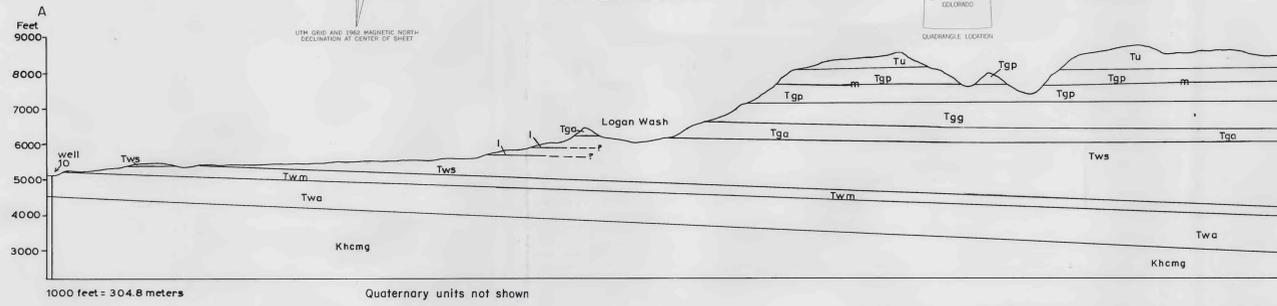




Base from U.S. Geological Survey, 1962

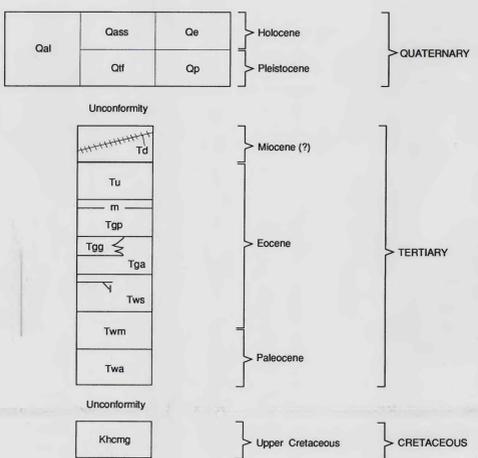
Geology mapped by J.R. Donnell in 1963-1965.  
Geology modified by L.J. Schmitt in 1987-1991,  
assisted by Joe Nahama in 1987.  
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GEOLOGIC MAP OF THE RED PINNACLE QUADRANGLE, GARFIELD COUNTY, COLORADO

By  
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CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

- Qal Alluvium (Holocene and Pleistocene?)**—Deposits of unconsolidated clay, silt, sand, and gravel in stream beds, low terraces, and floodplains of major streams and tributaries. Well-sorted and well-sorted nonlocally derived clasts of crystalline clasts are common in alluvium of Colorado River; alluvial clasts in other drainages are derived mostly from local outcrops.
- Qass Alluvial and eolian sand and silt (Holocene)**—Yellowish-brown silt and sand, and reddish-brown silt; generally well sorted. Derived mostly from local sedimentary rocks; mapped only in southern part of quadrangle. Maximum thickness about 30 ft (9 m).
- Qe Earthflow deposits (Holocene)**—Relatively small, active, recent earth flows developed in mudstone beds of Wasatch Formation. Separation cracks are clearly visible.
- Qof Terrace and fan deposits (Pleistocene)**—Poorly sorted to well-sorted, angular to well-rounded pebble, cobble, and boulder gravel in a sandy matrix. Clasts are commonly basalt but some are sedimentary rocks; cobbles of igneous and metamorphic rocks are abundant near Colorado River. Mapped only in southern and northeastern parts of quadrangle. Considered by Yeend (1969) as part of Grand Mesa Formation (Pleistocene). Maximum thickness about 100 ft (30 m).
- Qop Pediment deposits (Pleistocene)**—Subangular to subrounded pebble, cobble, and boulder gravel in a sandy matrix; covers gently sloping erosional surfaces on Wasatch Formation. Composed mostly of sandstone, siltstone, claystone, and marlstone clasts of Green River and Wasatch Formations; contains some basalt boulders. Underlying pediments represent an earlier erosional cycle related to higher Colorado River base level. Mapped only in southern and northeastern parts of quadrangle. Thickness generally less than 50 ft (15 m).
- Td Dike (Miocene?)**—Steeply dipping to vertical mafic dike having diabasic texture and chilled margins. Dike rock is fractured and spheroidally weathered. Only known occurrence is in southeastern part of quadrangle. May be related to Miocene basalt flows that cover Grand and Battlement Mesas. Petrographic analysis of rock indicates it contains significant amounts of labradorite feldspar, clinopyroxene (probably augite), and magnetite, and is probably a basalt, originally olivine basalt. Dike is about 6 ft (2 m) wide.
- Tu Ulna Formation (Eocene)**—Rocks deposited in various environments, representing ultimate filling of Eocene lake in which lacustrine beds of underlying Green River Formation were deposited. Light-brown siltstone and fine- to medium-grained sandstone; light-brown to light-gray marlstone; some lenticular oil-shale beds in lower part. Underlies highest land surface in quadrangle; generally well weathered. Basal contact with Green River Formation appears to be conformable. Original thickness in quadrangle is unknown because top is eroded away. Thickness of incomplete formation is about 800 ft (244 m).
- Tgp Parachute Creek Member (Eocene)**—Sediments deposited in a variety of mostly lacustrine environments. Parachute Creek Member—Black, dark-brown, and dark-gray, commonly laminated marlstone; weathers light gray. Includes both papery and massive oil shale, some calcareous siltstone and fine-grained sandstone, and numerous thin beds of analcized tuff; locally contains ostracodal limestone and stromatolitic marlstone. Weathers to form prominent whitish cliffs and steep slopes. Upper part of member contains thickest and richest oil-shale beds and is, therefore, of economic interest. Thickness 900-1,200 ft (274-366 m).
- m Mahogany bed**—Persistent bed of very rich oil shale within Parachute Creek Member. That part of unit overlain by Parachute Creek Member. Thickness 2-6 ft (1-2 m).
- Tgg Garden Gulch Member**—Gray marlstone, fissile shale, some oil shale, and claystone; some interbedded thin siltstone and sandstone; minor oolitic, ostracodal, and algal limestone. Similar to overlying Parachute Creek Member but contains less, and generally leaner, oil shale. Distinguished from underlying Anvil Points Member by lack of significant amounts of sandstone. In eastern part of quadrangle, the Garden Gulch grades through a facies change into Anvil Points Member, and change is indicated on map by arbitrary facies boundaries. Areal distribution of Garden Gulch Member was taken from a map by Waldron and others (1951). Thickness 500-900 ft (152-274 m).
- Anvil Points Member**—Brown, fine- to coarse-grained, massive sandstone interbedded with gray siltstone and marlstone; includes some oil shale. Represents a sandy nearshore facies of the Green River Formation. That part of unit overlain by Garden Gulch Member was previously mapped as Douglas

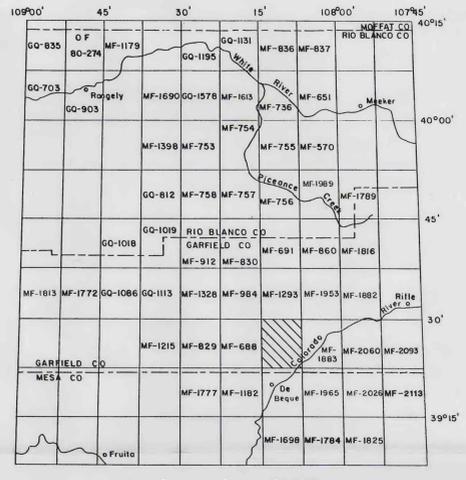
- Shire Member (Eocene)**—Consists mostly of variegated red, brown, lavender, purple, and gray mudstone containing some lenticular beds of gray or yellowish-gray, calcareous, fine- to coarse-grained sandstone. Sandstone beds are generally less than 30 ft (9 m) thick. Measured reference section of Shire Member is in southeastern part of De Beque quadrangle, which adjoins this quadrangle to the south (Donnell, 1969, p. M17-M18). Maximum thickness about 2,000 ft (610 m).
- Lacustrine beds**—In middle of fluvial Shire Member in southwestern part of quadrangle. Consist of pale-yellow and tan, fine-grained sandstone, thin-bedded to laminated siltstone and silty mudstone, and gray, papery shale; some beds contain ostracodes and oolites. Some shale beds contain coal seams. These beds form three or four separate cliff-forming lacustrine units that are probably equivalent to beds in Cow Ridge Member of Green River Formation. Type section of Cow Ridge Member is in sec. 31, T. 7 S., R. 98 W., on south side of Cow Ridge in Long Point quadrangle to the west (Johnson, 1984). Beds thin to east or southeast. Individual lacustrine beds are as much as 50-80 ft (15-24 m) thick.
- Molina Member (Eocene and Paleocene)**—Gray and brown, fine- to coarse-grained, massive arkosic sandstone interbedded with lenticular gray, greenish-gray, or lavender mudstone or siltstone. Ledge-forming sandstone beds are conspicuous, and basal sandstone bed of the Molina is generally persistent. Exposed only in southern and southwestern parts of quadrangle. A measured reference section of this unit is in southern part of De Beque quadrangle to the south (Donnell, 1969, p. M14-M15). Thickness about 200 ft (61 m).
- Twa Atwell Gulch Member (Paleocene)**—Mostly yellowish-gray mudstone or claystone. Only uppermost part of member is present in southwestern corner of quadrangle and is obscured by wash from overlying Molina Member. Maximum exposed thickness is about 30 ft (15 m).
- Khcmg Hunter Canyon and Mount Garfield Formations, undifferentiated (Upper Cretaceous)**—Pale-yellowish-gray, light-brown, and gray, fine- to coarse-grained sandstone interbedded with gray shale. Interpreted from well logs and shown only in cross section. Thickness about 3,400 ft (1,036 m).

NOTE

- Structure contour**—Drawn showing top of Mahogany bed of Parachute Creek Member of Green River Formation. Dashed where datum was removed by erosion. Contour interval 100 ft (30.5 m).
- Test well**—Oil and gas test hole of unknown production status. Number keyed to table 1.
- Drill hole**—Oil shale evaluation drill hole. Letter keyed to table 2.
- Facies boundary**—Arbitrarily placed at gradational lateral facies change between Garden Gulch and Anvil Points Members of Green River Formation in eastern part of quadrangle.
- Syncline**

ECONOMIC GEOLOGY

Several oil and gas test wells were drilled in this quadrangle, but there is no known production. The deepest well, 1-27 Arco Deep Test #1, was drilled to a depth of 14,731 ft (4,490 m). The Green River Formation of Eocene age contains oil shale of economic interest. Some of the richest oil shale is in the upper part of the Parachute Creek Member. Eleven known holes were drilled through the oil shale in the quadrangle but generally have not penetrated much below the Mahogany oil-shale zone of the Parachute Creek Member. Oil-shale resource estimates for this quadrangle were made for the Mahogany zone, R-6 zone, and L-5 zone of the Parachute Creek Member on the basis of resource information from Pitman and Johnson (1978), Pitman (1979), and Pitman and others (1989). Other zones in the Parachute Creek Member contain rich oil shale, but available information is insufficient to estimate oil resources. In this quadrangle the Mahogany zone is estimated to contain approximately 1.74 × 10<sup>9</sup> barrels (0.28 × 10<sup>9</sup> m<sup>3</sup>) of oil. The R-6 zone contains approximately 8.15 × 10<sup>8</sup> barrels (1.30 × 10<sup>8</sup> m<sup>3</sup>) of oil, and the L-5 zone contains approximately 1.30 × 10<sup>9</sup> barrels (0.21 × 10<sup>9</sup> m<sup>3</sup>). Total known oil resources in oil shale in the quadrangle are estimated at 2.68 × 10<sup>9</sup> barrels (0.43 × 10<sup>9</sup> m<sup>3</sup>), but this figure does not include all potentially economic oil shales, nor does it allow for losses caused by mining methods.



INDEX MAP SHOWING LOCATION OF THIS QUADRANGLE (PATTERED) AND OTHER PUBLISHED U.S. GEOLOGICAL SURVEY (USGS) 7 1/2-MINUTE GEOLOGIC MAPS IN THE PICEANCE CREEK BASIN AREA, NORTHWESTERN COLORADO. Published USGS maps include: Geologic Quadrangle Maps (GQ), Miscellaneous Field Studies Maps (MF), and Open-File Reports (OF).

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Table 1. Oil and gas test wells; approximately located

Well No.	Section	Company and well name	Total depth
			Feet Meters
1	29	Barrett Energy Co. T. 6 S., R. 96 W.	4,630 1,411
2	30	Barrett Energy Co. MV 35-29	9,150 2,789
3	32	Barrett Energy Co. Crystal Creek A-1	2,539 774
4	32	Barrett Energy Co. TN-1-32 Union	7,260 2,213
5	27	Barrett Energy Co. MV-5-32 Arco	14,731 4,490
6	8	Barrett Energy Co. T. 7 S., R. 96 W.	6,570 2,003
7	29	Barrett Energy Co. MV 15-9 Federal	1,200? 366?
8	11	Barrett Energy Co. TW 2-29 Federal	9,300 2,835
9	5	Coors Energy Co. T. 6 S., R. 97 W.	4,788 1,459
10	8	Sanco USA 1-5 LW	3,009 917
		Federal #1	

Table 2. Oil-shale evaluation drill holes; approximately located

[no data]			
Well No.	Section	Company and drill hole name	Total depth
			Feet Meters
a	26	Sinclair Oil & Gas Co. Haystack 1-1	-- --
b	34	Pacific Oil Co. Allen 1	770 235
d	1	Sinclair Oil & Gas Co. Haystack 1-1	-- --
e	10	Shell Oil Co. 26X-10	1,490 454
f	11	Shell Oil Co. 44X-11	-- --
g	11	Sinclair Oil & Gas Co. Haystack 11-1	611 186
h	13	U.S. Bureau of Land Management triangulation station shale 1	801 244
i	24	Schuyler Estate Schuyler 2	-- --
j	24	U.S. Bureau of Land Management triangulation station shale 2	742 226
k	25	Occidental Oil Shale LW-156	1,004 306
l	25	Garrett Research LW-41	822? 251?