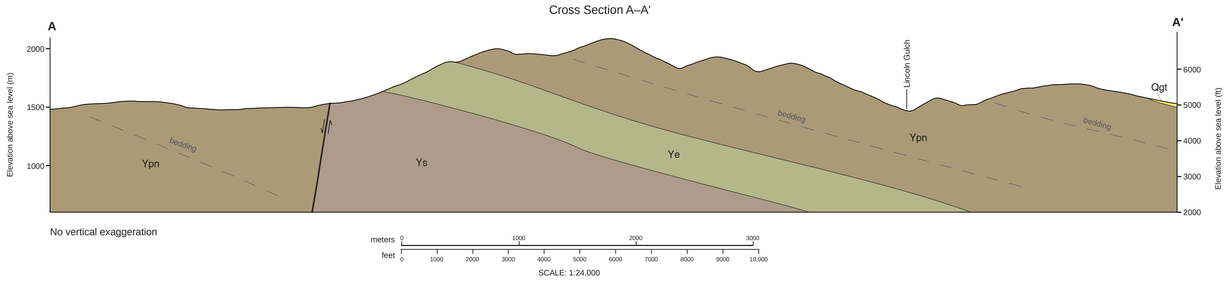
Base from U.S. Geological Survey
Moose Creek 7.5' topographic quadrangle
Map date: 1968
Projection: UTM zone 12; 1927 NAD
UTM grid declination 1°19' West
1968 Magnetic North Declination 19° East

N

SCALE 1:24,000
1 MILE
1000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Shaded relief created from 10 meter digital elevation model from U.S.Geological Survey National Elevation Dataset.

Cross Section A–A'

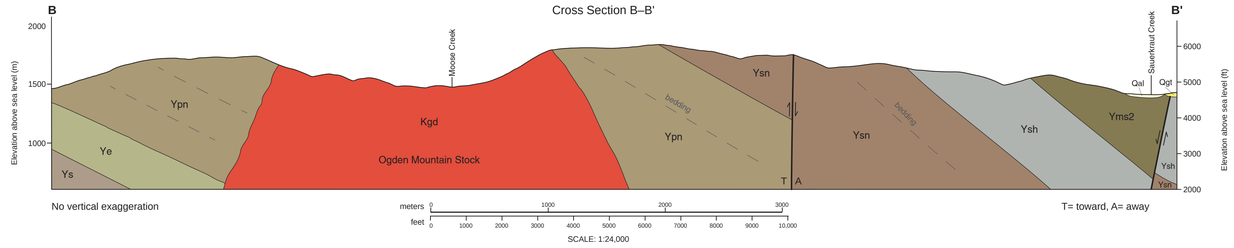


No vertical exaggeration

meters 0 1000 2000 3000
feet 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10,000

SCALE: 1:24,000

Cross Section B–B'



No vertical exaggeration

T= toward, A= away

meters 0 1000 2000 3000
feet 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10,000

SCALE: 1:24,000

INTRODUCTION

The Montana Bureau of Mines and Geology (MBMG), in conjunction with the STATEMAP advisory committee, selected the Moose Creek 7.5' quadrangle in south-central Montana for detailed mapping to provide new information on stratigraphy and structure in an area with mostly reconnaissance mapping. The mapping is part of the MBMG's effort to complete the Elliston 30' x 60' geologic map.

GEOLOGIC SUMMARY

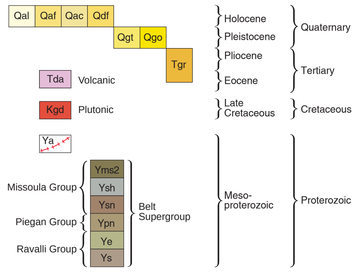
The Moose Creek quadrangle is underlain by a thick [> 4,875 m (16,000 ft)] succession of metasedimentary rock of the Mesoproterozoic Belt Supergroup. The Spokane and Empire Formations, part of the lower Belt Ravalli Group, are the oldest rocks exposed. They are dominantly fine-grained, thin-bedded argillite and siltite. The overlying dolomite and limestone of the Piegan Group (Wallace and Helena Formations, Winston, 2007) forms the thickest and most widespread map unit. The Snowslip, Shepard, and Mount Shields Formations of the upper Belt Missoula Group overlie the Piegan Group and are the youngest Belt strata exposed. The Missoula Group strata are predominantly quartzite and argillite. The Mesoproterozoic rocks are intruded by Neoproterozoic meta-andesite and metadiorite sills, and the Late Cretaceous Ogden Mountain Stock. The youngest rock and deposits are Tertiary (Eocene) dacite flows and unconsolidated Quaternary glacial, alluvial, and valley-fill sediment.

The principal structural elements are northwest-striking, high-angle faults that offset the Belt rocks. The faults are associated with the Lewis and Clark Line (Billingsley and Locke, 1941), a major WNW-striking zone of faults and folds that transects the NNW-striking structural grain of the northern Rockies. Stratigraphic displacement and lateral transport along the faults suggest dip-slip and strike-slip motion. Structures related to the Lewis and Clark Line are considered Early Cretaceous to Eocene age (Sears and Hendrix, 2004).

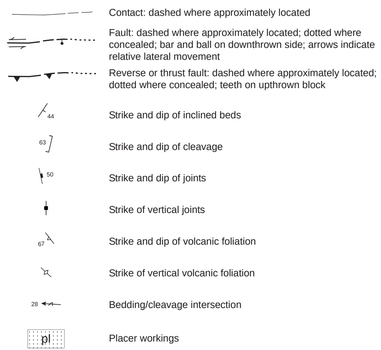
PREVIOUS MAPPING

The entire quadrangle was included on a 1:250,000 scale map by Lewis (1998). The eastern third of the quadrangle was mapped by Whipple and others (1987) at 1:48,000 scale.

CORRELATION DIAGRAM



MAP SYMBOLS



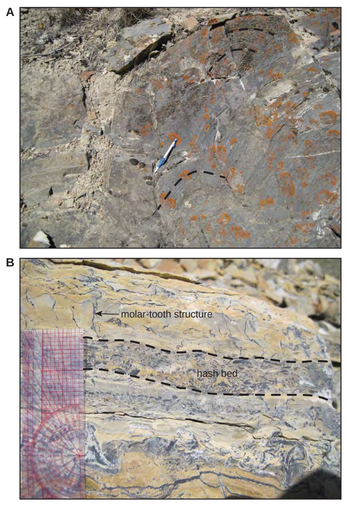
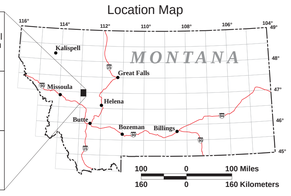


Figure 1. Carbonates of the Piegan Group (map unit Ypn) underlie a large part of the Moose Creek quadrangle and are characterized by beds of stromatolites and molar-tooth structure. (A) Beds of domal stromatolites (black lines) and (B) Close-up of molar-tooth structure (dark, wavy structures). Near the center of the photograph is a thin (approximately 2 cm thick) bed of molar-tooth hash.

Location Map

Coopers Lake	Arrastra Mountain	Stonewall Mountain
Marcum Mountain	**Moose Creek**	Lincoln
Helmville	Nevada Lake	Finn



Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G13AC00210. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

GIS production: Yiwen Li and Paul Thale, MBMG. Map layout: Susan Smith, MBMG.
Editing: Susan Barth, MBMG.

Maps may be obtained from:
Publications Office
Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
Phone: (406) 496-4174 Fax: (406) 496-4451
http://www.mbmg.mtech.edu

DESCRIPTION OF MAP UNITS

Qal **Alluvium (Quaternary: Holocene)**—Gravel, sand, silt, and clay along modern streams and tributaries. Most clasts are rounded to subrounded cobbles and smaller, but boulders also are present. Includes older alluvial deposits along the Blackfoot River. Thickness generally less than 10 m (33 ft).

Qaf **Alluvial-fan deposit (Quaternary: Holocene)**—Gravel, sand, silt, and clay in fan-shaped, matrix and clast-supported deposits. Locally derived coarse clasts are dominantly cobbles, but include boulders and pebbles. Thickness generally less than 15 m (50 ft).

Qac **Alluvium and colluvium (Quaternary: Holocene)**—Unconsolidated rock fragments, blocks, gravel, sand, and silt deposited by sheet wash and gravity; includes alluvium in drainage bottoms. Thickness generally less than 8 m (20 ft).

Qdf **Debris flow deposit (Quaternary: Holocene and Pleistocene?)**—Matrix-supported sediment along Sauerkraut Creek with clasts of upslope-derived quartzite, hornfels, and granodiorite. Clasts range from granules to boulders. Unknown thickness.

Qgt **Glacial deposit (Quaternary: Holocene and Pleistocene?)**—Unconsolidated and poorly sorted boulders, gravel, sand, silt, and clay. Clasts are predominantly quartzite and carbonate, but include minor amounts of granodiorite and volcanics. Thickness probably less than 50 m (165 ft).

Qgo **Glacial outwash (Quaternary: Pleistocene)**—Light brown to brown silt, sand, granules, pebbles, and cobbles with a few angular to rounded boulders having an average diameter of 0.3–1 m (1–3 ft). Clasts are dominantly rounded quartzite, but also include argillite and igneous rocks. Thickness not determined.

Tgr **Gravel (Tertiary)**—Poorly to moderately sorted, boulder and cobble gravel in a light brown silty to sandy matrix. Clasts are rounded to subrounded and dominantly quartzite, dolomite, argillite, granodiorite, and andesite. Forms isolated deposits that mantle bedrock in southwest part of map. Estimated thickness as much as 30 m (100 ft).

Tda **Dacite, aphanitic (Tertiary: Eocene)**—Dark gray and dark greenish gray, aphanitic and weakly porphyritic dacite. Flows commonly exhibit a conspicuous flow foliation and form flaggy, angular talus, often with red iron staining on parting surfaces. Aphanitic lavas exhibit a strong trachytic texture consisting mainly of plagioclase microcrystals, but also include minor amounts of pyroxene, magnetite, and volcanic glass. Porphyritic flows contain subhedral to euhedral phenocrysts of plagioclase, amphibole, and minor biotite. Unknown thickness.

Kgd **Granodiorite (Cretaceous)**—Light to dark gray, equigranular to weakly porphyritic granodiorite to porphyritic quartz monzonite; composed of plagioclase, orthoclase, quartz, biotite, and hornblende. Forms the Ogden Mountain Stock dated at 81.1 ± 2.8 Ma (biotite) and at 85.4 ± 3.9 Ma (hornblende) (Schmidt and others, 1994).

Ya **Meta-andesite and metadiorite sills (Mesoproterozoic)**—Blackish gray to dark grayish green, fine-grained, metamorphosed andesite and diorite, often porphyritic (Whipple and others, 1987). Sills are typically less than 3 m (10 ft) thick. Poorly exposed and difficult to trace laterally. Occur mostly in Helena Formation.

Yms2 **Mount Shields Formation, member 2 (Mesoproterozoic)**—Pink to red, poorly sorted, medium- to coarse-grained, feldspathic quartzite. Abundant planar and trough crossbeds. Contains sparse subangular quartz granules. Lower part consists of couples of white to pink, medium-grained quartzite and thin red argillite with abundant red mudchips common at the bases of quartzite beds. The lower part was included in the top part of member 1 of Schmidt and others (1994). Two slabbed and stained samples from the nearby Ophir Creek 7.5' quadrangle (Lonn and Vuke, 2015) contained 65–75 percent quartz, 5–15 percent potassium feldspar, and 20 percent plagioclase. Exposed thickness about 365 m (1,200 ft) thick.

Ysh **Shepard Formation (Mesoproterozoic)**—Dolomitic and non-dolomitic, dark green siltite and light green argillite in microlaminae and couplets of non-dolomitic red quartzite to argillite. Poorly exposed, but weathers into thin plates that, where dolomitic, have a characteristic orange brown rind. Ripple marks and load casts are common; mudcracks are rare. The upper half of the formation contains intervals of pink to gray, fine-grained feldspathic quartzite that were probably included in Mount Shields member 1 by Schmidt and others (1994). However, for this map, the upper contact is placed at the top of a 50-m (160-ft)-thick interval of distinctive rose-colored dolomitic siltite–argillite couplets as was done in areas to the west (Lonn and others, 2010). The lower contact is placed at the bottom of the lowest dolomite-bearing beds, although in areas to the west the Snowslip Formation also contains dolomite-bearing intervals (Lonn and others, 2010). A stromatolite bed is commonly exposed near the base. Thickness about 550–610 m (1,800–2,000 ft).

Ysn **Snowslip Formation (Mesoproterozoic)**—Interbedded intervals of quartzite to red argillite couplets, and dark green siltite to light green argillite couplets and microlaminae. Desiccation cracks and mud rip-up clasts are common throughout. Argillite beds often contain irregular "bumps" that are thought to be ill-defined salt casts. Contains beds and lenses of distinctive white, coarse-grained, well-sorted, feldspar-poor quartzite that contains some well-rounded, frosted quartz grains. The upper 50–75 m (160–245 ft) is red, flat-laminated medium-grained quartzite in beds 0.5–1.0 m thick. The lower 50 m (160 ft) is dominated by microlaminated green dolomitic siltite and argillite that characterizes the gradational contact with the underlying Piegan Group. Thickness approximately 1,430 m (4,700 ft).

Ypn **Piegan Group (Mesoproterozoic)**—Gray to dark gray dolomitic limestone, limestone, calcareous siltite, dark-gray argillite, and minor fine-grained quartzite; weathers yellowish orange to gray. Common sedimentary structures include planar and wavy lamination, molar-tooth structure (fig. 1), syneresis cracks, oolites, recessive weathering calcitic pods, assymetrical ripple marks, scour-and-fill, and fluid-escape structures. The upper 300 m (1,000 ft) consists of 1- to 8-m-thick cycles of dark gray limestone interbedded with dark gray calcareous argillite. It typically forms platy talus slopes and may correlate with the Wallace Formation (Winston and Sears, 2014). Below this interval is the Helena Formation characterized by 1- to 7-m-thick cycles with a basal clastic zone of tan to gray siltite and fine-grained quartzite overlain by tan dolomite and capped by dark gray argillaceous limestone (Schmidt and others, 1994). Near the Ogden Mountain Stock, the Piegan Group is metamorphosed to calc-silicate and hornfels. The gradational contact with the underlying Empire Formation is placed at the first interval where siliciclastic and calcitic beds, with sharp scoured bases overlain by intraclasts of molar-tooth fragments, predominate. Estimated thickness about 1,525 m (5,000 ft), about the same as that reported by Eby (1977) at Red Mountain, approximately 11 km (7 mi) to the northeast.

Ye **Empire Formation (Mesoproterozoic)**—Grayish green, medium green, and light green argillite and siltite. Thinly bedded and often lenticular with microlaminae and mudcracks; contains some calcareous and dolomitic beds with rare stromatolites. The gradational contact with the underlying Spokane Formation is placed at the first thick (>1 m) interval of green argillite. Thickness about 410 m (1,350 ft).

Ys **Spokane Formation (Mesoproterozoic)**—Grayish red, red, dark greenish, and purplish-red argillite and siltite with even microlaminae and couplets. Commonly contains desiccation cracks, mud rip-up clasts, and some uncracked, lenticular, and wavy couplets and beds of flat-laminated couples. Exposed thickness about 425 m (1,400 ft) but base not exposed in quadrangle. Reported to be about 1,000 m (3,280) thick east of the study area (Schmidt and others, 1994).

REFERENCES

Billingsley, P., and Locke, A., 1941, Structure and ore deposits in the continental framework: American Institute of Mining and Metallurgical Engineers Transactions, v. 144, p. 9–59.

Eby, D.E., 1977, Sedimentation and early diagenesis within eastern portions of the 'Middle Belt Carbonate Interval' (Helena Formation), Belt Supergroup (Precambrian-Y), western Montana: Stony Brook, State University of New York, Ph.D. dissertation, 702 p.

Lewis, R.S., 1998, Geologic map of the Butte 1° x 2° quadrangle: Montana Bureau of Mines and Geology Open-File Report 363, 16 p., scale 1:250,000.

Lonn, J.D., and Vuke, S.M., 2015, Geologic map of the Ophir Creek 7.5' quadrangle, Lewis and Clark and Powell Counties, Montana: Montana Bureau of Mines and Geology Open-File Report 666, scale 1:24,000.

Lonn, J.D., McDonald, C., Sears, J.W., and Smith, L.N., 2010, Geologic map of the Missoula East 30' x 60' quadrangle, western Montana: Montana Bureau of Mines and Geology Open-File Report 593, 2 sheets, scale 1:100,000.

Sears, J.W., and Hendrix, M., 2004, Lewis and Clark line and the rotational origin of the Alberta and Helena salients, North American Cordillera, *in* Sussman, A.J., and Weil, A.B., eds., Orogenic curvature: integrating paleomagnetic and structural analyses: Geological Society of America Special Paper 383, p. 173–186.

Schmidt, R.G., Loen, J.S., Wallace, C.A., and Mehnert, H.H., 1994, Geology of the Elliston region, Powell, and Lewis and Clark Counties, Montana: U.S. Geological Survey Bulletin 2045, 25 p., scale 1:48,000.

Whipple, J.W., Mudge, M.R., and Earhart, R.L., 1987, Geologic map of the Roger's Pass area, Lewis and Clark County, Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1642, scale 1:48,000.

Winston, D., and Sears, J.W., 2014, Stratigraphy of the Proterozoic Belt Supergroup and structure of the Belt Basin: Glacier National Park and Blackfoot River Canyon, Montana: Northwest Geology, v. 42, p. 237–256.

Winston, Don, 2007, Revised stratigraphy and depositional history of the Helena and Wallace Formations, Mid-Proterozoic Piegan Group, Belt Supergroup, Montana and Idaho, U.S.A., *in* Link, P.K., and Lewis, R.S., Proterozoic geology of western North America and Siberia: SEPM Special Publication 86, p. 67–100.

MBMG
Montana Bureau of Mines and Geology

MBMG Open-File Report 686

Geologic Map of the Moose Creek 7.5' Quadrangle, Lewis and Clark and Powell Counties, Montana

Catherine McDonald

2017