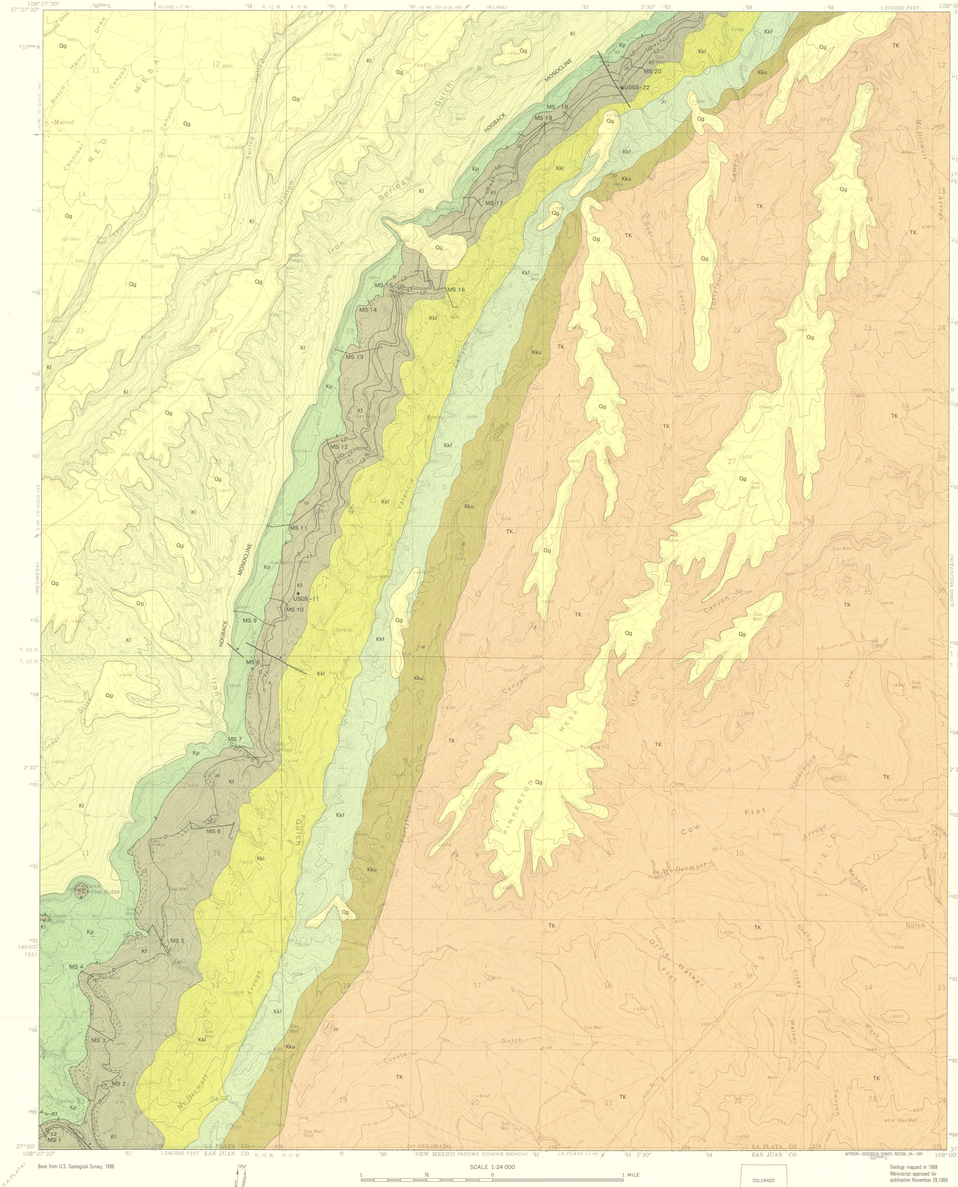
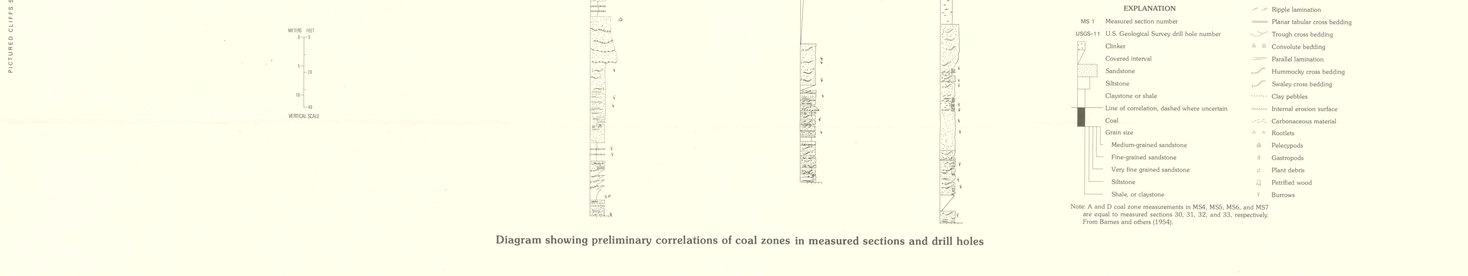
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
SOUTHERN UTE TRIBE

COAL INVESTIGATIONS
MAP C-138



Geologic map of the Pinkerton Mesa Quadrangle



Note: A and D coal zone measurements in MS4, MS5, MS6, and MS7 are equal to measured sections 30, 31, 32, and 33, respectively. From Barnes and others (1954).

Diagram showing preliminary correlations of coal zones in measured sections and drill holes

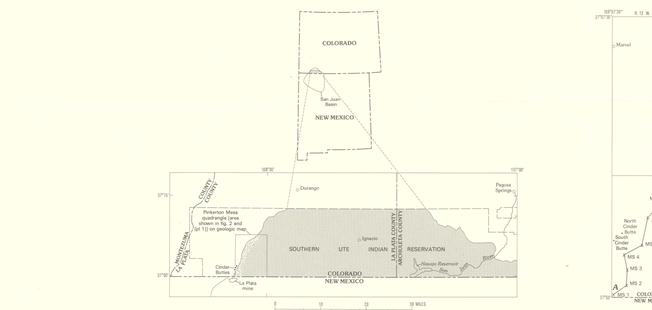


Figure 1.—Index map of the Southern Ute Indian Reservation showing general locality of coal-zone mapping (stippled) within the Pinkerton Mesa quadrangle. Area underlain by coal-bearing Fruitland Formation is shaded.

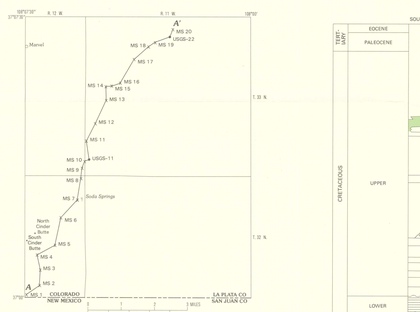


Figure 2.—Map of Pinkerton Mesa quadrangle showing locations of measured sections, drill holes, and line of section A-A'.

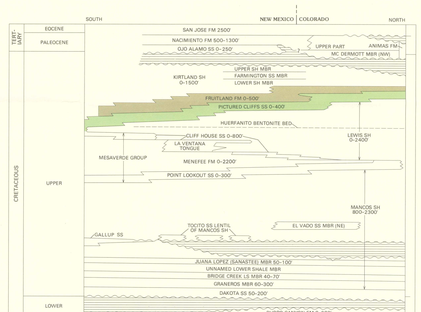


Figure 3.—Stratigraphy of Cretaceous and Tertiary rocks in the San Juan basin. Formations discussed in text are colored. Modified from Molenaar, 1977. FM, Formation; SS, Sandstone; MBR, Member; SH, Shale; LS, Limestone.

INTRODUCTION

Coal within the Upper Cretaceous Fruitland Formation has potential for development in the Pinkerton Mesa 7 1/2-minute quadrangle, located in the western part of the Southern Ute Indian Reservation, La Plata County, Colorado (fig. 1). A cooperative project, between the U.S. Geological Survey and the Southern Ute Tribe, was initiated to gather data on the coal zones in the Fruitland Formation. During the summer of 1988, U.S. Geological Survey personnel mapped the coal zones, measured stratigraphic sections, and drilled coal exploratory holes along a 1-mile-wide strip of the Fruitland outcrop in the Pinkerton Mesa quadrangle. The purposes of the investigation were to provide the Southern Ute Tribe with information on the location of coal zones, the areal distribution of coal deposits, and the stratigraphic correlations of the coal zones and associated lithologic units within the Fruitland Formation. This report presents additional data obtained by mapping the coal zones and measuring stratigraphic sections. Results of the drilling project are in a report by Roberts (1989).

Most of the coal zones in the study area were first described, and mapped at a scale of 1:62,500, by Barnes and others (1954). Shomaker and Feldman (unpub. data, 1978) assessed the coal resources within and north of the study area, using data from coal exploratory drilling by Peabody Coal Company in 1963 and by Sunedco in 1977. The map of coal zones that accompanied their report was based on projections from subsurface information. Sandberg (in press) also assessed coal resources within the study area, but included tonnage figures for coal beds more than 200 ft below ground level in the Pinkerton Mesa quadrangle.

METHOD OF INVESTIGATION

The field work during 1988 consisted of field checking coal-zone outcrop locations described by Barnes and others (1954), mapping coal zones on a 1:24,000-scale base map (Pinkerton Mesa quadrangle), examining and describing newly discovered coal-zone outcrops, and measuring complete and partial sections through the Fruitland Formation and the Pictured Cliffs Sandstone (fig. 2). Color areal photographs of the study area were used in the field to help locate coal-zone outcrops. The photographs were later placed on a PG-2 Stereo Plotter to determine the elevations of the bases of coal zones and to plot precise locations on the base map.

ACKNOWLEDGEMENTS

Personnel of the Energy Resources Office, Southern Ute Tribe, provided support during the mapping. Brad Boyce, Manager of Exploration and Production, was particularly helpful. U.S. Geological Survey personnel who provided assistance in the field include Art Clark, Mark Kirschbaum, Steve Roberts, and Peter McCabe. Gayle Cutler, photogrammetric technician in the Geologic Division, Digital/Photogrammetric Plotter Laboratory, also assisted in the field and provided expertise on the areal photographic portion of the investigation.

STRUCTURE

The study area is located in the northwesternmost part of the San Juan basin. The Hogback monocline trends north-northeast through the Pinkerton Mesa quadrangle. The strata dip southeast from 5°, in the southern part of the study area, to 26° in the northern part. This structural deformation, associated with the Hogback monocline, is the principal factor controlling the depth at which the Fruitland coal zones occur.

Four high-angle (about 70° dip) normal faults were mapped within the study area. The faults trend northwest and displacement is down on the northeast side. Displacement along the faults ranges from less than 20 ft along the faults in sec. 36, T. 33 N., R. 12 W., to as much as 70 ft along the fault in sec. 23, T. 32 N., R. 12 W. The extent of the faults is not known because the fault traces disappear under covered slopes. Information obtained from closely spaced drill holes in the area leased by San Juan Coal Company, adjacent to the study area on the south, indicates that several northwest-trending faults exist (Scott Hacking, written commun.). It is likely, therefore, that more faults exist in the southern part of the study area than are shown on [plate 1] the geologic map, but they are not exposed at the surface.

STRATIGRAPHY

The stratigraphic sequence of the Fruitland Formation and related rocks is shown in figure 3. For descriptions of lithologies, bedding characteristics, environment of deposition, nature of formational contacts, and thickness of the rock units in the study area, see Barnes and others (1954) and the report on Cretaceous geology by Aubrey (in press). Some surficial deposits such as alluvium and slope wash, which cover these rocks in much of the study area, are not shown on [plate 1] the geologic map.

PICTURED CLIFFS SANDSTONE

Three sections were measured through the Upper Cretaceous shoreline deposits of the Pictured Cliffs Sandstone ([pl. 2].) The lower 60–80 ft of the Pictured Cliffs consists of alternating thin beds of yellowish-gray to light-gray sandstone and light-gray to dark-gray siltstone and shale. The sandstones in the lower part are very fine grained and parallel and ripple laminated to hummocky crossbedded, indicating deposition between storm-wave base and fair-weather, wave base (Dott and Bourgeois, 1982). The upper 100 ft of the Pictured Cliffs Sandstone is massive to swaley crossbedded, very fine to medium-grained sandstone; the grain size generally coarsens upward. Based on the presence of swaley crossbedding and *Ophiomorpha* burrows, the sands in this upper part were probably deposited above fair-weather, wave base (Leckie and Walker, 1982). The lithologic sequence upward through the Pictured Cliffs Sandstone represents deposits along a prograding shoreline, as the Late Cretaceous sea retreated from this area. Thickness of the formation decreases from 285 ft near the Colorado–New Mexico State line to 215 ft in the northern part of the quadrangle (Barnes and others, 1954).

FRUITLAND FORMATION

The contact of the non-marine Fruitland Formation with the underlying Pictured Cliffs Sandstone is conformable and sharp. The sandstone of the Pictured Cliffs is directly overlain by the first coal zone of the Fruitland Formation in most of the study area; however, locally the first coal zone occurs within about 15 ft of the top of the Pictured Cliffs. In this report, we have defined the base of the Fruitland as the base of this lowest coal zone. [pls. 1 and 2.]

The Fruitland Formation averages about 500 ft thick in the study area. It consists of interbedded sandstone, siltstone, carbonaceous siltstone, claystone, carbonaceous claystone, and coal. The sandstone beds are light to medium gray and very fine to medium grained. Sedimentary structures found in the sandstones include trough and planar tabular cross beds, and parallel and ripple laminae. The interbedded claystone and siltstone beds are medium to dark gray and contain varying amounts of organic debris.

Coal zones are present throughout the formation, but the thickest, most persistent beds occur in the lower 200 ft. The lower part of the formation contains more sandstone than the upper part. In several places in the study area, thick channel sandstones split the coal beds. This is especially evident in the northwest corner of sec. 31, T. 33 N., R. 11 W., where the D coal zone is split into the upper and lower D coal zones. Sediments that formed the lower part of the Fruitland Formation accumulated in lagoons and swamps, and in migrating stream channels on a broad, flat, coastal plain (Shomaker and Holt, 1973).

The upper part of the formation, which lacks the thick laterally persistent coal zones and thick sandstones, consists primarily of siltstone and shale. The sediments in this part of the formation were probably deposited higher on the coastal plain. Forty-two paleocurrent indicators, measured on sands throughout the Fruitland Formation, suggest that the rivers and streams flowed generally east-northeast during deposition of the Fruitland sediments.

COAL DEPOSITS

Although individual coal beds are too thin and lenticular to map, the zones where the coal beds occur can be mapped for several miles. The coal zones consist of bright coal, bony coal, and numerous partings of shale, siltstone, and claystone; the latter has been identified as altered volcanic ash layers (Don Triplehorn, U.S. Geological Survey, personal commun.).

The coal zone designations (A and D coal zones) are from Shomaker and Feldman (unpub. data, 1978). The A and D coal zones correlate with the no. 1 and no. 2 coal beds, respectively, which are currently being mined at the La Plata mine, south of the study area (fig. 1). The A coal zone is persistent throughout the study area, but thins northward. The D coal zone contains thicker and more numerous partings than are found in the A coal zone and in most places contains abundant petrified wood. The D coal zone is laterally continuous, but splits to the north into the upper and lower D coal zones.

The correlation of coal zones above the D coal zone, especially north of where the D zone splits, is less reliable because these coal zones are poorly exposed. However, availability of drill-hole information adds reliability to the correlations that would not be possible with only outcrop information. The Local 1, Local 2, and Local 3 coal zones are designations used specifically for this report, because they can not be correlated with coal beds identified in previous reports.

The thicker coal beds of the Fruitland Formation have burned back from the outcrop in much of the study area. The resulting heat has baked and fused the overlying rocks into a brittle, resistant clinker. Clinker beds are a prominent feature, especially in the southwestern part of the Pinkerton Mesa quadrangle, where they form the Cinder Buttes (fig. 1).

COAL QUALITY

Based on proximate analyses of 153 coal core samples collected in this area during the 1988 drilling project (Roberts, 1989), the apparent rank, on an as-received basis, of the A, D, upper D, lower D, and Local 1 coal zones of the Fruitland Formation is high-volatile B bituminous coal. Apparent rank was determined using the Parr Formula for moist, mineral-matter-free Btu according to ASTM Standards (American Society for Testing and Materials, 1988, D388-88, p. 184). Average sulfur content is 0.75 percent, average ash content is 21 percent, and average gross calorific value, on a moist, mineral-matter-free basis, is 13,570 Btu/lb.

REFERENCES CITED

American Society for Testing and Materials, 1988, Standard specification for classification of coals by rank (ASTM designation D-388-88), *Annual book of ASTM standards*, v. 05.05, p. 182–185.

Aubrey, W.M., in press, Framework geology of Cretaceous and Tertiary rocks, on the Southern Ute Indian Reservation and adjacent areas in the northern San Juan basin, southwestern Colorado: U.S. Geological Survey Professional Paper 1505–B.

Barnes, Harley, Baltz, E.H., Jr., and Hayes, P.T., 1954, Geology and fuel resources of the Red Mesa area, La Plata and Montezuma Counties, Colorado: U.S. Geological Survey Oil and Gas Investigations Map OM–149, scale 1:62,500.

Condon, S.M., in press, Geologic and structure contour map of the Southern Ute Indian Reservation and adjacent areas, southwest Colorado and northwest New Mexico: U.S. Geological Survey map I–1958, scale 1:100,000.

Dott, R.H., Jr., and Bourgeois, Joanne, 1982, Hummocky stratification—significance of its variable bedding sequences: Geological Society of America Bulletin, v. 93, no. 8, p. 663–680.

Leckie, D.A., and Walker, R.G., 1982, Storm- and tide-dominated shorelines in Cretaceous Moosebar–lower Gates interval; outcrop equivalents of Deep Basin gas trap in western Canada: American Association of Petroleum Geologists Bulletin, v. 66, no. 2, p. 138–157.

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

Roberts, L.N.R., 1989, Results of 1988 coal exploratory drilling in the Fruitland Formation, southern part of the Southern Ute Indian Reservation, La Plata County, Colorado: U.S. Geological Survey Open-File Report 89–487, 224 p.

Sandberg, D.T., in press, Coal resources of Upper Cretaceous Fruitland Formation in the Southern Ute Indian Reservation, southwestern Colorado: U.S. Geological Survey Professional Paper 1505–D, 24 p.

Shomaker, J.W., and Holt, R.D., 1973, Coal resources of Southern Ute and Ute Mountain Ute Indian Reservations, Colorado and New Mexico: New Mexico State Bureau of Mines and Mineral Resources Circular 134, 22 p.

CONVERSION TO METRIC UNITS

This report uses the inch-pound units of measurement. The factors used for converting to the metric system are tabulated below:

To convert	To	Multiply by
feet	meters	0.3048
miles	kilometers	1.609
Btu/lb	kcal/kg	0.556

COAL GEOLOGY AND PRELIMINARY COAL ZONE CORRELATIONS IN THE FRUITLAND FORMATION, WESTERN PART OF THE SOUTHERN UTE INDIAN RESERVATION, LA PLATA COUNTY, COLORADO

By
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