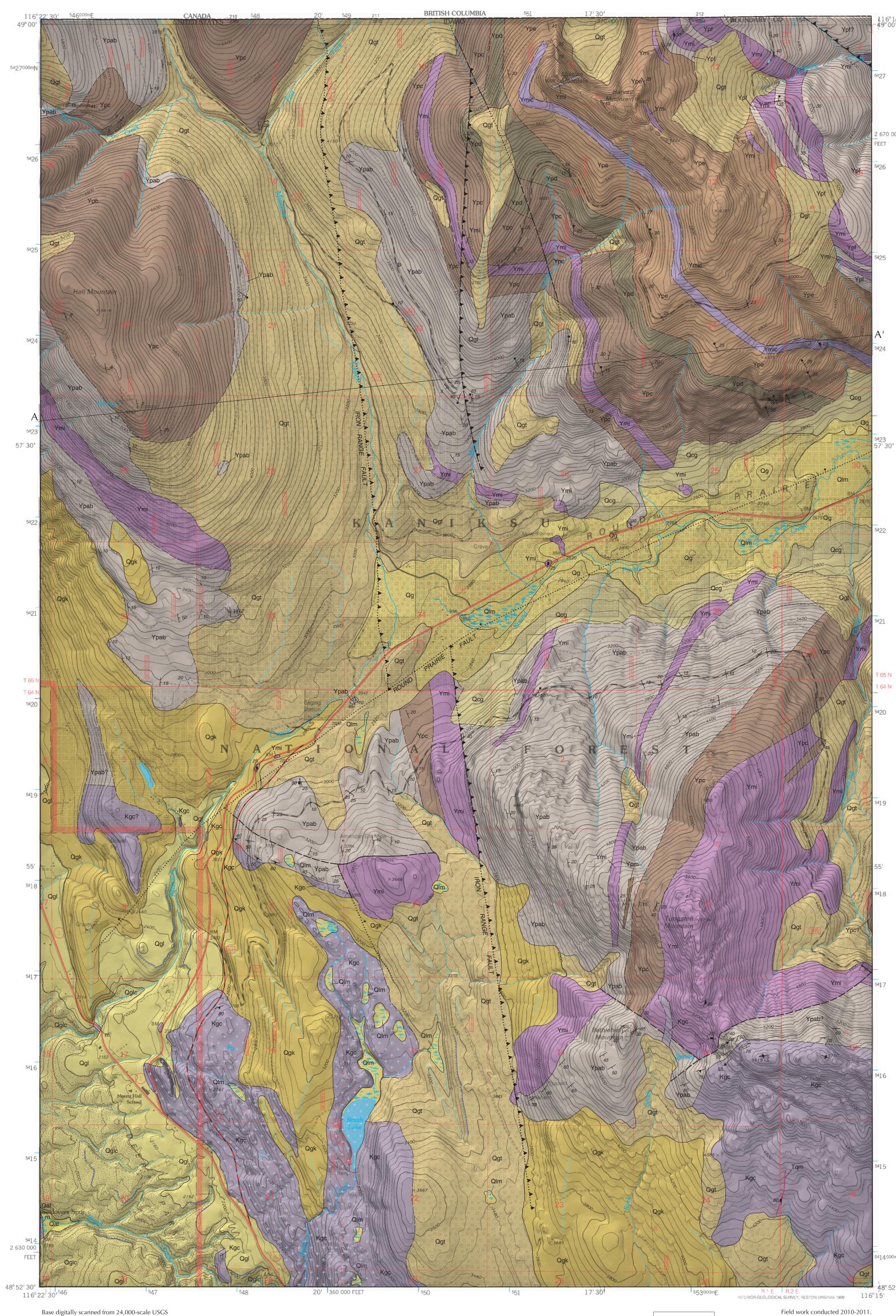
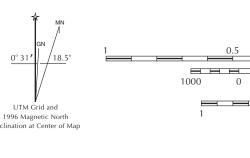
# Geologic Map of the Hall Mountain Quadrangle, Boundary County, Idaho

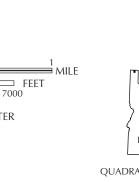
Russell F. Burmester, Roy M. Breckenridge, Reed S. Lewis, and Mark D. McFaddan 2011



film separates, 1965. Revision by the USDA Shaded elevation from 10 m DEM. Topography compiled 1963. Planimetry derived from imagery taken 1992. Public Land Survey Projection: Idaho coordinate system, west zone (Transverse Mercator). 1927 North American 10,000-foot grid ticks based on Idaho coordinate 1000-meter Universal Transverse Mercator grid



Contour interval 40 feet Supplementary contour interval 20 feet

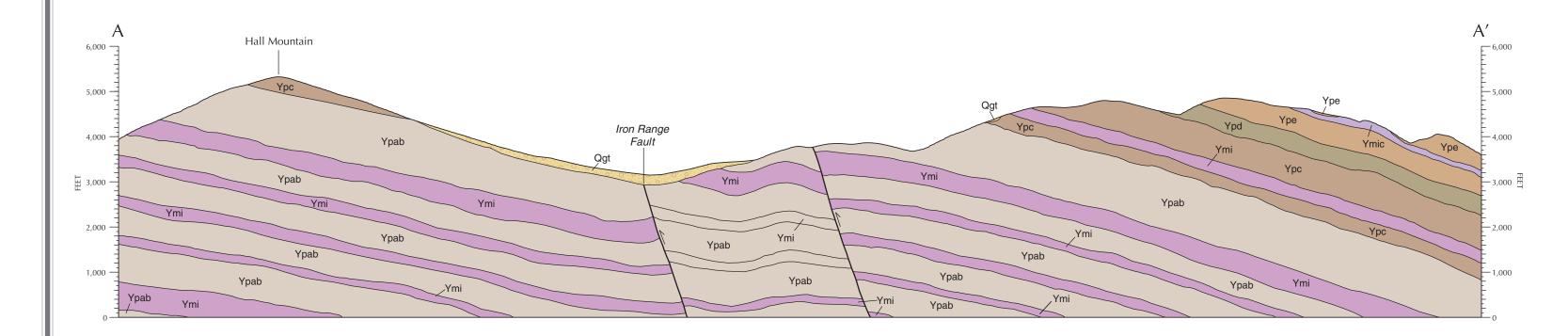


QUADRANGLE LOCATION ADJOINING QUADRANGLES

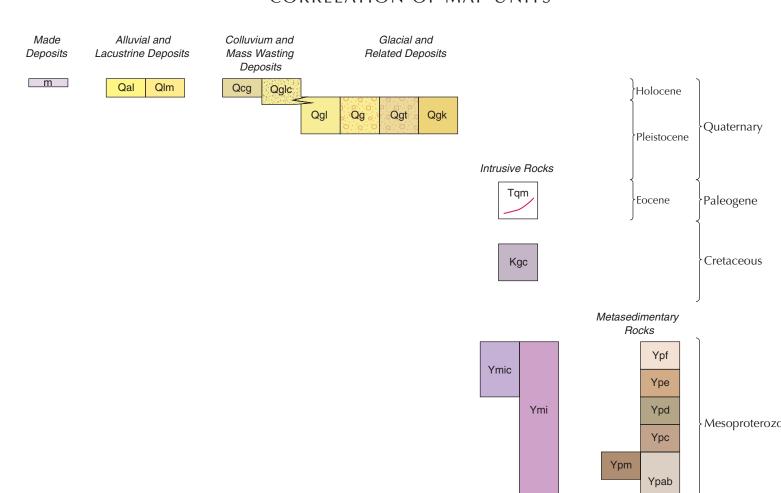
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PDF (Acrobat Reader) map may be viewed online at

www.idahogeology.org.



### CORRELATION OF MAP UNITS



### INTRODUCTION

Quaternary deposits on this 1:24,000-scale quadrangle were mapped in 2010 by R.M. Breckenridge. Bedrock was mapped in 2010 and 2011 by R.F. Burmester, R.S. Lewis, and M.D. McFaddan to modify previous mapping (Miller and Burmester, 2004) for consistency with unit definitions and contact placements used in more recent mapping to the south.

The oldest and most abundant rocks in the Hall Mountain quadrangle are low metamorphic grade metasedimentary rocks of the Mesoproterozoic Prichard Formation, Belt-Purcell Supergroup. These host penecontemporaneous mafic and differentiated sills. Dips are generally homoclinal to the east, with some repetition across steep north-south faults that have displacements up on the east. In the south are Cretaceous plutons. During Pleistocene glaciations a lobe of the Cordilleran Ice Sheet repeatedly advanced southward across the quadrangle from Canada. Locally, tributary valley glaciers of the Cabinet Range contributed to the ice stream. Sections of glacial till, outwash, and lacustrine deposits filled the valleys. After retreat of the continental ice, mountain valley glaciers persisted until nearly 10,000 years ago in the higher circues of the Cabinet Range. Holocene alluvium, colluvium, and lacustrine sediments are mostly derived from

#### DESCRIPTION OF MAP UNITS

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 for igneous rocks. 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 (1963), and Winston (1986). Thicknesses and distances are given in abbreviation of metric units (e.g., dm=decimeter). Unit thickness and elevation are listed in both meters (m) and feet (ft). Multiple lithologies within a rock unit description are listed in order of decreasing abundance. Soil descriptions for Quaternary units are after Chugg and Fosberg (1980) and Weisel (2005).

#### MAN-MADE DEPOSITS

m Made land (historical)—Highway fills.

#### ALLUVIAL AND LACUSTRINE DEPOSITS Qal Alluvium (Holocene)—Alluvial deposits of Brush Creek. Mostly finer grained in alluvial plains and coarser grained in tributary drainages. Moderately

sorted to well sorted silt, sand, and local pebble and cobble gravels. Mostly reworked glacial deposits in the valley and post glacial colluvium in surrounding mountains. Schnoorson-Ritz-Farnhampton soils association; typical soils are very deep silty clay loams, silt loams, and mucky silt loams in basins and swales and on low terraces, flood plains, and natural levees. Thickness is several to more than 10 m (6 to >30 ft).

**Lacustrine and mud deposits (Holocene)**—Organic muck, mud, and peat bogs in poorly drained paleoglacial outwash channels, kettles and bedrock scour and depressions. Interbedded with thin layers of fine sand, silt, and clay. Soils of the Pywell series. Thickness from 1 to 5 m (3-16 ft).

### COLLUVIAL AND MASS WASTING DEPOSITS

Qcg Colluvial deposits (Holocene)—Silt, sand, and gravel colluvium. Forms debris fans and colluvial aprons along steeper escarpments and gullies of glacial terraces and benches. Includes small unmappable mass movements. Mostly in escarpments of *Qglc* where mapped. Varied thickness, typically

Glaciolacustrine deposits (Pleistocene to Holocene)—Mixed deposits of silt, sand, and gravel colluvium, slope wash, and small landslides. Steep slopes of reworked and locally transported Qgl. Soils are silt loams of the Wishbone-Crash association. Maximum thickness 10 m (30 ft).

## GLACIAL DEPOSITS

Qgl Glaciolacustrine deposits (Pleistocene to Holocene)—Massive to well bedded and finely laminated clay, silt, and sand deposited in Glacial Lake Kootenai at the northward retreating ice margin in the Purcell Trench. Exhibit well developed rhythmites and beds of sand and silt and scattered dropstones. Contorted bedding and loading structures are common. This unit forms several prominent terrace levels from an elevation about 670 to 700 m (2,200 to 2,300 ft) and discontinuous terraces in tributary valleys. Mostly well sorted and finely laminated. Overlain by glaciofluvial outwash deposits on terraces and in tributary valleys. Soils are silt loam and silty sandy loams of the Wishbone-Crash association. Exposed thickness maximum 100 m (300 ft).

#### **Till and kame deposits (Pleistocene)**—Mapped where *Qgt* and *Qgk*, described below, are not separable at the map scale.

**Till deposits (Pleistocene)**—Dense silt, pebble, and cobble till with local boulders deposited by the Purcell Trench lobe of the Cordilleran Ice Sheet and local mountain glaciers. Poorly stratified compact basal till includes ground moraine and some interbedded proglacial gravel. Forms end moraines in mountain valleys. Deposit includes kame terraces and some outwash. Soils include silt loams and gravelly silt loams of the Pend Oreille-rock outcrop and the Stien-Pend Oreille associations. Thickness varies; 1-30 m (3-100 ft) in subsurface.

Kame deposits (Pleistocene)—Poorly stratified and compact silty to sandy boulder lodgement till; locally includes ground moraine and some interbedded proglacial and ice contact and outwash deposits. Includes multiple kame terraces along the east side of the Purcell Trench. Soils include silt loams and gravelly silt loams of the Stien-Pend Oreille association. Thickness varies; may exceed 50 m (160 ft).

## INTRUSIVE ROCKS

**Quartz monzonite dike (Eocene)**—Single mafic dike in *Kgc* near southeast corner of map. Assigned to this unit on basis of similar occurrence northwest of Bonners Ferry (Breckenridge and others, 2009). Alternatively, may be lamprophyre dike as found in Moyie Springs quadrangle (Burmester and others, 2010) to the south.

Kgc Granodiorite of Copeland (Cretaceous)—Porphyritic, medium to coarsegrained hornblende-biotite and biotite granodiorite ranging to equigranular hypidiomorphic hornblende monzogranite and biotite granite. Microcline phenocrysts, 2-4 cm in length, comprise 5-25 percent of the rock. Plagioclase has strong oscillatory zonation and average composition of an<sub>28</sub>. Quartz typically in aggregates 4-8 mm across. Myrmekitic intergrowth of quartz and feldspar common. Color index 10-20. Accessories include abundant epidote and sphene, and subordinate zircon, apatite, opaque minerals, and allanite. Inclusions, both cognate and xenoliths with characteristics of the Prichard Formation, are widespread. Both inclusions and megacrysts are aligned to form a mappable fabric only near the northern contact. U-Pb zircon age of 110  $\pm$  2 Ma determined on a sample of this pluton collected 8 km (5 mi) southeast of Copeland in the quadrangle to the west (Richard Gaschnig, written commun., 2011). Hornblende and biotite from a sample along the railroad 0.5 km (0.3 mi) southeast of Copeland gave potassium-argon ages of 95 Ma and 90 Ma respectively (Miller and Engels, 1975; recalculated using current IUGS constants in Steiger and

Jaeger, 1977). These are considered cooling ages. Ymi Mafic intrusive rocks, undivided (Mesoproterozoic)—Fine- to mediumgrained, rare coarse-grained hornblende gabbro and quartz diorite as mostly concordant intrusions. Variants have acicular hornblende, laths of plagioclase, or quartz as large grains or in granophyre. Granophyre concentrations about 1 cm across common in one or more sills in Ypf. Grain size and quartz and mafic mineral content vary among intrusions and commonly within single bodies both along and across strike. Mediumgrained quartz diorite and biotite granophyre differentiates most common at or near tops of bodies, but also occur separately. Most are Moyie sills, which are tabular overall but laterally change thickness, include rafts of country rock, branch into multiple sills, end abruptly or pinch out (Bishop, 1976). Includes apparent dike on Mission Mountain. Although sills lower and higher in the Aldridge Formation (Prichard correlative in Canada) are similar in chemistry (Anderson and Goodfellow, 2000), they seem to have intruded in at least two separate events. Early intrusions were at shallow levels closely following sedimentation of the Lower Aldridge equivalent Ypab (Höy and others, 2000; Gorton and others, 2000; Cressman, 1989; Sears and others, 1998; Poage and others, 2000). Age of sills in *Ypab* is probably close to U-Pb dates on zircons from near Kimberley, British Columbia (Sullivan Mine, Figure 1) about 50 km (30 mi) to the north (1.468 Ga; Anderson and Davis, 1995) and from Plains, Montana, about 170 km

Ymic | Mafic intrusive rocks, Crossport C sill (Mesoproterozoic)—Medium- to coarse-grained hornblende gabbro to quartz diorite. This sill is the northern continuation of the middle or "C" sill of Bishop (1973, 1976), defined in the Moyie Springs quadrangle to the south. Most exposures in this map area are thinner and have less quartz than Ymic there or adjacent Meadow Creek and Eastport quadrangles. Identification here is based on stratigraphic position low in *Ype*. Thickness where most continuously exposed southeast of Harvey Mountain is about 36 m (120 feet).

(106 mi) southeast (1.47 Ga; Sears and others, 1998).

### BELT-PURCELL SUPERGROUP Lower Belt

**Prichard Formation (Mesoproterozoic)**—White to gray siltite, white to gray to black argillite, and white to gray feldspathic quartzite and white quartzite. Siltite in 1-5 dm beds typically rusty weathering due to abundant sulfides, commonly pyrrhotite. Some siltite beds grade to argillite tops, others have bar code-like patterns formed by alternating dark and light layers that persist regionally for over 100 kilometers (Huebschman, 1973). Some of these were used as markers by Cominco for correlation purposes (Hamilton and others, 2000). Siltite and argillite couplets commonly graded to black, rarely white argillite tops. Their lamination characteristically even and parallel in some members, uneven, wavy or undulating in others. Quartzite in 2-20 dm beds light weathering, averages about 60 percent quartz, 20 percent plagioclase, with the rest mostly white micas and 5 percent biotite (Cressman, 1989). Siltite and argillite have less quartz and more micas but about the same feldspar content. Previous mapping in this area had paralleled Cressman and Harrison (1986) in subdividing only the top of the Prichard. However, subdivision in northern Idaho now uses alphabetic member assignments following usage of Cressman (1989) south of 48 degrees north. Presence versus absence of sedimentary structures reflecting strong currents or soft sediment deformation are lithologic criteria used to distinguish adjacent members, but assigning similar quartzite packages to different members was facilitated by two factors. One factor was that mapping with control based on "markers" was recently released by Cominco (Michael Zientek, written commun., 2003). This control served for the upper units down through *Ype*. Locations of some of these markers north of the international border (Glombick and others, 2010) aided matching contacts. The other factor was recognition that the lower-middle Aldridge contact (the *Ypab-Ypc* contact here) was near the top of a concentration of sills just north of the border (Lydon, 2008) and above the distinctive massive lithology of *Ypm*.

Prichard Formation, member f (Mesoproterozoic)—Rusty weathering, even parallel laminated, tabular, light and dark gray siltite and dark gray argillite, and minor lighter quartzite. Siltite with marker-bed like layering more common in this unit than others. Tabular beds of very fine- to fine-grained biotite-feldspar quartzite comprise 5-10 percent of unit; most are 1-4 dm thick with tops graded to dark argillite. Ovoid carbonate concretions as large as 1 dm in diameter common. Top not exposed in map area. Thickness possibly 900 m (3,000 feet); uncertainty due to fault truncation and folding of upper part.

Prichard Formation, member e (Mesoproterozoic)—Light gray to white weathering siltite and quartzite with darker argillite. Siltite dominates over feldspathic quartzite; both occur as 2-20 dm thick beds. Some beds parallel laminated, but many exhibit features of current traction such as rippled tops, ripple cross lamination and trough cross bedding. Soft-sediment deformation features common; load casts and ball and pillow structures locally abundant. Mud chips litter some bedding surfaces on Mission and Harvey mountains. Carbonate concretions present but less common than in Ypf and Ypc. Some quartzite beds that are coarser grained and less feldspathic than typical of the Prichard have rounded medium quartz grains, especially at bed bases. Rounded medium quartz grains also rarely in black argillite near top. Hosts Idaho Archeology system #10BY12 quarry in silicified rock on Harvey Mountain. Upper contact placed above highest zone of quartzite with abundant current features and below thick section of uniformly parallel laminated rusty weathering siltite. Thickness approximately 1,200 m (3,600 feet including thin sill *Ymic*).

Prichard Formation, member d (Mesoproterozoic)—Tabular light gray siltite and dark gray argillite couplets, gray siltite, and quartzite. Most lamination uneven, but there are abundant intervals of thinner (1-5 mm) even parallel laminated, rusty weathering, dark gray to white siltite and dark gray argillite couplets and microlaminae. Less common are 1-3 m thick intervals of white weathering, very fine- to fine-grained quartzite beds, or rusty-weathering white siltite beds 1-3 dm thick. Some of these occur as cosets. Exposed well in the map area only low on the south flank of Harvey Mountain and the west shoulder of Mission Mountain; generally poorly and discontinuously exposed with quartzite over-represented in float. Upper contact placed below Ymic at lowest occurrence of sedimentary structures indicative of currents in siltite and quartzite. Thickness estimated at 120 m (400 feet).

Prichard Formation, member c (Mesoproterozoic)—Light weathering quartzite, darker siltite, and rusty weathering unevenly laminated, dark gray siltite and argillite couplets. Fine-grained to rare medium-grained quartzite, similar to that of Ype but in thinner packages, is scattered throughout the unit. Some beds have ripple and cross lamination, coarser grains at bases and gradation to siltite at tops; others have coarser grains in middle. Carbonate concretions as large as 6 cm in diameter commonly have alteration "halos". Hosts one or two undifferentiated sills. Top placed above set of quartzite beds and below interval of more evenly laminated siltite and argillite. Thickness estimated at 210 m (700 feet).

Prichard Formation, members a and b (Mesoproterozoic)—Even parallel laminated, rusty weathering, dark gray siltite and argillite couplets, siltite, and lighter quartzite. Couplets typically not graded and less than one cm thick; argillite tops locally light weathering. Siltite layers from 2 cm to 3 dm in thickness typically dark gray, some weathering light gray. Light gray to white weathering quartzite as isolated beds 1-3 dm thick and as rare 3-10 dm beds in cosets as much as 3 m in thickness more common toward top of unit. Intimately associated with a massive unit (Ypm) present at or toward the top. Hosts Moyie sills that range from tabular with differentiated tops to irregular with no differentiation. Top placed at base of interval of thick quartzite beds that have medium quartz grains, above highest Ypm, or, where such are absent, below a sill at the level where such criteria are found. Base not exposed, but gravity modeling (Kleinkopf, 1977) suggests that below Ypm exposed in the Sylvanite anticline (Fig. 1) there is a minimum of 3,000 m (10,000 feet) of sedimentary strata above the basement (Cressman and Harrison, 1986).

Prichard Formation, massive unit (Mesoproterozoic)—Structureless, poorly sorted quartzite and siltite to quartz-rich fine-grained biotite granodiorite. Commonly has granofels texture with fine biotite and muscovite common. Locally stratiform but generally discontinuous laterally and nonuniform in thickness. Commonly floored, less commonly capped by mafic sills. Locally contains clasts of laminated siltite and argillite 1-3 cm thick, some of which have apparent reaction rims.

## ROUND PRAIRIE FAULT

Northeast-striking fault in Round Prairie that is nowhere exposed. Kirkham and Ellis (1926) invoked it to explain lack of continuity of sills across Round Prairie and suggested that it was a south-dipping normal fault with vertical throw of more than 300 m (1,000 ft). We show it with north side down because of the apparent left offset of the east-dipping Ypab-Ypc contact across it, and lack of Ype to the south. It is shown to offset the Iron Range fault so would be younger. This contrasts with the relative ages of it and the Carroll Creek fault to the east on the Eastport map.

## IRON RANGE FAULT

faults (Brown and others, 1994). Displacement north of the international border shown schematically as 100-200 m (300-650 ft) on individual faults (Brown and others, 1995). North of Round Prairie, faults between Mission Creek and Mission Mountain may be part of the same system. South of Round Prairie, repetition of the *Ypab-Ypc* contact and kinematic indicators in a broad cataclastic and mylonitic zone are consistent with east-side-up motion and therefore southward continuation of this system, although displacement across this zone may be larger than on single faults in

Named in British Columbia for a 1 km (0.06 mi) wide zone of east-side-up

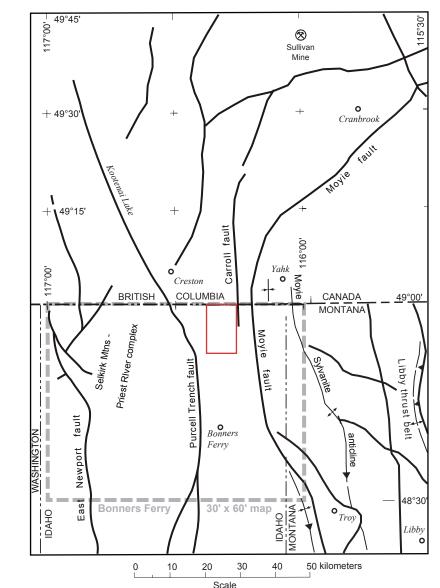


Figure 1. Location of Hall Mountain 7.5' quadrangle (red box) with respect to major structural and physiographic features.

#### SYMBOLS

Contact: dashed where approximately located.

· Thrust fault: teeth on upper plate; dashed where approximately located; dotted where concealed.

····· Normal fault: ball and bar on downthrown side; dashed where approximately located; dotted where concealed.

————— Fault: dashed where approximately located; dotted where concealed.

\ 10 Strike and dip of bedding.

\$\frac{1}{20}\$ Strike and dip of bedding; ball indicates bedding known to be upright.  $\chi^{20}$  Strike and dip of bedding, strike variable.

Estimated strike and dip of bedding.

Strike and dip of foliation.

★ Strike of vertical foliation. Strike and dip of cleavage.

 $\checkmark_{30}$  Strike and dip of joint.

rotation viewed down plunge.

Bearing and plunge of lineation, type unknown. # Bearing and plunge of asymmetrical small fold showing counterclock-

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

Glacial striation.

Moraine crest or kame ridge. Terrace escarpment.

Area of subglacial tunnel erosion and scattered kame deposits.

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