Geologic Map of the Eastport Quadrangle, Boundary County, Idaho

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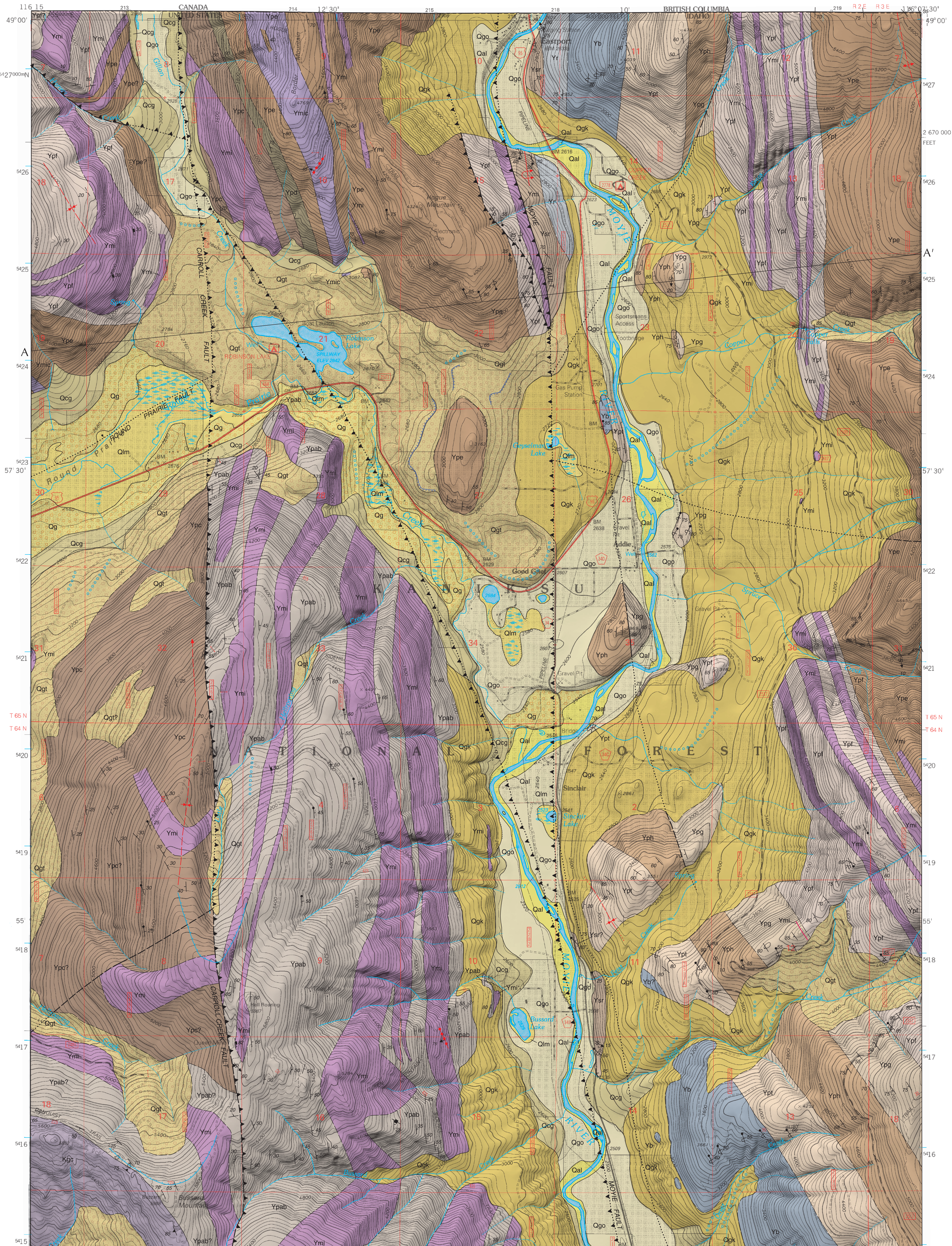
2011



Base digitally scanned from 24,000-scale USGS film separates, 1965. Revision by the USDA Forest Service 1996.
Shaded elevation from 10 m DEM.
Topography compiled 1963. Planimetry derived from imagery taken 1992. Public Land Survey System and survey control current as of 1996.
Projection: Idaho coordinate system, west zone (Transverse Mercator). 1927 North American Datum.
10,000-foot grid ticks based on Idaho coordinate system, west zone.
1000-meter Universal Transverse Mercator grid ticks, zone 11.

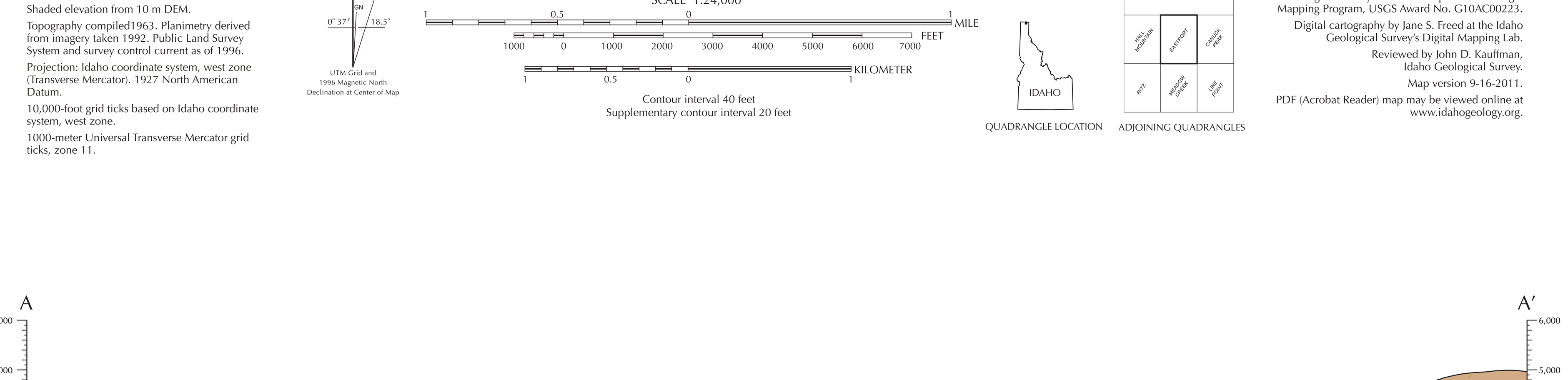
SCALE 1:24,000

Contour interval 40 feet
Supplementary contour interval 20 feet

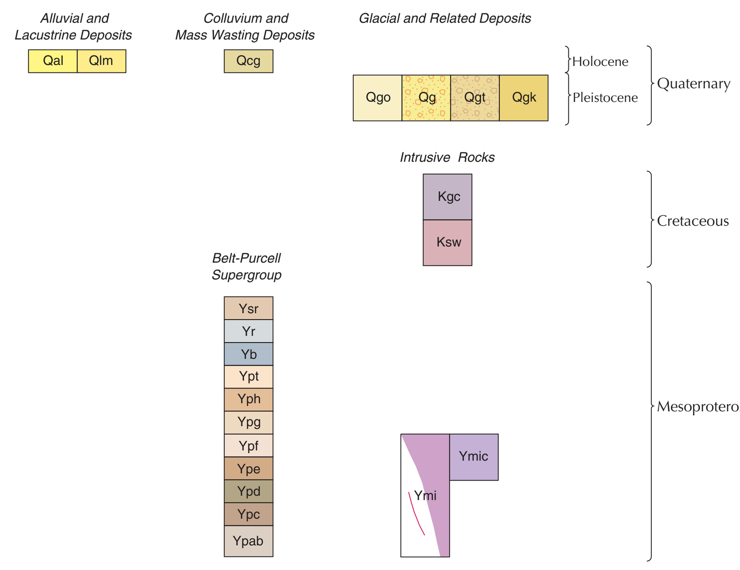
QUADRANGLE LOCATION

ADJOINING QUADRANGLES

Field work conducted 2010.
This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program, USGS Award No. G10AC00223.
Digital cartography by Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.
Reviewed by John D. Kauffman, Idaho Geological Survey.
Map version 9-16-2011.
PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.



CORRELATION OF MAP UNITS



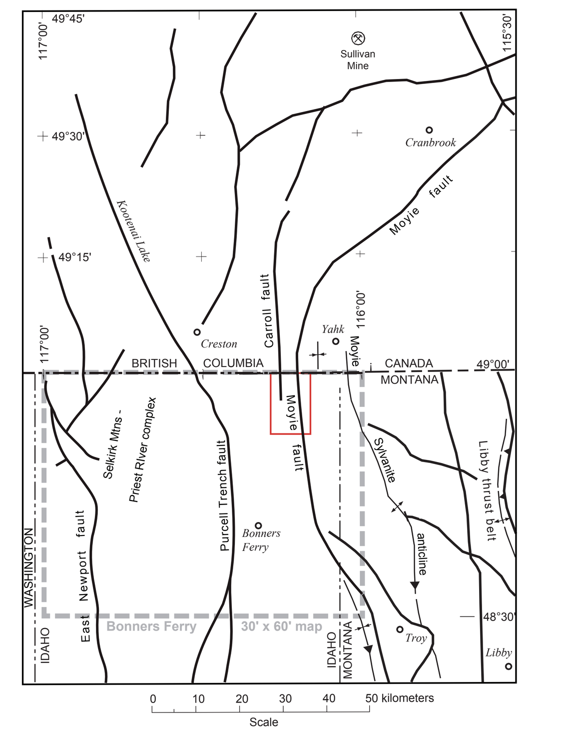


Figure 1. Location of Eastport 7.5' quadrangle (red box) with respect to major structural and physiographic features.

INTRODUCTION

Quaternary deposits on this 1:24,000-scale quadrangle were mapped in 2010 by R.M. Breckenridge, who augmented this work with observations and logs from the natural gas pipeline trench dug in 1992. Bedrock was mapped in 2010 by R.F. Burmester, R.S. Lewis, and M.D. McFaddan to modify previous mapping (Burmester, 1985) for consistency with unit definitions and contact placements used in more recent mapping to the south.

The oldest and most abundant rocks in the Eastport quadrangle are low metamorphic grade metasedimentary rocks of the Mesoproterozoic Belt-Purcell Supergroup. The lowest strata host penecontemporaneous mafic and differentiated sills. The oldest rocks occur in the western part of the map area and generally have tops to the east, but are partly repeated by the Carroll Creek fault. The youngest, on the west flank of the Sylvanite anticline east of the Moyie fault (Figure. 1), have tops to the west. Units exposed along the fault suffer structural complications that are difficult to understand because of poor and discontinuous exposure. 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 cirques of the Cabinet Range. Holocene alluvium, colluvium, and lacustrine sediments are mostly derived from glacial deposits.

DESCRIPTION OF MAP UNITS

Intrusive rocks are classified according to IUGS 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 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 and feet. 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).

ALLUVIAL AND LACUSTRINE DEPOSITS

Qal **Alluvium (Holocene)**—Alluvial deposits of the Moyie River, Round Prairie Creek and their tributary streams. Mostly finer grained in the Moyie River alluvial plain 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 river valley and post glacial colluvium in the 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).

Qlm **Lacustrine and mud deposits (Holocene)**—Organic muck, mud, and peat bogs in poorly drained paleoglacial outwash channels, kettles, and scoured bedrock depressions. Interbedded with thin layers of fine sand, silt, and clay. Soils of the Pywell series. Thickness 1-5 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 steep valleys and gullies mostly derived of glacial deposits. Includes small unmappable mass movements. Varied thickness, typically 5 m (15 ft).

GLACIAL DEPOSITS

Qgo **Outwash deposits, undivided (Pleistocene)**—Silty and sandy gravels. Moderately sorted and rounded pebbles and cobbles. The presence of Glacier Peak Tephra (11,200 B.P.) gives a minimum date for retreat of the ice lobe from the trench (Richmond, 1986). Soils are sandy loams and loamy sands of the Selle-Elmira Association. Maximum thickness about 20 m (60 ft).

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

Qgt **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 till includes ground moraine and forms end moraines around Robinson Lake. Deposit includes kame terraces and some interbedded proglacial gravels. 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.

Qgk **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 Moyie River. Soils include silt loams and gravelly silt loams of the Stien-Pend Oreille association. Thickness varies; may exceed 50 m (160 ft).

INTRUSIVE ROCKS

Kgc **Granodiorite of Copeland (Cretaceous)**—Porphyritic, medium- to coarse-grained hornblende, hornblende-biotite, and biotite granodiorite. Megacrysts of poikilitic microcline as long as 8 cm comprise from about 5 to 20 percent of the rock. Where exposed southwest of the quadrangle, plagioclase has strong oscillatory zonation and average composition of an_{28}. Quartz typically in aggregates 4-8 mm across. Myrmekitic intergrowth of quartz and feldspar common. Color index 13-17, but near contact, interlayered with more mafic, equigranular phase. Accessories include abundant sphene, epidote, and subordinate zircon, apatite, opaque minerals, and allanite. North-south and steep foliation 30 m from nearest *Ksw* appears to parallel contact and crosscut southeast striking fabric in *Ksw*. U-Pb zircon age of 110 ± 2 Ma determined on a sample of this pluton collected 8 km (5 mi) southeast of Copeland two quadrangles 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 (Steiger and Jaeger, 1977). These are considered cooling ages.

Ksw **Syenite of Wall Mountain (Cretaceous)**—Medium gray to blue-gray hornblende quartz syenite. Only northern tip of a single small elongate stock exists on map. Overall the stock is highly varied fine to very coarse grained, equigranular to porphyrytic and hypidiomorphic to idiomorphic granular (Burmester and others, 2010b). Locally, more mafic variety appears layered and cut by porphyritic variety. U-Pb zircon age of 114 ± 3 Ma determined on a sample of this pluton collected in the Meadow Creek quadrangle to the south (Richard Gaschnig, written communication, 2011).

Ymi **Mafic intrusive rocks, undivided (Mesoproterozoic)**—Fine- to medium-grained, rarer coarse-grained hornblende gabbro and quartz diorite. Variants have laths of plagioclase, or quartz as large grains or in granophyre. Grain size and quartz and mafic mineral content vary among intrusions and commonly within single bodies both along and across strike. Differentiates of medium-grained quartz diorite and biotite granophyre most common at or near tops of bodies. Most intrusions are Moyie sills, locally concordant, but some laterally pinch and swell, include rafts of country rock, branch into multiple sills, end abruptly or gradually pinch out (Bishop, 1976). 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). Generation of a distinct massive lithology (*Ypm* on maps to south and west) was probably synchronous with shallow intrusion events. Later intrusions sport chilled margins and contact aureoles, evidence that they invaded consolidated rock at a later time. Age of sills in *Ypab* is probably close to U-Pb dates on zircons from near Kimberley, British Columbia (Sullivan Mine, Fig. 1) about 40 km (25mi) to the north (1.468 Ga; Anderson and Davis, 1995) and from Plains, Montana, about 160 km (100 mi) southeast (1.47 Ga; Sears and others, 1998).

Ymic **Mafic intrusive rocks, Crossport C sill (Mesoproterozoic)**—Fine- to medium-grained hornblende gabbro to quartz diorite. Finer-grained variety typically near top and bottom. Characterized by higher concentration of quartz-rich differentiates than typical *Ymi*. This sill is the northern continuation of the middle or "C" sill of Bishop (1973, 1976), defined in the Moyie Springs quadrangle (Burmester and others, 2010a) to the south. It is recognized only on Border Mountain west of Eastport. Thickness there about 320 m (1,050 ft).

BELT-PURCELL SUPERGROUP

Ravalli Group

Ravalli Group strata are mapped discontinuously east of the Moyie fault. Internal divisions are not easily made due to poor exposure and structural complications where the units are cut out, folded, and present as slices along the Moyie fault.

Ysr **St. Regis Formation (Mesoproterozoic)**—Pale purple and green siltite and argillite, and rare quartzite. Siltite and argillite couplets commonly graded and uneven with mud cracks. Quartzite fine-grained and feldspathic in irregular 5-20 cm beds with uneven purple layering, 2-5 cm ripple cross lamination and ripples foundered into underlying mud. Based on more complete exposure in the Meadow Creek quadrangle (Burmester and others, 2010b) to the south, lower strata are entirely shades of purple. Green lithologies occupy 1-10 m thick zones in the middle. Those become progressively thicker and increasingly carbonate-bearing toward the top as purple zones become thinner. Carbonate was found only near the international border both disseminated and as 1 cm concentrations that weather to pits in some pale green siltite beds. Neither the top nor bottom was observed, so contact relations and thickness are not known within the map area.

Yr **Revett Formation (Mesoproterozoic)**—Pale purple siltite and darker argillite, white and purple-striped quartzite. Siltite and argillite couplets similar to those in upper Burke or lower St. Regis. Very fine-grained 1-5 dm quartzite beds exposed best east of Eastport are fractured and folded, preventing internal stratigraphy from being characterized and obscuring any cosets of thick sets of quartzite used to define the Revett elsewhere (Hayes, 1983; Hayes and Einaudi, 1986). However, Revett is mapped on the east side of the Sylvanite anticline (Cressman and Harrison, 1986) and correlated with the middle Creston north of the border where copper-silver-cobalt mineralization is similar to that in the Revett to the south (Hartlaub, 2009), so it is carried here as the quartzite-rich strata between more typical Burke and St. Regis formations. No thickness or contact relations were determined.

Yb **Burke Formation (Mesoproterozoic)**—Green to gray-green and purple siltite and argillite and gray to white quartzite. Lower part dominantly 10-20 cm thick siltite beds typically with macroscopic but sub-mm magnetite octahedra exposed in the south part of the map and in a small fault slice south of Eastport. In more continuous exposure east of Eastport near the international border includes purple-banded or zebra-striped quartzite in beds 10-30 cm thick and platy to paper shaly green, rare maroon, non-carbonate argillite zones. Upper contact placed at base of lowest thick white quartzite. Thickness east of Eastport approximately 600 m (2,000 ft).

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 more than 100 km (62 mi) (Huebschman, 1973). Some of these were used as markers by Cominco for correlation purposes (Hamilton and others, 2000). Siltite and argillite couplets commonly graded with 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 lack of sedimentary structures reflecting strong currents or soft sediment deformation are lithologic criteria used to distinguish members, but assigning quartzite packages with similar characteristics to different members was facilitated by two factors. One factor was that mapping with control based on "markers" was released by Cominco (Michael Zientek, written commun., 2003). This control served for the upper units down through *Ype*. Locations 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 a distinctive massive lithology.

Ypt **Prichard Formation, transition member (Mesoproterozoic)**—Gray, dark blue-gray to greenish-gray to white siltite commonly graded to dark gray to black argillite, with scattered white quartzite beds. Siltite and argillite couplets uneven to pinch and swell due to slight loading or channeling at bases. Argillite caps typically cut by clastic dikelets have discontinuous cracks on surfaces. Siltite as 10 cm thick beds are cross laminated or have internal grading from light to dark gray in couples where internal structure visible. Quartzite fine grained and characterized by dark horizontal planar laminations, as well as common ripple and larger low angle cross laminations, hummocky cross lamination, small "dish" structures, scattered load structures to 15 cm in depth, and manganiferous carbonate concretions about 1 decimeter in diameter. Talus flaggy to platy, commonly shows black argillite surfaces. Upper contact placed above uppermost recognized dark gray argillite tops, where lighter greenish-gray argillite of *Yb* dominates. Thickness about 500 m (1,600 ft). Mapped here and immediately to the east (Cressman and Harrison, 1986) as "transition zone" into overlying Burke Formation whereas elsewhere included in Burke (e.g., Cressman, 1985) or Creston Formation (Brown and others, 1994).

Yph **Prichard Formation, member h (Mesoproterozoic)**—Laminated gray siltite and black argillite couplets to microlaminated black argillite with white siltite "lines", and minor brownish siltite and light-weathering quartzite. Laminae and microlaminae characteristically very even and continuous. Parting commonly 2 mm to 5 cm. Weathers with a distinct rusty veneer. Siltite slabby, 3-10 cm beds; quartzite 3-5 dm in middle of unit. Uppermost contact placed at lowest occurrence of white quartzite and pinch and swell siltite and argillite couplets of overlying *Ypt*. Thickness about 500 m (1,600 ft). Nicknamed the "lined unit" of the Prichard Formation; is equivalent to the Upper Aldridge in Canada.

Ypg **Prichard Formation, member g (Mesoproterozoic)**—Green-gray siltite, dark gray argillite and gray to white feldspathic quartzite. Platy, even parallel siltite and dark gray argillite, which also occurs as graded tops of quartzite and siltite beds. Fine- to very fine-grained quartzite as 1-5 dm, rarely thicker beds. Ripple cross lamination, rippled tops. Top placed below thick interval of flat laminated dark siltite and argillite. Thickness about 500 m (1,600 ft).

Ypf **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 as 1-5 dm thick tabular beds with internal lamination obscured by surface staining; bases uneven with load-cast and tops graded to dark argillite; rarely as fine-coarse-fine graded packets. Also as light gray bases of couplets graded to darker argillite. Siltite with marker-bed-like layering more common in this unit than others. Tabular beds of very fine- to fine-grained poorly sorted biotite feldspar quartzite comprise 5-10 percent of unit; most are 1-4 dm thick with tops graded to dark argillite; some are 10 dm thick. Ovoid carbonate concretions to about 1 dm in diameter common. Upper contact placed at lowest occurrence of uneven bedding, cross lamination, or concentration of quartzite. Thickness east of the Moyie fault possibly over 1,000 m (3,300 ft) including sills; thickness west of the fault uncertainty due to truncation and folding of upper part.

Ype **Prichard Formation, member e (Mesoproterozoic)**—Light gray to white weathering siltite and quartzite with darker argillite tops and siltite and argillite couplets. Siltite in 2-10 cm beds dominates over feldspathic quartzite. 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, flute and groove casts less common. Some quartzite beds coarser grained and less feldspathic than typical of the Prichard have rounded medium quartz grains, especially at bed bases. Carbonate concretions concentrated in some horizons, absent from others. Siltite and argillite couplets light weathering with uneven to undulating lamination. Upper contact placed above highest zone of quartzite with abundant current features and below thick section of uniformly parallel laminated rusty weathering siltite. Quartzite-rich sections commonly form clear ribs and talus slopes. Thickness approximately 1,000 m (3,400 ft) west of the Moyie fault; base not exposed to the east.

Ypd **Prichard Formation, member d (Mesoproterozoic)**—Laminated, generally tabular light gray siltite and dark gray argillite, minor quartzite. Exposed well only west of Border Mountain. Elsewhere, very rusty weathering dark gray to white siltite and dark gray argillite couplets uneven and even parallel laminated and microlaminated. Rusty weathering siltite and white, very fine- to fine-grained quartzite in beds as thick as 1 dm. Upper contact placed at lowest occurrence of siltite and quartzite with abundant sedimentary structures indicative of currents. Thickness 200-500 m (600-1,600 ft), uncertainty probably due to poor exposure of contacts.

Ypc **Prichard Formation, member c (Mesoproterozoic)**—Dark gray siltite, rusty weathering, unevenly laminated, dark gray siltite and argillite couplets, and light weathering quartzite. Fine-grained to rare medium-grained quartzite similar to that of *Ype* but in thinner packages is scattered throughout the unit. Some beds have ripples and cross lamination, coarser grains at bases and gradation to siltite at the top. Others as thick as 3 m appear structureless or have coarser grains in middle as well as bases. Circular brown spots as large as 6 cm diameter with alteration "halos" probably formed from concentrations of (manganese) carbonate. 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 700 m (2,100 ft).

Ypab **Prichard Formation, members a and b (Mesoproterozoic)**—Even parallel laminated to undulating, 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 2-5 cm and 1-5 dm, typically dark gray, some weather light gray. Isolated 1-10 dm beds of light gray to white weathering quartzite appear structureless or show internal scour, small white mud chips. Intimately associated with a massive unit not mapped separately here. Hosts Moyie sills that range from tabular with differentiated tops to irregular with no differentiation. Top placed at base of lowest biotite-poor quartzite that has medium quartz grains or, in absence of such, at a similar distance below the lowest sill in *Ypc*. Base not exposed, but gravity modeling (Kleinkopf, 1977) suggests that under the Sylvanite anticline east of the Moyie fault (Figure 1), there is a minimum of 3,000 m (10,000 ft) of sedimentary strata above the basement (Cressman and Harrison, 1986).

STRUCTURE

MOYIE FAULT

The major structure in the map area is the Moyie fault. It is characterized regionally as an east-vergent thrust. Here it juxtaposes older rocks on the west (hanging wall) against younger rocks on the east, consistent with this interpretation. However, strata of the hanging and foot walls face each other, giving the impression that the fault occupies a syncline. Support for a synclinal fold geometry comes from existence of a slightly east-verging southward-plunging syncline west of the Moyie fault south of the map area (Miller and Burmester, 2004) and an open, northward-plunging syncline north of the international border (Brown and others, 1995; Brown, 1998). One hypothesis is that these are remnants of a syncline that was paired with the Sylvanite anticline to the east before contraction was accommodated by faulting. Synclines near the fault, however, appear overturned to the east, consistent with generation by west-side-up drag on an east-verging Moyie fault. A splay of this fault through Robinson Lake is nowhere exposed, but accommodates juxtaposition of *Ypab* to the south against younger members to the north.

CARROLL CREEK FAULT

Named in British Columbia where diagrammatically shown to have about 5,000 m (15,000 ft) up on the east displacement (Brown and others, 1994). Repetition of *Ype* unit across Gillon Creek and narrow syncline south of Round Prairie are consistent with this sense of motion.

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 300m (1,000 ft). It does not appear to offset of Carroll Creek fault, so is judged older and shown truncated by that fault. In contrast, Kirkham and Ellis (1926) showed it truncating faults from the north and continuing to the Moyie fault.

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.

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

Anticline.

Syncline.

Overturned anticline.

10 Strike and dip of bedding.

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

20 Strike and dip of bedding, strike variable.

Strike of vertical bedding.

70 Strike and dip of overturned bedding.

35 Estimated strike and dip of overturned bedding.

55 Strike and dip of overturned bedding: ball indicates bedding known to be upright.

10 Estimated strike and dip of bedding.

70 Strike and dip of foliation.

Strike of vertical foliation.

65 Strike and dip of mylonitic foliation.

35 Strike and dip of cleavage.

30 Strike and dip of joint.

Strike of vertical joint.

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

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

25 Bearing and plunge of mylonitic lineation.

65 Quartz vein: arrow indicates dip of vein.

Cirque headwall: ticks on glaciated side.

Moraine crest or kame ridge.

Terrace escarpment.

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