Re-interpretation of Snowshoe Group stratigraphy across a southwest-verging nappe structure and its implications for regional correlations within the Kootenay terrane

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Abstract

The Snowshoe Group represents most of the Barkerville subterrane in northern Kootenay terrane. It is composed of Proterozoic to Paleozoic siliciclastics with minor carbonate and metavolcanic rocks. Re-interpretation of Snowshoe stratigraphy suggests that the present upper Snowshoe Group is a structural repetition of the lower sequence across a southwest-verging, second phase nappe of 25 km amplitude. This structural and stratigraphic interpretation indicates that Downey, Keithley, Ramos and possibly Tregillus successions, together with the Kee Khan marble, comprise one unit. Harveys Ridge and Hardscrabble rocks are equivalent, with Hardscrabble rocks representing a fine-grained facies. Coarse siliciclastic rocks of the Goose Peak and Eaglesnest successions are also correlative. Bralco limestone is interpreted to be a horizon within the lower Harveys Ridge succession and its absence within much of the terrane is due to a facies transition to shale deposition.

Mafic metavolcanic rocks occur within the Downey and Harveys Ridge successions. Chemical analyses indicate an overall alkaline, within-plate affinity, although some basalts display N-MORB and E-MORB abundances. The chemical signature suggests that Snowshoe rocks were deposited during a period of rifting.

Definitive dating of these rocks is difficult, due to lack of diagnostic fossils and suitable material for radiometric dating. Parts of the re-interpreted stratigraphy share similarities with Late Proterozoic to Early Cambrian successions in Cariboo terrane, suggesting that much of the Snowshoe Group is of this age. The revised stratigraphy resembles se-

quences in southern Kootenay terrane, particularly the Eagle Bay assemblage and successions extending from the northern Selkirk Mountains into the Kootenay arc region.

Résumé

Le Groupe de Snowshoe constitue la majeure partie du sous-terrane de Barkerville dans la partie nord du terrane de Kootenay. Il est composé de roches siliciclastiques protérozoïques à paléozoïques et d'un peu de carbonates et de roches métavolcaniques. La ré-interprétation de la stratigraphie du Snowshoe permet de supposer que la partie supérieure de l'actuel Groupe de Snowshoe est une répétition structurale de la partie inférieure, par l'effet d'une nappe de deuxième phase de vergence sud-ouest et d'une amplitude de 25 kilomètres. Cette interprétation structurale et stratigraphique indique que les successions de Downey, de Keithley, de Ramos, et peut-être de Tregillus, avec le marbre de Kee Khan, constituent une unité. Les roches de Harveys Ridge et de Hardscrabble sont équivalentes, et les roches de Hardscrabble représentent un faciès à grains fins. Les roches siliciclastiques grossières des successions de Goose Peak et de Eaglesnest sont aussi des équivalents. Selon cette interprétation, les calcaires de Bralco serait un horizon de la portion inférieure de la succession de Harveys Ridge, son absence ailleurs dans le terrane s'expliquant par une transition à un milieu de dépôt de faciès de schiste argileux.

Il y a des roches métavolcaniques mafiques au sein des successions de Downey et de Harveys Ridge. Les analyses chimiques dépeignent une affinité alcaline d'intraplaque en général, mais certains basaltes montrent des volumes significatifs de N-MORB et d'E-MORB. La signature chimique permet de croire que les roches de Snowshoe ont été déposées durant une période tectonique d'extension (ouverture de fossé tectonique).

Une datation définitive de ces roches demeure problématique, étant donné le manque de fossiles diagnostiques et de matériau permettant une datation radiométrique. Des similarités entre des portions de cette stratigraphie ré-interprétée et celle des successions allant du Protérozoïque supérieur au Paléozoïque inférieur du terrane de Cariboo permettent de croire qu'une grande partie du Groupe de Snowshoe serait de cet âge. Cette stratigraphie révisée évoque des séquences similaires de la portion sud du terrane de Kootenay, particulièrement l'assemblage de Eagle Bay et les successions qui affleurent de la partie nord des monts Selkirk jusqu'à la région d'arc de Kootenay.

INTRODUCTION

The recent discovery of the Frank Creek massive sulphide occurrence by Barker Minerals Ltd. in the Cariboo Lake area and the renewed interest in lode gold mineralization in the Wells region by International Wayside Gold Resources Ltd. have refocused exploration interest within rocks of the Barkerville subterrane (Fig. 1). These discoveries spurred the B.C. Geological Survey to initiate two regional mapping programs within rocks of the Snowshoe Group; one in the area around the Frank Creek occurrence (Ferri, 2001a, b; Ferri and O'Brien, 2002, 2003) and another farther north in the Wells-Barkerville area (Schiarizza and Ferri, 2003). The data and conclusions put forth in this paper are a direct result of these projects.

The Barkerville subterrane represents the northern continuation of the Kootenay terrane (Fig. 1; Monger and Berg, 1984; Struik, 1986). Although these terranes share many structural and stratigraphic characteristics, there are sufficient differences in our current knowledge of the stratigraphy to warrant subdivision. The Barkerville subterrane is dominated by the Snowshoe Group, a Proterozoic to Paleozoic package of predominantly siliciclastic rocks. The definition of its internal stratigraphy has undergone numerous revisions over the years due to a paucity of fossil data and relative homogeneity of the sequence (see Struik, 1988). Recent mapping of the type Snowshoe Group by the B.C. Geological Survey has led to a re-interpretation of this stratigraphy whereby current upper Snowshoe units, as defined by Struik (1988), are believed to be structural repeats of the lower succession, duplicated across a large, southwest-verging second phase fold (nappe) structure (Schiarizza and Ferri, 2003; Ferri and O'Brien, 2002, 2003; Ferri, 2001a, b). The stratigraphic order proposed here is simpler, and shows a greater degree of similarity with Kootenay terrane stratigraphic sequences farther south.

REGIONAL SETTING

The Snowshoe Group underlies the northern extent of the Kootenay terrane, which has been referred to as the Barkerville terrane or subterrane (Struik, 1986; Monger and Berg, 1984; Figs. 1, 2). These dominantly siliciclastic rocks, of probable Proterozoic to Paleozoic age, are pericratonic in nature and most likely represent the distal edge of ancestral North America. Stratigraphic similarities exist between sections of the Snowshoe Group and Early Cambrian sequences of the Cariboo terrane, found to the east, across the westerly-verging Pleasant Valley thrust, suggesting a link between the two terranes, and ultimately with the ancestral North American margin

(Struik, 1986, 1988). The Cariboo terrane represents a displaced piece of the ancestral North American margin, and contains units suggesting a more proximal setting to the carbonate shelf. Although siliciclastics comprise thick sequences in this terrane, carbonate sections are more abundant than within the Kootenay terrane, and stratigraphic units can be more easily correlated eastward into the North American miogeocline.

The western boundary of the Barkerville subterrane is marked by an easterly-verging fault termed the Eureka thrust (Struik, 1988) or Quesnel Lake shear zone (Rees, 1987). Lenses of variably sheared mafic and ultramafic rocks of the Crooked Amphibolite that occur along this boundary are assigned to the Slide Mountain terrane, a Late Paleozoic oceanic assemblage. The Slide Mountain terrane is locally represented, in large part, by the Antler Formation, an imbricated assemblage of late Paleozoic age, comprising chert, argillite, basalt and gabbro thrust onto the Barkerville and Cariboo terranes along the Pundata thrust (Struik, 1988).

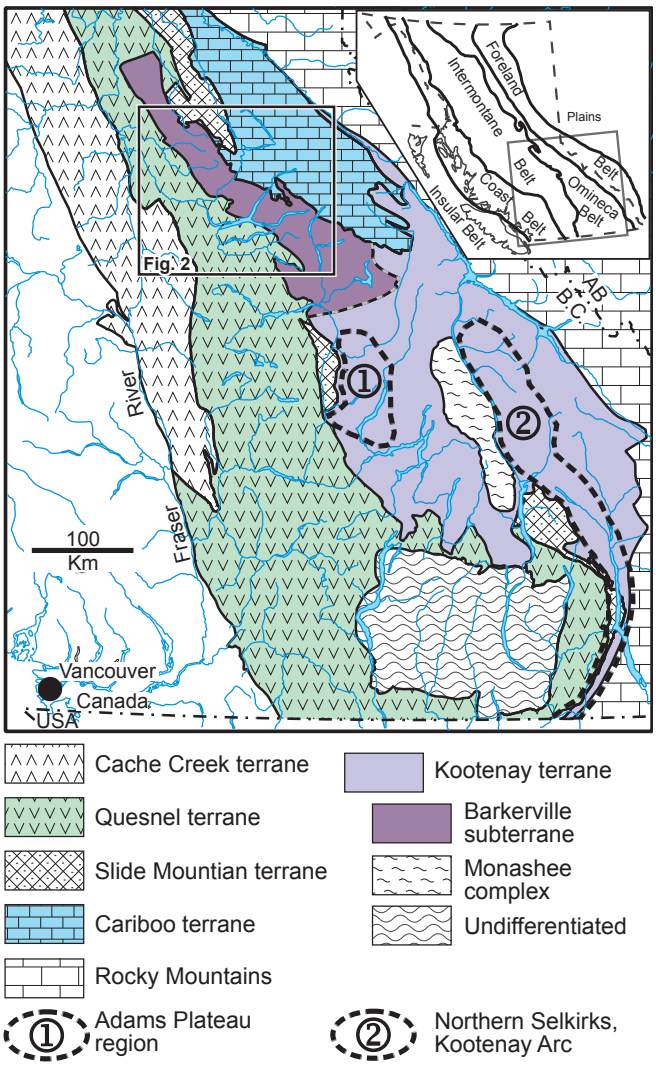

Figure 1. *Terrane map of the southeastern Canadian Cordillera.*

Quesnel terrane rocks are found unconformably above, and thrust onto, the Crooked Amphibolite, or in the immediate hanging wall of the Eureka thrust where amphibolite is absent. The Quesnel terrane is dominated by Mesozoic arc volcanic and sedimentary strata of the Nicola Group, and is locally represented by Middle to Upper Triassic fine-grained clastic and lesser tuffaceous deposits of the 'Black phyllite' unit (Rees, 1987).

The Snowshoe Group is intruded by several large granitic sills and numerous smaller gabbroic and dioritic bodies in the Cariboo Lake area (Figs. 3, 4). The most areally extensive are granitic sills, composed of coarsely crystalline, foliated potassium feldspar megacrystic granite to granodiorite of Early Mississippian age, termed the Quesnel Lake gneiss (Ferri *et al.*, 1999). This unit locally displays gneissic texture where it is highly sheared, particularly near the Eureka thrust. Numerous smaller bodies of Early Permian gabbro to diorite are found throughout the area, the largest occurring in the Mount Barker region (Ferri and O'Brien, 2002, 2003).

Although there is evidence for older, Devono-Mississippian and Late Permian periods of deformation within the northern and southern Kootenay terrane (Read and Okulitch, 1977; McMullin *et al.*, 1990), the intensity of late Early Jurassic to mid-Middle Jurassic deformation was such that the present map patterns and penetrative structures are dominated by this protracted episode of polyphase deformation and metamorphism (Ross *et al.*, 1985; Brown *et al.*, 1986; Rees, 1987). It occurred in response to the eastward obduction of Quesnel arc rocks onto the northern Kootenay terrane along the Eureka thrust. Eastward obduction was followed by southwest-vergent folding of the terrane boundary and earlier structures, accompanied by greenschist to amphibolite facies metamorphism. Peak metamorphism was attained prior to (Fillipone and Ross, 1990) or during (Rees, 1987) the southwest-directed folding, and is dated as

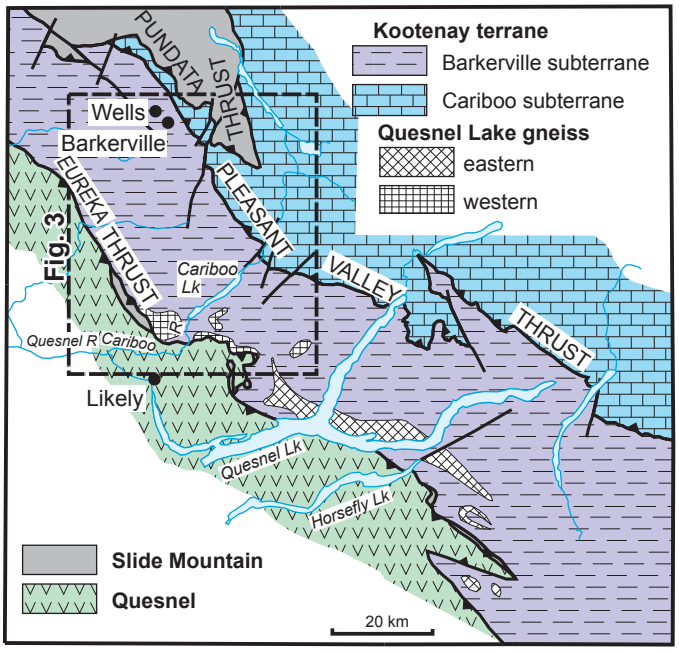

Figure 2. *Geology between the Wells-Barkerville and Quesnel Lake areas.*

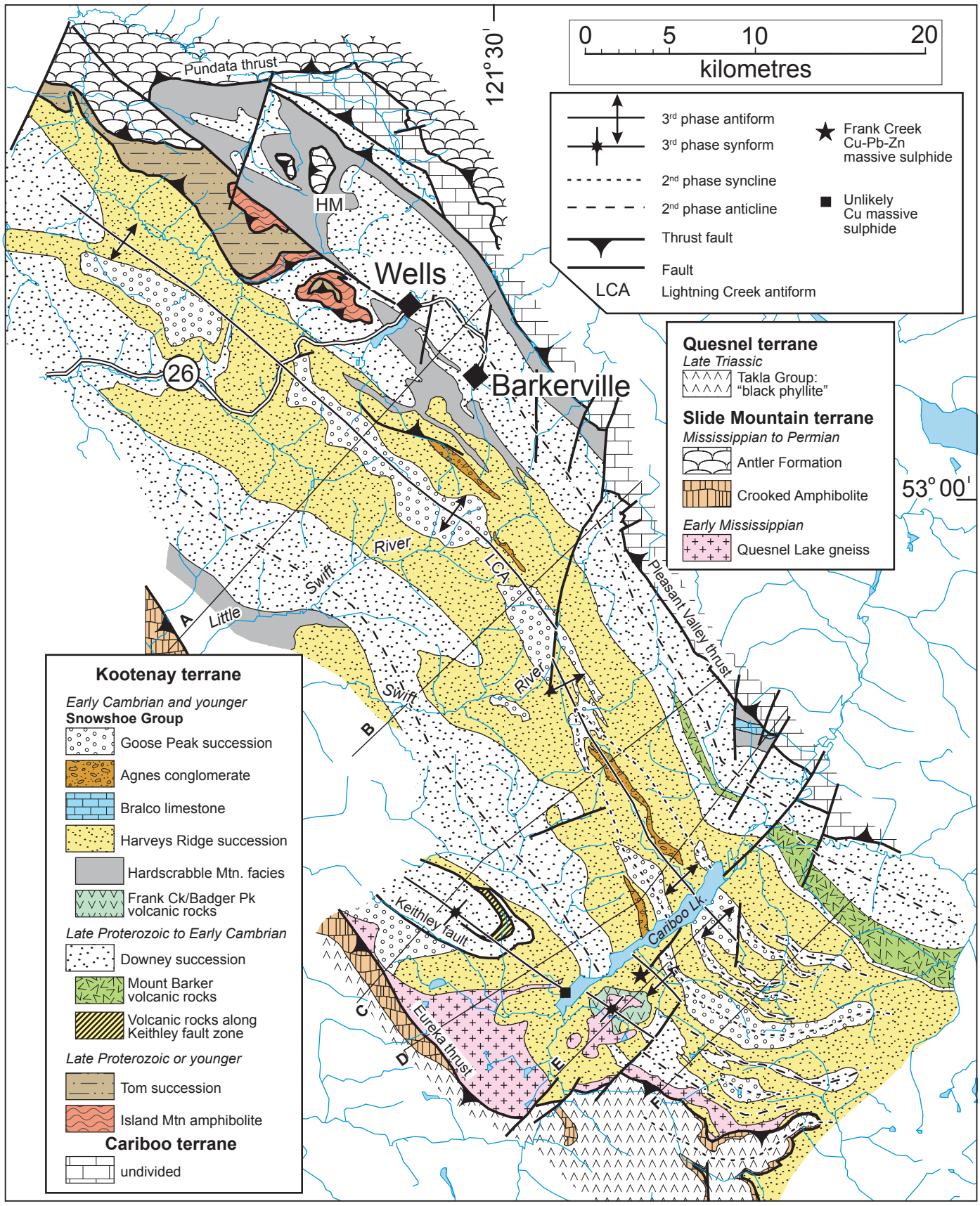

Figure 3. *Caption on facing page.*

Middle Jurassic on the basis of a 174 ± 4 Ma U-Pb age on metamorphic sphene from near Quesnel Lake (Mortensen *et al*., 1987). Similar southwest-vergent, synmetamorphic folds are prominent structural features throughout much of Barkerville, Kootenay and western Cariboo terranes (Raeside and Simony, 1983; Schiarizza and Preto, 1987; Murphy, 1987; Struik, 1988; Ferri and O'Brien, 2002), and are constrained or interpreted to be of late Early to Middle Jurassic age (Murphy *et al*., 1995; Colpron *et al*., 1996). These southwest-verging structures are refolded by upright to northeast or southwest-vergent, mainly late- to post-metamorphic folds (Rees, 1987; Struik, 1988; Ferri and O'Brien, 2002). However, studies within and adjacent to the southern Cariboo Mountains, near the Barkerville/Cariboo terrane boundary, indicate that structures which postdate the major southwest-vergent folding there are associated with a younger metamorphic event of Early Cretaceous age (Currie, 1988; Digel *et al*., 1998; P.S. Simony, personal communication, 2002).

Among the youngest structures in the region are orogen-parallel, dextral strike-slip faults and related folds that are documented within the Cariboo Mountains east of the Barkerville subterrane (Reid *et al*., 2002). These structures are thought to be Late Cretaceous to Eocene in age, and thus coeval with other major dextral strike-slip fault systems in the Canadian Cordillera (Struik, 1993; Umhoefer and Schiarizza, 1996).

SNOWSHOE GROUP

History of Nomenclature

The history of stratigraphic nomenclature for rocks presently assigned to the Snowshoe Group goes back almost as far as the first geologic investigations within the Canadian Cordillera, a rich geologic history that has led to a plethora of names over the years. This historical timeline is summarized by Struik (1988; see his table 2), from which the following account is partially summarized.

Bowman (1889) first described rocks presently assigned to the Snowshoe Group and designated them the Cariboo Schists. Johnston and Uglow (1926) renamed these the Cariboo Series and subdivided them into several formations. Hanson (1935) and later Lang (1938) expanded on several of the formations named by Johnston and Uglow (1926), subdividing the Richfield Formation into several members (Basal, Lowhee, B.C., Rainbow, Baker) still used by lode gold miners in the Wells-Barkerville area to describe mineralized sequences or rocks hosting mineralized veins. Holland (1954), describing rocks hosting mineralized veins in the Yanks Peak to Roundtop Mountain area, converted the Cariboo Series to Group and redefined the stratigraphy, applying formation names (Cunningham to Midas) still in use within the present Cariboo Group. Holland (1954) named the upper unit of this group the Snowshoe Formation, after its exposures near Snowshoe Creek.

Sutherland Brown (1957) carried this nomenclature from the Yanks Peak area northwards to Wells and then into the Cariboo Mountains farther east (Sutherland Brown, 1963). Campbell *et al.* (1973) realized that, although there are similarities between Cariboo Group rocks in the Cariboo Mountains and the type area at Yanks Peak, enough differences existed such that sequences in the two areas could not be equated. As such, Campbell *et al.* (1973) recommended that the Cariboo Group be redefined based on type sections now within the Cariboo terrane. They also suggested that the Snowshoe Formation, interpreted as the uppermost formation of the Cariboo Group in the Yanks Peak area, might actually be equivalent to the Kaza Group, which underlies the Cariboo Group in the central Cariboo Mountains.

These questions and recommendations were re-examined in subsequent regional mapping programs by Struik (1981, 1982a, b, 1986, 1987, 1988), who concluded that the Quesnel Highlands stratigraphy was indeed different from that in the Cariboo Mountains. Like Campbell *et al.* (1973), he retained the term Cariboo Group (as well as most of the original formational names, excluding Snowshoe Formation) for the stratigraphic succession of the Cariboo Mountains, and following Monger and Berg (1984) used the term Cariboo terrane for the larger package of rocks, or facies belt, that contains the group. Struik (1986, 1988) assigned most of the Quesnel Highlands succession to the Snowshoe Group, utilizing the name Barkerville terrane (Monger and Berg, 1984) for the facies belt that includes the group. Struik (1986, 1987, 1988) redefined the Snowshoe Group into 13 informal units of possible Late Proterozoic to late Paleozoic age (Fig. 5A). Struik (1988) also noted that some of these units may be stratigraphically equivalent and, due to the scale of mapping, left much of the Snowshoe Group undivided.

This study builds on the work of Struik (1988), but differs from it in suggesting that much of the higher units of Struik's (1988) Snowshoe Group are structural repetitions of lower stratigraphy. Much of the descriptive work and detailed geologic relationships upon which this paper is based can be found in Schiarizza and Ferri (2003), Ferri and O'Brien (2002, 2003), Ferri (2001a, b), Struik (1988) and Rees (1987).

Stratigraphic Reinterpretation

As a result of our recent mapping in the Cariboo Lake area, the stratigraphy of the Snowshoe Group has been redefined as shown schematically in Figure 5B and in detail on Figure 6. The stratigraphic sequence, as presented here, redefines the Snowshoe Group into three major units termed the Downey, Harveys Ridge and Goose Peak successions.

Several key observations and relationships have led us to propose this new Snowshoe Group stratigraphy. Ferri (2001a, b) showed that parts, or all of Downey rocks, sit stratigraphically beneath the Harveys Ridge succession and are capped by the Keithley

Figure 3. *(facing page) Generalized geologic map of the study area, extending from the Cariboo Lake region to Wells-Barkerville. KCF – Keithley Creek Fault; LCA – Lightning Creek antiform; HM – Hardscrabble Mountain. Shows locations of cross sections shown in Figure 4.*

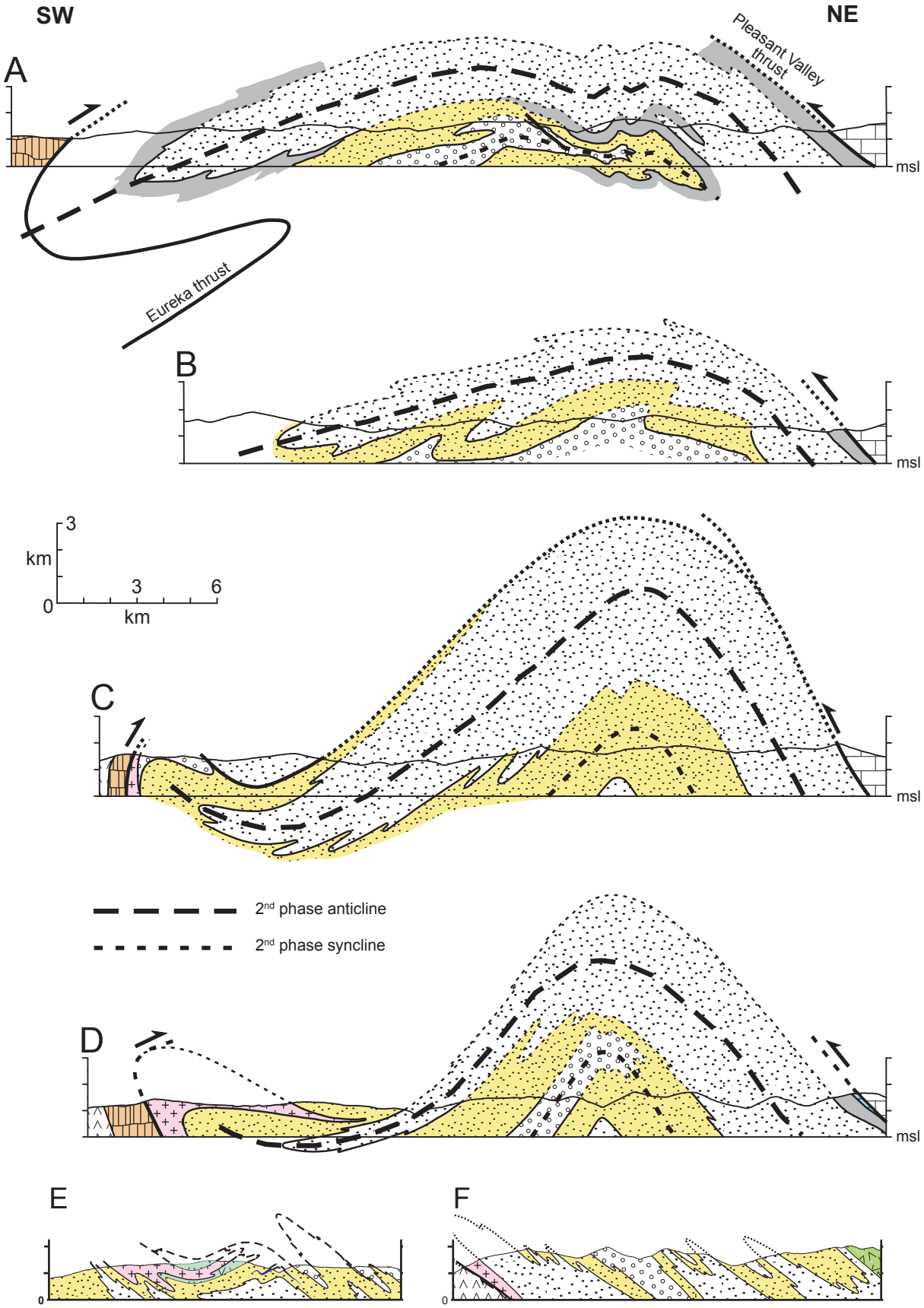

Figure 4. *Interpretive structural cross-sections through various parts of the map sheet. Locations are shown in Figure 3.*

quartzite (units as defined by Struik, 1988). Ferri (2001a, b) also introduced the concept of the transitional Harveys Ridge unit for much of Struik's (1988) undivided Snowshoe Group. He showed that the Agnes conglomerate occurs within its upper part, and that the Goose Peak succession sits stratigraphically above the Harveys Ridge succession. Ferri and O'Brien (2002, 2003) presented evidence indicating that Keithley and Ramos rocks in the Yanks Peak – Keithley Creek areas interfinger and are essentially one unit (Fig. 6). These revisions require a major repetition across the Snowshoe belt, which Ferri and O'Brien (2003) ascribed to a refolded southwest-verging nappe.

Schiarizza and Ferri (2003) conducted reconnaissance-scale mapping northwards to Wells (Fig. 3) and came to the following conclusions: (1) Rocks mapped as the Hardscrabble succession between Wells and Barkerville, and known to be structurally beneath, but stratigraphically above, the adjacent Downey succession, interfingered southward with rocks equivalent to the transitional Harveys Ridge succession. This forms the north end of a continuous belt of Harveys Ridge and Harveys Ridge transitional rocks extending from the Cariboo Lake region. These rocks sit structurally below, but stratigraphically above, Downey rocks along the entire belt. (2) Rocks mapped as Keithley succession and undivided Snowshoe Group by Struik (1988) near the Swift and Little Swift rivers, along strike from the Keithley/Ramos belt of Yanks Peak, are lithologically very similar to the Downey succession, thus supporting the correlations of Ferri and O'Brien (2002, 2003), and the likelihood of a major structural repetition across the belt.

The Downey succession, as defined here, combines rocks formally assigned to the Downey, Keithley, Ramos, Kee Khan and Tregillus successions. This unit crops out as two separate belts; the eastern belt corresponds to Struik's (1988) Downey succession, whereas the western belt comprises rocks of the former Keithley and Ramos successions (Fig. 3). We propose the term 'Keithley quartzite' be retained to describe orthoquartzite at the top of the redefined Downey succession. Farther north, beyond the limit of mapping, the western belt of rocks apparently passes into rocks mapped as Tregillus, Kee Khan and Keithley successions (plus undifferentiated Snowshoe Group). In this revision, the Kee Khan marble would equate to one of the thicker carbonate horizons found within the Downey succession.

The Harveys Ridge succession includes rocks formerly of the Harveys Ridge and Hardscrabble Mountain successions. In addition, it is dominated by rocks originally mapped as undifferentiated Snowshoe Group by Struik (1988). These latter rocks are broadly correlative with the transitional Harveys Ridge unit of Ferri (2001a, b) and Ferri and O'Brien (2002, 2003). This unit also includes much of the finer grained portion of the Eaglesnest succession.

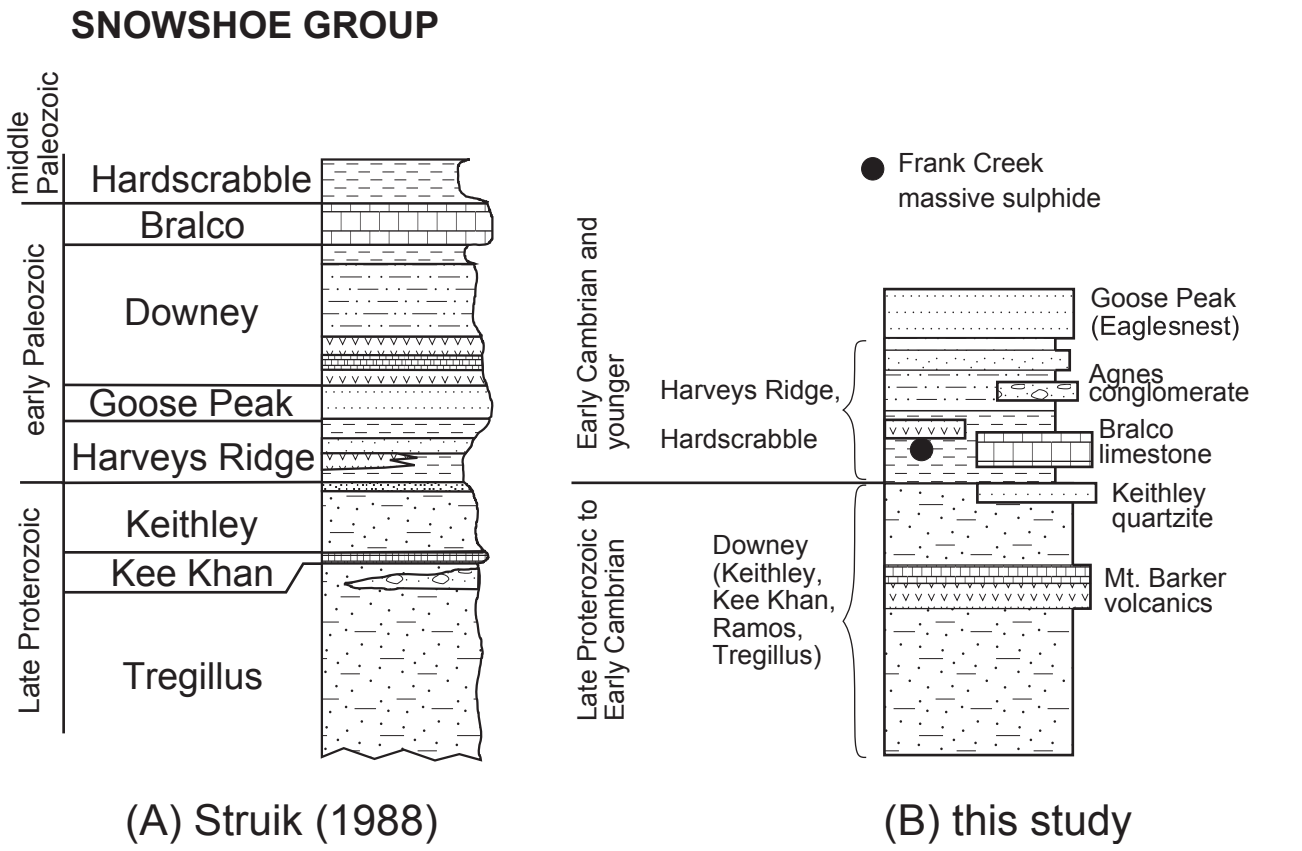

Figure 5. *(A) Stratigraphic column for the Snowshoe Group as proposed by Struik (1988). (B) Revised Snowshoe Group stratigraphy as proposed in this paper. Names within brackets are units previously used by Struik (1988). Symbol legend shown in Figure 6.*

It is proposed that the term 'Hardscrabble Mountain facies' be retained to define the finer grained facies of the Harveys Ridge succession. Quartzite cobble to boulder conglomerate of the Agnes conglomerate is recognized as a discontinuous unit within the Harveys Ridge succession. The Bralco limestone is interpreted to occupy a position within the lower Harveys Ridge succession and is believed to pass westward into a shale facies (Fig. 6). The Bralco limestone is only found in the footwall of the Pleasant Valley thrust, and is never seen along the western extent of the Snowshoe Group.

The Goose Peak succession includes rocks formally assigned to the Goose Peak and Eaglesnest successions. Eaglesnest rocks included in this unit represent the stratigraphically higher, thick bedded, coarser, feldspathic quartzite.

The preceding redefinition of the Snowshoe Group rearranges clastic rocks into three broad compositional packages which are, from oldest to youngest:

- Downey succession — greenish-grey, micaceous quartzite or feldspathic quartzite, phyllite or schist, locally with a distinctive orthoquartzite at the top of the sequence;
- Harveys Ridge succession — dark grey to black phyllite, siltstone, quartzite with light grey quartzite and feldspathic quartzite becoming more abundant up section;

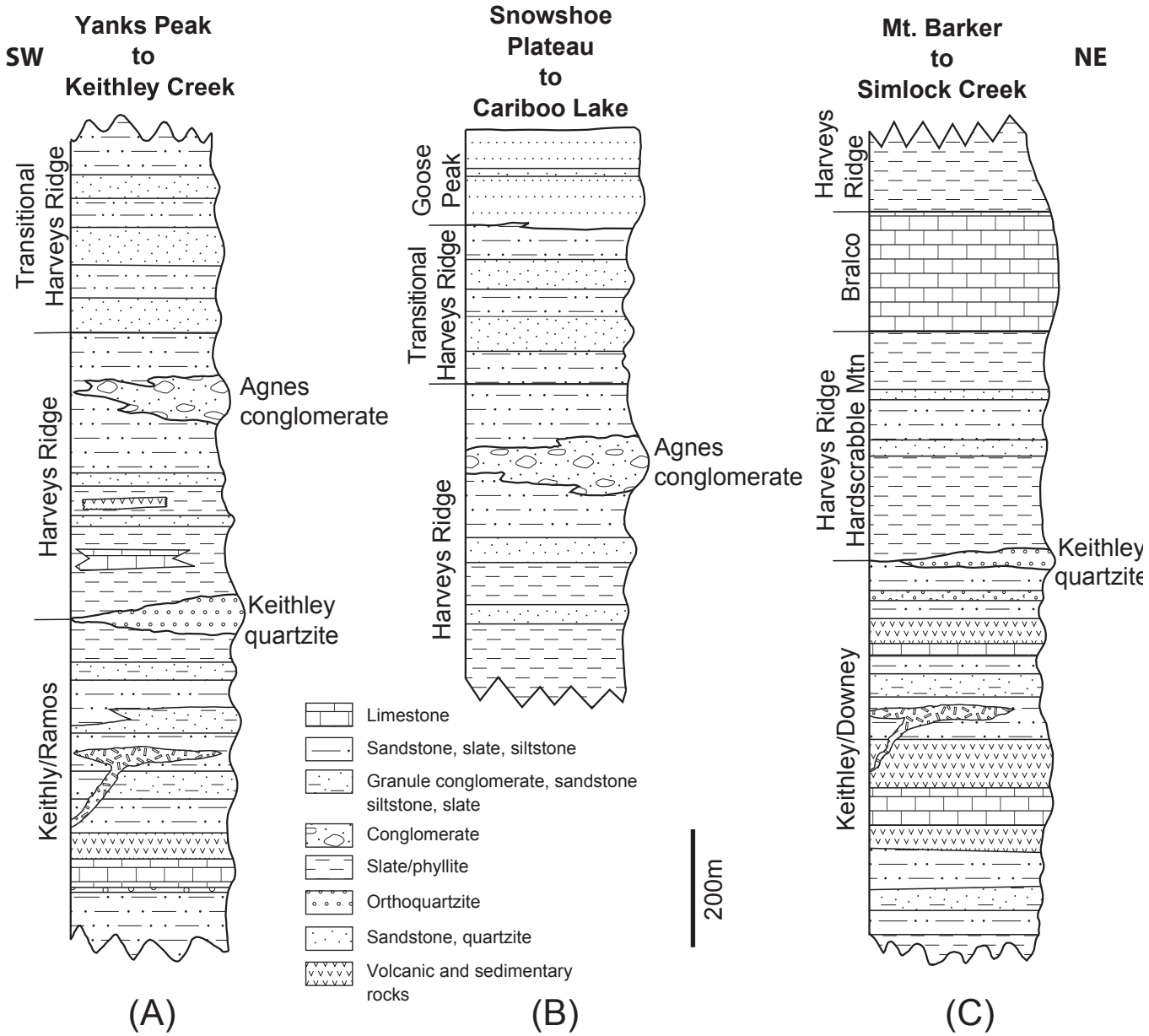

Figure 6. *Simplified stratigraphic columns for Snowshoe Group rocks immediately north of Cariboo Lake. These three sections were compiled from outcrop distributions in the following areas from southwest to northeast. (A) Yanks Peak to Keithley Creek; (B) Snowshoe Plateau to Cariboo Lake and (C) Mount Barker to Simlock Creek. The stratigraphic names used in this diagram correspond to those used by Struik (1988), in order to show the similarities between the various units, particularly the Downey, Keithley and Ramos successions.*

- Goose Peak succession — light grey to light greenish grey quartzite to feldspathic quartzite with interbedded dark grey phyllite and siltstone.

The contact between Downey and Harveys Ridge successions is sharp, whereas the contact between Harveys Ridge and Goose Peak seems to be gradational, with Goose Peak-like quartzites and grits occurring throughout much of the Harveys Ridge Succession. Harveys Ridge rocks are characterized by abundant black quartz clasts. The Downey succession commonly contains relatively thick, discontinuous carbonate horizons, which are associated with mafic metavolcanic rocks. The Harveys Ridge succession, in the vicinity of Frank Creek and Badger Peak, also includes relatively thick sections of mafic to intermediate metavolcanic rocks.

Black siltstone and slate in the lower part of the Harveys Ridge succession host Cu-Pb-Zn massive sulphide mineralization of the Frank Creek occurrence and Cu-rich sulphide mineralization at the nearby Unlikely showing (Figs. 3, 5; see Ferri, 2001a, b; Ferri and O'Brien, 2002, 2003). The occurrence of these showings within black clastic rocks, and the association of nearby metavolcanic rocks, suggest volcanogenic mineralization of sediment-volcanic-hosted, or Besshi-type, although a sedimentary exhalative origin cannot be ruled out. Later in the paper, we compare the stratigraphic setting and style of mineralization of the Barkerville stratabound sulphide occurrences with the Goldstream deposit of southern Kootenay terrane. No new fossil or radiometric age determinations were obtained during the course of 2000 to 2002 field seasons. Only three fossil localities are listed within the Snowshoe Group by Struik (1988). Two are from the Downey succession and one from the Bralco limestone. All give broadly Paleozoic ages; bryozoan and ostracod? remains in one sample from a locality considered to be within the Downey succession suggest a post-Cambrian age (Struik, 1988). The usefulness of this latter fossil locality with respect to determining the age of the Downey succession proper is questioned, in light of the uncertainty in assigning the structural panel of rocks hosting these fossils to this unit (see map 1635A, Struik, 1988). As mapped, this panel sits in the immediate footwall of the northern termination of the Pleasant Valley thrust: it could be, alternatively, a structural repeat of Cariboo terrane rocks in the hanging wall of the fault.

Age constraints based on U-Pb dating of intrusive rocks are also inconclusive. Early Permian meta-diorite intrudes rocks of the Downey and Harveys Ridge successions (Ferri and O'Brien, 2002) and the Early Mississippian Quesnel Lake gneiss intrudes rocks of the Downey and Harveys Ridge successions (Ferri *et al*., 1999), indicating that parts of the Snowshoe Group are pre-Early Mississippian in age.

In light of this, determining the broad ages of the various units of the Snowshoe Group may be attempted by correlations with similar lithologies elsewhere within parts of the ancestral North American margin. Since Holland (1954) first defined parts of the Cariboo Group at Yanks Peak and traced these units westward into the Cariboo Mountains, it has been realized that parts of Snowshoe stratigraphy are similar to units of the Cariboo Group within the present day Cariboo terrane (Fig. 7). In fact, the Yankee Belle, Yanks Peak and Midas formations of the present Cariboo Group (Cariboo terrane) originally had their type sections in the Yanks Peak area, within rocks of the Snowshoe Group (Barkerville subterrane). Orthoquartzite at the summit of Yanks Peak (presently part of the Downey succession) bears a strong resemblance to Early Cambrian (Placentian) orthoquartzite of the Yanks Peak Formation, although the former is generally better sorted and purer (Fig. 7). Greenish phyllite, micaceous quartzite, siltstone and limestone of the Downey succession below the orthoquartzite, particularly in the Yanks Peak area, bears some resemblance to the Late Proterozoic Yankee Belle Formation. Overlying dark phyllites and siltstones of the Harveys Ridge succession are quite similar to the Early Cambrian Midas Formation, although the latter does not contain coarser, feldspathic sections typical of the Harveys Ridge succession.

The Bralco limestone, sitting presently within the Harveys Ridge succession along the eastern extent of the Snowshoe Group, may correlate with the Early Cambrian (Waucoban) Mural Formation of the Cariboo Group. Overlying shales, assigned to the Harveys Ridge succession, would be equivalent to units of the Cambrian Dome Creek and/or parts (Ordovician) of the lower Black Stuart Group (Struik, 1988). The absence of the Bralco limestone along western parts of the Snowshoe Group is assumed to be a function of non-deposition (*i.e.* shale out), although erosional removal cannot be ruled out.

Struik (1986, 1988) suggests that Hardscrabble rocks, particularly the muddy conglomerate and greywacke along Hardscrabble Mountain 10 km northwest of Wells, share many similarities with mid-Paleozoic successions of the Eagle Bay assemblage and Milford Group, making them younger than the Cambrian age suggested in this paper. Although this is a possibility, these lithologies are similar to those of the Agnes conglomerate and transitional Harveys Ridge succession. If this sequence is younger, as Struik (1986, 1988) suggests, and sits above the Downey succession, as defined in this paper, then an unconformity must exist at the base of the Hardscrabble Mountain facies. Hardscrabble rocks are best developed in the northern part of the map area, and along the upper limb of the nappe structure shown in Figure 3. This distribution would not negate the existence of the nappe structure, although modification of the lower syncline would be required in section A of Figure 4.

FOLDED NAPPE STRUCTURES

The map area has undergone polyphase deformation of Early to Middle Jurassic age. At least three cross-cutting structural fabrics (S_1 to S_3) can be observed on outcrop scale, and can be correlated with meso- and megascopic fold elements (F_1 to F_3). These structures are interpreted to have formed in three deformational events (D_1 to D_3). The oldest fabric is layer-parallel flattening (S_1), which is refolded by moderately dipping to flat lying, southwest-verging folds on outcrop scale (F_2). Commonly, S_1 fabric has been transposed into parallelism with S_2 foliation. It is only in the core of these D_2 folds that S_1 can be seen crenulated by S_2. A steep, northwest-striking crenulation (S_3) is usually found across the area.

Mesoscopic F_2 folds are common, and southwest-verging megascopic structures have been interpreted in the southeastern part of the area. The southwest-verging Pleasant Valley thrust is a major

syn- to post? nappe discontinuity, which may be a late D_2 structure. F_3 folds are common at outcrop scale and produce large, map scale structures, the most notable being the Lightning Creek antiform, which can be traced from Wells to Cariboo Lake (Figs. 3, 4).

D_1 deformation is manifested by small, rootless isoclinal folds and layer-parallel fabric. D_1 mesoscopic fold structures have not been mapped based on stratigraphic facing or repetition, unless the large fold repeating Snowshoe stratigraphy is in fact D_1 and not D_2, as interpreted here. Resolving this would require further work, and ultimately may not be possible. The only megascopic structure assigned to D_1 deformation in the area is the Eureka thrust (see Rees, 1987; Figs. 3, 4).

Geologic units of the Snowshoe Group, north of Cariboo Lake, are folded into a large, southwest-vergent nappe that is folded by the younger Lightning Creek antiform (Ferri and O'Brien, 2003). The Downey succession forms the core of the early recumbent anticline. The axial trace of this structure had previously been recognized within the eastern belt of Downey rocks, because the Hardscrabble Mountain facies occurs on both sides of the Downey succession (Struik, 1988). Furthermore, the western part of the Downey succession in this belt has long been known to be overturned on the basis of detailed work in the Wells mining camp (Benedict, 1945; Skerl, 1948), where bedding/cleavage relationships and fold asymmetry show that the structure is related to formation of the regional synmetamorphic cleavage. The interpretation that this fold is actually the root zone of a large nappe, however, is based on the revised stratigraphic sequence presented here, and in particular, on the interpretation that the Downey succession, together with flanking Hardscrabble Mountain/Harveys Ridge successions, is repeated to the west, in part, as rocks that had previously been mapped as Keithley succession (Figs. 3, 4). Struik (1982b) inferred similar recumbent fold structures, based on a preliminary stratigraphic inter-

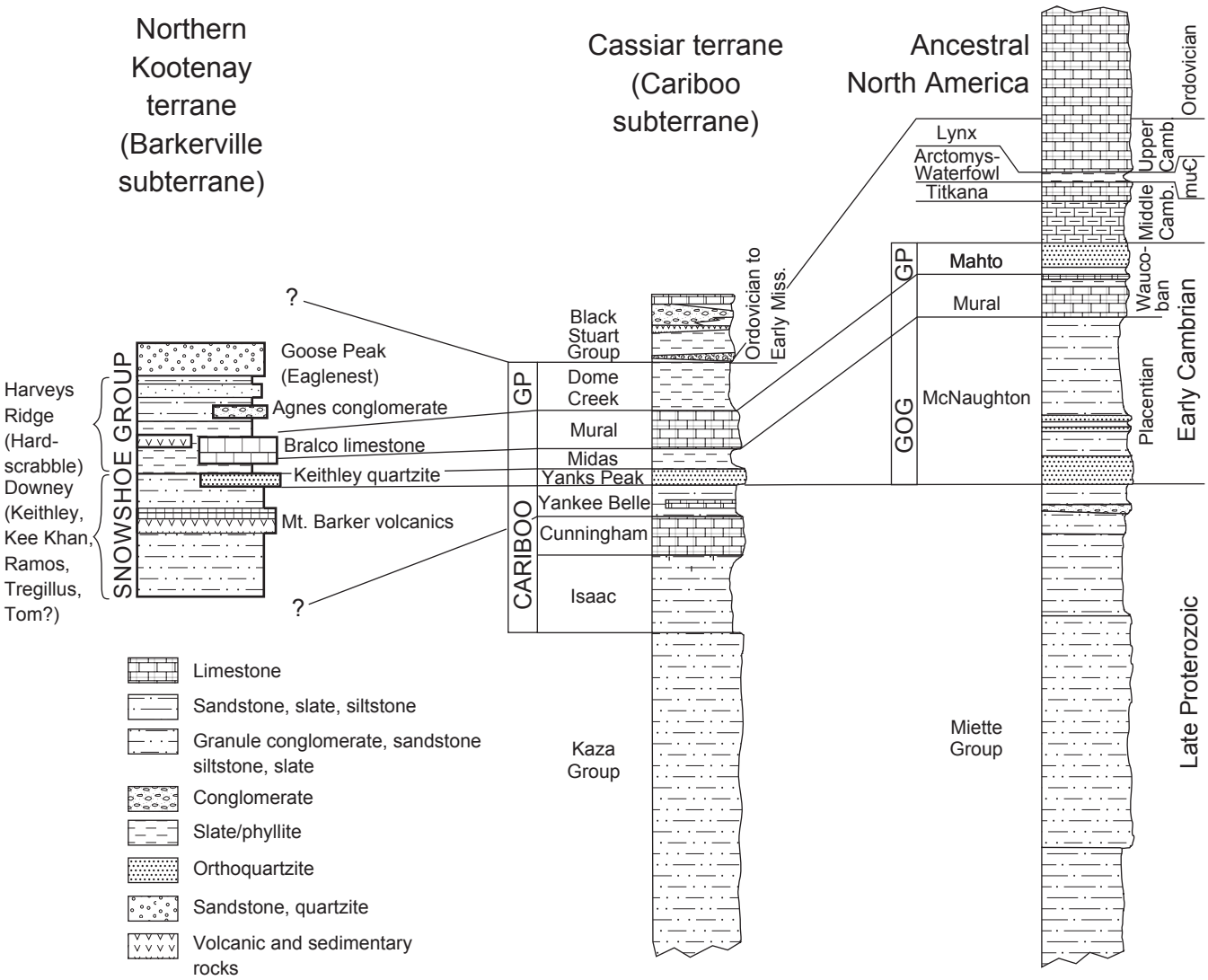

Figure 7. *Proposed correlation of Snowshoe stratigraphy to units of the Cariboo terrane and ancestral North America. Stratigraphy of Cariboo terrane and ancestral North America modified from Struik (1986, 1988) and Campbell* et al. *(1972).*

pretation that correlated the Harveys Ridge and Hardscrabble Mountain successions; his later cross sections (*e.g.*, Struik, 1988) do not show such structures, because he subsequently interpreted the Hardscrabble Mountain succession to be younger than the Harveys Ridge.

At Hardscrabble Mountain, approximately 10 km north of Wells, rocks of the Hardscrabble Mountain facies are mapped enclosing the Downey succession and delineating an overturned anticline (Map 1635A, Struik, 1988). This geometry is in clear conflict with cross-section A shown in Figure 4, in that it links the two belts of Hardscrabble rocks on either limb of the fold structure over approximately 5 km, as opposed to occurring some 25 km to the west (Figs. 3, 4). Resolution of this problem within the context of the large nappe structure can be accommodated in several ways. It is possible that all Hardscrabble Mountain rocks in this area may in fact be part of the Slide Mountain terrane or of some other package (*i.e.,* distal Black Stuart equivalents), structurally emplaced after nappe development. Although these rocks do share similarities with the Slide Mountain terrane, the muddy conglomerate and greywacke in this sequence are consistent with lithologies of the Agnes conglomerate and transitional Harveys Ridge succession (Ferri, 2001a; Ferri and O'Brien, 2002). If rocks at Hardscrabble Mountain are part of the Hardscrabble Mountain succession, then a fault must separate the two panels of Hardscrabble Mountain facies, making one part of the upper limb of the nappe structure (at Hardscrabble Mountain) and the other in the lower limb. A late, southeast-trending normal fault is mapped west of Hardscrabble Mountain, separating Hardscrabble rocks from those of the Tom succession and Island Mountain Amphibolite, and based on present mapping could be modified to separate the two panels (Fig. 3, see map 1635A, Struik, 1988). Alternatively, the thrust faults carrying Tom and Island Mountain rocks may swing eastward and connect with the Pleasant Valley structure, structurally separating rocks in the hanging wall of the thrusts from rocks to the southeast.

In the Hardscrabble Mountain area, klippe of Slide Mountain terrane strata above the Hardscrabble succession, and the presence of tectonic slices of the Island Mountain Amphibolite and Tom succession, present other structural challenges. The structures emplacing Tom and Island Mountain rocks clearly cut across nappe geometry, indicating that they are later structures. The nappe model presented here would suggest that the fault carrying the klippe of Slide Mountain rocks at Hardscrabble Mountain may not be the Pundata thrust as shown by Struik (1988); but is instead either a late structure related to thrust faults carrying Tom and Island Mountain rocks, or that it is the Pleasant Valley thrust. This implies that all or parts of the remaining Pundata thrust may also be related to the Pleasant Valley thrust system. The other implication is that the Pleasant Valley thrust is most likely a post-nappe structure. Proper resolution of these problems clearly requires further detailed mapping in this area.

The main synmetamorphic cleavage within the map area is axial planar to the recumbent, southwest-vergent nappe structures, and is suspected to be early Middle Jurassic in age (Mortensen *et al*., 1987). These F_2 folds have amplitudes in the order of 25 km, extending across the entire width of the Kootenay terrane at this latitude and are interpreted to be the dominant structural feature of the map area.

Folds of similar age, magnitude and character occur throughout Kootenay terrane rocks. Immediately south of the study area, near Crooked Lake, the Crooked Amphibolite and the boundary between the Kootenay and Quesnel terranes outlines a shallow-dipping structure of similar scale. In the Vavenby area, a large, recumbent fold structure was outlined within the Eagle Bay assemblage by Schiarizza and Preto (1987). Farther south, in the Scrip Range, Raeside and Simony (1983), delineated the Scrip nappe within the Horsethief Creek Group. Similar southwest-vergent folds and nappes, of comparable scale to the structure inferred here, and of known or suspected Middle Jurassic age, have been documented in other parts of the Kootenay terrane (Ross *et al*., 1985; Brown and Lane, 1988).

NATURE AND GEOCHEMISTRY OF METAVOLCANIC ROCKS

Mafic metavolcanic rocks within the Downey and Harveys Ridge successions were analyzed to: (1) determine initial compositions and their tectonic settings; (2) characterize associated mineralization; and (3) assist in correlating Snowshoe Group rocks with other Kootenay terrane units farther south. The Downey succession is characterized by chlorite schist and thin horizons of metavolcanic rocks. Only in two areas are they extensive enough to be clearly portrayed in Figure 3: (1) Mount Barker and (2) a highly deformed panel of mafic metavolcanic rocks, mafic intrusive rocks and associated deformed ultramafite along the Keithley fault zone. The Harveys Ridge succession includes two sections of metavolcanic rocks, the Frank Creek volcanics, associated with massive sulphide mineralization, and mafic metavolcanic rocks found along Badger Peak, occurring in roughly the same stratigraphic position as Frank Creek volcanics.

Mount Barker metavolcanics, well exposed on the ridge containing Mount Barker, are dominantly chloritic to amphibolitic (actinolite) phyllite or schist. Locally, bedding and, in rare instances, gradational structures are preserved in tuffaceous sequences. These mafic metavolcanic rocks are commonly interbedded with limestone or dolomite in sections tens of metres thick. They can be mapped southeast of the study area (Struik, 1983a, b), but appear to thin north of the Cariboo River, although chlorite schist can be seen associated with carbonate rocks of the Downey succession in outcrop throughout the area shown in Figure 3. Chloritic or amphibolitic schist, associated with carbonate or marble, is also observed to the west, within rocks formerly assigned to the Keithley and Ramos successions.

Highly sheared chlorite schist, amphibolite to amphibolitic gneiss, metadiorite and ultramafite are found along the Keithley Creek fault zone, southwest of Keithley Creek. Texturally and modally, they appear very similar to sheared mafic igneous rocks of the Crooked Amphibolite. Exposure is poor in this area, but it appears that these rocks are fault bounded. Chemically these rocks are alkaline in nature (Fig. 8) in contrast to the mid-ocean ridge basalt signature of the Crooked Amphibolite.

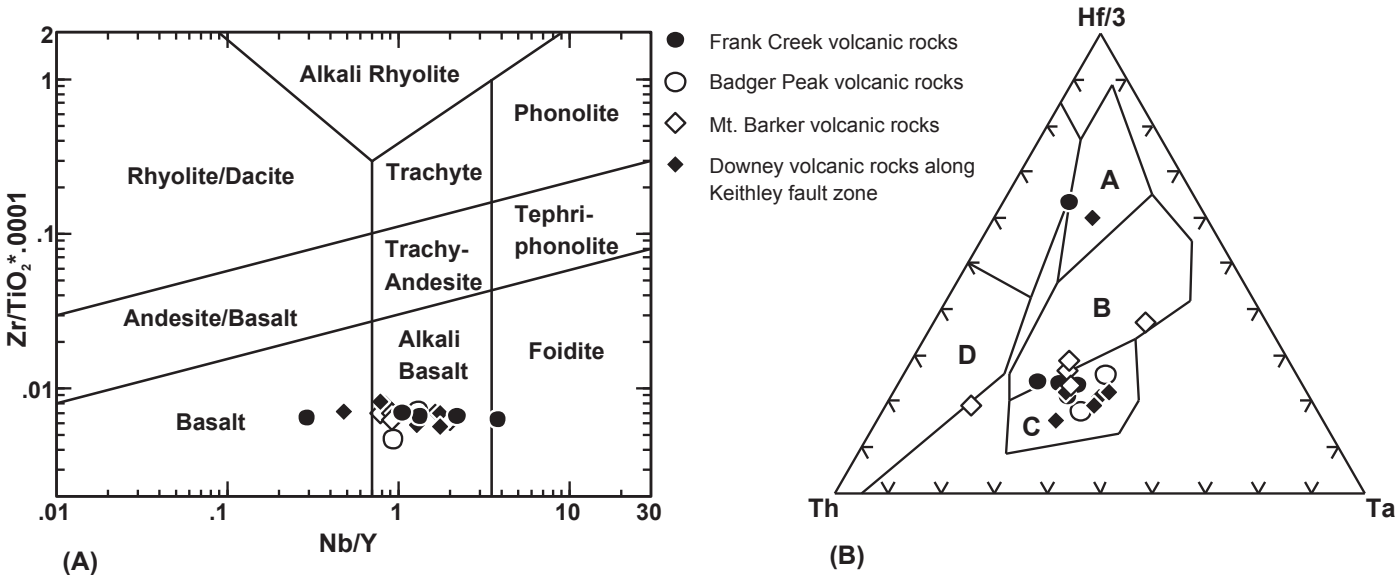

Figure 8. *Geochemical discrimination plots for metavolcanic rocks of the Snowshoe Group (data in Table 1). These include the Mount Barker volcanics, metavolcanic rocks along the Keithley Creek fault and Frank Creek volcanics. (A) modified Winchester and Floyd (1977) diagram. The new field limits shown in this diagram were proposed by Pearce (1996). (B) tectonic discrimination diagram of Wood (1980). A = N-MORB (mid-ocean ridge basalts); B = E-MORB and tholeiitic WPB (within-plate basalts) and differentiates; C = Alkaline WPB and WPB and differentiates; D = Destructive plate-margin basalts and differentiates.*

In the Frank Creek area, dark phyllites of the Harveys Ridge succession interfinger with mafic volcanic rocks, informally referred to as the Frank Creek volcanics. They are typically well-foliated chlorite-actinolite schists, and commonly have no primary depositional features preserved. Two varieties are discernible in the field and verified by geochemical analysis: (1) a more siliceous (51-59% SiO_2), paler green to green package within which layered tuffs or lapilli tuffs and volcanic breccia are sometimes preserved; and (2) a darker green, more mafic chloritic schist that locally contains pillowed to massive porphyritic flows. South of Badger Peak, a section of chlorite actinolite schist, mafic gneiss and meta gabbro, originally assigned to the Crooked Amphibolite by Rees (1987), forms two distinct packages separated by sedimentary strata of the Snowshoe Group. The presence of quartz clastics within sections of chlorite schist, together with geochemical analysis, suggests that these metavolcanic rocks are probably part of Snowshoe stratigraphy.

Major, minor, trace and rare earth element analysis for selected samples from the various suites are shown in Table 1. The following discussion relies on minor, trace and rare earth element analysis, as major elements are considered mobile at mid-greenschist to lower amphibolite facies. In addition, only rocks of mafic composition were used, in light of the difficulties interpreting volcanics of more evolved compositions. Although rocks in the map area have undergone various levels of ductile deformation, samples in Table 1 display textural characteristics consistent with a mafic volcanic origin, and occur within sequences that appear interbedded with surrounding sedimentary strata. The map area contains abundant Early Permian dioritic to gabbroic intrusive sills and dikes, that are of N-MORB, E-MORB or calc-alkaline geochemical affinity (Ferri and O'Brien, 2002). Because it is difficult to distinguish between highly sheared gabbro and basalt, some of the analyses in Table 1, and data points in diagrams of Figures 8 to 10, may be from these suites. This may be particularly true for samples with MORB signature. Samples in Table 1 are predominantly from metavolcanic localities, where relationships suggest that they are interbedded with surrounding sedimentary strata.

Generally, all four suites display alkaline compositions, although some samples fall into the subalkaline field of the modified Winchester and Floyd (1977) Zr/TiO_2 *vs.* Nb/Y diagram (Fig. 8A; Pearce, 1996). These rocks, for the most part, display patterns consistent with a within plate setting (Fig. 8B). Some of the samples, from all the suites, fall within the N-MORB and E-MORB fields of Wood (1980), suggesting a mid-ocean ridge influence in the production of these volcanic rocks (see cautionary note in preceding paragraph). The slopes, and enriched nature of the elements Sm to Th relative to Lu to Gd, are consistent with alkaline compositions, and point to an enriched mantle source rock (Figs. 9A-C). The extended rare earth element plots of Figures 10A, B and C support this inference, and also display the MORB signature of several of the samples from the Downey and Frank Creek volcanic suites. Interestingly, some of the samples of Downey succession from the Mount Barker and Keithley Creek areas display negative Nb anomalies on the extended rare earth element plots of Figure 10, possibly suggesting contamination by continental crust. The positive Nb anomaly displayed by both samples with broadly MORB signatures within the

Table 1. Major, minor, trace and rare earth element analyses for selected samples of volcanics from the Snowshoe Group.

Sample	00FFE-34-6	00FFE-34-8	00FFE- 6-1	01FFE-17-2	BO- 15-7a	01FFE-9-4a	01FFE-11-8	01FFE-11-7a	01FFE-11-7b	01FFe-41-1a	01FFe-41-1b	00FFE-4-14	00FFE-8-10	00FFE-8-11	00FFE- 9-7	01FFE- 8-8	00FFE-23-5	00FFE-23-6
Unit[1]	MB	MB	MB	MB	MB	KC	KC	KC	KC	KC	KC	FC	FC	FC	FC	FC	BP	BP
UTM[2] E	621300	621325	618855	613025	613981	605812	601192	601064	601064	596524	596524	609712	610179	610090	608683	608950	616125	616164
UTM N	5849441	5849754	5852940	5858272	5857068	5845055	5849676	5850147	5850147	5856980	5856980	5842941	5844196	5844241	5842293	5849809	5837760	5837567
SiO_2	48.86	42.7	42.88	44.38	45.04	43.65	42.38	43.52	45.13	47.86	44.72	43.81	45.36	46.47	49.77	44.29	41.11	41.59
TiO_2	1.57	2.27	1.27	2.67	2.44	2.25	2.54	2.02	2.74	1.58	1.19	2	1.66	1.97	1.55	1.75	2.2	1.23
Al_2O_3	16.27	12.47	9.1	14.82	14.15	14.42	14.71	13.57	14.94	14.52	16.39	13.86	19.32	14.59	15.4	14.22	17.2	12.03
Fe_2O_3	14.07	10.57	14.1	12.47	12.4	12.5	13.15	12.73	12.39	11.17	11.03	11.5	9.71	10.26	11.26	11.43	13.96	9.8
MnO	0.09	0.18	0.15	0.12	0.09	0.14	0.15	0.18	0.15	0.15	0.15	0.07	0.1	0.12	0.14	0.14	0.25	0.12
MgO	4.53	5.42	17.71	5.59	8.18	9.81	8.64	13.11	9.09	8.31	9.13	7.61	6.82	6.73	5.9	7.46	9.64	14.22
CaO	3.46	12.69	8.9	6.92	6.11	9.22	12.02	9.4	9.73	8.55	8.81	5.51	3.22	9.02	8.38	5.84	8.02	11.43
Na_2O	4.94	3.79	0.07	3.94	2.94	0.95	1.82	1.00	2.75	3.02	2.24	3.5	2.95	3.58	3.8	4.32	1.12	1.35
K_2O	0.52	0.17	0.02	0.15	0.01	2.16	0.75	0.83	0.47	0.81	1.21	0.76	2.6	0.05	0.4	0.01	0.14	0.18
P_2O_5	0.28	0.33	0.1	0.34	0.27	0.31	0.4	0.2	0.5	0.2	0.23	0.33	0.2	0.25	0.14	0.27	0.41	0.09
LOI[3]	5.13	8.68	4.84	8.28	8.06	3.83	2.93	2.85	1.65	3.07	3.2	10.28	5.86	6.42	2.52	9.97	5.69	7.57
Total	99.79	99.28	99.15	99.69	99.7	99.56	99.53	99.51	99.57	99.62	99.12	99.37	98.93	99.7	99.39	99.71	99.75	99.62
Zr	121	158	79	183	154	158	177	114	158	113	98	131	104	130	100	120	156	58
Y	18	31	8	25	22	17	17	13	21	29	19	17	6	10	34	19	29	15
Nb	15	24	16	23	20	28	30	23	27	14	15	23	23	22	10	20	38	14
V	322	288	228	270	319	294	204	227	263	297	223	263	261	275	353	224	257	207
Ba	730	59	19	121	70	3232	381	1015	286	3763	8246	1444	11286	2389	1253	107	114	105
Rb	19	10	4	11	11	57	23	19	17	18	31	20	45	3	16	8	11	9
Sr	243	464	24	313	223	338	512	117	451	322	323	181	128	489	532	335	421	211
Th	4.39	2.64	1.15	4.52	1.48	4.02	4.59	3.24	3.09	0.68	3.80	2.98	2.30	2.55	0.44	2.24	4.19	1.01
Ta	1.01	1.89	0.83	3.37	2.59	2.91	4.56	3.05	3.40	0.59	2.56	2.19	1.22	2.04	0.23	1.50	3.49	1.08
La	22.77	22.80	10.85	29.32	24.80	28.65	35.42	24.32	20.98	8.92	24.70	19.12	17.91	20.64	4.60	18.07	35.92	9.56
Ce	46.75	48.82	23.95	60.54	57.45	57.81	70.66	48.74	42.80	22.56	46.50	40.56	35.72	44.09	12.89	36.99	68.42	19.57
Pr	5.93	6.21	3.09	7.42	7.95	7.09	8.50	5.96	5.25	3.36	5.24	4.99	4.32	5.41	2.07	4.78	7.75	2.42
Nd	24.50	25.89	13.07	30.71	34.36	29.35	34.94	24.67	22.25	17.06	20.75	20.76	17.55	22.39	10.83	20.69	30.70	10.53
Sm	5.40	5.84	2.93	6.62	6.24	6.00	7.40	4.98	5.26	5.25	4.07	4.73	3.85	4.55	3.62	4.53	6.04	2.36
Eu	1.72	1.91	0.82	2.12	1.94	1.76	2.39	1.48	1.73	1.98	1.50	1.52	0.76	1.36	1.29	1.55	1.90	0.73
Gd	5.00	5.48	2.78	6.06	6.00	5.93	6.68	4.87	5.10	6.52	3.87	4.61	3.58	4.30	4.78	4.56	5.60	2.37
Tb	0.70	0.78	0.39	0.89	0.83	0.86	0.98	0.70	0.77	1.09	0.62	0.67	0.51	0.62	0.80	0.66	0.83	0.35
Dy	4.00	4.48	2.26	5.04	4.90	4.89	5.47	3.94	4.43	7.20	3.92	3.89	2.96	3.57	5.47	3.76	4.97	2.11
Ho	0.73	0.86	0.44	0.89	1.19	0.88	0.95	0.70	0.79	1.40	0.75	0.76	0.57	0.72	1.20	0.67	1.01	0.43
Er	1.96	2.46	1.26	2.32	3.12	2.31	2.49	1.83	2.13	4.08	2.17	2.19	1.61	2.05	3.79	1.74	2.94	1.23
Tm	0.23	0.31	0.16	0.31	0.40	0.31	0.33	0.24	0.28	0.56	0.29	0.27	0.20	0.26	0.50	0.23	0.37	0.16
Yb	1.35	1.86	0.94	1.90	2.50	1.88	2.02	1.45	1.76	3.83	2.02	1.66	1.19	1.54	3.16	1.40	2.24	0.95
Lu	0.20	0.27	0.13	0.29	0.29	0.26	0.30	0.20	0.26	0.55	0.29	0.25	0.17	0.21	0.47	0.19	0.32	0.14
Hf	3.92	4.90	2.42	7.28	7.27	5.79	7.31	4.46	5.46	5.71	3.60	4.11	3.33	4.16	3.39	3.47	4.90	2.13

Notes:
[1]MB: Mount Barker metavolcanic rocks (Downey succession); KC: metavolcanic rocks along Keithley fault zone (Downey succession); FC: Frank Creek metavolcanic rocks (Harveys Creek succession); BP: Badger Peak metavolcanic rocks (Harveys Creek succession).
[2]Universal Transverse Mercator (UTM) projection, zone 10, North American Datum 1983; E: Easting; N: Northing.
[3]LOI: loss on ignition.
Analytical methods: Major oxides determined by fused disc - X-ray fluorescence and reported in weight per cent. Trace elements (Zr, Y, Nb, V, Ba, Rb, Sr) determined by pressed pellet - X-ray fluorescence and reported in parts per million. Major and trace element analysis by Cominco Research Laboratories, Vancouver, B.C. Th, Ta to Hf determined by peroxide fusion-inductively coupled plasma/mass spectrometer analysis at laboratories of Memorial University. Reported in parts per million.

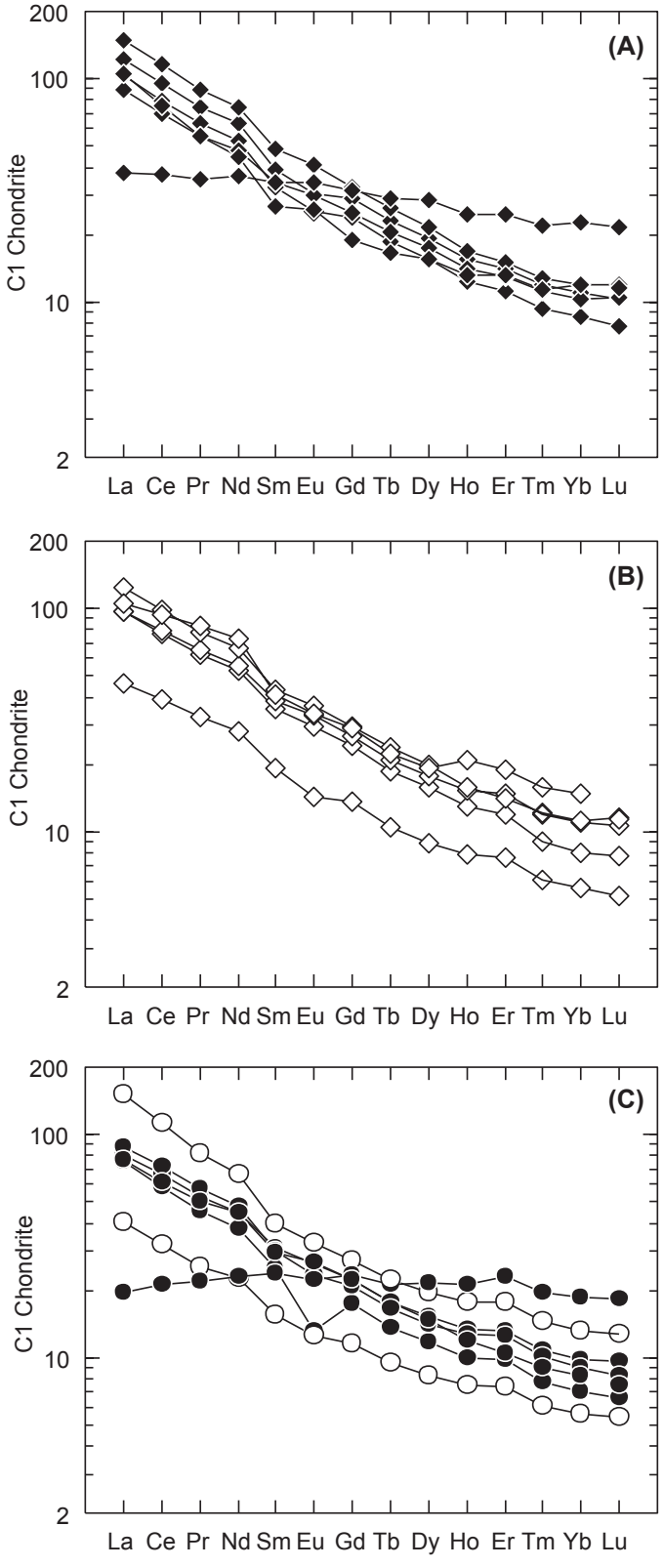

Figure 9. *(A-C) Snowshoe Group rare earth element plots. Normalization values from Sun and McDonough (1989). Symbol designation as in Figure 8.*

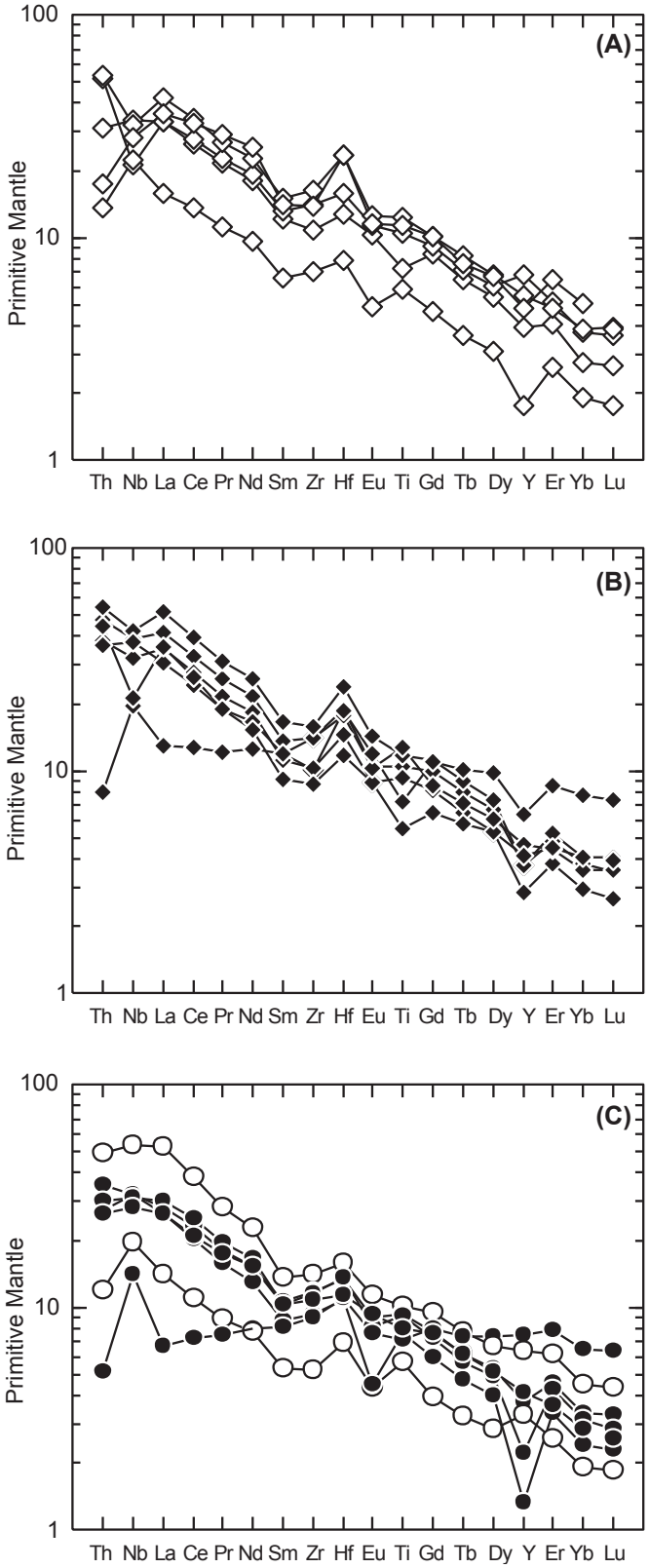

Figure 10. *(A-C) Snowshoe Group extended rare earth element plots. Normalization values from Sun and McDonough (1989). Symbol designation as in Figure 8.*

extended rare earth element plots of Figure 10 suggest influence of enriched mantle in the production of these magmas.

The enriched composition and elemental abundances of the mafic metavolcanic rocks within the Downey and Harveys Ridge successions suggest eruption within an extensional tectonic environment. The presence of basalts with MORB signatures is compatible with this setting, and suggests the influence of ocean ridge or back-arc volcanism in the formation of these volcanics, although a lack of volcanic rocks with calc-alkaline affinities would support the former. Deposition of Snowshoe stratigraphy appears to have occurred within an extensional regime. The presence of volcanism at several stratigraphic levels suggests extension was a protracted event, although of broadly Cambrian age. Coarse clastic rocks within the Downey succession and the thick, coarse grained feldspathic quartzite of the Goose Peak succession and Agnes conglomerate may be a reflection of uplift associated with this extension. Although Yankee Belle clastic rocks within the Cariboo terrane record sedimentation similar to that of the Downey succession, there are no equivalents to the Goose Peak succession within Cariboo terrane, suggesting that the latter part of this extensional event was confined to the Kootenay terrane. Cambrian-age extension comparable to that inferred here for the Cariboo Lake area has also been inferred for other parts of the Kootenay terrane (Colpron *et al*., 2002; Logan and Colpron, this volume; Paradis *et al*., this volume; Devlin, 1989).

REGIONAL CORRELATIONS

Struik (1986), in defining the Snowshoe Group (Barkerville subterrane), suggested that it could be correlated with Kootenay terrane sequences further south, although he also indicated that it had unique characteristics, particularly the Bralco limestone and Goose Peak course clastic rocks. Subsequent workers have, for the most part, agreed that Barkerville and Kootenay terranes are essentially equivalent, but have proposed a variety of different correlations for specific units of the Snowshoe Group (*e.g.,* Höy and Ferri, 1998; Höy, 1999; Ferri and O'Brien, 2002). We propose a new set of correlations based on the revised stratigraphic interpretation of the Snowshoe Group (Fig. 11). These correlations, like those proposed by Struik (1986), are with the Eagle Bay assemblage near Adams Lake (Schiarizza and Preto, 1987; Paradis *et al*., this volume) and the Lardeau Group in the Kootenay arc and contiguous northern Selkirk Mountains (Colpron and Price, 1995; Logan *et al*., 1996; Logan and Colpron, this volume).

Orthoquartzite and carbonate at, or near, the boundary between Proterozoic and Paleozoic successions constitute one of the most widespread and correlative units in southern Kootenay terrane. Struik (1986) recognized that the Keithley quartzite represented this horizon within the Snowshoe Group, although the section lacked an immediately overlying carbonate horizon. The redefined Snowshoe Group stratigraphy presented here suggests that the Bralco limestone is probably Early Cambrian in age. Keying the stratigraphic sections to this Keithley-Bralco couplet (and to Keithley quartzite alone, in areas where the Bralco limestone is absent) allows regional correlations for rocks above and below.

In the northern Selkirk Mountains, clean lowermost Cambrian quartzite, which we correlate with the Keithley quartzite, comprises the upper unit of the Hamill Group. Underlying portions of the Hamill Group are mainly quartzites and phyllites, which therefore correlate with the Downey succession. The Hamill Group does not contain carbonates such as those found in the Downey succession, but the middle Hamill does include a substantial mafic volcanic component that may correlate with volcanic rocks of the Downey (Devlin, 1989). The Hamill volcanics have yielded a latest Neoproterozoic U-Pb zircon date of 569.6 ± 5.3 Ma (Colpron *et al*., 2002). Associated mafic metavolcanic rocks contain elemental abundances consistent with alkaline affinities (Logan and Colpron, this volume). The clean quartzite at the top of the Hamill is overlain by the archaeocyathid-bearing Badshot limestone, which we correlate with the Bralco limestone. The Badshot is in turn overlain by the Index Formation of the Lardeau Group, the lower unit of which comprises black phyllite that is readily correlated with black phyllite and siltstone that characterize the Hardscrabble facies of the Harveys Ridge succession.

This correlation between the Harveys Ridge and Index Formation is enhanced by the presence of mafic volcanic rocks and related Besshi-type massive sulphide mineralization (Goldstream deposit and others) within the lower Index (Logan and Colpron, this volume). They are reasonable correlatives of the massive sulphide mineralization at the Frank Creek occurrence and Unlikely showing, which occur within black clastic strata near the base of the Harveys Ridge succession, associated with the Frank Creek/Badger Peak volcanics. The MORB signature of Index basalts contrasts with the predominantly within-plate affinities of Harveys Ridge volcanics, although some sections of the latter do display MORB abundances (Figs. 8 , 9 and 10; Logan and Colpron, this volume). In the northern Selkirk Mountains, black phyllite of the lower Index Formation is overlain by quartzite, phyllite, grit and minor carbonate of the Akolkolex Formation, mafic volcanic rocks of the Jowett Formation, and an upper, grit-dominated package, assigned to the Broadview Formation (Fig. 11). The Jowett Formation is not apparently represented in the Snowshoe Group, but the Akolkolex and Broadview formations are reasonably correlated with the Harveys Ridge transitional and Goose Peak successions, respectively.

In the Adams Plateau - Vavenby areas, a heterogeneous assemblage of mafic volcanic and sedimentary rocks, assigned to unit EBG of the Eagle Bay assemblage, contains rocks that we correlate with the Downey and Harveys Ridge successions of the Snowshoe Group (Schiarizza and Preto, 1987). The Tshinakin limestone, a discontinuous but commonly very thin carbonate within unit EBG, contains Early Cambrian archaeocyathids at one locality. It therefore correlates with the Badshot and Mural formations, and, we suggest here, also with the Bralco limestone of the Snowshoe Group. A discontinuous but widespread sedimentary succession beneath the Tshinakin invariably includes a unit of very pure quartzite (unit EBGq) that is here correlated with the Keithley quartzite.

Rocks underlying unit EBGq comprise limestone intercalated with mafic volcanic rocks. They may correlate with the mafic volcanic/limestone intervals found within the Downey succession. This

lower part of unit EBG is gradationally underlain by grey to green quartzites, phyllites and grits (unit EBH) that are similar to, and here correlated with, the typical clastic rocks of the Downey succession (Fig. 11). The upper part of unit EBG, above the Tshinakin limestone, includes a continuous unit of black phyllite, with local intercalations of dark grey limestone and quartzite (unit EBGp), that we correlate with the Harveys Ridge succession of the Snowshoe Group. If this is the case, then the mafic volcanic rocks of Unit EBG may actually represent two or more pulses of volcanism that correlate with Mount Barker volcanics at the base of the unit, and the Frank Creek/Badger Peak volcanics at the top of the unit (Fig. 11). Geochemically, the mafic metavolcanic rocks of unit EBG display predominantly within-plate, and lesser E-MORB and N-MORB characteristics, consistent with the chemistry of metavolcanic rocks from the Snowshoe Group (Paradis *et al*., this volume, Bailey, 2002; Bailey *et al.,* 2001).

The upper part of unit EBG is truncated by a thrust fault in some areas, and by a suspected unconformity beneath Devono-Mississippian rocks in others, so the stratigraphic top of the unit is not well understood. Elsewhere within Eagle Bay exposures, however, is a heterogeneous unit dominated by phyllitic grit, quartzite and subordinate phyllite, that also underlies Devono-Mississippian rocks and is suspected to be younger than Unit EBG. This unit (Unit EBS of Schiarizza and Preto, 1987) is lithologically similar to, and tentatively correlated with, the upper, transitional Harveys Ridge succession and the overlying Goose Peak succession of the Snowshoe Group (Fig. 11).

CONCLUSIONS

The stratigraphy of the Snowshoe Group, as proposed in this paper, can be subdivided into three broad packages. The lower division, called the Downey succession, includes units formerly referred to as the Downey, Keithley and Ramos successions by Struik (1988). Rocks of the Tregillus and Kee Khan marble may also correlate with this unit. The Downey succession is dominated by grey-green quartzite, phyllite and grit, but also includes intermittent intervals of carbonate and mafic volcanic rocks. The middle division, termed

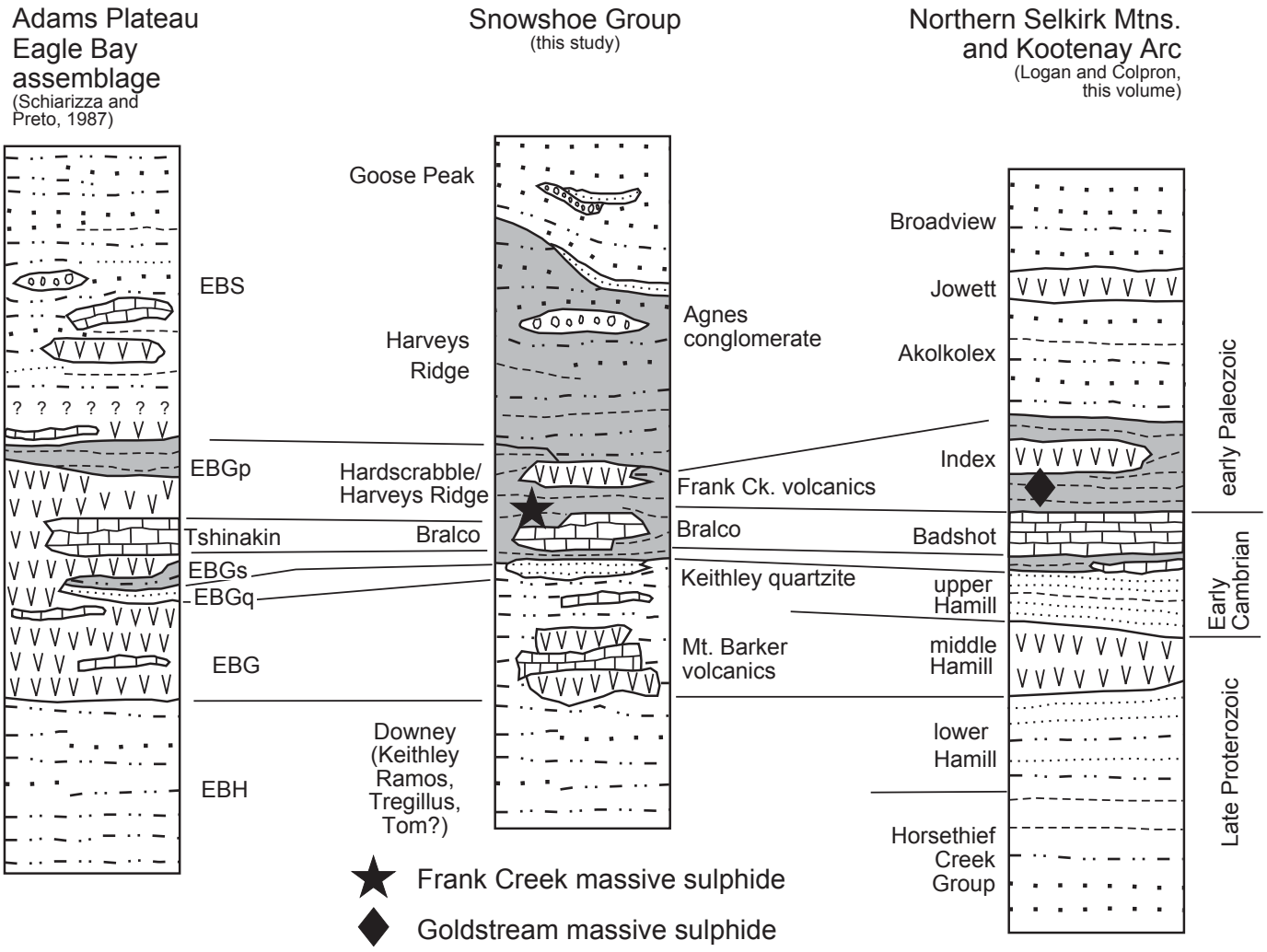

Figure 11. *Proposed stratigraphic correlations of the Snowshoe Group with stratigraphic sequences found in the southern Kootenay terrane. These include Eagle Bay assemblage rocks of the Adams Plateau region and stratigraphy extending from the northern Selkirk Mountains into the Kootenay arc region. The location of these areas is shown Figure 1.*

the Harveys Ridge succession, includes lithologies previously assigned to the Hardscrabble Mountain and Harveys Ridge successions of Struik (1988), and Harveys Ridge transitional succession of Ferri (2001a, b) and Ferri and O'Brien (2002, 2003). It also includes the lower parts of Struik's (1988) Eaglesnest succession. The Harveys Ridge is characterized by dark grey to black phyllite, siltstone and quartzite, but also includes grey to black limestone, mafic metavolcanic rocks and intervals of clean quartzite in the upper part. The Agnes conglomerate forms discontinuous lenses in the upper part of the Harveys Ridge Succession, and the Bralco limestone is found near its base, although it is believed to be restricted to eastern exposures. The Goose Peak succession, which represents the upper division, corresponds to rocks formerly assigned to the Goose Peak and upper Eaglesnest successions of Struik (1988). This unit is gradational with underlying Harveys Ridge rocks and is dominated by light grey feldspathic quartzite.

An inferred age for these rocks is afforded by correlating sections of the sequence, particularly the portion spanning the Keithley quartzite to Bralco limestone, with rocks of the Cariboo terrane to the east. We suggest that the Keithley quartzite and the Bralco limestone are both Lower Cambian, and correlate respectively with the Hamill Group and overlying Mural Formation. This suggests that the lower part of the Snowshoe Group (Downey succession) is Late Proterozoic to Early Cambrian in age, and that rocks of the upper Harveys Ridge and Goose Peak successions are post-Early Cambrian. It should be noted that the coarse-grained feldspathic sandstones of the Harveys Ridge and Goose Peak successions have no lithologic equivalents in the Cariboo terrane.

Snowshoe Group stratigraphy is interpreted to be repeated along refolded, southwest-verging nappe structures. These folds are large, being some 25 km in amplitude and spanning the entire width of the Kootenay terrane at this latitude. They are comparable in scale to regional fold structures elsewhere in the Kootenay terrane. The upper limb of the nappe in the Cariboo Lake area is cut by the Pleasant Valley thrust, which may have post-dated nappe development, or have formed late in the same deformational event.

Deposition of the Snowshoe Group occurred in part, or in whole, within a continent-margin extensional environment, and is similar to sequences elsewhere within the Kootenay terrane.

The new stratigraphic sequence presented in this study shares many similarities with Kootenay terrane stratigraphy farther south, particularly with rocks of the Eagle Bay assemblage (Paradis *et al*., this volume) the northern Selkirk Mountains and the Kootenay arc (Logan and Colpron, this volume). These correlations indicate that Snowshoe stratigraphy, and by extension, the Barkerville subterrane, shares fundamental similarities with the southern Kootenay terrane. These similarities suggest that subdivision of Kootenay terrane into the Barkerville subterrane is probably unnecessary, and that the term Kootenay terrane be extended northward into the Barkerville region of central British Columbia, and even beyond.

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