STRATIGRAPHY AND PETROLOGY OF THE STEWART MINING CAMP (104B/1)

By D. J. Alldrick

INTRODUCTION

This report summarizes stratigraphic and intrusive relationships in the Salmon River valley which trends north of Stewart for 35 kilometres (Fig. 115). Mineral deposits in the area show stratigraphic relationships that may provide exploration guides.

VOLCANIC AND SEDIMENTARY ROCKS

Significant revisions have been made to the stratigraphic column of Alldrick (1984, Fig. 58; *see* Table 1A, Fig. 116). These revisions include recognition of porphyritic andesite flows and regional siltstone marker beds within the andesite sequence, and subdivision of 'map unit 4 - transition sequence' into separate black tuff and sedimentary units.

MAP UNIT 1 - ANDESITE SEQUENCE (AS)

The andesite volcanic sequence is composed of massive, green to greenish grey tuff with minor amounts of interbedded siltstone, epiclastic rocks, and volcanic flows. The fragmental volcanic rocks range from dust to ash tuff, crystal tuff, lapilli tuff, and pyroclastic breccia.

The tuffs show no evidence of either sorting within individual beds, or preferred orientation of crystals or lithic fragments. Hematitic epiclastic lenses are interbedded with the andesite tuffs. The sequence represents a predominantly subaerial accumulation with two periods of submergence marked by the regionally developed interbedded black siltstone members.

Volcanic Flows (1f, 1g)

Bimodal, feldspar-porphyritic andesite flows (1g) outcrop along the bottom of Summit Lake, along the west side of Mount Dillworth, and uphill from the Silbak Premier minesite (Fig. 115). Phenocrysts comprise small (3 to 5-millimetre) white, subhedral to euhedral plagioclase crystals and larger (1 to 5-centimetre) buff-coloured, euhedral orthoclase crystals; locally, 5 to 10-millimetre hornblende crystals occur; the matrix is fine grained. The Summit Lake and Mount Dillworth exposures are probably parts of the same flow, indicating a minimum strike length of 4.5 kilometres. In the Mount Dillworth area (Fig. 115) the 100-metre-thick exposure is divided by a hematitic siltstone band, parallel to the borders of the flow, suggesting subaerial weathering between two flows. Texturally, these distinctive flows are identical to dykes of Premier porphyry, which cut the underlying andesites, siltstones, and Texas Creek granodiorite (Fig. 116).

Dupas (this volume) describes an augite-porphyritic andesite flow (1f) in the Long Lake area. This rock type, which also lies at the top of the andesite sequence, may be a stratigraphic equivalent of the feldspar-porphyritic flows.

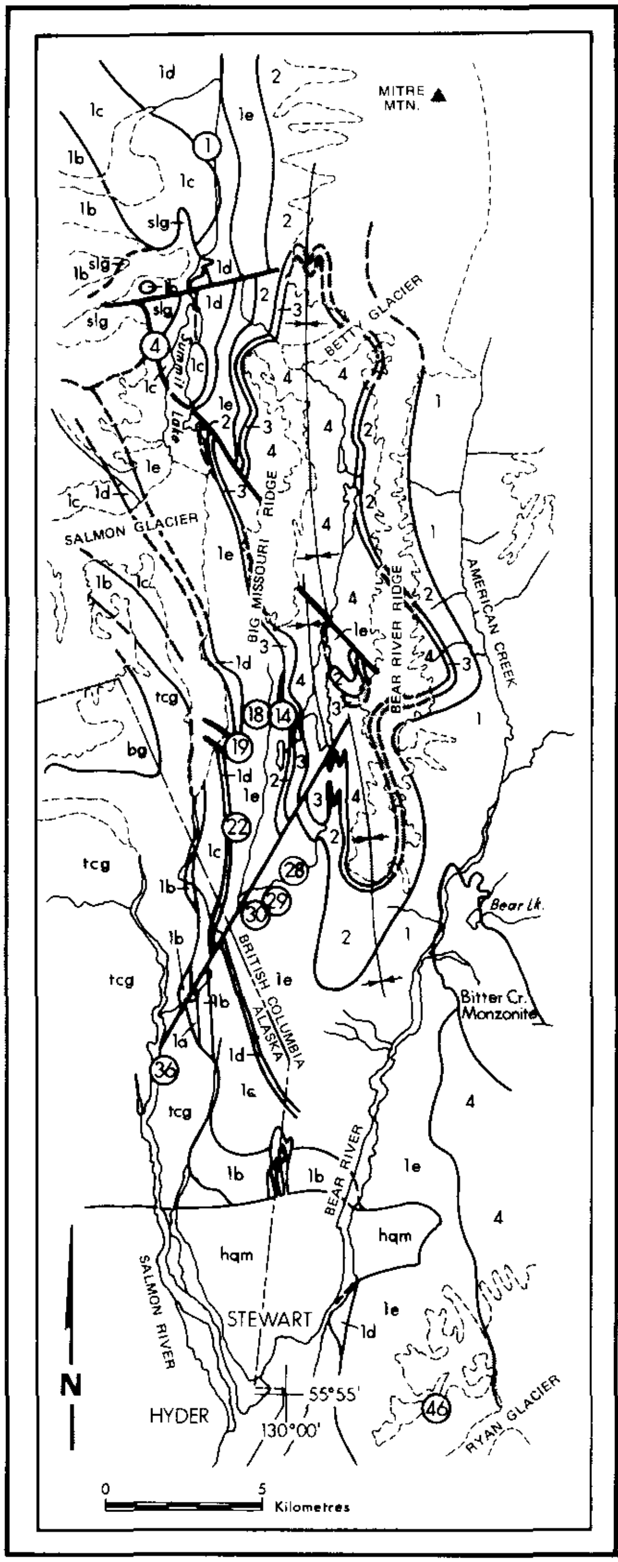
Sedimentary Rocks

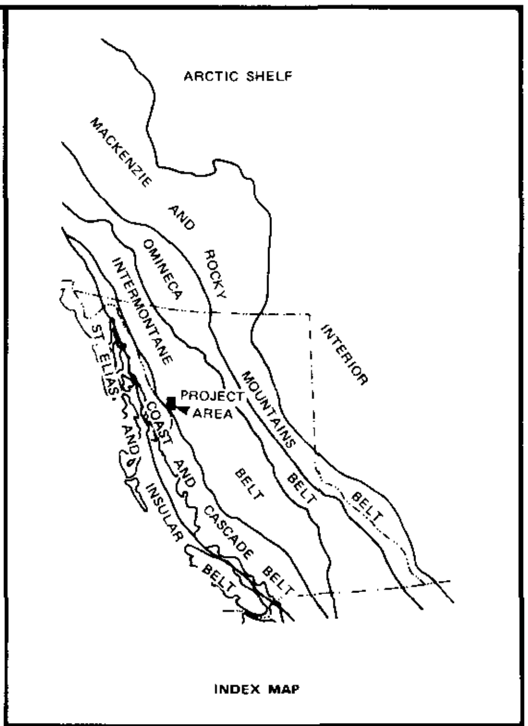
Epiclastic Rocks [1e(Ep)]: Within the upper 2 000 metres of andesite tuffs (1e) are local lenses and pods of epiclastic, maroon to purple, siltstone, sandstone, and conglomerate. Epiclastic rocks represent quiescent periods when weathering and erosion took place during development of the andesitic volcano. These red units are distinctive and may be useful marker horizons on property scale.

Siltstone Members (1b, 1d): Two dark grey to black, thin-bedded siltstone members of regional extent provide stratigraphic and structural markers within the andesitic pile. The units strike north-northwest; they facilitate determination of bedding attitudes, stratigraphic tops, and fault offsets throughout the map-area.

The lower siltstone member (1b), the Mount Dolly member, lies mainly west of the map-area along most of the Salmon River valley. It forms a roof pendant in the Summit Lake granodiorite and reappears to the south at the Outland Silver Bar prospect (Fig. 115). The siltstone outcrops in the bed of the Salmon River at the north and south ends of Mineral Hill. In the Skookum (Mountain View) adit, the siltstone exposures are purple-brown, banded hornfels. At Mount Dolly this member is a thick sequence of east-trending thin-bedded, pyritic siltstone that forms the summit.

The upper siltstone member (1d), the August Mountain member, can be traced southward from the Haida claim (Portland prospect) to the crest of Bear River Ridge (Fig. 115). Midway between Mount Welker and Mount Dolly, the No. 5 International Boundary marker peg is cemented into these siltstones. Further southeast this unit may be the purple-brown hornfelsed, calc-silicate-veined siltstone that hosts minor amounts of sulphide mineralization in the Molly B and Red Reef adits on Mount Rainey. The upper siltstone also hosts precious metal veins at the East Gold mine. Weathering of local pyrite alteration in the siltstones produced the brightly coloured, gossanous exposures that crop out from north of the East Gold mine southward to the Millsite fault. The unit provides evidence for major offsets along the Millsite fault, the Morris Summit fault, and the Slate Mountain fault.





MAJOR MINERAL DEPOSITS

EAST GOLD MINE	1
SCOTTIE GOLD MINE	4
DAGO HILL DEPOSIT	14
BIG MISSOURI MINE (S–1 ZONE)	18
CONSOLIDATED SILVER BUTTE DEPOSIT	19
INDIAN MINE	22
SEBAKWE MINE	28
B.C. SILVER MINE	29
SILBAK PREMIER MINE	30
RIVERSIDE MINE	36
PROSPERITY AND PORTER IDAHO MINES	46

Figure 115. Geology and major mineral deposits, Salmon River area. See Tables 1A and 1B for lithologic symbols.

TABLE 1A
TABLE OF FORMATIONS

UNIT SYMBOL	NAME AND LITHOLOGY	THICKNESS (metres)
4-SS	SEDIMENTARY SEQUENCE	
4b-SS	Sedimentary sequence: carbonaceous and calcareous sedimentary rocks; argillite, siltstone, slate, sandstone, conglomerate, lesser limestone	>300
4a-TZS	Transition zone sedimentary rocks: black grits, sandstone, argillite, limestone, fossiliferous limestone, pumice conglomerates, weakly pyritic facies with upper Middle Jurassic-Bajocian to Callovian fossils	4-10
3-FVS	FELSIC VOLCANIC SEQUENCE	20-120
3f-BT	Black tuff: carbonaceous and lithic lapilli air fall tuff with interbedded sedimentary rocks	0-80
3e-PFT	Pyritic felsic tuff: siliceous air fall lapilli tuff and tuff breccia with 5 to 15 per cent disseminated pyrite	0-8
3d-UFT	Upper felsic tuff: siliceous, massive air fall lapilli tuff, and tuff breccia; partially welded	5-20
3c-MFT	Middle felsic tuff: felsic ash flows, single and compound units	10-40
3b-LFT	Lower felsic tuff: felsic, aphanitic, air fall dust tuff	5-15
3a-BF	Basal pumice facies: erosional remnants of air fall pumiceous tuff	0-16
2-ES	EPICLASTIC SEQUENCE	4-1 200
2b-EF	Epiclastic facies: conglomerate, sandstone, siltstone, lesser limestone	4-600
2a-DF	Dacitic volcanic facies: tuffs, crystal tuffs, lapilli tuffs, porphyritic flows	0-600
1-AS	ANDESITIC SEQUENCE	
1g-PPF	Premier porphyry flows: bimodal feldspar porphyritic andesite	0-60
1f-PPF	Augite porphyry flows: augite porphyritic andesite	0-60
1e-UAT	Upper andesite tuffs: dust tuffs, ash tuffs, crystal tuffs, lapilli tuffs, tuff breccias; interbedded epiclastic sedimentary rocks	2 000
1d-USM	Upper siltstone member: argillite, siltstone, sandstone, limestone, conglomerate	15-150
1e-MAT	Middle andesite tuffs: dust tuffs, ash tuffs, lapilli tuffs	1 750
1b-LSM	Lower siltstone member: argillite, siltstone, sandstone	50-200+
1a-LAT	Lower andesite tuffs: ash tuffs	100+

TABLE 1B
TABLE OF INTRUSIVE ROCKS

UNIT SYMBOL	NAME AND LITHOLOGY	AGE (Ma)
tcg	Texas Creek granodiorite: hornblende, granodiorite, coarse grained, local coarse feldspar porphyritic phases	210
pp	Premier porphyry dykes: bimodal feldspar porphyritic diorite/andesite, ± hornblende, ± quartz phenocrysts	(?) Lower Jurassic
slg	Summit Lake granodiorite: hornblende granodiorite; medium to coarse grained	(?) Same as tcg?
mp	Mill porphyry dykes: bimodal feldspar-porphyritic diorite/andesite	(?) Same as pp?
bg	Boundary granodiorite: biotite granodiorite, golden sphene, ± hornblende; medium grained	52
hqm	Hyder quartz monzonite: biotite granodiorite to quartz monzonite, golden sphene, ± hornblende	50
pc	Portland Canal dyke swarm: early granodiorite, middle microdiorite, late lamprophyre	(?) Same as hqm?

MAP UNIT 2 - EPICLASTIC SEQUENCE (ES)

The epiclastic sequence comprises sedimentary rocks and interbedded dacitic tuffs and flows. The formation, which varies in thickness from 4 to 1 200 metres within the map-area, is interpreted to be a subaerial accumulation of reworked debris and onlapping dacitic volcanic flows that overlie the slopes of an andesitic stratovolcano.

Sedimentary Rocks (2b)

The sedimentary facies consists of conglomerates, sandstones, and siltstones. The hematized sedimentary rocks are generally purple to bright maroon coloured, but local greenish and mottled purple and green units occur within the sequence. The environment of deposition was predominantly subaerial and the conglomerate units may represent debris flows. A small, white limestone lens, 250 metres long by 6 metres thick, that outcrops on the southwest slope of Mitre Mountain is evidence of local lacustrine or marine conditions.

Monolithic epiclastic conglomerate beds coincide with areas in which the epiclastic formation is thin. These locations, on Mount Dillworth (Fig. 118) and at the north end of Long Lake (Dupas, this volume), are interpreted to be paleotopographic highs. The textures of the conglomerate cobbles are identical to those of the underlying andesitic rocks. Hematitic zones underlying these conglomerates may be lithified regoliths developed on the underlying andesitic strata.

Dacitic Volcanic Rocks (2a)

Dacitic dust tuff, crystal tuff, lapilli tuff, and porphyritic flows are interbedded within the epiclastic sequence. The dacites are of local extent because some sections through the epiclastic formation have no interbedded dacitic rocks. On Mount Rainey, however, the andesite formation of map unit 1 is capped by a thick sequence of dacitic volcanic rocks and there are no interbedded sedimentary rocks (Fig. 116). Therefore the dacite flows and tuffs may be onlapping units extruded from other nearby volcanic centres.

MAP UNIT 3 - FELSIC VOLCANIC SEQUENCE (FVS)

The felsic volcanic sequence provides an important regional marker. The rocks are mainly dense, resistant, variably welded tuffs. They display distinct lateral facies variations and compositional changes that can be related to paleotopography and depositional environment.

Basal Pumice Facies (3a)

On the northwest slope of Mount Dillworth, a narrow zone of massive pumiceous tuff is sandwiched between the andesitic sequence (unit 1) and the lower felsic tuff (3b; Fig. 116). The exposed pumice zone, which is 16 metres thick and 12 metres wide, consists of purple, massive, fine pumiceous ash with scattered rounded pumice lapilli up to 3 centimetres in diameter; the rock has local light grey lenses. The pumice must have been deposited near the vent area then rapidly eroded. Only remnants were preserved, such as this exposure apparently deposited in a deep stream channel or trough that was eroded through the unlithified epiclastic sediments to andesitic bedrock.

Lower Felsic Tuff (3b)

The lower member of the felsic volcanic sequence is a massive aphanitic dust tuff composed of volcanic dust and fine lithic particles. The rock is typically pale olive-grey to grey, but bright turquoise-coloured zones occur near Summit and Divide Lakes. Hematitic purple and bright maroon alteration zones give the rock a swirled or marbled pattern. The unit has sharp, conformable contacts with adjacent units.

At the southeast corner of Summit Lake (Fig. 115) the dust tuff contains fine, silica-filled vesicles and large euhedral pyrite crystals up to 1 centimetre in diameter.

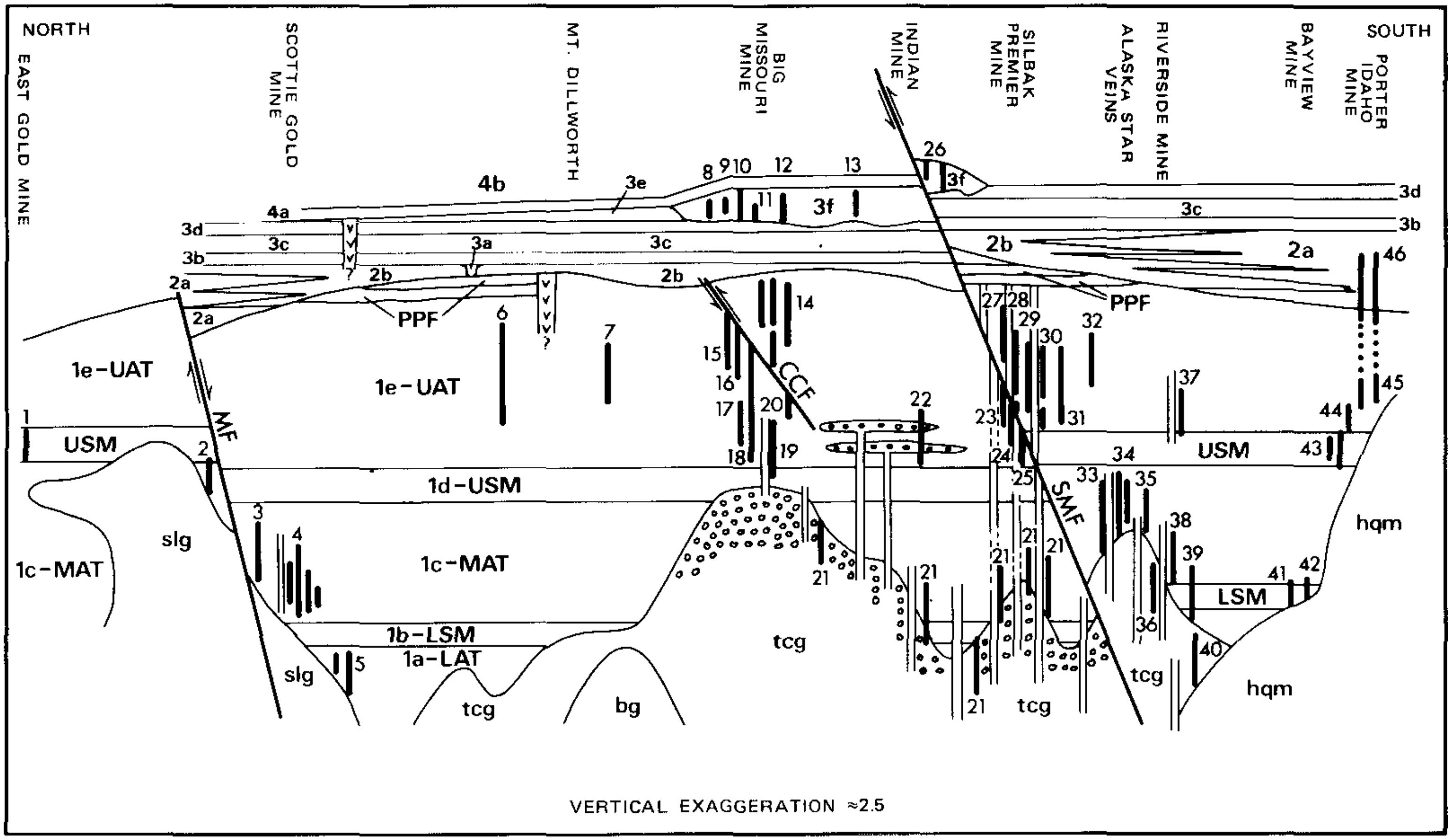


Figure 116. Schematic cross-section showing stratigraphic position of mineral deposits, Salmon River valley. See Table 1 and Figure 115 for legend.

LEGEND

VEIN DEPOSIT

VENT FACIES

PREMIER PORPHYRY DYKE OR VOLCANIC NECK

SILL OF POPRHYRITIC TEXAS CREEK GRANODIORITE

PORPHYRITIC BORDER PHASE OF TEXAS CREEK GRANODIORITE

SYMBOLS

FAULT	
MILLSITE FAULT	MF
MORRIS SUMMIT FAULT/ MINERAL GULCH FAULT	MSF
SPIDER FAULT	SF
CASCADE CREEK FAULT	CCF
SLATE MOUNTAIN FAULT	SMF
SYNCLINE AXIS	

KEY TO MINERAL DEPOSITS

1 EAST GOLD MINE
2 BEND VEIN (PYRRHOTITE)
3 SCOTTIE NORTH PROSPECT (PYRRHOTITE–PYRITE)
4 SCOTTIE GOLD MINE (O, M, N, L ZONES)
5 HICKS' VEINS (PYRRHOTITE)
6 49 PROSPECT
7 MARTHA ELLEN ZONE
8 LION GROUP (SILVER HILL)
9 SILVER CREST
10 SILVER TIP MINE
11 H VEIN
12 VEINS 400 METRES NORTHEAST OF BIG MISSOURI POWERHOUSE
13 VEINS ON WEST SLOPE OF SLATE MOUNTAIN
14 DAGO HILL PROSPECT (SEVERAL VEINS)
15 UNICORN NO. 1 (INCLUDES GOOD HOPE)
16 A VEIN
17 PROVINCE ZONE
18 BIG MISSOURI MINE (S-1 ZONE)
19 CONSOLIDATED SILVER BUTTE PROSPECT
20 TERMINUS PROSPECT
21 MASSIVE PYRRHOTITE VEINS ALONG FLOOR OF SALMON RIVER
22 INDIAN MINE
23 HOPE PROSPECT (GRANDUC ROAD SHOWING)
24 PREMIER EXTENSION
25 WOODBINE
26 LAKESHORE WORKINGS, SOUTH OF MONITOR LAKE
27 BUSH WORKINGS
28 SEBAKWE WORKINGS
29 B.C. SILVER WORKINGS
30 PREMIER WORKINGS
31 PREMIER BORDER WORKINGS

(27–31: SILBAK PREMIER MINE)

32 PICTOU WORKINGS
33 UNNAMED PYRRHOTITE VEIN
34 UNNAMED PYRRHOTITE VEIN
35 SCHAFT CREEK COPPER VEIN (PYRRHOTITE)
36 RIVERSIDE MINE
37 TITAN PROSPECT
38 UNNAMED PYRRHOTITE VEIN
39 ROANAN COPPER VEIN (PYRRHOTITE)
40 VEINS IN SKOOKUM/MOUNTAINVIEW ADIT
41 UPPER BAYVIEW VEINS
42 LOWER BAYVIEW VEINS
43 MOLLY B AND RED REEF VEINS
44 ORAL M VEIN
45 SILVERADO MINE
46 PROSPERITY/PORTER IDAHO MINES

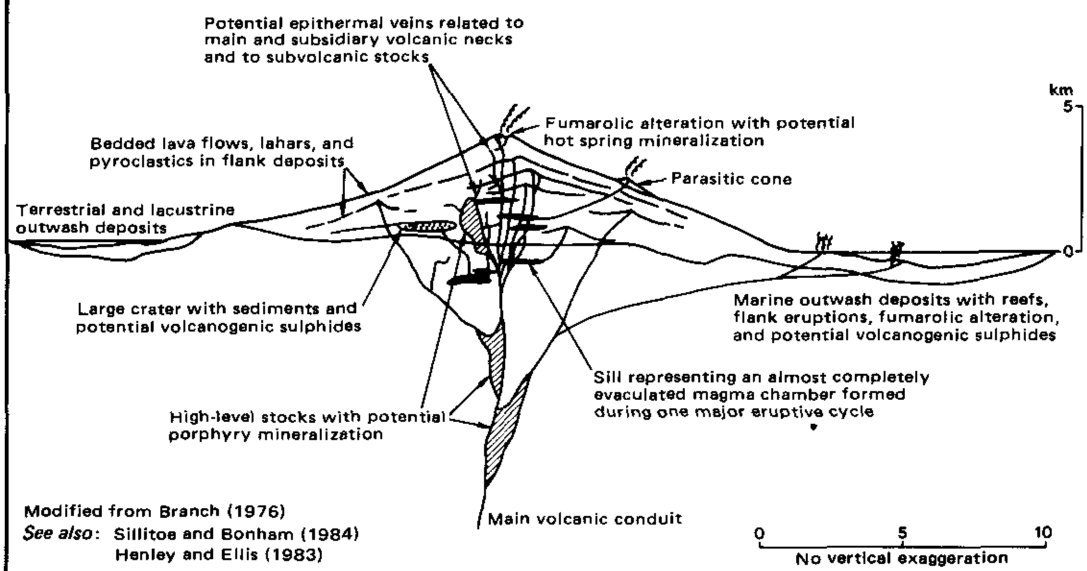


Figure 117a: Idealized model of ore deposit types related to an andesitic stratovolcano.

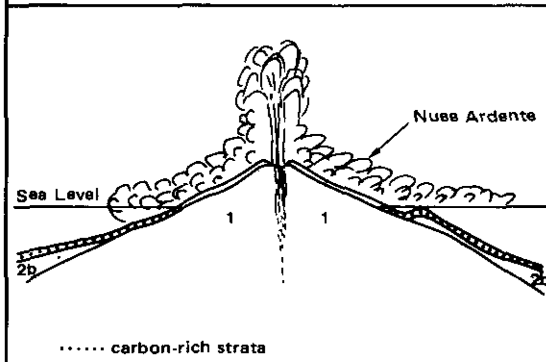


Figure 117b: Deposition of carbon-free and carbon-rich facies of Units 3c and 3d.

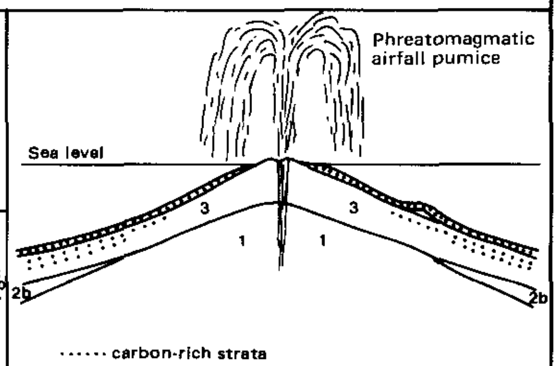


Figure 117c: Deposition of carbonaceous, fossiliferous, ash and pumice-rich sediments of Unit 4a.

Figure 117d: Relationship between paleotopography and present erosion surface.

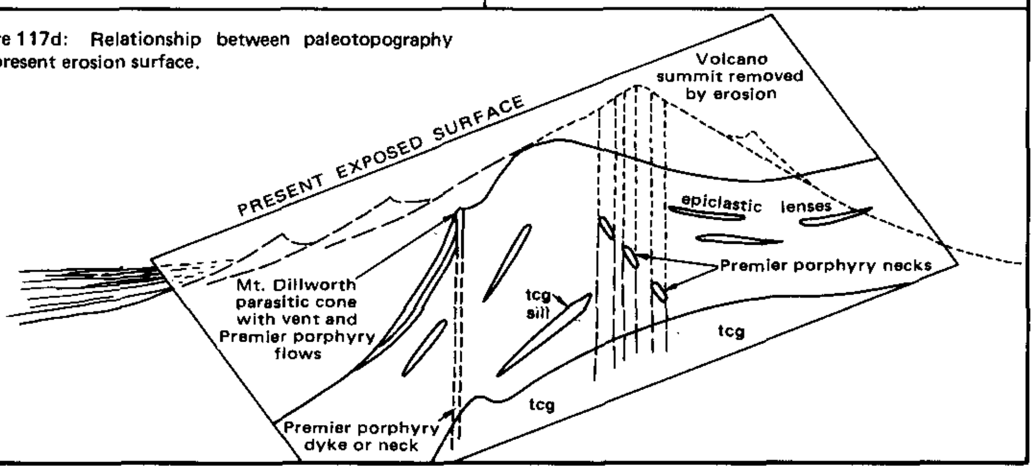


Figure 117. Metallogeny, evolution, and paleotopography of andesitic stratovolcano.

Middle Felsic Tuff (3c)

Variably welded ash flow tuff comprises the middle member of this felsic volcanic sequence. In the Mount Dillworth to Monitor Lake area (Fig. 115) sections of this member contain mixed fiamme and angular felsic lapilli and are overlain by pumice lapilli. Well-exposed sections show progressive welding down section; equidimensional pumice give way to black glassy fiamme. Outside the Mount Dillworth area subrounded pumice lapilli are abundant but the rocks are not welded.

Upper Felsic Tuff (3d)

The upper member of the felsic volcanic sequence is a siliceous lapilli tuff to tuff breccia that extends throughout the map-area. The unit may be partially welded but contains neither pumice fragments nor fiamme. Along much of its strike length the matrix of the unit is medium to dark grey (Fig. 117 b and c).

Pyritic Felsic Tuff (3e)

A pyritic, felsic lapilli tuff to tuff breccia trends along the west side of Mount Dillworth and along the east side of Summit Lake (Fig. 115). This unit ends sharply in a cliff at the south end of Mount Dillworth but progressively thins northward, finally wedging out along the west side of Troy Ridge (Fig. 116). Fragment size decreases progressively northward, from rounded 0.5-metre boulders to cobbles, then lapilli. The upper and lower contacts of this unit are sharp but irregular.

Cylindrical fumarolic pipes, 2 centimetres by 30 centimetres, oriented perpendicular to bedding in the pyritic tuff, are exposed along the top of a cliff at the southeast corner of Summit Lake. These pipes are lined with encrustations of fine to medium-grained pyrite.

This unit is interpreted to be air fall lapilli tuff to tuff breccia that was deposited in a shallow, sulphur-rich, reducing marine environment. Fragment size variations indicate the source area of this unit is at the south end of Mount Dillworth (Fig. 116).

Black Tuff (3f)

The black tuff member is a thick unit of carbonaceous crystal and lithic lapilli tuffs with local argillaceous siltstone lenses. The lapilli consist of crowded porphyry flows or crystal tuffs, limestone, and rare pumice.

This member forms the uppermost unit of the felsic volcanic package. It extends from the south end of Mount Dillworth southward to the crest of Slate Mountain and is also exposed in a few outcrops south and south-southeast of Monitor Lake (Fig. 115). This rock type is well displayed in the dumps at the south end of the penstock tunnel near the Long Lake dam and in abandoned drill core near the Lakeshore workings south of Monitor Lake (Fig. 115). The black tuff overlies the upper felsic tuff (3d) and is stratigraphically equivalent to the pyritic lapilli tuff (3e). The contact relationships between the black tuff and the pyritic tuff are unknown. Both units host sulphide mineralization; thus they may be important keys to metallogenic interpretation of deposits in the underlying volcanic pile.

Two possible interpretations explain the limited strike extent of this distinctive, thick black tuff unit: (1) it may represent an erosional remnant of an originally extensive unit or (2) deposition was restricted to the area it now occupies. The latter interpretation indicates that the tuff was deposited in topographic low, such as a volcanic crater or a caldera.

MAP UNIT 4 - SEDIMENTARY SEQUENCE (SS)

Transition Zone Sedimentary Rocks (4a)

The transition zone sedimentary rocks were originally considered as a separate unit (Alldrick, 1984), but, on the basis of preliminary fossil examination, are now interpreted to be the basal unit of the main sedimentary sequence. The best exposures of this unit are seen at the cliff top near the southeast corner of Summit Lake, north of the 49 Ridge, and on the crest of Slate Mountain (Fig. 115).

The basal member consists of dark grey to black grits, ash-rich argillaceous siltstones, and local lenses and thin beds of fossiliferous limestone and conglomerate. These sedimentary rocks contain local horizons with sparsely disseminated pyrite. Thin conglomerate layers at Summit Lake and on Slate Mountain contain rounded pebbles of pumice. H. W. Tipper (personal communication, 1984) has identified pectin-like bivalves from the fossil-rich limestones of this unit to be of Bajocian to Callovian (upper Middle Jurassic) age.

The basal member lies disconformably on volcanic lapilli tuffs of the pyritic felsic and black tuff units (3e and 3f). Its upper contact is marked by a regional bedding plane fault that separates this unit from the overlying main sedimentary sequence (Alldrick, 1984, Figs. 58 and 60).

Sedimentary Sequence (4b)

The main sedimentary sequence, which is well exposed on the east side of Mineral Gulch, southeast of Summit Lake, is described by Grove (1971) and Alldrick (1984). The lower 100 metres of this formation comprise black, thin to medium-bedded argillites, calcareous siltstones, and shales with minor intercalations of light grey limestone, and cherty beds that may be tuffaceous. Above these are medium grey greywackes, sandstones, and intraformational conglomerates. Trace amounts of disseminated pyrite outline some bedding planes within the siltstones.

The upper contact of the main sedimentary sequence was not observed in the study area; the lower contact is marked by a 5 to 30-metre-thick zone of intense deformation and quartz veining adjacent to the bedding plane fault.

INTRUSIVE ROCKS

TEXAS CREEK GRANODIORITE

The Texas Creek granodiorite is a distinctive coarse-grained hornblende granodiorite that has been studied by Buddington (1929), Grove (1971, 1973), and Smith (1977). Buddington (1929, p. 22) first noted the spatial relationship between the Texas Creek stock and mineral deposits in the Salmon River valley and suggested a genetic link.

Core Phase

The core of the main intrusive is a massive, equigranular, medium to coarse-grained hornblende granodiorite, with up to 15 per cent coarse, euhedral hornblende. This hornblende-rich, coarse-grained texture is a characteristic feature of the Texas Creek granodiorite that can be recognized through all alteration and deformation.

Border Phase

Along the Salmon River, the Big Missouri Ridge and the Bear River Ridge (Fig. 115), the eastern margin of the stock comprises coarse-grained feldspar-porphyritic hornblende granodiorite; this zone is several hundred metres wide. The phenocrysts in the border phase are 1 to 4-centimetre euhedral orthoclase crystals similar to phenocrysts in the Premier porphyry dykes and flows. Prismatic hornblende and orthoclase crystals display a subtle preferred orientation in some samples.

Characteristically, the margins of the Texas Creek granodiorite contain a narrow zone, up to a few tens of metres wide, of medium to dark greenish grey chloritic alteration that is sometimes accompanied by fractures and a crude foliation. Shearing and broken grains suggest that this narrow zone results from crushing along the contact of the granodiorite.

Sill Phase

P. McGuigan and G. Dawson (personal communication, 1984) have identified two sill-like feldspar-porphyritic lenses of Texas Creek granodiorite at

TABLE 2
WHOLE ROCK AND TRACE ELEMENT ANALYSES

	27622[1]	27623[2]	27624[3]	27625[4]	27626[5]	27627[6]	27628[7]	27629[8]	27630[9]	27631[10]	27632[11]	27633[12]	27634[13]
SiO_2	49.24	61.31	57.54	65.34	65.87	61.43	59.17	38.50	53.09	57.49	53.31	66.12	60.01
Al_2O_3	24.83	18.23	14.47	16.22	12.27	13.82	14.13	5.63	14.19	15.31	14.02	13.51	16.10
Fe_2O_3	12.47	7.24	4.86	5.28	11.53	9.48	9.62	1.52	8.33	6.58	4.54	7.68	8.32
MgO	1.84	2.46	1.65	1.80	3.18	1.61	0.72	0.52	5.94	2.80	0.59	0.56	3.34
CaO	0.13	2.14	7.34	4.37	1.03	3.70	2.06	28.46	4.98	4.34	9.68	<0.03	0.38
Na_2O	1.82	2.13	0.24	3.45	0.52	4.16	3.69	1.47	2.45	3.43	4.59	0.03	0.81
K_2O	4.33	3.12	4.74	2.05	0.92	0.48	2.10	1.01	2.93	3.19	1.52	4.45	3.77
TiO_2	1.24	0.77	0.52	0.48	1.11	0.97	1.19	0.35	0.64	1.39	1.16	1.26	0.63
MnO	0.106	0.107	0.270	0.099	0.060	0.101	0.049	0.119	0.210	0.130	0.152	<0.004	0.062
FeO	2.64	5.18	2.08	1.24	7.09	7.66	2.23	0.57	6.99	4.69	1.72	1.20	4.23
S	0.01	0.01	1.39	<0.01	0.01	<0.01	5.40	0.7	0.28	0.04	2.19	5.17	0.35
FeS_2							10.1				1.91	4.5	
CO_2	<0.07	0.14	5.31	0.21	0.49	2.81	1.26	22.11	3.87	2.83	7.32	1.04	1.87
H_2O-	0.71	0.32	0.31	0.29	0.33	0.36	0.42	0.22	0.22	0.24	0.25	0.25	0.96
H_2O+	4.39	3.17	2.82	2.07	3.60	2.84	1.36	1.30	3.35	2.47	1.53	2.01	3.59
L.O.I.	3.7	3.0	3.1	2.1	5.0	5.0	6.7	22.3	6.9	4.8	9.3	6.0	5.5
Ni	13	2	<2	2	<2	4	<2	17	38	14	5	5	5
Cr	14	3	3	3	2	8	7	22	38	15	5	4	25
Ba	0.21	0.21	0.3	0.21	0.09	0.05	0.15	0.13	0.23	0.23	0.10	0.16	0.23
Sr	0.04	0.04	0.02	0.02	0.03	0.03	0.03	0.05	0.02	0.04	0.03	7.0 ppm	37 ppm
P	<0.04	0.13	0.1	0.15	N.D.	0.2	0.28	0.19	0.15	0.25	0.25	N.D.	0.31

[1]Maroon epiclastic siltstone (map unit 2). Northeast of Big Missouri powerhouse.
[2]Felsic lapilli tuff (map unit 2). East and uphill of Silbak Premier mine.
[3]Premier Porphyry dyke. Granduc road. Road cut north of Silbak Premier mine.
[4]Purple epiclastic pebble conglomerate, heterolithic (map unit 2). Crest of Bear River Ridge, east of Silbak Premier mine.
[5]Maroon dust tuff (map unit 3b). Northeast of Monitor Lake.
[6]Cream-coloured felsic tuff; massive, aphanitic. Base of map unit 2c. East of Monitor Lake.
[7]Pyritic felsic tuff breccia (map unit 3e). South end of Mount Dillworth.
[8]Carbonaceous, calcareous grit (map unit 4a). South end of Mount Dillworth.
[9]Black, carbonaceous, massive fine-grained ash tuff (map unit 1). In hangingwall of upper siltstone member. Granduc road 10.5-mile marker.
[10]Leucocratic felsic tuff or flow, massive (map unit 1). South of Indian Lake.
[11]Pyritic felsic lapilli tuff (map unit 3e). North end of Mount Dillworth.
[12]Dark grey pyritic pumice lapilli tuff (top of map unit 3c). Between Harris Creek and Mount Dillworth.
[13]Black, carbonaceous, lapilli tuff (map unit 1). In hangingwall of upper siltstone member. North of Consolidated Silver Butte prospect.

Note: Recalculation of S values as FeS_2 yields points 7', 11', and 12' on Figure 118.

the Indian mine. These north-trending sills dip 70 degrees east, parallel to bedding in nearby outcrops of the upper siltstone member. Branch (1976) suggests that such coarse-grained, subvolcanic sills may represent evacuated and collapsed magma chambers from early eruptive cycles (Fig. 117a).

The sills consist of large orthoclase phenocrysts in a medium to coarse-grained hornblende granodiorite matrix. This matrix texture, the higher hornblende content, and the absence of chloritic alteration, distinguish Texas Creek granodiorite from the finer grained, hornblende-poor chloritic matrix of dykes and flows of Premier porphyry.

PREMIER PORPHYRY

Typical Premier porphyry dykes are medium to dark green porphyritic rocks composed of large (1 to 4-centimetre) orthoclase phenocrysts and smaller (0.5-centimetre) plagioclase phenocrysts in a fine-grained crystalline matrix. Samples also commonly contain euhedral hornblende phenocrysts up to 1 centimetre long, and scattered quartz eyes that make up to 4 per cent of the rock by volume. A whole rock analysis of a Premier porphyry dyke plots within the overlapping andesite-dacite field (Fig. 118).

These dykes cut the margins of the Texas Creek granodiorite and all the rocks within the andesite sequence. Within the Texas Creek granodiorite, the dyke matrix is medium grained and less chloritic. One 3-metre-wide dyke exposed in the bed of the Salmon River shows dark, 6-centimetre-thick chilled margins along both edges. These dykes were discussed by Buddington (1929) and Grove (1971) who interpreted them as a contemporaneous peripheral dyke phase of the main Texas Creek stock. Published maps by Grove (1971, Fig. 3; 1983) include the Premier porphyry dykes as part of the main granodiorite mass, therefore his contact is highly irregular and extends well east of the actual contact of the main Texas Creek pluton, which is relatively regular. The Premier porphyry dykes are generally interpreted to form tabular sheets; however, at Silbak Premier mine they form elliptical pipes, plugs, or volcanic necks. At Silbak, the elliptical pipes have an east-southeast-trending long axis and plunge 60 degrees toward the west-northwest. The many ore deposits of the Silbak Premier mine occur as crescent-shaped vein networks and breccia zones along the contacts of these plugs.

The Premier porphyry dykes are not restricted to the area of the Silbak Premier mine; they occur as far south as the Riverside mine and as far north as the toe of the Salmon Glacier (Fig. 115). The 'Mill porphyry' dyke at the lower portal of Scottie Gold mine is texturally identical to other Premier porphyry dykes, but is light grey and lacks the characteristic pervasive chloritic alteration.

Porphyritic volcanic flows with bimodal feldspars are present at the top of the andesitic volcanic sequence near the Silbak Premier mine, along

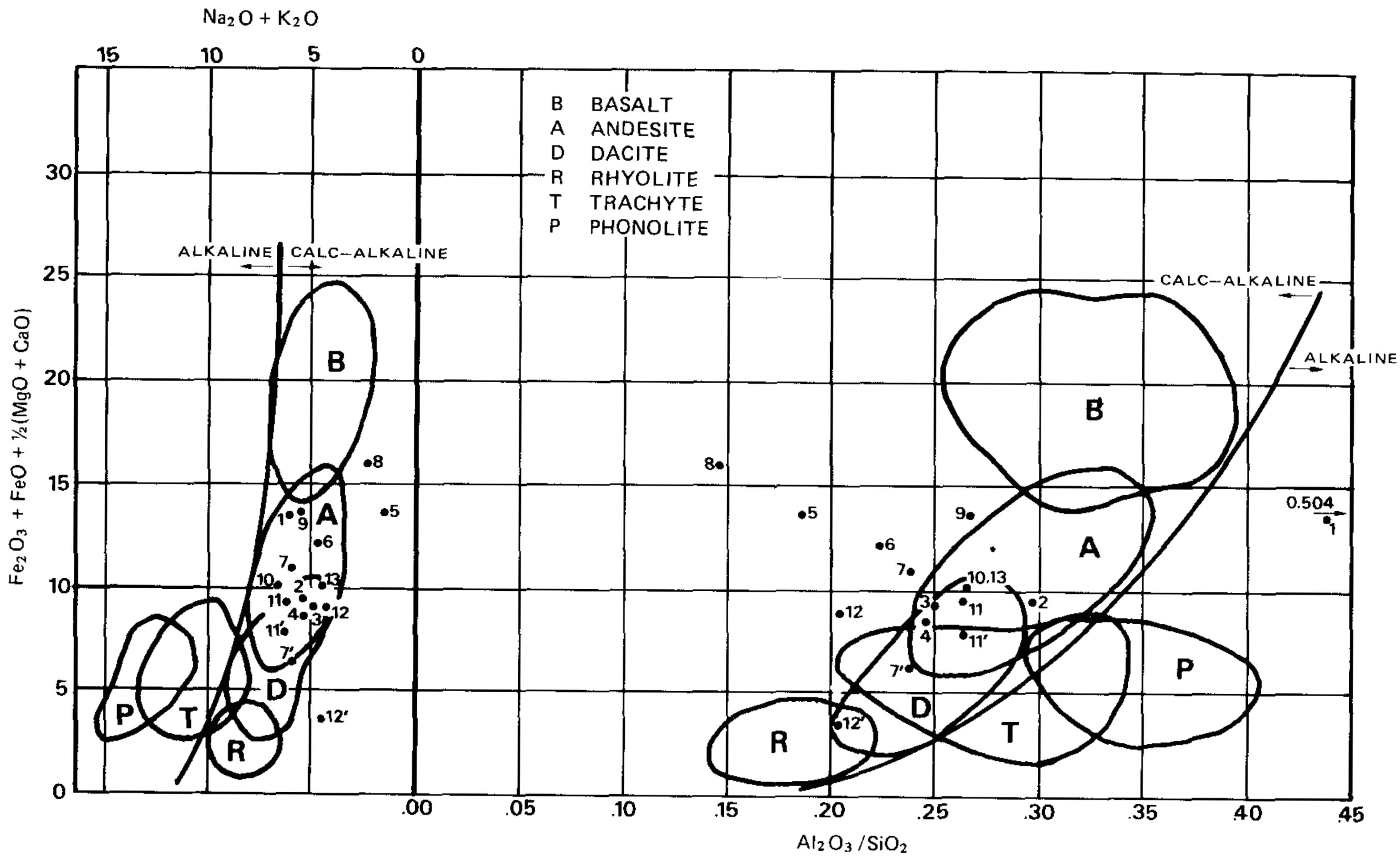


Figure 118. Compositions of 16 volcanic and volcaniclastic rocks analysed from Salmon River area (results are listed in Table 2).

the west side of Mount Dillworth and in the bed of Summit Lake (Fig. 116). The Premier porphyry dykes are interpreted to have fed these flows and are considered to be a late magmatic phase of the main Texas Creek granodiorite pluton.

It should be noted that the 'Premier porphyry' dykes are not the same rocks as the 'Premier dyke swarm,' which was discussed in some early reports. The Premier dyke swarm consists of subparallel granodiorite, diorite, and lamprophyre dykes of probable Tertiary age.

SUMMIT LAKE GRANODIORITE

The Summit Lake stock, also termed the Berendon granodiorite, was described by Grove (1971, 1973). The rock is a medium to coarse-grained hornblende granodiorite with minor amounts of fine biotite. The stock is elongated east-northeast, partly because of 1 200 metres of right lateral offset along the Millsite fault (Alldrick, 1984, Fig. 59). Roof pendants of country rock in the stock outcrop along the cliff top on the south side of Berendon Glacier, 1 kilometre west of the Granduc millsite (Fig. 115).

Grove (1973) concluded that although the Summit Lake granodiorite was probably Tertiary, it could be an outlier of the Mesozoic Texas Creek granodiorite. The Summit Lake and the Texas Creek granodiorites have several similarities: both are hornblende granodiorites, both have spatially associated Premier porphyry (Mill porphyry) dykes, both predate Tertiary dyke swarms, and both have peripheral gold-bearing massive pyrrhotite veins; none of these features occur at other stocks in the region. They also have significant differences: the Texas Creek granodiorite has both a distinctive orthoclase-porphyritic border phase and a sheared, chloritized margin - the Summit Lake stock does not; the Summit Lake stock has an extensive aureole of hornfelsed, silicified, and pyritized country rock - the Texas Creek stock does not. Despite the differences, field evidence suggests that the Summit Lake and Texas Creek granodiorites are correlative.

HYDER QUARTZ MONZONITE

The Hyder stock ranges in composition from quartz monzonite to granodiorite (Buddington, 1929; Grove, 1971, 1973; Smith, 1977). The rock is predominantly coarse-grained biotite granodiorite with minor amounts of hornblende; orthoclase is pink and slightly prophyritic, and fine-grained golden sphene crystals are characteristic.

The Hyder pluton is spatially related to silver-rich galena-sphalerite-freibergite veins of the Prosperity/Porter Idaho mine (Alldrick and Kenyon, 1984), the Silverado mine (White, 1946), and the Bayview mine (Fig. 116).

White to cream aplite dykes described by Buddington (1929, pp. 28, 29), which crop out around the periphery of the Hyder stock, are probably genetically related to it. In two exposures along Skookum Creek these dykes contain scattered knots, up to 2 centimetres diameter, of coarse molybdenite flakes. Molybdenite mineralization occurs within a few metres of a similar dyke in the Molly B adit.

Smith (1977; *see* Table 3) listed a biotite K/Ar age of 50 Ma for the stock. None of the major Tertiary dyke swarms in the region cuts the stock; therefore this age places a possible upper limit on the age of the dyke swarms.

TABLE 3
RECALCULATED K/Ar DATES

Data presented by Smith (1977) have been recalculated with the decay constants of Steiger and Jager (1977):

SAMPLE NO.	MINERAL	AGE (Ma)	UNIT AND LOCATION
68ASj-160	Hornblende	210.8±6	Texas Creek granodiorite. East side of
	Biotite	108.2±3	Ferguson Glacier.
3S-008	Hornblende	202.3±6	Texas Creek granodiorite. 1.0 km north of
	Biotite	130.4±3	toe of Ferguson Glacier.
68ASj-52	Biotite	50.4±2	Hyder quartz monzonite. Small road cut at International Boundary near Hyder.
68ADn-47	Biotite	47.3±1	Hyder quartz monzonite. East margin of Soulé Glacier.
68ADn-75	Hornblende	51.6±2	Boundary granodiorite. Boundary Glacier,
	Biotite	52.2±4	near Border Monument 16.
8S-163	Hornblende	49.9±2	Boundary granodiorite. Nunatak in
	Biotite	50.5±2	Chickamin Glacier, 400 m north of border.

BOUNDARY GRANODIORITE

The Boundary granodiorite, which straddles the Canada-United States border southwest of Salmon Glacier (Fig. 115), was not examined in this study. The texture, mineralogy, modal composition, and radiometric age of this granodiorite are identical to those of the granodiorite phase of the Hyder quartz monzonite (Smith, 1977).

LONG LAKE AUGITE PORPHYRY

The Long Lake 'stock' underlies the north end of Long Lake, 3 kilometres northeast of the Big Missouri mine (Fig. 115). In the literature this rock is described as an augite-porphyritic diorite intrusion (Schofield and Hanson, 1922, p. 25; Hanson, 1929, p. 12, 1935, p. 20; Grove, 1971, 1973, 1983). Mapping during the 1984 season showed that the rock unit predates and stratigraphically underlies epiclastic rocks of map unit 2. It displays no intrusive relationships (Dupas, this volume) and is more likely an extrusive rock. This unit is, therefore, interpreted to be an augite porphyritic andesite flow and the upper unit of the andesitic volcanic sequence (unit 1). Other augite-porphyritic rocks that have been mapped as intrusions in the area (Hanson, 1929, maps 215A, 216A; Grove, 1971, Figs. 3A, 3B) should be re-examined.

DYKES

Tertiary (?) Dyke Swarms

Rocks in the Salmon River valley are cut by three swarms of felsic to mafic dykes. The Portland Canal dyke swarm occupies the widest area and is the longest of the three swarms. Dykes in the swarm dip steeply southwest and trend east-southeast to southeast. The swarm goes past the south end of the Mount Dillworth snowfield, crosses the north end of Long Lake, and continues over Bear River Ridge at Mount Bunting (Fig. 115; Grove, 1971, Fig. 3).

Another narrower dyke swarm trends south along Tide Lake Flats, and across the upper portal area of Scottie Gold mine to August Mountain (Wares and Gewargis, 1982). At August Mountain the zone swings southeast (Grove, 1971, Fig. 3C) and continues over the crest of Mount Dillworth. Southeast of Mount Dillworth, toward Mount Bunting, this zone merges with the wider Portland Canal dyke swarm.

A third, major southeast-striking dyke swarm subparallels the international boundary near the Silbak Premier mine (Grove, 1971, Figs. 3A, 3B). This swarm was called the 'Mount Dolly dyke swarm' by Smith (1977) but the 'Premier dyke swarm' by Grove (1971). Both terms are misleading and are rejected; these dykes do not cross Mount Dolly, and a similar term, 'Premier porphyry dykes,' refers to an entirely different rock type. Here this dyke swarm is termed the 'Mount Welker dyke swarm' which indicates an area of excellent exposures of these dykes.

Each swarm contains three dyke lithologies. The oldest are massive, fine to medium-grained, light grey biotite or biotite-hornblende granodiorites that may be up to 60 metres in width. These are intruded by aphanitic, granular, greyish green microdiorite or 'andesite' dykes up to 10 metres in width. These in turn are cut by swarms of thin, dark brownish grey, variably porphyritic lamprophyres. These lamprophyre dykes rarely exceed 50 centimetres in width.

In the centre of these dyke swarms the intrusive rock comprises more than 50 per cent of the bedrock, only narrow lenses and slices of country rock separate the anastamosing dykes. Together, the three dyke swarms represent a northeasterly crustal extension of at least 1.5 kilometres. The three swams are probably of Tertiary age; they do not cut the 50 Ma old Hyder quartz monzonite stock and are probably contemporaneous with it.

Other Dyke Rocks

Other dykes in the Salmon River valley include buff, flow-banded aplite dykes that 'meander' through the country rock. Only four such dykes were noted, all along the west side of Mount Dillworth (Fig. 115).

Pale pink aplite dykes are common within the Hyder quartz monzonite stock. The surrounding country rock is cut by white to cream aplite dykes at the Skookum adit, at Silver Falls, and at the toe of Barney Glacier.

Premier porphyry dykes are reviewed under a separate heading in this report; additional information is given by Alldrick (1984).

PETROCHEMISTRY

Galley (1981, pp. 80-88) reports the results of 16 whole rock analyses from the Big Missouri mine area; an additional 13 whole rock analyses were completed as part of this study. These results are listed in Table 2 and plotted on Figure 118. Samples of hematitic epiclastic siltstone, hematitic dust tuff, and black carbonaceous grit were included in the sample suite to determine whether rocks derived from volcanic parent rocks are chemically distinctive.

As Galley found, most of the volcanic rocks show high potassium values relative to magnesium, calcium, and sodium. The variably textured tuffs of map unit 1 are of andesitic composition, while the more leucocratic, pumiceous tuffs and ash flow tuffs of map unit 3 are dacitic. The volcanic rocks are subalkaline and become slightly more calc-alkaline up section.

PALEOTOPOGRAPHY

Individual units within all four major stratigraphic sequences show distinct lateral facies changes that reflect the structure and paleotopography of this volcanic complex (Fig. 117). The accumulation of andesitic pyroclastic breccias along Mount Dillworth and the location of a volcanic vent or fissure at the top of the andesite section suggest that the 49 Ridge area on Mount Dillworth was a local paleotopographic high. The decrease in thickness of the overlying epiclastic rocks supports this interpretation and suggests a similar paleotopographic high at the north end of Long Lake.

The thickest section of felsic volcanic rocks is about 2 kilometres north of the 49 Ridge area. A narrow, 1.5-metre-wide fissure within the felsic volcanic rocks is exposed in the cliff at the southeast corner of Summit Lake. Incorporation of augite porphyritic andesite boulders in felsic volcanic strata at Long Lake indicates a felsic vent also broke through the andesitic pile in that area.

The upper part of the middle felsic tuff (3c) is variably impregnated with carbon suggesting either that it was deposited in a reducing, subaqueous environment or was inundated shortly afterward. No similar carbon impregnation of this unit occurs along Mount Dillworth or in the Summit Lake area, indicating that the unit was emegent there (Fig. 117b). Similarly, the overlying felsic lapilli tuff (3d) is carbon rich in many areas, but not along Mount Dillworth ridge.

Gradation of fragment size within the pyritic felsic tuff (3e) indicates a vent for this unit near the south end of Mount Dillworth. The disseminated pyrite may indicate fumarolic activity in either high water table or shallow marine conditions.

The black tuff (3f) represents accumulation of crystal and lithic lapilli tuff in subaqueous conditions in a volcanic crater, caldera, or lateral basin. The pumice conglomerate beds of unit 4a are evidence that the onset of sedimentation was contemporaneous with waning felsic volcanic activity (Fig. 117c).

AGE RELATIONSHIPS

Age dates for intrusive rocks of the Salmon River valley are shown in Table 1B. Smith's (1977) K/Ar dating results have been recalculated with revised decay constants (Steiger and Jager, 1977) and are listed in Table 3. Sedimentary rocks at the base of unit 4 have fossil suites of upper Middle Jurassic age (H. W. Tipper, personal cummunication, 1984; Grove, 1973).

The following field relationships indicate several sequential geologic events. The Texas Creek granodiorite stock intruded the lower 2 000 metres of the andesitic volcanic pile but not the upper 2 000 metres. The margins of the Texas Creek granodiorite and all units of the andesitic volcanic sequence are cut by Premier porphyry dykes but these dykes do not cut any of the epiclastic or younger rocks (units 2, 3, and 4). Extensive volcanic flows of Premier porphyry and augite porphyry mark the top of the andesite sequence. The andesitic volcanic sequence is overlain by epiclastic rocks (unit 2) which include boulders of Premier porphyry and augite porphyry. The epiclastic rocks are overlain by felsic volcanic tuffs and ash flow tuffs (unit 3) which in turn are overlain by a sedimentary sequence with a distinctive basal sedimentary facies (unit 4a). These basal sedimentary rocks include fossiliferous limestone lenses with upper Middle Jurassic fossils; thin beds with rounded pumice pebbles may represent contemporaneous felsic volcanism.

The following history fits field relationships and age dates together and is summarized in Table 4. The Texas Creek granodiorite pluton has a minimum K/Ar age of 210 Ma. Thus, the lower part of the andesitic volcanic sequence and perhaps the entire unit is probably of Late Triassic age or older. The Premier porphyry dykes and flows are probably

Early Jurassic in age (210 to 190 Ma), because they cut and overlie the andesite sequence. The Texas Creek stock is interpreted to be coeval and epizonal; it formed a subsidiary magma chamber in the andesitic stratavolcano, and was emplaced at a depth of about 2 kilometres (Williams and McBirney, 1979, p. 69; Gill, 1981, pp. 59-61). Thus the Texas Creek granodiorite is an integral part of the Mesozoic volcanic package and not part of the Coast Plutonic Complex, as suggested by Brew and Morrell (1983).

TABLE 4
GEOLOGIC HISTORY

Age (Ma)	Event
~ 50	Formation of argentiferous vein deposits and spatially associated MoS_2 and WO_3 deposits
50	Intrusion of Hyder quartz monzonite and Boundary granodiorite stocks
~ 50	Crustal extension and intrusion of major dyke swarms
?	Deformation, north-trending fold axes
~ 180	Marine transgression, onset of sedimentation (unit 4)
~ 180 ?	Formation of gold-silver vein deposits
~ 180	Felsic volcanism (unit 3); predominantly subaerial
190	Deposition of epiclastic sediments and interbedded dacitic tuffs and flows (unit 2)
~ 200	Emplacement of Premier porphyry dykes and flows
210	Intrusion of Texas Creek granodiorite and Summit Lake granodiorite stocks
230-200	Andesitic volcanic activity (unit 1); predominantly subaerial, with two periods of marine transgression

A period of subaerial weathering and erosion (190 to 180 Ma) was followed by an episode of felsic volcanism (180 Ma). This episode was probably short-lived because no intraformational sedimentary rocks are preserved within the felsic volcanic sequence. As felsic volcanism waned in Middle Jurassic time (180 Ma), transgressing seas covered even the highest topographic areas. Deposition of sedimentary strata began and continued until middle Late Jurassic time (180 to 150 Ma; Tipper and Richards, 1976).

Sedimentation was followed by moderate deformation with low grade metamorphism of sub-greenschist to lower greenschist facies, by intrusion of the major dyke swarms, and finally, by intrusion of the Hyder and Boundary stocks (50 Ma). These three events were nearly contemporaneous but their relative sequence can be seen in field relationships.

STRATIGRAPHIC DISTRIBUTION OF MINERAL DEPOSITS

An idealized cross-section (Fig. 116) shows the stratigraphic position of all major and some minor sulphide veins within the Salmon River valley. Six general relationships concerning deposit distribution are illustrated. These are listed here with deposit names and Mineral Inventory file numbers:

(1) The margins and peripheral country rock of the two hornblende granodiorite plutons are characterized by gold-bearing massive pyrrhotite veins with silver:gold ratios of less than or about 1:1. These include the Scottie Gold mine, 104B-34; Scottie North zone, 104B-74; Bend vein (Camp vein); Hicks veins; several pyrrhotite veins outcropping in the bed of the Salmon River between the toe of the glacier and the Daly-Alaska workings at the 18.5-mile marker on the Granduc road; and five veins on the Alaska Star property of Pulsar Energy and Resources Incorporated, that outcrop east and uphill of the Riverside mine.

(2) The 2 000-metre section of andesitic strata between the upper siltstone member (1d) and the epiclastic sequence (2) hosts many deposits of base and precious metal-rich sulphides; they occur in brecciated quartz-carbonate veins. The vein structures enclose fragments of wallrock, chalcedonic quartz, and sulphides. These veins have silver:gold ratios ranging from 500:1 to 2:1; most fall in the range 100:1 to 3:1. This deposit type includes those in the Big Missouri mine area, 104B-2, 104B-38, 104B-39, 104B-40, 104B-46, 104B-92, and 104B-93; the Consolidated Silver Butte prospect; the Silbak Premier mine, 104B-53, 104B-54; the Indian mine, 104B-31; the East Gold mine, 104B-33; and possibly several others such as Woodbine; Premier Extension, 104B-52; Pictou; Titan, 104B-71; Lila; Cassiar Rainbow; Outland Silver Bar, 104B-30; and the Portland prospect, 104B-82.

(3) Vuggy quartz-breccia veins are characteristic of the black tuff (3f). These contain fragments of chalcedonic quartz and host coarse galena-sphalerite-freibergite mineralization. Such veins have silver:gold ratios of 200:1 and higher. These deposits include those seen at Lakeshore, 104A-14; the Lion Group, 104B-41; Silver Crest, 104B-42; Silver Tip, 104B-43; Unicorn No. 3, 104B-44; Mineral Hill, 104B-45; H-Vein; and unnamed veins on the west slope of Slate Mountain, and on the ridge 400 metres east of the Big Missouri power plant.

(4) Along the western edge of the Mount Dillworth snowfield, felsic air fall lapilli tuff and tuff breccia of unit 3e contain 10 to 15 per cent finely disseminated pyrite over a thickness of as much as 8 metres. This stratabound pyritic zone is barren of base and precious metals; however, it may indicate potential for volcanogenic exhalative massive sulphide deposits at this stratigraphic position elsewhere in the Hazelton Group of central British Columbia (for example, Tom MacKay Lake, 104B-8).

(5) The massive galena-sphalerite-freibergite veins that occupy shears and faults around the margin of the Eocene Hyder quartz monzonite stock have silver:gold ratios greater than 1 000:1. Examples of this type are Prosperity/Porter Idaho mine, 103P-89; Silverado mine, 103P-88; Flat Vein; and Bayview mine, 103P-51.

(6) Structurally deeper levels around the perimeter of the Hyder stock are characterized by biotite hornfels alteration of siltstone horizons and by low-grade tungsten deposits with associated molybdenum, as seen at the Molly B adit, 103P-85; the Skookum/Mountainview adit, 103P-45; and the Riverside mine, 104B-73.

Mineral deposits that do not fit into this classification include: the arsenopyrite-rich veins on the hill northwest of the Granduc millsite; and several gold-bearing, banded or crustified quartz veins around the margin of the Texas Creek granodiorite on the Alaska Star property (Fig. 118).

Precious metal deposition occurred within the period 190 to 50 Ma, but no evidence exists to allow for a more specific time of mineralization to be determined. The vein deposits clearly postdate map unit 1 and no veins are reported within the epiclastic rocks or carbonaceous siltstones of map units 2 and 4. Most veins predate the emplacement of the major dyke swarms, although the Blueberry vein near the Scottie Gold camp is localized in a shear zone that cuts a hornblende-porphyritic lamprophyre dyke (P. McGuigan, personal communication, 1984).

The author believes that formation of the precious and base metal veins of categories (1) to (4) was related to the period of shallow submarine sulphide deposition which accompanied the waning stages of felsic volcanism and deposition of unit 4a. This event slightly postdates deposition and lithification of the pyritic lapilli tuff and the black tuff (units 3e and 3f). Angular fragments of sulphides and chalcedony in mineralized veins of categories (2) and (3) suggest repeated episodes of vein formation and sulphide deposition.

The veins of categories (5) and (6) apparently accompanied intrusion of the 50 Ma Hyder quartz monzonite.

CONCLUSIONS

A differentiated andesitic to dacitic calc-alkaline volcanic pile with interbedded sedimentary facies hosts precious metal-rich vein deposits of the Salmon River valley. These Upper Triassic to Lower Jurassic subaerial volcanic rocks are overlain by sedimentary rocks of Middle Jurassic age. Facies variations indicate that volcanic vents and paleotopographic highs were centred at Mount Dillworth and at Long Lake; other volcanic centres were likely located nearby.

A coeval, epizonal subsidiary magma chamber underlay the Mesozoic stratovolcano at a depth of about 2 kilometres. From this chamber, late magmatic, bimodal feldspar-porphyritic feeder dykes and volcanic necks were injected which cut the entire andesite sequence and extruded at surface.

The many gold-silver-bearing veins of the belt show regional zoning patterns with respect to sulphide mineral associations, vein textures, and silver:gold ratios. The zoning is spatially related to the coeval Texas Creek pluton and to the stratigraphic position of the veins within the volcanic-sedimentary sequence. The precious metal veins are late to post-intrusive epithermal veins that were emplaced in the andesitic to dacitic host rocks at the close of felsic volcanic activity, about 180 Ma ago.

A later episode of silver-rich galena-sphalerite-freibergite vein formation is related to intrusion of biotite granodiorite stocks of the Coast Plutonic Complex during Eocene time. Tungsten and molybdenum deposits in the area may represent deeper level deposits of this intrusive episode.

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REFERENCES

Alldrick, D. J. (1983): Salmon River Project, Stewart, British Columbia (104B/1), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1982, Paper 1983-1, pp. 182-195.

.... (1984): Geologic Setting of the Precious Metal Deposits in the Stewart Area (104B/1), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1983, Paper 1984-1, pp. 149-164.

Alldrick, D. J. and Kenyon, J. M. (1984): The Prosperity/Porter Idaho Silver Deposits (103P/13), *B.C. Ministry of Energy, Mines & Pet. Res.*, Geological Fieldwork, 1983, Paper 1984-1, pp. 165-172.

Branch, C. D. (1976): Development of Porphyry Copper and Stratiform Volcanogenic Orebodies During the Life Cycle of Andesitic Stratavolcanoes, *in* Volcanism in Australasia, R. W. Johnson, editor, *Elsevier*, pp. 337-342.

Brew, D. A. and Morrell, R. P. (1983): Intrusive Rocks and Plutonic Belts of Southeastern Alaska, U.S.A., *in* Circum-Pacific Plutonic Terranes, *Geol. Soc. Am.*, Mem. 159, pp. 171-194.

Buddington, A. F. (1929): Geology of Hyder and Vicinity, Southeastern Alaska, *U.S.G.S.*, Bull. 807, 124 pp.

Church, B. N. (1975): Quantitative Classification and Chemical Comparison of Common Volcanic Rocks, *Geol. Soc. Am.*, Bull., Vol. 86, pp. 257-263.

.... (1978): Shackanite and Related Analcite-bearing Lavas in British Columbia, *Cdn. Jour. Earth Sci.*, Vol. 15, pp. 1669-1672.

Galley, A. (1981): Volcanic Stratigraphy and Gold-silver Occurrences on the Big Missouri Claim Group, Stewart, British Columbia, M.Sc. thesis, *Univ. of Western Ontario*, 181 pp.

Gill, J. B. (1981): Orogenic Andesites and Plate Tectonics, *Springer-Verlag*, 390 pp.

Grove, E. W. (1971): Geology and Mineral Deposits of the Stewart Area, British Columbia, *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 58, 219 pp.

.... (1973): Geology and Mineral Deposits of the Stewart Complex, British Columbia, Ph.D. thesis, *McGill Univ.*, 434 pp.

.... (1983): Geology of the Unuk River-Salmon River-Anyox Map-area, *B.C. Ministry of Energy, Mines & Pet. Res.*, Miscellaneous map series (coloured maps to accompany Bull. 63, in preparation).

Hanson, G. (1929): Bear River and Stewart Map-areas, Cassiar District, British Columbia, *Geol. Surv., Canada*, Mem. 159, 84 pp.

.... (1935): Portland Canal Area, British Columbia, *Geol. Surv., Canada*, Mem. 175, 179 pp.

Henley, R. W. and Ellis, A. J. (1983): Geothermal Systems Ancient and Modern: A Geochemical Review, *Earth Sci. Rev.*, Vol. 19, pp. 1-50.

Palmer, A. R. (1983): The Decade of North American Geology 1983 Geologic Time Scale, *Geology*, Vol. 11, pp. 503, 504.

Schofield, S. J. and Hanson, G. (1922): Geology and Ore Deposits of Salmon River District, British Columbia, *Geol. Surv., Canada*, Mem. 132, 81 pp.

Sillitoe, R. H. and Bonham, H. F. Jr. (1984): Volcanic Landforms and Ore Deposits, *Econ. Geol.*, Vol. 79, pp. 1286-1298.

Smith, J. G. (1977): Geology of the Ketchikan D-1 and Bradfield Canal A-1 Quadrangles, Southeastern Alaska, *U.S.G.S.*, Bull. 1425, 49 pp.

Steiger, R. H. and Jager, E. (1977): Submission on Geochronology: Convention on the Use of Decay Constants in Geo- and Cosmochronology, *Earth Planet. Sci. Lett.*, Vol. 36, pp. 359-362.

Tipper, H. W. and Richards, T. A. (1976): Jurassic Stratigraphy and History of North-central British Columbia, *Geol. Surv., Canada*, Bull. 270, 73 pp.

Wares, R. and Gewargis, W. (1982): Scottie Gold Mines Surface Geology Map Series, *B.C. Ministry of Energy, Mines & Pet. Res.*, Assessment Report 10738.

White, W. E. (1946): Big Four Silver Mines Ltd., *Minister of Mines, B.C.*, Ann. Rept., 1946, pp. 74-78.

Williams, H. and McBirney, A. R. (1979): Volcanology, *Freeman, Cooper and Co.*, 397 pp.

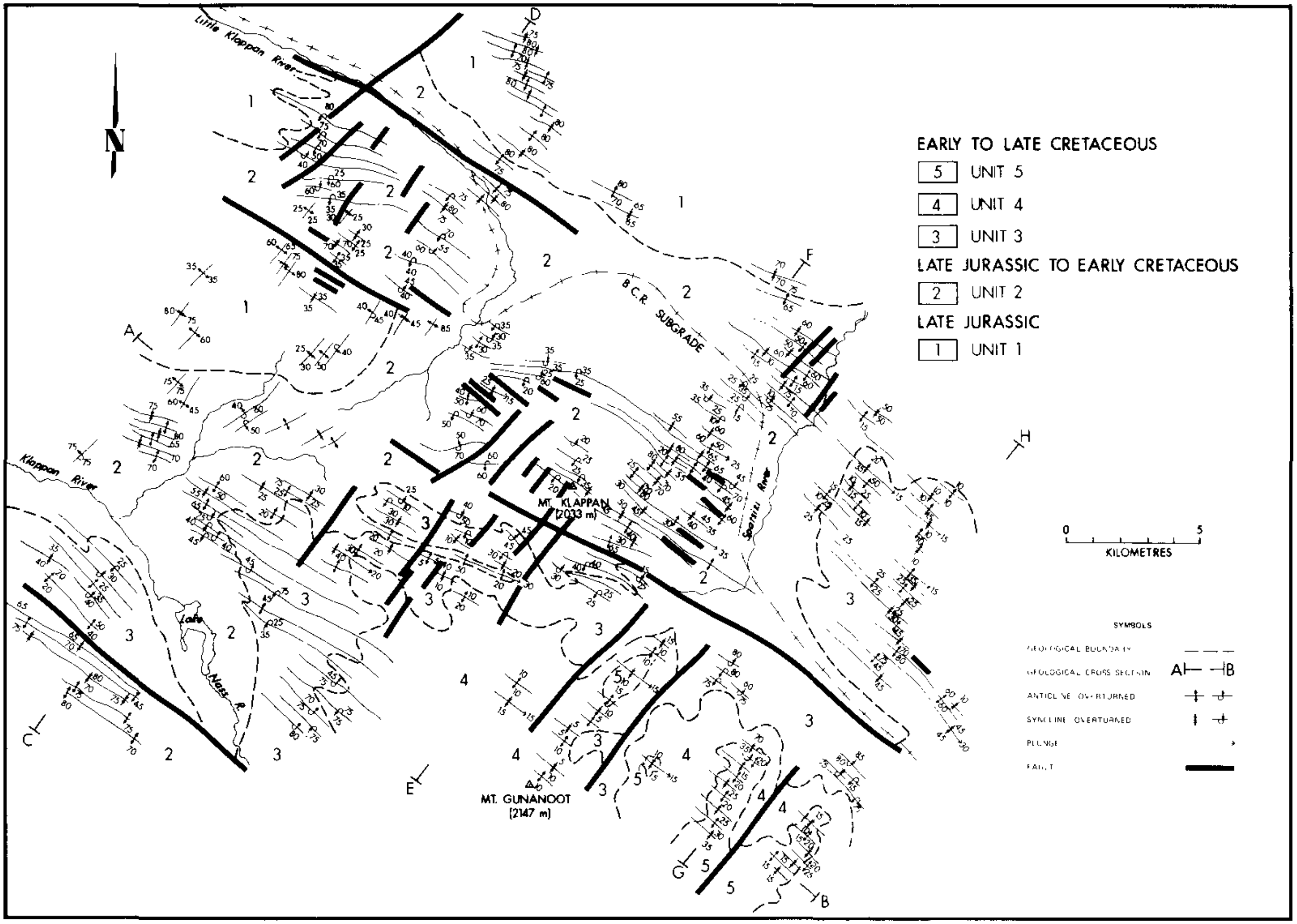

Figure 119. Geology of the Mount Klappan area.