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COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
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Table of Contents

ILLUSTRATIONS

TABLE

PLATES

REPORT DOCUMENTATION

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DISCLAIMER

ABSTRACT

The deepest, highest ranking and probably gassiest coals in the San Juan River coal region of southwestern Colorado are found in the 100 mile (mi) wide San Juan Basin of Colorado and New Mexico. The thickest and most continuous coal beds in the basin are found in the Cretaceous Fruitland Formation.

Logs from 231 petroleum exploration drill holes were used to produce the following: a Fruitland Formation isopach, a Pictured Cliffs structure map, Fruitland Formation net coal and net sand isopachs, and Fruitland coal percentage and sand percentage maps. Of the 231 holes, 8 produced natural gas from sandstones in coal bearing zones, 5 were production tested in mixed sandstone and coal intervals (one well had an initial production of 1.6 MMCFGPD), and 5 were drill stem tested in coal bearing zones (one flowed 1 MMCFG in 35 min).

The authors calculate 19.7 billion tons of coal are present in the study area. The coals are ranked high-volatile B (hvB) and high-volatile A (hvA) with local upgrading to medium-volatile (mv). Comparing gas contents of Cretaceous Raton Mesa coals to San Juan Basin coals, a gas potential ranging from 72 cubic feet/ton (cu ft/ton) to 514 cu ft/ton exists. The authors estimate a gas resource in the study area ranging from 1.4 to 10.0 trillion cubic feet.

INTRODUCTION

The Colorado Geological Survey (CGS) is currently involved in a U.S. Dept. of Energy grant entitled "Evaluation of the Methane Content of Unmined/Unminable Coal Beds in Colorado." Coal mine gas occurrences, coal analyses, coal gas content data, and the geologic literature indicate that the San Juan River coal region of southwestern Colorado contains methane gas trapped in coal beds. As noted by Ferebee (1955, p. 175), "the gas in the Fruitland-Pictured Cliffs reservoir [of the San Juan Basin] is exceptionally "dry", more than 98 percent methane, and contains almost no heavier hydrocarbons..some regard it as mostly coal gas." Such evidence justified a detailed methane study of the region. The results of that study are summarized below.

TECTONIC SETTING

Goolsby and others (1979, p. 38), have defined the San Juan River coal region as the area in southwestern Colorado bounded by the lower contact of the coal-bearing Dakota Formation (Figure 1). The primary structure of the coal region is the San Juan Basin, a deep, roughly circular depression approximately 100 mi in diameter (Woodward and Callender, 1977, p. 209). The study area lies within this basin (Figure 1).

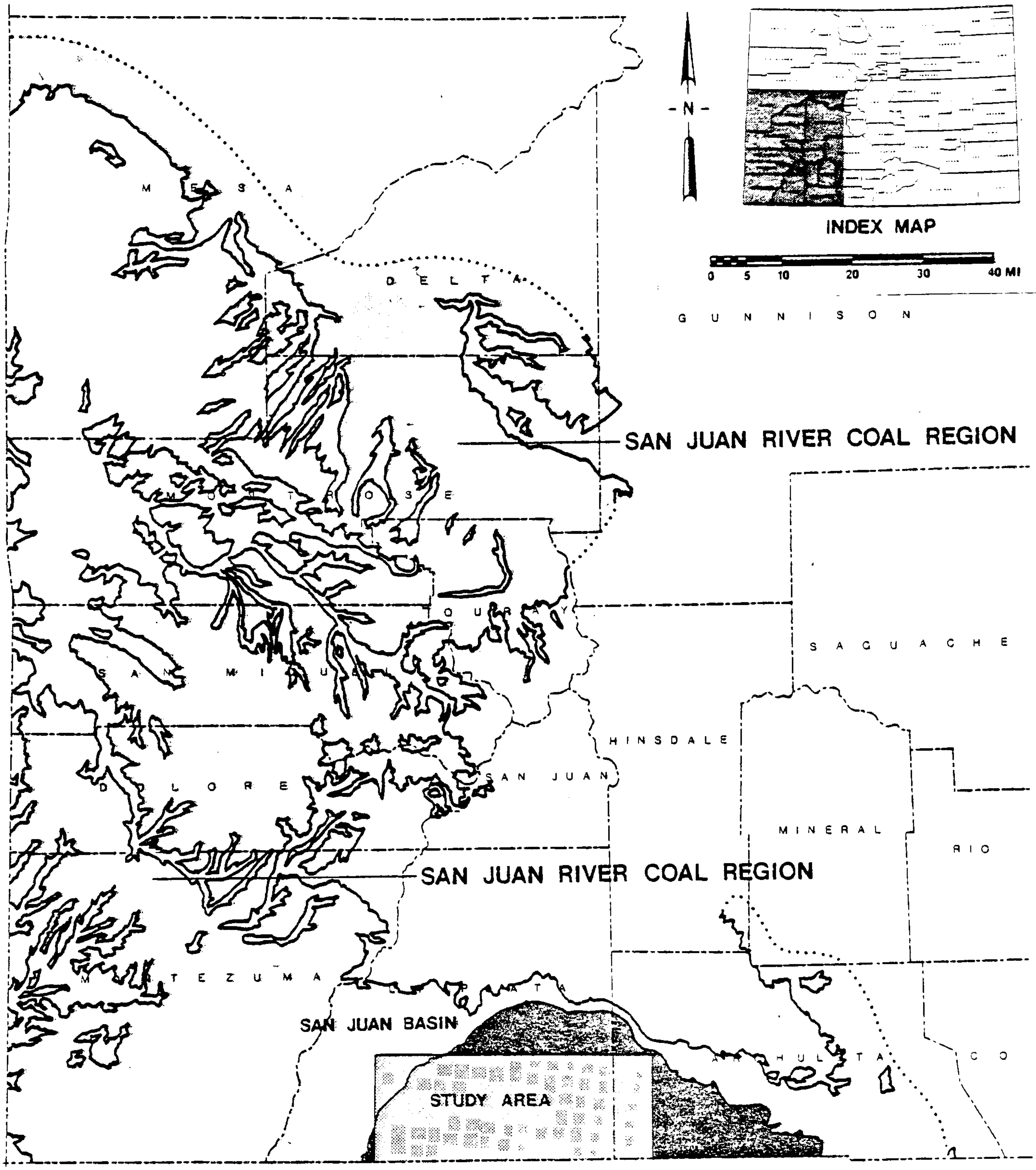


Figure 1. San Juan River Coal Region, southwestern Colorado.

The San Juan Basin is an assymetrical syncline (Figure 2) with at least 13,000 ft of structural relief (Woodward and Callender, 1977, p. 210). The basin's arcuate axis lies south of the Colorado-New Mexico border. The U-shaped Hogback Monocline forms the northern rim of the basin. This monocline dips as much as 60° and has up to 8,000 ft of structural relief (Woodward and Callender, 1977, p. 209). To the east, the Gallina-Archuleta Arch and the Nacimiento Uplift bound the basin. To the south, the basin grades into the Chaco Slope. The southwestern boundary of the basin is formed by the Defiance Monocline.

En echelon northwest-trending folds, and northeast trending high-angle faults of small displacement occur along the basin's eastern boundary (Woodward and Callender, 1977, p. 210). Around the basin's perimeter are radial folds plunging towards the basin's center and minor folds parallel to the basin's margins. The structures shown in Figure 2 formed principally during Late Cretaceous Laramide time. The entire area was eperogenically uplifted, as much as a mile (Kelly, 1951, p. 129), causing removal of upper, middle, and some lower Tertiary sediments. Igneous intrusions were emplaced along the basin's margin during Tertiary times.

STRATIGRAPHY

The Precambrian basement has been encountered between 4,685 and 14,030 ft below the surface in the San Juan Basin. The basement is overlain by sediments from Cambrian to Quaternary in age. These sediments are briefly described in the stratigraphic chart of the San Juan Basin (Figure 3).

The Cretaceous system contains all the coal-bearing sediments in the basin, and for this reason, only the Cretaceous .stratigraphy will be discussed in this paper. The stratigraphic descriptions only apply to the Colorado portion of the basin.

In the study area, the Stanolind Ute Indian B#6 well (SE1/4, NW1/4, Sec. 17, T.33N., R.7W.) penetrated over 5,000 ft of Cretaceous sediments and the Precambrian was encountered at 13,047 ft. A combination Gamma Ray/SP-Resistivity log of the Cretaceous sediments is shown in Figure 4.

Cretaceous System

Dakota Sandstone

The Dakota Formation is the oldest Cretaceous unit in the basin. This formation represents a transgressive sequence, recording a marine advance from either east to west or east-southeast to west-northwest (Molenaar, 1977, p. 160). It ranges from 175 to 275 ft in thickness and is usually divided into three zones. The lowest zone, which unconformably overlies the Morrison Formation, is a fluvial coarse conglomerate. The middle zone is a paludal, carbonaceous shale and coal sequence with occasional fluvial sandstones. The upper zone is a fine grained, marginal marine sandstone. Facies changes make correlation of these three zones across the basin extremely difficult.

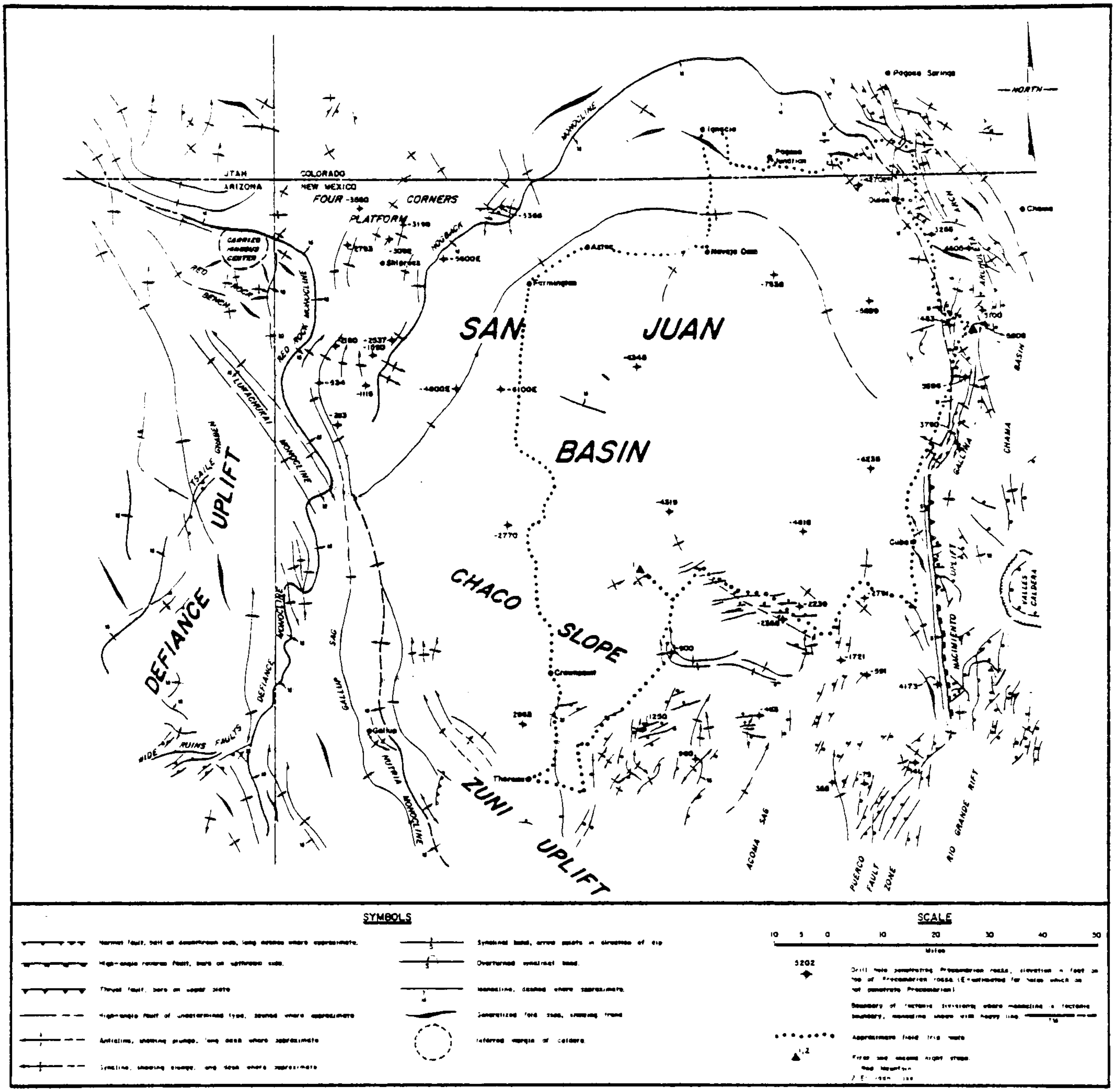


Figure 2. Tectonic map of the San Juan Basin (from Woodward and Callender, 1977, p. 210).

AGE	FORMATION		LITHOLOGY	● OIL AND ☼ GAS SHOWS
EOCENE AND PALEOCENE	San Jose Fm	250'-400'	Gray to brn ss and varg sh	
PALEOCENE AND UPPER CRETACEOUS	Nacimiento Fm	350'	Brn & gray ss, grnsh & gray sh	
UPPER CRETACEOUS	Animas Fm	1100'-2600'	Brn ss with varg sh	
	McDermott Mbr		Conglomeratic ss & sh	
	Kirtland Sh	1000'-1200'	Gray sh and brn ss	
	Fruitland Fm	100'-600'	Gray sh with gray and brn ss, coal	☼
	Pictured Cliffs Ss	125'-400'	Lt gray ss with sh	☼
	Lewis Sh	100-2500'	Gray sh with ss lenses	☼
	Mesaverde Group: Cliff House Ss, Menefee Sh, Point Lookout Ss	350'-1100'	Massive ss, brn & gray sh, with coals in the Menefee Fm.	☼
? ?	Mancos Sh	400'-2000'	Dk gray sh with ss lenses, calc at base	●
LOWER CRETACEOUS	Dakota Ss	175'-275'	Lt brn ss w/sh lenses, coal	☼ ●
JURASSIC	Morrison Fm	300'-600'	Gray & brn ss, sh	☼
	San Rafael Group: Bluff Ss	?	Grnsh-gray ss	
	San Rafael Group: Summerville Fm	80'+	Red-brn gypsif sh	
	San Rafael Group: Todilto Fm	?	Plty, impure ls	
	San Rafael Group: Entrada Ss	50'-200'	Red & orange ss with dk red sh	
	San Rafael Group: Carmel Fm	25'-100'	Sft red-brn sdy sh	
TRIASSIC	Glen Canyon: Navajo Ss	0'-300'	Buff & red ss	
	Glen Canyon: Kayenta Fm	0'-40'	Red-brn sdy sh, locally calc	
	Glen Canyon: Wingate Ss	0'-750'	Dk red-brn sft ss	
	Chinle Fm	1500'	Red sh & ss	
	Shinarump Cong	0'-125'	Crm to red-brn crs ss & cong	
	Moenkopi Fm	0'-200'	Red-brn choc & gray sh locally calc	
PERMIAN	Cutler Fm	1400'	Red ss & red sh	
PENNSYLVANIAN	Rico Fm	0'-150'	Red-brn sh with thin ls	
	Hermosa Fm	1000'-2000'	Ls ss & sh	
	Paradox Fm	0'-3000'	Salt, gypsum & blk sh with thin ls	☼ ●
	Molas Fm	25'-100'	Dk gray & purple sh	
MISSISSIPPIAN	Leadville Ls	100'	White & brn ls	
DEVONIAN	Ouray Ls	100'	Gray ls	
	Elbert Fm	0'-150'	Ls, ss & sh	
CAMBRIAN	Tintic-Ignacio Fm	0'-80'	Quartzite, sdy sh & cong	
PRECAMBRIAN			Granite & schist	

Figure 3. Generalized stratigraphic column of the San Juan Basin, Colorado (modified from Barnes and Hemenway, 1950, p. 97).

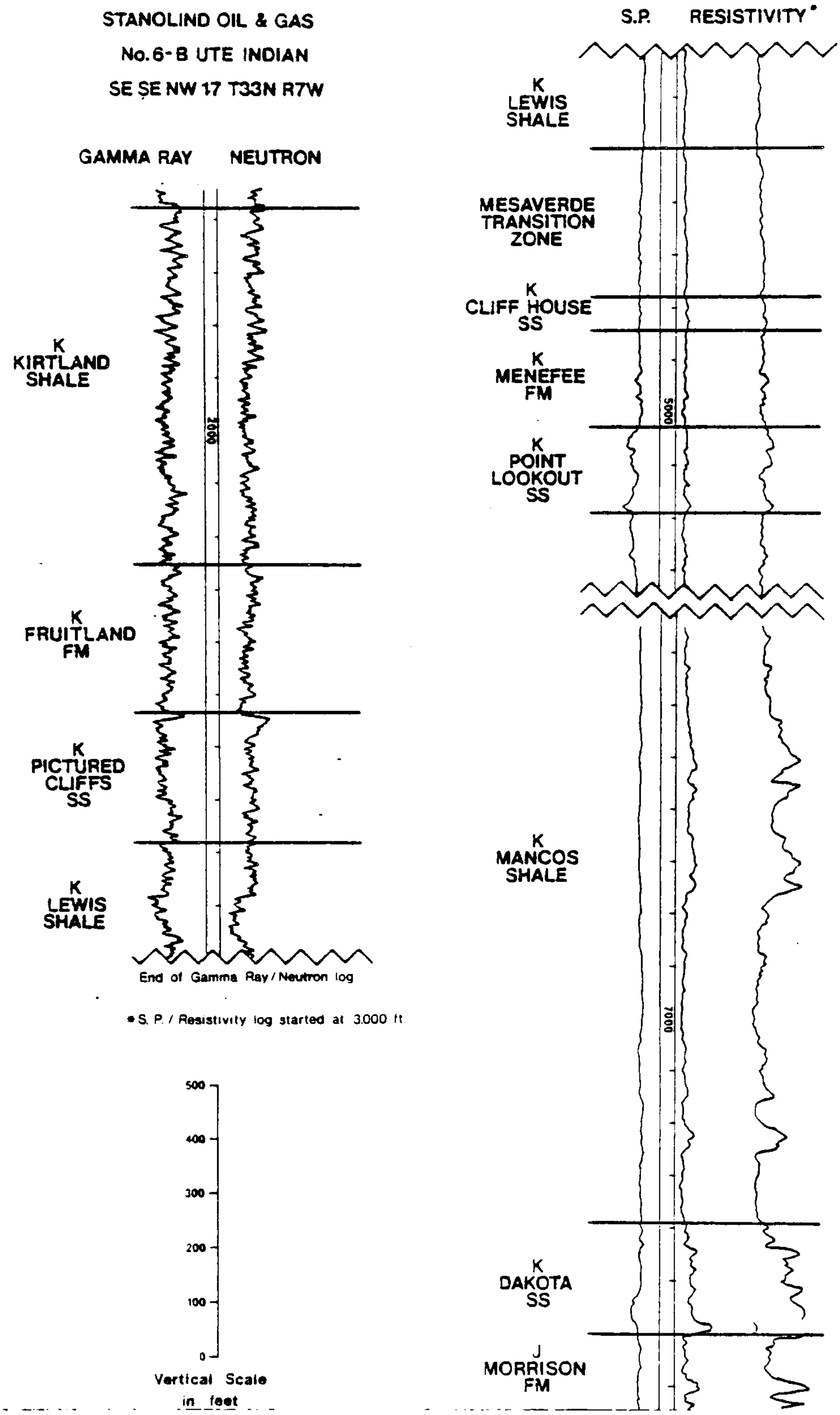


Figure 4. Coal-bearing Cretaceous (Dakota, Menefee, and Fruitland) and associated formations in the San Juan Basin.

Mancos Shale

The Mancos is a marine shale conformably resting on the Dakota. This formation, ranging from 400 to 2,000 ft in thickness, makes up the bulk of the marine sediments of the basin. The Mancos was deposited in a deep water, low energy environment. It is predominantly a dark shale with a few calcareous concretions and bentonite beds. A thin limestone horizon occurs near its base, and offshore sandstone deposits near its top. Some authors divide the Mancos into two subgroups separated by an unconformity (Lamb, 1973, p. 72).

Mesaverde Group

The Mesaverde Group is a 350 to 1,100 ft thick regressive sequence divided into three formations: the basal Point Lookout, the Menefee, and upper Cliff House.

The Point Lookout Formation is a regressive barrier beach sandstone deposited during a period of greater sediment influx than basin subsidence (Sears, et al, 1941, p. 116). It is a gray to brown, medium grained, sandstone ranging from 100 to 300 ft in thickness. Root marks occasionally occur in the contact zone between the Point Lookout and the overlying Menefee Formation.

The Menefee Formation is a series of paludal carbonaceous shales, fluvial sandstones, floodplain shales, and coals deposited above the barrier beach sands of the Point Lookout (Molenaar, 1977, p. 164). Its thickness ranges from 0 ft where the Point Lookout and Cliff House intertongue on the eastern edge of the study area to a maximum of 400 ft.

The Cliff House Formation is a transgressive sandstone sequence overlying the Menefee Formation. Formation thickness ranges from 150 to more than 450 ft. This gray sandstone weathers yellowish to a reddish brown. It contains lenses of hard, fine to medium grained sandstone, interbedded with softer, fine grained sandstones, mudstones, and shales. These lenses which intertongue with the Lewis and Menefee Formations are the result of minor regressions in the transgressive sequence.

Lewis Shale

The Lewis Shale is another major marine, transgressive deposit ranging in thickness from less than 100 ft to greater than 2,500 ft in the northeast. The Lewis is dark gray, gray-green, and black in color. It contains sandy intervals, calcareous concretions, and numerous bentonite beds. The most prominant bentonite is the Huerfanito Bentonite Bed. This marker bed is usually picked on resistivity, conductivity, and transit-time geophysical logs and has been correlated across the entire basin (see Fassett and Hinds, 1971, p. 6).

Pictured Cliffs Sandstone

The Pictured Cliffs Formation is a regressive, coastal-barrier sandstone overlying the Lewis Shale. The formation thickness varies from

125 to 400 ft due to minor transgressions and regressions. The lower portion of the Pictured Cliffs is primarily interbedded sandstone and shales and the upper portion is a quartzitic, fine to medium grained sandstone.

Fruitland Formation

The Fruitland Formation is a coastal plain deposit of paludal carbonaceous shales, siltstones, sandstones, and coals deposited behind the regressing Pictured Cliffs strand line (Figure 5). The formation ranges from less than 100 ft to greater than 600 ft in thickness and contains evidence of fresh and brackish water environments. The sandstones are soft to hard and gray-white to brown in color. The shales are firm and gray, brown and black in color. The coals were deposited in lagoons, marshes, swamps, and abandoned channels and covered by fluvial shales and sandstones. The Fruitland-Kirtland contact occurs at the top of the highest coal or carbonaceous shale bed, above the base of the Fruitland.

Kirtland Shale

The Kirtland Formation is a 1,000 to 1,200 ft thick sequence deposited in back coastal areas and floodplains. Fassett and Hinds (1971, p. 23) divide this formation into two members. The lower member is a gray to gray-brown shale similar to the upper Fruitland shales. The upper Kirtland member, here called the Farmington-Upper Shale Member, is a combination of interbedded sandstones and shales. The shales of this member are gray, brown, green, and white in color and the sandstones are fine to medium grained and poorly sorted. The absence of carbonaceous shales and coals in this formation suggests a depositional environment in which higher stream gradients and good drainage prevented accumulation of organic material (Fassett and Hinds, 1971, p. 23).

Cretaceous-Tertiary System

Animas Formation

The Animas Formation is divided into two members: the lower McDermott Member and the Upper Member. The McDermott Member is up to 400 ft thick and is composed of lenticular sandstones, shales, and purplish conglomerates (rich in andesitic debris). The Upper Member is a grey-green to tan shale with numerous conglomerates. It is 1,100 to 2,600 feet thick (Newman and McCord, 1980, p. 3-14).

Tertiary System

The Tertiary System in the study area is a basin fill sequence consisting of the Cretaceous-Tertiary Animas Formation, and the Tertiary Nacimiento, and San Jose Formations. Since the Tertiary Formations do not contain coal, they are not discussed in this paper. A description of these formations can be found in Newman and McCord (1980, p. 3-16).

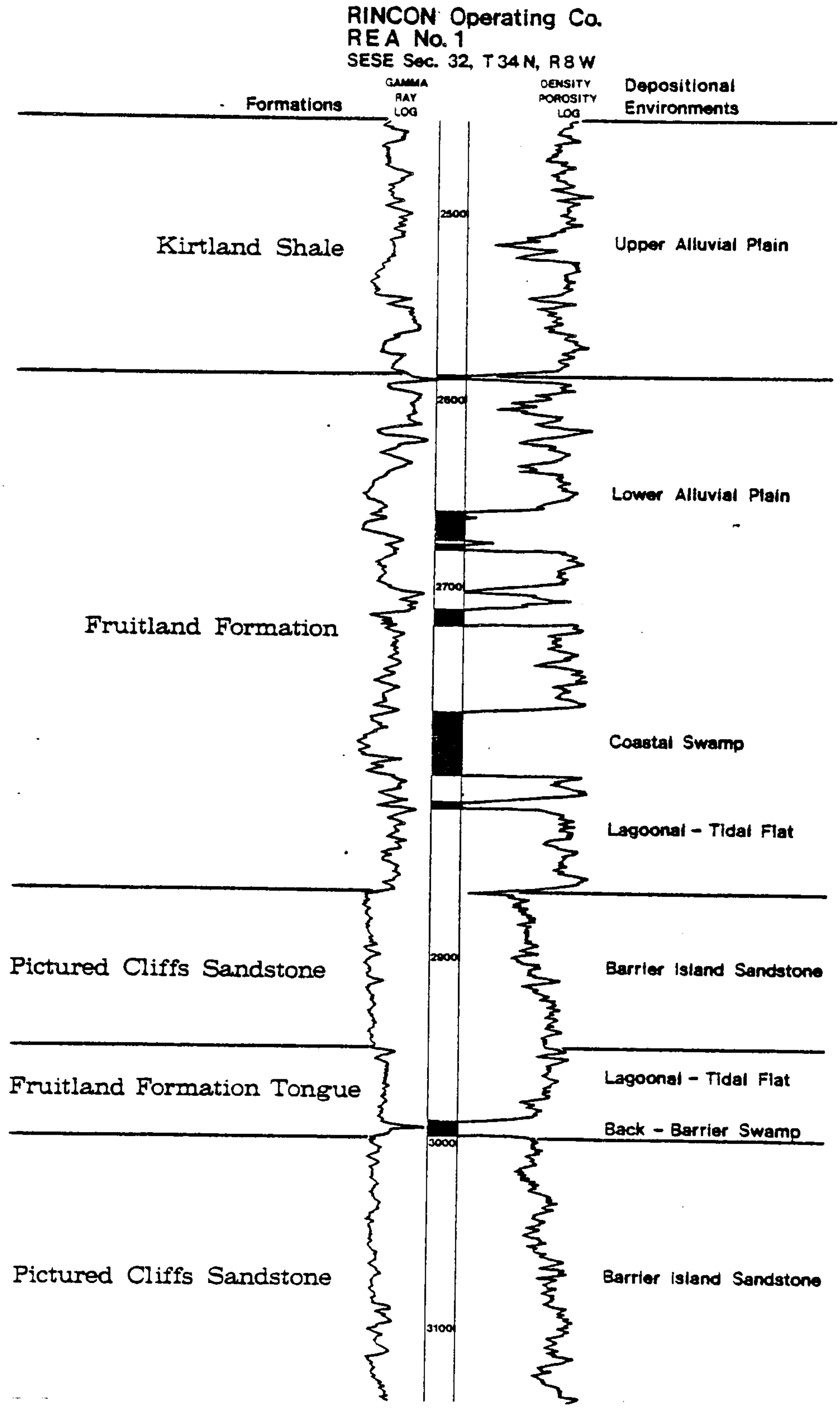


Figure 5. Upper Cretaceous formations of the San Juan Basin. Coals are shown in black.

COAL

Coal Bearing Formations

Three of the formations described previously contain coal in the San Juan River region. In ascending order, they are the Dakota, the Menefee (Mesaverde Group), and the Fruitland Formations.

Four major coal horizons have been delineated in surface exposures of the Dakota Formation (see Boreck and Murray, 1979, p. 54). Seams average from 2 to 8 ft in thickness (Wilson and Livingston, 1980, p. 70) but locally may reach 15 ft. All seams are discontinuous and grade laterally into carbonaceous shale. The Dakota Formation was probably deposited in a flood-plain/braided stream environment with greater peat accumulation during more stable periods.

Like the Dakota coals, the Menefee coals are extremely lenticular. There are 3 major coal bearing horizons, which may contain multiple beds of coal (Boreck and Murray, 1979, p. 55). The seams generally range from 2 to 8 ft in thickness and locally may attain thicknesses of 12 ft. Deposition of peat occurred on a delta-plain between distributary channels.

The Fruitland Formation, which averages 400 ft in thickness, has the thickest and most continuous coal seams in the region. It contains two major coal zones with an occasional third zone where a Fruitland Formation tongue is present (Figure 6). The thickest and most continuous seams are found in the lowermost 70 ft of the formation. Seam thicknesses throughout the entire formation range from less than 1 ft to 72 ft (see Appendix A). The areas of greatest peat deposition probably occurred behind the barrier coastline in brackish to fresh-water lagoons and marshes, with minor deposition on the upper coastal plain (Figure 7).

Coal Fields

The study area includes part of the Durango Coal Field where Menefee and Fruitland coals have been mined. Figure 8 shows the locations of the mines in the study area and the surrounding region. Over 30 mines have produced Fruitland Formation coals since the mid-1880's. Coal bed names generally vary with the location of the mine and with the operator (Figure 6).

Production

Production data on the mines of this area are hard to obtain. Often, no records were kept and many mines were not operated on a year-round basis, due to the lack of a rail system and a small local demand. As of 1977, the available cummulative production figures for the mines in the Fruitland Formation were 141,765 short tons of bituminous coal and 17,728 short tons of subbituminous coal (Boreck and Murray, 1979, p. 57).

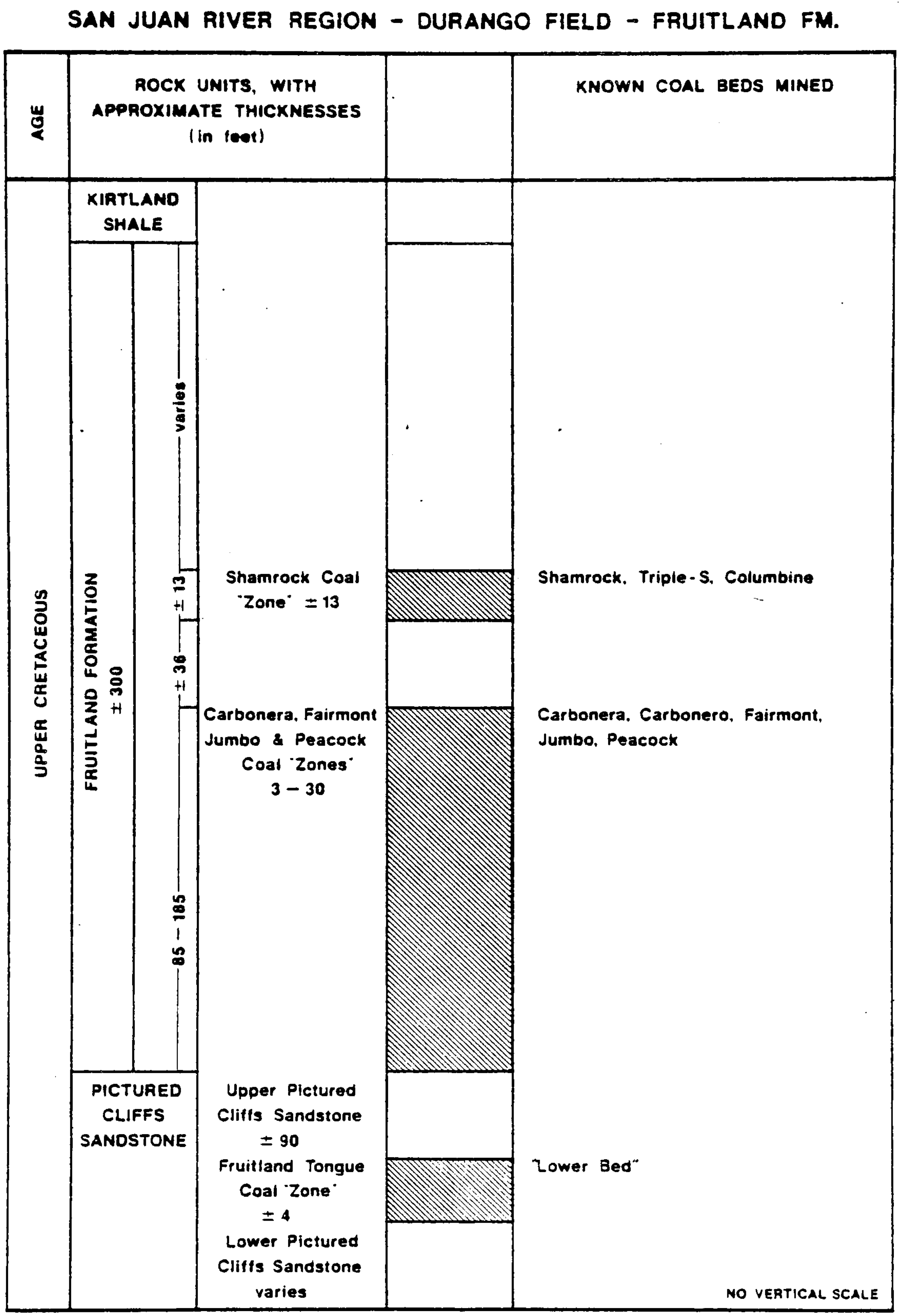


Figure 6. Generalized columnar section of coal-bearing rocks in the Fruitland Formation, Durango field, San Juan River region, Colorado (from Boreck and Murray, 1979, p. 56).

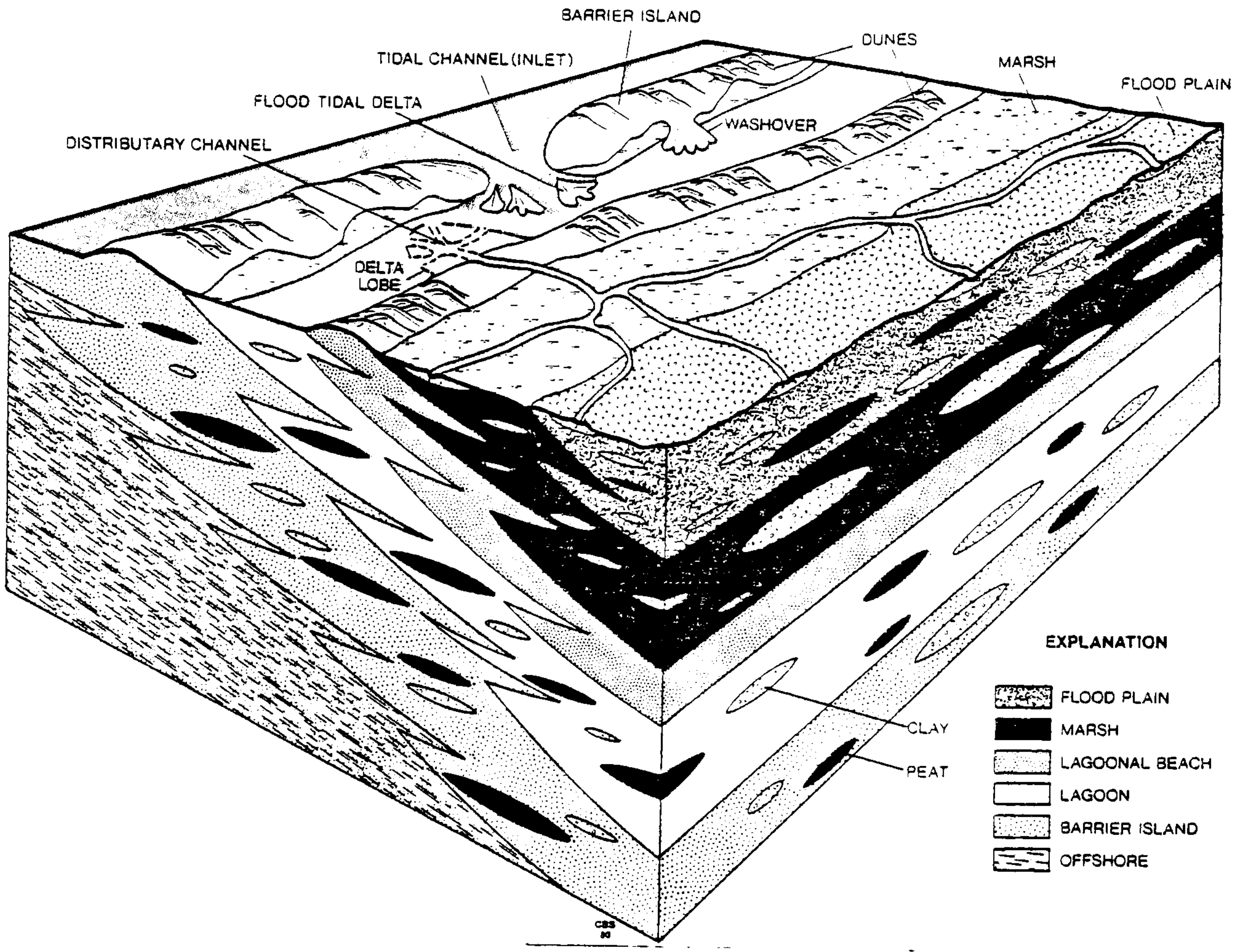


Figure 7. Schematic block diagram showing depositional environments of Fruitland coals.

Resources

Study Area

The authors chose a 590 sq mi study area in the Colorado portion of the basin for coal resource and coal bed methane evaluation because it contained some coals of medium-volatile rank (Figure 9). A great deal of methane gas is generated at this rank (Figure 10). In addition, the overburden in this area is probably sufficient to prevent gas loss and there are enough logs available in the area so that the coals can be mapped. The Fruitland coals are considered the best potential methane targets in this area for the following reasons:

1. The Fruitland Formation contains a larger number of thick coal beds than either the Menefee or Dakota Formations. Individual coal beds up to 72 feet have been identified in the Fruitland Formation in the study area (see Appendix A), while typical thicknesses of Menefee and Dakota coal beds average 8 ft or less.

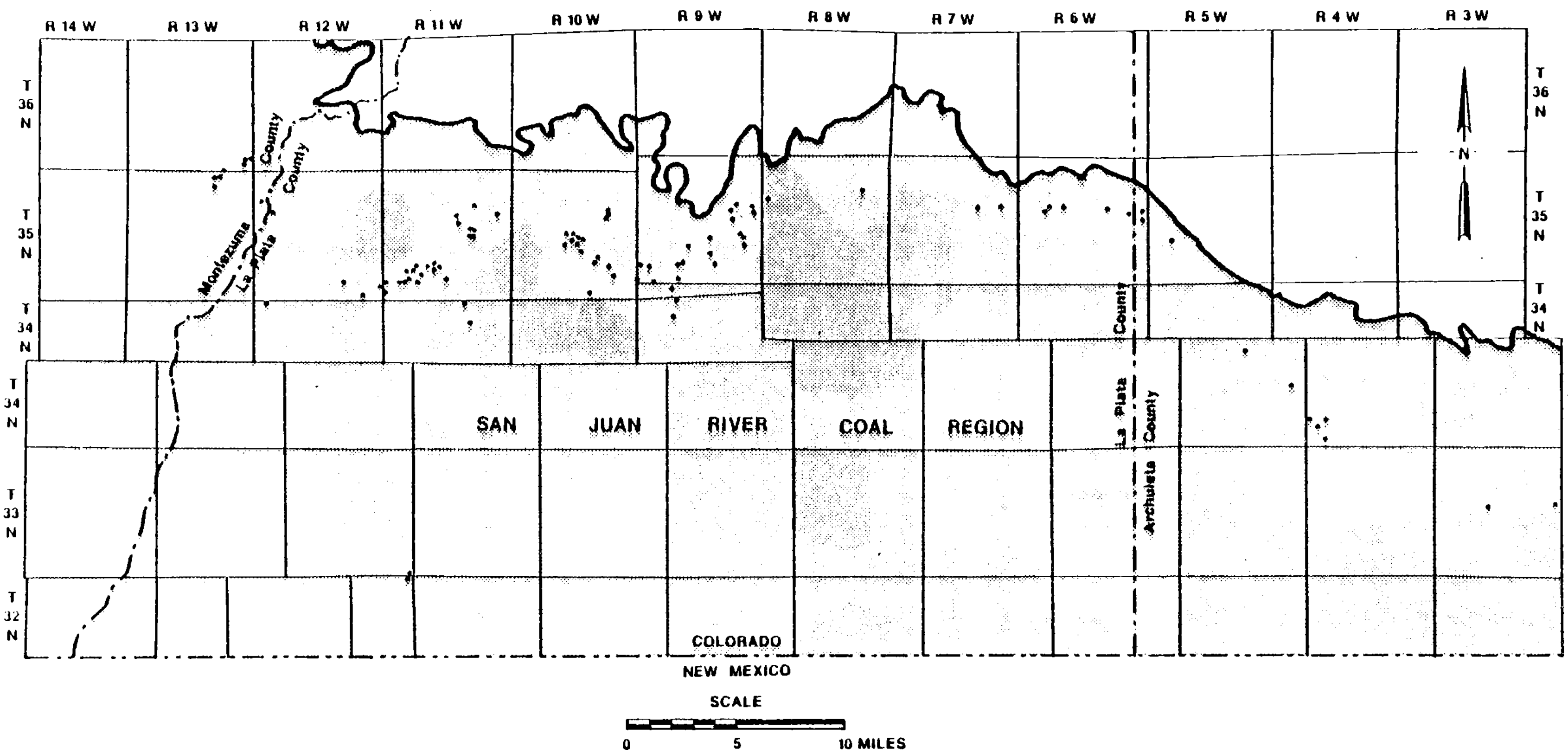


Figure 8. Active and historical coal mines in the San Juan River coal region, southwestern Colorado (from Boreck and Murray, 1979).

2. The Fruitland Formation coal beds formed behind regressive barrier islands in marshes and lagoons (see Figure 6 and Fassett and Hinds, 1971, p. 17; Shomaker and Holt, 1973, p. 6; Fassett, 1977, p. 193). Such coal beds are more continuous than those formed in the deltaic depositional environments of the Menefee and Dakota Formations.

3. Overburden thicknesses on Fruitland Formation coal beds are 4,000 ft or less. In comparison, overburdens on Menefee coals often exceed 5,000 ft and overburdens on Dakota coals can exceed 8,000 ft.

Please note: The study area and target Fruitland Formation were chosen not only because of high methane potential but also because of data availability. Additonal areas within the San Juan Basin and the deeper Menefee and Dakota Formations could also contain large quantities of methane gas (see Appendix B).

Maps

Nine maps were constructed to show the coal resources of the Fruitland Formation in the study area. Logs from 231 of 719 drill holes in the study area could be used for coal bed determination. Radioactivity logs (gamma ray-neutron logs), bulk density logs, sonic logs, neutron porosity logs, density porosity logs, and compensated density porosity logs were used to identify coal beds.

Interpretation of these logs was based on the following observations. Coals usually have low natural radiation which is seen as a low response on gamma ray logs. They also reflect low apparent density (high apparent porosity) on neutron, sonic, and density logs (Figure 11). Caliper logs were used when available to prevent confusing caved zones with coal seams.

SP-resistivity and gamma ray neutron logs can mislead the interpreter when looking for coals. The response of a SP-resistivity log in a freshwater-bearing sandstone is very similar to the response in coal zone. The Fruitland Formation has freshwater sandstones interbedded with the coals; therefore these logs were not used for picking coals. The response of gas bearing sandstones and coals can be confused on gamma-ray neutron logs. Since this type of log was used for picking coals in this study, it should be noted that the total coal thickness may be exaggerated by the inclusion of gas-bearing sandstones.

Coal bed and sandstone thicknesses obtained from the geophysical logs are conservative estimates. Coal thicknesses, depths, partings, and roof and floor rocks are listed in Appendix A. The subsurface maps on Plates 1, 2, and 3 were constructed from the data in Appendix A.

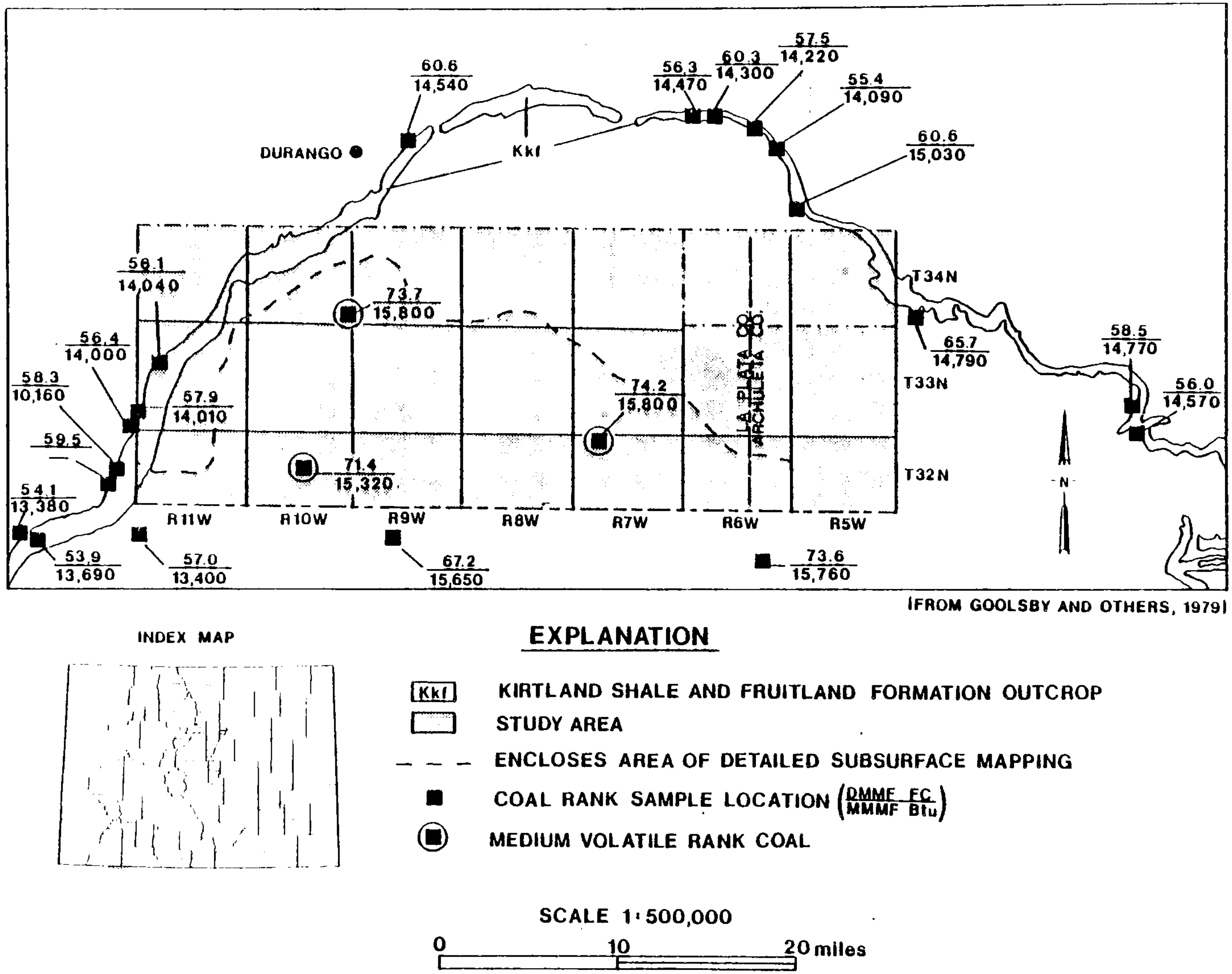
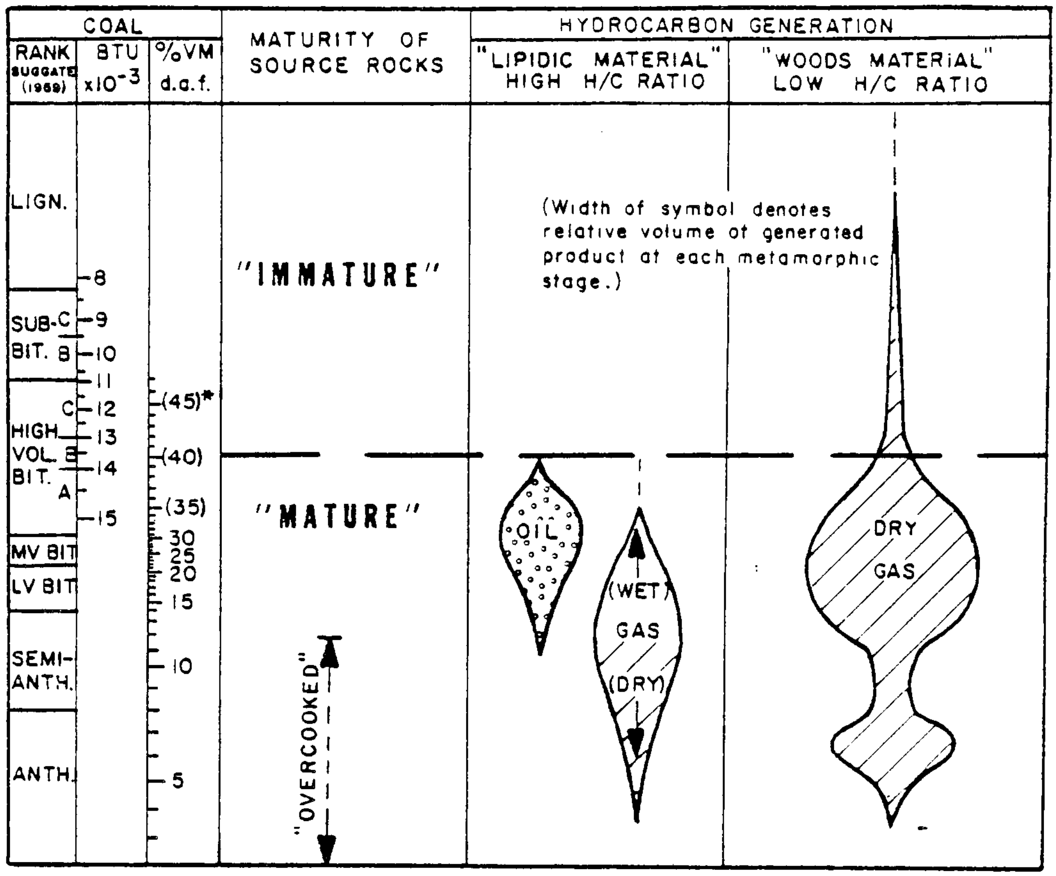


Figure 9. Coal rank sample location map of the study area and surrounding region (from Goolsby and others, 1979).



*% VOLATILE MATTER IN PARENTHESIS IS SUITABLE ONLY FOR HUMIC, VITRINITIC COALS.

Figure 10. Organic metamorphism in coals and its relation to hydrocarbon generation (from Dolly and Meissner, 1977, p. 261).

Plate 1

Map A, Plate 1 shows the location of petroleum exploratory drill holes used in this study.

Map B, Plate 1 is a surface geologic map. The Cretaceous-Tertiary Animas Formation and younger sediments outcrop within the study area. The Fruitland Formation is only exposed at the basin's steeply dipping margins.

Map C, Plate 1 is a structure map contoured on the Fruitland-Pictured Cliffs contact. Periods of stability and minor transgressions, during the overall regression, created intertonguing of the Pictured Cliffs and Fruitland Formations in some areas. The gray shaded areas on Map C show

Figure 11

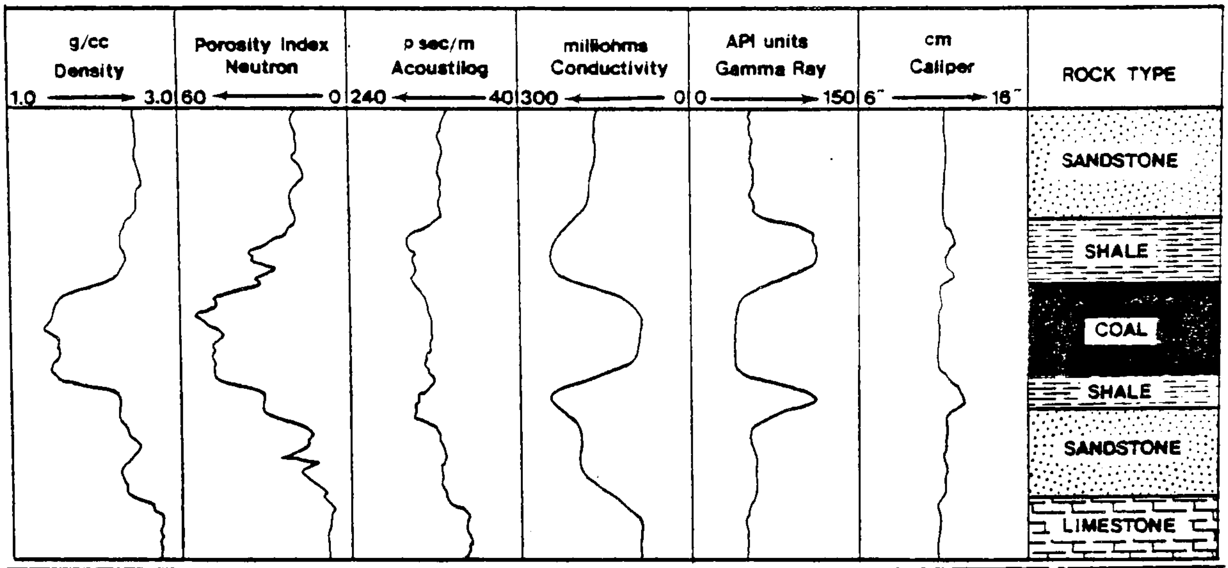


Figure 11. Appearances of coal and associated lithologies on geophysical logs (from Kowalski and Fertl, 1976, p. 2).

where the intertonguing is visable on the geophysical logs used in this study. Due to the presence or absence of intertonguing, three different depositional sequences are possible in the Fruitland-Pictured Cliffs contact zone. The three sequences are described along with the contacts chosen by the authors.

1. Non-tonguing contact-The coals, shales, and sandstones of the Fruitland can directly overlie the obviously massive Pictured Cliffs Sandstone. In this case, the contact was chosen atop the thick Pictured Cliffs Sandstone, below the lowest Fruitland coal bed (see Fassett and Hinds, 1971, p. 19).

2. Tonguing with coal contact-A coal bearing tongue of the Fruitland can bisect the Pictured Cliffs Sandstone. Here, the contact was chosen at the base of the lowest coal within the tongue (gray shaded area on Map C, Plate 1).

3. Tonguing without coal contact-A shaley, non-coal bearing tongue of the Fruitland can bisect the Pictured Cliffs Sandstone. Since the authors found this case hard to distinguish on the geophysical logs, they used the same contact as in case one--the top of the Pictured Cliffs Sandstone, beneath the lowest Fruitland coal bed.

Plate 2

Map A, Plate 2 is an isopach map of the Fruitland Formation.

Map B, Plate 2 (a net coal thickness map of the Fruitland coals) shows the areas of greatest coal development.

Map C, Plate 2 is a coal percentage map of the Fruitland Formation in the study area.

Plate 3

Map A, Plate 3 is a net sand thickness map of the Fruitland Formation.

Map B, Plate 3 is a sand percentage map of the Fruitland.

These maps were constructed to locate the major channel systems in the Fruitland Formation study area. The areas on these maps of greatest net sand thickness and sand percentage should represent areas of major stream develoment and channel overlapping.

Map C, Plate 3 is the map used to determine the coal resource estimate of the study area. It is modified from the net coal thickness map (Map B, Plate 2). Areas of average coal thickness are screened and shaded to show how the map is broken down for planimetering. The total planimetered area is 276.48 square miles. In this area, a reserve of 1.97 X 10^{10} short tons (bituminous) is estimated (see map key for further explanation).

Map Interpretations

Several conclusions can be drawn from these maps:

1. The isopach shows the Fruitland Formation is thickest in the western part of the study area or west and south of the migrating regressive strand line (the gray area on the structure map). The net coal thickness map shows that the greatest amount of coal also occurs landwards (southwestwards) of this strand line. Stable continental deposition continued in these areas for relatively long periods of time, resulting in the formation of a thick Fruitland Formation containing thick coal bodies. Planimetering the total coal thickness map of the Fruitland coals (as shown in Map C, Plate 3) gives a Fruitland coal resource in the study area of 19.7 billion short tons.

2. The areas of greatest coal percentage are found north and east of the strand line. Rapid change in sedimentation occurred during the final regression of the Cretaceous epicontinental sea. As a result, the Fruitland Formation is generally thinner in the northeast and coal represents a larger percentage of the formation.

3. No obvious stream patterns are visible on the sand percentage or net sand thickness maps. This is probably due to the wide spacing of the data points and the ambiguous manner of choosing the upper Fruitland Formation contact on the top of the uppermost coal bed.

OIL AND GAS PRODUCTION

Oil was first discovered in the San Juan Basin during 1911 in New Mexico. From 1911 to 1951, exploration was sporadic due to unfavorable market conditions and transportation costs (Barnes, 1951, p. 156). The completion of El Paso Natural Gas Company's 24 in. pipeline to California in 1951 (Figure 12) and the recent increase in stimulation of "tight" formations has regenerated interest in this region.

Fields

The four major oil and gas fields in the study area are: the Barker Dome Field, the Alkali Gulch Field, the Red Mesa Field, and the Ignacio Blanco Field (Figure 12). They produce oil and gas from Pennsylvanian, Jurassic, and Cretaceous rocks.

Barker Dome Field produces natural gas from the Pennsylvanian Ismay and Paradox Formations and a small amount of oil from the Paradox Formation. The Colorado Oil and Gas Commission reports a total production of 1,084 barrels of oil and 1,534,271 MCF of gas from this field during 1979.

Alkali Gulch Field also produces natural gas from the Pennsylvanian Paradox Formation. The 1979 production was 334,387 MCF.

Red Mesa Field produces oil and natural gas from several Cretaceous horizons. The Dakota Formation produces both oil and gas, the Gallup and Mancos Formations oil only, and the Mesaverde Group natural gas only. The 1979 production for this field was 47,603 barrels of oil and 56,310 MCF of gas.

The largest field in the study area is the Ignacio-Blanco Field (Blanco Mesaverde-Basin Dakota in New Mexico). Production is primarily natural gas from the Jurassic Morrison and the Cretaceous Dakota, Lewis, Gallup, Mesaverde, Pictured Cliffs, and Fruitland Formations. Dual completions are common and the total field production in Colorado for 1979 was 25,192,481 MCF of natural gas.

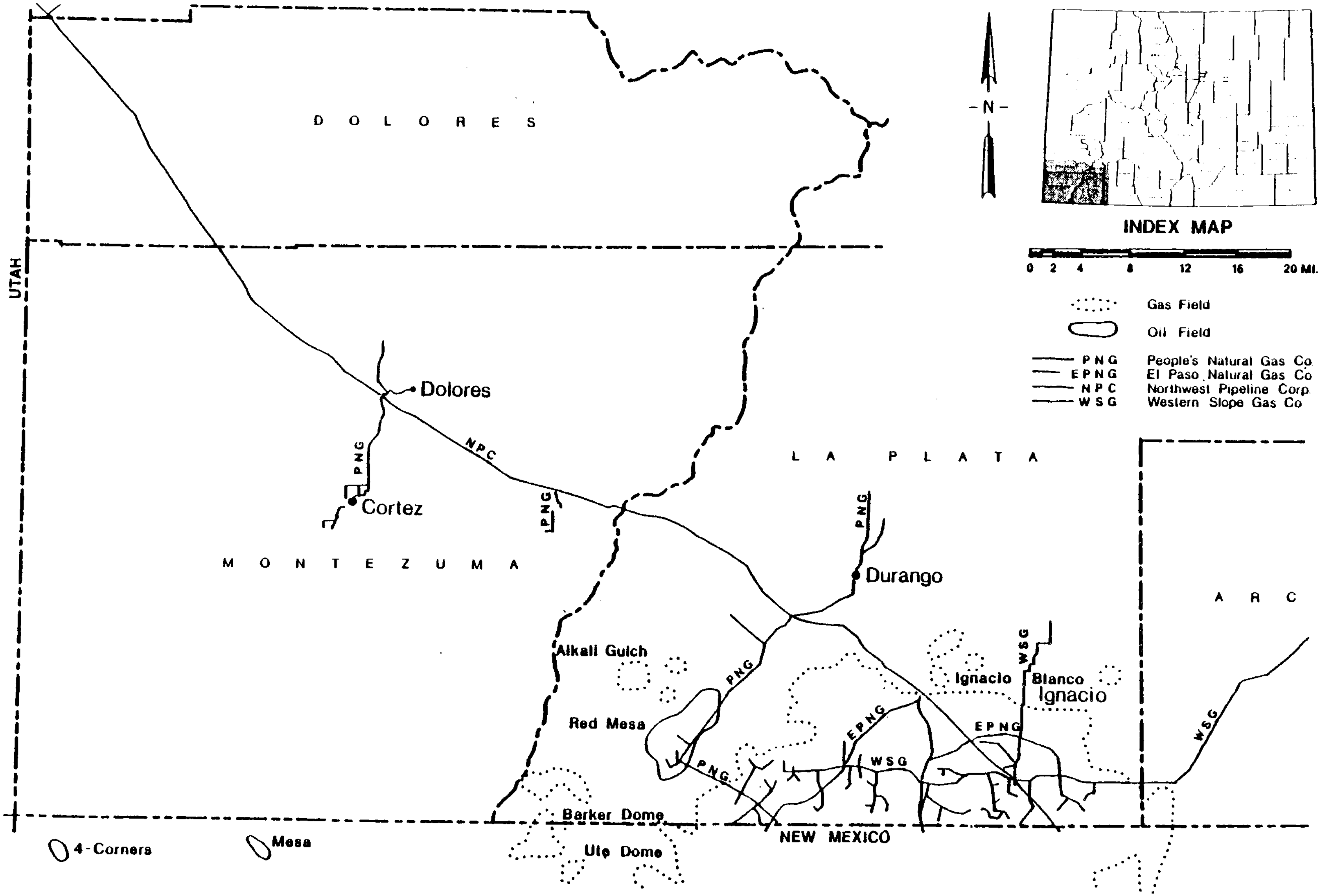


Figure 12. Oil and gas fields and pipelines of southwestern Colorado.

Traps

The Pennsylvanian producing formations are carbonates: limestones, dolomites, oolititic limestones, calcarenites, and calcirudites. Traps are either anticlinal, stratigraphic, or a combination of both. However, it is generally agreed that "stratigraphic variations, from porous reservoir beds to nonporous units, are a major factor in the control of the gas accumulations" (Picard, 1968, p. 1341). Porosity is either intercrystalline, vuggy, intra-oolitic, fracture or some combination of these.

Most Jurassic and Cretaceous reservoirs in the study area are lithologically similar sandstones. These sandstones are medium to fine-grained, argillaceous, slightly calcareous, and somewhat fractured (Silver 1950, p. 117). They often have low permeabilities and porosities. Traps are either anticlinal, stratigraphic or a combination of both.

COAL BED METHANE

In a 1955 discussion of Ignacio-Blanco Field, Ferebee stated that "the Fruitland Formation contains gas in tight, shaley sands, sandy shale, and coal beds." He further noted that this gas was "exceptionally dry, more than 98 percent methane and contains almost no heavier hydrocarbons" and that "some regard it as mostly coal gas."

Since that time, a number of methods for locating coal bed methane have been developed: 1) locating gas occurrences in coal mines, 2) direct desorption of coal samples, 3) locating high ranking coal, and 4) searching for coal gas shows in petroleum exploratory drill holes.

Gas in Coal Mines

Fender and Murray (1978, Plate 1), mapped gas occurrences in 3 mines in the San Juan River coal region. Their map is reproduced in Figure 13. However, these gas occurrences cannot be correlated directly with the gas content of the coal (see Boreck and Strever, 1980, p. 10).

U.S. Bureau of Mines Direct Method

Coal gas content can be measured directly by the U.S. Bureau of Mines direct desorption method. In this method, a sample of coal approximately 1,000 g in weight is obtained from a conventional core. This sample is sealed in a desorption cannister immediately after the core has been removed from the core barrel. The gas emitted by the encapsulated coal is measured daily by water displacement in a graduated cylinder until emission (desorption) ceases (Figure 14). The gas lost from the coal between the time it was first penetrated by the core bit and the time it was sealed in the cannister is estimated using a "back calculation" method. After desorption (1 week to 6 months), the residual gas in the coal is measured as the coal is crushed in a sealed ball mill. The estimated lost gas, plus the measured desorbed and residual gas, are added to give the total in-place gas content (in cc/g or cu ft/ton) of the coal bed. [Refer to McCulloch and others, (1975, p. 3) for a more complete description of this method].

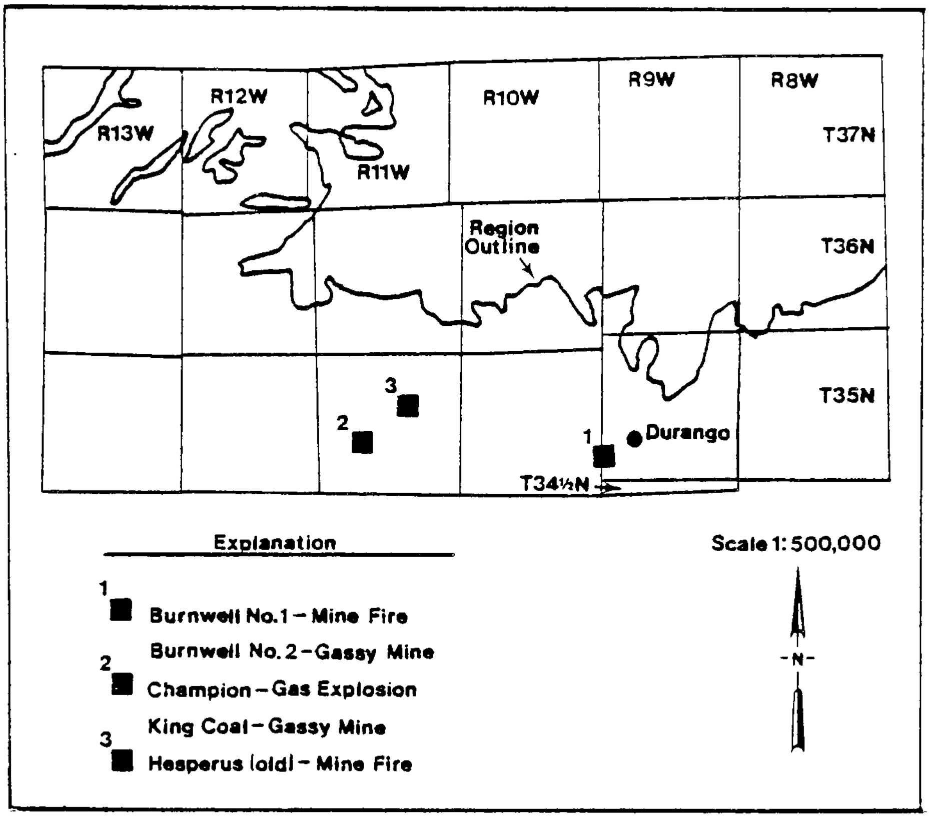


Figure 13. Gassy mines of the San Juan River region.

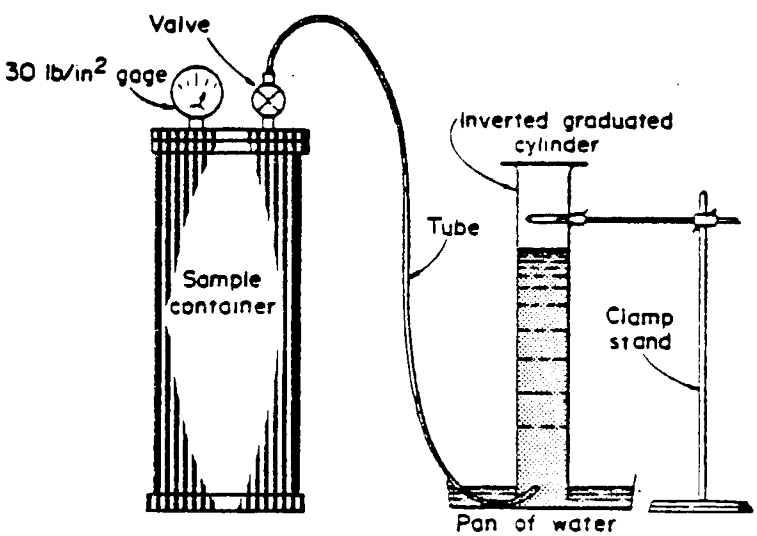


Figure 14. Methane desorption equipment (from Tremain, 1980, p. 35).

This desorption procedure has also been attempted on coal cuttings and coal sidewall cores. Gas contents of desorbed cuttings and sidewall cores seem to be lower than gas contents of conventional core samples of the same coal bed.

Lent (1980, p. 5-7) gives the results of 10 desorption measurements in the San Juan River coal region (see Table 1).

Coal Rank

Coal rank indicates the degree of metamorphism a coal has undergone. There are two standard methods of determining rank--proximate and/or ultimate analyses of coal samples and vitrinite reflectance. In proximate and ultimate analyses, the chemical constituents of a coal sample (100 g or more in weight) are determined in the laboratory using ASTM (American Society of Testing Materials) procedures (see 1978 Annual Book of ASTM Standards, Part 26, p. 380). In the vitrinite reflectance method, the percentage of light reflected by a polished surface of the vitrinite maceral (equivalent to a mineral) indicates the rank of a coal (see Crelling and Dutcher, 1980, p. 15). A 100 g sample of coal is needed for this method also.

Table 1. Desorption results of coal samples from the San Juan River coal region, New Mexico and Colorado.

Test No.	State	Formation	Collector	Depth to bed (ft)	Bed thickness(ft)	cu ft methane/ ton of coal (cm^3/gm)	Apparent rank
1	Colorado	Menefee	CoGs	295	9.0+	5.3(.17)	hvA
2	Colorado	Menefee	CoGS	310	7.5	10.2(.32)	hvA
3	New Mexico	Fruitland	TRW	407	8	44.5(1.5)	hvB
4	New Mexico	Fruitland	TRW	407	8	10.3(0.3)	hvB
5	New Mexico	Fruitland	BuM	1475	11	134.0(4.2)	hvA
6	New Mexico	Fruitland	BuM	1475	11	123.0(3.8)	---
7	New Mexico	Fruitland	BuM	640	7	65.0(2.0)	hvC
8	New Mexico	Fruitland	BuM	733	23	61.0(1.9)	hvC
9	New Mexico	Fruitland	BuM	458	5	124.0(3.9)	hvC
10	New Mexico	Fruitland	BuM	580	12	79.0(2.5)	hvB

BuM - U.S. Bureau of Mines

CoGS - Colorado Geological Survey

TRW - TRW,Inc. (DOE contractor)

Goolsby and others (1979, Plate 2) mapped coal analyses data for numerous Fruitland coal samples in and around the study area (Figure 9). The three samples in the study area are medium volatile in rank. It has been shown that gas generation increases as rank increases. In addition, the greatest amount of gas is generated when a coal is medium to low volatile in rank (see Figure 10).

Gas Shows in Coal Beds

Once the boundaries of a high coal bed methane potential area are ascertained by checking coal thickness, rank, depth, desorption data, etc., gas shows found in coals in petroleum exploratory drill holes can substantiate the presence of a resource. After the coals were located in the 231 drill holes of the mapped area, the authors searched Petroleum Information completion cards and Colorado Oil and Gas Commission well file data for any indication of gas in the coals or coal zones of these wells.

1. Two wells had gas kicks in coal beds (Nos. 18 and 32). These wells are represented by a (✱) on Map A, Plate 1.

2. The five wells marked with a (■) on this map were drill stem tested in coal-sandstone zones. Well number 80 produced an estimated 1 million cubic ft of gas in 35 minutes from a 111 ft zone containing 33 ft of coal.

3. The five wells marked with a (▲) were perforated in both sandstones and coals and were production tested in these zones. Well No. 109 had an initial production of 1,585 MCFGPD from a 130 ft zone containing 54 ft of coal.

4. The 8 wells marked by a (✳) on the map, were found to be producing from Fruitland or Mesaverde sandstones interbedded with coal.

Drilling report data, drill stem test data, and production test data from coal beds or mixed sandstone and coal zones are listed in Appendix B.

Methane Resource Estimates

As mentioned in the Coal Section of this text, planimetering the net coal thickness map (as seen in Map C, Plate 3) gives a Fruitland coal resource in the study area of 19.7 billion short tons. Since the authors had no deep desorption data for the study area, they used gas content data for correlative coals from the Raton Mesa region of Colorado. This correlation is based on the following similarities of the two regions: coal rank, overburden depth, stratigraphic positions, and localized upgrading due to intrusives. Using gas contents obtained in the Raton region (see Tremain, 1980, p. 34) the following range of methane resource estimates were obtained:

Example 1. Assuming all coal is hvB and has a gas content of 72 cu ft/ton--

1.97×10^{10} tons X 72 cu ft/ton = 1.4×10^{12} cu ft methane

Example 2. Assuming all coal is mv and has a gas content of 514 cu ft/ton--

1.97×10^{10} tons X 514 cu ft/ton = 1.0×10^{13} cu ft methane

The lack of deep sample analysis and sample desorption prevents the authors from concluding that the study area contains coals of a specific rank and a specific gas content. Therefore the authors estimate a range of 1.4 trillion cubic feet to 10.0 trillion cubic feet of coal gas could be present in the study area.

CONCLUSIONS

The data indicates that gas is present in the coals of the study area. This gas has been produced from sandstones adjacent to the coals and possibly from the coals themselves. Therefore, it might pay to test the Fruitland coals encountered while drilling for deeper targets. With the right economic factors and development of completion techniques for coal bed methane, this gas resource may prove to be important. Data gained from vitrinite reflectance of cuttings, desorption of cuttings, and desorption of conventional cores will continue to support the existing evidence that coal bed gas is being generated and trapped in the deeper portions of the San Juan Basin.

References Cited

American Society for Testing and Materials, 1978, Classification of coals by rank: Part 26, D 388-77, p. 220-223.

Barnes, F. C., 1951, History of development and production of oil and gas in the San Juan Basin, in Guidebook of the South and West sides of the San Juan Basin, New Mexico and Arizona: New Mexico Geological Society, Second Field Conference, p. 155-160.

Barnes, F. C., and Hemenway, G., 1950, Generalized geologic column of the San Juan Basin, in Guidebook of the San Juan Basin, New Mexico and Colorado: New Mexico Geological Society, First Field Conference, p. 97.

Boreck, D. L., and Murray, D. K., 1979, Colorado coal reserves depletion data and coal mine summaries: Colorado Geological Survey Open-File Report 79-1, 65 p.

Boreck, D. L., and Strever, M. T., 1980, Conservation of methane from Colorado's mined/minable coal beds - A feasibility study: Colorado Geological Survey Open-File Report 80-5, 95 p.

Crelling, J. C., and Dutcher, R. R., 1980, Principles and applications of coal petrology: Society of Economic Paleontologists and Mineralogists, SEPM Short Course Notes No. 8, 127 p.

Dolly, E. D., and Meissner, F. F., 1977, Geology and gas exploration potential, Upper Cretaceous and Lower Tertiary strata, northern Raton Basin, Colorado, in Exploration frontiers of the Central and Southern Rockies: Rocky Mountain Association of Geologists, p. 247-270.

Fassett, J. E., 1977, Geology of the Point Lookout, Cliff House, and Picture Cliffs Sandstone of the San Juan Basin, New Mexico and Colorado, in Guidebook to the San Juan Basin III: New Mexico Geological Society, 28th Field Conference, p.193-197.

Fassett, J. E., and Hinds, J. S., 1971, Geology and fuel resources of the Fruitland formation and Kirtland shale of the San Juan Basin, New Mexico and Colorado: U.S. Geological Survey Professional Paper 676, 76 p.

Fender, H. B., and Murray, D. K., 1978, Data accumulation on the methane potential of the coal beds of Colorado: Colorado Geological Survey Open-File Report 78-2, 25 p.

Ferebee, D. M., 1955, Ignacio gas field, La Plata County, Colorado: American Association of Petroleum Geologists, Rocky Mountain Section, Geological Records, p. 173-184.

Goolsby, S. M., Reade, N. B. S., and Murray, D. K., 1979, Evaluation of coking coals in Colorado: Colorado Geological Survey Resource Series 7, 72 p.

Kelly, V. C., 1951, Tectonics of the San Juan Basin, in Guidebook of the south and west sides of the San Juan Basin, New Mexico and Arizona: New Mexico Geological Society, 2nd Field Conference, p. 124-131.

Kowalski, J., and Fertl, W. H., 1976, Application of geophysical well logging to coal mining operation: Dresser Technical Memorandum, v. 7, no. 8, 11 p.

Lamb, G. M., 1973, The lower Mancos Shale in the northern San Juan Basin, in Cretaceous and Tertiary rocks of the Southern Colorado Plateau, A Memoir: Four Corners Geological Society, p. 72-77.

Landis, E. R., 1959, Coal resources of Colorado: U.S. Geological Survey Bulletin 1072-C, p. 131-132.

Lent, J., 1980, San Juan Basin Report - A study of Upper Cretaceous geology, coal, and coal bed methane resources of the San Juan Basin, in Colorado and New Mexico: Prepared by TRW Energy Systems, Planning Division for the U.S. Dept. of Energy under contract number DE-AC21-78MC08089.

McCulloch, C. M., Levine, J. R., Kissel, F. N., and Deul, M., 1975, Measuring the methane content of bituminous coal beds: U.S. Bureau of Mines Report of Investigations, RI 8043, 22 p.

Molenaar, C. M., 1977, Stratigraphy and depositional history of Upper Cretaceous rocks of the San Juan Basin area, New Mexico and Colorado, with a note on economic resources, in Guidebook to the San Juan Basin III: New Mexico Geological Society, 28th Field Conference, p. 159-166.

Newman, K., and McCord, J., 1980, Detailed Site Investigation - Northern San Juan Basin: Prepared by TRW Energy Systems, Planning Division for the U.S. Dept. of Energy under contract number DE-AC21-78MC08089.

Peterson, J. A., and others, 1949, Sedimentary history and economic geology of the San Juan Basin: Bulletin of the American Association of Petroleum Geologists, v. 49, no. 11, p. 2076-2119.

Picard, M. Dane, 1968, Outline of occurrences of Pennsylvanian gas in Four Corners Region, in Natural Gases of North America: American Association of Petroleum Geologists, Memoir 9, v. 2, p. 1327-1356.

Sears, J. D., Hunt, C. B., and Hendricks, T. A., 1941, Transgressive and regressive Cretaceous deposits in southern San Juan Basin, New Mexico, in Shorter contributions to general geology, 1938-40: U.S. Geological Survey Professional Paper 193-F, p. 101-121.

Shomaker, J. W., and Holt, R. D., 1973, Coal resources of Southern Ute and Ute Mountain Ute Indian Reservations, Colorado and New Mexico:

New Mexico Bureau of Mines and Mineral Resources, Circular 134, 2 22 p.

Silver, C., 1950, The occurrence of gas in the Cretaceous rocks of the San Juan Basin, New Mexico and Colorado, in Guidebook of the San Juan Basin, New Mexico and Colorado: New Mexico Geological Society, 1st Field Conference, p. 109-123.

Wilson, W. L., and Livingston, A. L., 1980, Stratigraphy and coal resources of Dakota Sandstone in Sage Plain, Southwestern Colorado and Southeast Utah, in Proceedings of the Fourth Symposium on the Geology of Rocky Mountain Coal: Colorado Geological Survey Resource Series 10, p. 69-72.

Woodward, L. A., and Callender, J. F., 1977, Tectonic framework of the San Juan Basin, in Guidebook to the San Juan Basin III: New Mexico Geological Society, 28th Field Conference.

APPENDIX A, INDIVIDUAL COAL BED DATA FOR THE FRUITLAND FORMATION FROM GEOPHYSICAL LOG ANALYSIS

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
1	American Petroleum - Argenta Fee #17	6463	6478	3011	sh	sh	48	
	(Sec. 3 T.32N. R.6W.)			2965	ss	sh	3	
				2936	slt	sh	6	
2	Feldt & Maytag - Ute Govt. No. 1	6552	6565	3139	sh	ss	4	
	(Sec. 4 T.32N. R.6W.)			3105	slt	sh	6	
				3074	sh	sh	6	
				3024	sh	sh	24	(1-1)
				2997	ss	sh	3	
				2868	slt	ss	4	
3	Taylor Oil Corp. - #1 McDonald	6141	6152	2792	sh	sh	18	(2-4)
	(Sec. 7 T.32N. R.6W.)			2623	ss	slt	4	
				2591	sh	slt	9	
				2562	sh	sh	4	
4	Kimbark Operating Co. - Penrose No. 1	6399	6411	2821	sh	ss	3	
	(Sec. 8 T.32N. R.6W.			2792	ss	sh	23	
				2730	slt	sh	10	
				2704	sh	slt	15	
				2673	ss	sh	5	
				2622	sh	ss	11	(1-1)
5	Feldt & Maytag - Tubbs No. 1	6279	6289	2767	slt	slt	3	
	(Sec. 9 T.32N. R.6W.)			2760	slt	slt	3	
				2712	sh	sh	18	(1-2)
				2681	sh	sh	21	(1-3)
				2652	ss	sh	2	
6	Feldt & Maytag - Walton No. 1	6246	6257	2820	sh	sh	6	
	(Sec. 10 T.32N. R.6W.)			2806	sh	sh	12	(2-2)
				2794	slt	sh	8	
				2772	sh	slt	8	(1-2)
				2720	ss	sh	3	
7	American Petro. Energy Co. Inc. - Argenta Fee No. 18	6374	6389	2945	sh	sh	46	(1-1)
	(Sec. 11 T.32N. R.6W.)			2922	sh	slt	3	
				2879	sh	sh	3	
8	Feldt & Maytag - Luchini No. 1	6253.5	6267	2845	sh	ss	3	
	(Sec. 12 T.32N. R.6W.			2792	sh	sh	47	
				2640	ss	slt	5	
9	Feldt & Maytag - Perino No. 1	6135	6148	2654	sh	ss	7	
	(Sec. 13 T.32N. R.6W.)			2647	ss	sh	3	
				2612	slt	sh	6	
				2589	slt	sh	4	
				2569	slt	sh	17	
10	Feldt & Maytag - Cox No. 1	6170	6182	2696	sh	ss	10	
	(Sec. 14 T.32N. R.6W.)			2662	sh	sh	20	
				2620	slt	slt	25	(1-2)
				2607	sh	ss	3	
11	Feldt & Maytag - McKeen No. 1	6149	6162	2613	sh	sh	4	
	(Sec. 15 T.32N. R.6W.)			2594	ss	sh	6	
				2537	sh	slt	12	
				2524	ss	sh	2	
12	Feldt & Maytag - Espinosa No. 1	6317	6328	2802	slt	sh	2	
	(Sec. 16 T.32N. R.6W.)			2780	ss	sh	18	(1-2)
				2700	sh	sh	20	(1-2)
				2691	sh	sh	2	
				2685	slt	sh	3	
13	D. M. Ferelee - Lopez No. 1	6443	6455	2980	slt	sh	12	
	(Sec. 18 T.32N. R.6W.)			2944	sh	sh	6	
				2892	ss	sh	3	
				2867	slt	slt	13	
14	El Paso Natural Gas Co. - Allison No. 30	6333	6343	2830	sh	slt	24	(2-6)
	(Sec. 20 T.32W. R.6W.)			2778	ss	sh	3	
				2744	sh	slt	14	
				2722	slt	slt	3	
15	Keebler & Matthews - No. 1 "B" Bone	?	6208	2742	sh	sh	2	
	(Sec. 24 T.32N. R.6W.)			2706	sh	sh	8	
				2684	sh	sh	3	
				2664	slt	sh	10	
				2650	sh	slt	4	
				2627	sh	slt	3	
				2618	sh	sh	3	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
16	Pacific Northwest Pipeline - Colorado 32-7 #1-3 (Sec. 3 T.32N. R.7W.)	?	6467	3112	sh	sh	6	
				3000	sh	sh	6	
				2995	ss	sh	4	
				2950	sh	slt	20	(2-2)
				2878	slt	sh	8	
				2821	slt	sh	7	
				2714	slt	sh	4	
17	Pan American Petrol. Corp. - Snook Gas Unit "B" #1 (Sec. 5 T.32N. R.7W.)	6370	6382	3003	slt	sh	15	
				2920	sh	sh	18	
				2884	sl	sh	10	
				2822	ss	sh	7	
				2790	sh	sh	2	
18	Atlantic Richfield Co. - Southern Ute 6-2, No. 32-7 (Sec. 6 T.32N. R.7W.)	6446	6459	3201	sh	slt	3	
				3195.5	sh	sh	3.5	
				3089	sh	ss	4	
				3081	sh	sh	6	
				3006	sh	slt	22	(4-4)
				2963	sh	slt	12	(1-2)
				2952	slt	slt	2.5	
				2936	ss	sh	10	
				2894	slt	slt	5	(1-0.5)
19	Atlantic Richfield Co. - Southern Ute 7-2, 32-7 (Sec. 7 T.32N. R.7W.)	6907	6920	3716	sh	sh	4	
				3606	sh	ss	12	(1-1)
				3531	sh	sh	23	
				3527	slt	sh	9	
				3509	ss	slt	9	(1-3)
				3463	sh	sh	15	(1-3)
20	Amoco Production Co. - Snooks Gas Unit "A" #1A (Sec. 7 T.32N. R.7W.)	6484	6497	3295	slt	sh	9	(1-1)
				3182	sh	sh	14	(2-3)
				3078	sh	sh	41	(1-2)
				3047	sh	slt	18	
				2963	slt	sh	2	
21	Pan American Petro. Corp. - Wirt Gas Unit "L" #1 (Sec. 8 T.32N. R.7W.)	6298	6310	2935	sh	sh	5	
				2880	sh	slt	14	
				2860	sh	sh	10	
				2811	ss	sh	9	
				2791	sh	ss	5	
22	Johnston & Shear - 1-11 #32-7 (Sec. 11 T.32N. R.7W.)	6243	6253	2968	sh	sh	4	
				2842	ss	sh	4	
				2825	sh	ss	3	
				2822	sh	sh	2	
				2812	slt	sh	4	
				2790	sh	slt	15	
				2778	slt	sh	8	
23	Tadd Petro. Co. - Tiffany No. 1-12 (Sec. 12 T.32N. R.7W.)	6373	6387	3088	sh	sh	4	
				2866	slt	sh	25	
				2802	ss	sh	15	
				2772	sh	sh	9	
				2725	ss	sh	6	
24	Abel & Bancroft - Southern Ute #5 (Sec. 14 T.32N. R.7W.)	6713	6727	3346	sh	sh	8	
				3329	sh	sh	5	
				3255	sh	sh	27	(1-3)
				3217	ss	sh	3	
				3192	sh	slt	6	
25	Abel & Bancroft - Southern Ute #4 (Sec. 15 T.32N. R.7W.)	6262	6274	3040	slt	sh	4	
				2868	sh	sh	6	
				2850	slt	sh	13	
				2816	ss	sh	5	
				2781	slt	sh	24	
				2755	sh	sh	8	
				?	slt	sh	3	
26	Abel & Bancroft - Southern Ute #6 (Sec. 16 T.32N. R.7W.)	6260	6274	3044	slt	sh	4	
				2934	slt	sh	4	
				2918	sh	ss	2	
				2877	slt	slt	29	
				2855	sh	sh	5	
				2806	slt	sh	8	
				2762	sh	sh	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
27	Atlantic Richfield Co. - Southern Ute 18-3, 32-7	6850	6863	3587	slt	slt	14	
	(Sec. 18 T.32N. R.7W.)			3491	slt	slt	31	
				3434	sh	slt	12	
				3372	sh	ss	2	
28	Atlantic Richfield Co. - Southern Ute 18-4, 32-7	6466	6479	3301	sh	ss	2	
	(Sec. 18 T.32N. R.7W.)			3294	sh	sh	2	
				3203	slt	slt	2	
				3164	slt	slt	4	
				3100	slt	slt	29	
				3078	sh	slt	10	(1-2)
				3038	slt	sh	16	
				2985	sh	sh	2	
29	Murchison Trusts - Block 1, #1-19	6616	6625	3322	slt	sh	4	
	(Sec. 19 T.32N. R.7W.)			3246	sh	sh	29	
				3137	sh	sh	24	(1-4)
				3041	ss	sh	4	
30	Abel & Bancroft - Southern Ute #8	6731.5	6744	3570	sh	slt	6	
	(Sec. 21 T.32N. R.7W.)			3563	sh	sh	3	
				3577	slt	sh	3	
				3368	sh	sh	30	
				3255	sh	sh	40	
				3173	ss	sh	3	
31	Atlantic Richfield Co. - Southern Ute 1-3, 32-8	7169	7182	3909	slt	slt	11	
	(Sec. 1 T.32N. R.8W.)			3808	ss	sh	14	
				3756	ss	slt	12	
				3731	slt	slt	8	
				3678	ss	ss	10	
				3649	sh	slt	3	
				3627	ss	sh	11	
				3574	sh	ss	3	
32	Atlantic Richfield Co. - Southern Ute 1-4, 32-8	6689	6702	3437	slt	sh	6	
	(Sec. 1 T.32N. R.8W.)			3325	sh	ss	11	(1-2)
				3261	sh	sh	18	(1-3)
				3241	sh	sh	6	
				3208	sh	sh	7	
				3194	ss	sh	3	
				3180	ss	sh	10	(1-1)
				3135	sh	slt	2	
33	Atlantic Richfield Co. - Southern Ute 2-4, 32-8	7165	7178	3919	slt	sh	3	
	(Sec. 2 T.32N. R.8W.)			3789	sh	sh	6	
				3749	ss	slt	17	(2-3)
				3712	sh	slt	7	(1-2)
				3686	sh	sh	4	
				3669	ss	ss	8	(1-1)
				3657	ss	slt	2	
				3628	slt	sh	9	
34	Atlantic Richfield Co. - Southern Ute 2-3, 32-8	6990	7003	3755	slt	sh	7	
	(Sec. 2 T.32N. R.8W.)			3664	sh	sh	14	(1-2)
				3626	sh	sh	2	
				3608	slt	sh	12	
				3528	slt	sh	9	
				3508	slt	sh	3	
				3495	ss	sh	10	
				3428	sh	sh	2	
				3358	slt	slt	3	
35	Pacific Northwest Pipeline Corp. - Mesa 32-8, No. 2-4	7209	7219	3818	sh	sh	6	
	(Sec. 4 T.32N. R.8W.)			3770	sh	slt	14	
				3713	sh	sh	4	
				3701	sh	sh	9	
				3672	sh	slt	7	
				3532	ss	sh	2	
36	Pacific Northwest Pipeline Corp. - Mesa 32-8, No. 1-6	7268	7280	3859	sh	sh	3	
	(Sec. 6 T.32N. R.8W.)			3851	slt	sh	4	
				3838	sh	slt	8	
				3825	sh	sh	10	
				3810	slt	sh	3	
				3750	sh	sh	9	(1-2)
				3740	sh	sh	6	(1-1)
				3700	slt	sh	6	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
37	Arco Oil & Gas Co. - Southern Ute 11-2, 32-8	6902	6913	3553	sh	sh	24	(1-2)
	(Sec. 11 T.32N. R.8W.)			3498	sh	sh	16	
				3450	sh	sh	16	(2-4)
				3422	slt	ss	2	
				3330	ss	sh	4	
38	Atlantic Richfield Co. - Southern Ute 12-3, 32-8	7111	7125	3893	slt	sh	15	(1-1)
	(Sec. 12 T.32N. R.8W.)			3820	slt	sh	15	(2-2)
				3762	slt	sh	13	
				3700	slt	sh	25	(2-5)
				3682	sh	sh	4	
				3656	sh	slt	18	(1-5)
				3600	ss	sh	2	
39	Atlantic Richfield Co. - Southern Ute 12-4, 32-8	6909	6922	3726	ss	sh	4	
	(Sec. 12 T.32N. R.8W.)			3632	slt	sh	16	(1-1)
				3600	sh	sh	2	
				3568	slt	sh	21	
				3544	ss	slt	19	(1-1)
				3502	ss	sh	23	
				3453	ss	sh	3	
				3421	ss	ss	2	
40	Arco Oil & Gas Co. - Southern Ute 13-3, 32-8	6900	6911	3721	ss	sh	2	
	(Sec. 13 T.32N. R.8W.)			3610	slt	sh	8	
				3594	ss	slt	3	
				3559	sh	sh	11	
				3499	ss	slt	36	(2-7)
				3474	sh	slt	11	
				3400	sh	slt	2	
41	Atlantic Richfield Co. - Southern Ute 14-2, 32-8	6843	6856	3700	slt	slt	3	
	(Sec. 14 T.32N. R.8W.)			3514	slt	sh	7	
				3553	slt	ss	4	
				3547	slt	slt	10	
				3510	slt	slt	6	
				3448	sh	sh	38	(3-7)
42	Atlantic Richfield Co. - Southern Ute 16-1, 32-8	6945	6959	3758	sh	ss	2	
	(Sec. 16 T.32N. R.8W.)			3751	sh	sh	4	
				3681	slt	sh	6	
				3603	slt	sh	6	
				3584	sh	sh	2	
				3563	slt	sh	17	
				3517	sh	sh	3	
				3506	sh	sh	6	
				3465	slt	sh	33	(3-6)
				3460	ss	slt	2	
				3450	sh	sh	2	
43	Murchison Bros. - Block 3 No. 6-18	7168	7183	4004	sh	ss	3	
	(Sec. 18 T.32N. R.8W.)			3926	slt	sh	9	
				3836	slt	sh	11	(1-2)
				3827	sh	slt	4	
				3791	slt	sh	33	(1-2)
				3781	sh	sh	3	
				3738	sh	sh	9	
				3701	sh	ss	6	(1-1)
				3694	ss	sh	2	
				3679	slt	ss	6	
44	Menlo Corp. - Block 3, #5-19X	6873	6885	3643	slt	slt	10	
	(Sec. 19 T.32N. R.8W.)			3631	slt	slt	10	
				3551	ss	sh	11	
				3505	slt	ss	15	(1-3)
				3406	slt	sh	14	
				3425	slt	slt	9	
				3205	slt	sh	4	
				3005	sh	sh	5	
45	Atlantic Richfield Co. - Southern Ute 22-1, 32-8	6784	6798	3671	sh	ss	14	(1-2)
	(Sec. 22 T.32N. R.8W.)			3640	slt	slt	5	(1-1)
				3532	slt	slt	2	
				3502	sh	sh	3	
				3482	slt	sh	14	
				3468	sh	slt	6	
				3439	sh	sh	10	
				3393	ss	ss	32	(2-5)

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
46	Atlantic Richfield Co. - Southern Ute No. 1-1, 32-9 (Sec. 1 T.32N. R.9W.)	7246	7259.5	3962	sh	sh	3	
				3953	slt	slt	5	
				3906	ss	slt	7	(1-2)
				3779	ss	slt	37	(2-6)
				3699	ss	sh	2	
				3683	slt	ss	2	
				3659	sh	sh	10	(1-3)
47	Atlantic Richfield Co. - Southern Ute 1-2, 32-9 (Sec. 1 T.32N. R.9W.)	7233	7246	3967	sh	sh	3	
				3951	ss	slt	8	(2-3)
				3914.5	sh	sh	3	(1-0.5)
				3806	sh	slt	13	(3-3)
				3778	sh	sh	25	(6-9)
				3737	sh	slt	8	(2-1.5)
				3725	sh	sh	3	
				3702	ss	slt	14	(3-4.5)
				3678.5	sh	sh	3.5	
				3670	slt	ss	6	(1-1)
				3656	slt	sh	3	
				3646	slt	slt	6	
				3628	sh	slt	2.5	
48	Atlantic Richfield Co. - Southern Ute 2-1, 32-9 (Sec. 2 T.32N. R.9W.)	7720	7233.5	3881	slt	slt	2	
				3848	slt	slt	2	
				3793	slt	slt	2	
				3718	sh	slt	45	(4-10)
				3707	sh	sh	3	
				3676	ss	sh	22	(3-7)
				3635	slt	sh	7	(1-2)
				3601	ss	slt	4	
				3595	slt	sh	3	
				3585	slt	slt	2	
49	Getty Oil Co. - Sam Burch #6 (Sec. 3 T.32N. R.9W.)	6873	6885	3549	slt	slt	3	
				3441	ss	slt	2	
				3395	slt	sh	6	
				3387	slt	slt	5	
				3374	sh	slt	9	
				3325	slt	sh	8	
				3267	sh	sh	5	
				3176	slt	sh	4	
				3161	slt	slt	3	
50	Skelly Oil Co. - Sam Burch #9 (Sec. 4 T.32N. R.9W.)	6606	6619	3215	sh	ss	3	
				3099	slt	sh	36	(3-6)
				3076	sh	slt	10	
				3012	sh	sh	12	
				2987	ss	sh	10	(1-2)
				2932	sh	sh	6	(2-3)
				2866	slt	slt	4	
51	Murchison Bros. - Block 6, Well #3-5, (Ute) (Sec. 5 T.32N. R.9W.)	6636	6647	3254	ss	sh	4	
				3212	ss	slt	5	
				3169.5	sh	slt	3	
				3155	slt	sh	12	
				3147	slt	slt	4	
				3138	slt	slt	8	
				3125	ss	slt	8	
				3015	ss	sh	10	(1-1.5)
				2987	slt	sh	4	
52	Murchison Bros. - Block 6, Well #5-6 (Ute) (Sec. 6 T.32N. R.9W.)	6481	6492	2971	slt	sh	41	(3-5)
				2858	sh	slt	6	
				2829	slt	slt	3	
				2610.5	sh	sh	3	
53	Murchison Trust - Block 13, No. 1-8 (Sec. 8 T.32N. R.9W.)	6468	6497	3143	sh	sh	4	
				3095	ss	sh	2	
				3080	sh	sh	2	
				3031	sh	sh	46	(3-7)
				2966	sh	sh	10	
				2906	sh	sh	2	
				2873	sh	sh	4	
				2964	sh	sh	2	
				2784	ss	sh	2	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
54	Skelly Oil Co. - Sam Burch No. 1 (Sec. 9 T.32N. R.9W.)	6499	6511	3204	sh	sh	2	
				3189	sh	sh	5	
				3173	sh	sh	6	
				3163	sh	sh	5	
				3094	slt	sh	50	(3-3)
				3080	slt	slt	2	
				2980	sh	sh	8	
				2942	sh	sh	6	
				2839	ss	sh	3	
55	Getty Oil Co. - Sam Burch No. 7 (Sec. 10 T.32N. R.9W.)	6678	6690	3376	slt	sh	3.5	
				3363	ss	slt	7	
				3212	sh	sh	14	(1-1.5)
				3196	sh	sh	12	
				3174	slt	sh	11	
				3131	slt	sh	6	
				3121	slt	sh	3	
				3099	sh	sh	8	
				3060	ss	slt	6	
				3045	sh	ss	3	
56	Atlantic Richfield Co. - Southern Ute 11-2, 32-9 (Sec. 11 T.32N. R.9W.)	7122	7135	3903	sh	ss	3	
				3890	sh	sh	3	(1-1)
				3741	sh	sh	4	
				3733	sh	sh	8	
				3707	slt	sh	23	(3-6)
				3639	sh	sh	2	
				3634	sh	sh	3	
				3605	sh	sh	4	
				3598	slt	sh	2	
				3585	ss	sh	4	(1-1)
				3564	slt	sh	4	
57	Atlantic Richfield Co. - Southern Ute 11-1, 32-9 (Sec. 11 T.32N. R.9W.)	7216	7229.5	3944	sh	ss	4	
				3931	sh	sh	4	
				3752	sh	sh	41	(3-10)
				3650	sh	sh	5	
				3643	slt	sh	3	
				3631	ss	sh	6	(1-1)
				3609	ss	slt	4	
				3584	sh	slt	2	
58	Murchison Bros. - Block 11, No. 3-12 (Sec. 12 T.32N. R.9W.)	7201	7213	3800	ss	sh	2	
				3758	slt	sh	36	(2-5)
				3754	sh	slt	2	
				3689	sh	sh	15	(1-2)
				3654	ss	sh	2	
59	Atlantic Richfield Co. - Southern Ute 13-1, 32-9 (Sec. 13 T.32N. R.9W.)	7165	7177	3962	slt	slt	3	
				3921	slt	sh	2	
				3893	ss	sh	6	(1-1)
				3790	slt	sh	11	(1-1)
				3755	sh	slt	35	(3-7)
				3687	sh	sh	4	
				3677	sh	sh	3	
				3643	ss	sh	6	(1-2)
				3615	slt	sh	5	
60	Arco Oil & Gas Co. - Southern Ute 15-1, 32-9 (Sec. 15 T.32N. R.9W.)	6511	6524	3252	sh	sh	5	
				3242	slt	sh	4	
				3080	slt	sh	52	
				2953	sh	sh	10	(2-3)
				2926	sh	sh	3	
				2903	slt	sh	9	
				2886	sh	slt	3	
61	Murchison Trusts - Block 12, No. 1-16 (Sec. 16 T.32N. R.9W.)	6533	6542	3251	sh	sh	8	
				3237	sh	sh	4	
				3224	sh	sh	2	
				3105	sh	sh	65	(5-11)
				3014	sh	sh	6	
				2915	ss	sh	2	

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
62	Murchison Bros. - 4-17 Ute	6443	6454	3183	sh	slt	3	
	(Sec. 17 T.32N. R.9W.)			3166	slt	slt	5	
				3156	slt	slt	4	
				3141	ss	sh	2	
				3047	slt	sh	43	(2-3)
				2920	slt	ss	7	
				2903	slt	sh	3	
				2879	ss	ss	6	
				2850	slt	sh	2	
				2803	ss	slt	3	
63	Arco Oil & Gas Co. - Southern Ute 20-2, 32-9	6527	6538	3246	slt	sh	5	
	(Sec. 20 T.32N. R.9W.)			3107	sh	sh	46	(2-2)
				3049	sh	sh	12	
				2998	sh	sh	5	
				2984	sh	sh	5	
				2890	ss	sh	3	
				2861	slt	slt	2	
64	Arco Oil & Gas Co. - Southern Ute 22-1, 32-9	6690	6701	3424	sh	sh	4	
	(Sec. 22 T.32N. R.9W.)			3412	sh	sh	7	
				3250	slt	slt	45	(1-1)
				3165	sh	sh	3	
				3161	sh	sh	3	
				3138	sh	slt	2	
				3119	sh	sh	3	
				3088	slt	sh	9	
65	Arco Oil & Gas Co. - Southern Ute 23-1, 32-9	6913	6924	3684	slt	sh	3	
	(Sec. 23 T.32N. R.9W.)			3678	sh	sh	3	
				3627	slt	slt	7	
				3481	sh	slt	42	(2-4)
				3453	slt	slt	3	
				3447	slt	slt	3	
				3423	sh	sh	4	
				3413	slt	sh	7	
				3399	sh	sh	3	
				3373	sh	ss	4	
				3361	slt	ss	5	
66	Compass Exploration - Bondad No. 2-1	6049	6059	2660	sh	ss	2	
	(Sec. 1 T.32N. R.10W.)			2650	sh	sh	5	
				2630	sh	sh	5	
				2537	sh	sh	45	(3-5)
				2438	ss	sh	4	
				2386	sh	slt	8	(1-1)
				2373	ss	sh	2	
67	Ladd Petroleum - North Cox Canyon No. 2-2	6380	6392	3031	slt	sh	3	
	(Sec. 2 T.32N. R.10W.)			3018	sh	sh	5	
				2986	slt	slt	7	
				2899	sh	sh	49	(1-1)
				2828	ss	sh	7	
				2773	sh	sh	2	
				2767	sh	sh	3	
				2725	ss	sh	3	
				2683	sh	sh	4	
				2654	sh	slt	3	
				2638	slt	slt	2	
68	Compass Exploration - North Cox Canyon No. 1-3	6617	6628	3211	sh	sh	4	
	(Sec. 3 T.32N. R.10W.)			3201	sh	sh	6	
				3193	sh	sh	7	
				3122	sh	sh	46	(2-6)
				3047	ss	ss	3	
				3015	sh	sh	3	
				2997	ss	sh	9	
				2950	sh	sh	2	
69	Murchison Trusts - Block 5, No. 2-4	6491	6501	3230	slt	slt	5	
	(Sec. 4 T.32N. R.10W.)			3223	sh	slt	3	
				3122	sh	slt	33	(1-2)
				3100	sh	sh	2	
				3090	sh	sh	10	
				2965	sh	slt	3	
				2894	ss	sh	3	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
70	Compass Exploration Inc. - NW Cox Canyon No. 1-5 (Sec. 5 T.32N. R.10W.)	7307	7320	3893	ss	sh	4	
				3754	sh	sh	64	(3-6)
				3630	ss	sh	25	(2-6)
				3500	sh	sh	2	
				3481	slt	sh	2	
				3473	slt	slt	4	
71	Murchison Trust - Block 5, No. 1-9 (Sec. 9 T.32N. R.10W.)	6529	6539	3155	sh	slt	5	
				3140	sh	sh	7	
				3132	sh	sh	5	
				3060	sh	sh	52	
				2918	sh	sh	2	
				2908	sh	sh	5	
				2887	sh	sh	2	
				2868	ss	sh	2	
72	Murchison Trust - Block 7, No. 5-9 (Sec. 9 T.32N. R.10W.)	6496	6506	3143	sh	sh	3	
				3133	sh	sh	6	
				3031	ss	sh	62	(2-3)
				2972	ss	sh	2	
				2890	slt	sh	3	
				2840	ss	sh	2	
73	Pacific Northwest Pipeline Co. - NW Cedar Hill 32-10, #8-10 (Sec. 10 T.32N. R.10W.)	6354	6365	3038	sh	sh	5	
				3025	sh	sh	4	
				3016	sh	sh	5	
				2905	sh	sh	55	(3-5)
				2770	slt	sh	11	
				2729	ss	sh	3	
74	Pacific Northwest Pipeline Corp. - NW Cedar Hill 32-10, #7-12 (Sec. 12 T.32N. R.10W.)	6014	6026	2630	ss	sh	8	
				2540	sh	sh	50	(3-8)
				2398	ss	sh	9	
75	Atlantic Richfield - Southern Ute 14-1, 32-10 (Sec. 14, T.32N. R.10W.)	6629	6638	3313	sh	slt	2	
				3294	sh	sh	4	
				3252	slt	sh	4	
				3244	sh	slt	3	
				3187	slt	sh	45	(7-8.5)
				3065	slt	slt	18	
				3021	sh	ss	3	
				3016	sh	sh	2.5	
				2976	ss	sh	2	
				2930	ss	sh	2	
76	Murchison Trusts - Block 7-2-15 (Sec. 15 T.32N. R.10W.)	(?)6459	(?)6471	3142	sh	sh	4	
				3131	slt	sh	4	
				3118	sh	slt	9	
				3004	sh	sh	42	
				2909	sh	sh	9	
77	Murchison Bros. - Block 7 #7-16 (Sec. 16 T.32N. R.10W.)	6405	6420	3070	sh	sh	3	
				3059	slt	sh	8	
				3026	sh	sh	7	
				2960	sh	slt	52	
				2922	sh	slt	6	
				2910	ss	sh	4	
				2871	sh	sh	7	
				2866	ss	sh	3	
				2835	sh	sh	4	
				2785	sh	sh	6	
				2772	slt	sh	4	
				2697	sh	slt	2	
78	Pacific Northwest Pipeline Corp. - NW Cedar Hill No. 4-17 (Sec. 17 T.32N. R.10W.)	6587	6599.5	3260	ss	sh	3	
				3252	slt	sh	2	
				3138	sh	sh	62	(1-6)
				3086	sh	sh	3	
				3081	sh	sh	3	
				3062	slt	sh	10	
				3039	sh	sh	2	
				2983	sh	sh	3	
79	Pacific Northwest Pipeline Corp. - NW Cedar Hill 9-19 (Sec. 19 T.32N. R.10W.)	6546	6569	3238	sh	sh	12	(1-1)
				3112	sh	sh	72	(3-8)
				3029	sh	sh	3	
				3022	sh	sh	2	
				3011	sh	sh	9	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
80	Pacific Northwest Pipeline Corp. - NW Cedar Hill 32-10, #2-20	6466	6479	3162	sh	sh	6	
	(Sec. 20 T.32N. R.10W.)			3155	sh	sh	3	
				3147	sh	sh	3	
				3086	sh	sh	6	
				3057	slt	sh	12	
				3036	slt	slt	15	
				2936	slt	sh	18	
				2879	sh	sh	4	
81	Pacific Northwest Pipeline - NW Cedar Hill 3-20	6642	6653	3174	ss	sh	38	(1-2)
	(Sec. 20 T.32N. R.10W.)			3094	slt	sh	20	
				3078	ss	sh	4	
82	Carter Oil Co. - Ute No. 1	6419	6431	3101	sh	sh	3	
	(Sec. 23 T.32N. R.10W.)			3087	sh	sh	11	
				3022	sh	sh	46	(4-6)
				2899	sh	sh	11	
83	Southern Union Production Co. - Ute "A" No. 10	6355	6366	2860	slt	?	21	(1-2)
	(Sec. 1 T.32N. R.11W.)			2783	sh	sh	36	(2-5)
				2691	ss	sh	5	(1-2)
				2668	sh	sh	10	(1-1)
				2656	sh	slt	3	
				2488	slt	sh	3	
84	Southern Union Gas - Ute No. 3-A	6353	6363	2854	sh	sh	14	
	(Sec. 1 T.32N. R.11W.)			2773	sh	ss	38	(2-4)
				2677	sh	sh	3	
				2660	ss	sh	3	
85	Compass Exploration - South Ute No. 1-2	6303	6314	2846	slt	sh	7	
	(Sec. 2 T.32N. R.11W.)			2797	slt	sh	17	
				2780	slt	slt	2	
				2682	ss	sh	36	(2-4)
86	Southern Union Gas Co. - Ute No. 1-C	6240	6251	2770	sh	sh	6	
	(Sec. 10 T.32N. R.11W.)			2714	sh	sh	32	(1-3)
				2677	slt	sh	2	
				2638	sh	sh	42	(3-4)
				2480	sh	sh	4	
87	Compass Exploration Co. - Southern Ute No. 1-10	6249	6263	2757	ss	sh	2	
	(Sec. 10 T.32N. R.11W.)			2748	sh	sh	5	
				2718	sh	sh	20	
				2713	sh	sh	2	
				2613	sh	sh	40	(2-3)
				2582	ss	sh	2	
				2497	ss	sh	3	
88	Southern Union Gas Co. - Ivie No. 2	6306	6316	2804	sh	sh	13	
	(Sec. 11 T.32N. R.11W.)			2797	slt	sh	3	
				2723	sh	sh	40	(1-3)
				2705	sh	sh	2	
				2662	sh	sh	7	
				2596	sh	sh	4	
89	Southern Union Production Co. - Ute B No. 2	6312	6323	2794	ss	sh	20	(1-3)
	(Sec. 11 T.32N. R.11W.)			2768	sh	sh	41	(1-3)
				2690	slt	sh	4	
				2635	ss	sh	2	
				2573	slt	sh	2	
				2566	sh	sh	2	
				2400	slt	sh	2	
90	Southern Union Gas Co. - Ivie No. 1	6466	6477	3063	sh	sh	2	
	(Sec. 12 T.32N. R.11W.)			2960	sh	sh	50	(1-4)
				2953	sh	sh	2	
				2902	slt	sh	8	
91	Southern Union Gas Co. - Ute 7-A	6525	6535	3026	sh	sh	58	(2-5)
	(Sec. 13 T.32N. R.11W.)			3016	sh	slt	4	
				2988	slt	sh	11	
				2943	ss	sh	3	
				2907	ss	sh	3	
				2860	slt	sh	2	
				2852	ss	slt	3	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
92	Supron Energy Corp. - Ute No. 11 (Sec. 13 T.32N. R.11W.)	6594	6604	3213	slt	?	10	(1-4)
				3175	sh	slt	11	
				3098	slt	sh	54	(4-11)
				3065	sh	sh	3	
				3028	ss	sh	4	
				2999	slt	sh	8	
				2986	slt	slt	4	
				2936	sh	sh	4	
				2839	sh	sh	3	
				2800	ss	sh	4	
93	Southern Union Gas Co. - Ute 2-A (Sec. 14 T.32N. R.11W.)	6346	6357	2875	sh	sh	2	
				2849	sh	sh	25	(2-4)
				2788	sh	sh	31	(2-9)
				2682	slt	sh	3	
94	Southern Union Gas Co. - Farmer No. 1 (Sec. 15 T.32N. R.11W.)	6305	6314	2754	sh	sh	25	(1-3)
				2670	sh	sh	36	(1-6)
				2649	slt	sh	2	
				2579	slt	slt	3	
				2565	slt	slt	4	
95	Southern Union Production Co. - Ute #7 (Sec. 15 T.32N. R.11W.)	6280	6291	2751	slt	sh	29	(1-2)
				2688	sh	sh	48	(3-7)
				2646	sh	sh	2	
				2666	sh	sh	7	
				2579	sh	sh	4	
				2569	sh	sh	2	
96	Southern Union Gas Co. - Ute #6 (Sec. 16 T.32N. R.11W.)	6201	6211	2587	slt	sh	26	(1-3)
				2507	slt	sh	43	(1-2)
				2480	sh	sh	2	
				2424	ss	sh	2	
				2410	sh	sh	3	
				2387	slt	sh	3	
97	Murchison Trusts - Block 17, 4-18 (Sec. 18 T.32N. R.11W.)	6095	6105	1502	sh	?	6	(1-1)
				1454	sh	sh	37	(1-4)
				1312	ss	sh	46	(2-4)
				1150	slt	slt	3	
98	Murchison & Trusts - Block 17, No. 2-19 (Sec. 19 T.32N. R.11W.)	5997	6008	2160	sh	slt	4	
				2112	slt	sh	28	(2-3)
				1944	sh	sh	48	(3-5)
				1868	sh	sh	3	
				1860	ss	sh	2	
99	Murchison & Trusts - Block 17 Well 1-20 (Sec. 20 T.32N. R.11W.)	6184	6194	2527	sh	sh	8	
				2474	ss	slt	10	
				2360	sh	sh	40	
				2260	slt	sh	2	
100	Southern Union Gas Co. - Ute No. 5 (Sec. 20 T.32N. R.11W.)	6208	6218	2650	sh	sh	2	
				2630	sh	sh	6	
				2584	sh	sh	7	
				2578	sh	sh	4	
				2503	sh	sh	45	(4-5)
				2375	ss	sh	2	
101	Southern Union Gas Co. - Ute No. 4 (Sec. 21 T.32N. R.11W.)	6290	6302	2714	sh	sh	30	(1-4)
				2640	sh	sh	42	(2-2)
				2568	slt	sh	2	
102	Southern Union Gas Co. - Ute No. 3 (Sec. 22 T.32N. R.11W.)	6387	6398	2850	slt	sh	20	(1-3)
				2800	sh	sh	40	
				2758	slt	sh	2	
				2681	ss	sh	3	
103	Supron - Virbeth Land Co. #1-A (Sec. 23 T.32N. R.11W.)	6471	6483	2948	slt	slt	49	(4-6)
				2879	slt	sh	10	
				2846	ss	sh	4	
				2815	sh	sh	10	
				2803	sh	sh	4	
				2609	slt	sh	3	
104	Southern Union Gas Co. - Ute Govt. #4"A" (Sec. 24 T.32N. R.11W.)	6574	6583	3246	sh	slt	8	
				3174	slt	sh	4	
				3099	slt	sh	41	(1-5)
				3023	slt	sh	7	
				2950	slt	sh	2	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
105	Amoco Production Co. - Candelaria No. 1	6392	6405	2774	sh	sh	3	
	(Sec. 10 T.33N. R.5W.)			2749	slt	sh	18	
				2743	slt	slt	2	
				2726	sh	slt	8	(2-2)
				2673	ss	slt	2	
106	Sun Oil Co. - Wright #1	6196	6210	2739	sh	sh	4	
	(Sec. 16 T.33N. R.5W.)			2699	sh	sh	35	
				2621	slt	sh	3	
107	Sun Oil Co. - Llama & Dunagan #1	6154	6167	2674	ss	ss	42	(1-3)
	(Sec. 28 T.33N. R.5W.)			2603	sh	ss	5	
				2596	sh	ss	3	
108	Consolidated Oil & Gas Co. - Superior Ute No. 2-4	7212	7224	3674	sh	sh	39	
	(Sec. 4 T.33N. R.6W.)			3618	sh	sh	2	
				3582	sh	sh	6	
				3498	ss	sh	8	
109	Consolidated Oil & Gas Co. - Superior Ute No. 1-6	6709	6721	2865	slt	sh	45	
	(Sec. 6 T.33N. R.6W.)			2813	sh	sh	3	
				2775	sh	sh	9	
				2750	ss	sh	3	
110	Fuelco-Sun-Fuelco Sun No. 1 Holt	6476	6486	3013	sh	sh	4	
	(Sec. 30 T.33N. R.6W.)			2951	sh	sh	54	
				2921	sh	sh	2	
				2894	slt	sh	5	
111	Durango Syndicate - Jones No. 1	6495	6507	2835	sh	sh	11	
	(Sec. 31 T.33N. R.6W.)			2767	sh	sh	33	
				2685	slt	sh	3	
112	Pacific Northwest Pipeline Corp. - Ignacio 33-7 No. 7-7	6498	6509	2550	sh	sh	33	
	(Sec. 7 T.33N. R.7W.)			2522	sh	sh	4	
				2478	ss	sh	2	
113	Pacific Northwest Pipeline Corp. - Ignacio 33-7	6453	6463	2578	sh	slt	30	
	(Sec. 16 T.33N. R.7W.)			2540	slt	slt	4	
				2527	slt	slt	3	
				2492	sh	slt	10	
				2466	sh	sh	2	
				2458	ss	sh	2	
114	Amoco Production Co. - Ute Gas Unit "X" 1	6584	6596	2572	sh	sh	43	(1-6)
	(Sec. 17 T.33N. R.7W.)			2559	ss	sh	3	
				2521	ss	slt	5	
				2501	sh	ss	10	
				2459	ss	ss	2	
115	Amerada Petroleum Co. - No. 1 Ute "T" M.V. Gas Unit	6529	6542	2540	sh	sh	40	(2-3)
	(Sec. 18 T.33N. R.7W.)			2532	sh	sh	4	
				2509	ss	sh	2	
				2442	ss	sh	2	
				2369	sh	sh	11	
116	Amoco Production Co. - Ute Gas Unit "Y" 1	6415	6427	2441	ss	sh	59	(3-9)
	(Sec. 21 T.33N. R.7W.)			2386	sh	sh	9	
				2338	sh	sh	3	
117	Stanolind Oil and Gas Co. - Ute Indian B-3	6558	6566	2561	slt	sh	3	
	(Sec. 27 T.33N. R.7W.)			2558	sh	sh	15	
				2538	slt	sh	2	
				2513	sh	sh	3	
				2486	sh	ss	7	
				2450	sh	slt	2	
118	Pan American Petroleum Corp. - Simms Gas Unit No. 1	6487	6501	2850	sh	slt	2	
	(Sec. 30 T.33N. R.7W.)			2787	slt	sh	35	(3-5)
				2746	sh	sh	12	
				2731	ss	sh	4	
				2705	ss	slt	3	
				2690	sh	slt	3	
119	T.H. McIlvain - Aspaas Payne No. 1	6480	6492	2896	sh	sh	4	
	(Sec. 30 T.33N. R.7W.)			2850	sh	sh	3	
				2823	sh	sh	22	
				2817	sh	sh	4	
				2800	slt	ss	6	
				2770	slt	sh	13	
				2758	sh	slt	4	

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
120	Pan American Petroleum Corp. - Wirt Gas Unit "A" No. 1	6431	6443	2895	sh	sh	4	
	(Sec. 31 T.33N. R.7W.)			2840	sh	sh	20	(2-4)
				2830	sh	slt	4	
				2790	sh	sh	8	
				2865	slt	sh	7	
				2857	sh	slt	2	
				2728	sh	slt	3	
121	Pacific Northwest Pipeline Corp. - Ignacio 33-7 No. 8-32	6400	6411	2820	sh	sh	4	
	(Sec. 32 T.33N. R.7W.)			2750	ss	sh	15	(1-3)
				2697	slt	sh	8	
				2645	sh	sh	5	
				2641	sh	sh	2	
122	Mobil Oil Co. - Southern Ute 22-33	6361	6371	2731	slt	sh	4	
	(Sec. 33 T.33N. R.7W.)			2711	sh	sh	4	
				2702	sh	sh	3	
				2654	sh	sh	26	
				2614	sh	sh	8	
				2592	sh	sh	8	
				2540	sh	sh	2	
123	Pacific Northwest Pipeline Corp. - Ignacio 33-7, 3-34	6613	6622	2794	slt	sh	48	(3-6)
	(Sec. 34 T.33N. R.7W.)							
124	Pacific Northwest Pipeline Corp. - San Juan 33-8 Mesa 2-1	6637	6643	2831	slt	sh	3	
	(Sec. 1 T.33N. R.8W.)			2823	ss	slt	4	
				2683	sh	slt	51	(3-7)
				2603	slt	slt	7	
125	Pacific Northwest Pipeline Corp. - Ignacio Unit 33-8 Well	6627	6639	2823	slt	sh	3	
	No. 3-2 (Sec. 2 T.33N. R.8W.)			2701	slt	slt	4	
				2618	slt	sh	20	
				2514	sh	sh	3	
126	Amoco Production Co. - Ford Gas Unit "D" No. 1	6650	6662	3007	sh	sh	2	
	(Sec. 3 T.33N. R.8W.)			2882	ss	sh	9	(1-1)
				2846	slt	sh	6	(1-2)
				2773	ss	slt	17	(2-3)
				2730	ss	sh	3	
				2681	slt	sh	8	(1-2)
				2647	sh	ss	2	
				2616	slt	sh	4	(1-2)
127	Pacific Northwest Pipeline Corp. - Ignacio 33-8 No. 6-4	6643	6656	2898	sh	sh	8	
	(Sec. 4 T.33N. R.8W.)			2888	sh	sh	2	
				2857	sh	sh	17	(1-2)
				2738	slt	sh	8	
				2743	sh	sh	3	
				2712	slt	slt	5	
128	Rincon Operating Co. - Maestes No. 1	6539	6551	2834	sh	ss	7	
	(Sec. 5 T.33N. R.8W.)			2815	ss	sh	9	
				2767	sh	sh	30	(1-4)
				2723	slt	sh	17	(1-2)
				2678	sh	sh	2	
				2672	sh	sh	3	
				2655	sh	sh	16	(1-2)
				2645	sh	sh	3	
				2615	slt	slt	2	
				2605	sh	sh	2	
129	Pacific Northwest Pipeline Corp. - Ignacio 33-8 No. 12-5	6679	6690	2971	sh	sh	3	
	(Sec. 5 T.33N. R.8W.)			2962	sh	sh	2	
				2901	sh	sh	36	(1-3)
				2851	sh	sh	3	
				2843	sh	sh	3	
				2797	sh	sh	2	
				2768	slt	sh	6	
				2711	sh	ss	2	
130	Embark Operating Co. - Barnes No. 1	6421	6433	2914	ss	ss	3	
	(Sec. 6 T.33N. R.8W.)			2757	slt	ss	8	
				2749	slt	slt	3	
				2736	slt	slt	6	
				2686	ss	slt	38	
				2632	ss	slt	9	
				2593	ss	sh	9	
				2571	ss	ss	3	
				2553	ss	ss	6	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
131	Amerada Petroleum Corp. Olsen Mesa Verde Gas Unit No. 1 (Sec. 8 T.33N. R.8W.)	6656	6668	2930	sl	sh	8	(1-2)
				2913	sl	sh	3	
				2907	sl	sh	3	
				2870	sl	sh	18	(2-4)
				2862	sh	ss	2	
				2841	sh	sh	4	
				2827	slt	sh	7	(1-1)
				2756	sh	sh	2	
				2750	sh	sh	2	
				2680	slt	ss	8	
				2664	slt	sh	3	
132	Amerada Petroleum Corp. - Ford - Olsen Unit No. 1-A (Sec. 9 T.33N. R.8W.)	6719	6732	3052	sh	sh	3	
				3044	slt	slt	2	
				2948	sh	ss	5	
				2938	sh	sh	5	
				2890	slt	sh	18	(1-2)
				2863	slt	sh	17	(2-5)
				2758	sh	slt	2	
				2715	slt	sh	6	
				2707	sh	sh	2	
				2700	sh	slt	2	
				2682	sh	sh	3	
133	Amoco Production Co. - Ford Gas Unit A #2 (Sec. 10 T.33N. R.8W.)	6662	6674	2983	slt	?	8	
				2870	slt	sh	11	
				2828	slt	sh	9	
				2756	sh	slt	4	
				2738	sh	sh	12	
				2650	slt	sh	8	
134	Amoco Production Co. - Gallegas Gas Unit "L" No. 1 (Sec. 12 T.33N. R.8W.)	6562	6574	2727	sh	ss	7	
				2666	ss	sh	18	
				2607	ss	sh	14	(1-3)
				2528	ss	sh	3	
				2505	sh	ss	2	
135	Amerada Petroleum Corp. - Haha Gas Unit No. 1 (Sec. 15 T.33N. R.8W.)	6704	6717	3110	sh	sh	4	
				3010	sh	sh	2	
				3002	sh	sh	6	
				2966	slt	sh	11	(1-3)
				2877	sh	sh	16	(2-5)
				2806	sh	slt	4	
				2641	ss	sh	2	
136	Amerada Petroleum Corp. - Helton No. 1 M.V. Unit (Sec. 18 T.33N. R.8W.)	6731	6743	3105	sh	sh	3	
				3092	sh	sh	8	
				3013	sh	ss	3	
				3000	sh	sh	3	
				2966	sh	sh	8	
				2917	sh	sh	4	
				2847	slt	sh	8	(1-1)
				2767	ss	slt	7	(1-2)
137	Amerada Petroleum Corp. - McElvain Harmon Unit No. 1 (Sec. 19 T.33N. R.8W.)	6837	6849	3284	sh	slt	3	
				3272	ss	sh	2	
				3256	ss	sh	2	
				3220	slt	sh	4	
				3165	sh	sh	15	(1-3)
				3154	sh	sh	3	
				3140	sh	sh	8	
				3057	ss	sh	2	
				3024	sh	slt	3	
				3015	sh	sh	5	
				2990	sh	slt	3	
				2985	sh	sh	2	
				2949	ss	sh	3	
				2927	sh	slt	3	
138	Atlantic Refining Co. - Southern Ute Herrara Gas Unit No. 1 (Sec. 20 T.33N. R.8W.)	6923	6935	3471	sh	sh	2	
				3427	ss	sh	22	(1-2)
				3333	sh	sh	15	
				3272	sh	sh	34	(2-4)
				3254	sh	sh	12	
				3232	sh	slt	2	
				3226	slt	sh	2	
				3153	ss	sh	7	
				3119	sh	sh	3	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
139	Amerada Petroleum Co. - Crigler No. 1 Mesa Verde Unit (Sec. 21 T.33N. R.8W.)	6770	6781	3130	sh	sh	3	
				3121	sh	sh	7	
				3088	sh	sh	9	
				3056	sh	sh	7	
				2983	sh	sh	8	
				2973	sh	sh	7	
				2948	sh	sh	2	
				2860	sh	sh	6	
141	Pan American Petroleum Corp. - Pan American Fee Gas Unit "B" No. 1 Inc. (Sec. 23 T.33N. R.8W.)	6639	6652	2970	sh	slt	10	
				2900	sh	sh	17	(1-3)
				2882	sh	sh	6	
				2873	sh	sh	5	
				2863	sh	sh	7	
142	Pan American Petroleum Corp. - Wirt Gas Unit C-1 (Sec. 25 T.33N. R.8W.)	6515	6526	2978	sh	sh	5	
				2953	sh	sh	4	
				2935	sh	sh	15	(1-2)
				2900	sh	sh	7	
				2893	ss	sh	3	
				2866	ss	sh	3	
				2858	sh	sh	4	
				2834	sh	slt	3	
				2824	sh	sh	5	
143	T.H. McIlvain - Docar No. 2 (Sec. 26 T.33N. R.8W.)	6615	6627	3120	sh	sh	5	
				3070	sh	sh	20	
				3029	ss	sh	9	(1-2)
				2993	sh	sh	10	
				2962	sh	sh	8	
144	Penrose - Zachary Operating Co. - Jaquez No. 4 (Sec. 27 T.33N. R.8W.)	7320	7335	3895	sh	sh	6	
				3846	sh	sh	21	
				3831	sh	sh	6	
				3821	slt	sh	4	
				3811	sh	sh	7	(1-1)
				3739	slt	sh	4	
				3714	sh	slt	8	
145	Northwest Production Co. - Ignacio 33-8, No. 11-30 (Sec. 30 T.33N. R.8W.)	7399	7408	3946	sh	ss	4	
				3932	slt	sh	3	
				3875	ss	sh	5	
				3836	sh	sh	14	(2-5)
				3792	sh	sh	22	(1-2)
				3712	sh	sh	3	
146	Atlantic Richfield Co. - Southern Ute 31-1, 33-8 (Sec. 31 T.33N. R.8W.)	7338	7351.5	3974	sh	ss	5	
				3830	slt	slt	50	(1-6)
				3781	ss	sh	7	
				3760	sh	slt	4	
				3744	slt	sh	6	
				3706	slt	sh	3	
				3699	sh	sh	2	
				3674	ss	sh	2	
				3667	ss	ss	3	
147	Atlantic Richfield Co. - Southern Ute #32-1, 33-8 (Sec. 32 T.33N. R.8W.)	7238	7251.5	3868	slt	sh	3	
				3822	sh	sh	16	
				3774	ss	slt	30	
				3723	sh	sh	6	
				3708	ss	sh	5	
				3668	slt	sh	9	(1-3)
				3654	ss	sh	4	
				3632	sh	ss	10	(1-2)
148	Pan American Petroleum Co. - Briggs Gas Unit No. 1 (Sec. 35 T.33N. R.8W.)	6855	6865	3417	slt	sh	3	
				3412	ss	slt	2	
				3362	slt	sh	14	(1-3)
				3328	slt	sh	5	(1-1)
				3290	sh	sh	8	
				3257	ss	sh	11	
149	El Paso Natural Gas Co. - Ignacio 33-8, No. 19 (Sec. 35 T.33N. R.8W.)	6853	6864	3450	sh	sh	11	(1-3)
				3396	slt	sh	13	
				3355	slt	sh	19	(2-5)
				3317	sh	sh	2	
				3293	sh	sh	9	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
150	Pan American Petroleum Corp. - Wirt Gas Unit "B" No. 1	6507	6517	3063	sh	slt	7	
	(Sec. 36 T.33N. R.8W.)			3013	slt	slt	13	(1-2)
				2967	sh	sh	9	(1-2)
				2933	sh	sh	8	
				2914	ss	slt	6	
151	Pacific Northwest Pipeline Corp. - Bondad 33-9, No. 12-1	6466	6480	2910	sh	sh	6	
	(Sec. 1 T.33N. R.9W.)			2793	sh	ss	4	
				2767	sh	slt	10	
				2697	slt	ss	10	(1-1)
				2652	sh	sh	3	
				2591	ss	sh	2	
				2560	ss	sh	9	(1-2)
152	Pacific Northwest Pipeline Corp. - Bondad 33-9, No. 22-2	6388	6400.5	2837	sh	sh	3	
	(Sec. 2 T.33N. R.9W.)			2801	sh	slt	4	
				2742	sh	sh	6	(1-2)
				2698	sh	sh	6	
				2689	slt	sh	5	
				2628	slt	sh	10	(1-2)
				2578	sh	sh	8	(1-2)
				2554	sh	sh	4	
				2493	sh	sh	20	
153	Pacific Northwest Pipeline Corp. - Bondad 33-9, No. 5-3	6283	6296	2690	sh	ss	4	
	(Sec. 3 T.33N. R.9W.)			2681	sh	sh	5	
				2667	sh	sh	7	
				2639	sh	slt	11	(1-2)
				2616	sh	sh	5	
				2604	sh	sh	6	
				2484	slt	sh	6	
				2458	slt	sh	14	(1-2)
				2336	slt	sh	16	
154	Mesa Petroleum Co. - Ute Indian #4A	6333	6346	2736	slt	sh	4	
	(Sec. 4 T.33N. R.9W.)			2725	sh	slt	6	(1-2)
				2707	slt	slt	4	
				2660	slt	slt	12	
				2643	slt	slt	2	
				2629	slt	slt	2	
				2602	slt	sh	3	
				2579	ss	sh	11	
				2550	ss	slt	2	
				2535	sh	slt	3	
				2524	sh	sh	2	
				2517	slt	sh	3	
				2508	ss	sh	2	
				2429	slt	slt	3	
				2409	slt	slt	3	
				2404	slt	slt	2	
				2391	sh	slt	9	
155	Northwest Production Co. - Bondad 33-9, No. 20-5	6630	6642	3032	sh	slt	4	
	(Sec. 5 T.33N. R.9W.)			3008	ss	sh	5	
				2967	sh	sh	4	
				2942	sh	sh	13	(1-2)
				2855	slt	sh	12	(1-2)
				2822	sh	sh	7	
				2807	sh	sh	3	
				2798	ss	sh	2	
156	Pacific NW Pipeline Corp. - Bondad 33-9, No. 13-6	6485	6495	2856	sh	ss	7	
	(Sec. 6 T.33N. R.9W.)			2839	sh	sh	5	
				2817	slt	sh	7	
				2760	sh	sh	12	
				2704	sh	sh	40	(3-6)
157	Pacific NW Pipeline Corp. - Bondad 33-9, No. 6-7	6464	6476.7	2866	sh	ss	2	
	(Sec. 7 T.33N. R.9W.)			2842	sh	ss	6	
				2828	sh	slt	6	
				2804	sh	sh	9	
				2770	ss	sh	14	
				2733	sh	sh	19	(1-2)
				2685	sh	sh	10	
				2660	sh	sh	6	
				2595	sh	sh	7	
				2583	ss	sh	5	
				2466	ss	sh	8	
				2453	ss	ss	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
158	Mesa Petroleum - Ute Indian #6A (Sec. 9 T.33N. R.9W.)	6360	6373	2751	sh	ss	2	
				2740	sh	slt	6	
				2730	sh	sh	6	
				2708	slt	sh	8	
				2651	sh	sh	13	
				2629	sh	sh	8	
				2530	slt	sh	5	
				2513	slt	slt	4	
				2462	sh	sh	8	(1-1)
				2451	slt	sh	3	
				2443	sh	slt	4	
				2429	sh	slt	2	
				2345	slt	slt	2	
				2330	sh	slt	8	(2-3)
159	Mesa Petroleum Co. - Ute Indian #3A (Sec. 10 T.33N. R.9W.)	6734	6747	3030	slt	slt	46	(2-8)
				3020	sh	sh	3	
				2989	sh	sh	9	
				2974	slt	slt	6	
				2947	slt	sh	3	
				2899	slt	sh	13	(1-2)
				2866	slt	slt	2	
				2845	slt	slt	15	(1-3)
				2820	slt	slt	9	(1-2)
				2713	slt	sh	8	
				2695	sh	slt	10	(3-4)
160	Mesa Petroleum Co. - Ute Indian #8A (Sec. 11 T.33N. R.9W.)	6546	6560	2963	slt	slt	4	
				2953	slt	slt	5	
				2908	slt	slt	4	
				2877	ss	sh	6	
				2824	slt	slt	5	
				2813	ss	sh	6	
				2741	ss	sh	3	
				2693	sh	sh	2	
				2660	slt	slt	13	(4-7)
				2599	slt	sh	14	(1-1)
				2591	sh	slt	4	
				2552	sh	sh	3	
161	Mesa Petroleum Co. - Ute Indian #11A (Sec. 12 T.33N. R.9W.)	6625	6639	3022	slt	sh	4	
				2980	sh	sh	12	(1-1)
				2927	slt	sh	2	
				2881	sh	sh	8	
				2864	sh	sh	9	
				2822	sh	sh	4	
				2785	slt	sh	3	
				2764	slt	slt	8	(1-2)
				2742	sh	sh	2	
				2717	sh	slt	2	
				2694	ss	sh	4	
				2670	sh	slt	10	(2-5)
				2634	sh	sh	2	
162	Pacific Northwest Pipeline Corp. - Bondad Unit 33-9 No. 7-13 (Sec. 13 T.33N. R.9W.)	6668	6678	2900	ss	sh	4	
				2938	sh	sh	6	
				2901	sh	sh	15	(1-1)
				2870	sh	sh	20	
				2815	sh	sh	6	
				2770	sh	sh	8	
				2718	sh	sh	2	
				2697	ss	sh	3	
163	Standard Oil and Gas Co. - J. L. McCarville No. 1 (Sec. 14 T.33N. R.9W.)	6754	6773	3080	ss	sh	15	(2-4)
				3038	sh	sh	2	
				3008	ss	sh	5	
				2925	sh	sh	11	
				2898	sh	sh	4	
				2870	ss	sh	3	
				2862	ss	ss	3	
				2857	sh	ss	3	
				2837	sh	sh	3	
				2820	sh	sh	3	
				2806	ss	sh	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
164	U.S. Smelting, Refining, and Minting Co. - Southern Ute	6738	6756	3103	sh	sh	5	
	33-9, 4-16 (Sec. 16 T.33N. R.9W.)			3093	slt	sh	5	
				3034	sh	sh	11	
				3029	sh	sh	3	
				3003	sh	sh	12	(1-2)
				2977	sh	sh	8	
				2962	sh	sh	8	
				2942	ss	sh	3	
				2908	sh	ss	2	
				2802	sh	sh	2	
				2676	sh	ss	12	(1-2)
165	E. E. Fundingslund - Sunical - Federal No. 1	6213	6227	2630	slt	sh	12	(1-2)
	(Sec. 17 T.33N. R.9W.)			2540	sh	ss	5	
				2524	ss	sh	13	
				2503	slt	ss	15	(1-3)
				2426	sh	sh	3	
				2415	ss	sh	7	
				2360	ss	sh	3	
166	El Paso Natural Gas Co. - Bondad 33-9, 23-18	6411	6421	2863	ss	sh	2	
	(Sec. 18 T.33N. R.9W.)			2855	sh	ss	4	
				2843	sh	sh	5	
				2764	sh	sh	3	
				2753	sh	sh	5	
				2746	sh	sh	4	
				2729	sh	sh	11	(1-3)
				2720	sh	ss	3	
				2650	ss	sh	4	
				2607	sh	sh	3	
167	Northwest Pipeline Corp. - Carr No. 1	6155	6167	2619	sh	ss	4	
	(Sec. 20 T.33N. R.9W.)			2609	sh	sh	7	
				2587	sh	sh	7	
				2530	sh	sh	4	
				2507	slt	sh	10	(1-2)
				2460	sh	sh	5	
				2453	sh	sh	2	
				2372	sh	sh	9	(1-2)
				2309	sh	sh	4	
				2302	ss	sh	3	
				2287	slt	sh	2	
				2279	sh	ss	2	
				2193	ss	sh	2	
168	Pacific Northwest Pipeline Corp. - Bondad 33-9, No. 39-21	6635	6646	3116	sh	sh	5	
	(Sec. 21 T.33N. R.9W.)			3105	sh	sh	6	
				3061	slt	sh	4	
				3044	sh	slt	14	(1-2)
				3028	sh	slt	2	
				2978	sh	sh	2	
				2963	slt	sh	7	
				2871	slt	sh	3	
				2850	sh	sh	11	
169	Pacific Northwest Pipeline Corp. - 9-23	6640	6656	3125	sh	ss	5	
	(Sec. 23 T.33N. R.9W.)			3110	sh	sh	7	(1-1)
				3047	slt	sh	7	
				3021	sh	slt	14	
				2984	slt	sh	6	
				2880	slt	sh	4	
170	Tex-Star Oil & Gas Corp. - Martinez Unit No. 1	6754	6766	3176	sh	ss	4	
	(Sec. 24 T.33N. R.9W.)			3168	sh	sh	2	
				3108	ss	sh	2	
				3085	sh	sh	3	
				3062	sh	sh	17	(2-3)
				3036	sh	sh	11	(2-2)
				2967	sh	sh	4	
171	Robert L. Haynie - Ute 33-9 No. 5	7426	7439	3978	slt	ss	4	
	(Sec. 25 T.33N. R.9W.)			3901	slt	slt	2	
				3867	slt	slt	18	(1-3)
				3839	slt	slt	19	
				3821	sh	sh	5	
				3801	slt	sh	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
172	Lynco Oil Co. - Southern Ute No. 3	7387	7399	3983	slt	ss	3	
	(Sec. 26 T.33N. R.9W.)			3963	ss	sh	5	
				3945	slt	ss	11	(1-2)
				3909	ss	slt	3	
				3863	sh	slt	19	(1-3)
				3827	ss	slt	25	(3-6)
				3734	sh	sh	5	
				3724	ss	sh	3	
				3720	sh	ss	2	
				3671	slt	sh	3	
173	Murchison Trusts - Block 6, No. 2-29	6594	6605	3130	sh	ss	3	
	(Sec. 29 T.33N. R.9W.)			3120	sh	sh	5	
				3080	sh	sh	20	(1-3)
				2998	sh	slt	2	
				2948	slt	sh	2	
				2904	slt	sh	4	
				2870	ss	sh	10	(2-4)
174	Atlantic Richfield Co. - Southern Ute #30-1, 33-9	6341	6354	2843	slt	slt	4	
	(Sec. 30 T.33N. R.9W.)			2828	slt	slt	6	
				2793	slt	slt	28	(2-2)
				2656	sh	sh	30	(3-7)
				2615	sh	slt	5	
				2604	slt	slt	4	
				2593	slt	sh	6	
				2585	ss	sh	2	
				2524	slt	sh	2	
				2480	slt	sh	3	
				2468	ss	sh	5	
175	Dixie M. McLane Trust - Spatter No. 4	6058	6070	2618	ss	slt	7	
	(Sec. 31 T.33N. R.9W.)			2601	sh	sh	7	
				2534	ss	slt	26	(2-4)
				2466	sh	sh	4	
				2348	slt	sh	5	
				2322	slt	slt	2	
				2313	ss	sh	2	
				2252	sh	slt	2	
				2221	sh	sh	2	
				2210	ss	sh	3	
176	Murchison Trusts - Block 6, No. 1-32	6474	6485	3046	sh	sh	4	
	(Sec. 32 T.33N. R.9W.)			3018	slt	slt	2	
				2950	sh	sh	34	(1-3)
				2932	sh	sh	8	
				2855	ss	sh	7	(1-2)
				2818	sh	sh	6	
177	Northwest Production Corp. - No. 21-36	7273	7284	3879	slt	sh	5	
	(Sec. 36 T.33N. R.9W.)			3835	sh	sh	18	(2-4)
				3801	sh	sh	23	
				3786	sh	sh	4	
178	Compass Exploration Inc. - Animas 1-1	6199	6211	2560	sh	sh	4	
	(Sec. 1 T.33N. R.10W.)			2549	sh	sh	5	
				2530	sh	sh	6	
				2507	slt	sh	3	
				2493	slt	sh	4	
				2475	sh	sh	10	(2-2)
				2405	slt	sh	35	(3-7)
				2348	slt	sh	4	
				2313	slt	sh	16	(3-6)
				2290	ss	sh	4	
				2181	ss	sh	3	
179	Pacific Northwest Pipeline Corp. - No. 16-2	6235	6247	2560	sh	sh	8	
	(Sec. 2 T.33N. R.10W.)			2533	sh	sh	7	
				2493	sh	slt	3	
				2472	sh	sh	12	(1-3)
				2422	sh	sh	38	(1-3)
				2360	sh	sh	20	(1-2)
				2333	sh	sh	3	
				2300	slt	sh	3	
				2200	ss	sh	2	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
180	Lynco Oil Co. - West Animas #1 (Sec. 3 T.33N. R.10W.)	6519	6530	2785	slt	slt	10	
				2768	sh	slt	6	
				2707	slt	slt	16	(1-2)
				2590	ss	sh	12	(1-1)
				2568	sh	slt	5	
				2558	sh	sh	2	
181	Lynco Oil Co. - Jacquez No. 1 (Sec. 4 T.33N. R.10W.)	6553	6564	2876	slt	sh	8	(1-2)
				2854	slt	slt	13	(2-3)
				2805	slt	slt	19	(4-6)
				2764	slt	sh	23	(4-9)
				2652	sh	sh	19	(4-5)
				2641	ss	slt	4	(1-0.5)
				2603	slt	sh	4	
				2595	ss	slt	3	
				2579	ss	ss	3	
				2573	slt	ss	3	
				2533	ss	slt	3	
				2479	slt	slt	3	
182	Lynco Oil Co. - La Posta Can on No. 1 (Sec. 5 T.33N. R.10W.)	6709	6720	3042	slt	slt	8	
				3019	slt	slt	12	
				2969	slt	sh	19	
				2925	ss	sh	14	
				2874	sh	sh	6	
				2813	ss	sh	23	(1-4)
				2758	slt	sh	3	
				2684	ss	slt	7	(1-2)
				2580	sh	slt	27	(3-8)
				2514	slt	sh	10	(1-2)
				2480	ss	slt	4	
				2454	sh	sh	10	
				2429	ss	slt	16	(1-2)
183	American Petroleum Energy Co. Inc. - Argenta Ute Well No. 5 (Sec. 6 T.33N. R.10W.)	7037	7048	3350	slt	sh	45	(7-16)
				3332	slt	slt	18	(2-6)
				3292	slt	slt	3	
				3270	ss	ss	14	(3-4)
				3205	ss	sh	5	(1-1)
				3152	ss	sh	22	(4-5)
				3048	ss	sh	3	
				3030	slt	slt	3	
				2955	slt	ss	4	
				2935	ss	slt	3	
				2912	ss	slt	3	
184	Lynco Oil Corp. - Black Mountain No. 1 (Sec. 8 T.33N. R.10W.)	6864	6876	3175	sh	slt	9	
				3158	slt	slt	3	
				3110	slt	ss	35	(1-6)
				3079	slt	slt	18	
				3011	slt	slt	34	(1-5)
				2966	slt	sh	3	
				2925	sh	sh	3	
				2900	slt	slt	5	
				2858	slt	sh	3	
				2730	slt	slt	3	
185	Skelly Oil Co. - Ute "L" No. 1 (Sec. 9 T.33N. R.10W.)	6515	6528	2880	slt	slt	4	
				2863	sh	sh	7	
				2837	sh	sh	6	
				2828	sh	sh	4	
				2788	sh	sh	18	
				2723	slt	sh	56	
				2638	ss	sh	2	(3-6)
				2512	sh	sh	4	
186	Joseph B. Gould - Gould Ute "D" No. 8 (Sec. 10 T.33N. R.10W.)	6393	6406	2762	sh	sh	2	
				2754	sh	sh	4	
				2721	sh	sh	4	
				2679	sh	sh	21	(2-2)
				2630	ss	sh	28	
				2509	sh	slt	9	
				2477	sh	sh	2	
				2463	sh	sh	3	
				2380	ss	sh	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
187	Compass Exploration - Animas No. 1-11	6303	6313	2631	sh	sh	8	
	(Sec. 11 T.33N. R.10W.)			2625	sh	slt	2	
				2600	sh	sh	3	
				2561	slt	slt	3	
				2549	sh	slt	4	
				2496	sh	sh	26	(2-3)
				2454	sh	sh	20	(2-4)
				2356	slt	sh	3	
				2342	ss	sh	2	
188	El Paso Natural Gas Corp. - No. 20-14	6329	6339	2728	sh	sh	4	
	(Sec. 14 T.33N. R.10W.)			2700	ss	sh	5	
				2622	sh	sh	16	(1-2)
				2582	slt	sh	30	
				2478	ss	sh	3	
				2435	sh	sh	5	
189	Lynco Oil - Cox Canyon No. 1	6770	6782	3234	slt	slt	7	
	(Sec. 21 T.33N. R.10W.)			3170	slt	slt	12	(1-3)
				3109	slt	slt	51	(5-17)
				3014	sh	slt	3	
				2992	ss	sh	4	
				2947	ss	sh	3	
				2885	sh	slt	3	
				2842	ss	slt	4	
				2833	ss	ss	3	
190	Murchison Trusts - Block 8, No. 3-22	6446	6457	2991	sh	sh	6	
	(Sec. 27 T.33N. R.10W.)			2981	sh	sh	6	
				2954	ss	sh	3	
				2911	sh	sh	29	(3-7)
				2865	sh	sh	44	(2-5)
				2755	sh	ss	3	
				2722	sh	sh	5	
				2698	sh	slt	2	
				2658	sh	sh	4	
191	Atlantic Richfield Co. - Southern Ute 23-1, 33-10	6252	6265	2738	slt	sh	6	
	(Sec. 23 T.33N. R.10W.)			2727	sh	slt	7	
				2695	slt	sh	7	
				2584	sh	sh	37	
				2547	sh	sh	9	
				2509	sh	sh	6	
				2495	sh	sh	2	
				2478	sh	sh	7	
				2457	slt	sh	6	(1-2)
				2426	sh	sh	4	
				2417	sh	sh	3	
				2395	ss	sh	5	
				2373	slt	ss	6	
192	Atlantic Refining Co. - Southern Ute 24, 1-33	6161	6173	2645	sh	slt	5	
	(Sec. 24 T.33N. R.10W.)			2636	sh	sh	6	
				2664	sh	sh	6	
				2595	sh	sh	4	
				2567	sh	slt	18	(1-2)
				2510	sh	sh	43	(3-7)
				2430	sh	sh	4	
				2297	ss	sh	3	
193	Pacific Northwest Pipeline Corp. - No. 3-25	6113	6124	2636	slt	sh	14	
	(Sec. 25 T.33N. R.10W.)			2625	sh	sh	4	
				2597	slt	sh	23	(1-3)
				2521	slt	sh	16	
				2419	sh	sh	21	(2-4)
				2407	sh	sh	3	
				2381	sh	sh	3	
				2345	sh	ss	4	
				2291	ss	sh	3	
194	Murchison Trusts - Block 8, No. 1-26	6546	6556	3127	slt	slt	5	
	(Sec. 26 T.33N. R.10W.)			3110	sh	sh	4	
				3027	sh	sh	29	(2-6)
				2963	sh	sh	21	(2-4)
				2944	sh	sh	8	
				2868	ss	sh	2	
				2834	ss	sh	2	
				2784	sh	sh	2	

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
195	Murchison Trusts - Block 8, No. 2-27 (Sec. 27 T.33N. R.10W.)	6720	6731	3357	slt	sh	6	
				3340	slt	sh	4	
				3250	slt	sh	29	(2-6)
				[illegible]	sh	sh	19	
				3170	sh	sh	12	(1-2)
				3115	sh	sh	3	
				3090	sh	sh	3	
				3069	sh	ss	3	
				2959	ss	sh	3	
196	Pacific Northwest Pipeline Corp. - No. 8-28 (Sec. 28 T.33N. R.10W.)	6680	6690	3196	sh	sh	4	
				3189	slt	sh	4	
				3135	ss	sh	3	
				3100	ss	sh	4	
				3072	slt	sh	9	
				3054	ss	sh	3	
				3038	sh	sh	2	
				2938	sh	sh	3	
197	St. Louis Car Co. - Block 9, No. 2-30 (Sec. 30 T.33N. R.10W.)	6686	6699	3225	sh	sh	12	
				3190	slt	sh	16	(1-3)
				3172	slt	sh	8	
				3163	slt	slt	4	
				3127	sh	sh	23	
				3020	slt	sh	7	
				3008	sh	sh	3	
198	St. Louis Car Co. - Block 5, No. 5-31 (Sec. 31 T.33N. R.10W.)	7053	7066	3564	sh	sh	58	(5-8)
				3491	slt	sh	14	
				3410	sh	sh	5	
				3388	sh	slt	3	
199	Murchison Bros. - Block 5, No. 6-32 (Sec. 32 T.33N. R.10W.)	7352	7363	3950	ss	ss	4	
				3875	ss	sh	5	
				3798	sh	sh	32	(3-4)
				3732	slt	sh	14	
				3686	sh	sh	4	
				3671	sh	sh	3	
				3659	slt	sh	7	
				3616	slt	sh	2	
				3594	sh	sh	2	
				3590	slt	sh	2	
				3492	sh	sh	3	
200	Pacific NW Pipeline Corp. - Bondad 33-10, No. 19-33 (Sec. 33 T.33N. R.10W.)	6570	6583	3192	sh	sh	10	
				3182	sh	sh	6	
				3120	sh	sh	32	(2-8)
				3027	sh	sh	6	
				3020	sh	sh	3	
				3007	slt	sh	3	
				2996	sh	sh	4	
				2967	sh	slt	3	
				2956	slt	sh	3	
201	U.S. Smelting, Refining, and Mining Co. - Southern Ute 33-10, No. 2-35 (Sec. 35 T.33N. R.10W.)	6248	6260	2822	sh	sh	8	
				2701	sh	sh	35	(3-6)
				2617	slt	sh	6	
				2590	sh	slt	14	
				2473	sh	sh	5	
202	Pacific Northwest Pipeline Corp. - Bondad 33-10, No. 18-36 (Sec. 36 T.33N. R.10W.)	6068	6078	2618	sh	sh	4	
				2604	sh	sh	3	
				2500	sh	sh	50	(3-7)
				2432	sh	sh	3	
				2372	sh	ss	12	
				2326	sh	sh	2	
				2279	sh	sh	7	
				2256	sh	sh	4	
203	Transocean Oil, Inc. - Ute No. 1-17 (Sec. 17 T.33N. R.11W.)	7061	7073	3473	sh	slt	17	
				3368	sh	sh	32	
				3359	slt	sh	2	
				3313	sh	sh	18	
				3262	sh	sh	15	
				3205	ss	sh	18	(2-3)
				3108	slt	slt	3	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
204	American Petroleum Energy Co. Inc. - Argenta-Ute No. 9	6780	6795	3237	sh	ss	21	(1-2)
	(Sec. 13 T.33N. R.11W.)			3159	ss	ss	10	
				3151	sh	ss	3	
				3128	sh	sh	19	
				3089	sh	sh	16	
				3015	ss	slt	13	(1-1)
				2975	slt	slt	7	
				2947	sh	slt	2	
				2896	sh	ss	6	
				2890	ss	sh	3	
				2771	slt	sh	5	
205	American Petroleum Energy Co. Inc. - Argenta-Ute No. 16	6845	6860	3250	slt	ss	23	
	(Sec. 14 T.33N. R.11W.)			3153	slt	slt	37	(1-2)
				3069	sh	sh	14	
				3023	sh	ss	9	
				2991	sh	sh	11	
				2966	slt	sh	2	
				2906	sh	sh	3	
				2890	slt	slt	3	
				2830	sh	slt	2	
206	American Petroleum Energy Inc. - Argenta Ute No. 8	7083	7095	3463	sh	ss	20	(2-4)
	(Sec. 14 T.33N. R.11W.)			3370	sh	sh	2	
				3321	sh	sh	23	(3-6)
				3270	slt	sh	15	(3-3)
				3221	sh	sh	11	(2-2)
				3196	ss	sh	10	(2-3)
207	American Petroleum Energy Co. - Argenta Ute Lease #10	6771	6786	3209	sh	sh	27	
	(Sec. 23 T.33N. R.11W.)			3197	sh	slt	8	
				3124	sh	sh	26	
				3056	slt	sh	18	
				3007	slt	sh	12	
				2944	slt	sh	14	
				2849	sh	sh	6	
208	Lion Oil Co. - Ada No. 1	6534	6545	3065	slt	sh	13	(1-2)
	(Sec. 25 T.33N. R.11W.)			3041	sh	sh	6	
				2947	slt	sh	18	(1-3)
				2894	sh	sh	11	(1-2)
				2862	sh	sh	6	
209	Lion Oil Co. - Ute No. 1	6725	6736	3163	slt	sh	7	
	(Sec. 27 T.33N. R.11W.)			3123	sh	slt	17	(2-4)
				3021	sh	slt	45	(3-7)
				2956	sh	sh	7	
				2902	sh	sh	6	
				2875	sh	sh	3	
210	Val R. Reese and Assoc. - Ute 2-34	6675	6686	3186	ss	sh	2	
	(Sec. 34 T.33N. R.11W.)			3170	sh	sh	6	
				3163	sh	sh	2	
				3112	ss	sh	30	(3-6)
				3067	sh	sh	3	
				3022	sh	sh	38	(2-4)
				2918	ss	sh	2	
				2888	sh	sh	4	
				2880	slt	slt	2	
				2817	sh	slt	3	
211	Consolidated Oil and Gas Co. - Spring Creek No. 2-29	6895	6906	2973	sh	sh	3	
	(Sec. 29 T.34N. R.6W.)			2933	sh	sh	27	(2-4)
				2866	sh	sh	4	
				2851	ss	sh	7	
				2793	sh	sh	3	
				2752	sh	sh	4	
				2744	ss	sh	4	
212	Tuelco - Southern Ute No. 1	6705	6718	2905	ss	sh	4	
	(Sec. 26 T.34N. R.7W.)			2835	slt	slt	32	
				2780	ss	slt	7	
				2757	sh	slt	12	
				2739	sh	slt	10	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
213	Northwest Production Corp. - #2-8 Ignacio	6790	6803	2396	sh		4	
	(Sec. 8 T.34N. R.8W.)			2375	sh	sh	14	(1-2)
				2302	sh	slt	4	
				2253	sh	sh	32	
214	Fuelco - No. 1 Sun-Tyner Lunt	6764	6778	2587	slt	ss	3	
	(Sec. 18 T.34N. R.8W.)			2570	sh	sh	6	
				2470	sh	sh	21	
				2401	ss	sh	7	(1-1)
				2371	ss	sh	4	
				2350	slt	slt	4	
215	Rincon Operating Co. - REA No. 1	6547	6560	2988	slt	ss	8	
	(Sec. 32 T.34N. R.8W.)			2815	sh	sh	4	
				2767	slt	sh	35	
				2711	sh	sh	8	
				2659	slt	slt	21	(2-3)
				2586	ss	sh	3	
216	Rincon Operating Co. - Berry No. 1	6735	6747	3027	sh	ss	3	
	(Sec. 33 T.34N. R.8W.)			2998	slt	sh	2	
				2956	slt	sh	19	
				2877	sh	sh	7	
				2819	slt	sh	7	
217	Northwest Production Corp. - Ignacio 34-8, No. 1-34	6653	6363	2955	sh	sh	3	
	(Sec. 34 T.34N. R.8W.)			2904	sh	sh	6	
				2883	sh	slt	7	
				2863	sh	sh	2	
				2852	ss	sh	8	(1-1)
				2806	sh	sh	3	
				2787	slt	sh	3	
				2774	slt	sh	5	
218	Fuelco - Craig No. 1	6758	6770	2646	slt	slt	28	(1-3)
	(Sec. 16 T.34N. R.9W.)			2561	slt	ss	9	
				2536	ss	slt	18	(1-2)
				2481	sh	sh	30	
				2390	ss	sh	26	(4-9)
219	Rincon Operating Co.- Rincon Clarey No. 1	6543	6556	2792	ss	slt	14	(1-1)
	(Sec. 19 T.34N. R.9W.)			2773	slt	sh	10	
				2761	slt	sh	6	
				2727	slt	slt	11	
				2695	sh	slt	23	
				2609	sh	sh	16	
				2574	slt	slt	6	
				2417	ss	sh	15	(1-2)
				2412	slt	ss	3	
				2388	slt	slt	5	
				2381	sh	slt	4	
				2359	slt	sh	3	
220	Southern Union Production Co. - Mason #1	6578	6588	2831	sh	sh	3	
	(Sec. 29 T.34N. R.9W.)			2825	sh	sh	5	
				2814	sh	sh	6	
				2787	sh	sh	13	
				2717	sh	sh	43	(2-6)
				2627	sh	sh	3	
221	Southern Union Gas Co. - Beston No. 1	6612	6622	2922	sh	sh	3	
	(Sec. 29 T.34N. R.9W.)			2913	sh	sh	4	
				2903	ss	sh	3	
				2858	sh	sh	3	
				2797	sh	slt	46	(4-10)
				2753	slt	sh	4	
				2704	slt	sh	4	
				2616	ss	sh	4	
222	Compass Exploration - Beaston Fee No. 1-30	6553	6565	2833	sh	sh	3	
	(Sec. 30 T.34N. R.9W.)			2825	sh	sh	5	
				2806	sh	sh	7	
				2755	sh	slt	4	
				2690	sh	sh	40	(3-5)
				2655	sh	ss	3	
				2598	ss	sh	3	
				2574	sh	sh	5	
				2555	slt	ss	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
223	Compass Exploration - No. 2-31	6518	6533	2883	sh	sh	3	
	(Sec. 31 T.34N. R.9W.)			2873	sh	sh	5	
				2848	sh	sh	6	
				2792	sh	sh	7	(1-1)
				2742	sh	slt	36	
				2634	sh	slt	2	
				2616	ss	sh	2	
224	Southern Union Production Co. - Sutton No. 2	6676	6687	3078	sh	sh	4	
	(Sec. 33 T.34N. R.9W.)			3048	sh	sh	5	
				3038	ss	sh	2	
				3000	sh	slt	9	
				2983	sh	slt	6	
				2977	sh	sh	2	
				2932	sh	sh	3	
				2846	sh	ss	4	
225	Cabeen Exploration Corp. - Thompson No. 1	6624	6631	2815	sh	sh	5	
	(Sec. 22 T.34N. R.10W.)			2807	slt	sh	4	
				2796	sh	slt	6	
				2650	sh	sh	23	(1-3)
				2743	sh	sh	3	
				2676	sh	sh	21	(1-3)
				2650	slt	slt	2	
				2565	sh	sh	28	(2-5)
				2553	ss	ss	3	
				2536	sh	sh	4	
				2485	sh	sh	4	
				2437	?	?	4	
226	Fynco Oil Company - Dorothy Gould No. 8	6371	6382	2587	sh	slt	14	(2-5)
	(Sec. 24 T.34N. R.10W.)			2569	ss	slt	9	(1-4)
				2556	slt	sh	3	
				2506	slt	slt	8	(1-2)
				2474	slt	slt	22	(4-7)
				2375	ss	slt	20	(4-6)
				2326	sh.	sh	4	
				2320	slt	sh	3	
				2273	sh	sh	3	
				2252	slt	ss	3	
				2156	ss	sh	8	(1-2)
				2136	slt	slt	2	
227	American Petroleum Energy Co., Inc. - Argenta No. 2	6879	6892	3325	slt	slt	3	
	(Sec. 31 T.34N. R.10W.)			3273	slt	sh	27	(3-12)
				3204	sh	slt	21	(2-6)
				3114	slt	slt	11	(2-5)
				3038	slt	sh	10	(1-2)
				3015	ss	sh	12	(3-6)
				2996	slt	sh	8	(1-2)
				2964	ss	sh	3	
				2870	ss	sh	3	
				2862	slt	slt	3	
228	Northwest Production Corp. - Bondad 1-32, No. 10-34	6862	6873	3230	sh	sh	8	
	(Sec. 32 T.34N. R.10W.)			3221	sh	sh	5	
				3214	sh	sh	3	
				3147	sh	sh	19	(1-3)
				3122	sh	sh	3	
				3084	sh	sh	12	(1-2)
				3019	sh	slt	3	
				2986	sh	sh	8	
				2973	slt	sh	2	
				2967	sh	slt	2	
				2944	sh	sh	4	

Appendix A (continued)

Map Number	Drill Hole Identification	Ground Elevation(ft)	Geophysical Log Datum(ft)	Coal Bed Depth(ft)	Roof Lithology	Floor Lithology	Coal Bed Thickness(ft)	No. Partings and Thickness(ft)
229	Robert L. Haynie - Ute 34-10 No. 1 (Sec. 33 T.34N. R.10W.)	6992	7005	3327	slt	sh	13	(1-2)
				3308	slt	slt	12	(1-2)
				3260	sh	slt	20	
				3217	sh	sh	17	
				3116	sh	sh	10	
				3101	sh	sh	7	
				3095	sh	sh	3	
				3076	sh	sh	6	
				3020	sh	slt	4	
				3014	ss	sh	2	
				2956	slt	slt	2	
				2933	slt	slt	2	
230	Johnston-Shear Co. - Bondad No. 2-34 (Sec. 34 T.34N. R.10W.)	6485	6497	2777	slt	sh	4	
				2762	sh	sh	5	
				2736	sh	sh	4	
				2724	sh	sh	5	
				2709	sh	sh	11	
				2665	sh	sh	18	
				2574	sh	sh	16	
231	Pacific Northwest Pipeline Corp. - Bondad 34-19, No. 3-36 (Sec. 36 T.34N. R.10W.)	6213	6224	2530	sh	sh	3	
				2515	sh	sh	5	
				2494	slt	sh	4	
				2486	slt	sh	4	
				2465	sh	sh	3	
				2420	slt	sh	16	(1-2)
				2341	sh	sh	7	
				2336	ss	sh	2	
				2295	sh	sh	2	
				2111	sh	slt	4	

APPENDIX B

Gas Kicks in Coals

Well Nos.	Details
18	"Gas kick 2875-96'." "Mud:9.5#" (Coal at 2894-2899')
32	"Sml gas kick @3185'." "Mud:9.3#" (Coal at 3180-3190')

Drill Stem Tests Over Mixed Sandstone and Coal Zones

Well Nos.	Details
80	"DST-2888-2997, 2 hrs, SI 30 min, gas in 25 min, rec 60 GCM, FPO-625#." (Coal at 2936-2954').
	"DST-3000-3147', 2 1/2 hrs, SI 30 min, gas in 4 min, est 1000 MCF in 35 min, flowed wtr in 2 hrs, FP 500-1305#." (Coal at 3036-3051'; 3057-3069'; 3086-3092')
107	"DST 2641-2725, op 23, SI 45, op 47, SI 45, GTS in 9 min, no gauge, rec 250 GCM, FP 137-157, SIP 1219-1258, HP 1487-1461." (Coal at 2674-2716')
109	"DST 2756-2916 (Fruitland) 1 hr, gas in 2 min @200 MCFPD, rec 165 GCM, FP 96#,. SIP (30 min) 1240# HP 1400#." (Coal at 2775-2784', 2813-2816', 2865-2910')
160	"DST 2505-2965, op 10, SI 30, op 150, SI 240, rec 441 mud, 1125 HGCM, FP 235-374, 511-702, SIP 1131-1386, HP 2487-2961." (61' coal between 2552-2967, see Appendix A)
163	"DST 2790-3107, 2 hrs, gas in 9 min, @rate 75 MCF, 1345' GMC, FP 560-830#, SIP (1 1/2 hrs) 1420#." (52' coal between 2806-3905', see Appendix A)

Production Tests in Mixed Sandstone and Coal Zones

Well Nos.	Details
107	"Perf <u>2607</u>*, 2614, 2621, 2628, 2635, 2642, 2649, 2654, <u>2660</u>, 2665. Acidized w/500 gals. Perf <u>2680-89</u> w/1 pf. Acidized w/500 gals. Perf 2720-24 w/1pf. Acidized w 500 gals. F 6 MCFGPD." (Coals at 2603-2608', 2674-2716')
109	"Jet-2 per ft- 2744-50, 2760-68, <u>2778-82</u>, 2790-97, 2801-08, <u>2870-74</u>, 1 per ft-2820-60; sdfract.

	28,000#sd, 31,000 gals water. 1 PF (Fruitland) 1585 MCFGPD, 3/4 "ck" (Coals at 2775-2784', 2865-2910')
114	"12-4-73 perforated Fruitland intervals 2505-09, 2521-24, 2578-82, 2592-96 with 2 SPF. Displaced hole with 1% KCl water. Spotted 500 gallons 15% HCl at 2596'. Pumped in 3500 gallons water treated with 1% KCl and 10 pounds Gel per 1,000 gallons. Sand-water fraced with 6,630 gallons water, treated as above, and 6,000 pounds 10-20 sand. BDP 1200. Established injection rate of 36 BPM at 3200 psi. After 6,000 pounds sand in formation, rate dropped from 36 to 30 BPM and pressure increased to 3500 psi in 45 seconds. Bled off pressure and attempted to frac again. Only got 18 BPM at 3500 psi. On 12-5-73 spotted 500 gallons 15% HCl acid and reperfed intervals 2502-09, 2521-24, 2578-96 with 2 SPF. Pumped 3,240 gallons treated water and sand-water fraced with 17,870 gallons treated water, 5,800 pounds 20-40 sand and 8,000 pounds 10-20 sand and started to sand off. Rate dropped to 10 BPM with 3500 psi. Backflowed for 8 minutes and flushed. Maximum and average pressure 3500 psi. AIR 31 BPM. Tested well by alternately flowing and swabbing well with gas too small to measure. (Coals at 2459-2461', 2501-2511', 2521-2526', 2572-2615')
117	"Initial Production: 622 MCF Gas Per Day, SIP 1379#, Perf. 292 shots 2569-2640'." (Coal at 2581-84')
134	"Perf 2596-2610, 2614-20, 2666-74, 2679-83 w/2pf. Fract w/40,320, gals wtr, 40,000 sd" "made large quantities of water and very little gas." (Coal at 2607-2621', 2666-2684')

*underlined perforations are in coal beds

Wells Producing from Sandstones in Coal Bearing Zones
(coals are listed in Appendix A)

Well Nos.	Details
83	"IPF 377 MCFGPD, 3/4" ck, TP 19#, CP 84#." in Fruitland sandstone, "perf. 2520-38 w/2pf."
86	"IPF 2237 MCFGPD, 3/4" ck, 3 hrs., TP 172#, CP 349#" in Fruitland and Picture Cliffs sandstones, "perf 2448-62 w/2pf sdwtrfract" and "perf 2796-2820 w/1pf sdwtrfract."
89	"IPF 824 MCFGPD, 3/4" ck, TP 56#, CP 184#" in

	Fruitland sandstone, "perf 2610-30 w/2pf sdwtrfract."
92	"IPCAOF 7326 MCFGPD" in Mesaverde sandstones, "perf 5317-5801" gross
95	"IPF 44 MCFGPD, 3/4" ck, CAOF 351 MCFGPD" in Fruitland sandstones, "perf 2416-2552 (gross)"
103	"IPF 7653 MCFGPD" in Mesaverde sandstones, "perf 5079-5560 (gross)."
133	"SI Gas" perf "2610-85 (gross)" in Fruitland sandstones
160	"IPCAOF (Fruitland) 420 MCFGPD," perf Fruitland sandstones 2769-96 (gross)

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By Bruce S. Kelso, Steven M. Goolsby, and Carol M. Tremain

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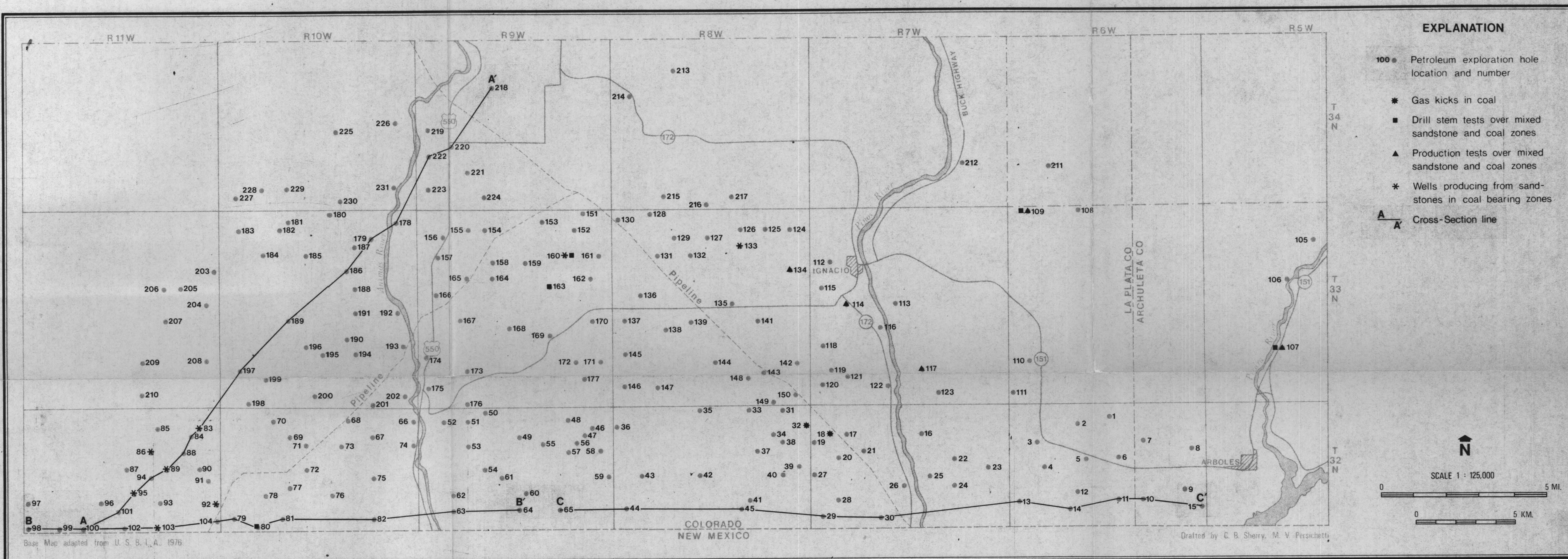
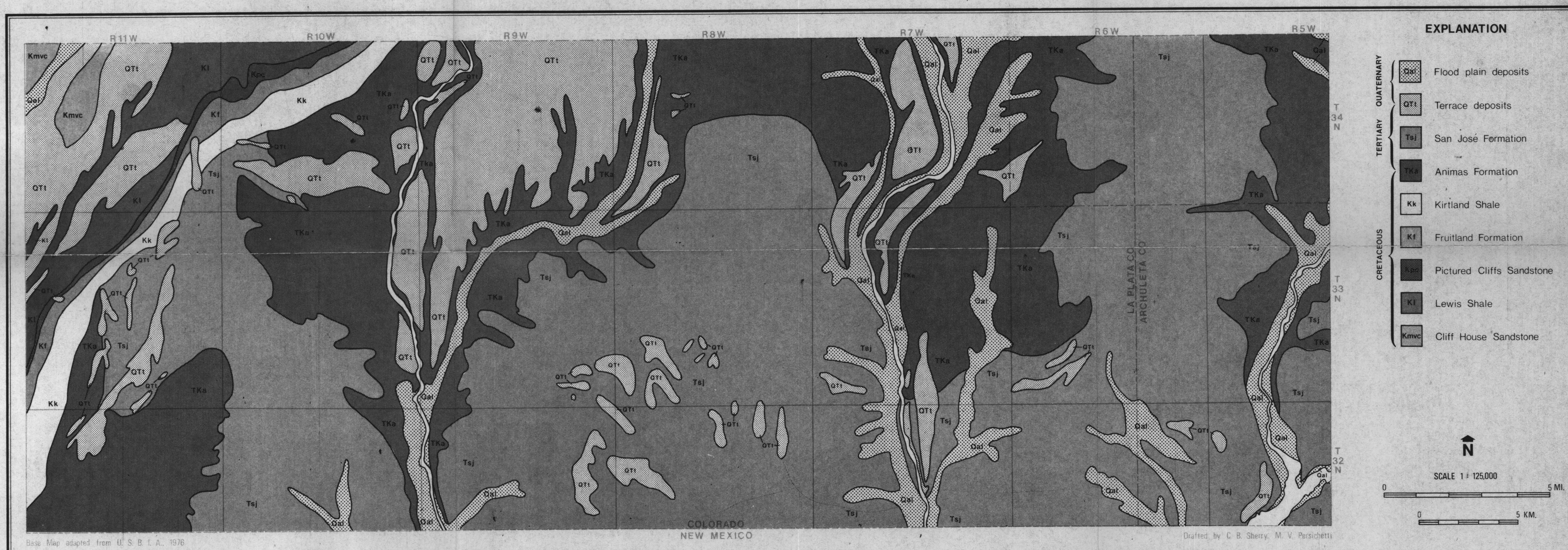
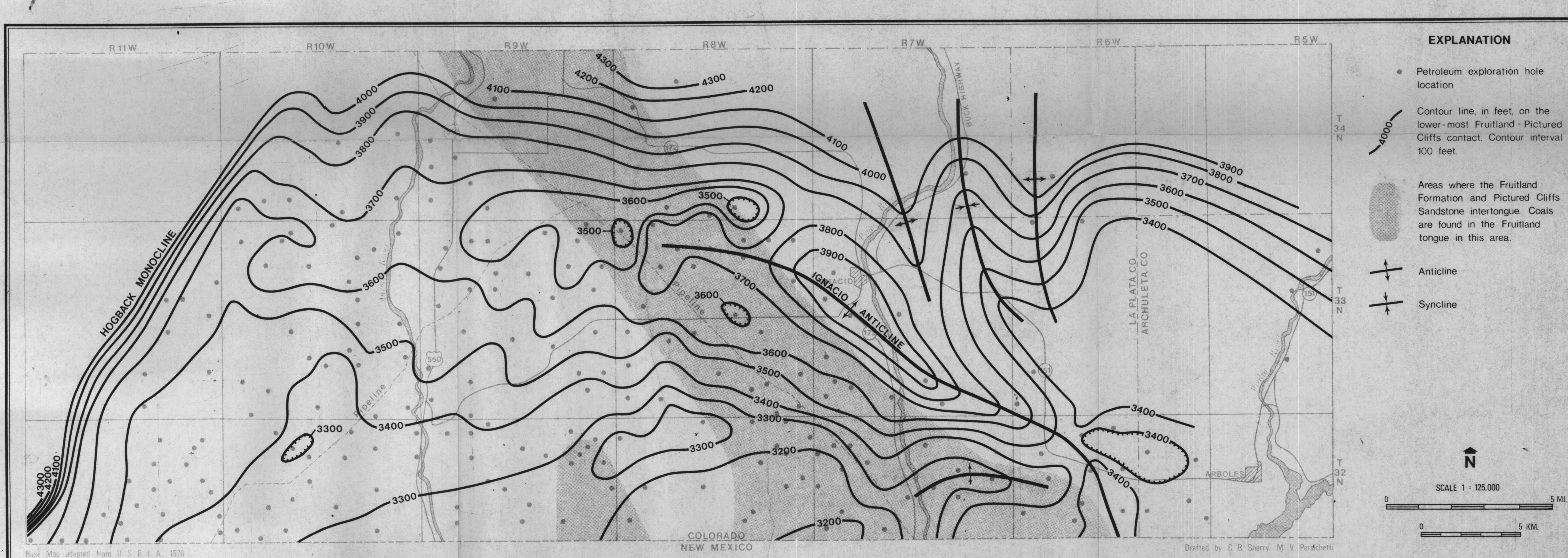
PLATE 1 OF 6



MAP A - PETROLEUM EXPLORATION HOLE LOCATION MAP, A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP B - GEOLOGIC MAP OF A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP C - STRUCTURE MAP ON THE LOWER-MOST FRUITLAND-PICTURED CLIFFS CONTACT, A PORTION OF THE SAN JUAN BASIN, COLORADO

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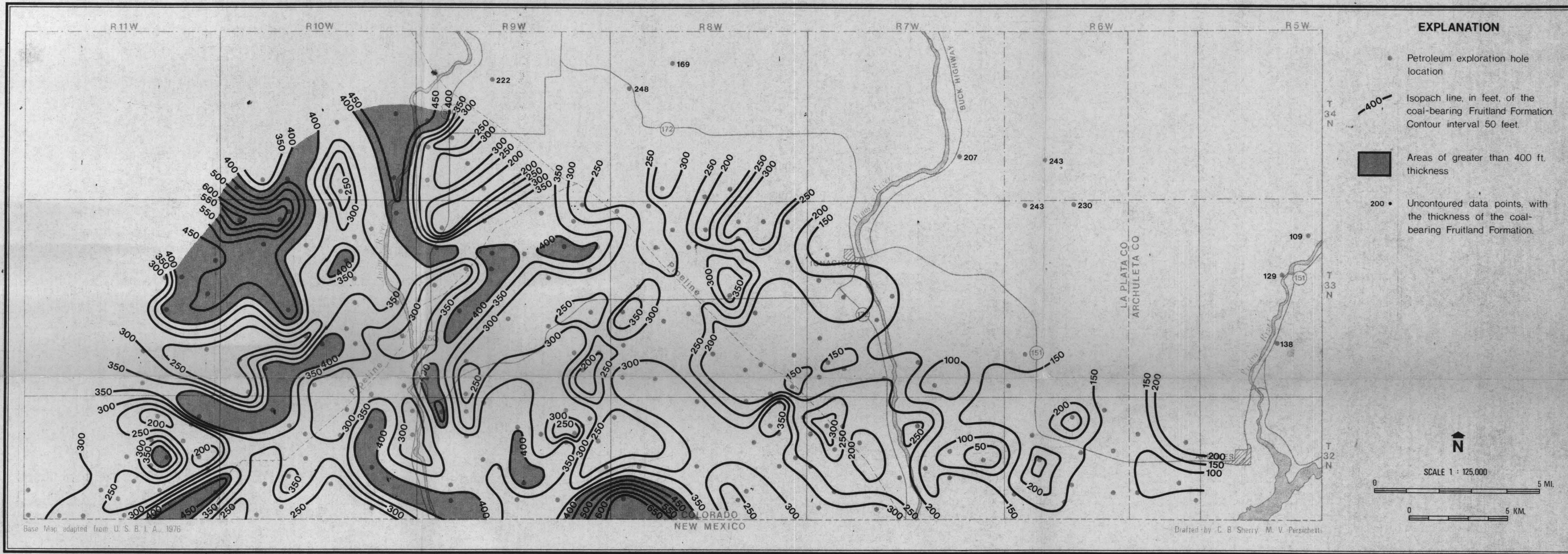
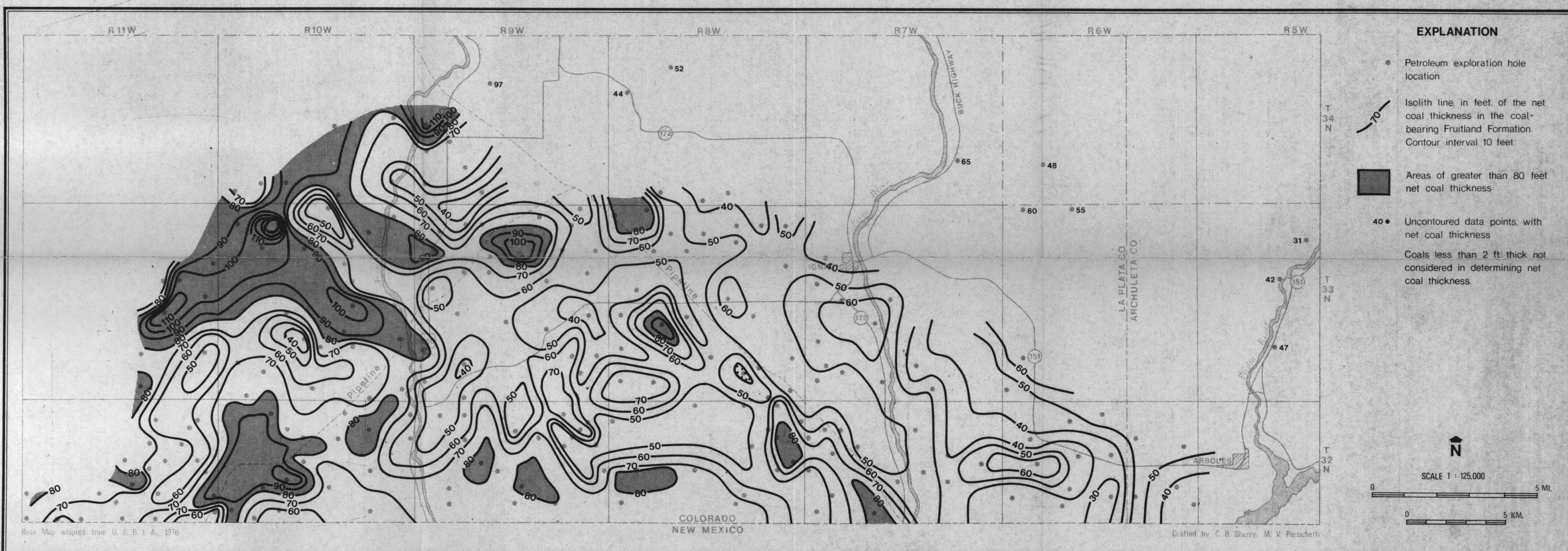
DEEP COAL BED METHANE POTENTIAL OF THE SAN JUAN RIVER COAL REGION, SOUTHWESTERN COLORADO

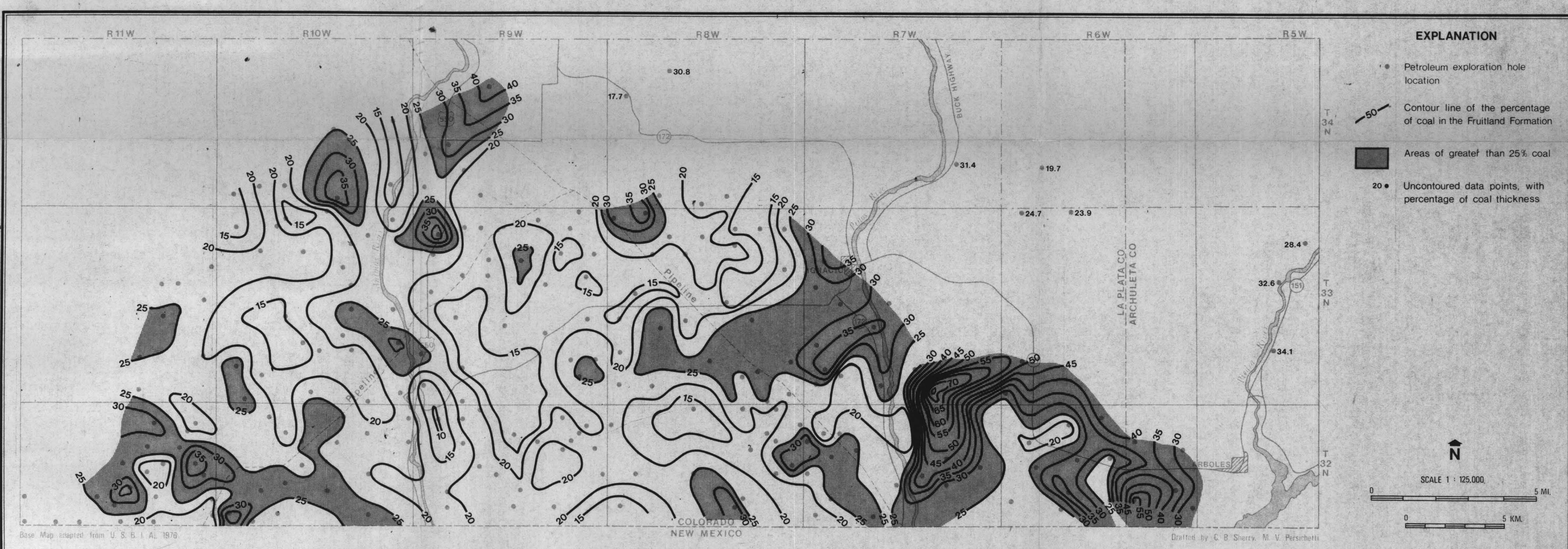
By Bruce S. Kelso, Steven M. Goolsby, and Carol M. Tremain



MAP A - ISOPACH MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP B - NET COAL THICKNESS MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP C - COAL PERCENTAGE MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO

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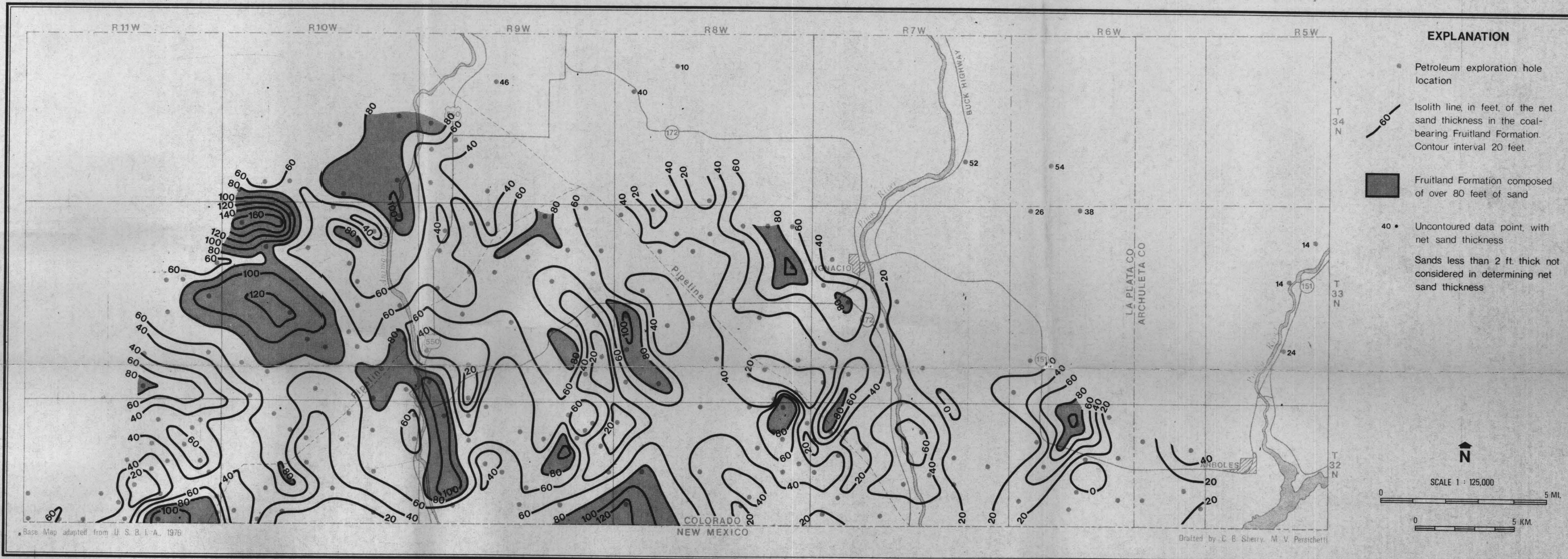
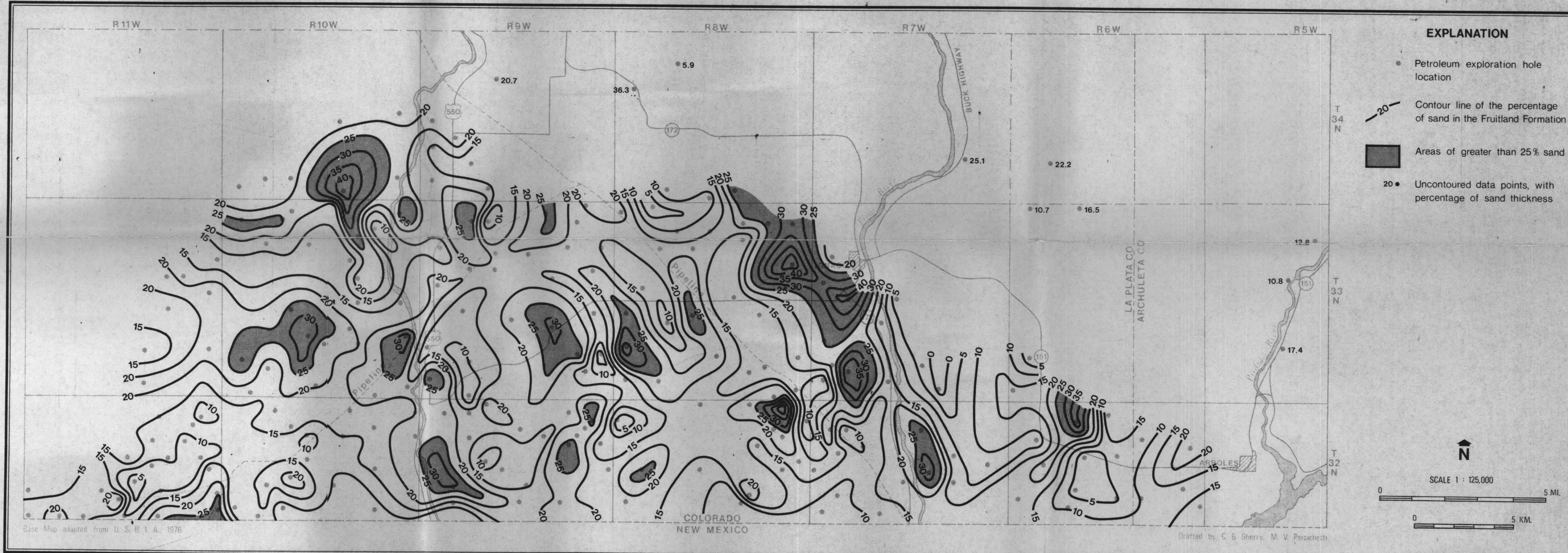
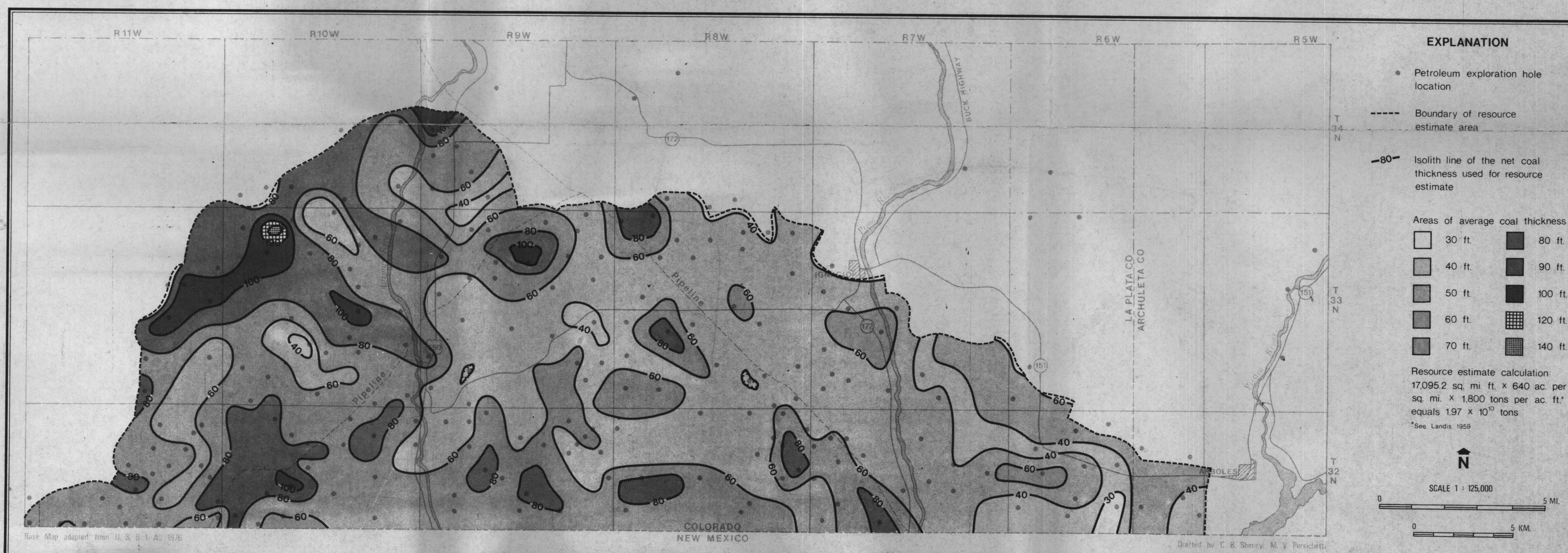
COLORADO GEOLOGICAL SURVEY
OPEN-FILE REPORT 80 - 2
PLATE 3 OF 6



MAP A - NET SAND THICKNESS MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP B - SAND PERCENTAGE MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO



MAP C - COAL RESOURCE ESTIMATE MAP OF THE COAL-BEARING FRUITLAND FORMATION, A PORTION OF THE SAN JUAN BASIN, COLORADO

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COLORADO GEOLOGICAL SURVEY
OPEN-FILE REPORT 80-2
PLATE 4 OF 6

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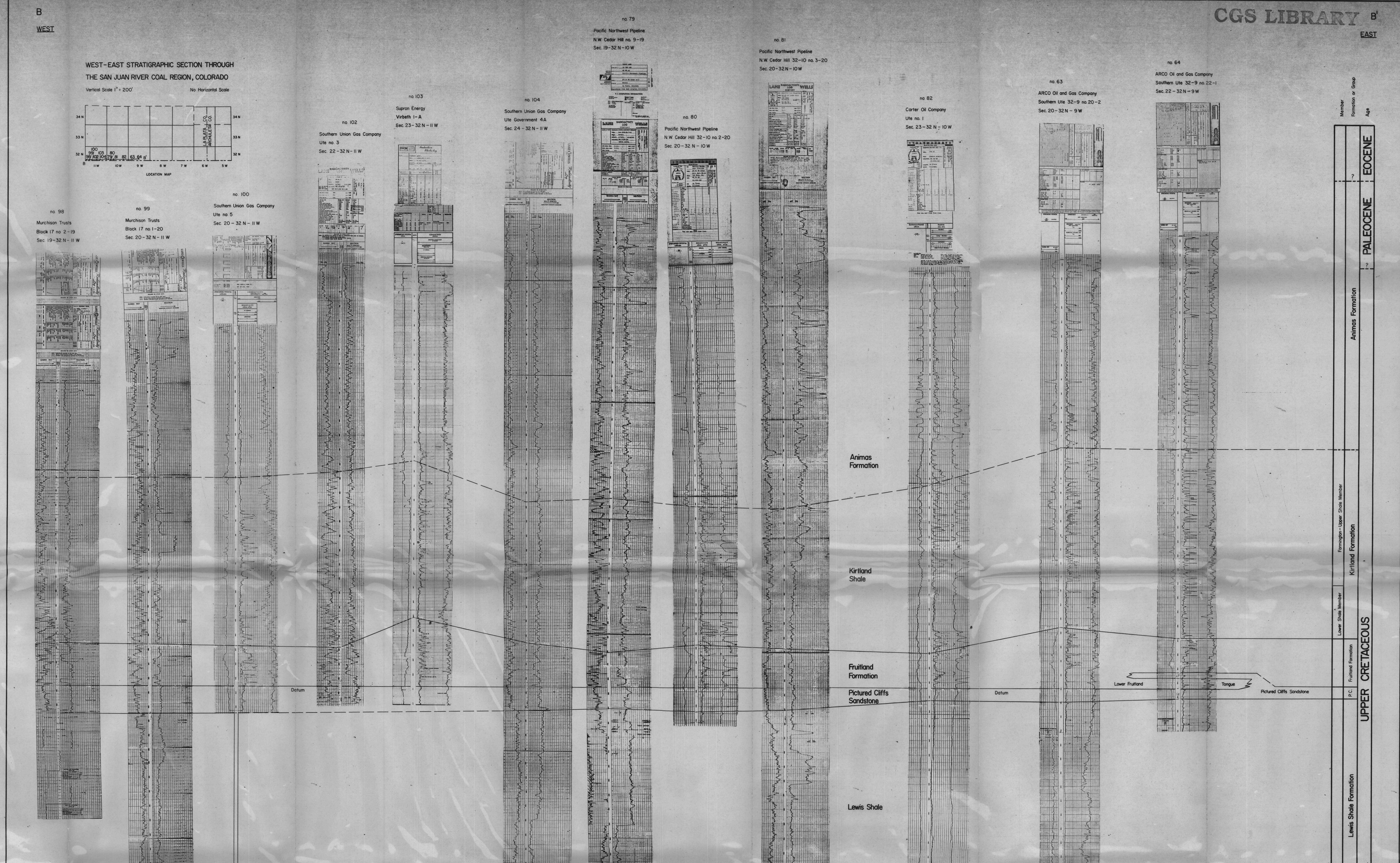
COLORADO GEOLOGICAL SURVEY
OPEN-FILE REPORT 80-2
PLATE 5 OF 6



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COLORADO GEOLOGICAL SURVEY
OPEN-FILE REPORT 80-2.
PLATE 6 OF 6