GEOLOGY AND COAL RESOURCES OF THREE QUADRANGLES IN THE CENTRAL DATIL MOUNTAINS COAL FIELD, SOCORRO COUNTY, NEW MEXICO

by
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ABSTRACT

The Central Datil Mountains coal field is located in the Datil Mogollon Physiographic Subprovince on the southeastern edge of the Colorado Plateau. The study area is made up of three 7 1/2′ quadrangles: Pueblo Viejo Mesa, Table Mountain, and Indian Spring Canyon. Sedimentary and igneous rocks of Mesozoic and Cenozoic Age are present on the surface of the study area. The area is underlain by gently dipping, Cretaceous rocks that are structurally complicated by broad scale folds and small displacement faults, and have been intruded by igneous rocks. The youngest Mesozoic rocks, the Crevasse Canyon Formation of Cretaceous Age, consists of a marginal marine to continental sequence that is sporadically coal-bearing in the basal 600 feet above the contact with the Gallup Sandstone. The coals are lenticular and discontinuous, and were likely deposited in coastal backswamps with strong fluvial influence. The top of the Crevasse Canyon Formation is buried throughout the study area under a Tertiary gravel that is known to reach thicknesses of 200 feet in the study area. Structural cross-sections of the area suggest that the Crevasse Canyon Formation could be considerably thicker than what is seen in outcrop, hence, there is a possibility that deeper and more closely-spaced drilling could greatly increase coal resources in the area.

Fifteen core samples collected from coal exploratory drill holes in the area indicate that the coals have a mean rank of high-volatile B bituminous. Coal quality tests on these same core samples yielded average values of 13.4% ash, 0.6% sulfur, and heating values of 11,727 BTU/ lb. on an as-recieved basis.

Coal resources for the study area were calculated using depth,thickness, and reliability categories. Only measured and indicated resources were calculated because of the discontinuous nature of the coal beds and the structural complexities of the area. Demonstrated resources for the area amount to 78.3 million tons. About 70% of all resources are within 150 feet of the surface, but only 25% of all resources could be mined with a stripping ratio of less than 10:1.

INTRODUCTION

Purpose and scope

The purpose of this investigation was to collect, evaluate, and characterize data on the Mesaverde Group coal beds occurring in the Pueblo Viejo Mesa, Table Mountain, and Indian Spring Canyon quadrangles in the the Central Datil Mountains in Socorro and Cibola Counties, New Mexico. This was a jointly funded project between the New Mexico Bureau of Mines and Mineral Resources and the Minerals Management Service of the U. S. Department of the Interior. This report consists of three 1:24,000 scale geological quadrangle maps with coal outcrop and drillhole locations plotted (Plates 1-3), geologic cross-sections (Plate 4), a stucture contour map drawn on the top of the Gallup Sandstone (Plate 5), summary drillhole sheets for all known oil and gas and uranium tests in the study area and drillholes drilled as part of this project (Appendix 1), coal quality summaries (Appendix 2), and an accompanying geologic report emphasizing stratigraphy and coal resource potential for the area.

This project began in the spring of 1980 with field mapping and aerial photo interpretation by S. M. Cather and J. C. Osburn of Table Mountain and Pueblo Viejo Mesa qudrangles, respectively. Coal outcrop data from Winchester

(1921) was rechecked and revised as necessary. Indian Spring Canyon quadrangle was compiled in 1981-82 from three thesis maps (Jackson, 1979, Mayerson, 1979, and Cather, 1980), one published map (Tonking, 1957), and one Open-file map (G. R. Osburn, 1978) by G. R. Osburn and J. C. Osburn. Structural analyses, aerial photo interpretation and informal cross-sections revealed many inconsistencies and problems with portions of two of the thesis maps. These problems have been corrected and the original maps remain available on Bureau open-file for comparison.

Seventeen drillhole locations were chosen, based on the geologic mapping of the Crevasse Canyon Formation in these quadrangles, to test the coal potential of all parts of the Crevasse Canyon Formation. Three additional drillhole locations were chosen to test the coal potential on the Puertecito quadrangle, within the boundaries of the Alamo Band Navajo Reservation, directly to the north and east of the study area. These drillholes were proposed to and accepted by the U. S. Geological Survey as part of a companion project to study the coal potential of the Alamo Band Navajo Reservation (Osburn, 1982). These three drillholes are located a maximum of 1.5 miles from the proper boundaries of the study area.

Location and Accessibility

The study area is located about 20 miles north of Magdalena, New Mexico in northwestern Socorro and southeastern Cibola counties. It can be reached by NM state highway 52 from the south and the unpaved Acoma-Sky City road from the north. The only paved road in the study area is located on the Alamo Band Navajo Reservation which encompasses portions of Indian Spring Canyon and Table Mountain quadrangles. Fair-weather dirt roads and tracks are present throughout the area.

Land Ownership

Ownership map (figure 1-6) were compiled using county, U. S. Bueau of Land Management, U. S. Forest Service, and Indian records. The county records are the most complete for state land and privately-owned land, and are kept current by annual tax billings. County records are commonly incomplete for reservation and Federal land tracts. Land under various Federal ownership classifications can usually be sorted out using a variety of Bureau of Land Management and U. S. Forest Service records. In some cases, there was no agreement among the various sources. Most of these were resolved using the most reliable source for the tract in question. If there was no evidence to help resolve a conflict in ownership, the tract is listed in Table 1.

The surface ownership in the study is complex, especially in the portion of the area that lies on the Alamo Indian Reservation. The surface ownership within the study area is divided among private parties (63%), three different categories of Indian ownership (26%), Federal ownership (9%), and state ownership (2%). There are three major ranches in the study area: the Red Lake Ranch, the Burns-Lindsey Ranch, and the Henderson Ranch. These ranches account for 95% of privately-owned land in the area. The remaining private lands are small investment properties scattered throughout the area. Federal surface ownership includes both public domain lands and national forest lands. The majority of the Indian-controlled land belongs to the Alamo Band Navajo Indians. Lesser amounts belong to individual members of the Band and the entire Navajo Tribe. Details of Indian ownership in the area can be found in Osburn (1982).

Surface Ownership of Indian Spring Canyon Quadrangle

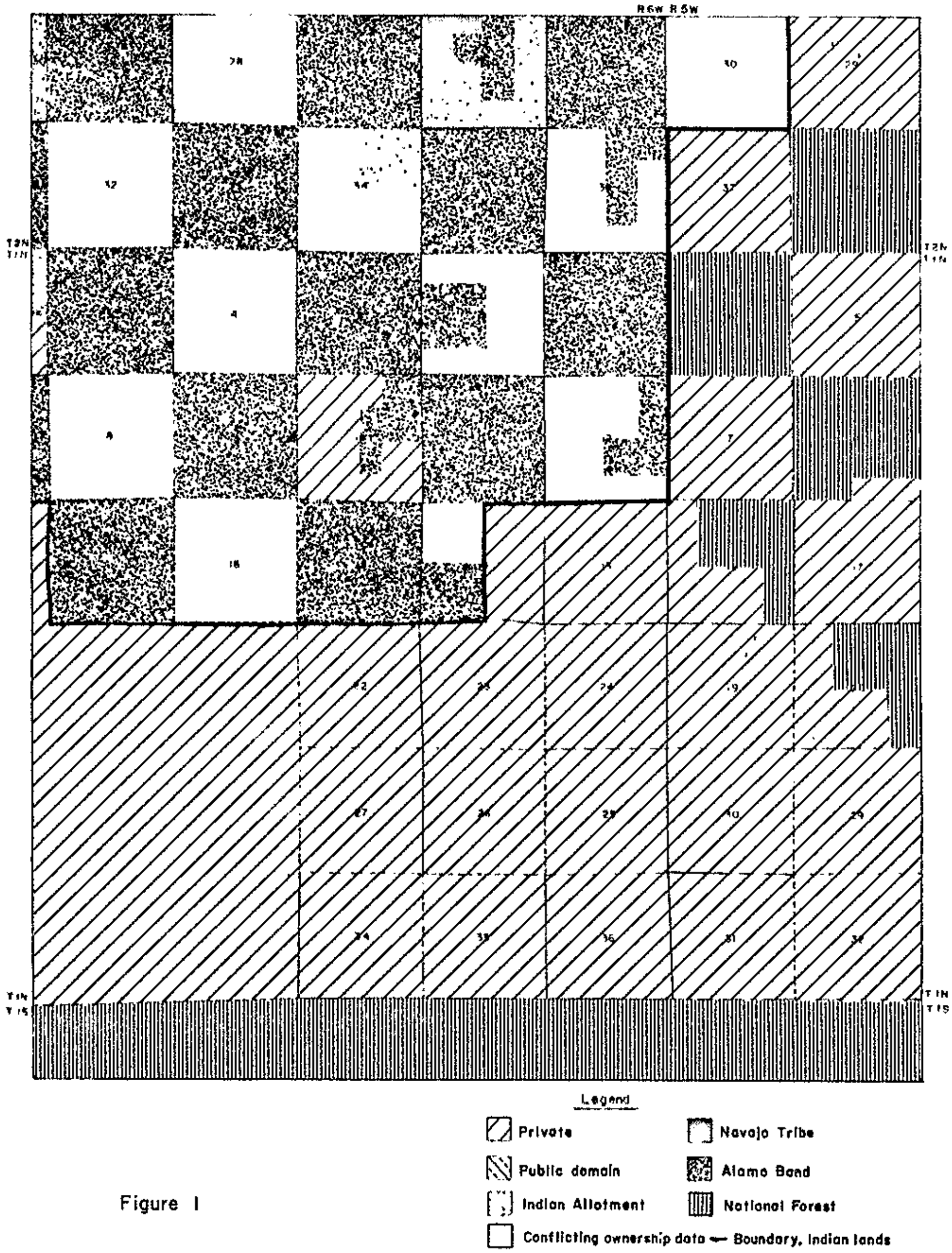


Figure I

Surface Ownership — Pueblo Viejo Mesa

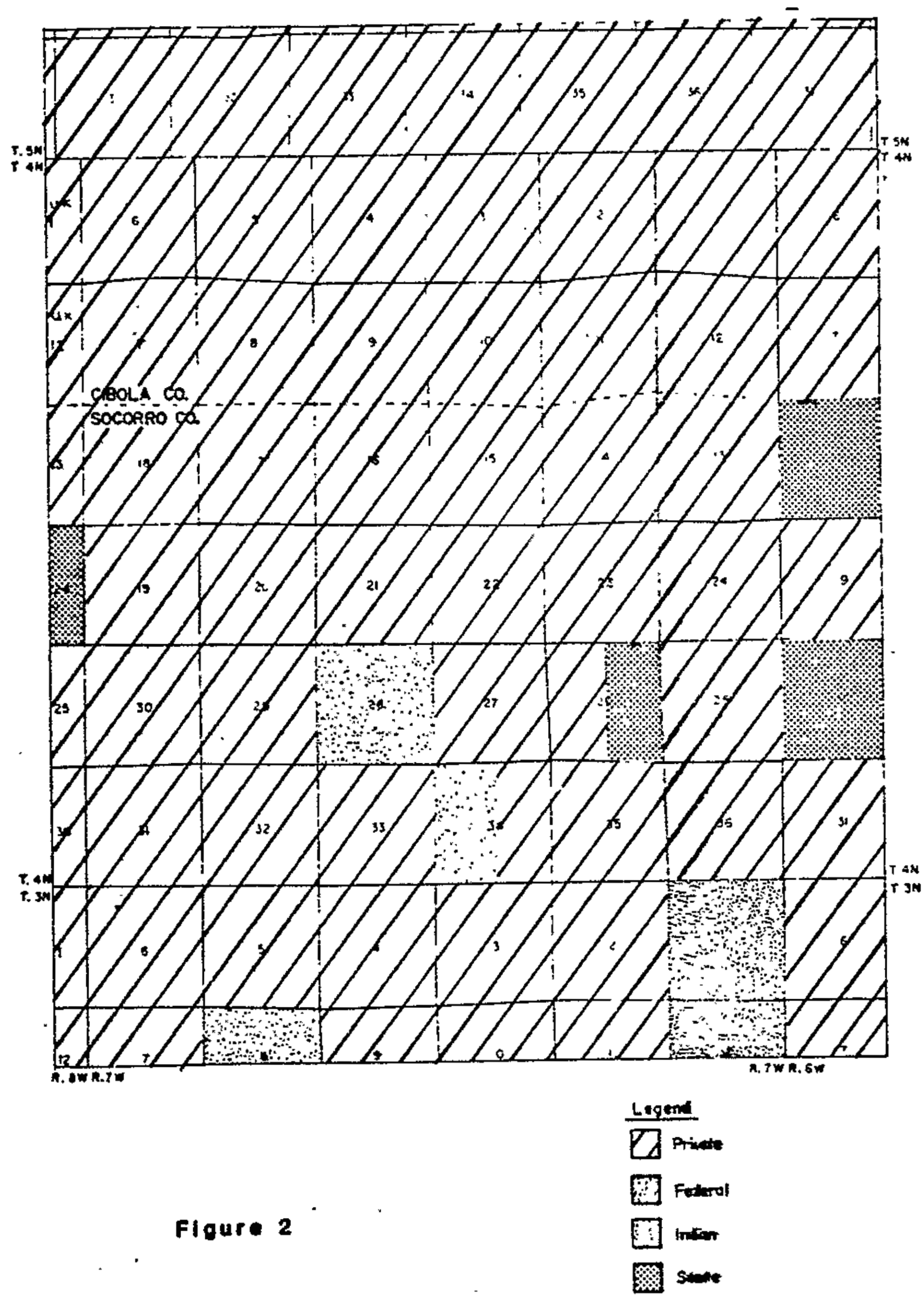


Figure 2

Surface Ownership of Table Mountain Quadrangle

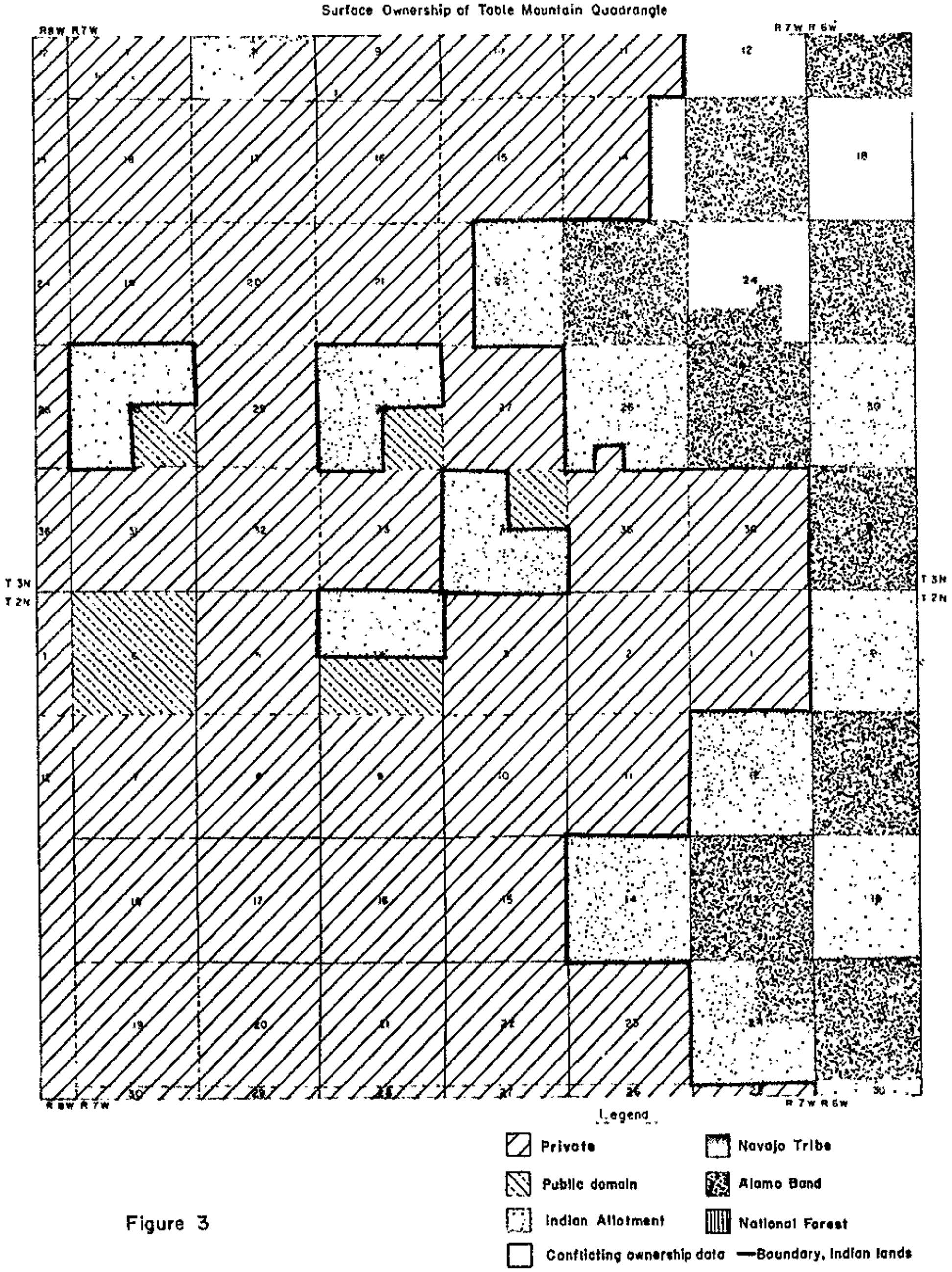


Figure 3

Mineral Ownership of Indian Spring Canyon Quadrangle

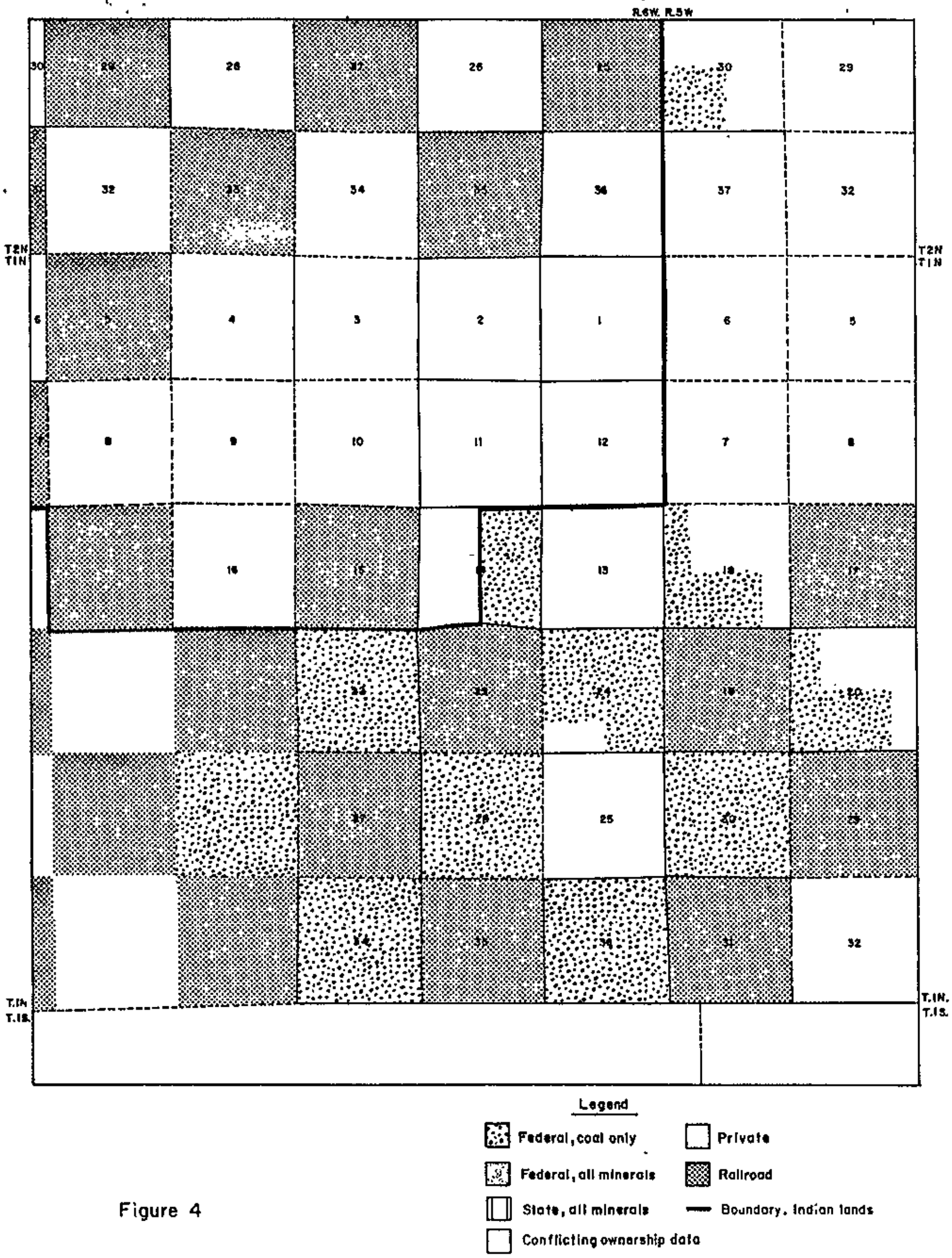
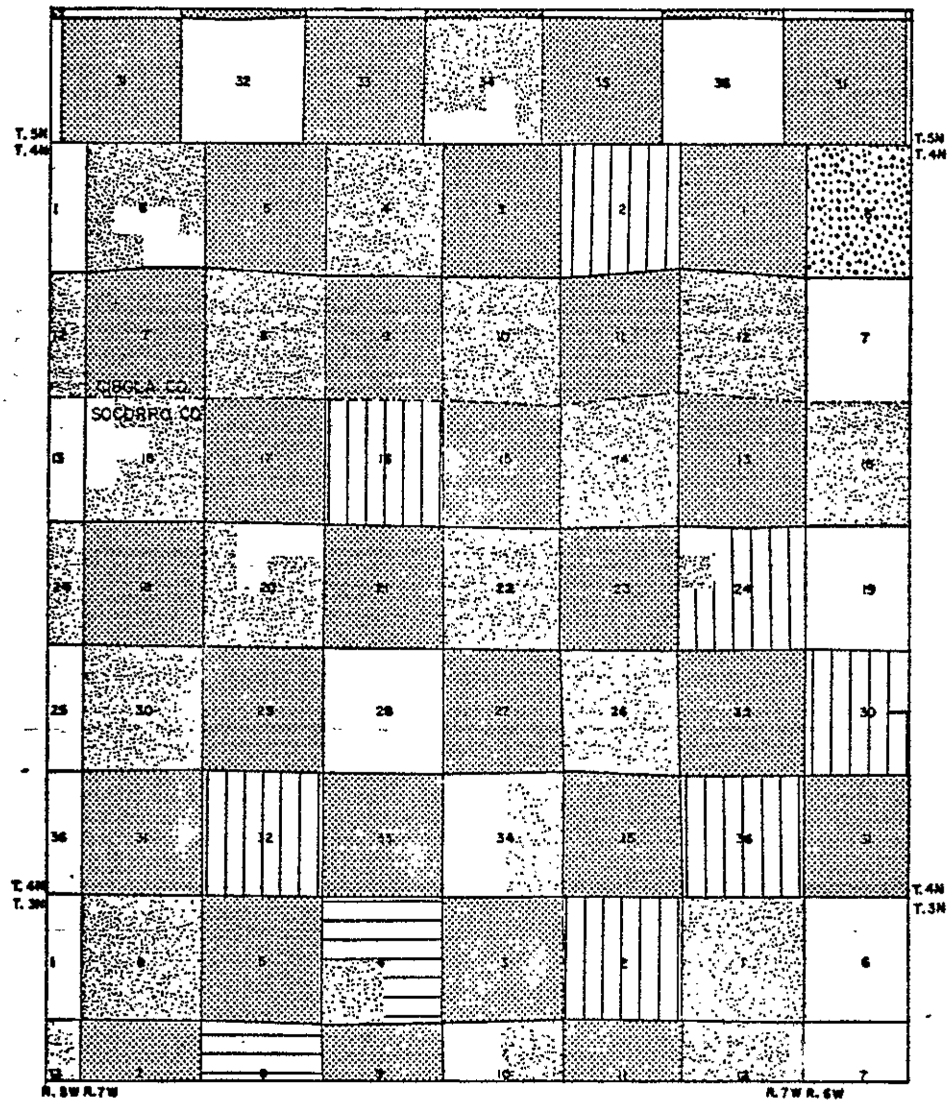


Figure 4

Mineral Ownership — Pueblo Viejo Mesa



Legend

Private

State

Federal, all minerals

Indian

Federal, coal only

Railroad

Figure 5

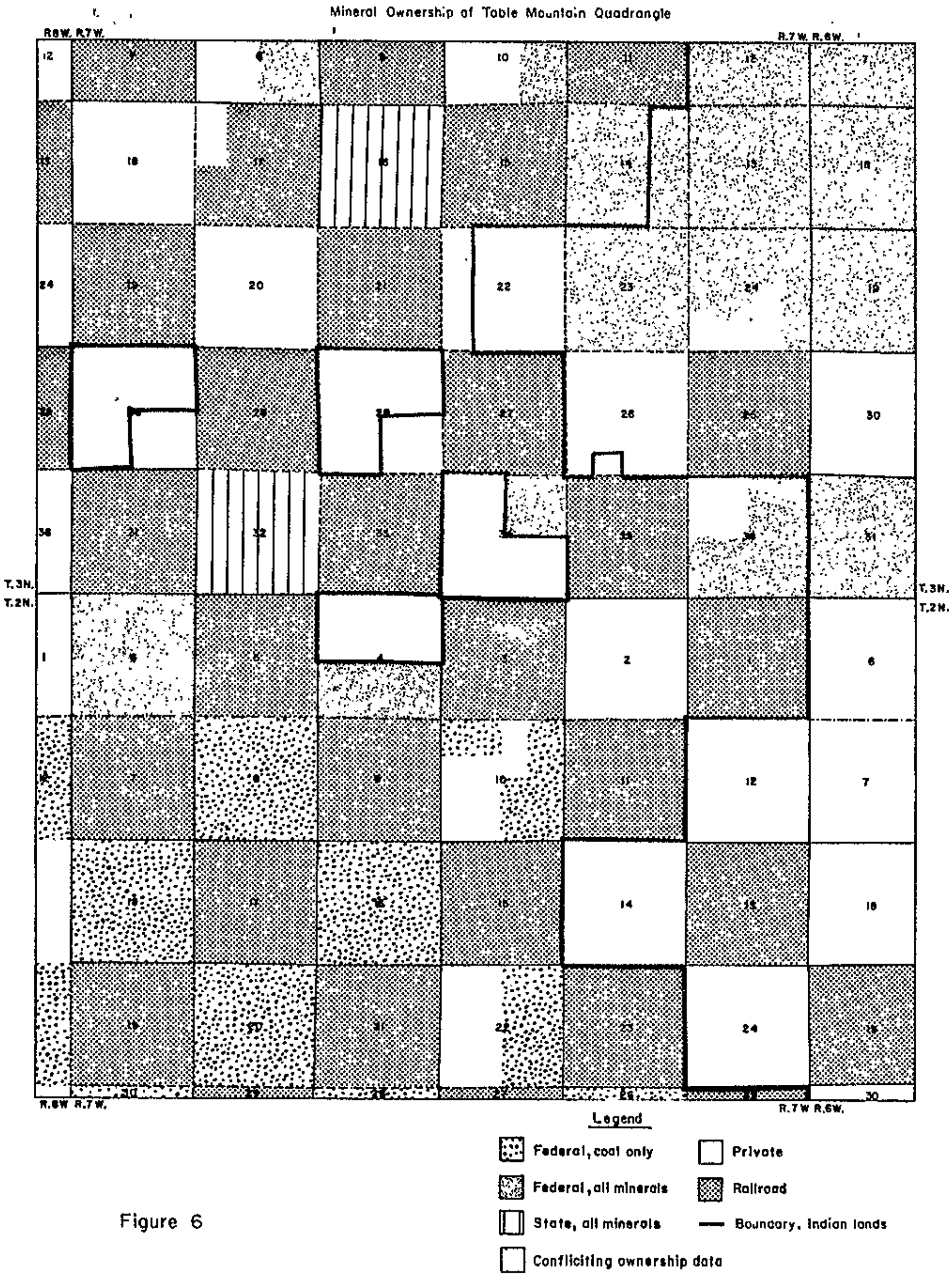

Mineral Ownership of Table Mountain Quadrangle
R.8W. R.7W.
R.7W. R.6W.
T.3N.
T.2N.
Legend
Federal, coal only
Federal, all minerals
State, all minerals
Conflicting ownership data
Private
Railroad
Boundary, Indian lands

Figure 6

TABLE 1

Conflicting surface ownership data on the Alamo Band Navajo Reservation

Location	County Records 1981 tax records, deeds	BLM Records MTP's, color quads	Indian Records 1979 Bovay Eng. Map	U.S. Forest Service Oral com. J. Logan, 1981
	Sources of surface ownership information			
T. 1 N., R. 6 W.				
Sec. 2, E½, N½NW¼ and S½SW¼;	Alamo Band Navajo Land	Indian land	Navajo land	Private land
Secs. 4 and 8;	"	"	"	"
Sec. 10, W½, S½SE¼, NE¼SE¼, and W½NW¼NE¼;	"	"	"	"
Sec. 12, W½, W½NE¼, and S½SE¼;	"	"	"	"
Sec. 16;	"	"	"	"
Sec. 18, NW¼;	"	"	"	"
Sec. 14, NW¼.	National Forest	Indian land	Indian Allotment	Private land
T. 2 N., R. 5 W.				
Sec. 30.	Private land	Indian land	Indian Allotment	Private land
T. 2 N., R. 6 W.				
Sec. 14, NW¼;	Navajo lands	Indian land	Indian Allotment	Private land
Sec. 28, NE¼	"	"	"	"
Sec. 32;	"	"	"	"
Sec. 34, W½, SE¼;	"	"	"	"
Sec. 28, W½, SE¼;	"	"	"	Indian land
Sec. 36, W½, S½SE¼, NE¼SE¼, SE¼NE¼.	"	"	Navajo land	Private land
T. 3 N., R. 6 W.				
Sec. 14;	Santa Fe Railroad	Indian lands	Navajo lands	--
Sec. 22;	"	"	"	--
Sec. 26.	"	"	"	--
T. 3 N., R. 6 W.				
Sec. 36, E½, SW¼	Private land	Indian land	Navajo Tribe	
Sec. 36, NW¼.	"	"	Indian Allotment	

Physiography

The study area lies in the Datil-Mogollon Subprovince, a transitional zone between the Basin and Range Province and the Colorado Plateau Province (Hawley and Love, 1981). The landscape on Pueblo Viejo Mesa and Table Mountain quadrangles is dominated by basalt-capped mesas and broad alluvial valleys. The Upper Cretaceous rocks crop out as small sandstone-capped hills in the flat areas, are exposed on the slopes of basalt-capped mesas, and are commonly buried by talus or piedmont deposits throughout the study area. A broad, southward-plunging anticline in Pueblo Viejo Mesa quadrangle exposes the entire Upper Cretaceous section and forms a focal point in the area. The landscape on Indian Spring Canyon quadrangle is dominated by volcanoclastic piedmont slopes. North-south trending faults on Indian Spring Canyon quadrangle break the Cretaceous rocks into a series of gently-dipping sandstone-capped hogbacks.

Local relief in the study area is about 1995 feet. The low point in the area is about 6075 feet in the channel of the Rio Salado. The highest point in the study area is 8069 feet in the extreme southwestern portion of Indian Spring Canyon quadrangle.

Previous Work

Published reports including the area date back to 1900 when Herrick published a reconnaissance map and report with measured sections of western Socorro and (then) Valencia counties. The oil and gas potential of the area was examined in reports by Wells (1919) and Winchester (1921). Winchester extensively examined the coal-bearing Cretaceous rocks in the upper Rio Salado drainage basin, and measured numerous sections in the Datil Mountains during 1913 and 1914. Most of these sections sections measured by Winchester contained coal beds, and these unpublished measured sections provide the most comprehensive outcrop coal data available in the Datil Mountains coal field even today.

In 1957, Tonking mapped the Puertecito 15´ quadrangle which includes the entire Indian Spring Canyon quadrangle. He was the first to extend the Crevasse Canyon nomenclature into the area to describe the coal-bearing sequence. Field relationships defined by Tonking stand today and later work has been necessary only to redefine Tonking's La Cruz Peak Formation (since abandoned unit comprised of intertonguing rocks of the Dakota Sandstone and Mancos Shale) into units that are easily correlative over large distances, and to make similar refinements in the Tertiary volcanic section.

Givens (1957) redefined the La Cruz Peak Formation on the Dog Springs 15′ quadrangle including the Table Mountain 7.5′ quadrangle, but his map is best used for historical perspective.

Landis and others (1973) extended the Twowells Tongue of the Dakota Sandstone into the area. In the late 1970′s, Mayerson (1979) and Jackson (1979) under the direction of C. E. Chapin remapped portions of Indian Spring Canyon quadrangle using some of the refinements and revisions in stratigraphic nomenclature of Cobban and Hook (1978, 1979; Hook and Cobban, 1979). During the same time period, Hook and Massingill updated but never published the geology of the northwestern quarter of Tonking′s map to include the Mancos Shale and Tres Hermanos Formation nomenclature. G. R. Osburn (1978) mapped the Popotosa Formation on the southeast quarter of Indian Spring Canyon quadrangle. Chapin and others (1979) presented a summary of the mineral potential of both the Alamo Band Navajo Reservation and the Riley area to the east; an area which includes the majority of Indian Spring Canyon quadrangle. Briggs and Maxwell (1980) provided a mineral potential summary of the Alamo Indian Lands to the Bureau of Indian Affairs.

Acknowledgments

I would like to thank the ranchers in the area for allowing us to map and drill on their land, and for their hospitality. These people include: Len Cox and Sue Hill of the Red Lake Ranch, Roy Rogers of the Burns-Lindsey Ranch, and M. S. Major of the Field Ranch. Without the cooperation of these people, we could not have worked in the area. Both Robert Gray and Dale Trubey of Santa Fe Mining, Inc. helped with determine both surface and mineral ownership in the area and gave us permission to drill on company property. Jessie Apachito, President of the Alamo Band Navajo and George Austin of the New Mexico Bureau of Mines and Mineral Resources worked together to allow us access to the Reservation for mapping and drilling.

Stephen Hook provided helpful advice and suggestions on the stratigraphic problems in the area and reviewed an early version of this report as did Edwin Landis of the U. S. Geological Survey. G. Robert Osburn aided in the map compilation, especially on the Indian Spring Canyon quadrangle and also offered many suggestions on the volcanics and the regional structural framework. Steven Cather allowed me to include his unpublished map of Table Mountain quadrangle and offered suggests which were incorporated into the map legend for the three quadrangles.

Finally, Frank Kottlowski, Frank Campbell, and Gretchen Roybal provided willing 'sounding boards' each time a new problem or theory came up.

This project has been partially funded by a contract from the Minerals Management Service, U. S. Department of the Interior; contract number 14-08-0001-18722. Rick Fulton, formerly of this Service, offered many helpful suggestions on logistics and interpretations of the contract. Ralph Wilcox of the Minerals Management Service critically reviewed a final draft of this report. Some of the drilling costs on the Alamo Band Navajo Reservation were provided by a companion contract from the Geologic Division of the U. S. Geological Survey, control number 9420-0067.

STRUCTURE

Structural complications including folding and faulting affect all but the youngest rocks in the area. Most of the major faults in the study area are associated with the opening of the Rio Grande Rift. In addition, there are a few potentially historic block faults.

Several scales of generally open folds affect both Cretaceous sedimentary and Tertiary volcanic rocks. The folds affecting the Cretaceous rocks have been thought of as being related exclusively to Laramide compressional tectonics in central New Mexico (Robinson, 1980; Mayerson, 1979). However, some of these folds warp both Cretaceous rocks and Tertiary rocks and obviously formed after Laramide Time. The folds that affect the Cretaceous rocks can therefore be either Laramide or much younger in age. Broad-scale anticlines and synclines are prominent features in the area. The axes of these structures typically trend north to northwest and plunge to the south. Recent work about 15 miles to the south on the Lion Mountain area by Osburn and Laroche (1981) show similar broad-scale folds with similar trends that fold the Oligocene volcanic section. This work suggests that not all the folding in the area is necessarily associated with the Laramide uplift. More work needs to be done on the implications of folding in an overall extensional regime (G. R. Osburn, oral communication, 1982).

Numerous small-displacement normal faults occur in the eastern part of the study area. All of these faults trend north to northwest and are down dropped to the west. Chapin and others (1979) suggest that these faults developed during the early stages of the development of the Rio Grande Rift.

Other faults are present in the area that have different characteristics than those associated with the Rio Grande Rift. These faults trend generally to the northeast, sometimes make 90 degree turns, and usually have large displacements downdropped on the western side. For example, on the eastern side of Table Mountain quadrangle (Plate 3), one of these faults cuts the Pliocene basalt flows on Tres Hermanos Mesa and juxtaposes the Twowells Tongue of the Dakota Sandstone against the Crevasse Canyon Formation, a displacement of at least 700 feet. This fault continues to the south where it turns east and cuts off about 400 feet of the Crevasse Canyon Formation.

STRATIGRAPHY

Triassic System

Triassic redbeds that make up the Chinle Formation are the oldest rocks exposed in the study area (about 200 m.y.). The unit is a slopeformer, and usually is poorly exposured except in stream cuts. The best exposures of the Chinle Formation in the Datil Mountains area are located to the east and northeast of the study area along the Rio Salado. The Chinle is easily recognized in the field and on aerial photographs by its characteristic red color and the resistant Dakota Sandstone caprock that lies unconformably above it.

The Chinle Formation consists of red, purple, and gray mudstones, siltstones, and claystones with lesser amounts of conglomeratic lenses and crossbedded sandstones. Paleocaliches have been seen in at least one exposure in the area (sec. 18, T. 3 N., R. 6 W.), and the unit is at least slightly calcareous throughout. The maximum thickness of the Chinle Formation in the study area is difficult to ascertain. About 120 feet is exposed in the study area on Indian Spring Canyon quadrangle (Mayerson, 1979), but Massingill (1979) reports up to 500 feet of Chinle to the east near Riley. Tonking (1957, p. 15) divides the Chinle into lower and upper units which reach thicknesses of 300 feet and 800 feet, respectively in exposures about seven mile northeast of the study area. The cross sections included in this report are prepared based on an assumption of a thickness of 1000 feet for the Chinle Formation but currently no subsurface information is available to test this thickness estimate.

A floodplain depositional environment is indicated for the Chinle Formation by the predominance of fine-grained sediments. The lentils of conglomerate, and the presence of discontinuous, crossbedded sandstones suggest that there were channels flowing on the floodplain. O'Sullivan (1977) suggested that the upper Triassic sediments were deposited by streams flowing northward across broad, floodplains that covered much of New Mexico in Triassic time.

Cretaceous System

About 1900 feet of Upper Cretaceous rocks crop out in the study area. These rocks record deposition from Cenomanian to Coniacian time and represent offshore marine, paralic and continental fluvial paleoenvironments (Robinson, 1980). Five formations are represented: the Dakota Sandstone, the Mancos Shale, the Tres Hermanos Formation, the Gallup Sandstone, and the Crevasse Canyon Formation in ascending order. These units, with the exception of the Tres Hermanos Formation, have been described in other basins in the state including the San Juan Basin and the Zuni Basin, and have been extended into the Datil Mountains area. Recent and continuing work in west-central New Mexico by members of the U. S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources has extensively revised the lithostratigraphic nomenclature used in this area (Landis and others, 1973; Hook and others, 1980).

Dakota Sandstone

The Dakota Sandstone lies unconformably on the Chinle Formation. In the study area three units are recognized: the lower part of the Dakota Sandstone, the Paguate Tongue, and the Twowells Tongue. The Paguate Tongue pinches out just west of Victorino Mesa on Pueblo Viejo Mesa quadrangle and is not found south or east of Victorino Mesa (Plate 2). The Twowells Tongue apparently pinches out six miles south of the Rio Salado on Indian Spring Canyon quadrangle and is not recognized south of this point (Plate 1).

The lower part of the Dakota Sandstone exposed in the area is generally an upward-fining sequence of resistant, well-sorted quartzose sandstone containing conglomeratic lenses at the base and intercalated shales at the top. The base of the Dakota Sandstone is typically erosional and is made up of a weathered gravel of well-rounded quartzite, chert pebbles, and siltstone chips derived from the top of the Chinle Formation (Mayerson, 1979). The contact between lower part of the Dakota Sandstone and the overlying part of the Mancos Shale is gradational and has been mapped inconsistently by various workers. In this project, the contact of the lower part of the Dakota Sandstone with the overlying Mancos Shale is placed at the point where thin shales first appear intercalated with a slightly fining-upward sand sequence typical of the Dakota.

The name Paguate was first used to describe a sandstone and siltstone sequence near Paguate, New Mexico (Landis and others, 1973). The Paguate Tongue is only found in the northern-most portion of Pueblo Viejo Mesa quadrangle in the study area. This appears to be the southeastern limit of this sandstone unit in the Datil Mountains. Here the unit consists of a yellowish-brown, fine to medium-grained, clayey sandstone with intense bioturbation and minor cross-stratification. The Paguate Tongue reaches a maximum thickness of 30 feet in the area. The Paguate Tongue of the Dakota Sandstone lies stratigraphically between two open-water marine tongues of the Mancos Shale and appears to represent an offshore bar complex.

The Twowells Tongue of the Dakota Sandstone is a thin, gray to yellow sandstone stratigraphically occurring between the lower part of the Mancos and the Rio Salado Tongue of the Mancos Shale. The Twowells Tongue is well-exposed on Pueblo Viejo Mesa and Table Mountain quadrangles but pinches out to the southeast on Indian Spring Canyon quadrangle. Jackson (1979), Mayerson (1979), and Massingill (1979) all mapped the Alamito Well tongue to denote the strata above the main-body Dakota and below the Tres Hermanos Formation where the Twowells Tongue is not present. However, this is an informal name and will not be used in this report.

Mancos Shale

The name Mancos Shale was first applied to a 1200-foot thick sequence of dark-colored shales cropping out near the town of Mancos in southwestern Colorado (Cross, 1899). The Mancos is split into multiple tongues in the San Juan, Zuni, and Acoma basins in New Mexico. Recent workers have demonstrated marker faunal and bentonite beds in the Mancos tongues occurring in New Mexico that serve as useful stratigraphic correlation tools (Hook and others, 1978-1980; Hook and others, in preparation; Molenaar, 1974; Landis and others, 1973).

Four Mancos units are mapped in the northern part of the study area: the lower part of the Mancos between the main-body portion of the Dakota and the Paguate Tongue of the Dakota, the Whitewater Arroyo Tongue between the Paguate and Twowells Tongues of the Dakota, the Rio Salado Tongue between the Twowells Tongue of the Dakota and the Tres Hermanos Formation, and the D-Cross Tongue between the Tres Hermanos Formation and the Gallup Sandstone in ascending order. Both the Paguate and Twowells Tongues of the Dakota pinch out to the southeast and are not recognized throughout the entire study area. Since the original definitions of these units depend on the presence of these Dakota tongues, the Whitewater Arroyo designation cannot be used beyond the pinchout of the Paguate Tongue. Similarly, beyond the Twowells pinchout in the southeastern part of the area, the lower part of the Mancos represents the shale interval between the Dakota Sandstone and the Tres Hermanos Formation (Plate 1). Massingill (1978) recognized the stratigraphic problem of applying this terminology developed in the Laguna-Acoma area in the Datil Mountains and used an informal name, the Alamito Well tongue, to describe all the shales below the Tres Hermanos Formation beyond the pinchout of the Twowells Tongue.

Lower part of the Mancos Shale

The lower part of the Mancos Shale in west-central New Mexico is made up of rocks of different time equivalency that cannot be included in established formal units because of complex intertonguing relationships that negate the original formational descriptions (Landis and others, 1973). The lower part of the Mancos in this report denotes a series of medium to dark gray shales and thin, silty sandstones between the main-body part of the Dakota and the next stratigraphically higher tongue of the Dakota at a given location. At most places in the study area, the upper limit of the lower part of the Mancos is defined by the Twowells Tongue of the Dakota. In the extreme northern part of the study area, the Paguate Tongue is present and forms the upper boundary of the lower part of the Mancos Shale. Where the Twowells is absent, the upper boundary of the lower Mancos is placed at the base of the Tres Hermanos Formation. The thickness of the lower part of the Mancos Shale ranges from 70 to 280 feet, depending on local presence of the Dakota Sandstone Tongues.

The lower part of the Mancos Shale exposed in the study area was deposited in a low energy environment as an offshore, shelf mud. Minor silty sandstones present throughout the lower part of the Mancos probably represent storm sedimentation (Mayerson, 1979). The offshore mud sequence of the lower part of the Mancos Shale grade laterally into lower shoreface sandstones that comprise the Dakota Sandstone or Atarque Member of the Tres Hermanos Formation beyond the pinchout of the Twowells Tongue of the Dakota.

Whitewater Arroyo Tongue

The Whitewater Arroyo Tongue is present only in the extreme northern part of the study area and is represented by a 90 foot-thick shale interval between the Paguate and the Twowells Tongues of the Dakota (Plate 2). This shale interval represents the same stratigraphic interval as the Whitewater Arroyo Tongue present in the Laguna area (Landis and others, 1973; Dane and others, 1971). The Whitewater Arroyo Tongue of the Mancos is very similar to the lower part of the Mancos in the area; both outcrop poorly and consist of dark-gray shales and thin sandstone interbeds. To date, there are no biostratigraphic tools available to separate the lower part of the Mancos from the Rio Salado Tongue and it is unlikely that these shale units could be positively identified if the stratigraphic sequence was interrupted.

Rio Salado Tongue

The Rio Salado Tongue of the Mancos Shale consists of the shales that separate the Twowells Tongue of the Dakota Sandstone from the Tres Hermanos Formation (Hook, Molenaar and Cobban, in preparation). The Rio Salado Tongue is named for exposures along the Rio Salado near Puertecito on the

Alamo Reservation. The unit is typically about 70 feet thick in the study area. The Rio Salado Tongue is typically a medium-gray to brownish-gray silty mudstone with thin, light brownish-gray nodular limestones throughout. About ten feet above the basal contact with the Twowells, the Rio Salado contains Sciponocerous gracile, a standard zone ammonite of the Western Interior Cretaceous (Cobban and Scott, 1972). The top of this ammonite zone is accepted as the Cenomanian-Turonian boundary. An oyster, Pycnodonte newberryi (Stanton), also occurs in the S. gracile Zone, and serves as a very good marker because it is confined to the light-colored calcareous shales and limestones in the basal Rio Salado Tongue. It has a very limited vertical extent (Hook and Cobban, 1978). Cobban and Hook (1979) have identified a Mammities depressus (Powell) and Collognoniceras woollgari woollgari in the upper part of the Rio Salado Tongue near D Cross Mountain west of Table Mountain quadrangle. Several partial specimens of M. depressus have been found in concretions near the top of the Rio Salado Tongue on the Alamo Reservation. The presence of this ammonite indicates a middle Turonian age for the upper part of the Rio Salado Tongue (Cobban and Hook, 1979).

D-Cross Tongue

The D-Cross Tongue of the Mancos Shale was originally defined by Dane and others (1957) as the shale body between the lower part of the Gallup Sandstone and the Gallego Sandstone (now recognized as the Tres Hermanos Formation and the Gallup Sandstone, respectively.) The type locality is at D Cross Mountain, about five miles west of the study area.

The D-Cross Tongue is Late Turonian in age (Hook and Cobban, 1979). Hook and Cobban have collected the same suite of fossils in the lower part of the D-Cross Tongue that are present in the Juana Lopez Member of the Mancos Shale in the San Juan Basin. Hence, they consider the lower D-Cross Tongue and the Juana Lopez Member to be time-equivalent units.

The D-Cross Tongue is a slope-forming unit present throughout the study area. The unit ranges in thickness from about 75 feet at Pueblo Viejo Mesa to an estimated thickness of 140 feet in the northern part of Indian Spring Canyon quadrangle. The D-Cross can be conveniently divided into lower and upper parts. The lower part is a medium gray, bioturbated, slightly calcareous to uncalcareous, silty shale containing many fossil-bearing concretions. Fossils identified in the lower portion of the D-Cross include: _Prinocyclus novimexicanus_, _Scaphites ferronenis_, Coilopocerous inflatum, and Scaphites whifieldi. The upper portion of the D-Cross is generally more silty than the lower portion of the unit. In addition, there are several sandstones less than one foot thick present in this part of the D-Cross. At least one of these sands appears to be mappable in exposures both on Pueblo Viejo Mesa and Table Mountain quadrangles. Fossils identified from the upper portion of the D-Cross include: Lopha sannionis, Prinocyclus novimexicanus, and Baculites yokoyami (Hook and Cobban, 1979). The contact of the D-Cross Tongue with the underlying Fite Ranch Member of the Tres Hermanos Formation is gradational over about fifteen feet. Similarly, the upper contact of the D-Cross with the overlying Gallup Sandtone is also gradational. The base of the Gallup Sandstone is mapped at the base of the first sandstone interval thicker than one foot (Robinson, 1980).

Robinson (1980) assumes a shallow, nearshore, transitional zone between shoreface sands and clean offshore muds for the environment of deposition of the D-Cross Tongue. Evidence that points to this conclusion includes the silty nature of the shales and the abundance of fossils in the unit.

Tres Hermanos Formation

The name Tres Hermanos was first used by Herrick (1900) to describe Cretaceous rocks that outcrop east of the intrusive Tres Hermanos Peaks along the Rio Salado on the Alamo Indian Reservation. Since that time, the name has been applied to many different sandstones in the Upper Cretaceous section (Dane and others, 1971; Hook, oral communication, 1981). Hook, Molenaar, and Cobban (written communication, 1981) have redefined the unit and have elevated the Tres Hermanos to formational status. The Tres Hermanos Formation comprises a basal coastal sandstone, a middle paludal to continental sequence, and an upper, coastal marine sandstone. Hook and others (oral communication, 1981) have defined the limits of the Tres Hermanos Formation based on their interpretation of Herrick's original descriptions and have defined members corresponding to the fore-mentioned lithologic breaks. These members are called in ascending order: the Atarque Member, the Carthage Member, and the Fite Ranch Member. Though these members are generally mappable throughout the Datil Mountains, they were not yet proposed when most of the mapping of the study area was done. The members were only mapped separately on Pueblo Viejo Mesa quadrangle.

The lower member of the Tres Hermanos, the Atarque Member, consists of about 70 feet of yellowish gray, thin to medium bedded sandstone. This sandstone shows a number of sedimentary structures including cross-bedding, bioturbation, ripples, and abundant fossils in concretions and lentils. Massingill (1979) has identified the following fossils to the east at Riley: *Collignoniceras woollgari woollgari*, *Baculites yokoyami*, *Proplacenticeras pseudoplacenta*, *Cardium pauperculum*, and *Gyrodes depressus*.

The middle member of the Tres Hermanos Formation, the Carthage Member, is a sequence of paludal shales and thin, calcareous sandstones. Petrified wood and large pelecypods are common in the Carthage Member on the east side of Tres Hermanos Mesa. Sandstones in the Carthage Member are typically cross-bedded and have scoured, sharp bases. Thin usually lenticular, coals, less than 1.2 feet thick, are present in the upper portion of the interval. The Carthage Member probably represents sedimentation on a marshy coastal plain.

The upper member of the Tres Hermanos Formation, the Fite Ranch Member, consists of 10-50 feet of fine to very fine-grained sandstone in the study area. This sandstone generally coarsens upward, is bioturbated, burrowed and in some places has medium-grained, fossiliferous sandstone lenses. Like the Atarque Member, the Fite Ranch Sandstone

Member probably represents coastal barrier and shoreface deposits.

MESAVERDE GROUP

Gallup Sandstone

The Gallup Sandstone in the study area is a cliff-forming, 30-85 foot thick sandstone that lies conformably above the D-Cross Tongue of the Mancos Shale. Winchester (1921) originally named this interval the Gallego Sandstone for exposures on Pueblo Viejo Mesa quadrangle (Plate 2).

The basal contact of the Gallup with the underlying D-Cross Tongue of the Mancos Shale is gradational and the Gallup is mapped beginning at the base of the first resistant sandstone. The Gallup contact with the the overlying Crevasse Canyon Formation is sharp and represents the boundary between the upper shoreface/foreshore sands of the Gallup and the finer grained lagoonal sediments of the lower part of the Crevasse Canyon Formation.

The Gallup Sandstone is a generally coarsening upward sequence of fine to medium-grained sandstone. The lower part of the Gallup contains abundant horizontal laminations, planar cross-beds, and burrow mottling. This lower part of the Gallup represents a transitional zone between the offshore muds of the D-Cross Tongue and lower shoreface sands found in the lower part of the Gallup. The guide fossil, Lopha sannionis occurs in the Gallup in dark-colored, massive, thin, medium-grained sandstone layers. Higher in the Gallup, the sandstones become bioturbated and then intensely burrowed in the portion deposited in lower shoreface environments. In contrast, the upper part of the Gallup is characterized by stacked planar cross-beds that are only moderately burrowed.

Crevasse Canyon Formation

Allen and Balk (1954) first used the Crevasse Canyon nomenclature to describe a coal-bearing sequence between the Gallup Sandstone and the Point Lookout Formation on the western flank of the San Juan Basin. Tonking (1957) and Givens (1957) first extended the terminology into the study area.

The Crevasse Canyon Formation crops out in the study area as a southeast-trending band of gently dipping cuestas capped by thin, resistant sandstones. Throughout the study area, the unit is often obscured by Tertiary gravels or Quaternary landslide debris. The contact with the Tertiary gravels is erosional. South of the Rio Salado, an extensive fault system downdrops and buries about 400 feet of the lowest Crevasse Canyon (Plate 3). For these reasons, it is difficult to measure a maximum thickness in the area. Structure contour maps prepared in the area suggest that the unit reaches thicknesses of at least 1100 feet in the area (Plate 5). More detailed mapping and more closely-spaced drilling in the study area would probably show that the maximum thickness of the Crevasse Canyon in the study area is actually greater than 1100 feet.

The Crevasse Canyon Formation is made up of a sequence of generally fine-grained sediments and associated coals. The unit can be effectively divided into three parts: a lower coastal swamp sequence about 400 feet thick, a middle coastal plain sequence about 300 feet thick, and an upper freshwater swamp sequence that reaches thicknesses of at least 300 feet in the study area. Thin channel sands occur in the lowest part of the formation and sandstones up to forty feet thick occur in the highest portion of the formation exposed in the area.

The lowest portion of the formation is a coastal swamp or lagoonal sequence. This part of the formation is typically comprises interbedded mudstones, coals, siltstones, and occasional, slightly calcareous, thin sandstones. The thickest coals that occur in the study area begin about 60 feet above the Gallup Sandstone and continue up to 400 feet above the contact with the Gallup. This coal zone probably is the stratigraphic equivalent of the Dilco Coal Member (Molenaar, 1973) present in the Zuni Basin.

The middle unit in the Crevasse Canyon Formation is composed of about 300 feet of interbedded siltstones and very fine-grained sandstones with thin dolomite and limestone layers. Lenticular pods of silts and sands suggest deposition on a flat, coastal plain by an anastomosing stream system. The coals that are present in this interval reach a maximum thickness of three feet and are more lenticular than coals in the lower part of the Crevasse Canyon. Drilling done for this project encountered silty sandstone aquifers capable of producing 10 to 20 gallons/ minute in this part of the Crevasse Canyon Formation.

The highest part of the Crevasse Canyon Formation exposed in the study area crops out as isolated hills on the western side of Table Mountain quadrangle. This interval is better known from drillhole data than from outcrop data and reaches extimated thicknesses of 300 feet(Plate 5). This interval is dominated by a series of very fine-grained sandstones. Siltstones and mudstones with thin coals make up about 40% of the upper unit. Coals present in this interval range in thickness from six inches to two feet. These coals are not as thick, continuous, nor numerous as the coals present in the lower part of the Crevasse Canyon

Formation. This suggests that the coal was deposited in isolated, freshwater swamps adjacent to fluvial channels on the upper coastal plain. Palynologic studies of coals from this portion of the Crevasse Canyon Formation show angiosperm pollen and no marine or brackish water indicators supporting a lack of marine influence during the deposition of the upper interval (Chapin and others, 1979).

TERTIARY SYSTEM

Tertiary rocks present in the study area document a wide range of geologic processes and events including fluvial sedimentation, widespread volcanism, injection of dikes and sills, and widespread erosion. The oldest Tertiary rocks in the study area are the Eocene Baca Formation. Volcanism to the south of the area during Oligocene time was the source of the volcaniclastic apron called the Spears Formation exposed in the southern parts of Table Mountain and Indian Spring Canyon quadrangles. Dikes of Miocene Age that are common features west of Indian Spring Canyon in the study area were emplaced along faults and fractures associated with the opening of the Rio Grande Rift. Deposits of Pliocene Age include extensive basalt flows and piedmont deposits derived from erosion of earlier Tertiary deposits.

Eocene

Baca Formation

The Baca Formation is composed of sediments deposited during Laraide time in a large intermontane basin stretching from Carthage, New Mexico westward to the Arizona border (Cather, 1982). The lower contact of the Baca with the underlying Crevasse Canyon Formation is unconformable while the upper contact of the Baca with the overlying Spears Formation is conformable (Cather, 1982).

The Baca Formation in the study area comprises a redbed sequence of sandstones, siltstones, shales, and conglomerates. Cather (1980) measured a 941-foot section of the Baca on the Alamo Reservation. He recognized three informal map units in the area: the lower red unit, a middle sandstone unit, and the upper red unit following the conventions of Potter (1970). These units represent distal braided alluvial plain, fine-grained lacustrine delta, and lacustrine basinal facies, respectively (Cather, 1980).

The Baca Formation has received considerable attention as a potential source of uranium. A substantial amount of drilling has been done just southeast of the Reservation on Indian Spring Canyon quadrangle but has yet to discover significant amounts of ore. Cather (1980), suggests that uranium mineralization in this area is confined to the lacustrine delta facies of the Baca. It is probable that this facies is buried under younger gravels in the southern portion of the Indian Spring Canyon quadrangle and that future uranium tests should be confined to this area.

Oligocene

Spears Formation

The Spears Formation crops out in the southwest corner of Indian Springs Canyon quadrangle as gently south-dipping hogbacks. Within this area, the Spears Formation is composed mainly of volcanoclastic sedimentary rocks with minor quantities of interbedded lava flows and pyroclastic units. The most common lithologies present are feldspathic sandstones, conglomerates, and debris-flow deposits. Volcanic units constitute a greater proportion of the Spears here than to the south and southwest where sedimentary deposits dominated the Spears Formation. The environment of deposition during Spears time consisted of alluvial fans prograding into the former Baca lake area. The sedimentary facies of the Spears show complex lateral facies relationships.

The Spears Formation conformably overlies the older Baca Formation. The lower contact of the Spears with the Baca Formation is usually gradational and placed at the lowest point where recognizable volcanic detritus is found. In some areas, lacustrine sedimentation may have continued into Spears time (S. M. Cather, personal communication). The Spears Formation is overlain unconformably by the Hells Mesa or La Jencia Tuffs within the study area, whereas regionally these tuffs overlie the Spears Formation conformably (G. R. Osburn, oral communication, 1982). The unconformable nature of the contact of the Spears Formation with overlying tuffs in the study area probably indicates that the period of erosion and uplift in this area continued at least until La Jencia time (~30 m.y. b.p.). Simple explanations for this anomalous area of doming could be: a local magmatic intrusion at depth, complex structural development along the southern Colorado Plateau margin, or movement along the Puertecito fault zone.

Within the study area, the Spears Formation is about 1000 ft thick. In areas to the west and south of the study area, where more volcanic units are present within this formation, the Spears may be as much as 2000 feet thick.

Hells Mesa Tuff

The Hells Mesa Tuff is a crystal-rich ash-flow tuff erupted from the North Baldy cauldron in the Central Magdalena Mountains (Chapin and others, 1978). Within the study area, the unit is present only on Indian Spring Canyon quadrangle near Abbe Spring and in the southwest corner of the quadrangle. The Hells Mesa Tuff in the study area is typically a pale-red, densely welded, crystal-rich tuff that weathers to grayish red angular blocks (Mayerson, 1979). The unit rests unconformably on the Spears Formation in the area and ranges from 0 to 500 feet in thickness (G. R. Osburn, oral communication, 1982).

La Jencia Tuff

The La Jencia Tuff denotes two cooling units separated by about 330 feet of La Jara Peak Basaltic Andesite in the study area. The La Jencia Tuff was formerly called the A-L Peak Tuff; recent advances in the understanding of the regional volcanic stratigraphy merited this nomenclature change (G. R. Osburn, oral communication, 1981). The La Jencia Tuff is divided into a lower and upper member, both of which are present in the study area near Abbe Spring. The lower member consists of an orange-pink tuff that is poorly welded at the base and densely welded at the top. It rests unconformably on the Hells Mesa Tuff, and varies from 20 to 200 feet in thickness as a result of filling in post-Hells Mesa topography (Mayerson, 1979). The upper member is interbedded with the La Jara Peak Basaltic Andesite in the study area. The upper member crops out as pinnacles of grayish red to pale reddish brown tuff with elongate, flattened pumice fragments that define a prominent foliation and ranges in thickness from 10 to 1000 feet. Both the lower member and the upper member of the La Jencia Tuff change thickness dramatically over small horizontal distances in the study area. Mayerson (1979) measured 78 feet of the upper member of the La Jencia Tuff section near Abbe Spring. He noted a 1000 foot section of the upper member near Jaralosa Creek and attributed its thickness to ponding in a paleovalley along the Tijeras linement.

La Jara Peak Basaltic Andesite

The La Jara Peak Basaltic Andesite is a geographically widespread unit that was first named for La Jara Peak, a volcanic neck just northeast of the study area (Tonking, 1957). In the study area the unit consists of two tongues separated by the upper member of the La Jencia Tuff.

The lower tongue lies unconformably on the lower member of the La Jencia Tuff or on the Hells Mesa Tuff. Mayerson (1979) measured about 350 feet of the lower tongue near Abbe

Spring. The upper member of the La Jencia Tuff lies disconformably above the lower La Jara Peak tongue.

The upper tongue of the La Jara Peak Basaltic Andesite ranges from 300 to 655 feet thick in the study area (Mayerson, 1979). The lower contact of this tongue is disconformable with the upper member of the La Jencia Tuff. The contact of the upper tongue with the overlying Popotosa Formation is gradational and some interbedding occurs.

The La Jara Peak Basaltic Andesite typically crops out as low benches and subdued topography. The unit is typically brownish black in the massive portion of an individual flow, and ranges to dusky red in scoriaceous, autobrecciated tops and bottoms of flows. Mayerson (1979) reports thin lenses of volcanoclastic sandstone interbedded between the individual lava flows within the formation.

Miocene

Popotosa Formation

The Popotosa Formation, the basal formation of the Santa Fe Group in Socorro County, crops out on the eastern side of Indian Spring Canyon quadrangle. In the study area, the unit consists of a poorly to moderately well-indurated sandy conglomerate. G. R. Osburn (1978) did pebble counts on this unit to find the local source of the volcanic debris which comprise this unit. The clasts making up the Popotosa in this area are primarily La Jara Peak Basaltic Andesite, La Jencia Tuff, and Hells Mesa Tuff. The Popotosa Formation in the area has steep and erratic dips that make thickness estimates difficult. The Popotosa Formation probably ranges from several hundred feet to over one thousand feet in thickness in the study area (G. R. Osburn, oral communication, 1982).

Mafic Intrusions

Mafic dikes are common features on the eastern side of Indian Spring Canyon quadrangle. These rocks were emplaced along extensional fault zones related to the opening of the Rio Grande Rift (Chapin and others, 1974). The dikes are typically tabular structures, less than eight feet in width and range from a few to thousands of feet in length. The dikes consist of a sugary textured, aphanitic, olive green to dark gray, porphyritic rock. The dikes resemble man-made rock walls in the field, due to often intense weathering and alteration of the dikes.

Mafic sills in the area are confined to a northwest-trending band along Jaralosa Creek. Hand specimens of the sill rocks generally resemble the mafic dike rocks in the area. The sills are nearly flat-lying and are generally less than 20 feet thick.

Pliocene

Basalt flows

Basalt flows cap Victorino Mesa, Tres Hermanos Mesa, and Table Mountain in the north and west portions of the study area (Plates 2 and 3). These flows typically have ropey flow structures, are porphyritic, have oxidized, red vesicular tops and brecciated bottoms. Petrographically, these flows are alkalic basalts (S. Baldridge, LASL, oral communication, 1982). The occurrence of this type of basalt is uncommon in central New Mexico and detailed work on the flows present on Tres Hermanos Mesa and Table Mountain continues in an effort to detemine the significance of these deposits (S. Baldridge, LASL, oral communication, 1982).

There are three distinct flows present on Victorino Mesa and Tres Hermanos Mesa, and probably only two flows that continue south to Table Mountain. The flows get younger in age to the east. One or all of these flows are probably coeval with flows to the north that have been dated at 3-6 m.y. b.p. (Bachman and Menhert, 1979). The volcanic necks that form Tres Hermanos Peaks on Table

Mountain quadrangle are probably the same age as the basalt flows on Tres Hermanos Mesa and Victorino Mesa.

Several volcanic vent features occur in the basalts on Tres Hermanos Mesa (Plate 2). The most interesting of these is a maar on the east side of the mesa. This structure is essentially a large, alluvium-floored depression about 1000 feet across, rimmed with basaltic blocks that dip steeply outward in a radial fashion. This type of volcanic feature is formed when lava encounters the water table while erupting, thus causing an explosive eruption. In addition to the maar, there are several spatter cones and small shield type cones marking more quiescent eruptions.

Tertiary Gravels

Tertiary gravels cover broad areas to the west and south of the Crevasse Canyon outcrop belt in the study area (Plates 1 through 3, Plate 5). These sediments are made up of clasts of Oligocene volcanic rocks in a silty sand matrix. These gravels are primarily piedmont deposits formed by coalescing alluvial fans formed on the flanks of the Gallinas Mountains. The gravels are of multiple age, and were deposited on a deeply eroded, northward-sloping, geomorphic surface on the Crevasse Canyon Formation. The oldest gravels are probably equivalent to the Popotosa

Formation. Transport directions from pebble imbrications measured on Pueblo Viejo Mesa quadrangle point north in lowest part of the gravels. This suggests that the gravels were in part being deposited prior to the establishment of the Rio Salado drainage system. In contrast, younger sediments included in this unit clearly grade southward to the Rio Salado.

Quaternary

Quaternary sediments in the area have been divided by both relative age and type of deposit. All deposits with minor or no soil development are classified as young deposits. These deposits include: sediments deposited in active stream channels, young valley alluvium, slope wash, undissected piedmont slope deposits, and blow sands infilling behind slump blocks. Those alluvial deposits with appreciable soil development, often in the form of soil carbonate, are mapped as older alluvium. These deposits include older valley alluvium and dissected piedmont deposits. Talus and colluvium occupy extensive surface area on the sides of hills and mesas. Talus and colluvium have been split into map units that are comprised of mainly basaltic clasts, such as those on Tres Hermanos Mesa, and those that are mainly comprised of Cretaceous sandstones which slid downslope on underlying shales only on Pueblo Viejo Mesa quadrangle. Both types of overburden deposits are mapped together on Indian Spring Canyon and Table Mountain quadrangles.

Coal Geology

Coal Quality

Proximate, ultimate, BTU, and forms of sulfur analyses were performed by Hazen Research in Golden, Colorado. Fifteen samples from nine drillcores were selected for analyses (Appendix 2).

The total sulfur content of the coals in the Central Datil Mountains is among the lowest in New Mexico, averaging 0.58%. Fifteen drill core samples were analyzed with respect to forms of sulfur. An average of 83% of the sulfur present is organic sulfur, 16% is present as pyrite, and an average of 1% is present as sulfate (Table 2).

The as-received average BTU value for the fifteen samples collected is 11,727 BTU/lb. The average moist, mineral-matter free BTU is 13,702 BTU/lb. This is within the range of high volatile B bituminous coals according to the rank classification system of the American Society of Testing and Materials standard D388-77. Coal in the Datil Mountians coal field has previously been considered to be of subbituminous rank (Read and others, 1950). It is suspected that this inconsistency has occurred because earlier workers commonly analyzed samples of weathered outcropping coal. Coal samples from outcrops generally yield lower rank determinations upon analysis than fresh coal samples from active mining faces or drill core. When the Datil Mountains coal is compared with coal from the Salt Lake coal field and with coal of comparable age in the San Juan Basin, the Datil Mountains coal is consistently higher in rank (Table 3). It is possible that the higher heating values of the Datil Mountains coal (when compared with coal from the same stratigraphic intervals in the San Juan Basin) reflect greater thermal maturation of Datil Mountains coal as a result of the field being on the tectonically active edge of the the Colorado Plateau (T. Hemler, Amoco Oil Co., oral communication, 1981).

Table 2

FORMS OF SULFUR IN CORE COAL SAMPLES TAKEN IN THE STUDY AREA
(as recieved values, Hazen Research, Inc.)

Drill hole number	Interval sampled (feet)	Total S,%	Pyritic S,%	Organic S,%	Sulfate S,%
26-7-1	188.0´-190.5´	0.66	0.07	0.59	0.00
26-9-1	59.0´- 60.2´	0.58	0.03	0.55	0.00
26-9-1	124.0´-126.0´	0.72	0.19	0.53	0.00
26-15-1	285.8´-287.0´	0.55	0.09	0.46	0.00
26-25-2	140.0´-142.0´	0.50	0.05	0.45	0.00
27-1-1	38.0´- 40.0´	0.54	0.15	0.39	0.00
27-1-1	72.0´- 74.0´	0.44	0.07	0.37	0.00
27-13-1	100.5´-103.0´	0.41	0.07	0.34	0.00
030705-1	146.0´-148.0´	0.63	0.19	0.40	0.04
030705-1	175.0´-177.0´	0.58	0.09	0.49	0.00
040730-2	36.5´- 37.5´	0.54	0.02	0.48	0.04
040730-2	54.0´- 55.5´	0.71	0.14	0.57	0.00
040730-2	60.0´- 62.0´	0.73	0.09	0.62	0.02
040730-3	66.5´- 67.5´	0.49	0.05	0.44	0.00
040730-3	125.0´-128.0´	0.65	0.07	0.57	0.01

Table 3

Comparison of Datil Mtns. coals with Salt Lake coals and lower Mesaverde Group coals in the San Juan Basin (modified from Campbell, 1981)

	Datil Mtns. coalfield		Salt Lake coalfield		lower Mesaverde Group coals San Juan Basin	
# of samples	15		12		109	
	mean	S.D.	mean	S.D.	mean	S.D.
vol. mat.	38.5	3.1	34.6	3.3	36.3	4.3
Fixed Carb.	43.3	3.6	40.1	6.3	43.9	6.3
Carbon	65.0	4.6	56.7	7.8	58.1	9.3
Moisture	4.8	2.4	4.6	3.5	11.6	5.3
Hydrogen	5.0	0.4	4.4	0.4	4.9	0.5
Nitrogen	1.1	0.2	1.1	0.1	1.2	0.2
Oxygen	10.1	1.2	11.6	1.5	14.9	7.1
Sulfur	0.6	0.1	0.9	0.3	1.0	0.9
Ash	13.4	5.7	20.7	9.2	8.4	4.7
as-received BTU/lb.	11,727		9,920		11,255	

Coal Resources

A total of twenty stratigraphic test hole locations were chosen in the area (Plate 5). Only seventeen of the twenty drillholes were located within the study area boundaries; three holes were drilled on Puertecito quadrangle which is located immediately adjacent to Table

Mountain and Indian Spring Canyon quadrangles. Eighteen of the drillholes were chosen to penetrate the Crevasse Canyon Formation. The remaining two are in Pueblo Viejo Mesa quadrangle, and have tested a known coal interval in the Carthage Member of the Tres Hermanos Formation and the thickness of the Tertiary piedmont gravels, respectively.

The drillholes average 283 feet in depth with a range of 197-350 feet. These holes are numbered by township, range, and section and the ordinal number in which the holes were drilled in the section. For example, the first known drillhole location placed in T. 2N., R. 7W., sec. 6 would be numbered 27-6-1. Some of the drillholes in this study were named using a variation of this method with zeros before single-digit numbers to simplify computer entry. Using this method, the same drillhole in T. 2N., R. 7W., sec. 6 would be numbered 020706-1. Though two types of drillhole designations in a single project may be confusing, the New Mexico Bureau of Mines staff agrees that this practice is much better than risking lost data by changing a drillhole name after geophysical logs, chemical analyses, and other data bear the original drillhole designation.

Drillhole summaries including: coal seams encountered, geophysical logs run, and other data available comprise Appendix 1. Rock cuttings from drilling were taken at five-foot intervals and lithologic logs were prepared and summarized (Plate 6) for all rotary drillholes. Drillhole 27-1-1 was deepened to 320 feet to clarify stratigraphic position. Fifteen of these holes contained coal beds thicker than fourteen inches. Eleven of these holes were twinned to obtain core samples of the thicker coals for analyses. The lenticularity and discontinous nature of the coal beds was emphasized during core drilling. Three seams, each greater than 2.5 feet thick, were not present in the twinned drillhole, 20 feet away from the rotary hole. In place of the coal beds in these cores were very-fine grained to fine-grained, cross-bedded sandstones with abundant coal fragments in the lower parts of the sandstone sequences. The presence and physical characteristics of these sandstone bodies suggest that the coals were cut out by migrating fluvial channels.

The coals present in the study area are bituminous in rank and hence, all resource calculations were done using a minimum coal seam thickness of fourteen inches according to U. S. Geological Survey practices. Qualifying coal seams range from 1.2 to 4.5 feet in thickness and average 2.0 feet thick in the study area. Identified coal resources were tabulated by thickness categories as stated in U. S. Geological Survey Bulletin 1450-B (Table 4). Only the coal resources in the portions of individual townships within the study area are presented and townships with no coal

TABLE 4

Demonstrated Coal Resources of Pueblo Viejo Mesa, Indian Spring Canyon, and Table Mountain Quadrangles

(in millions of short tons; all values rounded; 1800 short tons/acre-foot used in calculations; maximum depth, 350 feet; only sections with data reported; only portions of sections within study area reported; township totals tabulated at the end of each township.)

Location			Measured Thickness of coal bed, in feet			Indicated Thickness of coal bed, in feet			Demonstrated
Twp.	Rng.	Sec.	1.2-2.3	2.3-3.5	>3.5	1.2-2.3	2.3-3.5	>3.5	measured & indicated
1N.	5W.								
		6	0.15	-	-	-	-	-	0.15
		7	0.43	-	-	-	-	-	0.43
		18	0.24	-	-	-	-	-	0.24
									0.82
1N.	6W.								
		1	0.72	-	-	-	-	-	0.72
		12	0.31	-	-	-	-	-	0.31
		13	0.29	-	-	-	-	-	0.29
		24	0.56	-	-	-	-	-	0.56
									1.88
2N.	5W.								
		30	0.53	-	-	-	-	-	0.53
		31	0.46	-	-	-	-	-	0.46
									0.99
2N.	6W.								
		6	0.28	0.12	0.06	2.28	1.00	-	3.74
		7	1.26	0.45	0.46	2.14	0.75	-	5.06
		18	0.47	-	-	-	-	-	0.47
		25	1.23	-	-	4.72	-	-	5.95
		36	0.20	-	-	1.58	-	-	1.78
									17.00
2N.	7W.								
		1	0.79	0.31	0.99	2.74	1.40	4.46	10.69
		2	0.42	0.09	0.29	2.41	.94	3.00	7.15
		12	0.70	0.15	-	2.63	-	-	3.48
		13	0.50	0.41	-	1.98	1.65	-	4.54
									25.36
3N.	7W.								
		4	0.36	-	-	0.80	-	-	1.16
		5	0.26	-	-	1.27	-	-	1.53
		16	0.40	-	-	1.62	-	-	2.02
		17	0.27	-	-	1.51	-	-	1.78
		20	-	-	-	0.24	-	-	0.24
		21	-	-	-	0.40	-	-	0.40
		26	0.22	-	-	-	-	-	0.22
		34	0.24	-	-	2.21	-	-	2.45
		36	0.20	0.18	0.27	-	-	-	0.65
									10.45
4N.	7W.								
		8	0.30	-	-	-	-	-	0.30
		15	0.46	-	-	-	-	-	0.46
		18	-	0.18	-	-	-	-	0.18
		19	0.35	0.17	0.33	1.96	0.69	1.86	5.36
		20	0.13	-	0.15	.84	-	0.96	2.08
		29	0.35	0.36	0.40	.83	-	0.95	2.89
		30	1.10	0.47	0.62	2.09	1.25	1.64	7.17
									18.44
4N.	8W.								
		13	0.26	-	-	-	-	-	0.26
		24	0.84	1.44	-	0.31	0.62	-	3.21
		25	0.09	0.19	-	0.30	0.62	-	1.20
									4.67
Totals			15.37	4.52	3.57	34.86	8.92	12.87	80.11

resources are omitted from the tables. To calculate the coal resources present from a given data point, the thickness, lateral continuity, and depth to coal of each qualifying coal bed at a given data point was calculated using both measured and indicated categories for subeconomic resources as defined by U.S. G. S. Bulletin 1450-B (p. 6). Coal resources were calculated to a maximum depth of 350 feet due to the limitations of the available subsurface information. Individual coal seams were projected to a one quarter mile radius from the observation point for the measured category and to a circle segment one quarter mile to three quarters of a mile away from the observation point for the indicated category. The density of subsurface information was not sufficient for seam correlation between most drillholes.

The Crevasse Canyon Formation in the study area contains measured coal resources of 23.5 million tons considering both outcrop and surface data. Indicated resources are calculated using only subsurface data and equal 56.6 million tons of coal (Table 4). Hence, demonstrated resources for the study area total 80.1 million tons. When coal resources are separated into depth categories it is found that 70% of the resources or 55 million tons occur at depths less than 150 feet, 23% or 18.6 million tons occur from 150 to 250 feet, and 6% occur at depths greater than 250 feet (Table 5).

TABLE 5

DEMONSTRATED RESOURCES IN DEPTH CATEGORIES FOR PUEBLO VIEJO MESA, TABLE MOUNTAIN, AND INDIAN SPRING CANYON QUADRANGLES
(millions of short tons)

location	0-150 ft	150-250 ft	>250 ft
T.1N.,R.5W.	0.82	0.00	0.00
T.1N.,R.6W.	1.88	0.00	0.00
T.2N.,R.5W.	0.99	0.00	0.00
T.2N.,R.6W.	9.46	3.98	3.56
T.2N.,R.7W.	13.17	12.69	0.00
T.3N.,R.7W.	8.48	1.97	0.00
T.4N.,R.7W.	18.44	0.00	0.00
T.4N.,R.8W.	4.67	0.00	0.00
	-----	-----	----
	57.91	18.64	3.56

Stripping ratios (thickness of the overburden to thickness of each coal seam) were calculated for coal resources in the study area (Table 6). The range of acceptable stripping ratios of a given surface mining operation is dependant on many factors including rank of coal, dip of strata, method of mining, ease of mining interburden, and distance to a railhead or road. Present active coal mines in the San Juan Basin are planning to strip coals with mining ratios approaching twenty to one (R.

W. Wilcox, Minerals Management Service, written communication, 1982). However, it is unlikely that economic stripping ratios in an undeveloped coal field such as the Datil Mountains would be that high. Stripping ratios for the study area present the most serious problem facing any potential surface mining operation. Only 25% of all resources (19.66 million tons) have a stripping ratio of less than ten to one (Table 6).

TABLE 6

STRIPPING RATIO FOR DEMONSTRATED COAL RESOURCES IN PUEBLO VIEJO MESA, TABLE MOUNTAIN, AND INDIAN SPRING CANYON QUADRANGLES

location	stripping ratio		
	<10:1	10:1-20:1	>20:1
T.1N.,R.5W.	0.82	0.00	0.00
T.1N.,R.6W.	1.88	0.00	0.00
T.2N.,R.5W.	0.99	0.00	0.00
T.2N.,R.6W.	0.99	0.00	16.01
T.2N.,R.7W.	4.37	0.00	21.49
T.3N.,R.7W.	0.39	0.00	10.06
T.4N.,R.7W.	9.96	0.00	8.48
T.4N.,R.8W.	0.26	0.00	4.41
	-----	-----	-----
	19.66	0.00	60.45

Leasing

At the current time, there are no federal lands under lease for coal in the area and none are being considered. The next scheduled coal lease sale in the area will occur in 1990 (Debra Agnolet, BLM, 1981). The federal government does allow emergency lease sales to speed up the leasing process in the event of a new discovery or extension of an existing mine, but the burden of proof of resource potential falls on the prospective leasee. There are presently many active oil and gas leases in the area.

Potential for Mining

The coals beds in the Crevasse Canyon Formation in the central Datil Mountains are typical of those coals deposited in environments with strong fluvial influence. They are thin, lenticular, and discontinuous over a few thousand feet. The heating values of these coals are among the highest in the state, however, small tonnages, structural complications, lack of transportation facilities, and large amounts of overburden prohibit large-scale mining possibilities. The lowermost 400 feet of the Crevasse Canyon Formation contain the thickess coals in the formation in the study area. The resource potential of the highest portion of the formation present in the study area is unknown at this time. Deeper testholes through Tertiary gravels and the Baca Formation could help define the resource potential of this part of the Crevasse Canyon Formation in the study area.

Transportation remains a serious problem even if large resources were discovered. There are no major roads, railroads, or nearby populations center to utilize any potential resource.

At the current time, the Central Datil Mountains should not be considered to have great coal resource potential. Small resource figures coupled with a remote location demand that any utilization of this resource be done on a local scale. There are many outcrop occurrences scattered throughout the area. These coal outcrops may prove useful as a domestic resource for the Indians of the Alamo Reservation and the local ranches in the area.

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APPENDIX 1

Well Name: #21 Hook
Location: nw¼se¼ne¼ sec 8 T1n R5w
Company: Gulf Nuclear Drlg.
Footage: 4250 ft E of W line 3350 ft N of S line
Quadrangle: Indian Spring Canyon
Confidential: n
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical Logs: n
Total Depth: 955 ft
Date Drilled: ?
Elevation: 6620 ft
Mineral ownership: pr Surface ownership: fed Analysis: n Cuttings: y

Formation	Depth	Elevation
Tsp	0.0 ft	6620.0 ft

Well Name: #10 Hook
Location: sw¼sw¼se¼ sec 18 T1n R5w
Company: Gulf Nuclear Drlg.
Footage: 3450 ft E of W line 500 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical Logs: n
Total Depth: 1175 ft
Date Drilled: ?
Elevation: 6920 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Tp	0.0 ft	6920.0 ft

Well Name: #12 Hook
Location: ne¼ne¼nw¼ sec 18 T1n R5w
Company: Gulf Nuclear Drlg.
Footage: 2100 ft E of W line 4700 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical logs: n
Total Depth: 500 ft
Date Drilled: ?
Elevation: 6680 ft
Mineral ownership: pr Surface ownership: fed Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6680.0 ft

Well Name: #20 Hook
Location: sw¼se¼se¼ sec 20 T1n R5w
Company: Gulf Nuclear Drlg.
Footage: 4700 ft E of W line 800 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical logs: n
Total Depth: 500 ft
Date Drilled: ?
Elevation: 6965 ft
Mineral ownership: pr Surface ownership: fed Analysis: n Cuttings: y

Formation	Depth	Elevation
Tp	0.0 ft	6965.0 ft

Well Name: #16 Hook
Location: sw¼sw¼se¼ sec 14 T1n R6w
Company: Gulf Nuclear Drlg.
Footage: 2880 ft E of W line 300 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical logs: n
Total Depth: 900 ft
Date Drilled: ?
Elevation: 6830 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6830.0 ft

Well Name: #19 Hook Location: ne¼ne¼se¼ sec 18 T1n R6w
Company: Gulf Nuclear Drlg. Footage: 4920 ft E of W line 2400 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns. County: Socorro Water: ?
Geophysical logs: n
Total Depth: 1390 ft Date Drilled: ? Elevation: 7020 ft
Mineral ownership: pr Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Tsp	0.0 ft	7020.0 ft

Well Name: #13 Hook Location: ne¼ne¼ne¼ sec 24 T1n R6w
Company: Gulf Nuclear Drlg. Footage: 5000 ft E of W line 4880 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns. County: Socorro Water: ?
Geophysical logs: n
Total Depth: 600 ft Date Drilled: ? Elevation: 6760 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6760.0 ft

Well Name: #15 Hook Location: sw¼nw¼se¼ sec 24 T1n R6w
Company: Gulf Nuclear Drlg. Footage: 3150 ft E of W line 2000 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns. County: Socorro Water: ?
Geophysical logs: n
Total Depth: 510 ft
Mineral ownership: pr Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6800.0 ft

Well Name: #1 Hook Location: sw¼se¼ne¼ sec 26 T1n R6w
Company: Gulf Nuclear Drlg. Footage: 4380 ft E of W line 2680 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns. County: Socorro Water: ?
Geophysical logs: n
Total Depth: 727 ft Date Drilled: ? Elevation: 6860 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Tsp	0.0 ft	7200.0 ft

Well Name: #18 Hook Location: ne¼nw¼ne¼ sec 28 T1n R6w
Company: Gulf Nuclear Drlg. Footage: 3280 ft E of W line 4580 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns. County: Socorro Water: ?
Geophysical logs: n
Total Depth: 1535 ft Date Drilled: ? Elevation: 7100 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Tsp	0.0 ft	7100.0 ft

Well Name: #1 Henderson
Location: ne¼sw¼se¼ sec 35 T1n R6w
Company: TransOcean
Footage: 3800 ft E of W line 1265 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: 850-860 ft (log)
Geophysical logs: gamma, caliper, induction, rest., s.p.
Total Depth: 9379 ft
Date Drilled: 3/5/77
Elevation: 6982 ft
Mineral ownership: Santa Fe Railroad Surface owners: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Kg	0.0 ft	6982.0 ft

Well Name: #1SFP David-Pueblo
Location: sw¼sw¼sw¼ sec 35 T1n R6w
Company: Whigham
Footage: 330 ft E of W line 330 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical logs: n
Total Depth: 1163 ft
Date Drilled: 5/7/79
Elevation: 7071 ft
Mineral ownership: Santa Fe Railroad Surface ownership: pr Analysis: n Cuttings: n

Formation	Depth	Elevation
Kcc	0.0 ft	7071.0 ft

Well Name: #7 Hook
Location: nw¼se¼ne¼ sec 36 T1n R6w
Company: Gulf Nuclear Drlg.
Footage: 4000 ft E of W line 3700 ft N of S line
Quadrangle: Indian Spring Canyon
Field: Datil Mtns.
County: Socorro
Water: ?
Geophysical logs: n
Total Depth: 1810 ft
Date Drilled: ?
Elevation: 7430 ft
Mineral ownership: fed Surface ownership: pr Analysis: n Cuttings: y

Formation	Depth	Elevation
Qpy	0.0 ft	7430.0 ft

Well Name: 26-7-1
Location: ne¼nw¼nw¼ sec 7 T2n R6w
Company: New Mexico Bureau of Mines
Footage: 1000 ft E of W line 4900 ft N of S line
Quadrangle: Table Mtn.
Confidential: n
Geophysical logs: gamma, cal, dens, rest, s.p., pors/neut
Total Depth: 261 ft
Date Drilled: 8/4/81
Elevation: 6230 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6230.0 ft

COAL 8.2 ft total

Thickness	Depth	Elevation
1.2 ft	25.0 ft	6205.0 ft
1.5 ft	107.0 ft	6123.0 ft
1.5 ft	125.5 ft	6104.5 ft
2.5 ft	188.0 ft	6042.0 ft
1.5 ft	253.0 ft	5977.0 ft

Well Name: 26-9-1 Location: se¼se¼sw¼ sec 9 T2n R6w
Company: New Mexico Bureau of Mines Footage: 2500 ft E of W line 400 ft N of S line
Quadrangle: Puertecito Confidential: n
Field: Datil Mtns. County: Socorro Water: 164-166 ft, trace
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 300 ft Date Drilled: 8/18/81 Elevation: 6160 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6160.0 ft

COAL 7.5 ft total

Thickness	Depth	Elevation
1.2 ft	59.0 ft	6101.0 ft
2.0 ft	124.0 ft	6036.0 ft
1.5 ft	249.5 ft	5910.5 ft
2.8 ft	254.2 ft	5905.8 ft

Well Name: 26-15-1 Location: nw¼se¼sw¼ sec 15 T2n R6w
Company: New Mexico Bureau of Mines Footage: 1800 ft E of W line 700 ft N of S line
Quadrangle: Puertecito Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, rest, cal, dens, s.p., neut/pors
Total Depth: 301 ft Date Drilled: 8/20/81 Elevation: 6350 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6350.0 ft

COAL 3.0 ft total

Thickness	Depth	Elevation
1.2 ft	285.8 ft	6064.2 ft
1.8 ft	290.0 ft	6060.0 ft

Well Name: 26-17-1 Location: ne¼nw¼nw¼ sec 17 T2n R6w
Company: New Mexico Bureau of Mines Footage: 1300 ft E of W line 5000 ft N of S line
Quadrangle: Puertecito Confidential: n
Field: Datil Mtns. County: Socorro Water: 212 ft, 40 gpm
Geophysical logs: gamma, cal, rest, dens, s.p., neut/pors
Total Depth: 300 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6180.0 ft

COAL 1.7 ft total

Thickness	Depth	Elevation
1.7 ft	78.5 ft	6101.5 ft

Well Name: 26-25-1 Location: se¼se¼sw¼ sec 25 T2n R6w
Company: New Mexico Bureau of Mines Footage: 2300 ft E of W line 300 ft N of S line
Quadrangle: Indian Spring Canyon Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total depth: 319 ft Date Drilled: 9/1/81 Elevation: 6360 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6360.0 ft

COAL 2.7 ft total

Thickness	Depth	Elevation
1.2 ft	160.0 ft	6200.0 ft
1.5 ft	285.0 ft	6075.0 ft

Well Name: 26-25-2 Location: nw¼se¼se¼ sec 25 T2n R6w
Company: New Mexico Bureau of Mines Footage: 4500 ft E of W line 700 ft N of S line
Quadrangle: Indian Spring Canyon Confidential: n
Field: Datil Mtns. County: Socorro Water: 25-30 ft, 20 gpm
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 197 ft Date Drilled: 9/24/81 Elevation: 6310 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6310.0 ft

COAL 6.7 ft total

Thickness	Depth	Elevation
1.3 ft	36.0 ft	6274.0 ft
1.2 ft	135.0 ft	6175.0 ft
1.9 ft	138.0 ft	6172.0 ft
2.2 ft	140.0 ft	6170.0 ft

Well Name: 26-26-1 Location: sw¼se¼ne¼ sec 26 T2n R6w
Company: New Mexico Bureau of Mines Footage: 4400 E of W line 2600 N of S line
Quadrangle: Indian Spring Canyon Confidential: n
Field: Datil Mtns. County: Socorro Water: 119-123 ft, 15 gpm
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 200 ft Date Drilled: 8/27/81 Elevation: 6260 ft
Mineral ownership: Indian allotment Surface ownership: Indian allotment Analysis: n
Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6260.0 ft

COAL no coal beds $\geq$ 1.2 ft

Well Name: 27-1-1 Location: nw¼nw¼nw¼ sec 1 T2n R7w
Company: New Mexico Bureau of Mines Footage: 600 ft E of W line 5000 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: 52-55 ft, 5 gpm
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 199 ft Date Drilled: 7/23/81 Elevation: 6210 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6210.0 ft

COAL 11.4 ft total

Thickness	Depth	Elevation
4.0 ft	36.0 ft	6174.0 ft
2.0 ft	76.0 ft	6138.0 ft
2.5 ft	111.5 ft	6098.5 ft
1.3 ft	168.2 ft	6041.8 ft
1.6 ft	194.0 ft	6016.0 ft

Well Name: 27-1-1a Location: nw¼nw¼nw¼ sec 1 T2n R7w
Company: New Mexico Bureau of Mines Footage: 600 ft E of W line 5000 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: not logged
Total Depth: 320 ft Date Drilled: 10/7/81 Elevation: 6210 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	200.0 ft	6010.0 ft

COAL 6. ft total (from cuttings)

Thickness	Depth	Elevation
4. ft	204.0 ft	6006.0 ft
2. ft	250.0 ft	5960.0 ft

Well Name: 27-7-1 Location: se¼ne¼ne¼ sec 7 T2n R7w
Company: New Mexico Bureau of Mines Footage: 4900 ft E of W line 3900 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtn. County: Socorro Water: n
Geophysical logs: gamma, cal, dens, rest, neut/pors, s.p.
Total depth: 242 ft Date Drilled: 10/30/81 Elevation: 6560 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Qvy	0.0 ft	6560.0 ft
Tpg	24.0 ft	6534.0 ft
Kcc	85.0 ft	6475.0 ft

COAL no coal beds ≥ 1.2 ft

Well Name: 27-10-1 Location: se¼sw¼se¼ sec 10 T2n R7w
Company: New Mexico Bureau of Mines Footage: 3450 ft E of W line 300 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: 141-148 ft, 10 gpm
Geophysical logs: gamma, caliper, rest, dens, s.p., neut/pors
Total Depth: 164 ft Date Drilled: 11/12/81 Elevation: 6485 ft
Mineral ownership: fed Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Qvy	0.0 ft	6485.0 ft
Kcc	24.0 ft	6461.0 ft

COAL no coal beds ≥ 1.2 ft

Well Name: 27-12-1 Location: ne¼ne¼se¼ sec 12 T2n R7w
Company: New Mexico Bureau of Mines Footage: 5100 ft E of W line 2400 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 300 ft Date Drilled: 8/9/81 Elevation: 6210 ft
Mineral ownership: Indian Surface ownership: Indian allotment Analysis: n
Cuttings: y

Formation	Depth	Elevation
Kcc	8.0 ft	6202.0 ft

COAL 3.5 ft total

Thickness	Depth	Elevation
1.5 ft	78.5 ft	6131.5 ft
2.0 ft	241.0 ft	5969.0 ft

Well Name: 27-13-1 Location: se¼nw¼ne¼ sec 13 T2n R7w
Company: New Mexico Bureau of Mines Footage: 4000 ft E of W line 4300 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: 175-180 ft, 10 gpm
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 300 ft Date Drilled: 8/12/81 Elevation: 6280 ft
Mineral ownership: Santa Fe Railroad Surface ownership: Alamo Analysis: y Cuttings: y

Formation	Depth	Elevation
Kcc	5.0 ft	6275.0 ft

COAL 4.0 ft total

Thickness	Depth	Elevation
2.5 ft	100.5 ft	6179.5 ft
1.5 ft	158.0 ft	6122.0 ft

Well Name: 030705-1 Location: se¼nePne¼ sec 5 T3n R7w
Company: New Mexico Bureau of Mines Footage: 5000 ft E of W line 4200 ft N of S line
Quadrangle: Pueblo Viejo Mesa Confidential: n
Field: Cent. Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, caliper, s.p., por., n-n, density, resistance
Total Depth: 300 ft Date Drilled: 7/3/81 Elevation: 6475 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: y Cuttings: y

Formation	Depth	Elevation
Qvy	0.0 ft	6475.0 ft
Kcc	10.0 ft	6465.0 ft

COAL 2.0 ft total

Thickness	Depth	Elevation
2.0 ft	145.0 ft	6330.0 ft

Well Name: 37-16-1 Location: nw¼nw¼sw¼ sec 16 T3n R7w
Company: New Mexico Bureau of Mines Footage: 300 ft E of W line 2200 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Geophysical logs: gamma, cal, dens, rest, s.p., pors/neut
Total Depth: 240 ft Date Drilled: 10/19/81 Elevation: 6340 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6340.0 ft

COAL 3.0 ft total

Thickness	Depth	Elevation
1.6 ft	57.0 ft	6283.0 ft
1.4 ft	86.0 ft	6254.0 ft

Well Name: 37-35-1 Location: sw¼se¼sw¼ sec 35 T3n R7w
Company: New Mexico Bureau of Mines Footage: 1600 ft E of W line 400 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: 141 ft, 15 gpm
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 261 ft Date Drilled: 11/20/81 Elevation: 6310 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6310.0 ft

COAL 1.5 ft total

Thickness	Depth	Elevation
1.5 ft	177.8 ft	6132.2 ft

Well Name: 37-35-2 Location: nw¼sw¼nw¼ sec 35 T3n R7w
Company: New Mexico Bureau of Mines Footage: 500 ft E of W line 3650 ft N of S line
Quadrangle: Table Mtn. Confidential: n
Field: Datil Mtns. County: Socorro Water: 203-210 ft, 15 gpm
Geophysical logs: gamma, caliper, rest, dens, s.p., neut/por
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Kcc	0.0 ft	6240.0 ft

COAL no coal beds ≥ 1.2 ft

Well Name: 040706-1 Location: sw¼nw¼ne¼ sec 6 T4n R7w
Company: New Mexico Bureau of Mines Footage: 2600 ft E of W line 4000 ft N of S line
Quadrangle: Pueblo Viejo Mesa Confidential: n
Field: Cent. Datil Mtns. County: Cibola Water: n
Geophysical logs: gamma, s.p., neut/por, density, caliper, resistivity
Total Depth: 210 ft Date Drilled: 6/29/81 Elevation: 6740 ft
Mineral ownership: fed Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Ktf	0.0 ft	6740.0 ft
Ktc	60.0 ft	6680.0 ft

COAL no coal beds ≥ 1.2 ft

Well Name: 040730-2 Location: ne¼ne¼ne¼ sec 30 T4n R7w
Company: New Mexico Bureau of Mines Footage: 5000 ft E of W line 4900 ft N of S line
Quadrangle: Pueblo Viejo Mesa Confidential: n
Field: Cent. Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, caliper, density, s.p., neut/por, resistivity
Total Depth: 350 ft Date Drilled: 6/30/81 Elevation: 6600 ft
Mineral ownership: fed Surface ownership: priv Analysis: y Cuttings: y

Formation	Depth	Elevation
Qvy	0.0 ft	6600.0 ft
Kcc	5.0 ft	6547.0 ft
Kg	197.0 ft	6403.0 ft

COAL 7.5 ft total

Thickness	Depth	Elevation
1.5 ft	36.0 ft	6564.0 ft
2.0 ft	53.0 ft	6547.0 ft
4.0 ft	57.0 ft	6543.0 ft

Well Name: 040730-3 Location: sw¼nw¼nw¼ sec 30 T4n R7w
Company: New Mexico Bureau of Mines Footage: 30 ft E of W line 4900 ft N of S line
Quadrangle: Pueblo Viejo Mesa Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, cal, dens, rest, s.p., neut/pors
Total Depth: 350 ft Date Drilled: 7/3/81 Elevation: 6670 ft
Mineral ownership: fed Surface ownership: priv Analysis: y Cuttings: y

Formation	Depth	Elevation
Qvy	0.0 ft	6670.0 ft
Kcc	18.0 ft	6652.0 ft

COAL 4.5 ft total

Thickness	Depth	Elevation
1.5 ft	58.5 ft	6611.5 ft
3.0 ft	124.0 ft	6546.0 ft

Well Name: 040731-1 Location: nw¼se¼nw¼ sec 31 T4n R7w
Company: New Mexico Bureau of Mines Footage: 1500 ft E of W line 3600 ft N of S line
Quadrangle: Pueblo Viejo Mesa Confidential: n
Field: Datil Mtns. County: Socorro Water: n
Geophysical logs: gamma, cal, rest, dens, s.p., neut/pors
Total Depth: 350 ft Date Drilled: 7/3/81 Elevation: 6750 ft
Mineral ownership: Santa Fe Railroad Surface ownership: priv Analysis: n Cuttings: y

Formation	Depth	Elevation
Tpg	0.0 ft	6750.0 ft
Kcc	183.0 ft	6567.0 ft

COAL no coal beds $\geq$ 1.2 ft

APPENDIX 2

Proximate and Ultimate Data for Datil Mountain Coals

(as received)

Drill hole number	Depth interval analyzed	Volatile matter	Fixed carbon	Water	Ash	Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen
26-7-1	188-190.5'	37.27	44.78	6.93	11.02	65.51	4.92	1.09	0.66	9.87
26-9-1	59-60.2'	38.96	33.07	2.12	25.85	57.22	4.64	1.08	0.58	8.51
26-9-1	124-126'	41.32	47.42	2.93	8.33	71.90	5.46	1.03	0.72	8.33
26-15-1	285.8-287'	40.50	42.75	3.25	13.25	66.03	5.30	1.06	0.55	10.31
26-25-2	140-142'	33.77	45.10	0.34	20.79	65.64	4.80	1.02	0.50	6.91
27-1-1	38-40'	38.20	46.97	3.22	11.61	66.71	5.10	1.40	0.54	11.42
27-1-1	72-74'	43.98	46.39	3.80	5.83	72.26	5.70	1.54	0.44	10.43
27-12-1	100.5-104'	43.76	44.93	6.28	5.03	69.21	5.50	1.46	0.41	12.11
030705-1	146.148'	34.08	39.19	8.94	17.79	57.51	4.36	0.77	0.63	10.00
030705-1	175-177'	38.09	42.74	9.19	9.98	63.35	4.92	0.95	0.58	11.03
040730-2	36.5-37.5'	35.03	45.12	5.25	14.60	63.42	4.62	1.00	0.54	10.57
040730-2	54-55.5'	34.46	39.54	5.31	20.69	57.27	4.53	0.95	0.71	10.54
040730-2	60-62'	39.41	43.28	2.94	14.37	65.94	5.07	0.91	0.73	10.04
040730-3	65.5-67.5'	39.91	42.11	3.86	14.12	65.37	5.29	0.92	0.49	9.95
040730-3	125-128'	38.69	46.70	7.31	7.30	68.36	5.15	1.22	0.65	10.01

APPENDIX 3

GEOLOGIC MAP EXPLANATION

Quaternary Alluvial Deposits

ALLUVIAL DEPOSITS: (0-50 ft) Quaternary alluvial deposits have been separated by age with the exception of talus and colluivium. All the deposits with little or no soil development are classified as young and indicated by the addition of a letter suffix ´y´. Older alluvial deposits with significant soil development are classified as old and are denoted by the addition of a letter suffix ´o´.

[Qvy]-young valley alluvium; includes sands, silts, and gravels on floodplains, alluvial plains, and blowsands and silts infilling behind slump blocks.

[Qsg]-sand and gravel deposits in active, ephemeral stream channels.

[Qt]-fluvial terrace deposits.

[Qvo] older dissected deposits of sands and gravels in active stream channels, or finer grained deposits (mostly sands and silts) of alluvial plains with appreciable soil development, often calicified.

PIEDMONT SLOPE DEPOSITS: (0-50 ft), Fanglomerates, containing mixed clasts of all major rock types exposed in the current highlands.

[Qpy]-piedmont slope deposits with little or no soil development.

[Qpo]-older piedmont slope deposits with appreciable soil development, often calichified.

[Qtc]-talus/colluvium consisting of unconsolidated talus, soil-stabilized talus and slope wash deposits.

[Qbt]-basaltic talus derived from the mesa-capping basalts. (mapped only on Pueblo Viejo Mesa quadrangle)

Tertiary Deposits

Pliocene

Tpg]-TERTIARY PIEDMONT GRAVELS: (10- 200+ ft) volcaniclastic unit made up of clasts of Oligocene ash flow tuffs, and mudflows deposits in a silty sand matrix. Typically the unit is made up of a calicified, unconsolidated silty sandstone containing occassional volcanic pebbles and a lag gravel of volcanic pebbles at the top of the unit. Transport directions trend to the north in areas north of the Rio Salado. Age of the unit is bracketed by radiometric dating as Late Oligiocene to Late Pliocene (discussed in text).

[Tbf1,2,3]-basalt flows (20-100 ft) vesicular and porphyritic, clearly becoming younger to the east. Interbedded with the TERTIARY PIEDMONT GRAVELS. Numbers on Pueblo Viejo Mesa denote relative age with "1" being the oldest and "4" being the youngest.

Miocene

[Tp]-POPOTOSA FORMATION:(0-1000+ft)Conglomeratic sedimentary rocks.

Oligiocene

[Ti]-mafic intrusive dikes and sills ((2-10 ft), broken down to [Tid] and [Tis], respectively, where stratigraphic relationships are clear, could be to as young as Pliocene in some cases. Volcanic necks labelled [Ti].

[Tju]-LA JENCIA TUFF, UPPER MEMBER: (0-200+ ft) Light gray, moderately welded, crystal-poor, pumiceous, rhyolite ash-flow tuff. Normally less than 40 ft thick but thickens to 200ft in paleovalleys. Separated from the lower member by the LA JARA PEAK ANDESITE.

[Tlp]-LA JARA PEAK ANDESITE: (0-650+ ft) Microporphyritic, basaltic-andesite lava flows, commonly containing vesicles filled with calcite.

[Tjl]-LA JENCIA TUFF, LOWER MEMBER: (20-200 ft) Multiple-flow, compound cooling unit of densely-welded ash-flow tuffs.

[Thm]-HELLS MESA TUFF: (0-500 ft) Multiple flow, simple cooling unit of moderately to poorly welded, crystal-rich, quartz-rich ash-flow tuff.

[Tsp]-SPEARS FORMATION: (1000 ft) Grayish purple to yellowish gray, intermediate-composition laharic breccias, volcanic conglomerates, mudflow deposits, and volcaniclastic sandstones.

Eocene

[Tb] - BACA FORMATION: (950 ft) red to brown sandstones, calcareous mudstones, and minor conglomerates. Sandstones are very fine-grained to coarse grained and commonly have parallel laminations and minor trough cross-bedding.

Cretaceous Deposits

MESAVERDE GROUP

[Kcc]-CREVASSE CANYON FORMATION: (1000+ ft) Continental sequence of thinly bedded sandstones, grey shales, carbonaceous shales, and coals. Coals are concentrated in the lower half of the formation but thin coals occur throughout the unit.

[Kg]-GALLUP SANDSTONE: (10-85 ft) Yellow-brown, fine to medium grained sandstone sequence characterized by stacked planar cross-bedded sets, burrows (Ophiomorpha), and a distinctive bedding plane split, often containing the guide-fossil, Lopha sannionis.

[Kth]-TRES HERMANOS FORMATION: (240 ft) A marginal marine sequence consisting of a regressive sandstone at the base, a continental shale in the center, and a transgressive sandstone at the top. The continental sequence is locally coal-bearing. Three members are recognized and have been mapped on Pueblo Viejo Mesa, the members continue to the south and east but were not mapped by the original workers in these areas.

[Ktf]-FITE RANCH SANDSTONE MEMBER: (10-50 ft) Transgressive fine-grained sandstone, light gray to buff, typically trough and planar cross-bedded, minor burrows, bioturbated, moderately sorted, medium bedded, laminations common, top marked by dark brown concretions and orange calcarinite.

[Ktc]-CARTHAGE MEMBER: (50-150 ft) medium to dark gray shales, thin light brown sandstones, and coals up to 18" thick. Vertebrate fossils, brackish-water pelecypods, and wood common.

[Kta]-ATARQUE SANDSTONE MEMBER: (5-40 ft) orange gray, fine-grained, coarsening upward sandstone with planar and trough cross-bedding, clay clasts, top is marked by a dark brown coquina.

MANCOS SHALE: a paladual to offshore silty shale that intertongues with the DAKOTA SANDSTONE. Commonly green-gray to medium gray with abundant fossils usually found in concretions, especially in the D CROSS-TONGUE.

[Kmd]-D-CROSS TONGUE: (75-140 ft) medium gray to moderate olive gray, non to slightly calcareous, bioturbated silty mudstone containing abundant, fossil-bearing concretions. Fossils identified include: Prinocyclus novimexicanus, Coilopscerous inflatum, and Lopha bellaplicata .

[Kmr]-RIO SALADO TONGUE: (60-70 ft) gray calcareous shale at base grading to medium brown noncalcareous shale within 20 feet of the top of the unit. Guide fossil Pycnodonte newberryi occurs abundantly 10 feet above base.

[Kmw]-WHITEWATER ARROYO TONGUE:(0-90 ft) poorly exposed, medium gray, silty shale. Present only on Pueblo Viejo Mesa quadrangle where the PAGUATE TONGUE is recognized.

[Kml]-LOWER PART OF THE MANCOS:(70- 280 ft) medium to dark gray shale, includes only shales below the TWOWELLS TONGUE on Pueblo Viejo Mesa quadrangle, but includes all shales up to the base of the TRES HERMANOS FORMATION past the southeastern- pinchout of the TWOWELLS TONGUE.

DAKOTA SANDSTONE

[Kdt]-TWOWELLS TONGUE: (10-30 ft) light gray, fine-grained sandstone characterized by 2-3 inch upward-fining cycles of a bioturbated cycle and then a burrowed cycle.

[Kdp]-PAGUATE TONGUE:(0-30 ft) yellow brown, fine to medium grained sandstone, with minor crossbedding. Pinches out to the south and east of T. 5 N., R. 7 W.

[Kdm]-MAIN-BODY DAKOTA: (10-30 ft) yellow brown, medium-grained sandstone unit with trough crossbeds. Base of this unit marked by a lag gravel of well-round quartzite pebbles, probably reworked from the Triassic and Jurassic.

Triassic deposits

[TRc]-CHINLE:(0-120 ft) very poorly exposed series of interbedded shales and siltstones. Shales are typically red to lavender,mottled and silty.

SYMBOLS

geologic contact, dashed where approximate

fault, dashed where approximate, dotted where inferred; ball on downthrown block

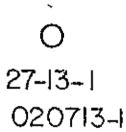
strike and dip of bedding

transport direction in conglomerates (pebble imbrications)

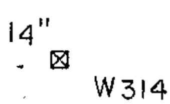
trace of anticlinal axis, dashed where approximate

trace of synclinal axis, dashed where approximate

volcanic vent



drillhole location- NMBMMR drillholes numbered by township, range, section and ordinal number of drillhole in section. Commmercial drillholes numbered with an abbreviated version of the original name.



measured coals (outcrop) - left of symbol is thickness in inches. In some cases, these are Winchester´s (1913) original measured coal sections; in this case, Winchester´s original outcrop numbers are given at right. All locations have been checked by NMBMMR staff.

Geology of Indian Spring Canyon quadrangle,

Socorro County, New Mexico

compiled by G. R. Osburn & J. C. Osburn, 1982

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

INDIAN SPRING CANYON QUADRANGLE
NEW MEXICO—SOCORRO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1963. Field checked 1964

Polyconic projection. 1927 North American datum
10,000-foot grid based on New Mexico coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

Certain land lines are omitted because of insufficient data

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Plate 1

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Light-duty .... Unimproved dirt

INDIAN SPRING CANYON, N. MEX.
N3415—W10722.5/7.5

1964

AMS 4552 IV SW—SERIES V881

SPECIAL PRINTING
Contours and woodland symbols omitted

O.F. 164 1 of 6

Socorro and Cibola Counties, New Mexico

by J. C. Osburn, 1981

O.F. 164 2 of 6

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PUEBLO VIEJO MESA QUADRANGLE
NEW MEXICO
7.5 MINUTE SERIES (TOPOGRAPHIC)

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1963. Field checked 1964

Polyconic projection. 1927 North American datum
10,000-foot grids based on New Mexico coordinate system, central and west zones
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Plate 2

ROAD CLASSIFICATION

Light-duty Unimproved dirt

QUADRANGLE LOCATION

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

PUEBLO VIEJO MESA, N. MEX.
N3430—W10730/7.5

1964

AMS 4453 II SE—SERIES V881

Geology of Table Mountain quadrangle,

Socorro County, New Mexico

by S. M. Cather, 1981

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

NEW MEXICO

QUADRANGLE LOCATION

Plate 3

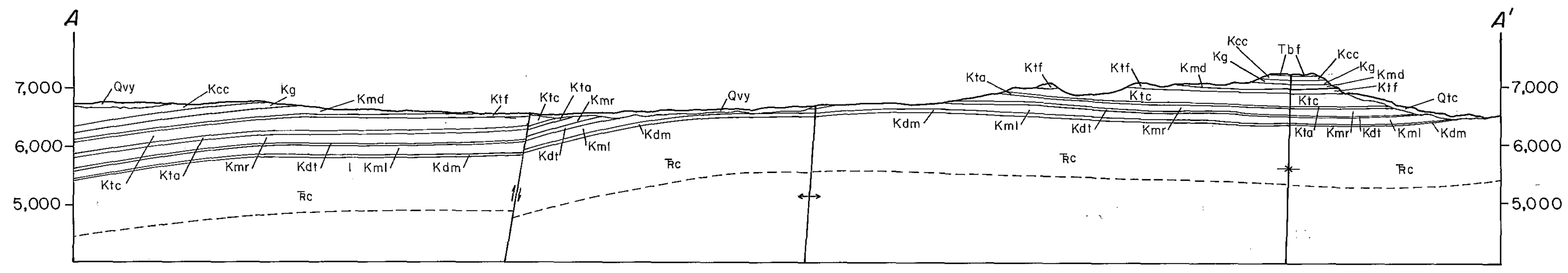
O.F. 164 3 of 6

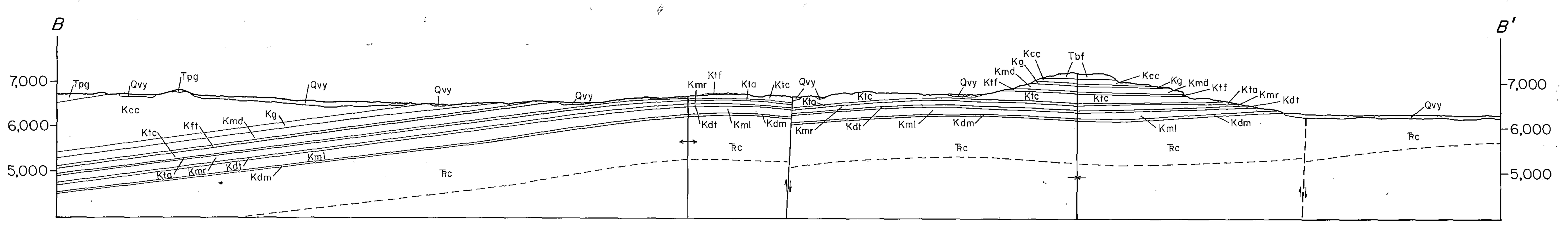
Geologic cross-sections of Pueblo Viejo Mesa, Table Mountain and Indian Spring Canyon quadrangles, Socorro and Cibola Counties, New Mexico

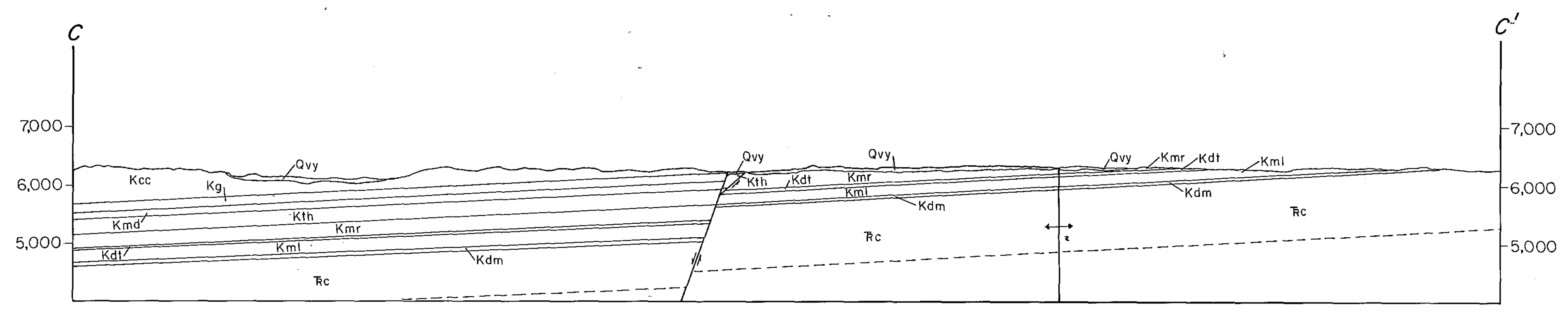
by

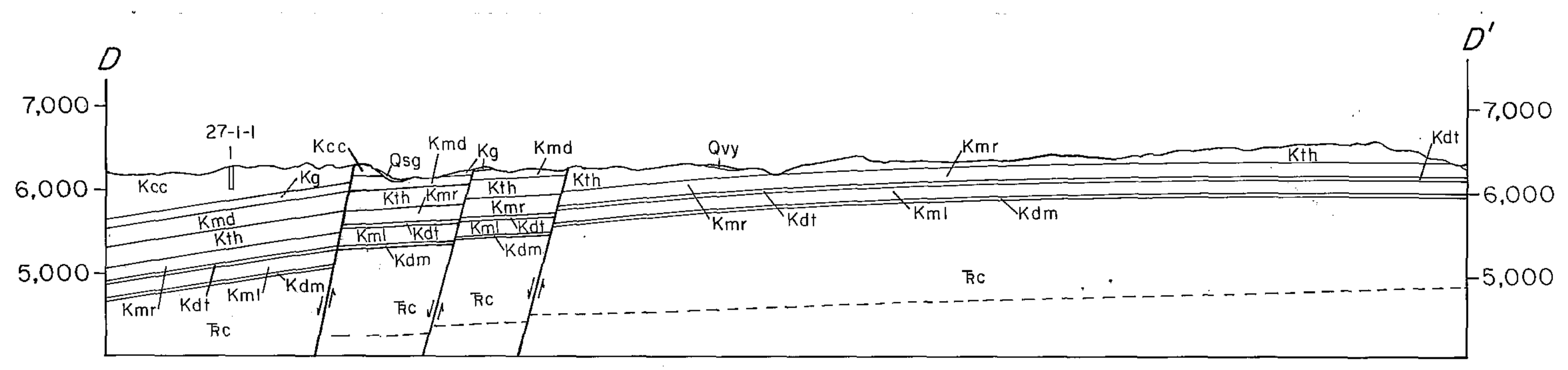
J.C. Osburn

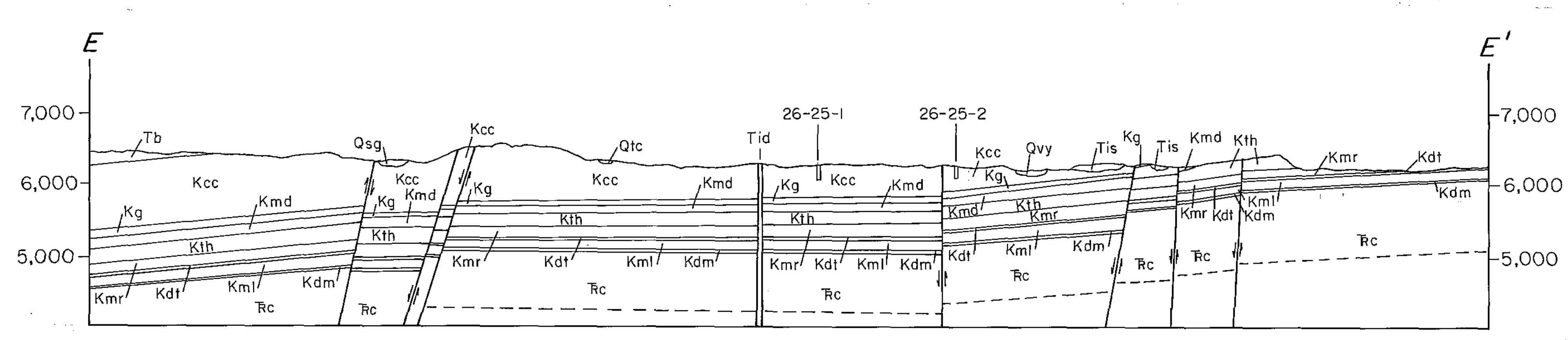
1982









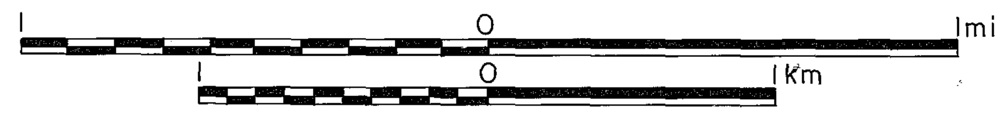


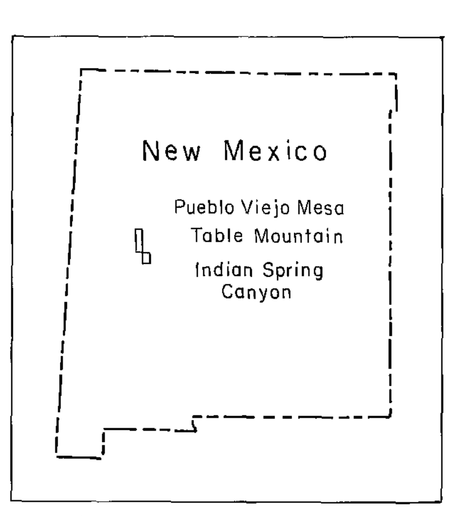
All cross sections face north to northwest

Thin alluvial units not shown in area of high detail

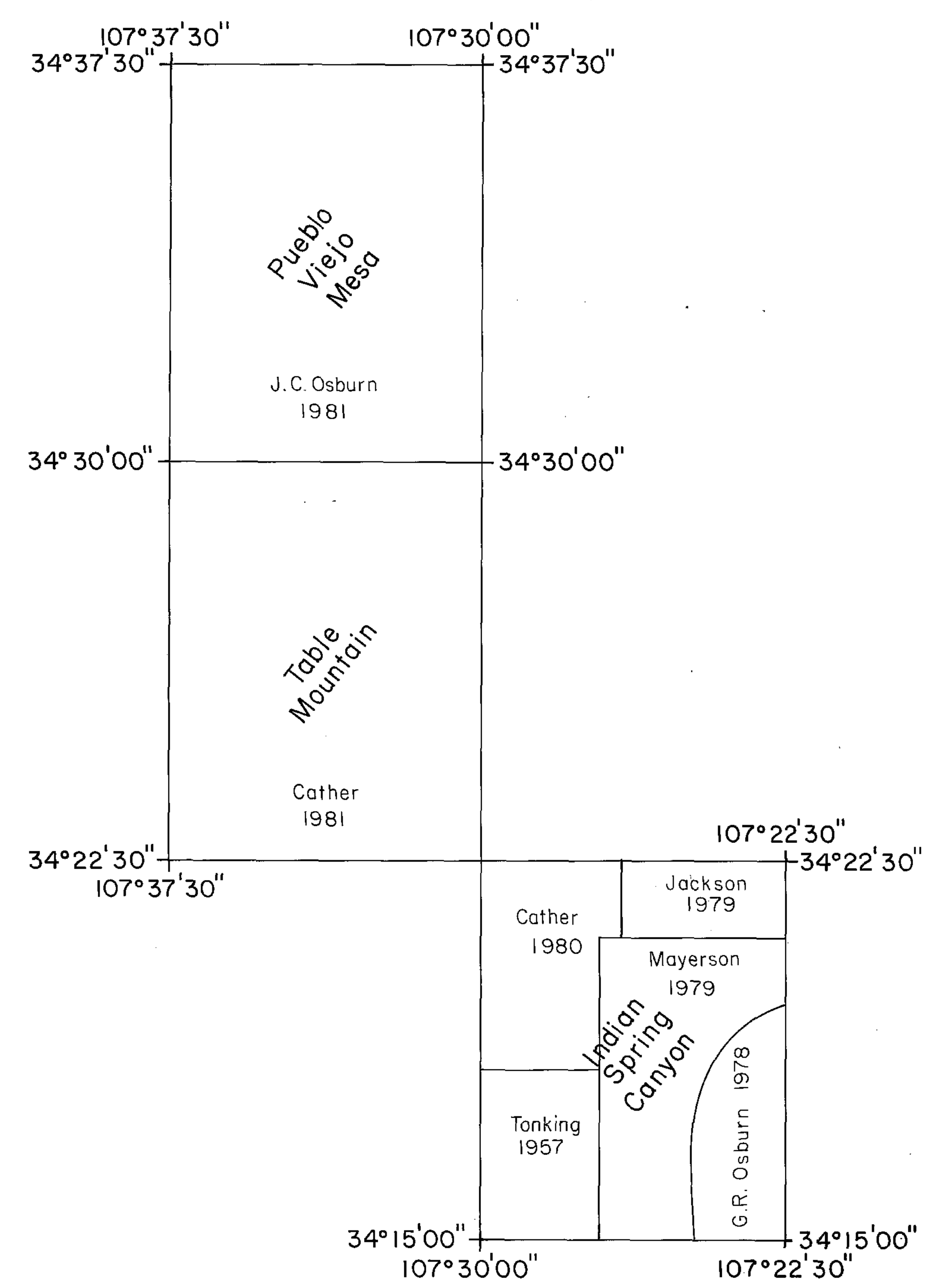
No vertical exaggeration

SCALE 1:24,000





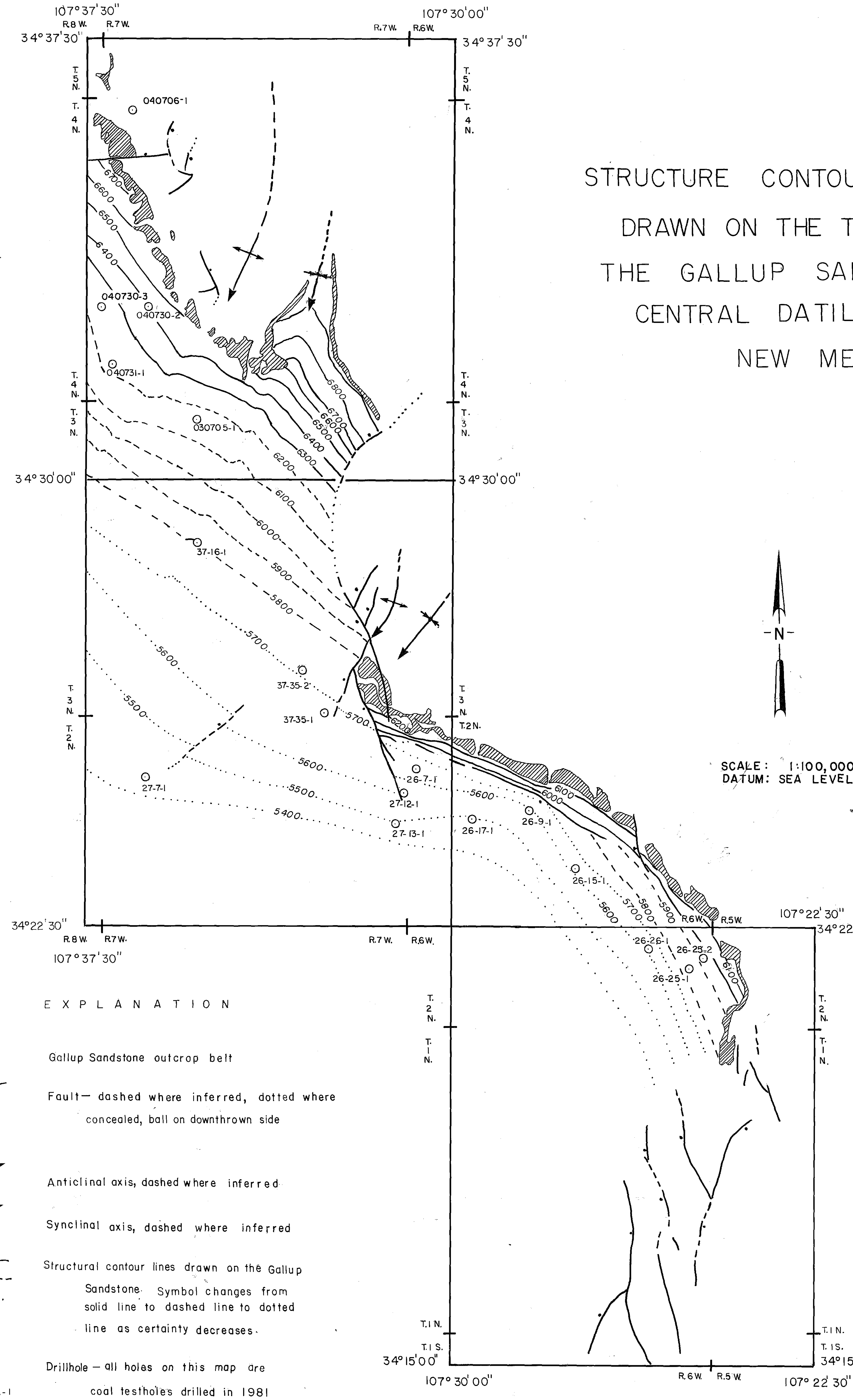
Location Map



Original mapping responsibilities

Plate 4

STRUCTURE CONTOUR MAP
DRAWN ON THE TOP OF
THE GALLUP SANDSTONE
CENTRAL DATIL MOUNTAINS
NEW MEXICO



E X P L A N A T I O N

Gallup Sandstone outcrop belt

Fault— dashed where inferred, dotted where concealed, ball on downthrown side

Anticlinal axis, dashed where inferred

Synclinal axis, dashed where inferred

6400 / 6400 / 6400 — Structural contour lines drawn on the Gallup Sandstone. Symbol changes from solid line to dashed line to dotted line as certainty decreases.

27-12-1
020712-1
Drillhole — all holes on this map are coal testholes drilled in 1981 for this project.

Plate 5

O.F. 164

5 of 6 OF 164

CORRELATION OF DRILLHOLES PENETRATING THE CREVASSE CANYON FORMATION,

CENTRAL DATIL MOUNTAINS, NEW MEXICO