GEOLOGY AND MINERALIZATION OF THE GATAGA MOUNTAIN AREA, NORTHERN ROCKY MOUNTAINS (94L/10, 11, 14 AND 15)

Filippo Ferri, Chris Rees and JoAnne Nelson

(Contribution to the Canada - British Columbia Mineral Development Agreement 1991-1995)

KEYWORDS: Northern Rocky Mountains, Gataga River, Kechika Trough, Gog Group, Cambrian, Kechika Group, Road River Group, Earn Group, sedimentary exhalatives, barite, lead, zinc.

INTRODUCTION

This report summarizes 1995 fieldwork on the Gataga Mapping Project in the central part of the Kechika Trough in northeastern British Columbia (Figures 1, 2). This trough or basin is delineated by Cambrian to Mississippian rocks exposed along the western margin of the northern Rocky Mountains. The basin is host to numerous sedimentary exhalative barite-lead-zinc deposits collectively known as the Gataga mineral district. Deposits occur at various levels, although the most numerous and economically important are Late Devonian, and include the Cirque (Stronsay) and Driftpile deposits.

This mapping program is part of an ongoing cooperative project with the Geological Survey of Canada which began in 1994 and is funded, in part, by the second Mineral Development Agreement between the governments of British Columbia and Canada. The program includes a regional stream sediment and water survey covering the 1994 and 1995 mapping areas (Jackaman *et al.*, 1996, this volume), and detailed studies of major Devono-Mississippian sedimentary exhalative deposits within the Kechika Trough.

The 1995 map area covers the northern termination of the Rocky Mountains along the eastern flank of the Northern Rocky Mountain Trench (Figure 2). Terminus Mountain is the last 'Rocky' Mountain in this chain. The lower relief in this area reflects the disappearance of the thick Cambrian carbonates and coarse siliciclastics which characterize the large thrust stacks in the northern part of the Rocky Mountains to the south. The subdued terrain in the northern part of the map area includes parts of the Rabbit River Plateau and Liard Lowland.

The map area is bounded to the east by the Netson Lake - Netson Creek valleys and to the west by the Northern Rocky Mountain Trench (Figure 3). The southern boundary is roughly delineated by Brownie Mountain and Netson Lake, and the northern limit coincides with the southern part of Horneline Creek. The region between Terminus and Brownie mountains is characterized by rugged, alpine terrain. This becomes more subdued to the north and east where only the very tops of the hills reach timberline and outcrop density is less than 5 percent.

The Kechika Trough represents a long-lived basin of early to middle Paleozoic age. It connects northward with the Selwyn Basin of the Yukon and Northwest Territories, with which it shares similar stratigraphic and tectonic relationships. The Kechika Trough was delineated through time by 'shale-outs' of shelf and platformal successions. Its stratigraphy is characterized by dark, fine-grained siliciclastics and chert, representing quiet, deeper water deposition. This environment of slow sedimentation coupled with tectonism was conducive to the formation of sedimentary exhalative deposits at various times within the basin. Upper Devonian rocks in the Earn Group are the most economically important within the Kechika Trough and are the focus of the present multidisciplinary study. A more detailed description of the regional setting and related references are given in Ferri *et al.* (1995a). A useful regional overview is provided by MacIntyre (1992).

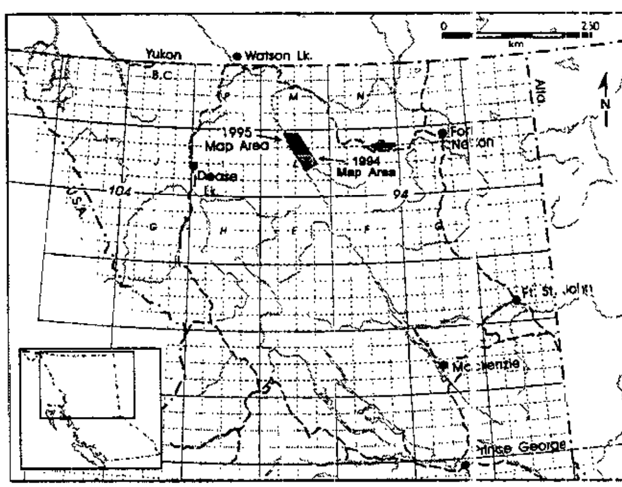

Figure 1: Northeastern British Columbia showing the location of the 1995 and 1994 map areas.

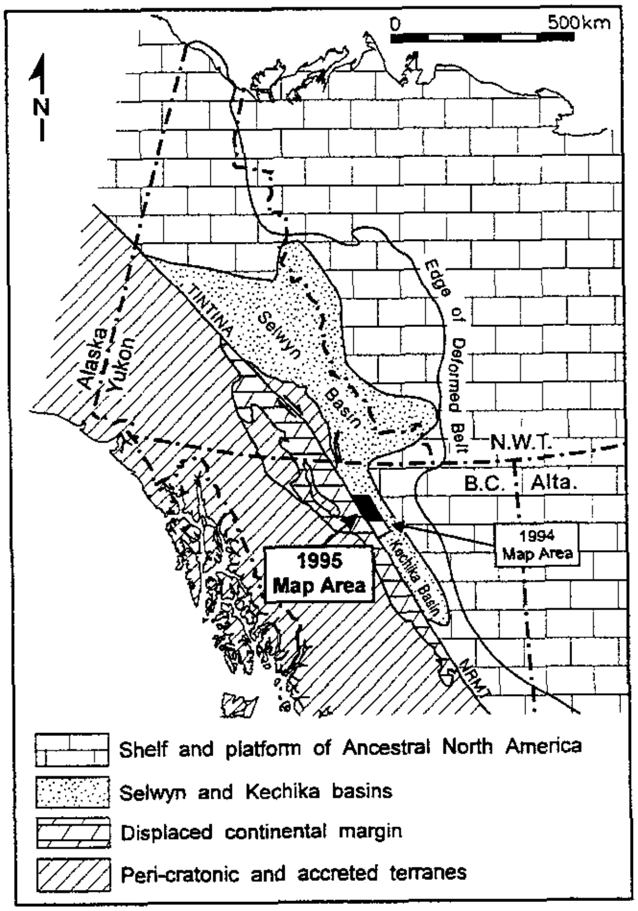

Figure 2: Simplified map of the northern part of the Canadian Cordillera showing the shelf-off-shelf boundary during Ordovician to Silurian time (modified from Cecile and Norford, 1991). NRMT - Northern Rocky Mountain Trench.

STRATIGRAPHY

The stratigraphy of the map area comprises units ranging in age from Early Cambrian to early Mississippian (Figures 3, 4). These include: Lower to Upper(?) Cambrian siliciclastics, carbonates and volcanics which are, in part, equivalent to the Gog Group; slate, calcareous slate and argillaceous limestone of the Upper Cambrian to Lower Ordovician Kechika Group; siltstone, slate and minor limestone of the Middle Ordovician to Middle Devonian Road River Group, and siltstone and slate of the Middle Devonian to Mississippian Earn Group.

One of the most striking large-scale features in the map area is the lithological and thickness variation exhibited by Cambrian and Ordovician packages. Cambrian thrust panels in the southwest contain thick sequences of shallow-water coarse siliciclastics, carbonates and volcanics which are not present in panels to the northeast, where they are replaced by fine-grained, deep-water siliciclastics. The overlying Kechika Group also changes from thick, calcareous slates and limestone in the southwest to a much thinner package of slates and minor chert in the northeast, which is difficult to distinguish from overlying Road River slates. The coincidence of facies variations in these two units suggests similar stratigraphic and tectonic controls.

CAMBRIAN

Cambrian rocks are exposed in several thrust panels in the map area. By far the thickest and best exposed sections are in the southwest where the rugged range extending from Gataga Mountain to Terminus Mountain consists almost entirely of Cambrian strata (Figures 3,4). Cambrian rocks are also exposed in the east of the map area, on the ridges west of the Netson Creek valley. Thrust panels in the centre of the area consist mainly of younger stratigraphic units, and the Cambrian is present only in relatively narrow zones.

As documented by Ferri *et al.* (1995a, b), the Cambrian in the region is characterized by siliciclastic and carbonate lithological units which interfinger such that the stratigraphy varies within and between thrust panels, making correlation difficult. In the previously mapped area to the southeast, the presence of archaeocyathid fossils in some areas indicates an Early Cambrian age. On this basis these rocks were correlated with the Lower Cambrian Gog Group, the type area of which is in the southern Rocky Mountains, and they were so named. Overlying the Gog Group in many places are either thick carbonates, which were assigned to an unnamed Middle to Upper Cambrian unit, or a thick, coarse polymictic conglomerate which was correlated with very similar deposits in the Rocky Mountains to the east, which have been dated by fossils as Middle Cambrian (Ferri *et al.* 1995a; Fritz, 1991). Where archaeocyathids or these distinctive Middle Cambrian carbonate or conglomerate facies are absent, replaced by ubiquitous sandstone, siltstone and slate, the Cambrian stratigraphy was generally mapped as a composite Cambrian unit, "Gog Group and younger rocks", because the Lower Cambrian could not be differentiated.

The same criteria and terminology are used in the current map area. However, there are two notable features of the Cambrian stratigraphy that differ from that mapped in 1994, the main one being the presence of volcanic and volcaniclastic rocks in the Gataga Mountain area. They occur within a succession, at least 3000 metres thick (base not seen), of fine to coarse-grained, calcareous and noncalcareous siliciclastics, and carbonates (Figure 4, a). The volcanics were recognized by Gabrielse (1962) who tentatively dated them as Devonian to Mississippian, and subsequently revised the age to Middle Ordovician (Gabrielse and Yorath, 1991). However, our work has shown that the volcanics are Cambrian; Early Cambrian

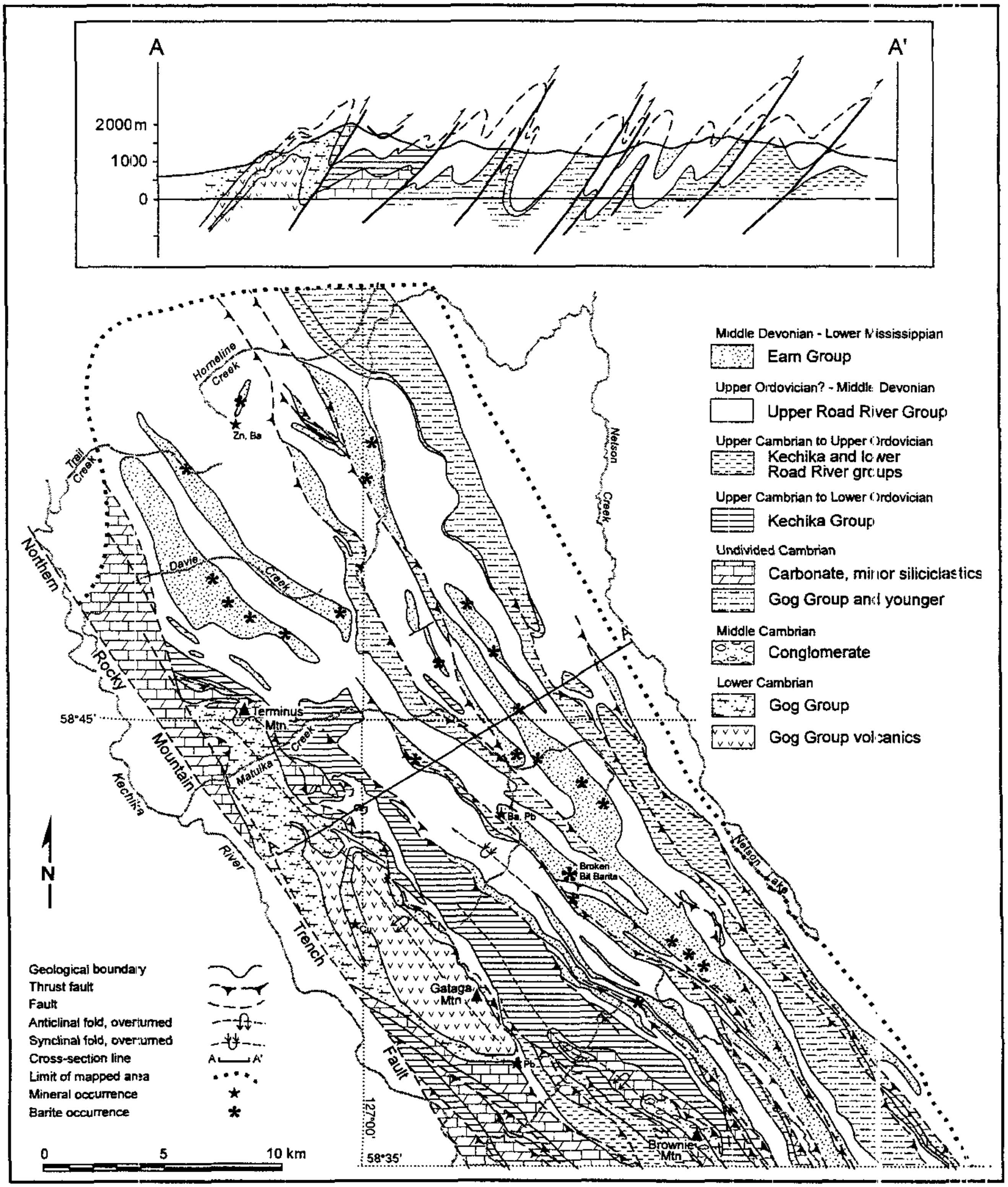

Figure 3: Simplified geological map and cross-section of the study area. The southeastern part of the map, between the south end of Netson Lake and Brownie Mountain, overlaps part of the 1994 field area (Ferri *et al.*, 1995a, b). Note that the cross-section scale is larger than the map scale.

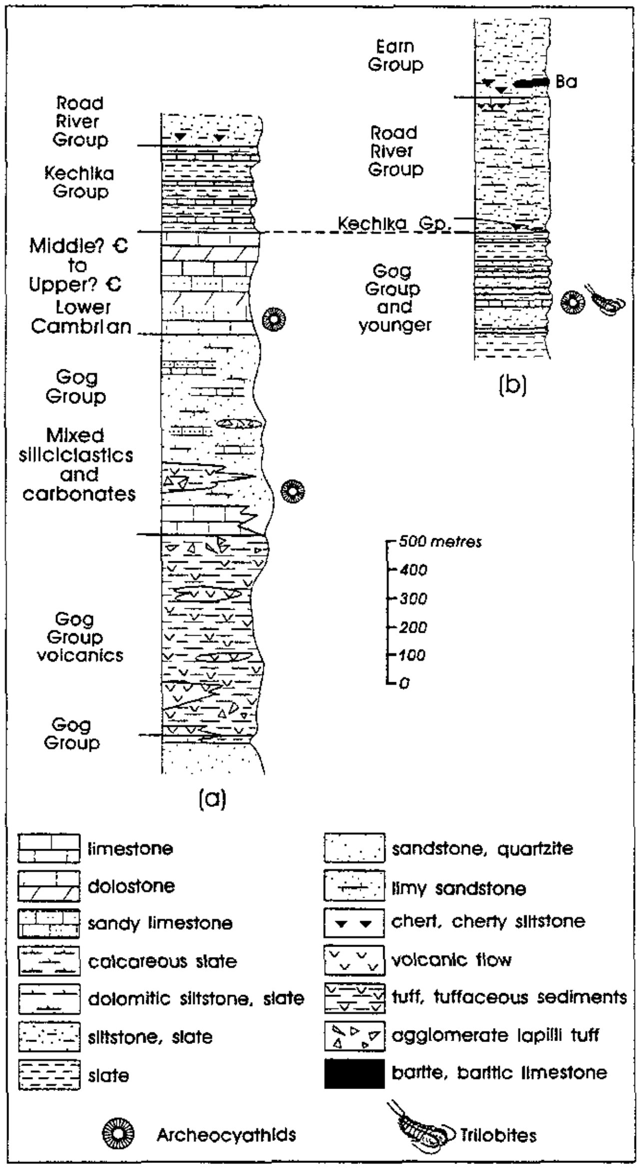

Figure 4: Simplified stratigraphic columns for eastern and western parts of the map area. Section (a) is a composite section of units exposed within the thrust panel in the southwest, containing the Cambrian volcanics. Section (b) represents the eastern and northeastern parts of the map. The two sections show the variation in lithologies and thicknesses of the Cambrian sequence and the Kechika Group. See text for details.

archaeocyathids were found in limestone near the top of the volcanic succession.

Another important difference is that the thick Middle to Upper Cambrian carbonates, mapped to the southeast in 1994, do not appear to continue northwestwards, at least not far beyond the southern edge of the area mapped in 1995. One explanation is that these carbonate build-ups did not accumulate in this part of the miogeocline. Alternatively, they did continue northwards, but are not exposed at the present erosion level, or were eroded in the later Cambrian or Ordovician, before younger rocks were deposited. Evidence for an unconformity at about this time is found in other parts of the map area, where Silurian Road River rocks overlie Lower Cambrian rocks, with little or no intervening Kechika Group or Ordovician Road River (Figure 4, b). More than one of these explanations may apply.

The following sections describe the Cambrian in the map area. The first two deal with the Cambrian stratigraphy in the well exposed Gataga Mountain - Terminus Mountain thrust panel in the southwest, which is dominated by volcanics and relatively coarse grained siliciclastics and carbonates. We believe that this panel is mostly Lower Cambrian, as explained above, with the possibility that the highest limestones may extend into the Middle Cambrian; consequently, it is provisionally assigned to the Gog Group. This is followed by a brief account of Middle and Upper Cambrian conglomerate and carbonates, respectively, which occur in the extreme south of the area. The last section describes the stratigraphy in the central and eastern thrust panels. Some of these rocks contain archaeocyathids locally, and so are partly coeval with the southwestern facies, but they are characterized by slates and siltstones, a paucity of limestone, and the absence of volcanics, indicating that they were deposited in a quite different and probably more basinal environment.

GOG GROUP: VOLCANIC AND VOLCANICLASTIC ROCKS (LOWER CAMBRIAN)

Volcanic rocks crop out around Gataga Mountain where they form much of a large, complex northeasterly overturned anticline (Photo 1). The core of this fold contains the oldest rocks in the map area, thickly bedded calcareous and noncalcareous quartz sandstones and quartzites. These rocks are overlain by dolostones and limestones followed by slates and siltstones, which grade into the volcanic and volcaniclastic rocks.

Typically, the volcaniclastics comprise pale to mid-green or greenish grey tuffs. Very fine to medium-grained ash tuff and lithic tuff may be massive and homogeneous, or bedded in units up to about 1 metre thick. Some rocks are more thinly bedded or laminated and were mapped as volcanic wacke or tuffaceous siltstone. Grading is not uncommon and crossbedding was tentatively identified in some outcrops. Rarely, lenses of creamy grey chert and calcareous siltstone, or pods of grey limestone, are present within the tuffs. At one locality, the base of the volcanics rests on a dolomitic limestone. Here, the first few metres of tuff are micaceous and pale grey rather than the usual green colour, probably due to carbonate and sericitic alteration at the contact.

Volcanic flows are subordinate, forming about 25% of the volcanic sequence. Some are tens of metres thick. They are usually pale to mid-green and very fine to medium grained. They may be vesicular and

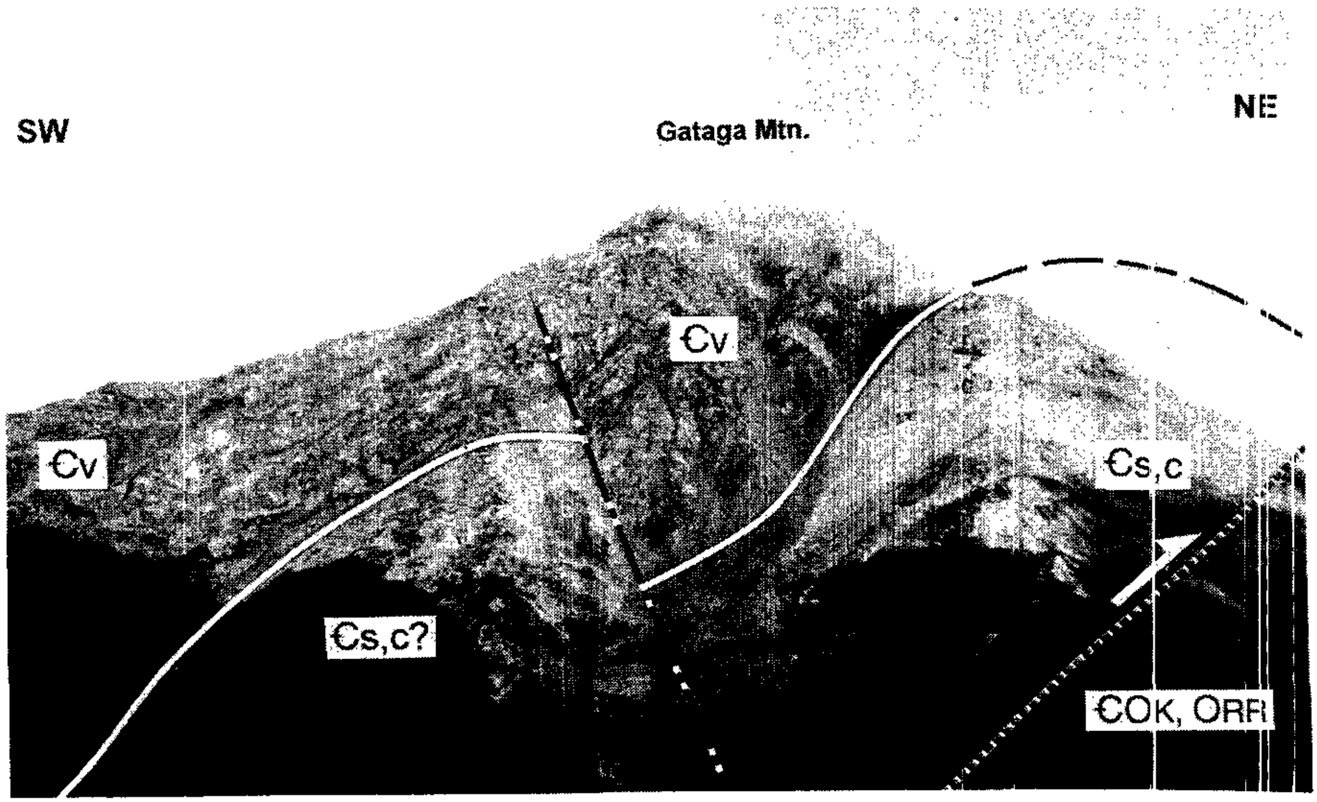

Photo 1: Looking northwest at Gataga Mountain, composed essentially of an anticlinal fold of Lower Cambrian volcanics (Ꞓv) and underlying slate and calcareous and quartzitic rocks (Ꞓs,c). All are correlated with the Gog Group. Thrust at right places the Cambrian on strongly deformed Kechika and Road River group slates (ꞒOK, ORR; *cf.* Photo 9).

amygdaloidal, and some are finely porphyritic. Dark green spots in some volcanic rocks may be chloritized amygdules or pyroxene phenocrysts. Pillows, pillow breccia and flow breccia are fairly common (Photo 2); some pillows are a metre across and many show radiating pipe vesicles and zoning. Preliminary lithogeochemical analysis of the volcanics indicates that they are generally alkalic basalt.

Felsic to intermediate volcanics were mapped in a few localities. The largest body, a few kilometres southeast of Gataga Mountain, consists of pale grey, sericitic and siliceous crystal-lithic dacitic or rhyolitic tuff. It is at least tens of metres thick. A similar but much smaller body on Gataga Mountain itself, is a quartz-feldspar-porphyritic flow or crystal tuff of basaltic andesite composition, with textural features suggesting welding. Both subunits were sampled for radiometric analysis.

One of the most common and distinctive lithologies is a coarse lapilli tuff or agglomerate, which underlies large areas on the slopes west of Gataga Mountain. This rock is generally massive and contains rounded to angular rock fragments in a coarse-grained chloritic or ferro-carbonate clastic matrix (Photo 3). The most common clasts are pale green or buff-grey, and very fine grained, and are thought to be variably altered volcanic rock, possibly carbonatized or sericitized basaltic lava or tuff, although some material may have originally been more felsic. Some are porphyritic. Less commonly, fragments consist of quartzite and siltstone, and rarely limestone. Some clasts are maroon, suggesting partially subaerial sources. The largest clasts are 30 to 40 centimetres across (Photo 4), but most are much smaller. Overall, the deposit is poorly sorted or unsorted. The matrix is grey to green and generally weathers to a grey to rusty orange-brown colour due to the ferroan carbonate. The rock is provisionally interpreted as a volcaniclastic deposit laid

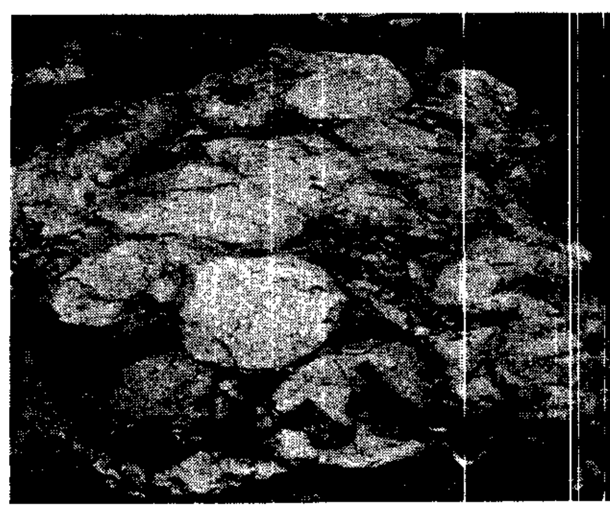

Photo 2: Pillows in the volcanic unit, Lower Cambrian Gog Group, Gataga Mountain.

Photo 3: Lapilli tuff in the volcanic unit, Lower Cambrian Gog Group, northwest of Gataga Mountain. Scale at bottom is 15 centimetres long.

down in a carbonate environment. This is supported by the presence of pods or zones of limestone, orange-brown weathering dolostone, and rusty calcareous siltstone within the agglomerates, as well as in other parts of the volcanic sequence.

Cleavage is variably developed, and is most evident in some of the finer grained, bedded tuffs. A reversal in cleavage-bedding relationships can be mapped across the axial surface of the overturned fold at Gataga Mountain. The matrix of the agglomerates is also well foliated and many clasts are flattened parallel to the fabric.

At least one other lenticular body of volcanics is present slightly higher in this thrust panel. It is similar in composition to the main body, comprising discrete volcanic flows, or possibly sills, up to 4 metres thick, well bedded and laminated tuffaceous wacke and siltstone, and lapilli tuff and agglomerate as described above.

The presence of this volcanic succession in the Cambrian is important. Preliminary observations indicate that the volcanics and their stratigraphic setting are typical of other, rift-related alkalic volcanic sequences documented in the northern Cordilleran miogeocline of British Columbia and Yukon (Goodfellow *et al.*, 1995). These are widespread but sporadically distributed in restricted lenses or piles within the various basinal elements or platform margin of the miogeocline, and range in age from Late Proterozoic to Devonian. Many of the volcanic sequences are characterized by high barium, and are associated with abrupt facies changes in surrounding sedimentary rocks, suggesting "a genetic link between extensional tectonism, magmatism, hydrothermal activity, and the formation of Zn-Pb-barite deposits found in many locations in the Northern Cordillera" (Goodfellow *et al.*, 1995).

GOG GROUP: SILICICLASTICS AND CARBONATES (LOWER CAMBRIAN)

The volcanic subunits form fairly distinct facies in the Cambrian in the Gataga Mountain area. In contrast, the underlying and overlying Cambrian strata in this thrust panel are typical of the region, being predominantly moderately to well bedded siliceous sediments and carbonates with little or no evidence of volcanism. As mentioned earlier, the oldest rocks, below the lower

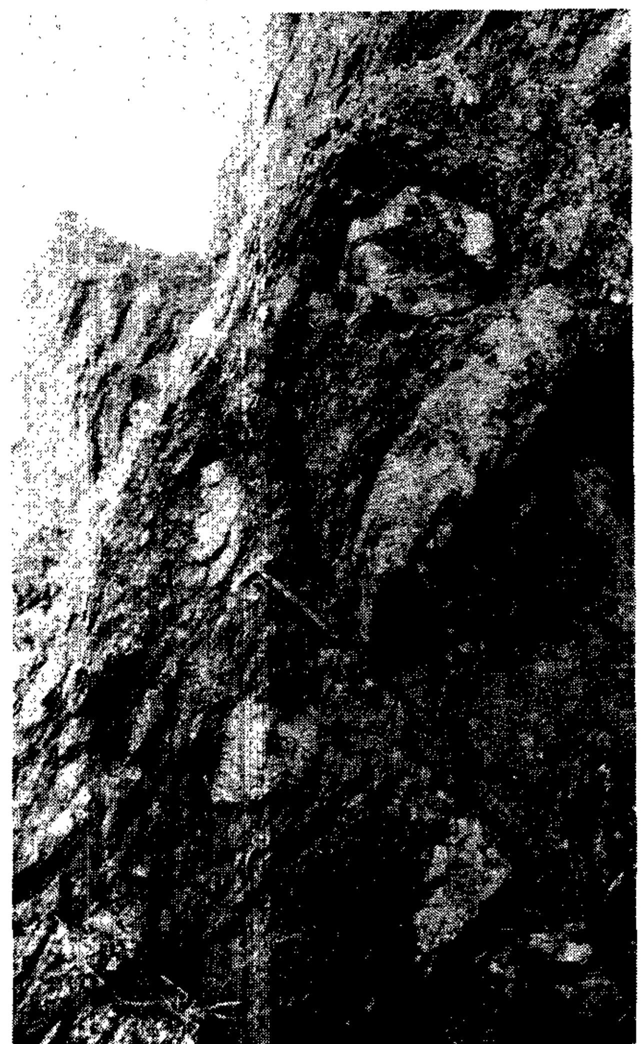

Photo 4: Agglomerate in the volcanic unit, Lower Cambrian Gog Group, northwest of Gataga Mountain. Looking northwest; cleavage dips steeply to southwest.

volcanics, are quartzite, quartz sandstone, dolomitic sandstone, dolostone and limestone. These quartzose rocks are moderately to thickly bedded, and have round sand grains, grading, cross-stratification and ripple laminations. A few metres of grey to greenish slate, cherty slate and siltstone, with minor dolomitic nodules and lenses, are exposed at the top of the section, just below the base of the volcanics.

Above the lower volcanics, the rest of the Cambrian is a mixed succession of sandstone and quartzite (partly limy), limestone and dolostone, and lesser slate and siltstone. The coarser siliciclastics are generally well bedded on a scale of centimetres to decimetres, and some beds show grading, well developed 'herringbone' crossbedding (Photo 5) and, rarely, ripple marks and trace fossils such as worm trails and burrows. Quartzites and quartz sandstones are pale grey to pink or beige, and are more thickly bedded to massive. They are locally calcareous, especially close to limestone. Intervals of platy limestone to limy sandstone are common, forming beds or a series of beds within the siliciclastics. Slate and siltstone are generally subordinate, comprising thin interbeds in the other rocks. Quartz-pebble conglomerate is found interbedded with grey to maroon limestone, sandstone and siltstone at one locality.

A substantial thickness of grey to buff, pale orange-brown weathering dolostone and limestone is exposed just above the lower volcanics on the slopes west of Gataga Mountain. It is fine to medium grained with a sugary crystalline texture, and is somewhat siliceous. These rocks are overlain by a conspicuous unit of well bedded and laminated, maroon siltstone to sandstone, slate and minor tuffaceous interbeds, with a maximum thickness of about 100 metres. The sediments alternate in colour between maroon and a pale yellowish green. The smaller, thinner volcanic unit, referred to in the previous section, overlies these varicoloured siltstones.

This limestone-dolostone, maroon siltstone and thin volcanic sequence appears to pinch out to the northeast within this thrust sheet, replaced by the prevailing mixed siliciclastic and carbonate lithologies, much of which have the striking maroon colour of the previously described siltstones. An unusual conglomerate is mapped at about this stratigraphic level or possibly higher: it is composed almost entirely of well rounded, pebble to cobble-sized clasts of grey or cream-coloured limestone or sandy limestone up to 15 centimetres across, with a few pebbles of maroon siltstone or grey-black chert. It is up to 10 metres thick, well sorted and clast supported, and has a brownish maroon, sandy carbonate matrix.

Lying above all these rocks, the stratigraphically highest rocks in this thrust sheet are thick limestones and lesser dolostones, well exposed north and south of Matulka Creek, particularly at the top of Terminus Mountain. The limestone is generally pale to medium grey and buff-grey, very fine to medium grained and more homogeneous and massive than those lower in the stratigraphy which are interbedded with the siliciclastics; however, it is not as uniform as the thick Middle to Upper Cambrian carbonates exposed in the 1994 map area to the southeast. Bedding is generally indistinct, although locally the limestone is sandy and oolitic, or has argillaceous laminae, and bedding is more clearly defined. Dolostone to sandy dolostone is fairly common and weathers pale orange-brown. A few beds of limestone rich in dark grey to black oncolites up to 4 centimetres across were noted. Archaeocyathids were found in limestone near the base of these carbonates, high on the slopes on both sides of Matulka Creek. It is possible that some of the overlying limestones straddle the Lower-Middle Cambrian boundary.

Photo 5: Herringbone crossbedding in limy quartzite, Lower Cambrian Gog Group, northwest of Gataga Mountain.

The northeastern boundary of this thrust panel is a thrust fault, placing Cambrian limestone structurally on top of Kechika or Road River Group rocks. The limestone at the contact is locally very well foliated, with a streaky translucent appearance indicative of a very fine grain size produced by a high degree of ductile strain.

CONGLOMERATE AND LIMESTONE (MIDDLE AND UPPER CAMBRIAN)

The core of an overturned anticlinal fold in the south of the map area consists of conglomerate overlain by thick limestone and dolostone, believed to be of Middle and Late Cambrian age, respectively. Both map units are the same as those mapped on Brownie Mountain in 1994 (Ferri *et al.* 1995a, b). The conglomerate is massive, matrix supported and polymictic, containing well rounded granule to boulder-sized clasts of mainly quartzite, and lesser, subequal amounts of limestone, siltstone and volcanics. Much of the matrix is green and chloritic, and we speculate that much of it is tuffaceous, implying that the conglomerate was derived from the erosion of volcanic as well as sedimentary rocks.

The conglomerate is overlain by pale to medium grey, very fine grained and variably foliated limestone, dolomitic limestone and dolostone. The carbonates are generally massive and fairly 'clean'. Unlike the Lower Cambrian carbonates described earlier, thin beds of sandy limestone or limy sandstone are relatively uncommon. Quartz-carbonate veins with malachite are a feature of these rocks.

GOG GROUP AND YOUNGER: SLATES AND SILTSTONES, EASTERN FACIES (UNDIVIDED CAMBRIAN)

Cambrian strata outcrop in a continuous belt west of the Netson Creek valley, and in several narrower belts in the centre of the map area, in the cores of anticlinal folds or along the base of thrust panels. These rocks are dominated by noncalcareous slate, slaty siltstone and sandstone, with only minor quartzite and limestone. Slate and slaty siltstone are usually medium to dark grey to olive green, and locally have thin colour laminations. The rocks are fine grained, although laminae of paler grey coarse siltstone or sandstone are quite common. Medium-grained flakes of mica are readily visible on some cleavage surfaces, which weather a rusty brown colour. These micas, the sandy laminae, and worm trails on some surfaces are useful features distinguishing these slates from the slates of other units in the region.

Where sandstone is present it generally forms intervals or interbeds within the slates. It is pale to dark grey, medium grained, micaceous and locally feldspathic, and usually forms well and thinly bedded (1 to 10 cm) outcrops with flaggy to platy partings. Bedding planes are commonly undulose, suggesting rippled surfaces. Locally, larger bodies or beds of white to grey quartzite or feldspathic quartzite are associated with the sandstones and slates. Rarely, thin beds of oolitic or argillaceous limestone are present.

Very locally there are lenses of grey or pale orange weathering, archaeocyathid-rich limestone in the slates. They measure from less than a metre to tens of metres in length, and have a 'rough' or rubbly texture. They represent small biohermal build-ups, and may contain fragments of large trilobites as well as archaeocyathids. One such fauna is identified as late Early Cambrian (B.S. Norford, personal communication, 1995).

Overall, the Cambrian lithologies in the eastern half of the map area are much more pelitic and finer grained, and much less calcareous than those in the major Cambrian thrust panel in the southwest. Restoring the thrust shortening would probably result in a considerable separation between the two depositional environments. A preliminary interpretation of these observations is that the southwestern Cambrian facies represents a relatively shallow marine to intertidal setting, with sedimentation fluctuating between coarse siliciclastic and carbonate deposition, resulting in interfingering lithological units. This may have been due to periodic fault-controlled extension, uplift and subsidence, which was probably related to episodes of submarine alkalic basaltic volcanism. In contrast, the contemporaneous sedimentation represented by the Cambrian rocks farther east probably took place in deeper water and more uniform conditions.

KECHIKA GROUP (UPPER CAMBRIAN TO LOWER ORDOVICIAN)

The Kechika Group exhibits a marked facies change and thinning from southwest to northeast within the map area. This transition is quite abrupt and roughly corresponds to the disappearance of the underlying thick sequences of Lower to Upper(?) Cambrian limestone and quartzite. In the southern part of the map area, the Kechika Group is characterized by interlayered grey to dark grey soft slate, calcareous slate or rare silty slate and grey, buff or orange-weathering, very finely crystalline limestone or dolostone. The carbonate layers are discontinuous to lenticular and typically 0.1 to 2 centimetre thick, although they reach several metres in thickness locally. They comprise up to 50% of the section with an average of 20%. This facies is exposed above thrust panels of Cambrian limestone west of Gataga Mountain and can be traced along the footwall of the thrust carrying the Cambrian volcanic succession from the Brownie Mountain area northward to just northwest of Terminus Mountain. The northernmost outcrop area of this lithology is on the lower slopes of the Rocky Mountain Trench immediately north of Davie Creek and is characterized by banded to mottled, orange to brown-weathering, grey to dark grey calcareous slate to silty slate. This facies of the Kechika Group covers a wide area in its southern trace, reflecting the northward plunge of the large northeast-verging anticline outlined by thick Cambrian carbonates along the ridge containing Brownie Mountain (Figure 3). Kechika rocks also cover a large area along the lower reaches of Matulka Creek. The thickness of Kechika slates and carbonates is difficult to determine due to their strong deformation. Structural sections suggest upwards of 500 metres of Kechika rocks immediately south of Matulka Creek.

The calcareous nature of the Kechika Group is lost up-section and the upper half or one-third is characterized by grey to dark grey or black, blocky to shiny fissile slate, with characteristic faint discontinuous, paler grey laminae (Figure 4, a). Thin, discontinuous or lensoidal beds of finely crystalline limestone are occasionally present in the lower part of this sequence. Sections of dark grey banded slate up to 100 metres thick, within typical calcareous sections of Kechika slates west of the Gataga Mountain, are probably infolded sequences of lower and upper Kechika Group. These upper slates are difficult to differentiate from Ordovician Road River slates and have been grouped with them over most of the map area (see below).

East of the headwaters of Matulka Creek the pale coloured and soft calcareous facies of the Kechika Group is recognized in only a few localities. Interlayered grey to buff-weathering, thin limestone and slate or calcareous slate are found along the top of the first ridge northwest of Netson Lake. These lithologies are exposed near the base of a sequence which passes upward through dark grey to black slate into black graptolitic slates of the Road River Group. This section appears to be several hundred metres thick. Elsewhere in the central and northern parts of the map area, calcareous Kechika rocks are uncommon, replaced by a thin section of dark grey or black slate (Figure 4, b).

No macrofossils were found in the Kechika Group within the map area during the course of the summer. Macrofossils (Ferri *et al.*, *1995*a, b) and conodonts collected during the 1994 field season suggest a Cambrian to Early Ordovician age (Arenig; B.S. Norford, personal communication, 1994; M. J. Orchard, personal communication, 1995). Fossil collections elsewhere in the Northern Rocky Mountains suggest a latest Cambrian to Early Ordovician age (Cecile and Norford, 1979).

KECHIKA - LOWER ROAD RIVER GROUPS (UPPER CAMBRIAN TO MIDDLE ORDOVICIAN)

In the central and eastern parts of the map area, dolomitic siltstones of the upper Road River Group are sometimes separated from Cambrian siliciclastics by a relatively thin section of blocky to fissile, dark grey to black slate to siliceous slate (Figure 4, b). Structural sections suggest thicknesses of, at the most, 100 metres. In many parts of the map area the proximity of Road River siltstones to Cambrian siliciclastics leaves little room for intervening slates of either the lower Road River or Kechika groups. It is difficult to determine whether the apparent absence of slaty lithologies at this horizon reflects non-deposition or poor exposure of this relatively thin section of recessive slates.

This package of slates has more affinities with the Ordovician Road River Group than with the Kechika Group. It is best developed on the west side of the Netson Creek valley where there are poor creek exposures of grey to brown-weathering, grey to dark grey or black, shiny slates. These slates are locally quite soft and fissile. Faint, paler grey colour banding or laminations are common and sometimes grade into more silty horizons with the characteristic mottling of the overlying Road River siltstones. Some outcrops contain sections of sooty black, slaty siltstone. This unit is sometimes characterized by dark grey to black siliceous argillite or slate with 1 to 3-centimetre beds of grey to black chert.

Dark grey banded slates pass downward into typical soft, light coloured calcareous slates and interlayered limestones of the Kechika Group along the southern part of the ridge immediately west of the north end of Netson Lake. This unit is in excess of several hundred metres thick and is exposed within the core of a northerly plunging anticline. Graptolitic black slates, typical of the Ordovician Road River Group, crop out along the east flank of this anticline just before outcrop is lost towards Netson Lake. These slates are markedly thinner in the next thrust panel to the west where exposures of older and younger units suggest less than 50 metres of section. Extensive exposures of light coloured Kechika slates to the east, across the Netson valley (Gabrielse, 1962), indicate eastward thickening of Kechika and Road River slates.

Only one macrofossil (graptolite) collection was made from this unit, in the southeastern portion of the map area; it is interpreted as Early Ordovician (B.S. Norford, personal communication, 1995).

The lack of identifiable Kechika and Ordovician Road River rocks in the central and northeastern parts of the map area may reflect either negligible thickness or a sub-Silurian Road River unconformity. Underlying Cambrian rocks also undergo a transition within the map area, changing from carbonate and siliciclastics in the south and west, to dominantly pelitic rocks in the north and east. It is not clear if all these stratigraphic features are related, but their coincidence does suggest that this part of the basin was subject to tectonic instability in the Cambrian and Ordovician, leading to marked facies changes and thinning or erosion of stratigraphy. Sub-Lower Silurian erosion or non-deposition has been postulated for the northern Kechika Trough region by Cecile and Norford (1991), and significant lower Paleozoic unconformities have been demonstrated in the Tuchodi Lakes map area immediately to the east (Taylor and Stott, 1973).

ROAD RIVER GROUP (ORDOVICIAN TO MIDDLE DEVONIAN)

Two units of the Road River Group are recognized in the map area: a lower succession of Ordovician black slates with lesser limestone and chert, and a succeeding section of Siluro-Devonian dolomitic siltstone and minor limestone and chert. True sections of Ordovician Road River Group were recognized in only a few localities; elsewhere the group is represented by the dolomitic siltstone unit.

ORDOVICIAN

Black to blue-grey weathering, black to dark grey shiny slate to siltstone is the dominant lithology of the lower Road River Group. The slate is typically soft and friable although zones of cherty slate or argillite were observed locally. Slaty sections may contain thin, paler grey bands or laminations. Siltstone is graded and intercalated with beds of buff to orange-weathering calcareous slate to silty limestone or dolostone up to 3 centimetres in thickness. These carbonate horizons locally contain tiny (0.1 to 5 mm) authigenic barite crystals. Thin (1 to 2 cm) sandstone beds were observed very locally.

Slates that can be confidently assigned to this unit are known in only a few localities in the east-central part of the map area. Ordovician black slate is structurally interleaved or folded with Road River siltstone and Kechika slate immediately east of Gataga Mountain in the footwall of the thrust carrying Cambrian volcanics and sediments. This structural imbrication becomes less complicated some 5 kilometres to the northwest where 50 to 75 metres of Ordovician black slates, siltstones and carbonates are found between Kechika slates and Road River siltstones in the immediate footwall of this thrust fault. Ordovician slates with interbeds of baritic limestone are found in the centre of the map area, approximately 2 kilometres south of the first big bend in Matulka Creek, along a creek cutting the western overturned limb of a syncline. This section appears to be several hundred metres thick, although this is probably the result of structural thickening.

Elsewhere it is difficult to separate slates of the Ordovician Road River from those of the Kechika Group and they have been grouped together in many cases (see previous section). The weathering characteristics and overall lithology of these slates and siltstones can also be very similar to those of the Earn Group, making it difficult to differentiate between them, especially in isolated outcrops. This is particularly true in the low-relief area east and northeast of Brownie Mountain where a series of tight folds and related faults repeat Road River dolomitic siltstone and Earn Group lithologies. It is quite possible that some of these poorly exposed 'Earn' lithologies could be misrepresented Ordovician Road River Group.

Two graptolite collections were made over the course of the summer's mapping. Both indicate an Early Ordovician age (Tremadoc to Arenig). One collection 2 kilometres west of Terminus Mountain originates from the lowermost part of the Ordovician Road River, approximately 1 metre above its lower contact, and contains early to middle Arenig graptolites (*T. akzharensis* Zone, *P. fruticosus* Zone or possibly lower part of *D. bifudus* Zone; B.S. Norford, personal communication, 1995). Conodont and graptolite collections from the 1994 field season suggest a Middle to Late Ordovician age (Ferri *et al.*, 1995a, b; B.S. Norford, personal communication, 1994; M.J. Orchard, personal communication, 1995).

SILURO-DEVONIAN ('SILURIAN SILTSTONE')

Buff-brown to orange-weathering, grey to greenish grey siltstone to dolomitic siltstone of the Siluro-Devonian Road River Group is areally the most extensive lithology in the map area. It covers over 60% of the northern half of the map sheet but is largely confined to the central and eastern parts of the southern half, except for narrow zones in the immediate footwall of the thrust carrying the Cambrian volcanics and sediments. It is relatively competent compared to the other basinal facies in the area and tends to form the ridges in the more subdued terrain east and north of Matulka Creek. The transition with the underlying Ordovician slates was not observed within the map area, although upper parts of the Ordovician slate sequence contain paler grey slate to silty slate bands which become thicker and more silty up-section and exhibit a mottling typical of the overlying siltstones. This suggests a transitional contact, as mapped in the Gataga River area to the southeast (Ferri *et al.*, 1995a).

The dominant siltstone lithology is thin to thickly bedded or massive. In many outcrops bedding is discerned by subtle colour variations reflecting changes in argillaceous or dolomite content (Photo 6). It is commonly bioturbated, producing a mottled or wispy texture due to the disruption of laminae, which makes recognition of bedding difficult. Partings are typically blocky, although, in the absence of bioturbation, the relatively planar stratification produces platy to flaggy outcrops. Several trace fossils were observed. The most common type is a series of overlapping, oval, dish-like impressions on bedding surfaces, tentatively identified as *Zoophycus*. They are open at one end, marked by concentric ridges, and up to tens of centimetres wide (Photo 7). Less common are worm casts, 0.5 to 1 centimetre thick, either inclined or perpendicular to bedding. Sediment infills of these tubes or burrows are concave up and are a useful tops indicator where visible in cross-section.

Siltstone is locally quite argillaceous and is grey to dark grey in colour and much more slaty. Sections of grey, nondescript slate to silty slate, over a hundred metres thick, are common within this succession, and are similar to those mapped in 1994 to the south (Ferri *et al.*, 1995a). These slaty lithologies are generally not dolomitic, making identification uncertain. Buff-weathering, grey, wavy laminated to thinly layered limestone locally forms metre-thick sections within this unit in the northern part of the map area.

The top of the siltstone section is locally marked by a limestone-chert couplet from 5 to over 20 metres in

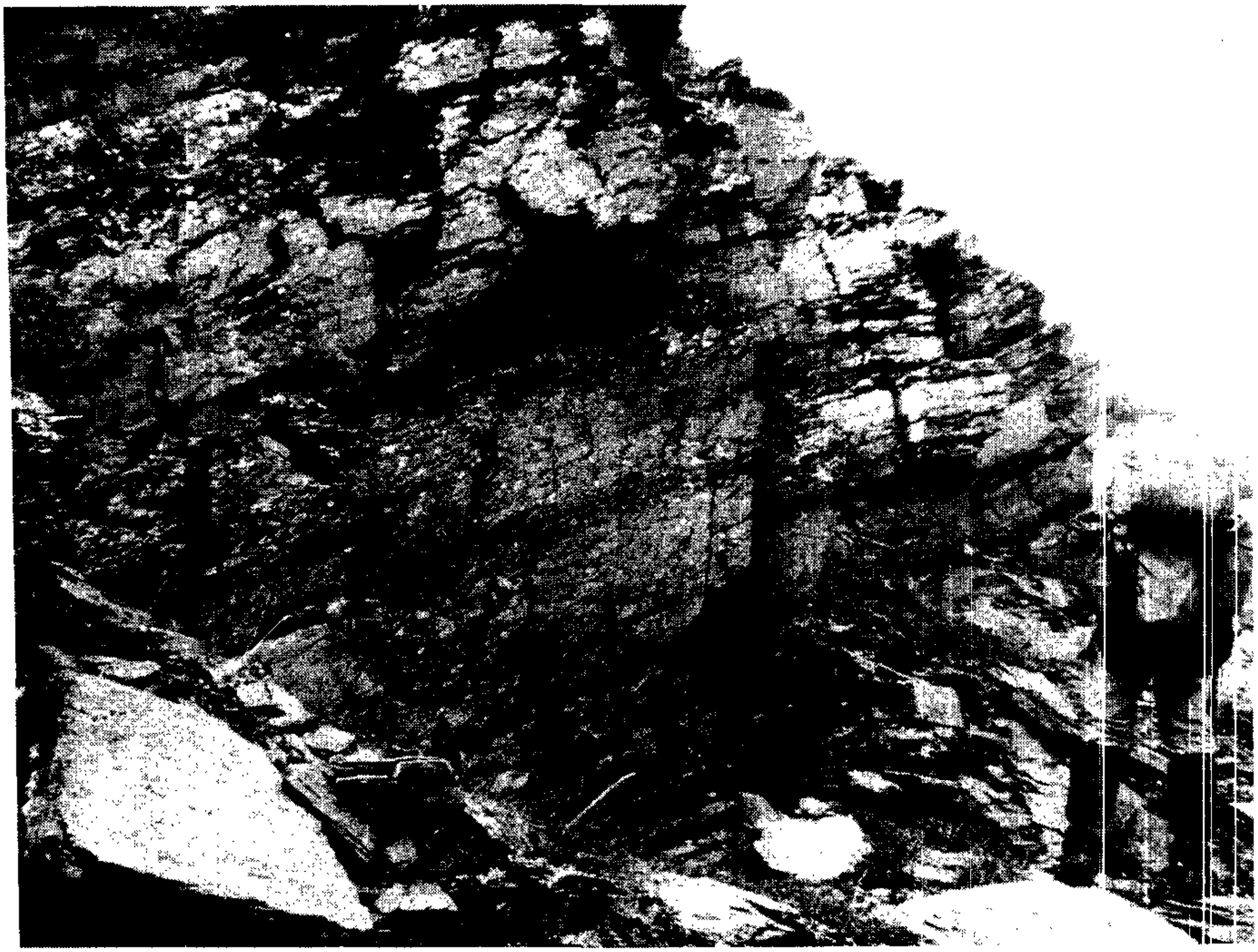

Photo 6: Typical exposure of well cleaved dolomitic siltstone and slate of the Siluro-Devonian Road River Group. Bedding is shown by subtle variations in colour or shade; elsewhere it is often obscure due to bioturbation.

thickness. These subunits are best developed in the northern and eastern parts of the map area. In many localities this unit is overlain immediately by siltstones and slates of the Earn Group. This, together with its distinctive character, makes it an excellent marker unit within the map area.

The limestone is micritic and dolomitic, grey to buff weathering, dark grey to grey-brown, and is up to 20 metres thick. It commonly displays faint laminar bedding traces and breaks into blocky or platy pieces from 1 to 20 centimetres thick. It is locally argillaceous and has a slight fetid odour on breakage. The limestone also contains 1 to 5-centimetre interbeds of argillite to cherty argillite, similar to the overlying chert member.

Chert to argillaceous chert, up to 2 metres thick, is typically found above the limestone, although they are interlayered in some localities. Chert is pale grey to black, orange-brown to maroon in colour. Bedding is planar to very poorly developed, with beds ranging from 1 to 50 centimetres thick. This unit is commonly shot through with tiny quartz veinlets and has blocky to platy partings.

This limestone-chert succession is at the same stratigraphic level and bears some lithologic similarities to a limestone-chert succession described in the Gataga River area (Ferri *et al.*, 1995a) although there, the limestone apparently overlies the chert.

The thickness of the siltstone member of the Road River Group varies significantly over the map area. No sections were measured, but structural interpretations indicate thicknesses ranging from 200 metres in the southeast to possibly 1000 metres in the north. The large expanse of Road River siltstone in the northern half of the map area may reflect this increased thickness, together with the effect of low-amplitude folding and moderate faulting. The stratigraphy may be more complicated in detail, however. At one locality south of Horneline Creek, Earn lithologies rest in apparent disconformity above Cambrian siliciclastics, suggesting either non-deposition of the Road River Group or a substantial pre-Earn unconformity.

No macrofossils were found in this unit during the 1995 field season. Collections made during the 1994 season, together with conodonts recovered in the Gataga River area, suggest a Late Ordovician to Middle Devonian age. Early Silurian graptolites (Wenlock, possibly late Llandovery; B.S. Norford, personal communication, 1994) were collected from the middle of the unit in the Gataga River area (Ferri *et al.*, 1995a). Late

Photo 7: Common type of trace fossil in dolomitic siltstone of Siluro-Devonian Road River Group, found on bedding surfaces. Tentatively identified as *Zoophycus*.

Ordovician to Silurian conodonts were also recovered from nearby dolomitic limestones (M.J. Orchard, personal communication, 1995). Limestone from the limestone-chert couplet, only a few metres below the contact with the Earn Group, just south of Bluff Creek contains late Early Devonian (Emsian) conodonts (M.J. Orchard, personal communication, 1995). Middle Devonian (early? Eifelian) conodonts were collected along the east side of the Kechika River from grey to dark grey, fetid and partly oolitic limestone interlayered with dark grey to black argillite to siliceous argillite originally mapped as Ordovician Road River Group (M.J. Orchard, personal communication, 1995; Ferri *et al.*, 1995b). These rocks may represent deeper water equivalents of Akie and Pesika reefs seen in the southern Kechika Trough (MacIntyre, 1992).

EARN GROUP (MIDDLE DEVONIAN TO LOWER MISSISSIPPIAN)

Earn Group slates, siltstones and minor carbonates are the youngest rocks recognized within the map area. They are primarily confined to the low-relief region along the central axis of the map, although they also outcrop along the northeast-facing slopes overlooking the Netson Creek valley and along the lower parts of Davie Creek. These comparatively recessive lithologies are best exposed along creeks; a particularly good section occurs along a north-flowing tributary of Davie Creek, about 5 kilometres north of Terminus Mountain. Stratigraphic thicknesses are difficult to determine, but structural sections suggest at least several hundred metres are present in thrust panels and folds in the eastern and northwestern parts of the map area. The contact between Road River and Earn rocks was observed in only one locality, along the western limb of an easterly overturned syncline approximately 1 kilometre upstream from the mouth of the large creek flowing west into Matulka Creek. The limestone-chert marker is not developed at this locality, and dolomitic siltstones of the Road River Group are abruptly succeeded by slates and siltstones of the Earn Group.

Most of the Earn Group in the map area is dark grey to blue-grey-weathering, dark grey to black, sooty to siliceous slate, argillite to cherty argillite or chert with lesser silty slate to siltstone or cherty siltstone. Beds in the argillaceous to cherty rock types are from 1 to 20 centimetres thick. Slate is quite fissile to splintery, and very locally contains nodules of radiating barite crystals up to several centimetres in diameter. Grey to dark grey weathering, grey to black argillaceous limestone is rare; it is nodular to well bedded (beds 1 to 30 cm) in sections up to 2 metres thick. Bedded barite up to several metres thick occurs at numerous localities within the Earn Group; it is commonly calcareous and grades into silty baritic

Photo 8: Massive barite with nodules of black chert, in Earn Group.

limestone. The limestone and baritic units sometimes have thin interlayers, lenses or nodules of dark grey to black chert (Photo 8). Barite is also associated with finely laminated, grey to dark grey siltstone or mudstone of possible turbiditic origin, in the southeastern part of the map area.

The predominant, fine-grained and siliceous Earn lithologies are similar to the Gunsteel facies of the Earn Group described in the southern Kechika Trough by MacIntyre (1992). Local, less siliceous slate to silty slate and siltstone in the upper parts of Earn sections may be equivalent to MacIntyre's Akie facies. Coarser siliciclastics were mapped in the Earn Group locally, such as those exposed along a steep-sided, north-flowing tributary of Davie Creek. This section consists of interlayered, finely laminated to crosslaminated brown to buff-weathering, grey siltstone to very fine grained sandstone and dark grey to black fissile slate, up to 10 metres thick. Siltstone/sandstone horizons are 0.1 to 30 centimetres thick and are faintly micaceous on bedding surfaces. These coarser lithologies may be distal tongues of the Warneford facies which, in the southern Kechika Trough, represents westerly derived clastics in the upper part of the Earn (MacIntyre, 1992).

No fossils have been recovered from the Earn Group within the map area. Conodont collections from the southern Kechika Trough indicate that the base of the Earn Group is late Givetian in age (late Middle Devonian) and that syngenetic mineralization is Frasnian to Famennian (Late Devonian; MacIntyre, 1992; Irwin, 1990; S. Paradis and J. Nelson, personal communication, 1995).

STRUCTURE

The structure of the area is characterized by moderate to very tight, northeasterly overturned folds and northeast-verging thrust faults, typical of the western parts of the Rocky Mountain fold and thrust belt. The thrusts and axial surface traces trend consistently northwest, and most are moderately to steeply dipping. Bedding dips to the southwest in general, but rotates to subhorizontal and northeast dips in fold hinge zones. Cleavage is well developed in argillaceous lithologies and dips moderately to steeply southwest. Folding and thrusting are intimately related; most thrusts carry detached anticlines, generally with overturned strata in the hangingwall.

A few major and numerous minor thrusts control the map pattern. Many of these structures are clearly continuations of those mapped last year (Ferri *et al.* 1995b). One large thrust panel in the southwest of the area is composed of a thick succession of Cambrian rocks, forming a northeasterly overturned anticline, at least 4 kilometres wide (Figure 3). For the most part, it structurally overlies strongly folded Ordovician and Siluro-Devonian Road River rocks, west of an unusually broad belt of Kechika slates and limestone (Photo 9) The anomalous width of the Kechika here is due to structural thickening in the hinge zone of another large, northeast-verging anticlinal fold. Elsewhere, the incompetent Kechika generally outcrops in only narrow zones; in part, this is because of its tendency to be attenuated or form detachment horizons during this style of deformation, but another factor is an apparent thinning of the unit towards the north of the map area.

The structure in the footwall of the thrust sheet in the southwest is particularly complicated southeast of Matulka Creek. Isolated knobs 1 or 2 kilometres east of the thrust are actually klippen of grey to white Cambrian limestone, resting on Silurian Road River siltstone. It is unlikely that they are remnants of the main thrust sheet, as this would require the existence of a large nappe, which was later tightly folded. The preferred explanation is that they are remnants of another thrust panel or horse that formed beneath the main thrust. They both have the same footwall. The limestone in the klippen is more typical of the Middle and Upper Cambrian than of the Lower Cambrian that forms the main thrust sheet.

Most of the rest of the map area, to the north and east, is underlain by Siluro-Devonian Road River siltstone, and Earn slates (Figure 3). The outcrop area of the Road River Group widens northwards. This may simply be due to an increase in thickness, but it may, at least partly, be the effect of more gentle folding and fewer, smaller thrust ramps in this area. Bedding dips are indeed moderate and strikes are variable. If this interpretation is correct, the reason for the change in deformation style northwards may be the conjectured decline in this direction of thick carbonates in the underlying Cambrian; the absence or thinning of the latter might have inhibited the formation of larger fault ramps during thrusting, allowing thrust sheets to develop a more gently undulose form.

The Earn Group is also moderately folded and outcrop belts are generally wider than in the 1994 map area to the southeast. Some outcrop belts of Earn are probably synclinal infolds within a single thrust sheet, rather than separate thrust repetitions. Narrow, alternating belts of Earn and Road River rocks about 7 kilometres east of Gataga Mountain are probably the result of a combination of tight folding and local thrust imbrication.

ECONOMIC GEOLOGY

The Kechika and Selwyn basins in British Columbia and Yukon Territory, respectively, define a metallogenic province which contains economically significant sedimentary exhalative Pb-Zn-Ba deposits. They occur at several stratigraphic horizons within the basins and

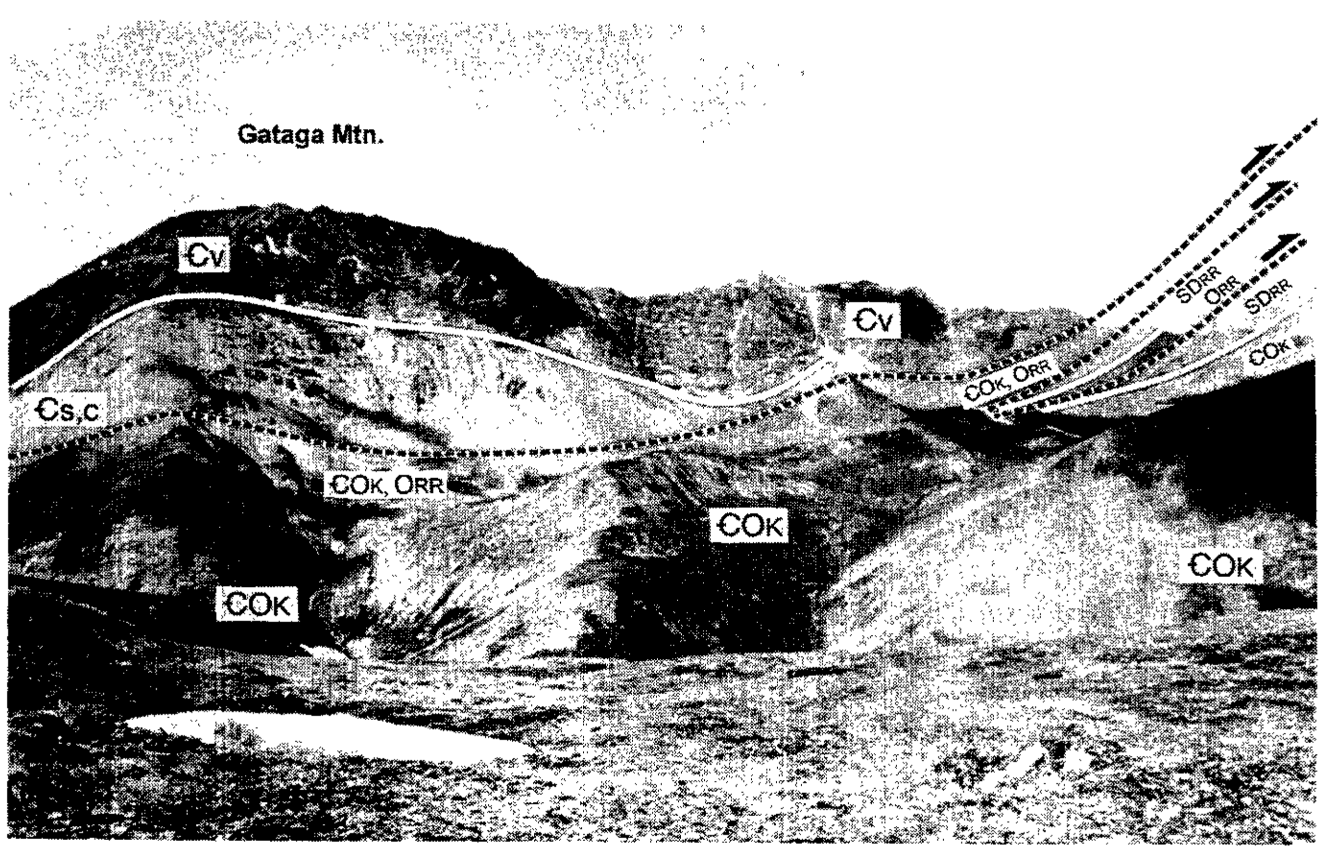

Photo 9: Looking west towards Gataga Mountain, at the leading edge of major Cambrian thrust panel. The hangingwall is a truncated, northeasterly verging anticline (*cf.* Photo 1) comprising volcanics (Ꞓv) overlying quartzites and carbonates (Ꞓs,c) which pinch out northwestwards (to right). Two thin thrust sheets lie in the footwall, in the distance at right, consisting of Kechika (ꞒOK) and Road River (ORR, SDRR) rocks. They appear to die out southeastwards into a zone of highly deformed slates of the Kechika and Ordovician Road River groups (ꞒOK, ORR) at the foot of Gataga Mountain. Tightly folded Kechika Group (ꞒOK) extends from there to the observer.

include the Cambro-Ordovician Anvil mineral district, the Silurian Howard's Pass deposits, and the important Devonian deposits in the MacMillan Pass and Gataga districts (Abbott *et al.*, 1986). Sulphide and barite occurrences of probable sedimentary exhalative origin also occur in the Ordovician (MacIntyre, 1992).

Mapping over the course of the summer located numerous stratiform barite occurrences, nearly all of them in the Devono-Mississippian Earn Group. Other significant mineral occurrences include a zone of lead-rich veinlets in Earn rocks, and a previously known zinc and barite rich, crosscutting breccia in chert and limestone of the uppermost Road River Group. Minor mineral occurrences were noted in Cambrian rocks, including: epigenetic galena in slate; malachite staining in maroon and green siltstones associated with the volcanic unit; and chalcopyrite and tetrahedrite(?)-bearing quartz veins in carbonate rocks.

STRATIFORM BARITE

With one exception, all the stratiform barite in the map area is hosted by the Earn Group. One occurrence was observed within the Ordovician Road River Group.

Eighteen occurrences of barite in the Earn Group were documented over the course of the 1995 field season (Figure 3). Virtually every thrust panel or fold enclosure of Earn rocks contains barite showings along its trace. Most have not been reported in the literature. The showings range from disseminated authigenic barite crystals, or nodules of radiating barite, to massive-bedded barite reaching several metres in thickness, and locally producing 'kill zones' covering tens to thousands of square metres. The most impressive concentration of these occurrences is in the southeastern part of the map area. Here barite showings occur along strike from each other, and in adjacent thrust sheets, suggesting at least one continuous or semi-continuous horizon which has been tectonically disrupted and masked by poor exposure. The most important occurrence in this area we call the 'Broken Bit barite', after a nearby outfitters' camp. This previously unreported barite kill zone is well below timberline, and is approximately 6 kilometres northwest along strike from a horizon of bedded barite, over 2 metres thick, which was traced for several kilometres. Thrust sheets immediately to the west and east also contain bedded barite from 0.5 to 2 metres in thickness. Elsewhere, more than 2 metres of barite is exposed east of the headwaters of Trail Creek (Photo 10), and 1 to 1.5

Photo 10: Calcareous barite layer, 2 metres thick, in Earn Group, north-centre of map area.

metres of barite crops out along a north-flowing tributary of Davie Creek.

Barite tends to occur in the lower part of the Earn Group, although occurrences in the southeast appear to be in the upper part. Metre-scale sections of baritic rock pinch and swell along strike and disappear over tens of metres. Barite beds are sometimes interlayered with slate and siltstone. Due to the lack of exposure, deformation and poor stratigraphic control, it is not known if more than one baritic interval is involved. Enclosing rocks are generally dark grey to black siliceous argillites, slates and lesser siltstone. In the southeast, hostrocks are grey, laminated mudstone to siltstone which appear to be higher in the Earn stratigraphy.

Barite weathers grey and is dark grey to black and forms individual beds from 1 to over 50 centimetres thick (Photo 8). It is medium to coarsely crystalline and invariably calcareous. The most calcareous varieties have a strong fetid odour when broken. Interstitial, orange-weathering iron carbonate may be present, and some bedding surfaces are micaceous. Individual beds sometimes show internal laminations, but commonly are quite massive. Sulphides are conspicuously absent, although in some showings, the baritic layers are associated with sooty black pyritic slate.

The Broken Bit barite kill zone (Figure 3) is the most significant mineral discovery made in this program to date. It is inconspicuous from a distance, as it is not gossanous and looks like a slide in post glacial alluvium. It covers some 3500 square metres, measuring approximately 70 by 50 metres (Photo 11). It consists almost entirely of rubble of massive calcareous barite, some paler grey baritic limestone and a lesser amount of blue-grey-weathering siliceous slate. The largest block of barite is 30 centimetres across and crudely layered. No bedrock is exposed. Little or no sulphides were noted but sporadically the barite is rusty weathering. A sample of calcareous barite assayed 41.46% Ba; more limy material contains about half as much barium. Coarse granular 'sand' below the rubble contains 47.91% Ba, accounting for the lack of vegetation and even lichen. A small creek gully 500 metres along strike to the southeast of the kill zone contains rubble of grey calcareous barite to baritic limestone, suggesting that the barite horizon extends at least this far.

The region east and southeast of the Broken Bit occurrence was prospected in the late 1970s by several companies which were investigating anomalous zinc and copper in stream sediment samples (Stewart, 1980; Boyle, 1978). Subsequent soil sampling confirmed strongly anomalous zinc, lead and copper values, but it was reported that bedrock prospecting around these anomalies did not reveal the presence of significant sulphides, although some barite was found to the south of the area of interest. It was pointedly noted that a number of zinc-rich calcrete deposits occur in the vicinity of the geochemical anomalies (Boyle, 1978).

An overturned panel of Ordovician Road River Group slates, exposed along a creek 2 kilometres south of the first large bend in Matulka Creek, contains thin (1 to 3 cm) beds of orange-weathering baritic silty dolostone with authigenic barite crystals. No barite-bearing carbonates were recognized in other sections of Ordovician Road River slates.

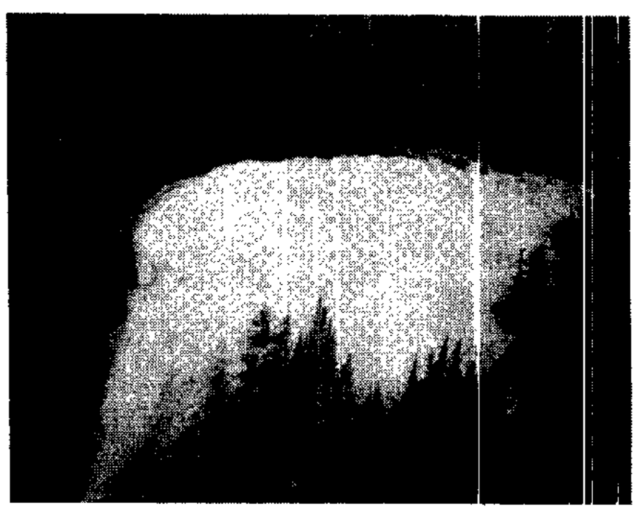

Photo 11: Broken Bit barite 'kill zone', viewed from the air. Zone measures approximately 70 by 50 metres.

LEAD AND ZINC SULPHIDES

Two main occurrences of epigenetic sulphide mineralization were recorded: one in the uppermost Road River Group and the other in the Earn Group.

A sphalerite-barite-rich breccia zone crosscuts chert, cherty argillite and argillaceous limestone of the Road River Group, near the top of a ridge at the head of Horneline Creek (Figure 3). The host-rocks are thought to belong to the chert-limestone couplet which is typically found immediately below the Earn Group. The breccia zone is marked by gossanous weathering of pyrite-rich sections, and loose pieces of rock are noticeably heavy. The zone is about 10 metres long and varies from less than 0.5 metre to over 3 metres in thickness before disappearing below scree. Its geometry is difficult to determine, but it appears to have a pipe-like shape which pinches and swells along its trace. Breccia clasts vary from less than 0.1 centimetre to over 20 centimetres across, and are composed of chert, limestone and argillite. The matrix is predominant, and is part rusty, oxidized material and part carbonate. Pyrite is finely disseminated in the matrix and clasts. No sphalerite is visible, but the breccia reacts strongly to diethylaniline stain ('zinc zap'). Select grab samples from the breccia assay up to 3.4% Zn, 9.1 g/t Ag and 1.0% Ba. More oxidized material contains only 0.2% Zn, 1.1 g/t Ag and only 0.1% Ba. Analysis also shows anomalous concentrations of copper, cadmium and antimony.

The shape of the breccia zone and the absence of shear fractures in it or the host-rocks argues against a tectonic control. One possibility is that the zone represents a hydrothermal conduit or feeder system to overlying Earn group exhalites. About 500 metres to the north of the occurrence is a small area of Earn cherty siltstone and slate with metre-scale lenses of black, baritic limestone.

This showing is documented as the Smoke occurrence (MINFILE 094L 016), and was investigated by Noranda Exploration Company, Limited in 1980 (MacArthur, 1981). Noranda conducted a soil survey in the area around the breccia, but this work did not outline any other targets.

The other sulphide occurrence of note is in Earn Group rocks exposed along Matulka Creek, approximately 5 kilometres downstream from its headwaters. The outcrop consists of slate and siltstone to siliceous siltstone, interbedded with thin, grey to orange-weathering baritic limestone, and is in the same, narrow synclinal fold that contains the Broken Bit barite showing, 4 kilometres to the southeast. A large boulder of fractured, silicified siltstone and slate, almost certainly derived from this exposure, contains galena in quartz veinlets and disseminated in the rock. A selected grab sample assayed over 3% Pb, 15.7 g/t Ag, 0.1% Zn and 0.1% Ba. Comparison of a preliminary Pb/Pb isotopic age obtained from this galena with others from the Selwyn Basin suggests that it is Devonian in age (J.E. Gabites and C.I. Godwin, personal communication, 1995). If correct, this suggests that although the galena and silicification postdate formation of the hostrock, they may be related to a postdepositional feeder system that led to stratiform mineralization in overlying Earn Group sediments, such as might be represented by the nearby Broken Bit barite.

MINERAL OCCURRENCES IN CAMBRIAN ROCKS

Disseminated, patchy galena was found on the southeast side of a ridge some 4 kilometres southeast of Gataga Mountain. It occurs at the base of a sequence of strongly sheared, dark grey to grey-green slates, immediately above grey carbonates. This succession is stratigraphically below the Cambrian volcanic unit. The galena is confined to a zone of silicification in the lowest 5 to 10 centimetres of the sheared slates; its strike length was not determined. A selected grab sample assayed 5% Pb, 30.1 g/t Ag and 0.6% Zn.

A small copper showing is situated approximately 7 kilometres northwest of Gataga Mountain, along the lower slopes of the Northern Rocky Mountain Trench. Malachite staining was observed in interlayered maroon and pale green, micaceous slate to siltstone. Cambrian volcanic rocks lie stratigraphically above and below these sediments, and may interfinger with them locally. A grab sample of mineralized siltstone contains 0.2% Cu together with elevated silver and barium concentrations.

Chalcopyrite and tetrahedrite(?)-bearing quartz veins from 0.01 to 1.5 metres thick cut carbonate rocks along the northern extension of the ridge containing Brownie Mountain. Some of the larger veins are quite conspicuous and can be traced for some distance. The veins are planar to irregular in shape and generally trend 100° to 110°. They can contain wallrock fragments, and vugs lined with tiny quartz crystals are common. Malachite and azurite staining is extensive in copper-rich zones. Similar copper-bearing quartz-carbonate veins were found locally in Cambrian carbonates farther northwest, on the ridges between Gataga Mountain and Terminus Mountain.

CONCLUSIONS

- Mapping in the Gataga Mountain-Terminus Mountain area has demonstrated that most units and major structures delineated last year in the Gataga River area continue to the north. These include: Cambrian carbonates and siliciclastics which are partly equivalent to the Gog Group; Upper Cambrian to Lower Ordovician Kechika Group; Lower

Ordovician to Middle Devonian Road River Group; and Middle Devonian to lower Mississippian(?) Earn Group.

- Volcanic rocks between Gataga and Terminus mountains are predominantly alkalic basalt, and are believed to be entirely Early Cambrian in age.
- Cambrian rocks exhibit marked facies changes in the map area. Both the volcanics and thick sections of carbonates and coarse siliciclastics and conglomerate disappear northeastward into finer grained siliciclastics and rare carbonate, suggesting basin deepening.
- Kechika Group and lower Road River Group rocks also show a pronounced thinning to the northwest, and are apparently absent in much of the northern part of the map area.
- Many previously undocumented occurrences of bedded barite have been located in the Earn Group. Many of these are 2 metres or more in thickness and are traceable for kilometres. The most substantial deposit is associated with a 'kill zone' 3500 square metres in size.

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REFERENCES

Abbott, J.G., Gordey, S.P. and Tempelman-Kluit, D.J. (1986): Setting of Stratiform, Sediment-hosted Lead-Zinc Deposits in Yukon and Northeastern British Columbia; *in* Mineral Deposits of Northern Cordillera, Morin, J.A., Editor, *Canadian Institute of Mining and Metallurgy*, Special Volume 37, pages 1-18.

Boyle, P.J.S. (1978): Report on Geological and Geochemical Surveys on the Solo 1 to 4 Mineral Claims; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 7292.

Cecile, M.P. and Norford, B.S. (1979): Basin to Platform Transition, Lower Paleozoic Strata of Ware and Trutch Map Areas, Northeastern British Columbia; *in* Current Research, Part A, *Geological Survey of Canada*, Paper 79-1A, pages 219-226.

Cecile, M.P. and Norford, B.S. (1991): Ordovician and Silurian Assemblages, Chapter 7; *in* Geology of the Cordilleran Orogen in Canada, Gabrielse, H. and Yorath, C.J., Editors, *Geological Survey of Canada*, Geology of Canada, No. 4, pages 184-196.

Ferri, F., Nelson, J. and Rees, C. (1995a): Geology and Mineralization of the Gataga River Area, Northern Rocky Mountains (94L/7, 8, 9 and 10 ; *in* Geological Fieldwork 1994, Grant, B. and Newell, J.M., Editors, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1995-1, pages 277-298.

Ferri, F., Nelson, J. and Rees, C. (1995b): Preliminary Geology of the Gataga River Area, British Columbia, NTS 94L/7, 8, 9 and 10; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1995-4.

Fritz, W.H. (1991): Cambrian to Middle Devonian Assemblages, Chapter 7; *in* Geology of the Cordilleran Orogen in Canada, Gabrielse, H. and Yorath, C.J., Editors, *Geological Survey of Canada*, Geology of Canada, No. 4, pages 155-184.

Gabrielse, H. (1962): Geology, Kechika (94L); *Geological Survey of Canada*, Map 42-1962.

Gabrielse, H. and Yorath, C.J. (1991): Tectonic Syntheses, Chapter 18; *in* Geology of the Cordilleran Orogen in Canada, Gabrielse, H. and Yorath, C.J., Editors, *Geological Survey of Canada*, Geology of Canada, No. 4, pages 679-705.

Goodfellow, W.D., Cecile. M.P. and Leybourne, M.I. (1995): Geochemistry, Petrogenesis, and Tectonic Setting of Lower Paleozoic Alkalic and Potassic Volcanic Rocks, Northern Canadian Cordilleran Miogeocline; *Canadian Journal of Earth Sciences*, Volume 32, pages 1236-1254.

Irwin, S.E.B. (1990) Late Devonian Conodont Biostratigraphy of the Earn Group with Age Constraints for Stratiform Mineral Deposits, Selwyn and Kechika Basins, Northern British Columbia and Yukon; unpublished M.Sc. thesis, *The University of British Columbia*, 311 pages.

Jackaman, W. Cook, S., Lett, R., Sibbick, S. and Matysek, P. (1996): 1995 Regional Geochemical Survey Program: Review of Activities; *in* Geological Fieldwork 1995, Grant, B. and Newell, J.M., Editors, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1996-1, this volume.

MacArthur, R.G. (1981): Geochemical Report on the Smoke Mineral Claim, Liard Mining Division; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 9467.

MacIntyre, D.G. (1992): Geological Setting and Genesis of Sedimentary Exhalative Barite and Barite-Sulfide Deposits, Gataga District, Northeastern British Columbia; *Exploration and Mining Geology*, Volume 1, No. 1, pages 1-20.

Stewart, A. (1980): Geochemical Report on the MAT 1-4 Claims; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 8379.

Taylor, G.C. and Stott, D.F. (1973): Tuchodi Lakes Map Area, Northeastern British Columbia; *Geological Survey of Canada*, Memoir 373, 37 pages.