# Geology and Mineral Occurrences of the Nehalliston Plateau, South-Central British Columbia (92P/7, 8, 9, 10)

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***KEYWORDS:*** Nehalliston Plateau, Quesnel Terrane, Nicola Group, Harper Ranch Group, Triassic-Jurassic plutons, skarn, porphyry copper, gold, platinum, dextral strike-slip.

## INTRODUCTION

The Bonaparte project is a new multi-year bedrock mapping program of the British Columbia Geological Survey (BCGS) concentrating on Mesozoic arc volcanic and plutonic rocks of the Quesnel Terrane in the northeastern part of the Bonaparte Lake (92P) map sheet (Figure 1). The area encompasses a northwest-trending belt of high mineral potential that includes a number of interesting mineral occurrences, as well as numerous regional geochemical survey and till geochemical anomalies. The project will improve the quality and detail of bedrock maps for the area, which are based primarily on 1:250 000-scale mapping carried out by the Geological Survey of Canada in the 1960s. The mapping will be facilitated by much-improved road access, and will benefit from a more thorough understanding of regional geology and mineral occurrences provided by earlier BCGS projects on the same belt of rocks to the north (Nelson and Bellefontaine, 1996; Panteleyev *et al*., 1996). The new mapping will help attract mineral exploration to the region by providing an improved geologic framework for interpreting the mineral occurrences and geochemical anomalies, and for predicting favourable settings for future discoveries.

Here, we present preliminary results of the first year of mapping for the Bonaparte project. The fieldwork was carried out by the authors in July and August, 2000. The area mapped covers about 700 square kilometres within and adjacent to the informally-named Nehalliston Plateau, which comprises the northeastern tip of the Thompson Plateau of the south-central interior of British Columbia (Holland, 1976). The area is bounded on the east by the North Thompson River, which is followed by Highway 5 and the main line of the Canadian National Railway. It is bisected by Highway 24, which branches westward from Highway 5 at the town of Little Fort, eventually to connect with Highway 97 south of 100 Mile House. Access to most parts of the area is easily attained by an extensive network of logging and Forest Service roads that branch from highways 5 and 24.

The geological interpretations presented here build on the 1:250 000-scale mapping of Campbell and Tipper (1971), whose work incorporated earlier studies along the North Thompson River by Uglow (1922) and Walker (1931). Our work also builds on the study of Preto (1970a) which focused on mineral occurrences in the area north of Eakin Creek. Descriptions of geology and mineralization of a more local nature are found in assessment reports and annual reports of the Ministry of Energy and Mines.

## REGIONAL GEOLOGIC SETTING

The Nehalliston Plateau is situated in the eastern Intermontane Belt, which is underlain mainly by Upper Paleozoic to Lower Mesozoic arc volcanic, plutonic and sedimentary rocks of the Quesnel Terrane. Farther west within the Intermontane Belt are coeval Paleozoic and Mesozoic rocks of the oceanic Cache Creek Terrane. At the latitude of the present study area, the boundary between the Cache Creek and Quesnel terranes is hidden beneath a broad area of Tertiary volcanic rocks and unconsolidated Quaternary sediments (Figure 1). Directly east of the Quesnel Terrane are rocks of the Omineca Belt, represented at this latitude by Upper Paleozoic basalt, chert, gabbro and associated rocks of the Slide Mountain Terrane, and Proterozoic and Paleozoic metasedimentary, metavolcanic and metaplutonic rocks of the pericratonic Kootenay Terrane. Jura-Cretaceous granitic rocks, including the Raft and Baldy batholiths, crosscut the boundaries between the Kootenay, Slide Mountain and Quesnel terranes.

The Kootenay Terrane is characterized by a lower Paleozoic succession, represented in part by the Lardeau Group of the Kootenay Arc (Fyles, 1964), that includes graphitic pelite, immature coarse clastic rocks and mafic volcanic rocks. Other distinctive elements include a Devono-Mississippian succession of calc-alkaline to alkaline volcanic rocks and associated granitoid intrusions, found mainly in the Eagle Bay assemblage directly east of the Nehalliston Plateau (Schiarizza and Preto, 1987), and evidence for a pre mid-Mississippian deformation event (Read and Wheeler, 1976; Smith and Gehrels, 1992). This Paleozoic succession differs profoundly from

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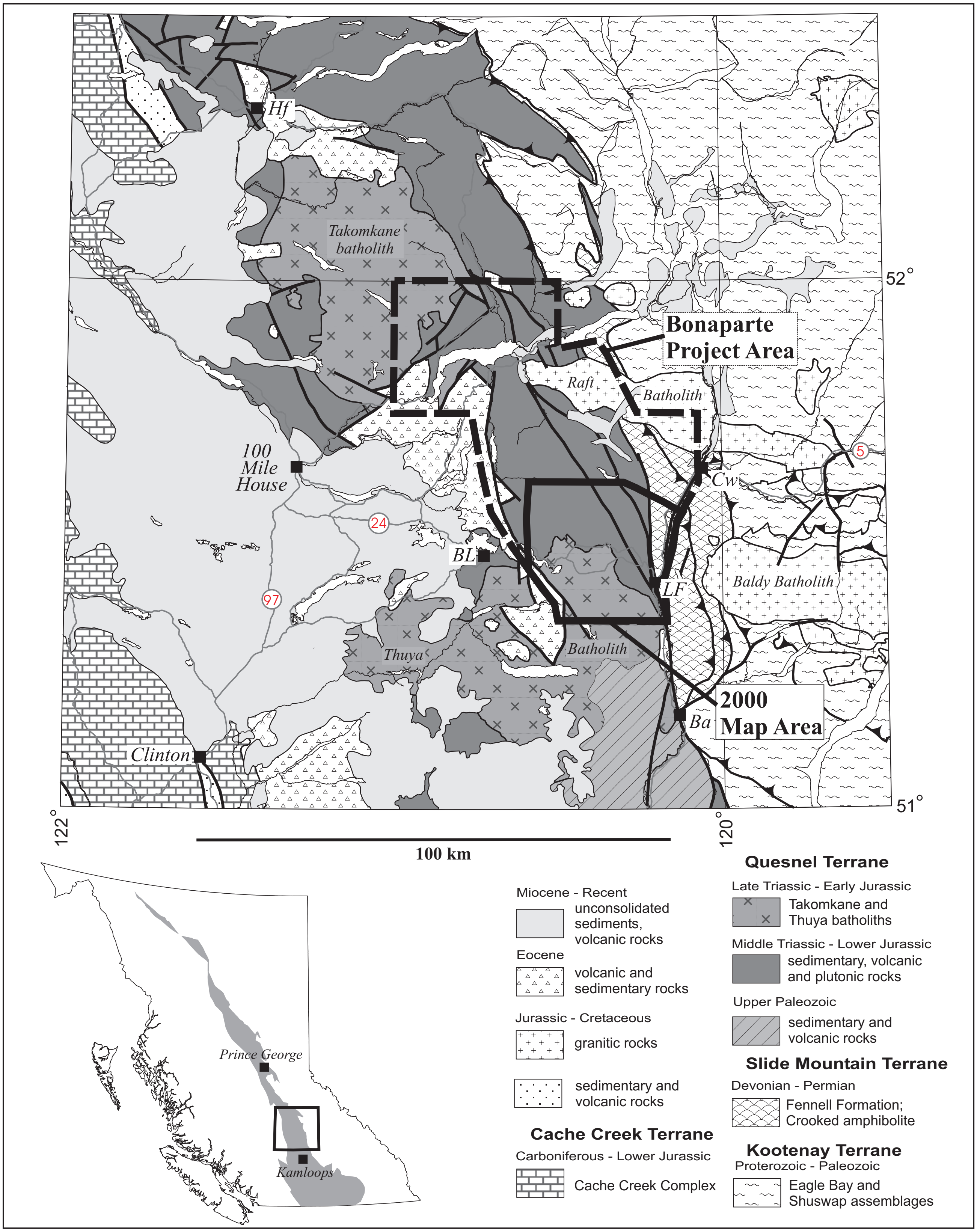



Figure 1. Regional geologic setting of the Bonaparte project area. Abbreviations: Ba, Barriere; BL, Bridge Lake; Cw, Clearwater; Hf, Horsefly; LF, Little Fort. Inset shows location of the map in south-central British Columbia, with distribution of the Quesnel Terrane shown in grey.

homotaxial carbonates and shales of the North American miogeocline, leading to its assignment to a suspect terrane (Monger and Berg, 1984), and the suggestion that it might be part of an allochthon that was thrust eastward over the miogeocline during the Devono-Mississippian Antler orogeny (Smith *et al*., 1993). However, recent work in and near the north end of the Kootenay arc (Colpron and Price, 1995) has confirmed the original stratigraphic interpretations (*eg*. Fyles and Eastwood, 1962; Fyles, 1964) which had this distinctive Paleozoic succession in stratigraphic contact with underlying Lower Cambrian carbonates and mature quartzites that are part of the North American miogeocline. The Kootenay Terrane is therefore, at least in part, a western facies belt of the North American miogeocline rather than an allochthonous terrane. Colpron and Price suggest that the pulses of mafic volcanism and coarse clastic sedimentation that characterize the lower Paleozoic rocks of the Kootenay Terrane reflect intermittent extensional deformation in the outer miogeocline. Younger, Devono-Mississippian volcanic and plutonic rocks may be part of a continental margin arc, reflecting the initiation of east-dipping subduction beneath the North American plate (Schiarizza, 1989).

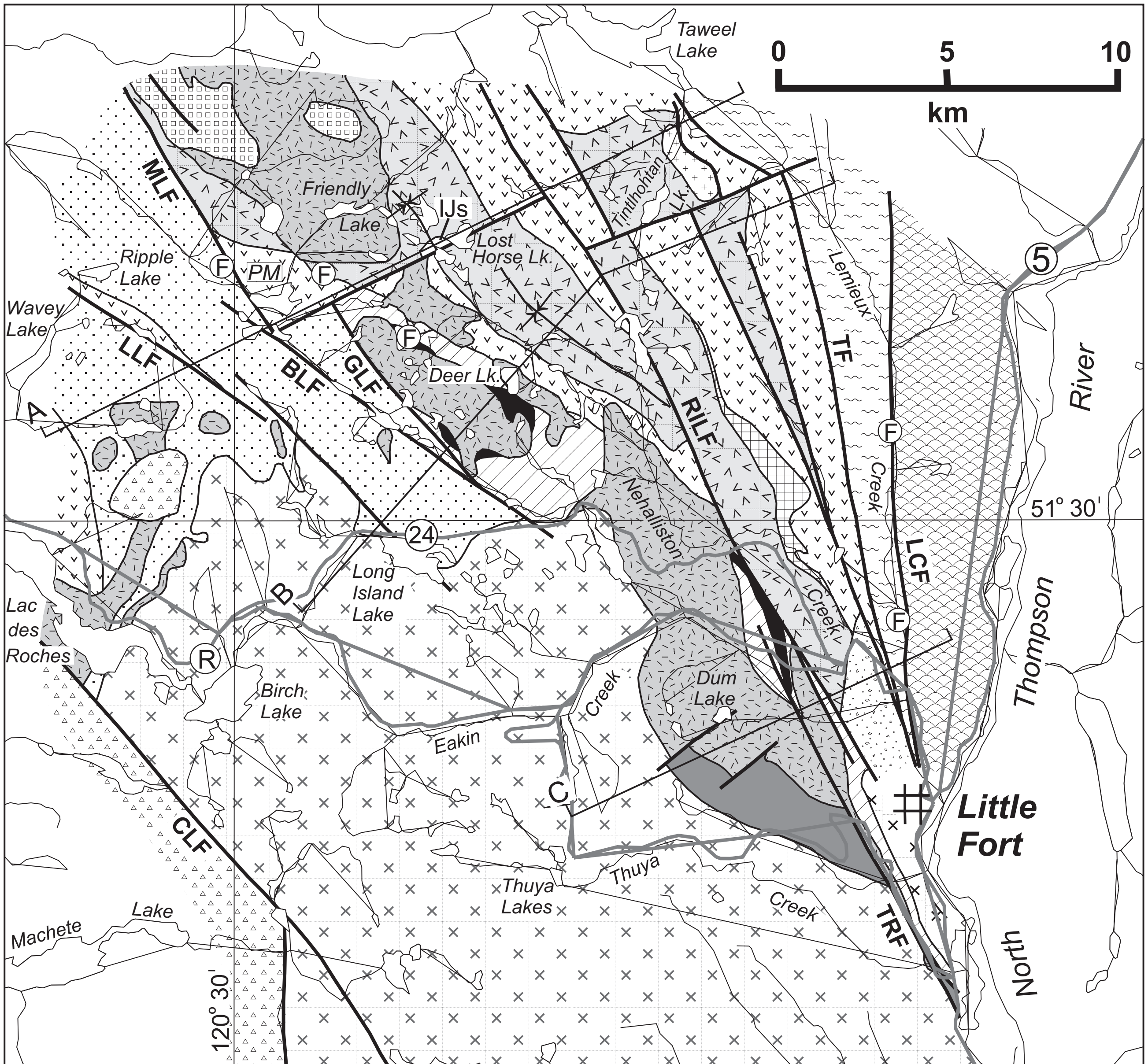
The Slide Mountain Terrane comprises the most inboard tract of oceanic rocks in the Canadian Cordillera. At the latitude of the Nehalliston Plateau it is represented by the Fennell Formation, a structurally imbricated assemblage of Devonian to Upper Permian rocks that is dominated by chert, basalt, gabbro and diabase (Schiarizza and Preto, 1987). North of the Raft batholith it is represented mainly by a thin unit of amphibolite, greenstone, gabbro and ultramafic rocks, referred to as the Crooked amphibolite, that marks the faulted contact between the Quesnel and Kootenay terranes (Rees, 1987; Bloodgood, 1990). East-directed thrusting of the Quesnel Terrane, and underlying Crooked amphibolite, over the Kootenay Terrane occurred in the Lower Jurassic, and was overprinted by west-vergent folds and thrust faults that formed in Middle Jurassic time (Brown *et al*., 1986; Rees, 1987). A similar scenario, involving post-early Late Permian imbrication and emplacement above Kootenay terrane, followed by west-directed folding and thrust faulting, is documented for the Fennell Formation (Schiarizza, 1983). Schiarizza (1989) suggests, however, that the structural imbrication and emplacement of the Fennell Formation occurred in the late Permian or early Triassic, in an event correlated with the Sonoma orogeny. Although it is allochthonous, the Fennell Formation includes lithologic units, such as Mississippian quartz sandstone and Devonian rhyolite, that may be correlated with rocks in the Kootenay Terrane. Direct or indirect ties with the North American miogeocline are also documented in the Slide Mountain Terrane to the south and north, leading to the common interpretation that it represents the remnants of a marginal or back-arc basin that formed directly outboard of North America (Klepacki and Wheeler, 1985; Schiarizza, 1989; Roback *et al*., 1994; Ferri, 1997)

The Quesnel Terrane is characterized by an Upper Triassic to Lower Jurassic magmatic arc complex that formed above an east-dipping subduction zone (Mortimer, 1987). The Cache Creek Terrane to the west, which locally includes Late Triassic blueschist-facies rocks (Paterson and Harakal, 1974; Ghent *et al*., 1996), is inferred to include the remnants of the associated accretion-subduction complex (Travers, 1977). In southern and central British Columbia the early Mesozoic arc of the Quesnel Terrane is represented mainly by Upper Triassic volcanic and associated sedimentary rocks of the Nicola Group, together with abundant Late Triassic to Early Jurassic calc-alkaline to alkaline intrusions (Schau, 1970; Lefebure, 1976; Preto, 1977, 1979). Lower Jurassic volcanic rocks rest stratigraphically above Triassic arc volcanic rocks in areas north of the Nehalliston Plateau (Panteleyev *et al*., 1996; Nelson and Bellefontaine, 1996), but in southern British Columbia Lower Jurassic arc rocks of the Rossland Group (Hoy and Dunne, 1997) are found well east of the axis of Triassic magmatism.

In southern British Columbia, Mesozoic rocks of the Quesnel Terrane rest stratigraphically above a diverse assemblage of Paleozoic rocks, commonly across an angular unconformity (Read and Okulitch, 1977). Within and south of the Nehalliston Plateau, the Paleozoic part of the Quesnel Terrane comprises the Harper Ranch Group, which is interpreted as part of a late Paleozoic arc complex (Monger, 1977; Smith, 1979; Danner and Orchard, 2000). Elsewhere in southern British Columbia, Mesozoic rocks of the Quesnel Terrane rest stratigraphically above Paleozoic rocks of more oceanic aspect. These include rocks assigned to the Okanagan subterrane by Monger *et al*. (1991), and, along the eastern edge of the Quesnel Terrane, rocks included in the Slide Mountain Terrane (Campbell, 1971; Klepacki and Wheeler, 1985; Rees, 1987). In both southern and central British Columbia there is indirect evidence suggesting that Late Paleozoic arc rocks correlated with the Harper Ranch Group may have formed above a basement with North American affinities (Roback and Walker, 1995; Ferri, 1997). Furthermore, recent mapping just to the south of the Nehalliston Plateau, in the Vernon and Ashcroft map areas, suggests that pericratonic rocks correlative with those in the Kootenay Terrane extend farther west than previously thought, and underlie Permian and Triassic rocks of the Quesnel Terrane across an unconformable stratigraphic contact (Erdmer *et al*., 1999). Some of these complex relationships are explained by models in which the Paleozoic arc rocks of the Quesnel Terrane formed on a fragment of continental crust that rifted away from ancestral North America during back-arc extension that produced the Slide Mountain ocean basin. Subsequent collapse of the Slide Mountain basin in Permo-Triassic time may have formed a diverse, thrust-imbricated basement on which the Triassic-Jurassic arc of the Quesnel Terrane formed (*eg*. Ferri, 1997; Schiarizza, 1989).

## LITHOLOGIC UNITS

The Nehalliston Plateau is underlain mainly by Upper Triassic volcanic and sedimentary rocks of the Nicola Group, together with contemporaneous to slightly younger intrusions (Figure 2). These rocks constitute the early Mesozoic magmatic arc that is the most definitive feature of the Quesnel Terrane. Paleozoic sedimentary rocks of the underlying Harper Ranch Group are represented locally, as are Lower Jurassic sedimentary rocks that overlie the Nicola Group. Paleozoic basalt of the adjacent Slide Mountain Terrane, represented by the Fennell Formation, occurs along the eastern edge of the map area. Younger rocks exposed in the area include a small Cretaceous stock that intrudes the Nicola Group northeast of Tintlhohtan Lake, and Eocene sedimentary and volcanic rocks of the Kamloops Group.




BLF: Blowdown Lake fault; CLF: Caverhill Lake fault; GLF: Gammarus Lake fault; LCF: Lemieux Creek fault; LLF: Long Lake fault; MLF: Monticola Lake fault; RILF: Rock Island Lake fault; TF: Taweel fault; TRF: Thuya Road fault.

F = fossil locality; R =Radiometric date locality PM: Pooytl Mountain

Figure 2a. Generalized geology of the Nehalliston Plateau map area.

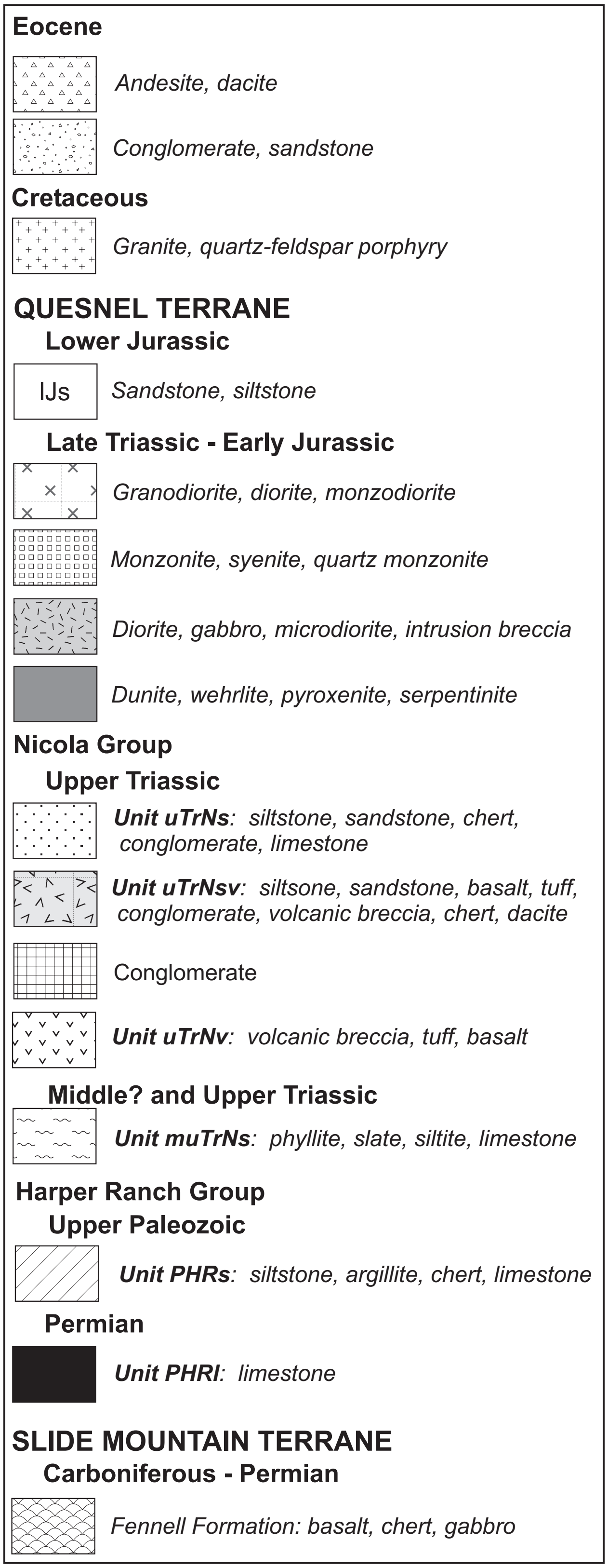



Figure 2b. Legend to accompany Figure 2a.

## Fennell Formation

The Fennell Formation was defined by Uglow (1922) to include fine to medium-grained greenstone and associated gabbro and bedded chert which he mapped along the east side of the North Thompson River valley between the Barriere River and Joseph Creek. Campbell and Tipper (1971) traced the Fennell Formation to the north edge of the Bonaparte Lake map sheet, and correlated it with the Antler Formation of the Slide Mountain Group, which crops out 150 kilometres to the north in the Cariboo River area. These rocks, together with apparent correlatives to the north and south, were subsequently assigned to Slide Mountain Terrane, the most inboard oceanic tract within the Canadian Cordillera (Monger *et al*., 1982).

Detailed mapping of the Fennell Formation between the Barriere River and Clearwater by Schiarizza (1983, 1989) established that the formation could be separated into two major divisions. The structurally lower division comprises a heterogeneous assemblage of bedded chert, gabbro, diabase, pillowed basalt, sandstone, quartz-feldspar-porphyry rhyolite and intraformational conglomerate. The upper structural division consists almost entirely of pillowed and massive basalt, together with minor amounts of bedded chert and gabbro. Conodonts extracted from bedded chert range in age from Early Mississippian to early Late Permian (M.J. Orchard *in* Schiarizza and Preto, 1987) and demonstrate that the Fennell Formation comprises an imbricated assemblage and not a simple stratigraphic succession. Internal imbrication occurred in conjunction with emplacement of the Fennell Formation above Mississippian sandstone of Kootenay Terrane across a system of easterly-directed thrust faults. These east-vergent thrusts were subsequently deformed by southwest-vergent synmetamorphic folds and thrust faults, dated regionally as Middle Jurassic (Brown *et al*., 1986; Colpron *et al*., 1996), which comprise the dominant map-scale structures within Kootenay and Slide Mountain terranes in this area (Schiarizza and Preto, 1987).

Within the present map area, the Fennell Formation crops out along a low ridge system, including Mount Olie, Mount Loveway and Skwilatin Mountain, that extends north from Little Fort and separates Lemieux Creek from the North Thompson River. It consists almost entirely of pillowed to massive basalt, with very local intercalations of bedded chert and rare dikes and sills of diabase and gabbro. The basalts form prominent brown-weathered exposures throughout much of the belt, and are well exposed in roadcuts along Highway 5. These rocks belong to the upper structural division of Schiarizza and Preto (1987), which has yielded Pennsylvanian and Permian conodonts to the east and southeast. They are separated from Triassic sedimentary rocks of Quesnel Terrane by a north-striking fault that follows the Lemieux Creek valley.

## Harper Ranch Group

Sedimentary rocks of inferred Paleozoic or Precambrian age within the southeastern part of the present map area were assigned to the Badger Creek Formation by Uglow (1922). These rocks were traced to the southern boundary of the Bonaparte Lake sheet by Campell and Tipper (1971) who established their Late Paleozoic age and referred to them as the eastern Cache Creek Group. This followed the usage of Cockfield (1948), Jones (1959) and earlier workers, who had assigned contiguous Paleozoic rocks in the Nicola and Vernon map areas to the Cache Creek Group. This belt of Upper Paleozoic rocks was subsequently recognized to be distinct from those in the type area of the Cache Creek Group to the west (*eg*. Monger, 1977); they were referred to as the Thompson assemblage by Okulitch (1979) and the Harper Ranch Group by Smith (1979). The latter term is currently used, and is derived from good exposures on the Harper family ranch, located east of Kamloops on the north side of the South Thompson River. There, the Harper Ranch Group comprises a Devonian to Upper Permian assemblage of carbonates, siltstones, mudstones, volcaniclastic sandstones and local andesitic volcanic rocks (Smith, 1979; Danner and Orchard, 2000). These rocks are stratigraphically overlain, above an angular unconformity, by Upper Triassic sedimentary and volcanic rocks of the Nicola Group (Danner and Orchard, 2000), and therefore comprise part of the Paleozoic underpinnings of Quesnel Terrane.

Campbell and Tipper (1971) assigned an undated assemblage of sedimentary rocks extending from Highway 5 to north of Eakin Creek to their eastern Cache Creek Group. They also documented an occurrence of fossiliferous Permian limestone located 3 kilometres northwest of Deer Lake. However, they did not map it as a separate unit, but included it as part of a belt of volcanic and sedimentary rocks assigned primarily to the Upper Triassic Nicola Group (their Unit 11). Here, the Permian limestone is mapped separately, as part of the Harper Ranch Group (Unit PHRl), and correlated with several other discontinuous limestone exposures to the southeast near Deer Lake (Figure 2). These limestone units occur within a belt of poorly exposed, fine-grained clastic sedimentary rocks that apparently underlie mafic volcanic rocks included in the Nicola Group. These clastic rocks are also included in the Harper Ranch Group and mapped as Unit PHRs. They are correlated with the undated rocks along Eakin Creek and Highway 5 that Campell and Tipper included in the eastern Cache Creek Group. The belt along Eakin Creek includes a limestone unit that is tentatively correlated with those near Deer Lake (Figure 2).

### *UNIT PHRL - LIMESTONE*

The fossiliferous Permian limestone sampled by Campbell and Tipper (1971) northwest of Deer Lake was located and resampled for both macrofossils and microfossils. It comprises about 10 metres of medium to dark grey, light grey weathered limestone containing a few thin interbeds of dark grey argillite and chert. Parts of the limestone contain abundant bioclastic fragments, up to 3 centimetres in size, together with dark grey, sparry calcite crystals from 2 to 4 millimetres in size. Fossil fragments include corals, brachiopods, crinoids, bryozoans and fusulinids. The fossiliferous limestone is discontinuously exposed along its northwest strike for less than 100 metres, partly on a new logging road just to the northwest of the original locality described by Campbell and Tipper. The limestone is within a belt of sedimentary rocks, assigned mainly to Unit PHRs, that is bounded by a diorite pluton to the southwest, and by mafic volcanic rocks of the Nicola Group and another diorite stock to the northeast. Its relationships to adjacent sedimentary rocks of Unit PHRs is not clear. It may be a discontinuous or poorly exposed layer within them, or it may be part of a more extensive unit that underlies them and has been truncated by the diorite body to the southwest.

Limestone exposures south of Deer Lake are along strike from the fossiliferous Permian unit and are tentatively correlated with it. Where unaltered, the limestone at Deer Lake is typically dark grey, medium to light grey weathered, and locally displays distinct thin beds and laminae. However, much of it is skarn-altered and mineralized. Limestone crops out as scattered exposures over a fairly large area, but diorite and microdiorite dikes are abundant within it, and there is local evidence for folding. Therefore, its actual thickness is difficult to determine.

The limestone exposures directly south of Deer Lake are bounded to the southwest by the same diorite pluton that lies to the southwest of the fossiliferous Permian limestone. Exposures of limestone and skarn-altered limestone also occur along the southwest margin of this pluton, two to three kilometres south-southwest of Deer Lake. These are also tentatively correlated with the Permian unit, and may be on the southwest limb of an anticlinal structure that is largely obscured by the diorite pluton (Figure 3, Section B). Silicified and skarn-altered limestone assigned to Unit PHRl also crops out discontinuously between Eakin and Nehalliston creeks, on the northeast margin of the Dum Lake intrusive complex. It occurs within a belt of fine-grained clastic rocks that is correlated with, and more or less along strike from, the belt that contains the limestone units near Deer Lake (Unit PHRs).

Macrofossils were not observed in any of the limestone units southeast of the fossiliferous exposure described by Campbell and Tipper (1971). Samples have been collected from most of these units, and are being processed for conodont extraction in an attempt to determine their age.

### *UNIT PHRS - SILTSTONE AND ARGILLITE*

Unit PHRs consists mainly of thin-bedded siltstone and siliceous argillite, with local thin interbeds of dark grey limestone and chert. It occurs in two separate belts, one near Deer Lake and the other extending discontinuously from Highway 24 to Highway 5, along the west side of the Rock Island Lake fault. The two belts are more or less along strike from one another, but are separated by intrusive rocks of the Dum Lake complex. Rocks within the two belts are correlated on the basis of this along strike relationship, their lithologic similarity and the presence, within each belt, of mappable limestone units assigned to Unit PHRl. They are inferred to be Late Paleozoic in age because associated limestone of Unit PHRl contains Permian fossils at one locality northwest of Deer Lake.

The most continuous, across-strike exposures of Unit PHRs are found on the Eakin Creek road, although the section is complicated by much faulting, local folding and the presence of gabbro and diorite dikes related to the Dum Lake intrusive complex. There, it comprises a steeply-dipping interval of brown to rusty-weathered, thin-bedded siltstones and slaty siltstones, with local thin interbeds of fine-grained sandstone, chert, or siliceous argillite. The siltstone succession is intruded by gabbroic rocks of the Dum Lake complex to the west, and is in contact with limestone of Unit PHRl to the east. The latter contact is apparently conformable and gradational, marked by about 2 metres of interbedded siltstone and limestone, but the stratigraphic facing direction is unknown. A narrow interval of altered and faulted siltstone also occurs along the east side of Unit PHRl, separating the limestone from gabbro and pyroxenite of the Dum Lake complex. This suggests that the limestone unit is either a conformable layer within the predominantly siltstone succession of Unit PHRs, or that it is folded into Unit PHRs at this locality.

The best exposures of Unit PHRs south of Eakin Creek are found along Highway 5, although these rocks are commonly highly sheared, probably due to their proximity to faults of the Rock Island Lake system. The exposures along Highway 5 comprise thin-bedded siltstones and siliceous argillites with local, thin intervals of limestone and chert. Chloritic schist forms local isolated exposures within or along the belt between Highway 5 and Eakin Creek. These might represent mafic volcanic or volcaniclastic rocks within Unit PHRs, but it is more likely that they were derived from mafic dikes or sills related to the Dum Lake intrusive complex.

The rocks assigned to Unit PHRs in the Deer Lake belt are represented by small, scattered exposures that in-

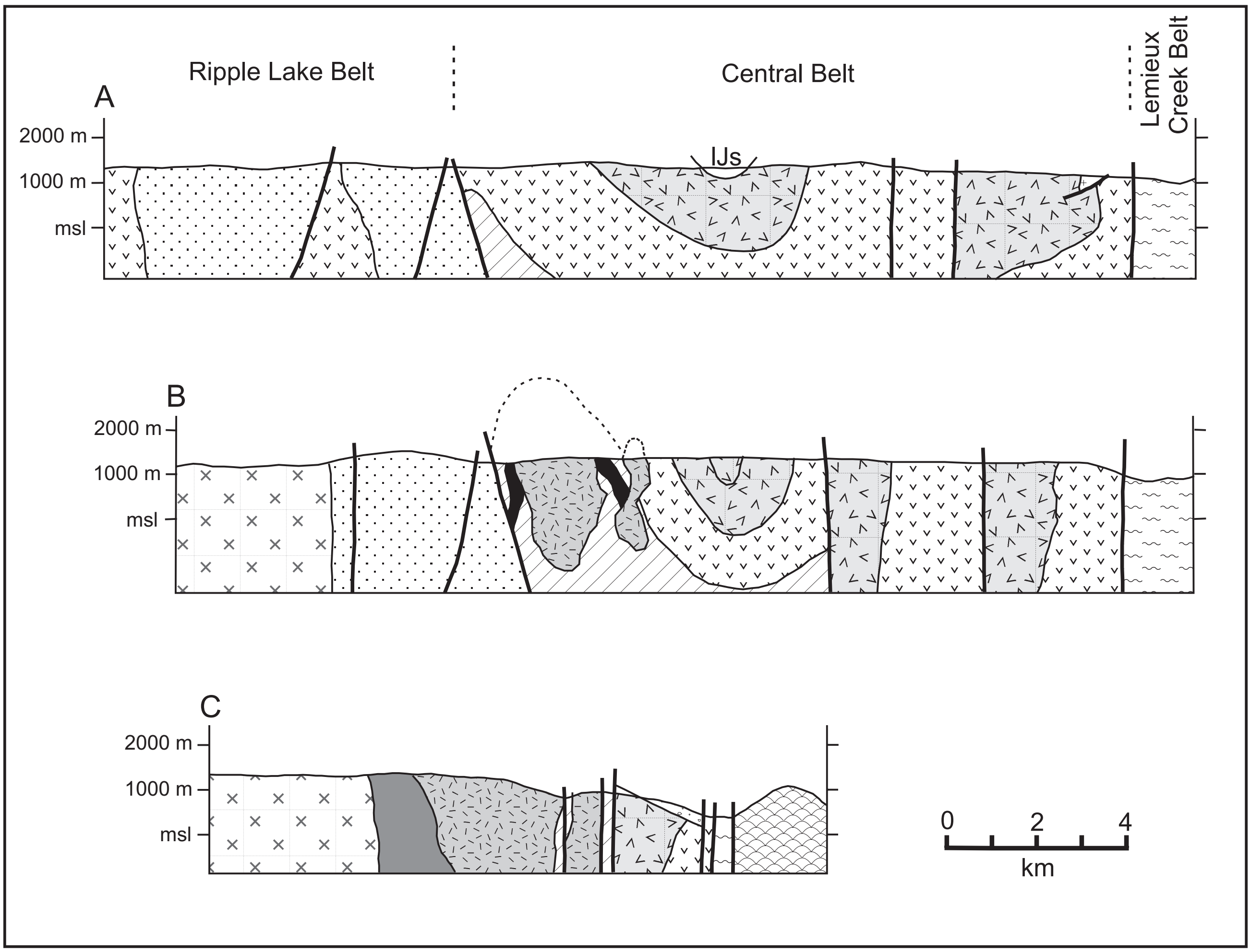



Figure 3. Schematic cross sections across the Nehalliston Plateau. *See* Figure 2a for location of sections and Figure 2b for legend.

clude laminated siltstone, thin-bedded siltstone and argillite, skarn, siliceous hornfels and thinly-interbedded chert, argillite and limestone. The belt also includes a few isolated outcrops of greenstone and pyroxene or hornblende±plagioclase phyric mafic rock. These are thought to be dikes or sills related to the numerous dioritic plutons in the area and/or the overlying volcanic rocks of the Nicola Group.

The rocks assigned to the Harper Ranch Group in the Deer Lake area are intruded by gabbro and diorite of the Dum Lake complex and the three related stocks around Deer Lake. The Paleozoic rocks are bounded by inferred faults to the southwest and northwest, but may be in stratigraphic contact beneath volcanic rocks of the Upper Triassic Nicola Group (Unit uTrNv) to the northeast. However, this contact was not observed and in most places is projected between outcrops of volcanic versus sedimentary rock hundreds of metres apart. Furthermore, the contact projects through areas that are in large part occupied by two dioritic stocks. Therefore, the relationship between the Harper Ranch and Nicola groups is largely unconstrained. The belt of inferred Paleozoic rocks that extends southeastward from Highway 24 provides no additional information, as these rocks are intruded by undated rocks of the Dum Lake complex to the southwest, and bounded by the Rock Island Lake fault to the northeast.

## Nicola Group

The term Nicola Series was first used by Dawson (1879) in reference to Triassic volcanic rocks and associated limestone that he described from the south side of Nicola Lake. Later, he expanded his use of the term to encompass a more extensive area of mainly Upper Triassic volcanic and sedimentary rocks in the Kamloops map sheet (Dawson, 1896). The term Nicola Group was retained for these rocks by Cockfield (1948, Nicola map area), and was also used for Upper Triassic rocks in the adjacent Princeton (Rice, 1947), Vernon (Jones, 1959) and Ashcroft (Duffell and McTaggart, 1952) map areas. Collectively, these rocks comprise a diverse assemblage of mainly Upper Triassic volcanic, volcaniclastic and sedimentary rocks that crop out over a broad area in south-central British Columbia, where they are commonly associated with coeval and younger plutons.

Campbell and Tipper (1971) traced the Nicola Group from the Nicola map area into the southern Bonaparte Lake map area via continuous exposures along the Deadman River. They also mapped belts of Nicola Group in the central and northern parts of the map area, where they are separated from each other and the Deadman River exposures by extensive tracts of younger rocks. The Nicola rocks along the north margin of the Bonaparte Lake sheet comprise the south end of a continuous belt of correlative Triassic and associated Lower Jurassic volcanic and sedimentary rocks that extends north-northwest for more than 600 kilometres (Wheeler and McFeely, 1991). These rocks have been given a variety of local names, but are assigned to the Nicola Group in many recent reports (*eg*. Panteleyev *et al*., 1996). Middle to Upper Triassic rocks at the north end of the belt are assigned to the Takla Group (Armstrong, 1949; Nelson and Bellefontaine, 1996).

Campbell and Tipper (1971) assigned the Mesozoic volcanic and sedimentary rocks in the Nehalliston Plateau area to 4 separate map units. Only one of these, their Unit 11, was included in the Nicola Group, and mapped as a belt of volcanic and sedimentary rocks that extended northwestward from the north margin of the Thuya Batholith. Structurally interleaved with their Unit 11 were two map units assigned Lower to Middle Jurassic ages; one of predominantly sedimentary rocks (Unit 15) and the other dominated by volcanic rocks (Unit 16). Their inferred Jurassic age was based, in part, on correlation with a sedimentary section near Windy Mountain, just 5 kilometres north of the northwest corner of the present map area, which yielded fossils of probable Lower Jurassic age. Campbell and Tipper's fourth Mesozoic unit comprised Upper Triassic sedimentary rocks that form a belt along Lemieux Creek (their Unit 10; Unit muTrNs of this report). They did not include Unit 10 in the Nicola Group, and mapped an extensive, fault-bounded belt of Jurassic rocks between it and their Nicola Group to the west.

Preto (1970a) followed the stratigraphic framework of Campbell and Tipper (1971; released in preliminary format as Geological Survey of Canada Map 3-1966) with only slight modifications. He demonstrated the existence of Lower Jurassic rocks in the present map area by finding an ammonite of probable Early Jurassic age a short distance west of Lost Horse Lake.

The interpretation of Mesozoic stratigraphy presented here differs substantially from that of Campbell and Tipper (1971). The belt of Triassic sedimentary rocks along Lemieux Creek remains essentially the same as they show it, but is included in the Nicola Group following more recent assignments along strike to the north, where these rocks are regarded either as the stratigraphic base of the group (Panteleyev *et al*., 1996) or an eastern, sedimentary facies of the group (Struik, 1988). Volcanic and less common sedimentary rocks extending from the Lemieux Creek belt westward to, and partly west of, the Rock Island Lake fault were assigned to the Jurassic by Campbell and Tipper. However, we do not recognize a lithologic distinction between these rocks and those directly to the west that Campbell and Tipper assigned to the Nicola Group on the basis of sparse fossil data. Consequently, we include almost all the Mesozoic rocks west of the Lemieux Creek belt in the Upper Triassic Nicola Group. The exception is a small area of argillite and siltstone near Lost Horse Lake where Preto (1970a) discovered a Jurassic ammonite. These rocks are interpreted as a small, partially fault-bounded outlier of Jurassic rocks (Unit lJs) that rest stratigaphically above the Nicola Group. Campbell and Tipper (1971) also mapped a southeast-tapering, fault-bounded belt of Jurassic sedimentary rocks in the area encompassing Ripple Lake in the northwest part of the present map area. Our mapping shows these rocks to be part of an extensive belt of mainly sedimentary rocks that is faulted against a predominantly volcanic facies of the Nicola Group to the east. The sedimentary belt includes a single Upper Triassic fossil locality, and so is assigned to a predominantly sedimentary facies of the Nicola Group.

In the descriptions that follow, the Nicola Group is discussed in terms of three fault-bounded belts of contrasting lithology and stratigraphy, all of which contain Upper Triassic rocks and therefore may be at least partially coeval. Easternmost is the Lemieux Creek belt, consisting entirely of sedimentary rocks. To the west are the predominantly volcanic facies of the central belt which, in its western part also includes abundant plutonic rocks. This belt may represent the axis of the Nicola magmatic arc at this latitude. The western, Ripple Lake belt consists dominantly of sedimentary rocks, but also includes volcanic rocks that are similar to some of those in the central belt. These belts are similar in some respects to the facies belts of the Nicola Group defined by Preto (1979) in the Merritt - Princeton area, and adopted by Monger and McMillan (1989) throughout the Ashcroft map area, directly south of the Bonaparte Lake area.

### *LEMIEUX CREEK BELT (Unit muTrNs)*

Metasedimentary rocks assigned to Unit muTrNs occur within a single, fault-bounded belt that forms the eastern edge of the Quesnel Terrane north of Little Fort. Within the present map area these rocks are well exposed only along parts of Lemieux Creek. They consist mainly of medium to dark grey slates and slaty siltstones that commonly contain thin beds and lenses of siliceous argillite and quartzose siltite. Locally, in exposures a few kilometres southeast of Taweel Lake, the slaty rocks enclose thin lenticular beds of fine-grained quartzose metasandstone that contain flakes of muscovite and biotite that may be of detrital origin. Limestone is common within exposures of Unit muTrNs for about 10 kilometres north of Highway 24. Dark grey bioclastic limestone forms fractured and brecciated exposures along the Lemieux Creek fault, but also occurs as well-defined thin to medium beds intercalated with slate in exposures to the west of the fault.

Collections of poorly-preserved macrofossils from limestone exposures within Unit muTrNs north of Highway 24, including bivalve, ammonoid and belemnoid fragments, suggest a Late Triassic age (Campbell and Tipper, 1971). Conodonts recovered from limestone within this same belt of rocks, about 50 kilometres northwest of Taweel Lake, also indicate a Late Triassic, probably Carnian age (Okulitch and Cameron, 1976). Still farther to the north, conodonts of both Middle and Late Triassic ages have been recovered from rocks that are probably correlative (Panteleyev *et al.*, 1996). Several collections of limestone made during the 2000 field season are currently being processed for conodont extraction.

Within the Nehalliston Plateau map area, Unit muTrNs is bounded to both the west and east by steeply-dipping faults that are interpreted as components of an Eocene dextral strike-slip system. Farther north, correlative rocks along the eastern edge of the Quesnel Terrane are imbricated, across west-dipping thrust faults, between volcanic rocks of the Nicola Group to the west and the Slide Mountain and Kootenay terranes to the east (Rees, 1987; Struik, 1988). These east-vergent, Lower Jurassic thrust faults are overprinted by Middle Jurassic west-vergent folds and thrust faults (Rees, 1987), possibly including the pre-batholith east-dipping fault defining the east side of the unit north of the Raft batholith (Campbell Tipper, 1971). Okulitch and Cameron (1976) considered the Triassic rocks of this belt to be an eastern, predominantly sedimentary facies of the Nicola Group. This is also the view of Struik (1988), who suggested that this eastern sedimentary facies was separated from the predominantly volcanic facies to the west by a west-dipping thrust fault of regional extent. However, Panteleyev *et al*. (1996) consider these rocks to be the base of the Nicola Group. They recognize the thrust-imbrication in the eastern part of the Quesnel Terrane, but map sedimentary rocks, correlated to the Middle and Upper Triassic sedimentary facies that dominates eastern exposures, stratigraphically beneath volcanic rocks across the full extent of the western volcanic belt.

Preliminary results from the Nehalliston Plateau suggest that stratigraphic and facies relationships among volcanic and sedimentary rocks of the Nicola Group are complex. Unit muTrNs is apparently absent or very thin (and included within the predominantly Paleozoic rocks of Unit PHRs) within the central volcanic belt because pillowed basalt at the base of the Nicola volcanic package crops out only 250 metres away from fossiliferous Permian limestone of the Harper Ranch Group. Sedimentary rocks are prominent in the Ripple Lake belt to the west, but these are stratigraphically above volcanic rocks of uncertain thickness or extent. Relationships within and among the various facies belts will be an ongoing focus of the Bonaparte project.

### *CENTRAL BELT*

On the scale of Figure 2, the central volcanic belt of the Nicola Group can be subdivided into two units: One (Unit uTrNv) consists entirely of mafic volcanic breccias, flows and tuffs, while the other (Unit uTrNsv) comprises similar volcanic and volcaniclastic rocks intercalated with fine to coarse-grained sedimentary rocks. The transition from the entirely volcanic unit to the mixed volcanic-sedimentary unit occurs within each of two west-facing fault panels to the east of the Rock Island Lake fault, and on both limbs of the Nehallison syncline west of the fault. Facing directions from sedimentary structures in each of the two eastern fault panels, and on the western limb of the Nehalliston syncline, show that the mixed volcanic-sedimentary unit stratigraphically overlies the volcanic unit. This is consistent with the map-scale distribution of older and younger units, as the volcanic unit is in contact with Permian rocks on the west limb of the Nehalliston syncline, and Lower Jurassic rocks apparently overlie the mixed unit in the core of the syncline (Figure 3).

### Volcanic Unit (uTrNv)

Unit uTrNv consists mainly of mafic volcanic breccias containing clasts of pyroxene-phyric basalt. Also present are massive and pillowed basaltic flows and well-bedded mafic tuffs and volcanic sandstones. Most of the rock types typical of Unit uTrNv are found in a series of good exposures on and around Pooytl Mountain in the northwestern part of the map area (*PM* on Figure 2). It is also well exposed in the northern and central parts of the belt that extends south-southeast from Tintlhohtan Lake, and on ridges north of Lost Horse Lake.

The breccias which dominate the volcanic unit commonly form resistant, blocky, green-brown to rusty-brown weathered outcrops. Fresh surfaces are various shades of medium to dark green. In virtually all exposures the fragments are dominantly or exclusively pyroxene-phyric basalt, although there is commonly considerable textural variation among clasts based on size and abundance of phenocrysts. Feldspar-pyroxene-phyric fragments are also common, and other rock types, including feldspar-phyric andesite or dacite, aphyric greenstone, microdiorite, and hornblende pyroxenite were observed locally. In exposures east of the Rock Island Lake fault, fragments commonly contain amygdules of analcite, calcite, or zeolite minerals.

Pyroxene porphyry fragments within the breccias are typically angular to subangular and unsorted to poorly sorted. The fragments are commonly up to 10 centimetres in size, locally range up to several tens of centimetres, and in places were observed to be more than a metre across. The matrix typically consists of pyroxene plus or minus feldspar crystals and small, commonly pyroxene-bearing lithic grains. In many exposures it is virtually indistinguishable from the fragments, such that the breccia texture is not readily apparent. Stratification, or contacts between different breccia units are generally not evident.

Finer grained, well-bedded tuffs and/or epiclastic rocks are a relatively minor component of the volcanic unit but were observed in all belts where the unit is well exposed. They are most common in the upper part of the unit, and locally form a transition into the overlying mixed sedimentary-volcanic unit. They typically comprise thin to medium beds of volcanic sandstone and siltstone, locally intercalated with thick to very thick beds of volcanic breccia similar to that which characterizes most of the volcanic unit. The volcanic sandstone beds are commonly graded, and scours and load casts may be apparent along their bases. They contain whole and broken crystals of pyroxene and feldspar as well as mafic lithic grains.

Massive basaltic to andesitic flows are locally interspersed with the dominant breccias of the volcanic unit. On Pooytl Mountain one such flow unit consists of 3 to 5 percent pyroxene phenocrysts, 1 to 3 millimetres in size, together with rare calcite amygdules, within a pale to medium green, somewhat chloritized groundmass. Elsewhere, apparently massive pyroxene±feldspar-phyric flows or sills contain a higher proportion of larger phenocrysts, similar to most clasts within the associated breccias. Pillowed flows are common within the belt that passes northeast of Deer Lake, on the southwest limb of the Nehalliston syncline, and were also observed at one locality on the offset northwest extension of this belt, near Pooytl Mountain. The pillows and associated pillow breccias occur within pyroxene±feldspar-phyric basalt. Commonly the pillowed basalts are highly vesicular, and contain abundant calcite as vesicle fillings and pods within inter-pillow spaces.

The volcanic rocks of Unit uTrNv are not directly dated. The belt that passes northeast of Deer Lake apparently lies above sedimentary rocks of units PHRs and PHRl, and pillowed basalt included in the volcanic unit crops out just 250 metres northeast of fossiliferous Permian limestone. East of Pooytl Mountain, this same belt of volcanic rocks is overlain by fossiliferous limestone, near the base of Unit uTrNsv, that has yielded Upper Triassic fossils (Figure 2). Because volcanic rocks similar to those of the volcanic unit continue, stratigraphically upward, to be an important component of Unit uTrNsv, the volcanic unit is allied more closely with the overlying Triassic section and presumed to also be Triassic.

### Mixed Volcanic-Sedimentary Unit (uTrNsv)

Unit uTrNsv includes volcanic rocks, mostly similar to those of underlying Unit uTrNv, intercalated with sedimentary rocks that include siltstone, slate, sandstone, conglomerate and minor amounts of chert and limestone. The contact is drawn at the first significant occurrences of sedimentary rocks within the succession. However, the proportions of volcanic versus sedimentary rocks within the unit vary widely from place to place, and many thick sections are dominated by volcanic rocks that are indistinguishable from those of the underlying unit. Unit uTrNsv is well represented by a series of exposures along Highway 24, east of the Rock Island Lake fault.

The most widespread sedimentary rocks within Unit uTrNsv comprise rusty-weathered, thin-bedded intervals of light to medium grey siltstone intercalated with dark grey slate or weakly cleaved argillite. Bedding varies from planar to slighly wavy, and beds are commonly lenticular on the scale of an outcrop. Somewhat thicker, thin to medium beds of grey-green volcanogenic sandstone also occur, and some of these provide facing directions from graded bedding and scoured bases.

The intercalation of fine-grained, thin-bedded sediments, such as those described above, with volcanic sandstones, conglomerates and breccias, is well displayed in roadside exposures just west of the prominent north to west bend in Highway 24, one kilometre east of where it crosses the Rock Island Lake fault. There, grey-green volcanic sandstone or crystal-lithic tuff forms distinct graded beds, between 10 and 100 centimetres thick, intercalated with thin-bedded intervals of black argillite and grey siltstone. The volcanic sandstone units contain pyroxene and feldspar crystals, as well as lithic grains that commonly contain these minerals as phenocrysts. The fine-grained sedimentary intervals between these beds are commonly 10 to 20 centimetres thick, but some are thicker and some are represented only by rip-up clasts incorporated into the bases of amalgamated volcanic sandstone beds. Also present are beds, commonly several metres thick, of poorly sorted breccia containing pyroxene±feldspar-phyric volcanic clasts, and local fragments of argillite/siltstone.

Boulder to pebble conglomerate occurs at several places within Unit uTrNsv, most notably as a locally thick lens along the base of the unit in the panel east of the Rock Island Lake fault, where it is separated out as a mappable unit on Figure 2. The conglomerates are poorly sorted, matrix to clast supported and not conspicuously stratified. Clasts are angular to subrounded, rarely rounded, and occur within a silty to gritty matrix that generally reflects the composition of the clasts. The clast population is typically dominated by pyroxene±feldspar-phyric volcanic rocks. Siltstone, laminated siltstone and argillite clasts are almost invariably present, and clasts of chert (and/or siliceous volcanic rock), aphyric greenstone, arkosic sandstone and limestone were noted in some conglomerate units. This suite of clast types essentially mimics the lithologies found within units uTrNsv and uTrNv, and the conglomerates are inferred to reflect fairly local reworking of these associated rocks.

Thin-bedded to laminated chert was observed within Unit uTrNsv at a few localities west of the Rock Island Lake fault. It is interbedded with siltstone at one locality, in stratigraphic contact with a pyroxene porphyry breccia unit at another, and in contact with mafic rocks that might be sills or flows at other locations. Limestone was observed at only three localities within Unit uTrNsv. It occurs as a narrow bed within black argillite along Highway 24 just east of the Rock Island Lake fault, and occurs near the base of the unit on both limbs of the Nehalliston syncline, south-southwest and north-northeast of Friendly Lake, respectively. The dark grey limestone exposures on the southwest limb of the syncline are interbedded with feldspar-rich volcaniclastic sandstone to small-pebble conglomerate. Macrofossils collected from this area previously were assigned a Late Triassic, probably Late Carnian age (Campbell and Tipper, 1971; fossil locality shown on Figure 2). This is the only age constraint currently available for Unit uTrNsv. However, samples of limestone and chert collected during the 2000 field season are being processed for microfossils.

Volcanic rocks within Unit uTrNsv are mainly pyroxene porphyry breccias and pyroxene±feldspar-phyric basalts or andesites, identical to the dominant volcanic rocks of underlying Unit uTrNv. Pillowed flows are not as common as within the underlying unit, although possible pillow forms were observed at 2 localities, both apparently near the base of the unit. The relatively good exposures provided by Highway 24 roadcuts indicate, in part from local cross-cutting relationships, that some of the massive pyroxene and pyroxene-feldspar-phyric units within the succession are sills and dikes rather than flows. The contacts between sills and enclosing sedimentary rocks commonly occur across complex zones of intermingling that include irregular lobes of mafic rock penetrating the sediments and wispy lenses of argillite within the mafic rock. Locally the contact zones include breccias in which fragments of both pyroxene porphyry and argillite/siltstone occur within either an igneous or fine-grained sedimentary matrix. These may be peperite breccias, suggesting that the sills intruded unconsolidated wet sediments, as would be expected if they are broadly contemporaneous with the lithologically similar flows and fragmental units that are intercalated with the sedimentary rocks.

Felsic volcanic rocks were observed at one locality within Unit uTrNsv, on the southwest limb of the Nehalliston syncline a short distance east of the fossiliferous limestone exposure. Neither the upper nor the lower contact is exposed. The lower part of the interval is a fragmental rock, comprising 95 percent felsic volcanic clasts and 5 percent dark grey argillite fragments in a foliated sericite-chlorite martix. This passes northeastward (presumably up-section) into a massive to weakly foliated aphanitic siliceous volcanic rock. Vague feldspar phenocrysts occur within felsic clasts in the fragmental interval, as well as in the overlying massive volcanic. A single quartz phenocryst was seen in one clast within the fragmental interval.

## *RIPPLE LAKE BELT*

### Volcanic Rocks (Unit uTrNv)

Volcanic rocks occur in two areas of limited extent within the Ripple Lake belt. One narrow lens is bounded by the Long Lake fault to the southwest, and is stratigraphically overlain by the predominant sedimentary rocks of the belt to the northeast. The other area is north of Lac des Roches along the western boundary of the map area. It is suspected that these rocks correlate with the lens to the north, and likewise occur stratigraphically beneath the sedimentary rocks that contact them to the north. However, this is not proven as neither the contact nor the stratigraphic facing direction was observed in this area.

The volcanic rocks of the Ripple Lake belt consist mainly of pyroxene porphyry breccias and pyroxene-feldspar-crystal-lithic tuffs that are very similar to rocks found in Unit uTrNv to the east. They are therefore included in Unit uTrNv on Figure 2, although this correlation is only meant in the very general sense that they are a similar volcanic facies within the Upper Triassic Nicola Group. More mapping to the northwest is required to determine if they are part of a major mappable unit that underlies the sedimentary rocks of the Ripple Lake belt, or constitute a volcanic lens within a predominantly sedimentary succession.

### Sedimentary Rocks (Unit uTrNs)

The predominantly sedimentary succession of the Ripple Lake belt is assigned to Unit uTrNs on Figure 2. It includes siltstone, slate, argillite, chert, limestone, sandstone and conglomerate. Pyroxene-phyric basaltic rocks occur rarely, but it is not clear if these are intercalated volcanic rocks or sills.

An important reference section for Unit uTrNs occurs between the Long Lake and Monticola Lake faults. This section includes the base of the unit, above volcanic rocks of Unit uTrNv, contains several determinations of stratigraphic facing direction, which consistently indicate that the rocks face to the northeast, away from the volcanic rocks, and the uppermost part of the exposed succession contains the only fossil date presently available for the unit. This fossil locality, on a low ridge west of Pooytl Mountain (Figure 2), comprises Halobiid fragments that were assigned a probable Upper Triassic age (Campbell and Tipper, 1971). The sedimentary succession is truncated by the Monticola Lake fault a short distance to the northeast of the fossil locality, so its stratigraphic top is not defined.

The base of the unit is exposed on an old logging road about 1 kilometre southeast of Long Lake, where pyroxene porphyry breccia and overlying crystal-lithic tuff of the volcanic unit are overlain by dark green, light grey-green weathered, fine to medium-grained volcanic sandstone that is assigned to Unit uTrNs. The sandstone is laminated and locally cross-laminated and includes rare thin interbeds of siltstone. Bedding is near vertical in this area and the northeast facing direction is determined from cross-beds in the sandstone. Similar sandstone forms the dominant rock type over a fairly well exposed interval that extends for about 300 metres to the northeast. Dark green to grey, light grey-weathered, laminated to thin-bedded chert is intercalated with the sandstone over most of this interval and becomes dominant in the upper part. In some exposures the volcaniclastic sandstone forms channels that cut into the chert.

Exposures to the northeast of the volcaniclastic sandstone/chert unit at the base of Unit uTrNs comprise a fairly uniform succession of thin-bedded siltstones intercalated with dark grey argillites and weakly cleaved slates. These lithologies dominate all the way to the Monticola Lake fault. Thin, lenticular beds of fine to medium-grained sandstone, some of which are graded, occur locally. Dark grey micritic limestone and limy argillite are also present, mainly near the northwest corner of the map area and to the north of Long Island Lake. The limestone occurs as thin to thick beds intercalated with siltstone, argillite and, locally (north of Long Island Lake), thin-bedded chert.

Exposures of Unit uTrNs southwest of the Long Lake fault consist largely of fine to medium-grained volcaniclastic sandstone intercalated with thin-bedded chert, argillite and siltstone; lithologies that are very similar to those that define the unit north of the fault. Also present to the south are substantial intervals of pebble to cobble conglomerate containing clasts of mainly sedimentary rock types. The conglomerates are predominantly clast supported, moderately to poorly sorted, and poorly stratified. The subangular to rounded clasts are dominated by laminated siltstone, cherty argillite and argillite, but also include chert, limestone, pyroxene and/or feldspar-phyric volcanic rocks and, locally, hornblende-plagioclase-phyric microdiorite. The matrix commonly varies from a siltstone to a gritty sandstone, and in some conglomerate units is distinctly calcareous.

Conglomerate is also found within Unit uTrNs in the wedge-shaped belt between the Gammarus Lake and Blowdown Lake faults (Figure 2). There, pebble conglomerate occurs locally as layers and lenses up to several metres thick within a succession of mainly thin-bedded cherty argillites and siltstones, that also includes thin to thick beds of green volcanic sandstone. The angular to subrounded pebbles are mainly argillite, chert and siltstone, but also include feldspathic and pyroxene-feldspar-phyric volcanic rocks. The pebbles in most conglomerate units are supported by a silty to siliceous argillite matrix, but conglomerates with tightly packed pebbles and little matrix also occur. Also present are rare limestone-matrix conglomerate units that, in addition to the previously mentioned clast types, also contain limestone and sandstone clasts.

The presence of probable Halobia fossil fragments within Unit uTrNs west of Pooytl Mountain was confirmed during the 2000 field season. Unit uTrNs is thought to be entirely Upper Triassic because this probable Upper Triassic fossil locality is near the top of the section exposed between the Long Lake and Monticola Lake faults, and the basal part of the section overlies volcanic rocks typical of the Upper Triassic Nicola Group. Samples of chert and limestone collected during the 2000 field season are currently being processed for microfossils in order to test this assumption.

## Triassic-Jurassic Plutonic Rocks

Calc-alkaline and alkaline plutons of Late Triassic to Early Jurassic age are a prominent feature of the Quesnel Terrane and can host important porphyry Cu (±Au) and skarn deposits. The predominantly granodioritic Thuya batholith, part of which underlies much of the southern half of the map area, has long been recognized as one of these plutons, as has the Takomkane batholith to the north-northwest (Figure 1; Campbell and Tipper, 1971). During the present study, a prominent belt of more mafic plutonic rocks, only partially shown on previous maps, was mapped northwestward from the northeast margin of the Thuya batholith. This belt includes, from southeast to northwest, the Dum Lake ultramafic-mafic intrusive complex, several diorite stocks near Deer Lake, and the Friendly Lake diorite-syenite intrusive complex at the northwest boundary of the map area (Figure 2). These rocks intrude the west side of the central, predominantly volcanic belt of the Nicola Group, as well as underlying Paleozoic rocks of the Harper Ranch Group. It is suspected that they are older than the Thuya batholith and approximately coeval with the associated Nicola Group volcanic rocks. Whiteaker (1996) has documented a similar situation at the Ann porphyry copper property on the east margin of the Takomkane batholith. There, Nicola volcanic rocks, including an andesite that has yielded a U-Pb zircon date of 203.9±4.2 Ma are intruded by a suite of mainly dioritic to monzonitic intrusions, one of which gives a U-Pb titanite age of 203±4 Ma. Granodiorite of the adjacent Takomkane batholith gives a younger, tightly constrained U-Pb zircon date of 193±0.6 Ma.

## *DUM LAKE INTRUSIVE COMPLEX*

The Dum Lake complex comprises ultramafic and mafic plutonic rocks that may be part of an Alaskan-type intrusive body, partially truncated by the Thuya batholith on its southwest side. On the scale of Figure 2 it is subdivided into an ultramafic and a mafic unit. The ultramafic rocks were in part mapped by Campbell and Tipper (1971) as a small lens of serpentinite and serpentinized peridotite along the margin of the Thuya batholith. Some of the associated coarse-grained mafic plutonic rocks were included in the Thuya batholith by Campbell and Tipper, but much of the northeastern part of the complex underlies an area previously mapped as Nicola Group. Campbell and Tipper also mapped a small area of serpentinized peridotite along Highway 5, five and a half kilometres south of Little Fort. These may represent a sliver of the ultramafic portion of the Dum Lake complex, offset along the dextral Thuya Road fault.

The ultramafic portion of the Dum Lake complex includes an assemblage of variably serpentinized, locally carbonate and talc-altered rocks that, from outcrop and hand specimen-scale observations, apparently consists largely of clinopyroxenite, wehrlite and dunite. The proportions and internal distribution of the different rock types are not well known, although clinopyroxenite to clinopyroxene-rich wehrlite seem to dominate along the northeastern margin of the unit. Locally, dikes and veins of clinopyroxenite cut wehrlitic rocks. Elsewhere clinopyroxenite and wehrlite seem to form parallel layers up to several metres thick, but it was not determined if these represent magmatic layering or dikes of one rock type within the other.

The mafic part of the Dum Lake complex is dominated by coarse to medium-grained gabbro and diorite, but locally includes clinopyroxenite, monzogabbro, monzodiorite, microdiorite, and tonalite. The contact between the mafic rocks and the ultramafic unit was observed at one place, 1.5 kilometres southeast of Dum Lake. Clinopyroxenite containing 5 percent disseminated pyrite is in contact with monzogabbro across a sharp, steeply-dippping, northwest-striking contact. An intimate relationship between the two rock types is suggested by relationships within the clinopyroxenite, where identical monzogabbro occurs as isolated patches, up to 10 centimetres in size, that display diffuse contacts with the enclosing clinopyroxenite. Similar patches, of either gabbro or monzogabbro, occur within clinopyroxenite elsewhere along the northeast margin of the ultramafic unit, and clinopyroxenite grading to gabbro was observed at several localities within the mafic part of the complex.

Relationships within the mafic part of the Dum Lake body are very complex, and any given outcrop commonly contains a variety of dioritic to gabbroic phases that show varying degrees of epidote-chlorite alteration and veining, and contact one another across a variety of sharp, diffuse or sheared contacts. Near Dum Lake much of the northeast margin of the complex is an intrusion breccia comprising angular fragments of gabbro, diorite and microdiorite within a matrix (locally more of a mesh-like vein network) of fine to medium-grained leucocratic diorite consisting of plagioclase and two to five percent chloritized hornblende. Associated with these rocks are units of mafic microdiorite that grade into strongly foliated chlorite-hornblende schist. In places, lenses of non-foliated microdiorite are aligned within this foliation, and locally folded around it, whereas other veins and dikelets of leucocratic diorite to tonalite cut the foliation at a high angle. Locally, schistose rocks, similar to the foliated microdiorite, occur as fragments within intrusion breccia that are clearly crosscut by the leucodiorite matrix. Although they are not well understood, these relationships indicate that locally significant ductile strain attended intrusion of the Dum Lake complex.

## *FRIENDLY LAKE INTRUSIVE COMPLEX*

The Friendly Lake intrusive complex comprises two distinct stocks of monzonite, syenite and granite, together with a broad area between and south of these stocks that consists largely of microdiorite, diorite, gabbro, and related intrusion breccias (Figure 2). The monzonitic stocks were mapped by previous workers (Campbell and Tipper, 1971; Preto, 1970a), but the associated dioritic rocks were included in the Nicola Group on previous maps. This may be because they consist mainly of fine-grained microdiorite that is not readily distinguished from an andesitic volcanic rock in isolated exposures. However, the intrusive nature of most of the complex is apparent in several recent logging cuts around Friendly Lake. Exposure is not as good to the north, but scattered outcrops suggest that the same suite of rocks extends to the northern limit of our mapping, in large part encompassing the monzonitic stocks.

Exposures south, west and northwest of Friendly Lake are dominated by medium green, grey-brown to rusty-brown weathered microdiorite. In fine-grained varieties, which are commonly somewhat chloritized, mineral grains and textures may not be apparent, but in many exposures these fine-grained rocks were observed to grade into fine to medium-grained microdiorites and diorites, consisting of randomly oriented, interlocking grains of hornblende±pyroxene and plagioclase. The most definitive evidence of an intrusive origin for these fine-grained green rocks comes from several good exposures south of Friendly Lake, where they comprise distinct dikes, some with chilled margins, that cut through medium-grained diorite and microdiorite-hosted intrusion breccia. Dikes of feldspar porphyry and hornblende-feldspar porphyry were also seen cutting diorite.

Other rock types observed around Friendly Lake include medium to coarse-grained pyroxene gabbro, dark grey pyroxene-feldspar porphyry and intrusion breccia. The pyroxene-feldspar porphyry units typically form tabular bodies, up to a few metres wide, within dioritic rocks. They are suspected to be dikes, although this was not proven. Intrusion breccia was observed in several outcrops south of the west end of Friendly Lake. It comprises tightly packed fragments of diorite, monzodiorite, microdiorite and pyroxene-feldspar porphyry in a sparse matrix of fine-gained microdiorite.

Exposures north of Friendly Lake, around, and directly south of, the monzonitic stocks, include diorite, microdiorite and intrusion breccia that are similar to rocks found in the better-exposed area south of Friendly Lake. Some exposures in this area, however comprise fine-grained greenstone, chloritic schist and skarn-altered rock of uncertain protolith. Furthermore, some intrusion breccias, particularly those near the margins of the largest monzonitic stock, include fragments of siltstone and chert, together with dioritic rocks. It is suspected, therefore, that screens of country rock may form a significant portion of this part of the complex.

The discrete stocks in the northern part of the Friendly Lake complex form resistant pinkish outcrops of medium-grained, leucocratic, porphyritic quartz monzonite to monzonite, locally grading to granite, quartz syenite and syenite. Their contacts are sharp, but dikes and veins of similar composition occur locally in adjacent rocks. Commonly, diorite and greenstone along the margins of the stocks are cut by coarse-grained monomineralic amphibole veins, or by veins with amphibole rims and orthoclase-rich cores. Skarny greenstone along the western margin of the smallest stock is, in part, strongly foliated. Veins of non-foliated monzonite typically cut across the foliation, but some are foliation-parallel and slightly boudinaged. These relationships are somewhat similar to those along the eastern margin of the Dum Lake complex, where the youngest intrusive phases, leucodiorite and tonalite, largely, but not entirely, postdate ductile deformation within associated microdiorite.

## *OTHER DIORITE PLUTONS*

Diorite, locally accompanied by gabbro, microdiorite and intrusion breccia, forms 3 stocks in the Deer Lake area which intrude mainly Paleozoic rocks of the Harper Ranch Group. These stocks define the central portion of the northwest-trending linear belt of intrusions that includes the Dum Lake complex to the southeast and the Friendly Lake complex to the northwest. The plutons around Deer Lake are less varied lithologically than the Friendly Lake and Dum Lake complexes, and are made up of dioritic to gabbroic rocks that are essentially identical to large parts of the adjacent complexes. All of the plutons within this northwest-trending belt are assumed to reflect a common tectonic environment, probably in the roots of the Late Triassic Nicola magmatic arc.

Dioritic rocks also form a number of plugs and small stocks that intrude Nicola Group rocks in the southern part of the Ripple Lake belt, and may represent a more diffuse expression of the magmatism within the central belt to the east. These small intrusions consist mainly of medium-grained, mostly equigranular hornblende diorite, but also include hornblende-plagioclase porphyritic diorite, microdiorite and coarse-grained pyroxene gabbro. The narrow body along the margin of the Thuya batholith, north of Lac des Roches, consists of variably, but locally strongly foliated microdiorite and hornblende-biotite-feldspar schist, that locally contains screens of hornfelsed metasedimentary rock aligned in the foliation. Foliated microdiorite and mafic schist also occur locally along the southeastern margin of the larger, elongate diorite body to the west. On Highway 24, an outcrop on the southeastern margin of this diorite body comprises strongly foliated microdiorite interspersed with skarn lenses. Also present are lenses of fine to medium-grained monzonite that mostly cut across the foliation, but locally seem to be rotated into the folitation. These relationships are not unlike those observed in parts of the Dum Lake and Friendly Lake complexes, where ductile strain localized in some intrusive units largely predates younger intrusive phases.

## *THUYA BATHOLITH*

Granodiorite and related rocks of the Thuya Batholith underlie much of the southern half of the map area. These exposures represent only a relatively small part of the batholith, which extends for a considerable distance to the south and west (Campbell and Tipper, 1971; Figure 1). Along its northwestern margin, the batholith clearly intrudes sedimentary rocks included in Unit uTrNs of the Nicola Group. Along its northeast margin it apparently intrudes ultramafic and mafic rocks of the Dum Lake intrusive complex, but the contact is not well exposed and unequivocal crosscutting relationships were not observed. South of Little Fort the eastern margin of the batholith is defined by the dextral Thuya Road fault. The batholith is also cut by faults in the southwestern part of the map area, where Eocene volcanic rocks of the Skull Hill Formation occur as a down-faulted block within it (Figures 1 and 2).

Within the present map area the Thuya Batholith consists mainly of medium-grained, more or less equigranular and isotropic, hornblende-biotite granodiorite. Mafic phases commonly comprise 10 to 20 percent of the rock, although the ratio of hornblende to biotite seems to vary considerably. Epidote (± chlorite) alteration is ubiquitous, but variable in intensity. Minor, apparently gradational compositional variations to quartz monzodiorite, tonalite and quartz diorite occur locally. However, the northern part of the batholith, particularly that portion northwest of highway 24 between Lac des Roches and Long Island Lake, is more heterogeneous. It consists largely of hornblende-biotite quartz monzonite and quartz monzodiorite, but also includes monzodiorite, diorite and monzonite. Locally within this area, hornblende diorite and hornblende±biotite monzodiorite occur as alternating layers several centimetres thick with diffuse but approximately planar contacts.

Jung (1986) reports K-Ar and Rb-Sr radiometric dates for a sample of hornblende-biotite monzodiorite collected near Highway 24 a short distance east of Lac des Roches (location shown on Figure 2), while Calderwood *et al*. (1990) report a preliminary U-Pb zircon date from the same locality. The K-Ar dates from hornblende and biotite separates are 191±7 Ma and 186±6 Ma, respectively, similar to previous K-Ar dates on unaltered samples from the batholith to the south and west (summarized by Jung, 1986). The Rb-Sr whole rock - mineral isochron date is 183.6±4.4 Ma, with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7042, while the U-Pb zircon upper intercept is 205±9.3 Ma. The relatively large error permits a Late Triassic or Early Jurassic crystallization age for this part of the batholith. A sample of relatively unaltered granodiorite from near Thuya Creek, in the southeastern part of the map area, has been submitted for U-Pb dating in an attempt to further constrain the batholith's age.

## Lower Jurassic Sedimentary Rocks

Preto (1970a) collected poorly preserved ammonites of probable Late Sinemurian or Early Pleinsbachian age from argillite in an exploration trench west of Lost Horse Lake. The area was revisited during the present study and an ammonite fragment was collected from the workings excavated from the trench. The fossiliferous rocks occur within a poorly exposed interval of unaltered argillites and siltstones, mapped as Unit lJs on Figure 2, that seeems to be of very limited extent. It is inferred to comprise a small outlier resting stratigraphically above Unit uTrNsv in the core of the Nehalliston syncline, and truncated to the south by the northeast-striking fault that passes through Lost Horse Lake.

The exploration trench that originally yielded the Jurassic ammonites of unit lJs was excavated during an exploration program aimed at evaluating widespread alteration and local base metal sulphide mineralization within and adjacent to the Friendly Lake intrusive complex. An interesting aspect of Unit lJs is its unaltered state when compared to adjacent silicified and chlorite-epidote altered rocks of Unit uTrNsv and the Friendly Lake intrusive complex. Furthermore, fossiliferous Lower Jurassic rocks near Windy Mountain, about 13 kilometres to the northwest, include conglomerates that contain syenite clasts that Campbell and Tipper (1971) specifically relate to the syenitic rocks here included in the Friendly Lake intrusive complex. These observations suggest that mineralization and alteration in this area was closely related to intrusion of the Friendly Lake intrusive complex, which must be of latest Triassic or earliest Jurassic age, and that deposition of the Jurassic rocks followed a period of uplift and erosion that partially unroofed the intrusive complex and its associated alteration-mineralization system. The 2001 field program will cover the Windy Mountain area and, it is hoped, allow us to evaluate more fully the relationship of the Lower Jurassic rocks to the Nicola Group and associated intrusions.

## Cretaceous Granite Northeast of Tintlhohtan Lake

A small granitic stock, which hosts the Anticlimax molybdenum-tungsten prospect, occurs within volcanic and sedimentary rocks of the Nicola Group a short distance northeast of Tintlhohtan Lake (Figure 2). The stock consists mainly of medium-grained, leucocratic granite, containing a few percent fresh to chloritized biotite. Associated phases include quartz-feldspar porphyry, pegmatite and aplite (Stevenson, 1940; Preto, 1970b). Soregaroli (1979) obtained a K-Ar date of 102±5 Ma from unaltered magmatic biotite separated from fresh granite within the central part of the stock. Similar mid-Cretaceous K-Ar cooling ages have been obtained from the main body of the Baldy batholith to the southeast (summarized by Jung, 1986), which has also yielded an Early Cretaceous U-Pb (zircon) upper intercept date of 115.9±4.6 Ma (Calderwood, 1990). It is suspected that the Tintlhohtan Lake stock is part of the same suite of late Early Cretaceous plutons.

On its north, west and south sides, the Tintlhohtan Lake stock is in contact with a mixed assemblage of sedimentary and volcanic rocks assigned to Unit uTrNsv. Although the contact was not observed, it is inferred to be intrusive because these country rocks are weakly hornfelsed (Enns, 1980; this study). The stock's eastern contact, with pyroxene porphyry breccias of Unit uTrNv, is mapped as a gently-dipping fault, following Kirkham and Sinclair (1988). Their interpretation was based on diamond drill holes that passed completely through the intrusion, cutting highly sheared and argillically-altered granite before passing into relatively unaltered and unmetamorphosed volcanic breccias. It is consistent with observations made during the present study, as volcanic breccia immediately to the east of the stock is not hornfelsed and is cut by numerous gently-dipping faults.

## Eocene Sedimentary and Volcanic Rocks

Eocene rocks in the Bonaparte Lake map area are included in the Kamloops Group, which is further subdivided into the sedimentary Chu Chua Formation and the mainly volcanic Skull Hill Formation (Uglow, 1922; Campbell and Tipper, 1971). Both formations are represented to a limited extent in the Nehalliston Plateau area.

### *CHU CHUA FORMATION*

The Chu Chua Formation is represented by conglomerates and conglomeratic sandstones that occur mainly in a largely fault-bounded, wedge-shaped belt that extends for about 6 km northwestward from Little Fort. Exposures are found mainly in the canyons of Nehalliston and Eakin creeks. A much smaller outlier of the Chu Chua Formation is exposed along the lower reaches of Thuya Creek (Uglow, 1922) but it was not examined during the present study. The Chu Chua Formation northwest of Little Fort is dominated by poorly sorted conglomerate comprising rounded to angular boulders, cobbles and pebbles that grade into a gritty sandstone matrix. Clasts are dominated by dioritic to granodioritic plutonic rocks, but locally include substantial amounts of vein quartz and greenstone of probable mafic volcanic origin. Bedding is not well defined, but a crude stratification is commonly apparent in the conglomerates, and is locally accentuated by thick interbeds of gritty to pebbly sandstone. Where observed, the bedding dips 15 to 25 degrees east.

The eastern contact of the Chu Chua Formation was observed in Nehalliston Creek, where it is a north-northwest striking, steeply-dipping fault that may splay from the Taweel Lake fault to the east. The southwest contact of the formation was not observed, but apparently corresponds to the Rock Island Lake fault. The northwest contact was not observed either, but the orientation of stratification in the conglomerate suggest that this contact is reasonably interpreted as an east-dipping unconformity across which the Chu Chua Formation rests above southwest-dipping volcanic and sedimentary rocks of the Nicola Group (Figure 3, Section C).

The rocks described above as Chu Chua Formation are not dated. However, they are readily correlated, on the basis of lithology and mode of occurrence, with a fault and unconformity-bounded interval of conglomerates and associated finer-grained rocks exposed along the lower reaches of Joseph Creek, 5 kilometres to the east (Schiarizza and Preto, 1987). There, shale and siltstone intercalated with the conglomerates have yielded collections of plant fossils and palynomorphs indicating an Eocene age (Uglow, 1922; Campbell and Tipper, 1971).

### *SKULL HILL FORMATION*

Volcanic rocks of the Skull Hill Formation crop out along the southwest boundary of the map area, south and southeast of Lac des Roches. A volcanic outlier also included in the formation overlies sedimentary rocks of the Nicola Group and an associated dioritic intrusion 3 kilometres north of Lac des Roches (Figure 2). These rocks are markedly less-altered and deformed than the Mesozoic volcanic rocks within the map area. They are assigned to the Skull Hill Formation following Campbell and Tipper (1971), who mapped them as part of a north-northwest trending belt of Eocene volcanic rocks that extends for almost 70 kilometres between Bonaparte and Canim lakes (Figure 1).

Most exposures of Skull Hill Formation observed south and southeast of Lac des Roches consist of friable, rusty-brown-weathered andesite and associated flow breccia, commonly with sparse hornblende phenocrysts and chloritic amygdules. Also present are more competent grey-brown weathered, pyroxene-phyric basalt or andesite flows, and light grey biotite-feldspar-phyric dacite. Sedimentary intervals up to 10 metres thick are locally intercalated with the andesitic flows. These consist of biotite-rich arkosic sandstone containing discontinuous lenses of granule to pebble conglomerate with granitic and volcanic clasts, and thin shale layers containing abundant plant debris.

The volcanic outlier north of Lac des Roches was observed at only one locality near its southern limit, but its aerial extent is readily mapped from air photos. Where seen, it consists of dark grey, brown-weathered basalt containing about 5 percent olivine and pyroxene phenocrysts, 1 to 3 millimetres in size.

## Dikes

Dikes of diorite, microdiorite and hornblende-feldspar porphyry are common within sedimentary and volcanic rocks of the Nicola and Harper Ranch groups peripheral to the map-scale dioritic intrusive units that cut these groups west of the Rock Island Lake fault. The dioritic rocks, as well as the adjacent country rocks, are in turn cut by dikes and lenses of tonalite and granodiorite along the north and northwest margins of the Thuya batholith. As discussed previously, some units of massive pyroxene porphyry within the central volcanic belt of the Nicola Group are sills and dikes cutting sedimentary and volcanic rocks, although in many exposures they are difficult to distinguish from flows.

The dikes described above are inferred to be Late Triassic - Early Jurassic in age, and related to the Mesozoic magmatic arc of the Quesnel Terrane. Younger dikes include dark green to grey, fine grained basalt and dark grey, biotite-bearing lamprophyre that are most common within the zone of northwest to north-striking faults east of the Rock Island Lake fault. These dikes are oriented more or less parallel to the faults and, like the faults, are suspected to be Eocene in age. Light grey to pink flow-banded dacite to rhyolite that is intermittently exposed for about 3 kilometres along the splay west of the Taweel fault, 2 to 5 kilometres south of the Tintlhohtan Lake cross fault, may also represent one or more dikes emplaced within this fault system. Dacitic sills or dikes were also observed within sedimentary rocks of the Nicola Group in the western part of the area, where they are spatially associated with, and oriented approximately parallel to, the Long Lake fault.

# STRUCTURE

## Mesoscopic Structures

Fine-grained Paleozoic and Triassic sedimentary rocks throughout the area commonly display a weak to moderately developed slaty cleavage, whereas associated volcanic and coarse-grained clastic rocks are not generally foliated. As discussed in previous sections, local zones of strong foliation within, or along the margins of, several dioritic plutons appear to be in local zones of high strain that formed during the late stages of intrusion. Steeply-dipping, moderate to intense foliation is also evident in many rocks along fault zones, particularly along faults in the southern part of the Rock Island Lake system.

Mesoscopic folds were noted rarely, generally in thin-bedded siltstone/slate or chert/argillite intervals. The slaty cleavage is axial planar to most folds which, together with bedding/cleavage intersection lineations, plunge to the northwest or southeast. Rarely, folds with similar plunges fold the slaty cleavage. Because they are pervasive, although variably and commonly weakly developed, across the map area, the cleavage and associated folds are inferred to be manifestations of regional contractional deformation accompanied by low-grade metamorphism. They may have formed in Lower to Middle Jurassic time, when compressional tectonic events are well documented elsewhere in the region. More specifically, south-plunging, east-vergent folds associated with west-dipping slaty cleavage within Unit muTrNs may relate to regional, east-directed thrusting that imbricated this unit and placed it above the Kootenay Terrane (Brown *et al.*, 1986; Rees, 1987; Struik, 1988; Bloodgood, 1990).

In the Deer Lake area, there were no obvious differences in mesoscopic fabric or metamorphic grade noted between the Paleozoic rocks and nearby Triassic rocks. In contrast, rocks assigned to the Harper Ranch Group in the belt between highways 24 and 5 are commonly strongly foliated, and are locally folded by two generations of folds. These rocks, however, form a narrow belt that is sandwiched between the northeast margin of the Dum Lake intrusive complex, where local zones of strong syn-plutonic deformation are documented, and faults of the Rock Island Lake system. It is suspected, therefore, that the relatively intense mesoscopic-scale deformation within this belt is of more local than regional significance.

## Map-Scale Structures

The macroscopic structure of the Nehalliston Plateau is dominated by northwest to north-striking faults. In the eastern part of the area these faults comprise the north to north-northwest trending Rock Island Lake system which cuts rocks as young as Eocene and shows evidence of mainly dextral strike-slip displacement. In the western part of the area, northwest-striking faults also locally cut Eocene rocks and are interpreted as mainly southwest-side-down normal faults. Collectively, these faults, together with associated northeast-striking cross-faults, are part of a system of predominantly Eocene dextral strike-slip and related extensional faults that are well documented throughout much of the Intermontane Belt and adjacent portions of the Canadian Cordillera (Price, 1979; Ewing, 1980; Struik, 1993). The structure within the Nicola volcanic-plutonic belt in the central part of the map area is dominated by a fold system represented mainly by the Nehalliston syncline. The folding apparently affects rocks as young as Lower Jurassic (Figure 3, Section A), but its timing is not well constrained. It might be related to Lower to Middle Jurassic compressional deformation that is well-documented elsewhere in the region (Brown *et al.*, 1986; Rees, 1987; Schiarizza and Preto, 1987; Bloodgood, 1990), but could be as young as Eocene. The southeastern boundary of this fold system, and defining the boundary between central volcanic-plutonic belt and the adjacent Ripple Lake belt, is the northwest-striking Monticola Lake - Gammarus Lake fault system. These faults may have a history dating back to the Late Triassic.

### *ROCK ISLAND LAKE FAULT SYSTEM*

The macroscopic structure in the eastern part of the map area is dominated by a system of north-northwest to north-striking faults that are interpreted as part of a Tertiary (probably Eocene) dextral strike-slip system. They are collectively referred to as the Rock Island Lake fault system, after one of the dominant through-going strands within the fault zone. The fault system is almost 10 kilometres wide in the northeastern part of the map area, but individual faults converge southward to a narrow zone confined to the North Thompson River valley south of Little Fort. In the following paragraphs, individual faults are discussed from east to west across the system.

The north-striking Lemieux Creek fault separates Unit muTrNs from the Fennell Formation north of Little Fort. Outcrops near the inferred trace of the fault are commonly brecciated, carbonate-altered, and cut by variably oriented brittle faults. Although the overall trend of the fault is northerly on the scale of Figure 2, on a more detailed scale parts of the system comprise an anastomozing network of north-northeast to north-northwest trending fault strands. These expressions of brittle faulting are suspected to relate to relatively minor amounts of Tertiary displacement on this strand of the Rock Island Lake fault system. Major Tertiary displacement is precluded by the fact that the fault does not apparently cut the Jura-Cretaceous Raft batholith 15 kilometres to the north (Figure 1). There, the contact between the Fennell Formation and Unit muTrNs is mapped as an east-dipping thrust fault of probable Middle Jurassic age (Campbell and Tipper, 1971; Brown *et al.*, 1986; Calderwood *et al.*, 1990).

The Taweel fault separates Unit muTrNs from volcanic rocks of Unit uTrNv. It trends slightly more westerly than the Lemieux Creek fault, resulting in a widening of the Unit muTrNs outcrop belt northward from Little Fort. The fault zone is exposed along the lower reaches of Nehalliston Creek, where it is marked by close to 100 metres of rusty iron carbonate-quartz-altered rocks cut by a dense network of brittle faults. The faults show a wide variety of orientations, but north to northwest strikes and steep dips are most common. Lenses of black phyllite, siltstone and crystal-lithic tuff occur throughout the zone; some are fault bounded, while others appear to grade into the pervasively quartz-carbonate-altered host across alteration fronts. The eastern limit of the fault zone is not defined in this area. To the west it passes abruptly into well-foliated chlorite schist that locally grades into lenses of massive pyroxene porphyry basalt. About 100 metres of these variably foliated mafic volcanic rocks, part of unit uTrNv, are exposed along the creek. They are bounded to the west by another fault, apparently a splay from the Taweel fault, that juxtaposes them against Eocene conglomerates of the Chu Chua Formation. This fault is marked, from east to west at creek level, by about 5 metres of very friable chlorite schist interleaved with narrow gouge zones, passing into a couple metres of water-saturated clay and then abruptly into unaltered Eocene conglomerate. Individual brittle faults within and adjacent to the fault zone strike slightly west of north and dip steeply. Fault striations and mineral fibres on the fault planes are more or less horizontal and, where movement sense can be inferred from accretion steps, dextral.

The Rock Island Lake fault has been traced from Little Fort to the north boundary of the map area, and is suspected to continue northwestward as the main through-going strand within the system (Figure 1). Its trace is defined mainly by truncations of map-scale features, including the Dum Lake intrusive complex and Chu Chua conglomerate in the south, and the Nehalliston syncline and northeast-striking faults farther north (Figure 2). On highway 24, the inferred trace of the fault is marked by a 200-metre-wide topographic depression that separates intensely faulted and silicified exposures of microdiorite, diorite and skarn-altered sedimentary rocks on the west from chlorite schist and phyllite of Unit uTrNsv to the east (Figure 2). The strong north-northwest striking vertical foliation in the latter rocks is uncharacteristic of most rocks within this unit and is inferred to relate to the faulting. Adjacent outcrops to the east display abundant brittle faults of about the same orientation, and local folds that plunge steeply to the north-northwest. Similar intensely faulted to foliated rocks characterize rocks in proximity to the inferred trace of the fault southeastward to Highway 5, over which distance the fault is fairly well constrained but not actually observed. Brittle faults typically display gently-plunging striations or mineral fibres and dextral movement-sense from accretion steps. There are few bedrock exposures proximal to the fault northwest of Highway 24, where its inferred trace follows a series of linear topographic depressions.

The Thuya road fault is well-defined for about 6 kilometres northwest of Highway 5, where it truncates the Thuya batholith and adjacent ultramafic rocks of the Dum Lake intrusive complex on its western side. The fault zone is marked, at least locally, by rusty-weathered, completely altered carbonate-silica rock. Adjacent granodioritic rocks of the Thuya batholith become strongly fractured, fracture cleaved and locally penetratively foliated as the fault contact is approached. The steeply-dipping foliation strikes up to 20 degrees more westerly than the fault zone, suggesting a dextral sense of shear. Dextral offset of at least 3 to 4 kilometres is also suggested by outcrops of serpentinized ultramafic rock directly east of the fault along Highway 5, which may be displaced from the ultramafic portion of the Dum Lake intrusive complex. At least some of the movement is inferred to be Eocene or younger since the fault apparently bounds exposures of the Chu Chua Formation along Thuya Creek (Uglow, 1922).

The Rock Island Lake fault system follows the North Thompson river valley from the present study area to just south of Barriere, where it apparently continues southeastward as the Louis Creek fault system (Campbell and Tipper, 1971; Okulitch, 1979). The Rock Island Lake fault does not correspond to any faults mapped by previous workers to the northwest, but it is tentatively projected to the east end of Canim Lake, possibly truncating the west end of the Raft batholith (Figure 1). From there it may connect with a system of faults mapped by Campbell and Tipper along the northeast margin of the Takomkane batholith. These ideas will be evaluated as the Bonaparte mapping program continues northward in future years.

## *NORTHEAST-STRIKING FAULTS*

A northeast-striking fault that passes through Lost Horse Lake is inferred from the truncations of several mappable units within the central belt of the Nicola Group (Figure 2). Most truncated units have counterparts on the opposite side of the fault, showing apparent sinistral separations of 600 to 2600 metres. The northeast-striking fault is apparently cut by the Rock Island Lake fault to the east, but a northeast-striking fault passing near the south end of Tintlhohtan Lake is a possible counterpart, showing about 2000 metres of apparent dextral offset along the Rock Island Lake fault. This northeast-striking fault also shows apparent sinistral offsets of mappable units across it.

The northeast striking fault near Tintlhohtan Lake cuts across eastern strands of the Rock Island Lake fault system, but is apparently offset along the main Rock Island Lake fault. This suggests that the northeast-striking structures are broadly contemporaneous with Eocene displacement along the Rock Island Lake fault system. The apparent sinistral offsets are consistent with the interpretation that the northeast-striking structures are antithetic faults within the north-northwest striking dextral strike slip system. An implication of the broadly coeval nature of the two fault sets is that, even if the two northeast-striking strands were once a single fault, the apparent two kilometres of subsequent displacement along the Rock Island Lake fault might measure only a small increment of the total displacement along it.

A pair of northeast-striking faults mapped north of Thuya Creek mark apparent sinistral offsets of the contact separating ultramafic from mafic portions of the Dum Lake intrusive complex. There are no constraints on the actual movement sense along these faults, and their age can only be inferred to be post Late Triassic or Early Jurassic. They may be Tertiary structures, broadly contemporaneous with the northeast-striking faults to the north, or they might be much older, as suggested by the lack of apparent offset of the Thuya Batholith across the northernmost fault (Figure 2).

## *NEHALLISTON SYNCLINE*

The Nehalliston syncline is inferred mainly from relationships in the Friendly Lake area, where right-way-up, northeast-dipping volcanic and volcaniclastic rocks of Unit uTrNv underlying Pooytl Mountain are inferred to be repeated as an interval of lithologically similar volcanic breccias that are exposed on prominent ridges north and northeast of Lost Horse

Lake (Figure 3, Section A). The fold is cored mainly by a mixed volcanic-sedimentary succession assigned to Unit uTrNsv, but the core also includes the small outlier of Lower Jurassic sedimentary rocks exposed southwest of Lost Horse Lake. South of the northeast-striking fault that crosses Lost Horse Lake, the axial trace of the fold is inferred to be within a mixed volcanic-sedimentary succession that is likewise bounded by volcanic rocks of Unit UTrNv to both the northwest and southeast, although there are no facing directions documented within these panels. However, a further symmetry is provided by a unit of volcanic breccias and flows in the core of the fold (not shown on Figure 2, but shown in outline on Figure 3, Section B) that is bounded by lithologically similar conglomerate units to both the northeast and southwest, which are inferred to be repetitions of the same stratigraphic level. As defined in this way, the southern part of the Nehalliston syncline has a more more westerly trend than the Rock Island Lake fault to the east, and is gradually truncated along the fault (Figure 2).

In the Deer Lake area, the Nicola volcanic unit on the southwest limb of the Nehalliston syncline is in contact with, and presumably stratigraphically underlain by, the Harper Ranch Group to the southwest. The internal structure of the Harper Ranch Group is not well understood, but the presence of potentially correlative limestone units on both sides of the diorite stock southwest of Deer Lake suggests that it may be folded into an anticline complimentary to the Nehalliston syncline (Figure 3, Section B).

The Nehalliston syncline apparently formed after depostion of the Lower Jurassic rocks of Unit lJs, (Figure 3, Section A), although relationships are not well enough constrained to be sure that the Lower Jurassic rocks are actually folded into the syncline, rather than unconformably overlying it. The folding occurred before at least some of the movement on the Rock Island Lake fault, which is thought to be mainly Eocene. It is suspected that it formed during the Early to Middle Jurassic compressional deformation documented elsewhere in the region (*eg*. Brown et al., 1986), but it could be older (see next section), and its orientation is permissive for folding, or tightening of a pre-existing fold, during Eocene dextral translation along the Rock Island Lake fault system.

## *MONTICOLA LAKE - GAMMARUS LAKE FAULT SYSTEM*

The Monticola Lake fault is a northwest-striking structure that juxtaposes the Nicola volcanic belt against sedimentary rocks of the Ripple Lake belt in the northwest part of the map area. At its south end it follows a prominent linear depression that corresponds to an abrupt truncation of Unit uTrNv on its northeast side. The Gammarus Lake fault, which places the Harper Ranch Group and an associated diorite stock against the Ripple Lake belt, is inferred to be the southern continuation of the Monticola Lake fault which has been offset across the northeast-striking fault that passes through Lost Horse Lake. The Gammarus Lake fault and the northeast-striking cross-fault are both apparently truncated by the Blowdown Lake fault, which follows a prominent topographic lineament that, at one locality, contains subcrop of highly fractured and brecciated rocks. The Blowdown Lake fault is suspected to be a southwest-side-down Eocene fault, similar to the Long Lake and Caverhill faults to the southwest, which have parallel strikes.

The Monticola Lake - Gammarus Lake fault system forms the boundary between the central volcanic-plutonic belt of the Nicola Group and the adjacent Ripple Lake belt. The specific units juxtaposed across the fault system suggest relative northeast-side-up displacement, whereas the juxtaposition of markedly different facies of the Nicola Group suggests significant lateral telescoping of facies boundaries, and/or syn-Nicola fault activity that may have played a role in localizing the facies belts. Unfortunately, the dip of the fault, and the sense of movement along it, are totally unconstrained. Of note, however, is that the fault system corresponds to little or no apparent displacement of the northeast tip of the Thuya batholith. This suggests pre-Thuya and therefore syn to immediately-post Nicola activity. Corroborating evidence for uplift of the volcanic-plutonic belt at about this time is the presence of syenite clasts, possibly derived from those in the Friendly Lake complex, in Jurassic conglomerate near Windy Mountain (Campbell and Tipper, 1971).

## *CAVERHILL LAKE AND LONG LAKE FAULTS*

The Caverhill Lake fault, first mapped by Campbell and Tipper (1971), passes through the southwest corner of the Nehalliston Plateau map area. The southeastern part of the fault occurs mainly within the Thuya Batholith, but north of Machete Lake it separates the Eocene Skull Hill Formation from Mesozoic rocks to the northeast (Figure 2). The fault was not observed, but its trace is well defined south of Lac des Roches. There, faults observed within the Eocene rocks strike parallel to the inferred trace of the main fault, dip about 70 degrees southwest and show normal-sense offsets. These may reflect the orientation and sense of movement of the main fault.

The Long Lake fault occurs within the Ripple Lake belt of the Nicola Group, east of Wavey Lake, where it is mapped as the southwest boundary of a lens of volcanic rock within the predominantly sedimentary succession. The fault is inferred mainly from the highly fractured nature of the sedimentary rocks that occur locally near its inferred trace, which is approximately parallel to the Caverhill Lake fault. If the volcanic rocks were derived from near the base of the Ripple Lake belt, as is suspected, a southwest-side-down sense of displacemet, similar to Caverhill lake fault, is most likely.

As discussed in the previous section, the Blowdown Lake fault, which apparently cuts the Gammarus Lake fault to the east of the Long Lake fault, is suspected to correlate with the Caverhill and Long Lake faults in terms of age and sense of movement.

## MINERAL OCCURRENCES

The Nehalliston Plateau contains a large number of mineral occurrences, but the MINFILE database is incomplete at the present time. Expanding and updating this database will be an important component of the Bonaparte Project. Here, we provide a brief overview of the variety and distribution of known occurrences (Figure 4), and also highlight rock samples collected during 2000 fieldwork that yielded interesting geochemical values (Figure 4 and Table 1).

Most of the known base and precious metal mineral occurrences in the area are concentrated within and adjacent to the belt of ultamafic - mafic - syenitic plutons that defines the western part of the central Nicola belt. Some of these, such as platinum mineralization within ultramafic rocks of the Dum Lake complex, metalliferous skarns adjacent to Deer Lake and Dum Lake dioritic bodies, and porphyry-style copper occurrences in the Friendly Lake complex, are broadly coeval with the plutons. Others concentrated in this belt, such as numerous vein and shear-related gold showings, may be considerably younger than the intrusive rocks. Disseminated copper occurs within and along the margins of the Thuya Batholtih, and in association with dioritic stocks and dikes cutting sedimentary rocks near the northwest margin of the batholith. Mineral occurrences in the northeastern part of the area include molybdenum-tungsten mineralization within the Early Cretaceous Tintlhohtan Lake stock and polymetallic sulphide lenses within sedimentary rocks of Unit muTrNs.

### Occurrences Associated with the Dum Lake Intrusive Complex

The rocks within and adjacent to the Dum Lake intrusive complex are host to a variety of mineral occurrences, including skarns, gold-quartz veins, gold in quartz-carbonate-altered fault zones, and platinum in ultramafic rocks. The southern part of the complex is covered by the Golden Loon claim group, which was staked between 1984 and 1986, and has seen several exploration programs directed at gold and platinum since that time. The northern part of the complex includes skarn-related occurrences that were explored on the Cedar claims, and gold-bearing veins that were explored on the "G" claims.

#### *GOLDEN LOON*

The Golden Loon property includes several areas of known precious and base metal mineralization within ultramafic and mafic plutonic rocks of the Dum Lake complex; those that are well documented are shown as GL-1 through GL-6 on Figure 4. In addition, several samples collected from this area during our 2000 field program returned anomalous base metal values. The

**TABLE 1**
**GEOCHEMICAL DATA FOR SELECTED ROCK SAMPLES COLLECTED DURING THE 2000 FIELD SEASON**
**(THE GEOLOGICAL SETTINGS OF INDIVIDUAL SAMPLES ARE DISCUSSED IN THE TEXT)**

| Element | Mo | Cu | Pb | Zn | Ag | Ni | Co | As | Cd | Sb | Bi | Cr | Ba | W | Hg | Au | Pt | Pd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | ppm | ppm | ppm | ppm | ppb | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppb | ppb | ppb | ppb |
| Method | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | ARMS | FA | FA | FA |
| Lab | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM | ACM |
| Detection | 0.01 | 0.01 | 0.01 | 0.1 | 2 | 0.1 | 0.1 | 0.1 | 0.01 | 0.02 | 0.02 | 0.5 | 0.5 | 0.2 | 5 | 2 | 2 | 2 |
| Field # | | | | | | | | | | | | | | | | | | |
| 00SIS-17 | 2.89 | 9.55 | 9.1 | 13.4 | 2198 | 7.6 | 7.3 | 2.6 | 0.24 | 0.11 | 0.08 | 18.1 | 87.7 | 6.5 | 22 | 892 | 3 | 2 |
| 00SIS-23 | 72.61 | 1488.46 | 0.72 | 42.1 | 1248 | 7 | 41.1 | 1.9 | 0.31 | 0.48 | 0.05 | 9.1 | 30.1 | 0.3 | 53 | 90 | 10 | < 2 |
| 00SIS-26 | 82.14 | 29.24 | 33.6 | 22.2 | 3250 | 31 | 1514.5 | 66.3 | 0.49 | 1.16 | 17.21 | 42.5 | 85.4 | 101.7 | 367 | 845 | 3 | < 2 |
| 00SIS-29 | 2.8 | 13463.53 | 3.47 | 92.9 | 12590 | 24 | 69.1 | 29.1 | 0.4 | 0.52 | 0.17 | 5.9 | 74.9 | 0.6 | 65 | 72 | 13 | 62 |
| 00SIS-33 | 1.05 | 501.39 | 2.45 | 75.8 | 516 | 11.7 | 16.5 | 15.2 | 0.5 | 1.1 | 0.08 | 4.1 | 84.6 | 0.6 | 114 | 8 | < 2 | < 2 |
| 00SIS-215 | 11.11 | 118.16 | 30.6 | 313.4 | 1253 | 56.5 | 15.7 | 41.4 | 3.7 | 10.35 | 0.07 | 29.1 | 21.4 | 0.7 | 1071 | 56 | 8 | 4 |
| 00SIS-216 | 5.47 | 153.97 | 6.01 | 15.7 | 1109 | 6.2 | 1.4 | 9.9 | 0.14 | 71.23 | 0.6 | 14.4 | 216.4 | 5.2 | 2935 | 7 | 3 | < 2 |
| 00SIS-226 | 2.56 | 71.35 | 195.23 | 1379.5 | 18854 | 92.8 | 36 | 2434.4 | 24.02 | 1.89 | 1.49 | 197.7 | 81.5 | 0.6 | 347 | 1458 | 7 | 10 |
| 00SIS-269 | 6.84 | 33754.17 | 198.43 | 379.7 | 25434 | 7.7 | 10 | 10.8 | 32.9 | 2.9 | 65.15 | 6.9 | 80.2 | 1.4 | 263 | 37 | 208 | 149 |
| 00SIS-325 | 2.05 | 167.95 | 10.24 | 86.9 | 277 | 12.6 | 16.1 | 1.6 | 0.46 | 0.63 | 0.07 | 23.7 | 206.3 | < .2 | 15 | 3 | 3 | 3 |
| 00SIS-359 | 11.57 | 872.32 | 5.86 | 58.2 | 410 | 29 | 119.6 | 53.3 | 0.15 | 0.79 | 0.32 | 27.2 | 48.1 | 6.5 | 34 | 14 | 2 | 4 |
| 00PSC-14-2 | 1.85 | 1826.08 | 569.07 | 8.3 | 15104 | 5.6 | 2.1 | 11.8 | 0.13 | 0.24 | 2.78 | 24.1 | 27 | 7.6 | 33 | 704 | < 2 | 4 |
| 00PSC-76 | 0.43 | 16.24 | 12.25 | 10.3 | 101 | 409.6 | 68.6 | 9.8 | 0.15 | 1.35 | 0.08 | 458.7 | 28.9 | 0.5 | 44 | 5 | 65 | 3 |
| 00PSC-124 | 16.35 | 871.09 | 7.98 | 70.7 | 929 | 332.5 | 340.2 | 8 | 0.28 | 0.57 | 0.17 | 85.2 | 45.7 | 1.1 | 23 | 199 | 9 | 22 |
| 00PSC-283 | 90.91 | 96.98 | 21.78 | 25.8 | 557 | 23.7 | 12.5 | 250.8 | 0.04 | 1.78 | 1.48 | 33.2 | 156 | 8 | 68 | 693 | 5 | 4 |
| 00PSC-334 | 11.14 | 227.29 | 4.49 | 252.7 | 803 | 58.4 | 13.4 | 8.1 | 0.98 | 0.87 | 0.8 | 70.6 | 78.2 | 2 | 27 | 26 | 3 | 9 |
| 00PSC-337 | 13.41 | 262.53 | 2.24 | 56.2 | 341 | 67.1 | 99.4 | 22.1 | 0.02 | 0.67 | 0.18 | 35.4 | 65.2 | 1.3 | 9 | 10 | < 2 | 4 |

Analysis of steel-milled samples prepared by ACME analytical Ltd.
ARMS = Aqua regia digestion - ICPMS
FA = Lead fire assay-ICP finish
ACM = ACME Analytical, Vancouver

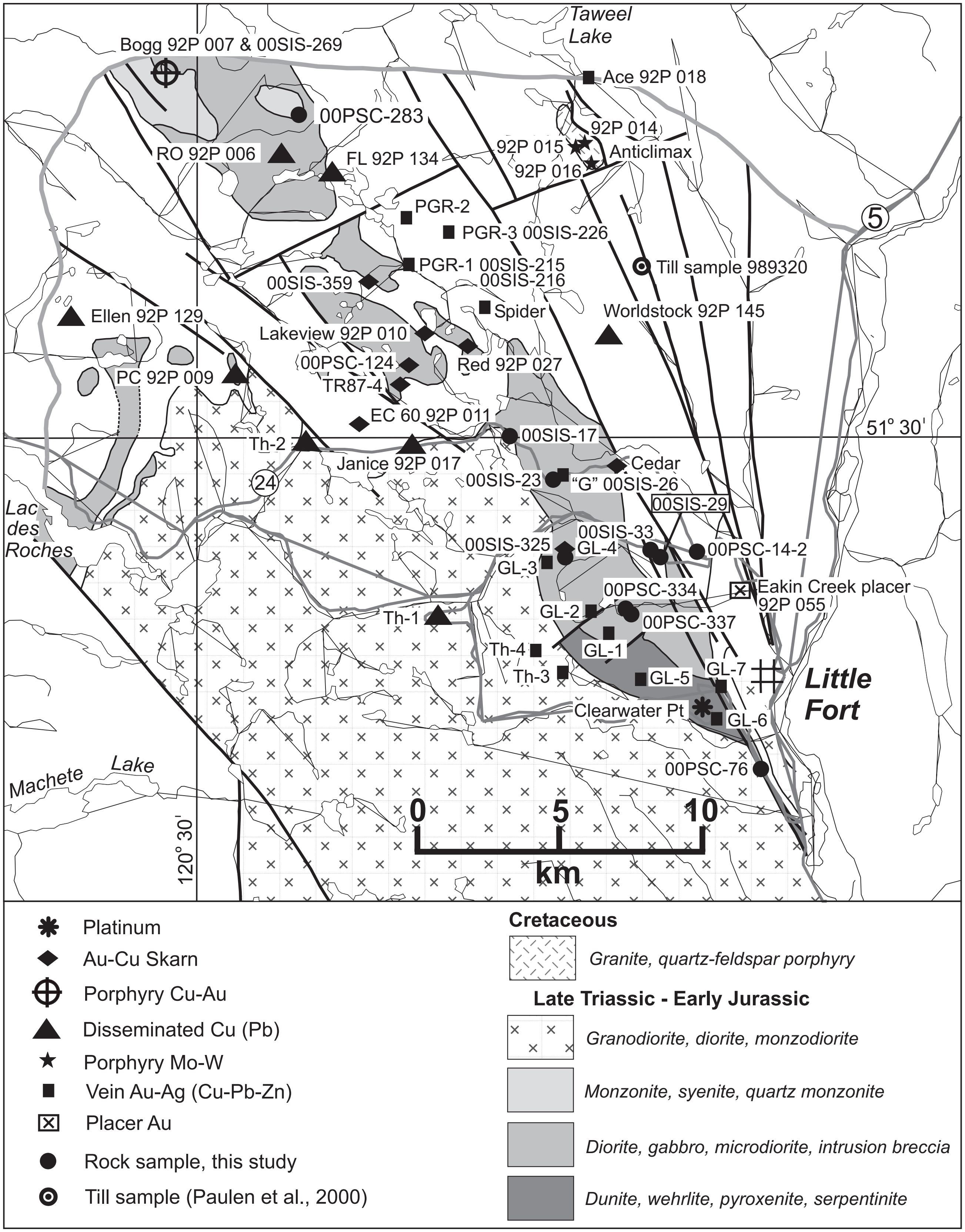



Figure 4. Locations of some of the precious and base metal mineral occurrences in the Nehalliston Plateau. Base map is derived from Figure 2, with only plutonic rocks and faults shown. The occurrences are discussed in the text.

Clearwater platinum prospect and occurrences associated with the Thuya Road fault are also on the Golden Loon claim group, but are discussed separately.

At GL-1, known as the “high grade zone”, a narrow quartz vein, dipping 50 degrees west and containing scattered pyrite, sphalerite, chalcopyrite and galena has been traced for about 50 metres (Dawson, 1977). Mineralized float continues along strike to the north, and a trench about 400 metres to the north exposes a quartz vein, 10 to 40 centimetres wide, which assayed up to 5.6 g/t Au and 75.6 g/t Ag. Drilling beneath the “high grade zone” in 1997 intersected a number of narrow quartz veins but gold grades were low (Dawson, 1997).

GL-2, known as the “low grade zone”, is described as a northwest-trending carbonate-silica-altered shear zone that is exposed along strike for about 150 metres (Dawson, 1997). A trench within the zone exposed more than 6 metres of pervasive silicification containing disseminated and fracture controlled specularite and pyrite. In a 1990 private report to Corona Corporation quoted by Dawson (1997), R.C. Wells and J.R. Bellamy state that “gold values in the 0.5 to 2.5 g/t range occur throughout the trench and average 1.17 g/t for all samples”. Gold values were also encountered in shallow drill holes bored beneath the “low grade zone”, with the best intersection being 2.67 g/t Au over 10.4 metres. About 100 metres along strike to the southeast of GL-2, a north-trending vein up to 70 centimetres wide contains up to 8.3 g/t Au and 66.7 g/t Ag. The wall rock, a bleached and silicified intrusive rock, returned values up to 2.0 g/t Au.

At GL-3 silicified diorite with quartz vein stockwork and 5 percent pyrite contained 736 ppb Au (sample 11941 of Wells and Metail, 1993). Approximately 1 kilometre to the northeast, at GL-4, strongly sheared fine-grained hornfels and skarn contain galena, sphalerite, pyrite and chalcopyrite in north-trending fractures. A sample of this mineralized material returned 476 ppm Cu, 544 ppm Pb, 8870 ppm Zn and 3195 ppm As (sample 11940 of Wells and Metail, 1993). In this same area, chlorite-epidote-altered gabbro locally contains disseminated pyrrhotite and chalcopyrite, with small splotches of malachite stain. A sample of this material (00SIS-325) returned 168 ppm Cu.

Skarn alteration was also observed within the Dum Lake intrusive complex over an 800 metre stretch along a deactivated logging road a short distance southeast of Dum Lake. There, a zone of strongly foliated microdiorite, grading to feldspar-epidote-chlorite schist, contains local lenses of pyrrhotite-pyrite skarn and silicified pyritic epidote-chlorite schist. One sample of silicified, pyritic schist (00PSC-334) returned 227 ppm Cu, 253 ppm Zn and 0.8 ppm Ag. Another (Sample 00PSC-337) returned 263 ppm Cu.

At GL-5, a 10 centimetre-wide quartz vein within the ultramafic portion of the Dum Lake intrusive complex returned .085 oz/T Au, 29.1 ppm Ag and 3764 ppm Pb (sample ZED 4 of Wells, 1988). Three kilometres to the southeast, a series of old trenches expose brecciated, silicified and chalcedony-veined ultramafic rock with sparse pyrite and galena. Wells (1988) reports that a sample of this mineralized material returned 270 ppb Au and 2.5 ppm Ag (location GL-6 on Figure 4).

## *THUYA ROAD FAULT*

The Thuya Road fault was recognized during the early stages of exploration on the Golden Loon property, and malachite staining was reported along the Thuya Creek logging road where it follows the fault (Wells, 1988). In addition, there were a number of small quartz veins noted directly east of the fault, over a strike length of about 1.5 kilometres, which returned anomalous gold values. Location GL-7, at the north end of this zone, represents the best assay reported by Wells (1988, sample EDF 10); this pyrite-galena-chalcopyrite-mineralized vein returned 355 ppb Au, 25.3 ppm Ag, 26 ppm Cu and 2700 ppm Pb.

Several samples were collected from carbonate-silica-altered rock along the southern part of the Thuya Road fault during the 2000 field season, but none yielded significantly anomalous Au or Ag values. One sample (00PSC-76), however, returned 65 ppb Pt.

## *CLEARWATER PLATINUM*

In the late summer of 1999, 150 rock samples collected from the ultramafic portion of the Dum Lake complex were analysed for platinum, paladium and gold (McDougall, 1999). Twenty of the samples were anomalous in Pt, including three which exceeded 100 ppb Pt. One of these, a football-sized sample of highly oxidized ultramafic material cut by thin chromite stringers, contained 13 798 ppb Pt, 25 ppb Pd and 23 ppb Au (McDougall, 1999, Sample 165509; this sample site shown as Clearwater Pt occurrence on Figure 4). A second highly anomalous sample was collected about 1 kilometre to the north. It comprised dark peridotite with chromite veins and yielded assays of 483 ppb Pt, 10 ppb Pd and 2 ppb Au. The property (Golden Loon claim group) was subsequently optioned, and an exploration program for platinum group elements, referred to as the Clearwater Platinum Project, was initiated in the summer of 2000. The results of this exploration program were not known at the time of writing this report.

## *CEDAR*

The Cedar claims were staked in December and January of 1983 and 1984 to cover mineralization exposed in a roadcut on Highway 24. The roadcut exposes highly faulted and skarn-altered limestones and associated silicified sedimentary rocks, here asssigned to the Harper Ranch Group, enveloped by diorite, microdiorite and silicified greenstone of the Dum Lake intrusive complex. The highly faulted nature of the outcop reflects its location just 100 metres west of the inferred trace of the Rock Island Lake fault.

The most significant mineralization occurs near the eastern end of the outcrop, where two separate sulphide zones, each approximately 1 metre wide, occur within silicified microdiorite and greenstone. The two zones contain about 35 and 20 percent sulphides, respectively, comprising veins, lenses and disseminations of pyrite, pyrrhotite and chalcopyrite (Yorston and Ikona, 1985). A one metre sample across the most sulphide-rich zone contained 7328 ppm Cu, 4.5 ppm Ag and 580 ppb Au, and a sample of the same width across the other sulphide zone contained 6154 ppm Cu, 4.2 ppm Ag and 160 ppb Au. Yorston and Ikona also report that a sample of the best sulphide material available yielded 11 475 ppm Cu, 9.1 ppm Ag and 1460 ppb Au.

The altered limestone exposed in the Highway 24 roadcut locally contains narrow lenses of heavily disseminated pyrrhotite-pyrite, with traces of chalcopyprite and molybdenite (Dom, 1989), in association with garnetiferous skarn. The limestone can be traced northward to Nehalliston Creek and southward to Eakin Creek and is sparsely mineralized with chalcopyrite, and locally galena, in a few places within this belt (Yorston and Ikona, 1985). Associated diorite also locally contains disseminated pyrite with traces of chalcopyrite. On the Eakin Creek road, faulted, silicified and skarn-altered limestone correlated with this unit crops out near the eastern side of the belt of rocks mapped as Harper Ranch Group. It is bounded by a section of siltstones to the west, and by pyroxenite and gabbro of the Dum Lake intrusive complex to the east. A sample of silicified limestone with up to 5 percent disseminated pyrite from the western part of the limestone unit contained 501 ppm Cu and 0.5 ppm Ag (Sample 00SIS-33). A sample from a narrow shear zone containing pyrite, chalcopyrite and malachite near the eastern edge of the limestone unit contained 13 463 ppm Cu, 12.6 ppm Ag, 72 ppb Au, 13 ppb Pt and 62 ppb Pd (Sample 00SIS-29).

### *G OCCURRENCE*

The G claims were staked in 1988 to cover an outcrop containing mineralized veins on Highway 24, 1.5 kilometres west of the Cedar occurrence. The outcrop, referred to as the Discovery Zone, includes variably oriented chlorite-calcite-quartz veins, 1 to 3 centimetres wide, within complexly veined and faulted diorite and gabbro of the Dum Lake intrusive complex. The veins are mineralized with pyrite and local traces of galena. They were explored for their precious metal content, and yielded assays of up to 3.15 g/t Au and 36.9 g/t Ag over 3.0 m (Dom, 1989). Along Nehalliston Creek, 500 metres to the northeast, a series of planar, moderately west-dipping quartz veins, averaging about 20 centimetres in width, cut microdiorite of the Dum Lake complex. These veins contain up to 2 percent pyrite and traces of galena. The best result out of a series of rock chip samples collected from these veins returned 450 ppb Au and 13.7 ppm Ag (Dom, 1989).

In 1991, investigation of soil geochemical anomalies for gold led to the discovery of abundant float of altered and mineralized intrusive rock extending for almost 1 kilometre south of the Discovery Zone. The float fragments commonly contain 3 to 5 percent disseminated pyrite and many are silicified and display breccia and stockwork textures (Gruenwald, 1992). Precious metal values range up to 0.121 oz/ton Au and 2.60 oz/ton Ag.

During the present study, a sample of pyritic rock from a narrow shear zone within the Discovery Zone outcrop yielded 82 ppm Mo, 29 ppm Cu, 3.3 ppm Ag and 845 ppb Au (sample 00SIS-26), whereas a sample of gabbro containing heavily disseminated pyrite from a separate outcrop along the highway, 400 metres to the west, contained 73 ppm Mo, 1488 ppm Cu, 1.2 ppm Ag, 90 ppb Au and 10 ppb Pt (sample 00SIS-23).

## Skarn Occurrences near Deer Lake

Skarn mineralization in the Deer Lake area occurs where limestone of the Harper Ranch Group is cut by Triassic-Jurassic dioritic rocks. The most significant is the Lakeview (MINFILE 92P 010) Fe-Cu-Au skarn occurrence, located near the southwest corner of Deer Lake (Figure 4). The mineralization was discovered in 1930 (Nichols, 1931) and continues to receive considerable attention, in part because of its high gold content. The skarn-alteration and mineralization at the main Lakeview prospect is well exposed in a series of trenches, pits and small adits. The area contains very little natural bedrock exposure, but local outcrops and trenches indicate that similar alteration and mineralization occurs, at least locally, for several hundred metres to the south and north, defining a northerly-trending belt more than one kilometre long (Bruland, 1990).

At the Lakeview occurrence, garnet-pyroxene exoskarn and endoskarn is developed where dioritic dikes, presumably related to larger stocks mapped a short distance to the northeast and southwest, intrude limestone of Unit PHRl. Mineralization associated with the skarn includes massive to semi-massive lenses, pods and veins of magnetite or pyrrhotite, containing variable amounts of pyrite and chalcopyrite. Westerman (1987) reports high gold values in an old open cut above the main adit. The gold occurs within a silicified and pyritized skarn unit, 3.9 metres wide, located between two massive pyrrhotite units, each about one metre wide. He chip-sampled the entire 3.9 metre width of the silicified skarn zone and obtained an average value of 6.61 g/t Au. Chip samples of the bounding pyrrhotite skarn units returned assays of 2.84 g/t and 2.20 g/t Au, respectively, across one metre widths.

The Lakeview occurrence is bounded to the south by a large diorite stock. Limestone and skarn are also exposed at two locations along the southeastern margin of this stock. In one of these areas, Westerman (1987) reports that a pyritic zone between limestone and skarn near the diorite contact assayed 1.01 g/t Au across one metre (location TR87-4 on Figure 4). A zone of skarn-alteration within the diorite pluton, between the Lakeview occurrence and location TR87-4, was sampled during our 2000 mapping program and returned values of 871 ppm Cu and 199 ppb Au (sample 00PSC-124).

The Red (MINFILE 92P 027) occurrence is located within the eastern part of the diorite stock that bounds the Lakeview prospect to the northeast (Figure 4). According to Naylor and White (1972) it is marked by two old adits that cut magnetite-pyrrhotite-chalcopyrite mineralization within fractured and epidote-carbonate altered diorite. Bruland (1990) reports that samples of locally-derived pyrite-chalcopyrite altered dioritic float from near the south margin of the stock, directly south of the Red occurrence, returned assay values of up to 0.71 percent Cu.

Several kilometres northwest of the Lakeview prospect, thin-bedded, locally skarn-altered, sedimentary rocks of Unit PHRs are separated from the diorite stock to the northeast by a poorly-exposed lens of massive pyrrhotite-pyrite, with traces of chalcopyrite. A sample from this sulphide lens returned 872 ppm Cu and 14 ppb Au (sample 00SIS-359).

## Gold Prospects North and East of Deer Lake

The PGR claim group, north of Deer Lake, includes a number of mineralized veins and alteration zones that have seen recent exploration directed mainly at their gold content. Three of the more prominent vein systems are shown on Figure 4 as locations PGR-1 throught PGR-3. Numerous other occurrences in the same area are shown on maps by Wells and Evans (1992) and Belik (1997).

The PGR-1 (Road zone) and PGR-2 (Zone A) occurrences are near the south and north ends, respectively, of an area containing several north-northwest trending quartz±carbonate vein systems and silicified stockwork/breccia zones cutting volcanic and sedimentary rocks of Unit uTrNsv (Belik, 1997). The vein systems are reported to have weak to moderately strong Au-Ag-Mo-Pb-Zn-Cu mineralization (Belik, 1997). Wells (2000) reports that assay samples from the road zone (PGR-1) returned up to 62.8 g/t Au, and that polymetallic veins at PGR-2 yielded values in the 1 to 5 g/t Au and 12 to 118 g/t Ag ranges. During the present study, a vuggy, pyritic quartz vein containing traces of chalcopyrite and malachite was sampled from the road zone (sample 00SIS-216) along with the silicified and pyritized wallrock (sample 00SIS-215) of uncertain protolith. The samples returned only moderately anomalous copper and silver values, but were very high in antimony and mercury (Table 1).

Location PGR-3 comprises a system of northerly-striking, polymetallic quartz-carbonate veins that contain up to 10 percent sulphides as blebs, stringers, disseminations and massive pods (Belik, 1997). The sulphide minerals include pyrite, galena, sphalerite, tetrahedrite and chalcopyrite. This vein system is referred to as the Silver Lake zone by Belik (1997), who states that the veins commonly return high silver values, but generally contain less gold than the vein and stockwork systems directly to the west. The veins occur mainly in sedimentary rocks of Unit uTrNsv, but cut volcanic rocks in the southern part of the system. A sample of silicified volcanic rock cut by quartz stockwork, and containing heavily disseminated pyrite with traces of chalcopyrite and malachite, was sampled during the present study (sample 00SIS-226). In addition to high base metal values, this sample returned 18.85 ppm Ag, 2434 ppm As and 1458 ppb Au.

The Spider occurrence, east of Deer Lake (Figure 4), comprises a northeast-trending zone of sulphide-bearing quartz-carbonate veins and stockwork that resembles some of the mineralization on the PGR claims to the north (Watt, 1999). Sulphide minerals include pyrite, chalcopyrite and galena.

## Occurrences Associated with the Friendly Lake Intrusive Complex

The Bogg (MINFILE 92P 007) occurrence comprises porphyry-style copper mineralization within and along the northeast margin of the largest monzonite-syenite stock within the Friendly Lake intrusive complex (Figure 4). Disseminated and fracture-controlled pyrite, chalcopyrite and bornite occur within both the syenitic rocks and adjacent greenstone, microdiorite and intrusion breccia. Edwards (1991) reports that pyroxene-potassium feldspar-calcite veinlets, interpreted to have formed in the late stages of intrusion of the syenite body, locally contain chalcopyrite and galena. Disseminated and fracture-controlled pyrite-chalcopyrite mineralization also occurs farther west, within a steeply-dipping, northwest-striking quartz-carbonate altered fault zone that cuts through the southwestern part of the monzonite-syenite stock. This zone is up to 300 metres wide and comprises silicified fragments of syenite, microdiorite, greenstone and altered sedimentary rocks cut be several episodes of quartz and carbonate veins.

Sample 00SIS-269 is from pyrite-chalcopyrite-bornite-rich intrusion(?) breccia in the main mineralized area of the Bogg occurrence. It returned 33 754 ppm Cu, 25 ppm Ag and, of particular interest, 208 ppb Pt and 149 ppb Pd (Table 1).

The smaller monzonite stock within the eastern part of the Friendly Lake complex is not apparently mineralized. However, a narrow zone of heavily disseminated pyrite was noted at one place along the southeast margin of the stock, where microdiorite is cut by abundant veins of monzonite, orthoclase-amphibole and carbonate. A sample of the pyritic rock (00PSC-283) returned 693 ppb Au.

Mineralization at the RO occurrence (MINFILE 92P 006), north of Friendly Lake, comprises disseminated galena, pyrite and chalcopyrite in fine-grained andesitic rock (microdiorite?) that is stongly altered to bluish antigorite, pyroxene, chorite and calcite (Preto, 1970a). Similar mineralization and alteration occurs to the east, near the eastern margin of he Friendly Lake complex (Preto, 1970a), and to the northwest, between the two monzonite-syenite stocks (Gamble and Farmer, 1986).

The FL occurrence (MINFILE 92P 134) is located near the east end of Friendly Lake, along the eastern margin of the Friendly lake intrusive complex. The mineralization is hosted by brecciated and carbonate-sericite-chlorite altered biotite hornfels derived from a mafic volcanic protolith (Rebagliati, 1987). It comprises disseminated fine-grained pyrite, with trace amounts of chalcopyrite, galena, sphalerite, molybdenite and arsenopyrite, within the breccia fragments and, to a lesser extent, the matrix (Rebagliati, 1987).

## Mineral Occurrences in the Southwestern Part of the Map Area

### *OCCURENCES IN THE THUYA BATHOLITH*

Disseminated copper occurs locally within and along the margins of the Thuya Batholith. The eastern part of the batholith also hosts auriferous quartz veins on and near the Golden Loon claim group, which are similar to veins within the Dum Lake complex to the east.

Sparse occurrences of chalcopyrite within granodiorite and related rocks of the Thuya Batholith, between Eakin Creek and Thuya Lakes, are described by Preto (1970a), and were confirmed during our 2000 fieldwork (Location Th-1 on Figure 4). Preto also described disseminated pyrite and chalcopyrite in hornfels near the northern contact of the batholith, northwest of Long Island Lake (Location Th-2). The Janice occurrence (MINFILE 92P 017) comprises similar disseminated pyrite and chalcopyrite in silicified and hornfelsed sedimentary rocks on the margin of the batholith northeast of Long Island Lake.

On the Golden Loon property, at location Th-3 on Figure 4, a quartz vein containing galena and pyrite returned assay values of .088 oz/T Au, 23.2 ppm Ag, 85 ppm Cu and 495 ppm Pb (Wells, 1988). At location Th-4, 1400 metres to the northwest, silicified granodiorite is cut by numerous quartz veins, commonly with pyrite, chalcopyrite and galena, many of which yield anomalous gold values (Wells and Metail, 1993). The best assay reported from this area returned 2080 ppb Au, 27.4 ppm Ag, 1106 ppm Cu and 5628 ppm Pb (sample 3808 of Wells and Metail, 1993). On Highway 24, an outcrop of epidote-altered hornblende diorite along the northeast margin of the Thuya Batholith is cut by a narrow, mineralized quartz vein that dips gently to the west. A sample of mineralized vein material (00SIS-17), which contains pyrite and traces of chalcopyrite, returned 2.2 ppm Ag and 892 ppb Au.

### *EC 60 (92P 011)*

The EC 60 occurrence is within calcareous shale, siltstone and chert of the Ripple Lake belt, about 800 metres north of Long Island Lake and the north contact of the Thuya Batholith (Figure 4). According to Preto (1970a) the mineralization comprises small sulphide lenses in a zone of skarny alteration 15 to 18 metres wide, that parallels bedding in the enclosing sedimentary rocks. Bedding dips steeply west to west-southwest, and is intruded by a 10-metre-wide sill of sericitized and weakly mineralized quartz-feldspar porphyry directly east of the mineralized zone. The sulphides include pyrrhotite, pyrite and galena, locally accompanied by minor amounts of chalcopyrite and sphalerite (Preto, 1970a; Bruland, 1990).

### *OCCURRENCES ASSOCIATED WITH DIORITE NORTHWEST OF THE THUYA BATHOLITH*

At the PC (MINFILE 92P 009) and Ellen (MINFILE 92P 129) occurrences (Figure 4), minor amounts of disseminated chalcopyrite occur within dioritic plugs, dikes and sills, or within adjacent pyritic hornfels of Unit uTrNs (Preto, 1970a; Wares and MacDonald, 1972). Wares and MacDonald also report minor amounts of molybdenite within diorite at the Ellen occurrence.

## Occurrences East of the Rock Island Lake Fault

### *ACE (MINFILE 92P 018)*

The Ace occurrence is along upper Lemieux Creek, a little more than 100 m downstream from the outlet of Taweel Lake. The mineralization was briefly mentioned by Davis (1925, p. B152), who reported that a sample submitted by a local prospector assayed 0.04 ounces gold per ton, 2.05 ounces silver per ton, 0.2 percent copper and 20 percent lead. Subsequent work is not well documented, but included the sinking of a shallow shaft on the southwest bank of Lemieux Creek, some trenching and some diamond drilling. Most of this work occurred in the early to mid 1900s, although three shallow diamond drill holes were drilled in 1988 (Steiner, 1988).

The Ace prospect is hosted by metasedimentary rocks of Unit muTrNs. The mineralization at the old shaft along Lemieux Creek consists of lenses of massive pyrrhotite-pyrite-arsenopyrite with minor chalcopyrite. Individual sulphide lenses are up to several tens of centimetres wide, and are hosted in dark grey phyllite containing contorted layers and fragments of lighter grey siltite and fine-grained quartzose metasandstone. Jenks (1999) reports that massive sulphide lenses, including sphalerite, galena, chalcopyrite and pyrite, also occur in trenches located about 600 metres northeast of the Lemieux Creek shaft, where they are hosted by similar brecciated metasedimentary rocks. He states that both zones have a significant gold content.

### *ANTICLIMAX (MINFILE 92P 014, 015, 016)*

The Anticlimax showing comprises molybdenum-tungsten mineralization within the Cretaceous granitic stock northeast of Tintlhohtan Lake. The mineralization was discovered in 1938, and since that time the property has been explored intermittently by several companies. The original workings were described by Stevenson (1940), and the results of subsequent exploration are summarized by McCammon (1962), Preto (1970b) and Kirkham and Sinclair (1988). The occurrence is currently listed in MINFILE as three separate showings, corresponding to three areas of mineralization described as "A", "B", and "C" by McCammon (1962), in the central, west-central and southern parts of the stock.

Stevenson (1940) reported that the highest grade molybdenum mineralization was in a gently-dipping lens, measuring about 2.5 metres in diameter and 65 centimetres wide, near the western margin of the stock (area "B" of McCammon, 1962). The lens (largely removed at the time of Stevenson's inspection) comprised heavily disseminated molybdenite associated with patches of quartz-felspar pegmatite within aplite and quartz-feldspar porphyry. Elsewhere, mineralization typically occurs in narrow quartz veins containing variable amounts of pyrite, molybdenite, bismuthinite, pyrrhotite, wolframite and fluorite (Preto, 1970b). Although widespread, and within all phases of the stock, the known mineralization is sporadic and below economic grade.

As discussed previously, a biotite separate from unaltered granite of the Tintlhohtan Lake stock yielded a K-Ar date of 102±5 Ma. Soregaroli (1979) also dated sericite from an alteration envelope bordering a mineralized vein and obtained a date of 90.7±3.3 Ma, concluding that the alteration and associated molybdenum-tungsten mineralization was genetically related to the host stock. These dates suggest that the Tintlhohtan Lake stock is part of the mid-Cretaceous Bayonne suite of intrusions, which is widespread in southeastern British Columbia and currently the focus of a study to assess its potential for plutonic-related gold mineralization (Logan, 2000).

### *WORLDSTOCK (MINFILE 92P 145)*

The Worldstock showing comprises an isolated outcrop of iron carbonate-chlorite-pyrite-silica-altered rock with traces of chalcopyrite. It was discovered in 1997, in a landing along a logging road, and returned 0.78 % copper over a 4 metre by 3 metre panel sample (Wells, 2000). The showing is located along or near the contact between pyroxene porphyry and volcanic breccia of Unit uTrNv and overlying conglomerate of Unit uTrNsv, although the actual protolith to the altered rock is uncertain. A pyrite-silica-altered rock exposed about 800 metres to the NW, however, appears to have been derived from a feldspar-phyric intrusive rock, consistent with the suggestion that the Worldstock showing may represent part of a porphyry system (Wells, 2000). A sample collected from the altered intrusive rock during the present study did not yield anomalous base or precious metal values.

### *TILL GEOCHEMICAL ANOMALY SOUTHEAST OF TINTLHOHTAN LAKE*

The BCGS till geochemistry program described by Paulen *et al*. (2000) yielded several interesting anomalies within the Nehalliston plateau map area. One of these (sample 989320) is a multi-element anomaly for zinc, copper, cadmium, molybdenum, nickel, cobalt and antimony in an area of poor bedrock exposure about 4 kilometres southeast of Tintlhohtan Lake. This anomalous sample is within a linear, north-northwest trending belt of till and soil geochemical anomalies that local prospectors traced for more than 10 kilometres in 1998 and 1999 (Figure 4; Mike Cathro, personal communication, 2000). The detailed geochemical exploration in this belt has yielded highly anomalous values for zinc, cadmium, copper, antimony, arsenic, barium and mercury. The linear anomaly appears to be along or near the contact between volcanic rocks of Unit uTrNv and overlying sedimentary rocks at the base of Unit uTrNsv, althouth the contact is locally marked by faults of the Rock Island Lake system. This geological setting suggests the possiblility of either an Eskay Creek-style VMS occurrence or a younger epithermal environment localized along the Rock Island Lake fault system. The area was further explored in the summer of 2000, but the results of this program were not known at the time of writing this report.

### *MINERALIZED QUARTZ VEIN ALONG HIGHWAY 24*

A ribboned quartz vein exposed along Highway 24 about 5 km NNW of Little Fort contains selvages of chlorite and rusty carbonate, and local malachite and azurite together with tiny grains of chalcopyrite and a grey sulphide of uncertain composition. The vein cuts a microdiorite sill that intrudes fine-grained sedimentary rocks of Unit uTrNsv. It is 1 metre wide, dips about 60 degrees to the west and was traced for 10 metres. A sample of mineralized vein material (00PSC-14-2) yielded 1826 ppm Cu, 569 ppm Pb, 15 ppm Ag and 704 ppb Au. Similar quartz veins occur elsewhere in the outcrop, but are not visibly mineralized.

### *EAKIN CREEK PLACER (MINFILE 92P 055)*

Placer gold was recovered from gravels in the lower reaches of Eakin Creek (referred to as Threemile Creek in early reports) periodically from the early 1920s through the early 1930s (Uglow, 1922; Nichols, 1926, 1932). There are no records as to the amount of gold recovered, but Nichols (1932) reports that some of the gold was quite coarse, and good nuggets were obtained locally from the gravel/bedrock interface. Uglow suggested that the placer gold might have been derived from a resistant conglomerate unit within the Chu Chua Formation, which formed a gorge directly above the original workings. Nichols (1926) did not consider such a local source probable, pointing to the fact that placer gold had subsequently been found above the gorge cutting through the conglomerate. As shown on Figure 4, numerous small gold occurrences are now known from within and around the drainage basin of Eakin Creek.

## SUMMARY OF MAIN CONCLUSIONS

Mesozoic volcanic and sedimentary rocks underlying the Nehalliston Plateau were subdivided into Triassic and Jurassic units by Campbell and Tipper (1971), but are here considered to be almost entirely Upper Triassic and part of the Nicola Group. Within the map area, the Nicola Group occurs in three fault-bounded belts of contrasting lithology which are thought to be at least partially coeval. The central belt consists mainly of volcanic rocks, and is flanked by entirely sedimentary rocks to the east, and by sedimentary and local volcanic rocks to the west. Paleozoic limestone and associated argillite and siltstone of the Harper Ranch Group underlie Triassic volcanic rocks of the central belt and are more widespread than previously thought.

A prominent belt of ultramafic - mafic - syenitic plutonic rocks, only partially shown on previous maps, extends northwestward from the northeast margin of the Thuya batholith. These rocks intrude the central, predominantly volcanic belt of the Nicola Group, as well as underlying Paleozoic rocks of the Harper Ranch Group. It is suspected that they are slightly older than the Thuya batholith and approximately coeval with the associated Nicola Group volcanic rocks. This northwest-trending plutonic belt apparently defines a prominent axis of magmatism within the Nicola arc.

Base and precious metal mineral occurrences are concentrated within and adjacent to the belt of ultamafic - mafic - syenitic plutons that defines the western part of the central Nicola belt. Some of these, such as platinum mineralization within ultramafic rocks of the Dum Lake complex, skarn occurrences adjacent to Deer Lake and Dum Lake dioritic bodies, and porphyry-style copper in the Friendly Lake complex, are broadly coeval with the plutons. Others, such as numerous vein and shear-related gold showings, although concentrated in this belt, may in part be considerably younger.

A limited amount of data suggests that a period of uplift and erosion affected the Nicola volcanic belt and associated alkalic intrusions prior to the deposition of Lower Jurassic sedimentary rocks. The Monticoa Lake - Gammarus Lake fault system, which defines the southwest boundary of the Nicola volcanic belt, may have a history of movement dating back to this time. The 2001 field season will encompass Jurassic rocks that may allow this idea to be more fully evaluated.

The structure of the Nehalliston Plateau is dominated by systems of mainly northwest-striking Eocene faults. Some faults in the western part of the area show southwest-side-down normal displacement, but a prominent system of dextral strike-slip faults, referred to as the Rock Island Lake fault system, dominates the structure in the eastern part of the area. The latter faults may be part of a significant dextral strike-slip system that has not been well documented in this part of the cordillera.

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