

DESCRIPTION OF MAP UNITS

RAYNESFORD 7.5-MINUTE QUADRANGLE, MONTANA

Qa1

FLOOD PLAIN AND CHANNEL ALLUVIUM (HOLOCENE)--Light-brown and gray gravel, sand, silt and clay deposited in flood plains and channels of active streams. Deposits are well to poorly stratified and moderately well sorted. Thickness not measured; estimated to be as much as 5 m (15 ft).

Q1s

LANDSLIDE DEPOSITS (HOLOCENE)--Slump and earthflow deposits that may be stable or unstable and generally consist of chaotic mixtures of clay- to boulder-size clasts but may be rotated blocks of bedrock that have retained internal integrity. Color, texture and lithology reflect that of parent rock. Thickness not measured; estimated to be generally less than 15 m (50 ft).

Qta

TALUS DEPOSITS (HOLOCENE)--Locally derived, angular rock fragments, generally cobble size or larger in piles or aprons on mountain slopes. Thickness not measured; estimated to be as much as 6 m (20 ft).

Qat

ALLUVIAL TERRACE DEPOSITS (HOLOCENE)--Light-brown to light-gray, crudely to well stratified and well sorted sand and gravel present 18 m (60 ft) above Cora Creek. Thickness approximately 2 m (6 ft).

Qc1

COLLUVIUM AND SHEETWASH ALLUVIUM (HOLOCENE and PLEISTOCENE?)--Poorly sorted and poorly stratified to nonstratified gravel, sand, silt and clay deposited on slopes. Color and texture reflect that of parent rock. Includes significant component of windblown silt and fine-grained sand. Thickness not measured; estimated to be as much as 4.5 m (15 ft).

Qdf

DEBRIS FLOW DEPOSITS (PLEISTOCENE?)--Dissected sheets of poorly sorted sediment with abundant angular and subangular clasts derived from local sources. Clasts range from pebble to boulder size and are supported by, and embedded in a fine-grained matrix of predominantly mud. Thickness generally ranges from 3 to 15 m (10 to 50 ft).

Qoa

OLDER QUATERNARY ALLUVIUM (HOLOCENE and PLEISTOCENE?)--Light-brown to light-gray crudely to well stratified and moderately to well sorted sand and gravel that occurs at an altitude of about 60 m (200 ft) above channels of active streams. Locally covered by windblown silt and sand. Thickness approximately 12 m (40 ft).

Tls(Kmk)

Tls(Kmu)

LANDSLIDE DEPOSITS (EOCENE)--Large block glide deposits up to several km in width, that have gravitationally slid on decollement planes probably in the bentonitic lower part of the Kevin Member of the Marias River Shale. Blocks have maintained internal integrity but have in most cases rotated so beds strike at angles to, and generally have dips from 5° to 35° greater than adjacent undisturbed rock. Tls(Kmu) indicates block glide deposits composed primarily

of Montana Group (undivided) rocks. T1s(Kmk) indicates block glide deposits composed primarily of the upper Kevin Member. Age inferred from relationship with Eocene dikes that cut across the blocks.

Tum

QUARTZITE, SILTITE AND HORNFELS (EOCENE)--Upper Cretaceous rocks of the Montana and Colorado groups that have been metamorphosed to quartzite, siltite and hornfels by underlying intrusives. In transitional areas sandstone is unchanged, but shale is hornfelsed. Up to 600 m (2000 ft) of section metamorphosed.

Kmu

MONTANA GROUP, UNDIVIDED (UPPER CRETACEOUS, CAMPANIAN)--Alternating pale-yellowish-brown to light-gray-weathering fine- to medium-grained planar- or trough-crossbedded sandstone and dark-gray- to dark-greenish-gray-weathering shale. Sandstone beds range from 40 cm (8 in to 15 m (50 ft) thick and are separated by 15 cm (5 in) to 23 m (75 ft) of shale. Sandstone beds are generally cemented by calcite or very light-gray clay; they are micaceous to nonmicaceous quartz arenite and litharenite with fine- to medium-grained organic fragments and have a "salt and pepper" appearance. Shale is moderately to poorly fissile and weathers into granule-size chips. Local carbonaceous beds, nodular-weathering limestone beds, thin ferruginous beds, light-brown ferrocalscareous concretions and grayish-purple- and grayish-orange-weathering mudstone and siltstone beds are present. A light-gray micrite bed approximately 4 m (12 ft) thick is present in several areas. Unit thickness at least 210 m (700 ft). Formations not individually mapped in Montana Group of this area because of facies

changes.

COLORADO GROUP

MARIAS RIVER SHALE

Kmk

KEVIN MEMBER (UPPER CRETACEOUS, CONIACIAN and SANTONIAN)--

Dark-gray, fossiliferous shale with abundant gray septarian limestone concretions. The lower part of the member contains numerous thin bentonite beds and medium-gray or orange-brown limestone concretions. The upper part of the member contains ferruginous concretions and beds and thin siltstone beds near the top. Thickness of member approximately 200 m (700 ft).

Kmfe

FERDIG MEMBER (UPPER CRETACEOUS, TURONIAN)--Noncalcareous,

dark-gray-weathering, fissile shale that contain lenticular-bedded siltstone and fine-grained sandstone and reddish-orange or reddish-brown ferruginous dolostone concretions that weather into small chips. A fine-grained, planar-bedded sandstone is present from 12 to 24 m (40 to 80 ft) above the base of the member. Thickness of member approximately 61 m (200 ft).

Kmc

CONE MEMBER (UPPER CRETACEOUS, CENOMANIAN and TURONIAN)--Lower part

of member dark-gray calcareous shale that contains a persistent bentonite bed. Upper part of member thin-bedded or platy, medium-gray- or grayish-orange-weathering petroliferous limestone that contains blue fish scales and pelecypod fragments. Thickness of member approximately 24 m (80 ft).

Kmfl

FLOWEREE MEMBER (UPPER CRETACEOUS, CENOMANIAN)--Dark-gray-

weathering, fissile shale that contains several thin beds of siltstone and fine-grained sandstone, some of which are wavy- and lenticular-bedded, and light-yellowish-gray, low-swelling bentonite beds. Locally contains septarian concretions and limonitic dolostone concretions that weather to small chips similar to those in the Ferdig Member. Thickness of member approximately 24 m (80 ft).

Kmo

MOWRY FORMATION (LOWER CRETACEOUS, ALBIAN)--Basal Arrow Creek Bed,
Arrow Creek Bed

labelled on the map, consists of very-light-gray (nearly white) and yellowish-gray porcellanite, tuff, and swelling bentonite that is overlain by dark-gray weathering lenticular- and wavy-bedded siliceous shale, siltstone and fine-grained sandstone, and flaser-bedded fine-grained sandstone. Uppermost part of formation consists of pale-yellowish-brown- to light-olive-gray-weathering, medium-grained relatively resistant, thin-bedded sandstone that locally contains fish scales and bones. Thickness of formation ranges from 0 to 24 m (80 ft).

BLACKLEAF FORMATION

Kbb

Arrow Creek Bed BOOTLEGGER MEMBER (LOWER CRETACEOUS, ALBIAN)--Dark-gray-weathering

fissile shale that contains two to six relatively prominent sandstone beds about 3 to 12 m (10 to 40 ft) thick separated by 15 to 30 m (50 to 100 ft) of shale that contains numerous bentonite beds. The fine- to medium-grained, light-brown- to moderate-yellowish-brown-weathering sandstones are commonly

KOOTENAI FORMATION

Kk₅

FIFTH MEMBER (informal map unit) (LOWER CRETACEOUS, APTIAN AND ALBIAN?)--Dominantly moderate-red mudstone that contains lenses of sandstone and limestone. The uppermost part of the member consists of massive, color-banded, greenish-gray, grayish-red-purple, moderate-red and very-dark-red mudstone with lenses of fine- to medium-grained trough-crossbedded, greenish-gray-weathering sandstone. Thickness of member approximately 37 m (120 ft).

Kk₄

FOURTH MEMBER (informal map unit) (LOWER CRETACEOUS, APTIAN)--Dusky-red or pale-reddish-brown-weathering fine- to medium-grained, thin- to medium-bedded micaceous, argillaceous, platy-bedded sandstone with abundant plant fragments and impressions interbedded with very dark-red-weathering mudstone. Basal contact is transitional with Third member and contains interbedded medium-gray or dusky-red siltstone and mudstone. Lowest sandstone beds are light-brown or moderate-yellowish-brown-weathering, becoming dusky-red- or pale-reddish-brown-weathering higher in the section. Low amplitude ripple marks, that are locally interference ripples commonly occur on bedding surfaces. Thickness of member approximately 37 m (120 ft).

Kk₃

THIRD MEMBER (informal map unit) (LOWER CRETACEOUS, APTIAN)--Well sorted resistant quartz arenite with interspersed limonite specks. Scour base locally with rip-up clasts and chert pebbles cuts into Second member. Up to 20% dark chert is present at

flaser-bedded or ripple-laminated with abundant trace fossils on bedding surfaces. Trough and hummocky bedding also occur higher in the section, and fish scales and bones are common in the upper sandstones. Locally the tops of sandstone beds contain black chert pebbles. A well cemented chert-pebble conglomerate or coarse-grained sandstone occurs at the top of the member. Sandstone beds persist over many square kilometers. The upper part of the Bootlegger in most of the map area is a facies equivalent of the Mowry Formation and contains the Arrow Creek Bed described above. Thickness of member approximately 67 m (220 ft).

Kbt

TAFT HILL MEMBER (LOWER CRETACEOUS, ALBIAN)--Medium-dark-gray to medium-light-gray-weathering bentonitic, silty shale with several thin, locally glauconitic sandstone beds. Thickness of member approximately 18 m (60 ft).

Kbf

FLOOD MEMBER (LOWER CRETACEOUS, ALBIAN)--Black- to dark-gray-weathering fissile shale. Lacks two prominent sandstone beds present in Great Falls area. Thickness of member approximately 40 m (130 ft).

base of Colorado Group

base, but higher in section it disappears almost entirely.

Thickness of member ranges from 0 to 17 m (55 ft). The regional eastern depositional limit of the member is in the southeastern part of this quadrangle.

Kk₂

SECOND MEMBER (informal map unit) (LOWER CRETACEOUS, APTIAN)--Poorly resistant red mudstone that overlies the First member with a sharp contact. Mudstone contains dense medium-gray micrite and argillaceous, light-brownish-gray micrite concretions that laterally become lenticular, irregular beds. Thin, lenticular chert-rich quartz arenite beds occur locally. A bed of intraformational-micrite-clast conglomerate occurs near the top of the member. Thickness of member approximately 30 m (100 ft).

Kk₁

FIRST MEMBER (APTIAN?)--Dominantly resistant, festoon-crossbedded, well sorted quartz arenite with 5-10% black, dark- and light-gray chert. Coarse-grained sandstone or chert-granule conglomerate occurs at scour base, typically with rip-up clasts of coal, plant fragments and impressions, and occasional pebble-size chert clasts. Grain size fines upward with upper part of member generally fine- to medium-grained. Thickness of member approximately 30 to 37 m (100 to 120 ft).

Jm

MORRISON FORMATION (JURASSIC, KIMMERIDGIAN)--Light-greenish-gray mudstone and shale with interbedded lenses of medium-gray micrite and fine- to medium-grained calcareous thin-bedded, moderate-yellowish-brown-weathering sandstone with subbituminous coal bed at


the top of formation. Thickness of formation is approximately 30 m (100 ft).

Je

ELLIS GROUP

SWIFT FORMATION (JURASSIC, OXFORDIAN)--Orangish-brown-weathering, calcareous, glauconitic fine- to coarse-grained sandstone that contains interbeds of shale and chert pebble conglomerate. Thickness of formation approximately 24 m (80 ft).

MAP SYMBOLS

 CONTACT--Dashed where approximately located; short-dashed where inferred.

FAULT--Showing relative movement; U on upthrown side; D on downthrown side. Dashed where approximately located; dotted where concealed.



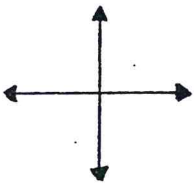
STRIKE AND DIP OF BEDDING--Showing direction and amount of dip; interpreted from aerial photographs where no dip amount shown.



ANTICLINE--Showing trace of crestline and direction of plunge; dotted where concealed.



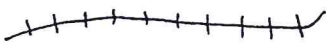
SYNCLINE--Showing trace of troughline and direction of plunge, dotted where concealed.



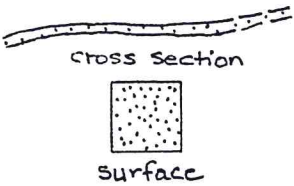
DOMES--Center where arrows cross.



DIKE (EOCENE)--Alkalic intrusive with high-angle attitude and thickness typically less than 4 m (13 ft).



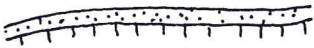
SILL (EOCENE)--Alkalic intrusive that parallels or subparallels bedding.



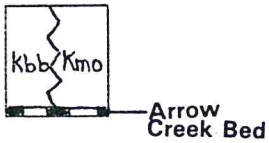
SANDSTONE BED--Thickness approximate, not all sandstone beds shown on map. Dashed where approximately located. Queried at limit of mapping.



SILL (EOCENE)--Intruded on top of sandstone bed.



SILL (EOCENE)--Intruded below sandstone bed.



FACIES CHANGE--From upper Bootlegger Member of Blackleaf Formation to Mowry Formation.



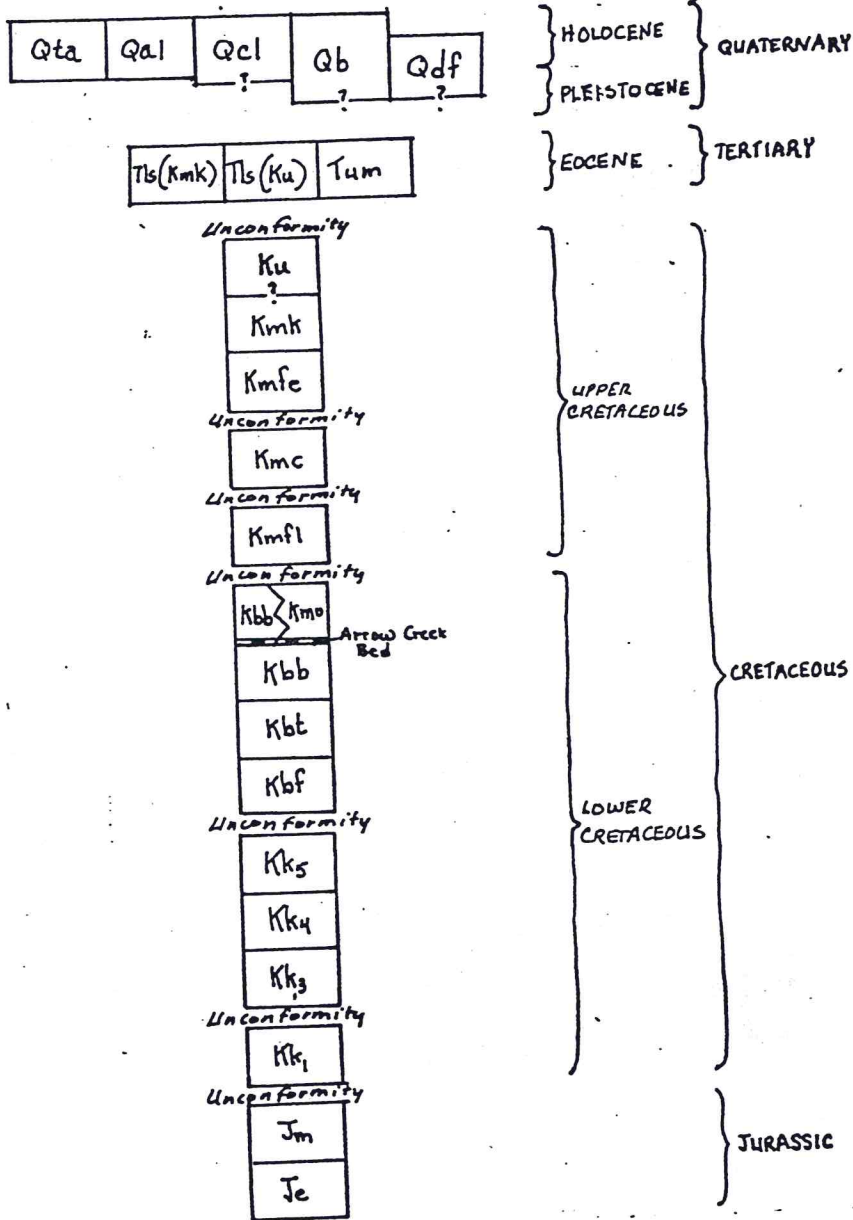
ARROW CREEK BED (LOWER CRETACEOUS, ALBIAN)--
Porcellanite and bentonite that occurs at base of Mowry Formation or in upper part of Bootlegger Member of Blackleaf Formation; labeled Arrow Creek Bed on map.



HYDROTHERMAL ALTERATION

CORRELATION OF MAP UNITS

RAYNESFORD 7.5-MINUTE QUADRANGLE



PREVIOUS GEOLOGIC MAPPING, RAYNESFORD 7.5-MINUTE QUADRANGLE

- Cannon, J. L., 1966, Outcrop examination of paleocurrent patterns of the Blackleaf Formation near Great Falls, Montana: Billings Geological Society, 17th Ann. Field Conference Guidebook, p. 71-111.
- Fischer, C. A., 1909a, Geology of the Great Falls coal field, Montana: U.S. Geological Survey Bull. 356.
- Fischer, C. A., 1909b, Geology and water resources of the Great Falls region, Montana: U.S. Geological Survey Water-Supply Paper 221.
- Pirsson, L. V., 1905, Petrography and Geology of the igneous rocks of the Highwood Mountains, Montana: U.S. Geological Survey Bull. 237.
- Reeves, F., 1929, Thrust faulting and oil possibilities in the plains adjacent to the Highwood Mountains, Montana: U.S. Geological Survey Bull. 806-E.
- Weed, W. H., 1899, Fort Benton Folio, Montana: U.S. Geological Survey Folio 55.