

Geologic Map of the Helmville basin, West-Central Montana

By

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Abstract

The Helmville basin, west-central Montana, is an intermontane basin ~60 miles east of Missoula, Montana. The basin is located within the Rocky Mountain Fold and Thrust Belt adjacent to the Lewis and Clark Lineament (Wallace and others, 1990; Sears and others, 2000) and contains mainly Tertiary sedimentary and volcanic fill (Rasmussen, 1969, 1977; Carter, 1982), along with abundant Quaternary sediment. Existing geologic maps of this area include those by Wallace (1987) and Lewis (1998); previous stratigraphic and sedimentological study of the area was conducted by Rasmussen (1969, 1977) and Carter (1982). Any discrepancies between previously published maps and this project are attributed to differences in map scale and attendant detail, and differences in the level of field investigation within the map area.

The purpose of the present study is to document the evolution of the Helmville basin through a combination of geologic field-based mapping and sedimentologic characterization and to assess the nature, quality and quantity of geological resources it contains. To these ends, I employed the following methods: 1) construction of a 1:24,000 scale geologic map of the study area; 2) measurement of key stratigraphic sections of Cenozoic strata within the basin; 3) compositional analysis of Cenozoic sandstone framework grains and conglomerate clast types for provenance analysis; and 4) measurement and analysis of Cenozoic paleoflow indicator directions where available.

Tertiary Eocene deposits consist of massive undifferentiated andesite and basalt on the western edge of the map area. Oligocene sedimentary strata of the Cabbage Patch beds (Renova Formation, Fields and others, 1985) include fluvial sandstones and paludal mudstones suggesting a meandering stream system that transported sediment from south to north. Miocene strata consist mainly of a massive gravel facies, the Sixmile Creek Formation, (Fields and others, 1985) composed mainly of Proterozoic metasedimentary clasts transported from west to east. The deposition of the gravel facies appears to be controlled by a down-to-west normal fault on the east side of the Helmville basin. Erosional excavation of Miocene gravels and older sediments and volcanics beginning in the late Miocene is suggested by the preserved thicknesses and regional distribution of these sediments across the study area. During the Quaternary, a large lobe of ice originating from the Monture Creek drainage blocked the upper Blackfoot River drainage, impounding a large proglacial lake in the study area. A Gilbert-style delta prograded into this glacial lake from Yourname Creek drainage on the western edge of the basin.

The existence of the Helmville basin is inferred to be controlled by a major southwest-facing normal fault located on the eastern edge of the basin, forming a half-graben. This fault is mostly obscured by Tertiary gravel. The presence of aligned tufa mounds within the southwest part of the map suggests the presence of at least one additional en echelon fault.

Description of Map Units

Quaternary

Qal

Alluvium (Holocene)

Semi-consolidated to unconsolidated fluvial and overbank deposits exposed along modern stream channels. Unit consists of gravel and sand with local mud-dominated floodplain deposits. Gravel is well rounded and poorly sorted with local boulder-sized clasts. Mud deposits are very fine and light brown in color. No apparent sedimentary structures. Anthropogenic deposits related to local agricultural activities are included in this unit. Less than 6 meters thick.

Qgl

Glacial Lacustrine (Pleistocene)

Lacustrine mudstone exposed along modern stream channels in the northwest corner of map area, particularly along the Blackfoot River. Unit consists of dm-scale interbedded clay and silt with local dropstones ranging in diameter from sub-millimeter to 20 centimeters and local soft sediment deformation. Mudstone is locally fissile and ranges from tan to red. Approximately 5 meters thick.

Qd

Glacial Deltaic (Pleistocene)

Poorly consolidated Gilbert-style delta deposit exposed in the northwest corner of map area. Unit consists of coarsening-upward sandy gravel foresets that commonly are trough cross-bedded and dip to the northeast with local symmetrical ripples. Approximately 6 meters thick.

Tertiary

Tsm

Sixmile Creek Formation (Miocene)

Poorly consolidated gravel and sand exposed on high terraces and along valley slopes. Unit consists of framework supported gravel with angular sand matrix. Individual gravel clasts measure up to 1 meter in diameter and are composed of metasedimentary (Proterozoic) and volcanic lithologies with minor percentages of sedimentary rocks. Pebble imbrication in the northwest part of map area shows west to east paleoflow. Up to 45 meters thick.

Tbc

Barnes Creek beds (Miocene)

Informal member of Sixmile Creek Formation. Unconformably overlain by Sixmile Creek Gravel and poorly exposed in map area. Where present, consists of finely

bedded sandstone, sandy mudstone, coarse sand and gravel of variable thickness. Local sedimentary structures include ripple foresets (sandstone) and pebble imbrication (gravel). West to east paleocurrent directions are suggested in the limited exposures. Approximately 18 meters thick.

- Tcp** **Cabbage Patch beds** (Oligocene)
Tabular m-scale beds of pebbly feldspathic sandstone and interstratified mudstone. In general, this unit is poorly exposed in the study area. Sandstone is very coarse and very well cemented; clasts are poorly sorted and angular with a maximum clast size of 1 centimeter. Sandstone is both normally and inversely graded in places with silica replacing wood fragments and clay rip-up clasts. Paludal mudstone varies from olive green to tan to gray, with some calcium carbonate mud and local root traces. Lacustrine gastropod fossils and sponge spicules are locally present suggesting a meandering fluvial system with a large floodplain containing abundant standing water. Ripple foresets in sandstones show south to north flow directions. Approximately 200 meters thick.
- Tft** **Tufa**
Sub-aligned concentric layered mounds (about 8 mounds) of tufa located in the southwest corner of map area. Unit forms distinct hill surrounded by andesite and basalt with abundant associated permineralized wood fragments. Unknown thickness.
- Tvd** **Volcanic Debris Flow** (Eocene)
Monomict debris flow deposit exposed in road cut in southwest corner of map area. Unit consists of stratified volcanic clasts in a mud matrix and thinly bedded gray ashy mudstone. Volcanic clasts are well rounded and range up to 20 centimeters. Clasts occur in local matrix support. Largest clasts occur at the top of the unit. Unit is capped by massive Tab basalt. Approximately 18 meters exposed.
- Tab** **Andesite and Basalt** (Eocene)
Massive undifferentiated andesite and olivine-bearing basalt forming western highlands of map area. Unit is highly fractured and readily forms cliffs. Vesicular and porphyritic in places with color ranging from black to red. 44-49 + 2 Ma K-Ar dates by Williams and others (1976) and Carter (1982). 0-200 meters thick (Carter 1982).

Proterozoic

- Ybo** **Bonner Quartzite**
Poorly exposed red/pink to tan, tabular quartzite located on the southwestern margin of map area. Beds are mm to cm thick and contain mud chips, matrix-supported pebbles, symmetrical ripples and sub-millimeter laminations. 210 meters exposed in map area.
- Yms** **Mount Shields Formation**
Reddish quartzite and subordinate argillite and siltite (Lewis, 1998). Unit is inferred in subsurface on cross section.
- Ysh** **Shepard Formation**
Cm- to dm-scale beds of red dolomitic tabular quartzite, siltite, and argillite beds. Abundant in southeast corner of map area. Argillite exhibits mudchips and microlaminations. Approximately 100 meters exposed in map area.
- Ysn** **Snowslip Formation**
Coarse pink to tan quartzite exposed in southeast corner of map area. Tabular mm- to cm-scale beds contain well rounded quartz grains without apparent sedimentary structures. Deposit is strongly brecciated near fault contact with Yc in southeastern part of map area. 30 meters exposed in map area.
- Yc** **Middle Belt carbonate**
Recently renamed Piegan Group (Winston, 2007). Dolomite and dolomitic argillite exposed in southeastern part of map area. Massive unit with karst topography containing m-scale pinnacles and depressions. Unit contains tabular beds from sub-mm to dm scale with molar-tooth structures; brecciated near fault contact with Ysn. No obvious sedimentary structures. About 200 meters exposed in map area.
- Ye** **Empire Formation**
Dolomitic argillite and siltite in southeast corner of map area with cm-scale lenticular beds where exposed. Color ranges from gray-green to red, finely laminated with local asymmetric ripples. 30 meters exposed in map area.
- Ys** **Spokane Formation**
Red tabular cm-scale siltite exposed in northeast corner of map area. Lacks obvious sedimentary structures but some

float blocks contain fine laminations. About 75 meters exposed in map area.


Map Symbols


Line Features

 Field area outline

 Contact


 Normal Fault

 Normal Fault (inferred)

 Normal fault (inferred and concealed)

 Cross-section location

Point Features

 Strike and dip of bedding

Period	Epoch/Era	Ma	Age	Map Units	
Quaternary	Holocene	0.0114		Qal	
	Pleistocene		Rancholabrean	Qgl	Qd
			Irvingtonian		
Neogene	Pliocene	2.02	Blancan		
		Miocene	5.03	Hemphillian	Tsm
	8.41		Clarendonian	Tbc	
	11.5		Barstovian		
	15.9		Hemingfordian		
	19.0				
	Paleogene		Oligocene	23.3	Arikarean
		30.0		Whitneyan	
		31.7		Orellan	
		Eocene	33.7	Chadronian	Tft
37.7			Duchesnean		
42.4			Uintan		
46.4			Bridgerian	Tab	Tvd
50.9			Wasatchian		
Paleocene			55.7		
Proterozoic		Late	65.5		
	543				
	Middle		900		Ybo
					Yms
					Ysn
				Ysh	
				Ye	
			Yc		
			Ys		

Sixmile Creek Fm. (Fields and others, 1985)

Renova Fm. (Fields and others, 1985)

Stratigraphic Correlation for The Helmville Basin. Montana Bureau of Mines and Geology Open File Report MBMG 574. North American Land Mammal ages and Ma from Rasmussen and Prothero (2003), Rasmussen (2003) and Fields and others (1985). 2003 International Stratigraphic Chart (ISC) ages and Ma. Modified from Portner (2005).

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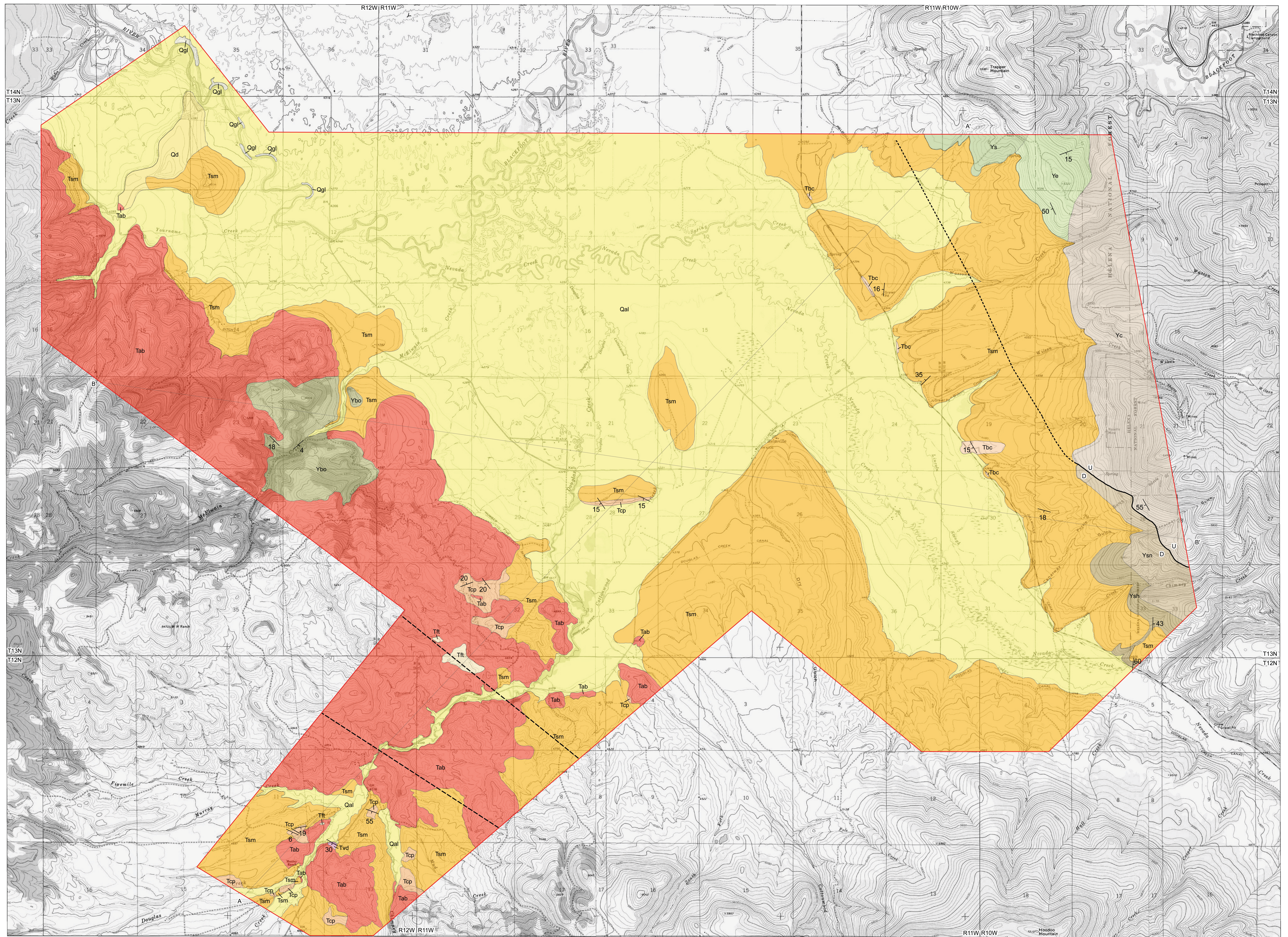
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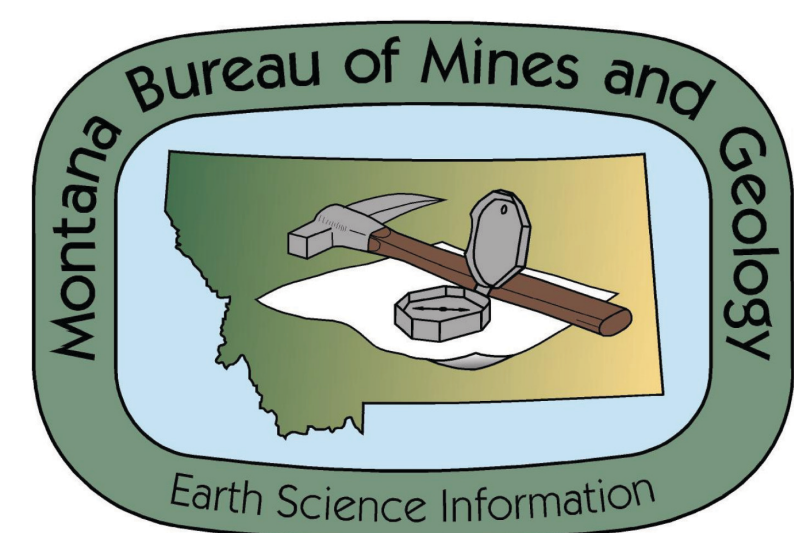
Geologic Map Units

- Holocene**
- Qal Alluvium
- Pleistocene**
- Qgl Glacial lacustrine
- Qd Glacial deltaic
- Miocene**
- Tsm Sixmile Creek Formation
- Tbc Barnes Creek beds
- Oligocene**
- Tcp Cabbage Patch beds
- Tr Tufa
- Eocene**
- Tvd Volcanic debris flow
- Tab Andesite and basalt
- Proterozoic**
- Ybo Bonner Quartzite
- Yms Mount Shields Formation (cross section only)
- Ysh Shepard Formation
- Yan Snowslip Formation
- Yc Middle Belt Carbonate (Piegan Group)
- Ye Empire Formation
- Ys Spokane Formation
- Line Features**
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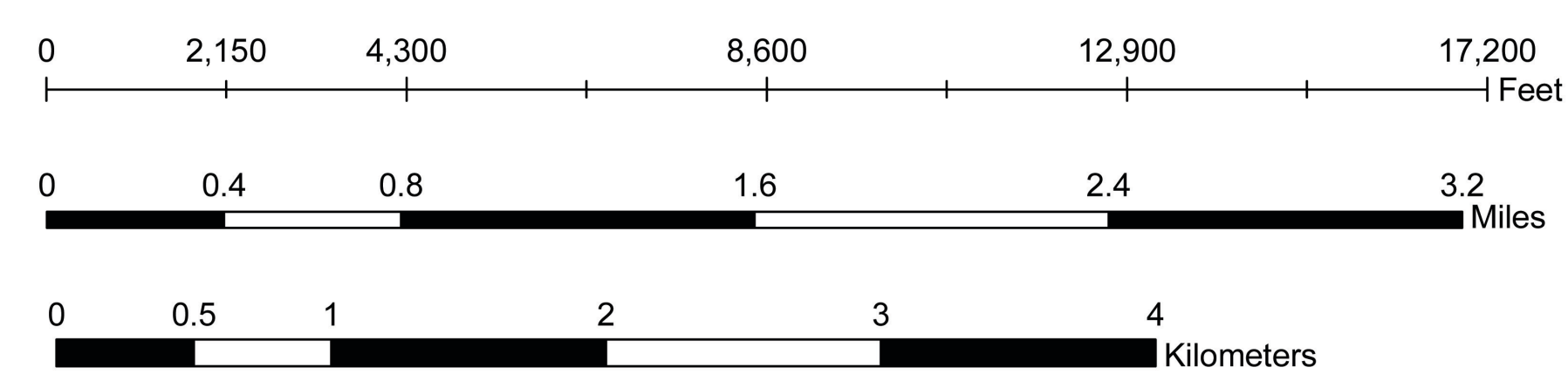


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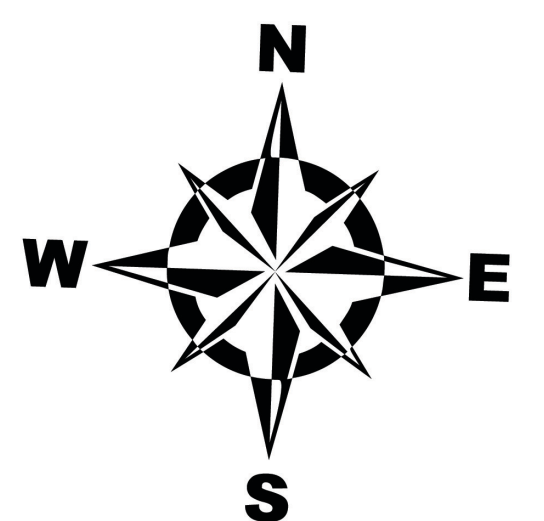
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Scale: 1:24,000
CI: 20-30 feet
NAD 1983 Datum
Montana State Plane Projection
Map Design and GIS: Julian G. McCune



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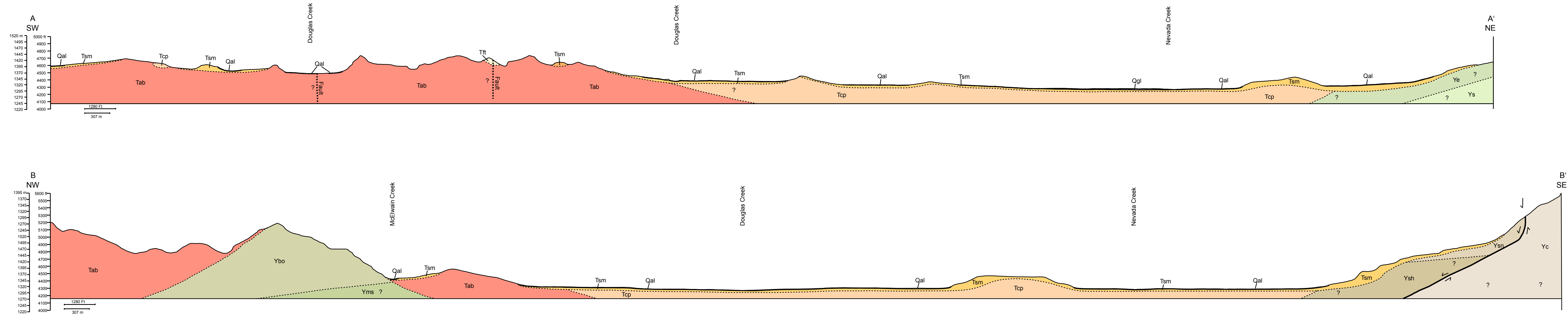


Plate 2: Geologic cross sections of the Helmville basin. Montana Bureau of Mines and Geology Open File Report MBMG 574. For locations and unit descriptions see accompanying geologic map and report. 3 times vertical exaggeration. Elevation datum is mean sea level.