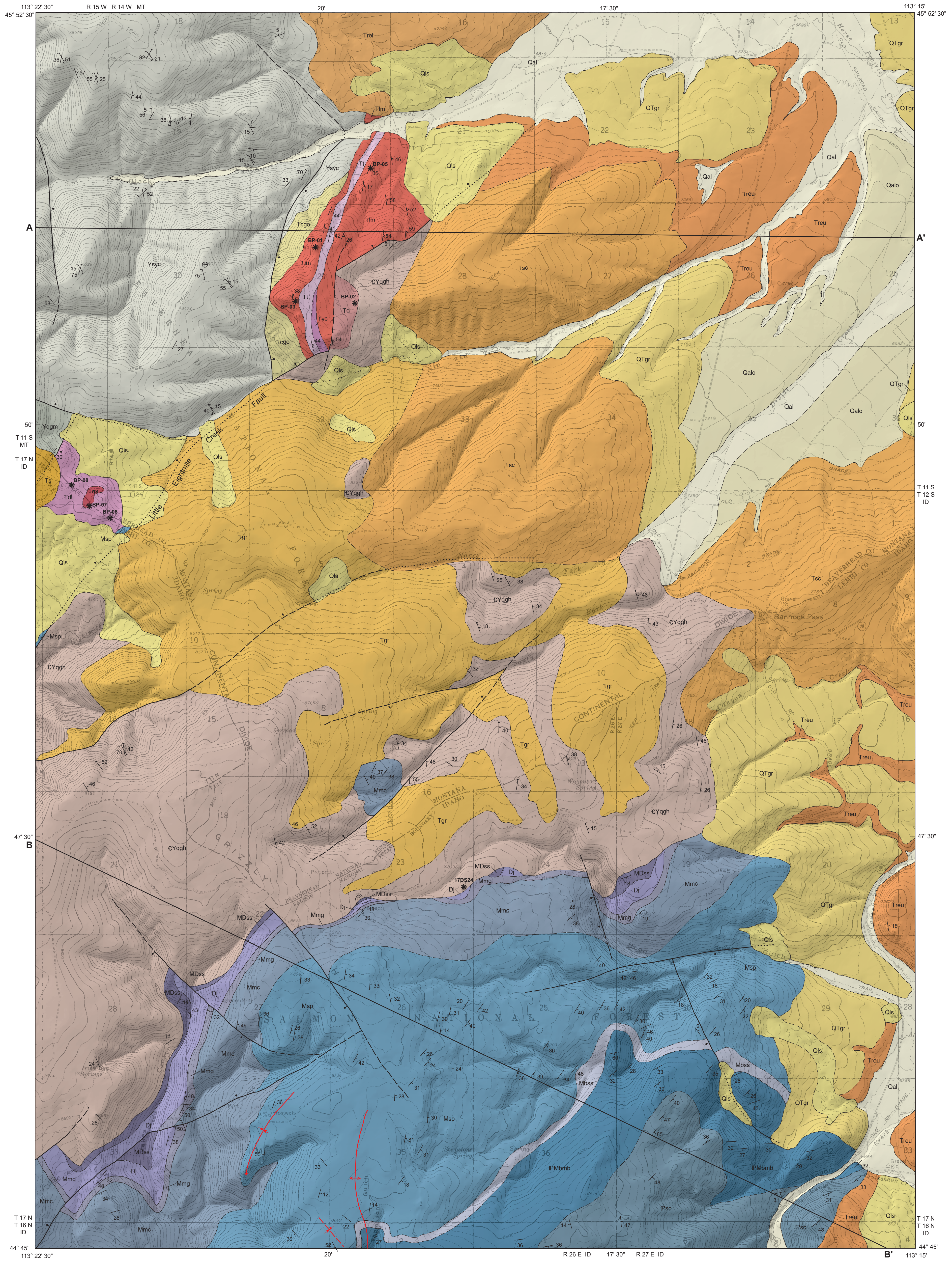
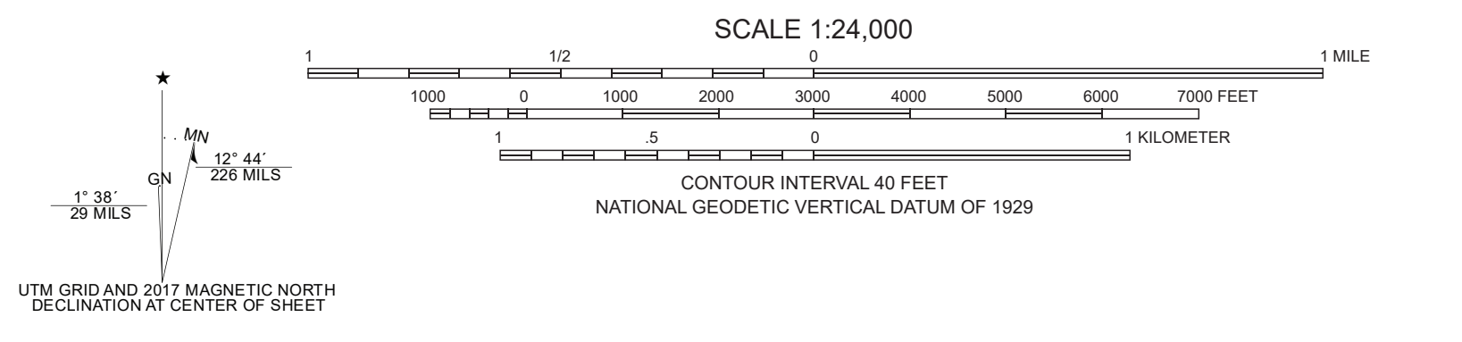


Base map produced by the United States Geological Survey
Bannock Pass 1:24,000-scale quadrangle map, 1965
Control by: USGS, and USC&GS
Compiled from aerial photographs taken 1964
Field checked: 1965
Projection: Polyconic
Grid:1000 meter Universal Transverse Mercator Zone 12
Vertical Datum: National Geodetic Vertical Datum of 1929
Horizontal Datum: 1927 North American Datum

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



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1300 West Park Street
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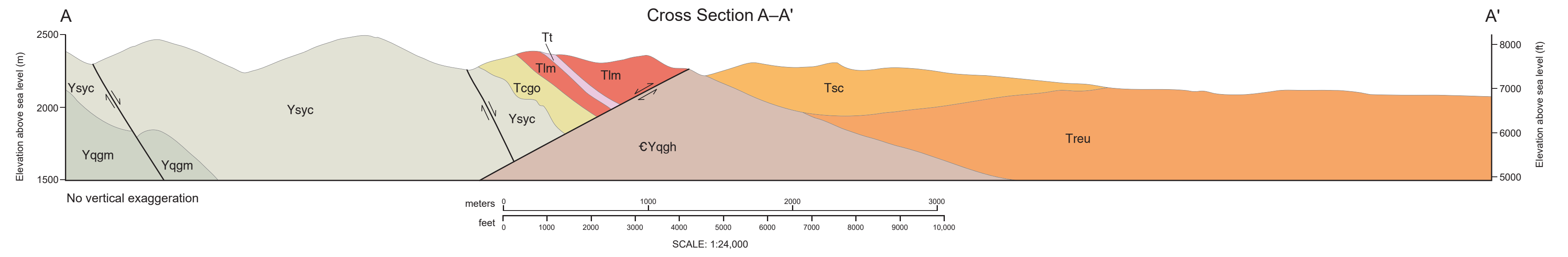
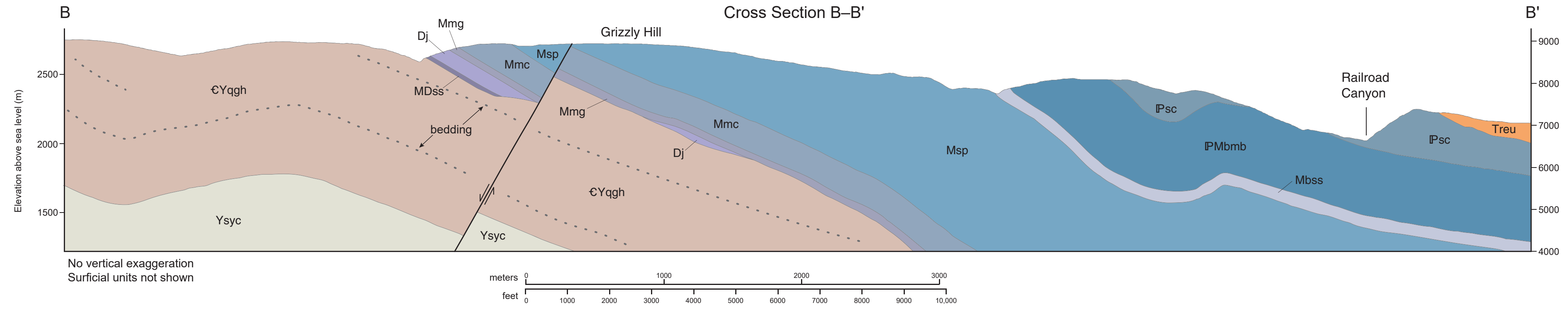
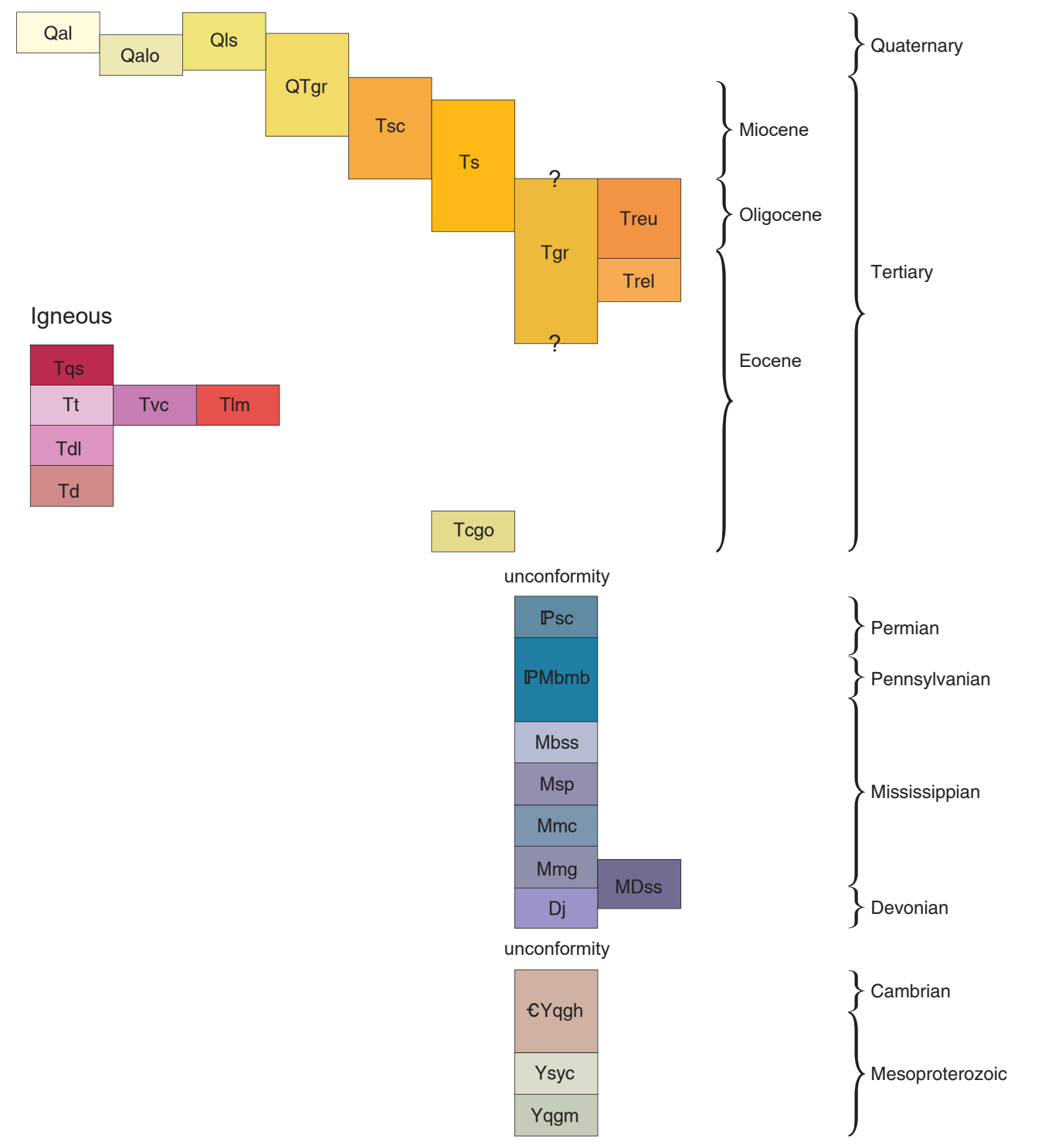
Phone: (406) 496-4174
http://mbmg.mtech.edu





CORRELATION DIAGRAM



MAP SYMBOLS

- Contact: dashed where approximately located, dotted where concealed
- Normal fault: dashed where approximately located, dotted where concealed, bar and ball on downthrown side
- Anticline—Identity and existence certain, location accurate
- Syncline—Identity and existence certain, location accurate. Arrow shows direction of plunge
- Horizontal bedding
- Strike and dip of inclined beds
- Inclined bedding, where strike and dip of beds is known from local features—showing strike and dip
- Inclined cleavage
- Strike and dip of igneous foliation
- ✱ BP-07 Sample point

INTRODUCTION

This map was produced as part of an ongoing cooperative Montana Bureau of Mines and Geology (MBMG)–Idaho Geological Survey (IGS) project to study the relationships between the Belt Supergroup of Montana and northern Idaho and the Lemhi Group (Ruppel, 1975) and related strata of east-central Idaho. It was partly funded by the U.S. Geological Survey's STATEMAP program. Mesoproterozoic rocks were mapped by J. Lonn, R. Burmester, and R. Lewis; Paleozoic rocks were mapped by D. Stewart and D. Pearson; volcanic rocks were mapped by J. Mosolf, and Cenozoic sedimentary rocks were mapped by C. Elliott and J. Lonn.

STRATIGRAPHIC SUMMARY

Paleozoic stratigraphy. Paleozoic strata are preserved in the southern part of the map. The base of the Paleozoic section is a time-transgressive boundary that varies in age across the map. In some places, Mississippian strata rest on the Cambrian–Mesoproterozoic quartzite of Grizzly Hill (€Yqgh); in others, the Devonian Jefferson Formation (Dj) is present (see cross section B–B'). A distinctive sandstone or conglomerate unit, MDss, is locally present at the angular unconformity, whether the overlying strata are Devonian or Mississippian. The distribution and thickness of this sandstone and conglomerate are consistent with onlap onto a surface characterized by valleys and ridges. Thick sands or conglomeritic sands accumulated in paleovalleys, while no sand accumulated on paleoridges. The difference in age of units above this angular unconformity documents paleotopography on a larger scale than in the ridges and valleys.

Mesoproterozoic stratigraphy. Low-grade metasedimentary rocks underlying the western part of the Bannock Pass quadrangle belong to the Lemhi subbasin strata (Burmester and others, 2016b) of the Mesoproterozoic Belt Supergroup. In adjacent areas, these rocks were assigned to the Swauger and Lemhi quartzites by Anderson (1961), the Gunsight Formation and unassigned quartzite and siltite units by Staatz (1973, 1979), and the Gunsight and Apple Creek Formations of Ruppel's (1975) Lemhi Group by Evans and Green (2003). All are very fine- to medium-grained quartzite, siltite, and argillite, but vary in details of bedding character and sedimentary structures. In this region, we previously followed revised stratigraphic nomenclature (Burmester and others, 2013, 2016b) that uses the coarsest unit, the Swauger Formation, to distinguish otherwise similar rocks that occur above and below it. Rocks with abundant spherical, medium, quartz grains occur in the Bannock Pass quadrangle. Such grains are rare in Lemhi Group units below the Swauger but common in and characteristic of it and the overlying Lawson Creek Formation. They are also reported in the Lake Mountain member of the Apple Creek Formation in the Salmon River Mountains (Gunsight Formation of Tysdal, 2003), and observed in the diamictite member of the Apple Creek Formation west of Hayden Creek in the northern Lemhi Range. Furthermore, chert occurs in most of the units in this quadrangle but not in Lemhi Group strata. Thus, none of the units in this quadrangle are likely in the Lemhi Group. However, the great differences between the units mapped here and units above the Swauger elsewhere make correlations uncertain. Therefore, we use local informal names for these units as we did on the west-adjacent Goat Mountain quadrangle (Lewis and others, in review), but speculate on correlations and structural interpretations based on lithologic characteristics.

STRUCTURE

Pre-Tertiary sedimentary rocks in the Bannock Pass quadrangle form a broad east- to southeast-dipping homocline with superimposed open, upright, north–northwest-trending folds. North to north–northwest-striking, steeply to moderately west-dipping cleavage is common in Mesoproterozoic units, and may be axial planar to these folds. Paleozoic sedimentary rocks rest in angular unconformity on €Yqgh, the quartzite of Grizzly Hill, demonstrating that tectonism and erosion occurred sometime between the Mesoproterozoic and the Devonian (see cross section B–B'). This is significant because Neoproterozoic-early Paleozoic tectonism has yet to be incorporated into mainstream orogenic models for the Rocky Mountains of Idaho and Montana (Dickinson, 2006; Yonkee and Weil, 2015). Confirmation that €Yqgh is indeed Cambrian would further constrain this tectonism to the Cambrian through Silurian Periods. Further evidence of early Paleozoic tectonism includes the Cambrian to Ordovician intrusions identified in the region (Evans and Green, 2003; Gillerman and others, 2010) and detrital zircon evidence for their rapid unroofing (Todt and Link, 2013; Link and others, 2017).

Pre-Tertiary rocks are also cut by a complex array of faults (see cross section A–A'). Relatively minor northwest-striking faults are subordinate to more major northeast- to east-striking faults. The most significant of these form a graben filled with Tertiary volcanic and sedimentary rocks that extends northeast from the west-adjacent Goat Mountain quadrangle (Lewis and others, in review). These faults, which include high-angle extensional faults, the low-angle Goat Mountain normal fault, and possibly the eastern extension of the Peterson Creek fault (Lewis and others, in review), probably have long and complex histories with multiple episodes of opposing movement. Lewis and others (in review) show the high-angle extensional faults as younger than both the Peterson Creek fault and the Goat Mountain low-angle normal fault, but poor exposures in the Bannock Pass quadrangle provide no proof. In our map interpretation, no faults appear to be younger than unit Tsc (Miocene), though little field evidence exists. The eastern range front does not appear to be fault-controlled. Instead, knobs of pre-Tertiary bedrock poke through the Tertiary sediments across the map, suggesting considerable Tertiary topographic relief.

CENOZOIC SEDIMENTARY ROCKS

Qal **Alluvium (Holocene)**—Modern stream and floodplain deposits. As much as 100 m (328 ft) thick.

Qalo **Older alluvium (Holocene and Pleistocene)**—Stream and floodplain deposits that are above the modern floodplain. Includes glacial outwash gravels, subrounded to rounded, well-sorted sandy cobble to boulder, gravel, and sand. Thickness unknown, but probably less than 150 m (490 ft).

Qls **Landslide deposits (Quaternary)**—Unsorted, unconsolidated sediments that slid downhill to form hummocky topography (fig. 1). Typically formed in ashy Renova Formation sediments.

QTgr **Gravel lag deposit (Miocene or younger)**—Pebble to cobble gravel. Unsorted, angular to well-rounded clasts of quartzite, granite gneiss, chert, basalt, and sandstone. In the south half of the quadrangle, QTgr appears to be a lag deposit that sits on the unconformity between Tsc and Treu. Generally 1 m (3 ft) thick or less.

Tsc **Sixmile Creek Formation (Miocene)**—Mudstone, siltstone, sandstone with gravel lenses. Gravel is dominant in the northern half of the quadrangle. Finer sediments are strongly bioturbated and have a distinctive pinkish color (5YR 7/2 grayish orange pink to 5YR 8/4 orange pink according to the Munsell soil color chart) and are finely laminated. Barnosky and others (2007) recognized aeolian, fluvial, and mudflow layers. A rich vertebrate fauna from the south side of Bannock Pass has North American Land Mammal ages of Hemingfordian and Barstovian (middle Miocene; Barnosky and others, 2007; Harris and others, 2017). Tsc overlies Treu on an angular unconformity that Harris and others (2017) have established as spanning ca. 21.5 to 21.4 Ma. Equivalent to Tm of M'Gonigle (1994) and M'Gonigle and Halt (1997), but not Tsc of M'Gonigle (1994). Equivalent to the Sediments of Bannock Pass of Vandenberg (1997) and Sequence 4 of Hanneman and Wideman (1991). Thickness as much as 600 m (1,970 ft).

Ts **Clastic sediments (Tertiary)**—Unconsolidated deposit of cobbles and pebbles of uncertain age capping the ridge north of Little Eightmile Creek at the west edge of the map. Thickness unknown, but probably less than 60 m (197 ft).

Tgr **Gravel (Tertiary)**—Immature Belt quartzite and siltite cobble to boulder gravel, poorly exposed as lag or residual, locally with fine gray or red matrix. Clasts are mostly angular, but some are subrounded. Local cobbles and boulders of cemented quartzite breccia. The monolithic nature of the clasts makes it difficult to distinguish Tgr from Mesoproterozoic bedrock. Stratigraphic position is only known as above €Yqgh. Here we present Tgr as below Tsc, though the contact between the two is not clear. If Tgr is above Tsc, it may be equivalent to QTgr.

Treu **Upper Renova Formation (Late Eocene–Oligocene)**—Gray to white mudstone and siltstone with sand and gravel lenses and thin tuff layers. Strongly bioturbated, poorly lithified and prone to slumping. Gravel is dominated by Mesoproterozoic quartzite cobbles. Zircons from tuff layers have U-Pb ages of 22.65 ± 0.37 Ma and 21.24 ± 0.27 Ma (Harris and others, 2017). Fossils from the unit have Arikareean North American Land Mammal ages (Fields and others, 1985; Barnosky and others, 2007; Harris and others, 2017). Treu is equivalent to the "Sediment of Everson Creek" of Vandenburg (1997), Tsc of M'Gonigle (1994), and Sequence 3 of Hanneman and Wideman (1991). Vandenburg and others (1998) reported a thickness of 1,400 m (4,595 ft).

Trel **Lower Renova Formation (Middle Eocene)**—Multicolored massive chert with conglomerate lenses exposed along Black Canyon. Represented by angular clasts and slabs of chert in float. Chert colors include white, pale pink, maroon, deep red, and black. Locally appears to be silicified limestone, some of which is fossiliferous. The age of the unit is established by the presence of the Middle Eocene gastropod *Gyraulus proceras* (Vandenburg, 1997) and by a $^{40}Ar/^{39}Ar$ age of 47.56 ± 0.59 Ma for interlayered volcanic breccia north of the Bannock Pass quadrangle (Vandenburg and others, 1998). Trel is equivalent to the "Sediment of Bear Creek" of Vandenburg (1997), and sequences 1 and 2 of Hanneman and Wideman (1991). Vandenburg and others (1998) estimated a thickness as much as 1,900 m (6,235 ft).

Tcgo **Conglomerate, older (Eocene?)—**Poorly sorted, angular to rounded, pebble to boulder gravel. Clasts are dominantly Belt quartzite, but include uncommon rounded basalt pebbles. Occurs as lenses underlying the Challis Volcanic Group. Equivalent to Tcg_1 on the west-adjacent Goat Mountain quadrangle (Lewis and others, in review).

CHALLIS VOLCANIC ROCKS

The mapped volcanic stratigraphy was based on previous work by Staatz (1972), Vandenburg (1997), and Burmester and others (2018).

Tqs **Quartz-sanidine tuff (Eocene)**—White weathering rhyolitic ash flow tuff. Contains abundant quartz crystals and sparse, euhedral to subhedral phenocrysts of sanidine and biotite. Matrix is composed of poorly sorted ash and lapilli with no evidence of welding. A sample collected in the headwaters of Nip and Tuck Creek (BP-07) yielded a U-Pb zircon age of 44.2 ± 0.4 Ma (table 1). Thickness estimated to be 60–85 m (200–280 ft).

Tt **Andesitic tuff (Eocene)**—Volcaniclastic tuff intercalated with mafic lava flows (Tlm) that exhibits a wide range of crystal, lithic, and vitric fragments. Phenocrysts are mainly pyroxene with subordinate quartz, feldspar, and biotite. Generally well sorted and thinly laminated to thin bedded. Likely an andesitic air-fall tuff deposit with some fluvial reworking. Thickness as much as 50 m (165 ft).

Tvc **Volcaniclastic conglomerate (Eocene)**—Massive, poorly sorted volcaniclastic conglomerate intercalated with mafic lava flows (Tlm). Contains clast-supported, subangular to angular pebbles, cobbles, and boulders (up to ~35 cm). Most clasts are fragments of mafic lava and plagioclase-hornblende porphyry. The matrix is a gray muddy ash containing abundant granule-size volcanic clasts. Likely a lahar deposit. As thick as 50 m (165 ft).

Tlm **Mafic lava (Eocene)**—Black to dark green-gray or dark brown-black aphanitic to porphyritic lava flows that are commonly autobrecciated. Phenocrysts are primarily plagioclase, pyroxene, and olivine, with minor amounts of hornblende. Secondary chalcedony and calcite are common. Chemical analysis shows SiO_2 contents that range from 48.1–66.1 wt percent and Na_2O+K_2O contents of 4.1–7.6 wt percent (table 2). Flows are intercalated with andesitic tuff (Tt) and volcaniclastic conglomerate (Tvc). As thick as 600 m (2,000 ft).

Tdl **Dacite lava (Eocene)**—gray to pink weathering porphyritic lava flows that are autobrecciated locally. Phenocrysts are primarily plagioclase and subordinate hornblende and pyroxene. A sample collected in the upper reaches of Nip and Tuck Creek (BP-06; 65.3 wt percent SiO_2; table 2) yielded a U-Pb zircon age of 48.0 ± 0.4 Ma (table 1). Minimum thickness estimated to be 60 m (200 ft).

Td **Dacite intrusion (Eocene)**—Brecciated and intensely weathered, gray, dark gray, or hematitic red intrusions containing phenocrysts of plagioclase with minor biotite and altered hornblende. Poorly exposed. An outcrop north of Nip and Tuck Creek (BP-02; 70.3 wt percent SiO_2; table 2) yielded a U-Pb zircon age of 48.7 ± 0.4 Ma (table 1).

PALEOZOIC SEDIMENTARY ROCKS

IPsc **Snaky Canyon Formation (Permian)**—Medium to light gray decimeter- to meter-scale bedded limestone and dolomite with interbedded gray to red-gray centimeter-bedded, fine-grained, calcareous sandstones to siltstones. The limestones and dolomites are sandy to silty throughout much of the formation, and locally contain abundant dark gray nodular to irregularly bedded chert. Top not exposed in the map area.

IPMbmb **Bluebird Mountain and upper Big Snowy/Railroad Canyon Formations, undivided (Permian to Mississippian)**—The upper part (Bluebird Mountain equivalent) consists of approximately 150 m (490 ft) of gray, decimeter- to centimeter-bedded, slightly to highly calcareous, fine-grained, quartzitic sandstone with minor gray, decimeter- to centimeter-bedded limestone. Limestone locally contains crinoid and other fossil fragments, black nodular chert up to 4 cm in diameter, and centimeter-bedded, gray, sandy limestone with an orange weathering rind. Basal 10 m is distinctive, with resistant sandy limestone and recessive limestone rhythmically bedded on a centimeter scale. Lower part (upper Big Snowy or Railroad Canyon equivalent) is approximately 150 m (490 ft) of mostly medium to dark gray to green gray, centimeter-bedded limestone. These formations are mapped undivided because outcrop in much of the map area is very discontinuous and the distinctive beds at the base of the Bluebird Mountain Formation do not crop out well. Thickness approximately 300 m (985 ft).

Mbss **Big Snowy Formation, basal siltstone and shale (Mississippian)**—Grayish red to purple siltstone to claystone 20 m (65 ft) thick overlain by 40 m (130 ft) of silver black to dark gray papery to highly fissile shale. Siltstone and claystone are slightly calcareous and laminated on a millimeter-scale with centimeter-scale shale interbeds near the top. Shale is calcareous to slightly calcareous, is interbedded with centimeter-thick red to orange siltstone near the top, and contains minor centimeter-scale limestone beds. Thickness 60 m (197 ft).

Msp **Scott Peak Formation (Mississippian)**—Medium to dark gray fossiliferous limestone, dolomitic limestone, and brownish gray siltstone. Bedding is on a decimeter- to meter-scale, with the lowest bed being meter-thick fossiliferous limestone. Black to dark gray chert beds 5 to 15 cm thick present in the upper and lower portions of the formation. Fossils include crinoids, horn corals, bryozoans, brachiopods, and cephalopods. These are best preserved in the middle part of the unit, whereas fragmental fossils are more common in the upper and lower parts. Unit, particularly the middle part, forms prominent cliffs and ledges. Upper contact not exposed. Thickness estimated at 1,200 m (3,940 ft).

Mmc **Middle Canyon Formation (Mississippian)**—Medium to very dark gray limestone and dolomite with abundant black chert nodules, thin black discontinuous chert beds, and thin tan platy siltstone. Bedding in limestone is on a centimeter- to decimeter-scale. Chert nodules as large as 6 cm in diameter and chert beds are less than 4 cm thick. Unit is not fossiliferous with the exception of one bed (10 cm thick), near the top of the formation, which contains crinoid columns as much as 1 cm in diameter. Lower part is composed of alternating dolomite, chert, and limestone; middle part of millimeter-laminated platy calcareous siltstone and silty limestone; and upper part of interbedded limestone, dolomitic limestone, siltstone, and chert. Weathers to a slope littered with dark chert. Contact with the overlying Scott Peak Formation is gradational and is placed at the lowest 1-m-thick ledge of fossiliferous limestone. Thickness approximately 200 m (656 ft).

Mmg **McGowan Creek Formation (Mississippian)**—Dark gray siltstone, shale, cherty shale, and tan calcareous siltstone to shale. Millimeter-scale lamination. Weathers to subdued slopes. A fissile thin-bedded black shale locally occurs near the base. Thickness greater than 60 m (197 ft).

MDss **Sandstone and conglomerate (Devonian to Mississippian)**—Golden orange to tan and gray sandstone, conglomeratic sandstone, and minor conglomerate present locally at base of Paleozoic section. Typically poorly sorted and matrix supported. Includes massive sandstones to thin conglomeratic lag deposits. Angular clasts as large as 3 cm in diameter are present at some horizons in clast-supported conglomerate. Locally dolomitic or calcareous. Moderately cemented with rare beds of well-sorted quartzite as much as 50 cm thick. Clasts consist entirely of underlying Mesoproterozoic quartzite. Upper part of unit locally contains thin beds or rip-up horizons of carbonate similar to overlying carbonate units. Forms cliffs and large float boulders. Contact of this onlap sandstone and conglomerate unit with overlying units is gradational. Thickness as much as 30 m (98 ft).

Dj **Jefferson Formation (Devonian)**—Dark gray massive to meter-scale bedded dolomite with faint millimeter-scale internal laminations. Locally contains sedimentary breccia. Fetid odor on fresh surfaces; not fossiliferous. Weathers to low ledges and subdued slopes. Contact with overlying McGowan Creek Formation placed at the top of the highest dolomite ledge. Thin-bedded silty limestones of the Three Forks Formation were not noted between the McGowan Creek and Jefferson Formations. Thickness approximately 40 m (131 ft).

CAMBRIAN AND MESOPROTEROZOIC STRATA

€Yqgh **Quartzite of Grizzly Hill (Cambrian and/or Mesoproterozoic)**—Red to light gray, thin- to thick-bedded, very fine- to medium-grained quartzite and minor siltite and argillite. Prominent crossbeds and ripples are common. Most is a poorly sorted mix of angular and rounded quartz grains. Contains rare chert grains. Hand samples appear feldspar-poor (atypical for Belt quartzites); four slabbed and stained samples contained an average of 87 percent quartz, 5 percent potassium feldspar, and 8 percent plagioclase. Stratigraphically overlies unit Ysyc, but the contact is everywhere covered by quartzite rubble. Texturally and compositionally similar to Cambrian quartzite mapped in the southern Pioneer Mountains 70 km (43 mi) to the north (Lonn and Lewis, 2012; McDonald and Lonn, in review; McDonald and Yakovlev, 2019). Features tentatively interpreted as trace fossils were observed in the southern part of the map, also suggesting a Cambrian age. Alternatively, could be a correlative of the Jahnke Lake member of the Apple Creek Formation if underlying Ysyc is Lawson Creek Formation. Lower contact with Ysyc is covered. Upper contact is an angular unconformity with various Mississippian and Devonian sedimentary units (see Stratigraphic section above). Detrital zircon data are ambiguous. A plot of sample 17DS24 (44.78650, -113.31474; location shown on map; plot shown in fig. 2) analyzed by Paul Link, Idaho State University, shows prominent peaks at 1720 and 1440 Ma, which are typical of Mesoproterozic Lemhi strata (Link and others, 2016). However, a similar age distribution was obtained (Link and others, 2016) for the Quartzite of Grace Lake in the northern Pioneer Mountains that is interpreted to be Cambrian (McDonald and others, 2012). Thickness uncertain due to faulting and lack of upper and lower contacts in the same section, but is likely to be more than 1,000 m (3,280 ft).

Ysyc **Siltite of Yerian Creek (Mesoproterozoic)**—Thinly bedded siltite and argillite, and white to gray green quartzite. Characterized by undulating, graded, non-cracked couplets (centimeter-scale) and rarer couples (decimeter-scale) of medium green siltite and light green to light gray argillite. Angular light-colored mud chips are common in bases of beds along with well-rounded fine, medium, and coarse quartz grains in dark green channels a few centimeter wide and as thick as 1 cm. Mud-cracked bedding surfaces much less common. Contains uncommon chert rip-ups and rare thin chert beds. Also contains intervals from 1 to 200 m (3 to 656 ft) thick composed of gray, fine- to very fine-grained, thick-bedded to massive, well-sorted quartzite. Three slabbed and stained samples of this fine-grained quartzite averaged 55 percent quartz, 10 percent potassium feldspar, 30 percent plagioclase, and 5 percent biotite and sericite. Upper contact with €Yqgh is covered and possibly unconformable; lower contact not exposed. Lithologic correlation with the Lawson Creek Formation is favored because of spherical medium to coarse quartz grains, mud cracks, mud chips, and chert. Thickness estimated to be more than 2,000 m (6,560 ft).

Yqgm **Quartzite of Goat Mountain (Mesoproterozoic)**—Fine- to coarse-grained, thick- to thin-bedded quartzite. Thicker beds commonly trough cross laminated, thinner ones flat laminated or planar cross laminated. Characterized by poor sorting and well-rounded to spherical quartz grains, high potassium feldspar to plagioclase ratio, and abundant medium and coarse grains. Exposed in the Bannock Pass quadrangle only on a small fault-bounded block at the western edge of the map, but extensively exposed on the west-adjacent Goat Mountain quadrangle (Lewis and others, in review). Twenty samples described from there averaged 83 percent quartz, 5 percent plagioclase, and 12 percent potassium feldspar. Correlated with the Swauger Formation based on predominance of medium quartz grains and potassium feldspar in excess of plagioclase (Burmester and others, 2016b), although it is finer grained and thinner bedded than that to the north (Burmester and others, 2016a). An interbedded tuff on the Goat Mountain quadrangle was dated at 1385.4 ± 9.3 Ma (Jesse Mosolf, written communication; see Lewis and others, in review, for more details). Thickness unknown due to structural complexities.

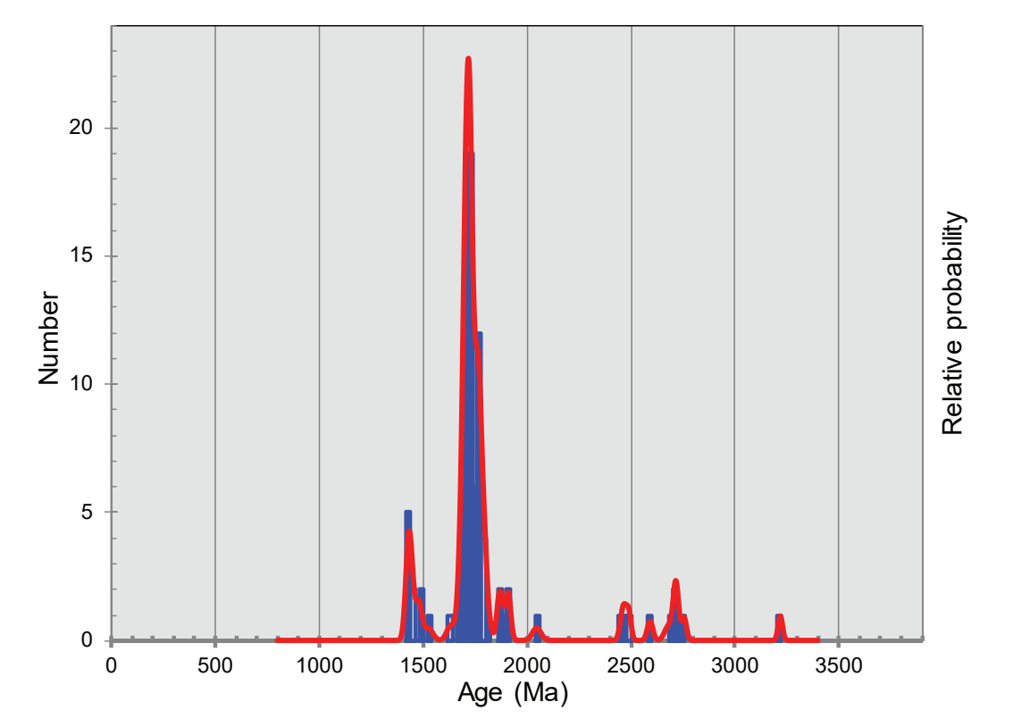


Figure 2. Histogram and probability density curves of detrital zircon ages from quartzite sample 17DS24. Analyses were acquired at the Arizona LaserChron Center using laser ablation-multicollector-inductively coupled plasma-mass spectrometry. Analyzed by Paul Link, Idaho State University.

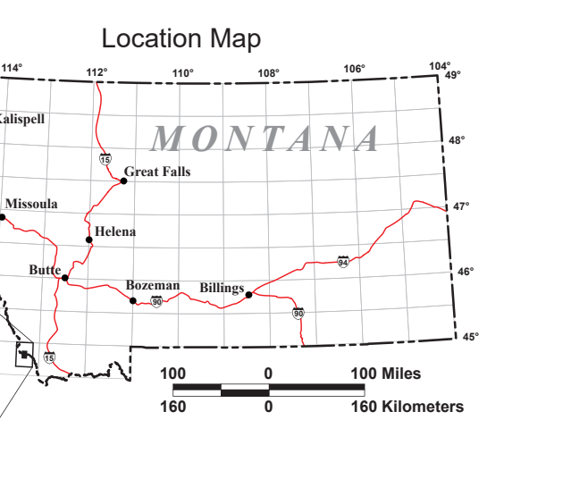


Table 1. U-Pb LA-ICP-MS geochronology.

Sample	Lithology	Unit	Latitude	Longitude	Age (Ma)	2σ	MSWD
BP-02	Dacite intrusion	Td	44.8456	-113.3305	48.7	0.4	1.0
BP-06	Dacite lava	Tdl	44.8238	-113.3653	48.0	0.4	1.2
BP-07	Quartz-sanidine tuff	Tqs	44.8251	-113.3683	44.2	0.4	1.3

Note. Reported ages are the weighted mean of $^{206}Pb/^{238}U$ ages obtained for each sample. MSWD is the mean Mean Square Weighted Deviation. Zircon separates were prepared at the MBMG and analyzed at the University of California, Santa Barbara by Jesse Mosolf. Latitudes and longitudes are in the 1984 World Geodetic Survey (WGS84) datum.

Table 2. Bulk rock geochemistry.

Sample ID	BP-01	BP-02	BP-03	BP-05	BP-06	BP-08
Map unit	Tlm	Td	Tlm	Tlm	Tdl	Tdl
Lithology	Trachydacite lava	Rhyolite intrusion	Trachydacite lava	Basalt lava	Trachydacite lava	Dacite lava
Latitude	44.8512	44.8456	44.8458	44.8592	44.8238	44.8272
Longitude	-113.3361	-113.3305	-113.3389	-113.3282	-113.3653	-113.3707
Major elements (wt %)						
SiO_2	66.1	70.3	64.4	48.1	65.3	62.0
TiO_2	0.6	0.5	0.6	0.5	0.7	0.7
Al_2O_3	15.8	14.0	16.2	8.2	16.2	15.9
FeO*	3.7	2.4	4.1	8.1	3.5	5.5
MnO	0.0	0.0	0.1	0.1	0.0	0.1
MgO	0.8	0.7	1.3	21.2	0.6	2.9
CaO	3.2	2.8	3.7	6.3	3.7	5.1
Na_2O	4.0	3.5	3.6	1.3	3.9	3.7
K_2O	3.6	3.2	4.0	2.8	3.8	2.2
P_2O_5	0.2	0.2	0.3	0.4	0.2	0.2
Sum	98.1	97.6	98.1	97.0	97.9	98.3
LOI	1.2	1.7	1.4	2.2	1.6	1.3
Trace elements (ppm)						
Ni+	10.1	18.3	6.5	837.3	20.7	18.8
Cr+	21.5	32.7	13.7	1727.6	76.3	45.9
V+	61.9	59.5	57.9	138.6	79.6	101.9
Ga+	19.9	18.1	19.6	10.3	20.3	18.9
Cu+	21.0	19.0	29.3	58.2	54.4	23.4
Zn+	56.2	48.6	67.0	62.5	40.8	68.8
La	70.9	59.1	77.6	25.8	79.6	54.0
Ce	125.1	108.9	141.6	53.3	134.4	98.1
Pr	13.9	11.7	15.4	6.8	15.2	11.0
Nd	46.9	40.4	52.4	27.3	51.5	38.9
Sm	7.6	6.7	8.5	6.0	7.9	6.6
Eu	1.6	1.4	1.7	1.4	1.8	1.7
Gd	5.1	4.8	6.0	4.7	5.4	5.1
Tb	0.7	0.7	0.9	0.7	0.8	0.8
Dy	3.9	3.7	4.9	3.5	4.2	4.2
Ho	0.7	0.7	1.0	0.7	0.8	0.8
Er	1.9	2.0	2.6	1.7	2.2	2.2
Tm	0.3	0.3	0.4	0.2	0.3	0.3
Yb	1.8	1.8	2.4	1.4	2.2	2.0
Lu	0.3	0.3	0.4	0.2	0.4	0.3
Ba	1629.4	1527.5	1568.3	1042.7	1679.0	1191.3
Th	19.4	16.5	20.8	8.4	21.5	12.8
Nb	24.1	19.1	24.8	7.1	26.4	14.3
Y	19.4	20.9	25.6	16.5	21.8	21.4
Hf	7.9	6.6	8.1	3.5	8.9	5.9
Ta	1.6	1.3	1.7	0.4	1.7	0.9
U	3.5	3.1	4.7	1.8	4.4	2.0
Pb	26.7	24.1	28.1	11.2	31.2	17.7
Rb	121.8	109.2	138.1	86.0	134.4	84.4
Cs	1.6	1.7	3.8	4.0	2.7	1.4
Sr	653.4	564.0	591.9	483.1	651.9	573.0
Sc	6.1	5.8	6.1	20.4	8.7	12.5
Zr	312.6	257.7	317.8	132.6	352.1	233.7

Note. Lithology abbreviations: And, andesite, Ba, basalt, Da, dacite, TAnd, trachyandesite. All major elements and trace elements denoted by + were analyzed by XRF, all other trace elements were measured by ICP-MS. FeO* indicates all Fe expressed as Fe^{2+}. LOI is loss on ignition. All samples analyzed by X-ray fluorescence (XRF) and inductively coupled plasma-mass spectrometry (ICP-MS) at the Peter Hooper GeoAnalytical Lab, Washington State University. Datum used for sample coordinates is World Geodetic Survey 1984 (WGS84).

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Figure 1. Quaternary landslides create hummocky topography (middle distance) in the southeast corner of the Bannock Pass quadrangle.

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Geologic Map of the Bannock Pass 7.5' Quadrangle, Beaverhead County, Montana, and Lemhi County, Idaho

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