REGIONAL GEOLOGICAL MAPPING IN THE NATION LAKES AREA (93N/2E, 7E)

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KEYWORDS: Regional geology, porphyry Cu-Au, alkaline intrusions, Takla Group, Inzana Lake formation, Witch Lake formation, Chuchi Lake formation, Hogem intrusive complex, Takla intrusions, alteration halos.

INTRODUCTION

The Nation Lakes area of central British Columbia is located approximately 75 kilometres north of Fort St. James and is accessed by well-maintained logging roads from Fort

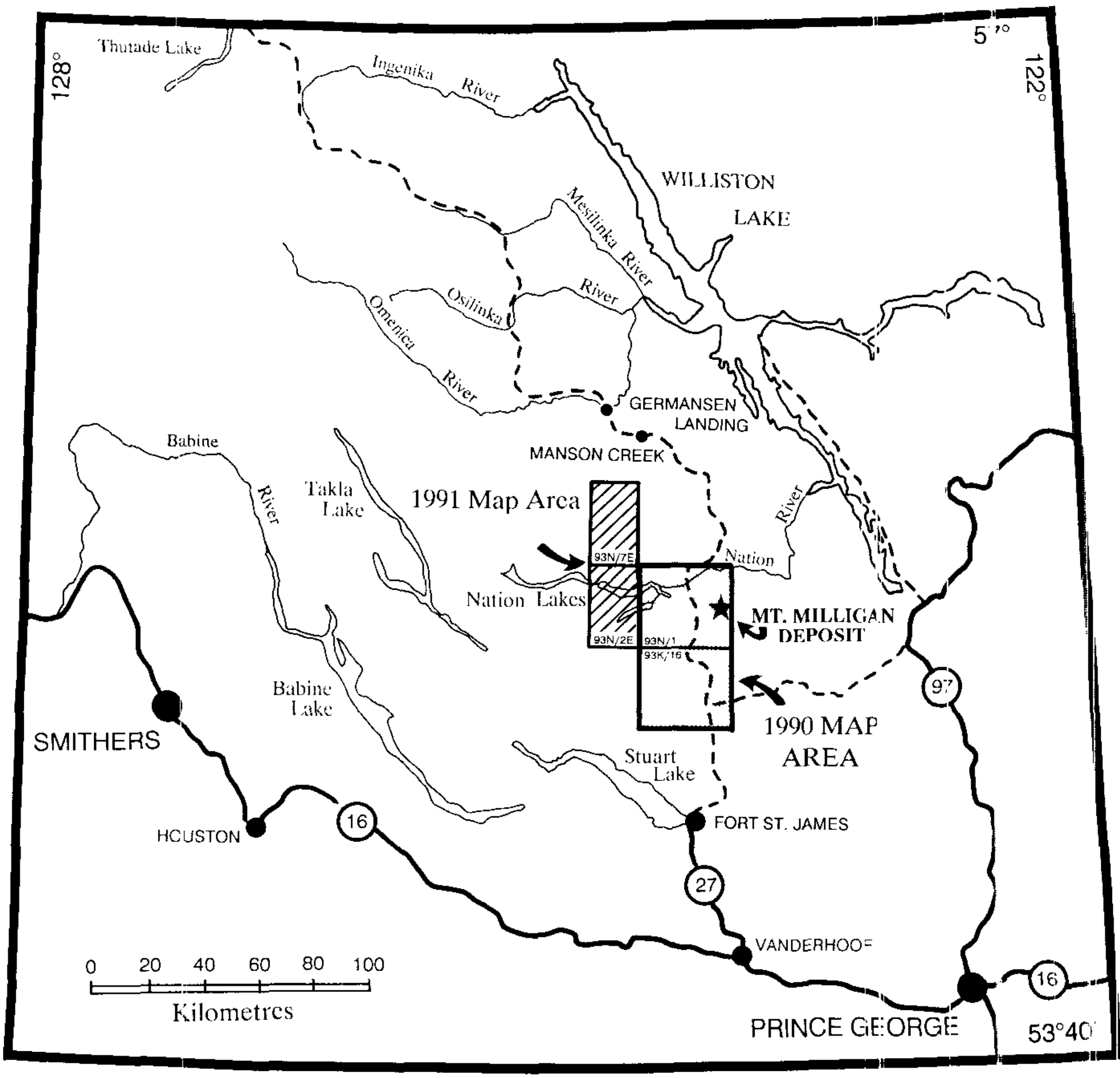

Figure 1-9-1. Location map, Nation Lakes project area.

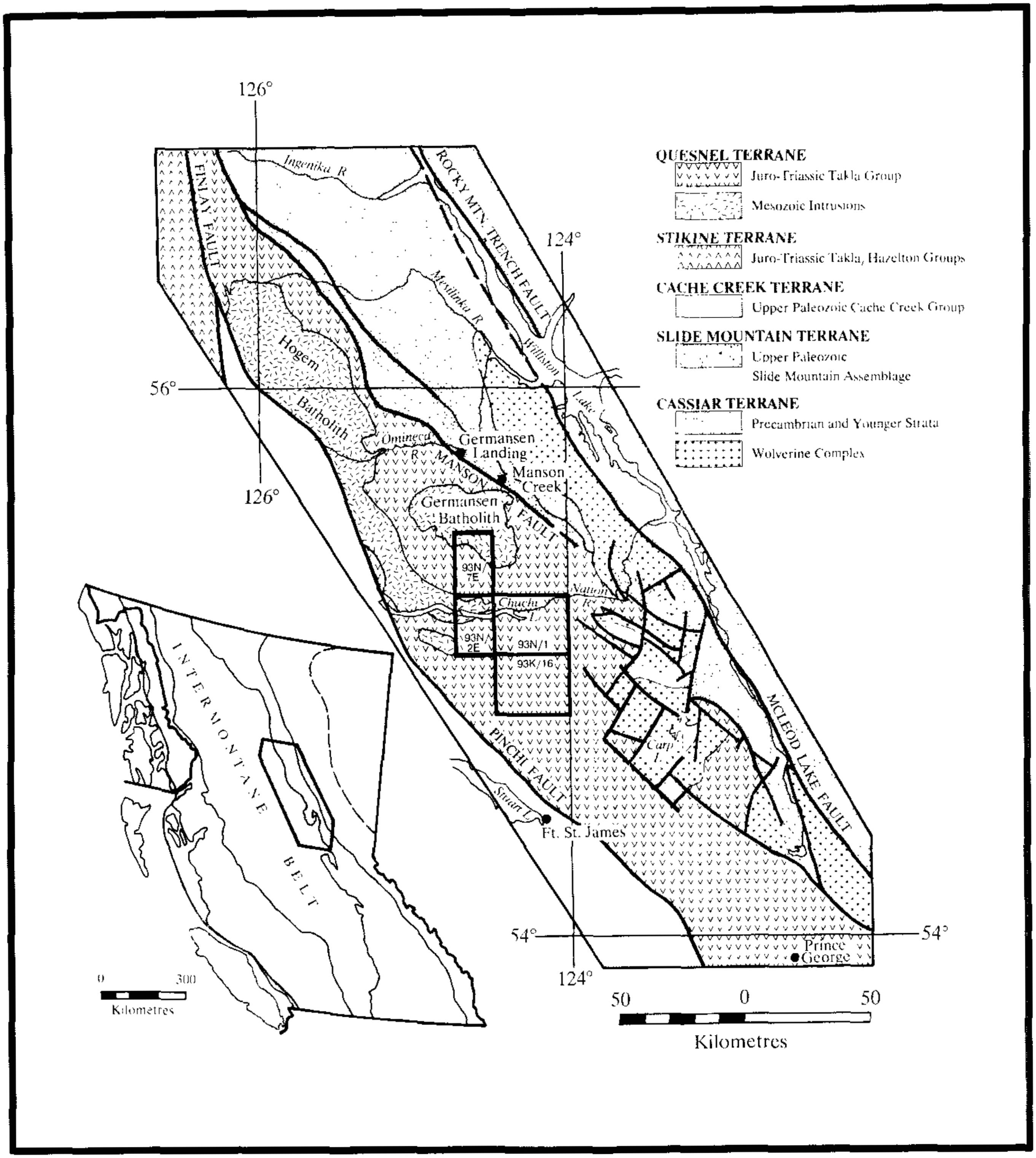

Figure 1-9-2. Tectonic setting of the Nation Lakes area.

St. James and Mackenzie (Figure 1-9-1). The Nation Lakes regional mapping project was started in 1990 to provide 1:50 000-scale geological maps to aid mineral exploration in the area, principally for alkaline porphyry copper-gold deposits similar to Mount Milligan. At time of writing (November, 1991) feasibility studies for Mount Milligan are still in progress, with results anticipated in early 1992.

Results of 1990 fieldwork on mapsheets 93N/1 and 93K/16 (Nelson *et al.*, 1991a, b) included:

- The establishment of a fourfold stratigraphic subdivision of the Takla Group.
- The identification of numerous Takla intrusions and associated alteration halos and mineralization.
- The delineation of a series of fault strands related to the Manson–MacLeod Lake transcurrent fault system, that divide the area near the Mount Milligan deposit into sets of horsts and grabens.

During 1991, this work was continued as mapping was extended to the west and north onto map sheets 93N/2E and 93N/7E (Figure 1-9-1). The resulting 1:50 000 maps are available as Open File 1992-4 (Nelson *et al.*, 1992).

REGIONAL SETTING

The Nation Lakes map area is part of the Quesnel Terrane and is underlain by Triassic-Jurassic island-arc rocks of the Takla Group (Monger *et al.*, 1990). The region is bordered by two major transform fault systems: the Manson–MacLeod Lake fault, which separates the Mesozoic volcanics from Paleozoic and younger strata to the east, and the Pinchi fault, which separates them from the oceanic Cache Creek Group to the west (Figure 1-9-2). Parts of two regional-scale batholiths are exposed in the map area. The southern end of the Early Jurassic and younger Hogem batholith intrudes the alkalic Takla volcanics on the shores of Chuchi Lake, and the southwestern margin of the Cretaceous Germansen batholith outcrops sparsely in the lowlands of the northeastern corner of 93N/7. The Takla Group volcanics are also intruded by roughly coeval, high-level, alkaline plutons which are responsible for the development of porphyry systems rich in copper and gold. For a more detailed discussion of the alkaline porphyry Cu-Au association and regional geological correlations refer to Nelson *et al.* (1991a).

GLACIAL GEOLOGY

The geomorphology of the Nation Lakes area bears a strong glacial imprint, particularly from the Fraser glaciation, the most recent ice advance. Glacial straie trend east to northeasterly, and large-scale glacial grooves are aligned at about 060°. Northeasterly regional ice-flow from the Coast Mountains was deflected by smaller ice masses originating in the Skeena Mountains to the north and the Cariboo Mountains to the south, resulting in flow directions that varied through time (Plouffe, 1991). Till and fluvioglacial deposits are thickest in the lowlands south and southwest of Witch Lake. Elsewhere, in most areas, scattered outcrops emerge from blanket to veneer till and outwash. Perched glacial channels occur on hillsides and are incised into the highest plateaus.

STRATIGRAPHY

TAKLA GROUP

Regional mapping of 93K/16 and 93N/1 during 1990 resulted in the subdivision of the Takla Group into four informal formations. From base to top these are the Rainbow Creek, Inzana Lake, Witch Lake and Chuchi Lake formations. The basal Rainbow Creek formation is comprised of dark grey and black basinal shales and siltstones correlative with the Triassic black phyllite unit near Quesnel. The Inzana Lake formation consists of interbedded distal and proximal pyroclastic volcanics and basinal sediments. It is overlain by, and interfingers with, the Witch Lake formation, which is dominated by augite-porphyritic volcanics and agglomerates. These rocks pass upward into plagioclase and augite-bearing fragmental rocks and flows of the Chuchi Lake formation.

Work done during the summer of 1991 shows an overall continuity of this stratigraphy with the addition of important facies transitions between and within the formations. In the eastern half of the Chuchi Lake map area (93N/2E), epiclastic sediments of the Inzana Lake formation interfinger eastwards with augite porphyry agglomerates of the Witch Lake formation from its base to near its assumed top. The Chuchi Lake formation has a much greater lithologic and petrologic diversity than previously thought, including augite and even olivine-phyric basalt flows and augite-plagioclase-phyric agglomerates as well as plagioclase and plagioclase-augite-phyric latites. Continuity within the Chuchi Lake formation is maintained by a sedimentary marker, erroneously denoted as Late Triassic in age [uTrCL(c); Nelson *et al.*, 1991a, b], which extends westward for 15 kilometres in 93N/7. Three Early Jurassic ammonite collections were made from this unit.

WITCH LAKE-INZANA LAKE RELATIONSHIPS

The Inzana Lake formation represents a submarine environment on the fringes of a dominantly augite-phyric, explosive basalt centre, such as is represented by the Witch Lake formation. Witch Lake agglomerates overlie Inzana Lake sediments in the nose of the regional anticline near Mudzenchoot Lake in 93N/1 (Nelson *et al.*, 1991a, b), and this contact extends westward into 93N/2 (Figure 1-9-3). However, south of Chuchi Lake in 93N/2, the monotonous Witch Lake augite porphyry agglomerates give way westward along strike to epiclastic sediments (dust tuffs, sandstones and siltstones) identical to the Inzana Lake formation (Figure 1-9-3). This contact is interpreted to be the western edge of a major basaltic edifice. The edifice extends eastwards to Mount Milligan, where it is truncated by the Cretaceous to Early Tertiary Great Eastern fault, and southwards to near Cripple Lake, where it may interfinger with Inzana Lake sediments under thick till (Nelson *et al.*, 1991a, b).

East of Klawli Lake (93N/7), Witch Lake lapilli tuffs and agglomerates interfinger with finer grained epiclastic sediments and appear below the south-dipping Chuchi Lake formation (Figure 1-9-4). Their inferred thickness is between 500 and 1300 metres, compared with more than

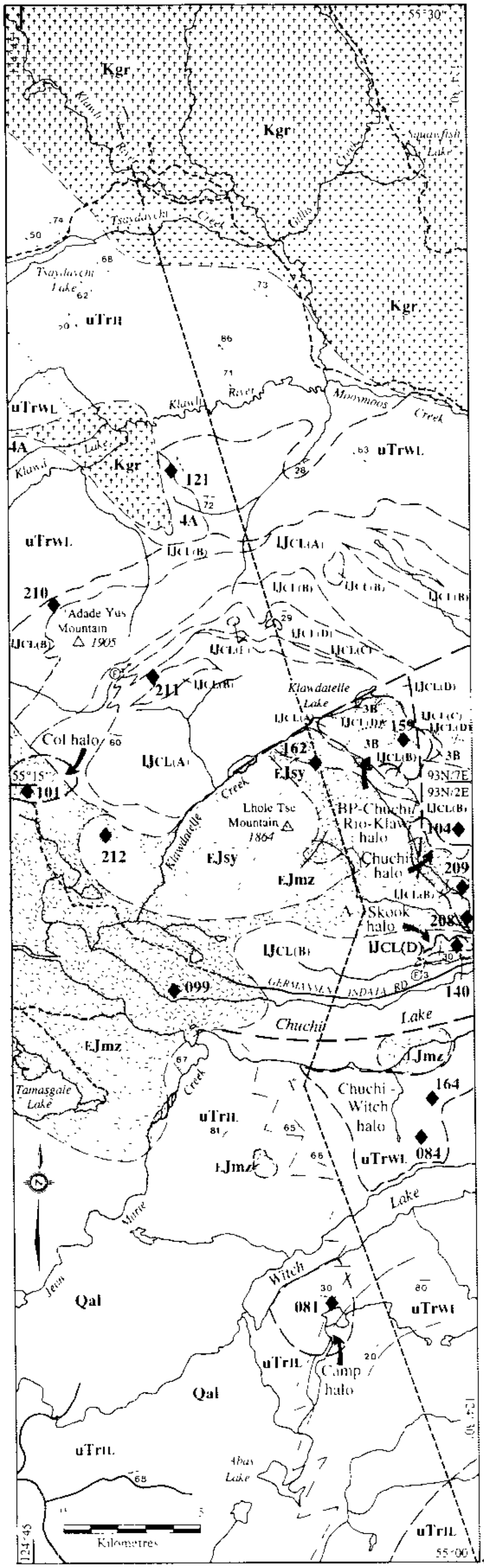

Figure 1-9-3. Generalized geology of 1992 project area, 93N/2 East Half and 93N/7 East Half.

LEGEND

LAYERED ROCKS

QUATERNARY

Qal	*UNCONSOLIDATED GLACIAL TILL AND ALLUVIUM*

UPPER TRIASSIC - JURASSIC

TAKLA GROUP

lJCL	**CHUCHI LAKE FORMATION: (A)** *HETEROLITHIC AGGLOMERATE;* **(B)** *PLAGIOCLASE ± AUGITE PORPHYRY ANDESITE, LATITE AND DACITE FLOWS;* **(C)** *AUGITE/HORNBLENDE ± PLAGIOCLASE ± OLIVINE BASALT FLOWS;* **(D)** *INTERVOLCANIC SEDIMENTS. SANDSTONE, SILTSTONE, SHALE, CHERTY TUFF;* **(E)** *CONGLOMERATE*
uTrWL	**WITCH LAKE FORMATION:** *AUGITE (± PLAGIOCLASE ± HORNBLENDE) PORPHYRY AGGLOMERATE, LAPILLI TUFF AND EPICLASTIC SEDIMENTS*
uTrIL	**INZANA LAKE FORMATION:** *VOLCANIC SANDSTONE, SILTSTONE, CHERTY TUFF, MUDSTONE, ARGILLITE, LAPILLI TUFF AND AUGITE PORPHYRY AGGLOMERATE*

INTRUSIVE ROCKS

MIDDLE TO LATE CRETACEOUS

GERMANSEN BATHOLITH

Kgr	*COARSE-GRAINED GRANITE, EQUIGRANULAR TO ORTHOCLASE MEGACRYSTIC*

EARLY JURASSIC

HOGEM INTRUSIVE COMPLEX

EJsy	*MEDIUM-GRAINED SYENITE ± QUARTZ*
EJmz	*COARSE-GRAINED EQUIGRANULAR MONZONITE*

EARLY JURASSIC?

SYN-TAKLA INTRUSIONS*

1	**GRANITE SUITE: (1A)** *COARSE TO MEDIUM-GRAINED, EQUIGRANULAR GRANITE;* **(1D)** *RHYODACITE/DACITE*
2	**SYENITE SUITE: (2A)** *COARSE TO MEDIUM-GRAINED, EQUIGRANULAR SYENITE;* **(2B)** *CROWDED PLAGIOCLASE-PORPHYRITIC SYENITE;* **(2C)** *MEGACRYSTIC SYENITE*
3	**MONZONITE SUITE: (3A)** *COARSE TO MEDIUM-GRAINED, EQUIGRANULAR MONZONITE;* **(3B)** *CROWDED PLAGIOCLASE-PORPHYRITIC MONZONITE;* **(3C)** *MEGACRYSTIC PLAGIOCLASE MONZONITE,* **(3D)** *SPARSELY PORPHYRITIC LATITE*
4	**DIORITE/MONZODIORITE SUITE: (4A)** *COARSE TO MEDIUM-GRAINED, EQUIGRANULAR DIORITE/MONZODIORITE;* **(4B)** *CROWDED PLAGIOCLASE-PORPHYRITIC DIORITE;* **(4C)** *MEGACRYSTIC PLAGIOCLASE (± AUGITE)-PORPHYRITIC DIORITE;* **(4D)** *SPARSELY PORPHYRITIC ANDESITE*
5	**GABBRO/MONZOGABBRO SUITE: (5A)** *COARSE TO MEDIUM-GRAINED, EQUIGRANULAR GABBRO/MONZOGABBRO*
6	**ULTRAMAFIC SUITE: (6A)** *COARSE-GRAINED EQUIGRANULAR LAMPROPHYRE*

* Not all lithologic types are present in the map area; however the complete listing is retained for consistency with Nelson *et al.*, 1991a and 1991b.

SYMBOLS

geologic contact (approximate, inferred)	— — ....
lithologic contact (approximate, inferred)	— — ......
facies relationship (inferred)	—..—..—
fault (approximate)	— — —
bedding (tops known, tops unknown, overturned)	50 50 50
foliation	78
area of alteration	
mineral occurrence and MINFILE number	◆164
fossil locality	Ⓕ3
elevation in metres	△ 1905

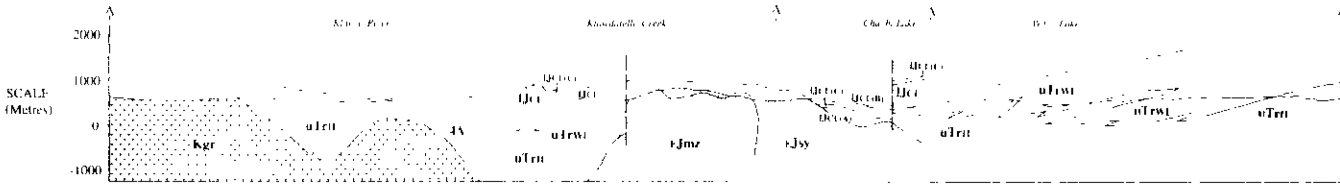

Figure 1-9-4. Geologic cross-section of 93N/2 East Half and 93N/7 East Half. The location of section A-A'-A"-A"' is on Figure 1-9-3.

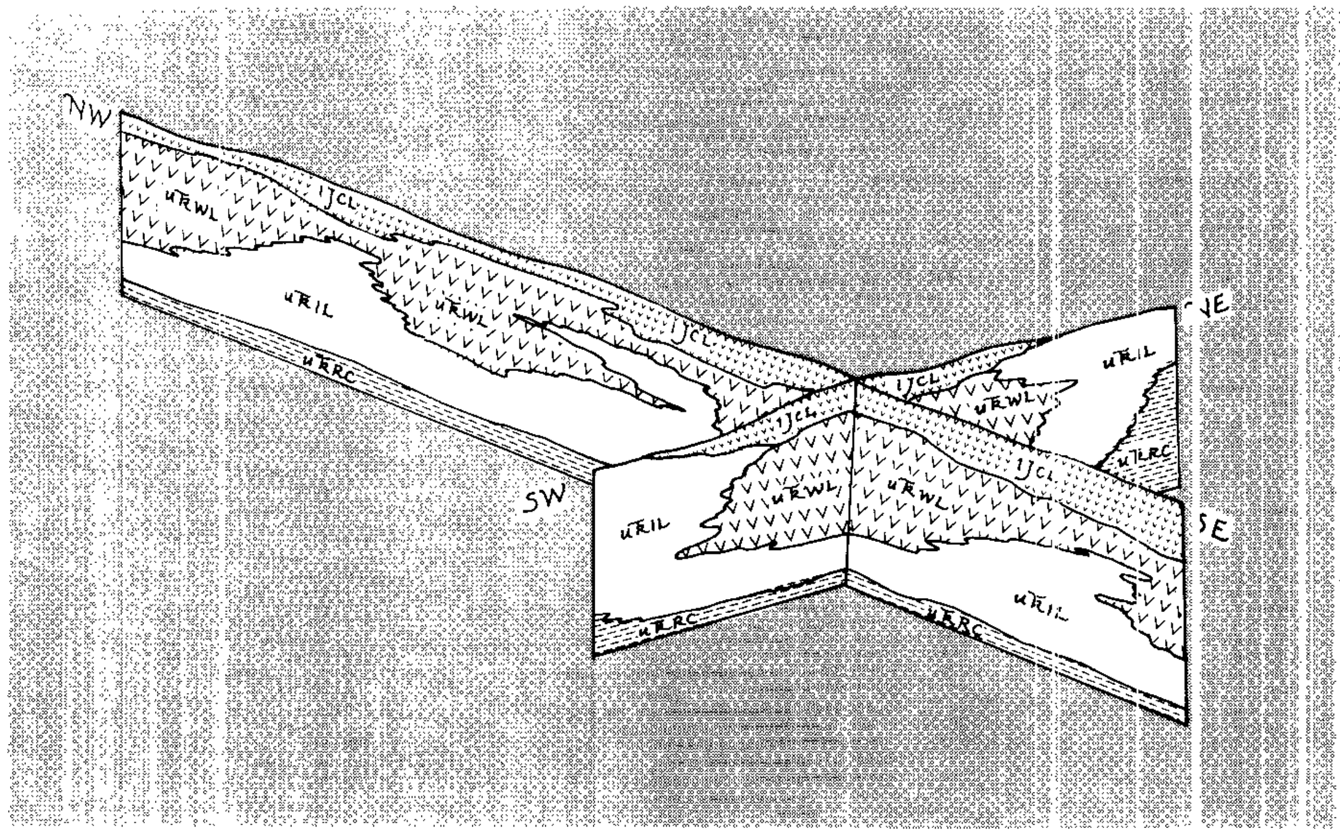

Figure 1-9-5. Sketch showing generalized Takla Group facies relationships along and across the arc axis. Augite-phyric basalts of the Witch Lake formation form coalescing piles along the arc axis. The dominantly epiclastic Inzana Lake formation underlies these piles, interfingers with them, and also dominates the fore arc and back arc. The basinal Rainbow Creek formation becomes more prominent further into the back-arc region.

5 kilometres of Witch Lake stratigraphy south of Chuchi Lake. This area may lie near the northern extent of the volcanic pile. Overall, the volcanic edifice extends over 1000 square kilometres in this region and probably formed by coalescing fissure eruptions.

These facies relationships demonstrate that the Witch Lake and Inzana Lake formations are lithostratigraphic rather than time-stratigraphic units. Simple stratigraphic columns generally depict the centres of basaltic edifices, such as the Mount Milligan area (Nelson *et al.*, 1991a) and near Quesnel (Bailey, 1989). Figure 1-9-5 provides a more general view of the early Takla arc, in which discrete basaltic centres are surrounded by blankets of epiclastic products in the fore-arc and back-arc areas as well as longitudinally between centres.

AGE OF THE INZANA AND RAINBOW CREEK FORMATIONS

Two preliminary conodont ages from the Tezzeron Creek map area (93K/16) help to constrain the onset of Takla volcanism. One, from the pre-volcanic Rainbow Creek formation near Dem Lake is late Carnian; the other, from the Inzana Lake formation, is Norian (M.J. Orchard, personal communication, 1991).

THE CHUCHI LAKE FORMATION

The Chuchi Lake formation north of Chuchi Lake (93N/1) consists of heterolithic plagioclase± augite-phyric lahars and lesser maroon plagioclase-phyric latite and trachyte flows, with a single west-northwesterly striking sandstone-siltstone unit near the northern border of the map area (Nelson *et al.*, 1991a, b). This marker horizon dips moderately south and extends northwestwards under cover towards the BP-Chuchi and Rio-Klaw properties, where sediments outcrop minimally but are intersected in many drill holes. North of Klawdetelle Creek, the sediment horizon is exposed in the cirques of 'Adade Yus Mountain (Figure 1-9-3), where it dips gently south and strikes nearly east-west, with an estimated thickness of 250 metres. It pinches out into volcanic flows toward the west. The sediments include brown-weathering sandstone, siltstone, dark grey shale and variable amounts of cherty, pale green dust-tuff.

The external relationships of the sedimentary marker illustrate the petrologic and lithologic variability of the Chuchi Lake formation (Figure 1-9-6). On 'Adade Yus Mountain (Figure 1-9-6A), a lower sedimentary interval 10 metres thick is interbedded with green and maroon amygdaloidal clinopyroxene±plagioclase-phyric and aphanitic basalt flows 150 metres below the main sedimentary unit. The major interval of sediments is overlain by heterolithic agglomerates with plagioclase±augite, augite±plagioclase, plagioclase±acicular hornblende porphyry clasts and locally altered and pyritized monzonite fragments. This unit is indistinguishable from the heterolithic agglomerate that lies below the sediments.

East of 'Adade Yus Mountain (Figure 1-9-6B), the sediments contain abundant fine-grained tuff and overlie a green porphyritic agglomeratic flow unit with plagioclase laths up to 1 centimetre in size and lesser augite. The sediments coarsen upwards into thick sandstone beds with abundant rip-up clasts of shale. These are overlain by pebbly grit and conglomerate with clasts of pink glassy flow-banded trachyte, welded trachytic tuff, quartz-jasper veins, subvolcanic intrusions and strongly epidotized volcanic rocks which represent both local and exotic source rocks. These conglomerates are overlain by heterolithic agglomerate.

In 93N/1 (Figure 1-9-6D), the sediments lie between identical heterolithic lahars. This package overlies an augite(-olivine)-phyric basalt flow (or flows?) that underlies much of the prominent ridge along the southern border of 93N/8. It may correlate with the flows below the sediments on 'Adade Yus Mountain. On the BP-Chuchi property (Figure 1-9-6C), the sediment package overlies and also interfingers with heterolithic agglomerates and lapilli tuffs that contain abundant crowded porphyry intrusive clasts. They are discussed further in the property description. The sediments are capped by a distinctive suite of plagioclase and augite-phyric intermediate flows with large phenocrysts. The flow unit continues south, interrupted by an apophysis of the Hogem batholith, to the Skook claims (Figure 1-9-6E). There volcanic flows overlie sandstones, siltstones

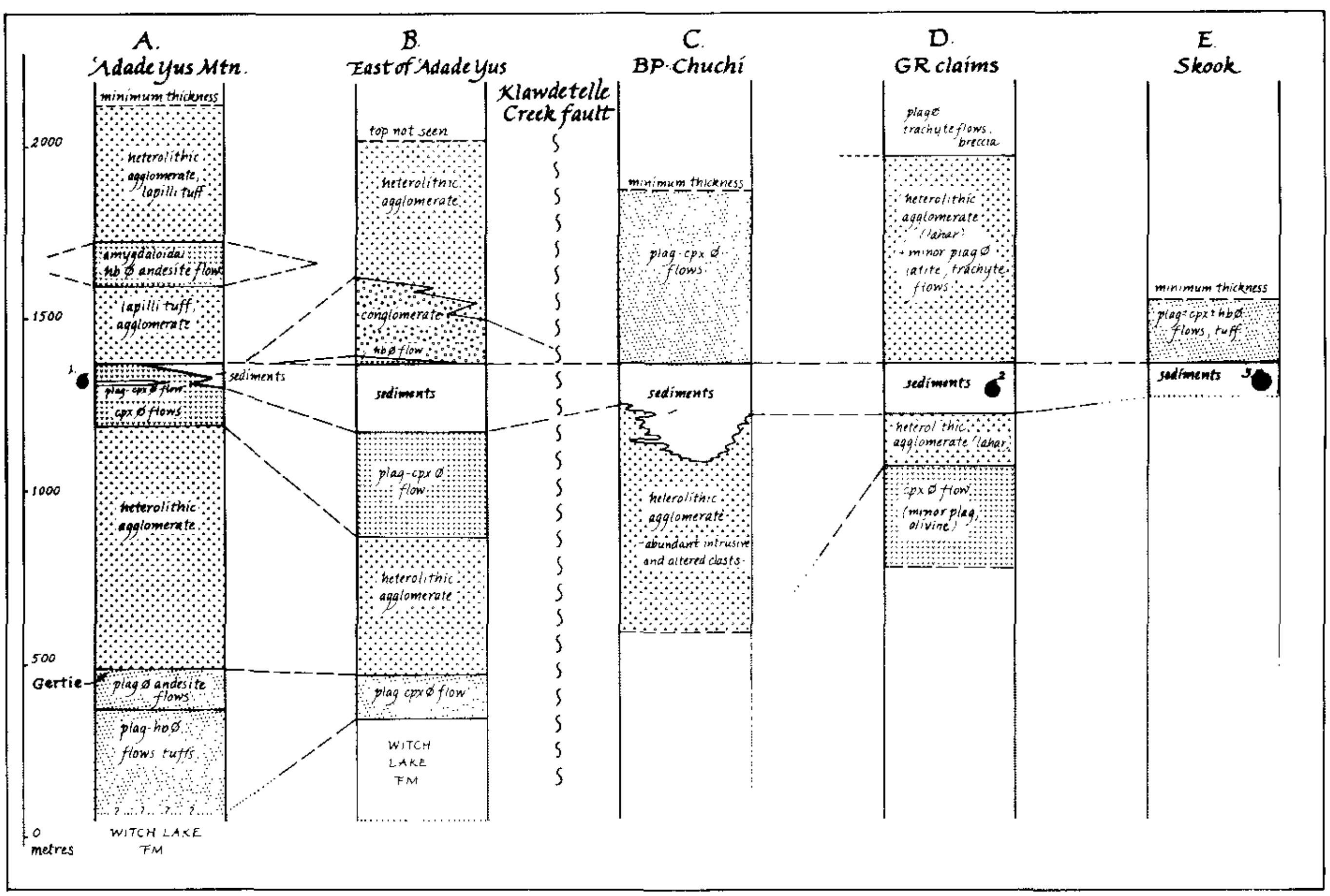

Figure 1-9-6. Selected stratigraphic columns through the Chuchi Lake formation.

and white-weathering cherty tuffs with limy nodules. In the cross-section (Figure 1-9-4) the Skook sediments are interpreted as an inlier of the main sedimentary marker.

In contrast to the underlying Witch Lake formation, the Chuchi Lake formation is characterized by extreme variability in rock composition and texture. The 1650 metres of Chuchi Lake stratigraphy are composed predominantly of heterolithic volcanic agglomerates, plagioclase and plagioclase±augite-phyric latites and andesites, lesser augite (and even olivine)-phyric basalts and trachytes. Internal facies variations within the flows are also pronounced. Local flow packages show consistency in textures and even in the shapes of phenocrysts. They grade laterally into heterolithic agglomerates and lahars which represent much broader textural and compositional parentage. Flows are especially prominent from the north shore of Chuchi Lake to Klawdatelle Creek and northwestwards towards 'Adade Yus Mountain. A major volcanic centre may be masked by the intrusive rocks of the Hogem batholith.

The basal contact of the Chuchi Lake formation is exposed on one ridge in east-central 93N/7. Augite-porphyry lapilli tuffs pass transitionally upwards into slightly maroon, heterolithic plagioclase±augite-phyric agglomerates. At this locality there is no suggestion of unconformable relationships between the two formations. However, at one locality between Chuchi and Witch lakes, a few outcrops of maroon plagioclase-porphyritic flows and fragmentals occur within an area otherwise underlain by dark green augite-porphyritic agglomerates and volcanic sediments of the Witch Lake formation. The maroon rocks are archetypical of the Chuchi Lake formation and may represent its base. If this interpretation is correct, then the base of the Chuchi Lake formation here is morphologically irregular and lithologically abrupt and thus may be a local unconformity. Alternatively, these rocks may represent part of a Witch Lake centre, deposited in conditions more typical of the Chuchi Lake formation (i.e., above wave base) or could belong to the Chuchi Lake formation proper and be a fault-bounded sliver, although there is no supporting evidence for the latter.

AGE OF THE CHUCHI LAKE FORMATION

Three collections of ammonites and two collections of brachiopods were made from the sedimentary marker in the Chuchi Lake formation. Collection 91-1 is from the 10-metre interval below the main marker on 'Adade Yus Mountain (Figures 1-9-3, 1-9-6A, Plate 1-9-1). Collection 91-2 is from map sheet 93N/8, 200 metres north of the western extent of the sedimentary unit as shown in Figure 1-10-4a of Nelson *et al.* (1991a). Collection 91-3 is from a stream gully 2 kilometres from the eastern border of 93N/2 and 500 metres north of the Germansen-Indata road (Figure 1-9-3). The ammonites were identified by Howard Tipper of the Geological Survey of Canada. Collections 91-1 and 91-2 are probably of early Pliensbachian age, and Collection 91-3 is of late Pliensbachian age (H.W. Tipper, personal communication, 1991; Table 1-9-1). These fossil collections demonstrate that Chuchi Lake formation volcanism continued at least as late as Pliensbachian time. This is the youngest documented age of volcanism in Quesnellia. The uppermost volcanic units near Quesnel, and the augite porphyries of the Elise Formation near Rossland, are overlain by sediments of Pliensbachian age (Bailey, 1989; Höy and Andrew, 1989; Tipper, 1984).

This Early Jurassic age for the Chuchi Lake formation indicates that the Takla Group in the Nation Lakes area spans the Triassic-Jurassic boundary. The Inzana Lake formation is, at least in part, of Norian age. The Slate Creek formation near Manson Creek (Ferri and Melville, in preparation) and the basal Takla sediments between the Pinchi fault and the Hogem batholith (Armstrong, 1949) are also Late Triassic. At this point, no regional unconformities that might correspond to the Triassic-Jurassic boundary have been recognized in the Takla Group in this area. The contact between the Inzana Lake and Witch Lake formations is transitional, as is the basal contact of the Chuchi Lake formation with the one exception noted above. The upper and lower contacts of the sedimentary marker unit show interbedding of sediments, flows and fragmental rocks. At the easternmost exposure of the sedimentary marker in 93N/1, 10 metres of brown sandstones and siltstones are interbedded with lahars. Wood fragments occur within both the sandstones and the lahars, and two brachiopods were discovered in the matrix of the underlying lahar. In summary, field evidence in the Nation Lakes area suggests a continuous Triassic-Jurassic volcanic sequence, with a volcanic lull during Pliensbachian time.

STRUCTURE

The structural fabric of the 1991 map area is simple, with few faults and only one regional fold. The lack of faults is in strong contrast to the Mount Milligan area, which is transected by strands of the Manson–MacLeod Lake fault system. The present map area, in central Quesnellia, is relatively unaffected by the Manson–MacLeod Lake or the Pinchi transcurrent faults.

A northwesterly trending regional anticline underlies the western part of 93K/16 and 93N/1 (Nelson *et al.*, 1991a, b). Its hinge zone and part of the western limb continues into 93N/2. Interfingering Witch Lake and Inzana Lake formations strike northeasterly and dip gently to moderately northwest (Figure 1-9-3). This regional-scale fold is not present north of Chuchi Lake; instead, an approximately homoclinal panel of Chuchi Lake formation dips gently to the south. A fault is therefore inferred under Chuchi Lake, based on these differences in stratigraphy and structural trends. The preferred interpretation for the disappearance of the anticline north of Chuchi Lake, is that the fault may have formed at a point of structural weakness along the plunge depression of the anticline. The open nature of the fold, and the gentle dips of bedding on both sides of Chuchi Lake, support the idea that the fold opens further to the north and loses its identity. Movement on the Chuchi Lake fault probably predated emplacement of the Hogem intrusive complex, since it does not offset the strong magnetic anomaly associated with the monzonite. Also, the fault may have acted as a guide for the satellite body of coarse-grained monzonite exposed on the south side of Chuchi Lake at the east end of the map area.

Other significant faults in the area include an east-northeasterly trending fault along Klawdetelle Creek and a northerly striking fault on the BP-Chuchi property that terminates against the Klawdetelle fault. Both of these structures offset the sedimentary marker unit in the Chuchi Lake formation. The Klawdetelle fault also seems to have exerted control over the northwestern margin of the Chuchi syenite, a late phase of the Hogem intrusive complex. Therefore this fault, like the Chuchi Lake fault, was probably active between Takla Group deposition and intrusion of the Hogem batholith.

The excellent exposures on, and east of, 'Adade Yus Mountain provide good control on the attitudes of regional bedding and the often strongly discordant orientations of individual beds within them. The Chuchi Lake formation as a whole is only gently warped in these exposures, in spite of the tight folds observed in thin-bedded sediments. In a more general sense, the complicated structural history unravelled from the Inzana Lake formation in 93K/16 (Nelson *et al.*, 1991a, b) is not shared by the Witch Lake and Chuchi Lake volcanic units: the Takla Group is disharmonically folded. Regional-scale structures are broad and open while incompetent layers such as the Inzana Lake formation are intensely deformed. Because of the conflicts between local and regional bedding attitudes, major contacts were used exclusively in construction of the cross-section of the project area (Figure 1-9-4).

Sporadic zones of strong northwesterly trending foliation, separated by areas with weaker fabrics, occur in the Inzana Lake formation around Tsaydaychi Lake and between the Klawli River and the Germansen batholith. In thin section, the foliation consists of strongly oriented actinolite needles and, less commonly, biotite trains that wrap around relict augite phenocrysts. Within a kilometre of the Germansen batholith, inside its thermal aureole, the foliation is overprinted by randomly oriented actinolite and biotite, and the matrix has a finely granular texture. The sporadic development of foliation resembles the structural style seen near fault strands in the Mount Milligan area (Nelson *et al.*, 1991a). Such a fault, perhaps part of the Manson Creek system, may have controlled the southwestern margin of the Germansen batholith. In addition, parts of the batholith margin, for example north of Moosmoos Creek, show post-solidus deformation and foliation. Microscopically the foliation is due to recrystallization of igneous biotite to finer grained trains, accompanied by subgrain formation in feldspars and neoblast recrystallization along grain boundaries. Thus, strain in this area both preceded and postdated intrusion of the Cretaceous Germansen batholith.

INTRUSIONS

TAKLA INTRUSIONS

Relatively fine-grained mafic to intermediate hypabyssal intrusions occur in several areas within the Takla Group.

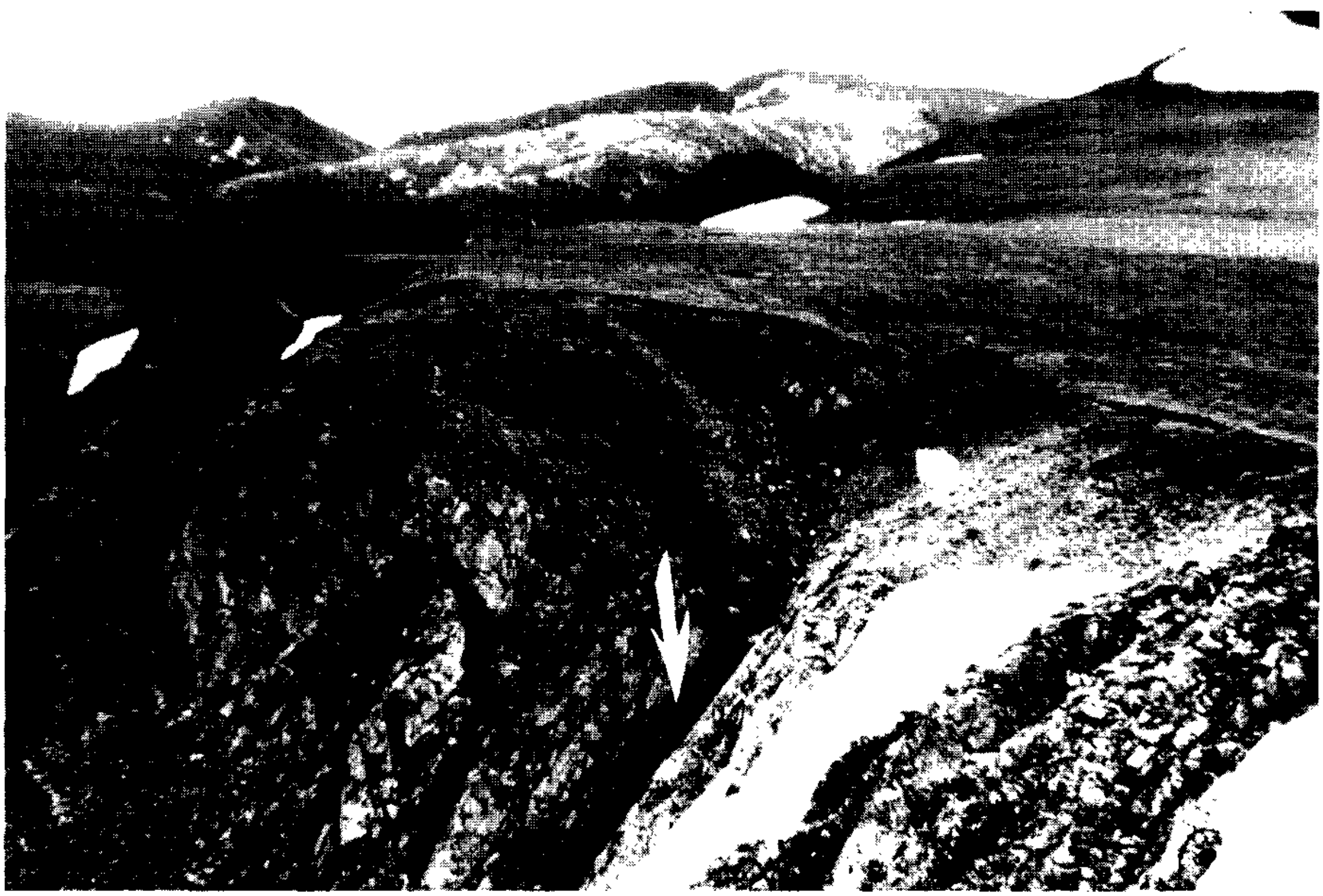

Plate 1-9-1. Lower sedimentary bed on 'Adade Yus Mountain, at the early Pliensbachian ammonite locality.

Their textures and alkalic character link them to the Takla Group; moreover hypabyssal clasts of these intrusions are abundant in parts of the Chuchi Lake formation. The intrusions are classified using the scheme developed by Nelson *et al.* (1991a); that is on the basis of their textures and compositions. Some intrusions are described in more detail in connection with their associated alteration halos. The intrusions are grouped from north to south and include the following:

(1) The older phase of the intrusion around Klawli Lake. This syn-Takla hypabyssal complex is made up of a variety of textural and compositional variants including equigranular diorite with 0 to 5 per cent quartz (4A), a border phase of microdiorite which is sometimes interbanded on a centimetre scale with a more leucocratic igneous phase giving the rock a fallacious gneissic appearance (4A), and rare biotite lamprophyre (6A; new classification, coarse-grained, equigranular ultramafite) comprised entirely of altered mafic minerals. Fragments of the equigranular diorite occur in the surrounding volcanic agglomerates, indicating that intrusion was contemporaneous with volcanism. Contact metamorphism has converted pyroxenes to amphiboles and hornfelsed the volcanic country rocks. The later potassium feldspar megacrystic granite intrusive phase has generated a contact aureole both in the intrusion and in the volcanic rocks around it. This body is probably related to the Germansen batholith and is discussed below.

(2) A small, pink, crowded plagioclase ± acicular hornblende monzonite porphyry (3B) that occurs in a glacial gully 4 kilometres north of Klawdetelle Lake. Its margins are composed of intrusive breccias with clasts of monzonite and volcanic lithologies (Plate 1-9-2).

TABLE 1-9-1
FOSSIL IDENTIFICATIONS

REPORT J7-1991-HWT

Report on three collections of Jurassic fossils, collected in 1991, from the Manson Creek map area (93N), British Columbia, submitted by Joanne Nelson, BCMEMPR.

Field No.:	91JN-19-4	GSC Loc. No: C-189721
Locality:	North of Chuchi Lake, Skook claims. In an east-west gully 0.5 km north of main logging road. UTM 403200E 611700N; 93N/2.	
Identifications:	*Leptaleoceras* aff. *accuratum* (Fucini) *Leptaleoceras* sp. *Fuciniceras?* sp. *Arieticeras* cf. *algovianum* (Oppel)	
Age and comments:	Late Pliensbachian. Lower part of the Kunae zone. This is a first occurrence of the late Pliensbachian in the Fort St. James area. Important new information for Quesnellia Terrane.	
Field No.:	91JN-93N8W	GSC Loc. No.: C-189719
Locality:	Clearcut north of Chuchi Lake, GR claim group. UTM 410550E 6123275N; 93N/8W.	
Identifications:	*Amaltheus* sp. *Fanninoceras?* sp. *Leptaleoceras* aff. *accuratum* (Fucini) *Arieticeras?* sp.	
Age and comments:	Late Pliensbachian. Lower part of the Kunae zone. Almost certainly equivalent to collection C-189721	
Field No.:	91CRE-7-3	GSC Loc. No.: C-189720
Locality:	'Adade Yus Mountain north of Chuchi Lake. UTM 392875E, 6128050N; 93N/7E.	
Identifications:	*Tropidoceras* sp. *Acanthopleuroceras?* sp. *Metaderoceras evolutum* (Fucini) *Gemmellaroceras??* sp. *Phricodoceras???* sp. bivalves	
Age and comments:	Early Pliensbachian. Whiteavesi zone. Material is compressed but the assemblage is clearly early Pliensbachian in age and almost certainly Whiteavesi zone; i.e., mid-early Pleinsbachian.	

H.W. Tipper
Research Scientist
R.I. Thompson
Subdivision Head
15 November 1991

Cordilleran Division
Geological Survey of Canada
100 West Pender Street
Vancouver, B.C. CANADA

(3) A very small plug or dike of equigranular, medium-grained, grey-green hornblende monzonite (3A) located 3.5 kilometres southeast of 'Adade Yus Mountain.

(4) The intrusive complex south of Klawdetelle Lake on the BP-Chuchi and Rio-Klaw properties (MINFILE 093N 159). Numerous small plutons and sills of crowded plagioclase-porphyritic monzonite (3B) and crowded plagioclase$\pm$acicular hornblende monzonite (3B) intrude the sedimentary unit in the Chuchi Lake formation. In terms of textures and compositions, these intrusions very closely match the suite at the Mount Milligan deposit. Fragmental rocks that contain abundant crowded-porphyry monzonite clasts, as well as altered clasts, are associated with these plutons.

(5) The crowded plagioclase-porphyritic monzonites (3B) on the Rio-Witch property (MINFILE 093N 164) between Chuchi and Witch Lakes. They are associated with finely milled intrusive breccias.

(6) A swarm of large hornblende-porphyritic dikes (4C) on the Camp property (MINFILE 093N 081) south of Witch Lake. The large blocky hornblende crystals in these dikes link them texturally with the dikes on the Tas property (MINFILE 093K 080; Nelson *et al.*, 1991a, b). Similar dikes, and also crowded plagioclase porphyries (3B) and one intrusive breccia occur as far as 5 kilometres southeast of the main Camp showing.

The Hogem Intrusive Complex

The southeastern end of the Hogem batholith outcrops on the north and south shores of Chuchi Lake. It comprises at least three main phases, each phase consisting of many textural and compositional variants. This intrinsic variability suggests that the Hogem batholith is better described as an intrusive complex. The earliest and most mafic phase forms a few outcrops at the northern margin of the complex 1.5 kilometres from the eastern border of 93N/2. It consists of layered gabbro and pyroxenite, cut by hornblende-plagioclase-epidote-magnetite pegmatite stringers and pods. Dikes of coarse pegmatitic monzonite and syenite establish this mafic marginal phase as older than the remainder of the complex.

Medium to coarse-grained equigranular monzonite dominates the second Hogem phase. It outcrops on the shores of Chuchi Lake and on the Col property (MINFILE 093N 101). In some areas the pluton appears uniform, but overall this phase is highly variable and includes textures ranging from fine grained to pegmatitic, equigranular to porphyritic and compositions spanning gabbro, monzogabbro, monzodiorite, diorite ($\pm$quartz) and syenite. These lithologies appear to grade into each other, although in some areas the more mafic lithologies are cut by felsic dikes. Porphyritic monzonite contains phenocrysts of plagioclase, hornblende and augite. Biotite can occur either as regular plates or as large oikocrysts and magnetite contents range up to 7 per cent.

The latest phase of the Hogem intrusive complex underlies Lhole Tse Mountain (also called Chuchi Mountain) and is referred to as the Chuchi syenite (Garnett, 1978). It includes syenite and quartz syenite, with quartz ranging up to 7 per cent. True granite is very rare. The predominant texture of the Chuchi syenite is medium grained, equigranular to aplitic, with hornblende and/or biotite ranging from 2 to 10 per cent. Medium to coarse-grained phases with megacrystic orthoclase are also present. They show that orthoclase was on the liquidus when the syenite was forming. This is in direct contrast to the less-evolved monzonite phase where potassium feldspar does not form phenocrystic phases. Dikes of syenite cut the coarse-grained monzonite on the flanks of Lhole Tse Mountain and on the Col property and xenoliths of monzonite occur in syenite; therefore the Chuchi syenite is the latest phase of the Hogem intrusive complex in the area.

Garnett (1978) reported K-Ar ages for the older parts of the Hogem intrusive complex ranging from 206 to 178 Ma (converted to new decay constants), corresponding to Sinemurian to Bajocian faunal zones. The older age is perhaps coeval with early Chuchi Lake volcanism, while the younger age postdates the collision of Quesnellia with the margin of ancestral North American.

Plate 1-9-2. Mixed monzonite-volcanic breccia along the steep margins of a small intrusion 4 km north of Klawdetelle Lake.

GERMANSEN BATHOLITH AND KLAWLI STOCK

The northeastern corner of 93N/7 is an area of very sparse outcrop underlain by Cretaceous granite of the Germansen batholith (106±4 Ma, K-Ar biotite; Ferri and Melville, in preparation). Unlike the Hogem intrusive complex, the Germansen batholith displays a monotonous uniformity of composition and texture It is coarse grained, with 25 to 35 per cent plagioclase, 25 to 40 per cent orthoclase, 20 to 30 per cent quartz and 7 to 15 per cent biotite and hornblende. Orthoclase forms megacrysts in about half of the outcrops visited. Magmatic crystal-alignment fabrics are not present. In a few areas near its southern margin, a subsolidus foliation characterized by wispy quartz stringers is evident. Unlike the Hogem monzonite, the Germansen batholith is only weakly magnetic.

The Klawli stock is texturally and compositionally identical to the Germansen batholith. It intrudes the core of the early dioritic Takla intrusion near Klawli Lake and mimics its shape. The Klawli stock is composed of unvarying coarse-grained granite with 20 per cent pink orthoclase megacrysts 1.5 to 2 centimetres in length and 5 to 10 per cent mafics (hornblende±biotite). We concur with Armstrong (1949) that the Germansen batholith and the Klawli stock belong to the same intrusive suite and are probably both Cretaceous in age.

METAMORPHISM

Regional metamorphism in the area increases from prehnite-pumpellyite grade in the Chuchi Lake formation near Klawdetelle Creek to lower greenschist grade in the Inzana Lake formation north of the Klawli River. The transition may be partly a function of stratigraphic depth; also, metamorphic grade increases in a northeasterly direction towards the Manson–MacLeod Lake fault zone in the Mount Milligan area (Nelson *et al.*, 1991a) and may show a similar pattern here.

Contact metamorphic textures are of two types. Very fine grained, flinty hornfelses with lavender shades are due to submacroscopic biotite concentrations and occur in the aureoles of the syn-Takla intrusions. Near the Germansen batholith and Klawli intrusion, and in places near the Hogem intrusive complex, coarse-grained hornfelses are developed with macroscopic actinolite and biotite, and patches, segregations and vesicle fillings of epidote, in some areas with garnet. The garnet probably formed at the expense of epidote as a result of the reaction: epidote + quartz = grossular-andradite + anorthite + magnetite + water. Planar fabrics are associated with the thermal peak in the inner contact aureole of the Klawli intrusion. They result from crystallographic alignment of biotite; the overall texture is granoblastic. These fabrics contrast strongly with the pre-intrusive deformation noted north of the Klawli River. They are consistent with forceful emplacement of the Klawli intrusion.

ALTERATION AND MINERALIZATION

Four halos of pervasive alteration are associated with syn-Takla intrusions in the map area. They range from well-defined to somewhat speculative porphyry copper-gold systems. The most prominent is the BP-Chuchi/Rio-Klaw halo, with roughly 30 million tonnes of geological reserves. Second most important is the Witch halo, currently being explored by Rio Algom Exploration Inc. This large halo is partly on 93N/1 (Nelson *et al.*, 1991a, b) and partly on 93N/2, where the Moss showing is located. The Skook halo lies north of Chuchi Lake. In it, a zone of potassic alteration is associated with a swarm of crowded monzonite porphyry dikes. It was drilled by BP Resources Canada Ltd. in 1991. In the Camp halo south of Witch Lake, minor amounts of chalcopyrite and malachite occur in a hornfelsed zone.

Two alteration halos are developed within the Hogem batholith: the western half of the Chuchi halo north of Chuchi Lake, and the Col halo west of Chuchi Mountain. In these, coarse-grained, pink secondary potassium feldspar occur with magnetite and copper sulphides in veins and pegmatites along discrete fractures.

In addition to alteration halos, two new mineral showings are highlighted. The Gertie and Hannah showings are not associated with large alteration systems but are indicative of porphyry and perhaps porphyry-related mineralization.

BP-CHUCHI/RIO-KLAW HALO (MINFILE 093N 159, CHUCHI LAKE)

This extensive intrusive complex and alteration halo lies in the southeastern corner of 93N/7, south of Klawdetelle Creek. The centre of the system is on the Phil claims, where BP Resources Canada Ltd. has been drilling since 1989 (Wong, 1990). The northern extension on the Klaw claims was drilled by Rio Algom Exploration Inc. in 1990 and 1991 (Campbell, 1990a, 1991). The alteration system is bounded to the east by a north-trending fault, and to the north by the fault in Klawdetelle Creek. Within it, crowded plagioclase-porphyritic monzonite stocks intrude the sedimentary horizon in the Chuchi Lake formation [lJCL(D)] and blossom out into sill swarms (Wong *et al.*, 1991). In many instances in drill core, hornfelsed sedimentary rocks show soft-sediment deformation and are intimately intercalated with monzonite: this association is considered by some BP geologists to indicate intrusion of the monzonites while the sediments were still unlithified (Russ Wong, personal communication, 1990), although further study is necessary to document this. The fine-grained, well-bedded sandstones, siltstones and tuffs grade downwards into massive coarse lapilli tuffs and agglomerates. In many cases, intrusive clasts form a large percentage of the fragmental material. Crowded plagioclase porphyry clasts with small blocky plagioclase crystals less than 2 millimetres across are common, and identical to the later porphyries that intrude the sediments. Clasts with pink secondary potassium feldspar, magnetite and epidote are also present.

Abrupt changes occur in the relative percentage of sedimentary rocks and fragmental material between closely spaced drill holes (Bernie Augsten, personal communication, 1991). Possible interpretations of this include rapid facies changes or local faulting. In the valley of Klawdetelle Creek, drill intersections of monotonous black argillites contain virtually no coarse components (Campbell, 1991).

The strong difference between these sections and the fragmental-rich sedimentary sections farther south and west may constitute evidence for facies changes over less than 2 kilometres.

On the ridge 1 kilometre south of the main mineralized area, the sedimentary section is overlain by a suite of plagioclase-augite and augite-plagioclase-phyric flows and minor, thin crystal tuffs of identical composition. These flows contain plagioclase laths 0.6 to 1 centimetre long, commonly synneused to give a ragged appearance to their terminations; and blocky augite crystals up to 0.8 centimetre in diameter. A partly brecciated plagioclase-augite porphyry dike with this distinct appearance cuts the crowded-porphyry monzonite in BP diamond-drill hole 1991-53.

The geological relationships described here point to an intimate relationship between the hypabyssal intrusions and sedimentation (Figure 1-9-7). Some intrusions predate the sedimentary unit, as clasts of them occur in and are also interbedded with the underlying fragmental units. Other intrusions cut the sediments but not the overlying flows. A possible feeder dike to the flows cuts one of the monzonites. The predominance of sills over dikes suggests that they were intruded before lithification was complete, as is observed with synsedimentary igneous activity in, for instance, the Guaymas Basin. It is also possible, albeit not proven, that the sills plastically deformed the sediments around them. The abundance of intrusive material in the surface fragmentals probably resulted from surface venting of intrusive breccias into the sedimentary basin.

In light of the geological evidence that sedimentation, intrusion and porphyry-style copper-gold mineralization were roughly coeval, the Early Jurassic, Pliensbachian fossil ages of the sedimentary horizon would also date the BP-Chuchi porphyry system. As at Mount Milligan (Dale Sketchley, personal communication, 1991), the presence of sediments in this system may have helped to enhance the size and intensity of the altered area, by providing a permeable zone for lateral expansion of the intrusions and the hydrothermal cells. Bailey (1988) cites alteration of Pliensbachian sediments by the Bullion Pit stock near the Quesnel River, dated as 193 Ma by K-Ar on biotite. This porphyry system may have been approximately coeval with the BP-Chuchi system.

Both the monzonite and the sediments at BP-Chuchi are extensively altered. Secondary potassium feldspar occurs in pink veinlets in the monzonite with magnetite, pyrite and chalcopyrite. The sedimentary rocks show a strong biotite hornfels overprint, with subsequent mottling by potassic and propylitic alteration. Hairline veinlets with bleached selvages and magnetite veinlets and disseminations are also characteristic of alteration. Rough geological reserves for this system are about 50 million tonnes with grades between 0.21 and 0.40 per cent copper and 0.21 and 0.44 gram per tonne gold (Digger Resources Inc., news release, October 17, 1991).

Chuchi-Witch Halo (Minfile 093N 084 Moss; Minfile 093 164, Witch)

This broad alteration halo spans the border of 93N/2 and 93N/1 between Chuchi and Witch lakes and covers an area of 3 by 5 kilometres (Nelson *et al.*, 1991a, b). Most of it lies on the Chuchi claims of Rio Algom Exploration Inc. (Campbell, 1990b; Campbell and Donaldson, 1991). Vol-

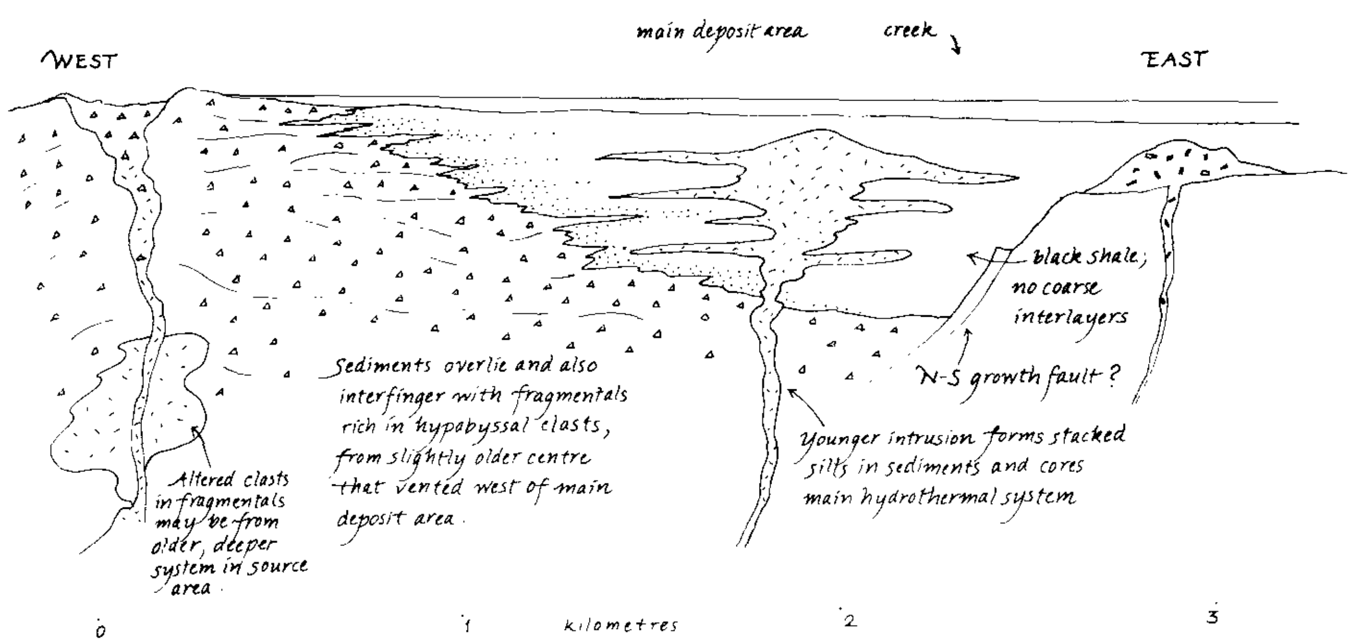

Figure 1-9-7. Cartoon of unit relationships around the BP-Chuchi deposit in Pliensbachian time. The anomalous thickness of sediments near the deposit is explained by half-graben development, with movement occurring on the north-trending fault located along the creek between the deposit and the "multi-element zone" to the east. To the west, the sediments pinch out against an edifice built of fragmental deposits, including intrusive debris, from a centre that predates the main intrusion.

canic rocks of the Witch Lake formation, including augite-porphyritic flows and fragmentals, aphanitic volcanics and minor tuffs, host the alteration system. In it, biotite hornfelsing is widespread. It is overprinted by patchy potassic and propylitic alteration. Pyrrhotite, pyrite and minor chalcopyrite occur throughout the halo. Secondary magnetite is locally abundant. Skarn occurs in several areas at the expense of limy tuffaceous sediments. Skarn minerals include epidote, garnet and diopside. In one thin section from 93N/1 diopside skarn is overprinted by secondary potassium feldspar.

In comparison to the BP-Chuchi/Rio-Klaw halo, the volume of exposed hypabyssal intrusive rock is very small. Crowded plagioclase-porphyritic monzonite forms tiny scattered stocks and dikes with associated intrusive breccias. The breccias are easily confused with surface fragmentals, except that they are more disorderly and the clasts are entirely intrusive. This region is also intruded by several phases of the Hogem intrusive complex including coarse-grained equigranular monzonite, sericite-bearing potassium feldspar pegmatite and coarse-grained syenite.

The best surface mineralization on the property is at the Moss showing. It consists of minor fracture coatings and blebs of chalcopyrite associated with abundant pyrite and pyrrhotite in a gossanous host (Campbell and Donaldson, 1991). Propylitic, potassic and carbonate alteration are so intense that original lithologies are not distinguishable.

CAMP HALO (MINFILE 093N 081, CAMP)

The Camp halo is developed in fine-grained dust-tuffs and siltstones of the Inzana Lake formation where it interfingers with augite porphyry agglomerates of the Witch Lake formation. A swarm of coarse hornblende-phyric dikes cuts the sediments. Pyrrhotite and pyrite are abundant in altered biotite hornfels and minor chalcopyrite and malachite occur as disseminations and along fracture surfaces. The main altered outcrops that constitute the Camp showing were trenched and drilled in the winter of 1990-1991 by Noranda Exploration Company, Limited. The area south of them is covered by extensive Quaternary alluvium. An RGS stream-sediment sample from a glacial gully 2 kilometres south of the showing returned 309 ppm copper, 1100 ppb mercury and 1.5 ppm silver. The sample location is in an obscure drainage plugged by numerous beaver dams. The only surficial materials are organic muck and glaciofluvial gravels exposed in stream banks. Thus the significance of this sample is in doubt. Five kilometres farther southeast, large hornblende-phyric dikes identical to those at the showing are accompanied by crowded plagioclase-porphyritic monzonite stocks and one body of intrusive breccia. It is possible that the Camp showing is part of a much more extensive halo that lies under thick Quaternary cover.

SKOOK HALO (MINFILE 093 140, SKOOK; MINFILE 093N 208, RIG BRECCIA; MINFILE 093N 209, GG)

The Skook alteration system contains several small showings and occurs primarily within the sedimentary unit of the Chuchi Lake formation near its contact with the Hogem intrusive complex. The CL11 zone is the area of most intense alteration and highest density of crowded monzonite porphyry intrusions. It is exposed in an east-trending gully in a logging cut. The sediments are bleached and hornfelsed; alteration minerals include potassium feldspar, chlorite, pyrite, sericite, epidote, biotite, calcite and minor tourmaline (Campbell, 1988). These rocks contain disseminated pyrite, pyrrhotite and minor chalcopyrite and bornite. White-weathering siliceous tuffs with limy nodules are baked and have developed weak skarn alteration minerals such as garnet and chlorite. A polymetallic quartz vein contains sphalerite, galena and chalcopyrite. The best assay results on grab samples from this locality are 13.4 ppm gold, 16.6 ppm silver and 2.3 per cent zinc (Campbell, 1988). The South zone lies 250 metres south of this vein and consists of a silicified zone in volcanics that contains quartz, calcite, pyrite and chalcopyrite. The GG polymetallic vein and the Rig Breccia zone are also hosted within the overlying flows and are probably part of an epithermal vein system near the Takla-Hogem contact.

COL HALO (MINFILE 093N 101, COL)

The Col property (Col and Kael claims) of Kookaburra Gold Corporation is located 5 kilometres north of the west end of Chuchi Lake, straddling the boundary between map sheets 93N/2 and 93N/7. The main copper-gold showings are situated near the southern end of the Hogem intrusive complex. They are hosted by alkaline intrusive rocks near the contact with volcanic flows of the Chuchi Lake formation. Medium to coarse-grained hornblende monzonite, fine to medium-grained pink syenite, aplite and pegmatite are the main intrusive phases. Copper mineralization including chalcopyrite, bornite and malachite is concentrated along steep, 140°-trending parallel fractures, enveloped by salmon-pink potassium feldspar rich alteration 1 to 4 centimtres thick. These zones may also contain quartz, minor magnetite and hairline seams of tremolite/actinolite and chlorite. Some outcrops are so heavily striped with alteration that they take on a gneissic appearance. While some of the zones appear to be late magmatic syenitic dikes, most appear to be the result of metasomatic alteration of the monzonite. A later crosscutting set of steep fractures strikes 050°, but contains only minor mineralization. A trench on the Col showings averaged 2.2 ppm gold and 3.16 per cent copper over a 4-metre interval (Nebocat and Rotherham, 1988).

CHUCHI HALO (MINFILE 093N 104, SRM)

The eastern tail of the Hogem intrusive complex in 93N/2 contains sparse, fracture-controlled chalcopyrite with pink orthoclase, epidote and magnetite. Scattered blebs of chalcopyrite are also present in flows of the Chuchi Lake formation near the margin of the intrusive complex. Chalcedonic quartz breccia veins and small swarms of quartz veinlets contain minor pyrite. In 93N/1 barren orthoclase veins and areas of abundant pyrrhotite in salt-and-pepper monzodiorite characterize the eastern edge of the Chuchi halo (Nelson *et al.*, 1991a). This system resembles other disseminated and vein-hosted mineralization (such as the

Col and Skook halos) near the contact between the Hogem intrusive complex and the Takla Group volcanics.

The Gertie Showing (Minfile 093N 210)

The Gertie copper showing was found on July 3, 1991, during this regional mapping program. It lies on the Jan 5 and 6 claims approximately 5 kilometres south of Klawli Lake and is hosted by volcanic flows of the Early Jurassic Chuchi Lake formation. The showing consists of two large outcrops spaced roughly 1 kilometre apart. The westernmost outcrop is exposed along a glacial gully. An amygdaloidal, maroon and grey, plagioclase-phyric flow hosts disseminated and fracture-controlled malachite and minor azurite. Pink calcite (rhodochrosite?) and jasperoid quartz occur as vesicle infillings. An assay on a single grab sample from this locality returned 0.2 per cent copper. A brecciated zone in a more greenish and aphanitic area of the outcrop contains minor chalcopyrite and has areas of bleaching and hairline fractures with chlorite envelopes. Multidirectional vuggy quartz veinlets are also present and some contain malachite. An altered and bleached intrusive body outcrops 150 metres south of the gully. It contains a crackle breccia that grades into a matrix-supported breccia with milled fragments of intrusive floating in a hematite-rich matrix; no sulphides were visible at this locality.

Native copper blebs 1 by 2 centimetres in size are associated with carbonate and jasper in open-space fillings and occur within a highly amygdaloidal part of the same flow package 75 metres north of the gully. Two, zones of strong propylitic alteration (epidote, chlorite), 1-metre wide, cut the outcrop and contain disseminated malachite.

The eastern outcrop is 1.2 kilometres northeast of the native copper showing. Brecciated green, grey and maroon crystal-lapilli tuff contains disseminated malachite, chalcocite and possibly tetrahedrite. A grab sample from this outcrop assayed 1.08 per cent copper and 17.5 grams per tonne silver.

Stratigraphically, the Gertie showing is located near the top of a maroon flow package that is overlain by massive and monotonous green-grey heterolithic agglomerates. The stratigraphy strikes 070° and dips gently to the south. The regional attitude of bedding suggests that the easternmost outcrop could be a strike extension of the main Gertie showing. The open-space nature of the mineralization points to a flow-top hosted copper occurrence. This showing resembles several other native copper occurrences in the Takla Group including some in the Hydraulic map area near Quesnel and the Sustut Copper deposit in north-central British Columbia. Native copper is hosted in Norian maroon augite-phyric alkali basalts west of Morehead Lake (Bailey, 1987). The Sustut Copper deposit is hosted by the Triassic Moosevale formation, the upper part of Takla Group. Disseminations and veinlets of chalcocite, bornite, chalcopyrite, pyrite and native copper occur in green and maroon volcaniclastics, volcanic breccia, and conglomerates at the transition between marine basaltic volcanism and non-marine intermediate volcanism (Church, 1975; Monger, 1977). Similar occurrences are also present in the Hazelton Group. Small discontinuous pods of high-grade copper and silver are hosted by amygdaloidal and brecciated flow tops of subaerial basalts in the Early Jurassic Telkwa Formation (MacIntyre and Desjardins, 1988; D. MacIntyre, personal communication, 1991). All of these occurrences are in subaerial volcanic flows. Their mineralogy and open-space character suggest that they are products of late-phase hydrothermal fluids related to volcanic activity (Church, 1974).

Although, in itself, the Gertie showing is not directly indicative of a porphyry system, this occurrence may attest to a favourable environment for mineral deposits. The overlying heterolithic agglomerate package hosts altered and mineralized porphyritic monzonite clasts (Hannah, MINFILE 093N 211) and cobbles of epithermal quartz. The volcanic flows that host the Gertie are also on strike with the Klawli showing (MINFILE 093N 032). Although this showing was not visited during the course of 1991 mapping, its potential significance warrants a short description. It is described as a system of mineralized calcite-quartz veins in a brecciated shear zone cutting altered porphyritic and amygdaloidal andesites (Shaede, 1987). Significant minerals include chalcopyrite, malachite, sphalerite, galena and pyrite. The best grab-sample assays reported include 6.7 per cent copper, 1200 grams per tonne silver and 14 grams per tonne gold (Shaede, 1987).

The Hannah Showing (Minfile 093N 211)

The Hannah showing occurs approximately 3.25 kilometres southeast of 'Adade Yus Mountain. It is an area of abundant altered and mineralized monzonite fragments within green, heterolithic volcanic agglomerates of the Early Jurassic Chuchi Lake formation. Up to 2 per cent of the fragments are fine grained and rusty weathering and contain disseminated pyrite and pyrrhotite (Plate 1-9-3).

Plate 1-9-3. Rusty, pyritic monzonite fragment in heterolithic agglomerate, 2.5 km northwest of the Hannah showing. Fragment is 4 cm in diameter.

Many of the clasts, including some crowded monzonite porphyry, are bleached and potassically? altered. Assays on grab samples from an area rich in rusty fragments yielded results up to 840 ppb gold and 224 ppm copper (David Cook, personal communication, 1991). The heterolithic agglomerates associated with the Hannah showing appear to have tapped a mineralized porphyry system.

DISCUSSION AND CONCLUSIONS

The Pliensbachian fossil ages (Table 1-9-1) for the sedimentary unit in the Chuchi Lake formation roughly date the middle of the later, more evolved part of the Takla Group; they may also date the crowded monzonite porphyries that are key to the alkalic porphyry copper-gold deposits, although U-Pb zircon ages are needed to establish this.

The Takla Group between Fort St. James and Germansen Landing represents the most protracted volcanic interval so far documented in Quesnellia, from Carnian to late Pliensbachian. Mixed latite-basalt-trachyte volcanism of the Chuchi Lake formation postdates the Rossland volcanics and the youngest preserved volcanic unit near Quesnel. It is coeval with and even younger than some parts of the Hazelton Group. Thus volcanism was "alive and well" in Quesnellia during Hazelton time. The major difference between the Jurassic volcanic history of Quesnellia and Stikinia is less one of timing than of style: while the chemistry of the Hazelton Group is dominantly calcalkalic, the later part of the Takla Group is mildly alkalic, with strong evolutionary ties to the earlier augite porphyries.

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