MINERAL RESOURCES OF THE WILD HORSE MESA AREA, NORTHEASTERN BURRO MOUNTAINS, GRANT COUNTY, NEW MEXICO

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Open-file Report 486

August 2005

New Mexico Bureau of Geology and Mineral Resources

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ABSTRACT

The alteration, vein textures, metal association, and proximity to the ring-fracture zone of the Schoolhouse Mountain caldera indicate that the mineral deposits at Wild Horse Mesa in the eastern Telegraph district of the northern Burro Mountains are volcanic-epithermal veins, including 1) epithermal fluorite veins, 2) uranium vein and minor stratabound, sandstone uranium, 3) base-metal veins, and 4) barite veins. Mineral distribution appears to be controlled by the north-south Schoolhouse Mountain fault. Fluorite and uranium veins are found west of the Schoolhouse Mountain fault, copper with gold and silver are found along the fault, and barite without significant metals is found east of the fault. The alteration and form of the veins indicate that ascending fluids, not descending fluids formed the vein deposits. The mineral-resource potential for undiscovered volcanic-epithermal vein and epithermal fluorite vein deposits in the Wild Horse Mesa area is moderate with a moderate certainty of assurance. The presence of gold concentrations in surface samples and the interpretation of the deposits being at the top of a volcanic-epithermal system suggest that additional deposits are most likely to be deep. The best potential is associated with faults west of, and including, the Schoolhouse Mountain fault. The mineral-resource potential for sandstone uranium deposits, REE-Th-U veins in alkaline rocks, and porphyry-copper (molybdenum, gold) deposits is low with a moderate certainty of assurance. However, due to the remoteness of the area and low grades, it is unlikely that these deposits will be mined in the near future.

INTRODUCTION

The Wild Horse Mesa area in the eastern Telegraph district (Fig. 1; North and McLemore, 1986; McLemore, 2001) lies along the southern ring-fracture zone of the Schoolhouse Mountain caldera in the northern Burro Mountains in Grant County, New Mexico. Volcanic-epithermal veins, specifically 1) epithermal fluorite veins, 2) uranium vein and minor stratabound, sandstone uranium, 3) base-metal veins, and 4) barite veins are found in the Wild Horse Mesa area. The purpose of this paper is to describe the geologic history, types of mineral deposits, relationship between the mineral deposits and the Schoolhouse Mountain caldera, and the mineral-resource potential. This report is an update of McLemore (2000) and includes new and published geochemical data (Appendix 1, 2), a geologic map (Map 1), and evaluation of the mineral-resource potential.

Numerous reports briefly describe the various mineral deposits in the area (Elston, 1957; Gillerman, 1952, 1964, 1968; Hewitt, 1959; Williams, 1966; McAnulty, 1978; Hedlund, 1980; O'Neill and Thiede, 1982; McLemore, 1983, 2000; Richter and Lawrence, 1983; Finnell, 1987; McLemore et al., 1996). Regional and local geologic mapping was by Hewitt (1959), Wahl (1980), Hedlund, (1980), Drewes et al. (1985), Finnell (1987), McLemore (2000), McLemore et al. (2000, 2003), and unpublished mapping by the author. The author first examined the Wild Horse Mesa area in 1980-1983, as part of a study of uranium resources in the state (McLemore, 1983). In 1993-1994, the area was examined again as part of the evaluation of mineral resources in the Bureau of Land Management’s Mimbres Resource Area (McLemore et al., 1996; Bartsch-Winkler, 1997). This investigation also indicated that previous mapping by Finnell (1987) did not adequately differentiate the diverse Proterozoic rocks or identify all of the faults in the area. Additional studies by the author occurred in 1998-2002 (McLemore, 2000) and are ongoing.

METHODS OF STUDY

The area was remapped at a scale of 1:12,000 and 1:1,000 in 1998-2002 as part of a regional study of the Proterozoic rocks in the northern Burro Mountains (Fig. 2, Map 1; McLemore, 2000; McLemore et al., 2000). Mineralized areas were examined and sampled; mines and prospects are listed in Table 1. Mineralized and altered samples were collected and analyzed for trace metals in 1993, 1994, and 1999-2002 to evaluate the economic potential of the area (Appendix 1, 2).

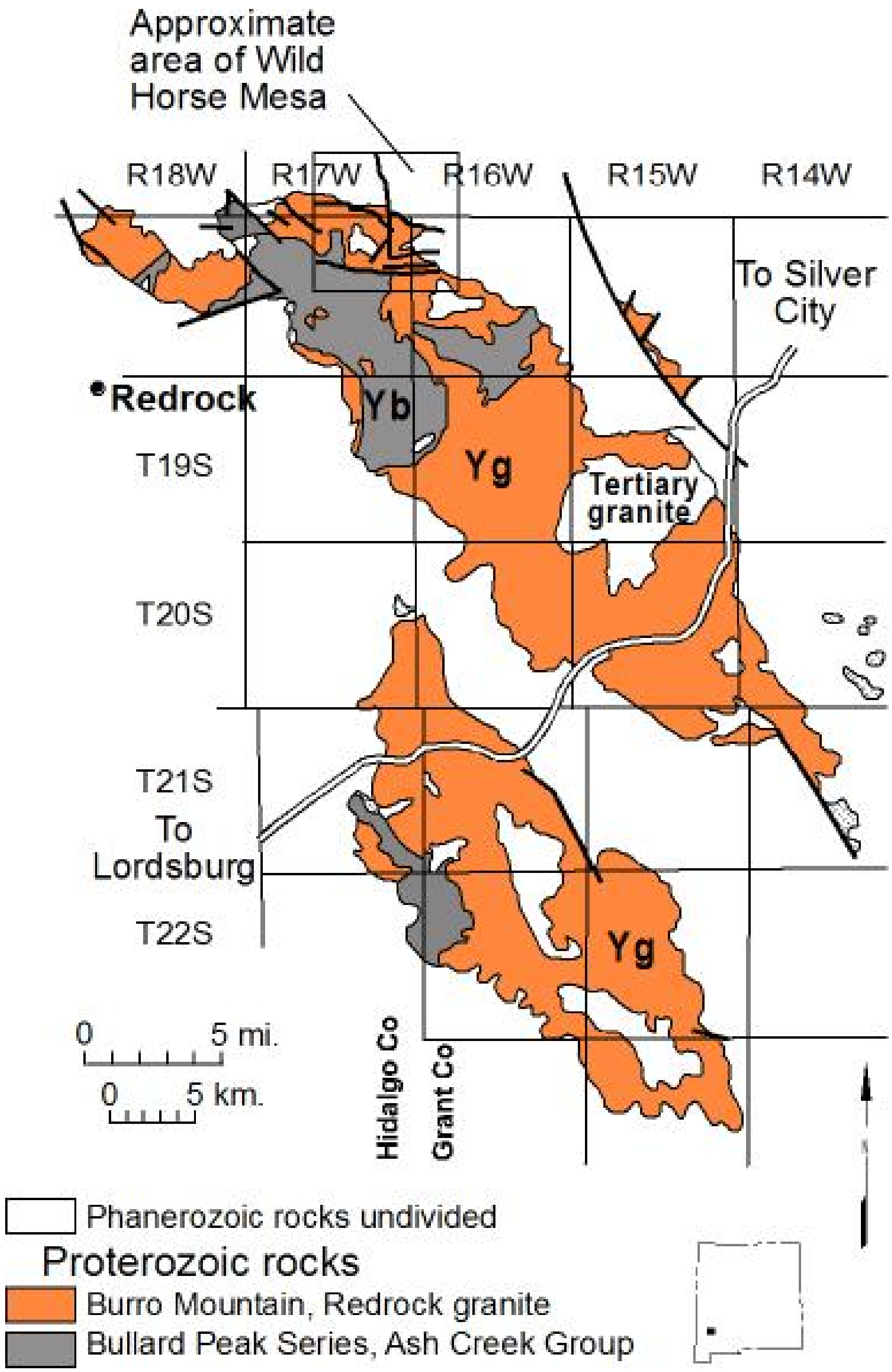

FIGURE 1. Location of the Wild Horse Mesa area, northern Burro Mountains, Grant County, New Mexico.

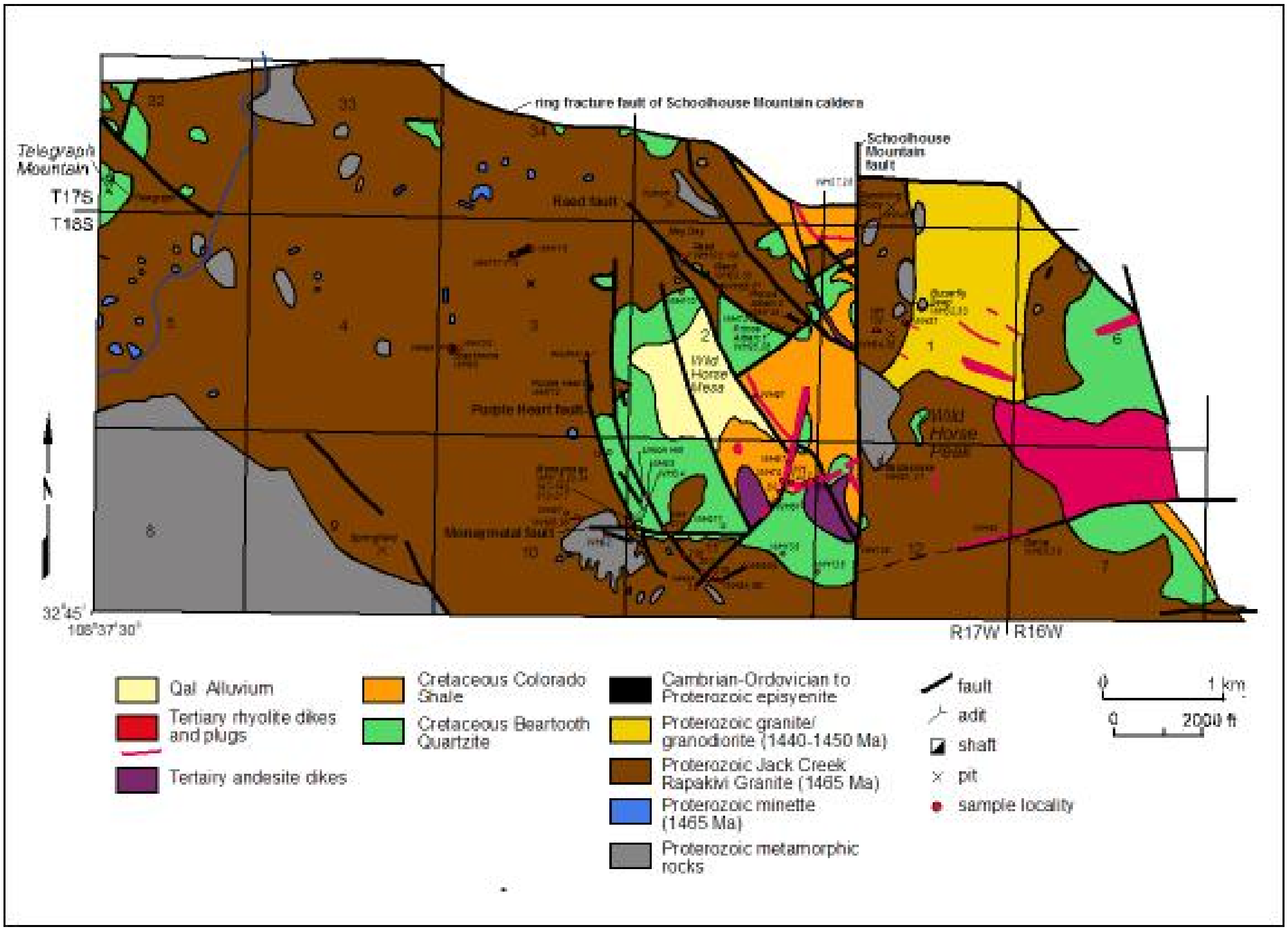

FIGURE 2. Geologic map of the Wild Horse Mesa area, northern Burro Mountains (see Map 1).

TABLE 1. Mines and prospects in the Wild Horse Mesa area, eastern Telegraph mining district, Grant County, New Mexico (Fig. 2, Map 1). Mine identification number refers to Mine_id in New Mexico Mines Database. * not shown on Figure 2 or Map.

Mine identification number	Mine name	Aliases	Latitude (degrees)	Longitude (degrees)	Location (section, township, range)	Commodities produced	Commodities present, not produced	Development
NMGR0053	May Day	May Day 1, 2	32.77757	108.5749	2, 18S, 17W		U	pit
NMGR0064	Prince Albert 1		32.76886	108.5651	2, 18S, 17W		U	adit (N300º), cut, pit
NMGR0065	Prince Albert 2		32.76963	108.5624	2, 18S, 17W		U	rim cuts, pit
NMGR0066	Purple Heart		32.76551	108.5817	3, 18S, 17W	F	U, Ba, Au, Ag	2 shafts, adit (N40º)
NMGR0068	Rambling Ruby		32.77758	108.5554	36, 17S, 17W		F, U, Ba	pits, shaft, trenches
NMGR0072	Reed	Fluorspar 1, Reed Fluorspar	32.77251	108.5708	2, 18S, 17W	F	U, Ba, Au	3 shafts, trenches, pits
*NMGR0074	Sandy		32.73154	108.687	22, 18S, 18W		F, U	shaft, pits
NMGR0078	Springfield	Winchester	32.75373	108.5984	9, 18S, 17W		U, Cu	2 shallow pits
NMGR0086	Union Hill		32.75826	108.5785	10, 18S, 17W		Mo, Pb, Sb, W, Zn, U	pits, drilling

NMGR0111	Nichols and Winslow		32.75903	108.5738	11, 18S, 17W		U	small pit
NMGR0112	Union Hill		32.75622	108.5782	10,11, 18S, 17W		U, Zn, Pb	pit
*NMGR0135	W F		32.76103	108.5581	12, 18, 17W		U, Au	outcrop
NMGR0139	Yukon Group	May Day 1, 2	32.78024	108.5725	35, 17S, 2, 18S, 17W		U	outcrop anomaly
NMGR0140	Moneymetal	Union Hill adit, Hot Spot	32.75621	108.5769	10,11, 18S, 17W		U, Au, Ag, Cu ,Pb, Zn, As	pits , adit (N110º)
NMGR0142	Barite		32.75553	108.5438	7, 18S, 16W		Ba, Ag, Cu	pit
NMGR0143	Rattlesnake	unknown	32.75921	108.5549	12, 18S, 17W		Cu, Ag, Zn	pit
*NMGR0144	Barite 2		32.74558	108.5311	18, 18S, 16W		Ba	pits
NMGR0145	Blackmoor	Cloverleaf, Blackamoor, Blackmore	32.76798	108.5939	3, 18S, 17W		F, Pb	shaft, pit
*NMGR0146	German	Hard Pan	32.74534	108.5913	15, 18S, 17W	Pb, Zn, Cu, Ag		shaft, 3 adits (N230º)
NMGR0147	Reed adit		32.7738	108.574	2, 18S, 17W	F		adit (N85º), now caved
NMGR0148	unknown		32.77217	108.5868	3, 18S, 17W		U, Th, REE	pit
*NMGR0149	Reed gold prospect		32.74479	108.5613	13, 18S, 17W		Au, Ag	pit
*NMGR0150	unknown		32.77394	108.5384	6, 18S, 16W		Au, Ag	pit
NMGR0151	unknown		32.76956	108.5564	1, 18S, 17W		Ag, Cu	shaft, pit
NMGR0152	Butterfly Seep		32.77088	108.5543	1, 18S, 17W		Ag, Cu	adit (N85º), pit
NMGR0153	unknown		32.7792	108.5806	34, 17S, 17W		U, Ag	pits
NMGR0473	Telegraph		32.7786	108.1244	32, 17S, 17W		F, Mn, Ag	2 shafts, adits

The most important stage in any geologic investigation is compilation and interpretation of all available published and unpublished geologic, geochemical, geophysical, and production data. Mineral databases were examined, including the Mineral Resource Data System (MRDS) of the U. S. Geological Survey, the Minerals Industry Location System (MILS) of the U. S. Bureau of Mines, and unpublished files at the New Mexico Bureau of Geology and Mineral Resources (NMGMMR). Using these data, known mineral occurrences, deposits, mines, and prospects are identified, plotted on base maps, and compiled in a database. Geophysical data and Landsat satellite imagery of the project area were studied. The National Uranium Resource Evaluation (NURE) data also were examined and evaluated; appropriate geochemical maps were plotted. Areas of anomalous structural complexity, hydrothermal alteration, and anomalous coloration were delineated and examined where possible during the field reconnaissance stage and samples were collected and analyzed. Sample sites for geochemical analyses were identified prior to field examination using these data.

Samples were analyzed by a variety of methods (Appendix 1, 2). Most samples collected for this project were analyzed for trace elements by X-ray fluorescence (XRF) at the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) X-ray laboratory and by flame atomic absorption (FAAS) at the NMGMMR Chemistry Laboratory. Samples also were analyzed by instrumental neutron activation analysis (INAA) by XRAL Laboratories or ICP by Bondar-Clegg and Co. Ltd. Samples collected for the Mimbres project (Bartsch-Winkler, 1997) were submitted to the U. S. Geological Survey for analyses by ICP and INAA. Thin sections of mineralized and unmineralized rocks were examined.

The final evaluation of the mineral-resource potential involves integration and interpretation of all available data to identify possible undiscovered mineral deposits that could occur within the Wild Horse Mesa area and delineate areas of potential occurrence. A number of factors must be 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 their formation, and geologic history. Goudarzi (1984) and McLemore (1985) explain in more detail, the process of evaluating mineral-resource potential.

MINING AND EXPLORATION HISTORY

The Wild Horse Mesa area of the eastern Telegraph district was first prospected for base and precious metal deposits in the late 1800s. The German mine was discovered prior to 1900 and minor production occurred. In 1947, John A. and Bernard Harrison discovered fluorite at the Purple Heart mine. The mine has changed ownership several times. Reported total production from the Purple Heart mine from 1947 to 1978 amounted to 1,388 short tons of fluorite ore (McAnulty, 1978). James L. Reed discovered the Reed fluorspar mine in 1951 and shipped 57 short tons of ore containing approximately 41% CaF_2 (Williams, 1966). In 1953-1954, Reed shipped 150-200 short tons of 60-75% CaF_2 (Gillerman, 1968). Other fluorite veins were found in the area, but they did not yield any ore production.

Floyd Walcop discovered uranium in the Wild Horse Mesa area about 1954 and sold the property to J. H. Winslow and Ernest Nickel (James Reed, personal communication, November 19, 1984). About 1957, Uran Mining Co. was formed to explore and develop the uranium deposits. On May 18, 1958 the New York State Attorney General's Office investigated a potential mail fraud by the company and directed that a 180-ft adit be driven along the Moneymetal fault to confirm the presence of uranium. Small pods and clusters of radioactive material were found in the adit (Gillerman, 1968; unpublished data, NMGMMR archives), but there has been no uranium production. Surface sampling, geophysical surveys, and shallow drilling have occurred from the 1950s until today, primarily looking for uranium. Recent exploration has expanded to include precious metals.

GENERAL DESCRIPTION OF POTENTIAL TYPES OF MINERAL DEPOSITS

Volcanic-epithermal deposits

Lindgren (1933) defined the term "epithermal" to include a broad range of deposits that formed by ascending waters at shallow to moderate depths (<4,500 ft), low to moderate temperatures (50°–200°C), which are typically associated with intrusive and/or volcanic rocks. It is now generally accepted that epithermal deposits were formed at slightly higher temperatures (50°–300°C) and relatively low pressures (a few hundred bars) based on fluid inclusion and isotopic data. Work by White (1955, 1981) established the now-recognized association between epithermal mineral deposits and active geothermal (or hot springs) systems. Subsequent work by Henley (1985) and associates (Henley and Brown, 1985) in New Zealand and many other researchers elsewhere confirmed this association. However, there are many small hot spring systems with no gold or base metals associated with them. The difficulty remains in identifying paleo-geothermal systems that contain economic concentrations of gold and/or base metals.

Epithermal mineral deposits in New Mexico like elsewhere in the world occur in structurally complex tectonic settings that provide an excellent plumbing system for circulation of hydrothermal fluids (Fig. 3). The characteristics of these deposits and a model for their formation were outlined by Buchanan (1981) and refined by later work (Rytuba, 1981; Henley, 1985; Henley and Brown, 1985; White and Hedenquist, 1990; McLemore, 1993). Not all epithermal deposits occur in igneous rocks; for example, the McLaughlin deposit in California is hosted in mafic and ultramafic metamorphic and sedimentary, and some Carlin-type deposits appear to be epithermal and are found in sedimentary rocks (Bagby and Berger, 1985; Berger and Henley, 1989). However, most known epithermal deposits in New Mexico are restricted to volcanic terrains and areas immediately adjacent to volcanic fields and are called volcanic-epithermal deposits in this classification scheme.

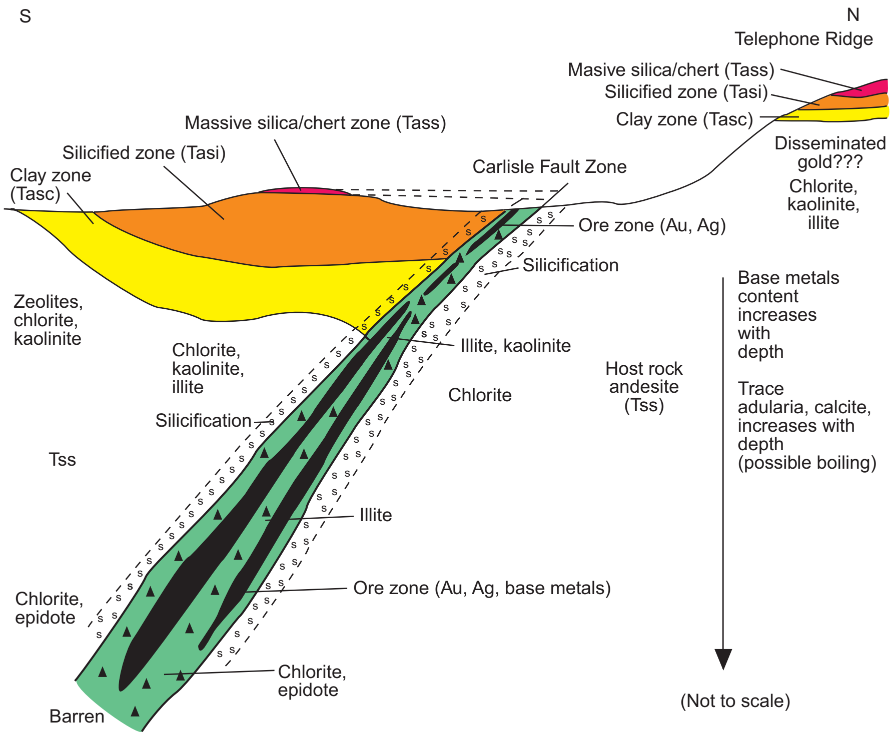

FIGURE 3. Relationship between alteration and vein deposits along the Carlisle fault (McLemore, 1993).

The volcanic-epithermal deposits of New Mexico formed largely in faults and fissures in rhyolitic ash-flow tuffs and andesites of Oligocene-Miocene age, commonly within or adjacent to resurgent caldrons (Elston, 1978; 1994; Rytuba, 1981). Where isotopic ages are available, the ore deposits tend to be 10-12 Ma younger than the associated volcanic activity (McLemore, 1994, 1996). The association between bimodal volcanic activity and volcanic-epithermal deposits is probably one of a favorable plumbing system in an area of abundant water, high, recurrent heat flow, and favorable structural and chemical traps. These deposits were formed during neutral to extensional back-arc tectonic settings.

Typical volcanic-epithermal deposits in the state occur as siliceous vein fillings, breccia pipes, disseminations, and replacement deposits along faults and fractures in intermediate to silicic volcanic and volcaniclastic rocks. Common ore textures characteristic of epithermal deposits include open-space and cavity fillings, drusy cavities, comb structures, crustifications, colloform banding, brecciation (typically multi-stage), replacements, lattice textures (quartz pseudomorphs, after bladed calcite) and irregular sheeting (Buchanan, 1981; Dowling and Morrison, 1989). The mineralogy and metal associations of these deposits are diverse. Common ore minerals include auriferous pyrite, native gold, acanthite, chalcopyrite, bornite, argentiferous galena, native silver, and sphalerite. Quartz, calcite, and pyrite are common gangue minerals and common alteration minerals are chlorite, epidote, illite/sericite, adularia, and kaolinite. Both gold and silver are usually produced from these deposits with variable amounts of base-metal production. Other minerals produced from some deposits include fluorite, uranium, tellurium, and vanadium. Ore shoots within a specific vein form at intersections of faults or at areas with deflections in strike and/or dip. Most veins are less than 3 ft wide, but economic veins are as wide as 30 ft. District zoning also is diverse, and in some districts precious metals occur in the upper levels of the epithermal system and grade into base metals at depth, such as in the Chloride and Steeple Rock districts (Buchanan, 1981; Harrison, 1986, 1988; McLemore, 1993). Typical deposits in New Mexico are a few hundred thousand short tons or less grading 0.2 oz/short ton gold and 6-20 oz/short ton silver or less (McLemore, 1996).

The alteration mineral assemblage associated with these deposits varies with changes in temperature, pressure (depth), permeability, fluid composition, original host rock composition, and duration of activity. Alteration assemblages include silicification, propylitic, argillic, advanced argillic, potassic, sericitic, illitic, and chloritic. Alteration assemblages also can be referred to by the composition of the prevailing fluid type as alkali-chloride, acid-sulfate, bicarbonate, or mixed fluids (McLemore, 1993).

Epithermal fluorite deposits

During the formation of large magmatic systems, fluorite (rarely barite) can be deposited along fractures and faults along the fringes of the mineralizing system, or in more central areas as the mineralizing event wanes. Host-rock response to fluids varies with competency and carbonate content, producing vein or replacement deposits. If the core system subsequently is exposed, the zonal relationship between the two deposit types is evident. If the porphyry is too deeply buried to be identified, fluorspar deposits can be the only manifestation of a larger system and can not be distinguished from deposits formed by other processes. Conversely, exposure of the porphyry system might indicate that distal fluorspar deposits have been eroded. Fluorite also can replace carbonate adjacent to magmatic systems. These deposits are termed skarns or carbonate-hosted Pb-Zn and Ag deposits by North and McLemore (1986) and McLemore (2001). Felsic (rhyolitic) and alkaline igneous systems are more likely to produce fluorite deposits than calc-alkaline systems. Felsic and alkaline igneous systems are relatively rare in southwestern New Mexico, and the number of related deposits can be correspondingly small.

Sandstone uranium deposits

Sandstone uranium deposits are disseminated deposits of uranium and other minerals hosted by sandstone and adjacent sedimentary rocks that were formed by uranium-bearing fluids moving through permeable sandstone. Sandstone uranium deposits account for the majority of the uranium production from New Mexico (McLemore and Chenoweth, 1989). The most significant deposits are those in the Morrison Formation, specifically the Westwater Canyon Member, where over 169,500 short tons of U_3O_8 were produced from 1948 to 1999. In contrast, production from other sandstone uranium deposits in New Mexico amounts to 234 short tons U_3O_8 (1952-1970, McLemore and Chenoweth, 1989).

REE-Th-U veins in alkaline rocks

REE-Th-U veins in alkaline rocks occur as spotty, discontinuous tabular bodies, narrow lenses, and breccia zones along faults, fractures, and shear zones (Fig. 4). They typically vary from a few feet to 1000 ft long and less than 10 ft wide and are of variable grade. The mineralogy of known deposits in New Mexico is poorly known, but brookite, crandallite, xenotime, bastnaesite, allanite, eudialyte, monazite, and microlite are some of the more common minerals reported (McLemore, et al., 1988a, b). The host rocks are alkaline and vary in composition from trachyte, alaskite, nepheline syenite, syenite, episyenite, diorite, alkali granite, and carbonatite. They are found at Laughlin Peak, Gallinas Mountains, Capitan Mountains, Cornudas Mountains, Caballo Mountains, Zuni Mountains, and Bromide district (McLemore et al., 1988a, b); similar host rocks are found in the Burro Mountains. The veins found in the Caballo and Zuni Mountains districts are probably Proterozoic to Cambrian-Ordovician in age, whereas the remaining deposits are mid-Tertiary in age and described as Great Plain Margin deposits.

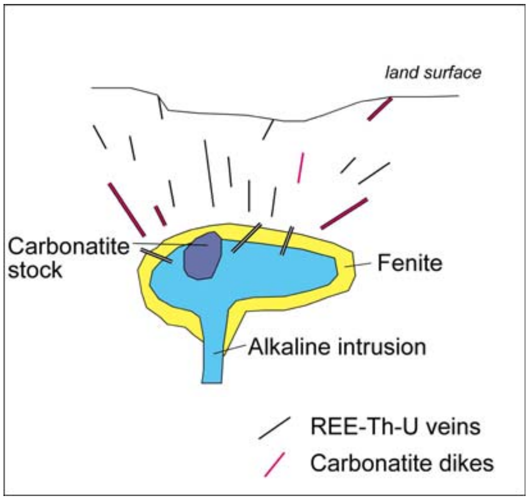

FIGURE 4. Relationship of REE-Th-U veins to alkaline rocks and carbonatites (modified from Staatz, 1992).

Porphyry copper, copper-molybdenum (±gold) deposits

Porphyry-copper (molybdenum, gold) deposits are large, low-grade (<0.8% Cu) deposits that contain disseminated and stockwork veinlets of copper and molybdenum sulfides with gold and are associated with porphyritic intrusions (Fig. 5; Schmitt, 1966; Lowell and Guilbert, 1970; Kesler, 1973; Lowell, 1974). Mineralization typically occurs in and around porphyritic diorite, granodiorite, monzonite, and quartz/monzonite plutons, which are surrounded by concentric zones of hydrothermal alteration (Lowell and Guilbert, 1970). In many deposits, the concentric zoning is destroyed and replaced by younger quartz/sericite alteration, such as at the Chino deposit. Low concentrations of silver and gold are present in most deposits and can be recovered as by-products by conventional milling techniques. Precious metals, including platinum-group metals, can be recovered from the anode slimes remaining after copper is refined. They occur as particles of native species and as solid solutions or exsolved species in sulfide minerals. The Chino mine in the Santa Rita district is the largest copper and gold and 9th largest silver-producing district in New Mexico.

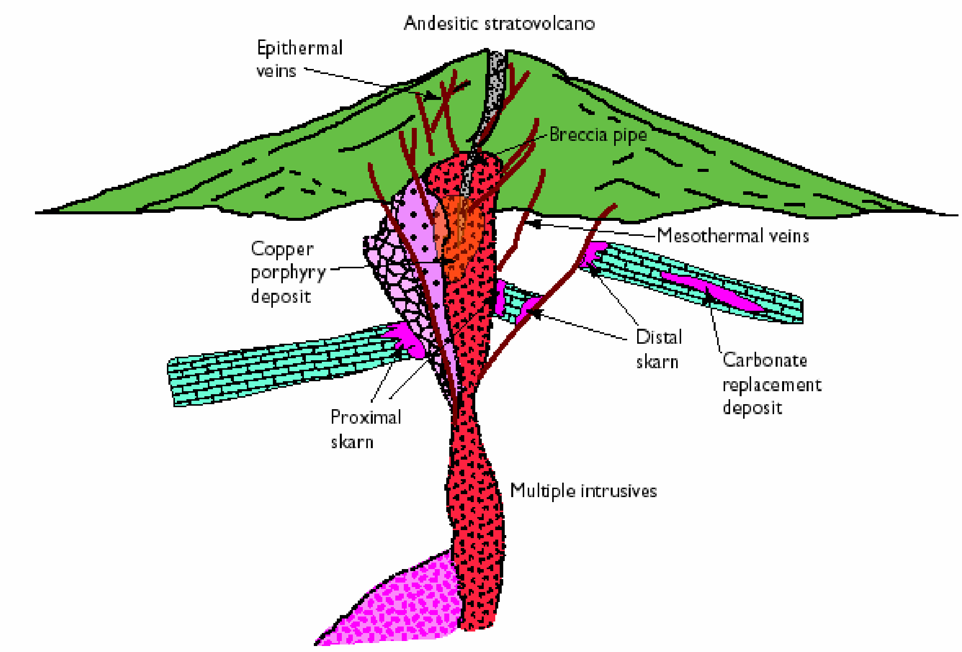

FIGURE 5. Simplified porphyry system.

There are five Laramide porphyry-copper deposits in New Mexico: Santa Rita, Tyrone in the Burro Mountains district, Copper Flat in the Hillsboro district, Hanover-Hermosa Mountain in the Fierro-Hanover district, and McGhee Peak in the Pelloncillo Mountains. Many other areas in the state have potential for porphyry-copper deposits, but there are no reported reserves or production. Some of the more favorable areas are associated with Laramide vein, volcanic-epithermal, Great Plains Margin, and Laramide skarn deposits.

The largest Laramide porphyry-copper deposit in New Mexico is Santa Rita, where copper sulfides occur in the upper part of a highly fractured granodiorite and adjacent sedimentary rocks. Several periods of supergene enrichment have further concentrated the ore (Cook, 1994). Adjacent copper skarns are becoming increasingly more important economically. Potassic, phyllic, argillic, and propylitic alteration zones are present, but are not everywhere concentric (Nielsen, 1968, 1970). Reported ages of the granodiorite stock range from 64.6 to 59.7±1.7 Ma (K-Ar, biotite; Schwartz, 1959; McDowell, 1971), but unpublished data by Phelps Dodge Corp. indicates the age of the stock is 58.6 Ma. Total production from 1911 to 1993 is estimated as 4.54 million short tons of copper from 500 million short tons of ore; more than 500,000 oz Au and 4.75 million oz Ag also have been.

The Tyrone porphyry-copper deposit in the Burro Mountains district occurs within a quartz-monzonite laccolith and adjacent Proterozoic rocks (Kolessar, 1970, 1982). The ore contains minor amounts of gold and silver, especially in the enriched zones. The age of the Tyrone stock is 54.5 Ma (unpublished data). At least three cycles of supergene enrichment have concentrated the ore (Cook, 1993, 1994). Approximately 300 million short tons of ore grading 0.81% Cu were processed at the concentrator from 1969 to 1992. Approximately 425 million short tons of ore grading 0.35% Cu have been leached (R. J. Stegen, Phelps Dodge Mining Co., written communication, October 3, 1994). Gold and silver were recovered only from the concentrate.

Many areas in New Mexico have potential for porphyry-copper deposits, but more exploration is needed to verify their occurrence. Exploration has occurred north of the Lordsburg and Eureka districts for porphyry-copper deposits, but the results are unknown. Both districts are known for polymetallic vein deposits as well as favorable alteration suggestive of porphyry-copper mineralization.

REGIONAL GEOLOGIC SETTING

The Burro Mountains lie in the Mexican highland section of the Basin and Range physiographic province in southwestern New Mexico. During the latest Proterozoic and Cambrian the Burro Mountains were uplifted and eroded. The Burro Mountains were either a highland during much of Phanerozoic time, or older sedimentary rocks were eroded before deposition of Cretaceous rocks when seas partially covered the mountain range. Laramide compressional tectonics and mid-Tertiary extensional tectonics have since affected the area. Andesites and rhyolites were intruded during the Laramide and mid-Tertiary.

The regional structural evolution of the southwestern United States and northern Mexico, specifically the Burro Mountains, has been dominated by a succession of dynamic and sometimes rapidly changing plate tectonic settings from the Proterozoic to the Recent (Coney, 1978; Karlstrom and Bowring, 1988; Karlstrom et al., 1990). This prolonged history of complex continental tectonics can be divided into ten phases:

(1) Mazatzal orogeny, 1660-1600 Ma (Karlstrom and Bowring, 1988, 1993; Karlstrom et al., 1990, 2001; 2004; Karlstrom and the CD-ROM working group, 2002),
(2) Late Proterozoic granitic plutonism, 1450-1350 Ma (Stacey and Hedlund, 1983; Karlstrom and Bowring, 1988; 1993; Adams and Keller, 1996; Karlstrom et al., 1997; Karlstrom and Humphreys, 1998; Karlstrom et al., 2004),
(3) pre-Grenville extension and formation of continental margin at 1300-1200 Ma (Adams and Keller, 1994, 1996; Karlstrom et al., 1997; Karlstrom and Humphreys, 1998; Barnes et al., 1999),
(4) 1200-1000 Ma period of mafic, volcanic, and A-type granitic intrusions in New Mexico, Texas, and Arizona, coincident with the Grenville orogeny and perhaps extension (Adams and Keller, 1996; Mosher, 1998; Barnes et al., 1999; McLemore et al., 2000; Bickford et al., 2000; Rämö et al., 2003),
(5) Paleozoic period of alkaline and carbonatite magmatism and extension at ~500 Ma (McLemore and McKee, 1988; McLemore et al., 1999; McMillan et al., 2000; McMillan and McLemore, 2004),
(6) Paleozoic period of basin formation and uplift as part of the Ancestral Rocky Mountains (Florida uplift, Pedregosa Basin, Ross and Ross, 1986),
(7) Cretaceous continental arc, shallow marine deposition (Drewes, 1991),
(8) Laramide compressional deformation and magmatic arc volcanism and plutonism (Late Cretaceous to early Tertiary, Drewes, 1991),
(9) mid-Tertiary calc-alkaline volcanism to bimodal volcanism with caldera formation (Schoolhouse Mountain caldera related to the Datil-Mogollon field, McIntosh et al., 1991; Chapin et al., 2004), and
(10) late Tertiary-Quaternary Basin and Range extensional deformation (Coney, 1978).

Each of these tectonic periods left remnant structural trends in the Burro Mountains that were either reactivated or crosscut by younger tectonic events and together have resulted in a structurally complex, relatively thin, brittle, and anisotropic crust in southwestern United States.

The Wild Horse Mesa area in the northern Burro Mountains comprise a complex Proterozoic terrain that spanned at least from 1633 to ~1000 Ma and provides a record of events relating to the growth and breakup of Laurentia. The Proterozoic rocks include metamorphic rocks (Bullard Peak and Ash Creek Group, >1633, 1550-1570 Ma) that were intruded by granitic and mafic rocks. Chemically and petrologically distinct granitic rocks in the Burro Mountains include (1) Burro Mountain granite (~1440-1460 Ma), (2) granite/granodiorite (~1440-1450 Ma), (3) Jack Creek Rapakivi Granite (~1465 Ma), (4) Redrock Granite (~1220 Ma), (5) rhyodacite-dacite porphyry dikes, (6) fine-grained alkali-feldspar and biotite granite dikes, and (7) pegmatite dikes (youngest). The mafic rocks include (1) an older period of gabbro/diabase/diorite intrusions, possibly related to formation of the juvenile Mazatzal crust (~1633 Ma), (2) several synplutonic lamprophyre (minette) dikes and numerous enclaves within the ~1465 Ma Jack Creek Rapakivi Granite, (3) approximately 50 anorthosite xenoliths (5 m in diameter to 270 m long and 30 m wide) within the Redrock Granite, and (4) a younger period of gabbro/diabase/diorite intrusions, mostly as dikes (<1200 Ma). The age relationships are summarized in Table 2.

TABLE 2. Age relationships of the Proterozoic and younger rocks in the northern Burro Mountains (Drewes et al., 1985; McLemore et al., 2000, 2003; Rämö et al., 2003).

Units
Tertiary rhyolite and quartz monzonite dikes and plugs
Tertiary-Cretaceous andesite sills and dikes
Cretaceous Colorado Shale
Cretaceous Beartooth Quartzite
Cambrian-Ordovician to Proterozoic episyenite bodies
Proterozoic rocks
Gabbro/diabase/diorite dikes
Pegmatite dikes
Serpentinite veins
Fine-grained alkali-feldspar and biotite granite dikes (~1200-1220 Ma)
Rhyodacite-dacite porphyry dikes (~1200-1220 Ma)
Redrock Granite (~1220 Ma)
Miarolitic biotite granite, alkali-feldspar granite
Hornblende granite
Biotite-hornblende granite
Anorthosite/leucogabbro xenoliths (~1225 Ma)
Granite/granodiorite (Ygd of Hedlund, 1980) (~1440-1450 Ma)
Burro Mountain granite (Yg of Hedlund, 1980) (~1440-1460 Ma)
Jack Creek Rapakivi Granite (~1465 Ma)
Porphyritic granite (~1440-1460 Ma)
Minette (~1465 Ma)
Gabbro/diabase/diorite intrusions (~1633 Ma)
Bullard Peak and Ash Creek metamorphic rocks (>1633, 1550-1570 Ma)
Quartzo-feldspathic gneiss (granulite of Hedlund, 1980)

The Schoolhouse Mountain caldera lies north of the Wild Horse Mesa area and is one of approximately 25 calderas that formed in southwestern New Mexico during the mid-Tertiary (Fig. 6; McIntosh et al., 1991). The caldera is interpreted to be asymmetrical, as much as 1.5 km deep, and filled with the tuff of Cherokee Canyon and Box Canyon (Schoolhouse Mountain Formation of Wahl, 1980; Finnell, 1987). The Box Canyon Tuff, first recognized by Elston (1957), is the crystal-rich, low silica outflow unit of the caldera exposed north of the Wild Horse Mesa area and is 33.5 Ma ($^{40}Ar/^{39}Ar$, McIntosh et al., 1991). Ring-fracture faults occur on the southern side of the caldera, in the Wild Horse Mesa area. Quaternary basalts and sedimentary rocks bury much of the northern caldera. Younger north- and northwest-trending Basin and Range faults offset the caldera boundary (Wahl, 1980; Finnell, 1987).

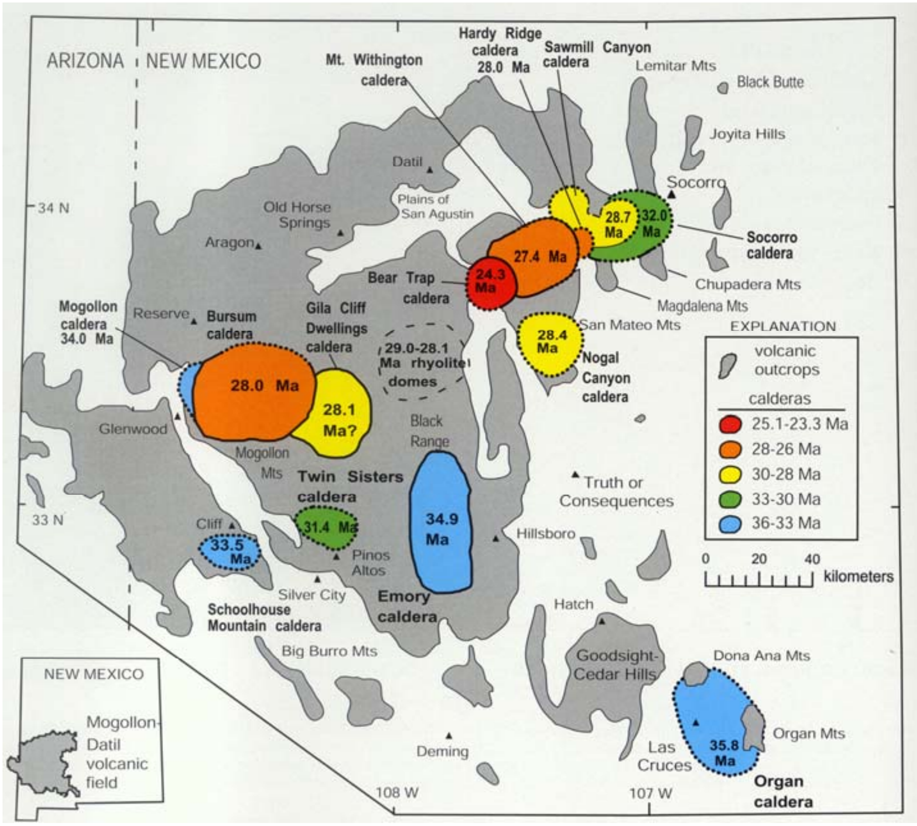

FIGURE 6. Map of the calderas in the Mogollon-Datil volcacnic field (Chapin et al., 2004).

LOCAL GEOLOGY

Proterozoic Rocks

Bullard Peak Series metamorphic rocks

The oldest rocks in the Wild Horse Mesa area are metamorphic rocks that Hewitt (1959) called the Bullard Peak Series (Table 2). These units consist of a variety of light-colored, fine- to medium-grained, quartz-feldspathic gneiss and schist, dark-colored biotite and hornblende schists, black to dark gray amphibolite, gray to greenish-gray phyllite, and gray to white quartzite (Hewitt, 1959). Individual units are irregular in shape, discontinuous, and difficult to map. Therefore, they are typically grouped as undifferentiated metamorphic rocks (Hedlund, 1980; Finnell, 1987; McLemore et al., 2000). Foliation is well to poorly developed and variable in orientation. The metamorphic rocks consist of interlayered units of igneous and sedimentary protolith that are cross-cut by granitic gneiss, pegmatites, and fine-grained biotite granite dikes. Migmatites are common along some contacts with the younger granitic intrusions; other contacts with the granite are sharp. A sample of the metamorphic gneiss was dated as 1560 Ma by U/Pb methods on zircon (Hedlund, 1980). A sample of diorite from the Redrock area was dated as 1632±5 Ma by U/Pb on zircon (Table 2, Rämö et al., 2003). Analyses of monazites by Sanders (2003) suggests deposition of the metasediments at about 1633-1668 Ma.

Granite/granodiorite

This unit is gray, medium- to coarse-grained, hypidiomorphic-granular to porphyritic granite to granodiorite that consists of microcline, oligoclase, quartz, biotite, hornblende, and trace amounts of sphene, zircon, apatite, epidote, pyrite, and magnetite. The granite/granodiorite is typically foliated and contains xenoliths of metamorphic rocks. Hedlund (1980) reports a K/Ar biotite age of 1380±45 Ma; $^{40}Ar/^{39}Ar$ dates of 1431.5±1.2 and 1447.3±1.8 Ma have been obtained from biotite separates (Table 2, unpublished data).

Jack Creek Rapakivi Granite

The Jack Creek Rapakivi Granite is pink-gray to red-orange and is medium to coarse grained. It is characterized by large K-feldspar phenocrysts, some of which are mantled by plagioclase to form the rapakivi texture. This granite consists of plagioclase, K-feldspar, quartz, biotite, and accessory apatite and magnetite. The rapakivi granite is locally foliated at the contact with the older granite/granodiorite in Wild Horse Canyon, east of the Schoolhouse Mountain fault (Fig. 2). The granite extends from north of Redrock, eastward to the Schoolhouse Mountain fault, east of Wild Horse Mesa. McLemore et al. (2000, 2003) named this unit after Jack Creek, which cuts through the granite in the Redrock area. A sample of the granite was dated as 1461±23 Ma by U/Pb on zircon (Table 2, Rämö et al., 2003).

Numerous xenoliths of older metamorphic rocks and possible comagmatic enclaves and synplutonic dikes of lamprophyre (minette) characterize the Jack Creek Rapakivi Granite (McLemore et al., 2000). Xenoliths are extraneous pieces of older country rock introduced into the magma, whereas enclaves are residues of melting or coeval magma (Didier and Barbarin, 1991). Xenoliths range in size from a few centimeters in diameter to lenses tens of meters across. Typically the metamorphic xenoliths are similar to the metamorphic rocks found in the Bullard Peak Series and consist predominantly of light-colored, fine-grained quartz-feldspathic gneisses and schists, although locally dark-colored biotite schists and amphibolites are common. Foliation of the larger individual xenoliths in most areas is randomly oriented, suggesting rotation of the blocks during granitic intrusion. The lamprophyre enclaves range in size from a few centimeters to several meters in diameter and occur as isolated pods or pillows, swarms of pods or pillows, and synplutonic dikes.

Minette

Isolated enclaves, swarms of enclaves, and synplutonic dikes of K-rich minette are found in the Jack Creek Rapakivi Granite and range in size from a few centimeters to several meters in diameter. The minette is dark gray, fine to medium grained, and porphyritic with dark mica and, presumably, pyroxene phenocrysts that have been altered into fine-grained amphibole; the main constituents in the groundmass are K-feldspar, dark mica, and amphibole. The enclaves are distinctly finer grained then the enclosing granite. The crenulate to cuspate margins of the synplutonic dikes and many of the enclaves show evidence for intensive mingling with the rapakivi granite host; quartz and K-feldspar megacrysts have been mechanically incorporated into the minette and the quartz xenocrysts are locally mantled by biotite or hornblende. Adjacent to the minette, feldspars within the rapakivi granite are locally surrounded by biotite and amphibole from the minette. Other minette pillows have sharp to diffuse contacts with the host granite. Locally, coarse-grained pegmatitic phases of the granite form a halo surrounding the minette pillows. A sample of the miette was dated as 1465±15 Ma by U/Pb on zircon (Table 2, Rämö et al., 2003).

Most minette pillows are rounded and ovoid in shape; cross sections are typically ellipsoid. Locally angular, lenticular, or cigar-shaped minette pillows are found. Flow foliations are typically absent except locally in the Wild Horse Canyon area where both the rapakivi granite and the enclaves exhibit slight foliation. The foliation continues from the granite into the minette without disruption.

Isolated enclaves scattered throughout the granite pluton are common. The majority of the minette swarms and synplutonic dikes are found along the middle Gila River canyon. The swarms consist of pillows of minette encompassing areas as large as several tens of square meters, locally containing 50-80% minette. Locally, the minette swarms form a linear trend, several tens of feet long and up to 100 ft wide; these are termed synplutonic dikes. South of the junction of Foxtail Canyon and the Gila River, a 9 ft-long minette dike cuts a large metamorphic xenolith hosted by rapakivi granite. At the contact between the xenolith and rapakivi granite, the dike breaks up into a linear zone of numerous enclaves of minette engulfed by granite. This zone is 3-4 ft wide and continues along strike for at least 15 ft. A 1.5 ft-wide pink, fine-grained biotite granite dike cuts both the rapakivi granite and the minette enclaves. The enclave swarms possibly indicate that fountaining (Campbell and Turner, 1986; Lowell and Young, 1999) occurred where the minette magma was injected into the granitic magma and the mafic melt disintegrated into gobules. The areas of concentrated minette enclaves most likely represent source areas where minette magma was injected into the granitic magma.

Pillows of hybrid magma are common on the edges of synplutonic dikes and within swarms of enclaves. The hybrid varieties have incorporated large K-feldspar and quartz phenocrysts that are embayed, corroded, and commonly surrounded by biotite or hornblende. Gradational boundaries are common, although locally the margins are finer grained, indicating a chilled margin.

Episyenite

Two outcrops of brick red, metasomatic episyenite plugs occur in rapakivi granite at Ramsey Saddle (Fig. 2). The term episyenite, as used by Leroy (1978), is used to describe rocks that were desilicated and metasomatized by hydrothermal solutions. These rocks now resemble syenites. The metasomatic episyenite consists of K-feldspar, biotite, and plagioclase; quartz is absent. The episyenite exhibits similar coarse-grained texture as the enclosing rapakivi granite. The episyenites contain 10.7-10.4% K_2O and 0.15-0.19% Na_2O (unpublished chemical analyses), two to three times background radioactivity, and are grossly similar in composition and occurrence to metasomatic episyenites and intrusive syenites that are characteristic of Cambrian-Ordovician alkaline magmatism in New Mexico (McLemore and McKee, 1988; McLemore et al., 1999; McMillan et al., 2000; McMillan and McLemore, 2004).

Pegmatites

Pegmatites are relatively rare in the Wild Horse Mesa area as compared to other Proterozoic terrains in New Mexico. They are simple pegmatites, consisting of quartz, plagioclase, and K-feldspar with rare biotite. They are pink-red and typically small, from a few centimeters to <1 m wide and only several tens of meters long. Locally, quartz forms an irregular core that is surrounded by intergrown plagioclase and K-feldspar.

Cretaceous Rocks

Beartooth Quartzite

The Beartooth Quartzite, the oldest Cretaceous unit exposed in the area, lies unconformably on or in fault contact with the Proterozoic rocks and is conformably overlain by the Colorado Shale. It typically forms ridges and caps mountaintops (Fig. 2). The Beartooth Quartzite consists of 80-115 ft of white to light gray to tan, fine- to medium-grained orthoquartzite and arkosic to lithic sandstone, with minor interbeds of conglomerate, shale, and siltstone. Thin beds of black chert-pebble conglomerate with chert pebbles less than 1 inch in diameter are common at the base of the unit, but thin conglomerate beds occur throughout the unit. Fragments of the underlying Proterozoic rocks are absent in the conglomerate. Most of the unit consists of light gray to brown-gray, thick-bedded, well sorted, fine- to medium-grained orthoquartzite, with silica cement and rounded grains of quartz and trace amounts of magnetite, hematite, and lithic fragments. Many quartz grains exhibit overgrowths of a second stage of quartz. Locally, the sandstones contain trace amounts of pyrite cubes and black organic material disseminated throughout the sandstone. Small-scale cross-beds are present in many sandstone beds. Porosity is low, except along fractures and bedding planes. The upper part of the unit contains thin beds of black shale. The unit was most likely deposited within a transgressive, epicontinental sea.

Colorado Shale

The Colorado Shale lies conformably on the Beartooth Quartzite and typically crops out in valleys and saddles of ridges. It consists of thinly bedded, fissile, silty, carbonaceous, brown to black shale. Locally, nodules of dark-gray limestone occur in the upper beds. Thin white to light gray to tan, fine- to medium-grained orthoquartzite and arkosic to lithic sandstone beds are found in the lower Colorado Shale that are indistinguishable from the Beartooth Quartzite.

Tertiary Rocks

Andesite

Andesite occurs as dark gray to black to dark to olive green, porphyritic dikes and consists of feldspar, biotite, and hornblende altered to chlorite, iron oxides, and sericite. The green color is a result of chloritization. Rhyolite dikes intruded the andesites locally. The andesites are offset by faults (Fig. 2) and can be as old as Late Cretaceous or as young as mid-Tertiary. Both Cretaceous and mid-Tertiary andesites are common in the northern Burro Mountains (Hedlund, 1980; Finnell, 1988).

Ash-flow tuffs

Rhyolite ash-flow tuffs lie unconformably on Cretaceous sedimentary rocks on Wild Horse Mesa (Fig. 2). The ash-flow tuffs are gray to tan to light brown, fine-grained to porphyritic, crystal poor, moderately to poorly welded and consist of altered pumice and <5% quartz, feldspar, and biotite phenocrysts. They are offset by faults (Fig. 2). The similarity in composition and spatial relationship to the intrusive rhyolite plugs, domes, and dikes suggest that the ash-flow tuffs can be extrusive equivalents to the rhyolite intrusions. The ash-flow tuffs can have been erupted from the Schoolhouse Mountain caldera. However, the ash-flow tuffs related to the caldera are lithic and crystal rich (Finnell, 1987), unlike the lithic- and crystal-poor ash-flow tuffs on Wild Horse Mesa.

Intrusive rhyolite

Rhyolite dikes are white to gray, fine grained, foliated, and consist of <5% quartz, feldspar, and biotite phenocrysts. They intruded Proterozoic granite, Cretaceous sedimentary rocks, andesite dikes and occur along and are offset by faults on Wild Horse Mesa (Fig. 2). Similar rhyolite plugs, domes, and dikes intruded the Proterozoic granite/granodiorite east of Schoolhouse Mountain fault and form many of the mountaintops (Finnell, 1987). These rhyolites are probably related to the Schoolhouse Mountain caldera.

STRUCTURAL GEOLOGY

Faults in the Wild Horse Mesa area trend north, east-west, northwest, and northeast (Fig. 2). The youngest and most prominent fault is the Schoolhouse Mountain fault, which trends N10°W to due north and dips steeply. The fault is radial to the Schoolhouse Mountain caldera and cuts the ring fractures and ash-flow tuffs associated with the caldera (Finnell, 1987). It forms the eastern edge of Wild Horse Mesa and places Cretaceous sedimentary and mid-Tertiary igneous rocks against Proterozoic granite/granodiorite (Fig. 2). However, the fault can not be traced in the Proterozoic granite/granodiorite south of Bear Canyon (Hedlund, 1980). The main fault is typically unmineralized, but mineralized vein and shear zones parallel the fault locally. A north-trending fault also is present at the Blackmoor mine, but this fault does not cut the ring fracture zone (Finnell, 1987).

Three east-west trending faults are found in the Wild Horse Mesa area. Two normal faults form the southern edge of Wild Horse Mesa and strike N75°W and dip 60-80°N. The northern fault, called the Moneymetal fault, is separated from the southern fault by approximately 150 ft of Proterozoic rapakivi granite (unpublished mapping at 1:1000 scale by the author). The Moneymetal adit lies along the Moneymetal fault. At the Barite prospect, east of the Schoolhouse Mountain fault, a rhyolite dike and barite vein intruded a third east-west fault, which can be a continuation of the Moneymetal fault (Fig. 2).

Four steeply-dipping normal faults trend northwest; the Purple Heart, Reed, a fault south of the Reed, and a fault north of the Reed (Fig. 2). Slickensides along the Purple Heart and Reed faults indicate that the last movement was dipslip. These faults are perhaps the oldest of the faults in the area, because they are offset by the Schoolhouse Mountain fault, Moneymetal fault, and northeast-trending faults. Fluorite, uranium, and quartz veins occur along the Purple Heart and Reed faults. Rhyolite and andesite dikes intruded along the other two northwest-trending faults.

The curvilinear northeast-trending faults cut the northwest-trending faults. A rhyolite dike intruded two of the faults (Fig. 2). These faults are unmineralized.

DESCRIPTION OF MINERAL DEPOSITS

Four types of volcanic-epithermal vein deposits are present in the Wild Horse Mesa area. These include 1) fluorite veins, 2) uranium veins and minor stratabound, sandstone deposits, 3) base-metal veins, and 4) barite veins. Fluorite veins are the most significant in size and past production. REE-Th-U veins in alkaline rocks are found northwest of the Purple Heart mine. Assays from some of these veins are in Appendix 2. Alteration is variable. The mineralized granite is typically altered to kaolinite, chlorite and sericite and exhibits iron staining. Silicification of the granite is locally intense, especially along faults, and in other areas minor. The mineralized Beartooth Quartzite is typically fractured, silicified, and exhibits iron staining.

Fluorite veins

Five fluorite deposits have been developed in the Wild Horse Mesa area (Table 1). All of the fluorite deposits, except the Rambling Ruby, are hosted by faults in Jack Creek Rapakivi Granite west of the Schoolhouse Mountain fault. The Purple Heart mine consists of two backfilled shafts (65 and 108 ft deep) and an adit. Fluorite occurs in two slightly radioactive veins striking N20-47°W and dipping 65°NE as fracture filling and crustiform masses cementing granite fragments in a fault breccia zone (Rothrock et al., 1946; Gillerman, 1952; Williams, 1966). The veins are only two to three times background radioactivity (McLemore, 1983). The veins are <3-6 ft wide and 600 ft long, and consist of fluorite, quartz, calcite, and a trace of pyrite and barite. A selected dump sample contained the highest gold and molybdenum concentrations in the area, 10.4 ppm Au and 1265 ppm Mo (Appendix 2, sample #Purple Heart). The adjacent granite is altered to chlorite and sericite; silicification occurs within the breccia zone. The paragenetic sequence is 1) early green-gray to black jasperoid breccia with pyrite, 2) brecciation, 3) blue-gray to black jasperoid with pyrite, 4) white to clear fluorite, 5) milky quartz and banded, crustiform quartz, 6) green, purple, and clear fluorite with quartz, 7) milky quartz, and 8) late white calcite with clear to white quartz crystals. Production in 1947-1958 amounted to 1388 short tons of 80-85% fluorite (McAnulty, 1978).

The Blackmoor (Clover Leaf, Blackmar) mine consists of green and purple fluorite with quartz and clay in Proterozoic Jack Creek Rapakivi Granite that is exposed by a 50 ft shaft (Gillerman, 1952; Williams, 1966). The vertical vein strikes N10°W and is 6 ft wide and 500 ft long. There is no reported production. The paragenetic sequence is 1) early quartz with trace pyrite, 2) green and purple fluorite (locally banded), and 3) late drusy quartz. Thin veins (8-15 cm) of galena, quartz, pyrite, and fluorite striking N90°E cut the granite near the main vein. A sample contained 20,680 ppm Cu and 0.3 ppm Ag (Appendix 2, sample #WH 98).

The Reed fluorspar deposit consists of green, purple, and clear fluorite, quartz, calcite, and trace of barite along a fault in Proterozoic granite. The mine consists of three shafts, 30-50 ft deep that are now caved and backfilled (Williams, 1966). The vein is less than 3 ft wide and is traceable along strike for approximately 1000 ft. The paragenetic sequence is 1) early quartz with trace pyrite, 2) green and purple fluorite (locally banded), 3) late drusy quartz. A sample from the Mayday claims along the Reed fault contained 0.009% U_3O_8 (McLemore, 1983). Production in 1951-1954 amounted to 200 short tons of 60-75% fluorite (McAnulty, 1978).

The Rambling Ruby prospect is along a shear zone near the intersection of the east-west ring fracture of the Schoolhouse Mountain caldera and a N15ºW trending fault subparallel to the Schoolhouse Mountain fault. The deposit consists of clay, quartz, fluorite, malachite, and chrysocolla in altered granite and rhyolite. A selected dump sample contained >20,000 ppm Cu (Appendix 2, sample #WH 28). Shallow pits expose the deposit. The altered shear zone is several tens of feet long and 6 ft wide.

Uranium deposits

Two types of uranium deposits, minor stratabound, sandstone uranium deposits and epithermal veins along faults and shear zones occur in the Wild Horse Mesa area. The vein deposits are the higher-grade uranium deposits and occur as thin veins and stringers along shear zones cutting the Proterozoic Jack Creek Rapakivi Granite and Beartooth Quartzite. Minor uranium also occurs within fluorite veins cutting the Proterozoic Jack Creek Rapakivi Granite. In most areas, the veins occur as thin fracture fillings within a breccia fault or shear zone; discrete megascopic veins are rare and typically found only as fluorite veins. In many faulted areas, mineralized stratabound zones continue laterally from the mineralized faults into the adjacent beds of the Beartooth Quartzite and along the unconformity, typically within 45 ft of the faults (Fig. 2; O'Neill and Thiede, 1982). The mineralized fault zones are typically <3 ft wide, although locally small occurrences can be as much as 4 ft wide, especially where hosted by the granite. The veins are typically thinner where located in the quartzite. The highest grade deposits are found along the Moneymetal fault, where uraninite and metatorbernite with pyrite has been found in veinlets and as disseminations within the quartzite along the fault zone. Assays range from 0.009% to 0.59% U_3O_8 (McLemore, 1983). A sample from Hot Hole No. 1 pit on the Moneymetal fault contained 7 ppb gold and 190 ppm U_3O_8, a second sample contained 181 ppm U_3O_8 (Appendix 2, #WH2, 148). Samples along the Moneymetal fault also contained elevated concentrations of zinc (Appendix 2). A sample from the pit from the Prince Albert 1 claim near Wild Horse Mesa assayed 0.09% U_3O_8 and trace gold (<0.7 ppm; McLemore, 1983).

Stratabound, sandstone uranium deposits occur as small lenses or pods in quartzite and rapakivi granite at the unconformity between the Proterozoic rapakivi granite and Beartooth Quartzite (Fig. 2). Other minor stratabound, sandstone uranium occurrences are found in permeable zones in the basal 30 ft of the Beartooth Quartzite near mineralized faults. Typically, dark red to reddish-brown, iron-stained, poorly sorted arkosic or lithic sandstones host the stratabound uranium deposits. Oxidized pyrite and carbonaceous material are present in some deposits. Most stratabound deposits in the Wild Horse Mesa area are found laterally within a few tens of feet from mineralized faults or shear zones. A sample from the pit on the Prince Albert 2 claim assayed 0.09% U_3O_8 (McLemore, 1983). Most samples contained low concentrations of other metals (Appendix 2).

Base-metal veins

Only a few base-metal veins are found in the Wild Horse Mesa area. The patented German mine (Hard Pan), in Little Bear Canyon, consists of three adits and one shaft; all are now caved. The adits are reported to have been 8-140 ft long (Gillerman, 1964). The mine was worked prior to 1900 and again during the late 1930s through early 1950s (Gillerman, 1964); production is undocumented and presumed small. Sulfide minerals (pyrite, chalcopyrite, sphalerite, and galena) occur as thin veins and stringers (<15 cm wide), nodules, and disseminations within amphibolite schist xenoliths in Proterozoic granite. The vein is covered at the surface. Hewitt (1959) reported it strikes east-west. Within the schist, fractures striking N40-50°E also are mineralized. The adjacent granite is unmineralized but it is altered to sericite and chlorite veins occur along the fractures. A sample from the lower dump assayed 41 ppm Au, 405 ppm Ag, 150,650 ppm Pb and 260,580 ppm Zn (Appendix 2, sample #WH 127). The paragenetic sequence is 1) early pyrite and quartz, 2) sphalerite, galena, chalcopyrite, quartz, and pyrite, 3) quartz, pyrite, calcite, and 4) late calcite. The vein is subparallel to an east-west trending andesite porphyry dike (Hewitt, 1959; Hedlund, 1980).

In the Butterfly Seep area, east of the Schoolhouse Mountain fault, several small veins of secondary copper minerals occur in Proterozoic granite/granodiorite, amphibolite schist, and quartz-feldspar gneiss. A 12-ft adit and shallow pit expose a vein that strikes N25°E and consists of quartz, calcite, and trace amounts of pyrite and malachite. The veins are only a few feet long and <2 ft wide. Samples collected along the veins contain variable amounts of copper (9-15,968 ppm), gold (<5-122 ppb), and other metals (Appendix 2).

Barite veins

Two barite and quartz veins occur east of the Schoolhouse Mountain fault. The Barite prospect consists of quartz, barite, and trace amounts of pyrite in a fault zone in gneissic granite/granodiorite. A rhyolite dike intruded the fault that strikes N80°E. Samples of the vein contain low concentrations of metals (Appendix 2, samples #WH 38, 39, 40). The Barite No. 2 prospect, south of the mapped area in Figure 2 (Hedlund, 1980), consists of quartz and barite in a silicified fault zone that strikes N60°W in granite/granodiorite. A rhyolite dike intruded this fault also. Background levels of radioactivity characterize both deposits.

REE-Th-U veins in alkaline rocks

Brick-red to reddish-orange alkali-feldspar syenite and quartz syenite dikes or plugs intruded the Proterozoic rocks northwest of the Purple Heart mine. The contacts with the metamorphic rocks are not exposed. In thin section, the alkaline rocks are aphanitic porphyritic and typically vesicular, with altered plagioclase phenocrysts set in felty to intergranular groundmasses; the rocks are almost devoid of ferromagnesian minerals. The alkali-feldspar syenites contain 90-95% alkali-feldspar with varying amounts of quartz, hematite, plagioclase, fluorite, and biotite, almost completely altered to chlorite. Some alkali-feldspar crystals are more than a centimeter long. Iron oxides exist as fine-grained, red-brown disseminations within the alkali-feldspar, producing the brick-red color. Fluorite is locally common as disseminations and along fractures cutting the syenite dikes. Locally, the fluorite is zoned from colorless to purple in as many as three bands. The dikes are radioactive, containing elevated U and Th and possibly REE, but the distribution of these elements is sporadic and low grade. The high-K alkali-feldspar syenites are probably metasomatic, as indicated by textures and chemistry similar to those found at Lobo Hill, Torrance County (McLemore et al., 1999), Caballo Mountains, Sierra County (McLemore, 1986), and elsewhere in the Burro Mountains (McLemore and McKee, 1988).

MINERAL DISTRIBUTION

Fluorite veins are prominent in the northwestern part of the Wild Horse Mesa area, west of the Schoolhouse Mountain fault and can form the center of the mineralization. The highest gold and silver concentrations are associated with the Purple Heart and Reed fluorite veins and east of the Schoolhouse Mountain fault (Appendix 2). Uranium forms the intermediate zone and occurs west of the Schoolhouse Mountain fault. The highest-grade uranium deposit is along the Moneymetal fault in the southwest part of the area. Low-grade copper and barite deposits with minor gold form the outer zone and typically occur east of the Schoolhouse Mountain fault.

The relationship of the German deposit to the other deposits in the Wild Horse Mesa area is unknown. The German deposit is associated with a metamorphic xenolith and can be Proterozoic in age. The deposits can also represent a separate volcanic-epithermal system that formed copper and fluorite deposits in the Redrock area in the western part of the Telegraph district. It also is possible that the Wild Horse Mesa area is part of a much larger volcanic-epithermal system in the Telegraph district. Future studies will further address the relationship of the deposits in the entire Telegraph district.

DISCUSSION

Alteration style, vein textures, metal association, and proximity to the Schoolhouse Mountain caldera indicate that the mineral deposits in the Wild Horse Mesa area are classified as volcanic-epithermal veins. The morphology, paragenesis, district zoning, and composition of the veins suggest they can represent the upper parts of a volcanic-epithermal system, most likely related to the Schoolhouse Mountain caldera. The age of mineralization is constrained by the age of the mineralized faults, which occurred after formation of the caldera; mineralization can be related to intrusion of the rhyolite plugs, domes, and dikes. The fluorite and uranium deposits also appear to be restricted to the outcrop of the Jack Creek Rapakivi Granite and the copper and barite deposits are restricted to the granite/granodiorite or metamorphic rocks, although this can be a coincidence.

Previous studies have suggested that the fluorite and uranium deposits are related to the same mineralizing event (Hewitt, 1959; O'Neill and Thiede, 1982). The fluorite veins are associated with minor amounts of uranium, but most of them are not significantly radioactive at the surface. The common metal association and similar alteration of the host rocks between the various types of veins in the Wild Horse Mesa area are supportive of a single mineralizing event (Appendix 2; O'Neill and Thiede, 1982).

The distribution of the alteration and form of the veins indicate that ascending fluids, not descending fluids (O'Neill and Thiede, 1982) formed the vein deposits. The highest-grade uranium deposits occur along faults at the base of the quartzite (Fig. 7). The upper beds of the Beartooth Quartzite along the mineralized faults are not mineralized. Uraniferous (and other metals) fluids probably moved upward along faults and precipitated uranium and other minerals where the fault zone intersected the Beartooth Quartzite. Fault and shear zones in the granite are wider and more permeable than in the harder, more resistant and less permeable quartzite. Locally, rhyolite dikes have not intruded the quartzite. Where the fluids reached the quartzite, permeability decreased and the fluids ponded, forming the mineralized fault zones. Locally, the fluids migrated along the permeable unconformity and rare permeable sandstone beds in the Beartooth Quartzite, forming the stratabound deposits. The presence of pyrite, organic material, and clay provided a reducing environment that allowed deposition of the uranium, forming localized stratabound uranium deposits.

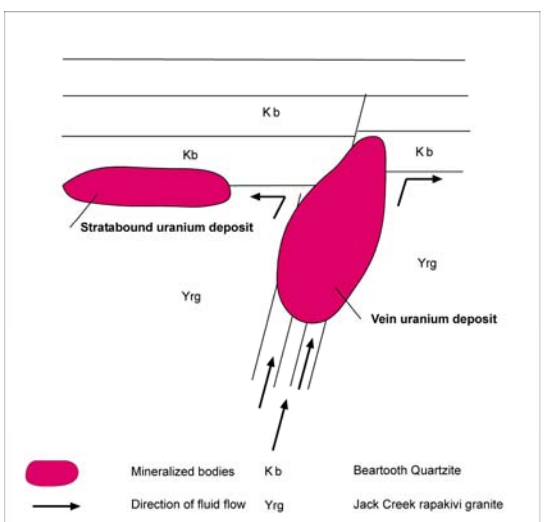

FIGURE 7. Schematic model for uranium deposition in the Wild Horse Mesa area.

ASSESSMENT OF MINERAL-RESOURCE POTENTIAL

Introduction

Definitions

Mineral resources are the naturally occurring concentrations of materials (solids, gas, or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions. Reports describing mineral resources vary from simple inventories of known mineral deposits to detailed geologic investigations.

A *mineral occurrence* is any locality where a useful mineral or material occurs. A *mineral prospect* is any occurrence that has been developed by underground or above ground techniques or by subsurface drilling. These two terms do not have any resource or economic implications. A *mineral deposit* is a sufficiently large concentration of a valuable or useful mineral or material that was extracted or can be extracted under current or future economic conditions. A *mine* is any prospect that produced or is currently producing a useful mineral or commodity.

The *mineral-resource potential* of an area is the probability that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions. Mineral-resource potential is preferred in describing an area, whereas mineral-resource favorability is used in describing a specific rock type or geologic environment (Goudarzi, 1984). The mineral-resource potential is not a measure of the quantities of the mineral resources, but is a measure of the *potential* of occurrence. Factors that could preclude development of the resource, such as the feasibility of extraction, land ownership, accessibility of the minerals, or the cost of exploration, development, production, processing, or marketing, are not considered in assessing the mineral-resource potential.

Classification

Classification of mineral-resource potential differs from the classification of mineral resources. Quantities of mineral resources are classified according to the availability of geologic data (assurance), economic feasibility (identified or undiscovered), and as economic or uneconomic. Mineral-resource potential is a qualitative judgement of the probability of the existence of a commodity. Mineral-resource potential is classified as high, moderate, low, or no potential according to the availability of geologic data and relative probability of occurrence (Fig. 8).

DEFINITIONS OF LEVEL OF RESOURCE POTENTIAL

N **No mineral resource potential** is a category reserved for a specific type of resource in a well defined area.

L **Low mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicated geologic environment where the existence of mineral resources is unlikely and is assigned to areas of no or dispersed mineralized rocks.

M **Moderate mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence.

H **High mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence. Assignment of high mineral-resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

DEFINITIONS OF LEVEL OF CERTAINTY

A Available information is not adequate for the 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-resource potential.

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

<table>
<tr><td rowspan="4">↑
INCREASING LEVEL OF RESOURCE POTENTIAL</td><td rowspan="4">U/A
Unknown Potential</td><td>H/B
High Potential</td><td>H/C
High Potential</td><td>H/D
High Potential</td></tr>
<tr><td>M/B
Moderate Potential</td><td>M/C
Moderate Potential</td><td>M/D
Moderate Potential</td></tr>
<tr><td rowspan="2">L/B
Low Potential</td><td rowspan="2">L/C
Low Potential</td><td>L/D
Low Potential</td></tr>
<tr><td>N/D
No Potential</td></tr>
<tr><td colspan="5">INCREASING LEVEL OF CERTAINTY →</td></tr>
</table>

FIGURE 8. Classification of mineral-resource potential and certainty of assurance (modified from Goudarzi, 1984).

High mineral-resource potential is assigned to areas where there are known mines or deposits where the geologic, geochemical, or geophysical data indicate an excellent probability that mineral deposits occur. All active and producing properties fall into this category as well as identified deposits in known mining districts or in known areas of mineralization. Speculative deposits, such as reasonable extensions of known mining districts and identified deposits or partially defined deposits within geologic trends are classified as high mineral-resource potential when sufficient data indicate a high probability of occurrence.

Moderate mineral-resource potential is assigned to areas where geologic, geochemical, or geophysical data suggest a reasonable probability that undiscovered mineral deposits occur in formations or geologic settings known to contain economic deposits elsewhere. Speculative deposits in known mining districts or mineralized areas are assigned a moderate potential if evidence for a high potential of economic deposits is inconclusive. This assignment, like other classifications, can be revised when new information, new genetic models, or changes in economic conditions develop.

Low mineral-resource potential is assigned to areas where available data imply the occurrence of mineralization, but indicate a low probability for the occurrence of an economic deposit. This includes speculative deposits in geologic settings not known to contain economic deposits, but which are similar to geologic settings of known economic deposits. Additional data can be needed to better classify such areas.

No mineral-resource potential is assigned to areas where sufficient information indicates that an area is unfavorable for economic mineral deposits. This evaluation can include areas with dispersed but uneconomic mineral occurrences as well as areas that have been depleted of their mineral resources. Use of this classification implies a high level of geologic assurance to support such an evaluation, but it is assigned for potential deposits that are too deep to be extracted economically, even though there can not be a high level of geologic assurance. These economic depths vary according to the commodity and current and future economic conditions.

Unknown mineral-resource potential is assigned to areas where necessary geologic, geochemical, and geophysical data are inadequate to classify an area otherwise. This assessment is assigned to areas where the degree of geologic assurance is low and any other classification would be misleading

Mineral-resource Potential

The mineral-resource potential for undiscovered volcanic-epithermal vein and epithermal fluorite vein deposits in the Wild Horse Mesa area is moderate with a high degree of certainty. The presence of gold concentrations in surface samples and the interpretation of the deposits being at the top of a volcanic-epithermal system suggest that additional deposits are most likely to be deep. The best potential is associated with faults west of, and including the Schoolhouse Mountain fault based upon chemical analyses and limited alteration.

The Beartooth Quartzite is relatively impermeable except where fractured adjacent to faults, and does not contain much organic material that could act as a host for uranium. Known deposits are found adjacent or near mineralized faults. Therefore, the mineral-resource potential for sandstone uranium deposits is low with a moderate certainty of assurance.

The mineral-resource potential for REE-Th-U veins in alkaline rocks deposits is low with a moderate certainty of assurance.

Porphyry-copper deposits are found associated with the Tyrone stock (54.5 Ma, $^{40}Ar/^{39}Ar$, McLemore, 2001) in the southern Burro Mountains. The Twin Peaks quartz monzonite (72.5 Ma, K/Ar, Hedlund, 1980) is southeast of the Wild Horse Mesa area, but no porphyry copper deposits have been found associated with it. Intrusions in the Wild Horse Mesa area are younger then the Schoolhouse Mountain caldera (33.5 Ma, $^{40}Ar/^{39}Ar$, McIntosh et al., 1991) and do not indicate a porphyry system in the Wild Horse Mesa area. Therefore, the mineral-resource potential for porphyry-copper (molybdenum, gold) deposits is low with a moderate certainty of assurance.

ECONOMIC FEASIBILITY

It is possible that precious-metal deposits, specifically gold, could be produced in the Wild Horse Mesa area. The price of gold is high enough to encourage such production. However, the deposit must be high enough in grade and tonnage to include development of a mill or transportation to a mill required for concentration of the ore. In addition, the cost of mining any deposit in the area must include regulatory and mine closure costs.

It is unlikely that base metals, fluorite, or barite could be produced from the Wild Horse Mesa in the near future. The deposits in the Wild Horse Mesa area are low in grade and tonnage for base metals, fluorite, and barite to be economic. Furthermore, there are no mills in the state to concentrate such ores. The Phelps Dodge properties at Chino, Cobre, and Tyrone, found in the southern Burro Mountains, are closed or being mined for heap leach only. The deposits at Wild Horse Mesa are not amenable to current heap leach techniques. Therefore, any potential production must account for development of a mill or transportation to a mill, then to a smelter. In addition, the cost of mining any deposit in the area must include regulatory and mine closure costs. It is unlikely that these commodities could be produced at a profit now or in the near future.

It is unlikely that uranium could be produced form the Wild Horse Mesa area now or in the near future. The potential for uranium production from New Mexico in the near future is dependent upon international demand for uranium, primarily for fuel for nuclear power plants. Modern regulatory costs will add to the cost of producing raw uranium in the U. S. There are no conventional mills remaining in New Mexico to process the ore, which adds to the cost of producing uranium in the state, especially in a remote area like Wild Horse Mesa area. High-grade, low-cost uranium deposits in Canada and Australia are sufficient to meet current international demands in the near future. Deposits in the Grants uranium district and in Wyoming have a greater potential for production than at Wild Horse Mesa. It is unlikely that uranium will be produced from underground mines in New Mexico in the near future.

RECOMMENDATIONS

The next stage in exploration of the Wild Horse Mesa area should be in targeting potential drill sites for gold veins. Soil surveys using partial extraction techniques such as Enzyme Leach are costly, but could possibly identify potential drill targets. Surface geophysical techniques such as radar imaging, magnetic, electromagnetic surveys also are costly, but also could identify potential drill targets.

ACKNOWLEDGMENTS—This report is part of on-going studies of mineral resources in New Mexico, supported by the New Mexico Bureau of Geology and Mineral Resources (NMGMMR), a division of New Mexico Institute of Mining and Technology, Peter Scholle, Director and State Geologist. Chris McKee (NMGMMR) analyzed some samples by X-ray-fluorescence using the Phillips PW 2400 instrument purchased with funds from NSF grant EAR-9316467. Lynn Brandvold and Ibrahim H. Gundiler (NMGMMR Chemistry Laboratory) analyzed some samples for Au, Ag, Cu, Pb, Zn, As, Mo, and Sb. Joe Aiello and associates are acknowledged for providing funding for sample preparation and analyses. Peter Rinkleff, Doug Jones, Robert Thompson, Kelley Donahue, and Erik Munroe assisted with the sample preparation.

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Appendix 1—Description of samples collected from the Wild Horse Mesa area. Chemical analyses are in Appendix 2. Mine identification number refers to Mine_id in New Mexico Mines Database. Most, but not all samples are shown in Figure 2 and Map.

Sample Number	Mine identification number	Type of sample	Sample description	latitude	longitude	Geology	Sample location	Location description of sample	Date collected
Moneymetal vein									
WH1	NMGR0140	grab	mineralized rock	32.756406	108.576522	junction of 2 faults, N155	torbernite along fractures	Moneymetal vein	9/3/1993
WH2	NMGR0140	grab	waste dump	32.756406	108.576522	shear zone N110, joints 1 ft or less	south side No. 1 pit	Moneymetal vein	9/3/1993
WH3		composite	mineralized rock	32.756701	108.577529	quartz vein N155	4 ft chip across veins in granite	Moneymetal vein	9/3/1993
WH4		composite	mineralized rock	32.757149	108.577638	fault zone N155, 65S	4 ft chip across yellowish zone in vein	Moneymetal vein	9/3/1993
WH23	NMGR0140	composite	mineralized rock	32.755527	108.579062	shear zone	5 ft chip across shear zone	Moneymetal vein	8/19/1994
WH24	NMGR0140	composite	mineralized rock	32.755833	108.578851	outcrop of silicified zone	6 ft chip across zone	Moneymetal vein	8/19/1994
WH92		select	mineralized rock	32.75535	108.57845	silicified zone, N110	silicified zone	rhyolite dike	9/2/1999
WH95		select	rock	32.75685	108.582567	andesite porphyry dike N85E	silicified zone	Moneymetal vein	9/2/1999
WH96		select	mineralized rock	32.757217	108.582017	white quartz vein N110	silicified vein	Moneymetal vein	9/2/1999
WH97		select	mineralized rock	32.756967	108.58345	quartz pods	quartz pods	Moneymetal vein	9/2/1999
WH147	NMGR0140	select	mineralized rock	32.755973	108.577264	in Beartooth along fault	fault	Moneymetal vein	9/9/1999
WH148	NMGR0140	select	mineralized rock	32.755973	108.577264	quartz breccia along fault	fault	Moneymetal vein	9/9/1999
WH149	NMGR0140	select	mineralized rock	32.755973	108.577264	quartz breccia along fault	fault	Moneymetal vein	9/9/1999
WH211-00		select	mineralized rock	32.75572	108.57838	pyrite in quartzite	select	Moneymetal vein	9/2/2000
WH212-00	NMGR0140	select	mineralized rock	32.756206	108.57691	black coating along fractures in quartzite	select	Moneymetal vein	9/2/2000
WH213-00	NMGR0140	select	mineralized rock	32.756206	108.57691	quartzite	select	Moneymetal vein	9/2/2000
WH214-00	NMGR0140	composite	mineralized rock	32.756206	108.57691	pyrite in quartzite	3 ft chip	Moneymetal vein	9/2/2000
WH215-00	NMGR0140	select	mineralized rock	32.75602	108.57835	quartzite	select	Moneymetal vein	9/2/2000

WH216-00	NMGR0140	select	mineralized rock	32.755973	108.577264	metatorbernite in fractures in quartzite	select	Moneymetal vein	9/2/2000
WH217-00	NMGR0140	select	mineralized rock	32.755973	108.577264	quartzite	select	Moneymetal vein	9/2/2000
WH219-00		composite	mineralized rock	32.7552	108.57483	quartz in quartzite	chip	Moneymetal vein	9/2/2000
veins east of Schoolhouse Mt fault									
WH20	NMGR0143	composite	mineralized rock	32.759214	108.55489	shear zone	4 ft chip across back at portal	veins east of Schoolhouse fault	8/19/1994
WH21	NMGR0143	composite	waste dump	32.759214	108.55489	shear zone	select of waste dump	veins east of Schoolhouse fault	8/19/1994
WH31		composite	mineralized rock	32.769783	108.553683	quartz vein N55	1 ft chip across vein	veins east of Schoolhouse fault	8/21/1994
WH32	NMGR0152	composite	waste dump	32.771067	108.554017	granite with amphibolite lense	select of waste dump	veins east of Schoolhouse fault	8/21/1994
WH33	NMGR0152	composite	waste dump	32.771067	108.554017	granite	select of waste dump	veins east of Schoolhouse fault	8/21/1994
WH34	NMGR0151	composite	waste dump	32.769067	108.555083	quartz veins in granite N160, 45E	select of waste dump	veins east of Schoolhouse fault	8/21/1994
WH35	NMGR0151	composite	mineralized rock	32.769067	108.555083	quartz veins in granite N160, 45E	1.5 ft chip across vein	veins east of Schoolhouse fault	8/21/1994
WH130		select	mineralized rock	32.769203	108.556161	white quartz vein N90E, 1-3 ft long	vein	veins east of Schoolhouse fault	9/6/1999
Beartooth									
WH53		grab	mineralized rock	32.761017	108.580133	altered Beartooth Quartzite	grab	Beartooth Quartzite	8/30/1999
WH110		select	mineralized rock	32.771845	108.573629	6-8 inch quartz vein cutting Beartooth	vein	Beartooth Quartzite	9/3/1999
WH135		select	rock	32.754414	108.564195	Beartooth		Beartooth Quartzite	9/8/1999
WH136		select	rock	32.753223	108.561264	Beartooth		Beartooth Quartzite	9/8/1999
WH139		select	mineralized rock	32.754117	108.557749	Beartooth along fault zone, Fe oxides	along fault	Beartooth Quartzite	9/8/1999
NM257-00		select		32.777761	108.626414		Beartooth Quartzite	Beartooth Quartzite	10/16/1999

WH220-00		select	mineralized rock	32.7552	108.57483	iron-stained quartzite	select	Beartooth Quartzite	9/2/2000
WH242-00		select	mineralized rock	32.77111	108.574764	silicified quartzite	select	Beartooth Quartzite	9/4/2000
rhyolite dikes									
WH22		grab	rock	32.760816	108.568324	contact between rhyolite with pyrite and shale		rhyolite dike	8/19/1994
WH79		composite	mineralized rock	32.7573	108.565733	rhyolite	4 ft chip across rhyolite	rhyolite dike	9/1/1999
WH80		select	rock	32.756833	108.5659	rhyolite	porphyry rhyolite dike	rhyolite dike	9/1/1999
WH81		select	rock	32.75665	108.565417	rhyolite	rhyolite	rhyolite dike	9/1/1999
WH86		select	rock	32.758717	108.56195	rhyolite	rhyolite	rhyolite dike	9/1/1999
WH87		select	rock	32.759883	108.5637	rhyolite	fresh rhyolite	rhyolite dike	9/1/1999
WH91		select	rock	32.764967	108.567017	rhyolite	rhyolite	rhyolite dike	9/1/1999
Reed-Prince Albert adit									
WH29	NMGR0072	grab	mineralized rock	32.77175	108.56985	fault N120E, 80S	grab of outcrop	Jimmy Reed fault	8/20/1994
WH30	NMGR0072	composite	mineralized rock	32.772511	108.57083	fluorite vein N120, 80S	1 ft chip across vein	Jimmy Reed fault	8/20/1994
WH66		composite	mineralized rock	32.772033	108.570167	silicified breccia	60 ft chip	Jimmy Reed fault	8/31/1999
WH67		select	mineralized rock	32.772033	108.570167	silicified breccia	select breccia vein cutting silicified body	Jimmy Reed fault	8/31/1999
WH74		composite	mineralized rock	32.758867	108.563117	rhyolite	1 ft chip across fault	Jimmy Reed fault	9/1/1999
WH72		select	mineralized rock	32.769533	108.565833	quartzite	Beartooth Quartzite	Jimmy Reed fault	8/31/1999
WH108	NMGR0147	select	mineralized rock	32.773798	108.573968	N85E, quartz, chlorite, kaolinite, sericite	across vein at portal	Jimmy Reed fault	9/3/1999
WH109	NMGR0147	select	waste dump	32.773798	108.573968	select of fluorite	waste dump	Jimmy Reed fault	9/3/1999
WH223-00	NMGR0064	composite	mineralized rock	32.768861	108.56511	clay zone along face	2 ft chip	Jimmy Reed fault	9/3/2000
WH224-00	NMGR0064	composite	mineralized rock	32.768861	108.56511	clay zone along face	2 ft chip	Jimmy Reed fault	9/3/2000
WH225-00	NMGR0064	composite	mineralized rock	32.768861	108.56511	mineralized zone	4 ft chip across back 5 ft in adit	Jimmy Reed fault	9/3/2000
WH226-00	NMGR0064	composite	mineralized rock	32.768861	108.56511	reddish quartzite	4 ft chip at portal	Jimmy Reed fault	9/3/2000
WH227-00	NMGR0064	composite	mineralized rock	32.768861	108.56511	sercitized granite	5 ft chip at portal	Jimmy Reed fault	9/3/2000
WH228-00		select	mineralized	32.76968	108.5653	sercitized granite with	select	Jimmy Reed	9/3/2000

			rock			quartz veins		fault	
Prince Albert									
WH25	NMGR0064	composite	mineralized rock	32.769633	108.56535	N125, 88S zone	3 ft chip across altered zone	Prince Albert	8/20/1994
WH26	NMGR0064	composite	mineralized rock	32.769633	108.56535	N125, 88S zone	0.5 ft chip across altered zone	Prince Albert	8/20/1994
Precambrian									
WH69		select	rock	32.7715	108.5644	rapakivi granite		Precambrian	8/31/1999
WH116		select	rock	32.774289	108.586312	metasomatized granite		Precambrian	9/4/1999
WH117		select	rock	32.77415	108.588021	metasomatized granite		Precambrian	9/4/1999
WH118		select	rock	32.774276	108.587449	Jack Creek Rapakivi Granite		Precambrian	9/4/1999
WH248-00		select	mineralized rock	32.75006	108.578	amphibolite dike	select	Precambrian	9/5/2000
Precambrian quartz vein									
WH5A		composite	mineralized rock	32.751719	108.570478	quartz vein N125	4 ft chip across quartz vein	Precambrian quartz veins	9/3/1993
WH5B		composite	mineralized rock	32.751719	108.570478	quartz vein N125	8 ft chip across quartz vein	Precambrian quartz veins	9/3/1993
WH6A		composite	mineralized rock	32.75105	108.569685	quartz vein N125	10 ft chip across quartz vein	Precambrian quartz veins	9/3/1993
WH6B		composite	mineralized rock	32.75105	108.569685	quartz vein N125	chip across vein	Precambrian quartz veins	9/3/1993
WH145	NMGR0065	select	mineralized rock	32.769633	108.562412	thin quartz veins along unconformity	in between pits	Prince Albert	9/8/1999
NM162-99							quartz breccia vein		
NM231-99		select		32.730628	108.647154		Precambrian quartz veins	Precambrian quartz veins	10/9/1999
WH206-00		select	mineralized rock	32.753911	108.572724	quartz veins with pyrite		Precambrian quartz veins	8/30/2000
WH207-00		composite	rock	32.752999	108.571469	schist	3 ft chip	Precambrian	8/30/2000
Wh208-00		composite	mineralized rock	32.752705	108.570563	quartz vein, N310, vertical	4 ft chip	Precambrian quartz veins	8/30/2000
WH209-00		composite	mineralized rock	32.752764	108.569001	quartz vein, N80, 50S	3 ft chip	Precambrian quartz veins	8/30/2000
WH218-00		select	mineralized rock	32.75518	108.57479			Precambrian quartz veins	9/2/2000
WH244-00		select	mineralized rock	32.75452	108.57668	quartz vein	select	Precambrian quartz veins	9/5/2000
WH245-00		composite	mineralized rock	32.75425	108.5763	quartz vein	5 ft chip	Precambrian quartz veins	9/5/2000

Rambling Ruby									
WH27	NMGR0068	composite	mineralized rock	32.777317	108.557833		outcrop	Rambling Ruby	8/20/1994
WH28	NMGR0068	grab	waste dump	32.777317	108.557833		select dump	Rambling Ruby	8/20/1994
WH146		select	mineralized rock	32.776694	108.5562	thin quartz vein N35E	vein	Rambling Ruby	9/9/1999
Barite									
WH38	NMGR0142	grab	mineralized rock	32.755528	108.543828	silicified vein N80E	center of vein	Barite vein	8/21/1994
WH39	NMGR0142	composite	mineralized rock	32.75557	108.544233	silicified vein N80E	6 ft chip across vein	Barite vein	8/21/1994
WH40	NMGR0142	grab	mineralized rock	32.755431	108.545028	silicified vein N80E	6 ft chip	Barite vein	8/21/1994
Purple Heart									
PurpleHeart1	NMGR0066	grab	waste dump	32.766819	108.581966	Purple Heart fault		Purple Heart fault	8/19/1994
Purple Heart	NMGR0066			32.76675	108.582074				
WH112	NMGR0066	select	mineralized rock	32.765506	108.58166	vein N25W	across vein	Purple Heart fault	9/3/1999
Blackmore									
WH98	NMGR0145	select	mineralized rock	32.767983	108.59388	4-6 in vein with galena	chip across vein	Blackmore vein	9/4/1999
WH99	NMGR0145	select	mineralized rock	32.767983	108.59388	fluorite	chip across vein	Blackmore vein	9/4/1999
WH100	NMGR0145	composite	rock	32.767983	108.59388	dike	chip across dike	Blackmore vein	9/4/1999
German									
WH124	NMGR0146	select	mineralized rock	32.74513	108.591061	green-gray miceaceous schist	3 ft chip	German	9/5/1999
WH125	NMGR0146	select	waste dump	32.74513	108.591061	waste dump with pyrite	select	German	9/5/1999
WH126	NMGR0146	select	rock	32.745951	108.590877	granite		German	9/5/1999
WH127	NMGR0146	select	waste dump	32.746287	108.590462	waste dump		German	9/5/1999
Tertiary volcanic rocks									
WH120		select	rock	32.760745	108.505411	TKr, rhyolite		volcanics	9/4/1999
WH121		select	rock	32.780847	108.500312	Tkar, ignimbrite		volcanics	9/4/1999
WH122		select	rock	32.754907	108.521074	Tap, andesite		volcanics	9/4/1999

WH123		select	rock	32.773906	108.50902	Tkag, ignimbrite		volcanics	9/4/1999
WH128		select	rock	32.768814	108.559136	andesite with quartz veinlets	dike	volcanics	9/6/1999
TP1		grab	rock	32.73617	108.5276	Twin Peaks pluton	volcanics	volcanics	9/4/2000
Reed Gold prospect									
WH36	NMGR0149	composite	waste dump	32.744793	108.561279		sample of dump	Barite vein	8/21/1994
WH37	NMGR0149	select	mineralized rock	32.744793	108.561279	quartz pod in rhyolite	Barite vein	8/21/1994	
WH200-00	NMGR0149	select	mineralized rock	32.745278	108.562731	rhyolite dike		Reed gold	8/29/2000
WH201-00	NMGR0149	select	mineralized rock	32.745278	108.562731	minette		Reed gold	8/29/2000
WH202M-00	NMGR0149	select	mineralized rock	32.745278	108.562731	minette		Reed gold	8/29/2000
WH202-00	NMGR0149	select	mineralized rock	32.745278	108.562731	minette		Reed gold	8/29/2000
WH204-00	NMGR0149	select	mineralized rock	32.746973	108.563564	rhyolite	dike	Reed gold	8/29/2000
WH205-00-SS	NMGR0149	select	mineralized rock	32.749445	108.57994	Fe-Mn oxide vein, 1-4 inches with pyrite	vein	rhyolite dike	8/29/2000
Cretaceous shale									
WH210-00		select	mineralized rock	32.76305	108.56901	shale with pyrite		shale	8/30/2000

Appendix 2—Chemical analyses of samples from Wild Horse Mesa area, Telegraph district. All analyses are in ppm (parts per million) except for gold which is in ppb (parts per billion). Samples WH1-WH40 and Purple Heart were analyzed by Bondar-Clegg and Co. Ltd. (Au by fire assay; Ag, Cu, Pb, Zn, Mo by FAAS; As, Sb by INAA; Hg by cold vapor AA). Samples WH71, 98, 124-125, 127, 148, 149 were analyzed by FAAS at the NMBMMR using four acid digestion. Remaining samples were analyzed by XRF spectrometry at the NMBMMR. Au and Ag were by fire assay at NMBMMR. — not analyzed for. Fe_2O_3-T is total iron expressed as Fe_2O_3.

X-ray fluorescence analyses (XRF)

SAMPLE	TiO_2	Fe_2O_3T	MnO	As	Ga	Zn	Cu	Mo	Ni	Ba	V	Cr	Pb	Th	Rb	U	Sr	Y	Zr	Nb
Moneymetal vein																				
WH 1				20		1,683	504	15					429							
WH 2				58		758	28	75					1,367							
WH 3				0.5		67	40	4					46							
WH 4				39		1,095	9	12					1,256							

WH 23				4.7		233	7	4					53							
WH 24				4.6		84	130	4					38							
WH92	0.36	4.64	0.04	2	10	147	8	<1	92	838	52	464	27	<1	22	16	22	8	79	<1
WH95	0.27	1.79	0.05	5	16	42	4	<1	7	1230	13	67	20	8	153	2	395	22	178	8
WH96	0.04	1.49	0.04	<1	3	13	65	<1	11	43	15	136	17	<1	5	2	5	4	8	<1
WH97	0.03	0.36	0.01	<1	3	5	7	<1	6	106	5	181	5	<1	12	2	20	<1	5	<1
WH147	0.5	7.94	<0.01	21	12	102	15	12	6	111	89	92	118	2	118	75	44	18	279	6
WH149	high Pb, U																			
WH148	0.2	1.39	<0.01	6	5	42	12	32	5	137	24	122	786	<1	20	181	65	8	268	3
WH211-00	0.21	0.71	<0.01	9	6	49	15	62	5	113	23	22	550	<1	11	392	55	9	301	9
WH212-00-SS	0.66	1.07	0.08	7	35	111	13	8	18	547	42	75	691	32	208	21	53	25	369	23
WH213-00	0.36	1.37	<0.01	20	8	79	28	51	11	603	41	30	367	6	46	215	52	22	283	13
WH214-00	0.28	0.81	<0.01	16	6	135	46	93	15	188	50	24	602	3	21	266	25	14	335	10
WH215-00-SS	0.52	0.83	<0.01	65	10	78	50	235	10	136	58	124	1300	<1	ND	>1000	61	6	456	33
WH216-00-SS	0.42	0.96	<0.01	97	10	263	735	164	16	199	50	150	1600	<1	ND	>1000	177	14	671	62
WH217-00	0.56	1.35	<0.01	10	10	125	15	27	12	76	44	48	462	8	5	190	98	24	442	15
WH219-00-SS	0.08	5.50	0.01	49	3	287	14	15	25	687	20	181	418	3	0	40	28	22	105	6
veins east of Schoolhouse Mt fault																				
WH 20				5.3		366	5	5					10							
WH 21				4.3		412	4	4					14							
WH 31				1.8		12	6	2					60							
WH 32				2.5		84	15,968	4					261							
WH 33				4.9		185	122	5					41							
WH 34				2.4		37	8,438	3					108							
WH 35				2.1		19	9,343	4					204							
WH130	0.03	0.32	<0.01	<1	<1	16	9	<1	6	43	6	170	17	<1	9	2	8	<1	<1	<1
Beartooth																				
WH53	0.36	3.26	<0.01	28	3	28	10	3	10	61	25	134	8	<1	5	6	9	17	349	6
WH110	0.02	0.48	0.01	2	2	6	14	4	5	23	7	151	10	<1	2	3	6	<1	11	<1
WH135	0.45	2.41	<0.01	6	10	28	9	8	8	484	27	81	44	3	67	41	14	20	353	7
WH136	0.56	13.52	0.03	19	6	2194	22	4	91	82	71	131	118	<1	4	7	19	28	264	4

WH139	0.1	0.44	0.02	3	3	17	7	<1	4	81	13	109	45	<1	11	2	5	4	129	<1
NM257-99	0.93	6.11	0.1	2	18	77	6	<1	171	2300	107	288	14	22	240	8	592	26	308	4
WH220-00	0.79	13.45	0.03	5	11	144	12	7	41	553	120	64	35	11	7	14	26	26	370	17
WH242-00	0.09	0.92	0.02	1	5	24	8	3	18	174	16	69	8	ND	24	4	17	3	25	2
rhyolite dikes																				
WH 22				2.3		17	3	<1					12							
WH79	0.12	0.8	0.02	2	14	35	6	<1	6	474	5	69	20	12	206	4	87	29	139	12
WH80	0.1	0.73	0.04	2	12	33	5	<1	4	77	5	49	21	11	22	4	72	30	127	12
WH81	0.33	1.88	0.08	14	17	49	11	<1	12	1620	21	24	32	9	172	5	394	26	200	8
WH86	0.21	1.29	0.09	<1	15	47	5	<1	5	910	8	54	24	11	192	3	52	28	145	10
WH87	0.2	1.32	0.02	2	14	43	6	<1	6	1120	9	53	18	11	248	4	54	30	135	9
WH91	0.21	1.21	0.02	<1	13	24	5	<1	4	722	11	58	22	9	220	2	21	17	132	9
Reed-Prince Albert adit																				
WH 29				36		65	101	9					130							
WH 30				1.4		15	39	1					26							
WH66	0.1	0.91	0.01	8	4	22	10	5	7	131	16	154	68	2	22	9	16	9	117	2
WH67	0.23	0.5	0.01	4	6	19	7	4	7	118	25	132	59	<1	52	9	14	14	175	3
WH74	high Fe																			
WH72	0.21	1.24	0.04	3	16	38	5	<1	4	939	12	11	23	12	194	3	99	30	146	11
WH108	0.19	4.3	0.03	2	17	33	6	<1	48	309	58	112	11	9	120	9	50	12	82	<1
WH109	0.03	0.35	<0.01	2	3	8	10	<1	7	97	8	118	<1	<1	8	2	83	41	9	<1
WH223	0.3	2.6	0.03	6	15	80	8	8	24	656	35	137	60	30	203	47	109	21	130	6
WH224																				
WH225	1.3	11.5	0.05	13	21	>200	14	4	60	358	139	190	38	21	157	50	83	11	138	10
WH226																				
WH227-00-SS	0.32	1.96	<0.01	15	11	23	21	65	9	106	44	122	34	21	59	92	11	13	253	10
WH228-00-SS	0.25	2.41	0.02	16	13	52	11	7	11	700	38	146	174	22	209	8	109	7	121	6
Prince Albert																				
WH 25				63		134	9	16					50							
WH 26				12		30	3	6					78							
Precambrian																				

WH69	0.3	2.14	0.05	2	17	37	6	<1	25	752	33	127	39	20	161	4	273	12	132	<1
WH116	0.63	4.84	0.04	7	16	132	19	<1	61	1280	57	454	57	43	312	10	154	19	227	5
WH117	0.46	2.85	0.04	1	18	27	4	<1	43	825	46	144	19	23	137	4	176	16	185	4
WH118	0.53	4.87	0.03	2	14	19	5	<1	37	1111	47	143	17	31	290	8	123	20	216	4
WH248-00	1.75	14.16	0.22	6	19	150	55	2	183	251	293	605	11	ND	98	3	293	38	156	6
Precambrian quartz vein																				
WH 5A				1.6		79	105	<1					42							
WH 5B				3.3		32	49	2					79							
WH 6A				0.6		32	21	3					27							
WH 6B				0.5		11	20	2					5							
WH145	0.46	11.12	0.01	13	23	225	10	4	22	1250	40	132	115	28	159	141	23	12	176	3
NM162-99																				
NM231-99																				
WH206-00	0.08	0.59	<0.01	2	2	22	9	3	8	>5000	17	17	13	ND	35	3	144	4	35	2
WH207-00	0.42	4.53	0.08	2	17	70	28	4	19	1041	41	37	71	7	165	6	32	32	144	12
WH208-00-SS	0.08	1.05	0.01	2	5	30	8	3	12	136	20	142	13	4	54	6	15	3	35	3
WH209-00	0.08	1.92	0.03	1	6	97	8	2	19	153	21	20	59	7	20	4	29	5	40	3
WH218-00	0.07	0.33	<0.01	ND	5	18	11	3	5	59	17	28	22	ND	17	5	61	12	27	2
WH244																				
WH245																				
Rambling Ruby																				
WH 27				3		30	9138	3					114							
WH 28				4		113	>20,000	31					106							
WH146	0.53	6.31	0.13	4	16	104	12	<1	13	1500	49	82	37	5	154	3	113	47	260	7
Barite																				
WH 38				2.9		47	59	<1					40							
WH 39				7.2		248	151	2					80							
WH 40				4.6		101	67	2					68							
Purple Heart																				
Purple Heart 1				523		26	8	1265					13							
Purple Heart	0.19	1.53	0.02	3	12	25	10	308	17	668	37	51	16	8	127	7	131	12	192	6

WH112	0.13	1.03	0.01	<1	8	19	11	<1	8	643	24	149	21	<1	105	2	70	10	61	3
Blackmore																				
WH98	high Pb																			
WH99	0.06	0.48	0.01	3	3	12	26	<1	6	200	8	127	24	<1	18	3	81	44	22	<1
WH100	0.3	1.95	0.03	2	20	29	7	<1	13	959	32	83	36	15	177	4	279	8	161	<1
German																				
WH124	high Pb, Zn																			
WH125	high Pb, Zn																			
WH126	0.53	3.39	0.07	2	16	537	25	<1	22	978	31	133	47	38	96	4	418	16	257	2
WH127	high Pb, U																			
Tertiary volcanic rocks																				
WH120	0.43	1.9	0.02	2	16	43	6	<1	6	1220	24	29	20	10	148	3	153	34	231	9
WH121	0.43	2.23	0.06	2	17	41	9	<1	7	920	32	46	16	11	144	4	284	25	161	10
WH122	0.49	3.7	0.11	3	17	66	9	<1	6	1330	39	78	13	<1	86	2	528	24	120	2
WH123	0.18	1.17	0.02	<1	15	43	7	<1	5	680	12	25	20	7	125	2	66	26	127	10
WH128	0.32	3.43	0.09	2	16	75	8	<1	5	398	33	25	31	<1	133	3	208	21	127	3
TP1	0.27	3.40	0.11	3	19	61	11	3	5	730	34	12	11	ND	48	2	712	19	122	7
Reed Gold prospect																				
WH 36				<0.1		299	161	5					351							
WH 37				1.9		42	169	3					8							
WH200-00	1.32	13.31	0.33	ND	22	215	51	3	102	200	318	222	52	ND	73	3	307	34	89	8
WH201-00	0.42	2.99	0.07	1	15	75	15	4	7	1285	41	8	21	11	208	4	195	18	172	12
WH202M-00	1.08	5.05	0.11	3	18	71	11	4	167	2100	113	231	56	34	294	10	470	41	417	21
WH202-00	1.34	12.84	0.20	1	19	137	66	3	98	236	322	220	21	ND	61	2	217	33	86	7
WH202M	1.09	5.08	0.11	3	18	71	11	4	168	2100	112	231	56	34	294	10	470	41	417	21
WH204-00	0.50	3.47	0.09	ND	18	54	15	4	7	834	49	10	22	10	166	5	148	25	212	12
WH205-00-SS	High Fe																			
Cretaceous shale																				
WH210-00	0.32	2.48	0.05	2	18	65	9	3	5	1110	21	9	21	10	115	4	265	22	212	12

SAMPLE	Au ppb	Na	Ca%	Sc	Cr	Fe%	Co	Ni	Zn	As	Se	Br	Rb	Mo	Ag	Sb	Cs	Ba	La	Ce	Nd	Sm	Eu	Tb	Yb
Moneymetal vein																									
WH 1	8														0.6	4.5									
WH 2	7														0.4	12									
WH 3	<5														<0.1	0.5									
WH 4	<5														0.6	1.7									
WH 23	<5														1	2.9									
WH 24	<5														0.2	1.1									
WH92	<5	<500	<1	7	530	3.1	18	110	180	<2	<5	1	<30	<5	<5	1.2	<3	880	17	37	14	2.6	0.5	<0.5	0.6
WH95	<5	27000	<1	3	120	1.2	<5	<100	<50	5	<5	<1	160	<5	<5	0.4	3	1500	50	100	30	6.2	1.2	<0.5	2
WH96	<5	<500	<1	<1	280	1.1	5	<100	<50	<2	<5	<1	<30	<5	<5	<0.2	<3	<100	4	11	<10	0.8	<0.2	<0.5	<0.5
WH97	<5	1400	<1	<1	360	0.3	<5	<100	<50	<2	<5	<1	<30	<5	<5	<0.2	<3	120	2	6	<10	<0.5	<0.2	<0.5	<0.5
WH147	<5	<500	<1	6	160	5.4	<5	130	150	25	<5	<1	130	37	<5	5.1	3	290	22	49	19	2.5	0.6	<0.5	2
WH149	<5	<500	3	6	220	0.9	6	950	70	12	<5	2	130	559	<5	29	6	3400	121	322	120	<0.5	2	1.6	6.2
WH148	<5	<500	<1	2	300	1.1	<5	120	56	10	<5	2	35	120	<5	12	<3	610	15	39	18	<0.5	0.3	<0.5	1.1
WH211-00	6	<500	1.6	2	15	0.5	45	199	<50	9	<5	<1	40	<5	<5	20.4	<3	1600	10	<3	84	29.6	0.5	<0.5	1.7
WH212-00-SS	<5	1020	<1	9	83	0.7	24	<100	120	13	<5	<1	211	<5	<5	4.1	30	476	106	197	46	13.8	2.2	1.8	2.4
WH213-00	6	<500	1	3	20	0.9	35	<100	70	21	<5	2	74	<5	<5	16.1	5	1450	23	25	77	20	0.8	0.9	2.8
WH214-00	13	<500	1.2	4	19	0.6	46	<100	68	14	<5	<1	49	<5	<5	19.8	<3	1460	16	17	61	21.2	0.3	<0.5	2.1
WH215-00-SS	6	<500	3.8	7	65	0.6	<5	292	<50	29	<5	<1	80	<5	<5	52	<3	7400	14	<3	504	130	<0.2	<0.5	2.6
WH216-00-SS	6	580	4.6	6	49	0.5	10	154	124	35	7	<1	<30	<5	<5	83.2	<3	19310	74	<3	1080	311	<0.2	1.6	6.8
WH217-00	9	<500	<1	6	46	0.9	20	<100	74	9	<5	2	<30	<5	<5	8	<3	667	27	42	59	16.4	<0.2	0.6	3.4
WH219-00-SS	<5	<500	<1	3	167	4.1	14	<100	230	83	<5	1	<30	<5	<5	3.1	<3	739	36	63	13	7.8	1	0.5	2.2
veins east of Schoolhouse Mt fault																									
WH 20	<5														0.3	1.4									
WH 21	<5														0.3	1.1									
WH 31	<5														<0.2	0.4									

WH 32	38														18.8	0.3									
WH 33	<5														0.5	1.3									
WH 34	122														5.5	0.9									
WH 35	109														6.4	1									
WH130	<5	<500	<1	<1	460	0.4	<5	<100	440	<2	<5	<1	<30	<5	<5	0.3	<3	<100	2	5	<10	<0.5	<0.2	<0.5	<0.5
Beartooth																									
WH53	<5	<500	<1	6	290	2.5	<5	<100	62	38	<5	<1	<30	<5	<5	0.5	4	<100	9	19	<10	1.3	0.2	<0.5	1.9
WH110	6	<500	<1	<1	330	0.4	<5	<100	<50	3	<5	<1	<30	6	<5	5.6	<3	<100	2	4	<10	<0.5	<0.2	<0.5	<0.5
WH135	<5	<500	<1	4	84	1.9	<5	<100	<50	7	<5	<1	76	22	<5	1.5	5	620	22	48	15	2.4	0.5	<0.5	2.3
WH136	<5	<500	<1	16	150	9.5	30	<100	2300	21	<5	<1	<30	<5	<5	1.1	13	<100	22	39	15	4	0.6	0.5	2.6
WH139	<5	<500	<1	<1	270	0.4	<5	<100	<50	4	<5	<1	<30	<5	<5	1.9	<3	<100	4	7	<10	0.5	<0.2	<0.5	0.5
NM257-99																									
WH220-00	7	<500	<1	18	52	10	25	136	100	8	<5	1	<30	<5	<5	1.5	13	383	13	6	<10	3	<0.2	1	2.5
WH242-00	<5	<500	<1	2	63	0.6	49	<100	<50	<2	<5	4	34	<5	<5	1.6	<3	184	6	21	17	1	<0.2	<0.5	<0.5
rhyolite dikes																									
WH 22	<5														<0.2	0.6									
WH79	<5	14000	<1	2	120	0.6	<5	<100	<50	<2	<5	<1	230	<5	<5	0.5	3	590	25	58	15	3.6	0.3	<0.5	3.4
WH80	<5	46000	<1	2	130	0.6	<5	<100	<50	2	<5	<1	<30	<5	<5	0.4	<3	<100	28	61	17	4.7	0.3	0.8	3.4
WH81	<5	19000	<1	3	220	1.3	14	<100	<50	13	<5	<1	180	<5	<5	0.7	9	1900	53	110	35	7	1.4	0.6	2.5
WH86	<5	12000	<1	3	100	0.8	<5	<100	<50	<2	<5	<1	200	<5	<5	0.2	6	1100	52	110	35	6.9	0.9	0.6	3.1
WH87	<5	5600	<1	3	82	0.8	<5	<100	<50	<2	<5	<1	270	<5	<5	0.5	6	1300	50	100	33	6.5	0.9	0.6	3
WH91	<5	1100	<1	3	140	0.8	<5	<100	<50	<2	<5	<1	220	<5	<5	0.4	4	690	9	21	<10	1.2	<0.2	<0.5	2.5
Reed-Prince Albert adit																									
WH 29	25														0.8	1.7									
WH 30	<5														<0.2	1									
WH66	10	<500	<1	2	400	0.8	<5	<100	<50	12	<5	<1	<30	5	<5	1.5	<3	150	8	19	<10	1	0.2	<0.5	1.4
WH67	<5	<500	<1	2	290	0.4	<5	<100	<50	7	<5	<1	57	7	<5	6.9	<3	150	5	11	<10	0.7	<0.2	<0.5	1.4
WH74	<5	<500	2	26	270	13.7	13	<100	330	58	<5	<1	170	<5	<5	2.5	11	550	47	56	38	8.4	2	0.8	3.1
WH72	<5	17000	<1	3	75	0.8	12	<100	<50	<2	<5	<1	200	<5	<5	0.4	4	1100	57	120	37	7.8	1	0.7	3
WH108	<5	3800	<1	6	160	3	11	<100	<50	<2	<5	<1	130	<5	<5	0.4	5	360	29	58	20	4.3	0.8	<0.5	1

WH109	<5	<500	21	<1	170	0.3	<5	<100	<50	<2	<5	<1	<30	<5	<5	0.5	<3	<100	9	21	<10	2.5	0.7	0.5	1.9
WH223	<5	3550	3.2	7	126	1.6	<5	<100	90	10	<5	<1	173	<5	<5	1.6	9	847	75	84	53	14.3	2.2	2	1.5
WH224	<5	3450	1.3	6	157	1.5	<5	<100	85	9	<5	1	136	<5	<5	1.2	11	479	64	62	52	13	2.5	1.3	1.8
WH225	8	3640	<1	16	137	8.1	9	<100	144	14	<5	5	168	<5	<5	0.7	6	526	12	6	17	5.9	0.8	0.9	1.4
WH226	14	5110	<1	14	168	3.7	7	105	90	26	<5	1	223	<5	<5	1.2	9	1160	23	54	30	7.7	1.5	0.8	1.5
WH227-00-SS	26	<500	<1	4	126	1.4	<5	<100	<50	20	<5	1	48	<5	<5	5.6	4	287	17	23	38	9.3	0.3	0.8	1.9
WH228-00-SS	7	4230	<1	4	131	1.8	<5	<100	83	19	<5	1	196	<5	<5	1.6	<3	651	18	36	16	2.2	0.4	1.9	0.9
Prince Albert																									
WH 25	40														3.2	1.9									
WH 26	11														1.9	1.5									
Precambrian																									
WH69	<5	27000	<1	4	260	1.5	7	<100	<50	<2	<5	<1	180	<5	<5	0.4	3	920	36	72	22	4.2	0.9	<0.5	1.1
WH116	<5	1200	<1	7	280	2.8	17	<100	<50	<2	<5	<1	350	<5	<5	0.3	<3	1800	35	61	24	4.7	1	<0.5	2
WH117	<5	27000	<1	5	72	1.8	19	<100	<50	<2	<5	2	130	<5	<5	0.3	<3	980	99	170	57	9.4	1.5	<0.5	1.2
WH118	<5	1200	<1	5	72	3.2	17	<100	<50	<2	<5	2	330	<5	<5	0.6	<3	1400	19	36	15	3.7	0.7	<0.5	1.6
WH248-00	20	14840	3.9	30	563	10.4	62	258	128	5	<5	<1	92	<5	<5	0.5	<3	190	17	36	34	6.6	2.4	0.6	3.7
Precambrian quartz vein																									
WH 5A	<5														<0.1	1.6									
WH 5B	<5														0.3	3.3									
WH 6A	<5														<0.1	0.6									
WH 6B	<5														<0.1	0.5									
WH145	<5	560	1	6	230	7.7	6	170	240	11	<5	<1	180	57	<5	1.7	12	1500	52	110	38	3.1	0.9	<0.5	1.1
NM162-99																									
NM231-99																									
WH206-00	<5	<500	<1	<1	21	0.4	87	<100	<50	<2	<5	2	46	6	<5	1	<3	9320	6	19	13	0.7	<0.2	<0.5	<0.5
WH207-00	<5	1370	1.1	11	23	3.3	27	113	51	<2	<5	<1	147	<5	<5	0.7	7	760	39	70	20	7.6	2.1	0.5	4
WH208-00-SS	<5	<500	<1	1	141	0.7	<5	<100	<50	<2	<5	1	60	<5	<5	4.4	<3	114	8	17	<10	1.2	0.3	<0.5	<0.5

WH209-00	<5	<500	<1	2	21	1.4	37	<100	65	2	<5	<1	<30	<5	<5	3.3	<3	<100	8	23	29	1.2	0.6	<0.5	<0.5
WH218-00	<5	<500	<1	<1	26	0.2	60	<100	<50	<2	<5	<1	<30	<5	<5	0.4	<3	138	22	35	44	5	0.4	<0.5	<0.5
WH244	9	<500	<1	1	34	0.6	70	<100	<50	<2	<5	1	32	<5	<5	1.8	<3	257	5	5	<10	0.6	0.2	<0.5	<0.5
WH245	7	<500	1	2	258	0.8	<5	<100	<50	2	<5	3	<30	<5	<5	1.6	<3	133	7	10	<10	1.2	0.4	<0.5	<0.5
Rambling Ruby																									
WH 27	<5														20.7	2.2									
WH 28	195														>50.0	5.8									
WH146	<5	1900	2	11	160	4	9	<100	96	<2	<5	<1	180	<5	<5	2.5	11	1700	56	120	41	9	1.7	1	4.9
Barite																									
WH 38	<5														0.3	6.2									
WH 39	<5														3.4	4.9									
WH 40	<5														0.8	7									
Purple Heart																									
Purple Heart 1	1043														0.5	12									
Purple Heart																									
WH112	<5	1500	2	2	210	0.7	<5	<100	<50	<2	<5	<1	110	<5	<5	1.1	4	690	16	32	11	2.1	0.4	<0.5	1
Blackmore																									
WH98	13	6800	<1	2	280	1.4	23	<100	220	150	6	2	45	745	<5	8.2	<3	440	38	73	24	4.6	0.7	<0.5	1.1
WH99	20	920	22	1	160	0.3	<5	<100	<50	<2	<5	<1	<30	<5	<5	0.9	<3	180	13	26	13	3.1	1.2	0.6	2.3
WH100	<5	29000	<1	3	130	1.2	<5	<100	<50	<2	<5	<1	200	<5	<5	0.3	<3	1100	35	72	21	4.1	0.8	<0.5	0.7
German																									
WH124	<5	1400	<1	9	160	2.6	13	<100	5360	<2	<5	<1	200	<5	<5	0.4	5	1900	38	88	32	6.6	1.1	0.8	2
WH125																									
WH126	<5	27000	<1	11	37	2.1	26	<100	540	<2	<5	<1	110	<5	<5	<0.2	<3	1300	119	240	82	16	2.2	0.9	1.1
WH127	<5	<500	5	2	66	2.5	140	<100	>10000	15	150	<1	<30	<5	170	7.9	<3	<100	13	20	<10	1.5	0.4	<0.5	<0.5
Tertiary volcanic rocks																								<0.5	
WH120	<5	26000	2	6	47	1.4	<5	<100	<50	<2	<5	<1	160	<5	<5	0.4	4	1400	62	130	44	9.1	1.5	0.8	3.7
WH121	<5	27000	2	4	120	1.9	5	<100	<50	<2	<5	<1	150	<5	<5	<0.2	<3	1100	40	79	24	5	1.2	<0.5	2.5
WH122	<5	26000	3	5	100	2.7	6	<100	<50	2	<5	<1	98	<5	<5	<0.2	<3	1800	26	53	21	4.8	1.1	<0.5	2.6

WH123	<5	21000	<1	4	57	0.8	<5	<100	<50	<2	<5	<1	130	<5	<5	<0.2	<3	930	38	84	26	5.7	0.6	0.5	2.8
WH128	<5	2900	2	4	53	2.4	<5	<100	85	<2	<5	<1	150	<5	<5	<0.2	17	470	21	39	16	3.7	0.8	<0.5	2.2
TP1																									
Reed Gold prospect																									
WH 36	245														2.7	<0.2									
WH 37	<5														0.7	0.7									
WH200-00	<5	18970	2.8	39	199	9.8	54	<100	149	<2	<5	<1	87	<5	<5	1.1	<3	226	15	14	27	4.7	1.6	0.6	2.9
WH201-00	5	24430	1.4	4	<10	2.2	16	<100	<50	<2	<5	1	163	<5	<5	0.9	4	1260	31	56	18	4.5	1.6	<0.5	1.6
WH202M-00	7	13990	3	11	209	3.4	30	<100	97	2	<5	2	325	7	<5	1	11	1600	63	178	32	15.2	3.8	<0.5	3.3
WH202-00	5	18580	3.6	39	213	9.1	55	<100	58	<2	<5	<1	66	<5	<5	0.7	<3	174	11	22	23	4.6	1	0.7	2.4
WH202M																									
WH204-00	<5	25060	<1	5	<10	2.4	21	<100	66	<2	<5	<1	176	<5	<5	0.3	<3	597	43	71	18	6.3	1	0.5	2.3
WH205-00-SS	6	5280	1.2	6	76	35.2	20	<100	116	41	8	1	129	<5	<5	2.4	10	1480	36	13	21	4.2	1.2	<0.5	0.9
Cretaceous shale																									
WH210-00																									

SAMPLE	Lu	Hf	Ta	W	U	Th
Moneymetal vein						
WH 1						
WH 2						
WH 3						
WH 4						
WH 23						
WH 24						
WH92	0.1	3	<1	<4	11	5.3
WH95	0.27	7	1	<4	1.3	12
WH96	<0.1	<1	<1	<4	0.6	1.2
WH97	<0.1	<1	<1	<4	<0.5	<0.5

WH147	0.29	9	<1	9	55.7	7.8
WH149	1.7	10	3	25	1050	16
WH148	0.15	9	<1	6	139	3.4
WH211-00	3.19	5	<1	272	448	4.8
WH212-00-SS	0.61	10	1	14	22.7	38.7
WH213-00	2	5	1	201	256	9.8
WH214-00	2.23	7	2	347	301	4.7
WH215-00-SS	14.7	8	<1	39	2120	7.8
WH216-00-SS	35	3	<1	39	5180	10.3
WH217-00	1.99	6	<1	135	223	10.8
WH219-00-SS	0.77	3	<1	5	49.9	5.3
veins east of Schoolhouse Mt fault						
WH 20						
WH 21						
WH 31						
WH 32						
WH 33						
WH 34						
WH 35						
WH130	<0.1	<1	<1	<4	<0.5	0.9
Beartooth						
WH53	0.3	12	<1	5	4.8	5.4
WH110	<0.1	<1	<1	<4	0.8	<0.5
WH135	0.33	12	<1	<4	33	8.5
WH136	0.35	8	1	<4	3.8	5.1
WH139	0.08	5	<1	<4	0.7	1.3
NM257-99						
WH220-00	0.58	8	<1	105	15.6	14.9

WH242-00	<0.05	<1	1	275	2.7	1.9
rhyolite dikes						
WH 22						
WH79	0.49	7	2	<4	2.5	17
WH80	0.47	6	1	<4	2.7	16
WH81	0.35	7	2	66	3	13
WH86	0.43	6	1	<4	1.6	17
WH87	0.41	6	2	<4	2.1	17
WH91	0.37	5	1	<4	1.3	14
Reed-Prince Albert adit						
WH 29						
WH 30						
WH66	0.2	5	<1	<4	6.7	5.5
WH67	0.19	6	<1	<4	5.9	4
WH74	0.46	7	<1	12	39	4.5
WH72	0.41	7	2	73	1.6	17
WH108	0.14	4	<1	<4	6.5	19
WH109	0.22	<1	<1	<4	0.7	1.8
WH223	0.61	4	<1	7	54.7	31
WH224	0.58	5	<1	7	49.3	25.8
WH225	0.64	4	<1	11	60.3	19.9
WH226	0.71	4	<1	<4	70.7	24.4
WH227-00-SS	1.12	6	<1	14	109	23.5
WH228-00-SS	0.27	4	<1	<4	7.1	28.4
Prince Albert						
WH 25						
WH 26						

Precambrian						
WH69	0.17	6	<1	<4	2.8	29
WH116	0.3	10	1	63	6.6	57.1
WH117	0.19	9	<1	70	4	45
WH118	0.26	9	2	63	5.3	47
WH248-00	0.58	2	<1	25	2.8	1.1
Precambrian quartz vein						
WH 5A						
WH 5B						
WH 6A						
WH 6B						
WH145	0.21	7	<1	<4	116	37
NM162-99						
NM231-99						
WH206-00	<0.05	3	1	456	2.1	5.7
WH207-00	0.69	2	<1	103	6	11.2
WH208-00-SS	0.15	1	<1	<4	4.1	7.3
WH209-00	<0.05	<1	<1	166	1.6	10.3
WH218-00	<0.05	<1	2	413	4.6	5.4
WH244	<0.05	1	1	373	0.9	1.2
WH245	<0.05	<1	<1	<4	2.1	1.3
Rambling Ruby						
WH 27						
WH 28						
WH146	0.67	10	1	<4	2	14
Barite						
WH 38						

WH 39						
WH 40						
Purple Heart						
Purple Heart 1						
Purple Heart						
WH112	0.15	2	<1	<4	1	6.1
Blackmore						
WH98	0.17	2	<1	<4	2.9	6.8
WH99	0.28	<1	<1	<4	<0.5	1.6
WH100	0.12	6	<1	<4	2.2	30
German						
WH124	0.31	6	<1	<4	4.9	14
WH125						
WH126	0.19	11	<1	110	2.5	62.4
WH127	<0.1	1	1	<4	<0.5	1.7
Tertiary volcanic rocks						
WH120	0.48	9	1	<4	1.8	17
WH121	0.36	8	1	<4	2	17
WH122	0.4	5	1	<4	0.7	4.4
WH123	0.36	6	1	<4	1	12
WH128	0.32	4	<1	<4	1.2	4.6
TP1						
Reed Gold prospect						
WH 36						
WH 37						
WH200-00	0.41	1	<1	10	2.6	0.6
WH201-00	0.2	2	<1	86	4.1	12.5
WH202M-00	0.59	6	1	36	4	38.8

WH202-00	0.41	<1	<1	16	3.3	3
WH202M						
WH204-00	0.28	1	<1	69	1.3	11.7
WH205-00-SS	0.18	<1	<1	44	5.4	13.8
Cretaceous shale						
WH210-00						