GEOLOGIC MAP OF THE GIBBONSVILLE, SHEWAG LAKE, AND ALLAN MOUNTAIN QUADRANGLES, AND PARTS OF THE LOST TRAIL PASS AND BIG HOLE PASS QUADRANGLES, LEMHI COUNTY, IDAHO, AND RAVALLI AND BEAVERHEAD COUNTIES, MONTANA

Eric D. Stewart, Travis D. Steel, David E. Stewart, and Paul K. Link
2014

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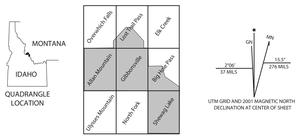
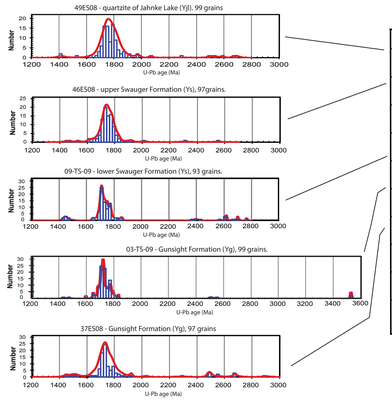
MAP LOCATION AND SCALE



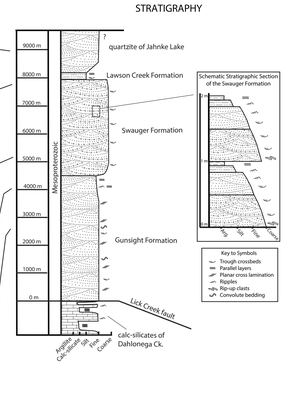
MAP SYMBOLS

- 45 — Strike and dip of bedding
- 57 — Strike and dip of bedding right-side-up
- 65 — Strike and dip of overturned bedding, inferred
- 65 — Strike and dip of overturned bedding
- 78 — Strike and dip of foliation
- 25 — Strike and dip of volcanic flow banding
- Contact, solid where known, dashed where inferred, dotted where covered
- Normal fault, solid where known, dashed where inferred, dotted where covered
- Thrust fault, solid where known, dashed where inferred, dotted where covered
- Fault (cross-section only), where the circle surrounding a cross indicates movement into the page, and the filled inner circle indicates movement out of the page
- 20 — Trend and plunge of fold hinge
- Plunging anticline, solid where known, dashed where inferred, dotted where covered
- Plunging syncline, solid where known, dashed where inferred, dotted where covered
- Overturned syncline, solid where known, dashed where inferred, dotted where covered. Arrows point in down-dip direction
- A — A′ — Surface trace of cross-section from A to A′
- 37ES08 — Detrital zircon sample location

DETRITAL ZIRCON U-PB AGE SPECTRA



STRATIGRAPHY



INTRODUCTION

Geologic mapping took place during the summers of 2008 through 2013. Mapping was undertaken as part of a larger regional effort led by the Idaho Geological Survey and Montana Bureau of Mines and Geology to understand the stratigraphy of the Lemhi sub-basin, and its relation to the Belt Supergroup. The stratigraphy used here follows revisions to the Lemhi sub-basin stratigraphy proposed by Burmester et al. (2013).

The Allan Mountain quadrangle was mapped by EDS, PKL and DES, the Shewag Lake quadrangle was mapped by TDS, PKL, and EDS, and the Gibbonsville, and parts of the Lost Trail Pass, and Big Hole Pass quadrangles were mapped by EDS and DES. The geology and stratigraphy of the Allan Mountain quadrangle has been revised from the Stewart et al. (2010) map.

STRUCTURE

CLEAVAGE

Mineral cleavages are common in the Proterozoic quartzites, often occurring sub-parallel to bedding. The quartzite of Jahnke Lake from the southeastern corner of the Allan Mountain quadrangle also contains zones of strong NNE-striking, ESE-dipping cleavage. Some zones are mylonitic. These fabrics are the continuation of a series of N- to NNE-striking shear zones mapped to the south in the Ulysses Mountain quadrangle (Lopez, 1982b). However, many of the strong fabrics do not produce noticeable offset of the stratigraphic units in the Allan Mountain quadrangle, suggesting that fabric strength does not necessarily correlate to strain. Much of the strong NNE-striking cleavage also occurs in rocks that show evidence of at least 2 fold events (Stewart et al., 2010).

LICK CREEK FAULT

Parts of the Lick Creek normal fault have been mapped by Lopez (1982a), Ruppel et al. (1993), Evans and Green (2003), and in the far north by Desmarais (1983). Our mapping suggests the Lick Creek normal fault strikes roughly east-west, and dips steeply to the south. It contains a northern and a southern segment offset by the Anderson Creek fault. Breccia occurs along the length of the fault, but along the southern segment, near the Anderson Creek fault, the breccia zone widens to more than two kilometers in width. Kinematic indicators were not observed along the fault.

We apply the revised stratigraphy of Burmester et al. (2013) to hanging wall and footwall rocks, and interpret the Lick Creek fault to be a major normal fault with significant stratigraphic offset (>7000 meters). We tentatively suggest the Lick Creek fault merges with the Anaconda detachment fault beneath the western Big Hole valley, indicating footwall rocks belong to the Anaconda Core Complex and the normal fault was strongly oblique. The Anaconda detachment fault was active during the Eocene and possibly into the early Oligocene (Foster et al., 2010). If the Lick Creek fault is part of the Anaconda detachment fault, then it presumably has a similar age.

ANDERSON CREEK FAULT

Gold mineralization along the Anderson Creek fault has been well known for more than a century (e.g. Bacorn, 1905; Lincoln, 1912; Livingston, 1919; Mayerle and Close, 1993). Tertiary? diorite lies east of the main fault for much of its length, while Proterozoic quartzites lie to the west. A distributed zone of faulting extends to the east of the main strand. Mineralized veins, generally striking NNW with a sub-vertical dip, are cut by later normal and reverse faulting throughout the distributed zone (Bacorn, 1905). The age of mineralization is unknown.

Underground workings on the main fault near the village of Gibbonsville suggest the Anderson Creek fault is orientated N20E/70SE (Livingston, 1919). However, it is likely the fault merges to the south with a steeply west-dipping normal fault mapped in the North Fork 7.5′ quadrangle (Lonn et al., 2013). Near the northern edge of the map area, our mapping along the Continental Divide also indicates the fault dips steeply west. Thus the fault may not have a consistent dip direction along its length.

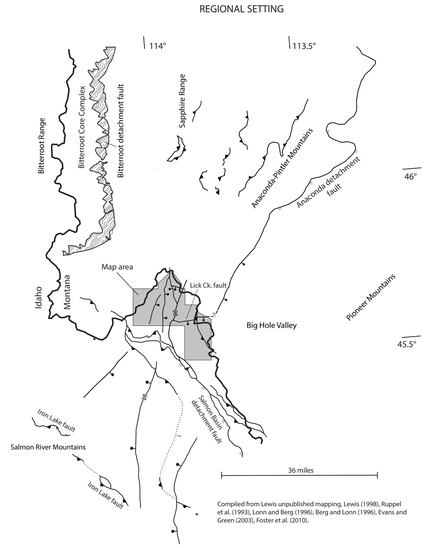
The fault kinematics also remain enigmatic. Lincoln (1912) and Lopez (1982) suggest west-side up motion along the fault, while Mayerle and Close (1993) suggest east-side up motion. Based on the revised stratigraphy of Burmester et al. (2013), our mapping favors the Mayerle and Close (1993) interpretation, and is consistent with mapping to the south by Lonn et al. (2013). We believe the units on the west, correlated to the Gunsight Formation, Swauger Formation, and quartzite of Jahnke Lake, are stratigraphically higher than the calc-silicate, quartzite and siltite of Dahlonega Creek (tentatively correlated to the Yellow Lake unit of the Lemhi Group) to the east, favoring down-to-the-west motion.

In addition, the Anderson Creek fault also contains a substantial right-lateral strike-slip component of motion. The Anderson Creek fault produced 11 kilometers of apparent right-lateral offset of the two segments of the steeply south-dipping Lick Creek fault. This apparent offset requires an unreasonably large amount of dip-slip motion on the Anderson Creek fault to be solely responsible for the apparent displacement. Right-lateral strike-slip movement was also observed by late 19th century and early 20th century miners in the distributed zone of faulting east of the main fault. There they found mineralized veins were often offset by small faults containing right-lateral motion (Bacorn, 1905; Mayerle and Close, 1993).

ACKNOWLEDGEMENTS

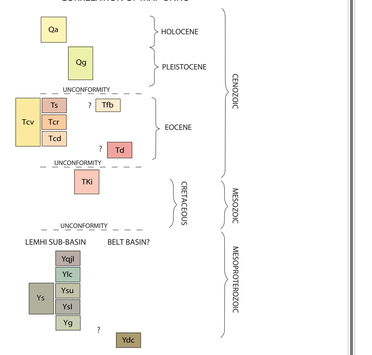
We are particularly indebted to Reed Lewis and Jeff Lonn, who helped connect the local geology of the Gibbonsville area to regional stratigraphy and regional structures. We also thank Don Winston, Mark McFaddan, Russ Burmester, and Dave Rodgers for field help and suggestions throughout the mapping process.

REGIONAL SETTING



Compiled from Lewis unpublished mapping, Lewis (1998), Ruppel et al. (1993), Lonn and Berg (1996), Berg and Lonn (1996), Evans and Green (2003), Foster et al. (2010).

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

ALLUVIAL DEPOSITS

Qa — **Alluvium (Quaternary)** - Stream deposits of locally derived mud, sand, and gravel. Along Ditch and Hughes Creek, reworked boulders (Tfb) are also common.

GLACIAL DEPOSITS

Qg — **Glacial Till (Quaternary)** - Surficial deposits consisting of locally derived angular gravels to boulders. Very poorly sorted.

TERTIARY IGNEOUS AND SEDIMENTARY ROCKS

Tfb — **Outwash Flood Boulders (Tertiary)** - Flood deposits. Boulders up to 70 centimeters in diameter mixed with cobbles, gravels, and sand. Exposed only along a small section of Ditch Creek, though much of the Quaternary alluvium along lower Ditch Creek and Hughes Creek are reworked flood boulders.

Ta — **Alluvium (Tertiary)** - Unconsolidated rounded cobbles of dominantly Challis Volcanics and Proterozoic quartzites. Forms flat surfaces and is easily eroded.

Tcr — **Challis Volcanics, Rhyolite (Tertiary)** - Biotite-quartz-rhyolite porphyry. Rounded, millimeter long phenocrysts of quartz are common, as are pumice clasts (Lopez, 1982a). The rhyolite is poorly to moderately welded, and has either a glassy or devitrified matrix (Lopez, 1982a).

Tcd — **Challis Volcanics, Dacite (Tertiary)** - Vitreous biotite-hornblende-dacite porphyry. Flow banding is common. Phenocrysts are up to several millimeters long. In places likely deposited as an ash flow tuff, elsewhere as a hypabyssal intrusive.

Tcv — **Challis Volcanics and Tertiary Sediments, undivided (Tertiary)** - Hypabyssal tuff, lava and dikes of quartz, potassium feldspar, hornblende dacite porphyry and quartz rhyolite tuff. Phenocrysts are up to several millimeters long. Unconsolidated fluvial sands and cobbles are interbedded within the volcanics.

Td — **Diorite (Tertiary?)** - Greenish-black, medium grained diorite, containing plagioclase, hornblende, pyroxene, biotite and magnetite (Lopez, 1982a, Lopez et al., 2004). Age uncertain.

TERTIARY-CRETACEOUS INTRUSIVE ROCKS

TKi — **Intrusives (Tertiary-Cretaceous)** - Undivided unit containing Tertiary and Cretaceous biotite granodiorite and Tertiary biotite-muscovite granite (Desmarais, 1983; Lopez et al., 2004).

MESOPROTEROZOIC STRATA

Yqjl — **Quartzite of Jahnke Lake (Mesoproterozoic)** - Generally pale grey to green, fine- to very fine-grained plagioclase-rich quartzite. Interbedded siltite and argillite is common. The quartzite is laminated to thinly bedded, and commonly shows ripples, climbing ripples, load casts, and trough and planar cross-bedding. Fluid escape structures, convolute bedding, and hummocky cross-bedding are rare. In the sediment type classification of Winston and Link (1993) the most common sediment types are cross-bedded sand, flat-laminated sand, and even couples. It is slightly finer grained than the Swauger Formation, and is equivalent to quartzite type II of Berg (1977).

Ylc — **Lawson Creek Formation (Mesoproterozoic)** - Varying from grey, fine-grained feldspathic quartzite to dark grey to black siltite and argillite. Fine-grained quartzite fines upward on the decimeter scale into siltite/argillite. Heavy mineral laminations, ripple cross-beds, and climbing ripples are common. This unit contains significantly more siltite and argillite than the Gunsight Formation and the Quartzite of Jahnke Lake.

Ysu — **Swauger Formation, upper (Mesoproterozoic)** - Largely white to light pink, coarse to medium-grained, well sorted, potassium feldspar-rich subarkosic arenite (quartzite). The unit is differentiated from the lower Swauger Formation in the Shewag Lake quadrangle by its lack of pebbles, but is otherwise the same. It contains upward fining cycles 75 cm to 1.5 m thick. Fine-grained quartzite and siltite cap the upward fining cycles. The caps are generally laminated and locally include small amounts of scapolite. In the sediment type classification of Winston and Link (1993) this unit includes cross-bedded sand, flat-laminated sand, and even couple sediment types.

Ysl — **Swauger Formation, lower (Mesoproterozoic)** - Largely white to light pink, coarse to medium-grained, well sorted, potassium feldspar-rich quartzite. Fining-upward cycles are common, grading from coarse- to medium-grained quartzite at the base to siltite and argillite caps at the top. Cycles average between 75 centimeters and 1.5 meters. The base of cycles locally contain rip-up clasts, and usually show trough cross-bedding that is defined by hematite-rich heavy mineral laminations. Fine-grained quartzites and siltites above show ripples and climbing ripples; siltite to argillite caps (~ 5–15 cm thick) are often laminated. Caps vary in color from dark green to light purple. Small quartz arenite pebbles, likely formed as lag deposits, are common at the base of the fining-upward cycles in the Shewag Lake quadrangle, but are not found to the northwest in the Allan Mountain quadrangle. These pebbles contain entirely Archean detrital zircon ages (Steel and Link, 2013), and were likely sourced from the Wyoming Craton to the east. The loss of pebbles to the west indicates facies changes are present at the scale of this map. In the sediment type classification of Winston and Link (1993) this unit includes cross-bedded sand, flat-laminated sand, and even couple sediment types. Cross-sections indicate the thickness of the lower Swauger is approximately 3000 meters.

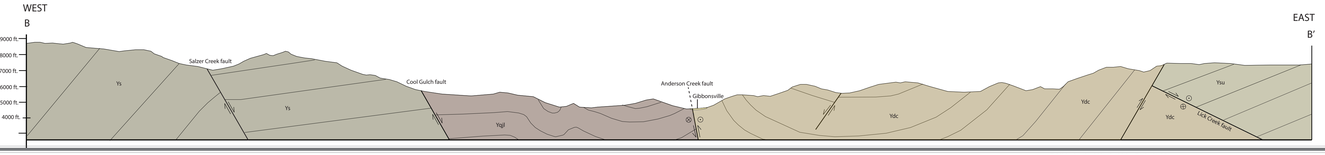
Ys — **Swauger Formation, undivided (Mesoproterozoic)** - White, light grey, or light pink fine to coarse-grained feldspathic quartzite. Though quartzite grain sizes range from fine to coarse, most beds are medium grained. The unit is well sorted, and though it is stratigraphically equivalent to both the lower and upper Swauger Formation, it contains no pebbles in its lower portion. Quartzite beds generally fine upward within laterally continuous beds between 75 and 150 cm thick. Thin, laminated siltite and argillite caps are present on the tops of many cycles. Approximately 3400 meters thick in the Allan Mountain quadrangle. The Swauger Formation is equivalent to quartzite type I of Berg (1977).

Yg — **Gunsight Formation (Mesoproterozoic)** - Grey to grey-green to tan, fine-grained feldspar-rich quartzite with abundant heavy mineral laminations and common soft-sediment deformation. The quartzite is well sorted, and is laminated to thinly bedded, commonly showing ripples, climbing ripples, load casts, and trough and planar cross-bedding. Sediment types (Winston and Link, 1993) in this unit include cross-bedded sand, flat-laminated sand, and even couples. It is slightly finer grained than the Swauger Formation. In the western portion of the map area, the top of the Gunsight Formation contains approximately 400 meters of green to light grey, siltite to fine-grained quartzite. The complete section is approximately 4500 m. thick.

Ydc — **Calc-silicate, quartzite and siltite of Dahlonega Creek, (Mesoproterozoic)** - Fine-grained feldspathic quartzite and siltite, with common scapolite and calc-silicate bearing beds. Quartzite-rich and calc-silicate-rich intervals are interbedded with each other on the approximately 100 meter scale. Total thickness is difficult to estimate due to intense folding, but is greater than 1 kilometer. May be correlative with the Yellow Lake unit of the Lemhi Group (as redefined by Burmester et al., 2013).

SOUTHWEST A — NORTHEAST A′

WEST B — EAST B′



REFERENCES

Bacorn, H.C., 1905, A Complicated Fault-System: The Engineering and Mining Journal, v. LXXIX, p. 324.

Berg, R.B., 1977, Reconnaissance geology of southernmost Ravalli County, Montana: Montana Bureau of Mines and Geology, Memoir 44, scale 1:40,000, sheet, 39 p. text.

Berg, R.B., and J.D. Lonn, 1996, The Preliminary Geologic Map of the Nez Perce Pass 30′ x 60′ Quadrangle: Montana Bureau of Mines and Geology Open-File Report 339, scale 1:100,000.

Burmester, R.F., Lonn, J.D., Lewis, R.S., and McFaddan, M.D., 2013, Toward a Grand Unified Theory for Stratigraphy of the Lemhi Subbasin of the Belt Supergroup: Northwest Geology, v. 42, p. 187-1-19.

Desmarais, N.R., 1983, Geology and geochronology of the Chief Joseph plutonic-metamorphic complex, Idaho-Montana [Ph. D. dissert.]: Seattle, University of Washington, 143 p.

Evans, K.V., and G.N. Green, 2003, Geologic map of the Salmon National Forest and vicinity, east-central Idaho: U.S. Geological Survey Geologic Investigations Series Map I-2765, 19 p., scale 1:100,000.

Foster, D.A., W.C. Grice, and T.J. Kalakay, 2010, Extension of the Anaconda metamorphic core complex: 40Ar/39Ar thermochronology and implications for Eocene tectonics of the northern Rocky Mountains and the Boulder batholith: Lithosphere, v. 2, p. 232-246.

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

Lincoln, F.C., 1912, Gold Deposits of Gibbonsville, Idaho: Mining and Scientific Press, v. 105, p. 47-49.

Livingston, D.C., 1919, Tungsten, Cinnabar, Manganese, Molybdenum, and Tin in Idaho: University of Idaho School of Mines Bulletin 2, v. 14, 72 p.

Lonn, J.D., and R.B. Berg, 1996, The Preliminary Geologic Map of the Hamilton 30′ x 60′ Quadrangle: Montana Bureau of Mines and Geology Open-File Report 340, scale 1:100,000.

Lonn, J.D., Ohlberg, K.L., Lewis, R.S., Burmester, R.F., Stanford, L.R., Stewart, D.E., 2013, Geologic Map of the North Fork Quadrangle, Lemhi County, Idaho: Idaho Geological Survey Digital Web Map DWM-160, scale 1:24,000.

Lopez, D.A., 1982a, Reconnaissance Geologic Map of the Gibbonsville Quadrangle, Lemhi County, Idaho and Beaverhead County, Montana: United States Geological Survey Miscellaneous Field Studies Map MF-1446, scale 1:24,000.

Lopez, D.A., 1982b, Reconnaissance Geologic Map of the Ulysses Mountain Quadrangle, Lemhi County, Idaho: United States Geological Survey Miscellaneous Field Studies Map MF-1445, scale 1:48,000.

Lopez, D.A., J.M. O'Neill, E.T. Ruppel, 2004, Preliminary Geologic Map of the Big Hole Pass-Lost Trail Pass Area Southwestern Montana: Montana Bureau of Mines and Geology Open-File Report MBMG 522, scale 1:48,000.

Mayerle, R.T., and T.J. Close, 1993, Mineral investigation of the Anderson Mountain study area, Lemhi County Idaho: U.S. Bureau of Mines, Mineral Land Assessment Open-File Report 25-93, 36 p.

Ruppel, E.T., J.M. O'Neill, and D.A. Lopez, 1993, Geologic map of the Dillon 1 degree x 2 degree quadrangle, Idaho and Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1803-H, scale 1:250,000.

Steel, T.D., and Link., P.K., 2013, Mesoproterozoic strata in the Shewag Lake quadrangle, Idaho and Montana: Northwest Geology, v. 42, p. 57-70.

Stewart, E.D., P.K. Link, and D.W. Rodgers, 2010, Geologic Map of the Allan Mountain Quadrangle, Lemhi County, Idaho and Ravalli County, Montana: Idaho Geological Survey Technical Report T-10-1, scale 1:24,000.

Winston, D., and P.K. Link, 1993, Middle Proterozoic rocks of Montana, Idaho, and Washington: The Belt Supergroup: in Reed., J., P. Simms, R. Houston, D. Rankin, P. Link, R. Van Schmus, and P. Bickford, editors, Precambrian of the conterminous United States: Boulder, Colorado, Geological Society of America, The Geology of North America, v. C-3, p. 487-521.

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