DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2008-B
FOLIO OF THE UINTA AND PICEANCE BASIN AREA
PAMPHLET

SURFACE VITRINITE-REFLECTANCE MAP OF THE UINTA, PICEANCE, AND EAGLE BASINS AREA, UTAH AND COLORADO

By

Vito F. Nuccio and Ronald C. Johnson

INTRODUCTION

The purpose of this map is to show the level of thermal maturity achieved by surface rocks in the area encompassing the Uinta, Piceance, and Eagle basins. Mean random vitrinite reflectance (Rm) is used to define the level of thermal maturity for this study. Vitrinite reflectance records the maximum degree of thermal maturity reached by a rock, and it is directly affected by local and regional thermal events. The thermal maturity of surface rocks can be used to estimate the thermal maturity of rocks in the subsurface. The spatial distribution of the levels of thermal maturity is essential for basin analysis because heat and heat flow play a major role in mineral formation, hydrocarbon generation and destruction, petroleum reservoir quality, and groundwater flow.

SAMPLING AND ANALYTICAL TECHNIQUES

In 1986, several hundred samples were collected from Pennsylvanian- through Quaternary-age rocks in the study area. Table 1 includes the location, formation, age, and field description for each sample. Dark-gray or black (commonly used as a possible indicator of organic richness) mudstone, shale, fine-grained sandstone, limestone, coal, and gypsum were collected after digging approximately 1-2 ft into the outcrop to obtain relatively fresh, unweathered samples. In some areas, dark-gray or black rocks were not available, so buff to white samples were collected.

Mean random vitrinite reflectance (Rm in percent) was measured on all samples to determine the level of thermal maturity. Table 1 shows the Rm value, number of vitrinite reflectance measurements per sample, standard deviation for each sample, and comments about the quality of vitrinite. The quality of each sample can be judged by the comments as well as by the number of measurements and the standard deviation; the larger the number of measurements and the lower the standard deviation, the better the quality of the sample.

In table 1, the column containing the sample number also indicates the type of sample preparation. If the sample was coal, denoted by "(coal)", it was mounted in epoxy, planed-off, polished, and analyzed. If the sample was of any other lithology, it required macerating, denoted by "(mac)", a technique used to extract the organic matter from the rock before analyzing.

PROBLEMS ASSOCIATED WITH SURFACE SAMPLING

The main problem with measuring vitrinite reflectance in surface samples (either coal or other rock types) is that organic matter in the samples can be weathered or oxidized. Weathering can generally be identified petrographically because the individual vitrinite grains exhibit a halo effect where the outer part of the grain is more weathered (higher reflectance) than the inner part (lower reflectance). These grains can be avoided when measuring vitrinite reflectance. Rarely, the weathering effects are so pervasive that the entire vitrinite grain is weathered, artificially raising the vitrinite reflectance.

Anomalously high Rm values are common in samples from highly oxidized fluvial sequences. In these sequences, coalified logs or coalified branches at the base of channel sandstone were collected. Even though these samples of coal were of very good quality, the resulting vitrinite reflectance values commonly were anomalously high when compared to nearby samples that were not taken from fluvial sequences. These anomalous reflectance values may indicate local thermal events. A more likely explanation is that these logs and twigs were subjected to extremely high temperatures, such as forest fires, before being incorporated into the sandstone. This problem is not obvious in the comments in table 1.

Before rock types other than coal can be analyzed for vitrinite reflectance, organic matter has to be separated from the rock using a chemical digestion and sink-float method called maceration. The organic extract commonly contains several populations of vitrinite reflectance values, because reworked organic matter as well as contemporary organic matter was incorporated into the sediment

during deposition. For surface samples, the population having the lowest vitrinite reflectance should yield the "true" maturity of the vitrinite. This population will have recorded the thermal history of the rock since the time of deposition. Macerated samples generally have higher standard deviations than coal samples due to the greater range of vitrinite reflectance values and the presence of other types of organic matter.

In organic-poor rocks, the paucity of vitrinite grains means that the data are not statistically valid and should be used with caution. In some cases, vitrinite grains may be totally reworked and the "true" vitrinite population will be absent. Samples of this type generally have anomalous Rm values.

VITRINITE REFLECTANCE AS A TOOL FOR RESOURCE EVALUATION

The level of thermal maturity is essential when identifying favorable areas for mineral and petroleum resources. For example, vitrinite reflectance can be used to define important thermal thresholds in the generation and destruction of hydrocarbons. In general terms, organic matter can be divided into three types: sapropelic or fatty (Type I), humic or coaly (Type III), and intermediate or Type II. Sapropelic organic matter is rich in hydrogen, generally occurs in rocks of marine origin, and generates primarily oil while undergoing thermal maturation (Tissot and others, 1974). Humic organic matter is hydrogen poor, occurs mainly in rocks of nonmarine origin, and generates methane gas during thermal maturation. The intermediate or Type II organic matter can be a source for both oil and gas (Tissot and others, 1974).

According to Waples (1980), the onset of oil generation in Types I and II organic matter occurs at a Rm of approximately 0.60 percent. Above a Rm of 1.20-1.30 percent, oil is unstable and breaks down into shorter chain hydrocarbons such as methane gas (Waples, 1980). The onset of methane gas generation by Type III organic matter occurs at approximately 0.73 percent Rm (Juntgen and Karweil, 1966). Waples (1980) suggested that gas could continue to be generated from source-rocks having Rm values as high as 4.80 percent.

OTHER SOURCES OF DATA USED IN THIS REPORT

Data from the Eagle basin area, Colorado, were selected from a more comprehensive report by Nuccio and Schenk (1986). Sampling in that study was very closely spaced and all of it could not be included at the scale used in this report.

Sample numbers beginning with "UGMS" are unpublished vitrinite reflectance data from the Utah Geological and Mineral Survey.

Sample numbers beginning with "39" and "24" are unpublished vitrinite reflectance data contributed by Robert Hite of the U. S. Geological Survey.

Samples having numbers beginning with either "U-86" or "UB-86" were collected by Karen Franczyk of the U. S. Geological Survey.

REFERENCES

Juntgen, Von Harald, and Karweil, Joachim, 1966, Gasbildung und gasspeicherung in steinkohlenflozen, Part I and II: Erdol and Kohle, Erdgas, Petrochemie, v. 19, p. 251-258 and 339-344.

Nuccio, V.F., and Schenk, C.J., 1986, Thermal maturity and hydrocarbon source-rock potential of the Eagle basin, northwestern Colorado, in D.S. Stone, ed., New interpretations of Northwestern Colorado Geology: Rocky Mountain Association of Geologists, p. 259-264.

Tissot, B.P., Durand, B., Espatalie, J., and Combaz, A., 1974, Influence of nature and diagenesis of organic matter in formation of petroleum: American Association of Petroleum Geologists Bulletin, v. 58, p. 499-506.

Waples, D.W., 1980, Time and temperature in petroleum formation; application of Lopatin's method to petroleum exploration: American Association of Petroleum Geologists Bulletin, v. 64, no. 6, p. 916-926.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
				State of Utah					
Tooele (1)	Center 35 8 S. 100 W.	86-3Q (mac)	Salt Lake	Miocene and Pliocene	Micaceous clayey sandstone in limestone sequence.	0.58	7	0.11	Organics scarce but have consistent reflectances.
Tooele (1)	NW1/4 2 9 S. 5 W.	86-3P (mac)	Oquirrh Group	Late Mississippian to Early Permian	Gray and red mudstone.	---	---	---	Barren of vitrinite.
Tooele (1)	SW1/4 36 8 S. 5 W.	86-3R (mac)	Ochre Mountain Limestone or Woodman	Late Mississippian	Dark-gray mudstone.	---	---	---	Barren of vitrinite.
Tooele (1)	NW1/4 5 9 S. 4 W.	86-3S (mac)	Alluvium	Quaternary	Gray claystone.	---	---	---	Barren of vitrinite.
Juab (2)	NE1/4 8 13 S. 3 W.	86-3T (mac)	Alluvium	Quaternary	Varicolored mudstone.	---	---	---	Barren of vitrinite.
Juab (2)	18 13 S. 3 W.	86-3U (mac)	Alluvium	Quaternary	Brown mudstone.	---	---	---	Barren of vitrinite.
Juab (2)	NW1/4 34 13 S. 4 W.	86-3V (mac)	Pogonip Group	Ordovician	Black limestone.	---	---	---	Barren of vitrnite.
Juab (2)	NW1/4NW1/4 2 13 S. 1 E.	86-3W (mac)	San Rafael Group	Middle Jurassic	Gray calcareous shale.	0.55	8	.16	Vitrinite grains very scarce.
Juab (2)	NE1/4 2 13 S. 1 E.	86-3X (mac)	San Rafael Group	Middle Jurassic	Dark-gray shale.	---	---	---	Barren of vitrinite.
Juab (2)	NE1/4NE1/4 1 13 S. 1 E.	86-3Y (mac)	San Rafael Group	Middle Jurassic	Dark-gray shale from base of coarsening-upward cycle.	0.84	26	.11	Vitrinite abundant, majority reworked. Lowest reflectance material measured.
Juab (2)	NE1/4NW1/4 6 13 S. 2 E.	86-3Z (mac)	San Rafael Group	Middle Jurassic	Dark-gray shale.	0.65	21	.14	Vitrinite grains small. Measured the lowest reflectance vitrinite population.
Salt Lake (3)	SW1/4 24 1 S. 1 E.	86-3A (mac)	Twin Creek Limestone	Middle Jurassic	Black limestone.	---	---	---	Barren of vitrinite.
Salt Lake (3)	19 1 S. 2 E.	86-3B (mac)	Twin Creek Limestone	Middle Jurassic	Dark-gray clayey limestone.	---	---	---	Barren of vitrinite.
Salt Lake (3)	Center 9 1 S. 2 E.	86-3C (mac)	Twin Creek Limestone	Middle Jurassic	Dark-gray limestone.	---	---	---	Barren of vitrinite.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Salt Lake (3)	NE1/4 13 1 S. 2 E.	86-3D (mac)	Kelvin	Early Cretaceous	Medium-gray silty shale with shell fragments.	1.06	14	0.11	Vitrinite scarce; measured lowest reflectance population.
Utah (4)	NE1/4 7 6 S. 3 E.	86-6A (mac)	Unknown	Missis--sippian(?)	Black shale.	---	---	---	Barren of vitrinite.
Utah (4)	SE1/4 23 5 S. 3 E.	86-6B (mac)	Phosphoria	Early Permian	Black shale.	0.79	6	.16	Vitrinite scarce. Some low-reflectance material, some higher reflectance reworked material, too.
Utah (4)	SW1/4 24 10 S. 7 E.	86-5R (mac)	Colton	Paleocene and Eocene	Dark-gray mudstone from variegated sequence.	1.46	34	.18	A wide range of reflectances. Measured the lowest reflectance population.
Utah (4)	SE1/4 21 10 S. 7 E.	86-5S (mac)	Green River	Eocene	Dark-gray carbonaceous shale.	1.32	45	.17	Organics abundant but have a weathered appearance.
Utah (4)	SE1/4 24 10 S. 6 E.	86-5T (mac)	Green River	Eocene	Dark-gray shale from interbedded gray shale and marlstone sequence.	0.47	15	.07	Not a lot of vitrinite, but some large, low reflectance grains.
Utah (4)	NW1/4 24 10 S. 6 E.	86-5U (mac)	Green River	Eocene	Gray silty shale from a shale and sandstone sequence.	---	---	---	Barren of vitrinite.
Utah (4)	SE1/4SW1/4 10 10 S. 6 E.	86-5V (mac)	Green River	Eocene	Gray silty shale from a shale and marlstone sequence.	---	---	---	Barren of vitrinite.
Utah (4)	SE1/4 1 10 S. 5 E.	86-5W (mac)	Green River	Eocene	Dark-gray silty shale.	0.32	14	.07	Vitrinite scarce, but some good low-reflectance grains.
Utah (4)	SW1/4 27 9 S. 4 E.	86-5X (mac)	Colton	Paleocene and Eocene	Gray siltstone.	0.40	37	.09	A large low-refectance vitrinite population.
Utah (4)	Center 28 9 S. 4 E.	86-5Y (mac)	Jurassic, undifferentiated	Jurassic	Gray shale.	0.51	16	.15	A wide range of reflectances, measured the lowest.
Utah (4)	SW1/4 35 8 S. 3 E.	86-5Z (mac)	Permian and Pennsylvanian undifferentiated	Pennsylvanian and Permian	Black shaley limestone.	0.32	7	.06	A wide range. There is a higher population in the 1.00 to 2.00 range.
SanPete (5)	NW1/4 26 15 S. 2 E.	86-4A (mac)	Flagstaff Limestone	Paleocene and Eocene	Gray claystone from a claystone and sandstone sequence.	0.41	4	.05	Some amorphous organic matter. A few vitrinite grains.

San Pete (5)	SW1/4NW1/4 27 15 S. 2 E.	86-4B (mac)	Flagstaff Limestone	Paleocene and Eocene	Gray shale from a variegated shale and sandstone sequence.	0.54	17	.18	A wide range of readings. Measured the lowest reflectance population.
SanPete (5)	SE1/4 7 18 S. 3 E.	86-4C (mac)	Flagstaff Limestone or North Horn	Paleocene and Eocene or Late Cretaceous to Eocene	Greenish-gray shale.	---	---	---	Barren.
Sevier (6)	SE1/4 33 21 S. 1 E.	86-4D (mac)	Flagstaff Limestone or North Horn	Paleocene and Eocene or Late Cretaceous to Eocene	Gray claystone from a variegated claystone sequence.	---	---	---	Barren.
Sevier (6)	SW1/4 6 22 S. 2 E.	86-4E (coal)	Price River	Late Cretaceous	Sandstone containing coal chips.	0.48	9	0.08	This coal is almost all fusinite. A few vitrinite grains.
Sevier (6)	NW1/4 8 22 S. 2 E.	86-4F (coal)	Price River	Late Cretaceous	Coal chips from base of channel sandstone.	0.86	18	.14	Not a good sample. Vitrinite shows signs of weathering.
Sevier (6)	NW1/4 9 22 S. 2 E.	86-4G (coal)	Price River	Late Cretaceous	Carbonaceous shale containing coal stringers	0.47	50	.05	A good coal.
Sevier (6)	SE1/4NE1/4 9 22 S. 2 E.	86-4H (coal)	Price River	Late Cretaceous	1.5-ft-thick coal bed below 15-ft-thick channel sandstone.	0.57	50	.05	A good coal.
Sevier (6)	NW1/4 14 22 S. 2 E.	86-4I (coal)	Price River	Late Cretaceous	1-ft-thick coal bed below 20-ft-thick channel sandstone.	0.51	52	.04	A good coal. Mineral matter associated with the vitrinite.
Sevier (6)	NE1/4 13 22 S. 2 E.	86-4J (coal)	Price River	Late Cretaceous	6-in.-thick coal in carbonaceous shale.	0.54	50	.05	A good coal.
Sevier (6)	NW1/4 20 22 S. 3 E.	86-4K (coal)	Price River	Late Cretaceous	Thin coal stringer in carbonaceous shale.	0.40	40	.04	A good coal.
Sevier (6)	NW1/4 21 22 S. 3 E.	86-4L (coal)	Price River or Blackhawk	Late Cretaceous	1 ft coal at base of channel sandstone	0.54	50	.06	A good coal.
Sevier (6)	NW1/4SW1/4 13 23 S. 3 E.	86-4M (coal)	Blackhawk?	Late Cretaceous	Thin coal in carbonaceous shale with 1-3 ft thick sandstone beds.	0.41	50	.05	A good coaly shale.
Sevier (6)	SW1/4 34 23 S. 4 E.	86-4N (coal)	Blackhawk?	Late Cretaceous(?)	Carbonaceous shale with coal stringers.	0.42	50	.05	A good, consistent, coaly shale.
Sevier (6)	SE1/4 34 23 S. 5 E.	86-4-O (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.43	45	.07	A good sample. A large low-reflectance population.
Wayne (7)	34 28 S 8 E.	39-12 (coal)	Mancos Shale	Late Cretaceous	Coal	0.52	---	---	---
Wayne (7)	19 28 S. 10 E.	39-11 (coal)	Tununk Member of Mancos Shale	Late Cretaceous	Coal	0.60	---	---	---

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Wayne (7)	13 28 S. 10 E.	39-14 (coal)	Dakota Sandstone	Late Cretaceous	Coal	0.52	---	---	---
Emery (8)	NW1/4NE1/4 30 23 S. 6 E.	86-4P (coal)	Mancos Shale	Late Cretaceous	3-ft-thick coal beneath 18-ft-thick channel sandstone.	0.51	48	0.04	A good coal.
Emery (8)	NW1/4 21 23 S. 6 E.	86-4Q (coal)	Mancos Shale	Late Cretaceous	2-ft-thick coal beneath 8-ft-thick channel sandstone.	0.54	49	.06	A fair coal.
Emery (8)	SW1/4 14 23 S. 6 E.	86-4R (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.45	40	.10	Vitrinite abundant.
Emery (8)	NE1/4 18 23 S. 7 E.	86-4S (mac)	Dakota Sandstone	Late Cretaceous	Gray shale from base of conglomeratic channel.	0.50	20	.07	Not a lot of vitrinite, but the quality is good.
Emery (8)	SW1/4 4 23 S. 8 E.	86-4T (mac)	Jurassic, undifferentiated	Jurassic	Gray silty sandstone.	0.64	10	.16	Low-reflectance population scarce. A higher reflectance, reworked population.
Emery (8)	NW1/4 2 23 S. 9 E.	86-4U (mac)	Glen Canyon Group	Late Triassic and Early Jurassic	Gray shale from maroon, gray, and green sandstone and shale sequence.	1.43	48	.20	Organic matter abundant. Measured the lowest reflectance population.
Emery (8)	SE1/4 29 22 S. 11 E.	86-4V (mac)	Moenkopi	Early and Middle(?) Triassic	Gray shale from maroon and gray sandstone and shale sequence.	0.68	7	.19	Vitrinite grains scarce and small.
Emery (8)	NW1/4NE1/4 9 22 S. 13 E.	86-4W (mac)	Moenkopi	Early and Middle(?) Triassic	Gray sandy shale.	---	---	---	Barren.
Emery (8)	SW1/4 3 22 S. 13 E.	86-4X (mac)	Moenkopi	Early and Middle(?) Triassic	Gray silty shale from coarsening-upward sandstone and shale cycle.	---	---	---	Barren.
Emery (8)	SW1/4 35 21 S. 13 E.	86-4Y (mac)	Moenkopi	Early and Middle(?) Triassic	Gray shale.	---	---	---	Barren.
Emery (8)	NW1/4NW1/4 1 22 S. 14 E.	86-4Z (mac)	Mancos Shale	Late Cretaceous	Black shale just above Dakota.	0.53	49	.07	A good sample. A large low-reflectance vitrinite population.
Emery (8)	SE1/4 15 21 S. 15 E.	86-5A (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.49	15	.11	A few good vitrinite grains.

Emery (8)	NW1/4 5 21 S. 15 E.	86-5B (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.64	34	0.14	A wide range of organic matter; measured the lowest vitrinite population.
Emery (8)	SW1/4 23 20 S. 14 E.	86-5C (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.43	33	.10	A fairly large low reflectance population.
Emery (8)	NW1/4SW31/4 34 19 S. 14 E.	86-5D (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.51	31	---	A large low reflectance population.
Emery (8)	Center 3 19 S. 14 E.	86-5E (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.52	31	.10	A large, fairly consistent low-reflectance population.
Emery (8)	SE1/4 4 18 S. 14 E.	86-5F (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.51	26	.11	A fairly good low-reflectance population.
Emery (8)	17 17 S. 14 E.	86-5G (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.62	30	.14	A wide reflectance range. Measured the lowest reflectance one.
Emery (8)	NW1/4 9 16 S. 13 E.	86-5H (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.49	50	.09	A very good sample.
Emery (8)	3 16 S. 14 E.	U86-KF 3VR (coal)	Blackhawk	Late Cretaceous	Coal	0.58	50	.05	A good coal.
Emery (8)	23 17 S. 15 E.	U86-19-KF-Tt (coal)	North Horn and Flagstaff Limestone, undifferentiated	Late Cretaceous to Eocene	Coal	1.28	51	.12	Sample looks weathered.
Carbon (9)	SW1/4 14 15 S. 12 E.	86-5I (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.61	48	.08	A large, low-reflectance population.
Carbon (9)	NE1/4 2 15 S. 11 E.	86-5J (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale from base of coarsening-upward cycle.	0.58	50	.06	A very good sample.
Carbon (9)	NW1/4 22 14 S. 10 E.	86-5K (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.58	47	.08	A good sample.
Carbon (9)	NE1/4 1 14 S. 9 S.	86-5L (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.59	50	.07	A good sample. Vitrinite abundant and consistent.
Carbon (9)	SE1/4NE1/4 11 13 S. 9 E.	86-5M (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.55	36	.05	A good consistent low-reflectance population.
Carbon (9)	NW1/4 1 13 S. 9 E.	86-5N (coal)	Blackhawk	Late Cretaceous	3-ft-thick coal bed.	0.61	48	.03	A good coal.
Carbon (9)	SE1/4 35 12 S. 9 E.	86-5-O (coal)	Blackhawk	Late Cretaceous	Coal	0.49	41	---	A fair coal.
Carbon (9)	SE1/4 16 12 S. 9 E.	86-5P (coal)	Blackhawk	Late Cretaceous	3-ft-thick coal bed.	0.54	50	0.05	A good coal.
Carbon (9)	SE1/4 5 12 S. 9 E.	86-5Q (coal)	Blackhawk	Late Cretaceous	Thin coal bed.	0.49	51	.04	A very good coal.
Carbon (9)	8 12 S. 9 E.	U86-KF-1VR (coal)	North Horn	Late Cretaceous and Paleocene	Coal	0.49	54	.03	A good clean coal.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wastach Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Carbon (9)	NE1/4NE1/4 33 13 S. 13 E.	U86-KF-1RC (coal)	North Horn and Flagstaff Limestone, undifferentiated	Late Cretaceous to Eocene	Coal	0.52	47	0.08	A fairly dirty coal. Mineral matter associated with the vitrinite.
Carbon (9)	SE1/4NW1/4 18 13 S. 12 E.	UGMS 594 (coal)	Mesaverde	Late Cretaceous	Coal	0.63	66	.03	---
Carbon (9)	SE1/4NW1/4 1 13 S. 11 E.	UGMS 588 (coal)	Mesaverde	Late Cretaceous	Coal	0.59	69	.04	---
Carbon (9)	SE1/4NW1/4 10 13 S 11 E.	UGMS 587 (coal)	Mesaverde	Late Cretaceous	Coal	0.61	57	.04	---
Carbon (9)	NW1/4NW1/4 9 13 S. 11 E.	UGMS 204 (coal)	Mesaverde	Late Cretaceous	Coal	0.70	46	.03	---
Wasatch (10)	SW1/4SE1/4 19 3 S. 9 W.	85-97G (mac)	Uinta	Eocene	Greenish-gray siltstone.	1.06	39	.10	Vitrinite scarce, but some nice pieces.
Summit (11)	NW1/4 35 1 S. 3 E.	86-3E (mac)	Morrison	Late Jurassic	Dark-gray silty shale.	1.30	12	.28	Grains scarce and small.
Summit (11)	SE1/4 25 1 N. 4 E.	86-3F (mac)	Kelvin	Early Cretaceous	Gray shale from shale and conglomeratic sandstone sequence.	---	---	---	Barren.
Summit (11)	Center 12 2 N. 5 E.	86-3G (mac)	Kelvin	Early Cretaceous	Carbonaceous shale above a 4-ft-thick channel sandstone.	0.68	50	.07	Vitrinite abundant; grains slightly weathered.
Summit (11)	NW1/4 34 3 N. 6 E.	86-3H (coal)	Frontier	Late Cretaceous	1/8" thick coal bed just below sandstone.	0.35	35	.03	A fair coal.
Summit (11)	NW1/4 31 3 N. 7 E.	86-3I (coal)	Evanston	Late Cretaceous and Paleocene	Coal from Boyer mine.	0.47	46	.04	A good coal.
Summit (11)	SW1/4 23 2 S. 6 E.	86-3J (mac)	Morgan or Round Valley	Early and Middle Pennsylvanian or Early Pennsylvanian	Dark-gray limestone.	---	---	---	Barren.

Summit (11)	SW1/4 15 2 S. 6 E.	86-3K (mac)	Morgan or Round Valley	Early and Middle Pennsylvanian or Early Pennsylvanian	Black shaley limestone.	---	---	---	Barren.
Summit (11)	NW1/4 16 3 S. 7 E.	86-3L (mac)	Weber	Middle Pennsylvanian to Permian	Dark-purple-gray mudstone from sandstone and mudstone sequence.	---	---	---	Barren.
Duchesne (12)	NW1/4 25 1 N. 9 W.	86-3M (mac)	Uinta	Eocene	Dark-gray shale from red and gray sandstone and shale sequence.	---	---	---	Barren.
Duchesne (12)	SE1/4 4 1 S. 8 W.	86-3N (mac)	Uinta	Eocene	Medium-gray shale.	0.98	14	.25	Grains scarce and small. Measured almost everything.
Duchesne (12)	NW1/4NE1/4 17 2 S. 7 W.	86-3-O (mac)	Uinta	Eocene	---	0.94	36	.15	Measured the lowest reflectance population.
Duchesne (12)	Center 32 3 S. 6 W.	85-97F (mac)	Uinta	Eocene	Dark-gray silty shale.	---	---	---	Barren.
Duchesne (12)	NE1/4 36 3 S. 6 W.	85-97E (coal)	Uinta	Eocene	Sandstone with carbonized plant fragments.	0.47	51	.03	A fairly good sample.
Duchesne (12)	SE1/4 2 4 S. 5 W.	85-77 (coal)	Uinta	Eocene	Coal from two 1-in.-thick beds, 8 in. apart, in carbonaceous shale.	0.48	50	.05	A very good coaly shale.
Duchesne (12)	NW1/4 1 3 S. 5 W.	85-97H (mac)	Uinta	Eocene	Dark-greenish-gray silty claystone.	0.75	13	.13	Vitrinite scarce.
Duchesne (12)	NW1/4 12 2 S. 5 W.	85-97I (mac)	Duchesne River	Paleocene to Oligocene	Green silty claystone.	1.00	14	.13	Vitrinite scarce.
Duchesne (12)	SE1/4 24 1 S. 5 W.	85-97J (coal)	Duchesne River	Paleocene to Oligocene(?)	Coaly carbonaceous shale.	0.45	100	.05	A very nice coal.
Duchesne (12)	SW1/4 31 3 S. 3 W.	85-76A (mac)	Uinta	Eocene	Dark-gray silty claystone.	0.60	4	.10	Grains very small. Abundant low-reflectance population too small to measure accurately, approximately 0.60.
Duchesne (12)	SW1/4 31 3 S. 3 W.	85-76B (mac)	Uinta	Eocene	Sandstone containing carbonized flakes.	1.04	10	.14	Vitrinite very lean. Could all be reworked.
Duchesne (12)	26 11 S. 10 E.	U86-KF 2VR (coal)	Green River	Paleocene and Eocene	Coal.	0.49	50	0.03	A very good coal.
Duchesne (12)	SE1/4 34 3 S. 3 W.	85-75 (mac)	Uinta	Eocene	Dark-gray sandy claystone.	---	---	---	Barren.
Duchesne (12)	SW1/4NW1/4 13 3 S. 2 W.	85-74 (coal)	Uinta	Eocene	Weathered sandstone containing carbonized fragments.	0.58	54	.05	A good sample.
Duchesne (12)	SE1/4 8 2 S. 1 W.	85-72 (mac)	Duchesne River	Paleocene to Oligocene(?)	Mottled gray and red mudstone.	---	---	---	Barren.
Duchesne (12)	NE1/4 6 1 S. 1 W.	85-73A (mac)	Duchesne River	Paleocene to Oligocene(?)	Gray shale.	0.45	32	.05	A coaly shale.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Duchesne (12)	NW1/4 5 1 S. 1 W.	85-73B (mac)	Duchesne River	Paleocene to Oligocene(?)	Red and gray mudstone.	0.80	20	.18	Vitrinite scarce and has a wide range. Could all be reworked.
Uintah (13)	NE1/4NE1/4 17 9 S. 22 E.	86-9A (mac)	Uinta	Eocene	Red and gray mudstone.	---	---	---	Barren.
Uintah (13)	NE1/4SW1/4 4 9 S. 20 E.	86-9B (mac)	Uintah	Eocene	Dark-gray silty and sandy mudstone.	0.88	2	.09	Organics lean.
Uintah (13)	NW1/4SW1/4 28 11 S. 19 E.	86-9C (mac)	Green River	Paleocene and Eocene	Low-grade oil shale.	0.59	9	.15	Organic matter lean.
Uintah (13)	NW1/4NE1/4 32 11 S. 19 E.	86-9D (mac)	Green River	Paleocene and Eocene	Calcareous mudstone containing carbonaceous debris.	0.35	19	.08	A low-reflectance population and a higher reflectance reworked population.
Uintah (13)	NE1/4NE1/4 32 11 S. 19 E.	86-9E (mac)	Green River	Paleocene and Eocene	Calcareous mudstone.	---	---	---	Barren.
Uintah (13)	SW1/4 24 9 S. 24 E.	85-97A (mac)	Uinta	Eocene	Gray silty claystone containing carbonaceous debris.	0.94	12	.13	Grains small.
Uintah (13)	NE1/4 35 9 S. 24 E.	85-97B (coal)	Uinta	Eocene	Carbonized wood chip in gray to brown sandsto	0.41	21	.05	A fairly good sample.
Uintah (13)	8 9 S. 23 E.	85-97C (mac)	Uinta	Eocene	Gray silty claystone.	---	---	---	Barren.
Uintah (13)	6 5 S. 21 E.	85-71 (mac)	Duchesne River	Paleocene to Oligocene(?)	Gray silty claystone.	0.76	24	.14	Organics scarce. A wide range of reflectances.
Uintah (13)	NE1/4NE1/4 26 6 S. 25 E.	84-55A (coal)	Mesaverde	Late Cretaceous	10-in.-thick carbonaceous shale containing coal stringers.	0.40	52	.04	A good coal.
Uintah (13)	NE1/4NE1/4 26 6 S. 25 E.	84-56 (coal)	Mesaverde	Late Cretaceous	Weathered carbonaceous shale containing coal.	0.46	53	.08	A good coal.
Grand (14)	23 21 S. 16 E.	39-16	Dakota Sandstone	Late Cretaceous	Coal.	0.57	---	---	---
Grand (14)	NE1/4NE1/4NE1/4 29 20 S. 20 E.	UGMS 531 (coal)	Mesaverde	Late Cretaceous	Coal.	0.59	70	0.05	---
Grand (14)	NE1/4NW1/4 1 19 S. 22 E.	UGMS 191 (coal)	Mesaverde	Late Cretaceous	Coal.	0.70	38	.03	---

Grand (14)	2 19 S. 25 E.	UB-86-KF-4VR (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.65	48	.04	A good coal.
Grand (14)	13 22 S. 22 E.	39-15 (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.75	---	---	---
Grand (14)	29 22 S. 24 E.	39-7 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	0.60	---	---	---
San Juan (15)	34 29 S. 24 E.	39-19 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	0.80	---	---	---
San Juan (15)	24 33 S. 22 E.	39-9 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	1.12	---	---	---
San Juan (15)	24 33 S. 26 E.	24-20 (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.60	---	---	---
				State of Colorado					
San Miguel (16)	3 42 N. 17 W.	24-3 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	1.14	---	---	---
San Miguel (16)	3 43 N. 17 W.	24-13 (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.67	---	---	---
San Miguel (16)	19 45 N. 12 W.	24-1 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	0.78	---	---	---
Montrose (17)	28 46 N. 16 W.	39-4 (mac)	Dakota Sandstone	Late Cretaceous	Shale.	0.89	---	---	---
Montrose (17)	21 46 N. 15 W.	24-17 (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.59	---	---	---
Montrose (17)	6 46 N. 15 W.	24-14 (coal)	Dakota Sandstone	Late Cretaceous	Coal.	0.55	---	---	---
Montrose (17)	SE1/4 16 48 N. 6 W.	86-14E (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.31	50	.07	A large low-reflectance population.
Montrose (17)	SE1/4 3 48 N. 7 W.	86-14F (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.51	38	.11	A good shale. Measured the lowest reflectance population.
Montrose (17)	NE1/4 6 48 N. 7 W.	86-14G (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.55	44	0.13	A good sample.
Montrose (17)	7 50 N. 6 W.	86-8I (coal)	Dakota Sandstone	Late Cretaceous	Coal chips in sandstone.	0.94	39	.11	A fair coal sample.
Mesa (18)	SW1/4NE1/4 15 9 S. 97 W.	86-2I (coal)	Wasatch	Tertiary	Coal chips from base of channel sandstone.	0.78	34	.09	Not a lot of vitrinite, but good quality.
Mesa (18)	NW1/4SE1/4 26 9 S. 97 W.	86-2J (coal)	Wasatch	Tertiary	Weathered coal chips from base of channel sandstone.	1.16	44	.10	A fair coal.
Mesa (18)	SW1/4NE1/4 16 10 S. 96 W.	86-2K (coal)	Wasatch	Tertiary	Carbonaceous shale containing coal stringers, 20 ft above Mesaverde.	0.58	51	.05	A good coal.
Mesa (18)	21 11 S. 96 W.	86-2L (mac)	Wasatch	Tertiary	Red and green mudstone rip-ups from channel sandstone.	---	---	---	Barren of vitrinite.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Mesa (18)	SE1/4NE1/4 16 8 S. 91 W.	86-7E (coal)	Mesaverde	Late Cretaceous	Coal chips from channel sandstone, possibly weathered.	0.71	25	.09	A poor quality coal.
Mesa (18)	SW1/4SE1/4 15 8 S. 91 W.	86-7G (mac)	Mesaverde	Late Cretaceous	Black shale.	0.45	44	.05	A coaly shale.
Mesa (18)	SE1/4 29 8 S. 91 W.	86-7I (mac)	Wasatch	Tertiary	Claystone rip-ups from channel sandstone.	---	---	---	Barren.
Mesa (18)	NE1/4 22 8 S. 92 W.	86-7K (mac)	Mesaverde	Late Cretaceous	Brown silty shale collected 5 ft below white channel sandstone.	0.81	20	.15	Measured all but a couple of high-reflectance grains.
Mesa (18)	NE1/4 28 8 S. 91 W.	86-7L (mac)	Wasatch	Tertiary	Brown silty shale in variegated shale.	---	---	---	Barren.
Mesa (18)	NE1/4 22 8 S. 92 W.	86-7M (mac)	Wasatch	Tertiary	Gray shale in gray and purple shale.	0.92	7	.09	A poor sample. Grains small and have a wide reflectance range.
Mesa (18)	SW1/4 29 8 S. 92 W.	86-7N (mac)	Wasatch	Tertiary	Brown sandy shale from variegated sequence just above white sandstone.	0.77	21	.17	Grains scarce. A few good low-reflectance grains but majority are high-reflectance; probably reworked.
Mesa (18)	20 9 S. 92 W.	86-7-O (mac)	Waaatch	Tertiary	Gray sandy shale from mostly red-bed sequence.	0.86	8	.15	Grains scarce. Measured the lowest reflectance population.
Mesa (18)	SW1/4NW1/4 12 10 S. 92 W.	86-7P (coal)	Wasatch	Tertiary	Coalified plant fragments from base of channel sandstone.	0.53	29	.06	A fairly good coal.
Mesa (18)	SE1/4NE1/4 25 10 S. 92 W.	86-7Q (coal)	Wasatch	Tertiary	Weathered coal stringers in sandstone.	0.45	50	.05	A fairly good coal.
Delta (19)	SE1/4NW1/4 23 12 S. 95 W.	86-7X (mac)	Green River	Eocene	Green, micaceous sandy shale just above white micaceous sandstone.	0.71	10	0.15	Organics scarce. A few relatively low-reflectance grains.
Delta (19)	NW1/4 24 12 S. 95 W.	86-7Y (mac)	Green River	Eocene	Dark-olive-gray clayey marl.	0.49	7	.13	Organic matter lean. Read almost every grain.
Delta (19)	SE1/4NW1/4 23 12 S. 95 W.	86-7Z (mac)	Green River	Eocene	Greenish ahale or silty marl.	0.55	20	.11	A good sample. A relatively large low-reflectance population.
Delta (19)	SE1/4SW1/4 10 12 S. 95 W.	86-8A (mac)	Wasatch	Tertiary	Gray shale from variegated maroon and gray shale.	0.71	39	.13	A good sample.

Delta (19)	NW1/4 10 12 S. 95 W.	86-8B (mac)	Green River	Eocene	Gray mudstone from mudstone and white sandstone sequence.	---	---	---	Barren.
Delta (19)	Center 31 14 S. 94 W.	86-8C (coal)	Dakota Sandstone	Late Cretaceous	Coal stringer in sandstone.	0.62	50	.04	A good coal sample.
Delta (19)	NW1/4NW1/4 33 14 S. 94 W.	86-8D (mac)	Mancos Shale	Late Cretaceous	Black shale.	0.38	49	.06	A good sample.
Delta (19)	31 14 S. 93 W.	86-8E (mac)	Mancos Shale	Late Cretaceous	Black shale from base of coarsening-upward cycle.	0.34	44	.08	A fair sample. A wide range of reflectances. Measured the lowest reflectance population.
Delta (19)	NE1/4 32 14 S. 92 W.	86-8F (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.53	23	.09	Measured the lowest reflectance population.
Delta (19)	SW1/4SW1/4 25 15 S. 92 W.	86-8G (mac)	Mancos Shale	Late Cretaceous	Black shale.	0.88	53	.12	Sample shows signs of weathering.
Delta (19)	31 15 S. 91 W.	86-8H (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.47	49	.05	A good sample.
Delta (19)	NE1/4 12 11 S. 91 W.	86-7R (mac)	Wasatch	Tertiary	Coal chips in sandstone.	0.68	15	.22	Organic matter scarce.
Garfield (20)	23 6 S. 104 W.	83-163H (coal)	Mesaverde	Late Cretaceous	Carbonaceous claystone containing coal.	0.59	101	.04	A very good coal.
Garfield (20)	24 6 S. 104 W.	83-139B (coal)	Mesaverde	Late Cretaceous	4-ft-thick coal bed.	0.64	101	.04	A very good coal.
Garfield (20)	21 6 S. 103 W.	83-146 (coal)	Mesaverde	Late Cretaceous	Coal in carbonaceous shale.	0.62	101	.05	A very good coal.
Garfield (20)	21 6 S. 103 W.	83-145 (coal)	Mesaverde	Late Cretaceous	10-in.-thick coal stringer in carbonaceous shale.	0.57	17	.05	A fair coal.
Garfield (20)	5 7 S. 103 W.	83-147 (coal)	Mesaverde	Late Cretaceous	8-ft-thick coal bed in carbonaceous shale.	0.65	102	.03	A very good coal.
Garfield (20)	8 6 S. 102 W.	VN-6A (coal)	Mesaverde	Late Cretaceous	Coal	0.60	101	0.05	A good coal.
Garfield (20)	8 6 S. 102 W.	VN-6B (coal)	Mesaverde	Late Cretaceous	Coal	0.63	101	.05	A good coal.
Garfield (20)	6 5 S. 101 W.	VN-6C (coal)	Green River	Eocene	Coal	0.32	150	.04	A very good coal.
Garfield (20)	13 5 S. 100 W.	C-144 (coal)	Uinta	Eocene	Coal chip in mudstone or sandstone.	0.38	101	.05	A good coal.
Garfield (20)	23 6 S. 97 W.	Bar-A-2 (coal)	Uinta	Eocene	Coaly shale.	0.45	21	.07	A coaly shale. Some good vitrinite grains.
Garfield (20)	32 7 S. 96 W.	86-2H (coal)	Wasatch	Tertiary	Coalified log at base of channel sandstone.	0.87	44	.04	A nice, clean, consistent coal.
Garfield (20)	SW1/4 31 5 S. 91 W.	86-2A (coal)	Wasatch	Tertiary	Badly weathered coal chips from base of channel sandstone.	0.55	20	.07	A poor-quality coal. Mineral matter associated with the vitrinite.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Garfield (20)	25 5 S. 92 W.	86-2B (coal)	Mesaverde	Late Cretaceous	Weathered coal chips from channel sandstone.	0.59	23	.08	A poor quality coal.
Garfield (20)	24 5 S. 92 W.	86-2C (coal)	Mesaverde	Late Cretaceous	Carbonaceous shale containing coal stringers.	0.57	40	.06	A fair coal.
Garfield (20)	NE1/4SE1/4 10 6 S. 92 W.	86-2D (coal)	Wasatch	Tertiary	0.25-in.-thick coal stringer in even-bedded sandstone.	0.49	45	.04	A fair to good coal.
Garfield (20)	NW1/4NE1/4 17 6 S. 93 W.	86-2F (coal)	Wasatch	Tertiary	Moderately to badly weathered coalified plant fragments in channel sandstone.	0.71	50	.07	A good clean coal.
Garfield (20)	SW1/4 22 6 S. 94 W.	86-2G (coal)	Wasatch	Tertiary	Coal stringer in carbonaceous shale from fresh road cut.	0.60	47	.03	A good consistent coal.
Garfield (20)	SW1/4NE1/4 31 6 S. 91 W.	86-1A (mac)	Wasatch	Tertiary	Gray- and rust-mottled mudstone.	0.83	5	.15	Vitrinite almost absent.
Garfield (20)	20 7 S. 91 W.	86-1B (coal)	Wasatch	Tertiary	0.5 x 3 in. coalified log from base of channel sandstone.	0.55	49	.06	A fair coal.
Garfield (20)	21 7 S. 91 W.	86-1C (coal)	Wasatch	Tertiary	0.25 x 2 in. coalified log from base of channel sandstone; good sample.	1.30	51	.06	A good coal.
Garfield (20)	NW1/4 31 7 S. 91 W.	86-1D (coal)	Wasatch	Tertiary	Coal chips from recently exposed channel sandstone, good sample.	1.58	36	.08	A fair coal.
Garfield (20)	1 8 S. 92 W.	86-1E (mac)	Wasatch	Tertiary	Medium-purple-gray claystone.	---	---	---	Barren.
Garfield (20)	7 7 S. 88 W.	N (mac)	Eagle Valley	Middle Pennsylvanian	Gray mudstone.	1.12	50	0.05	A good sample. Organics abundant.
Garfield (20)	SE1/4 13 6 S. 92 W.	86-1F (coal)	Wasatch	Tertiary	Fairly weathered coal chips from base of channel sandstone.	2.01	50	.12	A consistent coal.
Garfield (20)	24 7 S. 92 W.	86-7A (coal)	Wasatch	Tertiary	Coal chips from base of channel sandstone.	0.71	50	.06	A fair coal.
Garfield (20)	NW1/4NE1/4 5 8 S. 91 W.	86-7B (mac)	Mesaverde	Late Cretaceous	Badly weathered black claystone.	0.62	48	.06	A coaly shale.
Garfield (20)	NW1/4 4 8 S. 91 W.	86-7C (mac)	Mesaverde	Late Cretaceous	Black claystone.	0.60	50	.07	A good coaly shale.

Garfield (20)	NE1/4 9 8 S. 91 W.	86-7D (mac)	Mesaverde	Late Cretaceous	Gray shale.	1.05	48	.12	A fairly consistent shale. Grains abundant and large.
Garfield (20)	NE1/4 8 6 S. 91 W.	86-7H (coal)	Wasatch	Tertiary	Coal chips from base of channel sandstone	0.75	30	.08	A poor quality coal.
Garfield (20	NW1/4SE1/4 7 8 S. 91 W.	86-7J (mac)	Wasatch	Tertiary	Brown to dark-gray shale in variegated sandstone and shale sequence.	0.88	21	.20	A wide range of measurements.
Garfield (20)	NW1/4NE1/4 19 5 S. 91 W.	85-51 (coal)	Mesaverde	Late Cretaceous	10-ft-thick coal above sandstone.	0.82	76	.05	A good coal.
Garfield (20)	NW1/4SW1/4 21 5 S. 91 W.	85-56 (coal)	Mesaverde	Late Cretaceous	10-15 ft thick coal just above Rollins, clinkered nearby.	1.41	80	.10	A fair coal.
Garfield (20)	NE1/4NE1/4 24 5 S. 92 W.	85-57 (coal)	Mesaverde	Late Cretaceous	Coal mine sample.	0.63	96	.05	A very good coal.
Garfield (20)	NE1/4NE1/4 24 5 S. 92 W.	85-58 (coal)	Mesaverde	Late Cretaceous	Coal from abandoned mine in in Cozzette Sandstone.	0.66	96	.05	A very good coal.
Garfield (20)	SW1/4NE1/4 24 5 S. 92 W.	85-59 (coal)	Mesaverde	Late Cretaceous	Coal from abandoned mine.	0.68	61	.05	A good coal.
Garfield (20)	SW1/4NE1/4 24 5 S. 92 W.	85-60 (coal)	Mesaverde	Late Cretaceous	Coal from abandoned mine.	0.63	75	.03	A good coal.
Garfield (20)	SW1/4NE1/4 18 4 S. 100 W.	83-144P (coal)	Green River	Eocene	Coalified plant fragments in rich oil shale.	0.35	70	.03	Vitrinite grains scarce but large. Good cell structure.
Garfield (20)	SE1/4SE1/4 8 3 S. 102 W.	RS-86-P1 (mac)	Mesaverde	Late Cretaceous	Fairly fresh shale sample.	0.88	53	.15	A coaly shale.
Rio Blanco (21)	NE1/4NE1/4 16 2 S. 101 W.	84-40 (coal)	Mesaverde	Late Cretaceous	5-ft-thick coal bed.	0.40	61	0.04	A fairly good coal.
Rio Blanco (21)	SE1/4SE1/4 31 1 S 100 W.	84-9A (coal)	Mesaverde	Late Cretaceous	Carbonaceous shale containing coal	0.36	21	.05	A fair coal. Mineral matter associated with the vitrinite.
Rio Blanco (21)	NW1/4NW1/4 32 1 S. 100 W.	84-36A (coal)	Green River	Eocene	Thin coal in carbonaceous shale.	0.26	65	.02	A fair coal. Polish poor due to softness.
Rio Blanco (21)	NE1/4NE1/4 31 1 S. 100 W.	84-27G (coal)	Green River	Eocene	Thin coal in carbonaceous shale.	0.43	53	.04	Coal is all vitrinite.
Rio Blanco (21)	SW1/4NW1/4 2 2 S. 101 W.	84-2C (coal)	Mesaverde	Late Cretaceous	46-in.-thick coal bed.	0.56	58	.05	A very good trimaceralic coal.
Rio Blanco (21)	SE1/4SW1/4 13 1 S. 101 W.	85-70A (coal)	Mesaverde	Late Cretaceous	Thin coal in carbonaceous shale just above white sandstone.	0.66	8	.17	A poor sample. Material looks weathered.
Rio Blanco (21)	NW1/4NE1/4 3 1 S. 102 W.	84-47 (coal)	Mesaverde	Late Cretacdous	3-ft-thick coal.	0.38	53	.03	A good trimaceralic coal.
Rio Blanco (21)	NW1/4SE1/4 30 1 N. 101 W.	84-43B (coal)	Mesaverde	Cretaceous	3-6 in. thick coal.	0.52	59	.05	A very good coal.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Rio Blanco (21)	NW1/4NW1/4 26 1 N. 102 W.	84-46 (coal)	Mesaverde	Cretaceous	1-2 ft thick dirty coal.	0.43	62	.04	A fair coal.
Rio Blanco (21)	SE1/4NW1/4 13 1 N. 102 W.	84-45A (coal)	Mesaverde	Cretaceous	1-ft-thick coal in carbonaceous shale.	0.42	65	.03	A good coal.
Rio Blanco (21)	NE1/4NE1/4 12 1 N. 103 W.	84-48C (coal)	Mesaverde	Cretaceous	5-in.-thick coal.	0.47	64	.04	A good trimaceralic coal.
Rio Blanco (21)	SW1/4NW1/4 11 2 N. 101 W.	84-44C (coal)	Mesaverde	Cretaceous	10-ft-thick coal.	0.44	76	.04	A good coal.
Rio Blanco (21)	SW1/4NW1/4 7 2 N. 103 W.	84-53 (coal)	Mesaverde	Cretaceous	6-ft-thick coal from prospect pit.	0.41	65	.04	A good coal.
Rio Blanco (21)	NW1/4NW1/4 7 2 N. 103 W.	84-49 (coal)	Mesaverde	Cretaceous	6-in.-thick dirty coal.	0.37	55	.04	A fair coal.
Rio Blanco (21)	NW1/4 19 3 N. 103 W.	84-54A (coal)	Mesaverde	Cretaceous	2-3 ft coal from prospect pit.	0.36	54	.03	A fair coal.
Rio Blanco (21)	29 2 N. 99 W.	USGS CH-9 (coal)	Green River	Eocene	Coal chip in 3 gallon per ton oil shale at depth of 87 ft.	0.43	101	.05	A good coal.
Rio Blanco (21)	12 1 N. 100 W.	USGS CH-9A (coal)	Green River	Eocene	Coal chip at depth of 30 ft.	0.36	72	.05	A good coal.
Rio Blanco (21)	NE1/4NE1/4 25 2 N. 97 W.	85-64 (mac)	Wasatch	Tertiary	Carbonaceous shale.	0.62	50	.07	A good organic-rich shale.
Rio Blanco (21)	NW1/4NW1/4 14 1 S. 98 W.	C-155 (coal)	Uinta	Eocene	Coal chip in sandstone or mudstone.	0.51	101	.05	A good coal.
Rio Blanco (21)	28 1 S. 98 W.	C-153 (coal)	Uinta	Eocene	Coal chip in sandstone or mudstone.	0.56	101	.07	A good coal.
Rio Blanco (21)	29 1 S. 97 W.	C-299 (coal)	Green River	Eocene	Coal chip in sandstone or mudstone.	0.50	59	.06	A fair to good coal.
Rio Blanco (21)	SE1/4NW1/4 16 2 S. 97 W.	85-44 (coal)	Uinta	Eocene	Coal chip in sandstone.	0.24	20	.03	A poor coal sample.
Rio Blanco (21)	SE1/4NW1/4 31 2 S. 96 W.	85-45 (coal)	Uinta	Eocene	Coal chip in sandstone.	0.33	50	.05	A good coal. Nice cell structure.
Rio Blanco (21)	SE1/4SE1/4 3 3 S. 96 W.	85-46 (coal)	Uinta	Eocene	Coal chip in sandstone.	0.32	100	.05	A good coal.

Rio Blanco (21)	Center SW1/4 8 3 S. 95 W.	85-47 (coal)	Uinta	Eocene	Coal chip in sandstone.	0.33	60	.03	A good coal. Some nice spores.
Rio Blanco (21)	Center NE1/4 15 3 S. 95 W.	85-48 (coal)	Uinta	Eocene	Coal chip in sandstone.	0.37	50	.04	A fair coal.
Rio Blanco (21)	SE1/4NW1/4 24 3 S. 95 W.	USGS CH-2 (coal)	Green River	Eocene	Coal chip in marlstone.	0.35	108	.05	A good coal.
Rio Blanco (21)	26 2 S. 95 W.	USGS CH-3A (coal)	Green River	Eocene	Coal chip in marlstone.	0.43	150	.05	A very good coal.
Rio Blanco (21)	14 2 S. 95 W.	USGS CH-3 (coal)	Green River	Eocene	Coal chip in marlstone.	0.51	102	.06	A good coal.
Rio Blanco (21)	9 1 S. 95 W.	USGS CH-4 (coal)	Green River	Eocene	Coal chip in marlstone.	0.41	85	.06	A fair coal. Mineral matter associated with vitrinite.
Rio Blanco (21)	3 1 S. 93 W.	2 U (mac)	Mancos Shale	Late Cretaceous	Dark-gray mudstone.	1.07	60	.15	Vitrinite abundant.
Rio Blanco (21)	8 1 S. 91 W.	2 Q (mac)	Eagle Valley	Middle Pennsylvanian	Mudstone.	0.73	43	.14	Grains scarce and full of mineral matter.
Rio Blanco (21)	15 1 N. 90 W.	2 W (mac)	Maroon	Pennsylvanian/ Permian	Sandstone.	0.81	8	.13	Grains scarce and small.
Rio Blanco (21)	21 2 N. 88 W.	2 Y (mac)	Mancos Shale	Late Cretaceous	Dark-brown mudstone.	0.42	50	.17	A large low-reflectance population.
Rio Blanco (21)	36 3 N. 88 W.	2 Z (mac)	Mancos Shale	Late Cretaceous	Dark-brown mudstone.	0.52	71	.07	Vitrinite abundant. A large low-reflectance population.
Moffat (22)	NW1/4SE1/4 29 9 N. 90 W.	85-117B (mac)	Wasatch	Tertiary	Medium-gray-green silty shale.	1.07	49	.19	Organics abundant. Only one population.
Moffat (22)	SW1/4NW1/4 2 10 N. 91 W.	85-117D (mac)	Wasatch	Tertiary	Gray silty shale from purple and gray outcrop.	---	---	---	Barren.
Moffat (22)	SE1/4NW1/4 17 12 N. 91 W.	85-117E (mac)	Fort Union	Paleocene	Black claystone.	---	---	---	Barren of vitrinite. Some signs of bitumen.
Moffat (22)	NW1/4NE1/4 30 12 N. 92 W.	85-117G (mac)	Wasatch	Tertiary	Gray silty claystone.	0.52	8	.08	Vitrinite grains scarce but consistent.
Moffat (22)	29 2 N. 94 W.	85-117H (mac)	Upper Wasatch or Tipton Shale Member of Green River	Eocene	Gray silty claystone.	0.55	20	.12	Organics scarce.
Moffat (22)	NW1/4NE1/4 5 11 N. 96 W.	85-117J (mac)	Wasatch	Tertiary	Gray silty claystone.	0.61	21	.17	Some vitrinite spanning a wide range. Some bitumen.
Moffat (22)	NE1/4NE1/4 21 12 N. 99 W.	85-117M (mac)	Tipton Shale Member of Green River	Eocene	Gray silty shale.	0.45	24	.06	A good sample. Some bitumen.
Moffat (22)	NE1/4SW1/4 29 12 N. 101 W.	85-117-O (coal)	Luman Tongue of Green River	Eocene	Carbonaceous shale with coal stringers.	0.53	40	.06	A fair coal.
Moffat (22)	NW1/4SE1/4 8 11 N. 101 W.	85-117R (coal)	Luman Tongue of Green River	Eocene	6-in.-thick coal.	0.53	50	.06	A fair coal. Mineral matter associated with the vitrinite.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec.	T.	R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Routt (23)	31	3 N.	85 W.	3F (mac)	Mancos Shale	Late Cretaceous	Dark-brown mudstone.	0.48	52	.05	A good sample. A large low-reflectance population.
Routt (23)	23	2 N.	85 W.	3G (mac)	Mancos Shale	Late Cretaceous	Gray mudstone.	0.57	40	.11	Grains small. Measured the lowest reflectance population.
Routt (23)	16	1 N.	84 W.	3H (mac)	Mancos Shale	Late Cretaceous	Mudstone.	0.57	52	.09	Grains small. A good sample though.
Routt (23)	10	1 S.	84 W.	3M (mac)	Minturn	Middle Pennsylvanian	Mudstone.	0.69	45	.05	A good sample.
Eagle (24)	2	2 S.	84 W.	3-O (mac)	Minturn	Middle Pennsylvanian.	A dark-gray mudstone.	0.82	100	.09	A good sample.
Eagle (24)	17	2 S.	84 W.	3T (mac)	Mancos Shale	Late Cretaceous	Gray mudstone.	0.96	61	.11	Grains scarce but large.
Eagle (24)	16	2 S.	83 W.	8 (mac)	Minturn	Middle Pennsylvanian	Mudstone.	1.20	81	.10	A good sample. Two populations; measured the lower reflectance one.
Eagle (24)	6	3 S.	85 W.	3V (mac)	Maroon	Pennsylvanian and Permian	Red mudstone.	0.66	24	.07	Grains scarce.
Eagle (24)	15	3 S.	83 W.	7 (mac)	Mancos Shale	Late Cretaceous	Dark-gray mudstone.	0.50	67	.04	A very good sample.
Eagle (24)	9	4 S.	86 W.	3X (mac)	Belden	Early and Middle Pennsylvanian	Dark-gray mudstone.	2.47	60	.19	A good sample. Vitrinite abundant.
Eagle (24)	24	4 S.	84 W.	18 (mac)	Eagle Valley	Middle Pennsylvanian	Mudstone	1.18	50	.10	A good sample. Measured the lowest population.
Eagle (24)	15	4 S.	83 W.	4 (mac)	Dakota Sandstone	Late Cretaceous	Black mudstone.	0.74	65	.09	A good sample.
Eagle (24)	31	4 S.	86 W.	3Z (mac)	Belden	Early and Middle Pennsylvanian	Dark-gray mudstone.	2.68	52	.22	A good sample. Vitrinite abundant.
Eagle (24)	4	5 S.	85 W.	21 (mac)	Eagle Valley	Middle Pennsylvanian	Dark mudstone.	1.86	1.02	.25	A coaly mudstone.
Eagle (24)	5	5 S.	84 W.	4H (mac)	Eagle Valley	Middle Pennsylvanian	Black gypsum.	1.55	62	.14	A good sample. Vitrinite abundant.

Eagle (24)	24 5 S. 84 W.	4J (mac)	Eagle Valley	Middle Pennsylvanian	Gray mudstone.	1.08	45	.18	Measured the lowest population.
Eagle (24)	11 5 S. 82 W.	L (mac)	Eagle Valley	Middle Pennsylvanian	Gray mudstone.	1.35	53	.11	Poor quality, looks weathered.
Eagle (24)	15 5 S. 81 W.	C (mac)	Minturn	Middle Pennsylvanian	Mudstone	1.03	74	.10	Organics abundant.
Eagle (24)	20 5 S. 79 W.	B (mac)	Minturn	Middle Pennsylvanian	Sandstone	0.94	31	.24	A poor sample. Grains scarce.
Eagle (24)	29 5 S. 86 W.	4E (mac)	Eagle Valley	Middle Pennsylvanian	Mudstone	0.53	34	.07	Lowest reflectance population scarce.
Eagle (24)	5 6 S. 85 W.	4G (mac)	Maroon	Pennsylvanian and Permian	Sandstone	0.91	50	.09	A good sample. Vitrinite consistent.
Eagle (24)	16 6 S. 86 W.	4C (mac)	Eagle Valley	Middle Pennsylvanian	Gypsum	1.30	60	.14	Vitrinite is of poor quality.
Eagle (24)	12 6 S. 81 W.	2 (mac)	Belden	Early and Middle Pennsylvanian	Sandstone	3.72	80	.23	A good sample. Fairly consistent for this high level of maturity.
Eagle (24)	12 8 S. 87 W.	R (mac)	Mancos Shale	Late Cretaceous	Dark-brown mudstone.	0.74	63	.09	A large low-reflectance population.
Eagle (24)	10 8 S. 84 W.	Z (mac)	Belden	Early and Middle Pennsylvanian	Dark mudstone.	3.70	78	0.27	A large high-reflectance population only. Consistent.
Pitkin (25)	33 8 S. 86 W.	2B (mac)	Mancos Shale	Late Cretaceous	Dark-gray mudstone.	1.66	56	.14	Vitrinite abundant but small.
Pitkin (25)	28 9 S. 85 W.	2D (mac)	Mancos Shale	Late Cretaceous	Dark mudstone.	1.27	51	.11	A fair sample.
Gunnison (26)	12 11 S. 89 W.	2G (mac)	Mesaverde	Late Cretaceous	Black mudstone	0.71	49	.07	A very good coaly mudstone.
Gunnison (26)	SE1/4 5 11 S. 90 W.	86-7S	Mesaverde	Late Cretaceous	2-in.-thick coal stringer in sandstone.	0.53	50	.04	A good coal.
Gunnison (26)	19 11 S. 89 W.	86-7T (coal)	Mesaverde	Late Cretaceous	Coalified log in sandstone.	0.80	50	.06	Most of sample is cell structure.
Gunnison (26)	SE1/4SW1/4 5 12 S. 89 W.	86-7U (mac)	Mesaverde	Late Cretaceous	Dark shale stringer in sandstone.	0.65	50	.09	A fairly coaly shale.
Gunnison (26)	NW1/4 17 12 S 89 W.	86-7V (mac)	Mesaverde	Late Cretaceous	Carbonaceous shale.	0.75	65	.07	A good quality shale. Organic matter abundant.
Gunnison (26)	4 13 S. 89 W.	86-7W (coal)	Mesaverde	Late Cretaceous	6-in.-thick coal bed.	0.47	7	.04	Majority of sample is high reflectance grains. A few low-reflectance grains.
Gunnison (26)	NE1/4 11 13 S. 87 W.	86-13B (mac)	Mesaverde	Late Cretaceous	Dark-gray silty shale.	1.35	16	.29	A wide range of material. Measured the lowest reflectance population.
Gunnison (26)	SW1/4NW1/4 19 13 S. 86 W.	86-12J (mac)	Mesaverde	Late Cretaceous	Dark-gray silty shale.	4.24	49	.39	A good quality sample.

Table 1.--Location, formation, age, and vitrinite reflectance data for surface samples from the Uinta, Piceance, and Eagle Basins--Continued

[---, data unavailable; mac, macerated. Wasatch Formation is Eocene at some localities and Paleocene and Eocene at other localities. Mesaverde can be Group or Formation depending on location. To find sample locality on the map in table 1, use main map and index map to find state, county, and county number for sample locality. Then look under appropriate state, county, and county number in table.]

County and associated number on index map	Location sec. T. R.	Sample number and type of preparation	Lithostratigraphic unit (Formation unless otherwise designated)	Age	Sample description	Mean random vitrinite reflectance (R_m)	Number of measurements	Standard deviation	Comments on vitrinite reflectance analysis
Gunnison (26)	SW1/4NW1/4 19 13 S. 86 W.	86-12N (mac)	Mesaverde	Late Cretaceous	Dark-gray silty shale	1.21	46	.19	A good shale. Measured the lowest reflectance population.
Gunnison (26)	NE1/4NE1/4 18 15 S. 86 W.	86-14A (coal)	Mesaverde	Late Cretaceous	Coal from spoil pile of abandoned Baldwin mine.	0.51	50	.03	A very good coal.
Gunnison (26)	SW1/4NE1/4 8 15 S. 86 W.	86-14B (coal	Mesaverde	Late Cretaceous	1-ft-thick coal seam.	0.46	50	.05	A fair coal.
Gunnison (26)	NE1/4SE1/4 5 15 S. 86 W.	86-14C (coal)	Mesaverde	Late Cretaceous	Coal from spoil pile of abandoned Kubler mine.	0.58	50	.04	A good consistent coal.
Gunnison (26)	NE1/4NW1/4 29 15 S. 84 W.	86-8R (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	1.05	51	.13	A fair shale. No low-reflectance grains.
Gunnison (26)	NE1/4 20 13 S. 86 W.	86-8-O (coal)	Mesaverde	Late Cretaceous	Coal from spoil pile of abandoned Smith Hill mine.	2.81	50	0.17	A very good coal.
Gunnison (26)	SW1/4SE1/4 28 13 S. 86 W.	86-8P (coal)	Mesaverde	Late Cretaceous	Coal from spoil pile of abandoned Peanut mine.	2.77	52	.17	A very good coal.
Gunnison (26)	SE1/4NE1/4 33 13 S. 86 W.	86-8Q (coal)	Mesaverde	Late Cretaceous	Coal from spoil pile of abandoned mine.	1.87	50	.10	A very good coal.
Gunnison (26)	SW1/4SE1/4 11 13 S. 86 W.	86-14H (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.67	41	.09	Measured the lowest population.
Gunnison (26)	SW1/4 27 12 S. 86 W.	86-14I (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.78	16	.13	Organics lean.
Gunnison (26)	SE1/4 18 12 S. 86 W.	86-14J (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.52	2	.02	Grains very scarce. Able to measure two low-reflectance grains.
Gunnison (26)	NW1/4 27 48 N. 5 W.	86-14D (mac)	Mancos Shale	Late Cretaceous	Dark-gray shale.	0.53	39	.12	A fair shale.
Gunnison (26)	29 49 N. 5 W.	86-8J (mac)	Morrison?	Late Jurassic(?)	Light-green-gray mudstone in maroon and gray sequence.	---	---	---	Barren.
Gunnison (26)	33 49 N. 4 W.	86-8K (mac)	Morrison?	Late Jurassic(?)	Dark-red mudstone in all red sequence.	---	---	---	Barren.
Gunnison (26)	35 49 N. 4 W.	86-8L (mac)	Dakota Sandstone	Late Cretaceous	Black mudstone.	1.0	9	.13	A poor sample. Grains small.

Gunnison (26)	21 41 N. 3 W.	86-8M (coal)	Dakota Sandstone	Late Cretaceous	Coaly carbonaceous shale from sandstone cliff.	0.47	50	.05	A fair coal. Full of mineral matter.
Gunnison (26)	NW1/4 30 49 N. 2 W.	86-8N (mac)	Dakota Sandstone	Late Cretaceous	Dark material from base of highly weathered sandstone.	---	---	---	Barren.