

GEOLOGIC MAP OF THE ROUNDUP 30' x 60' QUADRANGLE  
CENTRAL MONTANA

by

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## **GEOLOGIC SUMMARY**

The Roundup quadrangle is located in central Montana in parts of Musselshell, Yellowstone, and Golden Valley counties (Fig. 1). Timbered upland relief formed on resistant Tertiary Fort Union sandstones dominates the quadrangle. The Bull Mountains occupy the center of a structural basin (Bull Mountains Basin) that influences outcrops and structures throughout the quadrangle. The Bull Mountains Basin is asymmetrical with shallow dips of two to 10 degrees on the southern limb and steeper dips of from 15 to 30 degrees on the northern limb. Drainages on the northern limb of the Bull Mountains Basin flow north into the Musselshell River, located in the northwestern part of the quadrangle. Drainages on the southern limb of the basin drain toward the Yellowstone River south of the map area.

Gravel-covered benches obscure bedrock in some areas, but elsewhere, deep incision by the Musselshell River drainage has provided excellent exposures of the stratigraphic section. The youngest bedrock exposed in the quadrangle is the lower part of the Tongue River Member of the Tertiary Fort Union Formation. Erosion of the Bull Mountains Basin has exposed Upper Cretaceous rocks along each side of the basin.

The southeastern nose of the Woman's Pocket Anticline is located in the northwestern part of the quadrangle. The anticline exposes older Upper Cretaceous rocks including the easternmost exposures of the Eldridge Creek Member of the Niobrara Formation.

A series of northwest-trending faults and folds, some newly mapped, are located in the northwest part of the quadrangle near the edge of the Bull Mountains Basin. In the southwestern corner of the quadrangle the series of en-echelon northeast-trending faults is part of the northwest-trending Lake Basin fault zone.

### **Sources of Previous Geologic Mapping in the Quadrangle**

This report integrates the previous geologic mapping in USGS bulletins and water-supply papers published from 1918 through 1956 (Fig. 1). It provides extensive new mapping of both the Tertiary and Upper Cretaceous sections. Mapped units have been integrated with recent geologic mapping completed by MBMG in the north-adjacent Musselshell 1:100,000 scale quadrangle (Porter and Wilde, 1999), and the east-adjacent Hysham 1:100,000 scale quadrangle (Vuke and others, 1990).

### **Stratigraphic Notes**

#### **Fort Union Formation**

Overall, this formation consists of buff to yellowish-gray sandstone, sandy claystone and shale, claystone, shale, and coal beds. This quadrangle includes part of the Bull Mountain Coal Field. The coal is subbituminous to bituminous in rank, and is not economic to mine commercially at this time. It most likely formed in overbank and interfluvial swamp environments present during the formation of the basin, and is currently found in the interbedded fine sandstone, siltstone, and claystone/shale sequences found throughout the formation. The coal-bearing rocks are mainly in the Tongue River Member of the Fort Union Formation and, to a much lesser extent, in the underlying Lebo and Tullock Members. Most of

the coal beds are lenticular with wide variations in thickness laterally. In general the coals appear to thin toward the west. The outcrops of the coal beds on the north side of the syncline are less visible because of an increase in surface-cover and vegetation. There are up to nineteen sub-economic coal beds present, but the Rehder, Roundup, and Mammoth beds are generally the thickest and contain the highest ranking coal. All three beds have been commercially mined in the past, and continue to be mined for local use. The coal beds serve as aquifers for the area and supply the water used by the town of Roundup.

The three members of the Tertiary Fort Union Formation are well exposed in the Roundup quadrangle. The upper Member, the Tongue River, contains a greater percentage of sandstone and siltstone than is observed in areas to the east. It contains well-developed channels that vary from 20 to more than 300 feet thick in the numerous stacked channel sequences. These channel sandstones form the steep cliffs in the central part of the Bull Mountains Basin. The sandstones often weather to a honeycomb appearance. They sometimes appear massive, and they are often covered by "desert varnish". The sandstone channel sequences grade laterally into interbedded light tan or gray siltstones and sandstones, dark brown to gray siltstones and claystones, and carbonaceous claystones and coal. This member supports the growth of pines and other trees and bushes. In some places, the base of the Tongue River is a distinct sequence of interbedded sandstone, siltstone and claystone. In a few places, a coal bed that is two to five feet thick marks the base, but it is more common for sandstone channel bases to form an indistinct boundary with the Lebo.

The middle Member, the Lebo, also contains more sand here than to the east. It is composed of some smaller, but well-defined channel sequences that are from 5 to 50 feet thick. It also contains areas of interbedded sand, silt, and carbonaceous clay that weather dark gray or greenish. Lateral changes from one lithologic sequence to another occur over short distances. The member commonly forms indistinct outcrops at the base of the Tongue River cliffs, or the bottoms of river-valleys in the quadrangle. In a few places it forms gently rolling topography that is generally devoid of trees but may be grass or crop covered. The contact between the Lebo and the Tullock Members is often an indistinct transitional zone. Where visible it is occasionally marked by a poor-quality coal bed or dark gray to black carbonaceous clay bed.

The lower Member, the Tullock, contains numerous channel sequences that are similar in appearance to those of the Tongue River Member. The channels are of smaller scale (15 to 70 feet thick), but contain the same sedimentary structures, and weathered surfaces are similar. Where channels are not present, outcrops appear light colored and sandy. The Tullock supports the growth of pines and other vegetation. The contact with the underlying Lance is transitional, but is often difficult to determine; both the Tullock Member and the Lance are dominantly sandstone. There is an indistinct color and grain-size change across the contact.

### **Lance Formation**

The term Lance has been extended into this area from the southeast. Lance Formation is used here because of the high content of sandstone. In the eastern part of the quadrangle, the Lance is the stratigraphic lateral equivalent of the Hell Creek and the Fox Hills formations mapped in the eastern part of the state. In the western part of this quadrangle, the Lance is higher in the section, and the Fox Hills is present.

The Lance Formation contains large well-formed channels that are from 10 to more than 100 feet thick, as well as interbedded sandstone, siltstone and claystone. The channel sandstones weather to a more rounded surface than those of the Fort Union Formation. In limited areas, outcrops more typical of the Hell Creek interbedded claystone, siltstone and sandstone that weather to a dark brown surface are recognizable, but are included in the Lance for mapping purposes. These sequences are more abundant and become thicker to the west and they are always located at the base of the Lance Formation.

The sandy "typical" Lance is present in all areas of outcrop. In the eastern part of the quadrangle, the Lance channels have completely removed the Hell Creek-like lithologies and have cut down through the Fox Hills Formation and into the top of the Bearpaw Formation. To the west, the Lance lithology rests on from 20 to 60 feet of the Fox Hills Formation. Farther to the west, the Lance lithology is higher in the section, and Hell Creek-like lithologies have been preserved above the Fox Hills Formation. Therefore, the basal Lance contact is erosional where the channels have cut into underlying formations and transitional where Hell Creek-like lithologies remain.

### **Niobrara and Carlile Formations**

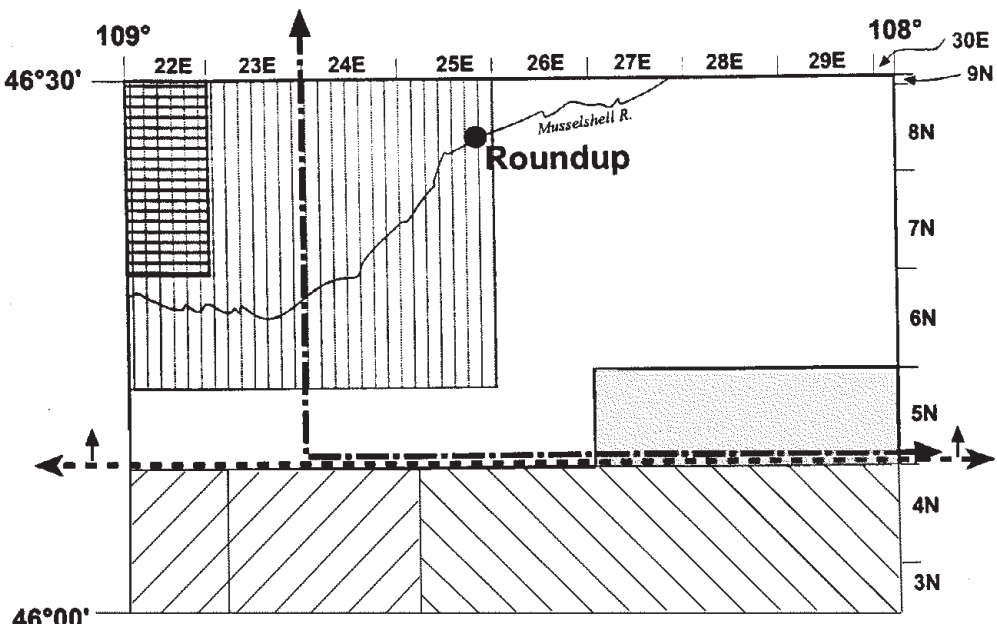
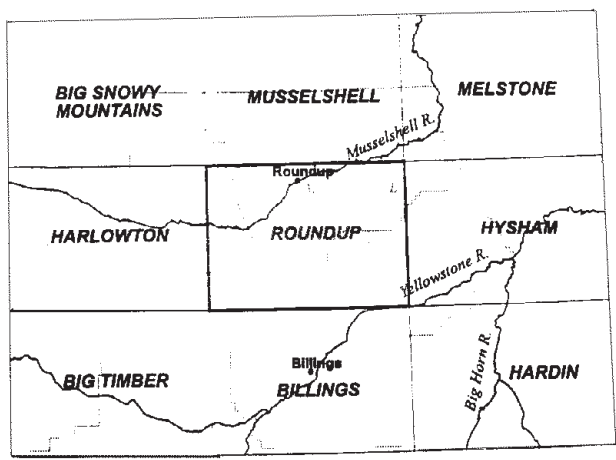
In the Roundup quadrangle, the marine-dominated Upper Cretaceous section below the Eagle Sandstone is exposed only in Woman's Pocket Anticline in the northwest corner of the map. The exposed interval includes, in descending order, the Telegraph Creek, Niobrara, and Carlile formations. To the north and east 15 to 25 miles, this interval is next exposed on Devils Basin Anticline in northern Musselshell County, but marked stratigraphic changes have occurred over this distance, particularly in the Niobrara-Carlile interval.

An increased amount of sandstone and coarse siltstone is present in this interval on Woman's Pocket Anticline compared with areas to the north and east (Porter and Wilde, 1993 (revised 1999)). This coarser sediment increases westward in the Shawmut Anticline area (Harlowton quadrangle; Porter, unpublished data), and probably originated farther to the southwest in the Livingston area. In the Livingston area, this interval is included in the Cody Shale (Roberts, 1972, Section 11, p. C68-C69). Berg and Lopez (2000) continue this usage for their mapping in that area. Apparently, the Harlowton and Roundup quadrangle areas are at the seaward, distal, edge of high volumes of sediment that were deposited in the sedimentary basin during early Late Cretaceous tectonism and volcanism in southwest Montana and northwest Wyoming. Still older evidence of increased, southwest-derived sediment volume is reflected in drill hole data on Woman's Pocket Anticline: the Big Elk Sandstone Member of the Frontier Formation, here stratigraphically equivalent to the Belle Fourche Shale (Mullen, 1950), is recognized. East and north of the Anticline, the Belle Fourche is a shale; coarse sediment is represented only by a three-inch to five-foot-thick pebbly sandstone in its lower part (Porter and Wilde, 1993 (revised 1999)).

On Woman's Pocket Anticline, the middle part of the Niobrara Formation contains a glauconitic, micaceous marine sandstone interval not recognized farther north and east. This lithology is equated with the Eldridge Creek Member of the Cody Shale named by Roberts (1964) in the Livingston area, and the same name is applied. However, the prominent pebbly sandstone bed found at the base of the Eldridge Creek Member farther west on the Shawmut Anticline (Porter, unpublished data) is absent on Woman's Pocket Anticline. This distinctive bed was named the MacGowan Concretionary Bed by Cobban and others (1959) at outcrops on the

Sweetgrass Arch and is recognized at outcrops west of Lewistown.

Although the Carlile Formation is strictly a shale in other parts of central Montana, on Woman's Pocket Anticline, this interval is primarily thin-bedded siltstone that is probably equivalent to the middle Carlile (Turner Member equivalent of the Black Hills region) elsewhere in central Montana. The characteristic central Montana upper Carlile shale unit (Sage Breaks Member equivalent of the Black Hills region) is apparently absent. Similarly, the characteristic central Montana lower Carlile shale unit (Blue Hill Member equivalent) is unexposed and possibly absent.










-  Woolsey and others 1917
-  Bowen 1918
-  Hancock 1918
-  Hancock 1920
-  Ellis and Meinzer 1924
-  Hall and Howard 1929
-  Zimmerman 1956

Figure 1. Location map for Roundup quadrangle showing areas covered by older geologic maps (see References).

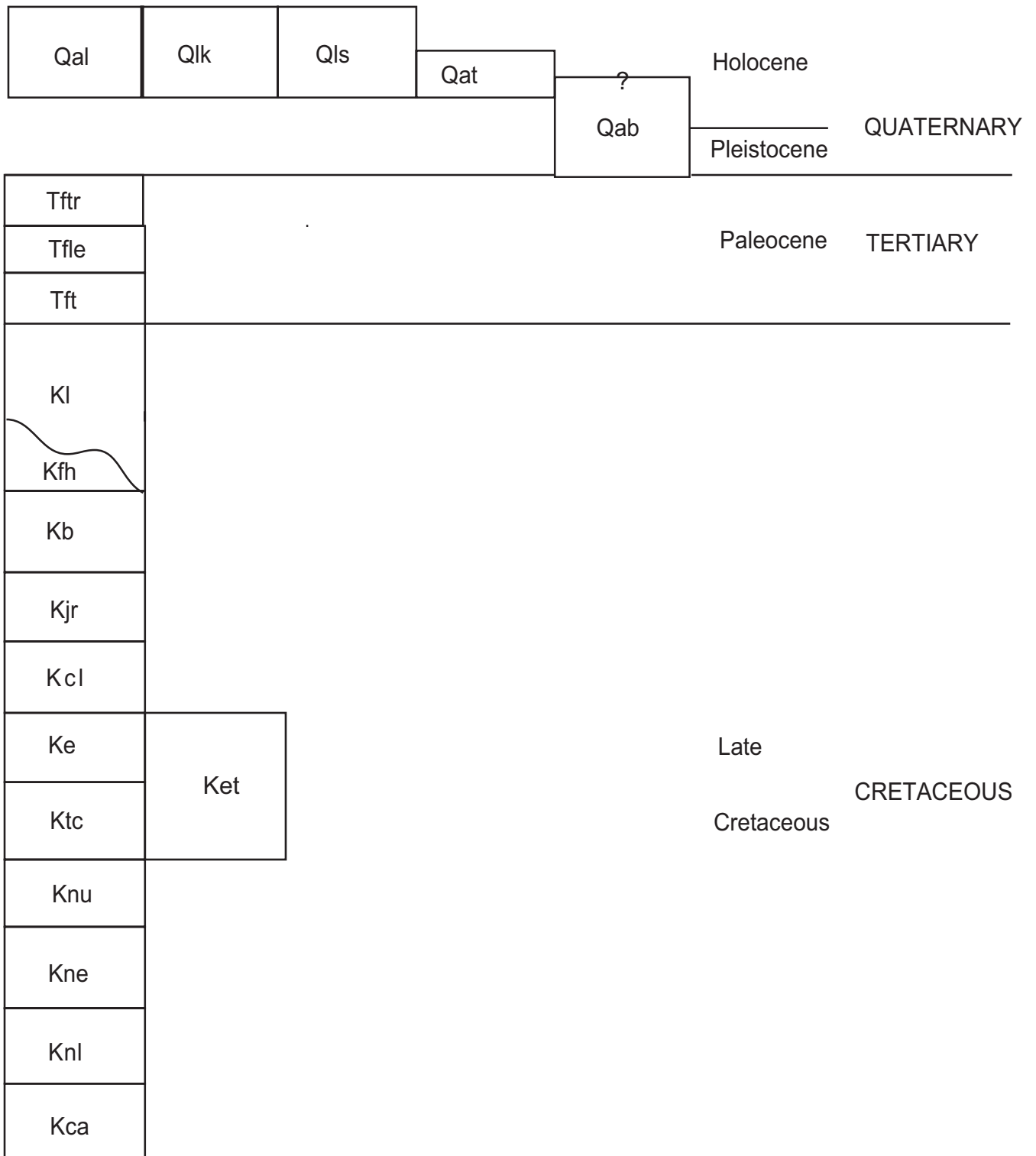


Figure 2. Age-correlation chart of map units for Roundup 30' x 60' quadrangle

## DESCRIPTION OF MAP UNITS

### Quaternary Deposits

- Qal ALLUVIUM OF MODERN FLOOD PLAINS AND CHANNELS (HOLOCENE). Fine- to medium-grained, tan sand and silt, generally unconsolidated and located along the banks of currently flowing streams. Some older fine gravel and fine- to coarse-grained sand of earlier channels may also be included. Thickness ranges from a few inches to as much as 30 feet.
- Qlk LAKE DEPOSITS, REWORKED LAKE DEPOSITS, AND EVAPORITE DEPOSITS (HOLOCENE). Fine-grained sands, silts and clays deposited in shallow standing water bodies, possibly reworked by recent fluvial action, and other surficial deposits of undetermined origin. Generally light gray to tan in appearance. Thickness varies from a few inches to a few feet.
- Qls LANDSLIDE DEPOSITS (HOLOCENE). Deposits of mixed sediments originating from relatively sudden down-slope movement of a bedrock or surficial sediment mass,
- Qat ALLUVIAL TERRACE DEPOSITS (HOLOCENE). Gravel, sand and silt deposited by fluvial processes while the river was at a higher level than present. Found in isolated bodies from a few feet to several tens of feet above the current river level. Consists of intrusive, metamorphic and sandstone clasts from a few centimeters to several inches in diameter.
- Qab ALLUVIUM OF FORMER BRAID PLAINS (QUATERNARY). Generally unconsolidated deposits of predominantly medium to coarse grained sand and fine to medium gravel; lesser amounts of silt and clay. Deposits appear to be remnants of formerly extensive braid plains developed on flanks of many central Montana ranges. Probably not all of same age. May include some terrace gravels not separately mapped. Thickness is from 2 to 15 feet.

### Tertiary Rocks

- Tftr TONGUE RIVER MEMBER OF FORT UNION FORMATION (PALEOCENE). Yellowish-gray to light-gray, fine- to medium-grained, trough cross-bedded, planar-bedded or massive- appearing sandstone interbedded with lesser amounts of brownish-gray carbonaceous shale, yellowish-gray siltstone, and coal beds. Contains numerous large channels and stacked channel sequences. Thicker sandstone units form ledges and rim rocks in the central part of the Bull Mountains Basin. Generally supports good growths of pines and other trees and bushes. The greatest thicknesses exposed (805 feet) are located along the axis of the Bull Mountains Basin.
- Tfle LEBO MEMBER OF FORT UNION FORMATION (PALEOCENE). Medium to dark gray and olive-gray shale that is commonly smectitic or carbonaceous, interbedded with silty shale, thin yellowish-gray sandstone and siltstone, and thin lenticular coal beds. Contains small scale light-gray, fine- to medium-grained channel



sandstones. Typically forms gently rolling, grass covered slopes where dips are slight. Thickness varies from 160 to 240 feet, and averages about 200 feet.

- Tft TULLOCK MEMBER OF FORT UNION FORMATION (PALEOCENE). Yellowish-gray, fine- to medium-grained trough cross-bedded, planar-bedded or massive appearing sandstone. Interbedded with lesser amounts of brownish-gray, greenish-gray claystone, or dark gray carbonaceous shale. Sandstone beds are thinner, more tabular and more persistent than those in the underlying Lance Formation. Channel sandstone sequences are larger than the channels found in the Lebo Member, but smaller than the channels found in the Lance Formation. Channels contain fine- to medium-grained, tan to light-brown upward-fining sandstone, siltstone and claystone. Commonly supports growth of bushes and small pines. Thickness of the member varies from 180 to 260 feet, averaging about 220 feet.

### Upper Cretaceous Rocks

- Kl LANCE FORMATION. Tan to light brownish-gray, cliff- and ledge-forming, fine- to coarse-grained, thick-bedded to massive-appearing sandstone. Supports sparse pine growth locally. Contains well-developed, cross-bedded channel sequences that are often stacked and generally of larger scale than Tullock Member channels. Locally, interbedded medium gray to olive-gray fissile shale and tan to greenish-gray clays can be seen laterally away from or between the sandstone channels. The channel lithology rises in the section from east to west. To the east it has eroded into the top of the underlying Bearpaw Formation, but to the west lithologies typical of Fox Hills beach sands and of the Hell Creek can be recognized. Where visible, contact between the basal Lance and the upper Fox Hills is either erosional, or marked by a calcareous sandstone ledge of dark tan to brown sandstone, or a thin bed of carbonaceous clay that changes laterally into poor quality coal. Total formation thickness is from 350 to 450 feet.
- Kfh FOX HILLS FORMATION. The Fox Hills consists of thin layers of interbedded tan sand, silt, and clay overlain by well sorted, very fine- to medium-grained upward coarsening, cross bedded, poorly consolidated sandstone. Generally appears as gentle grass covered slopes at the base of steep hills and cliffs formed by the Lance Formation. Becomes more clay rich at the base and contact with the underlying shale is transitional. Ranges from 10 to 110 feet in thickness.
- Kb BEARPAW FORMATION. Medium to dark gray, fissile, shale that weathers to a brownish-gray surface. Outcrops form flat to very gently rolling topography that is locally grass-covered. Contains a few scattered light gray limestone concretions that are generally fragmented, and locally contain marine fossils. Becomes increasingly sandy upward and grades into the interbedded silt and sand at the base of the Fox Hills Formation. It varies from less than 300 up to 800 feet thick.
- Kjr JUDITH RIVER FORMATION. Exposed only in the western part of this quadrangle. Consists primarily of medium- to fine-grained light-brown to tan sandstone.

Generally does not form prominent ridges or cliffs. Outcrops appear as sandy, grass-covered hills that sometimes have an orange tint when compared to surrounding formations. Central part of this formation sometimes contains dark brown interbedded silt, clay and coal; but where folded, this part of the formation is thinned or missing. It ranges from 300 to 500 feet thick.

- Kcl CLAGGETT SHALE. Exposed only in the western part of the quadrangle. Primarily brown, fissile shale, that contains numerous lenticular, fine-grained sandstone beds. In a few places, it contains orange-weathering concretions. It ranges from 180 to 300 feet thick.
- Ke EAGLE SANDSTONE. Light-gray to tan, fine- to medium-grained sandstone that often forms cliffs. Forms the rim of Woman's Pocket Anticline. In the southwestern part of the area the unit forms the central part of Broadview Dome, and is offset by the northeast-trending faults of the Lake Basin fault zone. The thickness varies from 200 to 300 feet, but is difficult to determine because of structural deformation.
- Ket EAGLE AND TELEGRAPH CREEK FORMATIONS, UNDIVIDED. These two formations mapped together where dips are steep and/or exposures are poor.
- Ktc TELEGRAPH CREEK. Exposed only in sections 30 and 31, T. 8 N., R. 22 E. on northeast flank of Woman's Pocket Anticline. These exposures consist of a pronounced yellow-gray-weathering sandstone that forms a subtle slope break around the interior of the anticline, and underlying sandy shale. Thickness not measured, but is estimated to be from 50 to 80 feet.
- Knu UPPER SHALE MEMBER, INFORMAL, OF NIOBRARA FORMATION. Occurs as a poorly resistant, unexposed interval between Eldridge Creek Member below and Telegraph Creek above. Mapped in southeastern part of Woman's Pocket Anticline based on topographic expression. Unit has been observed three miles to northwest in Harlowton quadrangle. Upper contact approximately placed beneath the also unexposed lower shaly part of the Telegraph Creek. Thickness not measured; estimated at 45 ft. based on a well log from Shawmut Anticline (section 13, T.7N, R 18 E).
- Kne ELDRIDGE CREEK MEMBER OF NIOBRARA FORMATION. Glauconitic, micaceous shale, mudstone and sandstone that weather greenish-gray. Sandstones are fine- and medium-grained; predominantly massive and bioturbated, but are occasionally preserved in thin, platy trough-cross sets. Contains prominent resistant, dark orange-weathering, calcareous to dolomitic, ferruginous concretions and concretionary beds up to 7 inches thick that are locally fossiliferous. Isolated, commonly large (up to 3 ft diameter), gray, weathering to dark reddish-orange, commonly fractured, septarian concretions with red and white vein filling are more common in lower part of member. Nodular to concretionary beds are more common in upper part of member. On Woman's Pocket Anticline, unit base picked at base of lowest greenish, glauconitic, blocky shale. Thickness not measured; estimated at 225 feet based on well log from Shawmut Anticline (sec. 13, T. 7 N., R. 18 E).

- Knl LOWER SHALE MEMBER, INFORMAL, OF NIOBRARA FORMATION. Medium gray, fissile, commonly soil-forming, poorly vegetated, calcareous shale with scattered fragments of yellow-white, fibrous calcite plates and pockets of abundant *Inoceramus* fragments. Except for stratigraphic position, unit is similar to Greenhorn Formation. Lower contact with Carlile beds not observed. Unit believed to be continuous upward into noncalcareous, fissile shale below Eldridge Member beds where several bands of white-gray calcareous, septarian concretions occur near contact. *Cremnoceramus crassus*, a lower Niobrara pelecypod, found in this interval at Shawmut Anticline about 15 feet below Eldridge Creek Member (Porter, unpublished data). Currently unit is mapped as all lower Niobrara; further study may suggest that its lower part should more properly be included with underlying Carlile Formation. Thickness not measured; estimate 250 ft. based on well log from Shawmut Anticline (sec. 13, T. 7 N., R. 18 E.).
- Kca CARLILE FORMATION. Light blue-gray weathering, thin (1/4 to 2 inches), micaceous, very evenly laminated and bedded siltstones interbedded with very dark gray, clayey shale. Siltstones generally calcareous and have characteristic shiny dark red coating on bedding-plane surfaces, especially on loose float slabs. Coating caused by concentration of mica and iron oxide. Beds commonly burrowed. Two related concretion types characterize unit: (1) fist-sized or larger, egg-shaped to bulbous, soft gray-brown-weathering, calcareous, septarian concretions with dark red calcareous vein filling; (2) large, massive, deep orange weathering, silty concretions, occasionally septarian, with white vein filling; cone-in-cone structure common and usually fragmented. In some parts of the map area these two concretion types seem stratigraphically separated, with the orange type slightly higher in section; elsewhere the two types are found in lateral association and sometimes intergrown. The orange type is the common concretion of the middle Carlile Formation farther northeast (Porter and Wilde, 1993); the first type has not been observed in this part of section elsewhere. Formation only exposed on Woman's Pocket Anticline; lowest part not exposed. No thickness measured; estimated at 415 ft. based on well log from Shawmut Anticline (sec. 13, T. 7 N., R. 18 E.).

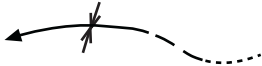
#### MAP UNITS LIMITED TO CROSS SECTIONS

- Tflt LEBO AND TULLOCK MEMBERS OF FORT UNION FORMATION, UNDIVIDED (PALEOCENE)
- Klfh LANCE AND FOX HILLS FORMATIONS, UNDIVIDED (UPPER CRETACEOUS)
- Kctc CLAGGETT, EAGLE, AND TELEGRAPH CREEK FORMATIONS, UNDIVIDED (UPPER CRETACEOUS)

## GEOLOGIC MAP SYMBOLS



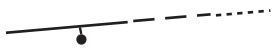
Contact; dashed where approximately located, dotted where concealed.



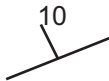
Synclinal fold showing trace of axial plane; dashed where approximately located, dotted where concealed. Single arrow indicates direction of plunge where known.



Anticlinal fold showing trace of axial plane; dashed where approximately located, dotted where concealed. Single arrow indicates direction of plunge where known.



Fault; dashed where approximately located, dotted where concealed. Ball and bar on down-thrown side.



Strike and dip of bedding; degree of dip indicated.

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