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The Lara Polymetallic Massive Sulphide Deposit

Vancouver Island, British Columbia

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Contents

INTRODUCTION

The Lara polymetallic massive sulphide deposits are located on southern Vancouver Island, 75 kilometres north of the city of Victoria in British Columbia, Canada (Figure 1). The mineralization is hosted by felsic to intermediate volcanic rocks of the Paleozoic age Sicker Group which is noted for the occurrence of volcanogenic massive sulphide deposits, particularly the Buttle Lake and Mount Sicker Mines.

The Mount Sicker deposit which is three kilometres east of the Lara property (Figure 2) produced 229,518 tonnes (253,000 tons) of ore grading 4.80 gm/T (0.14 oz/ton) gold, 100.11 gm/T (2.92 oz/ton) silver, 3.77% copper and an estimated 7% zinc and 1% lead intermittently between 1898 and 1946 (lead and zinc were not recovered). The Buttle Lake Mine which is 150 kilometres north of Lara (Figure 3) has produced 5.5 million short tons of ore grading 2.06 gm/T (0.06 oz/ton) gold, 113.14 gm/T (3.3 oz/ton) silver, 1.5% copper, 7.6% zinc and 1.1% lead. Reserves at Buttle Lake are currently 14.5 million tonnes (16 million tons) of similar grade.

Polymetallic massive sulphide mineralization occurs on the Lara property in the Coronation and Coronation Extension Zones. These zones which are on strike with one another have been traced over a strike length of about 2 kilometres and to a depth of 440 metres downdip from surface. Reserves at the end of 1986 stood at 837,332 tonnes (923,000 tons) grading 3.26 gm/T (0.095 oz/ton) gold, 89.49 gm/T (2.61 oz/ton) silver, 0.61% copper, 3.59% zinc and 0.81% lead. Grades, metal ratios and style of mineralization at Lara are similar to Buttle Lake and Mount Sicker.

The Lara property is about 11 kilometres east-west by 3 kilometres north-south and covers an area of 3725 hectares (9205 acres) (144 claim units). The property is owned 65% by Abermin Corporation and 35% by Laramide Resources Ltd., both of Vancouver. Abermin Corporation is the operator.

EXPLORATION HISTORY

Mining exploration in the area dates back to the late 1800's when the Mount Sicker deposits were discovered. The area is easily accessible and has been prospected sporadically ever since. Exploration intensified in the Sicker Group when the H.W. deposit was discovered at Buttle Lake in 1980. The Lara property was staked by Laramide Resources in 1981 and optioned to Abermin Corporation in 1982. Massive sulphides were discovered in the Coronation Zone by diamond drilling in December, 1984 (Figure 4).

Exploration on the Lara property from 1981 to 1984 consisted of soil sampling, geophysical surveys, prospecting and geological mapping. Rock exposure is poor, therefore much of the early work consisted of backhoe trenching in anomalous areas and over known showings. During this period, 13 showings were discovered. The most promising showing was at Zone 1 in the east half of the property where grab samples from trenches assayed 0.75 gm/T (0.022 oz/ton) gold, 32.91 gm/T (0.96 oz/ton) silver, 2.26% copper, 4.60% zinc and 0.08% lead (Figure 5). Unfortunately further trenching and diamond drilling on Zone 1 were not encouraging.

The Coronation Zone occurs about 3 kilometres along strike to the west of Zone 1. A trench in the area exposed a weak polymetallic showing at the contact between foliated pyritic rhyolite and more massive coarse grained, quartz eye rhyolite. Drilling beneath this trench resulted in the discovery of the Coronation Zone. The discovery hole, DDH 84-12, graded 3.463 gm/T (0.101 oz/ton) gold, 67.54 gm/T (1.97 oz/ton) silver, 0.68% copper, 3.01% zinc and 0.45% lead over a true thickness of 7.95 metres. Further trenching in the area exposed spectacularly high grade massive sulphides: Trench 86-43 graded 24.58 gm/T (0.717 oz/ton) gold, 513.60 gm/T (14.98 oz/ton) silver, 3.04% copper, 43.01% zinc and 8.30% lead over a true thickness of 3.51 metres.

To date, 206 diamond drill holes totalling 32,620 metres have been drilled on the Lara property. About 80% of this drilling has been on the Coronation Zone.

REGIONAL STRATIGRAPHIC AND TECTONIC OVERVIEW

The Paleozoic Sicker Group comprises the oldest rocks on Vancouver Island and represents the remnants of a mid-Paleozoic volcanic arc. Together with the overlying Vancouver (Triassic) and Bonanza (Jurassic) Groups, the Sicker Group is part of an allochthonous terrain referred to as Wrangellia (Massey and Friday, 1987). These rocks are intruded by the Middle Jurrassic Island Intrusions and are unconformably overlain by Cretaceous sedimentary rocks of the Nanaimo Group which were deposited in a successor basin along the east coast of Vancouver Island.

Sicker Group rocks are intruded by mafic sills and overlain unconformably by basaltic rocks of the late Triassic Karmutsen Formation (Vancouver Group) which is the dominant stratigraphic and structural unit on Vancouver Island (Sutherland Brown and Yorath, 1985). Karmutsen gabbroic sills generally intrude Sicker Group rocks along cleavage and therefore post date folding in the Sicker Group.

The present structural attitudes of Karmutsen and Sicker Group rocks are the result of several periods of post Late Triassic deformation (Yole and Irving, 1980). The most important of these appears to be Late

Cretaceous to early Tertiary folding and faulting. In the project area this event is represented by a series of reverse or high angle thrust faults. Pre-Jurassic faulting events in the project area probably controlled the emplacement of Island Intrusions (Massey and Friday, 1987).

GEOLOGY OF THE SICKER GROUP IN THE HORNE LAKE - COWICHAN UPLIFT

The Sicker Group is exposed in three major geanticlinal uplifts on Vancouver Island (Figure 3). The Lara project occurs towards the south eastern end of the Horne Lake-Cowichan Uplift, which extends in an arc from Saltspring Island to Port Alberni, a distance of about 140 kilometres.

The stratigraphic nomenclature of Muller (1980) is problematic in the Horne Lake-Cowichan uplift (Massey and Friday, 1987) and is currently under revision. Table 1 shows the relationship between Muller's nomenclature and the revised stratigraphic divisions which will be used in this paper.

Table 1 - Sicker Group Nomenclature

	Muller (1980)	Revised (1987)		Age
	Buttle Lake Formation		Buttle Lake Group	
Sicker Group	Sediment-Sill Unit	Cameron River Formation		Mississippian
	Myra Formation	McLaughlin Ridge Formation		Late Devonion
	Nitinat Formation	Nitinat Formation	Sicker Group	Mid Devonion?

The Nitinat Formation, which is the lowermost unit in the Sicker Group consists of mafic pyroclastics with subordinate volcanic flows (Brandon et al, 1986). The unit is commonly agglomeritic and is characterized by the presence of black augite phenocrysts which have been variably altered to uralite. These phenocrysts are up to 3 centimetres in diameter and comprise from 5 to 20% of the rock (Massey & Friday, 1987). Plagioclose phenocrysts are also abundant but are generally smaller. The Nitinat

Formation contains a chlorite-epidote-actinolite-plagioclase metamorphic assemblage which is consistent with upper green schist facies (Brandon et al, 1986).

The McLaughlin Ridge Formation conformably overlies the Nitinat Formation. It consists of aphyric andesite pillow flows and breccias, rhyolite, volcanic sandstone, siltstone, argillite and chert. In the central part of the belt, the rocks are predominantly volcaniclastic sediments with minor volcanic rocks (Massey and Friday, 1987). Felsic volcanic rocks are relatively uncommon, but are well developed at the southeastern end of the belt from just west of the Lara property to Saltspring Island and are host to the polymetallic massive sulphide deposits. A felsic volcanic centre is postulated to occur on the western portion of the Lara property (Massey, personal comm.)

Sicker Group rocks are in fault contact or are unconformably overlain by the Cameron River Formation which consists of epiclastic sedimentary rocks including turbiditic sandstone, siltstone and argillite. The base of the unit is marked by a thick sequence of chert and cherty tuff (Massey and Friday, 1987).

The geology of the eastern portion of the Horne Lake-Cowichan uplift is shown in Figure 4. Sicker Group rocks outcrop in a folded, structurally complex west-northwest-trending uplift which appears to plunge shallowly to the west. Progressively younger rocks are exposed from east to west along this trend. The belt is cut by several major cross faults along which differential uplift has taken place.

The Fulford Fault is a regionally extensive reverse fault which brings McLaughlin Ridge volcanics into contact with younger rocks of the Cameron River Formation and the Nanaimo Group. This faulting is associated with a Late Cretaceous to early Tertiary deformational event.

PROPERTY GEOLOGY

The property is underlain by the McLaughlin Ridge Formation which has been thrust (the Fulford Fault) over younger rocks of the Cameron River Formation and the Nanaimo Group (Figures 5 & 6). The McLaughlin Ridge Formation consists of northerly dipping, west-northwest-striking rhyolitic to andesitic rocks. This volcanic package has a true thickness of about 1700 metres. Bedding in these rocks generally dips steeply at 60° to 75°N, although dips of 30° to 45°N are common in the east half of the property. The volcanics are dominated by felsic rocks; quartz phyric units are common, particularly in the west half of the property. The most widespread lithology is light green to white, feldspar and quartz-feldspar crystal tuff. Lapilli tuff occurs locally.

Thick sequences of intermediate volcanic rocks occur at intervals in this felsic package. Intermediate rocks include fine grained andesite tuff and coarse grained lapilli tuff and breccia containing large epidotized fragments up to several centimetres in diameter.

Sedimentary rocks in the volcanic sequence include dark grey to black argillite, buff-coloured volcanic mudstone and tuffaceous quartz sandstones of both felsic and intermediate composition. While sedimentary rocks are a minor component of the stratigraphic package, they are useful as marker beds.

The Fulford Fault juxtaposes volcanic rocks of the McLaughlin Ridge Formation and sedimentary rocks of the Cameron River Formation and the Nanaimo Group. The fault dips at about 46° in the west half of the property and cross-cuts bedding in the volcanic rocks at a shallow angle.

The Cameron River Formation south of the Fulford Fault consists of basal pebble conglomerate and volcaniclastic units grading upward into a sandstone-argillite series and then to an upper argillite sequence with siltstone and chert interbeds. The Nanaimo Group, which unconformably overlies the Cameron River Formation includes conglomerate, sandstone and fossil-bearing mudstone.

In the northwest part of the property the volcanic rocks are again in contact with the Cameron River Formation which consists of greenish grey mudstone with argillite interbeds. A distinctive maroon schist package which is locally hematitic occurs immediately south of these sedimentary rocks and may represent the uppermost unit in the McLaughlin Ridge Formation.

Gabbroic sills which are probably feeders to the Triassic Karmutsen Formation are well developed within both the volcanic and sedimentary rock units of the Sicker Group. Emplacement of these sills is controlled by fold cleavage in Sicker Group rocks.

STRUCTURAL GEOLOGY

The structure of the volcanic sequence is complex and dominated by tight folding and reverse faulting. The stratigraphic sequence shown in Figure 6 represents a structurally thickened volcanic package in which stratigraphy is repeated by folding and faulting.

Sicker volcanic rocks generally exhibit a strong tectonic fabric which can make recognition of primary textures difficult. Most units are moderately to strongly foliated and locally schistose. Mullion structure, boudinage and tight minor folds have been noted locally in outcrop. Quartz eyes in the felsic units exhibit up to a 6 to 1 east-west elongation. The predominance of a linear fabric is consistent with strong elongation during deformation. This early fabric has been modified by shearing associated with later tectonic events.

Differential uplift has been noted to occur regionally along major north-south cross faults and it is probable that lesser cross faults exist on the Lara property. Late movement on these faults is implied by north-south displacement of the Nanaimo-Sicker contact (Figures 4 and 5) and this movement must have post-dated Late Cretaceous thrusting.

Dips of as low as 30°N occur on the Fulford Fault in the east half of the property. Because dips in the volcanic rocks are also shallower in this area it can be implied that late movement on the cross faults also involved differential tilting of structural panels.

ECONOMIC GEOLOGY

Polymetallic mineralization has been intersected by drilling in three widely separated intervals of rhyolite stratigraphy (Figures 5 and 6). The Coronation deposits which are discussed in some detail below, contain potentially mineable reserves. The Randy North Zone, discovered in 1986, has been tested by a few wide spaced reconnaissance drill holes. The zone contains from 3 to 6 zinc-rich polymetallic intervals over a tested strike length of about 2 kilometres and is considered to have good potential. A third polymetallic sequence occurs in the rhyolite package just north of the Coronation Zone. This mineralization was discovered in mid-1987 and has not yet been investigated in detail. Weak polymetallic mineralization has been detected at three stratigraphic levels over widths of several metres.

THE CORONATION DEPOSITS

The Coronation deposits include 3 polymetallic zones known as the Coronation Zone, the Coronation Extension Zone and the Hanging Wall

Zone. The deposits are classified as Kuroko type massive sulphides and are volcanic-hosted, stratiform accumulations of copper, lead, zinc, silver and gold. Although classified as massive sulphides, the predominant facies is not massive in character but consists of bands, laminae and stringers of sulphide minerals in a strongly silicified rhyolite host. The massive sulphide facies makes up about 20% of the reserve. The gross value of the deposits is contributed predominantly by gold and zinc with lesser silver, copper and lead.

The Coronation deposits occur in the felsic volcanic package immediately north of the Fulford Fault. The deposits dip to the north at 60° and exhibit considerable variation in both thickness and grade. Intercepts are up to 16 metres thick and average about 6 metres. The highest grades encountered to date are from a massive sulphide lens exposed by trenching in the Coronation Zone which graded 24.58 gm/T (0.717 oz/t) gold, 513.60 gm/T (14.98 oz/t) silver, 3.04% copper, 43.01% zinc and 8.30% lead over 3.51 metres.

The thickest, most extensive and economically significant of these deposits is the Coronation Zone which occurs primarily to the west of Solly Creek (Figure 7). The Coronation Extension Zone which occurs to the east of Solly Creek is generally narrower and less continuous but typically consists of high grade massive sulphides. The Hanging Wall Zone has only been recognized to the west of Solly Creek. Although the zone locally attains ore grade, it is somewhat sporadic and has not been included in reserve figures. The stratigraphy of the Coronation Deposits and the relationships between mineralized zones are shown on cross sections in Figures 8 through 10.

The Hanging Wall Zone is clearly at a different stratigraphic level than either the Coronation Zone or the Coronation Extension Zone. The stratigraphic relationship between the latter two zones is less well defined, as the main mineralized pods comprising the zones are separated laterally by a considerable interval in which drill control is limited. Because the zones apparently overlap on two drill fences as illustrated in Figure 8, it was initially assumed that they occupied different stratigraphic levels. However, the local presence of distinctive coarse grained quartz porphyry rhyolite in the immediate footwall of both suggests that they may be co-eval.

STRATIGRAPHY OF THE IMMEDIATE HOST ROCKS TO THE CORONATION DEPOSITS

The package of volcanic rocks which hosts the Coronation deposits has been tested by more than 150 drill holes and consequently its stratigraphy has been studied in some detail. It consists of andesite, which is referred to in the field as the Green Volcaniclastic Sequence, overlaying rhyolite, which hosts the polymetallic mineral deposits. The rhyolite has been broken down into two units which are referred to as the Rhyolite Sequence and the Footwall Sequence. The Footwall Sequence underlies the lowermost polymetallic mineralization.

The Green Volcaniclastic sequence is a lithologically complex unit which is greater than 250 metres thick, and is dominated by fragmental rocks of intermediate composition. The sequence shows a general gradation from coarse grained andesite at the base to relatively fine grained dacite tuff at the top. Thin argillite beds and laminae occur throughout the unit. An important argillite marker bed which is locally greater than 1 metre thick occurs in the transition zone from andesite to dacite. This unit is texturally variable, but commonly consists of felsic volcanic fragments in a dark grey argillaceous matrix. Laminated argillite beds may also be present.

The base of the section consists primarily of coarse grained andesite lithic tuff and breccia containing fragments up to several centimetres in diameter. Lithic fragments are generally strongly epidotized and their original composition is not known. Altered pyroxene crystals have been noted in some fragments. Quartz grains occur locally in small amounts in the matrix. These andesitic rocks occasionally exhibit poorly developed, fining upwards cycles of graded beds topped by argillite laminae, but are generally quite chaotic. Rare beds of chert pebble conglomerate have been noted towards the base of this sequence.

An important constituent of the andesite package is a series of felsic interbeds or possible dykes which are characterized by the presence of pale blue quartz eyes. These rocks increase in abundance toward the contact with the Rhyolite Sequence. Andesitic rocks are locally strongly silicified. This alteration is thought to be related to the volcanic or intrusive events represented by felsic units.

The origin of andesitic rocks in this sequence is not well understood. They may have originated as pyroclastic and possible flow breccias, but subsequent transport is suggested by the presence of graded fining upwards cycles.

The upper part of the Volcaniclastic Sequence is predominantly fine grained dacite crystal and ash tuff. These rocks are locally sandy and may grade into tuffaceous quartz sandstones. Lapilli tuff units are generally not well developed in this sequence.

The contact between the Green Volcaniclastic and Rhyolite Sequences is generally abrupt and is characterized by pronounced changes in colour, lithology and grain size. The contact is commonly accentuated by a well developed gouge zone which occurs at or near the andesite-rhyolite transition. The existence of this gouge zone poses the question of whether the contact is conformable or structural in nature. Broad structural considerations suggest that this feature may be a splay off of the Fulford Fault (Figure 6). Other lines of evidence however, are contradictory and the significance of this structure has not yet been resolved.

The possibility that rhyolite stratigraphy has been truncated along this contact is suggested on some drill sections in the Coronation Extension area, and at depth in the Coronation Zone. This truncation may be due to scouring by overlying rocks, however, this cannot be supported by existing information.

Elsewhere, data appear to favour a conformable contact along which shear stress has been localized because of a competency contrast between major geologic units. These data include the common presence of argillite and mudstone beds at the contact, local gradational contacts and the fact that gouge zones are not always present. Where they are present, they may be localized within a few metres of the contact in either the rhyolite or andesite sequence. The andesite-rhyolite contact also parallels folded stratigraphy in the Rhyolite Sequence on some drill sections. It can be conjectured that coarse fragmental units at the base of the Volcaniclastic Sequence preferentially overlie mineralized basinal areas in the Rhyolite Sequence, suggesting that substantial movement has not taken place along this fault.

The Rhyolite Sequence hosts the polymetallic zones along the Coronation Trend and is up to 75 metres thick. The sequence is lithologically uniform and consists predominantly of light grey, fine to coarse grained rhyolite crystal and ash tuff. Quartz eyes are commonly present but are generally small (< 2mm) and comprise less than 10% of the rock. These rocks are usually siliceous and locally cherty.

Coarse fragmental units are not common in the Rhyolite Sequence, however, mottled rhyolites consisting of irregular to rounded, light grey patches in a slightly darker lithologically identical matrix occur locally. These rocks have been interpreted as volcanic breccias but may represent relatively finer grained rocks which are mottled as a result of alteration.

Black argillite and buff coloured volcanic mudstone beds are a common constituent of the Rhyolite Sequence. These units generally range from less than a millimetre to several millimetres in thickness but are occasionally somewhat thicker. Argillite beds up to about a metre thick occur locally in the immediate footwall of the Coronation Zone. Mudstones, which are thought to be re-worked felsic volcanics may grade laterally or vertically into argillite beds.

Sedimentary units are volumetrically a relatively small part of the Rhyolite Sequence, however, they are the only lithologies other than mineralized zones that are sufficiently distinctive for use in correlation. While they are not unique to the Rhyolite Sequence, they have not been recognized in such relative abundance elsewhere. These units mark breaks in volcanic activity and their presence is consistent with basin development in the Rhyolite Sequence. It is evident from geologic cross sections (Figures 8,9,10) that sediments occur at the boundaries of pyritic intervals and are associated with most narrow pyritic zones. In addition, they commonly enclose, and mark natural grade boundaries within the zone.

The Footwall Sequence, like the Rhyolite Sequence, is dominated by light grey rhyolites, but is characterized by the local presence of coarse grained quartz porphyries. These rocks are texturally quite variable but are distinguished by the presence of abundant large quartz eyes. Porphyries containing up to 20% quartz eyes from 4 to 10 millimetres in diameter are common and quartz eyes greater than 1 centimetre have been noted. These rocks are also locally feldspar phyric and occasionally contain a few percent of small (<2 mm) dark green grains of chlorite or sericite. It is not known whether these are altered fragments or spotted alteration of the groundmass. Quartz porphyries are generally massive units and have been intersected by drilling over thicknesses of more than 40 metres.

Other rock types present in the Footwall Sequence include feldspar porphyry dykes, rhyolite tuff and rhyolite breccia. Mudstone and argillite beds are also present locally. Breccias and coarser grained tuffs commonly have a slightly muddy appearance, suggesting a clay-rich matrix. Breccias contain up to a few percent rhyolite fragments which are 2 or 3 centimetres across. The relationship between footwall lithologies is best illustrated in Figure 9.

MINERALOGY, FACIES AND MODE OF OCCURRENCE

The Coronation deposits can be divided into a massive sulphide facies, a banded and laminated facies and a stringer facies. The sulphide mineralogy of these facies is similar and consists primarily of sphalerite, chalcopyrite, galena and pyrite. Minor amounts of tetrahedrite and tennantite have also been noted. Minerals present in trace amounts include rutile, bornite, electrum, pearceite [$(Cu, Ag)_{16} (As, Sb)_2 S_{11}$)], arsenopyrite and barite. Gangue consists mainly of quartz and calcite with smaller amounts of muscovite, feldspar and barium-bearing feldspar. Sphalerite, in the massive sulphide facies, is typically medium to dark brown as opposed to the very pale brown sphalerite which is characteristic of the other facies.

The massive sulphide facies, is a relatively coarse grained (1-2mm) massive intergrowth of sulphide minerals and gangue (predominantly calcite) (Figure 11). Interbeds of rhyolite or sedimentary rock are rare, although small siliceous pods may be included in the sulphide mass. This facies occasionally exhibits a banded texture which is best represented by chalcopyrite-rich bands of 1 or 2 centimetres. Local accumulations of massive pyrite occur. These are commonly barren but may contain significant gold or zinc values. The massive sulphide facies is consistently high grade except for intersections of massive pyrite.

The predominant facies in the Coronation deposits is the banded and laminated facies which consists of sulphide laminae and bands up to a few centimetres thick in a siliceous host. The host rock varies from silicified rhyolite to a very fine grained siliceous mass with varying amounts of felsic tuffaceous debris. The mineralization is broadly conformable, however cross-cutting features are common within the conformable zones. Cross-cutting mineralization varies from occasional sulphide stringers to well developed breccia zones with sulphides in the matrix. Sulphides also occur disseminated in the rhyolite host. Primary textures are masked by a pronounced cataclastic overprint which is accentuated in this facies because of the competency contrast between thinly interbedded sulphide and volcanic units. Cataclasis may have caused mechanical remobilization of sulphides into breccia interstices. Although these features to some extent mask the primary depositional style, the overall stratiform character of the facies is demonstrated by the presence of sedimentary units which enclose and occur within the deposit, and which can be correlated over considerable distances (Figures 8-10).

The banded and laminated facies varies up to about 16 metres true thickness, the thickest intercept in the Coronation deposits. Although not as high grade as the massive sulphide facies, laminated and banded sulphides can attain significant grade. DDH 85-36 for example, intersected 4.18 metres grading 9.909 gm/T (0.289 oz/t) gold, 82.63 gm/T (2.41 oz/t) silver, 0.86% copper, 3.47% zinc and 0.50% lead. These intersections typically contain up to about 20% sulphide bands and laminae, and relative to the massive sulphide facies, contain a higher ratio of pyrite to total sulphides. Intersections usually contain from 3-5% pyrite, but concentrations of 10 to 15% pyrite are not uncommon locally.

The banded and laminated facies is finer grained than the massive sulphide facies; grain size generally averages less than 1 millimetre

The finer grain size is thought to be a primary feature, however, microscopic textures including disaggregation of mineral bands and grain rotation suggest that cataclasis may have been a contributing factor.

The stringer facies which is restricted, is best developed in the Hanging Wall Zone. The facies consists of narrow sulphide stringers generally less than 1 or 2 millimetre in a silicified rhyolite host. It is generally low grade but may be quite thick and is commonly rich in precious metals relative to base metals. The best example of this facies is found in DDH 86-140 which graded 0.960 gm/T (0.028 oz/t) gold 43.89 gm/T (1.28 oz/t) silver, 0.06% copper, 0.90% zinc, 0.29% lead over 10.52 metres. Sulphide minerals are fine grained as in the banded and laminated facies.

Although sulphides in the Coronation deposits are generally fine grained, chalcopyrite, galena and tetrahedrite are locally quite coarse (2-6mm). These coarse sulphide minerals are well developed in quartz veins, especially within the massive sulphide facies. Coarse sulphides also occur as irregular cross-cutting veinlets within finer grained sulphide masses. Coarse grained cross-cutting mineralization is thought to be due to recrystallization and remobilization during metamorphic or late tectonic events. Pyrite exhibits a bi-modal grain size distribution. Coarser (1-2mm) pyrite grains occur as well formed disseminated crystals which are interpreted as porphyroblasts.

GEOLOGICAL MODELLING

Knowledge of stratigraphic tops is fundamental to the understanding of the nature and genesis of the Coronation deposits. Most direct indicators of stratigraphic tops are somewhat ambiguous. Graded fining upwards cycles in the Green Volcaniclastic Sequence provide the best evidence to date and suggest that stratigraphy in the Coronation Trend faces north. The Footwall Sequence is therefore thought to represent the actual stratigraphic footwall of the deposits.

This conclusion is supported indirectly by geological modelling using isopach maps of the Rhyolite Sequence, the Coronation Zone and sedimentary units. Superimposition of these maps indicates that footwall quartz porphyries underlie the thinnest parts of the Rhyolite Sequence and that the thicker parts contain both polymetallic deposits and sedimentary rocks. This suggests that the Rhyolite Sequence was deposited in a basin which had considerable relief and that coarse grained footwall quartz porphyries formed local topographic highs. The Coronation Zone, mudstone and argillite occur preferentially in deeper basinal areas.

The Footwall Sequence appears to be the fundamental control on mineralization and facies distribution within the basin. Much of the footwall is made up of relatively fine grained rhyolite tuff. Localized coarse grained quartz porphyry rhyolites are thought to represent dome complexes with associated flows, pyroclastics and intrusive rocks. Volcanic breccia and coarse grained tuff in both the Rhyolite and Footwall Sequences generally lie on the flanks of domes and are thought to represent debris which has shed from these topographic highs.

Rhyolite domes not only control the topography and configuration of the basin, but also appear to have played a role in focussing the mineralizing fluids. High grade massive sulphides are spatially coincident with rhyolite domes (Figure 11). Moreover, grade of the banded and laminated facies is greatest adjacent to the domes and decreases away from them. Generally accepted fluid source indicators such as footwall feeder zones, footwall alteration and Cu/Cu + Zn ratios are somewhat ambiguous for the Coronation deposits and have not been useful in defining fluid source.

The banded and laminated facies occurs in basinal areas distal from rhyolite domes. The presence of mudstone and argillite laminae within this facies suggests that hydrothermal activity may have been episodic. Contour maps of sulphide peaks in Coronation Zone intersections show that deeper basinal areas contain more sulphide events. This is consistent with pooling of hydrothermal fluids originating outside of the basin and suggests that the banded and laminated facies is distal.

SUMMARY

The elongate configuration of the Coronation Zone shown in Figure 11 and the linear distribution of rhyolite domes along two axes (F_o, F_o'), suggests that the mineralization was deposited in a fault controlled basin or trough. The east-west elongation, however, may also in part reflect late tectonic stretching. Figure 11 also illustrates the possibility that the distribution of mineralization may have been controlled in part by secondary faults or small basins (F_1) which are roughly perpendicular to the main axis of the deposit.

The Coronation Zone shows a classic distribution of high grade proximal facies and lower grade distal facies. Linear fracture systems, which are thought to have controlled the emplacement of rhyolite flows and domes, also controlled the movement of hydrothermal fluids. Polymetallic sulphide mineralization was deposited on the sea floor as massive sulphides proximal to these linear vents, particularly F_o. The distal banded and laminated facies which is considerably thicker and more widespread, accumulated by pooling in basinal areas (Figure 12). The presence of a pyritic halo is suggested by the relative abundance of pyrite in the banded and laminated facies and by the presence of weakly pyritic felsic tuff in distal areas.

Cross cutting mineralization occurs within stratabound intervals in both the stringer facies and the banded and laminated facies. This style of mineralization can be interpreted as a local feature related to weak hydrothermal venting on subsidiary fracture systems. This is illustrated by considering the distribution of the stringer facies in the Hanging Wall Zone, relative to the Coronation Zone. The Hanging Wall Zone overlies the lower axis F_0' of the Coronation Zone west of Solly Creek. This suggests that the zone was formed by re-activation of hydrothermal activity along a pre-existing structure.

The relative abundance of sedimentary units in the Rhyolite Sequence is consistent with active basin development. The occurrence of sediments at contacts between pyritic and barren tuffs and at grade boundaries within the zone, suggests that they mark breaks in both volcanic and hydrothermal cycles. The abundance of sediments in the Rhyolite Sequence and the presence of polymetallic mineralization at different stratigraphic levels, reflects a dynamic environment characterized by episodic volcanism and mineralizing activity. This environment was probably controlled by faulting and characterized by substantial variations in relief which in the case of rhyolite domes may have been quite marked. These considerations explain the local poddy nature of the mineralization in the Coronation Extension Zone. This mineralization was probably deposited in small local basins or troughs (Figure 11).

POTENTIAL

The Lara Property is considered to hold excellent potential for the establishment of sufficient reserves to justify a mining operation. Relatively little drilling has been undertaken outside of the Coronation Trend, however polymetallic mineralization has been encountered at three additional stratigraphic levels. The presence of additional polymetallic zones in a predominantly felsic volcanic package and the presence of numerous untested geochemical and geophysical anomalies are encouraging for continued exploration on the property. These features are complimented by existing infrastructure including nearby power and population centres.

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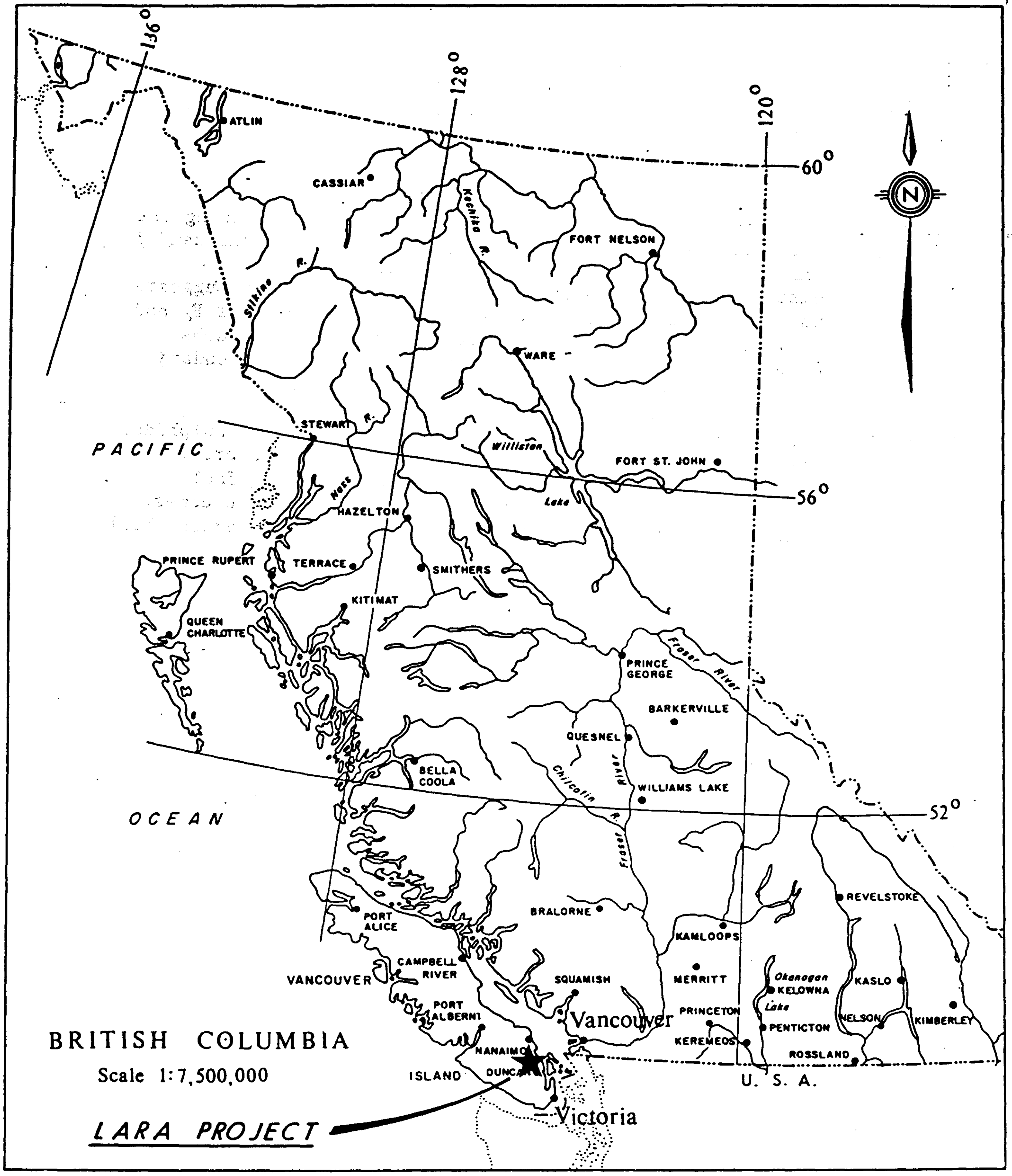
Figure Captions

Figure 11 Facies - thickness map of the Coronation Trend showing the distribution of the massive sulphide facies and the banded and laminated facies relative to rhyolite domes. The distribution of rhyolite domes and mineralization suggests that the basin is dominated by two major structures F_o and F_o'. Cross structures, F_1, are inferred from isopachs of the Coronation Zone and may have provided a secondary control on the distribution of mineralization.

Figure 12 Geological model of the Coronation Zone. Massive Sulphides are spatially coincident with rhyolite domes and are thought to represent a proximal facies originating along fault structures which controlled the emplacement of the domes. Banded and laminated mineralization is a distal facies which occurs in basinal areas.


136°
128°
120°
60°
56°
52°
N
ATLIN
CASSIAR
Kechika R.
FORT NELSON
Stikine R.
WARE
STEWART
Stewart R.
Williston
Lake
FORT ST. JOHN
PACIFIC
OCEAN
Nass
HAZELTON
PRINCE RUPERT
TERRACE
SMITHERS
KITIMAT
QUEEN CHARLOTTE
PRINCE GEORGE
Fraser River
BARKERVILLE
QUESNEL
BELLA COOLA
Chilcotin R.
River
WILLIAMS LAKE
Fraser R.
REVELSTOKE
BRALORNE
PORT ALICE
KAMLOOPS
CAMPBELL RIVER
VANCOUVER
SQUAMISH
MERRITT
Okanagan
KELOWNA
Lake
KASLO
PORT ALBERNI
Vancouver
PRINCETON
PENTICTON
NELSON
KIMBERLEY
BRITISH COLUMBIA
Scale 1:7,500,000
NANAIMO
KEREMEOS
ROSSLAND
ISLAND
DUNCAN
U. S. A.
Victoria
LARA PROJECT

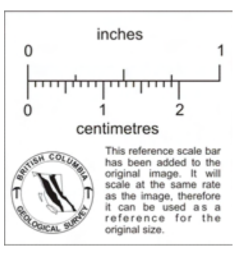

inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA
GEOLOGICAL SURVEY

Figure 1

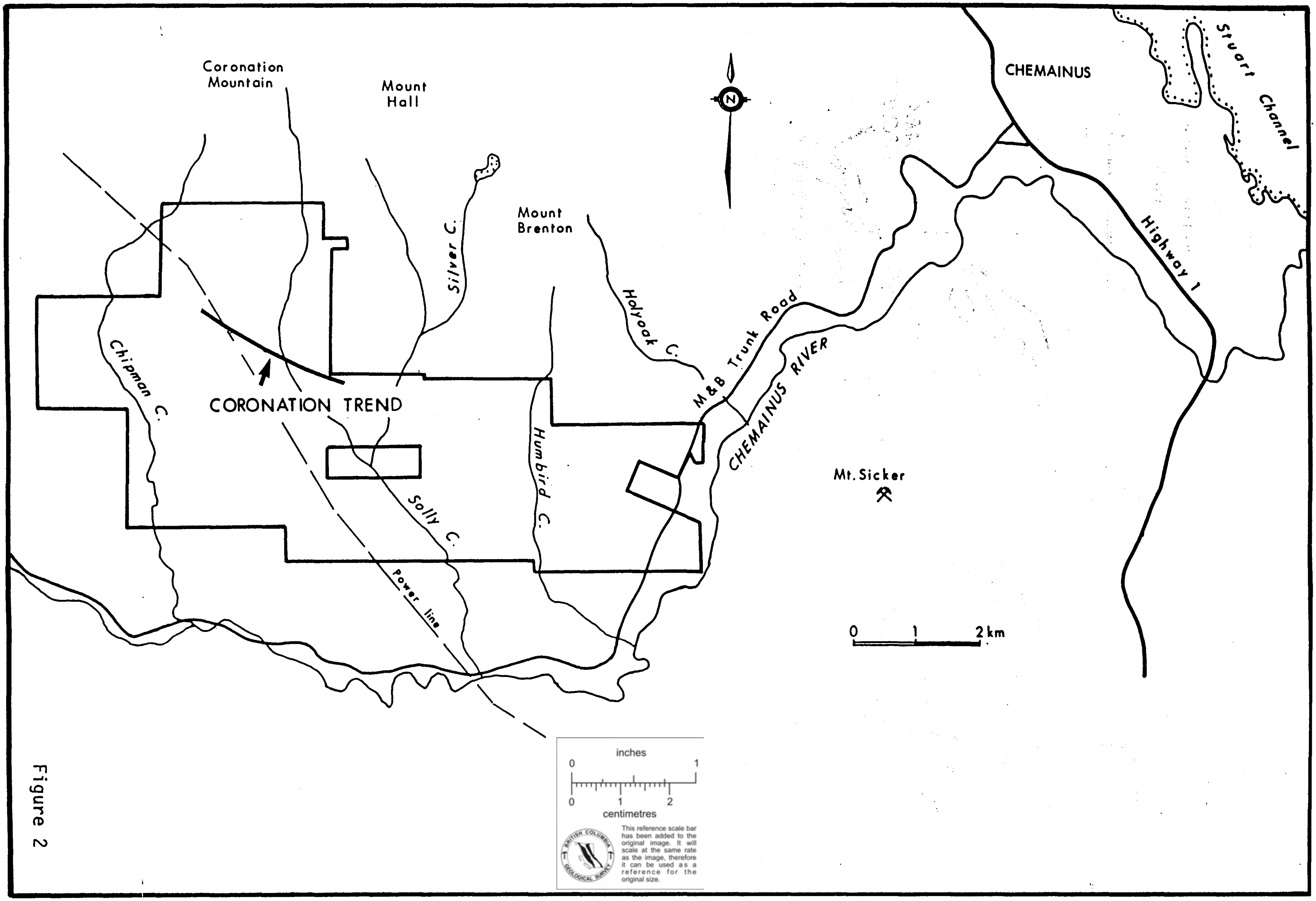
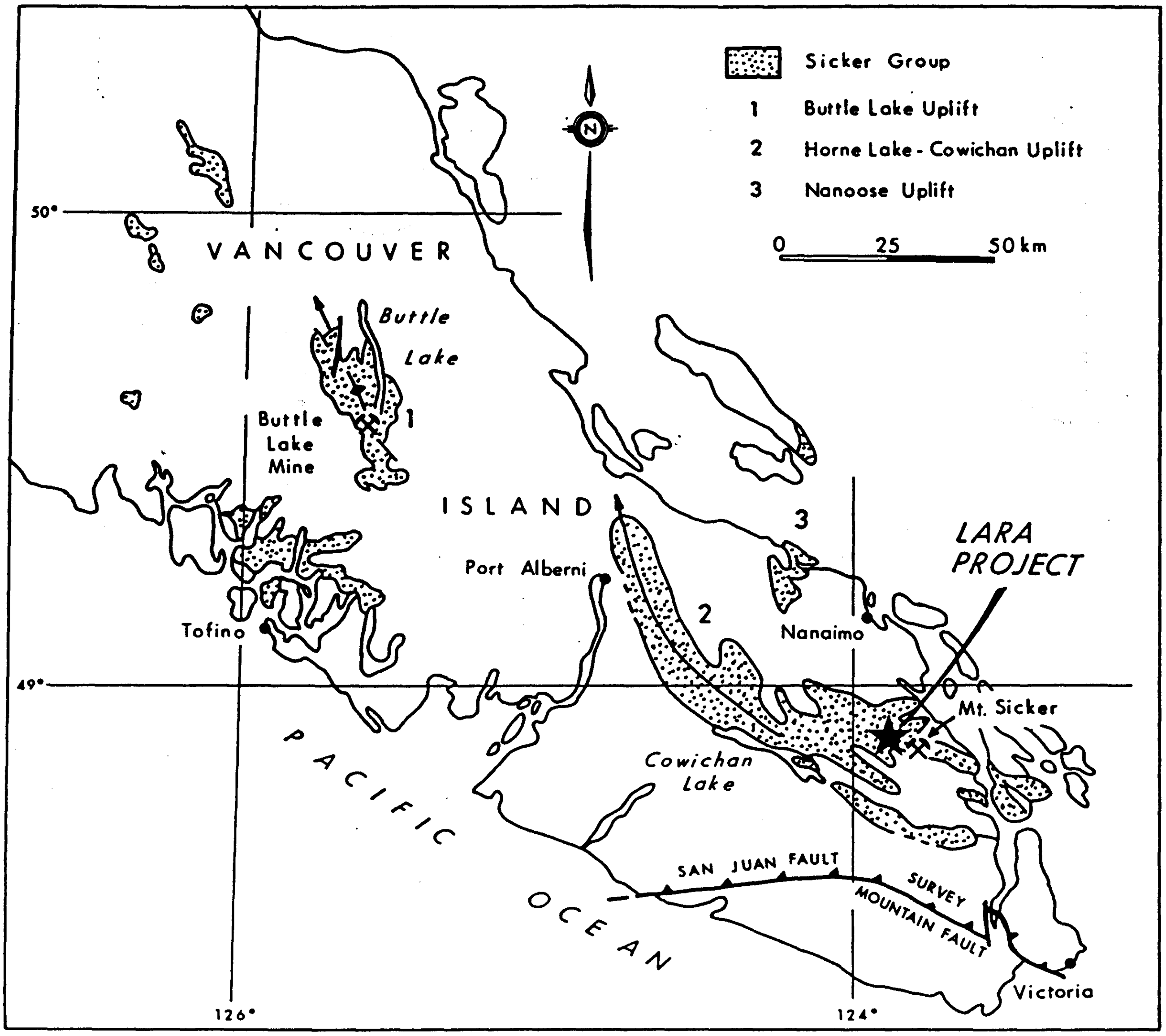

Coronation Mountain
Mount Hall
Mount Brenton
CHEMAINUS
Stuart Channel
Silver C.
Holyoak C.
M&B Trunk Road
CHEMAINUS RIVER
Highway 1
Chipman C.
CORONATION TREND
Humbird C.
Solly C.
Power line
Mt. Sicker
0 1 2 km
inches
0 1
0 1 2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY

Figure 2



After Massey and Friday 1986.

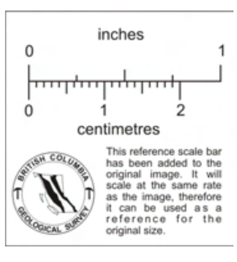
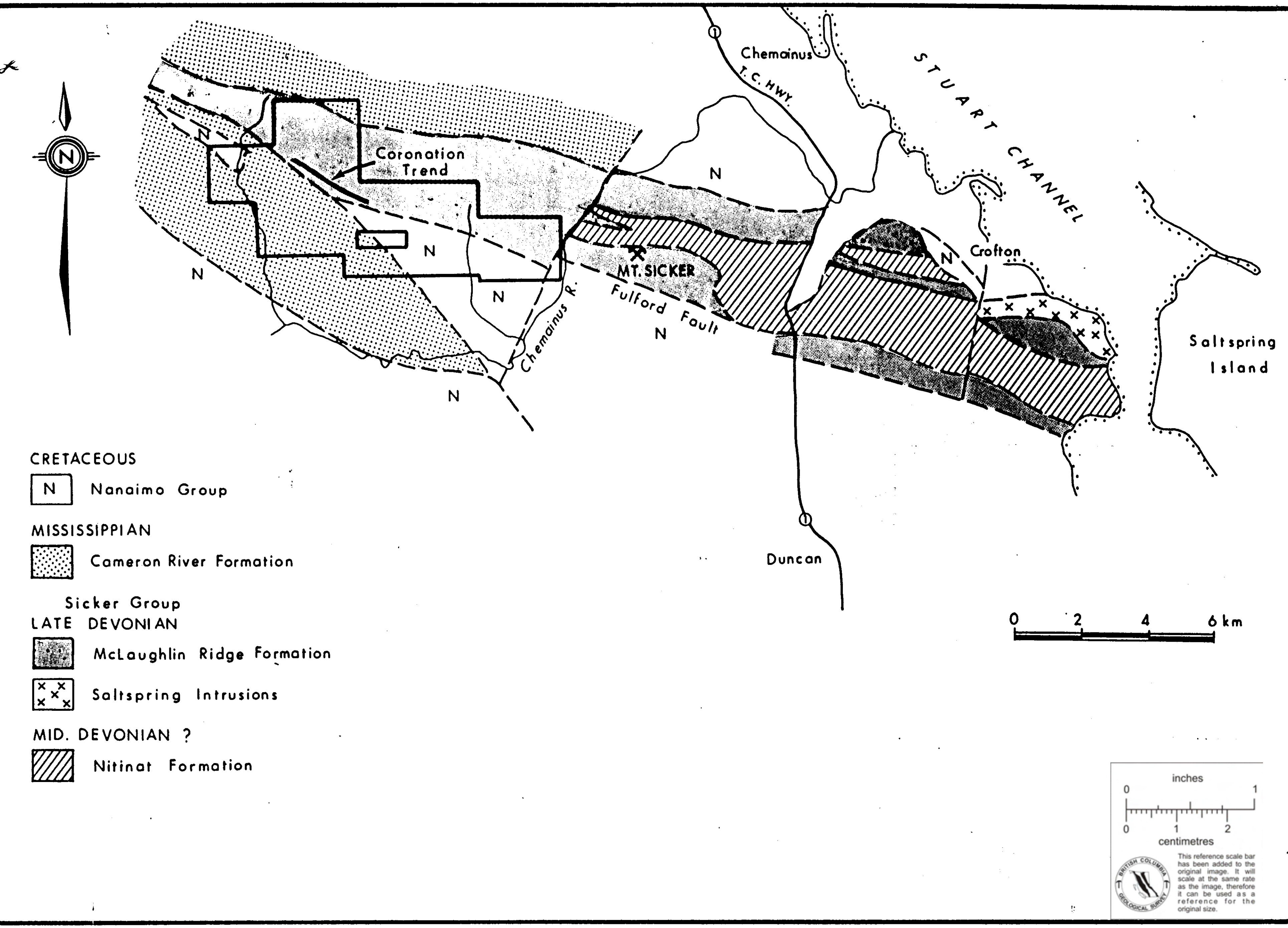


Figure 3



Coronation Trend
Chemainus
T.C. HWY.
STUART CHANNEL
N
MT. SICKER
Crofton
Chemainus R.
Fulford Fault
Saltspring Island
Duncan
CRETACEOUS
N Nanaimo Group
MISSISSIPPIAN
Cameron River Formation
Sicker Group
LATE DEVONIAN
McLaughlin Ridge Formation
Saltspring Intrusions
MID. DEVONIAN ?
Nitinat Formation
0 2 4 6 km
inches
0 1
0 1 2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY

Figure 4

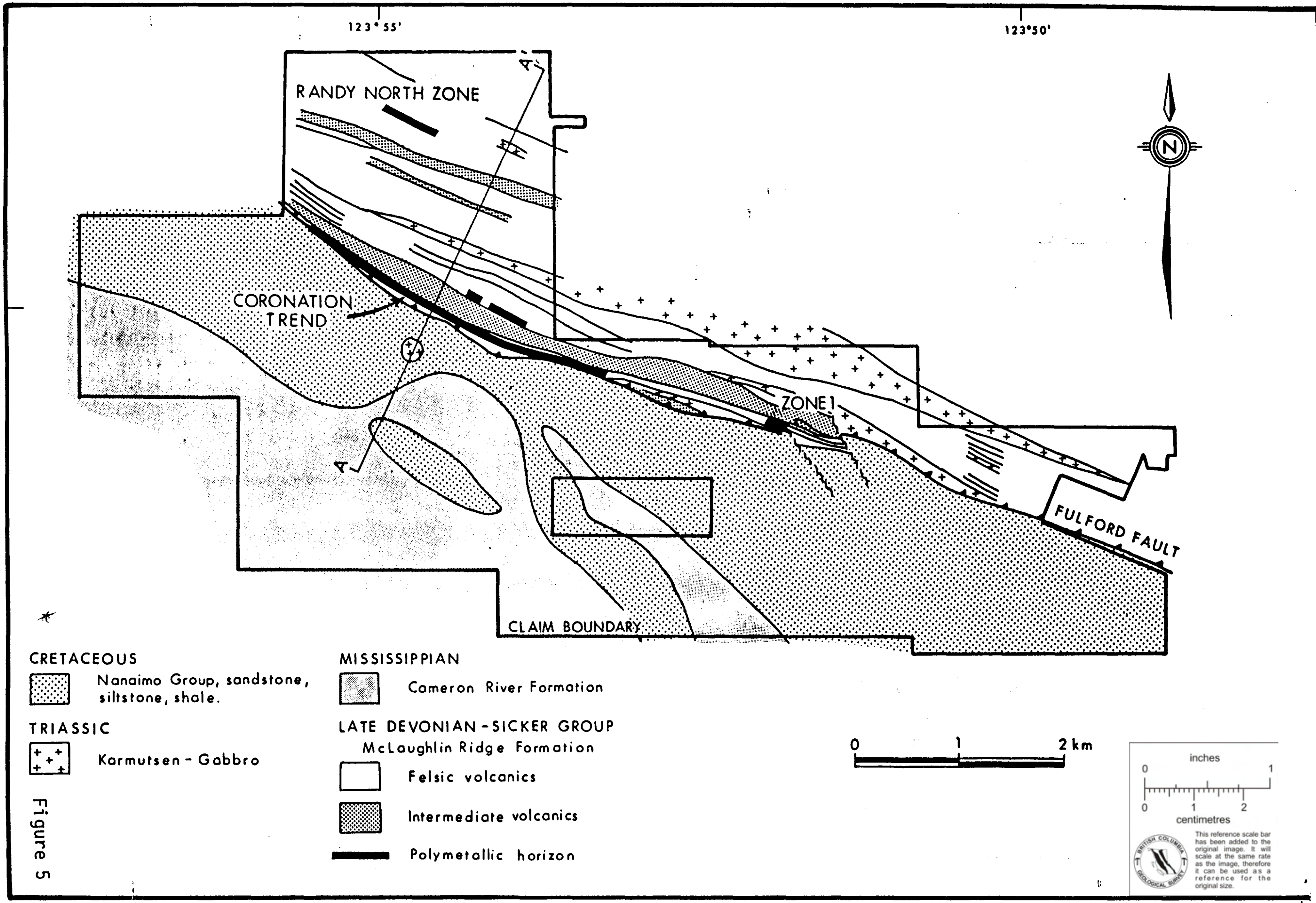

123°55'
123°50'
RANDY NORTH ZONE
A'
A
CORONATION TREND
ZONE 1
FULFORD FAULT
CLAIM BOUNDARY
N
CRETACEOUS
Nanaimo Group, sandstone, siltstone, shale.
TRIASSIC
Karmutsen - Gabbro
MISSISSIPPIAN
Cameron River Formation
LATE DEVONIAN - SICKER GROUP
McLaughlin Ridge Formation
Felsic volcanics
Intermediate volcanics
Polymetallic horizon
0
1
2 km
inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY

Figure 5

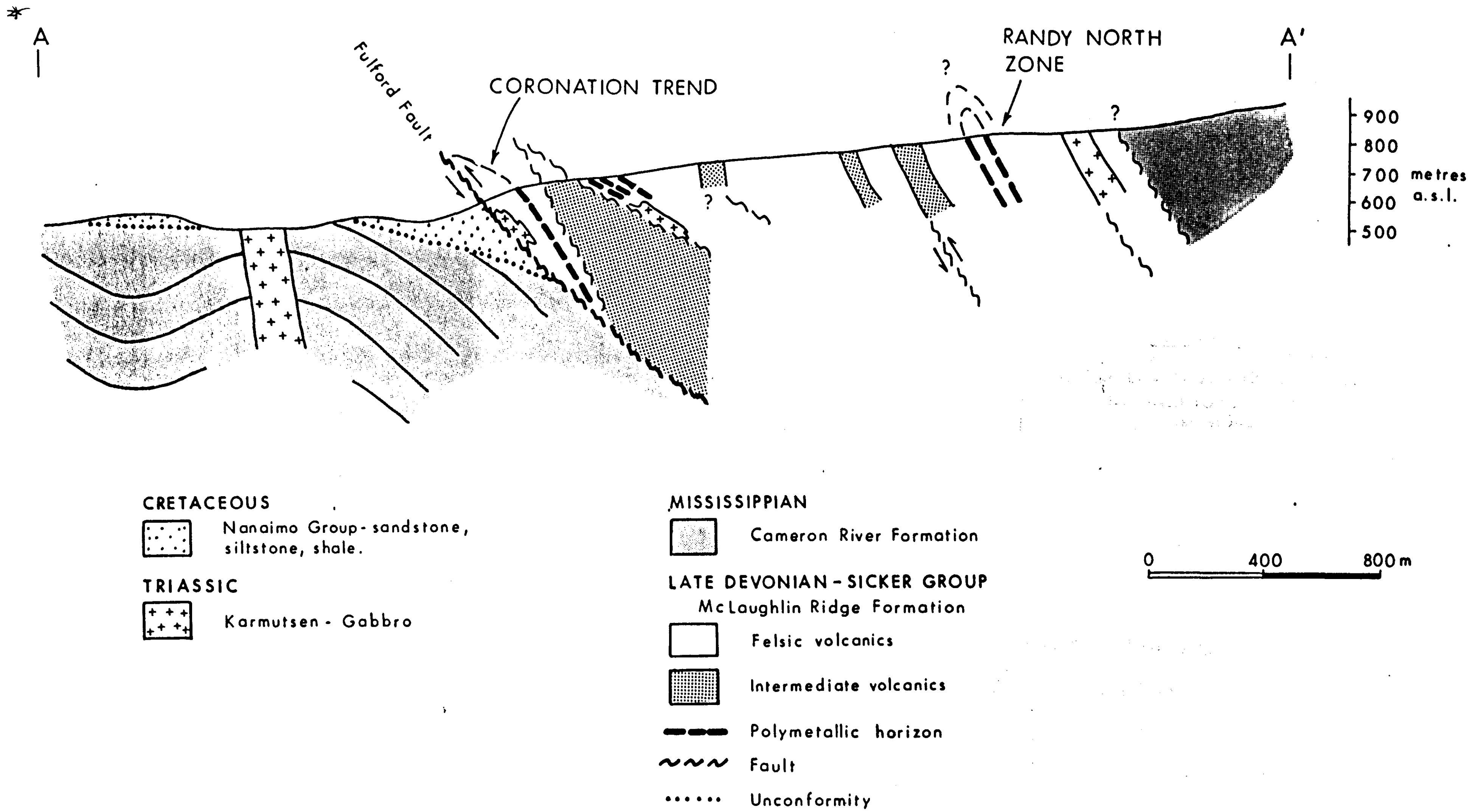

A
A'
Fulford Fault
CORONATION TREND
RANDY NORTH ZONE
?
900
800
700
600
500
metres a.s.l.
CRETACEOUS
Nanaimo Group - sandstone, siltstone, shale.
TRIASSIC
Karmutsen - Gabbro
MISSISSIPPIAN
Cameron River Formation
LATE DEVONIAN - SICKER GROUP
McLaughlin Ridge Formation
Felsic volcanics
Intermediate volcanics
Polymetallic horizon
Fault
Unconformity
0
400
800 m

Figure 6

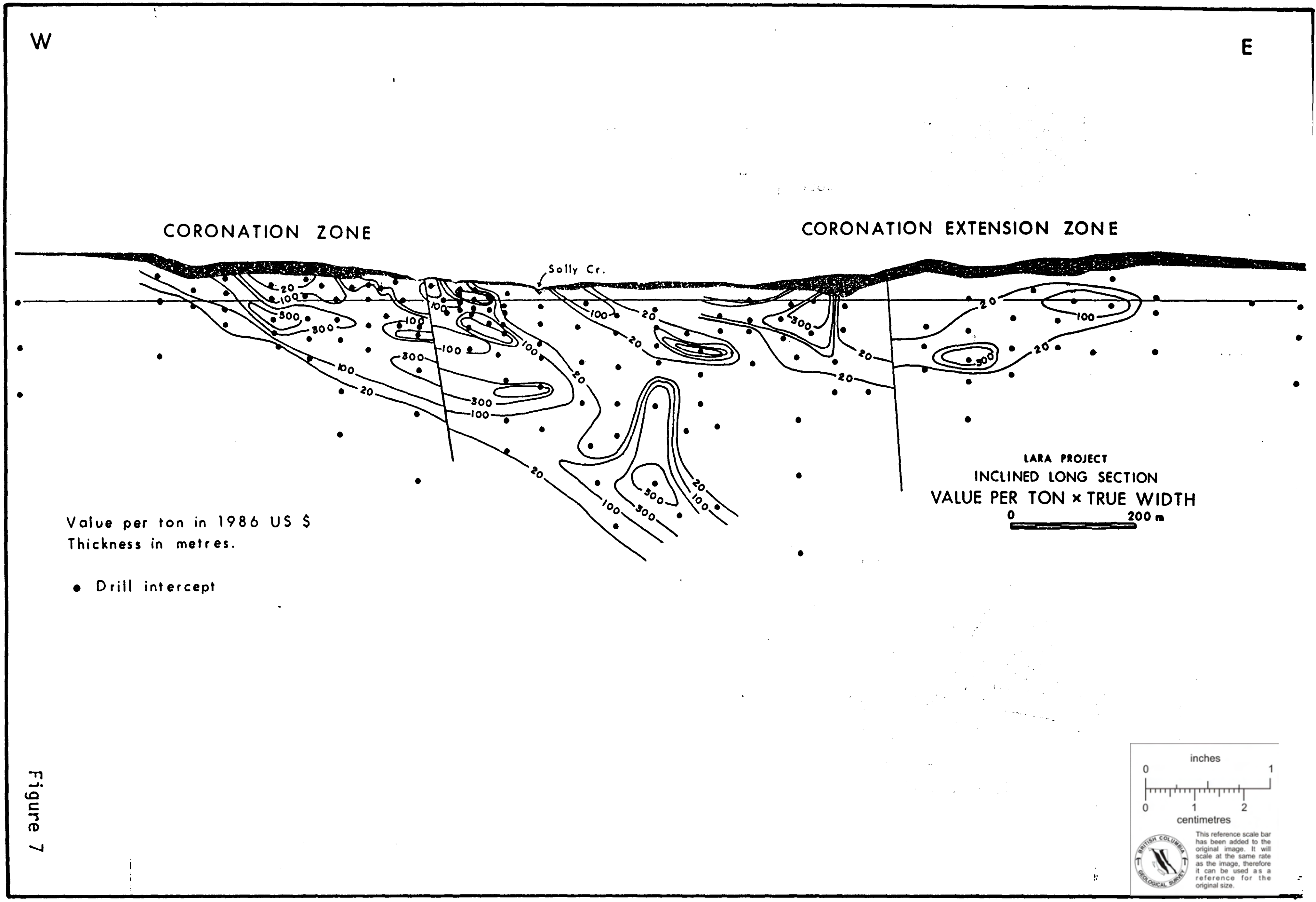
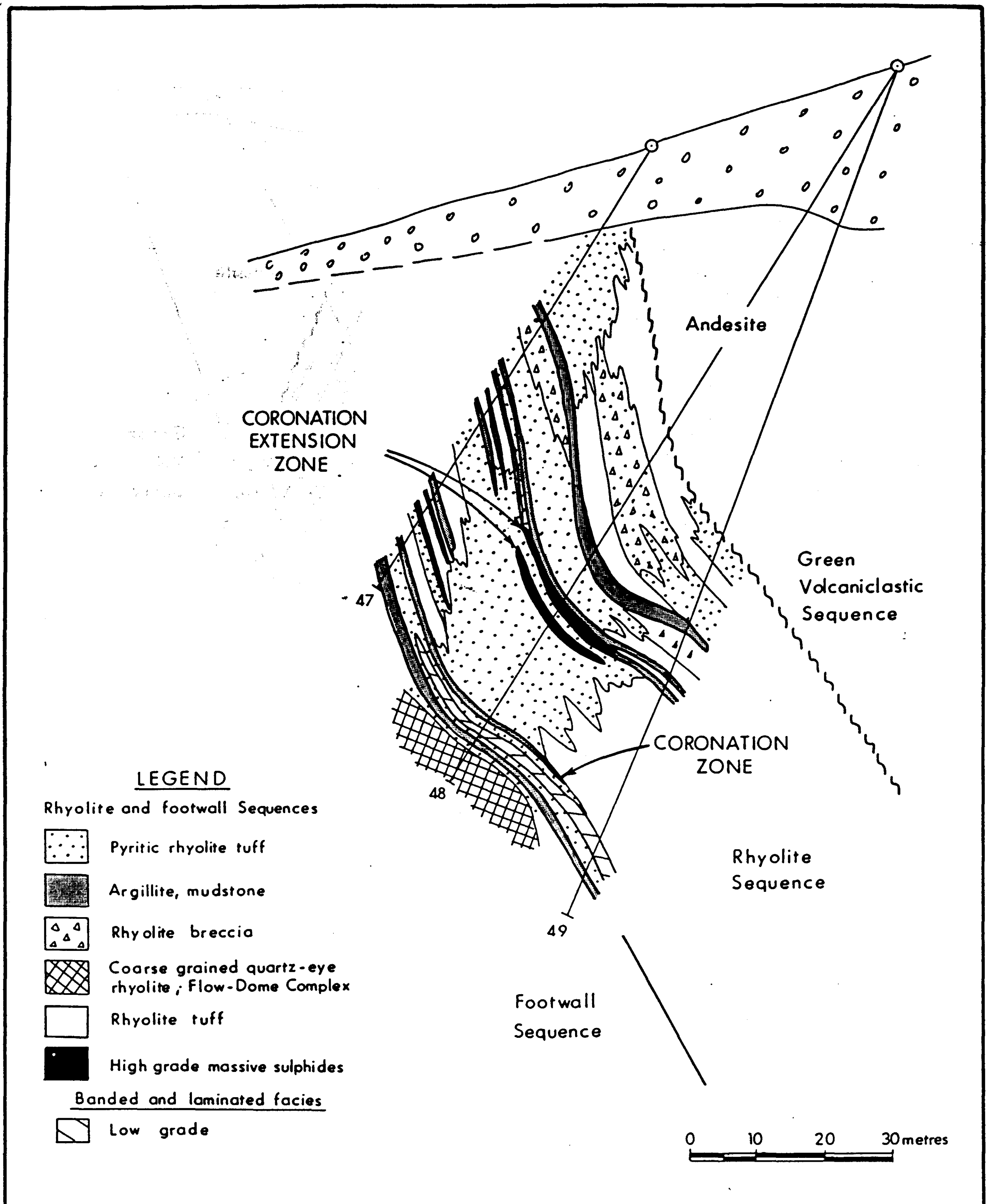

W
E
CORONATION ZONE
CORONATION EXTENSION ZONE
Solly Cr.
LARA PROJECT
INCLINED LONG SECTION
VALUE PER TON × TRUE WIDTH
0
200 m
Value per ton in 1986 US $
Thickness in metres.
Drill intercept

Figure 7


Andesite
CORONATION
EXTENSION
ZONE
Green
Volcaniclastic
Sequence
47
48
49
CORONATION
ZONE
Rhyolite
Sequence
Footwall
Sequence
LEGEND
Rhyolite and footwall Sequences
Pyritic rhyolite tuff
Argillite, mudstone
Rhyolite breccia
Coarse grained quartz-eye
rhyolite ; Flow-Dome Complex
Rhyolite tuff
High grade massive sulphides
Banded and laminated facies
Low grade
0
10
20
30 metres

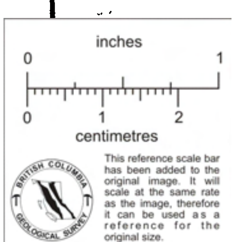
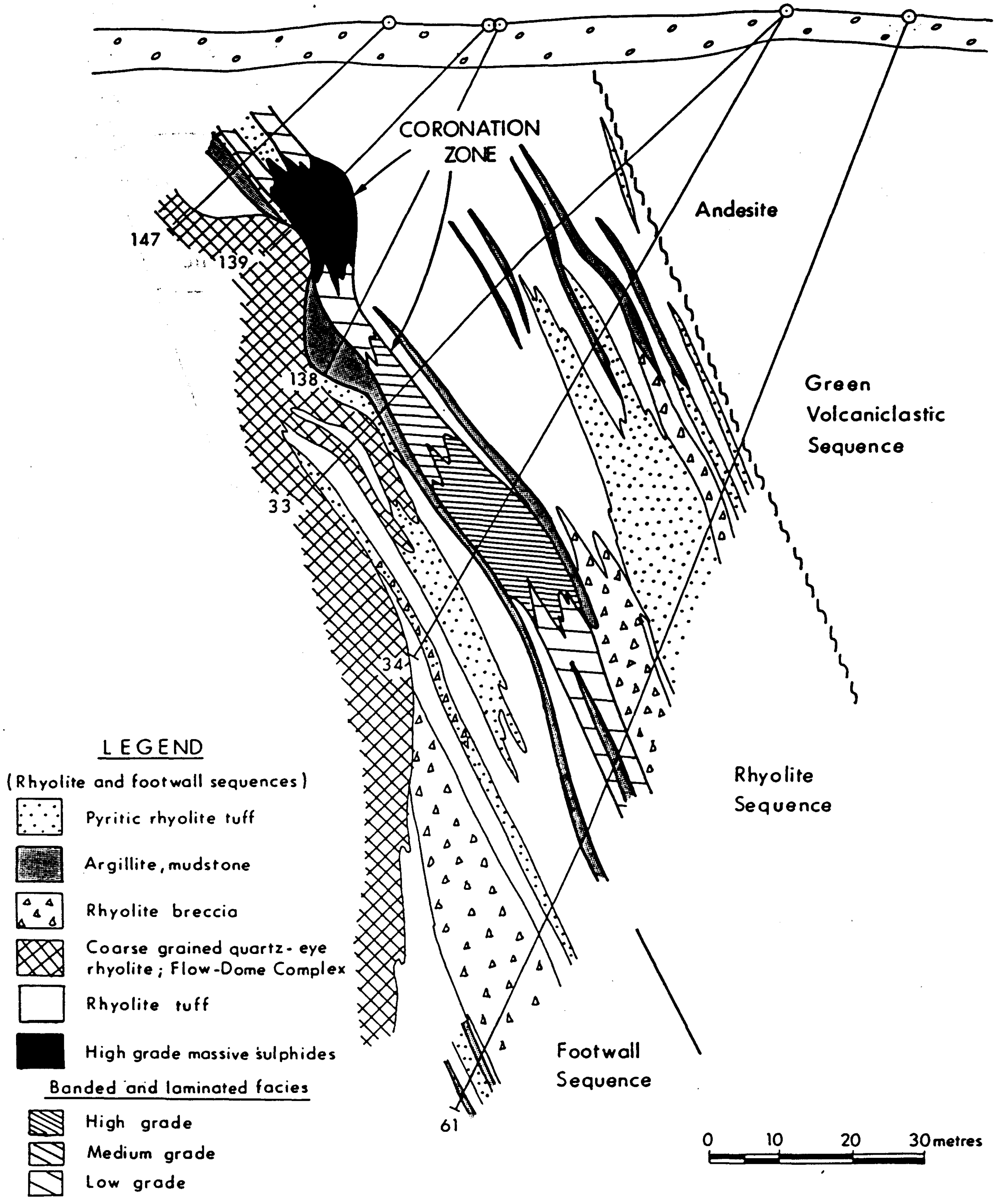
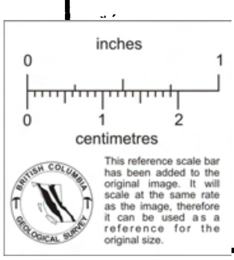

inches
0
1
0
1
2
centimetres

Figure 8


CORONATION
ZONE
Andesite
147
139
138
33
34
61
Green
Volcaniclastic
Sequence
Rhyolite
Sequence
Footwall
Sequence
0
10
20
30 metres
LEGEND
(Rhyolite and footwall sequences)
Pyritic rhyolite tuff
Argillite, mudstone
Rhyolite breccia
Coarse grained quartz-eye rhyolite; Flow-Dome Complex
Rhyolite tuff
High grade massive sulphides
Banded and laminated facies
High grade
Medium grade
Low grade


inches
0
1
0
1
2
centimetres
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BRITISH COLUMBIA
GEOLOGICAL SURVEY

* Figure 9

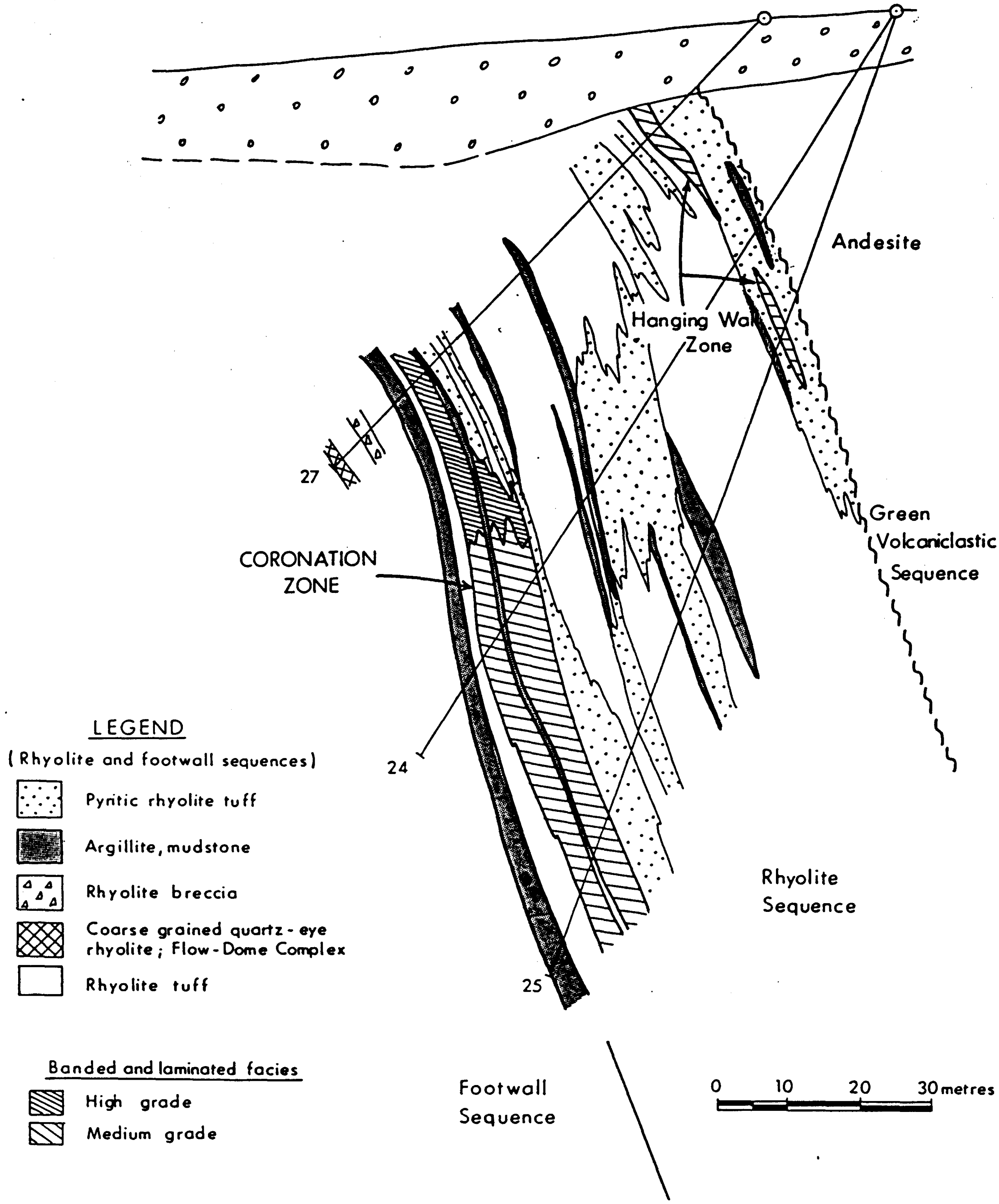
Andesite
Hanging Wall Zone
Green Volcaniclastic Sequence
27
CORONATION ZONE
24
25
Rhyolite Sequence
Footwall Sequence
0 10 20 30 metres
LEGEND
(Rhyolite and footwall sequences)
Pyritic rhyolite tuff
Argillite, mudstone
Rhyolite breccia
Coarse grained quartz - eye rhyolite ; Flow - Dome Complex
Rhyolite tuff
Banded and laminated facies
High grade
Medium grade

Figure 10

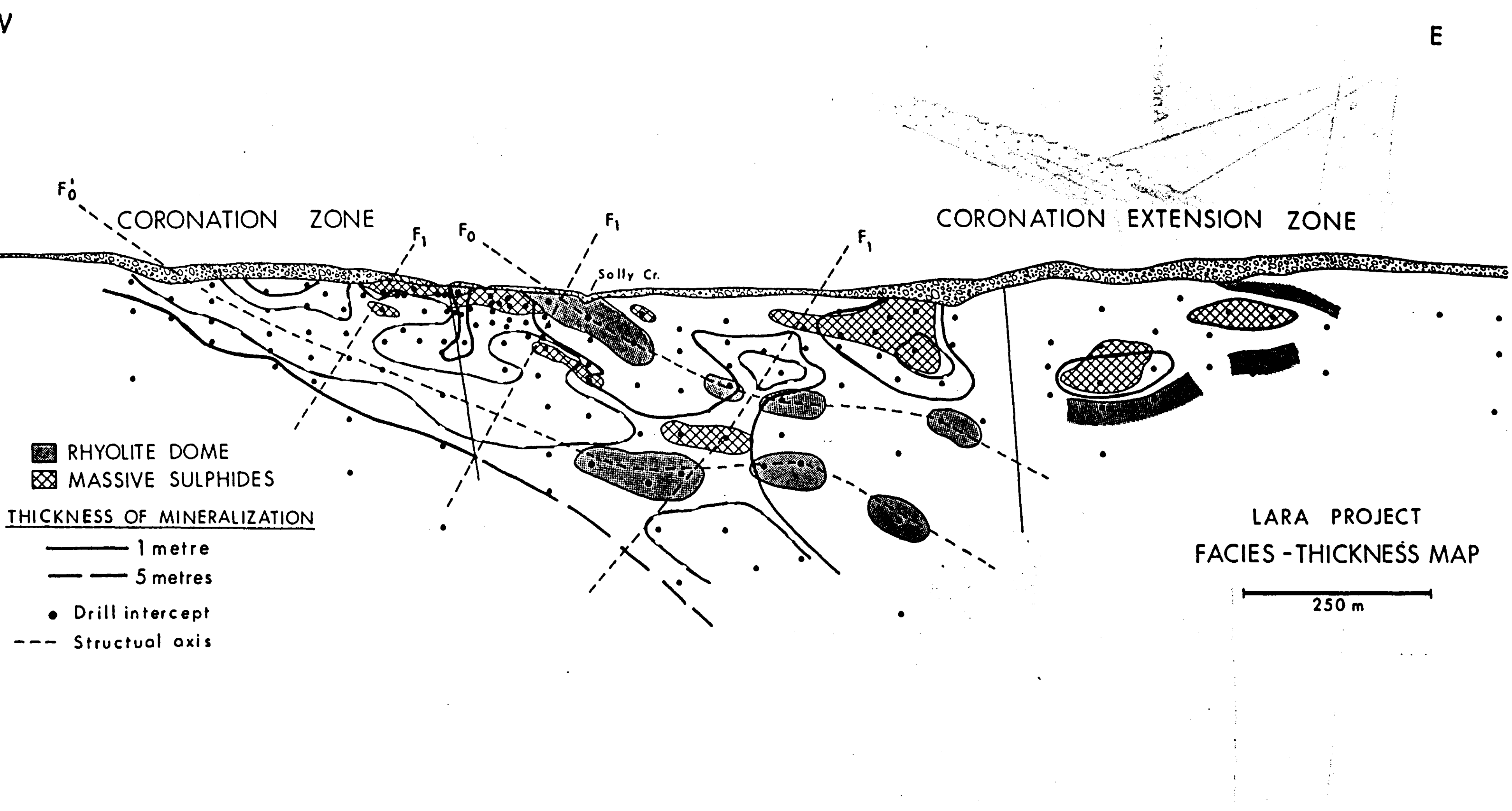
W
E
CORONATION ZONE
CORONATION EXTENSION ZONE
F'0
F1
F0
F1
F1
Solly Cr.
RHYOLITE DOME
MASSIVE SULPHIDES
THICKNESS OF MINERALIZATION
1 metre
5 metres
Drill intercept
Structual axis
LARA PROJECT
FACIES - THICKNESS MAP
250 m

Figure 11

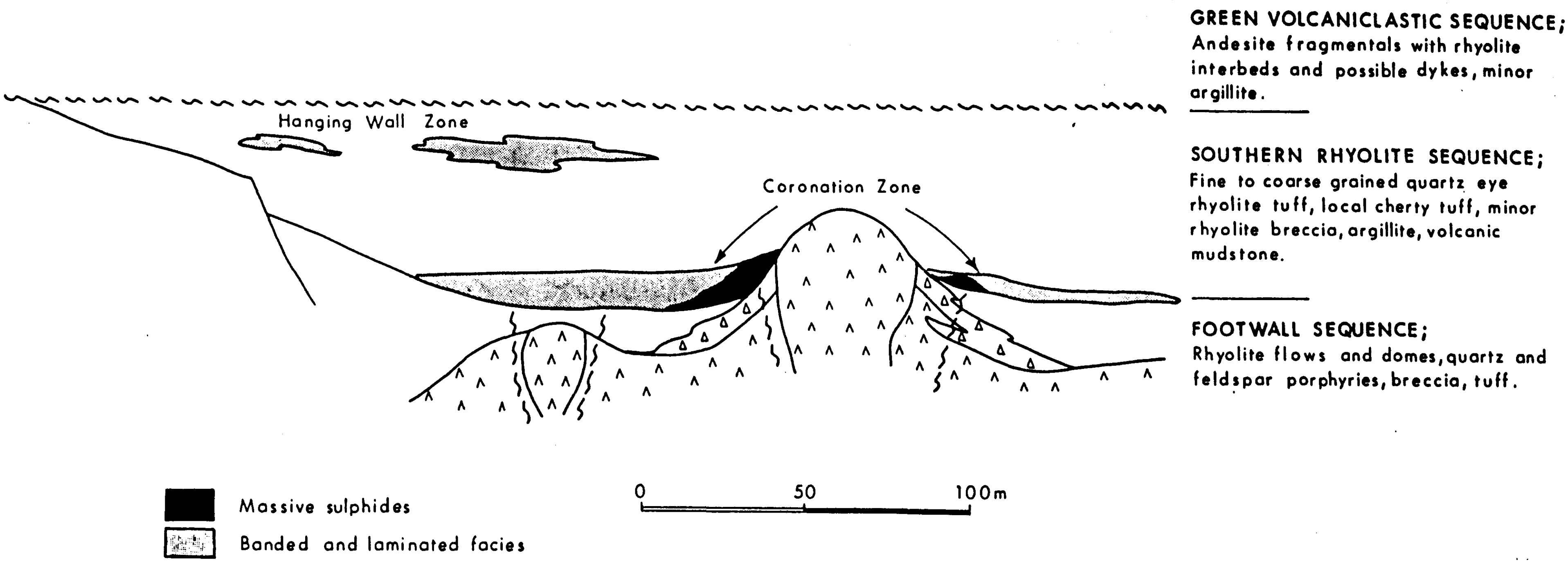
Hanging Wall Zone
Coronation Zone
GREEN VOLCANICLASTIC SEQUENCE;
Andesite fragmentals with rhyolite interbeds and possible dykes, minor argillite.
SOUTHERN RHYOLITE SEQUENCE;
Fine to coarse grained quartz eye rhyolite tuff, local cherty tuff, minor rhyolite breccia, argillite, volcanic mudstone.
FOOTWALL SEQUENCE;
Rhyolite flows and domes, quartz and feldspar porphyries, breccia, tuff.
Massive sulphides
Banded and laminated facies
0
50
100m

Figure 12