

## Geologic Map of the Lodge Grass 30' x 60' Quadrangle, Montana

Compiled and Mapped by Susan M. Vuke, Edith M. Wilde, David A. Lopez, and Robert N. Bergantino

2000 (Revised 2007)





Tw	Wasatch Formation
Tftr	Tongue River Member of Fort Union Formation
Tflt	Lebo & Tullock Members of Fort Union Formation
Klfh	Lance and Fox Hills Formations
Kjr	Judith River Formation
Kcl	Claggett Shale
Kga	Gammon Shale
Kn	Niobrara Formation
Kcgr	Carlile Shale & Greenhorn Formation*
Kbm	Belle Fourche & Mowry Shales*
Kt	Thermopolis Shale & Fall River Sandstone
KJkm	Kootenai & Morrison Formations*
Je	Ellis Group
ͳΡcg	Chugwater & Goose Egg Formations*
₽Mta	Tensleep & Amsden Formations*
Mm	Madison Group, undivided
DOtjb	Three Forks, Jefferson, and Bighorn Formations*
£s	Cambrian sedimentary rocks, undivided
Ag	Granitic gneiss, hornblende schist, and biotite schist
	* Units combined on cross section only

### MAP SYMBOLS

Contact: dotted where concealed
Strike and dip of inclined beds
<b>Fault:</b> dashed where approximately located; dotted where concealed, bar and ball on downthrown side
Reverse fault: open teeth on upthrown block
<b>Anticline:</b> showing trace of axial plane and plunge direction where known, dotted where concealed
Asymmetric anticline: showing trace of axial plane; dotted where concealed, shorter

Syncline: showing trace of axial plane and plunge direction where known, dotted where concealed

Monocline: showing axial plane trace of anticlinal flexure; dotted where concealed, shorter arrow on more steeply dipping limb

	107°00'				
$\square$					

# MONTANA BUREAU OF MINES AND GEOLOGY A Department of Montana Tech of The University of Montana

#### **DESCRIPTION OF MAP UNITS**

Qal	<b>Alluvium</b> (Holocene): Gravel, sand, silt, and clay along active channels of rivers, streams, and tributaries; well to poorly stratified, dominantly clast supported, and moderately well sorted; includes alluvial terrace deposits less than six feet above river or stream. Gravel of Big Horn River drainage alluvium is mainly pebbles, cobbles, and boulders of limestone and dolomite, andesite and	Кса	<b>Carlile Shale</b> (Upper Cretaceous): Very dark-gray to dar bluish-gray fissile shale with dark-gray sandy shale at th base and in the middle. The lower sandy shale contain two bentonite beds 2- to 3- feet-thick. The uppermost part contains closely spaced medium-gray calcareous septarian concretions with thick veins of dark-brown calcite. Thickness of formation 280 feet.
Qls	other mafic volcanic rocks, quartzite, granitic rocks, sandstone, and chert, in descending order of abundance (Agard, 1989). Thickness as much as 35 feet. <b>Landslide deposit</b> (Holocene and Pleistocene): Rock and soil that moved downslope in discrete units through	Kgr	<b>Greenhorn Formation</b> (Upper Cretaceous): Dark bluish gray calcareous, fossiliferous, poorly resistant shale tha weathers very light brownish-gray. Locally contains numerous light-gray calcareous septarian concretions, and a thick zone of bentonitic shale or bentonite at the
	mass-wasting processes that resulted in irregular or hummocky surfaces. Thickness of unit ranges from 100 to 150 feet.		base. Thickness of formation 115 feet. Belle Fourche Shale (Upper Cretaceous): Dark-gray
Qaf	<b>Alluvial fan deposit</b> (Holocene and Pleistocene): Gravel, sand, and silt, crudely stratified, deposited at mouth of ephemeral stream at base of Big Horn Mountains near Fort Smith; gravel matrix supported. Thickness as much as 50 feet.	Kbf	fissile shale and sandy shale. Contains (1) ferruginous concretions and a 6- to 7-foot-thick bentonite bed in lowe part; (2) the Soap Creek bentonite bed in the middle pa which is 197 feet thick; and (3) a 6- to 7-foot-thick bentonit bed, and light-gray and brownish-gray calcareous concretions in the upper part. Thickness of formation
Qgac	<b>Gravelly sheetwash alluvium and colluvium</b> (Holocene and Pleistocene): Gravel, sand, silt, and clay, poorly to moderately well stratified, and poorly to moderately well sorted; derived from higher level alluvial terrace deposits, and to a lesser extent from bedrock sandstone and shale. Thickness as much 25 m (Agard, 1988) (82 feet).	Km	475 feet. <b>Mowry Shale</b> (Upper Cretaceous): Light-gray to medium gray siliceous, very fine- to fine-grained sandstone and siltstone with silvery sheen interbedded with medium dark-gray fissile shale. Contains abundant fish scales o bedding surfaces, and several bentonite beds, includin
Qat	Alluvial terrace deposit (Pleistocene): Gravel, sand, silt, and clay underlying alluvial terrace surfaces adjacent		Clay Spur bentonite, which is 10 feet thick. Thickness of formation 395 feet.
	to and higher in elevation than modern streams and rivers. Poorly to moderately well stratified, and poorly to moderately well sorted with planar and trough cross bedding. At least eight, distinct terrace levels are recognized along Big Horn River and Little Big Horn River, ranging from 10 to 560 ft above the rivers; gravel composed of rounded to subrounded clasts of limestone	Kt	Thermopolis Shale and Fall River Sandstone, undivided (Lower Cretaceous): Thermopolis Shale: dark gray fissile shale in upper part, and dark-gray to olive- gray fissile shale with interbeds and laminae of olive-gra and light olive-gray, argillaceous sandstone in lower par Formation contains thin bentonite beds and zones of iridescent, very dusky-purple to grayish-black ferruginou
	and dolomite, andesite, and other mafic volcanic rocks, quartzite, granitic rocks, sandstone, and chert, in descending order of abundance; lowest terrace deposit has been dated at about 0.02 Ma and highest at 1.4 Ma. Thickness ranges 5 to 15 m (Agard, 1989) (16-49 feet).	Kk	concretions. Fall River Sandstone: light brownish-gray t moderate yellowish-brown sandstone that coarsens an thickens upward, interbedded with light brownish-gray shale. Combined thickness of formations 605 to 705 feet. <b>Kootenai Formation</b> (Lower Cretaceous): Reddish-
QTcl	<b>Clinker</b> (Holocene, Pleistocene, and Pliocene): Red, pink, gray, orange, black, and yellow resistant, thermally metamorphosed shale, siltstone, and sandstone of the Lance, Fort Union, and Wasatch formations. Bedrock was baked by burning of underlying coal and is dominantly red scoriaceous rock. Locally, baked rock was melted and fused to form buchite, a black, glassy, vesicular or scoriaceous rock. Thickness of unit as much as 130 feet.		brown, olive-gray, and dusky-purple bentonitic mudston interbedded with lenticular, fine- to coarse-grained sandstone. Thin zones of light-gray nodular limestone common in upper part. Locally contains dinosaur remains Greybull Sandstone member locally present at the top a thick, lenticular, fine-grained sandstone. The Pryor Conglomerate Member at the base is brown conglomerat and pebbly coarse-grained sandstone, 20 to 60 feet thicl Thickness of formation ranges from 195 to 245 feet.
Tw	<b>Wasatch Formation</b> (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. A brown-weathering calcareous coquina 0.1 to 0.4 m (6-8 in.) thick occurs about 250 feet above the base of the formation. Sandstone of the Wasatch	Jm	<b>Morrison Formation</b> (Upper Jurassic): Greenish-gray and pale reddish-brown variegated mudstone. Contain very fine- to fine-grained quartzose, calcareous, cross- bedded sandstone in the middle, generally 15 to 30 m (49–98 feet) thick, and dinosaur remains throughout th formation. Thickness of formation 295 to 345 feet.
	Formation is coarser grained and has more grain-size variation than sandstone in the underlying Tongue River Member of the Fort Union Formation. The Wasatch Formation typically weathers light gray to tan, and the upper Tongue River Member of the Fort Union Formation weathers very light gray. Each has a distinct heavy mineral	Js	—ELLIS GROUP— Swift Formation (Upper Jurassic): Greenish-gray to yellowish-gray fine- to coarse-grained, plane-bedded or cross-bedded, glauconitic, fossiliferous (mainly pelecypods and belemnites) sandstone or very sand
	suite (Denson <i>et al.</i> , 1990). Following these criteria, the contact on this map is in a lower stratigraphic position than on an adjacent 7.5' quadrangle (Pearl School) mapped by Galyardt and Murray (1979). Thickness of formation exposed in map area is 395 feet.		limestone coquina at the top. Medium-gray poorly resistant claystone interbedded with silty to sandy moderately resistant, greenish-gray claystone in the lower part. Greenish-gray to yellowish-gray, poorly resistant, glauconitic, fossiliferous sandstone at the base and one or more similar thin glauconitic
Tftr	—FORT UNION FORMATION— Tongue River Member (Paleocene): Yellowish-gray to grayish-yellow, fine- to medium-grained, trough cross- bedded, plane-bedded, or massive sandstone. Interbedded with carbonaceous shale (much less abundant than the sandstone) and light greenish-gray shale, brownish-gray to yellowish-gray siltstone, and 8 to 10 coal beds with associated clinker. A prominent zone	Jr	sandstones higher in the member. Contains numerou large fossil oyster shells. Thickness of formation 115 fee <b>Rierdon Formation</b> (Middle Jurassic): Light-gray limestone, brownish-gray, sandy oolitic limestone, ar light yellowish-gray, fine-grained calcareous sandstor at top that forms a resistant ridge. Greenish-gray to light-brown calcareous shale that contains abundan
	of silcrete beds occurs locally at the top of the Tongue River Member. Thickness of member 650 feet.		fossil oyster shells in lower part. Thickness of formatic 180 feet.
Tfle	<b>Lebo Member</b> (Paleocene): Medium-gray, dark-gray, and olive-gray smectitic or carbonaceous shale and silty shale with thin, interbedded yellowish-gray sandstone and siltstone, and thin lenticular coal beds. Shale locally contains ironstone concretions. Thickness of member ranges from 195 to 330 feet.	Jp	<b>Piper Formation</b> (Middle Jurassic): Brownish-red claystone with scattered streaks of green claystone interbedded with brownish-red siltstone in upper part. Contains a white dolomitic limestone bed and gray-to- lavendar chalcedony nodules. Medium-gray limestone and white dolomitic limestone interbedded with red claystone and white gypsum in middle part. Dark brownis
Tft	<b>Tullock Member</b> (Paleocene): Yellowish-gray, fine- to medium-grained trough cross-bedded, plane-bedded or massive sandstone. Interbedded with brownish-gray or dark-gray carbonaceous shale (much less abundant than the sandstone). Sandstone beds thinner, more tabular and persistent than those in underlying Lance Formation.	ЋРсg	red claystone with lenses of white gypsum underlain b massive white gypsum interbedded with some brownis red claystone, siltstone, and medium-gray limestone in lower part. Thickness of formation 131 feet.
KI	Thickness of member ranges from 230 to 395 feet. <b>Lance Formation</b> (Upper Cretaceous): Light brownish- gray, fine-grained, cross-bedded, lenticular-bedded or massive sandstone. Interbedded with light olive-gray to greenish-gray shale, less abundant than the sandstone. Contains calcite-cemented concretionary sandstone lenses. Laterally equivalent to the Hell Creek Formation in easternmost Montana. Sandstone beds thicker and more lenticular than those in overlying Tullock Member.		<b>Formation</b> (Permian), <b>undivided</b> : Chugwater Formatio red to dark reddish-brown, generally thin-bedded, local cross-bedded, calcareous or gypsiferous, fine-grained and very fine-grained sandstone and siltstone. Promine resistant ledge five feet thick, of light-gray limestone abo 115 feet below the top. Goose Egg Formation: light-gray very light-gray or pink, finely crystalline gypsum interbedded with red, fine-grained sandstone and siltston Occurs only locally. Combined thickness of formations 150 m (Agard, 1986, 1988) (492 feet).
	In many areas contains a very light-gray, fine- to medium- grained sandstone interbedded with coal in the lower part, with some associated clinker. This basal unit is probably equivalent to part of the Lennep Sandstone of older usage (e.g., Hall and Howard, 1929). Thickness of formation ranges from 460 to 525 feet.	IPt	<b>Tensleep Formation</b> (Pennsylvanian): Very light-brow to light yellowish-brown, very fine-grained to medium- grained, well-sorted, well-rounded, cross-bedded, porou to-tightly cemented sandstone. Contains some thin limestone beds, nodular chert, dolomite, or silty shale.
Kfh	<b>Fox Hills Sandstone</b> (Upper Cretaceous): Brownish- gray siltstone and fine-grained cross-bedded or hummocky-bedded, poorly resistant sandstone interbedded with dark gray shale. Thickness of formation 100 feet.	PMa	Thickness of formation 98 feet. <b>Amsden Formation</b> (Lower Pennsylvanian and Uppe Mississippian): Light-red to red, purple, green, or light brown shale, siltstone, and sandstone interbedded wit very light-gray to gray limestone and dolomite that local contains chert. Red shale and siltstone at base. Thickness
Kb	<b>Bearpaw Shale</b> (Upper Cretaceous): Dark-gray fissile shale interbedded with thin, brownish-gray siltstone and fine-grained sandstone beds. Pinches out to south in map area. Thickness of formation ranges from 0 to 150 feet. —JUDITH RIVER FORMATION—	Mm	of formation 262 feet. <b>Madison Group, undivided</b> (Middle Mississippian): Ligh gray to light brownish-gray, thick-bedded to massive, fossiliferous (mainly crinoids, brachiopods, corals, and stromatolites), micritic to coarse-grained, resistant
Kju	<b>Upper member</b> (Upper Cretaceous): Greenish-gray to brownish-gray sandy shale and shale interbedded with some thin, brown sandstone beds. Member pinches out north of map area. Thickness of member ranges from 200 to 445 feet.	Dtj	limestone and dolomitic limestone. Contains solution breccia in middle, and karst surface with sink holes infille with shale from the overlying Amsden Formation at the top. Thickness of group 656 feet. <b>Three Forks Formation and Jefferson Formation</b> ,
Кјр	Parkman Sandstone member (Upper Cretaceous): Yellowish-gray to brownish-gray and olive-green, fine- to medium-grained cross-bedded sandstone interbedded with yellowish-gray silty shale, less abundant than the sandstone. Thickness of member 255 feet. Claggett Shale (Upper Cretaceous): Brownish-gray and	24	undivided (Upper Devonian): Three Forks Formation: light gray to brownish-gray thin- to medium-bedded, sil to shaly limestone and dolomite interbedded with greenis gray shale, siltstone, and sandstone. Locally not prese in map area. Jefferson Formation: dark brownish-gray, dolomitic, partly granular limestone with fetid odor. Combined thickness of formations 198 feet.
Kcl Kga	<b>Claggett Shale</b> (Opper Cretaceous): Brownish-gray and dark-gray fissile or bentonitic shale. Contains distinctive yellowish-tan or orange septarian concretions, many of which contain fossils. Thickness of formation 395 feet. <b>Gammon Formation</b> (Upper Cretaceous): Yellowish- brown calcareous siltstone interbedded with yellowish-	Ob	<b>Bighorn Dolomite</b> (Middle Ordovician): Very light-gray to very pale-orange micritic dolomite and dolomitic limestone. Contains chert locally. Upper part thin to thic bedded, lower part massive and resistant. Thickness of formation ranges from 394 to 492 feet.
	brown weathering, brownish-gray, calcareous silty shale. Contains several yellowish-brown, fine-grained sandstone beds that may be equivalent to the Shannon Sandstone to the south and the Eagle Sandstone to the northwest. Contains a zone of reddish-orange ferruginous concretions in sandy shale in the northern part of the map area. Thickness of formation ranges from 325 to 855 feet.	Cs	Sedimentary rocks, undivided (Middle Cambrian): Gra thin-bedded, limestone interbedded with grayish-green mud-cracked shale, and intraformational limestone fla pebble conglomerate in upper part. Gray to grayish-green fissile, calcareous silty or sandy shale in lower part wir a basal reddish-brown, coarse-grained sandstone bec
Kn	<b>Niobrara Shale</b> (Upper Cretaceous): Dark brownish-gray fissile shale with abundant thin bentonite beds and medium light-gray to pale yellowish-brown concretions up to two		Equivalent to the Flathead, Gros Ventre, and Gallatin formations to the south, or the Flathead, Wolsey, Meaghe Park, and Pilgrim formations to the northwest. Thickness of unit ranges from 705 to 804 feet.

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