DEMONSTRATED RESERVE BASE FOR COAL IN NEW MEXICO

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Modified from final report for Cooperative Agreement DE-FC0193EI23974

TABLE OF CONTENTS

Tables

Figures

Abstract

The updated **demonstrated reserve base** estimate of coal for the San Juan Basin, New Mexico, is 11.24 billion short tons (st). This compares with 4.429 billion st in the Energy Information Administration's demonstrated reserve base of coal as of January 1, 1993 for all of New Mexico and 2.806 billion st for the San Juan Basin. The new **estimate** includes revised resource calculations in the San Juan Basin, in San Juan, McKinley, Sandoval, Rio Arriba, Bernalillo and Cibola counties, but does not include the Raton Basin and smaller fields in New Mexico. These estimated "remaining" coal resources however, include significant adjustments for **depletion** due to past mining (through 1994), and adjustments for **accessibility** and **recoverability**.

The updated estimates also incorporate analyses of available sulfur, heat, and ash content data appropriate for characterizing the State's remaining coal resources. Coal **quality** data were examined together with coal resource mapping. Samples from exploration drill holes and coal coring, and samples from locations in or near mines within traditional coal fields were used in the allocation of coal resources. These resources were subdivided based on sulfur and Btu content. The new allocations place 28 percent of the demonstrated reserve base of the San Juan Basin, New Mexico, in the 0.41–0.6 sulfur category. In the previous allocation by the Energy Information Administration 34 percent for all of New Mexico was in this sulfur category.

As part of the current study, factors affecting coal resource availability and recent data on mining recovery rates were also examined. Based on the new estimated demonstrated reserve base, the **accessible reserve** base for the San Juan Basin is 10.28 billion st, and **recoverable reserves** are 7.65 billion st for New Mexico.

Introduction

Background

The Coal Reserves Data Base (CRDB) program is a cooperative data base development program sponsored by the Energy Information Administration (EIA). The objective of the CRDB program is to involve knowledgeable coal resource authorities from the major coal bearing regions to update the Nation's coal **reserves** data. This report is the fourth study in the EIA's program to update State–level reserve **estimates** in cooperation with the geological survey of individual states.

The New Mexico Bureau of Mines and Mineral Resources (NMBMMR) entered into Cooperative Agreement DE-FC0193EI23974 with the U.S. Department of Energy (DOE), Energy Information Administration, to update coal resource estimates for northwestern New Mexico. The 12-month project began on June 15, 1993, and ended on June 14, 1994. This project was funded by the EIA.

The CRDB uses an updated set of criteria designed to be nationally consistent but flexible. This program is needed because the traditional source of EIA coal reserve estimates (the **demonstrated reserve base** -DRB- of coal) was adapted from older published studies from various contributors. Many of these studies followed different criteria than those preferred for the EIA's definition of DRB. Further, those earlier studies did not usually detail the point source data and coal characterization data necessary for current coal resource evaluation.

Purpose

The CRDB data are intended for use in coal supply analyses and to support analyses of policy and legislative issues. They are available to both Government and non-Government analysts. These data are part of the information used to supply United States energy data for international data bases and for inquiries from private industry and the public.

The EIA recognizes coal resource maps, drilling records, boundary locations of inactive mines, site-specific analytical data, and data on geologic features, are critical to reliable characterizations of calculated coal resource quantities. Those types of information have been used to various extent in the current study, as described in the following sections.

Following the terms of the CRDB program, the supporting data files and detailed documentation will remain with the NMBMMR. These data files will serve as the basis for future updates and revisions, and these records can be amplified with new data or modified for other (NMBMMR) objectives by the technical staff who developed the data. The EIA will maintain copies of the detailed county/formation–level data base and selected source files.

The information in this report was compiled under guidelines that emphasize use of previously unexploited coal resource and coal analytical data that is immediately available and can be assimilated during a short–term project. The resulting data base conforms to the criteria of CRDB Phase I level effort (Table 2). A Phase II level of effort may be pursued in selected States or areas, but would be optional and predicated on EIA priorities and funding availability. Phase II projects would allow development of updated coal resource and reserve estimates and coal characterizations that draw on available but previously unexploited data requiring extensive analysis. This level of effort would be especially beneficial in areas currently lacking reliable coal reserve data. No Phase II projects had been authorized at the time of this report.

Assumptions and methodology

Use of existing data

Existing data for this study consists of point source data in the NMBMMR computerized data base for the San Juan Basin (SJB). These data are from published sources, NMBMMR Oil and Gas Library geophysical logs, data provided by companies, Bureau of Land Management (BLM) data from inactive federal coal leases and tract delineation studies, and NMBMMR coal studies (Appendix A). Collection and entry of these data into the National Coal Resource Data System (NCRDS) is part of a cooperative grant with the U.S. Geological Survey (USGS). Point source data plotted on 7.5 minute quadrangle maps and hand–planimetered resource area measurements of these data were reexamined for this study. Areas of exposure of coal–bearing rock units derived from the latest geologic mapping were transferred onto these data–point maps to accurately delineate resource areas. Determination of coal **rank**, sulfur, Btu, and ash categories used all available data in the NMBMMR **quality** data base for the SJB. Production figures used for **depletion** of **original resources** were calculated from the following sources:

1) Percentages of total tonnage by depth and thickness for mining before 1962 are from individual mine data from Nickelson (1988);

2) the NMBMMR mine and resource data bases, and Territorial and State Mine inspector reports;

3) Data from the New Mexico Energy Minerals and Natural Resources Department (NMEMNRD) annual reports were used for production from 1970 through 1994.

Total county coal production tonnages for this study were derived by averaging the totals from the Territorial and State reports and data supplied from the DOE-EIA for this study. The DOE-EIA and State figures are comparable, although differences do occur. Thickness and depth categories for past mining had to be resolved using drill hole data or the geology of the mined area. If more than one thickness and/or depth category was mined, a percentage of the total production and mine-loss was assigned to each category.

The average total tonnage figures on a county basis for the years up to and including 1994 were multiplied by the standard **recovery factors**, 80% for surface and 50% for underground, to calculate production and mining losses. Recent mine production and losses during mining (1970–1994) were directly subtracted from the original demonstrated resources.

Surface and underground deposits in the SJB, northwestern New Mexico, are addressed in this study. The SJB includes several coal fields defined by formational and political boundaries (Fig. 1). The Fruitland, Menefee and Crevasse Canyon Formations are the major Upper Cretaceous coal–bearing units. The Gallup Sandstone also contains small resources of coal (Fig. 2a,b). Original resources of these units are evaluated by 1:100,000 quadrangles and by county. The remaining demonstrated reserve base (DRB), lbs of sulfur/MMBtu, MMBtu/ton, and ash categories are calculated on a county basis. All the county evaluations are based on formation totals from individual field totals in the data base. Accessibility criteria, based on land–use restrictions, are based on Table 1 in USGS Circular 1055 (Eggleston, Carter, and Cobb, 1990). These criteria were digitized on the 1:100,000 quadrangles and areas were overlain with digitized coal resource areas (formation basis) to find inaccessible regions. The following are the applied land-use restrictions and the total area affected by these land–use restrictions within the coal resource area:

Restrictions	Total Acreage in SJB coal areas
Abandoned Mines	18796
Cemeteries*	
Streams, Lakes, Reservoirs	61355
Residences, Towns, Public Buildings	22065
Historic Sites and non–Federal Public Parks	320
Highways and Railroads	5766

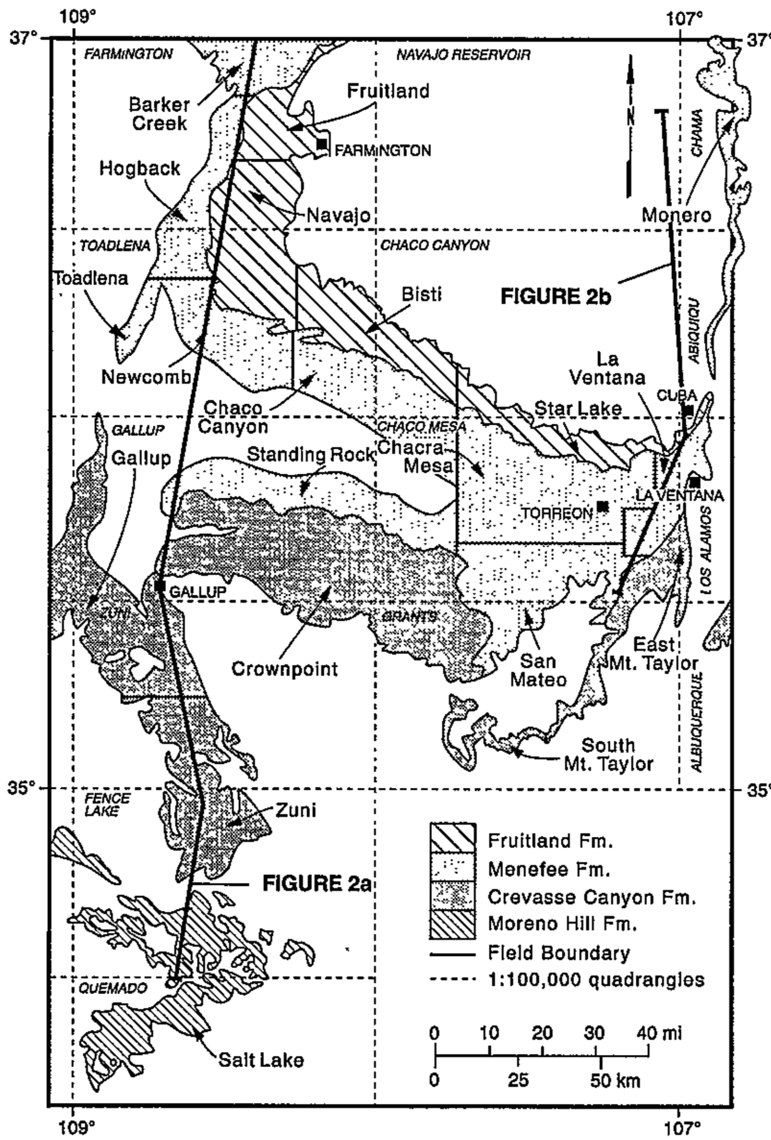

Figure 1. Coalfields in the San Juan Basin. Quadrangle names in italics. (Modified from Hoffman, Campbell, and Beaumont, 1993.)

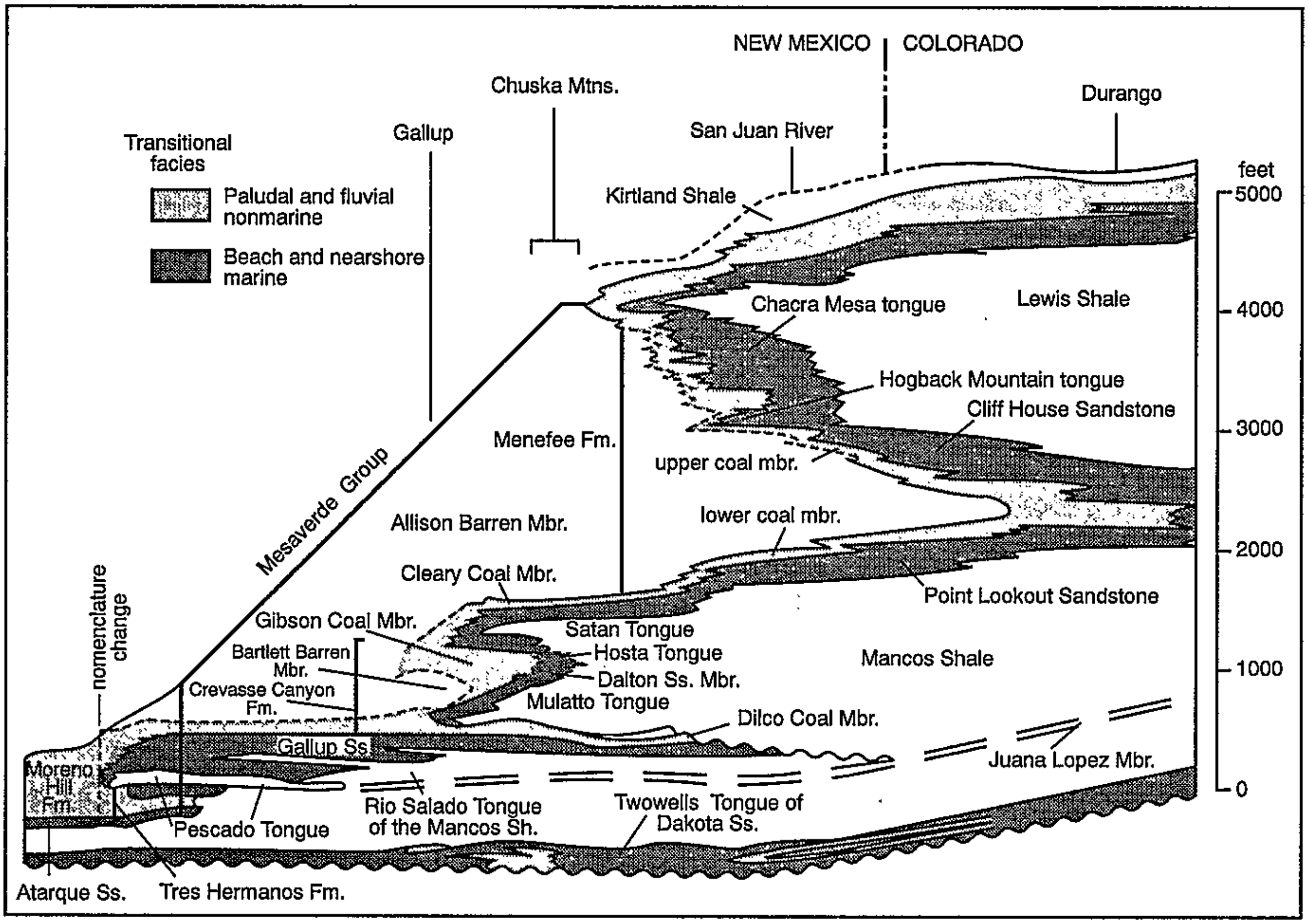

Figure 2a. Stratigraphic diagram showing sequence, thickness, and nomenclature of Cretaceous rocks in San Juan Basin, New Mexico and Colorado. Modified from Beaumont, 1982, Fig. 2.

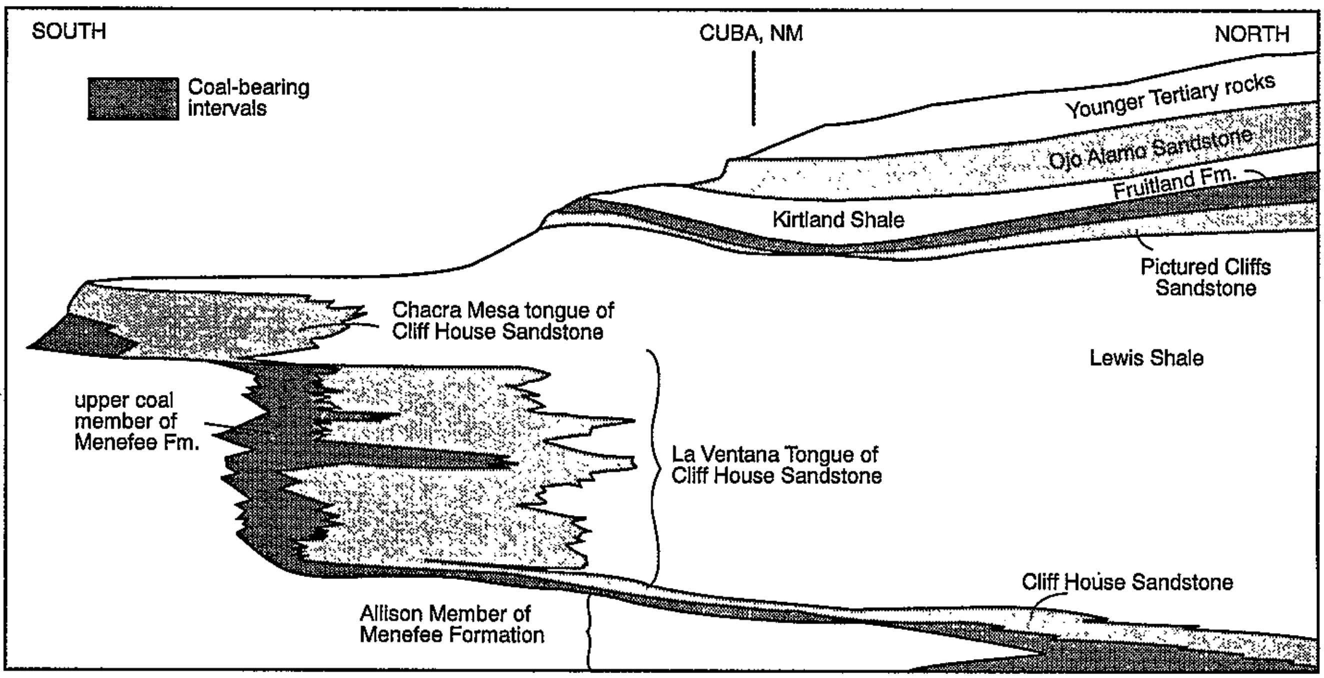

Figure 2b. Cross section showing relationship of Cliff House Sandstone and upper part of Menefee Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971, Fig. 7.

Powerlines, Pipelines	12404
National Parks, Wildlife Refuges, Recreation areas	17558
Wilderness Study Areas	42162
Oil and Gas Wells	151476
Total restricted acreage of coal resource areas:	**331902**

*Cemeteries are included in acreages for towns

Inaccessible regions within coal resource areas were compared to the total coal resource area on individual 1:100,000 quadrangles to calculate the percentage of accessible area. This percentage was applied to the DRB to determine the **accessible reserve** base. From the accessible reserve the surface and underground recoverable reserve was obtained using the average recovery factors for New Mexico (88% and 56%, respectively; EIA, 1993).

Reliability criteria

Estimates within the demonstrated category (**measured** plus **indicated resources**) are based on USGS Circular 891 (Wood et al., 1983). All chemical analyses used to find quality parameters are on an as-received basis with less than 33% ash yield and weighted on total bed thickness. In some areas the resource data and quality data are clustered in exploration or mine areas, but there are many areas that have sparse data coverage, particularly in areas of greater coal depth.

Mapping and physical criteria

This DRB was compiled using the USGS criteria for subbituminous and bituminous coals. Subbituminous coals were assigned a density factor of 1770 st/acre ft, and bituminous coal was assigned a density factor of 1800 st/acre ft, the standard values assigned by the USGS (Wood et al., 1983). Discussions at the beginning of this study contemplated using different values because of the high ash content of the SJB coals. The inconsistent coverage of analytical data made assigning different density values to all the areas covered by this study difficult. Allowing for this coverage, standard values were applied to all subbituminous and bituminous coals. In the calculation of resources by ash content, additional categories of 10.01-15 and greater than 15% ash were added to accommodate the greater percentage of ash in many SJB coals. Subbituminous demonstrated resources include coal 2.5 ft or greater in thickness; bituminous demonstrated resources include coal 28 inches or greater in thickness. The bituminous category of 14 to 18 inches was not used because the author did not think this thickness category would have any economic potential in the San Juan Basin. Table 1 lists the thickness and depth interval used for the resource estimates. Coal with less than 20 ft of overburden was subtracted from the original resource estimate and these figures were used for the remaining DRB analyses. Coal resources with less than 20 ft of overburden were eliminated because SJB coal within this interval is generally weathered and can not be used for energy production. Most operating mines in the SJB use the greater-than-20-ft depth criterion for calculating mine reserves. The EIA recovery factors for New Mexico of 88 and 56% (1993) for surface and underground mining were applied to the remaining DRB after adjustments for accessibility.

Selection and integration of coal quality data

For calculating rank and other coal quality categories, all available coal quality data

Table 1. Basic Resource Criteria. Modified from Wood et al., 1983.

Coal Seam Thickness (underground or surface mining)		**Overburden Thickness (depth from surface)**	
Bituminous	Subbituminous		
28-42 inches	2.5–5 ft	20 to 200 ft	Surface
> 42 inches	5–10 ft	200 to 500 ft	Underground
	> 10 ft	500 to 1000 ft	Underground

for the SJB at the NMBMMR were used. Most of these analyses in the NMBMMR data base are from cores or mine samples totaling 1313 individual analyses. Individual sample analyses were weighted by percent of total seam thickness and statistically averaged by township to decide quality categories for the DRB (Appendix B).

Use of judgment and/or extrapolation

Judgment was applied to every aspect of this study; analysis and inference were particularly important with respect to determining quality parameters. Many of the fields have very little quality data. This situation is particularly true for the smaller Menefee, Crevasse Canyon, and Gallup Sandstone fields where there has been very little exploration. The author examined the data available in these fields and data from adjacent areas to decide the quality parameters to assign to the DRB. The extent to which data from adjacent fields was used depended on the amount of data available within the field; reliance on outside data ranged from 10 to 50%. Although there is variation in specific coal quality parameters, the rank of the coal is generally constant within a formational unit, unless there are local changes in the geothermal gradient.

The MMBtu/st categories are considered to be rough approximations of the major rank classifications of coal (EIA, February 1993, p. 40):

Rank of Coal	**Million Btu per Short ton (MMBtu/st)**
Bituminous	=>26
Bituminous	23-25.99
Bituminous	20-22.99
Subbituminous	15-19.99
Lignite	<15

Rank is determined by mineral-matter-free Btu (mmfBtu), a mathematically-derived value that divides the as-received Btu value by percentages of the ash and sulfur content. The relatively high ash content of SJB coals lowers the rank, but the MMBtu/st value will indicate a higher rank. For these high-ash coals the moist-mineral-matter free value indicates a subbituminous, rather than bituminous rank. Many coals in the SJB fall in the range of high volatile C bituminous or subbituminous A (10,500-11,500 mmfBtu). These two categories are differentiated by the agglomeration properties. Most of the SJB coals are nonagglomerating and therefore are categorized as subbituminous A. These two conditions occur throughout the SJB for many of the coals in the 20-22.99 MMBtu/st range. The determined rank of the coal is used to classify the reserves, but the MMBtu/st category is also listed in Tables 2-7.

Results

Introduction

Individual coal beds within the Upper Cretaceous Crevasse Canyon, Menefee, and Fruitland Formations (ascending order), in the SJB are highly lenticular and their minable thicknesses rarely extend laterally for more than six miles. For the scale of this study, the lenticularity of the coals makes it impossible to discuss individual coal bed resources and highly speculative to calculate inferred resources. The resource descriptions are confined to the measured and indicated coal-bearing members and formations in an individual field or area. These coal fields in the SJB are defined by exposures of the coal–bearing formations and by some political boundaries (Shomaker, Beaumont, and Kottlowski, 1971).

The revised total DRB estimate for the SJB is 11.24 billion short tons (st) remaining as of January 1, 1995. This is four times greater than EIA's 1992 DRB for the SJB, as estimated from the coal resource and loss from production data used to compile the published 1992 EIA SJB part of the New Mexico DRB (Bonskowski, 1994). The EIA SJB estimates were based on older resource studies; primarily on confidential company file data compiled between 1977 and 1979 by the U.S. Bureau of Mines and EIA (Energy Information Administration, undated) and on Shomaker, Beaumont, and Kottlowski (1971). In 1983, the EIA updated the New Mexico DRB using data supplied by NMBMMR (Roybal, 1983). Only 188.0 million st were added in the SJB (Barker Creek area), because either EIA rank or bed thickness categories were incompatible, or the existing EIA DRB exceeded the 1983 NMBMMR DRB.

Regional results

The SJB is an irregular, asymmetric circular structural depression, which is deeper in the northeastern part of the basin. Late Cretaceous and Early Tertiary strata dip steeply into the basin on the northwest along the Hogback monocline, and on the east along the Archuleta arch and Nacimiento uplift (Fig. 3). Gentle dips predominate in the south and southwest sections on the Chaco slope. The deepest part of the SJB is about 30 mi west of the Monero field (Fig. 1) near the northeast edge of the basin, where the Cretaceous coal beds are as much as 9,000 ft below the surface. Along the southern edge of the SJB, the Zuni uplift and several structural features affect the Cretaceous coal-bearing units (Fig. 3). Faulting is more prevalent in the southeastern part of the basin.

The SJB coal fields are in San Juan, McKinley, Sandoval, Rio Arriba, Cibola, and

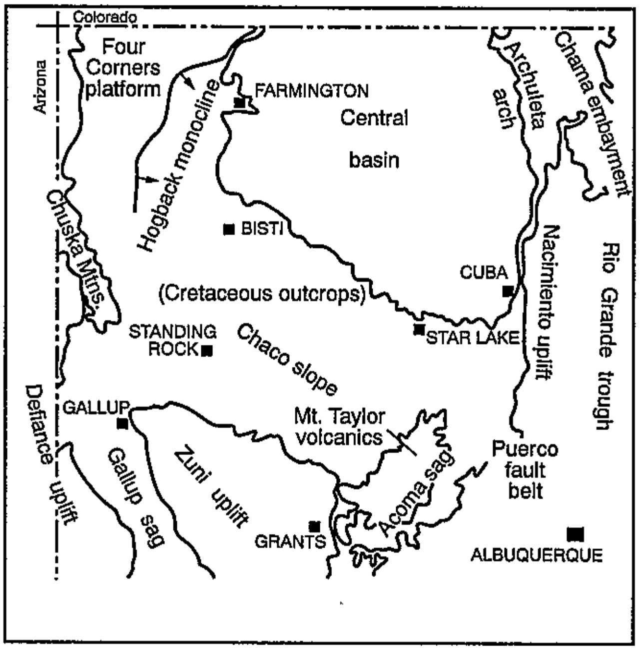

Figure 3. Tectonic map of San Juan Basin in New Mexico. From Beaumont, 1982, Fig. 3.

Bernalillo counties. Table 2 summarizes the remaining DRB in the SJB for bituminous and subbituminous coals by county and subdivided by depth and formation. Total remaining surface (20–200-ft depth) DRB is 1,255.65 million st of bituminous coal, and 5,026.89 million st of subbituminous coal, for a total of 6.283 billion st. Underground (200–1000-ft depth) remaining DRB in the SJB is 1,584.26 million st bituminous coal and 3,376.58 million st subbituminous coal, for an aggregate of 4.961 billion st. The DRB for underground coal is conservative because of the smaller data base available for these depths. San Juan County has the greatest DRB in the SJB, followed by McKinley County and Sandoval County. The Fruitland Formation contains the largest DRB of all the coal-bearing formations. These figures have been updated from the original analyses done for the DOE. Changes in rank used for calculations were suggested by reviewers; some fields had both subbituminous and bituminous rank based on the quality data available, but the geology did not support these divisions. Production and mine loss were updated to include 1994 data.

The DRB for the SJB is divided into four categories of sulfur content, although 86% of this resource has less than 1.24 lbs sulfur/MMBtu, and 28% of the total is in the lowest sulfur category (0.41–0.6 lbs sulfur/MMBtu). The remaining 14% of the DRB is within three heat categories (MMBtu/ton), ranging from 15 to 24.99 MMBtu/ton (Table 3). However, most of the resources fall within the lowest of these three, the 15–19.99 MMBtu/ton classification. In the 1992 DRB done by the EIA, 56% of New Mexico's total DRB is in the 15–19.99 MMBtu/ton category, whereas in the present study 64% of the total DRB is in this category. Table 3 lists the total DRB (million st) by heat and sulfur content.

Ash values for the DRB vary from 5.01 to greater than 15%. Many Fruitland

Table 2. Remaining DRB by county and formation, San Juan Basin, New Mexico in millions of st.

Bituminous										
				Lbs Sulfur/MMBtu				%Ash*		
County	**Formation**	**MMBtu/ton**	**Total**	**0.41–0.6**	**0.61–0.83**	**0.84–1.24**	**1.25–1.67**	**5.01–10**	**10.01–15**	**>15**
						Surface				
San Juan										
	Fruitland	20-22.99	535.62		67.04	468.58				535.62
	Menefee	20–22.99	112.94		112.94			112.94		
McKinley										
	Crevasse Canyon	20–22.99	537.77	355.62	174.13	8.02		537.77		
Sandoval										
	Menefee	20–22.99	61.69		20.85	40.84			61.69	
Rio Arriba										
	Menefee	23–24.99	7.63				7.63		7.63	
Totals		*20–22.99*	*1248.02*	*355.62*	*374.96*	*517.44*	*0.00*			
		23–24.99	*7.63*	*0.00*	*0.00*	*0.00*	*7.63*			
		Ash						*650.71*	*69.32*	*535.62*
Bituminous Surface Total			*1255.65*	*355.62*	*374.96*	*517.44*	*7.63*	*650.71*	*69.32*	*535.62*
						Underground				
San Juan										
	Fruitland	20–22.99	862.80		342.53	520.27				862.80
	Menefee	20–22.99	135.80		135.80			135.80		
McKinley										
	Crevasse	20–22.99	490.01	266.02	167.00	56.99		490.01		
Sandoval										
	Menefee	20–22.99	64.07		44.78	19.29			64.07	
Rio Arriba										
	Menefee	23–24.99	31.58				31.58		31.58	
Totals		*20–22.99*	*1,552.68*	*266.02*	*690.11*	*596.55*	*0.00*			
		23–24.99	*31.58*	*0.00*	*0.00*	*0.00*	*31.58*			
		Ash						*625.81*	*95.65*	*862.80*
Bituminous Underground Total			*1,584.26*	*266.02*	*690.11*	*596.55*	*31.58*	*625.81*	*95.65*	*862.80*
Bituminous Total			*2,839.91*	*621.64*	*1,065.07*	*1,113.99*	*39.21*	*1,276.52*	*164.97*	*1,398.42*

*%Ash undifferentiated by MMBtu/ton

Table 2. Remaining DRB by county and formation, San Juan Basin, New Mexico in millions of st, continued.

Subbituminous										
				Lbs Sulfur/MMBtu				**%Ash***		
County	**Formation**	**MMBtu/ton**	**Total**	**0.41–0.6**	**0.61–0.83**	**0.84–1.24**	**1.25–1.67**	**5.01–10**	**10.01–15**	**>15**
						Surface				
San Juan										
	Fruitland	15–19.99	2,536.55	1038.03	623.79	874.73				2,536.55
	Menefee	15–19.99	72.07			72.07			72.07	
		20–22.99	10.24			10.24		10.24		
McKinley										
	Fruitland	15–19.99	483.89		483.89					483.89
	Menefee	15–19.99	545.19			430.44	114.75	5.82	821.72	
		20–22.99	282.36	57.95		224.41				
	Crevasse	15–19.99	662.57				662.57		662.57	23.28
		20–22.99	23.28			23.28				
	Gallup SS	20–22.99	65.67		1.15	35.36	29.16		65.67	
Sandoval										
	Fruitland	15–19.99	117.35		117.35					117.35
	Menefee	20–22.99	188.54	48.03	39.88	100.63		170.04	18.50	
	Crevasse	15–19.99	12.41			12.41		12.41		
Cibola										
	Crevasse	20–22.99	13.92	13.92					13.92	
	Gallup SS	20–22.99	0.56			0.56			0.56	
Bernalillo										
	Crevasse	15–19.99	12.29			12.29		12.29		
Totals		*15–19.99*	*4,442.32*	*1,038.03*	*1,225.03*	*1,401.94*	*777.32*			
		20–22.99	*584.57*	*119.90*	*41.03*	*394.48*	*29.16*			
		Ash						*210.80*	*1,655.01*	*3,161.07*
Subbituminous Surface Total			*5,026.89*	*1,157.93*	*1,266.06*	*1,796.42*	*806.48*	*210.80*	*1,655.01*	*3,161.07*

*%Ash undifferentiated by MMBtu/ton

Table 2. Remaining DRB by county, and formation, San Juan Basin, New Mexico in millions of st, continued.

Subbituminous				Lbs Sulfur/MMBtu				%Ash*		
County	**Formation**	**MMBtu/ton**	**Total**	**0.41–0.6**	**0.61–0.83**	**0.84–1.24**	**1.25–1.67**	**5.01–10**	**10.01–15**	**>15**
						Underground				
San Juan										
	Fruitland	15–19.99	1,501.33	1,225.57	242.07	33.69				1,501.33
	Menefee	15–19.99	54.25			54.25			57.60	
		20–22.99	34.76	3.35		31.41		31.41		
McKinley										
	Fruitland	15–19.99	127.09		127.09					127.09
	Menefee	15–19.99	608.96			300.50	308.46	50.74	863.67	
		20–22.99	305.44	158.84		146.60				
	Crevasse	15-19.99	457.58				457.58		457.57	30.61
		20–22.99	30.61			30.61				
	Gallup SS	20–22.99	11.15			9.95	1.20		11.15	
Sandoval										
	Fruitland	15–19.99	52.21		52.21					52.21
	Menefee	20–22.99	186.07	56.01	20.03	110.03		172.78	13.29	
	Crevasse	15–19.99	0.00							
Cibola										
	Crevasse	20–22.99	5.80	5.80					5.80	
	Gallup SS	20–22.99	1.33			1.33			1.33	
Totals		*15–19.99*	*2,801.42*	*1,225.57*	*421.37*	*388.44*	*766.04*			
		20–22.99	*575.16*	*224.00*	*20.03*	*329.93*	*1.20*			
		Ash						*254.93*	*1,410.42*	*1,711.24*
Subbituminous Underground Total			*3,376.58*	*1,449.57*	*441.40*	*718.37*	*767.24*	*254.93*	*1,410.42*	*1,711.24*
Subbituminous Total			*8,403.47*	*2,607.50*	*1,707.46*	*2,514.79*	*1,573.72*	*465.73*	*3,065.43*	*4,872.31*

*%Ash undifferentiated by MMBtu/ton

Table 3. Remaining DRB by heat and sulfur content, San Juan Basin, New Mexico in millions of st.

		Lbs of Sulfur/MMBtu				
Depth	**MMBtu/ton**	**0.41–0.60**	**0.61–0.83**	**0.84–1.24**	**1.25–1.67**	**Total**
Surface	15-19.99	1,038.03	1,225.03	1,401.94	777.32	4,442.32
	20-22.99	475.51	415.99	911.92	29.16	1,832.58
	23-24.99				7.63	7.63
Total		1,513.54	1,641.02	2,313.86	814.11	
Underground						
	15-19.99	1,225.57	421.37	388.44	766.04	2,801.42
	20-22.99	490.02	710.14	926.48	1.20	2,127.84
	23.24.99				31.58	31.58
Total		1,715.59	1,131.51	1,314.92	798.82	

Formation coals have greater than 15% ash yield and make up the largest percentage of the DRB (Table 2).

The total San Juan Basin DRB in million st for each ash category is given below:

	% Ash		
Depth	**5.01-10**	**10.01-15**	**>15**
Surface	861.51	1724.33	3696.69
Underground	880.74	1506.07	2574.04

Accessible and **recoverable reserves** for each county and formation by sulfur content and heat value are listed in Table 4. Total accessible reserves averaged about 90% of the total DRB, the same factor used by the EIA. Total surface accessible reserves are 5,919.07 million st; recoverable reserves are 5,208.78 million st. Total underground accessible reserves are 4,360.54 million st and recoverable underground reserves are 2,441.90 million st for the San Juan Basin, New Mexico. Recoverable reserves are based on 88% recovery factor for surface mining, 56% recovery factor for underground mining (EIA, February 1993).

Fruitland Formation results

The Fruitland Formation is the youngest of the coal-bearing sequences in the SJB. It is a facies associated with the final retreat of the Late Cretaceous shoreline from the SJB. Most of the coals are within a few hundred feet of the contact with the underlying Pictured Cliffs Sandstone, a barrier beach deposit. Coal beds in the Fruitland Formation coals have the greatest lateral continuity of all the coal-bearing sequences in the SJB. Exposures of this unit are divided into four fields: Fruitland, Navajo, Bisti, and Star Lake (Fig. 1). Most of the

Table 4. Accessible and recoverable DRB by county and formation, San Juan Basin, New Mexico in millions of short tons.

Bituminous							Lbs Sulfur/MMBtu			
County	**Formation**	**MMBtu/ton**	**DRB Total**	**% Accessible**	**Accessible DRB**	**Recoverable DRB**	0.41-0.6	0.61-0.83	0.84-1.24	1.25-1.67
						Surface				
San Juan										
	Fruitland	20-22.99	535.62	0.89	476.70	419.50	0.00	52.51	366.99	0.00
	Menefee	20-22.99	112.94	0.74	83.08	73.11	0.00	73.11	0.00	0.00
McKinley										
	Crevasse	20-22.99	537.77	0.93	499.48	439.54	290.66	142.32	6.56	0.00
Sandoval										
	Menefee	20-22.99	61.69	0.91	56.13	49.40	0.00	16.69	32.70	0.00
Rio Arriba										
	Menefee	23-24.99	7.63	0.89	6.77	5.95	0.00	0.00	0.00	5.95
Totals		*20-22.99*	*1,248.02*		*1,115.39*	*981.55*	*290.66*	*284.63*	*406.25*	*0.00*
		23-24.99	*7.63*		*6.77*	*5.95*	*0.00*	*0.00*	*0.00*	*5.95*
Bituminous Surface Total			*1,255.65*		*1,122.16*	*987.50*	*290.66*	*284.63*	*406.25*	*5.95*
						Underground				
San Juan										
	Fruitland	20-22.99	862.80	0.80	688.43	385.52	0.00	153.05	232.47	0.00
	Menefee	20-22.99	135.80	0.67	91.58	51.29	0.00	51.29	0.00	0.00
McKinley										
	Crevasse	20-22.99	490.01	0.99	484.86	271.52	147.41	92.54	31.58	0.00
Sandoval										
	Menefee	20-22.99	64.07	0.94	59.99	33.59	0.00	23.48	10.11	0.00
Rio Arriba										
	Menefee	23-24.99	31.58	0.86	27.22	15.24	0.00	0.00	0.00	15.24
Totals		*20-22.99*	*1,552.68*		*1,324.87*	*741.92*	*147.41*	*320.35*	*274.16*	*0.00*
		23-24.99	*31.58*		*27.22*	*15.24*	*0.00*	*0.00*	*0.00*	*15.24*
Bituminous Underground Total			*1,584.26*		*1,352.09*	*757.17*	*147.41*	*320.35*	*274.16*	*15.24*
Bituminous Total			*2,839.91*		*2,474.25*	*1,744.67*	*438.07*	*604.99*	*680.41*	*21.20*

Table 4. Accessible and recoverable DRB by county and formation, San Juan Basin, New Mexico in millions of st, continued.

Subbituminous

County	Formation	MMBtu/ton	Total DRB	% Accessible	Accessible DRB	Recoverable DRB	Lbs Sulfur/MMBtu 0.41–0.6	0.61–0.83	0.84–1.24	1.25–1.67
						Surface				
San Juan										
	Fruitland	15–19.99	2,536.55	0.97	2,452.08	2,175.83	883.05	530.66	744.13	0.00
	Menefee	15–19.99	72.07	0.89	64.34	56.62	0.00	0.00	56.62	0.00
		20–22.99	10.24	0.89	9.14	8.05	0.00	0.00	8.05	0.00
McKinley										
	Fruitland	15–19.99	483.89	0.97	467.82	411.69	0.00	411.69	0.00	0.00
	Menefee	15–19.99	545.19	0.92	501.30	441.15	0.00	0.00	348.29	92.85
		20–22.99	282.36	0.92	259.63	228.47	46.89	0.00	181.58	0.00
	Crevasse	15–19.99	662.57	0.96	634.34	558.22	0.00	0.00	0.00	558.22
		20–22.99	23.28	0.96	22.29	19.61	0.00	0.00	19.61	0.00
	Gallup SS	20–22.99	65.67	0.99	65.08	57.27	0.00	1.00	30.84	25.43
Sandoval										
	Fruitland	15–19.99	117.35	0.97	113.55	99.84	0.00	99.84	0.00	0.00
	Menefee	20–22.99	188.53	0.90	169.66	149.30	38.03	31.58	79.69	0.00
	Crevasse	15–19.99	12.41	0.95	11.84	10.42	0.00	0.00	10.42	0.00
Cibola										
	Crevasse	20–22.99	13.92	0.95	13.25	11.66	11.66	0.00	0.00	0.00
	Gallup SS	20–22.99	0.56	1.00	0.56	0.49	0.00	0.00	0.49	0.00
Bernalillo										
	Crevasse	15–19.99	12.29	0.99	12.11	10.66	0.00	0.00	10.66	0.00
Totals		*15–19.99*	*4,442.32*		*4,257.30*	*3,746.43*	*883.05*	*1,042.18*	*1,170.12*	*651.07*
		20–22.99	*584.56*		*539.61*	*474.86*	*96.58*	*32.58*	*320.26*	*25.43*
Subbituminous Surface Total			*5,023.88*		*4,796.91*	*4,221.28*	*979.63*	*1,074.77*	*1,490.38*	*676.45*

Table 4. Accessible and recoverable DRB by county and formation, San Juan Basin, New Mexico in millions of st, continued.

Subbituminous										
County	**Formation**	**MMBtu/ton**	**Total DRB**	**% Accessible**	**Accessible DRB**	**Recoverable DRB**	**Lbs Sulfur/MMBtu 0.41–0.6**	**0.61–0.83**	**0.84–1.24**	**1.25–1.67**
						Underground				
San Juan										
	Fruitland	15–19.99	1,501.33	0.82	1,226.59	686.89	560.72	110.75	15.41	0.00
	Menefee	15–19.99	54.25	0.90	48.86	27.36	0.00	0.00	27.36	0.00
		20–22.99	34.76	0.90	31.31	17.53	1.69	0.00	15.84	0.00
McKinley										
	Fruitland	15–19.99	127.09	0.96	122.10	68.37	0.00	68.37	0.00	0.00
	Menefee	15–19.99	608.96	0.93	568.95	318.61	0.00	0.00	157.22	161.39
		20–22.99	305.44	0.93	285.37	159.81	83.11	0.00	77.70	0.00
	Crevasse	15–19.99	457.58	0.99	452.78	253.55	0.00	0.00	0.00	253.55
		20–22.99	30.61	0.99	30.29	16.96	0.00	0.00	16.96	0.00
	Gallup SS	20–22.99	11.15	0.93	10.36	5.80	0.00	0.00	5.18	0.62
Sandoval										
	Fruitland	15–19.99	52.21	0.96	50.16	28.09	0.00	28.09	0.00	0.00
	Menefee	20–22.99	186.07	0.94	174.61	97.78	29.43	10.53	57.82	0.00
Cibola										
	Crevasse	20–22.99	5.80	0.99	5.76	3.23	3.23	0.00	0.00	0.00
	Gallup SS	20–22.99	1.33	0.99	1.32	0.74	0.00	0.00	0.74	0.00
Totals		*15–19.99*	*2,801.42*		*2,469.43*	*1,382.88*	*560.72*	*207.21*	*200.00*	*414.94*
		20–22.99	*575.16*		*539.02*	*301.85*	*117.46*	*10.53*	*173.24*	*0.62*
Subbituminous Underground Total			*3,376.58*		*3,008.45*	*1,684.73*	*678.18*	*217.74*	*373.24*	*415.57*
Subbituminous Total			*8,403.46*		*7,805.36*	*5,906.01*	*1,657.81*	*1,292.51*	*1,863.63*	*1,092.07*

Fruitland Formation coal resources are within San Juan County; parts of the Star Lake field are in McKinley and Sandoval counties. Table 5 is a summary of the remaining DRB for the Fruitland Formation fields.

Fruitland field—This field includes the Fruitland Formation exposures from the San Juan River north to the New Mexico-Colorado state line, trending N–NE for about 25 mi, within San Juan County on the Farmington 1:100,000 quadrangle (Figs. 1, 4). The overlying Kirtland Formation is similar in lithology but has fewer sandstones and very thin coal beds (< 3 ft), therefore the contact between the Fruitland and Kirtland Formations is chosen arbitrarily at the top of the uppermost thick coal bed. The Fruitland Formation is relatively flat lying (≤3°E) in the southern part of the Fruitland field. The angle of dip increases to 18–30°SE along the Hogback monocline on the western edge of the coal-bearing sequence in the northern Fruitland field (Fig. 4).

Fruitland field coals are of bituminous rank and resources were calculated using the 1800 ton/acre ft density factor. The total and percentage division of the point source data in the Fruitland field is:

	Depth Category
Total points- 385	37% 20-200 ft
	44% 200-500 ft
	19% 500-1000 ft

Depletion of original resources in the Fruitland field is from the recent San Juan and La Plata mine production (110.84 million st) and some past underground mining production (0.16 million st). All past production and mine–loss tonnages are from coal greater than 42

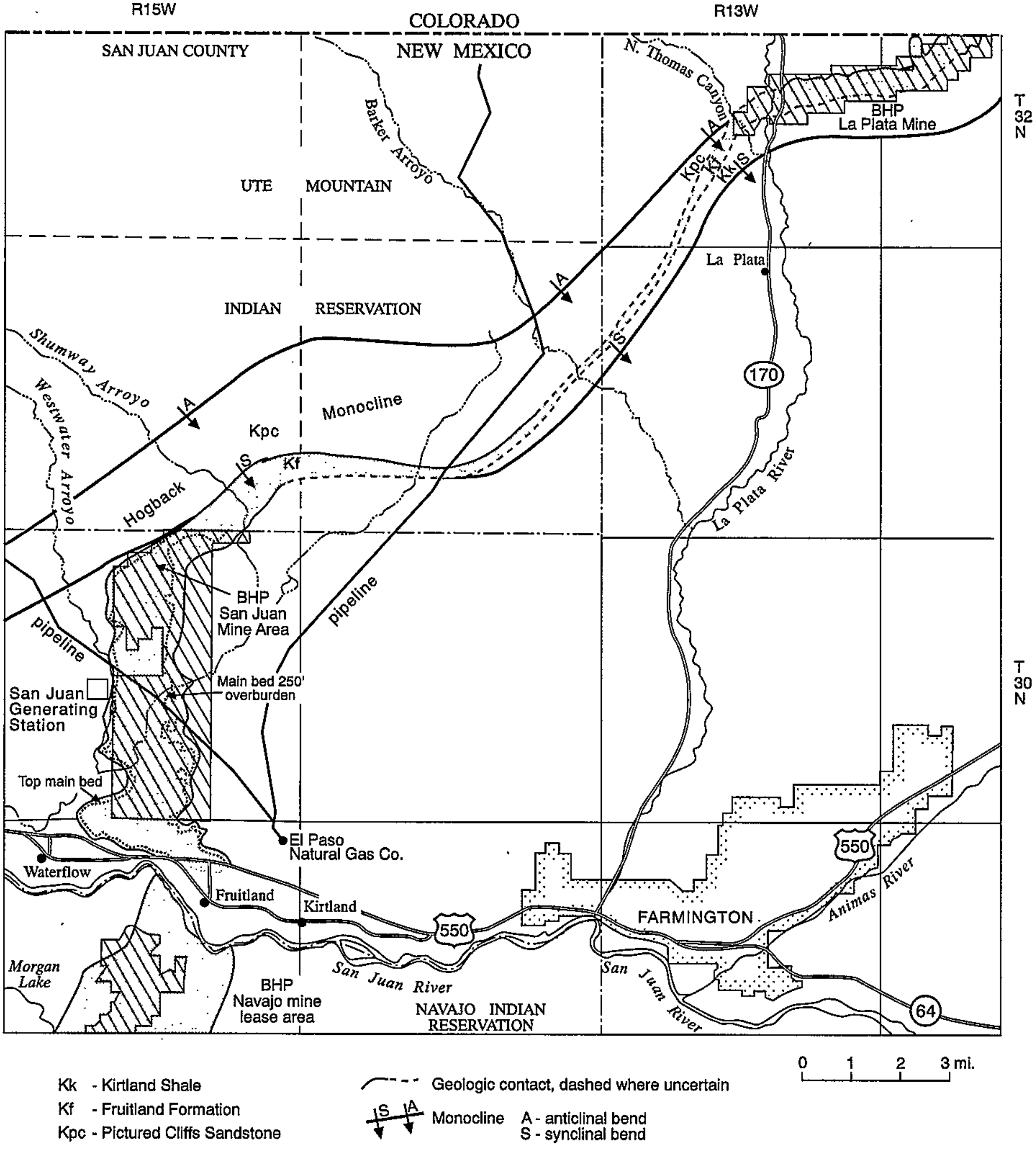

Figure 4. Index map of Fruitland field, Fruitland Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

inches and within 200 ft of the surface. Remaining surface (20–200 ft) DRB for the Fruitland field is 535.62 million st. Remaining underground (200–1000 ft) DRB is estimated at 862.80 million st. These resources fall into the 0.61-0.83 and 0.84-1.24 lbs sulfur/MMBtu categories (Table 5). These divisions were determined using the weighted averages for each township (where data was available) within the field. The DRB is divided between these two sulfur categories as follows:

Northern Fruitland field:

T32N, R12W-R13W 0.61–0.83 lbs Sulfur/MMBtu

Southern Fruitland field:

T29N-T31N, R15W 0.84-1.24 lbs Sulfur/MMBtu

The Fruitland field DRB is in the 20-22.99 MMBtu/ton category and considered bituminous in rank. All of the Fruitland field coals have ash yields greater than 15%; the entire remaining DRB for this field has an ash content greater than the categories stipulated for this study. The Fruitland, Navajo, and Bisti field coals average 19% ash, the Star Lake field coals average 22% ash.

Much of the Fruitland field that can be developed for mining is within the San Juan or La Plata mine areas. The Fruitland coal area between these two mines is on the Ute Mountain Ute Indian Reservation. A drilling program conducted by Public Service Company of New Mexico found 10–14 million st of surface–minable coal on this property near the southern boundary of the Ute Mountain Ute reservation. Northeast of this area the beds have steep dips (18°–30°) because of their proximity to the Hogback monocline (Shomaker and

Table 5. Remaining DRB for the Fruitland Formation, San Juan Basin, New Mexico in millions of st.

Rank	Field	MMBtu/ton	Total	Lbs Sulfur/MMBtu 0.41-0.6	0.61-0.83	0.84-1.24
				Surface		
Bituminous	Fruitland	20-22.99	535.62		67.04	468.58
Subbituminous	Navajo	15-19.99	1,319.72	165.79	279.20	874.73
	Bisti	15-19.99	872.24	872.24		
	Star Lake	15-19.99	945.83		945.83	
	Total	**15-19.99**	3,137.79	1,038.03	1,225.03	874.73
	Total	**20-22.99**	535.62	0.00	67.04	468.58
Bituminous Surface Total			*535.62*	*0.00*	*67.04*	*468.58*
Subbituminous Surface Total			*3,137.79*	*1,038.03*	*1,225.03*	*874.73*
				Underground		
Bituminous	Fruitland	20-22.99	862.80		342.53	520.27
Subbituminous	Navajo	15-19.99	184.84	57.05	94.10	33.69
	Bisti	15-19.99	1,168.52	1,168.52		
	Star Lake	15-19.99	327.27		327.27	
	Total	**15-19.99**	1,680.63	1,225.57	516.59	33.69
	Total	**20-22.99**	862.80	0.00	342.53	520.27
Bituminous Underground Total			*862.80*	*0.00*	*342.53*	*520.27*
Subbituminous Underground Total			*1,680.63*	*1,225.57*	*421.37*	*33.69*
Bituminous Total			*1,398.42*	*0.00*	*409.57*	*988.85*
Subbituminous Total			*4,818.42*	*2,263.60*	*1,646.40*	*908.42*

Holt, 1973) and unsuitable for mining. In the deeper coal areas east of the active surface mines, restrictions exist because of oil and gas development and population areas such as Farmington and development along the La Plata River valley. The San Juan River valley crosses surface and underground coal areas on the southern edge of the field, and two major highways, 64 and 170, intersect areas of surface and underground coal resources. Of the surface DRB, 89% is accessible; 80% of the underground DRB in the Fruitland field is accessible. Accessible and recoverable reserves are listed in Table 4, San Juan County, bituminous rank.

Navajo field—This field is defined by the Fruitland Formation exposures within the Navajo Indian Reservation. The Navajo field covers a distance of approximately 35 mi from the San Juan River south to Hunters Wash and Coal Creek (T23N), and east to the boundary of the reservation (Fig. 5). The Navajo field is within San Juan County, on the Farmington and Toadlena 1:100,000 quadrangles (Fig. 1).

The predominant dip of the Fruitland beds is less than 2°E–NE. Little or no significant faulting is evident in the Navajo field. This area is dissected by the Chaco River; north of the river, badlands are the dominant topography and to the south are rolling hills and low cuestas. Numerous coal beds are near the base of the Fruitland Formation, with as many as eight minable beds in the southern part of the field (Shomaker, Beaumont, and Kottlowski, 1971). Oscillations of the Late Cretaceous shoreline with minor stillstands, helped to create the relatively thick coal beds that imbricate to the north, with increasingly lower and older beds southward (Shomaker, Beaumont, and Kottlowski, 1971, p. 108). The

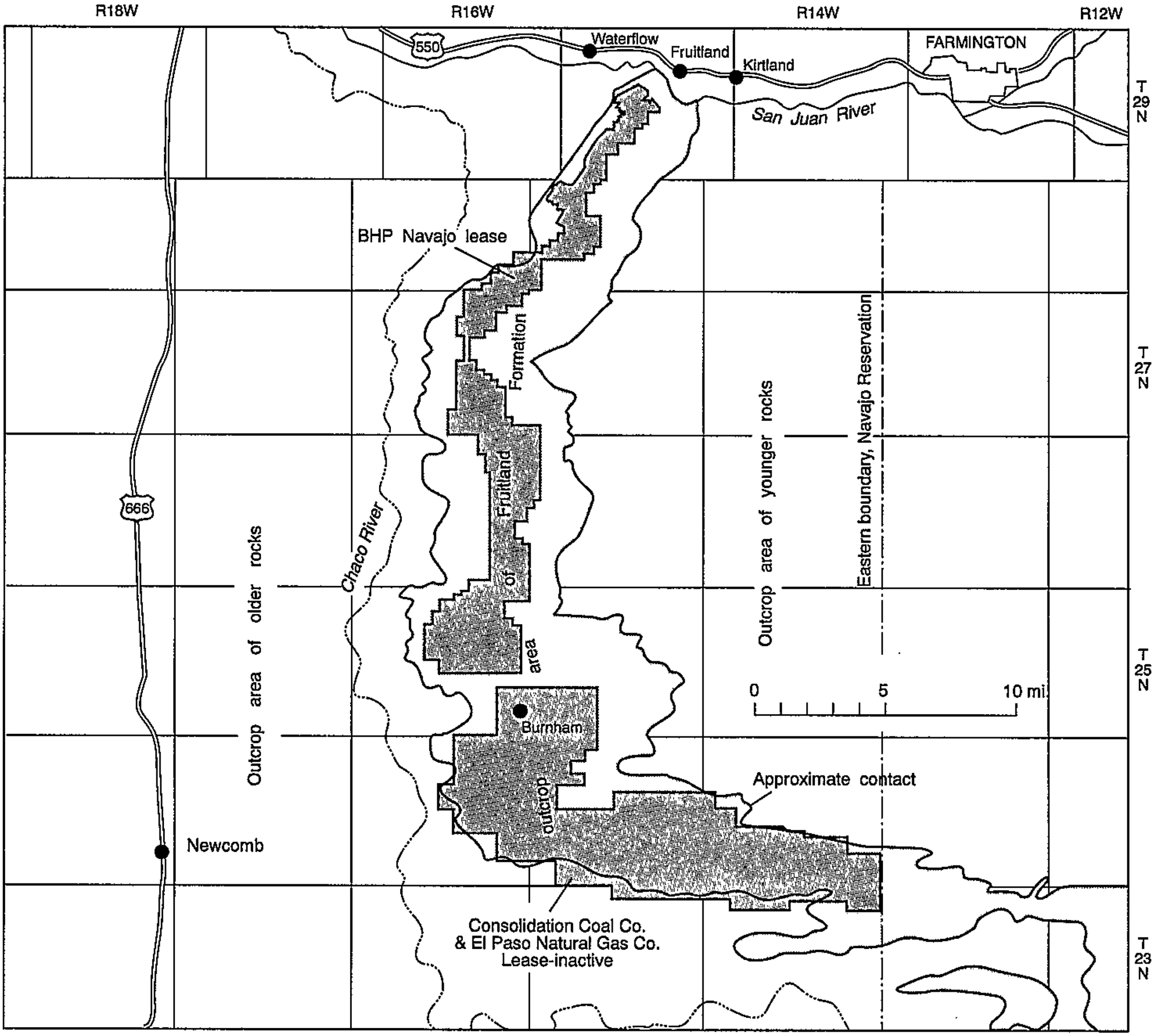

Figure 5. Navajo field, Fruitland Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Navajo field coal resources are subbituminous rank and total data point and percentages for different depth categories for this field are:

Total data points- 385:	84% 20–200 ft
	16% 200–500 ft

Depletion of original resources is virtually all from production and mining losses from the Navajo and Burnham mines. The Navajo mine production figures were used to supplement the original point source data for the northern part of the mine. Tonnage calculations for planimetered mined–out areas where no point source data were available were used to supplement the original resource figure estimate. The total Navajo mine production figure and mine loss was subtracted from the original DRB, a total of 231.06 million st (2.5-5 ft thick; 20-200-ft depth). In addition, 0.71 million st were subtracted for the Burnham mine production and mine loss. Remaining surface DRB for the Navajo field is 1.3197 billion st. Remaining underground DRB for the Navajo field is 184.84 million st, concentrated in the 200–500-ft depth category and in beds ranging from 2.5 to 10 ft thick.

The Navajo field DRB was divided into three sulfur categories. The 0.41-0.6 lbs sulfur/MMBtu category resources are from T24N, R14W at the southern end of the field. Resources in T29N R15W, T28N R16W, and T24N R15W are in the 0.61-0.83 lbs sulfur/MMBtu category. The highest sulfur category (0.84–1.24 lbs sulfur/MMBtu) resources are in T27N to T24N, R16W. The Navajo field coal resources are in the 15–19.99 MBtu/ton category and subbituminous in rank. All of the Navajo field remaining coal DRB has ash content averaging 19%.

The Navajo field is entirely within the Navajo Indian Reservation boundary. The

Navajo mine occupies most of the surface minable area in the field, except for the southernmost area, previously under lease to Consolidation Coal Company (Fig. 5). This company relinquished its coal lease with the Navajo Nation in 1991. There are few land use restrictions within the Navajo coal area, although there are oil and gas wells within underground coal area. The Chaco River and its tributaries transect this field, however most of the drainage is intermittent. In the surface minable area 97% of the coal resource area is accessible; 82% of the underground coal area in the Navajo field is considered accessible. The Navajo field accessible and recoverable reserves are grouped with the Bisti field for San Juan County, Fruitland Formation (Table 4).

Bisti field—This field includes the Fruitland Formation exposures that trend southeast from the eastern boundary of the Navajo Indian Reservation, more or less parallel to the Late Cretaceous shoreline (N55W). The Bisti field is about 35 mi long, and is arbitrarily separated from the Star Lake field at the boundary between R9W and R8W (Fig. 6). All of the field is within San Juan County and on the Toadlena and Chaco Canyon 1:100,000 quadrangles (Fig. 1).

The Bisti field lies within the Chaco slope physiographic area, resulting in gentle dips (3–5°N–NE). Erosion of the Fruitland Formation and overlying Kirtland Formation lithologies result in badlands topography. Overburden and interburden of the Fruitland coals is largely shale and fine-grained friable sandstone. Significant faulting and/or high-angle dips are lacking, making surface mining relatively economical in the Bisti field.

Bisti coals are considered subbituminous rank for this resource calculation. The total

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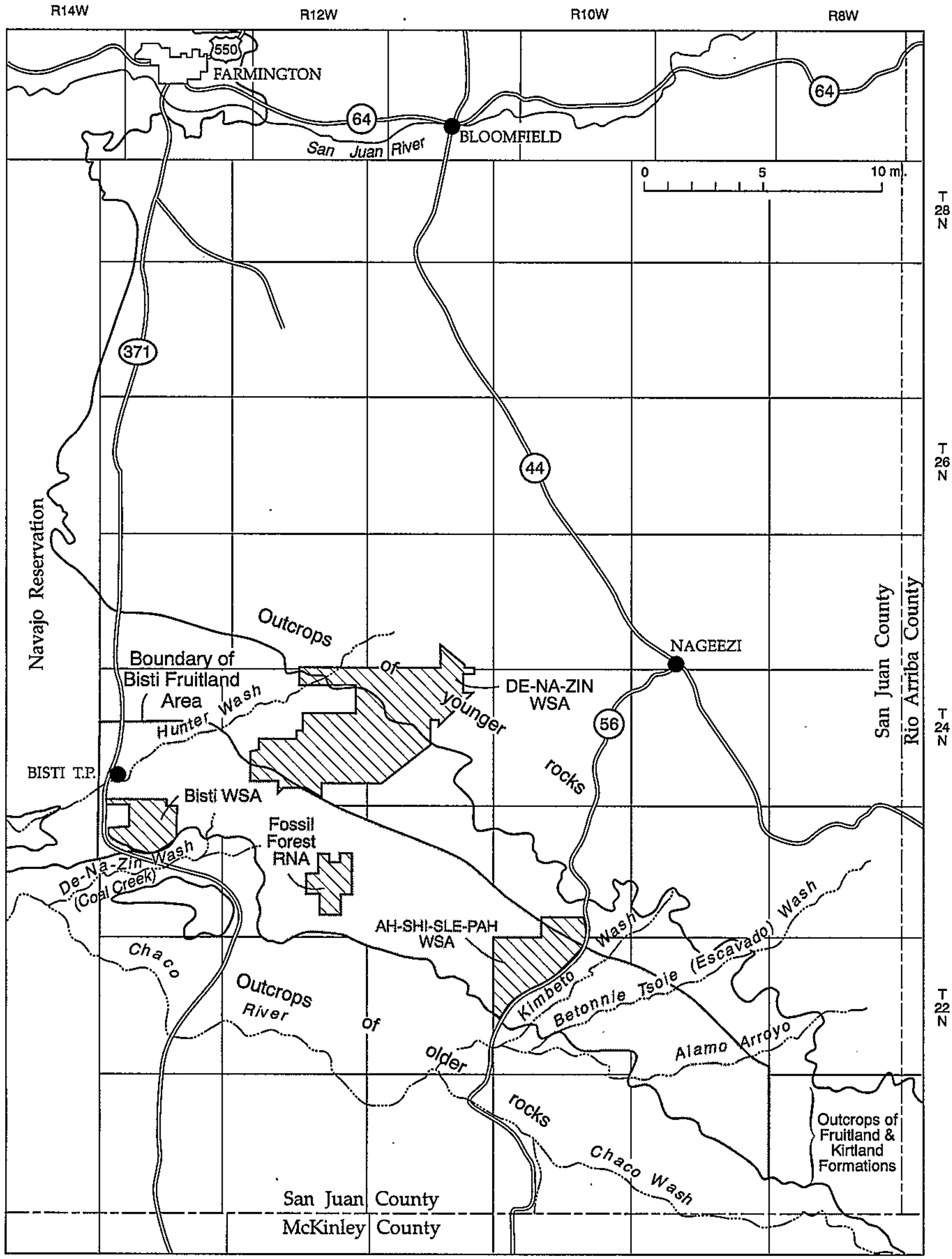

Figure 6. Bisti field, Fruitland Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

number of data points used in this study are:

	Depth Category
Total data points- 459:	67% 20–200 ft
	31% 200–500 ft
	2% 500–1000 ft

Depletion of original resources is from recent mining (De–Na–Zin and Gateway mines) of 2.42 million st of surface production and mine loss. Remaining surface DRB is 872.25 million st and remaining underground DRB is 1.169 million st for the Bisti field. All of the remaining DRB is within the 0.41-0.6 lbs sulfur/MMBtu and 15–19.99 MMBtu/ton categories. Ash yields for the Fruitland Formation Bisti field coals are greater than 15%, averaging 19% for the field (Table 5).

The Bisti, De-Na-Zin, and Ah–Shi–Sle–Pah Wilderness Study Areas are within the Bisti coal field, comprising 3,946, 19,700, and 6,400 acres of public land, respectively (Fig. 6). These areas contain Fruitland Formation and Kirtland Shale outcrops, creating badlands topography. The wilderness areas are managed by the Farmington BLM and have been withdrawn from mineral entry, therefore they cannot be considered part of the economic Bisti field coal resource. The Fossil Forest Research Natural Area (RNA) is also within the Bisti coal area. Heffern (1992) estimated 111 million st at depths less than 250 ft lie within the 2,770 acres withdrawn for this research area. The Hunter, Alamo Mesa, Kimbeto, and Escavada washes transect areas of surface and underground coal in the Bisti area, although most of these are considered intermittent streams. Pipelines and powerlines intersect this area and a few small oil and gas fields are within the underground coal areas of the Bisti field. Surface accessible reserves are 97% of the DRB, and underground accessible resources are 82% of the DRB (Table 4).

Star Lake field—This field extends east southeast from the Bisti field for 40 mi (Fig. 7). The Fruitland Formation becomes increasingly sandy and pinches out southwest of the town of Cuba. Hunt (1984) believed the lithology and overall thinning of the Fruitland in this part of the San Juan Basin was caused by differential subsidence during deposition. The beds dip less than 5°N–NE into the basin and some normal faulting occurs within the Star Lake field.

The Star Lake field is within San Juan, McKinley and Sandoval counties. Most of this field is on the Chaco Mesa 1:100,000 quadrangle (Fig 1) and San Juan County segment is on the Chaco Canyon 1:100,000 quadrangle. The subbituminous Star Lake original resource is based on the following point source data totals:

	Depth Category
Total data points- 442:	77% 20–200 ft
	18% 200–500 ft
	5% 500–1000 ft

No significant coal mining has occurred in the Star Lake field, therefore there is no depletion of original resources. Remaining surface DRB is:

Million st	County
117.35	Sandoval
483.89	McKinley
344.59	San Juan

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fig. 7-Star Lake Fruitland
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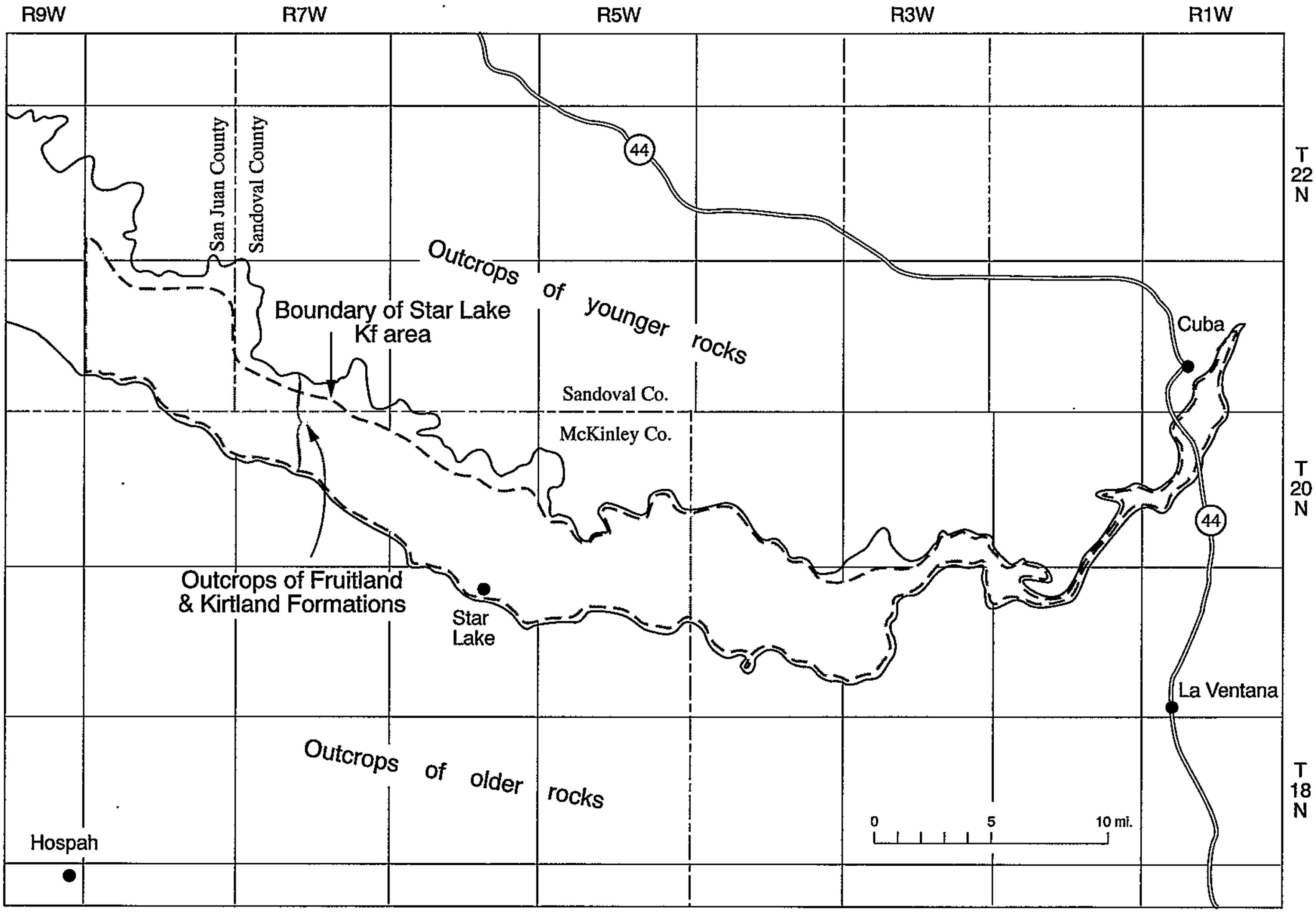

Figure 7. Index map of Star Lake Fruitland field, Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Total	*945.83*	

Remaining underground DRB for the Star Lake field is:

	Million st	**County**
	52.21	Sandoval
	127.09	McKinley
	147.97	San Juan
Total	*327.27*	

Star Lake field remaining DRB is within the 0.61–0.83 lbs of sulfur/MMBtu and 15–19.99 MMBtu/ton categories. These coals average 22% ash, the highest average ash content of all the Fruitland Formation coal fields (Table 5).

A small outlier of the Chaco National Historic Monument lies within the surface minable coal area of the Star Lake field. Several small oil and gas fields are within underground coal-resource areas. Two pipelines and a pumping station lie within the Fruitland Formation surface and underground resource areas in the Star Lake field. The surface-accesible reserves for this field are 97% of the total DRB; underground accesible reserves are 96% of the total DRB. The Star Lake field accessible and recoverable reserves are grouped with the Bisti and Navajo fields in San Juan County. The Fruitland Formation accessible and recoverable reserves in McKinley and Sandoval counties are entirely from the Star Lake field (Table 4).

Menefee Formation results

The Menefee Formation represents transitional sequences deposited during a major retreat and advance of the Late Cretaceous shoreline across the SJB. The lower coal-bearing sequence, the Cleary Coal Member was deposited landward of a retreating shoreline, in swamps behind the barrier beach sands that now constitute the Point Lookout Sandstone. The subsequent advance of the shoreline is represented by the deposits of the upper coal member of the Menefee Formation, the Cliff House Sandstone, and the lower Lewis Shale (Fig. 2b). Within this primarily transgressive sequence there are minor regressions and major stillstands in the shoreline that deposited the La Ventana Tongue and the Chacra Mesa tongue (Beaumont and Hoffman, 1992) of the Cliff House Sandstone. These units intertongue shoreward with the upper coal member of the Menefee Formation (Fig. 2b). A thick, barren continental sequence, the Allison Member lies between these two coal–bearing units. The two coal members are differentiated in the DRB in Table 6 but not in Tables 2 and 4. The individual discussions of the Menefee fields also discuss what coal members are present within specific fields. Table 6 summarizes the Menefee Formation DRB.

This formation is divided into nine fields within the SJB, the following list indicates name, county, and rank:

Field	County	Rank
Barker Creek:	San Juan	bituminous
Hogback:	San Juan	bituminous
Toadlena*:	San Juan	subbituminous
Newcomb:	San Juan	subbituminous
Chaco Canyon:	San Juan and McKinley	subbituminous
Chacra Mesa:	McKinley and Sandoval	subbituminous
Standing Rock:	McKinley	subbituminous
San Mateo:	McKinley and Sandoval	subbituminous
La Ventana:	Sandoval	bituminous and subbituminous
Monero:	Rio Arriba	bituminous

*Toadlena resources not calculated, no point source data

Table 6. Remaining DRB for the Menefee Formation, San Juan Basin, New Mexico in millions of st.

Rank	Field	Member	MMBtu/ton	Total	Lbs Sulfur/MMBtu 0.41–0.6	0.61–0.83	0.84–1.24	1.25–1.67	%Ash* 5.01–10	10.01–15
							Surface			
Bituminous	Barker Creek	upper	20–22.99	48.20		48.20			48.20	
		Cleary	20–22.99	19.75		19.75			19.75	
	Hogback	upper	20-22.99	44.99		44.99			44.99	
	Monero	undivided	23-24.99	7.63				7.63		7.63
	La Ventana	Cleary	20–22.99	61.69		20.85	40.84			61.69
Subbituminous	Newcomb	upper	15-19.99	72.07			72.07			72.07
	Chaco Canyon	upper	20-22.99	16.06			16.06		16.06	
	Chacra Mesa	upper	20-22.99	74.30	2.23		72.07		101.60	38.71
		Cleary	20-22.99	66.00	66.00					
	La Ventana	upper	20-22.99	55.50		39.88	15.62		}68.44	
		Cleary	20-22.99	12.94			12.94			
	San Mateo	Cleary	15-19.99	162.61			137.85	24.76		
			20-22.99	256.33	37.74		218.59			418.94
	Standing Rock	Cleary	15-19.99	392.20			302.21	89.99		392.20
		Total	**15-19.99**	617.23	0.00	0.00	512.13	114.75		
		Total	**20-22.99**	655.76	105.97	173.67	376.12	0.00		
		Total	**23-24.99**	7.63	0.00	0.00	0.00	7.63		
		Total	**Ash**						299.04	981.59
Bituminous Surface Total				*182.26*	*0.00*	*133.79*	*40.84*	*7.63*	*112.94*	*69.32*
Subbituminous Surface Total				*1,098.36*	*105.97*	*39.88*	*837.7647.41*	*114.75*	*186.10*	*912.27*
							Underground			
Bituminous	Barker Creek	Cleary	20-22.99	114.99		114.99			114.99	
	Hogback	upper	20-22.99	15.15		15.15			15.15	
		Cleary	20-22.99	5.66		5.66			5.66	
	Monero	undivided	23-24.99	31.58				31.58		31.58
	La Ventana	Cleary	20-22.99	64.07		44.78	19.29			64.07
Subbituminous	Newcomb	upper	15–19.99	46.24			46.24			46.24
		Cleary	15–19.99	8.01			8.01			8.01
	Chaco Canyon	upper	20–22.99	50.36			50.36		50.36	
		Cleary	20–22.99	31.78			31.78		31.78	
	Chacra Mesa	upper	20-22.99	115.50	54.49		61.01		}103.73	164.98
		Cleary	20-22.99	153.21	153.21					
	La Ventana	upper	20-22.99	64.77		15.75	49.02		}69.05	
		Cleary	20-22.99	4.28		4.28				
	San Mateo	Cleary	15-19.99	209.33			187.60	21.73		
		Cleary	20-22.99	108.26	10.51		97.75			}317.59
	Standing Rock	Cleary	15-19.99	448.49			161.76	286.73		448.49
		Total	**15-19.99**	712.07	0.00	0.00	403.61	308.46		
		Total	**20-22.99**	728.03	218.21	200.61	309.21	0.00		
		Total	**23-24.99**	31.58	0.00	0.00	0.00	31.58		
		Total	**Ash**						390.73	1080.96
Bituminous Underground Total				*231.45*	*0.00*	*180.58*	*19.29*	*31.58*	*135.80*	*95.65*
Subbituminous Underground Total				*1,240.23*	*218.21*	*20.03*	*693.53*	*308.46*	*254.92*	*985.31*
Bituminous Total				*413.71*	*0.00*	*314.37*	*60.13*	*39.21*	*248.74*	*164.97*
Subbituminous Total				*2,338.59*	*324.18*	*59.91*	*1,531.29*	*423.21*	*441.02*	*1,897.58*

*Tonnage for ash are not differentiated by MMBtu/ton or member.

Barker Creek field—The Menefee Formation Barker Creek field is on the northwest edge of the New Mexico portion of the SJB. It is defined by the Colorado–New Mexico boundary on the north and the township line between T31N and T30N to the south in San Juan County (Fig. 8). All of this field is on the Farmington 1:100,000 quadrangle (Fig. 1). Exposures of the Pictured Cliffs Sandstone and Point Lookout Sandstone delineate the east and west boundaries, respectively. The Hogback monocline on the eastern side of the field greatly influences the dip (10–38°E-SE) of the beds and several normal faults trending W-NW are associated with this structure (O'Sullivan and Beaumont, 1957). Northwest of the Hogback monocline the Menefee Formation is capped by Cliff House Sandstone, creating a dissected, steep-sided canyon and mesa topography. Both the upper and Cleary Coal members of the Menefee Formation are present.

Barker Creek original bituminous resources were estimated with sparse coal data:

	Depth Category
Total data points 46:	33% 20–200 ft
	61% 200–500 ft
	6% 500–1000 ft

Depletion of original surface resources is from production and mine loss of small underground mines operating before 1962, a total of 0.22 million st. Remaining surface DRB is 67.95 million st (48.20 million st upper coal member; 19.75 million st Cleary Coal Member) and remaining underground DRB is estimated at 114.99 million st, all in the Cleary Coal Member.

There are very few quality analyses for this field, therefore the quality categories used

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fig 8-Barker Ck Mesaverde
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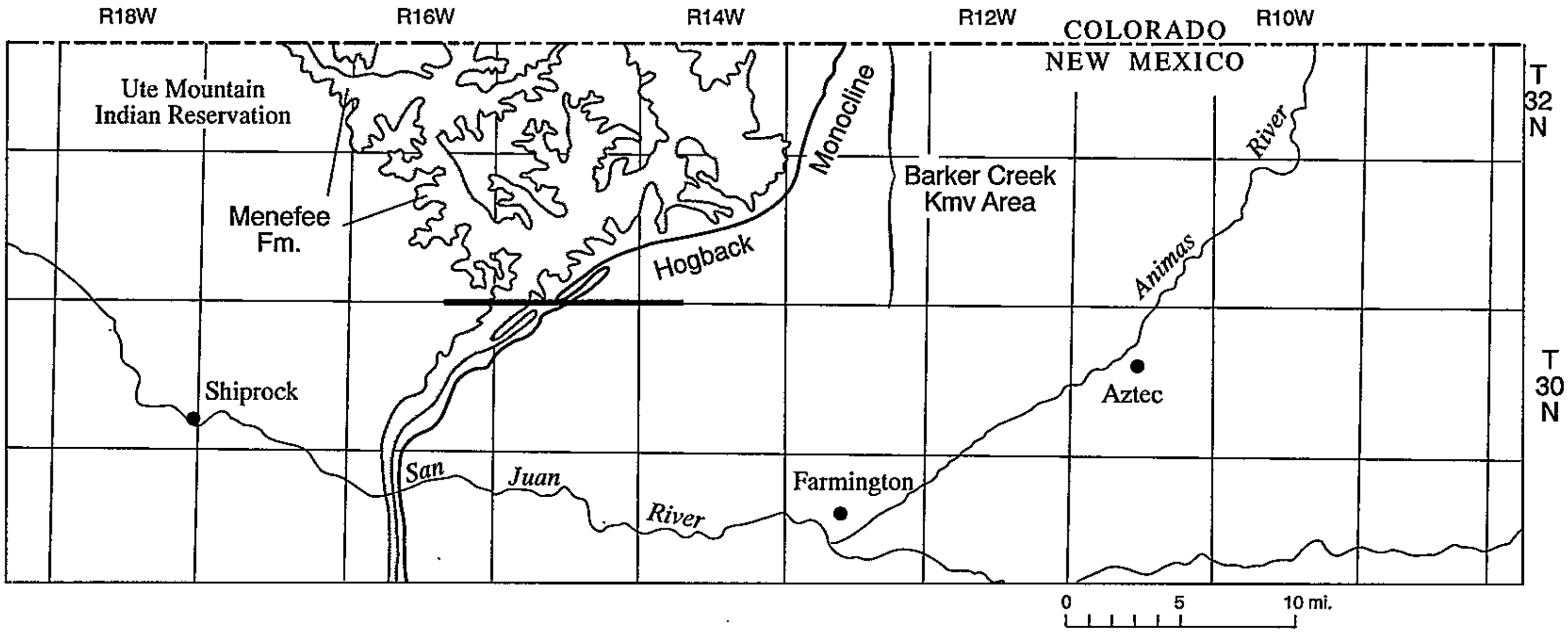

Figure 8. Index map of Barker Creek Menefee area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

are based on the judgment of the P.I. All of the Barker Creek data is in the 0.61–0.83 lbs sulfur/MMBtu, 20–22.99 MMBtu/ton and 5.01–10% ash categories (Table 6).

Most of the Barker Creek field is on the Ute Mountain Indian Reservation. In the southern part of the field, large areas are within producing oil and gas fields. The overlying thick sandstones and steeply dipping beds near the Hogback monocline precludes mining in the Barker Creek field. Accesible reserves are 74% and 67% for of the surface and underground DRB, respectively (Table 4, San Juan County, bituminous, Menefee.

Hogback field—The relatively small Hogback field (140 mi^2) is defined by the continuation of the Menefee Formation outcrop on the west side of the SJB, south of the Barker Creek field. The north and south boundaries of the Hogback field are T30N, R15–16W to T26N, R17–18W, within San Juan County. This field is located on the Farmington and Toadlena 1:100,000 quadrangles (Figs. 1,9). Contacts of the Pictured Cliffs Sandstone and the Point Lookout Sandstone with the Menefee Formation define the east and west boundaries, respectively. The east boundary along the Hogback monocline, creates a sharp, steep slope (Fig. 3). The Menefee beds dip as much as 38°E along this structure, decreasing to 10°E in the southern part of the field (O'Sullivan and Beaumont, 1957). Both the upper coal member and the Cleary Coal Member of the Menefee Formation are present in the Hogback field.

Very few data points are available for resource calculations in the Hogback field-

	Depth Category
Total data points 15:	40% 20–200 ft
	20% 200–500 ft

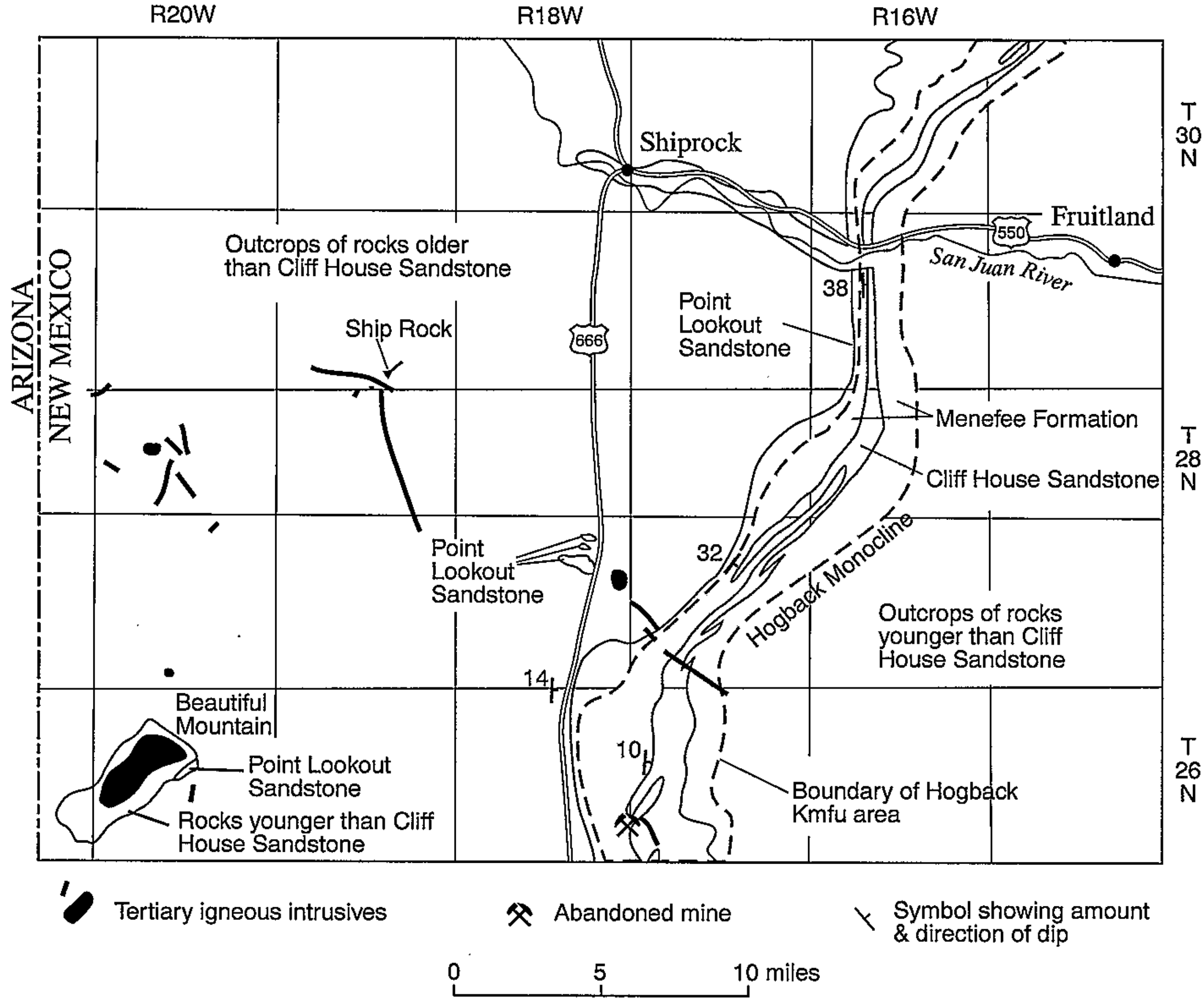

Figure 9. Index map of Hogback upper Menefee area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

40% 500–1000 ft

There is no depletion of the bituminous resources in the Hogback field. Remaining surface DRB is 44.99 million st, all in the upper coal member of the Menefee Formation. The remaining underground DRB is 20.81 million st (15.15 million st, upper; 5.66 million st, Cleary). All the Hogback field resources are in the 0.61–0.83 lbs sulfur/MMBtu, 20–22.99 MMBtu/ton, and 5.01–10.00% ash categories (Table 6). Quality data are sparse for this field, therefore these categories reflect the judgment of the author based on the data available.

The Hogback field is almost entirely within the Navajo Indian Reservation boundaries. The San Juan River valley and highway 550 crosses this field near the north end. The east edge of the field is defined by the Hogback monocline which contains beds too steeply dipping to permit surface mining. Accessible surface resources are 74% of the DRB and underground accesible reserves are 67% of the DRB for the Hogback field, grouped with the Barker Creek resources in Table 4.

Newcomb field—This field is on the Navajo Indian Reservation and encompasses the southwestern edge of the upper Menefee Formation outcrop where the strike of the beds change from a north-south to a northwest-southeast direction (Fig. 10). The Newcomb field is in San Juan County, and is located on the Toadlena 1:100,000 quadrangle (Fig. 1). Although the Cleary Coal Member is present, the upper coal member has greater economic potential. Thicknesses of coal beds at the surface are difficult to judge because the coal has been burned to masses of red clinker in most localities (Shomaker, Beaumont, and

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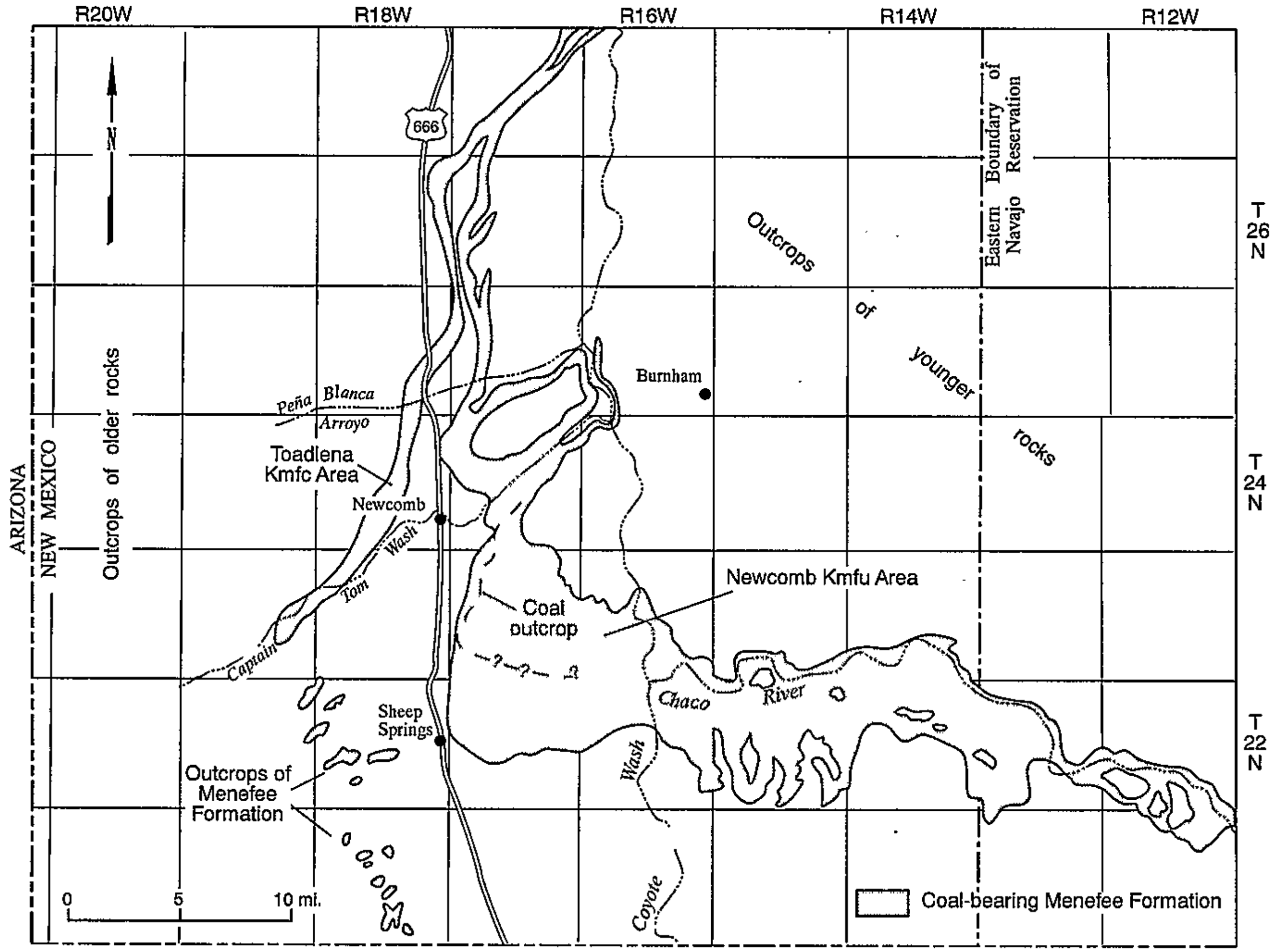

Figure 10. Index map of Toadlena and Newcomb upper Menefee areas. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Kottlowski, 1971). The upper Menefee Formation coals in this area are subbituminous in rank. There are few data points for this field:

	Depth Category
Total data points 16:	44% 20–200 ft
	38% 200–500 ft
	18% 500–1000 ft

There is no depletion of resources in the Newcomb field from previous mining. Remaining surface DRB is 72.07 million st, all from the upper coal member beds. The remaining underground DRB is 54.25 million st (46.24 million st, upper; 8.01 million st, Cleary). None of these resources are for coal beds thicker than 10 ft. The Newcomb field resources are within the 0.84–1.24 lbs sulfur/MMBtu, 15–19.99 MMBtu/ton, and 10.01–15% ash categories (Table 6). There is little quality data available for this field therefore these categories are based on the judgement of the author, using the available data.

As mentioned, the Newcomb field is within the Navajo Indian Reservation. The Chaco River and its tributaries run along the northern edge of this field. There are two small oil and gas fields near the southeast boundary of the Newcomb field. Taking into consideration the drainage areas and oil and gas fields, percentages of accesible reserves are 89% and 90% of the surface and underground DRB, respectively (Table 4, San Juan County, subbituminous).

Chaco Canyon field—This coal field extends from the eastern boundary of the Navajo Reservation to the Chacra Mesa field (R8W). The Chaco Canyon field lies within San Juan and McKinley counties on the Toadlena and Chaco Canyon 1:100,000 quadrangles (Figs. 1,11). The outcrops of the upper coal member of the Menefee Formation along the south side of the SJB defines the area. The northern boundary of the field is defined by the Cliff House Sandstone capping the prominent northeast-trending Chacra Mesa. The general strike of these beds is NW-SE and have gentle dips of 1-5^0 N-NE. Thirty-four data points were used in calculating the subbituminous resources for the Chaco Canyon field. The percentage of the total data points for each depth interval is:

Total data points 34:	9% 20-200 ft
	35% 200-500 ft
	56% 500-1000 ft

Resources have not been depleted by any significant mining in the Chaco Canyon field. The remaining DRB is:

Depth	**Million st**	**County**
Surface	5.82	McKinley
	10.24	San Juan
Total	*16.06- all upper coal member*	
Underground	50.74	McKinley
	31.41	San Juan
Total	*82.15- 50.36 upper, 31.78 Cleary Coal Member*	

All of the remaining Chaco Canyon field DRB is placed in the 0.84-1.24 lbs sulfur/MMBtu, 20-22.99 MMBtu/ton, and 5.10-10.00% ash categories (Table 6). Very few quality data are available for this field (Appendix B), therefore data from adjoining areas and available data from this field were considered to determine the quality categories.

The Chaco Canyon field includes the Chaco Canyon National Monument, an area of

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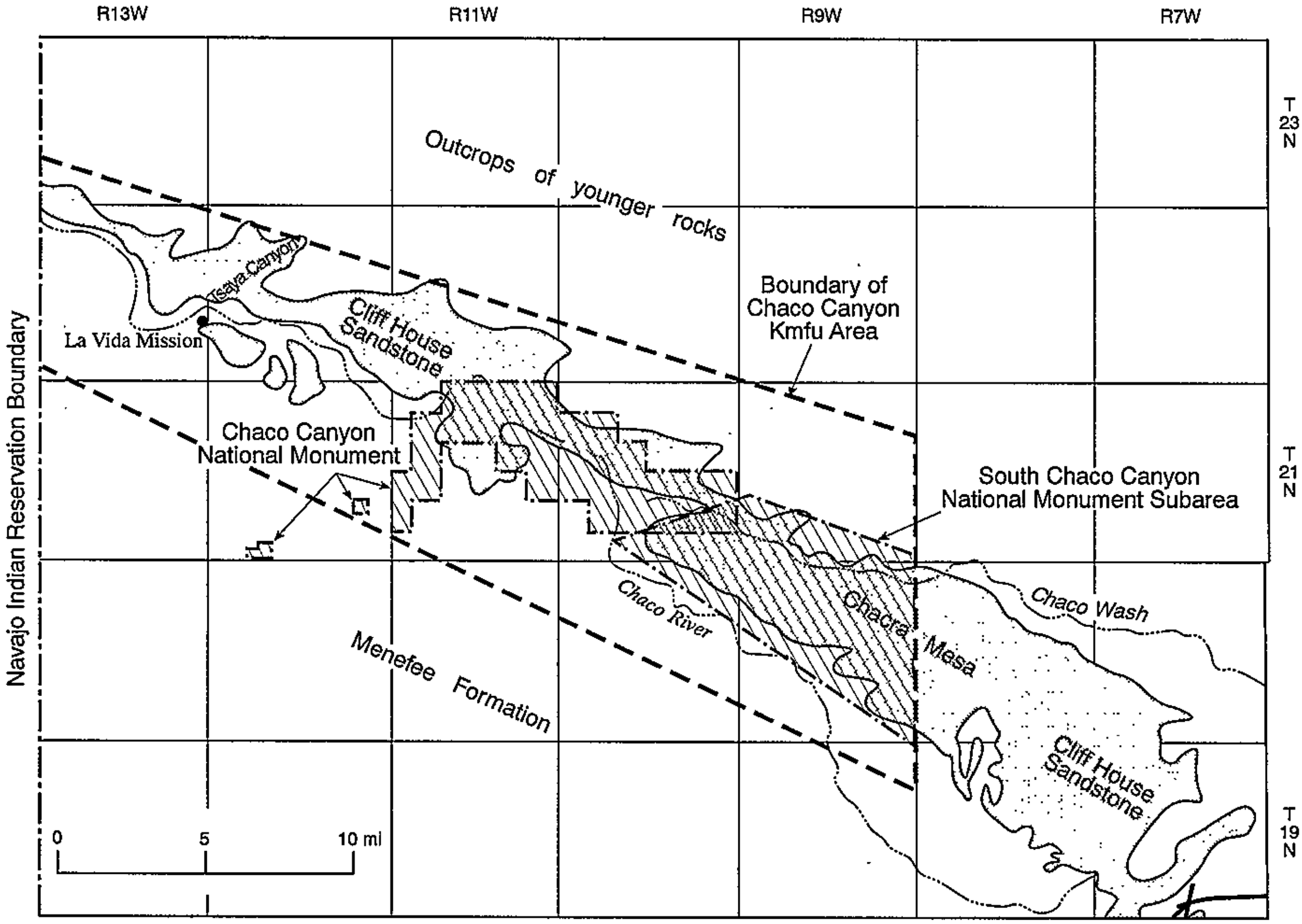

Figure 11. Index map of Chaco Canyon upper Menefee area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

2,763 acres withdrawn from mining interests. The Chaco River, a major drainage in this region is within this coal resource area. The upper member of the Menefee is, in many places, capped by thick sandstone beds of the Cliff House Sandstone, that can be prohibitive to surface mining. A few small oil and gas fields are within the underground resource area of the Chaco Canyon field. Eighty-nine percent of the surface DRB is accessible to mining; 96% of the underground DRB is accessible. The Chaco Canyon accessible and recoverable subbituminous reserves are grouped with the Newcomb field in San Juan County and the Chacra Mesa, Standing Rock, and San Mateo fields in McKinley County in Table 4.

Chacra Mesa field—This field is defined by the continuation of the Menefee outcrops on the Chaco slope, along the southern edge of the SJB east from the Chaco Canyon field. Much of this area is covered by northwest-trending valleys and mesas capped by Cliff House Sandstone that overlies and intertongues with the upper coal member of the Menefee Formation. The Chacra Mesa field includes outcrops of the Cleary Coal Member in the southern part of the field (Fig. 12). Most of this field is in McKinley and Sandoval counties on the Chaco Mesa 1:100,000 quadrangle, although a small percentage of underground coal is in San Juan County, on the Chaco Canyon 1:100,000 quadrangle (Fig. 1). A total of 160 data points were used to calculate the subbituminous DRB for the Chaco Mesa field. The division by depth of these data is:

Total data points- 160:	23% 20–200 ft
	37% 200–500 ft
	40% 500–1000 ft

The DRB for this field was not depleted by any significant production from past mining. The

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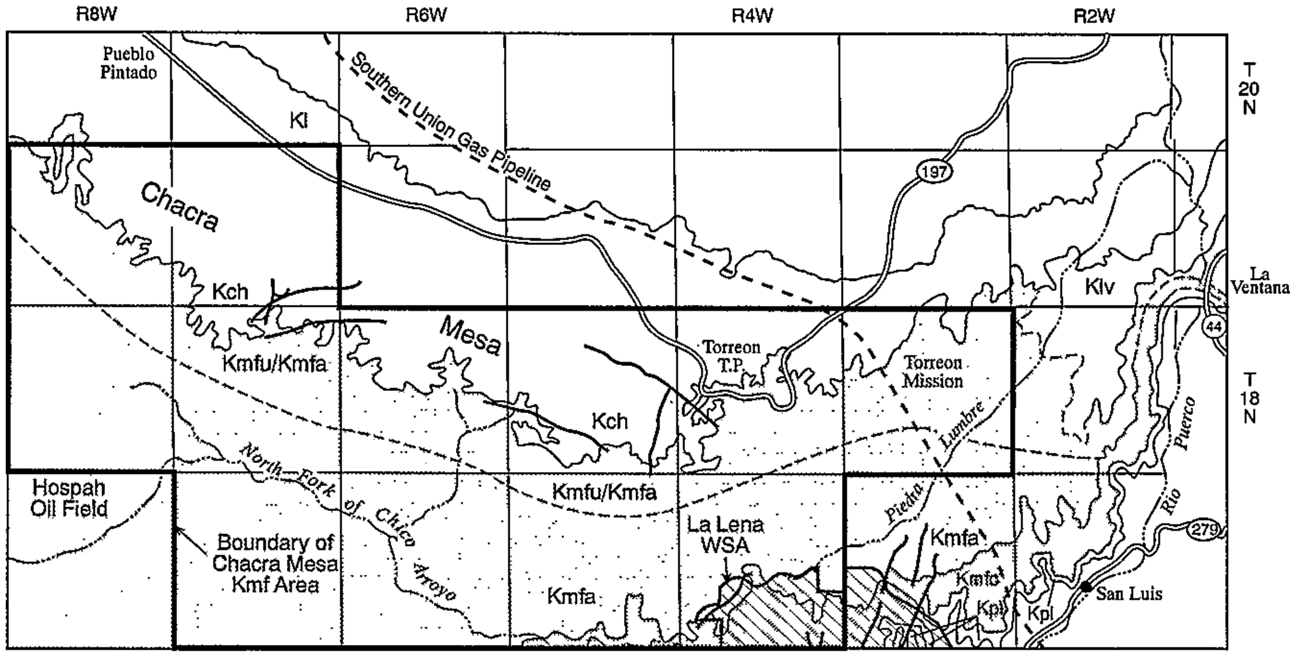

Kl - Cretaceous Lewis Shale
- Cretaceous Mesaverde Group
Kch - Cliff House Sandstone
Klv - La Ventana Tongue
Kmfu - Menefee Fm. - upper coal member
Kmfa - Menefee Fm. - Allison Member
Kmfc - Menefee Fm. - Cleary Coal Member
Kpl - Point Lookout Sandstone

Figure 12. Map of Chacra Mesa Menefee area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

remaining surface DRB:

	Million st	County	Cleary	upper
Surface	26.63	McKinley:	15.62	11.01
	113.67	Sandoval:	50.38	63.29
Total	*140.30*		*66.00*	*74.30*
Underground	3.35	San Juan		3.35
	148.34	McKinley	131.92	16.43
	117.02	Sandoval	21.31	95.72
Total	*268.71*		*153.23*	*115.50*

Sulfur Categories, all within 20-22.99 MMBtu/ton:

Depth	0.41-0.6	0.84-1.24	County
Surface	26.62		McKinley
	41.62	72.07	Sandoval
Total	*68.24*	*72.07*	
Underground	3.35		San Juan
	148.34		McKinley
	56.01	61.01*	Sandoval
Total	*207.70*	*61.01*	

* upper member coals in T18N R3W are in higher sulfur category.

Ash Categories:

Depth	5.01-10.01	10.01-15	County
Surface		26.62	McKinley
	101.60	12.09	Sandoval
Total	*101.60*	*38.71*	
Underground		3.35	San Juan
		148.34	McKinley
	103.73	13.29	Sandoval
Total	*103.73*	*164.98*	

The Chacra Mesa field is in a relatively populated part of the southern SJB. The Torreon Trading post (Fig. 12) is the center of a Navajo development that includes a mission and a school. A major paved highway (197) crosses this area as do two pipelines and several powerlines. Many oil and gas wells are within the Menefee coal resource area. A small part of the La Lena Wilderness Study Area intersects the southern Chacra Mesa field, in the Cleary Coal Member. The upper member coals, about half the total DRB of the Chaco Mesa field, are capped in many places by thick sandstones belonging to the La Ventana Tongue of the Cliff House Sandstone that could inhibit surface mining. About 90% of the DRB is accessible within the surface (20-200 ft) category and 93% is accessible in the underground DRB. The accessible and recoverable reserves of this field are listed under McKinley, San Juan, and Sandoval counties in Table 4. Accessible estimates do not exclude the area covered by the thick La Ventana Tongue sandstone.

La Ventana field—The La Ventana field is on the southeastern edge of the SJB, in Sandoval County, on the Chaco Mesa and Los Alamos 1:100,000 quadrangles (Figs. 1,13). The beds are gently dipping (2–5°N–NW) in the western part of the field. The eastern La Ventana field is close to the Nacimiento uplift where the dip of the beds increases from 35–45°NW–W to vertical. This field includes the Cleary Coal and upper coal members of the Menefee Formation. Coal beds average 3–6 ft thick in both coal-bearing sequences, although some individual coal beds in the upper coal member attain a thickness of 10–12 ft. La Ventana field resources are bituminous and subbituminous in rank. Bituminous coal is in T17N, R2W & R3W and the remaining areas of the La Ventana field are subbituminous for the resource calculations. Total data points used for bituminous resources are:

Depth Category

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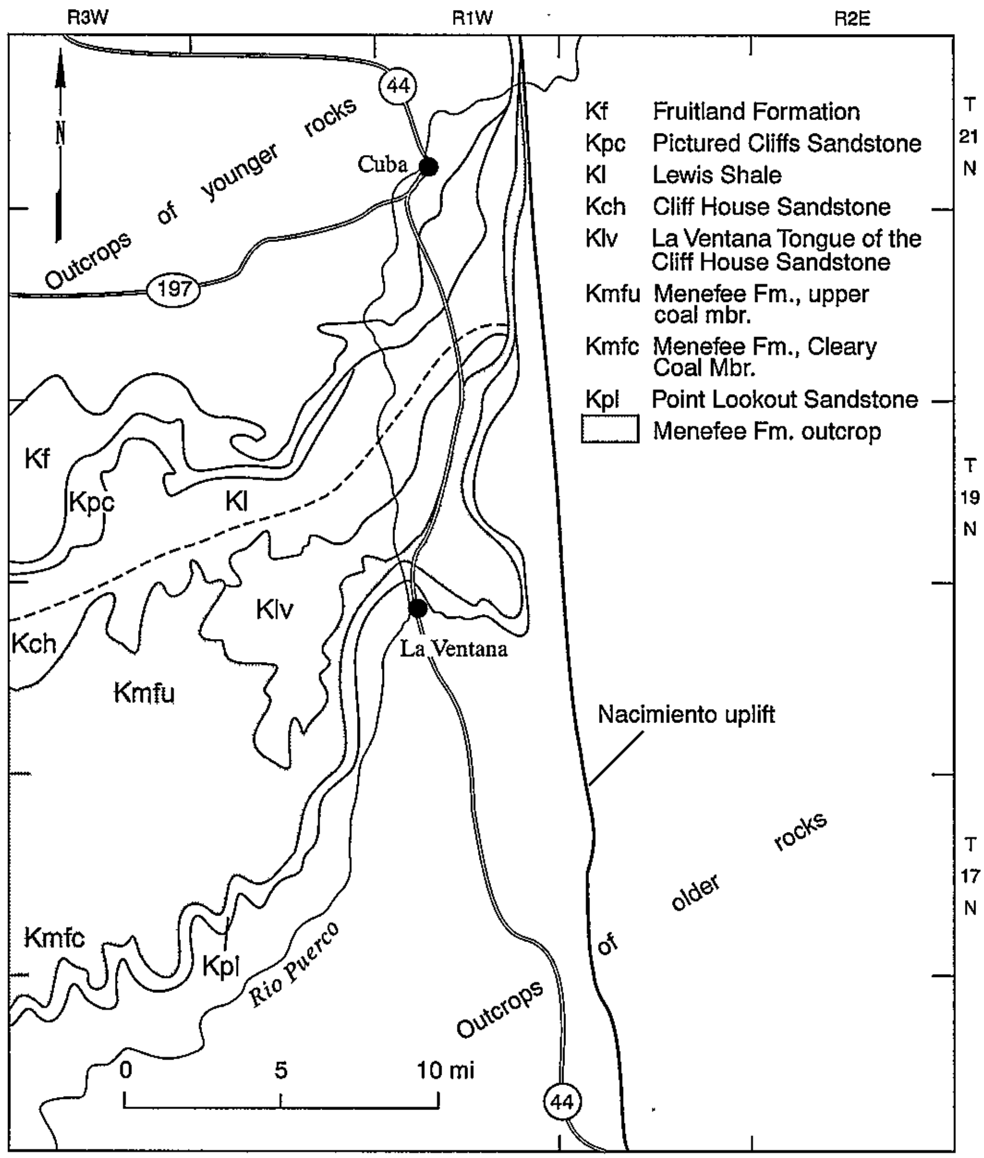

Figure 13. Map of La Ventana field, Menefee Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Total points 41:	71% 20–200 ft	12%
	200–500 ft	
	17% 500–1000 ft	

Total data points used for subbituminous resources are:

	Depth Category
Total points 40:	53% 20–200 ft
	27% 200–500 ft
	20% 500–1000 ft

Original surface bituminous resources in the La Ventana field were depleted by 0.1 million st from previous mine production and loss. The subbituminous original surface resources were depleted by 0.16 million st and underground resources by 0.25 million st from mine production and loss.

The remaining DRB for La Ventana field:

Depth	**Million st**	**Rank**	**Cleary**	**upper**
Surface	61.69	bituminous	61.69	
	68.44	subbituminous	12.94	55.50
Total	*130.13*		*74.63*	*55.50*
Underground	64.07	bituminous	64.07	
	69.05	subbituminous	4.28	64.77
Total	*133.12*		*68.35*	*64.77*

Sulfur Categories, all within 20–22.99 MMBtu/ton (in millions of st):

Depth	**0.61–0.83**	**0.84–1.24**	**Rank**
Surface	20.85	40.84	bituminous
	39.88	28.56	subbituminous
Total	*60.73*	*69.40*	
Underground	44.78	19.29	bituminous
	20.03	49.02	subbituminous

Total	*64.81*	*68.31*

The bituminous DRB is in the 10.01–15% ash category and the subbituminous DRB is in the 5–10% ash category (Table 6).

Highway 44 crosses the eastern edge of the field and the Rio Puerco parallels this major highway (Fig. 13). There are significant resources in the Cleary Coal Member and upper part of the Menefee Formation, but because of excessive dips on the east edge, near the Nacimiento uplift, and the thick La Ventana Tongue sandstones associated with the upper coal member, potential surface mining areas within the field are limited. The surface accesible reserves are 90% of the total DRB; underground accesible reserves are 93% of the DRB. Accessible and recoverable reserves are in Sandoval County, both bituminous and subbituminous, grouped with reserves from the San Mateo field in Table 4.

San Mateo field—This field is northwest of the Mount Taylor volcanic complex (Tb; Fig. 14) and south of the Chacra Mesa field. It includes exposures of the Allison (barren member) and Cleary Coal Members of the Menefee Formation (Fig. 2) in McKinley and Sandoval counties on the Chaco Mesa and Grants 1:100,000 quadrangles (Fig. 1). The San Mateo and San Miguel Creek domes, structural features in the southern San Mateo field, were positive areas during the deposition of the Cleary Coal Member and influenced the thickness and the trends of the coal beds (Beaumont, 1987). The coal-bearing units on the southwest side of the San Mateo field were also influenced by the Zuni uplift. The San Mateo field subbituminous resource were based on:

Depth Category

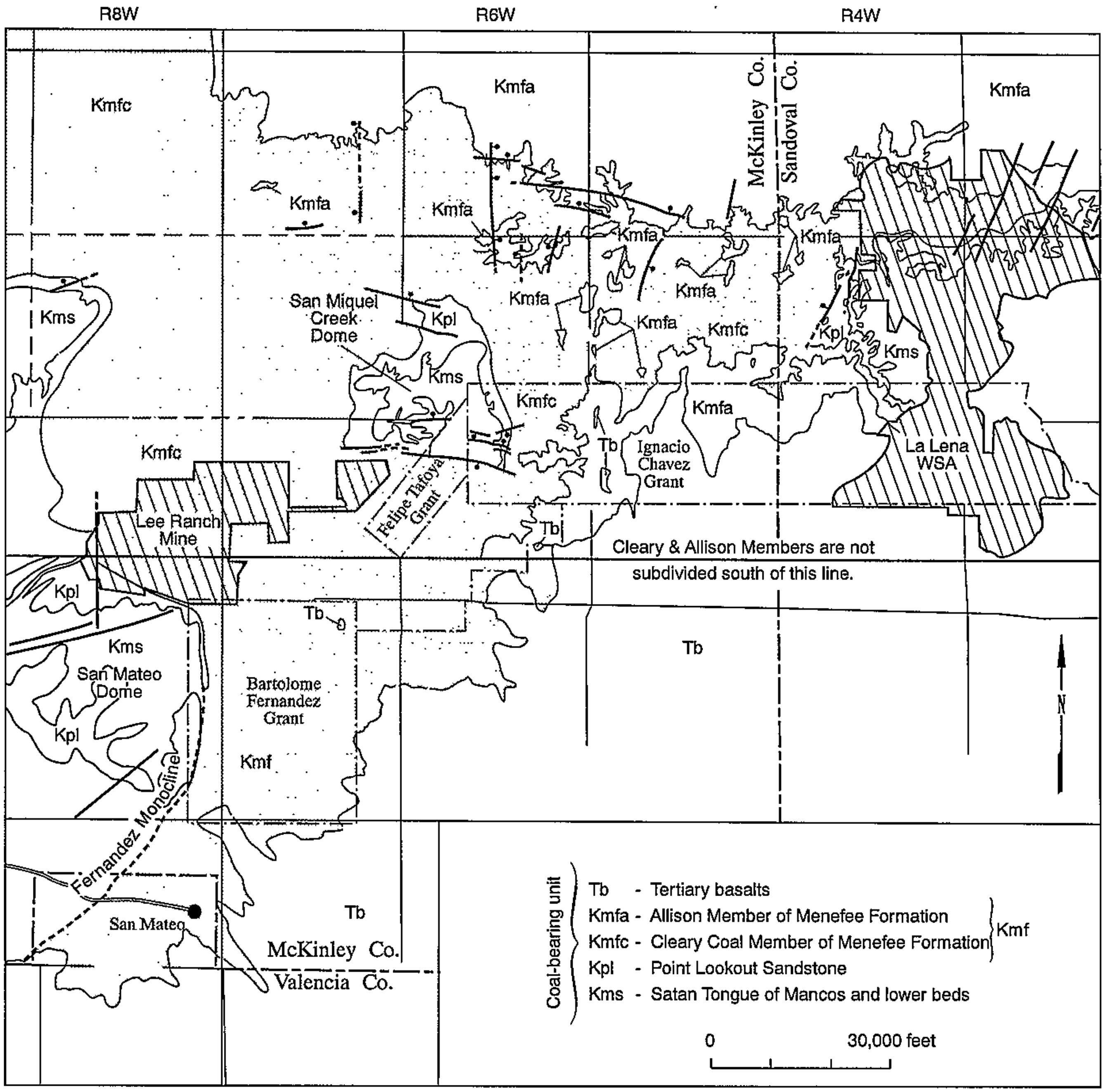

Figure 14. Geologic map of San Mateo Menefee area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Total data points–215:	70% 20–200 ft
	25% 200–500 ft
	5% 500–1000 ft

Original subbituminous resources were depleted by production and mine loss from the Lee Ranch mine (McKinley County) by 28.51 million st (includes production through 1994). The remaining subbituminous DRB for San Mateo field is:

Depth	**Million st**	**County**
Surface	*412.54*	*McKinley*
	6.40	*Sandoval*
Underground	*317.59*	*McKinley*

San Mateo DRB is divided into three categories of lbs of sulfur/MMBtu:

1)	0.41–0.60	T16N, R4W and R5W
2)	0.83–1.24	T15N, T16N, R7W and R8W
3)	1.25–1.67	T15N, R6W

All remaining DRB is within the 10.01–15% ash category.

Exposures of the Cleary Coal Member, Menefee Formation on the southeast edge of the San Mateo field are within the La Lena Wilderness study area on the Chaco Mesa quadrangle. San Miguel Creek dome in central San Mateo field (Chaco Mesa 1:100,000) is a positive area where the Menefee Formation has been removed by erosion. On the Grants 1:100,000 quadrangle, a large area of the potential underground coal resource is covered by the Mount Taylor volcanics. Using Dillinger's map (1989) to calculated this resource area, the total acreage is 13,900 acres of Cleary Coal Member at depths greater than 200 ft. The surface resource area on the Grants quadrangle encompasses the small town of San Mateo (320 acres), a few springs and lakes (137 acres), highways (68 acres), and power lines (184 acres). The total Cleary Coal Member surface resource area minus these minor restrictions is 60,693 acres on the Grants quadrangle. The Cibola National Forest, Bartolome Fernandez, Felipe Tafoya, and Ignacio Chavez land grants are within the San Mateo coal field boundaries. Percentage of accessibility applied to the DRB in this field is 92% and 93% for surface and underground resources, respectively. San Mateo field accessible and recoverable reserves are grouped with the Chaco Canyon, Chacra Mesa, and Standing Rock fields in McKinley County and with the La Ventana field reserves in Sandoval County (Table 4).

Standing Rock field— This field extends westward from the San Mateo field to the Gallup field. Standing Rock field is defined along the southern margin by the Point Lookout Sandstone—Menefee Formation contact. The northern boundary approximately coincides with the outcrop of the upper most Cleary Coal Member coal exposures (Fig. 15). An arbitrary boundary between the San Mateo and Standing Rock fields is the western border of R8W. The Standing Rock field is within the Chaco slope and the units dip gently N–NW into the SJB. This field is in McKinley County on the Chaco Mesa and Gallup 1:100,000 (Fig. 1). Coal resources are of subbituminous rank. Distribution of the data points in the Standing Rock field by depth categories is:

Total data points-153:	46% 20–200 ft
	49% 200–500 ft
	5% 500–1000 ft

No significant mining has occurred in the Standing Rock field, therefore the original

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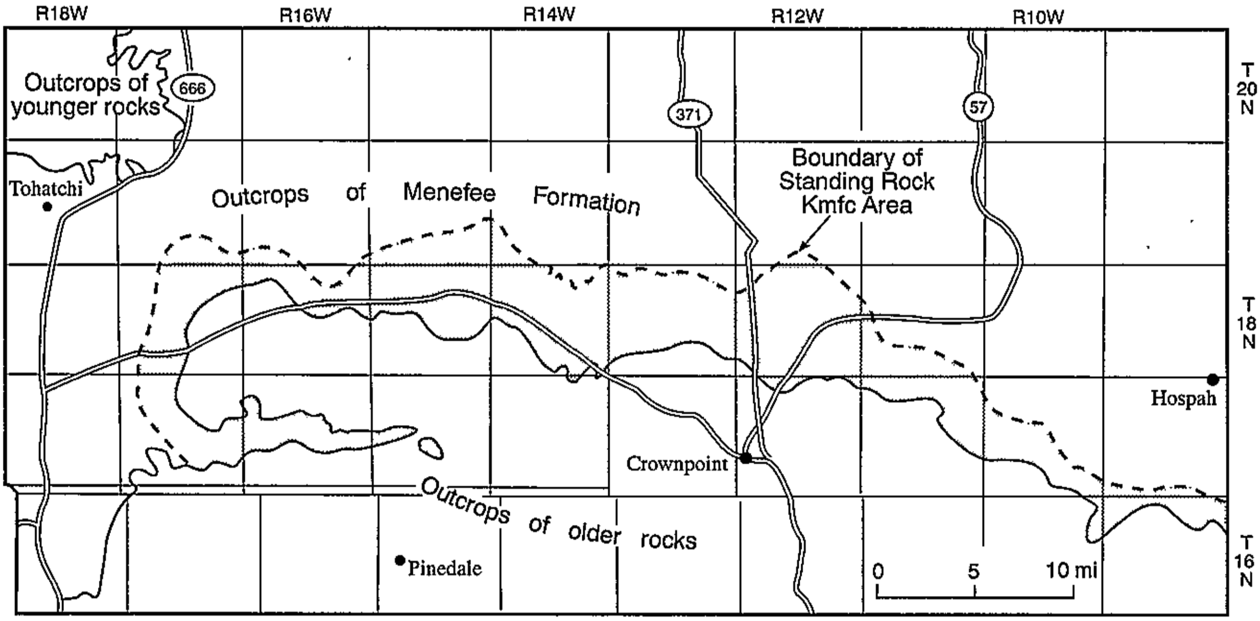

Figure 15. Map of Standing Rock field, Cleary Member, Menefee Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

resources are not depleted by production or mining loss. Remaining DRB is:

Surface	392.20 million st; 86% is from coal beds 2.5–10 ft thick
Underground	448.49 million st; 95% is from coal beds 2.5–10 ft thick

Standing Rock DRB is divided into two categories of lbs of sulfur/MMBtu:

Category	**Area**
0.84–1.24	T16N, R9W; T17N, R10W; T18N, R12W
1.25–1.67	T17N, R9W; T16N, R10W

Sulfur Categories, all within 15–19.99 MMBtu/ton (millions of st):

Depth	**0.83–1.24**	**1.25–1.67**
Surface	302.21	89.99
Underground	161.76	286.73

All the surface and underground DRB in the Standing Rock field is in the 10.01–15% ash category (Table 6).

On the Chaco Mesa quadrangle, there are several small oil and gas fields within the Standing Rock underground resource area. An outlier of the Chaco Canyon National Monument (160 acres) is within the surface coal resource area. Two pipelines cross this field, and on both quadrangles (Chaco Mesa and Gallup) highways 57 and 371 intersect the coal resource areas. Much of the western Standing Rock field on the Gallup quadrangle is on Indian surface ownership or within the Navajo Indian Reservation. Approximately 92% and 93% of the surface and underground DRB for this field is accessible, grouped with the other Menefee Formation fields in McKinley County (Table 4).

Monero field–This northeastern Menefee field is defined by outcrops of the Mesaverde Group (Fig. 2) that extend 26 mi. southward from the New Mexico–Colorado state line in Rio Arriba County (Chama 1:100,000 quadrangle; (Fig. 1; Fig. 16). The coal-bearing rocks in the Menefee and Fruitland Formations strike N–S, and are separated from the central SJB by the Archuleta arch (Fig. 3). Most of the northern Monero field is influenced by small domes and southwest–trending synclines that are part of the Archuleta arch (Dane, 1948a). The southern part of the field parallels the N30°W trend of the Gallina arch, a northern extenxion of the Nacimiento uplift. Several faults in the Monero field parallel the eastern edge of the basin and are associated and contemporaneous with the folding that took place along the eastern SJB (Dane, 1948a) during the Laramide tectonic activity. High angle normal faults with displacement of less than 100 ft are widespread (Dane, 1948a,b). These faults are generally downthrown to the west. The dips of the beds are variable because of the relatively complex structure. Outcrops of the Menefee and Fruitland Formations are limited to the steep canyon walls of the fault–block mesas on the eastern edge of the field. Only the Menefee Formation coal at shallow depths has economic significance in this field. The Menefee Formation thins to the northeast and is replaced by marine sandstones of the Point Lookout Sandstone or Cliff House Sandstone (Fig. 2a). Therefore the coal beds are mainly in the north–central to south–central parts of the field. Menefee Formation coal resources bituminous in rank were calculated from very sparse data:

	Depth Category
Total data points-7:	86% 20–200 ft
	14% 200–500 ft

Katny/Gretchen
fig 16--Monero Mesaverde
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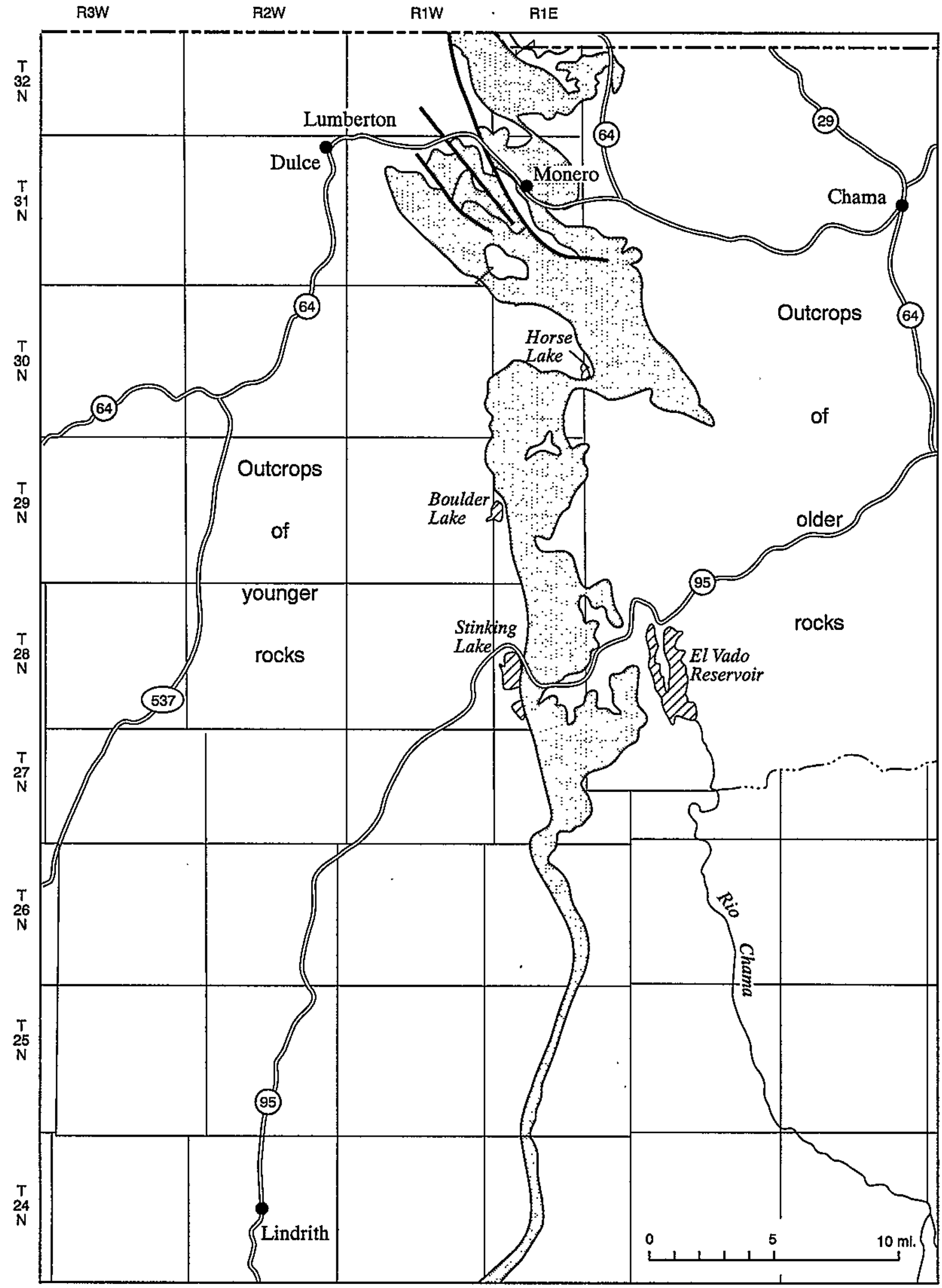

Figure 16. Index map of Monero Mesaverde field. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Lack of point-source data in the 500–1000-ft depth category were supplemented by demonstrated resource calculations from a study on the Jicarilla Apache Indian Reservation by Olsen and Gardner (1987). Although some data in this report are within the 0–500-ft depth category, these resources are grouped together, and therefore are not added to this DRB.

All of Rio Arriba County coal production (1882 to 1964) comes from the Monero area. A considerable amount (63%) of the total production and mine loss is estimated to be from depths of 200–500 ft. Coal resources in this category are very sparse, therefore this production and mine loss (2.12 million st) were first added to the original resource then subtracted to obtain the remaining DRB. Depletion of original surface resources totaled 1.25 million st.

Total remaining surface DRB is 7.63 million st. Total underground remaining DRB is 31.58 million st. All remaining resources are in the 1.25–1.67 lbs sulfur/MMBtu, 23–24.99 MMBtu/ton, and 10.01–15 % ash categories (Table 6).

Except for the northern two townships, the Monero field is on the Jicarilla Apache Indian Reservation. Another section east of T31N, R1E is on the Tierra Amarilla land grant. Highway 64-84 cuts through the northern third of the field and highway 95 crosses Mesaverde Group outcrops near Burford Lake. The southern part of this field has small oil fields. Most of the surface resources, northeast of Monero, are on fault block cuestas capped by Cliff House Sandstone. The accesible reserves are 89% and 86% of the total surface and underground DRB for the Monero field, Rio Arriba County (Table 5).

Crevasse Canyon Formation and Gallup Sandstone results

The Crevasse Canyon Formation coal-bearing members were deposited during a major retreat and lesser advance of the Late Cretaceous shorelines in the southern SJB (Fig. 2). The Dilco Coal Member was deposited landward of the marine Gallup Sandstone, and some coals are within the Gallup Sandstone, probably due to intertonguing of nonmarine sequences during oscillations in the shoreline (Fig. 2a). The Dilco Member is overlain by the thick, barren, continental Bartlett Barren Member. With the following advance of the shoreline, coal that developed in the swamps shoreward of the Point Lookout Sandstone belong to the Gibson Coal Member. The Point Lookout Sandstone forms the division between the Gibson Coal Member of the Crevasse Canyon and the Cleary Coal Member of the Menefee Formation. The Point Lookout Sandstone pinches out northeast of the town of Gallup. In the Gallup field the Gibson and Cleary Coal Members are undivided (Fig. 2a) and are referred to as the Gibson–Cleary coal member. All of the coal within this unit in the Gallup field is calculated as resources in the Crevasse Canyon Formation. Table 7 summarizes the Crevasse Canyon and Gallup Sandstone resources.

Six coal fields are delineated by the Crevasse Canyon exposures:

Field	County	Rank
Gallup	McKinley	bituminous
Zuni	McKinley and Cibola	subbituminous
Crownpoint	McKinley	subbituminous
S. Mt. Taylor	Cibola	subbituminous
E. Mt. Taylor	Cibola and Sandoval	subbituminous
Rio Puerco	Cibola and Sandoval	subbituminous

Table 7. Remaining DRB for the Crevasse Canyon Formation and Gallup Sandstone, San Juan Basin, New Mexico in millions of st.

Field	Formation	MMBtu/ton	Total	Lbs Sulfur/MMBtu 0.41–0.6	0.61–0.83	0.84–1.24	1.25–1.67	%Ash[1] 5.01–10	10.01–15	>15
					Surface					
Gallup	Crevasse	20–22.99	537.77	355.62	174.13	8.02	537.77			
	Gallup SS	20–22.99	1.15		1.15				1.15	
Zuni	Crevasse	20–22.99	23.34			23.34				23.34
	Gallup SS	20–22.99	35.91			35.91			35.91	
Crownpoint	Crevasse	15–19.99	662.51				662.51		662.51	
	Gallup SS	20–22.99	29.16				29.16		29.16	
S. Mt. Taylor	Crevasse	20–22.99	13.92	13.92					13.92	
Rio Puerco	Crevasse	15–19.99	24.70			24.70		24.70		
15–19.99	687.21	0.00	0.00	24.70	662.51					
	Total	**20–22.99**	641.25	369.54	175.28	67.27	29.16			
	Total	**Ash**						562.47	742.65	23.34
Bituminous Surface Total			*537.77*	*355.62*	*174.13*	*8.02*	*0.00*	*537.77*	*0.00*	*0.00*
Subbituminous Surface Total			*790.69*	*13.92*	*1.15*	*83.95*	*691.67*	*24.70*	*742.65*	*23.34*
					Underground					
Gallup	Crevasse	20–22.99	490.01	266.02	167.00	56.99	490.01			
Zuni	Crevasse	20–22.99	30.61			30.61				30.61
	Gallup SS	20–22.99	11.28			11.28			11.28	
Crownpoint	Crevasse	15–19.99	429.78				429.78		429.78	
	Gallup SS	20–22.99	1.20				1.20		1.20	
San Mateo	Crevasse	15–19.99	27.80				27.80		27.80	
S. Mt. Taylor	Crevasse	20–22.99	3.25	3.25					3.25	
E. Mt. Taylor	Crevasse	20–22.99	2.55	2.55					2.55	
	Total	**15–19.99**	457.58	0.00	0.00	0.00	457.78			
	Total	**20–22.99**	538.90	271.82	167.00	98.88	1.20			
	Total	**Ash**						490.01	475.86	30.61
Bituminous Underground Total			*490.01*	*266.02*	*167.00*	*56.99*	*0.00*	*490.01*	*0.00*	*0.00*
Subbituminous Underground Total			*506.47*	*5.80*	*0.00*	*41.89*	*458.78*	*0.00*	*475.86*	*30.61*
Bituminous Total			*1,027.78*	*621.64*	*341.13*	*65.01*	*0.00*	*1,027.78*	*0.00*	*0.00*
Subbituminous Total			*1,297.16*	*19.72*	*1.15*	*125.84*	*1,150.45*	*24.70*	*1,218.51*	*53.95*

[1]Ash undifferentiated by MMBtu/ton. Gallup field, Crevasse Canyon are bituminous. Note, all resources without footnote are subbituminous.

Gallup field—This field in southwestern SJB is defined on the east by the steeply dipping Nutria Monocline, and on the west by the Defiance uplift (Figs. 3,17). The structurally negative area between these two positive areas is occupied by two lesser positive features, the Torrivio and Gallup anticlines (Fig. 3). The arbitrary southern edge of the Gallup field is the southern boundary of T12N. Exposures of the Gallup Sandstone, the Dilco Coal Member, and the Gibson-Cleary coal members are present in this field. Bituminous coal resources were calculated for T12N R17W, T13N R17W and R18W, T14N R18W and R19W, T15N R18W-R20W; T16N R18–20W; T17N R20W. Division of Crevasse Canyon point source data for bituminous coal areas by depth are:

Total data points-710:	70% 20–200 ft
	22% 200–500 ft
	8% 500–1000 ft

The Gallup field is in McKinley County, on the Gallup and Zuni 1:100,000 quadrangles (Fig. 1). Most of the past and present production for this county is from the Gallup field. Depletion (production and mine loss) of bituminous original resources from underground mining prior to 1962 is 65.45 million st. Of this total only 9.59 million st was mined within 200 ft of the surface. Production and mine loss from surface mining in the bituminous resource area is 122.83 million st.

Remaining DRB for the bituminous resource is:

Surface	537.77 million st
Underground	490.01 million st

Kathy/Hoffman
fig 17-Crevasse Cyn. Fm.
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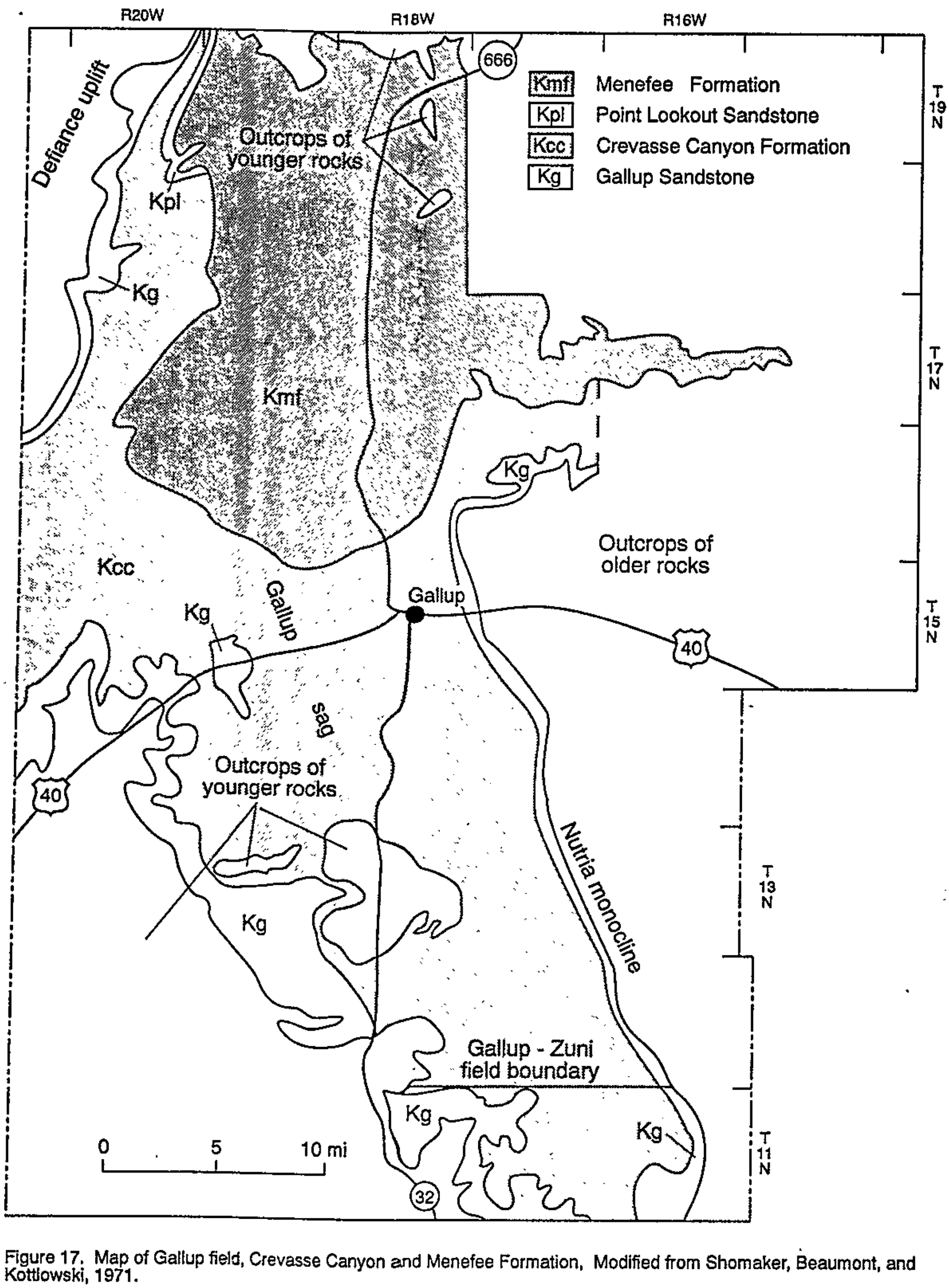

Figure 17. Map of Gallup field, Crevasse Canyon and Menefee Formation, Modified from Shomaker, Beaumont, and Kottlowski, 1971.

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fig 17-Crevasse Cyn. Fm.
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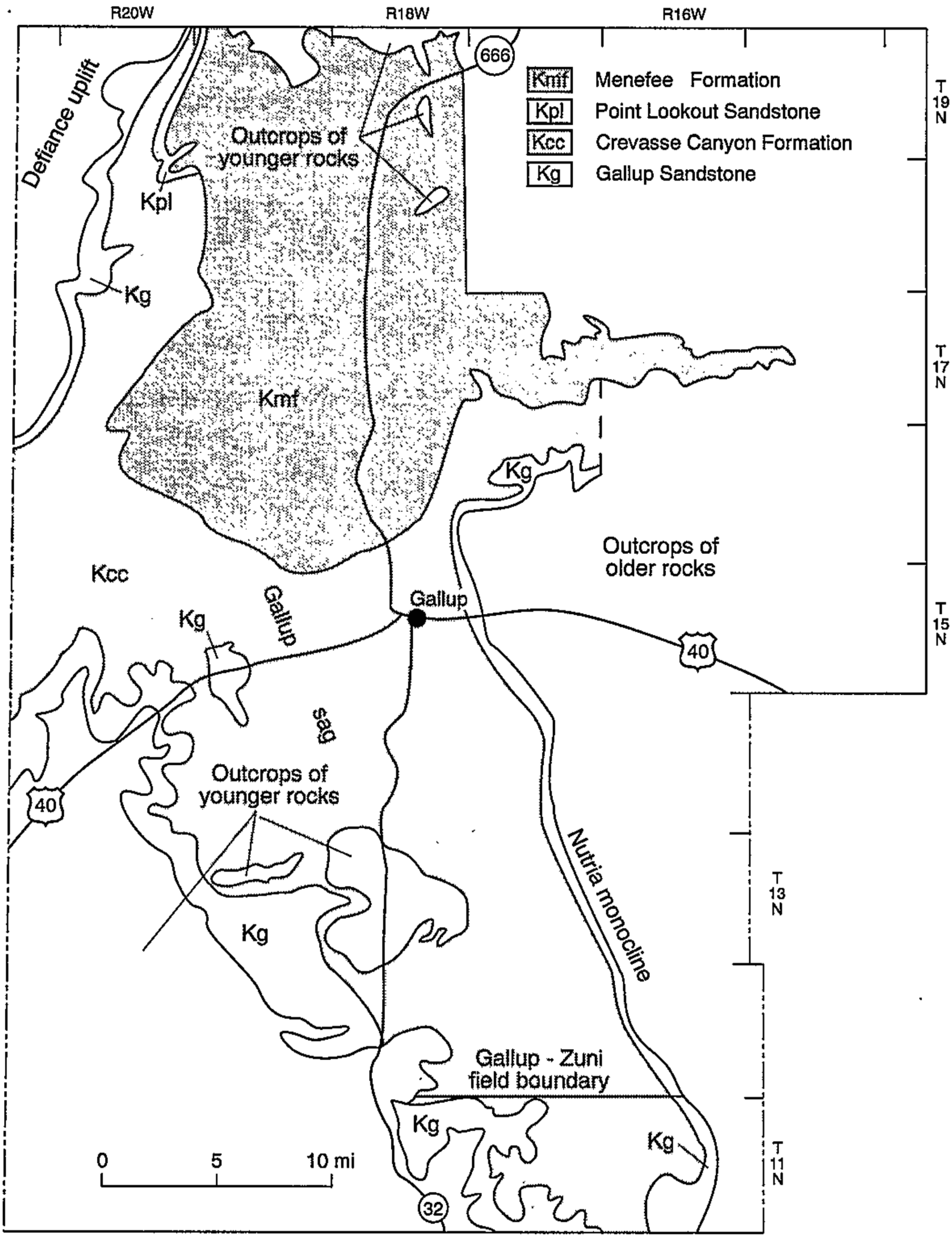


Figure 17. Map of Gallup field, Crevasse Canyon and Menefee Formation, Modified from Shomaker, Beaumont, and Kottlowski, 1971.

All Crevasse Canyon DRB are within the 20–22.99 MMBtu/ton and 5.01–10% ash categories, but are split into three sulfur/MMBtu categories. The division by sulfur content (lbs sulfur/MMBtu) is:

0.41–0.60	T17N, T16N
0.61–0.83	T15N, T14N, T13N
0.84–1.24	T12N

The Gallup Sandstone is exposed in the southern part of the field and west of the town of Gallup. The number of data points for this unit is very limited, and only one data point has coal of a qualifying bed thickness in the subbituminous rank categories. The original surface resources are 1.44 million st, and these are depleted by mine loss and production by 0.29 million st. The remaining DRB of 1.15 million st is in the 0.61–0.83 lbs of sulfur/MMBtu, 20–22.99 MMBtu/ton, and 10.01–15% ash categories (Table 7).

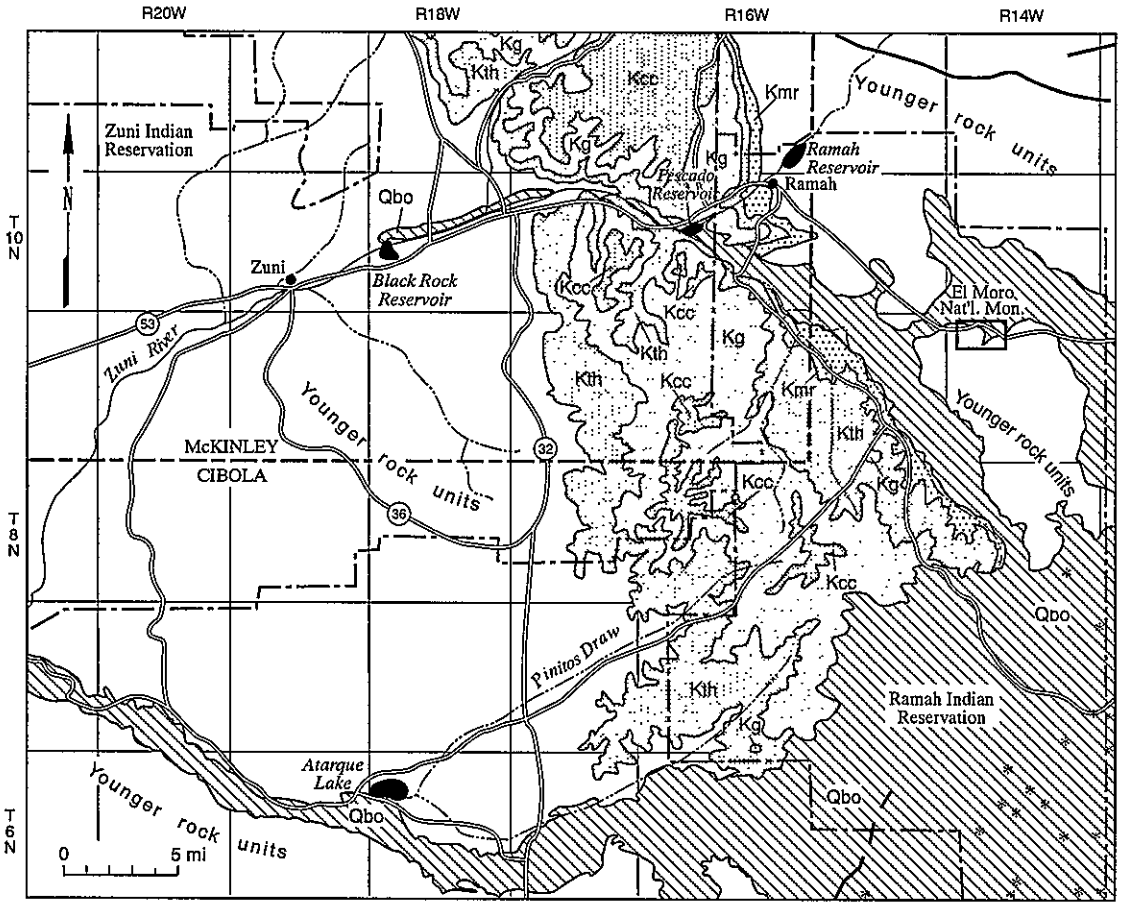
Structural features within and along the borders of the Gallup field make mining difficult. The Nutria and Defiance uplifts (Fig. 3) create steep dips along the east and west boundaries that can be deterrents to mining. The Gallup sag in the middle of the field has influenced the depth of the coal beds, and in fact most of this area has been mined by underground methods.

Significant underground mining near Gallup has resulted in a large area in T15N R18W and the southern third of T16N R18W that has old workings. The town of Gallup, in T15N R18W, has residential and commercial development on top of some these old mine workings. Most of the private land in the coal field is either immediately north or south of the town of Gallup. Interstate 40 and the Atchison, Topeka, and Santa Fe Railroad go through the town of Gallup and transect the coal field. Highway 666 goes north from Gallup and highway 32 heads south. Highway 264 crosses exposures of the Gibson-Cleary in the northwest Gallup field. This part of the field, including the northern part of the McKinley coal mine is on the Navajo Indian Reservation. The southeast Gallup field is on Zuni Indian Reservation land. Much of the field on the Zuni 1:100,000 quadrangle is on checkerboard ownership: private, Indian, and federal. The largest owner of land in the Gallup field is the Navajo Nation and individual Navajos. Accessible percentages are 93% and 99% for the surface and underground resources, respectively for the Gallup field. The Gallup area is grouped with the Crownpoint and Zuni fields in McKinley County for accessible and recoverable reserves (Table 5).

Zuni field— At the southern end of the Gallup sag (Fig. 3) the Dilco Coal Member of the Crevasse Canyon Formation and Gallup Sandstone coal-bearing sequences extend south into the Zuni field (Fig. 18). This field has exposures of the Tres Hermanos Formation (Fig. 2a) include some coal-bearing sequences, but the coal resources for this unit are not calculated. The Zuni field is in McKinley and Cibola counties on the Zuni and Fence Lake 1:100,000 quadrangles (Fig. 1). The data points for the subbituminous Dilco Coal Member resources are sparse:

Total data points 8: 50% 20–200 ft
50% 200–500 ft

Resources for this field are depleted by 0.02 million st from the Crevasse Canyon Formation and 0.01 million st from the Gallup Sandstone. Both of these production and mine loss figures come from mining within 200 ft of the surface from coals 2.5 to 5 ft thick.



Qbo - North Plains lava flow
Kcc - Crevasse Canyon
Kg - Gallup Sandstone
Kth - Tres Hermanos Formation
Kmr - Rio Salado Tongue of Mancos Shale
* - Volcanic vent

Figure 18. Map of Zuni coal area. Modified from Anderson and Jones, 1994.

Remaining surface DRB is 23.34 million st and 35.91 million st for the Crevasse Canyon Formation and Gallup Sandstone, respectively. Remaining underground DRB is 30.61 million st, Crevasse Canyon Formation and 11.28 million st, Gallup Sandstone. Total DRB for the Zuni field is in the 0.84–1.24 lbs sulfur/MMBtu, the 20–22.99 MMBtu/ton categories. Crevasse Canyon coals in the Zuni field have greater than 15% ash content, but the Gallup Sandstone coals in this field are in the 10.01–15% ash category (Table 7).

Most of the Zuni field is on the Zuni and Ramah Indian Reservations. Highways 32 and 53 cross the field. This area is sparsely populated and dominated by mesa capped by thick sandstones, canyons, and dissected by intermittent streams. Accessible and recoverable reserves for the Zuni field are listed in Table 7 under McKinley and Cibola counties. The Cibola County figure includes the Mount Taylor fields.

Crownpoint field— This is the largest coal field (930 mi^2) in the SJB, encompassing the Crevasse Canyon Formation exposures from northeast of the Gallup field to the western edge of the San Mateo field. The Zuni uplift (Fig. 3) controls the southern outcrops of the Crownpoint field, and faulting is widespread along the southeast border (Fig. 19). The coal-bearing Gallup Sandstone and the Dilco Coal and Gibson Coal Members of the Crevasse Canyon Formation are exposed in this field. No economic coal is known within the Gallup Sandstone in this area and the Dilco coal beds are thin and lenticular (Sears, 1936; Dillinger, 1990). The Gibson Coal Member contains the only coal considered economic in the Crownpoint field.

The Crownpoint subbituminous coal area is in McKinley County on the Gallup, Chaco

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fig 19-Crownpoint
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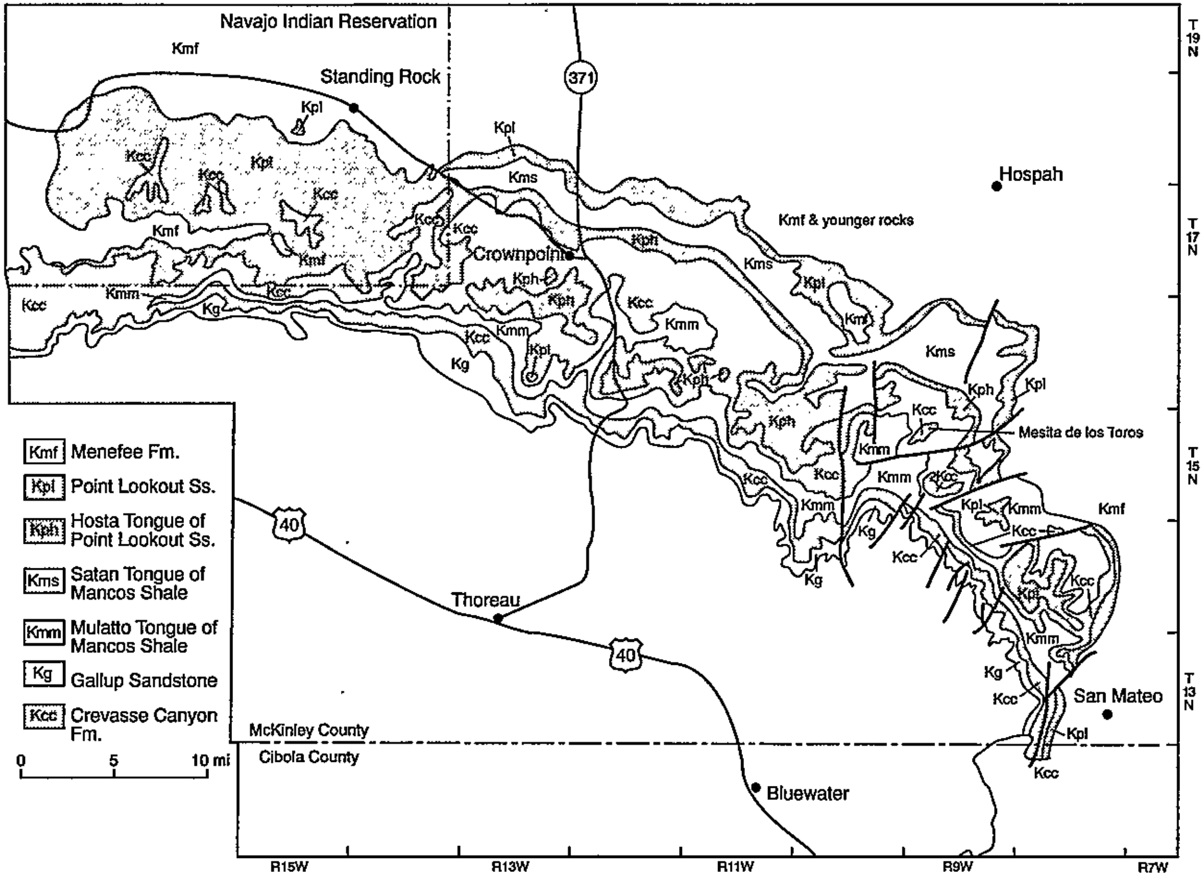

Figure 19. Map of Crownpoint field, Crevasse Canyon Formation. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Mesa, and Grants 1:100,000 quadrangles (Fig. 1). Resources were calculated using the following data distribution:

	Depth Category
Total points, Crevasse Canyon–313:	66% 20–200 ft
	25% 200–500 ft
	9% 500–1000 ft
Total points, Gallup Sandstone–10:	30% 20–200 ft
	70% 500–1000 ft

Crevasse Canyon DRB in the Crownpoint field is depleted by 0.11 million st from mining within 200 ft of the surface from coals 2.5–5.0 ft thick. Remaining surface resources (million st) are:

Formation	**Total DRB**	**Gibson**	**Dilco**
Crevasse Canyon	662.51	647.30	15.21
Gallup Sandstone	29.16		
Total	*691.66*		

Remaining underground resources (million st) are:

Formation	**Total DRB**	**Gibson**	**Dilco**
Crevasse Canyon	429.78	317.01	112.77
Gallup Sandstone	1.20		
Total	*430.98*		

A few data points for underground Crevasse Canyon coal resources are east of the Crownpoint field, within the San Mateo area. These data total 27.8 million st of underground coal resources.

The Crevasse Canyon resources in the Crownpoint field and underground coal in the

San Mateo area and the Gallup Sandstone are in the 1.25–1.67 lbs of sulfur/MMBtu, and 10.01–15 % ash categories. The Crevasse Canyon DRB is categorized as 15–19.99 MMBtu/ton and the Gallup Sandstone DRB in this field is in the 20–22.99 MMBtu/ton classification (Table 7).

The Gibson coals beds are lenticular, and in most parts of the field they are overlain by thick, massive Hosta Sandstone in the mesa-and-canyon terrain on the southwestern rim of the San Juan Basin (Fig. 19, Kph). The western Crownpoint field is on the Navajo Indian Reservation, and much of the land outside the reservation is Navajo ownership. The village of Crownpoint is within the surface resource area and several highways (Fig. 19) converge at this population center. Two small oil fields are within the underground resource area of this field, subtracting 800 acres from the total area. Accessible reserves for this field are 96% and 99% of the surface and underground DRB (Table 5).

East and South Mount Taylor fields—These small fields are delineated by exposures of Crevasse Canyon Formation along the south and east edges of the Mount Taylor volcanic complex and Mesa Chivato (Fig. 20, 21). The South and East Mount Taylor coal fields were first mapped in detail by Hunt (1936). In most places, the thick intrusive and extrusive volcanic rocks associated with Mount Taylor overlie the Gibson coal and prevent surface mining except in small areas in the southwest South Mount Taylor field at Guadalupe and Rinconada Canyons (T11N R8W) where the coal beds range from 2.5 to 5 ft thick (Dillinger, 1989). Beneath the volcanics, the Crevasse Canyon beds are probably influenced by the broad north-plunging McCartys syncline (Hunt, 1938). The Crevasse Canyon

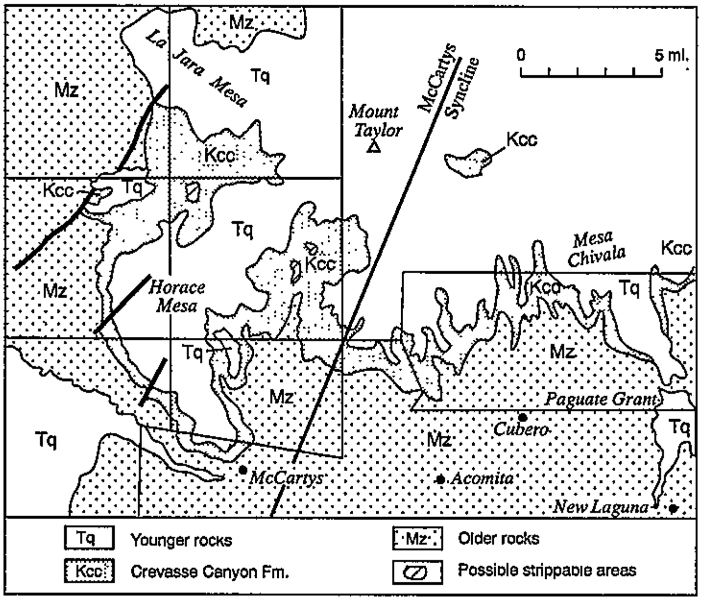

Figure 20. Map of South Mount Taylor, Crevasse Canyon area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

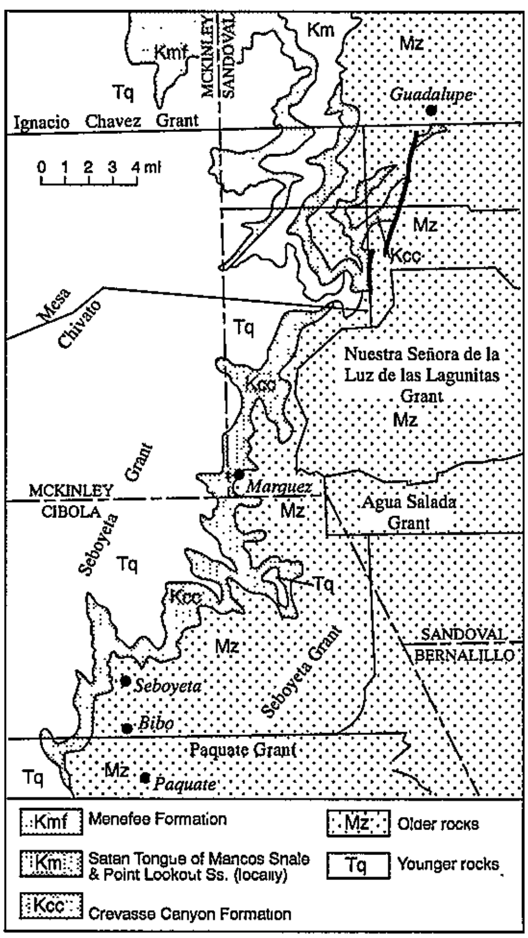

Figure 21. Map of East Mount Taylor, Crevasse Canyon area. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

Formation intertongues northeastward with marine strata and thus contains essentially no coal seams in the East Mount Taylor field. The East and South Mount Taylor fields are in Cibola County and East Mount Taylor extends into Sandoval County. No resource data are available in Sandoval County and data in Cibola County are sparse. Both these fields are on the Grants 1:100,000 quadrangle (Fig. 1). Only one data point is available for the East Mount Taylor field for coals greater than or equal to 2.5 ft thick.

South Mount Taylor field:	**Depth Category**
Total data points 8:	88% 20–200 ft
	12% 200–500 ft

The original resources are depleted by 0.02 million st in the South Mount Taylor field, (2.5–5 ft thick, 20–200 ft thick), the remaining surface DRB is 13.92 million st. There are no surface resources calculated for the East Mount Taylor field. Underground DRB is 3.25 million st and 2.55 million st for the South and East Mount Taylor fields, respectively. The DRB in these fields are in the 0.41–0.60 lbs of sulfur/MMBtu, 20–22.99 MMBtu/ton, and 10.01–15 % ash content (Table 7).

Lakes and reservoirs are within the Mount Taylor Dilco and Gibson coal resource areas on the Grants quadrangle (Fig. 1). Powerlines and one major highway cross this field. Underground coal resources are covered by hundreds of feet of basalt flows and volcanic rock associated with the Mount Taylor volcanic complex. The Mount Taylor fields are grouped with the Zuni field in the Crevasse Canyon accessible and recoverable reserves for Cibola County (Table 7).

Rio Puerco field—This field is an irregular outcrop belt of Mesaverde Group coal-bearing rocks in the Rio Puerco valley, an outlier of the SJB, about 15 mi southeast of the East Mount Taylor field, extending from T8N to T14N, in R1E-R3W (Fig. 22). The Dilco Coal and Gibson Coal Members of the Crevasse Canyon Formation are present in the Rio Puerco field, but the Dilco coal beds are too thin to mine. Gibson coal beds average 3.8 ft thick, although seams up to 5.6 ft have been mined for local use in the northern part of the field (Hunt, 1936). This field is within the Rio Puerco fault zone (Fig. 3), a N–NE–trending swarm of normal, en echelon faults (Slack and Campbell, 1976), thus the coal–bearing outcrops are in narrow, steeply–dipping fault blocks, and in no place do the coal beds appear favorable for surface mining, although the eastern part of the field is covered by sand that masks the underlying bedrock. Most of the Rio Puerco field is in Bernalillo County on the Grants 1:100,000 quadrangle (Fig. 1). Very few data points are available for this field; a total data points of seven, all in the 20–200-ft depth category.

Resources for the Rio Puerco field are depleted from previous mining and mine loss by 0.06 million st, therefore remaining surface DRB for this field is 24.70 million st. These resources are in the 0.84–1.24 lbs of sulfur/MBtu, 15–19.99 MMBtu/ton and 5.01–10% ash categories (Table 7). The Rio Puerco field is within the Laguna and Canoncito Indian Reservations. Accessible and recoverable reserves for this field are listed in Table 7 under Bernalillo County.

Recommendations

The ash content of the SJB coals is relatively high, and therefore influences the weight

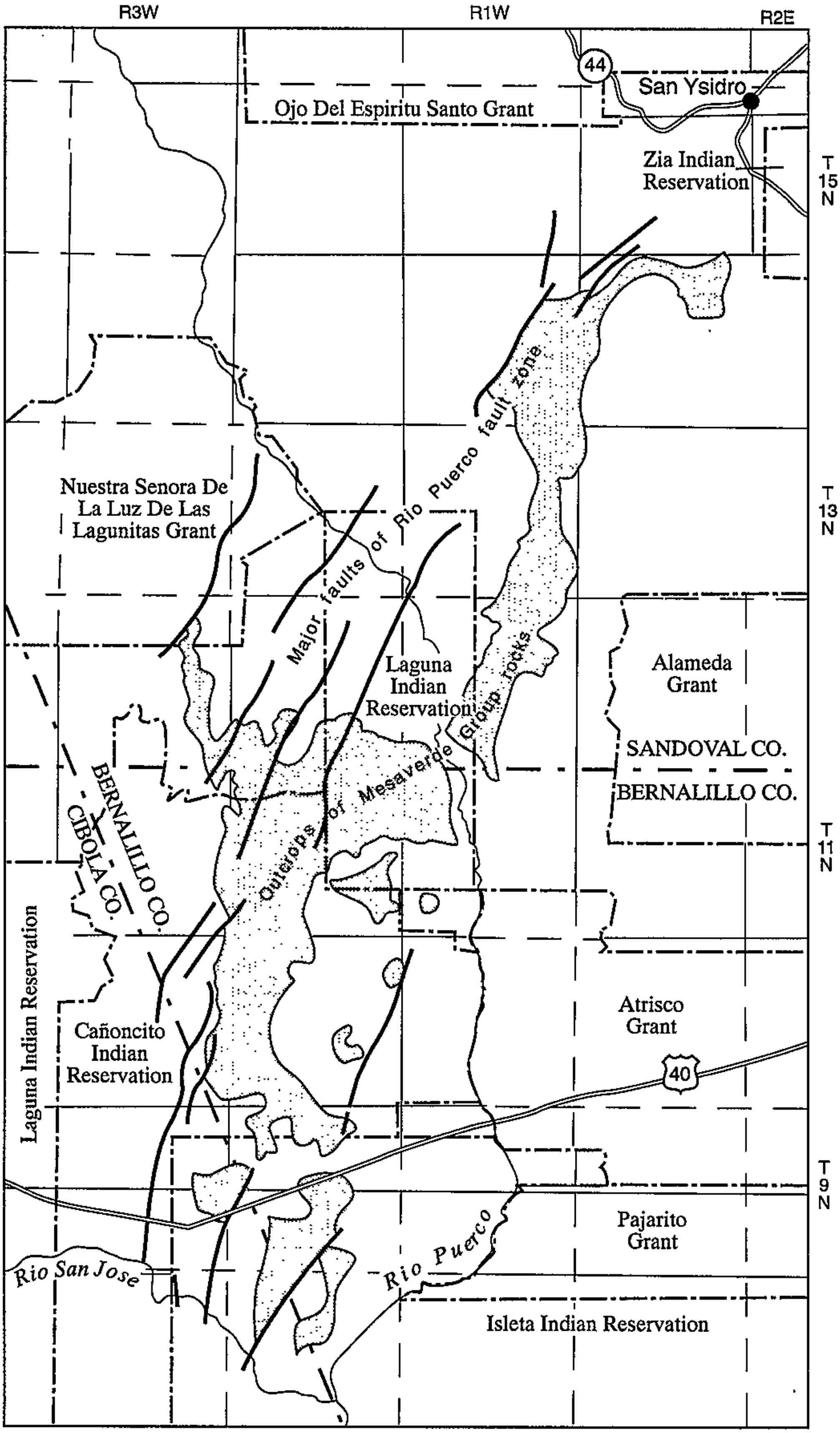

Figure 22. Map of Rio Puerco field, Mesaverde Group. Modified from Shomaker, Beaumont, and Kottlowski, 1971.

of the coals for resource calculations. As stated, this study used the USGS guidelines for subbituminous and bituminous coals using 1770 and 1800 tons/acre ft, respectively. If more quality data for all the coal areas were available, different numbers could have been used to calculated the demonstrated resources. If a 1.23 g/cm^3 is used for pure coal (Levine, 1993) and 2.5 g/cm^3 is used for the ash, based on the high percentage of the ash being SiO_2, a graph of the tons/acre ft vs percent ash (Fig. 23) illustrates the difference higher ash can make in calculating resource tonnages. For example, the Fruitland Formation coals have greater than 15% ash, increasing the tons/acre ft to greater than 1920. The Menefee and Crevasse Canyon coals fall into the two categories of 5–10% ash and 10.01–15% ash. The first category ranges from 1760 to 1850 tons/acre ft and the second 1850 to 1920 tons/acre ft. These factors would make quite a difference in the resource tonnage. As an example the Fruitland Formation, Fruitland field is bituminous with greater than 15% ash content, on average. If the high ash values are factored into the resource estimate, using 1920 ton/acre ft, the resources would be 6% greater than those calculated at 1800 tons/acre ft. This percentage becomes 8% with the subbituminous Fruitland coals with greater than 15% ash. The ash factor is an important consideration when looking at these high-ash coals and is an area of the DRB that needs more work.

This study included a preliminary assessment of the accessibility in the SJB using the criteria in USGS Circular 1055 (Eggleston, Carter, and Cobb, 1990). Because the data was not in a Graphic Information System (GIS), such as GRASS or ARCINFO, determining inaccessible areas was tedious. The basic parameters, major roads, oil and gas well areas, abandoned mine areas, pipelines, powerlines, parks, and centers of population were

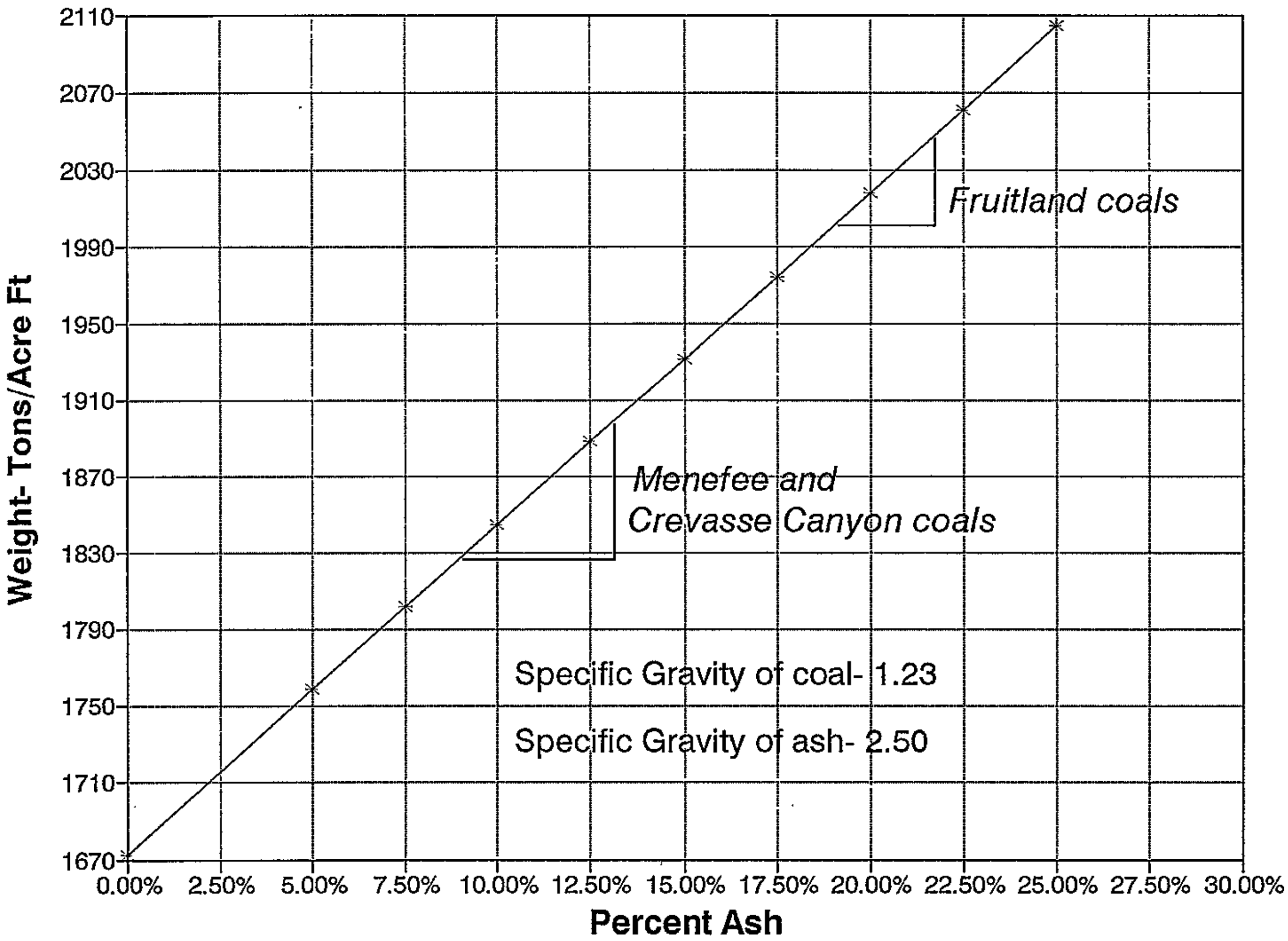

Figure 23. Ash vs density in tons/acre ft.

considered within the coal areas. With the implementation of a GIS all the data could be compared and more accurate accessibility numbers could be obtained. Although some technological restrictions were discussed in the text (i.e. thick sandstone overburden, steep dips) no quantitative assessment of these restrictions were included in the calculation of the accessible DRB.

Sources

Appendix A is a listing of sources for the point source data used to determine resources for this DRB. These data were collected as part of a cooperative project with USGS for the NCRDS that has been ongoing at the NMBMMR for the past fourteen years and is the basis for the NMBMMR resource data base. Many of these point source data are confidential and can only be presented as a composite, therefore individual seam thicknesses and point source locations are not given in Appendix A. Mine data for historic mine production was obtained from Nickelson (1988) and from Territorial and State Mine Inspector reports (1897–1979) and NMEMNRD Annual Reports (Anderson et al., 1977, Martinez, 1979-1980, Hatton, 1981-1995). DOE mine production data was used to fill in gaps and as a comparison to the production figures reported to the State agencies.

Appendix B lists the weighted average analyses by field, township, and range. Many of these data were collected as part of the cooperative NCRDS grant with the USGS and many were acquired through coal studies at the NMBMMR. A major source of quality and thickness data are from a NMBMMR study funded in part by the New Mexico Research and Development Institute. All the data from this study are available in NMBMMR Open–file

Report 377 (Hoffman, 1991). Many of the data from other sources are confidential and can only be presented in a composite form, such as that shown in Appendix B.

Acknowledgements

The author thanks Frank E. Kottlowski and Edward C. Beaumont for their participation in this study and review of this open-file text. Their help during all stages of this project and reviews of the work in progress made a significant difference in the final product. The technical reviews of Heinz Damberger at the Illinois Geological Survey and William Kaiser at the Texas Bureau of Economic Geology on quarterly reports preceding this summary were very beneficial. The author thanks Richard Bonskowski for his help and guidance throughout this project.

Glossary

accessibility-See accessible reserves

accessible reserves—That part of the demonstrated reserve base that can be accessed, excluding areas that are restricted by manmade or natural obstructions or environmental and other legal restrictions (EIA, February 1993).

demonstrated reserve base (DRB)—A collective term for the sum of coal in both measured and indicated resource categories of reliability. The DRB represent 100 percent of coal in place as of a certain date. Includes beds of bituminous coal and anthracite 28 inches or more thick and beds of subbituminous coal 60 inches or more thick that can be surfaced mined. Includes also thinner and/or deeper beds that presently are being mined or for which there is evidence that they could be mined commercially at this time. The DRB represents that portion of the in-place identified resources of coal from which reserves are calculated (EIA, February 1993).

depletion—The subtraction of both the tonnage produced and the tonnage lost to mining from the demonstrated reserve base and identified resources to determine the remaining tonnage as of a certain time. Term defined by EIA for use in coal resource and reserve reports (EIA, February 1993).

depletion factor—The multiplier of the tonnage produced that takes into account both the tonnage recovered and the tonnage lost due to mining. The depletion factor is the reciprocal of the **recovery factor** in relation to a given quantity of production. Term defined by EIA for use in coal resource and reserve reports (EIA, February 1993).

estimate—A determination as to the amount or tonnage of coal in an area. The term estimate indicates that the quantities of resources are known imprecisely. An estimate differs from an assessment, which is an analysis of all data concerning an area's coal resources and reserves with the objective of reaching a judgment about the geologic nature and economic potential of the coal resources and reserves of the area. (Wood et al., 1983)

indicated resources—Coal for which estimates of the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections. Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. Indicated coal is projected to extend as a 0.5-mile wide belt that lies more than 0.25 miles from the outcrop or points of observation or measurement (EIA, February 1993).

measured resources—Coal for which estimates of the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections. Measured resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. Measured coal is projected to extend as a 0.25-mile wide belt from the outcrop or points of observation or measurement (EIA, February 1993).

original resources—The amount of coal in-place before production. Where mining has occurred, the total of *original resources* is the sum of the identified resources, undiscovered resources, coal produced, and coal lost-in-mining (Wood et al., 1983).

quality or grade—Refers to individual measurements such as heat value, fixed carbon, moisture, ash, sulfur, phosphorous, major, minor, and trace elements, coking properties, petrologic properties, and particular organic constituents. The individual quality elements may be aggregated in various ways to classify coal for such special purposes as metallurgical, gas, petrochemical, and blending usages (EIA, February 1993).

rank—The classification of coal relative to other coals, according to their degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (Standard Classification of Coal by Rank, 1992 draft) American Society for Testing Materials, ASTM Designation D-388-91a (EIA, February 1993).

recoverability—That part of the reserve that can be recovered by present mining methods. See recovery factor, reserves

recovery factor—The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the demonstrated reserve base. For the purpose of calculating depletion factors only, the estimated recovery factors for the demonstrated reserve base, generally are 50% for underground mining methods and 80% for surface mining methods. More precise recovery factors can be computed by determining the total coal in place and the total recoverable in any specific locale (EIA, February 1993).

reserves—That portion of demonstrated resources that can be recovered economically with the application of extraction technology available currently or in the foreseeable future. Reserves include only recoverable coal; thus terms such as "minable reserves," "recoverable reserves," or "economic reserves" is redundant. Although "**recoverable reserves**" is considered redundant and implies recoverability in both words, the EIA prefers to use the term selectively, in contexts where it is essential to distinguish recoverable from in-ground resources (EIA, February 1993) .

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APPENDIX A

Data Sources for CRDB-Fruitland Formation

FRUITLAND Bituminous Field Source	FRUITLAND longitude	Formation latitude		SAN JUAN Total Coal No. of Seams	County Max Depth
BLM PROJECT-LA PLATA #2	1081258	365747	Max	125	510
	1081223	365657	Min	24	
BLM PROJECT-SAN JUAN BYPASS	1082426	364543	Max	32	390
	1082348	364542	Min	6	
CROCDP	1082440	365854	Max	244	933
	1080821	364436	Min	33	
HAYES AND ZAPP	1082657	364803	Max	19.7	104.2
	1082654	364730	Min	2	
LA PLATA MINE PLAN	1081127	370000	Max	798.84	701.5
	1080637	365834	Min	86	
NMBM Circular 134	1082352	365220	Max	220.9	988
	1081702	365057	Min	35	
NMRDI	1082456	365943	Max	266	407.15
	1080714	364605	Min	31	
USGS	1081255	365733	Max	99.1	763
	1081223	365619	Min	21	
USGS BULL 1938, Albert C. Bruce	1081932	365054	Max	8	828
	1081932	365054	Min	1	
USGS Bulletin 1938 - 3 states Natural Gas	1082125	365209	Max	41	388
	1082053	365209	Min	6	
USGS Bulletin 1938 - Humble Oil	1082115	365137	Max	16	520
	1082115	365137	Min	3	
USGS Bulletin 1938 - Jerome P. McHugh	1082004	365053	Max	10	719
	1082004	365053	Min	2	
USGS OF 78-960	1082327	364843	Max	578.11	762
	1082147	364602	Min	49	
WESTERN COAL	1082531	365101	Max	72.3	274
	1082307	364720	Min	14	
WESTERN COAL CO. SJM	1082540	365159	Max	684.6	441.2
	1082326	364602	Min	76	
NAVAJO Field	**FRUITLAND**	**Formation**		**SAN JUAN**	**County**
CONPASO BURNHAM MINE	1083113	362220	Max	219.2	228.4
	1082644	361949	Min	39	
CONSOLIDATION COAL	1083131	362213	Max	330.7	317.7
	1081629	361627	Min	66	

Source	longitude	latitude		Total Coal No.	Max Depth of Seams
CROCDP	1082401	364328	Max	45	463
	1081844	364108	Min	8	
DEPT INTERIOR FES 77-03	1082000	361708	Max	9	14.6
	1081652	361540	Min	3	
DEPT.INTERIOR FES 77-03	1082437	361856	Max	459.7	255.3
	1081630	361529	Min	87	
EL PASO COAL	1082453	361855	Max	534.6	282.5
	1081617	361530	Min	73	
HAYES AND ZAPP	1082407	364453	Max	15.9	51
	1082401	364436	Min	3	
PROSPECT	1081550	361621	Max	7.3	5.5
	1081550	361621	Min	1	
USGS MF 1076	1082956	362132	Max	25.2	6.9
	1082348	361549	Min	8	
USGS MF 1080	1082938	363029	Max	3.6	1
	1082938	363029	Min	1	
USGS MF-1080	1082901	363017	Max	3.8	1.2
	1082901	363017	Min	1	
USGS MF-1089	1082430	364437	Max	12.4	6.6
	1082407	364350	Min	4	
UTAH INTERNATIONAL	1083300	363736	Max	629.24	251.4
	1082851	362339	Min	116	

BISTI Field FRUITLAND Formation SAN JUAN County

ALAMITO COAL-GALLO WASH	1074817	360619	Max	638.2	324.5
	1074400	360141	Min	117	
ARCO COAL	1074511	360242	Max	8.6	93.2
	1074511	360242	Min	2	
BLM	1080437	361244	Max	140.05	401.6
	1074544	360556	Min	21	
CIRC 155 AND PROF PAPER 676	1075338	360927	Max	29	352
	1075338	360927	Min	3	
CROCDP	1080822	362626	Max	75	489
	1074407	360447	Min	13	
DENAZIN MINE PLAN	1081243	361418	Max	7	103.4
	1081243	361418	Min	1	
GATEWAY MINE PLAN	1081521	361641	Max	120.5	184.8
	1081421	361556	Min	21	

Source	longitude	latitude		Total Coal No.	Max Depth of Seams
MF 1074	1080927	361535	Max	48.4	346.2
	1080927	361535	Min	4	
MF 1117	1075910	361008	Max	345	348.8
	1075231	360756	Min	31	
MF 1118	1075028	360827	Max	23.3	235.2
	1075028	360827	Min	4	
MF 1120	1074643	360635	Max	16	435.9
	1074643	360635	Min	3	
NICKELSON	1081124	361142	Max	3	47
	1081124	361142	Min	1	
NMBM MEM 25	1080551	361212	Max	69	317
	1080152	361204	Min	5	
NMBM OIL & GAS LIBRARY	1081312	362200	Max	94	981
	1080731	361727	Min	12	
NMRDI	1081155	361545	Max	327.95	415.4
	1074427	360544	Min	37	
USGS OF 77-369	1081423	361510	Max	335.1	221
	1080800	361139	Min	58	
USGS OF 80-1289	1081607	361728	Max	568.72	363.8
	1080731	361302	Min	123	
WESTERN COAL BISTI	1081545	361636	Max	6.5	19
PROJECT	1081516	361618	Min	2	
WESTERN COAL-BISTI	1081609	361636	Max	135	252.3
PROJECT	1081028	361415	Min	20	
STAR LAKE Field	**FRUITLAND**	**Formation**		**MCKINLEY**	**County**
ARCO COAL	1073325	355823	Max	33	167
	1073325	355823	Min	1	
BLM PROJECT-STAR LAKE	1072440	355513	Max	54	240
EAST	1072052	355435	Min	10	
BLM PROJECT-STAR LAKE	1073205	355856	Max	123.5	373.5
WEST	1073028	355805	Min	8	
CHACO COAL CO.	1073329	355805	Max	25.4	132.4
	1073101	355716	Min	3	
CHACO ENERGY CO.	1073256	355754	Max	488	299.6
	1072526	355401	Min	72	
CROCDP	1073950	355957	Max	37.2	316
	1073745	355846	Min	8	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
MF 1220	1073201	355906	Max	22.3	20.2
	1073201	355906	Min	1	
MF 1248	1072452	355443	Max	85.5	158.7
	1072243	355353	Min	6	
MF 1249	1072125	355449	Max	34.8	77.2
	1072047	355445	Min	2	
NMRDI	1073615	355902	Max	134.15	403.05
	1071929	355454	Min	18	
PEABODY COAL	1073919	355952	Max	45.3	146
	1073708	355852	Min	8	
STAR LAKE MINE PLAN	1073311	355822	Max	663.15	264.9
	1072455	355341	Min	130	
USGS	1072430	355530	Max	6.5	260
	1072430	355530	Min	2	
USGS OF 77-369	1072738	361020	Max	31.6	501
	1072142	355543	Min	4	
USGS TRACT DELINEATION	1072800	355705	Max	53.5	314
	1072119	355445	Min	9	

STAR LAKE Field FRUITLAND Formation SAN JUAN County

ALAMITO COAL-GALLO WASH	1074345	360229	Max	326.5	286
	1074058	360138	Min	40	
ARCO COAL	1074617	360310	Max	128.4	228
	1073815	360014	Min	12	
BLM PROJECT-GALLO WASH	1074001	360215	Max	42	330
	1073822	360147	Min	4	
CROCDP	1074400	361409	Max	449.3	984
	1073755	360024	Min	57	
GALLO WASH MINE PLAN	1074315	360206	Max	19.2	146.2
	1074315	360206	Min	4	
MF 1124	1074314	360637	Max	65.7	720
	1073805	360221	Min	5	
NMBM MEM 25	1073930	360104	Max	19.3	55.5
	1073930	360104	Min	2	
NMRDI	1074337	360349	Max	89.7	345.6
	1073830	360043	Min	8	
PEABODY COAL	1074147	360658	Max	67.3	192
	1073910	360053	Min	12	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
STAR LAKE MINE PLAN	1071119	355409	Max	3.5	50
	1071119	355409	Min	1	
STAR LAKE Field	**FRUITLAND**	**Formation**		**SANDOVAL**	**County**
ARCO COAL	1073624	355939	Max	43.1	179
	1073152	355822	Min	4	
BLM DEAD FILES	1071733	355410	Max	41.7	112.6
	1071015	355317	Min	11	
CROCDP	1073552	360723	Max	51.4	988
	1073200	360010	Min	7	
CROCDP #14	1072152	355959	Max	3	661.5
	1072152	355959	Min	1	
NMRDI	1073518	360020	Max	41.45	354.05
	1070834	355359	Min	6	

Data Sources for CRDB-Menefee Formation

BARKER Field MENEFEE Formation SAN JUAN County
Bituminous

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
HAYES AND ZAPP	1082900	365948	Max	210.9	330
	1081559	365330	Min	24	
NMBM CIRC 134	1082137	365213	Max	69.4	534
	1082037	365127	Min	11	
NMBM OIL & GAS LIBRARY	1083843	365726	Max	102.5	930
	1081627	365250	Min	12	

HOGBACK Field MENEFEE Formation SAN JUAN County
Bituminous

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
CROCDP	1082957	365052	Max	59.3	916
	1082603	364752	Min	15	
HAYES AND ZAPP	1082903	364823	Max	22.1	52
	1082831	364540	Min	2	

NEWCOMB Field MENEFEE Formation SAN JUAN County

NMBM MEM 25	1083743	362105	Max	54	292
	1083528	361506	Min	11	
NMBM OIL & GAS LIBRARY	1081625	360533	Max	18	522
	1081612	360428	Min	5	

CHACO CANYON Field MENEFEE Formation MCKINLEY County

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
NMBM OIL & GAS LIBRARY	1080313	355954	Max	52	888.5
	1074725	354625	Min	16	
SINCLAIR OIL AND GAS	1075229	355046	Max	3	918
NO. 1 SANTA FE-84	1075229	355046	Min	1	
TIDEWATER OIL SANTA FE	1074834	354704	Max	7	785
- PACIFIC RR-E	1074834	354704	Min	2	
USBM TECH 569	1075759	355754	Max	3.7	5.2
	1075759	355754	Min	1	
USGS BULL 860C	1074748	355733	Max	9	19.5
	1074748	355733	Min	3	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
W. E. THOMPSON	1075040	354938	Max	3	898
GONSALES NO. 1	1075040	354938	Min	1	
CHACO CANYON Field	**MENEFEE**	**Formation**		**SAN JUAN**	**County**
CROCDP	1075207	360700	Max	21.5	836.5
	1074806	360130	Min	7	
NMBM CIRC 154	1074847	360203	Max	10	236
	1074847	360203	Min	3	
USGS OF 80-184	1080314	360447	Max	10.8	294.8
	1080026	360218	Min	3	
CHACRA MESA Field	**MENEFEE**	**Formation**		**MCKINLEY**	**County**
CROCDP	1074311	355401	Max	30.50	904
	1072805	354323	Min	10.00	
NMBM OIL & GAS LIBRARY	1074444	355206	Max	190.00	975
	1071841	353917	Min	52.00	
NMBMMR	1073940	354247	Max	4.00	595
	1073940	354247	Min	1.00	
NMRDI	1071833	354529	Max	2.65	187.85
	1071833	354529	Min	1.00	
S. FELDMAN'S URANIUM	1074021	354804	Max	4.00	234
LOG REPORT	1074021	354804	Min	1.00	
USGS BULL 860C	1074244	355338	Max	13.00	34.6
	1072435	354538	Min	4.00	
CHACRA MESA Field	**MENEFEE**	**Formation**		**SAN JUAN**	**County**
CROCDP	1074122	360302	Max	36.00	1000
	1074037	360208	Min	10.00	
CHACRA MESA Field	**MENEFEE**	**Formation**		**SANDOVAL**	**County**
DANE 1936, PL. 53 NO.	1071651	354628	Max	2.70	2.6
57	1071651	354628	Min	1.00	
NMBM OF 102	1071522	354837	Max	51.40	223.9
	1070704	354128	Min	13.00	
NMBM OIL & GAS LIBRARY	1072121	355243	Max	115.30	998.5
	1070628	354408	Min	33.00	
NMRDI	1071645	354934	Max	123.00	447.1
	1070651	354155	Min	33.00	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
USGS BULL 860C	1070613	354653	Max	3.00	132.7
	1070613	354653	Min	1.00	

LA VENTANA Field Bituminous	**MENEFEE**	**Formation**		**SANDOVAL**	**County**
BLM PROJECT-SAN LUIS MESA	1070525	354414	Max	66.50	291
	1070145	354117	Min	17.00	
BLM TRACT DELINEATION	1070407	354403	Max	40.50	136
	1070149	354230	Min	9.00	
NMBM OF 102	1071140	354052	Max	9.00	221.3
	1071021	353952	Min	2.00	
NMBM OIL & GAS LIBRARY	1071032	354403	Max	20.00	845
	1071032	354401	Min	5.00	
NMRDI	1071052	354315	Max	40.60	509.4
	1070322	354058	Min	10.00	

LA VENTANA Field	**MENEFEE**	**Formation**		**SANDOVAL**	**County**
BLM PROJECT-SAN LUIS MESA	1070214	354551	Max	14.00	313
	1070016	354434	Min	4.00	
BLM TRACT DELINEATION	1070106	354503	Max	7.00	46
	1070036	354444	Min	2.00	
DANE 1936 PL. 55, NO. 121, USGS BULL 860-C	1070110	354427	Max	5.50	27.8
	1070110	354427	Min	2.00	
DANE 1936 PL. 55, NO. 124	1070036	354437	Max	3.90	16.5
	1070036	354437	Min	1.00	
DANE 1936, PL. 54 NO. 113	1070122	354757	Max	3.90	16.3
	1070122	354757	Min	1.00	
DANE 1936, PL. 54 NO. 113, USGS BULL 860-C	1070122	354757	Max	2.50	20.5
	1070122	354757	Min	1.00	
DANE 1936, PL. 54 NO. 125, USGS BULL 860-C	1070006	354510	Max	4.60	49.7
	1070006	354510	Min	1.00	
DANE 1936, PL. 54 NO. 151	1065657	355231	Max	5.00	2.8
	1065657	355231	Min	1.00	
DANE 1936, PL. 54 NO. 158	1065445	355700	Max	9.20	10.1
	1065445	355700	Min	2.00	
DANE 1936, PL. 55 NO. 129, USGS BULL 860-C	1070015	354533	Max	2.70	58.5
	1070015	354533	Min	1.00	
DANE 1936, PL. 55 NO. 137	1070044	354821	Max	3.50	11
	1070044	354821	Min	1.00	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
DANE 1936, PL. 55 NO.	1070018	354903	Max	3.00	51.2
139, USGS BULL 860-C	1070018	354903	Min	1.00	
DANE, 1936,USGS BULL	1070529	355518	Max	23.80	489.3
860-C	1065510	354509	Min	6.00	
IDEAL BASIC MINE PLAN	1065940	355446	Max	83.40	967.2
	1065653	355324	Min	12.00	
NMBM OIL & GAS LIBRARY	1070457	355118	Max	4.00	249
	1070457	355118	Min	1.00	
NMRDI	1070435	355457	Max	54.40	349.55
	1065647	354619	Min	9.00	
SAN MATEO Field	**MENEFEE**	**Formation**		**MCKINLEY**	**County**
BLM PROJECT-LEE RANCH	1074350	353626	Max	183	219
TRACT	1072923	352947	Min	42	
CAPITOL OIL AND GAS	1072834	353602	Max	4.5	195
	1072834	353602	Min	1	
HUNT 1936 USGS BULL	1073239	353333	Max	5.7	20.3
860-B PL. 35 SEC. 145	1073239	353333	Min	1	
LEE RANCH MINE	1073937	353340	Max	105.05	291.5
	1073433	352951	Min	24	
LEE RANCH MINE PLAN	1074219	353608	Max	65.3	166
	1073825	352942	Min	10	
NMBM MEM 25	1073528	353228	Max	6	93.8
	1073528	353228	Min	2	
NMBM OF 102	1072208	353632	Max	2.5	49.5
	1072208	353632	Min	1	
NMBM OIL & GAS LIBRARY	1074204	353908	Max	131	772
	1073440	352403	Min	26	
NMRDI	1074356	353839	Max	117.6	224.6
	1072619	353012	Min	22	
S. FELDMAN'S URANIUM	1074401	353908	Max	106	720
LOG REPORT	1073320	352933	Min	26	
SANTA FE MINING	1073655	353017	Max	30.5	112.3
	1073651	352949	Min	7	
USGS	1074001	353204	Max	58.9	222.9
	1073724	352941	Min	10	
USGS-SANTA FE MINING	1074045	353433	Max	140.75	220.9
	1073416	352950	Min	22	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
SAN MATEO Field Bituminous	**MENEFEE**	**Formation**		**MCKINLEY**	**County**
NMBM OF 102	1072345	353900	Max	12.7	98.8
	1071712	353426	Min	4	
NMRDI	1072142	353900	Max	5.55	236.35
	1071945	353848	Min	2	
NORTHWESTERN RESOURCES	1072429	353909	Max	26.3	299.1
	1071912	353641	Min	9	
SAN MATEO Field Bituminous	**MENEFEE**	**Formation**		**SANDOVAL**	**County**
NMBM OF 102	1071825	353830	Max	3.5	165.5
	1071825	353830	Min	1	
MONERO Field Bituminous	**MENEFEE**	**Formation**		**RIO ARRIBA**	**County**
NMBM BULL 89	1064455	364635	Max	5	50
	1064455	364635	Min	1	
NMRDI	1065502	365450	Max	5.8	226.35
	1065021	365247	Min	2	
ROCHESTER COAL	1065617	365402	Max	13.16	120
	1064938	365341	Min	4	
STANDING ROCK Field	**MENEFEE**	**Formation**		**MCKINLEY**	**County**
BLM	1080849	355012	Max	16	425.5
	1080841	354702	Min	3	
CROCDP	1083729	354055	Max	5.5	10
	1083729	354055	Min	1	
CROWN COAL MINE PLAN	1080344	354352	Max	14.7	57.4
	1080330	354348	Min	2	
HUGHES AND HUGHES NO.	1074935	354101	Max	10	291
1 SANTA FE TRACT 13	1074935	354101	Min	3	
NMBM MEM 25	1082034	354839	Max	58.6	205
	1075059	353952	Min	12	
NMBM OIL & GAS LIBRARY	1081358	355908	Max	224.8	760
	1074431	353927	Min	39	
NMRDI	1080724	354814	Max	51.93	267.9
	1074503	353823	Min	11	
S. FELDMAN'S URANIUM	1080314	355110	Max	57	510
LOG REPORT	1074650	354030	Min	15	
SEARS 1934, PL.14,	1083427	354049	Max	4	120.2
NO.137	1083427	354049	Min	1	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
SEARS 1934, PL.17,	1082820	354204	Max	6.4	96.3
NO.272	1082820	354204	Min	2	
SEARS 1934, PL.17,	1082658	354147	Max	7.6	21.3
NO.274	1082658	354117	Min	2	
SINCLAIR OIL AND GAS	1075718	354535	Max	4	402
SANTA FE 77 SEVEN	1075718	354535	Min	1	
SOUTH HOSPAH MINE PLAN	1075417	354145	Max	225.9	410
	1074515	353839	Min	51	
USGS TRACT DELINEATION	1085906	354410	Max	57.3	115
	1075715	354157	Min	12	

Data Sources for CRDB- Crevasse Canyon Formation

CHACO CANYON Field	CREVASSE CANYON	Formation		MCKINLEY	County
Source	longitude	latitude		Total Coal No. of Seams	Max Depth
S. FELDMAN'S URANIUM	1080251	355311	Max	10	995
LOG REPORT	1080117	355231	Min	3	
MICHAEL WHYTE LOGS	1074838	360208	Max	4	948
	1074838	360208	Min	1	

CROWNPOINT Field	CREVASSE CANYON	Formation		MCKINLEY	County
ANACONDA	1083049	353929	Max	11.9	317.6
	1083049	353929	Min	1	
BLM	1080107	354027	Max	9	85
	1075848	353634	Min	3	
BLM PROJECT-DIVIDE	1075311	353554	Max	54.25	226
TRACT	1074726	353406	Min	17	
CROCDP	1083729	354055	Max	14.5	174.4
	1083729	354055	Min	2	
HUNT 1936, PL. 29, NO.	1075357	353258	Max	3.5	18.3
21	1075357	353258	Min	1	
HUNT 1936, PL. 29, NO.	1075254	353017	Max	2.6	21.1
8	1075254	353017	Min	1	
HUNT 1936, PL. 31 NO.	1074933	353213	Max	2.9	31
63	1074933	353213	Min	1	
HUNT 1936, PL. 31 NO.	1074710	353159	Max	2.8	4
71	1074710	353159	Min	1	
HUNT 1936, PL. 32 NO.	1074234	352409	Max	3.3	52
107	1074234	352409	Min	1	
HUNT 1936, PL. 32 NO.	1074318	352408	Max	3.3	52
108	1074318	352408	Min	1	
HUNT 1936, PL. 32 NO.	1074155	352407	Max	5.7	46.1
110	1074155	352407	Min	2	
HUNT 1936, PL. 32 NO.	1074151	352614	Max	5	134.3
117	1074151	352614	Min	2	
HUNT 1936, PL. 32 NO.	1074045	352623	Max	2.8	81
119	1074045	352623	Min	1	
MOBIL	1081708	354556	Max	479.2	837
	1080453	353944	Min	113	
NAVAJO TRIBE WW 15T	1075434	353333	Max	15	387
513	1075434	353333	Min	4	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
NMBM OIL & GAS LIBRARY	1081306	354037	Max	42	650
	1072804	352724	Min	12	
NMRDI	1081034	354308	Max	66.95	277.65
	1075402	353413	Min	21	
NX LAND-UNION CARBIDE	1080809	353645	Max	10	370
	1080809	353645	Min	3	
NZ LAND TETON	1081356	353907	Max	4	243
	1081356	353907	Min	1	
NZ LAND UNION CARBIDE	1080915	353628	Max	6	498
	1080655	353552	Min	2	
NZ LAND WESCO RESOURCES	1080524	353334	Max	6.5	403
	1080524	353334	Min	2	
NZ LAND WESTERN NUCLEAR	1081242	353823	Max	19	969
	1081028	353757	Min	5	
NZ LAND-CONOCO	1080542	354147	Max	13	724
	1080458	353931	Min	4	
NZ LAND-HFC OIL	1080800	353723	Max	24	963.5
	1080613	353431	Min	8	
OIL & GAS WELLS	1080257	353731	Max	69	672
	1075441	353443	Min	8	
S. FELDMAN'S URANIUM LOG REPORT	1084359	354231	Max	69	810
	1074232	353055	Min	18	
SEARS 1934 PL 11, NO. 18	1083838	353736	Max	3.5	87.5
	1083838	353736	Min	1	
SEARS 1934 PL 13, NO. 116	1083802	354043	Max	12	179.9
	1083802	354043	Min	1	
SEARS 1934 PL.16 NO 220	1080522	353706	Max	4.5	348.5
	1080522	353706	Min	1	
SEARS 1934, PL. 13, NO. 105	1084130	353941	Max	6.1	48.3
	1084130	353941	Min	2	
SEARS 1934, PL. 13, NO. 112	1083947	354019	Max	3.1	211.2
	1083947	354019	Min	1	
SEARS 1934, PL. 13, NO. 113	1083852	353948	Max	3.2	4.9
	1083852	353948	Min	1	
SEARS 1934, PL. 15 NO. 159	1082210	353922	Max	2.6	15.3
	1082210	353922	Min	1	
SEARS 1934, PL. 15 NO. 160	1082125	353905	Max	2.8	48.3
	1082125	353905	Min	1	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
SEARS 1934, PL. 15 NO. 161	1082103	353908	Max	2.5	157.9
	1082103	353908	Min	1	
SEARS 1934, PL. 15 NO. 162	1082020	353903	Max	6.5	148
	1082020	353903	Min	2	
SEARS 1934, PL. 15 NO. 163	1082007	353918	Max	5.5	120.6
	1082007	353918	Min	1	
SEARS 1934, PL. 15 NO. 164	1082031	353925	Max	3.3	24.3
	1082031	353925	Min	1	
SEARS 1934, PL. 15 NO. 191	1081450	353846	Max	2.5	100.9
	1081450	353846	Min	1	
SEARS 1934, PL. 15 NO. 193	1081337	353806	Max	4	212.3
	1081337	353806	Min	1	
SEARS 1934, PL. 15 NO. 199	1080833	354023	Max	3.5	42.6
	1080833	354023	Min	1	
SEARS 1934, PL. 15 NO. 205	1080802	353923	Max	2.6	6.1
	1080802	353923	Min	1	
SEARS 1934, PL. 16 NO. 212	1080803	353739	Max	5.8	156
	1080803	353739	Min	2	
SEARS 1934, PL. 16, NO. 214	1080633	353657	Max	2.5	127.1
	1080633	353657	Min	1	
SEARS 1934, PL. 16, NO. 228	1080658	353415	Max	4.1	252.4
	1080658	353415	Min	1	
SEARS 1934, PL. 16, NO. 230	1080537	353435	Max	2.8	226.9
	1080537	353435	Min	1	
SEARS 1934, PL. 16, NO. 234	1080503	353615	Max	5	164.5
	1080503	353615	Min	1	
SEARS 1934, PL. 16, NO. 235	1080415	353601	Max	2.5	180.7
	1080415	353601	Min	1	
SEARS 1934, PL. 16, NO. 240	1080319	353413	Max	8.5	93.1
	1080319	353413	Min	2	
SEARS 1934, PL. 16, NO. 241	1080232	353426	Max	7.1	115.8
	1080232	353426	Min	2	
SEARS 1934, PL. 16, NO. 244	1080635	353527	Max	5.4	60.3
	1080635	353527	Min	2	
SEARS 1934, PL. 16, NO. 2476	1080102	353535	Max	3.2	41.8
	1080102	353535	Min	1	
SEARS 1934, PL. 16, NO. 249	1080101	353430	Max	4.5	119
	1080101	353430	Min	1	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
SEARS 1934, PL. 16,	1075937	353316	Max	6.6	117.1
NO. 253	1075937	353316	Min	2	
SEARS 1934, PL. 16,	1075937	353234	Max	11.6	61.1
NO. 256	1075937	353234	Min	3	
SEARS 1934, PL.12,	1082940	353903	Max	3.5	7.5
NO.49	1082940	353903	Min	1	
SEARS 1934, PL.14	1083248	354408	Max	5	37.3
NO.125	1083248	354408	Min	1	
SEARS 1934, PL.14	1082732	353916	Max	7.7	68.3
NO.153	1082732	353916	Min	2	
SEARS 1934, PL.14,	1083420	354327	Max	8	85
NO.123	1083420	354327	Min	1	
SEARS 1934, PL.14,	1083258	354257	Max	2.8	28.5
NO.124	1083258	354257	Min	1	
SEARS 1934, PL.14,	1083016	354314	Max	3.8	25.8
NO.130	1083016	354314	Min	1	
SEARS 1934, PL.14,	1082917	354257	Max	12.1	109
NO.132	1082917	354257	Min	3	
SEARS 1934, PL.14,	1082549	354253	Max	10.4	70
NO.133	1082549	354253	Min	3	
SEARS 1934, PL.14,	1082504	354152	Max	4.3	75.2
NO.134	1082504	354152	Min	1	
SEARS 1934, PL.14,	1082508	354142	Max	5.6	76.4
NO.136	1082508	354142	Min	2	
SEARS 1934, PL.14,	1083213	353930	Max	6.2	99.5
NO.141	1083213	353930	Min	2	
SEARS 1934, PL.14,	1083014	354013	Max	10	51.3
NO.146	1083014	354013	Min	3	
SEARS 1934, PL.14,	1082944	354022	Max	2.5	20.4
NO.148	1082944	354022	Min	1	
SEARS 1934, PL.14,	1082748	354002	Max	5.4	115.1
NO.151	1082748	354002	Min	2	
SEARS 1934, PL.14,	1082552	353908	Max	3.1	25.3
NO.155	1082552	353908	Min	1	
SEARS 1934, PL.14,	1082354	353932	Max	11.5	20.7
NO.157	1082354	353932	Min	3	
SEARS 1934, PL.15	1081706	354230	Max	4.1	57.2
NO.171	1081706	354230	Min	1	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
SEARS 1934, PL.15, NO.167	1081848	354042	Max	2.5	48.3
	1081848	354042	Min	1	
SEARS 1934, PL.15, NO.169	1081742	354153	Max	2.5	36.4
	1081742	354153	Min	1	
SEARS 1934, PL.15, NO.174	1081713	354204	Max	3.5	48.2
	1081713	354204	Min	1	
SEARS 1934, PL.15, NO.175	1081715	354149	Max	3.5	63.8
	1081715	354149	Min	1	
SEARS 1934, PL.15, NO.176	1081722	354128	Max	13.1	160.3
	1081722	354128	Min	3	
SEARS 1934, PL.15, NO.177	1081655	354107	Max	10.8	141.9
	1081655	354107	Min	3	
SEARS 1934, PL.15, NO.178	1081647	354042	Max	6.1	128.6
	1081647	354042	Min	2	
SEARS 1934, PL.15, NO.180	1081748	351748	Max	5	117.2
	1081748	351748	Min	2	
SEARS 1934, PL.15, NO.181	1081738	353013	Max	2.5	104.4
	1081738	353013	Min	1	
SEARS 1934, PL.15, NO.184	1081838	353910	Max	4	26.7
	1081838	353910	Min	1	
SEARS 1934, PL.15, NO.185	1081808	353857	Max	6.1	296
	1081808	353857	Min	2	
SEARS 1934, PL.15, NO.186	1081738	353842	Max	9.1	265.4
	1081738	353842	Min	3	
UNITED ELECTRIC COAL CO.	1080530	354056	Max	21.4	76
	1075644	353631	Min	7	
GALLUP Field	**CREVASSE CANYON**	**Formation**		**MCKINLEY**	**County**
BOKUM CORP NO.78	1083338	351523	Max	13.8	211
	1083338	351523	Min	2	
CARBON COAL	1084218	351844	Max	6.5	596
	1084218	351844	Min	2	
DOBBIN 1932, UNPUB. MAP NO. 43	1085800	353222	Max	3	5.4
	1085800	353222	Min	1	
DOBBIN 1932, UNPUB. MAP NO. 65	1085737	353352	Max	2.5	3.1
	1085737	353352	Min	1	
MCKINLEY MINE PLAN	1090105	354433	Max	573	232
	1085501	353643	Min	120	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
NAVAJO TRIBE	1084537	352006	Max	2.7	230.5
	1084537	352006	Min	1	
NMBM OF 154	1084533	352005	Max	24	587
	1084118	351640	Min	7	
NMBM OF 154-UTAH INT'L	1084142	351847	Max	6.9	855
	1084142	351847	Min	2	
NMBM OIL & GAS LIBRARY	1083844	351821	Max	12.6	898
	1083844	351821	Min	3	
PITTSBURG & MIDWAY	1085829	354234	Max	207.28	858
	1083749	352415	Min	53	
S. FELDMAN'S URANIUM	1083433	353745	Max	4	356
LOG REPORT	1083433	353745	Min	1	
SEARS 1934, PL. 11,	1083822	353720	Max	4	133.9
NO. 19	1083822	353720	Min	1	
SEARS 1934, PL. 11,	1083940	353613	Max	2.9	137.3
NO. 5	1083940	353613	Min	1	
SEARS 1934, PL. 11,	1083930	353702	Max	3.6	137.3
NO. 8	1083930	353702	Min	1	
SOUTHWEST FOREST	1084006	352829	Max	66.8	324.8
INDUSTRIES	1083758	352619	Min	17	
USGS OF 77-369	1083957	352750	Max	23	201
	1083939	352738	Min	7	
USGS TRACT DELINEATION	1085037	352835	Max	31.5	255
	1084922	352507	Min	10	
UTAH INTERNATIONAL	1084633	351825	Max	5.5	185
	1084633	351825	Min	2	
USBM TECH 569	1083757	354136	Max	5	5
	1083757	354136	Min	1	
ZUNI Field	**CREVASSE CANYON**	**Formation**		**MCKINLEY**	**County**
CARBON COAL CO.	1083538	351240	Max	33.5	295.4
	1081517	351226	Min	8	
GALLUP Field Bituminous	**CREVASSE CANYON**	**Formation**		**MCKINLEY**	**County**
CARBON COAL	1084347	354226	Max	895.25	707.5
	1084226	352846	Min	200	
CARBON COAL MINE PLAN	1084304	352924	Max	2.5	14
	1084304	352924	Min	1	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
CITY OF GALLUP, RAY	1084731	353814	Max	29	990.5
NO. 1	1084731	353814	Min	8	
CONOCO URANIUM	1085211	353208	Max	12.2	216
	1084125	352940	Min	4	
DOBBIN 1932, UNPUB.	1085834	353747	Max	3	4.5
MAP NO. 59	1085834	353747	Min	1	
DOBBIN 1932, UNPUB.	1085745	353752	Max	2.5	10
MAP NO. 81	1085745	353752	Min	1	
EBASCO REPORT	1084420	353344	Max	11	440
	1084420	353344	Min	3	
MCKINLEY MINE PLAN	1085750	353721	Max	74	89
	1085611	353510	Min	15	
NAVAJO TRIBE 16T-550	1085656	353832	Max	18.5	960
	1085656	353832	Min	5	
NMBM OIL & GAS LIBRARY	1084602	353720	Max	15	976
	1084602	353720	Min	4	
NMRDI	1085456	353713	Max	141.58	499.95
	1084249	352850	Min	33	
PITTSBURG & MIDWAY	1090054	353901	Max	458.83	809
	1085513	352736	Min	93	
S. FELDMAN'S URANIUM	1085938	353807	Max	46	982
LOG REPORT	1084309	353501	Min	12	
SEARS 1925, PL. 11,	1084736	353258	Max	13.7	440.8
NO. D12, USGS BULL 767	1084736	353258	Min	4	
SEARS 1925, PL. 14,	1084522	353358	Max	16.9	340.2
NO. D118, USGS BULL	1084522	353358	Min	4	
SEARS 1925, PL.15, DH	1084420	353349	Max	10.9	426.4
NO.24, USGS BULL 767	1084420	353349	Min	3	
SEARS 1925, PL.8,	1084214	353654	Max	2.5	42.6
NO.62, USGS BULL 767	1084214	353654	Min	1	
SEARS 1934, PL. 7, NO.	1084439	353051	Max	3.9	107.4
3, USGS BULL 767	1084439	353051	Min	1	
TUSCON GAS & ELECTRIC	1085113	353429	Max	63.8	252
	1084929	353105	Min	17	
USBM TECH 569	1085111	353444	Max	41.09	8.6
	1084140	352957	Min	12	
USGS BULL 767	1084930	353528	Max	377.4	906
	1084303	352858	Min	85	

Source	longitude	latitude		Total Coal No. of Seams	Max Depth
E. MT. TAYLOR Field	**CREVASSE CANYON**		**Formation**	**CIBOLA**	**County**
USGS BULL 860-B	1072346	351357	Max	2.5	375
	1072346	351357	Min	1	
RIO PUERCO Field	**CREVASSE CANYON**		**Formation**	**BERNALILLO**	**County**
BLM TRACT DELINEATION	1070518	350307	Max	3	144
	1070518	350307	Min	1	
USGS BULL 860-B	1070409	351032	Max	12.1	60
	1070129	350636	Min	4	
USGS BULL 860-B	1064914	352823	Max	10.7	60
	1064636	352813	Min	2	
S. MT. TAYLOR Field	**CREVASSE CANYON**		**Formation**	**CIBOLA**	**County**
USGS BULL 860-B	1074307	351303	Max	29.3	200
	1073922	351104	Min	7	
USGS-BIA ACOMA REPORT	1074357	351002	Max	2.5	240.5
	1074357	351002	Min	1	
SAN MATEO Field	**CREVASSE CANYON**		**Formation**	**MCKINLEY**	**County**
NMBM OIL & GAS LIBRARY	1073855	353138	Max	45.5	960
	1073647	352604	Min	11	
S. FELDMAN'S URANIUM	1074259	353909	Max	18	737
LOG REPORT	1073331	352933	Min	4	
STANDING ROCK Field	**CREVASSE CANYON**		**Formation**	**MCKINLEY**	**County**
HUGHES AND HUGHES NO.	1074935	354101	Max	2.5	680
1 SANTA FE TRACT 13	1074935	354101	Min	1	
NMBM OIL & GAS LIBRARY	1081117	355658	Max	19.5	937
	1081101	355445	Min	6	
S. FELDMAN'S URANIUM	1080207	355118	Max	7	760
LOG REPORT	1075443	354854	Min	2	

Data Sources for CRDB- Gallup Sandstone

CROWNPOINT Field Source	GALLUP longitude	Formation latitude	MCKINLEY	County Total Coal No. of Seams	Max Depth
CONFIDENTIAL	1080953	354327	Max	4	936
	1080953	354327	Min	1	
MOBIL	1081544	354357	Max	22.3	911
	1080956	354203	Min	6	
WESTERN NUCLEAR	1081023	352927	Max	23	178.5
	1080952	352923	Min	3	
GALLUP Field	**GALLUP**	**Formation**	**MCKINLEY**	**County**	
DOBBIN 1932, UNPUB.	1085804	353435	Max	4	30.2
MAP NO. 64	1085804	353435	Min	1	
NMBM OF 154	1084526	352101	Max	3	962.5
	1084526	352101	Min	1	
S. FELDMAN'S URANIUM	1085938	353807	Max	12	743
LOG	1085507	353740	Min	4	
ZUNI Field	**GALLUP**	**Formation**	**CIBOLA**	**County**	
USGS	1083428	355707	Max	8.5	388.8
	1083357	355628	Min	3	
CARBON COAL CO.	1084039	351319	Max	3.3	191.9
	1084039	351319	Min	1	
HAMILTON BROS.	1083816	350810	Max	5.4	114.4
	1083816	350810	Min	2	
USGS	1083456	355835	Max	9.2	130.6
	1083456	355835	Min	3	
USGS BULL 767	1084403	351238	Max	58.5	260
	1083546	350502	Min	10	

APPENDIX B

Weighted Averages-Fruitland Formation

Fruitland Field		lb_sulfur/ mbtu	mbtu/ton	%ash	wtd avg			Averages by Township lb_sulfur/ mbtu	mbtu/ton	%ash	
-108.41	36.7133	0.69	19	20.1	1	29N	15W				
-108.41	36.7575	0.55	22	9.3	1	29N	15W				
-108.42	36.7606	0.84	20	18.2	1	29N	15W				
-108.42	36.7569	0.55	22	9.9	1	29N	15W				
-108.43	36.7619	0.85	19	18.8	1	29N	15W	0.73	20.29	15.80	Avg
-108.44	36.7611	0.66	21	13.9	1	29N	15W	0.14	1.28	4.39	Std
-108.44	36.6769	0.95	19	20.4	1	29N	15W	7	7	7	no.
-108.38	36.8147	2.29	21	12.7	1	30N	15W				
-108.39	36.8181	1.24	20	16.54	1	30N	15W				
-108.4	36.8506	0.79	21.3	14.3	1	30N	15W				
-108.4	36.8256	0.91	21	15.43	1	30N	15W				
-108.4	36.82	0.52	23	8.3	1	30N	15W				
-108.4	36.8106	1.15	20	19.28	1	30N	15W				
-108.4	36.7964	1.01	20	17.32	1	30N	15W				
-108.4	36.7889	0.82	20	17.82	1	30N	15W				
-108.4	36.7744	0.75	20	17.04	1	30N	15W				
-108.4	36.8325	0.59	21	15.93	1	30N	15W				
-108.4	36.8397	0.73	22	13.18	1	30N	15W				
-108.4	36.8042	0.71	21	16.72	1	30N	15W				
-108.4	36.7672	1.01	19.74	18.86	1.0001	30N	15W				
-108.4	36.8611	0.72	22.02	11.36	1	30N	15W				
-108.4	36.8611	0.69	21.97	11.57	1	30N	15W				
-108.41	36.7681	0.76	19.8	18.28	1	30N	15W				
-108.41	36.8256	0.84	19	19.37	1	30N	15W				
-108.41	36.8106	1.36	21	16.33	1	30N	15W				
-108.41	36.7889	0.82	21	14.91	1	30N	15W				
-108.41	36.7817	0.74	20.59	16.6	1	30N	15W				
-108.41	36.7672	0.87	19.3	18.24	0.9998	30N	15W				
-108.41	36.8106	1.33	21	15.74	1	30N	15W				
-108.41	36.8325	0.58	22	13.75	1	30N	15W				
-108.41	36.7744	0.78	20	17.19	1	30N	15W				
-108.41	36.8472	0.73	20.57	15.21	1	30N	15W				
-108.41	36.8397	0.76	20.65	16.43	0.9999	30N	15W				
-108.41	36.8367	0.71	21	14.82	1	30N	15W				
-108.41	36.7875	0.99	19.78	19.6	1	30N	15W				
-108.41	36.7744	0.99	20	17.26	1	30N	15W				
-108.42	36.8158	1.1	20	16.55	1	30N	15W				
-108.42	36.8325	0.77	20.49	15.78	1	30N	15W				
-108.42	36.8256	1.11	20.2	15.99	1	30N	15W				
-108.42	36.8039	0.35	17	24.66	1	30N	15W				
-108.42	36.7964	0.79	19	15.67	1	30N	15W				
-108.42	36.7672	0.83	19	17.56	1	30N	15W				
-108.42	36.8181	0.87	19.76	17.41	1	30N	15W				
-108.42	36.8397	0.7	20.97	13.34	1	30N	15W				
-108.42	36.7814	0.89	20	15.85	1	30N	15W				
-108.42	36.8178	0.86	21	13.2	1	30N	15W				
-108.42	36.7964	0.81	20	17.43	1	30N	15W				
-108.42	36.8397	0.88	18.17	14	1	30N	15W				
-108.42	36.8036	1.18	19	19.7	1	30N	15W				
-108.43	36.7672	0.69	19	18.31	1	30N	15W				
-108.43	36.8325	0.65	21	11.9	1	30N	15W				
-108.43	36.7892	0.62	21	15.17	1	30N	15W	0.87	20.37	15.94	Avg
-108.43	36.7817	0.72	22	13.04	1	30N	15W	0.29	1.09	2.71	Std
-108.44	36.7647	0.82	20	13.7	1	30N	15W	47	47	47	no.
-108.36	36.87	0.93	19	17.64	1	31N	15W				

Weighted Averages-Fruitland Formation

								Averages by Township			
-108.37	36.8694	1.04	19	19.84	1	31N	15W	1.03	19.76	16.66	Avg
-108.39	36.8611	1.01	20	15.92	1	31N	15W	0.08	0.85	2.41	STd
-108.39	36.8539	1.15	21.05	13.24	1	31N	15W	4	4	4	no.
-108.08	36.9725	0.61	23	13.1	1	32N	12W				
-108.12	36.9953	0.73	19.84	26.05	1	32N	12W				
-108.12	36.9953	0.8	18.68	28.11	1	32N	12W				
-108.13	36.9939	1	12.72	29.29	1	32N	12W				
-108.13	36.9925	1.07	16	19.09	1	32N	12W				
-108.13	36.9953	0.49	20	22.91	1	32N	12W				
-108.13	36.9967	0.57	21.45	19.77	1	32N	12W				
-108.13	36.9956	0.52	20	21.37	1	32N	12W				
-108.13	36.9956	0.41	25	12.5	1	32N	12W				
-108.13	36.9936	0.56	20	26.06	1	32N	12W				
-108.13	36.9956	0.87	20	25.06	1	32N	12W				
-108.13	36.9897	0.79	14	18.17	1	32N	12W				
-108.14	36.9961	0.4	23	14.01	1	32N	12W				
-108.13	36.9956	0.49	20.59	18.92	0.9543	32N	12W				
-108.14	36.9922	0.47	21	20.4	1	32N	12W				
-108.14	36.9964	0.51	21	20.97	1	32N	12W				
-108.14	36.9897	0.49	22.4	18.17	1	32N	12W				
-108.14	36.9878	1.15	15	25.41	1	32N	12W	0.66	19.55	21.06	Avg
-108.15	36.9856	0.53	18.77	21.67	0.925	32N	12W	0.22	3.04	4.58	Std
-108.17	36.9825	0.76	18.52	20.25	0.9131	32N	12W	20	20	20	no.
-108.15	36.9869	0.71	19.03	22.52	0.9381	32N	13W				
-108.15	36.9853	0.81	20.41	20.31	1	32N	13W				
-108.15	36.9842	0.8	19.52	26.34	1	32N	13W				
-108.16	36.9844	0.65	19.95	23.52	1.0001	32N	13W				
-108.17	36.9803	0.65	20.14	21.41	1	32N	13W				
-108.17	36.9867	1.09	17.75	29.75	1	32N	13W				
-108.18	36.9825	0.58	22	19.17	1	32N	13W				
-108.19	36.9806		25	10	1	32N	13W				
-108.19	36.9792	0.5	24	11	1	32N	13W				
-108.2	36.9736		25	8.4	1	32N	13W	0.79	21.22	18.91	Avg
-108.21	36.9675	1.13	23	11.9	1	32N	13W	0.20	2.39	6.65	STd
-108.22	36.9492	0.93	18.87	22.56	0.9726	32N	13W	10	12	12	no.
	Avg	0.81	20.27	17.50							
	STd	0.27	1.96	4.56							
	no	88	90	90							

Weighted Averages-Fruitland Formation

Navajo Field

Averages by Township

		lb/sulfur	mbtu/ton	%ash	Wtd Avg			lb_sulfur/ Mbtu	Mbtu/ton	%Ash	
-108.27	36.2744	0.42	16.87	19.43	1	24N	14W				
-108.34	36.2742	0.69	18	16.27	1	24N	14W	0.59	17.57	18.67	Avg
-108.38	36.2936	0.51	18.12	18.54	1	24N	14W	0.13	0.52	1.54	Std
-108.38	36.3158	0.73	17.28	20.45	1	24N	14W	4	4	4	no
-108.29	36.4458	1.34	15.88	27.14	0.9999	24N	15W	(discounted)			
-108.43	36.3156	0.98	19.4	15.89	1	24N	15W				
-108.43	36.2742	0.81	18	20.84	1	24N	15W				
-108.45	36.3625	0.92	16.82	22.95	1	24N	15W				
-108.45	36.3458	0.58	17.95	18	1	24N	15W	0.76	18.59	17.93	Avg
-108.47	36.3158	0.59	21	9.67	1	24N	15W	0.15	1.32	4.31	Std
	36.3625	0.7	18.39	20.24	1.0001	25N	15W	6	6	6	No.
-108.5	36.3158	1.27	18	19.29	1	24N	16W				
-108.53	36.3458	0.77	18.36	16.91	1	24N	16W	**			
-108.51	36.3961	0.69	15.94	21.13	1	25N	16W				
-108.51	36.4261	0.88	18.04	20.76	0.9999	25N	16W	0.86	17.62	20.03	Avg
-108.52	36.4172	0.99	18.23	19.25	0.9999	25N	16W	0.11	0.97	0.93	STd
-108.53	36.4142	0.88	18.25	18.96	1	25N	16W	3	3	3	no.
-108.51	36.4403	0.69	18.08	19.92	1	26N	16W				
-108.53	36.5067	0.64	17.37	14.08	0.904	26N	16W	**			
-108.48	36.5069	0.72	18.93	19.38	1.0001	27N	16W				
-108.5	36.5242	0.93	18.34	20.54	1	27N	16W				
-108.5	36.5583	0.82	17.84	22.02	1	27N	16W				
-108.51	36.5336	0.99	19.06	17.81	1.0001	27N	16W				
-108.51	36.5464	1.15	17.29	23.12	1	27N	16W				
-108.51	36.5061	0.91	18.26	19.01	1	27N	16W	0.90	17.91	20.71	Avg
-108.52	36.5633	0.65	16.44	20.96	0.9231	27N	16W	0.15	0.85	1.77	Std
-108.52	36.5844	0.99	17.13	22.83	1	27N	16W	8	8	8	no
-108.47	36.6125	2.07	19.19	16.6	1	28N	16W				
-108.47	36.6028	0.53	19	18.7	1	28N	16W				
-108.48	36.6267	0.84	18.3	19.88	1	28N	16W	0.71	18.72	18.72	Avg
-108.5	36.6208	0.75	18.19	21.45	0.9999	28N	16W	0.11	0.40	1.80	Std
-108.51	36.595	0.72	18.94	16.99	0.9999	28N	16W	4	5	5	no.
	Avg	0.81	18.03	19.34							
	STd	0.21	1.02	3.03							
	no	31	32	32							

Weighted Averages-Fruitland Formation

BISTI Field		lb_sulfur/ Mbtu	Mbtu/ton	%ash	wtd avg	t.	r.	Averages by Township lb_sulfur/ mbtu	mbtu/ton	%ash	
-107.72	36.027	0.46	21	7.59	1	21N	9W				
-107.74	36.0414	0.87	16	26.24	1	21N	9W				
-107.75	36.0486	0.32	18	17.45	1	21N	9W				
-107.75	36.0564	0.55	16	23.04	1	21N	9W				
-107.76	36.0636	0.6	16	23.5	1	21N	9W				
-107.77	36.0708	0.75	16	25.36	1	21N	9W				
-107.79	36.0856	0.6	16	24.93	1	21N	9W	0.58	17.38	19.97	Avg
-107.8	36.0814	0.49	20	11.66	1	21N	9W	0.16	1.93	6.55	STd
-107.87	36.1236	0.69	17.17	21.32	0.9996	22N	10W	8	8	8	no.
-107.88	36.1458	0.52	19	16.1	1	22N	10W				
-107.88	36.2019	0.59	17	21.8	1	22N	10W				
-107.91	36.2117	0.58	15.96	25.58	1	22N	10W	0.59	17.54	19.26	Avg
-107.92	36.1394	0.64	16.8	17.67	1	22N	10W	0.04	1.22	3.89	STd
-107.93	36.1811	0.64	18.95	15.16	1	22N	10W	5	5	5	no.
-107.74	36.0958	0.58	15.62	23.18	1	22N	9W				
-107.78	36.1122	0.76	16	28.65	1	22N	9W	0.69	16.18	24.44	Avg
-107.81	36.1089	0.69	16.11	24.15	1	22N	9W	0.07	0.51	2.58	STd
-107.84	36.1286	0.71	17	21.76	1	22N	9W	4	4	4	no.
-107.96	36.1844	0.61	14.11	26.37	1	23N	11W				
-107.99	36.1989	0.63	13.94	18.49	1	23N	11W	0.54	15.6875	21.565	Avg
-108.02	36.2014	0.34	17.61	19.61	1	23N	11W	0.12	1.67	3.02	Std
-108.03	36.1914	0.58	17.09	21.79	1	23N	11W	4	4	4	no.
-108.03	36.2356	0.52	15.24	21.76	0.9304	23N	12W				
-108.06	36.2356	0.55	18.16	14.65	1	23N	12W				
-108.08	36.2017	0.22	19.12	17.94	0.9999	23N	12W				
-108.09	36.2403	0.51	18	17.6	1	23N	12W				
-108.1	36.2033	0.67	15	19.3	1	23N	12W				
-108.13	36.2625	0.49	18.65	16.78	0.9932	23N	12W				
-108.13	36.2256	0.58	19.05	20.9	1	23N	12W				
-108.13	36.2389	0.5	21.42	13.32	1	23N	12W	0.50	18.45	16.77	Avg
-108.15	36.2336	0.48	21	12.3	1	23N	12W	0.11	1.97	3.16	Std
-108.16	36.2533	0.52	18.81	13.13	1.0001	23N	12W	10	10	10	no.
-108.17	36.255	0.72	15.33	25.58	1	23N	13W				
-108.2	36.2572	0.71	16.98	19.31	1	23N	13W				
-108.21	36.2447	0.7	18.12	17.42	1	23N	13W				
-108.22	36.2514	0.52	23	10.5	1	23N	13W				
-108.24	36.2514	0.79	18.13	18.31	1	23N	13W				
-108.24	36.2517	0.59	17.24	17.56	1	23N	13W				
-108.25	36.2686	0.5	16.49	20.21	1	23N	13W	0.64	18.25	17.31	Avg
-108.25	36.2394	0.63	20	12.3	1	23N	13W	0.09	2.12	4.23	STd
-108.27	36.2369	0.56	19	14.6	1	23N	13W	9	9	9	no.
-108.24	36.2444	0.59	17	28.7	1	24N	13W				
-108.24	36.2692	0.64	18	13.1	1	24N	13W				
-108.25	36.275	0.53	19	16.2	1	24N	13W				
-108.27	36.2747	0.64	19.14	11.85	1	24N	13W	0.58	18.64	16.46	Avg
-108.27	36.2817	0.7	18.68	22.69	1	24N	13W	0.10	0.94	7.38	STd
-108.27	36.2619	0.4	20	6.2	1	24N	13W	6	6	6	no.
	Avg	0.58	17.70	18.80							
	Std	0.12	1.93	5.34							
	no.	47	47	47							

Weighted Averages-Fruitland Formation

Star Lake field		lb_sulfur/ Mbtu	mbtu/ton	%ash	wtd avg			Averages by Township	lb_sulfur Mbtu	Mbtu/ton	%Ash	
-107.14	35.9128	0.96	15	30.7	1	19N	3W	**				
-107.2	35.9125	0.81	16	26.03	1	19N	4W					
-107.24	35.9097	0.75	17	24.66	1	19N	4W	**				
-107.36	35.9153	0.82	17	24.59	1	19N	5W					
-107.39	35.9133	0.6	18.22	22.41	1	19N	5W	**				
-107.42	35.9086	0.86	16.8	25.92	1	19N	6W					
-107.42	35.8961	0.44	18	15.55	1	19N	6W					
-107.42	35.9106	0.65	15.87	26.86	1	19N	6W		0.66	16.98	22.97	Avg
-107.43	35.9086	0.67	18.51	19.49	1	19N	6W		0.13	1.12	4.64	Std
-107.46	35.9103	0.69	15.72	27.03	1	19N	6W		5	5	5	no.
-107.35	35.9217	0.63	18	19.18	1	20N	5W					
-107.35	35.9169	0.62	18	21.71	1	20N	5W					
-107.38	35.9286	0.46	18.31	20.81	1	20N	5W					
-107.38	35.9186	0.63	18	22.06	1	20N	5W		0.59	17.86	21.71	Avg
-107.41	35.9178	0.59	18.27	22.42	1	20N	5W		0.06	0.58	1.49	Std
-107.42	35.9086	0.6	16.59	24.06	1	20N	5W		6	6	6	no.
-107.44	35.9486	0.63	17.39	23.38	1	20N	6W					
-107.44	35.9219	0.7	18	21.83	1	20N	6W					
-107.45	35.9214	0.54	16.5	27.23	1	20N	6W					
-107.46	35.9297	0.84	18	22.72	1	20N	6W					
-107.46	35.9294	0.75	17	24.77	1	20N	6W					
-107.48	35.9367	0.63	17.5	21.57	0.99	20N	6W					
-107.49	35.9364	0.59	16.35	25.33	1	20N	6W					
-107.49	35.9394	0.6	17	24.82	1	20N	6W					
-107.51	35.9653	0.64	17	26.6	1	20N	6W					
-107.51	35.9519	0.65	19	19.94	1	20N	6W		0.68	17.31	23.94	Avg
-107.52	35.9794	0.64	18	22.34	1	20N	6W		0.10	0.81	2.22	Std
-107.52	35.9611	0.9	16	26.71	1	20N	6W		12	12	12	no.
-107.53	35.9681	0.58	19.11	18.42	1	20N	7W					
-107.54	35.9783	0.59	17	22.91	1	20N	7W					
-107.54	35.9628	0.68	19.18	16.38	1	20N	7W					
-107.55	35.9542	0.57	17.18	22.01	1	20N	7W					
-107.56	35.9686	0.4	16	28.98	1	20N	7W		0.57	17.58	22.01	Avg
-107.6	35.9836	0.59	17	23.35	1	20N	7W		0.08	1.17	4.00	Std
-107.59	36.0056	0.39	17	22.99	1	21N	7W		6	6	6	no.
-107.56	36.0122	0.76	18.21	19.96	1	21N	8W					
-107.64	36.0322	0.5	18.36	15.61	1	21N	8W					
-107.66	36.0181	0.62	16.64	23.46	1	21N	8W					
-107.67	36.0314	0.63	16	27.76	1	21N	8W					
-107.68	36.0403	0.53	16	22.88	1	21N	8W					
-107.69	36.0342	0.54	17	21.15	1	21N	8W					
-107.71	36.0478	0.61	16.24	22.98	1.001	21N	8W					
-107.72	36.0675	0.91	22	9.5	1	21N	8W		0.65	17.36	20.64	Avg
-107.73	36.0639	0.82	16.17	23.18	1	21N	8W		0.13	1.74	4.76	Std
-107.73	36.0342	0.55	17	19.94	1	21N	8W		10	10	10	no.
	avg	0.65	17.31	22.72								
	std	0.13	1.21	3.81								
	no	45	45	45								

Weighted Averages-Menefee Formation

CHACRA	UPPER	lbs_sulfur Mbtu	Mbtu/ton	%ash	Wtd Avg		
-107.11	35.8119	1.18	18.94	11.35	1	18N	3W
-107.14	35.8261	1.17	21	5.66	1	18N	3W
-107.14	35.8175	0.94	19.69	11.95	1.0006	18N	3W
-107.14	35.8	1.63	19.8	10.16	1	18N	3W
-107.15	35.7814	1.04	19.42	7.11	1	18N	3W
-107.16	35.7703	0.6	20.16	8.97	1	18N	3W
-107.16	35.7569	0.57	19.76	7.53	1	18N	3W
-107.18	35.7756	0.9	21.84	8.39	1	18N	3W
-107.2	35.7883	0.67	22.91	7.45	1.003	18N	4W
-107.24	35.8008	0.26	19.27	7.02	0.99	18N	4W
-107.28	35.7717	0.41	22.45	6.85	1	18N	4W
-107.31	35.7583	0.32	19.9	11.93	1	18N	5W
-107.33	35.8125	0.33	19.69	17.5	1	18N	5W
-107.4	35.7739	0.17	20.95	13.77	1	18N	5W
	Avg	0.73	20.41	9.69			
	Std	0.41	1.19	3.17			
	no.	14	14	14			

LA Ventan upper		Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg		
-107.04	35.8158	0.66	21.09	6.38	1	18N	2W
-107.08	35.8142	1.19	21.24	6.33	0.999	18N	2W
0	0	0.98	21.22	7.54	1	19N	1W
-106.94	35.9111	2.04	20.62	4.8	1	19N	1W
-106.95	35.8917	1.09	20.36	7.14	1	19N	1W
-106.95	35.8858	1.68	20.9	6.01	1	19N	1W
-106.95	35.9056	1.16	19.43	8.5	1	19N	1W
-106.95	35.9128	1.69	19.74	9.36	1	19N	1W
-106.96	35.8844	1.63	21.03	7.32	1	19N	1W
-106.96	35.8917	1.28	20.72	5.17	1	19N	1W
-106.96	35.9061	1.49	16.88	25	1	19N	1W
-106.96	35.8431	0.8	17.58	4.5	1	19N	1W
-106.97	35.8919	1.7	21.84	6.96	1	19N	1W
-106.97	35.9061	1.17	21.43	10.2	1	19N	1W
-106.97	35.9125	0.79	20.97	6.5	1	19N	1W
-106.98	35.8594	2.56	21.88	7.6	1	19N	1W
-106.98	35.8433	0.6	21.07	8.77	1	19N	1W
0	0	0.64	20.72	5.36	1	19N	2W
-107.01	35.8328	1.25	20.86	7.3	1	19N	2W
-107.02	35.8344	1.35	17.82	9.9	1	19N	2W
-107.02	35.8347	0.67	20.8	10.1	1	19N	2W
-106.95	35.9158	1.78	20.6	5.05	1	20N	1W
	Avg	1.28	20.40	7.99			
	Std	0.50	1.31	4.08			
	no.	22	22	22			

NEWCO	UPPER						
-108.63	36.2519	0.65	15.32	22.7	1	23N	17W
-108.59	36.3511	1.3	19.42	12.29	1	25N	17W

Lbs Sulfur

Averages by Township

lbs_sulfur Mbtu	Mbtu/ton	%ash	
1.00	20.08	8.89	Avg
0.32	0.87	2.02	Std
8	8	8	no.
0.45	21.54	7.11	Avg
0.17	1.62	0.25	Std
3	3	3	no.
0.27	20.18	14.40	Avg
0.07	0.55	2.32	Std
3	3	3	no

Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
0.93	21.17	6.36	Avg
0.27	0.07	0.02	Std
2	2	2	no
1.38	20.38	8.36	Avg
0.51	1.40	4.72	Std
15	15	15	no.
0.98	20.05	8.17	Avg
0.32	1.29	1.96	Std
4	4	4	no.

Weighted Averages-Menefee Formation

Averages by Township

CHACRA	CLEARY	Mbtu	Mbtu/ton	% Ash	Wtd Avg			lbs_sulfur Mbtu	Mbtu/ton	%ash	
-107.22	35.6989	0.55	19.53	12.87	0.99	17N	4W				
-107.25	35.6908	0.35	22.54	9.8	1	17N	4W	0.42	21.80	11.97	Avg
-107.29	35.6575	0.35	23.32	13.24	1	17N	4W	0.09	1.63	1.54	Std
								3	3	3	no.

LA VENT	CLEARY										
-107.03	35.7372	0.89	21.14	16.89	1	17N	2W				
-107.04	35.7211	3.47	20.8	9.99	1.001	17N	2W	discount lb sulfur			
-107.04	35.7169	0.92	21.08	9.08	1	17N	2W				
-107.04	35.7111	0.55	20.56	11	1	17N	2W				
-107.05	35.7131	1.18	19.88	14.17	1	17N	2W				
-107.05	35.7103	1.28	19.95	14.7	1	17N	2W				
-107.05	35.7142	1.44	20.76	12.01	1	17N	2W				
-107.05	35.7194	1.31	22.01	9.02	1	17N	2W				
-107.07	35.7042	1.89	19.57	15.82	1	17N	2W				
-107.08	35.7156	0.72	20.06	9.99	1	17N	2W	1.11	20.77	11.82	Avg
-107.09	35.6878	0.78	22.5	8.05	1.001	17N	2W	0.37	0.83	2.78	Std
-107.09	35.7211	1.26	20.91	11.15	1.001	17N	2W	11	12	12	no.
-107.11	35.7033	0.94	21.66	10.43	1	17N	3W				
-107.14	35.6828	0.8	18.85	15.99	0.99	17N	3W				
-107.18	35.6769	0.59	23.66	8.7	1	17N	3W	0.74	21.20	12.78	Avg
-107.18	35.6878	0.64	19.97	12.88	0.99	17N	3W	0.12	1.66	2.91	Std
-107.2	35.6608	0.71	21.85	15.91	1	17N	3W	5	5	5	no.
-107.01	35.7714	0.45	22.02	8.1	1	18N	2W				
-107.01	35.7661	0.4	19.69	13.82	1	18N	2W				
-107.02	35.7458	0.9	21.46	6.65	1	18N	2W				
-107.02	35.7719	0.54	18.41	14.98	1	18N	2W	0.76	20.17	11.09	Avg
-107.03	35.7525	0.89	20.17	14.48	1	18N	2W	0.34	1.24	3.40	Std
-107.03	35.7478	1.38	19.27	8.48	1	18N	2W	6	6	6	no.
-106.92	35.8467	0.88	20.56	6.6	1	19N	1W				
-106.94	35.9006	1.35	19.81	8.39	1	19N	1W	0.84	20.94	7.02	Avg
-106.98	35.8333	0.56	21.58	7.2	1	19N	1W	0.33	0.80	0.91	Std
-106.99	35.8322	0.55	21.8	5.9	1	19N	1W	4	4	4	no.
	Avg	0.92	20.74	11.13							
	Std	0.36	1.17	3.31							
	no	26	27	27							

SAN MAT	CLEARY	Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg						
-107.44	35.5586	1.35	17.78	20.27	1	15N	6W				
-107.46	35.535	0.92	21.08	11.76	0.999	15N	6W				
-107.49	35.5097	1.64	19.57	11.77	0.999	15N	6W	1.35	19.91	13.31	Avg
-107.5	35.5156	1.21	19.93	11.72	1	15N	6W	0.27	1.24	3.49	STd
-107.5	35.5161	1.61	21.19	11.03	1	15N	6W	5	5	5	no.
-107.55	35.5033	1.24	20.05	12.11	1	15N	7W				
-107.57	35.5183	0.89	21.32	8.41	0.999	15N	7W				
-107.58	35.5628	1.14	19.66	16	1	15N	7W				
-107.59	35.5033	0.66	19.48	13.27	1	15N	7W				
-107.6	35.5119	1.14	19.52	12.71	1	15N	7W				
-107.6	35.5111	0.8	20.78	11.84	1	15N	7W	0.91	20.00	12.87	Avg
-107.61	35.5061	0.73	19.32	15.93	1	15N	7W	0.22	0.66	2.26	Std
-107.62	35.5344	0.67	19.87	12.72	0.999	15N	7W	8	8	8	no.

Weighted Averages-Menefee Formation / **Averages by Township**

								lbs_sulfur Mbtu	Mbtu/ton	%ash	
-107.63	35.5203	1.16	19.43	12.8	1	15N	8W				
-107.63	35.5203	1.16	19.43	12.76	1	15N	8W				
-107.64	35.5156	0.85	17.47	14.12	1	15N	8W				
-107.65	35.5058	0.51	20.75	9.79	0.9996	15N	8W				
-107.67	35.5111	1.06	20.72	8.98	1.001	15N	8W				
-107.68	35.5083	1.33	20.83	7.95	1	15N	8W				
-107.7	35.52	0.62	19.93	19.25	1	15N	8W				
-107.7	35.5411	0.7	20.38	10.45	1	15N	8W				
-107.71	35.5161	0.75	19.83	14.96	1	15N	8W				
-107.71	35.5197	0.67	19.5	7.4	1	15N	8W				
-107.71	35.5494	0.89	21.09	14.12	0.999	15N	8W				
-107.72	35.5597	1.35	18.64	17.39	1	15N	8W				
-107.72	35.5539	1.06	16.9	18.45	1	15N	8W				
-107.72	35.5639	2.09	20.31	14.39	1	15N	8W	1.08	19.61	13.44	Avg
-107.73	35.5586	1.47	19.09	19.68	1	15N	8W	0.41	1.14	3.77	Std
-107.73	35.5542	1.68	19.5	12.54	1	15N	8W	16	16	16	no.
-107.32	35.6483	0.64	21.07	11.95	1	16N	5W				
-107.33	35.6469	0.35	22.52	11.08	1	16N	5W				
-107.33	35.6331	0.5	21.97	5.59	1	16N	5W				
-107.36	35.65	0.46	21.28	15.32	0.99	16N	5W				
-107.39	35.6214	0.67	21.38	9.77	0.9962	16N	5W	0.57	21.56	10.95	Avg
-107.39	35.6239	0.8	20.94	15.08	0.999	16N	5W	0.14	0.51	3.32	Std
-107.41	35.6175	0.54	21.73	7.83	0.999	16N	5W	7	7	7	no.
-107.42	35.6036	0.74	19.78	16.74	1	16N	6W	0.60	18.83	17.82	Avg
-107.43	35.5789	0.45	17.87	18.9	1	16N	6W	0.15	0.96	1.08	Std
-107.57	35.5778	0.9	19.2	14.25	1	16N	7W				
-107.68	35.6072	1.08	20.55	11.06	1.001	16N	8W				
-107.69	35.5858	0.87	19.76	14.62	1	16N	8W	0.91	20.09	12.08	
-107.7	35.5922	0.72	19.89	10.94	1	16N	8W	0.13	0.30	1.50	
-107.73	35.6444	0.96	20.16	11.68	0.999	16N	8W	4	4	4	
	Avg	0.95	20.03	13.01							
	Std	0.38	1.17	3.42							
	no.	43	43	43							

STANDIN	CLEARY	Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg			Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
-107.84	35.6436	1.24	19.14	13.07	1	16N	10W	1.54	19.29	12.11	Avg
-107.84	35.6486	1.64	20.26	8.72	1	16N	10W	0.22	0.74	2.47	Std
-107.84	35.6453	1.74	18.46	14.55	1	16N	10W	3	3	3	no.
-107.75	35.64	0.84	20.76	8.1	1	16N	9W				
-107.78	35.6508	0.54	19.87	11.2	1	16N	9W				
-107.8	35.6528	0.84	18.15	18.1	1	16N	9W				
-107.81	35.6519	0.7	19.03	13.1	1	16N	9W				
-107.82	35.6525	0.71	19.2	11.34	1	16N	9W	1.01	19.20	13.14	Avg
-107.83	35.6478	2.19	17.69	17.7	1	16N	9W	0.52	0.97	3.34	Std
-107.83	35.6528	1.26	19.7	12.43	1	16N	9W	7	7	7	no.
-107.84	35.6567	0.77	19.11	11.78	1	17N	10W				
-107.85	35.6619	1.54	18.78	13.98	1	17N	10W				
-107.86	35.6594	1.83	18.92	13	1	17N	10W				
-107.86	35.6597	1.1	18.54	15.9	1	17N	10W				
-107.86	35.6697	1.02	18.94	13.5	1	17N	10W				
-107.87	35.6672	0.81	19.49	10.61	1	17N	10W				
-107.87	35.67	0.94	18.16	16.76	1	17N	10W				

Weighted Averages-Menefee Formation								**Averages by Township**			
								lbs_sulfur			
								Mbtu	Mbtu/ton	%ash	
-107.89	35.6689	1.08	19.77	9.59	1	17N	10W				
-107.9	35.6797	0.98	20.02	13.68	1	17N	10W				
-107.9	35.6781	1.29	19.34	13.46	1	17N	10W				
-107.91	35.6997	1.3	17.5	11.22	1	17N	10W	1.11	18.68	13.79	Avg
-107.93	35.7219	0.53	15.15	24.48	1	17N	10W	0.33	1.20	3.65	Std
-107.95	35.7394	1.23	19.12	11.31	1	17N	10W	13	13	13	no.
-107.79	35.665	1.31	19.22	13.26	1	17N	9W				
-108.06	35.7792	1.09	19.34	9.96	1	18N	12W	1.04	18.29	12.96	Avg
-108.08	35.8053	1.36	18.18	14.41	1	18N	12W	0.29	0.81	2.12	Std
-108.12	35.7972	0.66	17.36	14.52	1	18N	12W	3	3	3	no.
	Avg	1.13	18.86	13.32							
	STd	0.40	1.08	3.28							
	no	27	27	27							
Wtd Avg's		Lbs_Sulfur						Lbs_Sulfur			
BARKER		Mbtu	Mbtu/ton	% Ash				Mbtu	Mbtu/ton	% Ash	
-108.54	36.7944		21.06	12.7	1	30N	16W		22.99	7.03	Avg
-108.56	36.8028		24.18	3.4	1	30N	16W		1.38	4.06	Std
-108.56	36.7986		23.74	5	1	30N	16W		3	3	no
CHACO CANYON											
0	36.1167	1.47	20.44	7.5	1	21N	11W				
0	36.1181			8.4	1	21N	11W				
0	36.1194	0.88	20.44	10.2	1	22N	13W	0.88	20.41	7.80	Avg
-108.18	36.1383	0.88	20.38	5.4	1	22N	13W	0.00	0.03	2.40	Std
	Avg	1.08	20.42	7.88				2	2	2	no
	Std	0.28	0.03	1.73							
	no	3	3	4							
HOGBACK											
-108.53	36.8025	0.75	23.54	3.85	1	30N	16W				
		Lbs Sulfur/						Lbs Sulfur/			
MONERO		Mbtu	Mbtu/ton	% Ash				Mbtu	Mbtu/ton	% Ash	
-106.84	36.8797	1.78	23.13	10.29	1	31N	1E				
-106.84	36.8992	2.06	24.37	13.46	1	31N	1E				
-106.85	36.8917	0.9	24.44	13.8	1	31N	1E	1.61	24.35	10.55	Avg
-106.89	36.8936	2.75	25.48	9.9	1	31N	1E	0.79	0.74	3.07	Std
-106.9	36.8961	0.58	24.32	5.3	1	31N	1E	5	5	5	no
-106.89	36.8903	2.3	25.18	10.5	1	31N	1W				
-106.89	36.9161	0.4	19.88	6.5	1	31N	1W				
-106.92	36.9142	1.75	24.28	15.44	1	31N	1W				
-106.92	36.9181	1.7	25.92	10.4	1	31N	1W	1.43	24.60	10.21	Avg
-106.95	36.9181	1.9	24.86	11.51	1	31N	1W	0.71	2.33	3.00	Std
-106.95	36.9117	0.51	27.46	6.9	1	31N	1W	6	6	6	no
	Avg	1.51	24.48	10.36							
	Std	0.75	1.80	3.03							
	no	11	11	11							
NEWCOMB											
-108.64	36.3681	0.97	18.56	6.8	1	22N	14W				

Weighted Averages-Menefee Formation

Averages by Township

lbs_sulfur

Mbtu	Mbtu/ton	%ash

STANDING ROCK		Lbs_Sulfur/ Mbtu	Mbtu/ton	% Ash			
-107.85	35.6581	0.6	20.14	9.7	1	17N	10W
-108.33	35.7961	0.69	20.54	8.98	1	18N	14W
-108.34	35.8108	0.74	18.49	15.62	1	18N	14W
	Avg	0.68	19.72	11.43			
	STd	0.06	0.89	2.97			
	no	3	3	3			

Lbs_Sulfur/ Mbtu	Mbtu/ton	% Ash	
0.72	19.52	12.30	Avg
0.03	1.03	3.32	Std
2	2	2	no

Weighted Avg's for Mesaverde Group-(Crevasse Canyon)

Rio Puerco		Lbs_Sulfur Mbtu	Mbtu/ton	%ash	Sec.	T.	R.
0	35.3333	0.96	18.72	7.6	1	10N	2W
-107.09	35.0978	1.46	19.16	6.3	1	10N	2W
0	35.1667	1.09	18.4	10	1	11N	2W
-106.86	35.4633	0.41	19.28	9.5	1	14N	1E
	Avg	0.98	18.89	8.35			
	Std	0.38	0.35	1.48			
	no	4	4	4			

Weighted Avg's for Crevasse Canyon Fm

GALLUP	DILCO	Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	WTd Avg		
-108.71	35.2775	0.86	23.18	9	1	12N	18W
-108.74	35.2825	0.85	23.5	11	1	12N	18W
-108.7	35.5175	0.54	22.89	7.42	1	15N	18W
-108.71	35.5467	0.91	23.87	5.21	0.9998	15N	18W
-108.72	35.5256	0.5	24.2	4	1	15N	18W
-108.72	35.5364			8.11	0.9999	15N	18W
-108.73	35.4806	0.91	20.77	13.17	0.999	15N	18W
-108.74	35.5006	0.6	23.18	6.98	0.999	15N	18W
-108.75	35.5542	0.64	21.8	10	1	15N	18W
-108.75	35.5525	0.76	19.5	19.5	1	15N	18W
-108.82	35.4853	0.92	18.91	20.41	1	15N	19W
-108.85	35.5278	0.42	23.67	5.99	0.999	15N	19W
-108.85	35.5278	0.56	23.43	6.37	0.999	15N	19W
	Avg	0.71	22.41	9.78			
	STd	0.17	1.69	4.94			
	no	12	12	13			

Averages by Township

Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
Mbtu	Mbtu/ton	% Ash	
0.86	23.34	10.00	Avg
0.01	0.16	1.00	Std
0.69	22.32	9.30	Avg
0.16	1.59	4.67	STd
7	7	8	no.
0.63	22.00	10.92	Avg
0.21	2.19	6.71	Std
3	3	3	no

CROWNP	GIBSON	Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg		
-107.84	35.5972	0.97	20.93	6.56	1	16N	10W
-107.88	35.5736	0.91	20.9	10.57	1	16N	10W
-107.9	35.5703	1.29	20.92	9	1.0001	16N	10W
-107.9	35.6186	2.57	20.11	9.97	1	16N	10W
-107.92	35.5925	1.73	19.43	12.02	1	16N	10W
-107.97	35.6386	2.05	18.17	16.82	1	16N	11W
-107.99	35.6567	1.39	21.49	7.99	1	17N	11W
-108.01	35.6961	2.56	19.45	12.26	1	17N	11W
-108.51	35.6778	0.54	20.21	9.76	1	17N	11W
-108.59	35.6778	0.63	18.3	18.24	1	17N	11W
-108.61	35.6778	3.17	15.91	25.2	1	17N	11W
-108.18	35.7189	0.88	21.57	7.02	1	17N	13W
-108.63	35.6908	0.65	21.66	10.5	1	17N	17W
	Avg	1.35	19.93	11.99			
	Std	0.70	1.61	5.03			
	no.	12	13	13			

Averages

Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
1.49	20.46	9.62	Avg
0.61	0.60	1.82	STd
5	5	5	no.
1.43	18.92	15.05	Avg
0.79	1.76	5.80	Std
5	6	6	no.

GALLUP	GIBSON	Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg		
-108.74	35.5411	0.42	21.47	7.97	0.9994	15N	18W
-108.75	35.4903	0.81	19.19	6.36	1	15N	18W
-108.77	35.5408	0.41	22.17	5.92	0.999	15N	18W
-108.77	35.5408	0.55	22	5	1	15N	18W
-108.78	35.4856	0.51	22.3	9.64	1	15N	18W
-108.79	35.4983	0.45	22	8	1	15N	18W
-108.71	35.5831	0.99	21.35	8.59	0.9999	16N	18W

Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
0.53	21.52	7.15	Avg
0.14	1.07	1.55	Std
6	6	6	no

Weighted Avg's for Crevasse Canyon Fm

Averages by Township

								Lbs Sulfur/ Mbtu	Mbtu/ton	% Ash	
-108.72	35.5783	0.58	22.28	4.4	0.9995	16N	18W				
-108.73	35.5719	0.32	15.97	4.78	0.99974	16N	18W				
-108.74	35.5803	0.67	21.06	10.87	0.9999	16N	18W	0.56	21.01	7.30	Avg
-108.75	35.5683	0.42	22.04	6.77	0.9992	16N	18W	0.20	2.11	2.07	Std
-108.75	35.5678	0.46	21.79	7.83	0.9999	16N	18W	7	7	7	no
-108.76	35.5728	0.47	22.59	7.89	1.001	16N	18W				
-108.82	35.5683	0.47	20.49	14.77	1.0001	16N	19W	0.39	21.61	9.12	Avg
-108.86	35.5842	0.4	21.63	7.96	0.9999	16N	19W	0.07	0.90	4.22	STd
-108.9	35.5956	0.29	22.7	4.62	1	16N	19W	3	3	3	no
-108.92	35.6203	0.37	22.38	7.43	0.9999	16N	20W				
-108.93	35.6019	0.5	20.81	11.58	0.99999	16N	20W				
-108.94	35.5836	0.42	20.99	9.35	1	16N	20W				
-108.94	35.6019	0.61	19.67	15.75	1	16N	20W	0.46	21.22	10.30	Avg
-108.95	35.5936	0.49	20.35	12.69	1	16N	20W	0.09	1.18	3.52	STd
-108.96	35.6169	0.35	23.14	5	1	16N	20W	6	6	6	no.
-108.9	35.6756	0.36	21.45	5.7	0.99992	17N	19W				
-108.9	35.6767	0.46	21.08	7.56	1	17N	20W				
-108.91	35.6842	0.43	22.03	6.36	1.001	17N	20W				
-108.92	35.6561	0.77	15.89	25.48	1	17N	20W				
-108.92	35.7006	0.6	17.64	12.58	1	17N	20W				
-108.92	35.7094	0.63	20.4	7.57	1	17N	20W				
-108.92	35.6628	0.4	22.31	5.84	1	17N	20W				
-108.93	35.6764	0.5	20.01	16.4	1	17N	20W				
-108.93	35.6731	0.39	21.97	7.48	0.99999	17N	20W	0.53	20.20	11.73	Avg
-108.94	35.7022	0.57	21.84	8.4	1	17N	20W	0.11	2.04	6.33	Std
-108.95	35.6575	0.53	18.83	19.6	1	17N	20W	10	10	10	no.
	Avg	0.50	20.96	9.28							
	STd	0.15	1.74	4.63							
	no.	33	33	33							

S. MT.	TAYLOR	GIBSON					
-107.67	35.1769	0.5	21.26	7.1	1	11N	8W
-107.73	35.1681	0.59	23.67	13.6	1	11N	9W

COMBINED GIBSON & DILCO		Lb_sulfur/ Mbtu	Mbtu/ton	% Ash	Wtd Avg						
-108.7	35.5175	0.54	22.89	7.42	1	15N	18W				
-108.71	35.5467	0.91	23.87	5.21	0.9998	15N	18W				
-108.72	35.5256	0.5	24.2	4	1	15N	18W				
-108.72	35.5364			8.11	0.9999	15N	18W				
-108.73	35.4806	0.91	20.77	13.17	0.999	15N	18W				
-108.74	35.5006	0.6	23.18	6.98	0.999	15N	18W				
-108.75	35.5542	0.64	21.8	10	1	15N	18W				
-108.75	35.5525	0.76	19.5	19.5	1	15N	18W				
-108.74	35.5411	0.42	21.47	7.97	0.9994	15N	18W				
-108.75	35.4903	0.81	19.19	6.36	1	15N	18W				
-108.77	35.5408	0.41	22.17	5.92	0.999	15N	18W				
-108.77	35.5408	0.55	22	5	1	15N	18W	0.62	21.95	8.38	Avg
-108.78	35.4856	0.51	22.3	9.64	1	15N	18W	0.17	1.43	3.83	Std
-108.79	35.4983	0.45	22	8	1	15N	18W	13	13	14	no