Geology and Coal Resources of Wild Horse Canyon quadrangle Catron and Cibola Counties, New Mexico

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Geology of Wild Horse Canyon Quadrangle

INTRODUCTION

Wild Horse Canyon quadrangle straddles the Catron-Cibola County boundary 1.5 mi west of the northwestern corner of Socorro County in the central part of the Datil Mountains coal field (Fig. 1). The quadrangle is about 30 mi due north of Datil but is more easily reached from the south by NM-36 from Pietown or from the north by NM-117 from Grants. One well-maintained dirt road crosses the quadrangle from east to west in its northern third; access to the rest of the area is fair to good during dry weather via dirt roads and four-wheel-drive trails to stock tanks and windmills. Travel in the area is severely restricted during wet periods.

The Wildhorse Canyon quadrangle is situated in the Acoma-Zuni physiographic subprovince of the Colorado Plateau (Hawley and Love, 1981). Techado Mesa dominates the east-central part of the quadrangle and rises to 8430 ft as the highest point of the study area. The stream bed of Miguel Chavez Canyon in the extreme southeast corner of the quadrangle is the low point in the area at 6880 ft. Most of the landscape of northern third of the quadrangle comprises gentle hills and broad alluvial plains. The southern two-thirds of the area is characterized by flat-topped mesas and arduous steep-walled canyons. Blue Water Creek, Cebolla Creek, and Rio Salado are the larger intermittent streams in the area. In addition, there are many small tributaries originating at the heads of narrow canyons. Fault-controlled

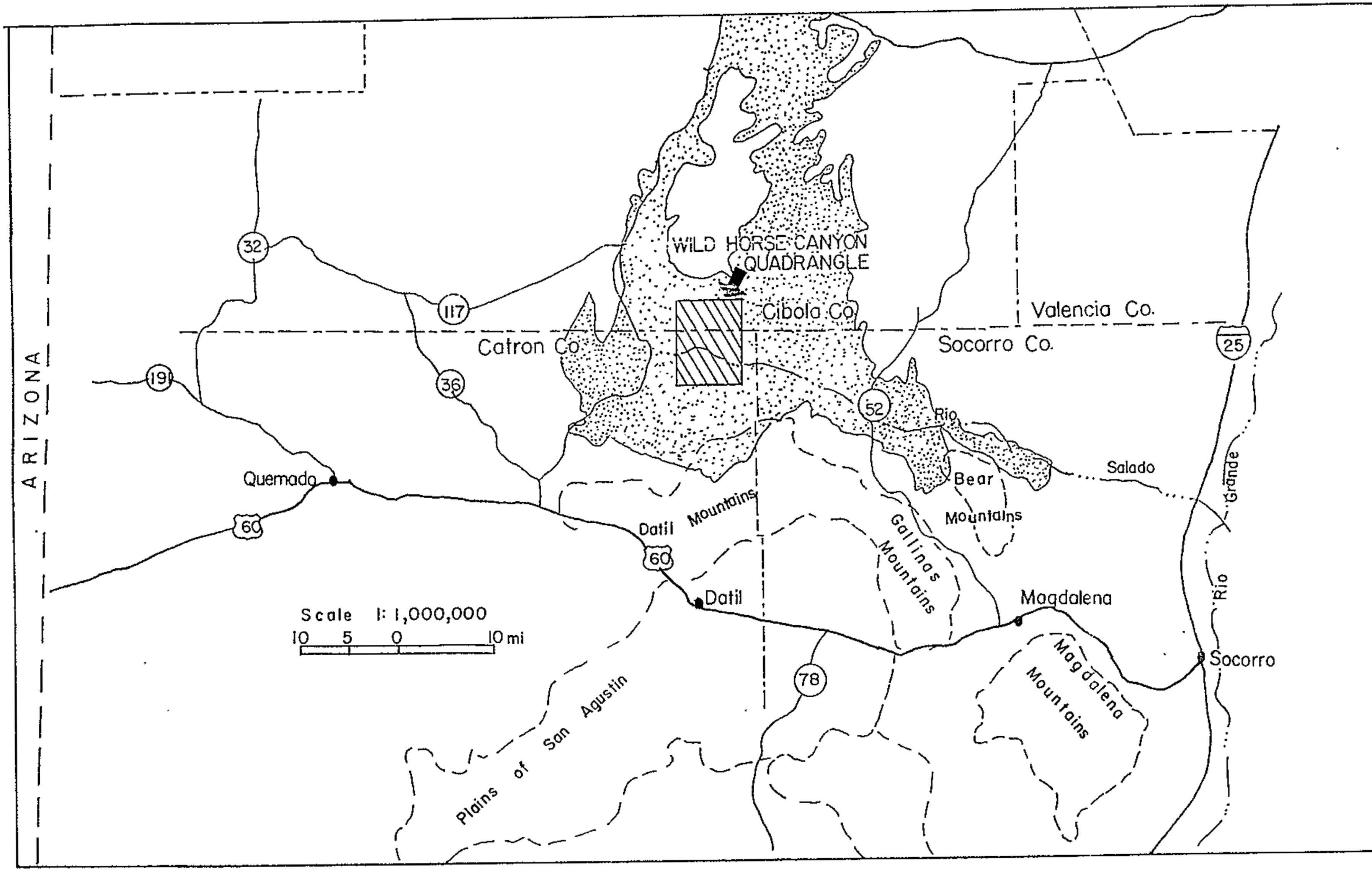


Figure 1: Index map to west-central New Mexico. Datil Mountains coal field shown in stippled pattern.

springs throughout the area provide stock water. Winchester (1920) was the first to work in the area. He discussed the oil and gas potential of the Cow Springs Anticline located in the south-central part of Wild Horse Canyon quadrangle. In addition, he located extensive coal outcrops in the area and identified major structural trends in the Alamosa Creek region. Wild Horse Canyon quadrangle was included in the discussion of the Upper Cretaceous stratigraphy of the McCarty-Alamosa Creek area. Dane and others (1957) measured stratigraphic sections in the Alamosa Creek Valley and assigned the rocks to stratigraphic units found in the San Juan Basin. An excellent synposis of the oil and gas exploration in Wild Horse Canyon quadrangle was given by Foster (1964). Frost and others (1979) drilled a coal test hole in the northeast part of the quadrangle as part of a coal reconnaissance study in the Datil Mountains coal field.

Land ownership in the map area forms a checkerboard pattern between federal and private land. State-owned land comprises about 10% of the total surface rights while the remaining land is divided almost equally between public domain and patented land. Mineral rights in the quadrangle are similarly divided among state, federal and private owners. The Atchison, Topeka, and Santa Fe Railroad has retained the mineral rights to over half of the patented lands. Land use in the area is largely confined to ranching activities. Two small sawmills operated in the early 1900's. Techado Mesa is home to about 20 wild burros, perhaps naming the quadrangle, Wild Horse Canyon.

The details of the depositional environments and the rocks representing the Upper Cretaceous stratigraphic sequence have not been previously evaluated in the Datil Mountains coal field. This map is the eighth in a series of 1:24,000 scale quadrangles to be mapped in the Datil Mountains coal field. The purpose of this work is to provide basic geologic information for those interested in expanding coal and petroleum exploration in the Datil Mountains coal field.

I would like to thank the people that live in Wild Horse Canyon quadrangle who gave me access to their properties and showed me hospitality during the field seasons of 1983 and 1984. These people include John Lee, Henry Summers, and Buddy Major. Santa Fe Mining, Inc. provided unreleased geophysical logs for study. Glenn R. Osburn analysed basalt samples from Techado Mesa. Orin Anderson, Ronald Broadhead, Glenn Osburn, and Brian Arkell reviewed the manuscript and made helpful suggestions.

Structure

The overall structural style present in the Wild Horse Canyon area is that of a gentle, southwest-dipping homocline typical of the southern Colorado Plateau. The homocline is broken by several mainly down to the east step-like normal faults trending north-northwest in the southern and western parts of the quadrangle. In addition, gentle folding is recognized in the south central part of the quadrangle. This deformation probably records Laramide folding and Late Cenozoic normal faulting.

Three major structural features exposed in the Wild Horse Canyon quadrangle were first identified by Winchester (1920).

These features include: the Pasture Canyon Fault, the Miguel Fault, and the Cow Springs Anticline (Plate 1). Both of the aforementioned normal faults are down-thrown to the east and trend north-northwest. Pasture Canyon Fault juxtaposes the Gallup Sandstone against beds of the lower to middle Crevasse Canyon Formation with a probable displacement of 200-300 vertical ft. Winchester (1920) suggested that the western side of the fault is a potential structural trap for oil accumulation but to date, this area has not been tested. The Miguel Fault is located to the east of Pasture Canyon Fault within the lower Crevasse Canyon Formation and has a maximum vertical displacement of 100 ft. The Cow Springs Anticline exposes a broad expanse of Gallup Sandstone in its nose. The fold trends northward and measures about 2 mi across its hinge. The limbs of the fold are cut off by the Miguel Fault to the east and the Pasture Canyon Fault to the west. The nose of the fold is unfaulted and has been the site of four oil tests drilled from 1925 to 1981, based on recommendations by Winchester (1920), Wengard (1959), and Foster (1964).

Several other small, normal faults are found on the eastern side of Wild Horse Canyon quadrangle (Plate 1). These faults trend north-northwest and have displacements of less than 100 ft. Three of these faults dissect Techado Mesa and clearly cut the basalt that caps the Mesa. Baldridge and others (1983) have dated correlative basalts to the east on Tres Hermanos Mesa at 3.3 to 4.0 m.y. b.p. thus restricting the age of the faulting to Pliocene or younger.

Stratigraphy

The rocks exposed in Wild Horse Canyon quadrangle range from Late Cretaceous (Turonian) to recent in age and include Gallup Sandstone, Crevasse Canyon Formation, Tertiary basalts and Quaternary alluvial deposits. Several geophysical logs in the area mark the subsurface D-Cross Tongue of the Mancos Shale, the upper two members of the Tres Hermanos Formation, the Fite Ranch Sandstone Member and the Carthage Member.

The Carthage Member of the Tres Hermanos Formation, the oldest rocks found in these drill holes, was recently defined by Hook and others (1983) as the medial, marginal marine, and non-marine part of the Tres Hermanos Formation situated between the two marine sandstone members. The Carthage can be identified in three geophysical log suites from drillholes in the area. The Carthage Member is here dominated by mudstone and interbedded mudstone and siltstone suggesting a paludal environment. Lesser amounts of sharp based, thin sandstones and silty sandstones are present throughout the unit. Based on earlier work by Hook and others (1983), Osburn (1982, 1984), and Robinson (1981), these sandstones probably represent small distributary channels, frontal and crevasse splay deposits, and bay-fill strata. Total estimated thickness of the Carthage Member in the Wild Horse Canyon area is 150-180 ft. Overlying the Carthage Member is the Fite Ranch Sandstone Member of the Tres Hermanos Formation. This unit represents a coastal barrier sandstone associated with the overlying transgressive D-Cross Tongue of the Mancos Shale (Hook and others, 1983). The Fite Ranch is present in five drill holes in the Wild Horse Canyon area and ranges from 24 to 36 ft in thickness. Lithologically, the unit consists of a slightly upward-coarsening sequence of silty sandstone.

The D-Cross Tongue of the Mancos Shale was defined by Dane and others (1957) as the shale body between the units now assigned to the Fite Ranch Sandstone Member of the Tres Hermanos Formation and the Gallup Sandstone. The stratotype of the D-Cross is located at D Cross Mountain, located about 2 mi southeast of Wild Horse Canyon quadrangle. The D-Cross is present in eight drill holes in the quadrangle and ranges from 150 to 200 ft in thickness. The tongue is made up of silty mudstones, siltstones and some very thin sandstone beds. Robinson (1981) noted five persistant calcareous concretionary zones in the D-Cross; these zones are easily recognized on some of the resitivity and density geophysical logs.

The Gallup Sandstone is the oldest stratigraphic unit that crops out in Wild Horse Canyon quadrangle. The Gallup is a regressive coastal barrier sandstone consisting of an upper very fine grained to upper fine grained, upward coarsening, subarkose between 75 and 100 ft thick. Field grain sizes were estimated using a grainsize comparison chart and a hand lens (American Stratigraphic, undated).

The Gallup and the overlying Crevasse Canyon Formation comprise a clastic wedge of coastal plain and alluvial sediments that prograded northeastward into the Western Interior Seaway starting in Late Turonian time (Molenaar, 1983). In some outcrop exposures, there is a 10 - 15 ft silty carbonaceous mudstone interval 30 to 40 ft from the base of the Gallup. This may represent local subsidence and marsh buildup behind the coastal barrier. The mudstone interval is not apparent in the nine drill holes in Wild Horse Canyon quadrangle that penetrate the Gallup but is very common in outcrop exposures to the east in Pueblo Viejo Mesa and Puertocito quadrangles. From subsurface data, the contact of the Gallup with the underlying D-Cross Tongue of the Mancos is gradational over about 15 ft and consists of an upward coarsening sequence from siltstone to very fine-grained sandstone. The D-Cross/Gallup contact is not surficially exposed in the study area. The contact with the overlying Crevasse Canyon Formation by contrast is sharp and conformable and represents the shoreward change from a beach environment dominated by sandstone to a lagoonal enviroment dominated by mudstones.

The Gallup Sandstone exposed in the study area is typical of Gallup present throughout the Datil Mountains coal field. Exposures are often in steep cliff faces making detailed study difficult. Much of the Gallup is intensely bioturbated further obscuring detail. Two outcrops in N 1/2 sec. 2 and 3, T. 4 N., R. 9 W. consist of 40 ft of massive very fine-grained sandstone with infrequent small feeding trails on bedding planes. Above the main sandstone is a partially-covered 15 ft-thick section of silty mudstone. A 20 ft-thick massive sandstone grading up from upper very fine grained to lower fine grained sandstone completes the Gallup in this area. In the area around Onion Spring (Plate 1), the top of the Gallup is present as a nearly flat pavement outcrop in the nose of the Cow Springs Anticline. Here the unit consists of up to 50 ft light yellowish-gray, lower fine grained sandstone with abundant, small (2 cm) ironstone concretions, burrow mottling, and Ophiomorpha-like branching burrows on bedding plane surfaces in the upper 20 ft of the Gallup. This is only a partial Gallup section and the lower sandstone and siltstone units are not exposed.

In Squirrel Canyon and Miguel Chavez Canyon, the Gallup Sandstone crops out in cliffs and is physically similar to that in the Onion Spring area. In addition to the above-described sedimentary structures, there are locally abundant, small-scale herringbone crossbeds which probably represent small tidal channels.

On a mesa in sec. 5 & 9, T. 3 N., R. 9 W. on the west side of Pasture Canyon Fault, a nearly complete (excepting the lower few feet which are talus-covered) section of Gallup is exposed. Here the Gallup consists of a very fine-grained sandstone about 35 ft thick, overlain by a 10 ft section of silty mudstone, and capped by a fine-grained sandstone about 30 ft thick. The contact with the overlying Crevasse Canyon Formation is marked by a five foot thick rip up clast breccia suggesting storm sedimentation before establishment of the quiet water paludal mudstones more typical of the lower part of the Crevasse Canyon Formation.

The Crevasse Canyon Formation was first named for exposures of nonmarine rocks in the southwestern part of the San Juan Basin (Allen and Balk, 1954). This unit was extended into the Datil Mountains coal field by Givens (1957). Various workers including Massingill (1979), Robinson (1981), and Osburn (1983) have on lithologic characteristics. These attempts have largely failed regionally because of a lack of marker beds and the general heterogeneous nature of any prograding clastic wedge. The Crevasse Canyon Formation in Wild Horse Canyon quadrangle is incomplete largely because of closely spaced faults and gentle folds. This unit comprises all of the outcrop on the western half of the quadrangle and much of the outcrop exposed in the south-east quarter of the quadrangle. Exposures vary from being very poor in mudrock-dominated parts of the formation to excellent where advantageously-positioned sandstone bodies protect thick mudstone sequences.

Subsurface information in the western part of the quadrangle shows that 700 ft of the Crevasse Canyon Formation is present within the area. These subsurface data are probably more reliable than those presented further east in Osburn (1982) because of clear Crevasse Canyon/Gallup contacts in drillholes making correlation much stronger. But it must be emphasized that the top of the Crevasse Canyon Formation has not been recognized anywhere in the Datil Mountains coal field and variable thickness of the formation is likely because of local structural complication and variable Cenozoic erosion.

Three lithofacies are present in outcrops of the Crevasse Canyon: a mudstone facies and two sandstone facies mapped together, a splay sandstone facies and a channel sandstone facies. The mudstone facies is volumetrically the most significant part of the formation but is seldom well exposed over any distance. This facies comprises carbonaceous mudstone, clayshale, siltstone, and mudshale with subordinate amounts of thin, lenticular coal beds, and thin, very fine-grained sandstones. The best exposures of mudstone facies are found where mudstones are capped by sandstone units, such as in NE 1/4 sec. 24, T. 4 N., R. 10 W. Here the mudstone facies consists of a thick sequence of dark to medium gray siltstone and carbonaceous, silty mudstone. Some of the mudstones exhibit thin, wavy bedding that is accentuated by abundant plant fragments and thin, infilling sandstone beds. Iron staining and zones of ironstone concretions are locally common, especially in association with coal beds. The presence of ironstone concretions, rooting traces, bioturbation, and early diagenetic features such as cone-in-cone and boxwork structures in the mudstone facies suggest long enough breaks between major depositional events to allow chemical and biological processes to be recorded in the stratigraphic record. Johansen (1983) speculates that the ironstone concretions may have originated as siderite-cemented clay or as organic-rich sediment. This is consistent with all of the paleoenvironments probably represented by the mudstone facies. These environments likely include: peat swamps and marshes on the lower part of the coastal plain and interdistributary bays and lagoons caused by differential compaction. Coal beds are found in the mudstone facies beginning about 40 ft above the Gallup Sandstone where a coal bed consistently exceeds 3 ft in thickness and is laterally persistent throughout much of the eastern and central part of the Datil Mountains coal field. In the Wild Horse Canyon area, there are three thinner coal beds present at intervals 80 to 160 ft above the Gallup. With the exception of a locally persistent two ft thick coal bed at 275 ft above the Gallup, most of the coal beds from 160 to 470 ft are thin and discontinuous. At about 470 ft above the Gallup, there is another thick coal bed present in a New Mexico Bureau of Mines and Mineral Resources drill hole, D-4, located in NW 1/4 sec. 2, T. 4 N., R. 10 W., and two Santa Fe mining, Inc. holes in the area. In D-4, the coal bed was reported to be 4 ft thick (Frost and others, 1979). Only these three drillholes penetrate this stratigraphic interval in Wild Horse Canyon, thus the areal extent of the coal bed is unknown. However, there are coal beds in the same interval that are continuous over several miles in the eastern part of the field, from 7 to 20 mi away (Osburn, 1982).

Thin siltstone and very fine-grained sandstone sheets are locally common in the mudstone facies. These sheets have sharp but unscoured bases and are thinly to very thinly bedded. Some of the sandstones exhibit rooting traces and bioturbation. These thin units probably are overbank deposits laid down in interdistributary bays during storms. In some cases, these sandstones may represent the distal ends of crevasse splay deposits (Johansen, 1983).

Sandstones within the Crevasse Canyon Formation are of two major types: overbank deposits and small channel deposits laid down by anastomosing streams similar to those described in the Niger Delta (Allen, 1965) and in the lower part of the Mississippi River delta plain (Coleman and Gagliano, 1965). All of the sandstones in the Crevasse Canyon Formation can be classified as representing some part of the fluvial system.

These sandstones range from thin individual channels and splay deposits from 1 to 6 ft thick concentrated in the lower part of the formation to thick vertically stacked sand sequences in the upper part of the formation attaining aggregate thicknesses of up to 60 ft. In some cases, sandstone bodies are isolated in mudstone and individual environments of deposition are easy to discern. More often though, a single stacked sandstone sequence includes many small channels, multiple crevasse splay deposits, and levee deposits. A good example of such a sequence can be seen in NW 1/4 sec. 26, T. 4 N., R. 10 W.

Sandstone packages gradually thicken up section and increase in frequency. This change probably can be linked to an upward transition from the lower coastal plain to inland fluvial environment. Similar textural changes can be observed in the eastern part of the Datil Mountains coal field and to the south in the Engle coal field and at Sierra Blanca (Arkell, pers. comm), (Wallin, 1983). Coarser clastic sources in the upper coastal plain may be related to a deformational event proposed by Johansen (1984) that caused erosion and deformation of the Mid-Jurassic arc of southern Arizona beginning about 89 mya.

Sandstone deposited by frontal and crevasse splays account for most of the sandstone preserved in the Crevasse Canyon Formation. Splay deposits range from the thin sheet sandstones and siltstones present in the mudstone facies to vertically stacked, splay sequences up to 60 ft thick and showing strong channel development on underlying splay deposits. A good example of a simple stacked splay deposit is found in NW 1/4 sec. 24, T. 4 N., R. 10 W. The splay prograded from east to west and

20 ft thick sequence of silty mudstone, very fine-grained and fine-grained sandstone. At the proximal end of the splay, the sequence strongly resembles a channel sandstone deposit. From the bottom to the top of each splay, the sequence consists of a one-foot-thick interval of jumbled, pebble-sized mudclast conglomerate in a silty matrix scoured into yellow gray mudstone typical of lagoonal deposits. A sharp-based, moderately sorted, wedge planar crossbedded sandstone comprises the main part of the splay, reaching thicknesses of 10 ft. Planar laminations and ripple laminations complete the single splay sequence. At this exposure, another splay is stacked on top of the above-described sequence yielding a combined thickness of about 20 ft. Splay sequences can be as little as a few feet in thickness or can range up to 30 ft for a single cycle and all deposits thin away from the source. The major sandstone unit in the splay generally fines upward and bedding also thins upward in each cycle. Though not present in this particular example, it is quite common for small channels to be scoured into the upper part of the splay sequence. This occurs as the splay builds out into the lagoon and flow becomes channelized on the platform and is carried out to the more distal parts of the splay.

In the more distal parts of the splay, the base of the splay is abrupt but unscoured. Planar beds and massive sandstones are much more common than in the proximal part of the deposit. Mudclast conglomerate is thinner and individual clasts are smaller than in the more proximal deposits. Ripple laminations on the top of each cycle are also more common in the more distal parts of the splay.

Channel sandstone in the Crevasse Canyon Formation are volumetrically the least significant of all the sandstones. Channels tend to be shoestring-shaped deposits that are fairly straight and decidely lenticular in cross section. The sequence preserved in channel sandstone is similar to the proximal part of large crevasse splays. The base of each channel is scoured into the underlying substrate and contains rip up clast breccia. The main part of the channel comprises fine-grained planar and wedge planar cross strata grading upward into small to medium scale scale trough strata, finally capped by laminated very fine-grained sandstone and ripple-laminated sandstone. These channel sequences generally fine upward and are most commonly found in close association with crevasse splay deposits. Trough cross-beds in the channels can be quite large, such as the 8 ft wide trough found in SW 1/4, T. 5 N., R. 10 W. However, troughs and channels that are this large are the exception in the Wild Horse Canyon area. Most of the channels are small (less than 15 ft wide) and have small width to depth ratios. Paleocurrent directions were measured on crossbeds in both crevasse splay and channel deposits greater than 6 ft in thickness results are presented in a rose diagram (Fig. 2). The flow was generally to the north and remarkably unimodal for a distributary network suggesting low sinuousity streams and/or strong structural control.

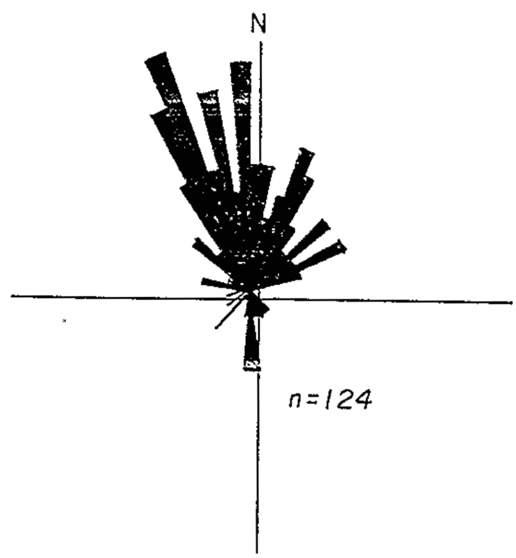


Figure 2: Paleocurrent directions measured on crossbeds present in sandstones thicker than 6 ft.

Tertiary System

Basalts flows

Basalt flows cap Techado Mesa and the small mesa north of Techado Mesa. The basalt is about 30 ft thick with the top and bottom of the flow being moderately vesicular. Field characteristics of the basalt include ropey flow structures and porphyritic textures with olivine phenocrysts. A vent area is preserved in the south central part of Techado Mesa. Two samples were collected for chemical analysis and fall close together but on opposite sides of the line separating the basalt and trachybasalt fields in the classification scheme of LeMaitre (1984), (Table 1). Probable age of these basalts are between 3.3 to 4.0 m.y. b.p. based on correlation with basalts to the east on Tres Hermanos Mesa (Baldrige and others, 1983).

Mafic Dike

A northwest-trending mafic dike intrudes the Crevasse Canyon Formation in the southwest edge of Wild Horse Canyon quadrangle. This dike continues four mi to the south in Pasture Canyon quadrangle (Osburn, 1983). The dike is tabular 3 to 6 ft wide and has a baked zone that extends into the host rocks. The core of the dike is a sugary textured prophyritic rock that is less resistant to weathering than the chill margins and forms topographic depressions. Probable age of the dike is either Oligocene or Miocene (G.R. Osburn, personal communication).

Table 1

X-ray fluorescence analyses of two basalt samples from Techado Mesa, SW 1/4 Sec. 9, T.4N., R.9W. Analysed by Glenn R. Osburn, New Mexico Bureau of Mines and Mineral Resources, July 1983.

	Sample No. 6368-1	Sample No. 61783-1
Major Oxides (%)		
SiO_2	47.07	45.73
TiO_2	2.30	2.24
Al_2O_3	15.06	14.63
Fe_2O_3	11.48	11.21
MnO	0.16	0.16
MgO	9.91	9.40
CaO	9.21	10.19
Na_2O	3.49	3.19
K_2O	1.60	1.52
P_2O_5	0.56	0.56
LOI	- 0.14	- 1.52
	100.69%	100.35%
Trace Elements (p pm)		
Nb	42	42
Pb	2	1
Rb	21	22
Sr	704	732
Th	1	1
U	1	0
Y	25	26
Zr	186	188

Quaternary System

Quaternary sediments present in Wild Horse Canyon quadrangle include young valley alluvium, blow sand, and a variety of talus and colluvium. Young valley alluvium is abundant in the broad floodplains of Cebolla, Bluewater, Cow Springs, and Pine Springs Creeks. This alluvium is commonly reworked into small sand dunes during the dry season by strong winds. Smaller amounts of valley alluvium are present in narrow canyons and topographically low spots. Blow sand is confined to the surface of Techado Mesa where it is trapped by ridges and swales in the basalt. Basaltic talus is abundant on the steep slopes of both Techado and the smaller mesa to the north. Small amounts of talus blocks and colluvium along faults and below Gallup Sandstone outcrops.

Economic Geology

The first formal minerals evaluation of Wild Horse Canyon quadrangle was carried out by Dean Winchester of the U.S. Geological Survey during the 1913 and 1914 field seasons. Winchester recorded many coal outcrops in the area and identified the large structural features in the Alamosa Creek Valley. His work was published in 1920 but the emphasis of the report was shifted from coal resources to the oil and gas potential of the area, reflecting a new excitement about petroleum exploration nationwide. Winchester recognized good reservoir characteristics of the sandstones now included in the Tres Hermanos Formation and the Dakota Sandstone and suggested that a shallow test of these units could be done on the Cow Springs Anticline, near the center of Wild Horse Canyon quadrangle. Two holes were drilled near the center of sec. 30, T. 4 N., R. 9 W. during 1925 and 1926 by the Red Feather Oil Company. Red Feather No. 1 was only 510 ft deep but Red Feather No. 2 bottomed in the Triassic Chinle Formation at a total depth of 1330 ft (Foster, 1964). In 1959, Spanel and Heinze drilled the No. 1 - 9609 Santa Fe Pacific Railroad in sec. 19, T. 4 N., R. 9 W. to test reported oil shows in the Dakota Sandstone. This well also bottomed in the Chinle Formation at 1200 ft. Graphic logs of both the Red Feather No. 2 and the spanel test are reproduced in Foster (1964). The final known test in the area is the Morris B. Jones No. 1 Santa Fe Pacific drilled in 1981. This well bottomed in the Precambrian at 5106 ft. Drill stem tests were done in the Pennsylvanian interval; the well was ultimately declared dry and abandoned.

Coal activity in the area began with Winchester's field work in 1913 and until very recently, was restricted to small prospecting efforts, probably for domestic use. The Raney prospect, located in SE 1/4 sec. 18 T. 4 N., R. 9 W., consisted of a 20 ft drift and the coal bed mined was reported as between 3 and 5 ft thick. The mine was permitted from 1942 to 1946 and production was reported by Raney to be 43 tons (U.S.G.S. unpub. field notes). The collapsed portal is all that remains of this effort. In the late 1970's renewed interest in coal prompted the New Mexico Bureau of Mines and Mineral Resources in cooperation with the U.S. Geological Survey to do a coal reconnaissance study in the Datil Mountains coal field. This work consisted of 5 widely-spaced drill holes and some reconnaissance surface geological mapping (Frost and others, 1979). During the same time period, Santa Fe Mining, Inc. drilled about 20 drill holes throughout the Datil Mountains coal field. Santa Fe Mining is the exploration arm of the Atchison, Topeka and Santa Fe Railroad that controls about one half of the mineral rights in Wild Horse Canyon quadrangle and much land throughout the coal field.

Coal data for Wild Horse Canyon quadrangle is derived from three main sources: field measurements made during the 1983 and 1984 field seasons, unpublished field data (Winchester, 1913-1914), and geophysical log interpretation of several holes drilled by Santa Fe Mining. These data were compiled following the guidelines described in U.S. Geological Survey Circular 891 (1983). Coal resource figures include data from proprietary drillholes but has been reported only by township. Almost 50% of the coal is found in beds from 14-28 in thick, the thinnest coal bed category suggested by the U.S. Geological Survey as a resource. Demonstrated coal resources for the quadrangle total 93 million short tons of coal (Tables 2 and 3).

Only one published coal analysis is known for Wild Horse Canyon quadrangle (Table 4). Based on this single analysis, rank of the coal in Wild Horse Canyon quadrangle is within the range of high volatile B bituminous. Though certainly definite conclusions should not be based on one analysis, the rank of this sample corresponds well to published analyses from nearby quadrangles in the Datil Mountains coal field (Osburn, 1982).

Table 2

Coal Resources of Wildhorse Canyon Quadrangle, Cibola County Portion (in millions of short tons, all values calculated using methods described in U.S. Geological Survey Circular 891, 1800 short tons/acre-foot used in calculations).

Location Twp. Rng.	Overburden range (feet)	Measured (inches)			Indicated (inches)			Demonstrated	Inferred (inches)		
		14-28	28-42	42-84	14-28	28-42	42-84	Measured and Indicated	14-28	28-42	42-84
4N. 9W.	0-200	0.68	0.37	---	1.18	2.88	---	5.11	---	8.25	---
	200-500	0.45	0.68	---	2.71	4.06	---	7.90	6.33	17.42	---
	> 500	0.45	0.68	---	2.71	4.06	---	7.90	11.00	7.80	---
4N. 10W.	0-200	---	1.31	0.86	---	9.03	4.50	15.70	2.17	19.31	13.62
	200-500	0.91	---	---	7.22	---	---	8.13	18.04	2.50	---
	> 500	---	---	---	---	---	---	---	4.16	---	---
5N. 10W	0-200	---	---	0.33	---	---	3.44	3.77	---	2.58	11.89
	200-500	---	---	---	---	---	---	---	2.06	---	---
	> 500	---	---	---	---	---	---	---	---	---	---
	Totals	2.49	3.04	1.19	13.82	20.03	7.94	49.91	43.76	57.86	25.51
			6.72			41.79		49.91		127.13	

Table 3

Coal Resources of Wildhorse Canyon Quadrangle, Catron County Portion (in millions of short tons, all values calculated using methods described in U.S. Geological Survey Circular 891, 1800 short tons/acre-foot used in calculations).

Location Twp. Rng.	Overburden range (feet)	Measured (inches) 14-28	Measured (inches) 28-42	Measured (inches) 42-84	Indicated (inches) 14-28	Indicated (inches) 28-42	Indicated (inches) 42-84	Demonstrated Measured and Indicated	Inferred (inches) 14-28	Inferred (inches) 28-42	Inferred (inches) 42-84
3N. 9W.	0-200	0.48	---	---	2.75	---	---	3.23	6.06	---	---
	200-500	---	---	---	---	---	---	---	---	---	---
	> 500	---	---	---	---	---	---	---	---	---	---
3N. 10W.	0-200	0.12	---	---	1.56	---	---	1.68	4.20	---	---
	200-500	---	---	---	---	---	---	---	---	---	---
	> 500	---	---	---	---	---	---	---	1.69	---	---
4N. 9W.	0-200	2.58	2.77	1.35	2.10	3.21	---	12.01	0.33	---	---
	200-500	---	0.57	---	0.83	5.10	---	6.50	3.76	10.91	---
	> 500	---	0.27	---	3.48	1.24	---	4.99	6.92	5.63	---
4N. 10W.	0-200	1.72	---	---	10.47	---	---	12.19	24.63	4.86	---
	200-500	0.34	---	---	2.71	---	---	3.05	11.82	0.93	---
	> 500	---	---	---	---	---	---	---	0.62	0.93	---
	Totals	5.24	3.61	1.35	23.90	9.55	0	43.65	60.03	23.26	0
			10.20			33.45		43.65		83.29	

Table 4

Composite drill core sample from D-4, intervals 8-10 ft and 66-69 ft. Drill hole location: NW 1/4, NE 1/4, NW 1/4 sec.2, T. 4 N., R. 10 W. (Frost and others, 1979)

PROXIMATE ANALYSIS (%)	As received	Dry mm free
Moisture	4.09	---
Ash	8.85	---
Volatile matter	41.29	46.91
Fixed Carbon	45.77	53.09
	100.00	
Calorific Value (Btu/lb)	12,017	12,188,34
Sulfur (%)	0.51	
Moist mineral matter free (Btu/lb)	13,300	

ULTIMATE ANALYSIS (%)	
Moisture	4.09
Carbon	68.47
Hydrogen	4.99
Nitrogen	1.35
Sulfur	0.51
Ash	8.85
Oxygen (by difference)	11.74
	100.00

References

Allen, J.E. and Balk, R., 1954, Mineral resources of the Fort Defiance and Tohatchi quadrangles, Arizona and New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 36, 192 p.

Allen, J.R.L., 1965, Late Quaternary Niger delta and adjacent areas: sedimentary environments and lithofacies: American Association of Petroleum Geologists, Bulletin, v. 49, pp. 547- 600.

Baldridge, W.S., Perry, F.V., Gladney, E.S., and Shafiguillah, M., 1983, Late Cenozoic basaltic volcanism at the Central Rio Grande Rift area, New Mexico (abst.): Geological Society of America, Rocky Mountain section, 36th annual meeting, p. 381.

Coleman, J.M. and Gagliano, S.M., 1965, Sedimentary structures: Mississippi River deltaic plain; in Primary sedimentary structures and their hydrodynamic interpretation: Society Economic Paleontologists and Mineralogists, Special Publication no. 12, pp. 113-148.

Dane, C.H., Wanek, A.A., and Reeside, J.B., Jr., 1957, Reinterpretation of section of Cretaceous rocks in Alamosa Creek valley area, Catron and Socorro Counties, New Mexico: American Association of Petroleum Geologists, Bulletin, v. 41, pp. 181-196.

Foster, R.W., 1964, Stratigraphy and petroleum possibilities of Catron County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 85, 55 pp.

Frost, S.J., Tabet, D.E., and Campbell, F.W., 1979, Coal exploratory drilling in the Datil Mountains coal field: New Mexico Bureau of Mines and Mineral Resources, Open-file Report 111, 49 pp.

Givens, D.B., 1957, Geology of Dog Springs quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 58.

Hawley, J.W., and Love, D.W., 1981, Overview of geology as related to environmental concerns in New Mexico: New Mexico Geological Society, Spec. Pub. 10, pp. 1-10.

Johansen, Steven, 1984, Provenance of the Mesaverde group, West-Central New Mexico: Geological Society of America, Rocky Mountain Section, Abstracts with program, Durango, CO, p.225

Johansen, Steven, 1983, The thick-splay depositional style of the Crevasse Canyon Formation, Cretaceous of West-Central New Mexico: New Mexico Geological Society Guidebook, 34th Field Conference, Socorro Region II, p. 173-178

Le Maitre, R.W., 1984, A proposal by the IUGS Subcommission on the systematics of igneous rocks for a chemical classification of volcanic rocks based on the total alkali silica (TAS) diagram: Australian Journal of Earth Sciences, v. 31, p. 243-255.

Massingill, G.L., 1979, Geology of the Riley-Puertecito area, southeastern margin of the Colorado Plateau, Socorro County, New Mexico: Ph.D. dissertation, University of Texas (El Paso), 301 pp.

Molenaar, C.M., 1983, Principal reference section and correlation of Gallup Sandstone, northwestern New Mexico; in Hook, S.C. (compiler) Contributions to mid-Cretaceous paleontology of New Mexico-part II: New Mexico Bureau of Mines and Mineral Resources, Circular 185.

Osburn, J.C., 1984, Geology of Pueblo Viejo Mesa quadrangle, Socorro and Cibola Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 55.

Osburn, J.C., 1983, Geology and coal resources of Pasture Canyon quadrangle, Catron County, NM: New Mexico Bureau of Mines and Mineral Resources, Open file report 182, 27 p., 1 plate.

Osburn, J.C., 1982, Geology and coal resources of three quadrangles in the central Datil Mountains coal field, Socorro County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open-file report 164, 82 pp., 6 plates.

Robinson, B.R., 1981, Geology of the D Cross Mountain quadrangle, Socorro and Catron Counties, New Mexico: unpublished Ph.D. dissertation, University of Texas at El Paso, 213 pp.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bulletin 1450-B, 7 pp.

Wallin, E.T., 1983, Stratigraphy and paleoenvironments of the Engle coal field, Sierra County, New Mexico: unpublished M.S. thesis, New Mexico Institute of Mining and Technology.

Wengerd, S.A., 1959, Regional geology as related to the petroleum potential of the Lucero region, west-central New Mexico: New Mexico Geological Society, Guidebook to 10th field conference, pp. 121-134.

Winchester, D.E., 1913, Coal sections, Datil Mountains coal field: U.S. Geological Survey field records file, Denver, CO.

Winchester, D.E., 1920, Geology of the Alamosa Creek valley, Socorro County, New Mexico with special reference to oil and gas: U.S. Geological Survey, Bulletin 716-A, pp. 1-15.

GEOLOGIC MAP EXPLANATION

Quaternary Deposits

Qvy - Young valley alluvium includes sands, silts, and gravels on flood plains, alluvial plains, and in active, ephemeral channels.

Qae - Blow sand (trapped by topography on Techado Mesa).

Qtc - Talus/colluvium consisting of unstabilized talus, soil-stabilized talus, and slope wash deposits.

Qbt - Basaltic talus derived from mesa-capping basalts.

Qtc/kcm -Talus that partially obscures mudstone facies of Crevasse Canyon Formation.

Tertiary Deposits

Tbf - Basalt flows; vesicular, porphyritic basalt capping mesas.

Tid - Mafic intrusive dike; a continuation of major dike on Pasture Canyon quadrangle.

Cretaceous Deposits

CREVASSE CANYON FORMATION: Progradational sequence consisting of lagoonal, paludal, and interdistributary mudstones and siltstones containing thin fluvial sandstones and coals grading upward into vertically-stacked sandstones of a fluvial sequence.

Kcm - fine-grained unit made up of predominantly mudstone and siltstone and coal with laterally discontinuous, thin channel and splay sandstones comprising less than 10% of the unit.

Kcc - individual, persistent channel and splay sandstones greater than 6 ft thick. Often occur as stacked sandstone packages.

Kg - GALLUP SANDSTONE: very fine-grained to fine-grained sandstone representing the change from lower shoreface to upper shoreface sedimentation.

SYMBOLS

	geologic contact, dashed where approximate
	fault, dashed where approximate, dotted where inferred; ball on down-thrown side.
4	strike and dip of bedding
⊕	horizontal bedding
	paleocurrent direction on crossbeds
45" ⊙ W102	measured coal (outcrop) - shows thickness in inches, sample numbers with "W" prefix were originally collected by Winchester (1913) and rechecked recently.
☼	drill hole location

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WILD HORSE CANYON 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 grid based on New Mexico coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

Certain land lines are omitted because of insufficient data

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION
Light-duty ——— Unimproved dirt - - - - -

QUADRANGLE LOCATION

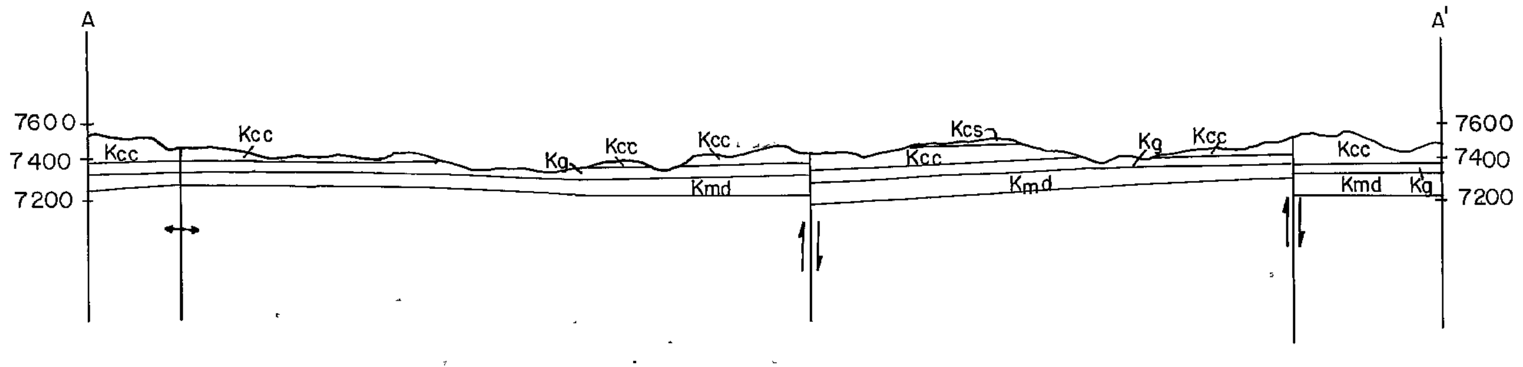
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

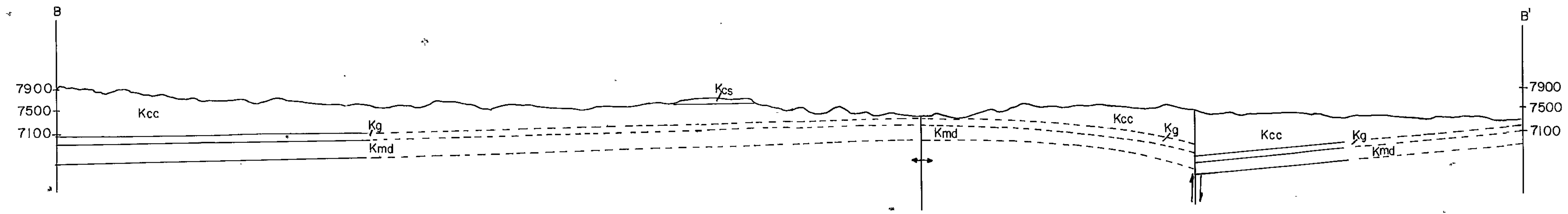
WILD HORSE CANYON, N. MEX.
N3430—W10745/7.5
1964
AMS 4453 III SE—SERIES V881

Plate 1

OF 227

Geological cross sections in Wild Horse Canyon quadrangle





KEY

Kcs - Crevasse Canyon Formation sandstone facies

Kcc - " " " undivided

Kg - Gallup Sandstone

Kmd - D-Cross Tongue of the Mancos Shale

Plate 2

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