

GEOLOGY OF THE NORTHERN KECHIKA TROUGH
(NTS 94L/14, 15; 94M/3, 4, 5, 6, 12, 13; 104P/8, 9, 15, 16)

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INTRODUCTION

This paper summarizes 1996 fieldwork on the Gataga Mapping Project that covered the northern part of the Kechika Trough in northern British Columbia (Figure 1). The Kechika Trough is a lower Paleozoic sedimentary off-shelf basin (Figure 2) characterized, in part, by numerous sedimentary exhalative Ba-Pb-Zn deposits of various ages. The most significant of the known deposits occur within the Devonian-Mississippian Earn Group. The aim of this project is to produce a detailed geologic database for the portion of the trough with the highest mineral potential. This mapping project, which began in 1994, is in conjunction with several British Columbia Geological Survey Branch - funded Regional Geochemical Surveys covering most of the 1994 to 1996 project areas. The Branch recently released results from a regional stream sediment survey covering the Gataga River (1994) and Gataga Mountain (1995) field areas of the Gataga Mapping Project (Jackaman *et al.*, 1996). A regional lake sediment survey covered the 1996 bedrock map area during the course of the summer and this data will be released later this year (Jackaman *et al.*, 1997).

Mapping during the 1996 field season completed planned coverage of the northern part of the Kechika Trough. The work continued from the northern

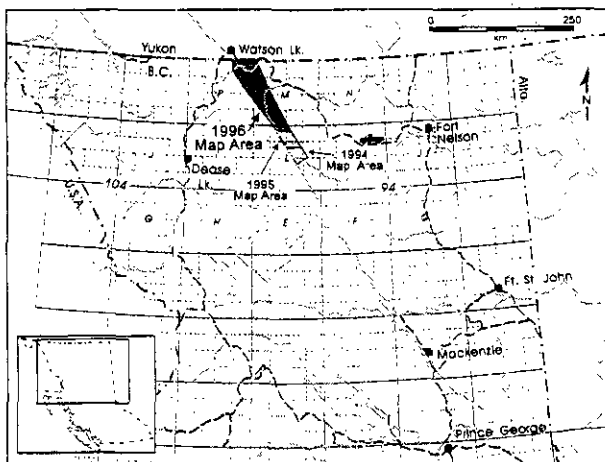


Figure 1: Northeastern British Columbia showing the location of the 1994, 1995 and 1996 map areas.

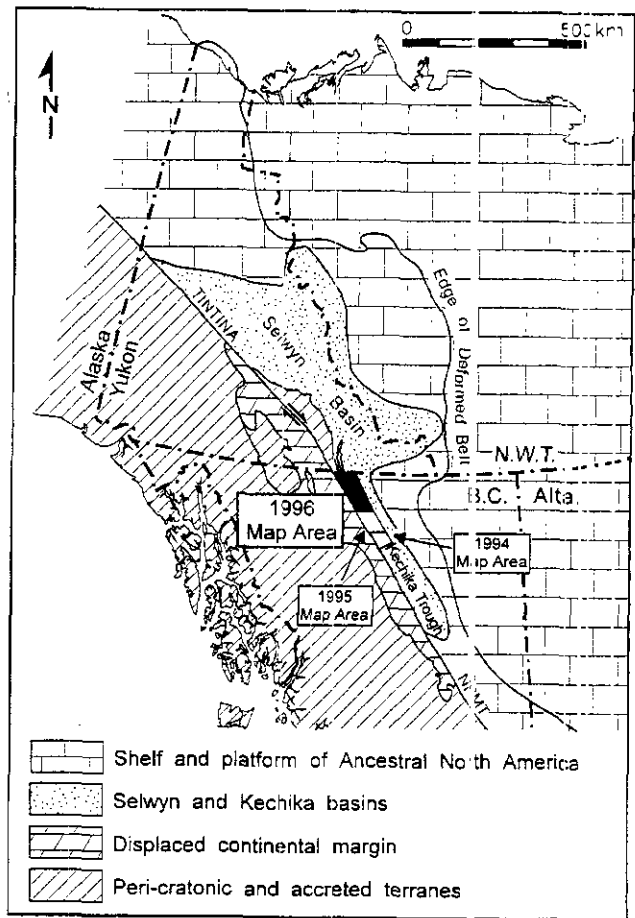


Figure 2: Simplified map of the northern part of the Canadian Cordillera showing the shelf to off-shelf boundary during Ordovician to Silurian time (modified from Cecil and Norford, 1991). NRMT - Northern Rocky Mountain Trench.

termination of the 1995 map area and extended to the British Columbia - Yukon border. This area covers the equivalent of approximately five 1:50 000 scale map sheets. Traverse density is less than that of typical 50 000 scale mapping, as carried out in the 1994 and 1995 field seasons, but is significantly greater than traditional 250 000 scale regional mapping. The very small amount of outcrop in the northern half of the map area led to efforts being concentrated in the southern part of the map area.

The southern border of the map area lies midway between the mouth of Horneline Creek and Terranus Mountain. The western map boundary follows the Northern Rocky Mountain Trench and its northward projection toward the British Columbia - Yukon border (Figure 3). The Trench is easily discernible in the southern half of the map area but effectively ends farther

north as it opens up into the Liard Plain. The eastern limit of mapping roughly follows Netson Creek and the Rabbit River, extends north to Tatisno Mountain, and then northwestwards to the British Columbia - Yukon border.

The sub-alpine peaks around Horneline Creek are part of the Northern Rocky Mountains. These give way northwestward to the rolling hills of the Rabbit Plateau which dominate the southern half of the map area. The northern half falls within the lowlands of the Liard Plain. Rock exposure within the project area is limited to about 1 per cent of the surface area. Scattered exposures can be found along the ridges in the Horneline Creek area. Elsewhere exposures are most readily found along creek valleys and the banks of major drainages. The area east of the Kechika River is old burn, and the dense second-growth forest makes bush travel unusually slow and difficult.

The poor exposure of bedrock within the map area hinders interpretation of the geology. Very few contact relationships were observed between major map units, and no critical stratigraphic sections are exposed. Interpretation relies heavily on a knowledge of the regional stratigraphy and structure gained previously in the better exposed Gataga River and Gataga Mountain areas to the southeast. One significant change to our mapping in the Gataga Mountain area in 1995 (Ferri *et al.*, 1996a, b) is noted here. This arises from recent, preliminary uranium-lead isotopic data which has shown that the volcanics we interpreted as part of the Lower Cambrian Gog Group are in fact Late Proterozoic in age (J. Mortensen, personal communication, 1996), and some 100 Ma older than immediately overlying Cambrian quartzites and carbonates, suggesting the presence of a major unconformity in this area.

Previous work within the project area was carried out by Gabrielse (1962a, b; 1963) who mapped the Kechika (94L), Rabbit River (94M) and McDame (104P) sheets at a 4-mile scale. To the west of the Kechika sheet, Gabrielse (1962c) also mapped the Cry Lake (104I) area at this scale.

The present map area lies along the western margin of the Rocky Mountain subprovince of the Canadian Cordilleran Foreland Belt. The western boundary of the area roughly follows the Northern Rocky Mountain Trench fault, which separates displaced continental margin rocks of the Omineca Belt from ancestral North American strata of the Rocky Mountains (Figure 2). The Omineca Belt is represented by rocks of the Cassiar terrane which bear similarities to those of the Northern Rocky Mountains, although direct correlation is precluded by 450 to 750 kilometres of right-lateral displacement along the Northern Rocky Mountain Trench Fault (Tempelman-Kluit, 1977; Gabrielse, 1985). Only a few traverses were made across the fault into Cassiar rocks.

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 platform successions. Its stratigraphy is characterized by dark, fine-grained siliciclastics and chert, representing quiet, deeper water deposition. This environment of slow sedimentation in restricted sub-basins, coupled with periodic extensional tectonism was conducive to the formation of sedimentary exhalative mineral deposits at various times within the basin. Upper Devonian rocks of the Earn Group host the most economically important known deposits 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).

STRATIGRAPHY

Mapping over the course of the summer encountered typical Kechika Trough geology. The stratigraphy that follows is divided into several sections, beginning with layered units familiar from the previous two field seasons and that are of reasonably well known age (Figures 3 and 4). These include: Cambrian siliciclastics, Cambro-Ordovician Kechika Group, Ordovician to Devonian Road River Group and the Devonian-Mississippian Earn Group. Also mapped were older and younger units not previously described in this project, namely coarse siliciclastics and carbonates of the Upper Proterozoic Hyland Group, vari-coloured chert of possible Mississippian to Permian age, and Tertiary-Quaternary basalt of the Tuya Formation.

The second section deals with two other informal map units of questionable age and affinity, namely the Aeroplane Lake panel, and the 'Kitza Creek facies'. This section is followed by a brief account of rocks west of the Northern Rocky Mountain Trench. These rocks, assumed to belong to the Cassiar terrane, were not examined in detail and no subdivision was attempted.

There are several types of intrusive rocks in the map area. The most notable are relatively large gabbroic bodies within the Kechika Group in the Gemini Lakes area. Most other intrusions consist of dikes or other small bodies.

A consequence of the large area covered is that most of the layered units show considerable compositional variations, and this should be taken into account in the following descriptions.

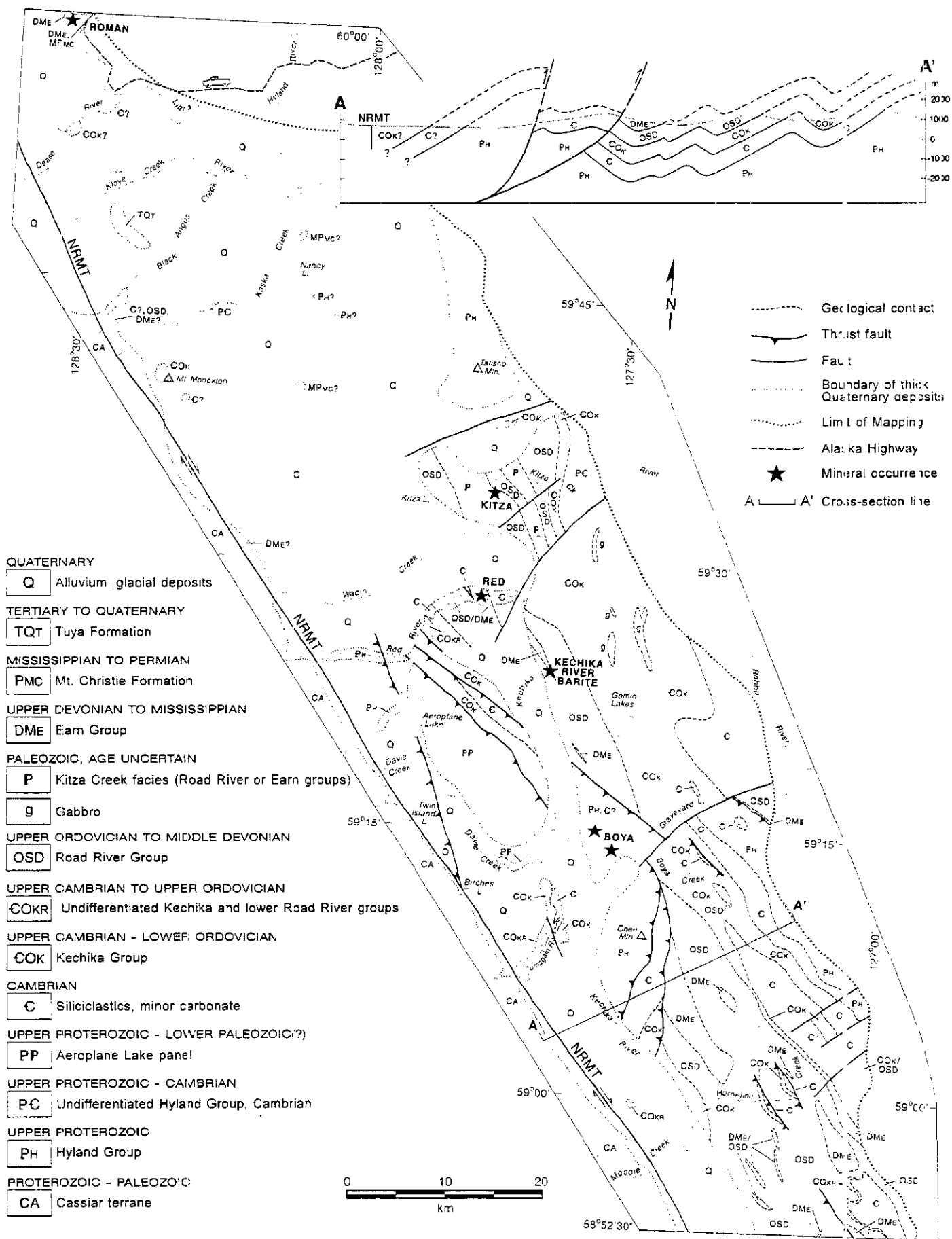


Figure 3: Simplified geologic map of the study area. The southern part of the area, south of Horneline Creek, overlaps with the northern part of the 1995 field area (Ferri *et al.*, 1996a, b). Cross-section A-A' is shown as an inset at the top of the diagram. Please note that this structural section is not at the same scale as shown on the map.

Layered rocks: Proterozoic to Quaternary

HYLAND GROUP (UPPER PROTEROZOIC)

Sections of grey to brown weathering sandstone and slate with distinctive sequences of fine to coarse, gritty, feldspar-bearing, quartz-rich sandstones and conglomerates have been assigned to the Upper Proterozoic Hyland Group, as defined by Gordey and conglomerates have been assigned to the Upper Proterozoic Hyland Group, as defined by Gordey and Anderson (1993) in the Selwyn Basin. Hyland Group rocks are found along the eastern and western margins of the map area (Figure 3). They were mapped along several creek valleys west of Aeroplane Lake, probably in a thrust panel, and Proterozoic coarse clastics are quite well exposed on the higher peaks and ridges east and northeast of Horneline Creek, at the eastern limit of mapping. The west side of Chee Mountain consists of a large thrust panel of Hyland Group rocks, which probably continues northwards across Boya Creek. Excellent exposures of Hyland Group sandstones and conglomerates occur on the ridges emanating from Tatisno Mountain in the northern part of the map area, and in the Liard Plain to the west, isolated outcrops of clastics are also thought to be Proterozoic.

The Hyland Group, in its type area, has been subdivided into the Yusezyu and Narchilla formations (Gordey and Anderson, 1993). The Yusezyu Formation is dominated by coarse clastics, shale and minor limestone whereas the Narchilla Formation contains thick sections of shale with lesser sandstone. Poor exposure in the present map area does not allow subdivision of the Hyland Group, although lithologies typical of each formation were recognized at some localities.

The Hyland Group on Chee Mountain is dominated by grey to olive green or red brown to maroon, well cleaved slate or phyllite to silty slate. Locally, slate forms sections up to several hundred metres thick. Almost as common as these pelitic rocks are thickly bedded to massive, grey-brown weathering, beige to grey quartz-feldspar sandstone to granule conglomerate, which were found along the top of Chee Mountain and on creeks cutting its western flank. Some quartz grains display an opalescent blue colour, and feldspar constitutes 5 to 15 per cent of the coarser clastics. Sandstone may be quite impure, approaching a wacke locally, with a greenish-grey argillaceous matrix. The immature nature of these coarse clastics is also indicated by poor sorting and sub-angular to sub-rounded nature of clasts.

Slaty or phyllitic rocks are generally interbedded with the coarse siliciclastics, in sections from 0.1 to 20 centimetres thick. Some display ball and pillow or flame

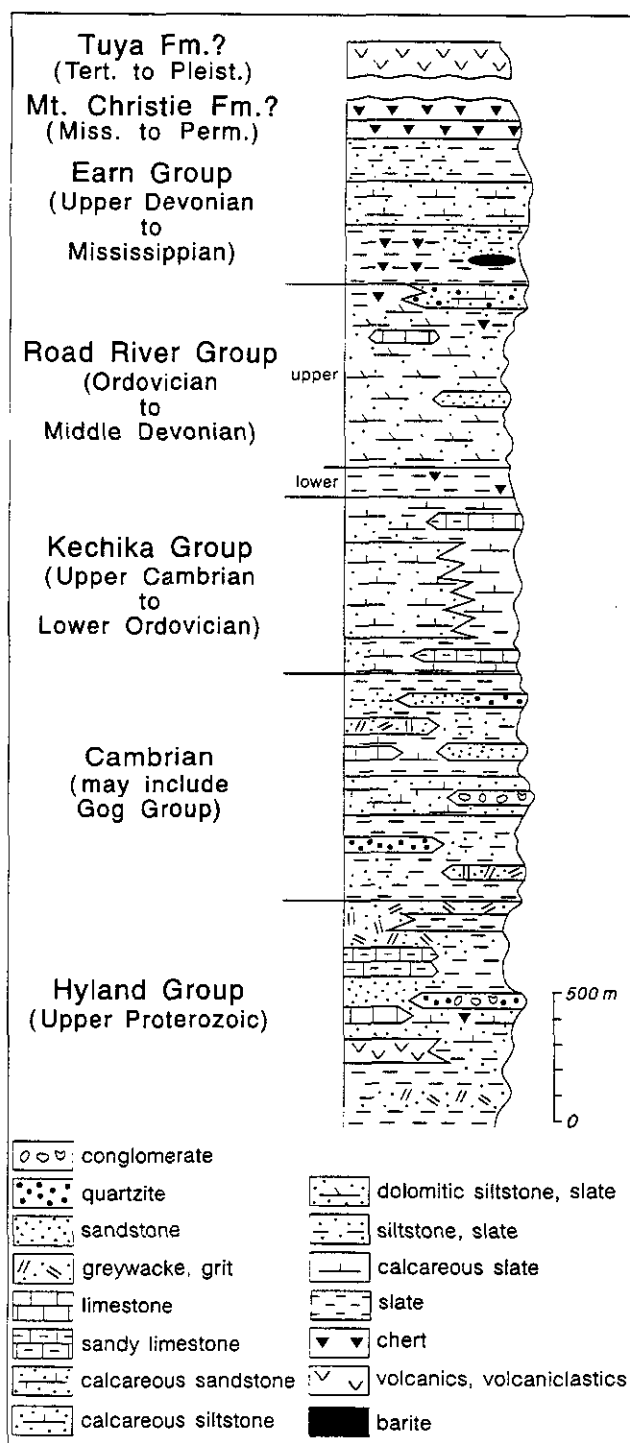


Figure 3: General stratigraphic column based on present work and previous mapping to the southeast in the Kechika Trough (Ferri *et al.*, 1995a, b; 1996a, b). Stratigraphy within each unit is poorly understood; lithology patterns indicate mainly variety and relative proportions of constituent rock types.

structures, and others may contain rip-ups of darker slate or siltstone.

Dark grey to brown or orange brown weathering, dark grey finely crystalline massive to platy limestone up

to 20 metres thick forms prominent outcrops along the top of Chee Mountain. It is not known if these outcrops represent different horizons or the structural repetition of one section of limestone. The upland immediately northwest of Boya Creek, informally called Boya Hill, is underlain by rocks believed to belong to the Hyland Group, but may include rocks of Cambrian age. Typical grey to orange-weathering, coarse sandstone to granule conglomerate of the Hyland Group occur at the southwest end of Boya Hill. Clasts are predominantly quartz with lesser feldspar and mica. These are associated with several ribs of medium to dark grey, massive to platy, sugary limestone and pale grey to greenish, massive and well cleaved slate. A large gossanous zone composed of iron carbonate and coarse, cream-coloured calcite and dolomite cuts across slate and limestone.

Northeastward, along the main part of Boya Hill, the rocks are variously hornfelsed, hydrothermally altered and mineralized. These are described later in this paper. Grey, massive to thickly bedded, equigranular, medium-grained crystalline limestone or sandy limestone forms the most prominent exposures along the top of the ridge. On the southeast-facing slopes, limestone may be thinly interlayered with dark grey slaty siltstone or pale grey chert. These interlayered rocks are associated with brown-weathering, grey to dark grey slate, slaty siltstone to fine quartz sandstone or greywacke, and green to brown volcanic rocks. Volcanic rocks are quite distinct and form a mappable unit several hundred metres thick, which is exposed at several localities. Typically they are buff to orange - brown weathering, green to brown tuff and lapilli tuff. Clasts are composed of feldspar(?) crystals and feldspar porphyry. The rock is very calcareous, suggesting intense alteration; in thin section it is evident that the original clastic components have been pseudomorphed by calcite and quartz. Peatfield (1979a) described agglomerates, flows and intermixed slates and chert in the area. Exposures on the northwest facing slopes of Boya Hill include interlayered laminated to cross-laminated quartz sandstone, siltstone and slaty siltstone; chert; interlayered chert and quartz sandstone or quartzite; and recrystallized limestone.

Overall lithologies on Boya Hill suggest a Precambrian to Cambrian age. The general stratigraphic or structural order was put forward by Peatfield (1979a) is supported by our mapping. It puts the coarser siliciclastic rocks at the base followed by an interlayered limestone, slate and chert package, which also contain the volcanic subunit. Thick to massive limestone and slate lie above and form the top of the section. Sandy limestone at the top of Boya Hill is similar to known Cambrian limestone seen farther south, but interlayered chert and limestone below this is not typical of Cambrian or Precambrian units. However, the associated volcanics bear a strong resemblance to those along Gataga Mountain (Ferri *et al.*, 1996a, b) which have recently been dated as Late Proterozoic (see Introduction, above). It should be noted



Photo 1: Thick bedded, feldspar - lithic - quartz conglomerate of the Hyland Group exposed along the ridges leading to Taisno Mountain. These graded, immature, high energy sediments suggest derivation from nearby steep terrain underlain, in part, by igneous and metamorphic lithologies.

that volcanism of this nature is widespread throughout the Selwyn and Kechika basins and ranges from Proterozoic to middle Paleozoic in age (Goodfellow *et al.*, 1995).

Southeast of Graveyard Lake, rocks assigned to the Hyland Group are very similar to those along Chee Mountain except that they lack the distinctive dark grey limestone. They consist mainly of grey argillite or slate, with sections of grey to brownish grey, coarse sandstone to granule or pebble conglomerate with characteristic opalescent blue quartz and chalky white feldspar clasts. Conglomerate clasts are sub-angular to sub-rounded and supported by a finer sandstone matrix. Interlayered with these coarse-grained rocks are massive to cross-laminated white to brownish quartzite, well laminated orange to brown weathering, grey to beige, well cleaved slate and siltstone, and dirty, orange to brown weathering sandstone. The latter contains minor detrital mica and displays flute casts.

Hyland Group rocks along the upper part of the Red River and west of Aeroplane Lake are very similar to

those described above. Differences include several intervals of buff to orange weathering, pale grey to cream, very finely crystalline and platy dolomitic limestone up to 10 metres thick.

Perhaps the best exposures of Hyland rocks in the map area can be found along Tatisno Mountain. Interlayered, well cleaved greenish-grey to grey or tan laminated slate to silty slate and fine-grained brown-weathering sandstone to quartzite are predominant. These lithologies are punctuated by massive, tan weathering, beige to white, very coarse sandstone to pebble conglomerate in beds up to 2 metres thick (Photo 1). The clasts are composed of angular to sub-angular quartz (some of which are polycrystalline and with a well developed fabric), white feldspar, grey to dark grey argillite or siltstone, and rare mica. The compositions, angular nature and size of the clasts, together with scouring at the base of many beds indicates that these are immature, high energy deposits most likely derived from an uplifted, steep source terrain dominated by igneous and metamorphic rocks.

Northwest of Tatisno Mountain, several kilometres south and east of Nancy Lake in the Liard Plain, sparse outcrops of coarse sandstone and conglomerate are tentatively assigned to the Hyland Group. They consist of grey to tan weathering, grey to cream, massive to thickly bedded, greywacke to conglomerate or breccia. The granule to pebble sized conglomerate clasts are supported by a coarse to very coarse-grained sandstone to wacke. Clasts are rounded to angular and composed of distinctive green chert, tan to grey or black chert or siliceous argillite, maroon argillite, quartz (locally blue), feldspar and tuffaceous granules.

CAMBRIAN

Slate, siltstone, quartz sandstone to quartzite, conglomerate and minor limestone belong to an unnamed sequence of probable Cambrian age. They occur in the far southeastern corner of the map area, along the eastern and western margins, and as fault slices along the Red River. No fossils were recovered from these rocks. Their age is based on similarities to units immediately to the southeast of the present map area which contain archaeocyathid-bearing limestone at their base, and a paucity of feldspar clasts in the siliciclastics which helps to distinguish this unit from otherwise similar lithologies in the Hyland Group. Also, a distinctive conglomerate northeast of Graveyard Lake is equated with a comparable coarse conglomerate on Brownie Mountain in the Gataga River area that has been correlated with the early Middle Cambrian 'Roosevelt facies' in the Rocky Mountains to the east (Ferri *et al.*, 1995a, 1996a).

Southeast of Graveyard Lake, the Cambrian is characterized by well cleaved, thinly interlayered brown to rusty weathering, laminated to banded or mottled, pale to dark grey micaceous slate, siltstone and grey to maroon

very fine sandstone to quartzite. Sandstone and quartzite make up to 30 per cent of the section and beds can reach several metres in thickness. Isolated outcrops of grey weathering, pale to medium grey, fine to medium crystalline, massive to platy limestone in the southeastern part of the map area are grouped with the Cambrian succession as they are found along strike with siliciclastics of this package.

On the south and east sides of Chee Mountain there is a package of rocks which resembles the upper Road River Group, but is correlated with the Cambrian because of its coarser, more siliceous component. It consists predominantly of thinly to thickly interlayered, laminar, orange to brown weathering, greenish grey, dolomitic to calcareous siltstone and grey to black slate to shale. Siltstone is locally bioturbated, and can form up to 70 per cent of the section. In addition, orange to brown weathering, grey to dark grey, thick bedded micaceous sandstone forms sections up to 10 metres thick. Clasts are very fine to fine grained, and composed of quartz and minor dark grey argillite. Sandstone typically shows laminar bedding, and locally it displays low angle or ripple cross laminations and load casts. Slate locally becomes cherty and can be interlayered with calcareous slate or phyllite.

West of the Kechika River, rocks assigned to the Cambrian comprise interlayered dark grey to bluish grey argillite, cherty argillite, slate to phyllite and pale grey, laminated micaceous quartz sandstone. These rocks contain thick sections of massive to thickly bedded grey calcareous quartz sandstone with distinctive rip ups of dark grey argillite. Other clasts consist of well rounded, vitreous quartz, chert, siltstone and limestone or calcite.

Northeast of Graveyard Lake, a broad, poorly exposed region is underlain by sandstone, siltstone, conglomerate and slate, believed to be Cambrian in age. These rocks are characterized by massive to thickly bedded, white or grey to maroon or brown calcareous sandstone or wacke to conglomerate, locally approaching 10 metres in thickness. Sand grains are dominated by spherical, vitreous quartz with lesser dark grey chert, argillite, carbonate and rare feldspar. Conglomerate clasts are typically granule to pebble in size, although locally they approach 30 centimetres (Photo 2). It is this conglomerate that is tentatively correlated with the Roosevelt facies. Clast composition is diverse, with varicoloured quartzite (white, red to maroon, grey to dark grey), grey limestone (some of which is oolitic), orange-weathering limestone, white to black chert, sandy limestone, grey siltstone and greenish grey sandstone. Quartzite clasts tend to be quite rounded but many range to sub-angular. Clasts are supported by a calcareous quartz sandstone matrix which can approach a sandy limestone in places. These coarser clastics are associated with cream to buff-weathering, blue-grey limestone, red-banded cherty siltstone, olive green chert and cherty argillite and grey slate.



Photo 2: Granule to boulder conglomerate of possible Middle Cambrian age found northeast of Graveyard Lake. Clasts are dominated by well rounded quartzite and chert with lesser argillite and carbonate. These rocks have been tentatively correlated with the Roosevelt facies of the Rocky Mountains; however, the association of other lithologies that may be part of the Kechika or Road River groups suggests they may be younger. See text for details.

Also in this area, thinly interlayered pale to medium grey, laminated and cross-laminated, fine calcareous siltstone to silty limestone and medium to dark grey silty slate may be found near outcrops of the sandstone and conglomerate. These rocks superficially resemble the Kechika Group. Outcrops of orange-weathering, dolomitic siltstone, possibly belonging to the Road River Group, were also noted. These occurrences could represent outliers of younger units, or they may simply be lithological variations within the Cambrian.

The age of the conglomerate and sandstone is debatable. Despite the similarities with the Middle Cambrian Roosevelt facies mentioned above, the association of other rocks more typical of the Kechika and Road River groups suggests that they could be younger than Cambrian. However, these groups do not contain such coarse siliciclastics anywhere in the northern Kechika Trough, and so presently a Cambrian age is favoured. Interpretation of relationships between the various lithologies in this area is hampered by the paucity of exposure.

KECHIKA GROUP (UPPER CAMBRIAN TO LOWER ORDOVICIAN)

Although poorly exposed, the Kechika Group is quite extensive in the map area and displays a degree of thickness and lithologic variations not seen in the other rock packages. It is less than 50 metres thick in the southern part of the map area, where it is difficult to distinguish from dark slates of the lower Road River Group. It quickly thickens to the northwest consisting of thinly to thickly interbedded calcareous slate and limestone or silty limestone.

On lower Horneline Creek, Kechika rocks consist primarily of thinly interlayered grey to dark grey slate, calcareous slate and limestone. Limestone can be discontinuous and display thin planar or rare cross laminations. It can form a large proportion of the section, with beds up to 1 metre thick. These rocks can be traced northward toward Chee Mountain where the slates have a characteristic silvery lustre. Southeast of Graveyard Lake, the Kechika Group comprises thinly interlayered, silty pale to dark grey slate, calcareous slate and pale to medium grey, fine to very fine grained limestone. Limestone may be well laminated and silty, and locally

bedding surfaces have mud cracks and worm burrows. Interbedding of slate and limestone varies from thin rhythmic tabular beds to discontinuous lenses, or on a larger scale, consists of alternating thicker sections of non-calcareous slate and platy grey limestone.

Northwest of Graveyard Lake, the Kechika Group occupies a large area which extends northwards to the Kechika River. The Kechika is unusual in this area, characterized by being more siliceous and more dolomitic. The rocks consist of thinly interlayered grey to orange weathering, pale to medium grey silty slate, calcareous slate, and calcareous siltstone to fine sandstone, all of which may be finely laminated to cross-laminated. Mica flakes are sometimes visibly on some bedding surfaces. These rocks locally grade into silty limestone or dolostone. North of Gemini Lakes, grey to beige weathering, dark grey, platy micritic limestone to argillaceous limestone occurs in sections up to 10 metres thick. This limestone can be dolomitic, contain thin slate partings and display a spaced cleavage in the more argillaceous parts.

This siliceous, planar to cross-laminated limestone and dolostone of the Kechika Group is not typical of the unit within the project area, although regional correlatives in the Selwyn Basin display similar features (Gordey and Anderson, 1993; Cecile, 1982). The transition to this more siliceous Kechika lithology occurs rather abruptly across the Graveyard Lake valley. This northeast trending valley may follow a long lived basinal element later utilized during contractional or strike - slip deformation.

No fossils were found from the Kechika Group within the 1996 map area. Graptolite and conodont collections made during the 1994 and 1995 field seasons, together with regional studies within the Kechika and Selwyn basins, indicate a Late Cambrian to Early Ordovician age (Ferri *et al.*, 1995a, b; 1996a, b).

ROAD RIVER GROUP (MIDDLE ORDOVICIAN TO MIDDLE DEVONIAN)

The Road River Group is widespread in the centre of the southern half of the map area. These rocks can be traced from the northern termination of the 1995 map area northward to Chee Mountain where they disappear below the thrusts carrying Cambrian and Proterozoic rocks. Road River rocks reappear north of Boya Hill and also crop in the lower Red River and Kitza Creek areas. No Road River Group was found farther north in the Liard Plain.

The Road River Group is divided into two informal subunits, although these cannot be separated on the map, as was possible in the 1994 and 1995 map areas. There is an unnamed lower sequence of black shale, siliceous shale, chert and minor limestone, known as the Duo Lake Formation in the Selwyn Basin (Gordey and Anderson, 1993; Cecile, 1982), and an upper sequence of distinctive buff-orange weathering, bioturbated dolomitic siltstone,



Photo 3: Orange - weathering, dolomitic and bioturbated siltstone of the upper Road River Group. This unit is informally referred to as the 'Silurian Siltstone' unit in the map area. It is one of the more uniform and distinct lithologies, and a helpful stratigraphic marker.

informally referred to in this project as the 'Silurian Siltstone'. Road River exposures are dominated by the Silurian Siltstone unit due to its relatively resistant nature.

No macro-fossils were found by us in the Road River Group, although Middle Ordovician graptolites have been recovered in the past from slates in the Kitza Creek area (Miller and Harrison, 1981a). Fossils collected during the previous two field seasons, together with regional work, suggests a Middle Ordovician to Middle Devonian age range for the group (Ferri *et al.*, 1995a, 1996a). The lower Road River Group was previously believed to be Middle to Late Ordovician in the Gataga map area, but conodonts recently recovered from lower Road River rocks in the Terminus Mountain area suggest an Early Silurian age for its upper limit (M.J. Orchard, personal communication, 1996). These conodonts were associated with barite mineralization and are very similar to those found within the Active Member of the Howard's Pass area (M.J. Orchard, personal communication, 1996). The Silurian Siltstone is broadly Silurian to Middle Devonian in age.

Lower Road River Group

The lower Road River Group is poorly represented in the map area due to its recessive nature. It was recognized at the southern end of the map area, along Horneline Creek and possibly along the Red River. This subunit closely resembles the Earn Group and it should be cautioned that sections mapped as Earn Group could in fact be part of the lower Road River Group, and *vice versa*. The difficulty in confirming their identity arises from the lack of fossils and the usually poor stratigraphic control. In isolated, small exposures, the lower Road River Group can also be confused with the Kechika Group, and since mapping in 1994 and 1995 revealed that the lower Road River can be very thin, it was appropriate in many places to combine it with the Kechika Group. This practice has been extended into the present map area, such as in the extreme southeast, in the Turnagain River, and in parts of the Red River valley.

Lower Road River rocks are characterized by dark grey to bluish grey carbonaceous black shale, siliceous shale to argillite, siltstone, cherty siltstone to chert and grey to bluish grey limestone. Bedding can be up to 30 centimetres thick. Interlayered cherty argillite and chert with lenticular bodies of limestone are locally developed. On Horneline Creek, lower Road River rocks are

composed of sooty black slate with interbeds of black argillite, and pale grey slate to silty slate. A bluish-grey weathering colour with yellow oxide staining is typical of slates and argillites, a feature shared by the Earn Group and which contributes to their potential confusion.

Silurian Siltstone

Compositionally, this is the most uniform unit within the map area. It consists of orange to brown weathering, grey to greenish grey, wispy, bioturbated siltstone to dolomitic siltstone, argillite and slate (Photo 3). It is thinly to thickly bedded. Stratification is difficult to discern in more massive beds due to the bioturbation, but is quite laminar in undisturbed sections and can display cross-stratification. Siltstone may contain recessive beds of grey to dark grey argillite to silty argillite which is gradational with siltstone. Minor lithologies include grey limestone, grey to grey-brown banded chert and fine to very fine-grained, grey to dark grey quartz sandstone to quartzite. On the east side of the Kechika River, just south of the junction with the Red River, the top of this unit contains several metres of massive, grey, calcareous quartz sandstone with well rounded, spherical quartz grains.



Photo 4: Looking southeast at spectacular fold developed within calcareous facies of the Earn Group along the south side of a creek flowing westward into the Kechika River, just south of the confluence with the Red River. Field of view approximately 5 metres across.

EARN GROUP (MIDDLE DEVONIAN TO MISSISSIPPIAN)

For the most part, the Earn Group is exposed in synclines within the Road River Group in the southern part of the map area. Other sections are believed to occur along the Red River and along the east side of the Kechika River, northwest of Graveyard Lake. The Earn Group is characterized by thinly to thickly bedded, carbonaceous, blue grey to dark grey or black argillite, cherty argillite, siltstone and slate. These rocks have a characteristic yellowish stain on weathered surfaces. Bedding is planar to wavy, and is generally accompanied by slaty cleavage except in chert, siltstone and some argillites.

On the east side of the Kechika River, just south of the junction with the Red River, typical Earn Group lithologies are notably calcareous and associated with thinly to thickly bedded, buff-weathering, grey to sooty black, fetid argillaceous limestone. This platy to blocky limestone may have gradational contacts and be found as individual beds or in sections several metres thick. It forms a spectacular fold at the mouth of one of the creeks in this area (Photo 4). These calcareous rocks are atypical of the Earn Group in the map area, if not regionally (Gordey, 1991). They are very similar to sooty argillite and calcareous argillite to argillaceous limestone of uncertain age found in the Kitza Creek area (see section on 'Kitza Creek facies') suggesting that the latter are part of the Earn Group. Alternatively if the Kitza Creek rocks prove to be older, it suggests that the Kechika River rocks are also older and have been structurally emplaced against the adjacent Road River Group.

No macro-fossils were collected from the Earn Group in the present map area. Fossil collections made elsewhere within the Kechika Trough indicate a late Middle Devonian to Early Mississippian age (Ferri *et al.*, 1995a, 1996a; MacIntyre, 1992).

MOUNT CHRISTIE FORMATION (?) (MISSISSIPPIAN TO PERMIAN)

Approximately 5 kilometres south of the Liard River, some 5 metres of grey to buff weathering, pale grey to dark grey and mottled, moderately to thickly bedded chert is found along the top of a small knoll. Bedding is planar to wavy and has extensive limonitic staining. Pale grey chert is also found along the top of Mount Earle. Thinly and well bedded, pale salmon and green chert with pale green argillite partings also occurs stratigraphically above the Earn Group at the Roman showing along the Liard River (Photo 5; see Economic Geology section).

No significant sections of pale coloured chert have been encountered within the Earn Group or older stratigraphy anywhere else in this mapping project, suggesting that these rocks are a different, younger unit. Thick sections of post-Earn Group chert have been



Photo 5: Thinly, well bedded pale salmon and green chert stratigraphically above the Earn Group. This section is found near the Roman showing, situated along the Liard River west of Lower Post. These cherts have been tentatively assigned to the Mount Christie Formation; they strongly resemble Mississippian to Permian cherts that overlie the Earn Group within the Cassiar terrane.

described in the Selwyn Basin and belong to the upper part of the Mississippian to Permian Mount Christie Formation (Gordey and Anderson, 1993). Farther east, within the Rocky Mountains, chert of similar age belongs to the Permian Fantasque Formation (Bamber *et al.*, 1991). Pale red and green chert of broadly Mississippian to Permian age has been described from the Cassiar Mountains (Nelson and Bradford, 1993) and may be a western equivalent of the Liard River cherts.

These sporadically exposed, pale coloured cherts in the northern part of the map area are tentatively assigned to the Mount Christie Formation, in accordance with established Selwyn Basin nomenclature.

TUYA FORMATION (?) (TERTIARY TO QUATERNARY)

Massive to fragmental, fresh-looking basalt occurs on several hill tops between Black Angus and Kloye creeks,

approximately 10 kilometres southwest of the Liard River. These rocks consist of grey weathering, dark grey-brown to dark green, aphanitic or plagioclase-olivine phyric basalt. Basalt fragments can be vesicular, angular to sub-rounded and up to 30 centimetres in size; small pockets of black volcanic glass were also noted. The tuffaceous matrix displays a yellow to tan colour locally, indicating some alteration. It is not known if these volcanics are sub-aerial or sub-marine.

Pleistocene or Tertiary basalt has been described from the McDame (Gabrielse, 1963) and Jennings River (Gabrielse, 1969) map areas. The volcanics form prominent flat-topped volcanic cones in the Jennings River area and are grouped within the Tuya Formation (Gabrielse, 1969). The basaltic deposits in the present map area are similar to descriptions of Tuya Formation volcanics to the west and are grouped with them.

Layered Rocks of Uncertain age

'AEROPLANE LAKE PANEL' (UPPER PROTEROZOIC AND/OR LOWER PALEOZOIC?)

Low grade metamorphic rocks on the highland east of Aeroplane Lake and extending down through the lower parts of Davie Creek and towards the Turnagain River are of unknown affinity. Compositionally, certain sections bear a strong resemblance to the Kechika Group, and others to clastics and carbonates of Cambrian and Proterozoic age, respectively. In some places these lithologies occur along strike or intermixed with each other, precluding their simple assignment. Their stratigraphic placement is further complicated by the metamorphic recrystallization in certain areas which has masked primary features, and by the presence of a second phase of deformation generally not seen elsewhere in the map area. The stronger metamorphism and deformation in this package suggest it may at one time have been at a greater depth than surrounding rocks, and was later uplifted along a deep-rooted fault or thrust. This interpretation would imply that these rocks could be relatively old, perhaps a lower part of the Hyland Group. It is difficult to be more specific about the stratigraphic affinities of the Aeroplane Lake panel because of the *limited outcrop available*. The panel has been divided into three packages (not differentiated in Figure 3): 1) Calcareous phyllite and schist; 2) Siliceous schist and quartz sandstone; 3) Limestone, phyllite and sandstone.

Calcareous phyllite and schist

Along the Kechika River and on the lower part of Davie Creek are crenulated, finely laminated to banded calcareous phyllites and graphitic phyllites which locally approach schists in texture. Phyllite and schist can be

thinly interlayered with silty limestone which are locally recrystallized to marble. These higher grade, crenulated rocks continue northwestward into the ridge east of Aeroplane Lake along which are also found lower grade, thinly interlayered slate, calcareous slate and grey limestone very similar to the Kechika Group. Directly east of Aeroplane Lake, these calcareous rocks pass along strike into grey to greenish-grey phyllites, interlayered with sandy phyllites or thin laminae of quartz sandstone.

Siliceous schist and Quartz Sandstone

Dark grey to grey crenulated phyllite to schist crops out along the lower part of Davie Creek, and on the Kechika River opposite the junction of the Turnagain River. These rocks are found immediately along strike with brown-grey to blue-grey weathering, silvery-grey slate and phyllite, interlayered with micaceous quartz sandstone, wacke and siltstone. Siltstone can be graphitic and is found with dark grey platy limestone. Sections on Davie Creek texturally approach a schist and contain small porphyroblasts of biotite and a carbonate mineral (ankerite?).

East of Aeroplane Lake, siliciclastics consist of interlayered dark grey to grey graphitic banded crenulated slate, calcareous slate, siltstone and greenish grey, micaceous quartz sandstone. Sections up to 10 metres thick of beige to brown weathering dark grey, finely crystalline, platy to massive limestone with thin phyllite partings occur within the siliciclastics. However, overall this package is much less calcareous than the first one described above.

Limestone, phyllite and sandstone

Limestone is the dominant rock type in this package of the Aeroplane Lake panel. It crops out along the southern crest of the ridge east of Aeroplane Lake, in sections up to 15 metres thick. It is coarsely recrystallized to marble, strongly mottled, and contains small phlogopite crystals. Minor pelitic horizons are composed of crenulated muscovite-chlorite schist and greenish-grey calc-silicate. These rocks can be traced into areas of less metamorphosed grey to dark grey, massive to platy limestone with thin phyllite partings. Well layered platy limestone is commonly highly deformed, displaying several phases of deformation including an early layer-parallel fabric with associated small intrafolial folds, and a later series of upright folds. Sections of bluish dark grey micaceous quartz - feldspar sandstone to granule conglomerate is found associated with these calcareous rocks.

'KITZA CREEK FACIES' (LOWER OR MIDDLE PALEOZOIC)

Around Kitza Creek, there are mappable areas of Silurian Siltstone of the Road River Group, and also substantial areas of dark grey to black, carbonaceous calcareous siltstone, silty limestone, siltstone, argillite, slate and chert. The stratigraphic position of the latter group of rocks is not clear because no fossil control is yet available, and contact relations with the Road River have not been determined. Basically, it is not known if this lithological assemblage, which we have called the Kitza Creek facies, is older or younger than, or equivalent to the Road River Group. The slates and argillites resemble those of the Earn Group, but the associated abundant calcareous material is not typical of the Earn regionally. However, east of the Kechika River, similar lithologies apparently sit stratigraphically above the Silurian Siltstone and so have been assigned to the Earn Group despite their calcareous nature.

As an alternative, the Kitza Creek facies also have some properties compatible with rocks of broadly Ordovician to Silurian age of the lower Road River Group, although nowhere in the project area is this unit particularly calcareous. However, in the Paul River area of the southern Kechika Trough, Gabrielse (1981) mapped lower Road River Group rocks that consist of dark grey to black calcareous shale, slate and siltstone

succeeded by interbedded platy silty slate, shale and conspicuous limestone beds, a description that fits rocks of the Kitza Creek facies.

A third possibility is that the Kitza Creek facies is a distinct unit intermediate between the Road River and Earn, equivalent to an Early to Middle Devonian clastic and carbonate sequence documented in the southern Kechika Trough (MacIntyre, 1992). Fossil control is needed to resolve these possibilities.

Kitza Creek rocks are characterized by dark grey to black, carbonaceous siltstone to silty argillite and shaly slate. All of these can be calcareous to varying degrees and be interlayered with thinly to thickly bedded buff, pale to medium grey weathering, dark grey to black, silty to argillaceous fetid limestone. Limestone is platy to blocky and poorly cleaved, and in some sections is quite thick, forming prominent topographic ribs. Associated with these lithologies are thin layers of grey-weathering, calcareous quartz sandstone to sandy limestone and pale grey calcareous tuff. The sandstones consist of rounded quartz grains, and argillite and carbonate clasts. Sandstone horizons can be quite massive and several metres thick. Limestone is also found with thinly laminated, orange to brown weathering, grey dolomitic siltstone. Calcareous and siliciclastic rocks locally are interbedded with medium bedded, dark bluish grey to black chert. These rocks are associated, in one locality, with debris flows composed of angular chert clasts and

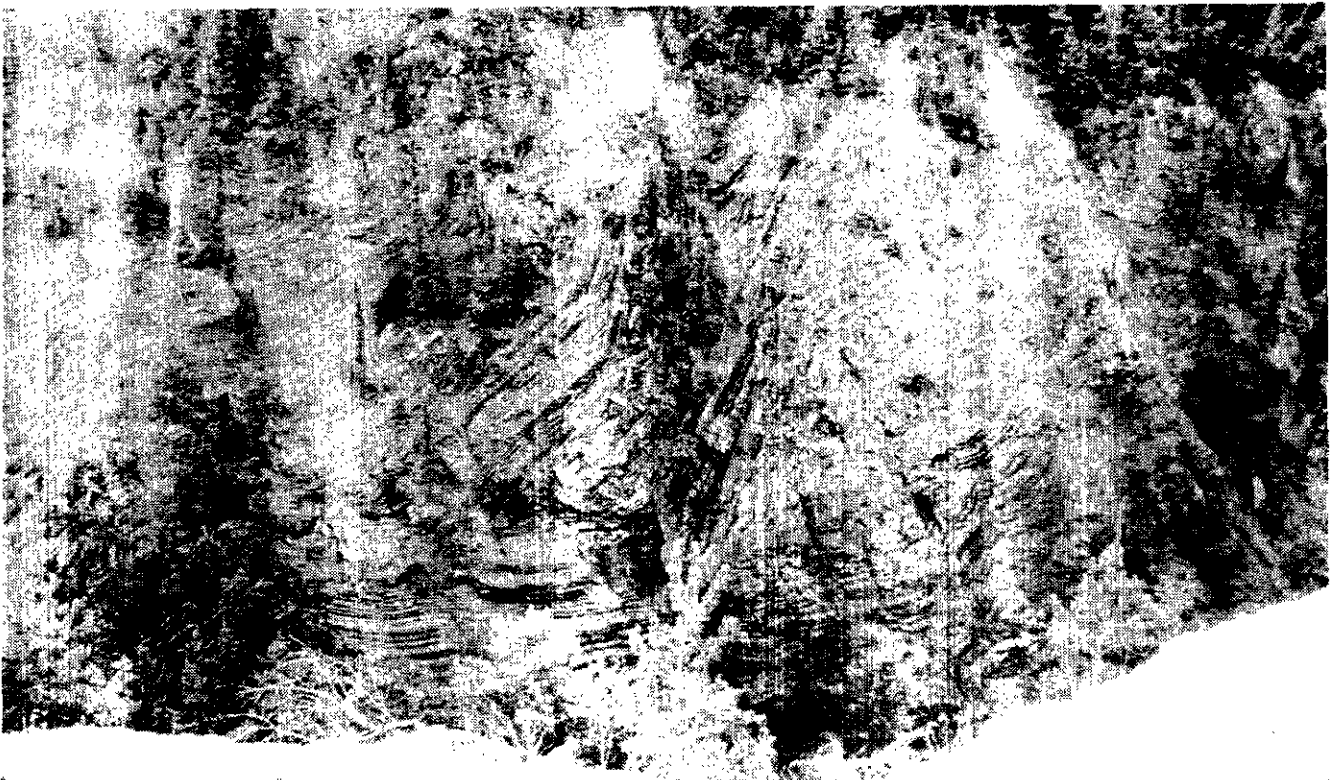


Photo 6: Looking south at a section of highly contorted rocks along the lower part of Horneline Creek. This rock face was inaccessible but the overall appearance is similar to that of Kitza Creek rocks seen elsewhere.

limestone intraclasts up to cobble size. Elevated barium concentrations occur in argillaceous limestone at one locality on Kitza Creek.

Rocks similar to the Kitza Creek facies are present along the Red River and along the lower parts of Horneline Creek (Photos 6, 7 and 8). Contact relationships with surrounding units in both localities are obscured or faulted. On the Red River, calcareous argillites and limestones (Photo 7), as found around Kitza Creek, are associated with rusty weathering, dark grey to black, carbonaceous slate or argillite with interbedded thin laminae or wispy layers of tan to buff weathering dolomitic siltstone. These dolomitic horizons give the rock a characteristic striped appearance (Photo 8). Siltstone layers are from 0.1 to 10 centimetres thick and comprise up to 50 per cent of the rock. The dark grey to black argillite and slate in these sections resembles those of the Earn Group, yet the dolomitic siltstone horizons are more characteristic of the Silurian Siltstone. This suggests these rocks may be part of the upper unit of the lower Road River Group, transitional with the Silurian Siltstone unit.

Cassiar Terrane

A few traverses were made across the Northern Rocky Mountain Trench. West of Mount Monckton¹, strong shearing in grey laminated phyllite is believed to

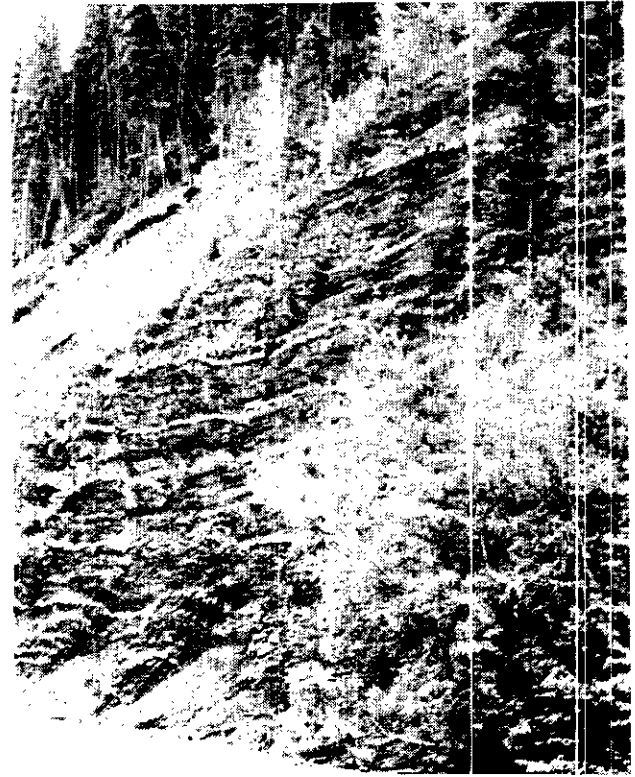


Photo 7: Dark grey to black calcareous argillite and argillite interlayered with white weathering, thin to thickly bedded argillaceous limestone exposed along the north bank of the lower Red River.



Photo 8: Folded, interlayered dark grey argillite and tan to buff weathering siltstone to dolomitic siltstone, along the south bank of the lower Red River. These rocks are also characterized by a conspicuous banding, as shown here.

reflect deformation in the fault zone. Immediately to the west, presumably in the Cassiar terrane, rocks are quite variable and range from quartz-feldspar bearing sandstones of Late Proterozoic age to siltstone of possibly Siluro-Devonian age. Medium grey, moderately to thickly bedded quartz sandstone with rare feldspar clasts and phyllitic partings are most likely Late Proterozoic and thus belong to the Ingenika Group. The affinities of the other rocks encountered are more problematic due to the paucity of available data. These include: grey to yellow or orange weathering, grey to green, massive to finely laminated dolomitic siltstone, cherty siltstone and chert; yellow to orange, grey, faintly laminated silty limestone to calcareous siltstone; and grey, coarse-grained calcareous quartz sandstone to quartzite and grey slate. These lithologies may belong to the Road River, Kechika and Atan groups, respectively.

Intrusive Rocks

Several intrusive rock types have been found in the map area. Gabbro, hosted by the Kechika Group, forms the only bodies of mappable size; the rest consist of small stocks or dikes.

GABBRO

Northeast of Gemini Lakes, gabbro is interpreted to form several elongate bodies within rocks of the Kechika Group. Intrusive relationships were seen in only a few localities, and in one it appears that the gabbro forms a sill - like body. Gabrielse (1962a) described dikes and sills of gabbro in rocks of Proterozoic and Early Paleozoic age, and has suggested that they are no younger than Kechika age as they are never found intruding younger rocks (H. Gabrielse, personal communication, 1996). Our observations support this.

Gabbro is orange-brown weathering, speckled green and white, non-foliated, equigranular and medium to coarse grained. Plagioclase is grey to pinkish and comprise between 40 to 50 per cent of the rock. The remainder is dark green pyroxene, hornblende and biotite.

BOYA HILL INTRUSIVES

Tungsten-molybdenum skarn mineralization on Boya Hill is related to dikes, sills and small stocks of medium grained quartz-biotite-feldspar porphyry and quartz porphyry (Peatfield, 1979a). The largest stocks are some 100 metres in diameter (Peatfield, 1979a), and all are altered. The age of these intrusions is believed to be 100 ± 3 Ma (late Early Cretaceous) based on whole rock potassium - argon systematics from surrounding hornfelsed sediments (T.G. Schroeter, personal communication, 1980). These intrusive rocks were not

examined in detail during our mapping and the following descriptions are taken from Peatfield (1979a).

Quartz-biotite-feldspar porphyry is of quartz monzonite or granodiorite composition. The unaltered rock has abundant potassium feldspar in the groundmass. Quartz porphyry is leucocratic and only weakly porphyritic such that it locally appears aplitic. The groundmass typically contains abundant potassium feldspar and some localities contain sparse potassium feldspar and biotite phenocrysts. Also present in this area are thin dikes of quartz-feldspar \pm biotite porphyry with a dark purplish groundmass.

OTHER INTRUSIONS

Several feldspar and quartz-feldspar porphyry dikes were found within the low grade metamorphic rocks of the Aeroplane Lake panel, and also in the footwall of this thrust panel. The groundmass of these dikes can be medium bluish grey and weakly calcareous. Set in this are pink to orange-buff feldspar and brown biotite phenocrysts. These bodies are up to several metres across, and where observed have chilled margins and cut the fabric of the host rocks. Their age is unknown but they may be related to the Boya Hill intrusions, 10 kilometres to the southeast, in which case they would be Early Cretaceous.

Rocks underlying Mount Monckton are strongly hornfelsed, indicating the proximity of a large intrusive body. Several outcrops of intrusive rock were found in the area, which is along the extension of the Northern Rocky Mountain Trench fault zone, and their undeformed condition suggests they are younger than the fault, making them no older than latest Cretaceous or Early Tertiary.

Several kilometres west of Mount Monckton is a small body of speckled grey, medium grained granite or granodiorite with subhedral quartz phenocrysts up to 2 millimetres in diameter. Fracture surfaces are coated with magnetite or hematite. Another intrusion, of pale yellow, altered quartz porphyry was found a few kilometres southeast of Mount Monckton.

STRUCTURE

The overall structural style is one of northwest-trending folds and thrust faults similar to that mapped to the southeast in the Kechika Trough (Ferri *et al.* 1995a, b; 1996a, b), although folding may be more gentle in this area, and the map pattern appears to be less affected by the thrust repetition typical of the Rocky Mountains. This impression may be largely the result of the sporadic exposure. The poor control governing most of the geological contacts prevents distinguishing between a stratigraphic or tectonic relationship between map units,



Photo 9: Looking northwest at steep, northeast-verging folds in calcareous siltstone and argillaceous limestone of the Kitzka Creek facies, Wadin Creek.

and the apparent absence of even a thick map unit could be accounted for simply by non-exposure, and not necessarily by an unconformity or structural omission. As a result, a fairly conservative interpretation has been applied to the map and cross-section. The structure is characterized by open to moderate, upright to northeast-verging folding (Figure 3; Photos 4, 8 and 9), but there may be considerably more thrust faulting involved, and thickness variations, than has been assumed.

The most obvious major thrust is that on the east side of Chee Mountain, where Cambrian quartzites and slates overlie Earn Group rocks. West of the Cambrian rocks, on the west side of Chee Mountain, are Proterozoic grits and limestone of the Hyland Group which we think are separated from the Cambrian by another northeast-verging thrust fault. The two thrusts may merge to the north, just south of the Boya Creek valley. This Proterozoic thrust panel probably continues northwards across Boya Creek to Boya Hill. Another significant thrust carrying Proterozoic rocks passes through Aeroplane Lake in the Rocky Mountain Trench. Its northward extension, across the Red River, is obscure due to the absence of outcrop. Elsewhere in the map area, a few, relatively minor thrust faults are inferred to explain the juxtaposition of Cambrian rocks against the Road River Group or Earn Group.

Major fold axes and homoclines trend consistently northwest. Stereograms of bedding indicate that most dips are fairly gentle to moderate throughout the area. Dip directions are highly variable, but there is a bias towards the southwest. Overturned beds were noted in several localities, but no major overturned folds were recognized. Isolated, lenticular outcrop areas of black slates and argillites within Road River Group in the southern quarter of the map area may represent Earn Group in the cores of minor, doubly-plunging synclines. It is also possible that some are, in fact, lower Road River Group, in which case the folds would be anticlines. A larger, poorly exposed syncline of Earn Group is present in the footwall of the Chee Mountain thrust, extending south to Horneline Creek.

The dominant cleavage is generally parallel or subparallel to bedding. Stereograms reveal that cleavage is somewhat steeper with a more consistently northwest-striking and southwest-dipping attitude than bedding. Crenulation cleavage is rare, and is best developed in the metamorphic rocks of the Aeroplane Lake panel. This cleavage generally strikes north-northwest to north-northeast, and dips gently to steeply east. Crenulated phyllites and schists in the Aeroplane Lake panel are associated with polydeformed carbonate (see section on Aeroplane Lake panel). Limestone contains a strong, layer parallel fabric with associated tight folds and these are overprinted by broader, upright fold structures. The significance of this earlier deformation is uncertain.

The Northern Rocky Mountain Trench is a broad, well defined valley as far north as the Red River, beyond which it opens out into the Liard Plain. The dextral Northern Rocky Mountain Trench fault probably forms a wide fault zone in the valley. The fault itself has been tentatively positioned along the western border of this inferred fault zone, close to the basal slopes of the Cassiar Mountains (H. Gabrielse, personal communication, 1996), rather than in the centre of the Trench. The fault zone may be exposed in the Turnagain River valley where highly disrupted blue-black calcareous and non-calcareous slates and argillites are visible in scattered outcrops along the river banks for several kilometres. Farther north, in the Liard Plain, the position of the Northern Rocky Mountain Trench Fault is virtually unconstrained and is very tentative.

A number of steep, northeast-trending, dip-slip or oblique-slip faults are present in the map area. Those in the southeast, east of Horneline Creek, affect Proterozoic and Cambrian units, and the Kechika Group. They account for the minor offsets in their geological contacts across transverse valleys. Faults along the Graveyard Lake-Boya Creek valley, the northern stretch of the Kechika River, and south of Tatisno Mountain, are more significant in that the geology changes substantially across them. The 'block' between Graveyard Lake and the Kechika River is characterized by a facies of the Kechika Group possibly reflecting shallower water conditions (see

Stratigraphy, under Kechika Group). It is speculated that the faults bounding it might represent older basement structures which were reactivated during orogeny; originally they formed the sides of a localized, perhaps more shallow water depositional entity along the miogeoclinal margin where this shallower water Kechika facies formed. Northeast-trending structures in the paleocontinental margin basement are believed to have exerted significant control on lower Paleozoic stratigraphy and facies changes along the margin (Cecile *et al.*, 1997), particularly in this region near the transition between the Kechika Trough and the Selwyn Basin.

ECONOMIC GEOLOGY

Regionally, sedimentary exhalative deposits are by far the most economically significant mineral occurrences within the Kechika and Selwyn basins. Massive sulphides occur at various stratigraphic horizons within these basins: in the Cambro-Ordovician (Anvil district), the Early Silurian (Howard's Pass area) and the Late Devonian (Tom, Jason, Driftpile Creek, Cirque). Several occurrences of barite mineralization were examined in the present map area, including some new ones. Previously documented porphyry molybdenum and related tungsten skarn mineralization, and sulphide bearing quartz-carbonate veins are also present.

Sedimentary Exhalative Deposits

KECHIKA RIVER BARITE

A significant Earn-hosted barite-pyrite stratiform deposit was discovered during mapping in 1996. It is one of the few occurrences of this type known within the map area. It is situated along a creek valley approximately 9 kilometres northwest of Gemini Lakes and one kilometre upstream from the creek's junction with the Kechika River (Figure 3).

The bedded barite sequence is at least 4 metres thick, and its base is not exposed. The entire outcrop weathers a bright orange colour due to oxidation of iron sulphides. Individual barite beds are from 1 to 10 centimetres thick and make up approximately 30 per cent of the sequence (Photo 10). A pale coloured, well cleaved rock of unknown composition is interlayered with the barite. It may be either altered slate or possibly fine-grained felsic tuff. Barite is fine to medium-grained and contains fine pyrite laminations or tiny orange spots which may be the product of weathered sulphides. Locally, pyrite is also finely disseminated within the layers of the pale coloured rock. The barite sequence is overlain by medium to dark grey slate with flattened pyrite concretions, horizons of barite nodules and finely laminated pyrite.



Photo 10: Bedded barite at the Kechika River Barite showing. Hammer handle for scale. Fine to medium-grained barite contains fine pyrite laminations.

KITZA CREEK AREA

Another new but apparently minor occurrence was found on Kitza Creek, approximately 2 kilometres east of Kitza Lake (Figure 3). The host rocks consist of blocky to platy, medium to dark grey or black, fine to medium grained limy siltstone to silty limestone of the Kitza Creek facies. There are also thin, pale buff-grey calcareous sandstone beds within the section. These rocks are probably either part of the Earn Group or the lower Road River Group (see section in Stratigraphy, above). No barite was noted, but the calcareous rocks feel slightly heavy, and analysis reveals they are slightly anomalous in barium. The relevant mineral may be witherite rather than barite. The general area around Kitza Creek has been explored in the past (Miller and Harrison, 1981a) resulting in the discovery of numerous sulphide-bearing veins (see below).



Photo 11: Skarn mineralization at the lower contact of Proterozoic (?) marble, at the West Hill showing of the Boya prospect, on Boya Hill. The gossanous mineralization, 1 to 2 metres thick, below the marble consists of massive pyrrhotite, with diopside and quartz, lesser garnet and a trace amount of chalcopyrite.

ROMAN

Sulphide mineralization of possible stratiform nature is present at the Roman showing (MINFILE occurrence 104P 072), situated approximately 9 kilometres northwest of Lower Post on the Alaska Highway (Figure 3). This mineralization is associated with numerous sulphide-rich veins that are described below. The main showing occurs along the south bank of the Liard River just 1 kilometre south of the British Columbia - Yukon border. A smaller barite showing, related to this occurrence, occurs along the south bank of the Liard River some 8 kilometres to the northwest of the main showing. The Roman occurrence was first staked in the early 1960s and worked on intermittently until the late 1980s (Cukor, 1981; Rainsford, 1984 and Mark, 1988).

The main showing was not visited by the authors; the following account is taken from Mark (1988) and Rainsford (1984). The showing is hosted by black

graphitic slate and thin to moderately laminated dark grey silty limestone of the Earn Group. Carbonaceous sandstone to quartzite occurs above the sulphide bearing horizon. Several concordant to discordant sphalerite and galena bands, up to 20 centimetres thick, can be traced for 10 metres before they disappear under the Liard River. Fine pyrite laminations and barite lenses are described from a related site across the Yukon border. Reported assays of the sulphide horizons at the main showing are 22.6 per cent zinc, 46.3 per cent lead and 23 grams per tonne silver (Mark, 1988). The contact zone between carbonaceous slates and quartzites exhibits a pervasive muscovite-sericite alteration and bleaching, and there are numerous quartz veins cutting the silicified zone. Patches of galena, sphalerite and tetrahedrite are found within the silicified zone. Rainsford (1984) suggests these features are part of a sedimentary exhalative feeder system, although our observations of the vein system on the north side of the river suggest that it is much younger, and related to regional folding (see below). This does not rule out the possibility that some of these veins may indeed represent a syn-sedimentary feeder system.

On the opposite side of the river, rocks very similar to those at the main showing are overlain by well bedded and thinly interlayered pale salmon and green chert with thin pale green argillite partings. This unit is very similar to a chert unit of Mississippian to Permian age which overlies the Earn Group in the Cassiar Mountains (Nelson and Bradford, 1993). A small exposure of orange-weathering, carbonate-altered feldspar porphyry occurs immediately east of the main showing. East of this is dark grey to orange-weathering, finely planar to cross-laminated micaceous sandstone and argillite. The sandstone is bioturbated with bedding-parallel worm burrows. The exact age of these rocks is unknown. Their dip is the same as the section at the main showing, suggesting that they lie stratigraphically above it. This would make them younger than Permian, if the correlation of the cherts with those in the Cassiar Mountains is correct, and possibly Triassic. Unfortunately contact relationships between these two packages are covered, allowing the possibility that the coarser clastics represent a thrust panel of older rocks, perhaps of Cambrian or Silurian age.

Porphyry/Skarn

The Boya prospect (MINFILE occurrences 094M 016 and 021) is situated on Boya Hill, approximately 10 kilometres southwest of Graveyard Lake (Figure 3). It was discovered in the late 1970s by Texas Gulf Canada Ltd. during a regional exploration program that targeted sedimentary exhalative deposits in the northern Kechika Trough. It was initially staked as a tungsten skarn; subsequent exploration indicated molybdenum potential (Peatfield *et al.*, 1978). Encouraging initial results led to

an intensified exploration program, further ground acquisition and approximately 3950 metres of diamond drilling in 16 holes (Peatfield, 1979a, b, c; 1980a, b; 1981a, b). Low grades and structural complexities, particularly the truncation of mineralization at depth by a thrust fault, led to abandonment of the property.

Mineralization is concentrated at two localities. At the 'Main Face' showing (MINFILE 094M 021), contact metamorphism, patchy skarnification, and pyrite, chlorite and carbonate-sericite alteration are present near the quartz-biotite-feldspar porphyries where they intrude the Proterozoic host rocks. A distinctive, finely banded or mottled quartz-diopside calc-silicate rock, probably derived from calcareous slate or siltstone, is locally mineralized with pyrrhotite, chalcopyrite and scheelite. Samples assayed up to 0.11 per cent copper and 0.15 per cent oxide of tungsten (Peatfield *et al.*, 1978). Garnetiferous skarn in marble locally contains disseminated or semi-massive pyrrhotite, with lesser chalcopyrite, molybdenite and scheelite. The most significant mineralization is hosted by quartz stockworks and fracture-filling veins in the intrusions and altered metasediments and comprises thin streaks of molybdenite and minor scheelite. Traces of galena, sphalerite, bismuthinite, chalcopyrite and arsenopyrite were also reported in quartz veins.

At the other main locality, the 'West Hill' showing (MINFILE 094M 016), approximately 3.5 kilometres to the northeast, similar porphyritic bodies have intruded massive limestone, and interbedded slate, siltstone and quartz sandstone. Thermal aureoles around these intrusions are marked by hornfelsing and alteration. This is manifested as bands or zones of pyrrhotite-diopside-garnet-quartz and calc-silicate skarn around carbonate contacts (Photo 11). The skarn locally contains metre-scale lenses of massive pyrrhotite, with minor chalcopyrite and traces of very fine scheelite. As at the Main Face, values of copper and tungsten are low. Some areas of skarn contain more significant amounts of molybdenite. Minor amounts of arsenopyrite, sphalerite, galena and bismuthinite were found in the drill core (Peatfield, 1979c).

Veins

Low grade sulphide vein mineralization occurs in the Kitza Creek area and along the Red River. Host rocks in both areas belong, in part, to the 'Kitza Creek facies'. At the Roman showing along the Liard River, galena and sphalerite-bearing veins are hosted by the Earn Group.

RED RIVER

Vein mineralization along the Red River (the "Red" MINFILE occurrence 094M 020) was first reported in the early 1980s by St. Joseph Exploration, which later

became Sulpetro Minerals Ltd. (Miller and Harrison, 1981b, c). Preliminary work along the Red River indicated low grades; this, and the generally poor exposure discouraged further exploration. Mineralization occurs approximately 5 kilometres upstream from the junction with the Kechika River (Figure 3). There are three main localities of vein mineralization. The western showing is a 3-metre long quartz breccia zone with sphalerite, galena and pyrite. Smithsonite bearing quartz-calcite veins were also noted during our mapping in this area. Approximately 500 metres to the east is an outcrop containing quartz veins with minor chalcopyrite and pyrite. Both occurrences are hosted by rocks of uncertain affinity and could be either part of the Road River or Earn groups. These rocks also share similarities with lithologies described as the 'Kitza Creek facies' (see section above). Another 500 metres to the east a vuggy, irregular quartz vein with low grades of galena and sphalerite is found within rocks of Cambrian age.

KITZA CREEK

Mineralization in the Kitza Creek area (the "Kitza" MINFILE occurrence 094M 018) was discovered by Sulpetro Minerals Ltd. in the early 1980s as part of a larger regional program along the entire Kechika Trough (Miller and Harrison, 1981a). The veins occur in Kitza Creek facies rocks along a belt 8 kilometres long by 3 kilometres wide, centred roughly 3 kilometres east of Kitza Lake (Figure 3). Several dozen veins are known, containing one or more of tetrahedrite, honey-brown sphalerite, barite, quartz, calcite and rare galena. These veins are described as being restricted to calcareous mudstones (Miller and Harrison, 1981a). Smithsonite was reported as matrix in some fault zones and pale green fluorite was found in a few veins (Miller and Harrison, 1981a). The rocks in the area carry elevated metal levels, and Miller and Harrison (1981a) speculated that the veining may be related to de-watering of the host rocks. The low grade of the veins, together with the limited exposure, led to abandonment of the property after a few years of preliminary exploration.

ROMAN

Mineralization of sedimentary exhalative origin at the Roman showing was described above. Sulphide-bearing veins at the property are, in part, interpreted to be much younger and probably related to regional tectonism, although (Rainsford, 1984) has suggested some may be part of a feeder system to sedimentary exhalative mineralization. The history of vein mineralization is complex and is related to at least three phases of deformation. The Earn Group host rocks contain lenses of pyrite along cleavage planes of the first phase of deformation (D_1). This cleavage is pervasive and related to northeast-verging folding and thrusting in the Northern

Rocky Mountains. These lenses are kinked (F_2) by northeast-trending folds, and pyrite is also concentrated in hinge areas of F_2 kinks. These zones show strong carbonate and silicate alteration and associated bleaching. Related to this are thick quartz-calcite-ankerite-tetrahedrite veins which cut the foliation. These veins are deformed by late, north-trending kinks (F_3); related fractures in the altered lithologies are coated with sphalerite, galena, marcasite and pyrite. The thick quartz-carbonate veins also cut the salmon and green chert unit (Mount Christie Formation?) that overlies the Earn Group.

A silica-carbonate altered felsic intrusion immediately east of the Roman vein mineralization may be genetically linked to these veins. The metals may have originated within this felsic body or may have been remobilized from elsewhere in the stratigraphy, possibly from sedimentary exhalative mineralization.

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ⁱ Mount Monckton is incorrectly labeled on the 1:250 000 scale map (104P) and Map 1110A (Gabrielse, 1963). The correct location is the 3881' peak, approximately 20 kilometres east of the indicated location on 104P.