HIGHLIGHTS OF 1991 MAPPING IN THE ATLIN-WEST MAP AREA (104N/12)

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KEYWORDS: Regional geology, Peninsula Mountain suite, Table Mountain complex, Fourth of July batholith, Atlin Mountain pluton, Atlin Mountain fault, Cache Creek Complex, Laberge Group, Sloko Group, Late Cretaceous, Carmacks Group, Nahlin fault.

INTRODUCTION

A geological mapping and economic-oriented sampling program in the Atlin area (104N/12W) was conducted over a 2.5-week period in 1991 to compliment a program of similar duration in 1990 (Figure 1-19-1; Mihalynuk *et al.*, 1991). Primary objectives were: to address problems with interpretation of 1990 field observations that became apparent during follow-up laboratory analyses; to complete map coverage at 1:50 000 scale of map sheet 104N/12W; and to investigate critical contact relationships that bear on the tectometallogenic history of the area.

Inconsistencies between new isotopic data (Mihalynuk *et al.*, in preparation) and earlier field observations are addressed here. Newly defined lithologic and structural elements are described and structures related to the emplacement of the Cache Creek Complex, and high-angle brittle faults affecting younger rocks, are placed within a regional tectonic framework. Base and precious metal analyses were incomplete as of this writing but are touched on briefly.

PREVIOUS WORK

Previous geological mapping in the area dates back to Cairnes (1913), with the first systematic coverage by Aitken (1959) at 1:250 000 scale. Bultman (1979) mapped significant parts of the southern and western areas. Recently, mapping to the immediate east and west has been conducted at 1:50 000 scale (Bloodgood *et al.*, 1989; Mihalynuk *et al.*, 1990). The focus of this report is on new data from the 1991 field season; for more complete descriptions of geologic units in the Atlin area the reader is referred to the above mentioned reports.

GENERAL GEOLOGY

Rocks within NTS map area 104N/12W are divisible into eastern and western structural domains which are juxtaposed along the north-trending, high-angle Nahlin fault; all three tectonic elements are intruded by the Late Cretaceous Atlin Mountain pluton (Figure 1-19-2).

The oldest rocks in the eastern domain are Mississippian to Triassic oceanic crustal and sedimentary rocks of the Cache Creek Complex. These include ultramafite, basalt, limestone, chert, argillite and wacke, and probably a mixed ultramafic, gabbro and pillow basalt unit designated the Graham Creek igneous suite (Mihalynuk and Mountjoy, 1990). They are intruded by $171^{+1}/_{-5}$ Ma Mihalynuk *et al.*, 1991) synkinematic to postkinematic, polyphase, primarily granitic rocks of the Fourth of July batholith and related dike swarms. Unconformably overlying both are basal conglomerates of the Cretaceous Table Mountain volcanic complex, formerly included with the older Peninsula Mountain volcanic suite of possible Middle to Late Triassic age. In some localities the Table Mountain complex is underlain by Peninsula Mountain volcanic rocks, which are now thought to have a much more restricted distribution than indicated by Mihalynuk *et al.*, (1991).

Basinal wacke and shale of the Lower Jurassic Laberge Group dominate the western structural domain. Paleocene felsic to intermediate volcanic and epiclastic rocks of the Sloko Group sit with angular unconformity on the Laberge. Regionally, these rocks form an overlap sequence on the Cache Creek and Stikine terranes (Wheeler *et al.*, 1988).

NEW STRUCTURAL AND STRATIGRAPHIC DATA FROM THE EASTERN STRUCTURAL DOMAIN

CACHE CREEK COMPLEX

The Cache Creek Complex was mapped in greater detail in 1991, resulting in the assignment of two additional units and greater confusion regarding the structural style and distribution of lithotypes.

A newly defined unit, mapped along the western shore and inland of Torres Channel (Figure 1-19-3), is characterized largely by its chaotic internal fabric and is here referred to as the Nahlin structural unit. It consists primarily of strongly sheared, fine to medium-grained volcanic wacke and mudstone with an undetermined amount of sheared basalt, localized zones of black cataclastic rock and lenses of dioritic to ultramafic rock. The unit probably first underwent soft-sediment deformation, producing small, rootless folds and dismembered compositional layers on a millimetre to centimetre scale. An outcrop to regional-scale penetrative shear fabric was then superimposed. Anastomosing shears isolate angular to ellipsoidal domains generally less than 2 centimetres long. Shear surfaces are chloritized or calcified and contain randomly oriented slickensides. Shears are randomly oriented, although on an outcrop and larger scale a vague, high-angle, northwest-striking trend is evident. This unit may reflect the presence of a shear zone that crosses Torres Channel. A strand of the Nahlin fault is projected by Mihalynuk *et al.* 1991) through this same locality.

Another important component of the Cache Creek Complex is wacke with conglomerate lenses which contain chert, quartz, limestone, granitoid and rare serpentinite

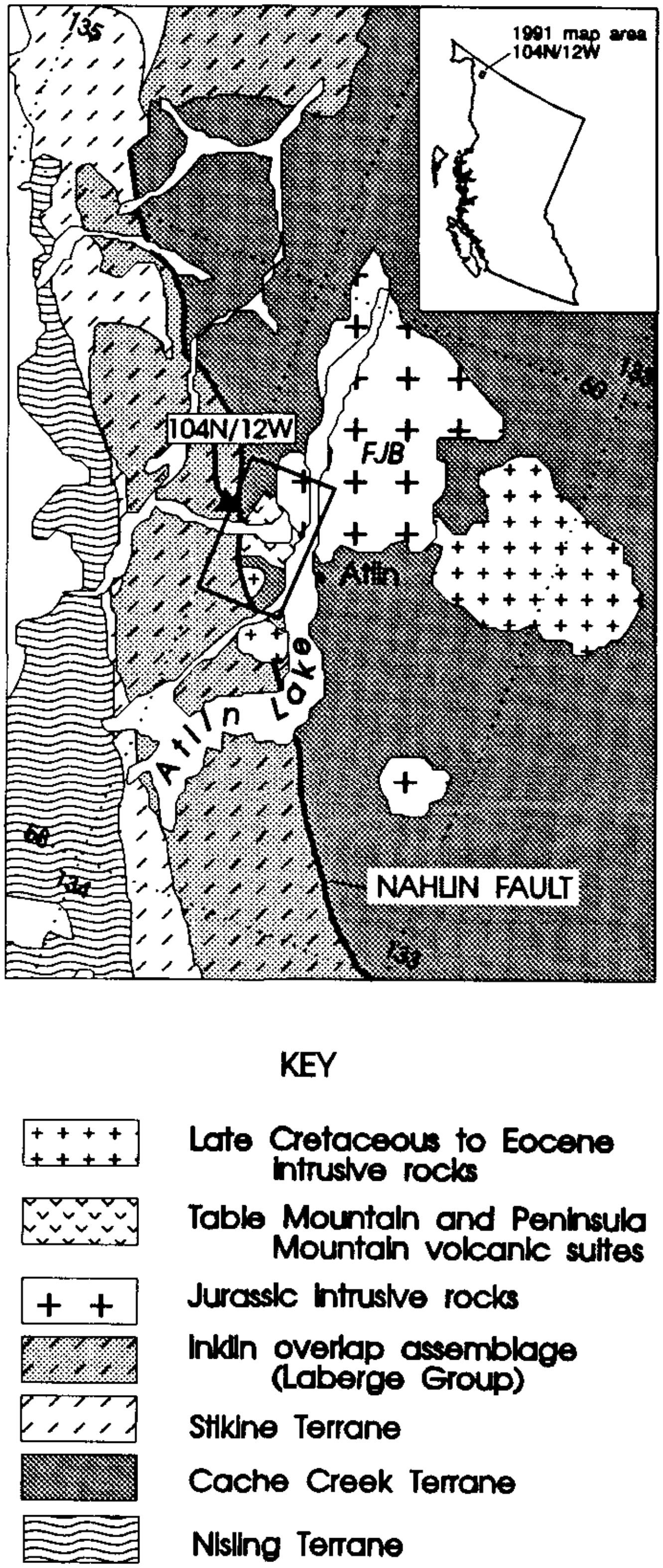

Figure 1-19-1. Location of the Atlin 104N/12W map sheet shown in relation to major tectonic features in northwestern British Columbia. Adapted from Wheeler *et al.*, 1988.

clasts. This unit is exposed at two localities south of Atlin River on the west shore of Atlin Lake (Figure 1-19-3), where it is intercalated with chert and argillite. A similar unit crops out along the northern shore of Graham Inlet (extreme western part of the map area) in association with pillow basalt. This unit in part reflects a continental sediment source and probably records interaction between the Cache Creek Terrane and ancestral North America.

Carbonate units provide one of the few markers that outline structures in the Cache Creek Complex. Carbonate bodies commonly form pods and lenses elongate in a north-northwest trend. On the northeast side of Teresa Island and nearby small islands (Figure 1-19-3), carbonate forms nearly flat-lying, massive sheets, folded about northwest-trending axes and cut by numerous moderate to high-angle faults. A different structural style characterizes the south side of the Atlin Mountain massif, where a kilometre-long, subhorizontal, east-trending, apparently cylindrical lens crops out in a cliff face.

The distribution of ultramafic rocks was mapped in greater detail as they are an important host to lode gold showings in the Atlin area. Those which do not appear on any previously published geological maps include a north-trending zone of listwanitized ultramafite at the north end of Torres Channel and a belt of tectonized harzburgite and serpentinite on the east flank of Atlin Mountain. Surface workings in the creek valley north of Torres Channel apparently followed a north-trending, opaline and coarsely crystalline quartz vein network in which individual veins are less than 10 centimetres thick. Ultramafite along the east flank of Atlin Mountain shows no sign of previous workings.

Fourth of July Batholith

The Fourth of July batholith is described fully by Aitken (1959) and features particular to the Atlin map area (104N/12W) are discussed by Mihalynuk *et al.* (1991). Mapping along its western margin in 1991 defined a north-northwest-trending, kilometre-wide belt of potassium feldspar megacrystic granite that extends from the north side of Deep Bay to the east side of Atlin Lake opposite Eight Mile Bay, and perhaps as far south as Como Lake in 104N/12E. It is bounded to the east by equigranular biotite hornblende granite and to the west by a mafic border phase. A later, alkali feldspar granite to alaskite "cupola" intrudes the border phase south of Deep Bay, and dikes of the same composition intrude the potassium feldspar megacrystic granite, the dioritic border phase and lamprophyre dikes.

Peninsula Mountain Volcanic Suite and Table Mountain Volcanic Complex

New isotopic and field data point to a much more restricted distribution of the Middle to Late Triassic(?) Peninsula Mountain volcanic suite than indicated by the preliminary mapping of Mihalynuk *et al.* (1991). We now assign a Late Cretaceous (~74 Ma) age to much of the section, based on new field data and Rb-Sr and U-Pb dates (Mihalynuk *et al.*, in preparation). Late Cretaceous volcanic rocks are present in the Whitehorse area to the north (vari-

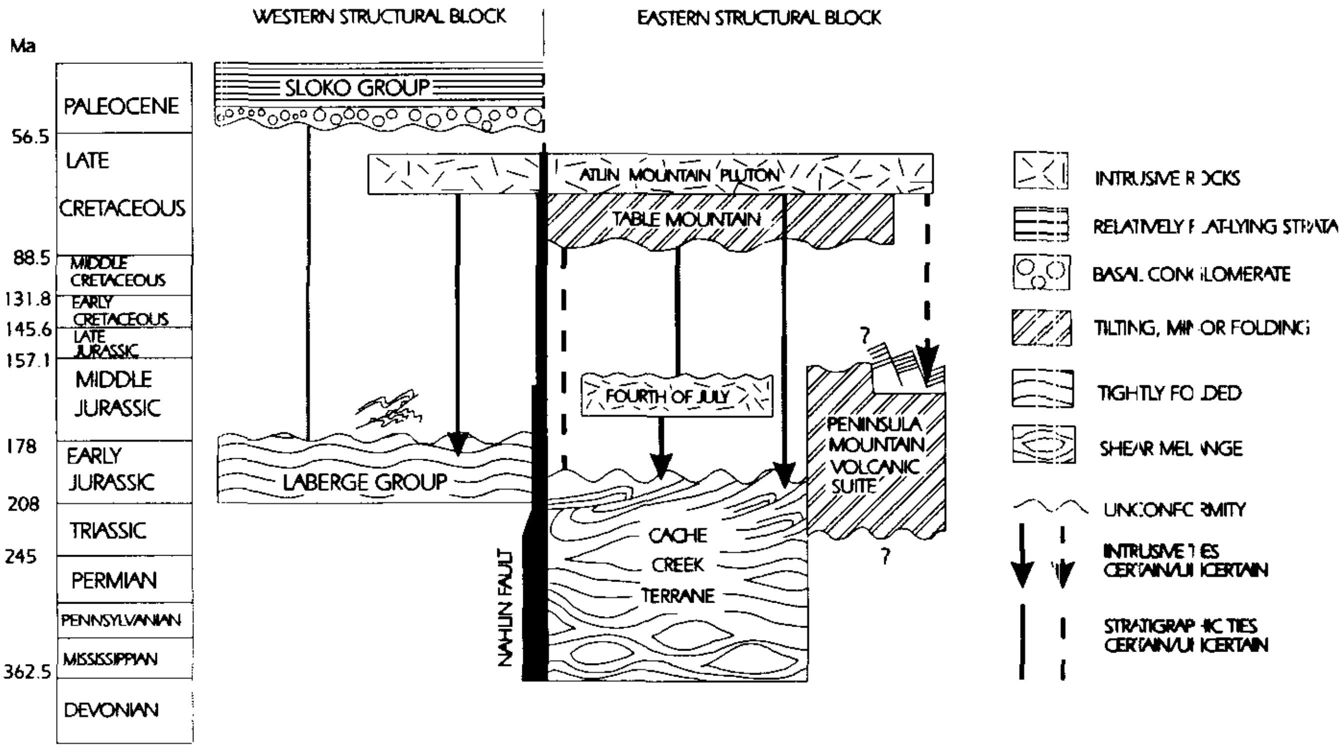

Figure 1-19-2. Box diagram illustrating age and geologic relationships in the map area. Age constraints are from Bultman (1979), Monger (1975), Mihalynuk *et al.* (1991; in press) and Cordey *et al.* (1991). Time scale is that of Harland *et al.* 1990). The width of the line representing the Nahlin fault is roughly proportional to the cumulative amount of offset experienced by adjacent units.

ously referred to as the Carmacks Group, Hutshi, and Mount Nansen volcanics; *e.g.*, Bultman, 1979; Wheeler and McFeely, 1987; Hart and Radloff, 1990), and the volcanic rocks on Table Mountain have been previously correlated with them (*e.g.*, Grond *et al.*, 1984; Bultman, 1979); this interpretation thus appears to be correct for at least part of the section. The name "Table Mountain volcanic complex" reflects the distribution of these Late Cretaceous volcanic rocks and coeval intrusions in the Atlin map area.

Peninsula Mountain Volcanic Suite

The older Peninsula Mountain suite is distinguished from the Table Mountain volcanic complex in the field by: a high degree of induration; the generally green colour of rocks; and epidote-chlorite-silica alteration. Distribution of the revised Peninsula Mountain volcanic suite corresponds mainly to the lowest unit and overlying indurated sediments of the suite as originally mapped by Mihalynuk *et al.* (1991). It includes: massive to sparsely pyroxene-phyric, dark green flow(?) rocks, some with altered, partially digested, cobble-sized clasts; strongly pyritic rhyolite flows and domes(?); and an epiclastic unit not described by Mihalynuk *et al.* (1991).

Rocks of the Peninsula Mountain epiclastic unit are strongly indurated, light weathering, chlorite-epidote-silica altered, and locally contain up to 1 per cent pyrite as irregular blebs. In places they are probably tuffites, with coarse ash layers and blocks of acicular hornblende plagioclase porphyry and rarely clasts of pyroxene porphyry and flow-banded rhyolite. Elsewhere the unit displays graded bedding in silt to gravel derived from feldspathic volcanic porphyry. Most clasts are subangular to subrounded. The unit is also characterized by the presence of interbedded, pyroxene-phyric amygdaloidal basalt flows.

Table Mountain Volcanic Complex

Rocks of the Table Mountain volcanic complex comprise the upper rhyolite, intermediate lapilli tuff and quartz-phyric ash-flow units of the former Peninsula Mountain volcanic suite of Mihalynuk *et al.* (1991), and a suite of felsic to intermediate intrusive rocks, previously unmapped or assigned to the Fourth of July intrusive suite.

As contrasted with the Peninsula Mountain suite, volcanic rocks of the Table Mountain Complex are typically less well indurated, orange, maroon or grey weathering, and have not undergone extensive chlorite-epidote alteration. Coarse, plagioclase-phyric volcaniclastic rocks (tuff, agglomerate and breccia) are volumetrically the most significant rock type.

The intrusive suite includes a small stock of orange to buff-weathering, feldspar-rich porphyry, exposed along approximately 2 kilometres of shoreline on the west side of Graham Inlet (Figure 1-19-3) and adjacent islands. Rocks similar in appearance crop out on the east side of Graham inlet and may be part of the same stock. Phenocrysts consist

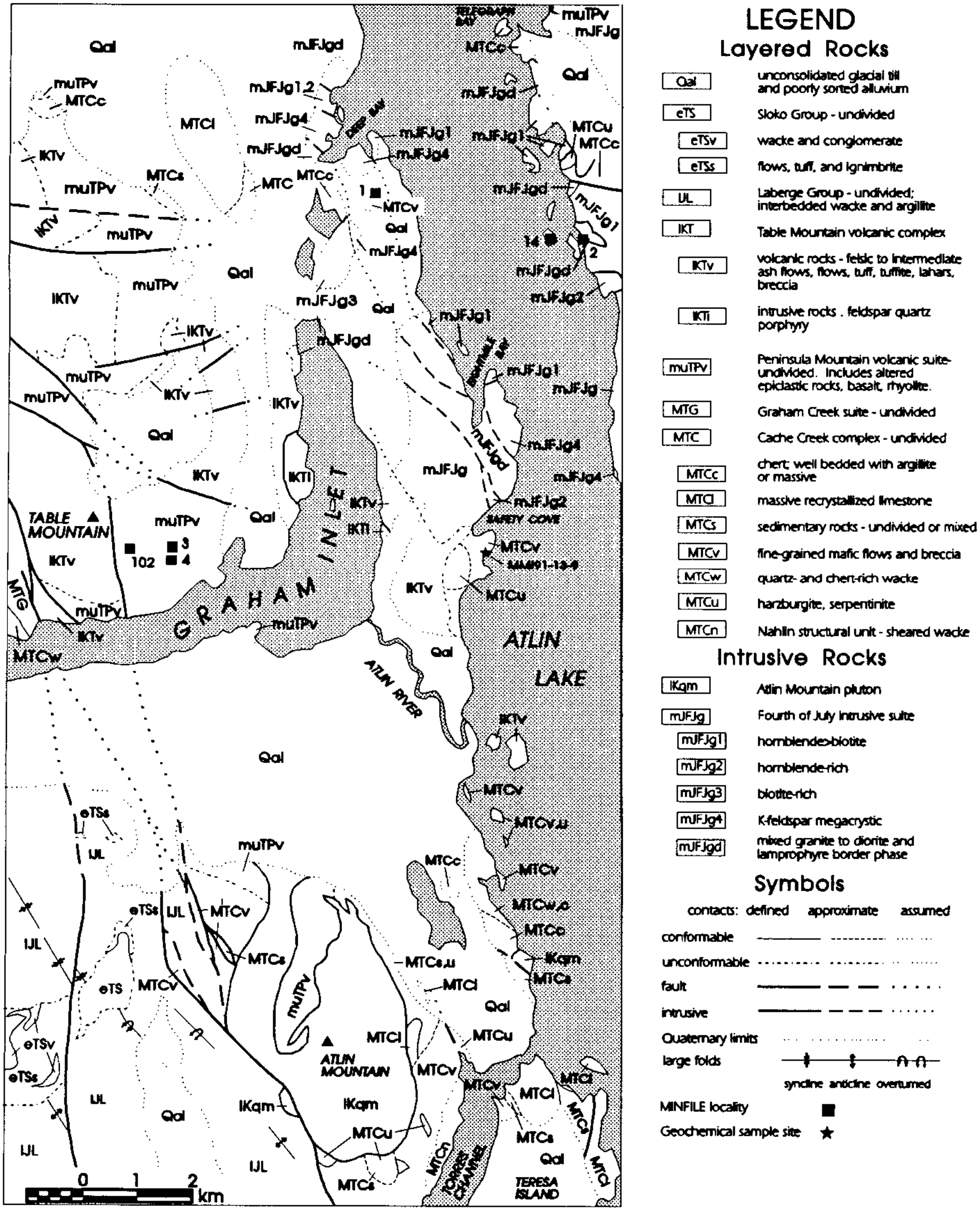

Figure 1-19-3. Generalized geologic map of the Atlin west map area, after Mihalynuk *et al.* (1991; 1992).

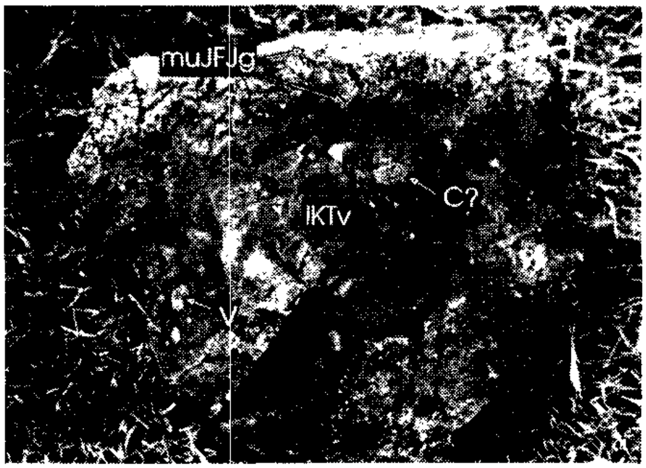

Plate 1-19-1. A sample of the contact between oxidized diorite of the Fourth of July batholith border phase (white, muJFJg) and basal volcaniclastic strata of the Table Mountain volcanic complex (lKTv). Clasts within the basal unit include chert (C?) of the Cache Creek Complex, porphyritic volcanic fragments probably derived from the Peninsula Mountain suite (V) and diorite derived from muJFJg. Elsewhere the unit also includes clasts of serpentinite and carbonate from the Cache Creek Complex.

of potassium feldspar (25–50%), plagioclase (50–60%, albite to oligoclase: glomeroporphyritic with potassium feldspar) and quartz (5–25%). Accessory minerals include biotite in altered booklets, hornblende, apatite and zircon. Quartz is clear and embayed, while all other components are partly altered to fine-grained chlorite, clay, opaque minerals and calcite. The fine-grained groundmass is holocrystalline and consists of potassium feldspar, oligoclase and quartz. Textural characteristics indicate that this stock is a relatively high-level intrusion. Exposures on islands and the adjacent shoreline are coarse, equigranular, and appear to represent more interior regions of the stock.

Dikes of the intrusive suite are typically orange or greenish weathering with medium to coarse, zoned (white, grey and pink) glomeroporphyritic feldspar comprising about 25% of the rock. Biotite booklets (5%) are medium grained, xenomorphic to idiomorphic and may be chloritized. Medium-grained quartz eyes comprise 2 to 5 per cent of the rock. Dikes have irregular margins and variable trends with east-west and northwest orientations most prominent. One dike, 9 to 25 metres thick, appears to have a northwest strike length of over 5 kilometres. Similar dikes cut the Cache Creek Complex on both the west and east sides of Atlin Lake.

The intrusive suite is coeval with the upper quartz-biotite-feldspar-phyric ash flows in the upper Table Mountain extrusive volcanic section. A hypabyssal to extrusive transition is well displayed about 3.5 kilometres north-northwest of Table Mountain.

Contact Relationships

Excellent unconformable relationships are observed between the basal Table Mountain units and the Fourth of July batholith. Altered pebbles of granodiorite mixed with porphyritic volcanic clasts overlie a red, oxidized paleoregolith (Plate 1-19-1) on the west side of Graham Inlet. West of Safety Cove, rhyolitic tuffs and flows overlie the Fourth of July batholith, with a basal granule conglomerate noted in several locations. These relationships support the post-Middle Jurassic (Late Cretaceous, Grond *et al.*, 1984; Mihalynuk *et al.*, in preparation) age for the Table Mountain volcanic complex. They also confirm the presence of two volcanic packages: the Table Mountain package and the older Peninsula Mountain suite which is intruded and thermally metamorphosed by the Fourth of July batholith at Telegraph Bay (Mihalynuk *et al.*, 1991) and perhaps at Safety Cove.

Contact relationships between the Peninsula Mountain suite and the Cache Creek Complex remain obscure (as discussed by Mihalynuk *et al.*, 1991), as all contacts observed to date are covered or have been disrupted by later faulting.

NEW STRATIGRAPHIC AND STRUCTURAL DATA FROM THE WESTERN DOMAIN

Structures in the Laberge Group

Laberge Group rocks underlie much of the southwestern part of the map area. Southeast of the map area the Laberge Group is upright and gently to moderately dipping about relatively open folds. In contrast, rocks in the map area often assume a steep, northwest-striking, upright to overturned orientation. Folds are tight to isoclinal and have steep to vertical axial planes. Fold axes trend southeast with a low to moderate plunge. Numerous joint sets and bedding-parallel shears further deform the Laberge rocks.

A north-trending fault mapped by Mihalynuk *et al.* (1991) south of Graham inlet, along the western margin of the map area, can be extended south to the southern edge of the map area. Slickenside striae on anastomosing shears in this fault zone indicate that latest movement was dominantly dextral strike-slip. Northwest-striking bedding planes within the fault zone contain moderately east-plunging slickenside striae with sinestral shear sense, consistent with overall dextral movement on this fault zone.

Sloko Group

The Sloko Group consists primarily of rhyolitic to andesitic flows, breccia, tuff and ignimbrite, and epiclastic rocks. It is essentially flat lying, and rests on a deeply incised paleosurface over deformed Laberge Group strata. A unit interpreted as a basal conglomerate unconformably overlies and is in part tectonically interleaved with the Laberge Group on the summit of a knob 3 kilometres south of Graham Inlet (2 kilometres east of the map border). It consists of very well rounded pebbles, cobbles and boulders of wacke, chert, argillite, greenstone, felsic plutonic rocks and feldspar-quartz-phyric volcanic rocks in a medium to coarse sand matrix. The range of lithologic types suggests derivation from the Laberge, Table Mountain and Cache

Creek units, as well as some of the units that intrude them. The conglomerate grades up-section into angular pebble conglomerate and breccia derived from felsic to intermediate volcanic rocks which are more typical of the Sloko Group.

RELATIONSHIPS BETWEEN STRUCTURAL DOMAINS

Atlin Mountain Pluton

The Atlin Mountain pluton intrudes the contact between the two structural domains. It is composed of homogeneous medium-crystalline, locally potassium feldspar porphyritic quartz monzonite, consisting of 10 to 25 per cent hornblende, biotite and magnetite, 10 to 15 per cent quartz, and 60 to 70 per cent feldspar. A finely crystalline phase is exposed along the eastern margin of the pluton and as dikes and sills adjacent to it. Intrusive relationships with the Cache Creek Complex and Peninsula Mountain suite are well documented; an intrusive relationship with the Laberge Group is also mapped west of the Atlin Mountain fault. The Atlin Mountain intrusion was assigned an early Tertiary age by previous workers (*e.g.*, Aitken, 1959; Bultman, 1979), but a preliminary two-point Rb-Sr isochron suggests a Late Cretaceous age (Mihalynuk *et al.*, in press).

Atlin Mountain Fault

The high-angle, east-dipping Atlin Mountain fault approximately follows the western margin of the Atlin Mountain pluton (Bloodgood and Bellefontaine, 1990). Regional relationships indicate that it is a strand of the Nahlin fault, a deep-seated, terrane-bounding structure thought to separate the Cache Creek from the Stikine Terrane.

North and south of the Atlin Mountain pluton, the fault juxtaposes the Laberge Group and Cache Creek Complex. South of the pluton, this fault is marked by a zone of mylonitized harzburgite with a shear fabric suggestive of dextral motion. There is extensive brecciation of the Laberge Group and a dense pattern of anastomozing shears in the Cache Creek Complex within 20 to 30 metres of the fault. The fault follows the contact between the Laberge Group and Atlin Mountain pluton northward, then cuts the Atlin Mountain pluton for approximately 1 kilometre, where it is a narrow, altered breccia zone generally only a few metres wide. Continuing northward, the fault once again follows the margin of the pluton. North of the pluton, it is manifest as an impressive zone of brittle and ductile deformation, locally over 100 metres wide, with limited evidence for dextral offset.

Latest movement, as evidenced by structures where the fault cuts the pluton, is brittle, and is restricted to less than a few kilometres laterally and vertically, as the pluton on either side of the fault is apparently not offset greatly. The present distribution of the Atlin Mountain pluton suggests that latest movement was east side down. Structures to the north and south suggest substantially more offset and mainly ductile deformation. The simplest explanation for the observed features is that most movement on the fault zone predated the Atlin Mountain pluton and that latest movement post-dated it. Rhyolite dikes, believed to be feeders to overlying Sloko Group volcanic rocks, cut the fault and thus limit the youngest motion along the strand to pre-56 Ma.

ECONOMIC GEOLOGY

Analyses of rock samples collected during 1991 are at this time incomplete, but one assay result is notably anomalous in gold (250 ppb Au). The sample was collected from a quartz vein, 10 centimetres wide, associated with a set of altered, northeast-striking, quartz feldspar porphyry dikes that intrude the Cache Creek Complex south of Safety Cove (Figure 1-19-3). A suite of samples collected to assess the paleoplacer potential of the basal Table Mountain conglomerate yielded no anomalous results. Complete analytical results are included in Mihalynuk *et al.* (1992).

CONCLUSIONS

Mapping in 1991, in conjunction with better age constraints (Mihalynuk *et al.*, in preparation) supports several important revisions and interpretations in the Atlin map area, including:

- The Peninsula Mountain volcanic suite of Mihalynuk *et al.* (1991) can be divided into two distinct suites: a lower, epidote-chlorite-altered suite, which predates the Fourth of July batholith and retains the name Peninsula Mountain suite; and an upper unit, the Table Mountain volcanic complex, which unconformably overlies the Fourth of July batholith and is dated as Late Cretaceous by U-Pb and Rb-Sr techniques.
- The Atlin Mountain pluton, which is apparently Late Cretaceous in age, intrudes the Cache Creek Complex, Peninsula Mountain suite and Laberge Group. It both cuts and is cut by the Atlin Mountain fault, a strand of the terrane-bounding Nahlin fault. This evidence suggests a long history of movement along the Nahlin fault, which was active from prior to Early Jurassic (Laberge overlap) to post-Cretaceous time.
- The Cache Creek Complex contains: a structural unit with steep shear fabrics that may be related to the Nahlin fault; sandstone and conglomerate derived in part from a granitic and/or continental terrain; and extensive units that are, on the whole, relatively flat-lying, as evidenced by the distribution of limestone bodies.

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