UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

OPEN-FILE REPORT 80-031

1985

FEDERAL COAL RESOURCE OCCURRENCE MAPS OF THE TSE BONITA SCHOOL 7 1/2-MINUTE QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

[Report includes 3 plates]

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TSE BONITA SCHOOL QUADRANGLE

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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) maps of the Tse Bonita School 7 ½ minute quadrangle, McKinley County, New Mexico. These maps and report are part of an evaluation of fifty-six 7 ½ minute quadrangles in northwestern New Mexico which were completed under U. S. Geological Survey Contract No. 14-08-0001-17459 (see figs. 1 and 2).

The purpose of this Coal Resource Occurrence-Coal Development Potential program, which was conceived by Congress as part of its Federal Coal Leasing Amendments Act of 1976, is to obtain coal resource information and to determine the geographical extent of Federal coal deposits. In addition, the program is intended to provide information on the amount of coal recoverable by various mining methods and to serve as a guide for land-use planning.

The U. S. Geological Survey initiated the program by identifying areas underlain by coal resources. These areas were designated Known Recoverable Coal Resource Areas based on the presence of minable coal thicknesses, adequate areal extent of these coal deposits, and the potential for developing commercial quantities of coal at minable depths.

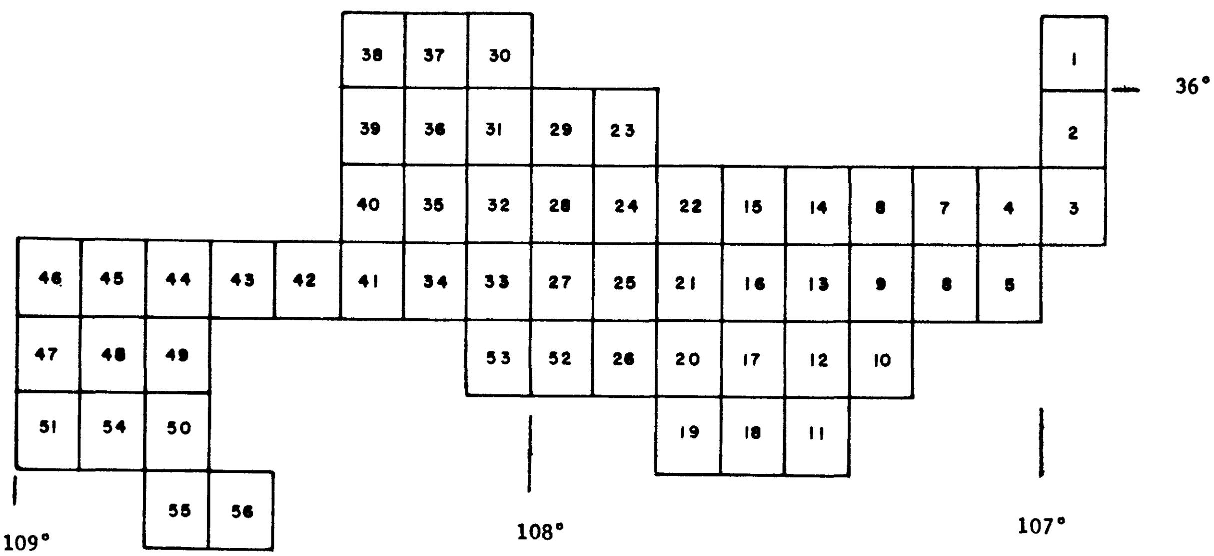
This report is limited to coal resources which are 3,000 ft (914 m) or less below ground surface. Published and unpublished public information was used as the data base for this study. No new drilling or field mapping was performed as part of this study, nor were any confidential data used.

LOCATION OF PROJECT AREA

FIGURE 1

FIGURE 2.--Index to USGS 7 1/2-minute quadrangles and coal resource occurrence/ coal development potential maps for the southern San Juan Basin area, New Mexico

Map No.	Quadrangle	Open-file report	Map No.	Quadrangle	Open-file report
1	Cuba	79- 623	31	Nose Rock	79- 641
2	San Pablo	79- 624	32	Becenti Lake	79-1124
3	La Ventana	79-1038	33	Heart Rock	79- 642
4	Headcut Reservoir	79-1043	34	Crownpoint	79-1125
5	San Luis	79-1044	35	Antelope Lookout Mesa	79-1376
6	Arroyo Empedrado	79-1045	36	Milk Lake	79-1377
7	Wolf Stand	79-1046	37	La Vida Mission	79-1378
8	Tinian	79- 625	38	The Pillar 3 SE	79-1379
9	Canada Calladita	79- 626	39	Red Lake Well	79-1380
10	Cerro Parido	79- 627	40	Standing Rock	79-1381
11	El Dado Mesa	79- 628	41	Dalton Pass	80- 026
12	Mesa Cortada	79- 629	42	Oak Spring	80- 027
13	Mesita del Gavilan	79- 630	43	Hard Ground Flats	80- 028
14	Rincon Marquez	79- 631	44	Big Rock Hill	80- 029
15	Whitehorse Rincon	79- 632	45	Twin Lakes	80- 030
16	Mesita Americana	79- 633	46	Tse Bonita School	80- 031
17	El Dado	79- 634	47	Samson Lake	80- 032
18	Cerro Alesna	79- 635	48	Gallup West	80- 033
19	San Lucas Dam	79- 636	49	Gallup East	80- 034
20	Piedra de la Aguila	79-1039	50	Bread Springs	80- 035
21	Hospah	79- 637	51	Manuelito	80- 036
22	Whitehorse	79-1040	52	Borrego Pass	80- 037
23	Seven Lakes NE	79- 638	53	Casamero Lake	80- 038
24	Kin Nahzin Ruins	79- 639	54	Twin Buttes	80- 039
25	Orphan Annie Rock	79-1041	55	Pinehaven	80- 040
26	Mesa de los Toros	79-1122	56	Upper Nutria	80- 041
27	Laguna Castillo	79- 640			
28	Seven Lakes	79-1042			
29	Seven Lakes NW	79-1123			
30	Kin Klizhin Ruins	79-1047			



Location

The Tse Bonita School 7½ minute quadrangle includes acreage in Tps. 16, 17, and 18 N., Rs. 19 and 20 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

U. S. Highway 68 (Highway 264 on fig. 1) passes through the southern part of the quadrangle and provides access to the city of Gallup, 13 mi (21 km) SE, and to the town of Window Rock, Arizona, 5 mi (8 km) west of the quadrangle. Light-duty and unimproved dirt roads traverse most parts of the area. The main line of the Atchison, Topeka, and Santa Fe Railroad line passes about 7 mi (11 km) south of the quadrangle (see fig. 1). A spur line of the Atchison, Topeka, and Santa Fe Railroad which provides railway services to Pittsburg and Midway's McKinley coal mine passes less than 0.5 mi (0.8 km) south of the Samson Lake quadrangle.

Physiography

The Tse Bonita School quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The topography of the quadrangle is characterized by rugged badlands.

No perennial streams are present in the quadrangle. Local drainage is provided by several intermittent arroyos which include Tse Bonita Wash, Coal Mine Wash, Slick Rock Wash, Black Creek, Deer Springs Wash, and Black Springs Wash. Elevations within the quadrangle range from less than 6,680 ft (2,036 m) along the southern boundary to 7,860 ft (2,396 m) along the northern boundary of the quadrangle.

Climate

The climate of this area is semiarid to arid. The following temperature and precipitation data were reported by the National Oceanic and Atmospheric Administration for the Tohatchi 1 ESE Station. The Tse Bonita School quadrangle is about 10 mi (16 km) SW of the Tohatchi 1 ESE Station. Average total annual precipitation for eleven of the previous fifteen years is 9.13 in. (23.19 cm). Intense thunderstorms in July, August, and September account for the majority of precipitation. The area is susceptible to flash flooding associated with these thunderstorms. Mean annual temperature for four of the previous fifteen years is 51.8^{o}F (11.0^{o}C). The average daily temperatures in January and July are 31.2^{o}F (-0.4^{o}C) and 73.8 F (23.2^{o}C), respectively.

Land status

The Federal Government holds coal rights to approximately 4 percent of the Tse Bonita School quadrangle. For the specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownership. The Navajo Indians own the coal mineral rights to the northern three-fourths of the Tse Bonita School quadrangle. All of the quadrangle south of the Navajo Indian Reservation boundary is within the Gallup Known Recoverable Coal Resource Area. About 3,600 acres (1,457 ha) of Federal Coal Leases held by the Pittsburg and Midway Coal Mining Company are within the Tse Bonita School quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Dobbin (1932) who mapped coal outcrops in the area and included measurements of Gibson Coal Member outcrops in the Tse Bonita School quadrangle. Shomaker, Beaumont, and Kottlowski (1971) estimated coal reserves of 250 million short tons (227 million t) within 10 to 150 ft (3 to 46 m) of the surface and 180 million short tons (163 million t) from 150 to 250 ft (46 to 76 m) below the surface in a five township area which includes T. 16 N., R. 20 W., T. 17 N., R. 19 W., and T. 17 N., R. 20 W. Portions of these areas are within the Tse Bonita School quadrangle. They noted coals in other parts of the quadrangle which were deeply buried or steeply dipping. Hackman and Olson (1977) compiled surface mapping and structural data from many sources for the area.

Stratigraphy

Within the San Juan Basin, the shoreline positions of the Cretaceous seaways changed innumerable times. The overall regional alignment of the shorelines trended N. 60° W. - S. 60° E. (Sears, Hunt, and Hendricks, 1941). The transgressive and regressive shoreline migrations are evidenced by the intertonguing relationships of continental and marine facies. Rates of trough (geosynclinal) subsidence and the availability of sediment supplies are the major factors that controlled the transgressive-regressive shoreline sequences.

Exposed rock units in the Tse Bonita School quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium along drainages in the area.

The Gallup Sandstone is a prominent sandstone marker in most of the San Juan Basin which represents nearshore or littoral deposits that formed during a major regression of the Cretaceous seaways. Pink to gray, fine-to very coarse-grained, massive sandstone, interbedded gray shales, and coal beds comprise the lithologies of the unit, which averages 310 ft (94 m) thick locally. The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents continental sediments which were deposited inland from the beach area during the deposition of the Gallup Sandstone. Medium to dark gray siltstone with interbedded medium-grained, tan sandstones, and coal beds comprise the lithologies of the Dilco Coal Member, which averages 230 ft (70 m) thick in the area.

The Dalton Sandstone Member, which divides the Dilco Coal Member into upper and lower portions in the eastern adjacent Twin Lakes quadrangle, is not present in the Tse Bonita School quadrangle. Overlying the Dilco Coal Member, the Bartlett Barren Member of the Crevasse Canyon Formation represents floodplain deposits, and consists of yellowish-brown to olive-gray siltstone, light gray shales, white to brown calcareous sandstones, and thin local coal beds. Thickness of the unit ranges from 230 to 260 ft (70 to 79 m) locally.

The Crevasse Canyon Gibson-Menefee Cleary undifferentiated unit overlies the Bartlett Barren Member, and was combined based on similar lithologies and stratigraphic continuity representing essentially continuous continental deposition. Light to medium gray, carbonaceous siltstone with interbedded gray to tan sandstones, gray shales, and coal beds comprise the lithologies of the Crevasse Canyon Gibson-Menefee Cleary unit, which averages 400 ft (122 m) thick locally. Portions of the Allison Member of the Menefee Formation are probably present in the northeastern part of the Tse Bonita School quadrangle.

Depositional environments

The Cretaceous System sedimentary units in the quadrangle represent transgressive and regressive depositional conditions. There were innumerable minor cycles of widely varying duration and extent within the major sedimentary sequences. The paucity of data in this quadrangle and the intended scope of this report permit only general interpretations of the depositional environments.

The Cretaceous coal deposits of the San Juan Basin are products of former coastal swamps and marshes. These swamps and marshes were supported by heavy precipitation and a climate conducive to rapid vegetal growth in moderately fresh water. Due to the relatively low sulfur contents of the San Juan Basin coals, Shomaker and Whyte (1977) suggest the coals formed in fresh water environments.

Most of the coal-bearing units were deposited in coastal plain environments. The majority of the peat deposits formed in a transition zone between lower and upper deltaic sediments during periods of relative shoreline stability. Coals also formed in lake margin swamps inland from the coastal area. Shoreline oscillations and the subsequent influx of continental or marine debris upon the peat accumulations produced the vertical buildup or "stacking" of peat deposits. This sediment debris is represented by variable ash contents, rock partings, and splits within the coal seams.

The peat accumulated in lenses or pods which were generally parallel to the ancient shorelines. The coals in the lower portions of the coal-bearing units represent regressive depositional conditions (Sears, Hunt, and Hendricks, 1941). The coals in the upper portions of these units are relatively sporadic in occurrence.

Structure

The Tse Bonita School quadrangle is in the Defiance Monocline and Gallup Sag structural divisions in the southwestern portion of the structural depression known as the San Juan Basin (Kelley, 1950). No faults have been mapped by any previous workers in the area. Dips of the rock units range from 1° to 2° SE in the southern part of the quadrangle and from 4° SE to 22° NE in the northern part of the area. Hackman and Olson (1977) mapped southeastward-plunging anticlines and synclines in the quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified eight coal beds and three coal zones in a water well log and Dobbin's (1932) surface mapping. These coal beds and coal zones are here informally called the Gallup coal zone, Gallup No. 1 coal bed, Crevasse Canyon Dilco No. 2, No. 3, and No. 5 coal beds, Crevasse Canyon Dilco coal zone, Crevasse Canyon Dilco No. 8 coal bed, Crevasse Canyon Gibson coal zone, and the Crevasse Canyon Gibson No. 5, No. 6, and No. 8 coal beds.

Stratigraphically, the Gallup coal zone contains the lowest identified coal bed in the Tse Bonita School quadrangle. A single 2.0 ft (0.6 m) thick bed which occurs about 87 ft (27 m) below the top of the Gallup Sandstone comprises the Gallup coal zone. The Gallup No. 1 coal bed contains 2.0 ft (0.6 m) of coal in a single bed which occurs 80 ft (24 m) below the top of the Gallup Sandstone. The Crevasse Canyon Dilco No. 2, No. 3, and No. 5 coal beds occur 55 ft (17 m), 100 ft (30 m), and 163 ft (50 m) above the Gallup Sandstone, respectively. A single 1.5 ft (0.5 m) thick bed which occurs 190 ft (58 m) above the Gallup Sandstone comprises the Crevasse Canyon Dilco coal zone. The Crevasse Canyon Dilco No. 8 coal bed occurs at the top of the Dilco Coal Member and is represented by a single 2.0 ft (0.6 m) thick bed in this quadrangle.

Up to eight individual coal beds comprise the Crevasse Canyon Gibson coal zone, which occur from 105 to 289 ft (32 to 88 m) above the top of the Bartlett Barren Member. These zone coals, as with all zone coals identified in this quadrangle, may be correlated for limited distances in portions of the area, but they lack sufficient continuity with poorly defined stratigraphic position and cannot be designated as persistent coal beds. The Crevasse Canyon Gibson No. 5, No. 6, and No. 8 beds occur 205 ft (62 m), 285 ft (87 m), and 294 ft (90 m) above the top of the Bartlett Barren Member, respectively. These coal beds, as with all alphanumerically designated beds in this quadrangle, are inferred to be continuous, although they may be several individual coal beds that are stratigraphically equivalent.

A published coal quality analysis of Crevasse Canyon Gibson-Menefee

Cleary undifferentiated coal beds from Pittsburg and Midway Co. McKinley mine (sample 1, table 1) in the Tse Bonita School quadrangle has been reported by Shomaker, Beaumont, and Kottlowski (1971) and is shown in table 1. Three other Gibson Coal Member mine samples of the authors' Crevasse Canyon Gibson No. 5 (sample 2), No. 6 (sample 3), and No. 8 (sample 4) (the Gibson No. 5, No. 3, and No. 1 beds, respectively, of Sears, 1925) from 8.5 to 10.5 mi (13.7 to 16.9 km) southeast of the quadrangle have been reported by the U. S. Bureau of Mines (1936) and are shown in table 1. Rank of the Gibson Coal Member beds is high volatile C bituminous in this area.

There are no known published coal quality analyses for Dilco Coal Member beds from the Tse Bonita School quadrangle. Analyses of Dilco Coal Member beds from the abandoned Otero mine (Thatcher bed of Sears, 1925) sample 1, table 2; Gallup Southwestern mine (Black Diamond bed of Sears, 1925) sample 2, table 2; Caretto mine (Otero bed of Sears, 1925) sample 3, table 2 and Dilco (Jones) mine (Dilco 1 or Defiance bed of Sears, 1925) sample 4, table 2, have been reported by the U. S. Bureau of Mines (1936) and are shown in table 2. The Dilco Coal Member beds analyzed are probably similar in quality to the Dilco Coal Member beds in this quadrangle. Rank of the Dilco Coal Member beds is probably high volatile C bituminous in this area.

Crevasse Canyon Gibson No. 8 coal bed

The Crevasse Canyon Gibson No. 8 coal bed was identified in the water well log and two outcrop measured sections by Dobbin (1932). Thickness of the bed ranges from 2.0 to 5.0 ft (0.6 to 1.5 m). The mine sample

Table 1. - Analyses of coal samples from the Gibson Coal Member of the Crevasse Canyon Formation.

[Form of analysis: A, as received; B, moisture free; C, moisture and ash free]

Sample 1 from Shomaker, Beaumont, and Kottlowski, 1971

Samples 2, 3, and 4 from U. S. Bureau of Mines, 1936

Sample	Type of sample	Location Sec.	Location T. N.	Location R. W.	Form of analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
1	tipple sample (McKinley mine)	(approximate) --	16	20	A	15.20	--	--	7.95	0.42	10,637
2	mine sample (composite of Navajo No. 2 mine)	33	SW¼ SE¼ 16	18	A	13.2	37.7	41.2	7.9	0.5	10,920
					B	--	43.5	47.3	9.2	0.6	12,580
					C	--	47.9	52.1	--	0.6	13,850
3	mine sample (Heaton mine)	35	NW½ 16	18	A	15.3	38.2	42.0	4.5	0.4	11,070
					B	--	45.1	49.6	5.3	0.5	13,060
					C	--	47.6	52.4	--	0.5	13,790
4	mine sample (Navajo mine)	33	SE¼ 16	18	A	12.5	38.9	39.4	9.17	0.43	10,800
					B	--	44.4	45.1	10.49	0.49	12,350
					C	--	49.7	50.3	--	0.55	13,800

Remarks:
A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yields heating values of 11,643 Btu/lb (27,082 kJ/kg; sample 1), 11,947 Btu/lb (27,789 kJ/kg; sample 2), 11,641 Btu/lb (27,077 kJ/kg; sample 3), and 11,995 Btu/lb (27,900 kJ/kg; sample 4). No agglomerating characteristics were included with the analyses.

Table 2. - Analyses of coal samples from the Dilco Coal Member of the Crevasse Canyon Formation.

[Form of analysis: A, as received; B, moisture free; C, moisture and ash free]

<u>from</u> U. S. Bureau of Mines, 1936

Sample	Type of sample	Location Sec.	T. N.	R. W.	Form of analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
1	mine sample (Otero mine)	NW¼ 14	15	18	A	9.7	41.4	40.8	8.1	1.55	11,620
					B	--	45.9	45.2	8.9	1.72	12,870
					C	--	50.4	49.6	--	1.88	14,130
2	mine sample (Gallup South-western mine)	SE¼ 21	15	18	A	11.4	39.9	42.2	6.5	0.75	11,640
					B	--	45.0	47.7	7.3	0.85	13,140
					C	--	48.5	51.5	--	0.92	14,180
3	mine sample (Caretto mine)	SW¼ 14	15	18	A	10.6	40.6	44.4	4.40	0.59	12,100
					B	--	45.4	49.7	4.92	0.66	13,530
					C	--	47.7	52.3	--	0.69	14,230
4	mine sample (Dilco-Jones Mine)	NW¼ 22	15	19	A	15.4	38.2	41.3	5.11	0.92	11,130
					B	--	45.1	48.9	6.04	1.09	13,160
					C	--	48.0	52.0	--	1.16	14,000

Remarks:
A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yeilds heating values of 12,768 Btu/lb (29,698 kJ/kg; sample 1), 12,534 Btu/lb (29,154 kJ/kg; sample 2), 12,716 Btu/lb (29,577 kJ/kg; sample 3), and 11,795 Btu/lb (27,435 kJ/kg; sample 4). No agglomerating characteristics were included with the analyses.

from the Navajo mine (sample 4, table 1) is the same coal bed as the author's Crevasse Canyon Gibson No. 8 coal bed. Because of the limited areal extent of the bed, the isopach, structure contour, and overburden isopach maps are included in this text as page-sized maps (figs. 3, 4, and 5). Based on Crevasse Canyon Gibson No. 8 coal data from the southern adjacent Samson Lake quadrangle, the bed was inferred to thicken to 6 ft (2 m) within the Tse Bonita School quadrangle (see fig. 3).

Crevasse Canyon Gibson No. 5 coal bed

The Crevasse Canyon Gibson No. 5 coal bed was identified in the water well log and five outcrop measured sections by Dobbin (1932) where the bed ranges from 2.6 to 5.0 ft (0.8 to 1.5 m) thick. The mine sample from the Navajo No. 2 mine (sample 2, table 1) is the same coal bed as the author's Crevasse Canyon Gibson No. 5 coal bed. Because of the limited areal extent of the bed, the isopach, structure contour, and overburden isopach maps are included in this text as page-sized maps (figs. 6, 7, and 8). The bed is inferred to pinch out in the eastern portion of the mapped area (see fig. 6), based on data from adjacent quadrangles.

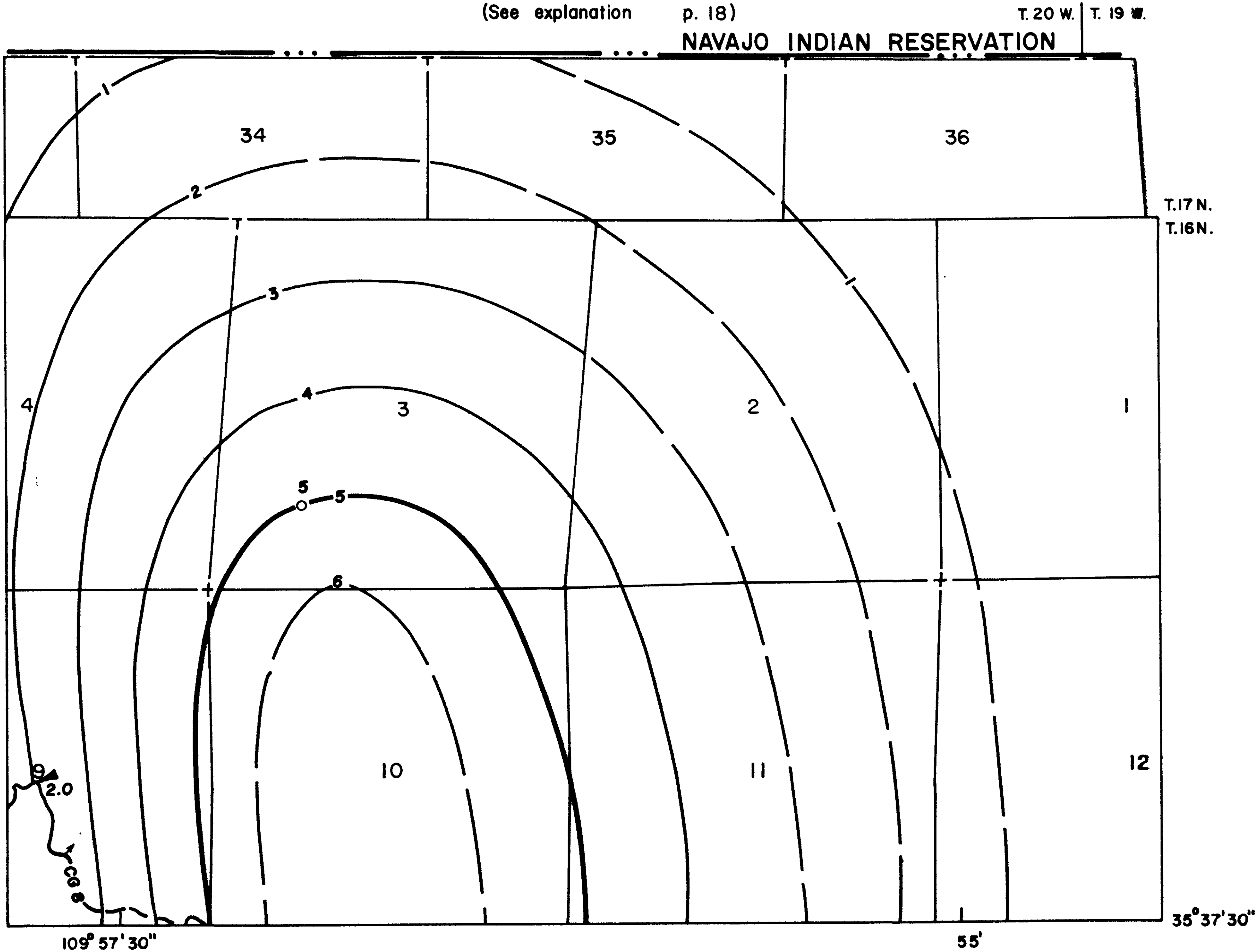
Crevasse Canyon Dilco No. 8 coal bed

The Crevasse Canyon Dilco No. 8 coal bed was identified in the water well log with a thickness of 2.0 ft (0.6 m). The mine sample from the Dilco (Jones) mine (sample 4, table 2) is the same coal bed as the author's Crevasse Canyon Dilco No. 8 coal bed. Because of limited data,

Figure 3

ISOPACH MAP OF THE CREVASSE CANYON GIBSON NO. 8 COAL BED

(See explanation p. 18)

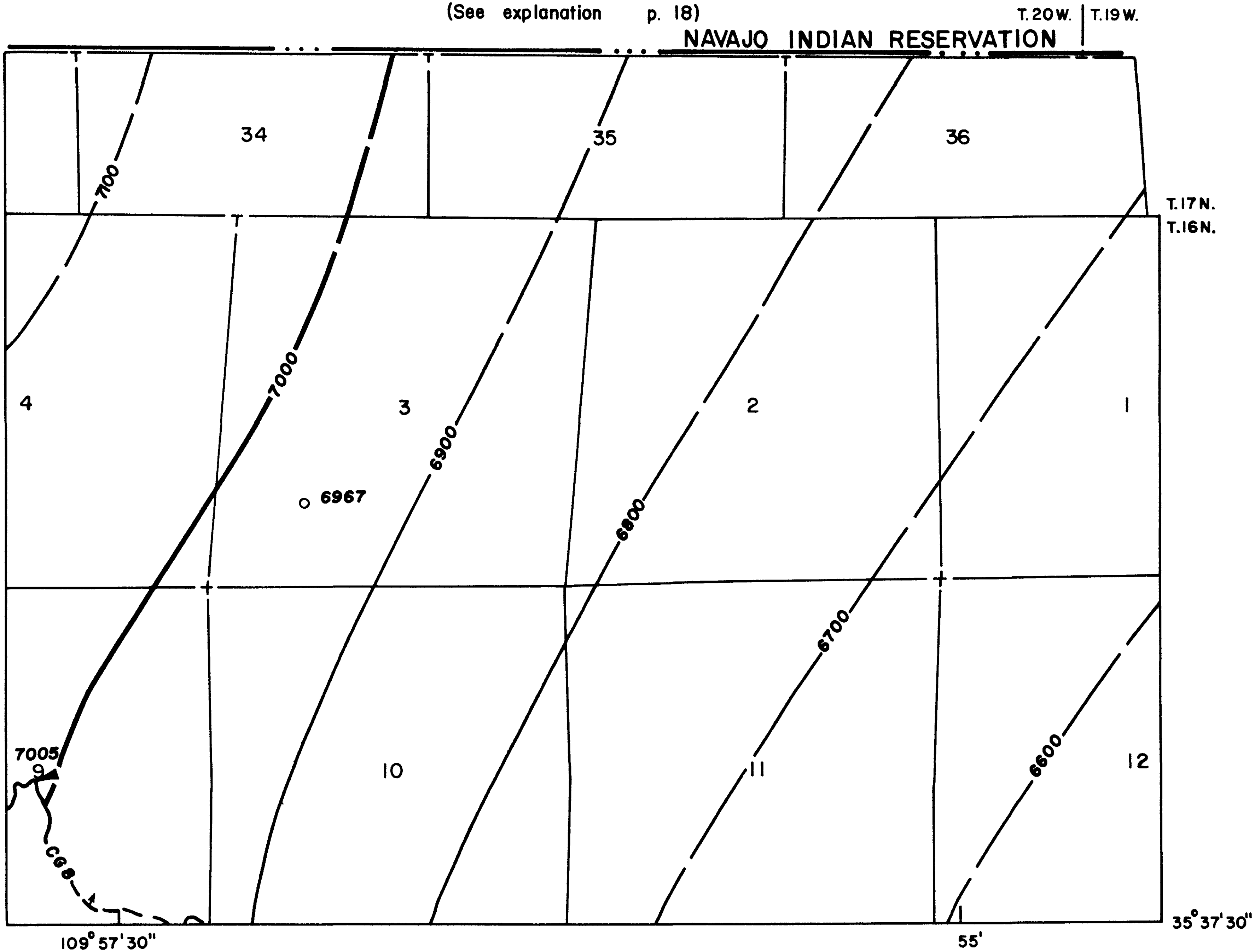


SCALE 1:24,000

Figure 4

STRUCTURE CONTOUR MAP OF THE CREVASSE CANYON GIBSON NO. 8 COAL BED

(See explanation p. 18)

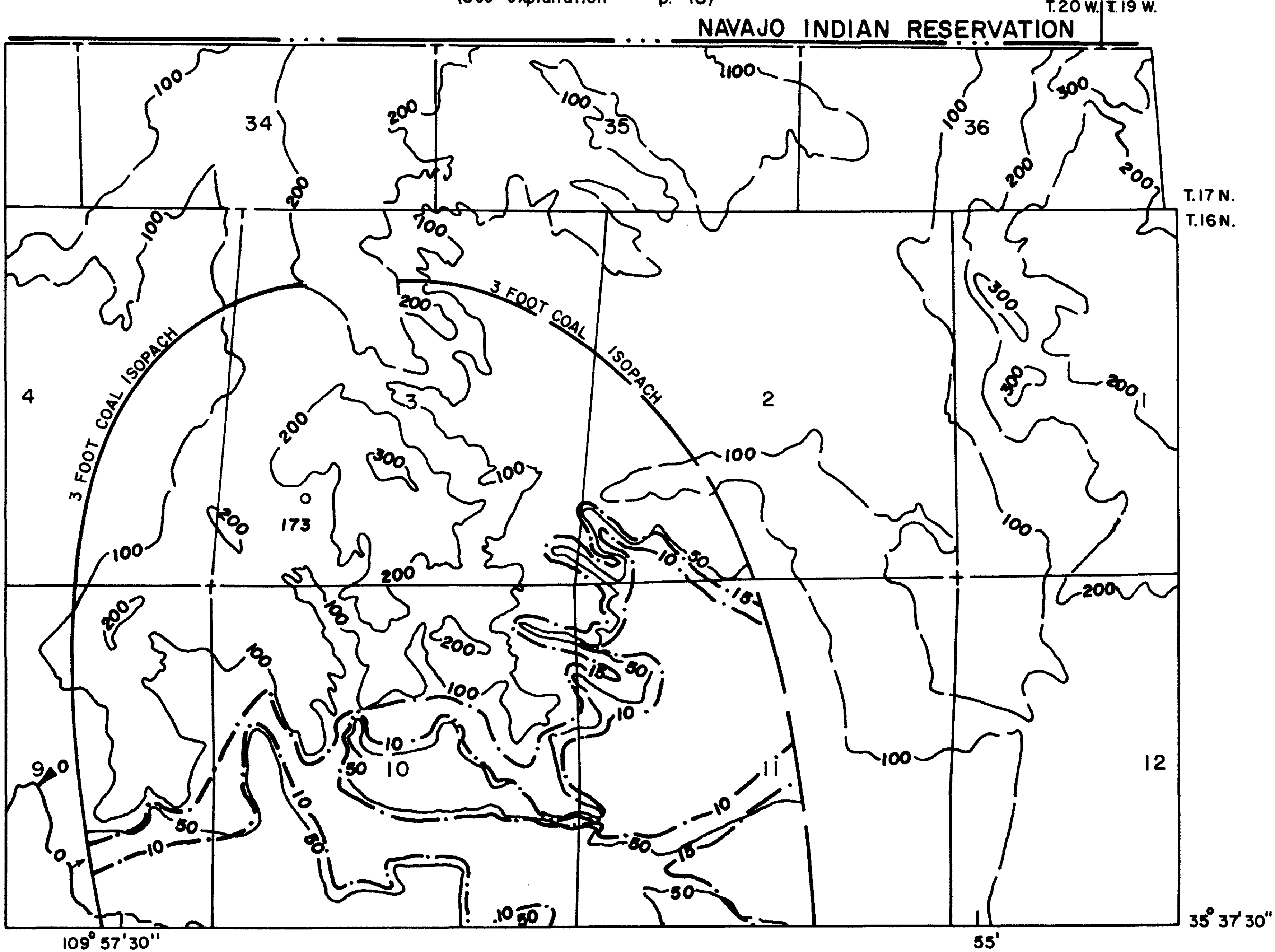


SCALE 1:24,000

Figure 5

ISOPACH MAP OF OVERBURDEN OF THE CREVASSE CANYON GIBSON NO. 8 COAL BED

(See explanation p. 18)



SCALE 1:24,000

Figure 3

EXPLANATION

——— 4 ———
——— 5 ———

ISOPACHS OF THE CREVASSE CANYON GIBSON NO. 8 COAL BED-Showing thickness in feet. Isopach interval 1 foot (0.3 meter). Isopachs dashed where inferred.

o 5

DRILL HOLE-Showing thickness of the Crevasse Canyon Gibson No. 8 coal bed in feet.

— CG 8 — 2.0

TRACE OF COAL BED OUTCROP-Showing coal thickness, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 4

EXPLANATION

——— 6900 ———
——— 7000 ———

STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Gibson No. 8 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level. Contours dashed where inferred.

o 6967

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Gibson No. 8 coal bed in feet.

— CG 8 — 7005

TRACE OF COAL BED OUTCROP-Showing altitude, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 5

EXPLANATION

——— 100 ———

OVERBURDEN ISOPACHS-Showing thickness of overburden, in feet, from the surface to the top of the Crevasse Canyon Gibson No. 8 coal bed (refer to CRO figure 4). Isopach interval 100 feet (30.5 meters) with supplemental 50 foot (15.2 meter) isopach. Isopachs dashed where inferred. Stripping limit is 200 feet (61 meters).

o 173

DRILL HOLE-Showing thickness of overburden, in feet, of the Crevasse Canyon Gibson No. 8 coal bed.

— 0 — 0 —

TRACE OF COAL BED OUTCROP-Showing no overburden at triangle. Arrow points toward the coal-bearing area.

—·—·— 15 —·—·—

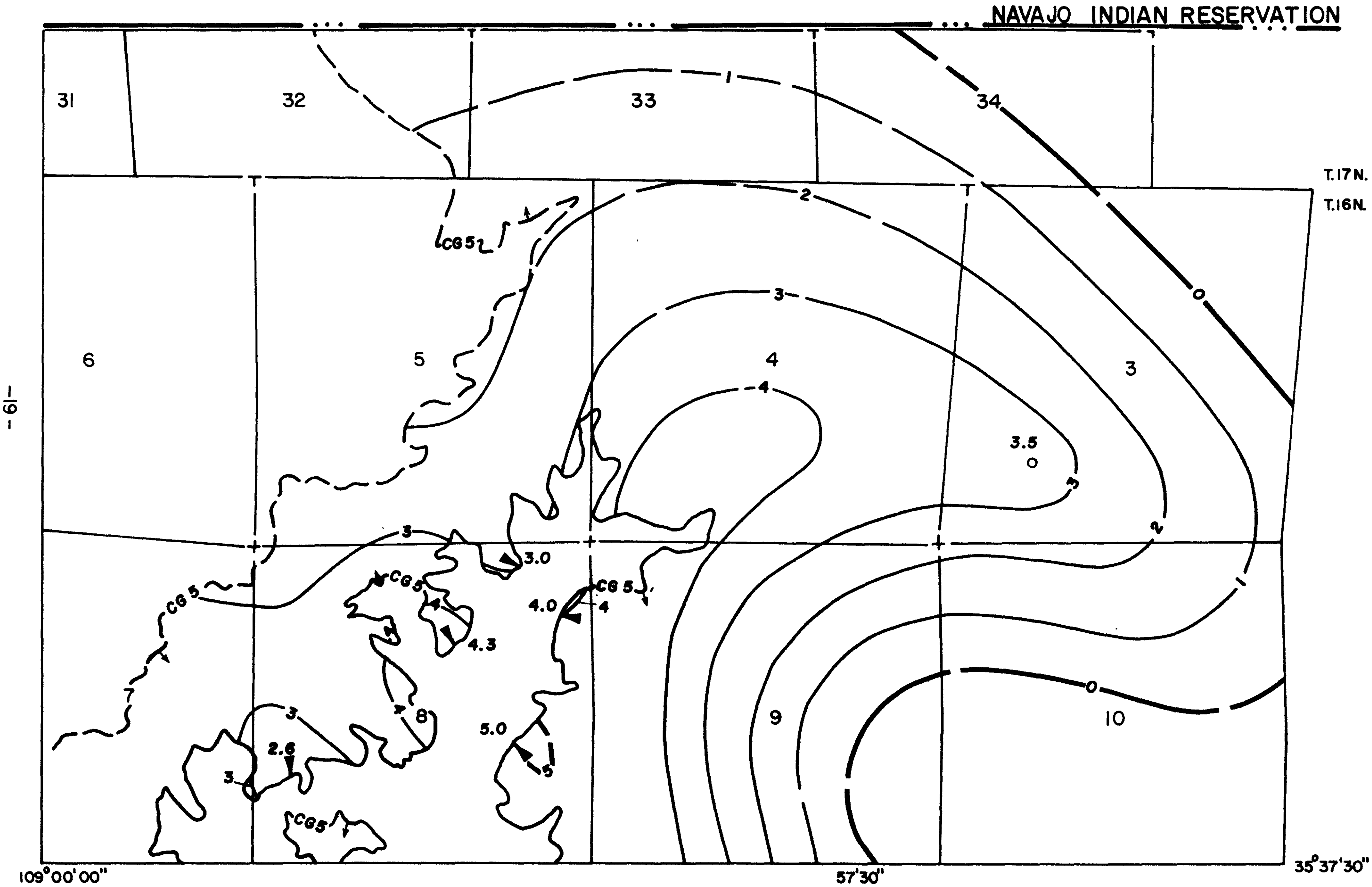
MINING RATIO CONTOUR FOR THE CREVASSE CANYON GIBSON NO. 8 COAL BED-Number indicates cubic yards of overburden per ton of recoverable coal by surface-mining methods. Contours shown only in areas suitable for surface mining within the stripping limit, less than 200 feet (61 meters) of overburden.

To convert feet to meters, multiply feet by 0.3048.

Figure 6

ISOPACH MAP OF THE CREVASSE CANYON GIBSON NO. 5 COAL BED

(See explanation p. 22)

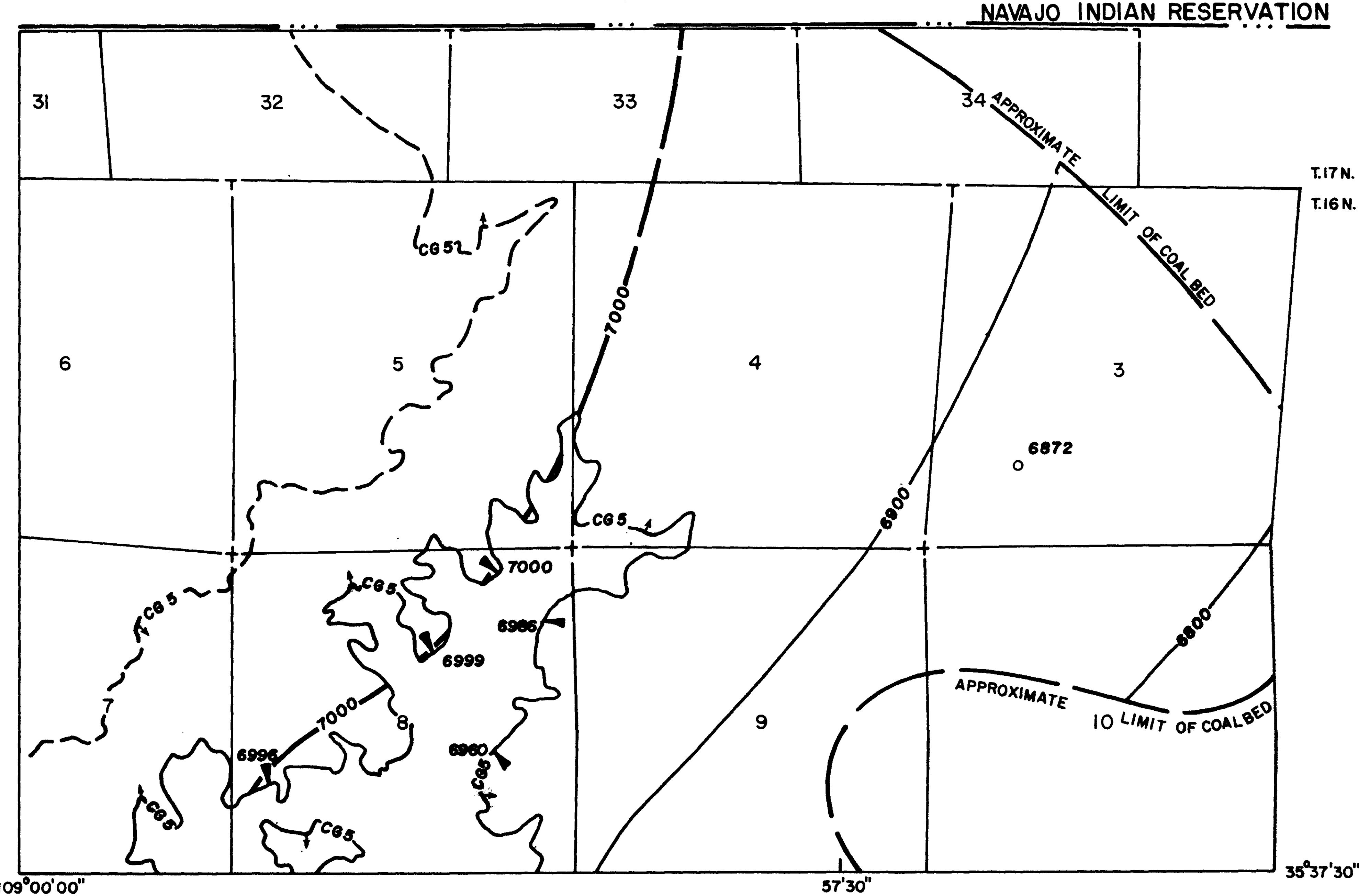


SCALE 1:24,000

Figure 7

STRUCTURE CONTOUR MAP OF THE CREVASSE CANYON GIBSON NO. 5 COAL BED

(See explanation p. 22)

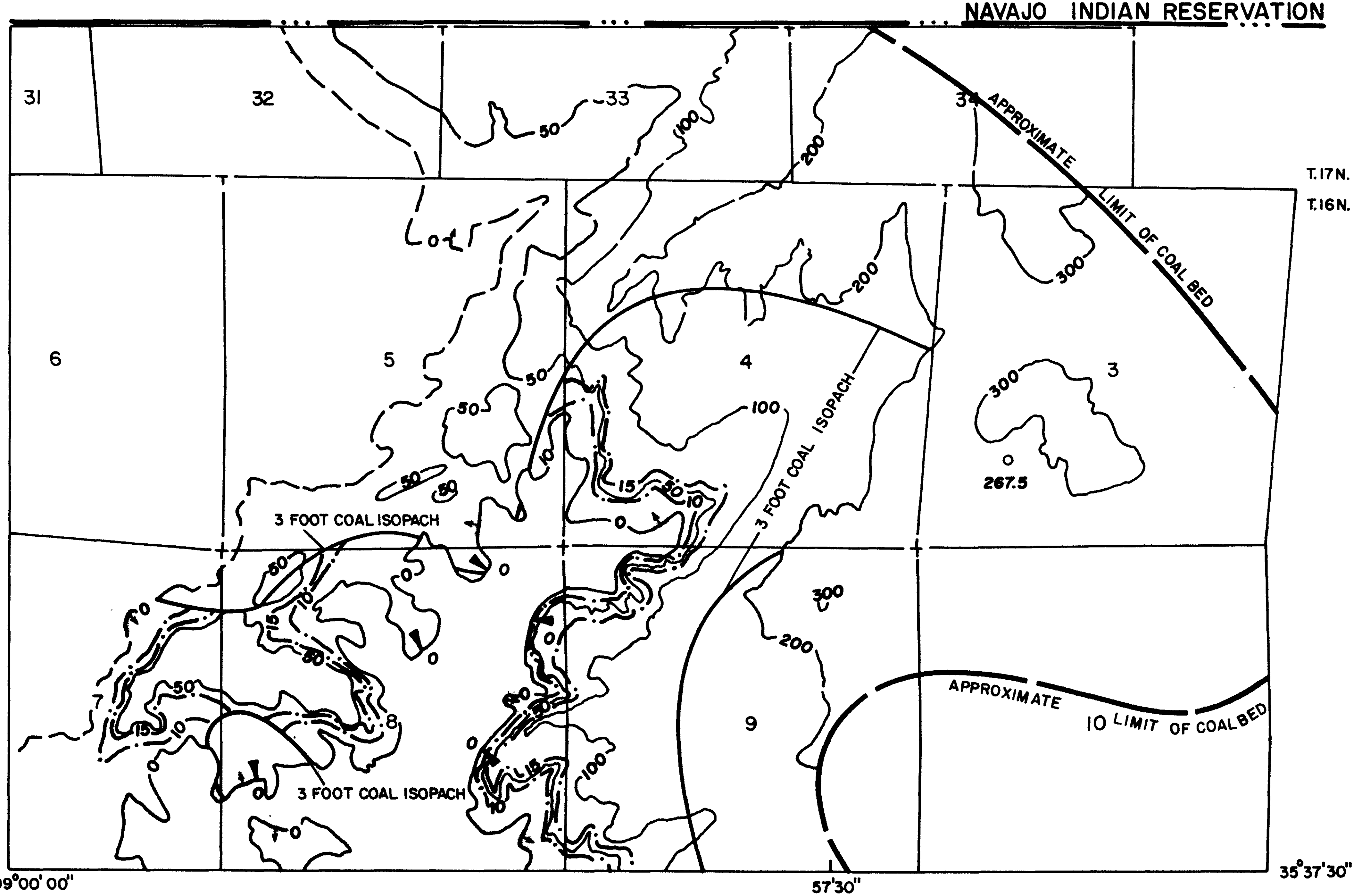


SCALE 1:24,000

Figure 8

ISOPACH MAP OF OVERBURDEN OF THE CREVASSE CANYON GIBSON NO. 5 COAL BED

(See explanation p. 22)



SCALE 1:24,000

Figure 6

EXPLANATION

4

5

ISOPACHS OF THE CREVASSE CANYON GIBSON NO. 5 COAL BED-Showing thickness in feet. Isopach interval 1 foot (0.3 meter). Isopachs dashed where inferred.

o 3.5

DRILL HOLE-Showing thickness of the Crevasse Canyon Gibson No. 5 coal bed in feet.

4.3 C6 5

TRACE OF COAL BED OUTCROP-Showing coal thickness, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 7

EXPLANATION

6900

7000

STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Gibson No. 5 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level. Contours dashed where inferred.

o 6872

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Gibson No. 5 coal bed in feet.

6999 C6 5

TRACE OF COAL BED OUTCROP-Showing altitude, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 8

EXPLANATION

100

OVERBURDEN ISOPACHS-Showing thickness of overburden, in feet, from the surface to the top of the Crevasse Canyon Gibson No. 5 coal bed (refer to CRO figure 7). Isopach interval 100 feet (30.5 meters) with supplemental 50 foot (15 meter) isopach. Isopachs dashed where inferred. Stripping limit is 200 feet (61 meters).

o 267.5

DRILL HOLE-Showing thickness of overburden, in feet, of the Crevasse Canyon Gibson No. 5 coal bed.

0 0

TRACE OF COAL BED OUTCROP-Showing no overburden at triangle. Arrow points toward the coal-bearing area.

15

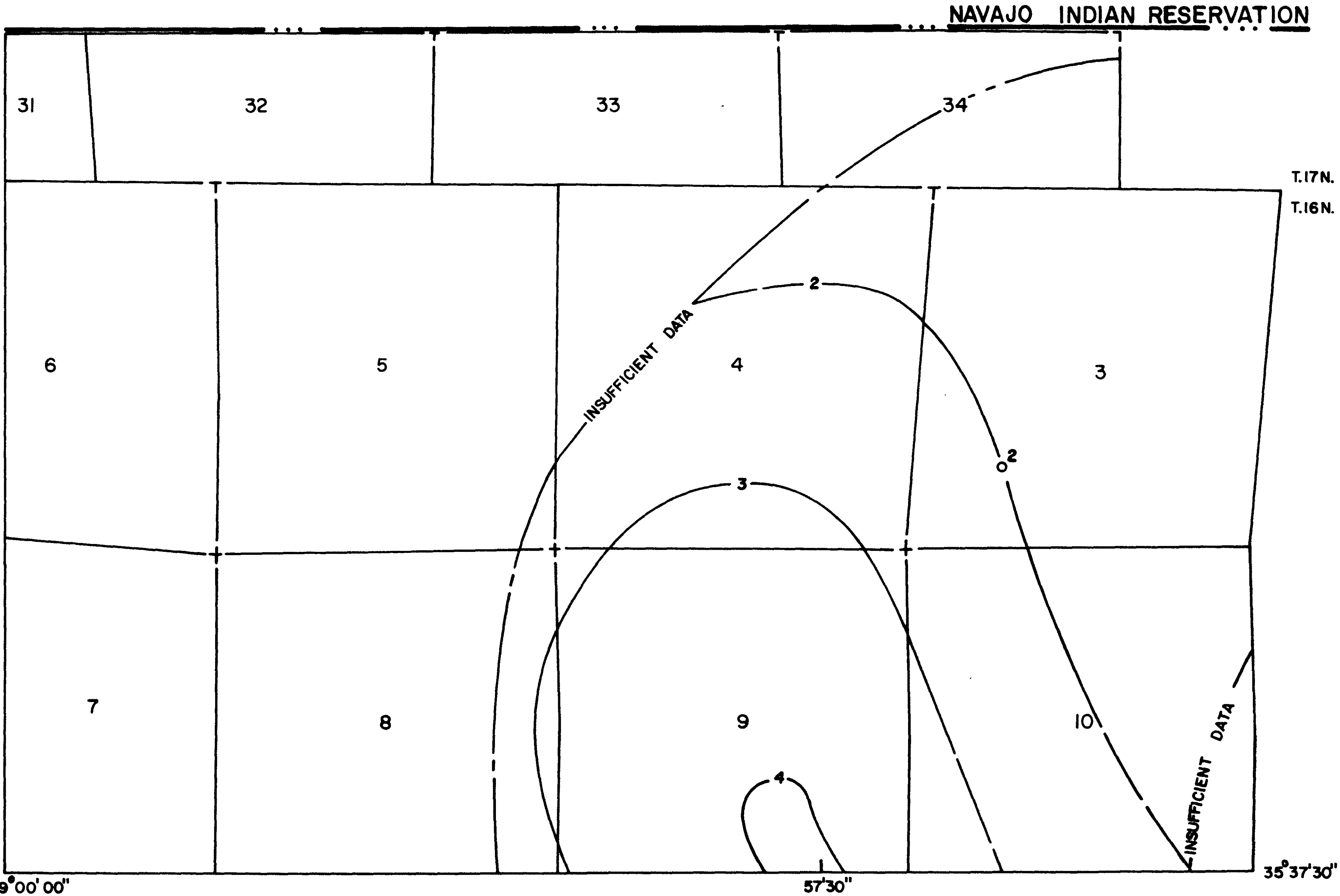
MINING RATIO CONTOUR FOR THE CREVASSE CANYON GIBSON NO. 5 COAL BED-Number indicates cubic yards of overburden per ton of recoverable coal by surface-mining methods. Contours shown only in areas suitable for surface mining within the stripping limit, less than 200 feet (61 meters) of overburden.

To convert feet to meters, multiply feet by 0.3048.

Figure 9

ISOPACH MAP OF THE CREVASSE CANYON DILCO NO. 8 COAL BED

(See explanation p. 26)

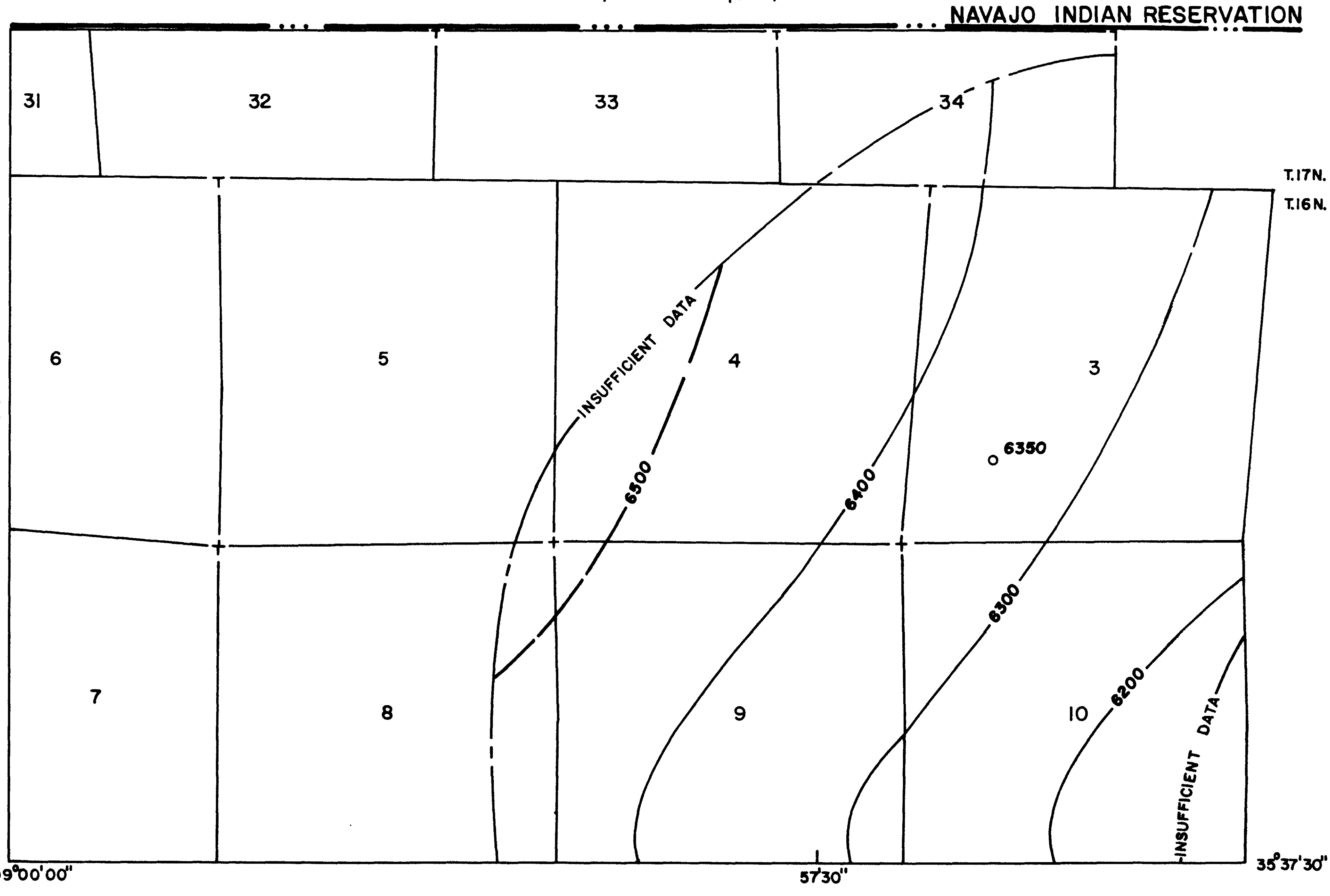


SCALE 1:24,000

Figure 10

STRUCTURE CONTOUR MAP OF THE CREVASSE CANYON DILCO NO. 8 COAL BED

(See explanation p. 26)

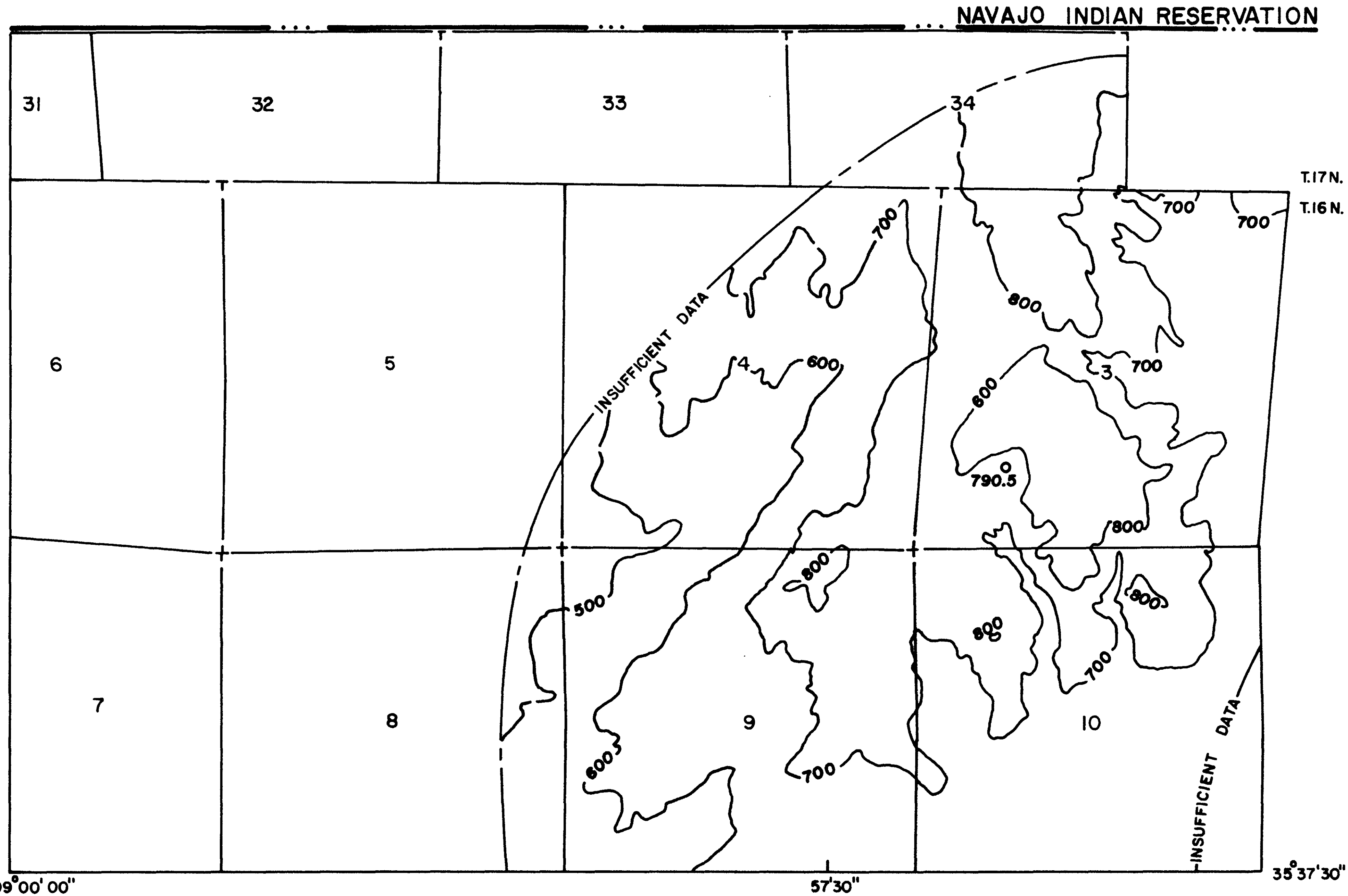


SCALE 1:24,000

Figure 11

ISOPACH MAP OF OVERBURDEN OF THE CREVASSE CANYON DILCO NO. 8 COAL BED

(See explanation p. 26)



SCALE 1:24,000

Figure 9

EXPLANATION

—— —— 3 ——

ISOPACHS OF THE CREVASSE CANYON DILCO NO. 8 COAL BED-Showing thickness in feet. Isopach interval 1 foot (0.3 meter). Isopachs dashed where inferred.

o 2

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Dilco No. 8 coal bed in feet.

To convert feet to meters, multiply feet by 0.3048.

Figure 10

EXPLANATION

—— ——6400 ——

—— ——6500——

STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Dilco No. 8 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level. Contours dashed where inferred.

o 6350

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Dilco No. 8 coal bed in feet.

To convert feet to meters, multiply feet by 0.3048.

Figure 11

EXPLANATION

—— ——800 ——

OVERBURDEN ISOPACHS-Showing thickness of overburden, in feet, from the surface to the top of the Crevasse Canyon Dilco No. 8 coal bed (refer to CRO figure 10). Isopach interval 100 feet (30.5 meters). Isopachs dashed where inferred.

o 790.5

DRILL HOLE-Showing thickness of overburden, in feet, of the Crevasse Canyon Dilco No. 8 coal bed.

To convert feet to meters, multiply feet by 0.3048.

the isopach, structure contour, and overburden isopach maps are included in this text as page-sized maps (figs. 9, 10, and 11). Based on Crevasse Canyon Dilco No. 8 coal data from the southern adjacent Samson Lake quadrangle, the bed was inferred to thicken to 4.0 ft (1.2 m) in the Tse Bonita School quadrangle (see fig. 9).

COAL RESOURCES

No resource evaluations were made for the Crevasse Canyon Dilco No. 8 coal bed or Crevasse Canyon Gibson No. 5 or No. 8 coal beds because the beds' thicknesses were less than 3.0 ft (0.9 m) on Federal coal lands where data were sufficient to justify mapping the beds in the Tse Bonita School quadrangle. Coal beds with 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B.

COAL DEVELOPMENT POTENTIAL

The factors used to determine the development potential are the presence of a potentially coal-bearing formation, and the thickness and overburden of correlative coal beds. The U. S. Geological Survey supplied the criteria to evaluate the coal development potential for Federal lands in this quadrangle. These criteria are based on current industry practice, U. S. Geological Survey Bulletin 1450-B, and anticipated technological advances. All available data were utilized for the surface and subsurface coal development potential evaluations.

Any area underlain by a potentially coal-bearing formation with

200 ft (61 m) or less of overburden has potential for surface mining. The U. S. Geological Survey designated the 200 ft (61 m) maximum depth as the stripping limit. Areas where a potentially coal-bearing formation is overlain by more than 200 ft (61 m) of overburden have no potential for surface mining. Areas with no correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) in thickness and overlain by 200 ft (61 m) or less of overburden have unknown surface mining potential.

Any area underlain by a potentially coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining. Areas where a potentially coal-bearing formation is overlain by more than 3,000 ft (914 m) of overburden have no subsurface mining potential. Development potential for subsurface mining methods is unknown where a potentially coal-bearing formation within 200 to 3,000 ft (61 to 914 m) of the surface contains no identified correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) thick.

The coal development potential of this quadrangle is subject to revision. As further coal information becomes available, it is possible that correlative coal beds with sufficient thicknesses may be identified. These coal data will likely define areas of Federal coal lands with development potentials other than unknown.

Development potential for surface mining methods

Based on coal development potential criteria, all Federal coal lands in the Tse Bonita School quadrangle where data are sufficient to determine potentials have unknown development potential for surface mining methods.

Development potential for subsurface mining methods and in situ gasification

Based on coal development potential criteria, all Federal coal lands in the Tse Bonita School quadrangle where data are sufficient to determine development potentials have unknown development potential for subsurface mining methods.

In situ gasification of coal has not been done on a commerical scale in the United States and criteria for rating the development potential of this method are unknown.

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GLOSSARY

coal bed--A stratified sequence of coal, composed of relatively homogeneous material, exhibiting some degree of lithologic unity and separated from the rocks above and below by physically rather well defined boundary planes.

coal bed separation line--A line on a map plate separating areas where different coal beds or zones are mapped.

coal bench--One of two or more divisions of a coal bed separated by rock.

coal conversion factor--A factor used to convert acre-feet of coal into short tons of coal; bituminous coal is 1800 tons/acre-ft; subbituminous coal is 1770 tons/acre-ft.

coal development potential--A subjective determination of the comparative potential of Federal coal lands for development of a commercially viable coal mining operation.

coal exploration license--An area of Federal coal lands in which the licensee is granted the right, after outlining the area and the probable methods of exploration, to investigate the coal resources. An exploration license has a term not to exceed 2 years and does not confer rights to a lease.

coal lease--An area of Federal coal lands in which the Federal Government has entered into a contractual agreement for development of the coal deposits.

coal split--A coal bed resulting from the occurrence of a noncoal parting within the parent coal bed which divides the single coal bed into two or more coal beds.

coal zone--A distinctive stratigraphic interval containing a sequence of alternating coal and noncoal layers in which the coal beds may so lack lateral persistence that correlating individual beds in the zone is not feasible.

Federal coal land--Land for which the Federal Government holds title to the coal mineral rights, without regard to surface ownership.

hypothetical resources--Undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, hypothetical resources are in broad areas of coal fields where points of observation are absent and evidence is from distant outcrops, drill holes or wells. Exploration that confirms their presence and reveals quantity and quality will permit their reclassification as a Reserve or Identified Subeconomic Resource.

identified resources--Specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

indicated--Coal for which estimates for the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

inferred--Coal in unexplored extensions of demonstrated resources for which estimates of the quality and quantity are based on geologic evidence and projections.

isopach--A line joining points of equal bed thickness.

Known Recoverable Coal Resource Area (KRCRA)--Formerly called Known Coal Leasing Area (KCLA). Area in which the Federal coal land is classified (1) as subject to the coal leasing provisions of the Mineral Leasing Act of 1920, as amended, and (2) by virtue of the available data being sufficient to permit evaluation as to extent, location, and potential for developing commercial quantities of coal.

measured--Coal for which estimates for rank, quality, and quantity can be computed, within a margin of error of less than 20 percent, from sample analyses and measurements from closely spaced and geologically well known sample sites.

mining ratio--A numerical ratio equating the in-place volumes, in cubic yards, of rocks that must be removed in order to recover 1 short ton of coal by surface mining.

overburden--A stratigraphic interval (composed of noncoal beds and coal beds) lying between the ground surface and the top of a coal bed. For coal zones, overburden is the stratigraphic interval lying between the ground surface and the structural datum used to map the zone.

parting--A noncoal layer occurring along a bedding plane within a coal bed.

Preference Right Lease Application (PRLA)--An area of Federal coal lands for which an application for a noncompetitive coal lease has been made as a result of exploration done under a coal prospecting permit. PRLA's are no longer obtainable.

quality or grade--Refers to measurements such as heat value; fixed carbon; moisture; ash; sulfur; phosphorus; major, minor, and trace elements; coking properties; petrologic properties; and particular organic constituents.

rank--The classification of coal relative to other coals, according to degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (Classification of coals by rank, 1973, American Society for Testing and Materials, ASTM Designation D-388-66).

recovery factor--The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the Reserve Base in the ground.

reserve--That part of identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base.

reserve base--That part of identified coal resource from which Reserves are calculated.

stripping limit--A vertical depth, in feet, measured from the surface, reflecting the probable maximum, practical depth to which surface mining may be technologically feasible in the forseeable future. The rock interval, expressed in feet, above the stripping limit is the "strippable interval."

structure contour--A line joining points of equal elevation on a stratum or bed.