Geological Setting of the Frank Creek Massive Sulphide Occurrence near Cariboo Lake, East-Central British Columbia (93A/11, 14)

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INTRODUCTION

The recent discoveries of the Frank Creek and Ace showings within the Snowshoe Group of the Cariboo Lake area has underlined the potential for these rocks to host volcanogenic massive sulphide (VMS) mineral occurrences. This should not have been a surprise considering that the Snowshoe Group represents the northern continuation of the Kootenay Terrane which, to the south, hosts important sedex and VMS occurrences in rocks of Cambrian and Devonian age. These include the Spar, Mosquito King and Homestake occurrences of the Eagle Bay Assemblage and the Goldstream deposit found within rocks of the Lardeau Group.

Except for the Downey succession, the dearth of volcanic rocks shown on existing maps of the Snowshoe Group has resulted in this area being little considered for hosting VMS occurrences. A cursory description of the metavolcanics in the Frank Creek area was produced by Martin (1989); however the presence of these volcanics is not widely known and their compositional and tectonic significance is not understood. In addition, Höy and Ferri (1998) proposed, based on correlation with lithologies in the southern Kootenay Terrane, that Snowshoe stratigraphy as defined by Struik (1986, 1988), may in part be inverted implying different ages (and mineral potential) for the various units.

In 2000 the B.C. Geological Survey Branch initiated a new mapping program which would provide: 1) a better understanding of the geological setting of the Frank Creek and Ace mineral occurrences; 2) information on the regional extent, nature and significance of metavolcanic rocks at the Frank Creek showing; 3) evaluation of the nature and significance of metavolcanic rocks within the Downey succession and 4) test a model suggesting the inversion of Snowshoe stratigraphy.

The following article summarizes preliminary results of this mapping program. Although mapping commenced in the Frank Creek area, detailed mapping only reached the alpine areas of Mount Barker during the summer of 2000 and no mapping was carried out in the immediate vicinity of the Ace property. Therefore the subsequent summary deals primarily with the geological setting of the Frank Creek showing.

A total of 60 days were spent in the field from the middle of June to the end of August. A base was set up in Likely, which represents the nearest community to the Frank Creek area that contains basic services. This small centre is reached by paved road from a turn-off some 20 kilometres south of Williams Lake on Highway 97 (Figure 1). Logging roads extend from Likely westward and cover a large portion of the southern, northern and western parts of the sub-alpine regions of the map area.

The project area lies within the Goose Range of the Quesnel Highlands and is bounded to the north by the Little River, the west by Cariboo Lake and River, the south by Sellers Creek and to the east by Grain and Barker Creeks (Figure 1). The Goose Range is located south of the Snowshoe Plateau, across the Cariboo River valley. These mountains represent the first high peaks as one leaves the interior plateau and before entering the rugged Cariboo Mountains to the east. Relief is moderate with peaks reaching 2100 metres and alpine occurring at approximately 1700 metres.

In light of the economic significance of the Wells - Barkerville area, the region immediately north of the present map area has been examined by many workers over the years (*see* Struik, 1988 for a listing). Mapping within the present project area has been carried out on a regional scale by Campbell (1978) and at a more detailed level by Struik (1983a, b; 1988). Panteleyev *et al*. (1996) examined Quesnel Terrane rocks to the west and also gives a good account of regional geology. Rees (1987), as part of a Ph.D. dissertation, examined in considerable detail the boundary between the Quesnel and Barkerville terranes between Cariboo Lake and Mount Brew.

The present study is linked to the Ancient Pacific Margin NATMAP program and is part of a multi- disciplinary effort by the B.C. Geological Survey Branch within the region. Ray *et al*. (2001) and Dunne *et al.* (2001) are conducting a detailed examination of gold mineralization at the newly discovered Bonanza Ledge zone in the Wells area. Bichler and Bobrowsky (2001) have carried out a till orientation survey in the vicinity of the Ace property and a regional till survey around the Lottie massive sulphide showing northwest of Wells.

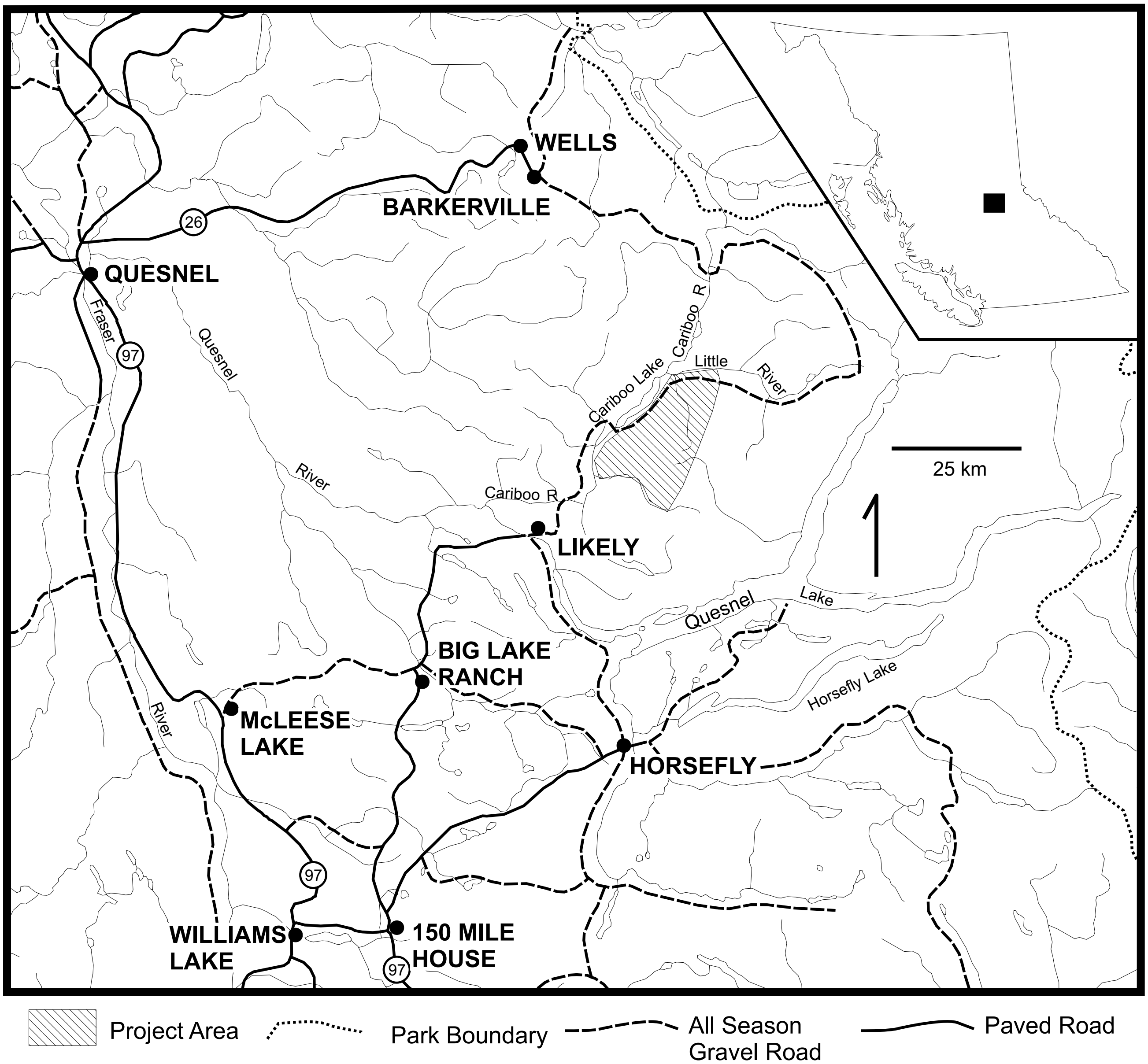


Figure 1. Location diagram centered on the map area showing main access routes and drainages.

REGIONAL SETTING

The Late Proterozoic to Paleozoic Snowshoe Group is a dominantly siliciclastic package of continental derivation and most likely represents the distal western edge of Ancestral North America. This fault-bounded sequence is stratigraphically distinct from other packages around it and as such has been called the Barkerville Subterrane, a subset of the Kootenay Terrane, with which it shares many similarities (Struik, 1986, 1988). To the east of the Snowshoe Group, across the westerly-verging Pleasant Valley Thrust, are rocks of the Kaza, Cariboo and Black Stuart groups which also contain an abundance of siliciclastics, but with facies that suggest a more proximal continental shelf setting. Many of these units can be correlated with similar stratigraphy within Ancestral North American rocks. These rocks are placed within the Cariboo Subterrane, representing, like the Cassiar Terrane to which it belongs, a displaced piece of Ancestral North America (Struik, 1986, 1988). The west flank of the Snowshoe Group is occupied by the Quesnel Terrane, a composite volcanic-arc sequence dominated by Mesozoic mafic to intermediate volcanic rocks. It is separated from the Snowshoe Group by the easterly-directed Eureka thrust fault along which are found slivers of mafic and ultramafic rocks assigned to the Crooked Amphibolite. These latter rocks have been correlated with rocks of the Slide Mountain Terrane, a package of ocean floor volcanics and sediments which structurally straddle the Barkerville and Cariboo terrane lithologies along the Pundata Thrust north of Wells (Figure 2).

Although the Snowshoe Group has an overall stratigraphic sequence which is distinct from that of the Cariboo Subterrane, there are similarities between the two, particularly with rocks of the Cariboo Group (Figure 3). This resulted in early workers taking stratigraphic terminology developed within the Snowshoe Plateau and extending it eastward into rocks of Cariboo Mountains (see Struik, 1988). This led to stratigraphic problems and it was not until Campbell *et al*. (1973) realized that the two sequences were quite distinct, requiring redefinition and new type sections. As a result Struik (1988) formally reassigned rocks within the Snowshoe Plateau to the Snowshoe Group.

The present structural interleaving of the various terranes and dominant structural fabrics resulted from deformation which began in early Middle Jurassic time, although there may be earlier events of Permo-Triassic or Devono-Mississippian age. The latter is supported by the presence of the Early Mississippian Quesnel Lake Gneiss, possibly related to arc volcanism (Ferri *et al.*, 1999). This deformation resulted from the easterly thrusting of Quesnel and Slide Mountain terrane rocks on to the Snowshoe Group along Eureka and Pundata thrusts. There are three sets of cross-cutting structural features within the map area with metamorphism reaching amphibolite grade during the second period of deformation.

The Snowshoe Group has been subdivided into several informal units or successions by Struik (1988; Figure 3). It is dominated by siliciclastic rocks with lesser carbonate and volcanic sequences. Due to the penetrative fabric, together with lack of suitable lithologies for geochronology and preservation of fossils, there are few age constraints for this package. Regional correlations and scant trace fossils indicate a Late Proterozoic to Late Paleozoic age (Figure 3). The lower to middle Snowshoe Group is broadly correlative with the Kaza and lower to middle Cariboo Group (Figure 3, Struik, 1986). The coarse clastics of the Goose Peak quartzite, in conjunction with the volcanics of the Downey and inferred Late Paleozoic age for the Bralco Limestone have no direct correlatives within rocks of the Cariboo Subterrane. This would be resolved, in part, if the Bralco Limestone correlates with the Mural Formation, a suggestion indirectly inferred by Struik (1988) who correlates the Bralco with the Archaeocyathid-bearing Tshinakin limestone of the Eagle Bay Formation (Schiarizza and Preto, 1987) implying it is age equivalent to the Mural Formation.

STRATIGRAPHY

Mapping this past summer encountered units from the middle part of the Snowshoe Group and include rocks of the Keithley, Harveys Ridge, and possibly Downey successions together with the Goose Peak quartzite and Agnes conglomerate. Marble along the north side of Sellers Creek may be part of the Kee Khan marble although it is presently assigned to the Keithley succession. These rocks are intruded by several bodies of the Early Mississippian Quesnel Lake Gneiss and post-deformation mafic dikes or plugs. Geologically, the southern part of the map area is structurally bounded by mafic to ultramafic rocks of the Crooked Amphibolite and dark grey phyllites and siltstones of Late Triassic age which belong to the basal Nicola Group (as per Panteleyev *et al*., 1996) and have been informally termed the "Black Phyllite" (Rees, 1987).

The light coloured, relatively thin, orthoquartzite at the top of the Keithley succession serves as an excellent marker within the map area and facilitated in the delineation of major fold structures shown in Figure 5. Although poorly exposed in sub-alpine areas, this unit can be used in conjunction with the contrasting lithologies of the Keithley schists and sandstones, and dark phyllites and sandstones of the Harveys Ridge, to establish overall map patterns.

Late Mafic Intrusions

Numerous small mafic intrusions are present within Snowshoe Group lithologies. They are typically less than 10 metres in size and it is commonly difficult to ascertain if they are dikes or small plugs. These are undeformed, compositionally quite variable and are typically porphyritic containing up to 30 per cent hornblende and feldspar phenocrysts, although others are accompanied by biotite and pyroxene. One intrusive body south of Goose Peak is noteworthy in that it contains rounded xenoliths of granite, gneiss and sediments up to 30 centimetres in size.

Quesnel Lake Gneiss

Several deformed granitic bodies of Early Mississippian age are found within the map area and are collectively termed the Quesnel Lake Gneiss (see Ferri *et al*., 1999). These large sill-like bodies have been subdivided into a megacrystic, peraluminous western suite and metaluminous eastern suite. Only the Western Quesnel Lake Gneiss was encountered within the current map area. The unit invariably displays a strong flattening fabric and lineation, the latter amplified by the alignment of potassium feldspar megacrysts. Although the extreme flattening displayed by many outcrops of this unit leads to the use of the term "orthogneiss" in its description, some outcrops exhibit less deformation and should be simply described as deformed granite.

Lithologically, the Quesnel Lake Gneiss is characterized by megacrysts of potassium feldspar from 1 to over 5 centimetres in length, which can comprise up to 30 per cent of the rock. These are commonly broken parallel to lineation with fractures healed by quartz. Quartz can form recrystallized masses up to 0.5 centimetre in diameter, although these are typically flattened and can form "ribbons" several centimetres long. These porphyroclasts are set in a coarsely crystalline matrix composed of quartz, plagioclase, potassic feldspar, muscovite, biotite

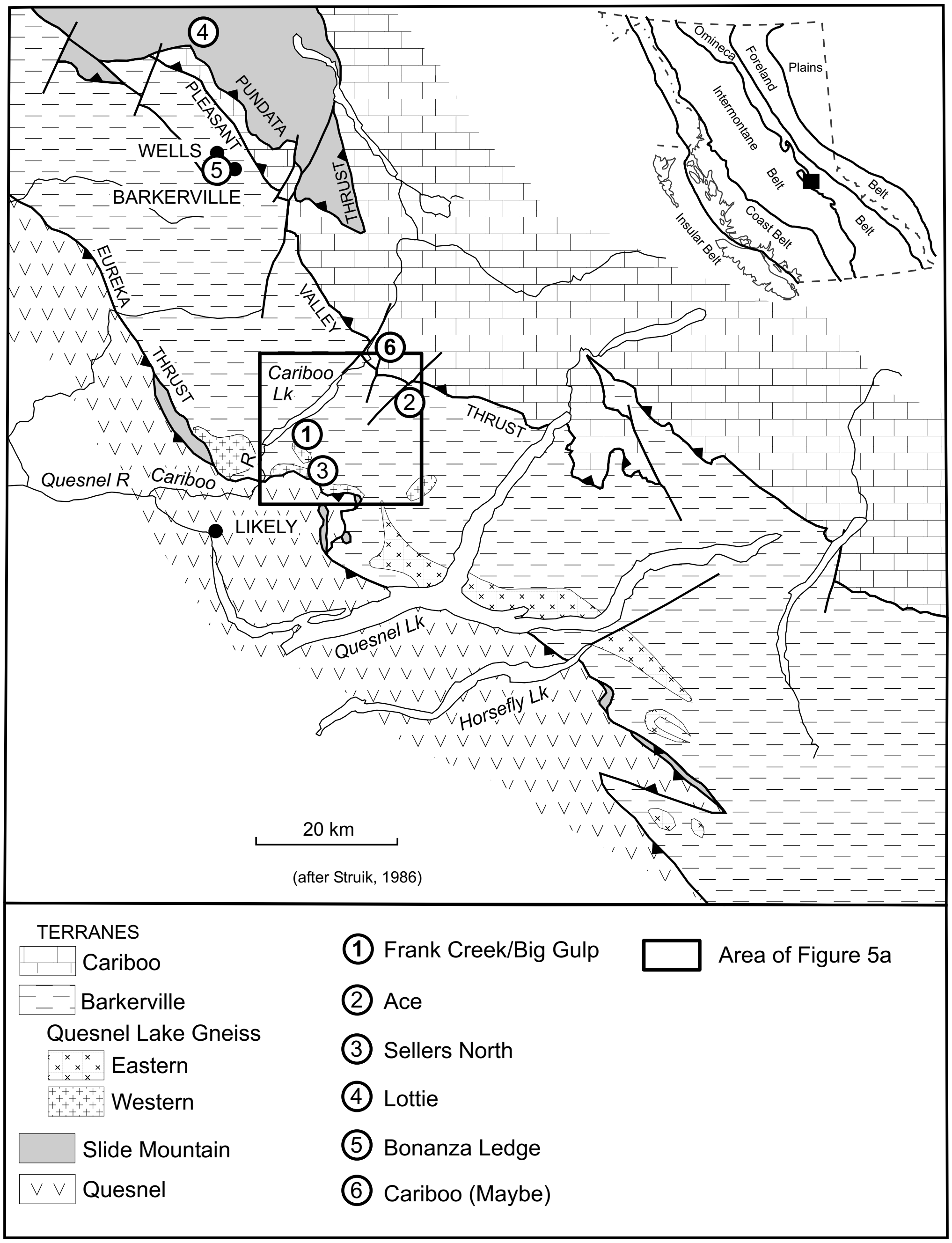


Figure 2. General geology in the vicinity of the project area showing the major geologic elements and selected mineral occurrences.

(chloritized) and locally garnet. Feldspar is typically altered to muscovite.

The contact of the Quesnel Lake Gneiss with the Snowshoe Group is exposed along a logging road-cut southeast of Browntop Mountain where it intrudes a package of interlayered schist and marble. A small finger of the Quesnel Lake Gneiss is mapped at this locality and it appears that the body intruded along bedding supporting the interpretation that they are sills.

The significance of the Quesnel Lake Gneiss has been the subject of much debate. Ferri *et al.*, (1999) suggests these bodies are related to Late Devonian to Early Mississippian arc volcanism whereas others (Montgomery and Ross, 1989) propose that the alkaline geochemistry found within parts of the Eastern Quesnel Lake Gneiss may imply intrusion in an extensional regime.

Black Phyllite

The Black phyllite unit was only encountered along the north slopes of Sellers Creek. Where seen, it consists of rusty-weathering dark grey to blue grey or silvery

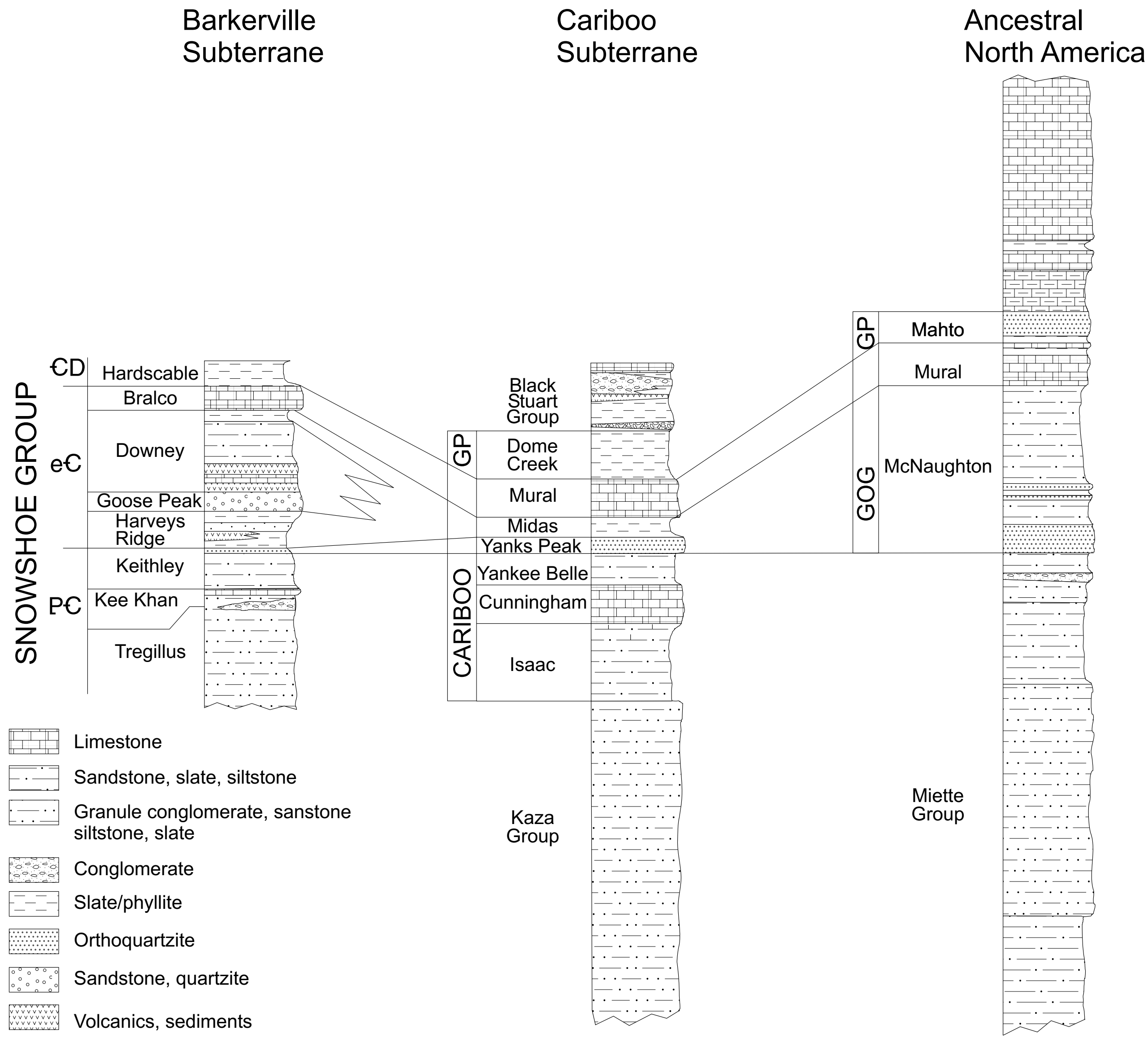


Figure 3. Generalized stratigraphic columns of the Barkerville and Cariboo subterranes and Ancestral North American rocks showing possible correlations of Snowshoe Group stratigraphy [modified from Struik (1986)].

phyllite. It contains thin horizons or bands of siltstone and may have argillaceous partings. Some of the siltstone beds are up to 5 centimetres thick and locally grade into very fine-grained sandstone. It is usually quite friable in comparison to the denser and more indurated Harveys Ridge phyllites and siltstones, and commonly displays a crenulation cleavage near its contact with the Snowshoe Group.

These rocks are believed to be Late Triassic in age (see Panteleyev *et al*., 1996) and form basement to the Nicola arc to the west. Western exposures of the Black phyllite contain sections of mafic tuffaceous sediments which interfinger with volcanic rocks typical of the Nicola Group (Panteleyev *et al., ibid.*)

Crooked Amphibolite

Outcrops of Crooked amphibolite are found south of Browntop Mountain and Badger Peak. These commonly consist of chlorite schist and amphibolite (actinolite) which display a strong fabric. Talc schist, with large porphyroblasts of iron-carbonate, are present in a few localities and is commonly associated with serpentinite.

The Crooked amphibolite is a thin, mafic to ultramafic unit which is intermittently found at the contact between the basal Nicola and Snowshoe groups. Its chemistry suggests ocean floor affinities (Rees, 1987; Figure 6) and it can be traced periodically southwards into the Black Riders Complex, a klippe of oceanic lithosphere (Radloff, 1989), and further south into rocks of the Fennell Formation, all of which infers it is correlative with the Late Paleozoic Slide Mountain Terrane.

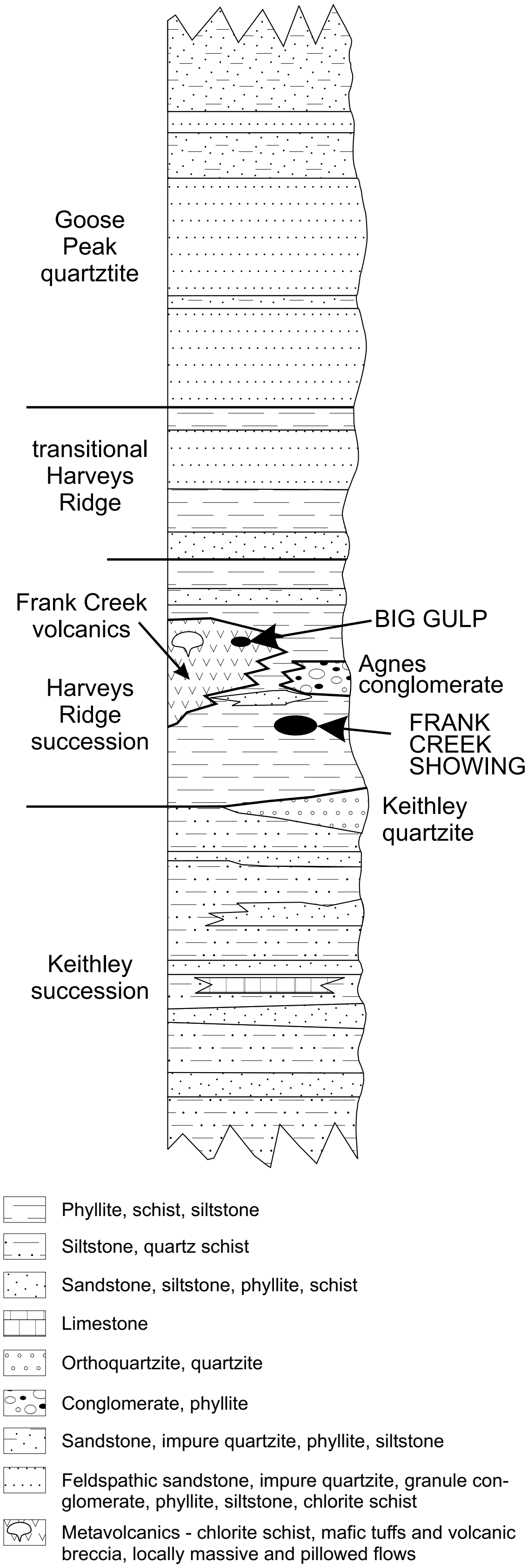


Figure 4. Generalized stratigraphic column of main rock units found within the map area.

Snowshoe Group

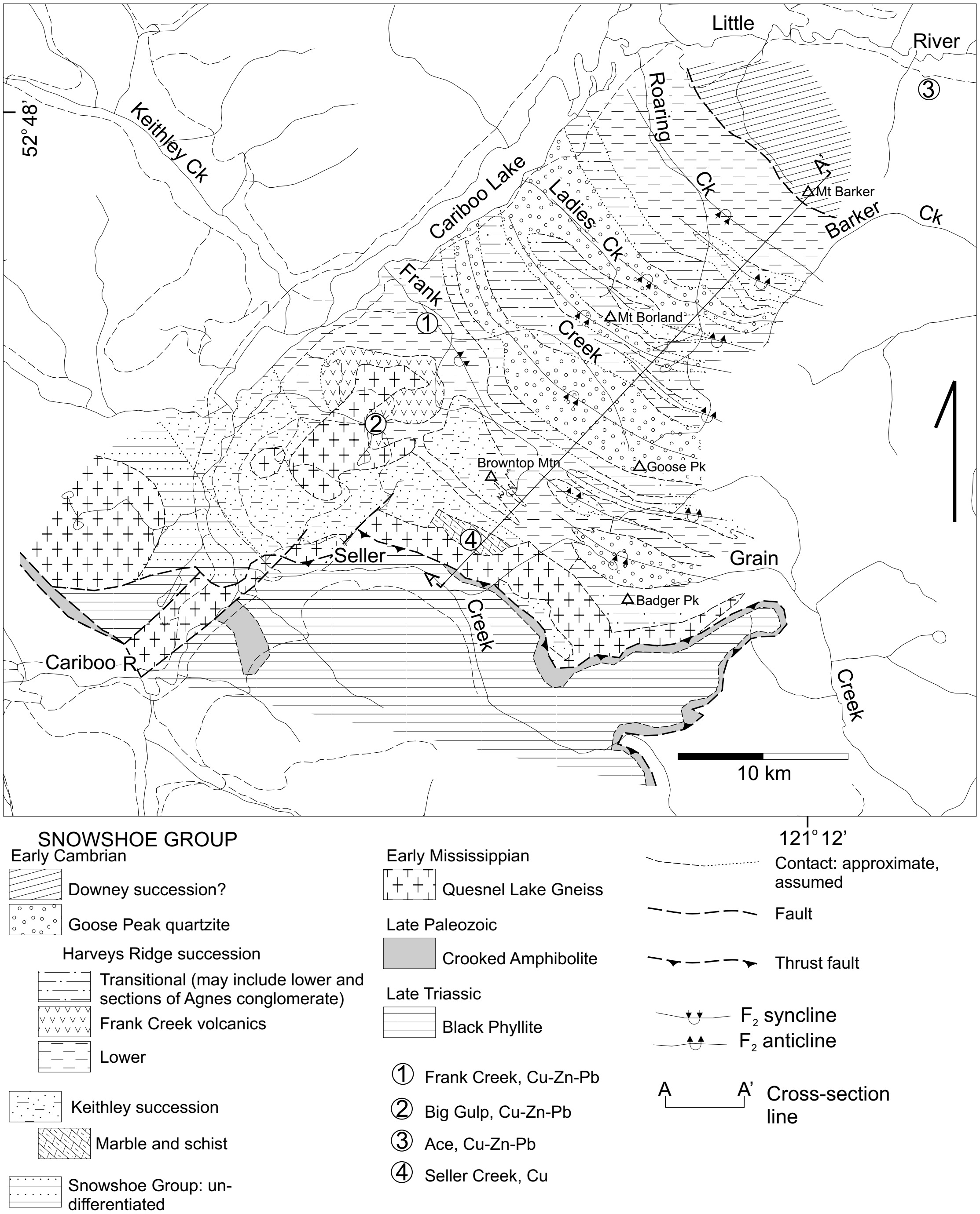
KEITHLEY SUCCESSION

The bulk of the Keithley succession consists of thin to medium bedded and interlayered light green to grey micaceous quartz sandstone to siltstone and green to grey phyllite to schist. These rocks are also characterized by being brown to rusty brown weathering, probably a reflection of the abundant pyrite porphyroblasts found throughout most exposures. This unit is commonly capped by a quartzite to orthoquartzite. Sandstone can be beige to white in places, up to 30 centimetres thick and approaching a quartzite in composition. Grading is present locally and white, chalky feldspar can constitute several per cent of the thicker sandstone beds. Thin interlayers of brown-weathering grey limestone were also seen in the Sellers Creek area. The thickness of the unit is difficult to determine as the base was not seen and it is only poorly exposed along the low ground west of Browntop Mountain. Struik (1988) states that the unit is less than 300 metres in thickness.

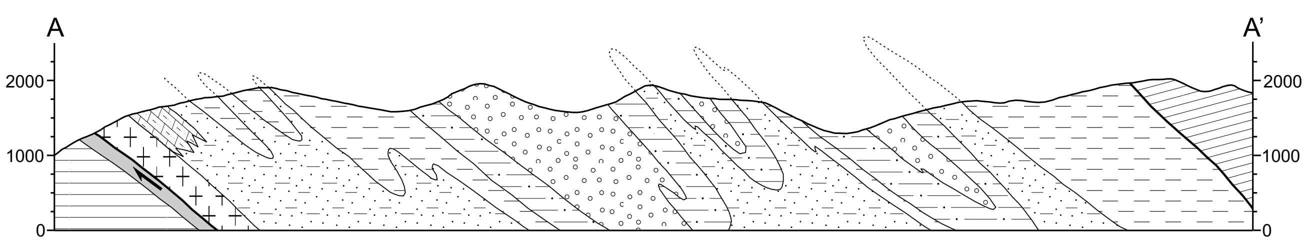
Orthoquartzite at the top of the Keithley succession is quite distinct within the map area. It is usually light coloured, being white, cream, beige, pink or purplish and when pure forms massive outcrops in which bedding is not discernible. Commonly there are micaceous partings between thin to thick quartzite beds and the quartzite can be impure with several per cent mica and white feldspar grains. It is typically less than 10 metres in thickness, although massive outcrops in excess of 100 metres are found in the valley north of Browntop Mountain which may represent thickening in the core of second phase folds. This horizon can be traced to the southeast where the unit is only several metres thick in the saddle. Although the unit is typically found at the very top of the Keithley, there are areas, such as near Browntop Mountain, where orthoquartzite occurs up to 10 metres below the transition into dark Harveys Ridge lithologies. Locally (*e.g.* north of Mount Borland and west of Browntop Mountain) the orthoquartzite is not present. Typically, if one crosses into Harveys Ridge lithologies without initially finding the quartzite, a few moments of searching will usually uncover thin to thick lenses of light coloured orthoquartzite. These lenses probably resulted from tectonic thinning of the quartzite along the limbs of second phase folds.

The upper contact of the orthoquartzite with siltstones and phyllites of the Harveys Ridge is quite abrupt and it is not possible to discern if it is conformable. Where the orthoquartzite is missing, greenish phyllites or schists and sandstones of the Keithley grade abruptly into dark lithologies of the Harveys Ridge suggesting a conformable contact.

Southwest of Browntop Mountain, along a logging road cut, is a section of rusty-weathering chloritic schists, green micaceous sandstones, beige to white quartzite and beige to brown weathering, grey to white banded marble. These are intruded along the western part of the exposure by the Quesnel Lake Gneiss. The marble is found in two



(a)



(b)

Figure 5. (a) Simplified geologic map of the project area. Geology of the southwestern boundary from Struik (1983a). (b) Structural cross-section across the map area. Location is shown in Figure 5a.

sections, both 50 to 75 metres thick. They are interpreted as different horizons since second phase vergence structures suggests they are on the same overturned fold structure. The overall aspect of the schists are similar to those of the Keithley succession. They are quite chloritic in places and suggest a volcanic origin. The quartzite is notable as it contains disseminations of chalcopyrite, sphalerite and galena.

HARVEYS RIDGE SUCCESSION

The Harveys Ridge succession is characterized by grey to dark grey or black phyllite, schist, siltstone, sandstone to impure quartzite and mafic volcanics. Dark grey to black phyllite and siltstone predominate and are found near the base of the unit. Pyrite porphyroblasts can be an important constituent, comprising up to 15 per cent of the unit and leading to a rusty to brown-weathering surface. These sections are monotonous and commonly lack discernible bedding. Phyllite and schist are characterized by millimetre-thin, discontinuous layers of white siltstone to fine sandstone which constitute less than 30 per cent of the rock. Dark grey to black siltstone along the ridge west of Browntop Mountain is pure and massive, essentially composed of fine grained, dark grey to black vitreous quartz. Thin to thick interbeds of blocky to platy dark grey to grey sandstone is seen up section in several localities and is characterized by floating grains of dark to black, vitreous quartz. Isolated outcrops of these coarser lithologies can sometimes be confused with those of the Keithley succession. Generally, coarser grained sections of Harveys Ridge lithologies tend to be planar bedded and are darker in colour than those of the Keithley succession.

The upper contact of the Harveys Ridge is gradational with both the Agnes conglomerate and Goose Peak quartzite. Matrix to much of the Agnes conglomerate is a black to dark grey phyllite or siltstone like the Harveys Ridge. As well, sections of phyllite and siltstone of the Harveys Ridge contain sections of Agnes conglomerate in the upper parts.

The top of the Harveys Ridge succession is characterized by an influx of coarse grained feldspathic sandstones very and wackes similar to those of the Goose Peak quartzite (Photo 1). These beds are thin to thickly bedded and comprise less than 50 per cent of the section. They commonly display a darker colour than typical Goose Peak lithologies and together with the abundance of darker Harveys Ridge rock types, these sections have an overall darker appearance on weathered surfaces than sections of the Goose Peak quartzite or Keithley succession. The contact with the Goose Peak quartzite is placed at the first thick section of clean, feldspathic quartz sandstone to quartzite. Grey to beige feldspathic and micaceous sandstone, like that of the Goose Peak or the transitional unit, is found near the Frank Creek massive sulphide showing.

The thickness of the Harveys Ridge unit is quite variable. It is over 500 metres in the Frank Creek area and in excess of 1000 metres south of Mount Barker, in the core of a second phase fold. Along the alpine ridges north of Badger Peak it can be less than a few hundred metres in thickness. In some areas, such as near Mount Borland, the basal dark grey to black phyllite and siltstone unit is not developed and one only sees the upper transitional sandstone/siltstone sequence.

In the Frank Creek area, dark phyllites of the Harveys Ridge interfinger with mafic volcanics here informally referred to as the Frank Creek volcanics. These metavolcanics cover an area of some 5 to 6 square kilometres and are intruded by a northeast-trending prong of Quesnel Lake Gneiss. They are typically well foliated, chlorite-actinolite schists and typically have no primary depositional features preserved. Two varieties are discernible in the field: 1) a more siliceous, lighter green to green package within which layered tuffs or lapilli tuffs and volcanic breccia are sometimes preserved (Photo 2) and 2) a darker green, chloritic schist which locally contains pillowed to massive porphyritic volcanics (Photo 3). The latter are poorly represented and are well exposed along the high ground between the Big Gulp and Frank

Photo 1. Transitional Harveys Ridge succession. This is in the core of an F_2 fold. Lighter coloured quartz and feldspathic quartz sandstones, similar to those of the Goose Peak quartzite, can be seen interfingered with dark grey to grey siltstones, wackes, sandstones and phyllites of the Harveys Ridge suc-

Photo 2. Fragmental volcanics within the Frank Creek volcanics. These volcanics are more siliceous than the pillows shown in Photo 3 and may reflect an original intermediate or basaltic-andesite composition.

Photo 3. Pillowed mafic (basalt) volcanics of the Frank Creek volcanics, located approximately 1.25 kilometres southwest of the Frank Creek massive sulphide showing. The chemical signature of these volcanics suggests an alkaline affinity.

Creek showings and display alkaline basalt compositions. Phenocrysts are altered and consist of 5 to 10 per cent pseudomorphs of actinolite, after pyroxene, up to 1 centimetre in size, and 5 to 10 per cent sericitized carbonatized laths of feldspar. The more siliceous varieties are more widespread and range into andesitic compositions with possible calc-alkaline affinities. Abundant iron-carbonate porphyroblasts and a light green mica (mariposite?) are locally present within the metavolcanics.

South of Badger Peak is a section of chlorite schist, mafic gneiss and meta-gabbro within rocks tentatively assigned to the upper transitional unit of the Harveys Ridge succession. Rees (1987) assigned these meta-volcanics to the Crooked Amphibolite. They form two distinct packages in the Badger Peak area and are separated by sediments of the Snowshoe Group. Placing these volcanics with the Crooked amphibolite would require imbrication and/or folding of the basal thrust carrying the Crooked Amphibolite prior to second phase deformation. The presence of quartz clastics within sections of chlorite schist, together with geochemical analysis, suggests that these meta-volcanics are probably part of the Snowshoe stratigraphic sequence.

Badger Peak metavolcanics consist of nondescript crenulated chlorite-actinolite-clinozoisite-feldspar ± carbonate schists and contain a strong fabric. Sections are differentiated into mafic and felsic-rich bands and appear gneissic. Schist and sandstone up to 100 metres in thickness separate two horizons of meta-volcanics.

AGNES CONGLOMERATE

Rocks which have been mapped as the Agnes conglomerate by Struik (1988, 1983a) are found north and south of the lower part of Frank Creek and along the main logging road south of Cariboo Lake (Struik (1983) originally called these rocks the Pine Creek conglomerate). This unit occurs in the upper part of the Harveys Ridge succession, within a section that is transitional into the Goose Peak Quartzite. Regional mapping by Struik (1988) has shown that this unit is probably a lateral equivalent of the Goose Peak quartzite. The mapping here supports this in that it places the conglomerate within the upper transitional unit of the Harveys Ridge which contains lithologies found within the Goose Peak quartzite.

The occurrence of the Agnes conglomerate is quite restricted within the map area. It was encountered along the lower parts of Frank Creek, occurring within the upper limb of a large second phase structure. It can be traced southeast, along strike, at the same structural and stratigraphic level and is recognized as far south as the Goose Peak area. This unit was not seen in any other panel of Harveys Ridge succession or Goose Peak quartzite.

The Agnes conglomerate consists of clasts of quartzite to feldspathic quartzite very similar in appearance to quartzite of the Goose Peak. Clasts are poorly sorted and range from granule to boulder in size. Clasts are commonly matrix-supported with the matrix typically being dark grey phyllite (Photo 4a), although a few localities in the Frank Creek area consist of quartzite clasts in a quartzite matrix (Photo 4b). Phyllite supported conglomerate usually has less than 50 per cent clasts whereas the quartzite-matrix conglomerate is clast-rich. Clasts are commonly elongate due to deformation. Along the southwest flank of the ridge containing Goose Peak, the conglomerate consists of 10 to 20 per cent cobbles of grey-green feldspathic sandstone and grey micaceous sandstone to siltstone set in a dark grey phyllite to siltstone typical of the Harveys Ridge succession.

The presence of Goose Peak-like clasts of feldspathic sandstone within the Agnes conglomerate suggests that it and the Goose Peak are, in part, a lateral equivalent of the Harveys Ridge succession. This inference is supported by the transitional nature of the Harveys Ridge succession and Goose Peak quartzite.

The thickness of the Agnes conglomerate is quite variable. It is lest than 1 metre thick south of Goose Peak and is estimated to be between 10 and 20 metres thick in the Frank Creek area. Struik (1988) states that it is generally less than 30 metres thick and up to 60 metres locally. The sporadic nature of this unit suggests it may form lenses within the upper part of the Harveys Ridge succession.

GOOSE PEAK QUARTZITE

The Goose Peak quartzite is characterized by thick to massive beds of greenish-grey to grey micaceous and feldspathic sandstone to quartzite and contains minor amounts of grey to dark grey phyllite or schist, siltstone wacke and chlorite schist (metavolcanics). This resistive unit forms the tops of many of the higher ridges within the map area, including near Badger Peak, the ridge containing Goose Peak and in the Mount Borland area. The lower part of the unit is transitional into the Harveys Ridge succession.

Massive to thick bedded quartzite with a "limestone grey" colour is also distinguishing feature of Goose Peak sections. Thin interbeds or partings of dark grey to grey

Photo 4. Agnes conglomerate. (a) Clasts of quartz sandstone (some feldspathic) "floating" in dark grey to black phyllite or siltstone. This locality is found immediately south of the Frank Creek massive sulphide showing and is surrounded by lithologies typical of the Harveys Ridge succession. Quartz sandstone clasts are similar in appearance to sandstone within the Goose Peak quartzite. (b) Quartzite clast conglomerate the matrix of which is also quartz sand giving an almost intraformational appearance to the unit. This exposure is also found very close to the Frank Creek massive sulphide occurrence.

4b

phyllite to siltstone are common. Sections or beds of quartzite are commonly over 2 metres in thickness and some were seen to be in excess of 5 metres. Mica can form up to 5 or 10 per cent of the rock. White Feldspar grains are broken and commonly sericitized. They are typically composed of plagioclase and lesser microcline, and can comprise up to 10 per cent of the section. Sandstone is commonly coarse grained and locally grades into granule conglomerate. Thin section examination shows that some of the coarser quartz grains can be polycrystalline. Chlorite schist was seen at several localities within Goose Peak sections and are believed to represent metavolcanics.

The thickness of this unit is quite variable due to deformation. It ranges from several hundred metres to over 1 kilometre within the core of the syncline along Goose Peak. Struik (1988) estimates the Goose Peak quartzite is 250 metres in thickness and is lensoidal on a regional scale.

DOWNEY SUCCESSION?

Schist, sandstone, carbonate and metavolcanics along Mount Barker have been assigned to the Downey succession by Struik (1988, 1983a). Work this past summer suggests that these rocks may be part of the Keithley succession. The mapping of Harveys Ridge rocks northward towards Mount Barker has shown that they form the core of a large southwesterly verging, second phase syncline. A 10 metre section of white, beige to purplish pink orthoquartzite was found on the upper, overturned limb of this structure at the change from Harveys Ridge lithologies into those presently assigned to the Downey succession. This quartzite appears very similar to that at the top of the Keithley succession and is found structurally and stratigraphically at the proper position with respect to the Harveys Ridge. Furthermore, top indicators suggest that the volcanics found along the peak containing Mount Barker are overturned and sit stratigraphically below the orthoquartzite section.

Assignment of these rocks along Mount Barker to the Keithley raises regional stratigraphic problems. These metavolcanics and metasediments can be traced northwestward into sections of typical Downey lithologies (Struik, 1988). As such, until more information can be obtained about the true stratigraphic setting of these units, they will remain as part of the Downey succession, albeit with a cautionary note.

Structurally above the orthoquartzite, southwest of Mount Barker, is a 200 metre section of interlayered dark grey to grey or green-grey schist and beige to grey-green micaceous quartz sandstone beds up to 1 metre thick, all of which are not unlike parts of the Keithley succession. These rocks contain a 50 metre thick section of dark grey magnetite-bearing chloritic schist in the upper part. Parts of this chlorite schist appear to be tuffaceous, although this interpretation is tenuous due to deformation.

The above rocks are followed by a thick (approximately 500 metres) section of mafic metavolcanics consisting primarily of crystal to lithic tuff. These tuffs are commonly massive and can contain lenses of orange weathering carbonate alteration up to 1 by 5 centimetres in size. In some areas relict crystals of feldspar and pyroxene are seen (now altered to chlorite - actinolite - sericite ± clinozoisite and carbonate) within the tuff forming overturned, graded beds up to 15 centimetres thick. Sections of coarse to very coarse-grained meta-gabbro up to 5 or 10 metres thick were encountered within this section and may represent co-magmatic subvolcanic intrusions. A 50 to 75 metre thick section of rusty weathering, greenish grey to grey muscovite schist is found in the lower part of this unit and may represent felsic meta- volcanics.

A mixed sequence of red-brown weathering, light grey schist, dark grey to black banded limestone, orange to honey weathering, grey to cream limestone, dark grey to black phyllite and cream, unevenly bedded quartzite are found intermixed with mafic metavolcanics in a succession some 200 metres thick northeast of Mount Barker. These metasediments form sequences in excess of 30 metres thick with individual sections of phyllite, quartzite or limestone ranging from 1 to 10 metres.

Although metavolcanics and sediments can be traced onto the ridge running east from Mount Barker, they become thinner and sections of massive to thickly bedded, greenish grey micaceous and feldspathic quartz sandstones, similar to those of the Goose Peak quartzite, are found suggesting either a facies change or a late fault as suggested by Struik (1988).

Mafic metavolcanics are encountered on the lower, north facing slope of Mount Barker and are also found with meta-gabbro and greenish micaceous sandstone. Keithley-like metasediments and light coloured quartzite occur west of Clair Creek and between metasediments of the Harveys Ridge and chlorite schists (metavolcanics) similar to those on Mount Barker.

Preliminary Geochemistry of Igneous Rocks

Major and partial trace element geochemistry was obtained for selected metavolcanics of the Snowshoe Group and Crooked amphibolite (Table 1). Some of these will then be analyzed for rare-earth-element geochemistry in hopes of further characterizing the various units. Major element concentrations should be used with caution due to probable mobilization during upper greenschist to lower amphibolite metamorphic conditions and high loss on ignition (LOI) values. In light of this, the classification and comparison of the chemical signatures of the various volcanic packages will be based on trace element abundances which are believed to be less affected by these metamorphic conditions (see Rollinson, 1993).

Three main packages of volcanics were analyzed within the Snowshoe Group: the Frank Creek volcanics, volcanics in the Badger Peak area and volcanics presently assigned to the Downey succession. In addition several samples of the Crooked Amphibolite were analyzed for comparative purposes. Metavolcanics in the Badger Peak region have been correlated with the Crooked Amphibolite by Rees (1987), although mapping this summer suggests they are part of the Snowshoe Group. It was hoped that chemical analysis would help determine the affinity of these metavolcanics.

A cursory examination of major element concentrations reveals compositional trends also reflected by the trace element data (Table 1, Figure 6a). Based strictly on SiO_2 contents, Downey, Badger Peak and many of the Frank Creek volcanics are basaltic, with some of the Frank Creek volcanics ranging from basaltic andesite to andesite (Table 1). Most of the basalts fall within the alkaline field or are transitional on the SiO_2 versus total alkali plot (Figure 6a). Only the more siliceous varieties of the Frank Creek volcanics display sub-alkaline trends and these are calc-alkaline based on their position within the AFM plot (not shown).

The broad classification of these rocks based on $Zr/Ti0_2$ versus Nb/Y indicates that most were originally alkaline basalts in composition, although some analyses fall within the sub-alkaline basalt field and some of the Frank Creek volcanics trend into andesitic compositions (Figure 6b). Chemical analyses suggests that Badger Peak volcanics are not part of the Crooked Amphibolite. This is based on their alkaline nature, the within-plate signature displayed by data plotted in diagrams in Figures 6c, e and f, and on the comparison of trace element abundances with those of the Crooked Amphibolite as shown in Figures 6b to f.

Both the Frank Creek and Downey volcanics display alkaline to subalkaline compositions (Figure 6a, b). Furthermore there is also a subdivision of this data which corresponds to broad lithologic characteristics displayed by these rocks. The darker, more mafic (*i.e.* lower SiO_2 content) and commonly porphyritic Frank Creek volcanics have lower Zr/TiO_2 ratios in Figure 6a than the more silicic, lighter coloured fragmental metavolcanics which also plot closer to the andesite and trachyandesite field. The more mafic Frank Creek volcanics are similar in composition to those in the Badger Peak area. Downey volcanics also show two clusters: coarser, gabbroic samples display subalkaline compositions whereas finer chloritic schists are alkaline in nature (Figure 6a, b).

These lithologic and chemical similarities are also evident within the other discrimination diagrams shown in Figures 6c to f. The overall trace element concentrations within these volcanics suggests within-plate alkali and tholeiitic basalt, and E-type MORB characteristics (Figure 6c). Subalkaline, gabbroic volcanics of the Downey together with the subalkaline sample of the mafic Frank Creek volcanics all plot within the E-type MORB field. The clustering of data is much more evident when examining the levels of Ti and V in comparison to some of the other trace elements.

Relative levels of Ti are lower within the lighter coloured, more silicic Frank Creek volcanics and gabbroic Downey volcanics such that they plot within the calc-alkalic basalt field of the Ti versus Zr plot of Figure 6e. A similar pattern is also displayed within the Ti-Zr-Y

TABLE 1
MAJOR AND PARTIAL TRACE ELEMENT GEOCHEMISTRY OF SNOWSHOE GROUP AND CROOKED AMPHIBOLITE METAVOLCANICS

	00FFE-15-9	00FFE-22-1	00FFE-22-2	00FFE-24-2	00FFE-23-5	00FFE-23-6	00FFE-24-6	00FFE-6-1	00FFE-34-4	00FFE-34-6	00FFE-34-8	00FFE-34-5
	CA	CA	CA	CA	BP	BP	BP	DV	DV	DV	DV	DVg
Easting	610828	614272	614538	616084	616125	616164	616791	618855	621228	621300	621325	621233
Northing	5839105	5835709	5835485	5836461	5837760	5837567	5837284	5852940	5849252	5849441	5849754	5849302
SiO_2	48.15	52.13	48.72	48.84	41.11	41.59	45.27	42.88	46.79	48.86	42.70	46.52
TiO_2	0.99	1.37	2.19	1.72	2.20	1.23	1.75	1.27	0.79	1.57	2.27	0.89
Al_2O_3	14.97	14.57	14.56	14.39	17.20	12.03	15.47	9.10	15.02	16.27	12.47	14.82
Fe_2O_3	9.57	10.67	12.59	12.17	13.96	9.80	10.86	14.10	11.67	14.07	10.57	12.23
MnO	0.11	0.07	0.15	0.17	0.25	0.12	0.11	0.15	0.17	0.09	0.18	0.18
MgO	7.28	8.22	6.21	4.21	9.64	14.22	11.21	17.71	4.59	4.53	5.42	5.11
CaO	6.13	5.96	6.84	6.55	8.02	11.43	7.21	8.90	7.11	3.46	12.69	7.73
Na_2O	3.89	2.90	4.65	4.88	1.12	1.35	2.66	0.07	4.42	4.94	3.79	3.54
K_2O	0.05	0.23	0.05	0.21	0.14	0.18	0.31	0.02	0.27	0.52	0.17	0.15
P_2O_5	0.11	0.14	0.18	0.14	0.41	0.09	0.37	0.10	0.21	0.28	0.33	0.25
LOI	8.35	3.44	3.50	6.34	5.69	7.57	4.38	4.84	8.65	5.13	8.68	8.07
SUM	99.61	99.72	99.65	99.63	99.75	99.62	99.62	99.15	99.71	99.79	99.28	99.5
Zr	53	94	135	106	156	58	138	79	77	121	158	83
Y	21	34	43	38	29	15	23	8	21	18	31	20
Sr	242	231	185	157	421	211	272	24	449	243	464	431
Nb	3	9	9	4	38	14	31	16	7	15	24	9
Th	4	<3	3	6	<3	<3	9	<3	<3	15	3	7
Ta	<3	<3	12	<3	4	<3	<3	5	<3	5	<3	<3
V	320	320	369	307	257	207	228	228	291	322	288	272
La	7	11	4	9	28	8	27	22	23	27	13	18
Ce	36	6	20	53	100	26	52	53	45	31	55	32
Ba	49	177	69	28	114	105	175	19	188	730	59	39
Rb	10	10	<3	20	11	9	15	4	14	19	10	10

	00FFE-35-2	00FFE-36-7	00FFE-4-14	00FFE -9-7	00FFE-8-10	00FFE-8-11	00FFE-4-1	00FFE-4-7	00FFE-4-11	00FFE-8-2	00FFE-38-1
	DVg	DVg	FCm	FCm	FCm	FCm	FC	FC	FC	FC	FC
Easting	621817	620252	609712	608683	610179	610090	607352	608730	609883	608248	609864
Northing	5849596	5851854	5842941	5842293	5844196	5844241	5844008	5843209	5843781	5844719	5841876
SiO_2	48.20	45.43	43.81	49.77	45.36	46.47	52.49	59.13	54.91	53.90	51.06
TiO_2	0.77	0.87	2.00	1.55	1.66	1.97	0.61	0.64	0.58	0.62	0.79
Al_2O_3	16.60	15.73	13.86	15.40	19.32	14.59	16.54	17.12	16.94	17.22	15.31
Fe_2O_3	12.30	11.82	11.50	11.26	9.71	10.26	6.23	6.21	5.94	5.65	6.23
MnO	0.14	0.15	0.07	0.14	0.10	0.12	0.10	0.05	0.05	0.07	0.07
MgO	7.17	5.09	7.61	5.90	6.82	6.73	4.78	3.97	4.76	5.59	4.00
CaO	5.21	7.01	5.51	8.38	3.22	9.02	10.43	3.58	9.92	8.11	7.90
Na_2O	4.84	4.40	3.50	3.80	2.95	3.58	2.96	2.67	0.69	3.48	1.66
K_2O	0.10	0.25	0.76	0.40	2.60	0.05	1.65	2.31	2.76	2.43	2.66
P_2O_5	0.23	0.25	0.33	0.14	0.20	0.25	0.10	0.07	0.07	0.15	0.14
LOI	4.25	8.77	10.28	2.52	5.86	6.42	2.68	3.39	2.35	1.82	9.30
SUM	99.82	99.8	99.37	99.39	98.93	99.7	99.04	99.39	99.21	99.25	99.46
Zr	70	80	131	100	104	130	92	114	99	100	151
Y	22	25	17	34	6	10	11	11	15	13	24
Sr	477	290	181	532	128	489	848	474	557	520	262
Nb	10	8	23	10	23	22	17	12	13	16	15
Th	14	<3	9	<3	5	13	18	19	6	11	19
Ta	<3	7	<3	5	<5	<3	3	3	<3	<3	11
V	246	271	263	353	261	275	78	82	114	104	121
La	26	20	63	14	7	15	37	50	50	39	37
Ce	43	50	32	6	10	10	10	55	14	48	<3
Ba	83	285	1444	1253	11286	2389	4698	2455	2436	2071	3395
Rb	9	8	20	16	45	3	51	71	92	85	87

NOTES

Steel mill grinding at the B.C. Geological Survey Branch. Chemical analysis at Cominco Research Laboratories, Vancouver, B.C.
Major oxides determined by fused disc - X-ray fluorescence and reported in per cent (%). Trace elements determined by pressed pellet - X-ray fluorescence and reported in parts per million (ppm).
LOI = loss on ignition @ 1100^{o}C. SUM = sum of oxides. CAL = calculated sum.
CA: Crooked Amphibolite; BP: Badger Peak volcanics; DV: Downey volcanics, g - gabbro; FC: Frank Creek volcanics, m - mafic;

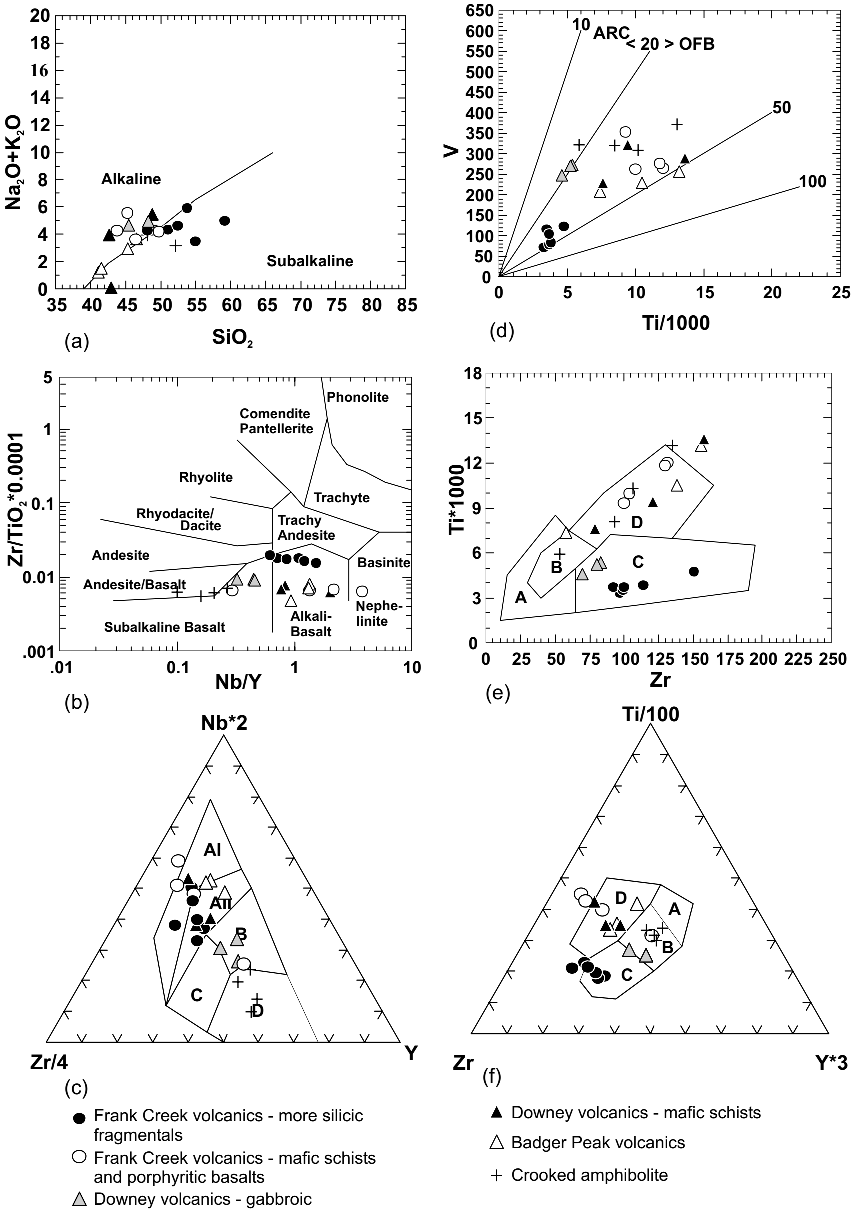


Figure 6. Major and trace element geochemical plots for selected volcanics from the project area. (a) Silica versus K_2O+Na_2O showing the separation between alkaline and subalkaline igneous rocks (Irvine and Baragar, 1971) (b) $Zr/TiO_2*0.0001$ versus Nb/Y (Winchester and Floyd (1977). (c) Nb*2 - Zr/4 - Y (Meschede, 1986); AI - within-plate alkali basalts; AII - within-plate alkali basalts and within-plate tholeiites; B - E-type MORB(mid-ocean ridge basalt) ; C - within-plate tholeiites and volcanic-arc basalts; D - N-type MORB and volcanic-arc basalts. (d) V versus Ti/1000 (Shervais, 1982); ARC - volcanic arc basalts; OFB - ocean floor basalts. (e) Ti*1000 versus Zr (Pearce and Cann, 1973); A - island-arc tholeiites; B - MORB, calc-alkali basalts and island-arc tholeiites; C - calc-alkali basalt; D - MORB. (f) Ti/100 Zr - Y*3 (Pearce and Cann, 1973); A - island-arc tholeiites; B - MORB, island-arc tholeiites and calc-alkali-basalts; C - calc-alkali basalts; D - within-plate basalts.

diagram of Figure 6f. The clustering of data is even more evident when comparing Ti versus V (Figure 6d) where the more silicic Frank Creek volcanics have a relatively low concentration of V. Gabbroic Downey volcanics, although higher in V, cluster away from the other volcanics due to their low Ti values.

Preliminary analyses suggest that the alkalinity displayed by the bulk of the volcanics record eruption within an extensional environment. The significance of the chemical variation, particularly the low Ti concentrations, is not fully understood. Do they reflect other tectonic processes (*i.e.* nearby volcanic arc) which are influencing the chemical composition of these within-plate volcanics? Clearly further chemical and field data is needed.

Regional Correlations

Struik (1988 and 1986) correlated the Keithley quartzite with the Early Cambrian Yanks Peak Formation of the Cariboo Subterrane. Struik (1988) also suggested that the Bralco limestone may be correlative with the Early Cambrian Tshinakin limestone of the Eagle Bay Formation. This latter unit, based on age and composition, has been correlated with the Badshot Formation in the Kootenay Arc (Schiarizza and Preto, 1987). The Badshot, and underlying Hamill Formation, have been equated eastward with the Mural and McNaughton formations, respectively, of the Gog Group within Ancestral North American stratigraphy. This circuitous correlation would suggest that the Bralco limestone is also correlative with the Mural Formation of the Cariboo Subterrane and would make all units between the Bralco limestone and Keithley quartzite (Harveys Ridge, Agnes conglomerate, Goose Peak quartzite, Eaglenest succession and Downey succession) Early Cambrian in age (Figure 3) and correlative to the Midas Formation (Figure 3).

Parts of the Midas Formation have similarities to the dark grey to black phyllite and siltstone of the Harveys Ridge succession together with parts of the overlying transitional unit (Struik, 1988). There are no direct equivalents within Midas sections for lithologies contained within the Goose Peak quartzite, Agnes conglomerate or Eaglenest succession. The only coarse, distinctive unit within the Midas Formation is the Vic Sandstone (Struik, 1988) and correlating rocks of the Goose Peak, Agnes and Eaglenest (all facies correlatives) would suggest a profound facies change. If this is the case, clearly the depositional basin now represented by the Barkerville Subterrane was closer to a higher energy source which was unroofing rocks of igneous composition and was also experiencing igneous activity not seen further east.

Based on the above arguments, the sequence encompassing the Keithley, Harveys Ridge, Agnes, Goose Peak, Eaglenest, Downey and Bralco limestone is broadly correlative with Early Cambrian units EBQ, EBH and EBG of the Eagle Bay Assemblage (Schiarizza and Preto, 1987). Units EBQ and EBH have similarities to the Keithley succession whereas schists and limestone of unit EBG are similar to those of the Harveys Ridge, Downey and Bralco limestone. The coarse clastics of the Goose Peak quartzite, Agnes conglomerate and Eaglenest succession have no correlatives within Cambrian rocks of the Eagle Bay Assemblage or elsewhere within the Kootenay Terrane and are, as Struik (1988) points out, unique to the Snowshoe Group.

The above relationships led Höy and Ferri (1998) to suggest re-assignment of ages to various units within the Snowshoe Group. They suggested that the Downey correlate with the Lardeau Group and the Ramos with Devono-Mississippian rocks that elsewhere contain a felsic volcanic component. Subsequent U-Pb dating of zircons from possible felsic tuff in the Ramos succession is inconclusive (unpublished data). All recovered zircons were detrital and Proterozoic in age suggesting the “tuff” was probably sedimentary in origin. Work this summer could not resolve this question as no rocks of Ramos age were encountered. Correlation of the Downey succession with the basal Lardeau was also not resolvable due to incomplete data; Downey rocks were only briefly encountered. As a result, I will adhere to Struik’s (1986, 1988) designation until further mapping helps resolve these proposed correlations.

STRUCTURE AND METAMORPHISM

Structurally the map area is complex due to the presence of multiple periods of deformation. Overprinting relationships between structural elements at the outcrop scale indicate that strata within the map area have been affected by at least three episodes of penetrative deformation. In addition, a regional, prograde metamorphic event, which reached lower amphibolite grade in the map area, accompanied the second phase of folding. Although this would suggest a protracted structural history, stratigraphic and structural relationships together with geochronological data presented by Rees (1987) and Struik (1988) suggests that this deformation was probably initiated in the late Early Jurassic in response to eastward overthrusting of Quesnel rocks and that folding related to the last period of deformation was over in late Middle Jurassic times.

The first period of deformation (D_1) is manifested by a layer-parallel fabric which is subsequently crenulated by later folding events (Figure 7a). This can be observed along pelitic horizons within the core of second phase folds. This fabric is strongest along the contact between Quesnel and Barkerville rocks, forming a well developed mylonitic fabric within rocks of the Quesnel Lake Gneiss. Although outcrop scale rootless F_1 folds are sometimes seen, no large-scale structures have been attributed to this period of folding. This deformation is believed to be eastward verging based on analysis of meso and microscopic structural elements (rotated feldspar megacrysts, shear bands, etc.) within the mylonitic fabric developed at the terrane boundary (Ferri, 1982; Rees and Ferri, 1983).

The well developed mineral lineation within the Quesnel Lake Gneiss has been attributed to D_1 deformation (Figure 7b; Rees, 1987). It is interesting that the two bodies of gneiss within the map area display very different orientations for this lineation. The easiest explanation for this is folding about F_2 and/or F_3 fold axis, which are very close in orientation to the required rotation axis.

Stretched-pebbles or grains within Snowshoe sediments have orientations parallel to F_2 fold axes or S_0 /S_2 intersection lineations (Figure 7g and h). This fold axis-parallel stretching is a common feature within folds of this generation within the cordillera.

The second phase of deformation (D_2) is southwest verging and has produced megascopic folds which essentially control the distribution of map patterns within the area (Figure 5). The trace of the Eureka Thrust fault, and the Crooked Amphibolite, reflect F_2 folding. In the Sellers Creek area this fault is on the overturned limb of

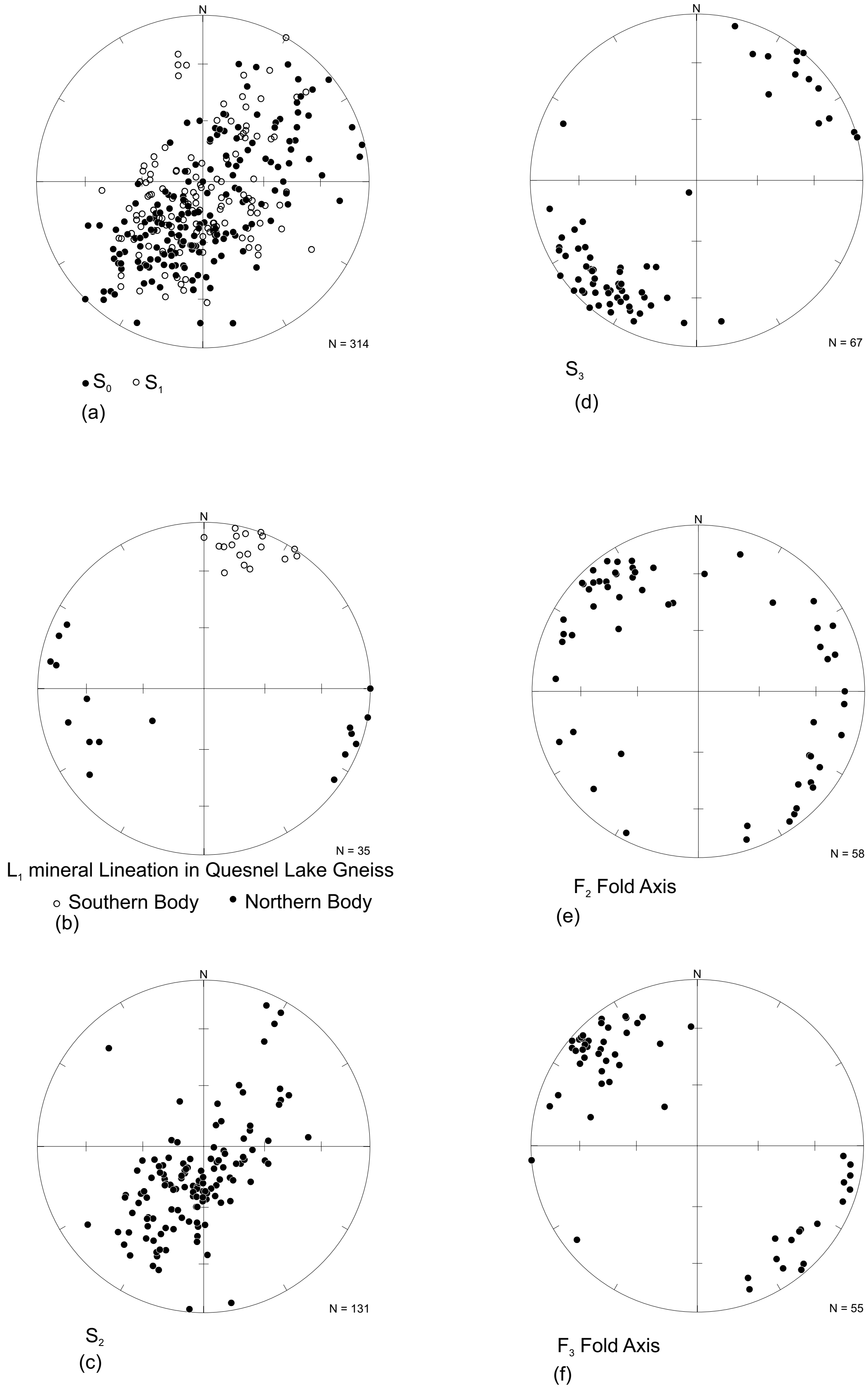


Figure 7. Equal area plots of structural data collected within the map area. (a) S_0 and S_1 foliations. (b) L_1 mineral lineations within the Quesnel Lake Gneiss. (c) S_2 foliations. (d) S_3 foliations. (e) F_2 fold axes. (f) F_3 fold axes. (g) L_2 stretching lineations in Snowshoe sediments. (h) S_0/S_2 intersection lineations.

an F_2 anticline. These folds are quite large, some traceable across the map area (greater than 10 kilometres in length) and having wavelengths several kilometres in size. Axial planes, in accordance with the mean dip of S_2 foliation (Figure 7c), dip moderately to the northeast. Although S_2 foliation is commonly parallel to sub-parallel with compositional layering (and S_1 foliation) on the limbs of F_2 folds, small scale folds structures and bedding cleavage relationships, together with delineation of key stratigraphic units, has allowed the delineation of F_2 fold structures seen in Figure 5. On outcrop scale these folds display a similar style suggesting ductile conditions during their formation. This is consistent with their production concurrent with the peak of regional metamorphism.

A vertical to steeply southeast dipping crenulation affects both S_1 and S_2 foliations within the map area (Figure 7e and f). Commonly this crenulation cleavage is parallel with open to moderately tight folds that contain hinges without appreciable thickening. Map-scale F_3 structures have only been delineated in the Frank Creek area where S_2 foliation is broadly folded across several kilometres.

Most of the map area occurs within middle to upper greenschist grade metamorphism. Typically chlorite and muscovite are the only metamorphic minerals developed within the metasediments. Metavolcanics contain mostly chlorite, although actinolite is not uncommon within many of the outcrops in the Frank Creek area. Metamorphic grade increases to the southeast resulting in the consistent appearance of biotite and then garnet porphyroblasts. Textural relationships between porphyroblasts suggest that growth occurred after D_1 fabrics were developed (as seen by inclusion trails in garnet) and during D_2 deformation. The latter inference is supported by the growth of biotite flakes sub-parallel with S_2 foliation and the concurrent flattening of this fabric around these porphyroblasts. Chlorite and muscovite porphyroblasts are sometimes seen growing parallel to S_3 crenulation planes indicating, as Rees (1987) suggested, that D_3 deformation occurred near the end of metamorphism. Although the above relationships are consistent throughout most of the map area, immediately east of Badger Peak one locality contains idiomorphic garnet porphyroblasts that are post-D_2 or show little or no deflection of S_2 foliation. Rees (1987) also noted that the timing between peak metamorphic conditions and D_2 deformation varied in a similar fashion between Mount Brew and Cariboo Lake and suggested that either metamorphism or D_2 deformation propagated at different rates. The age of this metamorphism is believed to be Middle Jurassic based on the U-Pb dating of metamorphic sphene recovered from the Quesnel Lake Gneiss in the Isosceles Mountain area (Mortensen *et al*., 1987).

MINERAL OCCURRENCES

Rocks of the Snowshoe Group have produced an abundance of lode and placer gold from the Wells - Barkerville area. Lode gold production has been primarily from veins and replacement bodies within metasediments of the Downey succession. Nearby placer deposits are believed to be weathering by-products of these deposits. Similar mineralization has been traced southward to the Cariboo Lake area; however, no substantial placer production or vein mineralization has been documented south of the lake.

Although the search for VMS targets within Snowshoe Group lithologies has gone on intermittently since the early 1980s, the Ace and Frank Creek properties represent the first significant showings of this type within these rocks (Lane and MacDonald, 2000). Massive sulphide mineralization was first discovered in the map area by Louis Doyle (now of Barker Minerals Ltd.) who found mineralized boulders within till along the south side of the Little River. This led to the discovery of the Ace property (093A 142), which possibly represents a sheared, besshi-style system within meta-sediments and volcanics of the Downey succession (Höy and Ferri, 1998; Payne, 1998, 1999 and Lammle, 1995; Lane and MacDonald, 2000). In light of this, Barker Minerals Ltd. carried out further exploration within the region leading to the discovery of the Big Gulp (093A 143) and Frank Creek (093A 152) sulphide showings within the Harveys Ridge succession. Exploration efforts in the Frank Creek area benefited from work carried out by exploration companies and prospectors in the 1980s who were led to the area by the discovery of massive sulphide boulders by placer gold prospectors along the lower parts of Frank Creek (*see* Lane and MacDonald, 2000 and Barkerminerals.com for a more detailed account of early exploration in this area). The other newly discovered mineral occurrence of note is the Sellers Creek showing (093A 131) consisting of Cu-Pb-Zn disseminations within quartz sandstone. The following descriptions will deal with the Big Gulp, Frank Creek and Sellers Creek occurrences.

The mixed volcanic and sedimentary succession, together with the Cu-Zn-Pb mineralogy of the Frank Creek and Big Gulp occurrences indicate that these are besshi-type sulphide showings. The relatively high Pb content simply reflects the influence of continental crust in their formation. Furthermore, the stratigraphic position of these occurrences above the Keithley quartzite, which has been correlated with the basal lower Cambrian Yanks Peak Formation (a correlative of the lower Hamill Formation found further south) suggests that these occurrences may be age equivalent to deposits such as the Mosquito King, Lucky Coon, Elsie and King Tut of the Eagle Bay Formation (Höy, 2000), although these are SEDEX in nature.

Big Gulp (093A 143)

The Big Gulp occurrence is located on the "C" logging road approximately 3 kilometres due east of the south end of Cariboo Lake (Figure 5). This occurrence was discovered by Barker Minerals Ltd. in 1996 and consists of disseminations and thin layers (several centimetre thick and 2 to 5 centimetres long) of sphalerite, chalcopyrite and pyrite (4.5 and 0.06 per cent Zn and Cu, respectively from a grab sample; Höy and Ferri, 1998) within mafic tuffs now assigned to the Frank Creek volcanics, a unit of the Harveys Ridge succession. Mineralization is found sporadically along the outcrop immediately north of the main logging road. Brown to orange-weathering carbonate and muscovite are associated with sulphide mineralization and may reflect primary alteration features. Mineralization is also found within quartz stringers which are now parallel to S_1 foliation and can be elongate parallel to the strong D_2 mineral lineation. Although deformation has virtually obliterated primary depositional features, relic structures in several areas suggests these volcanics were originally fine to coarse tuffs and possibly lapilli tuffs. These volcanics are part of the more siliceous fragmentals which display mafic to intermediate compositions.

Frank Creek (093A 152)

The Frank Creek Cu-Zn-Pb-Ag massive sulphide occurrence was discovered by Barker Minerals Ltd. in 1999 following a program tracing massive sulphide float and stream sediment geochemical anomalies. It is located on the "D" logging road 2 kilometres southeast of the mouth of Frank Creek (Figure 5). The main showing consists of a 1 metre thick massive sulphide horizon in dark grey to black phyllites of the Harveys Ridge succession. Extensive drift cover has masked the three dimensional configuration of the massive sulphide body. Massive pyrite-chalcopyrite pods several 10s of centimetres in length were also seen within the dark phyllites (Lane and MacDonald, 2000). Grab sample analyses by Lane and MacDonald (2000) indicate values up to 0.65 per cent Cu, 0.12 per cent Pb, 0.10 per cent Zn, 0.14 grams per tonne Au and 69 grams per tonne Ag. Average grab samples analysis reported by Barker Minerals Ltd. Are 2.13 percent Cu, 1.06 percent Zn, 0.16 percent Pb, 129.4 grams per tonne Ag and 215 ppb Au. A few hundred metres below the main showing, and also along the D road, is a thin zone of disseminated sulphides (pyrite and chalcopyrite) also within dark grey phyllites of the Harveys Ridge succession. Grab sample analysis of this stringer zone shows values up to 4.7 per cent Cu, 0.5 per cent Pb, .6 per cent Zn and 194 grams Ag (Barkerminerals.com).

Although a few top indicators in the vicinity are present (*i.e.* pillows) showing overturned bedding, the overall sequence youngs to the west in the immediate area of the showings. The Frank Creek volcanics sit stratigraphically above the dark grey phyllites hosting the massive sulphide mineralization. Southeast of these, one can trace orthoquartzite and metasediments of the Keithley succession from along Browntop Mountain and show that they plunge below the volcanics and associated dark lithologies of the Harveys Ridge succession. Furthermore, structural and stratigraphic data suggest mineralization together with the Frank Creek volcanics are within the core of a F_2 fold which is modified by F_3 folding. This latter warping has folded S_1 and S_2 foliations into west dipping attitudes around the deposit, opposite to their regional easterly dip.

Agnes conglomerate is found several hundred metres south and east of the Frank Creek showing. This conglomerate is found immediately down slope (stratigraphically below) an unknown thickness of light coloured feldspathic sandstone which can be traced for several hundred metres. It is locally characterized by the presence of large (up to 1 centimetre) dark grey and lesser opalescence blue quartz clasts. It appears to sit above the Frank Creek showing, within dark grey phyllite of the Harveys Ridge succession and is very similar in appearance to sandstones within the Goose Peak quartzite. A similar sandstone is faulted against dark grey phyllite of the Harveys Ridge succession just north of the disseminated sulphide occurrence found down slope from the main Frank Creek showing. The sandstone has been described as a felsic tuff by Barker Minerals Ltd. although the author believes it displays characteristics consistent with a sedimentary origin (*i.e.* dominantly detrital quartz grains, many of larger are polygonal, lack of embayment features on quartz and lack of preservation of crystal faces on quartz and feldspar grains). Frank Creek mafic metavolcanics are found up slope (and stratigraphically up section) from the Frank Creek showing, across a thickness of several hundred metres of dark grey to black phyllite and siltstone of the Harveys Ridge succession.

Sellers Creek (093A 131)

The Sellers Creek showing was also discovered by Barker Minerals Ltd. in 1999 and occurs towards the end of the "C" logging road, approximately 2 kilometres south of Browntop Mountain. This showing consists of disseminated chalcopyrite, galena and sphalerite found within a quartz sandstone immediately adjacent to white and grey banded marble and can be traced for several hundred metres. Reported grab sample values are: 0.39 per cent Cu, 0.19 per cent Pb and 0.1 per cent Zn (Lane and MacDonald, 2000). The sandstone horizon is from 2 to 3 metres thick and locally contains a calcareous cement. The banded marble, sandstone and chloritic schists have been tentatively assigned to the Keithley succession although the marble may be older or younger (*i.e.* Kee Khan marble or Downey succession). Malachite staining was also observed within chloritic schists, at their contact with marble.

CONCLUSIONS

Mapping in the Frank Creek area encompasses units assigned to the Snowshoe Group and includes lithologies of the Keithley, Harveys Ridge and possibly Downey successions together with rocks of the Goose Peak quartzite and Agnes conglomerate.

Massive sulphide mineralization at the Frank Creek showing occurs within black shales of the Harveys Ridge succession and are spatially associated with mafic to intermediate volcanics of alkaline composition. This, in conjunction with the Cu-Zn-Pb sulphide mineralogy suggests a besshi-type VMS setting.

Although three periods of deformation are evident within the rocks of the map area, second phase fold structures dominate the megascopic map patterns. The peak of regional metamorphism occurred during second phase deformation.

Testing of the stratigraphic correlations put forth by Höy and Ferri (1998) was not possible due to incomplete data.

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