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Field Trip Guidebook

TRIP 9

MINERAL DEPOSITS OF VANCOUVER ISLAND: WESTMIN RESOURCES (Au-Ag-Cu-Pb-Zn), ISLAND COPPER (Cu-Au-Mo), ARGONAUT (Fe)

by

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MINERAL DEPOSITS OF VANCOUVER ISLAND: WESTMIN RESOURCES (Au-Ag-Cu-Pb-Zn), ISLAND COPPER (Cu-Au-Mo), ARGONAUT (Fe)

BY

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May 13 - 16, 1983

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INTRODUCTION

This field excursion will examine three mines, each of which illustrate an important mineral deposit type on Vancouver Island. Westmin Resources' mine at Buttle Lake is a polymetallic massive sulfide deposit associated with felsic volcanic rocks. Island Copper's mine at Holberg Inlet is a porphyry copper deposit which contains significant gold and molybdenum. The Argonaut iron mine (past producer) near Campbell River is a magnetite skarn deposit with associated minor copper. The Island Copper and Westmin Resources mines are the only two, major, current producers on Vancouver Island.

Each of these three deposits occurs in a different stratigraphic group. The excursion will provide the opportunity to see examples of stratigraphic and intrusive lithologies which underlie much of Vancouver Island. The regional geology of Vancouver Island was the subject of a G.A.C. - M.A.C. annual meeting field trip in 1981, led by J.E. Muller. Figures 1 through 4 are taken from Muller (1981) and summarize the distribution and stratigraphy of rock units on Vancouver Island. The locations of the three mines which are the subject of this field trip have been added to Figure 1.

Most of Vancouver Island is underlain by rocks of the Insular Belt of the Canadian Cordillera. In recent years the lower part of the Insular Belt stratigraphy, comprising at least the Paleozoic Sicker Group and the Triassic Vancouver Group, has been recognized as part of an allochthonous terrane derived from more southern latitudes (Muller 1977, Jones et al 1977, Muller 1981, and Jones et al 1982). This major allochthonous block has been named Wrangellia by Jones et al (1977). Wrangellia, the foundation of Vancouver Island, apparently docked with the North American plate during the Early Jurassic, coincident with the deposition of the volcanic Bonanza Group and contemporaneous Island Intrusions. Terrigenous sediments unconformably overlie the Bonanza Group.

The Westmin Resources massive sulfide deposits occur in the Myra Formation of the Sicker Group. The Argonaut Skarn deposit occurs in altered limestone of the Quatsino Formation of the Vancouver Group. The porphyry copper deposit of Island Copper occurs in volcanics of the Bonanza Group and intrusive rock of the Jurassic Island Intrusions.

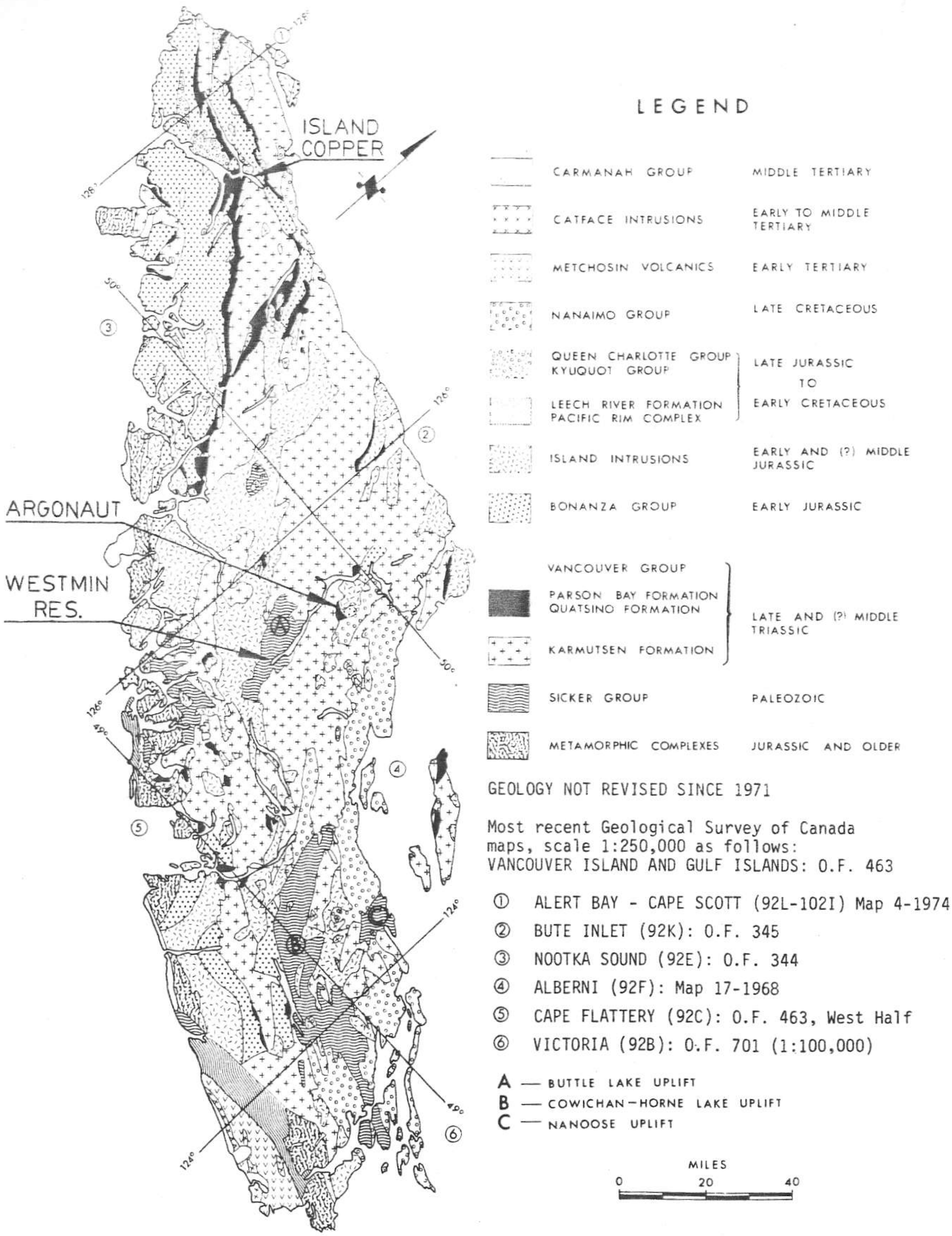


Figure A. Geological sketch map of Vancouver Island showing most recent published geological maps.
(from Muller, 1981)

TABLE OF FORMATIONS OF VANCOUVER ISLAND

SEQUENTIAL LAYERED ROCKS

Era	Period		Stage	Group	Formation	Symbol	Ave. Thick.	Lithology
CENOZOIC					late Tert. volcs of Port McNeill	Tvs		
					SOOKE	mpTsb		conglomerate, sandstone, shale
			EOCENE to	CARMANAH	HESQUIAT	eoTc	1,200	sandstone, siltstone, cogiomerate
			OLIGOCENE		ESCALANTE	eTe	300	conglomerate, sandstone
			early EOCENE		METCHOSIN	eTm	3,000	basaltic lava, pillow lava, breccia, tuff
MESOZOIC		LATE	MAESTRICHTIAN		GABRIOLA	uKGA	350	sandstone, conglomerate
					SPRAY	uKs	200	shale, siltstone
					GEOFFREY	uKG	150	conglomerate, sandstone
					NORTHUMBERLAND	uKN	250	siltstone: shale, sandstone
			CAMPANIAN	NANAIMO	DE COURCY	uKDC	350	conglomerate, sandstone
					CEDAR DISTRICT	uKCD	300	shale, siltstone, sandstone
					EXTENSION - PROTECTION	uKEP	300	conglomerate, sandstone, shale, coal
					HASLAM	uKH	200	shale, siltstone, sandstone
			SANTONIAN		COMOX	uKc	350	sandstone, conglomerate, shale, coal
		EARLY	CENOMANIAN ALBIAN	QUEEN	Conglomerate Unit	lKQC	900	conglomerate, greywacke
			APTIAN ?	CHARLOTTE	Siltstone–Shale Unit	lKQP	50	siltstone, shale
			VALANGINIAN BARREMIAN		LONGARM	lKL	750	greywacke, conglomerate, siltstone
	JURASSIC	MID. LATE	TITHONIAN	KYUQUOT	ONE TREE	lKOT	500	siltstone, argillite, conglomerate
			CALLOVIA		KAPOOSE	uJK		
		EARLY	TOARCIAN?		Volcanics	lJB	1,500	basaltic to rhyolitic lava, tuff, breccia, minor argillite, greywacke
			PLIENSBACHIAN SINEMURIAN	BONANZA	HARBLEDOWN	lJH		argillite, greywacke, tuff
	TRIASSIC	LATE	NORIAN		PARSON BAY	uTrPB	450	calcareous siltstone, greywacke, silty-limestone, minor conglomerate, breccia
			KARNIAN	VANCOUVER	QUATSINO	uTrQ	400	limestone
					KARMUTSEN	muTrK	4,500	basalic lava, pillow lava, breccia, tuff
		MID	LADINIAN		Sediment - Sill Unit	Tr ds	750	metasiltstone, diabase, limestone
PALEOZOIC	PENN. and ? PERM.				BUTTLE LAKE	CPBL	300	limestone, chert
					"NANOOSE"	CPss	600	metagreywacke, argillite, schist, marble
				SICKER	Sediment - Sill Unit	PTrds	500	metagreywacke, argillite diabase
	DEV. or EARLIER ?				MYRA	PM	1,000	silicic tuff, breccia argillite
					NITINAT	PN	2,000	basic breccia, tuff, lava, greenschist

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	PTrb			
metavolcanic rocks	PMmv			metavolcanic rocks, minor metasediments; limestone, marble
SALTSPRING INTR / TYEE QTZ PORPHYRY	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 B . From Muller, 1981

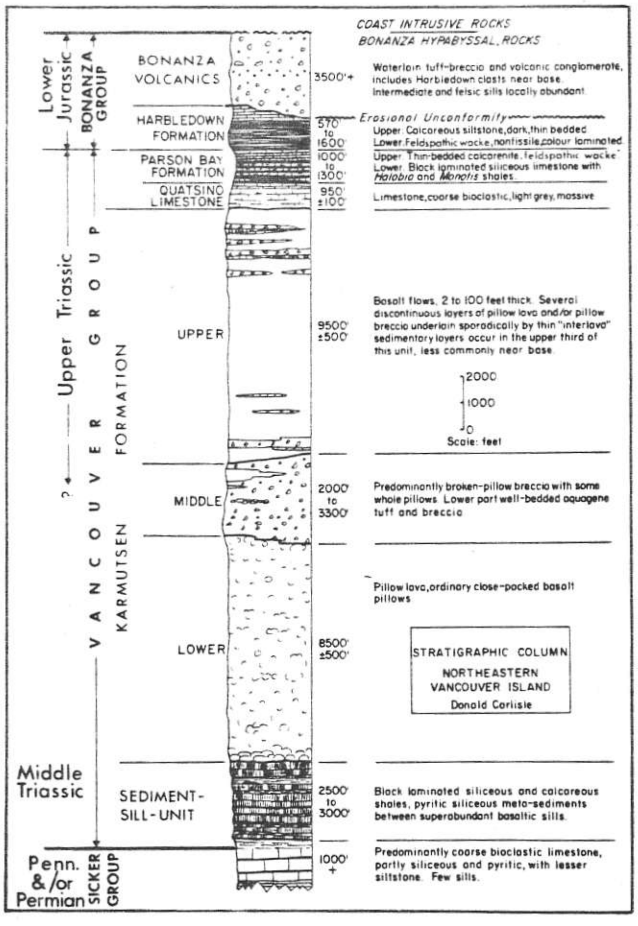


Figure C . From Muller et al 1974.

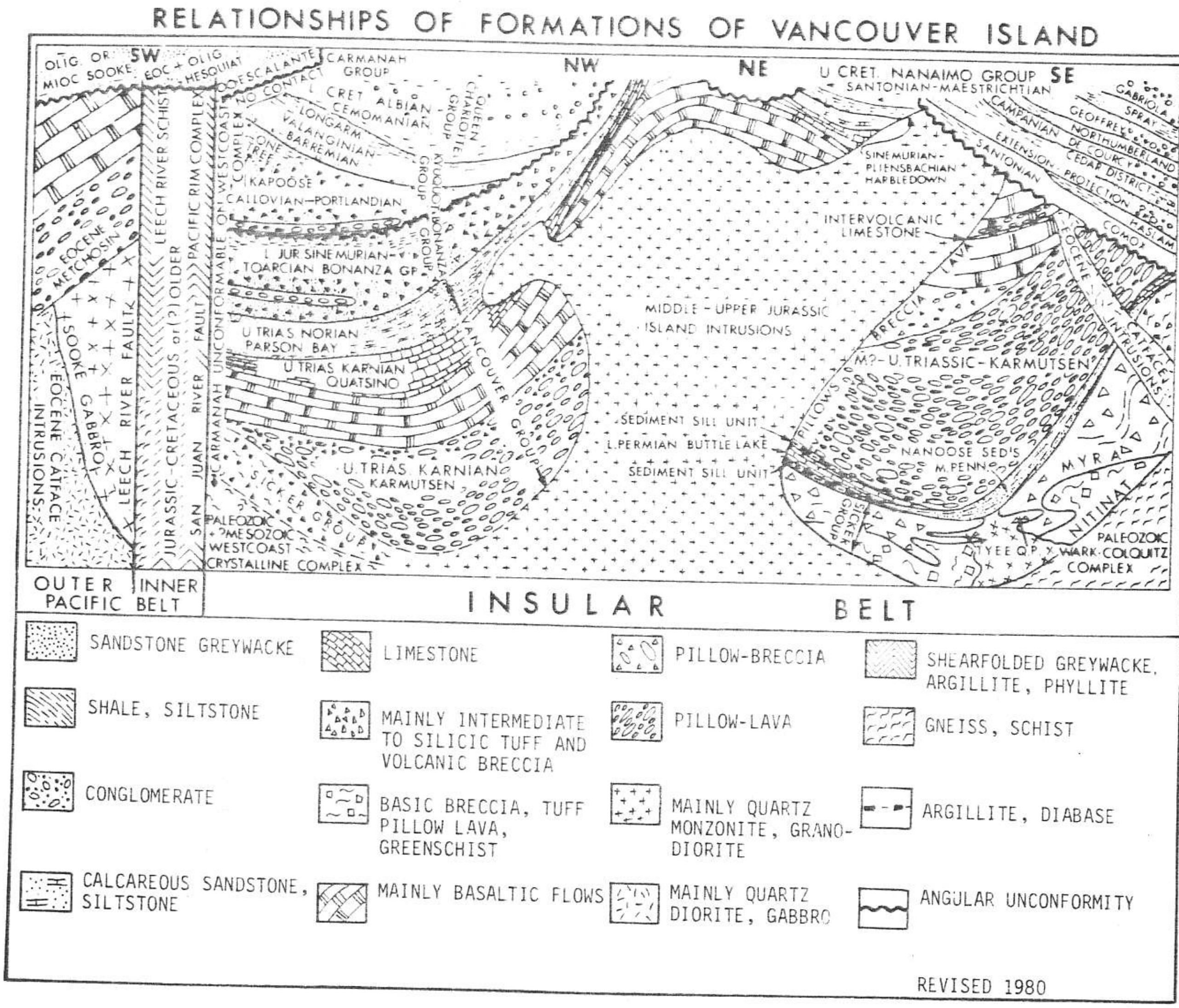


Figure D. Diagram of stratigraphic-structural relationships of formations of Vancouver Island (From Muller, 1981).

DAY 1:

WESTMIN RESOURCES' MASSIVE SULFIDE DEPOSITS

R.R. Walker

Westmin Resources Ltd., Campbell River, B.C.

INTRODUCTION

The Westmin Resources minesite is located at the south end of Buttle Lake at the centre of Vancouver Island. A 92 Km paved highway provides access from Campbell River. The Buttle Lake deposits occur as many individual ore bodies organized into several major zones. These ore zones are currently being mined underground from two mines - Lynx and Myra. Two mines, discovered in 1979, are in development stage - Price and H-W (Fig. 1). Production since start-up in 1966, to the end of 1982, has been from Lynx and Myra mines and has totaled 5,204,300 short tons which averaged 0.06 oz Au/T, 3.2 oz Ag/T, 1.5% Cu, 1.1% Pb, 7.6% Zn. Proven mining reserves in Lynx, Myra and Price mines at the end of 1982 totalled 1,021,000 short tons averaging 0.06 oz Au/T, 2.6 oz Ag/T, 1.0% Cu, 0.9% Pb, 7.4% Zn. Geological reserves in the H-W mines at the end of 1982 totalled 15,232,000 tons probable plus possible with a combined average grade of 0.07 oz Au/T, 1.1 oz Ag/T, 2.2% Cu, 0.3% Pb, 5.3% Zn.

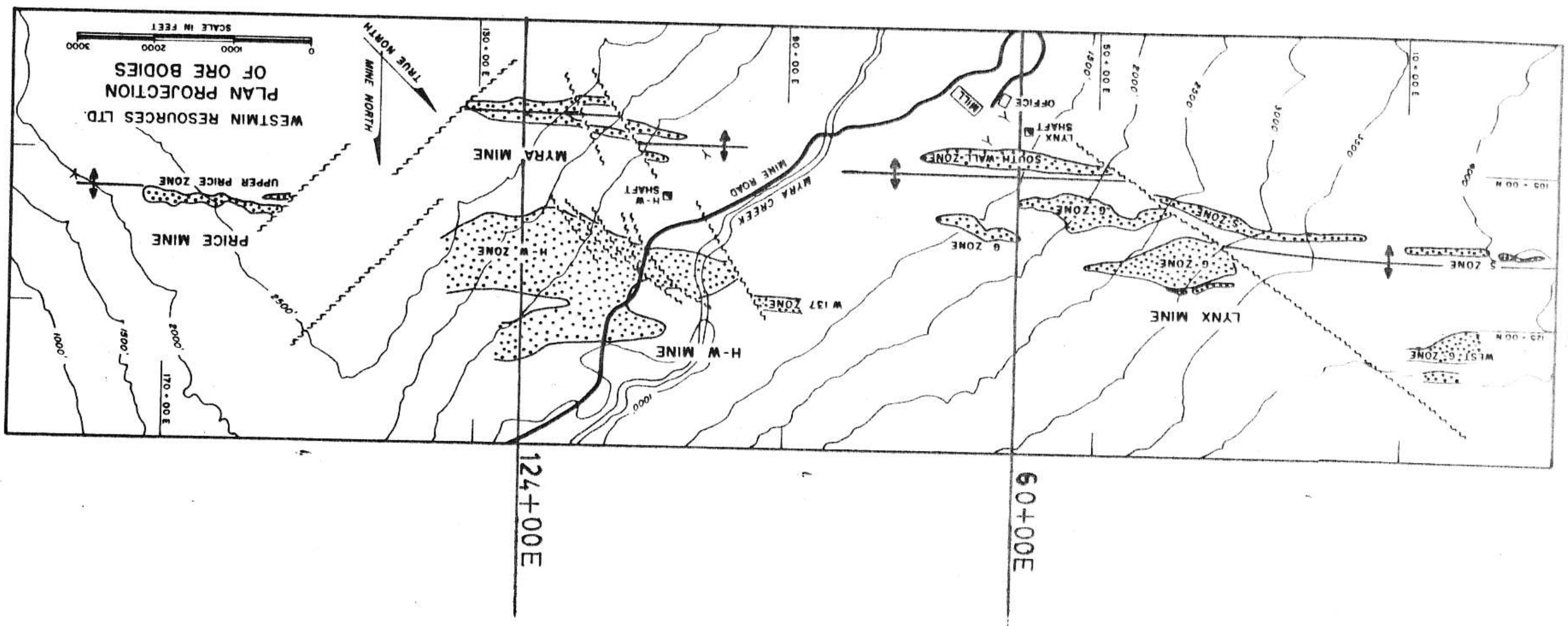
Westmin currently produces approximately 930 short tons of ore per day from Lynx and Myra mines. In conjunction with development of the H-W mine, the company is engaged in expanding production to 3000 tons per day. This expansion includes a new 2350 ft. shaft, mill, mine offices and surface tailings disposal system. Approximately 4 million dollars were invested in environmental control measures in 1982. A new ore zone, representing a significant extension of ore potential in the Lynx mine, was discovered in 1982.

GEOLOGICAL SETTING

The Buttle Lake deposits occur in the Myra Formation of the Sicker Group. The Sicker Group is the oldest stratigraphic unit recognized on Vancouver Island and has been subdivided into three formations by Muller (1980).

The Nitinat Formation is primarily composed of pyroxene and feldspar porphyritic, basaltic volcanics and volcaniclastics which form the lower part of the Sicker Group. Muller (1981) estimated the thickness of the Nitinat Formation at about 6000 ft. and it's age as Ordovician to Silurian.

The Myra Formation conformably overlies the Nitinat Formation and is composed of a variable sequence of differentiated and bedded volcanics, volcaniclastics and sediments. The volcanic component ranges from basalt to rhyolite. Sedimentary rocks are primarily volcanic graywacke with interbedded argillite and chert which range from black to green and gray with local jasper+magnetite. Muller (1981) estimated a thickness for the Myra Formation of about



Day 1 Figure 1. Plan projection of ore zones, Westmin Resources Minesite

3000 ft. although at Buttle Lake the formation appears to be greater than 6000 ft. thick. Age is possibly latest Silurian (Muller, 1980). In places a unit of graywacke, argillite and intercalated diabase sills lies at the top of the Myra Formation. This unit has been termed the Sediment-Sill Unit, estimated at about 1500 ft. thick, and has yielded Early Mississippian radiolaria (Muller, 1980).

The Buttle Lake Formation marks the top of the Sicker Group. It is composed primarily of limestone, commonly crinoidal, with associated chert, graywacke and argillite. The formation is about 500 to 1500 ft. thick and has been variously dated by paleontology as Middle Pennsylvanian and Early Permian (Muller, 1980).

The Sicker Group is exposed on Vancouver Island, primarily in three major areas or structural uplifts. The Buttle Lake ore deposits are exposed in the core of the Buttle Lake uplift. Only Myra Formation and Buttle Lake Formation rocks are exposed in this uplift. Throughout Vancouver Island, the Sicker Group appears to have been deformed and metamorphosed primarily in the greenschist facies. Folding and tectonic fabrics are variably developed but schistose and lineated rocks are common. Locally, amphibolite facies metamorphic rocks are exposed especially adjacent Jurassic Island Intrusions. A few K-Ar dates (Muller, 1980) suggests a metamorphic episode in the Early Jurassic, consistant with the age of the Island Intrusions and contemporaneous Bonanza Group volcanics.

The general geology of the Buttle Lake area is illustrated in Figure 2 from Muller (1981).

MINE GEOLOGY

Known occurrences of ore and rhyolite in the mine area are limited to a stratigraphic zone approximately 1500 ft. thick. This mine sequence is underlain by primarily andesitic volcanic and volcaniclastic rocks and is overlain by a thick unit of bedded tuff or volcanic wacke with interbedded green to gray chert. This overlying unit is in the order of 1500 ft. thick and is locally called the sharp banded tuff unit. A few thousand feet of volcaniclastic rocks, primarily lapilli tuff with some coarser breccias, overlie the sharp banded tuff and are in turn overlain by the Buttle Lake Formation. Major, sill-like units of diabasic-textured, basaltic rock are intercalated within the sharp banded tuff unit and overlying stratigraphy.

Mine Sequence

The stratigraphic zone which hosts the Buttle Lake orebodies is characterized by complex stratigraphy involving a wide range of volcanic, volcaniclastic and sedimentary rocks. The volcanic component includes basalt, andesite dacite and rhyolite. All of these rock types occur both as extrusive massive phases and as fragments in extensive volcaniclastics which range from monolithic to heterolithic. The volcaniclastics range from fine tuff to coarse breccias and include in situ brecciated phases of massive volcanic rocks. The mine sequence is predominantly basaltic to andesitic and predonimantly volcaniclastic. Subordinate sediments include black argillite and siltstone, black, green, gray and red chert, massive sulfide and barite.

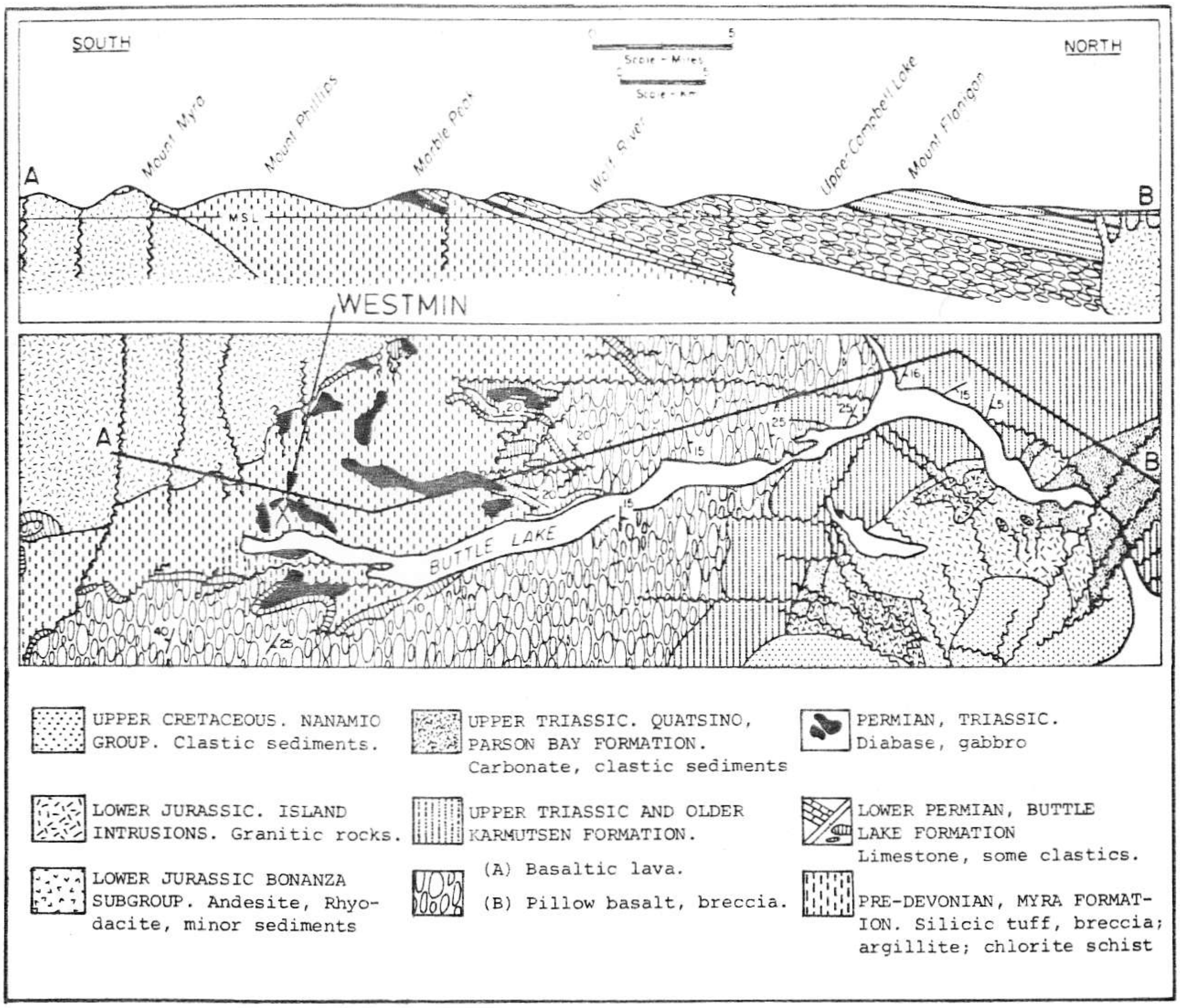


Figure 2. General geology of Buttle Lake area (from Muller, 1981).
Day 1

The mine sequence is variably bedded but individual bedding units are lensiodal and discontinuous. Bedding varies from laminations and thin beds in chemical sediments and fine volcaniclastic to very thick (several tens of feet or more) in coarse volcaniclastics and flow units. Graded beds are common especially in the size range from fine tuff to coarse lapilli, but grading is also recognized in coarser clastics. Graded beds in general appear to fine upwards in a single cycle. The bedded volcaniclastic rocks are fair to well sorted with better sorting in the finer clastics. The coarse clastics are relatively matrix-poor with generally less than 15 to 20 percent apparent matrix. Individual clasts are predominantly angular to subangular. Mixed volcaniclastics contain fragments of all rock types mixed in widely varying proportions. Locally fragments include tuff, argillite, chert, jasper, massive sulfide and barite. The volcaniclastics at Buttle Lake appear to have been deposited primarily by cold, submarine density flows and turbidity currents although hot ash flow deposits may be present locally.

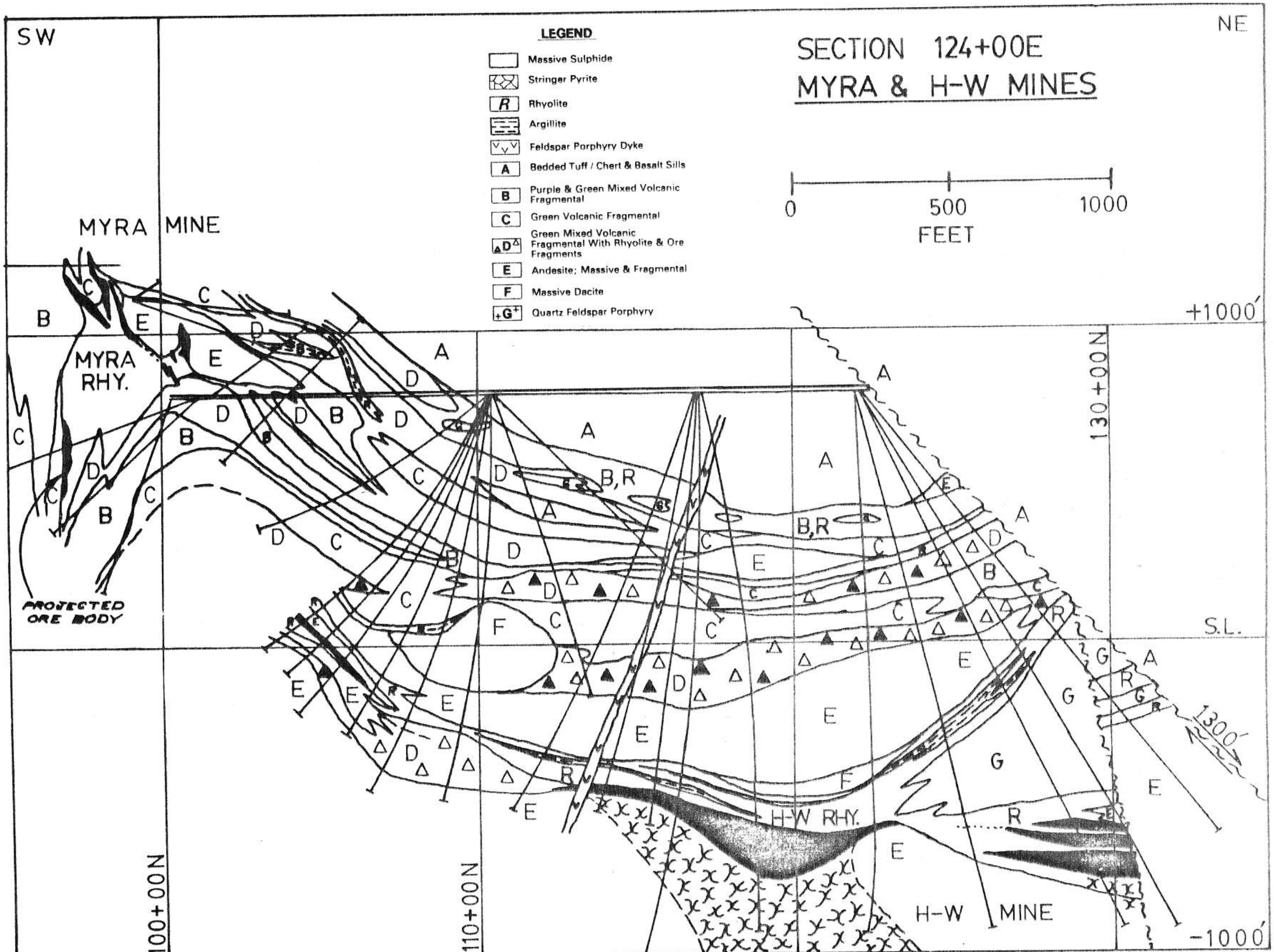


Figure 3. Cross section through Myra and H-W mine areas. See Fig. 1 for section location.

Day 1

The mine sequence is characterized by extremely rapid lateral facies variations. These variations are most pronounced in a northeast-southwest direction. Continuity of units and stratigraphic zones is best developed in a northwest-southeast direction parallel to the strike and trend of ore zones. Despite lateral facies variations, there is a recognizable vertical stratigraphic ordering within the mine sequence.

The base of the mine sequence is marked by the H-W rhyolite, the lowest rhyolite unit which has been recognized and correlated through the mine property. It is apparently the most extensive and locally thickest rhyolite recognized. It varies from a thin, bedded zone of black argillite and rhyolite tuff to a complex assemblage of various rhyolite phases aggregating up to more than seven hundred feet thick. The H-W rhyolite is composed of predominantly clastic rocks ranging from coarse breccia to fine tuff. Massive and in situ brecciated rhyolite phases are present locally and appear to represent domes up to 400 ft. thick. The rhyolite varies from non-porphyritic to strongly quartz and feldspar porphyritic. This rhyolite unit is host to the H-W orebody which lies principally at or near the base of the rhyolite.

The H-W rhyolite is overlain by several hundred feet of complex stratigraphy distinguished by the presence of extensive units of coarse, mixed clastics which contain a small proportion of rhyolite clasts and a very small proportion of massive sulfide clasts. These predominantly andesitic clastics are interclalated with andesite flow units and flow to dome-like units of massive siliceous dacite. Individual andesite and dacite flows range up to a few hundred feet thick. This stratigraphic interval is locally called the ore clast breccia zone although much of the interval consists of non-rhyolitic mixed clastics which lack sulfide clasts, and a significant proportion consists of finer clastics - tuff to lapillistone with minor chert beds. The occurrence of sulfide clasts is not limited to this interval. Locallized lenses of rhyolite tuff to lapilli tuff occur throughout the ore clast breccia zone.

The Lynx-Myra-Price rhyolite unit occurs at, or near the top of, the ore clast breccia zone and hosts the orebodies of Lynx, Myra and Price mines. The rhyolite is composed of predominantly sorted tuff to lapilli-tuff with some coarser fragmentals and possibly massive phases occuring principally near the south-east end of Lynx mine. The rhyolite clastics vary from apparently non-porphyritic to quartz and feldspar porphyritic. Well developed bedding is recognized in places and ranges from laminations in fine tuff to thick beds graded from coarse lapilli size to fine tuff.

The Lynx-Myra-Price rhyolite has been documented over a strike length of 19,000 ft. in a northwest-southeast direction and over this entire length is host to many individual ore lenses which occur primarily at the top of and within the rhyolite. On cross sections oriented northeast-southwest, this rhyolite varies from a broad sheet-like layer more than 3500 ft. on dip length at the northwest end of Lynx mine to a narrow thick lens several hundred feet wide in Price mine to the southeast. The rhyolite varies in thickness from zero to perhaps as much as a few hundred feet although a few tens to several tens of feet is typical.

The long axis of the Lynx-Myra-Price rhyolite is coincident with a flat, northwest trending, anticline axis with ore lenses lying on both limbs. The

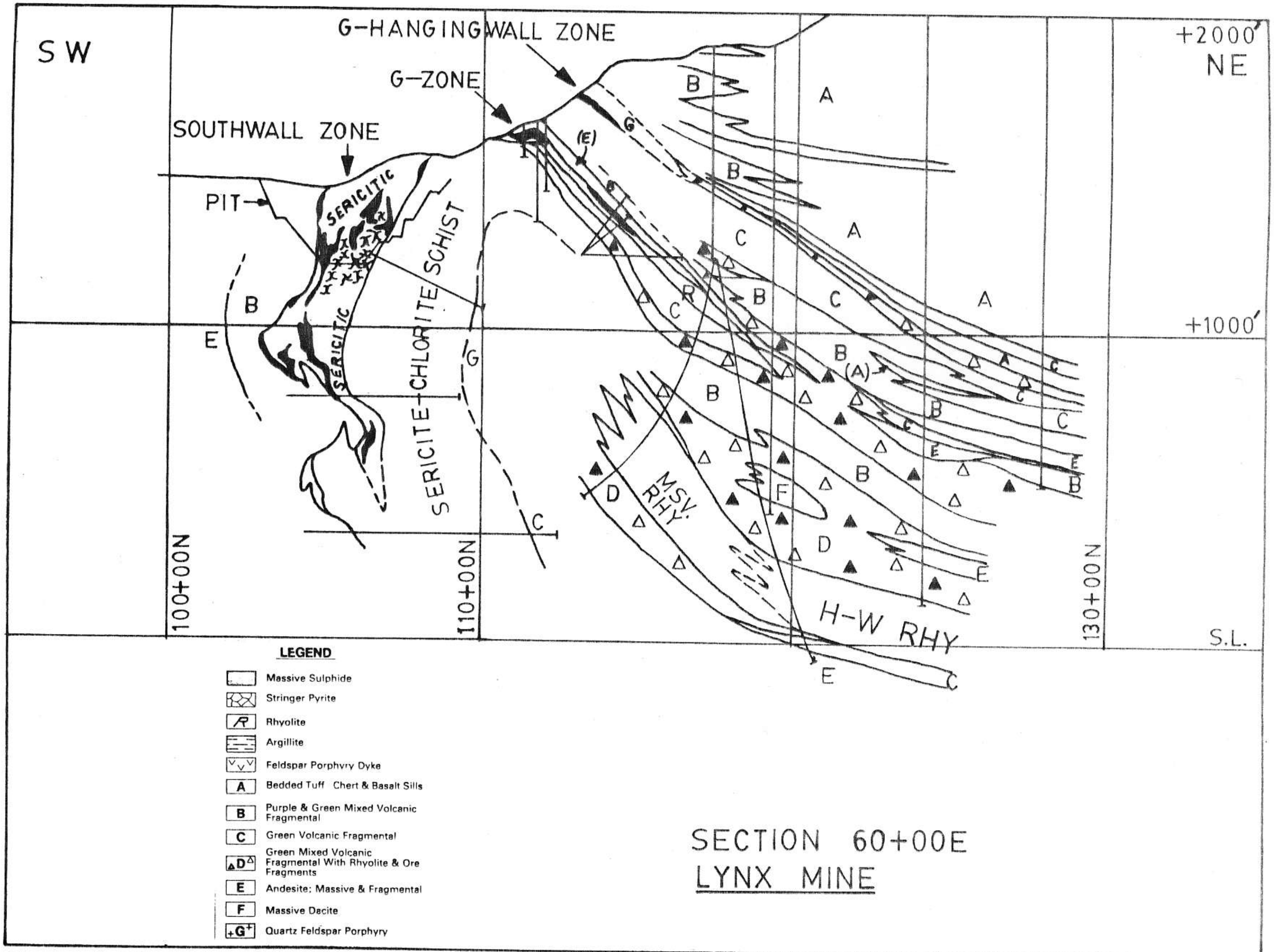


Figure 4. Cross section through Lynx mine
Day 1

anticline is asymetric with a steep, northeast dipping axial plane parallel to the predominent schistosity. The northeast limb dips on average about 30 to 40 degrees northeast whereas the dip of the southwest limb averages vertical and varies from 50 degrees southwest to 70 degrees northeast. The average vertical dip of the southwest limb has been documented in Lynx mine over an elevation range of 2000 ft. In Myra mine the rhyolite lens appears compressed in the axis of the anticline and has a dip length in the order of 1000 ft. (total of both limbs). Present form varies from nearly isolclinal to asymetric. In Price mine the rhyolite has a dip length of several hundred feet and hosts massive sulfide principally on the northeast limb which dips about 40 to 50 degrees northeast. The southwest limb hosts only minor massive sulfide and dips near vertical to steep southwest. The Lynx and Myra ore zones have been separated by erosion in Myra Valley which cut down through the anticline axis. The Myra and Price ore zones were separated by displacement on a major cross fault.

The Lynx-Myra-Price rhyolite and ore is commonly, but not everywhere overlain by flow units of basalt or andesite. This relationship is best developed in Lynx and Myra mines where flow units range up to several tens of feet thick and commonly contain minor fragments of jasper. In rare instances limited jasper lenses have been observed close to the top contact of ore lenses in both north and south limbs of the anticline. Jasper is not unique to this stratigraphic position but its occurrence here is noteable. In addition to these mafic flow units, the stratigraphy above the Lynx-Myra-Price rhyolite includes variable, fine to coarse, mixed volcaniclastics with or without clasts of rhyolite and massive sulfide.

A third major laterally extensive rholite horizon lies about 200 to 500 feet above the Lynx-Myra-Price rhyolite and has to date been recognized only on the northeast limb of the Lynx and Myra mines. This rhyolite, named the G-hanging wall rhyolite, is in large part distinctly quartz and feldspar porphyritic and varies from zero to at least 150 ft. thick. It includes massive and clastic phases, and associated black argillite and black chert. This rhyolite hosts at least limited massive sulfide lanses in Lynx mine and was the source of limited production where it was exposed in the Lynx pit. This rhyolite unit lies very close to the transition into the overlying sharp banded tuff unit. The stratigraphic and structural relations of the G-hanging wall rhyolite in Lynx mine are as yet poorly understood.

Inherent in the mine sequence is an upward stratigraphic zonation from nonhematitic rocks to hematitic rocks which generally occur within the upper third to half of the mine sequence. Hematitic units are primarily defined by purple and green volcaniclastics in which some, but rarely all, of the clasts are colored various shades of dark purple or mauve due to microscopic dissemination of hermatite "dust". These purplish volcanic clasts are mixed in all proportions with the otherwise similar, green to gray clasts of basalt, andesite or dacite. Locally some clasts show purple rims around greenish cores or vice-versa. Uncommonly, clasts exhibit up to several alternating, concentric rings of purple and green coloration. In some areas purple clasts are preferentially dacite and are mixed with green mafic and dacite clasts. In places, purple and green clastics contain minor, angular chips, up to several millimeters, of massive dark red hematite. Locally, occasional jasper clasts of all sizes are found. Massive dacite units within purple and green zones may be mauve and massive mafic flows commonly contain streaks and seams of dark red hematite or occasional fragments of jasper. Fine tuffs and argillaceous rocks may be dark maroon.

In general, fragments of massive sulfide do not occur in purple and green mixed clastics and rhyolite clasts in purple and green beds are recognized only in association with the G-Hanging wall rhyolite unit.

Purple and green intervals are typically intercalated with green intervals on a scale that ranges from individual beds to broader intervals encompassing many beds and flows. The overall purple and green zone, which encompasses many alternating purple and green intervals, is in part intercalated with the upper part of the ore clast breccia zone and in part overlies the ore clast breccia zone. From the area of the Price mine, through Myra mine, to the southeast end of Lynx mine, the base of the purple and green zone occurs somewhat below the level of the Lynx-Myra-Price rhyolite and ore. Through the central and northwest parts of Lynx mine, the base of the purple and green zone lies immediately above the Lynx rhyolite. To the northeast, down-dip from Lynx mine purple and green intervals appear to stack downwards into somewhat lower stratigraphic levels. From these lower limits, purple and green intervals extend at least up to the base of the sharp banded tuff unit which overlies the mine sequence. The purple and green zone in general, as well as individual purple and green intervals within the zone are used as important guides for stratigraphic correlation.

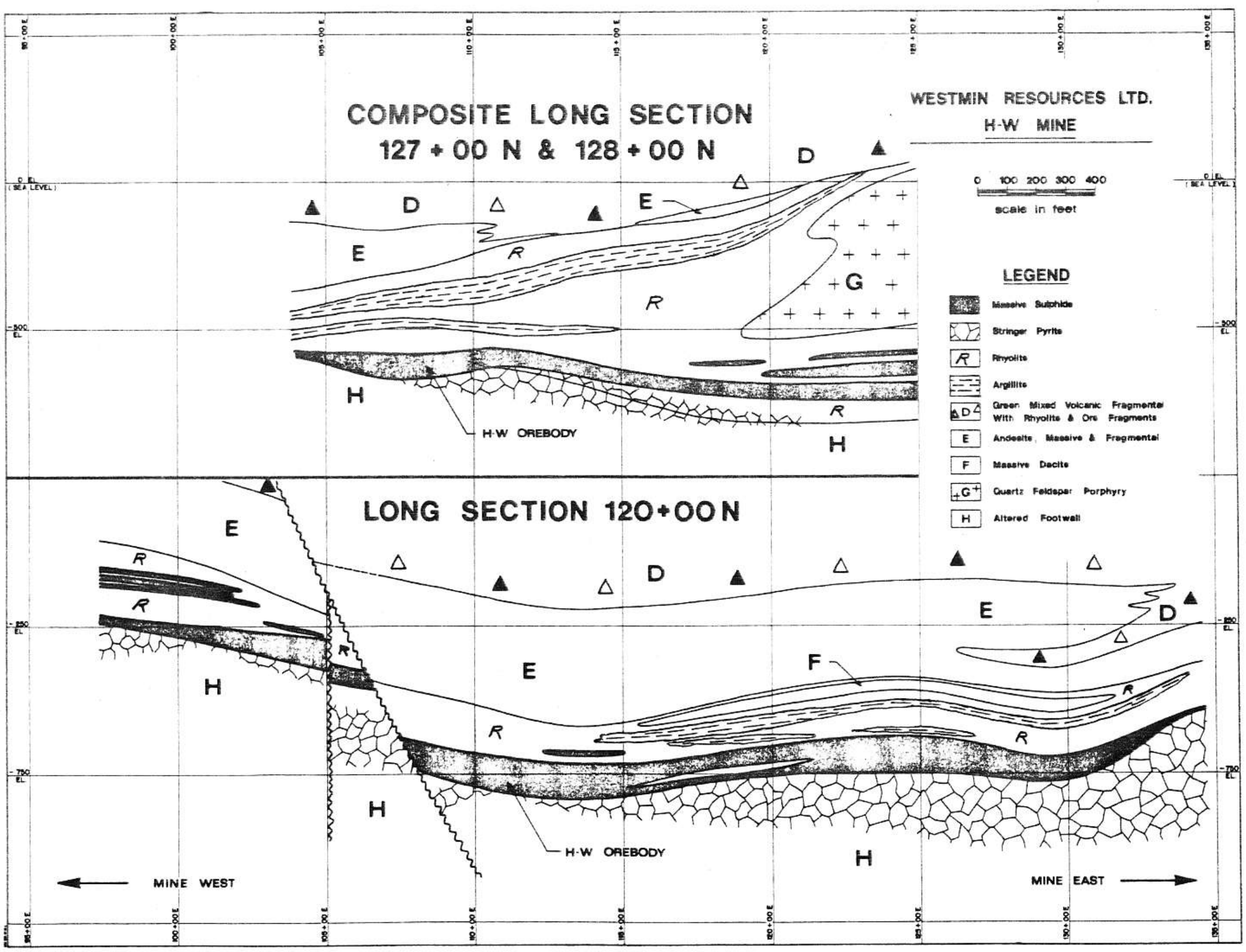


Figure 5. Longitudinal sections through H-W mine
Day 1

In summary, the mine sequence is a complex heterolithic zone, approximately 1500 ft. thick, characterized by bedded, mixed volcaniclastics, volcanic flows and subordinate chemical sedimentary rocks. Individual lithologic units are discontinuous with a distinct northwest-southeast trend. The sequence is predominantly mafic, with major rhyolitic units which host ore recognized at the bottom, middle and top of the mine sequence. Localized rhyolite and sulfide occurrences are found throughout. Despite rapid lateral facies variations, a general ordering of litho-stratigraphic zones is recognized within the mine sequence. In current mine terminology, the general order of these overlapping and intercalated lithologic zones is, from bottom to top: H-W rhyolite, ore clast breccia zone, Lynx-Myra-Price rhyolite, purple and green zone and G-hanging wall rhyolite.

Structure and Metamorphism

The Myra Formation at Buttle Lake appears to have been affected by regional dynamothermal metamorphism. The metamorphic facies is apparently lower greenschist and deformational rock fabrics are variably developed. The preceeding description of the mine sequence has been in terms of inferred primary lithologies. However, many of these rocks are intensely deformed and inferences about the original lithologies are commonly difficult to draw. For this reason, many rock units have a long history of description as schists and in some cases little else can be done. The mine production mapping system has been, and still is, focused on the key lithologies termed sericite schist, sericite-chlorite schist and chlorite schist. These schists are very fine grained and typically phyllitic in appearence. The predominant strike of schistosity through the mine property is northwest. Although the dip of schistosity shows considerable variation it averages 75 to 85 degrees northeast.

Schistosity surfaces show a pronounced mineral lineation which varies in plunge from about 10 degrees northwest to 10 degrees southeast. Rock fragments in volcaniclastic lihhologies are commonly enlongate parallel to this mineral lineation with little or no flattening parallel to schistosity. Length to width ratios of these stretched clasts in places exceeds 10:1. Many rocks appear stretched even where schistosity is very weakly developed or not apparent. In general, the lineation formed by sericite and chlorite and the long axes of stretched clasts parallels the hinge (b-axis) of the megascopic anticline described previously, as well as the hinges of widespread mesoscopic folds. The stretched but non-schistose rocks could be described as b-tectonites. A prominant fracture direction is developed parallel to the a and c fold axes. This fracture set varies from simple joints, to quartz and carbonate filled tension joints, to a crenulation fracture cleavage in some schists.

Deformational rock fabrics vary widely in their degree of development from not apparent to very strong and penetrative. In general, sericitic rocks are most schistose with chlorite schists more locally developed adjacent sericite schists. Large volumes of chloritic, mafic meta volcanic rocks are not schistose. Schistosity tends to be more strongly developed in proximity to ore and in apparent hydrothermal alteration zones beneath ore.

Small scale (mesoscopic to a few hundred feet) fold structures are common and are best defined in massive sulfides and associated sericite schists. Fold geometry is commonly complex in cross sections but axes typically trend northwest with flat plunge.

Post-metamorphic, brittle deformation of more than one age has produced abundant faults and fractures of many different orientations. Faults with offsets up to 2800 ft. have been documented. Zones of gouge and broken ground are common, especially marginal to massive sulfide and along major faults. Such zones commonly require timber support.

Ore and Alteration

Orebodies at Buttle Lake are primarily lensoidal beds of massive sulfide which have been variably folded and disrupted by faults. The principle minerals are pyrite, sphalerite, chalcopyrite, galena and barite. Minor minerals include tennantite, bornite, and pyrrhotite. Traces of gold or electrum and arsenopyrite have been recognized although the ore mineralogy has not been sytematically studied. Composition of the massive sulfide varies widely both within lenses and among lenses. As an example the H-W orebody averages 70 weight percent pyrite whereas the Lynx, Myra and Price ores average about 15 weight percent pyrite. The H-W orebody exhibits strong lateral zoning from a massive pyrite central portion with high copper to zinc ratio to a sphalerite and barite rich marginal phase with low copper to zinc ratio and significant lead. Higher silver concentrations are associated with lead and barite rich ores but gold is more uniformly distributed.

Ore textures are primarily fine grained and massive or banded. Locally fragments of wallrock are included in massive sulfide but ore composed of sulfide clasts is not apparent. Ore clasts are widespread in the mine sequence but are typically dispersed in small proportions in volcaniclastic rocks.

Ore-related alteration has been metamorphosed and is now manifested by broad zones of pyritic, sericitic schist. Within the more extensive sericitic schists, which contain a few percent disseminated pyrite, three seperate zones of pyrite stringer mineralization have been recognized. The largest pyrite stringer zone underlies the H-W orebody. Here the pyrite content ranges from several to more than 30%. The pyrite is typically coarsely crystalline (a few to several millimeters) in contrast to the overlying, typically fine grained, massive pyrite. Individual stringers are composed of pyrite and quartz and range up to at least a few feet thick. Rarely does such stringer mineralization contain economic copper grades and then only directly under massive ore. A similar pyrite stringer zone underlies massive ore in the south wall zone of Lynx Mine (southwest limb of the Lynx anticline). This stringer zone lies near the southeast end of Lynx and is exposed in the old open pit where the field party will examine exposures. A smaller stringer zone, unusual in it's copper content, has been mined from Myra mine. Smaller zones of galena and sphalerite bearing stringer mineralization are recognized generally peripheral to, or away from, the major pyrite stringer zones described above.

FIELD STOPS

The field excursion will be given a surface tour comprising the following stops briefly enumerated here. Supplementary location and descriptive material will be made available on-site.

STOP 1: Upper Lynx Pit

The first exposure will be a sectional view of a massive sulfide lens exposed on a northeast-southwest oriented bench face. The lens is in G-zone on the northeast limb of the Lynx anticline. The same ore lens will then be examined along strike a few hundred feet northwest. From here the party will traverse a bench which transects the Lynx anticline from northeast to southwest, finishing in the southwest limb of the ore horizon. The traverse will be at about +1600 ft. elevation on mine section 56+50E from 110+50N to 105+50N (refer to Fig. 4).

STOP 2: Lower Lynx Pit

A major pyrite stringer zone is exposed along the northeast wall of the lower pit. This position is northeast of, or stratigraphically below, massive sulfides in the southwall zone of Lynx Mine. The exposures examined are at about +1090 elevation on mine section 69+00E at 106+50N (refer to Fig. 4).

STOP 3: Drill Core

A drill hole through the complete mine sequence, including the H-W orebody, will be reviewed. A summary log will be available.

STOP 4: Ore Stockpile

A stockpile of high grade ore from a small lens in Lynx lower pit will be examined. This ore lens in part overlies directly the stringer zone examined at stop 2.

STOP 5: Sharp Banded Tuff Unit

2.0km from mine gate

A road-cut exposure of the sharp banded tuff unit will be examined. This unit directly and conformably overlies the mine sequence. Thin to thick beds of mafic tuff or graywacke are interbedded with thin bedded to laminated chert to cherty tuff. Some graded beds can be recognized. A feldspar porphyry dyke is exposed.

3.0km: Bridge over Thelwood Creek.

STOP 6: South end of Buttle Lake

3.5km

Bedded mixed volcaniclastics of the Myra Fm. are exposed in a road cut. The rocks range from very thin to medium bedded green tuff-wacke to very thick beds of coarse, heterolithic breccia containing clasts up to 3 ft. Clasts are mafic to felsic with minor quartz eyes locally detectable. Bedding dips 35 degrees southwest with occasional graded beds indicating right way up.

STOP 7:

7.2km

Outcrops over a few hundred feet along the road illustrate folding and deformational textures. The rocks vary from thin bedded fine tuff-wacke with cherty laminations to medium bedded lapillistone. Bedding strikes northwest with dip ranging from vertical to horizontal both southwest and northeast. Phyllitic schistosity dips 90 degrees to 75 degrees NE and is variably developed. Lineation plunges 0 to 15 degrees SE. Prominant a-c joints dip 90 degrees to 75 degrees NW. The hinge zone of a mesoscopic concentric anticline is well exposed. The hinge trends NW with flat plunge. On the northeast flank of this fold schistosity becomes more intense and the dip steepens.

11.7km Ralph River Bridge

STOP 8: Ralph River Boat Ramp
15.6km

Buttle Lake Formation limestone is exposed in road cuts. The crinoidal limestone is variably recrystallized to marble. The shallow dip is predominantly north to northeast. One interval several feet thick is an intraformational, coarse, limestone breccia. A chert bed up to 10 ft. thick occurs within the limestone which locally contains nodules and ribbons of chert. A thick diabase sill (?) overlies the limestone to the north.

STOP 9:
30.9km

Karmutsen Formation basalts are exposed in large road cuts. These pillowed basalts are from the lower pillowed interval of the Karmutsen Formation. Pillows have interstitial spaces filled with quartz, hyaloclastite and minor gray chert. Stacked lenses of quartz within pillows have flat bottoms and convex-up tops which can be used as dip and facing indicators. One large lava tube about 15 ft. across is about two thirds filled with basalt and one third filled with quartz containing angular basalt clasts from the top of the tube.

STOP 10:
34.5km

Roadcuts and boulders are of basaltic pillow breccia and hyaloclastite from the middle unit of the Karmutsen Formation. Broken pillow breccia with clasts several inches across is matrix supported with hyaloclastite matrix. Some bedded hyaloclastite exhibits beds 4 inches to a few feet thick which are in part graded from coarse to fine reworked hyaloclastite.

37.5km: Gold River Bridge

STOP 11:
45.7km

Massive basalt flows from the upper unit of the Karmutsen Formation. The basalt is variably amygdaloidal with tight flow contacts.

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