Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources
GEOLOGICAL SURVEY BRANCH

MEMORANDUM

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VG → Vancouver Island

Memo To:

From: Robert Pinsent

Date: September 14th, 1992

Subject: MEMPR MPB MINE TOUR; V.I.: Sept. 15-18th, 1992:

The three operational mines on Vancouver Island are excellent representatives of three of the most important classes of mine found in the Province of British Columbia. The H-W occurrence is a classic example of a selectively mined "high-grade", "low-tonnage", "massive sulphide" deposit exploited by underground extraction methods. The Quinsam mine is a typical example of a combined strip and underground coal mine and Island Copper provides an excellent example of a bulk tonnage open-pit "porphyry copper" operation. Each gives considerable insight into a fundamentaly important type of mineral deposit and the most appropriate method of mineral extraction.

The following notes will provide (1) an overview of each operation, (2) a discussion on the factors controlling the location of the deposit type and (3) some of the factors considered by geologists and engineers in attempting to locate and develop each type of deposit. Note that the descriptions are simplified and somewhat generic. They are more concerned with process and concept than specific local detail.

MYRA FALLS: WESTMIN RESOURCES LIMITED

MYRA FALLS (p.1,2,3,4)

The Myra Falls Operation of Westmin Resouces Limited (MAPSHEET 92F/12E; MINFILE NUMBER 92F 330), 90 Km south west of Campbell River, started production in 1966. It produces approximately 3,650 tonnes of ore daily from the H-W and Lynx underground mines. The Company mined 1,081,400 tonnes of ore grading 3.29% Zn, 1.71% Cu, 0.19% Pb, 26.2 g/t Ag and 2.09 g/t Au in 1991.

The Operation had mineable reserves of 9,975,000 tonnes grading 3.7% Zn, 1.8% Cu, 0.3% Pb, 32.0 g/t Ag and 2.1 g/t Au as of 1st January, 1992 (Annual Report; 1991). The Company recently announced the presence of a substantial new mineable reserve in it's Gap and Battle Zones 1.7 million tonnes grading 10.9% Zn, 2.2% Cu "with significant precious metal credits" (Northern Miner, August 17th, 1992).

MYRA FALLS

The Operation exploits a cluster of "Kuroko-type massive sulphide" lenses within "island arc" volcanic rocks of the Paleozoic Sicker Group (see attachments). The deposits are formed in a zone of tectonic instability established on the flanks of a large felsic (quartz-rich and therefore explosive) submarine volcano.

The deposits are largely comprised of sulphide lenses formed in sea floor depressions that form as a result of differential movement on faults defining the long axis of the zone of instability. Their shape is controlled by several factors including (1) the topography of the floor of the depression, (2) the size of the feeder stockwork underlying the mound, (3) the rate of growth of the sulphide mound, (4) the time available before the depression is choked with extraneous material such as volcanic flows, airborne tuff, breccia or sediment or (5) the time available before tectonic activity cuts off, or re-routes, the flow of the hydrothermal fluid feeding the mound.

Most of the lenses are approximately ten to twenty metres thick, fifty metres wide and several hundred metres in length. They commonly contain between 200,000 and 2,000,000 tonnes of sulphide. The H-W and Battle Zones are unusual in that they are appreciably larger. The H-W lens contained approximately 15,000,000 tonnes of relatively low-grade ore prior to production. The dimensions of the Battle Zone have yet to be defined.

The composition of a given lens is governed by the temperature and composition of the final fluid passing through the underlying stockwork. The process of mound formation is not well documented. It appears that mineralized fluids discharge their sulphide into sea water until such time as it's interaction with sea water creates a sulphate crust over the vent. The crust inhibits the release of the hydrothermal fluid and allows it to cool and precipitate copper and zinc sulphide prior to mixing with sea water. The mound grows from below.

Note that changes in fluid temperature will affect the composition of the mound. Copper sulphide is generally precipitated from hotter fluid than lead, zinc or iron sulphide. Stockworks feeder systems below mounds are commonly formed from hotter fluids that also alter the rock and deposit quartz. They tend to be richer in copper sulphide than the tops and outer fringe lenses.

The grade of a "massive sulphide" lens is governed by the proportions of the various sulphide minerals present and the amount of extraneous material. The low grade of the H-W lens is a function of it's high content of (worthless) pyrite.

MYRA FALLS

The zone of tectonic instability that hosts the mineralization is defined by a 500 metre thick stratigraphic package "Mine Series" that has been traced for a strike length of 12 kilometres. The package is complex as rock deposition was affected by the presence of contemporary faults that also had a profound affect on the flow of hydrothermal fluid. It is not uncommon to find stacked sulphide lenses formed through repeated reestablishment of a structurally controlled plumbing system. The package is covered by massive volcanic rock that shows no sign of mineralization.

The "Mine Series" has been deformed about a anticlinal fold axis that more or less parallels the strike of the northwesterly trending zone of instability. This has caused some flattening and disruption of the sulphide lenses. Those on the steep southwesterly limb have been rotated into a (Lynx) vertical aspect (G-Zone). Those on the flatlying northeasterly limb (H-W, Battle) are close to flat lying. This has implications for mining as the vertical lenses are easier to handle.

Kuroko-type "Volcanogenic Massive Suphides" are exceedingly attractive exploration targets as they are generally polymetallic (precious-metal bearing) and relatively high grade. This makes them less sensitive to small fluctuations in metal price than lower-grade operations.

The deposits are generally small tonnage (<10,000 t/d) operations mined by underground methods. The mine plan will call for the removal of the minimum amount of waste rock possible to access ore. The actual extraction methods used ("long-hole stoping", "cut and fill" etc.) will be governed by a trade-off between extraction cost and ore grade. Exceptionaly high-grade material may be worth selective mining, which is exensive. Low-grade material may be worth bulk mining, which is cheaper but less efficient. More waste will be extracted with the ore. Note that the absolute amount of rock extracted is a small fraction of that generated by an open-pit "porphyry" mine.

Modern mine operations try to limit the amount of pyritic (iron-sulphide) waste-rock as it may react with oxygen and rain water in the surficial environment to generate weak sulphuric acid. This creates "acid mine drainage".

Exploration for "massive sulphide" deposits is exceedingly difficult as individual lenses make extremely small targets (see above). Exploration geologists attempt to locate regionally favourable geological environments (felsic centres in "island arc" volcanic belts and sort out the

MYRA FALLS

geology of the area around the volcanic vent. Items of importance are (1) local stratigraphic complexity indicative of tectonic instability and synvolcanic faulting, (2) evidence for time breaks (sediment, chert) in the volcanic stratigraphy, (3) direct evidence of "massive sulphide" mineralization, or (4) indirect evidence of mineralization based on the presence of hydrothermal (foot-wall stockwork) alteration.

Companies will commonly fly airborne and/or conduct ground geophysical surveys over the volcanic centre looking for electrical conductors. The approach is good for near-surface copper or iron sulphide bodies but zinc sulphides are not particularly conductive. A good conductor, like graphite, in sediment adjacent to a sulphide lens will over-power the sulphide signal.

The hydrothermal fluids that create sulphide lenses react with underlying rock in transit to the surface and change it's chemistry. Companies will conduct extensive lithogeochemical sampling surveys designed to locate alteration zones beneath sulphide lenses.

Note that most favourable volcanic packages in the Province are more or less deformed, which means that a stratigraphic surface that contains a sulphide lens may have any orientation with respect to the modern land surface. It may be vertical (as it commonly is in Central Canada) or it may be essentialy horizontal. It may or may not intersect surface. There is very little mineralization on surface at Myra Falls as the "Mine Series" is only breaches surface in the valley of Myra Creek. It is very difficult to locate buried lenses from above. Hence Westmin's requirement for underground development to explore the Battle and Gap lenses.

QUINSAM (p.4,56)

QUINSAM COAL: HILLSBOROUGH RESOURCES

The Quinsam Coal Mine (MAPSHEET 92F/14; MINFILE NUMBER 92F 319), at Middle Quinsam Lake near Campbell River, is owed by Hillsborough Resources Limited. It has been in production since 1986 and produced approximately 400,000 tonnes of low-sulphur bituminous thermal coal in 1991. The Company expects to increase production to a rate of 500,000 tonnes in 1992 (Annual Report; 1991). It has approximately of 44 million tonnes of accessible reserves.

The Quinsam "coal measures" are Cretaceous in age (see attachments). They are part of the Comox Formation, a sedimentary unit that is part of the more widespread Nanaimo Group.

The Comox Formation was deposited in an erosional basin formed on the east side of Vancouver Island. It is composed of a three units, (1) a basal unit comprised of conglomerate (Benson Member), (2) a central unit comprised of interbedded sandstones, siltstones, mudstone and coal (Cumberland Member) and (3) an upper unit comprised of sandstone (Dunsmuir Member). The three units reflect differing environments of sediment accumulation. The basal member was formed from sediment accumulation in river channels cut into an irregular land surface. The central member was formed in a shallow water, estuarine, environment and the upper member was deposited on a coastal plain under shallow marine conditions.

Coal beds form from forest growth that accummulates on estuarine flood plains. Trees die and accumulate under fetid "swamp" conditions. There is minimal decay and recycling of organic material. Debris accumulates as long as the water level remains constant. If it falls (marine regression), the swamp will dry out and erosion will occur. If it rises (marine transgression), the swamp will be inundated with seawater, growth will cease and the "coal beds" will be covered by sediment. Note that coal-bearing horizons will tend to "shale out" if the water gets too deep to support growth. The thickness of a bed will, in part, be governed by the time available for forest growth prior to marine transgression. The quality or rank of the coal formed (anthracite, bituminous coal, thermal coal) is a function of it's depth of burial and post-depositional tectonic history.

There is commonly a cyclicity to the sediment sequence that makes a set of "coal measures". The cyclicity reflects periodicity in marine transgression and regression.

Coal beds differ from most metallic mineral deposits in that the product is commonly reasonably "pure", containing only a minimal amount of intermixed sediment. There is far less grade variability than is found in "massive sulphide" deposits and no posibility of "high-grading" a deposit above a fixed maximum value. There may be small chemical differences that affect the saleability of the coal and it may, as at Quinsam, be necessary to blend coal from different seams or areas within a seam in order to acheive an optimun trace element content (low sulphur, low iron, low ash, high BTU) and decrease extraction cost to increase profit. The key variables in coal mining are extraction costs and engineering constraints. Mineability is governed by variables such as (a) seam thickness (minimum mining width at Quinsam 1.5 metres); (b) amount of structural dislocation as result of faulting; (c) seam orientation, particulaly dip angle, and relation to ground surface; (d) hanging-wall rock stability and (e) specific composition.

Prior to the recent merger, Consolidated Brinco produced much of it's coal from an "open pit" strip mine operation. Hillsborough is discontinuing this form of mining as the coal price will no longer support the cost of waste removal. The Company is switching to "room and pillar" underground mining using two "continuous miners". This method of extraction will provides for 100% recovery at the cost of a small relatively small amount of surface subsidence. The Company is currently planning it's extraction progamme to provide up to 500,000 tonnes a year of suitably blended material.

Coal measures are readily recognizable. The key for exploration geologists is to locate thick seams of saleable product (within terms set by the consumer) that are ameanable to extraction by either open cut or underground mineable methods. Geologists pay particular attention to stratigraphy and the depositional environment of sediment. It is important to recognise rocks deposited under estuarine conditions and in coastal lagoons. The principal tools are (1) geological mapping; (2) seismic geophysical surveys (designed to show rock structure at depth) and (3) rotary drilling with or without down-hole geophysical surveys. To this one could also add driving around in a truck until it sticks in black carbonaceous mud (the method I used in Alberata!).

ISLAND COPPER (p. 6, 7, 8)

ISLAND COPPER: BHP-UTAH MINES LIMITED

The Island Copper "porphyry copper" deposit is at the head of Holberg Inlet, approximately 15 kilometres due south of the community of Port Hardy (MAPSHEET 92L 11/W; MINFILE NUMBER 92L 158). It is an "open pit" operation that has been in continuous production since 1971. In an average year it produces approximately 175,000 tonnes of copper concentrate, 4,600 tonnes of molybdenum concentrate and some 40,000 to 60,000 ounces of gold (GCNL Sept. 29th, 1990). It currently processes approximately 50,000 tonnes of ore per day at an average grade of approximately 0.35% Cu and 0.2g/t Au. + rhenium

The mine is reaching the end of it's life and it is planning for the decommissioning process. The pit went through a major, and probably final, "push-back" that involved the construction of a retaining wall in 1990. As of September, 1991 it had mineable reserves of 130 million tonnes of ore grading approximately 0.35% Cu. By the end of it's active life, it will likely have produced approximately 400 million tonnes of ore at an average grade of 0.45% Cu, 0.017% Mo and 0.0064 o/t Au at cut-off figure of 0.2% Cu.

The Island Copper deposit was formed during the development of the Jurassic-age "Bonanza Group" volcanic arc (see attachment). The deposit formed from hydrothermal fluid that was focused by a complex mineralizing "dyke" or pluton as it was emplaced into pre-existing volcanic rock late in the development of the volcanic arc.

The mineralizing dyke at Island Copper is a tabular body that intruded along an extensional structure in the volcanic arc and introduced fluid into the surrounding rock. This caused the alteration and mineralization.

"Porphyry copper" deposits are commonly formed from plutons emplaced beneath volcanic vents. The plutons are magmatic on emplacement and contain a small percentage of fluid within their make-up. The fluid builds up near the apical tip of the pluton and eventually creates a pressure that can only be released by explosive activity. Once this occurs, the rock surrounding the apical tip will be shattered and permeable. Fluid will migrate into the open space, alter the rock and deposit both sulphide and, commonly, quartz. The spaces will seal and the pressure will build again until there is another pressure relieving volcanic explosion. Deposits are commonly made up of mineralized veins formed by several explosive events.

The fluid released from the pluton will react with plutonic rock as well as "country rock". The affect that the alteration process has will be governed by the nature of the fluid, the composition of the rock and physio-chemical conditions such as temperature, pressure and level of oxygen in the fluid. The fluid will change as it reacts, migrates and cools. This creates alteration "shells" around a central core. The fluid tends to dump potassium, creating biotite and feldspar, where it is hottest (near the core) and sericite furthur out. The best copper and molybdenum values commonly occur at the transition from feldspar to sericite. Cool fluids, that have deposited their copper and molybdenum commonly migrate outward and create an outer shell of chlorite, carbonate and pyrite alteration. Note that the mineralizing process waxes and wanes. The process will colapse inward as the pluton cools off and ground water starts to interact with the system.

At Island Copper, there is a large amount of breccia and the process has created shells of both alteration and mineralization peripheral to, and above the main feeder dyke. Note that alteration zones above a "porphyry copper" deposit are commonly removed by erosion and thus not available for study. At Island Copper one can see a small amount of "pyrophyllite breccia" - a clay rich alteration product formed as a result of upward streaming of spent fluids that was involved in the creation of the underlying deposit.

"Porphyry Copper" deposits tend to be large in volume and low in grade and thus unit value. The operations are highly susceptible to minor fluctuations in metal price and they require economies of scale to be cost effective. "Porphyry copper" mines process anywhere between 40,000 and 120,000 tonnes of ore a day. In addition, the operator may have to remove two or three times as much waste rock in order to obtain the depth necessary to extract the ore.

Pushing back the walls of a deposit can create problems as the operator is required to strip and store material from the "pyritic halo" that forms around the main deposit. It is possible for the pyrite to oxidise and create acid but this need not be a problem as the same fluids that deposited the pyrite may have deposited calcite, a mineral that neutralizes acid. The amount of acid produced will reflect the relative proportions of the two minerals.

Exploration geologists looking for "porphyry copper" deposits have a reasonably large target to aim for. They are usualy looking for the apical tip of a pluton. They may concentrate on exploring eroded volcanic centres and small stocks peripheral to major batholiths. It is less common to explore large plutons but they can be mineralized (It would be a pity to miss Highland Valley).

Deposits eroded to the right level will usualy provide a large geochemical anomaly on surface. This may show up in stream sediment sample surveys and should show up in grid soil geochemical surveys.

Geophysical methods can be useful in defining the shape of a deposit. Induced Polarization surveys respond to disseminated pyrite in the "pyritic halo" around the main zone of mineralization. If you find the halo and move inside you may find the deposit.

Once a deposit has been identified, the critical question, as with all deposits, is one of tonnage and grade and mineability. The former comes from diamond drilling and a careful study of the geology of the deposit and the latter comes from detailed engineering studies and an understanding of economic considerations.

- submarine tailings deposition
- custom milling potential
+ increased expl'n eg. Expo, Red Dog

R. H. Pinsent

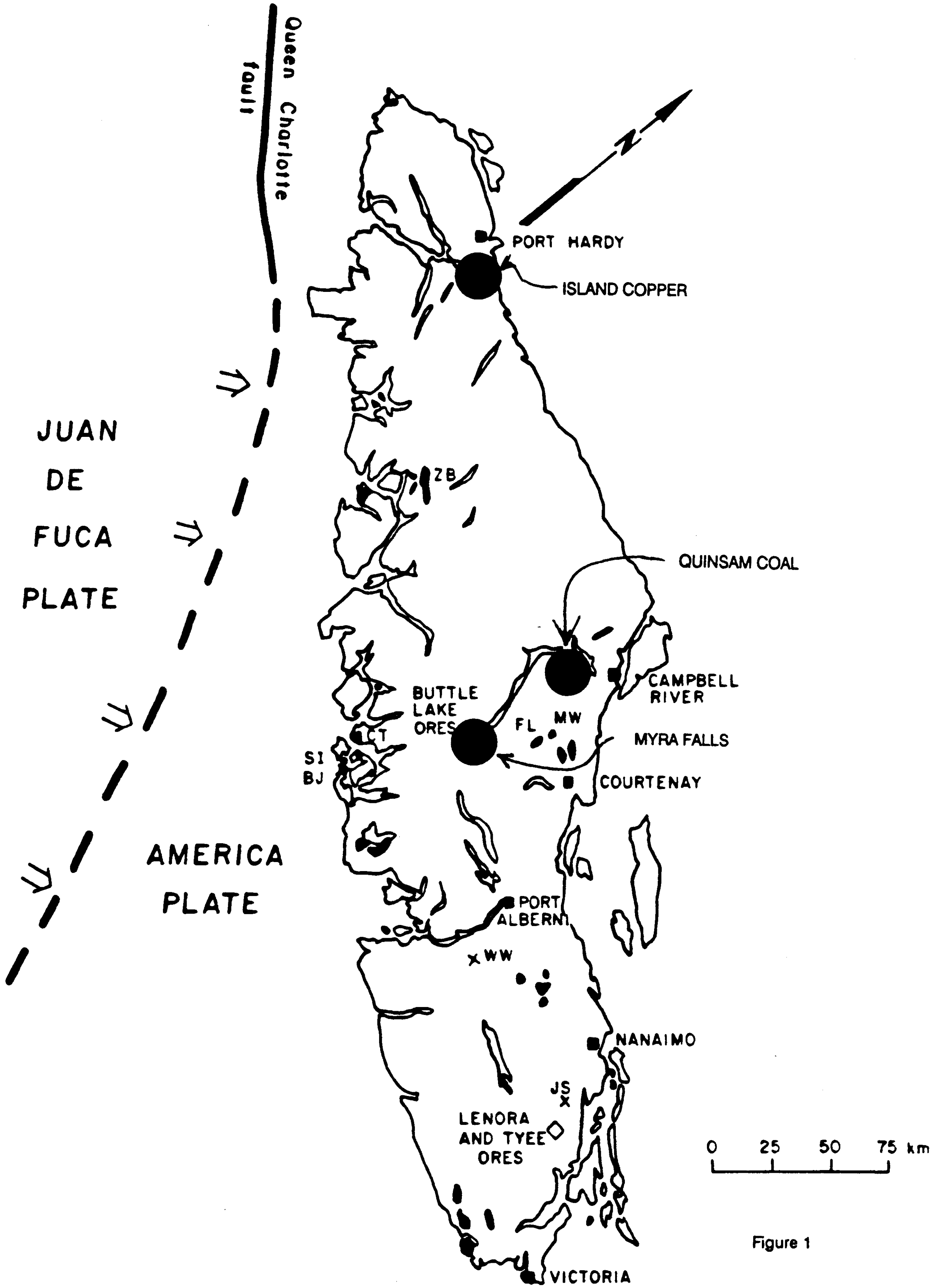
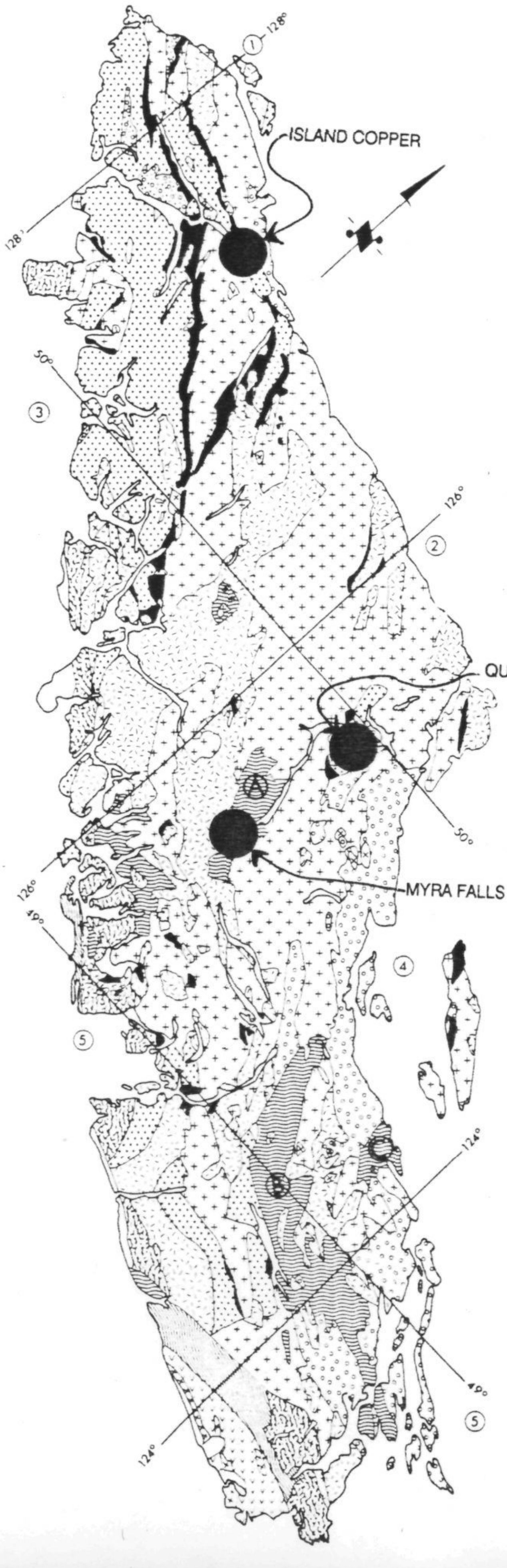


Figure 1

Distribution of Eocene Catface intrusions (solid areas), Vancouver Island, British Columbia. Dots with abbreviated sample names mark whole-rock sample locations (Table 1). Galena sample locations are shown as crosses, except for six samples from the Zeballos mining camp marked ZB. Present locations of plate boundaries are indicated. Diamonds mark some major Paleozoic ore deposits.



Geological sketch map of Vancouver Island.

LEGEND

CARMANAH GROUP	MIDDLE TERTIARY
CATFACE INTRUSIONS	EARLY TO MIDDLE TERTIARY
METCHOSIN VOLCANICS	EARLY TERTIARY
NANAIMO GROUP	LATE CRETACEOUS
QUEEN CHARLOTTE GROUP KYUQUOT GROUP	LATE JURASSIC TO EARLY CRETACEOUS
LEECH RIVER FORMATION PACIFIC RIM COMPLEX	
ISLAND INTRUSIONS	EARLY AND (?) MIDDLE JURASSIC
BONANZA GROUP	EARLY JURASSIC
VANCOUVER GROUP	LATE AND (?) MIDDLE TRIASSIC
PARSON BAY FORMATION QUATSINO FORMATION	
KARMUTSEN FORMATION	
SICKER GROUP	PALEOZOIC
METAMORPHIC COMPLEXES	JURASSIC AND OLDER

1. ALERT BAY – CAPE SCOTT, 92 L – 102 I (G.S.C. PAPER 74–8)
2. BUTE INLET, 92 K (IN PREPARATION), O.P. MAP 345
3. NOOTKA SOUND, 92 E (IN PREPARATION)
4. ALBERNI 92 F (G.S.C. PAPER 68–50)
5. VICTORIA, 92 B, C (FIELD WORK IN PROGRESS: SEE G.S.C. PAPERS 75–1A, p. 21–26; 76–1A, p. 107–111, 77–1A, p. 287–294.)

A — BUTTLE LAKE UPLIFT
B — COWICHAN – HORNE LAKE UPLIFT
C — NANOOSE UPLIFT

MILES
0 20 40

FIGURE 2

TABLE OF FORMATIONS OF VANCOUVER ISLAND

SEQUENTIAL LAYERED ROCKS

Era	Period		Stage	Group	Formation	Symbol	Ave. Thick. in m	Lithology
CENOZOIC					late Tert. volc's of Port McNeill	Tvs		
CENOZOIC			EOCENE to OLIGOCENE		SOOKE BAY	mpTSB		conglomerate, sandstone, shale
CENOZOIC			EOCENE to OLIGOCENE		CARMANAH	eoTC	1,200	sandstone, siltstone, coglomerate
CENOZOIC			EOCENE to OLIGOCENE		ESCALANTE	eTE	300	conglomerate, sandstone
CENOZOIC			early EOCENE		METCHOSIN	eTM	3,000	basaltic lava, pillow lava, breccia, tuff
MESOZOIC		LATE	MAESTRICHTIAN	NANAIMO	GABRIOLA	uKGA	350	sandstone, conglomerate
MESOZOIC		LATE	MAESTRICHTIAN	NANAIMO	SPRAY	uKS	200	shale, siltstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	GEOFFREY	uKG	150	conglomerate, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	NORTHUMBERLAND	uKN	250	siltstone, shale, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	DE COURCY	uKDC	350	conglomerate, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	CEDAR DISTRICT	uKCD	300	shale, siltstone, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	EXTENSION - PROTECTION	uKEP	300	conglomerate, sandstone, shale, coal
MESOZOIC		LATE	CAMPANIAN	NANAIMO	HASLAM	uKH	200	shale, siltstone, sandstone
MESOZOIC		LATE	SANTONIAN	NANAIMO	COMOX	uKC	350	sandstone, conglomerate, shale, coal
MESOZOIC		EARLY	CENOMANIAN ALBIAN	QUEEN CHARLOTTE	Conglomerate Unit	lKqc	900	conglomerate, greywacke
MESOZOIC		EARLY	APTIAN?	QUEEN CHARLOTTE	Siltstone Shale Unit	lKqp	50	siltstone, shale
MESOZOIC		EARLY	VALANGINIAN BARREMIAN		LONGARM	lKL	250	greywacke, conglomerate, siltstone
MESOZOIC	JURASSIC	MID LATE	TITHONIAN CALLOVIAN		Upper Jurassic Sediment Unit	uJs	500	siltstone, argillite, conglomerate
MESOZOIC	JURASSIC	EARLY	TOARCIAN?	BONANZA	Volcanics	lJB	1,500	basaltic to rhyolitic lava, tuff, breccia, minor argillite, greywacke
MESOZOIC	JURASSIC	EARLY	PLIENSBACHIAN SINEMURIAN	BONANZA	HARBLEDOWN	lJH		argillite, greywacke, tuff
MESOZOIC	TRIASSIC	LATE	NORIAN	VANCOUVER	PARSON BAY	uŦPB	450	calcareous siltstone, greywacke, silty-limestone, minor conglomerate, breccia
MESOZOIC	TRIASSIC	LATE	KARNIAN	VANCOUVER	QUATSINO	uŦQ	400	limestone
MESOZOIC	TRIASSIC	LATE	KARNIAN	VANCOUVER	KARMUTSEN	muŦK	4,500	basalic lava, pillow lava breccia, tuff
MESOZOIC	TRIASSIC	MID	LADINIAN	VANCOUVER	Sediment - Sill Unit	Tds	750	metasiltstone, diabase, limestone
PALEOZOIC	PENN. and ? PERM.			SICKER	BUTTLE LAKE	CPBL	300	limestone, chert
PALEOZOIC	PENN. and ? PERM.			SICKER	Sediments	CPss	600	metagreywacke, argillite, schist, marble
PALEOZOIC	PENN. and ? PERM.			SICKER	Volcanics	CPsv	2,000	basaltic to rhyolitic metavolcanic flows, tuff, agglomerate
PALEOZOIC	DEV. or EARLIER							

CRYSTALLINE ROCKS, COMPLEXES OF POORLY DEFINED AGE

Name	Symbol	Isotopic Age Pb/U	Isotopic Age K/Ar	Lithology
SOOKE INTRUSIONS silicic	Tg		32–59	quartzdiorite, trondhjemite, agmatite, porphyry
SOOKE INTRUSIONS basic	Tgb		31–49	gabbro, anorthosite, agmatite
METCHOSIN SCHIST, GNEISS	Tmn		47	chlorite schist, gneissic amphibolite
LEECH RIVER FM.	JKL		38–41	phyllite, mica schist, greywacke, argillite, chert
PACIFIC RIM COMPLEX	JKP			greywacke, argillite, chert, basic volcanics, limestone
ISLAND INTRUSIONS	Jg		141–181	granodiorite, quartzdiorite, granite, quartz monzonite
WESTCOAST COMPLEX silicic	PMns	264	163–192	quartz-feldspargneiss, metaquartzite, marble
WESTCOAST COMPLEX basic	PMnb			hornblende-plagioclase gneiss, quartz diorite, agmatite, amphibolite
diabase sills	PŦb			
metavolcanic rocks	PMmv			metavolcanic rocks, minor metasediments; limestone, marble
TYEE INTRUSIONS	Pg	>390		metagranodiorite, metaquartzdiorite, metaquartz porphyry
COLQUITZ GNEISS	Pns	>390		quartz feldspar gneiss
WARK DIORITE GNEISS	Pnb	>200	163–182	hornblende-plagioclase gneiss quartz diorite, amphibolite

FIGURE 3

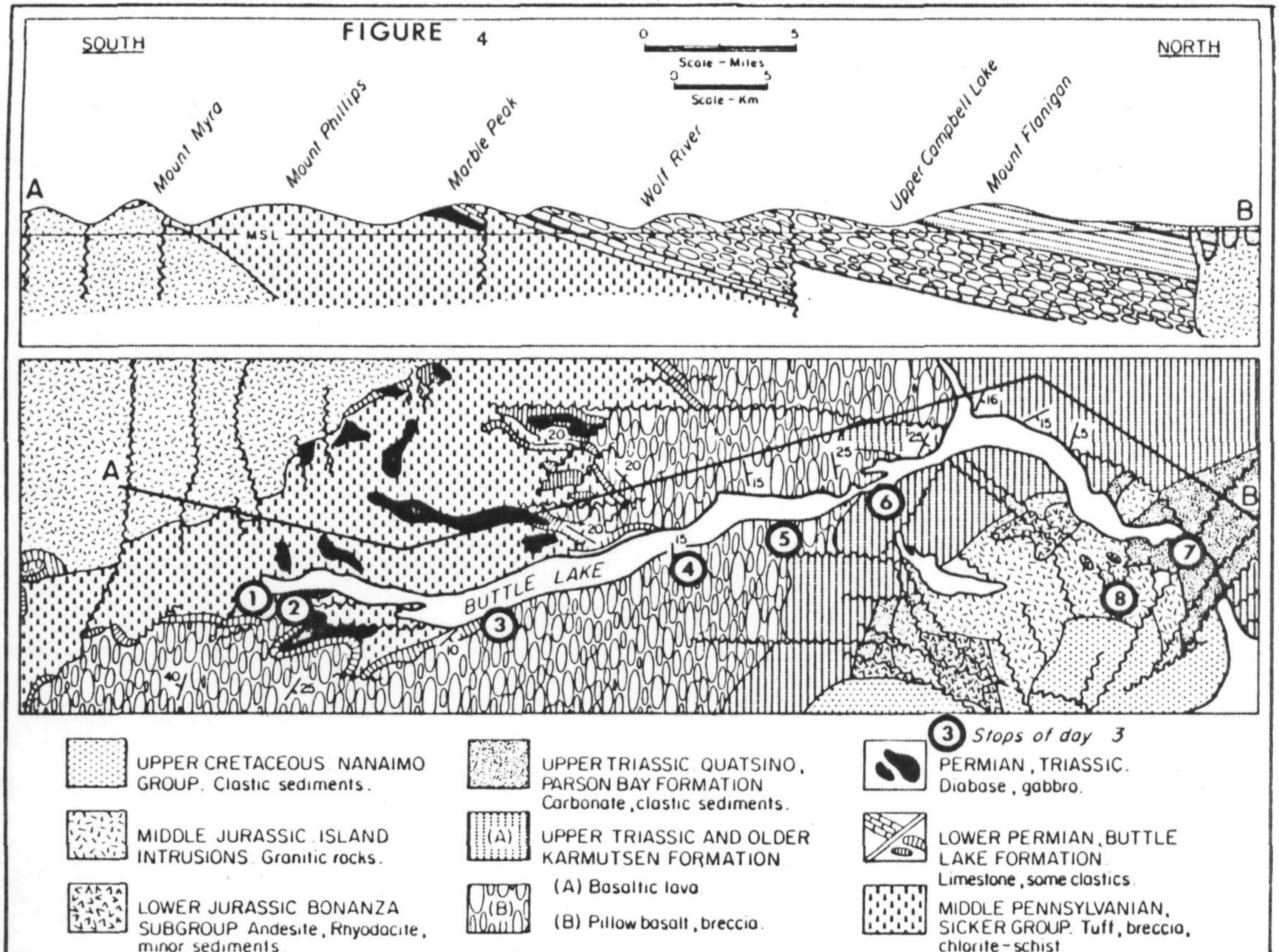

SOUTH
NORTH
Scale - Miles
Scale - Km
Mount Myra
Mount Phillips
Marble Peak
Wolf River
Upper Campbell Lake
Mount Flanigan
A
B
MSL
BUTTLE LAKE
Stops of day 3
UPPER CRETACEOUS NANAIMO GROUP. Clastic sediments.
MIDDLE JURASSIC ISLAND INTRUSIONS. Granitic rocks.
LOWER JURASSIC BONANZA SUBGROUP. Andesite, Rhyodacite, minor sediments
UPPER TRIASSIC QUATSINO, PARSON BAY FORMATION. Carbonate, clastic sediments.
UPPER TRIASSIC AND OLDER KARMUTSEN FORMATION
(A) Basaltic lava
(B) Pillow basalt, breccia.
PERMIAN, TRIASSIC. Diabase, gabbro.
LOWER PERMIAN, BUTTLE LAKE FORMATION. Limestone, some clastics.
MIDDLE PENNSYLVANIAN, SICKER GROUP. Tuff, breccia, chlorite-schist

FIGURE 4

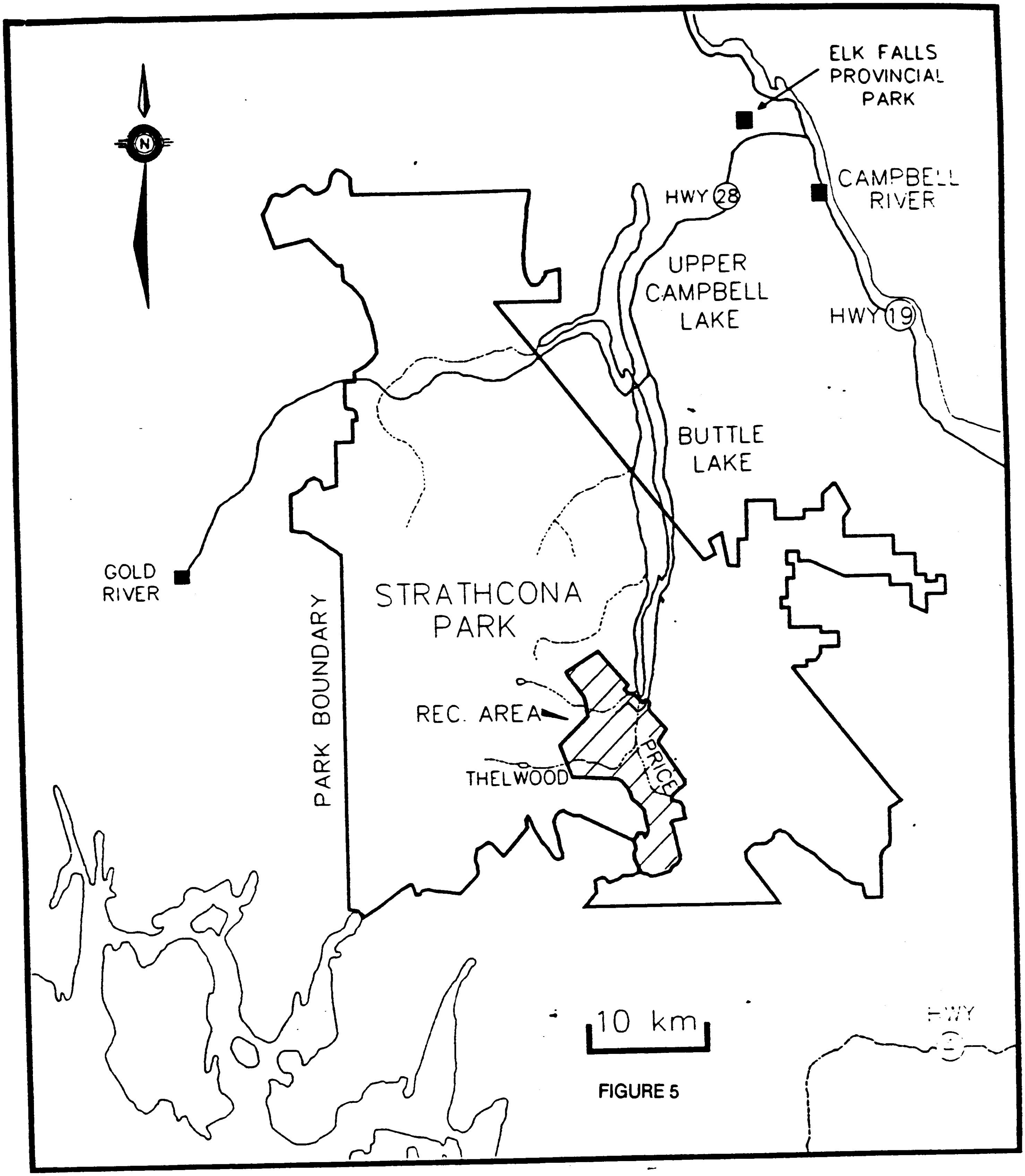
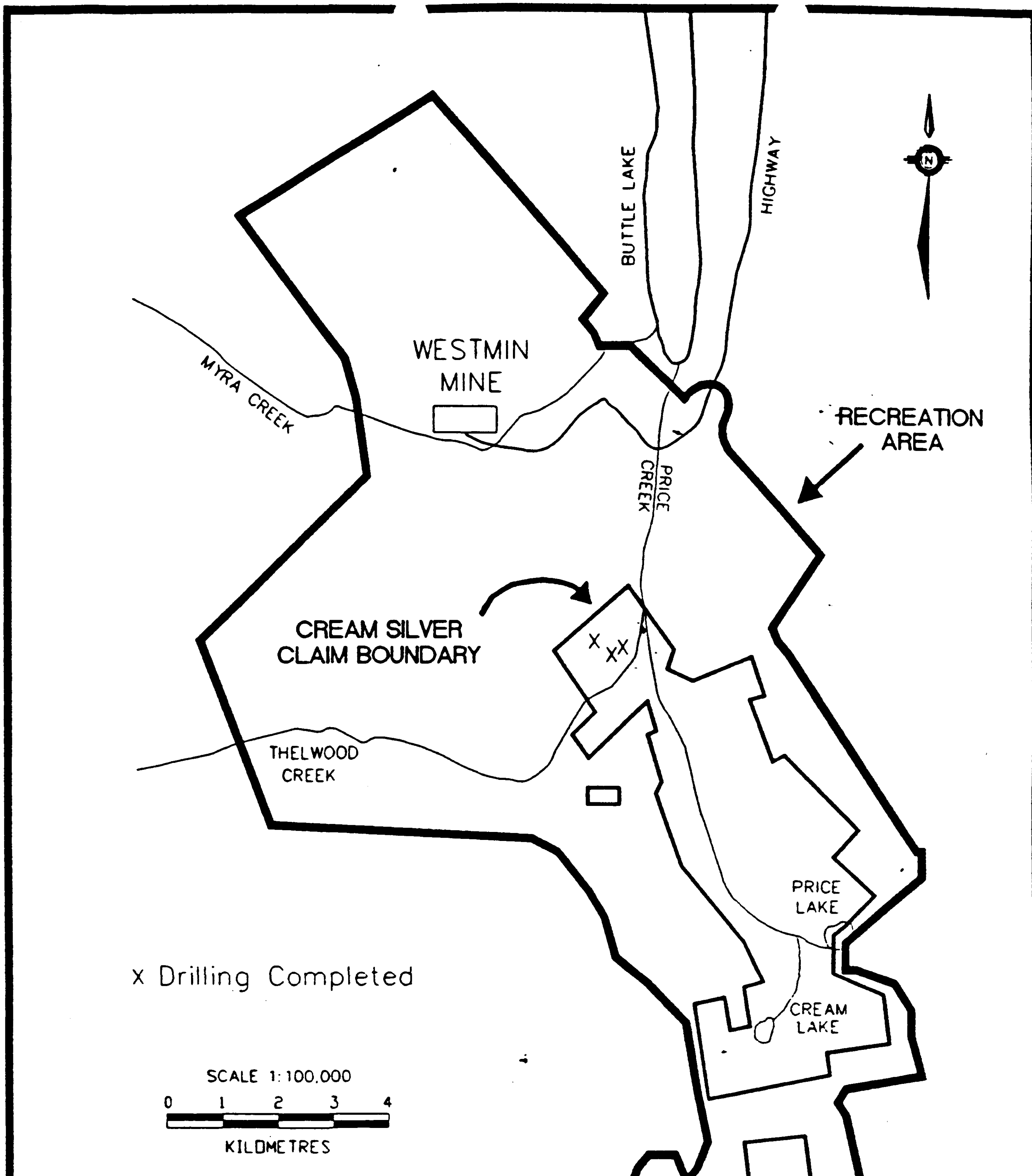

ELK FALLS PROVINCIAL PARK
CAMPBELL RIVER
HWY 28
UPPER CAMPBELL LAKE
HWY 19
BUTTLE LAKE
GOLD RIVER
STRATHCONA PARK
PARK BOUNDARY
REC. AREA
PRICE
THELWOOD
10 km

FIGURE 5



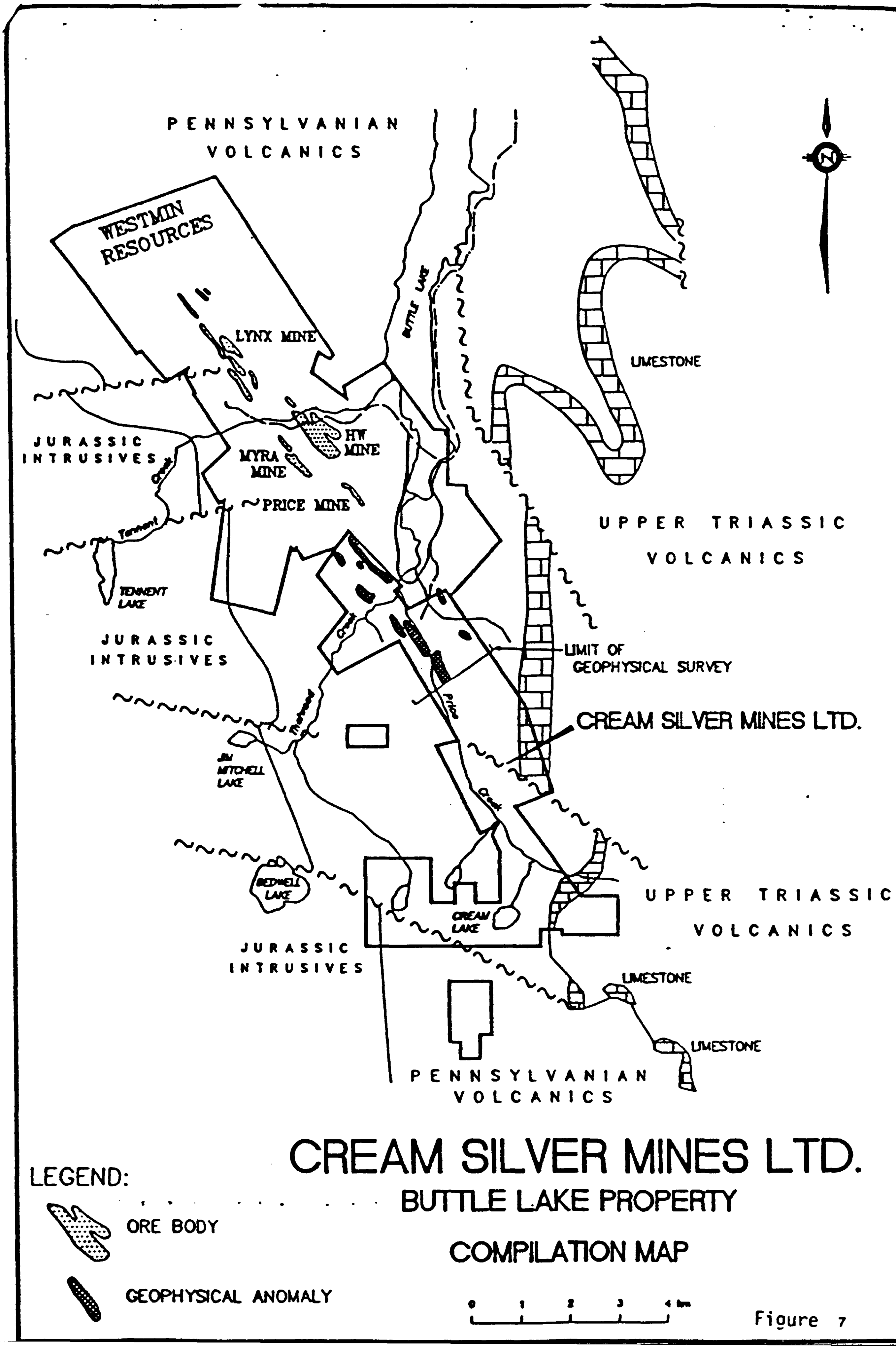
CREAM SILVER MINES LTD.

BUTTLE LAKE

DRILL HOLE LOCATION MAP

BY: P.S.
DATE: APRIL, 1988

FIGURE: 6


PENNSYLVANIAN VOLCANICS
WESTMIN RESOURCES
LYNX MINE
BUTTLE LAKE
LIMESTONE
JURASSIC INTRUSIVES
MYRA MINE
HW MINE
PRICE MINE
Creek
Tennent
UPPER TRIASSIC VOLCANICS
TENNENT LAKE
JURASSIC INTRUSIVES
LIMIT OF GEOPHYSICAL SURVEY
Price
CREAM SILVER MINES LTD.
JIM MITCHELL LAKE
Creek
BEDWELL LAKE
UPPER TRIASSIC VOLCANICS
CREAM LAKE
JURASSIC INTRUSIVES
LIMESTONE
LIMESTONE
PENNSYLVANIAN VOLCANICS
CREAM SILVER MINES LTD.
BUTTLE LAKE PROPERTY
COMPILATION MAP
LEGEND:
ORE BODY
GEOPHYSICAL ANOMALY
0 1 2 3 4 km
Figure 7

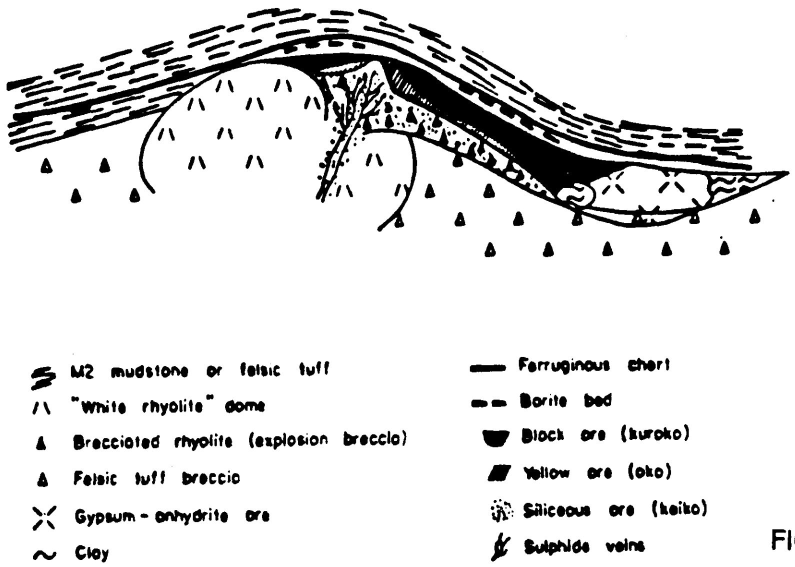


FIGURE 8

Schematic section of a typical Kuroko unit orebody, after Sato (1970). Based on the Uchinotai deposits, Kosaka Mine.

Lambert *et al.*, (1974) described seven distinct ore zonations to the "type" Kuroko massive sulphide deposit. In ascending order these are as follows:

1. Siliceous ore: pyrite-chalcopyrite-quartz stockwork ore. The structures of the original felsic volcanic rocks can frequently be discerned but are sometimes masked by extensive development of cryptocrystalline quartz.

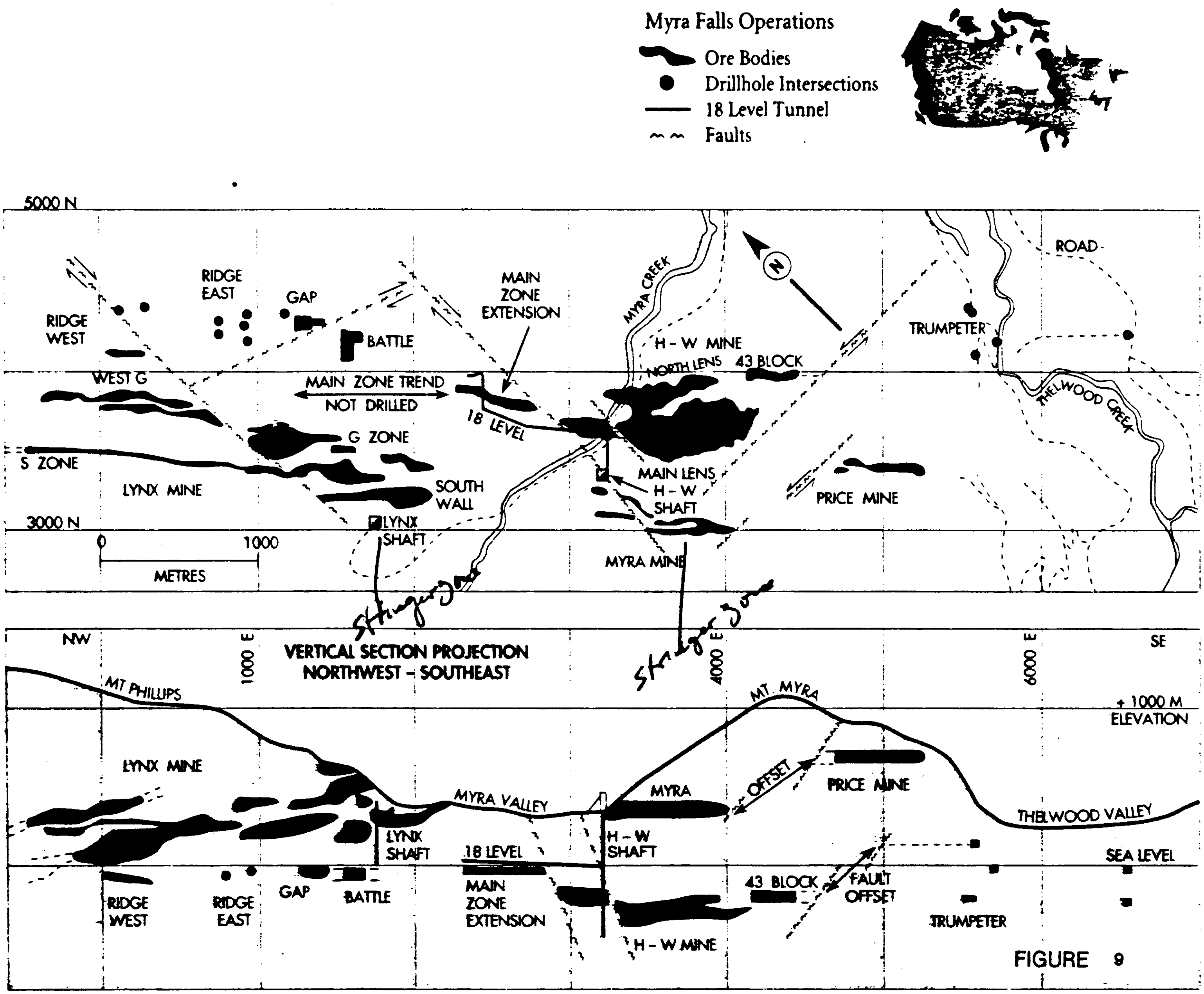
2. Gypsum ore: gypsum-anhydrite-(pyrite-chalcopyrite-sphalerite-galena-quartz-clays) stratabound ore; less commonly veins. This ore can occur on top of/or beside siliceous ore, or beside yellow ore.

3. Pyrite ore: pyrite-(chalcopyrite-quartz) ore. This is usually stratiform but occasionally occurs as veins and disseminations.

4. Yellow ore: pyrite-chalcopyrite-(sphalerite-barite-quartz) stratiform ore.

5. Black ore: sphalerite-galena-chalcopyrite-pyrite-barite stratiform ore. Towards the top of this zone there are significant amounts of tetrahedrite-tennantite. Bornite is abundant in a minority of deposits.

6. Barite ore: thin, well-stratified, bedded ore consisting almost entirely of barite, but sometimes containing minor amounts of calcite, dolomite, and siderite.



Myra Falls Operations
Ore Bodies
Drillhole Intersections
18 Level Tunnel
Faults
5000 N
3000 N
RIDGE WEST
RIDGE EAST
GAP
BATTLE
MAIN ZONE EXTENSION
MYRA CREEK
N
H - W MINE
NORTH LENS
43 BLOCK
TRUMPETER
ROAD
THELWOOD CREEK
WEST G
MAIN ZONE TREND
NOT DRILLED
18 LEVEL
G ZONE
S ZONE
LYNX MINE
SOUTH WALL
LYNX SHAFT
MAIN LENS
H - W SHAFT
PRICE MINE
MYRA MINE
0
1000
METRES
NW
1000 E
VERTICAL SECTION PROJECTION
NORTHWEST - SOUTHEAST
4000 E
6000 E
SE
MT PHILLIPS
MT. MYRA
+ 1000 M ELEVATION
LYNX MINE
MYRA VALLEY
MYRA
OFFSET
PRICE MINE
THELWOOD VALLEY
LYNX SHAFT
18 LEVEL
H - W SHAFT
SEA LEVEL
RIDGE WEST
RIDGE EAST
GAP
BATTLE
MAIN ZONE EXTENSION
43 BLOCK
FAULT OFFSET
TRUMPETER
H - W MINE

FIGURE 9

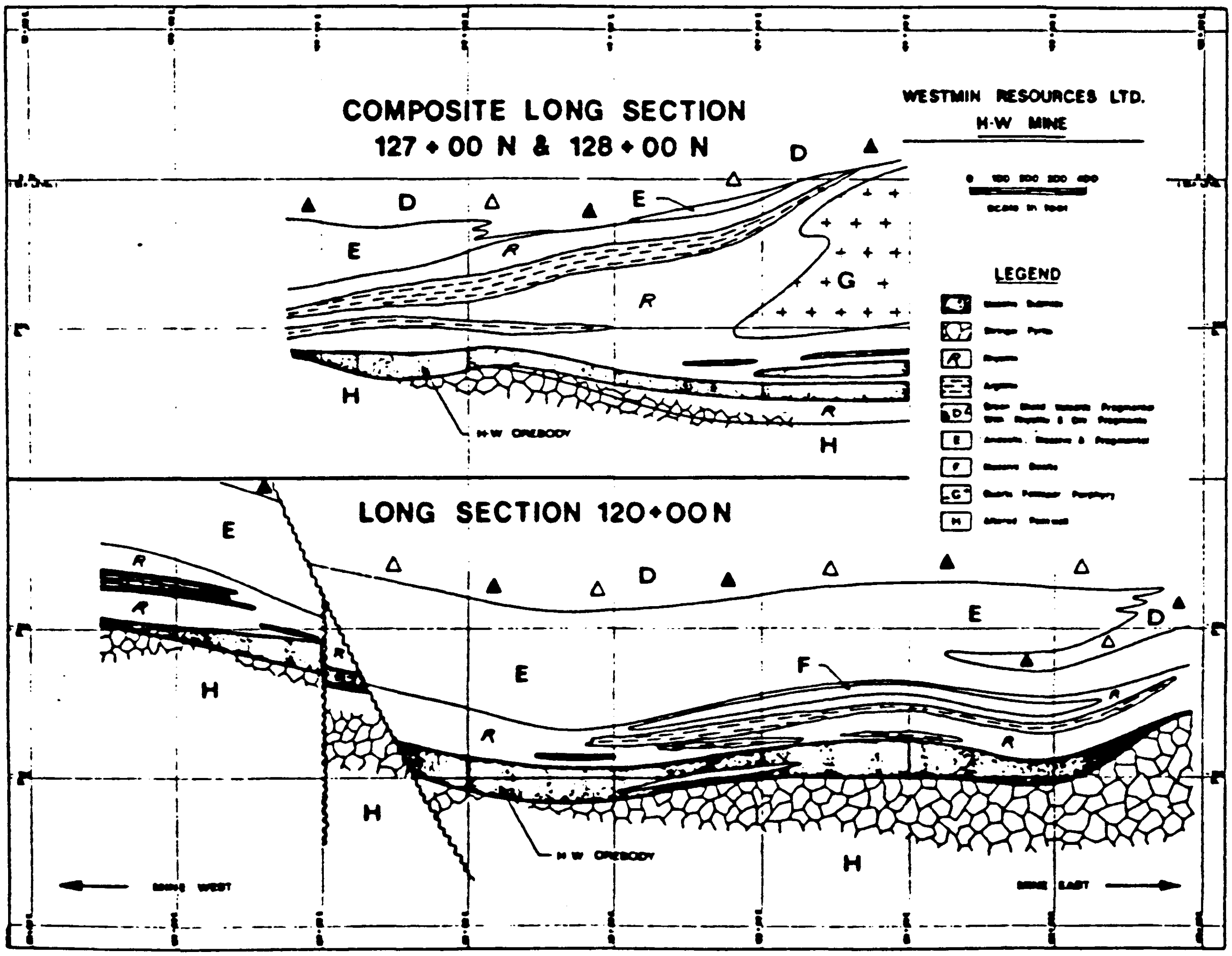


Figure 10. Longitudinal sections through H-W mine

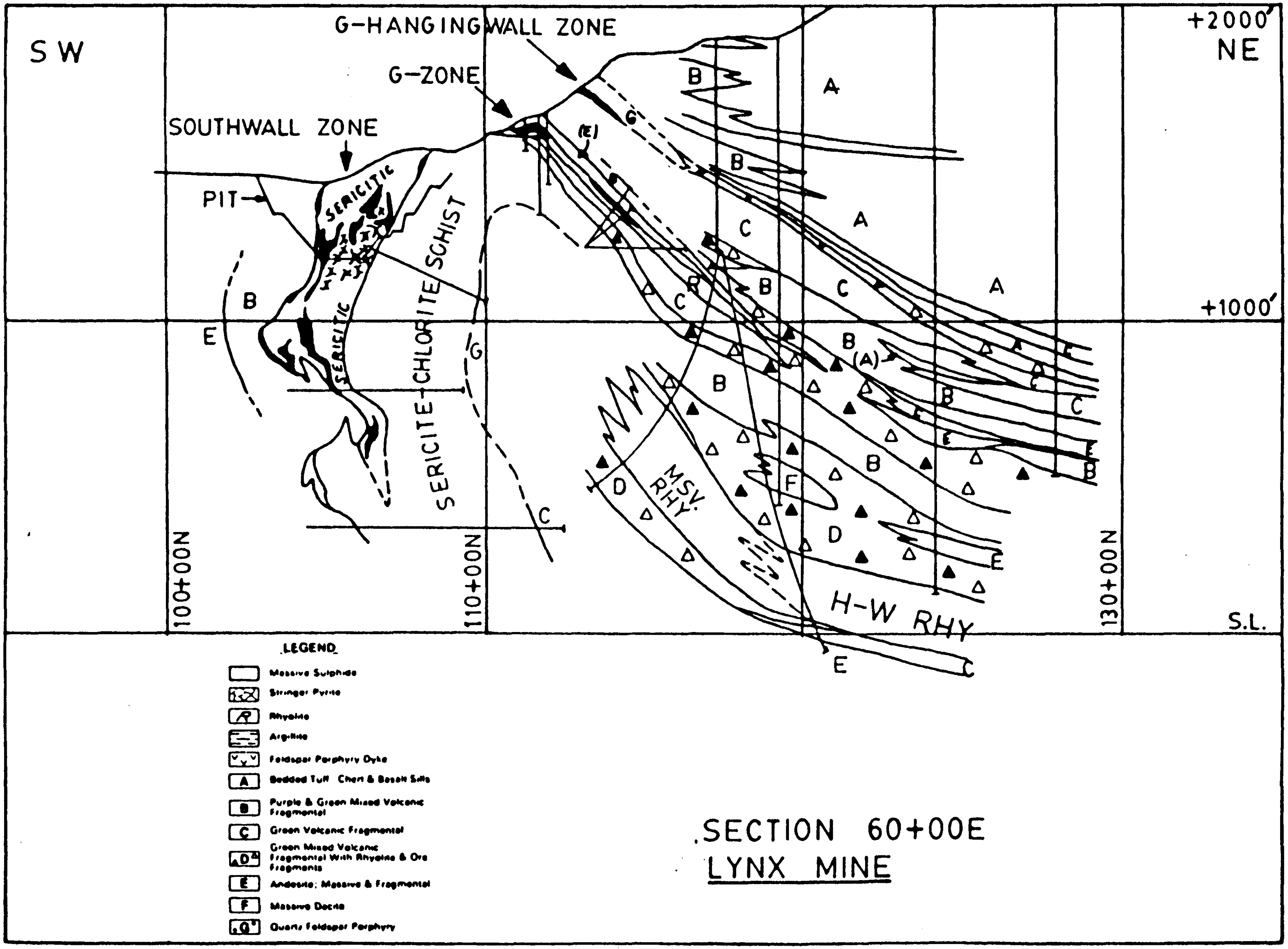
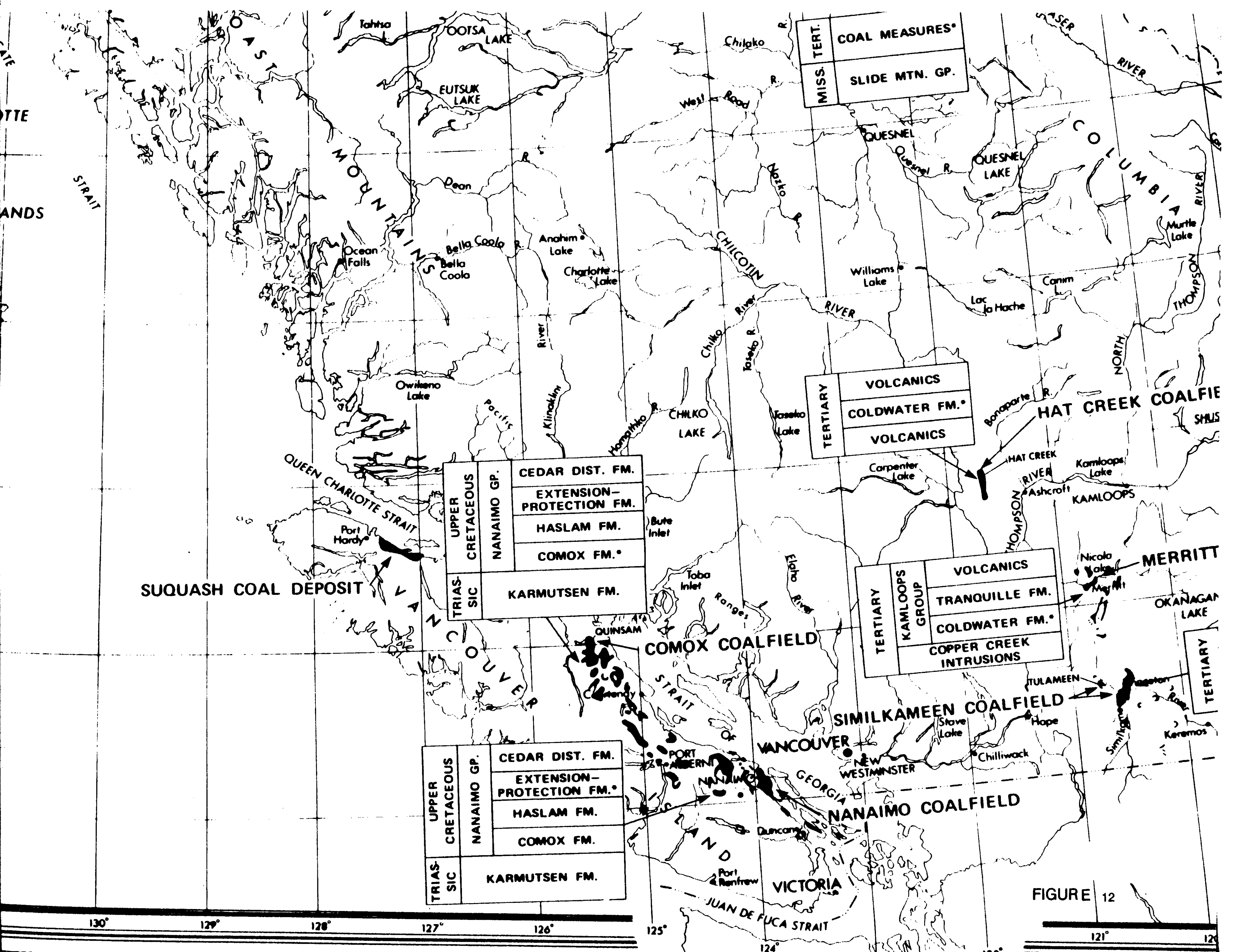
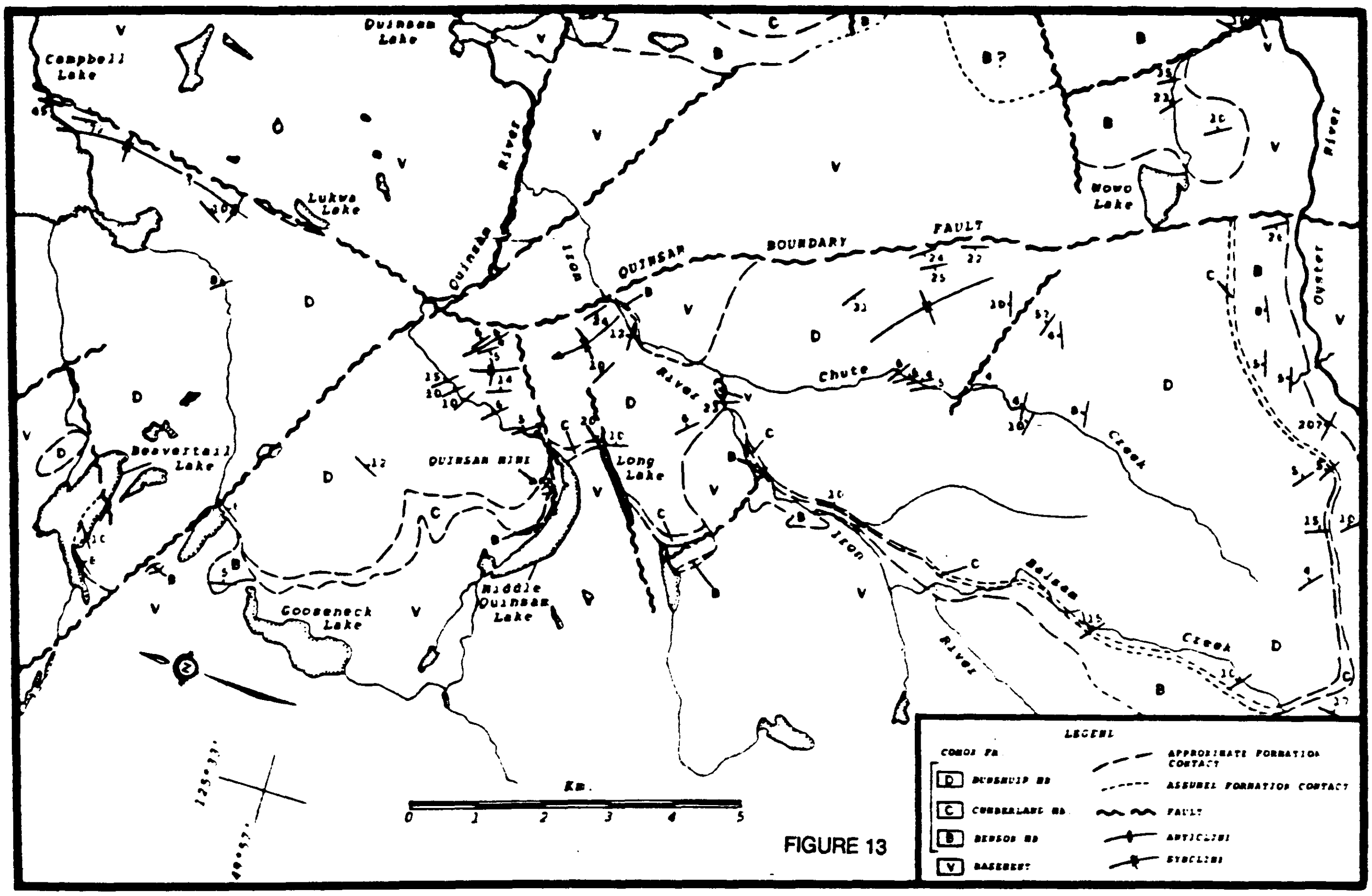


Figure 11. Cross section through Lynx mine



COAST MOUNTAINS
STRAIT
VANCOUVER ISLAND
BRITISH COLUMBIA
Tahtsa
OOTSA LAKE
EUTSUK LAKE
Chilako R.
West Road R.
QUESNEL
Quesnel R.
QUESNEL LAKE
Nazko R.
FRASER RIVER
NORTH THOMPSON RIVER
Murtle Lake
Dean R.
Bella Coola R.
Bella Coola
Ocean Falls
Anahim Lake
Charlotte Lake
CHILCOTIN RIVER
Williams Lake
Lac la Hache
Canim L.
Chilko River
Taseko R.
River
Owikeno Lake
Pacific
Klinaklini
Homathko R.
CHILKO LAKE
Taseko Lake
Bonaparte R.
HAT CREEK COALFIELD
HAT CREEK
Kamloops Lake
KAMLOOPS
Ashcroft
THOMPSON RIVER
Carpenter Lake
QUEEN CHARLOTTE STRAIT
Port Hardy
SUQUASH COAL DEPOSIT
Bute Inlet
Toba Inlet
Ranges
Elaho River
QUINSAM
COMOX COALFIELD
Courtenay
STRAIT OF GEORGIA
Nicola Lake
Merritt
MERRITT
OKANAGAN LAKE
TULAMEEN
Princeton
Similkameen
Keremeos
SIMILKAMEEN COALFIELD
Stave Lake
Hope
Chilliwack
VANCOUVER
NEW WESTMINSTER
PORT ALBERNI
NANAIMO
NANAIMO COALFIELD
Duncan
Port Renfrew
VICTORIA
JUAN DE FUCA STRAIT
130°
129°
128°
127°
126°
125°
124°
121°
TERT. | COAL MEASURES*
MISS. | SLIDE MTN. GP.
TERTIARY | VOLCANICS
COLDWATER FM.*
VOLCANICS
UPPER CRETACEOUS | NANAIMO GP. | CEDAR DIST. FM.
EXTENSION-PROTECTION FM.
HASLAM FM.
COMOX FM.*
TRIASSIC | KARMUTSEN FM.
TERTIARY | KAMLOOPS GROUP | VOLCANICS
TRANQUILLE FM.
COLDWATER FM.*
COPPER CREEK INTRUSIONS
UPPER CRETACEOUS | NANAIMO GP. | CEDAR DIST. FM.
EXTENSION-PROTECTION FM.*
HASLAM FM.
COMOX FM.
TRIASSIC | KARMUTSEN FM.
TERTIARY

FIGURE 12



Geology of the Quinsam area.

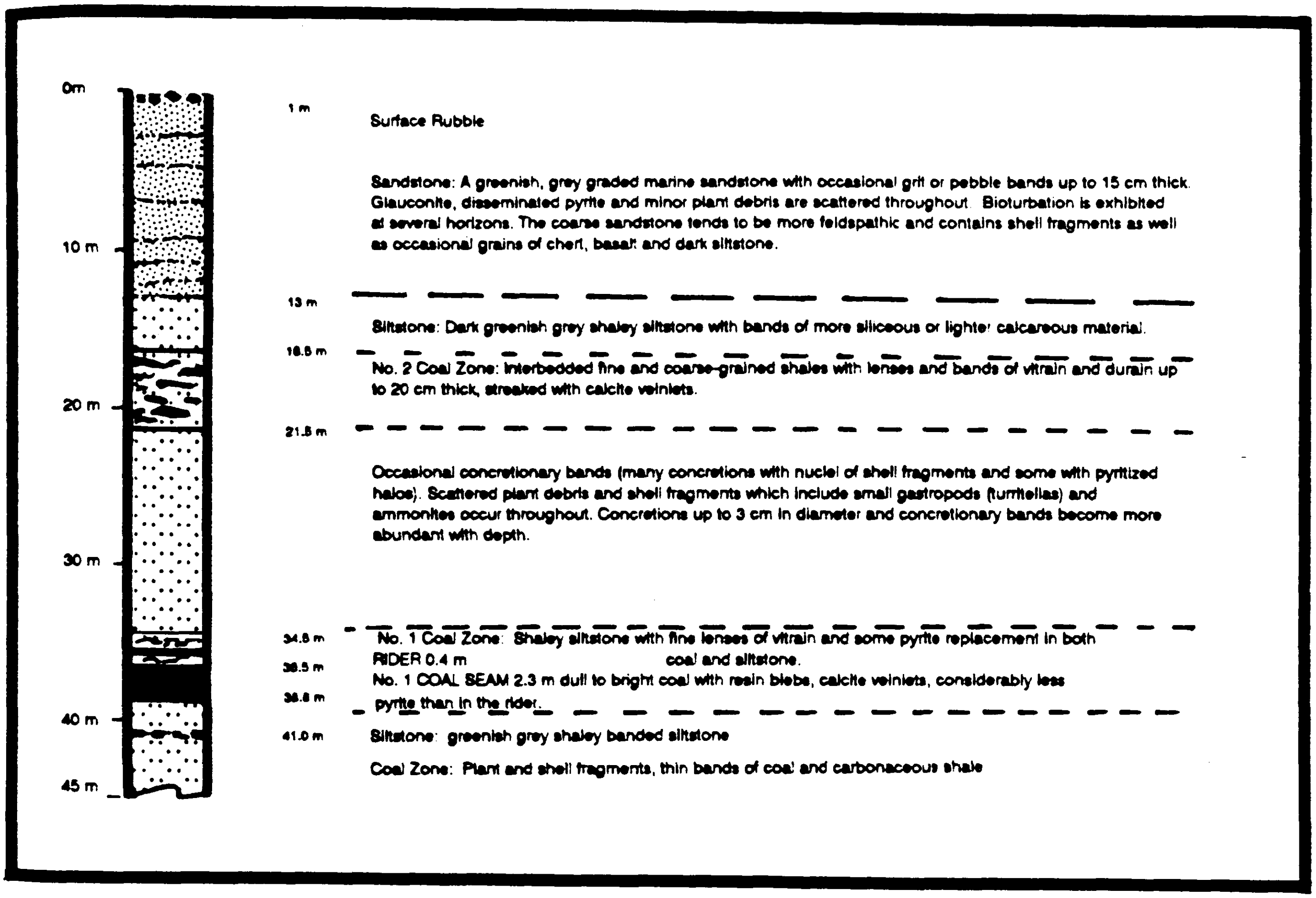


Figure 14 .. Cross section. Quinsam mine.

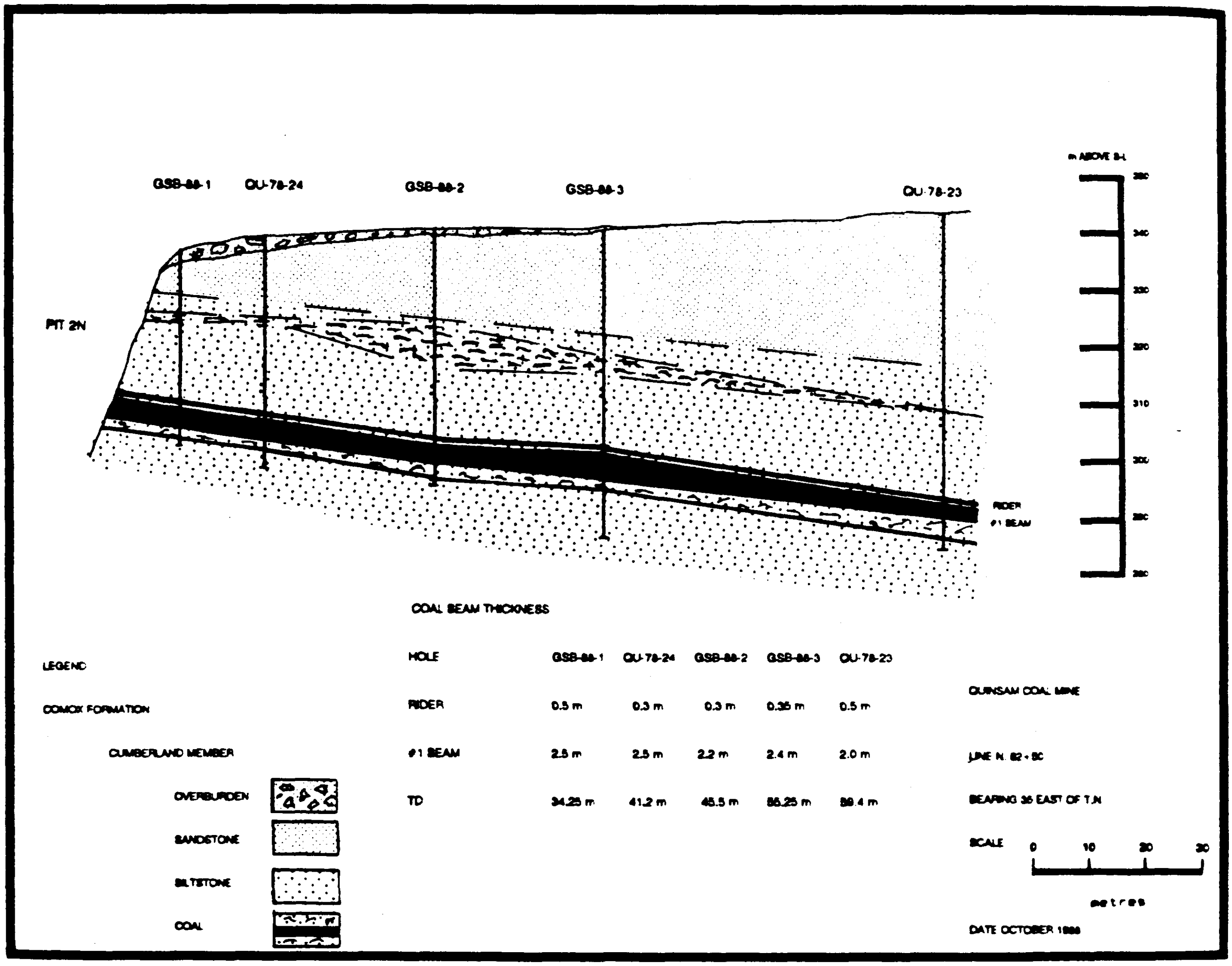


Figure 15 Type section. Comox Formation coal measures.

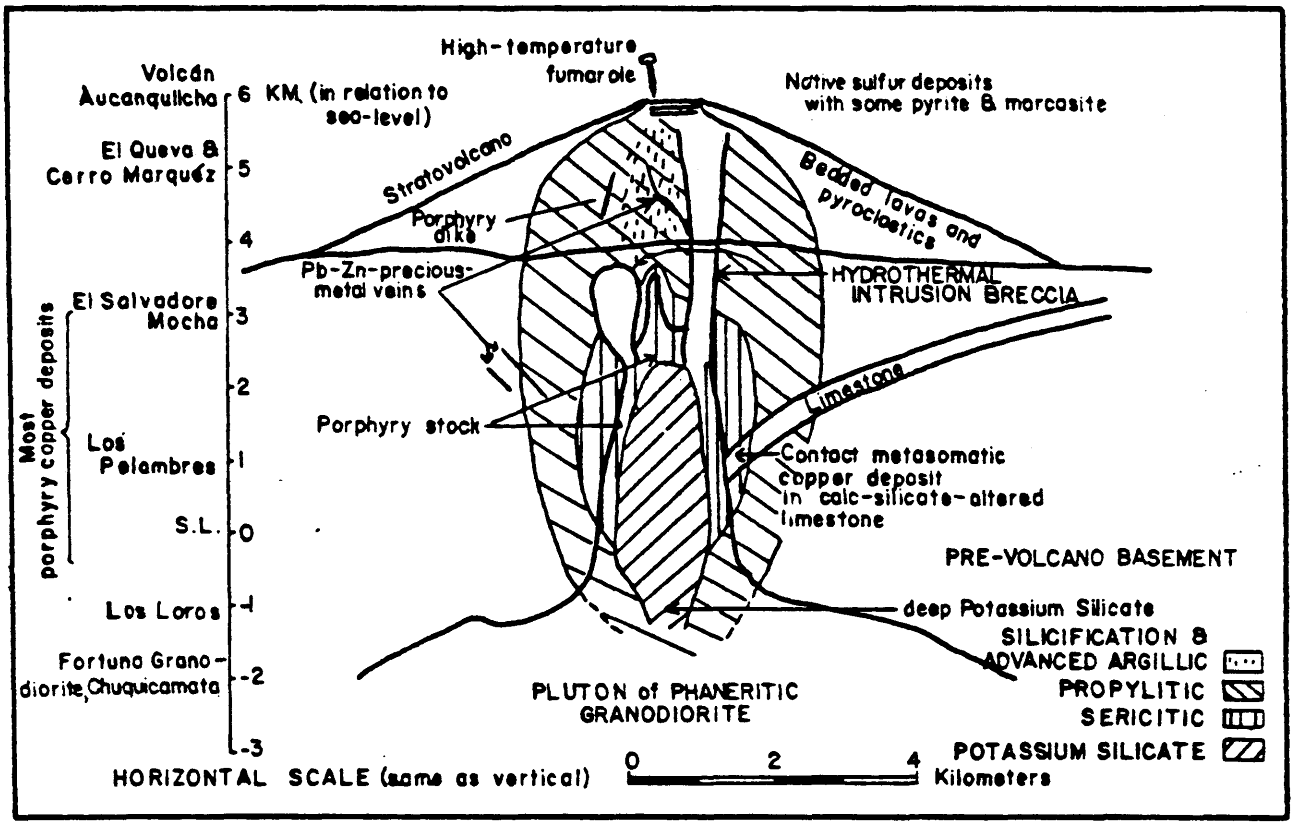


Figure 17 Schematic section of a typical porphyry copper deposit showing its position at the boundary between plutonic and volcanic environments. (After Sillitoe, 1973).

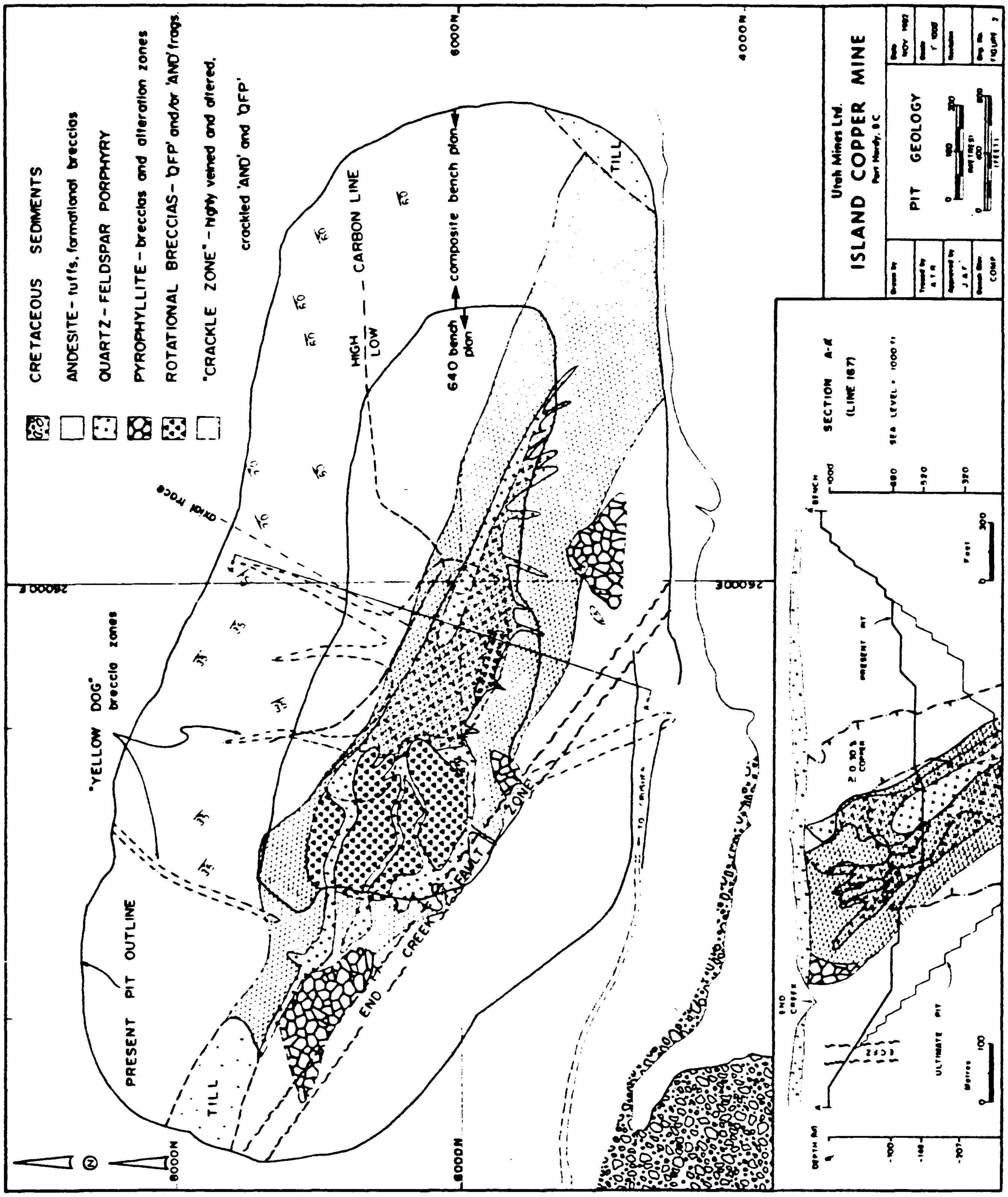


FIGURE 1.8 - PLAN, COMPOSITE PLAN AND SECTION OF GENERALIZED PIT GEOLOGY.

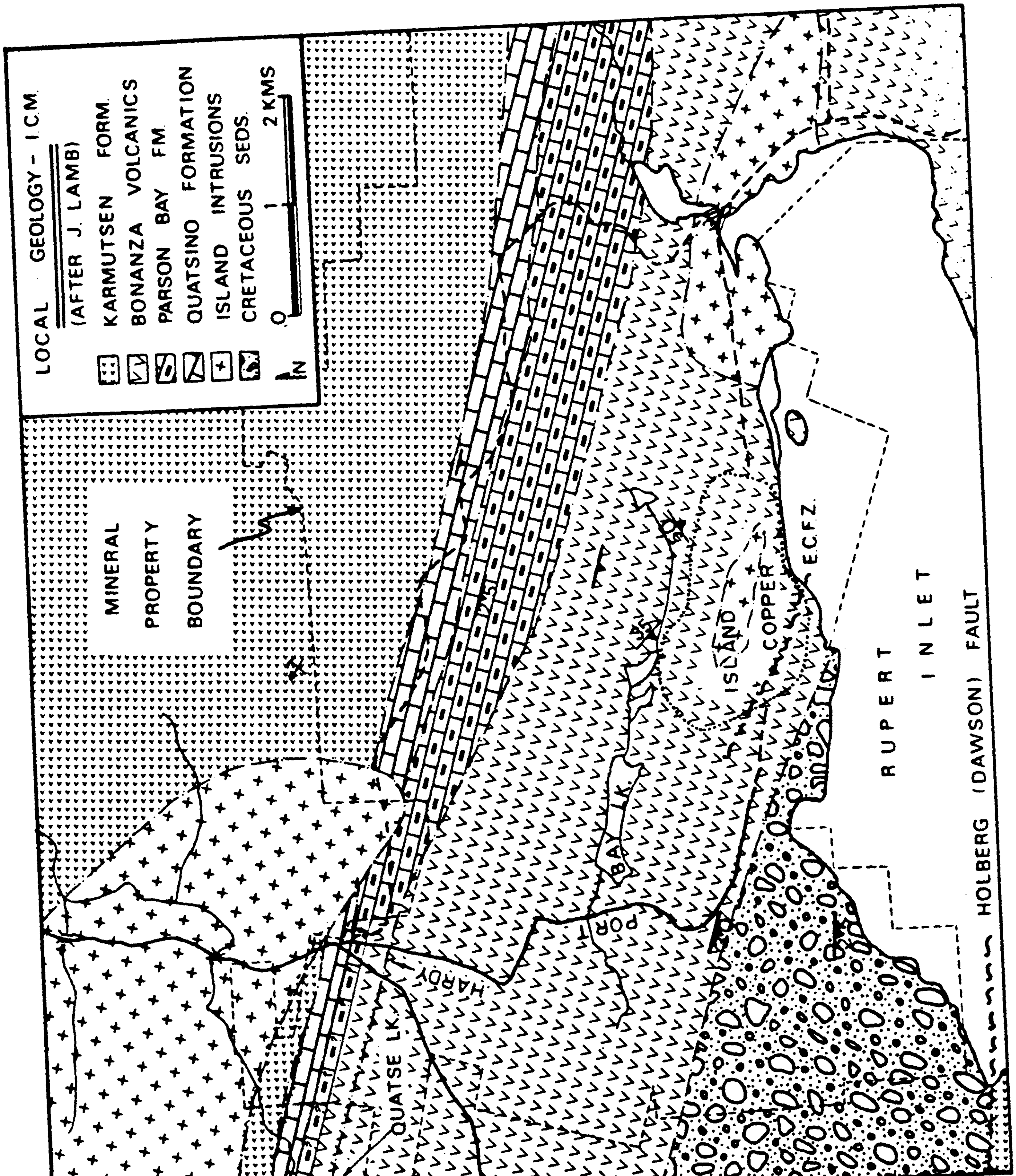


FIGURE 19 - GEOLOGY OF THE ISLAND COPPER PROPERTY.

VGS -> Vancouver Is.

Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources
GEOLOGICAL SURVEY BRANCH

MEMORANDUM

Suite 301, 865 Hornby Street, Vancouver, B.C. V6Z 2G3 Telephone: (604) 660-2708 Fax: (604) 775-0313

Note: Original, colour RGS maps on file with Pinsent!

Memo To: Paul Matysek

From: Robert Pinsent

Date: April 7th, 1993

Subject: RGS Maps for Vancouver Island

Steve Sibbick very kindly sent the Vancouver Office a selection of, 1:2,000,000 scale, colour-coded RGS data maps for Vancouver Island. I am suitably impressed. The maps are as good, if not better, than any I have seen elswhere.

The data provide an extremely important supplement to the geological database. I see patterns that beg for analysis and anomalies that clearly warrant investigation. I wish I had the time to turn an explorationists eye to the dataset.

My one regret is that Strathcona Park was not included in the survey. Not only does the absence of data break the flow of linear anomalies, leaving one begging for completion of the patterns formed but it misses what must, unquestionably, be the most important set of anomalies on the Island.

There is little doubt in my mind that the stratigraphic package that hosts the Myra Falls "volcanogenic massive sulphide" deposit forms a linear belt that extends for many kilometres into Strathcona Park, both northwest and southeast of the mine site.

Although I can appreciate that there was considerable sensitivity to any our actions at the time of the survey, I am not aware of any legal impediment to our collecting samples in the park for base-line data and I regret that it was not done. The survey will be incomplete until the park has been sampled.

It is perhaps, particularly unfortunate as it is my understanding from BCParks that existing parks are "on the table" under the current round of Protected Area Strategy. By providing alternative park areas under PAS we might be able to free-up some of Westmin's "mine series" stratigraphy.

Budget not withstanding, is there any chance of getting the park covered?

R.H. Pinsent

R. H. Pinsent

CC: T.Schroeter

TOS -> Van. Is.

INTEROFFICE MEMORANDUM

Date: 17-Feb-1994 04:17pm PST
From: wardk@mp.gsb.empr.gov.bc.ca
wardk@mp.gsb.empr.gov.bc.ca@GEMS@
Dept:
Tel No:

TO: (see below)

Subject: Vancouver Island CORE Results

Here is the impacts of the various land classifications on the threefold mineral potential breakdown. Each mineral potential category contains roughly 1/3 of the Vancouver Island land area.

	MINERAL POTENTIAL CATEGORIES		
Land Class	HIGH	MEDIUM	LOWEST
Cultivated	.42%	2.52%	6.11%
Multi-use	82.79%	66.6%	67.9%
Protected	7.9%	15.08%	38.52%
Regional Sign.	8.08%	12.37%	22.79%
Settlement	.85%	3.43%	9.78%

This information was produced by the CORE GIS group and obtained from Gregg Stewart. I only calculated the lowest mineral potential category statistics. The Mineral Potential ranking has a favourable correlation with the land use categories.

Ward

Distribution:

TO: gstewart@VENUS.GOV.BC.CA (gstewart@VENUS.GOV.BC.CA@GEMS@VENUS
TO: dlefebure (dlefebure@A1)
TO: egrunsky (egrunsky@A1)
TO: pmatysek (pmatysek@A1)
TO: rsmyth (rsmyth@A1)
TO: wmcmillan (wmcmillan@A1)
TO: gmcarthur (gmcarthur@A1)

T68 → Van. Is.

I N T E R O F F I C E   M E M O R A N D U M

Created: 02-Jul-1997 01:45pm PDT
From: Robert Pinsent of EI
RPINSENT
Title. District Geologist
Dept: Employment & Investment
Tel No: 660-0223

TO: Rolf Schmitt of EI (RSCHMITT)

CC: Ted Hall of EI (TJHALL)

Subject: Mineral Tenure Holdings on Vancouver Island

FYI: As of 31st May, 1997, there were 298 "Free Miners" with active tenure holdings on Vancouver Island. These include 225 individual and 73 corporate licences.

Just under half of the tenure owners live on Vancouver Island (loosely defined to include Texada and the Gulf Islands). A total of 148 tenure holders (139 individuals and 9 companies) live there. Predictably, their residences correlate with population density and decease as one goes north.

There are around 57 individuals and 5 companies resident south of Ladysmith. Principal communities include Victoria 43 (includes the 5 companies), Duncan 6, Sooke 5 and Ladysmith 3.

There are around 38 individuals and 3 companies resident in Central Vancouver Island. Principal communities include Nanaimo 14, Port Aberni 9, Tofino/Ucluelet 6 and Parksville 3.

There are around 34 individuals and 1 company resident in northern Vancouver Island. Principal communities include Gillies/Vananda on Texada Island 12, Campbell River 10, Courtenay 4 and Quadra Island 3.

This leaves 10 unaccounted for - one-off individuals living in small localities that are beyond my ken.

There are 150 tenure holders who don't live on Vancouver Island. Off these, 12 (including 8 companies) are resident outside of BC in such exotic places as Calgary, Toronto, Montreal & Seatle. The remaining 138 are based in BC. Needless to say, the vast majority 109 (including 54 companies) live in the Lower Mainland (Vancouver 73, West Vancouver 6, Surrey and Richmond 6 apiece, North Vancouver 4 etc.). Interestingly, there are also 7 tenure holders in Powell River.

The listing tells us a lot about our client base. Firstly, I expected to see more than 300 tenure holders. It doesn't seem that many given the size of the island. Secondly, I expected to see a greater percentage of the individual tenure holders resident on Vancouver

Island. Infact, there are 139 living there versus 84 in the rest of BC. Thirdly, I had hoped to see more "major company" involvement in exploration on Vancouver Island. Apart from the limestone producers (Lafarge, Chemical Lime, Imperial, Imasco & Holnam) only Noranda, Westmin, Falconbridge & Catface Copper, Quinsam actually OWN mineral tenures. Fourthly, I expected to see more "local" companies (SYMC, Beau Pre etc.). Infact, there are very few. Most of the companies owning claims are Vancouver-based "juniors".

The data show the importance of Lower Mainland-based "clients" to exploration on Vancouver Island. It would be a pity to exclude them from a "Vancouver Island Mineral Exploration Group". It seems to me that it is essential that any Exploration Group we set up should take on the responsibility of circulating a Quarterly News Letter as part of its mandate in order to include and encourage membership from the 50% of explorationists that live in the Lower Mainland.

Robert

cc. T. Schroeter
B. Hoskins