HIGHLIGHTS OF 1990 FIELDWORK IN THE ATLIN AREA (104N/12W)

By M.G. Mihalynuk, K.J. Mountjoy, W.J. McMillan, C.H. Ash and J.L. Hammack

KEYWORDS: Regional geology, Cache Creek complex, Peninsula Mountain suite, Graham Creek suite, Laberge Group, Sloko Group, Fourth of July batholith, Nahlin fault, isotopic age, rare-earth elements, geochemistry, gold, metallogeny.

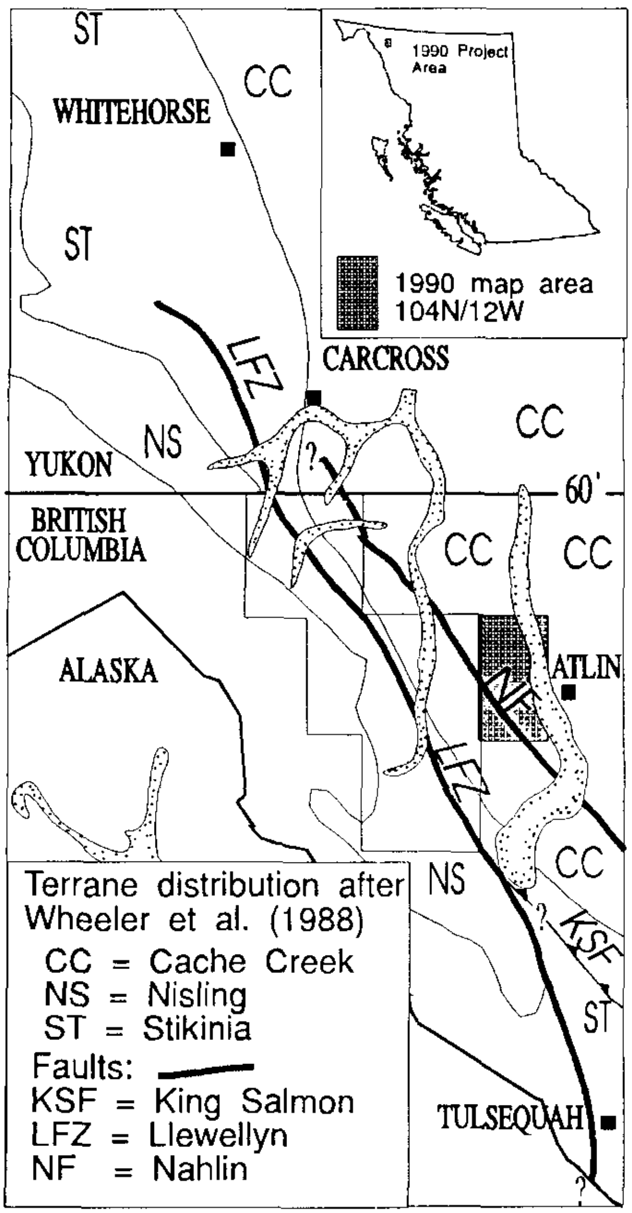

Figure 1-15-1. Tectonic elements of northwestern British Columbia in the vicinity of 104N/12W.

INTRODUCTION

Fieldwork in the Atlin area was confined to a four-week period in 1990. About two weeks were spent on reconnaissance mapping of the western half of the Atlin 1:50 000 map-sheet (104N/12W) incorporating mapping done in 1989 as part of a study by Bloodgood and Bellefontaine (1990). The contact zone between the Cache Creek Terrane and terranes to the west is exposed in this half map-sheet (Figure 1-15-1). This paper focuses on geological highlights of mapping along the contact zone and presents new rare-earth element data, anomalous geochemical gold analyses and previously unpublished isotopic age data.

GENERAL GEOLOGIC SETTING

The geology of the area is dominated by three lithotectonic packages. From east to west these are: oceanic crustal rocks and overlying sediments of the Triassic to Mississippian Cache Creek complex; probable Middle to Upper Triassic intermediate to felsic volcanic-arc strata of the Peninsula Mountain suite, and Lower to Middle Jurassic sedimentary rocks of the Laberge Group. In the southern part of the map area the Cache Creek rocks are juxtaposed against the Laberge Group across the Nahlin fault. To the north, the Peninsula Mountain volcanic package separates these packages and displays structural and stratigraphic relationships with both the Laberge Group and Cache Creek complex. The Fourth of July batholith intrudes deformed Cache Creek Complex and probable Peninsula Mountain lithologies. All of these rocks are overlain by at least two younger volcanic suites .

PREVIOUS WORK

A more regional geological perspective can be found in Cairns (1913), Aitken (1959) and Bultman (1979). Geology west of NTS mapsheet 104N/12W is covered by Mihalynuk *et al.* (1988a,b; 1989a,b; 1990), Mihalynuk and Mountjoy (1990) and Mihalynuk and Rouse (1988a,b), and to the immediate east by Ash and Arksey (1990b). Geological data compiled in Figure 1-15-2 were augmented in specific areas by property-scale mapping (Aspinall, 1969; Anuik, 1970).

CACHE CREEK COMPLEX

"Cache Creek complex" is used here in preference to the more commonly used "Cache Creek Group" as component units include rocks of sedimentary, volcanic, metamorphic (ultramafic) and structural (fault mélange) origin.

Within the complex, units are generally fault bounded and vary in dimension from just a few metres to several kilometres. In 104N/12W, Cache Creek lithologies include

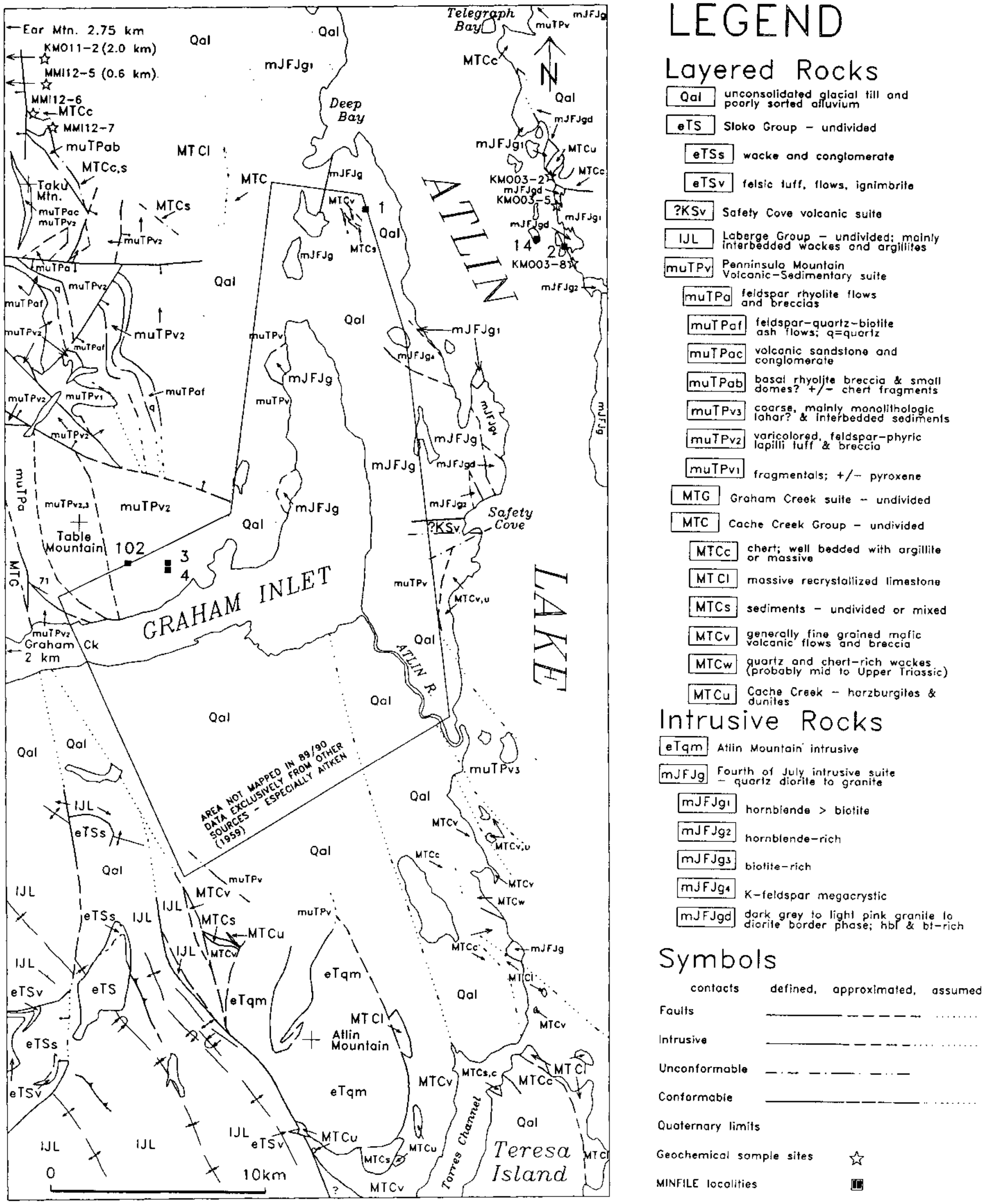

Figure 1-15-2. Generalized geological map of the Tagish area.

massive, white carbonate, chert, mint-green basalt breccia, harzburgite, dunite (and serpentinized equivalents), and a variety of clastic sediments including silty argillite and coarse quartz-bearing wackes.

Descriptions of lithologic units have been furnished previously by Monger (1975, regional geology and paleontology), Ash and Arksey (1990b, ultramafic rocks), and Bloodgood and Bellefontaine (1990, sedimentary rocks) among others, and are not reproduced here. However, quartz-rich strata within the Cache Creek complex are less well known in this region. Such strata are potentially very useful for establishing linkages between the oceanic Cache Creek Terrane and adjacent, more evolved crustal masses. An investigation of possible linkages is currently in progress.

GRAHAM CREEK IGNEOUS SUITE AND PENINSULA MOUNTAIN VOLCANIC SUITE: RELATIONS AND CORRELATIONS

Rocks of the Graham Creek and Peninsula Mountain suites form a northwest-trending belt beginning at Atlin Mountain, with best exposures on Table and Taku mountains. Along the northwest flank of the belt, tectonized harzburgite has a recurrent spatial association with chert and pillow basalt; together these rocks comprise the Graham Creek suite (Mihalynuk and Mountjoy, 1990). In most cases contacts between the two suites are verifiably faulted. There is some evidence for local stratigraphic continuity between the pillow basalts and lower Peninsula Mountain volcanics, but it is circumspect (*cf.* Mihalynuk and Mountjoy, 1990). Rare-earth element (REE) data emphasize the differences between the two suites. However, they represent two compositionally distinct volcanic packages, with the Peninsula Mountain volcanic rocks tending to be porphyritic and more felsic overall, such that preliminary REE data from the two suites (Figure 1-15-3) cannot be directly compared. The data do show that the Graham Creek pillow basalt and

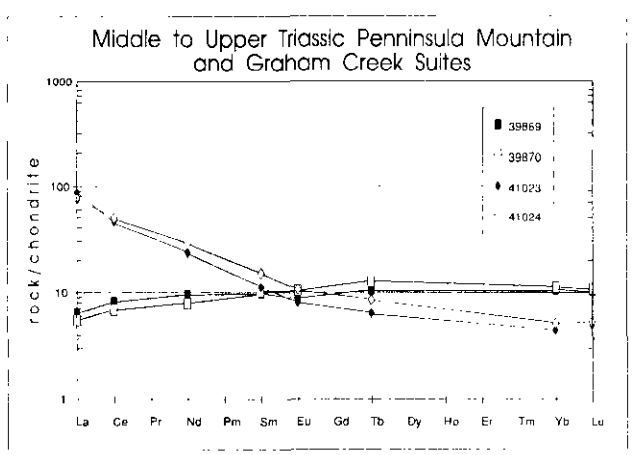

Figure 1-15-3. Chondrite normalized REE plot of selected samples from the Graham Creek igneous suite (squares) and the Peninsula Mountain volcanic suite (diamonds). Normalizing factors used are those of Nakamura (1974); the shaded MORB field is adapted from Saunders and Tarney (1979).

gabbro fall in the centre of the mid-ocean ridge basalt (MORB) field of Saunders and Tarney (1979), confirming their genetic association with spatially affiliated tectonized harzburgites.

Within the Peninsula Mountain suite, widespread eruptive units, particularly quartz-phyric ash flows and other distinct lithologies, are marker horizons that allow for the development of a tentative stratigraphy consisting of six eruptive packages. Stratigraphic relationships are not simple as interfingering and onlapping of units is probably common.

At the base of the succession are green and light grey to tan, epidote and chlorite-altered, coarse, vessicular andesitic breccias containing medium-grained feldspar and sparse medium to coarse-grained pyroxene. These rocks are well exposed in a steep valley that dissects Table Mountain, where they stratigraphically underlie feldspar-phyric lapilli tuffs and abundant feldspar-quartz-biotite-phyric ash flows.

North of Table Mountain, fine to medium-grained tabular feldspar-phyric lapilli tuffs of intermediate composition are interfingered with, and underlie, ash flows. Maroon, green, and orange varieties may be locally foliated, particularly near their contacts with pyritic white rhyolite which occurs as small domes(?) or as chert-bearing breccias and interbedded epiclastics.

Ash flows are mauve, tan, grey and light green and generally display crude flow layering and lapilli elongation. Individual cooling units are generally homogeneous and monolithologic. Thin, well-bedded epiclastic interbeds are common.

The rhyolite unit separates the bulk of the volcanic strata from sediments of the Cache Creek Terrane. Lithologically it resembles younger rhyolites. It is, however, thought to be part of the Peninsula Mountain suite as the provenance of associated epiclastics (particularly chert cobbles) appears to be the same as for epiclastic beds within some of the oldest Peninsula Mountain lapilli tuffs. Relationships between the rhyolite breccia and other volcanics of the Middle to Upper Triassic package are illustrated in Figure 1-15-4.

Volcanic strata near the mouth of the Atlin River are included as part of the Peninsula Mountain suite on the basis of limited lithologic similarities. These rocks are relatively undeformed and may actually be younger than the Peninsula Mountain suite. They comprise massive, coarse, predominantly clast-supported laharic breccias and lesser pyroclastic units with minor interbeds of well-layered epiclastics which dip gently to moderately eastward. They are bordered on all sides by Cache Creek lithologies, although nowhere can the contact be observed directly.

Blocks within laharic units are typically rounded and of decimetre size, but range up to several metres diameter. They are generally of one or two compositions. Rounded, red, purple, orange or green andesitic blocks containing about 35 per cent fine to medium-grained, trachytically aligned feldspar are most common. Less common are white, grey or light green blocks which may be slightly more angular, are flow layered and have a planar fracture and a waxy fresh surface.

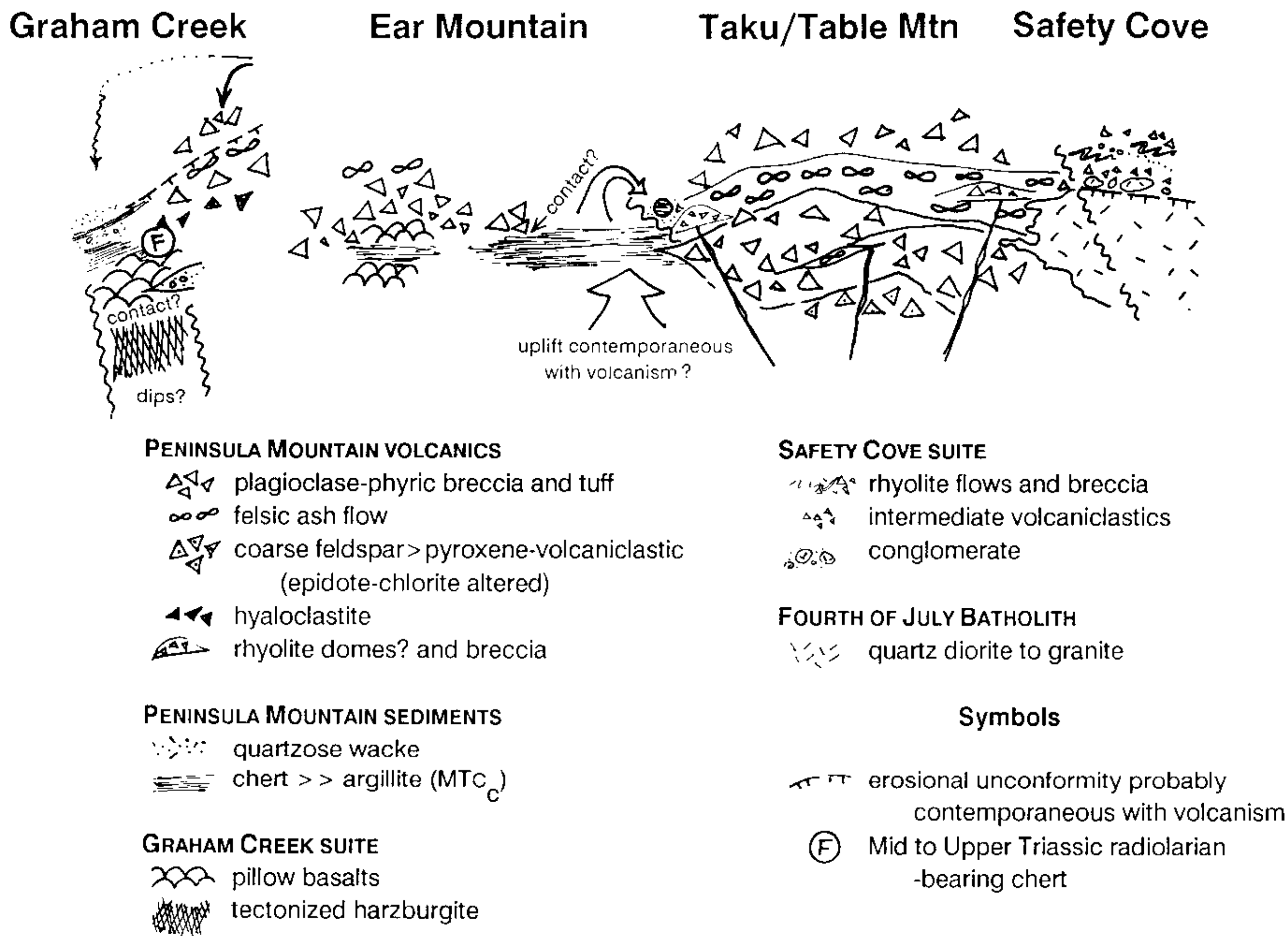

Figure 1-15-4. Schematic representation of stratigraphic relationships between the Peninsula Mountain suite and the Graham Creek suite which may both be partly correlative with rocks of the Cache Creek complex. (Especially tectonized harzburgite and cherts).

At the mouth of the Atlin River, pyroclastic breccia units from 1 metre to greater than 5 metres thick are interbedded with dense, ochre-coloured flows that have vesicular tops. Pyroclastic units are distinctive in that they incorporate abundant charred plant fragments. In places they appear to grade into flow-top breccia, but are otherwise quite similar in appearance to laharic units.

AGE AND CORRELATION

Just off the northwest corner of 104N/12W hornblende-quartz-phyric volcaniclastic rocks are interbedded with massive white to tan chert (Ear Mountain, Figure 1-15-4. A few kilometres to the southwest, well-bedded, tan chert is interbedded with coarse quartz, feldspar and hornblende-bearing wackes probably derived from the volcanics. These well-bedded cherts yield radiolarians identified by Cordey (1990) as Middle to Upper Triassic age. Pyroclastic rocks associated with the massive cherts are believed to be part of the intermediate and felsic Peninsula Mountain suite volcanics. At Telegraph Bay, Peninsula Mountain volcanic strata are thermally metamorphosed by the 171 Ma Fourth of July batholith. The same intrusive relationship is shown by Aitken (1959) on northern Graham Inlet; such relationships support the Middle to Upper Triassic age of these rocks. Furthermore, the Peninsula Mountain suite shares many characteristics with the Upper Triassic massive sulphide bearing Kutcho Formation in the Dease Lake area (Thorstad and Gabrielse, 1986; Mihalynuk and Mountjoy, 1990).

Despite a growing body of geological evidence that indicates a Middle to Upper Triassic age for the Peninsula Mountain suite, a Rb-Sr isochron, defined largely on the basis of a sample collected from Table Mountain, returned an age of 72.4±2.1 Ma (Grond *et al.*, 1984). At present we are unable to accommodate this date. We do not recognize a separate, younger volcanic package above the Peninsula Mountain suite, nor are we able to reasonably apply this date to the Peninsula Mountain suite as a whole. We suspect that either the sample was atypical, either a dike or a fault sliver, or it is chemically aberrant (perhaps altered).

FOURTH OF JULY BATHOLITH AND RELATED DIKES

Just north of the town of Atlin, the Fourth of July batholith underlies an area of approximately 650 square kilometres. In the map area, this polyphase intrusive body is composed primarily of pink granite, granodiorite and monzonite. Zoning is apparent with varying abundances of porphyritic potassium feldspar, biotite and hornblende. Zoning is particularly evident near the margins, where biotite and, to a lesser degree, hornblende are much more abundant within a monzodiorite or monzonite phase (*cf.* Aitken (1959) for a more detailed description).

Everywhere the batholith is crosscut by dikes that are thought to be residuals of late-stage magmatic intrusion. These dikes generally have the same composition as the more mafic portions of the batholith. Very biotite-rich varieties have a distinctive knobbly weathering habit in which sparse, pink feldspar clots (xenocrysts? or immiscible droplets) may form resistant spikes. Dikes are typically 0.3 to 3 metres thick and trend 315° with moderately steep dips to the east. They comprise 10 to 20 per cent of the outcrop volume and extend into the Cache Creek section where abundance decreases and their orientation is less consistent.

AGE OF FOURTH OF JULY BATHOLITH

Until recently an inferred Jurassic age for the Fourth of July batholith was based on relative geologic age constraints (Aitken, 1959). Bloodgood *et al.* (1989) referenced K-Ar (hornblende and biotite) dates of 110±4 and 73.3±2.6 Ma from rocks collected within 150 metres of the younger Surprise Lake batholith by Christopher and Pinsent (1982). In the latter paper Christopher and Pinsent list these dates in "Table 2. K/Ar Ages from the Surprise Lake Batholith" and they are indicated as having been obtained from a sample with "Reference Number A-KAR-5". The same sample is listed in their "Table 1" of whole-rock geochemical data where it is labelled "Fourth of July" and displays a geochemical signature that is radically different from other samples from the Surprise Lake batholith. Their written location description of Sample A-KAR-5 places it as part of the Fourth of July batholith on both their map and the map of Sutherland Brown (1970). Thus, these data do appear to have been derived from Fourth of July rocks as inferred by Bloodgood *et al.*; however, as implied by Christopher and Pinsent, the ages probably reflect resetting during the intrusion of the nearby Surprise Lake batholith.

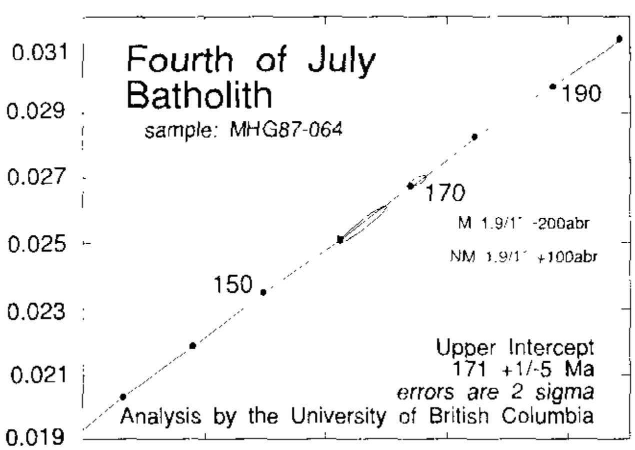

Figure 1-15-5. Conchordia plot for clear, colourless, euhedral, doubly terminated zircons of the Fourth of July batholith (analyzed by The University of British Columbia). Analyses of both fractions are essentially concordant giving a $^{206}U/^{238}Pb$ date of 171±5 Ma.

Donelick (1988) determined a zircon fission-track age of 215±20 Ma from the Fourth of July batholith at Mount Hitchcock and 193±18 Ma and 128±8.7 Ma were acquired from other Fourth of July localities. This Upper Triassic age indicates the time at which these rocks cooled through 200°C and, if not misrepresentative, should be the minimum age of the intrusive body. However, a sample collected by the Geological Survey Branch recently returned a concordant U-Pb zircon date of 171±5 Ma. These new data, shown in Figure 1-15-5, are thought to most accurately reflect the age of the Fourth of July batholith and most closely replicate the early age assignment of Aitken (1959) based upon geological relationships. However, since the Fourth of July batholith is a composite intrusive body, some variability in the isotopic age data is to be expected.

TECTONIC IMPLICATIONS

In the northeast corner of 104M/12W, intermediate and felsic pyroclastic rocks, like those on Atlin Mountain, sit adjacent to well-bedded, deformed ribbon cherts of the Cache Creek complex (contact not exposed). Both are thermally metamorphosed and crosscut by the Fourth of July batholith as well as later dikes which also extensively cut the batholith. This association indicates that: the volcanic rocks are older than 171 Ma; unless the Fourth of July batholith is decapitated, it represents a pin point that pierced the Cache Creek succession (which is apparently a stack of thrust slices) during the Middle Jurassic and limits the age of ophiolite emplacement to before this time; North of Atlin volcanic and batholithic rocks cross Atlin Lake, indicating no major structural offset across this portion of the lake since the Middle Jurassic. Thus, any major post-Middle Jurassic motion must have been accommodated along the northward continuation of the Nahlin fault (Mihalynuk *et al.*, 1990).

Within a few hundred metres south of Safety Cove, biotite-rich dikes of the Fourth of July suite are not only offset by extensive high-angle brittle faults, but also cut these fault planes. Clearly this style of deformation accompanied late stages of Fourth of July batholith emplacement. Furthermore, a very consistent dike swarm orientation of about 315°/75°E suggests crustal extension of 10 to 20 per cent southwestward during their emplacement.

JURASSIC TO TERTIARY VOLCANIC SUITES

Two separate packages of volcanic strata appear to postdate the Fourth of July batholith. At Safety Cove, a deformed package of volcanic rocks has obscure contacts

TABLE 1-15-1
REGIONAL GEOCHEMICAL SURVEY RESULTS*

Sample Number	Easting	Northing	NTS 104 . . .	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Co ppm	As ppm	Sb ppm	Ba ppm
KMO90-3-2B	569000	6620100	N12/W	7	<5	22	4	37	36	36	7.5	1900
KMO90-3-5	569150	6619400	N12/W	6	<5	80	41	110	41	41	0.5	3700
KMO90-3-8	569550	6618050	N12/W	6	<5	43	11	72	42	42	0.3	1500
KMO90-11-2	554100	6622750	M/9E	37	<5	4	15	71	17	17	6.2	8600
MMI90-12-5	555450	6622150	M/9E	<5	<5	6	41	217	27	9	1.6	250
MMI90-12-6	556775	6621450	N12/W	1510	<5	11	13	27	100	9	8.9	270
MMI90-12-7	557250	6621125	N12/W	<5	<5	9	19	26	28	13	0.9	1800

* Au and Ba determinations by NAA, all others by AAS.

Note the anomalous gold values obtained in an argillite-quartz breccia in the contact zone between Cache Creek Complex and Peninsula Mountain suites (MMI90-12-6).

and can not be reliably correlated, whereas, in west-central 104N/12W, undeformed volcanic rocks of the Sloko Group can be correlated with certainty.

Safety Cove Volcanic Suite

Probably the oldest of the two volcanic packages crops out on the western shore of Atlin Lake, at Safety Cove. These rocks vary compositionally from dark, andesitic(?), nonporphyritic ash and sparse-lapilli tuffs, to rhyolite flows and breccia. Where well exposed they are extensively crosscut by dikes of equally variable composition.

The age of these rocks is not established, but is partly constrained by their relationship to the Fourth of July batholith. At Safety Cove, a significantly altered biotite-rich border phase of the batholith shares an enigmatic contact with structurally overlying and generally fine-grained, brown and green tuffs with sparse fragmental texture. Locally these rocks are highly strained and appear, in places, to contain blocks of the Fourth of July border phase. Several metres "above" the contact zone, a white rhyolite breccia displays thin (<10 cm) epiclastic interbeds containing altered biotite-rich pebbles, presumably derived from the mafic border phase. It appears then, that though the contact is now deformed, originally it was probably an unconformity. Thus, alteration of the Fourth of July batholith at Safety Cove is probably due to weathering at or beneath an erosional surface, and rounded blocks of border phase intrusive are probably conglomerate boulders, not milled fault blocks. If this is correct, Safety Cove volcanics are post-Middle Jurassic in age and their unconformable contact with the Fourth of July batholith, like many other unconformities within the Tagish area, is rather strongly deformed.

Sloko Group

The Sloko Group are the youngest rocks recognized in 104N/12W where they occur as erosional remnants on several of the highest mountains. They are composed mainly of rhyolite and derived epiclastic strata and rest on a well-exposed, deeply incised paleosurface on deformed Laberge Group strata. Numerous rhyolite dikes cutting the Laberge Group probably represent feeders to the Sloko rhyolite. Except where involved in high-angle faulting, they are flat-lying and undeformed.

Contact relationships, composition and the flat-lying nature of these strata are diagnostic. There is little doubt that they correlate with the main mass of Sloko Group rocks at the south end of Atlin Lake.

METALLOTECTS IN 104N/12W

Metallotects of particular interest within 104N/12W include altered ultramafic rocks, deep-seated faults, and acid volcanic rocks that may in part be submarine.

Fault-bounded, carbonatized serpentinites along the west shore of Atlin Lake are potential candidates for the ultramafic lode gold association that is thought to be the source of placer gold in the Atlin camp (Ash and Arksey, 1990a, b). Of note, but not shown in Table 1-15-1, are analyses from a northwest-trending belt of pillow basalts mapped as the Peninsula Mountain Group by Mihalynuk *et al.* (1990). Unaltered samples of these rocks yield high background gold values and, in combination with carbonatized ultramafics, may be the ultimate sources for the placer gold in Graham Creek. Along-strike continuation of these rocks may also explain a delapidated sluice operation on the unnamed drainage northwest of Graham Creek (UTM 551450, 6615900).

Deep-seated faults such as the Nahlin (*cf.* Mihalynuk and Mountjoy, 1990; Mihalynuk *et al.*, 1990), and perhaps related structures at the eastern margin of Peninsula Mountain suite exposures, are metallotects with largely undetermined potential. A silicified breccia zone of untested extent marks the contact between volcanic rocks on Taku Mountain and cherts and argillites of the Cache Creek complex (Figure 1-15-2). A single sample collected from the breccia yielded a gold assay of 1510 ppb (Table 1-15-1). Motion in this zone is difficult to assess. It could be regional in scale or merely localized at the contact of contrasting lithologies.

Also near the eastern boundary of the Peninsula Mountain suite are small pyritic rhyolite domes(?) and breccia bodies closely associated with argillite and chert of the Cache Creek complex. Although the exact relationship between the two lithotectonic packages is not clear, the setting contains many of the lithologic elements typical of a Kuroko deposit setting (*e.g.* Urabe and Sato, 1978). Tentative correlation of the Peninsula suite with the Kutcho Formation, host to the Kutcho Creek massive sulphide deposit (Thorstad and Gabrielse, 1986), underscores the importance of these strata as a potential metallotect.

ACKNOWLEDGMENTS

This paper has benefited from discussions with Craig Hart and Jay Jackson. Norm Graham of Capital Helicopters Inc., in his typical good style, helped us make the best use of a short field season and a limited budget. Dave Lefebure and Mike Gunning collected a sample of the Fourth of July batholith for isotopic age dating, and Dave kindly agreed to have the date published in this paper.

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