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Geologic Map of the Homer Youngs Peak Quadrangle, Lemhi County, Idaho and Beaverhead County, Montana

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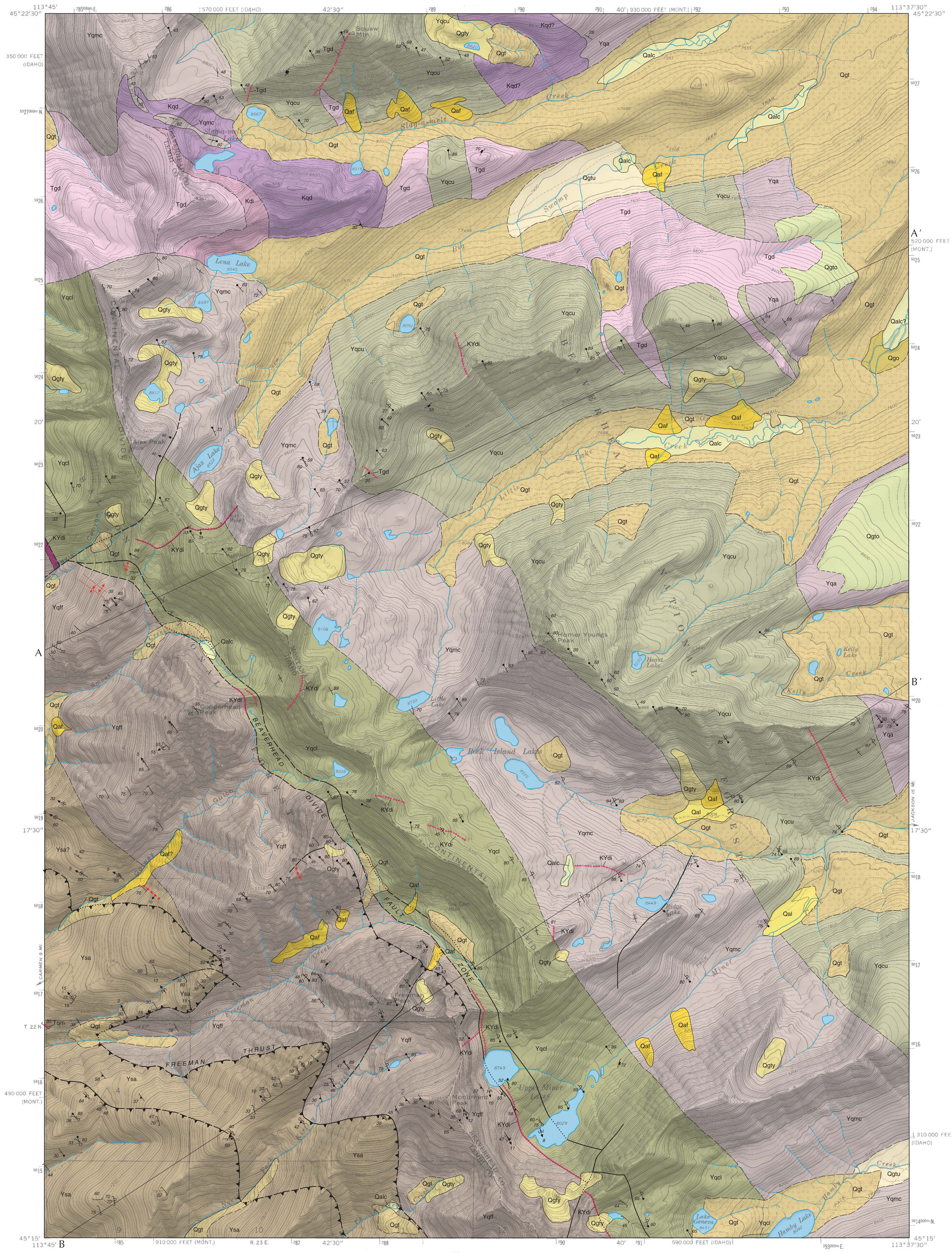
2008



Base map scanned from USGS film positive, 1966.
Shaded elevation from 10 m DEM, vertically exaggerated 2x.
Topography by photogrammetric methods from aerial photographs taken 1963. Field checked 1966.
Polyconic projection. 1927 North American Datum.
10,000-foot grid ticks based on Montana coordinate system, south zone, and Idaho coordinate system, central zone.
1000-meter Universal Transverse Mercator grid ticks, zone 12.

SCALE 1:24,000

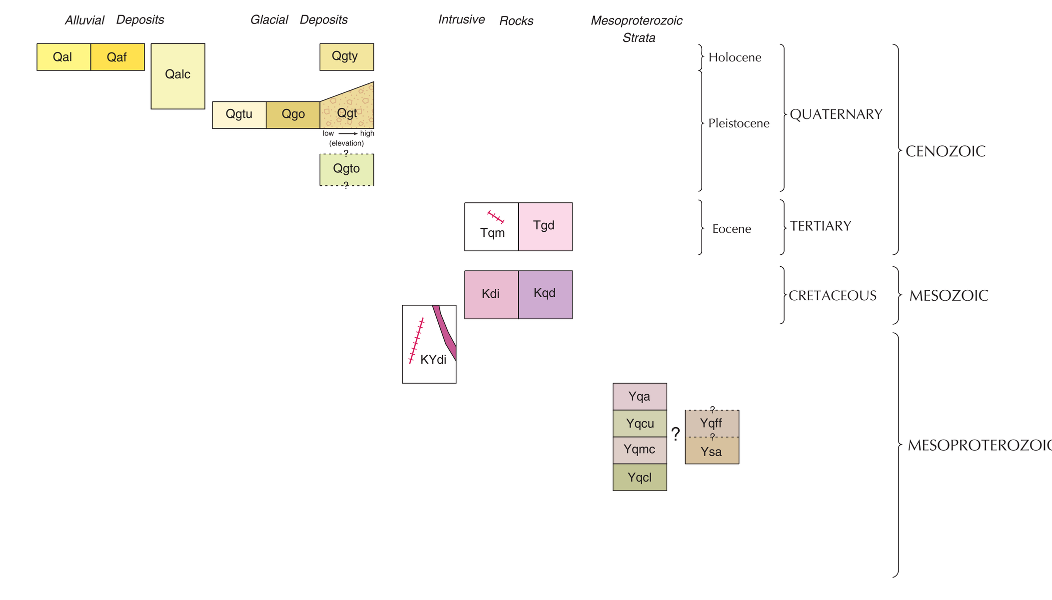
Contour interval 40 feet

QUADRANGLE LOCATION

ADJOINING QUADRANGLES

[1]Montana Bureau of Mines and Geology
[2]Idaho Geological Survey
Field work conducted 2007.
This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program, USGS Award No. 07HQAG0070.
Digital cartography by Loudon R. Stanford and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.
Note on printing: The map is reproduced at a high resolution of 600 dots per inch. The inks are resistant to run and fading but will deteriorate with long-term exposure to light.
Map version 6-19-2008.
PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.

CORRELATION OF MAP UNITS



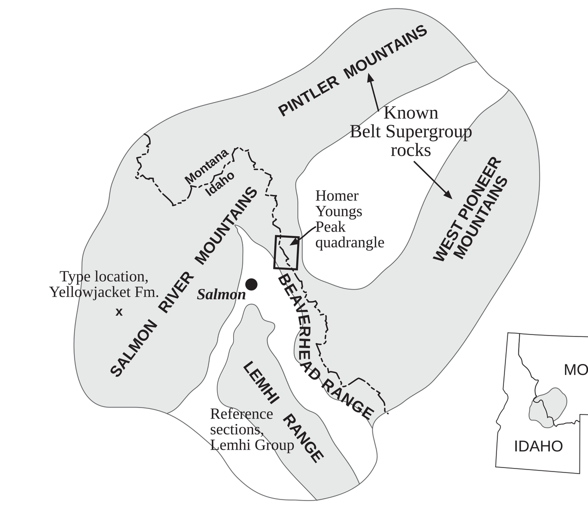


Figure 1. Location of Homer Youngs Peak 7.5' quadrange with respect to known Belt Supergroup rocks and the reference and type sections of the Lemhi Group and Yellowjacket Formation. Shaded areas represent mountain ranges containing Mesoproterozoic sedimentary rocks.

INTRODUCTION

The Montana Bureau of Mines and Geology (MBMG) and the Idaho Geological Survey (IGS) selected the Homer Youngs Peak 7.5' quadrangle in the northern Beaverhead Mountains along the Montana-Idaho border for a 1:24,000-scale collaborative mapping project because of its excellent exposures of two different Mesoproterozoic sedimentary rock packages. To the east and northeast, in the West Pioneer and Pintler Mountains (Figure 1), are exposures of known Belt Supergroup rocks (Ruppel and others, 1993; Lonn and McDonald, 2004a, 2004b), whereas to the southwest in the Lemhi Range and Salmon River Mountains are the reference sections of the Lemhi Group, Swauger Formation, and Yellowjacket Formation (Ross, 1934; Ruppel, 1975). In the intervening Beaverhead Mountains, both the stratigraphic and structural interpretations have been controversial among previous workers (MacKenzie, 1949; Tucker, 1975; Ruppel and others, 1993; Winston and others, 1999; Evans and Green, 2003; O'Neill, 2005; Tysdal and others, 2005). The MBMG/IGS collaborative team plans to continue 1:24,000-scale mapping southward to Lemhi Pass in an attempt to resolve some of the long-standing controversies.

Bedrock mapping in 2007 by Lonn, Lewis, and Burmester was supplemented by their earlier reconnaissance work in 2000 and 2005. Unpublished work by Lonn and J. Michael O'Neill in 2000 documented the existence of the 19,000-ft-thick vertical sequence of coarse-grained quartzite northeast of the Beaverhead Divide fault, in the Miner Lakes area, and their data were used on this map. Surficial deposits were mapped in 2007 by Stanford. Previous mapping by Kilroy (1981) was used to delineate intrusive phases in the northwest part of the quadrangle.

DESCRIPTION OF MAP UNITS

Intrusive rocks are classified according to International Union of Geological Sciences nomenclature using normalized values of modal quartz (Q), alkali feldspar (A), and plagioclase (P), on a ternary diagram (Streckeisen, 1976). Mineral modifiers are listed in order of increasing abundance. Grain size classification of unconsolidated and consolidated sediment is based on the Wentworth scale (Lane, 1947). Bedding thicknesses and lamination type are after McKee and Weir (1953), and Winston (1986). Distances and bed thicknesses are given in abbreviation of metric units (e.g., dm=decimeter). Formation thickness is listed in both meters and feet. Multiple lithologies within a rock unit description are listed in order of decreasing abundance.

ALLUVIAL DEPOSITS

Qal **Modern stream alluvium (Holocene)**—Rounded to subrounded cobble to boulder gravel and sand. Mostly derived from re-worked till and outwash gravels. Thickness 1-3 m (3-10 ft).

Qaf **Alluvial fan and debris flow fan gravels (Holocene)**—Angular to subangular poorly sorted boulder gravels and sand. Found on steep valley walls. Thickness 1-10 m (3-30 ft).

GLACIAL DEPOSITS

Qgly **Young glacial and periglacial deposits (Holocene?)**—Poorly sorted angular to subangular boulder gravel and till. Sandy boulder till on some ramparts or moraines. Includes pro-talus ramparts, inactive rock glaciers, and moraines of the Little Ice Age and older(?) deposits in cirques and northeast-facing protected areas above 2500 m (8200 ft). Lichens common on all but youngest (uppermost) deposits. The largest of these deposits is about 720 m (2,400 ft) from head to toe, located in a cirque at the headwaters of Little Lake Creek (45.319°N, 113.711°W). MacKenzie (1949) classified these deposits as rock glaciers, but well developed and tree covered lateral moraines indicate that an earlier glacier evolved into a rock glacier as the climate changed. Today, deposits appear inactive and debris-covered ice is found only in protected areas above youngest ramparts or moraines at or above 2800 m (9300 ft).

Qglc **Fine-grained deposits in glaciated uplands (Holocene-Pleistocene)**—Silt and sand deposited behind end moraines.

Qgt **Glacial till of last local glacial maximum (Pinedale) (Pleistocene)**—Poorly sorted sandy to clayey boulder till. Clasts subangular to subrounded. Also includes younger till deposited near or just below cirque floors up to 2600 m (8600 ft). Includes end moraine, recessional moraine, and some outwash. Up to 60 cm of sandy loam soil on till. Thickness up to 120 m (400 ft).

Qglu **Glacial deposits of last local glacial maximum, undivided (Pinedale) (Pleistocene)**—Predominantly till, lesser outwash, and minor modern stream alluvium.

Qgo **Glacial outwash gravels of last local glacial maximum (Pinedale) (Pleistocene)**—Rounded and sorted sandy cobble to boulder gravel.

Qglo **Older till deposits of the last glacial maximum (Pleistocene)**—Poorly sorted bouldery till. Mostly subangular to rounded quartzite clasts. Moraine remnants present on interfluve surfaces 60-180 m (200-600 ft) above more recently glaciated valley floors. Thickness at least 6 m (20 ft).

INTRUSIVE ROCKS

Tigm **Quartz monzonite sill (Eocene)**—Fine-grained biotite quartz monzonite in thin sill north of Freeman Creek at west edge of map.

Tgd **Granodiorite (Eocene)**—Hornblende-biotite granodiorite. Part of the granodiorite unit of Kilroy (1981) that is more extensively exposed to the west of the quadrangle where it has also been described by MacKenzie (1949) and Anderson (1959). Plagioclase, quartz, microcline, hornblende, and biotite are the major constituents. Eocene age based on $^{40}Ar/^{39}Ar$ dating of biotite and hornblende from a sample collected about 2 km west of Lena Lake, immediately west of the quadrangle boundary, and biotite from a sample collected in the nearby quartz diorite unit (Kilroy, 1981).

Kqd **Quartz diorite (Cretaceous)**—Biotite-hornblende quartz diorite. Part of the quartz diorite unit of Kilroy (1981), composed of plagioclase along with hornblende, biotite, quartz, and orthoclase. Cretaceous age based on $^{40}Ar/^{39}Ar$ dating of hornblende from samples collected about 2.2 km due east of Squaw Mountain and from the cirque at the head of Slag-a-melt Creek near the contact with the Kdi unit (Kilroy, 1981). These hornblende ages of about 81 Ma are considered the minimum age for this unit. Younger $^{40}Ar/^{39}Ar$ ages of biotite from these two samples may reflect slow uplift and cooling, or reheating during the Eocene.

Kdi **Diorite (Cretaceous?)**—Hornblende diorite equivalent to the hornblende meladiorite unit of Kilroy (1981). Composed of plagioclase along with hypersthene, enstatite, actinolite, quartz, and opaque minerals (Kilroy, 1981). Plagioclase is reversely zoned andesine. Contains small hornblende pyroxenite xenoliths, the least altered of which contain poikilitic augite enclosing hypersthene and hematite.

KYdi **Diorite dikes and sills (Proterozoic?, Cambrian?, or Cretaceous?)**—Medium- to fine-grained hornblende diorite. Described by MacKenzie (1949) as meladiorite composed of altered hornblende, albite, biotite, chlorite, and clinozoisite, with andesine and orthoclase in some of the less altered rocks. Long, irregular ribbons of leucosome are interpreted to be a strained alteration product of an original several percent of ilmenite. Unaltered magnetite is present locally in considerable amounts, particularly in dikes bordering the Beaverhead Divide fault.

MESOPROTEROZOIC STRATA

Low metamorphic grade metasedimentary rocks of Mesoproterozoic age underlie most of the Homer Youngs Peak quadrangle. These rocks have been variously assigned by previous workers to the Belt Supergroup, the Lemhi Group, and (or) the Yellowjacket Formation. We describe three main metasedimentary rock packages in the quadrangle: 1) poorly sorted, coarse-grained quartzite northeast of the Beaverhead Divide fault; 2) well-sorted, fine-grained quartzite southwest of the Beaverhead Divide fault; and 3) siltite and argillite found mostly southwest of the Freeman thrust. Because package 1 is separated from the others by a fault, its stratigraphic relationship to them is unknown.

Mesoproterozoic Strata Northeast of the Beaverhead Divide Fault

Northeast of the Beaverhead Divide fault is a near-vertical, east-facing, 6000 m (19,000 ft) thick stratigraphic sequence of poorly sorted, feldspathic, medium- to coarse-grained quartzite. This sequence is tentatively correlated with the Missoula Group of the Belt Supergroup because of similarities to known upper Missoula Group rocks east and northeast of the map area in the western Pintler Mountains (Lonn and McDonald, 2004a) and West Pioneer Mountains (Ruppel and others, 1993; Lonn and McDonald, 2004b). This correlation is in agreement with Evans and Green (2003), but conflicts with Tysdal and others (2005) assignment of it to the Gunsight Formation of the Lemhi Group. MacKenzie (1949) described this section from the lower 2100 m (7000 ft) of this sequence as containing 50-70 percent quartz, 5-10 percent orthoclase, 5-15 percent microcline, 10-15 percent sericite, 2-5 percent magnetite, and a trace to 1 percent albite. We divided this thick sequence into four informal units based on grain size and sedimentary structures.

Yqa **Quartzite and argillite (Mesoproterozoic)**—Pink to white, medium- to coarse-grained, trough and planar crossbedded quartzite in beds 15 cm to 1 m thick, interbedded with purple to green siltite and argillite in planar beds 0.6 to 3 cm thick. Top of unit not exposed, but thickness at least 300 m (1000 ft).

Yqcu **Upper coarse-grained quartzite (Mesoproterozoic)**—White to light gray, poorly sorted, coarse-grained, trough and planar crossbedded feldspathic quartzite. Beds are 30-180 cm thick, separated by black argillite interbeds up to 8 cm thick. Contains abundant granule-sized grains and sparse floating pebbles. Large black mud rip-up clasts are common. Thickness approximately 1500 m (5000 ft).

Yqmc **Multi-colored quartzite (Mesoproterozoic)**—White, purple, dark gray, and green, fine- to coarse-grained quartzite and siltite. Characterized by intervals of white to dark-gray (biotite-bearing?), flat-laminated, fine- to medium-grained quartzite in beds 30-60 cm thick alternating with intervals of thin bedded quartzite, purple siltite, and black and green argillite in beds 1-3 cm thick. Ripple marks are common. Contains some small pebbles along bedding planes. Fine grained intervals contain some green calc-silicate minerals and scapolite. Outcrops have a tabular-bedded appearance. Thickness approximately 2100 m (7000 ft).

Yqcl **Conglomeratic quartzite (Mesoproterozoic)**—White to light gray, poorly sorted, medium- to coarse-grained, trough and planar crossbedded, feldspathic quartzite in beds as much as 180 cm thick. Floating pebbles as much as 2.5 cm in diameter of quartz, quartzite, and hornblende granite are abundant. Granitic pebbles are angular; quartzite pebbles are rounded. Some conglomeratic beds up to 60 cm thick are present. Contains black argillite interbeds as much as 8 cm thick with desiccation cracks. Some carbonate cement present, and some beds exhibit soft sediment deformation. Sample from divide southwest of Ajax Lake contains about 15 percent potassium feldspar and 3 percent plagioclase. Similar quartzite along strike to the northwest in the adjoining quadrangle also has potassium feldspar in excess of plagioclase. Thickness approximately 1800 m (6000 ft).

Mesoproterozoic Strata Southwest of the Beaverhead Divide Fault

Yqff **Fine-grained feldspathic quartzite (Mesoproterozoic)**—Fine-grained, medium- to thick-bedded, light-weathering feldspathic quartzite and minor darker siltite and argillite. Plagioclase is the only feldspar in two samples, constituting 40-50 percent of the rock; a third contained 25 percent plagioclase and 1 percent potassium feldspar and a fourth contained up to 10 percent potassium feldspar in some layers. Bedding defined by dark laminations in layers up to 2 mm thick is distinctive of this unit. Magnetic hysteresis and Curie temperature measurements on laminations from two samples from this quadrangle and one from the type section of the Gunsight Formation indicate that the dark material is specular hematite. Despite well-developed cleavage or foliation, dark laminations define large, high-angle planar cross bedding, ripple and climbing ripple cross lamination as well as flat lamination. Some steep laminations (30°-60°) truncate underlying laminations; some define loads that apparently grew during deposition. Argillite is present as thin layers or skins (some discontinuous) on quartzite parting surfaces, rarely as mud chips, and as graded tops of darker siltite and argillite couplets within the unit. Tentatively correlated with the type Gunsight Formation of the Lemhi Group (Ruppel, 1975) based on similarity with rocks in the type section. Yqff is shown stratigraphically above Ysa in the western part of the map and in cross section B-B', but this relationship is uncertain. Relative age of Yqff and Ysa tentatively based on correlation with units in the Lemhi Range. At least 1500 m (5000 ft) thick.

Ysa **Siltite and argillite (Mesoproterozoic)**—Laminated to thin-bedded dark gray siltite and darker gray argillite. Siltite layers dm scale approximately equal in volume to cm scale siltite and argillite couplets. Some zones characterized by graded siltite and argillite couplets. Commonly cleaved to foliated (schistose). Some cleavage and schistosity is axial planar to tight folds, some is deformed by west-vergent folds. Where contact metamorphosed near Tgd immediately west of the map area includes cm-scale brown-weathering spots in white matrix. Green and pink casts of non-spotted laminae suggest rock is calc-silicate although little residual carbonate was found. East of Tgd, layering contorted, spots flattened and rock locally broken into dm size blocks along healed shears. More thinly laminated parts tentatively correlated with the Yellow Lake unit of the Apple Creek Formation of the Lemhi Group (Tysdal, 2000) based on uniform fine grain size, thin bedding, and interpretation of original carbonate. Thicker and graded parts correspond more closely with the coarse siltite unit of the Apple Creek Formation as mapped northwest of Yellow Lake (Tysdal and Moye, 1996; Tysdal, 2003). However, pinch and swell sediment type characteristic of the banded siltite unit found above the coarse siltite unit, and coarse clastics of the diamictite unit found below it in the Lemhi Range and Salmon River Mountains (Tysdal, 2003) were not recognized. Base not exposed, but a minimum thickness of 600 m (2000 ft) likely.

STRUCTURE

The two major structures, the Beaverhead Divide fault and the Freeman thrust, separate the map area into the three major structural packages, termed here the coarse quartzite, fine quartzite, and siltite and argillite domains after their dominant rock type. These domains and depictions of bedding and mylonitic foliation are shown in cross sections A-A' and B-B'. Plots above B-B' are lower hemisphere equal-area projections of poles to bedding and cleavage planes. Downward poles to bedding are shown in blue, upward poles to overturned beds in red. These plots include best-fit great circles (green) and their poles (black dot). Shown separately are means of bedding (blue) and cleavage (orange) poles with 95 percent confidence regions. Plots were constructed using FORTRAN programs modified from Tauxe (1998) and plotxy from Parker and Schure (2008). The three structural domains and their bounding structures are discussed below, from east to west, followed by a description of later, cross-cutting structures.

COARSE QUARTZITE DOMAIN

Northeast of the Beaverhead Divide fault is a thick (6000 m, 19,000 ft) east-facing panel of steep to overturned (75° average dip east) strata (*Yqa, Yqcu, Yqmc, Yqcl*), tentatively assigned to the Missoula Group. It is interpreted as the west limb of a giant east-verging syncline similar to the gigantic folds mapped by Tysdal (2002) in the Lemhi Range southwest of the map area. Poles to bedding of these rocks define a weak girdle with a pole about 147° 11° (trend and plunge). The weakly developed southeast-striking cleavage in this domain has an average dip of 60° southwest but defines a girdle with a pole 153°, 28°.

BEAVERHEAD DIVIDE FAULT ZONE

The Beaverhead Divide fault was first described by MacKenzie (1949) who referred to the structure as the Miner Lakes fault. Anderson (1959) mapped its extension northwest and Tucker (1975) extended it southeast.

Ruppel and others (1993) interpreted it as a major structure separating the Missoula Group to the northeast from the Mesoproterozoic Yellowjacket Formation and Lemhi Group to the southwest. Evans and Green (2003) mapped it as a thrust reactivated as a normal fault, separating Missoula Group from Lemhi Group. More recently, O'Neill (2005) interpreted it as a low-angle normal fault that has been rotated to vertical, with unmetamorphosed upper plate rocks now to the northeast and metamorphosed lower plate rocks now to the southwest.

Our mapping suggests that the Beaverhead Divide fault is a steeply southwest-dipping zone of both ductile and brittle deformation whose activity may span a long time (Proterozoic to Eocene?). We mapped two strands of the Beaverhead Divide fault. The eastern strand, characterized by chloritic breccia, is within conglomeratic quartzite (*Yqcl*), and separates weakly foliated, east-facing vertical strata on the northeast from strongly foliated and tightly folded rocks on the southwest. The breccia contains randomly oriented clasts of strongly foliated quartzite. Chaotic folds that occur in the zone between the eastern and western strands may be sheath folds.

The western strand of the Beaverhead Divide fault is a zone of 35°-65° southwest-dipping mylonitic foliation that approximately parallels the 142° strike of the zone. It separates the lithologic units *Yqcl* and *Yqff*. A thin section from this zone showed mylonitic foliation defined by ribbons of recrystallized quartz separated by phyllosilicate films. Shear sense indicators were not obvious, and mineral lineations could not be seen in outcrop or hand sample. This ductile shear zone contains mafic dikes (*KYdi*) that exhibit foliation parallel to that of the shear zone. This zone is folded both at the outcrop and thin section scale.

FINE QUARTZITE DOMAIN

West of the ductile strand of Beaverhead Divide fault is strongly foliated, fine quartzite (*Yqff*) that is tentatively correlated with the Gunsight Formation of the Lemhi Group. In the southern part of the map area mostly east-facing beds with a thickness >1500 m (5000 ft) parallel the coarse quartzite panel northeast of the Beaverhead Divide fault. Poles to bedding have a bimodal distribution that reflects short wavelength folding within the unit and form a well-defined girdle whose pole and inferred fold axis plunges gently northwest (319°, 9°). Poles to cleavage with average attitude of 140°, 56° SW form a less well-defined girdle that has a similar pole (317°, 5°). This similarity can be explained by folding of both fabrics together; the cleavage is not axial planar to the small folds but bears a consistent angular relationship to bedding.

FREEMAN THRUST

The Freeman thrust, named herein, bounds the southwest side of the fine quartzite domain. It appears on the Salmon National Forest geologic map (Evans and Green, 2003), although in a slightly different location. It strikes approximately 135°, dips moderately to gently southwest, and is mylonitic. Lineations are poorly developed (at one locality north of Freeman Creek they plunge 20° west), and definitive shear sense indicators could not be found in outcrop or thin section. However, in the Freeman Creek and North Fork Kirtley Creek areas, steep beds in the footwall quartzite appear dragged into parallel with the fault (see cross section B-B') suggesting reverse movement. Locally in *Yqff* some outcrop-scale, asymmetric, east-verging folds that may be related to the Freeman thrust are interpreted to have an axial planar cleavage that is later than the regional cleavage. A few thumbnail-sized s-type porphyroclasts observed within the mylonitic fabric show the same shear sense. This fault also appears to have been deformed by later folding.

SILTITE AND ARGILLITE DOMAIN

The Freeman thrust carries the siltite and argillite unit (*Ysa*), tentatively assigned to the Apple Creek Formation, in its hanging wall. Bedding is generally transposed and shallower than in the other domains but the girdle of poles to bedding and the pole to this girdle (326°, 1°) are not much different. The well-developed cleavage in this domain has an average attitude of 149°, 41° SW, but the pole to its girdle (314°, 12°) differs little from that of the fine quartzite domain in the Freeman thrust footwall. However, some outcrop-scale folds have an axial planar cleavage, so the strong cleavage is interpreted to be related to the younger cleavage in *Yqff* near the Freeman thrust and not to the steeper cleavage in the quartzite domains.

INTERPRETATION

Our interpretation is that the rocks of the coarse and fine quartzite domains were affected by the same cleavage-forming event. Parallelism of the fabric in the western strand of the Beaverhead Divide fault with that in the bounding strata suggest a coeval and (or) similar stress field for formation. This penetrative fabric could have developed during contraction and folding above a basal decollement and propagation of an out of sequence thrust (the western strand) through the limb of a fold. This requires that *Yqff* was stratigraphically (or structurally from an undocumented event) beneath the coarse quartzite domain. Continued deformation between the two strands of the Beaverhead Divide fault brecciated the foliated quartzite, and latest motion appears to have been concentrated along the eastern strand and juxtaposed more (west) and less (east) deformed rocks. Whether the change in deformation style was during the same event or from separate events is uncertain but the last motion might have been normal faulting on the eastern strand as interpreted by Evans and Green (2003). It also is uncertain whether the Freeman thrust was active coevally with the Beaverhead Divide fault motion. The observation that the Freeman thrust cuts and deforms cleaved *Yqff* strata suggests that movement post-dates at least some of the activity on the Beaverhead Divide fault.

The broad similarity of great circles fit to bedding poles and to cleavage poles among all domains and the observation that cleavage is clockwise of bedding when viewed in cross-section (e.g., for east dipping beds, cleavage is either steeper or dips west, and for west dipping beds, cleavage is shallower), suggest that factors that govern their distribution within and between domains are the same. Thus it seems likely that a widespread event folded strata and cleavages in all domains and both fault systems. That event may be what formed the west verging folds and crenulation cleavage described below.

NORTHEAST-STRIKING BRITTLE FAULTS

A set of northeast- to east-striking brittle faults of varied dip postdates the ductile fabrics. One fault in the southernmost part of the quadrangle clearly offsets both strands of the Beaverhead Divide fault zone. Some of these northeast structures have been intruded by mafic dikes. One northeast-striking dike near Ajax Lake in the northwestern part of the map area is strongly foliated parallel to the attitude of the dike. Gold-silver-lead mineralization in the Homer Youngs Peak quadrangle is typically associated with these dikes and faults.

CRENULATION CLEAVAGE AND WEST-VERGING FOLDS

West-verging crenulation folds that deform the strong earlier cleavage are accompanied by a gently southwest-dipping crenulation cleavage. The shallow dip of the crenulation cleavage and asymmetry of the folds suggest vertical shortening and top-to-the-west horizontal extension. The crenulations are especially well-developed along and southwest of the Beaverhead Divide fault zone preferentially at high elevations. We tentatively interpret them to be related to the extensional event that formed the top-to-the-southwest Salmon Basin detachment fault (Janecke and others, 2001; Janecke and Blankenau, 2003) that bounds the west side of the Beaverhead Range south and west of the map area. They may alternatively be related to the late normal(?) movement on the brittle, eastern strand of the Beaverhead Divide fault.

SYMBOLS

Fault: dashed where approximately located; dotted where concealed; arrow indicates dip of shear or fault plane.

Contact: dashed where approximately located.

Thrust fault: dashed where approximately located; dotted where concealed.

Normal fault: dashed where approximately located; dotted where concealed.

Fold axis: dotted where concealed; arrow indicates plunge direction.

Anticline axial trace, dashed where approximately located.

Syncline axial trace, dashed where approximately located.

Strike and dip of bedding.

Strike of vertical bedding.

Strike and dip of bedding; ball indicates bedding known to be upright.

Strike and dip of bedding, strike variable.

Strike and dip of bedding known to be overturned.

Strike and dip of bedding interpreted to be overturned.

Estimated strike and dip of bedding.

Horizontal bedding.

Strike and dip of foliation.

Strike and dip of mylonitic foliation.

Strike and dip of cleavage.

Strike of vertical fracture cleavage.

Strike and dip of joint.

Strike of vertical joint.

Bearing and plunge of lineation, type unknown.

Bearing and plunge of mylonitic lineation.

Bearing and plunge of intersection lineation.

Bearing and plunge of asymmetrical small fold showing counterclockwise rotation viewed down plunge.

Bearing and plunge of small fold axis.

Bearing and plunge of crenulation lineation.

Vein.

Mylonite.

Dike.

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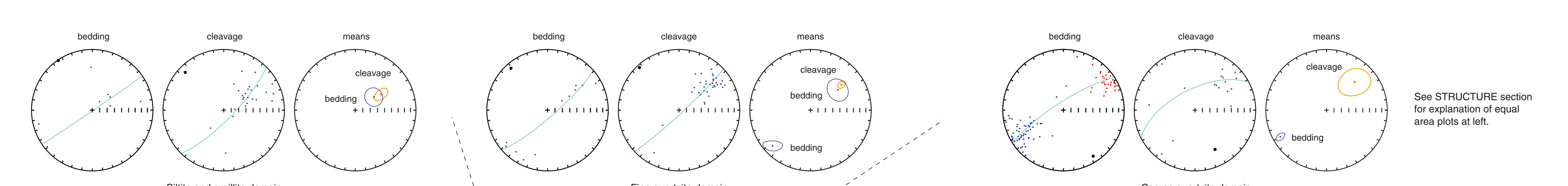

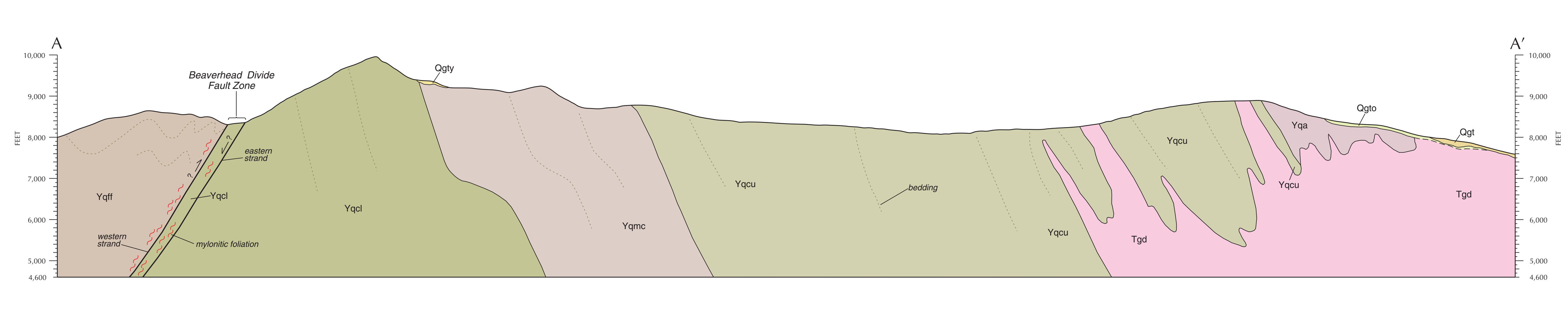

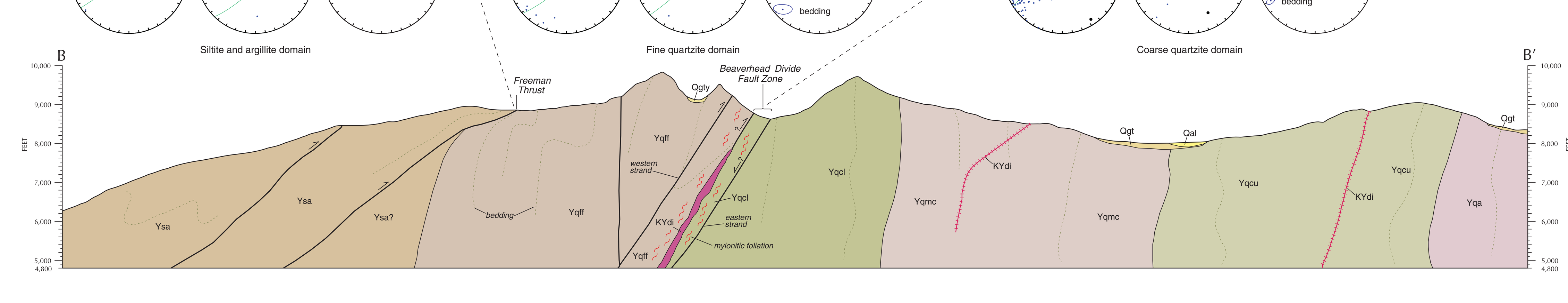

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