DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
MONTANA BUREAU OF MINES AND GEOLOGY
AND THE UNITED STATES BUREAU OF LAND MANAGEMENT

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-847-D (SHEET 1 OF 2)

CORRELATION OF MAP UNITS

Qal, Qt	Holocene and Pleistocene	QUATERNARY
Tw	Eocene	TERTIARY
Tft, Tfl	Paleocene	TERTIARY
Tftu	Paleocene	TERTIARY
Khc, Kb	Upper Cretaceous	CRETACEOUS
Kp	Upper Cretaceous	CRETACEOUS

DESCRIPTION OF MAP UNITS

	GENERAL DESCRIPTION	WATER-YIELDING CHARACTERISTICS
Qal	ALLUVIUM (0–100 ft or 0–30 m)—Sand, silt, clay, and local lenses of gravel. Coarse well-rounded gravel interbedded with finer material is common along the Yellowstone River; beds are mostly reworked terrace deposits. Gravel consists of clinker fragments on many smaller streams. Deposits are as much as 75 feet (23 m) thick along the Tongue River, 50 feet (15 m) thick along the Yellowstone River, and 40 feet (12 m) thick along smaller streams. Unit includes many low-lying terraces adjacent to streams	Alluvium composed of coarse gravels may yield several hundred gallons of water per minute to properly developed wells in local areas along larger perennial streams; along smaller streams with thinner saturated thicknesses yields of 100 gal/min (6.3 L/s) may be possible. Yields commonly are 30 gal/min (1.9 L/s) or less to stock and domestic wells
Qt	TERRACE DEPOSITS (about 0–70 ft or 0–21 m)—Gravel, sand, silt, and clay. Well-rounded pebbles and sand-sized particles of igneous, sedimentary, and metamorphic rocks are common. Deposits are confined mainly to valley sides and upland areas along the Yellowstone River; deposits are scattered in other parts of the area	Most terraces are topographically high and are mostly unsaturated. Along major streams, at lower altitudes, these deposits yield as much as 5 gal/min (0.32 L/s) to domestic and stock wells
Tw	WASATCH FORMATION (0–400 ft or 0–120 m)—Brownish-gray to light-gray fine- to coarse-grained lenticular beds of sandstone and interbedded gray shale and coal. Contains a fossiliferous zone of clams and snails as much as 30 feet (9.1 m) thick. Zones of clinker crop out along the coal horizons. Base of unit is mapped as the top of the thick and persistent Roland coal bed, as defined by Baker (1929). Conformable contact with underlying unit	Most wells are shallow and yield less than 20 gal/min (1.3 L/s). Where wells tap coarse-grained deposits or large saturated thicknesses, yields may be higher
Tft	FORT UNION FORMATION Tongue River Member (0–2,500 ft or 0–760 m)—Light-yellow to light-gray fine- to medium-grained thick-bedded to massive locally crossbedded and lenticular, calcareous sandstone and siltstone; weathers to a buff color. Commonly contains light-buff to light-gray shaly siltstone and shale, and brown to black carbonaceous shale. Contains numerous coal beds; as much as 80 feet (24 m) thick. Burning of the coal along outcrops has formed thick red and lavender clinker and baked shale beds. Base of unit is mapped as the change from predominantly siltstone and sandstone to predominantly shale of underlying unit	Sandstone and coal beds are the aquifers; the shales are not water bearing. Unit contains major aquifers in much of study area; measured yields are as high as 160 gal/min (10 L/s) in wells penetrating large saturated thicknesses. Fractured clinker beds are highly permeable and may yield as much as 50 gal/min (3.2 L/s). Many aquifers are under artesian pressure and many wells along the Tongue and Powder Rivers and their principal tributaries flow; flowing well yields may be as much as 10 gal/min (0.63 L/s) A limited source of water in the study area; in selected areas where saturated coarse-grained channel deposits are penetrated, well yields may be as much as 10 gal/min (0.63 L/s)
Tfl	Lebo Shale Member (0–600 ft or 0–180 m)—Predominantly dark shale containing interbeds of light-gray and brown to black carbonaceous shale, siltstone, and locally thin coal beds. Shales contain altered and devitrified volcanic ash and brown ferruginous concretions. Base of unit is mapped as the change from predominantly shale to predominantly fine-grained sandstone and shale of underlying unit. Conformable contact with underlying unit; however, the Lebo exists locally as scoured channel deposits developed well into the Tullock Member	
Tftu	Tullock Member (0–800 ft or 0–240 m)—Lower part of member is interbedded medium-gray to light-gray shale, fine-grained light-gray sandstone and siltstone, and thin but persistent coal beds; grades upward to light-gray carbonaceous shale. Locally at the top is a resistant sandstone that forms a well-developed rimrock. Base of unit is mapped as the change from fine-grained thin-bedded sandstone, siltstone, shale, and coal beds to predominantly massive channel sandstone and dark-gray shale of underlying unit (Brown, 1952; Dunlap, 1958)	Fine-grained sandstones and coal beds supply small quantities of water for domestic use. Well yields may be as much as 40 gal/min (2.5 L/s), but generally average about 15 gal/min (0.95 L/s). Where aquifers are confined, flowing well yields generally are less than 10 gal/min (0.63 L/s).
Khc	HELL CREEK FORMATION (0–850 ft or 0–260 m)—Gray to yellowish-gray silty clayey sandy carbonaceous and bentonitic shale and siltstone; locally, a yellowish-gray to tan fine- to medium-grained silty sandstone containing thin coal beds predominates. Lower contact is gradational; mapped as the change from predominantly silty shale and siltstone to predominantly sandstone of underlying unit. Contact probably unconformable with underlying Fox Hills Sandstone and Bearpaw Shale	Upper Hell Creek—limited as a water supply in study area; a few flowing wells yield as much as 4 gal/min (0.25 L/s)
Not exposed in study area	FOX HILLS SANDSTONE (0–280 ft or 0–85 m)—Near-shore sand facies that is the last marine deposit in the area. Two members are recognized: Colgate Member—Very light gray fine- to medium-grained massive sandstone Unnamed lower member—Gray to brownish-gray fine-grained thin-bedded sandstone; interbedded with gray sandy shale and siltstone. Lower contact is gradational; considered to be the base of transition zone between sandstone above and shale of underlying unit. Conformable contact with underlying unit	Lower Hell Creek and Fox Hills Sandstone—Considered to represent one aquifer in the study area. Reliable source of water for artesian wells; yields as much as 20 gal/min (1.3 L/s) to flowing wells along the Tongue and Powder River valleys. Yields as much as 70 gal/min (4.4 L/s) to domestic and stock wells and 200 gal/min (13 L/s) to industrial wells
Kb	BEARPAW SHALE (0–800 ft or 0–240 m)—Gray to black marine shaly claystone and shale. Contains some thin-bedded siltstone and silty sandstone and locally thin beds of bentonite. Base of unit is mapped as the change from shale and siltstone to sandstone of underlying unit. Disconformable contact with underlying unit	A confining bed; not known to yield water to wells in study area
Kp	PARKMAN SANDSTONE (50–300 ft or 15–91 m)—In northwestern part of area consists of light-colored clay and yellow fine- to coarse-grained massive sandstone. In southwestern part consists of massive basal sandstone overlain by dark silty to sandy carbonaceous shale and thick sandstone containing local coal beds near its top	Wells tapping the basal sandstone yield as much as 75 gal/min (4.7 L/s). Where the sandstone is absent, well yields are small

Contact—Dashed where approximately located

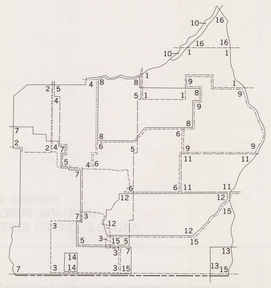
Fault—Long dashed where approximately located; short dashed where inferred. Bar and ball on downthrown side

2000 Structure contour—Shows altitude of top of Bearpaw Shale. Contour intervals 100, 200, and 1000 feet (30, 60 and 300 m). Datum is mean sea level

A — A' Trace of geologic section (sheet 2)

Strike and dip of beds

23 Location and number of well or test hole used in geologic section



INDEX TO PREVIOUS GEOLOGIC MAPPING

1. Collier and Smith (1909)
2. Rogers and Lee (1923)
3. Baker (1929)
4. Dobbin and Reeside (1930)
5. Renick (1929)
6. Bass (1932)
7. Thom, Hall, Wegemann, and Moulton (1935)
8. Pierce (1936)
9. Parker and Andrews (1939)
10. Torrey and Swenson (1951)
11. Bryson (1952)
12. Warren (1959)
13. Robinson, Mapel, and Bergendahl (1964)
14. Law and Grazis (1972)
15. Bryson and Bass (1973)
16. Lewis (this report)

Base from U.S. Geological Survey
State base map 1:500,000, 1968

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 500 FEET (150 METERS)
DATUM IS MSAN SEA LEVEL

MAGNETIC DECLINATION AT SOUTH EDGE OF MAP VARIED FROM 14½° EAST IN 1970 TO 16° IN 1967

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Geology reviewed, modified, and where necessary remapped by B. D. Lewis, 1975

MAP SHOWING GEOLOGY AND CONFIGURATION OF TOP OF BEARPAW SHALE

GEOLOGY AND WATER-YIELDING CHARACTERISTICS OF ROCKS OF THE NORTHERN POWDER RIVER BASIN, SOUTHEASTERN MONTANA

By
Barney D. Lewis and Robert S. Roberts

1978

For sale by Branch of Distribution, U.S. Geological Survey, Box 25286 Federal Center, Denver, CO 80225