Geologic Map of the Canuck Peak Quadrangle, Boundary County, Idaho and Lincoln County, Montana

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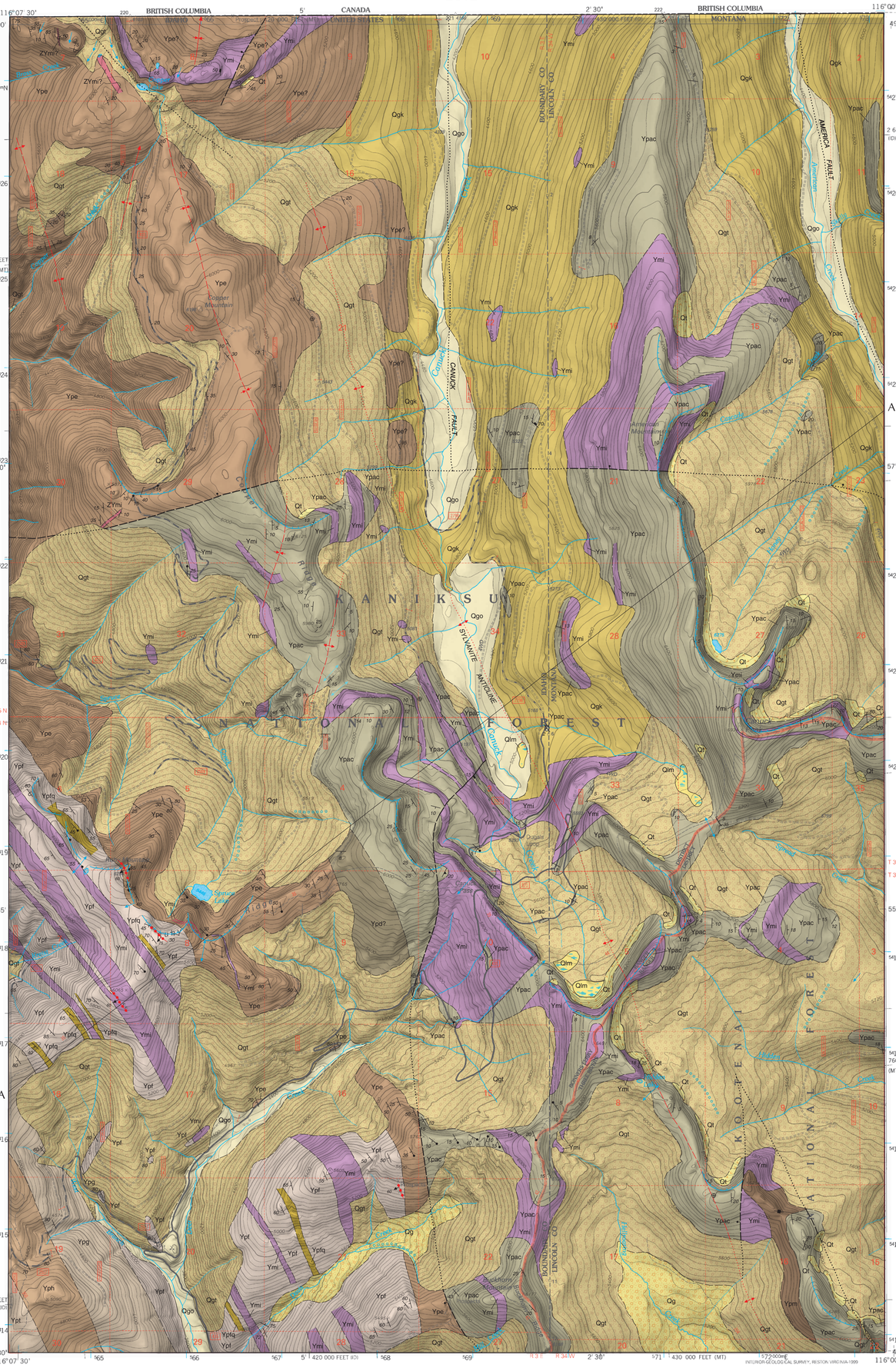
2012



Base Map Credit

Base digitally scanned from 24,000-scale USGS film separates, 1996.

Shaded elevation from 10 m DEM.

Topography compiled 1963. Planimetry derived from imagery taken 1992. Public Land Survey System and survey control 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 16.

UTM Grid and 1996 Magnetic North Declination at Center of Map

SCALE 1:24,000

Contour interval 40 feet

QUADRANGLE LOCATION

ADJOINING QUADRANGLES

[1]Idaho Geological Survey
[2]Montana Bureau of Mines and Geology

Field work conducted 2010-2011.

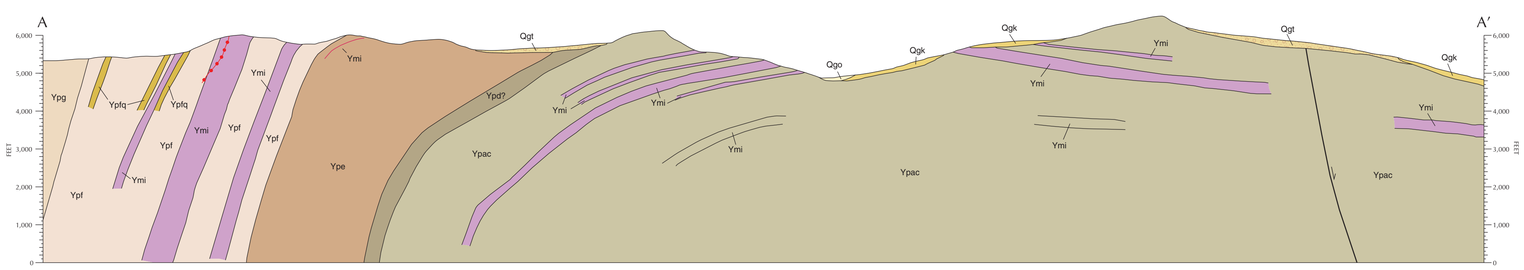
This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program, USGS Award No. G11AC0207 (IGS) and Award No. G11AC0257 (MBMG).

Digital cartography by Collette Gantenbein and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

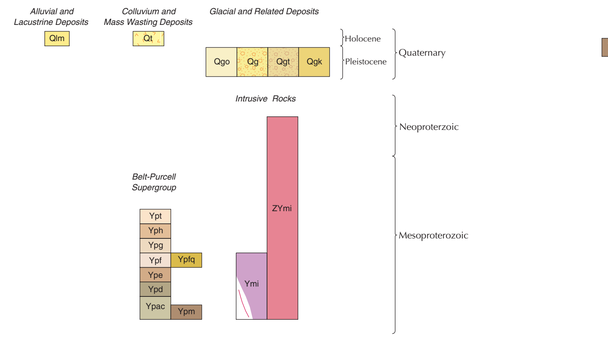
Reviewed by John D. Kauffman, Susan M. Vuke, and Catherine McDonald.

Map version 11-16-2012.

PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.



Correlation of Map Units



Introduction

Quaternary deposits on the Canuck Peak 1:24,000-scale quadrangle were mapped in 2010 and 2011 by R.M. Breckenridge. Bedrock was mapped in 2010 and 2011 by R.F. Burmester, M.D. McFaddan, R.S. Lewis, and J.D. Lonn to modify previous mapping (Burmester, 1985) for consistency with unit definitions and contact placements used in more recent mapping.

The oldest and most abundant rocks in the Canuck Peak quadrangle are low metamorphic grade metasedimentary rocks of the Mesoproterozoic Prichard Formation, Belt-Purcell Supergroup. These metasedimentary rocks host penecontemporaneous mafic and differentiated sills. The metasedimentary rocks and sills are exposed east of the Moyie fault on the west limb of the Sylvanite anticline (Fig. 1). During Pleistocene glaciations, the Cordilleran Ice Sheet repeatedly advanced southward across the quadrangle from Canada. Cosmogenic ^{10}Be surface exposure ages (mean weighted) constrain the glacial maximum ice limit near the Clark Fork ice dam at 14.1 ± 0.6 ka (Breckenridge and Phillips, 2010). Kame deposits near the United States-Canada border constrain the ice recession (^{10}Be range) from 13.3 to 7.7 ka (William Phillips, written commun., 2011). Locally, tributary valley glaciers of the Purcell Mountains 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 in the higher cirques of the Purcell Mountains.

Symbols

- Contact: dashed where approximately located.
- Normal fault: ball and bar on downthrown side; dashed where approximately located; dotted where concealed.
- Anticline axial trace, arrow indicates direction of plunge; dashed where approximately located; dotted where concealed.
- Syncline axial trace, arrow indicates direction of plunge; dashed where approximately located; dotted where concealed.
- 10 Strike and dip of bedding.
- 20 Strike and dip of bedding; ball indicates bedding known to be upright.
- 70 Strike and dip of overturned bedding.
- 10 Estimated strike and dip of bedding.
- Horizontal bedding.
- 70 Strike and dip of foliation.
- 30 Strike and dip of cleavage.
- Strike of vertical cleavage.
- 50 Strike and dip of joint.
- Strike of vertical joint.
- 20 Bearing and plunge of small fold axis.
- Ice flow direction.
- Col.
- 65 Quartz vein: arrow indicates dip of vein.
- Cirque headwall: ticks on glaciated side.
- Moraine crest or kame ridge.

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). Linear dimensions are given in abbreviation of units (e.g., dm=decimeter, ft=feet). Bed thicknesses are given only in metric; unit thickness and elevation are listed in both meteric and English units. 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

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

Qt **Talus (Holocene)**—Blocky and tabular, poorly sorted angular clasts of Belt-Purcell Supergroup rocks form talus deposits below cirque headwalls and cliffs oversteepened by glaciation. Generally no soil development. Thickness varies, usually 3-9 m (10-30 feet).

Glacial Deposits

Qgo **Outwash deposits, undivided (Holocene and Pleistocene)**—Bouldery and sandy gravels. Moderately sorted and rounded pebbles and cobbles. Includes small unmappable deposits of alluvium. 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. Poorly stratified compact basal till includes ground moraine and some interbedded proglacial deposits. Deposit includes kame terraces and some outwash along the south margin. 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).

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

Intrusive Rocks

ZYmi **Mafic intrusive rocks (Neoproterozoic or Mesoproterozoic)**—Fine- to medium-grained diorite as dikes. Judged younger than Moyie sills because some appear to intrude joints in folded Prichard Formation. Mapped only west of Copper Ridge, but some *Ymi* elsewhere (e.g., irregular intrusion with silicified chilled margins on Ruby Ridge east of Spruce Lake) may be this unit. Possibly coeval with intrusions in and above the Piegan Group in quadrangles to the south, so may be related to the Purcell lava (rhyolite about 50 km (30 mi) east dated 1.443 Ga; Evans and others, 2000), or a sill complex farther east (760 Ma; Burtis and others, 2003).

Ymi **Mafic intrusive rocks, undivided (Mesoproterozoic)**—Fine- to medium-grained, rarer coarse-grained hornblende gabbro and quartz diorite. Variants have plagioclase laths, quartz as large grains, and quartz in granophyre. Grain size, quartz, and mafic mineral content vary among intrusions and commonly within single bodies, both along and across strike. Medium-grained quartz diorite and biotite granophyre differentiates most common at or near tops of bodies (e.g., on Copper Ridge). Other bodies (e.g., southwest of Canuck Pass and north of Buckhorn Mountain) appear autobrecciated or have internal chilled margins. All are probably Moyie sills, generally concordant but some laterally pinch and swell, include rafts of country rock, branch into multiple sills, end abruptly, or gradually pinch out (Bishop, 1976); discordant bodies are rare. 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 (Höy and others, 2000; Gorton and others, 2000; Cressman, 1989; Sears and others, 1998; Poage and others, 2000). Age of these sills is probably close to U-Pb dates on zircons from near Kimberley, British Columbia (Sullivan Mine, Fig. 1) about 90 km (55 mi) north (1.468 Ga; Anderson and Davis, 1995), and from Plains, Montana, about 200 km (125 mi) south-southeast (1.47 Ga; Sears and others, 1998).

Belt-Purcell Supergroup

Lower Belt

The Prichard Formation consists of the lowest strata of the Belt-Purcell Supergroup. It is equivalent to the Aldridge Formation in Canada.

Ypf **Prichard Formation (Mesoproterozoic)**—White to gray siltite, white to gray to black argillite, 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. 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; siltite and argillite have less quartz and more micas but about the same feldspar content (Cressman, 1989). Previous mapping in this area had paralleled Cressman and Harrison (1986) in subdividing only the top of the Prichard. Here, we follow alphabetic member assignment that Cressman (1989) used south of 48 degrees north latitude. Presence versus lack of sedimentary structures reflecting strong currents or soft sediment deformation are lithologic criteria used to distinguish adjacent 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 communication, 2003). This 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 across it. The other factor was recognition that the lower-middle Aldridge contact (the Ypb-Ypc contact, not mapped here) was near the top of a concentration of sills just north of the border to the west (Glombick and others, 2010) and above the distinctive massive unit *Ypm*. However, we did not map the base of *Ypc* in this quadrangle and therefore included it with lower units as *Ypac*.

Ypt **Prichard Formation, transition member (Mesoproterozoic)**—Gray, dark blue-gray to greenish-gray to white siltite commonly graded to dark gray or black argillite, with scattered white quartzite beds. Siltite and argillite couplets pinch and swell due to slight loading or channeling at bases. Argillite caps typically concave up between clastic dikelets that form 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 is visible. Quartzite, about 15 percent of unit, is fine grained and characterized by dark horizontal planar lamination, as well as ripple and larger low-angle cross lamination, hummocky cross lamination, small "dish" structures, scattered load structures to 15 cm in depth, and manganiferous carbonate concretions 2-8 cm in diameter. Talus is flaggy to platy, commonly showing black argillite surfaces. Only base exposed in southwest corner of map. Thickness to the south 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, parallel and continuous. Parting commonly 2 mm to 5 cm. Weathers with a distinct rusty veneer. Siltite beds 3-10 cm thick; quartzite beds 3-5 dm, concentrated in middle, comprise less than 5 percent of unit. Upper contact placed below lowest occurrence of white quartzite and pinch and swell siltite and argillite couplets of overlying *Ypt*. Exposed where cut by FS Rd 2517, southwest corner of map. Thickness about 500 m (1,600 ft). Nicknamed the "lined unit" of the Prichard Formation; 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 as couplets and as tops of graded quartzite and siltite beds. Fine- to very fine-grained quartzite decreases upward from 30-40 percent to 10-20 percent and beds thin from 5-10 dm to 1-2 dm. Quartzite displays ripple cross lamination, rippled tops, some bottom marks. Top placed below thick interval of flat laminated dark siltite and argillite. Poorly exposed where cut by FS Rd 2571, southwest corner of map. Thickness about 500 m (1,600 ft).

Ypfq **Prichard Formation, member f quartzite (Mesoproterozoic)**—Light gray- to white-weathering fine-grained feldspathic quartzite. Mapped only across Ruby Ridge where well enough exposed to show dominance of decimeter- and meter-thick quartzite beds, some in cosets, that range from tabular to broad channel shapes.

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, which varies in concentration from about 10 to 40 percent through 10 m of section. Some beds parallel laminated, but many exhibit features of current traction such as rippled tops, ripple cross lamination, trough cross bedding, and inclusion of white argillite chips. 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, but rounded medium quartz grains not as prevalent as west of the Moyie fault or in *Ypac* in this area. Carbonate concretions concentrated in some horizons, absent from others. Siltite and argillite couplets light weathering with uneven to undulating lamination. Thin sill near middle has irregular base likely due to intrusion into soft sediment. 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. Best exposed across Ruby Ridge and on east slopes of ridge northwest of Ruby Mountain. Upper part reasonably exposed over Buckhorn Ridge. Thickness approximately 1,000 m (3,400 ft).

Ypd **Prichard Formation, member d (Mesoproterozoic)**—Laminated, generally tabular light gray siltite and dark gray argillite, minor quartzite. Very rusty-weathering dark gray to white-weathering siltite and dark gray argillite couplets that are uneven and even parallel laminated and microlaminated. Rusty-weathering siltite and white, very fine- to fine-grained quartzite in beds 2 cm to 2 dm thick. Upper contact placed at lowest occurrence of siltite and quartzite with abundant sedimentary structures indicative of currents. Recognized only across Ruby Ridge. Thickness there 200-500 m (600-1,600 ft), uncertainty due to poor exposure of contacts and varied attitude.

Ypac **Prichard Formation, members a, b and c (Mesoproterozoic)**—Dark gray siltite, rusty-weathering unevenly laminated, dark gray siltite and argillite couplets, and light-weathering quartzite. Lower part is finer grained, characterized by contorted bedding attributed to soft sediment deformation but not well exposed in quadrangle. Contains more metamorphic micas near border east of Canuck Creek than typical. Garnets 1 mm in diameter found in semi-schist at one location south of Canuck Pass may be localized due to a favorable combination of protolith composition and strain, perhaps concentrated near contact with more competent thick sill. Upper part is about half fine-grained to rare medium-grained quartzite similar to that of *Ype* but in thinner packages. Some beds have ripple and cross lamination, coarser (medium) grains at bases and gradation to siltite at the top. Others 3 dm to 3 m thick appear structureless or have coarser grains in middle as well as bases. Circular brown spots 3-6 cm diameter with alteration "halos" probably formed from concentrations of manganiferous carbonate. Hosts undifferentiated sills with total thickness greater than 300 m (1,000 ft) in northeast part of map. Top placed above set of quartzite beds and below interval of more evenly laminated, rusty-weathering siltite and argillite. Well exposed across southern end of Copper Ridge. Exposed thickness estimated at 700 m (2,100 ft), but gravity modeling (Kleinkopf, 1977) suggests that there is a minimum of 3,000 m (10,000 feet) of sedimentary strata between *Ypm* and basement.

Ypm **Prichard Formation, massive unit (Mesoproterozoic)**—Structureless, poorly sorted quartzite and siltite. Massive rock characterized by rare clasts of laminated siltite and argillite 1-5 cm thick and 3-20 cm long. Some clasts have apparent reaction rims, others appear deformed. Consists largely of plagioclase (in part interstitial), quartz, and biotite; muscovite present as porphyroblasts. Occurs only in southeast corner of map where contorted quartzite with thin argillite layers appears to grade laterally into hornblende gabbro through its nonchilled margin. May have formed from increased pore fluid pressure due to heating by the early sills (Anderson and Höy, 2000).

Structure

The major structure in the map area is the Sylvanite anticline (Fig. 1). Over most of the map strata in its crest have low dips; those to the southwest dip steeply west (see cross section). Gravity modeling suggests it is cored by a fault slice of crystalline basement (Kleinkopf, 1977). If *ZYmi* is pre-Cretaceous and cuts folded strata, early folding may date from the East Kootenay orogeny (McMechan and Price, 1982) or Grenville-age deformation, ages of which are seen in garnets in higher grade terrane to the south-southwest (Doughty and Chamberlain, 2008) and south-southeast (Nesheim and others, 2012). Most faults strike north-south with down-to-the-west displacement. They most likely date from Eocene extension or at least were reactivated at that time. They could have started as reverse faults during contraction. Age of the down-to-the-north fault across the northern part of the map (right side cross section) is unknown. The Round Prairie fault in quadrangles to the west is similar, but its age relationship with steep reverse faults that may date from Cretaceous or earlier contraction is ambiguous (Burmester and others, 2011a, b).

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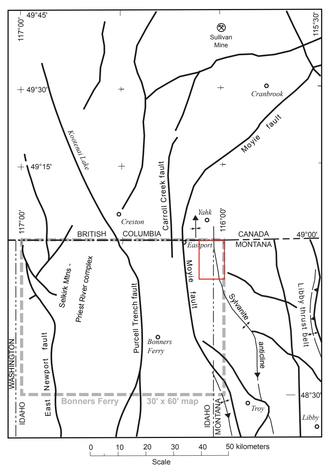

Figure 1. Location of Canuck Peak 7.5' quadrangle (red box) with respect to major structural and physiographic features.

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