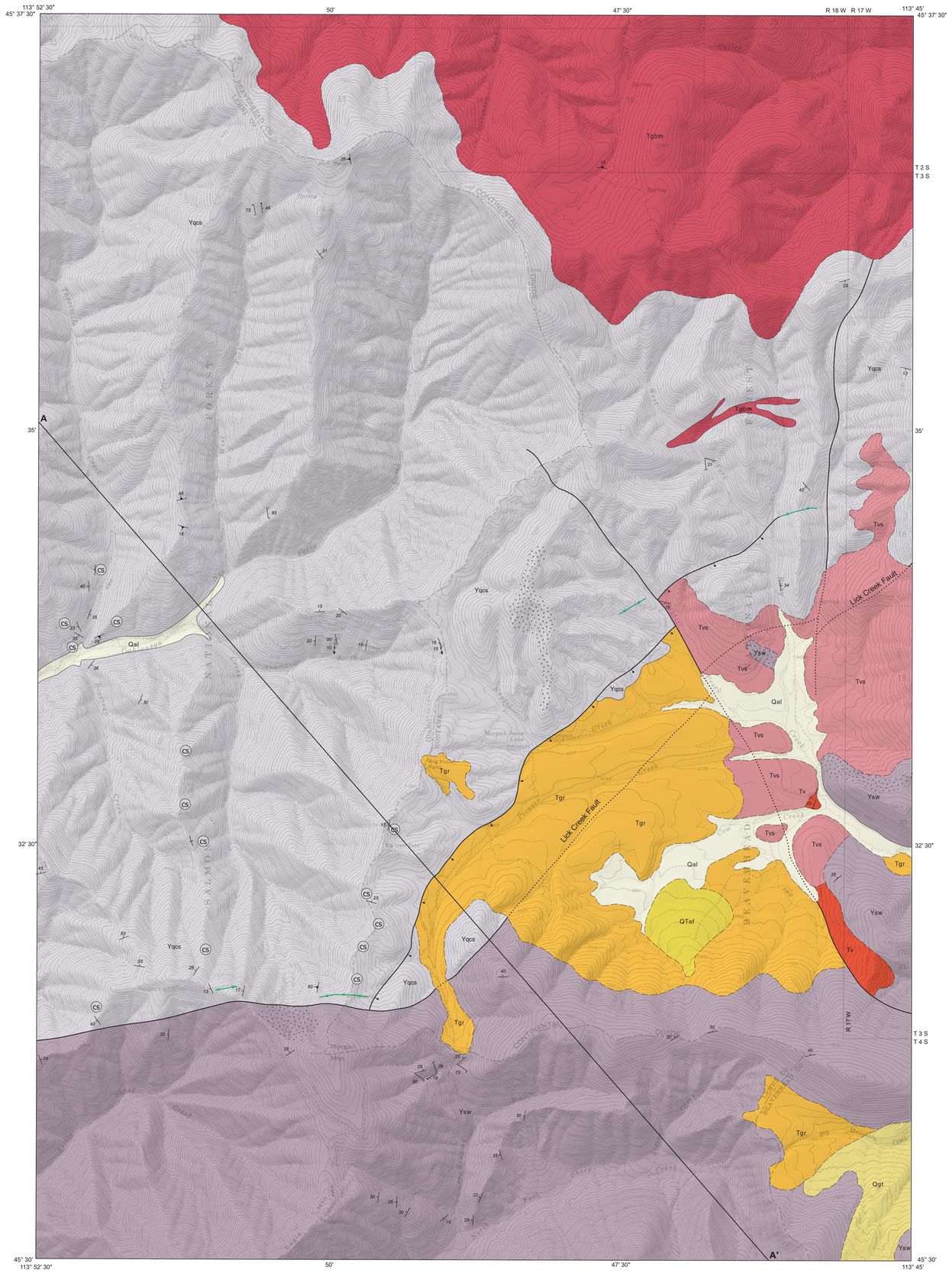


Base map produced by the United States Geological Survey
Big Hole Pass 1:24,000-scale quadrangle map
Control by: USGS and NOS/NOAA
Compiled from aerial photographs taken 1965
Field checked: 1966
Projection: Transverse Mercator, zone 12
Vertical Datum: National Geodetic Vertical Datum of 1929
Horizontal Datum: 1927 North American Datum

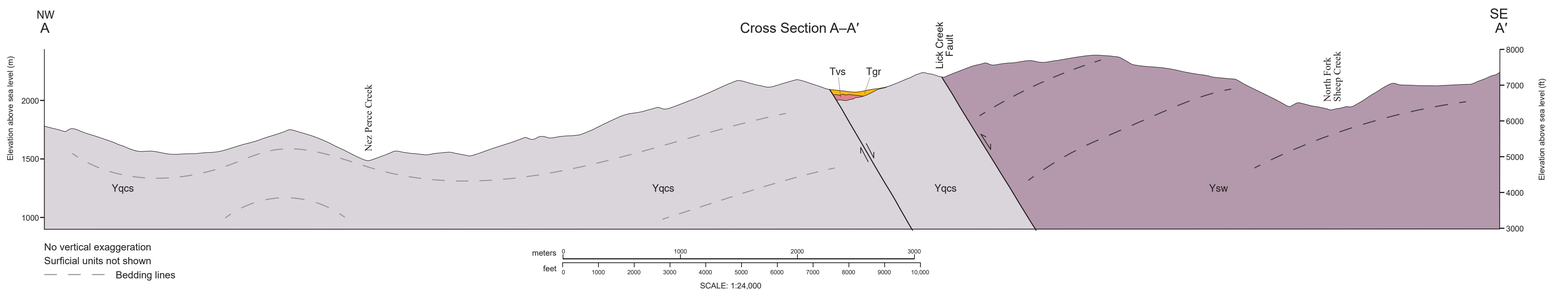
Shaded relief created from 10-meter digital elevation model from U.S. Geological Survey National Elevation Dataset.

UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
MN
GN
2°1′
36 MILS
12°45′
227 MILS

SCALE 1:24,000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

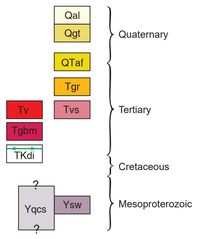
Maps may be obtained from:
Publications Office
Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
Phone: (406) 496-4174

This map can be downloaded in PDF format from www.idahogeology.org and www.mbmg.mtech.edu.



No vertical exaggeration
Surficial units not shown
— — — Bedding lines

CORRELATION DIAGRAM



MAP SYMBOLS

- Contact: dashed where approximately located
- Normal fault: dotted where concealed, bar and ball on downthrown side
- TKdi dikes
- Brecciated area
- Calc-silicate
- Inclined bedding—Showing strike and dip
- Vertical bedding—Showing strike
- Inclined bedding, where top direction of beds is known from sedimentary structures—Showing strike and dip
- Inclined cleavage (generic or type unspecified)—Showing strike and dip
- Inclined metamorphic or tectonic foliation—Showing strike and dip
- Inclined metamorphic or tectonic foliation parallel to bedding—Showing strike and dip
- Inclined fold hinge of generic (type or orientation unspecified) small, minor fold—Showing bearing and plunge

Symbols for locations with multiple measurements

- Inclined bedding—Showing strike and dip
- Inclined bedding where top direction of beds is known from sedimentary structures—Showing strike and dip
- Inclined cleavage (generic or type unspecified)—Showing strike and dip
- Vertical cleavage (generic or type unspecified)—Showing strike

Introduction

The Big Hole Pass 7.5′ quadrangle map continues detailed 1:24,000-scale geologic mapping in the Wisdom 30′ x 60′ quadrangle, a long-term Montana Bureau of Mines and Geology (MBMG) STATEMAP program goal to fill remaining gaps in the 1:100,000-scale geological coverage of Montana. It also continues a long-term collaboration between the MBMG and the Idaho Geological Survey (IGS) to reconcile conflicting stratigraphic and structural interpretations across the Montana–Idaho border. Not only were existing maps incongruous, but they predated the current understanding of Mesoproterozoic stratigraphy developed by the MBMG–IGS team. The Big Hole Pass quadrangle is near the northern end of the Beaverhead Mountains that contain poorly known Mesoproterozoic Belt Supergroup strata. This map area was chosen to further our understanding of regional Mesoproterozoic stratigraphic relationships and to provide insight into the Cretaceous–Tertiary tectonic regime that affected these strata.

Previous Work

The entire quadrangle was mapped at the 1:250,000-scale by Ruppel and others (1993). The Idaho part was mapped at the 1:100,000-scale by Evans and Green (2003) and at 1:40,000-scale by Stewart and others (2014). Lopez and others (2005) mapped the Montana part at 1:48,000-scale and modeled the area as a Cretaceous metamorphic core complex (O'Neill, 2005). All four previous maps interpret the Mesoproterozoic stratigraphy differently, and therefore all also disagreed on the structural geology.

Geologic Summary

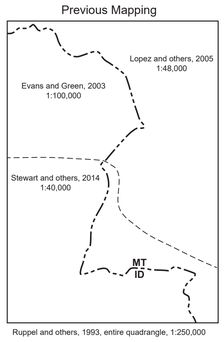
The Big Hole Pass quadrangle and the entire northern Beaverhead Mountains are dominated by strata correlated with rocks of the Lemhi subbasin, a southern arm of the Belt Basin characterized by sandy strata (Burmester and others, 2016; Lonn and others, 2020, 2023). Two Mesoproterozoic units are identified: fine- to coarse-grained quartzite of the Swauger Formation (Ysw) and a thinner bedded, finer grained quartzite, siltite, and argillite unit (Yqcs) that also contains calc-silicate intervals as much as 10 m (33 ft) thick. The two units are separated by a fault that crosses the quadrangle from east to west, named the Lick Creek fault by Stewart and others (2014). We are uncertain whether Yqcs lies stratigraphically above or below Ysw. Sense of movement, dip, and age of the Lick Creek fault remain unknown. Stewart and others (2014) postulated that it is offset northward and then continues west as the Cool Gulch fault on the northwest-adjacent Lost Trail Pass 7.5′ quadrangle (Stewart and others, in preparation). Diorite dikes (TKdi) occur in proximity to the fault. Strata on both sides of the fault are mostly gently dipping, deformed into broad gentle folds (cross section A–A′), preventing exposure of significant stratigraphic sections.

In the northern part of the map, a large pluton intruded unit Yqcs and metamorphosed these strata to upper greenschist facies. Yqcs includes intervals of muscovite-biotite schist and calc-silicate interbedded within the quartzite.

The Lick Creek fault and other faults form a small basin containing Tertiary sediments unconnected to the large Big Hole Basin to the east. Two Tertiary sedimentary units are identified: a multi-lithologic, tilted older one (Tvs) and a younger gravel unit (Tgr) that appears to be nearly flat-lying. A Tertiary volcanic unit (Tv) appears to interfinger with the Tvs unit. The Tertiary sediments were extensively mined for placer gold.

Quaternary glacial till is exposed in the southeastern corner of the map.

Previous Mapping



Ruppel and others, 1993, entire quadrangle, 1:250,000

DESCRIPTION OF MAP UNITS

Quaternary and Tertiary Sedimentary Deposits

Qal **Alluvium (Quaternary: Holocene)**—Gravel, sand, silt, and clay in channels of modern streams. Clasts generally subrounded to well-rounded, resistant rock. Variable thickness, typically less than 10 m (30 ft).

Qgt **Glacial till (Quaternary: Pleistocene)**—Unsorted clay to boulder deposits in lateral, ground, and medial moraines. Characterized by hummocky terrain scattered with large subangular to subrounded boulders up to 3 m (10 ft) in diameter. Variable thickness, typically less than 60 m (200 ft).

QTaf **Alluvial fan deposit (Quaternary: Pleistocene, or Tertiary: Pliocene?)**—Poorly exposed subangular boulders and cobbles in a fan-shaped deposit in the southeastern part of the map. Clasts are quartzite derived from adjacent uplands. Thickness probably less than 15m (50 ft).

Tgr **Gravel (Tertiary)**—Poorly exposed cobble and boulder gravel in sand and silt matrix overlying Tvs, mostly occurs as lag deposits. Clasts are angular to well-rounded, and may have tan weathering rinds. Rounding appears to increase downslope. Clasts are dominated by feldspathic quartzite, but include argillite, schist, gneiss, and white quartzite. Characterized by smooth rounded topographic surfaces. May be equivalent to Miocene Sixmile Creek Formation gravel and conglomerate that crops out on the east side of the Big Hole Valley (Hanneman and Nichols, 1981; Roe, 2010; Elliott, 2022). Thickness unknown, but probably less than 30 m (100 ft).

Eocene Volcanic Rocks and Related Sedimentary Rocks

Tvs **Sediments related to Lowland Creek/Challis volcanic rocks (Eocene)**—Gravel, sand, and clay with thin rhyolite layers, including rhyolite tuff and ash. Light gray, weathering to rust and tan. Clasts dominated by feldspathic quartzite but include rhyolite, conglomerate, and two-mica granite. Appears to be tilted in the quadrangle. Poor exposures prevent thickness estimates.

Tv **Lowland Creek/Challis volcanic rocks (Eocene)**—Rhyolite and dacite with abundant quartz eyes and euhedral phenocrysts of potassium feldspar, biotite, and some hornblende. Similar in lithology to the Lowland Creek Volcanic Suite, which is a southwest-trending belt of flows, tuffs, and plugs over 80 km (50 mi) long, starting north of Butte, MT. Dated at 53–48 Ma (Dudás and others, 2010; Scarberry and others, 2019). The Tv and Tvs in the Big Hole Pass quadrangle are characteristic of the edges of the Lowland Creek Volcanic Suite where thin volcanic lenses are interlayered with thicker sedimentary layers.

Tertiary and Cretaceous Plutonic Rocks

Tgbm **Granite, biotite-muscovite (Paleocene-Eocene)**—White, fine- to coarse-grained, biotite-muscovite granite and granodiorite. Othoclase and microline pheocrysts are common, and matrix grain size ranges between fine and very coarse. Accessory minerals include apatite, monaxite, zircon, and ilmenite (Desmarais, 1983). Is part of the Chief Joseph Plutonic and Metamorphic Complex of Desmarais (1983). Tgbm elsewhere in the complex has U-Pb zircon ages of 60.87 ± 0.6 Ma and 65.4 ± 3.9 Ma (Howlett and others, 2020) and $^{40}Ar/^{39}Ar$ mica cooling ages between 41 and 39 Ma (Foster and others, 2010).

TKdi **Diorite dikes (Tertiary or Cretaceous)**—Dense, medium-grained, equigranular mafic rock with plagioclase, hornblende, pyroxene, and minor quartz visible in hand sample. Dikes occur in proximity to and along the Lick Creek fault. Forthcoming age data are expected to help constrain the fault's age. Several dikes have been prospected.

Mesoproterozoic Units

Yqcs **Quartzite and calc-silicate (Mesoproterozoic)**—Dominantly gray, flat-laminated, very fine- to fine-grained quartzite in centimeter- to meter-thick beds separated by thin muscovite-biotite schist skins. Metamorphism and deep weathering have obscured original sedimentary structures in most exposures, but heavy mineral lamination and crossbedding are preserved in less weathered exposures along the state line in the northwest corner of map. Includes intervals of interbedded, thinly layered quartzite and muscovite-biotite schist. Also contains local calc-silicate intervals as much as 10 m (33 ft) thick with centimeter-scale layering that contain abundant actinolite, plagioclase, and local scapolite. Calc-silicate beds are restricted to the southwestern part of the map, with observed locations designated by CS. Yqcs is equivalent to the quartzite, siltite, and calc-silicate unit (Ydc) of Stewart and others (2014), and also occurs on the northwest-adjacent Lost Trail Pass 7.5' quadrangle (Stewart and others, in preparation). Its contact with the Swauger Formation (Ysw) is everywhere a fault, leaving stratigraphic position unknown. Resembles the Apple Creek and Lawson Creek Formations, undivided, in the eastern part of the Wisdom 30′ x 60′ quadrangle (Elliott and others, in preparation), except lacks the intervals of diagnostic coarse-grained quartzite. The Lemhi Group (Ruppel, 1975), which underlies the Swauger Formation and lacks coarse-grained quartzite, is an alternative correlative. Poor exposure and folding preclude thickness estimates, but possibly over 1 km (3,280 ft) thick (Stewart and others, 2014).

Ysw **Swauger Formation (Mesoproterozoic)**—White to light gray, dominantly medium-grained quartzite in beds 75–150 cm (2.5–4.9 ft) thick. Although grain-size varies from fine to coarse, it is typically well-sorted. Thin skins of siltite and argillite commonly separate beds. Distinguished from Yqcs by its slightly coarser grain size, thicker beds, and lack of interbedded muscovite-biotite schist and calc-silicate. Approximately 3,400 m (11,155 ft) thick in the Allan Mountain quadrangle 10 km (6.2 mi) to the west (Stewart and others, 2014).

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MBMG Montana Bureau of Mines and Geology
IDAHO GEOLOGICAL SURVEY

MBMG Geologic Map 94
IGS Digital Web Map 226

Geologic Map of the Big Hole Pass 7.5′ Quadrangle, Southwestern Montana and Eastern Idaho

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