GEOLOGIC MAP OF THE GLENDIVE 30' x 60' QUADRANGLE EASTERN MONTANA AND ADJACENT NORTH DAKOTA

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DESCRIPTION OF MAP UNITS

Qal **Alluvium (Holocene and Pleistocene)**--Light-brown, reddish-brown, yellowish-brown, grayish-brown, brown, olive, gray, and light-gray gravel, sand, silt, and clay deposited in stream and river channels and on flood plains. Clasts are well sorted to poorly sorted, and are as much as 0.6 m (2 ft) in diameter. Deposits are poorly to well stratified. Thickness generally less than 6 m (20 ft) but as much as 12 m (40 ft) thick.

Qat **Alluvial terrace deposit (Holocene and Pleistocene)**--Light-brown, grayish-brown, and light- gray gravel, sand, and silt in terrace remnants at two general elevations, one between 0.5 and 21 m (2 to 70 ft) higher than the Yellowstone River, Beaver Creek, and their tributaries, and the other between 21 and 31 m (70 to 100 ft) higher. Clasts are generally well sorted, and most are well rounded, especially brown quartzite pebbles and cobbles reworked from older gravel deposits. Clasts are brown, reddish, or yellowish quartzite with minor amounts of porphyritic rocks, silicified wood, and clinker. Largest clasts are generally smaller than 20 cm (8 inches) in diameter. Bedding is crudely to well stratified. Thickness of deposits ranges from 3 to 9 m (10 to 30 ft).

Qt **Till (Pleistocene)**--Heterogeneous mixture of light-brown, grayish-brown, and light-gray, clay, silt, sand, and gravel with rare to abundant cobbles and boulders. Montmorillonite is dominant clay mineral. Deposited by continental ice sheets during three glaciations. Clasts are poorly sorted. Locally contains lenses and stringers of sorted clay, silt, sand, and gravel. Mapped across areas where extensive and continuous, or where small, discontinuous outcrops are closely spaced. Includes some glacial lake deposits that veneer till. Thickness generally less than 5 m (16 ft), but as much as 30 m (100 ft) in buried valleys.

QTc **Clinker (Holocene, Pleistocene and Pliocene?)--**Red, pink, orange, black, and yellow very resistant metamorphosed shale, siltstone, and sandstone of Fort Union and Hell Creek Formations. Bedrock was baked by natural burning of underlying lignite. Locally, baked rock was melted and fused to form buchite, a black, glassy, vesicular or scoriaceous rock. Thickness generally above 6 m (20 ft) but locally as much as 23 m (75 ft).

QTat **Alluvial terrace deposit (Pleistocene and Pliocene?)**--Light-brown, yellowish-brown, brown, and light-gray gravel, sand, and silt at elevations higher than Qat. Alluvium of several terraces of different ages and elevations have been included in this unit. Unit also includes sandy, silty, pebbly sheetwash alluvium in fans or aprons on highest parts of terrace remnants adjacent to bedrock outcrops. Crudely to well stratified, and poorly to moderately well sorted. In places deposits have been cemented to conglomerate by calcium carbonate or iron oxide. Nearly all clasts are well rounded and are mostly quartzite, chert, volcanic rocks, ironstone concretions, sandstone, and siltstone, and minor amounts of shale, agate, silicified wood, jasper, chalcedony, and clinker. Clasts are as much as 40 cm (16 inches) in diameter but most are less than 5 cm (2 inches). Deposits are crudely to well stratified. Equivalent in age, but not in composition, to Flaxville Gravel of the Missouri River drainage. Thickness generally about 9 m (30 ft) but locally more than 12 m (40 ft).

Fort Union Formation (Meek and Hayden, 1862)

Tfsb **Sentinel Butte Member (Paleocene)** (Leonard and Smith, 1909)--Orangish-brown or brown, iron oxide-stained, cross-bedded sandstone, primarily fluvial. Clasts are medium- to coarse-grained, angular to subangular and poorly sorted. Crossbedding is dominant sedimentary structure. Channel bases display scour features including abundant rip-up clasts. In most exposures within the map area, sandstone overlies gray or grayish-brown poorly resistant mudstone about 6 m (20 ft) thick. Upper part of member has been removed by erosion. Prominent coal beds are present at the base and just above the base of the member in some areas. Thickness of about 60 m (200 ft) is exposed in the map area.

Tftr **Tongue River Member (Paleocene)** (Taff, 1909)--Dominantly yellow, orange, or tan fine-grained sandstone and thinner interbeds of yellow-brown, orange, or tan siltstone and light-colored mudstone and clay. Clay dominantly nonswelling. Contains thick to thin, poorly cemented fluvial sandstone that locally weathers into cavernous cliffs. Member is generally poorly cemented and weathers to badland topography. Plant and small vertebrate fossils occur in some beds. Contains several prominent coal beds. In part of the map area (shown with pattern over Tftr) the lower part of the unit contains orange silty limestone beds associated with light-colored beds that may contain white- or light gray-weathering silcrete and other siliceous paleosols. These paleosols characteristically contain molds of plant stems and roots and range from 2 to 45 cm (1 to 17 inches) thick and locally weather to rubbly clasts ranging from pebble to boulder size. The relatively resistant orange silty limestone beds form flat-topped caprocks, producing a characteristic topography. Thickness of member ranges from 100 to 200 m (330 to 650 ft).

Tfld **Ludlow Member (Paleocene)** (Lloyd and Hares, 1915)--Dominantly gray and gray-brown sandstone, siltstone, and mudstone interbedded with thinner yellow or orange fine-grained sandstone beds up to 30 m (100 ft) thick. In some areas, the gray and

gray-brown sandstone, siltstone, and mudstone are interbedded in planar beds. In other areas gray, cross-bedded, lenticular, fine-grained, clay-rich sandstone that contains abundant calcium carbonate-cemented concretions is abundant. The member is generally poorly cemented and weathers to badland topography. In contrast to the dominantly non-swelling clays in the Tongue River Member, abundant smectite in the Ludlow Member produces characteristic "popcorn" weathering. Contains several lignite beds, persistent within the map area. Thickness of the Ludlow Member ranges from 70 to ~50 m (230 to 500 ft).

Khc **Hell Creek Formation (Upper Cretaceous, Maastrichtian)** (Brown, 1907)--Dominantly gray and gray-brown sandstone, smectitic silty shale and mudstone, and a few thin beds of lignite or carbonaceous shale. Sandstones are fine- or medium-grained and calcium carbonate-cemented concretions are common in the fine-grained sandstones. The beds are generally poorly cemented and weather to badland topography. Swelling clays produce characteristic "popcorn" weathering. The upper part of the formation contains the youngest dinosaur remains. The top of the formation occurs at the base of a coal bed that persists throughout exposures in the map area. In several places a light-gray silcrete bed, similar to silcrete beds in the Ludlow and Tongue River Member, occurs near the top of the formation. Contact with underlying Colgate Member of Fox Hills Formation ranges from apparently conformable to disconformable. The formation ranges from 80 to 100 m (260 to 330 ft.) thick.

Fox Hills Formation (Upper Cretaceous, Maastrichtian) (Meek and Hayden, 1862)

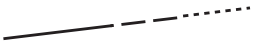
Kfhc **Colgate Member** (Calvert, 1912)--White or light gray, micaceous, fine- to medium-grained sandstone that contains carbonaceous shale or lignitic, carbonaceous shale beds locally as much as 6.0 cm (2.36 in.) thick in upper part. Sandstone is composed of angular quartz, feldspar, and volcanic rock fragments and scattered flakes of muscovite, and is cemented by white sericite and illite that give the sandstone its light color. Tabular and trough cross-bedding are well developed. Channel bases in the sandstone display well developed scour features including large rip-up clasts composed of carbonaceous shale or mudstone. Characteristically weathers into high-angle, fluted surfaces. The type section of the Colgate Member is within the map area east of Colgate Station in secs. 27 and 28, T15N, R55E (about 5 miles south of Glendive in the Forest Park 7.5-minute quadrangle). Member ranges from 20 to 40 m (66 to130 ft) thick.

Kftt **Timber Lake and Trail City members, <u>undivided</u>**-- *<u>Timber Lake Member</u>* (Morgan and Petsch, 1945)--Brownish-gray siltstone and fine-grained sandstone that weather to a moderate brown. Hummocky bedding and trough crossbedding are characteristic of member, and locally it contains *Ophiomorpha* burrows. Thickness of member ranges from 15 to 22 m (49 to 70 ft).
<u>Trail City Member</u> (Morgan and Petsch, 1945)--Interbedded light-gray siltstone and dark- gray shale. Member is a transitional zone between the underlying Pierre Shale

and the sandy Timber Lake Member. Thickness of member about 10 m (33 ft).

Kp **Pierre Shale (Upper Cretaceous, Maastrichtian)** (Meek and Hayden, 1862)--Dark-gray and black bentonitic mudstone and shale with thin jarosite layers, and fossiliferous limestone concretions containing marine ammonites and pelecypods. Thickness of about 6 m (20 ft.) exposed in map area.

EXPLANATION OF MAP SYMBOLS



Contact--Dashed where approximately located, dotted where concealed

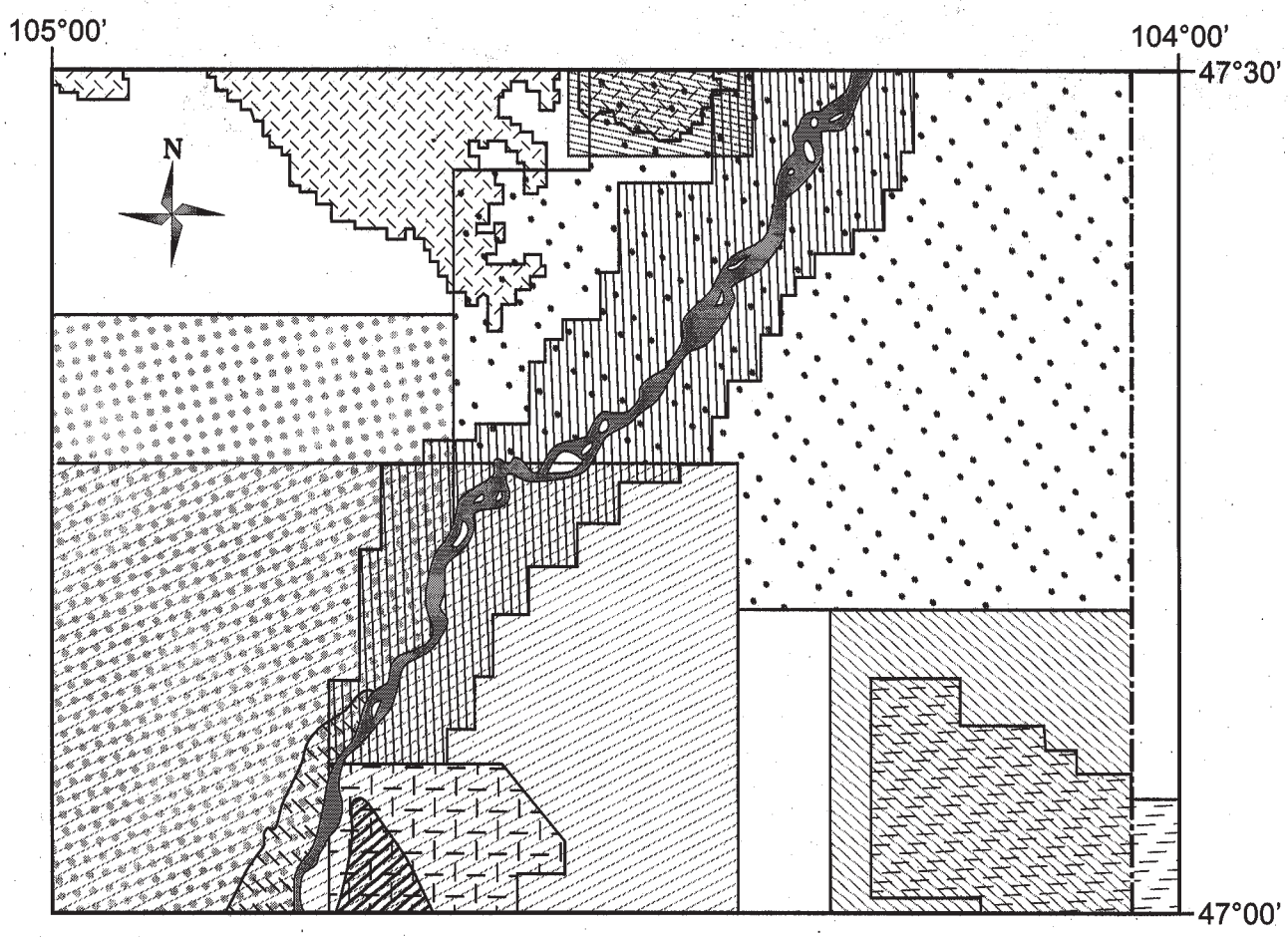
Asymmetric anticline--Showing axial trace of fold and direction of plunge; dotted where concealed. Shorter arrow on more steeply dipping limb.

Strike and dip of bedding

Paleosol unit

Silcrete bed

Clinker



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Butler, R. D. 1980.

Culbertson, W. C. 1954.

Hance, C. J. 1912.

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Moulder, E. A., and Kohout, F. A. 1958.

Spencer, J. M. 1976.

Stebinger, E. 1912.

Entire map — Stoner, J. D., and Lewis, B. D. 1980

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