



U.S. Geological Survey
OPEN FILE REPORT
This map is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

Base from U.S. Geological Survey, 1951

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Map by Laura W. McGrew, assisted by Paula Westfall, 1965, and Virginia Passmore, 1966

SCALE 1:24,000
CONTOUR INTERVAL 20 FEET
DATING IS MEAN SEA LEVEL

GEOLOGIC MAP OF THE SIXTEEN NE QUADRANGLE, GALLATIN, MEAGHER, AND PARK COUNTIES, MONTANA
By
Laura W. McGrew
1974

CORRELATION OF MAP UNITS		
Qa	Qc	Q1
UNCONFORMITY		
Qb	Qd	
UNCONFORMITY		
Tf		
UNCONFORMITY		
Tbs	Tbg	
UNCONFORMITY AND MAJOR UPLIFT		
Kbc		
Ksl		
Ksb		
Ksm		
Kss		
Ke		
Ktc		
Kc		
Kf		
Kmt		
Kk		
Jm		
UNCONFORMITY		
Fa		
UNCONFORMITY		
Mm		
UNCONFORMITY		
Dj		
UNCONFORMITY		
pCs		
pGsu		

DESCRIPTION OF MAP UNITS

Qa ALLUVIUM (QUATERNARY)--Gravel, sand, silt, and clay associated with present drainages

Qc COLLUVIUM (QUATERNARY)--Angular fragments of underlying bedrock

Q1 LANDSLIDE DEPOSITS (QUATERNARY)--Accumulations of angular debris derived from upslope rocks and emplaced by mass sliding

Q1b BASALT FLOW (QUATERNARY OR TERTIARY)--Basalt, black, weathering grayish-brown, very finely crystalline with sparse black glass inclusions

S Scoria--Brick red

QTg LAG GRAVEL (QUATERNARY AND TERTIARY)--Gravel, rounded to subrounded, probably largely lag from Fort Logan Beds; probably includes colluvium near contact with older rocks

Tf FORT LOGAN BEDS (LOWER MIOCENE)--Siltstone, light-grayish-orange, sandy and conglomeratic, tuffaceous; interbedded light-gray volcanic ash, light-gray to white hard fresh-water gastropod limestone, and many conglomerate and gravel lenses of rounded to subrounded pebbles to boulders. Coarse components of gravel and conglomerate are mostly Precambrian shale and sandstone of the Belt Supergroup and Paleozoic limestone with subordinate amounts of Paleozoic and Mesozoic sandstone and porphyrite of Black Butte Mountain, derived partly from the west and north and partly from immediately surrounding bedrock. Abundant fossil mammal and turtle bone scrap is present in gravels. A probable early Miocene age is based on a Carnegie Museum collection from N 1/2 NE 1/4 sec. 11, T. 6 N., R. 6 E., consisting of: *Cephalothalia* cf. *C. gradatus*, *Eurya* sp., *Palaetolagus* sp. between *P. barkeri* and *P. hypocoelus*, *Proteromysacocherus* sp., or *Mesomysodon* sp., *Cyolopadus* sp. (C. C. Black, written commun., 1966). Exposures 100 feet (30.5 m) or more thick are common but a meaningful aggregate thickness is difficult to estimate due to relief on the deposition surface

BRECCIA (TERTIARY)--Emplaced by Meadow Creek erosion thrust faulting after major folding and erosion but before deposition of Fort Logan Beds

Tbs Breccia containing Spokane Shale

Tbg Breccia containing upper member of Greyson Shale

Kbc BILLMAN CREEK FORMATION (UPPER CRETACEOUS)--Mudstone, gray, greenish-gray, subordinately green and red; interbedded siltstone and volcanic sandstone and conglomerate lenses; small gray calcareous sandstone nodules as much as 2 inches (50.8 mm) in diameter form a conspicuous lag on slopes; abundant zeolites; sparse dinosaur bone, fossil wood, and carbonaceous material; except for some sandstone and conglomerate lenses the formation is generally nonresistant forming slopes and valleys; mostly covered. 1,000+ feet (304+ m) thick

FORMATION AT SEDAN (UPPER CRETACEOUS):

Ksl Lenny Sandstone equivalent--Volcanic sandstone, grayish-brown to yellowish-brown; tuffaceous; locally magnetite rich; mostly very fine to medium grained; locally conglomeratic; interbedded brown mudstone; abundant spherical calcareous "cannonball" concretions and carbonaceous material; iron staining gives unit a characteristic overall rusty-brown color; a ridge-forming magnetite sandstone three-six feet (76.2-152.4 mm) thick is present about 300 feet (91.4 m) above the base in the northeast corner of map area; brackish-water fauna (W. A. Cobban, written commun., 1967) collected from dark-brown mudstone near base of member in NW 1/4 SE 1/4 sec. 19, T. 5 N., R. 8 E. (fossil loc. no. 4); unit is generally well exposed forming a conspicuous ridge. 250-600 feet (76.2-182.9 m) thick

Ksb Bearpaw Shale equivalent--Mudstone, gray, green, and brown; thin beds of gray and green sandstone and yellowish-gray bentonite; forms valley, mostly covered. 150-250 feet (45.7-76.2 m) thick

Ksm Mudstone member, lower part--Mudstone, olive-gray to brown; interbedded light-gray and green to dark-green and brown fine-grained to conglomeratic volcanic sandstone and light-yellowish-gray bentonite; zeolites abundant throughout; sparse silicified wood, dinosaur bone, and carbonaceous plant remains

Altered crystal and vitric tuff, interbedded with green, dark-gray-green, and brown sandstone, about 150 feet (45.7 m) thick, just above middle, is a conspicuous ridge former and marker bed throughout the map area. 600-700 feet (182.9-213.4 m) thick

Kas Middle and lower sandstone members, undivided--Volcanic sandstone and conglomerate, gray-green and olive, weathering dark brown; interbedded dark gray-green and brown siliceous mudstone; lignite near base in some localities; magnetite-rich sandstone lenses in lower 200 feet (61 m); leaf and twig impressions and carbonaceous plant debris abundant throughout; sparse silicified wood and dinosaur

Persistent conglomerate and conglomeratic sandstone in upper 500 feet (152.4 m) consists of volcanic pebbles, cobbles, and boulders in purple to green mudstone and volcanic sandstone matrix; tentatively correlated with member F of the intermediate volcanic and volcanoclastic rocks of the Maudlow area of Skipp and Peterson (1965)

Interbedded green to greenish-gray welded tuff and light-gray crossbedded friable sandstone 240 feet (73.2 m) thick about 500 feet (152.4 m) above base of member; sandstone is tentatively correlated with Parkman Sandstone and welded tuff is correlated with member D of the intermediate volcanic and volcanoclastic rocks of the Maudlow area of Skipp and Peterson (1965)

Chert-pebble conglomerate locally present about 500 feet (152.4 m) above the base in the northern part of map area and in the southern part of Ringling quadrangle to the north; pollen and spores recovered from a lignite bed at base of member (U.S. G.S. Mesozoic locality D4670, C W 1/2 W 1/2 sec. 6, T. 4 N., R. 8 E.) were identified by R. H. Tschudy (Skipp and Peterson, 1972, p. 101) as representing "an interval above *Scaphites depressus* zone and below the *Scaphites hippoprepis* zone." *Clasaphites* sp. (either *vermiformis* or *chotaensis*) from the Telegraph Creek Formation (op. cit) narrows the member to the interval between the *Clasaphites chotaensis* zone below and the *Scaphites hippoprepis* zone above. 2,000-2,800 feet (609.6-853.4 m) thick

EAGLE SANDSTONE (UPPER CRETACEOUS)--Sandstone, light-yellowish-gray to greenish-gray; very fine to coarse grained; thin bedded to massive; locally magnetite rich; interbedded thin dark-gray mudstone; abundant brown-rind calcareous sandstone "cannonball" concretions, commonly with carbonaceous plant material. Resistant sandstone unit about 150 feet (45.7 m) thick at base with abundant volcanic debris and a magnetite-rich bed about 50 feet (15.2 m) from the top is correlated with the Virgelle Member; thin-bedded unit above is less resistant and mostly covered. 350-600 feet (106.7-182.9 m) thick

TELEGRAPH CREEK FORMATION (UPPER CRETACEOUS)--Shale and mudstone, dark-gray weathering light-gray; silty, biotitic, calcareous; light-gray limestone concretions common, many with fossil invertebrate nuclei; interbedded minor light-gray fine-grained very thin bedded sandstone; mostly covered; *Clasaphites vermiformis* collected from the lower part of the formation at two localities (numbers 1 and 3, fossil locality list and on map) suggests a Middle Santonian age for the Telegraph Creek Formation in the map area. 300-900 feet (91.4-274.3 m) thick

CODY SHALE (UPPER CRETACEOUS)--Shale and mudstone, gray to dark-gray; gray limestone concretions as much as 2 feet (60.8 mm) or more in diameter commonly contain fossil invertebrate nuclei; rusty ironstone concretions and cone-in-cone structures; interbedded sandstone and siltstone that are grayish green, quartzose, glauconitic, argillaceous, fine grained, thin bedded, locally crossbedded, ripple marked, and fossiliferous; persistent grayish-green glauconitic thin-bedded resistant sandstone near middle of formation is correlated with the Eldridge Creek Member. Sandstone beds form ledges, shale and mudstone beds mostly covered. 600-1,000 feet (182.9-304.8 m) thick

FRONTIER FORMATION (UPPER CRETACEOUS)--Sandstone, light-gray to yellowish and greenish-gray; weathers dark gray and brown with "salt-and-pepper" appearance; fine to coarse-grained interbedded dark-gray shale and siliceous mudstone, thin dark-gray quartzite, dark-gray chert-pebble conglomerate containing shark teeth and bone fragments, siliceous limestone, and fossil oyster banks. Sandstone and conglomerate beds generally form ridges. Shale and mudstone beds mostly covered. 500-700 feet (152.4-213.4 m) thick

MOWRY AND THERMOPOLIS SHALES (LOWER CRETACEOUS)--Shale and siliceous mudstone, dark-gray; interbedded gray to greenish-gray medium to coarse-grained sandstone in upper part; grayish-orange ledge-forming quartzitic sandstone at base. Upper part mostly covered. 400-550 feet (121.9-167.6 m) thick

KOOTENAI FORMATION (LOWER CRETACEOUS)--Mudstone, red, gray, and purple; mottled with white irregular lines; interbedded light-gray sandstone, chert-pebble conglomerate, and light-gray fresh-water gastropod-bearing limestone nodules in upper part; greenish-gray chert-rich sandstone at base is gray with some red and yellow iron-stain banding; crossbedded; fine grained to conglomeratic. Upper part mostly covered; basal sandstone generally forms ridge. 400-550 feet (121.9-167.6 m) thick

MORRISON FORMATION (UPPER JURASSIC)--Sandstone, light-gray and yellowish-orange, weathering rusty brown; calcareous; quartzose; locally crossbedded; gray fresh-water limestone beds and nodules in upper part; red mudstone and siltstone with thin beds of rusty-brown sandstone in lower part. 200-300 feet (61-91.4 m) thick

AMSDEN FORMATION (PENNSYLVANIAN)--Dolomite, light-gray, weathering to white, thin to thick-bedded; interbeds of pale-grayish-orange fine-grained quartzite or quartzitic sandstone in upper part; red sandstone, siltstone, and mudstone interbedded with gray limestone in lower part; gray limestone and dolomite breccia locally at base. 250-600 feet (76.2-182.9 m) thick

MISSION CANYON LIMESTONE (UPPER AND LOWER MISSISSIPPIAN)--Limestone, gray to light-gray, cherry, massive; red-siltstone-filled cavernous zones, limestone breccia beds, and gray dolomite locally in upper part. Generally forms massive cliffs. 350-900 feet (106.7-274.3 m) thick

JEFFERSON DOLOMITE (UPPER DEVONIAN)--Dolomite, brownish-gray, feebly; interbedded gray limestone; stromatolites locally present; thick bedded to massive. Forms low ridge. 400-500 feet (121.9-152.4 m) thick

SPOKANE SHALE (PRECAMBRIAN)--Argillite, grayish-red with moderate amounts of light-grayish-green; sparse thin gray to reddish-gray limestone and gray to yellowish-gray quartzite and sandstone; thin bedded; ripple marks common. 3,000-3,200 feet (906.4-975.4 m) thick (Skipp and Peterson, 1965)

GREYSON SHALE (PRECAMBRIAN)--Upper member--Quartzite and sandstone, gray to yellowish-gray; interbedded greenish-gray micaceous argillite, grayish-red argillite, and thin gray limestone and stromatolite beds in upper part. 0-1,400 feet (0-426.7 m) thick (Skipp and Peterson, 1965)

NOTE: Lines on geologic map: dashed where approximately located; short dashed where inferred; dotted where concealed (all but contacts).

CONTACT

THRUST FAULTS--Sawteeth indicate upper plate; type and number of sawteeth indicate the following episodes of thrusting from oldest to youngest

Valley-of-the-Dolls and Horse Butte thrusts--Upper Paleocene folds overturned and thrust to the east

Red Basin thrust--Folding, overturning, and thrusting of Precambrian core of upper Paleocene Middle Fork anticline probably after much of Paleozoic and younger rocks had been stripped away by erosion. Skipp discollement folded along with Cambrian and Precambrian rocks and thrust over Valley-of-the-Dolls thrust trace onto rocks as young as the Cretaceous Frontier Formation

Meadow Creek erosion thrust--Later movement on Red Basin thrust shed brecciated blocks of Spokane Shale (Tbs) and Greyson sandstone and quartzite (Tbg) off the toe of the thrust; plate onto rocks as young as Cody Shale in eroded folds to the east

HIGH-ANGLE FAULT--U, upthrown side; D, downthrown side

ANTICLINE--Showing crestline and direction of plunge

OVERTURNED ANTICLINE--Showing crestline, direction of dip of limbs, and direction of plunge

SYNCLINE--Showing troughline and direction of plunge

OVERTURNED SYNCLINE--Showing troughline, direction of dip of limbs, and direction of plunge

STRIKE AND DIP OF BEDS

Inclined

Vertical

Overturned

Horizontal

INVERTEBRATE FOSSIL LOCALITY--Numbers refer to the following identifications by W. A. Cobban, U.S. Geological Survey, Denver, Colorado.

1. U.S.G.S. Mesozoic locality D6036, sec. 1, T. 5 N., R. 7 E., *Clasaphites vermiformis* (Creek and Hayden)
2. U.S.G.S. Mesozoic locality D6037, sec. 15, T. 5 N., R. 7 E., *Clasaphites* sp.
3. U.S.G.S. Mesozoic locality D6038, sec. 22, T. 5 N., R. 7 E., *Basilites asper* Morton, *Clasaphites vermiformis* (Creek and Hayden)
4. U.S.G.S. Mesozoic locality D6039, sec. 19, T. 5 N., R. 8 E., *Famozia* sp., *Corbula* aff. *C. peruviana* (Creek and Hayden), *Melania*? *whitepasi* Stanton.

TEST WELL FOR OIL AND GAS

REFERENCES

McGrew, L. W., 1974, Geologic map of the Black Butte Mountain quadrangle, Meagher County, Montana: U.S. Geol. Survey open-file report 74-106.

1974, Geologic map of the sixteen quadrangle, Gallatin and Meagher County, Montana: U.S. Geol. Survey open-file report 74-103.

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Skipp, Betty, 1974, Geologic map of the Wallrock quadrangle, Gallatin and Park Counties, Montana: U.S. Geol. Survey open-file report 74-110.

Skipp, Betty, and McGrew, L. W., 1972, The upper Cretaceous Livingston Group of the western Crazy Mountain Basin, Montana, in Montana Geol. Soc. Guidebook 21st Ann. Field Conf.: p. 99-106.

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Skipp, Betty, and Peterson, A. D., 1965, Geologic map of the Maudlow quadrangle, southwestern Montana: U.S. Geol. Survey Misc. Geol. Inv. Map 1-452.

Skipp, Betty, Hepp, M. M., and McGrew, L. W., 1968, Late Paleocene thin-silicified formation of the western edge of the Crazy Mountain Basin, Montana, in Abstracts for 1967: Geol. Soc. America Spec. Paper 115, p. 446.

Index showing location of sixteen NE quadrangle (stippled), nearby U.S. Geological Survey maps, and generalized major structures.

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Frontone (Sixteen NE quad). Map 1-452, 1974.
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