# GEOLOGY OF WHITESAIL REACH AND TROITSA LAKE MAP AREAS* (93E/10W, 11E)

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## INTRODUCTION

This report describes the geology and several types of mineral occurrences, indicative of an epithermal setting, found in the Whitesail Reach (93E/10W) and Troitsa Lake (93E/11E) map areas. About 650 square kilometres was mapped at 1:25 000 scale and the geology compiled on 1:50 000 map sheets. The geological map, accompanied by a mineral occurrence and alteration location map of the area covered during 1986, will be published as an Open File series in January 1987. This regional mapping constitutes the initial phase of a four-year program jointly funded under the Canada/British Columbia Mineral Development Agreement. The main objective of regional mapping in the Whitesail Lake area is to evaluate Upper Cretaceous and Tertiary volcanic and coeval plutonic rocks as a probable host for epithermal and mesothermal gold-silver-copper-lead-zinc mineralization.

## LOCATION AND ACCESS

The study area is accessible from Burns Lake by 60 kilometres of pavement to Ootsa Landing and then by an all-weather gravel road to the Alcan boat launch at Andrew Bay, 31 kilometres to the west (Figure 3-5-1). Shallow draught boats are an economical and effective mode of access to areas of subdued topography adjacent to Tahtsa Reach, Whitesail Reach and Whitesail Lake. The mountainous terrain of the Whitesail Range is accessible by helicopter from bases at either Smithers or Houston, 130 kilometres and 90 kilometres to the north respectively.

Outcrop is extensive in the Whitesail Range, where alpine conditions prevail. At elevations below 1450 metres Quaternary gravel, forest and swamp obscure most rock exposure. The best outcrops below treeline are along the shorelines of Tahtsa Reach and Whitesail Lake and in stream valleys.

## TECTONIC SETTING

The Whitesail Lake map area is near the boundary of the Coast Crystalline and Intermontane Belts (Figure 3-5-2). At this latitude the Coast Crystalline Belt is mainly comprised of metamorphosed and deformed rocks of probable Paleozoic age that are gradational into, or intruded by Cretaceous and Tertiary plutonic rocks (Woodsworth, 1979). Immediately to the east, the Intermontane Belt is underlain by mildly deformed Lower Jurassic to Tertiary volcanic and sedimentary rocks disrupted by block faults.

## LOCAL GEOLOGY

The oldest rocks within the study area are the Telkwa Formation, Smithers Formation and Ashman Formation of Early to Middle Jurassic age. These rocks are overlain with angular discordance by the Ootsa Lake Group, which is thought to be Upper Cretaceous to Lower Tertiary. The distribution of rocks mapped in the study area is shown in Figure 3-5-3 and their relative stratigraphic positions summarized in Figure 3-5-4.

Faults delimit downdropped blocks that locally preserve thick sections of Ootsa Lake Group strata. Elsewhere within the area these rocks have been eroded, exposing variably deformed Lower Jurassic rocks.

In several areas quartz veins and zones of pervasive hydrothermal alteration, spatially associated with high-level intrusions, contain anomalous concentrations of gold, mercury and arsenic.

## LOWER TO MIDDLE JURASSIC ROCKS

Jurassic rocks conform with the stratigraphic divisions proposed by Tipper and Richards (1976) for north-central British Columbia. Heterogeneous pyroclastic rocks and flows of the Telkwa Formation form the basement in the area. These rocks are overlain by the Smithers Formation, which consists mainly of arkosic sediments, locally gradational into an upper, dominantly pyroclastic section. The youngest rocks of Jurassic age are interbedded sandstone, siltstone and shale assigned to the Ashman Formation.

### *TELKWA FORMATION (UNIT 1)*

The Telkwa Formation has widespread distribution southeast of the Whitesail Range to the shore of Whitesail Lake. It consists mainly of andesitic lapilli tuff and tuff breccia irregularly interlayered with flows ranging in composition from basalt to rhyolite. These rocks typically are green to maroon and have ubiquitous chlorite, epidote, calcite and laumontite developed in the matrix and in fractures. Plagioclase phenocrysts, ranging from 2 to 5 millimetres long, and chloritized mafic minerals are diagnostic features of the porphyritic rocks.

Rhyolite occurs as homogeneous flows, locally more than 200 metres thick. They are salmon pink, cream and less commonly green or grey in colour. Flow layering and spherulites are common textures.

### *SMITHERS FORMATION (UNIT 2)*

The lower, dominantly marine sedimentary facies of the Smithers Formation forms scattered outcrops in the low forested terrain adjacent to Tahtsa Reach. This sequence is more than 880 metres thick in the western Whitesail Range. It consists of alternating grey-green beds of coarse arkosic sandstone, siltstone and granule-pebble conglomerate. Chert, shale, limestone and concretionary siltstone interbeds are also present, but are not widespread. Individual beds generally range from 10 centimetres to more than 1 metre thick. Planar and graded bedding is common, but cross-stratification is rare.

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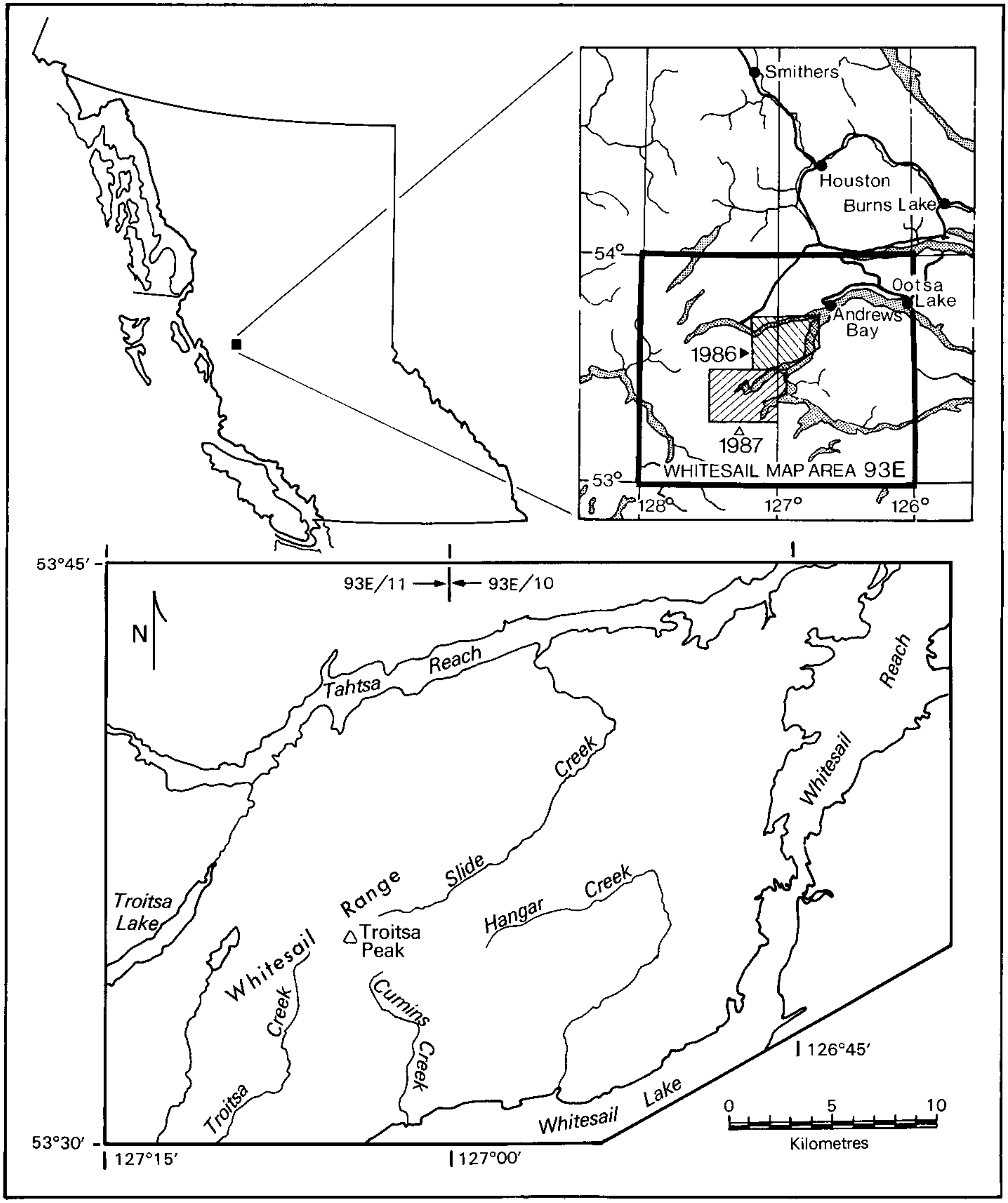


Figure 3-5-1. Location map and physiography of the study area.

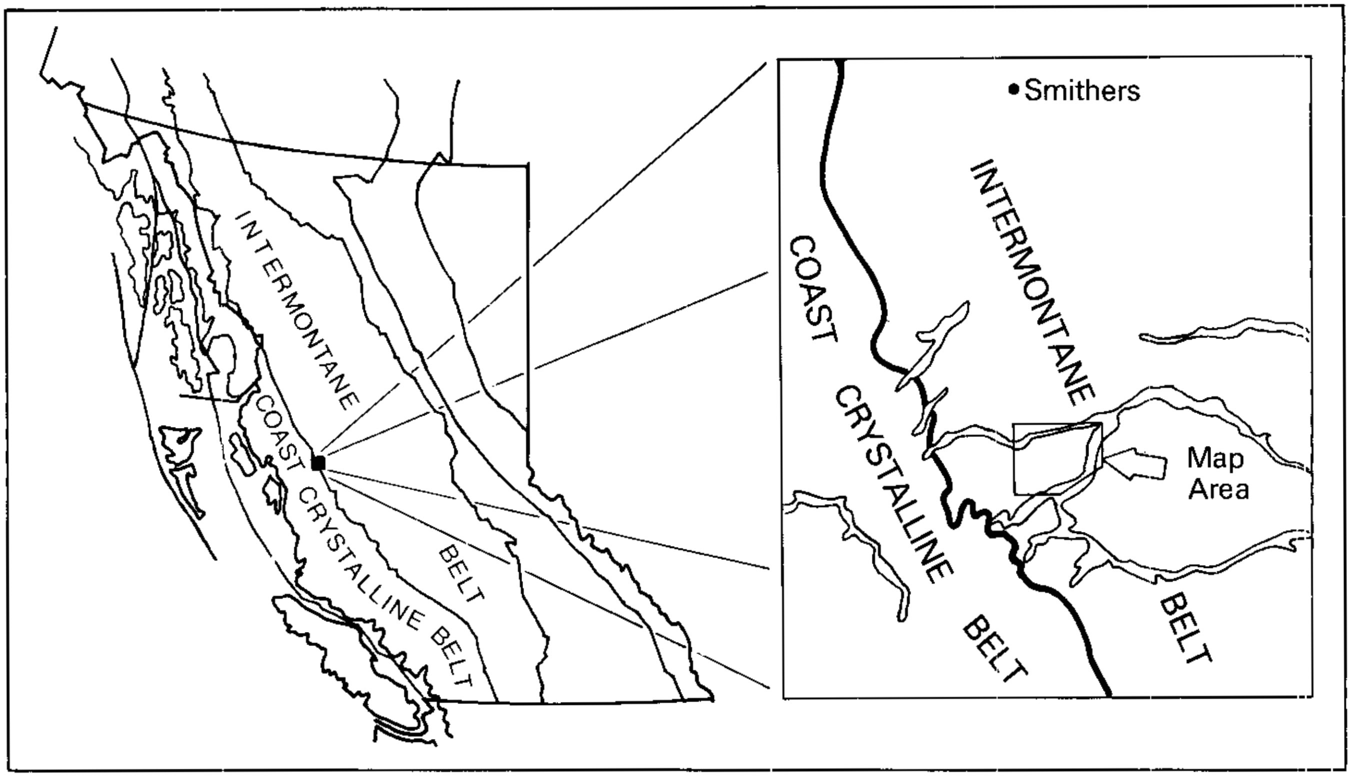


Figure 3-5-2. Tectonic setting of the study area.

In thin section arkosic rocks contain 30 to 80 per cent euhedral feldspar mixed with subrounded volcanic granules. The preponderance of feldspar suggests a nearby source; these rocks are probably derived from exposed Telkwa volcanics.

Shallow-marine fossils, including brachiopods, pelecypods, belemnites, gastropods and ammonites, are found in siltstone beds. Ammonites in particular have been useful in assigning a Middle Toarcian to Early Bajocian age to these strata (H.W. Tipper and R.L. Hall, personal communication, 1986; Figure 3-5-5). The Smithers Formation is defined by Tipper and Richards (1976) as Middle Toarcian to Early Callovian in age.

### Unit 2A

Red and green lapilli tuff and tuffite have a gradational contact with underlying feldspathic sandstone and pebble conglomerate southwest of Troitsa Peak. These rocks comprise at least 800 metres of massive beds 50 centimetres to 10 metres thick. Accretionary lapilli occur within thinly laminated and graded beds 25 centimetres thick. The fragments in tuffs are angular to subrounded and have an aphanitic basaltic appearance. These rocks represent a transition from early shallow marine sedimentary deposition to later subaerial volcanism during Smithers time.

### *ASHMAN FORMATION (UNIT 3)*

The Ashman Formation is exposed in one creek valley southeast of Troitsa Peak. The rocks are typically medium to thickly bedded siltstone, chert pebble conglomerate, coarse sandstone and shale. These lithologies closely resemble the Smithers Formation, making a positive identification difficult. Fossil fauna indicates a Late Bathonian to Callovian age (H.W. Tipper, personal communication, 1986; Figure 3-5-5).

## LOWER CRETACEOUS ROCKS

### *SKEENA GROUP (UNIT 4)*

Rocks of the Skeena Group were not identified in the study area. Extensive exposure of these rocks is found near Tahtsa Reach and Tahtsa Lake. The reader is referred to MacIntyre (1985) for a description of lithologies characterizing the Skeena Group in these areas.

## UPPER CRETACEOUS (?) AND LOWER TERTIARY

### *OOTSA LAKE GROUP*

The Ootsa Lake Group was proposed by Duffell (1959) for rhyolitic flows and less voluminous basalt, andesite, and pyroclastic and sedimentary rocks exposed at Ootsa Lake. A Late Cretaceous to Early Tertiary age is inferred from shelly fauna and plant debris found in conglomerate near the base. Similar lithologies occupy much of the Whitesail Range and underlie the low terrain adjacent to Whitesail Reach and the eastern end of Tahtsa Reach. Within the study area, the Ootsa Lake Group is subdivided into six rock units on the basis of outcrop appearance and lithology. These rocks rest with angular discordance on Lower to Middle Jurassic Smithers Formation. Age determinations on four volcanic units are currently in progress.

### Andesitic Flows (Unit 5)

Andesitic flows containing several per cent biotite phenocrysts represent the lowest stratigraphic rock unit of the Ootsa Lake Group in Whitesail Range. These lavas comprise the base of a layered volcanic sequence in the northern Whitesail Range. The lower contact is not exposed, however a minimum thickness of 200 metres

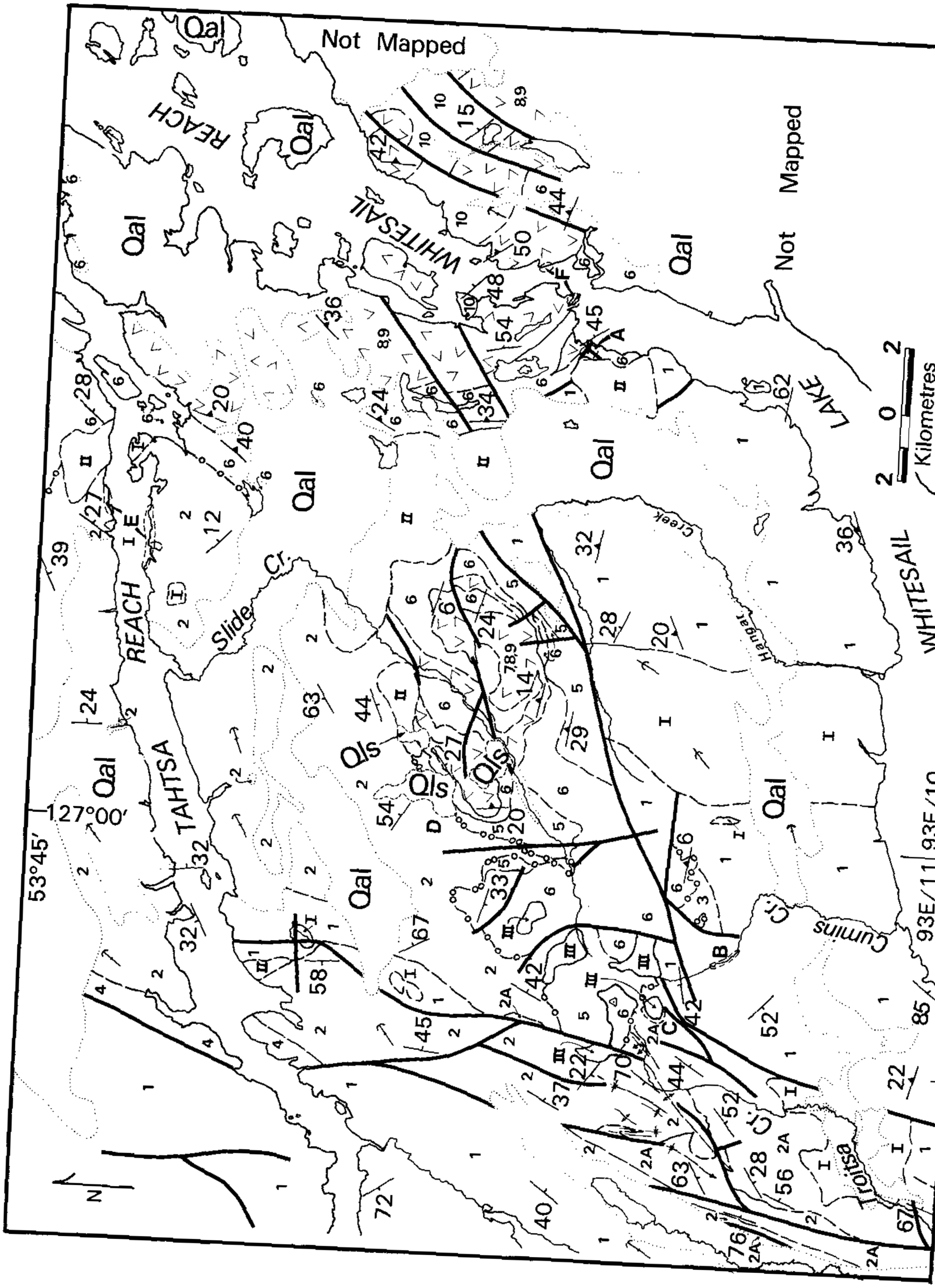


Figure 3-5-3. General geology of Whitesail Lake area, west-central British Columbia.

## LEGEND

### QUATERNARY

| | |
|---|---|
| Qal | *Glacial till and alluvium* |
| Qls | *Landslide* |

### UPPER CRETACEOUS (?) AND TERTIARY

OOTSA LAKE GROUP

| | |
|---|---|
| 10 | *Polymictic conglomerate, minor sandstone* |
| 9 | *Andesitic flows; 2 to 5 per cent biotite and hornblende phenocrysts* |
| 8 | *Rhyolitic flows and autoclastic breccia; sparse biotite phenocrysts* |
| 7 | *Andesitic flows and black vitrophyric flows interlayered with lahar* |
| 6 | *Basaltic flows, containing coarse-grained augite and plagioclase phenocrysts, interflow breccia, debris flows and air-fall crystal ash tuff* |
| 5 | *Andesitic flows containing 1 to 2 per cent biotite phenocrysts, local flow-banded andesite interbedded with lapilli ash tuff; unconformably overlies Jurassic rocks* |

### LOWER CRETACEOUS

SKEENA GROUP

| | |
|---|---|
| 4 | *Micaceous sandstone, pebble conglomerate and shale* |

### MIDDLE JURASSIC

BOWSER LAKE GROUP

| | |
|---|---|
| 3 | *ASHMAN FORMATION: Siltstone, shale and arkosic wacke; fossiliferous* |

### LOWER TO MIDDLE JURASSIC

HAZELTON GROUP

| | |
|---|---|
| 2b | *SMITHERS FORMATION: Lapilli tuff; gradational contact with unit 2a* |
| 2a | *Siltstone, arkosic sandstone and conglomerate, minor chert, shale and limestone; fossiliferous* |
| 1 | *TELKWA FORMATION: Andesitic and lesser rhyolite flows, tuff and breccia, minor epiclastic interbeds* |

## INTRUSIVE ROCKS

### EARLY TERTIARY

| | |
|---|---|
| III | *Coarse-grained feldspar porphyry, probable feeders to unit 6 flows; porphyritic quartz-biotite-feldspar plugs and dykes* |

### LATE CRETACEOUS

| | |
|---|---|
| II | *Porphyritic biotite-hornblende diorite, equigranular quartz diorite and gabbro* |
| I | *Granite, syenite, granodiorite and monzodiorite; equigranular to locally pegmatitic* |

## SYMBOLS

Unconformity; defined, assumed ..................

Flow layering; inclined ..........................

Glacial ridge, striae ............................

Veins and alteration ............................ B

Figure 3-5-3a. Legend for Figure 3-5-3.

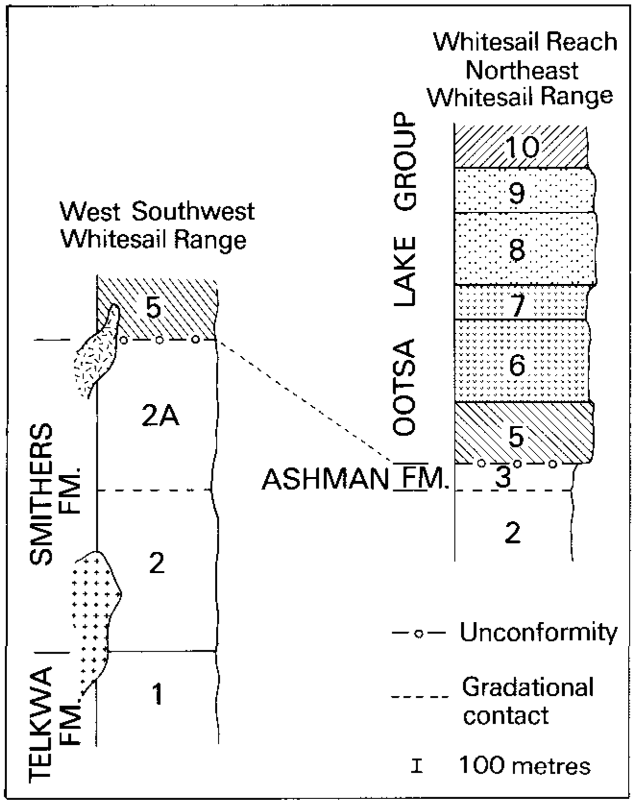


Figure 3-5-4.
Composite stratigraphic column for the Whitesail Lake area.

is estimated. The flows are mauve in colour and exhibit flow layering defined by aligned plagioclase and up to 2 per cent biotite phenocrysts. The mineral lineation imparts a slabby parting in outcrops.

Lapilli tuff and tuff breccia containing biotite-bearing fragments form subtly layered deposits, which in places interfinger with laminated grey flows lacking biotite phenocrysts. These rocks are gently inclined and rest with a profound angular unconformity on steeply dipping beds of the Smithers Formation near Troitsa Peak. The tuffs are commonly composed of subangular rhyolitic fragments which contain biotite phenocrysts set in a green chloritic matrix.

**Amygdaloidal Basalt Flows (Unit 6)**

Basalt flows have a sharp lower contact with Unit 5 northeast of Troitsa Peak. This contact is not exposed between Whitesail Lake and Tahtsa Reach, but it is thought to be an unconformity with Jurassic rocks. Conglomerate, which may mark the unconformity, is reported by Duffell (1959) underlying basalt on the eastern shore of Whitesail Lake. These exposures are now submerged.

The basalt flows attain a thickness of more than 425 metres. Individual flows range from 2 to 5 metres thick, and commonly are separated by oxidized interflow breccia as thick as 3 metres. Debris flows composed of rounded basaltic blocks up to 1.5 metres in diameter constitute deposits of variable thickness, interlayered with basalt. These rocks are more than 100 metres thick east of Troitsa Peak, but they thin rapidly to the west and north.

The flows are characteristically dark green to grey. Their texture varies from amygdaloidal porphyry to massive and aphyric. The porphyritic flows commonly contain coarse-bladed plagioclase up to 3 centimetres long and augite from 2 to 6 millimetres long. Most flows are highly vesiculated with agate, calcite and chabazite infilling vesicles.

Airfall crystal ash tuff, containing platy plagioclase 2 centimetres in diameter, forms a recessive marker bed within the basalt flows. This deposit is distinctly layered and ranges from 2 metres to more than 50 metres thick. Tree fragments found in the tuff near the top of the basalt unit suggest it is locally a subaqueous deposit.

**Andesitic Flows (Unit 7)**

Andesitic flows, vitrophyric flows and debris flows are about 200 metres thick in the northern Whitesail Range where they have a sharp contact with basaltic flows of Unit 6. Andesitic flows at the base of the sequence have a pronounced slabby parting developed parallel to flow layering. This primary layering is accentuated by sparse plagioclase phenocrysts 2 to 5 millimetres long set in a brown aphanitic matrix. Microscopically these flows contain phenocrysts of plagioclase, augite and scarce hornblende and biotite. The groundmass is composed of plagioclase microlites with trachytic texture and iron oxide granules.

The vitrophyric flows are typically black vitreous beds up to 10 metres thick. Their texture varies from sparsely porphyritic to massive and less commonly vesicular and coarsely porphyritic. In some sections fine-grained lithic fragments and fiamme-like structures are easily confused with collapsed pumice in welded ash flow deposits. In thin section, euhedral plagioclase phenocrysts are set in flow-laminated glass that often has a perlitic texture.

The debris flows form lenticular deposits more than 50 metres thick, occupying channels cut through vitrophyric flows. They are characterized by unstratified, poorly sorted rounded blocks derived mainly from vitrophyric flows.

**Rhyolitic Flows (Unit 8)**

Homogeneous rhyolitic flows more than 400 metres thick and characterized by sparse biotite phenocrysts, overlie basalt flows of Unit 6 between Tahtsa Reach and Whitesail Reach. Similar rocks, more than 150 metres thick, have an abrupt contact with Unit 6 and Unit 7 in the northern Whitesail Range. The rhyolite flows form cliffs with a massive, rusty weathered appearance. The rocks are pink, brownish-red or grey in colour. Most exposures exhibit a conspicuous bedding plane parting, flow layering, aligned phenocrysts, and uncommonly spherulites and mariolitic cavities. Petrographically, plagioclase is the dominant phenocryst, potassium feldspar and biotite are subordinate. The matrix commonly has a pilotaxitic texture.

Breccia bodies composed entirely of rhyolite fragments occur as thin irregular deposits presumably marking the top or front of flows. Elsewhere monolithic breccia is confined to discordant zones 75 centimetres to more than 3 metres wide. These breccia occurrences are thought to have formed during degassing of thick flows, since there is no evidence for shear-related movement.

**Andesitic Flows (Unit 9)**

Andesitic flows, characterized by 2 to 5 per cent biotite phenocrysts, have a sharp lower contact with Unit 8 at Whitesail Reach. This rock weathers to massive light pinkish-red blocks. Aphanitic fragments with wispy outlines are ubiquitous and resemble eutaxitic texture developed in ash flow deposits. In thin section, the fragments are not shards, but consist of fine fluidal banded glass that has undergone variable amounts of devitrification. Plagioclase and biotite are the dominant phenocrysts comprising up to 40 per cent of the rock, augite and hornblende occur in trace amounts. Locally a brownish-red laminated vitrophyric flow about 1 metre thick, with or without spherulites, is found at the base of Unit 9.

**Conglomerate (Unit 10)**

Conglomerate constitutes the youngest unit mapped in the study area. This unit is localized at Whitesail Reach where it rests on the eroded top of Unit 9. The conglomerate is composed of rounded to

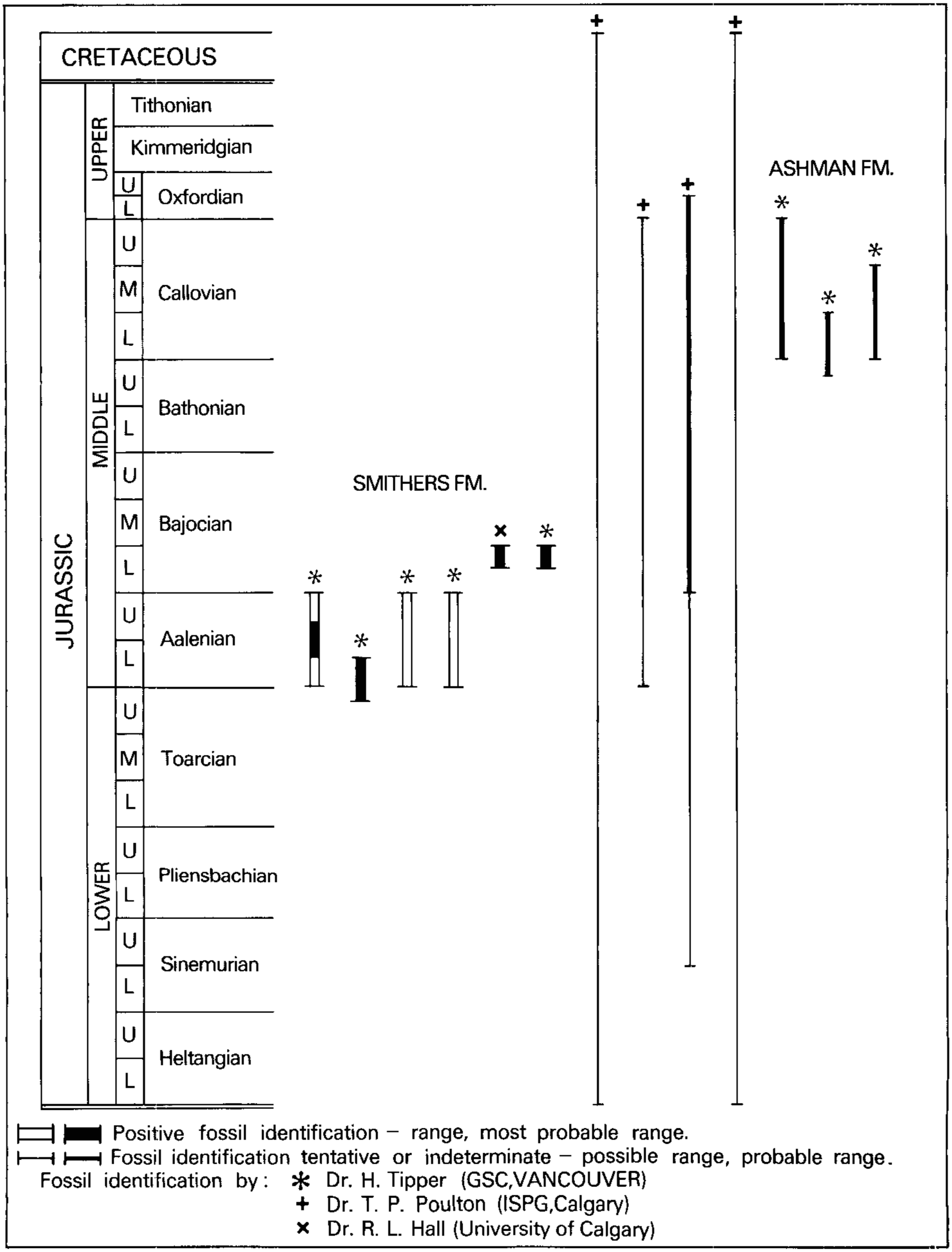


Figure 3-5-5. Ages of fossil fauna from the Smithers Formation and Ashman Formation, Whitesail Lake area.

subangular clasts that range from several centimetres to about 1 metre in diameter. The majority of clasts are derived from flows of Unit 8 and Unit 9. A few basaltic clasts resemble Unit 6 and locally quartz phyric rhyolite clasts are prominent. The conglomerate is poorly sorted and unstratified, but contains layered sand to granule-sized clastic interbeds as thick as 45 centimetres. Plant debris, tree fragments and amber are found within the finer clastic beds.

### INTRUSIVE ROCKS

Intrusive rocks in the Whitesail Lake area include stocks and cupolas of granite, syenite, granodiorite, diorite and gabbro. The largest of the intrusive bodies underlies about 32 square kilometres between Cummins Creek and Hangar Creek. The contacts are generally sharp and contact metamorphism is negligible. The rock is red to pink, coarse-grained, equigranular granite and syenite.

On Tahtsa Reach a similar syenitic rock is locally pegmatitic on the margin of an intrusion that grades inwards to a gabbroic core. The core zone is medium-grained and consists of plagioclase and interstitial augite. A broad area of pervasive hydrothermal alteration affects Smithers Formation host rocks near this intrusion.

Porpnyritic hornblende-biotite granodiorite and a dioritic intrusion occupy the central part of the map area. The porphyritic stock contains euhedral plagioclase averaging 5 millimetres long and 3 to 5 per cent combined biotite and hornblende. The dioritic body near the west shore of Whitesail Lake is a medium-grained equigranular rock which has *en échelon* quartz veins occurring adjacent to a sharp northeast contact.

Near Troitsa Peak a group of porphyritic hypabyssal plugs intrudes and locally alters the basal unit of the Ootsa Lake Group. These rocks are typically dark green and contain plagioclase phenocrysts varying from 0.8 to 2.5 centimetres long. They are thought to be the intrusive equivalents of flat-lying columnar-jointed flows capping Troitsa Peak. These flows in turn are probably temporally related to the coarse phyric flows characteristic of Unit 6.

The ages of intrusive rocks in the area are undetermined, but they are assumed to be correlative with the late Cretaceous and early Tertiary Bulkley and Coast intrusions.

## STRUCTURE

A combination of folds and faults controls the present distribution of rocks in the Whitesail area. Rocks of the Ootsa Lake Group at Whitesail Reach and in the Whitesail Range appear to be preserved within the synclinal hinges of gentle open folds. The axes of these folds trend north to northeasterly. Folds that deform Smithers Formation sediments west of Troitsa Peak also trend northeast. They are generally open and locally tightly appressed and overturned. In contrast, the overlying Ootsa volcanics are only gently warped. It is uncertain whether this variation in fold style reflects one or more phases of deformation.

Faults disrupt the Telkwa volcanics through to the youngest Ootsa strata. They have a dominant northeast trend, however some trend more northerly. The faults are generally steeply inclined with normal movement.

Locally faults delimit downdropped and tilted blocks, preserving younger strata. The thick section of Ootsa Lake Group rocks exposed in the Whitesail Range is thought to be preserved within a downdropped block that is juxtaposed against a block of exhumed Telkwa volcanics. A similar pattern of block faults is evident in the western Whitesail Range where west-side-down displacement preserves and apparently thickens east-dipping Smithers strata.

## MINERAL PROSPECTS

Mineral prospects in the study area are categorized according to their morphology and structural setting. Two potential exploration targets with features common in an epithermal-mesothermal gold-silver setting are recognized:

(1) Fracture and shear-controlled veins,
(2) Pervasive clay-silica-pyrite ± barite replacing country rock near intrusions.

### VEIN OCCURRENCES

Quartz veins with anomalous gold geochemistry occur on the west shore of Whitesail Lake and at Cummins Creek. At Location A (Figure 3-5-3) quartz veins are hosted by Smithers Formation sedimentary rocks in contact with a dioritic intrusion. Individual veins range in width from 1 millimetre to 15 centimetres, strike between 120 and 160 degrees and dip steeply. Arsenopyrite and pyrite are present in grey-black quartz veins and in silicified breccia. Chip samples of a quartz vein 10 centimetres wide and a breccia zone 50 centimetres wide returned gold analyses of 584 and 4400 parts per billion (ppb), respectively; silver was not detected. The veins have been tested by 13 drill holes; a best intercept returned an assay of 2.80 grams per tonne gold over 3.9 metres (Goad and Harris, 1983).

At Cummins Creek *en échelon* quartz veins trending roughly 170 degrees cut Telkwa volcanic rocks (Location B, Figure 3-5-3). The veins range in width from several centimetres to 1.5 metres and are traceable intermittently for up to 35 metres along strike. Pyrite and trace amounts of galena are found in white quartz and gold analyses ranging up to 1800 ppb have been reported (Cawthorn, 1982).

### PERVASIVE HYDROTHERMAL ALTERATION

Broad areas of clay minerals, fine-grained silica, pyrite and in places, barite, variably replace Smithers Formation sediments and Ootsa Lake Group volcanics over broad areas at Locations C, D, E and F (Figure 3-5-3).

Exposures of altered rock are commonly cream-white and weather to rusty fragments. The primary texture is obscured by secondary clay minerals and cryptocrystalline silica which imparts a homogeneous porcelaneous appearance to the rocks. Pyrite is ubiquitous and occurs as fine-grained disseminations and euhedral crystals. In several localities coarsely crystalline barite occupies fractures and cements breccia fragments in zones of pervasive alteration.

Pervasive alteration is spatially associated with high-level plutons at Tahtsa Reach (Location E) and near Troitsa Peak (Location C). Similar alteration at Location D cannot be related to an intrusion exposed nearby, however interestingly the three alteration zones occur at or close to the unconformity. Bleaching is widespread in rhyolitic flows near the south end of Whitesail Reach (Location F). This alteration is probably related to granitic rocks noted in a former canyon at this location (Galloway, 1916). Marshall (1925) reported specks of free gold, with pyrite and chalcopyrite, in highly altered rhyolites at a site closely corresponding with Location F.

## ANALYTICAL RESULTS

Quartz veins and zones of argillic alteration were chip sampled at 37 sites. Each sample was analysed for gold, silver, mercury, arsenic, antimony and barium. The location of sample sites will be plotted on the alteration-mineral occurrence map scheduled for release in January 1987. The analytical results are summarized below:

(1) Gold in most samples is lower than a detection limit of 30 ppb, however values of 220, 659, 584 and 4400 ppb were obtained from three separate veins.

(2) Silver analyses are consistently less than 14 parts per million (ppm). The highest concentration of 123 ppm corresponds with a zone of argillic alteration.
(3) Mercury concentrations range from less than 20 ppb to about 2900 ppb. Groups of anomalous mercury values occur within broad areas of pervasive argillic alteration.
(4) Arsenic concentrations vary directly with mercury in altered rocks, but are negligible in most veins.
(5) Antimony is invariably below a detection limit of 10 ppm.
(6) Barium analyses are not yet available and will be reported at a later date.

## CONCLUSIONS

The general stratigraphic section in the Whitesail area has a base of volcanic and shallow marine sedimentary rocks of the Lower to Middle Jurassic Hazelton Group. The sedimentary member of the Smithers Formation is nearly identical to the Ashman Formation of the Bowser Group. These formations cannot be adequately separated on the basis of lithology.

The Ootsa Lake Group lies above an angular unconformity. It is a sequence dominated by subaerial flows ranging in composition from basalt to rhyolite. The lack of epiclastic and pyroclastic rocks interlayered with the flows indicates volcanism was continuous. These rocks probably represent weak eruptions associated with small composite cones and exogenous domes.

The regional structure in the study area is characterized by gentle folding about north-trending axes that probably reflects deformation associated with the Pacific Orogen. Rocks of the Ootsa Lake Group are disrupted by northeast-trending faults. They are preserved in the troughs of broad open folds and in a tilted block bounded on one side by a fault.

Quartz veins, containing arsenopyrite, pyrite and minor base metals together with areas of pervasive hydrothermal alteration characterized by clay minerals-silica-pyrite $\pm$ barite, are potential exploration targets for epithermal to mesothermal gold-silver mineralization. The veins occur in extensional fractures near stocks or in areas with no apparent relationship with intrusive rocks. A close spatial association exists between zones of pervasive alteration, intrusions and the unconformity separating Jurassic and Tertiary volcanic rocks.

## ACKNOWLEDGMENTS

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