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COAL BED METHANE POTENTIAL OF THE PICEANCE BASIN, COLORADO

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DISCLAIMER

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ABSTRACT

The 4,000 square miles of the Piceance Basin contain significant coal and gas resources in Cretaceous Mesaverde coal seams. The author has mapped coals from several hundred to 12,000 feet deep. Individual beds range up to 52 feet thick with net total coal thicknesses up to 200 feet. There are approximately 250 billion tons of deeply buried (3,000 feet+) high volatile A to semi-anthracite coals containing up to 77 trillion standard cubic feet of gas. These estimates are based on the included coal isopach and rank maps, the approximately 200 desorption tests (0-765 cubic feet of gas/ton of coal), the 47 gassy mines (some producing over 1MMCFD), the numerous shows in oil and gas wells, and the 8 holes that tested anywhere from 0-440 MCFGD in the basin.

INTRODUCTION

The Uinta coal region of northwestern Colorado covers approximately 7,200 square miles as defined at the base of the Cretaceous Mesaverde Formation (Figure 1). The Piceance Basin, approximately 4,000 square miles of the Uinta coal region, has excellent potential for the development of coal bed methane, the natural gas emitted by coals as they mature.

Coal, oil, and gas have been produced in the region since the late 1800's. Throughout this period, coal miners have been troubled by the production of explosive methane along with the coal. Oil men also encountered this coal associated methane and some have concluded that in Upper Cretaceous Mesaverde sandstones "coal and carbonaceous shale furnished much of the gas" (Millison, 1968). This report was written under a U.S. Department of Energy grant to better determine the extent of this coal bed methane hazard/resource. The basin structure, stratigraphy, coal and oil and gas resources are briefly described to give the setting of the coal bed methane occurrence here.

BASIN SETTING AND STRUCTURE

The Piceance Basin, a part of the Colorado Plateau physiographic province, forms a high plateau lying 5,000 to 8,000 feet above sea level. It is drained and dissected by the westward-flowing Colorado, Yampa, White, and Gunnison Rivers. The basin is bounded by: the Axial Basin uplift in the north, the Grand Hogback Monocline in the east, the Elk and West Elk Mountains and the Gunnison Uplift in the south, the Uncompahgre Uplift in the southwest, and the Douglas Creek Arch in the west.

This Laramide basin is assymetric in shape with a steeply dipping eastern flank and a gentle western flank. The northwest trending axis of the basin parallels Grand Hogback Monocline. Northwest-southeast trending anticlines cross the interior of the basin (Figure 2).

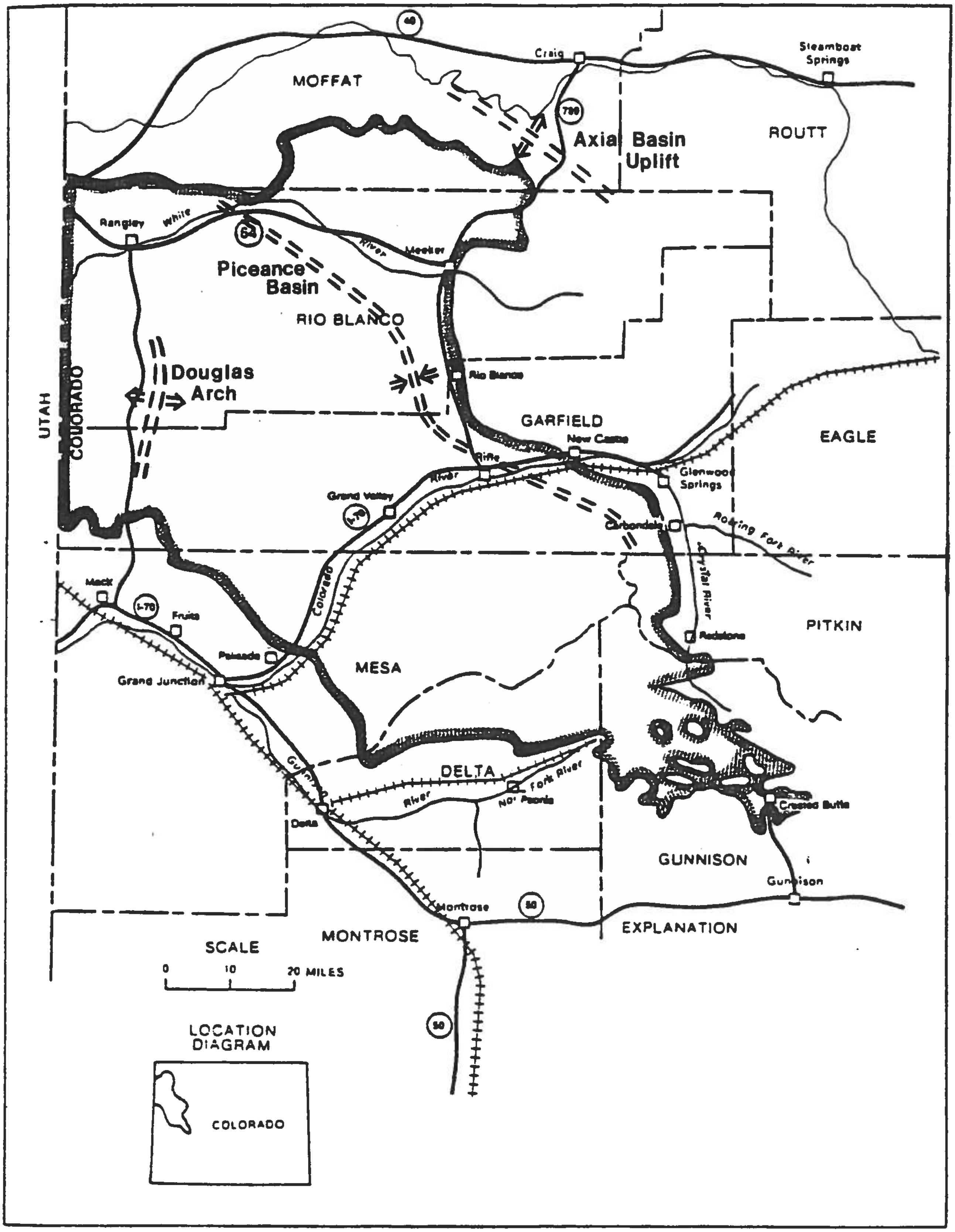

Figure 1. Index map of the Uinta coal region, northwest Colorado (after Ameri et al, 1981).

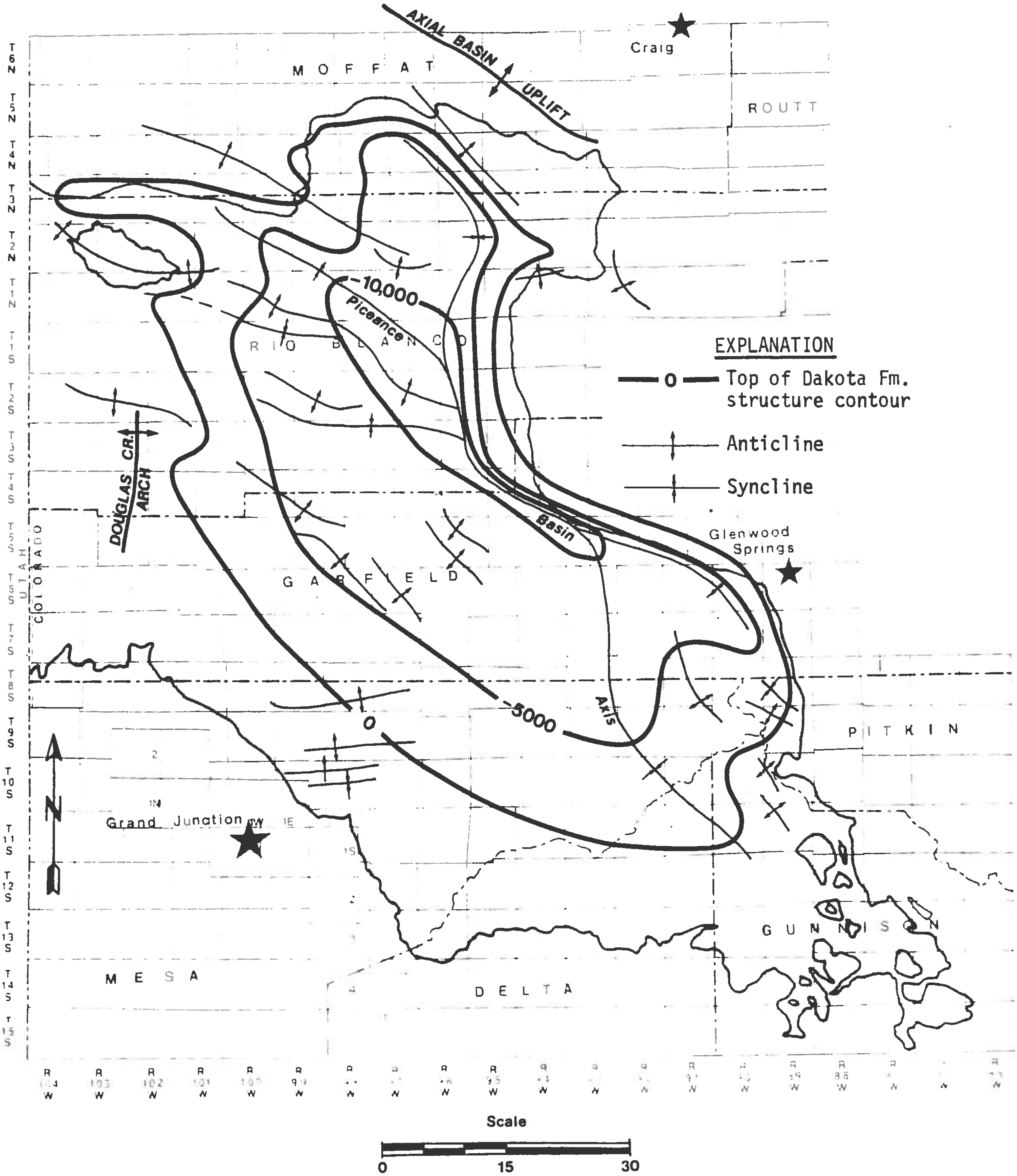

Figure 2. Tectonic map of the Piceance Basin.

STRATIGRAPHY

The Precambrian basement is 18,000 feet below sea level at the deepest point of the basin. There are over 25,000 feet of Cambrian through Quaternary sediments at this point (Murray, 1980). Most of these sediments are not coal bearing and hence are not described in this paper. The stratigraphic chart, Figure 3, shows these formations and their correlative formations in other areas of the state.

The Cretaceous sediments contain the coal bearing formations in the Piceance. There are 6,000 to 11,000 feet of marine and non-marine sediments in the Cretaceous. These sediments were deposited in a 1,000-mile-wide sedimentary basin that stretched from the Gulf of Mexico to the Arctic as shown in Figure 4. The major formations of the Cretaceous are the Lower Cretaceous Dakota Formation, the Upper Cretaceous Mancos, and the Upper Cretaceous Mesaverde Formations.

The Dakota Formation consists of several hundred feet of marginal marine, fluvial, and paludal sediments deposited on the edge of the Cretaceous epicontinental sea. The formation is found throughout the state. It gets younger to the west and the south since the sea transgressed from northeastern Colorado all the way into Utah. The Dakota is coal bearing in the San Juan Basin in the southern part of Colorado and could possibly contain coal in the Piceance Basin.

The Dakota Formation is overlain by 4,000 to 7,000 feet of gray to black marine Mancos shale deposited while the coastline of the epicontinental sea was still in Utah. The Mancos thins up to 800 feet over the Douglas Creek on the west side of the basin (Quigley, 1965) signalling the start of the Laramide orogeny.

As the Laramide orogeny progressed, the Mancos sea retreated to the east across Colorado. Childs (1980) estimates 4,600 to 6,500 feet of fluvial to marginal marine Mesaverde sediments were deposited on the western margin of the retreating sea as part of a south-southeastward prograding delta complex (Collins, 1976). The source of most of the Mesaverde sediments was an uplift in Utah, as shown in Figure 5. The Mesaverde is the major coal (and coal bed methane) bearing formation in the Piceance.

COAL

Resources

Mesaverde coal occurs throughout the basin from the surface to 12,000 feet deep in beds up to 52 feet thick (see Plate 1). Net coal thicknesses of beds three feet or greater exceed 200 feet in the northeast corner of the basin (see Plate 2). Figure 6 shows three prominent outcrops of these coal beds along the east side of the basin.

Coal rank ranges from subbituminous C in the northeast where the coal was not deeply buried to anthracite in the southeast where the coal was upgraded by neighboring intrusions (see Plate 3). However, most of the coal is in the high volatile B to low volatile range.

COLORADO STRATIGRAPHIC NOMENCLATURE CHART

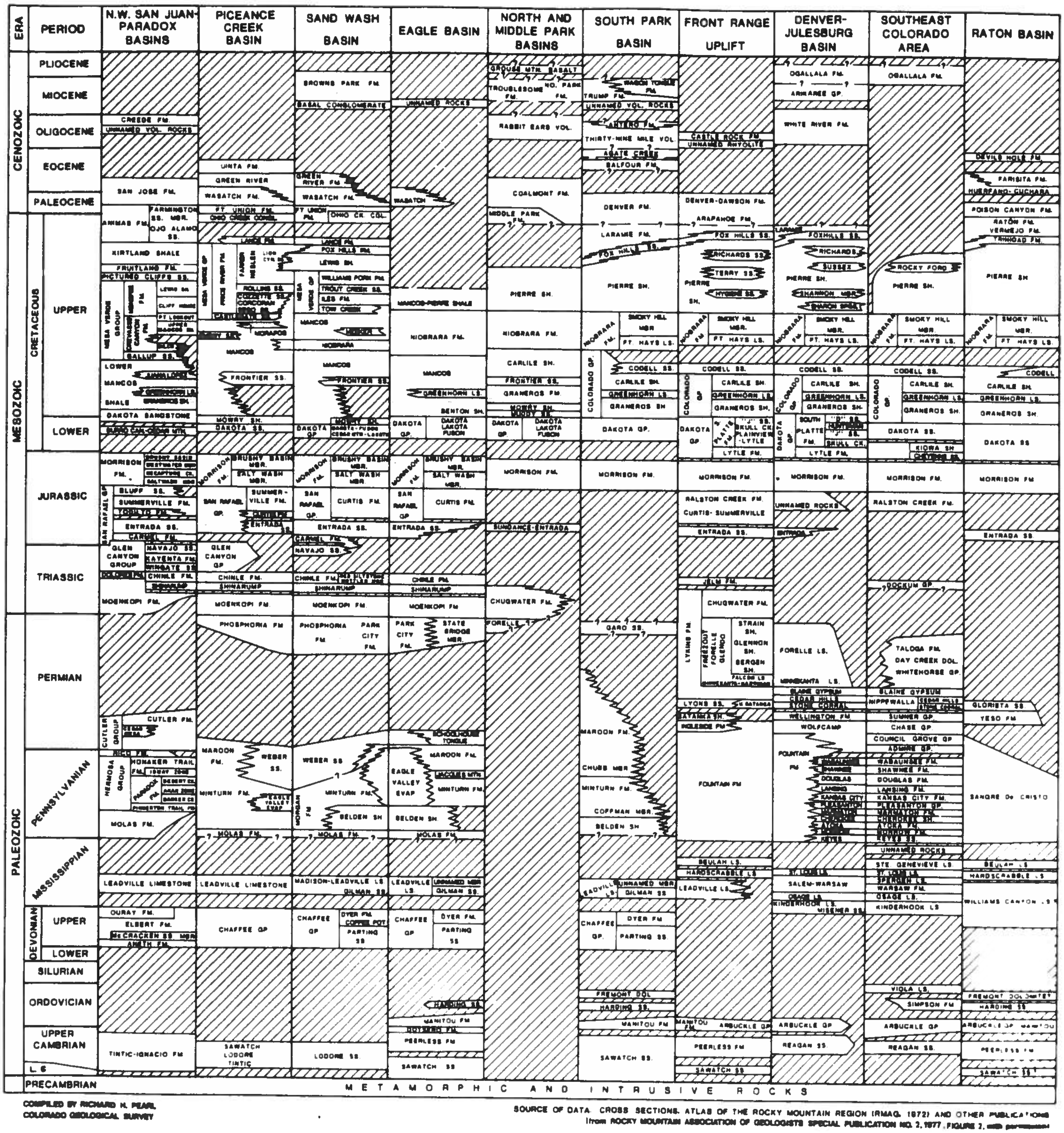

Figure 3. Colorado stratigraphic nomenclature chart.

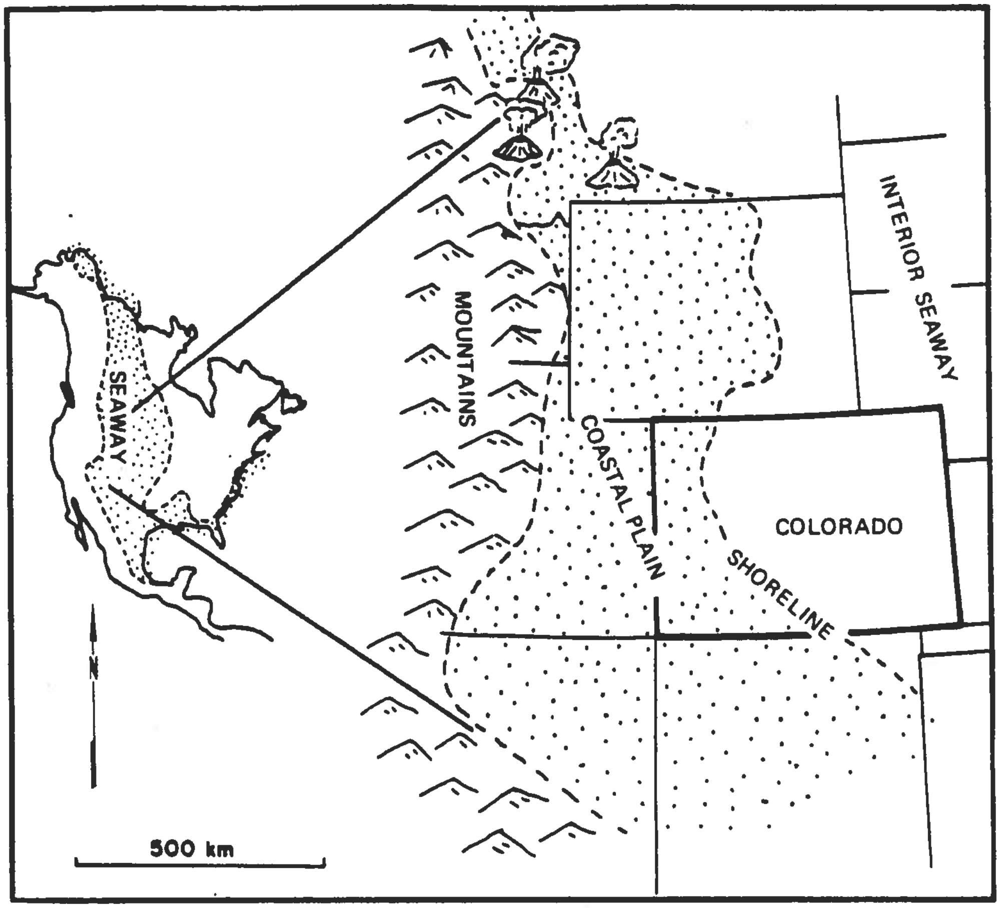

Figure 4. The Cretaceous epeiric seaway (after Lorenz, 1982).

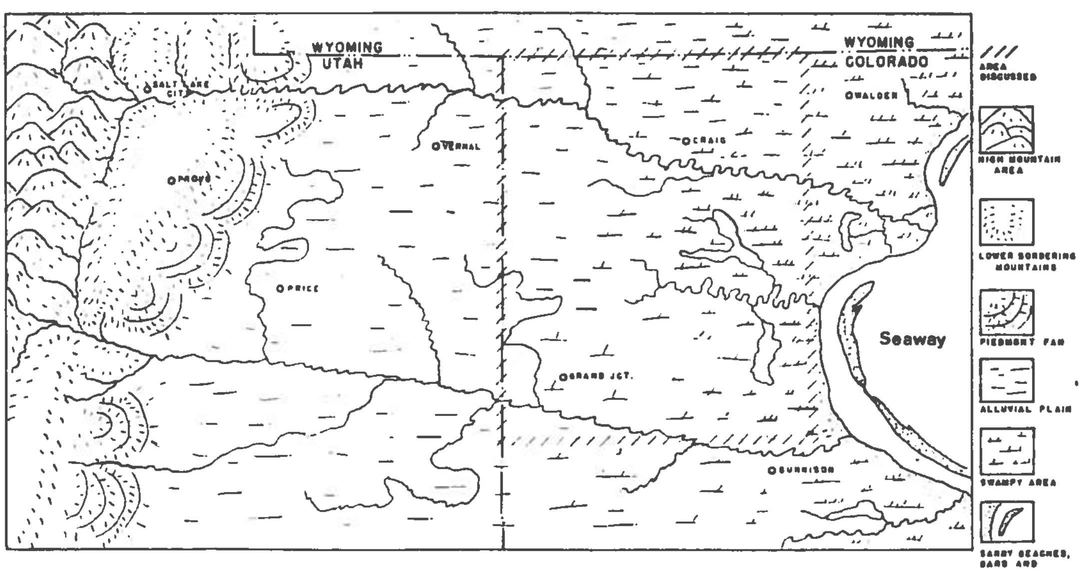

Figure 5. Cretaceous paleogeography during the deposition of Mesaverde sediments (from Curtis, 1962).

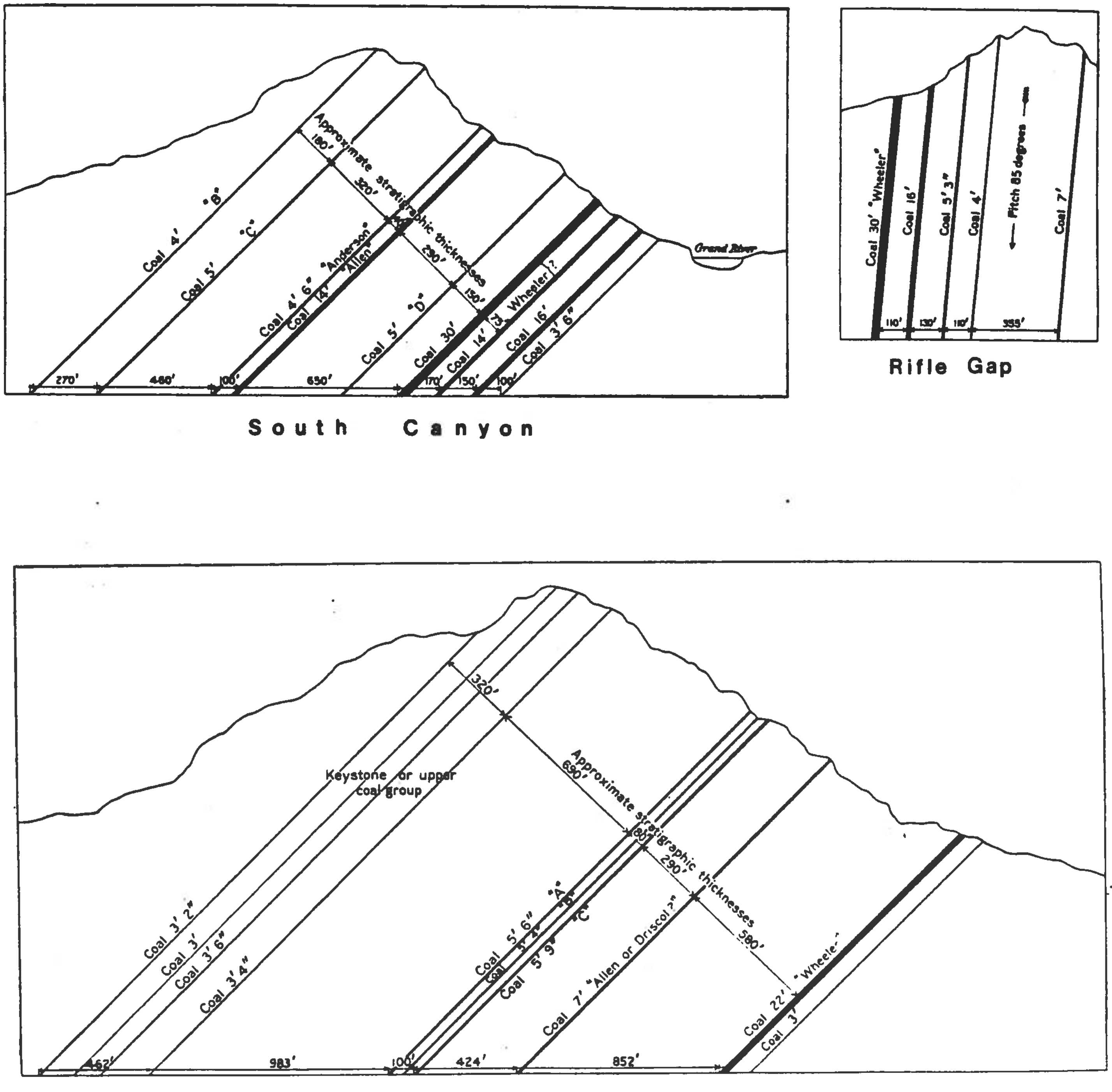

Figure 6. Three coal outcrop profiles along the Grand Hogback, eastern edge of the Piceance Basin (from Gale, 1910).

This coal forms 26 percent of the state's total coal resources (Murray, 1980). Coal is mined from 8 coal fields around the margin of the basin (Figure 7), and the Piceance Basin leads the state in production of underground and coking coal. Since the late 1800's, the basin has produced more than 91.5 million short tons (approximately 15% of Colorado's total production) from 300 mines.

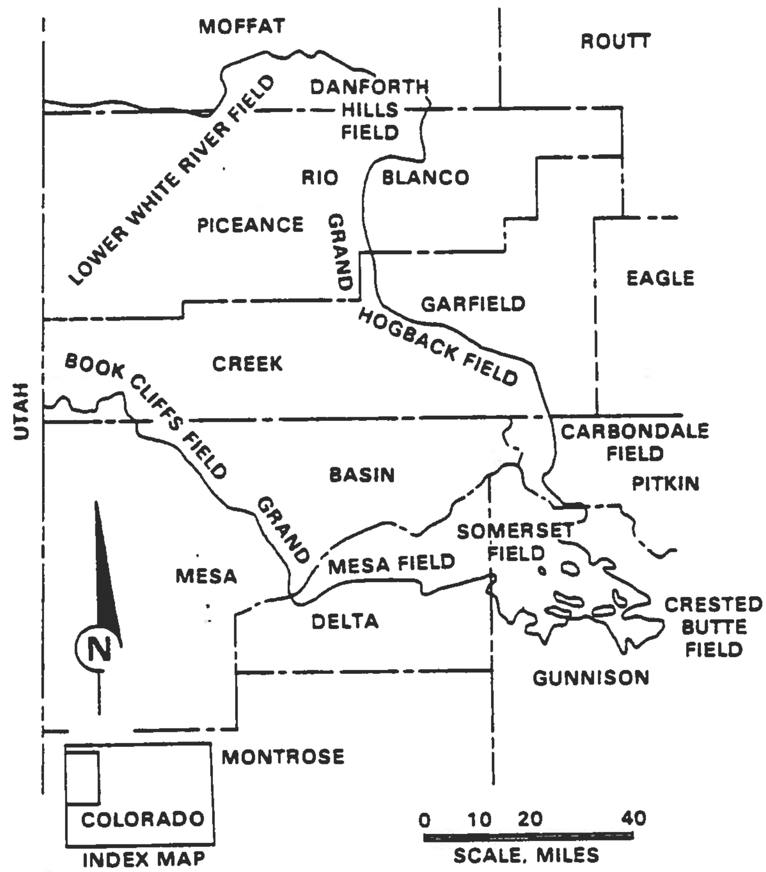

Figure 7. Coal fields of the Uinta coal region, Colorado (from Childs, 1980).

Depositional Environment

The lowermost part of the Mesaverde group is a transitional zone of blanket regressive marine to beach sandstones that intertongue with the Mancos Shale (Figure 8). The seaward limits of some of the more widespread sandstones, such as the Cozzette, the Corcoran, and the Sego, are shown in Figure 9. On the northern and western side of the Basin, inland from their seaward limits, these sandstones are often accompanied by minable coal beds.

However, the one coal sequence found throughout the entire Piceance Basin occurs in the approximately 1,000 feet above the Rollins-Trout Creek Sandstone, the youngest basinwide regressive sandstone. This sequence consists of mixed sandstone, shale and coal. According to a study by Collins in the southeastern part of the basin, (1976) the coals closest to the Rollins were probably deposited in brackish interdistributary marshes and formed from the remains of grasses and reeds. Coals higher in the

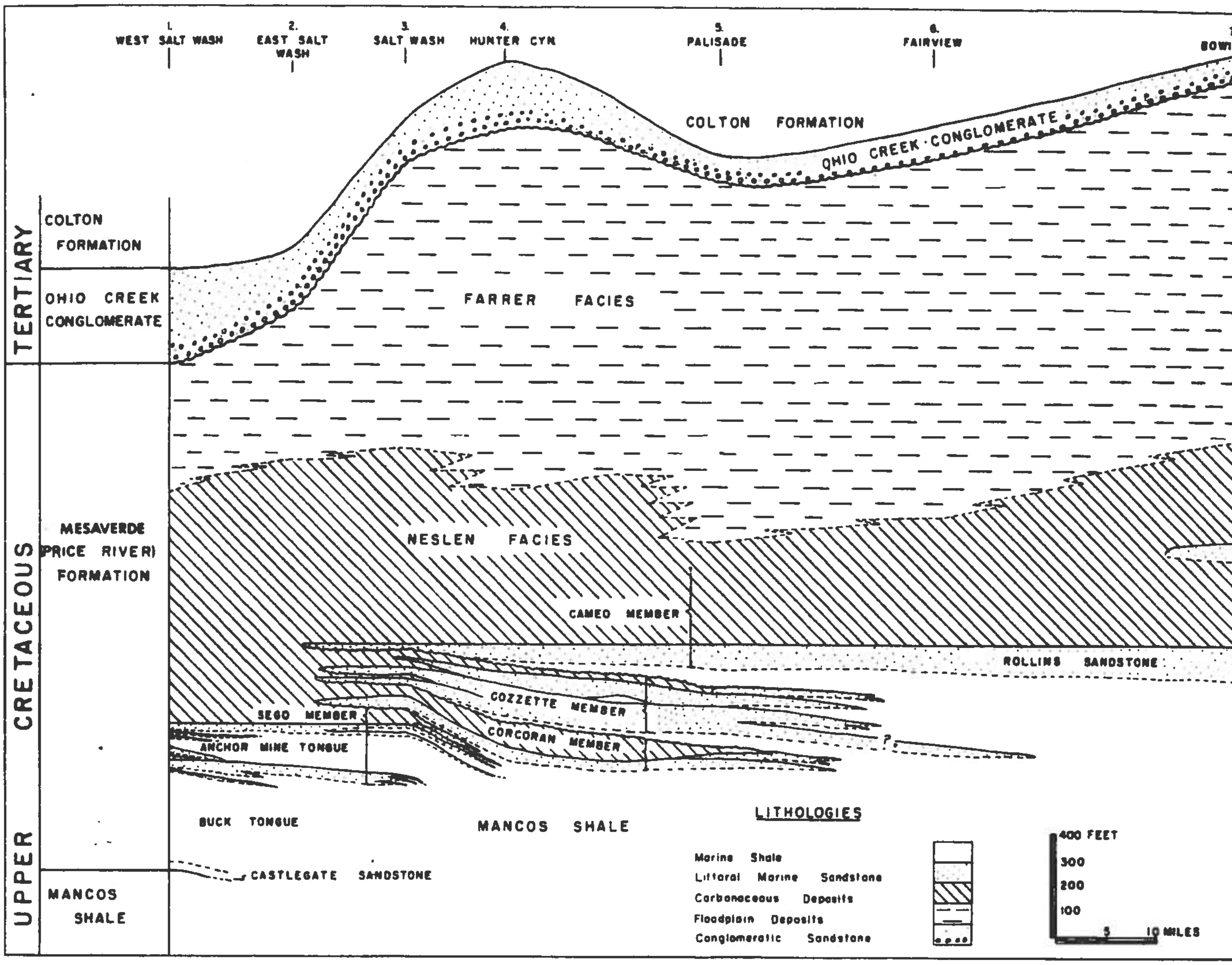

Figure 8. Late Cretaceous deposits of the southern Uinta coal region, Colorado (from Young, 1959).

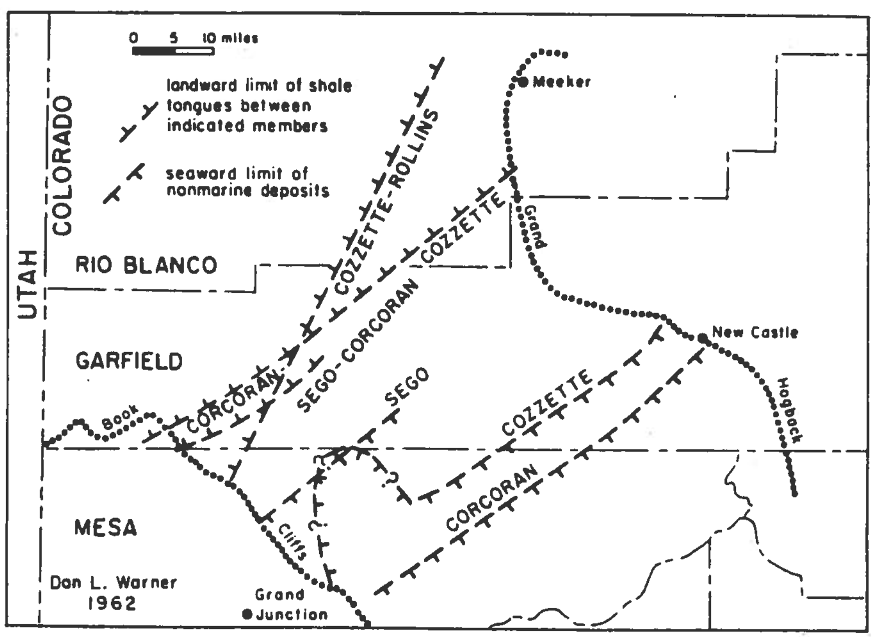

Figure 9. Shoreline trends of some lower Mesaverde regressive sandstones (from Warner, 1964).

section were deposited further back in the delta in forested fresh water swamps. Channel and crevasse splay sandstones and mudstones split the coals. In the CER-MWX 1 and 2 wells of Section 34, Township 6 South, Range 94 West, only 63% of these sandstones are continuous for a distance of 139 feet (CER, 1982); however, all the coals (3 feet or thicker) are continuous over that distance. Unfortunately, correlations by the author in different parts of the basin indicate that even the thickest coals (30 to 50 feet) rarely maintain their thickness for more than a couple of square miles. Figure 10 illustrates the depositional environment of this widespread coal sequence.

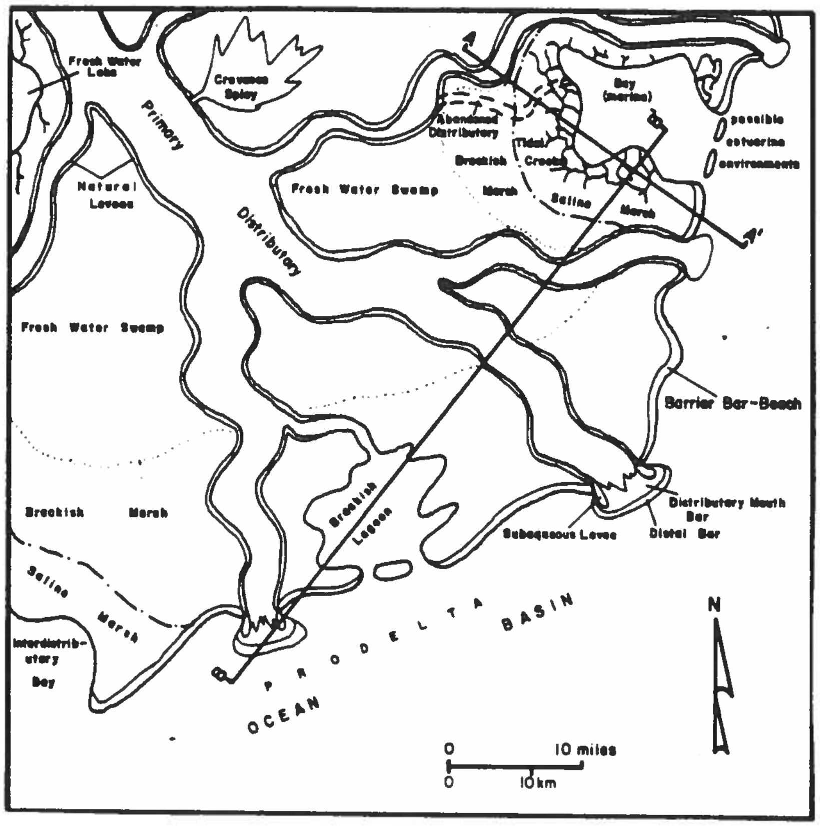

Figure 10. Depositional environment of Mesaverde coals (from Collins, 1976).

Overlying the coal bearing zone of the Mesaverde are several thousand feet of fluvial sandstones and shales essentially barren of coals. Due to the vast extent of the basin, and the varying facies of the Mesaverde Group there, the group has been split into a number of formations, members, and facies. Figure 11 gives this nomenclature. Plate 4 contains three type logs showing the appearance of the Mesaverde Formation in different parts of the basin.

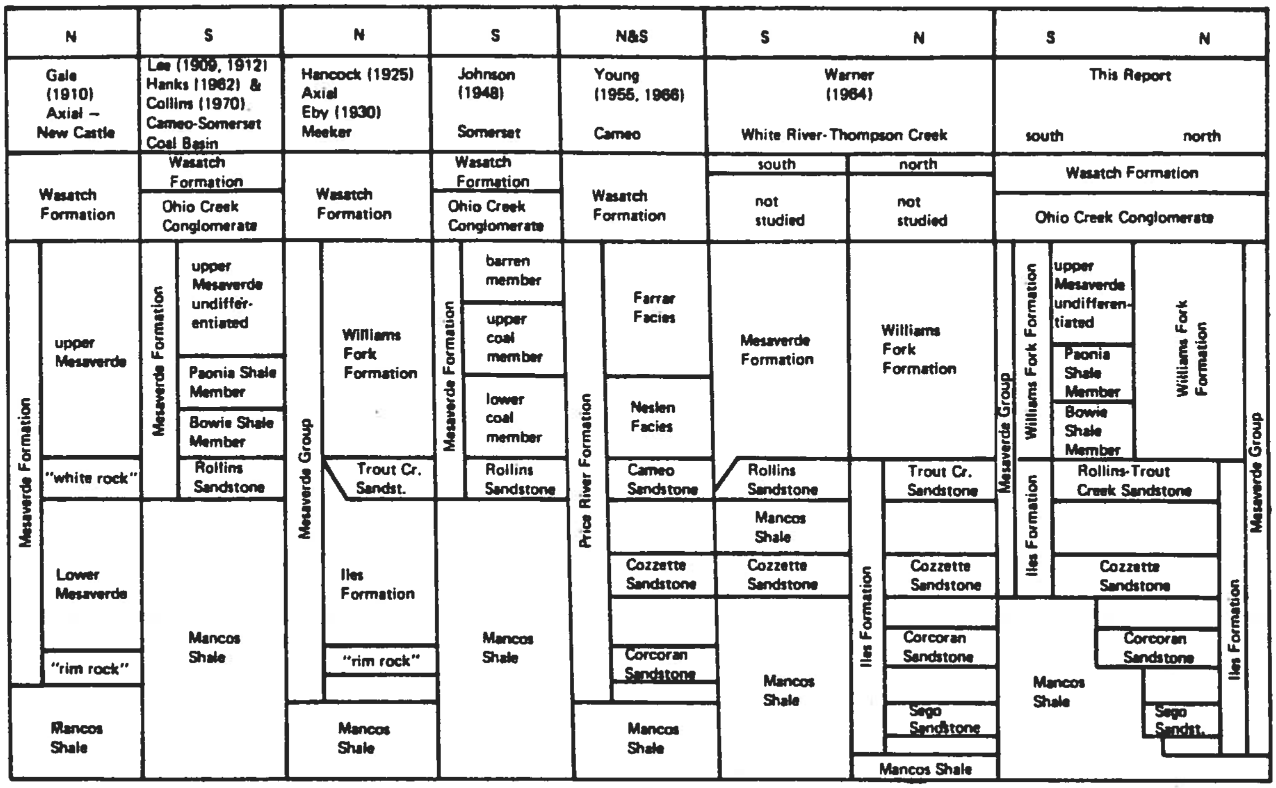

Figure 11. Nomenclature for Upper Cretaceous and early Tertiary rocks in the Piceance Basin (from Collins, 1976).

OIL AND GAS

In addition to coal, oil and gas are significant fossil fuels found in the Basin. The first well was drilled in the Piceance Basin in 1890. However, the first important gas discovery did not occur until 1930. Most of the oil and gas is found in structural, stratigraphic or hydrodynamic traps. Oil and gas is produced from the Pennsylvanian Weber to the Eocene Green River Formations; producing formations and fields are listed in Appendix 1. However, as can be seen from the oil and gas field map (Figure 12), natural gas, most of it stratigraphically trapped, forms the principal production of the basin.

In fact, only gas is produced from the dominantly non-marine Mesaverde Formation. Gas is found in both the fluvial-paludal and the lower transitional facies of the Mesaverde Formation (see map of DST & perforation recoveries from the Mesaverde Group, Nuncio & Johnson, 1981). Most of the established reservoirs are in the lower transitional facies in such marine sandstones as the Cozzette and Corcoran. However, "the non-marine facies probably contains much more gas in place than does the lower facies" (Dunn, 1974). Much of this gas has not been produced because the sandstone reservoirs of this non-marine facies are clay filled or tightly cemented. The CER-MWX wells mentioned earlier in this report are part of a U.S. Dept. of Energy experiment to develop the technology to economically complete wells in these tight, non-marine sandstones.

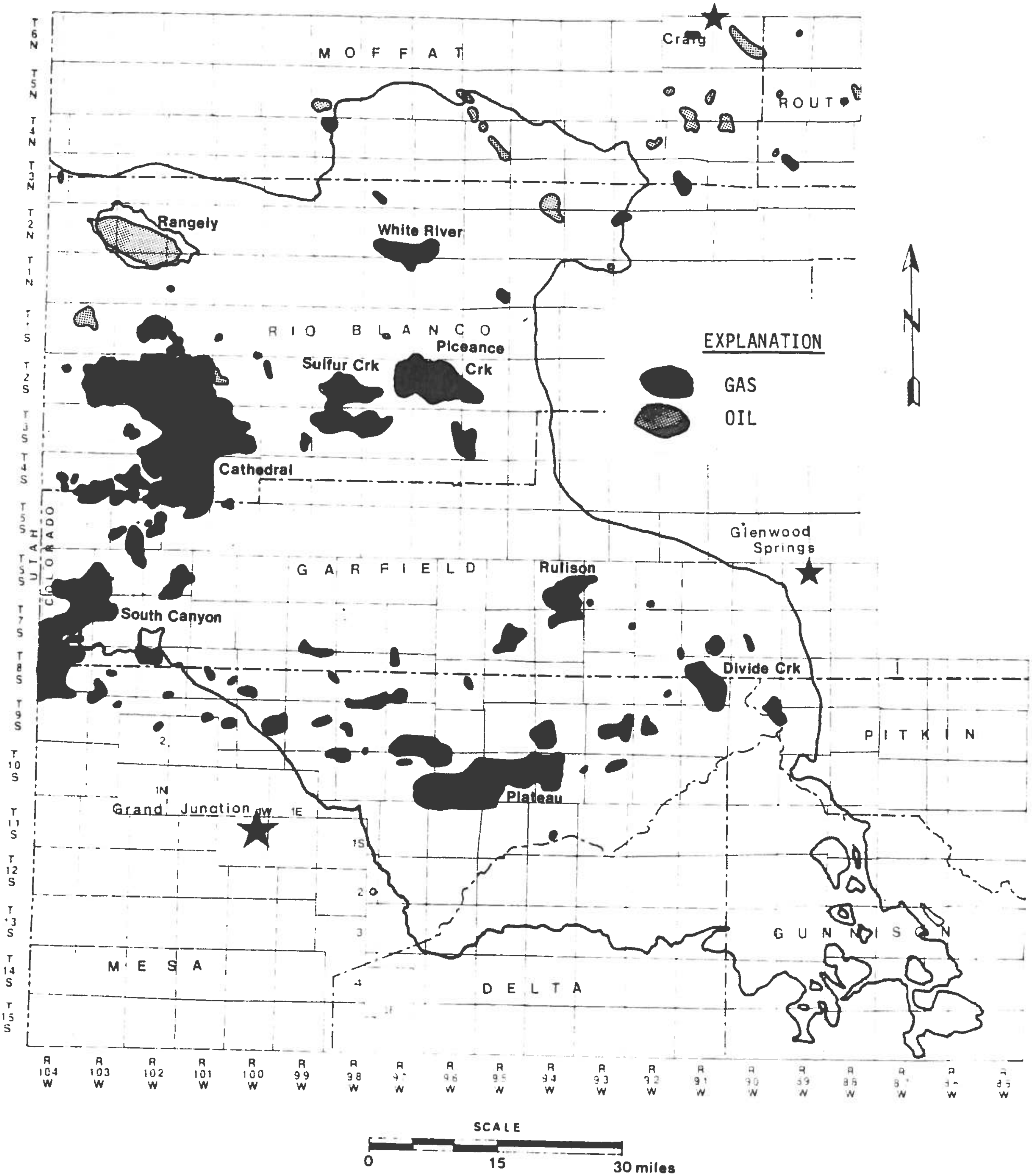

Figure 12. Oil and gas fields of the Peceance Basin area (after Scanlon, 1983).

Numerous authors (Millison, 1968; MacMillan, 1980; Sanborn, 1977) have suggested that the gas in the non-marine section of the Mesaverde is probably generated by the coals and trapped in sandstones as shown in Figure 13. Rice (personal communication), after analyzing Mesaverde gas samples from the CER-MWX wells both chemically and isotopically, concluded that the gas from the paludal zone seemed to come from the coals.

COAL BED METHANE

Direct Evidence

In addition to the coal generated gas trapped in Mesaverde sandstones, there is direct evidence of the existence and possible producibility of coal generated gas still in the coals. This evidence consists of: 1) gas producing coal mines; 2) gas shows in coals in oil and gas exploration holes, and 3) desorption data.

1. Gassy Mines

Fender and Murray (1978) listed 47 coal mines in the region that had reported gas occurrences including twelve gas explosions, five dust explosions (possibly methane related), and six mine fires. These gas occurrences are shown on the map (Plate 5) and listed in Appendix 2. More recently, a gas explosion killed fifteen miners in a Carbondale field mine.

Indeed, the most gassy mines are in the Carbondale field (T7-10S, R89W) where the coal ranks medium volatile. In this field, the L. S. Wood Mine emitted 2,170 MCFGD (million cubic feet of gas a day), the Dutch Creek No. 1 Mine emitted 1,338 MCFGD, and the Dutch Creek No. 2 Mine emitted 1,426 MCFGD for the period 1974 through 1976 (Tremain et al, 1981).

Mid-Continent is currently draining methane from gob areas in two of these mines and using it to dry their coal (see Choate, et al, 1981). Furthermore, a methane drainage plan has been drawn up for a mine in the Somerset field (see Boreck and Streever, 1980).

2. Gas Shows in Coals in Oil and Gas Tests

In addition to the gassy mines around the basin margin, are gas shows in coal beds in oil and gas drill holes scattered throughout the interior of the basin. Appendix 3 details these shows and Figure 14 gives their locations. This data can be summarized as follows:

1) 21 holes with gas in drilling mud while coals were being drilled
2) 15 holes with production tests of sandstones in paludal zones of the Mesaverde Formation
3) 15 holes with drill stem tests of intervals containing at least one coal bed
4) 6 holes with production tests in which both sandstones and coals were perforated
5) At least 8 holes where coals were individually production tested

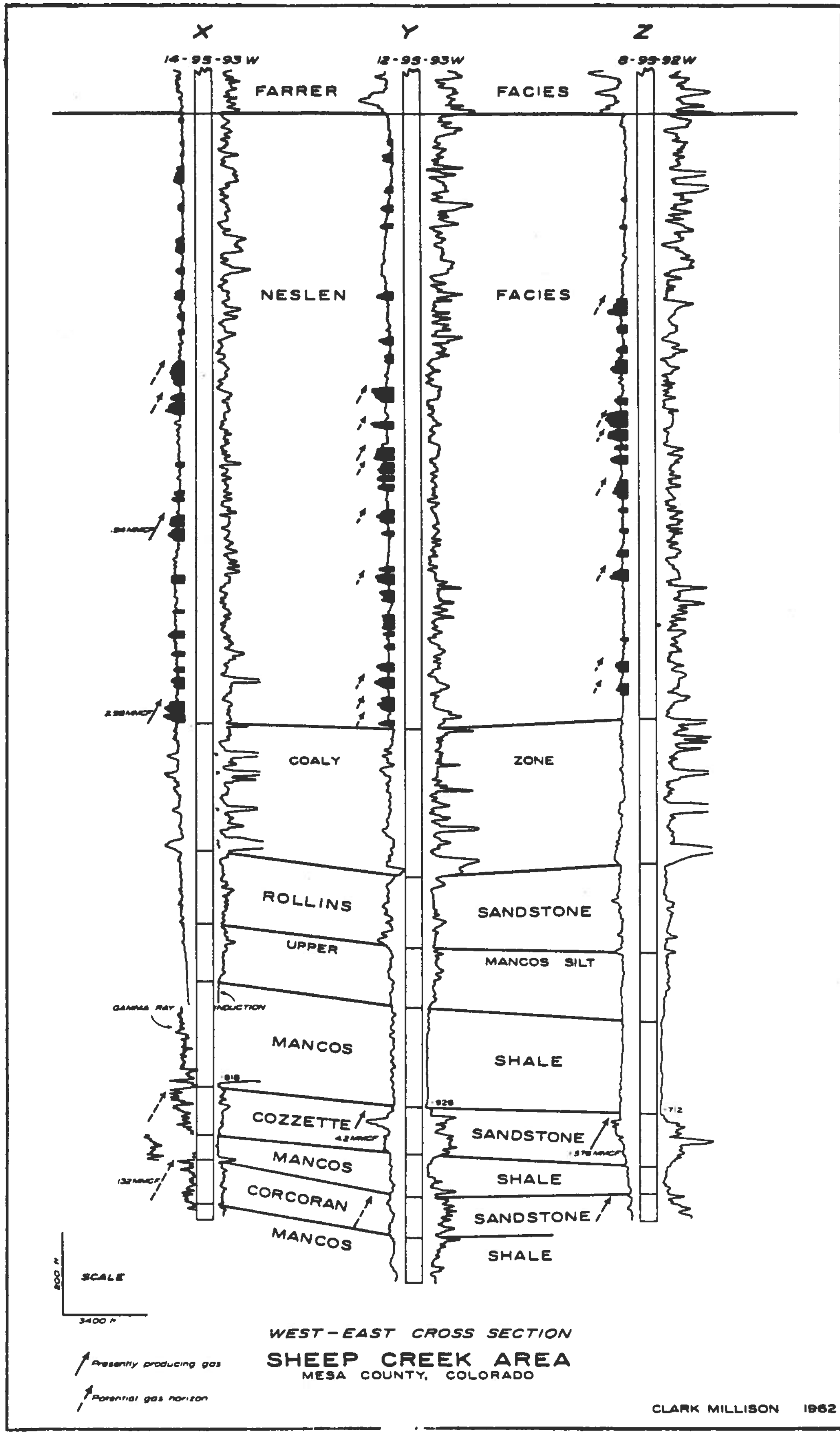

Figure 13. Gas, probably from coal seams, trapped in lower Mesaverde sandstones (from Millison, 1962).

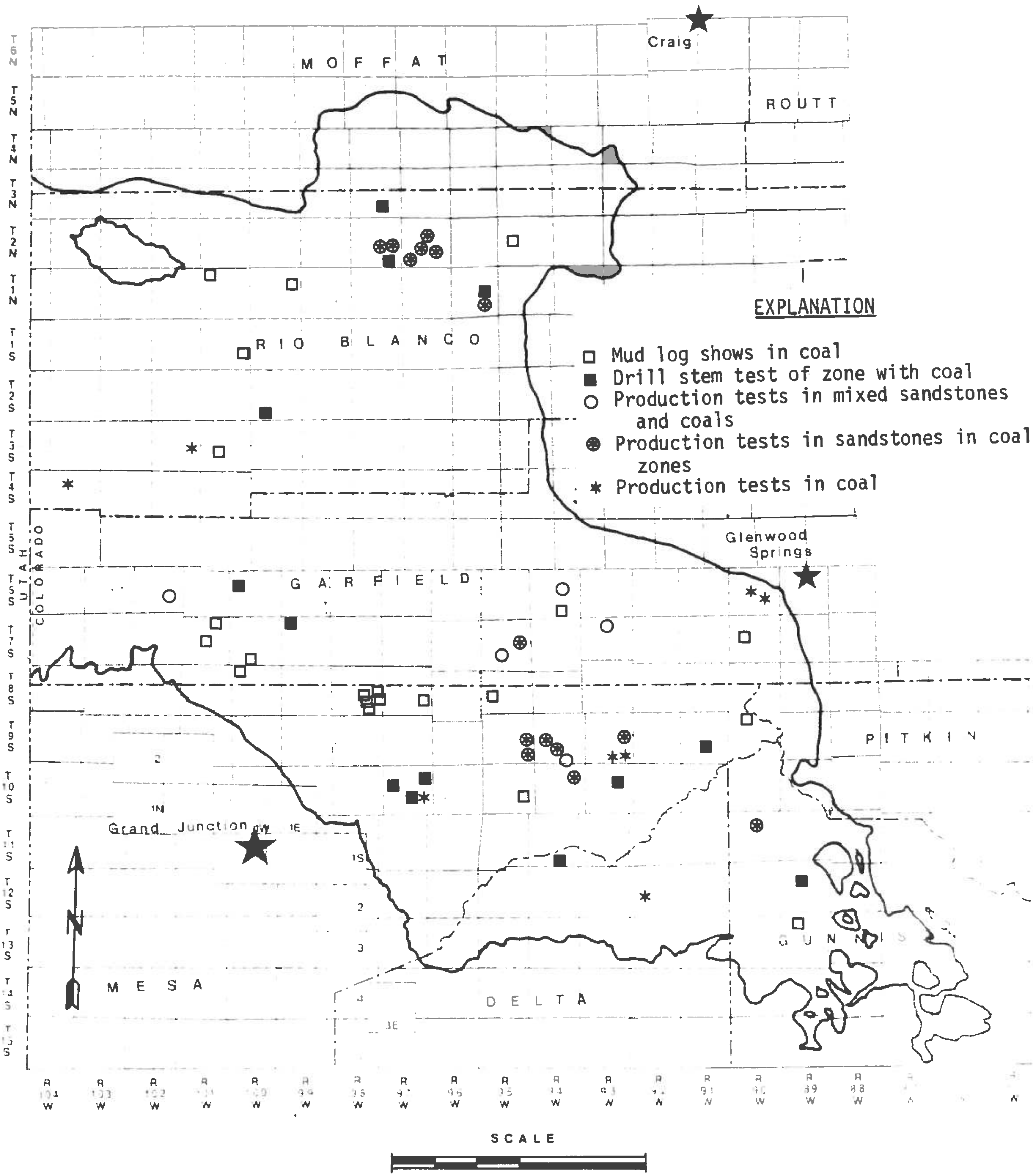

Figure 14. Shows in oil and gas wells in the Piceance Basin area.

Gas shows in mud during the drilling of coals indicate gas presence but are not quantifiable. These shows are scattered throughout the basin, even in areas where directly measured coal gas contents are only moderate. Nor can wells completed in paludal Mesaverde sandstones which were probably sourced by coal beds give valid potentials for methane production from the coal beds themselves. The same problem exists for holes drill stem tested or production tested in zones containing both coal and sandstones.

The only true indicator of coal reservoir potential comes from the 8 holes in which coals were production tested. Of these 8 holes, the first 2 holes listed in Appendix 3, Section 5, were probably tested in coals of low gas content. Of the other holes listed, the 5 for which test data are available and which produced anywhere from "small quantities" to "440 MCFGPD" may not have been completed in the manner most conducive to sustained gas production or may have been completed in coals of very high water saturation. Although no economic successes are listed in this section, testing has not necessarily been completed on all the holes, and successful production may yet result.

3. Desorption

Desorption, or measuring the gas emitted by encapsulated coal core samples, is currently our best attempt at quantifying the coal gas content of a particular coal bed. For a description of the U.S. Bureau of Mine's desorption method, see Appendix 4. Appendix 5 is a table containing desorption gas content data for 107 samples desorbed by the Colorado Geological Survey, and 92 samples desorbed by TRW Inc., the U.S. Bureau of Mines, and U.S. Steel. The locations of these samples are shown in Figure 15. Total gas contents of all but the 44 U.S. Steel samples range from 0 to 438 cf/ton (cubic feet of gas per ton of coal). U.S. Steel, using a modified Bureau of Mines method, has gas contents ranging from 250 to 765 cf/ton. (These figures are averages of several samples.)

It must be noted that the gas contents in Appendix 5 are not in standard cubic feet per ton. For the Colorado Geological Survey samples, standard cubic feet per ton numbers are approximately 20 per cent lower than the totals listed.

The general conclusions that can be drawn from this desorption data are: higher rank coals have higher gas contents, coals with less than 1,000 feet of cover, regardless of rank, have low gas contents, and the southeast section of the basin has the highest measured gas contents.

Projecting Methane Occurrence

On the basis of these general conclusions, associating high rank coals under sufficient overburden with high gas contents, we can project methane contents for areas of the basin that have no direct data. To make this projection, we need a coal rank map and an overburden map.

Plate 4 is a coal rank map of the Piceance Basin. In general, rank increases with depth of overburden on top of the coal according to Hilt's law. This pattern can be seen in the Piceance with the highest rank coal overlying the basin's axis. However, there are anomalous high rank coals in the southeastern portion of the Piceance Basin. As can be seen from Figures 16 and 17, this is also an area of high heat flow and high geothermal gradient. This high heat flow could have accelerated coalification locally.

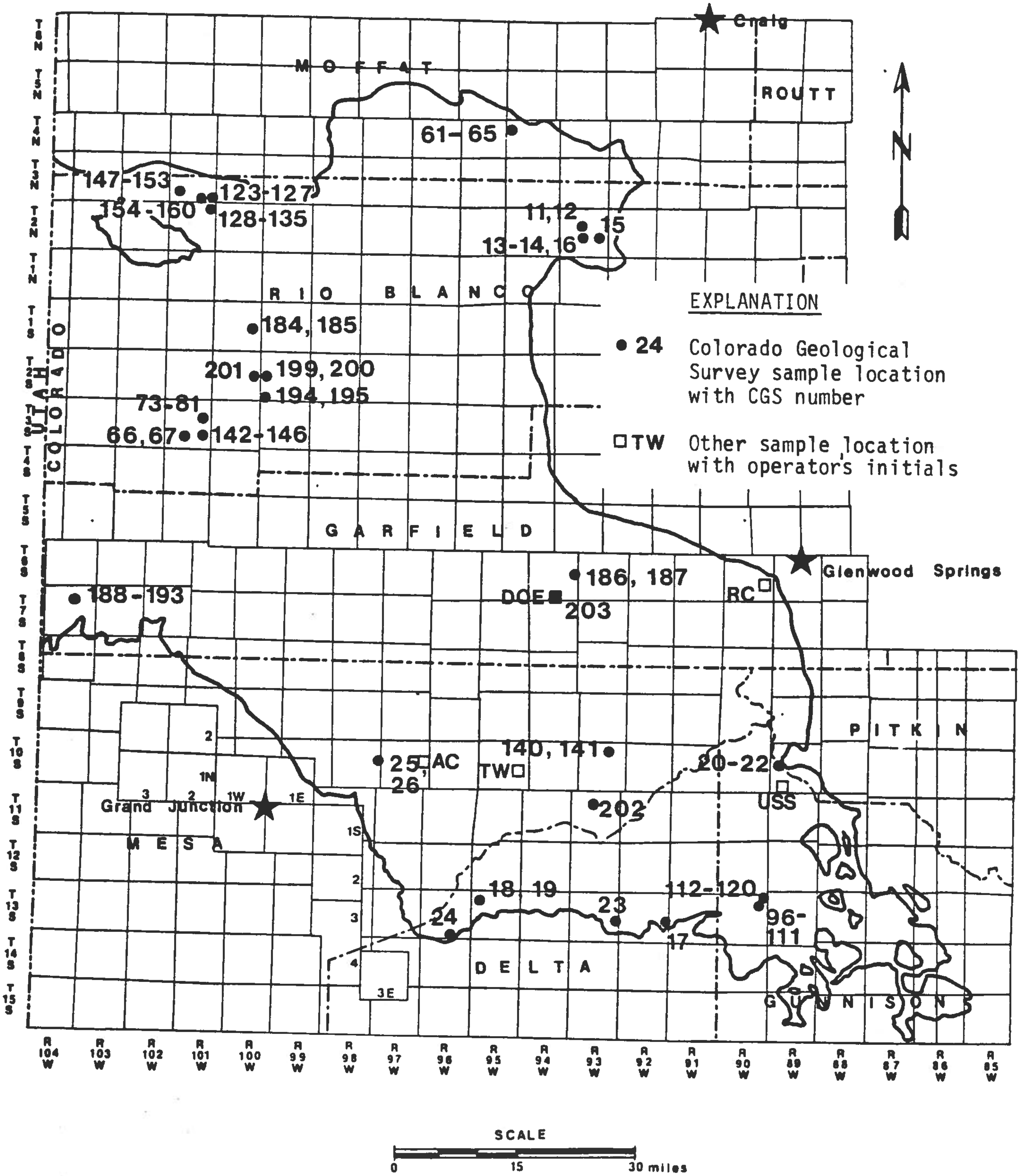

Figure 15. Locations of Colorado Geological Survey and other desorption samples in the Piceance Basin area.

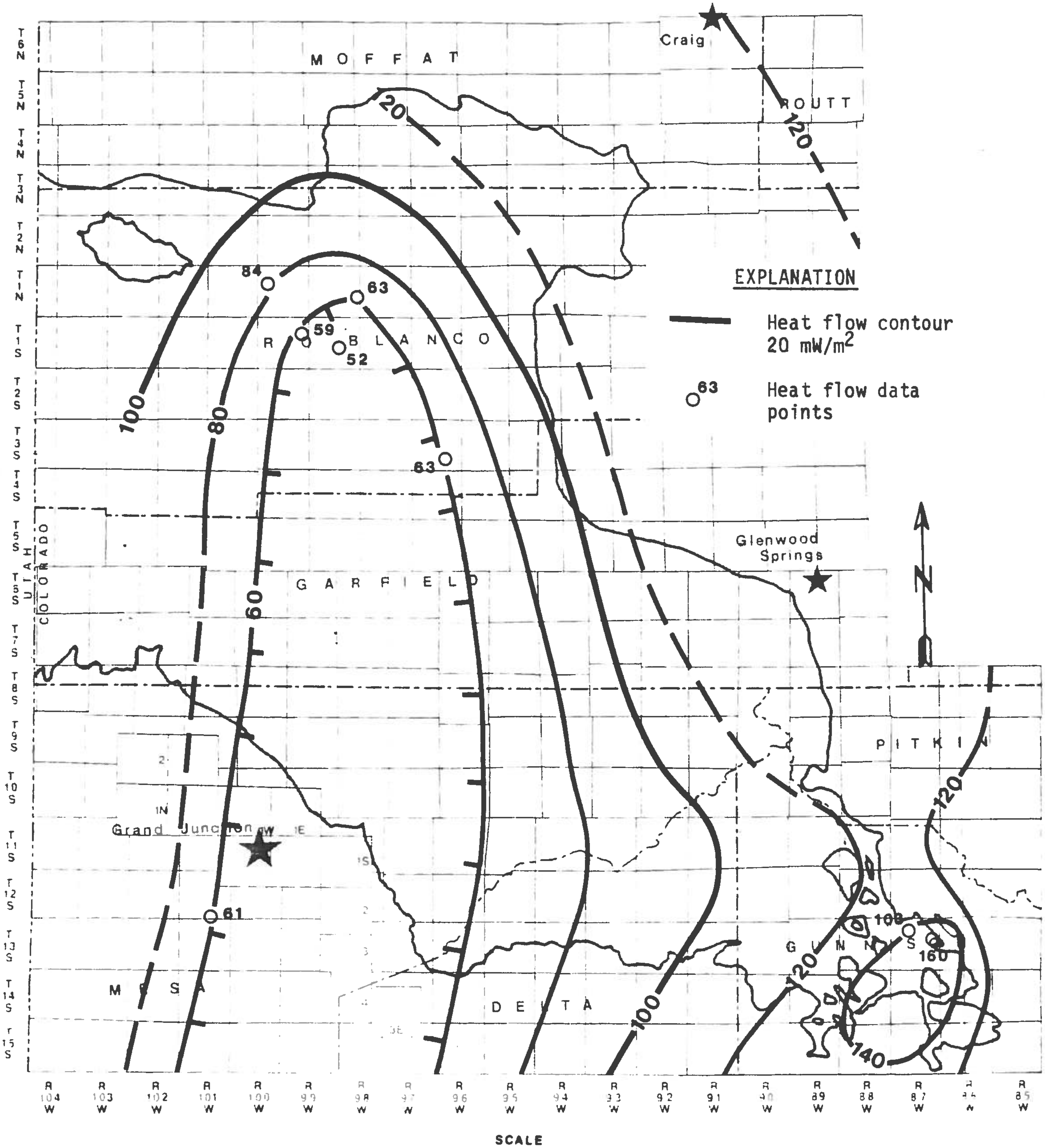

Figure 16. Heat flow map of the Piceance Basin (after Zacharakis, 1981).

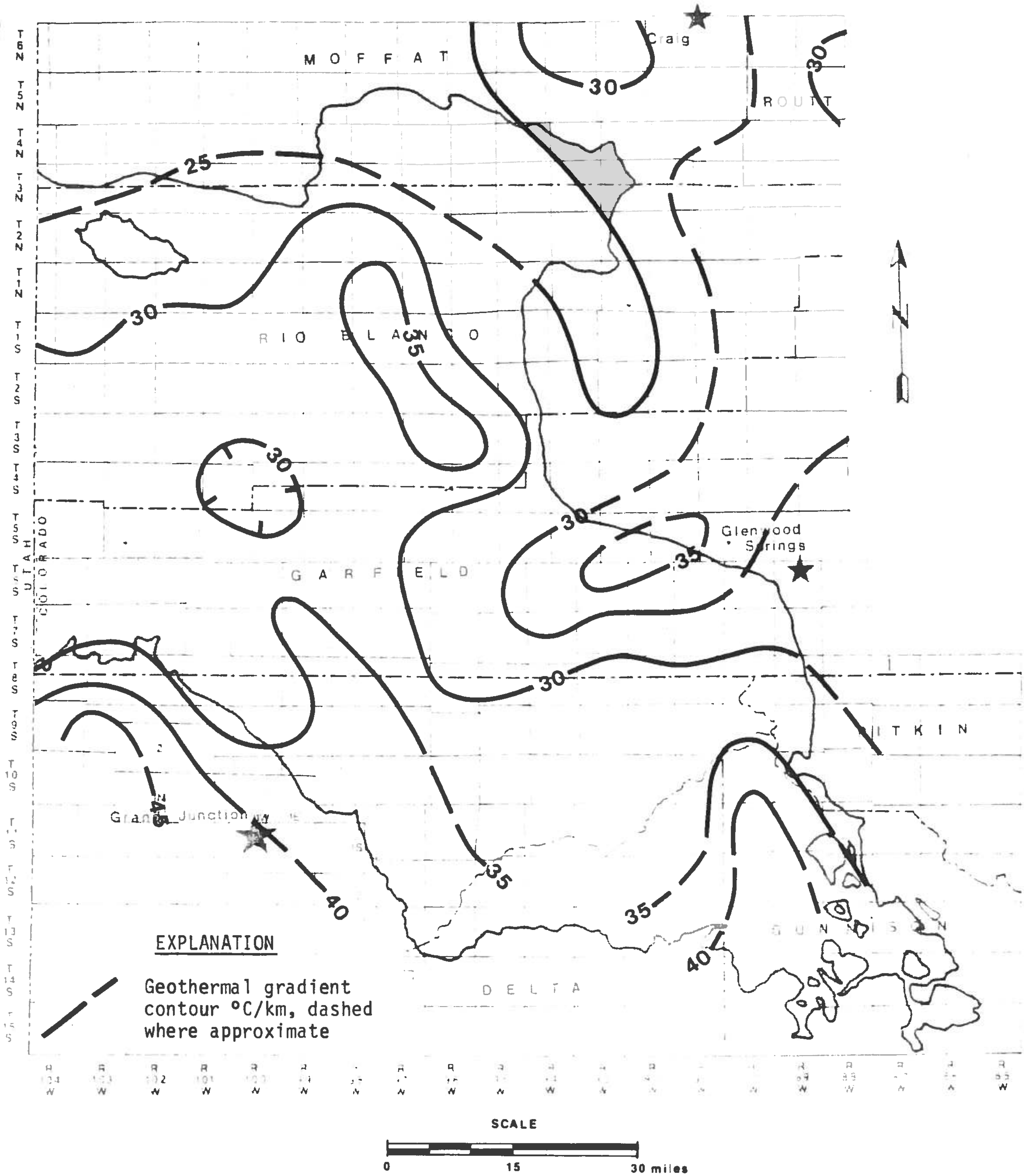

Figure 17. Geothermal gradient map of the Piceance Basin area (after Repplier et al, 1981).

The approximate overburden on the coals in the Piceance Basin can be found by subtracting a Rollins structure map from a topographic map. Choate et al (1981) have produced such a map for a large part of the basin and Ron Johnson of the U.S.G.S. will shortly publish a revised Rollins structure map.

Methane Estimate

In order to estimate the amount of methane that could be contained in the coals, we can make some volumetric calculations. First, we estimate the volume of coals for each rank. This is done by combining the net coal map (Plate 2) and the coal rank map (Plate 3) and planimetering the areas of coal in each coal rank-thickness polygon. All the volumes of coal calculated for one rank are summed to give the total coal volume at that rank. Then by multiplying the average gas content at that rank (calculated from Appendix 5 or Figure 18) by the volume of the coal, by the specific gravity of the coal, (from Ameri et al, 1981) and by a conversion factor, we can estimate the total gas resource for each coal rank type in the basin. In practice, since most of the gas is generated when coals reach high volatile A and higher ranks as shown in Figure 19, gas contents have only been estimated for these coals. The equations used for each of these coal rank categories are listed below:

High volatile A:	65,447 sq mi ft x 1.36 x .8698 x 10^{-3}	=	
	77 billion tons x 200 cf/t	=	15 TCF
Medium volatile:	70,541 sq mi ft x 1.36 x .8698 x 10^{-3}	=	
	83 billion tons x 450 cf/t	=	37 TCF
Low volatile:	69,285 sq mi ft x 1.36 x .8698 x 10^{-3}	=	
	82 billion tons x 500 cf/t	=	41 TCF
Semi anthracite:	5166 sq mi ft x 1.36 x .8698 x 10^{-3}	=	
	6 billion tons x 550 cf/t	=	3 TCF
Total Gas:		=	96 TCF
	96 TCF - 20%	=	77 TSCF

(trillion standard cubic feet)

The U.S. Department of Energy estimates 53 trillion cubic feet for the entire basin (Ameri et al, 1981) and TRW, Inc. estimated 60 trillion cubic feet (Choate et al, 1981).

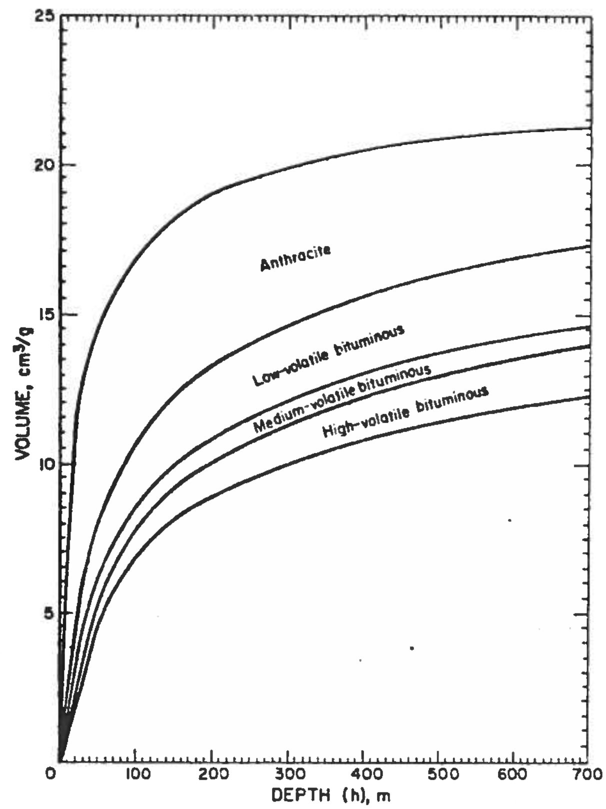

Figure 18. Estimated methane content with depth and rank (from Kim, 1977).

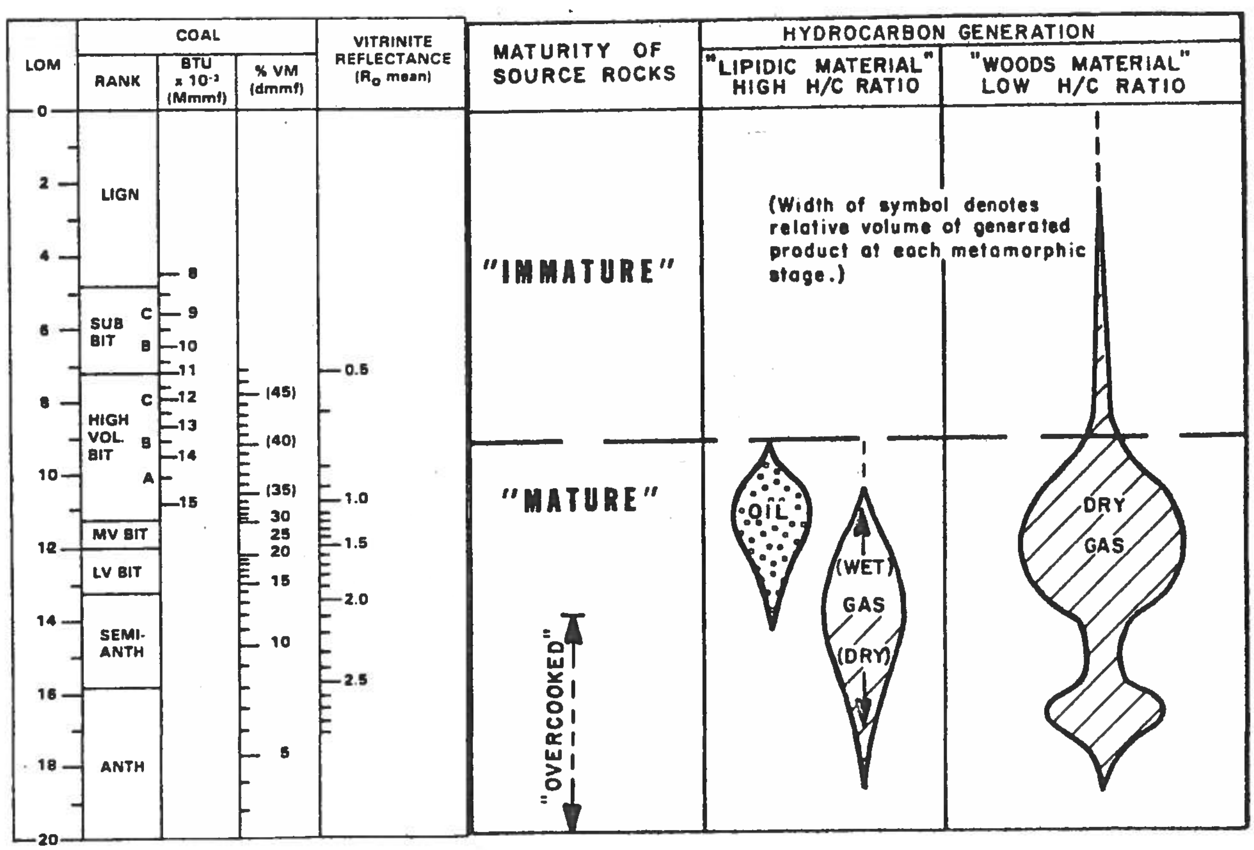

Figure 19. Gas generation at various coal ranks (after Childs, 1980 and Dolly et al, 1977).

Factors Affecting Producibility of Coal Bed Methane

However, having estimated this tremendous gas resource, we must note that only a small percentage of it may eventually be produced. Factors affecting the producability of coal bed methane include: 1) water saturation, 2) natural fracturing, 3) the extent of the reservoirs, 4) economics, and 5) drilling and completion techniques.

1. Water

Coal must be dewatered to allow the methane to desorb from the micropores in which it is held. This can be a problem if the hole is near a water recharge area, such as a stream, river or outcrop. The three American Public Gas Association coal bed methane holes drilled on the Purgatoire River west of Trinidad, Colorado, and a Snyder Oil Co. well near the outcrop of the Mesaverde Formation southwest of Glenwood Springs may be in such recharge areas. Of course, any water produced must be disposed of in an ecologically sound manner and aquifers must be protected according to the regulations of the Colorado Oil and Gas Conservation Commission.

Furthermore, in addition to the amount of water that a well might produce, the direction of water flow must be considered. Flow direction will influence hole locations if the wells are to be drilled in a pattern. (Pattern drilling is recommended by the U.S. Bureau of Mines to achieve dewatering most efficiently). The data needed to determine both the amount and direction of flow is sparce. The drill stem test data the author could find in lower Mesaverde coals and sandstones is presented in Table 1. Using this data, Bob Koenig (personal communication), calculated apparent depth to water of the wells tested within 100 ft above the Rollins Sandstone and found depths ranging from 96 to 5783 ft and averaging 2,650 ft in wells approximately 4,000-5,000 ft. Permeabilities were less than 2 millidarcies. However, he stated that this data may not be reliable in the basin since wells ranged from dry to flowing.

2. Natural Fracturing

Natural fractures will enhance the permeability of coals to both gas and water. Figure 20 is a lineation map of the northern part of the Piceance Basin by Frank Welder (1970), and is included as an aid in indicating fracture directions. The majority of the lineations on this map trend west-northwest. D. L. Sawatsky and Earl Berbeek, of the U.S. Geological Survey, are currently doing additional lineation studies in the basin. However, examination of air photographs of specific locations may be more helpful in selecting the most promising drill sites.

3. Extent of Reservoirs

The extent of the coal reservoirs is another important consideration affecting the eventual production of coal bed methane at any location. Individual beds anywhere from a few inches to 52 feet are present in the mapped area. However, thicknesses can vary over short distances. As mentioned earlier, thin beds correlated 139 feet in the MWX wells, but thick coal beds in the southeastern part of the basin maintained their thicknesses for only a few square miles.

Piceance Basin - heads calculated from DST data - $hw=z+p/Pgrad$*

Well Location	Height above Rollins SS	Kelly Bushing Elevation	Recorder Depth	KB-RD =z	Maximum Shut In Pressure	hw Head of water
27-10S-96W	17	5985	2953	3032	158	3391
26-10S-96W	15	6009	3135	2874	210	3351
12-8S-97W	112	5168	4128	1040	1890	5335
12-9S-93W	539	7602	7431	171	580	1489
8-9S-92W	422	7665	7336	329	264	929
14-7S-99W	194	5990	3711	2279	1450	5574
22-6S-100W	28	6403	3182	3221	50 (20 min)	3335
13-11S-95W	36	9900	6529	3371	2280	8553
13-11S-92W	66	9436	6714	2722	1489	6106
12-10S-96W	269	6119	3656	2463	162 (30 min)	2831
31-8S-98W	32	5862	2308	3554	125 (15 min)	3838
32-2S-99W	69	7646	6885	761	2828	7188
7-6S-100W	60	6910	2798	4112	49	4223
6-7S-99W	54	8256	5522	2734	414	3675
28-9S-91W	624	9179	7298	1881	2582	7749
10-10S-93W	12	8304	7648	656	1892	4956
17-12S-89W	406	6764	2144	4620	75	4790
34-11S-94W	3	10133	6215	3918	190	4350
23-10S-97W	7	5981	2760	3221	121	3496

*Pgrad (Pressure gradient) estimated at .44 from several water samples from MV fm.

Another important question is the trend directions of the coal beds. If the environmental interpretations mentioned earlier in this report are correct, the lowest coal beds near the regressive marine sandstones should be parallel to the ancient shoreline, and the higher fluvial-paludal coal beds parallel to the streams, or roughly perpendicular to the shore lines. As shown in Figure 7, shoreline trends are northeast-southwest. Lorenz (1983) reports northwest-southeast channel trends in the paludal zone based on sandstone percentage maps. Cross beddings trends from oriented cores from the CER-MWX wells may verify these sandstone trends in the future.

4. Economics

There are numerous economic factors affecting coal bed methane producability. Depth is a definite factor as drilling costs increase with depth. Gas price is affected by the gas market (currently depressed) and government regulations (currently coal bed methane is a decontrolled occluded gas). The presence of pipelines make an area more attractive. Fortunately, pipelines are already present in a good part of the Piceance Basin (see pipeline map, Figure 21).

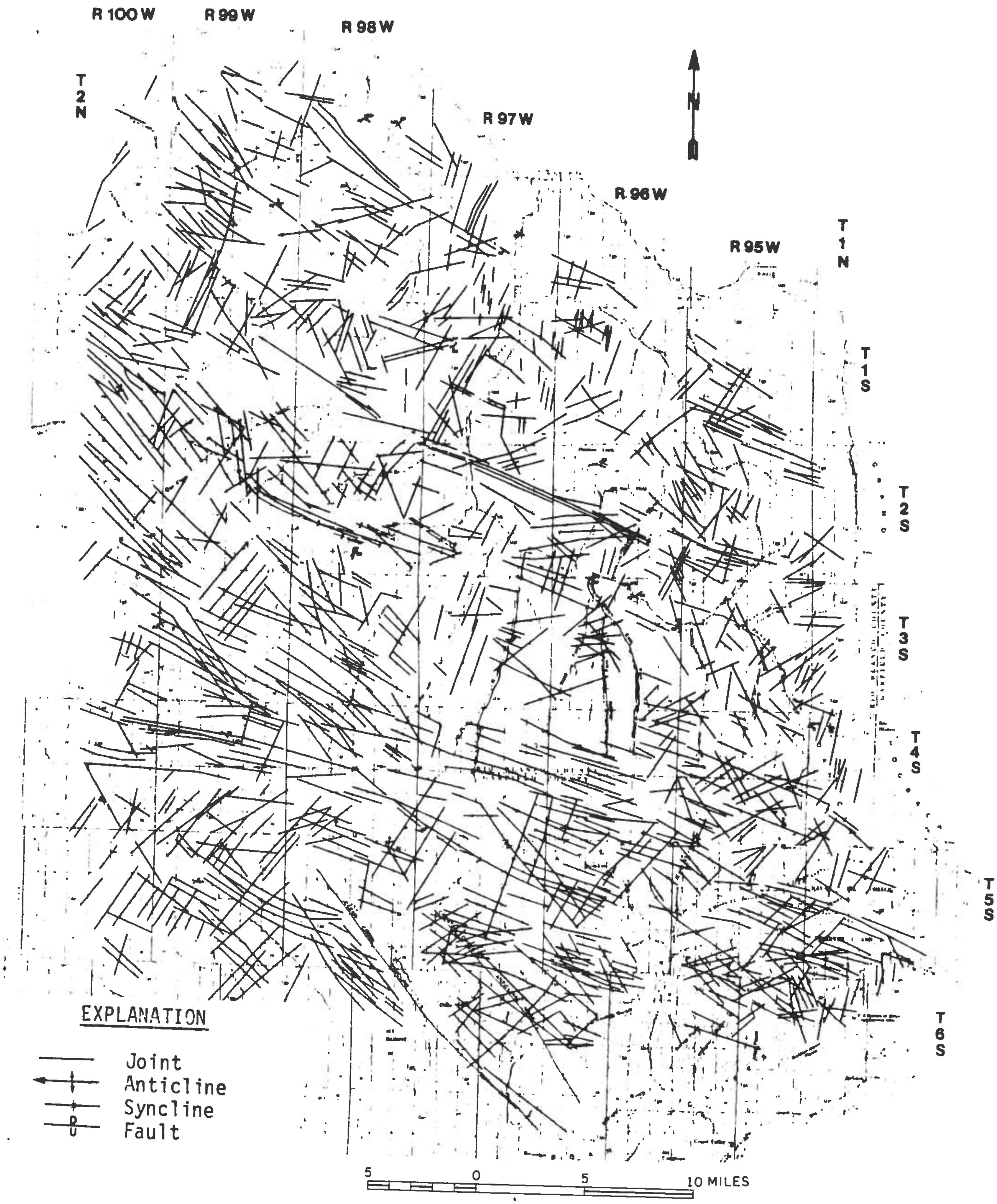

Figure 20. Lineation map of the northern Piceance Basin (from Welder, 1970).

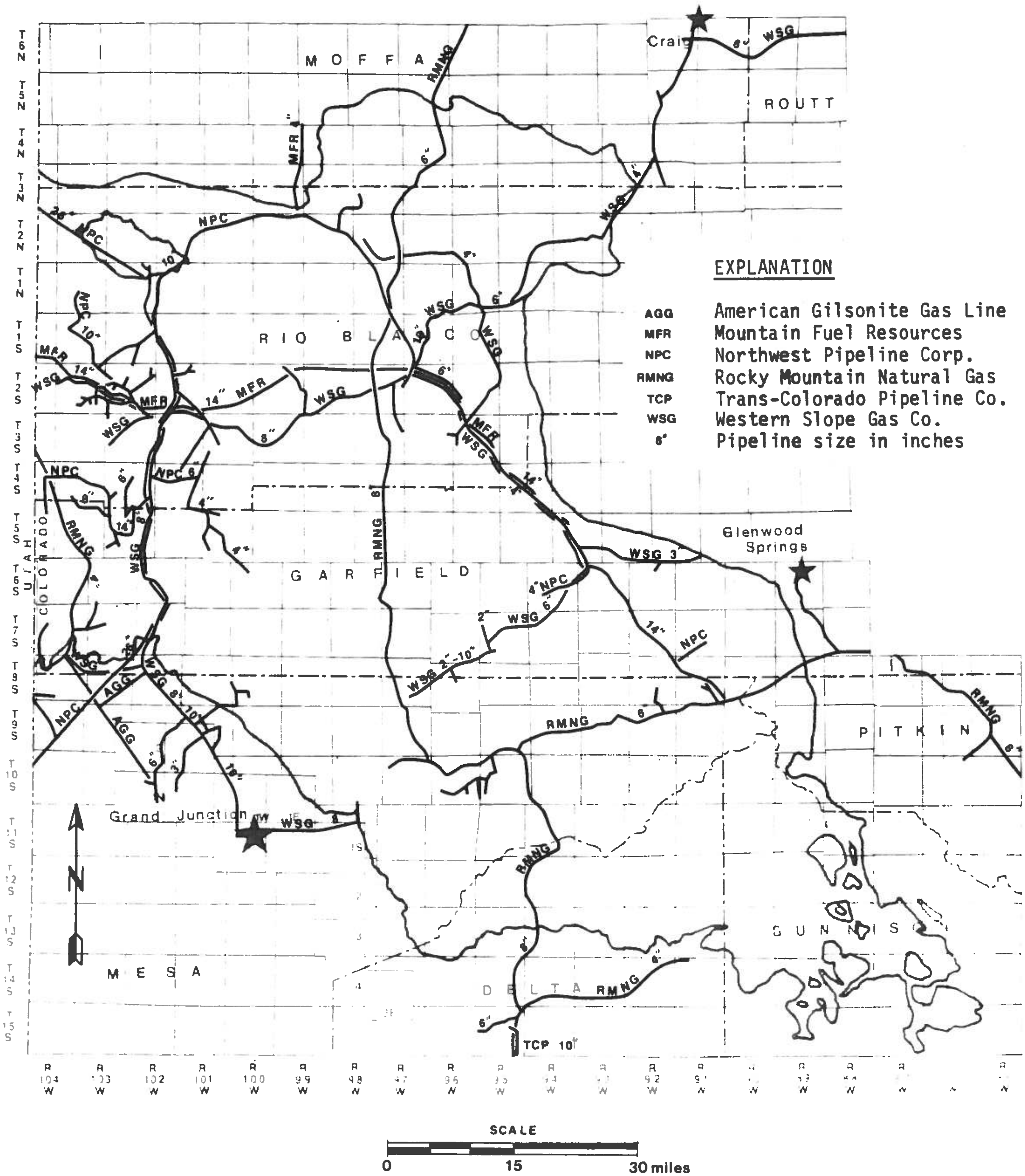

Figure 21. Gas pipelines in the Piceance Basin (from Colorado Public Utilities Commission, 1982).

5. Drilling and Completion Techniques

Drilling and completion techniques also can add significantly to the cost and affect the economic viability of a particular location. The best techniques for coal bed methane still are being determined.

Drilling with mud may damage the coal formation. This is suspected at the Tiffany Glover #1 well in the San Juan Basin and the three APGA holes in the Raton Basin. However, Amoco successfully completed several mud drilled holes in the New Mexico portion of the San Juan Basin. There is a precedent for air, gas, and foam drilling of easily damaged zones such as the Mesaverde Formation in the Piceance Basin; Sneed and Mencher (1962) describe these methods. The use of gas soluble oil based mud, while it may prevent damage to Mesaverde sandstones, seems to adversely affect desorption results from coal core samples (Choate, personal communication) and may also cause reservoir damage.

Perforating and fracturing the coal beds may not be a successful strategy in the Piceance Basin. The Snyder, Exxon, Rio Colorado, and Coseka wells listed in Appendix 3, Section 5, all were perforated and fractured in coal beds and did not have satisfactory sustained production. Possible problems these wells may have encountered include: coal fines plugging the perforations or fractures, loss of fracturing fluid, the driving of formation-damaging mud further into the formation, or the lack of gell breakdown.

On the other hand, open hole completion has been successful in the San Juan and Raton Basins of Colorado. Amoco has open hole completed several wells in the San Juan Basin by merely under-reaming coals to a 14-inch hole diameter. These wells are approximately 3,000 feet deep, and one has a production of 1 MMCFGD after a three-year production history. In addition, Wood, McShane, and Thams have completed three out of four holes drilled in the Raton Basin as gas wells using open hole completions. No production data is yet available on these wells. Open hole completion is recommended by the U.S. Bureau of Mines after extensive experience completing coal seams in the eastern part of the country (Lambert et al, 1980). Open hole foam fracturing has been a successful stimulation procedure for the U.S. Bureau of Mines in the East, although this strategy has not been successful in the three APGA holes mentioned earlier. Possibly Western Cretaceous coals are not as mechanically strong as Eastern Pennsylvanian age coals and tend to produce more fracture clogging fines.

Many of these questions may soon be answered. The Gas Research Institute, in cooperation with industry, intends to conduct a multiple well deep coal seam gas drainage project near Collbran, Colorado in the southern half of the Piceance Basin. The first well should spud this year. Appendix 6 is an excerpt from their research and development plan.

CONCLUSION

There are numerous indications that coal bed methane is present in the Piceance Basin. This methane appears of sufficient quantity and present in large enough reservoirs to make the Piceance the basin with the greatest amount of methane in the country. However, the best production and completion techniques for recovering coal bed methane in the basin have not yet been determined as evinced by the number of unsuccessful completions. Nor have the geological factors affecting production been more than approximated. It is hoped that future drilling, and particularly the multi-well coal bed methane experiment to be carried out by GRI will answer some of these questions.

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APPENDIX 1 - Oil and Gas Fields in the Piceance Basin Area

COUNTY FIELD NAME (Oil, Gas) Year Discovered/ Abandoned	GENERAL LOCATION Twp., Rge.	NO. WELLS PROD'G OR CAPABLE OF PROD'G	PRODUCING FORMATION OR ROCK UNIT	AGE	CUMULATIVE PRODUCTION TO 12-31-81 OIL(bbls)	GAS(Mcf)	CONDENSATE (bbls)	FIELD STATUS	WATER FLOOD (No. Injection Wells)	GAS INJECTION (No.wells)	REMARKS
GARFIELD COUNTY											
BALDY CREEK (G)	7S - 90W		Mancos Sh/	U.K.		5,922		A			Mancos Abd. 1962;
1959/			Corcoran								re-activated 1981
		2	Cozette	U.K.		241,012		2P			
BAXTER PASS (G)	4S - 103W	1	Mancos 'B'	U.K.		3,424		1SI			
1958/ (see Rio Blanco Co.)	FIELD TOTALS FOR RIO BLANCO & GARFIELD				1,106	1,089,629					
BAXTER PASS-SOUTH (G)	5S - 102W	3	Morrison	J		242,445		1SI;2P			
1958/											
BRIDLE (G)	8S - 104W	18	Dak-Mor	U.J.-		5,508,995	9	18P			
1976/				L.K.							
		1	Entrada	J	3,822			1AL			
CARBONERA (G)	7S - 104W	1	Buckhorn/	L.K.		310,709		1P			
1957/			Dakota	L.K.							
		2	Dakota	L.K.	121	744,570		1SI;1P			
CASTLE	7S - 99W	2		U.K.				SI			No production
1957/											recorded.
DIVIDE CREEK (G)	7S - 91W	1	Mv Grp.	U.K.		1,279,632		1P			
1956/	8S - 91W	1	Rollins/			29,640		1P			
(see Mesa Co.)	7S - 91W		Corcoran/Corc.	U.K.		894					
	FIELD TOTALS FOR MESA & GARFIELD					45,614,123					
DOUGLAS PASS (G)	5S - 102W	4	Dakota	L.K.		391,251		4P			
1977/		2	Dak-Morr	U.J.-L.K.		942,198	123	2P			
EVACUATION CREEK (G)	4S - 102W	1	Dakota	L.K.		45,546		1P			
1977/ (see Rio Blanco Co.)	FIELD TOTALS FOR GARFIELD & RIO BLANCO					546,667					
FOUNDATION CREEK (G)	4S - 102W	1	Mancos 'B'	U.K.		59,283		1P			
1973/ (see Rio Blanco Co.)	FIELD TOTALS FOR GARFIELD & RIO BLANCO				6,688	2,091,620	31				
GARMESA (G)	7S - 103W	2	Entrada	J		3,349,998		2SI			
1925/		1	Morr-Dak	U.J.-							
				L.K.		2,001,213		1SI			
		1	Dakota	L.K.		1,784,403		1SI			
MAM CREEK (O)	6S - 93W	2	Mv Grp.	U.K.	443	762,842		1P;1SI			
1959/											
PRAIRIE CANYON (G)	7S - 104W	2	Dak-Morr/	U.J. &		2,284,657		2P			
1958/			Dak.	L.K.							
ROCK CANYON (G)	5S - 102W	2	Dakota	L.K.		188,797		2P			
1973/		1	Salt Wash	U.J.		411,969		1P			
RULISON (G)	6S - 93W	20	Mv Grp.	U.K.		4,927,084	4,964	1SI;19P			
1956/	6S - 94W	30	Wasatch	Tertiary		2,081,318		30P			
	7S - 94W										
	7S - 95W										
SOLDIER CANYON (G)	4S - 100W	2	D	U.K.		43,343		2SI			
1976/ (see Rio Blanco Co.)		1	Mancos 'B'	U.K.	200	9,799		1P			
	FIELD TOTALS FOR GARFIELD & RIO BLANCO				200	107,392					
SOUTH CANYON (G)	6S - 103W	46	Buckhorn	L.K.		19,442,828	470	2SI;44P			
1957/	7S - 103W		Dakota								
(see Mesa Co.)	6S - 104W	26	Dak-Morr	U.J.-		5,805,222	3,733	1SI;25P			
	7S - 102W			L.K.							
	FIELD TOTALS FOR GARFIELD & MESA					25,253,860	4,203				
TRIAL CANYON (G)	4S - 101W	2	Dakota	L.K.		232,270		2P			
1969/ (see Rio Blanco Co.)		1	Mancos 'B'	U.K.		1,443		1P			
	FIELD TOTALS FOR GARFIELD & RIO BLANCO				3,845	4,499,465	72				
TWIN BUTTES (G)	5S - 102W	1	Morrison	J		3,412,316	44	1P			Abd. 1967-1976
1951/		2	Dak-Morr	U.J.-L.K.		742,335		1SI;1P			
		3	Dakota	L.K.		167,362		1SI;2P			
		1	Niobrara	U.K.	3,478	6,260		1SI			
MESA COUNTY											
ASBURY CREEK (G)	9S - 101W		Dakota	L.K.		2,406,841		A		2SI	storage project
1949/1965											
BAR X (G)	8S - 104W	8	U. Morr./	J	21,280	4,457,647		4SI;3P;1AL			
1953/			Saltwash/	J							
			Dakota	L.K.							
		2	Entrada	J		899,084	410	2P			
		3	Morrison	J	8,874	253,401		2P;1AL			
BRONCO FLATS (G)	9S - 98W	1	Cedar Mtn.	L.K.		59,567		1P			
1981/		1	Dakota	L.K.		22,347		1P			
		1	Dak./Morr.	U.J.-L.K.		58,914		1P			
BUZZARD (G)	9S - 94W	5	Mv/	U.K.		1,489,891		2SI;3P			
1958/	10S - 94W		Cozzette/								
	9S - 94W		Corcoran								
BUZZARD CREEK (G)	9S - 93W	2	Mv	U.K.		4,599,076		1SI;1P			
1955/		1	Cozz./Corc.	U.K.		22,649		1P			
CAMEO (G)	9S - 98W	2	Dakota	L.K.		29,238		2SI			SI for pipeline
1961/	9S - 99W										
COAL GULCH (G)	8S - 101W	1	Mv Grp.	U.K.		122,489		1P			
1966/											
COON HOLLOW (G)	8S - 98W	1	Mancos	U.K.		389		1SI			Activated 11/81
1958/		1	Mv	U.K.		352		1P			
DeBEQUE (G)	8S - 97W	5	Mv	U.K.		207,464	110	1SI;4P			
1902/											
DIVIDE CREEK (G)	8S - 91W	5	Mv Grp.	U.K.		44,304,851		5P			
1956/ (see Garfield Co.)	FIELD TOTALS FOR MESA & GARFIELD					45,614,123					
FRUITA (G)	9S - 101W		Morr.	J		607,228		A		SI	storage project
1961/1971											
GRAND MESA (G)	11S - 94W		Mv Grp.	U.K.		741		A			
1958/1973											
HELLS GULCH (G)	8S - 92W		Mv Grp.	U.K.		150,397		P & A 1/81			
1964/1981											
HIGHLAND CANAL (G)	9S - 103W		Dakota	L.K.		89,288		A			Abd.-1956. Reac-
1951/1961			Salt Wash	U.J		184,129		A			tivated prior to
											1960 - no record.
HORSETHIEF CREEK (G)	8S - 96W	1	Wasatch	Eocene		141,282		1SI			SI indefinitely
1964/											

COUNTY FIELD NAME (Oil, Gas) Year Discovered/ Abandoned	GENERAL LOCATION Twp., Rge.	NO. WELLS PROD'G OR CAPABLE OF PROD'G	PRODUCING FORMATION OR ROCK UNIT	AGE	CUMULATIVE PRODUCTION TO 12-31-81 OIL(bbls)	GAS(Mcf)	CONDENSATE (bbls)	FIELD STATUS	WATER FLOOD (No. Injection Wells)	GAS INJECTION (No.wells)	REMARKS
MESA COUNTY (CONT.)											
HUNTERS CANYON (G)	8S - 100W	5	Mv Grp.	U.K.		2,275,768		1SI;4P			
1955/		1	Dakota	L.K.		41,002		1P			
MACK CREEK (G)	9S - 102W		Morrison	J		238,007		A			
1957/1970			Burro Canyon	L.K.		13,171		A			
LEON CREEK	10S - 93W	1		U.K.				1SI			
1961/											No production
PEACHTREE	9S - 103W										recorded.
1979/											No production
PLATEAU (G)	10S - 95W	74	Mv Grp.	U.K.		10,566,868	423	9SI;65P			recorded.
1958/	10S - 96W										
ROBERTS CANYON (Unit)	9S - 97W	1	Dakota	L.K.		375,713		1SI			SI indefinitely
1960/ (G)	10S - 97W										
	9S - 98W										
ROCK (O)	8S - 103W	1	Dakota	L.K.	628			1SI			
1976/											
SHEEP CREEK (G)	9S - 92W		Cozz./Corc.	U.K.		1,820		A			P & A 1964
1958/1973			Marapos	U.K.		65,190		A			
SHIRE GULCH (G)	10S - 96W	2	Dakota	L.K.		280,873		2P			Dakota Abd.
1960/	9S - 97W	12	Corcoran	U.K.		517,472		2SI;10P			1965.
		1	Dak./Front.	L.K./U.K.		43,436		1P			
		1	Mancos	U.K.		17,168		1P			
		4	Mv	U.K.		214,486		4P			
SOUTH CANYON (G)	8S - 104W	1	Dakota	L.K.		2,022		1P			
1981/ (see Garfield Co.)		1	Dak.-Morr.	U.J.-L.K.		3,788		1P			
FIELD TOTALS FOR GARFIELD & MESA						25,253,860	4,203				
VEGA (G)	10S - 93W	3	Cozzette	U.K.			143,575	1SI;2P			
1977/											
MOFFAT COUNTY											
BELL ROCK	6N - 92W	1						1SI			No production
1973/											recorded.
BIG GULCH (G)	7N - 93W	4	Mv Grp.	U.K.		3,045,509	4,182	2SI;2P	DW		
1960/			Frontier	U.K.							No production recorded.
BIG HOLE (G)	10N - 94W	10	Lewis Sh.	U.K.		2,928,877	20,434	2SI;8P			
1968/											
BLACK MOUNTAIN (G)	10N - 90W	3	Lewis Sh.	U.K.	72	17,465		3P			
1981/											
BLUE GRAVEL (G)	9N - 91W	7	Lewis Sh.	U.K.		3,317,653	767	4SI;3P			
1968/											
BUCK PEAK (O)	6N - 90W	3	Weber	Penn/	2,871	2,276,296	466	P&A 10/77			
1956/				Permian				3SI			
			Shinarump Cng	Triassic	329	340		P&A 4/57			
		6	Niobrara	U.K.	1,864,930	2,031,340		6AL			
		4	Mancos	U.K.	1,635,395	1,855,976		4AL			
		2	Trout Creek	U.K.		514,310		2SI			
CRAIG DOME (G)	6N - 91W		Marapos	U.K.		213,873		A			Marapos abd.
(BREEZE DOME)		1	Frontier	U.K.		1,501,587	466	1P			prior to 1960,
1932/											no records.
											Frontier acti-
CRAIG-NORTH (G)	8N - 90W	13	Lewis	U.K.	2,887	10,573,198	19,347	1SI;11P;			vated 1966.
1956/								1F			
DANFORTH HILLS (O)	5N - 95W	1	Weber	Penn/	381,857	8,098		1AL			
1954/				Permian							Inj. started
		1	Sundance	J	1,697,157	36,799		1AL	1		6/63 - Sundance
		1	Morrison	J	1,051,519	142,987		1AL	1		
			Dakota	L.K.	251,719	88,903					Inj. started
		1	Shinarump Cng	Tr.	34,679	5,546		1AL			3/62 - Morrison
DANFORTH HILLS-NORTH	5N - 95W		Moenkopi	Tr.	727	565		P&A 10/59			
1958/ (O)		3	Morrison	J	370,089	115,223		3AL			Inj. started
DINOSAUR (O)	3N - 104W	1	Mancos 'B'	U.K.	107			1SI			3/16/62
1977/											
ELK SPRINGS (O)	5N - 98W	1	Weber	Penn/	530,369	13,030		1AL			
1926/				Perm.							
FOUR MILE CREEK (G)	11N - 91W		Lance	U.K.		311,059		A			
1958/1971	12N - 91W										
GREAT DIVIDE (G)	9N - 93W	4	Mid. Lewis	U.K.		1,584,347	12,045	4P			
1978/											
HIAWATHA (G)	12N - 100W	9	Ft. Union	Pal.	75,601	17,322,661	89,579	1SI;6P;1F;1AL			
1926/		34	Wasatch	Pal.	3,513,851	93,512,732	59,023	16SI;12P;6AL			
		1	Entrada/Nugget	J		1,124,867		1P	DW		
HIAWATHA-WEST (G)	12N - 100W	26	Ft.Union/Wasatch/	Pal./Eoc.	9,112	128,715,572	197,968	5SI;21P			
	12N - 101W		Lewis/	U.K.							
			Mv/	U.K.							
			Lance/	U.K.							
			Dakota	L.K.							
HORSE GULCH (O)	5N - 91W		Dakota	L.K.	211,590			A (1971)			Inactive 1971 &
1965/		1	Shinarump Cng	Tri.	7,933			1AL			1980
ILES (O)	4N - 92W	10	Sundance	J	16,850,785	1,984,566		1SI;9AL			
1924/		1	Curtis	J	62,495			1AL			
		1	Morrison	J	1,334,836	55,186		TA			Slow production
			Mowry	L.K.	147,470			P&A 1953			
IRISH CREEK (G)	12N - 99W	1	Mv	U.K.		14,393		1P			
1961/											
LAY CREEK (G)	8N - 92W	1	L. Mv Grp.	U.K.		5,604,355	25	1P			
1955/	8N - 93W										
LITTLE SNAKE (G)	12N - 95W		Ft. Union	Pal.		386,045		A			
1958/1969											
MAUDLIN GULCH (O)	4N - 95W		Weber	P-Perm.	6,337	799		P&A 10/74			
1947/		2	Sundance/	J	2,487,046	352,948		2AL	2 DW		
			Morrison	J							
		12	Dakota	L.K.	4,302,006	893,101		6SI;6P			
MOFFAT (O)	5N - 91W		Minturn	P	2,990			P&A 1965			
1924/			Weber	P-Perm.	724,228	148,798		P&A 4/73			Inj. began
		3	Shinarump Cng/	Tri.	8,351,910	82,532		3AL			11/63 - Dakota
			Sundance/	J							
			Dakota/Moffat	L.K.							
		3	Niobrara	U.K.	94,965	14,031		1SI;1F;1AL			
POLE GULCH (G)	12N - 92W	3	Lewis	U.K.	4,480	6,388,991	1,344	3P			
1965/											
POWDER WASH (G)	11N - 97W	68	Ft. Union	Pal.	780,180	101,864,573	784,477	16SI;46P;6F			Water inj. started
1931/	12N - 97W	32	Wasatch	Eocene	4,496,830	82,754,125	402,630	12SI;15P;5AL			5/68 - Wasatch

COUNTY FIELD NAME (Oil, Gas) Year Discovered/ Abandoned	GENERAL LOCATION Twp., Rge.	NO. WELLS PROD'G OR CAPABLE OF PROD'G	PRODUCING FORMATION OR ROCK UNIT	AGE	CUMULATIVE PRODUCTION TO 12-31-81 OIL (bbls)	 GAS (Mcf)	CONDENSATE (bbls)	FIELD STATUS	WATER FLOOD (No. Injection Wells)	GAS INJECTION (No. wells)	REMARKS
MOFFAT COUNTY (CONT.)											
ROUND TABLE (O)	12N - 96W		Ft. Union	Pal.	954			A			
1967/1969											
SHELL CREEK (G)	11N - 100W		Ft. Union	Pal.	1,440	158,290	4,100	A (1971)			
1955/		1	Nugget	J		2,695,897	110	1P			
SLATER DOME	12N - 89W			U.K.(?)							
1954/											No production recorded
STATE LINE (G)	12N - 94W	3	Ft. Lewis/	U.K.		146,325		1SI;2P			
1976/			Lance/Lewis								
SUGAR LOAF (G)	12N - 101W	14	Mv	U.K.	2,302	60,068,003	244,377	14P			
1953/		2	Ft. Union	Pal.	430	198,265	2,113	1SI;1P	DW		
TEMPLE CANYON (O)	4N - 95W	2	Shinarump Cng	Tri.	169,649	19		2AL			
1953/			Morrison	J	27,263	17,500		P&A 10/62			
			Dakota	L.K.	783	140		P&A 11/68			
THORNBURG (MARAPOS)	3N - 91W	4	Weber	P-Perm.	753,686	6,408,283		3SI;1P			
1925/ (G)		2	Entrada/	J		5,190,936		2SI			
(see Rio Blanco Co.)			Sundance	J							
			Dakota	L.K.		3,375,611		A			
WADDLE CREEK (O)	4N - 90W	4	Niobrara	U.K.	413,336	10,496		1SI;3AL			
1964/											
WEST SIDE CANAL (G)	12N - 92W	1	Lance/	U.K.		2,920,116		1SI			
1966/			Lewis	U.K.							
WILLIAMS FORK (O)	5N - 91W		Shinarump Cng	Tri.	51,271	4,671		TA	DW		
1962/		1	Morrison	J		259,633		1SI			
			Dakota	L.K.	724,291	30,326		TA			
			Frontier	U.K.		29,456					
			Weber	P-Perm.	7,366						Recom. in Morrison 7/72. Recom. in Dak.
WINTER VALLEY (G)	4N - 98W		Dakota	L.K.	274,405	12,780,289					
1958/		2	Weber	P-Perm.	28,777	4,457		1SI;1AL			
RIO BLANCO COUNTY											
BANTA RIDGE (O)	1S - 103W		Dakota	L.K.	1,484	12,378		4SI			
1972/											
BAXTER PASS (G)	4S - 103W	8	Dak./Morr.	U.J.-L.K.	1,106	1,086,205		2SI;6P			
1958/ (see Garfield Co.) FIELD TOTALS FOR RIO BLANCO & GARFIELD					1,106	1,089,629					
BIG RIDGE	1S - 100W		Mancos 'B'	U.K.							
1981/											No production recorded.
BLUE CLOUD (G)	4S - 102W	1	Dakota	L.K.		40,943		1P			
1974/		4	Mancos	U.K.		582,503		4P			
BOONDOCKS (G)	4S - 103W		Dakota	L.K.		3,116					
1977/											
CATHEDRAL (G)	3S - 100W	1	Dakota	L.K.		511,829		1P			
1960/		2	Emery	U.K.		26,115		2P			
		116	Mancos	U.K.	4,355	8,966,616		3SI;112P;1AL			
COLOROW GULCH (G)	3N - 97W		Frontier	U.K.		10,502	977	T.A.			
1978/		1	Shinarump	Tri.		375,673	20,902	1P			
CORRAL CREEK (G)	1S - 100W	2	Dakota	L.K.		63,662	68	2P			
1978/		1	Dak./Morr.	U.J.-L.K.		274,749	23	1P			
		2	Mancos 'B'	U.K.		144,667	484	1SI;1P			
DOUGLAS CREEK	2S - 101W	1	Dakota	L.K.		8,578,080		1P			
1943/ (Unit) (G)	3S - 101W	16	Mancos-	U.K.		14,871,056		16P			
	2S - 102W		(Emery)								
	3S - 102W										
DOUGLAS CREEK-NORTH	1S - 101W	1	Weber	P-Perm.	24,328			1AL			
1956/ (G)	1S - 102W	28	Mancos 'B'	U.K.	142	7,775,165		28P			
		8	Mancos 'A'	U.K.		15,320,839		6P;2SI			
DOUGLAS CREEK-SOUTH	3S - 101W	6	Morrison/	U.J.				6P			
1963/ (G)	4S - 101W		Dakota/	L.K.		1,592,923	216				
	4S - 102W		Buckhorn	L.K.							
		1	Niobrara	U.K.		68,637		1P			
		8	Mancos	U.K.		756,868		8P			
		2	Marapos	U.K.		178,715		2P			
DOUGLAS CREEK-WEST	2S - 102W	12	Emery 'B'	U.K.	337	20,980,370		12P			
1953/ (G)	2S - 103W										
DRAGON TRAIL (G)	2S - 101W	110	Mancos	U.K.	8,348	99,702,198	568	5SI;105P			
1959/	2S - 102W		(Emery)								
	3S - 102W										
DRAGON TRAIL-NORTH	1S - 101W	4	Mancos 'B'	U.K.	17,394	330,342		1SI;3P			
1961/ (G)											
EVACUATION CREEK (G)	4S - 102W	7	Mancos 'B'	U.K.		501,121		7P			
1977/ (see Garfield Co.) FIELD TOTALS FOR GARFIELD & RIO BLANCO						546,667					
FAWN CREEK	3S - 98W										
1957/											No production recorded.
FOUNDATION CREEK	4S - 102W	1	Cedar Mtn.	L.K.	6,668	534,811		1P			
1973/ (G)		1	Buckhorn	L.K.		133,937		1P			
(see Garfield Co.)		2	Dakota	L.K.		110,450		2P			
			Dak./Morr.	U.J.-L.K.		11,123		A			Dak.-Morr. Recomp. in Mancos 'B'.
		16	Mancos 'B'	U.K.		1,242,016	31	16P			
FIELD TOTALS FOR GARFIELD & RIO BLANCO					6,668	2,091,620	31				
GILLIAN DRAW (G)	1N - 101W		Dakota	L.K.		84,718		A			
1956/1960											
HELLS HOLE CANYON (G)	2S - 103W	1	Castlegate	U.K.		369,048		1SI			
1951/	2S - 104W										
LOWER HORSE DRAW (Unit)	2S - 103W	47	Mancos 'B'	U.K.	2,976	43,158,729	22,577	34P;13SI			
1960/ (G)		2	Dakota	L.K.	65	1,593,010	313	2P			
MISSOURI CREEK	3S - 102W										
1960/	3S - 103W										No production recorded.
NINE MILE (G)	2N - 92W	3	Dakota	L.K.		979,313		3AL			
1966/	2N - 93W										
PHILADELPHIA CREEK	2S - 101W	42	Mancos 'B'	U.K.		1,874,949	77	2SI;40P			
1975/ (G)											
PICEANCE CREEK (Unit)	3S - 95W	13	Douglas Crk	Tert.	450	51,431,363		1SI;11P			
1930/ (G)	2S - 96W	2	Mesaverde	U.K.		1,334,363	8,666	2P			
	3S - 96W	1	Douglas Crk/	Tert.		340,389		1SI			
	2S - 97W		Wasatch 'A'	Eocene							
		32	Wasatch 'A'	Eocene		67,453,004	7,207	1SI;31P			
		1	Wasatch 'D'	Eocene		366,400		1P			
		3	Wasatch 'F'	Eocene		97,090		3SI			
		3	Wasatch 'F'&'G'	Eocene		463,446	397	1SI;2P			
		6	Wasatch 'G'	Eocene		61,424,197	100,989	1SI;5P			

COUNTY FIELD NAME (Oil, Gas) Year Discovered/ Abandoned	GENERAL LOCATION Twp., Rge.	NO. WELLS PROD'G OR CAPABLE OF PROD'G	PRODUCING FORMATION OR ROCK UNIT	AGE	CUMULATIVE PRODUCTION TO 12-31-81 OIL(bbls)	GAS(Mcf)	CONDENSATE (bbls)	FIELD STATUS	WATER FLOOD (No. Injection Wells)	GAS INJECTION (No.wells)	REMARKS
RIO BLANCO COUNTY (CONT.)											
PICEANCE CREEK-SOUTH 1964/ (G)	3S - 95W 3S - 96W	4	Douglas Crk	Tert.		2,219,798		3SI;1P			
PINNACLE (0) 1956/	3N - 86W	2	Shinarump Cng	Tri.	199,806	17,938		2AL			
POWELL PARK (G) 1957/	1N - 95W		Dakota	L.K.	991	57,991		P&A 1969			Abd. 1969-1971
			Mesaverde	U.K.	3,102	16,354					
			Ft Union	Pal.		251,532	189				Abd. 1966-1971
			Wasatch	Eocene	1,016						
		1	Mancos 'B'	U.K.		7,376		1SI			
RANGELY (0) 1902/	1N - 101W	454	Weber	P-Perm.	635,250,908	687,912,782		48SI;1P;405AL	263		Inj. started 12/57-Weber Sd. Gas inj. 12/50 to 4/69.
	2N - 101W		Shinarump Cng	Tri.	212,087	51,937		P&A 8/63			
	1N - 102W		Entrada	J		52,293		P&A 10/61			
	2N - 102W	5	Morrison	J	49,620	1,916,308		4SI;1P			
	2N - 103W	1	Mancos/Dak.	U.K.	60	3,150		1SI			
		175	Mancos	U.K.	13,158,467	139,134		106SI;69AL			
ROCKY POINT (0) 1976/	2S - 100W	1	Mancos 'B'	U.K.	7,808	2,927		1AL			
SAGE BRUSH HILLS (G) 1978/	2S - 99W		Dak./Morr.	U.J.-L.K.		16,050					
		2	Mancos	U.K.		67,989	188	2SI			
SCANDARD DRAW 1958/	3S - 97W	1	Mv	U.K.		1,063		1SI			
SOLDIER CANYON (G) 1976/ (see Garfield Co.)	4S - 100W	2	Dakota	L.K.		54,250		2SI			No production recorded.
FIELD TOTALS FOR RIO BLANCO & GARFIELD					200	107,392					
SULPHUR CREEK (G) 1955/	2S - 97W	4	Mv Grp.	U.K.	229	23,319		4SI			
	2S - 98W	5	Wasatch	Eocene	865	2,917,696	277	1SI;4P			
	3S - 98W		Green River/ Piceance Crk	Eocene	583						
	2S - 99W		Ft Union/Wasatch	Pal./Eoc.	122	303					
		1	Mancos 'B'	U.K.		23,852		1SI			
			Parachute/ Green River	Eocene		6,551					
SULPHUR CREEK-SOUTH 1957/ (G)	3S - 99W	1	Wasatch G	Eocene		391,461		1SI			
			Parachute/ Green River	Eocene							
TEXAS MOUNTAIN (G) 1964/	3S - 102W	2	Dakota	L.K.		1,324,642		1SI;1P			
		1	Mancos/Castlegate	U.K.		467,661		1P			
		2	Marapos	U.K.		2,387,545		2SI			
		2	Castlegate	U.K.		994,130		2P			
		6	Mancos	U.K.	61,118	3,136,902	35	1SI;4P;1AL			
THORNBURG (G)(MARAPOS) 1925/1965 (see Moffat Co.)	3N - 91W		Dakota	L.K.		684,211		A			
FIELD TOTALS FOR RIO BLANCO & MOFFAT					753,686	15,659,041					
THUNDER (G) 1977/	4S - 102W	6	Dakota	L.K.		1,305,029	432	6P			
		18	Mancos 'B'	U.K.		1,262,429		18P			
TRAIL CANYON (G) 1969/ (see Garfield Co.)	4S - 101W	18	Dakota	L.K.		3,572,690		3SI;15P			
		1	Dak./Morr.	U.J.-L.K.		2,132		1P			
		17	Mancos 'B'	U.K.	3,845	690,930	72	17P			
FIELD TOTALS FOR RIO BLANCO & GARFIELD					3,845	4,499,465	72				
WHITE FACE BUTTE (G) 1978/	3S - 104W	1	Mancos 'B'	U.K.				1SI			No production recorded.
WHITE RIVER (G) 1890/	1N - 97W	8	Mv Grp	U.K.	11,076	1,318,612	5,225	3SI;5P	DW		Abd. prior to 1960,no records; React. 1972.
	2N - 96W	10	Wasatch	Eocene		490,755		3SI;7P			
	2N - 97W										
WILLOW CREEK (G) 1956/	4S - 97W							SI			No production recorded.
WILSON CREEK (0) 1938/	2N - 94W	7	Sundance	J	24,530,308	4,835,480		2SI;5AL	3	1	Inj. started 5/46 - Morrison. Inj. started 3/61 - Sundance.
	3N - 94W	36	Morrison	J	56,634,772	54,849,571		15AL;21SI	5		

APPENDIX 2. OCCURRENCE OF METHANE GAS IN UINTA REGION COAL MINES

MAP NO.	COUNTY (FIELD) MINE NAME	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U)=Unknown	COAL RANK(1)	DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION (CU.FT./DAY) (1st. qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	OCCURRENCE OF GAS IN MINES(2) YEAR
	DELTA									
1	(Somerset) Blue Ribbon	2, 13S-91W		6	(U)	B-hv	Closed			G
2	(Grand Mesa) Independent	13, 13S-95W	#2	6.2	100	B-hv	Closed			MF(1930)
3	(Somerset) King	9,10,11,14,15,13S-91W	Uncorrelated	16	2000	B-hv				G MF(1911)
4	(Grand Mesa) Tomahawk	10,15,16,13S-95W	Green Valley	11	(U)	B-hv	Closed			G
	(Grand Mesa) Orchard Valley Mine	24,13S-92W	"B"	27' avg.	450'-1800'	B	600	None	0	
	GARFIELD									
1	(Grand Hogback) Black Raven	16,5S-92W		22	D-257	B-hv	Closed			MF(1963)
2	Coryell	2,6S-91W,31,32,5S-90W	Allen	14.5	0-125	B-hv	Closed			GE(1901)
3	(Carbondale) Four Mile	34,7S-B9W	"A","C","D"	9.5	0-1100	B-hv	40		0	GE(1B97)
4	(Grand Hogback) Harvey Gap (Old)	24,5S-92W		6	(U)	B-hv	Closed			GE(1926)
5	Harvey Gap #2	19,5S-91W,24,5S-92W	"F"	5-11	(U)	B-hv	Closed			G
6	Harvey Gap #3	24,5S-92W		6	17-211	B-hv	Closed			G
7	IHI #3	16,5S-92W		9	281-667	B	Closed			GE(1954)
8	McLearn	12,5S-93W,7,5S-92W		6-7	(U)	B	Closed			G
9	New Castle	30,31,32,5S-90W 36,5S-91W,1-6S,91W	Wheeler	8-42	(U)	B-hv	Closed			GE(1901)MF(1954) DE(1888)
10	New Castle-Vulcan	1,6S-91W	Allen	B-14	350-400	B-hv	Closed			MF(1962)
11	South Canon #1	14,6S-90W	"D" Wheeler "E" Allen	18 (Ave.)	500-550	B-hv B-hv	Closed			GE(1912) MF(1951)
12	(Book Cliff) Stove Canon	11,12,BS-102W	Palisade	3.2-7	300-700	B-hv	Closed			G
13	(Grand Hogback) Sunny Ridge	24,5S-92W		7	140	B-hv	Closed			DE(1951)DE(1952)
14	Vulcan	1,6S-91W	Allen	14-47	350-400	B	Closed			DE(1913)GE(1896) GG(1978)GE(1956)
15	Vulcan #3	1,6S-91W			(U)		Closed			GE(191B)GE(1956)

	GUNNISON									
1	(Somerset) Bear	9,16,13S-90W	Juanita "C"	8	290-1440	B-hv	600	259,000	431.6	G
2	Black Beauty	1,2,10,11,12,13S-90W	"E"	10	B97	B-hv	Closed			G
3	(Crested Butte) Crested Butte	3,10,11,15,14S-B6W	Crested Butte	5-25	300-400	B-hv	Closed			GE or OE(1883) GE(1884)
4	(Somerset) Edwards	8,17,13S-90W	"B" "C"	6 6	511-634 511-634	B-hv B-hv	 Closed			G G
5	(Carbondale) Center	20,11S-88W		3.2-4.9	14B-705	A	Closed			GE(1925)
6	(Somerset) Oliver #2	10,15,13S-90W	Oliver	7	(U)	B-hv	Closed			G
7	Oliver #3	10,13S-90W	"E"	7	174-500	B-hv	Closed			G
8	Somerset	8,9,13S-90W,2,10,12S-90W	Var. B C	 25 7	- 1000-1500 -	B-hv B-hv B-hv	4500	1,692,000	376	G G G
9	(Somerset) Hawk's Nest West	12,13S-90W	"E"	8-9	1600-2000	hvB	800	425,000	531	
10	Hawk's Nest East	11,13S-90W	"E"	7-9	1600 max	hvB	150	29,000	193	
11	(Crested Butte) O.C. Mine #2	16,15S-86W	"C" Kubler	5.5-6.0	1800-2000	B	20	None	0	
	MESA									
1	(Book Cliffs) Cameo	27,28,33,34,10S-98W	Cameo	6-9.5	2000	B-hv				G
2	(Grand Mesa) Grandview	11,11S-98W		4-5		B-hv	Closed			GE(1908)
3	(Book Cliffs) McGinley	5,9S-100W	Cameo	11	500	B-hv				G
4	(Grand Mesa) Midwest	10,11,11S-98W	Palisade	4.8	100	B	Closed			GE(1923)
5	(Book Cliffs) Palisade	3,4,5,11S-98W	Palisade	3-4	(U)	B-hv	Closed			MF(1900)
	(Book Cliffs) C.M.C. Mine	34,10S-98W	Cameo "B"	7	< 1800	B-hv	300	24,000	80	
	MOFFAT									
1	(Danforth Hills) Red Wing	34, 35, 4N-93W 2,3-3N-93W	Collum	23	100-1000	B-hv	Closed			MF(1974)

	<u>PITKIN</u>									
1	(Carbondale) Bear Creek	<u>21</u>,10S-89W	Coal Basin "B"	7	200-1500	B-mv	480	885,000	492 1843.7	G
2	Coal Basin	5,8,10S-89W	Coal Basin "B" and "C"	6.9-8	150-600	B-mv	431	1,750,000	1821 4060.3	G
3	Dutch Creek #1	<u>17</u>,10S-89W	Coal Basin "B"	7	0-2100	B-mv	642	2,235,000	2631 3481.3	GE(1965) DE(1957)
4	Dutch Creek #2	<u>17</u>,10S-89W	Dutch Creek	7	1370-1800	B-mv	1008	1,489,000	867.7 1477.1	G
5	L.S. Wood	<u>8</u>,10S-89W	Coal Basin "B"	7	0-1650	B-mv	1800	1,867,000	2087 1037.2	G
6	Placita (Old)	<u>6</u>,11S-88W		3.4	200?	B	Closed			GE(1923)
7	Spring Gulch	15,<u>22</u>,23,26,27-8S-89W	Anderson Allen	4.5-6 8-11.5	0-1000	B	Closed			DE(1901)
8	Thompson Creek #1	<u>34</u>,35,8S-89W	"A" "B"	8 8	300+ 300±	B-hv B-hv	 113	 18,000	 159.2	GE(1956)
9	Thompson Creek #2	<u>34</u>,35,8S-89W	"A" & "B"	7	80-100	B-hv	Closed			G
10	Thompson Creek #3	<u>34</u>,8S-89W	Sunshine	9	(U)	B-hv	?	None		G
	<u>RIO BLANCO</u>									
1	(Lower White River) White River	2,<u>10</u>,11,2N-101W		7.8	(U)	B-hv	Closed			G

(1) A - anthracite
B - bituminous
SB - subbituminous
hv - high-volatile
mv - medium-volatile
lv - low-volatile

(2) G - gassy mine
GE - gas explosion
GS - gas suffocation
DE - dust explosion (methane related?)
MF - mine fire

<u>Note</u>: Numerous minor mine explosions are not listed.

APPENDIX 3 - Coal Bed Methane Shows

1. <u>Production Tests in Sandstones in Coal Bearing Zones</u>

22-1N-95W, Michigan Wisconsin Pipeline, 1 HD Lake
"Prod. Zone: Mesaverde 8428-9136 (gross)."
"Int. Prod.: IPF (est) 88 BO, 1BW, 246 MCFGPD, gty 44."
"Perf.: 8428-42, 8452-56, 9112-26, 9130-36 w/1 pf."
(6' coal @ 8463', 4' coal @ 8472', 10' coals @ 8485' & 8496'.)

20-2N-96W, Fuel Resources Development, 6-M Federal
"Prod. Zone: Mesaverde 6170-6852 (gross)."
"Int. Prod.: IPF 3681 MCFGPD, 32/64" ck."
"Perf.: 6170-78, 6245-60, 6382-93, 6455-62, 6744-58,
6846-52 w/2 pf., 6739-44 w/4pf."
(5' coal @ 6297', 7' coal @ 6338', 3' coal @ 6357', 6' coal @ 6670')

28-2N-96W, Fuel Resources Development, 1 Unit
"Prod. Zone: Mesaverde 6040-6932 (gross)."
"Int. Prod.: IPF 5460 MCFGPD."
"Perf.: 6040-47, 6191-6200, 6816-22, 6924-32."
(5' coal @ 6354', 12' coal @ 6411', 4' coal @ 6576', 3' coals @ 6723',
6841', 6881', 5' coal @ 6891'.)

29-2N-96W, Fuel Resources Development, 3-M Federal-White River Dome Unit
"Prod. Zone: Mesaverde 6176-7392 (gross)."
"Int. Prod.: IPF 475 MCFGPD, 28/64" ck (natural)."
"Perf.: 6176-94, 6214-22, 6754-60, 6822-32, 6950-58, 7136-44, 7221-25,
7300-12, 7366-92, w/2 pf."
(5' coal @ 6488', 8' coal @ 6504', 5' coal @ 6603', 3' @ 6611',
18' coal @ 6667', 3' coal @ 6710'.)

31-2N-96W, Fuel Resources Development, 1 Govt.
"Prod. Zone: Mesaverde 5284-6950."
"Int. Prod.: IPF 1100 MCFGPD, 3/4" ck, FTP 90#."
"Perf.: 5284-5307, 5464-72, 5489-99, 5600-04, 5652-74, 5708-12,
5760-90, 5890-94, 5996-6000, 6218-32, 6352-64, 6662-66, 6758-62,
6774-78, 6933-50, 7180-7204, 7295-7330, w/1 pf."
(6' coal @ 5556', 5592', & 6107', 8' coal @ 6118', 4' coal @ 6184',
5' coals @ 6205' & 6238', 19' coal @ 6263', 3' coal @ 6306',
4' coals @ 6545', 4' coal @ 7240'.)

26-2N-97W, Cities Service Oil, 4 Federal-A
"Prod. Zone: Mesaverde 5385-6764 (gross)."
"Int. Prod.: IPF 1160 MCFGPD, 1" ck TP 230#, CP 390#."
"Perf.: 5786-5806, 5872-81, 5928-46, 5558-5606, 5385-97, 6124-30,
6460-6506, 6592-96, 6612-18, 6624-38, 6720-28, 6740-64."
(3' coal @ 4545', 2' coal @ 6086', 3' coal @ 6089', 4' coal @ 6110',
3' coals @ 6249', 4' coals @ 6407', 3' coal @ 6432'.)

26-2N-97W, Cities Service Oil, 5 Federal-5
"Prod. Zone: Mesaverde 5268-6145 (gross).":
"Int. Prod." IPF 536 MCFGPD."
"Perf.": 5268-77, 5357-62, 5411-16, 5517-35, 5844-50, 5964-74, 6078-83, 6100-05, 6136-45."
(4' coal @ 5351', 3' coal @ 5404', 6' coal @ 6042', 4' coal @ 6050', 6' coal @ 6116'.)

14-7S-95W, Southern Union Production, 14-95 Federal
"Prod. Zone: Mesaverde 6009-8794."
"Int. Prod.: IPF 2610 MCFGPD, 3/4" ck, SITP 2220#."
"Perf.: 5994-6002, 6009-6013, 6039-6058, 6136-6152, 6194-6220, 6311-6329, 6335-6340, 6346-6362, 6421-6429 w/2 pf., 6676-6702, 6946-6958, 6982-6988, 7250-7270, 7355-7364, 7471-7481, 7520-7543 w/2 pf., 8428-8470, 8484-8492, 8535-8557 w/2 pf., 8450-8454, 8536-8540 w/ 3 pf., 8680-8690, 8720-8782, 8788-8794 w/2 pf."
(10' coal @ 7786', 11' coal @ 7734', 4' coal @ 8026', 4' coal @ 8016', 3' coal @ 8522', 3' coal @ 8665', 4' coal @ 8692', 2' coal @ 8702'.)

14-9S-93W, Union Oil, 2 Govt.
"Prod. Zone: Mesaverde 6774-7245."
"Int. Prod.: 942 MCFGPD from perfs 6774-6812; 2980 MCFGPD from perfs 7216-7245."
"Perf.: 6768, 6774, 6797, 6806, 7216, 7224, 7245, 3 holes at each depth."
(3' coal @ 6869', 3' coal @ 6827', 8' coal @ 7152'.)

29-9S-94W, Fred W. Pool, 1 Clyde-Govt.
"Prod. Zone: Mesaverde 4687-5682."
"Int. Prod.: IPF 1830 MCFGPD."
"Perf.: 4687-5682 (gross)."
(4' coal @ 5365', 6' coal @ 5430', 2' coal @ 5550' and 4' coal @ 5554', 18' coal @ 5620'.)

24-9S-95W, Fred W. Pool, 1 Donnor
"Prod. Zone: Mesaverde 4638-5495."
"Int. Prod.: IPF 950 MCFGPD.:
"Perf.: 4638-5495." "1 shot @ intervals, 51 shot total."
(6' coal @ 5216', 12' coal @ 5306', 3' coal @ 5350', 13' coal @ 5397', 5' coal @ 5472').

36-9S-95W, Teton; Wacker Oil, 1 Garner
"Prod. Zone: Mesaverde 4187-4934."
"Int. Prod.: IPF 396 MCFGPD, 3/4" ck, SICP 630#."
"Perf.: 4490-4569, 4187-4248, 4594-4934 (gross) w/1 pf."
(3' coal @ 4811', 6' coal @ 4830', 21' coal @ 4877', 6' coal @ 4935', 3' coal @ 4949', 8' coal @ 4974'.)

19-9S-94W, Fred W. Pool, 1 Hudson
"Prod. Zone: Mesaverde 4643-5556."
"Int. Prod.: IPF 900 MCFGPD."
"Perf.: 4643-5556." "1 shot @ intervals, 36 holes total."
(5' coal @ 5250', 6' coal @ 5337', 11' coal @ 5428'.)

11-10S-94W, Fred W. Pool, 1 Robbins
"Prod. Zone: Mesaverde 5480-6587."
"Int. Prod.: IPF 2300 MCFGPD, open ck."
"Perf.: 5480-5598, 5600-5796, 5938-6587 (gross) w/1 pf."
"57 shots total."
(6' coal @ 6310', 10' coal @ 6357',13' coal @ 6437', 26' coal @ 6546'.)

9-11S-90W, Fred W. Pool, 1 Henderson
"Prod. Zone: Mesaverde 3982-4154."
"Int. Prod.: IPF 1200 MCFGPD, open ck."
"Perf.: 3982-3986, 4134-4138, 4150-4154 w/1 pf."
(3' coal @ 4029', 6' coal @ 4037'.)

2. <u>Drill Stem Tests of Zones Containing Coal</u>

22-1N-95W, Michigan Wisconsin Pipeline, 1 HD Lake

"DST 7850 - 90, op 15, S1 90, op 90, S1 180, rec 1890 mud, 720 GCM, FP 257#, 574#, SIP 350-2214, 816-1581, HP 3389-3426#."
(11' coal @ 7857'.)

35-2N-97W, Trend Exploration, 1-35 Parker Unit
"DST 5530-5741, op 10 mins., SI 1 hr, op 1 hr, SI 180 min., rec. .92 bbls SGCM, .59 bbls VHGCM, FP 82-123, 136-139#, SIP 1090, 959, HP 2694-2680#." (3' coal @ 5670', 5' coal @ 5707'.)

27-3N-97W, E. M. Leverson, 1"A" Coyote Basin
"DST 4506-62, 15 min, rec 30' GCM, FP 0#, SIP 25#, HP 2250#."
(3' coal @ 4508'.)

32-2S-99W, American Minerals, 3 Ryan Creek-Govt.
"DST 6841-95, op 60 mins., strong blow throughout, trace GTS in 55 mins., SI 90 mins., rec 1170 HGCM, FP 576, -617#, FSIP 2828#, HP 3550-3139#."
(22' coal @ 6851'.)

7-6S-100W, Chorney Oil, 1-7 Chorney-Rowan Creek
"DST 2690-2808, op 10, SI 30, op 45, SI 90, rec 90 VSGCM, FP 5-8, 8-8, SIP 8-49, 8-42, HP 1103-1181."
(3' coal @ 2724', 5' coal @ 2729', 5' coal @ 2757', 3' coal @ 2804'.)
"DST 2914-2983, op 10, SI 30, op 45, SI 90, rec 70 SG & WCM. FP 36-41, 74-74, SIP 41-680, 74-353, HP 1369-1369."
(5' coal @ 2928'.)
"DST 3158-3227, op 15, SI 30, op 45, SI 90, rec 90 SGCM, FP 90-95, 99-106, SIP 95-786, 106-828, HP 1572-1572."
(4' coal @ 3162'.)

6-7S-99W, El Paso Natural Gas, 1 Standard Shale
"DST 5392-5532, ISI 20 min., op 40 min., strong blow, dead in 30 min., no GTS, SI 30 mins., rec 120 sli GC & WCM, FP 45-65#, SIP 414-130#, HP 2639#."
(17' coal @ 5389', 4' coal @ 5470', 4' coal @ 5487', 8' coal @ 5516', 4' coal @ 5526'.)

28-9S-91W, Mountain States Drilling, 28-1 Govt.
"DST 7190-7217, 1 hr, gas in 7 min, rec 15 mud, FP 69-164#, SIP (30 min) 204#, HP 3835#.
(8' coal @ 7192'.)
"DST 7251-7308, 30 min, gas in 23 min, rec 93 mud, FP 150-360#, SIP (30 min) 2582#, HP 3689."
(4' coal @ 7258.)

10-10S-93W, Exxon Corp., 3 Vega Unit
DST 7585-7658, flow rate of 80 MCFD.
(14' coal @ 7598', 28' coal @ 7625'.)
Extrapolated maximum reservoir pressure 1892-1273#.

26-10S-96W, Scott Hammonds, Blanco Oil, 26-1 Moran-Govt.
DST 3124-3145, open 1 1/2 hrs, SI 45 mins, gas in 4 mins, too small to measure, rec 100 sli GCM, FP 63-72#, FSIP 210#.
(19' coal @ 3124'.)

27-10S-96W, Norris Oil, 27-2 Moran-Govt.
DST 2938-63, SI 30 min, open 90 min, SI 2 hr, rec 10' mud, FP 14-14#, SIP 120-158#, HP 1315-1315#.
(14' coal @ 2936'.)

1-10S-97W, McCulloch Oil of California, 1 Williams
"DST 3110-3224, op 1 hr weak steady blow thruout, SI 20 mins., rec 175 sli GCM, FP 95-120#, SIP (20 min) 260#, HP 1610-1590#."
(3' coal @ 3147', 3' coal @ 3152'.)

7-10S-97W, Big Horn Powder River Corp., 1-A Federal
"DST 2205-2306, SI 30 mins, open 3 hrs, SI 30 mins, gas in 3 min, too small to gauge, 3 to 4 ft flare, no rec, FP 38-76#, SIP 706-629#, HP 1158-1150#."
(4' coal @ 2222', 6' coal @ 2240'.)

23-10S-97W, Adolph Coors, Nichols 1-23CM
"DST 2708-2723, op 10 mins, SI 60 mins, op 60 mins, SI 4 hr, rec. 2' of borehole fluid no blow, FP 8.1-8.1, SIP 13.5-13.5, HP 1187.1-1173.8 (11' coal @ 2715')."
"DST 2754-2769.5, op 10 mins, SI 60 mins, op 60 mins, SI 2 hr, rec a very small blow of gas and 40' of borehole fluid, FP 13.5-26.9, SIP 120.7-93.9, HP 1240.1-1226.8."
(3' coal @ 2754')

34-11S-94W, Apache Oil, 2 Mickelson-Govt.
"DST 6155-6225, 1 1/2 hrs, rec 90 mud, FP20-40#, SIP (30 min) 190#, HP 2720#."
(42' coal @ 6156', 8' coal @ 6214'.)

17-12S-89W, Delhi-Taylor Oil, 1 McLaughlin-Govt.
"DST 1870-1923, open 1 hr, gas in 5 min, too small to measure, rec 30 mud, FP 15-15#, SIP (20 min) 190#."
(3' coal @ 1889'.)
"DST 1870-2012, open 3 1/2 hrs, gas in 2 hrs, too small to measure, rec 95 mud, FP 45-45#, SIP (30 min) 145#."
(3' coal @ 1889'.)
"DST 2148-2154, open 2 hrs, rec 20 mud, FP 38-50#, SIP (30 min) 75#."
(17' coal @ 2140'.)

3. <u>Mud Log Shows in Coal</u>

6-1N-100W, Charney Oil, 1-6 Govt
12-1N-99W, Pacific Transmission Supply Co., Barcus Creek Fed 22-12
17-2N-94W, Husky-Belco, 16-17 Bailey
25-1S-100W, David M. Munson, 25-1-100 Jerry Chambers
20-3S-100W, Utex, 1 Cathedral
34-6S-94W, CER MWX-1
17-7S-90W, Dome Petroleum, Dome Baldy Creek Unit #1-17
33-7S-100W, Dyce Petroleum, 33-1 Federal
2-7S-101W, Dyco Petroleum, 2-1, Fuelco Federal
15-7S-101W, Dyco Petroleum, 15-1 Albertson
19-8S-95W, Teton Energy Co., Knox 19-1
25-8S-97W, Teton Energy, 1 Fee
25-8S-98W, Teton Energy, 25-4 Federal
25-8S-98W, Teton Energy, 25-3 Govt
26-8S-98W, Teton Energy, 26-3 Federal
26-8S-98W, Teton Energy, 26-4 Federal
35-8S-98W, Teton Energy, 35-2 Federal
6-8S-100W, Dyco Petroleum, 6-3 Mesagar Federal
5-9S-90W, Rainbow Resources, 1-5 Federal-Divide Creek
23-10S-95W, Teton Energy, 23-2 Walck
8-13S-89W, Kd Drilling Co.-Mile High Oil Co. & Feldt-Robinson, 1 Terre II

4. <u>Production Tests in Mixed Sandstone and Coals</u>

15-6S-94W, Northwest Exploration, 6 McNary
"Prod. Zone: Mesaverde
"Int. Prod." 484 MCFGPD."
"Perf." 6789, 6965, 6995, 7003, 7027, 7055, 7108, 7134, 7153, 7164, 7196, 7288, 7305, 7456, 7510, 7530, 7544, 7572, 7604, 7643, 7663, 7691, 7698 w/1 pf."
(6' coal @ 7506', 4' coal @ 7542'.)

23-6S-102W, American Resources Management, 23-1
"Prod. Zone: Mesaverde 550-684, 708-748."
"Int. Prod." SI TSTM."
"Perf.: 550, 551, 552, 553, 554, 679, 680, 681, 682, 683, 684, 708, 711, 713, 715, 717, 738, 740, 742, 744, 746, 748."
(6' coal @ 734')

27-7S-91W, Piute Energy, 6-27-7-91 Federal,
"Init. Prod.: 404.5 MCFD."
"Perf.: 6980-90, 6665-78, 6060-6057, 4991-4998, 5002-5005, 4962-4969 with 1 shot per foot."
(7' coal @ 4991.)

9-7S-93W, Chevron Oil, #1 (22-9) Skonberg
"Prod. Zone: Mesaverde (open hole) 6839-8741."
"Init. Prod.: IPF 350 MCFGPD (natural)."
(8' coal @ 8496', 3' coal @ 8616')

28-7S-95W, Southern Union Production, #28-95 Federal
"Perf.: 5084, 5096, 5270, 5281, 5306, 5513, 5523, 5538, 5691, 5701, 5714, 5773, 5797, 5857, 5871, 5906, 5952, 6061, 6073, 6082, 6125, 6244, 6252, 6297, 6313, 6340, 6360, 6375, 6385, 6393, 6425, 6441, 6550, 6714, 6722, 6797, 6859, 6870, 6913, 6977, 7149, 7161, 7173, 7182, 7189, 7213 w/1 shot each. Sdfract. Flowed 3750 MCFGPD."
(5' coal @ 6796')

33-9S-94W, Fred W. Pool; Walker Oil, 1 Hawkins
"Prod. Zone: Mesaverde 4907-5695."
"Int. Prod." IPF 188 MCFGPD."
Perf.: 4907, 4910, 5015, 5018, 5021, 5023, 5027, 5030, 5033, 5037, 5040, 5045, 5047, 5088, 5092, 5261, 5263, 5267, 5269, 5275, 5414, 5461, 5513, 5554, 5585, 5634, 5663, 5695 w/1 pf.
(16' coal @ 5688'.)

5. <u>Production Tests in Coal Beds</u>

13-3S-101W, Twin Arrow, C & K #1-13
"Perf.: 573-581, 627-665, 726-736, 801-810, 1 shot per foot. Acid treated with 500 gal. 7.5% HF. Swabbed dry. No pressure, no flow through 1/8" orifice."
(2' coal @ 575', 4' coal @ 628', 5' coal @ 661', 3' coal @ 726', 4' coal @ 732', 10' coal @ 801'.)

16-4S-103W, Coseka Resources Federal 1-16
"While being drilled with air-mist, 108 MCFD was produced from a Mesaverde coal zone between 1166 and 1192 feet."
"Perf.: 2 pf from 1170-1174 & 1186-1191. Fract. w/ 580 gal 15% acid & 10,500 gal foam w/ 28,500# 20-40 sd and 4000 barrels 100 mesh sd. Prod. for 75 days @ average rate of 9.2 MCFGD & 8.6 BWD."
(9' coal @ 1167', 10' coal @ 1184'.)

16-6S-90W, Snyder Oil, 1-16 Snyder Parton Porter
"Perf.: (Cameo) 6572-6600 fract w/ 35,238 gal wtr, 24,700 40/70 sd."
"Prod." 1MCFGPD, 110 BW.

23-6S-90W, Rio Colorado Oil and Gas, 1 Cactus Valley 23-6-90
"Perf.: 2440-2550, 2740-3320, 3868-4130. Foam fract."
"Well pumping approximately 4 BWD and flowing 4 MCFD from the perforated coal seams."

34-9S-93W, Exxon Corp., 2 Vega Unit
"Perf.: 7847-7851, 7863-7867, 7985-8007, 8046-8052. IPF 440 MCFGPD, 109 BWPD, 64/64" ck."
(8' coal @ 7845', 19' coal @ 7862', 25' coal @ 7984', 8' coal @ 8044'.)

35-9S-93W, Exxon Corp., 4 Vega Unit
"Perf.: 7956-7968, 8050-8078 w/1 p2f. IPF 140 MCFGPD, 706 BWPD, 20/64" ck."
(15' coal @ 7954', 30' coal @ 8049'.)

24-10S-97W, Adolph Coors Nichols 1-24

"Perf.: 2625-2633 w/ 4 holes per foot."

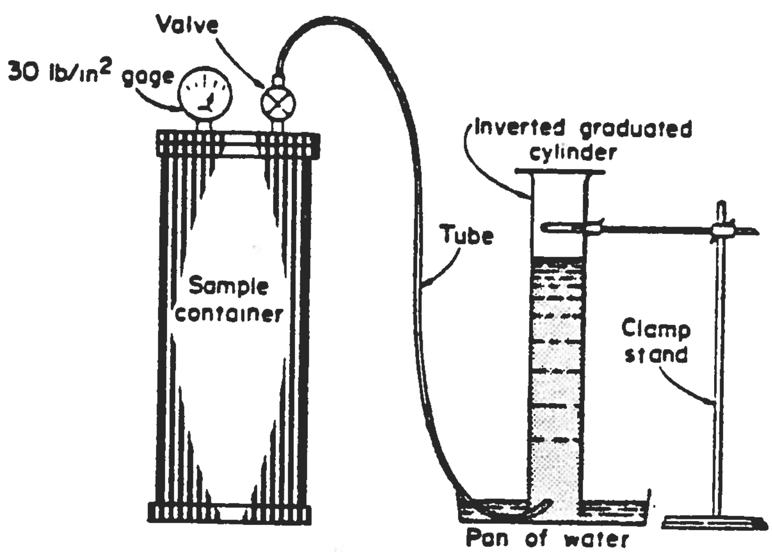
"Foam fraced with 52,500 gallons of 75% nitrogen foam & 49,000 lbs of sand. After flowing back well and swabbing frac fluid and nitrogen, well failed to produce methane in any economical production rate. Small quantities of gas were observed, but flow fell off to zero in 5-10 minutes."

20-12S-92W, Amoco Production Company, #1 Green Mountain Unit

tight hole, "proposed coal degasification test of Rollins Coal."

APPENDIX 4
THE U.S. BUREAU OF MINES DIRECT METHOD

In this method, a coal core sample (approximately 2 lbs in weight) is sealed in an airtight plastic or aluminum cannister and the gas it emits (desorbs) is measured by water displacement in an inverted graduated cylinder (see Figure 10). The coal sample is weighed so its gas content can be stated in cc/g (cubic centimeters/gram) or cf/t. Gas lost by the sample before it is sealed in the cannister can be estimated using a back calculation method. Gas remaining in the structure of the coal sample after natural desportion ceases is measured by crushing the sample in a sealed ball mill and again using water displacement. The desorbed, lost, and remaining gas are all added to give the total gas content. Diamond and Levine (1981) describe the direct method in greater detail.



U.S. Bureau of Mines equipment for direct method desorption of coal samples (after Diamond and Levine, 1981, p. 6).

APPENDIX 5. Unita Region Desorption Data

PART 1--COLORADO GEOLOGICAL SURVEY DATA

CGS NO.	LOCATION (Sec.,Twp.,Rge.)	FORMATION NAME	DEPTH TO COAL BED (ft)	BED THICKNESS (ft)	TOTAL GAS (cc/g)	TOTAL GAS (cf/t)	APPARENT RANK OF COAL	% METHANE IN GAS	HEATING VALUE OF GAS (Btu/cf)
11	16-2N-93W	Williams Fork	2216	15	.50	16 [1]	--	[2]	
12	"	Williams Fork	2243	4	1.31	42	--		
13	21-2N-93W	Williams Fork	2122	12	.98	31	--		
14	"	Williams Fork	2106	8	.10	3	--		
15	23-2N-93W	Williams Fork	48.7	10.8	0	0	hvCb		
16	21-2N-93W	Williams Fork	502.6	12	0	0	hvCb		
17	24-13S-92W	Williams Fork	504	5.8	.19	6	hvCb		
18	8-13S-95W	Williams Fork	706.7	7.6	5.62	179	hvCb		
19	"	Williams Fork	706.7	7.6	.82	26	hvCb		
20	17-10S-89W	Williams Fork	1500	8.7	1.7 [3]	54	mvb		
21	"	Williams Fork	1300-1500	25	.215 [3]	7	mvb		
22	"	Williams Fork	2000	20	.22 [3]	7	mvb		
23	24-13S-93W	Mesaverde Gp.[4]	992.5	14.5	.46	15	hvCb		
24	34-13S-96W	Mesaverde Gp.	579	4.5	0	0	hvCb		
25	13-10S-98W	Mesaverde Gp.	809	5.5	2.5	80	hvAb		
26	"	Mesaverde Gp.	1284.5	3.5	7	223	hvAb		
61	18-4N-94W	Williams Fork	144	13	0.36	12	subA-hvCb		
62	"	Williams Fork	144	13	0.39	13	subA-hvCb		
63	"	Williams Fork	163.5	19.5	0.24	8	subA-hvCb		
64	"	Williams Fork	287.5	4.3	0.15	5	subA-hvCb		
65	"	Williams Fork.	294.8	20.7	0.116	4	subA-hvCb		
66	28-3S-101W	Mesaverde Gp.	1588	3	0.667	21	hvBb		
67	"	Mesaverde Gp.	1607	3	0.489	16	hvBb		
73	14-3S-101W	Mesaverde Gp.	685.2	.4	3.58	115	shale		
74	"	Mesaverde Gp.	698.1	.35	6.68	214	shale		
75	"	Mesaverde Gp.	772.35	.6	1.45	126	siltstone		
76	"	Mesaverde Gp.	770.88	.57	0.76	66	shale		
77	"	Mesaverde Gp.	759.2	.8	2.69	156	hvBb		
78	"	Mesaverde Gp.	809.3	.4	7.61	243	hvBb		
79	"	Mesaverde Gp.	835 ?	4.7	2.76	130	hvBb		
80	"	Mesaverde Gp.	835 ?	4.7	4.31	138	hvBb		
81	"	Mesaverde Gp.	962 ?	7.8	3.47	111	hvBb		
96	11-13S-90W	Williams Fork	873	4.8	2.49	80	hvBb		
97	"	Williams Fork	896	6.1	3.2	102	hvAb		
98	"	Williams Fork	905	1.6	3.74	120	hvAb		
99	"	Williams Fork	948	2.9	3.88	124	hvAb		
100	"	Williams Fork	1133	6.7	0.28	9	hvAb		
101	"	Williams Fork	1133	6.7	6.81	218	hvAb		
102	"	Williams Fork	1187	14	5.82	186	hvAb		
103	"	Williams Fork	1187	14	5.94	190	hvAb		
104	"	Williams Fork	1207	6.8	6.15	197	hvAb		
105	"	Williams Fork	1227	1.2	3.72	119	hvAb		
106	"	Williams Fork	782	13	6.06	194	hvAb		
107	"	Williams Fork	782	13	6.77	217	hvAb		
108	"	Williams Fork	719	6	6.62	212	hvAb		
109	"	Williams Fork	1182	6.9	5.70	182	hvAb		
110	"	Williams Fork	1236	12.7	5.93	190	hvAb		
111	"	Williams Fork	1260	5.3	6.53	209	hvAb		
112	1-13S-90W	Williams Fork	1516	12	3.16	101	hvAb		
113	"	Williams Fork	1583	8	3.36	108	hvAb		
114	"	Williams Fork	1583	8	4.12	132	hvAb		
115	"	Williams Fork	1783	12	5.42	173	hvAb		
116	"	Williams Fork	1783	12	2.99	96	hvAb		
117	"	Williams Fork	1830	14.65	6.10	195	hvAb		
118	"	Williams Fork	1830	14.65	5.53	177	hvAb		
119	"	Williams Fork	1854	6.7	5.98	191	hvAb		
120	"	Williams Fork	1854	6.7	7.66	245	hvAb		
123	36-3N-101W	Mesaverde Gp.	1324.68	1.17	2.04	65	hvCb		
124	"	Mesaverde Gp.	1330.6	8.21	2.25	72	hvCb		
125	"	Mesaverde Gp.	1330.6	8.21	2.19	70	hvCb	(47.63) [5]	
126	"	Mesaverde Gp.	1330.6	8.21	2.06	66	hvCb	(33.11)	
127	"	Mesaverde Gp.	1349.75	2.05	1.81	58	hvCb		
128	1-2N-101W	Mesaverde Gp.	741.75	6.43	0.64	20	hvCb	(49.51)	
129	"	Mesaverde Gp.	758.71	6.43	2.05	80	hvCb		
130	"	Mesaverde Gp.	758.71	2.22	2.25	72	hvCb		
131	"	Mesaverde Gp.	764.92	5.08	2.50	80	hvCb	(57.66) 58.6	610
132	"	Mesaverde Gp.	770	2.5	2.79	89	hvCb	(46.10) 49.2	506
133	"	Mesaverde Gp.	794.65	2.15	2.34	74	hvCb	(38.27) 39.3	403
134	"	Mesaverde Gp.	797.5	4.0	2.23	71	hvCb	(38.27) 37.8	388
135	"	Mesaverde Gp.	805.8	5.37	1.35	43	hvCb		
140	10-10S-93W	Mesaverde Gp.	7598	18	13.69	438	mvb	(82.99) 82.1	942
141	"	Mesaverde Gp.	7598	18	11.90	381	lvb	(79.63) 85.9,	854,960
142	26-3S-101W	Mesaverde Gp.	1148.9	8	1.11	36	hvCb		
143	"	Mesaverde Gp.	1148.9	8	0.76	24	hvBb		
144	"	Mesaverde Gp.	1207	8.7	0.92	29	hvBb		
145	"	Mesaverde Gp.	1207	8.7	0.64	20	hvBb		
146	"	Mesaverde Gp.	1223	2	0.95	30	hvBb		
147	29-3N-101W	Mesaverde Gp.	878.75	.4	0.03	1	shale		
148	"	Mesaverde Gp.	879	3.3	0.29	9	hvCb		
149	"	Mesaverde Gp.	892.72	8.8	0.02	1	siltstone		
150	"	Mesaverde Gp.	898.45	8.8	0.02	1	siltstone		
151	"	Mesaverde Gp.	904.3	7.7	0.13	4	hvCb		
152	"	Mesaverde Gp.	904.3	7.7	0.20	6	hvCb		
153	"	Mesaverde Gp.	912.4	.95	0.01	0	shale		
154	35-3N-101W	Mesaverde Gp.	1186.5	1.88	0.02	1	sandstone		
155	"	Mesaverde Gp.	1190.96	2.74	0.03	1	shale		
156	"	Mesaverde Gp.	1197.15	3.05	0.03	1	siltstone		
157	"	Mesaverde Gp.	1197.35	3.05	1.32	42	hvCb		
158	"	Mesaverde Gp.	1198.65	8.4	1.19	38	hvCb		
159	"	Mesaverde Gp.	1208.34	1.32	0.01	0	siltstune		
160	"	Mesaverde Gp.	1187.7	3.5	0.97	31	hvCb		
184	23-1S-100W	Green River	795.3	?	0.17	5	oil shale		
185	"	Green River	1189.7	?	0.65	21	oil shale		
186	13-6S-94W	Williams Fork	7445	1	4.28	137	carb. shale		
187	"	Williams Fork	7476.5	1	1.81	58	carb. shale		
188	10-7S-104W	Williams Fork	292	2.5	.16	5	hvBb		
189	"	Williams Fork	292	2.5	.08	3	hvBb		
190	"	Williams Fork	299.5	4.6	.07	2	hvBb		
191	"	Williams Fork	303.9	6.8	0.0	0	hvBb		
192	"	Williams Fork	303.9	6.8	.02	1	hvBb		
193	"	Williams Fork	307.5	6.8	.12	4	hvBb		
194	31-2S-99W	Green River	1147.8	?	.69	22	oil shale		
195	"	Green River	1546.7	?	.40	13	oil shale		
199	19-2S-99W	Green River	1276.2	?	0.0	0	oil shale		
200	"	Green River	1485.6	?	.17	5	oil shale		
201	24-2S-100W	Green River	936.3	?	.32	10	oil shale	(85.91)	
202	9-11S-93W	Mesaverde Gp.	6945	1	3.55	114	carb. shale	(79.94,77.38)	
203	34-6S-94W	Mesaverde Gp.	6826.9	?	.58	18 [6]	lvb		

1. total gas in cubic feet per ton not standard cubic feet per ton
2. blanks indicate gas analyses not run
3. mine samples; gas contents probably higher
4. Gp. = group
5. heating value not measured if methane percentage in parentheses
6. sample desorbed for a month before put in canister

PART 2--OTHER AVAILABLE DATA

USBM NO.	Teton Energy Walck 23-2 1	FORMATION NAME	DEPTH TO COAL BED (ft)	BED THICKNESS (ft)	TOTAL GAS (cc/g)	TOTAL GAS (cf/t)	APPARENT RANK OF COAL
1600	23-10S-95W	Mesaverde Gp.	4688	13	1.7	54	coal + shale
1601	"	Mesaverde Gp.	4730	8	1.2	38	shale
1602	"	Mesaverde Gp.	4730	8	3.7	118	shale
1603	"	Mesaverde Gp.	4740	4.5	0.3	10	shale
1604	"	Mesaverde Gp.	4752	12	6.2	198	carb. shale
1605	"	Mesaverde Gp.	4752	12	10.0	320	hvAb
1606	"	Mesaverde Gp.	4752	12	5.0	160	coal cuttings
1607	"	Mesaverde Gp.	4752	12	6.0	192	shale + coal
1608	"	Mesaverde Gp.	4802	12	9.9	317	hvAb
1609	"	Mesaverde Gp.	4802	12	9.3	298	hvAb
1610	"	Mesaverde Gp.	4802	12	10.2	326	hvAb

TRW NO.	DOE MWX-2 1	FORMATION NAME	CORE INTERVAL	TOTAL GAS (cc/g)	TOTAL GAS (cf/t)	RANK OF COAL
1	34-6S-94W	Mesaverde Gp.	7203.7-7204.2	9.90	317	lvb 2
2	"	Mesaverde Gp.	7224.4-7224.7	10.50	336	lvb
3	"	Mesaverde Gp.	7229.5-7229.8	3.58	125 3	lvb
4	"	Mesaverde Gp.	7234-7236,7238-7242	0.29	9	cuttings
5	"	Mesaverde Gp.	7234.6-7234.9	8.94	286	lvb
6	"	Mesaverde Gp.	7374-7386	2.06	65	cuttings
7	"	Mesaverde Gp.	7374-7386	0.45	14	cuttings
8	"	Mesaverde Gp.	7374-7386	0.45	14	cuttings
9	"	Mesaverde Gp.	7375.8-7376.1	8.64	303	lvb
10	"	Mesaverde Gp.	7380.3-7380.6	8.71	279	lvb
11	"	Mesaverde Gp.	7384.3-7384.6	8.43	295	lvb

USBM NO.	LOCATION (Sec.,Twp.,Rge.)	FORMATION NAME	DEPTH TO COAL BED (ft)	BED THICKNESS (ft)	TOTAL GAS (cc/g)	TOTAL GAS (cf/t)	APPARENT RANK OF COAL
Rio Colorado Cactus Valley 4							
1029	23-6S-90W	Mesaverde Gp.	3316	?	6.6	211 ?	hvAb
1036	"	Mesaverde Gp.	3880	?	12.6	403	hvAb
1028	"	Mesaverde Gp.	3312	?	11.1	355	hvAb
1037	"	Mesaverde Gp.	3882	?	12.3	394	hvAb
1033	"	Mesaverde Gp.	3333	?	9.8	314	hvAb
1032	"	Mesaverde Gp.	3323	?	8.9	285	hvAb
1031	"	Mesaverde Gp.	3322	?	9.9	317	hvAb
1030	"	Mesaverde Gp.	3322	?	11.6	371	hvAb
1073	"	Mesaverde Gp.	3881	?	11.5	368	hvAb
1035	"	Mesaverde Gp.	3879	?	12.1	387	hvAb
1038	"	Mesaverde Gp.	3896	?	3.1	99 ?	hvAb
1034	"	Mesaverde Gp.	3315	?	?	?	hvAb
1040	"	Mesaverde Gp.	3976	?	7.5	240 ?	hvAb
1039	"	Mesaverde Gp.	3975	?	5.3	170 ?	hvAb
1041	"	Mesaverde Gp.	3980	?	2.4	77	cuttings

TRW NO.	LOCATION (Sec.,Twp.,Rge.)	FORMATION NAME	DEPTH TO COAL BED (ft)	BED THICKNESS (ft)	TOTAL GAS (cc/g)	TOTAL GAS (cf/t)	APPARENT RANK OF COAL
Adolph Coors Nichols 1-23 CM 1							
1	23-10S-97W	Mesaverde Gp.	2634	2.6	3.54	113	coal cuttings
2	"	Mesaverde Gp.	2675	?	.07	2	sandstone
3	"	Mesaverde Gp.	2676	3.8	2.74	88	hvAb
4	"	Mesaverde Gp.	2715	11.4	4.94	158	hvAb
5	"	Mesaverde Gp.	2715	11.4	5.18	166	hvAb
6	"	Mesaverde Gp.	2732	9	2.80	90	hvAb
7	"	Mesaverde Gp.	2732	9	4.54	145	hvAb
8	"	Mesaverde Gp.	2754	3.6	6.17	197	hvAb
9	"	Mesaverde Gp.	2770	5.6	0.56	18	sandstone
10	"	Mesaverde Gp.	2770	5.6	6.21	199	hvAb
11	"	Mesaverde Gp.	2770	5.6	5.70	182	hvAb

HOLE NO.	LOCATION (Sec.,Twp.,Rge.)	FORMATION NAME	CORE INTERVAL	BED THICKNESS (ft)	AVERAGE	AVERAGE	NO. OF SAMPLES
U.S. Steel							
16	32-10S-89W	Mesaverde Gp.	1570.2-1575.7	5.5	23.9	765.3 5	4
	"	Mesaverde Gp.	1874.5-1859.6	12.1	22.4	716.4	8
	"	Mesaverde Gp.	2251.4-2260	8.6	15.0	480.5	2
	"	Mesaverde Gp.	2269.6-2277.7	8.1	16.3	520.9	2
17	33-10S-89W	Mesaverde Gp.	1219.7-1226.4	6.7	13.6	435.9	3
	"	Mesaverde Gp.	1506.9-1518.5	12	19.7	630.4	4
	"	Mesaverde Gp.	1964.9-1971.9	7	7.8	249.5	1
18	32-10S-89W	Mesaverde Gp.	2018.5-2032.6	14.1	23.7	759	4
	"	Mesaverde Gp.	2467.2-2475.1	7.9	16.8	537	3
	"	Mesaverde Gp.	2480.9-2488.2	7.5	17.3	553	2
19	32-10S-89W	Mesaverde Gp.	2093.6-2107.1	14.6	16.5	527	5
	"	Mesaverde Gp.	2530.1-2539.7	9.6	19.6	628	3
	"	Mesaverde Gp.	2546.6-2554.3	7.7	10.3	329	3

1. Analyses done by TRW Energy Systems Group.
2. Gas contents are low for this rank coal at this depth possibly due to absorption of methane by petroleum based mud.
3. Much gas lost due to fine sample size.
4. Analyses done by U.S. Bureau of Mines.
5. Residual gas not calculated by U.S. Bureau of Mines Direct Method; totals approximate.

Project Description Continued...

SITE CHARACTERIZATION

While limited site information is necessary for site nomination, the site of choice will be extensively characterized before any stimulation and production tests are initiated. The following activities will form the basis for site characterization:

- **Coring** – A core will be taken to determine the chemical and physical properties of the coal, and adjacent strata. These data will be useful for input into fracture design and modeling as well as the permeability parameters of the coal.
- **In-situ state of stress** – These data will also be useful for fracturing design and modeling.
- **Hydrology** – If the coal seam is saturated, basic hydrologic drawdown tests, vertical flow profiles, dewatering characteristics and directional flow parameters will be acquired. These parameters will be useful in overall reservoir characterization because of the need to reduce the hydrostatic head to induce gas production.
- **Dewatering** – If dewatering is necessary, an optimized dewatering system will be employed based on GRI's dewatering system study while utilizing the basic hydrologic drawdown parameters.
- **Completion** – If any deviations from standard oil field and/or water well practice are necessary, information from GRI casing and cementing procedures will be utilized to optimize completions.
- **Baseline Production** – Dewatering, baseline production characteristics of the well will be determined for input into the reservoir model and as a reference point prior to stimulation.
- **Environmental** – The required baseline enviromental parameters will be measured. Sufficient groundwater quality data will be collected to anticipate treatment needs, if any, for product water disposal.

STIMULATION AND PRODUCTION TESTING

Currently a nine production well and eight observation well array is envisioned for the field test. At the beginning of the testing only 2 to 3 wells will have been drilled and the spacing for further wells will be determined after testing has begun. The well pattern in Figure 2 is an example of what the final well pattern might look like.

The crucial part of the deep seam test is well stimulation quantification. It is premature to specify an exact variation of the types of fracturing fluids or fracturing techniques to be tested but the following is shown for an example:

(1) Baseline – state of the art;

(2) Other possibilities;

- multi-stage
- advanced proppants
- improved fluids

The following is an example of a sequence of operations that might be followed:

- Preliminary Operations Sequence
  - Drill, test and frac two wells using a conventional fracturing technique
  - Drill, test and frac two wells using a new or modified technique

- Drill, test and frac two wells using another new or modified technique
- Drill, test and frac two or three wells using improved fluids
- Compare effectiveness and define additional tests
- Update frac designs
- Drill, test, and frac remaining wells using refined techniques or, possibly, a horizontal hole.

It is intended to provide sufficient data acquisition capability including observation wells and time between fracturing tests to allow the results of one test to impact the designs of subsequent tests. In addition, workshops will be conducted during the course of this investigation to allow for dissemination of results as well as to acquire inputs related to new stimulation techniques which might be utilized in this program.

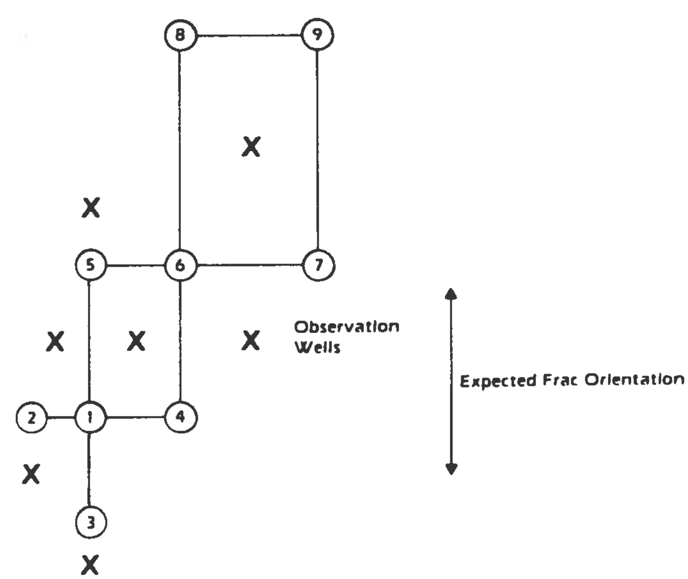
DISSEMINATION OF RESULTS

GRI expects that at the completion of this project the following products will result:

- Commercially proven Deep Coal Stimulation Techniques;
- Improved Completion and Production Technology;
- Practical Resource Recovery Estimating Procedures;
- A Strong Basis for Economic Projections;
- An Impact on Near-Term Gas Supply.

The experimental results will be incorporated into a data base and procedural handbooks for utilization of technologies by industry.

Figure 2.
Preliminary Site Layout



Mesaverde Coals in the Piceance Basin, Colorado

by Carol M. Tremain

COLORADO GEOLOGICAL SURVEY
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OPEN-FILE 82-1
PLATE 1
1982

Mesaverde Net Coal Thickness, Piceance Basin, Colorado

by Carol M. Tremain

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OPEN-FILE 82-1
PLATE 2
1982

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OPEN FILE 82-1
PLATES 3, 4, 5
1982

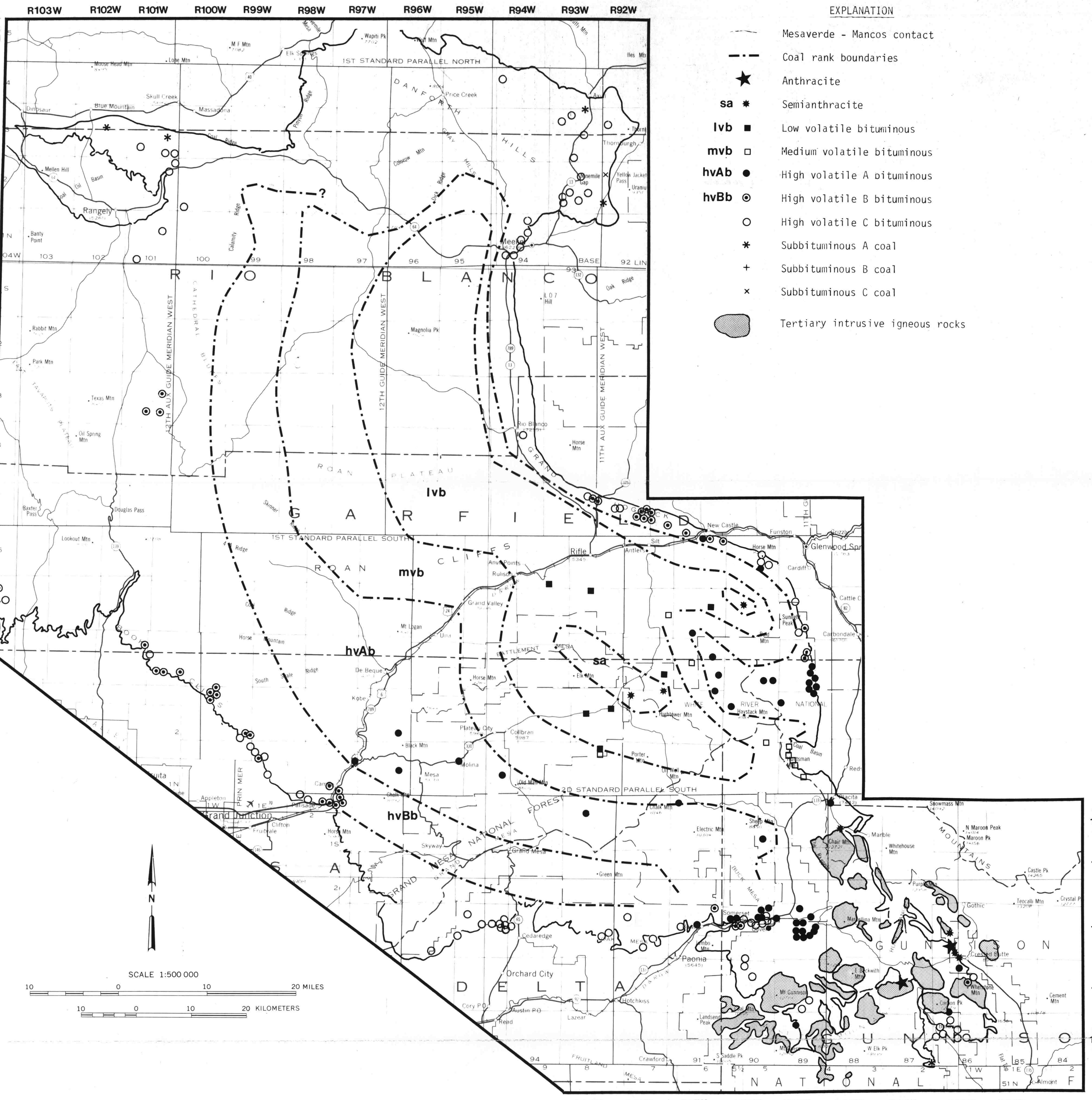

PLATE 3
COAL RANK MAP OF THE PICEANCE BASIN

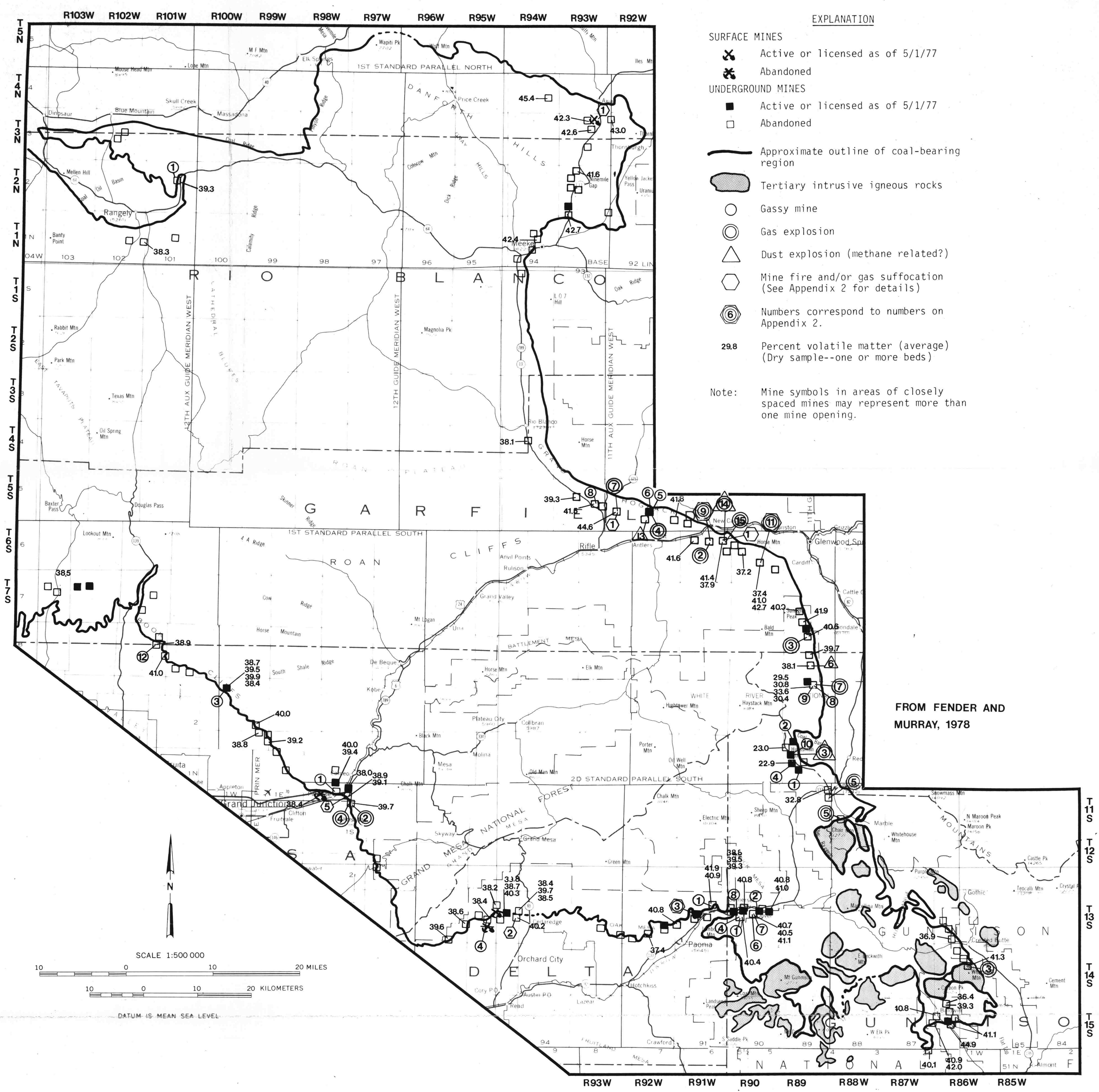

PLATE 5
METHANE IN PICEANCE BASIN COAL MINES

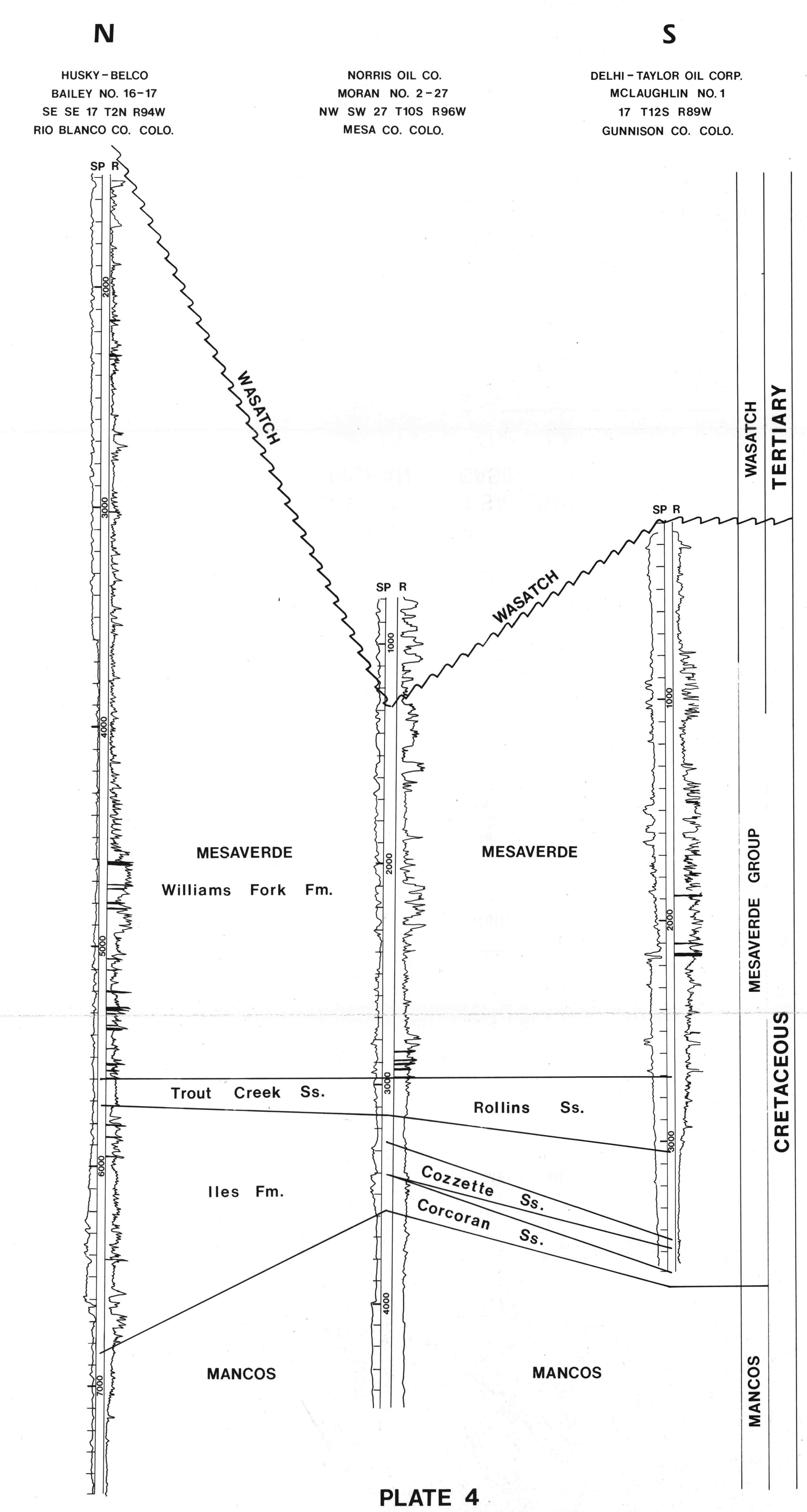

PLATE 4
THREE TYPE LOGS OF THE MESAVERDE FORMATION, PICEANCE BASIN