

**GEOLOGIC MAP OF THE BROADUS 30' x 60' QUADRANGLE,
EASTERN MONTANA**

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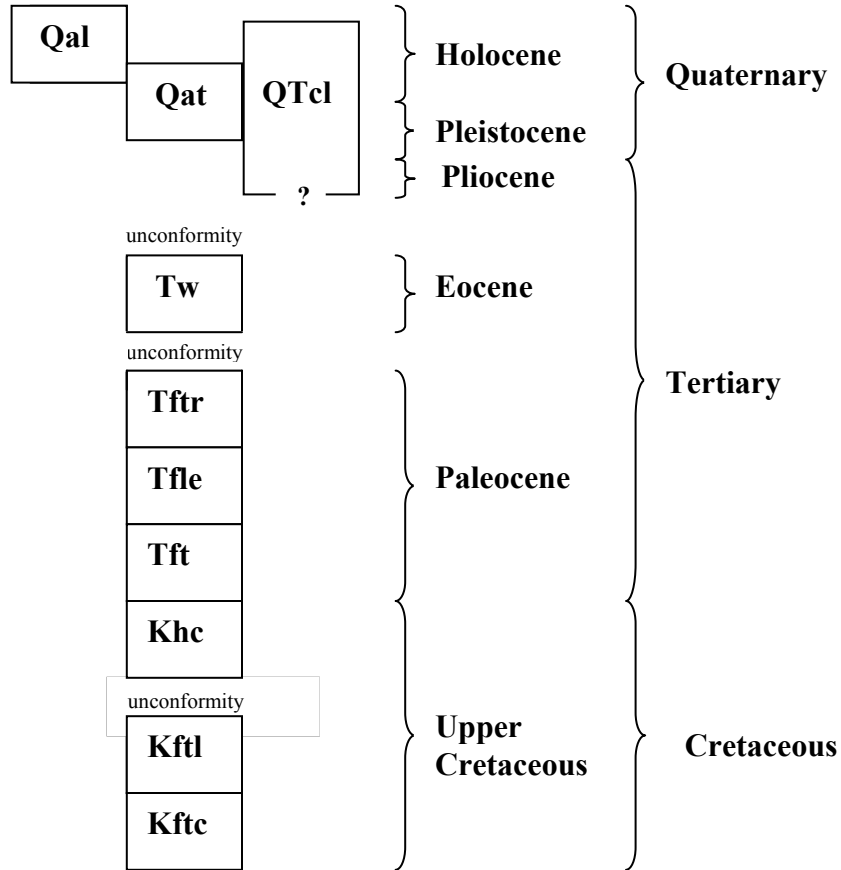
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CORRELATION DIAGRAM
BROADUS 30' x 60' QUADRANGLE



DESCRIPTION OF MAP UNITS
BROADUS 30' x 60' QUADRANGLE

Note: Thicknesses are given in feet because original field maps were on 7.5' quadrangles with contour intervals in feet. To convert feet to meters (the contour interval unit on this map), multiply feet x 0.3048.

- Qal Alluvium (Holocene)**—Light-gray and light-brown gravel lenses, and sand, silt, and clay deposited in stream and river channels and on their flood plains. Clasts are composed of quartzite, chert, and igneous rocks, and are dominantly well rounded. Deposits are poorly to well sorted and stratified. Thickness as much as 35 ft under larger floodplains, but generally less than 15 ft.
- Qat Alluvial terrace deposit (Holocene and Pleistocene)**—Light-gray to light-brown gravel, sand, silt, and clay in terrace remnants at elevations 15–150 ft above the Little Powder River, and from 20 to 300 ft above the Powder River. Clasts are generally well rounded and are composed of Fort Union Formation sandstone and clinker in dominantly poorly sorted deposits of flat pebbles, although some clasts are as much as 1 ft in diameter (Bryson and Bass, 1973). Most clasts are locally derived, but there are subordinate clasts of metamorphic and igneous rocks from sources outside the map area that are typically more rounded than the locally derived clasts. Thickness 10–40 ft.
- QTcl Clinker (Holocene, Pleistocene, and Pliocene?** [Coates and Heffern, 2000])—Red, pink, orange, black, and yellow, very resistant metamorphosed sandstone, siltstone, and shale of the Fort Union and Wasatch Formations. Bedrock was baked by natural burning of underlying coal, and collapsed into voids created by burning. Locally, baked rock was melted and fused to form buchite, a black, glassy, vesicular or scoriaceous rock. Thickness 10–500 ft.
- Tw Wasatch Formation (Eocene)**—Yellowish gray to light-gray siltstone and medium- to coarse-grained, massive or cross-bedded sandstone interbedded with medium-gray shale, brown carbonaceous shale, coal, and associated clinker. Formation typically weathers light-gray to tan, and has a distinct heavy-mineral suite (Connor and others, 1976; Denson and others, 1990). At least four different stratigraphic criteria have been used previously to define the Wasatch-Tongue River contact (Seeland and others, 1993). The contact on this map follows that of Denson and others (1990) and is at the stratigraphic position of a regional unconformity. Thickness 150 ft (much thicker west of map area).
- Fort Union Formation (Paleocene)**
- Tftr Tongue River Member**—Yellow, orange, or tan, fine-grained sandstone with thinner interbeds of yellowish brown, orange, or tan siltstone; light-bluish or

light-yellowish brown mudstone and clay; and coal beds. Sandstone is massive or crossbedded. Clay is dominantly non-swelling. Coal beds in the map area include Anderson, Dietz, Canyon, Carney, Otter, Wall, Pawnee, Brewster-Arnold, Knobloch, Flowers-Goodale, and Kendrick (McLellan and Biewick, 1988). Upper part of member was removed by erosion in map area. Some workers state that the Tongue River-Lebo contact cannot be differentiated in this area because of rapid facies changes and lack of good exposures (Denson and Crysedale, 1991; Denson and others, 1993; Denson and others, 1992; Denson and Pierson, 1991). White line within the Tongue River on map indicates contact mapped by Bryson and Bass (1973), placed at the Olsen coal bed; contact was “arbitrarily chosen to represent the basal bed of the Tongue River Member...” (Bryson and Bass, 1973). This contact placement has been followed on subsequent regional maps that include this area (Bergantino, 1980; Colton and others, 1978; Ellis and Colton, 1994; Stoner and Lewis, 1980). In this report, the basal Tongue River contact of Robinson, Mapel, and Bergendahl (1964) is used in the southern part of the map because it reflects thickening of the Tongue River Member at the expense of the Lebo Member which can be seen both in the field and in the subsurface (McLellan, 1991; McLellan and others, 1990). Thickness of as much as 900 ft exposed in map area.

- Tfle** Lebo Member—Gray, smectitic shale and mudstone that contain lenses of gray and yellow, very fine- to fine-grained sandstone, and a few thin coal beds. Some workers state that the Tongue River-Lebo contact cannot be differentiated in this area because of rapid facies changes and lack of good exposures (Denson and Crysedale, 1991; Denson and others, 1993; Denson and others, 1992; Denson and Pierson, 1991), but others have mapped this contact (Brown, 1993; Robinson, Mapel, and Bergendahl, 1964), and their contact placement is used in this report. Thickness 175–200 ft.
- Tft** Tullock Member—Light-yellow and light-brown planar-bedded very fine- to medium-grained sandstone interbedded with less dominant gray shale, gray mudstone, and light-orange, argillaceous limestone beds that locally contain plant fragment molds. Locally contains silcrete beds about 5 inches thick that may contain molds of plant stems and roots. In this area, the Tullock Member is distinguished from the Hell Creek Formation by its light color, even bedding, and thin coal beds (Brown, 1993). The basal contact is placed at the base of the lowest coal bed (Brown, 1993). Thickness of member about 300 ft.
- Khc** **Hell Creek Formation**—Yellowish gray cross-bedded channel sandstone at top that is 25 ft thick and contrasts with the evenly bedded sandstone of the overlying lower Tullock Member. White line on map within the Hell Creek Formation represents the Tullock-Lance (Hell Creek) contact of Robinson and others (1964). This contact placement has been followed on subsequent regional maps that include this area (Bergantino, 1980; Colton and others,

1978; Ellis and Colton, 1994; Stoner and Lewis, 1980). In this report, all of the area within this white-line “contact” is interpreted as the upper Hell Creek Formation based on lithology (channel sandstone rather than evenly bedded sandstone of basal Tullock), and the lack of thin coal beds. Contact also based on fossils (dinosaur bones and teeth, Cretaceous mammal bones [U.S. Bureau of Land Management data], and Cretaceous palynomorphs [D. Nichols, written communication, 1992] from the highest stratigraphic position bounded by the white-line contact). Nichols and Brown (1992) concluded in a detailed palynostratigraphic study of the Tullock Member, that the Cretaceous-Tertiary boundary is at the base of the Tullock Member in some parts of the Powder River Basin and below it in others. This conclusion strongly suggests that the area of Cretaceous fossils within the white-line “contact” on the map is Hell Creek Formation rather than Tullock Member. Below the upper channel sandstone, the Hell Creek is gray or greenish gray, massive, smectitic, silty mudstone with “popcorn” weathering and secondary grayish yellow to moderate-yellowish brown, crossbedded and ripple-laminated, micaceous, fine- to medium-grained channel sandstone in some areas. In other areas fine- to medium-grained grayish yellow, micaceous sandstone dominates the section where tongues of the west-proximal Lance facies are present. Thickness 700–750 ft.

Fox Hills Formation (Upper Cretaceous)

- Kftl** Timber Lake Member—Brownish gray siltstone, and fine- to medium-grained coarsening-upward sandstone that weather to moderate-brown. Hummocky beds and trough crossbeds are characteristic of member, and locally it contains *Ophiomorpha* burrows, and selenite crystals, and may have a sulfurous odor. Thickness of member 50–75 ft.
- Kftc** Trail City Member—Interbedded light-gray siltstone that coarsens upward to fine-grained sandstone, and dark-gray shale. Member is a transitional zone between the underlying Pierre Shale and the sandy Timber Lake Member. Base of member not exposed in map area. Exposed thickness 25 ft.

MAP SYMBOLS
BROADUS 30' x 60' QUADRANGLE



Contact—Dotted where concealed.



(white line)

Contact—Used on many previous maps. Not used on this map for reasons given in the description of map units.



Strike and dip of bedding— Number indicates amount of dip.



Fault— Ball and bar on downthrown side, approximately located.



(purple)

Silcrete bed—Siliceous paleosol bed in Tullock Member of Fort Union Formation.

PREVIOUS GEOLOGIC MAPPING AND INDEX OF 7.5' QUADRANGLES
BROADUS 30' x 60' QUADRANGLE

Numbers below correspond to index map on following page.

1. Brown, J.L., 1993, Fig. 13, scale 1:316,800.
2. Bryson, R.P., and Bass, N.W., 1973, plate 1, scale 1:63,360.
3. Matson, R.E., and Blumer, J.W., 1974, plates 10, 17, 18, 19, 20, 21, 23, 24, 25, scale 1:126,720.
4. McLellan, M.W., and Biewick, L.H., 1989a, scale 1:24,000.
5. McLellan, M.W., and Biewick, L.H., 1989b, scale 1:24,000.
6. McLellan, M.W., and Biewick, L.R.H., 1990, scale 1:24,000.
7. Robinson, C.S., Mapel, W.J., and Bergandahl, M.H., 1964, plate 1, scale 1:96,000.
8. Warren, W.C., 1959, plate 19, scale 1:63,360.

Entire quadrangle

Bergantino, R.N., 1980, scale 1:250,000.

Colton, R.B., Whitaker, S.T., Ehler, W.C., Holligan, J., and Bowles, C.G., 1978, scale 1:250,000.

Denson, N.M., Gibson, M.L., and Sims, G.L., 1992, scale 1:200,000.

Denson, N.M., Gibson, M.L., and Sims, G.L., 1993, scale 1:200,000.

Denson, N.M., and Pierson, C.T., 1991, scale 1:200,000.

Ellis, M.S., and Colton, R.B., 1994, scale 1:500,000.

Heffern, E.L., Coates, D.A., Whiteman, J., and Ellis, M.S., 1993, scale 1:175,000.

Lewis, B.D., and Hotchkiss, W.R., 1981, scale 1:100,000.

Lewis, B.D., and Roberts, R.S., 1978, scale 1:125,000.

Stoner, J.D., and Lewis, B.D., 1980, scale 1:500,000.

Vuke, S.M., Bergantino, R.N., and Wilde, E.M., 1989, scale 1:100,000.

MAP SOURCES
BROADUS 30' x 60' QUADRANGLE

106°	105°								
45°30'		Three-mile Buttes	Sonnette	Epsie	Epsie NE	Broadus	Monday Creek	Little Pilgrim Butte	Lightning Butte
		3	3, 8	3, 8	3, 8	2, 8	2		
		Phillips Butte	Hodsdon Flats	Yarger Butte	Lonesome Peak	Eldon Mountain	Fighting Butte	Dry Creek Butte	Boyes
		3, 8	3, 8	8	2, 8	2	2		
		Sayle	Bloom Creek	Huckins School	Baldy Peak	Bear Skull Mountain	Pine Creek	Sanburn Reservoir	Belle Creek North
		3	3, 4	2	2, 3	1, 2, 7	1, 2, 7	7	7
		Bradshaw Creek	Moorhead	Three Bar Ranch	Bay Horse	Wild Bill Creek	Biddle	Belle Creek SW	Belle Creek South
45°		3	5	2, 3, 6	2, 3	1, 2, 7	1, 2, 7	7	7

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BROADUS 30' x 60' QUADRANGLE

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