BABINE PORPHYRY BELT PROJECT: BEDROCK GEOLOGY OF THE FULTON LAKE MAP AREA (93L/16), BRITISH COLUMBIA

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(British Columbia Ministry of Energy, Mines and Petroleum Resources contribution to the Nechako National Mapping Program)

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INTRODUCTION

The Babine porphyry belt project is part of the new Nechako National Mapping Program (NATMAP), a joint effort of the Geological Survey of Canada and the British Columbia Geological Survey Branch of the Ministry of Energy, Mines and Petroleum Resources (McMillan and Struik, 1996, this volume). This is a multidisciplinary project with separate components for bedrock and surficial geology, till and silt geochemistry. The objective of the Babine Porphyry Belt project is to map the Fulton Lake (93L/16), Old Fort Mountain (93M/1) and Nakinilerak Lake (93M/8) map sheets over the next four years (Figure 1). This report summarizes the results of bedrock mapping completed in 1995. The reader is cautioned that this report is very preliminary and is being written without the benefit of paleontological identifications, radiometric age dating, whole-rock and trace element geochemistry or petrographic analysis, any of which may significantly change our understanding of the geology of the Fulton Lake map sheet.

PROJECT DESCRIPTION

The Babine porphyry belt is located in west-central British Columbia and is centred on the northern third of Babine Lake (Figure 1). The belt is approximately 80 kilometres long and includes twelve significant porphyry copper deposits and prospects including the Bell and Granisle past producers. The mineral potential of the area was ranked the fourth highest of the 97 tracts evaluated in the Skeena-Nass mineral potential project (MacIntyre *et al.*, 1995). The estimated value of known in-ground mineral resources in the area is $1.96 billion and the value of past production is estimated at $1.13 billion (1986 dollars). In spite of the high mineral potential and obvious economic significance of the area, the most recent published geological mapping in the belt was by Carter (1973). Since then there has been extensive logging in the area, providing new access and

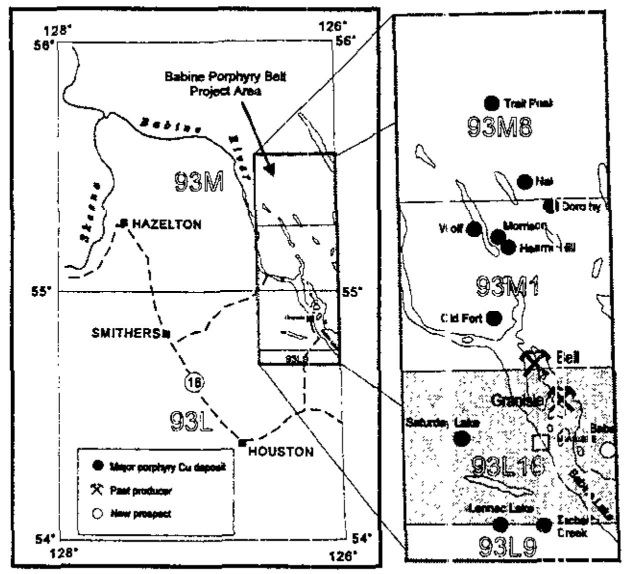

Figure 1. Location of the Babine Porphyry Belt project area, West-central British Columbia. Shaded area was mapped in 1995 and is the subject of this report.

better bedrock exposure, especially in areas of extensive drift cover. This, coupled with renewed interest in porphyry copper deposits as an exploration target and the need for economic diversification in the economy of the area, make this project particularly timely. It is hoped that new bedrock and surficial mapping, together with regional geochemistry and airborne geophysical surveys, will stimulate additional exploration in the belt and lead to new discoveries. Drift prospecting, lake geochemistry and airborne geophysics will be especially important in defining new targets in drift-covered areas. The Quaternary geology and till geochemical sampling completed in 1995 are discussed in separate reports (Huntley *et al.*, 1996, this volume; Stumpf *et al.*, 1996, this volume)

ACCOMPLISHMENTS

The 1995 bedrock mapping crew consisted of Don MacIntyre, Ian Webster and Kim Bellefontaine of the British Columbia Geological Survey Branch in Victoria, and John Bryant, a Geological Survey of Canada summer student. This crew completed 1:50 000-scale geological mapping of the Fulton Lake map sheet

(93L/16). In addition to regional bedrock mapping, major mineral deposits and new prospects in the area were mapped in detail and sampled. Samples were also collected for radiometric dating in conjunction with Mike Villeneuve of the Geological Survey of Canada and this information will help to further refine the geology of the area. Major geological accomplishments made during the 1995 field season are summarized below.

- Development of a possible Permo-Triassic statigraphy in the area west of Granisle. Permian rocks are tentatively correlated with the Asitka Group, Triassic rocks with the Stuhini Group.
- Recognition of possible Triassic rocks on the Newman Peninsula (Bell mine). These rocks were previously mapped as Lower Jurassic Telkwa Formation.
- Correlation of Lower Jurassic stratigraphy in the Babine Lake area with the type area of the Telkwa Formation in the Telkwa Range. This suggests the Howson subaerial facies extends much farther east than originally thought.
- Recognition of several distinct phases within the Late Triassic - Early Jurassic Topley intrusions.
- Collection of samples for U-Pb and Ar-Ar dating by Mike Villeneuve of the Geological Survey of Canada. These data will help refine the ages of some of the map units in the area.
- Development of a stratigraphy for the Eocene Newman volcanics. Argon-argon age dating and whole-rock geochemistry will be used to help refine our understanding of the relationships between these rocks and the Babine Plutonic Suite.
- Location of two new epithermal systems, one of which has elevated zinc values, three new copper showings, one of which carries anomalous gold and a new molybdenum showing.
- Discovery of a biotite-feldspar porphyry (bfp) dike cutting Topley intrusions on the Babs property. This was the first time bfp was found in outcrop and indicates that the mineralized porphyry float may be locally derived.
- Mapping and sampling of recent trenching at the Lennac Lake porphyry prospect. This work documents a new zone on the property which was trenched by Cominco and Kennecott in 1992 and 1993. Although low grade copper mineralization occurs over a wide area, this zone has never been tested by drilling.

SUMMARY STATISTICS

A total of 223 person days was required to complete 1:50 000-scale mapping of Fulton Lake map sheet (93L/16). A total of 796 geologic stations were recorded in the 89 000 hectare map area. The station density was approximately 9 stations per 1000 hectares. This relatively low density reflects the lack of bedrock exposure in a large part of the map area. A summary of the samples collected from the area is given below.

Sample Type	Number
Conodonts	7
Macrofossils	7
U-Pb zircon	4
Ar-Ar	8
Assay	40
Whole rock	21
Silt	44

FUTURE PLANS

Geoscientific studies will continue in the Babine Lake area contingent upon funding of the Nechako NATMAP program. The target for bedrock mapping in 1996 will be to complete 1:50 000-scale mapping of the Old Fort Mountain map sheet (93M/1, Figure 1). The major porphyry copper deposits on this map sheet include Bell, Morrison and Hearne Hill. Hopefully regional silt and lake geochemistry, detailed mineral deposit studies and possibly airborne geophysical surveys can be added as components of the project next year.

PREVIOUS WORK

Geologic mapping and mineral property evaluations by the Geological Survey of Canada and the British Columbia Department of Mines (now Ministry of Energy, Mines and Petroleum Resources) date back to the turn of the century. Earliest reports on the geology of west-central British Columbia are by G.M. Dawson (1881) who described porphyritic flows in the Francois Lake and Skeena River areas. Volcanic rocks in the Hazelton and Smithers area were first described by Leach (1910) who proposed a two-fold subdivision between Jurassic volcanics, which he called the Hazelton Group, and Cretaceous sedimentary strata which he named the Skeena series. Hanson (1925) further subdivided the Hazelton Group into a lower volcanic division, a middle sedimentary division and an upper volcanic division. This division remained unchanged for many years until Armstrong (1944a, 1944b) included the Skeena series with the Hazelton Group

In 1976, the Geological Survey of Canada published Tipper and Richards (1976a) bulletin *Jurassic Stratigraphy and History of North-central British Columbia.* This comprehensive publication included previously unpublished data on numerous fossil localities and measured stratigraphic sections, including several in the Babine Lake area. This bulletin complimented the release of an open file, 1:250 000-

scale, geological map of the Smithers area (Tipper and Richards, 1976b).

Tipper and Richards subdivided the Hazelton Group into several different formations. They also resurrected the name Skeena Group for Early Cretaceous coal-bearing, overlap sedimentary strata that Armstrong (1944a, 1944b) originally placed in the Hazelton Group.

Carter mapped the Babine porphyry belt in detail between 1965 and 1972 as part of a British Columbia Ministry of Mines regional study of porphyry deposits in west-central British Columbia. This excellent work was released as Preliminary Map 12 (Carter, 1973) and remains the only published geological map of the belt. Because of improved access via logging roads, better bedrock exposure in clear-cuts and a better understanding of regional stratigraphic relationships, we were able to expand on this earlier mapping and place it in a modern stratigraphic framework.

The Babine porphyry belt is one of the most important mineral camps in British Columbia (Carter *et al.* 1995). Numerous reports have been published on individual deposits. Carson and Jambor (1974), Wilson *et al.* (1980) and Zaluski *et al.* (1994) have discussed hydrothermal alteration and fluid geochemistry in the district; Fahrni *et al.* (1976), Carson *et al.* (1976) and Dirom *et al.* (1995) have described the geology and mineralization at the Granisle and Bell mines; Carson and Jambor (1976) and Ogryzlo *et al.* (1995) have described the Morrison and Hearne Hill deposits.

ACCESS

The main access to the area is from Highway 16, which follows the Bulkley River valley from the town of Houston through Telkwa and Smithers and north to Hazelton (Figure 1). Smithers, located approximately half way between Prince George and Prince Rupert, is the largest town in the area and is a major transportation centre with daily jet service to Vancouver, Terrace and Prince George.

There are two main routes into the study area from Highway 16. The Smithers Landing - Granisle connector route which leaves Highway 16 south of Smithers and goes through McKendrick Pass on its way to Granisle is 78 kilometres long and is mainly gravel. The Topley - Granisle road is paved; it leaves Highway 16 at Topley and terminates at Granisle, a distance of 48 kilometres. An extensive network of logging roads provides access to much of the map area, especially east of Babine Lake. The east side of the lake is accessible by ferry between Mill Bay, just north of Topley Landing, and Nose Bay on the east side of the lake. Crossing time is approximately 20 minutes. The ferry is run by Northwood Lumber Co. based in Houston, and is free to the public with the acquisition of a permit. On the east side of the lake, the Hagan, Jinx and Nose Bay haulage roads, which are radio controlled and heavily used by logging trucks, are the main access routes.

PHYSIOGRAPHY

The physiography of the Babine Lake area is characterized by rolling hills and extensive drift-covered areas of low relief. Bedrock exposure is found on the crests of small glaciated knolls, in deeply incised creek valleys and along the shores of Babine and Fulton lakes. Clear-cut logging in the area has also exposed bedrock along road cuts and in areas subject to soil erosion. Huntley *et al.* (this volume) discuss the physiography and Quaternary history of the study area.

TECTONIC HISTORY AND REGIONAL GEOLOGIC SETTING

The study area is entirely within Stikinia, which is the largest terrane of the Intermontane tectonic belt (Figure 1, McMillan and Struik, 1996, this volume). Stikinia includes Lower Devonian to Middle Jurassic volcanic and sedimentary strata of the Asitka, Stuhini, Lewes River and Hazelton assemblages and related comagmatic plutonic rocks. The oldest rocks are upper Paleozoic carbonates and island-arc volcanic and volcaniclastic rocks locally referred to as the Stikine assemblage (Monger, 1977; Brown *et al.*, 1991). Areas with this assemblage, which east of the Bowser Basin is called the Asitka Group, represent remnants of a tectonically dismembered, shallow-water island-arc environment with carbonate buildups fringing emergent volcanic islands. Permian and possibly older rocks occur in the study area and these rocks are tentatively correlated with the Asitka Group.

The Paleozoic island-arc regime was followed by a depositional hiatus prior to development of a Late Triassic volcanic arc and eruption of the predominantly basaltic Stuhini Group. By Early Jurassic time the area was part of the regionally extensive Hazelton calcalkaline volcanic arc. The orientation of this arc and the polarity of related subduction zones is still much in debate. However, facies relationships suggest there was a central marine trough that was bounded by northwest-trending island-arcs. This apparent paleogeography is complicated by significant right-lateral displacement of the Hazelton rocks along northeast-trending transcurrent faults. A northeast-dipping subduction zone seems likely for the western part of the Hazelton arc. The basaltic to andesitic island-arc volcanics exposed in the study area can be correlated with the Stuhini and Hazelton groups on the basis of lithology and inferred stratigraphic position.

Collision of Stikinia with the Cache Creek Terrane in Middle Jurassic time resulted in uplift of the Skeena Arch and formation of the Bowser Basin. From Late Jurassic to Early Cretaceous time, continued uplift and erosion of the Skeena Arch and Omineca crystalline belt resulted in deposition of thick molasse deposits in the Bowser Basin, which lies just north of the study area. In the Early Cretaceous, rocks of the Skeena Group were deposited in fault-controlled basins along the southern

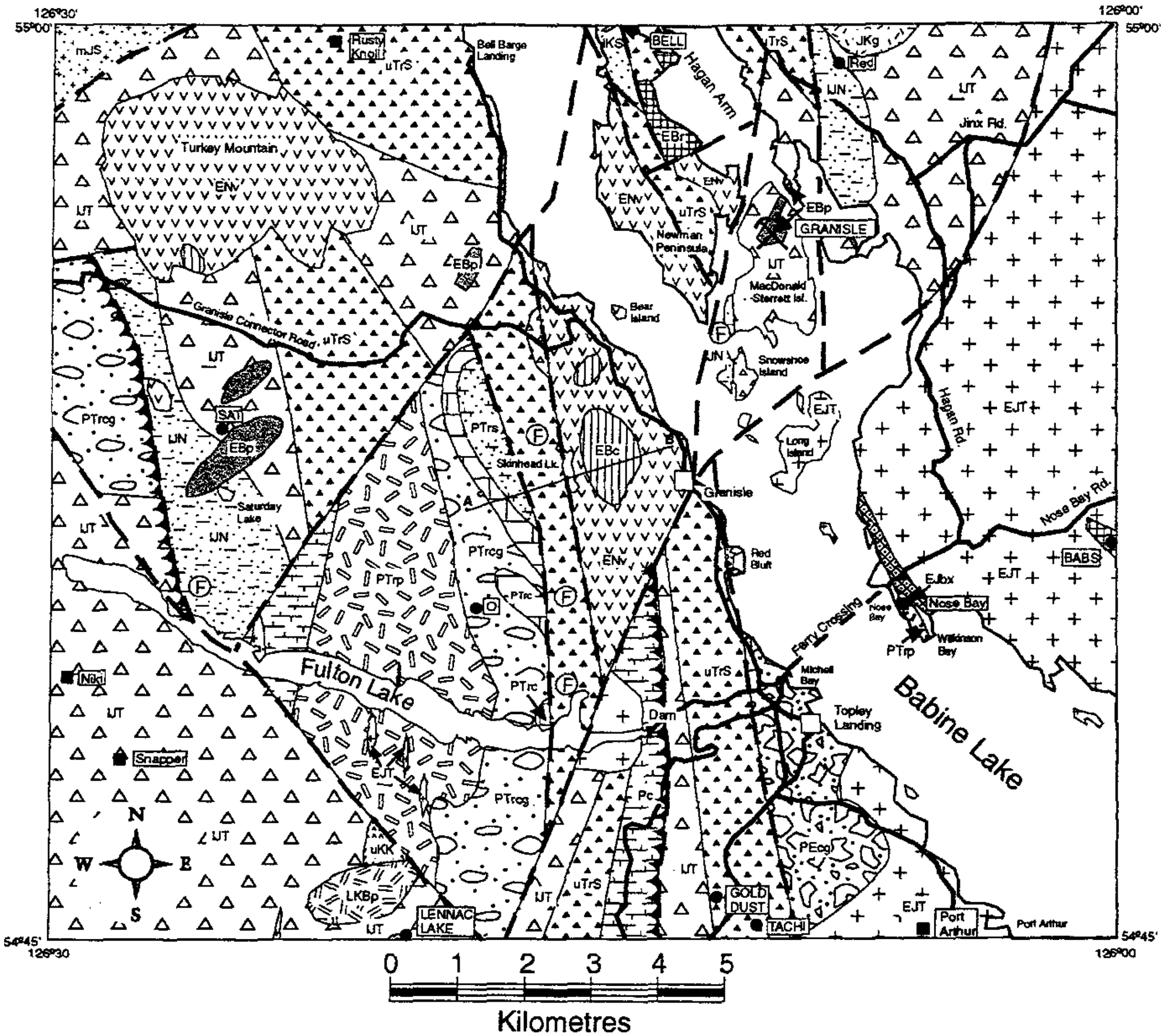

Figure 2. Generalized bedrock geology of the Fulton Lake map sheet, 93L/16. See Figure 3 for legend. Solid squares are new mineral showings; solid circles are know occurrences discussed in this report. Line A-B is the location of section shown in Figure 5.

margin of the Bowser Basin. The Upper Jurassic to Lower Cretaceous rocks of the Bowser Lake and Skeena groups host important coal deposits. Although these overlap assemblages are well represented elsewhere in the Babine Lake area, they underlie less than 5% of the area mapped in 1995.

A major plate collision in middle Cretaceous time resulted in uplift of the Coast Mountains and extensive folding and thrust faulting of rocks to the east. Debris from rising metamorphic-plutonic complexes was shed eastward and deposited in the Sustut basin. This was followed by the growth of north-trending, eastward-migrating Andean-type volcanic arcs in middle Cretaceous to Eocene time. These arcs are believed to be the result of oblique, eastward subduction of oceanic crust along the leading edge of the North American plate, with volcanic centres localized along zones of extension within a transtensional tectonic regime. Calcalkaline volcanic rocks of the Upper Cretaceous Kasalka Group and Eocene Ootsa Lake Group are the remnants of these arcs which were built on uplifted and eroded blocks of Stikinia and its Upper Jurassic to Lower Cretaceous overlap assemblages. In the study area, Eocene porphyritic flows and breccias of

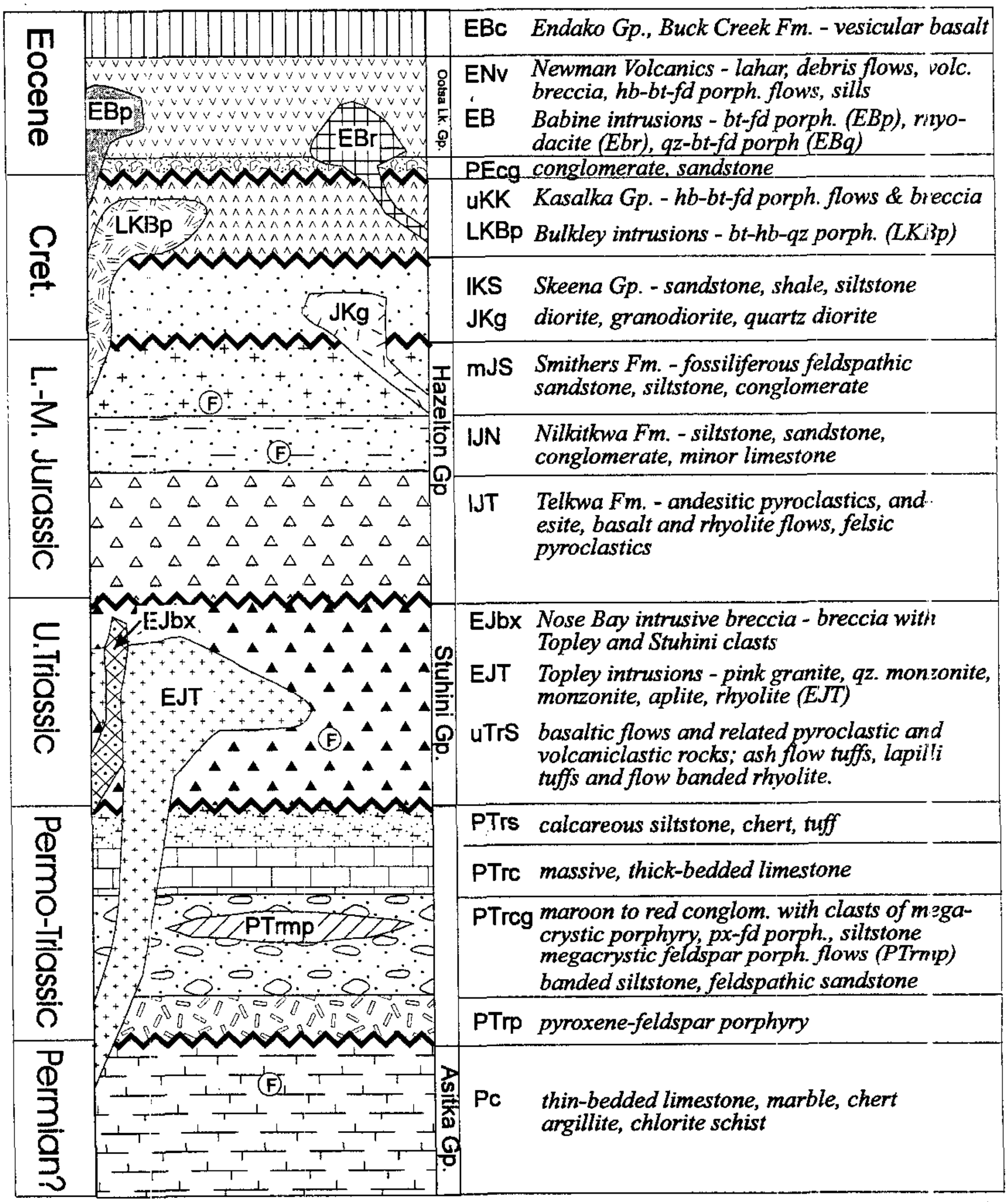

Figure 3. Stratigraphic column for the Fulton Lake map area. Fossil control shown by F inside a circle.

the Newman volcanics are correlated with the Ootsa Lake Group; the Kasalka Group is not well represented, being restricted to one small outlier. The Middle to Late Cretaceous Bulkley intrusions and the Eocene Babine intrusions (Carter, 1981) are the plutonic roots of these younger continental volcanic arcs. Mineral deposits in the study area are associated with emplacement of these intrusions. The most economically important exploration targets are porphyry copper and molybdenum deposits and related mesothermal precious metal veins.

The middle Cretaceous to Late Eocene transtensional tectonic regime produced the basin-and-range geomorphology that controls the current map pattern of the area. The latest tectonic event appears to be northeast displacement along right-lateral transcurrent faults and tilting of fault blocks to the southeast. This right-lateral displacement has offset earlier northwest-trending grabens and horsts containing Eocene and younger volcanic and sedimentary strata (MacIntyre *et al.*, 1989). Extension of the crust in Eocene to Miocene time was accompanied by extensive outpouring of continental lava flows of the Endako and Chilcotin groups which now cover large parts of the Interior Plateau.

LITHOLOGIC UNITS

The geology of the study area, based on mapping completed in 1995 and the earlier mapping of Carter (1973), Tipper and Richards (1976) and Richards (in press), is shown in Figure 2. Figure 3 illustrates our current understanding of the stratigraphic relationships between the different map units; Figure 4 is a diagrammatic section across the map area.

The geologic framework of the study area consists of a series of uplifted, tilted and folded fault blocks containing rocks ranging from possibly pre-Permian to Eocene. A north-trending graben centred on Babine Lake is defined by a series of inward dipping, progressively down-dropped fault blocks. Eocene and possibly younger volcanic rocks are preserved in the core of this graben. The graben and surrounding geology are truncated and offset by several northeast-trending dextral shear zones of probable Late Eocene age.

PERMIAN AND OLDER? ROCKS (Pc)

The oldest rocks in the map area are probably exposed in the canyon below the Fulton River dam. These rocks are distinct because they often have a well-developed schistosity. This section, which includes partly recrystallized limestone, chert, slate, phyllite, chlorite schist, amygdaloidal basalt and maroon tuff, is structurally complex and may include imbricated thrust panels of rocks ranging in age from Permian to Jurassic.

A steeply dipping, partly recrystallized limestone containing coral debris is exposed in the canyon walls at the Fulton River dam site and in a quarry just west of the dam. The limestone is thin to medium bedded, with alternating dark grey and white bands and is at least 50 metres thick. Outcrops at the dam site were sampled for radiolaria by Bert Struik of the Geological Survey of Canada. These sedimentary rocks are cut by near-vertical feldspar porphyry dikes. Near the dikes, the sediments are rusty weathering due to the presence of disseminated pyrite. Above the dam the sediments are tightly folded next to one of the dikes. The dikes may be related to a large stock of Topley quartz monzonite which crops out on the shores of Fulton Lake a few hundred metres west of the limestone outcrops.

The limestone exposed at the Fulton River dam apparently contains Permian fossils (H.W. Tipper, personal communication, 1995). Based on this assumed age these rocks are tentatively correlated with the Asitka Group (Lord, 1948; Monger, 1977) which is found east of the Bowser Basin in the McConnell Creek map area (94D).

The limestone member is overlain by dark grey chert, silty argillite and chlorite schist. Maroon tuffs and amygdaloidal basalt flows are exposed further up section, but these rocks are probably part of the Lower Jurassic Telkwa Formation. The contact is probably a high-angle thrust fault, with the Telkwa Formation rocks thrust northeastward over strongly magnetic chlorite schists. These metavolcanics may be Triassic in age.

PERMO-TRIASSIC ROCKS

Limestone and mafic volcanics that have previously been mapped as Permian and Triassic in age (Tipper and Richards, 1976b) crop out as a series of uplifted fault blocks in the centre of the map area. The best section is exposed in the large clearcut west of Granisle (Figure 5).

The Permo-Triassic succession includes a distinctive, thick-bedded limestone member which has previously been mapped as Permian. However, there are no fossil data to confirm this age and the limestone may actually be Triassic (H.W. Tipper, personal communication, 1995). Our mapping suggests the limestone is conformably underlain by a red to maroon polymictic conglomerate that contains coarse, bladed feldspar porphyry clasts. Although outcrop is limited, it appears that the conglomerate sits on pyroxene-feldspar porphyry flows that are strongly magnetic.

Limestone is the most distinctive lithology of the Permo-Triassic succession and can be several hundred metres thick. The limestone contains coral debris. Seven samples were collected from this member and these are currently being dissolved for possible conodont extraction.

PYROXENE-FELDSPAR PORPHYRY (PTrp)

Medium to coarse-grained, greenish grey pyroxene-feldspar porphyry crops out north and south of Fulton Lake. These porphyritic rocks are interpreted to be basaltic flows that formed islands within an island-arc environment. They, have equant to tabular feldspar phenocrysts up to 3 millimetres in length and pyroxene phenocrysts to 1 millimetre. Hornblende and rare biotite phenocrysts may be present. The flows locally have chlorite, quartz or carbonate-filled amygdules and are often strongly magnetic. Not surprisingly, areas underlain by these rocks produce a strong aeromagnetic

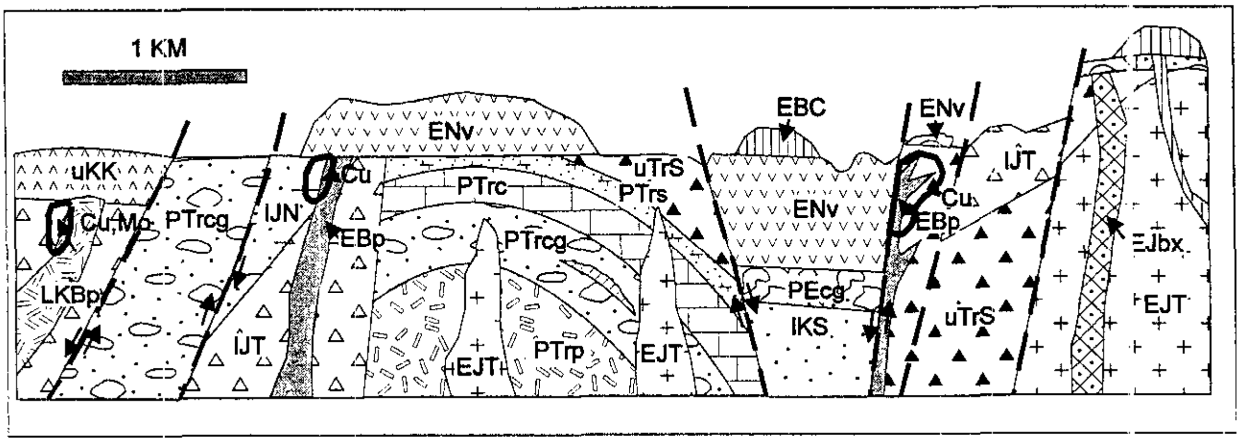

Figure 4. Diagrammatic section showing relationships of the map units in the Fulton Lake area. See Figure 3 for legend.

response and this characteristic has helped to define their extent in areas of limited or no outcrop.

The stratigraphic position of the pyroxene-feldspar porphyry flows is not certain. Based on sporadic outcrops, and assuming there are no major fault displacements, they would form the core of a north-trending antiform with its axis located near the centre of Fulton Lake. If this interpretation is correct, the porphyritic flows are overlain by interbedded tuffaceous siltstones, maroon mudstones and volcanic conglomerates. As clasts of pyroxene-feldspar porphyry occur in these conglomerates, this stratigraphic position seems likely.

CONGLOMERATE AND SANDSTONE (PTrcg)

A unit of red to maroon-weathering, poorly sorted, polymictic boulder to pebble conglomerate, and lesser greenish grey feldspathic sandstone and siltstone, crops out in a large clear-cut north of Fulton Lake. These rocks strike northwest and dip steeply northeastward below the main cliff exposures of limestone (Figure 5). Because of similar bedding attitudes, we believe the conglomerate member conformably underlies the limestone. Alternatively the limestone and overlying strata may have been thrust to the southwest over the conglomerate.

A distinctive feature of the conglomerate is the occurrence of coarse-grained tabular feldspar porphyry boulders up to 30 centimetres in diameter. The same porphyry occurs as massive sills or flows within the unit, suggesting the boulders are locally derived. Other clasts in the conglomerate are greenish chert, sandstone, siltstone, lapilli tuff and fine-grained porphyritic andesite. The conglomerate is also cut by northeast-trending, steeply dipping, epidote-rich basaltic dikes which are probably feeders for flows higher in the stratigraphic succession.

A southeasterly trending series of resistant ridges and knolls extends from the Smithers connector road at the western edge of the map area to Fulton Lake. They are underlain by conglomerate, coarse feldspathic sandstone, siltstone, minor mudstone and pyroxene-feldspar porphyry. The conglomerate is greenish grey to maroon, poorly sorted, feldspar rich and matrix-supported with subangular to subrounded, 2 to 30-centimetre clasts of bladed pyroxene-feldspar porphyry, banded tuffaceous siltstone, fine-grained felsic volcanics, chert and rare limestone. The dark green sandstone and conglomerate contain angular feldspar crystals and crystal fragments, that are often interlocking, and locally contain pyroxene crystals that comprise up to 8% of the rock. Minor pale green, thin mudstone beds have rare belemnite holes whereas the grey coarse feldspathic sandstone is generally massive, contains approximately 30% feldspar and is devoid of fossils. The conglomerate is tentatively correlated with the maroon to red-weathering conglomerate that apparently lies stratigraphically below massive, thick-bedded limestone.

A distinctive member of thin-bedded, dark grey tuffaceous mudstone, siltstone and granule conglomerate crops out in the northwest corner of the map area. These rocks may overlie, and in part be interbedded with, the pyroxene-feldspar porphyry flows. The siltstone is strongly contorted in places and much of this deformation appears to have occurred prior to lithification. Irregular, wispy rip-up clasts of siltstone also occur in overlying conglomerates, suggesting erosion of the siltstone prior to complete lithification. It seems that the siltstone and conglomerate have similar ages, with no major depositional hiatus between them.

The conglomerate and interbedded maroon and green sandstones are interpreted to be intervolcanic sediments derived from the exposure and erosion of volcanic islands comprised mainly of pyroxene-feldspar porphyry flows and associated poorly lithified marine and nonmarine sediments.

MEGACRYSTIC FELDSPAR PORPHYRY (PTrmp)

A distinctive porphyry (Photo 1), which has bladed to equant feldspar phenocrysts up to 3 centimetres long, in

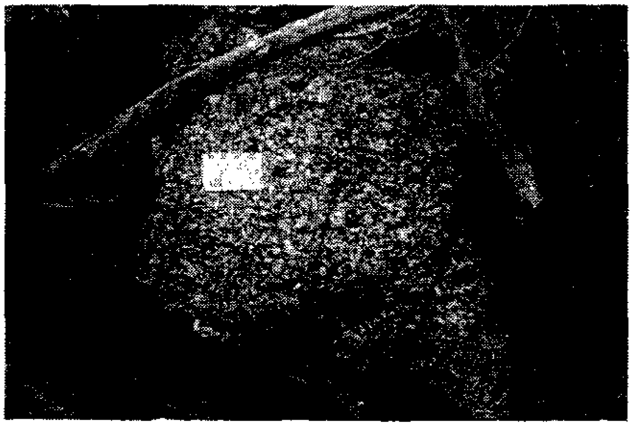

Photo 1. Megacrystic porphyry, unit PTrmp

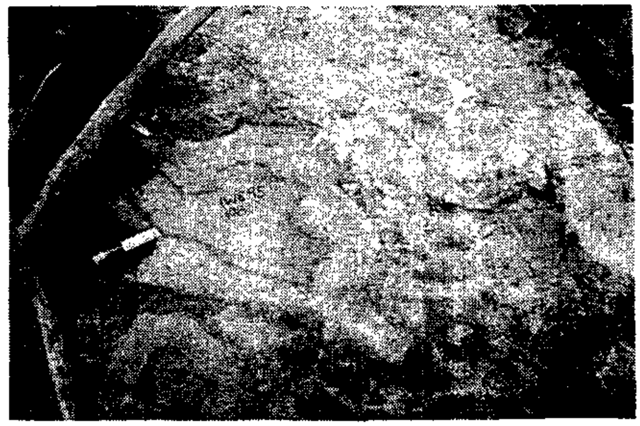

Photo 2. Volcanic breccia with rhyolitic bombs, uTrS

a greenish grey chloritic groundmass, crops out in the large clear-cut area west of Granisle and north of Fulton Lake. The porphyry, which is locally amygdaloidal, forms massive, conformable bodies within the maroon to red conglomerate-sandstone member. As mentioned earlier, clasts of this porphyry occur within the conglomerate suggesting the porphyry is the same age as its hostrocks and is more likely a flow than a sill. The same megacrystic porphyry has been noted in the conglomerate-sandstone unit south of Fulton Lake and west of Saturday Lake.

LIMESTONE (PTrc)

The most distinctive member of the Permo-Triassic succession is a medium to thick-bedded white to grey weathering, cliff-forming limestone. The limestone is best exposed along the west-facing slope of a north-trending ridge near the centre of the map sheet. Here the limestone member dips 45° to 50° to the northeast and is well exposed along several near-vertical cliff faces. This location has been examined for its industrial mineral potential (Cart prospect, MINFILE 93L 306). A similar limestone member occurs west of the dam on the north shore of Fulton Lake and dips moderately to the west.

CALCAREOUS SILTSTONE (PTrs)

Well bedded calcareous siltstones and pebble conglomerates conformably overlie the limestone member (Figure 5). These rocks are exposed on the crest of a ridge immediately east of the chain of limestone cliffs in the centre of the map area. They are in fault contact with overlying Stuhini volcanic rocks.

UPPER TRIASSIC STUHINI GROUP

A bimodal volcanic sequence overlies Permo-Triassic limestone and calcareous sediments and is tentatively correlated with the Upper Triassic Stuhini Group (uTrS) based on the occurrence of the fossil *Halobia* (H.W. Tipper, personal communication, 1995). The volcanic rocks are well exposed as a series of north-trending ridges in the large clear-cut west of Granisle and appear to be part of a continuous stratigraphic succession that dips moderately to the northeast (Figure 5). In general there is a change from maroon to green colour up section, suggesting a change from subaerial to submarine conditions. This succession is comprised of volcanic breccia, aquagene tuff and autobrecciated basaltic flows, interbedded with lapilli tuff, volcanic conglomerate and sandstone. The most distinctive lithology within the suspected Triassic succession is a greenish grey to slightly maroon volcanic breccia. The breccia is poorly sorted and contains lapilli to block-sized, rounded to subrounded volcanic clasts in a greenish grey feldspathic matrix. The clasts vary from light grey to dark green in colour and from dense, aphanitic to feldspar phyric and amygdaloidal. Medium to strong epidote alteration, often with quartz, occurs either pervasively or as veins and clots. White-weathering, flow-banded rhyolite and weakly welded ash-flow tuff members occur near the middle of the succession. A minor amount of marine sediment also occurs in the upper half of the section and contains poorly preserved bivalve fossils and possible corals. Attitudes are measured from thin tuffaceous sandstone, feldspar crystal tuff and ash tuff beds that are intercalated with the more massive volcanic rocks.

The lower part of the Triassic section is mainly massive beds of volcanic breccia with feldspar-phyric clasts in a fine-grained dark maroon matrix, separated by thin intervals of well bedded feldspar crystal tuff and volcanic conglomerates. The crystal tuffs sometimes contain minute quartz and biotite crystal fragments. Very fine grained dark maroon veinlets cut these rocks and epidote occurs as clots. Grading in the conglomerates indicates stratigraphic top is to the northeast.

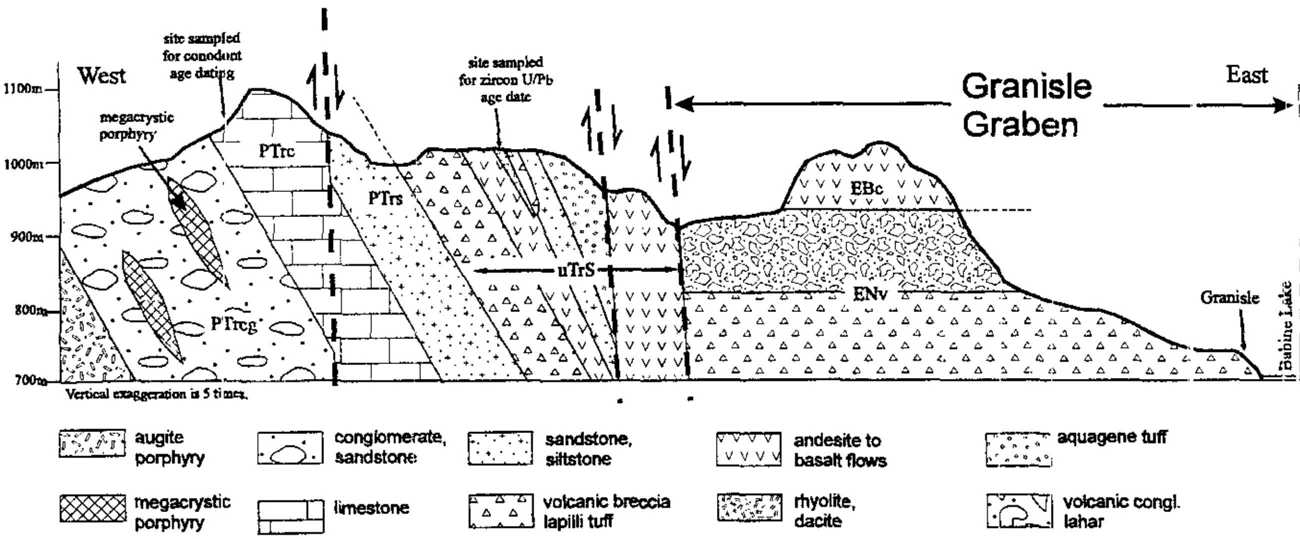

Figure 5. Section through Permo-Triassic and Eocene rocks, west of Granisle. See Figure 2 for section location, Figure 3 for legend.

Overlying the breccias is a unit of basalt to andesite flows. The flows are typically amygdaloidal and locally autobrecciated. Intense epidote alteration and veining is common. The flows weather a light brown colour and vary from maroon to greenish grey on fresh surfaces. They appear to be mostly subaerial in origin.

Overlying the flows, or possibly intruding them, are light grey weathering, discontinuous, lensoidal to dome-like bodies of flow-banded rhyolite. Flow banding is defined by cream and maroon bands, approximately 1 to 2 millimetres wide. Some of the bands are comprised almost entirely of white spherulites. The maximum thickness of this member is approximately 15 metres.

The next member in the sequence is a heterolithic, clast-supported volcanic breccia or agglomerate that contains white-weathering, 25-centimetre to 1-metre subrounded bombs of the flow-banded rhyolite. The bombs have deep reaction rims indicating that they were hot at the time of lithification (Photo 2). The breccia was probably the result of a phreatic explosion. Immediately overlying this breccia is a thin amygdaloidal basalt flow.

The next prominent ridge in the section is comprised of light grey to white-weathering, well bedded lapilli tuffs, ash-flow tuffs and volcanic debris-flows. The ash-flow tuffs are weakly welded to un-welded and contain light coloured, lapilli-sized clasts that include aphanitic rhyolite, flow-banded rhyolite and scoriaceous tuff in a fine-grained, greyish green, feldspar-phyric matrix (Photo 3). Mike Villeneuve of the Geological Survey of Canada collected a sample from this unit for U-Pb isotopic dating of zircons. Debris flows in the section contain clasts of the ash-flow tuffs and are probably locally derived.

Overlying the felsic lapilli and ash-flow tuffs is a section of interbedded medium to coarse-grained volcanic wacke, aquagene tuff and autobrecciated, amygdaloidal basalt flows. These rocks weather a distinctive orange-tan colour and have a dark green chloritic matrix. The volcanic wackes have poorly defined cross and graded bedding and locally contain poorly preserved bivalve fossils *(Halobia?)* indicating a marine depositional environment. Irregular bodies of light grey, recessive, lime mud are also associated with the fossil bearing beds and these have been sampled for conodonts.

A high-angle, north-trending normal fault displaces the Triassic section downward just west of Skinhead Lake. A sequence of greenish grey weathering, autobrecciated basaltic flows and aquagene tuffs crops out east of the fault and these rocks presumably occur near the top of the Triassic section. The flows vary from aphanitic to intensely amygdaloidal. Epidote alteration and veining is locally intense. In one locality, an aphanitic flow has a bulbous weathering pattern that is suggestive of pillows.

The Triassic section is truncated by a north-trending normal fault that traces through Skinhead Lake. East of the fault is the Granisle graben which contains flat-lying Eocene Newman and Buck Creek volcanics. The bedding attitude in the Triassic section becomes more northerly and near vertical towards the edge of the graben, probably due to downward movement on bounding faults.

Rocks similar to those exposed in the Skinhead Lake section crop out down the middle of the Newman Peninsula and on the east shore of the Hagan Arm of Babine Lake. These rocks were previously mapped as part of the Lower Jurassic Telkwa Formation, but we believe they are Triassic in age and correlative with the Stuhini Group. This conclusion is based on lithologic similarity. In both areas the rocks are mixed basalt and rhyolite in composition with pyroclastic and epiclastic members characterized by angular felsic clasts in a green chloritic matrix. The section may include minor amounts of marine siltstone and limestone.

Photo 3. Lapilli tuff with felsic clasts, unit uTrS.

Photo 4. View looking northwest toward Turkey Mountain.

PRE-TOPLEY FOLIATED DIORITE

Medium-grained equigranular, hornblende-biotite diorite underlies the high hills just outside of the northeast corner of map sheet 93L/16. The diorite has a pronounced mineral foliation defined by the alignment of hornblende and biotite. In one locality this foliation has an attitude of 095/65S. Xenoliths of biotite microdiorite, up to 10 centimetres in diameter, have indistinct (resorbed?) margins and are abundant in the intrusive. Fine-grained, pink aplitic dikes of the Topley intrusive suite cut the diorite, suggesting that the latter is an older phase and may possibly be comagmatic with Upper Triassic Stuhini volcanics. In general, the diorite does not resemble any phase of the Topley suite due to its apparent lack of potassium feldspar. An Ar-Ar geochronology sample collected from this intrusion may yield important age constraints and cooling history information.

LATE TRIASSIC TO EARLY JURASSIC TOPLEY INTRUSIONS (EJT)

The Topley intrusions, as defined by Carter (1981), include quartz diorite to quartz monzonite of Late Triassic to Early Jurassic age. Earlier studies (Carr, 1966; Kimura *et al.*, 1976) used the term Topley intrusions for granite, quartz monzonite, granodiorite, quartz diorite, diorite and gabbro intrusions of probable Jurassic age that intrude Triassic volcanic rocks from Babine Lake to Quesnel. Included in this Topley suite were high-potassium intrusions associated with the Endako porphyry molybdenum deposit. However, subsequent K-Ar isotopic dating showed most of these intrusions were Late Jurassic to Early Cretaceous in age. Consequently, the intrusions around Endako were renamed the Francois Lake intrusions to distinguish them from the older Topley suite.

Potassium-argon isotopic dates for the Topley intrusions, as defined by Carter (1981), would include ages as young as 178 Ma, but most are between 199 and 210 Ma (Early Jurassic) using the old decay constants. Most of these dates are from large plutons in the Topley area and southwest of Babine Lake. In the current study, we restrict the term Topley intrusions to typically pink, potassium feldspar rich granite and quartz monzonite of apparent Late Triassic to Early Jurassic age. We consider the type area to be the southeast corner of the Fulton Lake map sheet where a large, multiphase intrusive body, the Tachek stock, is well exposed in clear-cuts and along the shores of Babine Lake. The high-potassium composition of these rocks distinguishes them from older and younger plutonic suites that are mainly granodiorite to quartz diorite. Phases of the Topley intrusions, as defined in this study, intrude rocks believed to be correlative with the Permian Asitka and Late Triassic Stuhini groups. The only locality where a Topley intrusion has been observed cutting Telkwa Formation rocks is in a creek exposure 3 kilometres west of Lennac Lake. Here, a fine-grained, pink aplitic dike, typical of the youngest phase of the Topley suite, cuts maroon lapilli tuffs.

In the current study area there are only two localities where the Topley intrusions have been dated (Table 1). A 205$\pm$9 Ma age (210 Ma revised) was determined on hornblende extracted from coarse-grained porphyritic monzonite exposed on a small island 8 kilometres north of Topley Landing (Wanless, 1974); a 176 Ma$\pm$7 Ma age (178 Ma revised) was determined on biotite from a biotite-quartz-feldspar porphyry dike at the Tachek porphyry copper prospect (Carter, 1981). Based on lithology and apparent age we do not consider the dikes at the Tachek property to be part of the Topley suite. They are more likely related to compositionally similar rocks in the Telkwa Formation although the 178 Ma age is too young even for this correlation.

TOPLEY INTRUSIVE PHASES

The Topley intrusions have been divided into several mappable phases based on macroscopic field

TABLE 1. K-Ar DATES IN THE FULTON LAKE MAP AREA.

NTS Map	UTM Easting	UTM Northing	Description	Type	Lab Number	Reference	Original date	Revised date	error
93L/16	677314	6091091	Newman BFP; Bear Isl., Babine L.	bt	GSC 73-43	Wanless et al., 1974	44.3	45.1	2
93L/16	665878	6094217	Newman HFP; 12.9 km N of Saturday L.	hb	GSC 73-37	Wanless et al., 1974	45.3	46.8	2.7
93L/16	662856	6089781	Newman HFP, small stock; 6.4 km NW Saturday L.	hb	GSC 73-39	Wanless et al., 1974	49.0	50.2	3
93L/16	662856	6089781	Newman HBFP stock; 6.4km NW Saturday L.	bt	GSC 73-40	Wanless et al., 1974	48.9	50.2	3
93L/16	677036	6096223	Babine BFP, late phase, weakly mineralized; S central part of Bell Cu plug	bt	NC-67-22	Carter, 1981	49.8	50.7	2.1
93L/16	682022	6091781	quartz, biotite, apatite, chalcopyrite and bornite vein; S end of Granisle orebody	bt	NC-69-8	Carter, 1981	50.2	51.0	2.1
93L/16	677036	6096223	Babine BFP, late phase, mineralized; NE part of intrusion at Bell mine	bt	NC-67-23	Carter, 1981	51.0	51.5	3
93L/16	682022	6091781	Babine BFP, late dike; E. side Granisle pit	bt	NC-68-1	Carter, 1981	51.0	51.5	2
93L/16	682022	6091781	Babine BFP, late dike, unmineralized; 900 m SW of Granisle orebody	bt	NC-67-5	Carter,1981	51.0	51.6	2
93L/16	679391	6090746	Newman HFP; SW end of Newman Peninsula	hb	NC-67-43	Carter, 1981	51.5	52.4	1.9
93L/16	682022	6091781	Babine BFP, mineralized; SW part of Granisle orebody	bt	NC-67-4	Carter, 1981	55.0	55.8	3
93L/16	681279	6070396	Topley hornblende-biotite-quartz porphyry, late dike, *mineralized; Tachek Creek*	bt	NC-69-4	Carter, 1981	176	178	7
93L/16	683883	6082888	Topley monzonite, coarsely porphyritic, slightly foliated; island 8 km N of Topley Landing	hb	GSC 73-45	Wanless et al., 1974	205	210	9
93L/09	671768	6066311	Bulkley hornblende-biotite-quartz-feldspar porphyry, mineralized; Lennac Lake (Thezar) property	bt	NC-72-1	Carter, 1981	77.0	78.3	2.5

HBFP = hornblende-biotite-feldspar porphyry
BFP = biotite-feldspar porphyry
hb=hornblende
bt=biotite

observations and modal abundances. Names of phases were assigned using the IUGS classification scheme for intrusive rocks. Future work, to better characterize the intrusive suite, will involve staining, thin section examination and whole-rock geochemistry. Following is a brief description of the plutonic phases from oldest to youngest.

Monzonite to Quartz Monzonite Phase

This phase occupies the eastern part of the Tachek stock on the Fulton Lake map sheet. It typically weathers orange and forms some of the conspicuous, large orange outcrops in clear-cuts on the east side of Babine Lake. This phase is mainly a leucocratic, medium to coarse-grained, equigranular and plagioclase-phyric intrusive that varies from monzonite to predominantly quartz monzonite in composition. The groundmass is composed of intergrown potassium feldspar and quartz crystals. Slightly larger plagioclase phenocrysts (up to 7 mm) sometimes give the rock a porphyritic appearance. The rocks commonly contain biotite with or without hornblende, with mafics totalling less than 3% by volume. Miarolitic cavities occur only in this phase of the Topley suite. They are filled with terminated quartz crystals which may have a black coating, and less frequently with epidote crystals. The cavities vary from several millimetres to 2 centimetres in diameter with the average being 1 centimetre. Mike Villeneuve of the Geological Survey of Canada collected a sample from this phase for U-Pb isotopic dating, in an overgrown clear-cut on the east side of the lake.

A slightly different monzonite was observed in contact with the coarse-grained main monzonite phase in two localities. Although noteworthy, this unit may not be of regional significance. The phase is a very fine grained monzonite with densely packed, bladed feldspars on a millimetre scale. The contact between it and the main monzonite is diffuse and suggests that both rocks were molten when intruded and that they could possibly be segregations of the same magma. In another locality, an apophysis of the coarse-grained monzonite has invaded a fine-grained phase that also appears to have been only partially crystallized.

Other variations in the monzonite include a fine-grained phase with bladed hornblende crystals and small areas of finer grained intrusive with lesser plagioclase, which may be closer to syenite in composition.

Granite Phase

The granite phase, which crops out on the east and west shores of Babine Lake and on Long and Double islands, comprises the largest proportion of the Topley intrusions in the study area. The granite is more monotonous in composition and visual appearance than the quartz monzonite phase. It typically has a medium to coarse-grained equigranular texture and weathers pale pink. Locally the granite is sparsely porphyritic with scattered orthoclase megacrysts up to 2 centimetres long. Quartz phenocrysts up to 1 centimetre long occur as irregularly shaped, elongate crystals that are intergrown with a groundmass of orthoclase, plagioclase and lesser quartz. This phase may also carry up to 2% biotite and/or hornblende phenocrysts. A very weak foliation, defined by the alignment of quartz and mafic minerals locally occurs in the granite. A stronger foliation, with a gentle to moderate northeast dip, is present in outcrops on Double Island. This foliation is probably structurally controlled.

In one clear-cut near the Jinx Road, the granite grades into crowded porphyritic granodiorite. Although the granodiorite is more plagioclase rich than the granite, it still has sporadic potassium feldspar megacrysts and occasional large quartz grains. The groundmass of the granodiorite is composed of rounded plagioclase crystals up to 5 millimetres in diameter with very fine grained mafic minerals comprising 7 to 10% of the rock. This phase contains small xenoliths of dark grey microdiorite and clusters of hornblende crystals up to 3 centimetres long.

The coarse-grained phase is more recessive than the quartz monzonite and therefore not as well exposed. Intrusive relationships between the two phases have not yet been observed. However, in one locality, on the east side of Babine lake, a brecciated zone in the granite contains a single rounded clast of quartz monzonite, suggesting that the latter is slightly older. Overall, the two phases are considered to be very similar in age and derived from the same magmatic source. Mike Villeneuve of the Geological Survey of Canada collected a sample of the granite for U-Pb radiometric dating from an excellent exposure in a quarry near the Port Arthur landing on the west shore of Babine Lake, south of Topley Landing. A basalt dike of probable Eocene age cuts the granite near the northeast end of the quarry.

Pink Aplite to Rhyolite Phase

There are several later dike phases that intrude both the quartz monzonite and granite phases of the Tachek stock and surrounding rocks. The dikes appear to have a similar potassium-rich composition to the main granitoid phases and are therefore included as part of the intrusive suite. They typically have vertical contacts and a predominant northeast trend. All of the dikes have an aphanitic to sugary textured groundmass that can be pink, orange, orange-brown, orange-tan or light grey in colour. The dikes are locally sparsely porphyritic with two distinct phenocryst assemblages. One has orthoclase phenocrysts up to 4 millimetres long, the other has both orthoclase and glassy quartz eyes up to 3 millimetres.

The composition of these fine-grained, dense rocks is unknown until staining and thin section work can be completed. Rock names such as aplite, rhyolite, syenite and monzonite all seem appropriate, depending on the colour of the rock and its mineralogy. This apparent variation in dike chemistry may mimic the range of compositions in the main phases of the Topley suite. In several localities, the borders of dikes are flow banded and/or spherulitic, suggesting these are high-level, volatile-rich rhyolitic intrusions. An excellent example of flow banded dikes crops out on the western shore of Double Island. Occasionally the flow banded dikes are chalky weathering and this is probably due to devitrification.

XENOLITHS

Xenoliths are rare in the Topley intrusions. All of the xenoliths occur as pods several metres in diameter and are composed of mafic volcanic rocks of probable Triassic age. Although few of the contacts are exposed, the xenoliths show no apparent sign of metamorphism or assimilation and no fingers of Topley intrude them. In one locality, a xenolith of dark grey mafic volcanic flow, with 1 to 2-millimetre feldspar laths, grades into a fine-grained flow-top breccia with recessive calcite-filled cavities.

ALTERATION

Most of the Topley rocks are relatively fresh, with only minor chlorite alteration of hornblende and biotite. Fractures sometimes have potassium feldspar alteration envelopes around them, typically a few millimetres wide. This alteration is probably related to discharge of volatile-rich fluids during the final stages of crystallization. Epidote veins and clots are locally observed and generally have no consistent orientation. Rarely a criss-crossing network of chloritic veinlets penetrates the rock. Some of the Topley rocks near the Babs prospect have a chalky, whitish appearance. This argillic alteration may be related to a younger hydrothermal system active during emplacement of biotite-feldspar porphyry dikes.

CORRELATION OF THE TOPLEY SUITE

The high potassium content of the Topley intrusions is reflected in the presence of potassium feldspar either as large 2 to 3-centimetre phenocrysts or as a pervasive fine-grained groundmass. Previous workers (Carter, 1981) felt these intrusions were comagmatic with the Lower Jurassic Telkwa Formation. However, the Telkwa Formation is a typical calcalkaline andesitic arc assemblage. The plutonic equivalents of such an arc should be granodiorites and quartz diorites, not the potassium-rich granites and monzonites exposed in the Babine Lake area. The Topley suite appears to be too potassium rich (and possibly too old) to be related to the Telkwa Formation andesites. Intrusions that may be comagmatic with the Telkwa Formation do occur elsewhere in the Skeena Arch and in the Coast Plutonic Complex and some of them were previously included in the Topley suite. We feel these intrusions, which are possibly younger and clearly compositionally different from the type intrusions of the Topley suite, should be treated separately.

In terms of composition and age, the Topley intrusions (as defined in this report) are most similar to the Black Lake intrusions in the Toodoggone River area. These rocks are believed to be comagmatic with the high-potassium Early Jurassic Toodoggone volcanics which host important epithermal deposits (Diakow *et al*., 1991). This raises an intriguing question: are the Black Lake intrusions in the Toodoggone River area the northwardly displaced equivalent of the Topley intrusions? This would require over 200 kilometres of right-lateral displacement on the Takla-Ingenika-Finlay fault system, considerably more than the 115 kilometres proposed by Gabrielse (1991). However, if this correlation is correct then it has important implications for the mineral potential of Jurassic volcanic rocks southeast of the Topley intrusions. Some of these rocks may be equivalent to the Toodoggone Formation and may host epithermal gold deposits. The southern extent of the Takla fault projects into the Fulton Lake map sheet. However, low topography and limited outcrop makes establishing the true trace and nature of this structure impossible. We currently believe that the contact of the Tachek stock in the southeast corner of the study area is a fault and may in fact connect to the Takla fault system. Telkwa Formation rocks adjacent to this fault are not thermally metamorphosed, do not contain Topley dikes and are locally sheared, further evidence that the contact is a fault.

NOSE BAY INTRUSIVE BRECCIA

A distinctive breccia, which we believe to be intrusive, crops out on the east shore of Babine Lake, just south of Nose Bay. This breccia, which we have named the Nose Bay intrusive breccia, trends northwest, has near-vertical contacts with surrounding Topley rocks, and is over 5 kilometres long and up to 1 kilometre wide. One of the best exposures occurs at the Nose Bay ferry landing on the east side of Babine Lake. Here, the breccia crosscuts the main granite phase of the Early Jurassic Tachek stock. Clast types are dominated by milled and broken fragments of Topley granite with lesser monzonite and fine-grained aplitic phases. The breccia can be both matrix and clast-supported. The matrix is greenish in colour and appears to be mainly basaltic in composition. In many exposures it is evident that the matrix, despite its apparent volcanic composition, has forcibly intruded the host granite, breaking, injecting and milling the rock into fragments during the process.

One of the best examples of fragment milling is exposed at Wilkinson Bay where the matrix of the breccia contains abundant broken crystals of quartz and feldspar. At this locality the breccia also contains larger clasts of granite, augite-porphyritic basalt and rare limestone. The latter are probably Permian or Upper Triassic in age and indicate that the breccia cuts through these rocks at depth. This also suggests that the Tachek stock is a large, epizonal, mushroom-shaped body, which is partially floored by older Asitka and/or Stuhini rocks.

Other exposures of the Nose Bay intrusive breccia, especially those along the main logging road, have a larger proportion of volcanic clasts than Topley clasts. The volcanic clasts include dense augite-phyric basalt, augite-plagioclase-phyric basalt, amygdaloidal basalt, equigranular diorite, quartz, and strongly epidotized volcanic rock, all of which are believed to be derived from the Stuhini Group.

The Nose Bay breccia is clearly younger than the main granitoid phases of the Topley intrusions which it cuts. It is also located close to the contact between quartz monzonite and granite phases and a fault-bounded panel of augite-phyric basalt that is probably Triassic in age. This implies emplacement of the breccia was in part structurally controlled. In one locality along the road it appears that the intrusive breccia is cut by vertical, late-stage Topley aplitic dikes. If these dikes are in fact part of the Topley suite, it indicates formation of the intrusive breccia occurred during the waning stages of Topley plutonism. However, a younger age for the breccia cannot be ruled out. Mafic dikes of possible Eocene or younger age also cut the breccia.

The Nose Bay breccia unequivocally intrudes a large structural zone. Many questions arise about how it fits into the regional tectonic framework of the Babine Lake area and where its eruptive equivalents, if any, may be. One possible locality where such rocks may occur is adjacent to and within the Topley intrusive body exposed south of Tachek creek. Here, maroon, feldspar-phyric volcanic breccias contain angular, pink-weathering clasts of the Topley intrusions. These breccias, which were originally called the Tachek Group by Carter (1973), appear to have been deposited directly on exposures of Topley intrusive rocks. Although the breccias may be correlative with the Lower Jurassic Telkwa Formation, they are also lithologically similar to the Nose Bay intrusive breccia and may be the extrusive equivalent of these rocks. More work is needed to better define these relationships.

South of the map area, Eocene basaltic flows of the Buck Creek Formation disconformably overlie both the Topley intrusions and surrounding Triassic and Jurassic volcanic rocks. This indicates that the intrusions were unroofed sometime prior to the Eocene and perhaps as early as Middle Jurassic when the Skeena Arch was formed.

LOWER TO MIDDLE JURASSIC HAZELTON GROUP

The Hazelton Group (Leach, 1910) is a calcalkaline island-arc assemblage that evolved in Early to Middle Jurassic time. Tipper and Richards (1976a) divided the group into three major formations. These are, from oldest to youngest, the subaerial to submarine, predominantly calcalkaline volcanic Telkwa Formation, the marine sedimentary and volcanic Nilkitkwa Formation and the shallow water, marine transgressive Smithers Formation. The Telkwa Formation underlies the southwest and northeast corners of the study area, whereas only minor exposures of the Nilkitkwa and Smithers formations are present.

LOWER JURASSIC TELKWA FORMATION (lJT)

The type area for the Telkwa Formation is in the Telkwa Range, where a thick section of Early Jurassic volcanic rocks is well exposed. Regionally, the formation varies from marine to nonmarine and ranges from Sinemurian to early Pliensbachian in age. In the type area the predominant lithologies are air-fall tuffs, volcanic breccias and amygdaloidal basalt flows; these rocks constitute the Howson subaerial facies of the formation (Tipper and Richards, 1976a).

Previous mapping in the type area (MacIntyre *et al.*, 1989) suggests the Telkwa Formation is divisible into three members, each representing a distinct cycle of arc volcanism. These members are characterized by their predominant lithologies, although internal facies variations are common. In ascending stratigraphic order they are: (1) an andesitic pyroclastic member comprised of thick-bedded, massive, maroon andesitic lapilli, crystal and ash tuffs with minor interbeds of siliceous-banded ash flows and grey, welded lapilli tuffs; (2) a basaltic flow member which is predominantly dark green to maroon, amygdaloidal to aphyric basalt; and (3) a felsic pyroclastic member that includes interbedded ash-flow tuff, felsic lapilli and crystal tuff, flow-banded spherulitic rhyolite, volcanic breccia and related epiclastic rocks.

A succession of maroon tuffs and amygdaloidal basalt flows crops out in the southwest and northeast corners of the Fulton Lake map sheet and on MacDonald-Sterrett Island. Lithologically and stratigraphically these rocks are identical to the Howson subaerial facies of the Telkwa Formation in the type area west of Telkwa. Both the andesitic pyroclastic and basaltic flow members are present in the Babine Lake area although the upper felsic pyroclastic member is absent or very thin. Here, as in the type area, air-fall tuffs predominate and typically contain feldspar-phyric maroon and grey andesite clasts in a feldspar-rich matrix. In the Babine Lake area, lapilli tuffs and volcanic breccias predominate near the top of the Telkwa section and finer grained maroon ash and crystal tuff interbedded with tuffaceous sandstone and mudstone occur near the base of the section.

The Telkwa rocks are assumed to rest unconformably on Triassic Stuhini rocks although this contact has not yet been observed. Everywhere in the current study area the contact between suspected Triassic or older rocks and the Telkwa Formation is a fault.

The best section through the Telkwa Formation is on MacDonald-Sterrett Island (Granisle mine). Here the Telkwa rocks dip moderately to the northwest and are overlain conformably by fossiliferous marine sedimentary rocks of the Nilkitkwa Formation. Underlying the sedimentary rocks are amygdaloidal basalt flows which we correlate with the middle member of the Telkwa Formation (the upper felsic pyroclastic member is absent or very thin here). The basaltic flow member is underlain by the andesitic pyroclastic member which, going from highest statigraphic position to lowest, includes maroon volcanic breccia, ridge-forming, massive porphyryitic andesite flows and recessive, interbedded maroon crystal and ash tuff.

East of Babine Lake, maroon volcanic breccias and lapilli tuffs, similar to those on MacDonald-Sterrett island, are found in sporadic outcrops west and east of the Hagen and Jinx haulage roads. Here, as on the island, the Telkwa rocks dip moderately to the northwest. The occurrence of coarse volcanic breccias and porphyritic flows suggests a proximal, subaerial volcanic environment similar to the Howson subaerial facies as defined by Tipper and Richards (1976) in the type area of the Telkwa Formation. However, Tipper and Richards assign the Telkwa rocks in the Babine Lake area to the submarine Kotsine facies. Our work does not support this correlation. We feel all of the Telkwa rocks in the Babine Lake area are vent-proximal, subaerial calcalkaline volcanics. The occurrence of these rocks as far east as Babine Lake implies that Telkwa subaerial volcanism extends much further east than originally thought.

Although the andesitic pyroclastic member of the Telkwa Formation is predominantly air-fall tuff, flow-banded, spherulitic rhyolite domes and welded ash-flow tuffs do crop out in the west-central part of the map area, just south of Fulton Lake. These siliceous rocks appear to sit stratigraphically above amygdaloidal basalt flows and are, therefore, tentatively correlated with the upper felsic pyroclastic member of the Telkwa Formation. The felsic pyroclastic member, which represents the final explosive stages of Telkwa volcanism, is very thin or absent elsewhere in the Babine Lake area.

LOWER JURASSIC NILKITKWA FORMATION (lJN)

Tipper and Richards (1976a) assigned thick sections of Pliensbachian to Toarcian shale, greywacke, tuff, breccia and minor limestone, that are well exposed in the Nilkitkwa and Bait ranges, to the Nilkitkwa Formation. In the type area the formation is as much as 1000 metres thick. Limestone and chert beds occur in the lower part of the section and help distinguish Nilkitkwa rocks from younger, lithologically similar formations. Shallow-water fossiliferous limestone, interbedded with pebble conglomerate and feldspathic sandstone, is particularly common where Nilkitkwa sediments onlap Telkwa volcanics.

The only known occurrences of the Nilkitkwa Formation in the current study area are on the northwest shore of MacDonald-Sterrett Island and in Broughton Creek, west of Saturday Lake. On MacDonald-Sterrett

Island, fossiliferous feldspathic sandstone, siltstone and pebble conglomerate conformably overlie the amygdaloidal basalt member of the Telkwa Formation. Fossils from this locality, including well preserved *Weyla*, are similar to fossils found in late Sinemurian to early Pliensbachian beds in the Telkwa Range (MacIntyre *et al.*, 1989). One locality on a small island just south of Sterrett Island is Late Sinemurian in age (H.W. Tipper, personal communication, 1995). The Broughton Creek locality is younger and contains late Pliensbachian macrofossils (H.W. Tipper, personal communication, 1995).

Although outliers of Nilkitkwa Formation were mapped south and north of Fulton Lake by Tipper and Richards (1976a), we believe these rocks are actually older and part of the Permo-Triassic succession because of their apparent stratigraphic position and lithology.

MIDDLE JURASSIC SMITHERS FORMATION (mJS)

The only known exposures of the Smithers Formation are in the extreme northwest corner of the study area. Here, a northeast-trending fault separates a down-dropped block of Smithers Formation and older Jurassic and Triassic volcaniclastic rocks. Smithers Formation lithologies include maroon to greenish grey glauconitic feldspathic sandstone, siltstone and shale, lithic wacke, tuff and minor pebble conglomerate and limy siltstone. The sediments, which were deposited in a shallow-water marine to nonmarine environment, are locally fossiliferous with numerous Belemnite holes.

UPPER JURASSIC TO LOWER CRETACEOUS BOWSER LAKE GROUP

There are no known outcrops of Bowser Lake Group in the Fulton Lake map area. This may be due to the fact that it lies between the Bowser Basin and the Skeena Arch and Bowser Lake Group rocks were not deposited in this area, or alternatively they were deposited and subsequently removed by erosion. Coal-bearing chert-pebble conglomerates of the Trout Creek Formation do occur in down-thrown fault blocks immediately west and north of the map area. These rocks are at the base of the Bowser Lake Group and were deposited in a high-energy, near-shore environment that probably bordered uplifted areas in Late Jurassic to Early Cretaceous time.

JURA-CRETACEOUS INTRUSIONS (JKg)

A stock of medium-grained diorite crops out in a clear-cut in the northeast corner of the study area. The stock apparently intrudes Lower Jurassic Nilkitkwa Formation sedimentary rocks and is therefore Jurassic or younger. The diorite is similar to other intrusions in the district that have yielded 100 Ma ages.

LOWER CRETACEOUS SKEENA GROUP (lKS)

The Skeena Group (Leach, 1910) is characterized by well bedded, quartz and muscovite-bearing, marine sedimentary rocks that overlap Jurassic and older rocks along the southern margin of the Bowser Basin. The main Skeena lithologies are dark grey shaly siltstone, greywacke and chert-pebble conglomerate These sediments were deposited in a fluviodeltaic, near-shore marine environment (Basset, 1991). The only rocks in the current study area that may be part of the Skeena Group are siltstones and sandstones immediately west of the Bell mine and sporadic outcrops in a large clear-cut that parallels the northern edge of the map area.

LATE CRETACEOUS BULKLEY INTRUSIONS (LKBp)

The term Bulkley Intrusions was first used by Kindle (1954) for granitic rocks in the Hazelton area. This suite of intrusions is Late Cretaceous in age and includes large porphyritic and equigranular stocks of quartz monzonite, granodiorite and quartz diorite and smaller plutons and dikes of feldspar porphyry, hornblende-biotite-quartz-feldspar porphyry and quartz porphyry. Potassium argon isotopic ages range from 70 to 84 Ma (Carter, 1976). The plutons define a north-trending belt that extends from north of the Babine River south to the Eutsuk Lake area. They are believed to be the roots of an eastward-migrating magmatic arc that formed during a major transtensional tectonic event in Middle to Late Cretaceous time.

In the study area, the only known Bulkley intrusions crop out northeast of Lennac Lake. These intrusions, which cut maroon tuffs of the Telkwa Formation and have associated porphyry copper mineralization, are coarse-grained crowded porphyries with 30 to 40% biotite and plagioclase phenocrysts in a medium-grained quartz-plagioclase groundmass. Phases containing hornblende and quartz phenocrysts are also common. A characteristic of the intrusions near Lennac Lake is the presence of 0.5 to 1 centimetre wide books of biotite. A 77.0$\pm$2.5 Ma K-Ar age (78.3 Ma using new decay constants, Table 1) was determined on biotite from a biotite-hornblende-feldspar porphyry intrusion at the west zone on the Lennac Lake property (Carter, 1976).

UPPER CRETACEOUS KASALKA GROUP (uKK)

The type area for the Kasalka Group is at Tahtsa Lake where Middle to Upper Cretaceous calcalkaline volcanics overlie the Skeena Group with angular discordance (MacIntyre, 1985). These volcanics are part of a north-trending continental volcanic arc that transected west-central British Columbia in Late

Cretaceous time. The predominant rock types are hornblende-feldspar-phyric latite-andesite and andesite, volcanic breccia, lapilli tuff and lahar. Sutherland Brown (1960) mapped similar rocks as the Brian Boru Formation in the Rocher Déboulé Range north of Smithers and MacIntyre and Desjardins (1988) documented Kasalka Group rocks in the Babine Range west of the study area. Our mapping suggests a small, fault-bounded block of Kasalka volcanics occurs 3 kilometres north of the west zone at the Lennac Lake property. Although outcrop is very limited, two small outcrops of volcanic breccia with clasts of medium-grained, crowded, hornblende-biotite phyric andesite, typical of the Kasalka Group, were located. One of the breccias contains clasts of coarse-grained quartz-biotite-feldspar porphyry that is identical to a large intrusive body less than 2 kilometres to the south. This suggests the breccia is slightly younger than the intrusions.

EOCENE BABINE INTRUSIONS

The Babine intrusions (Carter, 1976; 1981) include small plugs and dikes of crowded biotite-feldspar porphyry (bfp) and lesser granodiorite, quartz diorite and rhyodacite that occur as multi-phase intrusive centres in a north-trending belt that extends from Fulton Lake to Trail Peak (Figure 1). Potassium-argon isotopic ages range from 49 to 55 Ma (50.2 to 55.8 using new decay constants, see Table 1) indicating the intrusions are early Eocene in age. The intrusions, which are believed to be the subvolcanic roots of a calcalkaline magmatic arc, cut volcanic and sedimentary strata ranging in age from Triassic to Early Cretaceous. The Newman volcanics are the extrusive equivalents of the intrusions and these rocks are preserved close to intrusive centres on the Newman Peninsula and at Saturday Lake. The fact that the volcanic edifices have not been completely removed by erosion is further evidence that the Babine intrusions and associated porphyry copper deposits such as Bell and Granisle are exposed at a subvolcanic level.

Compositionally, the Babine intrusions and Newman volcanics are very similar to the older Bulkley intrusions and Kasalka volcanics found further to the west. This suggests similar, transtensional, volcanic environments prevailed during the Late Cretaceous and, Eocene, with the locus of volcanism moving progressively eastward with time.

BIOTITE-FELDSPAR PORPHYRY (EBp)

The most characteristic rock type of the Babine intrusive suite is a crowded, dark grey biotite-feldspar porphyry which typically occurs as small plugs and dikes. This rock type contains 40 to 60%, 2 to 3-millimetre phenocrysts of biotite, plagioclase and rarely hornblende and quartz, in a finer grained groundmass of plagioclase, quartz, biotite and minor potassium feldspar. The porphyries are quartz diorite to granodiorite in composition and are typical of plutonic rocks found in a continental calcalkaline magmatic arc environment.

QUARTZ-BIOTITE-FELDSPAR PORPHYRY AND QUARTZ FELDSPAR PORPHYRY (EBq)

Quartz-phyric intrusions with or without biotite postdate the main phase of stockwork mineralization at the Bell mine and apparently cut the earlier biotite-feldspar porphyry phase (Dirom *et al.*, 1995). The quartz-phyric rocks are weakly mineralized relative to the bfp phase and contain partially resorbed quartz phenocrysts. This intrusive phase is restricted to the area around the Bell pit and is not found elsewhere in the map area other than perhaps at the Babs property where quartz eyes have been noted in altered rhyolitic rocks.

RHYODACITIC INTRUSIVE-EXTRUSIVE COMPLEX (EBr)

An intrusive-extrusive complex of probable Eocene age crops out on the Newman Peninsula south of the Bell mine. It is comprised of interbedded amygdaloidal basalt or andesite and greenish grey feldspar porphyry, with distinctive, zoned, partly resorbed, 1 to 5-millimetre plagioclase phenocrysts, intruded by dikes and plugs of white to cream, flow-banded rhyodacite. Rhyodacite plugs and dikes also crop out in the vicinity of the Bell deposit and appear to bracket the main phase of biotite-feldspar porphyry. It is uncertain whether rhyodacite in this complex is the same age as rhyodacite intrusions in the vicinity of the Bell pit. The intrusive-extrusive complex is interpreted to be an eruptive centre coeval with the main phase of Newman volcanism.

EOCENE OOTSA LAKE GROUP

The Ootsa Lake Group, as defined by Duffell (1959), is a succession of continental calcalkaline volcanic rocks with minor nonmarine sedimentary interbeds. In the type area around Ootsa Lake, the volcanic members are differentiated andesites, dacites and rhyolites. The dacites and rhyolites occur both as flows and flow-breccia dome complexes of limited areal extent; the andesites and tuffs are more extensively distributed. Several dates determined in the Whitesail Lake area indicate that the Ootsa Lake volcanics erupted 50 million years ago for a period as short as 1 million years (Diakow and Mihalynuk, 1987). In the study area, hornblende-biotite-phyric andesite flows, breccias and lahars of the Newman volcanics yield similar ages and are therefore mapped as part of the Ootsa Lake Group.

NEWMAN VOLCANICS (ENv)

In the Babine Lake area, hornblende-biotite-plagioclase porphyry flows, breccias and lahars sit with angular discordance on Triassic and Jurassic volcanic

Photo 5. Columnar-jointed hornblende-biotite-feldspar porphyry, Newman Peninsula.

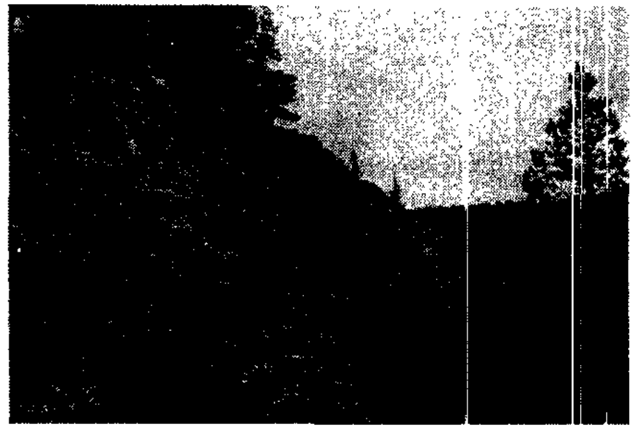

Photo 6. Stratified lahar of the Newman volcanics exposed on the west side of Turkey Mountain.

and sedimentary rocks. These rocks are well exposed on both sides of the Newman Peninsula and were given the name Newman volcanics by Tipper and Richards (1976a). On the east side of the peninsula the Newman volcanics appear to rest with angular discordance on folded Triassic or Jurassic volcanics. They also form a subcircular volcanic plateau in the northwest corner of the study area. This plateau, which is locally known as Turkey Mountain, may be the eroded remains of a large volcanic cone (Photo 4). Good exposures of the Newman volcanics also occur sporadically along the western shore of Babine Lake and on Bear Island.

The Newman volcanics are Early Eocene based on previous K-Ar dating which ranges from 44.3±2 to 51.5±1.9 Ma (45.1 to 52.4 using new decay constants, Table 1). These ages overlap those determined for lithologically identical porphyries of the Babine intrusions and the volcanics are, therefore, considered to be the extrusive equivalent of these rocks.

The Newman volcanics can be subdivided into three units or members. The lowest member is mainly columnar to sheet-jointed hornblende-biotite-feldspar porphyry flows and/or sills that are lithologically similar to biotite-feldspar porphyries of the Babine intrusions. These rocks are overlain by a middle member which is mainly volcanic breccia composed of angular clasts identical to the underlying porphyries. Towards the top of the section lahars, debris flows and volcanic-pebble conglomerate predominate. A gently east dipping, heterolithic conglomerate exposed in Tachek Creek, and sitting with angular discordance on Triassic volcanic rocks, may be the basal member of the Newman volcanics.

Hornblende±Biotite-Feldspar Porphyry Member

The best exposures of the hornblende±biotite-feldspar porphyry member are along the west side of the Newman Peninsula. Here, a columnar jointed flow or sill is well exposed along the shoreline for several hundred metres (Photo 5). A sheet-jointed flow or sill crops out higher up on the steep west face of a prominent knoll near the end of the peninsula. Across the lake, to the west, columnar jointed porphyry is exposed on the shoreline cliffs of Bear Island.

Northwest of Saturday Lake and south of Turkey Mountain, columnar jointed hornblende-biotite-feldspar porphyry crops out as a small, steep-sided knoll. The porphyry is either a flow that rests on folded sediments of the Nilkitkwa Formation or the remnants of a steep-sided plug or volcanic neck.

Volcanic Breccia Member

A northeast-dipping section through the Newman volcanics is well exposed along the access road on the east side of the Newman Peninsula. Massive hornblende±biotite-feldspar porphyry crops out at the south end of the road and is probably near the base of the section. The porphyry grades into a volcanic breccia that contains angular clasts identical to underlying flows but in a finer grained, greenish grey hornblende±biotite-feldspar phyric andesitic matrix. Near the top of the section, the breccias become more recessive and are interbedded with monolithic lahar and volcanic conglomerate. The volcanic breccia member appears to occupy a similar stratigraphic position on the west side of the peninsula although these relationships are complicated by a series of northwest-trending faults.

Lahar Member

The upper part of the Newman volcanics is dominated by chaotic debris flows or lahars with lesser interbedded volcanic conglomerate. These rocks are well exposed on steep cliff faces surrounding Turkey Mountain in the northwest corner of the map area (Photo 6). The lahars are typically very poorly sorted with subangular to subrounded, hornblende-biotite-feldspar porphyry clasts, ranging from several metres to less than 10 centimetres in diameter, floating in a matrix of poorly consolidated light grey ash and 1 to 2-

TABLE 2. MINERAL OCCURRENCES

MINFILE Number	Name	Status	NTS Map	UTM Easting	UTM Northing	Commodity	Type
093L 144	Tachi	show	93L16	681534	6070716	Cu,Mo	Porphyry
093L 145	Newman	show	93L16	680973	6091274	Pb, Zn, Ag, Au, Cu	Vein
093L 146	Granisle	pp	93L16	682187	6092097	Cu, Ag, Au, Mo	Porphyry
093L 163	O	show	93L16	673355	6080915	Cu	unknown
093L 164	Mine	show	93L16	673510	6088875	Cu	unknown
093L 167	Alp	show	93L16	669203	6077353	Cu	unknown
093L 190	Thezar 75	pros	93L09	671448	6070012	Cu, Mo	Porphyry
093L 191	Thezar 81	show	93L09	671638	6069710	Cu	Porphyry
093L 192	Cortina	show	93L16	675772	6073892	Cu	Porphyry
093L 199	Totem	show	93L09	687176	6070637	Cu	Porphyry
093L 207	Hag	show	93L16	683966	6096502	Cu, Pb, Zn	Vein
093L 208	Trek	show	93L16	683991	6095884	Cu, Pb, Zn	Stratiform
093L 209	Mag	show	93L16	683577	6095008	Cu, Pb, Zn	Vein
093L 212	Donna	show	93L16	679091	6075879	Cu	Porphyry
093L 215	Badge	show	93L16	671274	6079288	Fe, magnetite	Porphyry
093L 219	Ketza	show	93L16	679012	6093516	Cu	Porphyry
093L 220	Kare	show	93L16	686747	6093832	Cu	Porphyry
093L 224	Sat	show	93L16	665361	6084637	Cu	Porphyry
093L 225	Pro	show	93L16	680668	6072229	Cu, Mo	Porphyry
093L 306	Cart	show	93L16	672949	6082168	limestone	Limestone
093L 308	Calcite	show	93L16	674235	6077545	limestone	Limestone
093L 315	Gold Dust	show	93L16	681229	6071633	Cu, Mo, Au, Ag	Vein
093L 325	Babs	show	93L16	692500	6082500	Cu, Au	Porphyry

Note: show = showing, pros = prospect, pp = past producer.

millimetre hornblende and plagioclase crystal fragments. The lahars are very susceptible to weathering and decompose easily, producing residual deposits of porphyry boulders in a feldspar, quartz and hornblende-rich sand. North of the Granisle connector road, differential erosion of lahars and breccias along a steep cliff has produced spectacular hoodoos.

EOCENE ENDAKO GROUP

The Endako Group is comprised of basaltic flows that conformably overlie the Ootsa Lake Group. They represent the last stage of volcanic activity in the evolution of an Eocene transtensional volcanic arc. Endako Group rocks also sit directly on the large Tachek stock located immediately south of the study area in 93L/9. Within the study area there is one small outlier of the Endako Group which is tentatively correlated with the Buck Creek Formation (Church 1973).

BUCK CREEK FORMATION (EBC)

A circular knoll immediately west of Granisle is comprised of flat-lying, very vesicular basalt flows. Sporadic outcrops near the base of the knoll are lahar of the Newman volcanics, suggesting the basalt flows are stratigraphically above these rocks. The basalt flows, which are clearly Eocene or younger, have been previously mapped as the Buck Creek Formation of the Endako Group (Tipper and Richards, 1976b).

A large, north-trending dike and a plug of massive basalt cut the Newman volcanics on Turkey Mountain. These intrusions may have been feeders to Buck Creek flows.

STRUCTURE

The structure of the Babine Lake area is characterized by north-trending grabens offset by northeast-trending, right-lateral shear zones. Both graben development and right-lateral displacement of fault blocks are believed to be related to an Eocene transtensional event that is widely recognized within the Nechako and Interior plateaus. At least some crustal subsidence occurred after the main period of magmatic and hydrothermal activity, as both the Babine intrusions and Newman volcanics have been displaced by movement on faults bounding the grabens. Arc volcanism and porphyry copper mineralization appear to have been early events in the Eocene transtensional tectonic regime.

The Permo-Triassic and Early to Middle Jurassic rocks of the area are folded and locally have a well developed penetrative cleavage. This deformation is believed to be related to the Middle Jurassic collision of Stikinia with the Cache Creek Terrane. Folds are offset and truncated by high-angle faults which are probably Eocene or younger in age. Eocene volcanics rest with angular discordance on Triassic and Jurassic volcanics and also on the Topley intrusions, suggesting considerable uplift and erosion prior to the Eocene.

The most intense deformation is in Permo-Triassic and possibly Early Jurassic rocks that crop out between the Fulton Lake dam and north of Shoulder Mountain. Here a strong north-trending, steeply dipping foliation is developed in intensely folded and possibly thrust faulted volcanics and sediments. The area of penetrative cleavage is bounded to the north and south by unfoliated rocks. The northerly trend of foliation and fold axes within this anomalously deformed zone are consistent with stress generated between northeast-trending dextral shear zones. These shear zones may be the southwest extension of the Takla fault system, a major zone of dextral displacement.

MINERAL OCCURRENCES

The most important mineral occurrences in the Babine Lake area are porphyry copper deposits associated with the Eocene Babine intrusions and Late Cretaceous Bulkley intrusions (Carter, 1981; Carter *et al.*, 1995). The Granisle past producer and the Saturday Lake and Babs prospects are the main porphyry copper occurrences in the study area (Table 2). In addition, the Lennac Lake and Tachek porphyry prospects occur on or just south of the southern boundary of the study and are also discussed in this report. A detailed description of these deposits is not included here and the reader is referred to excellent review papers by Fahrni *et al.* (1976), Carson *et al.* (1976) and Dirom *et al.* (1995).

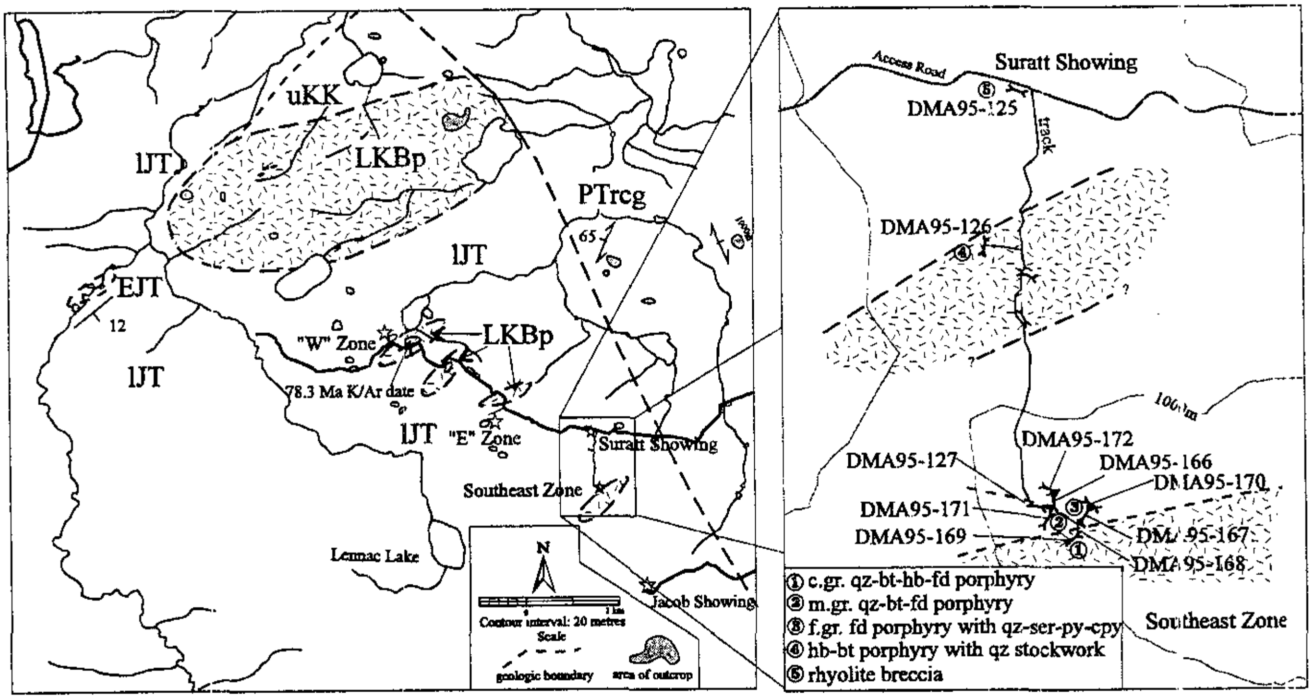

Figure 6. Geology of the Lennac Lake porphyry copper property. Inset shows sample location sites in the southeast zone. Analytical results are given in Table 3. See Figure 2 for property location; Figure 3 for legend.

GRANISLE (MINFILE 93L 146)

The Granisle pit is located on MacDonald-Sterrett Island (Figure 2). The mine was in production from 1966 to 1982 during which time 214 300 tonnes copper, 6833 kilograms gold and 69 753 kilograms of silver were produced from 52.7 million tonnes of ore (Dirom *et al.*, 1995). The average grade was 0.47% Cu and the average waste to ore ratio was 1.37:1. The town of Granisle was built to provide accommodation for workers at the mine.

The Granisle porphyry copper deposit is asymmetrically zoned about a northeast-trending multi-phase stock that cuts Lower Jurassic Telkwa Formation tuffs and amygdaloidal flows. The main intrusive phases, in order of relative age, are quartz diorite microporphyry and biotite-feldspar porphyry. Alteration assemblages include biotite-magnetite, carbonate-sericite-quartz-pyrite and chlorite-carbonate-epidote. The geology and mineralogy of the Granisle mine are described in detail by Fahrni *et al.* (1976) and Dirom *et al.* (1995).

RED (MINFILE 93L 207,208,209)

The Red property is located 6 kilometres north of the Granisle mine-site in an area of very limited outcrop. Granby Mining Company Limited first explored the property in the mid 1960's followed in 1966 by Bethex Explorations Ltd. Bethex drilled nine holes in 1967. Canadian Superior Exploration Limited and Quintana Minerals Corporation completed induced polarization and geochemical surveys in 1972. The property was restaked by Gerard Auger in 1984 and he subsequently optioned it to Anglo Canadian Mining Corporation. Anglo in turn optioned the property to Equity Silver Mines Limited. In 1987; Equityt completed 963 metres of diamond drilling in seven inclined holes. An additional 914 metres was drilled in six holes in 1989.

The only mineral occurrence exposed on surface is a 0.3 metre wide quartz-carbonate vein with galena, sphalerite and chalcopyrite, in sheared, rusty sedimentary rocks near the northwest corner of the property. The main target is a pyrite-pyrrhotite zone that produces a strong geophysical conductor. The zone has been drill-tested over a strike length of 2?0 metres. Drill intersections with core lengths of between 30 and 50 metres have contained massive and stringer sulphides with elevated copper, zinc, lead, silver and gold values (N.C. Carter, personal communication, 1995). Hostrocks are Lower Jurassic Nilkitkwa Formation argillaceous siltstones and greywackes with interbedded felsic and intermediate volcanic rocks. One outcrop of the sedimentary rocks occurs in a south-flowing creek gully on the west side of the property. Here, the beds strike north and dip moderately to the west. A Jura-Cretaceous diorite stock crops out in the large clear-cut on the north end of the property.

O-SHOWING (MINFILE 93L 163)

The O showing (MINFILE 93L 163) is located near three small lakes, approximately 3 kilometres north of Fulton Lake and 7.5 kilometres west of Babine Lake. Very coarse, bladed feldspar porphyry flows, brick-red to maroon conglomerate and green coarse sandstone to grit underlie the property. These rocks are believed to be Triassic or older based on our mapping in 1995. Bedding strikes 033° and has a near vertical dip. The feldspar porphyry is locally amygdaloidal and is probably a flow. The red conglomerate contains coarse plagioclase crystals which were probably derived from the porphyry. The conglomerate is very similar to that seen in drill core at the Cortina showing (MINFILE 93L 192) 7 kilometres to the south.

Minor amounts of bornite, chalcocite and malachite have been reported at the O showing, but this mineralization was not located. A small outcrop with an orange-buff weathering quartz and calcite stockwork was sampled (IWE95-290) but no significant assays were returned (Table 3). Previous soil sampling has defined four areas with copper concentrations greater than 400 ppm and one greater than 600 ppm. The source of these anomalies is still unknown. Till sampling in the area may help define new targets on the property.

TACHI (MINFILE 93L 144)

The Tachi showings (MINFILE 93L 144) are centred on Tachek Creek, just below the scenic lookout on the Topley-Granisle highway. The best exposure occurs on steep canyon walls where medium-grained porphyritic hornblende-biotite granodiorite dikes, trending approximately 155°, cut fractured and altered siliceous volcanic rocks of Permo-Triassic or Jurassic age. Rare, green and orange gossanous patches, 1 metre wide, also occur on the canyon face. Orange-weathering potassium feldspar with minor chlorite and sericite occurs as diffuse patches and fracture coatings throughout the volcanic rock. Associated mineralization includes pyrite, chalcopyrite and minor molybdenite as disseminations and veinlets. One sample (IWE95-9, Table 3) returned low copper and molybdenum assays. A K-Ar isotopic age of 176±7 Ma (178 Ma using new decay constants, Table 1) was determined by Carter (1981) for one of the dikes at the Tachi showing. Medium-grained quartz monzonite also crops out in the creek but crosscutting relationships with the porphyry dikes could not be determined.

GOLD DUST (MINFILE 93L 315)

The Gold Dust (MINFILE 93L 315) showing is situated north of the Tachi prospect, on the north side of the Topley-Granisle highway. Here, a 2-metre section of chlorite schist of probable Triassic age is cut by numerous quartz veins, 20 centimetres wide. The veins and schistosity strike approximately 010° and are vertical. The schistosity is imparted by 1-millimetre bands of chlorite and very fine magnetite that pinch and swell, locally giving the rock a spotted appearance. The white quartz veins are often rimmed by coarse potassium feldspar crystals. No sulphide minerals were seen in these rocks which are well exposed at the top of a prominent knoll. A grab sample (IWE95-25, Table 3) returned very low assay values.

LENNAC LAKE (MINFILE 93L 190,191)

Amax Exploration Inc. discovered the Lennac Lake porphyry copper-molybdenum prospect in 1971 while following up a soil anomaly on its regional soil sampling grid. Sampling on this grid, which covered most of the Babine Lake area, was done every 500 feet (approximately 150 metres) on parallel, northeast-trending lines 0.5 mile (approximately 800 metres) apart. Subsequent work on the property defined four areas of low-grade copper mineralization, namely the west, east, southeast and Jacob zones, over a distance of approximately 4 kilometres (Figure 6).

The Lennac Lake property was originally staked as the Thezar claims (Leary and Allen, 1972). Following induced polarizaton, magnetometer and soil geochemical surveys in 1971 and 1972, Amax drilled 44 percussion holes (3462 metres) in 1973 and five diamond-drill holes (919 metres) in 1974. This work confirmed the presence of low-grade copper mineralization in the west and east zones. The west zone was shown to contain approximately 0.2% copper over an area of 300 by 300 metres and to a depth of 100 metres, and the east zone approximately 0.1% copper over an area of 800 by 800 metres. At the same time British Newfoundland Exploration Limited drilled eleven percussion (450 metres) and three diamond-drill holes (180 metres) on the Jacob showing near Baboon Lake. The claims were subsequently allowed to lapse.

In 1990 the Lennac Lake property was restaked by L. Bourgh and optioned to Kennecott Explorations (Canada) Limited. Kennecott completed geological mapping, prospecting and trenching and discovered additional copper showings on the east side of the property (southeast zone). Cominco Limited optioned the property in 1993 and did additional prospecting, soil geochemistry and trench sampling (Jackisch, 1993) in the southeast zone.

TABLE 3. ANALYTICAL RESULTS FOR ROCK SAMPLES COLLECTED FROM THE 1995 STUDY AREA

Lab Number	Field Number	NTS Map	UTM Zone	UTM Easting	UTM Northing	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Au ppb	Ni ppm	Mn ppm	As ppm	Sr ppm	Sb ppm	V ppm	La ppm	Ba ppm	Ti %	Al %	Na %	Ca %	Fe %	Mg %	K %
51025	DMA95-2	93 K/13	10	307464	6082464	74	10491	< 3	31	1.9	411	20	109	3	40	< 2	76	9	91	0.19	1.4	0.12	0.47	3.6	0.9	1.06
51026	DMA95-3	93 K/13	10	307717	6082752	11	16	< 3	18	0.3	15	1	8	3	6	< 2	< 1	9	26	< .01	0.5	0.17	0.01	0.3	0	0.24
51036	DMA95-25	93 M/1	9	666404	6122098	20	614	< 3	41	< .3	5	38	358	66	142	17	54	18	131	< .01	1.6	0.01	2.81	3.1	1.2	0.1
51050	DMA95-29	93 M/8	9	675341	6130074	3	3362	< 3	20	1	23	8	100	9	50	< 2	24	16	389	< .01	1	0.05	1.98	1	0.6	0.33
51053	DMA95-40	93 M/8	9	674809	6130655	1	15	5	18	< .3	4	9	198	73	17	2	40	15	150	0.01	1.2	0.21	0.14	2.9	0.4	0.2
51052	DMA95-42	93 M/8	9	676500	6130500	7	226	23	65	< .3	14	28	469	26	28	< 2	33	19	78	< .01	1.7	0.01	1.74	2	0.5	0.06
51037	DMA95-99	93 L/16	9	671945	6077317	< 1	8	< 3	5	< .3	< 2	< 1	3685	< 2	106	< 2	7	6	17	< .01	0.1	< .01	37	1.1	0.1	< .01
51030	DMA95-100	93 L/16	9	671148	6077897	1	192	7	70	0.3	26	8	580	15	38	< 2	78	7	75	< .01	0.9	0.02	3.55	3.9	0.8	0.37
51032	DMA95-107	93 L/16	9	665144	6087027	1	76	< 3	52	< .3	5	131	629	2	44	< 2	153	1	29	0.42	2	0.05	7.86	4.1	2.7	0.01
51018	DMA95-125	93 L/9	9	673391	6068992	8	3287	29	89	5.2	16	3	455	534	28	27	6	12	110	< .01	0.9	0.01	0.63	0.6	0.3	0.29
51019	DMA95-126	93 L/9	9	673335	6068771	58	877	3	53	0.6	45	6	223	185	32	8	39	6	87	0.01	0.7	0.07	1.13	0.9	0.3	0.29
51022	DMA95-127	93 L/9	9	673420	6068375	31	392	6	51	1	12	1	274	52	92	< 2	31	11	784	0.01	1.2	0.09	1.83	2.5	0.5	0.39
51040	DMA95-166	93 L/9	9	673451	6068378	12	1215	11	106	2.4	32	1	441	313	32	7	23	22	180	< .01	1	0.04	1.05	1.9	0.2	0.5
51042	DMA95-167	93 L/9	9	673487	6068349	4	192	7	121	0.6	27	1	475	44	17	3	25	8	195	< .01	0.9	0.06	0.58	2.9	0.2	0.45
51043	DMA95-169	93 L/9	9	673472	6068322	1	16	11	325	0.4	8	4	660	7	23	2	19	15	271	< .01	0.9	0.03	0.9	1.9	0.1	0.38
51044	DMA95-170	93 L/9	9	673503	6068378	2	265	9	55	0.5	23	1	510	77	18	5	18	7	74	< .01	0.7	0.03	1.15	3.3	0.2	0.47
51045	DMA95-171	93 L/9	9	673439	6068356	43	313	4	68	1.5	11	1	532	67	21	20	10	10	281	< .01	0.3	0.01	1.12	1.3	0.2	0.16
51046	DMA95-172	93 L/9	9	673442	6068395	6	440	14	128	3.2	15	1	940	148	17	71	4	8	135	< .01	0.7	0.01	0.5	0.8	0.2	0.51
51021	IWE95-9	93 L/16	9	681440	6070665	102	536	< 3	33	0.7	6	4	248	4	145	< 2	53	8	91	0.16	1.3	0.16	0.71	2.9	1.1	0.21
51024	IWE95-25	93 L/16	9	680773	6071902	1	4	< 3	39	< .3	2	< 1	321	2	6	< 2	3	4	46	0.04	0.3	0.04	0.15	0.8	0.1	0.14
51033	IWE95-39	93 L/16	9	680525	6077345	1	32	3	50	< .3	3	12	385	11	149	< 2	106	1	13	0.36	2	0.1	2.04	4.1	1.3	0.07
51028	IWE95-51	93 L/16	9	679696	6077233	3	9	< 3	29	0.6	5	2	170	3	23	< 2	3	63	979	< .01	0.4	0.2	0.12	1.6	0.1	0.12
51029	IWE95-54	93 L/16	9	686771	6070873	819	4	< 3	7	3.5	< 2	< 1	94	3	7	< 2	3	1	33	< .01	0.1	0.02	0.07	0.1	0	0.06
51027	IWE95-85	93 L/16	9	675003	6082129	2	6	4	62	< .3	4	11	521	6	129	< 2	92	5	56	0.4	2.7	0.07	2.13	3	1.6	0.05
51054	IWE95-117	93 L/16	9	675437	6085512	1	36	9	50	< .3	< 2	2	406	3	42	2	35	10	137	0.3	1.2	0.12	0.68	1.9	0.5	0.32
51034	IWE95-155	93 L/16	9	668425	6097164	14	187	6	213	< .3	8	31	511	20	97	2	135	< 1	68	0.38	3.4	0.44	1.86	4.6	1.5	0.12
51061	IWE95-237	93 L/16	9	686875	6079930	< 1	10838	5	158	18	246	76	1155	7	296	< 2	110	2	18	0.27	2.8	0.11	2.51	5.7	2.5	0.09
51059	IWE95-249	93 L/16	9	681425	6087800	3	128	30	142	1.7	3	2	574	12	9	2	67	5	125	0.01	1.7	0.08	0.04	4.7	1	0.17
51058	IWE95-275	93 L/16	9	668800	6096920	1	281	4	481	0.7	23	16	680	22	87	< 2	121	1	75	0.29	3.3	0.45	3.13	5	1.1	0.23
51060	IWE95-290	93 L/16	9	673655	6080200	1	4	6	42	< .3	2	< 1	495	2	16	2	18	11	50	0.01	0.9	0.09	1.97	1.4	0.5	0.1
51039	KBE95-4	93 M/1	9	683900	6101500	1	28	3	105	< .3	2	11	799	15	56	< 2	54	10	98	0.01	2	0.06	1.97	4.2	1	0.38
51020	KBE95-25	93 L/16	9	663011	6078619	1	134	54	84	< .3	< 2	2	640	3	15	< 2	32	10	134	0.04	0.7	0.09	1.96	1.9	0.3	0.23
51023	KBE95-28	93 L/16	9	662963	6079059	< 1	182	29	153	0.7	2	< 1	1062	4	18	< 2	95	10	321	0.04	0.8	0.01	2.36	4	0.2	0.37
51038	KBE95-44	93 L/16	9	665050	6094174	< 1	32	6	88	0.3	5	17	355	3	98	< 2	78	7	162	0.12	1.4	0.19	0.75	3	0.8	0.36
51047	KBE95-51	93 L/16	9	662841	6073790	< 1	12	11	84	0.3	2	14	1095	9	59	< 2	123	6	70	0.05	1.4	0.11	2.28	5	0.9	0.07
51049	KBE95-58	93 L/16	9	662841	6074730	1	1314	< 3	46	4.9	4	2	601	< 2	95	4	26	12	67	0.07	1.3	0.12	0.68	1.9	0.7	0.13
51048	KBE95-61	93 L/16	9	660888	6027293	1	4196	19	59	< .3	4	29	699	3	177	< 2	164	4	18	0.3	1.4	0.07	6.1	4.6	1.2	0.02
51055	KBE95-146A	93 L/16	9	691150	6083300	1	3	4	78	< .3	6	3	825	3	92	< 2	57	10	41	0.06	2.2	0.09	0.78	3.4	1.8	0.1
51056	KBE95-146B	93 L/16	9	691150	6083300	2	8	7	46	< .3	2	4	452	2	34	< 2	26	7	86	0.01	1	0.18	0.15	1.7	0.7	0.17
51057	KBE95-152	93 L/16	9	692300	6087300	6	4	3	13	< .3	5	< 1	155	2	19	< 2	5	13	153	0.06	0.7	0.12	0.16	0.8	0.2	0.29
					Detection limit	1	1	3	1	0.3	2	1	2	2	1	2	1	1	1	0.01	0	0.01	0.01	0	0	0.01

Method: aqua regia-ICP, Au by fire assay and ICP finish; analysis by ACME Analytical

Porphyry copper mineralization and alteration are associated with a series of northeast-trending dikes of biotite-hornblende-feldspar±quartz porphyry that intrude maroon lapilli tuffs and volcaniclastic rocks of the Lower Jurassic Telkwa Formation. The porphyry, which is quartz monzonite to granodiorite in composition and typical of the Late Cretaceous Bulkley intrusions, contains euhedral biotite books, hornblende, plagioclase and locally quartz eyes up to 1 centimetre in diameter. Phenocrysts comprise up to 30% of the rock.

The main areas of mineralization on the Lennac Lake property are the west, east, southeast and Jacob zones. The west zone, which was discovered first, is mainly disseminated and fracture-coating pyrite, chalcopyrite and trace molybdenite in relatively fresh, coarse-grained porphyry and hornfelsed volcanics. The east zone is mainly fracture coatings and veinlets of pyrite and chalcopyrite with associated chlorite-epidote alteration envelopes. This alteration is superimposed on biotite hornfelsed Telkwa volcanic rocks.

The Suratt showing comprises chalcopyrite, pyrite and tetrahedrite in a rhyolite breccia that has been exposed by trenching along the main access road. A zone of quartz-molybdenite stockwork in a quartz-sericite-altered quartz-biotite-feldspar porphyry intrusion is exposed in trenches along a cat trail that heads south from the Suratt showing. The trail ends 600 metres to the south (inset, Figure 6) where several trenches have exposed disseminated and fracture controlled chalcopyrite and pyrite in fine-grained quartz-sericite-altered feldspar porphyry (altered Telkwa Formation andesite?) and a medium to coarse-grained quartz-biotite-feldspar porphyry intrusion. Samples DMA95-127 and 166-172 were collected from these trenches. These chip samples returned only low copper assays (Table 3). However, the area is still considered favourable because copper mineralization occurs in widely space trenches within an area of no outcrop and there is strong quartz-sericite alteration and quartz vein stockworking in a multi-phase porphyryitic intrusion. To date this area has not been tested by diamond drilling.

SAT (MINFILE 93L 224)

The Saturday Lake porphyry copper occurrence (SAT claims) was staked by Amoco Canada Peroleum Company Ltd. in 1972. Amoco conducted induced polarization, magnetometer and electromagnetic surveys and soil, silt and rock geochemistry, followed by 2000 metres of diamond drilling in 19 holes. The results of this drilling were never published but Leahey (1982) states that one hole (72-3) apparently intersected 40 metres of 0.10% copper. Amoco allowed the claims to lapse in 1974. The property was subsequently restaked by Cities Services Minerals Corporation in 1974 and Great Western Petroleum Corporation in 1980, who subsequently optioned the property to Noranda. Additional IP, magnetometer and soil geochemical surveys by Noranda failed to define any new targets (Leahey, 1982).

A cursory examination of the drill core still at the old Saturday Lake campsite confirms the presence of biotite-feldspar porphyry intrusions of the Babine intrusive suite cutting volcanic and sedimentary rocks of probable Triassic age. Low grade copper mineralization in the form of disseminated and fracture controlled chalcopyrite is present in some of the core but much of the remaining core appears to be unmineralized and has never been split or assayed. The core boxes for several holes could not be found.

BABS (MINFILE 93L 325)

The Babs property is located in the southeast corner of the map area and straddles the border between 93L/16 and 93K/13 (Figure 7). Although the property has been known for some time it has only recently been assigned a MINFILE number (93L 325). An unrelated property (MINFILE 93L 220) with the same name is located 16 kilometres to the northwest and this has caused some confusion in the past.

The Babs property, which has very little outcrop, was staked to cover a southeast-trending train of well-mineralized, subangular biotite-feldspar porphyry boulders. The boulders are typical of the Eocene Babine intrusions, which are the hostrocks at the Bell and Granisle mines. Over 80 boulders, ranging from 10 to 150 centimetres in diameter, have been located within an area of 150 by 300 metres.

Work on the Babs property has defined coincident chargeability and soil geochemical anomalies. In 1992, Equity Silver Mines Ltd. drilled seven NQ holes peripheral to, but not within, the boulder train. All of these holes were terminated shortly after encountering bedrock, with the maximum depth of bedrock penetration being 4.1 metres. One of the holes, BB92-6, was resampled by Noranda and returned 0.34% Cu for the 3 metres of bedrock that was cored. This hole was collared 300 metres east of the boulder train and 300 metres west of copper showings in a borrow bit on Pat's road. In 1992, Noranda drilled two 100-metre holes (BS93-8 and BS93-9) within the area of the boulder train. The top 10.4 metres of hole BS93-8 returned 0.21% Cu and 12.0 g/t Ag (Kemp and Robertson, 1994). Two additional holes were drilled in 1994 (NB94-10 and NB94-11) and these were 400 and 1000 metres east of the boulder train, respectively (Kemp and Robertson, 1994). Surprisingly, none of the drilling to date has tested the up-ice area of the boulder train.

The best bedrock exposure is along the eastern margin of the Babs boulder train, in a stripped area (borrow pit) along the east side of Pat's road. Here, over 30 metres of gossanous, clay-altered, quartz-phyric crystal and lapilli tuffs containing minor disseminated pyrite, chalcopyrite and malachite are exposed. Kemp and Robertson (1994) report assay values up to 726 ppm Cu and 16 ppm Ag. Noranda diamond-drill hole NB94-10, which was drilled 125 metres northwest of the borrow pit, intersected 0.19% Cu over 77.3 metres.

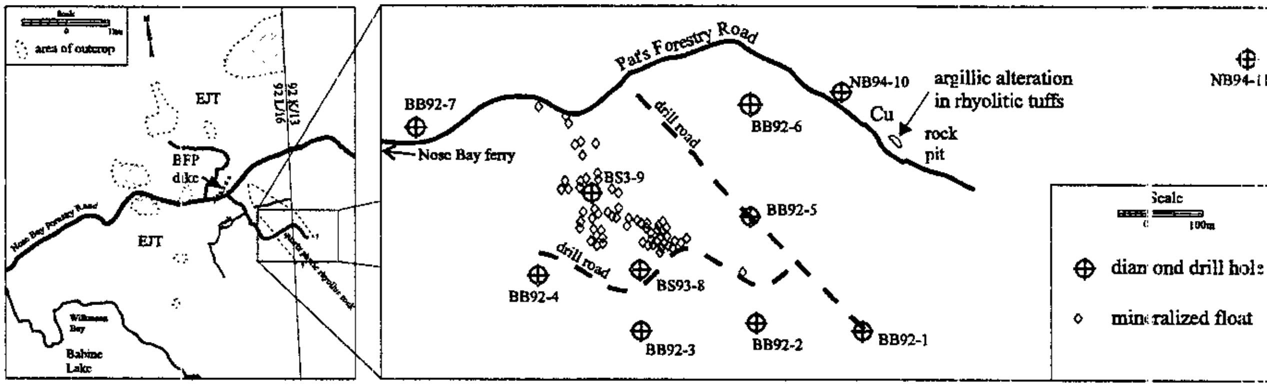

Figure 7. Geology and drill hole locations on the Babs property. See Figure 2 for property location; Figure 3 for legend.

Another small outcrop of clay-altered quartz-phyric tuffs occurs on the south side of Pat's road, near the northern limit of the boulder train. Similar rocks occur as large angular blocks or subcrop within the area of the boulder train and were also intersected in drilling in this area by Equity Silver in 1992 and Noranda in 1994.

Many of the boulders on the Babs property are strongly magnetic, have intense stockwork veining or crackle breccia textures and contain secondary biotite. The boulders are very similar to ore grade material at the Granisle mine, 14 kilometres up-ice to the northwest. Because of this it was believed for many years that the boulders were glacially transported from Granisle and little work was done on the property . However, subsequent drilling has shown that low-grade copper-silver mineralization occurs in clay-altered, quartz-phyric tuffs that underlie the boulder train and the boulders may be locally derived (see Stumpf *et al.*, 1996, this volume). Although the source of the boulders has not yet been located, a northeast-trending dikelet of dark grey biotite-feldspar porphyry was found cutting Topley monzonite in a small drainage ditch near the junction of the Nose Bay and Pat's haulage roads. Disseminated pyrite is associated with the dikelet, which is up-ice from the mineralized boulder train.

A large angular block of biotite-feldspar porphyry with a chalcopyrite-pyrite quartz stockwork was located by prospector and property owner Ralph Keefe in a new clear-cut at the southeast limit of the boulder train. A sample from this block (DMA95-2, Table 3) assayed 1.05% Cu and 0.41 g/t Au.

The Babs occurrence is in a northwest-trending belt of altered quartz-phyric pyroclastic rocks enclosed in a large, multi-phase stock of the Topley intrusions. Although the contact with the Topley rocks is not exposed, it is most likely a fault. The felsic pyroclastics are probably Eocene in age and part of the Babine intrusive suite based on lithologic similarity to quartz-phyric rocks on the Newman Peninsula.

NEW SHOWINGS

Several new mineral showings were located during the 1995 bedrock mapping program and these are briefly described below. Locations are shown on Figure 2. Some of these showings may have been found by exploration companies working in the district in the past but this information has never been put in the public record. None appear to be significant.

NIKI AND SNAPPER Cu SHOWINGS

Two small copper showings were found in a large clear-cut, approximately 6 kilometres south of the west end of Fulton Lake (Figure 2). One of these (sample KBE95-61, Table 3) is from a southeast-striking, northwest-dipping quartz-epidote veinlet, 5 millimetres wide, containing pyrite and malachite. The vein cuts maroon crystal-lithic tuff beds of the Lower Jurassic Telkwa Formation that strike 124° and dip 40° southwest. We have named this showing the Niki.

Sample KBE95-58 (Table 3) is from malachite-coated quartz-epidote veins and veinlets that cut at least four small bodies of orange-weathering quartz monzonite. These rocks intrude contorted maroon ash and crystal tuff beds of the Telkwa Formation. We have named this showing the Snapper.

NOSE BAY Cu-Ag-Au SHOWING

Copper mineralization was found in a poorly defined fault zone cutting a shoreline bluff of Stuhini augite-phyric basalt, 2 kilometres south of Nose Bay, on the east shore of Babine Lake. A sample from the shear zone (IWE95-237, Table 3) contained disseminated malachite and chalcocite and assayed 1.08% Cu, 17.5 g/t Ag and 0.246 g/t Au .

RUSTY KNOLL Zn SHOWING

A strongly gossanous, cliff face occurs on the southwest side of a prominent knoll, 160 metres high near the north edge of the study area, 4 kilometres west of Babine Lake. The rock at the base of the cliff is strongly altered and light bluish-grey in colour. Alteration is associated with a crackle breccia of very thin microcrystalline quartz veinlets that carry fine-grained magnetite, an unidentified silver-white metallic mineral and a fine acicular green mineral which may be pyrophyllite. Larger veinlets roughly parallel widely spaced, near vertical gossanous fractures that trend approximately 020°. The protolith within the mineralized zone is masked by the intense veining and alteration. However, away from this zone, further up the knoll the rock is a medium grey augite-phyric basalt of probable Triassic age. Samples of intensely veined rock (IWE95-155, IWE95-275, Table 3), with approximately 1% disseminated pyrite, had elevated zinc and copper concentrations. The mineralized knoll is only a few kilometres southeast of the Fireweed prospect and a similar geochemical signature suggests these occurrences may be related to the same mineralizing system. A major northeast-trending fault occurs just north of the knoll and may also have controlled localization of mineralizing fluids. The nature of the mineralization suggests an epithermal environment.

PORT ARTHUR Mo SHOWING

A new molybdenum showing was discovered 8 kilometres south-southeast of Topley Landing. Here, a small outcrop exposes a quartz vein 20 centimetres wide cutting pale orange aplitic Topley intrusive rocks. The vein contains approximately 1% finely disseminated molybdenite. A sample returned anomalous molybdenum values (sample IWE95-54, Table 3). The extent of the vein was not determined but the amount of float present suggests other veins may be present and further exploration may be warranted.

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