: N 32° 33' 51"; W 105° 29' 17" (determined from topo map)
6. Rock unit (formation, member, etc.): Panther Seep Formation
7. Rock age: Pennsylvanian
8. Field occurrence: 4800-4900 ft. depth; cuttings; Zapata Petroleum No. 1 Federal 14
9. Rock field description: Shale, black to grey
10. Rock structures:
11. Measured section (yes, no): no
12. Sample locality photo number: none
13. Remarks:
14. References:

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-1RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: select dump		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-2RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: 3 ft chip across replacement pod		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-3RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: select dump		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated red limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-4RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: select outcrop of wall of trench		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides, chrysocolla		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-5RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: 2 ft vertical chip		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, iron oxides		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-6RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: select dump		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-7RM		**COLLECTOR**: VTM
AREA: Red Lake		**FIELD DATE**: 3/5/97
MINING DISTRICT: Red Lake		
PROPERTY NAME: Red Lake		
QUADRANGLE: Red Lake		**SCALE**: 1:24,000
TOWNSHIP: 17S	**RANGE**: 28E	**SECTION**: C29
LATITUDE: 32° 48' 3"		**LONGITUDE**: 104° 11' 35"
SAMPLE TYPE: select dump		
ROCK TYPE: Permian Yeso? limestone		
ALTERATION: replacement pods in fractured and brecciated limestone		
MINERALIZATION: hemimorphite, malachite, iron oxides, barite, dolomite, wulfenite		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-8RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/6/97
MINING DISTRICT: Calumet		
PROPERTY NAME: Lucky 13 mine		
QUADRANGLE: El Paso Gap		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 21E	**SECTION**: 15
LATITUDE: 32° 2' 17"		**LONGITUDE**: 104° 46' 50"
SAMPLE TYPE: 2 ft chip		
ROCK TYPE: Seven Rivers Formation limestone		
ALTERATION: Fe oxides		
MINERALIZATION: clay, quartz		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-9RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/6/97
MINING DISTRICT: Calumet		
PROPERTY NAME: Lucky 13 mine		
QUADRANGLE: El Paso Gap		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 21E	**SECTION**: 15
LATITUDE: 32° 2' 17"		**LONGITUDE**: 104° 46' 50"
SAMPLE TYPE: dump grab		
ROCK TYPE: Seven Rivers Formation limestone		
ALTERATION: Fe oxides		
MINERALIZATION: clay, quartz		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-10RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/6/97
MINING DISTRICT: Guadalupe Mountains		
PROPERTY NAME: Devils Den mine		
QUADRANGLE: El Paso Gap		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 21E	**SECTION**: 15
LATITUDE: 32° 1' 51"		**LONGITUDE**: 104° 46' 2"
SAMPLE TYPE: select dump		
ROCK TYPE: Seven Rivers Formation limestone		
ALTERATION: Fe oxides		
MINERALIZATION: malachite, azurite, bornite, pyrite, clay, quartz		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-11RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/6/97
MINING DISTRICT: Calumet		
PROPERTY NAME: Devils Den mine		
QUADRANGLE: El Paso Gap		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 21E	**SECTION**: 15
LATITUDE: 32° 1' 51"		**LONGITUDE**: 104° 46' 2"
SAMPLE TYPE: 1 ft vertical chip		
ROCK TYPE: Seven Rivers Formation limestone		
ALTERATION: Fe oxides		
MINERALIZATION: malachite, azurite, bornite, pyrite, clay, quartz		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-12RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/7/97
MINING DISTRICT: Lone Eagle		
PROPERTY NAME: Golden Eagle		
QUADRANGLE: Carlsbad West		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 25E	**SECTION**: SW 14
LATITUDE: 32° 28' 27"		**LONGITUDE**: 104° 21' 58"
SAMPLE TYPE: 2 ft chip		
ROCK TYPE: Yates Formation sandstone		
ALTERATION: Fe oxides, organic material		
MINERALIZATION: malachite, azurite, bornite, pyrite, tenorite, chalcocite		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-18RM		**COLLECTOR**: VTM
AREA: Guadalupe Mountains		**FIELD DATE**: 3/7/97
MINING DISTRICT: Lone Eagle		
PROPERTY NAME: Golden Eagle		
QUADRANGLE: Carlsbad West		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 25E	**SECTION**: SW 14
LATITUDE: 32° 2' 10"		**LONGITUDE**: 104° 27' 15"
SAMPLE TYPE: dump		
ROCK TYPE: Seven Rivers Formation limestone		
ALTERATION: Fe oxides		
MINERALIZATION: pyrite		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-50M		**COLLECTOR**: VTM
AREA: Three Buttes		**FIELD DATE**: 5/9/97
MINING DISTRICT: Three Buttes		
PROPERTY NAME: western Three Buttes		
QUADRANGLE: Desert		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 8E	**SECTION**: NW SW 7
LATITUDE: 32° 8' 32"		**LONGITUDE**: 106° 9' 57"
SAMPLE TYPE: 2 inch chip of calcite vein along fracture, strike N125°, vertical dip, 5 ft long		
ROCK TYPE: Panther Seep limestone		
ALTERATION: reddish stain (iron oxides) along bedding plane		
MINERALIZATION: calcite, minor iron oxides		
PHOTO NUMBER: VTM97-50a,b,c		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-51		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: Three Buttes		
QUADRANGLE: Desert		**SCALE:** 1:24,000
TOWNSHIP: 25S	**RANGE:** 8E	**SECTION**: NW SW 7
LATITUDE: 32° 8' 32"		**LONGITUDE**: 106° 9' 57"
ROCK UNIT: Panther Seep Formation-sampled black chert within limestone		
ROCK AGE: Pennsylvanian		
FIELD OCCURRENCE: outcrop of chert		
ROCK DESCRIPTION: black chert lenses within massive limestone		
ROCK STRUCTURES: fractures		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-50a, 51		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-52		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: Three Buttes		
QUADRANGLE: Desert	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 6E	**SECTION**: NW SW 7
LATITUDE: 32° 8' 32"	**LONGITUDE**: 106° 9' 57"	
ROCK UNIT: Panther Seep Formation-sampled black limestone		
ROCK AGE: Pennsylvanian		
FIELD OCCURRENCE: limestone outcrop		
ROCK DESCRIPTION: massive bedded limestone		
ROCK STRUCTURES: fractures, black chert lenses (sample VTM97-51)		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-50a, 51		
REMARKS: RB-TB1		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Three Buttes	**SAMPLE NUMBER**: VTM97-53S	
FIELD DATE: 5/9/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 32"	**LONGITUDE**: 106° 9' 58"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: NW SW 7
OTHER:		
SAMPLE DESCRIPTION: active channel coming off of the quarry- channel 1 ft wide, mostly blow sand		

STREAM SEDIMENT SAMPLE FORM

AREA: Three Buttes	**SAMPLE NUMBER**: VTM97-54S	
FIELD DATE: 5/9/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 57"	**LONGITUDE**: 106° 8' 14"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: monzonite	**SECTION**: C NW 16
OTHER:		
SAMPLE DESCRIPTION: blow sand with large pebbles of monzonite		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-55		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: Three Buttes		
QUADRANGLE: Desert	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 8E	**SECTION**: C NW 16
LATITUDE: 32° 8' 22"	**LONGITUDE**: 106° 8' 20"	
ROCK UNIT: quartz monzonite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: quartz, feldspar, biotite, epidote		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-55		
REMARKS: collected for hand specimen, thin section, chemistry, age?		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: south of Red Hill, Hueco Mountains	**SAMPLE NUMBER**: VTM97-56S	
FIELD DATE: 5/9/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 4"	**LONGITUDE**: 105° 57' 59"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: NENE 25
OTHER:		
SAMPLE DESCRIPTION: limestone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-57		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: south of Red Hill, Hueco Mountains		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE SE 24
LATITUDE: 32° 1' 20"	**LONGITUDE**: 105° 58' 21"	
ROCK UNIT: Panther Seep Formation		
ROCK AGE: Pennsylvanian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray micrite		
ROCK STRUCTURES: calcite veins (mm wide)		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: RB-H-1		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-58		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: Red Hill, Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NE SW 24
LATITUDE: 32° 1' 48"		**LONGITUDE**: 105° 58' 48"
ROCK UNIT: Panther Seep Formation		
ROCK AGE: Pennsylvanian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: black shale with iron oxides on fractures and bedding planes		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: RB-H-3		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-59M		**COLLECTOR**: VTM
AREA: McGregor		**FIELD DATE**: 5/9/97
MINING DISTRICT: Red Hill, Hueco Mountains		
PROPERTY NAME: none		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NE SW 24
LATITUDE: 32° 1' 48"		**LONGITUDE**: 105° 58' 48"
SAMPLE TYPE: 1 inch chip select of calcite veins, no strike		
ROCK TYPE: hosted by limestone		
ALTERATION: iron oxides, bleaching		
MINERALIZATION: calcite, iron oxides		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-60		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/9/97		
LOCATION: Red Hills, Hueco Mountains		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: C24
LATITUDE: 32° 1' 39"	**LONGITUDE**: 105° 58' 38"	
ROCK UNIT: alkali-feldspar trachyte sill in Panther Seep Formation		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: weathered and altered trachyte, green to green-gray		
ROCK STRUCTURES: fractures with iron oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Red Hill, Hueco Mountains	**SAMPLE NUMBER**: VTM97-61S	
FIELD DATE: 5/9/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 41"	**LONGITUDE**: 105° 58' 39"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: diorite, limestone	**SECTION**: C 24
OTHER: diorite sill upstream, sample VTM97-60		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Red Hill, Hueco Mountains	**SAMPLE NUMBER**: VTM97-62S	
FIELD DATE: 5/9/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 58"	**LONGITUDE**: 105° 58' 31"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE NW 24
OTHER:		
SAMPLE DESCRIPTION: drains Red Hill intrusion		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-63		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/20/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 10E	**SECTION**: NE NE 33
LATITUDE: 32° 5' 20"	**LONGITUDE**: 105° 55' 5"	
ROCK UNIT: trachyte sill		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: porphyritic, tan; quartz, feldspar, hornblende		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: sampled for thin section, chemistry, hand specimen, age date?		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-64S	
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 17"	**LONGITUDE**: 105° 55' 7"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW NE 33
OTHER:		
SAMPLE DESCRIPTION: 4 ft channel, mostly <4 mm		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-65S	
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 16"	**LONGITUDE**: 105° 55' 4"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: none	**SECTION**: SW NE 33
OTHER:		
SAMPLE DESCRIPTION: mostly <4 mm		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-66S	
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 25S
LATITUDE: 32° 4' 58"	**LONGITUDE**: 105° 54' 40"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: none	**SECTION**: SE SW 34
OTHER:		
SAMPLE DESCRIPTION: mostly <4 mm silt and sand		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-67		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/10/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Owl Tank Canyon East	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 10E	**SECTION**: C E 13
LATITUDE: 32° 7' 43"	**LONGITUDE**: 105° 52' 20"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: red shale-possibly Abo tongue		
ROCK STRUCTURES: white zones forming fractures		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-67 of hill		
REMARKS: RB-H-4		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-68		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/10/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Owl Tank Canyon East	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 10E	**SECTION**: NE 13
LATITUDE: 32° 7' 43"	**LONGITUDE**: 105° 52' 19"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: brown-gray, grainy limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-67 of hill		
REMARKS: above VTM97-68, RB-H-4		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-69		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/10/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Owl Tank Canyon East	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 10E	**SECTION**: NE 13
LATITUDE: 32° 7' 44"	**LONGITUDE**: 105° 52' 21"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: red sandstone, beach facies		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-67 of hill		
REMARKS: marked with red VTM		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-70S	
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**:	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 22"	**LONGITUDE**: 105° 53' 8"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: C S 11
OTHER:		
SAMPLE DESCRIPTION: mostly <4mm		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-71S	
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 44"	**LONGITUDE**: 105° 54' 36"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW SW 10
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-72S	
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**:	**TOWNSHIP**: 24S
LATITUDE: 32° 10' 37"	**LONGITUDE**: 105° 56' 7"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: none	**SECTION**: NW NE 32
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-73S
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 24S
LATITUDE: 32° 10' 55"	**LONGITUDE**: 105° 59' 11"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: none	**SECTION**: NE 35
OTHER:		
SAMPLE DESCRIPTION: 3 ft channel, downstream of road		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-74S
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 11"	**LONGITUDE**: 105° 59' 32"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW SW 11
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 3 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-75S
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 19"	**LONGITUDE**: 105° 59' 41"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW SW 11
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 4 ft channel		

Numbers VTM97-76 to -80 are for standard and duplicate samples

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-81S
FIELD DATE: 5/10/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert NE	**TOWNSHIP**: 25S
LATITUDE: 32° 8' 22"	**LONGITUDE**: 106° 00' 53"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NE SE 9
OTHER:		
SAMPLE DESCRIPTION: 3 ft channel in 15 ft wide stream		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-82		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/10/97		
LOCATION: Hueco Mountains, School Tank		
QUADRANGLE: Desert NE	**SCALE**: 1:24,000	
TOWNSHIP: 25S	**RANGE**: 9E	**SECTION**: SE 9
LATITUDE: 32° 8' 23"	**LONGITUDE**: 106° 00' 55"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: massive gray limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-82		
REMARKS:		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande, north Monte Carlo Gap	**SAMPLE NUMBER**: VTM97-83S	
FIELD DATE: 5/11/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 21S
LATITUDE: 32° 28' 19"	**LONGITUDE**: 106° 5' 28"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: diorite or monzonite	**SECTION**: NW NW NE 23
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande, south Monte Carlo Gap	**SAMPLE NUMBER**: VTM97-84S	
FIELD DATE: 5/11/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 21S
LATITUDE: 32° 27' 50"	**LONGITUDE**: 106° 5' 25"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE SW NW 23
OTHER: same locality as VTM97-85C		
SAMPLE DESCRIPTION: 4 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande, south Monte Carlo Gap	**SAMPLE NUMBER**: VTM97-85C	
FIELD DATE: 5/11/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 21S
LATITUDE: 32° 27' 50"	**LONGITUDE**: 106° 5' 25"	**RANGE**: 8E
SAMPLE TYPE: concentrate sample	**OUTCROP**: alluvium	**SECTION**: SE SE NW 23
OTHER:		
SAMPLE DESCRIPTION: same locality as VTM97-84S		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-86S
FIELD DATE: 5/11/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 6"	**LONGITUDE**: 106° 6' 5"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NE 34
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-87S
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 36' 18"	**LONGITUDE**: 105° 5' 44"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: sand dunes	**SECTION**: NE SE SE 36
OTHER: concentrate sample VTM97-88C, float chip sample VTM97-89F(59F), photo VTM97-87S		
SAMPLE DESCRIPTION: limestone gravel, <1% Fe oxides		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-88C
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 36' 18"	**LONGITUDE**: 105° 51' 44"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: sand dunes	**SECTION**: NE SE SE 36
OTHER: stream sediment VTM97-87S, float chip sample VTM97-89F(59F), photo VTM97-87S		
SAMPLE DESCRIPTION: limestone gravel, <1% Fe oxides		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-89F(59)F		**COLLECTOR**: VTM
AREA: Sacramento Mountains		**FIELD DATE**: 5/12/97
MINING DISTRICT: Culp Canyon		
PROPERTY NAME:		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 19S	**RANGE**: 10E	**SECTION**: NE SE SE 36
LATITUDE: 32° 36' 18"		**LONGITUDE**: 105° 51' 44"
SAMPLE TYPE: float chip		
ROCK TYPE: altered limestone (some large boulders up to 6 inches long)		
ALTERATION: Fe oxides, silica, chert, calcite		
MINERALIZATION:		
PHOTO NUMBER: VTM97-87S		
OTHER: stream sediment sample VTM97-87S, concentrate sample VTM97-88C		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-90S
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 36' 14"	**LONGITUDE**: 105° 46' 54"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: SW SE 35
OTHER:		
SAMPLE DESCRIPTION: mostly limestone gravel, 6 ft wide channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-91S
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 36' 16"	**LONGITUDE**: 105° 46' 53"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: SW SE 35
OTHER:		
SAMPLE DESCRIPTION: mostly limestone gravel, 6 ft wide channel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-92		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/12/97		
LOCATION: Sacramento Mountains-Grapevine Canyon		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NE NE 34
LATITUDE: 32° 36' 47"		**LONGITUDE**: 105° 47' 52"
ROCK UNIT: Helms or Rancheria Formation		
ROCK AGE: Upper Mississippian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: thinly bedded shale within limestone		
ROCK STRUCTURES: fault block		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: sampled limestone VTM97-93		
REFERENCES: Pray (1961, sheet 2)		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-93		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/12/97		
LOCATION: Sacramento Mountains-Grapevine Canyon		
QUADRANGLE: Culp Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NE NE 34
LATITUDE: 32° 36' 47"	**LONGITUDE**: 105° 47' 52"	
ROCK UNIT: Helms or Rancheria Formation		
ROCK AGE: Upper Mississippian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: thinly bedded limestone with thinly bedded shale		
ROCK STRUCTURES: fault block		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: sampled shale VTM97-92		
REFERENCES: Pray (1961, sheet 2)		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-94		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/12/97		
LOCATION: Sacramento Mountains-Grapevine Canyon		
QUADRANGLE: Culp Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NE NE 34
LATITUDE: 32° 36' 34"	**LONGITUDE**: 105° 47' 41"	
ROCK UNIT: possibly Fusselman Formation		
ROCK AGE: Silurian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: massive bedded dolostone		
ROCK STRUCTURES: fault block		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: VTM97-95 Devonian chert collected		
REFERENCES: Pray (1961, sheet 2)		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-95		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/12/97		
LOCATION: Sacramento Mountains-Grapevine Canyon		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NE NE 34
LATITUDE: 32° 36' 34"		**LONGITUDE**: 105° 47' 41"
ROCK UNIT: possibly Sly Gap Formation		
ROCK AGE: Devonian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: banded chert formation		
ROCK STRUCTURES: fault block		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: VTM97-93-94 collected		
REFERENCES: Pray (1961, sheet 2)		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-96M		**COLLECTOR**: VTM
AREA: McGregor		**FIELD DATE**: 5/12/97
MINING DISTRICT: Sacramento Mountains-Grapevine Canyon		
PROPERTY NAME: Grapevine Canyon		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: SW 34
LATITUDE: 32° 36' 31"		**LONGITUDE**: 105° 47' 21"
SAMPLE TYPE: Fe oxides in sandstone, 2 ft vertical chip across bed		
ROCK TYPE: sandstone		
ALTERATION:		
MINERALIZATION: calcite, Fe oxides		
PHOTO NUMBER: VTM97-96a,b		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains-Pipeline Canyon		**SAMPLE NUMBER**: VTM97-97S
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 35' 56"	**LONGITUDE**: 105° 49' 20"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: C N 4
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains-Pipeline Canyon		**SAMPLE NUMBER**: VTM97-98S
FIELD DATE: 5/12/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 35' 57"	**LONGITUDE**: 105° 49' 20"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: C N 4
OTHER:		
SAMPLE DESCRIPTION:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-99S
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Bug Scuffle Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 37' 33"	**LONGITUDE**: 105° 50' 30"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW SE 29
OTHER:		
SAMPLE DESCRIPTION: limestone gravel and boulders		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-100S		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/13/97		
LOCATION: Sacramento Mountains-Culp Canyon		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 11E	**SECTION**: NE 7
LATITUDE: 32° 34' 57"		**LONGITUDE**: 105° 50' 51"
ROCK UNIT: blow sand, orange sand dunes		
ROCK AGE: Quaternary		
FIELD OCCURRENCE: surface		
ROCK DESCRIPTION: sand		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

Skip VTM97-101-105 for standards and duplicates

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains-Culp Canyon	**SAMPLE NUMBER**: VTM97-106S	
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 47"	**LONGITUDE**: 105° 50' 39"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, dune sand	**SECTION**: NE NE SE 7
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 30 ft channel, sampled 10 ft trench in active channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains-Culp Canyon	**SAMPLE NUMBER**: VTM97-107S	
FIELD DATE: 5/13/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 45"	**LONGITUDE**: 105° 50' 40"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, sand dune	**SECTION**: SE 7
OTHER:		
SAMPLE DESCRIPTION: limestone and tan sandstone gravel, 10 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-108S	
FIELD DATE: 5/13/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 48"	**LONGITUDE**: 105° 47' 2"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: C S S 23
OTHER:		
SAMPLE DESCRIPTION: 8 ft channel, limestone gravel		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-109M	**COLLECTOR**: VTM	
AREA: Culp Canyon	**FIELD DATE**: 5/13/97	
MINING DISTRICT: Sacramento Mountains		
PROPERTY NAME: Culp Canyon		
QUADRANGLE: Culp Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 20S	**RANGE**: 11E	**SECTION**: NW NW NW 25
LATITUDE: 32° 32' 42"	**LONGITUDE**: 105° 46' 30"	
SAMPLE TYPE: 2 ft chip		
ROCK TYPE: limestone		
ALTERATION: Fe oxides, calcite		
MINERALIZATION:		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-110S	
FIELD DATE: 5/13/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 43"	**LONGITUDE**: 105° 46' 31"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: C S S 23
OTHER:		
SAMPLE DESCRIPTION: limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains-Culp Canyon	**SAMPLE NUMBER**: VTM97-111S	
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 42"	**LONGITUDE**: 105° 44' 55"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE18
OTHER:		
SAMPLE DESCRIPTION: 25 ft channel, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-112S	
FIELD DATE: 5/13/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 6"	**LONGITUDE**: 105° 45' 47"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NE 24
OTHER:		
SAMPLE DESCRIPTION: limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-113S	
FIELD DATE: 5/13/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 42"	**LONGITUDE**: 105° 44' 55"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: SE 18
OTHER:		
SAMPLE DESCRIPTION: 12 ft channel, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains, Tinney Tank	**SAMPLE NUMBER**: VTM97-114S	
FIELD DATE: 5/14/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 24S
LATITUDE: 32° 13' 27"	**LONGITUDE**: 105° 58' 50"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: SW 12
OTHER:		
SAMPLE DESCRIPTION: 1 ft channel, mostly <4 mm sand		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-115S	
FIELD DATE: 5/14/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 4' 10"	**LONGITUDE**: 105° 55' 23"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SW 4
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 3 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-116S	
FIELD DATE: 5/14/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 3' 57"	**LONGITUDE**: 105° 55' 26"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 4
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 3 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-117S	
FIELD DATE: 5/14/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 4' 37"	**LONGITUDE**: 105° 55' 46"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW 4
OTHER:		
SAMPLE DESCRIPTION: 1 ft channel in 30 ft arroyo, limestone gravel and boulders		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa-East Side	**SAMPLE NUMBER**: VTM97-118S	
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon East	**TOWNSHIP**: 24S
LATITUDE: 32° 12' 28"	**LONGITUDE**: 105° 47' 33"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: caliche, alluvium	**SECTION**: SE 15
OTHER:		
SAMPLE DESCRIPTION: 1 ft channel, mostly caliche gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa-North	**SAMPLE NUMBER**: VTM97-119S	
FIELD DATE: 5/14/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 22S
LATITUDE: 32° 21' 37"	**LONGITUDE**: 105° 45' 23"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NE SE 25
OTHER:		
SAMPLE DESCRIPTION: limestone in arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-120S	
FIELD DATE: 5/15/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 16"	**LONGITUDE**: 105° 40' 1"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, caliche	**SECTION**: C S 1
OTHER:		
SAMPLE DESCRIPTION: drainage approximately 2 ft, limestone and caliche crops out in arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon	**SAMPLE NUMBER**: VTM97-121S	
FIELD DATE: 5/15/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 52"	**LONGITUDE**: 105° 40' 2"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C N N 1
OTHER: photo VTM97-121S		
SAMPLE DESCRIPTION: 10 ft trench in 100 ft arroyo, limestone gravels with trace of sandstone		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon	**SAMPLE NUMBER**: VTM97-122C	
FIELD DATE: 5/15/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: EL Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 52"	**LONGITUDE**: 105° 40' 2"	**RANGE**: 12E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: C N N 1
OTHER: photo VTM97-121S		
SAMPLE DESCRIPTION: 10 ft trench in 100 ft arroyo, limestone gravels with trace of sandstone		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon	**SAMPLE NUMBER**: VTM97-123S	
FIELD DATE: 5/15/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 57"	**LONGITUDE**: 105° 40' 26"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE SE 26
OTHER:		
SAMPLE DESCRIPTION: 15 ft trench in 100 ft arroyo, limestone and minor sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon	**SAMPLE NUMBER**: VTM97-124S	
FIELD DATE:	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 6"	**LONGITUDE**: 105° 40' 55"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C SW 26
OTHER:		
SAMPLE DESCRIPTION: 12 ft trench in 15 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon	**SAMPLE NUMBER**: VTM97-125S	
FIELD DATE: 5/15/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 38"	**LONGITUDE**: 105° 41' 25"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: sandstone	**SECTION**: SE SE SE 22
OTHER: collected in the rain		
SAMPLE DESCRIPTION: 20 ft channel, limestone and sandstone gravel		

Skip VTM97-126-129 for standards and duplicates

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, El Paso Canyon		**SAMPLE NUMBER**: VTM97-130S
FIELD DATE: 5/15/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 41"	**LONGITUDE**: 105° 42' 6"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW SW 22
OTHER:		
SAMPLE DESCRIPTION: 8 ft trench in 10 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains, Sulfur Tank		**SAMPLE NUMBER**: VTM97-131S
FIELD DATE: 5/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert NE	**TOWNSHIP**: 24S
LATITUDE: 32° 14' 48"	**LONGITUDE**: 106° 1' 24"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, caliche	**SECTION**: 4
OTHER: photo VTM97-131S		
SAMPLE DESCRIPTION: 2 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains, South Tank		**SAMPLE NUMBER**: VTM97-132S
FIELD DATE: 5/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert NE	**TOWNSHIP**: 24S
LATITUDE: 32° 13' 36"	**LONGITUDE**: 106° 00' 27"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 12
OTHER: road follows and cuts drainage, photo VTM97-132S, military ordinance upstream		
SAMPLE DESCRIPTION: caliche float, 1 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hay Meadow Canyon		**SAMPLE NUMBER**: VTM97-133S
FIELD DATE: 5/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: T22S
LATITUDE: 32° 21' 53"	**LONGITUDE**: 105° 50' 14"	**RANGE**: R11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 29
OTHER:		
SAMPLE DESCRIPTION: 3 ft channel, limestone gravel float		

STREAM SEDIMENT SAMPLE FORM

AREA: Hay Meadow Canyon		**SAMPLE NUMBER**: VTM97-134S
FIELD DATE: 5/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 22S
LATITUDE: 32° 21' 54"	**LONGITUDE**: 105° 50' 41"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 30
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in a 40 ft arroyo, shrapnel in area, sandstone and limestone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-135		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/16/97		
LOCATION: Hay Meadow Canyon		
QUADRANGLE: Otero Mesa South	**SCALE**: 1:24,000	
TOWNSHIP: 22S	**RANGE**: 11E	**SECTION**: W C 30
LATITUDE: 32° 31' 44"	**LONGITUDE**: 105° 51' 23"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop, 5-8 ft thick beds		
ROCK DESCRIPTION: orange, medium-grained sandstone overlain by limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-136		
REMARKS: 6 inch sample, hand specimen, thin section, and chemistry samples taken		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-136		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/16/97		
LOCATION: Hay Meadow Canyon		
QUADRANGLE: Otero Mesa South	**SCALE**: 1:24,000	
TOWNSHIP: 22S	**RANGE**: 11E	**SECTION**: W C 30
LATITUDE: 32° 21' 44"	**LONGITUDE**: 105° 51' 23"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop, interbedded shales, siltstones, and limestones		
ROCK DESCRIPTION: orange siltstone to claystone interbedded with sandstone (VTM97-135)		
ROCK STRUCTURES: thinly laminated		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-136		
REMARKS: 1 inch chip sample of clay		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hay Meadow Canyon	**SAMPLE NUMBER**: VTM97-137S	
FIELD DATE: 5/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 22S
LATITUDE: 32° 21' 41"	**LONGITUDE**: 105° 51' 27"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C E 25
OTHER:		
SAMPLE DESCRIPTION: series of pits across 10 ft interval in a 80 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande, west of Alice mine	**SAMPLE NUMBER**: VTM97-138S	
FIELD DATE: 5/20/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 23' 14"	**LONGITUDE**: 106° 6' 22"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 15
OTHER: photo VTM97-138b, VTM97-139C from same site		
SAMPLE DESCRIPTION: 4 ft trench in 80 ft arroyo, draining west side of Three Bears Group, limestone and monzonite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande west of Alice	**SAMPLE NUMBER**: VTM97-139C	
FIELD DATE: 5/20/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 23' 14"	**LONGITUDE**: 106° 6' 22"	**RANGE**: 8E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: NW 15
OTHER: photo VTM97-138b, VTM97-138S from same site		
SAMPLE DESCRIPTION: 4.5 ft trench in 80 ft arroyo, draining west side of Three Bears mine, no large mines in drainage basin, limestone and monzonite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: West McAfee Canyon, Sacramento Mountains	**SAMPLE NUMBER**: VTM97-140S	
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 11"	**LONGITUDE**: 105° 40' 11"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C W 25
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench in 20 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: West McAfee Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-141S
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 25"	**LONGITUDE**: 105° 39' 28"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, limestone	**SECTION**: C E 25
OTHER:		
SAMPLE DESCRIPTION: 25 ft trench, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: West Mcafee Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-142S
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 32"	**LONGITUDE**: 105° 39' 13"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 30
OTHER:		
SAMPLE DESCRIPTION: 6 ft trench in 15 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: West McAfee Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM 97-143S
FIELD DATE: 5/20/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 39"	**LONGITUDE**: 105° 39' 12"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, caliche, alluvium	**SECTION**: NW NW 30
OTHER: photo VTM97-143S		
SAMPLE DESCRIPTION: 10 ft trench in 30 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: El Paso Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-144S
FIELD DATE: 5/20/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 44"	**LONGITUDE**: 105° 40' 3"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C SW 13
OTHER:		
SAMPLE DESCRIPTION: 10 ft trench in 30 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: El Paso Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-145S
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 15"	**LONGITUDE**: 105° 40' 40"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: caliche	**SECTION**: C NE 14
OTHER: Eric photo #3, same locality as VTM97-146F		
SAMPLE DESCRIPTION: 2 ft trench in 4 ft arroyo, base of waterfall, limestone gravel		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-146F		**COLLECTOR**: VTM, Eric Monroe
AREA: Sacramento Mountains		**FIELD DATE**: 5/20/97
MINING DISTRICT: El Paso Canyon		
PROPERTY NAME:		
QUADRANGLE: El Paso Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 12E	**SECTION**: C NE 14
LATITUDE: 32° 34' 15"		**LONGITUDE**: 105° 40' 40"
SAMPLE TYPE: float chip		
ROCK TYPE: altered limestone		
ALTERATION: minor Fe oxides, calcite		
MINERALIZATION: calcite veins		
PHOTO NUMBER:		
OTHER: same locality as VTM97-145S		

STREAM SEDIMENT SAMPLE FORM

AREA: EL Paso Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-147S
FIELD DATE: 5/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 19"	**LONGITUDE**: 105° 40' 39"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW NW NE 14
OTHER:		
SAMPLE DESCRIPTION: 4 ft channel, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: El Paso Canyon, Sacramento Mountains		**SAMPLE NUMBER**: VTM97-148S
FIELD DATE: 5/20/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 19"	**LONGITUDE**: 105° 40' 50"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C S S 11
OTHER: same locality as VTM97-149F		
SAMPLE DESCRIPTION: 10 ft trench in 30 ft arroyo, limestone gravel with trace of calcite veins		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-149F		**COLLECTOR**: VTM
AREA: Sacramento Mountains		**FIELD DATE**: 5/20/97
MINING DISTRICT: El Paso Canyon		
PROPERTY NAME:		
QUADRANGLE: El Paso Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 12E	**SECTION**: C S S 11
LATITUDE: 32° 34' 19"		**LONGITUDE**: 105° 40' 50"
SAMPLE TYPE: float chip		
ROCK TYPE: altered limestone		
ALTERATION: Fe oxides, silica, calcite		
MINERALIZATION:		
PHOTO NUMBER:		
OTHER: same site as VTM97-148S		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-150		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/21/97		
LOCATION: Jarilla Mountains (Orogrande)		
QUADRANGLE: Tres Hermanos SE		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 9E	**SECTION**: SE 6
LATITUDE: 32° 30' 15"		**LONGITUDE**: 106° 3' 50"
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop, highwall of quarry		
ROCK DESCRIPTION: brown shale interbedded with black limestone, shale has minor zones of red alteration		
ROCK STRUCTURES: thin calcite veins		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-150		
REMARKS: sample for chemistry and clay analyses, shale is 2 ft thick, highwall of pit is approximately 20 ft high and consists mostly of limestone		
REFERENCES: Seager et al. (1987)		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-151		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/21/97		
LOCATION: Jarilla Mountains (Orogrande)		
QUADRANGLE: Tres Hermanos SE	**SCALE**: 1:24,000	
TOWNSHIP: 21S	**RANGE**: 9E	**SECTION**: SE 6
LATITUDE: 32° 30' 15"	**LONGITUDE**: 106° 3' 50"	
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop, highwall of quarry		
ROCK DESCRIPTION: black limestone with minor interbeds of shale (VTM97-150), massive bedded, 2-4 ft thick		
ROCK STRUCTURES: thin calcite veins		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-150		
REMARKS: sample for chemistry, thin section, and hand specimen, petrid odor		
REFERENCES: Seager et al. (1987)		

STREAM SEDIMENT SAMPLE FORM

AREA: North Jarilla Mountains, Orogrande	**SAMPLE NUMBER**: VTM97-152S	
FIELD DATE: 5/21/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Tres Hermanos SE	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 28"	**LONGITUDE**: 106° 6' 26"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE NE 3
OTHER: same site as VTM97-153C		
SAMPLE DESCRIPTION: 3 ft trench in 5 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: North Jarilla Mountains, Orogrande	**SAMPLE NUMBER**: VTM97-153C	
FIELD DATE: 5/21/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Tres Hermanos SE	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 28"	**LONGITUDE**: 106° 6' 26"	**RANGE**: 8E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: SE NE 3
OTHER: same site as VTM97-152S		
SAMPLE DESCRIPTION: 3 ft trench in 5 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: North Jarilla Mountains, Orogrande	**SAMPLE NUMBER**: VTM97-154S	
FIELD DATE: 5/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 35' 25"	**LONGITUDE**: 106° 6' 25"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C N 3
OTHER: same site as VTM97-155C, standard collected, photo VTM97-154S		
SAMPLE DESCRIPTION: 8 ft trench in 50 ft arroyo, limestone, shale, sandstone, monzonite gravel, copper carbonates, grossularite, chalcopyrite, magnetite, hematite in gravel, mines upstream		

STREAM SEDIMENT SAMPLE FORM

AREA: Jarilla Mountains, Orogrande	**SAMPLE NUMBER**: VTM97-155C	
FIELD DATE: 5/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 25' 25"	**LONGITUDE**: 106° 6' 25"	**RANGE**: 8E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: C N 3
OTHER: photo VTM97-154S, same site as VTM97-154S		
SAMPLE DESCRIPTION: 8 ft trench in 50 ft arroyo, limestone, sandstone, monzonite gravel, Cu carbonate, grossularite, chalcopyrite, magnetite, hematite in gravel, mines upstream		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande near Three Bears mine	**SAMPLE NUMBER**: VTM97-156S	
FIELD DATE: 5/21/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 23' 41"	**LONGITUDE**: 106° 5' 55"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW NE NE 15
OTHER: same site as VTM97-157C		
SAMPLE DESCRIPTION: 4 ft trench in 50 ft arroyo downstream of Three Bears mine, limestone, monzonite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Orogrande, Three Bears mine	**SAMPLE NUMBER**: VTM97-157C	
FIELD DATE: 5/21/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande North	**TOWNSHIP**: 22S
LATITUDE: 32° 23' 41"	**LONGITUDE**: 106° 5' 55"	**RANGE**: 8E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: NW NE NE 15
OTHER: same site as VTM97-156S		
SAMPLE DESCRIPTION: 4 ft trench in 50 ft arroyo, downstream of Three Bears mine, limestone, monzonite gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-158		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/22/97		
LOCATION: Martin Canyon		
QUADRANGLE: Otero Mesa South	**SCALE**: 1:24,000	
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: NE 19
LATITUDE: 32° 17' 30"	**LONGITUDE**: 105° 51' 5"	
ROCK UNIT: Abo tongue in Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: brown, fine-grained sandstone, approximately 4 ft thick		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-158a,b,c		
REMARKS: Abo thicker here then reported in literature, collected VTM97-159, 160		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-159		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/22/97		
LOCATION: Martin Canyon		
QUADRANGLE: Otero Mesa South	**SCALE**: 1:24,000	
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: NE 19
LATITUDE: 32° 17' 30"	**LONGITUDE**: 105° 51' 5"	
ROCK UNIT: Abo tongue in Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: red silty fine-grained sandstone with calcite casts		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-158a,b,c		
REMARKS: VTM97-158, 160 collected		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-160		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/22/97		
LOCATION: Martin Canyon		
QUADRANGLE: Otero Mesa South	**SCALE**: 1:24,000	
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: NE 19
LATITUDE: 32° 17' 30"	**LONGITUDE**: 105° 51' 5"	
ROCK UNIT: Abo tongue in Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray siltstone, thinly bedded		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-158a,b,c		
REMARKS: VTM97-158, 159 collected		

Samples VTM97-161-164 for standards and duplicates

STREAM SEDIMENT SAMPLE FORM

AREA: Martin Canyon	**SAMPLE NUMBER**: VTM97-165S	
FIELD DATE: 5/22/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 23"	**LONGITUDE**: 105° 51' 24"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C 19
OTHER: upstream of burned area, photo VTM97-165S		
SAMPLE DESCRIPTION: 15 ft trench in 40 ft arroyo, limestone and sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Martin Canyon	**SAMPLE NUMBER**: VTM97-166C	
FIELD DATE: 5/22/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 23"	**LONGITUDE**: 105° 51' 24"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C 19
OTHER: sampled upstream of burn area		
SAMPLE DESCRIPTION: 15 ft trench in 40 ft arroyo, sandstone and limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Martin Canyon	**SAMPLE NUMBER**: VTM97-167S	
FIELD DATE: 5/22/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 16' 26"	**LONGITUDE**: 105° 52' 00"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW NE 25
OTHER:		
SAMPLE DESCRIPTION: < 4 mm material		

STREAM SEDIMENT SAMPLE FORM

AREA: South of Boyle Tanks		**SAMPLE NUMBER**: VTM97-168S
FIELD DATE: 5/22/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon West	**TOWNSHIP**: 24S
LATITUDE: 32°13' 13"	**LONGITUDE**: 105° 54' 40"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: NW 15
OTHER:		
SAMPLE DESCRIPTION: 2 ft channel in 30 ft arroyo, limestone and minor sandstone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-169		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/23/97		
LOCATION: Jarilla Mountains, Orogrande		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: NW 19
LATITUDE: 32° 22' 33"		**LONGITUDE**: 106° 3' 54"
ROCK UNIT: quartz monzonite porphyry		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: white, gray, black, porphyritic monzonite, feldspar, hornblende, biotite, quartz, weathers brown, numerous inclusions of hornfels and limestone		
ROCK STRUCTURES: columnar jointing		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-169a,b,C, 172		
REMARKS: sharp contact with sediments, no skarn or any alteration/mineralization		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-170		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/23/97		
LOCATION: Jarilla Mountains, South Orogrande		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: NW 19
LATITUDE: 32° 22' 32"		**LONGITUDE**: 106° 3' 53"
ROCK UNIT: shale in Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: thinly laminated brown to gray shale		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-170		
REMARKS: within 50 ft of intrusion		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-171		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/23/97		
LOCATION: Jarilla Mountains, South Orogrande		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: NW 19
LATITUDE: 32° 22' 32"		**LONGITUDE**: 106° 3' 53"
ROCK UNIT: Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: limestone, black, petrid odor, numerous fossils, thin to thick bedded		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-170		
REMARKS: within 50 ft of intrusion		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-172M		**COLLECTOR**: VTM
AREA: South Orogrande		**FIELD DATE**: 5/23/97
MINING DISTRICT: South Orogrande		
PROPERTY NAME: Rock Quarry		
QUADRANGLE: Orogrande North		**SCALE**: 1:24,000
TOWNSHIP: 22S	**RANGE**: 9E	**SECTION**: NW 19
LATITUDE: 32° 22' 34"		**LONGITUDE**: 106° 3' 53"
SAMPLE TYPE: shale from contact between Hueco and Tertiary monzonite, 10 ft chip		
ROCK TYPE: brown shale		
ALTERATION: Fe oxides, calcite		
MINERALIZATION:		
PHOTO NUMBER: VTM97-172M		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-173		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/2/97		
LOCATION: Jarilla Mountains, South Orogrande		
QUADRANGLE: Orogrande South	**SCALE**: 1:24,000	
TOWNSHIP: 8E	**RANGE**: 22S	**SECTION**: NW 25
LATITUDE: 32° 21' 54"	**LONGITUDE**: 106° 4' 22"	
ROCK UNIT: quartz monzonite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: white, black, gray monzonite, feldspar, quartz, hornblende, biotite		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: VTM97-173a,b		
REMARKS: photo of Orogrande district		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: east of CCC Tank	**SAMPLE NUMBER**: VTM97-174S	
FIELD DATE: 5/23/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Wilde Tank	**TOWNSHIP**: 22S
LATITUDE: 32° 24' 32"	**LONGITUDE**: 105° 55' 39"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 8
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench sampled in 10 ft arroyo, limestone gravel with minor calcite veining, trace of sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Rough Canyon	**SAMPLE NUMBER**: VTM97-175S	
FIELD DATE: 5/23/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Wilde Tank	**TOWNSHIP**: 22S
LATITUDE: 32° 22' 31"	**LONGITUDE**: 105° 52' 46"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 23
OTHER: photo VTM97-175a,b of hills and missile		
SAMPLE DESCRIPTION: 4 ft trench in 80 ft arroyo, limestone and trace of sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: west of Rough Canyon	**SAMPLE NUMBER**: VTM97-176S	
FIELD DATE: 5/23/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Wilde Tank	**TOWNSHIP**: 22S
LATITUDE: 32° 22' 50"	**LONGITUDE**: 105° 55' 5"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, Abo sandstone	**SECTION**: NW 21
OTHER: photo VTM97-176		
SAMPLE DESCRIPTION: 3 ft trench in 6 ft arroyo, next to gravel bar, limestone and sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: East McGregor Range		**SAMPLE NUMBER**: VTM97-177S
FIELD DATE: 5/23/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 43"	**LONGITUDE**: 106° 3' 26"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 18
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 6 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-178S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 21"	**LONGITUDE**: 105° 59' 6"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE 26
OTHER:		
SAMPLE DESCRIPTION: trenches across 20 ft arroyo, limestone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-179		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/24/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE 26
LATITUDE: 32° 00' 31"		**LONGITUDE**: 105° 59' 10"
ROCK UNIT: Tertiary syenite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: feldspars, Fe oxides disseminated and along fractures		
ROCK STRUCTURES: fractures		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: altered		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-180S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 35"	**LONGITUDE**: 105° 59' 13"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: NW SE 26
OTHER: drains Red Hills syenite		
SAMPLE DESCRIPTION: 2 ft trench in 15 ft arroyo, limestone and syenite float with a trace of hornfels		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-181S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 37"	**LONGITUDE**: 105° 59' 24"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: C S 26
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 40 ft arroyo, limestone and syenite float		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-182S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 22"	**LONGITUDE**: 105° 59' 2"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 26
OTHER: same site as VTM97-183C		
SAMPLE DESCRIPTION: 5 ft trench in 25 ft arroyo, limestone and syenite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-183C
FIELD DATE: 5/24/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 22"	**LONGITUDE**: 105° 59' 2"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: SW 26
OTHER: same site as VTM97-182S		
SAMPLE DESCRIPTION: 5 ft trench in 25 ft arroyo, limestone and trace syenite gravel		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-184M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/24/97
MINING DISTRICT: near Red Hills		
PROPERTY NAME:		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NW NE 36
LATITUDE: 32° 00' 16"		**LONGITUDE**: 105° 58' 27"
SAMPLE TYPE: 2 ft thick chip		
ROCK TYPE: altered limestone within unaltered limestone		
ALTERATION: Fe oxides, calcite, quartz		
MINERALIZATION:		
PHOTO NUMBER: 24, 2, 3		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-185S
FIELD DATE:	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 15"	**LONGITUDE**: 105° 58' 17"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, syenite, limestone	**SECTION**: NW NE 36
OTHER: photo #5		
SAMPLE DESCRIPTION: 5 ft trench in 30 ft arroyo, limestone and syenite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-186S
FIELD DATE: 5/24/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 31"	**LONGITUDE**: 105° 55' 44"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C E 20
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 15 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-187S
FIELD DATE: 5/24/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 20"	**LONGITUDE**: 105° 55' 40"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C S 16
OTHER: same site as VTM97-188F		
SAMPLE DESCRIPTION: 5 ft trench in 10 ft arroyo, limestone and brown altered limestone in gravel		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-188F		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/24/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME:		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 10E	**SECTION**: C S 16
LATITUDE: 32° 2' 20"		**LONGITUDE**: 105° 55' 40"
SAMPLE TYPE: float chip		
ROCK TYPE: altered limestone (brown)		
ALTERATION: Fe oxides, silica, calcite		
MINERALIZATION: calcite veining		
PHOTO NUMBER:		
OTHER: same site as VTM97-187S		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-189S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 41"	**LONGITUDE**: 105° 57' 47"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE SE 25
OTHER: same locality as VTM97-190F, 191C		
SAMPLE DESCRIPTION: 8 ft trench in 20 ft arroyo, limestone, Fe oxides altered limestone, trace syenite gravel		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-190F		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/24/97
MINING DISTRICT: near Red Hills		
PROPERTY NAME:		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NE SE 25
LATITUDE: 32° 00' 41"		**LONGITUDE**: 105° 57' 47"
SAMPLE TYPE: float chip		
ROCK TYPE: brown altered limestone		
ALTERATION: Fe oxides, quartz, calcite		
MINERALIZATION: zone in Hueco Limestone		
PHOTO NUMBER:		
OTHER: same site as VTM97-189S, 191C		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-191C
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 00' 41"	**LONGITUDE**: 105° 57' 47"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**:	**SECTION**: NE SE 26
OTHER: same site as VTM97-189S, 190F		
SAMPLE DESCRIPTION: 3 ft trench in 20 ft arroyo, limestone, Fe oxide altered limestone, trace syenite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-192S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 43"	**LONGITUDE**: 105° 58' 00"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE NE 13
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-193S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 53"	**LONGITUDE**: 105° 57' 44"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE SE SE 12
OTHER:		
SAMPLE DESCRIPTION: 1 ft channel on limestone ledge		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-194M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/24/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME:		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: W 6, 7
LATITUDE: 32° 3' 45"		**LONGITUDE**: 105° 57' 28"
SAMPLE TYPE: 3 ft chip of jasperoid		
ROCK TYPE: jasperoid in Hueco limestone		
ALTERATION: silica, Fe oxides, calcite		
MINERALIZATION:		
PHOTO NUMBER: 5-9		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-195M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/24/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME:		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: W 6, 7
LATITUDE: 32° 3' 44"		**LONGITUDE**: 105° 57' 28"
SAMPLE TYPE: 5 ft chip of jasperoid		
ROCK TYPE: jasperoid in Hueco limestone		
ALTERATION: silica, Fe oxides, calcite		
MINERALIZATION:		
PHOTO NUMBER: 5-9		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains, Red House Tanks		**SAMPLE NUMBER**: VTM97-196S
FIELD DATE: 5/24/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 3' 49"	**LONGITUDE**: 105° 57' 40"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: SW SW SW 6
OTHER: photo #15		
SAMPLE DESCRIPTION: 2 pits in 20 ft arroyo near washout, limestone and jasperoid gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-197S
FIELD DATE: 5/24/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 4' 40"	**LONGITUDE**: 106° 56' 55"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C 6
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 45 ft arroyo, jasperoid and limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-198C
FIELD DATE: 5/25/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 58"	**LONGITUDE**: 105° 58' 31"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: NE NW 24
OTHER:		
SAMPLE DESCRIPTION: drains Red Hill syenite, 5 ft trench in 15 ft arroyo		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-199		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/25/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE NE 23
LATITUDE: 32° 1' 46"		**LONGITUDE**: 105° 58' 52"
ROCK UNIT: Red Hills syenite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray, brown, syenite, feldspar, biotite, hornblende		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: 20		
REMARKS: age dating sample		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-200M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/25/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: Red Hills pit		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE SE NE 23
LATITUDE: 32° 1' 39"		**LONGITUDE**: 105° 58' 52"
SAMPLE TYPE: 5 ft vertical chip across brown magnetite-hematite zone		
ROCK TYPE: silicified limestone roof pendent in Tertiary syenite		
ALTERATION: Fe oxides, silica, calcite		
MINERALIZATION: trace pyrite, chalcopyrite?, bornite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-201M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/25/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: Red Hills pit		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE SE NE 23
LATITUDE: 32° 1' 39"		**LONGITUDE**: 105° 58' 52"
SAMPLE TYPE: 5 ft vertical section across green-gray skarn		
ROCK TYPE: silicified limestone roof pendent in Tertiary syenite		
ALTERATION: Fe oxides, calcite, quartz, epidote, chlorite		
MINERALIZATION: trace pyrite, chalcopyrite?, bornite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-202M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/25/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: Red Hills pit		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SE SE NE 23
LATITUDE: 32° 1' 39"		**LONGITUDE**: 105° 58' 52"
SAMPLE TYPE: dump select		
ROCK TYPE: recrystallized and brecciated limestone cemented with quartz, white to gray		
ALTERATION: silicified limestone roof pendent in Tertiary syenite		
MINERALIZATION: malachite, trace pyrite, chalcopyrite?, bornite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-203M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/25/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: Red Hills		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NE SE 23
LATITUDE: 32° 1' 29"		**LONGITUDE**: 105° 58' 55"
SAMPLE TYPE: 6 inch chip		
ROCK TYPE: gray-green silicified bed in limestone at contact with Tertiary syenite		
ALTERATION: silica, chlorite		
MINERALIZATION: trace pyrite, chalcopyrite?, bornite?		
PHOTO NUMBER: 25		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-204S
FIELD DATE: 5/25/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 26"	**LONGITUDE**: 105° 58' 56"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, minor recrystallization and silicification	**SECTION**: NE SE 23
OTHER: photo #26		
SAMPLE DESCRIPTION: 2 ft trench in 6 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-205S
FIELD DATE: 5/25/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 27"	**LONGITUDE**: 105° 58' 55"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: NE SE 23
OTHER: photo #26		
SAMPLE DESCRIPTION: 2 ft trench in 6 ft arroyo		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-206M		**COLLECTOR**: VTM
AREA: Hueco Mountains		**FIELD DATE**: 5/25/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: Little Cement Tank		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: NW SW SW 24
LATITUDE: 32° 1' 23"		**LONGITUDE**: 105° 58' 48"
SAMPLE TYPE: 1 ft vertical section		
ROCK TYPE: hornfels zone within limestone near Tertiary syenite		
ALTERATION: chlorite, epidote, calcite, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-207S
FIELD DATE: 5/25/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE:32° 1' 22"	**LONGITUDE**: 105° 58' 42"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, some silicified and recrystallized	**SECTION**: NE SW SW 24
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 6 ft arroyo, limestone, skarn, jasperoid, Fe oxides gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-208S
FIELD DATE: 5/25/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 13"	**LONGITUDE**: 105° 58' 35"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE SW SW 24
OTHER:		
SAMPLE DESCRIPTION: 6 ft trench in 20 ft arroyo, limestone, skarn, syenite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-209S
FIELD DATE: 5/25/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 13"	**LONGITUDE**: 105° 58' 34"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE SW SW 24
OTHER: photo #1		
SAMPLE DESCRIPTION: 4 ft trench in 10 ft arroyo, skarn, limestone, syenite gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-210S
FIELD DATE: 5/25/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 4' 41"	**LONGITUDE**: 105° 56' 50"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE NE NE 6
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 50 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-211S
FIELD DATE: 5/25/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 00"	**LONGITUDE**: 105° 56' 50"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 32
OTHER:		
SAMPLE DESCRIPTION: 1.5 ft trench in 8 ft arroyo, limestone, sandstone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-212		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/25/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 10E	**SECTION**: SW 32
LATITUDE: 32° 5' 3"		**LONGITUDE**: 105° 56' 53"
ROCK UNIT: syenite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: altered pink syenite, biotite, feldspar, Fe oxides		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: 5		
REMARKS: veins of Fe oxides, overlain by limestone		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Martin-Hay Meadow Canyon road		**SAMPLE NUMBER**: VTM97-213S
FIELD DATE: 5/26/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mack Tank	**TOWNSHIP**: 23S
LATITUDE: 32° 18' 54"	**LONGITUDE**: 105° 52' 48"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: sandstone, limestone, siltstone, shale of Abo	**SECTION**: SE 11
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 4 ft arroyo, sandstone, siltstone, shale, limestone		

STREAM SEDIMENT SAMPLE FORM

AREA: Martin-Hay Meadow Canyon Road		**SAMPLE NUMBER**: VTM97-214S
FIELD DATE: 5/26/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mack Tank	**TOWNSHIP**: 23S
LATITUDE: 32° 10' 45"	**LONGITUDE**: 105° 53' 35"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: sandstone, siltstone, limestone, shale	**SECTION**: SE SW 11
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 20 ft arroyo, sandstone, siltstone, shale, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: McGregor		**SAMPLE NUMBER**: VTM97-215S
FIELD DATE:5/26/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mack Tank	**TOWNSHIP**: 24S
LATITUDE: 32° 15' 15"	**LONGITUDE**: 105° 56' 45"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 5
OTHER:		
SAMPLE DESCRIPTION: 10 ft trench across 20 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: South McGregor		**SAMPLE NUMBER**: VTM97-216S
FIELD DATE: 5/26/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 44"	**LONGITUDE**: 106° 3' 48"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 30
OTHER:		
SAMPLE DESCRIPTION: 8 inch trench in 3 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: South McGregor		**SAMPLE NUMBER**: VTM97-217S
FIELD DATE: 5/26/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 46"	**LONGITUDE**: 106° 3' 48"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 19
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench in 5 ft arroyo, upstream of gravel pit now bunker, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-218S
FIELD DATE: 5/27/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 4"	**LONGITUDE**: 106° 00' 10"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE NE NE 27
OTHER: same site as VTM97-219C		
SAMPLE DESCRIPTION: 15 ft trench in 50 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-219C
FIELD DATE: 5/27/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 4"	**LONGITUDE**: 106° 00' 10"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: syenite, alluvium	**SECTION**: NE NE NE 27
OTHER: same site as VTM97-210S		
SAMPLE DESCRIPTION: 15 ft trench in 50 ft arroyo, gray and brown syenite, skarn, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-220S
FIELD DATE: 5/27/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 2"	**LONGITUDE**: 106° 00' 9"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE SE SE 22
OTHER: same site as VTM97-221C		
SAMPLE DESCRIPTION: 4 ft trench in 10 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-221C
FIELD DATE: 5/27/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 1' 2"	**LONGITUDE**: 106° 00' 9"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: syenite, alluvium	**SECTION**: SE SE SE 22
OTHER: same site VTM97-220S		
SAMPLE DESCRIPTION: 4 ft trench in 10 ft arroyo		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-222		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/27/97		
LOCATION: 5/27/97		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SW 23
LATITUDE: 32° 1' 36"	**LONGITUDE**: 105° 59' 39"	
ROCK UNIT: syenite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray to brown syenite, epidote alteration, Fe oxides, feldspar, hornblende, biotite		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: 11		
REMARKS: altered		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-223		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/27/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SW 23
LATITUDE: 32° 1' 36"	**LONGITUDE**: 105° 59' 34"	
ROCK UNIT: syenite dike		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: yellow-brown syenite, Fe oxides, feldspar		
ROCK STRUCTURES: liesegang banding		
MEASURED SECTION: no		
PHOTO NUMBER: 12		
REMARKS: strike N0E, 4 ft thick, altered		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-224		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/27/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SW 23
LATITUDE: 32° 1' 38"	**LONGITUDE**: 105° 59' 29"	
ROCK UNIT: syenite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray syenite, feldspars, biotite, hornblende		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: altered		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-225M	**COLLECTOR**: VTM	
AREA: Hueco Mountains	**FIELD DATE**: 5/27/97	
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: west Red Hills		
QUADRANGLE: Mountain Tank	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: SW 23
LATITUDE: 32° 1' 37"	**LONGITUDE**: 105° 59' 44"	
SAMPLE TYPE: 2 ft chip		
ROCK TYPE: altered zone at contact between limestone and syenite		
ALTERATION: skarn-epidote, calcite, clay, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains	**SAMPLE NUMBER**: VTM97-226S	
FIELD DATE: 5/27/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**:	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 3"	**LONGITUDE**: 106° 00' 3"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: altered brown syenite	**SECTION**: SE SE SE 15
OTHER: same site as VTM97-227C		
SAMPLE DESCRIPTION: 2 ft trench in 5 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-227C
FIELD DATE: 5/27/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 3"	**LONGITUDE**: 106° 00' 3"	**RANGE**: 9E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: altered syenite	**SECTION**: SE SE SE 15
OTHER: same site VTM97-226S		
SAMPLE DESCRIPTION: syenite, skarn, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-228S
FIELD DATE: 5/27/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 43"	**LONGITUDE**: 106° 00' 49"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 16
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 4 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-229S
FIELD DATE: 5/27/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 26S
LATITUDE: 32° 2' 44"	**LONGITUDE**: 106° 1' 28"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: NW 16
OTHER: photo #19		
SAMPLE DESCRIPTION: 6 ft trench in 50 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa		**SAMPLE NUMBER**: VTM97-230S
FIELD DATE: 5/28/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa North	**TOWNSHIP**: 22S
LATITUDE: 32° 23' 39"	**LONGITUDE**: 105° 48' 34"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 15
OTHER: photo #22		
SAMPLE DESCRIPTION: 2 ft trench in 5 ft arroyo, mostly silt and clay, minor limestone and sandstone gravel		

Skip VTM97-231-234 for standards and duplicates

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa		**SAMPLE NUMBER**: VTM97-235S
FIELD DATE: 5/28/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa North	**TOWNSHIP**: 22S
LATITUDE: 32° 35' 7"	**LONGITUDE**: 105° 49' 24"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: C E 5
OTHER:		
SAMPLE DESCRIPTION: mostly clay and silt, minor limestone and sandstone gravel, 2 ft trench in 10 ft arroyo		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-236		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/28/97		
LOCATION: west of Otero Mesa		
QUADRANGLE: Pipeline Canyon		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 10E	**SECTION**: SW 2
LATITUDE: 32° 30' 22"		**LONGITUDE**: 105° 53' 42"
ROCK UNIT: Abo tongue of Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: green shale		
ROCK STRUCTURES: interbedded with limestones, sandstone, and gypsum		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-237		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/28/97		
LOCATION: west of Otero Mesa		
QUADRANGLE: Pipeline Canyon		**SCALE**: 1:24,000
TOWNSHIP: 21S	**RANGE**: 10E	**SECTION**: SW 2
LATITUDE: 32° 20' 22"		**LONGITUDE**: 105° 53' 42"
ROCK UNIT: Abo tongue of the Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: red shale		
ROCK STRUCTURES: shales interbedded with limestones, siltstones, sandstone, and gypsum		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, Chatfield Canyon	**SAMPLE NUMBER**: VTM97-238S	
FIELD DATE: 5/28/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 43"	**LONGITUDE**: 105° 32' 36"	**RANGE**: 14E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW SW SW 5
OTHER:		
SAMPLE DESCRIPTION: 6 ft trench in 20 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, Chatfield Canyon	**SAMPLE NUMBER**: VTM97-239S	
FIELD DATE: 5/28/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Sixteen Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 44"	**LONGITUDE**: 105° 33' 31"	**RANGE**: 14E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW NW 7
OTHER: photo #2		
SAMPLE DESCRIPTION: several pits across 10 ft in 70 ft arroyo, limestone, trace yellow sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, Chatfield Canyon	**SAMPLE NUMBER**: VTM97-240S	
FIELD DATE: 5/28/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Sixteen Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 00"	**LONGITUDE**: 105° 35' 21"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW SW SW 11
OTHER: western most channel sampled		
SAMPLE DESCRIPTION: 2 ft channel in 5 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, Negro Ed Canyon	**SAMPLE NUMBER**: VTM97-241S	
FIELD DATE: 5/29/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Bug Scuffle Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 40' 15"	**LONGITUDE**: 105° 51' 59"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: W 7
OTHER: photo #24, 1,2		
SAMPLE DESCRIPTION: 2 pits across 50 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains, Negro Ed Canyon	**SAMPLE NUMBER**: VTM97-242C	
FIELD DATE: 5/29/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Bug Scuffle Canyon	**TOWNSHIP**: 19S
LATITUDE: 32° 40' 15"	**LONGITUDE**: 105° 51' 59"	**RANGE**: 11E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: W7
OTHER: photo #24, 1, 2, same site as VTM97-241S		
SAMPLE DESCRIPTION: 2 pits across 50 ft arroyo		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-243		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/29/97		
LOCATION: Sacramento Mountains		
QUADRANGLE: Bug Scuffle Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: W7
LATITUDE: 32° 40' 13"	**LONGITUDE**: 105° 51' 49"	
ROCK UNIT: El Paso Formation		
ROCK AGE: Ordovician		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: gray limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER: 3		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-244		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/29/97		
LOCATION: Sacramento Mountains		
QUADRANGLE: Bug Scuffle Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NW NW NW 18
LATITUDE: 32° 39' 37"	**LONGITUDE**: 105° 51' 37"	
ROCK UNIT: black gabbro		
ROCK AGE: Proterozoic		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: altered black gabbro, feldspar, hornblende, biotite, trace quartz		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: need to assay for PGM, irregular top		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-245		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 5/29/97		
LOCATION: Sacramento Mountains		
QUADRANGLE: Bug Scuffle Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NW NW NW 18
LATITUDE: 32° 39' 40"	**LONGITUDE**: 105° 51' 35"	
ROCK UNIT: quartzite		
ROCK AGE: Cambrian-Ordovician		
FIELD OCCURRENCE: Bliss or El Paso Formation		
ROCK DESCRIPTION: brown quartzite, well rounded grains, fine-grained		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: 5 ft thick, contacts not exposed		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-246		
PROJECT: McGregor		
COLLECTOR: Eric Monroe		
FIELD DATE (mo/day/yr): 5/29/97		
LOCATION: Sacramento Mountains		
QUADRANGLE: Bug Scuffle Canyon	**SCALE**: 1:24,000	
TOWNSHIP: 19S	**RANGE**: 11E	**SECTION**: NE 18
LATITUDE: 32° 39' 51"	**LONGITUDE**: 105° 51' 39"	
ROCK UNIT: Percha?		
ROCK AGE: Devonian		
FIELD OCCURRENCE: outcrop, 120 ft thick		
ROCK DESCRIPTION: brown shale, thinly bedded		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: some rock fragments in shale		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: northeast of Coyote Tank	**SAMPLE NUMBER**: VTM97-247S	
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 9"	**LONGITUDE**: 106° 4' 28"	**RANGE**: 8E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: E 36
OTHER: photo #22, same site as VTM97-248F, 249F, 250c		
SAMPLE DESCRIPTION: 12 ft trench in 20 ft arroyo, limestone, trace syenite, jasperoid gravel, cartridges in arroyo		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-248F		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/16/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: northeast of Coyote Tank		
QUADRANGLE: Desert SE		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 8E	**SECTION**: E 36
LATITUDE: 32° 5' 9"		**LONGITUDE**: 106° 4' 28"
SAMPLE TYPE: float chip		
ROCK TYPE: brown jasperoid		
ALTERATION: Fe oxides		
MINERALIZATION: trace pyrite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-249F		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/16/97
MINING DISTRICT: Hueco Mountains		
PROPERTY NAME: northeast of Coyote Tank		
QUADRANGLE: Desert SE		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 8E	**SECTION**: E 36
LATITUDE: 32° 5' 9"		**LONGITUDE**: 106° 4' 28"
SAMPLE TYPE: float chip		
ROCK TYPE: white limestone cut by quartz-calcite veins		
ALTERATION: silicification		
MINERALIZATION: trace pyrite, chalcopyrite?, bornite?		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: northeast of Coyote Tank, Hueco Mountains		**SAMPLE NUMBER**: VTM97-250C
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Desert SE	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 9"	**LONGITUDE**: 106° 4' 28"	**RANGE**: 8E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: E 36
OTHER: photo, same site as VTM97-248F, 249F, 247s		
SAMPLE DESCRIPTION: 12 ft trench in 20 ft arroyo, limestone, trace syenite, jasperoid gravel, cartridges in arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Hueco Mountains		**SAMPLE NUMBER**: VTM97-251S
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mountain Tank	**TOWNSHIP**: 26S
LATITUDE: 32° 3' 57"	**LONGITUDE**: 105° 54' 40"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE SW SW 3
OTHER:		
SAMPLE DESCRIPTION: 5 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa north of Wet Weather Pond	**SAMPLE NUMBER**: VTM97-252S	
FIELD DATE: 6/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon East	**TOWNSHIP**: 24S
LATITUDE: 32° 13' 29"	**LONGITUDE**: 105° 49' 15"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 9
OTHER: near NURE anomaly		
SAMPLE DESCRIPTION: 3 ft trench in 20 ft arroyo, most of sediment less than 4 mm		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa	**SAMPLE NUMBER**: VTM97-253S	
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Owl Tank Canyon East	**TOWNSHIP**: 24S
LATITUDE: 32° 14' 18"	**LONGITUDE**: 105° 45' 30"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, caliche	**SECTION**: SE 1
OTHER:		
SAMPLE DESCRIPTION: 2 ft arroyo, mostly <4 mm gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa north of End of Line Tank	**SAMPLE NUMBER**: VTM97-254S	
FIELD DATE: 6/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 18' 30"	**LONGITUDE**: 105° 45' 17"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE SE SE 12
OTHER:		
SAMPLE DESCRIPTION: 2.5 ft trench in 12 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa north of End of Line Tank	**SAMPLE NUMBER**: VTM97-255S	
FIELD DATE:	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 18' 30"	**LONGITUDE**: 105° 45' 17"	**RANGE**: 1E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE SE SE 12
OTHER: duplicate collection of VTM97-254S		
SAMPLE DESCRIPTION: 2.5 ft trench in 12 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa		**SAMPLE NUMBER**: VTM97-256S
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 18' 00"	**LONGITUDE**: 105° 45' 13"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 13
OTHER: same site as VTM97-257		
SAMPLE DESCRIPTION: 1.5 ft trench in 8 ft arroyo, near NURE anomaly		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-257		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/16/97		
LOCATION: Otero Mesa		
QUADRANGLE: Otero Mesa South		**SCALE**: 1:24,000
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: SE 13
LATITUDE: 32° 18' 00"		**LONGITUDE**: 105° 45' 13"
ROCK UNIT: Permian Hueco Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: float next to outcrop		
ROCK DESCRIPTION: green-gray limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: same site as VTM97-256S		
REFERENCES:		

STREAM SEDIMENT SAMPLE FORM

AREA: northwest of Corner Tanks, Otero Mesa		**SAMPLE NUMBER**: VTM97-258S
FIELD DATE: 6/16/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 16' 21"	**LONGITUDE**: 105° 46' 43"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C26
OTHER:		
SAMPLE DESCRIPTION: 5 ft trench in 20 ft arroyo, trace limestone gravel, mostly sand		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa, Martin Tank		**SAMPLE NUMBER**: VTM97-259S
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**:	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 29"	**LONGITUDE**: 105° 49' 22"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: line between 20, 21
OTHER: photo #25		
SAMPLE DESCRIPTION: 1 ft channel in 30 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Otero Mesa, Martin Tank		**SAMPLE NUMBER**: VTM97-260S
FIELD DATE: 6/16/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 13"	**LONGITUDE**: 105° 49' 30"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, limestone, sandstone	**SECTION**: SE 20
OTHER:		
SAMPLE DESCRIPTION: 5 ft trench in 8 ft channel, sandstone, limestone gravel		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-261		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/16/97		
LOCATION: Otero Mesa-Martin Tank		
QUADRANGLE: Otero Mesa South		**SCALE**: 1:24,000
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: SE 20
LATITUDE: 32° 17' 14"		**LONGITUDE**: 105° 49' 31"
ROCK UNIT: Permian Mesita Blanca Member, Yeso Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: chip of outcrop		
ROCK DESCRIPTION: brown, fine-grained sandstone, 10 ft bed		
ROCK STRUCTURES: calcite veinlets		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: same site as VTM97-262		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-262		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/16/97		
LOCATION: Otero Mesa-Martin Tank		
QUADRANGLE: Otero Mesa South		**SCALE**: 1:24,000
TOWNSHIP: 23S	**RANGE**: 11E	**SECTION**: SE 20
LATITUDE: 32° 17' 14"		**LONGITUDE**: 105° 49' 31"
ROCK UNIT: Permian Yeso Formation		
ROCK AGE: Permian		
FIELD OCCURRENCE: 5 ft chip of outcrop		
ROCK DESCRIPTION: yellow siltstone, gypsum		
ROCK STRUCTURES: calcite veinlets		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: same site as VTM97-261		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-263M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/17/97
MINING DISTRICT: Northern Franklin Mountains		
PROPERTY NAME: unknown		
QUADRANGLE: Anthony		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 4E	**SECTION**: SE 32
LATITUDE: 32° 6' 18"		**LONGITUDE**: 106° 33' 1"
SAMPLE TYPE: 4 ft chip across face end of 80 ft adit		
ROCK TYPE: brown vein within fault in limestone		
ALTERATION: Fe oxides, calcite, quartz		
MINERALIZATION: barite, fluorite, smithsonite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-264M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/17/97
MINING DISTRICT: Northern Franklin Mountains		
PROPERTY NAME: unknown		
QUADRANGLE: Anthony		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 4E	**SECTION**: SE 32
LATITUDE: 32° 6' 18"		**LONGITUDE**: 106° 33' 1"
SAMPLE TYPE: select dump		
ROCK TYPE: brown vein within fault in limestone		
ALTERATION: Fe oxides, calcite, quartz		
MINERALIZATION: barite, fluorite, smithsonite?		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-265M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/17/97
MINING DISTRICT: Northern Franklin Mountains		
PROPERTY NAME: unknown		
QUADRANGLE: Anthony		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 4E	**SECTION**: SE 32
LATITUDE: 32° 6' 10"		**LONGITUDE**: 106° 33' 00"
SAMPLE TYPE: select dump		
ROCK TYPE: white and light brown vein within fault in limestone		
ALTERATION: Fe oxides, calcite, quartz, jarosite		
MINERALIZATION: barite		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-266M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/17/97
MINING DISTRICT: Northern Franklin Mountains		
PROPERTY NAME: unknown		
QUADRANGLE: Anthony		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 4E	**SECTION**: SE 32
LATITUDE: 32° 4' 58"		**LONGITUDE**: 106° 32' 24"
SAMPLE TYPE: 25 ft chip across brown jasperoid outcrop		
ROCK TYPE: jasperoid along fault within Fusselman and Sly Gap		
ALTERATION: Fe oxides, calcite, quartz, liesegang banding		
MINERALIZATION:		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-267M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/17/97
MINING DISTRICT: Northern Franklin Mountains		
PROPERTY NAME: unknown		
QUADRANGLE: Anthony		**SCALE**: 1:24,000
TOWNSHIP: 25S	**RANGE**: 4E	**SECTION**: SE 32
LATITUDE: 32° 6' 19"		**LONGITUDE**: 106° 33' 00"
SAMPLE TYPE: select dump		
ROCK TYPE: fluorite pod within Fusselman Dolomite		
ALTERATION: calcite		
MINERALIZATION: barite, fluorite		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: Northern Franklin Mountains		**SAMPLE NUMBER**: VTM97-268S
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Doña Ana	**QUADRANGLE**: Anthony	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 7"	**LONGITUDE**: 106° 32' 37"	**RANGE**: 4E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SE 32
OTHER: photo #12, same site as VTM97-269C		
SAMPLE DESCRIPTION: limestone gravel, 3 ft trench in 15 ft arroyo, downstream of Barite-fluorite mine		

STREAM SEDIMENT SAMPLE FORM

AREA: Northern Franklin Mountains		**SAMPLE NUMBER**: VTM97-269C
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Doña Ana	**QUADRANGLE**: Anthony	**TOWNSHIP**: 25S
LATITUDE: 32° 5' 7"	**LONGITUDE**: 106° 32' 37"	**RANGE**: 4E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: limestone	**SECTION**: SE 32
OTHER: photo #12, same site as VTM97-268S		
SAMPLE DESCRIPTION: limestone gravel, 3 ft trench in 15 ft arroyo, downstream of Barite-fluorite mine		

Skip VTM97-270-275 for standards and duplicates

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River, northern border		**SAMPLE NUMBER**: VTM97-276S
FIELD DATE: 6/17/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyor Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 38"	**LONGITUDE**: 105° 33' 50"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C N 25
OTHER:		
SAMPLE DESCRIPTION: 10 ft trench in 40 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-277S
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 5"	**LONGITUDE**: 105° 35' 00"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, sandstone	**SECTION**: S 26
OTHER:		
SAMPLE DESCRIPTION: along gravel bar on top of sandstone ledge, 5 ft trench in 20 ft arroyo, limestone, sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-278S
FIELD DATE: 6/17/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 40"	**LONGITUDE**: 105° 35' 35"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 35
OTHER:		
SAMPLE DESCRIPTION: 10 ft trench in 20 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-279S
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 16"	**LONGITUDE**: 105° 35' 9"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: SW 35
OTHER:		
SAMPLE DESCRIPTION: 10 ft trench in 20 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-280S
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 3"	**LONGITUDE**: 105° 35' 25"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 35
OTHER:		
SAMPLE DESCRIPTION: 5 ft trench in 15 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-281S
FIELD DATE: 6/17/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 3"	**LONGITUDE**: 105° 35' 1"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone	**SECTION**: SW 35
OTHER:		
SAMPLE DESCRIPTION: 15 ft trench in 15 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento River		**SAMPLE NUMBER**: VTM97-282S
FIELD DATE: 6/17/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 15"	**LONGITUDE**: 105° 34' 27"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: S 1,2
OTHER:		
SAMPLE DESCRIPTION: 2 pits across 30 ft of 100 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: South Orogrande		**SAMPLE NUMBER**: VTM97-283S
FIELD DATE: 6/18/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande South	**TOWNSHIP**: 23S
LATITUDE: 32° 16' 38"	**LONGITUDE**: 106° 3' 20"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 30
OTHER:		
SAMPLE DESCRIPTION: limestone float, pits across 12 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: South Orogrande		**SAMPLE NUMBER**: VTM97-284S
FIELD DATE: 6/18/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Orogrande South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' "28	**LONGITUDE**: 106° 3' 31"	**RANGE**: 9E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE20
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 7 ft channel		

STREAM SEDIMENT SAMPLE FORM

AREA: Martin Canyon		**SAMPLE NUMBER**: VTM97-285S
FIELD DATE: 6/18/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa South	**TOWNSHIP**: 23S
LATITUDE: 32° 17' 45"	**LONGITUDE**: 105° 51' 24"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: C 19
OTHER: sampled upstream of burned area, limestone and sandstone gravel		
SAMPLE DESCRIPTION: 20 ft trench sampled in 40 ft arroyo, same site as VTM97-165S, 166C		

STREAM SEDIMENT SAMPLE FORM

AREA: South Orogrande		**SAMPLE NUMBER**: VTM97-286S
FIELD DATE: 6/18/97	**COLLECTOR**: Eric Monroe	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Mack Tank	**TOWNSHIP**: 23S
LATITUDE: 32° 15' 30"	**LONGITUDE**: 105° 56' 19"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 32
OTHER:		
SAMPLE DESCRIPTION: limestone float, 1 ft trench in 100 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Wright Tank		**SAMPLE NUMBER**: VTM97-287S
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Wilde Tank	**TOWNSHIP**: 21S
LATITUDE: 32° 28' 25"	**LONGITUDE**: 105° 53' 50"	**RANGE**: 10E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 15
OTHER:		
SAMPLE DESCRIPTION: limestone and sandstone float, 6 ft trench		

STREAM SEDIMENT SAMPLE FORM

AREA: Wright Tank		**SAMPLE NUMBER**: VTM97-288C
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Wilde Tank	**TOWNSHIP**: 21S
LATITUDE: 32° 28' 25"	**LONGITUDE**: 105° 53' 50"	**RANGE**: 10E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: alluvium	**SECTION**: SW 15
OTHER:		
SAMPLE DESCRIPTION: limestone and sandstone float, 6 ft trench		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-289S
FIELD DATE: 6/20/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 40"	**LONGITUDE**: 105° 38' 12"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 20
OTHER:		
SAMPLE DESCRIPTION: 2 trenches across 15 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-290S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 52"	**LONGITUDE**: 105° 38' 11"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 18
OTHER:		
SAMPLE DESCRIPTION: 3 trenches across 20 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains (Garden Tank)	**SAMPLE NUMBER**: VTM97-291S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM, JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 50"	**LONGITUDE**: 105° 37' 20"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 33
OTHER:		
SAMPLE DESCRIPTION: limestone float, 6 ft trench in 15 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains (Garden Tank)	**SAMPLE NUMBER**: VTM97-292S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Surveyors Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 47"	**LONGITUDE**: 105° 37' 23"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**:	**SECTION**: NW 33
OTHER: photo 14		
SAMPLE DESCRIPTION: minor limestone float, 3 ft trench in 6 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains (McAfee Canyon)	**SAMPLE NUMBER**: VTM97-293S	
FIELD DATE: 6/20/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 50"	**LONGITUDE**: 105° 38' 35"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW SW SW 20
OTHER:		
SAMPLE DESCRIPTION: limestone float, 20 ft trench in 20 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-294S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 32' 54"	**LONGITUDE**: 105° 38' 57"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 19
OTHER:		
SAMPLE DESCRIPTION: limestone float, 12 ft trench in 12 ft arroyo, same site as VTM97-295F		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-295F		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/20/97
MINING DISTRICT: Sacramento Mountains		
PROPERTY NAME: none		
QUADRANGLE: El Paso Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 13E	**SECTION**: SE 19
LATITUDE: 32° 32' 54"		**LONGITUDE**: 105° 38' 57"
SAMPLE TYPE: float chip		
ROCK TYPE: calcite veins in limestone		
ALTERATION: dissolution, brecciation		
MINERALIZATION: calcite, Fe oxides		
PHOTO NUMBER:		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains		**SAMPLE NUMBER**: VTM97-296S
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 35' 00"	**LONGITUDE**: 105° 42' 25"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 10
OTHER:		
SAMPLE DESCRIPTION: 8 ft channel, limestone and sandstone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains (Culp Canyon)		**SAMPLE NUMBER**: VTM97-297S
FIELD DATE: 6/20/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 34' 53"	**LONGITUDE**: 105° 45' 45"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: NW 9
OTHER:		
SAMPLE DESCRIPTION: limestone, trace sandstone float, 6 ft trench in 10 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains (Culp Canyon)		**SAMPLE NUMBER**: VTM97-298S
FIELD DATE: 6/20/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: EL Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 33' 55"	**LONGITUDE**: 105° 43' 57"	**RANGE**: 16E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 17
OTHER: photo		
SAMPLE DESCRIPTION: 6 ft trench in 15 ft arroyo, limestone, trace sandstone float		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-299S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 11"	**LONGITUDE**: 105° 49' 54"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 32
OTHER:		
SAMPLE DESCRIPTION: 4 ft trench in 10 ft arroyo, limestone float		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-300S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 51"	**LONGITUDE**: 105° 48' 18"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NW 3
OTHER:		
SAMPLE DESCRIPTION: 6 ft trench in 15 ft arroyo, limestone float		

Skip VTM97-301-305 for standards and duplicates.

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-306S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 30"	**LONGITUDE**: 105° 43' 14"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: W 33
OTHER:		
SAMPLE DESCRIPTION: limestone float, 6 ft trench in 15 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-307S	
FIELD DATE:	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 28"	**LONGITUDE**: 105° 43' 12"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: W 33
OTHER:		
SAMPLE DESCRIPTION: limestone float, 6 ft trench in 15 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-308S	
FIELD DATE: 6/20/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 20S
LATITUDE: 32° 31' 00"	**LONGITUDE**: 105° 43' 2"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: S 30
OTHER:		
SAMPLE DESCRIPTION: limestone outcrop, 6 ft trench in 15 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-309S	
FIELD DATE: 6/20/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 40"	**LONGITUDE**: 105° 43' 50"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: NW 4
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 10 ft trench in 20 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-310S	
FIELD DATE: 6/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Draw	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 33"	**LONGITUDE**: 105° 38' 35"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 7
OTHER:		
SAMPLE DESCRIPTION: limestone float, 1 ft trench in 1 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-311S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Draw	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 58"	**LONGITUDE**: 105° 39' 5"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: NE 7
OTHER:		
SAMPLE DESCRIPTION: limestone float, 3 ft trench in 6 ft arroyo draining into stock tank		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-312S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Draw	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 34"	**LONGITUDE**: 105° 39' 5"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SE 7
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench in 10 ft arroyo, limestone float		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-313S	
FIELD DATE: 6/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Draw	**TOWNSHIP**: 21S
LATITUDE: 32° 28' 10"	**LONGITUDE**: 105° 37' 50"	**RANGE**: 13E
SAMPLE TYPE: stream sediment	**OUTCROP**: limestone, alluvium	**SECTION**: NE NW 20
OTHER:		
SAMPLE DESCRIPTION: 2 ft trench in 8 ft arroyo, limestone gravel		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-314S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 15"	**LONGITUDE**: 105° 42' 53"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, limestone	**SECTION**: SE 4
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench in gravel bar, limestone float		

STREAM SEDIMENT SAMPLE FORM

AREA: Sacramento Mountains	**SAMPLE NUMBER**: VTM97-315S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: El Paso Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 5"	**LONGITUDE**: 105° 42' 40"	**RANGE**: 12E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium	**SECTION**: SW 3
OTHER:		
SAMPLE DESCRIPTION: limestone gravel, 3 ft trench in 8 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: McGregor Range	**SAMPLE NUMBER**: VTM97-316S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Culp Canyon	**TOWNSHIP**: 21S
LATITUDE: 32° 30' 5"	**LONGITUDE**: 105° 49' 43"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: alluvium, Yeso	**SECTION**: SE 5
OTHER:		
SAMPLE DESCRIPTION: 3 ft trench in 6 ft arroyo, sandstone, trace limestone float		

STREAM SEDIMENT SAMPLE FORM

AREA: McGregor Range	**SAMPLE NUMBER**: VTM97-317S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Otero Mesa Draw	**TOWNSHIP**: 21S
LATITUDE: 32° 29' 42"	**LONGITUDE**: 105° 50' 18"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: caliche	**SECTION**: NW 8
OTHER:		
SAMPLE DESCRIPTION: limestone, caliche, sandstone float, 1 ft trench in 3 ft arroyo		

STREAM SEDIMENT SAMPLE FORM

AREA: High Rolls district, Sacramento Mountains	**SAMPLE NUMBER**: VTM97-319S	
FIELD DATE: 6/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: High Rolls	**TOWNSHIP**: 16S
LATITUDE: 32° 54' 40"	**LONGITUDE**: 105° 50' 00"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: sandstone, alluvium	**SECTION**: SE 17
OTHER:		
SAMPLE DESCRIPTION: below Courtney mine, pits across 5 ft arroyo, same site as VTM97-320C		

STREAM SEDIMENT SAMPLE FORM

AREA: High Rolls district, Sacramento Mountains	**SAMPLE NUMBER**: VTM97-320C	
FIELD DATE: 6/21/97	**COLLECTOR**: VTM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: High Rolls	**TOWNSHIP**: 16S
LATITUDE: 32° 54' 40"	**LONGITUDE**: 105° 50' 00"	**RANGE**: 11E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: sandstone, alluvium	**SECTION**: SE 17
OTHER:		
SAMPLE DESCRIPTION: below Courtney mine, pits across 5 ft arroyo, same site as VTM97-319S		

STREAM SEDIMENT SAMPLE FORM

AREA: High Rolls district, Sacramento Mountains	**SAMPLE NUMBER**: VTM97-321S	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Sacramento Peak	**TOWNSHIP**: 16S
LATITUDE: 32° 52' 00"	**LONGITUDE**: 105° 50' 5"	**RANGE**: 11E
SAMPLE TYPE: stream sediment	**OUTCROP**: sandstone, shale	**SECTION**: SE 32
OTHER:		
SAMPLE DESCRIPTION: below Addy Culp mine, 3 ft channel, same site as VTM97-322C		

STREAM SEDIMENT SAMPLE FORM

AREA: High Rolls district, Sacramento Mountains	**SAMPLE NUMBER**: VTM97-322C	
FIELD DATE: 6/21/97	**COLLECTOR**: JVM	**STATE**: NM
COUNTY: Otero	**QUADRANGLE**: Sacramento Peak	**TOWNSHIP**: 16S
LATITUDE: 32° 52' 00"	**LONGITUDE**: 105° 50' 5"	**RANGE**: 11E
SAMPLE TYPE: heavy mineral concentrate	**OUTCROP**: sandstone, shale	**SECTION**: SE 32
OTHER:		
SAMPLE DESCRIPTION: below Addy Culp mine, 3 ft channel, same site as VTM97-321S		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-323dM		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/25/97
MINING DISTRICT: Hueco Geothermal field		
PROPERTY NAME: Drill hole 46-6, box 67, depth 1299.5		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 12"		**LONGITUDE**: 106° 9' 55"
SAMPLE TYPE: core fragments		
ROCK TYPE: white to pink clay or talc zone		
ALTERATION: clay		
MINERALIZATION: clay		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-324dM		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/25/97
MINING DISTRICT: Hueco Geothermal field		
PROPERTY NAME: Drill hole 46-6, box 68, depth 1313-1319.2		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 12"		**LONGITUDE**: 106° 9' 55"
SAMPLE TYPE: core fragments of breccia zone		
ROCK TYPE: brown breccia zone		
ALTERATION: calcite, clay, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-325dM		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/25/97
MINING DISTRICT: Hueco Geothermal field		
PROPERTY NAME: Drill hole 46-6, box 66, depth 1288-1299		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 12"		**LONGITUDE**: 106° 9' 55"
SAMPLE TYPE: core fragments of breccia zone		
ROCK TYPE: white to pink breccia clay or talc zone		
ALTERATION: clay, calcite, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-326d		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/25/97		
LOCATION: Hueco Geothermal field, Drill core hole 46-6, box 65, depth 1284-1288 ft		
QUADRANGLE: Desert SW	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 12"	**LONGITUDE**: 106° 9' 55"	
ROCK UNIT: Tertiary rhyolite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: 1284-1288 ft depth drill core		
ROCK DESCRIPTION: pink porphyritic rhyolite with feldspar, quartz, and black coating on fractures		
ROCK STRUCTURES: fractures		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-327d		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/25/97		
LOCATION: Hueco Geothermal field, Drill core hole 45-5, box 119, 436.1-437.1 ft depth		
QUADRANGLE: Desert SW	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 5
LATITUDE: 32° 4' 23"	**LONGITUDE**: 106° 8' 54"	
ROCK UNIT: Tertiary rhyolite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 436.1-437.1 ft depth		
ROCK DESCRIPTION: pink to brown rhyolite		
ROCK STRUCTURES: Fe oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-328dM		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/25/97
MINING DISTRICT: Hueco Geothermal field		
PROPERTY NAME: Drill hole 45-5, box 186, depth 861.7-863.7		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 5
LATITUDE: 32° 4' 23"		**LONGITUDE**: 106° 8' 54"
SAMPLE TYPE: core fragments		
ROCK TYPE: white to light gray altered rhyolite		
ALTERATION: clay/talc, calcite		
MINERALIZATION:		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-329d		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/25/97		
LOCATION: Hueco Geothermal field, Drill core hole 61-6, 795.8-796 ft depth		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 42"		**LONGITUDE**: 106° 9' 45"
ROCK UNIT: Tertiary rhyolite sill		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 795.8-796 ft depth		
ROCK DESCRIPTION: white porphyritic rhyolite with quartz, feldspar		
ROCK STRUCTURES: thin quartz veins		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-330d		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 6/25/97		
LOCATION: Hueco Geothermal field, Drill core hole 51-8, box 5, depth 570 ft		
QUADRANGLE: Desert SE		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 16
LATITUDE: 32° 3' 2"		**LONGITUDE**: 106° 7' 58"
ROCK UNIT: Tertiary monzonite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 570 ft depth		
ROCK DESCRIPTION: pink to gray-brown, porphyritic monzonite, Fe oxides, quartz, feldspar		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-331dM		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 6/25/97
MINING DISTRICT: Hueco Geothermal field		
PROPERTY NAME: Drill hole 51-8, box 12, depth 627 ft		
QUADRANGLE: Desert SE		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 16
LATITUDE: 32° 3' 2"		**LONGITUDE**: 106° 7' 58"
SAMPLE TYPE: core fragments		
ROCK TYPE: pink to brown altered trachyte		
ALTERATION: quartz veins, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-332d		
PROJECT: McGregor		
COLLECTOR: Ron Broadhead		
FIELD DATE (mo/day/yr): 6/12/97		
LOCATION: Hueco Geothermal field, Drill core hole 51-8, depth 1417 ft		
QUADRANGLE: Desert SE	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 16
LATITUDE: 32° 3' 2"	**LONGITUDE**: 106° 7' 58"	
ROCK UNIT: upper shale		
ROCK AGE: Devonian		
FIELD OCCURRENCE: drill core 1417 ft		
ROCK DESCRIPTION: black shale interbedded with mudstone to argillaceous limestone		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: RB-518-3		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-333d		
PROJECT: McGregor		
COLLECTOR: Ron Broadhead		
FIELD DATE (mo/day/yr): 6/12/97		
LOCATION: Hueco Geothermal field, Drill core hole 51-8, depth 1466 ft		
QUADRANGLE: Desert SE	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 16
LATITUDE: 32° 3' 2"	**LONGITUDE**: 106° 7' 58"	
ROCK UNIT: middle chert unit		
ROCK AGE: Devonian		
FIELD OCCURRENCE: drill core 1466 ft depth		
ROCK DESCRIPTION: black chert with interbedded to interlaminated cherty limestone		
ROCK STRUCTURES: none		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: RB-518-4		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-334d		
PROJECT: McGregor		
COLLECTOR: Ron Broadhead		
FIELD DATE (mo/day/yr): 6/12/97		
LOCATION: Hueco Geothermal field		
QUADRANGLE: Desert SE		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 16
LATITUDE: 32° 3' 2"		**LONGITUDE**: 106° 7' 58"
ROCK UNIT: lower shale		
ROCK AGE: Devonian		
FIELD OCCURRENCE: drill core 1500 ft depth		
ROCK DESCRIPTION: black shale, basal unit, 2.5 ft above Fusselman dolomite		
ROCK STRUCTURES:		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS: RB-518-5		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-350d		
PROJECT: McGregor		
COLLECTOR: Doug Jones		
FIELD DATE (mo/day/yr): 9/5/97		
LOCATION: Hueco Geothermal field, Drill core hole 45-5, 1890 ft depth		
QUADRANGLE: Desert SW		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 5
LATITUDE: 32° 4' 23"		**LONGITUDE**: 106° 8' 54"
ROCK UNIT: Tertiary rhyolite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 1890 ft depth		
ROCK DESCRIPTION: pink to brown rhyolite		
ROCK STRUCTURES: Fe oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-351d		
PROJECT: McGregor		
COLLECTOR: Doug Jones		
FIELD DATE (mo/day/yr): 9/5/97		
LOCATION: Hueco Geothermal field, Drill core hole 45-5, 2500 ft depth		
QUADRANGLE: Desert SW	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 5
LATITUDE: 32° 4' 23"	**LONGITUDE**: 106° 8' 54"	
ROCK UNIT: Tertiary rhyolite		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 2500 ft depth		
ROCK DESCRIPTION: pink to brown rhyolite		
ROCK STRUCTURES: Fe oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-352d		
PROJECT: McGregor		
COLLECTOR: Doug Jones		
FIELD DATE (mo/day/yr): 9/5/97		
LOCATION: Hueco Geothermal field, Drill core hole 61-6, 1600 ft depth		
QUADRANGLE: Desert SW	**SCALE**: 1:24,000	
TOWNSHIP: 26S	**RANGE**: 8E	**SECTION**: 6
LATITUDE: 32° 4' 42"	**LONGITUDE**: 106° 9' 45"	
ROCK UNIT: Tertiary rhyolite sill		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: drill core 1300 ft depth		
ROCK DESCRIPTION: white porphyritic rhyolite with quartz, feldspar		
ROCK STRUCTURES: iron oxides		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-380F		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 9/25/97
MINING DISTRICT: Sacramento Mountains		
PROPERTY NAME:		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 11E	**SECTION**: 25
LATITUDE: 32° 32' 36"		**LONGITUDE**: 105° 46' 30"
SAMPLE TYPE: float chip		
ROCK TYPE: jasperiod		
ALTERATION: red to brown, quartz, calcite, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

MINERALIZATION AND ALTERATION SAMPLE FORM

SAMPLE NUMBER: VTM97-381M		**COLLECTOR**: VTM
AREA: McGregor Range		**FIELD DATE**: 9/25/97
MINING DISTRICT: Sacramento Mountains		
PROPERTY NAME:		
QUADRANGLE: Culp Canyon		**SCALE**: 1:24,000
TOWNSHIP: 20S	**RANGE**: 11E	**SECTION**: 25
LATITUDE: 32° 32' 35"		**LONGITUDE**: 105° 46' 30"
SAMPLE TYPE: 3 ft chip of outcrop		
ROCK TYPE: jasperiod with veins		
ALTERATION: white to gray, quartz, calcite, Fe oxides		
MINERALIZATION:		
PHOTO NUMBER:		

GEOCHEMICAL SAMPLING AND CHARACTERIZATION FORM

SAMPLE NUMBER: VTM97-382		
PROJECT: McGregor		
COLLECTOR: VTM		
FIELD DATE (mo/day/yr): 9/25/97		
LOCATION: Hueco Mountains		
QUADRANGLE: Mountain Tank		**SCALE**: 1:24,000
TOWNSHIP: 26S	**RANGE**: 9E	**SECTION**: 13
LATITUDE: 32° 3' 4"		**LONGITUDE**: 105° 59' 00"
ROCK UNIT: Tertiary syenite sill		
ROCK AGE: Tertiary		
FIELD OCCURRENCE: outcrop		
ROCK DESCRIPTION: brown medium grained syenite sill, 20 ft thick		
ROCK STRUCTURES: feldspar, biotite, hornblende		
MEASURED SECTION: no		
PHOTO NUMBER:		
REMARKS:		
REFERENCES:		

JB-IM029, 040-44 for standards and duplicates

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APPENDIX 4:

MINERALOGICAL DESCRIPTIONS
OF SAMPLES FROM MCGREGOR RANGE

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Table A4.1 Summary of X-Ray Diffraction Studies on Mineralized, Altered, and Igneous Rocks from McGregor Range Collected in 1997.[1]

Sample Number	Major Mineralogy
VTM97-50	Calcite
VTM97-55	Quartz, calcite, K-feldspar, albite
VTM97-59	Calcite, quartz
VTM97-60	Albite, K-feldspar, quartz
VTM97-63	Anorthoclase, sanidine, microcline, quartz
VTM97-89F	Quartz, cuprite?
VTM97-96	Quartz, gypsum
VTM97-109	Calcite, dolomite
VTM97-169	albite, orthoclase, nepheline
VTM97-173	Quartz, albite, actinolite
VTM97-179	Albite, quartz, muscovite
VTM97-188F	Quartz, calcite
VTM97-190F	Quartz, calcite
VTM97-199	Quartz, albite
VTM97-212	Quartz, sanidine, enstatite
VTM97-222	Albite, phlogopite, aegirine-augite
VTM97-223	Albite, orthoclase
VTM97-224	Albite, quartz
VTM97-248F	Quartz, calcite, albite
VTM97-249F	Quartz, orthoclase, albite, calcite
VTM97-263	Barite, fluorite, bornite?
VTM97-264	Fluorite, quartz, barite, calcite
VTM97-265	Fluorite, quartz, barite, calcite
VTM97-266	Quartz
VTM97-267	Dolomite, fluorite, quartz, calcite
VTM97-295F	Calcite
VTM97-323D	Quartz
VTM97-324D	Quartz, calcite
VTM97-325D	Quartz, calcite
VTM97-326D	Quartz, orthoclase
VTM97-327D	Quartz, microcline, albite
VTM97-328D	Quartz, orthoclase, calcite
VTM97-329D	Quartz, albite, orthoclase
VTM97-330D	Quartz, albite, anorthite, dolomite, illite
VTM97-331D	Quartz, calcite, albite, orthoclase

[1] Eric Monroe and V. T. McLemore.

Table A4.2 Clay Mineralogy of Selected Shales and Altered Samples from McGregor Range Collected in 1997.[1]

Lab No.	Sample No.	Kaolinite	Illite	Chlorite	Smectite	Illite/Smectite (Mixed Clays)	Other
GA97098	VTM97-58	3	2	3	1	1	Calcite, quartz, feldspar
GA97099	VTM97-92	3	4	—	—	3	Calcite, quartz
GA97100	VTM97-67	8	1	—	Trace	Trace	Dolomite
GA97101	VTM97-150	2	4	—	—	4	Calcite, quartz, dolomite, feldspar
GA97102	VTM97-236	2	3	3	—	2	Dolomite
GA97103	VTM97-237	2	3	2	—	3	Dolomite, feldspar
GA97104	VTM97-136	6	3	—	—	1	—
GA97105	VTM97-246		6	2	—	2	Quartz, calcite, dolomite
GA97106	VTM97-160	2	4	2	Trace	2	Dolomite
GA97107	VTM97-325D	8	1	—	Trace	1	Quartz
GA97108	VTM97-172	2	3	—	1	4	Calcite, quartz
GA97109	VTM97-170	1	3	—	Trace	6	Quartz, feldspar

[1] Analyses by X-ray diffraction (G. S. Austin).

Table A4.3 Mineralogy of Igneous Rocks from the McGregor Range.[1]

Sample	Lithology	P[2]	K[2]	Q[2]	M[2]	B[2]	H[2]	Other
VTM97-55	Quartz monzonite	25	20	10	5	2	2	36
VTM97-60	Alkali-feldspar trachyte	5	65	5	5	5	10	5
VTM97-63	Trachyte	15	30	5	5	5	10	30
VTM97-169	Quartz monzonite	35	25	15	tr	0	10	15
VTM97-173	Quartz monzonite	20	15	15	5	5	5	35
VTM97-179	syenite	20	40	5	tr	5	5	25
VTM97-199	Syenite	25	45	3	tr	5	5	27
VTM97-212	Syenite	20	45	5	5	5	5	15
VTM97-222	Syenite (nepheline)	20	40	0	5	5	5	25
VTM97-223	Syenite	20	45	5	5	5	5	15
VTM97-224	Syenite	20	45	10	5	5	5	10
VTM97-244	Gabbro	35	0	5	5	10	20	25
VTM97-326d	Rhyolite	1	41	50	1	1	0	6
VTM97-327d	Rhyolite	25	25	40	tr	tr	0	10
VTM97-329d	Rhyolite	25	30	35	tr	0	0	10
VTM97-330d	Monzonite	25	25	15	5	10	5	15
VTM97-350d	Rhyolite	35	25	25	5	5	0	5
VTM97-351d	Rhyolite	40	30	20	5	5	0	0
VTM97-352d	Rhyolite	30	25	35	tr	tr	0	10
ORO706	Monzonite	40	25	10	5	5	tr	15
VTM97-382	Syenite	20	40	5	tr	5	5	25

[1] Values are in %.

[2] P—plagioclase, K—K-feldspar, M—magnetite/ilmenite, B—biotite, H—hornblende; tr—trace amounts.

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APPENDIX 5:

MULTI-ELEMENT ANALYSES
OF SAMPLES FROM MCGREGOR RANGE

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MULTI-ELEMENT ANALYSES OF SAMPLES FROM MCGREGOR RANGE

Samples were collected from McGregor Range and nearby areas and were then sent to a commercial laboratory (XRAL Laboratories) for analyses. NMBMMR internal (nepheline syenite, marble, rhyolite, basalt, and sand) and commercial certified standards and duplicates of selected samples were submitted blind to the commercial laboratory with each sample batch of 25 samples to assure analytical quality and assurance. NMBMMR has archived a split of all samples for future studies. Crustal abundance is from Greenwood and Earnshaw (1986). A list of chemical symbols and their definitions is in Appendix VTM1. Sample locations are in Appendix VTM2 and sample descriptions are in Appendix VTM3. XRF—Four samples (VTM97-380F, 381, 382, High 10) and several duplicate samples were analyzed by NMBMMR X-ray Fluorescence laboratory (Chris McKee, Manager) in October 1997, because of insufficient time to submit to XRAL.

Sample numbers with the appropriate analytical parameters are repeated on pages A5-2 through A5-9, A5-10 through A5-17, and A5-18 through A5-25.

Guide to Footnotes:

[1] na = not available.

[2] Fe_2O_3 is total iron calculated as Fe_2O_3.

[3] if = results not available due to analytical interference.

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
Terr. Abundance	58.3	15.7	8.7	4.6	3.1	2.2	8.9	0.1	1.1	0.3	na[1]	0.03		0.08	1.8	4	9	390	2
Detection Limit	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.5	1	1	10	20	1
Method	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	LECO		ICP	INAA	DCP	ICP	XRF	ICP
Geochemical Charcterization Sample Results																			
Chert																			
VTM97-51	92.60	0.35	3.40	0.39	0.03	0.06	0.20	<0.01	0.02	0.07	3.10	0.06	100.28	<0.5	9	2	30	<50	<1
VTM97-95	76.50	0.21	8.36	4.46	<0.01	0.03	0.24	0.01	0.01	<0.01	10.60	0.01	100.43	<0.5	1	4	10	<50	<1
VTM97-333d	60.00	1.99	12.20	7.42	0.04	0.68	0.82	0.01	0.11	0.15	16.80	0.49	100.71	<0.5	2	<1	20	60	<1
Limestone																			
JB-IM002	5.97	0.05	46.00	5.71	<0.01	<0.01	0.41	<0.01	<0.01	<0.01	42.10	0.02	100.24	<0.5	1	<1	<10	<20	<1
JB-IM003	1.69	0.08	54.00	0.56	<0.01	<0.01	0.12	<0.01	<0.01	<0.01	42.70	0.02	99.15	<0.5	1	<1	<10	<20	<1
JB-IM006	5.68	0.82	50.30	1.04	0.09	0.06	0.77	0.05	0.04	<0.01	40.50	0.06	99.35	<0.5	3	<1	<10	520	<1
JB-IM013	6.35	0.86	50.40	0.84	<0.01	0.06	0.67	0.03	0.03	0.02	40.20	0.04	99.46	<0.5	2	<1	<10	<20	<1
JB-IM016	7.30	0.40	43.00	7.04	<0.01	0.03	0.73	<0.01	0.01	0.07	41.60	0.04	100.18	<0.5	3	10	<10	<20	<1
JB-IM026	61.50	0.15	22.00	0.13	<0.01	0.02	0.35	<0.01	0.01	0.08	16.00	0.03	100.24	<0.5	4	<1	<10	<20	<1
ORO711	16.00	1.07	45.10	0.44	0.28	0.06	0.41	0.04	0.15	<0.01	36.40	0.05	100.00	<0.5	<1	<1	<10	<50	<1
ORO712	6.44	0.70	50.40	0.40	0.19	0.02	1.18	0.07	0.02	0.18	40.20	0.05	99.85	<0.5	<1	2	<10	<50	<1
VTM97-52	3.68	0.33	51.80	0.95	<0.01	0.04	0.18	<0.01	0.01	0.08	42.40	0.02	99.49	<0.5	4	4	<10	<50	<1
VTM97-57	3.78	0.18	52.00	1.00	<0.01	<0.01	0.29	0.01	0.01	<0.01	42.20	0.01	99.48	<0.5	1	<1	<10	70	<1
VTM97-68	4.91	0.77	49.60	1.98	0.03	0.13	0.40	0.03	0.05	<0.01	41.80	0.03	99.73	<0.5	1	8	<10	80	<1
VTM97-82	5.29	0.09	52.30	0.74	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	41.40	0.01	99.90	<0.5	<1	5	<10	<50	<1
VTM97-93	19.40	1.41	42.70	0.60	0.02	0.32	0.82	0.04	0.08	0.09	34.80	0.05	100.28	<0.5	<1	3	<10	60	<1
VTM97-94	2.51	0.02	30.20	20.90	0.02	<0.01	0.26	0.01	<0.01	<0.01	45.80	<0.01	99.72	<0.5	<1	3	<10	<50	<1
VTM97-151	1.99	0.18	54.00	0.60	<0.01	<0.01	0.13	<0.01	0.01	<0.01	42.90	0.03	99.84	<0.5	<1	2	<10	<50	<1
VTM97-171	5.25	0.26	51.80	0.64	<0.01	0.02	0.21	<0.01	0.01	<0.01	41.60	0.03	99.82	<0.5	<1	9	<10	<50	<1
VTM97-243	1.88	0.18	30.70	20.80	0.03	0.03	0.17	0.03	0.01	0.04	45.90	<0.01	99.77	<0.5	1	3	<10	<50	1
VTM97-257	2.17	0.24	39.50	13.40	<0.01	0.02	0.29	0.01	0.01	0.02	44.30	<0.01	99.96	<0.5	2	<1	<10	90	<1
Caliche																			
JB-IM011	31.20	3.44	34.90	0.56	0.95	0.71	0.63	<0.01	0.10	<0.01	27.60	0.02	100.09	<0.5	1	<1	<10	160	1
JB-IM021IS	66.80	7.03	8.00	2.64	1.83	0.68	3.15	0.03	0.77	0.10	9.20	0.06	100.23	<0.5	11	2	30	240	2
Igneous rock																			
Syenite																			
VTM97-60	61.90	16.10	1.85	0.82	5.91	5.43	4.56	0.13	0.82	0.32	1.15	<0.01	98.99	<0.5	2	<1	20	1200	6
VTM97-63	61.20	17.00	2.93	0.92	5.62	5.12	4.27	0.09	0.85	0.37	1.45	0.01	99.83	2.2	<1	<1	<10	1100	5
VTM97-179	65.80	16.90	0.54	0.30	5.86	5.38	2.41	0.04	0.69	0.21	1.15	<0.01	99.28	<0.5	<1	6	<10	830	5
VTM97-199	64.00	17.40	1.44	0.36	6.10	5.81	2.77	0.09	0.65	0.16	0.20	0.01	98.99	<0.5	<1	2	<10	570	7
VTM97-212	63.20	16.40	2.46	0.39	4.82	5.48	3.36	0.17	0.64	0.19	3.05	0.01	100.17	0.8	<1	3	<10	740	5
VTM97-222	60.80	17.90	3.29	0.82	6.39	4.65	3.37	0.08	1.16	0.31	0.55	0.02	99.34	<0.5	<1	1	<10	950	5
VTM97-223	63.00	18.30	0.61	0.06	6.77	5.14	2.21	<0.01	0.77	0.26	1.10	0.03	98.25	<0.5	6	2	<10	1500	4
VTM97-224	65.30	16.70	1.33	0.38	5.72	5.64	2.55	0.08	0.55	0.17	0.40	<0.01	98.82	<0.5	<1	5	<10	680	11
VTM97-382 (XRF)	58.71	17.43	2.33	1.05	5.20	5.85	4.03	0.19	0.98	0.35	4.27	na[1]	100.39	na[1]	<2	na[1]	na[1]	1209	
Rhyolite																			
VTM97-326d	76.60	13.60	<0.01	0.19	0.13	6.82	0.54	0.05	0.07	<0.01	2.10	<0.01	100.10	<0.5	15	6	<10	1300	2
VTM97-327d	75.20	13.70	0.08	0.37	2.18	5.23	0.68	0.03	0.07	<0.01	2.25	<0.01	99.79	<0.5	18	<1	<10	1600	3
VTM97-329d	73.40	13.30	1.34	<0.01	3.35	4.98	0.79	0.10	0.07	0.02	1.65	0.02	99.02	<0.5	1	<1	<10	1800	<1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**ppm**	**ppm**	**ppb**	**ppm**	**ppm**	**ppm**
VTM97-350d	68.80	15.20	1.91	0.16	3.96	4.24	1.34	<0.01	0.21	0.09	2.15	0.71	98.77	<0.5	4	20	10	1500	3
VTM97-351d	68.30	15.10	1.34	0.36	5.78	3.49	2.01	<0.01	0.23	0.08	1.95	<0.01	98.64	<0.5	1	4	<10	1100	3
VTM97-352d	74.50	13.90	0.15	0.10	3.42	4.61	0.70	<0.01	0.06	<0.01	1.20	<0.01	98.64	<0.5	6	6	<10	1300	2
Quartz monz.																			
ORO706	56.90	15.80	6.00	2.33	3.58	2.97	6.73	0.10	0.75	0.34	3.90	0.02	99.42	<0.5	3	<1	<10	1400	3
VTM97-55	64.00	15.70	3.90	1.24	4.41	3.63	3.81	0.10	0.47	0.19	2.65	0.01	100.11	<0.5	<1	3	10	1700	3
VTM97-169	64.00	15.00	2.89	1.93	3.80	3.59	3.73	0.07	0.41	0.18	4.00	<0.01	99.60	<0.5	<2	<1	<10	1600	2
VTM97-173	65.30	15.50	3.26	1.56	4.60	3.75	3.73	0.06	0.43	0.19	1.70	0.02	100.10	<0.5	<1	3	<10	1600	2
VTM97-330d	62.30	15.70	3.89	0.86	3.71	4.53	3.75	0.07	0.45	0.18	4.55	0.02	100.01	<0.5	2	<1	<10	1500	3
Other																			
ORO720	43.50	14.80	10.40	7.62	3.36	1.80	11.60	0.19	2.33	0.67	1.65	0.05	97.97	<0.5	1	<1	<10	560	3
High 10 (XRF)	55.99	8.27	12.09	1.31	1.27	0.42	6.07	0.19	1.28	0.17	12.79	na[1]	99.85	na[1]	2	na[1]	na[1]	98	na[1]
Precambrian rocks																			
VTM97-244	45.10	17.90	5.26	8.29	2.87	2.22	12.00	0.22	1.09	0.09	5.10	<0.01	100.14	<0.5	<1	2	40	410	2
VTM97-245	95.70	0.78	0.68	<0.01	<0.01	0.29	1.33	<0.01	0.29	0.33	0.90	0.08	100.30	<0.5	2	<1	<10	60	<1
Shale																			
VTM97-58	57.70	15.40	5.85	4.09	1.06	2.80	4.00	0.03	0.79	0.13	8.35	<0.01	100.20	<0.5	6	1	60	280	4
VTM97-67	73.10	7.77	4.42	2.11	0.94	2.46	2.46	0.03	0.56	0.08	6.30	<0.01	100.23	0.5	2	<1	60	300	1
VTM97-92	68.00	4.70	11.70	0.54	0.02	1.08	2.04	<0.01	0.28	0.19	11.60	0.02	100.17	<0.5	4	5	40	90	<1
JB-IM013SH	29.20	5.80	32.00	1.23	0.22	1.01	2.40	0.07	0.40	0.16	27.50	0.04	99.99	<0.5	5	<1	40	50	2
JB-IM021SH	44.80	14.90	8.82	5.51	0.54	3.29	5.98	0.04	0.84	0.12	15.10	0.02	99.94	<0.5	7	<1	130	250	4
VTM97-136	48.50	7.70	18.80	1.11	0.13	2.37	2.85	0.02	0.55	0.07	18.20	0.05	100.35	<0.5	5	6	80	320	<1
VTM97-150	43.40	15.70	11.40	3.12	0.28	3.89	5.19	0.05	0.77	0.11	16.40	0.06	100.37	<0.5	2	<1	160	200	3
VTM97-160	49.40	9.32	9.11	8.83	0.70	2.55	2.33	0.09	0.58	0.10	17.20	0.08	100.29	<0.5	4	2	70	260	2
VTM97-170	55.30	16.00	5.56	2.02	0.42	3.34	5.16	0.03	0.83	0.23	11.30	1.26	101.45	<0.5	4	7	130	170	2
VTM97-236	46.10	17.40	3.88	7.66	0.40	3.58	7.01	0.03	0.85	0.06	13.20	0.83	101.00	<0.5	33	5	170	300	6
VTM97-237	39.90	13.70	7.94	7.84	0.48	4.04	7.44	0.04	0.61	0.12	18.20	0.11	100.42	<0.5	11	3	180	160	2
VTM97-246	56.00	15.80	3.51	4.17	0.12	5.67	4.50	0.03	0.75	0.07	9.55	0.03	100.17	<0.5	10	3	90	470	3
VTM97-332d	53.20	7.83	15.50	1.73	0.38	2.54	3.13	0.01	0.61	0.69	14.50	1.63	101.75	<0.5	11	2	70	230	<1
VTM97-334d	18.70	3.86	23.30	15.70	0.07	1.34	1.10	0.05	0.19	0.13	35.70	0.10	100.24	0.6	6	<1	40	60	3
Sandstone																			
VTM97-69	66.40	7.29	11.30	0.27	0.16	2.63	1.53	0.03	0.11	0.03	10.60	0.01	100.36	<0.5	17	5	<10	540	<1
VTM97-135	36.20	3.48	22.60	6.93	0.05	0.96	2.08	0.02	0.26	0.05	27.60	0.03	100.26	<0.5	1	1	30	120	<1
VTM97-158	71.00	7.75	7.42	0.85	0.08	2.10	2.23	0.02	0.59	0.08	8.10	0.05	100.27	<0.5	10	1	60	380	1
VTM97-159	61.80	7.39	11.00	2.42	0.08	1.99	2.56	0.04	0.65	0.09	12.30	0.02	100.34	<0.5	<1	<1	60	230	<1
VTM97-261	4.69	0.92	30.80	17.80	0.06	0.17	1.72	0.03	0.05	<0.01	43.80	0.07	100.04	<0.5	9	<1	<10	120	<1
VTM97-262	33.60	5.43	26.70	4.24	0.05	1.49	2.00	0.03	0.36	0.06	26.10	0.02	100.06	<0.5	18	<1	40	160	<1
Sand																			
VTM97-100	89.50	4.62	0.62	0.13	0.60	1.96	0.96	<0.01	0.21	0.02	1.60	0.01	100.22	<0.5	2	1	<10	460	1
Stream Sediment (sand-silt) Sample Results																			
VTM97-53S	75.00	4.67	8.56	0.26	0.75	1.76	1.43	0.01	0.28	0.03	7.45	0.02	100.22	<0.5	3	7	<10	400	<1
VTM97-54S	80.60	7.37	1.79	0.38	1.27	2.46	2.29	0.03	0.45	0.05	3.25	0.01	99.95	<0.5	3	5	10	630	<1
VTM97-56S	19.90	3.12	39.20	0.90	0.41	0.80	1.12	0.03	0.18	0.06	34.40	0.03	100.15	<0.5	2	6	<10	180	<1
VTM97-61S	36.00	9.02	24.50	1.51	2.11	2.21	3.97	0.12	0.59	0.13	19.90	0.02	100.08	<0.5	9	3	20	520	2

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
VTM97-62S	44.60	12.90	22.60	1.42	1.82	2.20	5.59	0.15	0.68	0.12	8.05	0.02	100.15	<0.5	16	5	40	410	1
VTM97-64S	47.00	10.00	14.00	1.44	0.91	2.49	3.63	0.07	0.55	0.19	20.00	0.05	100.33	<0.5	6	6	30	490	1
VTM97-65S	58.70	8.51	11.30	1.27	1.18	2.41	2.92	0.05	0.56	0.08	13.30	0.03	100.31	<0.5	4	4	30	480	<1
VTM97-66S	57.10	10.50	9.68	1.19	1.22	2.61	3.60	0.07	0.57	0.14	13.60	0.02	100.30	<0.5	6	2	30	530	2
VTM97-70S	50.50	9.30	13.00	2.49	0.87	2.36	3.49	0.05	0.52	0.12	17.60	0.03	100.33	<0.5	6	6	40	640	<1
VTM97-71S	52.50	10.60	10.80	2.21	0.96	2.66	3.80	0.07	0.59	0.17	15.60	0.02	99.98	<0.5	6	4	40	500	2
VTM97-72S	27.20	4.09	34.00	1.41	0.40	1.03	1.71	0.05	0.21	0.08	30.10	0.03	100.31	<0.5	5	5	10	260	<1
VTM97-73S	46.90	6.11	21.60	0.94	0.86	1.69	2.34	0.04	0.40	0.07	19.40	0.02	100.37	<0.5	4	3	20	340	<1
VTM97-74S	28.70	3.07	35.80	0.57	0.39	0.90	1.29	0.03	0.19	0.06	29.10	0.03	100.13	<0.5	4	7	<10	180	<1
VTM97-75S	40.60	4.06	27.90	0.56	0.61	1.26	1.59	0.04	0.31	0.06	23.30	0.02	100.31	<0.5	3	4	10	270	<1
VTM97-81S	36.60	4.69	28.70	0.82	0.70	1.39	1.72	0.03	0.29	0.07	25.10	0.03	100.14	<0.5	2	5	20	250	<1
VTM97-83S	49.30	9.51	16.70	1.19	1.91	2.56	3.58	0.09	0.39	0.16	14.70	0.02	100.11	<0.5	4	8	10	890	<1
VTM97-84S	50.80	9.56	16.20	1.22	1.76	2.38	3.63	0.06	0.36	0.15	14.10	0.02	100.24	<0.5	14	14	20	960	<1
VTM97-86S	30.80	3.45	33.20	0.51	0.43	0.93	1.54	0.03	0.20	0.10	29.10	0.03	100.32	<0.5	8	8	<10	210	<1
VTM97-87S	58.10	3.63	18.00	0.90	0.46	1.27	2.27	0.02	0.24	0.06	15.30	0.04	100.25	<0.5	100	3	<10	320	<1
VTM97-90S	21.80	2.92	35.80	3.34	0.22	0.69	2.80	0.05	0.24	0.06	32.30	0.05	100.22	<0.5	15	<1	<10	140	<1
VTM97-91S	23.20	2.75	34.60	4.27	0.27	0.64	1.58	0.03	0.25	0.05	32.40	0.04	100.04	<0.5	3	1	<10	110	<1
VTM97-97S	36.80	2.60	27.50	3.73	0.29	0.85	2.39	0.03	0.20	0.04	25.70	0.04	100.13	<0.5	10	1	<10	220	<1
VTM97-98S	30.30	3.57	29.80	3.57	0.27	0.88	3.65	0.05	0.41	0.08	27.70	0.07	100.28	<0.5	8	<1	<10	170	<1
VTM97-99S	29.90	2.31	33.70	2.19	0.25	0.63	1.61	0.03	0.21	0.05	29.30	0.04	100.18	<0.5	5	<1	<10	110	<1
VTM97-106S	16.60	1.21	42.20	2.38	0.08	0.33	1.06	0.02	0.11	0.04	36.00	0.05	100.03	<0.5	4	<1	<10	130	<1
VTM97-107S	31.20	2.37	35.40	0.33	0.28	0.66	1.10	0.04	0.23	0.05	28.60	0.02	100.26	<0.5	3	<1	<10	180	<1
VTM97-108S	22.00	2.54	39.00	1.37	0.16	0.81	1.52	0.03	0.18	0.04	32.60	0.04	100.25	<0.5	9	<1	<10	130	<1
VTM97-110S	21.00	2.35	39.00	1.77	0.17	0.64	1.70	0.03	0.16	0.05	33.40	0.04	100.27	<0.5	10	<1	<10	300	1
VTM97-111S	20.70	2.00	37.20	4.10	0.12	0.52	0.87	0.02	0.14	0.05	34.50	0.04	100.22	<0.5	2	<1	<10	90	<1
VTM97-112S	14.40	1.78	42.80	2.17	0.09	0.52	1.20	0.03	0.12	0.04	36.90	0.05	100.05	<0.5	3	<1	<10	820	<1
VTM97-113S	21.50	2.06	37.90	3.00	0.11	0.62	1.38	0.03	0.15	0.04	33.40	0.04	100.19	<0.5	4	<1	<10	90	<1
VTM97-114S	57.90	9.35	11.60	1.15	1.12	2.30	2.95	0.04	0.50	0.10	13.00	0.02	100.01	<0.5	5	<1	20	530	2
VTM97-115S	26.10	4.40	33.40	0.70	0.87	1.42	1.42	0.05	0.20	0.06	30.40	0.03	99.05	<0.5	3	10	<10	210	<1
VTM97-116S	13.60	2.03	44.20	0.99	0.18	0.51	0.96	0.03	0.12	0.06	37.40	0.03	100.11	<0.5	3	8	<10	110	<1
VTM97-117S	16.00	2.54	42.30	0.80	0.43	0.77	1.15	0.03	0.12	0.05	35.80	0.02	100.01	<0.5	4	6	10	130	2
VTM97-118S	43.60	6.27	23.00	1.06	0.80	1.62	2.11	0.03	0.39	0.07	21.40	0.02	100.37	<0.5	4	6	20	530	1
VTM97-119S	15.70	2.51	42.50	1.24	0.18	0.70	1.01	0.06	0.17	0.11	36.00	0.04	100.18	<0.5	5	<1	<10	220	1
VTM97-120S	37.70	6.54	25.50	1.18	0.67	1.60	2.23	0.04	0.39	0.12	24.20	0.04	100.17	<0.5	4	<1	<10	320	2
VTM97-121S	20.50	2.58	40.30	0.88	0.27	0.68	1.00	0.02	0.17	0.09	33.50	0.03	99.99	<0.5	2	<1	<10	120	1
VTM97-123S	18.20	1.73	42.60	0.90	0.14	0.45	0.73	0.01	0.11	0.07	35.10	0.03	100.04	<0.5	2	<1	<10	90	<1
VTM97-124S	23.00	2.17	36.90	3.03	0.15	0.53	1.03	0.02	0.14	0.07	33.30	0.03	100.34	<0.5	2	1	<10	100	<1
VTM97-125S	29.10	1.86	35.70	1.47	0.11	0.47	1.08	0.01	0.13	0.06	30.20	0.03	100.19	<0.5	3	<1	<10	60	<1
VTM97-130S	26.00	2.71	36.90	1.06	0.23	0.67	1.24	0.03	0.18	0.08	31.10	0.03	100.20	<0.5	3	<1	<10	120	<1
VTM97-131S	29.00	3.04	35.30	0.72	0.33	0.95	1.51	0.03	0.20	0.06	29.10	0.03	100.24	<0.5	3	<1	<10	170	<1
VTM97-132S	25.90	2.93	37.50	0.64	0.36	0.85	1.07	0.03	0.18	0.06	30.70	0.03	100.22	<0.5	3	<1	<10	200	<1
VTM97-133S	27.90	4.30	34.40	0.88	0.59	1.16	2.01	0.05	0.24	0.06	28.60	0.03	100.19	<0.5	5	<1	20	350	<1
VTM97-134S	29.30	4.64	32.40	1.37	0.47	1.17	1.78	0.04	0.28	0.09	28.60	0.04	100.14	<0.5	4	<1	10	270	<1
VTM97-137S	42.70	6.19	23.10	1.09	0.76	1.81	2.30	0.04	0.42	0.10	21.60	0.04	100.11	<0.5	4	<1	10	380	1
VTM97-138S	59.70	6.04	15.10	0.61	1.10	1.72	4.72	0.06	0.35	0.08	10.40	0.02	99.88	<0.5	7	7	<10	450	1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
VTM97-140S	28.00	3.73	33.50	2.48	0.33	0.87	1.35	0.02	0.24	0.09	29.70	0.03	100.31	<0.5	2	<1	<10	280	<1
VTM97-141S	13.10	0.83	46.80	0.94	0.02	0.13	0.49	<0.01	0.04	0.07	37.70	0.04	100.12	<0.5	2	<1	<10	<20	<1
VTM97-142S	23.40	3.50	37.40	0.85	0.30	0.82	1.42	0.03	0.20	0.17	32.10	0.03	100.19	<0.5	2	<1	<10	140	<1
VTM97-143S	21.00	2.23	41.00	0.41	0.21	0.55	0.98	0.02	0.14	0.07	33.60	0.03	100.21	<0.5	2	<1	<10	90	<1
VTM97-144S	40.80	4.37	26.30	1.13	0.38	1.01	1.74	0.03	0.28	0.08	24.10	0.03	100.22	<0.5	3	<1	<10	200	1
VTM97-145S	10.40	1.30	48.20	0.33	0.06	0.23	0.60	0.01	0.07	0.06	39.00	0.04	100.26	<0.5	1	1	<10	<20	<1
VTM97-147S	20.00	2.96	40.20	0.37	0.20	0.61	1.47	0.03	0.19	0.09	34.00	0.03	100.12	<0.5	4	<1	<10	120	<1
VTM97-148S	31.00	2.35	34.70	0.84	0.20	0.53	1.12	0.02	0.16	0.08	29.30	0.03	100.30	<0.5	3	<1	<10	110	<1
VTM97-152S	41.40	5.15	26.00	1.42	0.68	1.13	3.02	0.04	0.33	0.08	20.70	0.04	99.95	<0.5	10	2	<10	270	<1
VTM97-154S	57.70	11.00	10.60	0.75	2.98	2.29	9.44	0.08	0.41	0.17	4.65	0.05	100.07	<0.5	13	26	<10	720	2
VTM97-156S	54.00	9.76	13.50	0.66	2.62	2.11	10.40	0.09	0.27	0.13	6.55	0.03	100.09	<0.5	15	4	<10	720	2
VTM97-165S	11.40	1.62	41.00	5.95	0.07	0.39	1.01	0.03	0.10	0.05	38.60	0.04	100.22	<0.5	4	3	<10	110	<1
VTM97-167S	49.60	10.50	11.80	3.45	0.77	2.63	3.91	0.07	0.57	0.14	16.70	0.05	100.14	<0.5	6	3	40	480	2
VTM97-168S	28.60	4.46	33.40	1.02	0.49	1.19	1.95	0.06	0.27	0.08	28.60	0.04	100.12	<0.5	5	5	<10	260	<1
VTM97-174S	15.30	2.20	43.50	0.98	0.18	0.42	1.35	0.03	0.12	0.06	36.00	0.04	100.14	<0.5	4	4	<10	110	<1
VTM97-175S	10.90	1.77	43.30	3.21	0.11	0.42	1.78	0.03	0.11	0.05	38.60	0.04	100.28	<0.5	8	1	<10	80	<1
VTM97-176S	20.30	4.09	35.70	3.81	0.51	0.74	1.96	0.04	0.23	0.07	32.70	0.02	100.15	<0.5	3	2	20	130	<1
VTM97-177S	52.50	3.18	22.50	0.41	0.47	1.15	1.23	0.02	0.21	0.04	18.40	0.03	100.11	<0.5	3	<1	<10	260	<1
VTM97-178S	24.90	5.45	35.10	1.12	1.07	1.32	2.41	0.08	0.27	0.09	28.40	0.03	100.21	<0.5	7	<1	<10	260	1
VTM97-180S	32.00	7.75	27.20	2.10	1.63	1.77	4.21	0.10	0.33	0.10	23.00	0.03	100.19	<0.5	21	<1	20	370	2
VTM97-181S	23.80	5.39	36.20	1.07	1.09	1.25	2.28	0.08	0.23	0.09	28.50	0.03	99.98	<0.5	7	3	<10	270	1
VTM97-182S	26.40	6.73	34.30	1.19	1.16	1.44	3.04	0.09	0.32	0.10	25.30	0.02	100.07	<0.5	7	<1	<10	290	2
VTM97-185S	18.00	4.17	40.60	0.72	0.69	0.98	1.75	0.05	0.20	0.08	32.90	0.03	100.14	<0.5	5	2	<10	160	1
VTM97-186S	25.20	2.93	38.10	0.64	0.40	0.78	1.04	0.03	0.18	0.05	30.70	0.02	100.05	<0.5	3	<1	<10	200	<1
VTM97-187S	17.60	2.21	42.60	0.72	0.25	0.59	0.90	0.04	0.14	0.07	35.00	0.03	100.12	<0.5	3	1	<10	140	<1
VTM97-189S	24.60	3.54	37.30	0.57	0.43	1.20	1.35	0.05	0.18	0.06	30.90	0.02	100.18	<0.5	4	<1	<10	190	1
VTM97-192S	46.20	11.00	18.20	0.83	3.01	3.37	2.86	0.08	0.54	0.15	13.70	0.02	99.94	<0.5	5	<1	10	640	3
VTM97-193S	57.20	9.23	12.80	0.93	1.68	2.55	2.60	0.05	0.47	0.09	12.60	0.02	100.20	<0.5	4	<1	<10	560	2
VTM97-196S	23.10	4.48	37.40	0.89	0.85	1.23	1.75	0.05	0.23	0.09	30.20	0.02	100.27	<0.5	8	<1	<10	220	2
VTM97-197S	12.80	1.55	45.30	0.91	0.18	0.42	1.43	0.09	0.10	0.04	37.30	0.03	100.12	<0.5	18	<1	<10	150	4
VTM97-204S	45.10	11.70	22.10	2.50	1.36	2.31	4.43	0.11	0.65	0.14	9.55	0.05	99.95	<0.5	14	1	70	410	4
VTM97-205S	46.10	11.80	21.30	2.06	1.40	2.05	5.36	0.20	0.64	0.13	8.80	0.04	99.84	<0.5	13	1	40	410	4
VTM97-207S	34.30	8.57	28.80	2.19	0.90	1.74	3.40	0.08	0.46	0.13	19.50	0.03	100.07	<0.5	7	<1	<10	310	3
VTM97-208S	31.20	8.40	28.10	1.45	1.67	1.89	3.58	0.08	0.41	0.12	23.10	0.02	100.00	<0.5	8	<1	20	380	3
VTM97-209S	35.60	9.27	28.50	2.17	0.80	1.54	4.12	0.10	0.50	0.13	17.30	0.03	100.03	<0.5	11	2	30	290	3
VTM97-210S	14.00	2.05	44.50	0.87	0.17	0.49	1.25	0.04	0.12	0.05	36.40	0.03	99.94	<0.5	5	<1	<10	100	1
VTM97-211S	39.00	5.87	25.90	0.99	0.79	1.57	2.12	0.04	0.35	0.08	23.40	0.03	100.11	<0.5	6	<1	<10	300	2
VTM97-213S	32.90	5.39	25.60	4.06	0.17	0.82	4.52	0.07	0.41	0.06	26.10	0.05	100.10	<0.5	55	<1	20	380	3
VTM97-214S	34.20	4.73	27.00	3.78	0.61	1.25	1.90	0.04	0.30	0.06	26.30	0.03	100.17	<0.5	5	<1	10	240	2
VTM97-215S	13.00	2.50	43.90	1.11	0.20	0.51	1.73	0.04	0.14	0.05	36.80	0.04	100.02	<0.5	3	<1	40	60	<1
VTM97-216S	35.10	5.52	28.30	1.53	0.67	1.29	2.15	0.04	0.31	0.07	24.80	0.03	99.81	<0.5	5	<1	20	260	<1
VTM97-217S	15.10	2.41	41.90	1.91	0.29	0.49	1.60	0.04	0.13	0.06	36.30	0.03	100.26	<0.5	3	<1	20	50	<1
VTM97-218S	35.30	8.19	26.60	1.06	1.92	2.27	3.02	0.10	0.44	0.13	21.10	0.02	100.15	<0.5	8	3	<10	390	3
VTM97-220S	49.70	14.00	14.80	1.56	3.52	3.03	5.21	0.11	0.90	0.24	6.90	0.02	99.99	<0.5	9	8	20	640	3
VTM97-226S	46.20	11.50	16.40	0.84	3.70	3.31	3.58	0.12	0.32	0.14	14.10	0.02	100.23	<0.5	8	12	20	530	3

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
VTM97-228S	15.20	2.47	43.10	0.84	0.40	0.75	1.40	0.03	0.16	0.05	35.70	0.02	100.12	<0.5	3	4	<10	130	<1
VTM97-229S	23.40	4.99	36.20	0.91	1.08	1.35	1.88	0.04	0.29	0.08	29.80	0.02	100.04	<0.5	3	2	10	250	<1
VTM97-230S	65.20	11.20	3.83	1.27	1.11	2.76	3.69	0.07	0.60	0.13	10.00	0.01	99.87	<0.5	6	2	30	630	1
VTM97-235S	66.40	10.50	4.04	1.16	1.18	2.83	3.41	0.06	0.60	0.14	9.65	0.02	99.99	<0.5	5	10	30	580	<1
VTM97-238S	18.00	2.40	40.00	2.29	0.32	0.60	0.95	0.02	0.17	0.08	35.30	0.03	100.16	<0.5	1	10	<10	100	<1
VTM97-239S	25.50	3.17	35.60	1.99	0.37	0.84	1.04	0.02	0.21	0.07	31.40	0.03	100.24	<0.5	2	20	<10	190	<1
VTM97-240S	27.70	3.19	35.90	0.86	0.36	0.93	1.11	0.03	0.23	0.07	29.90	0.03	100.31	<0.5	3	10	<10	220	<1
VTM97-241S	21.30	2.08	40.50	1.47	0.07	0.40	1.56	0.03	0.13	0.11	32.40	0.02	100.07	<0.5	4	8	<10	30	<1
VTM97-247S	34.40	7.00	29.20	0.83	1.77	1.97	2.00	0.06	0.33	0.10	22.30	0.02	99.98	<0.5	6	2	<10	370	2
VTM97-251S	21.50	3.06	39.30	0.54	0.30	0.84	1.16	0.05	0.20	0.08	33.20	0.03	100.26	<0.5	4	<1	<10	190	<1
VTM97-252S	65.70	10.10	4.77	1.27	0.98	2.75	3.41	0.07	0.53	0.14	10.40	0.02	100.14	<0.5	6	<1	30	610	2
VTM97-253S	62.00	12.90	2.95	1.46	1.01	3.00	4.47	0.09	0.65	0.14	11.30	0.01	99.98	<0.5	7	<1	30	640	1
VTM97-254S	53.10	9.20	14.00	1.16	0.95	2.27	2.98	0.05	0.50	0.11	15.90	0.02	100.24	<0.5	5	<1	20	580	<1
VTM97-255S	51.80	9.00	15.10	1.18	1.01	2.19	2.84	0.04	0.48	0.12	16.00	0.02	99.78	<0.5	5	<1	20	600	<1
VTM97-256S	59.30	10.60	8.15	1.23	0.98	2.63	3.51	0.07	0.57	0.11	12.80	0.02	99.97	<0.5	7	<1	30	560	<1
VTM97-258S	65.60	12.20	1.80	1.50	1.01	3.05	4.12	0.08	0.61	0.14	9.85	0.02	99.98	<0.5	6	<1	30	630	1
VTM97-259S	58.30	8.46	10.70	1.45	0.98	2.40	2.77	0.04	0.52	0.13	14.50	0.04	100.25	<0.5	4	7	<10	530	1
VTM97-260S	15.60	2.59	39.70	3.62	0.14	0.74	1.48	0.05	0.15	0.08	36.00	0.04	100.15	<0.5	6	<1	<10	220	<1
VTM97-268S	47.80	6.65	19.00	2.15	0.75	1.88	2.93	0.04	0.39	0.11	18.30	0.04	100.00	<0.5	22	<1	<10	620	<1
VTM97-276S	22.50	2.96	34.20	4.73	0.29	0.75	1.13	0.02	0.19	0.06	33.20	0.05	100.03	<0.5	2	<1	<10	140	<1
VTM97-277S	19.70	2.94	39.30	1.67	0.27	0.72	1.05	0.02	0.17	0.09	34.20	0.04	100.13	<0.5	2	<1	<10	130	<1
VTM97-278S	8.59	0.92	48.90	0.87	0.05	0.16	0.53	0.01	0.06	0.09	40.00	0.03	100.18	<0.5	1	<1	<10	20	<1
VTM97-279S	21.00	2.80	39.70	0.99	0.27	0.73	1.06	0.03	0.19	0.10	33.40	0.04	100.27	<0.5	2	<1	<10	140	<1
VTM97-280S	23.50	4.14	36.60	0.80	0.34	0.95	1.58	0.04	0.26	0.10	31.90	0.04	100.21	<0.5	3	<1	<10	170	<1
VTM97-281S	13.70	1.49	43.90	2.51	0.12	0.36	0.68	0.01	0.09	0.07	37.30	0.04	100.23	<0.5	2	<1	<10	70	<1
VTM97-282S	23.30	2.94	37.80	1.45	0.32	0.80	1.08	0.02	0.20	0.08	32.30	0.04	100.29	<0.5	2	<1	<10	140	<1
VTM97-283S	47.50	3.90	24.10	0.70	0.48	1.29	2.25	0.03	0.37	0.05	19.50	0.02	100.17	<0.5	3	<1	<10	260	<1
VTM97-284S	35.60	2.88	32.00	0.55	0.34	0.96	1.24	0.02	0.22	0.07	26.30	0.03	100.18	<0.5	3	<1	<10	230	<1
VTM97-285S	19.20	2.33	36.70	5.05	0.18	0.67	1.21	0.03	0.16	0.06	34.60	0.04	100.19	<0.5	5	<1	<10	160	<1
VTM97-286S	49.50	6.53	19.60	0.83	0.91	1.77	2.21	0.04	0.42	0.10	18.20	0.03	100.11	<0.5	4	<1	<10	380	<1
VTM97-287S	52.70	7.65	16.20	1.53	0.85	1.96	2.62	0.04	0.42	0.09	16.10	0.03	100.16	<0.5	4	6	<10	440	<1
VTM97-289S	54.30	9.36	12.70	0.78	0.83	2.13	3.31	0.06	0.58	0.10	15.90	0.04	100.05	<0.5	4	<1	<10	480	1
VTM97-290S	24.60	2.92	38.10	0.50	0.29	0.71	1.05	0.02	0.18	0.08	31.80	0.04	100.25	<0.5	2	<1	<10	130	<1
VTM97-291S	8.14	0.97	50.30	0.42	0.03	0.11	0.33	<0.01	0.05	0.08	39.70	0.04	100.13	<0.5	1	<1	<10	<20	<1
VTM97-292S	50.00	9.23	16.00	0.81	0.81	1.98	3.20	0.07	0.51	0.10	17.60	0.03	100.31	<0.5	5	<1	<10	440	1
VTM97-293S	10.60	1.24	48.30	0.47	0.07	0.16	0.48	0.01	0.07	0.06	38.80	0.04	100.26	<0.5	2	<1	<10	20	<1
VTM97-294S	22.10	2.90	39.40	0.55	0.26	0.68	1.08	0.02	0.18	0.08	33.00	0.03	100.25	<0.5	2	<1	<10	120	<1
VTM97-296S	30.70	1.77	34.60	1.86	0.07	0.36	1.34	0.02	0.10	0.05	29.30	0.03	100.20	<0.5	3	<1	<10	60	<1
VTM97-296S	31.50	1.80	34.40	1.77	0.06	0.38	1.30	0.03	0.12	0.05	28.90	0.03	100.31	<0.5	3	<1	<10	60	<1
VTM97-297S	27.40	2.05	36.10	1.76	0.14	0.59	1.13	0.02	0.14	0.05	30.80	0.04	100.22	<0.5	2	<1	<10	110	<1
VTM97-298S	31.20	2.75	35.30	0.80	0.26	0.67	1.25	0.02	0.18	0.06	27.70	0.03	100.22	<0.5	3	<1	<10	190	<1
VTM97-299S	14.40	1.59	43.10	2.37	0.07	0.46	1.15	0.02	0.09	0.05	36.80	0.04	100.14	<0.5	12	<1	<10	70	<1
VTM97-300S	16.00	1.75	41.90	2.42	0.10	0.49	0.98	0.02	0.11	0.05	36.10	0.04	99.96	<0.5	5	<1	<10	70	<1
VTM97-306S	22.10	2.61	36.20	2.10	0.26	0.65	1.20	0.03	0.16	0.05	32.90	0.04	98.30	<0.5	4	<1	<10	140	<1
VTM97-307S	20.80	1.96	38.70	2.86	0.12	0.47	1.02	0.02	0.13	0.05	34.20	0.03	100.36	<0.5	3	<1	<10	110	<1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
VTM97-308S	23.60	1.97	37.00	3.17	0.15	0.44	1.00	0.02	0.12	0.06	32.70	0.03	100.26	<0.5	4	<1	<10	110	<1
VTM97-309S	18.50	2.01	40.00	2.87	0.15	0.44	1.10	0.02	0.13	0.05	34.90	0.04	100.21	<0.5	3	3	<10	120	<1
VTM97-310S	27.20	3.31	35.90	0.69	0.37	0.94	1.22	0.04	0.21	0.11	30.10	0.03	100.12	<0.5	3	<1	<10	200	<1
VTM97-311S	50.20	7.21	18.60	0.84	0.86	2.03	2.31	0.04	0.39	0.12	17.50	0.03	100.13	<0.5	4	3	10	430	1
VTM97-312S	23.70	3.00	38.50	0.45	0.35	0.77	1.06	0.03	0.19	0.09	32.10	0.04	100.28	<0.5	2	<1	<10	170	<1
VTM97-313S	33.70	5.19	30.30	0.67	0.50	1.37	1.72	0.04	0.30	0.10	26.30	0.03	100.22	<0.5	3	5	<10	260	1
VTM97-314S	35.50	3.60	30.40	1.88	0.34	1.02	1.65	0.04	0.24	0.07	25.40	0.03	100.17	<0.5	4	<1	<10	240	<1
VTM97-315S	17.40	1.86	41.20	2.51	0.09	0.39	1.06	0.03	0.11	0.07	35.40	0.04	100.16	<0.5	4	<1	<10	130	<1
VTM97-316S	65.00	7.17	10.50	0.97	0.89	2.09	2.25	0.03	0.45	0.07	10.70	0.03	100.15	<0.5	5	<1	20	500	1
VTM97-317S	39.10	4.27	26.60	2.15	0.55	1.42	1.42	0.03	0.28	0.05	24.20	0.03	100.10	<0.5	5	<1	<10	300	<1
VTM97-319S	49.40	10.00	13.40	2.11	0.95	1.61	4.70	0.09	0.55	0.06	17.00	0.04	99.91	<0.5	7	2	40	910	4
VTM97-321S	47.50	10.50	12.50	3.33	0.98	1.81	5.11	0.11	0.77	0.07	17.50	0.03	100.21	<0.5	6	<1	50	400	3
Mineralized Area and Float Chip Sample Results																			
VTM97-50M	3.75	0.22	52.40	0.79	<0.01	0.03	0.14	0.02	0.01	0.05	42.40	0.05	99.86	<0.5	13	6	<10	420	<1
VTM97-59M	25.70	1.01	35.30	2.66	<0.01	<0.01	3.21	0.09	0.05	0.04	31.70	0.02	99.78	<0.5	9	<1	<10	70	<1
VTM97-89F(59F)	74.70	0.34	2.13	0.06	0.04	0.08	18.90	<0.01	0.01	0.10	3.35	0.20	99.91	<0.5	1300	6	<10	2100	3
VTM97-96M	33.80	3.71	17.50	0.08	0.03	0.74	17.30	0.07	2.90	0.11	12.90	8.06	97.20	<0.5	210	7	20	360	4
VTM97-109M	7.73	1.66	45.70	3.00	0.06	0.46	1.19	0.02	0.09	0.02	40.30	0.05	100.28	<0.5	6	4	20	50	<1
VTM97-146F	3.58	0.30	53.40	0.27	<0.01	0.04	0.22	<0.01	0.01	0.05	42.30	0.02	100.17	<0.5	1	<1	<10	<20	<1
VTM97-149F	23.40	0.83	41.10	1.05	<0.01	0.12	0.46	<0.01	0.04	0.08	33.10	0.03	100.18	<0.5	4	<1	<10	<20	<1
VTM97-172M	45.80	13.30	15.10	1.86	0.22	2.17	5.18	0.06	0.76	0.15	15.40	2.13	100.00	<0.5	4	1	100	130	3
VTM97-184M	15.60	2.72	42.40	0.54	0.08	0.53	3.04	0.12	0.11	0.09	34.80	0.08	100.03	<0.5	3	<1	10	2100	<1
VTM97-188F	61.60	0.45	12.90	0.05	0.14	0.12	13.00	0.07	<0.01	0.03	12.10	0.02	100.48	<0.5	510	<1	<10	60	64
VTM97-190F	51.70	0.25	13.00	0.32	<0.01	0.05	19.00	2.81	0.01	0.02	13.20	0.02	100.38	1.4	73	2	<10	800	4
VTM97-194M	85.00	0.20	3.64	1.59	<0.01	0.04	4.34	0.02	0.03	0.04	5.40	0.06	100.30	<0.5	74	<1	<10	70	30
VTM97-195M	92.30	0.44	1.25	0.44	<0.01	0.07	2.75	0.02	0.03	0.06	2.65	0.04	100.01	<0.5	21	<1	<10	90	27
VTM97-200M	37.70	9.65	28.30	1.37	0.70	1.04	9.51	1.17	0.49	0.19	9.45	0.03	99.57	0.5	40	<1	<10	450	4
VTM97-201M	41.00	11.20	23.40	1.99	2.72	1.46	5.15	0.95	0.54	0.22	11.30	0.03	99.93	<0.5	51	1	<10	510	4
VTM97-202M	42.00	10.50	27.50	3.18	1.84	0.94	4.34	0.25	0.53	0.15	8.00	0.11	99.23	<0.5	9	1	<10	330	3
VTM97-203M	53.20	15.30	12.20	2.68	1.38	7.55	3.30	0.05	0.81	0.50	1.80	0.28	98.77	<0.5	5	11	<10	1200	2
VTM97-206M	46.40	11.70	22.60	3.91	0.13	3.40	4.74	0.05	0.64	0.15	5.20	0.04	98.92	<0.5	9	<1	<10	340	2
VTM97-225M	41.40	5.62	26.30	2.28	1.33	0.70	2.32	0.10	0.33	0.15	19.60	0.14	100.13	<0.5	6	<1	<10	90	2
VTM97-248F	59.10	11.50	6.18	0.33	3.06	4.36	10.00	0.06	0.37	0.15	4.95	0.06	100.12	<0.5	100	<1	<10	990	3
VTM97-249F	55.70	10.30	14.10	1.40	1.81	4.61	1.49	0.06	0.47	0.08	10.10	0.05	100.17	<0.5	3	<1	<10	490	2
VTM97-263M	9.41	0.35	16.90	0.49	0.28	0.27	13.20	0.04	<0.01	0.03	8.30	5.93	55.20	11.0	5200	<1	<10	300000	4
VTM97-264M	24.40	0.26	24.10	1.16	0.34	0.01	5.90	0.04	<0.01	0.02	14.40	3.46	74.09	5.9	720	<1	<10	210000	2
VTM97-265M	19.60	0.18	26.90	<0.01	<0.01	0.25	1.37	<0.01	<0.01	0.02	4.60	4.77	57.69	20.0	840	<1	<10	270000	3
VTM97-266M	96.20	1.56	<0.01	0.02	<0.01	0.37	0.75	<0.01	0.09	0.14	0.95	0.08	100.16	0.7	35	7	<10	890	<1
VTM97-267M	19.90	1.04	36.10	8.23	0.04	0.30	0.71	0.14	0.03	0.14	23.80	0.34	90.77	1.2	33	3	<10	12000	<1
VTM97-295F	3.19	0.17	52.80	0.21	<0.01	0.03	0.12	0.01	0.01	0.07	41.70	0.02	98.33	<0.5	1	1	<10	<20	<1
VTM97-323dM	74.10	12.80	0.25	0.88	0.33	2.25	2.03	<0.01	0.54	0.15	6.60	0.37	100.30	<0.5	92	2	150	2600	8
VTM97-324dM	47.20	5.08	21.20	0.17	0.07	0.35	6.44	0.16	0.11	0.53	18.60	0.08	99.99	<0.5	180	<1	10	1100	10
VTM97-325dM	76.20	5.95	5.76	0.25	0.16	0.79	3.73	0.03	0.33	0.17	6.60	0.18	100.15	<0.5	240	1	40	2100	4
VTM97-328dM	72.80	12.60	3.04	<0.01	0.11	6.61	0.48	<0.01	0.08	<0.01	4.45	<0.01	100.17	<0.5	18	<1	<10	1100	2
VTM97-331dM	45.90	12.40	16.20	0.27	2.19	3.70	4.06	0.18	0.36	0.14	14.40	0.08	99.88	<0.5	48	<1	<10	3300	6

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**ppm**	**ppm**	**ppb**	**ppm**	**ppm**	**ppm**
VTM97-380F (XRF)	8.80	1.85	48.61	0.57	<0.01	0.61	0.90	0.03	0.12	0.03	38.83	na[1]	100.35	na[1]	4	na[1]	na[1]	74	na[1]
VTM97-381M (XRF)	25.72	4.15	34.40	2.67	0.03	1.39	1.33	0.02	0.24	0.04	31.02	na[1]	101.01	na[1]	4	na[1]	na[1]	131	na[1]
VTM97-1RM	15.10	0.12	10.20	3.78	<0.01	<0.01	25.60	0.26	<0.01	0.04	20.70	0.35	75.80	86.0	250	57	20	10000	4
VTM97-2RM	8.82	0.11	40.80	0.33	<0.01	<0.01	7.52	1.25	<0.01	0.03	33.20	1.14	92.06	<0.5	200	13	<10	37000	1
VTM97-3RM	9.56	0.41	29.90	11.50	<0.01	0.05	7.55	0.61	0.04	0.03	38.10	0.09	97.75	4.9	100	22	30	1900	1
VTM97-4RM	10.30	0.86	32.00	7.51	<0.01	0.17	4.94	0.73	0.01	0.04	35.30	0.65	91.86	1.6	75	34	20	19000	1
VTM97-5RM	44.80	0.30	8.73	0.37	<0.01	0.05	27.50	0.16	<0.01	0.03	11.40	0.68	93.34	<0.5	340	110	<10	34000	5
VTM97-6RM	2.96	0.10	8.29	0.14	0.02	0.03	2.44	0.15	0.01	0.01	6.90	10.40	21.05	1.6	27	7	<10	560000	<1
VTM97-7RM	15.50	0.14	19.50	0.93	<0.01	<0.01	11.60	0.51	<0.01	0.02	20.30	1.45	68.50	100.0	69	12	10	42000	2
VTM97-8RM	41.30	12.50	1.52	0.55	0.03	1.51	31.80	0.03	0.70	0.13	10.10	0.08	100.17	<0.5	62	5	100	350	5
VTM97-9RM	14.40	2.30	0.28	0.20	0.05	0.34	66.70	0.07	0.27	0.10	11.10	0.15	95.81	<0.5	84	9	<10	<20	9
VTM97-10RM	0.46	<0.01	30.70	20.70	<0.01	<0.01	0.39	0.02	<0.01	<0.01	46.20	<0.01	98.47	<0.5	84	<1	<10	<20	<1
VTM97-11RM	0.77	0.05	31.00	20.70	0.02	<0.01	0.46	0.02	<0.01	<0.01	46.10	<0.01	99.12	<0.5	80	<1	<10	<20	<1
VTM97-12RM	83.40	8.24	0.29	0.15	<0.01	1.45	0.49	<0.01	0.38	0.07	3.70	0.02	98.17	1.4	6	2	100	220	<1
VTM97-18RM	43.40	4.62	10.20	0.26	0.02	0.78	27.70	0.06	0.35	0.08	12.70	0.10	100.17	<0.5	10	<1	20	380	4
Standards And Duplicates																			
JB-IM029	3.30	0.05	47.20	5.85	<0.01	<0.01	0.38	<0.01	<0.01	<0.01	42.90	0.02	99.68	<0.5	1	<1	<10	<20	<1
JB-IM040	71.00	13.90	1.63	0.35	3.59	4.76	2.32	0.05	0.45	0.12	0.70	<0.01	98.87	<0.5	3	3	<10	1100	3
JB-IM041	51.30	16.00	8.36	6.71	3.73	1.29	11.20	0.15	1.65	0.32	<0.7	<0.01	100.71	<0.5	<1	<1	<10	400	3
JB-IM043	0.34	0.08	56.00	0.05	<0.01	<0.01	0.03	<0.01	<0.01	0.01	43.20	<0.01	99.71	<0.5	<1	<1	<10	<20	<1
JB-IM044	59.00	18.60	1.16	0.18	7.70	5.05	5.48	0.26	0.14	0.10	2.45	<0.01	100.12	<0.5	4	<1	<10	100	14
VTM97-76	30.30	2.33	35.90	0.33	0.25	0.67	1.14	0.04	0.23	0.06	29.00	0.03	100.25	<0.5	4	<1	<10	170	<1
VTM97-77S	22.40	2.04	35.30	4.03	0.14	0.49	0.89	0.02	0.12	0.05	34.50	0.04	100.02	<0.5	2	8	20	100	<1
VTM97-78	55.20	10.50	12.00	1.13	2.69	2.40	7.59	0.07	0.39	0.16	7.80	0.05	99.98	<0.5	12	14	20	730	2
VTM97-79	61.80	13.70	2.94	2.49	1.50	2.42	4.97	0.07	0.56	0.14	9.60	0.08	100.27	<0.5	16	<1	70	900	7
VTM97-80	29.40	0.93	33.60	2.08	<0.01	0.03	3.65	0.08	0.04	0.04	30.20	0.02	100.07	<0.5	7	2	<10	60	<1
VTM97-101	58.20	18.60	1.16	0.21	7.70	5.31	5.43	0.26	0.14	0.10	2.55	<0.01	99.66	4.8	1	3	<10	120	14
VTM97-102	71.80	14.10	1.64	0.37	3.60	4.68	2.49	0.05	0.43	0.12	0.75	<0.01	100.03	<0.5	4	1	<10	1100	4
VTM97-103	1.22	0.31	54.50	0.09	0.07	0.09	0.20	<0.01	0.01	0.02	43.20	<0.01	99.71	<0.5	<1	<1	<10	<50	<1
VTM97-104	55.00	10.10	12.50	1.12	2.59	2.38	7.66	0.07	0.39	0.16	7.95	0.05	99.92	<0.5	13	10	10	810	3
VTM97-105	64.30	11.80	4.44	1.68	1.53	2.99	4.05	0.08	0.54	0.17	8.60	0.04	100.18	3.7	98	4	30	730	3
VTM97-126	59.30	6.06	15.40	0.69	1.08	1.73	4.32	0.06	0.34	0.08	11.10	0.02	100.16	<0.5	7	1	<10	460	<1
VTM97-127	58.10	18.40	1.13	0.17	7.72	5.34	5.40	0.26	0.15	0.10	2.65	<0.01	99.42	<0.5	2	3	<10	100	14
VTM97-128	54.90	10.40	12.40	1.17	2.62	2.21	7.79	0.07	0.38	0.16	8.05	0.04	100.15	<0.5	14	6	<10	770	2
VTM97-129	6.37	0.73	49.80	0.38	0.19	0.04	1.13	0.07	0.02	0.17	40.40	0.05	99.35	<0.5	<1	4	<10	<50	<1
VTM97-231	58.20	18.60	1.18	0.18	7.72	5.37	5.45	0.25	0.15	0.10	2.50	<0.01	99.70	4.7	3	6	<10	150	14
VTM97-232	1.61	0.44	54.30	0.07	0.10	0.11	0.15	<0.01	0.02	0.02	43.20	<0.01	100.02	<0.5	<1	3	<10	<50	<1
VTM97-233	56.60	15.40	3.32	4.11	0.14	5.52	4.45	0.03	0.75	0.07	9.90	0.05	100.29	<0.5	10	<1	100	470	3
VTM97-234	58.90	18.70	1.17	0.18	7.64	5.01	5.48	0.26	0.14	0.10	2.50	<0.01	100.08	<0.5	3	<1	<10	110	14
VTM97-263	10.70	1.47	16.90	0.62	0.37	0.27	22.60	0.06	0.02	0.04	8.70	5.79	61.75	9.1	5600	4	<10	290000	3
VTM97-270	51.30	16.10	8.35	6.66	3.79	1.30	11.10	0.15	1.64	0.32	<0.75	<0.01	100.71	<0.5	<1	<1	<10	450	2
VTM97-271	72.30	13.80	1.64	0.37	3.54	4.47	2.54	0.05	0.44	0.12	0.75	<0.01	100.02	<0.5	3	<1	<10	1100	3
VTM97-272	55.40	10.30	12.00	1.15	2.63	2.37	7.68	0.07	0.39	0.17	7.95	0.04	100.11	<0.5	13	<1	<10	750	3
VTM97-273S	44.40	11.40	22.60	2.58	1.38	2.08	4.46	0.11	0.64	0.15	10.30	0.06	100.10	<0.5	15	3	130	390	4

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3[2]	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Units	%	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppb	ppm	ppm	ppm
VTM97-274	58.80	18.70	1.28	0.18	7.64	4.99	5.48	0.26	0.14	0.10	2.55	<0.01	100.12	<0.5	4	3	<10	100	15
VTM97-301	20.60	1.63	38.70	3.48	0.11	0.39	0.95	0.02	0.10	0.07	34.20	0.03	100.28	<0.5	3	1	<10	100	<1
VTM97-302	37.00	4.09	27.80	2.24	0.51	1.32	1.42	0.02	0.25	0.05	25.40	0.03	100.13	<0.5	5	<1	<10	290	<1
VTM97-303S	21.30	3.16	39.30	0.55	0.31	0.81	1.27	0.05	0.18	0.07	33.30	0.03	100.33	<0.5	5	<1	<10	190	<1
VTM97-304S	52.00	7.49	16.60	1.58	0.86	2.04	2.57	0.04	0.42	0.09	16.40	0.03	100.09	<0.5	5	<1	<10	400	<1
VTM97-335	75.50	13.60	<0.01	0.39	2.21	5.24	0.67	0.03	0.07	<0.01	2.20	<0.01	99.91	<0.5	20	<1	20	1600	3
VTM97-336	55.30	10.30	12.10	1.12	2.68	2.39	7.78	0.08	0.38	0.16	7.85	0.04	100.18	<0.5	12	1	20	750	2
VTM97-337	57.90	18.50	1.14	0.17	7.76	5.46	5.38	0.26	0.15	0.10	2.50	<0.01	99.32	<0.5	4	<1	<10	100	14
VTM97-341	51.30	16.00	8.29	6.75	3.73	1.30	11.20	0.15	1.64	0.31	<0.6	<0.01	100.67	<0.5	<1	<1	<10	440	<1
VTM97-342	55.40	10.20	12.10	1.12	2.65	2.37	7.78	0.07	0.38	0.16	7.95	0.05	100.18	<0.5	15	<1	<10	770	1
VTM97-343	51.40	16.00	8.23	6.74	3.80	1.34	11.20	0.15	1.63	0.32	<0.55	<0.01	100.81	<0.5	<1	<1	<10	400	3
VTM97-344	71.70	14.00	1.60	0.37	3.57	4.71	2.53	0.05	0.42	0.13	0.90	<0.01	99.98	<0.5	4	<1	<10	1100	3
VTM97-345	58.80	18.70	1.14	0.17	7.67	5.12	5.49	0.26	0.14	0.10	2.50	<0.01	100.09	<0.5	10	<1	<10	80	14
VTM97-346	50.50	15.90	8.24	6.60	3.80	1.40	11.00	0.15	1.61	0.31	<0.6	<0.01	99.51	<0.5	<1	<1	<10	410	2
VTM97-347	57.90	18.40	1.98	0.22	7.57	5.07	5.40	0.26	0.14	0.10	2.75	<0.01	99.79	<0.5	3	<1	<10	80	11
VTM97-348	55.20	10.30	12.20	1.16	2.66	2.28	7.68	0.08	0.40	0.16	8.00	0.05	100.17	<0.5	16	26	10	760	2
VTM97-349	71.70	14.00	1.74	0.40	3.58	4.61	2.51	0.05	0.42	0.12	0.85	<0.01	99.98	<0.5	3	2	<10	1100	3
VTM97-353	34.50	5.82	20.70	8.27	0.96	1.46	2.47	0.08	0.36	0.11	25.50	0.02	100.23	<0.5	3	5	20	230	1
VTM97-354	64.00	12.10	4.29	1.65	1.51	2.99	4.10	0.08	0.53	0.18	8.60	0.05	100.03	3.8	96	14	40	740	3
VTM97-355	61.70	13.60	2.88	2.43	1.53	2.43	5.03	0.07	0.56	0.14	9.80	0.09	100.17	<0.5	18	170	60	980	7
VTM97-357	57.30	18.20	1.27	0.17	7.62	5.39	5.37	0.25	0.18	0.09	2.60	0.01	98.44	<0.5	4	<1	<10	40	13
VTM97-358	49.70	15.80	8.26	6.48	3.69	1.35	10.90	0.15	1.60	0.31	<0.6	<0.01	98.24	<0.5	<1	<1	<10	330	3
VTM97-359	70.20	13.90	1.97	0.34	3.53	4.66	2.34	0.05	0.45	0.11	0.75	0.01	98.30	<0.5	4	22	<10	1000	4
VTM97-360	57.20	18.30	1.27	0.18	7.61	5.39	5.84	0.26	0.16	0.10	2.45	<0.01	98.76	<0.5	3	<1	<10	40	13
Duplicates By NMBMMR XRF																			
VTM97-59	23.79	0.94	37.26	2.20	<0.01	<0.01	2.69	0.07	0.05	0.05	32.30	na[1]	99.35	na[1]	8	na[1]	na[1]	96	na[1]
VTM97-80	20.24	1.10	38.59	2.92	<0.01	<0.01	3.05	0.07	0.05	0.05	33.48	na[1]	99.55	na[1]	8	na[1]	na[1]	72	na[1]
JB-IM002	3.82	0.09	44.88	5.58	<0.01	<0.01	0.28	0.01	0.02	<0.01	43.11	na[1]	97.79	na[1]	2	na[1]	na[1]	15	na[1]
ORO706	57.34	16.11	5.87	2.40	3.63	2.88	6.81	0.11	0.76	0.35	4.20	na[1]	99.24	na[1]	4	na[1]	na[1]	1379	na[1]
ORO720	45.07	15.32	10.60	7.68	3.53	1.89	11.78	0.19	2.39	0.70	1.89	na[1]	101.04	na[1]	3	na[1]	na[1]	477	na[1]
VTM97-89F	77.46	0.42	1.43	0.11	0.02	0.08	13.41	<0.01	0.03	0.09	2.79	na[1]	95.84	na[1]	882	na[1]	na[1]	1830	na[1]
VTM97-200	37.01	9.45	28.97	1.59	0.59	1.00	8.76	1.09	0.46	0.20	10.12	na[1]	99.24	na[1]	45	na[1]	na[1]	571	na[1]
VTM97-201	37.65	10.73	20.24	2.23	2.60	1.50	4.02	0.82	0.45	0.19	12.60	na[1]	93.03	na[1]	57	na[1]	na[1]	547	na[1]
VTM97-202	38.71	10.33	27.22	3.00	1.76	0.88	4.03	0.23	0.52	0.15	8.26	na[1]	95.09	na[1]	7	na[1]	na[1]	797	na[1]
VTM97-203	53.26	15.65	10.76	2.70	1.32	7.69	3.09	0.06	0.81	0.51	2.06	na[1]	97.91	na[1]	9	na[1]	na[1]	1310	na[1]
VTM97-301S	21.95	1.88	35.26	3.15	0.12	0.39	0.87	0.02	0.10	0.06	33.55	na[1]	97.35	na[1]	4	na[1]	na[1]	163	na[1]
VTM97-308S	21.24	1.86	35.65	3.46	0.13	0.39	0.83	0.02	0.11	0.07	34.13	na[1]	97.89	na[1]	2	na[1]	na[1]	154	na[1]

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Terr. Abundance	0.008	2.5	0.16	29	122	2.6	68	1.5	2.8	1.2	20	99	13	78	0.2	25.0	0.05	2.1	384
Detection Limit	3	1	1	1	2	1	0.5	10	1	2	2	1	2	2	0.2	0.5	3	10	2
Method	ICP	INAA	ICP	ICP	XRF	INAA	ICP	ICP	INAA	ICP	XRF	ICP	ICP	XRF	INAA	INAA	INAA	XRF	XRF
Geochemical Charcterization Sample Results																			
Chert																			
VTM97-51	<3	3	1	21	19	1	2.5	<10	<1	1	<10	13	<2	<10	0.8	<0.5	<3	<10	63
VTM97-95	<3	2	<1	13	14	<1	1.4	<10	<1	<1	<10	3	4	<10	0.2	<0.5	<3	<10	20
VTM97-333d	<5	3	<1	8	21	3	2.3	<10	1	3	10	8	7	37	0.2	3.1	<3	<10	53
Limestone																			
JB-IM002	<5	3	<1	2	7	<1	<0.5	<10	<1	3	19	1	<2	16	<0.2	<0.5	<3	<10	747
JB-IM003	<5	4	<1	1	7	<1	<0.5	<10	<1	3	26	<1	<2	31	<0.2	<0.5	<3	<10	2540
JB-IM006	<5	9	<1	<1	8	<1	<0.5	<10	<1	2	19	3	<2	5	<0.2	1.0	<3	<10	1380
JB-IM013	<5	3	<1	<1	10	<1	<0.5	<10	<1	6	16	5	<2	<2	<0.2	1.1	<3	<10	1250
JB-IM016	<5	4	<1	1	13	<1	<0.5	<10	<1	3	20	4	<2	11	0.3	0.6	<3	<10	211
JB-IM026	<5	2	<1	5	15	<1	<0.5	<10	<1	1	14	5	<2	14	0.7	<0.5	<3	<10	266
ORO711	<3	1	<1	5	6	<1	1.1	<10	<1	2	17	<1	7	<10	<0.2	0.9	<3	<10	689
ORO712	<3	1	<1	1	7	1	<0.5	<10	<1	<1	17	<1	15	<10	<0.2	0.5	<3	<10	635
VTM97-52	<3	3	<1	2	14	<1	<0.5	<10	<1	<1	18	4	<2	10	<0.2	<0.5	<3	<10	525
VTM97-57	<3	1	<1	<1	5	<1	<0.5	<10	<1	<1	21	1	5	<10	<0.2	<0.5	<3	<10	687
VTM97-68	<3	2	<1	<1	9	<1	<0.5	<10	<1	<1	17	2	<2	<10	<0.2	0.6	<3	<10	358
VTM97-82	<3	2	<1	<1	13	<1	<0.5	<10	<1	<1	15	<1	<2	<10	<0.2	<0.5	<3	<10	729
VTM97-93	<5	2	<1	3	18	2	<0.5	<10	<1	2	16	5	3	8	<0.2	1.9	<3	<10	536
VTM97-94	<3	3	<1	<1	<2	<1	<0.5	<10	<1	<1	22	<1	<2	19	<0.2	<0.5	<3	<10	48
VTM97-151	<3	3	<1	<1	3	<1	<0.5	<10	<1	<1	18	<1	<2	<10	<0.2	<0.5	<3	<10	756
VTM97-171	<3	2	<1	<1	9	<1	<0.5	<10	<1	1	17	2	<2	<10	<0.2	<0.5	<3	<10	1190
VTM97-243	<3	2	<1	8	<2	<1	<0.5	<10	<1	<1	19	<1	<2	15	<0.2	<0.5	<3	<10	66
VTM97-257	<5	5	<1	2	6	<1	<0.5	<10	<1	3	23	3	<2	12	0.2	<0.5	<3	<10	125
Caliche																			
JB-IM011	<5	5	<1	4	6	1	<0.5	<10	2	<1	13	1	<2	17	0.2	1.0	<3	<10	173
JB-IM0211S	<5	2	<1	9	15	1	7.1	<10	13	1	17	11	6	21	0.5	6.8	<3	<10	202
Igneous rock																			
Syenite																			
VTM97-60	5	2	<1	8	<2	1	<0.5	<10	16	<1	87	<1	<2	130	0.2	4.5	<3	<10	250
VTM97-63	7	2	<1	9	6	<1	<0.5	<10	14	<1	58	<1	3	111	0.2	3.6	<3	<10	491
VTM97-179	3	<1	<1	4	4	<1	<0.5	<10	14	3	67	<1	4	128	<0.2	2.5	<3	<10	237
VTM97-199	4	<1	<1	9	5	2	<0.5	<10	16	<1	88	<1	14	163	<0.2	1.6	<3	<10	303
VTM97-212	4	<1	<1	6	5	<1	<0.5	<10	20	2	68	<1	8	136	<0.2	3.1	<3	<10	142
VTM97-222	12	<1	<1	12	6	<1	<0.5	<10	15	2	110	<1	7	88	0.3	2.7	<3	<10	669
VTM97-223	6	<1	<1	10	4	1	0.8	<10	13	1	59	<1	12	146	0.4	1.3	<3	<10	372
VTM97-224	<3	<1	<1	11	4	2	<0.5	<10	15	<1	78	<1	16	135	0.3	1.6	<3	<10	308
VTM97-382 (XRF)			na[1]	na[1]	53	na[1]	6.0	na[1]	na[1]	4	67	4	290	144	na[1]	na[1]	na[1]	na[1]	406
Rhyolite																			
VTM97-326d	<5	1	<1	10	4	4	<0.5	<10	3	2	15	<1	34	235	2.2	0.5	<3	<10	58
VTM97-327d	<5	1	<1	15	<2	2	<0.5	<10	5	1	18	<1	12	171	2.1	<0.5	<3	<10	187

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
VTM97-329d	<5	1	<1	19	2	1	6.3	<10	3	3	13	6	20	138	0.5	<0.5	<3	<10	257
VTM97-350d	<5	1	<1	47	<2	1	1.4	<10	5	<1	9	<1	14	127	0.4	1.7	<3	<10	455
VTM97-351d	<5	1	<1	40	4	1	0.6	<10	5	<1	10	1	14	102	0.3	1.8	<3	<10	318
VTM97-352d	<5	1	<1	22	<2	2	2.2	<10	3	<1	13	<1	19	162	2.6	<0.5	<3	<10	173
Quartz monz.																			
ORO706	<5	2	<1	10	55	3	8.4	<10	6	<1	11	7	26	93	1.4	11.3	<3	<10	1100
VTM97-55	4	2	<1	14	7	1	4.0	<10	7	<1	15	<1	10	107	<0.2	4.6	<3	<10	800
VTM97-169	<3	<1	<1	12	8	1	1.6	<10	<1	<1	18	3	11	121	<0.2	5.4	<3	<10	704
VTM97-173	<3	<1	<1	12	10	<1	<0.5	<10	<1	<1	19	2	10	142	<0.2	5.4	<3	<10	839
VTM97-330d	<5	2	<1	28	5	7	4.6	<10	9	3	17	<1	23	156	0.9	3.9	<3	<10	497
Other																			
ORO720	28	2	<1	48	160	1	42.7	<10	5	2	62	110	33	27	0.2	25.0	<3	<10	721
High 10 (XRF)	na[1]	na[1]	na[1]	na[1]	<5	na[1]	16.0	na[1]	na[1]	2	9	46	15	17	na[1]	na[1]	na[1]	na[1]	177
Precambrian rocks																			
VTM97-244	<5	<1	<1	49	61	69	93.7	<10	2	1	4	110	19	71	1.1	30.1	<3	<10	362
VTM97-245	<5	2	<1	44	10	1	1.8	<10	3	<1	5	2	5	5	0.2	2.8	<3	<10	57
Shale																			
VTM97-58	5	1	<1	11	95	12	16.9	<10	5	<1	15	41	32	151	0.8	15.8	<3	<10	698
VTM97-67	<3	1	<1	6	45	5	5.7	<10	9	<1	22	15	7	78	0.8	5.9	<3	<10	91
VTM97-92	<3	2	<1	8	66	6	8.2	<10	3	2	<10	28	11	36	0.7	6.0	<3	<10	144
JB-IM013SH	<5	2	<1	6	34	6	3.7	<10	4	3	15	11	9	51	0.4	6.1	<3	<10	557
JB-IM021Sh	<5	3	<1	11	83	9	31.2	<10	4	1	19	33	10	142	0.5	16.6	<3	<10	364
VTM97-136	<3	10	<1	8	46	4	11.4	<10	7	10	16	21	15	61	0.6	6.4	<3	<10	236
VTM97-150	6	1	<1	14	84	19	19.3	<10	2	8	18	43	18	193	0.6	13.2	<3	<10	337
VTM97-160	<3	6	<1	8	44	6	9.6	<10	3	<1	16	19	11	88	<0.2	7.2	<3	<10	221
VTM97-170	5	11	<1	13	87	23	26.1	<10	5	5	21	43	20	218	0.9	13.7	<3	<10	152
VTM97-236	5	<1	<1	21	102	7	19.9	<10	4	<1	21	43	14	172	0.6	16.1	<3	<10	503
VTM97-237	3	4	<1	13	84	7	2.5	<10	3	<1	17	29	6	171	1.0	13.0	<3	<10	240
VTM97-246	<5	4	<1	11	77	19	19.1	<10	5	17	15	40	31	212	2.0	15.4	<3	<10	85
VTM97-332d	<5	4	<1	8	220	14	46.7	<10	8	8	15	98	19	104	2.6	7.7	15	<10	195
VTM97-334d	<5	3	1	3	36	4	91.9	<10	1	5	18	34	42	61	1.6	5.3	9	<10	78
Sandstone																			
VTM97-69	<3	2	<1	12	9	1	166.0	<10	4	2	<10	10	13	56	0.5	1.5	<3	<10	130
VTM97-135	<3	2	<1	3	18	1	2.3	<10	4	3	16	9	4	24	0.2	2.6	<3	<10	165
VTM97-158	<3	<1	<1	6	42	3	1.7	<10	7	4	12	11	7	61	0.4	5.2	<3	<10	101
VTM97-159	<3	<1	<1	10	45	3	3.1	<10	8	1	14	13	7	58	0.5	5.1	<3	<10	142
VTM97-261	<5	11	<1	4	9	<1	<0.5	<10	<1	3	22	6	5	12	0.5	1.0	<3	<10	173
VTM97-262	<5	5	<1	8	31	2	5.6	<10	4	4	16	12	10	42	0.9	4.8	<3	<10	241
Sand																			
VTM97-100	<5	2	<1	4	10	1	3.1	<10	4	<1	10	3	11	60	0.5	1.7	<3	<10	79
Stream Sediment (sand-silt) Sample Results																			
VTM97-53S	<3	1	<1	5	19	1	3.2	<10	8	<1	12	4	8	50	0.5	1.8	<3	<10	189
VTM97-54S	<3	2	1	5	30	2	6.3	<10	11	<1	15	6	18	76	9.6	3.2	<3	<10	170
VTM97-56S	<3	6	<1	2	22	1	3.3	<10	4	<1	16	5	9	26	0.2	1.9	<3	<10	470

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-61S	3	4	<1	6	46	<1	5.4	<10	5	2	30	13	12	63	1.1	5.1	<3	<10	559
VTM97-62S	5	2	<1	9	56	2	6.5	<10	8	<1	47	13	19	81	1.6	6.9	<3	<10	376
VTM97-64S	<3	9	<1	7	44	5	18.3	<10	6	<1	17	16	21	84	0.9	7.5	<3	<10	276
VTM97-65S	<3	4	<1	6	45	4	11.8	<10	11	<1	16	11	19	75	0.8	5.9	<3	<10	386
VTM97-66S	<3	11	<1	7	45	5	13.1	<10	7	<1	19	14	17	92	0.9	6.9	<3	<10	234
VTM97-70S	<3	8	<1	7	45	4	13.4	<10	6	<1	16	15	15	87	0.8	7.2	<3	<10	280
VTM97-71S	3	9	<1	7	47	5	16.0	<10	6	<1	20	17	14	102	0.9	8.0	<3	<10	273
VTM97-72S	<3	7	<1	5	16	2	5.8	<10	3	<1	18	7	8	31	0.4	3.0	<3	<10	699
VTM97-73S	<3	6	<1	6	36	2	6.4	<10	7	<1	14	8	11	52	0.7	4.1	<3	<10	498
VTM97-74S	<3	6	<1	3	15	1	3.3	<10	4	<1	16	5	6	28	0.4	1.9	<3	<10	732
VTM97-75S	<3	5	<1	5	22	1	4.7	<10	7	<1	11	6	8	26	0.4	2.5	<3	<10	558
VTM97-81S	<3	4	<1	3	24	2	5.5	<10	5	1	13	6	11	38	0.4	2.8	<3	<10	664
VTM97-83S	<3	2	<1	10	18	3	10.9	<10	4	<1	<10	6	27	76	0.7	5.2	<3	<10	575
VTM97-84S	<3	3	<1	12	17	2	6.7	<10	4	<1	14	8	19	77	0.7	4.9	<3	<10	518
VTM97-86S	<3	6	<1	4	19	1	3.7	<10	4	<1	17	6	9	31	0.4	2.0	<3	<10	487
VTM97-87S	<5	4	<1	5	19	2	2.7	<10	5	3	11	8	8	36	7.8	2.2	<3	<10	210
VTM97-90S	<5	4	<1	7	18	1	3.6	<10	3	4	15	10	9	19	1.4	3.0	<3	<10	358
VTM97-91S	<5	4	<1	5	15	1	1.3	<10	3	3	15	6	4	16	0.4	2.8	<3	<10	278
VTM97-97S	<5	4	<1	6	14	2	3.9	<10	2	5	10	8	8	17	0.7	2.5	<3	<10	290
VTM97-98S	<5	3	<1	7	23	2	6.7	<10	3	4	14	14	10	26	0.8	4.4	<3	<10	347
VTM97-99S	<5	4	<1	7	16	1	0.8	<10	3	2	13	7	3	13	0.7	2.2	<3	<10	274
VTM97-106S	<5	4	<1	4	11	1	<0.5	<10	2	3	15	3	<2	3	0.2	1.3	<3	<10	322
VTM97-107S	<5	5	<1	5	11	1	0.7	<10	2	1	14	4	7	16	0.3	2.2	<3	<10	287
VTM97-108S	<5	7	<1	3	17	2	<0.5	<10	3	3	13	6	4	18	0.5	2.2	<3	<10	244
VTM97-110S	<5	5	<1	3	14	1	0.9	<10	2	4	14	6	5	16	0.4	1.9	<3	<10	243
VTM97-111S	<5	6	<1	5	13	1	<0.5	<10	2	3	13	4	4	6	0.2	1.6	<3	<10	299
VTM97-112S	<5	5	<1	3	13	1	<0.5	<10	2	4	15	5	4	11	0.3	1.7	<3	<10	339
VTM97-113S	<5	5	<1	4	13	1	0.9	<10	3	4	15	6	3	9	0.4	2.0	<3	<10	268
VTM97-114S	<5	7	<1	10	35	4	9.4	<10	8	2	16	13	14	77	0.7	6.3	<3	<10	297
VTM97-115S	<3	6	<1	3	17	1	3.2	<10	4	2	24	6	7	40	0.4	1.9	<3	<10	652
VTM97-116S	<3	6	<1	2	18	1	2.7	<10	2	1	18	5	4	17	0.3	1.6	<3	<10	697
VTM97-117S	<3	5	<1	1	16	1	2.1	<10	2	2	20	5	4	25	0.3	1.4	<3	<10	687
VTM97-118S	<3	9	<1	4	26	2	5.5	<10	6	<1	15	8	7	51	0.7	3.9	<3	<10	292
VTM97-119S	<5	11	<1	5	16	1	0.7	<10	2	3	15	7	5	13	0.4	2.1	<3	<10	316
VTM97-120S	<5	9	<1	6	29	3	7.1	<10	5	2	17	10	14	49	0.6	4.5	<3	<10	332
VTM97-121S	<5	6	<1	3	19	1	<0.5	<10	3	3	14	4	<2	16	0.3	1.9	<3	<10	360
VTM97-123S	<5	4	<1	3	17	1	<0.5	<10	2	3	14	4	<2	11	0.2	1.3	<3	<10	357
VTM97-124S	<5	5	<1	6	16	1	<0.5	<10	2	2	15	4	4	13	0.3	1.7	<3	<10	244
VTM97-125S	<5	4	<1	3	13	1	0.7	<10	2	3	10	5	6	7	0.2	1.5	<3	<10	242
VTM97-130S	<5	7	<1	3	20	1	0.6	<10	3	3	12	5	8	13	0.4	2.1	<3	<10	273
VTM97-131S	<5	6	<1	4	17	1	0.6	<10	4	2	16	5	2	26	0.4	2.2	<3	<10	779
VTM97-132S	<5	8	<1	4	13	1	<0.5	<10	4	3	18	4	2	29	0.3	2.0	<3	<10	888
VTM97-133S	<5	8	<1	5	17	2	1.8	<10	4	3	14	8	11	35	0.5	2.6	<3	<10	305
VTM97-134S	<5	9	<1	5	20	2	5.5	<10	5	3	20	7	12	40	0.5	3.4	<3	<10	263
VTM97-137S	<5	8	<1	6	27	3	7.0	<10	8	2	44	8	14	54	0.6	4.2	<3	<10	235

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-138S	<5	3	<1	9	23	1	23.3	<10	9	2	350	7	18	53	0.6	3.0	<3	<10	198
VTM97-140S	<5	4	<1	5	26	2	0.5	<10	4	3	15	6	3	21	0.4	2.9	<3	<10	289
VTM97-141S	<5	5	<1	3	14	<1	<0.5	<10	<1	2	17	3	<2	4	0.2	0.8	<3	<10	381
VTM97-142S	<5	8	<1	4	22	1	0.6	<10	3	2	18	6	<2	26	0.4	2.6	<3	<10	371
VTM97-143S	<5	6	<1	10	15	1	<0.5	<10	2	2	15	4	<2	12	0.3	1.6	<3	<10	353
VTM97-144S	<5	6	<1	7	27	2	2.8	<10	5	2	14	6	7	27	0.5	3.2	<3	<10	295
VTM97-145S	<5	5	<1	3	16	1	<0.5	<10	1	3	21	3	<2	13	0.2	1.2	<3	<10	418
VTM97-147S	<5	7	<1	5	18	1	<0.5	<10	3	3	17	5	<2	13	0.4	2.3	<3	<10	312
VTM97-148S	<5	5	<1	8	19	1	<0.5	<10	3	2	11	4	<2	8	0.3	1.8	<3	<10	292
VTM97-152S	<5	6	<1	11	25	2	8.3	<10	4	4	14	11	15	39	0.6	4.1	<3	<10	485
VTM97-154S	6	3	<1	20	30	1	234.0	<10	6	5	28	15	28	55	0.5	5.1	<3	<10	344
VTM97-156S	5	2	<1	14	17	1	115.0	<10	5	5	22	9	31	60	0.6	3.1	<3	<10	293
VTM97-165S	<5	5	<1	3	12	<1	3.9	<10	1	3	24	4	2	14	0.2	1.9	<3	<10	219
VTM97-167S	<5	11	<1	8	41	7	13.0	<10	6	2	140	18	16	96	0.8	8.4	<3	<10	208
VTM97-168S	<5	9	<1	5	20	2	3.8	<10	5	2	15	7	7	36	0.5	3.5	<3	<10	612
VTM97-174S	<5	8	<1	4	13	1	<0.5	<10	2	3	20	5	5	18	0.3	2.0	<3	<10	811
VTM97-175S	<5	6	<1	3	13	1	<0.5	<10	1	3	70	6	5	15	0.3	1.7	<3	<10	273
VTM97-176S	<5	5	<1	6	27	2	2.3	<10	2	2	18	8	6	32	0.4	4.4	<3	<10	341
VTM97-177S	<5	5	<1	5	15	1	0.7	<10	5	1	14	3	6	38	0.4	1.6	<3	<10	456
VTM97-178S	<5	5	<1	5	19	1	2.5	<10	4	3	29	8	13	36	0.6	3.2	<3	<10	460
VTM97-180S	<5	3	<1	6	26	2	7.7	<10	5	5	41	14	12	62	1.0	4.6	<3	<10	542
VTM97-181S	<5	4	<1	4	18	1	1.6	<10	4	3	31	8	9	38	0.7	2.9	<3	<10	484
VTM97-182S	<5	4	<1	4	28	1	2.2	<10	4	3	28	8	9	40	0.7	3.9	<3	<10	477
VTM97-185S	<5	6	<1	3	12	1	0.6	<10	3	2	31	5	9	37	0.4	2.2	<3	<10	435
VTM97-186S	<5	7	<1	3	15	1	<0.5	<10	4	2	18	5	4	26	0.3	1.8	<3	<10	416
VTM97-187S	<5	6	<1	6	14	1	<0.5	<10	2	2	17	5	<2	16	0.3	1.6	<3	<10	426
VTM97-189S	<5	6	<1	5	14	1	<0.5	<10	4	3	22	4	7	36	0.5	1.8	<3	<10	341
VTM97-192S	<5	3	<1	5	26	1	0.9	<10	9	3	40	6	7	81	0.6	4.0	<3	<10	400
VTM97-193S	<5	5	<1	5	29	3	4.4	<10	7	2	18	8	13	69	0.7	4.9	<3	<10	287
VTM97-196S	<5	6	<1	4	20	1	<0.5	<10	4	2	21	5	5	31	0.7	2.4	<3	<10	525
VTM97-197S	<5	4	<1	5	12	1	<0.5	<10	1	2	15	4	<2	6	1.4	1.1	<3	<10	603
VTM97-204S	<5	3	<1	6	50	1	5.6	<10	7	3	27	11	10	62	0.9	7.8	<3	<10	523
VTM97-205S	<5	3	<1	6	54	2	7.3	<10	7	2	28	13	28	60	1.2	8.2	<3	<10	444
VTM97-207S	<5	4	<1	6	52	3	6.8	<10	4	2	15	16	17	69	1.1	7.2	<3	<10	495
VTM97-208S	<5	4	<1	9	35	2	1.6	<10	4	3	28	12	6	47	1.0	5.3	<3	<10	426
VTM97-209S	<5	4	<1	8	53	3	6.2	<10	4	3	19	16	13	58	1.2	7.4	<3	<10	445
VTM97-210S	<5	7	<1	4	16	1	1.3	<10	1	4	19	6	<2	26	0.3	1.8	<3	<10	845
VTM97-211S	<5	6	<1	6	26	3	5.3	<10	6	2	17	7	11	50	0.7	3.7	<3	<10	515
VTM97-213S	<5	7	<1	10	32	3	6.8	<10	5	5	17	14	6	41	1.1	5.3	<3	<10	1060
VTM97-214S	<5	5	<1	5	22	2	2.4	<10	4	3	15	6	7	37	0.5	3.7	<3	<10	266
VTM97-215S	<5	6	<1	5	19	1	<0.5	<10	2	4	17	7	7	17	0.2	2.7	<3	<10	1050
VTM97-216S	<5	5	<1	6	30	2	9.5	<10	5	3	16	9	14	54	0.7	3.7	<3	<10	584
VTM97-217S	<5	4	<1	4	19	1	2.5	<10	2	3	19	10	6	14	0.4	2.2	<3	<10	618
VTM97-218S	<5	3	<1	7	24	1	3.2	<10	6	4	33	8	15	58	0.7	3.3	<3	<10	501
VTM97-220S	<5	3	<1	10	28	2	4.9	<10	11	3	51	12	22	91	0.7	5.6	<3	<10	637

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-226S	<5	3	<1	7	23	1	3.0	<10	8	3	49	8	8	69	0.7	3.3	<3	<10	321
VTM97-228S	<5	5	<1	3	21	1	<0.5	<10	2	2	18	5	6	15	0.3	1.5	<3	<10	686
VTM97-229S	<5	5	<1	4	14	1	<0.5	<10	4	3	25	6	5	37	0.3	2.0	<3	<10	906
VTM97-230S	<5	16	<1	10	42	5	14.8	<10	8	2	17	23	20	103	0.9	7.8	<3	<10	174
VTM97-235S	<5	15	<1	9	45	5	13.2	<10	10	1	15	15	21	95	0.7	7.2	<3	<10	164
VTM97-238S	<5	5	<1	2	20	1	<0.5	<10	3	3	16	5	2	11	0.2	1.5	<3	<10	424
VTM97-239S	<5	7	<1	4	23	1	0.6	<10	4	3	15	5	6	19	0.3	2.3	<3	<10	362
VTM97-240S	<5	8	<1	5	21	1	<0.5	<10	4	3	14	5	8	20	0.4	2.1	<3	<10	329
VTM97-241S	<5	3	<1	9	25	1	<0.5	<10	1	3	16	11	3	16	0.5	2.4	<3	<10	469
VTM97-247S	<5	4	<1	13	20	1	1.2	<10	6	3	31	5	8	52	0.5	2.4	<3	<10	664
VTM97-251S	<5	9	<1	5	21	1	2.2	<10	4	4	15	7	7	23	0.4	2.4	<3	<10	628
VTM97-252S	<5	6	<1	12	38	5	13.2	<10	10	2	19	15	24	92	0.9	7.1	<3	<10	166
VTM97-253S	<5	14	<1	12	50	7	16.9	<10	8	2	20	21	23	114	1.0	9.9	<3	<10	154
VTM97-254S	<5	8	<1	10	30	4	9.5	<10	8	<1	14	12	16	76	0.7	6.0	<3	<10	221
VTM97-255S	<5	7	<1	10	37	4	8.8	<10	8	2	18	11	13	73	0.7	5.9	<3	<10	245
VTM97-256S	<5	13	<1	13	44	6	13.2	<10	8	2	17	16	22	93	1.0	7.9	<3	<10	193
VTM97-258S	<5	11	<1	13	44	6	15.3	<10	8	2	18	19	24	110	0.9	9.0	<3	<10	150
VTM97-259S	<5	8	<1	10	35	4	9.1	<10	11	<1	18	9	16	75	0.7	5.4	<3	<10	189
VTM97-260S	<5	8	<1	9	15	1	<0.5	<10	2	3	17	5	2	17	0.3	2.2	<3	<10	301
VTM97-268S	<5	5	<1	8	38	3	8.5	<10	7	6	15	11	52	66	2.8	4.6	<3	<10	315
VTM97-276S	<5	6	<1	3	22	1	<0.5	<10	3	3	16	4	2	24	0.3	2.1	<3	<10	329
VTM97-277S	<5	6	<1	3	19	1	<0.5	<10	3	2	17	4	2	21	0.3	2.1	<3	<10	417
VTM97-278S	<5	4	<1	3	14	<1	<0.5	<10	<1	3	15	3	<2	<2	<0.2	0.7	<3	<10	471
VTM97-279S	<5	6	<1	3	19	1	<0.5	<10	3	2	18	4	<2	23	0.3	2.0	<3	<10	455
VTM97-280S	<5	8	<1	6	29	2	1.2	<10	4	3	16	6	3	32	0.5	3.1	<3	<10	432
VTM97-281S	<5	6	<1	2	19	<1	<0.5	<10	2	3	17	4	<2	9	0.2	1.2	<3	<10	445
VTM97-282S	<5	6	<1	3	22	1	<0.5	<10	4	2	17	5	<2	20	0.4	2.0	<3	<10	418
VTM97-283S	<5	4	<1	7	25	1	1.7	<10	8	3	16	5	4	38	0.5	2.7	<3	<10	613
VTM97-284S	<5	8	<1	3	13	1	<0.5	<10	4	2	13	4	<2	23	0.4	1.8	<3	<10	585
VTM97-285S	<5	5	<1	5	14	1	<0.5	<10	3	3	14	4	<2	11	0.3	2.4	<3	<10	195
VTM97-286S	<5	7	<1	7	28	2	4.5	<10	10	2	17	7	9	60	0.6	4.1	<3	<10	498
VTM97-287S	<5	5	<1	6	33	4	6.3	<10	7	1	19	8	7	79	0.7	5.3	<3	<10	404
VTM97-289S	<5	12	<1	8	48	4	7.5	<10	9	2	17	12	14	79	0.7	6.8	<3	<10	318
VTM97-290S	<5	6	<1	7	20	1	<0.5	<10	4	3	18	4	4	25	0.4	2.0	<3	<10	411
VTM97-291S	<5	5	<1	2	14	<1	<0.5	<10	1	2	19	3	<2	5	0.2	0.8	<3	<10	510
VTM97-292S	<5	7	<1	7	36	4	8.2	<10	7	2	22	11	14	89	0.7	6.4	<3	<10	312
VTM97-293S	<5	5	<1	3	14	<1	<0.5	<10	1	3	17	3	<2	4	0.2	1.0	<3	<10	407
VTM97-294S	<5	5	<1	3	16	1	<0.5	<10	3	2	17	4	<2	17	0.3	2.0	<3	<10	383
VTM97-296S	<5	4	<1	9	16	1	0.9	<10	1	3	12	8	6	20	0.3	1.6	<3	<10	219
VTM97-296S	<5	5	<1	4	13	1	<0.5	<10	2	3	13	4	<2	9	0.3	1.7	<3	<10	225
VTM97-297S	<5	6	<1	4	13	1	<0.5	<10	3	3	12	5	<2	14	0.3	1.6	<3	<10	175
VTM97-298S	<5	6	<1	3	19	1	0.6	<10	4	3	15	5	7	18	0.3	2.0	<3	<10	260
VTM97-299S	<5	5	<1	4	12	1	<0.5	<10	2	3	19	4	5	22	0.4	1.5	<3	<10	290
VTM97-300S	<5	5	<1	3	15	1	<0.5	<10	2	4	15	5	7	14	0.3	1.7	<3	<10	267
VTM97-306S	<5	6	<1	7	17	2	<0.5	<10	3	3	19	5	4	25	0.3	2.0	<3	<10	261

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-307S	<5	5	<1	4	14	1	<0.5	<10	3	3	14	4	<2	14	0.3	1.8	<3	<10	228
VTM97-308S	<5	6	<1	5	19	1	<0.5	<10	3	3	18	4	4	25	0.3	1.7	<3	<10	247
VTM97-309S	<5	6	<1	4	15	1	<0.5	<10	2	3	19	5	2	25	0.3	1.7	<3	<10	305
VTM97-310S	<5	8	<1	5	22	1	0.7	<10	5	2	15	5	9	31	0.4	2.2	<3	<10	351
VTM97-311S	<5	10	<1	6	38	3	6.6	<10	7	1	15	9	14	64	0.6	4.8	<3	<10	257
VTM97-312S	<5	7	<1	5	22	1	0.7	<10	4	3	16	5	9	29	0.3	2.0	<3	<10	391
VTM97-313S	<5	8	<1	6	26	2	4.8	<10	5	2	14	8	11	45	0.5	3.7	<3	<10	321
VTM97-314S	<5	6	<1	7	24	1	2.3	<10	5	2	14	8	10	24	0.5	2.7	<3	<10	216
VTM97-315S	<5	7	<1	6	14	1	<0.5	<10	2	3	16	5	2	20	0.3	1.8	<3	<10	268
VTM97-316S	<5	4	<1	7	35	4	6.0	<10	12	2	15	8	17	68	0.6	4.6	<3	<10	182
VTM97-317S	<5	6	<1	12	23	2	2.4	<10	6	2	15	6	11	40	0.5	2.8	<3	<10	233
VTM97-319S	<5	4	<1	13	52	4	9.6	<10	7	3	18	18	20	98	0.8	9.0	<3	<10	240
VTM97-321S	<5	3	<1	15	64	5	49.4	<10	9	2	19	22	25	95	0.9	11.3	<3	<10	367
Mineralized Area and Float Chip Sample Results																			
VTM97-50M	<3	11	<1	<1	6	<1	2.1	<10	<1	<1	18	23	<2	<10	0.9	<0.5	<3	<10	1010
VTM97-59M	<3	1	<1	4	8	<1	2.4	<10	<1	1	12	5	<2	<10	0.5	0.9	<3	<10	756
VTM97-59F(89F)	<3	1	5	14	14	<1	5.3	<10	<1	24	<10	12	12	<10	86.0	<0.5	<3	<10	78
VTM97-96M	11	2	<1	28	50	3	5.6	<10	5	5	17	56	9	23	38.0	7.6	<3	<10	520
VTM97-109M	<3	5	<1	<1	10	2	2.9	<10	1	<1	17	6	2	15	0.2	1.9	<3	<10	184
VTM97-146F	<5	3	<1	<1	13	<1	<0.5	<10	<1	3	24	2	6	15	0.2	<0.5	<3	<10	661
VTM97-149F	<5	2	<1	3	11	<1	<0.5	<10	<1	2	14	4	8	11	0.2	1.0	<3	<10	383
VTM97-172M	<5	3	<1	11	74	16	14.7	<10	3	4	28	29	20	164	0.8	13.6	<3	<10	921
VTM97-184M	<5	2	<1	6	14	1	<0.5	<10	<1	5	16	7	9	26	0.5	2.7	<3	<10	128
VTM97-188F	<3	1	2	15	9	<1	3.6	<10	<1	9	<10	39	5	<10	7.8	<0.5	<3	<10	96
VTM97-190F	<3	1	<1	10	13	1	4.9	<10	<1	73	<10	70	130	<10	8.1	<0.5	31	<10	185
VTM97-194M	<5	1	<1	17	11	1	2.7	<10	<1	5	3	10	8	<2	1.9	<0.5	<3	<10	55
VTM97-195M	<5	1	<1	25	24	1	2.8	<10	<1	3	4	6	6	3	4.2	0.6	<3	<10	25
VTM97-200M	<5	1	<1	11	65	3	7.5	<10	5	7	17	12	100	38	2.8	7.4	<3	<10	315
VTM97-201M	<5	1	4	9	82	6	25.2	<10	3	5	17	22	190	61	2.2	10.3	<3	<10	553
VTM97-202M	<5	1	<1	14	73	1	36.6	<10	4	2	19	36	22	37	1.0	10.2	<3	<10	263
VTM97-203M	<5	2	<1	21	91	11	2.6	<10	5	3	27	45	13	283	0.9	15.3	<3	<10	1670
VTM97-206M	<5	2	<1	13	81	7	16.9	<10	5	2	15	31	24	189	0.8	11.5	<3	<10	600
VTM97-225M	<5	8	<1	7	64	<1	8.6	<10	2	3	13	44	5	9	0.2	5.9	<3	<10	574
VTM97-248F	9	2	<1	14	21	2	6.8	<10	17	13	86	8	32	154	15.0	3.2	<3	<10	285
VTM97-249F	<5	2	<1	11	20	2	9.1	<10	9	10	39	7	16	146	0.6	3.3	<3	<10	427
VTM97-263M	8	3	24	14	26	<1	15.3	<10	<1	370	72	46	9500	66	560.0	1.5	<3	<10	116
VTM97-264M	<5	2	61	14	<2	<1	4.8	<10	<1	150	48	53	1200	33	120.0	<0.5	<3	<10	206
VTM97-265M	<5	1	5	7	17	<1	3.4	<10	<1	100	60	6	2200	67	46.0	1.0	<3	<10	14
VTM97-266M	<5	2	<1	39	19	1	5.4	<10	<1	120	9	1	29	24	6.3	0.9	<3	<10	181
VTM97-267M	<5	1	<1	5	15	<1	7.0	<10	1	32	20	19	28	21	5.7	1.8	<3	<10	340
VTM97-295F	<5	2	<1	<1	11	<1	<0.5	<10	<1	4	20	3	<2	6	<0.2	<0.5	<3	<10	503
VTM97-323dM	<5	1	<1	1	310	21	0.7	<10	3	12	16	11	88	173	19.0	9.4	<3	<10	564
VTM97-324dM	<5	1	<1	5	70	3	<0.5	<10	1	13	7	42	170	32	54.0	6.0	<3	<10	2120
VTM97-325dM	<5	2	<1	6	120	8	2.9	<10	2	29	10	11	97	60	41.0	3.5	<3	<10	392
VTM97-328dM	<5	<1	<1	12	3	1	<0.5	<10	3	13	13	<1	12	195	10.0	0.5	<3	<10	67

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-331dM	<5	1	<1	14	6	2	26.7	<10	5	8	18	1	58	121	2.8	2.6	<3	<10	296
VTM97-380F	na[1]	na[1]	na[1]	na[1]	18	na[1]	9.0	na[1]	na[1]	2	2	12	5	15	na[1]	na[1]	na[1]	na[1]	178
VTM97-381M	na[1]	na[1]	na[1]	na[1]	27	na[1]	11.0	na[1]	na[1]	2	4	12	5	34	na[1]	na[1]	na[1]	na[1]	133
VTM97-1RM	11	2	8	8	210	<1	286.0	<10	<1	630	11	72	64000	92	0.6	<0.5	<3	<10	719
VTM97-2RM	if[3]	2	13	100	17	<1	7340.0	<10	<1	16	2	16	1500	6	12.0	<0.5	<3	<10	798
VTM97-3RM	if[3]	5	13	340	23	1	>30000	<10	<1	17	<2	4	570	5	3.5	<0.5	<3	<10	101
VTM97-4RM	if[3]	5	2	31	18	<1	>30000	<10	<1	31	<2	3	180	12	4.2	0.8	<3	<10	590
VTM97-5RM	15	4	<1	15	230	<1	507.0	<10	<1	34	2	110	7700	14	2.9	<0.5	<3	<10	471
VTM97-6RM	if[3]	3	2	16	if	<1	1180	<10	<1	4	<2	2	140	12	1.0	<0.5	<3	<10	7030
VTM97-7RM	<5	<1	270	18	52	<1	316.0	<10	1	260	3	21	24000	27	<0.3	<0.5	<3	<10	1120
VTM97-8RM	19	4	<1	11	160	4	124.0	<10	7	13	11	49	3400	59	3.5	9.4	<3	<10	990
VTM97-9RM	36	3	<1	<1	210	1	90.9	20	3	30	<2	63	1300	<2	4.8	4.2	<3	<10	6730
VTM97-10RM	if[3]	5	3	1	25	<1	2430.0	10	<1	5	<2	1	10	3	2.8	<0.5	<3	<10	47
VTM97-11RM	if[3]	5	2	2	18	<1	1890.0	50	<1	4	<2	2	10	4	2.2	<0.5	<3	<10	46
VTM97-12RM	if[3]	2	<1	<1	76	1	13300	<10	6	11	8	4	19	43	1.4	4.1	<3	<10	391
VTM97-18RM	14	2	<1	40	150	1	31.5	<10	7	45	6	130	45	26	1.1	4.8	<3	<10	194
Standards And Duplicates																			
JB-IM029	<5	3	<1	6	7	<1	<0.5	<10	<1	3	21	1	<2	3	<0.2	<0.5	<3	<10	734
JB-IM040	<5	1	<1	11	4	3	3.6	<10	6	<1	23	3	14	157	0.3	4.5	<3	<10	299
JB-IM041	<5	<1	<1	36	178	<1	31.1	<10	4	2	24	66	11	31	<0.2	21.6	<3	<10	462
JB-IM043	<5	2	<1	2	<2	<1	<0.5	<10	<1	2	17	1	<2	<2	<0.2	<0.5	<3	<10	80
JB-IM044	<5	2	<1	8	5	4	<0.5	<10	32	5	150	<1	<2	155	0.4	1.3	<3	<10	68
VTM97-76	<5	5	<1	4	12	1	<0.5	<10	3	2	14	4	7	11	0.4	2.1	<3	<10	292
VTM97-77S	<3	5	<1	3	14	1	1.7	<10	2	<1	18	4	5	24	0.2	1.6	<3	<10	336
VTM97-78	<3	2	<1	13	29	2	119.0	<10	6	2	12	11	14	65	0.8	4.8	<3	<10	401
VTM97-79	<3	7	<1	10	125	6	28.5	<10	4	1	13	68	16	99	9.0	11.6	<3	<10	234
VTM97-80	<3	1	<1	6	6	<1	3.4	<10	<1	1	12	5	4	<10	0.5	0.9	<3	<10	667
VTM97-101	<3	2	<1	7	7	3	1.7	<10	33	5	150	<1	4	163	0.3	1.4	<3	<10	65
VTM97-102	<3	1	<1	12	3	2	6.7	<10	6	<1	24	3	18	158	0.3	4.8	<3	<10	306
VTM97-103	<3	1	<1	2	<2	<1	<0.5	<10	<1	<1	20	2	<2	<10	<0.2	<0.5	<3	<10	94
VTM97-104	<5	2	<1	12	28	2	115.0	<10	6	3	13	10	22	61	0.7	4.9	<3	<10	391
VTM97-105	6	6	35	8	44	7	99.4	<10	8	2	19	16	990	112	21.0	9.1	<3	<10	239
VTM97-126	<5	3	<1	9	23	2	21.9	<10	8	2	15	6	16	55	0.6	3.0	<3	<10	208
VTM97-127	<5	2	<1	8	<2	3	<0.5	<10	31	6	150	<1	<2	155	0.5	1.2	<3	<10	63
VTM97-128	<5	3	<1	12	26	1	119.0	<10	6	3	12	10	20	63	0.8	4.8	<3	<10	400
VTM97-129	<3	1	<1	3	7	<1	<0.5	<10	<1	<1	14	<1	17	<10	<0.2	0.6	<3	<10	598
VTM97-231	<3	<1	<1	8	<2	4	1.9	<10	35	5	150	<1	6	168	0.3	1.3	<3	<10	74
VTM97-232	<3	<1	<1	2	3	<1	<0.5	<10	<1	<1	19	2	<2	<10	<0.2	<0.5	<3	<10	90
VTM97-233	<5	6	<1	11	77	19	18.8	<10	5	16	16	42	31	211	2.0	15.9	<3	<10	81
VTM97-234	5	1	<1	7	<2	3	0.6	<10	31	5	150	<1	<2	146	0.5	1.3	<3	<10	65
VTM97-263	10	5	26	11	<2	<1	19.0	<10	<1	410	7	43	7700	43	770.0	1.9	<3	<10	120
VTM97-270	14	1	<1	39	174	<1	35.0	<10	4	2	23	70	17	31	<0.2	23.2	<3	<10	455
VTM97-271	<5	2	<1	13	3	3	4.2	<10	7	<1	22	3	19	146	0.2	4.8	<3	<10	299
VTM97-272	<5	3	<1	13	27	2	101.0	<10	6	3	15	9	13	67	0.8	5.0	<3	<10	400
VTM97-273S	<5	5	<1	5	55	1	5.6	<10	8	3	31	11	12	66	1.1	8.0	<3	<10	548

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-274	<5	1	<1	8	4	3	<0.5	<10	30	5	160	<1	<2	154	0.5	1.3	<3	<10	67
VTM97-301	<5	6	<1	4	15	1	<0.5	<10	2	3	13	4	5	18	0.3	1.7	<3	<10	253
VTM97-302	<5	6	<1	7	27	2	2.9	<10	6	3	13	6	8	35	0.5	2.9	<3	<10	228
VTM97-303S	<5	9	<1	7	20	1	2.0	<10	3	4	19	7	9	27	0.4	2.3	<3	<10	640
VTM97-304S	<5	6	<1	7	31	3	6.5	<10	7	2	15	8	10	64	0.5	5.2	<3	<10	388
VTM97-335	<5	<1	<1	14	<2	3	<0.5	<10	3	<1	14	2	10	162	2.1	0.5	<3	<10	175
VTM97-336	<5	2	<1	13	29	2	117.0	<10	5	4	11	11	21	60	0.7	4.7	<3	<10	384
VTM97-337	<5	<1	<1	8	10	3	<0.5	<10	31	6	150	<1	<2	161	0.6	1.3	<3	<10	68
VTM97-341	<5	1	<1	37	177	1	30.8	<10	4	1	23	69	12	32	<0.2	21.9	<3	<10	448
VTM97-342	<5	2	<1	12	29	2	118.0	<10	6	4	13	10	14	67	0.7	5.0	<3	<10	399
VTM97-343	6	<1	<1	40	190	<1	31.4	<10	4	1	22	76	20	34	<0.2	21.5	<3	<10	446
VTM97-344	<5	2	<1	13	<2	3	4.3	<10	6	<1	20	3	21	155	0.4	4.5	<3	<10	293
VTM97-345	<5	3	<1	7	<2	5	<0.5	<10	68	6	150	<1	<2	159	0.8	2.6	<3	<10	65
VTM97-346	8	1	<1	41	210	<1	35.4	<10	4	1	22	74	19	27	<0.2	22.4	<3	<10	441
VTM97-347	<5	1	<1	8	<2	4	<0.5	<10	32	7	150	<1	<2	152	<0.2	1.4	<3	<10	66
VTM97-348	<5	3	<1	11	47	2	109.0	<10	6	3	13	9	21	73	1.0	5.1	<3	<10	390
VTM97-349	<5	2	<1	12	5	4	4.2	<10	6	<1	21	3	21	149	0.4	4.7	<3	<10	293
VTM97-353	<5	6	<1	4	24	1	15.3	<10	5	2	7	9	16	35	0.3	5.2	<3	<10	215
VTM97-354	<5	6	38	9	43	6	111.0	<10	7	2	17	18	1100	110	21.0	8.9	<3	<10	237
VTM97-355	<5	8	<1	11	120	6	35.8	<10	4	2	9	77	32	91	10.0	11.8	<3	<10	221
VTM97-357	<5	2	<1	6	31	3	1.4	<10	30	7	150	3	18	148	0.5	1.3	<3	<10	35
VTM97-358	22	1	<1	40	190	<1	39.2	<10	4	2	22	78	26	26	<0.2	23.8	<3	<10	435
VTM97-359	<5	2	<1	13	3	3	6.3	<10	6	<1	20	4	34	146	0.4	4.6	<3	<10	295
VTM97-360	<5	1	<1	<1	32	3	3.9	<10	33	12	150	15	9	145	0.4	1.4	<3	<10	33
Duplicates By NMBMMR XRF																			
VTM97-59	na[1]	na[1]	na[1]	na[1]	9	na[1]	5.0	na[1]	na[1]	1	<1	7	2	<1	na[1]	na[1]	na[1]	na[1]	684
VTM97-80	na[1]	na[1]	na[1]	na[1]	10	na[1]	6.0	na[1]	na[1]	2	<1	9	4	<1	na[1]	na[1]	na[1]	na[1]	789
JB-IM002	na[1]	na[1]	na[1]	na[1]	17	na[1]	4.0	na[1]	na[1]	<1	<1	4	<1	<1	na[1]	na[1]	na[1]	na[1]	711
ORO706	na[1]	na[1]	na[1]	na[1]	70	na[1]	9.0	na[1]	na[1]	7	9	8	13	88	na[1]	na[1]	na[1]	na[1]	1107
ORO720	na[1]	na[1]	na[1]	na[1]	209	na[1]	51.0	na[1]	na[1]	67	7	134	6	22	na[1]	na[1]	na[1]	na[1]	735
VTM97-89F	na[1]	na[1]	na[1]	na[1]	21	na[1]	<1	na[1]	na[1]	18	<1	10	7	<1	na[1]	na[1]	na[1]	na[1]	73
VTM97-200	na[1]	na[1]	na[1]	na[1]	42	na[1]	18.0	na[1]	na[1]	7	12	21	81	36	na[1]	na[1]	na[1]	na[1]	310
VTM97-201	na[1]	na[1]	na[1]	na[1]	75	na[1]	35.0	na[1]	na[1]	5	12	35	176	73	na[1]	na[1]	na[1]	na[1]	529
VTM97-202	na[1]	na[1]	na[1]	na[1]	87	na[1]	50.0	na[1]	na[1]	3	13	45	33	28	na[1]	na[1]	na[1]	na[1]	254
VTM97-203	na[1]	na[1]	na[1]	na[1]	103	na[1]	11.0	na[1]	na[1]	4	10	44	8	287	na[1]	na[1]	na[1]	na[1]	1776
VTM97-301S	na[1]	na[1]	na[1]	na[1]	36	na[1]	7.0	na[1]	na[1]	2	2	10	6	12	na[1]	na[1]	na[1]	na[1]	231
VTM97-308S	na[1]	na[1]	na[1]	na[1]	18	na[1]	5.0	na[1]	na[1]	2	2	7	6	12	na[1]	na[1]	na[1]	na[1]	231

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
Terr. Abundance	1.7	8.1	2.3	136	1.2	31	76.0	162	35.0	66	40	7.0	2.1	1.2	3.1	na[1]	10	15	na[1]
Detection Limit	1	1	0.5	10	3	2	0.5	2	0.5	3	5	0.1	0.2	0.5	0.2	0.05	10	1	1
Method	INAA	INAA	INAA	ICP	INAA	XRF	ICP	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	DCP	DCP	ICP
Geochemical Characterization Sample Results																			
Chert																			
VTM97-51	<1	<1	4.6	<10	210	<10	49.0	<10	1.1	<3	<5	0.2	0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-95	<1	<1	0.5	<10	140	<10	14.0	37	1.0	<3	<5	0.2	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-333d	<1	2	1.3	20	76	20	22.0	82	13.5	23	10	1.9	0.4	<0.5	0.7	0.12	<10	<1	<1
Limestone																			
JB-IM002	<1	<1	1.4	<10	28	10	9.2	<2	0.7	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
JB-IM003	<1	<1	2.4	<10	12	23	10.0	<2	0.6	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
JB-IM006	<1	1	3.5	10	8	17	1.7	<2	12.3	24	10	1.9	0.4	<0.5	0.4	0.06	<10	<1	<1
JB-IM013	<1	<1	5.6	10	7	11	2.2	<2	4.5	9	<5	0.8	0.2	<0.5	0.3	<0.05	<10	<1	<1
JB-IM016	<1	<1	6.3	<10	8	13	27.0	<2	1.9	3	<5	0.4	<0.2	<0.5	<0.2	<0.05	<10	4	<1
JB-IM026	<1	<1	3.8	10	69	17	16.0	42	3.3	5	<5	0.4	<0.2	<0.5	0.2	<0.05	<10	<1	<1
ORO711	<1	1	4.1	<10	26	24	3.2	26	10.5	24	11	2.8	0.5	<0.5	0.7	0.09	10	<1	<1
ORO712	<1	<1	0.5	<10	8	21	6.0	<10	4.5	9	<5	1.2	<0.2	<0.5	0.4	<0.05	10	<1	<1
VTM97-52	<1	<1	3.5	<10	24	22	18.0	<10	4.1	6	<5	0.4	0.2	<0.5	0.3	<0.05	<10	<1	<1
VTM97-57	<1	<1	1.8	<10	17	18	37.0	<10	1.7	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-68	<1	<1	2.0	<10	7	15	30.0	<10	5.8	9	<5	0.6	0.2	<0.5	0.3	<0.05	<10	2	<1
VTM97-82	<1	<1	2.2	<10	8	15	3.0	<10	0.9	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-93	<1	1	2.0	<10	17	23	19.0	3	14.1	25	10	1.7	0.4	<0.5	1.0	0.16	<10	3	<1
VTM97-94	<1	<1	0.5	<10	14	13	21.0	<10	1.2	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-151	<1	<1	2.0	<10	7	16	5.9	<10	0.9	<3	<5	<0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-171	<1	<1	2.7	<10	5	16	4.1	<10	0.7	<3	<5	<0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-243	<1	<1	<0.5	<10	15	<10	1.0	<10	0.9	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	1	<1
VTM97-257	<1	<1	1.6	<10	17	6	14.0	<2	2.9	5	<5	0.4	<0.2	<0.5	<0.2	<0.05	<10	1	<1
Caliche																			
JB-IM011	<1	2	0.9	<10	27	12	4.8	51	7.0	12	5	0.8	0.2	<0.5	0.5	0.08	<10	<1	<1
JB-IM021IS	1	8	4.6	90	50	46	15.0	460	32.2	63	28	5.6	1.0	0.9	3.6	0.54	<10	2	<1
Igneous rock																			
Syenite																			
VTM97-60	5	14	4.6	10	58	62	37.0	650	99.5	179	70	11.9	2.5	2.0	4.5	0.63	<10	<1	<1
VTM97-63	4	10	3.2	10	77	63	65.0	560	85.5	154	59	10.8	2.3	1.2	4.5	0.63	<10	<1	<1
VTM97-179	5	11	3.2	10	43	66	7.2	680	80.1	166	64	14.0	1.8	1.3	5.0	0.72	<10	<1	<1
VTM97-199	3	20	4.7	20	69	45	17.0	630	43.4	91	38	8.0	0.8	0.9	3.0	0.47	<10	<1	<1
VTM97-212	4	13	4.6	<10	59	74	54.0	660	90.0	179	77	14.1	2.3	1.9	5.9	0.84	<10	<1	<1
VTM97-222	11	16	3.9	50	100	64	39.0	590	97.0	197	84	15.9	2.5	2.2	4.4	0.61	<10	1	<1
VTM97-223	4	13	3.8	30	88	41	19.0	570	79.5	151	60	10.2	2.2	0.9	2.7	0.40	<10	<1	<1
VTM97-224	4	38	8.0	20	100	30	77.0	480	60.4	113	37	6.3	1.6	0.5	3.1	0.50	<10	<1	<1
VTM97-382 (XRF)	na[1]	14	4.0	35	na[1]	30	297.0	494											
Rhyolite																			
VTM97-326d	<1	6	3.9	<10	94	23	35.0	110	10.5	17	6	0.9	0.4	<0.5	1.0	0.17	10	4	<1
VTM97-327d	<1	5	3.1	<10	140	24	19.0	130	10.7	17	5	0.9	0.3	<0.5	1.0	0.18	<10	<1	<1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppb**	**ppb**	**ppm**
VTM97-329d	1	5	3.4	<10	150	18	20.0	120	10.5	17	6	0.9	0.4	<0.5	1.0	0.17	<10	1	<1
VTM97-350d	1	9	4.9	20	290	<2	13.0	110	26.0	43	14	2.3	1.1	<0.5	1.0	0.17	<10	<1	<1
VTM97-351d	1	10	3.9	20	250	2	19.0	100	28.7	47	15	2.4	0.7	<0.5	1.0	0.16	<10	<1	<1
VTM97-352d	1	5	3.3	<10	170	<2	29.0	62	6.6	11	<5	0.8	<0.2	<0.5	0.9	0.17	<10	<1	2
Quartz monz.																			
ORO706	<1	10	2.5	130	<3	20	62.0	210	51.7	101	39	7.3	1.7	0.9	3.1	0.45	<10	<1	<1
VTM97-55	1	12	2.8	60	100	36	37.0	220	42.6	80	29	5.1	1.4	0.6	2.3	0.35	<10	<1	<1
VTM97-169	1	10	1.7	60	68	30	21.0	180	32.3	66	25	5.6	0.5	0.7	1.8	0.27	<10	<1	<1
VTM97-173	<1	9	1.4	60	77	45	20.0	190	26.4	56	23	5.5	0.7	0.7	2.2	0.32	<10	<1	<1
VTM97-330d	1	13	4.3	60	200	36	59.0	250	41.7	76	30	5.2	1.3	0.6	2.7	0.44	<10	<1	<1
Other																			
ORO720	4	5	1.6	210	97	27	88.0	210	37.9	74	33	6.1	1.7	0.8	2.3	0.32	<10	<1	<1
High 10 (XRF)	na[1]	3	2.0	98	na[1]	53	352.0	220	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
Precambrian rocks																			
VTM97-244	<1	<1	<0.5	230	8	22	71.0	72	3.6	10	7	2.3	0.9	<0.5	1.8	0.25	<10	4	<1
VTM97-245	1	2	1.5	20	420	19	3.9	160	7.2	18	8	1.5	0.4	<0.5	1.7	0.24	<10	2	<1
Shale																			
VTM97-58	1	11	3.7	130	11	26	21.0	150	30.0	58	25	4.9	1.0	0.5	2.4	0.37	<10	<1	<1
VTM97-67	1	7	2.5	40	15	25	21.0	220	22.5	43	19	3.6	0.9	<0.5	2.2	0.34	<10	<1	<1
VTM97-92	<1	5	3.7	30	39	26	90.0	98	18.2	34	17	3.1	0.7	<0.5	1.7	0.28	<10	<1	<1
JB-IM013SH	1	6	3.8	80	9	31	4.9	92	26.7	53	23	4.4	0.9	0.6	2.1	0.30	<10	<1	<1
JB-IM021SH	1	13	4.2	160	7	33	53.0	140	41.9	80	35	6.3	1.2	0.8	2.7	0.40	<10	2	<1
VTM97-136	1	6	6.0	90	16	22	23.0	200	18.1	33	14	2.5	0.5	<0.5	1.5	0.23	10	1	<1
VTM97-150	1	10	4.0	90	6	29	24.0	140	25.1	56	30	6.8	1.0	0.9	1.6	0.28	<10	<1	<1
VTM97-160	<1	6	4.6	60	20	23	25.0	190	23.2	51	23	6.0	0.8	0.8	2.0	0.28	<10	<1	<1
VTM97-170	<1	12	6.1	90	7	37	16.0	180	35.4	83	42	10.3	1.0	1.2	2.8	0.39	<10	3	<1
VTM97-236	1	13	3.0	300	<4	34	50.0	170	31.6	67	32	7.0	1.0	0.8	2.8	0.41	<10	1	<1
VTM97-237	<1	10	7.4	200	9	28	23.0	120	23.7	52	23	5.1	0.8	0.7	1.6	0.23	<10	<1	<1
VTM97-246	1	11	10.5	130	18	32	46.0	180	36.6	66	25	4.3	0.7	0.6	2.6	0.38	<10	4	<1
VTM97-332d	<1	7	10.3	70	38	69	310.0	280	44.9	68	35	6.7	1.3	0.7	3.9	0.62	<10	5	1
VTM97-334d	<1	3	7.8	110	15	20	420.0	54	16.0	27	12	2.2	0.6	<0.5	1.0	0.16	<10	<1	2
Sandstone																			
VTM97-69	<1	1	1.4	10	90	21	19.0	120	4.7	10	5	1.2	0.6	<0.5	0.9	0.14	10	1	<1
VTM97-135	<1	2	3.2	20	22	14	17.0	150	11.2	21	10	1.7	0.4	<0.5	0.9	0.14	<10	<1	<1
VTM97-158	1	6	2.6	40	39	24	14.0	180	17.7	40	18	4.5	0.9	0.6	2.0	0.30	<10	<1	<1
VTM97-159	<1	7	2.0	40	42	27	15.0	250	20.7	47	23	5.4	0.7	0.8	2.4	0.32	<10	<1	1
VTM97-261	<1	1	2.0	10	14	8	17.0	16	4.5	9	<5	0.7	<0.2	<0.5	0.3	<0.05	<10	2	<1
VTM97-262	<1	4	3.9	60	32	22	42.0	110	15.4	30	13	2.6	0.5	<0.5	1.3	0.18	<10	<1	<1
Sand																			
VTM97-100	<1	3	0.8	10	32	20	14.0	230	13.5	25	10	1.7	0.6	<0.5	1.0	0.16	<10	2	<1
Stream sediment																			
VTM97-53S	1	5	1.8	30	40	19	15.0	180	16.6	31	12	2.3	<0.2	<0.5	1.1	0.20	<10	<1	1
VTM97-54S	<1	7	1.6	40	10	25	29.0	220	22.5	44	19	3.6	0.2	<0.5	1.9	0.28	<10	1	<1
VTM97-56S	<1	4	2.3	<10	13	25	23.0	93	21.4	41	18	3.7	0.5	<0.5	1.3	0.20	<10	<1	<1
VTM97-61S	1	8	3.4	50	15	36	40.0	230	32.2	69	30	6.4	1.1	0.7	2.3	0.32	<10	<1	<1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-62S	2	8	4.0	90	51	47	47.0	270	39.2	73	30	5.7	1.4	0.7	2.9	0.44	<10	<1	<1
VTM97-64S	1	9	2.5	60	10	25	53.0	220	31.1	59	26	4.6	1.1	0.6	2.3	0.35	<10	1	2
VTM97-65S	1	8	2.7	40	5	27	44.0	340	27.2	51	20	3.8	0.9	0.5	2.4	0.38	<10	<1	<1
VTM97-66S	1	9	2.5	50	4	34	52.0	250	33.4	63	28	5.0	1.2	0.5	2.5	0.40	<10	<1	<1
VTM97-70S	1	8	2.6	50	4	30	44.0	230	28.2	53	24	4.4	1.0	0.6	2.1	0.32	<10	2	<1
VTM97-71S	1	9	2.8	60	6	37	72.0	230	31.5	60	25	4.7	1.2	0.6	2.4	0.37	<10	1	<1
VTM97-72S	<1	4	2.1	30	15	37	23.0	110	23.5	44	19	3.6	0.9	<0.5	1.6	0.24	<10	1	<1
VTM97-73S	<1	6	2.9	40	32	23	25.0	280	21.7	40	17	3.1	0.7	<0.5	1.5	0.26	20	1	<1
VTM97-74S	1	3	2.6	20	17	24	17.0	150	16.4	30	13	2.5	0.6	<0.5	1.1	0.17	10	1	<1
VTM97-75S	<1	4	2.3	30	20	20	17.0	230	19.8	37	15	3.0	0.7	<0.5	1.5	0.24	<10	<1	<1
VTM97-81S	<1	4	3.2	30	13	22	20.0	220	17.3	32	15	2.5	0.6	<0.5	1.3	0.22	<10	1	<1
VTM97-83S	<1	8	3.3	60	36	18	51.0	150	29.6	54	20	3.5	1.1	<0.5	1.4	0.23	<10	<1	<1
VTM97-84S	<1	7	2.6	60	44	32	23.0	160	32.4	61	24	4.1	1.0	0.5	1.8	0.27	20	4	<1
VTM97-86S	<1	3	1.9	20	17	32	23.0	160	17.6	32	14	2.5	0.6	<0.5	1.2	0.20	<10	3	<1
VTM97-87S	<1	3	2.8	30	24	19	25.0	190	16.1	28	12	2.0	0.4	<0.5	1.2	0.19	<10	4	<1
VTM97-90S	<1	2	2.3	30	28	21	23.0	52	14.6	29	12	2.4	0.6	<0.5	1.1	0.16	<10	<1	<1
VTM97-91S	<1	2	2.1	20	24	13	17.0	62	11.4	22	10	1.9	0.6	<0.5	1.0	0.15	<10	2	<1
VTM97-97S	<1	2	2.2	20	30	15	23.0	58	12.5	23	11	1.9	0.4	<0.5	0.9	0.14	<10	8	<1
VTM97-98S	<1	3	2.5	40	20	22	32.0	79	14.5	27	13	2.5	0.9	<0.5	1.2	0.18	<10	<1	<1
VTM97-99S	<1	2	2.3	20	43	15	19.0	77	12.1	22	10	1.8	0.5	<0.5	1.0	0.15	<10	<1	<1
VTM97-106S	<1	1	2.0	<10	24	11	14.0	17	9.4	17	8	1.4	0.4	<0.5	0.6	0.09	<10	<1	<1
VTM97-107S	<1	2	0.9	<10	23	18	12.0	74	16.9	31	14	2.6	0.4	<0.5	1.2	0.17	<10	<1	<1
VTM97-108S	<1	3	2.6	10	8	13	20.0	59	15.2	28	13	2.4	0.6	<0.5	1.1	0.17	<10	1	<1
VTM97-110S	<1	3	2.0	10	10	19	25.0	52	13.9	26	12	2.3	0.6	<0.5	0.9	0.13	<10	<1	<1
VTM97-111S	<1	2	1.8	<10	18	9	20.0	44	8.8	17	8	1.4	0.5	<0.5	0.6	0.08	<10	1	<1
VTM97-112S	<1	2	2.3	<10	10	12	14.0	20	11.2	20	10	1.8	0.6	<0.5	0.8	0.12	<10	1	<1
VTM97-113S	<1	2	1.7	<10	16	14	16.0	59	10.5	20	10	1.8	0.4	<0.5	0.7	0.10	<10	<1	<1
VTM97-114S	<1	8	2.7	50	26	28	44.0	260	27.2	51	22	3.9	0.6	0.5	2.1	0.32	<10	<1	<1
VTM97-115S	1	4	3.4	10	10	34	21.0	170	21.7	41	16	3.1	0.7	<0.5	1.5	0.24	<10	3	<1
VTM97-116S	<1	2	3.1	20	11	22	29.0	38	15.8	20	13	2.4	0.5	<0.5	0.9	0.16	<10	2	<1
VTM97-117S	<1	2	3.2	10	12	25	22.0	67	15.7	29	12	2.2	0.6	<0.5	0.9	0.16	<10	1	<1
VTM97-118S	1	6	2.1	40	5	27	25.0	250	19.4	36	15	2.8	0.6	<0.5	1.6	0.25	<10	2	<1
VTM97-119S	<1	4	1.8	10	9	27	19.0	38	31.4	58	28	5.1	1.1	0.6	1.8	0.27	<10	<1	<1
VTM97-120S	1	6	2.2	20	8	23	43.0	150	22.1	41	17	3.2	0.6	<0.5	1.6	0.25	<10	<1	<1
VTM97-121S	<1	3	2.6	10	10	12	28.0	56	13.0	23	11	1.9	0.5	<0.5	0.9	0.14	<10	<1	<1
VTM97-123S	<1	2	2.3	<10	14	11	17.0	32	9.2	17	8	1.4	0.4	<0.5	0.6	0.10	<10	<1	<1
VTM97-124S	<1	2	2.0	10	18	14	21.0	51	10.2	19	7	1.6	0.4	<0.5	0.7	0.10	<10	<1	<1
VTM97-125S	<1	2	2.1	10	14	9	22.0	45	9.7	18	8	1.5	0.4	<0.5	0.7	0.10	<10	<1	<1
VTM97-130S	<1	3	1.9	10	11	15	29.0	60	16.8	31	14	2.7	0.6	<0.5	1.2	0.18	<10	<1	<1
VTM97-131S	<1	3	2.7	10	17	20	17.0	120	17.3	32	15	2.6	0.6	<0.5	1.1	0.17	<10	<1	<1
VTM97-132S	<1	3	2.4	10	23	22	13.0	95	16.1	29	13	0.1	0.5	<0.5	1.1	0.19	<10	1	<1
VTM97-133S	<1	5	3.0	40	19	25	20.0	86	23.6	44	19	3.7	1.0	<0.5	1.5	0.21	<10	2	<1
VTM97-134S	<1	5	3.0	30	14	25	28.0	110	21.6	39	19	3.5	0.6	<0.5	1.6	0.23	<10	<1	<1
VTM97-137S	<1	6	3.0	30	19	30	29.0	240	24.5	46	20	3.7	0.7	<0.5	2.0	0.33	<10	2	<1
VTM97-138S	<1	5	2.5	40	61	26	38.0	280	22.3	40	17	2.9	0.9	<0.5	1.5	0.25	<10	3	<1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-140S	<1	3	2.3	10	47	15	26.0	86	12.7	25	11	2.1	0.3	<0.5	1.0	0.16	<10	<1	1
VTM97-141S	<1	1	2.5	<10	32	12	13.0	<2	7.1	13	6	1.1	0.3	<0.5	0.4	0.07	<10	<1	2
VTM97-142S	<1	3	2.5	10	18	20	29.0	73	16.6	30	15	2.7	0.6	<0.5	1.2	0.18	<10	<1	1
VTM97-143S	<1	2	2.4	<10	41	13	17.0	43	12.3	22	10	1.9	0.4	<0.5	0.8	0.12	<10	<1	<1
VTM97-144S	<1	4	2.4	20	53	18	26.0	150	17.9	34	14	2.6	0.4	<0.5	1.3	0.20	<10	<1	<1
VTM97-145S	<1	2	2.7	<10	17	19	11.0	<2	10.4	18	9	1.7	0.4	<0.5	0.6	0.08	<10	1	<1
VTM97-147S	<1	3	2.2	20	20	17	21.0	48	17.4	32	15	2.8	0.6	<0.5	1.1	0.16	<10	<1	<1
VTM97-148S	<1	2	2.1	<10	48	12	26.0	69	12.5	19	10	1.9	0.5	<0.5	0.9	0.14	<10	<1	<1
VTM97-152S	<1	4	3.0	40	52	20	31.0	130	19.5	36	16	2.9	0.7	<0.5	1.4	0.21	<10	<1	<1
VTM97-154S	1	10	5.5	70	76	30	30.0	180	60.0	98	35	5.3	1.6	0.7	2.4	0.36	<10	4	<1
VTM97-156S	<1	6	3.8	50	74	26	51.0	130	26.6	48	20	3.1	1.0	<0.5	1.4	0.22	<10	3	<1
VTM97-165S	<1	2	2.5	<10	19	15	14.0	15	10.3	20	9	1.9	0.4	<0.5	0.8	0.13	<10	4	<1
VTM97-167S	1	8	2.6	60	9	30	50.0	190	29.7	56	25	4.6	0.9	0.7	2.2	0.32	<10	3	<1
VTM97-168S	<1	5	2.1	30	19	26	24.0	110	24.7	46	21	3.8	0.8	0.5	1.7	0.25	<10	3	<1
VTM97-174S	<1	3	2.5	10	10	22	14.0	31	15.2	29	13	2.5	0.6	<0.5	1.0	0.15	<10	4	<1
VTM97-175S	<1	2	3.2	10	12	15	15.0	9	10.3	19	9	1.8	0.3	<0.5	0.8	0.13	<10	2	<1
VTM97-176S	1	4	2.2	30	13	21	17.0	48	18.2	35	16	2.9	0.6	<0.5	1.2	0.19	<10	3	<1
VTM97-177S	<1	3	1.4	10	47	23	13.0	160	14.6	26	11	2.0	0.5	<0.5	1.0	0.15	<10	<1	<1
VTM97-178S	1	5	3.2	30	17	23	39.0	92	24.7	44	18	3.2	0.7	<0.5	1.5	0.23	<10	2	<1
VTM97-180S	2	7	4.1	50	16	36	47.0	160	31.3	56	22	3.9	0.8	0.6	2.0	0.29	<10	2	<1
VTM97-181S	1	4	3.2	20	15	28	36.0	88	26.0	47	19	3.3	0.8	<0.5	1.5	0.23	<10	4	<1
VTM97-182S	1	5	3.0	40	17	28	40.0	90	27.0	50	20	3.6	0.9	<0.5	1.6	0.26	<10	2	<1
VTM97-185S	1	4	2.6	10	15	29	30.0	61	23.6	43	18	3.2	0.7	<0.5	1.4	0.21	<10	4	<1
VTM97-186S	<1	3	2.1	10	14	22	17.0	98	16.0	29	13	2.4	0.5	<0.5	1.1	0.17	<10	<1	<1
VTM97-187S	<1	2	1.6	<10	17	23	21.0	45	17.0	29	14	2.6	0.6	<0.5	1.1	0.16	<10	2	<1
VTM97-189S	<1	5	2.1	<10	16	23	50.0	87	20.9	38	15	2.9	0.7	<0.5	1.6	0.24	<10	<1	<1
VTM97-192S	2	8	3.4	20	22	34	42.0	280	39.2	72	28	5.0	1.4	0.7	2.3	0.34	<10	<1	<1
VTM97-193S	1	7	2.5	40	20	26	40.0	260	29.4	54	23	4.1	0.7	0.6	2.1	0.32	<10	<1	<1
VTM97-196S	1	4	2.5	10	22	25	25.0	94	21.3	39	17	3.1	0.6	<0.5	1.3	0.20	<10	<1	<1
VTM97-197S	<1	2	2.4	<10	23	14	16.0	11	12.0	21	9	1.7	0.5	<0.5	0.7	0.10	<10	<1	<1
VTM97-204S	2	9	5.0	90	30	35	43.0	180	42.3	77	32	5.3	1.2	0.7	2.4	0.35	<10	<1	<1
VTM97-205S	1	9	6.7	80	28	39	76.0	190	45.3	82	33	5.6	1.2	0.8	2.6	0.37	<10	1	<1
VTM97-207S	<1	6	3.0	60	16	29	56.0	94	29.6	55	22	4.2	0.9	0.7	2.1	0.31	<10	<1	<1
VTM97-208S	1	6	3.5	40	34	24	46.0	130	32.7	59	25	4.2	1.0	0.5	1.9	0.29	<10	<1	1
VTM97-209S	1	7	3.7	30	34	31	57.0	97	33.3	59	25	4.5	0.9	0.6	2.1	0.31	<10	2	<1
VTM97-210S	<1	2	4.0	10	12	23	15.0	34	14.5	28	12	2.5	0.6	<0.5	0.9	0.13	<10	<1	<1
VTM97-211S	<1	5	3.0	20	21	25	28.0	190	22.0	41	17	3.1	0.5	<0.5	1.6	0.25	<10	<1	<1
VTM97-213S	<1	6	3.1	30	39	31	31.0	160	25.4	49	22	4.2	0.8	0.5	2.0	0.30	<10	<1	<1
VTM97-214S	<1	5	2.3	10	26	23	19.0	130	17.7	33	15	2.9	0.6	<0.5	1.3	0.20	<10	<1	<1
VTM97-215S	<1	3	3.5	20	14	16	18.0	23	16.1	28	13	2.4	0.6	<0.5	0.8	0.13	<10	<1	<1
VTM97-216S	<1	5	2.4	30	24	28	38.0	140	19.3	36	15	2.8	0.6	<0.5	1.4	0.20	<10	<1	<1
VTM97-217S	<1	2	2.7	20	18	18	28.0	33	12.4	22	10	1.7	0.4	<0.5	0.8	0.13	<10	<1	1
VTM97-218S	2	7	3.1	40	28	26	52.0	180	29.9	54	21	3.7	0.9	0.5	1.7	0.26	<10	3	<1
VTM97-220S	3	9	3.6	70	36	39	81.0	430	43.4	79	31	5.3	1.5	0.7	2.4	0.35	<10	5	<1
VTM97-226S	2	8	3.8	20	34	27	49.0	280	38.9	69	24	4.0	1.4	<0.5	2.0	0.32	<10	8	1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-228S	<1	3	2.9	20	14	16	28.0	43	14.7	26	12	2.0	0.4	<0.5	0.9	0.14	<10	4	<1
VTM97-229S	<1	4	3.7	20	18	23	30.0	97	19.7	36	15	2.7	0.8	<0.5	1.1	0.17	<10	3	<1
VTM97-230S	1	10	2.6	60	19	34	62.0	330	34.6	66	29	5.2	1.3	0.7	2.7	0.45	<10	4	<1
VTM97-235S	1	10	2.9	50	9	31	59.0	360	32.6	62	25	4.8	1.0	0.6	2.5	0.38	<10	10	1
VTM97-238S	<1	2	2.5	10	15	13	21.0	71	11.1	20	9	1.7	0.3	<0.5	0.8	0.12	<10	10	<1
VTM97-239S	<1	3	2.4	20	28	15	22.0	97	13.2	24	10	1.9	0.5	<0.5	1.0	0.15	50	14	<1
VTM97-240S	<1	4	2.5	10	23	18	19.0	110	17.8	33	15	2.7	0.6	<0.5	1.2	0.18	<10	9	<1
VTM97-241S	<1	2	3.0	10	22	17	30.0	21	11.5	21	10	1.8	0.5	<0.5	0.8	0.13	<10	12	1
VTM97-247S	1	5	3.1	20	44	24	36.0	150	24.2	44	18	2.9	0.7	<0.5	1.5	0.23	<10	4	1
VTM97-251S	<1	4	2.3	10	19	22	21.0	61	23.5	45	20	3.7	0.9	0.5	1.3	0.20	<10	<1	<1
VTM97-252S	1	9	2.2	50	50	34	60.0	340	33.3	63	26	4.9	1.1	0.6	2.5	0.38	<10	1	<1
VTM97-253S	1	12	2.6	60	10	38	77.0	300	40.9	78	32	6.2	1.4	0.8	3.1	0.46	<10	<1	2
VTM97-254S	<1	8	1.8	40	16	28	46.0	240	27.4	53	21	3.9	0.9	<0.5	1.9	0.31	<10	4	<1
VTM97-255S	1	8	2.3	50	14	30	43.0	250	25.6	51	20	3.7	0.8	<0.5	2.2	0.32	<10	2	<1
VTM97-256S	<1	10	2.5	50	25	33	58.0	290	35.7	69	28	5.4	1.2	0.8	2.9	0.40	<10	<1	<1
VTM97-258S	1	11	2.4	50	24	38	74.0	340	37.1	71	29	5.6	1.1	0.6	2.8	0.45	<10	2	<1
VTM97-259S	<1	8	2.3	30	38	35	49.0	360	27.9	52	23	4.1	0.9	0.6	2.3	0.34	<10	4	1
VTM97-260S	<1	3	2.0	<10	26	30	14.0	34	26.3	47	23	4.6	0.9	0.6	1.6	0.24	<10	1	1
VTM97-268S	1	6	3.4	40	45	29	73.0	220	23.6	44	19	3.3	0.7	0.5	1.9	0.28	<10	<1	<1
VTM97-276S	<1	3	2.5	10	23	16	17.0	83	14.5	26	12	2.1	0.4	<0.5	1.0	0.16	<10	2	1
VTM97-277S	<1	3	2.3	10	20	17	19.0	60	12.4	23	10	1.8	0.4	<0.5	0.9	0.14	<10	<1	2
VTM97-278S	<1	1	2.2	<10	34	8	17.0	<2	6.6	12	6	1.1	0.3	<0.5	0.4	0.06	<10	1	<1
VTM97-279S	<1	3	2.0	10	19	19	24.0	71	13.8	26	12	2.2	0.5	<0.5	1.0	0.16	<10	1	1
VTM97-280S	<1	4	2.5	20	24	21	26.0	83	18.1	34	16	2.8	0.5	<0.5	1.3	0.21	<10	1	1
VTM97-281S	<1	2	2.5	<10	13	13	17.0	22	8.1	15	7	1.3	0.3	<0.5	0.6	0.09	<10	1	1
VTM97-282S	<1	3	2.7	10	15	17	20.0	84	12.5	23	10	1.9	0.4	<0.5	1.0	0.16	<10	<1	<1
VTM97-283S	<1	4	2.9	20	35	24	19.0	250	16.8	32	13	2.6	0.6	<0.5	1.4	0.23	<10	1	1
VTM97-284S	<1	3	1.7	10	27	20	11.0	120	17.7	31	14	2.5	0.5	<0.5	1.3	0.19	<10	<1	<1
VTM97-285S	<1	2	2.9	10	40	14	13.0	51	12.1	23	11	2.2	0.5	<0.5	0.9	0.14	<10	<1	<1
VTM97-286S	1	6	2.8	40	41	30	27.0	310	23.1	44	19	3.3	0.6	0.5	1.9	0.29	<10	<1	1
VTM97-287S	<1	6	2.6	40	17	30	31.0	250	25.1	48	20	3.7	0.8	0.5	1.7	0.27	<10	2	<1
VTM97-289S	1	9	2.8	50	12	33	45.0	320	31.8	60	26	4.8	0.9	0.7	2.6	0.40	<10	1	1
VTM97-290S	<1	3	2.3	10	23	20	18.0	71	13.9	25	11	2.0	0.3	<0.5	0.9	0.14	<10	<1	<1
VTM97-291S	<1	1	2.5	<10	11	18	12.0	<2	8.4	15	7	1.4	0.3	<0.5	0.5	0.08	<10	<1	<1
VTM97-292S	1	8	2.4	40	14	40	48.0	250	31.5	58	25	4.7	0.8	0.6	2.3	0.34	<10	<1	<1
VTM97-293S	<1	1	2.3	<10	12	18	9.2	<2	10.5	17	9	1.7	0.3	<0.5	0.6	0.09	<10	<1	1
VTM97-294S	<1	3	2.2	10	19	16	18.0	56	13.4	25	10	2.1	0.5	<0.5	1.0	0.16	<10	<1	1
VTM97-296S	<1	1	2.1	10	29	13	18.0	41	9.5	18	8	1.6	0.4	<0.5	0.7	0.10	<10	<1	<1
VTM97-296S	<1	2	2.1	10	27	13	16.0	45	9.7	18	9	1.7	0.4	<0.5	0.8	12.00	<10	<1	<1
VTM97-297S	<1	2	1.3	10	20	13	15.0	53	12.4	22	11	0.1	0.5	<0.5	0.8	0.14	<10	<1	<1
VTM97-298S	<1	3	1.9	20	13	15	22.0	86	14.9	26	12	2.2	0.5	<0.5	1.1	0.17	<10	<1	<1
VTM97-299S	<1	2	2.4	10	14	12	20.0	12	10.8	21	10	1.8	0.5	<0.5	0.8	0.12	<10	<1	<1
VTM97-300S	<1	2	2.3	10	18	10	19.0	21	10.0	19	9	1.7	0.5	<0.5	0.7	0.11	<10	<1	1
VTM97-306S	<1	2	1.8	10	46	20	15.0	75	14.7	26	13	2.3	0.5	<0.5	1.0	0.15	<10	<1	<1
VTM97-307S	<1	2	1.8	10	28	12	19.0	44	10.5	20	10	1.9	0.3	<0.5	0.8	0.12	<10	<1	2

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-308S	<1	2	2.0	10	38	18	24.0	57	11.6	21	10	1.9	0.4	<0.5	0.9	0.14	<10	<1	<1
VTM97-309S	<1	2	1.7	10	22	16	19.0	41	12.3	24	10	1.9	0.4	<0.5	0.8	0.12	<10	<1	<1
VTM97-310S	1	4	1.6	20	21	21	25.0	120	18.3	35	15	2.9	0.8	<0.5	1.4	0.21	<10	3	<1
VTM97-311S	<1	7	2.2	40	9	24	41.0	210	23.1	43	17	3.3	0.8	0.5	1.8	0.28	<10	1	<1
VTM97-312S	<1	3	2.5	10	25	18	19.0	90	15.5	29	12	2.3	0.5	<0.5	1.1	0.16	<10	<1	<1
VTM97-313S	<1	5	2.3	30	23	23	33.0	130	23.3	44	19	3.5	0.8	0.5	1.7	0.26	<10	<1	<1
VTM97-314S	1	4	2.0	20	40	21	22.0	140	18.1	35	16	2.9	0.7	<0.5	1.3	0.20	<10	<1	<1
VTM97-315S	<1	3	1.8	10	24	19	19.0	25	18.4	34	15	2.8	0.5	<0.5	1.1	0.16	<10	<1	1
VTM97-316S	1	7	2.3	30	24	27	33.0	390	23.9	45	20	3.5	0.5	<0.5	2.0	0.33	<10	<1	<1
VTM97-317S	<1	4	2.3	30	52	17	21.0	170	15.2	29	11	2.2	0.4	<0.5	1.2	0.21	<10	<1	<1
VTM97-319S	1	11	3.1	60	38	50	66.0	230	45.9	93	41	7.8	1.2	1.1	4.1	0.61	<10	1	<1
VTM97-321S	<1	11	3.6	70	33	47	68.0	300	41.1	80	35	6.9	1.3	1.0	4.0	0.62	<10	<1	<1
Mineralized Area and Float Chip Sample Results																			
VTM97-50M	<1	<1	3.9	<10	4	14	74.0	24	1.7	<3	<5	0.2	<0.2	<0.5	<0.2	<0.05	<10	1	<1
VTM97-59M	<1	<1	1.4	40	38	17	12.0	<10	6.0	10	<5	0.6	0.2	<0.5	0.3	<0.05	<10	<1	<1
VTM97-59F(89F)	<1	<1	6.7	90	140	12	100.0	19	2.0	<3	<5	0.2	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-96M	1	2	6.0	140	29	33	94.0	220	8.8	19	11	3.0	1.1	0.7	2.3	0.42	<10	<1	<1
VTM97-109M	<1	1	2.0	20	<3	15	17.0	<10	5.7	10	5	1.0	0.3	<0.5	0.5	0.09	<10	1	<1
VTM97-146F	<1	<1	3.8	<10	8	14	29.0	<2	1.6	3	<5	0.2	<0.2	<0.5	<0.2	<0.05	<10	2	<1
VTM97-149F	<1	<1	4.0	<10	34	6	71.0	<2	2.5	4	<5	0.4	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-172M	1	11	4.9	60	6	51	25.0	150	35.9	70	28	5.5	1.1	0.6	2.5	0.39	<10	3	<1
VTM97-184M	<1	1	3.0	40	24	11	13.0	<2	8.3	15	6	1.1	0.4	<0.5	0.5	0.08	<10	1	<1
VTM97-188F	<1	<1	4.0	80	170	16	220.0	44	3.6	5	<5	0.4	0.2	<0.5	0.2	<0.05	<10	<1	<1
VTM97-190F	<1	<1	10.3	170	78	20	2400.0	35	15.1	23	8	1.0	0.2	<0.5	0.2	<0.05	10	<1	<1
VTM97-194M	<1	<1	1.2	30	180	6	67.0	74	1.4	<3	<5	0.2	<0.2	<0.5	<0.2	<0.05	<10	1	<1
VTM97-195M	<1	<1	1.6	10	270	13	37.0	87	2.0	5	<5	0.3	<0.2	<0.5	0.2	<0.05	<10	2	<1
VTM97-200M	1	7	10.9	60	74	34	500.0	94	93.3	130	33	5.0	1.3	0.6	2.2	0.31	<10	1	<1
VTM97-201M	1	8	6.4	50	60	26	1100.0	88	66.3	89	24	3.2	0.9	<0.5	1.5	0.24	<10	2	<1
VTM97-202M	1	9	7.0	30	54	33	100.0	96	55.7	77	26	3.9	0.6	0.5	2.0	0.29	<10	3	<1
VTM97-203M	1	11	6.5	80	120	42	37.0	180	48.8	88	34	6.1	1.0	0.8	1.9	0.24	<10	3	<1
VTM97-206M	1	9	2.7	90	84	41	87.0	98	34.2	63	28	5.0	1.3	0.5	2.3	0.36	<10	2	<1
VTM97-225M	<1	4	6.1	50	22	23	33.0	70	22.9	41	16	3.1	0.6	<0.5	1.5	0.24	<10	<1	<1
VTM97-248F	6	23	6.5	50	130	53	250.0	430	49.6	93	34	6.4	1.5	0.9	5.1	0.83	<10	1	<1
VTM97-249F	2	13	2.8	20	120	26	59.0	260	26.5	47	19	3.1	0.5	<0.5	1.9	0.29	<10	1	<1
VTM97-263M	<2	<1	5.0	<10	23	75	7700.0	230	30.5	38	10	1.0	1.1	<0.5	1.4	0.13	<10	1	3
VTM97-264M	1	<1	6.1	<10	54	40	12000	160	5.0	7	<5	0.4	<0.2	<0.5	0.9	0.12	<10	<1	<1
VTM97-265M	<1	<1	2.6	30	39	72	260.0	310	2.6	4	<5	0.3	<0.2	<0.5	0.6	0.09	<10	<1	1
VTM97-266M	1	1	1.7	30	330	21	15.0	120	12.8	21	9	1.4	0.4	<0.5	0.4	0.05	10	2	<1
VTM97-267M	<1	1	2.6	20	39	26	460.0	16	9.2	16	9	1.8	0.5	<0.5	0.5	0.06	<10	2	<1
VTM97-295F	<1	<1	2.2	<10	7	13	20.0	<2	0.9	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	2
VTM97-323dM	1	8	3.4	110	10	26	100.0	180	37.6	57	17	2.0	0.7	<0.5	1.8	0.29	<10	1	<1
VTM97-324dM	<1	2	3.7	50	34	39	270.0	80	39.5	71	31	6.2	1.6	0.7	1.1	0.16	<10	2	<1
VTM97-325dM	<1	5	5.5	60	45	18	110.0	130	31.7	51	18	2.3	0.4	<0.5	1.1	0.18	<10	1	<1
VTM97-328dM	1	5	4.2	<10	110	22	31.0	100	13.4	23	8	1.4	0.7	<0.5	1.2	0.21	<10	1	1
VTM97-331dM	1	10	3.6	50	53	36	120.0	170	44.4	81	31	5.4	1.7	0.6	2.6	0.41	<10	<1	1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-380F	na[1]	<1	2.0	25	na[1]	7	28.0	34	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-381M	na[1]	<1	3.0	33	na[1]	11	17.0	76	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-1RM	<1	<1	39.3	380	<3	<2	>10000	230	3.8	7	<5	0.4	0.2	<0.5	<0.2	if[a]	<10	<1	<1
VTM97-2RM	<1	<1	20.9	200	14	<2	1800.0	<2	1.2	<3	<5	0.4	<0.2	<0.5	<0.2	if[a]	<10	<1	<1
VTM97-3RM	<1	<1	20.3	210	<3	<2	2400.0	10	3.2	7	5	1.0	0.3	<0.5	<0.2	if[a]	<10	<1	<1
VTM97-4RM	<1	1	52.8	260	<3	<2	530.0	13	5.1	11	5	1.2	0.2	<0.5	0.2	if[a]	<10	<1	<1
VTM97-5RM	<1	<1	23.5	2300	5	<2	8600.0	5	2.2	4	<5	0.4	<0.2	<0.5	0.2	if[a]	<10	<1	<1
VTM97-6RM	<1	<1	17.6	100	120	<2	1000.0	<2	<1	<3	<5	<0.1	0.3	<0.5	<0.2	if[a]	<10	<1	<1
VTM97-7RM	<1	<1	24.6	360	<3	<2	>10000	5	7.2	<3	<5	<0.1	0.7	<0.5	<0.2	if[a]	<10	<1	<1
VTM97-8RM	<1	10	5.1	760	<3	4	3100.0	340	36.2	66	29	5.1	0.9	0.5	2.4	0,38	<10	<1	<1
VTM97-9RM	<1	3	3.5	540	<3	<2	4600.0	26000	11.8	21	9	1.6	0.3	<0.5	0.8	0.14	<10	<1	<1
VTM97-10RM	<1	<1	1.0	<10	<3	<2	100.0	3	1.0	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-11RM	<1	<1	0.5	<10	<3	<2	100.0	3	0.8	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
VTM97-12RM	<1	4	9.2	50	<3	5	13.0	170	18.8	36	16	3.0	0.5	<0.5	1.0	0.17	<10	<1	<1
VTM97-18RM	1	4	6.8	40	<3	11	110.0	240	14.7	29	15	2.9	0.6	<0.5	1.5	0.22	<10	<1	<1
Standards And Duplicates																			
JB-IM029	<1	<1	1.4	<10	30	6	11.0	<2	0.6	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1
JB-IM040	2	14	3.3	20	79	38	43.0	240	50.6	88	31	5.1	0.9	0.8	2.9	0.43	<10	2	<1
JB-IM041	1	2	<0.5	190	16	32	82.0	150	20.5	42	21	4.3	1.3	0.7	2.0	0.28	<10	<1	1
JB-IM043	<1	<1	<0.5	<10	3	11	4.8	<2	3.5	4	<5	0.5	<0.2	<0.5	0.3	<0.05	<10	1	1
JB-IM044	13	25	10.5	<10	30	55	150.0	1300	116.0	184	55	7.8	0.7	1.1	5.5	0.86	<10	<1	<1
VTM97-76	<1	2	1.0	10	16	18	11.0	64	16.8	33	14	2.6	0.6	<0.5	1.2	0.17	<10	<1	<1
VTM97-77S	<1	2	1.8	10	31	26	15.0	64	9.2	17	8	1.4	0.4	<0.5	0.6	0.10	<10	3	<1
VTM97-78	1	7	4.1	70	36	32	25.0	200	34.0	61	24	4.2	1.0	0.5	2.1	0.32	<10	1	<1
VTM97-79	<1	10	3.0	110	<3	28	78.0	160	23.2	45	18	3.5	0.8	<0.5	1.6	0.24	<10	1	<1
VTM97-80	<1	<1	1.6	40	48	15	8.2	13	4.7	9	<5	0.6	0.2	<0.5	0.2	<0.05	<10	1	<1
VTM97-101	13	26	7.6	<10	27	61	140.0	1300	118.0	195	59	8.2	0.7	0.9	5.6	0.93	30	<1	<1
VTM97-102	1	15	3.4	30	81	41	83.0	200	52.8	96	34	5.6	1.1	0.8	2.9	0.42	<10	<1	<1
VTM97-103	<1	<1	<0.5	<10	3	23	16.0	<10	3.4	5	<5	0.5	0.2	<0.5	0.3	0.05	<10	<1	<1
VTM97-104	1	8	4.3	60	34	28	37.0	190	38.2	68	26	4.2	1.0	0.5	2.0	0.30	<10	2	<1
VTM97-105	1	13	2.7	70	3	39	290.0	300	37.3	73	29	5.5	1.1	0.7	3.0	0.45	<10	2	<1
VTM97-126	<1	7	2.5	20	65	28	33.0	270	25.4	44	13	2.8	0.6	0.5	1.7	0.25	<10	2	<1
VTM97-127	13	24	9.5	<10	28	53	140.0	1200	111.0	179	54	7.4	0.7	0.9	5.0	0.87	<10	3	<1
VTM97-128	1	7	3.8	70	31	29	33.0	200	35.9	63	23	3.9	1.0	0.6	1.9	0.28	<10	3	<1
VTM97-129	<1	<1	0.8	<10	19	11	6.5	<10	5.0	12	5	1.1	<0.2	<0.5	0.6	0.07	<10	<1	<1
VTM97-231	12	26	11.3	<10	32	64	130.0	1300	125.0	218	70	10.4	1.4	1.6	5.7	0.84	<10	<1	<1
VTM97-232	<1	<1	<0.5	<10	4	14	4.9	<10	3.5	6	<5	0.6	<0.2	<0.5	0.2	<0.05	<10	<1	<1
VTM97-233	1	12	11.0	130	14	34	64.0	180	38.0	68	25	4.5	0.8	0.5	2.5	0.39	<10	1	<1
VTM97-234	12	24	8.7	<10	31	55	130.0	1300	111.0	174	53	7.3	0.9	0.8	5.0	0.89	<10	1	<1
VTM97-263	<1	<1	4.3	20	33	16	6700.0	7	36.0	40	11	1.2	1.1	<0.5	0.8	<0.05	<10	2	<1
VTM97-270	1	3	0.8	160	20	30	86.0	150	21.6	45	21	4.8	1.6	0.8	2.2	0.32	<10	<1	<1
VTM97-271	2	16	3.8	10	84	37	44.0	250	54.6	95	35	5.8	1.1	0.8	3.1	0.46	<10	<1	<1
VTM97-272	<1	8	4.2	70	34	31	33.0	210	38.6	68	25	4.3	1.1	0.5	2.0	0.30	<10	1	<1
VTM97-273S	2	9	5.4	80	25	38	49.0	190	45.5	78	31	5.3	1.2	0.8	2.5	0.37	<10	3	<1
VTM97-274	12	23	8.4	<10	25	58	140.0	1300	109.0	178	51	7.2	1.1	0.8	5.0	0.86	<10	1	1

Sample No.	Ta	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm
VTM97-301	<1	2	2.0	<10	37	13	24.0	33	11.0	22	10	1.9	0.4	<0.5	0.8	0.12	<10	<1	1
VTM97-302	<1	4	2.4	20	47	15	24.0	150	16.3	30	14	2.3	0.5	<0.5	1.3	0.21	<10	1	<1
VTM97-303S	<1	4	2.3	10	32	27	20.0	69	23.8	44	21	3.7	0.7	0.5	1.4	0.20	<10	<1	<1
VTM97-304S	1	6	2.4	30	32	26	32.0	240	24.3	46	20	3.6	0.7	0.5	1.8	0.26	<10	<1	<1
VTM97-335	1	6	3.3	<10	130	18	19.0	130	10.7	18	6	0.9	<0.2	<0.5	1.2	0.19	<10	<1	<1
VTM97-336	1	7	3.9	70	31	26	37.0	200	35.9	64	23	3.9	1.0	<0.5	1.7	0.28	<10	1	<1
VTM97-337	11	22	7.9	<10	29	56	150.0	1200	114.0	184	56	7.7	0.9	0.5	5.0	0.86	<10	1	<1
VTM97-341	1	2	0.7	140	18	28	84.0	150	20.9	44	22	4.5	1.4	0.5	2.0	0.31	<10	<1	<1
VTM97-342	<1	8	4.0	60	32	31	35.0	200	34.4	61	23	4.1	1.0	0.5	1.9	0.28	<10	<1	1
VTM97-343	2	2	0.6	180	17	27	88.0	140	19.9	40	21	4.2	1.6	0.5	1.9	0.29	<10	<1	1
VTM97-344	2	14	3.0	30	78	36	48.0	240	50.5	91	31	5.1	0.8	0.6	2.7	0.43	<10	<1	<1
VTM97-345	22	47	14.0	<10	63	56	150.0	1300	229.0	368	112	15.8	1.5	1.6	9.9	1.69	<10	<1	<1
VTM97-346	2	3	0.7	160	18	29	91.0	150	21.8	43	20	4.5	1.4	0.7	2.1	0.31	<10	<1	1
VTM97-347	13	26	10.0	<10	35	53	150.0	1200	123.0	201	59	8.2	1.2	0.8	5.7	1.00	<10	<1	1
VTM97-348	<1	8	4.6	50	32	28	35.0	210	40.0	70	27	4.2	1.3	0.5	2.3	0.36	<10	1	<1
VTM97-349	1	15	3.8	20	84	34	45.0	240	52.8	91	35	5.2	1.8	0.5	3.0	0.48	<10	<1	<1
VTM97-353	<1	3	1.2	20	<3	13	46.0	150	17.7	35	14	3.0	0.9	<0.5	1.5	0.23	<10	<1	<1
VTM97-354	<1	13	3.1	70	4	22	330.0	260	36.7	67	27	5.1	1.0	0.6	2.6	0.42	<10	<1	3
VTM97-355	<1	10	2.8	100	<3	15	100.0	140	23.1	46	18	3.4	0.9	<0.5	1.6	0.26	<10	<1	<1
VTM97-357	12	24	8.6	<10	<3	44	160.0	1200	109.0	178	54	7.9	0.7	0.8	4.8	0.86	<10	<1	<1
VTM97-358	1	3	1.0	170	21	23	98.0	180	22.1	47	25	4.9	1.8	0.6	2.2	0.33	<10	<1	<1
VTM97-359	2	15	3.7	20	86	22	56.0	170	51.6	91	33	5.5	0.9	0.9	2.9	0.41	<10	<1	<1
VTM97-360	12	25	8.4	<10	<3	46	160.0	1300	110.0	180	56	8.1	0.7	1.2	5.0	0.84	<10	<1	<1
Duplicates By NMBMMR XRF																			
VTM97-59	na[1]	<1	1.0	41	na[1]	5	14.0	<10	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-80	na[1]	<1	1.0	51	na[1]	4	17.0	<10	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
JB-IM002	na[1]	<1	2.0	5	na[1]	<1	16.0	<10	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
ORO706	na[1]	15	1.0	144	na[1]	30	55.0	174	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
ORO720	na[1]	4	1.0	212	na[1]	30	89.0	164	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-89F	na[1]	<1	6.0	95	na[1]	<1	59.0	7	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-200	na[1]	7	11.0	47	na[1]	26	838.0	155	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-201	na[1]	9	6.0	49	na[1]	17	1502.0	95	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-202	na[1]	9	7.0	38	na[1]	28	165.0	147	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-203	na[1]	18	5.0	85	na[1]	21	46.0	116	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-301S	na[1]	<1	1.0	20	na[1]	8	27.0	63	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]
VTM97-308S	na[1]	<1	1.0	18	na[1]	9	25.0	61	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]	na[1]

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APPENDIX 6:

DESCRIPTION OF MINES AND PROSPECTS ON MCGREGOR RANGE

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PROPERTY NAME: Three Buttes		**DATE OF EXAMINATION:** 5/9/97
ALIASES: none		**COUNTY:** Otero
MINERAL COMMODITY(IES): limestone		**MINING DISTRICT:** none
TYPE OF DEPOSIT: sedimentary		**QUADRANGLE:** Desert
SECTION: NW SW 7	**TOWNSHIP:** 25S	**RANGE:** 8E
LATITUDE: 32° 8' 32"		**LONGITUDE:** 106° 9' 57"
PRODUCTION: unknown amount of limestone for roads		
HISTORY: unknown		
DEVELOPMENT: open pit, 264 ft long, maximum width 89 ft, 15 ft high wall (Fig. M2)		
ACTIVITY/STATUS: inactive, now used as the end of a helicopter bombing range		
GEOLOGY: Pennsylvanian Panther Seep, limestone		
REMARKS: photos #3-6, samples VTM97-50-53s		
REFERENCES:		
EXAMINER: VTM		

PROPERTY NAME: Orogrande quarry		**DATE OF EXAMINATION:** 5/23/97
ALIASES: none		**COUNTY:** Otero
MINERAL COMMODITY(IES): limestone, diorite?		**MINING DISTRICT:** Orogrande
TYPE OF DEPOSIT: sedimentary		**QUADRANGLE:** Orogrande North
SECTION: NW 19	**TOWNSHIP:** 22S	**RANGE:** 9E
LATITUDE: 32° 22' 33"		**LONGITUDE:** 106° 3' 54"
PRODUCTION: limestone and possibly diorite for roads		
HISTORY: unknown		
DEVELOPMENT: 404 ft long, 81 ft wide, 30 ft high wall (Fig. M1)		
ACTIVITY/STATUS: on standby, crusher and screens on site		
GEOLOGY: Permian Hueco Formation (shales, limestone) intruded by Tertiary diorite.		
REMARKS: photos #5-10, samples VTM97-169-173 collected		
REFERENCES:		
EXAMINER: VTM, Eric Monroe		

PROPERTY NAME: Red Hills		**DATE OF EXAMINATION:** 5/25/97
ALIASES: none		**COUNTY:** Otero
MINERAL COMMODITY(IES): Cu, Au?, Ag?		**MINING DISTRICT:** Hueco Mountains
TYPE OF DEPOSIT: copper skarn		**QUADRANGLE:** Mountain Tank
SECTION: SE SE SE 23	**TOWNSHIP:** 26S	**RANGE:** 9E
LATITUDE: 32° 1' 39"		**LONGITUDE:** 105° 58' 52"
PRODUCTION: none		
HISTORY: unknown		
DEVELOPMENT: 10 ft long, 10 ft wide, 6 ft deep prospect pit (Fig. M3)		
ACTIVITY/STATUS: inactive		
GEOLOGY: Pit is within small roof pendent, probably Panther Seep limestone with Tertiary syenite. Limestone is altered to skarn and hornfels. Skarn consists of Fe oxides, magnetite, pyrite?, chalcopyrite?, trace of malachite, hornfels consists of chlorite, epidote?, pyrite, chalcopyrite?, bornite?, and malachite.		
REMARKS: photos, samples VTM97-200-202		
REFERENCES:		
EXAMINER: VTM, Eric Monroe, Jim McLemore		

PROPERTY NAME: unknown		**DATE OF EXAMINATION:** 6/17/97
ALIASES:		**COUNTY:** Otero
MINERAL COMMODITY(IES): Ba, F, Ag		**MINING DISTRICT:** N. Franklin Mountains
TYPE OF DEPOSIT: Rio Grande Rift		**QUADRANGLE:** Anthony
SECTION: SE 32	**TOWNSHIP:** 25S	**RANGE:** 4E
LATITUDE: 32° 6' 18"		**LONGITUDE:** 106° 33' 1"
PRODUCTION: none reported		
HISTORY:		
DEVELOPMENT: 80 ft adit, 2 shafts (30 ft deep), pits (Fig. N2)		
ACTIVITY/STATUS: abandoned		
GEOLOGY: jasperoids and mineralized pods in limestones along fault in Devonian Sly Gap and Silurian Fusselman Formations		
REMARKS: samples VTM97-263-269c taken, photos		
REFERENCES:		
EXAMINER: VTM, Eric Monroe, Scott Kamber		

APPENDIX 7:

THIN SECTION DESCRIPTIONS
OF SELECTED SAMPLES FROM MCGREGOR RANGE

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THIN SECTION DESCRIPTIONS OF SELECTED SAMPLES FROM MCGREGOR RANGE

Seventy thin sections of characterization and mineralization samples were examined by petrographic microscope for this project and are described in this appendix. Igneous rocks and mineralized samples were polished, whereas sedimentary rocks were unpolished sections. Field sample descriptions are in Appendix 3.

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-50	**FIELD DATE:** 5/9/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION calcite vein in limestone	
LATITUDE: 32° 8' 32"	**LONGITUDE:** 106° 9' 58"
OCCURRENCE: outcrop	**QUADRANGLE:** Desert
HAND SPECIMEN DESCRIPTION	
Color: red to gray	
General appearance: 2 inch calcite vein in limestone, strike N125°, vertical dip	
Structure/texture:	
MICROSCOPIC DESCRIPTION:	
Texture: very fined grained limestone with vein	
Structure: vein is zoned—coarse calcite next to wall rock to banded calcite to quartz to banded calcite to quartz to coarse calcite next to wall rock	
Mineralogy:	
Primary: calcite	
Secondary: hematite, clays	
Metamorphic:	
Accessory minerals: quartz	
Nature of ground mass or cement: calcite	
Mineralization or alteration: quartz and calcite, reddish hematite staining	
SPECIAL FEATURES:	
TYPE OF ROCK: vein in limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-51	**FIELD DATE:** 5/9/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 8' 32"	**LONGITUDE:** 106° 9' 58"
OCCURRENCE: outcrop	**QUADRANGLE:** Desert
HAND SPECIMEN DESCRIPTION	
Color: black	
General appearance:	
Structure/texture:	
MICROSCOPIC DESCRIPTION:	
Texture: very fine grained to microcrystalline	
Structure: veined and fractured, shell fragments, pellets, algae	
Mineralogy:	
Primary: 85% silica, 10% black organic material, 5% calcite and dolomite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration:	
SPECIAL FEATURES: lenses in limestone	
TYPE OF ROCK: black chert	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-52	**FIELD DATE:** 5/9/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 8' 32"	**LONGITUDE:** 106° 9' 58"
OCCURRENCE: outcrop	**QUADRANGLE:** Three Buttes
HAND SPECIMEN DESCRIPTION	
Color: gray to black	
General appearance: limestone with black chert lenses	
Structure/texture: massive	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: fine grained	
Structure: thin calcite vein	
Mineralogy:	
Primary: 95% fine grained calcite, 3% hematite, trace dolomite, 2% organic material	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration:	
SPECIAL FEATURES: pellets	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-55	**FIELD DATE:** 5/9/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 8' 22"	**LONGITUDE:** 106° 8' 20"
OCCURRENCE: outcrop	**QUADRANGLE:** Desert
HAND SPECIMEN DESCRIPTION	
Color: gray and white	
General appearance:	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, fined grained to porphyritic, subhedral, convolute plagioclase zoning	
Structure:	
Mineralogy:	
Primary: 5% opaque minerals (black magnetite, white leucoxene), 25% altered, zoned plagioclase (twinned), 20% K-feldspar, 10% quartz, 2% biotite, 2% aegirine, 1% apatite, 5% calcite, 30% sericite and clay	
Secondary: 30% hematite and sericite/clay alteration, minor chlorite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: altered clay and hematite	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: quartz monzonite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-57	**FIELD DATE:** 5/9/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 20"	**LONGITUDE:** 105° 58' 21"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance: fine grained	
Structure/texture: mm calcite veins in limestone	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 90% calcite, 5% dolomite (trace euhedral crystals), 3% opaque minerals, 2% black organic material, trace quartz	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-59	**FIELD DATE:** 5/9/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 48"	**LONGITUDE:** 105° 58' 48"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: white	
General appearance: veins	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 80%, quartz 10%	
Secondary: iron oxides 10%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, quartz	
Mineralization or alteration: hematite	
SPECIAL FEATURES: iron staining	
TYPE OF ROCK: calcite veins in dolomite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-60	**FIELD DATE:** 5/9/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 39"	**LONGITUDE:** 105° 58' 37"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: green to gray	
General appearance: 25 ft thick sill	
Structure/texture: iron oxides along fractures	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral granular and porphyritic, trachytic	
Structure:	
Mineralogy:	
Primary: 65% K-feldspar laths, 10% hornblende, 5% microcline, 5% quartz, 5% green augite, 5% magnetite, 5% biotite, trace apatite	
Secondary: 10% chlorite, clay, hematite, sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: devitrified glass to hematite and clay	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: alkali-feldspar trachyte sill	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-63	**FIELD DATE:** 5/20/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 5' 20"	**LONGITUDE:** 105° 55' 5"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: tan	
General appearance: sill	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral granular, porphyritic, trachytic	
Structure:	
Mineralogy:	
Primary: 5% light green hypersthene, 5% quartz, 30% altered K-feldspar, 15% plagioclase (twinned), 10% augite, 10% hornblende, 5% brown biotite, 5% magnetite, trace spinel, apatite	
Secondary: 5% calcite, 5% leucoxene, 5% clay	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: trachyte	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-68	**FIELD DATE:** 5/10/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 7' 43"	**LONGITUDE:** 105° 52' 20"
OCCURRENCE: outcrop	**QUADRANGLE:** Owl Tank Canyon East
HAND SPECIMEN DESCRIPTION	
Color: brown-gray	
General appearance: grainy	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 90% calcite, 5% quartz, 3% dolomite, 2% organic material	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: may be dolomitized (1.98% MgO)	
SPECIAL FEATURES:	
TYPE OF ROCK: grainstone limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-82	**FIELD DATE:** 5/10/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 8' 23"	**LONGITUDE:** 106° 00' 55"
OCCURRENCE: outcrop	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance: massive	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 90% calcite, 8% dolomite, 2% organic material	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-89F	**FIELD DATE:** 5/21/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 36' 18"	**LONGITUDE:** 105° 51' 44"
OCCURRENCE: float chip	**QUADRANGLE:** Culp Canyon
HAND SPECIMEN DESCRIPTION	
Color: red and white	
General appearance:	
Structure/texture: jasperoid/altered limestone	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: fine grained	
Structure:	
Mineralogy:	
Primary: 70% calcite and quartz matrix, trace magnetite (no pyrite)	
Secondary: 30% hematite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-93	**FIELD DATE:** 5/12/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 36' 47"	**LONGITUDE:** 105° 47' 52"
OCCURRENCE: outcrop	**QUADRANGLE:** Culp Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance:	
Structure/texture: thinly bedded	
Remarks: Upper Mississippian	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 65% calcite, 20% quartz, 8% chlorite, 5% K-feldspar, 2% iron oxides	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite cement	
Mineralization or alteration:	
SPECIAL FEATURES:	
SPECIAL FEATURES:	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-94	**FIELD DATE:** 5/12/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 36' 34"	**LONGITUDE:** 105° 47' 41"
OCCURRENCE: outcrop	**QUADRANGLE:** Culp Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance: massive	
Structure/texture:	
Remarks: Silurian	
MICROSCOPIC DESCRIPTION:	
Texture: fine grained	
Structure:	
Mineralogy:	
Primary: 80% calcite, 15% dolomite, 5% organic material	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, dolomite	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: dolomite (20.9% MgO)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-95	**FIELD DATE:** 5/12/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 36' 34"	**LONGITUDE:** 105° 47' 41"
OCCURRENCE: outcrop	**QUADRANGLE:** Culp Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance:	
Structure/texture:	
Remarks: Devonian Sly Gap Fm	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 75%, calcite 15%, dolomite 10%	
Secondary:	
Metamorphic:	
Accessory minerals: iron oxides	
Nature of ground mass or cement: quartz	
Mineralization or alteration: minor hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: chert	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-96	**FIELD DATE:** 5/12/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 36' 31"	**LONGITUDE:** 105° 47' 21"
OCCURRENCE: outcrop	**QUADRANGLE:** Culp Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance: Fe oxides	
Structure/texture:	
Remarks: Gobbler Fm.	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 40%, K-feldspar 5%, calcite 15%	
Secondary: iron oxides 40%	
Metamorphic:	
Accessory minerals: garnet	
Nature of ground mass or cement: quartz	
Mineralization or alteration: hematite, goethite	
SPECIAL FEATURES:	
TYPE OF ROCK: sandstone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-135	**FIELD DATE:** 5/16/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 31' 44"	**LONGITUDE:** 105° 51' 23"
OCCURRENCE: outcrop	**QUADRANGLE:** Otero Mesa South
HAND SPECIMEN DESCRIPTION	
Color: orange	
General appearance:	
Structure/texture: medium-grained sandstone	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 45% quartz, 37% calcite, 3% dolomite, 10% biotite	
Secondary: 5% iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite and silica cement	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: sandstone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-146F	**FIELD DATE:** 5/20/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 34' 15"	**LONGITUDE:** 105° 40' 40"
OCCURRENCE: float chip	**QUADRANGLE:** El Paso Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance: Fe oxides, calcite	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 90%, biotite 2%, quartz 2%	
Secondary: chlorite 3%, iron oxides 3%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES: fossils, bioturbation	
TYPE OF ROCK: altered limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-149F	**FIELD DATE:** 5/20/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 34' 19"	**LONGITUDE:** 105° 40' 50"
OCCURRENCE: float chip	**QUADRANGLE:** El Paso Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray to yellow-brown	
General appearance: Fe oxides, silica	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 60%, quartz 40%, K-feldspar trace	
Secondary: iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: altered limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-151	**FIELD DATE:** 5/21/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 30' 15"	**LONGITUDE:** 106° 3' 50"
OCCURRENCE: outcrop	**QUADRANGLE:** Tres Hermanos SE
HAND SPECIMEN DESCRIPTION	
Color: gray to black	
General appearance: thin calcite veins	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 88%, quartz 12%	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES: fossils, calcite veins	
TYPE OF ROCK: limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-158	**FIELD DATE:** 5/22/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 17' 30"	**LONGITUDE:** 105° 51' 5"
OCCURRENCE: outcrop	**QUADRANGLE:** Otero Mesa South
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture: fine-grained sandstone	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 70% quartz, 15% calcite, 10% biotite	
Secondary: 5% iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: silica cement	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: sandstone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-159	**FIELD DATE:** 5/22/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 17' 30"	**LONGITUDE:** 105° 51' 5"
OCCURRENCE: outcrop	**QUADRANGLE:** Otero Mesa South
HAND SPECIMEN DESCRIPTION	
Color: red	
General appearance: silty, fine grained	
Structure/texture: calcite casts	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 75%, K-feldspar 10%, calcite 15%	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, quartz	
Mineralization or alteration: hematite	
SPECIAL FEATURES: iron staining	
TYPE OF ROCK: siltstone-sandstone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-169	**FIELD DATE:** 5/23/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 22' 33"	**LONGITUDE:** 106° 3' 54"
OCCURRENCE: outcrop	**QUADRANGLE:** Orogrande North
HAND SPECIMEN DESCRIPTION	
Color: white, gray, black	
General appearance: inclusions of hornfels and limestone	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral, porphyritic, trachytic	
Structure:	
Mineralogy:	
Primary: 5% augite, 10% altered hornblende, 35% plagioclase (twinned), 25% K-feldspar, 15% quartz, trace apatite, magnetite	
Secondary: 10% chlorite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: quartz monzonite porphyry	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-171	**FIELD DATE:** 5/23/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 22' 32"	**LONGITUDE:** 106° 3' 53"
OCCURRENCE: outcrop	**QUADRANGLE:** Orogrande North
HAND SPECIMEN DESCRIPTION	
Color: black	
General appearance: thin to thick bedded	
Structure/texture:	
Remarks: petrid odor	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 85% calcite, 8% quartz, 5% organic material	
Secondary: 2% iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite cement	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-173	**FIELD DATE:** 5/2/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 21' 54"	**LONGITUDE:** 106° 4' 22"
OCCURRENCE: outcrop	**QUADRANGLE:** Orogrande South
HAND SPECIMEN DESCRIPTION	
Color: white, gray, black	
General appearance: slightly altered	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral, porphyritic, perthitic feldspars	
Structure:	
Mineralogy:	
Primary: 15% K-feldspar, 5% actinolite, 20% plagioclase, 15% quartz, 5% hornblende, 5% biotite, 5% magnetite altered to hematite, 30% groundmass, trace apatite	
Secondary: groundmass altered to hematite, clay, sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: altered	
Mineralization or alteration: minor clay and Fe oxides	
SPECIAL FEATURES:	
TYPE OF ROCK: quartz monzonite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-179	**FIELD DATE:** 5/24/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 00' 31"	**LONGITUDE:** 105° 59' 10"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance: altered	
Structure/texture: fractures filled with Fe oxides	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral granular	
Structure:	
Mineralogy:	
Primary: 5% quartz, 40% K-feldspar, 20% plagioclase, 5% hornblende, 5% biotite, trace apatite, magnetite	
Secondary: 15% hematite, 10% sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration: Fe oxides fill in between crystals, feldspars altered	
SPECIAL FEATURES:	
TYPE OF ROCK: syenite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-184	**FIELD DATE:** 5/24/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 00' 16"	**LONGITUDE:** 105° 58' 17"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 85%, quartz 10%	
Secondary: iron oxides 5%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite in and around calcite veinlets	
SPECIAL FEATURES:	
TYPE OF ROCK: altered limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-188F	**FIELD DATE:** 5/24/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 2' 20"	**LONGITUDE:** 105° 55' 40"
OCCURRENCE: float chip	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture: calcite veining	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: calcite vein, zoned	
Structure:	
Mineralogy:	
Primary: hematite, quartz, calcite, trace magnetite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration: chlorite and hematite veins	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-190F	**FIELD DATE:** 5/24/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 00' 4"	**LONGITUDE:** 105° 57' 47"
OCCURRENCE: float chip	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture:	
Remarks: Hueco limestone	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 55%, calcite 25%	
Secondary: 20% iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite, goethite	
SPECIAL FEATURES: hematite is pervasive	
TYPE OF ROCK: altered limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-195	**FIELD DATE:** 5/24/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 3' 44"	**LONGITUDE:** 105° 57' 28"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: brown jasperoid	
General appearance:	
Structure/texture:	
Remarks: Hueco Fm	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 90%, 5% calcite	
Secondary: 5% iron oxides, trace K-feldspar	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz	
Mineralization or alteration: hematite in cavities surrounded by quartz, spherical layers of quartz	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-199	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 46"	**LONGITUDE:** 105° 58' 52"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, medium grained, subhedral granular	
Structure:	
Mineralogy:	
Primary: 3% quartz, 45% K-feldspar, 25% plagioclase, 5% hornblende, 5% biotite, 2% augite, trace magnetite, apatite	
Secondary: 5% hematite, 10% sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: syenite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-200	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 39"	**LONGITUDE:** 105° 58' 52"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: brown and black	
General appearance: magnetite-hematite zone	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 35% red hematite and black magnetite with intergrown pyrite, 10% 2 generations of calcite, 20% green chlorite, 20% sericite, 15% quartz	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: iron oxides	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: magnetite-hematite skarn	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-201	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 39"	**LONGITUDE:** 105° 58' 52"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: green-gray	
General appearance: skarn	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 5% brown biotite, 80% groundmass of calcite, hematite, chlorite, sericite, 10% magnetite, trace pyrite cubes, 5% quartz	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, silica	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: skarn	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-202	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 39"	**LONGITUDE:** 105° 58' 52"
OCCURRENCE: dump	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: white to gray	
General appearance: recrystallized limestone	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: altered, recrystallized	
Structure:	
Mineralogy:	
Primary: 10% euhedral pyrite (embayed and fractured), intergrown with chalcopyrite, 25% quartz, 5% hornblende and chlorite, 5% biotite, 55% calcite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, silica	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: skarn	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-203	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 29"	**LONGITUDE:** 105° 58' 55"
OCCURRENCE: 6 inch chip	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: green-gray to blue-gray	
General appearance: recrystallized limestone	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: very fine grained	
Structure:	
Mineralogy:	
Primary: 5% corroded pyrite, 15% sericite, 15% quartz, 10% chlorite, 55% calcite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, silica	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: skarn	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-206	**FIELD DATE:** 5/25/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 23"	**LONGITUDE:** 105° 58' 48"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: green	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 40%, K-feldspar 15%, plagioclase 10%	
Secondary: calcite 10%, epidote and idingsite 25%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz, calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: hornfels	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-212	**FIELD DATE:** 5/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 6' 3"	**LONGITUDE:** 105° 56' 53"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: pink to brown	
General appearance:	
Structure/texture: Fe oxides veins	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, fine grained, trachytic, subhedral, perthitic	
Structure:	
Mineralogy:	
Primary: 5% quartz, 45% K-feldspar, 20% plagioclase, 5% hornblende/enstatite, 5% magnetite, 5% biotite, trace apatite	
Secondary: 10% hematite, 5% sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: syenite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-219C	**FIELD DATE:** 5/27/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 4"	**LONGITUDE:** 106° 00' 10"
OCCURRENCE: float chip	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: white and brown	
General appearance:	
Structure/texture:	
Remarks: not enough float to analyze	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 35%, calcite 30%, K-feldspar 10%	
Secondary: pyroxene 5%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz, calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: altered limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-222	**FIELD DATE:** 5/27/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 36"	**LONGITUDE:** 105° 59' 39"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance:	
Structure/texture: epidote, Fe oxides	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: medium grained, holocrystalline, subhedral granular	
Structure:	
Mineralogy:	
Primary: trace nepheline, 20% plagioclase, 40% K-feldspar, 5% hornblende/aegerine/augite, 5% magnetite, trace apatite	
Secondary: 5% hematite, 15% sericite, 10% epidote/chlorite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: nepheline syenite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-223	**FIELD DATE:** 5/27/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 36"	**LONGITUDE:** 105° 59' 34"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: yellow brown	
General appearance: Fe oxides	
Structure/texture: liesegang banding, dike	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: medium grained, trachytic, holocrystalline, subhedral	
Structure:	
Mineralogy:	
Primary: 45% K-feldspar, 20% plagioclase (zoned), 5% magnetite, 5% hornblende, 5% quartz, 5% biotite, trace apatite	
Secondary: 5% chlorite, 10% hematite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration: altered	
SPECIAL FEATURES:	
TYPE OF ROCK: syenite dike	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-224	**FIELD DATE:** 5/27/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 38"	**LONGITUDE:** 105° 59' 29"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: medium grained, holocrystalline, subhedral granular	
Structure:	
Mineralogy:	
Primary: 10% quartz, 20% plagioclase, 45% K-feldspar, 5% biotite, 5% magnetite, 5% hornblende, trace apatite	
Secondary: trace hematite, 10% sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: syenite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-225	**FIELD DATE:** 5/27/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 1' 37"	**LONGITUDE:** 105° 59' 44"
OCCURRENCE: outcrop	**QUADRANGLE:** Mountain Tank
HAND SPECIMEN DESCRIPTION	
Color: green-gray to white	
General appearance: recrystallized	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: fine grained	
Structure:	
Mineralogy:	
Primary: pyrite (euhedral and embayed, some altered to hematite), chlorite, calcite, light green epidote, quartz, very fine grained garnet	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, silica	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: skarn	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-243	**FIELD DATE:** 5/29/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 40' 13"	**LONGITUDE:** 105° 51' 59"
OCCURRENCE: outcrop	**QUADRANGLE:** Bug Scuffle Canyon
HAND SPECIMEN DESCRIPTION	
Color: gray to brown	
General appearance:	
Structure/texture:	
Remarks: El Paso Group	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 80%, dolomite 15%, quartz 4%, chlorite 1%	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, mud	
Mineralization or alteration: chlorite filling in quartz veins	
SPECIAL FEATURES:	
TYPE OF ROCK: dolomite (20.8% MgO)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-244	**FIELD DATE:** 5/29/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 39' 37"	**LONGITUDE:** 105° 51' 37"
OCCURRENCE: outcrop	**QUADRANGLE:** Bug Scuffle Canyon
HAND SPECIMEN DESCRIPTION	
Color: black and white	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: medium grained	
Structure:	
Mineralogy:	
Primary: 10% augite/aegerine, 35% plagioclase altered to sericite, 20% hornblende, 5% quartz, 10% biotite, 5% magnetite	
Secondary: 10% sericite, 5% chlorite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: quartz gabbro	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-245	**FIELD DATE:** 5/29/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 39' 40"	**LONGITUDE:** 105° 51' 35"
OCCURRENCE: outcrop	**QUADRANGLE:** Bug Scuffle Canyon
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance: well rounded grains, fine grained	
Structure/texture:	
Remarks: Bliss Fm.	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 90% quartz, 5% biotite, 2% chlorite, 2% iron oxides	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: silica	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: quartzite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-248F	**FIELD DATE:** 6/16/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 5' 9"	**LONGITUDE:** 106° 4' 28"
OCCURRENCE: float chip	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 70%, K-feldspar 22%, chlorite 5%, biotite 2%, calcite 1%	
Secondary:	
Metamorphic:	
Accessory minerals: epidote?	
Nature of ground mass or cement: silica	
Mineralization or alteration: hematite, marcarsite	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-249F	**FIELD DATE:** 6/16/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 5' 9"	**LONGITUDE:** 106° 4' 28"
OCCURRENCE: float chip	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: white	
General appearance:	
Structure/texture:	
Remarks: trace of pyrite	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 62%, calcite 21%, K-feldspar 15%	
Secondary: sericite 2%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: silica	
Mineralization or alteration: hematite, goethite, trace pyrite	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-257	**FIELD DATE:** 6/16/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 18' 00"	**LONGITUDE:** 105° 45' 13"
OCCURRENCE: outcrop	**QUADRANGLE:** Otero Mesa South
HAND SPECIMEN DESCRIPTION	
Color: green-gray to white	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 55%, dolomite 20%, quartz 15%	
Secondary: 10% iron oxides	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, mud	
Mineralization or alteration: hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: dolomite (13.4% MgO)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-261	**FIELD DATE:** 6/16/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 17' 15"	**LONGITUDE:** 105° 49' 31"
OCCURRENCE: outcrop	**QUADRANGLE:**
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture:	
Remarks: Mesita Blanca Member	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 50%, quartz 10%, dolomite 10%	
Secondary: chlorite 30%	
Metamorphic:	
Accessory minerals: iron oxides	
Nature of ground mass or cement: quartz, calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES:	
TYPE OF ROCK: calcareous sandstone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-264	**FIELD DATE:** 6/17/97
PETROGRAPHER: Erik Monroe, VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 6' 18"	**LONGITUDE:** 106° 33' 1"
OCCURRENCE: outcrop	**QUADRANGLE:** Anthony
HAND SPECIMEN DESCRIPTION	
Color: white	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 60% calcite, 35% quartz, 5% barite, fluorite, smithsonite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz	
Mineralization or alteration: goethite, marcasite, hematite, epidote, barite, fluorite	
SPECIAL FEATURES:	
TYPE OF ROCK: vein	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-265	**FIELD DATE:** 6/17/97
PETROGRAPHER: Erik Monroe, VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 6' 18"	**LONGITUDE:** 106° 33' 1"
OCCURRENCE: outcrop	**QUADRANGLE:** Anthony
HAND SPECIMEN DESCRIPTION	
Color: white to brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 50%, calcite 25%, barite 10%, fluorite 5%, trace pyrite	
Secondary: biotite 5%, chlorite 5%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz	
Mineralization or alteration: barite, fluorite, pyrite	
SPECIAL FEATURES:	
TYPE OF ROCK: vein	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-266	**FIELD DATE:** 6/17/97
PETROGRAPHER: Erik Monroe, VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 4' 58"	**LONGITUDE:** 106° 32' 24"
OCCURRENCE: outcrop	**QUADRANGLE:** Anthony
HAND SPECIMEN DESCRIPTION	
Color: brown	
General appearance:	
Structure/texture: liesegang banding	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 90%, K-feldspar 3%, biotite 2%	
Secondary: epidote 5%, iron oxides, pyrite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz	
Mineralization or alteration: iron oxides	
SPECIAL FEATURES:	
TYPE OF ROCK: jasperoid	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-267	**FIELD DATE:** 6/17/97
PETROGRAPHER: Erik Monroe, VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 6' 19"	**LONGITUDE:** 106° 33' 00"
OCCURRENCE: outcrop	**QUADRANGLE:** Anthony
HAND SPECIMEN DESCRIPTION	
Color: white and green	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 85%, quartz 10%	
Secondary: trace biotite, chlorite 5%, hematite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite, quartz	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: vein	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-295F	**FIELD DATE:** 6/20/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 32' 54"	**LONGITUDE:** 105° 38' 57"
OCCURRENCE: float chip	**QUADRANGLE:** El Paso Canyon
HAND SPECIMEN DESCRIPTION	
Color: white and brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: calcite 80%, quartz 7&, dolomite 13%	
Secondary:	
Metamorphic:	
Accessory minerals: iron oxides	
Nature of ground mass or cement: calcite	
Mineralization or alteration: hematite	
SPECIAL FEATURES: fossils	
TYPE OF ROCK: calcite veins in limestone	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-325d	**FIELD DATE:** 6/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 4' 12"	**LONGITUDE:** 106° 9' 55"
OCCURRENCE: drill core 46-6, 1288-1299 ft	**QUADRANGLE:** Desert SW
HAND SPECIMEN DESCRIPTION	
Color: white to pink	
General appearance:	
Structure/texture: breccia zone	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 75%, calcite 20%, K-feldspar 5%	
Secondary:	
Metamorphic:	
Accessory minerals: iron oxides	
Nature of ground mass or cement: quartz, calcite	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: silicified breccia	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-327d	**FIELD DATE:** 6/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 4' 23"	**LONGITUDE:** 106° 8' 54"
OCCURRENCE: drill core hole 45-5, 436.1 ft	**QUADRANGLE:** Desert SW
HAND SPECIMEN DESCRIPTION	
Color: pink to brown	
General appearance: Fe oxides	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: porphyritic, holocrystalline, very fine grained, subhedral	
Structure:	
Mineralogy:	
Primary: 40% quartz, 25% K-feldspar, 25% plagioclase, trace biotite, magnetite	
Secondary: 10% sericite, hematite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: rhyolite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-329d	**FIELD DATE:** 6/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 4' 42"	**LONGITUDE:** 106° 9' 45"
OCCURRENCE: drill core hole 61-6, 6795.8 ft	**QUADRANGLE:** Desert SW
HAND SPECIMEN DESCRIPTION	
Color: white	
General appearance:	
Structure/texture: porphyritic	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: holocrystalline, subhedral, very fine grained, porphyritic	
Structure:	
Mineralogy:	
Primary: 35% quartz, 25% plagioclase, 30% K-feldspar, trace apatite, magnetite	
Secondary: trace hematite, 10% sericite	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: rhyolite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-330d	**FIELD DATE:** 6/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 3' 2"	**LONGITUDE:** 106° 7' 58"
OCCURRENCE: drill core hole 51-8, 570 ft	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: pink to gray brown	
General appearance: porphyritic, Fe oxides	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture: hypocrystalline, subhedral granular, porphyritic, fine to medium grained, zoned plagioclases	
Structure:	
Mineralogy:	
Primary: 15% quartz, 25% K-feldspar, 25% plagioclase, 5% hornblende, 10% biotite, 5% magnetite, trace apatite	
Secondary: 5% hematite, 10% sericite/clay	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement:	
Mineralization or alteration:	
SPECIAL FEATURES:	
TYPE OF ROCK: monzonite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: VTM97-331d	**FIELD DATE:** 6/25/97
PETROGRAPHER: VTM	
FIELD DESCRIPTION	
LATITUDE: 32° 3' 2"	**LONGITUDE:** 106° 7' 58"
OCCURRENCE: drill core 5198, 627 ft	**QUADRANGLE:** Desert SE
HAND SPECIMEN DESCRIPTION	
Color: pink to brown	
General appearance:	
Structure/texture:	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: quartz 45%, calcite 25%, K-feldspar 5%, altered biotite 5%, plagioclase 5%	
Secondary: iron oxides 15%	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: quartz	
Mineralization or alteration: hematite, goethite	
SPECIAL FEATURES:	
TYPE OF ROCK: altered rhyolite	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: ORO-711	**FIELD DATE:** 5/11/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: : 32° 28' 13"	**LONGITUDE:** 106° 5' 44"
OCCURRENCE: outcrop	**QUADRANGLE:** Orogrande North
HAND SPECIMEN DESCRIPTION	
Color: black	
General appearance:	
Structure/texture:	
Remarks: petrid smell	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 85% calcite, 10% quartz, 5% chlorite	
Secondary: silica in pores	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite	
Mineralization or alteration:	
SPECIAL FEATURES: fossils	
TYPE OF ROCK: limestone (micrite)	

THIN SECTION DESCRIPTION FORM

SAMPLE NUMBER: ORO-712	**FIELD DATE:** 5/11/97
PETROGRAPHER: Erik Monroe	
FIELD DESCRIPTION	
LATITUDE: 32° 28' 26"	**LONGITUDE:** 106° 5' 57"
OCCURRENCE: outcrop	**QUADRANGLE:** Orogrande North
HAND SPECIMEN DESCRIPTION	
Color: gray	
General appearance:	
Structure/texture: edge of bioherm	
Remarks:	
MICROSCOPIC DESCRIPTION:	
Texture:	
Structure:	
Mineralogy:	
Primary: 90% calcite, 5% quartz, 3% iron oxides, 2% chlorite	
Secondary:	
Metamorphic:	
Accessory minerals:	
Nature of ground mass or cement: calcite cement	
Mineralization or alteration:	
SPECIAL FEATURES: fossils	
TYPE OF ROCK: limestone	

APPENDIX 8:

QUALITY CONTROL AND QUALITY ASSURANCE PROCEDURES AND RESULTS

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QUALITY CONTROL AND QUALITY ASSURANCE PROCEDURES AND RESULTS

PROCEDURES

A standardized protocol was followed after each sample is taken. Location data by GPS, type of sample, and field and laboratory petrographic descriptions were recorded. Each sample was clearly identified and a chain of custody process was followed to assure that all samples were transported to the laboratory, analyzed, and results archived. The sample number assigned to each sample follows the sample through all phases of analysis. The samples were transported from the field to NMBMMR, where each sample was crushed in jaw crushes and pulverized by tungsten-carbide disc grinders to a grain size of <35 μm. Each sample was homogenized at each crushing step by cone and quarter method. Standard equipment cleaning procedures were utilized following the preparation of each sample to limit cross-sample contamination. The samples were then sent to a commercial laboratory (XRAL Laboratories) for analyses. Four samples (VTM97-380F, 381, 382, High 10) and several duplicates were analyzed by X-ray Fluorescence (NMBMMR, Chris McKee, manager) only and are designated XRF in Table A8.1. NMBMMR internal (nepheline syenite, marble, rhyolite, basalt, and sand) and commercial certified standards and duplicates of selected samples were submitted blind to the commercial laboratory with each sample batch of 25 samples to assure analytical quality. NMBMMR has archived a split of all samples for future studies.

ACCURACY AND PRECISION OF DATA

The accuracy of the data is how close the measured value is to the true value. Analyzing certified standards as unknown samples and comparing with known certified values monitors accuracy. The precision of an analysis is the repeatability of a measurement. Precision is monitored by multiple analyses of many sample duplicates and internal standards. In general, analyses obtained from XRAL are in agreement with certified values of certified standards and precision is excellent between multiple analyses (Table A8.2). However, some differences between certified standards and duplicate pairs do exist.

Three certified samples were submitted to XRAL as unknowns (NIST2709, SO-3 and NIST2711; Table A8.2). The results obtained by XRAL compare within error with certified values for most elements. Nugget effects can account for variations in Ag, Au, and Zr, observed in some pairs of samples. A nugget effect is where a small grain of native gold or other minerals occurs in one split and not the other split and produces a higher concentration. Another variation between certified values and the results provided by XRAL is a result of different analytical techniques. XRAL used inductively coupled plasma spectrometry (ICP) methods for several elements, including Cu, Pb, Zn, Ni, Cd, and V. ICP requires acid digestion and analyses of a liquid-base solution. In many cases, not all of the solid rock will be completely digested and will result in a lower value than that obtained by certified values typically done by X-ray fluorescence (XRF) or instrumental neutron activation analysis (INNA). Samples of NMBMMR internal standards were analyzed for each batch and the difference between analysis by NMBMMR using XRF and XRAL using ICP is demonstrated in Figure 6. Cu is presented in the figure as an example of the comparison process utilized in this project.

The precision of XRAL analyses is acceptable for most samples (Table A8.1). There are numerous reasons why duplicate samples and/standards do not always agree. Some samples, such as rhyolite and basalt, grind into powder more easily than other samples, such as stream-sediment samples and nepheline syenites. Fusion techniques required for XRF analyses vary from lab to lab and may also differ between different personnel that could result in variations between sample pairs. This is demonstrated in Figures 7

and 8, where both NMBMMR and XRAL used XRF methods for barium and SiO_2. Ba and SiO_2 are presented in these figures as an example of the comparison process utilized in this project. Analytical error is higher for analyses with concentrations close to the detection limit. In addition, stream-sediment samples and alluvium, such as the Orogrande standard, are very heterogeneous and difficult to completely homogenize, as shown in the analyses of samples VTM97-115s and VTM97-77s (Table VTM10-1). Although these samples are split from the same sample collected in the field, the geochemical analyses are different (Table A8.2). The NMBMMR X-ray Laboratory reanalyzed each of these samples; the results agreed with the respective results from XRAL (Table A8.2). Most variations between duplicate stream-sediment samples are probably a result of sample inhomogenities and analytical errors related to low concentrations.

Another problem encountered with stream-sediment samples, is the variability of sample collection. Only three people collected the McGregor samples using the exact procedures to avoid variations between sample collectors. In addition, two samples were collected at two separate sites to estimate sample collection variability (Table A8.2). The same person collected samples VTM97-254s and VTM97-255s; two different people collected VTM97-165s and VTM97-285s. The variability between these two sets of duplicates is within accepted error for stream-sediment samples.

Three samples of igneous rocks were analyzed for PGE by NiS fire assay methods. Fire assay methods are time consuming and expensive; therefore only one reference standard was submitted blind to XRAL (Table A8.3). The concentrations of the reference standard are higher than the values by XRAL as a result of the nugget effect, but are within acceptable error limits for the detection of PGE (Table A8.3).

Sample numbers with the appropriate analytical parameters are repeated on pages A8-3 through A8-6, A8-7 through A8-10, and A8-11 through A8-14.

Table A8.1 Analytical Quality Assurance Results.

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Unit	%	%	%	%	%	%	%	%	%	%	%	%		ppm	ppm	ppb	ppm	ppm	ppm
Detection Limit	0	0	0	0	0	0	0	0	0	0	0	0		0.5	1	1	10	20	1
Method	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	LECO		ICP	INAA	DCP	ICP	XRF	ICP
Duplicates																			
VTM97-59	26	1	35	2.7	<0.01	<0.01	3.2	0.1	0.1	0	32	0	100	<0.5	9	<1	<10	70	<1
VTM97-80	29	0.9	34	2.1	<0.01	0	3.7	0.1	0	0	30	0	100	<0.5	7	2	<10	60	<1
ORO712	6.4	0.7	50	0.4	0.2	0	1.2	0.1	0	0.2	40	0.1	100	<0.5	<1	2	<10	<50	<1
VTM97-129	6.4	0.7	50	0.4	0.2	0	1.1	0.1	0	0.2	40	0.1	99	<0.5	<1	4	<10	<50	<1
VTM97-115S	26	4.4	33	0.7	0.9	1.4	1.4	0.1	0.2	0.1	30	0	99	<0.5	3	10	<10	210	<1
VTM97-115S*	27	4.4	34	0.8	0.9	1.3	1.3	0.1	0.2	0.1	29		99		4			325	
VTM97-77S	22	2	35	4	0.1	0.5	0.9	0	0.1	0.1	35	0	100	<0.5	2	8	20	100	<1
VTM97-77S*	22	2.1	36	3.8	0.1	0.5	0.8	0	0.1	0.1	34		99		2			139	
VTM97-250c			Ca 16		Na 8500		Fe 6.77							<5	21	<10		400	
VTM97-338c			Ca 16		Na 8600		Fe 6.55							<5	22	<10		400	
VTM97-322c			Ca 6		Na 8300		Fe 3.73							<5	7	<10		1300	
VTM97-339c			Ca 7		Na 8400		Fe 3.82							<5	6	<10		1500	
VTM97-251S	22	3.1	39	0.5	0.3	0.8	1.2	0.1	0.2	0.1	33	0	100	<0.5	4	<1	<10	190	<1
VTM97-303S	21	3.2	39	0.6	0.3	0.8	1.3	0.1	0.2	0.1	33	0	100	<0.5	5	<1	<10	190	<1
VTM97-327D	75	14	0.1	0.4	2.2	5.2	0.7	0	0.1	<0.01	2.3	<0.01	100	<0.5	18	<1	<10	1600	3
VTM97-335	76	14	<0.01	0.4	2.2	5.2	0.7	0	0.1	<0.01	2.2	<0.01	100	<0.5	20	<1	20	1600	3
VTM97-308S	24	2	37	3.2	0.2	0.4	1	0	0.1	0.1	33	0	100	<0.5	4	<1	<10	110	<1
VTM97-301	21	1.6	39	3.5	0.1	0.4	1	0	0.1	0.1	34	0	100	<0.5	3	1	<10	100	<1
VTM97-317S	39	4.3	27	2.2	0.6	1.4	1.4	0	0.3	0.1	24	0	100	<0.5	5	<1	<10	300	<1
VTM97-302	37	4.1	28	2.2	0.5	1.3	1.4	0	0.3	0.1	25	0	100	<0.5	5	<1	<10	290	<1
VTM97-304S	52	7.5	17	1.6	0.9	2	2.6	0	0.4	0.1	16	0	100	<0.5	5	<1	<10	400	<1
VTM97-287S	53	7.7	16	1.5	0.9	2	2.6	0	0.4	0.1	16	0	100	<0.5	4	6	<10	440	<1
JB-IM002	6	0.1	46	5.7	<0.01	<0.01	0.4	<0.01	<0.01	<0.01	42	0	100	<0.5	1	<1	<10	<20	<1
JB-IM029	3.3	0.1	47	5.9	<0.01	<0.01	0.4	<0.01	<0.01	<0.01	43	0	100	<0.5	1	<1	<10	<20	<1
VTM97-204S	45	12	22	2.5	1.4	2.3	4.4	0.1	0.7	0.1	9.6	0.1	100	<0.5	14	1	70	410	4
VTM97-273S	44	11	23	2.6	1.4	2.1	4.5	0.1	0.6	0.2	10	0.1	100	<0.5	15	3	130	390	4
VTM97-296S-1	31	1.8	35	1.9	0.1	0.4	1.3	0	0.1	0.1	29	0	100	<0.5	3	<1	<10	60	<1
VTM97-296S-2	32	1.8	34	1.8	0.1	0.4	1.3	0	0.1	0.1	29	0	100	<0.5	3	<1	<10	60	<1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Unit	%	%	%	%	%	%	%	%	%	%	%	%		ppm	ppm	ppb	ppm	ppm	ppm
VTM97-76	30	2.3	36	0.3	0.3	0.7	1.1	0	0.2	0.1	29	0	100	<0.5	4	<1	<10	170	<1
VTM97-107S	31	2.4	35	0.3	0.3	0.7	1.1	0	0.2	0.1	29	0	100	<0.5	3	<1	<10	180	<1
VTM97-263	9.4	0.4	17	0.5	0.3	0.3	13	0	<0.01	0	8.3	5.9	55	11	5200	<1	<10	300000	4
VTM97-263-5	11	1.5	17	0.6	0.4	0.3	23	0.1	0	0	8.7	5.8	62	9.1	5600	4	<10	290000	3
VTM97-246	56	16	3.5	4.2	0.1	5.7	4.5	0	0.8	0.1	9.6	0	100	<0.5	10	3	90	470	3
VTM97-233	57	15	3.3	4.1	0.1	5.5	4.5	0	0.8	0.1	9.9	0.1	100	<0.5	10	<1	100	470	3
VTM97-138S	60	6	15	0.6	1.1	1.7	4.7	0.1	0.4	0.1	10	0	100	<0.5	7	7	<10	450	1
VTM97-126	59	6.1	15	0.7	1.1	1.7	4.3	0.1	0.3	0.1	11	0	100	<0.5	7	1	<10	460	<1
Nepheline Syenite																			
avg XRF	55	18	1.1	0.3	7.4	4.8	4.9	0.3	0.1	0.1	2.7		95		3			56	
SD XRF	0.9	0	0	0	0.1	0.3	0.1	0							2			3	
VTM97-101	58	19	1.2	0.2	7.7	5.3	5.4	0.3	0.1	0.1	2.6	<0.01	100	4.8	1	3	<10	120	14
VTM97-231	58	19	1.2	0.2	7.7	5.4	5.5	0.3	0.2	0.1	2.5	<0.01	100	4.7	3	6	<10	150	14
VTM97-337	58	19	1.1	0.2	7.8	5.5	5.4	0.3	0.2	0.1	2.5	<0.01	99	<0.5	4	<1	<10	100	14
VTM97-345	59	19	1.1	0.2	7.7	5.1	5.5	0.3	0.1	0.1	2.5	<0.01	100	<0.5	10	<1	<10	80	14
VTM97-347	58	18	2	0.2	7.6	5.1	5.4	0.3	0.1	0.1	2.8	<0.01	100	<0.5	3	<1	<10	80	11
JB-IM044	59	19	1.2	0.2	7.7	5.1	5.5	0.3	0.1	0.1	2.5	<0.01	100	<0.5	4	<1	<10	100	14
VTM97-274	59	19	1.3	0.2	7.6	5	5.5	0.3	0.1	0.1	2.6	<0.01	100	<0.5	4	3	<10	100	15
VTM97-234	59	19	1.2	0.2	7.6	5	5.5	0.3	0.1	0.1	2.5	<0.01	100	<0.5	3	<1	<10	110	14
VTM97-127	58	18	1.1	0.2	7.7	5.3	5.4	0.3	0.2	0.1	2.7	<0.01	99	<0.5	2	3	<10	100	14
avg	58	19	1.3	0.2	7.7	5.2	5.4	0.3	0.1	0.1	2.6		100	4.8	3.8	3.8		104	14
stdev	0.4	0.1	0.3	0	0.1	0.2	0	0	0	0	0.1		0.3	0.1	2.5	1.5		21	1.1
Rhyolite																			
NMR-1	71	14	1.6	0.4	3.6	4.8	2.5	0.1	0.4	0.1	0.8		100		3.9			1168	
SD	0.4	0.1	0	0	0	0	0	0	0	0					0.3			15	
VTM97-102	72	14	1.6	0.4	3.6	4.7	2.5	0.1	0.4	0.1	0.8	<0.01	100	<0.5	4	1	<10	1100	4
VTM97-344	72	14	1.6	0.4	3.6	4.7	2.5	0.1	0.4	0.1	0.9	<0.01	100	<0.5	4	<1	<10	1100	3
VTM97-349	72	14	1.7	0.4	3.6	4.6	2.5	0.1	0.4	0.1	0.9	<0.01	100	<0.5	3	2	<10	1100	3
JB-IM040	71	14	1.6	0.4	3.6	4.8	2.3	0.1	0.5	0.1	0.7	<0.01	99	<0.5	3	3	<10	1100	3
VTM97-271	72	14	1.6	0.4	3.5	4.5	2.5	0.1	0.4	0.1	0.8	<0.01	100	<0.5	3	<1	<10	1100	3
avg	72	14	1.7	0.4	3.6	4.6	2.5	0.1	0.4	0.1	0.8		100		3.4	2		1100	3.2
stdev	0.5	0.1	0.1	0	0	0.1	0.1	0	0	0	0.1		0.5		0.5	1		0	0.4
Marble																			
avg XRF							0.1	0	0				0.1						
SD XRF							0												
VTM97-103	1.2	0.3	55	0.1	0.1	0.1	0.2	<0.01	0	0	43	<0.01	100	<0.5	<1	<1	<10	<50	<1
VTM97-232	1.6	0.4	54	0.1	0.1	0.1	0.2	<0.01	0	0	43	<0.01	100	<0.5	<1	3	<10	<50	<1
JB-IM043	0.3	0.1	56	0.1	<0.01	<0.01	0	<0.01	<0.01	0	43	<0.01	100	<0.5	<1	<1	<10	<20	<1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Unit	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**		**ppm**	**ppm**	**ppb**	**ppm**	**ppm**	**ppm**
avg	1.1	0.3	55	0.1	0.1	0.1	0.1		0	0	43		100			3			
stdev	0.7	0.2	0.9	0	0	0	0.1		0	0	0		0.2						
Orogrande																			
avg XRF	54	11	11	1.2	2.6	2.2	7.2	0.1	0.4	0.2	8.1		98		12			862	
SD XRF	1.1	0	0.2	0	0	0	0.4	0	0	0					1			16	
VTM97-78	55	11	12	1.1	2.7	2.4	7.6	0.1	0.4	0.2	7.8	0.1	100	<0.5	12	14	20	730	2
VTM97-340c			13		2.6		7							<5	13	<10		800	
VTM97-336	55	10	12	1.1	2.7	2.4	7.8	0.1	0.4	0.2	7.9	0	100	<0.5	12	1	20	750	2
VTM97-348	55	10	12	1.2	2.7	2.3	7.7	0.1	0.4	0.2	8	0.1	100	<0.5	16	26	10	760	2
VTM97-342	55	10	12	1.1	2.7	2.4	7.8	0.1	0.4	0.2	8	0.1	100	<0.5	15	<1	<10	770	1
VTM97-272	55	10	12	1.2	2.6	2.4	7.7	0.1	0.4	0.2	8	0	100	<0.5	13	<1	<10	750	3
VTM97-104	55	10	13	1.1	2.6	2.4	7.7	0.1	0.4	0.2	8	0.1	100	<0.5	13	10	10	810	3
VTM97-128	55	10	12	1.2	2.6	2.2	7.8	0.1	0.4	0.2	8.1	0	100	<0.5	14	6	<10	770	2
avg	55	10	12	1.1	2.6	2.3	7.6	0.1	0.4	0.2	7.9	0	100		14	11	15	768	2.1
stdev	0.2	0.1	0.2	0	0	0.1	0.3	0	0	0	0.1	0	0.1		1.4	9.5	5.8	27	0.7
NIST2709																			
cert values	64	14	2.7	2.5	1.6	2.5	5	0.1	0.6	0.1		0.1	93	0.4	18	0.3		968	
+-	0.5	0.1	0.1	0.1	0	0.1	0.2	0	0	0		0		0	0.8			40	
VTM97-79	62	14	2.9	2.5	1.5	2.4	5	0.1	0.6	0.1	9.6	0.1	100	<0.5	16	<1	70	900	7
NIST2711																			
cert values	65	12	4	1.7	1.5	3	4.1	0.1	0.5	0.2		0		4.6	105	0		726	
+-	0.4	0.2	0.1	0.1	0	0.1	0.1	0	0	0.2		0		0.4	8			38	
VTM97-105	64	12	4.4	1.7	1.5	3	4.1	0.1	0.5	0.2	8.6	0	100	3.7	98	4	30	730	3
Basalt																			
avg XRF	51	16	8.1	6.4	3.8	1.4	11	0.2	1.6	0.3	-0.7		99		1			387	
SD XRF	0	0.2	0.1	0.2		0	0.2	0										9	
CB-1	52	17	8.3	6.3	3.7	1.3	11	0.2	1.7				101						
SD	0.9	0.5	0.1	0.5	0.1	0.1	0.3	0	0.1										
VTM97-343	51	16	8.2	6.7	3.8	1.3	11	0.2	1.6	0.3	<0.55	<0.01	101	<0.5	<1	<1	<10	400	3
VTM97-346	51	16	8.2	6.6	3.8	1.4	11	0.2	1.6	0.3	<0.6	<0.01	100	<0.5	<1	<1	<10	410	2
VTM97-341	51	16	8.3	6.8	3.7	1.3	11	0.2	1.6	0.3	<0.6	<0.01	101	<0.5	<1	<1	<10	440	<1
JB-IM041	51	16	8.4	6.7	3.7	1.3	11	0.2	1.7	0.3	<0.7	<0.01	101	<0.5	<1	<1	<10	400	3
VTM97-270	51	16	8.4	6.7	3.8	1.3	11	0.2	1.6	0.3	<0.75	<0.01	101	<0.5	<1	<1	<10	450	2
avg	51	16	8.3	6.7	3.8	1.3	11	0.2	1.6	0.3			100					420	2.5
stdev	0.4	0.1	0.1	0.1	0	0	0.1	0	0	0			0.5					23	0.6
Duplicate Sample Collected on Two Different Days																			
VTM97-165S	11	1.6	41	6	0.1	0.4	1	0	0.1	0.1	39	0	100	<0.5	4	3	<10	110	<1
VTM97-285S	19	2.3	37	5.1	0.2	0.7	1.2	0	0.2	0.1	35	0	100	<0.5	5	<1	<10	160	<1

Sample No.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	S	Total	Ag	As	Au	B	Ba	Be
Unit	%	%	%	%	%	%	%	%	%	%	%	%		ppm	ppm	ppb	ppm	ppm	ppm
VTM97-254S	53	9.2	14	1.2	1	2.3	3	0.1	0.5	0.1	16	0	100	<0.5	5	<1	20	580	<1
VTM97-255S	52	9	15	1.2	1	2.2	2.8	0	0.5	0.1	16	0	100	<0.5	5	<1	20	600	<1
Standards Analyzed by NMBMMR X-ray Laboratory																			
Orogrande std	55	11	12	1.2	2.6	2.3	7.7	0.1	0.4	0.2	8.1		100		11			852	
Orogrande std	54	11	11	1.2	2.6	2.2	7.2	0.1	0.4	0.2	8.1		98		12			880	
Orogrande std	53	11	11	1.2	2.6	2.2	6.8	0.1	0.4	0.2	8.1		96		13			854	
avg	54	11	11	1.2	2.6	2.2	7.2	0.1	0.4	0.2	8.1		98		12			862	
sd	1.1	0	0.2	0	0	0	0.4	0	0	0	0		1.7		1			16	
basalt std	51	16	8	6.3	3.8	1.4	11	0.2	1.6	0.3	-0.7		98		bd			382	
basalt std	51	16	8.1	6.6	3.8	1.4	11	0.2	1.6	0.3	-0.7		99		1			398	
avg	51	16	8.1	6.4	3.8	1.4	11	0.2	1.6	0.3	-0.7		99		1			387	
sd	0	0.2	0.1	0.2	0	0	0.2	0	0	0	0		0.3					9.2	
marble std							0.1	0	0						bd			4	
marble std							0.1	0	0						bd			8	
marble std							0.1	0	0						bd			bd	
avg							0.1	0	0									6	
sd							0	0	0									2.8	
Wnd Mt std															5			53	
Wnd Mt std	55	18	1.2	0.3	7.5	5	5	0.3	0.1	0.1	2.7		96		2			56	
Wnd Mt std	54	18	1.1	0.3	7.3	4.5	4.9	0.2	0.1	0.1	2.7		94		2			59	
avg	55	18	1.1	0.3	7.4	4.8	4.9	0.2	0.1	0.1	2.7		95		3			56	
sd	0.9	0	0	0	0.1	0.3	0.1	0	0	0	0		1.6		1.7			3	
NMR (rhyolite)	71	14	1.6	0.4	3.6	4.7	2.6	0.1	0.5	0.1	0.8		100		3			1158	
NMR (rhyolite)	71	14	1.6	0.4	3.6	4.7	2.5	0.1	0.5	0.1	0.8		100		3			1142	
NMR (rhyolite)	72	14	1.6	0.4	3.5	4.7	2.5	0.1	0.4	0.1	0.8		100		4			1154	
avg	71	14	1.6	0.4	3.6	4.7	2.5	0.1	0.4	0.1	0.8		100		3.7			1150	
sd	0.2	0	0	0	0	0	0	0	0	0	0		0.2		0.6			6.7	

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr	Ta
Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Detection Limit	3	1	1	1	2	1	0.5	10	1	2	2	1	2	2	0.2	0.5	3	10	2	1
Method	ICP	INAA	ICP	ICP	XRF	INAA	ICP	ICP	INAA	ICP	XRF	ICP	ICP	XRF	INAA	INAA	INAA	XRF	XRF	INAA
Duplicates																				
VTM97-59	<3	1	<1	4	6	<1	2.4	<10	<1	1	12	5	<2	<10	0.5	0.9	<3	<10	756	<1
VTM97-80	<3	1	<1	6	6	<1	3.4	<10	<1	1	12	5	4	<10	0.5	0.9	<3	<10	667	<1
ORO712	<3	1	<1	1	7	1	<0.5	<10	<1	<1	17	<1	15	<10	<0.2	0.5	<3	<10	635	<1
VTM97-129	<3	1	<1	3	7	<1	<0.5	<10	<1	<1	14	<1	17	<10	<0.2	0.6	<3	<10	598	<1
VTM97-115S	<3	6	<1	3	17	1	3.2	<10	4	2	24	6	7	40	0.4	1.9	<3	<10	652	1
VTM97-115S*					23		8			2	10	11	10	37					583	
VTM97-77S	<3	5	<1	3	14	1	1.7	<10	2	<1	18	4	5	24	0.2	1.6	<3	<10	336	<1
VTM97-77S*					19		5			1	bd	8	6	16					290	
VTM97-250c		<5		18	40	<2			25	<20		<200			1.3	4.8	<20			66
VTM97-338c		<5		18	50	<2			27	<20		<200			1.2	4.7	<20			4
VTM97-322c		<5		19	30	3			20	<20		<200			0.7	9.7	<20			2
VTM97-339c		<5		19	50	2			20	<20		<200			0.7	10	<20			2
VTM97-251S	<5	9	<1	5	21	1	2.2	<10	4	4	15	7	7	23	0.4	2.4	<3	<10	628	<1
VTM97-303S	<5	9	<1	7	20	1	2	<10	3	4	19	7	9	27	0.4	2.3	<3	<10	640	<1
VTM97-327D	<5	1	<1	15	<2	2	<0.5	<10	5	1	18	<1	12	171	2.1	<0.5	<3	<10	187	<1
VTM97-335	<5	<1	<1	14	<2	3	<0.5	<10	3	<1	14	2	10	162	2.1	0.5	<3	<10	175	1
VTM97-308S	<5	6	<1	5	19	1	<0.5	<10	3	3	18	4	4	25	0.3	1.7	<3	<10	247	<1
VTM97-301	<5	6	<1	4	15	1	<0.5	<10	2	3	13	4	5	18	0.3	1.7	<3	<10	253	<1
VTM97-317S	<5	6	<1	12	23	2	2.4	<10	6	2	15	6	11	40	0.5	2.8	<3	<10	233	<1
VTM97-302	<5	6	<1	7	27	2	2.9	<10	6	3	13	6	8	35	0.5	2.9	<3	<10	228	<1
VTM97-304S	<5	6	<1	7		3	6.5	<10	7	2	15	8	10	64	0.5	5.2	<3	<10	388	1
VTM97-287S	<5	5	<1	6		4	6.3	<10	7	1	19	8	7	79	0.7	5.3	<3	<10	404	<1
JB-IM002	<5	3	<1	2		<1	<0.5	<10	<1	3	19	1	<2	16	<0.2	<0.5	<3	<10	747	<1
JB-IM029	<5	3	<1	6		<1	<0.5	<10	<1	3	21	1	<2	3	<0.2	<0.5	<3	<10	734	<1
VTM97-204S	<5	3	<1	6		1	5.6	<10	7	3	27	11	10	62	0.9	7.8	<3	<10	523	2
VTM97-273S	<5	5	<1	5		1	5.6	<10	8	3	31	11	12	66	1.1	8	<3	<10	548	2
VTM97-296S-1	<5	4	<1	9	16	1	0.9	<10	1	3	12	8	6	20	0.3	1.6	<3	<10	219	<1
VTM97-296S-2	<5	5	<1	4		1	<0.5	<10	2	3	13	4	<2	9	0.3	1.7	<3	<10	225	<1
VTM97-76	<5	5	<1	4	12	1	<0.5	<10	3	2	14	4	7	11	0.4	2.1	<3	<10	292	<1
VTM97-107S	<5	5	<1	5	11	1	0.7	<10	2	1	14	4	7	16	0.3	2.2	<3	<10	287	<1
VTM97-263	8	3	24	14	26	<1	15	<10	<1	370	72	46	9500	66	560	1.5	<3	<10	116	<2
VTM97-263-5	10	5	26	11	<20	<1	19	<10	<1	410	7	43	7700	43	770	1.9	<3	<10	120	<1
VTM97-246	<5	4	<1	11	77	19	19	<10	5	17	15	40	31	212	2	15	<3	<10	85	1
VTM97-233	<5	6	<1	11	77	19	19	<10	5	16	16	42	31	211	2	16	<3	<10	81	1

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr	Ta
Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-138S	<5	3	<1	9	23	1	23	<10	9	2	350	7	18	53	0.6	3	<3	<10	198	<1
VTM97-126	<5	3	<1	9	23	2	22	<10	8	2	15	6	16	55	0.6	3	<3	<10	208	<1
Nepheline Syenite																				
avg XRF					9		5			12	166	3	19	160					37	
SD XRF					5		0.6			0.6	1	0.6	0.6							
VTM97-101	<3	2	<1	7	7	3	1.7	<10	33	5	150	<1	4	163	0.3	1.4	<3	<10	65	13
VTM97-231	<3	<1	<1	8	<2	4	1.9	<10	35	5	150	<1	6	168	0.3	1.3	<3	<10	74	12
VTM97-337	<5	<1	<1	8	10	3	<0.5	<10	31	6	150	<1	<2	161	0.6	1.3	<3	<10	68	11
VTM97-345	<5	3	<1	7	<2	5	<0.5	<10	68	6	150	<1	<2	159	0.8	2.6	<3	<10	65	22
VTM97-347	<5	1	<1	8	<2	4	<0.5	<10	32	7	150	<1	<2	152	<0.2	1.4	<3	<10	66	13
JB-IM044	<5	2	<1	8		4	<0.5	<10	32	5	150	<1	<2	155	0.4	1.3	<3	<10	68	13
VTM97-274	<5	1	<1	8		3	<0.5	<10	30	5	160	<1	<2	154	0.5	1.3	<3	<10	67	12
VTM97-234	5	1	<1	7	<2	3	0.6	<10	31	5	150	<1	<2	146	0.5	1.3	<3	<10	65	12
VTM97-127	<5	2	<1	8	<2	3	<0.5	<10	31	6	150	<1	<2	155	0.5	1.2	<3	<10	63	13
avg	5	1.7		7.7	8.5	3.6	1.4		36	5.6	151		5	157	0.5	1.5			67	13
stdev		0.8		0.5	2.1	0.7	0.7		12	0.7	3.3		1.4	6.5	0.2	0.4			3.2	3.3
Rhyolite																				
NMR-1					15		9.4			2.4	22	6.7	19	153					295	
SD					7.1		0.9			1.4	1.8	0.8	1.2	0.9					1.3	
VTM97-102	<3	1	<1	12	3	2	6.7	<10	6	<1	24	3	18	158	0.3	4.8	<3	<10	306	1
VTM97-344	<5	2	<1	13	<2	3	4.3	<10	6	<1	20	3	21	155	0.4	4.5	<3	<10	293	2
VTM97-349	<5	2	<1	12	5	4	4.2	<10	6	<1	21	3	21	149	0.4	4.7	<3	<10	293	1
JB-IM040	<5	1	<1	11		3	3.6	<10	6	<1	23	3	14	157	0.3	4.5	<3	<10	299	2
VTM97-271	<5	2	<1	13	3	3	4.2	<10	7	<1	22	3	19	146	0.2	4.8	<3	<10	299	2
avg		1.6		12	3.7	3	4.6		6.2		22	3	19	153	0.3	4.7			298	1.6
stdev		0.5		0.8	1.2	0.7	1.2		0.4		1.6	0	2.9	5.2	0.1	0.2			5.4	0.5
Marble																				
avg XRF																				
SD XRF																				
VTM97-103	<3	1	<1	2	<2	<1	<0.5	<10	<1	<1	20	2	<2	<10	<0.2	<0.5	<3	<10	94	<1
VTM97-232	<3	<1	<1	2	3	<1	<0.5	<10	<1	<1	19	2	<2	<10	<0.2	<0.5	<3	<10	90	<1
JB-IM043	<5	2	<1	2		<1	<0.5	<10	<1	2	17	1	<2	<2	<0.2	<0.5	<3	<10	80	<1
avg		1.5		2	3					2	19	1.7							88	
stdev		0.7		0							1.5	0.6							7.2	
Orogrande																				
avg XRF					41		126			3	8	14	15	65					416	
SD XRF					3		0.6			0.6	0.6	0.6	0.6	1					4	
VTM97-78	<3	2	<1	13	29	2	119	<10	6	2	12	11	14	65	0.8	4.8	<3	<10	401	1
VTM97-340c		<5		17	20	<2			6	<20		<200			0.6	4.7	<20			<1
VTM97-336	<5	2	<1	13	29	2	117	<10	5	4	11	11	21	60	0.7	4.7	<3	<10	384	1
VTM97-348	<5	3	<1	11	47	2	109	<10	6	3	13	9	21	73	1	5.1	<3	<10	390	<1
VTM97-342	<5	2	<1	12		2	118	<10	6	4	13	10	14	67	0.7	5	<3	<10	399	<1
VTM97-272	<5	3	<1	13		2	101	<10	6	3	15	9	13	67	0.8	5	<3	<10	400	<1
VTM97-104	<5	2	<1	12	28	2	115	<10	6	3	13	10	22	61	0.7	4.9	<3	<10	391	1

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr	Ta
Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VTM97-128	<5	3	<1	12	26	1	119	<10	6	3	12	10	20	63	0.8	4.8	<3	<10	400	1
avg		2.4		13	30	1.9	114		5.9	3.1	13	10	18	65	0.8	4.9			395	1
stdev		0.5		1.8	9.1	0.4	6.7		0.4	0.7	1.3	0.8	4	4.4	0.1	0.1			6.6	0
NIST2709																				
cert values			0.4	13	130	5.3	35		3.7	2		88	19	96	7.9	12	1.6		231	
+-			0	0.7	4		0.7					5	0.5		0.6		0.1		2	
VTM97-79	<3	7	<1	10	125	6	29	<10	4	1	13	68	16	99	9	12	<3	<10	234	<1
NIST2711																				
cert values		5	42	10	47		114		7.3	1.6		21	1162	110	19	9	1.5		245	
+-			0.3				2					1.1	31		1.8		0.1		0.7	
VTM97-105	6	6	35	8	44	7	99	<10	8	2	19	16	990	112	21	9.1	<3	<10	239	1
Basalt																				
avg XRF					189		48			2	23	73	3	23					461	
SD XRF					8		1			0.7		2	0.6						1	
CB-1																				
SD																				
VTM97-343	6	<1	<1	40	190	<1	31	<10	4	1	22	76	20	34	<0.2	22	<3	<10	446	2
VTM97-346	8	1	<1	41	210	<1	35	<10	4	1	22	74	19	27	<0.2	22	<3	<10	441	2
VTM97-341	<5	1	<1	37		1	31	<10	4	1	23	69	12	32	<0.2	22	<3	<10	448	1
JB-IM041	<5	<1	<1	36		<1	31	<10	4	2	24	66	11	31	<0.2	22	<3	<10	462	1
VTM97-270	14	1	<1	39	174	<1	35	<10	4	2	23	70	17	31	<0.2	23	<3	<10	455	1
avg	9.3	1		39	191	1	33		4	1.4	23	71	16	31		22			450	1.4
stdev	4.2			2.1	18		2.3		0	0.5	0.8	4	4.1	2.5		0.7			8.2	0.5
VTM97-165S	<5	5	<1	3	12	<1	3.9	<10	1	3	24	4	2	14	0.2	1.9	<3	<10	219	<1
VTM97-285S	<5	5	<1	5	14	1	<0.5	<10	3	3	14	4	<2	11	0.3	2.4	<3	<10	195	<1
VTM97-254S	<5	8	<1	10	30	4	9.5	<10	8	<1	14	12	16	76	0.7	6	<3	<10	221	<1
VTM97-255S	<5	7	<1	10	37	4	8.8	<10	8	2	18	11	13	73	0.7	5.9	<3	<10	245	1
NMBMMR XRF																				
Orogrande std					39		126			4	9	14	15	64					412	
Orogrande std					40		125			3	8	15	15	66					418	
Orogrande std					45		126			3	8	14	14	65					418	
avg					41		126			3.3	8.3	14	15	65					416	
sd					3.2		0.6			0.6	0.6	0.6	0.6	1					3.5	
basalt std					189		47			bd	23	71	4	23					461	
basalt std					182		48			2	23	73	3	23					463	
basalt std					198		49			1	23	74	3	23					461	
avg					190		48			1.5	23	73	3.3	23					462	
sd					8		1			0.7	0	1.5	0.6	0					1.2	
limestone					7		4			bd	bd	5	bd	bd					79	
limestone					7		4			bd	bd	5	2	bd					79	
limestone					5		nd			bd	bd	5	bd	bd					80	
avg					6.3		4					5	2						79	
sd					1.2		0												0.6	
Wnd Mt					12		5			12	167	3	20	160					37	
Wnd Mt					bd		4			11	165	3	19	160					37	

Sample No.	Bi	Br	Cd	Co	Cr	Cs	Cu	Ge	Hf	Mo	Nb	Ni	Pb	Rb	Sb	Sc	Se	Sn	Sr	Ta
Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Wnd Mt					5		5			12	167	4	19	160					37	
avg					8.5		4.7			12	166	3.3	19	160					37	
sd					4.9		0.6			0.6	1.2	0.6	0.6	0					0	
NMR (rhyolite)					8		10			2	20	7	20	154					292	
NMR (rhyolite)					5		8			2	20	7	21	153					293	
NMR (rhyolite)					6		9			1	20	7	20	153					292	
NMR (rhyolite)					8		8			2	19	8	20	152					290	
avg					6.3		8.3			1.7	20	7.3	20	153					292	
sd					1.5		0.6			0.6	0.6	0.6	0.6	0.6					1.5	

Sample No.	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg	Ir
Units	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppb**	**ppb**	**ppm**	**ppb**
Detection Limit	1	0.5	10	3	2	0.5	2	0.5	3	5	0.1	0.2	0.5	0.2	0.1	10	1	1	
Method	INAA	INAA	ICP	INAA	XRF	ICP	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	DCP	DCP	ICP	
Duplicates																			
VTM97-59	<1	1.4	40	38	17	12	<10	6	10	<5	0.6	0.2	<0.5	0.3	<0.05	<10	<1	<1	
VTM97-80	<1	1.6	40	48	15	8.2	13	4.7	9	<5	0.6	0.2	<0.5	0.2	<0.05	<10	1	<1	
ORO712	<1	0.5	<10	8	21	6	<10	4.5	9	<5	1.2	<0.2	<0.5	0.4	<0.05	10	<1	<1	
VTM97-129	<1	0.8	<10	19	11	6.5	<10	5	12	5	1.1	<0.2	<0.5	0.6	0.1	<10	<1	<1	
VTM97-115S	4	3.4	10	10	34	21	170	22	41	16	3.1	0.7	<0.5	1.5	0.2	<10	3	<1	
VTM97-115S*	7	4	25		16	31	167												
VTM97-77S	2	1.8	10	31	26	15	64	9.2	17	8	1.4	0.4	<0.5	0.6	0.1	<10	3	<1	
VTM97-77S*	3	2	19		8	25	69												
VTM97-250c	8.6	4.6		40		<200		39	73	30	5.1	1.3	<2	3.4	0.6			<5	<50
VTM97-338c	9	5.2		60		<200		39	71	30	5.3	1.2	<2	3.2	0.5			<5	<50
VTM97-322c	13	5		50		<200		36	73	30	7.1	1.4	<2	6	0.9			<5	<50
VTM97-339c	14	5.1		40		<200		39	79	30	7.4	1.4	2	6.8	1			<5	<50
VTM97-251S	4	2.3	10	19	22	21	61	24	45	20	3.7	0.9	0.5	1.3	0.2	<10	<1	<1	
VTM97-303S	4	2.3	10	32	27	20	69	24	44	21	3.7	0.7	0.5	1.4	0.2	<10	<1	<1	
VTM97-327D	5	3.1	<10	140	24	19	130	11	17	5	0.9	0.3	<0.5	1	0.2	<10	<1	<1	
VTM97-335	6	3.3	<10	130	18	19	130	11	18	6	0.9	<0.2	<0.5	1.2	0.2	<10	<1	<1	
VTM97-308S	2	2	10	38	18	24	57	12	21	10	1.9	0.4	<0.5	0.9	0.1	<10	<1	<1	
VTM97-301	2	2	<10	37	13	24	33	11	22	10	1.9	0.4	<0.5	0.8	0.1	<10	<1	1	
VTM97-317S	4	2.3	30	52	17	21	170	15	29	11	2.2	0.4	<0.5	1.2	0.2	<10	<1	<1	
VTM97-302	4	2.4	20	47	15	24	150	16	30	14	2.3	0.5	<0.5	1.3	0.2	<10	1	<1	
VTM97-304S	6	2.4	30	32	26	32	240	24	46	20	3.6	0.7	0.5	1.8	0.3	<10	<1	<1	
VTM97-287S	6	2.6	40	17	30	31	250	25	48	20	3.7	0.8	0.5	1.7	0.3	<10	2	<1	
JB-IM002	<1	1.4	<10	28	10	9.2	<2	0.7	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1	
JB-IM029	<1	1.4	<10	30	6	11	<2	0.6	<3	<5	0.1	<0.2	<0.5	<0.2	<0.05	<10	<1	<1	
VTM97-204S	9	5	90	30	35	43	180	42	77	32	5.3	1.2	0.7	2.4	0.4	<10	<1	<1	
VTM97-273S	9	5.4	80	25	38	49	190	46	78	31	5.3	1.2	0.8	2.5	0.4	<10	3	<1	
VTM97-296S-1	1	2.1	10	29	13	18	41	9.5	18	8	1.6	0.4	<0.5	0.7	0.1	<10	<1	<1	
VTM97-296S-2	2	2.1	10	27	13	16	45	9.7	18	9	1.7	0.4	<0.5	0.8	12	<10	<1	<1	
VTM97-76	2	1	10	16	18	11	64	17	33	14	2.6	0.6	<0.5	1.2	0.2	<10	<1	<1	
VTM97-107S	2	0.9	<10	23	18	12	74	17	31	14	2.6	0.4	<0.5	1.2	0.2	<10	<1	<1	
VTM97-263	<1	5	<10	23	75	7700	230	31	38	10	1	1.1	<0.5	1.4	0.1	<10	1	3	
VTM97-263-5	<1	4.3	20	33	16	6700	7	36	40	11	1.2	1.1	<0.5	0.8	<0.05	<10	2	<1	
VTM97-246	11	11	130	18	32	46	180	37	66	25	4.3	0.7	0.6	2.6	0.4	<10	4	<1	
VTM97-233	12	11	130	14	34	64	180	38	68	25	4.5	0.8	0.5	2.5	0.4	<10	1	<1	

Sample No.	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg	Ir
Units	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppb**	**ppb**	**ppm**	**ppb**
VTM97-138S	5	2.5	40	61	26	38	280	22	40	17	2.9	0.9	<0.5	1.5	0.3	<10	3	<1	
VTM97-126	7	2.5	20	65	28	33	270	25	44	13	2.8	0.6	0.5	1.7	0.3	<10	2	<1	
Nepheline Syenite																			
avg XRF	27	9			41	153	1359												
SD XRF	0.6					2	8												
VTM97-101	26	7.6	<10	27	61	140	1300	118	195	59	8.2	0.7	0.9	5.6	0.9	30	<1	<1	
VTM97-231	26	11	<10	32	64	130	1300	125	218	70	10	1.4	1.6	5.7	0.8	<10	<1	<1	
VTM97-337	22	7.9	<10	29	56	150	1200	114	184	56	7.7	0.9	0.5	5	0.9	<10	1	<1	
VTM97-345	47	14	<10	63	56	150	1300	229	368	112	16	1.5	1.6	9.9	1.7	<10	<1	<1	
VTM97-347	26	10	<1	35	53	150	1200	123	201	59	8.2	1.2	0.8	5.7	1	<10	<1	1	
JB-IM044	25	11	<10	30	55	150	1300	116	184	55	7.8	0.7	1.1	5.5	0.9	<10	<1	<1	
VTM97-274	23	8.4	<10	25	58	140	1300	109	178	51	7.2	1.1	0.8	5	0.9	<10	1	1	
VTM97-234	24	8.7	<10	31	55	130	1300	111	174	53	7.3	0.9	0.8	5	0.9	<10	1	<1	
VTM97-127	24	9.5	<10	28	53	140	1200	111	179	54	7.4	0.7	0.9	5	0.9	<10	3	<1	
avg	27	9.8		33	57	142	1267	128	209	63	8.9	1	1	5.8	1	30	1.5	1	
stdev	7.6	2		12	3.7	8.3	50	38	61	19	2.8	0.3	0.4	1.6	0.3		1	0	
Rhyolite																			
NMR-1	13	3.4	25		31	48	187												
SD	0.7	0.4	1		2.5	0.4	3.9												
VTM97-102	15	3.4	30	81	41	83	200	53	96	34	5.6	1.1	0.8	2.9	0.4	<10	<1	<1	
VTM97-344	14	3	30	78	36	48	240	51	91	31	5.1	0.8	0.6	2.7	0.4	<10	<1	<1	
VTM97-349	15	3.8	20	84	34	45	240	53	91	35	5.2	1.8	0.5	3	0.5	<10	<1	<1	
JB-IM040	14	3.3	20	79	38	43	240	51	88	31	5.1	0.9	0.8	2.9	0.4	<10	2	<1	
VTM97-271	16	3.8	10	84	37	44	250	55	95	35	5.8	1.1	0.8	3.1	0.5	<10	<1	<1	
avg	15	3.5	22	81	37	53	234	52	92	33	5.4	1.1	0.7	2.9	0.4		2		
stdev	0.8	0.3	8.4	2.8	2.6	17	19	1.7	3.3	2	0.3	0.4	0.1	0.1	0				
Marble																			
avg XRF																			
SD XRF																			
VTM97-103	<1	<0.5	<10	3	23	16	<10	3.4	5	<5	0.5	0.2	<0.5	0.3	0.1	<10	<1	<1	
VTM97-232	<1	<0.5	<10	4	14	4.9	<10	3.5	6	<5	0.6	<0.2	<0.5	0.2	<0.05	<10	<1	<1	
JB-IM043	<1	<0.5	<10	3	11	4.8	<2	3.5	4	<5	0.5	<0.2	<0.5	0.3	<0.05	<10	1	1	
avg				3.3	16	8.6		3.5	5		0.5	0.2		0.3	0.1		1	1	
stdev				0.6	6.2	6.4		0.1	1		0.1			0.1					
Orogrande																			
avg XRF	10	4	75		23	47	192												
SD XRF	0.6	1	1		0.6	0.6	6												
VTM97-78	7	4.1	70	36	32	25	200	34	61	24	4.2	1	0.5	2.1	0.3	<10	1	<1	
VTM97-340c	7.7	4		30		<200		34	63	20	3.8	1.2	<2	2	0.3			<5	<50
VTM97-336	7	3.9	70	31	26	37	200	36	64	23	3.9	1	<0.5	1.7	0.3	<10	1	<1	
VTM97-348	8	4.6	50	32	28	35	210	40	70	27	4.2	1.3	0.5	2.3	0.4	<10	1	<1	
VTM97-342	8	4	60	32	31	35	200	34	61	23	4.1	1	0.5	1.9	0.3	<10	<1	1	
VTM97-272	8	4.2	70	34	31	33	210	39	68	25	4.3	1.1	0.5	2	0.3	<10	1	<1	
VTM97-104	8	4.3	60	34	28	37	190	38	68	26	4.2	1	0.5	2	0.3	<10	2	<1	

Sample No.	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg	Ir
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm	ppb
VTM97-128	7	3.8	70	31	29	33	200	36	63	23	3.9	1	0.6	1.9	0.3	<10	3	<1	
avg	7.6	4.1	64	33	29	34	201	36	65	24	4.1	1.1	0.5	2	0.3		1.5	1	
stdev	0.5	0.3	7.9	2	2.1	4.1	6.9	2.3	3.5	2.2	0.2	0.1	0	0.2	0		0.8		
NIST2709																			
cert values	11	3	112	2		106	160	23	42	19	3.8	0.9		1.6				1.4	
+-			5			3												0.1	
VTM97-79	10	3	110	<3	28	78	160	23	45	18	3.5	0.8	<0.5	1.6	0.2	<10	1	<1	
NIST2711																			
cert values	14	2.6	82	3	25	350	230	40	69	31	5.9	1.1		2.7					
+-			2.9			4.8													
VTM97-105	13	2.7	70	3	39	290	300	37	73	29	5.5	1.1	0.7	3	0.5	<10	2	<1	
Basalt																			
avg XRF	3	1	153		28	91	163												
SD XRF	0.6	0.6	3		0.6		0.6												
CB-1																			
SD																			
VTM97-343	2	0.6	180	17	27	88	140	20	40	21	4.2	1.6	0.5	1.9	0.3	<10	<1	1	
VTM97-346	3	0.7	160	18	29	91	150	22	43	20	4.5	1.4	0.7	2.1	0.3	<10	<1	1	
VTM97-341	2	0.7	140	18	28	84	150	21	44	22	4.5	1.4	0.5	2	0.3	<10	<1	<1	
JB-IM041	2	<0.5	190	16	32	82	150	21	42	21	4.3	1.3	0.7	2	0.3	<10	<1	1	
VTM97-270	3	0.8	160	20	30	86	150	22	45	21	4.8	1.6	0.8	2.2	0.3	<10	<1	<1	
avg	2.4	0.7	166	18	29	86	148	21	43	21	4.5	1.5	0.6	2	0.3			1	
stdev	0.5	0.1	19	1.5	1.9	3.5	4.5	0.8	1.9	0.7	0.2	0.1	0.1	0.1	0			0	
VTM97-165S	2	2.5	<10	19	15	14	15	10	20	9	1.9	0.4	<0.5	0.8	0.1	<10	4	<1	
VTM97-285S	2	2.9	10	40	14	13	51	12	23	11	2.2	0.5	<0.5	0.9	0.1	<10	<1	<1	
VTM97-254S	8	1.8	40	16	28	46	240	27	53	21	3.9	0.9	<0.5	1.9	0.3	<10	4	<1	
VTM97-255S	8	2.3	50	14	30	43	250	26	51	20	3.7	0.8	<0.5	2.2	0.3	<10	2	<1	
NMBMMR XRF																			
Orogrande std	9	3	74		23	47	199												
Orogrande std	10	4	76		23	46	190												
Orogrande std	10	5	74		22	47	188												
avg	9.7	4	75		23	47	192												
sd	0.6	1	1.2		0.6	0.6	5.9												
basalt std	3	1	157		28	91	164												
basalt std	2	1	151		27	91	163												
basalt std	3	2	151		28	91	163												
avg	2.7	1.3	153		28	91	163												
sd	0.6	0.6	3.5		0.6	0	0.6												
limestone std	bd	1	bd		6	12	bd												
limestone std	bd	1	bd		6	13	4												
limestone std	bd	bd	bd		7	12	4												
avg		1			6.3	12	4												
sd		0			0.6	0.6	0												
Wnd Mt std	27	9	bd		41	155	1369												
Wnd Mt std	27	9	bd		41	152	1357												

Sample No.	Th	U	V	W	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Pt	Pd	Hg	Ir
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppm	ppb
Wnd Mt std	28	9	bd		41	153	1352												
avg	27	9			41	153	1359												
sd	0.6	0			0	1.5	8.7												
NMR (rhyolite)	16	3	20		28	47	187												
NMR (rhyolite)	17	3	26		29	47	189												
NMR (rhyolite)	18	3	25		28	47	187												
NMR (rhyolite)	17	4	23		28	48	187												
avg	17	3.3	25		28	47	188												
sd	0.6	0.6	1.5		0.6	0.6	1.2												

Table A8.2 Selected Geochemical Analyses of Two Sets of Sample Pairs Collected at the Same Sites and Treated as Separate Samples.[1]

Sample	SiO_2 (%)	AL_2O_3 (%)	CaO (%)	MgO (%)	Na_2O (%)	Ba (ppm)	Cu (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Zn ppm)	Zr (ppm)	La (ppm)	Ce (ppm)
VTM97-165S	11.4	1.62	41	5.95	0.07	110	3.9	24	4	2	14	15	10.3	20
VTM97-285S	19.2	2.33	36.7	5.05	0.18	160	<0.5	14	4	<2	13	51	12.1	23
VTM97-254S	53.1	9.2	14	1.16	0.95	580	9.5	14	12	16	46	240	27.4	53
VTM97-255S	51.8	9.0	15.1	1.18	1.01	600	8.8	18	11	13	43	250	25.6	51

[1] Sample VTM97-165s and VTM97-285s are from the same site and VTM97-254s and VTM97-255s are from another site. Major elements are in percent and trace elements are in parts per million. Additional data are in Appendix 5.

Table A8.3 Platinum Group Elements (PGE) Analyses.[1]

Sample	Au	Os	Ir	Ru	Rh	Pt	Pd	Re
VMT97-275	150	7	19	9	45	550	330	11
Certified Value	182 (±0.4)	—	—	—	82	586 (±0.5)	792 (±2)	—

[1] In parts per billion (ppb). Sample VTM97-275 is a split of the Canadian standard reference material B, nickel-copper matte standard (Mcadam et al. 1971) by NiS fusion fire assay.

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APPENDIX 9:

NURE GEOCHEMICAL DATA

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NURE GEOCHEMICAL DATA

Geochemical data were collected as part of the National Uranium Resource Evaluation (NURE) program for detailed uranium exploration (Union Carbide Corp. 1981a, 1981b) and are presented in this section. The data presented are for stream-sediment samples collected within the Carlsbad and Las Cruces 1° x 2° quadrangles. Approximately 300 samples were collected within the McGregor Range. The NURE data are summarized in Tables A9.1a and A9.1b. All analyses are in parts per million (ppm).

The NURE sediment samples consist of eight types: dry and wet stream sediments, dry and wet natural-pond sediments, dry and wet-artificial pond sediments and dry and wet spring sediments. Only dry and wet sediments were evaluated for this report. All sediment samples were dried and sieved to minus 100 mesh (0.15 mm). The samples were analyzed by Oak Ridge National Laboratory by plasma source emission spectrometry using partial extraction techniques (Cagle 1977; Arendt et al. 1979). Therefore, because of different size fractions and analytical techniques, the NURE data set can not be combined with the McGregor data set.

Sample numbers with the appropriate analytical parameters are repeated on pages A9-2 through A9-9 and A9-10 through A9-17.

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7010978	32.6497	106.0036	<2	41100	13	522	1	27000	48	4	16	12	11700	15	17500
7011011	32.6111	106.0094	<2	49000	24	515	1	27700	44	5	26	15	16900	<15	14400
7011017	32.5728	106.0164	<2	37300	15	515	1	4900	53	4	19	8	16100	<15	10000
7011018	32.5586	106.0192	<2	37300	<10	530	1	4500	44	<4	18	11	15100	<15	10800
7011019	32.5444	106.0233	<2	42400	<10	488	1	27400	42	4	22	9	18400	<15	9700
7011020	32.5303	106.0281	<2	37300	<10	531	1	18000	34	<4	17	11	14100	<15	10100
7011021	32.5303	106.0086	<2	39100	11	537	1	7500	39	4	18	8	17000	<15	10500
7011022	32.5156	106.0342	<2	42100	16	518	1	11900	41	4	21	11	18700	<15	10000
7011023	32.5006	106.0408	<2	49100	18	517	1	5300	38	5	28	11	24100	58	10200
7011027	32.0833	106.1206	<2	45500	11	574	1	34800	33	<4	17	8	13200	<15	17900
7011028	32.0883	106.1031	<2	47400	10	590	1	33200	44	4	19	11	14900	<15	17100
7011029	32.0889	106.0872	<2	49700	15	555	1	49600	44	<4	20	13	15700	<15	18100
7011030	32.0883	106.0744	<2	46100	12	557	1	47600	48	4	20	11	16000	<15	15700
7011031	32.0964	106.0653	<2	48500	12	568	1	25700	43	4	21	12	19700	<15	18900
7011032	32.1006	106.0519	<2	45900	<10	569	1	18900	49	4	19	10	18200	<15	17900
7011033	32.1047	106.0431	<2	48000	12	544	1	31800	34	4	19	11	15100	<15	18900
7011034	32.1133	106.0244	<2	51800	13	567	1	37000	54	5	25	15	17800	15	17400
7011035	32.1219	106.0183	<2	55100	18	539	1	50000	45	5	27	21	19100	<15	18000
7011036	32.0675	106.0306	<2	42800	20	548	1	17700	44	5	32	11	24800	15	11800
7011037	32.0572	106.0258	<2	37300	20	499	1	55800	67	10	34	15	54600	<15	9800
7011038	32.0569	106.0269	<2	41100	21	519	1	61800	41	4	24	14	20900	<15	11000
7011039	32.0833	106.0867	<2	45600	23	513	1	55400	40	5	26	16	19400	<15	11700
7011040	32.0686	106.0869	<2	37700	16	542	1	23600	39	<4	24	11	17200	<15	10100
7011041	32.0572	106.0875	<2	38500	14	536	1	27600	35	<4	25	11	18600	<15	11200
7011043	32.0328	106.0778	<2	34600	19	468	1	92400	30	4	22	14	14500	<15	9400
7011045	32.0528	106.1153	<2	40900	10	590	1	17400	31	<4	17	9	14000	<15	15800
7011046	32.1281	106.0778	<2	43100	19	559	1	24400	37	4	23	12	17200	<15	13000
7011048	32.1575	106.0778	<2	40900	17	552	1	12400	37	4	25	12	19200	<15	13600
7011050	32.1689	106.0900	<2	52000	31	514	2	34900	42	5	32	16	20900	<15	12600
7011051	32.1453	106.0922	<2	39300	14	569	1	10600	37	4	24	9	16500	<15	11700
7011052	32.1331	106.1014	<2	46000	<10	577	1	6500	58	4	22	9	20500	<15	15500
7011053	32.1678	106.1231	<2	48300	11	551	1	59500	47	5	25	14	18800	<15	13400
7011054	32.1811	106.1017	<2	45100	12	590	1	5600	48	<4	20	10	15900	<15	15400
7011056	32.1978	106.0739	<2	43100	10	558	1	40800	38	<4	21	8	14300	<15	15000
7011057	32.2083	106.0639	<2	49700	14	570	1	19700	59	6	27	13	20800	<15	14500
7011058	32.2147	106.0531	<2	43600	12	597	1	17300	30	<4	16	8	13300	<15	16300
7011059	32.2128	106.0325	<2	45900	13	591	1	15400	45	4	20	10	15700	<15	15200
7011060	32.2031	106.0211	<2	54400	11	593	1	30000	50	5	26	15	18400	<15	16400
7011061	32.1944	106.0100	<2	47100	19	532	1	51100	43	5	26	12	16700	<15	14100
7011062	32.2292	106.0511	<2	47400	15	586	1	17800	41	5	22	11	16800	<15	15700
7011063	32.2411	106.0567	<2	43500	13	540	1	33400	46	5	22	11	22300	<15	14600
7011064	32.2408	106.0922	<2	43400	12	570	1	6500	44	4	20	10	18800	<15	16400
7011065	32.2306	106.1150	<2	50400	13	569	1	6300	50	4	26	10	21000	<15	16500
7011066	32.2261	106.1261	<2	39700	<10	546	1	11500	53	5	20	8	19000	<15	14500
7011067	32.2178	106.1403	<2	48100	15	585	1	10100	40	4	19	8	15000	<15	16400
7011068	32.2106	106.1567	<2	44100	11	563	1	13100	39	<4	16	26	13400	<15	16700

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7011069	32.2036	106.1731	<2	48500	13	537	1	31600	49	5	22	13	17200	<15	15600
7011070	32.2067	106.1897	<2	45900	16	601	1	25000	46	4	19	16	16200	<15	16500
7011071	32.2192	106.1853	<2	50900	15	592	1	19500	37	4	22	12	17300	<15	18800
7011072	32.2292	106.1764	<2	50800	15	571	1	8800	47	4	22	10	19000	16	18200
7011073	32.2425	106.1708	<2	46300	13	600	1	5300	42	<4	16	7	12400	<15	18500
7011074	32.1961	106.2006	<2	59900	15	762	1	17300	59	4	25	17	19800	<15	20200
7011075	32.1828	106.2067	<2	54500	18	578	1	29300	47	5	27	15	20200	<15	12800
7011076	32.1717	106.2156	<2	41700	12	553	1	40100	36	4	19	10	16600	<15	11700
7011077	32.1603	106.2206	<2	41400	12	932	1	40500	44	5	22	11	20100	<15	10900
7011078	32.1492	106.2306	<2	40600	13	542	1	38100	38	4	21	8	19600	<15	10800
7011079	32.1381	106.2344	<2	40900	17	565	1	23100	43	5	21	11	20000	<15	11700
7011080	32.1314	106.2231	<2	42200	<10	542	1	13900	45	4	24	11	22300	<15	11600
7011081	32.1256	106.2453	<2	44700	11	548	1	13000	57	5	28	11	23900	<15	11400
7011082	32.1258	106.2111	<2	47900	13	570	1	6400	39	4	23	10	18900	<15	12500
7011083	32.1431	106.1836	<2	39700	12	550	1	16500	36	<4	18	8	15600	<15	11300
7011084	32.1531	106.1683	<2	43000	15	545	1	20700	38	4	22	10	18500	<15	10800
7011085	32.1561	106.1578	<2	44500	18	587	1	18600	51	5	24	11	20300	<15	10400
7011086	32.0800	106.2000	<2	42500	12	587	1	13000	39	<4	21	9	18200	<15	11500
7011087	32.0789	106.2208	<2	39000	11	574	1	19600	37	4	20	8	18900	<15	10600
7011088	32.0778	106.2411	<2	40300	<10	595	1	21900	39	<4	18	10	16800	17	11100
7011089	32.0633	106.2217	<2	44500	13	563	1	6900	33	4	22	11	18000	<15	11500
7011090	32.0483	106.2186	<2	28800	<10	374	1	5200	34	<4	15	7	14100	<15	7800
7011091	32.0392	106.2292	<2	44300	<10	562	1	5900	45	5	22	11	19300	<15	10900
7011092	32.0322	106.2489	<2	44600	11	550	1	16400	50	6	29	13	24500	<15	10600
7011093	32.0300	106.2108	<2	44300	<10	565	1	27600	41	4	21	10	17300	<15	10400
7011094	32.0139	106.2083	<2	39300	<10	551	1	4700	30	<4	17	10	16900	<15	10500
7011095	32.0275	106.1886	<2	41100	<10	554	1	19300	47	5	21	9	19500	<15	10500
7011096	32.0275	106.1672	<2	41400	<10	542	1	21300	54	6	25	10	21400	<15	10300
7011097	32.0275	106.1506	<2	40600	<10	563	1	10700	45	5	24	11	21200	<15	10500
7011098	32.0136	106.1419	<2	41400	<10	547	1	6300	51	6	23	8	27200	<15	9400
7011099	32.0419	106.1458	<2	45900	<10	621	1	6900	40	<4	16	8	14700	<15	13400
7011100	32.0544	106.1356	<2	39100	<10	594	1	4000	22	<4	10	6	8200	<15	13900
7011101	32.0686	106.1442	<2	40100	<10	570	1	15100	35	4	17	13	15900	<15	12500
7011102	32.0819	106.1492	<2	45100	<10	582	1	5500	38	4	23	8	21400	<15	13400
7011103	32.0961	106.1556	<2	45400	<10	565	1	9500	58	5	28	11	26800	<15	12800
7011104	32.1086	106.1658	<2	45800	<10	567	1	26400	45	4	22	12	18500	17	13100
7011105	32.1206	106.1544	<2	47700	<10	572	1	7900	42	4	23	11	19900	18	14200
7011106	32.1150	106.1428	<2	43100	<10	583	1	9200	44	4	22	10	21900	<15	13200
7011107	32.1006	106.1411	<2	48700	11	536	1	92000	47	6	30	19	20100	<15	10800
7011108	32.0850	106.1386	<2	44400	<10	594	1	40700	36	<4	19	13	16200	<15	13000
7011165	32.0792	106.2747	<2	44000	15	517	1	11100	39	<4	20	10	18100	<15	14500
7011166	32.0933	106.2656	<2	46200	13	510	1	10300	51	<4	22	12	19400	<15	14400
7011167	32.1072	106.2569	<2	46900	13	509	1	7000	48	<4	21	14	18500	<15	14800
7011168	32.0667	106.2811	<2	33600	<10	468	1	11100	57	5	20	10	27600	<15	11900
7011169	32.0544	106.2886	<2	38600	10	473	1	14700	67	6	28	19	28200	<15	12400
7011170	32.0408	106.2969	<2	45000	12	524	1	12400	36	4	18	13	17000	<15	15400

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7011171	32.0267	106.3061	<2	41800	<10	518	1	16100	48	5	17	14	15300	<15	13900
7011172	32.0133	106.3147	<2	44000	14	507	1	11400	44	<4	17	18	15700	<15	15000
7011173	32.3656	106.0928	<2	48700	13	510	1	10700	46	5	21	23	16300	<15	16000
7011174	32.3519	106.0997	<2	38600	<10	473	1	12400	43	5	19	10	20700	<15	13900
7011175	32.3397	106.1083	<2	48700	16	472	1	15600	43	4	23	10	19600	<15	14100
7011176	32.3256	106.1178	<2	41400	11	484	1	8600	43	4	20	8	17300	<15	13600
7011177	32.3469	106.0739	2	51500	15	477	1	14700	50	5	25	14	19500	<15	15100
7011178	32.3361	106.0811	<2	37100	<10	475	1	3400	26	<4	14	6	13700	<15	13700
7011179	32.3206	106.0914	<2	46800	11	492	1	10900	41	4	22	9	18900	<15	15000
7011180	32.3147	106.0894	<2	44600	11	502	1	4700	32	<4	17	8	15100	<15	16300
7011181	32.2908	106.0847	<2	13800	<10	296	<1	89000	11	<4	6	3	6800	<15	7300
7011182	32.2842	106.0689	<2	40800	14	542	1	34600	40	4	22	9	19200	<15	13100
7011183	32.2775	106.0644	<2	29100	<10	402	<1	11200	100	16	45	38	81500	39	10200
7011184	32.3439	106.0564	<2	47000	21	508	1	5500	61	5	29	40	24500	<15	16200
7011185	32.3436	106.0419	<2	38300	15	513	1	8500	42	4	24	40	17300	<15	13800
7011208	32.3525	106.0211	<2	43900	23	475	1	30300	54	5	30	41	21900	<15	14400
7011209	32.3744	106.0119	<2	34200	15	438	1	18400	66	7	33	40	35800	20	12500
7011210	32.3289	106.0153	<2	34900	15	461	1	32100	48	6	26	36	24200	<15	13100
7011211	32.3083	106.0150	<2	46200	21	474	1	29100	53	6	31	42	22200	15	14200
7011212	32.3014	106.0158	<2	52300	34	435	1	47200	60	7	36	44	23400	<15	14100
7011213	32.2958	106.0142	<2	41700	21	472	1	49900	59	6	30	41	20500	<15	12900
7011214	32.2750	106.0128	<2	40800	17	500	1	34500	38	5	25	47	16700	25	14100
7011215	32.2600	106.0039	<2	54900	35	433	2	68700	56	7	39	54	23500	<15	14200
7011242	32.3031	106.1289	<2	46100	11	599	1	23100	47	4	18	17	21800	<15	18500
7011243	32.2897	106.1378	<2	43200	<10	569	1	4400	39	<4	14	8	16400	<15	17400
7011244	32.2767	106.1456	<2	50800	<10	571	1	30200	41	4	19	14	17800	<15	18300
7011245	32.2625	106.1553	<2	46000	<10	569	1	28600	43	<4	14	14	15800	<15	18100
7011247	32.4028	106.0806	<2	49000	<10	596	1	23700	41	4	15	16	17100	<15	19600
7011248	32.4156	106.0728	<2	56100	<10	668	1	40400	46	5	16	66	22400	<15	17300
7011249	32.4275	106.0675	<2	40900	<10	559	<1	13200	84	11	21	21	69300	<15	15400
7011250	32.4408	106.0628	<2	55000	10	708	1	29300	65	6	18	30	29700	<15	18500
7011256	32.4550	106.0583	2	49200	<10	613	1	43500	56	5	18	36	18800	<15	17200
7011257	32.4700	106.0525	<2	58500	16	571	1	43700	51	5	21	32	20600	<15	20000
7011258	32.4822	106.0472	<2	47300	13	541	1	29600	47	4	21	12	20500	<15	17200
7011259	32.4942	106.0425	<2	54000	15	567	1	11100	57	5	24	16	21600	<15	19900
7011260	32.4722	106.0281	<2	51500	<10	586	1	25900	46	4	21	19	23400	<15	18700
7011261	32.4858	106.0172	<2	39800	<10	550	1	42100	41	5	18	9	22400	<15	14900
7011262	32.4953	106.0075	<2	53600	11	594	1	52800	35	4	18	21	15900	<15	17900
7011263	32.4775	106.0011	<2	45000	11	588	1	8300	44	<4	18	33	16600	<15	18400
7011264	32.4503	106.0122	<2	46300	<10	558	1	4800	56	5	24	12	25100	<15	18100
7011265	32.3947	106.0503	<2	44900	<10	566	1	10500	51	4	20	15	22800	<15	18200
7011266	32.4008	106.0344	<2	39200	12	546	1	6500	37	<4	16	8	16900	20	16200
7011267	32.3947	106.0092	<2	36700	24	496	1	72200	36	4	20	15	13500	<15	12500
7011268	32.4067	106.0192	<2	36900	12	564	1	8800	32	<4	12	14	10200	<15	16100
7011269	32.4200	106.0183	<2	39200	15	532	1	15500	52	4	22	9	19200	<15	15800
7011270	32.4303	106.0178	<2	40600	13	530	1	4000	41	4	18	13	17000	<15	17000

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7031248	32.4781	105.7397	<2	32800	17	414	1	66600	39	4	18	9	11900	<15	11100
7031249	32.4775	105.7361	<2	47200	19	471	1	43000	46	6	24	15	18500	<15	14000
7031250	32.4761	105.7283	<2	45800	17	469	1	52700	35	5	20	13	16700	<15	14700
7031251	32.4750	105.7197	<2	48100	20	487	1	36900	46	6	24	14	18900	<15	14100
7031252	32.4736	105.7139	<2	38500	14	468	1	49500	37	4	19	11	13800	15	12600
7031253	32.4719	105.7047	<2	33600	11	449	1	50100	35	5	17	9	12300	35	11600
7031254	32.4706	105.6950	<2	51600	19	515	1	29900	51	7	29	16	20400	<15	14800
7031255	32.4692	105.6875	<2	52500	20	498	1	38700	55	7	29	18	22000	<15	13800
7031256	32.4675	105.6764	<2	27500	<10	366	1	46700	39	4	19	7	14500	<15	10200
7031257	32.4664	105.6497	<2	48400	11	567	1	14200	35	5	20	11	14800	<15	16600
7031258	32.4664	105.6439	<2	45800	14	503	1	36100	38	5	22	13	16900	<15	14800
7031259	32.4658	105.6375	<2	44400	19	500	1	53000	34	5	23	14	16800	<15	13200
7031260	32.4686	105.6314	<2	46900	17	459	1	72200	38	5	27	17	19400	<15	13000
7031261	32.4561	105.6608	<2	41300	13	477	1	20800	38	4	21	11	16300	<15	13800
7031262	32.4392	105.6478	<2	33700	11	443	1	55600	33	4	17	9	13500	<15	11300
7031263	32.4242	105.6392	<2	46900	17	495	1	20300	41	5	22	13	17800	<15	15200
7031265	32.3850	105.6831	<2	44400	17	531	1	16900	40	4	20	12	15600	<15	14900
7031266	32.3839	105.7017	<2	41700	12	540	1	17800	37	4	17	9	14400	<15	14500
7031267	32.3947	105.7447	<2	36300	11	508	1	20300	35	4	16	8	14200	<15	14000
7031269	32.3683	105.7400	<2	38900	13	523	1	15100	32	4	17	9	15300	<15	14800
7031271	32.3472	105.6539	<2	37000	12	495	1	17400	32	4	17	9	14000	<15	13000
7031272	32.3644	105.6517	<2	39900	10	523	1	20200	36	4	18	9	15000	19	14200
7031273	32.3181	105.6725	<2	40300	12	540	1	16900	40	4	17	9	13900	<15	14600
7031274	32.3083	105.6867	<2	47500	14	544	1	7600	44	7	22	11	18000	<15	15500
7031275	32.3161	105.7053	<2	40800	12	521	1	16500	36	5	18	11	15200	<15	14400
7031276	32.2958	105.6967	<2	38000	13	494	1	44600	45	4	20	11	16700	<15	12800
7031277	32.3008	105.7331	<2	45300	12	569	1	13000	41	5	18	11	14300	17	15200
7031278	32.3033	105.7414	<2	48600	15	537	1	13800	52	6	23	15	19800	<15	15300
7031279	32.2908	105.7022	<2	45700	13	562	1	23400	45	5	21	12	18700	42	14400
7031280	32.2747	105.7319	<2	46700	11	550	1	8300	45	5	22	12	19100	<15	15200
7031281	32.2661	105.7417	<2	47800	13	587	1	14400	42	4	22	10	17300	<15	15800
7031282	32.2647	105.7442	<2	47400	13	594	1	11200	36	<4	19	10	15600	<15	17500
7031322	32.4542	105.5517	<2	36800	10	407	1	52600	32	<4	21	11	13700	<15	10800
7031323	32.4575	105.5556	<2	35700	11	429	1	57300	41	4	22	9	13800	<15	10500
7031324	32.4936	105.5761	<2	33000	<10	427	1	20400	38	4	16	8	12400	<15	11300
7031325	32.4867	105.5942	<2	30200	12	379	1	52400	36	<4	18	7	10600	<15	9400
7031326	32.4800	105.6036	<2	36300	<10	460	1	31700	38	<4	18	9	13900	25	12500
7031327	32.4736	105.6122	<2	38600	11	462	1	27900	41	4	20	10	15800	<15	11500
7031335	32.6919	105.9556	<2	38200	17	385	1	61900	40	4	24	15	15400	<15	12100
7031336	32.6903	105.9389	<2	46900	23	444	1	33100	48	6	29	17	21200	<15	15100
7031337	32.6897	105.9236	<2	47100	27	385	1	49200	40	7	36	17	21600	<15	14000
7031340	32.6869	105.9964	<2	44100	20	421	1	43800	36	5	25	17	17600	<15	13400
7031341	32.6714	105.9983	<2	48000	18	489	1	39300	39	6	25	18	19500	29	14900
7032345	32.5375	105.9803	<2	44200	20	500	1	53300	39	5	23	16	15300	<15	15000
7032346	32.5519	105.9753	<2	49800	26	500	1	51900	37	5	26	15	18100	<15	15000
7032347	32.5622	105.9661	<2	50300	30	451	1	68000	36	5	29	20	18800	<15	15800

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7032348	32.5689	105.9483	<2	34400	13	507	1	25100	18	<4	10	7	7300	<15	16000
7032349	32.5744	105.9364	<2	32100	16	436	1	37500	42	4	19	11	16700	<15	13100
7032352	32.5044	105.9336	<2	42800	24	484	1	65200	31	4	21	15	13900	<15	14100
7032354	32.5200	105.8853	<2	43200	21	509	1	62800	38	4	21	14	14500	<15	14300
7032355	32.5350	105.8489	<2	38800	21	467	1	75700	32	4	19	14	13200	16	13500
7032356	32.5297	105.8317	<2	36900	10	500	1	41100	27	<4	18	9	14100	<15	14200
7032357	32.5250	105.8306	<2	37500	14	531	1	23400	32	<4	17	8	13700	<15	15400
7032358	32.5214	105.8303	<2	30300	14	476	1	38900	25	<4	12	9	10700	<15	13500
7032359	32.5806	105.8439	<2	31500	25	359	1	75500	22	4	19	11	13300	<15	12400
7032360	32.5531	105.7892	<2	31800	26	375	1	67400	31	4	19	12	11600	<15	11900
7032361	32.5469	105.7803	<2	33900	28	392	1	70400	27	<4	19	12	12000	<15	12800
7032362	32.5503	105.7697	<2	26700	19	346	1	69400	23	<4	16	8	10500	<15	10700
7032363	32.5553	105.7678	<2	28300	12	361	1	74100	28	<4	15	8	10800	<15	11500
7032364	32.5625	105.7583	<2	39600	19	450	1	57200	33	4	23	13	14100	<15	14000
7032365	32.5847	105.7281	<2	33500	18	407	1	39900	31	<4	18	8	12600	<15	12300
7032366	32.5833	105.7036	<2	41600	14	443	1	29600	36	4	22	12	13400	<15	13600
7032367	32.5475	105.6592	<2	40600	15	485	1	52300	41	5	27	12	16700	17	12600
7032368	32.5467	105.6575	<2	41700	14	524	1	30200	37	4	21	10	14000	<15	15300
7032369	32.5417	105.6636	<2	40700	23	461	1	59900	38	4	24	12	15200	<15	13700
7032370	32.5475	105.6947	<2	37400	18	496	1	49800	28	4	17	10	12600	<15	12300
7032371	32.5464	105.6964	<2	37500	15	468	1	48100	31	<4	21	10	14000	<15	12200
7032372	32.5169	105.6731	<2	48500	17	501	1	52100	37	4	26	16	17500	<15	13900
7032373	32.5011	105.7114	<2	36600	18	495	1	44500	26	<4	18	10	13300	<15	12300
7032374	32.5194	105.7211	<2	34100	21	415	1	70100	30	<4	18	10	11600	<15	11900
7032375	32.5217	105.7225	<2	31500	15	406	1	52200	27	<4	17	10	12800	22	11600
7032376	32.5128	105.7319	<2	39600	28	489	1	44100	38	<4	21	12	14100	<15	13500
7032378	32.5006	105.7642	<2	36600	11	514	1	18500	30	<4	14	9	10300	<15	16400
7032380	32.5189	105.8039	<2	36300	29	382	1	89000	28	<4	19	12	11600	<15	13100
7032383	32.5308	105.6228	<2	46100	17	516	1	45200	40	4	26	13	15700	<15	15700
7032404	32.6275	105.7719	<2	42300	47	341	1	106700	32	7	33	15	20200	<15	12400
7032405	32.6258	105.7692	<2	38500	34	358	1	87600	35	6	29	13	18300	<15	12400
7032406	32.6681	105.9303	<2	36200	17	483	1	22900	30	<4	20	10	13700	<15	16800
7032407	32.6708	105.8928	<2	37700	20	408	1	67600	31	5	26	12	15300	<15	15000
7032408	32.6711	105.8764	<2	34200	17	358	1	96500	28	5	27	18	15700	<15	12400
7032409	32.6839	105.9025	<2	47000	33	414	1	73700	45	7	37	18	20200	<15	15500
7032444	32.5300	105.5883	<2	45600	<10	424	1	66200	52	6	33	14	17900	<15	12800
7032579	32.0636	105.8975	<2	61900	24	622	1	9700	56	8	29	18	23300	<15	19000
7032580	32.0642	105.9131	<2	54900	15	606	1	33900	47	6	30	19	21700	<15	17000
7032638	32.0894	105.9481	<2	49800	30	541	1	79800	38	5	27	17	18600	<15	17600
7032639	32.0772	105.9544	<2	48300	22	606	1	52200	38	4	23	11	16700	<15	18400
7032640	32.0700	105.9622	<2	46000	21	574	1	51900	36	5	23	10	16300	<15	18000
7032641	32.0583	105.9650	<2	50000	25	602	1	45400	44	5	26	11	18200	<15	18400
7032642	32.0511	105.9692	<2	50100	25	617	1	41300	49	5	25	11	18500	<15	19900
7032649	32.1461	105.9372	<2	57600	44	536	2	78800	56	8	36	20	24700	<15	19000
7032650	32.1564	105.9161	<2	48900	23	631	1	22900	41	5	23	13	17100	<15	21200
7032652	32.1186	105.8931	<2	47200	30	550	1	61700	36	5	23	14	16200	<15	17900

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7032653	32.1186	105.8856	<2	45400	20	608	1	35700	22	-4	18	10	13300	<15	19400
7032654	32.1100	105.8856	<2	48500	21	600	1	28700	39	5	21	12	16700	<15	19200
7032655	32.1331	105.8883	<2	48200	22	639	1	24800	37	4	20	10	15800	<15	20500
7032658	32.2369	105.9794	<2	51000	32	527	1	69300	41	6	30	20	20200	<15	16000
7032659	32.2339	105.9978	<2	53900	35	508	1	80900	37	5	31	17	21600	<15	18600
7032660	32.1814	105.9244	<2	52100	19	637	1	20400	41	4	23	14	17300	<15	22200
7032661	32.1878	105.9031	<2	50000	26	603	1	38500	45	5	24	14	17500	<15	20100
7032663	32.2319	105.9117	<2	55200	46	510	1	99100	41	7	35	25	23700	<15	17800
7032665	32.2167	105.8933	<2	46100	21	593	1	23800	40	4	21	11	16400	<15	20100
7032666	32.2139	105.8775	<2	47000	19	621	1	15300	47	5	22	11	16500	<15	19600
7032667	32.2414	105.8744	<2	52800	32	607	1	31900	52	6	27	16	19300	<15	20700
7032668	32.2272	105.8242	<2	55000	32	588	1	46000	43	5	26	20	20500	<15	21000
7032669	32.2411	105.8192	<2	51600	22	608	1	11400	39	5	22	12	18400	<15	22700
7032671	32.2233	105.7864	<2	50400	21	507	1	64000	50	7	26	21	19000	<15	13800
7032672	32.2039	105.8050	<2	47800	13	578	1	28700	31	4	18	12	14100	<15	17400
7032673	32.1878	105.8214	<2	52500	19	568	1	11000	50	5	23	16	17300	<15	18600
7032674	32.1856	105.8231	<2	45600	11	563	1	20700	35	<4	17	12	13600	<15	16800
7032675	32.1583	105.8442	<2	53400	17	585	1	12500	47	6	25	16	20000	<15	16600
7032676	32.1467	105.8503	<2	41400	11	556	1	22700	45	4	19	12	16400	<15	15400
7032678	32.2664	105.9922	<2	49200	16	553	1	23600	42	5	22	16	16200	<15	16500
7032679	32.2669	105.9800	<2	52300	28	490	1	52700	46	6	30	18	20200	<15	16200
7032680	32.2683	105.9647	<2	55500	17	594	1	37000	39	6	23	15	17000	<15	18100
7032681	32.2569	105.9114	<2	58400	33	510	2	48800	52	7	34	21	23600	18	16600
7032682	32.2622	105.9247	<2	46200	16	534	1	40500	31	4	21	11	14600	<15	15500
7032684	32.2692	105.8969	<2	52500	25	526	1	37300	44	6	26	31	18200	<15	17600
7032685	32.2869	105.9056	<2	49300	28	482	1	40200	41	6	26	15	17700	<15	15600
7032686	32.2972	105.8983	<2	53100	49	395	1	55500	49	8	39	19	23800	<15	13900
7032687	32.3131	105.8883	<2	41900	31	379	1	66400	40	6	27	13	16600	<15	11900
7032688	32.3272	105.8814	<2	39700	19	451	1	46900	37	4	21	13	13800	<15	13000
7032690	32.3669	105.8597	<2	49600	21	497	1	40200	43	5	25	15	18000	<15	16200
7032691	32.3233	105.8139	<2	46400	15	547	1	5700	43	5	19	12	16300	<15	16400
7032692	32.3178	105.8169	<2	51500	15	550	1	7200	53	6	22	13	18200	<15	17000
7032693	32.2969	105.8192	<2	57700	24	557	1	14000	56	7	27	21	22100	<15	17100
7032695	32.2656	105.7722	<2	55400	22	537	1	8000	60	8	28	18	21500	<15	17300
7032696	32.3008	105.7606	<2	51900	18	556	1	21800	54	7	25	16	19500	<15	15300
7032697	32.3100	105.7631	<2	50300	18	560	1	14500	49	5	22	15	17700	<15	17800
7032698	32.3706	105.7514	<2	50500	19	546	1	17300	53	5	24	15	18000	<15	17400
7032699	32.3889	105.7592	<2	45500	17	535	1	36100	36	5	19	13	15800	<15	15600
7032700	32.3892	105.7786	<2	39600	11	533	1	18600	41	4	19	15	16100	<15	16000
7032701	32.4089	105.7922	<2	50300	17	553	1	13400	47	5	23	13	18900	<15	16800
7032702	32.4192	105.7992	<2	55200	22	543	1	8800	46	5	26	17	20600	<15	18400
7032703	32.4311	105.7986	<2	48500	13	549	1	25500	47	5	23	14	17400	<15	16000
7032705	32.4594	105.7525	<2	33800	16	405	1	67400	32	<4	17	9	11700	<15	12200
7032706	32.4864	105.7703	<2	36600	12	514	1	20300	33	<4	13	7	10100	<15	14200
7032707	32.4889	105.7828	<2	41300	15	474	1	36100	42	5	20	12	16700	<15	15000
7032708	32.4908	105.7981	<2	37800	14	517	1	21200	27	<4	13	8	9900	<15	14500

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7032709	32.4897	105.8086	<2	34100	12	465	1	38600	43	4	18	9	15200	<15	12900
7032710	32.4986	105.8514	<2	40400	24	415	1	74800	35	5	20	12	14700	<15	13600
7032712	32.3111	105.9458	<2	41500	11	531	1	18200	25	<4	16	9	13300	<15	17100
7032714	32.2833	105.9247	<2	43700	17	469	1	37300	33	5	22	12	16200	<15	16200
7032715	32.3147	105.9728	<2	50200	20	495	1	47500	37	5	25	16	18100	<15	17200
7032716	32.3114	105.9922	<2	60700	28	514	2	32500	53	7	32	23	24000	<15	17300
7032717	32.3256	105.9414	<2	46700	15	507	1	42800	32	4	22	14	15700	<15	16700
7032718	32.3331	105.9264	<2	40200	13	359	1	87600	28	5	25	14	16100	<15	12500
7032719	32.3492	105.9225	<2	47000	13	516	1	40800	28	4	20	12	14800	<15	16700
7032720	32.3528	105.9036	<2	45300	15	471	1	71600	28	5	21	15	14900	<15	14300
7032722	32.3867	105.9433	<2	48000	24	475	1	56300	38	5	24	16	17200	<15	14900
7032723	32.3956	105.9483	<2	42100	<10	461	1	55700	34	4	22	13	16100	<15	13900
7032724	32.4103	105.9378	<2	43700	15	504	1	39000	31	4	22	12	16200	<15	15400
7032725	32.4225	105.9314	<2	44400	26	409	1	75800	35	5	26	15	18100	<15	12800
7032727	32.4361	105.9844	<2	45600	23	445	1	69300	44	6	26	16	18100	<15	13700
7032729	32.4875	105.8986	<2	43600	14	493	1	49300	36	4	22	11	15300	<15	15600
7032731	32.4717	105.9122	<2	43800	29	431	1	59200	39	5	24	14	15700	<15	14200
7032732	32.4700	105.9261	<2	47900	29	440	1	65800	44	5	27	18	18500	<15	14100
7032733	32.4531	105.9581	<2	39700	18	493	1	47200	39	4	20	9	13800	<15	15500
7032734	32.4078	105.9922	<2	41300	17	497	1	22700	49	6	23	10	18800	<15	15900
7032735	32.3897	105.9878	<2	46600	29	483	1	54500	42	5	29	13	20000	15	16500
7032736	32.3567	105.9978	<2	46600	20	549	1	28400	43	5	23	14	17100	<15	18500
7032737	32.3564	105.9658	<2	42500	18	532	1	14900	45	4	21	9	16800	<15	17800
7032738	32.5286	105.9364	<2	50500	29	395	1	89300	39	7	36	15	22500	<15	12800
7032739	32.5317	105.9353	<2	36300	14	468	1	49500	33	4	20	8	14000	<15	13200
7032740	32.5472	105.9225	<2	38000	13	442	1	72600	36	4	22	10	15200	<15	13000
7032741	32.5578	105.9069	<2	32800	14	471	1	32500	43	4	20	8	15800	<15	13900
7032742	32.5700	105.8908	<2	34100	22	391	1	79400	30	<4	21	9	13700	<15	13300
7032743	32.5750	105.8875	<2	32000	12	467	1	34200	29	<4	16	7	12200	<15	14900
7032744	32.5994	105.8681	<2	32100	23	345	1	84900	36	5	23	11	16400	<15	12100
7032745	32.6064	105.8753	<2	31500	11	466	1	14800	49	5	21	7	26200	<15	14900
7032746	32.6256	105.8258	<2	27700	18	296	1	93300	28	4	19	7	11200	<15	9500
7032747	32.6222	105.8208	<2	31700	17	451	1	102500	22	<4	24	8	13100	<15	11100
7032748	32.6069	105.8017	<2	38300	30	366	1	90200	36	6	27	13	16200	<15	12700
7032749	32.6064	105.7892	<2	28000	26	280	1	99200	30	5	20	9	12400	<15	10000
7032750	32.6117	105.7892	<2	36700	20	331	1	146500	27	6	26	13	15800	<15	10300
7032752	32.6306	105.8869	<2	27500	21	300	1	99700	19	4	21	7	13700	<15	10000
7032753	32.6481	105.8911	<2	33700	17	399	1	63700	33	4	20	8	14300	<15	13600
7032754	32.6286	105.9022	<2	34100	22	361	1	88700	28	4	22	10	13800	<15	12600
7032756	32.6206	105.9631	<2	38400	22	427	1	55200	34	4	23	11	14900	<15	14700
7032757	32.6097	105.9744	<2	38500	22	449	1	39900	36	4	23	10	17800	<15	15200
7032758	32.6064	105.9889	<2	37300	16	485	1	19700	54	5	25	7	26400	<15	16100
7032759	32.6308	105.9197	<2	37000	28	369	1	80000	30	5	25	10	14600	<15	12900
7032760	32.6322	105.9603	<2	43900	24	442	1	54100	37	5	27	13	17400	<15	16400
7032761	32.6347	105.9806	<2	40400	13	520	1	23100	43	4	22	9	18900	<15	15800
7032762	32.6881	105.9889	<2	46300	26	445	1	53600	44	6	30	17	18800	<15	16800

Sample No.	Latitude	Longitude	Ag	Al	B	Ba	Be	Ca	Ce	Co	Cr	Cu	Fe	Hf	K
7032764	32.6669	105.9525	<2	39400	21	442	1	72700	36	5	24	14	15500	<15	14900
7032766	32.6544	105.9306	<2	49900	56	283	1	130700	50	9	45	19	23800	<15	12500
7032769	32.6769	105.8956	<2	43500	28	369	1	101300	41	7	36	15	19500	<15	13200
7032770	32.6689	105.8889	<2	42500	28	362	1	97100	37	6	33	16	18800	<15	13600
7032771	32.6450	105.9306	<2	33600	30	304	1	110700	27	4	26	9	14000	<15	10100
7033073	32.6256	105.8258	<2	30500	35	301	1	88600	29	4	19	9	11100	<15	10600
7033074	32.6231	105.8200	<2	36100	36	432	1	83000	34	5	26	12	15400	<15	12100
7033075	32.6086	105.8197	<2	38200	30	481	1	44900	43	8	26	13	21600	<15	14200
7033076	32.6089	105.7811	<2	37300	55	302	1	98400	20	5	25	13	14700	<15	11600
7033077	32.6108	105.7817	<2	29500	39	242	1	159500	26	5	26	10	14100	<15	9100
7033078	32.6114	105.7889	<2	39300	48	320	1	104700	30	6	28	16	16600	<15	12500
7033079	32.6247	105.8667	<2	30500	33	321	1	92200	33	4	21	9	11600	<15	10300

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7010978	21	17	3400	201	<4	10700	11	7	245	18	3	225	<2	2100	2.4	31	9	32	51
7011011	20	24	6900	290	<4	8400	8	13	443	21	4	198	6	1906	2.2	44	10	53	45
7011017	24	14	2600	223	<4	7300	11	9	120	19	3	155	8	2456	1.8	46	9	33	49
7011018	20	14	2400	206	<4	7000	8	4	121	28	3	136	8	2219	2.3	40	8	40	41
7011019	18	19	4400	214	<4	6200	11	11	176	21	3	192	10	2390	2.2	54	10	40	58
7011020	16	16	3400	191	<4	6800	6	6	173	25	3	185	4	1942	2.1	41	7	39	44
7011021	20	16	3000	241	<4	7100	8	6	129	15	3	159	7	2554	2.7	47	9	34	51
7011022	19	17	3900	237	<4	6400	8	8	185	23	3	149	12	2342	2.5	49	9	44	49
7011023	20	22	4100	268	<4	6500	11	11	171	16	4	147	3	2930	2.6	62	11	50	66
7011027	15	18	3400	228	<4	12700	10	8	246	15	2	234	<2	1892	2	33	8	35	44
7011028	20	17	3700	271	<4	13100	13	8	305	14	3	257	9	2163	2.4	38	9	40	49
7011029	18	22	4800	299	<4	13100	12	10	409	<10	3	284	8	2079	2.5	38	10	47	52
7011030	21	18	4300	301	<4	12200	14	9	321	15	3	295	5	2304	2.6	40	10	43	56
7011031	20	21	3800	326	<4	12600	14	7	335	<10	3	199	<2	3083	3	49	10	49	62
7011032	21	18	3400	278	<4	11600	12	9	227	18	3	179	6	2761	2.5	45	9	43	55
7011033	16	23	4500	264	<4	10500	9	8	335	<10	3	185	<2	1918	2	36	9	42	48
7011034	24	23	5100	298	<4	11300	10	10	391	20	4	246	10	2372	2.7	45	11	48	62
7011035	20	27	6600	369	<4	9400	8	12	656	29	4	253	5	1966	2.3	44	11	61	55
7011036	23	15	4200	339	<4	6700	15	12	243	11	4	164	8	3823	2.3	65	12	50	105
7011037	31	12	4600	913	<4	7200	40	12	489	24	4	242	7	8582	4.1	133	16	101	124
7011038	19	13	4500	445	<4	8300	23	10	395	14	3	267	<2	3535	3	50	13	54	80
7011039	19	16	5600	334	<4	6600	14	12	438	14	4	226	4	2646	2.3	44	12	53	71
7011040	19	10	3300	297	<4	6800	23	8	238	<10	3	185	8	2933	2.4	43	11	45	81
7011041	17	12	3600	326	<4	7000	20	9	268	16	3	197	7	3205	2.4	46	11	45	79
7011043	15	17	6000	230	<4	5900	14	8	237	19	3	407	3	2308	2.4	40	10	40	64
7011045	14	15	2600	225	<4	10000	11	5	153	11	2	163	<2	2428	1.8	33	8	28	58
7011046	18	14	4200	280	<4	6900	11	9	286	17	3	161	<2	2585	2.3	41	10	43	68
7011048	19	13	3000	299	<4	7500	12	10	195	18	3	146	3	3401	2.2	47	11	45	103
7011050	21	19	7300	412	<4	6100	14	14	665	12	5	196	7	2716	2.4	46	13	65	83
7011051	18	11	3100	254	<4	6700	10	9	211	15	3	151	2	2691	2.1	41	10	44	68
7011052	29	16	3100	294	<4	8800	12	11	143	16	3	146	11	3179	2.7	49	11	44	59
7011053	21	21	6400	254	<4	7100	10	15	307	13	4	247	11	2381	2.2	51	12	40	64
7011054	22	15	2700	238	<4	9400	10	11	154	16	3	155	4	2477	2	39	10	37	54
7011056	19	15	3300	214	<4	8800	9	9	227	<10	3	196	5	2205	2.1	35	9	32	56
7011057	27	17	4900	349	<4	8300	14	12	326	25	4	174	9	2869	2.7	48	13	49	70
7011058	15	15	3000	204	<4	9400	7	7	174	15	2	163	2	2051	2	30	9	32	50
7011059	21	15	4100	269	<4	8500	9	14	269	23	3	169	3	2204	1.9	37	10	38	55
7011060	23	21	6300	413	<4	9400	11	13	506	18	4	223	7	2294	2.3	42	12	48	62
7011061	21	18	5500	289	<4	8600	10	12	335	18	4	300	6	2200	2.4	40	10	42	58
7011062	19	16	4200	313	<4	8800	9	8	277	17	3	167	4	2289	2.1	38	10	40	56
7011063	21	17	4000	315	<4	7200	10	12	242	17	4	157	10	3249	2.3	55	10	49	65
7011064	21	16	2500	275	<4	8900	12	10	150	12	3	135	3	3019	3.7	46	10	39	60
7011065	25	19	3700	279	<4	9200	13	15	169	18	4	154	<2	3033	2.4	51	11	43	75
7011066	25	14	2500	261	<4	8100	13	11	132	16	3	145	5	3213	2.2	49	10	36	64
7011067	18	20	3100	173	<4	8800	9	12	119	20	3	159	5	1930	2.2	39	8	32	49
7011068	19	18	3000	164	<4	8800	8	9	137	<10	3	158	2	1854	2.5	36	8	39	47

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7011069	23	21	4700	217	<4	8300	11	12	228	<10	4	180	9	2318	2.2	45	10	39	58
7011070	21	20	4200	214	<4	9100	12	11	205	30	3	178	5	2295	2	42	9	74	50
7011071	17	23	4200	228	<4	10300	10	14	219	<10	3	182	<2	2369	2.1	45	9	41	59
7011072	22	23	3300	244	<4	10100	9	11	144	<10	3	159	<2	2712	2.7	49	10	42	59
7011073	20	18	2800	146	<4	9900	8	9	118	18	3	149	7	1618	2.3	30	8	28	45
7011074	27	24	4100	270	<4	11200	12	12	199	20	4	212	9	2903	2.4	54	12	46	63
7011075	22	25	6800	251	<4	7100	10	15	337	17	5	351	5	2382	2.3	73	11	48	62
7011076	18	18	4300	209	<4	6800	12	11	160	21	3	212	5	2312	2.4	44	9	43	48
7011077	20	21	5600	272	<4	6600	10	11	184	10	3	230	<2	2881	2.6	62	11	44	62
7011078	20	16	4300	251	<4	6400	10	13	151	11	3	186	6	2779	2.3	52	10	40	58
7011079	21	15	3800	264	<4	6700	12	10	173	28	3	173	6	2830	2.4	52	10	51	59
7011080	23	16	3200	304	<4	6900	12	11	165	11	3	155	3	3355	2.2	57	10	44	69
7011081	28	16	3500	313	<4	6800	13	10	195	20	4	154	9	3440	2.9	61	12	48	79
7011082	21	18	3400	224	<4	6800	10	11	169	20	4	140	5	2269	2.5	44	10	40	59
7011083	19	14	3200	215	<4	6700	9	7	175	<10	3	168	3	2306	2.1	40	8	34	47
7011084	21	15	4400	245	<4	6400	9	9	256	<10	4	164	6	2631	2.2	48	10	39	61
7011085	24	16	4900	296	<4	6300	11	12	243	12	4	195	8	2839	2.6	57	11	42	61
7011086	21	14	3400	260	<4	7400	9	6	165	19	3	173	<2	2868	2.2	45	10	40	57
7011087	22	16	4400	250	<4	6700	11	3	123	<10	3	189	<2	2846	2.6	47	10	38	60
7011088	21	17	4800	216	<4	7100	9	6	135	19	3	192	5	2457	2.4	43	9	39	51
7011089	18	14	3600	230	<4	7100	8	8	143	12	3	151	2	2514	2.2	41	9	42	56
7011090	17	9	2100	190	<4	4700	8	7	90	13	2	108	4	2108	2.5	34	8	31	45
7011091	23	14	3600	248	<4	6700	10	10	133	20	3	150	9	2540	2.5	45	10	43	59
7011092	26	14	4100	340	<4	6900	15	12	226	19	4	172	5	3720	2.3	61	13	55	74
7011093	22	14	4200	224	<4	6600	11	8	224	12	3	199	5	2329	2.2	43	10	40	53
7011094	17	12	2500	230	<4	6400	8	5	96	<10	3	136	<2	2460	2.7	40	9	38	50
7011095	23	14	4200	277	<4	6800	10	8	213	17	3	184	6	2968	2.6	51	11	44	63
7011096	26	14	4000	294	<4	6500	13	8	207	25	4	184	11	3276	2.6	54	11	48	67
7011097	25	12	2900	312	<4	7000	12	7	141	16	3	160	3	3503	2.1	54	10	48	66
7011098	26	10	2900	406	<4	6600	15	10	140	10	4	159	2	4731	2.4	66	12	47	77
7011099	19	13	2900	198	<4	8400	10	8	136	<10	3	159	4	2114	2.3	32	9	33	50
7011100	11	12	1400	102	<4	8200	6	5	78	12	1	126	3	1096	2.2	18	5	34	31
7011101	18	14	2800	229	<4	7800	10	10	125	12	3	160	2	2530	2.1	39	8	37	53
7011102	20	15	2600	298	<4	8600	13	10	121	<10	3	154	4	3471	2.3	52	10	41	70
7011103	30	16	3100	376	<4	8000	14	14	147	<10	4	159	<2	4272	2.7	67	12	53	80
7011104	24	22	4500	241	<4	7900	10	14	187	14	3	184	3	2729	2.1	48	10	44	63
7011105	22	20	3400	243	<4	8300	13	10	138	13	4	154	3	2785	2.5	49	11	45	63
7011106	21	15	2700	303	<4	8100	12	11	127	10	3	156	3	3513	2.7	55	9	45	64
7011107	24	18	7200	369	<4	7300	16	19	471	23	4	355	9	2457	2.8	47	13	62	69
7011108	19	14	4400	292	<4	9200	13	8	326	13	3	254	2	2306	2.3	39	10	48	53
7011165	19	17	3400	257	<4	8800	8	10	192	15	3	165	3	2733	2.3	50	9	48	56
7011166	25	18	3800	260	<4	8400	9	8	191	37	3	156	5	2733	2.4	52	10	54	64
7011167	22	19	3300	241	<4	9000	9	8	198	62	3	149	2	2592	2.2	49	10	52	61
7011168	27	12	2800	417	<4	6800	13	6	119	106	3	129	7	4460	3.4	84	10	65	57
7011169	29	15	3600	409	<4	7500	15	9	185	169	3	147	<2	4518	3.1	81	12	76	72
7011170	18	18	3500	239	<4	9000	8	9	201	39	3	158	7	2519	2.5	44	9	53	53

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7011171	20	16	3400	207	<4	8200	9	12	188	90	3	153	6	2142	1.9	41	9	53	46
7011172	19	16	3400	209	<4	8600	8	5	216	78	3	145	8	2080	2.2	40	8	58	51
7011173	20	19	3500	243	<4	9200	9	7	275	39	3	151	12	2019	2.3	42	9	51	49
7011174	19	16	2500	293	<4	7600	13	8	136	22	3	130	2	3318	2.6	60	9	47	54
7011175	19	23	3600	223	<4	7400	10	7	238	13	4	158	<2	2452	2.2	54	9	46	56
7011176	21	16	2700	230	<4	7800	9	7	180	17	3	140	4	2537	2.4	48	8	41	53
7011177	21	25	3800	217	<4	7900	12	9	239	25	4	160	4	2408	2.4	56	9	48	59
7011178	13	13	1700	198	<4	8000	7	3	93	13	2	118	3	2181	2.2	37	7	31	45
7011179	18	18	3500	255	<4	8300	9	10	216	17	3	137	4	2634	2.5	49	10	44	56
7011180	14	17	2800	209	<4	8800	8	8	179	10	3	126	5	2040	2.8	36	8	36	48
7011181	6	5	1400	98	<4	2400	6	3	96	<10	1	305	4	676	0.8	14	4	13	13
7011182	19	14	3700	285	<4	7400	10	10	189	17	3	186	7	3034	2.1	50	9	34	60
7011183	40	12	2900	1050	<4	5600	33	21	150	23	5	110	9	12271	3.4	211	15	131	122
7011184	26	22	3600	333	<4	9100	14	14	179	16	4	136	<2	3831	2	61	12	57	87
7011185	18	15	2600	256	<4	8000	11	9	169	21	3	131	3	2912	1.9	44	9	47	77
7011208	23	22	6100	303	<4	6500	13	11	291	15	4	158	8	3107	2.4	54	10	56	72
7011209	27	16	4400	508	<4	5600	18	14	186	17	4	117	6	5991	3.3	94	12	67	91
7011210	21	16	4500	323	<4	6600	13	10	151	14	3	164	2	3954	2.6	64	9	53	65
7011211	23	20	7000	342	<4	6000	13	16	382	16	5	150	5	2982	2.4	53	12	60	71
7011212	24	25	9000	402	<4	5300	12	20	604	21	6	199	10	2699	2.4	52	13	70	71
7011213	25	17	5400	281	<4	6000	13	15	363	21	4	180	7	2921	2.5	50	11	58	77
7011214	18	17	4200	256	<4	7800	10	12	269	12	3	178	2	2558	2.2	40	9	50	70
7011215	23	29	9700	408	<4	4900	10	27	704	12	6	238	6	2509	2.5	54	15	76	73
7011242	21	28	3500	271	<4	11600	10	32	161	21	3	191	5	3231	2.1	56	10	61	58
7011243	18	19	2000	223	<4	11200	8	5	113	13	2	153	3	2606	1.8	41	8	33	45
7011244	19	25	5200	247	<4	10500	9	9	305	10	3	197	7	2401	2.3	42	9	43	52
7011245	19	22	3900	225	<4	11100	9	4	196	15	3	198	5	2378	2.2	40	9	36	50
7011247	18	23	3600	268	<4	12700	10	6	256	18	3	195	<2	2186	2.1	39	9	42	43
7011248	22	25	6000	338	<4	13700	8	11	441	24	4	297	3	2292	2.4	49	12	65	46
7011249	33	16	3600	594	<4	11300	17	10	369	10	4	197	4	5236	4.5	202	17	57	52
7011250	28	25	4600	353	<4	13900	12	10	397	16	4	269	4	2890	2.5	82	12	53	48
7011256	25	22	4900	264	<4	12000	11	5	363	43	4	270	7	2289	2.2	49	11	47	47
7011257	23	35	5400	272	<4	10600	11	13	403	90	4	230	3	2358	2.2	49	11	66	49
7011258	19	24	3800	247	<4	9100	10	8	217	16	3	164	7	2699	2.5	51	9	47	48
7011259	25	28	4000	278	<4	11700	11	11	218	31	4	178	7	3074	2.7	55	11	51	62
7011260	21	28	3900	256	<4	10300	10	7	221	17	4	183	3	2860	2.5	61	10	48	53
7011261	19	20	3300	255	<4	8200	11	9	150	14	3	178	9	2911	2.2	63	9	33	50
7011262	16	31	5200	210	<4	10200	8	10	287	15	4	324	<2	1783	1.9	38	10	46	48
7011263	20	19	2900	225	<4	11000	9	11	152	16	3	157	3	2681	2	41	9	58	45
7011264	25	22	2400	339	<4	11200	12	8	154	10	3	147	4	4159	2.7	66	11	44	73
7011265	23	21	2600	309	<4	10800	12	10	156	11	3	150	5	3444	2	57	10	45	50
7011266	17	15	1700	249	<4	9400	11	4	110	14	2	132	3	2781	2.3	45	8	38	46
7011267	16	18	10900	344	<4	9500	9	8	685	16	3	473	3	2181	2.8	38	10	51	48
7011268	15	15	1800	127	<4	8200	7	5	118	18	2	118	<2	1509	1.6	26	6	27	34
7011269	25	17	2700	266	<4	8300	12	8	160	24	3	128	11	3060	2.1	52	8	52	58
7011270	20	18	2300	234	<4	9200	9	7	117	<10	3	119	5	2722	2.1	44	8	37	48

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7031248	16	16	6500	197	<4	5900	10	8	207	16	3	193	5	1733	2.2	32	9	30	49
7031249	21	21	5700	302	<4	6200	10	15	361	16	4	158	5	2195	2.3	41	11	47	56
7031250	17	22	5400	264	<4	6500	8	11	379	14	4	167	2	1929	2.1	37	10	43	51
7031251	20	20	6100	340	<4	6400	11	12	425	22	4	167	8	2269	2.3	42	11	49	60
7031252	17	18	5500	228	<4	7200	8	9	268	15	3	189	6	1927	2.3	34	9	38	52
7031253	16	14	3400	222	<4	6200	9	8	255	22	3	165	8	1777	2	30	8	31	43
7031254	24	21	6100	401	<4	6900	11	13	495	27	5	214	5	2365	2.5	46	13	58	61
7031255	26	23	5500	328	<4	5900	12	15	425	24	5	168	11	2512	2.4	49	13	54	65
7031256	18	12	3300	232	<4	5600	10	7	143	15	2	142	6	2571	2.6	38	8	32	51
7031257	18	17	3900	273	<4	9600	7	8	306	22	3	176	9	1909	1.9	32	9	41	49
7031258	17	19	4500	272	<4	7600	9	6	360	15	4	184	<2	2143	2.2	38	10	44	56
7031259	18	19	5400	287	<4	7000	10	14	532	23	4	225	5	2134	2.2	39	11	49	56
7031260	17	20	6100	313	<4	6500	11	13	455	<10	4	251	<2	2334	2.5	43	11	53	58
7031261	18	16	3900	250	<4	7200	10	9	264	17	3	140	7	2249	2.5	36	9	41	52
7031262	14	14	3400	210	<4	5800	10	8	211	13	3	153	5	2069	2.1	34	8	31	49
7031263	20	19	5000	309	<4	7200	9	12	326	19	4	149	<2	2318	2.3	38	10	45	55
7031265	20	17	4400	294	<4	7800	10	9	428	15	4	152	3	2061	2.1	35	10	45	51
7031266	18	16	3400	226	<4	7800	8	6	221	14	3	141	6	1954	1.9	33	9	34	49
7031267	16	14	2500	204	<4	7400	9	5	155	14	3	128	5	2415	2	35	8	31	48
7031269	17	15	3300	234	<4	7800	8	7	381	10	3	139	<2	2363	2	36	9	46	52
7031271	17	14	3400	223	<4	6900	9	6	201	12	3	141	7	2034	2.2	33	8	32	50
7031272	18	16	3700	237	<4	7800	8	9	222	15	3	151	5	2170	2.1	36	9	35	49
7031273	19	16	3000	209	<4	7900	9	6	186	20	3	139	3	2021	2.3	33	9	30	49
7031274	22	19	4100	311	<4	8600	9	7	237	14	4	147	6	2488	2.6	41	11	43	61
7031275	18	16	3500	239	<4	7700	9	8	230	20	3	137	<2	2155	2.3	35	9	39	50
7031276	21	15	3500	228	<4	6800	10	9	246	20	3	152	3	2571	2.5	40	10	37	56
7031277	19	16	3700	221	<4	8200	7	8	183	23	3	148	12	1818	2	31	9	46	49
7031278	23	19	4900	345	<4	7800	10	9	286	26	4	150	10	2611	2.4	43	12	50	64
7031279	21	17	4500	294	<4	7700	11	10	258	19	4	157	6	2558	2.4	41	10	43	58
7031280	22	18	4100	309	<4	8100	11	12	253	13	4	143	2	2549	2.6	42	11	47	59
7031281	21	17	4100	284	<4	9000	8	10	237	21	3	160	6	2654	2.8	42	10	45	64
7031282	19	17	3600	258	<4	9700	8	9	235	19	3	147	<2	2412	2.3	37	10	40	55
7031322	15	14	5400	255	<4	6200	7	10	337	<10	3	199	2	1820	2.3	31	9	38	48
7031323	18	14	6200	253	<4	6700	10	9	232	15	3	196	5	2121	2.7	35	9	33	50
7031324	17	12	3000	201	<4	6000	7	6	231	21	3	121	9	1947	2.2	30	8	32	43
7031325	18	13	3600	186	<4	5500	9	7	195	<10	2	167	7	1663	2.2	29	8	29	43
7031326	18	14	3300	233	<4	7300	8	8	219	<10	3	157	4	2109	2.3	33	8	34	48
7031327	19	15	3900	275	<4	6400	10	8	291	11	3	156	8	2199	2.5	36	9	40	51
7031335	18	29	10600	268	<4	5700	9	11	458	15	4	785	6	1876	2.5	38	10	45	48
7031336	22	23	7200	372	<4	6100	9	17	553	22	5	186	5	2665	2.7	49	12	56	55
7031337	18	25	8600	413	<4	5000	9	16	706	16	5	224	6	2358	2.8	50	13	67	49
7031340	17	23	8000	318	<4	6100	6	14	633	29	4	247	7	1856	2.5	40	10	56	46
7031341	18	26	10600	345	<4	7900	8	13	465	23	5	259	6	2098	2.3	48	10	65	48
7032345	17	20	6600	243	<4	6900	9	14	316	21	4	217	12	2109	2.3	45	9	38	56
7032346	18	23	8100	304	<4	6500	7	11	412	19	4	231	8	2212	2.4	48	10	44	61
7032347	17	25	9300	338	<4	5600	8	16	482	15	4	241	5	2209	2.4	49	10	49	59

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7032348	8	15	3300	123	<4	7100	<4	7	151	11	2	144	2	992	1.3	20	5	23	31
7032349	18	15	4800	282	<4	5500	9	8	201	21	3	154	7	2892	2.5	51	8	31	51
7032352	15	21	7700	245	<4	6000	7	13	352	15	3	222	7	1724	2	38	9	35	50
7032354	16	19	6000	247	<4	6500	10	9	326	10	3	234	4	1878	2	39	9	36	53
7032355	15	20	6900	226	<4	6200	9	11	257	<10	3	268	8	1927	2.2	38	9	32	55
7032356	14	15	3800	232	<4	7000	7	9	204	12	3	166	4	2328	2.2	39	8	29	58
7032357	15	14	3200	224	<4	7400	8	6	160	18	3	141	5	2337	2.1	39	7	28	54
7032358	12	13	3700	185	<4	5900	6	7	136	15	2	149	<2	1916	2.3	31	7	23	42
7032359	10	20	10300	214	<4	4700	6	10	189	<10	3	256	<2	1865	2.4	38	7	25	47
7032360	14	18	7100	196	<4	4300	8	7	202	16	3	173	8	1917	2.4	37	8	27	60
7032361	13	20	7800	199	<4	4500	7	10	207	<10	3	185	2	1971	2.5	38	8	27	61
7032362	11	14	5800	174	<4	4200	7	6	134	<10	2	164	7	1863	2.4	32	7	23	53
7032363	12	16	5900	184	<4	4700	7	11	146	<10	2	172	<2	1903	2.4	32	8	21	48
7032364	15	20	6300	232	<4	6000	7	12	299	15	3	181	9	2215	2.7	42	9	32	63
7032365	15	16	3800	226	<4	5500	9	7	147	10	3	127	<2	2146	2.1	38	8	31	57
7032366	18	19	4000	246	<4	5700	9	13	190	17	3	156	9	1951	2.1	40	9	34	55
7032367	20	15	3600	317	<4	6400	11	12	261	17	3	218	6	2825	2.6	49	11	43	68
7032368	16	16	2900	280	<4	7800	6	9	193	18	3	189	5	2364	2.5	40	9	34	53
7032369	16	18	4400	290	<4	6600	8	13	264	<10	3	220	3	2408	2.6	42	10	40	59
7032370	14	15	5600	229	<4	5800	6	11	218	12	3	172	7	1938	1.9	36	8	32	50
7032371	16	14	3900	250	<4	6200	8	10	241	17	3	174	6	2349	2.5	41	9	33	58
7032372	18	21	4900	274	<4	6600	9	14	323	20	4	198	3	2361	2.3	49	11	48	64
7032373	14	15	5200	237	<4	6100	11	9	205	<10	3	168	3	2230	2.2	37	9	29	59
7032374	14	17	6500	199	<4	5300	9	9	202	19	3	167	5	1904	2.2	35	8	29	60
7032375	12	15	5200	211	<4	5500	9	9	177	<10	2	153	3	2349	2.1	38	8	31	60
7032376	18	18	5400	241	<4	6600	8	11	270	13	3	200	7	2378	2.5	41	9	31	74
7032378	14	14	3100	168	<4	7500	7	4	180	17	2	133	5	1660	1.8	28	6	23	43
7032380	10	22	8000	199	<4	5000	6	11	267	10	3	249	6	1766	2.4	35	8	30	55
7032383	18	19	4000	311	<4	7500	8	14	305	14	3	241	8	2314	2.3	42	10	41	62
7032404	16	33	15300	272	<4	5100	10	20	266	<10	6	243	6	2113	2.5	54	11	37	55
7032405	16	27	13000	260	<4	5200	10	17	223	<10	5	229	9	2082	2.6	49	10	32	52
7032406	16	19	4100	228	<4	7800	7	10	288	<10	3	146	5	1969	1.9	35	9	33	46
7032407	16	25	6700	292	<4	8600	9	11	357	<10	4	218	6	2265	2.8	40	12	42	62
7032408	15	22	7200	262	<4	6500	8	15	412	<10	4	263	5	2118	2.9	41	11	42	55
7032409	22	29	9200	412	<4	6200	10	23	751	16	6	242	12	2231	2.8	51	14	63	59
7032444	22	21	6700	341	<4	6500	11	15	348	23	4	264	12	2298	2.9	45	12	48	61
7032579	29	27	6000	374	<4	9000	16	13	297	22	6	164	4	2742	2.4	47	15	58	81
7032580	24	22	5300	364	<4	10500	12	11	355	14	5	225	4	3144	2.7	49	12	55	79
7032638	20	28	6900	347	<4	10600	11	14	491	14	5	309	<2	2376	2.5	45	13	53	71
7032639	20	24	5400	332	<4	12100	11	11	371	10	4	261	<2	2394	2.2	41	12	45	65
7032640	20	23	4900	283	<4	12000	10	10	281	15	4	265	8	2395	2.5	42	11	41	65
7032641	24	25	5400	350	<4	12400	11	13	382	15	4	254	12	2643	2.5	46	13	49	69
7032642	24	25	5000	388	<4	13400	12	10	373	10	4	245	7	2770	2.4	45	13	50	68
7032649	27	37	10800	394	<4	8300	14	20	581	<10	6	342	12	2720	2.5	61	16	67	84
7032650	21	26	5800	305	<4	12200	10	11	332	18	4	348	11	2467	2.3	44	11	43	63
7032652	19	28	7800	298	<4	9900	8	13	437	16	4	221	6	2009	2.2	40	12	45	64

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7032653	14	24	5700	239	<4	11500	7	9	303	<10	3	222	<2	1821	1.9	32	9	32	53
7032654	20	24	5700	324	<4	10700	10	12	395	<10	4	184	4	2176	2.2	39	12	41	65
7032655	20	22	4500	251	<4	12400	9	10	241	10	4	203	2	2389	2.2	39	11	37	64
7032658	21	28	8400	383	<4	9100	11	17	539	14	5	386	4	2330	2.4	47	13	57	68
7032659	20	33	8800	419	<4	8900	11	18	677	<10	6	308	<2	2372	2.5	50	14	57	70
7032660	21	27	5800	339	<4	12300	9	13	389	13	4	206	2	2293	2.1	40	12	46	63
7032661	22	29	7600	310	<4	11500	10	12	384	11	4	255	7	2298	2.2	44	12	44	66
7032663	22	41	12300	388	<4	7500	13	21	729	<10	6	338	4	2415	2.6	58	15	62	72
7032665	22	23	4800	290	<4	11600	9	9	305	<10	4	180	5	2393	2.3	41	11	39	63
7032666	22	21	4500	282	<4	12200	10	11	265	21	4	197	8	2558	2.3	41	11	42	63
7032667	25	31	9000	406	<4	11800	10	15	574	13	5	252	7	2501	2.5	47	13	50	71
7032668	24	32	6700	406	<4	9900	11	19	597	13	5	200	<2	2438	2.1	45	15	59	72
7032669	23	27	4700	347	<4	11800	8	11	401	<10	4	162	<2	2513	2.4	41	13	49	66
7032671	23	21	6100	283	<4	6800	12	15	470	27	5	185	9	2150	2.3	42	13	64	62
7032672	16	18	3700	207	<4	9800	8	9	266	21	3	167	<2	1913	2.2	31	9	41	50
7032673	22	20	5000	354	<4	9200	9	14	377	22	4	157	4	2109	2.2	39	12	48	60
7032674	16	17	3300	191	<4	9400	8	9	218	23	3	151	5	1921	1.9	32	9	37	48
7032675	22	21	5400	403	<4	8900	9	13	342	24	4	166	7	2549	2.4	45	14	53	68
7032676	21	16	3300	249	<4	8400	10	12	170	18	3	158	12	2632	2.5	41	10	40	56
7032678	20	19	5000	291	<4	8900	9	10	334	24	4	190	14	1962	2.2	37	10	49	53
7032679	22	25	7700	458	<4	7700	10	15	526	20	5	261	10	2343	2.5	45	12	54	62
7032680	17	23	6000	536	<4	10100	8	15	421	12	4	234	4	1929	2.1	37	10	47	53
7032681	24	28	10700	470	<4	6500	10	20	595	18	6	211	7	2356	2.5	52	14	64	66
7032682	15	18	4700	244	<4	9300	9	11	243	12	3	246	4	1924	2.2	36	9	34	50
7032684	18	29	10400	437	<4	8800	8	17	350	20	4	188	8	2110	2.5	44	10	45	56
7032685	20	26	9500	317	<4	7200	10	18	377	17	4	171	3	2069	2.5	45	11	43	58
7032686	22	34	18300	351	<4	6800	10	22	368	17	6	252	3	2263	2.8	57	12	44	65
7032687	18	27	15100	270	<4	6000	9	16	291	16	4	207	6	1845	2.6	43	10	39	59
7032688	17	22	6900	234	<4	6200	9	11	269	19	4	208	9	1791	2.2	35	9	36	52
7032690	20	21	6300	338	<4	8400	10	11	422	14	4	174	4	2294	2.7	43	11	48	60
7032691	21	17	3600	287	<4	8500	9	4	254	13	4	134	4	2176	2.2	36	11	42	57
7032692	24	22	3800	310	<4	8100	10	14	219	20	4	128	7	2240	2.3	43	12	45	61
7032693	27	24	6900	525	<4	7800	10	18	575	31	6	167	10	2457	2.4	46	16	65	74
7032695	28	22	6100	442	<4	7500	12	14	489	32	5	138	11	2535	2.4	45	15	60	74
7032696	26	20	5300	343	<4	7500	12	12	349	25	5	154	8	2366	2.3	44	13	52	66
7032697	22	20	5000	321	<4	9300	11	11	379	21	4	157	3	2302	2.4	39	12	52	61
7032698	24	20	5100	334	<4	8800	11	12	389	21	4	159	10	2295	2.3	41	11	49	60
7032699	17	19	4700	260	<4	7800	10	9	293	15	4	178	9	2086	2.1	38	10	47	53
7032700	19	16	2900	255	<4	8800	10	6	184	10	3	145	<2	2676	2.8	43	10	36	54
7032701	21	19	4700	325	<4	8400	10	9	288	21	4	147	2	2508	2.4	43	12	50	59
7032702	23	21	5400	434	<4	8800	10	13	450	17	5	152	6	2471	2.5	44	14	59	69
7032703	22	19	4500	314	<4	7800	9	13	510	26	4	155	11	2186	2.6	42	11	44	57
7032705	15	16	6600	192	<4	6100	10	7	233	13	3	184	6	1771	2.3	31	9	37	47
7032706	16	14	2900	156	<4	6600	8	7	168	20	2	132	10	1310	1.6	25	7	27	34
7032707	21	17	4000	246	<4	6800	10	7	265	11	3	145	4	2329	2.5	41	10	54	53
7032708	14	14	3000	159	<4	6800	6	8	170	16	2	130	5	1194	1.5	24	6	27	31

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7032709	20	13	3000	231	<4	5900	10	7	181	20	3	127	11	2301	2.4	38	8	32	49
7032710	15	23	8800	262	<4	5500	8	11	332	21	4	216	5	1716	2.5	38	9	40	49
7032712	13	16	3400	203	<4	9100	8	9	168	<10	2	147	<2	2007	2.3	31	7	31	44
7032714	16	21	6500	260	<4	7600	8	12	254	10	4	147	5	2064	2.4	38	9	36	53
7032715	17	27	8200	286	<4	7500	8	16	323	15	4	185	6	2056	2.2	42	11	41	51
7032716	24	29	10200	523	<4	6800	9	17	586	19	6	175	6	2286	2.4	50	13	63	63
7032717	15	23	6800	254	<4	8900	7	10	349	10	4	201	5	2071	2.3	37	10	40	55
7032718	13	25	11900	250	<4	5500	9	18	319	10	4	221	2	1838	2.6	40	10	35	53
7032719	14	20	5900	293	<4	8700	7	8	383	<10	4	182	2	1844	2.3	36	9	38	50
7032720	13	22	8000	286	<4	7000	8	14	392	11	4	208	3	1715	2.3	36	10	40	49
7032722	19	24	8600	315	<4	7100	9	13	416	22	4	233	7	1963	2.4	40	11	52	52
7032723	17	19	5500	257	<4	7300	9	12	322	11	3	269	3	2045	2.6	39	10	39	51
7032724	16	20	5500	250	<4	8100	9	10	289	<10	3	202	<2	2195	2.6	40	9	37	53
7032725	16	28	12300	311	<4	6000	8	13	338	18	4	358	3	1787	2.5	44	10	42	48
7032727	18	26	9000	271	<4	5100	8	15	387	18	5	235	6	1876	2.4	46	10	42	47
7032729	16	19	5200	241	<4	8200	9	9	308	14	3	255	3	1998	2.4	38	9	37	49
7032731	16	24	10000	259	<4	7400	7	14	302	<10	4	254	3	1848	2.3	39	10	35	50
7032732	20	27	11100	323	<4	6000	10	17	444	18	5	208	6	1980	2.3	45	11	49	55
7032733	20	22	6700	229	<4	7900	9	9	230	<10	3	195	8	1789	2	36	10	31	50
7032734	25	20	4700	292	<4	7500	13	9	243	10	4	156	5	2744	2.1	48	11	41	62
7032735	22	27	7500	325	<4	7300	11	15	433	<10	5	208	8	2554	2.6	50	12	48	70
7032736	21	23	5400	317	<4	10200	11	10	341	15	4	192	7	2353	2.3	42	11	44	63
7032737	23	21	4600	278	<4	8200	8	9	246	<10	4	145	7	2316	2.1	42	11	42	57
7032738	19	33	10900	391	<4	5700	10	21	547	<10	6	332	6	2216	2.4	54	13	54	56
7032739	17	18	5800	237	<4	6900	10	10	256	<10	3	261	6	1996	2	37	10	32	49
7032740	17	20	7400	260	<4	7100	10	11	311	<10	4	334	5	2009	2.3	39	11	34	53
7032741	23	16	4000	251	<4	7400	10	8	170	<10	3	176	8	2780	2.6	44	10	31	59
7032742	15	21	8100	239	<4	6200	11	8	267	<10	3	236	6	1906	2.3	37	10	32	52
7032743	17	16	3200	196	<4	7900	9	6	142	<10	3	167	3	2242	1.7	34	9	26	48
7032744	17	25	12900	259	<4	5300	11	14	254	<10	4	292	2	2186	2.6	43	11	32	58
7032745	26	15	2900	406	<4	7500	14	8	136	<10	3	132	4	4533	2.2	72	11	45	69
7032746	13	21	9500	233	<4	5000	7	11	189	<10	3	153	5	1439	2.3	30	9	25	53
7032747	13	20	12400	228	<4	6000	7	14	340	<10	3	221	5	1674	2.4	34	11	49	46
7032748	17	27	11700	268	<4	5900	11	16	337	11	5	242	9	1979	2.5	44	12	45	63
7032749	13	24	13500	216	<4	4400	9	10	236	<10	3	192	6	1643	2.4	34	9	23	62
7032750	13	23	7400	223	<4	4800	11	14	374	<10	5	284	3	1838	2.6	40	12	43	50
7032752	10	21	9300	245	<4	5500	8	8	223	<10	3	175	2	2035	2.9	36	10	32	62
7032753	16	20	6000	254	<4	7200	8	9	293	<10	3	192	3	2061	2.5	37	11	34	52
7032754	15	24	9100	245	<4	6400	8	11	262	<10	4	206	7	1712	2.2	35	10	50	51
7032756	17	22	7400	255	<4	6900	8	14	330	<10	4	188	6	1855	2.1	38	10	36	48
7032757	20	21	6000	282	<4	6700	9	12	298	<10	4	186	4	2367	2.2	47	11	41	52
7032758	30	19	3600	417	<4	8400	15	9	189	<10	4	158	5	4543	2.9	73	13	47	67
7032759	15	26	9300	251	<4	6100	7	11	335	<10	4	204	11	1761	2.2	38	11	35	55
7032760	19	26	8600	324	<4	7700	9	13	410	<10	5	201	6	2105	2.3	43	12	45	55
7032761	21	19	4200	272	<4	8400	12	10	167	11	4	210	8	3007	2.3	51	11	39	66
7032762	22	28	8700	328	<4	7300	10	15	654	13	5	257	9	2184	2.4	45	13	53	59

Sample No.	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sc	Sr	Th	Ti	U	V	Y	Zn	Zr
7032764	18	21	5600	227	<4	7100	10	11	388	10	4	293	11	2056	2.3	40	11	39	52
7032766	21	43	17500	403	<4	2200	12	25	557	11	7	251	11	1807	2.7	63	14	59	54
7032769	20	29	9400	382	<4	5700	11	20	678	12	5	285	9	2149	3	50	14	59	56
7032770	18	29	9100	354	<4	6100	10	18	573	<10	5	276	8	2152	2.9	49	14	56	61
7032771	14	24	12700	258	<4	5300	10	11	296	<10	4	219	6	1668	2.4	36	11	35	56
7033073	12	20	9500	214	<4	5200	7	13	204	15	3	153	9	1570	0	33	8	24	54
7033074	15	20	7900	252	<4	5300	6	16	325	15	4	198	5	2276	0	45	10	35	63
7033075	19	18	4100	291	<4	5900	9	18	249	17	4	172	8	3197	0	61	10	45	62
7033076	11	28	16900	230	<4	4200	6	13	309	<10	4	204	<2	1833	0	44	9	33	63
7033077	14	16	21600	264	<4	3100	11	14	367	14	4	265	4	1708	0	46	12	32	45
7033078	14	29	17000	271	<4	4000	8	18	296	15	4	221	3	1991	0	50	9	35	58
7033079	14	19	9800	217	<4	5100	8	12	221	12	3	164	9	1791	0	36	9	24	61

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APPENDIX 10:

DESCRIPTION OF INDUSTRIAL MINERAL SAMPLES
COLLECTED ON MCGREGOR RANGE

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Sample	Geologic Description
JBIM001	Qe, eolian sand, red-brown, partly stabilized dune
JBIM002	Hueco Limestone, gray, sparse chert, caliche on joints
JBIM003	Hueco Limestone, medium gray, sparse chert, beds up to 1 ft thick
JBIM004	Qc, caliche, sandstone and limestone clasts, moderate to well indurated
JBIM005	Qc, caliche, earthy to well indurated
JBIM006	Hueco Limestone, gray, caliche on joints, beds up to 1 ft thick
JBIM007	Qc, caliche, Hueco limestone clasts, well indurated, regionally extensive on interfluves
JBIM008	Qal, alluvium, caliche and limestone clasts, very fine to coarse, poorly sorted clasts 6–8 inches in maximum diameter
JBIM009	Qal, alluvium, sandstone and limestone clasts,pebbles and cobbles in sand matrix, 2 inches in maximum diameter
JBIM010	Qc, caliche, San Andres limestone clasts, extensive on interfluves, 1–3 ft beds exposed
JBIM011	Qc, caliche, massive but friable, discontinuous drape over old Qe surface; actively mined pit
JBIM012	Qp, pediment, thin, over caliche, lag gravel and caliche clasts 3–5 inches, poorly sorted.
JBIM013	Hueco Limestone, gray, caliche on joints, shale inter-beds, thin to thick beds (>2 ft); active mine
JBIM014	Qp, pediment, over caliche, limestone clasts (>2in.) in brown fine sand/silt matrix
JBIM015	Qc, caliche, limestone clasts, extensive on interfluves, well indurated, a few feet thick
JBIM016	Yeso Fm., limestone, reddish to light gray, 1–2 ft, trace chert, caliche overprint; poorly exposed interbeds
JBIM017	Qp, pediment, extensive, very fine with a few pebbles, thick caliche; pods of limestone conglomerate
JBIM018	Qc, caliche, Hueco limestone clasts, thin bedded, several feet thick, large outcrop
JBIM019	Qab, bolson, very fine eolian sand with caliche pebbles, thin laminated caliche 1 ft below surface
JBIM020	Qp, pediment, conglomeratic, some caliche, clasts to 1 ft, few fines, mostly gray limestone
JBIM021	Abo Fm., tan limestone (1–2.5 ft), dolomite (?) and shale (up to 3 ft), caliche cap; dip 25°W

Sample	Geologic Description
JBIM022	Qaf, alluvial fan, cobble conglomerate, fine matrix, mainly rounded limestone clasts
JBIM023	Qaf, alluvial fan, cobble conglomerate, fine matrix, mainly rounded limestone clasts
JBIM024	Qab, bolson, very fine eolian sand with gypsum, not hummocky
JBIM025	Qaf, alluvial fan, gravel with fine mudstone and siltstone interbeds; >2 ft thick; extensive
JBIM026	Gobbler Fm., gray limestone with chert masses, interbedded fine sedimentary rocks
JBIM027	Qal, alluvium, red pebbly fine sand, aeolian (?); active pit, same as JBIM011
JBIM028	Qal, alluvium, mainly gray limestone pebbles; a former pit now fenced for waste disposal; perhaps some crushing was done

APPENDIX 11:

LOCATION AND GEOLOGIC DESCRIPTIONS OF SAMPLES COLLECTED BY THE NEW MEXICO HIGHWAY DEPARTMENT AND THE U.S. BUREAU OF MINES ON MCGREGOR RANGE

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Sample	Location	Geologic Description
New Mexico Highway Department Samples		
HTD-0247	SE1/4 Section 2, T18S, R10E	NA
HTD-0249	NW1/4 Section 26, T17S, R10E	NA
HTD-0281	NE1/4 Section 13, T18S, R11E	NA
HTD-0282	SW1/4 Section 30, T19S, R13E	NA
HTD-0283	SE1/4 Section 33, T19E, R13E	NA
HTD-0284	SW1/4 Section 25, T20S, R10E	NA
HTD-0285	NE1/4 Section 12, T20S, R10E	NA
HTD-0286	NE1/4 Section 7, T20S, R11E	NA
HTD-0287	SE1/4 Section 23, T20S, R11E	NA
HTD-0288	NW1/4 Section 2, T20S, R12E	NA
HTD-0289	SE1/4 Section 19, T20S, R13E	NA
HTD-0291	NW1/4 Section 25, T20S, R13E	NA
HTD-0292	SE1/4 Section 20, T19S, R15E	NA
HTD-0294	SW1/4 Section 14, T19S, R10E	NA
HTD-0307	SW1/4 Section 35, T18S, R11E	NA
HTD-0444	SW1/4 Section 29, T25S, R10E	NA
HTD-0445	NE1/4 Section30, T26S, R10E	NA
HTD-0446	N1/2 Section 36, T26S, R9E	NA
HTD-0450	Section 36, T25S, R8E	NA
HTD-0451	Section 30, T26S, R9E	NA
HTD-5854	NE1/4 Section 17, T18S, R10E	NA
U.S. Bureau of Mine Samples[1]		
USBM 1	SE1/4, Section 33, T20S, R10E	Gobbler Formation (Fm); gray, fine-grained, medium- to thick-bedded, strike N 30° E, dip 12°NW, sandy (?)

Sample	Location	Geologic Description
USBM 2	SE1/4, Section 25, T20S, R10E	Hueco Limestone; gray, fine-grained, thin-bedded, flat-lying, fractured, fossiliferous
USBM 3	SW1/4, Section 30, T20S, R11E	Hueco Limestone; dark gray, fine-grained, medium-bedded, flat-lying, fractured, fossiliferous
USBM 4	SE1/4, Section 12, T20S, R10E	Gobbler Fm; gray, fine-grained, very thick-bedded, flat-lying, iron-stained,
USBM 5	NW1/4, Section 7, T20S, R11E	Gobbler Fm; fine-grained, thick-bedded, strike N 60° W, dip 4° SW
USBM 6	NW1/4, Section 5, T20S, R11E	Gobbler Fm; gray, fine-grained, very thick-bedded, flat-lying, calcite stringers, iron-stained along fractures, fossiliferous (crinoids)
USBM 7	SE1/4, Section 17, T20S, R11E	Hueco Limestone; gray, fine-grained, medium-bedded, flat-lying, fractured, gypsum stringers and interbedded shale
USBM 11	SE1/4, Section 15, T20S, R11E	Yeso Fm; dark gray, fine-grained, medium-bedded, strike N 30°E, dip 12° SE
USBM 13	NW1/4, Section 23, T20S, R11E	Yeso Fm; gray, fine-grained, medium-bedded, strike N, dip 6° E, calcite-filled fractures, fossiliferous (crinoids, corals)
USBM 14	NW1/4, Section 27, T20S, R11E	Yeso Fm; dark gray, fine-grained, medium-bedded, strike N 60° W, dip 12° NE, calcite-filled fractures
USBM 15	NW1/4, Section 27, T20S, R11E	Yeso Fm; dark gray, fine-grained, thick-bedded, strike N 50° W, dip 10° NE, calcite vugs, petroliferous odor
USBM 16	SW1/4, Section 24, T20S, R11E	Yeso Fm; dark gray, fine-grained, medium-bedded, strike W, dip 8° S, iron-stained along fractures, petroliferous odor
USBM 17	SE1/4, Section 24 T20S, R11E ,	Yeso Fm; gray, fine-grained, thin- to medium-bedded, strike N 75° E, dip 14° SE, petroliferous odor
USBM 18	SW1/4, Section 19, T20S, R12E	Yeso Fm; gray, fine-grained, thick-bedded, flat-lying, calcite-filled fractures
USBM 19	NW1/4, Section 19, T20S, R12E	Yeso Fm; dark gray, fine-grained, strike N 70°, dip 10° SE, calcite-filled fractures
USBM 20	SE1/4, Section 18 , T20S, R12E	Yeso Fm; dark gray, fine-grained, medium- to thick-bedded, strike N 40° calcite, E, dip 5° SE, fossiliferous (ammonites, crinoids)
USBM 21	NW1/4, Section 21, T20S, R12E	Yeso Fm; gray, fine-grained, medium-bedded, flat-lying, calcite stringers, fossiliferous (crinoids)
USBM 22	SW1/4, Section 22 , T20S, R12E	Yeso Fm; gray, fine-grained, thick-bedded, strike N 35° E, dip 10° NW, calcite-filled fractures
USBM 23	NW1/4, Section 26, T20S, R12E	Yeso Fm; gray, fine-grained, thin to medium-bedded, strike N 50° E, dip 8° SE
USBM 24	SE1/4, Section 26, T20S, R12E	Yeso Fm; gray, fine-grained, medium-bedded, flat-lying, calcite vugs, fossiliferous (brachiopods)
USBM 25	SW1/4, Section 25, T20S, R12E	Yeso Fm; light gray, fine-grained, medium-bedded, strike N 70° E, dip 6° SE, petroliferous odor

Sample	Location	Geologic Description
USBM 26	NW1/4, Section 30, T20S, R13E	Yeso Fm; gray, fine-grained, very thick-bedded, flat-lying, calcite-filled vugs
USBM 27	NW1/4, Section 16, T20S, R12E	Yeso Fm; light brown, fine-grained, medium-bedded, strike N 70° E, dip 6° SE, 1 inch (2.5 cm) chert nodule layer parallel with bedding
USBM 28	SW1/4, Section 9, T20S, R12E	Yeso Fm; light gray, fine-grained, thin-bedded, strike N, dip 15° E, overlain by 6 inches (15 cm) sandstone bed and thick-bedded carbonates
USBM 29	NW1/4, Section 9, T20S, R12E	Yeso Fm; light brown, coarse-grained, very thick-bedded, flat-lying, calcite, minor iron staining
USBM 30	SE1/4, Section 4, T20S, R12E	Yeso Fm; dark gray, fine-grained, flat-lying, calcite veinlets, iron-stained along fractures, petroliferous odor
USBM 31	NW1/4, Section 11, T20S, R12E	Yeso Fm; light brown, coarse-grained, medium- to thick-bedded, strike N 46° W, dip 8° SW, calcite and limonite
USBM 32	SW1/4, Section 11, T20S, R12E	Yeso Fm; medium-grained, thick-bedded, flat-lying
USBM 33	SE1/4, Section 14, T20S, R12E	Yeso Fm; gray, fine-grained, thick-bedded, strike N 30° W, dip 8° SW, minor iron staining, fossiliferous (crinoids)
USBM 34	NE1/4, Section 24,	Yeso Fm; gray, fine-grained, very thick-bedded, flat-lying, minor iron
USBM 35	SE1/4, Section 19, T20S, R13E	San Andres Fm; light brown, fine-grained, medium-bedded, flat-lying, petroliferous odor
USBM 36	NW1/4, Section 20, T20S, R13E	San Andres Fm; gray, fine-grained, medium-bedded, flat-lying, calcite stringers, petroliferous odor
USBM 37	SE1/4, Section 7, T20S, R13E	San Andres Fm; gray, fine-grained, medium-bedded, strike N 40° E, dip 4° NW, calcite stringers
USBM 38	SE1/4, Section 19, T20S, R13E	San Andres Fm; gray, coarse-grained, thick-bedded, flat-lying, calcite stringers
USBM 39	SE1/4, Section 29, T20S, R13E	San Andres Fm; gray, coarse-grained, strike N 30° W, dip 3° SW, calcite stringers
USBM 40	SE1/4, Section 13, T20S, R13E	Yeso Fm; light brown, coarse-grained, thick- to very thick-bedded, strike W, dip 2° S
USBM 41	SW1/4, Section 24, T20S, R13E	San Andres Fm; light brown, coarse-grained, thick-bedded, strike N 30° E, dip 3° SE
USBM 42	NE1/4, Section 35, T20S, R13E	San Andres Fm; light brown, coarse-grained, thin- to medium-bedded, flat-lying
USBM 43	NE1/4, Section 2, T21S, R13E	San Andres Fm; dark gray, coarse-grained, thin- to medium-bedded, calcite stringers
USBM 44	SW1/4, Section 5, T21S, R14E	San Andres Fm; light gray, fine-grained, thick-bedded, strike N, dip 3° E
USBM 45	NW1/4, Section 7, T21S, R14E	San Andres Fm; light gray, fine-grained, flat-lying, chert pebbles & nodules parallel to bedding

Sample	Location	Geologic Description
USBM 46	NW1/4, Section 14, T21S, R13E	San Andres Fm; gray, coarse-grained, medium-bedded, flat-lying, petroliferous odor
USBM 47	SE1/4, Section 16, T21S, R13E	Yeso Fm; light brown, coarse-grained, strike N 65° E, dip 15° SE
USBM 48	SE1/4, Section 10, T21S, R12E	Yeso Fm; light brown, coarse-grained, flat-lying, calcite vugs and stringers
USBM 49	NW1/4, Section 1, T21S, R12E	San Andres Fm; gray, medium-grained, thick and stringers, fossiliferous (brachiopods, bryozoa, corals, crinoids)
USBM 50	NW1/4, Section 4, T21S, R12E	Yeso Fm; gray, medium-grained, medium-bedded, strike N 55° W, dip 2° SW
USBM 51	SW1/4, Section 9, T21S, R11E	Yeso Fm; gray, coarse-grained, thick-bedded, flat-lying; with calcite veinlets
USBM 52	SW1/4, Section 9, T21S, R11E	Yeso Fm; gray, coarse-grained, thick-bedded, strike W, dip 4° N; with calcite stringers
USBM 53	NW1/4, Section 16, T21S, R11E	Yeso Fm; gray, fine-grained, very thick-bedded, flat-lying, calcite stringers
USBM 54	SE1/4, Section 17, T21S, R11E	Yeso Fm; gray, fine-grained, medium-bedded, strike N 80° E, dip 7° SE, calcite stringers
USBM 55	NE1/4, Section 20, T21S, R11E	Yeso Fm; gray, medium-bedded, strike W, dip 14° S
USBM 59	SE1/4, Section 30, T21S, R11E	Yeso Fm; gray, fine-grained, thick-bedded, strike N 20° E, dip 5° SE
USBM 60	SE1/4, Section 30, T21S, R11E	Yeso Fm; gray, coarse-grained, thick-bedded, strike N 22° E, dip 8° SE, calcite stringers,fossiliferous (gastropods)
USBM 61	NW1/4, Section 31, T21S, R11E	Yeso Fm; gray, fine-grained, medium-bedded, strike N, dip 5° 1 E, calcite stringers, minor iron staining
USBM 62	NW1/4, Section 31, T21S, R11E	Yeso Fm; gray, fine-grained, thick-bedded, flat-lying, calcite stringers, minor iron staining
USBM 63	SW1/4, Section 31, T21S, R11E	Yeso Fm; gray, fine-grained, very thick-bedded, flat-lying, calcite stringers
USBM 64	SE1/4, Section 5, T22S, R11E	Yeso Fm; dark gray, fine-grained, very thick-bedded, strike N 25° E, dip 4° NW, calcite-filled vugs
USBM 65	NE1/4, Section 12, T22S, R10E	Yeso Fm; gray, medium-bedded, flat-lying, calcite stringers, minor chert
USBM 66	NE1/4, Section 11, T22S, R10E	Yeso Fm; gray, fine-grained, thick-bedded, strike N 5° W, dip 3° NE, minor iron staining.
USBM 67	NW1/4, Section 18, T22S, R11E	Yeso Fm; gray, fine-grained, thick-bedded, strike N 60° E, dip 4° SE, calcite filled vugs and stringers, fossiliferous
USBM 68	NE1/4, Section 19, T22S, R11E	Yeso Fm; light pink, medium-grained, medium-bedded, strike N 50° W, dip 9° NE, minor calcite
USBM 69	NW1/4, Section 20, T22S, R11E	Yeso Fm; fine-grained, thick-bedded, strike N 40° W, dip 5° NE, calcite stringers

Sample	Location	Geologic Description
USBM 70	NW1/4, Section 29, T22S, R11E	Yeso Fm; light pink, fine-grained, thick-bedded, flat-lying, minor chert, calcite-filled vugs and stringers
USBM 71	SE1/4, Section 25, T22S, R10E	Yeso Fm; tan, fine-grained, medium-bedded, strike N 20° W, dip 5° NE, minor iron staining
USBM 72	SE1/4, Section 25, T22S, R10E	Yeso Fm; dark gray, fine-grained, strike N 70° E, dip 14° SE, calcite-filled vugs and stringers, thin chert lenses parallel to bedding
USBM 73	SE1/4, Section 29, T22S, R11E	Yeso Fm; gray, fine-grained, medium- to thick-bedded, flat-lying, calcite-filled vugs, minor iron staining
USBM 74	NE1/4, Section 31, T22S, R11E	Yeso Fm; gray, fine-grained, medium-bedded, strike N 45° E, dip 3° SE, calcite stringers, fossiliferous, petroliferous odor
USBM 75	SE1/4, Section 31, T22S, R11E	Yeso Fm; light gray, medium-grained, thick-bedded, flat-lying, calcite-filled fractures, fossiliferous (brachiopods)
USBM 76	NW1/4, Section 7, T23S, R11E	Yeso Fm; tan, medium-grained, medium-bedded, flat-lying, calcite-filled vugs and fractures
USBM 77	NW1/4, Section 7, T23S, R11E	Yeso Fm; gray, fine-grained, very thick-bedded, strike N 22° W, dip 4° NE, calcite-filled fractures, fossiliferous (brachiopods)
USBM 78	NW1/4, Section 18, T23S, R11E	Yeso Fm; dark gray, fine-grained, medium- to thick-bedded, flat-lying, calcite-filled fractures, minor iron staining
USBM 79	NE1/4, Section 19, T23S, R11E	Yeso Fm; gray, medium-bedded, flat-lying, calcite-filled vugs and fractures, minor iron staining
USBM 80	NE1/4, Section 20, T23S, R11E	Yeso Fm; tan, fine-grained, thick-bedded, flat-lying, calcite-filled, Rugs and fractures, minor iron staining
USBM 81	SE1/4, Section 31, T23S, R12E	Yeso Fm; gray, coarse-grained, thick-bedded, strike N 65° W, dip 4° NE
USBM 82	SE1/4, Section 30, T23S, R11E	Yeso Fm; fine-grained, thick-bedded, flat-lying, minor chert and iron-staining
USBM 83	NE1/4, Section 6, T24S, R11 E	Yeso Fm; light gray, fine-grained, thick-bedded, strike N 70° W, dip 4° NE, chert pebbles and nodules parallel with bedding, fossiliferous (crinoids)
USBM 84	SE1/4, Section 6, T24S, R11E	Yeso Fm; light gray, fine-grained, thick-bedded, flat-lying, calcite stringers
USBM 85	SE1/4, Section 7, T24S, R11E	Yeso Fm; light gray, fine-grained, medium-bedded, flat-lying, calcite stringers
USBM 86	SE1/4, Section 18, T24S, R11E	Yeso Fm; gray, fine-grained, thick-bedded, flat-lying, calcite stringers
USBM 87	NW1/4, Section 20, T24S, R11E	Yeso Fm; gray, fine-grained, thick-bedded, flat-lying, minor chert
USBM 88	SE1/4, Section 36, T24S, R10E	Yeso Fm; light gray, fine-grained, medium- to thick-bedded, strike N 30° E, dip 5° SE, calcite stringers

Sample	Location	Geologic Description
USBM 89	SW1/4, Section 6, T25S, R11E	Yeso Fm; gray, fine-grained, medium-bedded, strike N 10° W, dip 12° NE, shaly with calcite stringers
USBM 90	NE1/4, Section 13, T25S, R10E	Yeso Fm; light gray, fine-grained, medium-bedded, flat-lying, calcite-filled vugs
USBM 91	NE1/4, Section 13, T25S, R10 E	Yeso Fm; gray, fine-grained, thin- to medium-bedded, strike N 60° E, dip 8° SE, calcite stringers, fractured
USBM 92	SE1/4, Section 13, T25S, R10 E	Yeso Fm; gray, fine-grained, flat-lying, calcite stringers, fractured
USBM 93	SE1/4, Section 14, T26S, R9E	Pennsylvanian-age limestone; tan, fine-grained, medium-bedded, flat-lying

[1] Source: Kness 1994 Table 1. Bed thickness ranges from very thin (<1 inches, <2.5 cm), thin (1-3 inches, 2.5–7.6 cm), medium (4–12 inches, 10–30 cm), thick (13–35 inches, 33–90 cm), and very thick (>3 ft >90 cm).

APPENDIX 12:

MINERALOGY OF THE CLAY-SIZED FRACTION
OF SAMPLED SHALES, MUDSTONES,
AND OTHER SHALY ROCKS

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MINERALOGY OF THE CLAY-SIZED FRACTION OF SAMPLED SHALES, MUDSTONES, AND OTHER SHALY ROCKS

Sample Number	KAO[1]	ILL[1]	CHL[1]	SME[1]	I/S[1]	Others[1]
JB-IM013	1	4	–	TR	5	CAL, QTZ
JB-IM021	–	4	3	–	3	(CAL), (DOL)
VTM 97-58	3	2	3	1	1	(CAL), (QTZ)
VTM 97-92	3	4	–	–	3	(CAL), (QTZ)
VTM 97-67	8	1	–	TR	TR	DOL
VTM 97-150	2	4	–	–	4	CAL, QTZ, DOL, FEL
VTM 97-236	2	3	3	–	2	(DOL)
VTM 97-237	2	3	2	–	3	DOL, FEL
VTM 97-136	6	3	–	–	1	–
VTM 97-246	–	6	2	–	2	QTZ, (CAL), (DOL)
VTM 97-160	2	4	2	TR	2	DOL
VTM 97-325	8	1	–	TR	1	QTZ
VTM 97-172	2	3	–	1	4	CAL, (QTZ)
VTM 97-170	1	3	–	TR	6	(QTZ), (FEL)

[1] KAO = kaolinite, ILL = illite, CHL = chlorite, SME = smectite, and I/S = mixed-layer illite and smectite. Clay minerals reported as parts in ten. TR = trace or less than 0.5 parts in 10. Non-clay minerals (in order of abundance): CAL = calcite, DOL = dolomite, FEL = feldspar, QTZ = quartz, - = not present, and ( ) = minor component.

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APPENDIX 13:

MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED
BY NEW MEXICO HIGHWAY DEPARTMENT
ON OR NEAR MCGREGOR RANGE

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MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED BY NEW MEXICO HIGHWAY DEPARTMENT ON OR NEAR MCGREGOR RANGE.[1]

Pit Number		HTD-0284	HTD-0285	HTD-0286	HTD-0287	HTD-0288	HTD-0289
Location		SW1/4 Sec. 25, T20S, R10E	NE1/4 Sec. 12, T20S, R10E	NE1/4 Sec. 8, T20S, R11E	SE1/4 Sec. 23, T20S, R11E	NW1/4 Sec. 2, T20S, R12E	NE1/4 Sec. 19, T20S, R13E
Formation (Fm.)		Alluvium	Alluvium	Eolian	Yeso Fm.	Yeso Fm.	Alluvium
Rock type		Gravel	Gravel & sand	Sand	Limestone		Gravel
Source rock (gravel)		Limestone	Limestone				Limestone
Material quality		Good	Excellent	Good	Good	Good	Excellent
Material thickness		4'	7' plus	5' plus	6'	7' plus	5'
Cap (caliche) thickness							
Material underlying Fm.		Silty sand	Silt	Limestone	Sandstone	Sandstone	Sandy silt
Overburden thickness		2'	1'	None	1'	1'	6'
P. I. (overburden)		Not plastic	Not plastic		Not plastic	14	7
Est. quantity (yds^3)		100,000	200,000	400,000	100,000	Unlimited	200,000
% LA Wear		35.0	28.4		26.0	41.0	27.4
Soundness loss							
Av. max. Size		8"	12"	No. 40 screen			7"
Plasticity index		Not plastic	Not plastic	Not plastic	Not plastic	Not plastic	Not plastic
% Retained 2" sieve		37	15				26
Pit average	Crushed to:	As received	As received		1"	1"	As received
% Passing	2"	63	35				52
	1"	51	67		100	100	36
	½"	36	40		52	61	24
	No. 4	21	22		21	25	16
	No. 10	15	13	100	11	15	13
	No. 200	2	3	4	3	4	7

[1] Data and modified table from New Mexico Highway Department, Geology and Aggregate Resources District II (1972).

MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED BY NEW MEXICO HIGHWAY DEPARTMENT ON OR NEAR MCGREGOR RANGE.[1]

Pit Number		HTD-0290	HTD-0291	HTD-0294	HTD-0433	HDT-0434	HDT-0435
Location		SE1/4 Sec. 5, T21S, R12E	NW1/4 Sec. 25, T20S, R13E	SW1/4 Sec. 14, T19S, R10E	N1/2 Sec. 15, T21S, R11E	N1/4 Sec. 18, T21S, R12E	SW1/4 Sec. 12, T21S, R12E
Formation (Fm.)		Yeso Fm.	Alluvium	Alluvium	Alluvium	Alluvium	Alluvium
Rock type		Caliche/limestone	Sand & gravel	Sand & gravel	Sand & gravel	Gravel	Gravel
Source rock (gravel)			Limestone	Limestone	Limestone	Limestone	Limestone
Material quality		Good	Excellent	Excellent	Excellent	Good	Good
Material thickness		4' plus	15'	6' plus	8' plus	4' plus	5' plus
Cap (caliche) thickness		0.5"				None	None
Material underlying Fm.		Limestone	Limestone	Silt & sand	Silt	Silt	
Overburden thickness		6"	1'	1'	None	1'	1'
P. I. (overburden)		Not plastic	12	Not plastic		Not plastic	Not plastic
Est. quantity (yds^3)		Unlimited	500,000	200,000	150,000	Unlimited	Unlimited
% LA Wear		24.4	24.8	20.0	21.2	17.2	21.0
Soundness loss							
Av. max. size			17"	25"	4"	9"	20"
Plasticity index		Not plastic	Not plastic	Not plastic	Not plastic	Not plastic	Not plastic
% Retained 2" sieve			10	15	18	25	30
Pit average	Crushed to:	1"	As received	As received	1"	As received	As received
% Passing	2"		90	89		74	85
	1"	100	80	60	100	46	46
	½"	62	67	42	59	32	46
	No. 4	25	26	27	26	22	22
	No. 10	14	12	23	17	18	11
	No. 200	3	3	8	5	6	3

[1] Data and modified table from New Mexico Highway Department, Geology and Aggregate Resources District II (1972).

MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED BY NEW MEXICO HIGHWAY DEPARTMENT ON OR NEAR MCGREGOR RANGE.[1]

Pit Number		HDT-0444	HDT-0445	HDT-0446	HDT-0450	HDT-0451
Location		SW1/4 Sec. 29, T25S, R10E	NE1/4 Sec. 30, T26S, R10E	N1/2 Sec. 36, T26S, R9E	Sec. 31, T25S, R8E	SW1/4 Sec. 30, T26S, R9E
Formation (Fm.)		Hueco Limestone	Alluvium	Intrusive rock	Alluvium	Pediment
Rock type		Limestone	Gravel	Rhyolite	Gravel	Gravel
Source rock (gravel)			Limestone & rhyolite		Limestone & rhyolite	Limestone
Material quality		Excellent	Good	Fair	Good	Good
Material thickness		20' plus	15' plus	Variable	30' plus	20' plus
Cap (caliche) thickness			None	None		0-1
Material underlying Fm.		Sandstone		Limestone		Limestone
Overburden thickness		0-2'	0-2'	0-10'	0-6'	2'
P. I. (overburden)		Not plastic	Not plastic		Not plastic	S. not plastic
Est. quantity (yds^3)		Unlimited	100,000	20,000	600,000 plus	600,000 plus
% LA Wear		20.0	25.0	35.2	20.0	21.2
Soundness loss						
Av. max. size		8"	8"		10"	12"
Plasticity index		Not plastic	Not plastic	Not plastic	4	Not plastic
% Retained 2" sieve			25		25	30
Pit average % Passing	Crushed to:	1"	As received	1"	As received	As received
	2"		76		74	57
	1"	100	61	100	59	42
	½"	66	44	77	35	27
	No. 4	27	27	30	20	17
	No. 10	13	17	15	13	10
	No. 200	2	6	2	5	4

[1] Data and modified table from New Mexico Highway Department, Geology and Aggregate Resources District II (1972).

MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED BY NEW MEXICO HIGHWAY DEPARTMENT ON OR NEAR MCGREGOR RANGE.[1]

Pit Number		HDT-0282	HDT-0283	HDT-0307	HDT-0436	HDT-0437	HDT-0443
Location		SW1/4 Sec. 30, T19S, R13E	SE1/4 Sec. 33, T19S, R13E	SW1/4 Sec. 35, T18S, R11E	SW1/4 Sec. 4, T22S, R14E	NW1/4 Sec. 30, T22S, R14E	NW1/4 Sec. 3, T26S, R11E
Formation (Fm.)		Alluvium	Alluvium	Hueco Limestone	Alluvium	Alluvium	Caliche
Rock type		Sand & gravel	Gravel	Limestone	Gravel	Gravel	Caliche
Source rock (gravel)		Limestone	Limestone		Limestone	Limestone	
Material quality		Excellent	Good	Excellent	Good	Good	Good
Material thickness		11'	25'	15' plus	14' plus	6' plus	2–4'
Cap (caliche) thickness					None	None	3'
Material underlying Fm.		Sandstone	Limestone	Silty sandstone		Limestone	Limestone
Overburden thickness		3'	1'	2'	1' plus	1' plus	0–2'
P. I. (overburden)		Not plastic	Not plastic	6'	Not plastic	4	Not plastic
Est. quantity (yds3)		200,000 plus	300,000 plus	Unlimited	Unlimited	Unlimited	200,000 plus
% LA Wear		27.4	28.4	26.0	23.0	24.0	42.0
Soundness loss			2.7				26.3
Av. max. size		24"	16"		10"	12"	
Plasticity index		6	Not plastic	Not plastic	Not plastic	4	Not plastic
% Retained 2" sieve		30	20		30	40	
Pit average	Crushed to:	As received	As received	1"	As received	As received	1"
% Passing	2"	71	45		58	68	
	1"	47	31	100	42	51	100
	½"	26	15	60	29	35	90
	No. 4	12	9	29	17	19	53
	No. 10	9	8	14	14	12	30
	No. 200	4	3	4	8	6	14

[1] Data modified table from New Mexico Highway Department, Geology and Aggregate Resources District II (1972).

MATERIAL PIT SUMMARY FOR SAMPLES COLLECTED BY NEW MEXICO HIGHWAY DEPARTMENT ON OR NEAR MCGREGOR RANGE.[1]

Pit Number		HDT-0449	HDT-0452	HDT-0612	HDT-5857	HDT-6404	HDT-6405
Location		NE1/4 Sec. 9, T23S, R8E	Sec. 35, T25S, R6E	NE1/4 Sec. 32, T23S, R13E	NE1/4 Sec. 15, T22S, R8E	NE1/4 Sec. 36, T26S, R5E	SW4 Sec. 14, T22S, R8E
Formation (Fm.)		Alluvium & bolson	Alluvium & bolson	Caliche	Alluvial fan	Alluvium & bolson	Pennsylvanian
Rock type		Caliche	Sand	Caliche	Gravel	Sand & gravel	Altered limestone
Source rock (gravel)					Monzonite, syenite & limestone	Limestone & quartz	
Material quality		Fair	Fair	Good	Fair	Excellent	Excellent
Material thickness		4'	6'	2.5' plus	20' plus	50' plus	25' plus
Cap (caliche) thickness		1'		2.5'			
Material underlying Fm.		Silt & sand		Limestone	Altered limestone		Limestone
Overburden thickness		1–4'	1'	0–1'	0–3'	5–12'	1'
P. I. (overburden)		S. not plastic	S. not plastic	S. not plastic	S. not plastic		Not plastic
Est. quantity (yds3)		100,000	150,000	Unlimited	200,000 plus	600,000 plus	100,000
% LA Wear		Cap: 57.8	Soft cal: 63.6	27.3	25.6	23.6	17.2
Soundness loss		38.9		26.3			5.3
Av. max. size			2"		8"	3"	
Plasticity index		Not plastic	Not plastic	Not plastic	Not plastic	Not plastic	Not plastic
% Retained 2" sieve		10				15	20
Pit average	Crushed to: 1"	1"	As received	As received	1"	As received	As received
% Passing	2"		89		79	90	
	1"	100	84		100	64	62
	½"	81	68		79	48	31
	No. 4	33	39		32	36	16
	No. 10	20	23	100	18	26	10
	No. 200	5	6	21	4	7	3

[1] Data modified table from New Mexico Highway Department, Geology and Aggregate Resources District II (1972).

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APPENDIX 14:

LA WEAR TEST RESULTS FROM SELECTED MCGREGOR RANGE SAMPLES

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Sample	Lithology	Percent Wear	Grading	Lab Remarks
JB-IM002	Limestone, chert, caliche	22.8	B	Very good
JB-IM003	Limestone	21.7	B	Good
JB-IM004	Caliche	37.5	B	Broke up
JB-IM005	Caliche, limestone	46.1	B	Flat & elongated
JB-IM006	Limestone	22.8	B	Average
JB-IM006DUP	Limestone	23.3	B	--
JB-IM007	Caliche, limestone, chert	35.1	B	Average
JB-IM010	Caliche, chert	27.7	B	Porous, friable
JB-IM013	Limestone	21.7	B	Ideal
JB-IM015	Caliche, limestone, chert	28.8	B	Fail stripping test
JB-IM016	Limestone, chert, caliche	25.6	B	Chert; caliche wore
JB-IM018	Caliche, limestone	28.3	B	Caliche wore
JB-IM019Cal	Caliche	38.3	B	Excessive fines
JB-IM021Ls	Limestone	14.6	B	Exceptional
JB-IM023	Limestone conglomerate	19.1	B	Caliche coating
JB-IM025	Limestone gravel	31.1	B	Splitting
JB-IM026	Limestone, chert, silt	34.3	B	Chipping, flaking

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APPENDIX 15:

LOCATION AND DESCRIPTION OF GYPSUM SAMPLES
COLLECTED ON MCGREGOR RANGE

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LOCATION AND DESCRIPTION OF GYPSUM SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample	Location	Description
USBM-8	SE1/4, Sec. 15, T20S R11E	Yeso Fm; 5 ft (1.5 m) thick bed, strike N 30° E, dip 8° SE, overlain and underlain by red beds.
USBM-9	SE1/4, Sec. 15, T20S R11E	Yeso Fm; 12 ft (4 m) exposed of lower bed, overlain by 20 ft (6 m) thick sandstone red beds.
USBM-10	SE1/4, Sec. 15, T20S R11E,	Yeso Fm; 3 ft (0.9 m) thick upper bed, overlain by talus.
USBM-12	NW1/4, Sec. 23, T20S R11E	Yeso Fm; 6 ft (1.8 m) thick bed in red beds, traceable 40 ft (12 m), strike N, dip 6° E, overlain and underlain by limestone.
USBM-56	SE1/4, Sec. 17, T2S R11E,	Yeso Fm; 10 ft (3 m) exposed in drainage, flat- lying.
USBM-57,	SE1/4, Sec. 17, T2S R11E	Yeso Fm; 25 ft (8 m) (?) exposed in drainage, flat lying.
USBM-58,	NE1/4, Sec. 20, T2S R11E	Yeso Fm; 25 ft (8 m) (?) exposed in drainage, flat lying.

[1] Collected by U.S. Bureau of Mines on McGregor Range, Fort Bliss Military Reservation, New Mexico. Source: Kness 1994:Table 3.

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APPENDIX 16:

ANALYTICAL DATA FOR GYPSUM SAMPLES COLLECTED ON MCGREGOR RANGE

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LOCATION AND DESCRIPTION OF GYPSUM SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	Free water[2]	Combined water[2]	SiO_2+ insol.[3]	Al_2O_3[3]	% CaO[3]	CO_2[3]	Fe_2O_3[3]	K_2O[3]	MgO[3]	MnO[3]	NaCl[3]	Na_2O[3]	SiO_2[3]	SO_3[3]	TiO_2[3]
USBM-8	0.021	18.2	5.10	0.61	30.2	<0.1	0.16	0.18	0.850	0.006	<0.04	0.12	4.70	42.1	0.03
USBM-9	0.012	19.9	0.65	0.13	32.3	<0.1	0.03	<0.01	0.180	0.003	<0.04	0.05	0.65	40.1	<0.01
USBM-10	0.005	20.0	0.57	0.05	32.3	<0.1	<0.01	<0.01	0.090	0.001	<0.04	0.04	0.17	42.3	<0.01
USBM-12	0.004	20.1	0.07	0.03	32.5	<0.1	<0.01	<0.01	0.045	<0.001	<0.04	0.07	0.09	44.1	<0.01
USBM-56	0.004	17.6	0.20	0.07	32.3	<0.1	0.01	<0.01	0.091	<0.001	<0.04	0.06	0.30	40.1	<0.01
USBM-57	0.015	19.8	0.90	0.21	32.0	<0.1	0.10	0.02	0.270	0.002	<0.04	0.07	0.94	39.1	0.01
USBM-58	0.004	19.8	0.15	0.05	32.2	<0.1	0.04	<0.01	0.430	0.001	<0.04	0.05	0.11	42.1	<0.01

1 Source: Kness 1994:Table 3.

2 Free and combined water analysis by Hazen Research, Inc., Golden, CO.

3 Other analysis by Skyline Labs, Wheatridge, CO. Al_2O_3, aluminum oxide; CaO, calcium oxide; CO_2, carbon dioxide; Fe_2O_3, iron oxide; K_2O, potassium oxide; MgO, magnesium oxide; MnO, manganese oxide; NaCl, sodium chloride; Na_2O, sodium oxide; SiO_2, silicon dioxide; SO_3, sulfur oxide; TIO_2, titanium dioxide insol., insolubles; <, less than. All samples are random chip.

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APPENDIX 17:

CALCULATED RESULTS OF GYPSUM SAMPLE DATA
COLLECTED ON MCGREGOR RANGE

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CALCULATED RESULTS OF GYPSUM SAMPLE DATA COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	$CaSO_4H_2O$[2]	$CaSO_4 \cdot ½ H_2O$[2]	$CaSO_4$[2]	R_2O_3[2]	$CaCO_3$[2]	$MgCO_3$[2]
USBM-8	86.96	73.30	2.82	0.77	1.29	1.78
USBM-9	95.08	80.15	0.00	0.16	2.37	0.38
USBM-10	95.56	80.56	0.00	<0.06	2.11	0.19
USBM-12	96.03	80.95	0.00	< 0.04	2.18	0.09
USBM-56	84.09	70.89	1.70	0.08	7.51	0.19
USBM-57	94.60	79.75	0.00	0.31	2.12	0.57
USBM-58	94.60	79.75	0.00	0.09	2.48	0.71

[1] Source: Kness 1994:Table 5.

[2] $CaSO_4$, calcium sulfate; H_2O, water; R_2O_3, iron and aluminum oxide; $CaCO_3$, calcium carbonate; $MgCO_3$, magnesium carbonate.

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APPENDIX 18:

ANALYTICAL DATA FOR CARBONATE ROCK SAMPLES
COLLECTED ON MCGREGOR RANGE

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ANALYTICAL DATA FOR CARBONATE ROCK SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	$CaCO_3$ (%)	$MgCO_3$ (%)	Al_2O_3 (%)	Cr_2O_3 (%)	Fe_2O_3 (%)	K_2O (%)	MnO (%)	Na_2O (%)	P_2O_5 (%)	SiO_2 (%)	TiO_2 (%)	LOI (%)
USBM-1	92.76	0.75	0.38	< 0.01	0.19	0.02	0.01	0.14	< 0.01	0.21	0.03	41.41
USBM-2	92.69	1.53	0.49	< 0.01	0.43	0.04	0.01	0.03	< 0.01	3.88	0.01	41.79
USBM-3	57.31	24.83	0.49	< 0.01	0.62	0.06	0.01	0.18	< 0.01	3.92	0.01	43.82
USBM-4	96.58	0.73	0.14	< 0.01	0.34	0.02	0.01	0.04	< 0.01	0.72	< 0.01	43.44
USBM-5	97.04	0.63	0.26	< 0.01	0.15	0.04	0.30	0.03	< 0.01	2.50	0.02	42.89
USBM-6	89.85	5.72	0.21	< 0.01	0.60	0.03	0.07	0.06	< 0.01	1.76	< 0.01	43.37
USBM-7	41.21	81.02	1.89	< 0.01	1.76	0.11	0.02	0.34	< 0.01	12.67	0.07	36.74
USBM-11	94.94	1.53	0.27	< 0.01	0.10	0.13	< 0.01	0.02	< 0.01	1.59	0.01	43.00
USBM-13	97.27	1.45	0.13	< 0.01	0.02	0.05	< 0.01	0.07	< 0.01	1.49	< 0.01	41.88
USBM-14	96.76	0.88	0.17	< 0.01	0.03	0.07	< 0.01	0.07	< 0.01	1.51	< 0.01	43.15
USBM-15	60.11	36.59	0.35	< 0.01	0.66	0.12	0.02	0.08	< 0.01	1.99	0.01	45.50
USBM-16	94.88	1.19	0.35	< 0.01	0.13	0.12	0.01	0.08	< 0.01	2.00	0.01	42.85
USBM-17	92.62	1.09	0.20	< 0.01	0.06	0.07	0.01	0.06	< 0.01	4.07	0.01	42.32
USBM-18	97.31	1.03	0.04	< 0.01	0.04	0.02	0.01	< 0.01	< 0.01	0.90	< 0.01	43.40
USBM-19	93.55	2.12	0.12	< 0.01	0.09	0.05	< 0.01	0.06	< 0.01	3.S8	< 0.01	42.23
USBM-20	85.58	5.70	0.90	< 0.01	0.31	0.22	< 0.01	0.06	< 0.01	5.72	0.04	41.16
USBM-21	88.22	0.86	0.33	< 0.01	0.03	0.09	< 0.01	0.04	< 0.01	9.26	0.01	39.52
USBM-22	96.72	0.42	0.12	< 0.01	0.01	0.03	< 0.01	< 0.01	< 0.01	1.97	< 0.01	42.44
USBM-23	53.92	44.37	0.29	< 0.01	0.20	0.05	0.02	0.05	< 0.01	1.66	< 0.01	45.17

[1] After Kness (1994). Analysis of samples by inductively coupled plasma-atomic emission-spectroscopy. $CaCO_3$, calcium carbonate; $MgCO_3$, magnesium carbonate; Al_2O_3, aluminum oxide; Cr_2O_3, chromium oxide; Fe_2O_3, Iron oxide; K_2O, potassium oxide; MnO, manganese oxide; Na_2O, sodium oxide; P_2O_5, phosphorous pentoxide; SiO_2, silicon dioxide; TiO_2, titanium dioxide; LOI, loss on ignition; <, less than. $CaCO_3$ and $MgCO_3$ are calculated, other detection limits are 0.01%. All samples are random chip.

ANALYTICAL DATA FOR CARBONATE ROCK SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	$CaCO_3$ (%)	$MgCO_3$ (%)	Al_2O_3 (%)	Cr_2O_3 (%)	Fe_2O_3 (%)	K_2O (%)	MnO (%)	Na_2O (%)	P_2O_5 (%)	SiO_2 (%)	TiO_2 (%)	LOI (%)
USBM-24	53.83	44.83	0.21	< 0.01	0.09	0.04	0.01	0.06	< 0.01	1.40	< 0.01	45.56
USBM-25	52.99	46.06	0.22	< 0.01	0.17	0.05	0.02	0.06	< 0.01	1.24	< 0.01	47.89
USBM-26	55.40	37.93	0.13	< 0.01	0.06	0.03	< 0.01	0.06	< 0.01	6.30	< 0.01	43.56
USBM-27	54.31	45.12	0.09	< 0.01	0.14	0.02	0.01	0.05	< 0.01	1.01	< 0.01	46.73
USBM-28	53.78	46.44	0.07	< 0.01	0.12	0.02	0.01	0.07	< 0.01	0.61	< 0.01	46.34
USBM-29	97.90	0.38	0.01	< 0.01	< 0.01	0.02	< 0.01	0.03	< 0.01	0.66	< 0.01	43.99
USBM-30	95.67	0.75	0.25	< 0.01	0.07	0.04	0.01	0.06	< 0.01	2.38	< 0.01	43.06
USBM-31	94.63	1.36	0.44	< 0.01	0.16	0.06	0.01	0.03	< 0.01	2.36	0.01	42.79
USBM-32	76.09	7.75	1.11	< 0.01	0.36	0.19	0.01	0.03	< 0.01	12.75	0.06	38.38
USBM-33	96.88	0.86	0.10	< 0.01	0.02	0.03	< 0.01	0.06	< 0.01	1.11	< 0.01	43.76
USBM-34	93.56	0.98	0.16	< 0.01	0.05	0.04	< 0.01	0.01	< 0.01	3.87	< 0.01	42.37
USBM-35	90.94	1.28	0.47	< 0.01	0.20	0.09	< 0.01	0.08	< 0.01	5.83	0.02	43.18
USBM-36	97.10	0.86	0.12	< 0.01	0.09	0.01	< 0.01	0.07	< 0.01	1.12	< 0.01	43.14
USBM-37	95.33	0.71	0.12	< 0.01	0.08	0.01	< 0.01	0.07	< 0.01	1.57	< 0.01	43.04
USBM-38	96.77	0.94	0.12	< 0.01	0.09	0.02	< 0.01	0.05	< 0.01	0.87	< 0.01	43.35
USBM-39	97.17	0.84	0.10	< 0.01	0.09	0.01	< 0.01	0.07	< 0.01	1.03	< 0.01	43.27
USBM-40	96.02	1.28	0.19	< 0.01	0.12	0.02	< 0.01	0.09	< 0.01	1.21	< 0.01	42.33
USBM-41	95.88	0.98	0.16	< 0.01	0.10	0.02	< 0.01	0.08	< 0.01	1.17	< 0.01	42.59
USBM-42	61.15	36.59	0.24	< 0.01	0.23	0.03	0.01	0.10	< 0.01	1.28	0.01	44.70
USBM-43	95.03	1.13	0.16	< 0.01	0.12	0.03	< 0.01	0.07	< 0.01	1.50	< 0.01	43.20
USBM-44	91.10	4.38	0.30	< 0.01	0.19	0.05	< 0.01	0.06	< 0.01	2.44	0.01	42.86
USBM-45	59.20	42.04	0.19	< 0.01	0.19	0.01	0.01	0.13	< 0.01	0.95	< 0.01	45.75

[1] After Kness (1994). Analysis of samples by inductively coupled plasma-atomic emission-spectroscopy. $CaCO_3$, calcium carbonate; $MgCO_3$, magnesium carbonate; Al_2O_3, aluminum oxide; Cr_2O_3, chromium oxide; Fe_2O_3, Iron oxide; K_2O, potassium oxide; MnO, manganese oxide; Na_2O, sodium oxide; P_2O_5, phosphorous pentoxide; SiO_2, silicon dioxide; TiO_2, titanium dioxide; LOI, loss on ignition; <, less than. $CaCO_3$ and $MgCO_3$ are calculated, other detection limits are 0.01%. All samples are random chip.

ANALYTICAL DATA FOR CARBONATE ROCK SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	$CaCO_3$ (%)	$MgCO_3$ (%)	Al_2O_3 (%)	Cr_2O_3 (%)	Fe_2O_3 (%)	K_2O (%)	MnO (%)	Na_2O (%)	P_2O_5 (%)	SiO_2 (%)	TiO_2 (%)	LOI (%)
USBM-46	96.04	0.80	0.17	< 0.01	0.10	0.02	< 0.01	0.06	< 0.01	2.21	< 0.01	42.22
USBM-47	96.15	0.96	0.25	< 0.01	0.15	0.04	< 0.01	0.06	< 0.01	1.58	0.01	42.99
USBM-48	59.44	36.34	0.35	< 0.01	0.85	0.03	0.07	0.09	< 0.01	1.76	0.01	45.50
USBM-49	90.99	3.00	0.24	< 0.01	0.09	0.07	< 0.01	0.05	< 0.01	4.34	< 0.01	42.30
USBM-50	84.64	5.70	0.66	< 0.01	0.33	0.11	0.01	0.11	< 0.01	5.73	0.04	41.29
USBM-51	97.52	0.86	0.23	< 0.01	0.09	0.07	< 0.01	0.06	< 0.01	2.30	< 0.01	42.93
USBM-52	85.24	11.65	0.34	< 0.01	0.25	0.06	0.01	0.07	< 0.01	3.09	0.01	43.99
USBM-53	96.61	1.05	0.21	0.01	0.21	0.04	< 0.01	0.09	< 0.01	2.55	0.01	42.82
USBM-54	92.74	4.61	0.11	< 0.01	0.10	0.07	< 0.01	0.05	< 0.01	1.41	< 0.01	43.77
USBM-55	58.86	34.66	0.69	< 0.01	0.40	0.17	0.01	0.08	< 0.01	4.79	0.03	44.28
USBM-59	89.99	1.30	0.38	0.01	0.23	0.09	< 0.01	0.10	< 0.01	6.26	0.02	41.19
USBM-60	94.76	1.80	0.20	0.01	0.19	0.04	< 0.01	0.11	< 0.01	2.35	0.01	42.53
USBM-61	89.55	6.06	0.38	0.01	0.29	0.08	< 0.01	0.09	< 0.01	2.60	0.02	43.08
USBM-62	94.58	1.00	0.25	0.01	0.19	0.05	< 0.01	0.10	< 0.01	2.76	0.01	42.61
USBM-63	91.96	1.15	0.39	0.01	0.31	0.04	< 0.01	0.14	< 0.01	6.03	0.02	41.36
USBM-64	93.83	3.60	0.20	0.35	0.23	0.03	0.01	< 0.01	< 0.01	0.95	< 0.01	43.50
USBM-65	86.32	10.02	0.22	0.32	0.25	0.04	< 0.01	< 0.01	< 0.01	2.05	< 0.01	43.28
USBM-66	57.12	33.53	0.67	0.21	0.49	0.14	0.01	< 0.01	< 0.01	5.54	0.03	43.28
USBM-67	88.24	4.36	0.54	0.33	0.31	0.12	< 0.01	< 0.01	< 0.01	3.78	0.02	42.06
USBM-68	64.79	29.76	0.39	0.24	1.07	0.06	0.03	< 0.01	<0.01	1.78	0.01	45.04
USBM-69	94.24	2.66	0.33	0.35	0.23	0.06	0.01	< 0.01	<0.01	1.60	0.01	43.12
USBM-70	89.24	1.17	0.90	0.33	0.44	0.18	<0.01	< 0.01	<0.01	6.00	0.04	40.71
USBM-71	59.94	32.63	0.74	0.22	1.43	0.16	0.05	< 0.01	0.01	3.76	0.03	44.03

[1] After Kness (1994). Analysis of samples by inductively coupled plasma-atomic emission-spectroscopy. $CaCO_3$, calcium carbonate; $MgCO_3$, magnesium carbonate; Al_2O_3, aluminum oxide; Cr_2O_3, chromium oxide; Fe_2O_3, Iron oxide; K_2O, potassium oxide; MnO, manganese oxide; Na_2O, sodium oxide; P_2O_5, phosphorous pentoxide; SiO_2, silicon dioxide; TiO_2, titanium dioxide; LOI, loss on ignition; <, less than. $CaCO_3$ and $MgCO_3$ are calculated, other detection limits are 0.01%. All samples are random chip.

ANALYTICAL DATA FOR CARBONATE ROCK SAMPLES COLLECTED ON MCGREGOR RANGE.[1]

Sample Number	$CaCO_3$ (%)	$MgCO_3$ (%)	Al_2O_3 (%)	Cr_2O_3 (%)	Fe_2O_3 (%)	K_2O (%)	MnO (%)	Na_2O (%)	P_2O_5 (%)	SiO_2 (%)	TiO_2 (%)	LOI (%)
USBM-72	93.81	1.26	0.33	0.35	0.20	0.07	< 0.01	< 0.01	< 0.01	2.20	0.01	42.59
USBM-73	90.55	2.37	0.65	0.33	0.33	0.14	< 0.01	< 0.01	< 0.01	4.49	0.03	41.48
USBM-74	83.76	9.20	0.34	0.30	0.31	0.07	0.01	< 0.01	< 0.01	3.37	0.01	42.73
USBM-75	97.11	0.69	0.15	0.34	0.12	0.03	< 0.01	< 0.01	< 0.01	1.72	< 0.01	42.47
USBM-76	59.08	34.27	0.48	0.21	0.72	0.09	0.01	< 0.01	< 0.01	2.44	0.02	45.20
USBM-77	94.13	1.30	0.27	0.33	0.16	0.06	< 0.01	< 0.01	<0.01	1.63	0.01	42.92
USBM-78	95.44	1.22	0.30	0.34	0.19	0.07	< 0.01	< 0.01	<0.01	1.87	0.01	42.80
USBM-79	65.18	30.95	0.49	0.23	0.40	0.13	0.01	< 0.01	<0.01	2.47	0.02	44.22
USBM-80	54.35	39.90	0.36	0.20	0.46	0.07	0.01	< 0.01	<0.01	3.39	0.01	44.87
USBM-81	66.22	25.04	0.87	< 0.01	0.73	0.24	0.03	0.09	<0.01	4.93	0.04	43.07
USBM-82	93.13	1.03	0.35	0.33	0.21	0.08	0.01	< 0.01	<0.01	3.28	0.01	42.13
USBM-83	79.64	15.42	0.30	< 0.01	0.31	0.06	0.01	0.08	<0.01	2.93	0.01	43.13
USBM-84	57.10	36.78	0.67	< 0.01	0.63	0.15	0.02	0.10	<0.01	3.66	0.03	44.86
USBM-85	59.51	35.54	0.30	< 0.01	0.39	0.07	0.01	0.09	<0.01	3.04	0.01	45.41
USBM-86	79.00	16.64	0.30	< 0.01	0.38	0.07	< 0.01	0.09	<0.01	2.36	0.01	43.98
USBM-87	62.70	33.43	0.39	< 0.01	0.55	0.09	0.01	0.11	<0.01	2.19	0.01	45.47
USBM-88	64.04	31.14	0.45	< 0.01	0.42	0.11	0.01	0.07	<0.01	2.67	0.02	44.82
USBM-89	95.94	0.86	0.24	< 0.01	0.19	0.04	< 0.01	0.06	< 0.01	1.30	0.01	43.11
USBM-90	56.99	38.46	0.37	< 0.01	0.57	0.07	0.01	0.07	< 0.01	2.82	0.01	45.40
USBM-91	97.99	1.19	0.29	0.01	0.19	0.05	< 0.01	0.11	< 0.01	1.20	0.01	43.43
USBM-92	95.22	1.11	0.43	< 0.01	0.21	0.08	< 0.01	0.07	< 0.01	1.67	0.02	43.13
USBM-93	43.14	3.60	9.83	0.17	3.98	0.81	0.02	1.15	0.18	41.53	0.53	15.17

[1] After Kness (1994). Analysis of samples by inductively coupled plasma-atomic emission-spectroscopy. $CaCO_3$, calcium carbonate; $MgCO_3$, magnesium carbonate; Al_2O_3, aluminum oxide; Cr_2O_3, chromium oxide; Fe_2O_3, Iron oxide; K_2O, potassium oxide; MnO, manganese oxide; Na_2O, sodium oxide; P_2O_5, phosphorous pentoxide; SiO_2, silicon dioxide; TiO_2, titanium dioxide; LOI, loss on ignition; <, less than. $CaCO_3$ and $MgCO_3$ are calculated, other detection limits are 0.01%. All samples are random chip.

APPENDIX 19:

MAJOR ELEMENT ANALYSES
FOR SELECTED SAMPLES
ON MCGREGOR RANGE

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Sample	SiO_2† (%)	Al_2O_3† (%)	CaO† (%)	MgO† (%)	Na_2O† (%)	K_2O† (%)	Fe_2O_3T† (%)	MnO† (%)	TiO_2† (%)	P_2O_5† (%)	LOI† (%)	S‡ (%)	Total (%)
Limestone													
VTM97-52	3.68	0.33	51.80	0.95	<0.01	0.04	0.18	<0.01	0.01	0.08	42.40	0.02	99.49
VTM97-57	3.78	0.18	52.00	1.00	<0.01	<0.01	0.29	0.01	0.01	<0.01	42.20	0.01	99.48
VTM97-68	4.91	0.77	49.60	1.98	0.03	0.13	0.40	0.03	0.05	<0.01	41.80	0.03	99.73
VTM97-82	5.29	0.09	52.30	0.74	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	41.40	0.01	99.90
VTM97-94	2.51	0.02	30.20	20.90	0.02	<0.01	0.26	0.01	<0.01	<0.01	45.80	<0.01	99.72
ORO711	16.00	1.07	45.10	0.44	0.28	0.06	0.41	0.04	0.15	<0.01	36.40	0.05	100.00
ORO712	6.44	0.70	50.40	0.40	0.19	0.02	1.18	0.07	0.02	0.18	40.20	0.05	99.85
VTM97-151	1.99	0.18	54.00	0.60	<0.01	<0.01	0.13	<0.01	0.01	<0.01	42.90	0.03	99.84
VTM97-171	5.25	0.26	51.80	0.64	<0.01	0.02	0.21	<0.01	0.01	<0.01	41.60	0.03	99.82
VTM97-243	1.88	0.18	30.70	20.80	0.03	0.03	0.17	0.03	0.01	0.04	45.90	<0.01	99.77
JB-IM002	5.97	0.05	46.00	5.71	<0.01	<0.01	0.41	<0.01	<0.01	<0.01	42.10	0.02	100.24
JB-IM003	1.69	0.08	54.00	0.56	<0.01	<0.01	0.12	<0.01	<0.01	<0.01	42.70	0.02	99.15
JB-IM006	5.68	0.82	50.30	1.04	0.09	0.06	0.77	0.05	0.04	<0.01	40.50	0.06	99.35
JB-IM013	6.35	0.86	50.40	0.84	<0.01	0.06	0.67	0.03	0.03	0.02	40.20	0.04	99.46
JB-IM016	7.30	0.40	43.00	7.04	<0.01	0.03	0.73	<0.01	0.01	0.07	41.60	0.04	100.18
JB-IM02II	66.80	7.03	8.00	2.64	1.83	0.68	3.15	0.03	0.77	0.10	9.20	0.06	100.23
JB-IM026	61.50	0.15	22.00	0.13	<0.01	0.02	0.35	<0.01	0.01	0.08	16.00	0.03	100.24
VTM97-93	19.40	1.41	42.70	0.60	0.02	0.32	0.82	0.04	0.08	0.09	34.80	0.05	100.28
VTM97-257	2.17	0.24	39.50	13.40	<0.01	0.02	0.29	0.01	0.01	0.02	44.30	<0.01	99.96
Caliche													
JB-IM011	31.20	3.44	34.90	0.56	0.95	0.71	0.63	<0.01	0.10	<0.01	27.60	0.02	100.09
Shale													
VTM97-58	57.70	15.40	5.85	4.09	1.06	2.80	4.00	0.03	0.79	0.13	8.35	<0.01	100.20
VTM97-67	73.10	7.77	4.42	2.11	0.94	2.46	2.46	0.03	0.56	0.08	6.30	<0.01	100.23
VTM97-92	68.00	4.70	11.70	0.54	0.02	1.08	2.04	<0.01	0.28	0.19	11.60	0.02	100.17
VTM97-136	48.50	7.70	18.80	1.11	0.13	2.37	2.85	0.02	0.55	0.07	18.20	0.05	100.35
VTM97-150	43.40	15.70	11.40	3.12	0.28	3.89	5.19	0.05	0.77	0.11	16.40	0.06	100.37
VTM97-160	49.40	9.32	9.11	8.83	0.70	2.55	2.33	0.09	0.58	0.10	17.20	0.08	100.29
VTM97-170	55.30	16.00	5.56	2.02	0.42	3.34	5.16	0.03	0.83	0.23	11.30	1.26	101.45
VTM97-236	46.10	17.40	3.88	7.66	0.40	3.58	7.01	0.03	0.85	0.06	13.20	0.83	101.00
VTM97-237	39.90	13.70	7.94	7.84	0.48	4.04	7.44	0.04	0.61	0.12	18.20	0.11	100.42
VTM97-332D	53.20	7.83	15.50	1.73	0.38	2.54	3.13	0.01	0.61	0.69	14.50	1.63	101.75
VTM97-334D	18.70	3.86	23.30	15.70	0.07	1.34	1.10	0.05	0.19	0.13	35.70	0.10	100.24
JB-IM013SH	29.20	5.80	32.00	1.23	0.22	1.01	2.40	0.07	0.40	0.16	27.50	0.04	99.99
JB-IM021SH	44.80	14.90	8.82	5.51	0.54	3.29	5.98	0.04	0.84	0.12	15.10	0.02	99.94
VTM97-246	56.00	15.80	3.51	4.17	0.12	5.67	4.50	0.03	0.75	0.07	9.55	0.03	100.17

† Method = XR; Detect. limit = 0.01.
‡ Method = LECO; Detect. limit = 0.01.

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APPENDIX 20:

FORMATION INFORMATION BY DRILL HOLE

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FORMATION INFORMATION BY DRILL HOLE.

Footages (KB)	Unit
WELL 45-5	
0 to 32	Tertiary/Quaternary basin fill
32 to 433	Pennsylvanian cherty limestone
433 to 464	Tertiary felsite porphyry sill
464 to 550	Pennsylvanian cherty limestone
550 to 864	Tertiary felsite porphyry sill
864 to 1195	Pennsylvanian cherty limestone
1195 to 1857	Devonian/Mississippian limestone and shale
1857 to 3099	Tertiary felsite porphyry sill
3099 to 3129	Devonian/Mississippian limestone and shale
3129 to 3649	Silurian Dolomite
3649 to 3961	Ordovician Dolomite
WELL 46-6	
0 to 684	Tertiary/Quaternary basin fill
684 to 1145	Pennsylvanian cherty limestone
1145 to 1284	Tertiary felsite porphyry sill
1284 to 1741	Pennsylvanian cherty limestone
1741 to 2258	Devonian/Mississippian limestone and shale
WELL 51-8	
0 to 460	Tertiary/Quaternary basin fill
460 to 655	Tertiary felsite porphyry sill
655 to 770	Pennsylvanian cherty limestone
770 to 1503	Devonian/Mississippian limestone and shale
1503 to 2239	Silurian Dolomite
2239 to 2240	thrust fault (gouge)
2240 to 2479	Mississippian limestone and shale (steeply overturned)
2479 to 2573	Pennsylvanian cherty limestone (steeply overturned)
WELL 61-6	
0 to 605	Tertiary/Quaternary basin fill
605 to 1430	Tertiary felsite porphyry sill
1430 to 1760	Pennsylvanian cherty limestone
1760 to 2018	Devonian/Mississippian limestone and shale

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