GSA, Field Trip 1985

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WESTMIN RESOURCES' MASSIVE SULFIDE DEPOSITS, VANCOUVER ISLAND

TRIP 1

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INTRODUCTION

Westmin Resources Ltd. is currently conducting mining and milling operations at their Myra Falls mine site located near the south end of Buttle Lake in the center of Vancouver Island (Fig. 1). A 90 km paved highway provides access from Campbell River.

The Myra Falls deposits occur as many individual ore bodies grouped into several major zones (Fig. 2). These ore zones are currently being mined underground from two mines - Lynx and Myra - at a rate of 930 short tons/day. These two mines have provided all production since start-up in 1967. Production to the end of 1983 totalled 5,478,087 short tons which averaged 0.06 oz Au/T, 3.3 oz Ag/T, 1.5% Cu, 1.1% Pb, 7.6% Zn.

The Price zone, discovered in 1979, represents a modest extension of reserves demonstrated through underground development and definition drilling, but has not yet been scheduled for production. The West G zone, discovered in 1982, represents a significant addition to reserves in the Lynx Mine and provided initial production in the latter part of 1984. Proven and indicated reserves in Lynx, Myra and Price mines at the end of 1983 totalled 1,243,000 short tons averaging 0.07 oz Au/T, 2.3 oz Ag/T, 1.0% Cu, 0.9% Cu, 0.9%Pb, 7.7% Zn.

The H-W ore body, discovered at the end of 1979, is being developed as a major, new, underground mine which will substantially transform operations at Myra Falls. Reserves in the H-W mine, at the end of 1983, totalled 15,232,000 short tons averaging 0.07 oz Au/T, 1.1 oz Ag/T, 2.2% Cu, 0.3% Pb, 5.3% Zn. In conjunction with development of the H-W mine, Westmin is engaged in expanding production to 3000 short tons per day. New facilities include a 2335 foot shaft, mill, offices, shop, surface tailings disposal system and hydroelectric power plant. H-W production will commence in mid 1985.

GEOLOGICAL SETTING

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, including the Paleozoic Sicker Group, Triassic Vancouver Group and Jurassic Bonanza Group (Fig. 3 to 5), has been recognized as part of an allocthonous terrane derived from more southern latitudes (Muller, 1977, Jones et al., 1977, Muller, 1981 and Jones et al., 1982). This major terrane has been named Wrangellia by Jones et al. (1977).

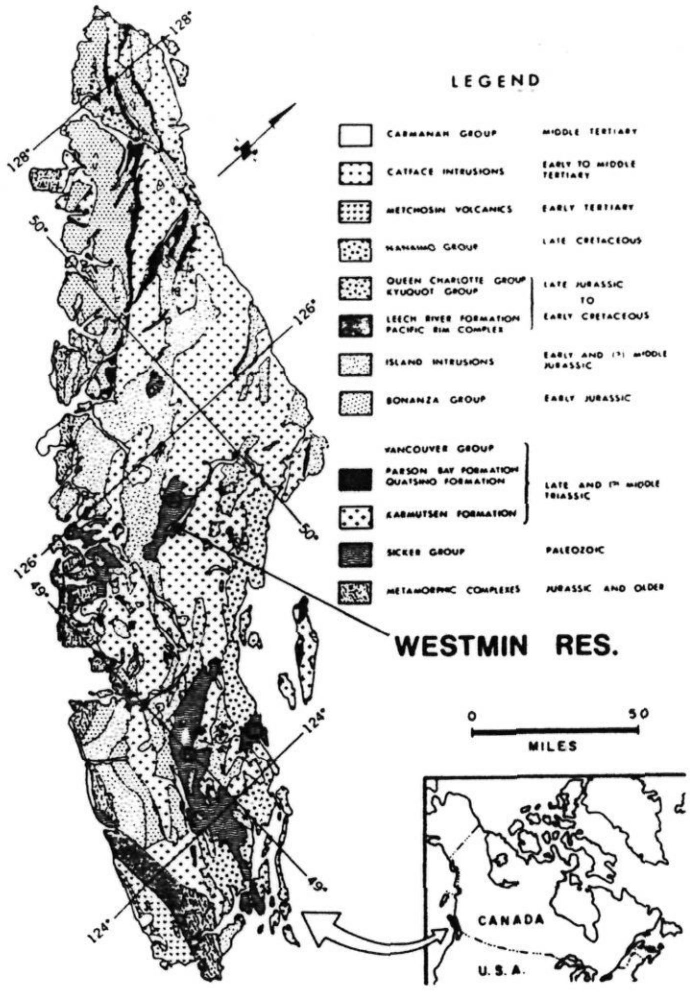

Figure 1. After Muller, 1981.

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 feet and its 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 greywacke with interbedded argillite and chert which range from black to green and grey with local jasper-magnetite beds. Muller (1981) estimated a thickness for the Myra Formation of about 3000 feet although at Buttle Lake the Formation appears to be greater than 6000 feet thick. Age is possibly latest Silurian (Muller, 1980). In places a unit of greywacke, argillite and intercalated diabase sills lies within the top of the Myra Formation. This unit has been termed the Sediment-Sill Unit, estimated at about 1500 feet 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, greywacke and argillite. The formation is about 500 to 1500 feet 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 green-schist 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) suggest a metamorphic episode in the Early Jurassic, consistent with the age of the Island Intrusions and contemporaneous Bonanza Group volcanics.

The general geology of the Buttle Lake area is illustrated in Figure 6 from Muller (1964).

MINE GEOLOGY

Known occurrences of ore and rhyolite in the mine area are limited to a stratigraphic zone approximately 1500 feet 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 grey chert. This overlying unit is

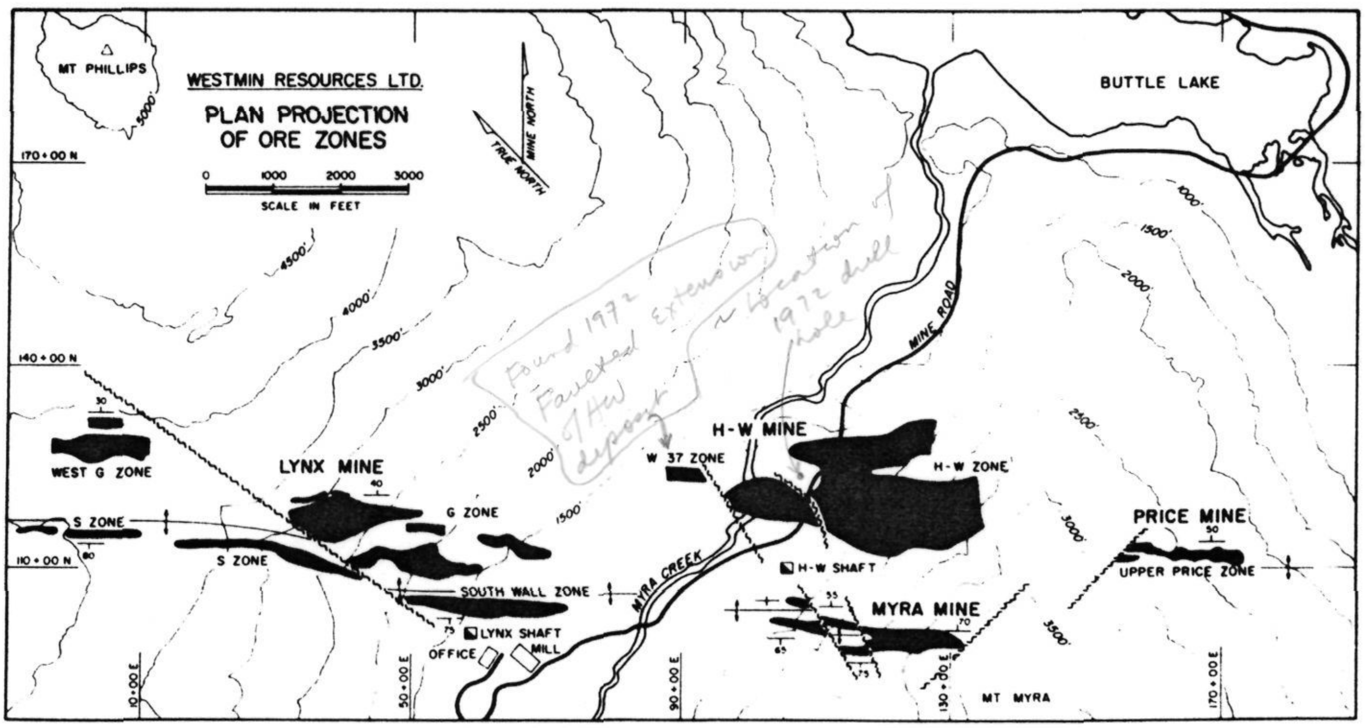

Figure 2.

in the order of 1500 feet 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.

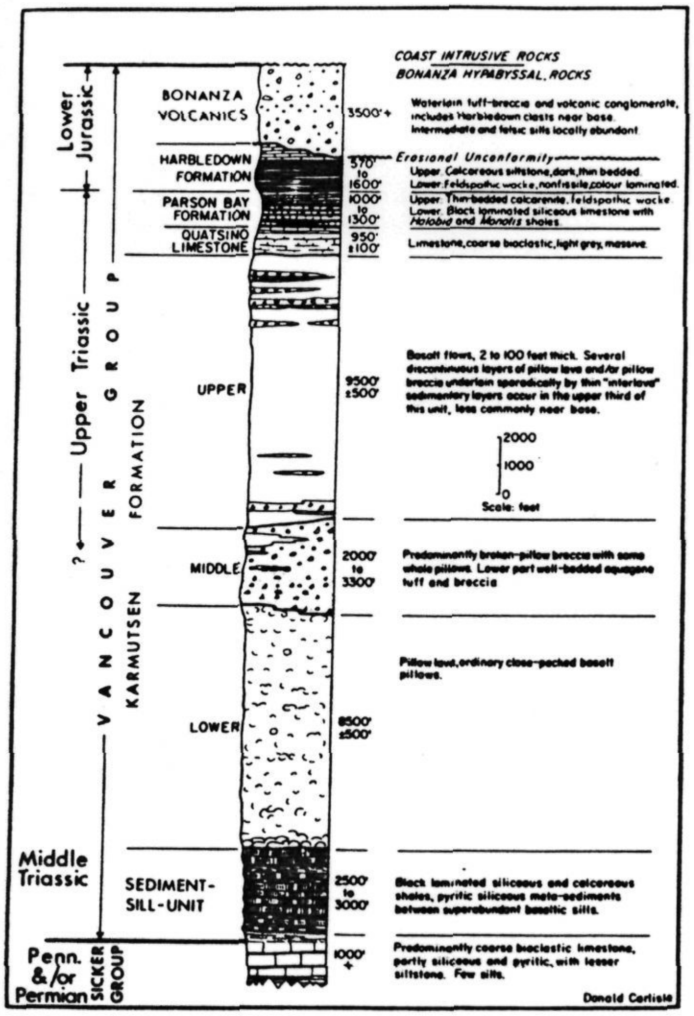

Figure 4. From Muller et al., 1974

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 breccia and include in situ brecciated phases of massive volcanic rocks. The mine sequence is predominantly basaltic to andesitic and predominantly volcaniclastic. Subordinate sediments include black argillite and siltstone, black, green, grey and red chert, massive sulfide and barite.

The mine sequence is variably bedded but individual bedding units are lensoidal 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 volcaniclastic 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% 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.

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 feet 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

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	mpl ss		conglomerate sandstone shale
		EOCENE to	CARMANAH	HESQUIAT	eolc	1500	sandstone siltstone conglomerate
		OLIGOCENE		ESCALANTE	ele	300	conglomerate sandstone
		early EOCENE		METCHOSIN	elm	3000	basaltic lava, pillow lava breccia tuff
MESOZOIC	LATE	MAESTRICHTIAN ?	NANAIMO	GABRIOLA	uKGa	350	sandstone conglomerate
				SPRAY	uKs	200	shale siltstone
				GEOFFREY	uKG	150	conglomerate sandstone
				NORTHUMBERLAND	uKn	250	siltstone shale sandstone
		CAMPANIAN		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 CHARLOTTE	Conglomerate Unit	lKqc	900	conglomerate, greywacke
		APTIAN ?		Siltstone-Shale Unit	lKqp	50	siltstone, shale
		VALANGINIAN BARREMIAN	KYUQUOT	LONGARM	lKl	250	greywacke conglomerate siltstone
	JURASSIC LATE / MID	TITHONIAN CALLOVIAN		ONE TREE	lKot	300	siltstone argillite conglomerate
				KAPOOSE	uJK		
	JURASSIC EARLY	TOARCIAN ? PLIENSBACHIAN SINEMURIAN	BONANZA	Volcanics	lJb	1500	basaltic to rhyolitic lava, tuff, breccia, minor argillite, greywacke
				HARBLEDOWN	lJh		argillite, greywacke tuff
	TRIASSIC LATE	NORIAN	VANCOUVER	PARSON BAY	uTrpb	450	calcareous siltstone greywacke silty limestone, minor conglomerate breccia
		KARNIAN		QUATSINO	uTrq	400	limestone
				KARMUTSEN	muTrk	4500	basaltic lava, pillow lava breccia, tuff
	TRIASSIC MID	LADINIAN		Sediment-Sill Unit	Tds	750	metasiltstone diabase, limestone
PALEOZOIC	PENN. and EARLIER ? PERM.		SICKER	BUTTLE LAKE	CPbl	300	limestone chert
				"NANOOSE"	CPss	600	metagreywacke argillite, schist, marble
				Sediment-Sill Unit	PTds	500	metagreywacke, argillite diabase
	DEV. or EARLIER			MYRA	Pm	1,000	silicic tuff, breccia argillite
				NITINAT	PN	2000	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		32-39	quartzdiorite trondhjemite agmatite porphyry
SOOKE INTRUSIONS basic	Tgb		31-49	gabbro anorthosite agmatite
METCHOSIN SCHIST GNEISS	Tmn		47	chlorite schist gneiss 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	PMmg	264	163-192	quartz-feldspar gneiss metaquartzite marble
WESTCOAST COMPLEX basic	PMmb			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 3. From Muller, 1981.

RELATIONSHIPS OF FORMATIONS OF VANCOUVER ISLAND

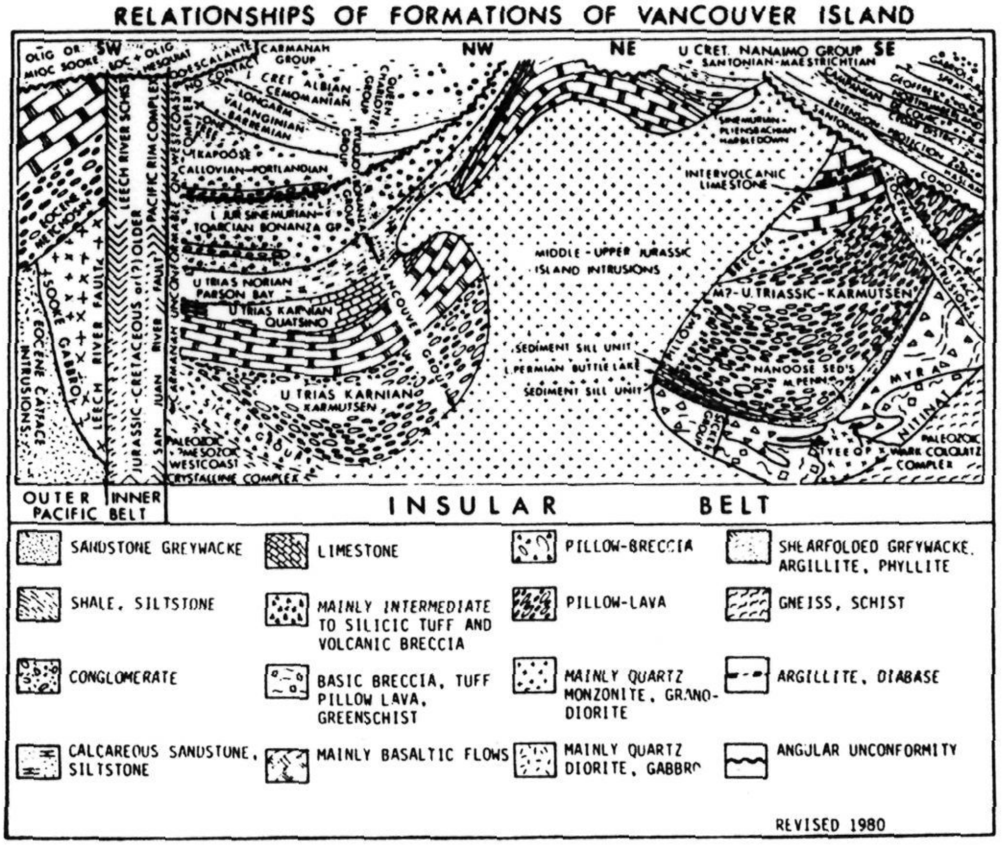

Figure 5. Diagram of stratigraphic-structural relationships of formations of Vancouver Island. From Muller, 1981.

very small proportion of massive sulfide clasts. These predominantly andesitic clastics are intercalated 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. Localized lenses of rhyolite tuff to lapilli tuff occur throughout the ore clast breccia zone.

The Lynx, Myra and Price ore zones lie within a stratigraphic interval up to approximately 500 feet thick. This interval extends from the middle of the mine sequence to about 300 feet below the top of the mine sequence. In places this interval overlaps the upper part of the underlying ore clast breccia zone. The Lynx, Myra and Price ore zones have been correlated as segments of a formerly continuous system of stratiform ore lenses and host rhyolite clastic beds documented over a strike length of 19,000 feet along a flat-plunging northwest-southeast trend. The Lynx and Myra zones were separated by erosion in Myra Valley whereas the Myra and Price zones were separated by displacement on an inclined cross-fault with 2800 feet of net slip. The Price fault block was uplifted about 1000 feet relative to Myra.

The long axis of the Lynx-Myra-Price ore system is coincident with a flat, northwest trending, anticline axis with ore bearing rhyolite beds lying on both limbs. The anticline is asymmetric with a steep, northeast dipping axial plane parallel to the predominant schistosity. The northeast limb dips on average about 30 to 40° northeast whereas the dip of the southwest limb averages vertical and varies from 50° southwest to 70° northeast (overturned). The average vertical dip of the southwest limb has been documented in Lynx mine over an elevation range of 2000 feet. The steep dipping ore bodies of the southwall zone and S-zone in Lynx mine are fault offset equivalents lying in the steep, southwest limb of the anticline (Figs. 2, 8 & 9). The moderately dipping ore bodies of G-zone, its fault offset equivalent west G-zone and the stratigraphically 300 to 500 feet higher G-hanging wall zone all lie in the north limb of the anticline. Within the south limb ore zones (southwall and S-zones) ore lenses lie on at least two stacked horizons separated by perhaps 50 to 300 feet stratigraphically. The G-hanging wall zone has been correlated directly to the south limb ore zones however G-zone may also correlate with the south limb ore zones and thus represent increasing stratigraphic separation of two horizons from south to north across the anticline.

In the northwest part of Lynx mine, the north limb mineralized rhyolite beds have been documented over a dip length of 1500 feet which, added to the south limb ore zones indicate a broad sheet-like distribution of rhyolite beds continuous for more than 3500 feet of dip length across the northwest trending anticline axis. Along trend to the southeast the lateral extent of the ore horizons diminishes to a total dip length of about 2700 feet at the southeast end of Lynx Mine. In Myra mine the host rhyolite lens appears compressed in the axis of the anticline and has a dip length in the order of 1000 feet (total of both limbs). Present form of the folded ore horizon varies from nearly isoclinal to asymmetric (Fig. 7). In Price mine the rhyolite has a dip length of several hundred feet and hosts massive sulfide principally on the northeast limb, which dips 40 to 50°. The southwest limb hosts only minor massive sulfide and dips near vertical to steep southwest.

In the Lynx-Myra-Price system, sedimentary massive sulfide lenses primarily occur within or on the top contact of the host rhyolite beds. The rhyolite is predominantly sorted tuff to lapilli tuff with subordinate coarser fragmentals and local massive phases. The rhyolite varies from apparently nonporphyritic to quartz and feldspar porphyritic. Well developed internal bedding is recognized in many places and ranges from laminations in fine tuff (locally interlayered with cherty beds) to thick beds graded from coarse lapilli size to fine tuff. The rhyolite is typically sericitic, schistose and contains a few percent disseminated pyrite. Ore sulfides and barite are commonly present in highly variable amounts.

The ore bearing rhyolite beds in Lynx and Myra mines are commonly, but not everywhere, overlain by flow and flow breccia units of basalt or andesite which range up to several tens of feet thick and commonly contain minor fragments of jasper. Locally jasper lenses have been observed close to the top contact of ore lenses in both limbs of the Lynx anticline. Jasper is not unique to this stratigraphic position but its occurrence here is notable. In addition to mafic flows, the stratigraphy between and above the Lynx, Myra and Price rhyolite beds includes fine to coarse mixed volcaniclastics with or without clasts of rhyolite and massive sulfide.

An upper rhyolite horizon lies 70 to 300 feet stratigraphically above the ore bearing rhyolite beds of Lynx and Myra mines in a position very near the top of the mine sequence. This horizon in characterized by an association of quartz-feldspar porphyry, black argillite to black chert, jasper and

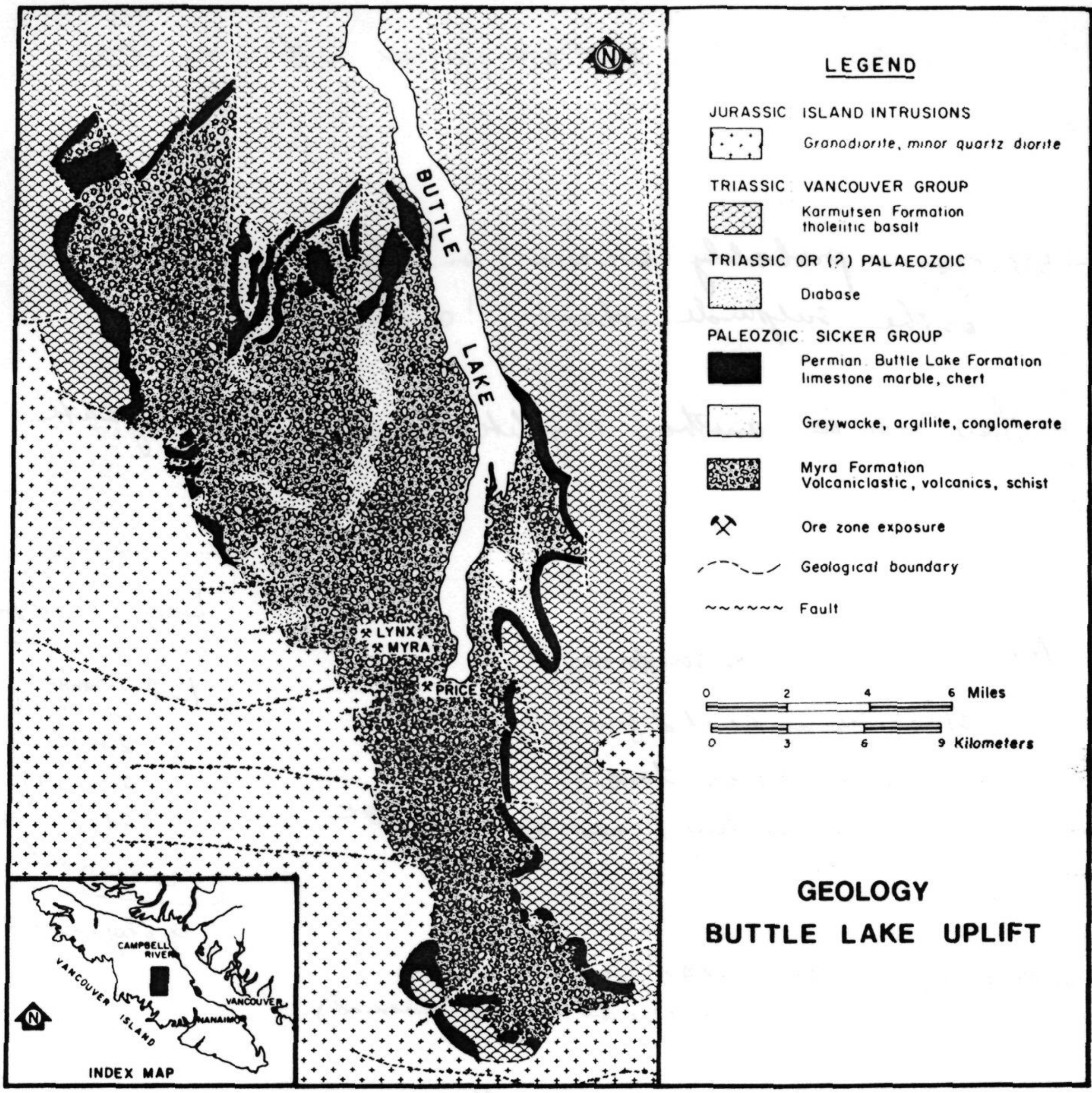

Figure 6. After Muller, 1964.

green to grey chert. The quartz-feldspar porphyry component varies from thin beds of sorted and graded tuff to a 150 foot thick interval of coarse breccia. No orebodies have been found in this horizon although massive sulfide clasts occur in the thickened breccia phase in at least one area. This upper horizon has been documented in both limbs of the Lynx anticline and surface mapping has traced it over the hinge with apparent continuity.

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 hematite "dust". These purplish volcanic clasts are

How was the HW discovery hole positioned?
stepped out 300' from 1972 drill hole –
the '72 hole got stringer ore with some cpy;

– ore zones probably occur on the same horizon as the sulphide clast 'debris flows'.

– there may be another rhyolite below the HW rhyolite

Mine sequence on surface
Steve Juras could give a tour
(when thesis done)
should finish next spring – UBC

HW Reserves

15 MTonnes
Cu ~ 2%?
Zn 5.5%
Au .071
Ag ~1 oz
grades holding up

geological ~25 MT

Submarine welded tuffs occur in sharp banded tuff (+ also the Mine sequence)

Juras concludes { Mine sequence = Myra
below – mafic volcs = Nitinat
etc

Zircon – Devonian

HW in synclinal position / Faulted – not as obviously folded
Flat, N-dipping flts (40-30°) / cuts orebody off

mixed in all proportions with the otherwise similar, green to grey 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 millimetres, 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 upper horizon.

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 up into 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.

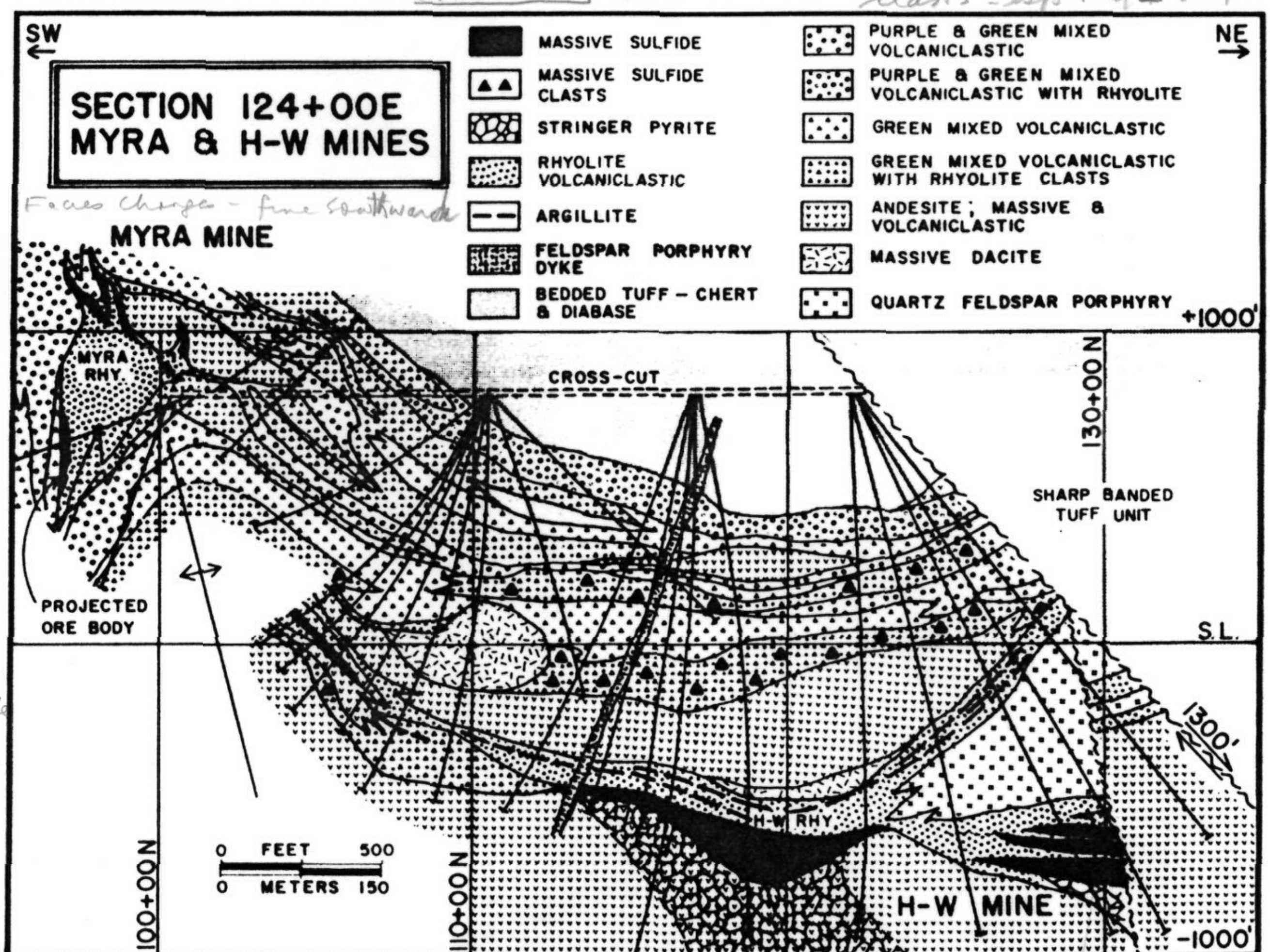

Figure 7.

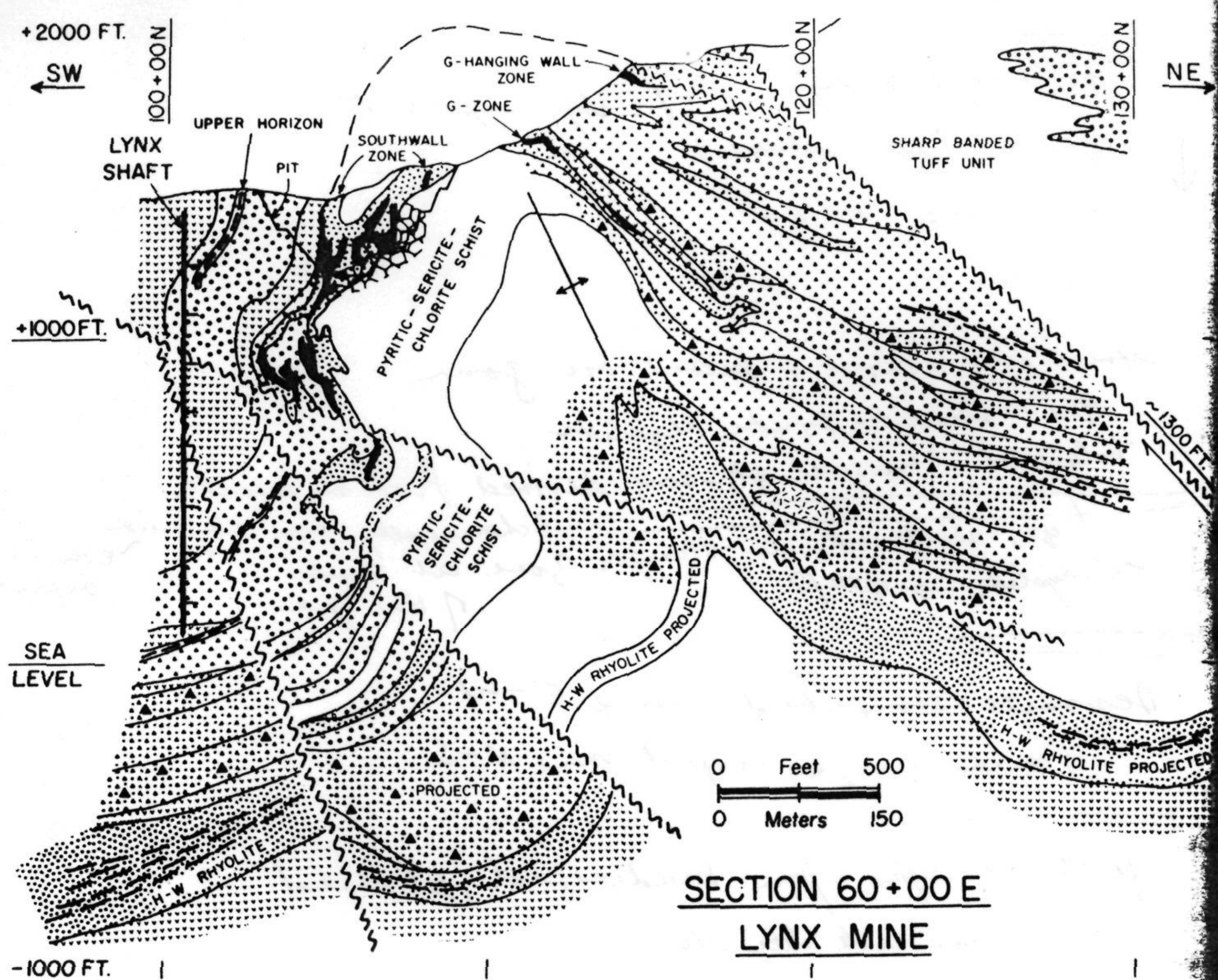

Figure 8.

In summary, the mine sequence is a *complex heterolithic zone, approximately* 1500 feet 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 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 lithostratigraphic 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 *rhyolites, purple and green zone and upper* horizon 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 preceding 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 sericite schist, sericite-chlorite schist and chlorite schist are very fine grained and typically phyllitic in appearance. The predominant *strike of schistosity through the mine* property is northwest. Although the dip of

Structure

HW avg 75% py
barite-rich fringes) fairly competent
↓
ser-altered rocks
andesite

---

altmn strong above + below ore zone
HW - sericitic pyrite rhyolite
below ore 'massive' qtz-ser derived from andesite (chemically now rhyolite) ~even Ti depleted.
qtz-albite rock in stringer zone at ends of HW zone
HW rhyolite → QFP

Deposits elongated more E-W
Facies changes rapid more N-S

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post ore dykes often boudinaged, sheared
Some look like sills

avg schistosity dips 70-80° strikes mine E-W

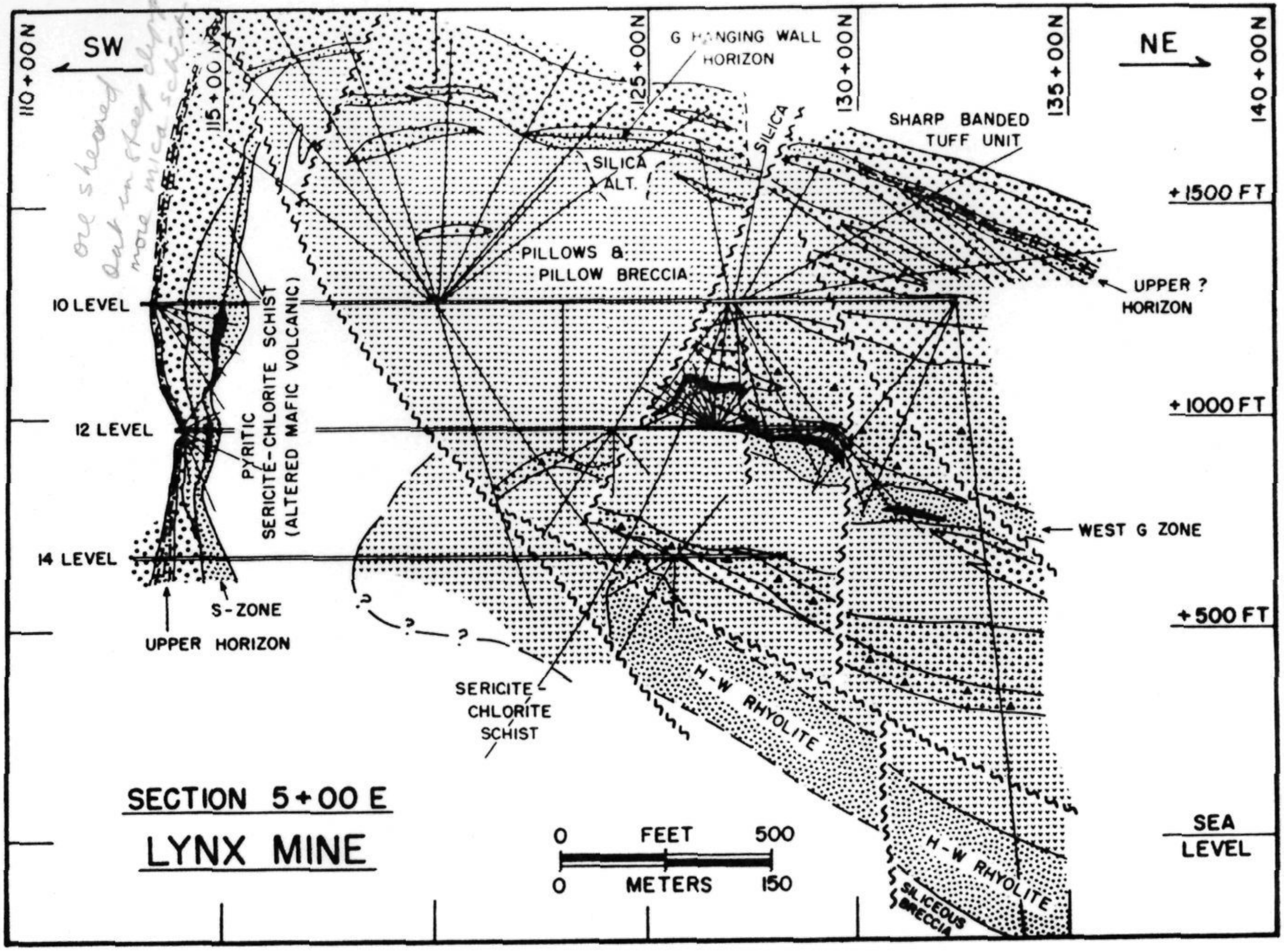

Figure 9.

ore in flat limbs less deformed

schistosity shows considerable variation it averages 75 to 85° northeast.

Schistosity surfaces show a pronounced mineral lineation which varies in plunge from about 10° northwest to 10° southeast. Rock fragments in volcaniclastic lithologies 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 exceed 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 nonschistose rocks could be described as b-tectonites. A prominent 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 metavolcanic 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. Locally schistosity is tightly folded.

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 feet have been documented. Zones of gouge and broken ground are common,

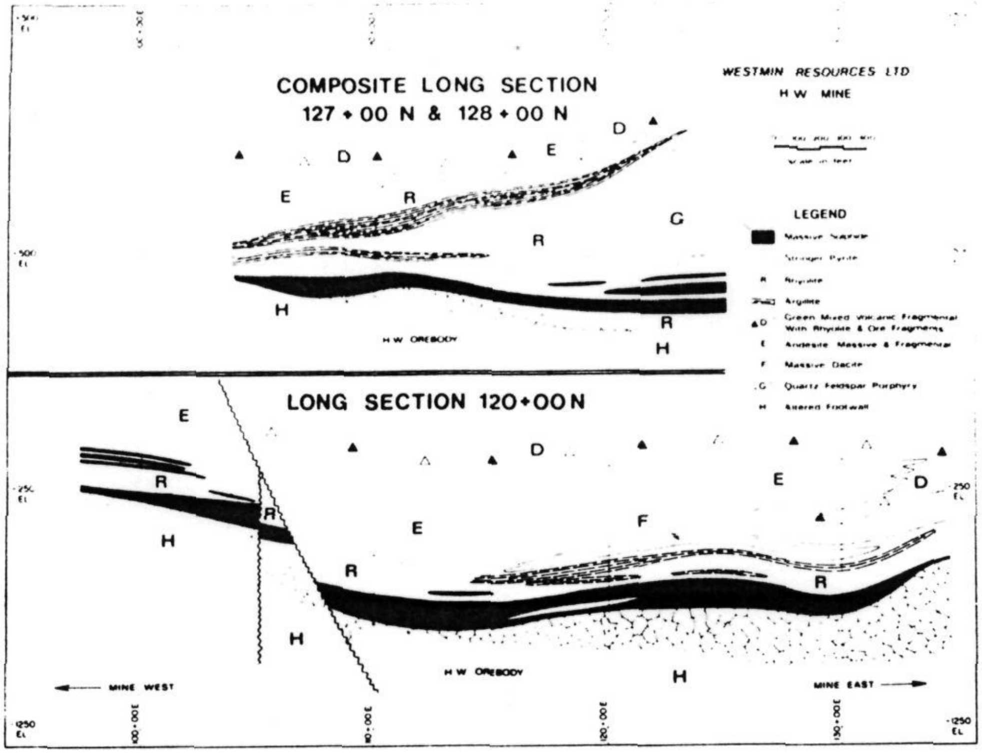

Figure 10.

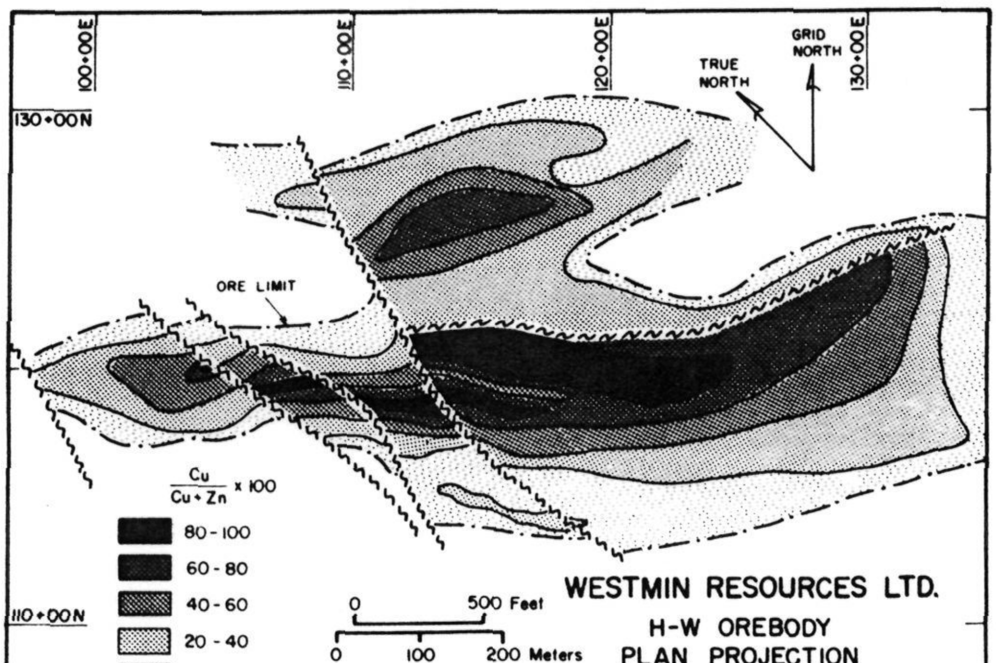

Figure 11.

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 systematically 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 (Fig. 11). 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 separate 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 millimetres) 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 southwall 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 (Fig. 8). A smaller stringer zone, unusual in its 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 feet elevation on mine section 56+50E from 110+50N to 105+50N (refer to Fig. 8).

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. 9).

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: 2.0 km from mine gate. Sharp Banded Tuff Unit. 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 greywacke are interbedded with thin bedded to laminated chert to cherty tuff. Some graded beds can be recognized. A feldspar porphyry dyke is exposed.

3.0 km Bridge over Thelwood Creek.

STOP 6: 3.5 km South end of Buttle Lake. Bedded mixed volcaniclastic of the Myra Fm. are exposed in a road cut. The rocks range from very thin to medium bedded green tuffwacke to very thick beds of coarse, heterolithic breccia containing clasts up to 3 feet. Clasts are mafic to felsic with minor quartz eyes locally detectable. Bedding dips 35° southwest with graded beds indicating right way up.

STOP 7: 7.2 km 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° to 75° NE and is variably developed. Lineation plunges 0 to 15°SE. Prominent a-c joints dip 90° to 75° 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.

11.7 km Ralph River Bridge.

STOP 8: 15.6 km Ralph River Boat Ramp. 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 feet 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: 30.9 km 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 grey 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 feet 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: 34.5 km 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.

37.5 km Gold River Bridge

STOP 11: 45.7 km Massive basalt flows from the upper unit of the Karmutsen Formation. The basalt is variably amygdaloidal with tight flow contacts.

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Schedule

@ Mine 0745

Travel 1¼ hrs

Smittys - drive 0530

at Mine

① Undergnd + HW

grubby/warm/humid

② Discussion

? ③ Lunch

④ Core across orebody/otcs

⑤ Hwy stops Sicker/Karmutsen

TRIP

20 → 23 Level

2 Stopes

Now mining the Lynx + HW

Gold .07-.08

Zinc 8%

Cu <1%

Price idle 300000 Tons left (Zinc ore)

Myra done

THURSDAY

LUNCHES NEEDED

1800' above SL

HW 500' below

Discovery - Dec '79

- Have found another zone + now being tested

- Sicker - basement

- ore - felsic volcs