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By N.W.D. Massey, P.Geo.

PAPER 1992-4

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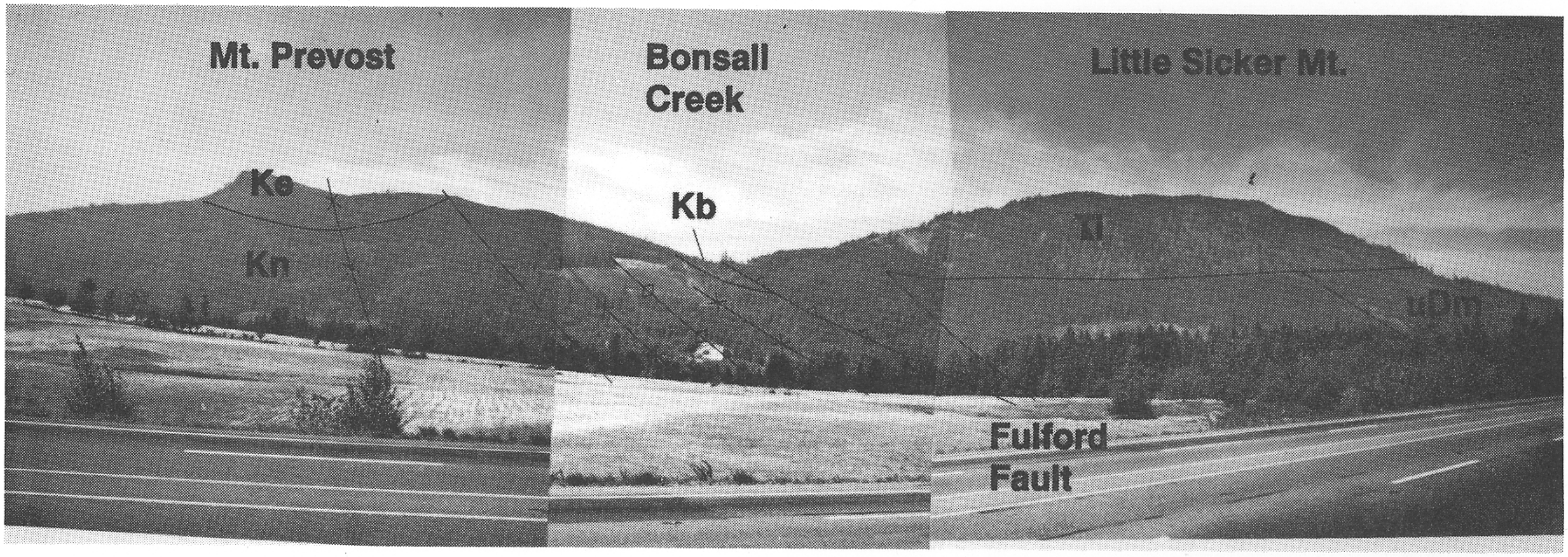
Fieldwork for this project was carried out during the period of 1986 through 1989.



Frontispiece: View of Mount Prevost and Little Sicker Mountain from the Island Highway north of Somenos. Bonsall Creek has eroded along the Fulford fault which separates Paleozoic volcanic rocks of the Sicker Group to the north from upper Cretaceous sediments of the Nanaimo Group to the south.

SUMMARY

The Duncan map area lies about 50 kilometres northwest of Victoria and includes parts of the Gulf Islands as well as Vancouver Island. The area lies at the southeastern end of the Vancouver Island Ranges and is characterized by fairly rugged topography with fault-line scarps and fault-controlled valleys, accentuated by glaciation. The area straddles the eastern end of the Cowichan uplift, one of a series of major geanticlinal structures constituting the structural fabric of Vancouver Island.

The oldest rocks in the Duncan area belong to the Paleozoic Sicker and Buttle Lake groups which contain volcanic and sedimentary units ranging from Middle Devonian to Early Permian age. The Devonian Sicker Group is a thick package of lower greenschist facies, metavolcanic and volcaniclastic rocks that formed in an oceanic island-arc environment. The lowest unit is the Duck Lake Formation which, in the Alberni - Nanaimo Lakes, area comprises a suite of grey to maroon and green pillowed basalts and basaltic breccias with chert, jasper and cherty tuff interbeds near the top of the sequence. In the Duncan map area, this unit is only found in the Bear Creek area, south of the Cowichan River.

Overlying the Duck Lake Formation is the Nitinat Formation, characterized by pyroxene-feldspar-porphyritic basalts and basaltic andesites. These typically occur as agglomerates, breccias, lapilli tuffs and crystal tuffs that formed as pyroclastic flows, debris flows and lahars. Pyroxene-phyric, amygdaloidal, pillowed and massive flows are also developed.

The Nitinat Formation is overlain, apparently conformably, by a heterogeneous sequence of mafic to felsic volcanics and volcaniclastic sediments of the McLaughlin Ridge Formation. The volcanics are predominantly intermediate pyroclastics, commonly feldspar crystal-lapilli tuffs, heterolithic lapilli tuffs and breccias and minor pyroxene-phyric lapilli tuffs. A thick package of felsic quartz-crystal, quartz-feldspar-crystal and fine dust-tuffs is developed in the Chipman Creek - Mount Sicker - Mount Richards area. It thins to the west, where it interfingers with andesitic lapilli tuffs and breccias. The uppermost unit is a distinctive maroon schistose heterolithic breccia and lapilli tuff with minor jasper, exposed in the Chipman Creek area. Coeval, and probably consanguineous, with the felsic volcanics in the McLaughlin Ridge Formation is a suite of granodiorite stocks and quartz porphyry dikes collectively known as the Saltspring Intrusive Suite. The Sicker Group volcanic rocks and associated intrusions form a coherent suite of medium-potassium calcalkaline chemistry typical of an island-arc.

The Buttle Lake Group is made up of a dominantly epiclastic and bioclastic limestone sedimentary sequence ranging from Mississippian to Early Permian in age. Within the Duncan area, the Buttle Lake Group is most often found in fault contact with the lower volcanic units of the Sicker Group. However, it is conformable on the McLaughlin Ridge Formation south of Sansum Point and in the Chipman Creek area and on the southwest limb of the Cowichan uplift, is unconformable on the lower volcanics.

The Fourth Lake Formation comprises mostly thin-bedded, often cherty sediments. South of the Chemainus River, the base of the formation is marked by a sequence of radiolarian ribbon cherts and cherty siltstones 100 to 200 metres thick, informally called the Shaw Creek member. This passes upwards into monotonous thinly bedded, sometimes cherty, turbiditic sandstone-siltstone-argillite intercalations. The ribbon cherts of the Shaw Creek member are absent north of the Chemainus River, where thinly bedded turbiditic clastic sediments conformably overlie the McLaughlin Ridge volcanics and dominate the sequence. Minor volcanism was synchronous with early Fourth Lake Formation sedimentation in the Coronation Mountain area. This "Coronation Mountain suite" consists of hornfelsed, amygdaloidal diabasic flows, which are generally massive but occasionally pillowed, and interbedded cherty tuffs and sediments. The basalts are slightly undersaturated olivine tholeiites or transitonal basalts, with somewhat enriched incompatible trace-element contents akin to ocean-island tholeiite or enriched ocean-floor basalt.

The Mount Mark Formation conformably overlies the Fourth Lake Formation, although outcrops of the formation are restricted to the Fairservice Mountain - Bear Creek area, south of the Cowichan River. It comprises massive and laminated crinoidal calcarenites with chert and argillite interbeds.

Basalts of the Karmutsen Formation are only exposed in the extreme southwest corner of the map area, on the west side of the Chanlog fault. They are comagmatic with the extensive mafic bodies of the Mount Hall gabbro, intrusive into the Paleozoic rocks. These intrusions are medium to coarse-grained diabase, gabbro and leucogabbro with minor diorite, commonly porphyritic with feldspar phenocrysts often forming glomeroporphyritic clusters. Thick gabbro bodies under Mount Hall and Coronation Mountain show layering of porphyritic

and nonporphyritic lithologies. The basalts, diabases and gabbros formed from an iron-titanium enriched tholeiitic magma, similar to continental tholeiite or enriched mid-ocean ridge basalt, probably in an oceanic flood-basalt province.

The Paleozoic and Triassic rocks have been intruded by granodioritic bodies of the Early to Middle Jurassic Island Plutonic Suite. With the exception of the large Ladysmith pluton, these granodiorite intrusions are elongate in surface outcrop shape, paralleling the overall structural grain of the area. The dominant lithology is a medium to coarse-grained, equigranular granodiorite to quartz diorite with a characteristic "salt-and-pepper" texture. Most of the large intrusive bodies are rich in mafic inclusions, especially in marginal agmatitic intrusive breccias. Contact metamorphic aureoles are developed around the intrusions causing hornfelsing and skarning in Paleozoic rocks. A variety of dikes and small irregular intrusions, that are probably coeval with the Island Plutonic Suite, occur throughout the area. Lithologically they include intermediate feldspar porphyry, hornblende feldspar porphyry and minor diabase. The Jurassic intrusions are coeval with the Bonanza volcanics, which outcrop in the Cowichan Lake area to the west. They form a metaluminous, medium to high-potassium calcalkaline suite typical of a convergent-margin environment.

Clastic sediments of the Upper Cretaceous Nanaimo Group lie unconformably on the older rocks. They are most thickly developed in the Maple Bay to Mount Prevost area, the Cowichan and Chemainus River valleys and the shoreline from Crofton to Ladysmith. The lower Benson Formation comprises basal cobble and boulder conglomerates and overlying medium to coarse-grained sandstones. These are succeeded by the black argillites and siltstones of the Haslam Formation. Pebble and cobble conglomerates of the Extension Formation conformably overlie Haslam Formation argillites on top of Mount Prevost and along the Chemainus River. Grey, medium to coarse-grained sandstones are interbedded with and overlie the conglomerates. Argillites of the Pender Formation, overlying the Extension Formation, are exposed in the incised gorge along the Chemainus River just below its confluence with Chipman Creek. Younger formations of the Nanaimo Group are absent.

Southern Vancouver Island has a complex structural history with frequent rejuvenation of previous structures. All Paleozoic rocks are affected by a series of southeast-trending, upright to overturned, southwest-verging folds. Penetrative axial planar foliation is absent throughout most of the area, except north of the Fulford fault, where foliation (schistosity in volcanics and cleavage in sediments) is well developed, trending north-northwest with generally steep northeasterly dips. Lineations plunge gently, up to 15°, to the west-northwest or east-southeast. Regional-scale warping of Vancouver Island occurred during the Early to Middle Jurassic, facilitating the emplacement of the Island Plutonic Suite intrusions and producing the geanticlinal Cowichan uplift. The present map pattern is dominated by the northwesterly trending contractional faults of the Tertiary Cowichan fold and thrust system. These are high-angle reverse faults which become listric at mid-crustal levels. They generally place older rocks over younger. Mesoscale footwall folds and minor imbricate faults are developed along most of the thrusts, particularly where thicker sections of Nanaimo sediments occur in the footwall, as in the Mount Prevost area where a deformational zone up to 1.5 kilometres wide occurs beneath the Fulford fault. The deformation probably took place during the crustal shortening accompanying the formation and emplacement of the Pacific Rim and Crescent terranes outboard of Wrangellia.

The Duncan area has had a somewhat intermittent history of mineral exploration since the late nineteenth century. Three mines on Mount Sicker (Leonora, Tyee and Richard III) formed the foci for one of the largest townsites in the area at the turn of the century. However, only sporadic production has ensued since then. The localization of metal deposits in the area is controlled by the interplay of stratigraphy and spatial association with later intrusions and structures. Three major metallogenic epochs are recognised. Syngenetic mineralization occurred during the building of the Sicker arc. Kuroko-style massive sulphides are associated with felsic volcanics in the upper part of the McLaughlin Ridge Formation. They occur in a belt extending from Saltspring Island to Rheinhart Creek, bounded to the south by the Fulford fault and appear to have formed close to the volcanic centre located in the Duncan - Saltspring Island area. Jasper and oxide-rich cherts occur within the volcanics of the Nitinat and McLaughlin Ridge formations but appear to have negligible economic mineralization. Thin syngenetic manganese oxide beds and sulphidic argillites occur within the radiolarian cherts of the basal Fourth Lake Formation.

The Early to Middle Jurassic arc was characterized by epigenetic mineralization of various types and styles, spatially related to the Island Plutonic Suite intrusions. Copper-molybdenum veins and stockworks occur within intrusions and volcanic country rock. Rhodonite forms by contact metamorphism of manganiferous chert.

Mesothermal gold-bearing quartz-carbonate veins are located along Tertiary structures and have been one of the main exploration targets in the area.

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INTRODUCTION

A 4-year program of 1:50 000-scale regional mapping was initiated by the British Columbia Geological Survey Branch on southern Vancouver Island in 1986, under the Canada/British Columbia Mineral Development Agreement 1985-1990. The program was planned to cover three 1:50 000 NTS sheets centred on the Paleozoic rocks that occur in the core of the Cowichan uplift (Figure 1). These units are the host to several types of mineral deposits including polymetallic Kuroko-style massive sulphides, for example the Mount Sicker camp, and mesothermal gold-bearing quartz-carbonate veins, for example, Mineral Creek zone. Preliminary results of mapping have been described by Massey and Friday (1987, 1988, 1989) and released as Open File maps (Massey *et al.*, 1987, 1988, 1989).

LOCATION AND ACCESS

The Duncan area lies about 50 kilometres northwest of Victoria and includes parts of the Gulf Islands as well as Vancouver Island. It occupies the southeastern end of the Vancouver Island Ranges (Holland, 1976) and displays moderately rugged topography with moderate to steep slopes. Fault-line scarps and fault-controlled valleys occur in the central and western portions of the area. The broad, flat valley of the Cowichan River lies in the south of the area and coastal flatlands extend from Crofton to Ladysmith. Elevations are generally low to moderate in the east, rarely rising above 500 metres, but become higher to the west reaching over 1200 metres. Mount Hall is the highest point in the area, at 1309 metres.

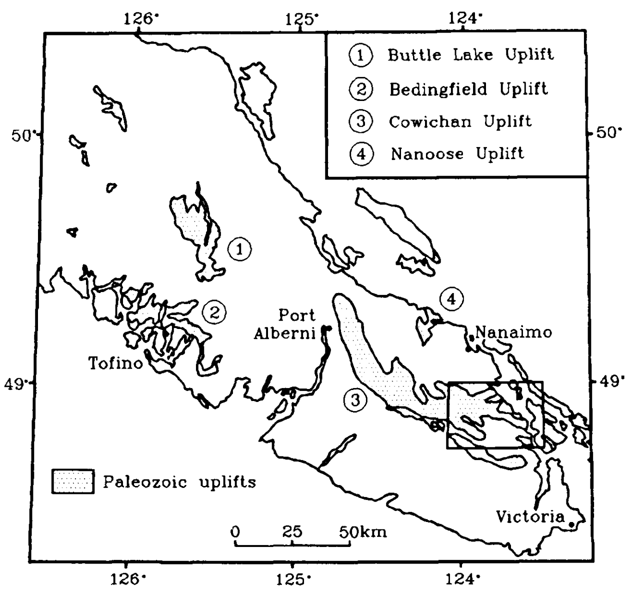

Figure 1. Location of the Sicker Project area, southern Vancouver Island. The four major uplifts cored by Paleozoic rocks are indicated. The Duncan map area is outlined.

Duncan is the principal community in the area. Ladysmith, Chemainus, Crofton and Maple Bay are also important centres and several smaller communities are located in the Cowichan Valley, along the shoreline and on Saltspring Island. Road access in the area is excellent with the main Island Highway running northwards through the centre of the map area. There are many other paved roads in the east and south within the municipalities of North Cowichan and Ladysmith and on the Gulf Islands. Access to the western half of the area is provided by an extensive network of logging roads in various states of upkeep. Shoreline exposures are easily accessible by boat.

Rock outcrops are numerous in roadcuts and are plentiful along the shoreline, in creek beds and on hillsides, though the latter may be under thick forest cover.

REGIONAL SETTING

The Duncan area straddles the eastern end of the Cowichan uplift, one of a series of major geanticlinal structures constituting the structural fabric of Vancouver Island (Figure 1). It lies within the Wrangellia Terrane, which on Vancouver Island comprises three thick volcano-sedimentary cycles - the Paleozoic Sicker and Buttle Lake Groups, the Upper Triassic Vancouver Group and the Lower Jurassic Bonanza Group. These are overlapped by Upper Cretaceous sediments of the Nanaimo Group. All these rocks are involved in the Tertiary Cowichan fold and thrust system (England and Calon, 1991).

PREVIOUS WORK

The first major examination of the rocks of the area was undertaken by Clapp as part of a reconnaissance of southern Vancouver Island (Clapp, 1912). He later undertook more detailed mapping in the Duncan and contiguous areas (Clapp, 1913, 1914; Clapp and Cooke, 1917). Limestone deposits of the area were briefly described by Mathews and McCammon (1957) and the Permian Mount Mark Formation south of the Cowichan River was studied in detail by Yole (1964). Muller and colleagues mapped large portions of Vancouver Island including the Duncan area (Muller, 1985). Detailed investigations of small areas around Duncan have also been reported on by Eastwood (1979b, 1980a, 1980b, 1982).

Biostratigraphic and radiometric dating of the rocks of southern Vancouver Island, including the map area, have been summarized by Muller and Jeletzky (1970), Brandon *et al.* (1986) and Armstrong *et al.*, (1986). Regional geochemical data have been released by Matysek *et al.* (1990), and mineral occurrences are described in the B.C. Ministry of Energy, Mines and Petroleum Resources mineral inventory database (MINFILE, 1990).

ACKNOWLEDGMENTS

The author would like to acknowledge the enthusiastic and capable assistance provided by Steve Friday, Paulette Tercier and Teresa Potter in the field and Janet Riddell in the office. Invaluable discussions of the regional geology with Atholl Sutherland Brown, Chris Yorath, Mark Brandon, Tim England, Richard Walker, Stephen Juras and Paul Wilton have enriched this project. Jenny Getsinger and Gord Allen (M.P.H. Consulting Ltd.) provided much useful local information. The staff of Abermin Corporation and Falconbridge Limited are thanked for their openness and willingly allowing access to maps, drill logs and core. Fieldwork could not have proceeded without the cooperation of MacMillan Bloedel Limited (Copper Canyon Division), Crown Forest Limited (Nanaimo Division), British Columbia Ministry of Forests (Duncan) and the Municipality of North Cowichan. This manuscript was improved by the editorial suggestions and comments of Paul Wilton and John Newell.

LITHOLOGY AND STRATIGRAPHY

The oldest rocks in the area belong to the Paleozoic Sicker and Buttle Lake Groups which contain volcanic and sedimentary units, ranging from Middle Devonian(?) to Early Permian age (Figure 2), that formed as an intra-oceanic arc and possible marginal basin. These are intruded by mafic sills of the Mount Hall gabbro, coeval with overlying oceanic flood-basalts of the Upper Triassic Karmutsen Formation. All of these sequences have subsequently been intruded by arc-related granodioritic stocks of the Early to Middle Jurassic Island Plutonic Suite. Upper Cretaceous sediments of the Nanaimo Group lie unconformably on the older sequences.

There have been several attempts to formally subdivide the Paleozoic rocks of Vancouver Island. Clapp (Clapp, 1912: Clapp and Cooke, 1917) first mapped these rocks in the Duncan area, naming them the "Mount Sicker Series". However, he incorrectly interpreted them as younger than the Triassic Karmutsen Formation (Vancouver Series). Later workers in the Buttle Lake and Cowichan Lake areas recognized them as indeed Paleozoic in age and referred to them as the Sicker Group (Gunning, 1931: Fyles, 1955; Yole 1963, 1964, 1969). In the first major synthesis of data on the Paleozoic rocks of Vancouver Island, Muller (1980) continued the use of the term "Sicker Group" and proposed four subdivisions which, in ascending stratigraphic order, are the Nitinat Formation, the Myra Formation, an informal sediment-sill unit and the Buttle Lake Formation. Recent paleontological and radiochronological studies (Brandon *et al.*, 1986), coupled with newer mapping (Sutherland Brown *et al.*, 1986; Sutherland Brown and Yorath, 1985), have thrown some doubt on these subdivisions and their applicability in the Cowichan uplift. Revised stratigraphic subdivisions have been proposed by Sutherland Brown (Yorath, in preparation) based on work in the Alberni area, and a similar revision has also been made independently by Juras (1987) in the Buttle Lake uplift. The major contribution of these studies has been the formal recognition that the Paleozoic rocks can be separated into an older volcanic-dominated sequence of Devonian age, renamed the Sicker Group *sensu stricto,* and a younger Mississippian to Permian sedimentary sequence renamed the Buttle Lake Group (Figure 3). The revised stratigraphic nomenclature of Sutherland Brown, with some revision by Massey and Friday (1989), has proven to be applicable and useful throughout the entire Cowichan uplift and has been adopted for this project. However, the previously adopted name of "Cameron River Formation" for the lower unit in the Buttle Lake Group (Massey *et al.*, 1987, 1988, 1989; Massey and Friday, 1988, 1989) has been abandoned in favour of "Fourth Lake Formation", introduced to avoid conflict with an already extant Cameron River Formation elsewhere in Canada.

SICKER GROUP

The Sicker Group is a thick package of volcanic and volcaniclastic rocks that forms the exposed basement on Vancouver Island. Biostratigraphic age control is lacking due to the paucity of fossils within the sequence; only scarce, unidentified plant debris and trace fossils in the McLaughlin Ridge Formation have been found to date. Whole-rock and mineral K-Ar radiometric dating of the volcanics have been inconclusive, yielding ages ranging from the Silurian to the Early Jurassic. Zircons from rocks of the Saltspring Intrusive Suite, believed to be cogenetic with the felsic volcanics in the upper part of the McLaughlin Ridge Formation, yield discordant dates suggesting an age of about 393 Ma (Table C3, Figure C, in pocket). However, resampling of Saltspring Island porphyries has yielded concordant U-Pb ages of 362± 2 and 367± 2 Ma (Parrish and McNicoll, 1991). These data point to a Late Devonian age for volcanism, in agreement with correlative rocks in the Buttle Lake uplift (Juras, 1987).

DUCK LAKE FORMATION

The lowermost unit in the Sicker Group comprises dominantly pillowed, amygdaloidal basalts with minor cherts and cherty tuffs (Massey and Friday, 1989). It is essentially confined to the western part of the Cowichan uplift (Massey 1992b). Within the Duncan area, however, massive and pillowed amygdaloidal basaltic flows outcrop in the Bear Creek area, south of the Cowichan River. These were previously mapped as Nitinat Formation (Massey *et al.*, 1988), but based on geochemistry and field characteristics, are now recognized as part of the Duck Lake Formation.

The flows are dark grey to green, aphyric to feldspar-phyric with variable chlorite-epidote alteration. They are mostly massive to weakly foliated, but one outcrop of maroon to green, variolitic pillows was observed. Structure is complex and outcrop rare in this area, but it appears that the flows pass northwards into pyroxene-phyric flows and breccias of the Nitinat Formation, and

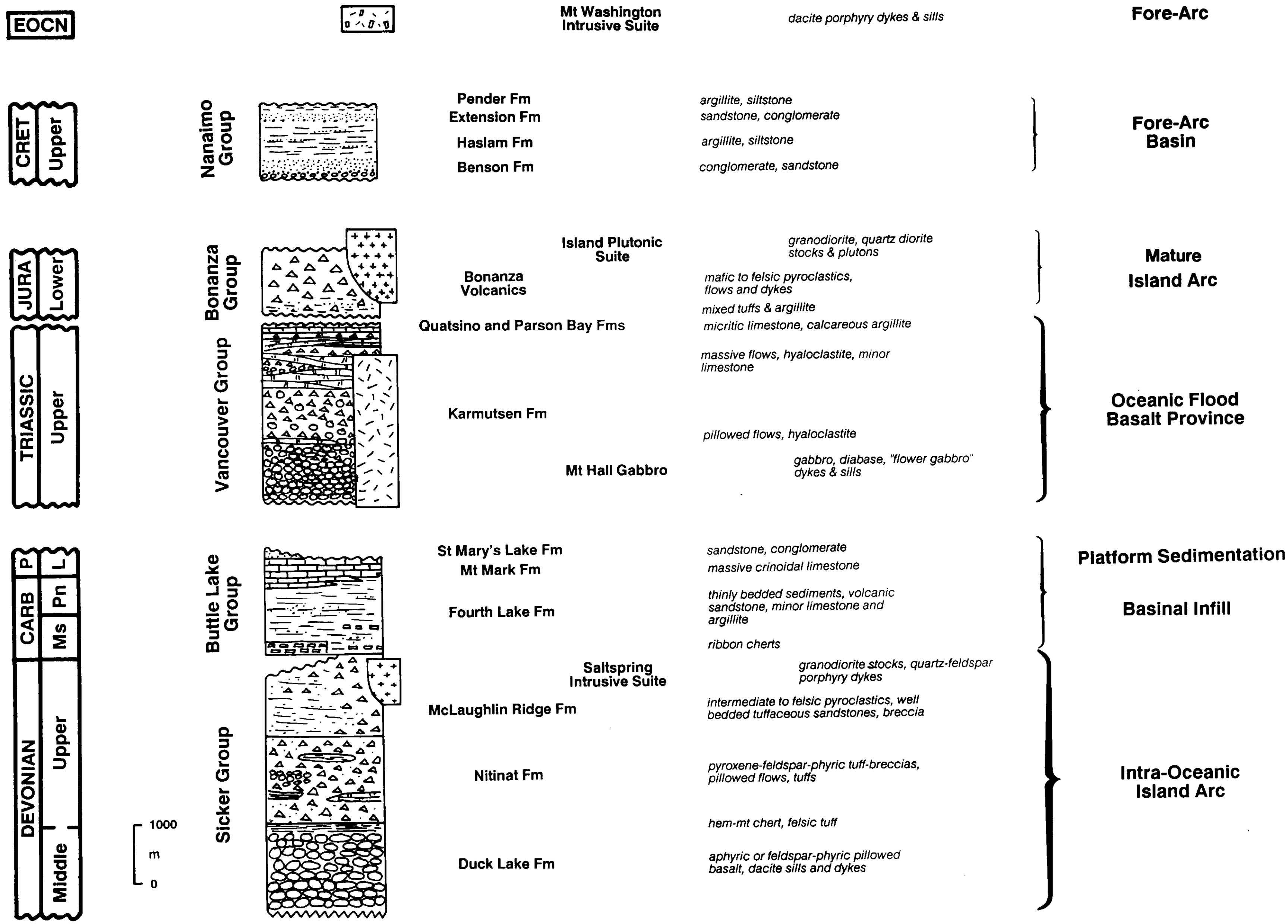

Figure 2. Stratigraphy and tectonic setting of rock units in the Cowichan uplift.

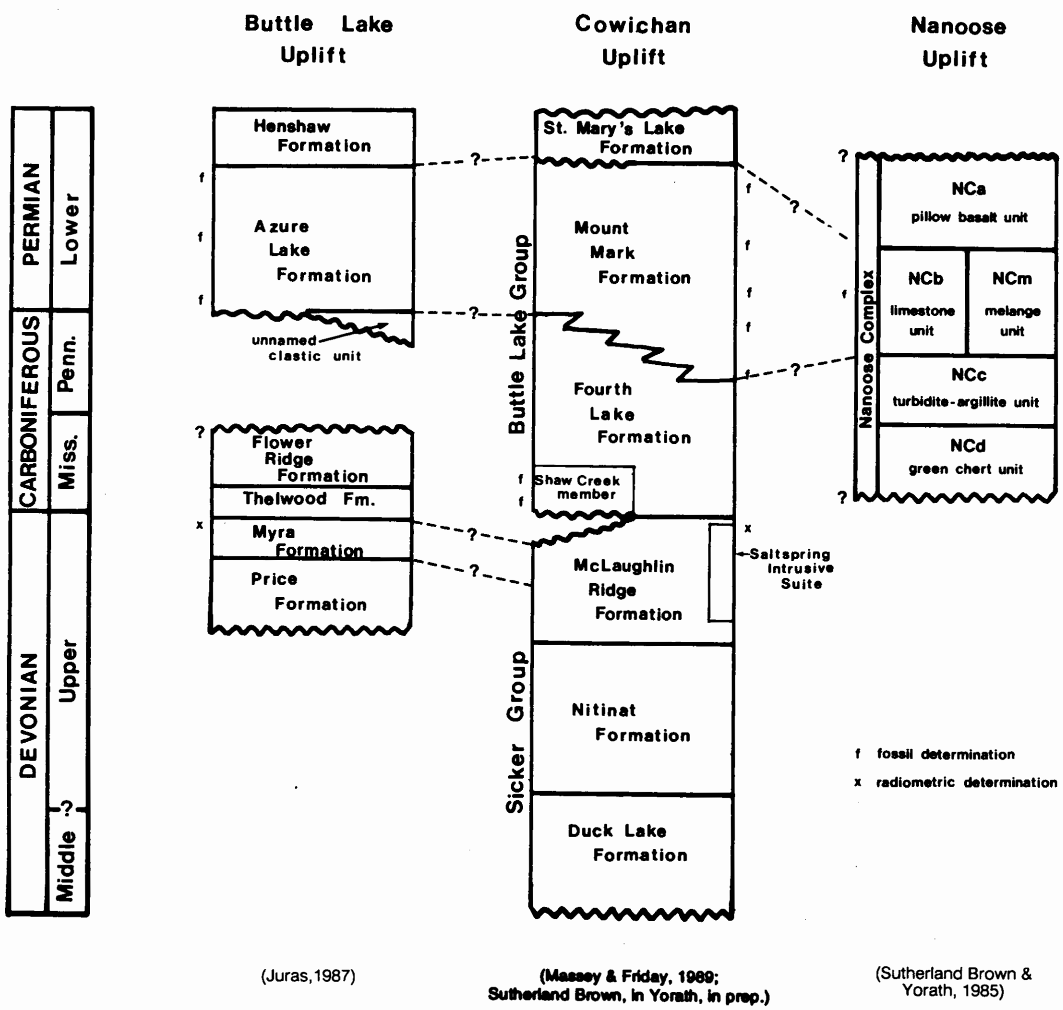

Figure 3. Comparative stratigraphy of the Paleozoic rocks of Vancouver Island. Stratigraphic columns are not drawn to scale. Note that stratigraphic divisions of the Nanoose Complex are informal and have been designated by letter only.

to the south are unconformably overlain by sediments of the Buttle Lake Group. Similar pillowed basalts, probably assignable to the Duck Lake Formation, underlie parts of the Koksilah Range to the south (Getsinger 1986a, 1986b; Sketchley and Gunning 1987).

Nitinat Formation

The Nitinat Formation is generally the lowermost unit recognized in the Sicker Group in the Duncan map area. It is a volcanic package characterized by pyroxene-feldspar-porphyritic basalts and basaltic andesites. They typically occur as agglomerates, breccias, lapilli tuffs and crystal tuffs that formed as pyroclastic flows, debris flows and lahars. Extensive pyroxene-phyric, amygdaloidal flows are also developed, particularly in the Banon Creek area (Plate 1). Pyroxenes are large, up to 1 centimetre in diameter, euhedral to subhedral, and comprise 5 to 20 per cent of the rock. Plagioclase is equally abundant, but phenocrysts are usually smaller, ranging up to 5 millimetres in diameter. Amygdules present in flows and clasts in coarser pyroclastics are infilled with chlorite, quartz, epidote or calcite. Minor laminated tuff and tuffaceous sandstone are present locally. In the Mount Richards - Maple Bay area alteration of the agglomerates and tuff-breccias has resulted in variable epidotization. Generally the clasts are epidotized and the matrix chloritized. Within the clasts the original fabrics may be obliterated although chlorite pseudomorphs after pyroxene phenocrysts may be preserved (Plate 2). Alteration varies from minor to complete even in adjacent clasts. Occasionally, the tuffaceous matrix is epidotized and the clasts unaltered.

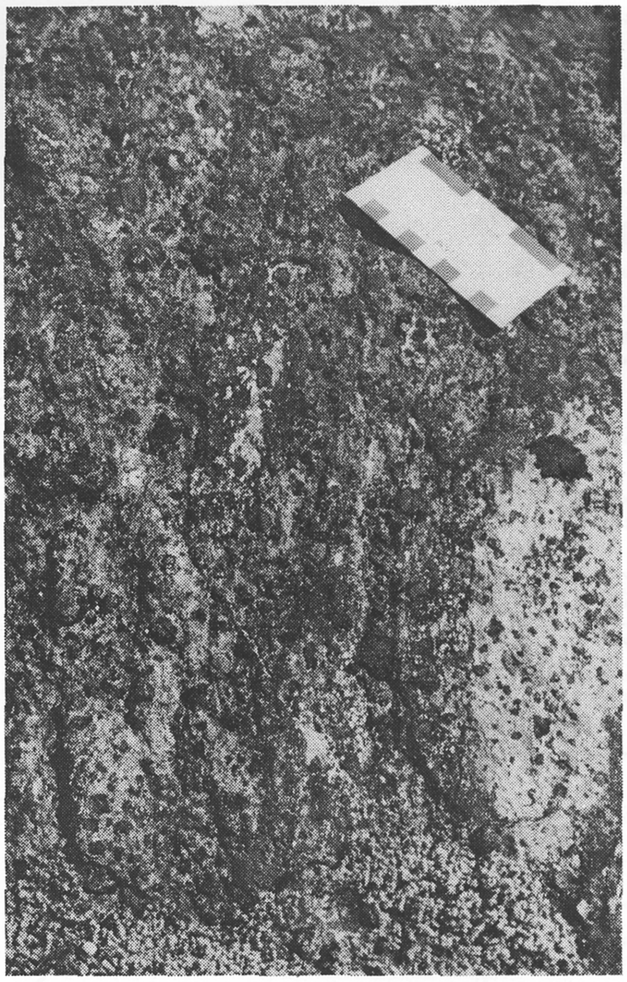

Plate 1. Amygdaloidal pyroxene-phyric basalt flow, Nitinat Formation (north of Holland Lake, NMA87-39-02: 5422323N; 439261E).

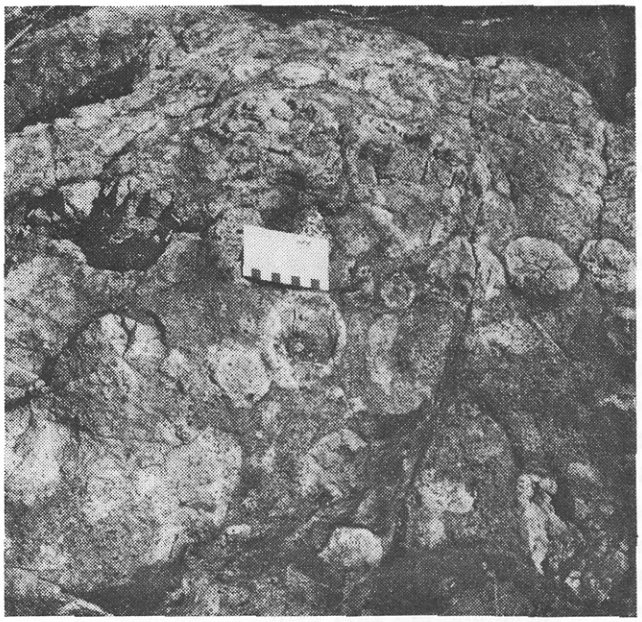

Plate 2. Agglomerate, Nitinat Formation. Partially to completely epidotized clasts of pyroxene-phyric basalt in pyroxene crystal-tuff matrix (Mount Richards; NMA87-41-05: 5409839N; 452196E).

McLaughlin Ridge Formation

The Nitinat Formation is overlain, apparently conformably, by a heterogeneous sequence of mafic to felsic volcanics and volcaniclastic sediments of the McLaughlin Ridge Formation. In contrast to the Alberni area, where tuffaceous sediments dominate, the McLaughlin Ridge Formation in the Duncan area comprises mainly volcanic rocks with only minor tuffaceous sediments. This gross lithofacies variation reflects changes from the proximal environment around a volcanic centre located in the present-day Saltspring Island - Mount Sicker area, to the more distal volcaniclastic-apron environment to the northwest (Figure 4).

The volcanics are predominantly intermediate pyroclastics, commonly feldspar crystal-lapilli tuffs (Plate 3), heterolithic lapilli tuffs and breccias and minor pyroxene-phyric lapilli tuffs. A thick package of felsic quartz-crystal, quartz-feldspar-crystal and fine dust-tuffs is developed in the Chipman Creek - Mount Sicker - Mount Richards area (Plates 4 and 5) and is host to polymetallic sulphide deposits. This package thins to the west, where it interfingers with andesitic lapilli tuffs and breccias. The felsic rocks appear to be stratigraphically high within the formation. A distinctive maroon schistose heterolithic breccia and lapilli tuff with minor jasper, exposed in the Chipman Creek area, forms the uppermost unit within the McLaughlin Ridge Formation and is overlain conformably by thinly bedded cherty sediments of the Fourth Lake Formation.

A suite of greenstone dikes, informally called the "older dikes", intrudes the felsic volcanics and maroon breccia. The dikes are too thin and scattered to be mapped and designated separately on the 1:50 000-scale maps of this project. They occur throughout the belt of

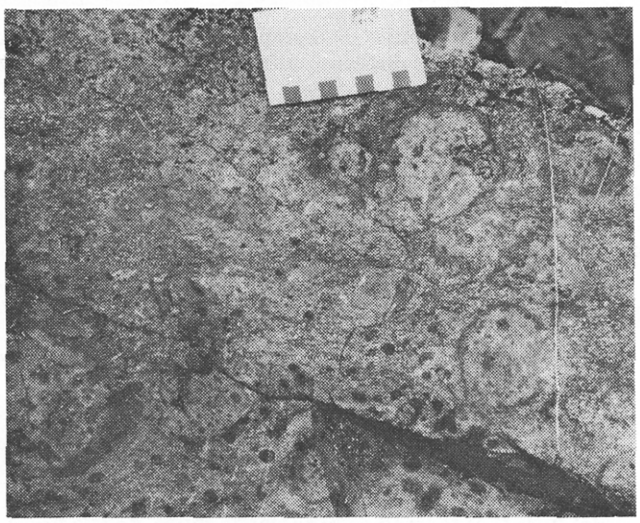

Plate 3. Feldspar crystal-lapilli tuff, McLaughlin Ridge Formation. Epidotized pyroxene-phyric basalt clasts in feldspar crystal-tuff matrix (Mount Richards; NMA87-40-09: 5410628N; 450201E).

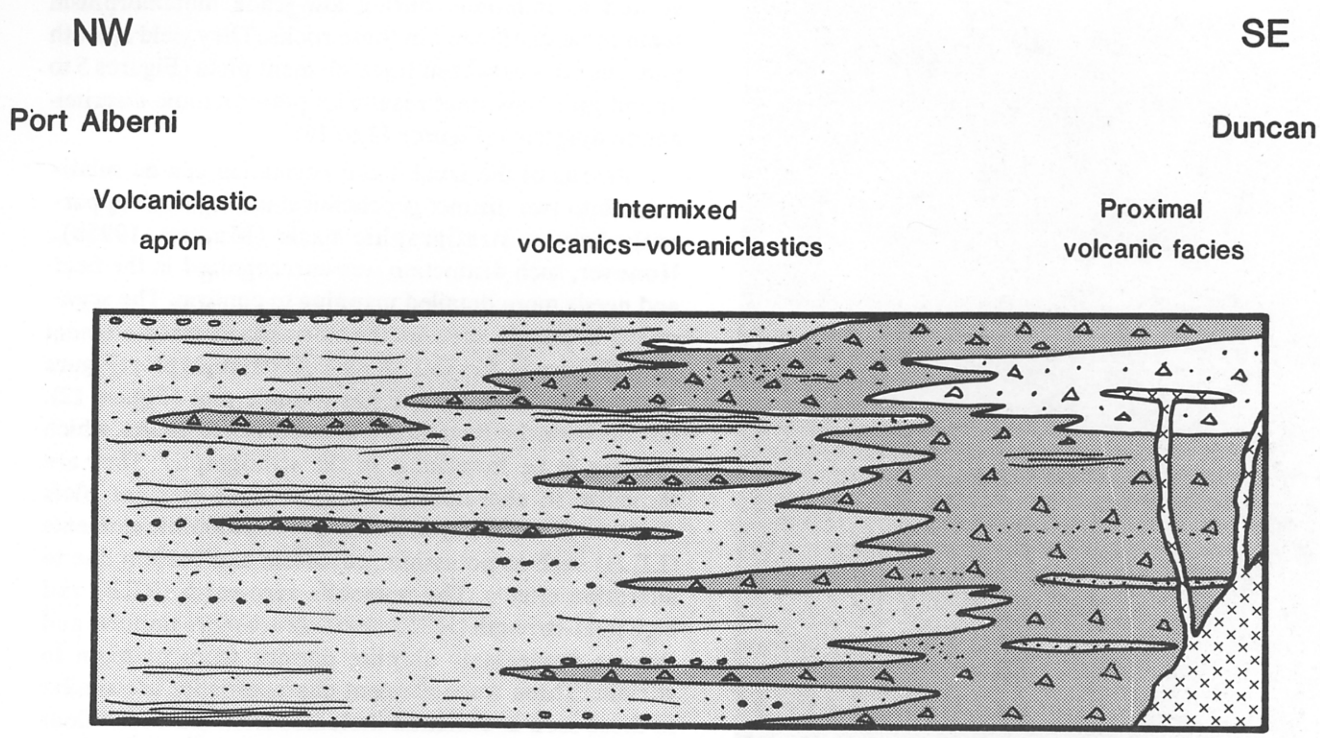

Figure 4. Lithofacies variations in the McLaughlin Ridge Formation along the length of the Cowichan uplift. Section is diagrammatic and not to scale. Volcaniclastic rocks are shown in the light shading, intermediate to mafic volcanics in the darker shading, felsic volcanics unshaded and felsic intrusions with the cross pattern.

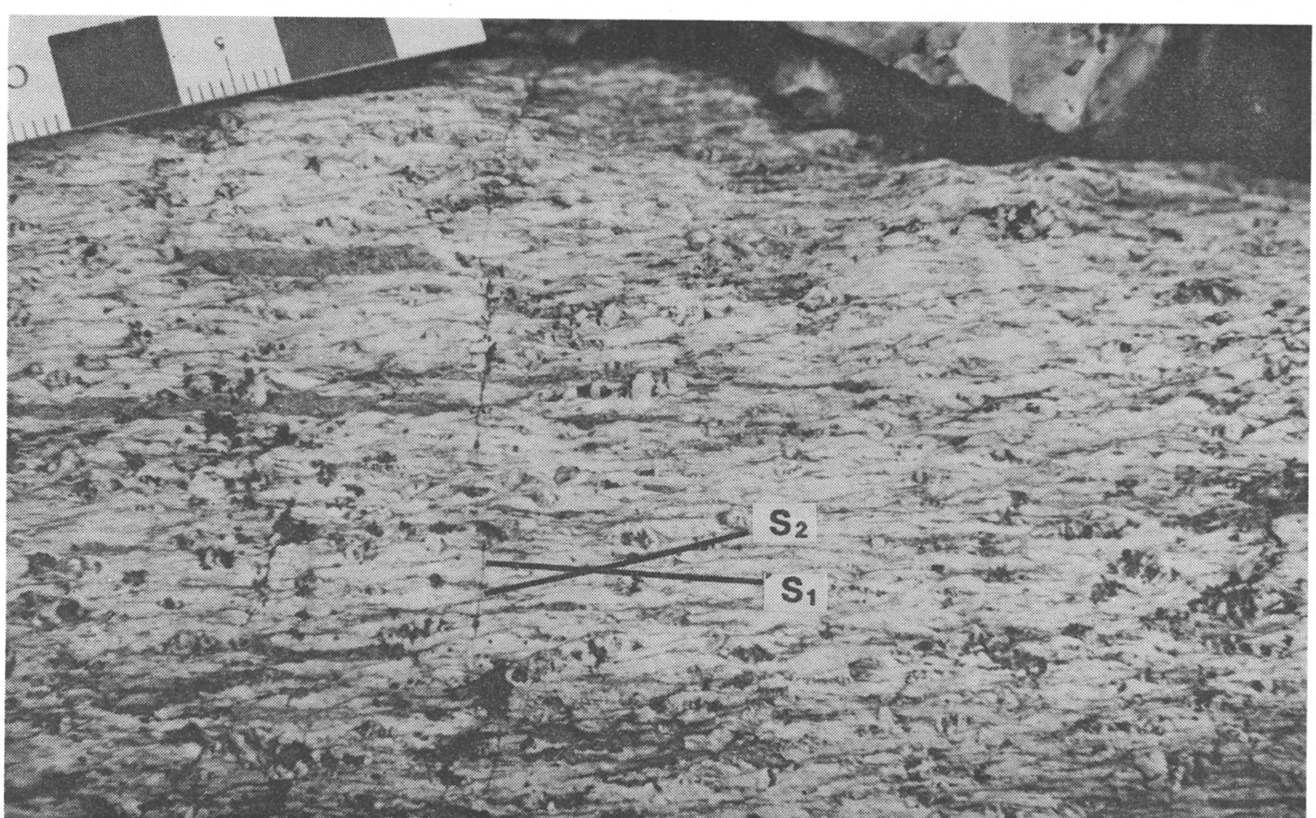

Plate 4. Schistose feldspar-quartz crystal tuff, McLaughlin Ridge Formation. Note chloritic clasts flattened parallel to schistosity (S_1). Spaced crenulation cleavage (S_2) crosscuts at an acute angle (west of Solly Creek; NMA87-27-04: 5416063N; 432602E).

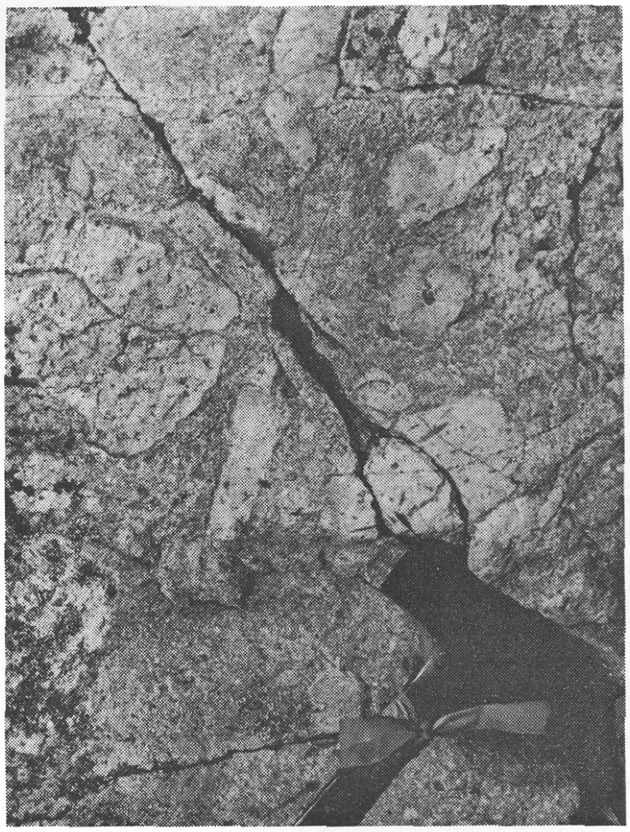

Plate 5. Quartz crystal-tuff breccia, McLaughlin Ridge Formation. Quartz porphyry clasts in quartz crystal-tuff matrix (Grave Point; TPO87-18-01-4: 5410443N; 456645E).

McLaughlin Ridge volcanics from Rheinhart Creek to Maple Mountain. They differ markedly from Late Triassic diabase dikes, also found in this area, in being generally aphyric, weak to moderately foliated and strongly altered to epidote-chlorite-actinolite-calcite assemblages. The significance of their recognition lies in their differing tholeiitic chemistry compared to the calcalkaline nature of the McLaughlin Ridge volcanic country rocks. The age of these dikes is unknown. They have not been observed to intrude Buttle Lake Group or younger rocks in outcrop, however, basaltic lapilli and breccia of similar chemistry to the "older dikes", interbedded with cherty sediments of the Fourth Lake Formation, were intersected in drill holes south of Mount Brenton (D.R. Stewart, personal communication 1990). The "older dikes" are probably contemporaneous with basaltic and dacitic volcanics within the lower Fourth Lake Formation (*see* below) and represent the last stages of magmatism in the Sicker arc.

Geochemistry of the Sicker Group

All samples of Sicker Group rocks analyzed show the effects of variable low-grade alteration. This is reflected in high values for CO_2 ($\pm$ CaO), loss-on-ignition, ferric/ferrous ratios and variable mobility of alkalis and possibly silica. However, many elements traditionally regarded as immobile during low-grade metamorphism seem to be unaffected in these rocks. They yield smooth patterns on normalized trace-element plots (Figures 5 to 8) and give consistent results on petrotectonic discrimination diagrams (Figures 11 to 16).

Basalts of the Duck Lake Formation can be subdivided into two distinct geochemical suites which apparently have a stratigraphic basis (Massey, 1995b). However, such distinction was unrecognized in the field and needs more detailed mapping to confirm. The separation is clearly seen in the normalized trace-element plots (Figure 5), the TiO_2-K_2O-P_2O_5 triangle plot (Figure 11) and the TiO_2-MnO-P_2O_5 triangle plot (Figure 12). Basalts from the Bear Creek area belong to Suite I, which appears to be lowermost in the stratigraphy. They are tholeiitic in character. Extended trace-element plots show much variability in the large-ion lithophile elements (LILE) such as potassium, rubidium and barium due to alteration effects. The immobile rare-earth (REE) and high field-strength (HFS) elements are more uniform and show a moderately dipping pattern from niobium to yttrium. These trace-element characteristics are similar to those seen in enriched tholeiites from the ocean floor or ocean islands. In particular they lack the negative niobium anomaly seen in the Suite II rocks and typical of arc volcanics. An affinity with E-type mid-ocean-ridge basalts is confirmed for Suite I by the various petrotectonic discriminant diagrams (Figures 11 to 16).

Suite II comprises a bimodal package of high-potassium calcalkaline basalt and basaltic andesite flows with dacite dikes and felsic tuffs, that lies stratigraphically above the tholeiites. They are exposed in the Alberni area (Massey 1995b) but are absent from the Duncan area.

Volcanic rocks of the Nitinat and McLaughlin Ridge formations form a coherent suite of medium-potassium calcalkaline chemistry (Figures 9 and 10) and fall within the appropriate calcalkaline or arc fields in petrotectonic discrimination diagrams (Figures 11 to 16). The Nitinat Formation is dominated by basalts and basaltic andesites with few intermediate or felsic rocks. Those dacites and rhyolites that do occur form dikes or sills and are indistinguishable from similar rocks within the McLaughlin Ridge Formation. Geochemically, the volcanics of the Nitinat Formation can be divided into two subgroups which are differentiated by incompatible element ratios (Figures 6 and 11). The TiO_2/P_2O_5 ratio for most samples is in the range 2 to 5. However, samples from the Meade Creek - east Shaw Creek area, north of Cowichan Lake, have TiO_2/P_2O_5 ratios less than 2. This subgroup also has lower niobium, higher zirconium and higher La/Nb, Ce/Sr and Ce/Y ratios. Both subgroups are typically calcalkaline and show considerable overlap in other chemical characteristics. All Nitinat Formation samples from the Duncan area are from the main subgroup with TiO_2/P_2O_5 greater than 2.

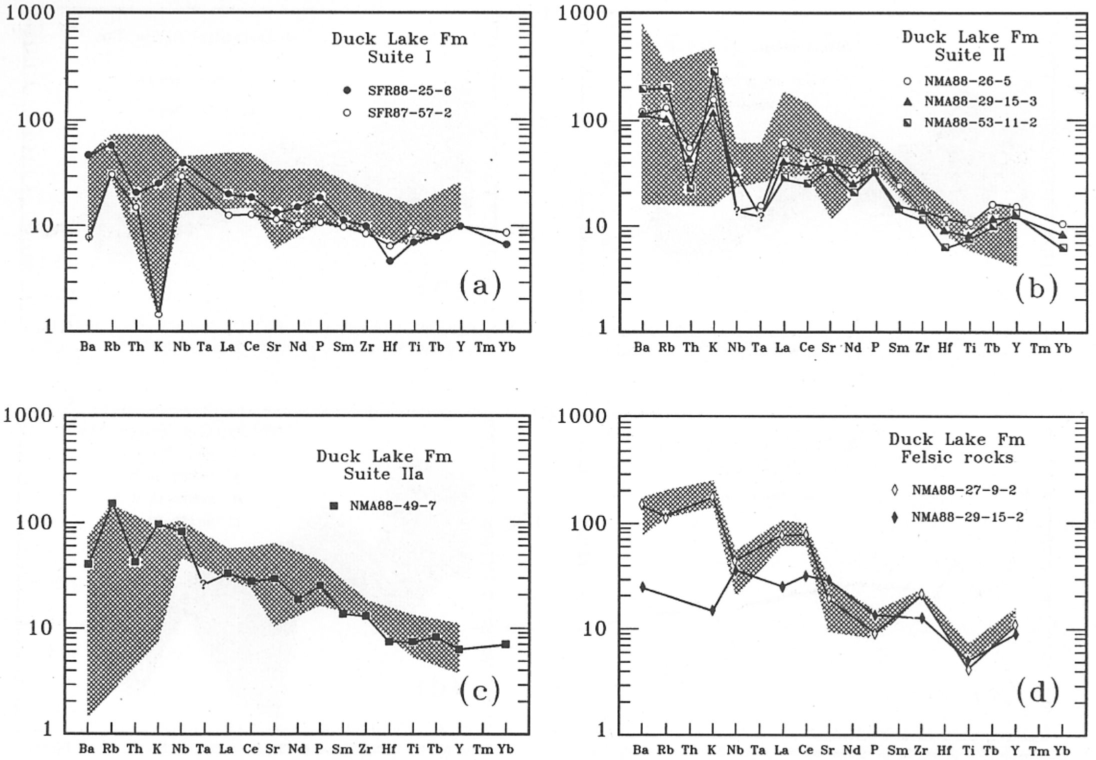

Figure 5. Normalized trace-element plots for volcanic rocks of the Duck Lake Formation. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area, based on XRF data only. Samples for which INAA data are available are plotted individually. (a) Suite I: E-MORB basalts; (b) Suite II: high-potassium calcalkaline basalts and basaltic andesites; (c) Suite IIa: high-potassium, high-niobium calcalkaline basalts; (d) felsic rocks of Suite II (open diamond and shaded field) and IIa (closed diamond).

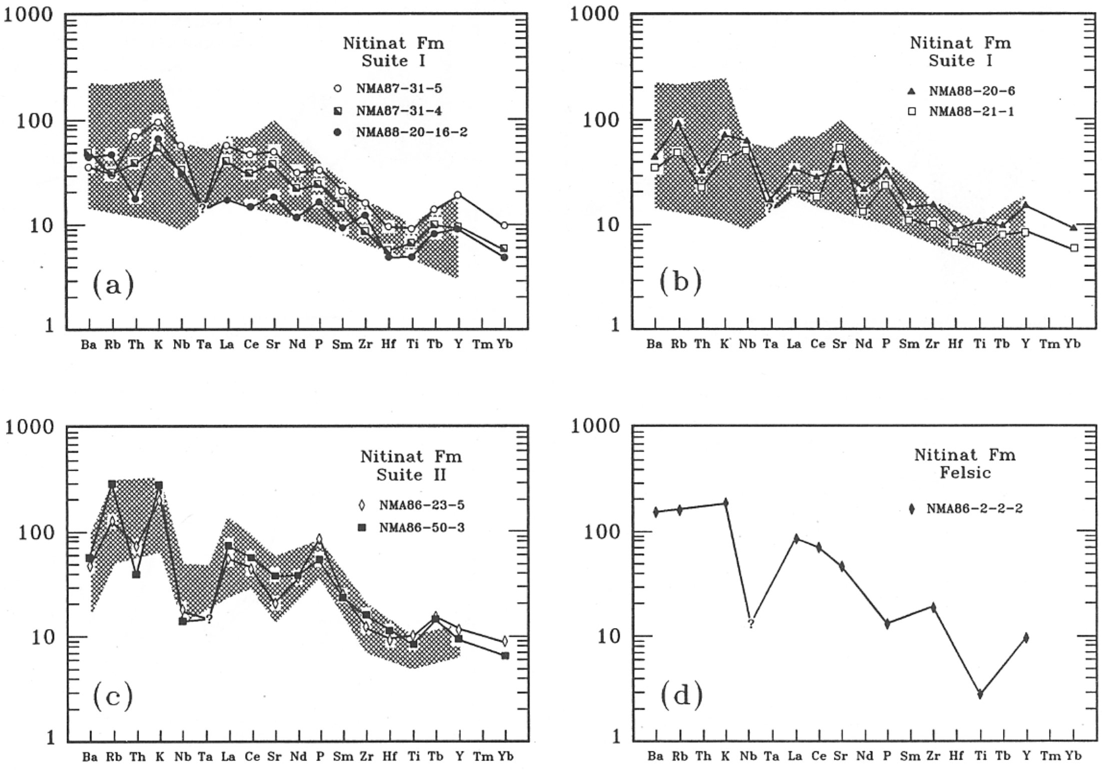

Figure 6. Normalized trace-element plots for volcanic rocks of the Nitinat Formation. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area, based on XRF data only. Samples for which INAA data are available are plotted individually. (a) and (b) Suite I: calcalkaline basalts and basaltic andesites; (c) Suite II: low Ti/ P càlcalkaline basalts and basltic andesites; (d) dacite, affinity unknown; compare with felsic rocks from the McLaughlin Ridge Formation, Figure 7.

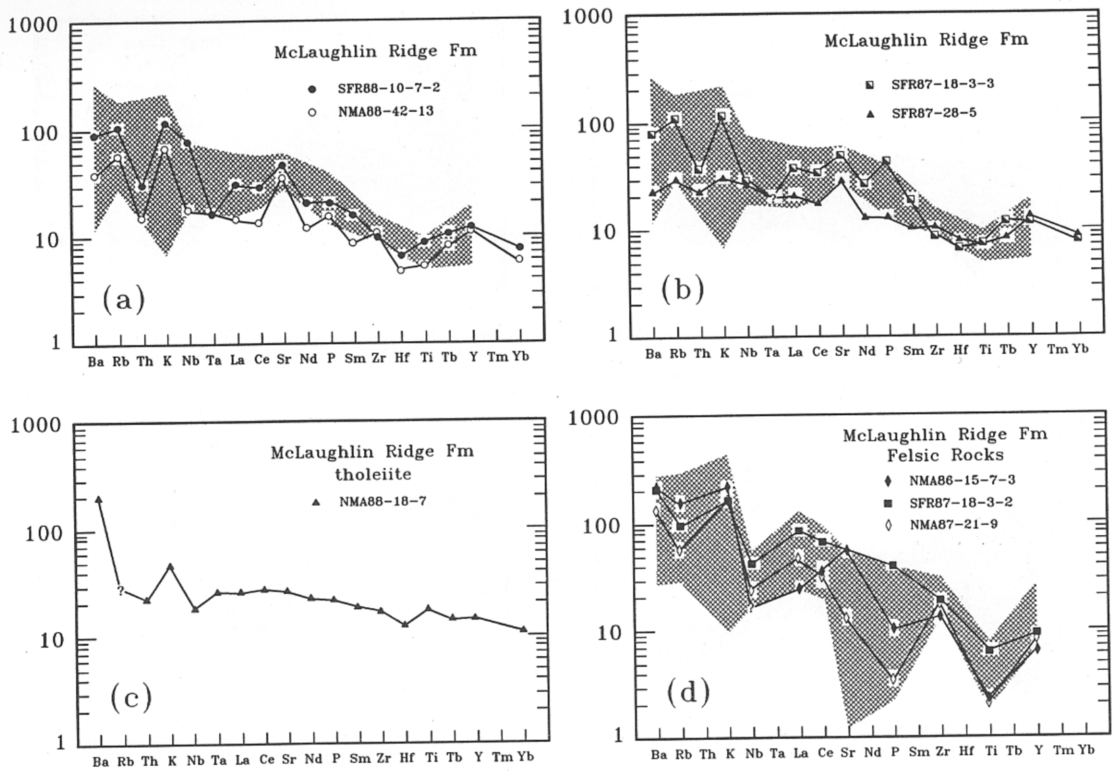

Figure 7. Normalized trace-element plots for volcanic rocks of the McLaughlin Ridge Formation. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area, based on XRF data only. Samples for which INAA data are available are plotted individually. (a) and (b) calcalkaline basalts and basaltic andesites; (c) tholeiite from the Nitinat River area (Massey 1993b); (d) felsic rocks.

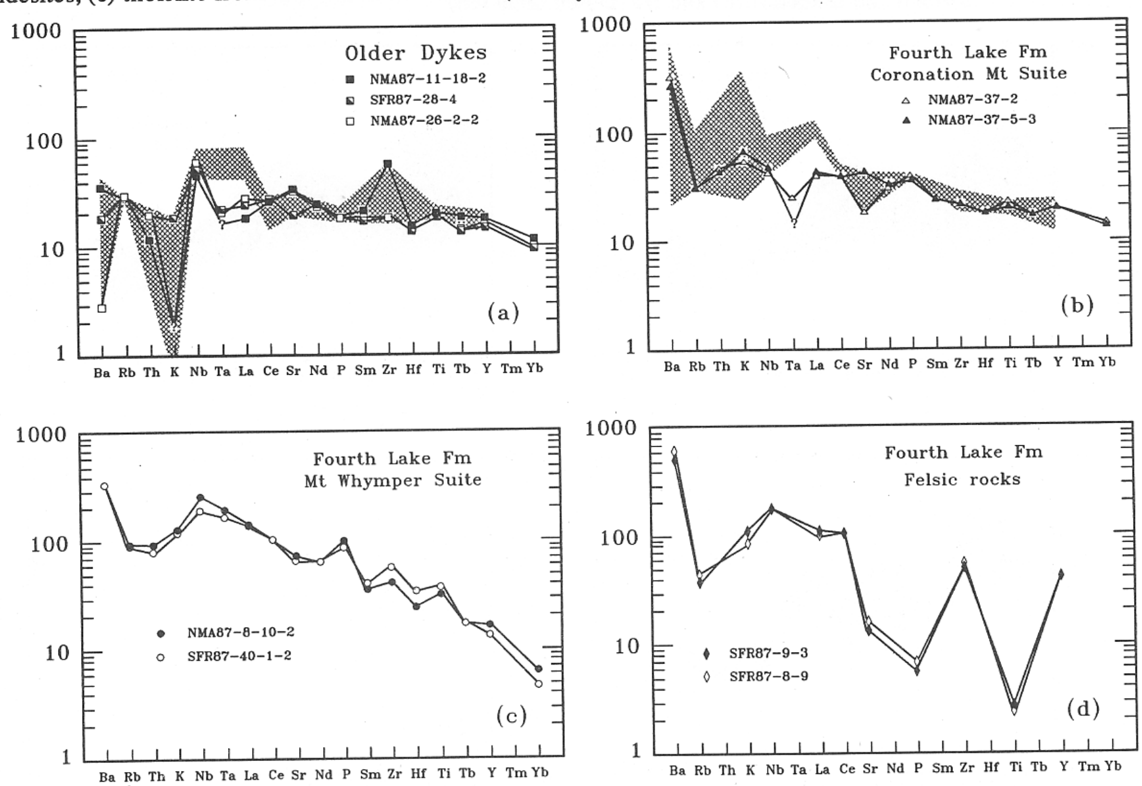

Figure 8. Normalized trace-element plots for volcanic rocks of the older dikes and Fourth Lake Formation. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area, based on XRF data only. Samples for which INAA data are available are plotted individually. (a) older dikes: high Fe-Ti tholeiites; (b) Coronation Mt. suite: transitional basalts; (c) Mt. Whymper suite: alkalic basalts; (d) dacites spatially and chemically related to the Mt. Whymper suite.

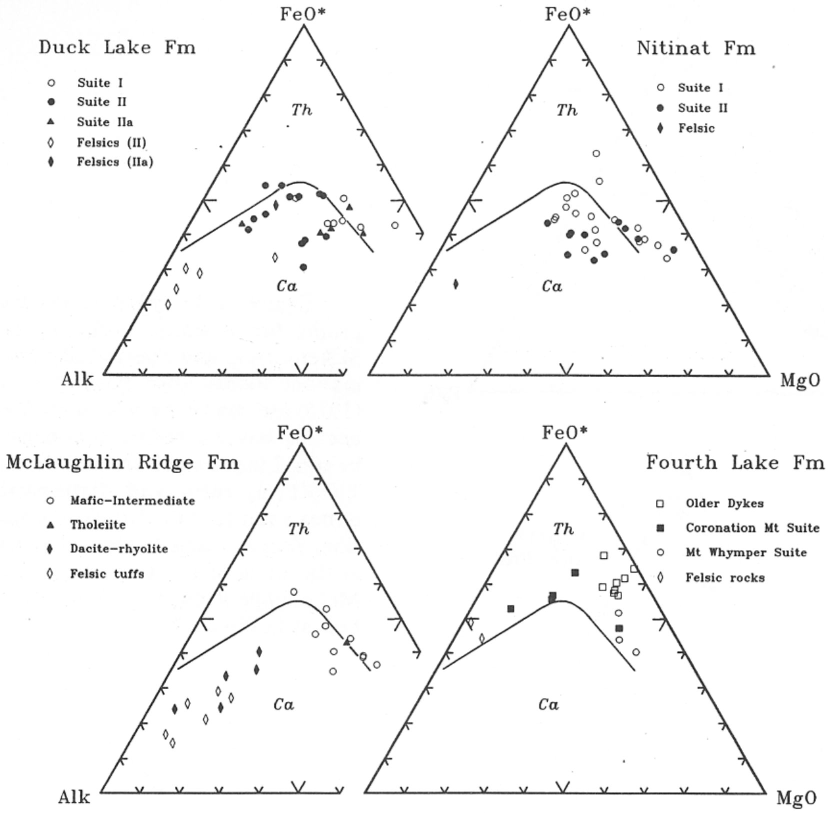

Figure 9. AFM triangle diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Tholeiite (Th) - calcalkaline (Ca) dividing line after Irvine and Baragar (1971). Alk = $Na_2O + K_2O$; FeO* = total iron as FeO.

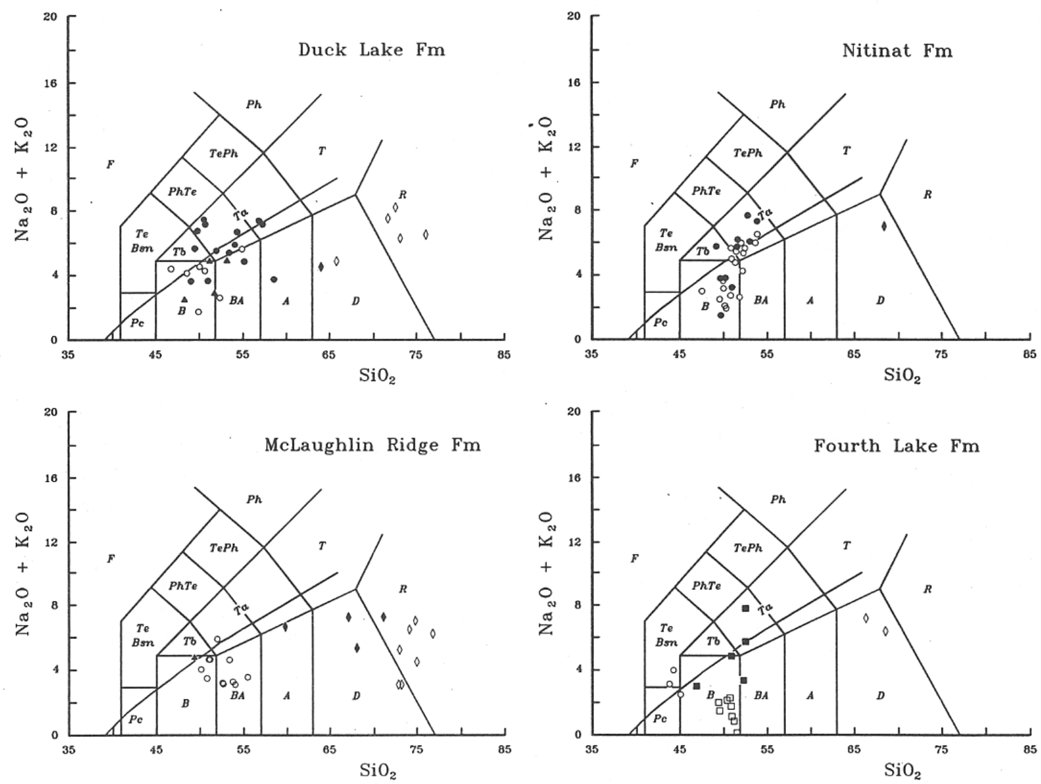

Figure 10. Alkali-silica diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Le Maitre (1984); F = foidites; Pc = picrobasalt; Bsn = basanite; Te = tephrite; PhTe = phontephrite; TePh = tephriphonolite; Ph = phonolite; Tb = trachybasalt; Ta = trachyandesite; T = trachyte and alkali trachyte; B = basalt; BA = basaltic andesite; A = andesite; D = dacite; R = rhyolite and alkali rhyolite. Dashed line divides alkaline rocks (above line) from subalkaline rocks (below line), after Irvine and Baragar (1971). Symbols as in Figure 9.

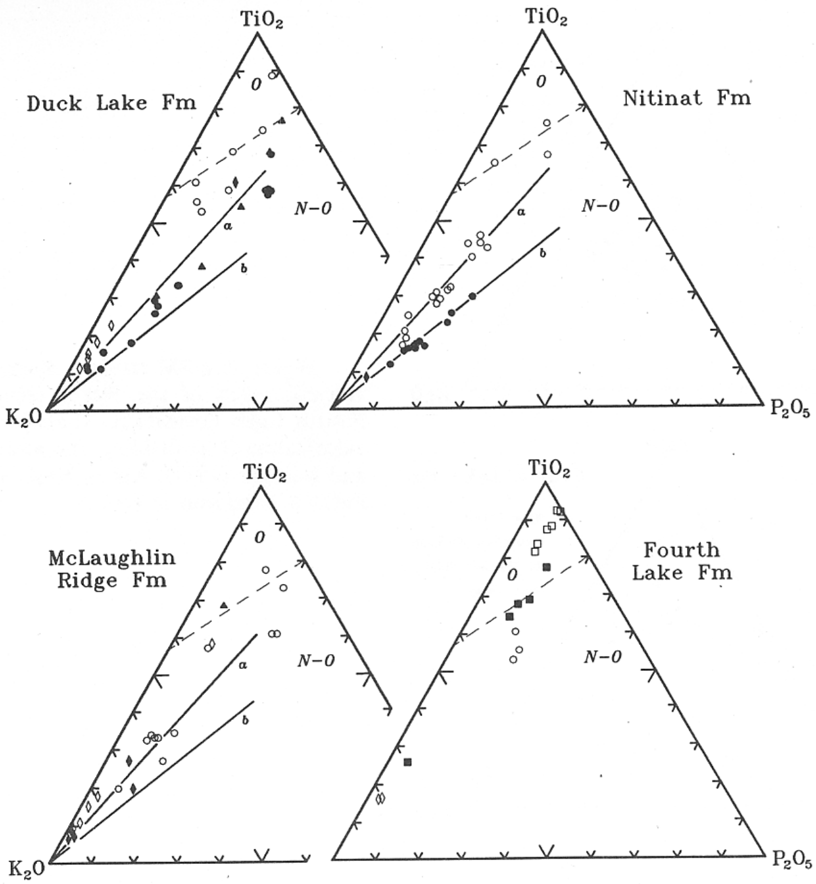

Figure 11. TiO_2-K_2O-P_2O_5 diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Pearce *et al.* (1975) are shown for reference; O= oceanic basalts; N-O= continental basalts. Lines a and b are of differing TiO_2/P_2O_5 ratio and distinguish Suites I and II of the Nitinat Formation. They are included for reference in the plots of the Duck Lake and McLaughlin Ridge formations. Symbols as in Figure 9.

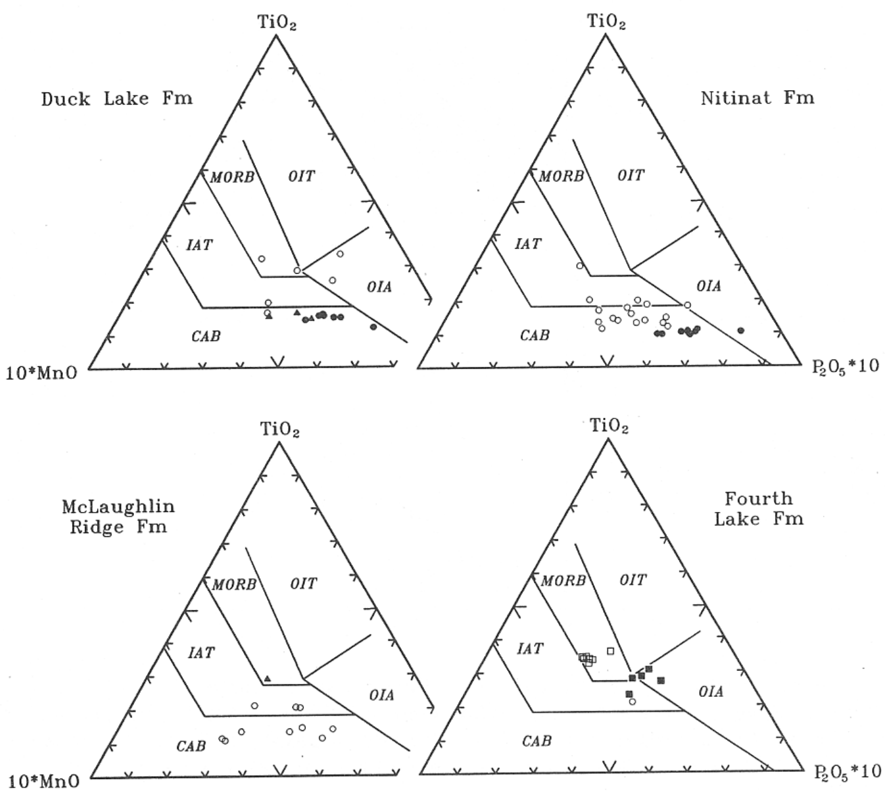

Figure 12. TiO_2-MnO-P_2O_5 diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Mullen (1983); CAB = calcalkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; OIT = ocean-island tholeiites; OIA = ocean-island alkalic basalts. Symbols as in Figure 9.

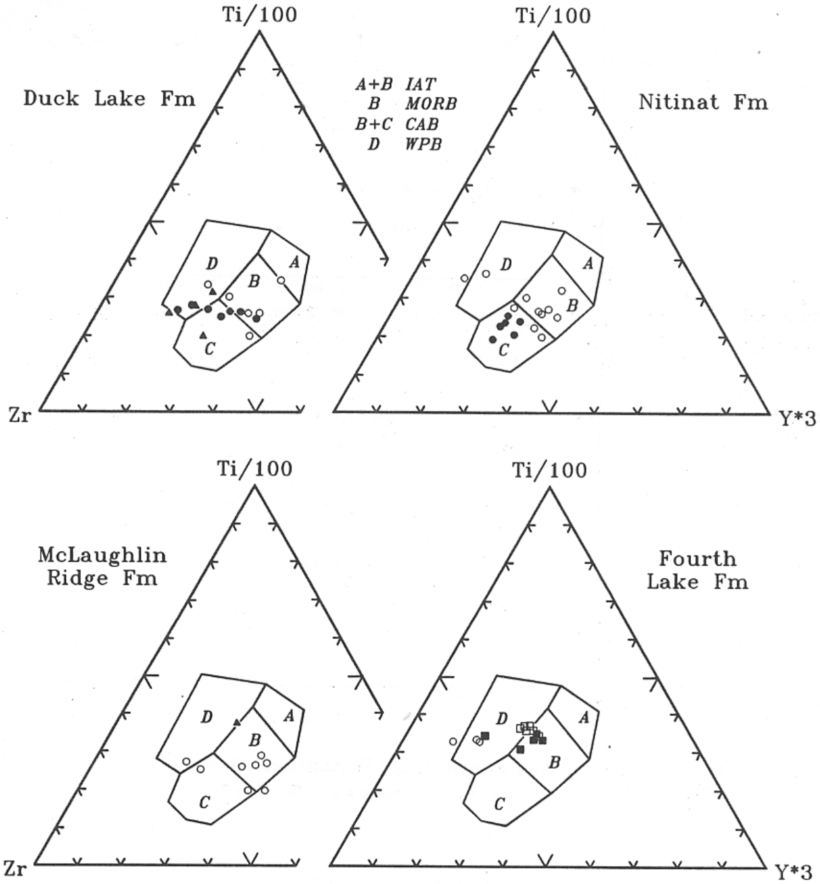

Figure 13. Ti-Zr-Y diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Pearce and Cann (1973); CAB = cal-calkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; WPB = within-plate basalts. Symbols as in Figure 9.

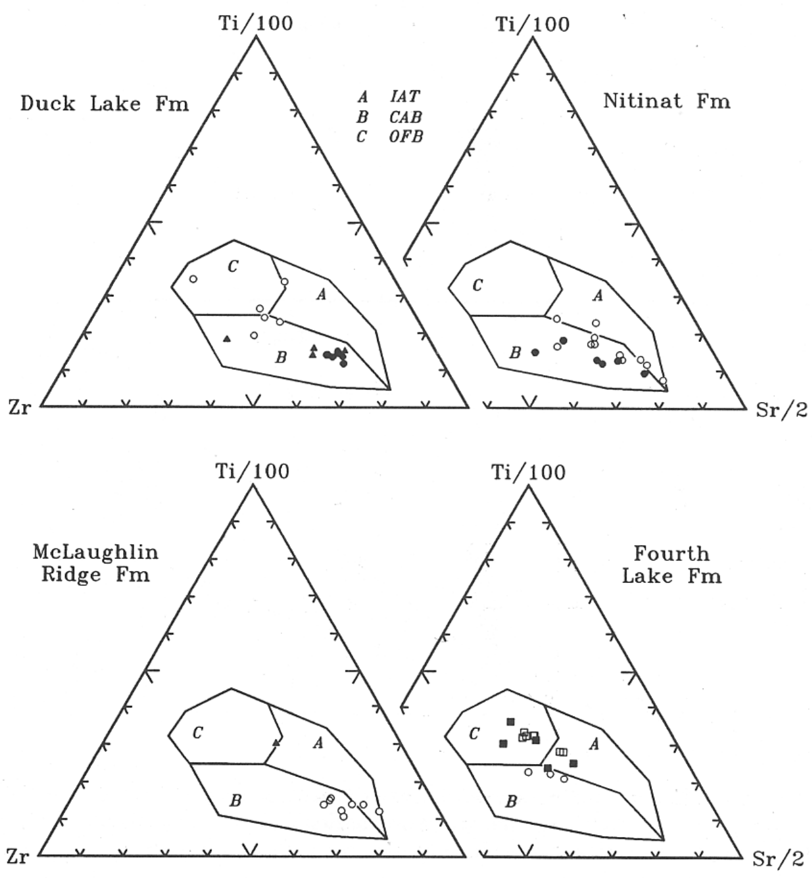

Figure 14. Ti-Zr-Sr diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Pearce and Cann (1973); CAB = cal-calkaline basalts; IAT= island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 9.

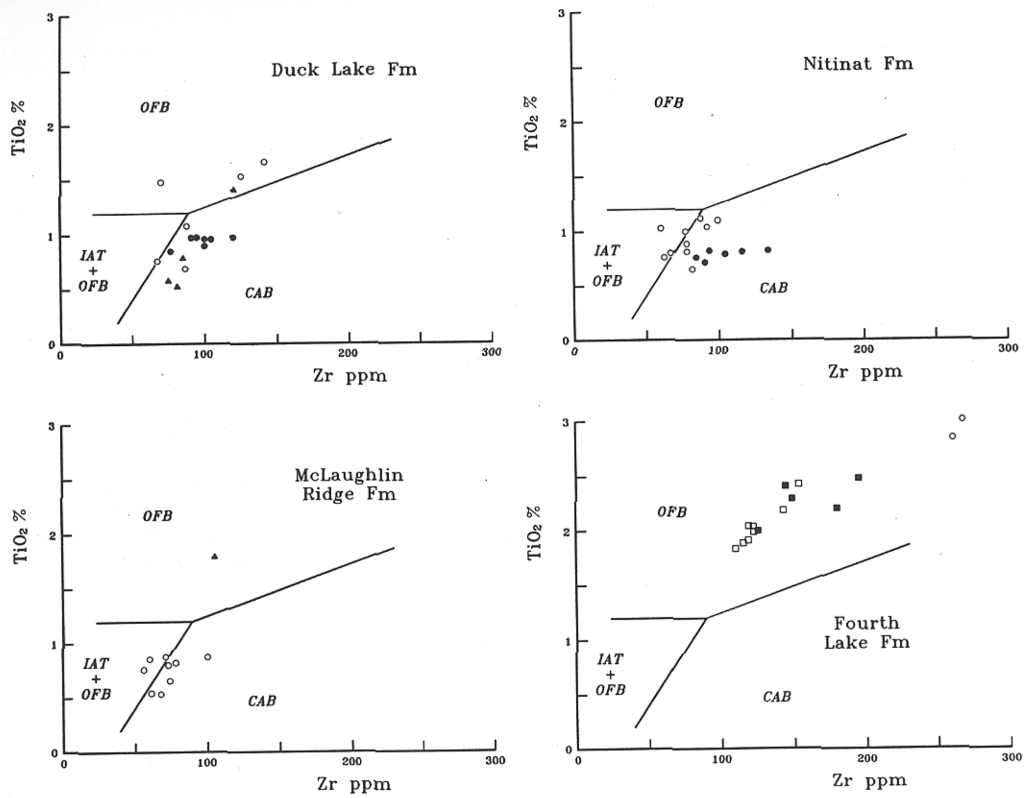

Figure 15. TiO_2-Zr diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Garcia (1978); CAB= calcalkaline basalts; IAT= island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 9.

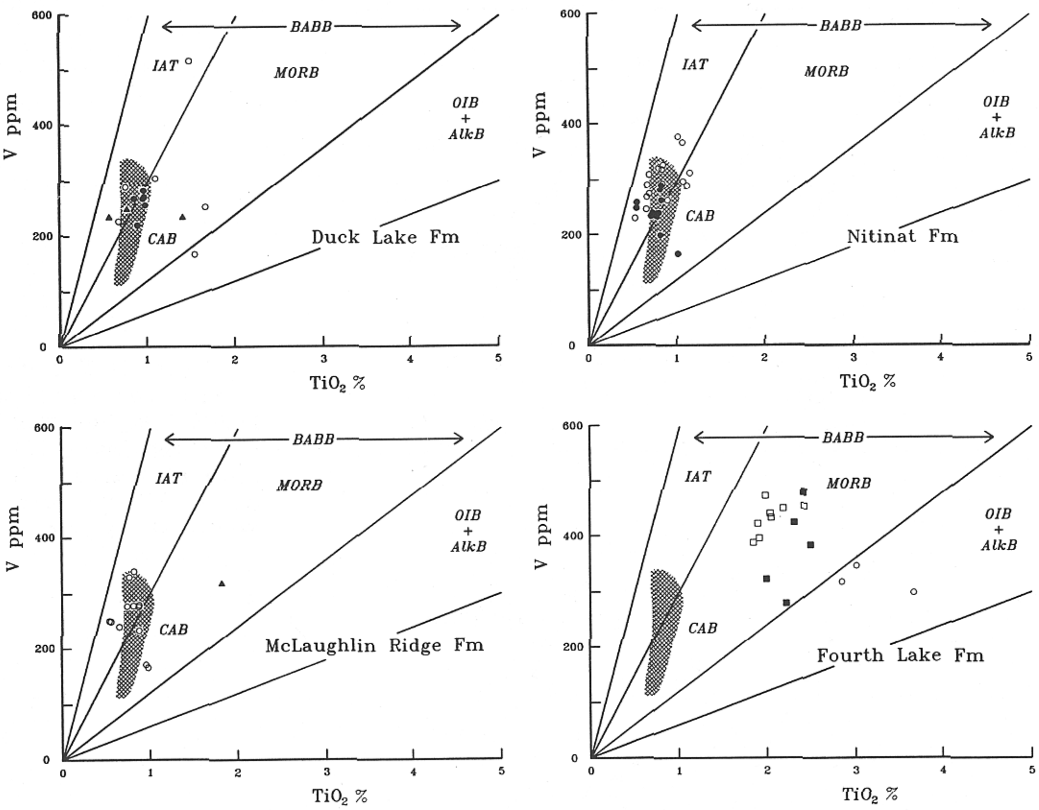

Figure 16. TiO_2-V diagrams for volcanic rocks of the Sicker Group and Fourth Lake Formation. Fields after Shervais (1982); IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; BABB = back-arc basin basalts; OIB = ocean-island basalt; AlkB = alkalic basalt. Shaded area labelled CAB is that occupied by typical calcalkaline basalts. Symbols as in Figure 9.

The McLaughlin Ridge Formation shows a complete range of compositions from mafic to felsic. Volumetrically, it is dominated by intermediate volcaniclastics, though these are under represented in the accompanying geochemical data which emphasize liquid compositions, that is flows and minor intrusions. The McLaughlin Ridge volcanics demonstrate the same typical calcalkaline geochemistry as the main Nitinat Formation Suite I (with TiO_2/P_2O_5 ratios between 2 and 5) with which they are probably consanguineous (Figures 7 and 9 - 16).

The "older dikes" which intrude the upper McLaughlin Ridge volcanics, differ noticeably from their hosts in being high iron-titanium tholeiites (Figure 9). Extended trace-element patterns are flat, MORB-like from cerium to yttrium but have elevated niobium, and possibly lanthanum, contents (Figure 8). This is similar to some Karmutsen flows and intrusions (*see* below). Petrotectonic discriminants suggest an affinity to transitional or enriched ocean-floor basalts (Figures 11 to 16).

The Sicker Arc

The Sicker Group records the complete evolution of an oceanic island arc. The lower tholeiitic basalts of the Duck Lake Formation represent the oceanic substrate upon which the arc developed. The age of the substrate relative to the overlying arc is unknown but there is no evidence to suggest that it is significantly older. The initiation of the arc produced the bimodal high-potassium calcalkaline suite of the Duck Lake Formation. Enriched lavas such as this are believed to characterize the renewal stages of arc construction after an episode of back-arc rifting, such as observed in the Marianas (Stern *et al.*, 1988). Evidence for the earlier back-arc basin is lacking in southern Vancouver Island. The initiation of a new subduction zone, however, normally marked by boninitic or low-potassium tholeiitic melts (Hawkins *et al.*, 1984, Stern *et al.*, 1988), may produce enriched calcalkaline magmas where an enriched mantle wedge is involved in magma generation. The prior generation of the lower Duck Lake Formation E-MORB lavas suggests that this may be the case for the Sicker arc.

As the arc developed, magmatism became typically medium-potassium calcalkaline in composition. In the Nitinat Formation, volcanism was fairly mafic and probably erupted from several volcanic centres. Abundant massive flows in the Banon Creek area probably erupted close to one such centre; other eruptive centres may be marked by the thick sequence of flows and coarse pyroclastics in the Nitinat River area (Massey, 1995b) and the differing chemistry of the Suite II rocks of the Meade Creek - East Shaw Creek area (Massey, 1995). Lithologies and sedimentary facies in the Nitinat Formation are very similar to those observed in young submarine arcs, both modern and in the geological record (Jones, 1967; Mitchell, 1970; Bogen, 1985).

Eruptive style changed during deposition of the McLaughlin Ridge Formation, with the development of a single large central volcano in the Duncan - Saltspring Island area, surrounded by a volcaniclastic apron extending to the Alberni area (Massey, 1993a, b). Magma chemistry evolved to andesitic and dacitic compositions. Rare plant material and trace fossils show that the volcano became subaerial for at least part of its history. This central volcano was contemporaneous with that developed in the Myra Falls area of the Buttle Lake uplift (Juras, 1987), though the spatial relationship between these two centres during the Late Devonian is uncertain, due to later tectonic disruption and differential rotation of structural blocks within Vancouver Island (Irving and Yole, 1987; Irving and Wynne, 1990).

Volcanism waned at the end of the McLaughlin Ridge time, with only comparatively minor eruptions occurring within the Fourth Lake Formation (*see* below). Magmatic compositions changed from calcalkaline to enriched tholeiitic (older dikes), transitional basalts and alkalic basalts and dacites (Fourth Lake Formation). This volcanism, and its associated sediments, is contemporaneous with deposition of the Thelwood and Flower Ridge formations of the Buttle Lake uplift, interpreted as forming in an extensional back-arc basin environment (Juras, 1987), and may have formed at the propagating tip of that developing rift. Extension, however, was very limited in the Cowichan uplift, the basin being dominated by sedimentary infill.

Throughout the Sicker Group, and succeeding Fourth Lake Formation, there is no evidence for continental influence on the developing arc. The oceanic substrate of the lower Duck Lake Formation, lithofacies of volcanics in the Nitinat and McLaughlin Ridge formations, the arc-derived debris of the Fourth Lake sediments, the lack of U-Pb inheritance in zircons, and the juvenile nature of neodymium and strontium isotopic data (Samson *et al.*, 1990) all support an intra-oceanic arc environment. However, two pieces of geochemical data seemingly point to continental influence. Lead isotope data from galenas and whole-rocks from the Sicker Group of the Buttle Lake uplift resemble those from other island-arc environments, but are more radiogenic than mid-ocean-ridge basalts or the proposed Devonian mantle (Andrew and Godwin, 1989). The radiogenic lead is interpreted to be derived from sedimentary rocks, implying that the subduction zone producing the Sicker arc was sediment rich and near a supply of continental detritus.

The ratio Zr/Y has been suggested (Pearce, 1983) as an effective discriminant between arcs formed on oceanic crust ($Zr/Y < 3$) and arcs formed on transitional or continental crust ($Zr/Y > 3$). The majority of Zr/Y ratios for Sicker arc rocks are higher than 3, suggesting a continental-arc environment (Figure 17). There is a tendency for

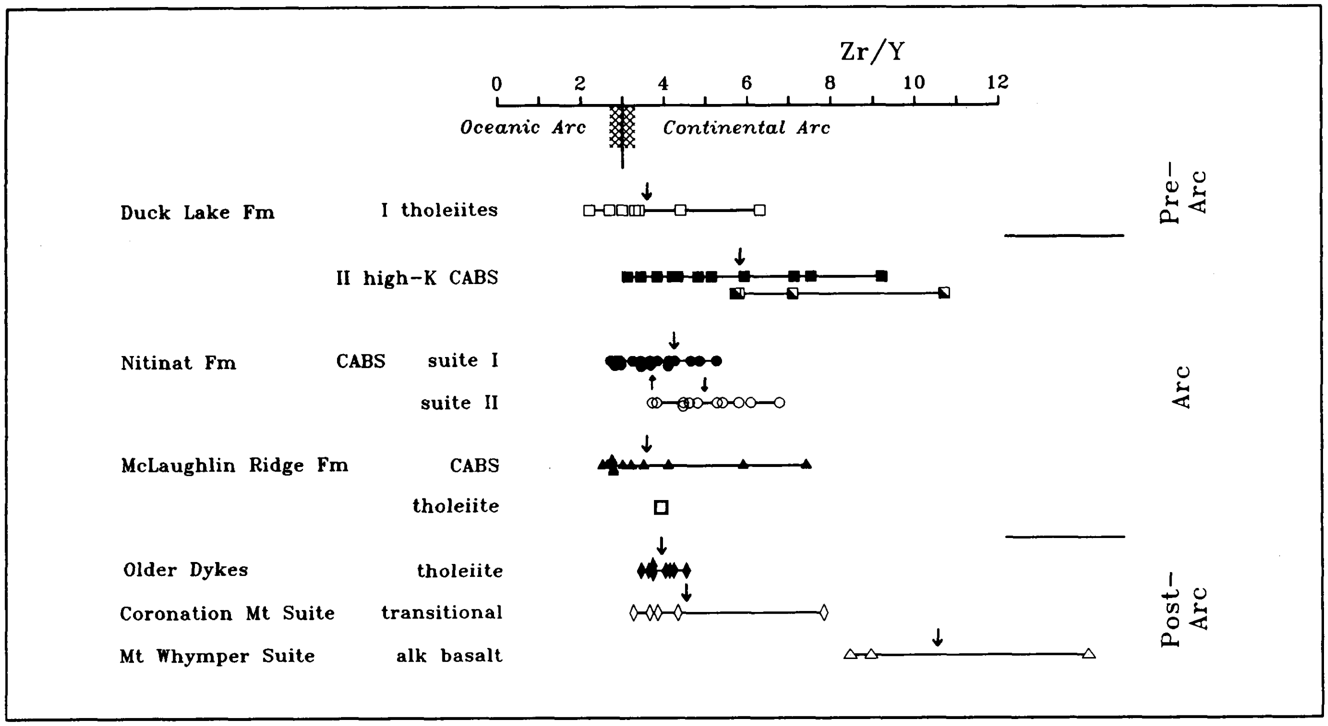

Figure 17. Zr/Y ratios in magmas of the Sicker arc. Oceanic-continental arc division from Pearce (1983). Range of data is plotted for each magma suite and formation; samples with yttrium below detection limit are omitted. The large arrow above the range designates the average ratio for the formation (or suite for the Duck Lake Formation); smaller arrows for the Nitinat Formation designate the average ratios for the separate suites. Duck Lake tholeiites are considered to represent the pre-arc oceanic substrate; the upper Duck Lake, Nitinat and McLaughlin Ridge formations to constitute the Sicker arc; and the older dikes and Fourth Lake volcanics to represent late or post-main-arc activity.

the average Zr/Y ratio to decrease with time from upper Duck Lake to McLaughlin Ridge formations, but this is complicated by possible spatial variations, for example the differences between Suites I and II in the Nitinat Formation. However, Zr/Y is a measure of the enrichment of the mantle source of the magmas and is also a characteristic of within-plate volcanics. If subduction took place beneath the source of trace-element enriched basalts, such as the lower Duck Lake Formation, it would be possible for magmas in an oceanic arc to possess high Zr/Y ratios and hence plot in the continental-arc field (Pearce, 1983). No modern example of this has been documented. Such a mantle source could also produce radiogenic-lead enriched isotope characteristics similar to those observed in Sicker Group rocks, without the need for involvement of continental sediment.

BUTTLE LAKE GROUP

The Buttle Lake Group is made up of a dominantly epiclastic and limestone sedimentary package ranging from Mississippian to Early Permian in age. On the northeast flank of the Cowichan uplift, the Buttle Lake Group is most often found in fault contact with the lower volcanic units of the Sicker Group, however, it is conformable on the McLaughlin Ridge Formation south of Sansum Point and in the Chipman Creek area. On the southwest limb of the uplift, the Buttle Lake Group is unconformable on the lower volcanics. The Fourth Lake sediments lie unconformably on the Nitinat Formation on Hill 60 Ridge and in the Paldi inlier. On Fairservice Mountain, the Fourth Lake Formation rests unconformably on the older volcanics but is overstepped to the west by the Mount Mark Formation limestones which, in turn, unconformably overlie the Sicker Group around Lake Cowichan, immediately to the west of the map area (Massey, 1993a).

FOURTH LAKE FORMATION

Referred to as the "Cameron River Formation" during earlier stages of the mapping.

In the southern part of the map area (Hill 60 and the Paldi inlier) the base of the Fourth Lake Formation is marked by a sequence of radiolarian ribbon cherts, laminated cherts and cherty tuffs with thin argillite interbeds, 100 to 200 metres thick, informally called the Shaw Creek chert member. This sequence continues westward into the Cowichan Lake area. The cherts pass upwards into monotonous, thinly bedded, turbiditic sandstone-siltstone-argillite intercalations that exhibit graded bedding, flame structures, argillite rip-ups (Plate 6), small-scale sandstone dikes and slump folds. Thicker beds of sandstone, granule sandstone and conglomerate containing clasts of cherty material, volcanic lithic clasts and feldspar

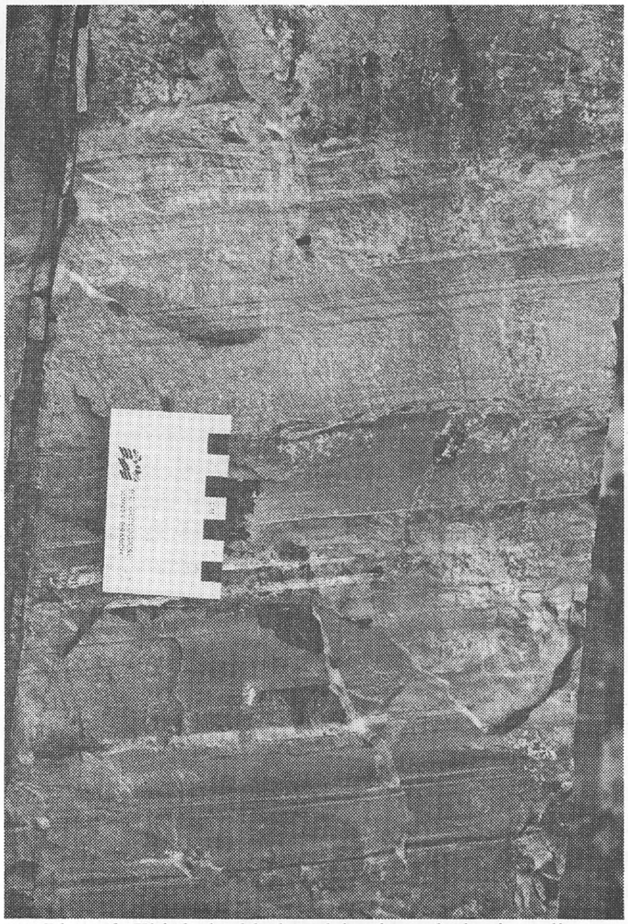

Plate 6. Thinly bedded and laminated clastic sediments, Fourth Lake Formation. Note argillite rip-ups just to right of the scale; weak grading in bed beneath (north slope of Mount Hall; NMA87-35-07: 5418942N; 435514E).

Plate 7. Polymictic granule conglomerate, Fourth Lake Formation (loose boulder on powerline west of Solly Creek; NMA87-21-12: 5413353N; 433827E).

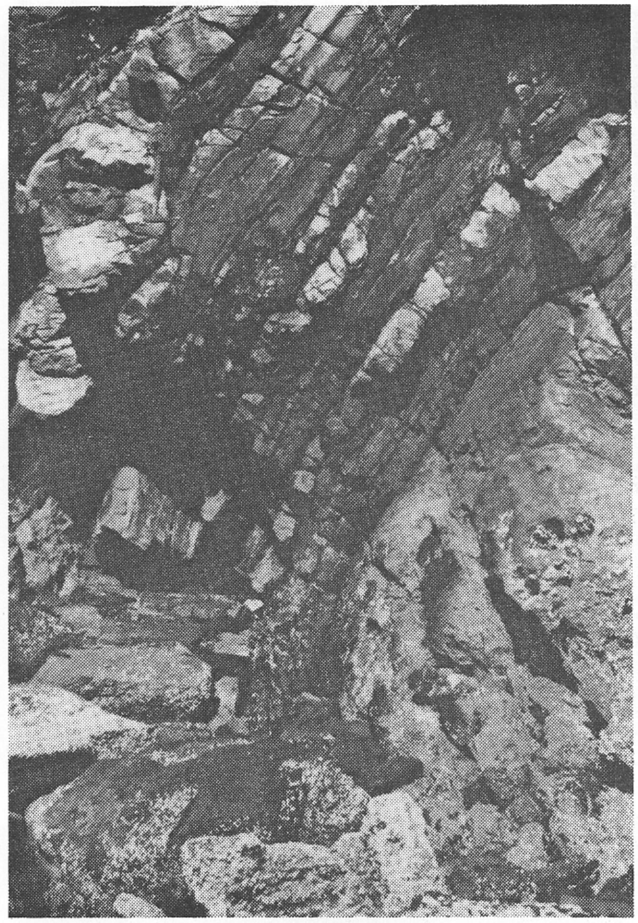

Plate 8. Interbedded argillite and calcarenite, Fourth Lake Formation (Separation Point, Sansum Narrows; NMA87-46-02: 5399279N; 458291E).

and pyroxene crystals are found on the north slope of Hill 60 Ridge and occasionally north of the Chemainus River (Plate 7).

The ribbon cherts are absent north of the Chemainus River, where the thinly bedded turbiditic clastic sediments conformably overlie the McLaughlin Ridge volcanics and dominate the sequence. However, cherty tuffs and argillites are found at the base of the formation at Sansum Point. Thin crinoidal calcarenites and limestones are interbedded with sandstone and argillite near the top of the formation at Mount Brenton, Separation Point (Plate 8) and in the Haslam Creek area. The thinly bedded sediments are intruded by numerous, thick gabbroic and diabasic dikes and sills of late Triassic age, which gave rise to Muller's (1980) informal term "sediment-sill complex" for part of this sequence.

The polarity of the Sicker arc is not suggested in the geochemical data from Sicker Group volcanics. However, the sedimentary facies of the lower Fourth Lake Formation are suggestive. The radiolarian cherts of the Shaw Creek member, sitting unconformably on the Sicker Group volcanics, probably developed on the open ocean side of the arc. In contrast, the conformable, clastic-domi-

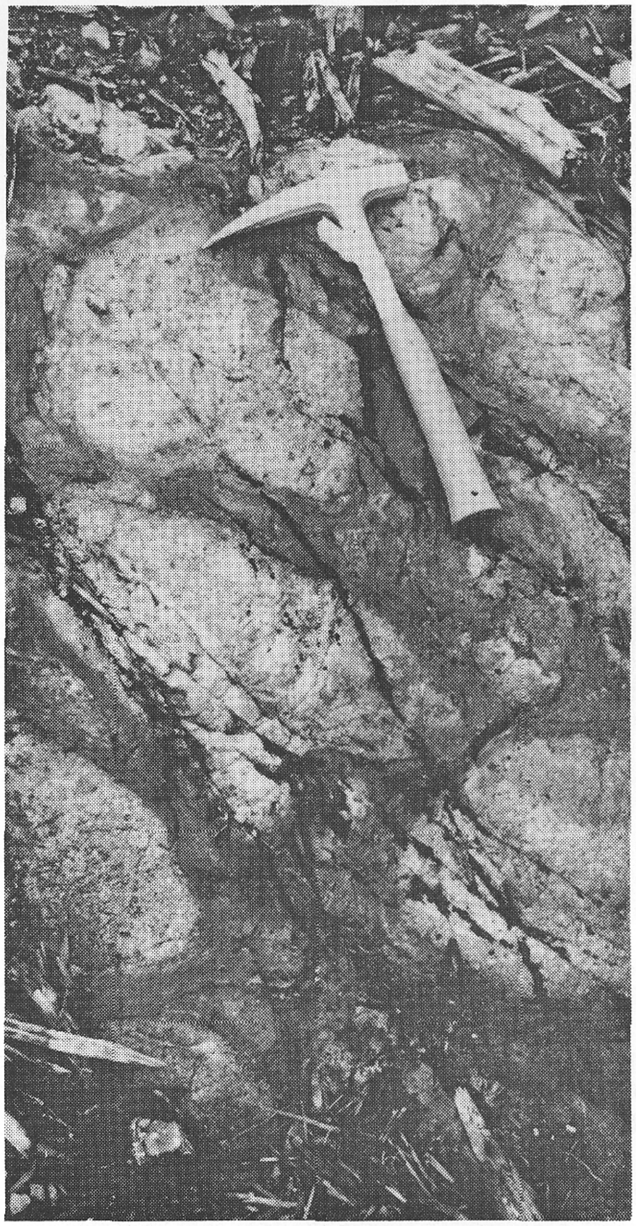

Plate 9. Pillowed diabasic flow, Coronation Mountain suite volcanics, Fourth Lake Formation. Maroon selvages and inter-pillow material; grey cores (unnamed hill north of Coronation Mountain; NMA87-37-07: 5421400N; 432002E).

nated sediments exposed on the northeast limb of the Cowichan uplift appear to have accumulated in the marginal basin adjacent to and behind the arc. As erosion proceeded, clastic sediment was shed to both sides of the extinct arc and buried it.

Minor, though significant, volcanic rocks are found interbedded with the sediments on the northeast limb of the Cowichan uplift. A dark green, vesicular pillowed basalt flow occurs within hornfelsed, thinly bedded sandstone-siltstone in a roadcut on the north slope of Chipman Creek about 3 kilometres west of Coronation Lake. No other outcrops of the basalt are reported in the vicinity. The flow is similar in chemistry to vesicular flows interbedded with Fourth Lake sediments in the Mount Whymper area. This Mount Whymper suite of volcanics differs markedly in chemistry from any of the Sicker Group volcanics or the possibly contemporaneous "older dikes" (Figures 8, 10, 15 and 16). The basalts are undersaturated, with normative mineralogy suggesting olivine tholeiite, whereas immobile trace elements point to a more alkalic chemistry. The flows are enriched in both compatible (Ni, Cr) and incompatible trace elements (Figure 8) and have a within-plate affinity on petrotectonic discriminant plots (Figures 11-16).

A more extensive outcrop area on the north slopes of Coronation Mountain, about 2.5 kilometres south of Coronation Lake, comprises hornfelsed, amygdaloidal diabasic flows and interbedded cherty tuffs and sediments. Pillows are seen in places (Plate 9) and display maroon and green alteration colours. Although spatially close to the Chipman Creek pillowed flow, the outcrop area is isolated from other Sicker Group and Buttle Lake Group rocks, being surrounded by gabbro and granodiorite intrusions. These diabasic flows had previously been mapped as possible Nitinat Formation (Massey *et al.*, 1988) but the intercalated sediments are very similar to Fourth Lake Formation lithologies. The flows also differ significantly from Sicker Group volcanics in chemistry and lithology. However, two dikes were sampled which proved to be chemically similar to these flows and have been included in the Coronation Mountain suite. One is intrusive into Saltspring granodiorite in Sansum Narrows just south of Grave Point. The other intrudes Nitinat Formation pyroxene-phyric flows in the Banon Creek area.

The Coronation Mountain volcanics have compositions intermediate between the Mount Whymper suite and the "older dikes" (Figures 8, 11, 15 and 16). They are slightly undersaturated olivine tholeiites or transional basalts, with somewhat enriched incompatible trace-element contents akin to ocean-island tholeiite or enriched ocean-floor basalt (Figures 11 to 16). The Coronation Mountain and Mount Whymper suites are believed to have formed at the propagating tip of a back-arc basin rift, with its more mature products including the volcanics of the Thelwood and Flower Ridge formations of the Buttle Lake uplift.

Mount Mark Formation

The Mount Mark Formation is the uppermost Paleozoic unit of the map area. It outcrops in the Fairservice Mountain - Bear Creek area, south of the Cowichan River, comprising massive and laminated crinoidal calcarenites with chert and argillite interbeds. Sections in this area have been described in detail by Yole (1964; 1969). The formation is absent north of the Cowichan River where the Fourth Lake Formation is overlain unconformably by Nanaimo Group sediments.

Biostratigraphy of the Buttle Lake Group

Detailed study of the biostratigraphy of the Buttle Lake Group has not yet been undertaken. However, enough regional data have accumulated from various investigators to indicate the broad age relationships (Table C1, Figure C, in pocket). The bulk of the Fourth Lake Formation is clastic in nature and unfossiliferous. However, its age can be bracketed by fossiliferous units at the top and bottom of the formation. The ribbon cherts of the Shaw Creek member have yielded a rich conodont fauna which indicates an early Mississippian age for the base. Radiolaria, though often poorly preserved in the cherts, support a Mississippian age. This age is only slightly younger than the upper parts of the Late Devonian McLaughlin Ridge Formation, despite the unconformable contact with the Sicker Group along the southwestern limb of the uplift. No fossils have been found in the basal cherty sediments on the northeastern limb, which are in conformable contact with the volcanic rocks, and it is not known whether or not they are older than the Shaw Creek cherts. The limestone-argillite interbeds in the upper parts of the Fourth Lake Formation contain a middle to late Pennsylvanian conodont fauna. The lack of both fossil data and distinctive lithological marker horizons in much of the Fourth Lake Formation makes it impossible to determine if sedimentation was continuous during the Carboniferous or punctuated by one or more nondepositional interludes.

The base of the Mount Mark Formation is time transgressive. In the Alberni area, the limestones yield conodont and macrofossil faunas that range from middle to late Pennsylvanian at the base, up to Early Permian in higher beds. The basal layers are thus time equivalent to the upper Fourth Lake limestone-argillite interbeds of the Cowichan and Duncan areas. The contact between the two formations is interpreted as a major facies boundary which migrated eastwards through time. Massive limestones of the Mount Mark Formation in the Fairservice area yield Early Permian macrofaunas but supporting conodont data are lacking.

VANCOUVER GROUP

Karmutsen Formation

Basalts of the Karmutsen Formation are only exposed in the extreme southwest corner of the map area, on the west side of the Chanlog fault. The flows are massive and amygdaloidal, with interbedded hyaloclastite breccia and isolated pillow hyaloclastite breccia. To the immediate west, in the Cowichan Lake area, the Karmutsen Formation unconformably overlies the Mount Mark Formation (Massey, 1993a). The basalts are comagmatic with intrusions of the Mount Hall gabbro (*see* below).

Nanaimo Group

Clastic sediments of the Nanaimo Group unconformably overlie older volcanic units and the Island Plutonic Suite. The stratigraphic nomenclature for the Nanaimo Group used in this report follows the suggestions of England (1989).

Only outcrops on Vancouver Island where mapped in this project; data for the off-shore Gulf Islands have been compiled from other sources (*see* references on Figure A, in pocket). On Vancouver Island, the Nanaimo Group is most thickly developed in the Maple Bay to Mount Prevost area, the Cowichan and Chemainus River valleys and the shoreline from Crofton to Ladysmith. The Nanaimo sediments constitute major fining-upward cycles (Muller and Jeletzky, 1970), of which the first two are developed in the Duncan area.

Benson Formation

The basal Tzuhalem Member of the Benson Formation (England, 1989) is a coarse, poorly bedded cobble and boulder conglomerate varying from about 100 metres

Plate 10. Boulder conglomerate, Tzuhalem Member, Benson Formation (east side of small hill at north end of Copper Canyon; NMA87-31-07: 5416210N; 442938E).

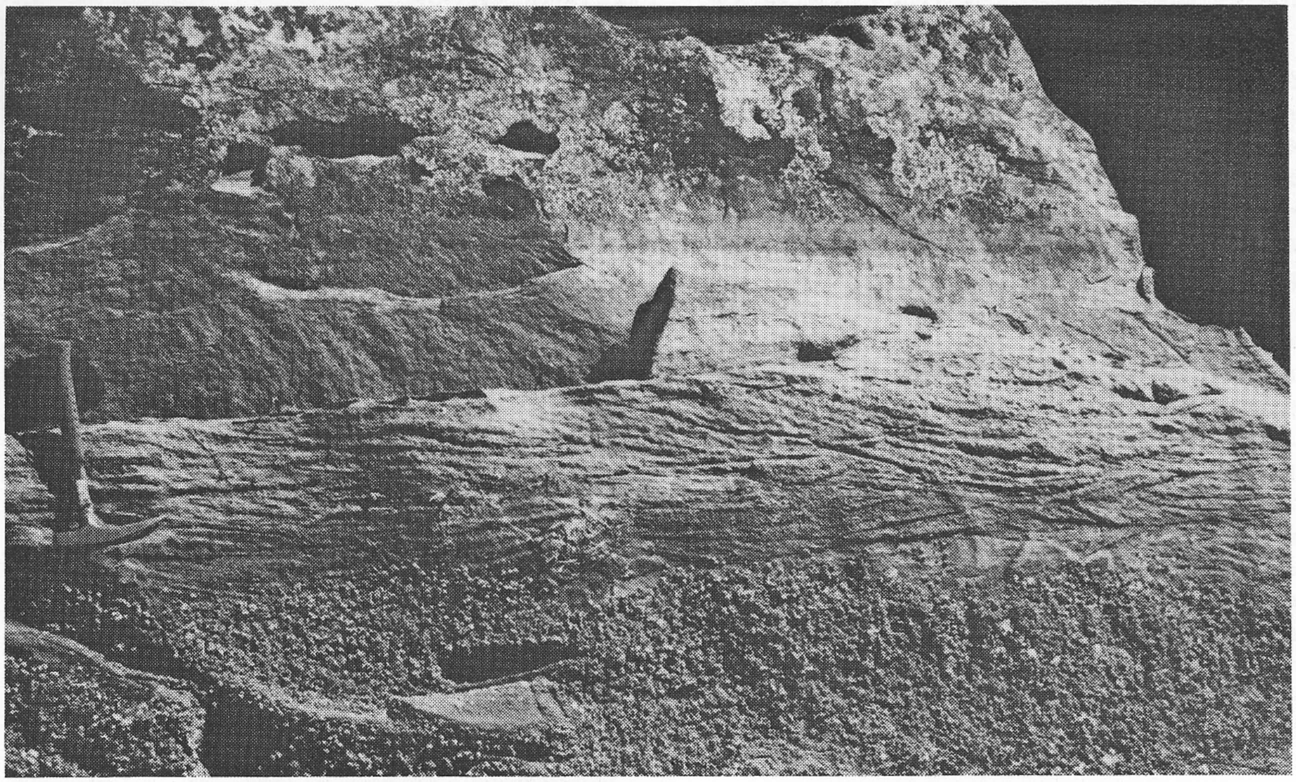

Plate 11. Cross-bedded sandstone, Saanich Member, Benson Formation (Bird's Eye Cove; NMA87-45-04; 5404581N; 456075E).

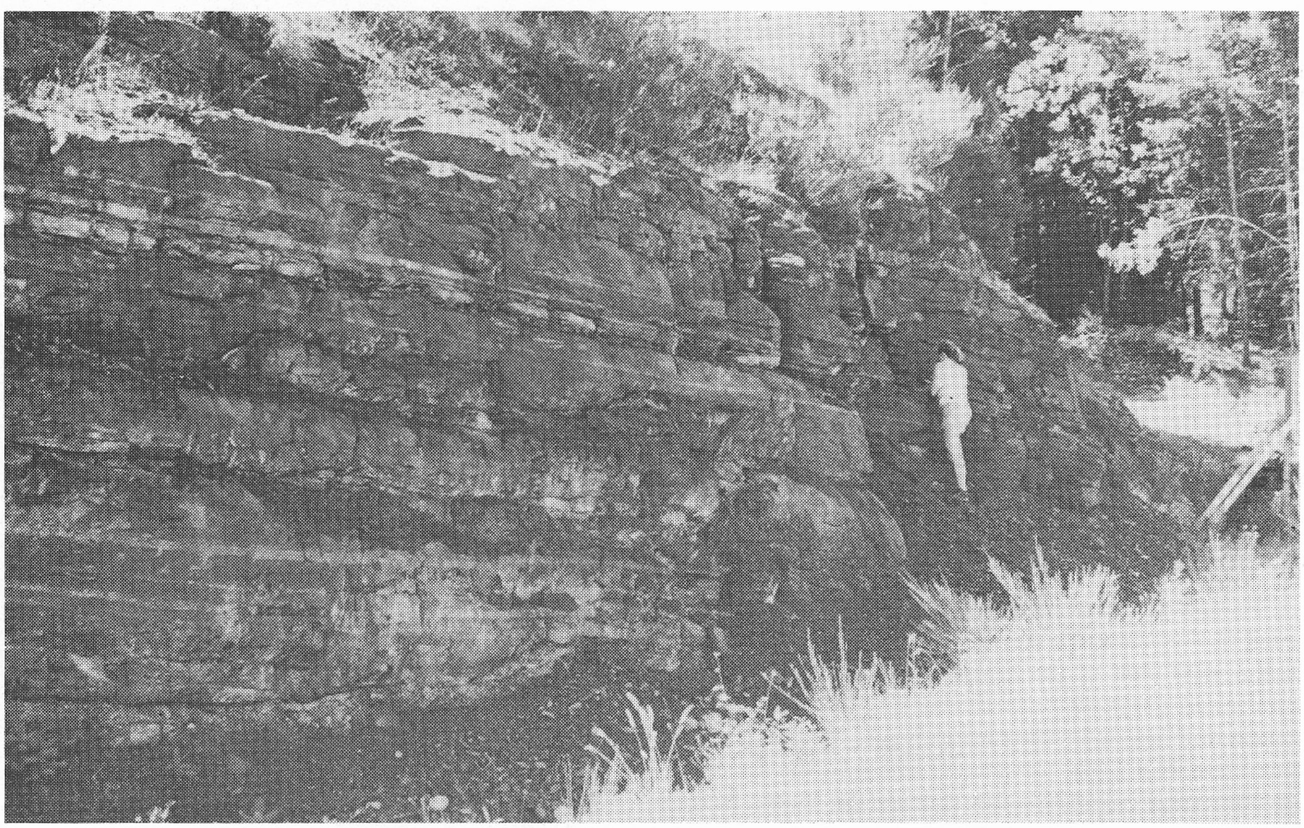

Plate 12. Well-bedded, laminated siltstones and argillites, Haslam Formation (new subdivision on north slope of Tzuhalem Mountain; SFR87-54-02: 5406299N; 455039E).

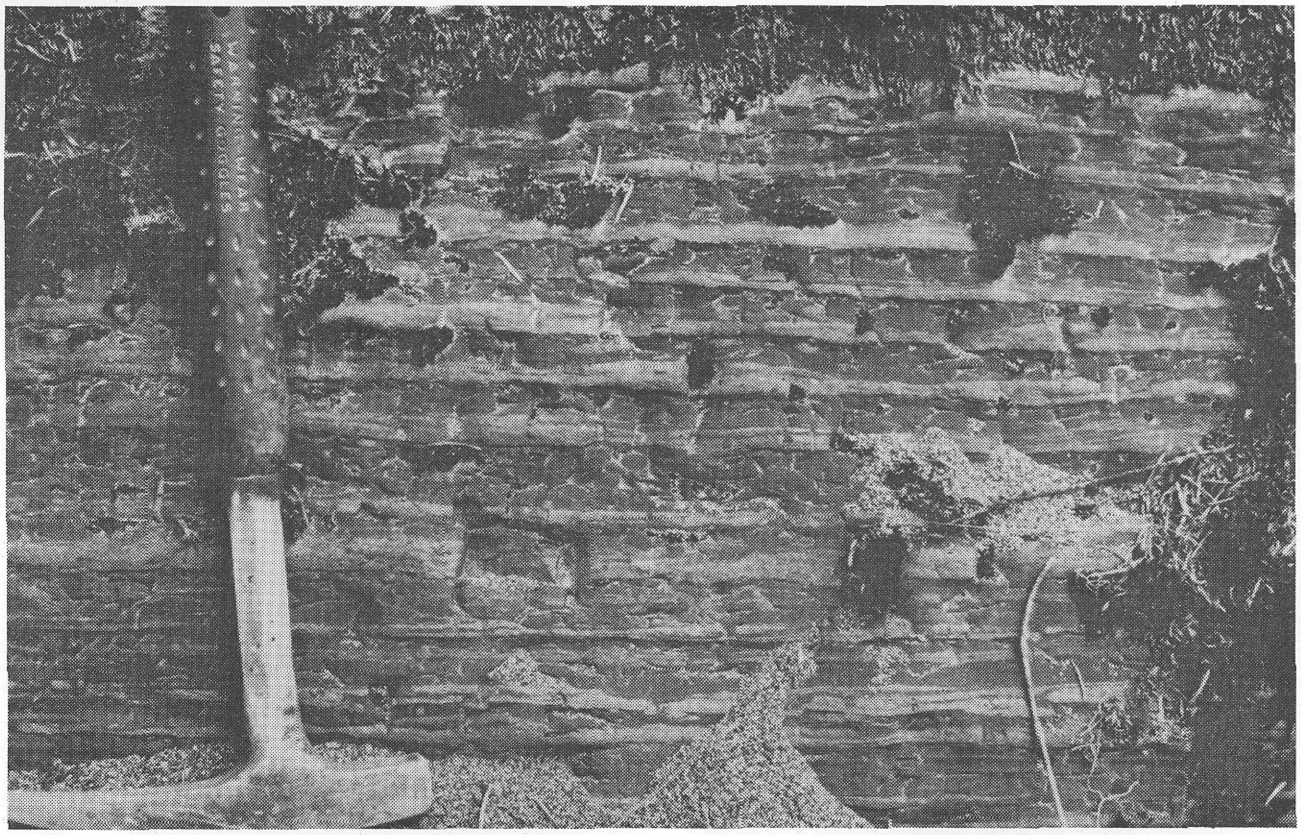

Plate 13. Graded siltstone-argillite beds of the Cowichan Member, Haslam Formation (Chemainus River; SFR87-22-02: 5410627N; 439707E).

thick in the Mount Tzuhalem and Stone Hill area in the east, to absent in other locations. The conglomerates have rounded clasts which consist of a variety of volcanic and intrusive lithologies of immediate local provenance (Plate 10); larger boulders are often angular.

Overlying sandstones of the Saanich Member (Plate 11) are medium to coarse grained, grey with rusty weathered surfaces. They contain feldspar crystals and abundant lithic fragments, mostly volcanic rocks of local provenance. Black plant-fragments are characteristic of many beds. Calcareous cement is common and concretions up to 1 metre diameter are developed locally. A few granule and pebble-conglomerate beds are interbedded with the sandstones. Several sandstone beds contain abundant fossil faunas, including gastropods, pelecypods and possible broken ammonites and nautiloids. The thickness of the Benson Formation is estimated to vary from 0 to 350 metres.

Haslam Formation

The Haslam Formation consists of characteristic rusty weathering, black argillite and siltstone. It is fine to silty, often poorly bedded, and friable, fracturing to pencil-shaped pieces. Interbeds of fine to medium-grained, grey silty sandstone are found within the argillites in the upper parts of the formation (Plates 12 and 13). These were called the Cowichan Member by Ward (1978). They vary in thickness up to 1 metre for massive to flaggy beds, although the more common graded sandstone-argillite turbidites average about 10 centimetres thick. Fossils are present within the Haslam Formation, although poorly preserved due to the ubiquitous pencil-and-rod fracturing, and include gastropods, pelecypods, ammonites and plant material. The thickness of the Haslam Formation may reach 600 metres in the Cowichan Valley (Ward 1978).

Plate 14. Bedded pebble conglomerate, Extension Formation (Chemainus River, south end of Copper Canyon; NMA87-26-08: 5409436N; 438481E).

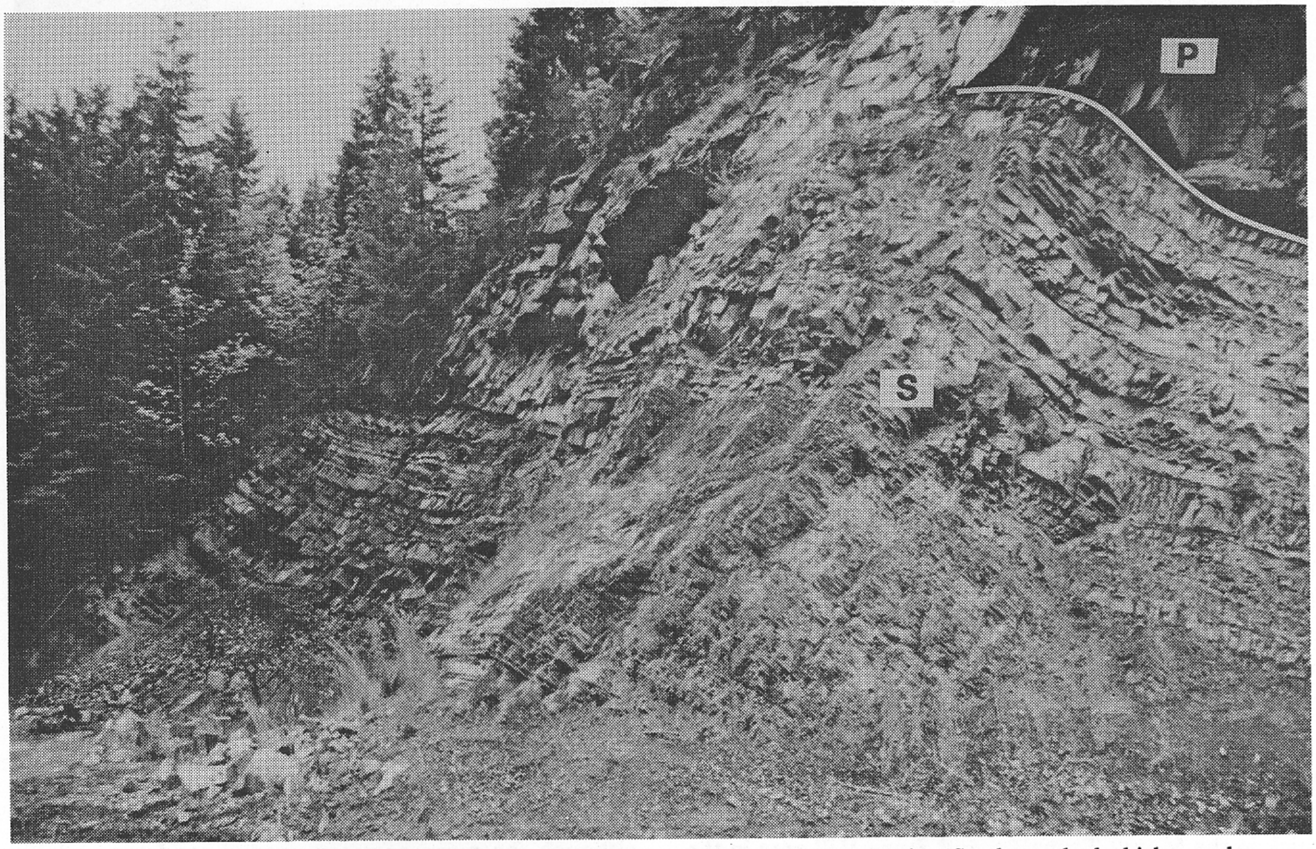

Plate 15. Well-bedded sandstones (s) and pebble conglomerate (p), Extension Formation. Sandstone beds thicken and coarsen upwards (Chemainus Main; PTE87-15-10-2: 5410349N; 432685E).

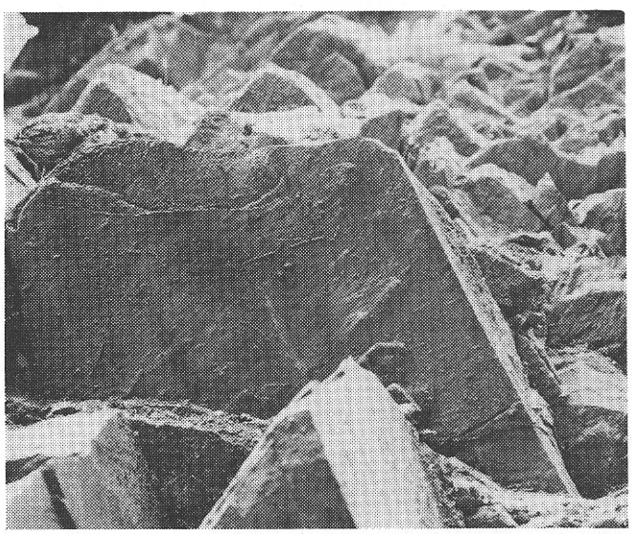

Plate 16. Flute casts and tool marks on base of sandstone bed, Extension Formation (Chemainus Main; PTE87-15-10-2: 5410349N; 432685E).

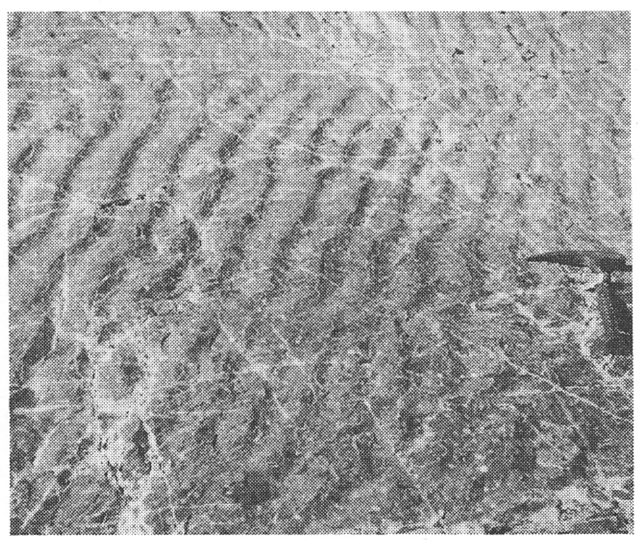

Plate 17. Assymetric ripples in sandstone bed, Extension Formation (Chemainus Main, south side of gorge; 5410100N; 433250E).

EXTENSION FORMATION

Conglomerates of the Extension Formation conformably overlie Haslam Formation argillites on top of Mount Prevost, representing the start of the second depositional cycle within the Nanaimo Group. Similar conglomerates are also found south of the Chemainus River and between Ladysmith and Chemainus. These pebble to cobble conglomerates are very similar to the Benson Formation conglomerates, being polymictic with subrounded to rounded clasts in a coarse sandstone matrix. Perhaps the only significant difference is the presence of clasts of white quartz in the Extension conglomerates (Plate 15), which is rare in the Benson Formation. Grey, medium to coarse-grained sandstones are interbedded with and overlie the conglomerates. In the valley of the Chemainus River, a sequence of turbiditic sandstones immediately overlies the Haslam Formation argillites. The sandstone beds thicken and coarsen upwards over about 8 metres and pass into a pebble conglomerate (Plate 15). The sandstones show several sedimentary structures including flume casts and tool marks (Plate 16) and asymmetric ripples (Plate 17).

PENDER FORMATION

Argillites of the Pender Formation, which overlie the Extension Formation, are best exposed in the incised gorge along the Chemainus River just below its confluence with Chipman Creek. Argillites assigned to the Haslam Formation coarsen upwards through turbiditic sandstones into pebble conglomerate of the Extension Formation. This in turn is succeeded by a fining-upward sequence of Pender Formation sandstones and argillites lithologically indistinct from the Haslam argillites.

INTRUSIONS

LATE DEVONIAN SALTSPRING INTRUSIVE SUITE

Coeval, and probably consanguineous, with the felsic volcanics in the McLaughlin Ridge Formation is a suite of granodiorite stocks and quartz porphyry dikes collectively known as the Saltspring Intrusive Suite.

The Mount Maxwell stock is centred on Saltspring Island but extends to the northern part of Maple Mountain. This body consists of light grey to green, weak to moderately foliated, medium-grained granodiorite with lesser tonalite, local fine-grained dacitic phases and a marginal feldspar porphyry. On the west coast of Saltspring Island, the granodiorite contains abundant large xenoliths of quartz diorite (Kveton, 1987). The stock intrudes Nitinat volcanics and is itself cut by a large Late Triassic gabbro body.

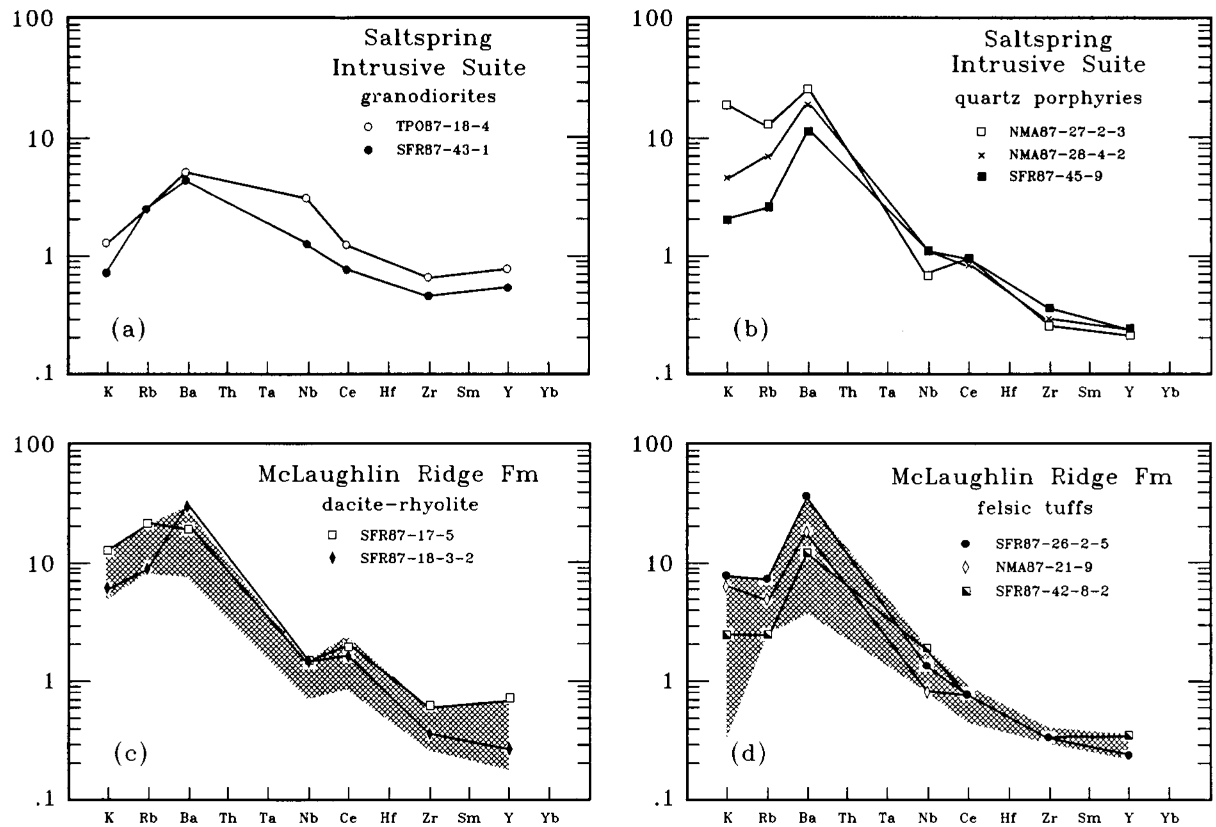

Figure 18. Normalized trace-element diagrams for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation. Normalizing values after Pearce *et al.* (1984): (a) Saltspring Intrusive Suite: granodiorite of the Mount Maxwell stock; (b) Saltspring Intrusive Suite: quartz feldspar porphyries ("Tyee porphyries"); (c) McLaughlin Ridge Formation: dacite and rhyolite flows and hypabyssal intrusions; (d) McLaughlin Ridge Formation: quartz-feldspar tuffs.

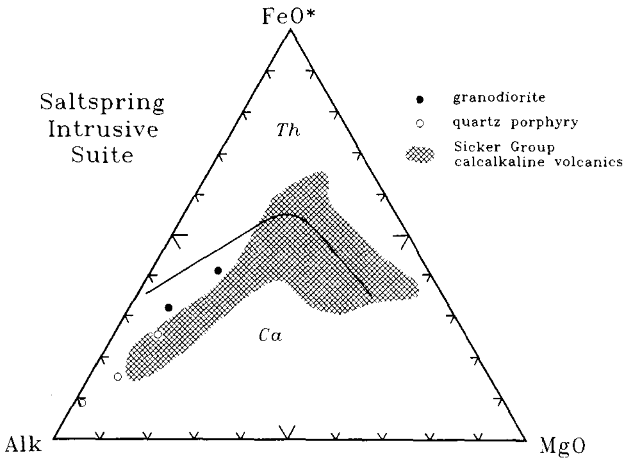

Figure 19. AFM triangle diagram for rocks of the Saltspring Intrusive Suite. Shaded field shows the range for all calcalkaline rocks of the Nitinat and McLaughlin Ridge formations. Tholeiite-calcalkaline dividing line after Irvine and Baragar (1971). Alk = $Na_2O + K_2O$; FeO* = total iron as FeO.

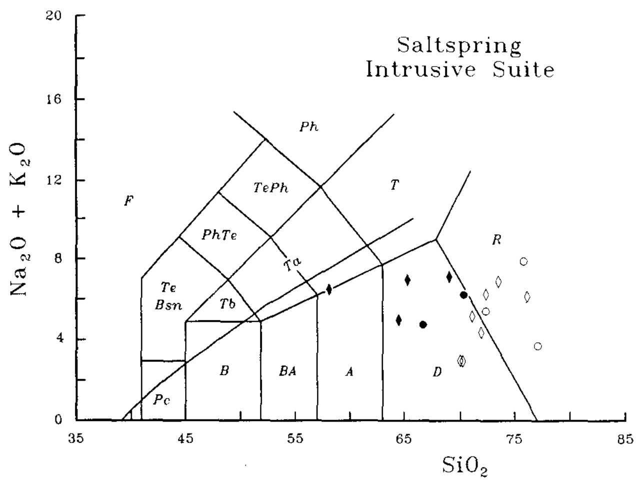

Figure 20. Alkali-silica diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation. Symbols: filled circles = granodiorite; open circles = quartz-feldspar porphyry; filled diamonds = dacite-rhyolite; open diamonds = quartz-feldspar tuffs. Fields after Le Maitre (1984); dashed line divides alkaline rocks (above line) from subalkaline rocks (below line), after Irvine and Baragar (1971).

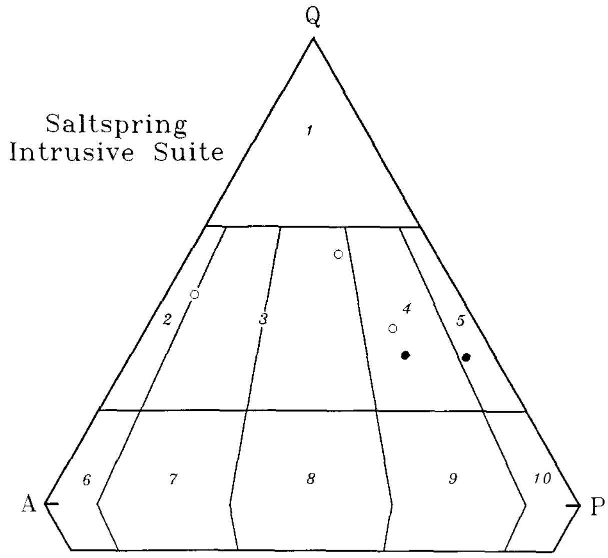

Figure 21. Normative Q-A-P-F diagram for rocks of the Saltspring Intrusive Suite. Fields after Streckeisen (1967); 1= quartz-rich granitoids; 2 = alkali feldspar granite; 3 = granite; 4 = granodiorite; 5 = tonalite-trondhjemite; 6 = alkali feldspar syenite; 7 = syenite; 8 = monzonite; 9 = monzodiorite, monzogabbro; 10 = diorite, gabbro. Normative albite is partitioned between alkali feldspar (A) and plagioclase feldspar (P) by the method of Le Maitre (1976); A = Or x T, P = An x T, where T = (Or + Ab + An)/(Or + An). Symbols as in Figure 19.

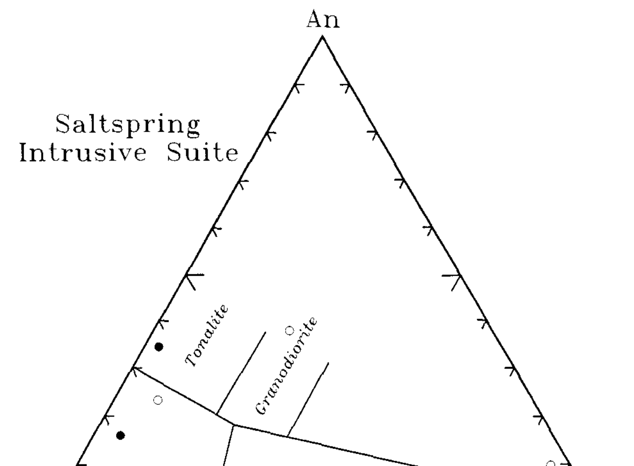

Figure 22. Normative An-Ab-Or diagram for rocks of the Saltspring Intrusive Suite. Fields are after Barker (1979) and O'Connor (1965). Symbols as in Figure 19.

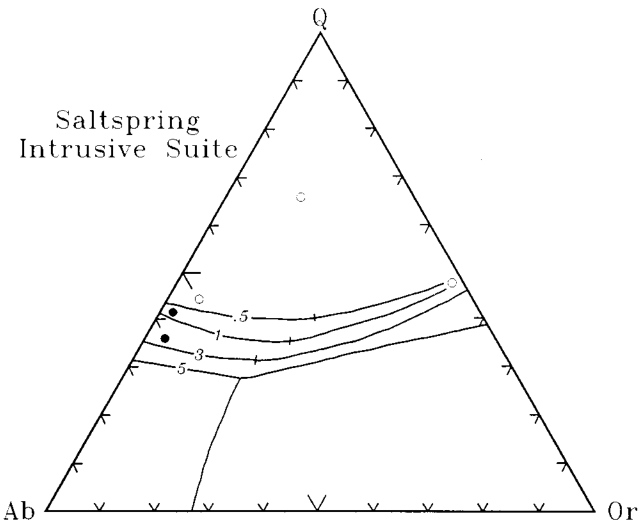

Figure 23. Normative Q-Ab-Or diagram for rocks of the Saltspring Intrusive Suite. Curves are for water-saturated liquids in equilibrium with quartz and alkali feldspar at indicated confining pressures in kilobars (Carmichael *et al.*, 1974, after data of Tuttle and Bowen, 1958). Isobaric minima are indicated on the curves except at 5 kilobars where a ternary eutectic is generated by intersection of the alkali feldspar solvus with the liquidus surface. Symbols as in Figure 19.

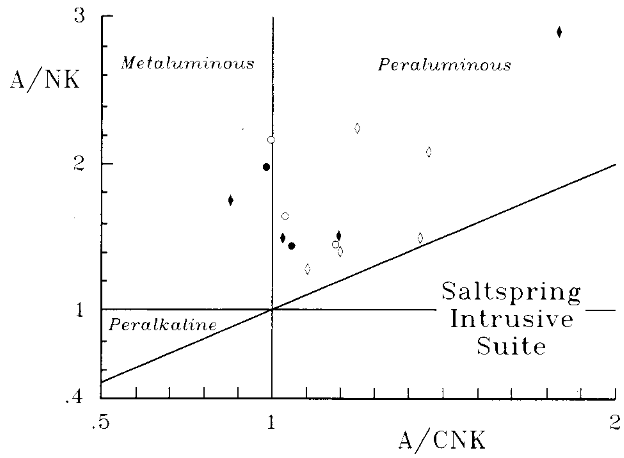

Figure 25. Shand's Index for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation (Shand, 1927). A, C, N and K are the molar values of Al_2O_3, CaO, Na_2O and K_2O respectively. Symbols as in Figure 20.

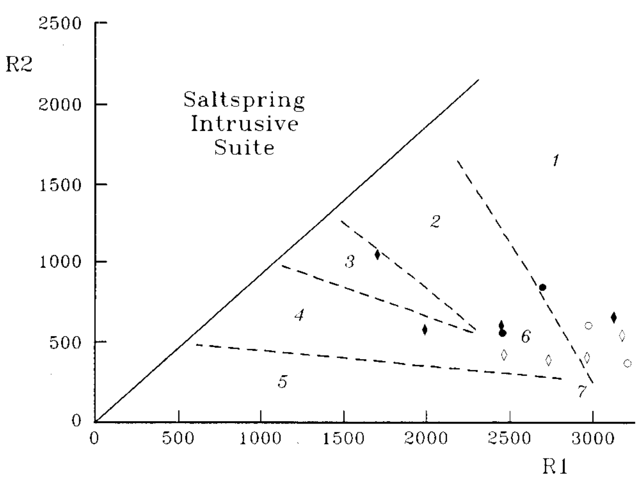

Figure 24. de la Roche R1 - R2 multicationic diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation (after de la Roche *et al.*, 1980); R1 = 4Si - 11(Na + K) - 2(Fe + Ti); R2 = 6Ca + 2Mg + Al. Fields after Batchelor and Bowden (1985): 1 = mantle fractionates; 2 = destructive plate margin (pre-plate-collision); 3 = post-plate-collision ("permitted" plutons); 4 = late orogenic (sub-alkaline); 5 = anorogenic (alkaline-peralkaline); 6 = synorogenic (anatectic); 7 = postorogenic. Symbols as in Figure 20.

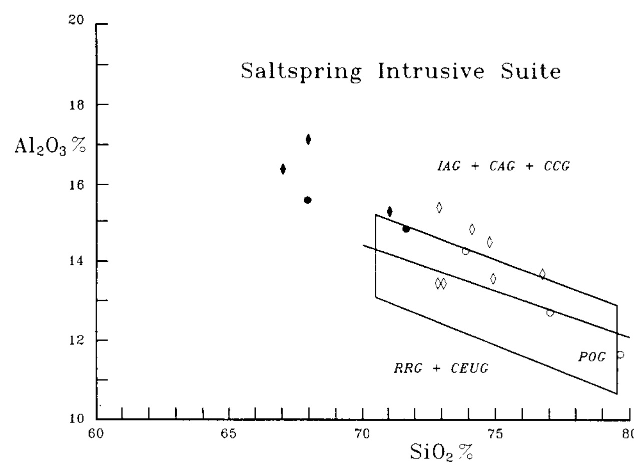

Figure 26. Al_2O_3-SiO_2 diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Maniar and Piccoli (1989). IAG = island-arc granitoids; CAG = continental-arc granitoids; CCG = continental-collision granitoids; POG = postorogenic granitoids; RRG = rift-related granitoids; CEUG = continental epeirogenic-uplift granitoids. Symbols as in Figure 20.

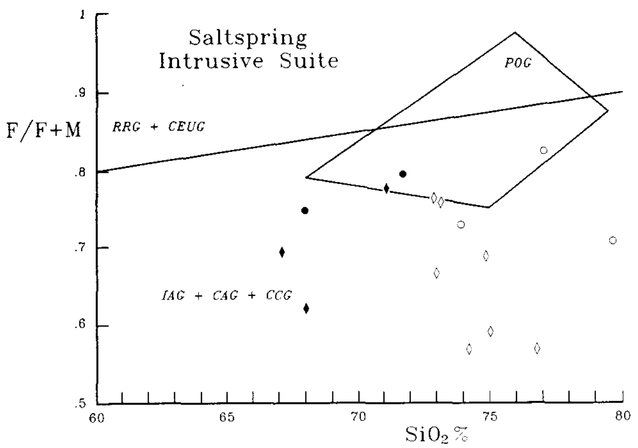

Figure 27. F/(F + M) versus SiO_2 diagram rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO. Field labels as in Figure 25. Symbols as in Figure 20.

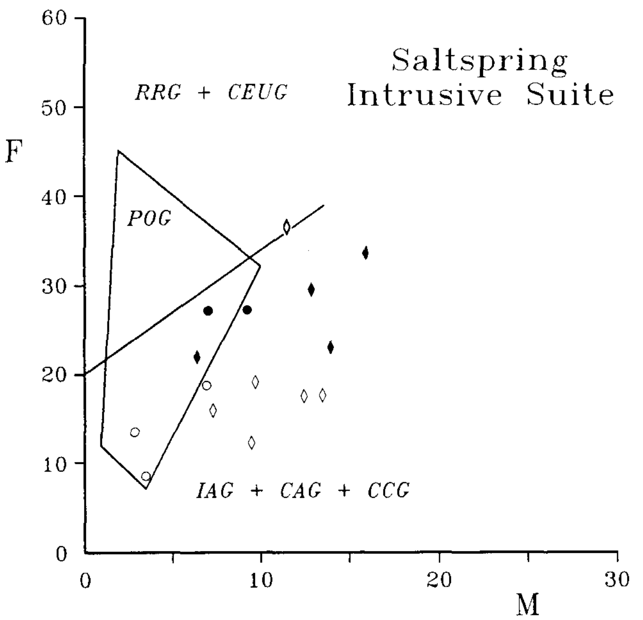

Figure 28. (F - M) diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO. Note that F and M, in this diagram, are the normalized values from plotting samples in the ternary (Al_2O_3 - Na_2O - K_2O)-(FeO^*)-(MgO) diagram. Field labels as in Figure 25. Symbols as in Figure 20.

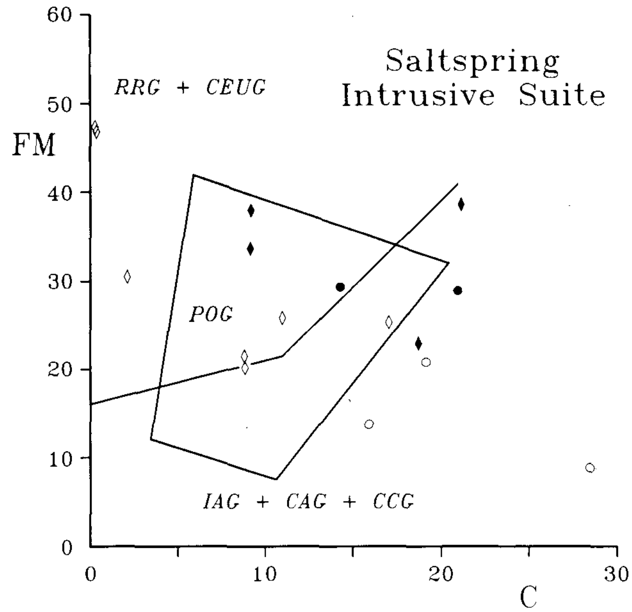

Figure 29. FM-C diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO; C = CaO. Note that FM and C, in this diagram, are the normalized values from plotting samples in the ternary (Al_2O3 - Na_2O - K_2O)-(FeO^* + MgO)-(CaO) diagram. Field labels as in Figure 25. Symbols as in Figure 20.

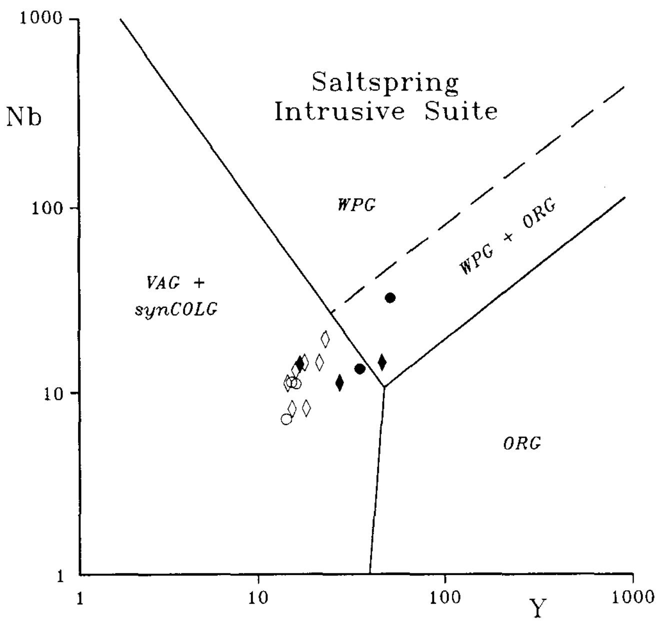

Figure 30. Nb-Y diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Pearce *et al.* (1984). VAG = volcanic-arc granites; synCOLG = syncollision granites; WPG = within-plate granites; ORG = ocean-ridge granites. Symbols as in Figure 20.

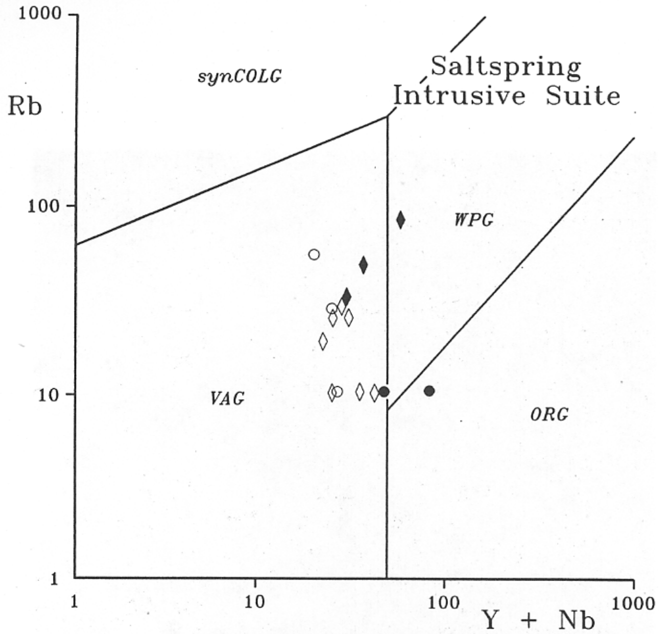

Figure 31. Rb-(Nb+ Y) diagram for rocks of the Saltspring Intrusive Suite and consanguineous felsic rocks of the McLaughlin Ridge Formation; fields after Pearce *et al.* (1984), labelled as in Figure 29. Symbols as in Figure 20.

Quartz and quartz feldspar porphyry dikes, previously termed the "Tyee porphyry" (Clapp and Cooke 1917), are contemporaneous with the granodiorite, though never seen in contact with it. They were probably feeders for felsic crystal tuffs in the McLaughlin Ridge Formation in the Chipman Creek - Mount Sicker area. The porphyries are usually well foliated and difficult to distinguish from the crystal tuffs when contact relationships with host volcanics are not clear. Quartz phenocrysts are up to 1 centimetre in diameter, rounded to ovoid in shape, and may be stretched in the plane of foliation. They comprise up to 20 per cent of the rock. Plagioclase phenocrysts are smaller and vary in shape from euhedral laths to rounded. They are sporadically altered to epidote.

Granodiorites and quartz porphyries of the Saltspring Intrusive Suite are comagmatic with the McLaughlin Ridge volcanics and display similar geochemical characteristics (Figures 18 to 20). Their normative mineralogy suggests a calcalkaline tonalite to granodiorite compositional range, though variable alteration of the alkalis causes wide dispersion (Figures 21 and 22). The normative mineralogy also suggests that the granodiorites crystallized at low pressures (0.5 to 3 kb) but not at the isobaric minimum (Figure 23). Quartz porphyries show the effects of quartz phenocryst accumulation and potassium alteration. The major and trace-element contents of the Saltspring Intrusive rocks support the interpretation of the upper Sicker Group forming in an island arc (Figures 24 to 31).

Late Triassic Mount Hall Gabbro

Thick mafic sills and dikes are widespread throughout the Paleozoic outcrop area though they are most commonly found intruding the Fourth Lake Formation north of the Chemainus River (in the informal "sediment-sill unit" of Muller, 1980). This area includes the type locality for the Mount Hall gabbro, the new lithostratigraphic name here proposed for this suite of intrusions. Clapp and Cooke (1917) originally termed them the "Sicker gabbro-diorite porphyrite" suggesting that they were comagmatic with the felsic porphyries of the Saltspring Intrusive Suite. However, these intrusions are now believed to be consanguineous with the basalt flows of the Carnian Karmutsen Formation. A hornblende separate from a dike north of Breen Lake yielded a K-Ar date of 363± 13 Ma (Eastwood, 1983). However, subsequent resampling has yielded a more reliable concordant baddeleyite U-Pb age of 227± 3 Ma (Parrish and McNicoll, 1991). This agrees with another dike, along Highway 1, which yielded slightly discordant zircon U-Pb ages in the range 217 to 222 Ma (Armstrong *et al.*, 1986).

The intrusions are medium to coarse-grained diabase, gabbro and leucogabbro (Plate 18) with minor diorite, commonly porphyritic with feldspar phenocrysts often forming glomeroporphyritic clusters up to 3 centimetres in diameter (Plate 19). Mafic phenocrysts are generally absent. Equigranular gabbros are also common

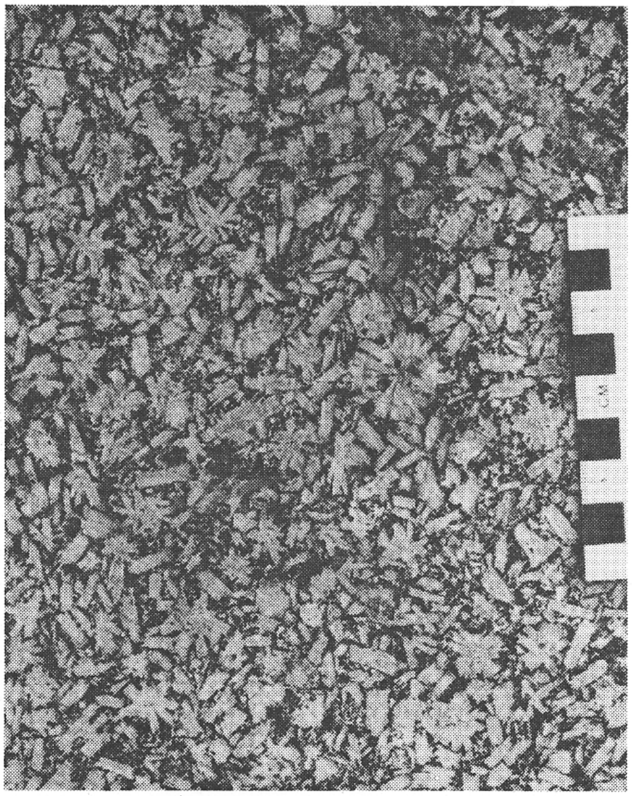

Plate 18. Leucogabbro, Mount Hall gabbro. Crowded euhedral and glomeroporphyritic feldspars (Holyoak Lake; PTE87-21-05: 5416893N; 438921E).

Plate 19. "Flower gabbro"; glomeroporphyritic feldspar gabbro, Mount Hall gabbro (Holyoak Lake; PTE87-21-05: 5416893N; 438921E).

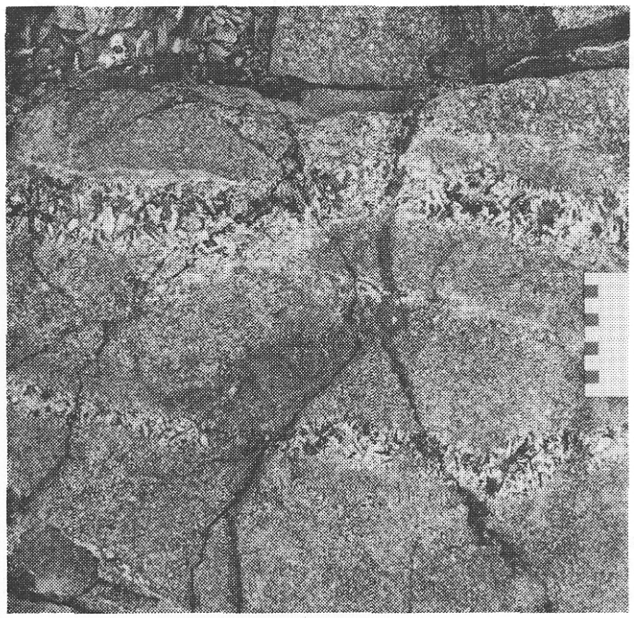

Plate 20. Pegmatite veins in coarse equigranular gabbro, Mount Hall Gabbro (south slope, Mount Hall; NMA87-34-04: 5417594N; 435224E).

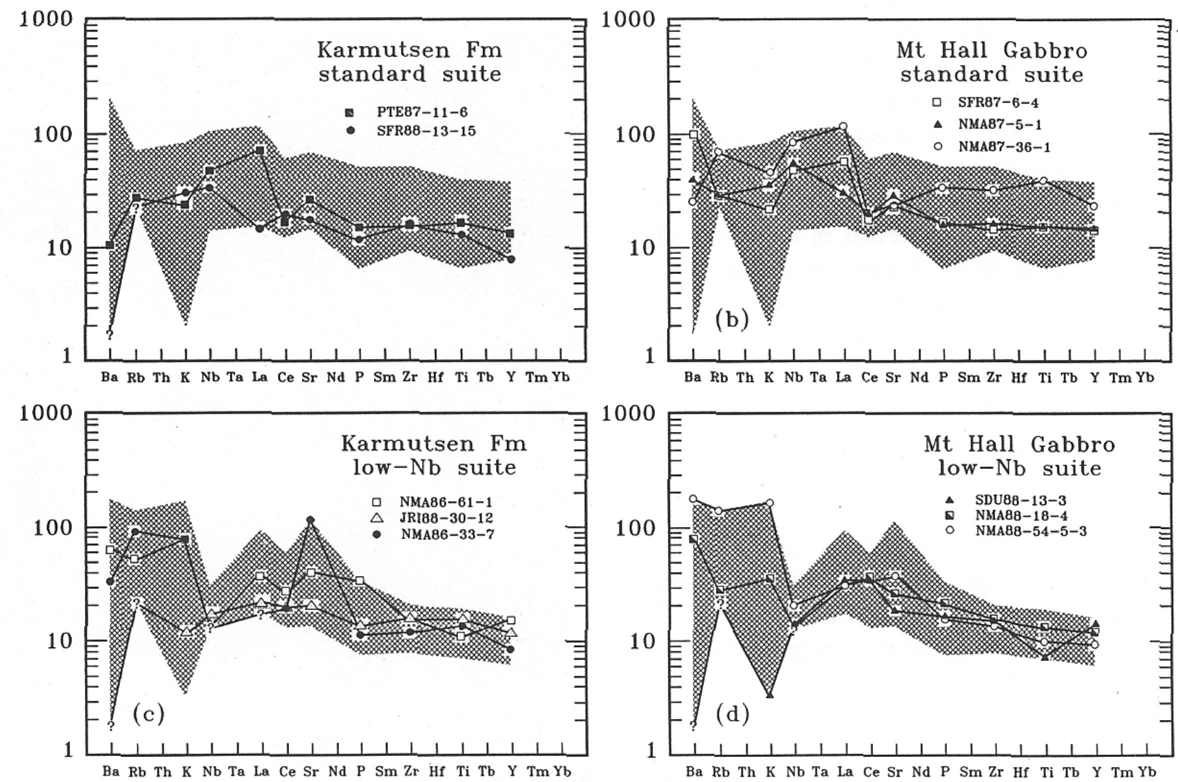

Figure 32. Normalized trace-element plots for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area. Selected representative samples are shown individually: (a) Karmutsen Formation, standard suite; (b) Mount Hall gabbro, standard suite; (c) Karmutsen Formation, low-niobium suite; (d) Mount Hall gabbro, low-niobium suite.

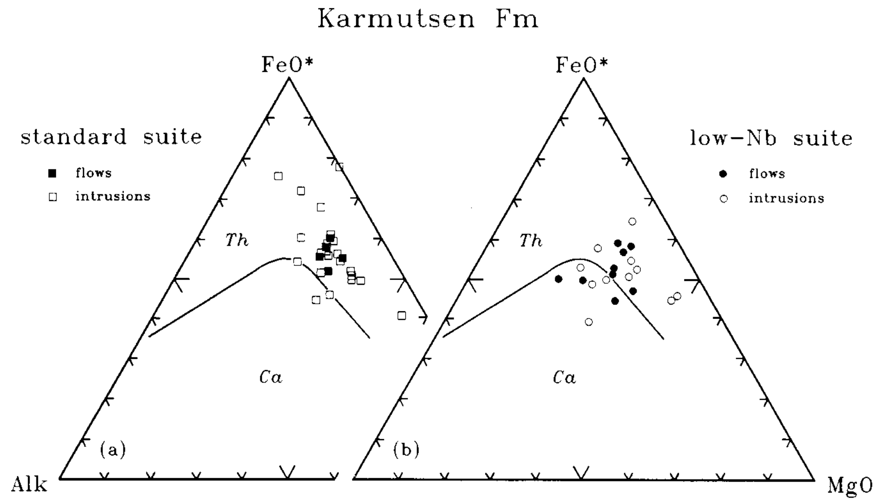

Figure 33. AFM triangle diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Tholeiite (Th) - calcalkaline (Ca) dividing line after Irvine and Baragar (1971). Alk = $Na_2O + K_2O$; FeO* = total iron as FeO.

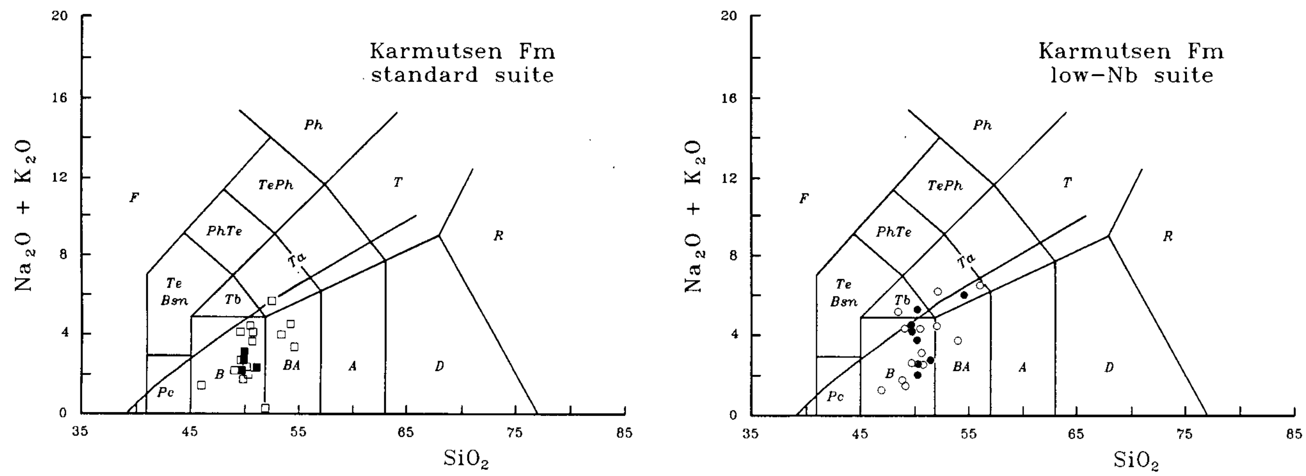

Figure 34. Alkali-silica diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Le Maitre (1984); F = foidites; Pc = picrobasalt; Bsn = basanite; Te = tephrite; PhTe = phontephrite; TePh = tephriphonolite; Ph = phonolite; Tb = trachybasalt; Ta = trachyandesite; T = trachyte and alkali trachyte; B = basalt; BA = basaltic andesite; A= andesite; D = dacite; R = rhyolite and alkali rhyolite. Dashed line divides alkaline rocks (above line) from subalkaline rocks (below line), after Irvine and Baragar (1971). Symbols as in Figure 9.

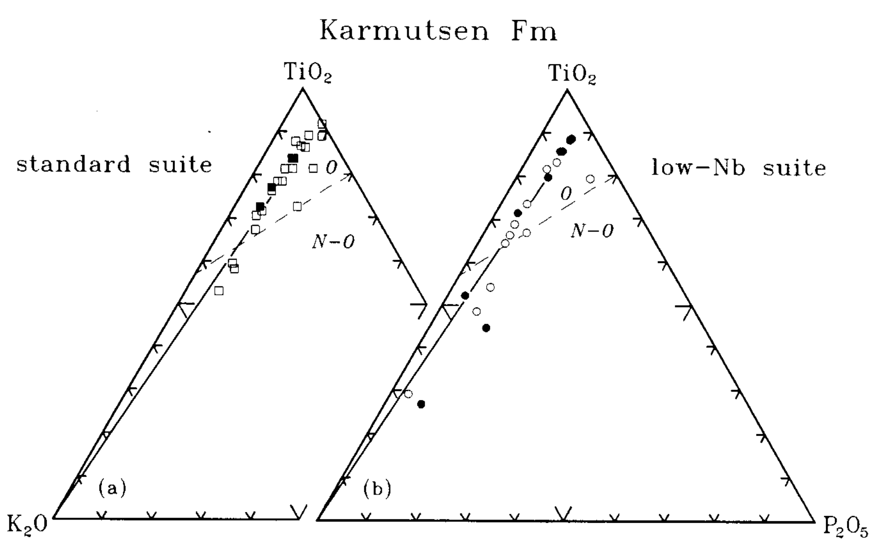

Figure 35. TiO_2-K_2O-P_2O_5 diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Pearce *et al.* (1975) are shown for reference; O = oceanic basalts; N-O = continental basalts. The TiO_2/P_2O_5 ratio reference line is the same for both plots. Symbols as in Figure 33.

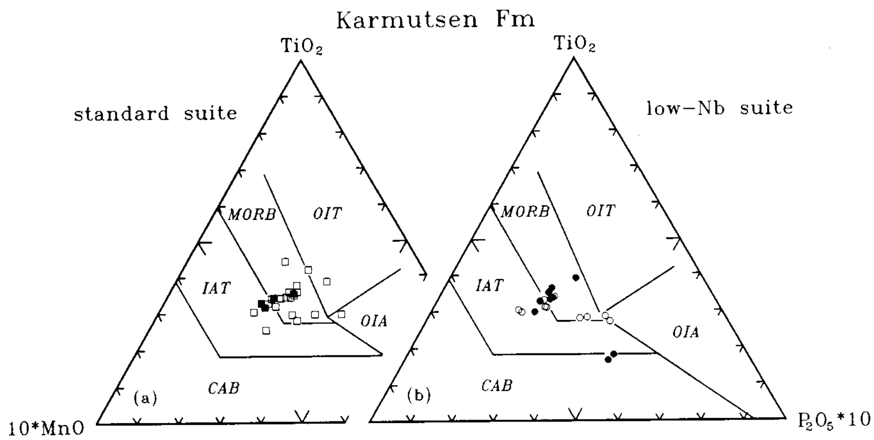

Figure 36. TiO_2-MnO-P_2O_5 diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Mullen (1983); CAB = calcalkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; OIT = ocean-island tholeiites; OIA = ocean-island alkalic basalts. Symbols as in Figure 33.

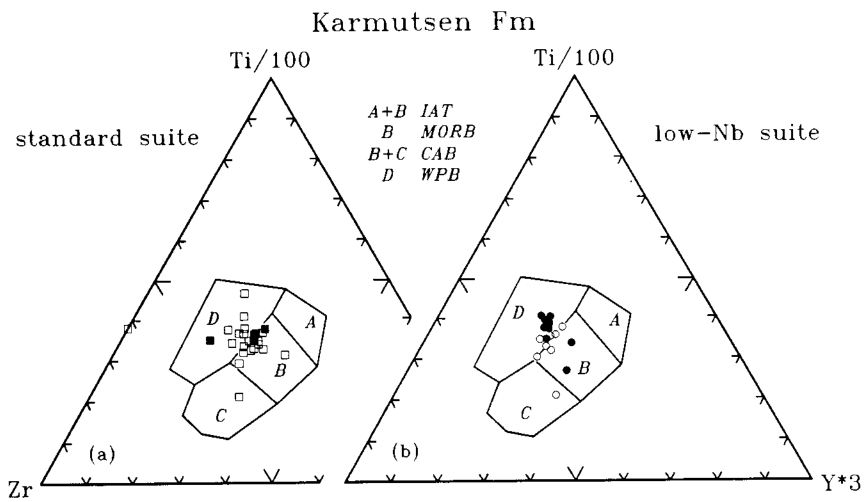

Figure 37. Ti-Zr-Y diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Pearce and Cann (1973); CAB = calcalkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; WPB = within-plate basalts. Symbols as in Figure 33.

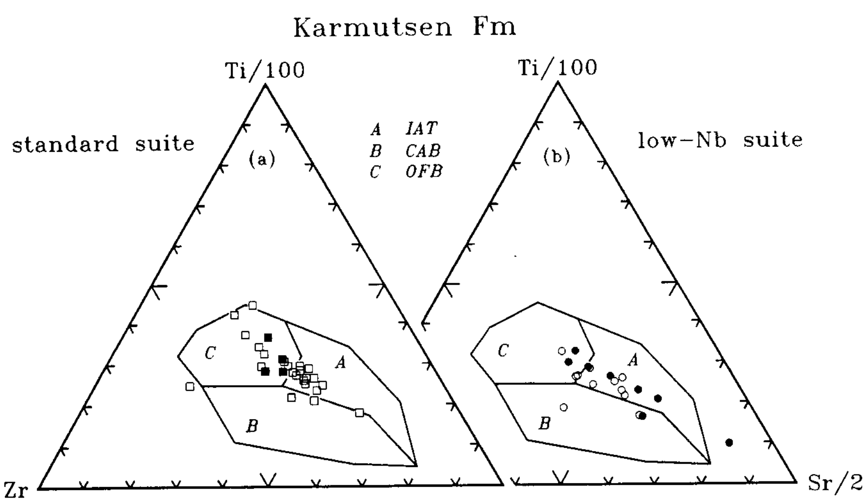

Figure 38. Ti-Zr-Sr diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Pearce and Cann (1973); CAB = calcalkaline basalts; IAT = island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 33.

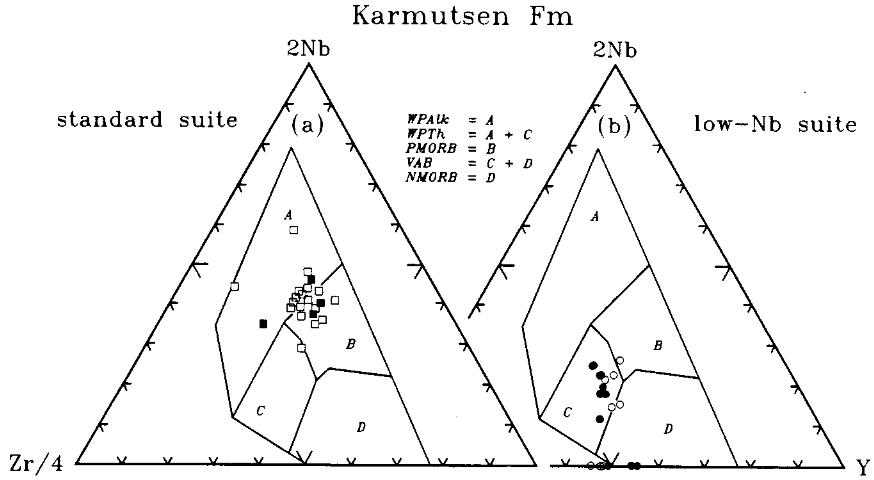

Figure 39. Nb-Zr-Y diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Menschede (1986); WPAlk = within-plate alkalic basalt; WPTh = within-plate tholeiite; PMORB = plume-type or enriched mid-ocean-ridge basalts; NMORB = normal mid-ocean-ridge basalts; VAB = volcanic-arc basalts (tholeiites). Symbols as in Figure 33. Data points on the Zr-Y margin of the triangle have niobium values below detection limit.

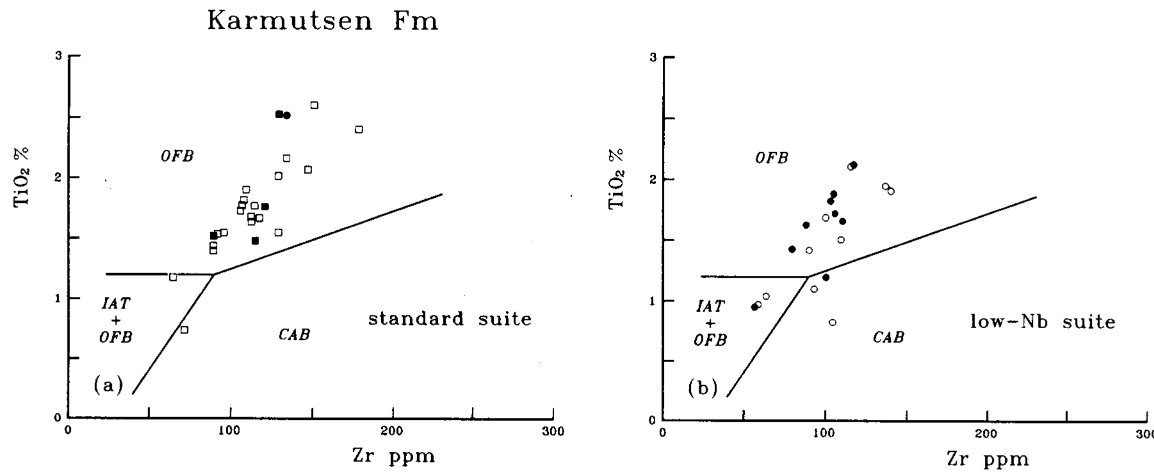

Figure 40. TiO_2-Zr diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Garcia (1978); CAB = calcalkaline basalts; IAT = island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 33.

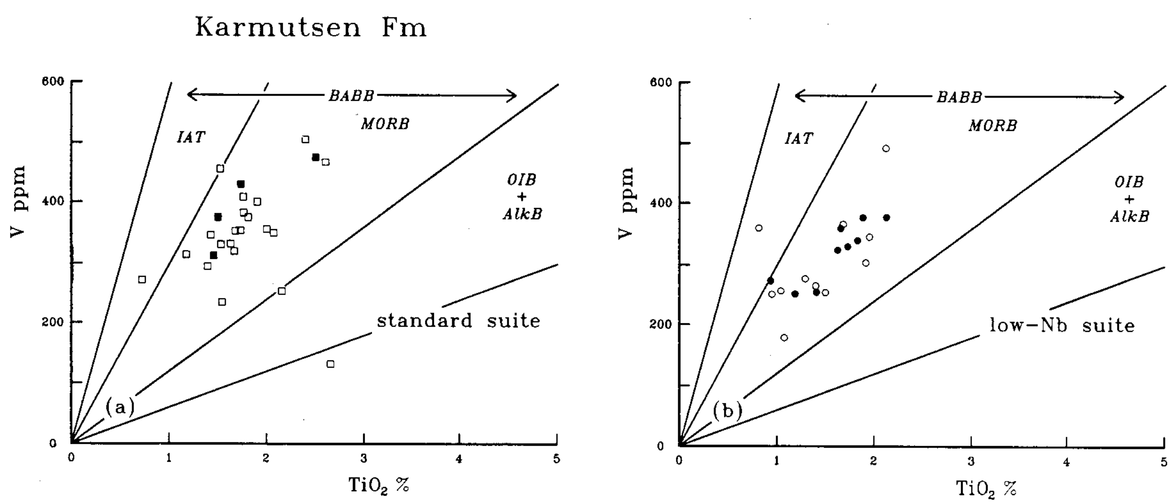

Figure 41. TiO_2-V diagrams for basalts of the Karmutsen Formation and intrusions of the Mount Hall gabbro. Fields after Shervais (1982); IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; BABB = back-arc basin basalts; OIB = ocean-island basalt; AlkB = alkalic basalt. Symbols as in Figure 33.

and coarse varieties contain frequent pegmatitic veins and pods (Plate 20). Thick gabbro bodies under Mount Hall and Coronation Mountain show layering of porphyritic and nonporphyritic lithologies. Contacts with country rock are usually finer grained and often are sheared and chloritic.

The intrusions vary in size and shape. Sill-like bodies are subconcordant with bedding in the sediments, for example Mount Hall, although they usually follow foliation where this is strongly developed, as in the Chipman Creek - Solly Creek area. The thick sills on Mount Sicker apparently crosscut foliation and bedding. They show a variety of attitudes from shallow dipping to vertical. They may be as little as a few metres or up to 200 metres thick. Discordant dikes are also common, varying from 10 centimetres to about 50 metres wide.

The numerous intrusions are believed to have occurred during dilation of the Paleozoic basement in the Late Triassic, and acted in part as feeders to the overlying volcanics. Elsewhere in Wrangellia the Karmutsen volcanics overlap onto the Paleozoic basement and evidence of the rifting is covered.

The geochemistry of the Late Triassic gabbros and diabases of the Duncan area shows that they formed from a iron-titanium-enriched tholeiitic magma. They are similar in composition to most Karmutsen lavas and intrusions on Vancouver Island (Barker *et al.*, 1989; Kuniyoshi, 1972). Extended trace-element diagrams of this "standard suite" show moderate enrichments in niobium and the light rare-earth elements (Figure 32). Lanthanum may be even more enhanced in more altered samples, together with relative depletions and enrichments of potassium, rubidium and barium. The major elements illustrate the tholeiitic character of the magma (Figures 33 and 34) while trace-element patterns and discriminant diagrams (Figures 35 to 41) suggest an affinity to an enriched mid-ocean ridge basalt or continental tholeiite. These geochemical characteristics, coupled with the thickness of the Karmutsen Formation, essentially basaltic character, dominant lithofacies, extent and short duration of formation (entirely within the Carnian, about 6 Ma), suggest that the Karmutsen Formation formed in an oceanic flood-basalt province.

The low-niobium magma suite found in the adjacent Cowichan Lake map area (Massey, 1993a) is apparently absent in the Duncan area, though may be expected south of the Chemainus fault in the Fairservice Mountain and Koksilah Ridge area.

JURASSIC ISLAND PLUTONIC SUITE

Several granodioritic stocks of Early to Middle Jurassic age occur in the area. They are coeval with the Bonanza Group volcanics, although these latter are not developed in the map area. Samples from plutons throughout Vancouver Island have yielded a composite

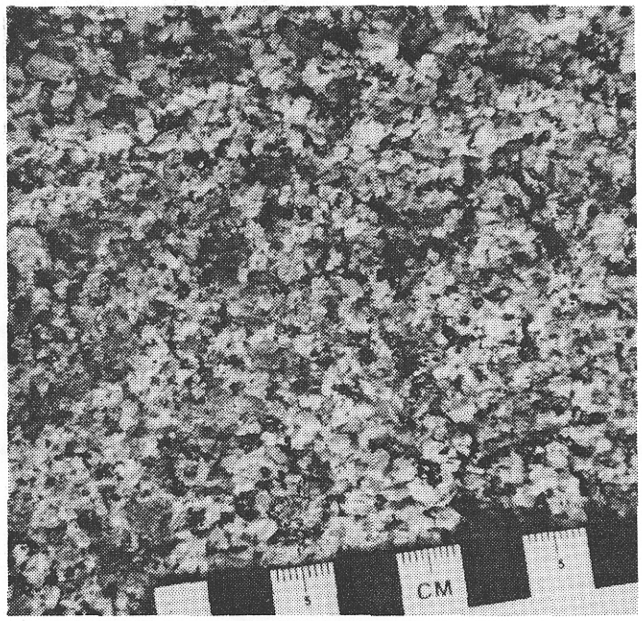

Plate 21. Hornblende biotite granodiorite with large quartz eyes, typical of the Ladysmith pluton, Island Plutonic Suite (Silver Lake; NMA87-34-05: 5417887N; 437505E).

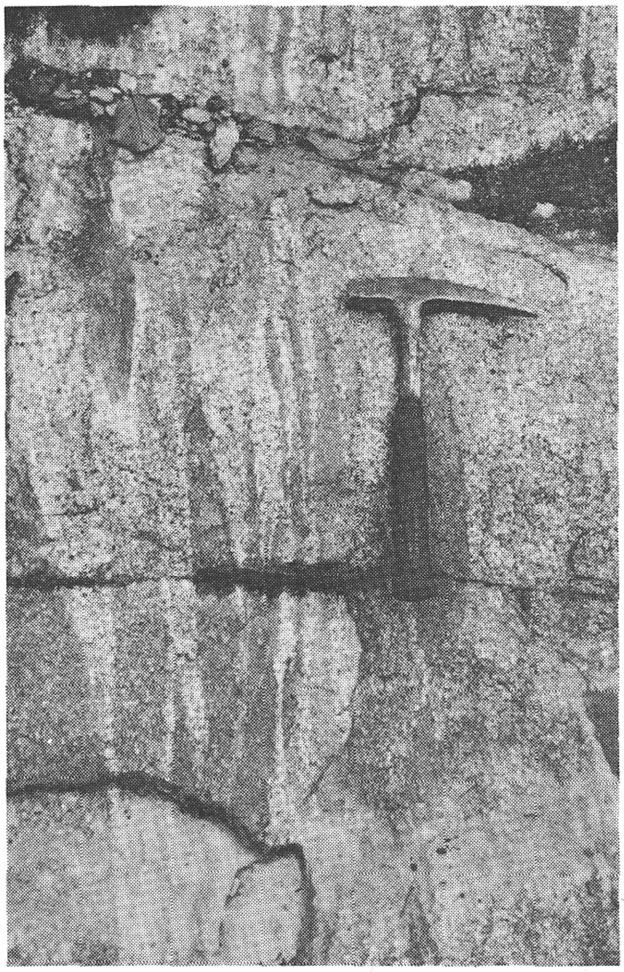

Plate 22. Aligned mafic xenoliths in weakly foliated granodiorite, Ladysmith pluton, Island Plutonic Suite (Haslam Main; PTE87-25-03: 5426299N; 433471E).

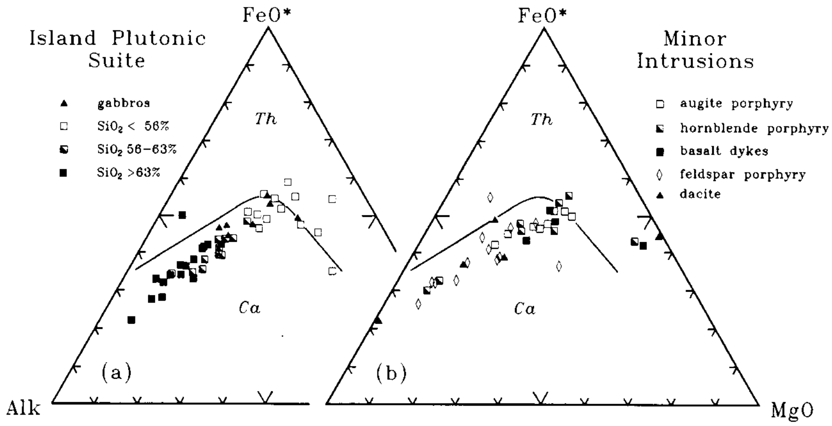

Figure 42. AFM triangle diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions. Tholeiite-calcalkaline dividing line after Irvine and Baragar (1971). Alk = Na_2O + K_2O; FeO* = total iron as FeO.

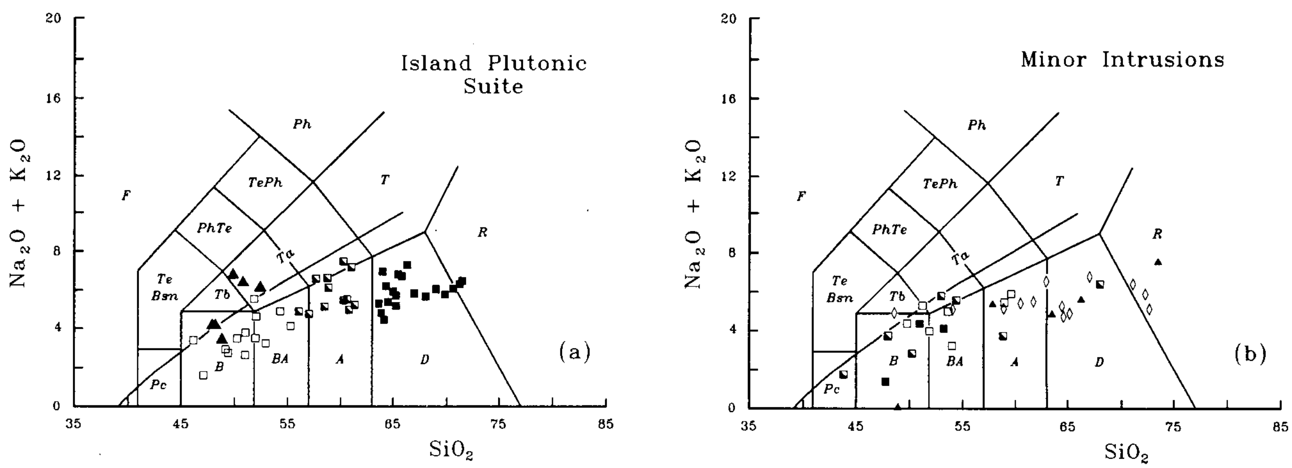

Figure 43. Alkali-silica diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Le Maitre (1984); dashed line divides alkaline rocks (above line) from subalkaline rocks (below line), after Irvine and Baragar (1971). Symbols as in Figure 42.

Rb-Sr isochron date of 183± 7 Ma (Armstrong *et al.*, 1986). However, a quartz diorite intrusion on Moresby Island, southeast of Saltspring Island, yielded younger, though slightly discordant, zircon U-Pb dates interpreted as being 168± 2 Ma with some Paleozoic inheritance. With the exception of the large Ladysmith pluton, these granodiorite bodies are elongate in surface outcrop shape, paralleling the overall structural grain of the area. The dominant lithology is a medium to coarse-grained, equigranular granodiorite to quartz diorite with a characteristic "salt-and-pepper" texture. Quartz is usually irregular in shape, often interstitial to the feldspars. However, in the Ladysmith pluton large (up to 8 millimetres) rounded quartz grains are ubiquitous (Plate 21). Feldspars are white, though some pink staining is seen on weathered surfaces, and usually form subhedral laths. Hornblende is the principal mafic mineral. It is tabular to acicular, black to greenish black in colour and may be slightly larger than the feldspars. Biotite is common in the Hill 60 and Ladysmith plutons. Chlorite replaces hornblende and biotite in altered rocks. Colour index varies from 10 to 20 in the granodiorites, but may range up to 40 in dioritic phases. White, fine-grained aplite dikelets and veins cut the granodiorites.

Most of the stocks are rich in inclusions, particularly in marginal zones where agmatitic intrusive breccias are developed. The angular to subrounded xenoliths are of local country rock lithologies showing a range of amphibolitization and assimilation features. The xenoliths are normally randomly oriented, but within the Ladysmith pluton some zones of inclusions have a parallel to subparallel arrangement (Plate 22).

Intrusions of the Island Plutonic Suite in the Cowichan uplift span the compositional range from gabbro to granite with the mean being granodiorite to quartz monzodiorite (Figures 42, 43, 47). They are a typical metaluminous, medium to high-potassium calcalkaline suite (Figures 42 to 49). Normative mineralogy suggests

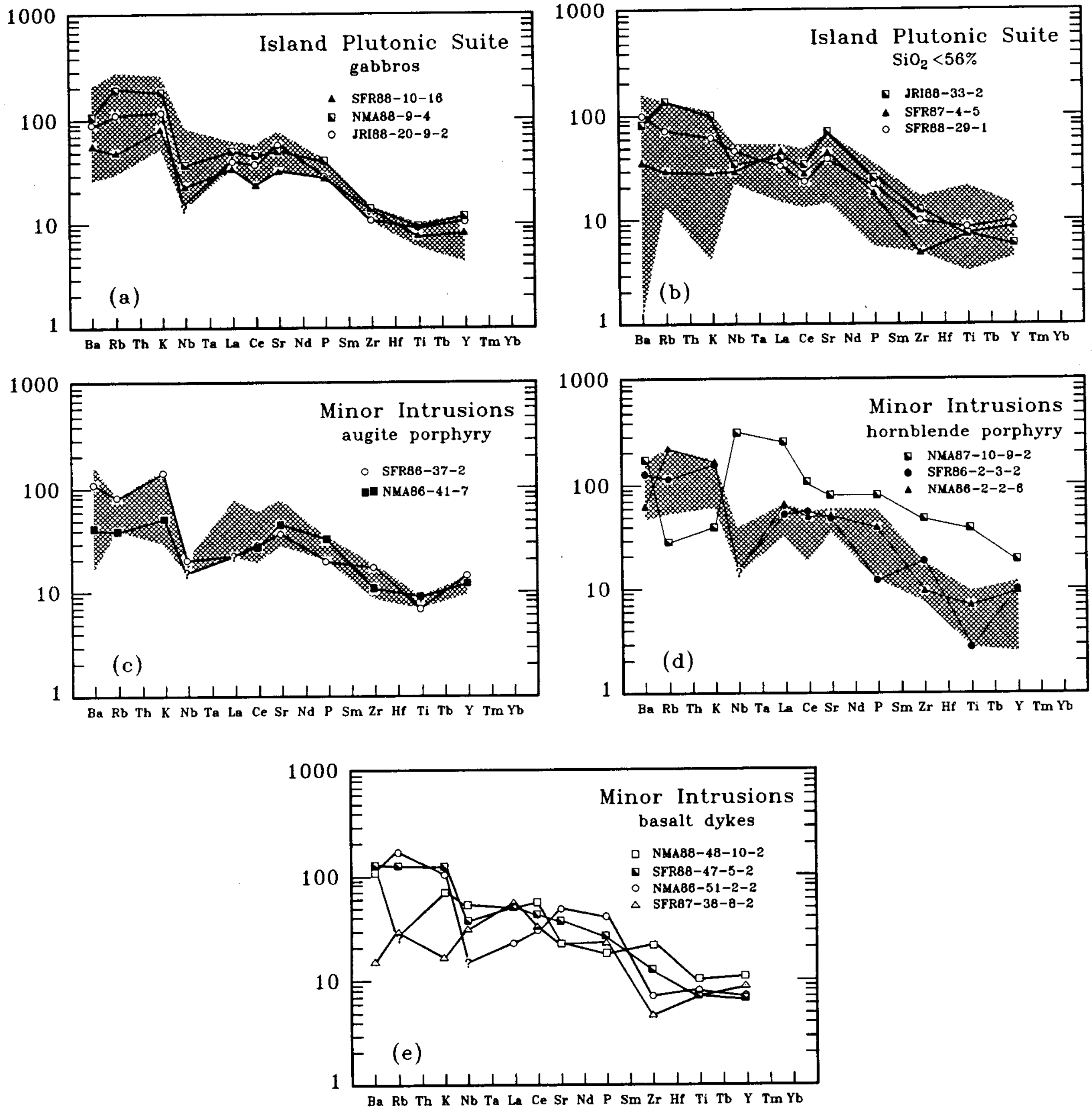

Figure 44. Normalized trace-element plots for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Normalizing values after Thompson *et al.* (1983). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area. Selected representative samples are shown individually. (a) gabbros from the Alberni area of unknown age, possibly part of the Island Plutonic Suite; (b) Island Plutonic Suite, $SiO_2 < 56\%$; (c) minor intrusions, augite porphyries; (d) minor intrusions, hornblende porphyries; (e) minor intrusions: basalt dikes.

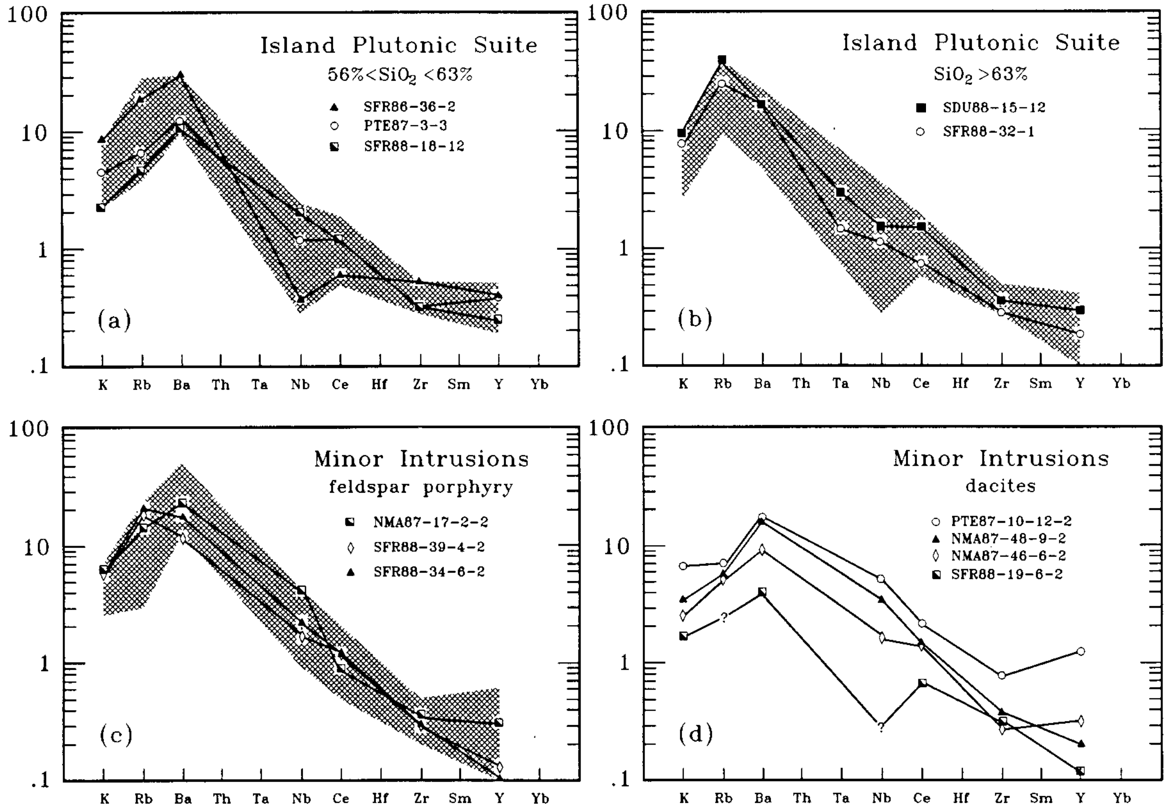

Figure 45. Normalized trace-element diagrams for intermediate to felsic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Normalizing values after Pearce *et al.* (1984). Shaded area represents the range of values for all samples of a particular suite in the Sicker Project area. Selected representative samples are shown individually: (a) Island Plutonic Suite, SiO_2 56 - 63%; (b) Island Plutonic Suite, $SiO_2 > 63\%$; (c) minor intrusions, feldspar porphyries; (d) minor intrusions, dacites.

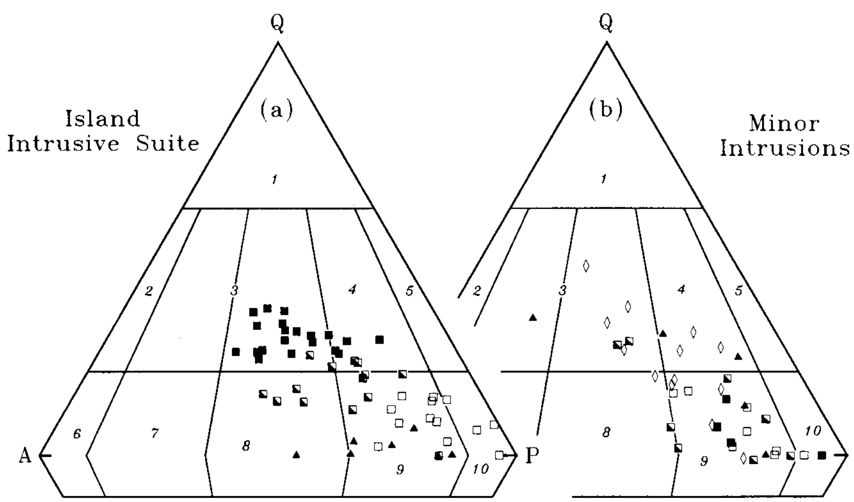

Figure 46. Normative Q-A-P-F diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Streckeisen (1967); 1 = quartz-rich granitoids; 2 = alkali feldspar granite; 3 = granite; 4 = granodiorite; 5 = tonalite-trondhjemite; 6 = alkali feldspar syenite; 7 = syenite; 8 = monzonite; 9 = monzodiorite, monzogabbro; 10 = diorite, gabbro. Normative albite is partitioned between alkali feldspar (A) and plagioclase feldspar (P) by the method of Le Maitre (1976); A = Or x T, P = An x T, where T = (Or + Ab + An)/(Or + An). Symbols as in Figure 42.

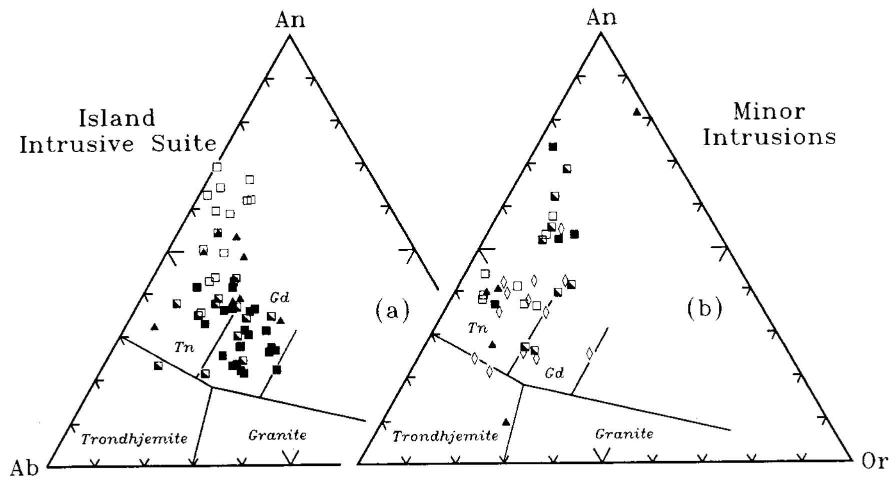

Figure 47. Normative An-Ab-Or diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions. Fields are after Barker (1979) and O'Connor (1965); Tn = tonalite; Gd = granodiorite. Symbols as in Figure 42.

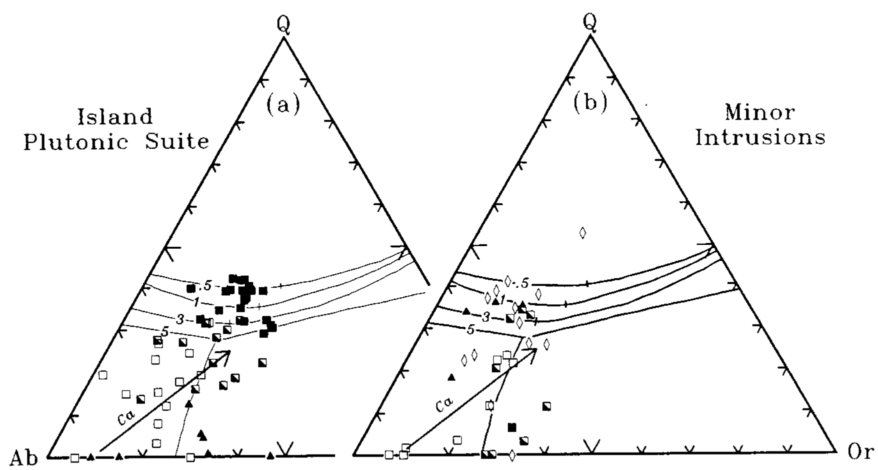

Figure 48. Normative Q-Ab-Or diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions. Curves are for water-saturated liquids in equilibrium with quartz and alkali feldspar at indicated confining pressures in kilobars (Carmichael *et al.*, 1974, after data of Tuttle and Bowen, 1958). Isobaric minima are indicated on the curves except at 5 kilobars where a ternary eutectic is generated by intersection of the alkali feldspar solvus with the liquidus surface. Ca = trend for typical calkalkine suite (Abdel-Rahman, 1990, after Arth *et al.*, 1978). Symbols as in Figure 42.

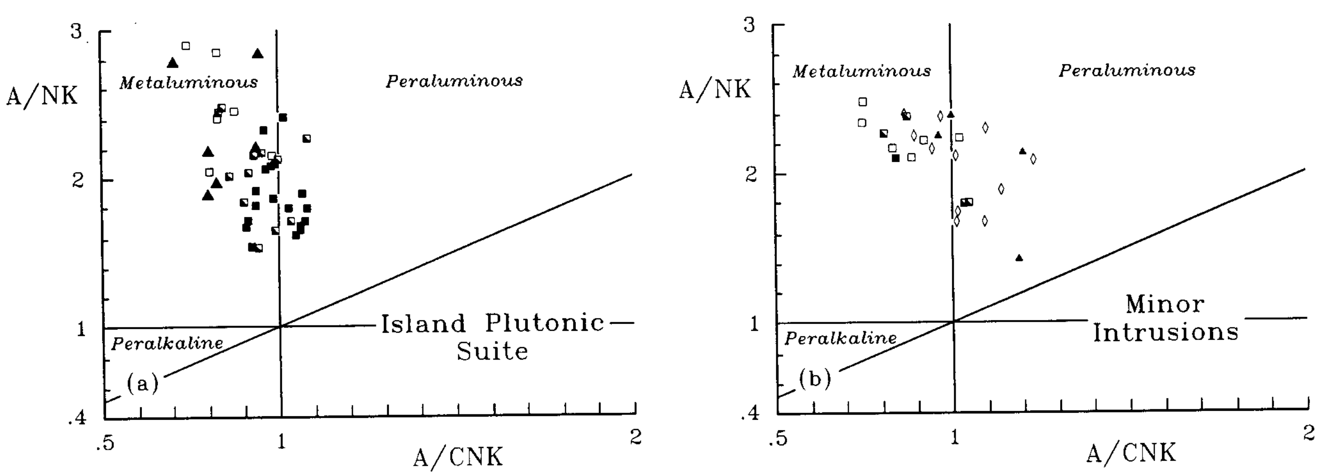

Figure 49. Shand's Index for rocks of the Island Plutonic Suite and probably coeval minor intrusions (Shand, 1927). A, C, N and K are the molar values of Al_2O_3, CaO, Na_2O and K_2O respectively. Symbols as in Figure 42.

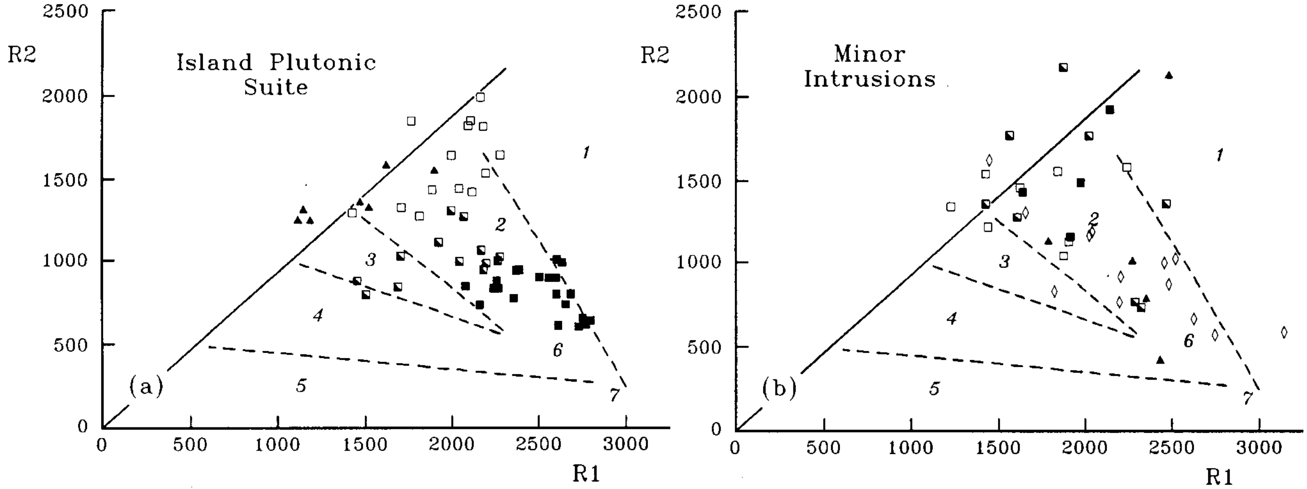

Figure 50. de la Roche R1 - R2 multicationic diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions (after de la Roche *et al.*, 1980); R1 = 4Si - 11(Na + K) - 2(Fe + Ti); R2 = 6Ca + 2Mg + Al. Fields after Batchelor and Bowden (1985): 1 = mantle fractionates; 2 = destructive plate-margin (pre-plate-collision); 3 = post-plate-collision ("permitted" plutons); 4 = late orogenic (sub-alkaline); 5 = anorogenic (alkaline-peralkaline); 6 = synorogenic (anatectic); 7 = postorogenic. Symbols as in Figure 42.

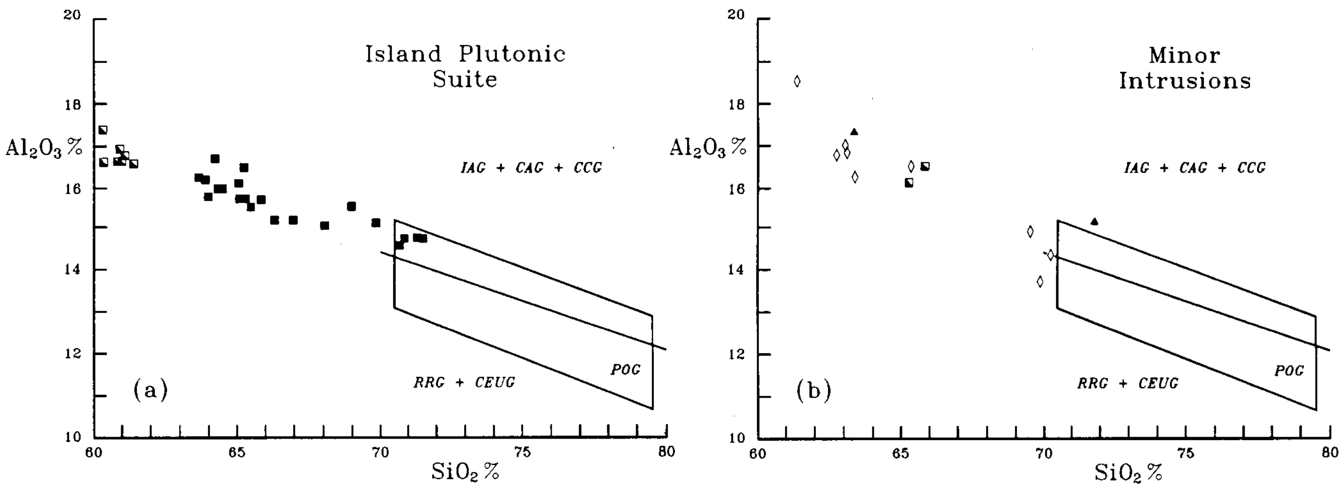

Figure 51. Al_2O_3-SiO_2 diagram for felsic lithologies of the Island Plutonic Suite and probably coeval minor intrusions; fields after Maniar and Piccoli (1989). IAG = island-arc granitoids; CAG = continental-arc granitoids; CCG = continental-collision granitoids; POG = postorogenic granitoids; RRG = rift-related granitoids; CEUG = continental epeirogenic-uplift granitoids. Symbols as in Figure 42.

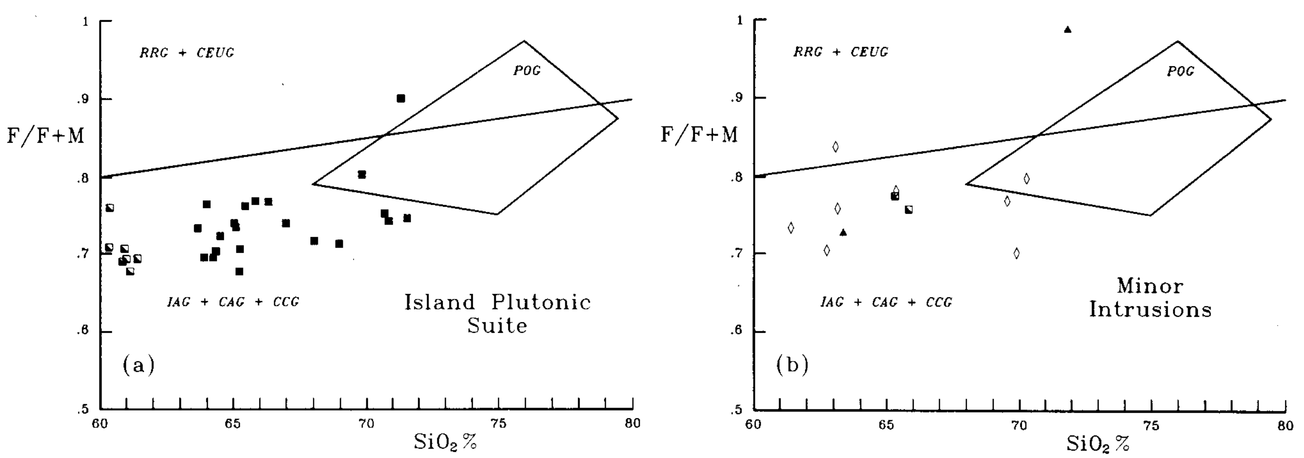

Figure 52. F/(F + M) versus SiO_2 diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO. Field labels as in Figure 51. Symbols as in Figure 42.

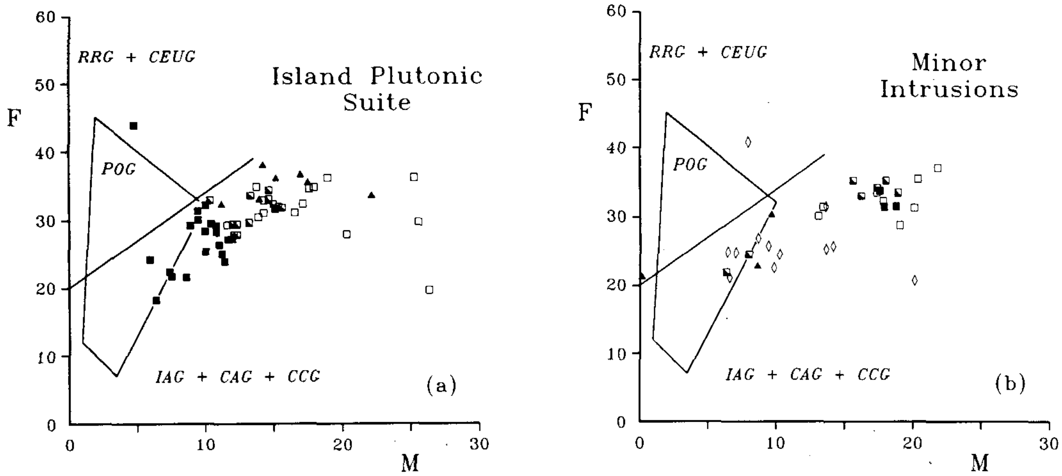

Figure 53. F-M diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO. Note that F and M, in this diagram, are the normalized values from plotting samples in the ternary (Al_2O_3 - Na_2O - K_2O)-(FeO*)-(MgO) diagram. Field labels as in Figure 51. Symbols as in Figure 42.

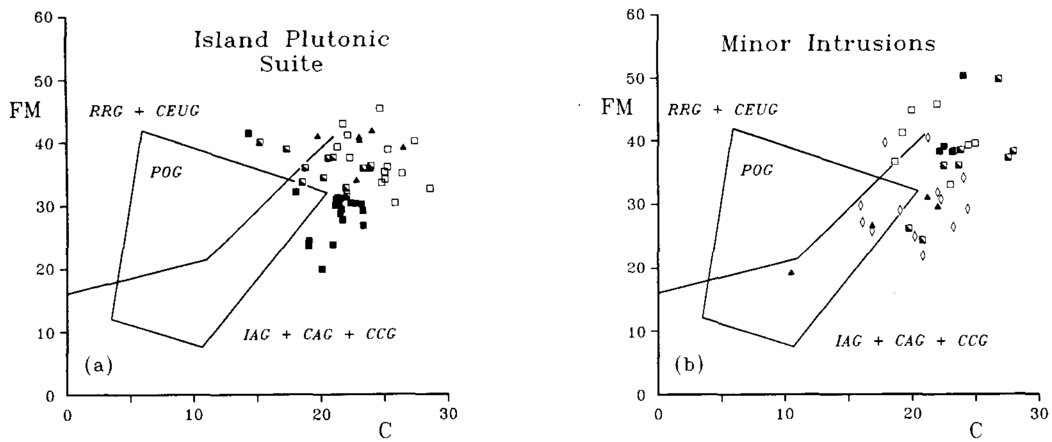

Figure 54. FM-C diagram for rocks of the Island Plutonic Suite and probably coeval minor intrusions; fields after Maniar and Piccoli (1989). F = total iron as FeO; M = MgO; C = CaO. Note that FM and C, in this diagram, are the normalized values from plotting samples in the ternary (Al_2O_3 - Na_2O - K_2O)-(FeO* + MgO)-(CaO) diagram. Field labels as in Figure 51. Symbols as in Figure 20.

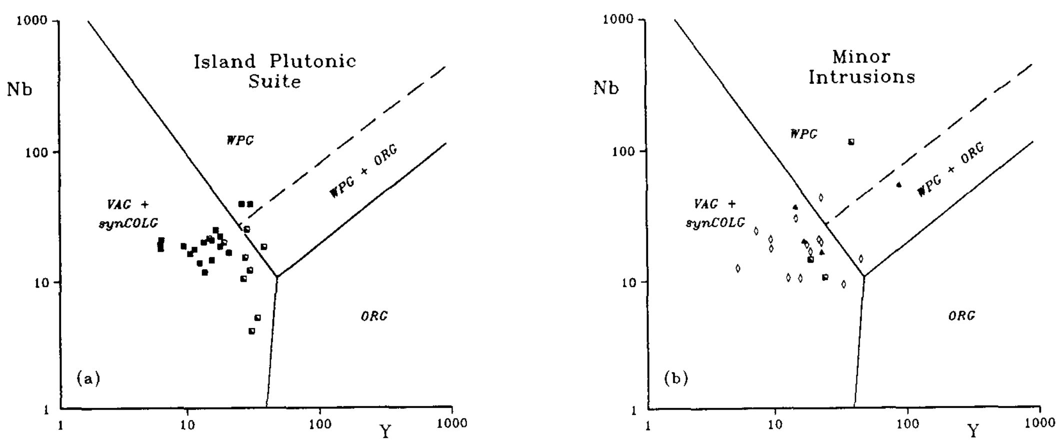

Figure 55. Nb-Y diagram for intermediate to felsic lithologies of the Island Plutonic Suite and probably coeval minor intrusions; fields fields after Pearce *et al.* (1984). VAG = volcanic-arc granites; synCOLG = syncollision granites; WPG = within-plate granites; ORG = ocean-ridge granites. Symbols as in Figure 42.

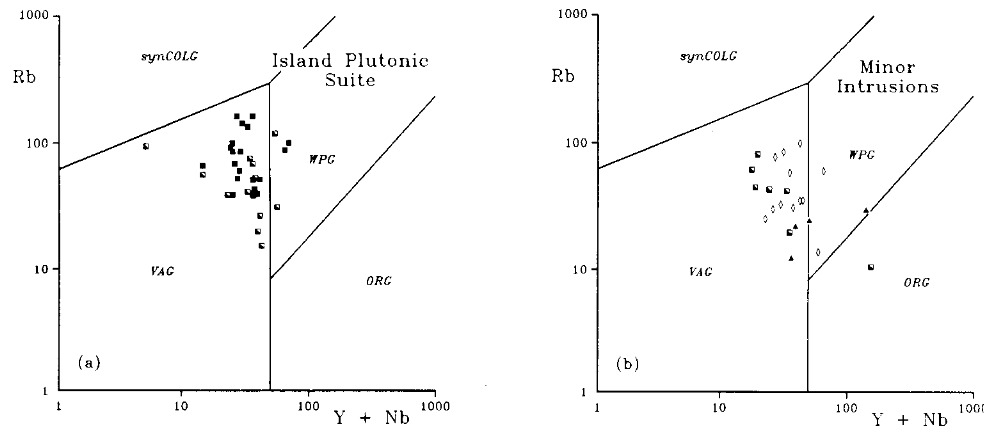

Figure 56. Rb-(Nb+ Y) diagram for intermediate to felsic lithologies of the Island Plutonic Suite and probably coeval minor intrusions; fields after Pearce *et al.* (1984), labelled as in Figure 55. Symbols as in Figure 42.

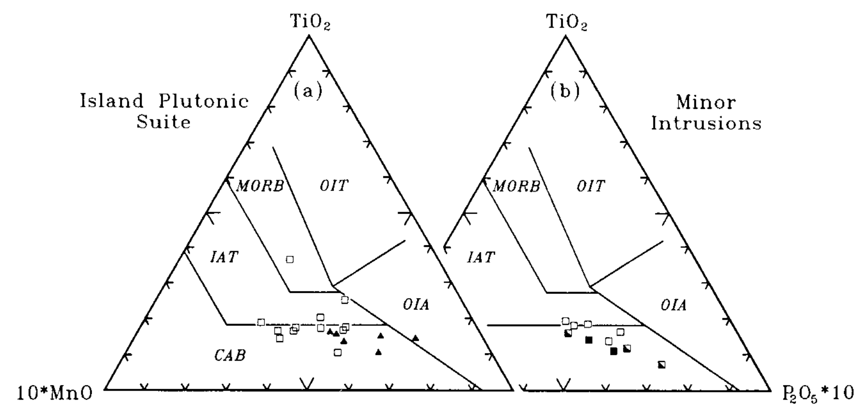

Figure 57. TiO_2-MnO-P_2O_5 diagrams for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Mullen (1983); CAB = calcalkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; OIT = ocean-island tholeiites; OIA = ocean-island alkalic basalts. Symbols as in Figure 9.

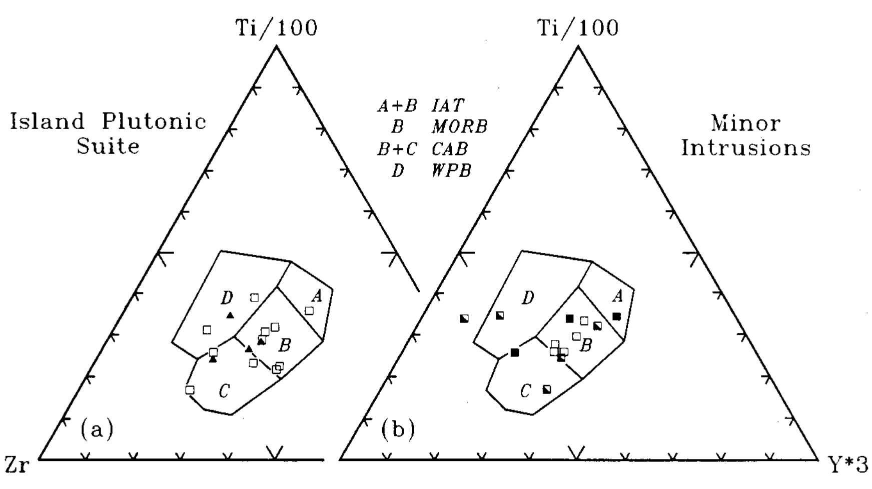

Figure 58. Ti-Zr-Y diagrams for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Pearce and Cann (1973); CAB = calcalkaline basalts; IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; WPB = within-plate basalts. Symbols as in Figure 42.

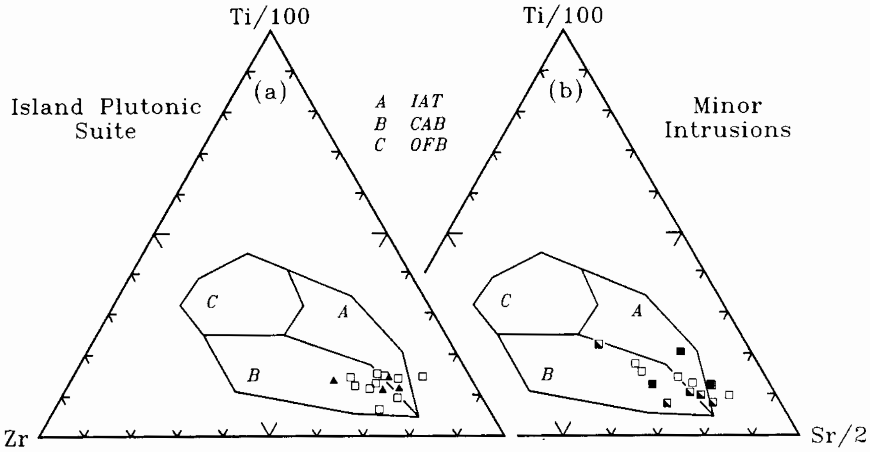

Figure 59. Ti-Zr-Sr diagrams for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Pearce and Cann (1973); CAB = calcalkaline basalts; IAT = island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 42.

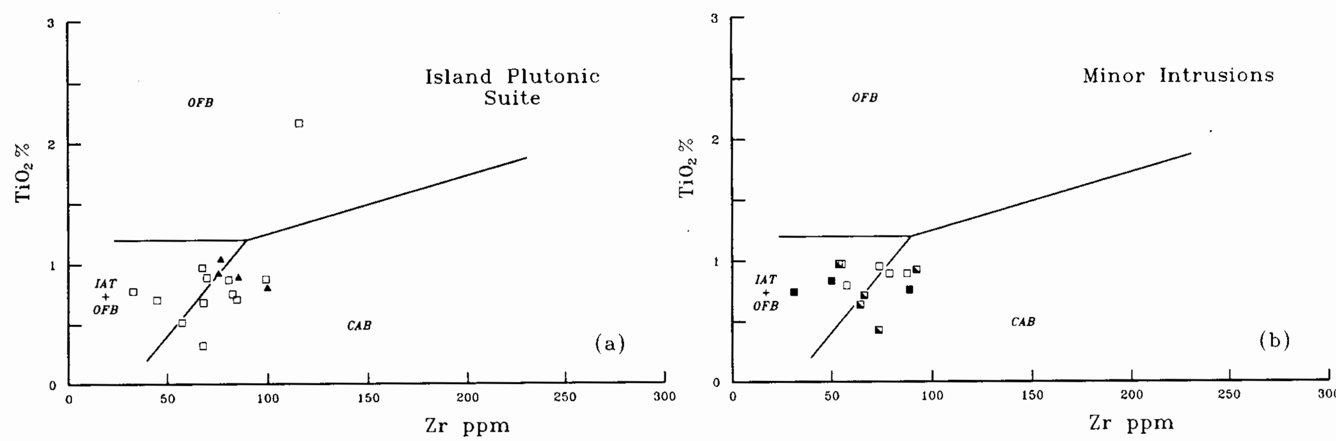

Figure 60. TiO_2-Zr diagrams for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Garcia (1978); CAB = calcalkaline basalts; IAT = island-arc tholeiites; OFB = ocean-floor basalts. Symbols as in Figure 42.

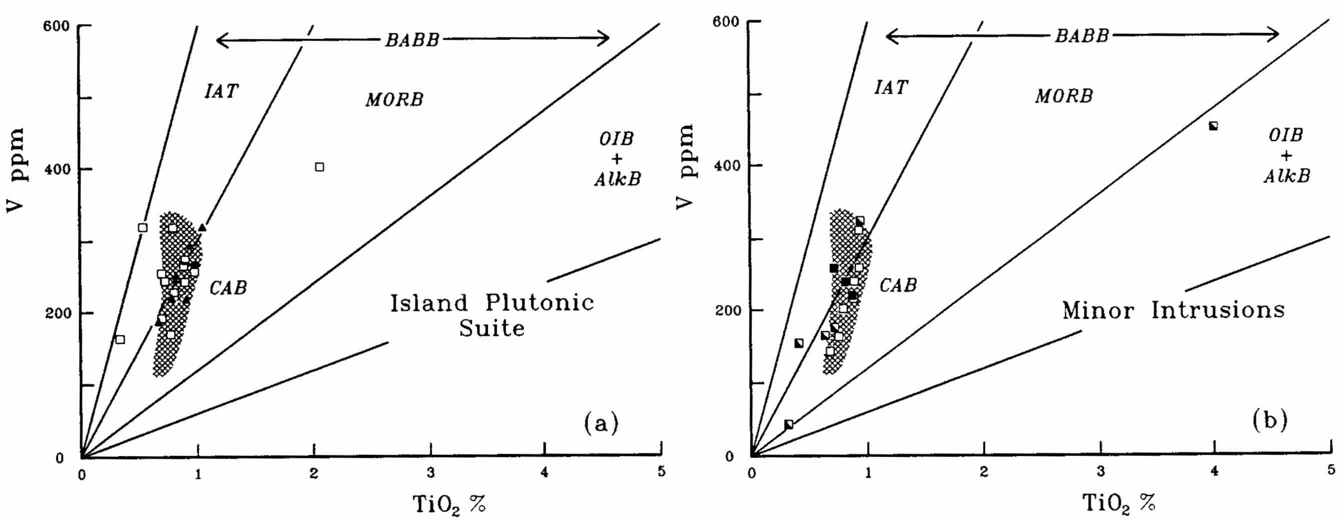

Figure 61. TiO_2-V diagrams for mafic lithologies of the Island Plutonic Suite and probably coeval minor intrusions. Fields after Shervais (1982); IAT = island-arc tholeiites; MORB = mid-ocean-ridge basalts; BABB = back-arc basin basalts; OIB = ocean-island basalt; AlkB = alkalic basalt. Shaded area labelled CAB is that occupied by typical calcalkaline basalts. Symbols as in Figure 42.

that the suite evolved from mafic compositions along a typical calcalkaline trend to the 5-kilobar eutectic (Figure 48). At lower pressures the melts cluster close to the trace of the isobaric minima. Major and trace-element discriminants show characteristics of a convergent-margin environment, for both the felsic and more mafic lithologies (Figures 50 to 61). Bonanza Group volcanics have very similar geochemical signatures and are probably consanguineous with the plutonic rocks (Massey, 1993a).

MINOR INTRUSIONS

A variety of dikes and small irregular intrusions occur throughout the area. Lithologically, they include intermediate feldspar porphyry, hornblende feldspar porphyry and minor diabase. They are probably coeval with the Island Plutonic Suite with which they are spatially related and geochemically indistinguishable (Plate 23, Figures 42 to 61). A hornblende andesite porphyry from Chipman Creek yielded a hornblende K-Ar age of 203± 7 Ma, slightly older than the 148 to 181 Ma range found for four hornblende porphyries in the Cowichan Lake area and the 145 to 184 Ma range reported for the Island Plutonic Suite (Armstrong *et al.*, 1986).

A suite of pale grey, fine-grained, aphyric dacite dikes of unknown age intrudes Fourth Lake Formation sediments and Triassic gabbro in the Sansum Narrows and Genoa Bay area. The areal extent of these dikes is uncertain as they are lithologically indistinguishable from dacites within the Sicker Group. Geochemically, they lack the negative niobium, phophorus and titanium anomalies in extended trace-element patterns of Jurassic felsic intrusions but are similarly calcalkaline with convergent-margin magmatic affinities (Figures 42 to 61).

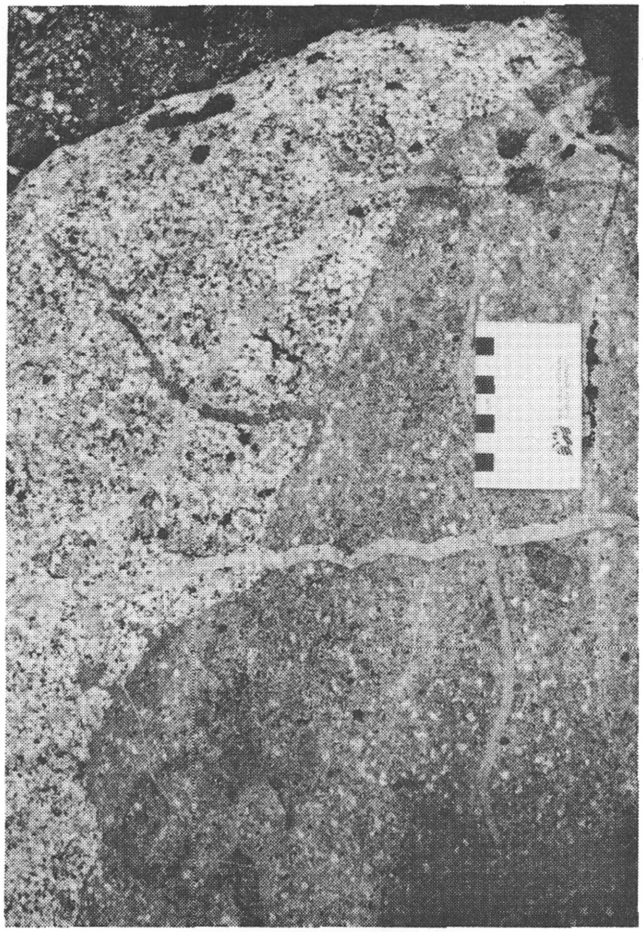

Plate 23. Hornblende biotite granodiorite intruded by darker coloured feldspar(-hornblende-biotite) porphyry, Ladysmith pluton, Island Plutonic Suite. Both are in turn cut by light-coloured aplite veins (Silver Lake; NMA87-34-05: 5417887N; 437505E).

STRUCTURE AND TECTONICS

Southern Vancouver Island has undergone a complex tectonic history with an alternation of major tectonic settings (Figure 2) and involving at least five major deformational events, which have often rejuvenated older structures. The present map pattern in the Duncan area is dominated by the effects of Eocene contraction, though older events are important in establishing relationships within individual thrust slices.

PHASE 1 - LATE DEVONIAN

Late Devonian to earliest Mississippian deformation produced large-scale open folds in the Sicker Group volcanics in the Cowichan Lake area and the southwestern part of the Duncan map area. Subsequent uplift and erosion are reflected in the unconformity below the Fourth Lake Formation along the southwestern limb of the Cowichan uplift. This deformation took place during the final stages of the Sicker arc.

PHASE 2 - MIDDLE PERMIAN - PRE-MIDDLE TRIASSIC

The second deformational event affected all Paleozoic rocks, producing a series of west-northwest-trending, southwest-verging, asymmetric folds with abundant parasitic minor folds. Major fold axes are often difficult to map in the field but can be interpreted from regional patterns and the results of exploration drilling programs. Overturning of beds is rarely observed.

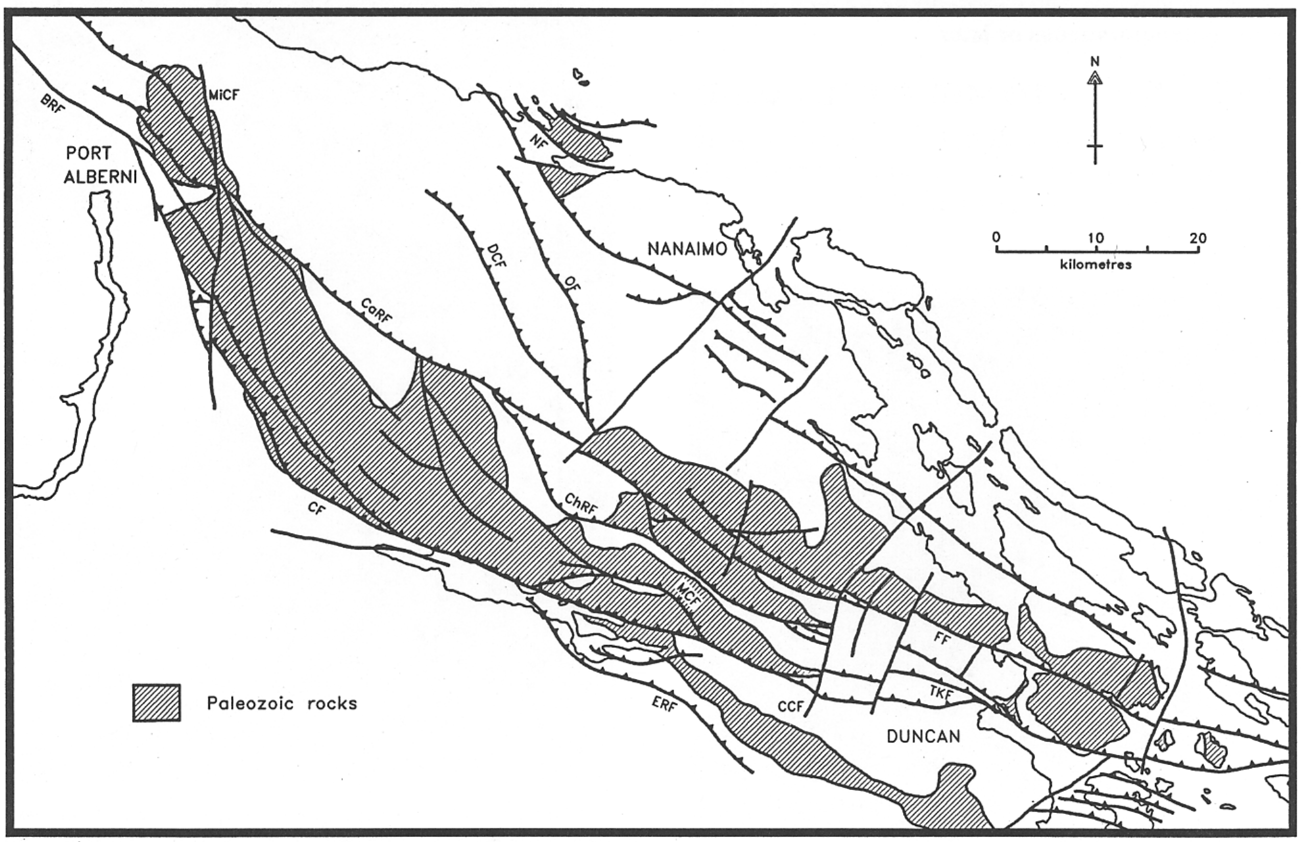

Figure 62. Major faults of the Cowichan fold and thrust system (after Massey and Friday, 1988; England and Calon, 1991). BRF= Beaufort Range fault; CF = Cowichan fault; CaRF = Cameron River fault; ChRF = Chemainus River fault; CCF = Copper Canyon fault; DCF = Dash Creek fault; ERF = East Robertson fault; FF = Fulford fault; MCF = Meade Creek fault; MiCF = Mineral Creek fault; NF = Nanoose fault; OF = Okay fault; TKF = Tzuhalem-Keppel fault.

Penetrative fabrics (schistosity in volcanics and cleavage in sediments) axial planar to the folds are well developed throughout most of the central part of the map area, north of the Chemainus River fault. They have moderate to steep northeasterly dips. Intense flattening normal to the foliation is observed in volcanic rocks, whereas Fourth Lake Formation sediments behaved more competently and lack flattening fabrics. Lineations due to bedding-foliation intersections and elongation of crystals and clasts are well developed. Plunges of the lineations are usually shallow, 5° to 15°, to the west-northwest or east-southeast. Regionally, however, the major folds plunge to the west-northwest. A crenulation cleavage is sporadically developed normal or slightly oblique to the axial schistosity in the more schistose volcanic rocks. This second foliation is particularly well developed in structural depressions and culminations marked by a change in azimuth of lineations and appears to be axial to broad open warps.

PHASE 3 - LATE TRIASSIC

Extensive crustal dilation accompanied the evolution of Karmutsen Formation lavas and intrusions of the Mount Hall gabbro. Structures specifically associated with this event have not yet been documented. Shear zones within gabbros, and especially along their margins, may be contemporaneous or later.

PHASE 4 - EARLY TO MIDDLE JURASSIC

Pre-Nanaimo Group deformation resulted in regional-scale warping of Vancouver Island, producing the three major geanticlinal uplifts cored by Sicker Group rocks (Figure 1), including the Cowichan uplift. Faulting, often axial, accompanied the folding and is best displayed south of Cowichan Lake (Massey, 1995a). Similar faulting is suspected north of the Cowichan River but has been obscured by reactivation during the Eocene event. Regionally, the plutons and stocks of the Middle Jurassic Island Plutonic Suite are often elongate parallel to the uplifts. However, they show little or no affects of the deformation themselves, suggesting the intrusions were syntectonic to postdeformation and deformation accompanied contraction during formation of the Bonanza arc. Uplift and erosion followed this deformational phase, establishing the pre-Nanaimo Group topography.

PHASE 5 - EOCENE

Large-scale west-northwesterly trending contractional faults of the Cowichan fold and thrust system (England and Calon, 1991) cut the map area into several slices (Figure 62). Three major fault zones are recognized

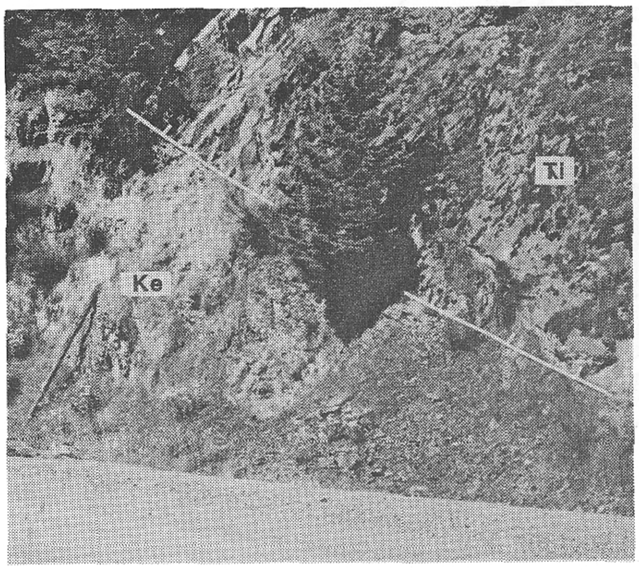

Plate 24. Imbricate thrust structurally beneath main Chemainus fault. Triassic gabbro (Tri) over Extension Formation sandstone and argillite (Ke) (Chemainus Main; NMA87-49-06: 5409680N; 434723E).

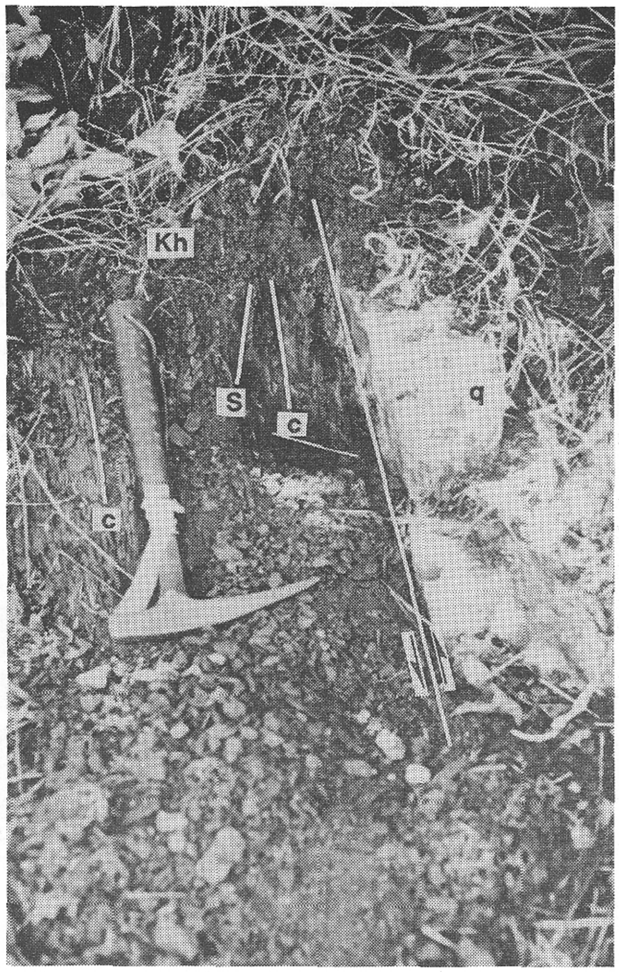

Plate 25. Fulford fault; quartz porphyry (q) of the Saltspring Intrusive Suite adjacent to Haslam Formation argillite (Kh). Note the well-developed c fabric and moderate s fabric indicate that motion on the fault was northside (*i.e.* quartz porphyry) up. The fault dips 80° northwards (Maple Bay; NMA87-45-10: 5407148N; 455307E).

within the area. The Fulford fault runs west-northwest from Maple Bay, between Mount Prevost and Big Sicker Mountain, across the southern slopes of Mount Brenton and along the western fork of Chipman Creek before continuing along the South Nanaimo river to join with the Cameron River fault. The Chemainus River fault divides into several splays in the Copper Canyon area. These splays have not been traced with any certainty to the east, though the southernmost one probably passes north of Duncan to join the Tzuhalem fault. The Cowichan fault lies beneath Quaternary cover, but is interpreted from seismic and other evidence (England and Calon, 1991) to pass eastwards into two major splays.

Where exposed, these faults are high-angle reverse faults (Plates 24 and 25) which dip between 45° and 90° to the north-northeast, paralleling the earlier axial foliation in Paleozoic rocks. They generally place older rocks over younger and become listric at midcrustal depths (Sutherland Brown and Yorath, 1985; England and Calon, 1991). Slip planes are relatively sharp and narrow, though wide schistose zones have formed in receptive lithologies. Mesoscale footwall folds and minor imbricate faults are developed along most of the thrusts, particularly where thicker sections of Nanaimo sediments occur in the footwall, as in the Mount Prevost area where a deformational zone up to 1.5 kilometres wide occurs beneath the Fulford fault. This deformational zone can be traced eastwards to Maple Bay and westwards to Solly Creek. Horizontal displacements along fault planes are unknown but are probably small, of the order of 1 to 10 kilometres. Vertical displacements are constrained by balanced sections to be about 1 to 2 kilometres (England and Calon, 1991). The regional map pattern suggests movement along the faults was directed to the west-southwest, although slickensides on fault planes indicate latest movement was horizontal and westerly directed.

The maximum age of faulting is bracketed by the involvement of Maastrichtian sediments of the Nanaimo Group in the Cowichan fold and thrust system and sandstones of the Eocene Chuckanut Formation (England *et al.*, 1992). However, in the Alberni area, the faults are intruded by Late Eocene porphyry dikes with an average age of 41 Ma (Massey, 1995b), which show only minor late-stage brittle fracturing. Apatites in footwall granodiorites and sediments in the Chemainus and Duncan area yield apparent fission-track ages ranging from 31± 3 Ma to 55± 7 Ma, averaging 42 Ma. Model ages for the apatite fission-tracks average 45± 5 Ma (England *et al.*, 1992). It is thus suspected that faulting took place during the Middle Eocene, possibly during crustal shortening accompanying the formation and accretion of the Pacific Rim and Crescent terranes to the south and west of the project area.

Several north-northeast-trending vertical cross-faults, such as the Copper Canyon fault, offset the thrusts with apparent sinistral sense. The age of faulting is unknown but it may be a late stage of the Eocene contractional event. However, similar northeast-striking transcurrent faults in the southern Coast Belt are early Miocene in age (Journeay and Csontos, 1989; Journeay, 1990), although these have dextral offsets.

METAMORPHISM AND ALTERATION

The metamorphic grade in the area is generally low, but increases with the age and structural position of the rocks. Nanaimo sediments are essentially unmetamorphosed, showing only diagenetic alteration of detrital iron oxides and calcareous cements. Karmutsen basalts show amygdule infillings and veins of chlorite, calcite, epidote and quartz, and alteration assemblages typical of the prehnite-pumpellyite facies. Triassic gabbros and diabases show only minor alteration of feldspar and pyroxene, except in chloritic shear zones.

Paleozoic rocks generally show greenschist facies assemblages, although the extent of alteration varies with structural position and lithology. The most altered rocks are found in the thrust slices overlying the Chemainus River and Fulford faults, although these are still typically greenschist facies. Felsic volcanics develop sericite, talc and chlorite along foliation planes and are interbedded with chlorite schists. Pervasive ankerite alteration is common in many schistose felsic rocks in the Chipman Creek - Mount Brenton area. Intermediate to mafic rocks have chloritic schistose matrixes with epidote and calcite alteration of feldspars. Lithic clasts in some tuffs and breccias may show partial to complete monomineralic replacement by epidote, particularly in the Mount Richards - Maple Mountain area (Plates 2 and 3). Volcanic rocks to the south of the Chemainus River fault and in the northeast are little altered and lack schistosity. Pyroxene basalts of the Nitinat Formation in the Banon Creek area show minor hydration and amygdaloidal infillings of chlorite, quartz and epidote. The typical thinly bedded sediments of the Fourth Lake Formation show very few affects of alteration except for diagenetic development of siliceous cement. Where involved in intense shearing, however, chlorite and sericite develop along foliation planes.

Stocks and plutons of the Island Plutonic Suite often have contact metamorphic aureoles developed around their perimeters. Porphyroblasts of chiastolite or biotite form in hornfelsed Fourth Lake sediments around several stocks and rhodonite forms in manganiferous cherts of the Shaw Creek member. Hornblende and pyroxene porphyroblasts are present in volcanic rocks adjacent to the Ladysmith pluton.

ECONOMIC GEOLOGY

HISTORY OF EXPLORATION

Exploitation of the mineral resources of the Duncan area has been undertaken since the late nineteenth century, though originally restricted to nonmetallic deposits. The turn of the century saw commencement of exploration for gold and base metals, particularly in the Chemainus River and Copper Canyon areas. Production was limited, except for the three mines on Mount Sicker (Leonora, Tyee and Richard III), the foci for one of the largest townsites in the area at that time. A lull in activity occurred between the World Wars and all mine production ceased. The Twin J (Lenora) mine on Mount Sicker was returned to production from 1943 to 1947. Over the next 30 years only sporadic exploration activity took place in the area for gold, base metals, manganese and iron ore. No production resulted. The present cycle of exploration followed the discovery of the H-W polymetallic massive sulphide orebody at Buttle Lake in 1979. Nearly all areas of Paleozoic outcrop in the Duncan area have since been staked and numerous exploration targets defined by mining companies and local prospectors. Extensive drilling has been carried out on many properties and approximately 600 metres of exploration underground workings were developed by Abermin Corporation on the Coronation zone of the Lara property in 1988.

CLASSIFICATION OF DEPOSITS

A variety of mineral deposit are present in the Duncan area:-

VOLCANOGENIC, POLYMETALLIC MASSIVE SULPHIDES AND EXHALATIVE OXIDES

Polymetallic massive sulphide deposits have been the principal exploration target in the Sicker Group rocks following the success of exploration at Westmin Resources Limited's Buttle Lake mine. The massive sulphides are hosted by the felsic volcanic tuffs of the McLaughlin Ridge Formation and restricted to a belt running from Chipman Creek to Mount Richards, in the hangingwall of the Fulford fault. Major occurrences are

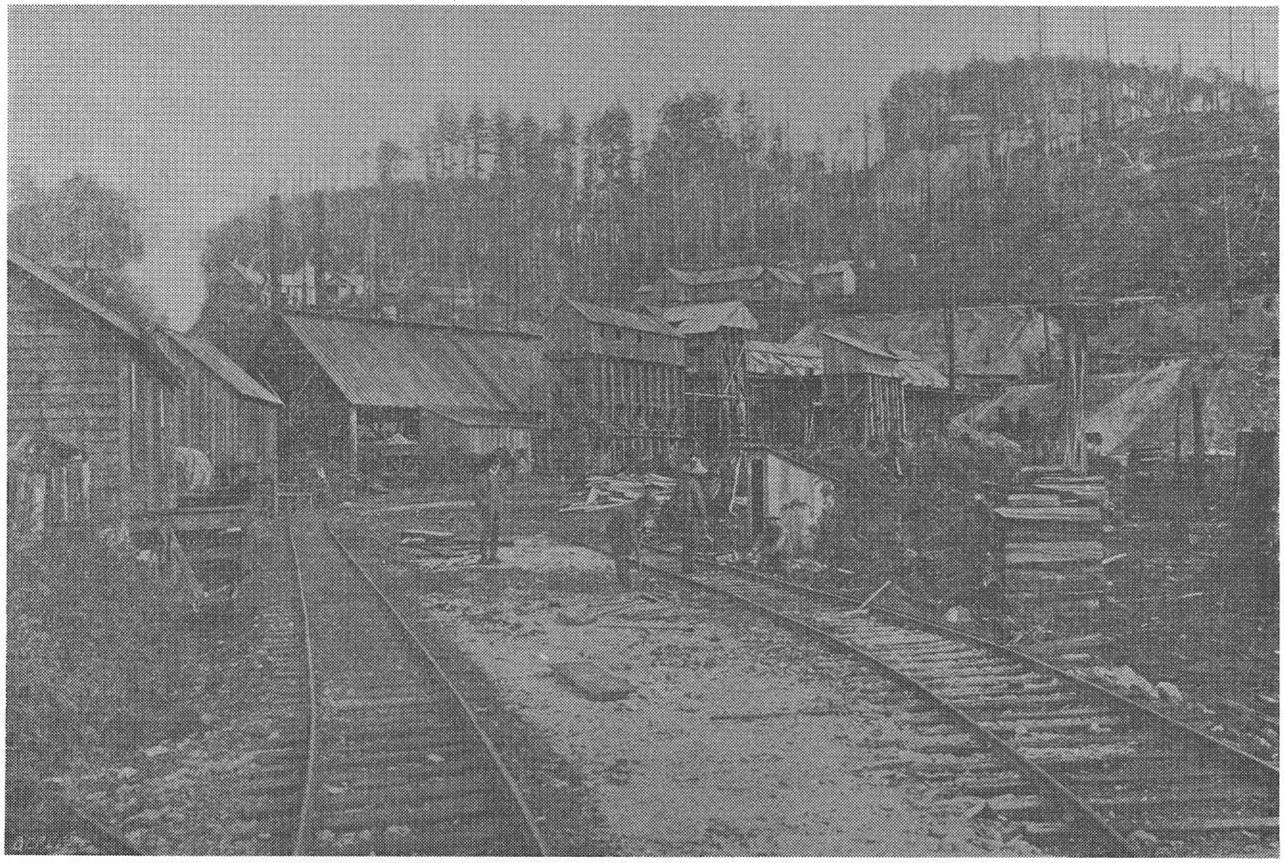

Plate 26. View of upper terminus of the Lenora, Mt. Sicker Railway on Mount Sicker. The ore bins, dump and buildings of the Lenora mine can be seen in the background. The Tyee mine appears up the hill to the right (Provincial Archives photograph HP58002).

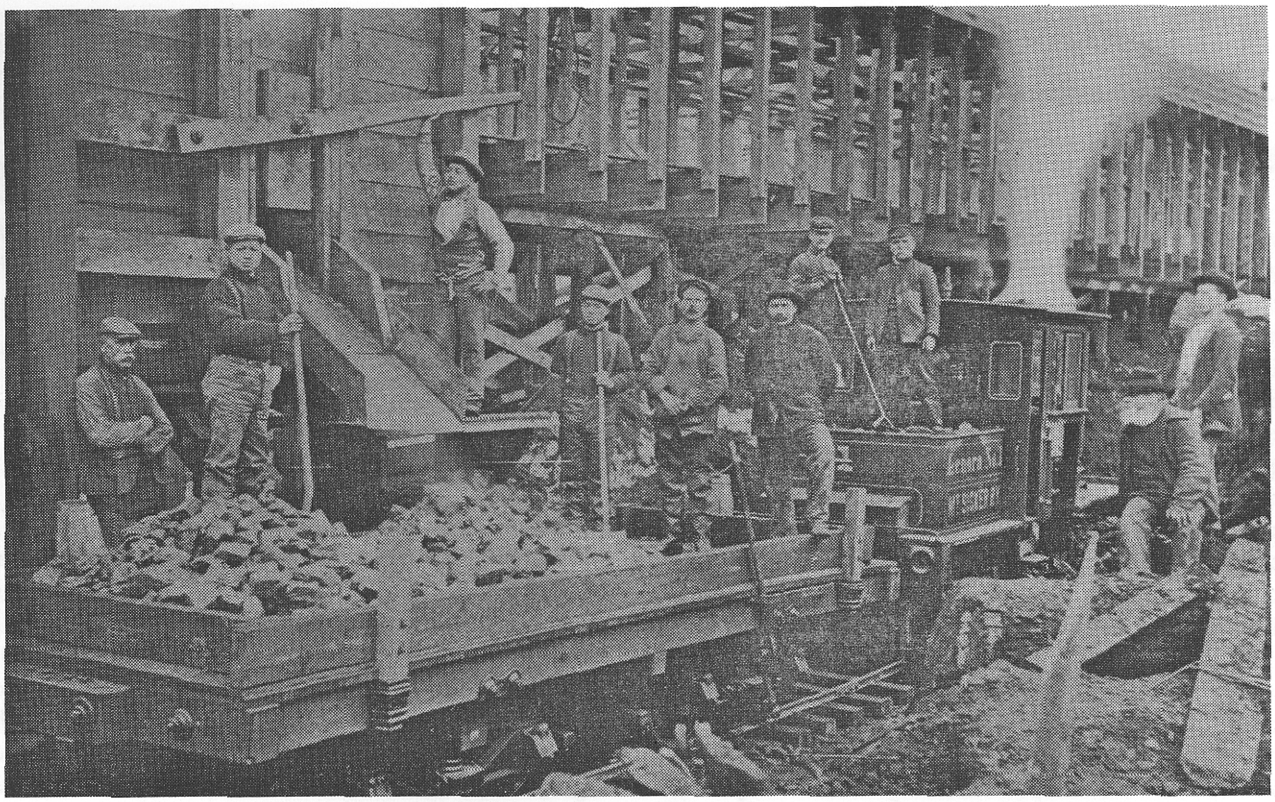

Plate 27. Lenora, No. 1 and ore bins at the Lenora mine, Mount Sicker (Provincial Archives photograph HP 56591).

Plate 28. Massive sulphides of the Coronation zone exposed in trench on the Lara property (NMA87-28-01: 5414699N; 433574E). Photograph courtesy of H.P. Wilton. Results of the sampling taking place in the photograph are compiled in Appendix 2.

found on the Mount Sicker and Lara properties. Sulphides have also been reported from southern Saltspring Island in the footwall of the Fulford fault.

On Mount Sicker, massive sulphides were discovered in 1898 and production was achieved from four mines (Leonora, Tyee, Richard III and Victoria) until 1909 (Plates 26 and 27). Further production ensued from the consolidated property operated by Twin J Mines Limited from 1943-47. Minor production also occurred in 1951. In total, 277 408 tonnes of ore has been produced yielding 9 192 550 kilograms of copper, 20 847 570 kilograms of zinc, 1 245 756 grams of gold and 26 166 611 grams of silver (Eastwood, 1979). Lead and cadmium were also recovered from the ore. At the time of writing the combined property is presently under exploration by Minnova Inc. (formerly Corporation Falconbridge Copper). Baritic laminated sulphides form two orebodies located within a distinctive, thinly bedded package of intercalated siliceous argillaceous sediments and tuffs up to 70 metres thick. The local stratigraphy is, however, disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusion of two thick, Late Triassic gabbro sills.

Exploration by Abermin Corporation on the Lara property started in 1981, continuing from late 1988 under the auspices of Minnova Inc. Volcanic rocks of the McLaughlin Ridge Formation in the northern part of the property are thrust over a panel of Fourth Lake Formation sediments, Late Triassic gabbros and Nanaimo Group sediments to the south. The volcanic package contains a lower felsic tuff, a middle andesitic crystal-lapilli tuff and an upper felsic crystal tuff. Boundaries between these units are probably structural rather than stratigraphic. Significant mineralization is hosted by the lower felsic tuff at two, possibly three, stratigraphic levels, of which the Coronation zone is the most promising (Plate 28). Mineralization consists of disseminated and bedded pyrite-sphalerite-chalcopyrite-galena within quartz crystal tuffs. Silica and carbonate are the principal gangue minerals, barite is lacking. The Coronation zone has been delineated by drilling for about 2 kilometres along strike, with intersections up to 14 metres wide and averaging 6 metres. Low-grade sphalerite-pyrite-chalcopyrite mineralization is also found in the upper felsic crystal tuffs in which carbonate alteration is widespread.

Other massive sulphide showings have been reported in the Chipman Creek area (the Anita, MINFILE number 092B 037), in Copper Canyon (Sharon, 040; Copper Canyon, 086) and on Mount Richards (Yreka, 038; Jane (New Ironclad), 049).

Iron oxide bearing jasper and chert occur at many stratigraphic levels within the Sicker Group, principally associated with the Nitinat Formation in the Banon Creek area (for example Utah Mines Limited JRM property) and the McLaughlin Ridge Formation in the Chipman Creek - Rheinhart Creek area (for example Lady A [029] and the Trek property). The jasper deposits consist of laminated hematite and magnetite in red or grey chert. Several deposits were investigated in the 1950s for taconite iron ore but found to be too small to be economic. Jasper beds are also found within the Fourth Lake Formation, often associated with manganese deposits, but also alone. Recent exploration has concentrated on the gold potential of the volcanic-hosted jaspers.

Manganese Deposits

Manganese minerals have been reported in several places as fracture coatings or lenticular masses in the cherts of the Shaw Creek member of the Fourth Lake Formation along the southwest margin of the Cowichan uplift. Rhodonite is the principal manganese mineral; manganese garnets, rhodochrosite, pyrolusite and manganite have also been reported. All occurrences are in the aureoles of Jurassic granodiorite intrusions and owe their origin to the contact metamorphism of manganiferous sediments and associated ribbon chert. The protolith manganiferous sediment may have been of an exhalative origin (Cowley, 1979; Danner and Cowley, 1980). However, contemporaneous volcanic rocks are apparently restricted in volume, occurring only on the northeast side of the Cowichan uplift and being absent in the immediate area of the manganese deposits. A low-temperature hydrogenous origin may be more likely. Oxidized deposits near Hill 60 were worked for manganese ore in 1919-20 producing 1013.1 tonnes (1117 tons) of ore yielding 1 058 679 kilograms of manganese (MINFILE, 1990). This and several other deposits in the Cowichan valley were further investigated during the Second World War as a source of manganese for the munitions industry, but proved to be too small and lean. The main potential for these deposits lies in the production of rhodonite for lapidary uses.

Copper-Molybdenum Quartz Veins and Skarn

Sulphide-bearing quartz veins occur in granodiorite and adjacent country rock on several properties in the Cowichan Lake area but are rarely reported from the Duncan area. However, chalcopyrite-pyrite veining is reported in Nitinat Formation tuffs at the RJ occurrence near Holland Lake, and a chalcopyrite-molybdenite-pyrrhotite-bearing skarn breccia is reported in a drill hole on the ANT property on Chipman Creek. Both of these occurrences are adjacent to the Ladysmith pluton, as is the Coronation showing described by Clapp and Cooke (1917).

Gold-Bearing Pyrite-Chalcopyrite-Quartz-Carbonate Veins Along Shears

Many of the faults and shears cutting the Sicker Group and Late Triassic gabbros are veined by rusty weathering quartz-carbonate. The age of the veining is

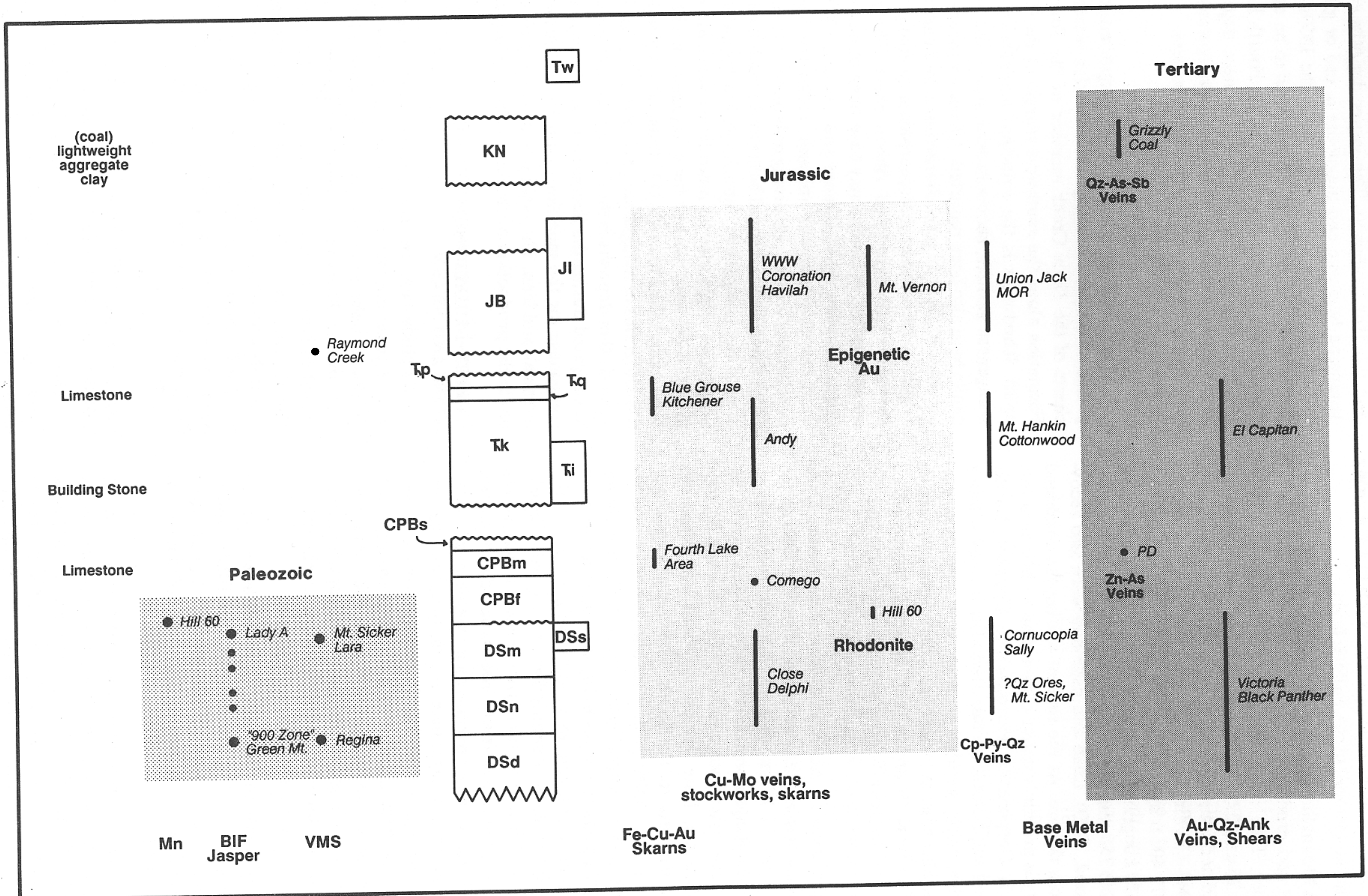

Figure 63. Stratigraphic distribution of mineral deposits in the Cowichan uplift. Stratigraphic column is diagrammatic and not to scale. Syngenetic deposits are illustrated to the left of the stratigraphic column and epigenetic deposits to the right. Shaded blocks indicate the three major metallogenic episodes.

uncertain, several events being suspected. Some veins are localized along the Tertiary thrusts and crossfaults, but others may represent older structures and mineralizing events. The veins are variable in lateral extent, and range up to about 1 metre wide, although quartz-carbonate alteration along some faults may be several metres wide. Commonly reported sulphides are pyrite, pyrrhotite, chalcopyrite and arsenopyrite. The carbonate is principally ankerite and calcite. Carbonate appears to be less common to the east. Though numerous veins have been investigated in the past, none have yet proven economic in the Duncan area.

Other Deposits

Various nonmetallic deposits have been exploited in the Duncan area, particularly Quaternary clays for brick-making and gravels for aggregate. Subeconomic concentrations of mica, talc, diatomite, limestone and limonite have been reported in the area.

Regional Metallogeny

Mineralization in southern Vancouver Island has resulted from three major metallogenic episodes, one of syngenetic character, the other two epigenetic (Figure 63). The localization of metal deposits is controlled by the interplay of stratigraphy and spatial association with later intrusions and structures.

The first major metallogenic episode took place in the Paleozoic during the development of the Sicker arc. Significant syngenetic metal mineralization is associated with these volcanic rocks. Polymetallic, volcanogenic massive sulphides are restricted to two major stratigraphic units. The most important, both for past production and present exploration, is the McLaughlin Ridge Formation in which Kuroko-style massive sulphides are associated with felsic volcanics in the upper part of the sequence. They occur in a belt extending from Saltspring Island to Rheinhart Creek, bounded to the south by the Fulford fault and appear to have formed close to the volcanic centre located in the Duncan - Saltspring Island area. Exhalites are also found in the uppermost Duck Lake Formation, associated with the initial stages of arc development. These are dominantly oxide facies although sulphides are present in some areas, for example the Regina property in the China Creek area south of Port Alberni. The oxide facies deposits themselves may be of some importance for their gold content, particularly where cut by later structures that may have enhanced the grade, as in the 900 zone of the Debbie property, Port Alberni area. This is somewhat analogous to the gold/iron formation association common in many Archean greenstone belts. However, within the map area, the Duck Lake Formation only oucrops south of the Cowichan River but may be more extensive in the Koksilah Range further to the south. Other jasper and oxide-rich cherts occur within the Nitinat and McLaughlin Ridge formations but appear to have negligible economic mineralization. The final phase of mineralization during this episode was the development of thin manganese beds and sulphidic argillites within the ribbon cherts of the Shaw Creek member.

The second major metallogenic episode took place during the Early Jurassic, again within an island-arc setting. Unlike the Paleozoic, however, this episode was characterized by epigenetic mineralization of various types and styles, spatially related to intrusions of the Island Plutonic Suite. Copper-molybdenum veins and stockworks occur both within intrusions and surrounding volcanic country rocks of either Paleozoic or Mesozoic age (Figure 63). Other deposits show stronger stratigraphic control. Iron-copper-gold skarns are developed in calcareous tuffs and limestones of the Karmutsen and Quatsino formations intruded by feldspar porphyry dikes or granodiorite bodies. Limestones of the Buttle Lake Group are rarely skarned, with the exception of small showings north of Fourth Lake (Massey, 1993b) and the copper-molybdenum skarns of the Comego property (Massey, 1995a). Rhodonite development is restricted to areas where manganiferous cherts of the Shaw Creek member are metamorphosed in the aureoles of granodiorite intrusions.

Metallogeny in the Tertiary differs significantly from the other two episodes. It took place in a contractional fore-arc setting with only limited associated magmatism. Mesothermal gold-bearing quartz-carbonate veins and alteration are common along the major west-northwest-trending contractional faults and crosscutting north-south faults. They are also hosted in older structures. Carbonate alteration varies along the Cowichan uplift, tending to die out to the east and be essentially absent in much of the Duncan area. The controls on the extent of alteration along faults and the deposition of gold within the zones is still poorly understood.

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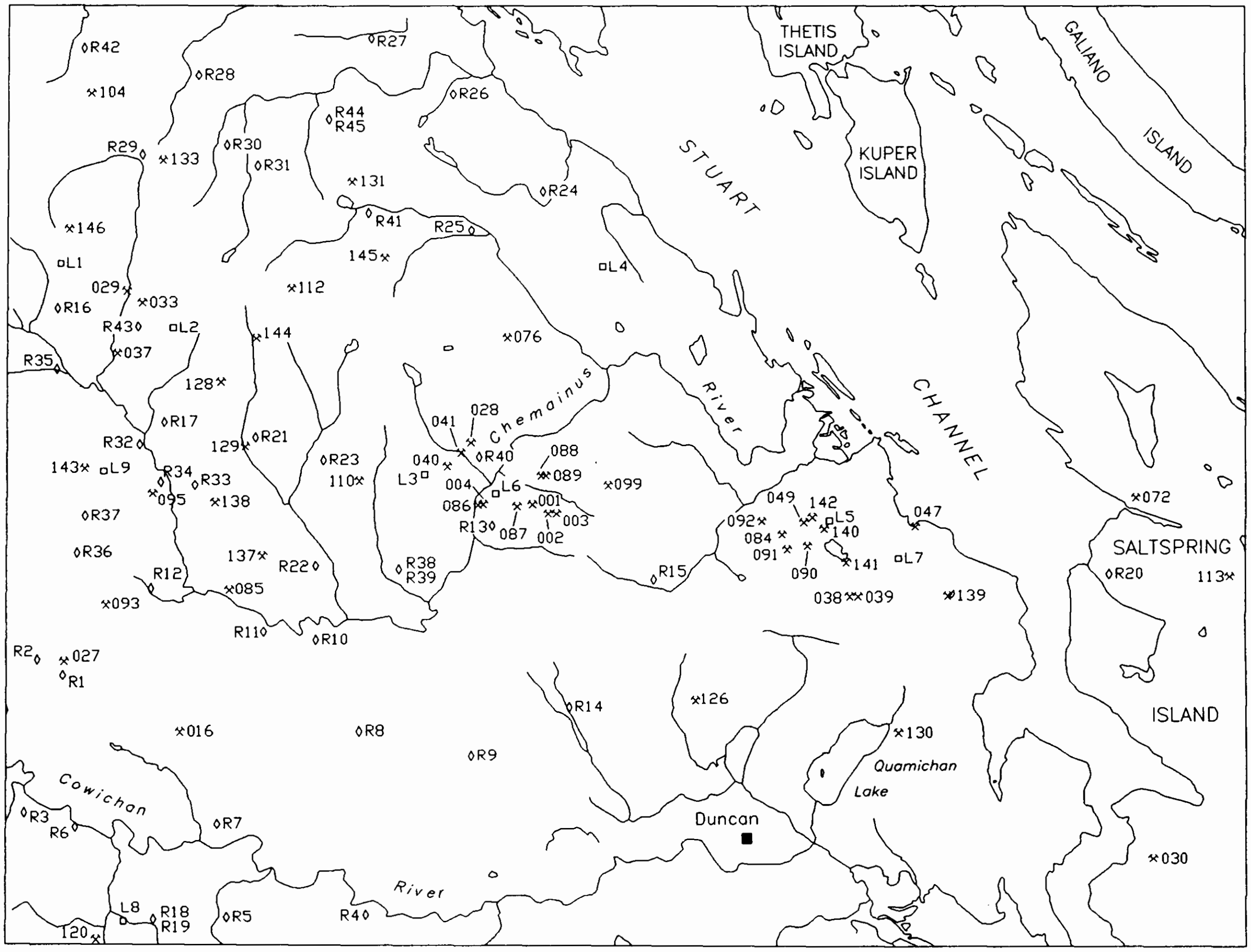
APPENDICES

APPENDIX 1

TABULATED MINFILE, LITHOGEOCHEMICAL ASSAY, AND RGS SAMPLE DATA



MINFILE (A1-1, Appendix 2) .... ✕

RGS samples (A1-3) .... ◊

Lithogeochemical assay samples (A1-2) .... ◻

APPENDIX 1 - TABLE 1
MAPPED OCCURRENCES IN THE DUNCAN MAP AREA

PROPERTY NAME	MINFILE NUMBER	STATUS	COMMODITIES
I Vocanogenic massive sulphides and exhalative oxides:			
(a) Mount Sicker - Copper Canyon			
LENORA (L.35G)	001	PAST PRODUCER	Cu, Au, Ag, Pb, Zn, Cd, Ba
TYEE (L.36G)	002	PAST PRODUCER	Cu, Au, Ag, Zn, Pb, Cd, Ba
RICHARD III (L.39G)	003	PAST PRODUCER	Cu, Au, Ag, Pb, Zn, Cd, Ba
VICTORIA (L.21G)	004	PAST PRODUCER	Cu, Au, Ag
SHARON COPPER	040	PROSPECT	Cu
WATER POWER-BRENTON	041	SHOWING	Cu, Ag
(b) ANITA	037	SHOWING	Cu, Pb, Zn, Ag, Au
(c) Lara			
RANDY NORTH	128	SHOWING	Zn, Cu, Pb, Ag, Au
LARA (Coronation Zone)	129	DEVELOPED PROSPECT	Au, Ag, Zn, Pb, Cu
HOPE	110	SHOWING	Au, Ag, Zn, Cu, Pb
(d) JANE	084	PROSPECT	Zn, Cu
(e) Chipman Creek			
LADY A (A ZONE)	029	DEVELOPED PROSPECT	Fe, Ma
LADY A (C ZONE)	033	PROSPECT	Fe, Ma
LADY B	146	SHOWING	Fe
(f) Mt Brenton - Coronation Mt			
LADY D	076	SHOWING	Fe, Ma, Au, Ag, Cu
ORN 3	112	SHOWING	Ma, Cu, Ag, Au, Pd
LADY C	145	SHOWING	Fe
(g) MESABI	030	SHOWING	Fe, Ma
(h) COW 10	143	SHOWING	Fe
II Copper- and gold-bearing veins along shears:			
(a) Mount Sicker			
COPPER CANYON (L.22G)	086	SHOWING	Cu
KEY CITY (L.37G)	087	PROSPECT	Cu
QUEEN BEE (L.100G)	088	SHOWING	Cu, Zn, Au
BELLE (L.55G)	089	SHOWING	Cu
BREEN LAKE	090	SHOWING	Cu, Zn
NORTHEAST COPPER ZONE	099	SHOWING	Cu, Ag
(b) Mount Richards			
CORNUCOPIA	038	PAST PRODUCER	Au, Ag, Cu
YREKA	039	SHOWING	Cu, Au, Ag
IRONCLAD	049	SHOWING	Cu, Talc
LUCKY STRIKE	091	SHOWING	Cu
SALLY 2	092	SHOWING	Cu
QUARRY	140	SHOWING	Cu
WEST 2	141	SHOWING	Cu
(c) ORN 1	144	SHOWING	Cu, Ag
III Copper-molybdenite veins and skarns			
(a) CORONATION MOUNTAIN	104	SHOWING	Cu, Mo
(b) BJ	131	SHOWING	Cu
(c) VV	133	SHOWING	Cu, Mo
IV Other base-metal veins, etc.			
POLY	138	SHOWING	Cu
MAPLE MOUNTAIN	139	SHOWING	Cu
TIDAL WAVE	142	SHOWING	Cu
V Manganese-rhodonite deposits:			
(a) Hill 60 Ridge			
MELORE	016	SHOWING	Ro, Mn
HILL 60	027	PAST PRODUCER	Mn, Ro, Gs, Cu
MYRA	093	SHOWING	Ro, Mn
(b) Chipman Creek			
NEVER SWEAT	095	SHOWING	Ro, Mn
POLY 2	137	SHOWING	Mn, Ro
VI Industrial Minerals			
ROSE	028	SHOWING	Mica, Sericite
CROFTON SLAG	047	PAST PRODUCER	Aggregate
BOOTH BAY	072	PAST PRODUCER	Sandstone, Building stone
RBGAL	085	SHOWING	Expanded shale
SALT SPRING ISLAND	113	SHOWING	Expanded shale
SKUTZ FALLS	120	SHOWING	Limestone
DUNCAN CLAY	126	PAST PRODUCER	Clay
QUAMICHAN LAKE	130	SHOWING	Diatomite

Commodities:

Ag: Silver
Au: Gold
Ba: Barite
Cd: Cadmium
Cu: Copper
Fe: Iron
Ma: Magnetite
Mn: Manganese
Mo: Molybdenum
Pb: Lead
Ro: Rhodonite
Zn: Zinc

APPENDIX 1 - TABLE 2
LITHOGEOCHEMICAL ASSAY SAMPLES FROM THE DUNCAN MAP AREA

MAP NUMBER	SAMPLE NUMBER	EASTING	NORTHING	MINZ/ALT*	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Co ppm	Ni ppm	Mo ppm	Cr ppm	Hg ppb	As ppm	Sb ppm	Ba ppm	Sr ppm
L1	NMA87-15-16-1	428244	5419941	SU/GO	<20	<0.5	44	4	89	30	12	<10	nd	<10	4	<0.5	nd	nd
L2	NMA87-23-10-1	431568	5417999	SU/GO	70	0.5	270	25	66	14	6	30	nd	<10	3	<0.5	nd	nd
L3	NMA87-26-02-3	438939	5413579	SU	80	<0.5	19	15	20	24	<5	18	nd	100	21	1	nd	nd
L4	NMA87-33-07-1	444259	5419689	SU/SI	100	0.7	51	50	0.45%	44	10	13	nd	175	45	0.5	nd	nd
L5	NMA87-43-01-2	450916	5412102	SU/SI	20	<0.5	105	10	45	33	14	28	nd	<10	40	0.9	nd	nd
L6	SFR87-27-05-1	441035	5412997	IF	100	<0.5	72	33	30	20	<5	230	nd	431	138	2	nd	nd
L7	SFR87-44-02-1	452959	5410967	SZ	<20	<0.5	3	5	32	19	<5	<10	nd	119	63	<0.5	nd	nd
L8	SFR87-56-07-1	429935	5400435	SZ	<20	<0.5	12	11	29	27	16	<10	nd	62	25	12	nd	nd
L9	PTE87-13-11-1	429477	5413762	SU	<20	<0.5	280	11	83	36	44	<10	nd	20	51	<0.5	nd	nd

* **Mineralization/ alteration codes:**
GO Gossan or rusty weathering
IF Iron formation
SI Silicification

nd: not determined
<20: below indicated detection limit

ANALYTICAL PROCEDURES FOR LITHOGEOCHEMISTRY

Analysis performed by B.C. Geological Survey - Analytical Sciences Laboratory

1. GOLD (Au)
Fire Assay/Atomic Absorption A 0.5 Assay Ton (approx. 15 gram) sample weight is subjected to a standard fire assay technique to generate a Au/Ag bead. The bead is dissolved in acid and Au is measured to a detection limit of <20 ppb by atomic absorption analysis.

2. SILVER AND BASE METALS (Ag, Cu, Pb, Zn, Co, Mo, Ni)*
Atomic Absorption Samples are digested using a mixed acid attack which includes HF. The dilute acid solution is further diluted to a specific volume and the elements are measured using AAS.

3. MERCURY (Hg)
Cold Vapour/Atomic Absorption A 0.1 g to 1 g sample is subjected to a HCl and HNO_3 digestion followed by the generation of Hg vapour using $SnCl_2$ as a reducing agent. The vapour is swept through a cell in the AAS light path and measured.

4. ELEMENTS As AND Sb
Hydride Generation A 1 g sample is digested using a mixture of HCl and HNO_3; a portion of the diluted sample solution is treated with $NaBH_4$ and the liberated hydride compound is swept into a hot cell in the light path of the AAS unit. The hydride decomposes to give a vapour of the element which is measured.

5. OTHER ELEMENTS (Sr, Ba, Cr)
X-Ray Fluorescence An approximately 4 gram pulverized sample is mixed with boric oxide and a fusion-flux (lithium tetraborate and lithium metaborate) and fused at 1150°C until completely dissolved in a platinum crucible. The resulting fused disk is then subjected to the x-ray fluorescence spectrometer.

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* - As samples are crushed using tungsten carbide equipment inevitable contamination of Co may occur.

APPENDIX 1 - TABLE 3
REGIONAL GEOCHEMICAL SURVEY MOSS-MAT STREAM SEDIMENT SAMPLES FROM THE DUNCAN MAP AREA

MAP NUMBER	RGS ID	EASTING	NORTHING	FORM**	Au1 ppb	Au2 ppb	Sb ppm	As ppm	Bi ppm	Cd ppm	Cr ppm	Co ppm	Cu ppm	F ppm	Fe %	Pb ppm	Mn ppm	Hg ppm	Mo ppm	Ni ppm	Ag ppm	Sn ppm	W ppm	U ppm	V ppm	Zn ppm	LOI %	F# ppb	U# ppb	pH#
R1	891002	428202	5407759	MJgd	24	0	2.5	140	0.3	0.3	53	14	70	220	4.44	15	1180	135	3	20	0.1	1	1	2.0	56	83	12.2	nd	nd	nd
R2	891003	427446	5408221	MJgd	2	0	0.1	2	0.1	0.2	44	6	12	140	1.82	4	433	59	2	5	0.1	1	1	4.2	32	40	10.1	74	0.02	7.1
R3	891004	426996	5403715	uKN	41	0	0.8	7	0.1	0.3	110	19	71	160	3.74	3	684	150	2	30	0.1	1	2	1.1	97	71	10.0	24	0.02	7.4
R4	891086	437091	5400562	uKN	1	0	0.4	6	0.1	0.2	78	6	18	160	2.10	2	285	60	2	17	0.1	1	1	1.2	39	36	8.6	38	0.02	7.0
R5	891087	432992	5400527	uKN	4	0	0.3	2	0.1	0.1	96	10	31	150	2.09	1	396	62	3	19	0.1	1	1	3.1	48	37	4.4	30	0.02	7.0
R6	891088	428521	5403266	uKN	3	0	0.4	3	0.1	0.2	102	17	76	150	3.46	3	526	115	2	27	0.1	1	1	0.5	75	49	17.4	26	0.02	7.2
R7	891089	432735	5403318	Cs	2	0	0.2	3	0.1	0.1	95	12	27	130	2.73	1	1400	63	2	18	0.1	1	1	1.3	59	69	8.2	28	0.02	6.5
R8	891090	436942	5406029	uKN	1	0	0.5	7	0.3	0.2	80	13	27	180	3.25	7	676	82	3	35	0.1	1	1	1.4	46	70	8.0	nd	nd	nd
R9	891091	440242	5405271	uKN	2	0	0.3	2	0.1	0.2	72	9	17	160	2.46	4	810	71	2	19	0.1	1	1	1.2	41	44	13.4	42	0.02	6.6
R10	891092	435687	5408729	Cs	3	0	0.3	4	0.1	0.1	74	11	27	190	2.35	2	673	57	2	26	0.1	1	2	1.4	43	45	9.6	30	0.02	6.6
R11	891093	434157	5408982	uKN	3	0	0.2	2	0.1	0.1	79	13	27	180	2.22	2	533	53	1	23	0.1	1	2	1.4	45	51	9.0	30	0.02	6.5
R12	891095	430851	5410285	uKN	25	0	0.3	4	0.2	0.1	75	12	33	300	2.74	3	591	65	2	19	0.1	1	1	1.4	51	46	16.0	nd	nd	nd
R13	891096	440917	5412038	Cs	3	0	0.5	6	0.2	0.2	87	15	36	210	2.91	5	479	84	2	31	0.1	1	2	1.8	50	66	9.0	34	0.02	6.7
R14	891097	443157	5406693	uKN	3	0	0.3	3	0.2	0.3	81	13	28	190	2.77	5	785	66	1	27	0.2	1	1	1.4	42	61	14.4	30	0.02	6.6
R15	891098	445700	5410407	uKN	5	2	0.3	3	0.1	0.2	112	11	40	160	2.45	3	336	35	2	21	0.1	1	2	2.0	51	42	6.8	28	0.02	6.7
R16	891099	428143	5418616	Cs	16	0	0.2	3	0.4	0.2	248	19	100	150	3.49	1	252	27	4	27	0.1	1	3	1.5	87	31	2.5	22	0.02	6.4
R17	891100	431285	5415204	Cs	284	29	0.5	5	0.1	0.2	98	12	42	170	2.73	1	419	40	1	18	0.1	1	4	1.8	58	44	5.6	24	0.02	6.7
R18	891132	430828	5400489	Cs	2	0	0.2	4	0.1	0.7	62	34	46	150	4.80	7	7450	110	3	19	0.1	1	2	0.8	76	70	30.5	nd	nd	nd
R19	891133	430828	5400489	Cs	2	0	0.2	4	0.1	0.8	59	34	45	180	4.62	8	8500	130	3	20	0.1	1	3	0.7	70	72	35.0	nd	nd	nd
R20	891142	459184	5410461	uKN	1	0	0.4	5	0.1	0.2	75	15	37	160	3.34	3	436	120	2	25	0.1	1	2	2.5	45	73	6.0	nd	nd	nd
R21	891143	433964	5414728	Cs	6	0	0.3	2	0.2	0.2	124	16	59	170	2.97	2	419	40	2	25	0.1	1	2	1.4	64	59	0.8	20	0.02	6.4
R22	891144	435706	5410893	Cs	11	0	0.7	9	0.2	0.4	67	15	53	130	3.58	6	832	83	2	17	0.1	1	2	0.9	52	62	0.8	nd	nd	nd
R23	891145	435965	5414027	Cs	1	1	0.8	6	0.2	0.1	92	16	40	190	3.15	6	443	50	1	28	0.1	1	2	1.4	55	61	6.2	20	0.02	6.5
R24	891146	442504	5421935	uKN	1	0	0.1	2	0.1	0.2	83	4	20	150	1.68	6	268	48	1	9	0.1	1	1	2.4	43	22	5.8	20	0.02	6.7
R25	891153	440383	5420793	uKN	1	0	0.1	1	0.1	0.1	100	6	24	180	1.91	1	283	32	1	8	0.1	1	1	2.4	58	20	4.2	10	0.02	6.1
R26	891154	439869	5424815	MJgd	3	0	0.2	3	0.2	0.4	78	7	25	180	1.55	22	898	76	2	12	0.1	1	2	4.3	35	45	24.0	nd	nd	nd
R27	891155	437479	5426490	MJgd	1	0	0.1	1	0.1	0.2	75	5	17	130	1.77	1	351	32	1	9	0.1	1	1	1.8	43	22	5.8	26	0.02	7.0
R28	891156	432391	5425450	MJgd	4	0	0.1	1	0.1	0.2	88	13	20	150	2.26	19	1400	68	1	10	0.1	1	1	1.8	47	35	16.4	10	0.02	6.1
R29	891157	430706	5423136	Cs	1	0	0.1	1	0.1	0.2	270	13	43	150	2.30	1	341	28	2	41	0.1	1	2	1.1	58	37	8.2	10	0.02	6.4
R30	891158	433199	5423381	MJgd	1	0	0.1	1	0.1	0.2	89	5	28	140	2.00	1	250	35	1	6	0.1	1	2	1.8	57	20	11.0	10	0.02	6.2
R31	891160	434098	5422763	Cs	3	0	0.1	2	0.1	0.2	95	7	52	160	2.24	1	233	35	2	9	0.1	1	3	2.1	82	23	2.4	10	0.10	6.4
R32	891162	430553	5414549	Cs	6	54	0.7	4	0.1	0.2	88	16	59	170	4.56	1	543	35	2	20	0.1	1	1	1.3	81	72	3.4	20	0.02	7.0
R33	891163	432167	5413331	Cs	1	0	0.5	5	0.1	0.2	93	15	45	190	3.15	1	468	44	3	18	0.1	1	1	1.5	67	61	6.2	24	0.02	7.0
R34	891164	431160	5413424	Cs	1	0	0.4	3	0.2	0.2	52	16	55	200	4.30	3	857	72	2	16	0.1	1	1	1.2	63	77	22.4	nd	nd	nd
R35	891165	428106	5416796	Cs	2	0	0.3	3	0.1	0.1	98	22	64	220	4.55	2	880	110	2	27	0.1	1	2	1.6	69	80	1.6	20	0.02	6.7
R36	891166	428662	5411358	uKN	13	0	0.9	6	0.2	0.2	54	16	40	230	3.47	7	574	69	3	17	0.1	1	2	2.3	74	66	6.8	22	0.02	6.9
R37	891167	428910	5412444	uKN	1	0	0.5	3	0.2	0.3	57	13	31	150	3.33	10	832	67	3	25	0.2	1	1	1.2	55	78	20.2	nd	nd	nd
R38	891168	438153	5410777	uKN	4	0	0.3	2	0.1	0.1	101	10	37	180	2.49	2	251	25	2	14	0.1	1	3	1.9	72	40	3.6	20	0.02	6.2
R39	891169	438153	5410777	uKN	5	0	0.2	2	0.1	0.2	103	10	39	200	2.46	1	260	27	2	14	0.1	1	2	2.2	73	39	2.2	20	0.02	6.1
R40	891170	440553	5414083	Cs	65	0	0.2	7	0.1	0.3	88	15	75	220	3.00	4	503	49	2	17	0.1	1	2	1.8	69	66	5.2	24	0.02	6.9
R41	891171	437344	5421348	Cs	8	0	0.1	1	0.1	0.1	70	9	28	140	1.90	5	370	35	2	8	0.1	1	1	2.0	52	31	5.8	20	0.02	6.6
R42	891178	429011	5426298	MJgd	71	0	0.2	2	0.1	0.2	147	10	44	200	2.42	2	368	40	2	17	0.1	1	1	2.0	70	47	6.0	10	0.02	6.5
R43	891179	430540	5418045	Cs	14	0	0.4	3	0.1	0.1	258	20	87	220	4.45	3	417	28	2	47	0.1	1	1	1.3	119	86	4.8	10	0.02	6.9
R44	893004	436204	5424109	MJgd	208	4	0.6	7	0.2	0.1	145	16	53	190	3.48	2	371	70	2	30	0.1	1	2	1.7	73	62	2.6	20	0.02	4.9
R45	893005	436204	5424109	MJgd	5	0	0.7	6	0.2	0.1	153	15	47	150	3.44	3	337	64	2	29	0.1	1	1	1.5	72	60	3.0	24	0.02	5.9

* Complete data and methods of sample analysis are contained within Matysek et al., 1990
* * Dominant geological formation in watershed (determined from Roddick et al., 1979)

\# in waters
Cs : Sicker Group
MJgd Island Plutonic Suite
uKN : Nanaimo Group

Au1: Initial gold determination
Au2: Repeat determination if sample was anomalous for Au1 (100ppb) or a pathfinder element (As,Cu,Pb,Zn,Sb,Hg)

APPENDIX 2

MINERAL OCCURRENCES IN THE DUNCAN MAP AREA

The data in this appendix has been extracted from the British Columbia Ministry of Energy, Mines and Petroleum Resources mineral inventory database MINFILE. Only the geological descriptions of the occurrences are included here; the complete data set is included in the MINFILE release for 92B Victoria (1991).

NOTE: This material is reproduced directly from the MINFILE database (June, 1990) for the convenience of the reader.

MINFILE NUMBER: 092B 001 **NAME: LENORA (L.35G)**
NORTHING: 5412800 EASTING: 442200 STATUS: Past Producer

CAPSULE GEOLOGY:

Several past-producers are located on Mount Sicker in the Cowichan uplift, one of three geanticlinal uplifts that expose rocks of the Paleozoic Sicker and Buttle Lake groups on Vancouver Island. Cretaceous sediments of the Nanaimo Group unconformably overlie the Paleozoic rocks; the contact is marked by a basal conglomerate containing volcanic fragments derived from the Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of two gabbro sills (informally known as the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation. The target of exploration activity has been the volcanogenic, polymetallic massive sulphides that are hosted within felsic volcanic tuffs of the McLaughlin Ridge Formation (Sicker Group) and restricted to a belt running from Chipman Creek to Mount Richards, in the hangingwall of the Fulford fault.

Massive sulphides were discovered on Mount Sicker in the late 1800s and production issued from three separate underground mines (Lenora - 092B 001, Tyee - 092B 002 and Richard III - 092B 003) for several years. These mines were later held as one operating mine, the Twin J mine (1942-1952). The Twin J mine was examined by J.S. Stevenson in the 1940s and the following description is derived from his paper (Geology of the Twin J Mine; Structural Geology of Canadian Ore Deposits, Volume 1, The Canadian Institute of Mining and Metallurgy, 1948).

The rocks in the mine, and nearby, include cherty tuffs, graphitic schists, rhyolite porphyry and diorite. The chert and graphitic schists together form a band of sediments 30 to 45 metres wide that near the workings are at least 640 metres long. The trend of the band and the strike of the sediments are 110 degrees. The dip of the sediments is 50 degrees southwest. Where relatively undeformed, the rocks are slaty, where moderately deformed their laminae are bent into small canoe-shaped folds, and where intensely deformed, either by close folding or shearing, they are highly schistose.

Rhyolite porphyry and diorite are the two most widespread rocks in the area. Rhyolite porphyry sills follow the folding of the sediments and dikes cut early phases of the diorite. Two phases of the diorite, fine grained and coarse grained, are present. Fine-grained diorite occurs as sills in the sediments; coarse-grained diorite is found as irregular intrusive bodies, and as well-defined dikes. Although all phases of the diorite are younger than the sediments, some phases are older and others younger than the rhyolite porphyry.

Two types of ore are found in association with cherty tuffs and graphitic schists: a barite ore consisting of a fine grained mixture of pyrite, chalcopyrite, sphalerite and a little galena in a gangue of barite, quartz and calcite; and a quartz ore consisting of mainly quartz and chalcopyrite.

The two main orebodies, known as the North orebody and the South orebody, are long, lenticular bodies lying along two main dragfolds in the band of sediments. The North orebody measures about 500 metres along strike, 37 metres downdip and from 0.3 to 3 metres in thickness. The South orebody, which is 46 metres from the North, and has its upper limit 45 metres higher, measures 640 metres along the strike, 45 metres downdip and is about 6 metres in thickness. Most of the ore mined in the early period came from the South orebody, but most of that mined by Twin J came from the North orebody.

Two main faults, striking east and nearly vertical, displace the orebodies. The north fault is between the two orebodies, and in going westward strikes into the South orebody at a small angle. This fault displaces the south orebody about 60 metres upward and an unknown distance eastward with respect to the North orebody. Long sections of barite drag-ore may be seen in the north fault below the South orebody. The south fault is south of the South orebody. Several diagonal faults cut the orebodies, but displace them only slightly horizontally and vertically. A few flat, or very gently dipping faults also cut the orebodies; but these displace the ore even less than most of the diagonal faults. In addition to movement along well-defined faults, considerable slippage has occurred between sharply folded beds in the graphitic schists.

A regional silicified and pyritized fracture zone can be traced by widely separated, mineralized outcrops, from Mount Richards on the east through the Twin J on Mount Sicker To Mount Brenton on the west, a total of 13 kilometres. The displacement along this break is unknown. At the Twin J, the fracture zones are manifested by vertical silicified zones on the south sides of both the North and South orebodies and by post-mineral breaks such as the north and south faults.

The Lenora mine, worked between 1898 and 1903 (inclusive) and in 1907, produced 321 886 grams of gold, 8 706 817 grams of silver and 3 226 034 kilograms of copper from a total of 71 50 tonnes mined. The Tyee mine was worked intermittently from 1901 to 1909 producing 762 553 grams of gold, 13 725 069 grams of silver and 5 840 593 kilograms of copper from a total of 152 668 tonnes mined. The Richard III mine produced, in three years between 1903 and 1907, 22 830 grams of gold, 522 14 grams of silver and 113 604 kilograms of copper from a total of 4903 tonnes of ore mined (Mineral Policy data).

The three mines were amalgamated and operated intermittently between 1942 and 1952 as the Twin J mine. From a total of 48 082 tonnes mined, the operation produced 63 730 grams of gold, 2 002 971 grams of silver, 364 55 kilograms of copper, 164 587 kilograms of lead, 1 926 111 kilograms of zinc and 4546 kilograms of cadmium (Mineral Policy data).

The property has undergone steady exploration by various companies from 1964 to present. Based on mapping, geochemical and geophysical surveys, trenching and diamond drilling from 1967 to 1970, ore reserves were estimated at 317 450 tonnes grading 1.6% copper, 4.11 grams per tonne gold, 140.57 grams per tonne silver, 0.65% lead and 6.6% zinc (Canadian Mines Handbook, 1972-1973).

MINFILE NUMBER: 092B 002 **NAME: TYEE (L.36G)**
NORTHING: 5412524 EASTING: 442670 STATUS: Past Producer

CAPSULE GEOLOGY:

Volcanogenic massive sulphides were discovered on Mount Sicker in the late 1800s with production from one main orebody issuing from three independent underground mines (Lenora - 092B 001, Tyee - 092B 002 and Richard III - 092B 003) for several years. These mines were later amalgamated and operated as the Twin J mine (1942-1952).

The massive sulphides are hosted within rhyolitic tuffs and associated sediments of the McLaughlin Ridge Formation, Sicker Group. The rocks in the mine include cherty tuffs and graphitic schists which together form a band of folded and/or sheared sediments 30 to 45 metres wide that near the workings are at least 640 metres long. The trend of the band and the strike of the sediments are 110 degrees. The dip of the sediments is 50 degrees southwest. See the Lenora deposit for further details of the geology.

Two types of ore are found in association with the cherty tuffs and graphitic schists: a barite ore consisting of a fine grained mixture of pyrite, chalcopyrite, sphalerite and a little galena in a gangue of barite, quartz and calcite; and a quartz ore consisting of mainly quartz and chalcopyrite.

The two main orebodies, known as the North orebody and the South orebody, are long, lenticular bodies lying along two main dragfolds in the band of sediments. The North orebody measures about 500 metres along strike, 37 metres downdip and from 0.3 to 3 metres in thickness. The South orebody, which is 46 metres from the North, and has its upper limit 45 metres higher, measures 640 metres along the strike, 45 metres downdip and is about 6 metres in thickness. Two main faults, striking east and nearly vertical, displace the orebodies. A fracture zone is manifested by vertical silicified zones on the south sides of both the North and South orebodies.

The Tyee mine was worked intermittently from 1901 to 1909 producing 762 553 grams of gold, 13 725 069 grams of silver and 5 840 593 kilograms of copper from a total of 152 668 tonnes mined (Mineral Policy data). See Lenora (092B 001) for the combined production and reserve figures that were derived after the three mines were amalgamated as the Twin J mine. Zinc, lead and cadmium are also reported in the Twin J production records.

MINFILE NUMBER: 092B 003 **NAME: RICHARD III (L.39G)**
NORTHING: 5412521 EASTING: 442915 STATUS: Past Producer

CAPSULE GEOLOGY:

Volcanogenic massive sulphides were discovered on Mount Sicker in the late 1800s with production from one main orebody issuing from three independent underground mines (Lenora - 092B 001, Tyee - 092B 002 and Richard III - 092B 003) for several years. These mines were later amalgamated and operated as the Twin J mine (1942-1952).

The massive sulphides are hosted within rhyolitic tuffs and associated sediments of the McLaughlin Ridge Formation, Sicker Group. The rocks in the mine include cherty tuffs and graphitic schists which together form a band of folded and/or sheared sediments 30 to 45 metres wide that near the workings is at least 640 metres long. The trend of the band and the strike of the sediments are 110 degrees. The dip of the sediments is 50 degrees southwest. See the Lenora occurrence for further details of the geology.

Two types of ore are found in association with the cherty tuffs and graphitic schists: a barite ore consisting of a fine grained mixture of pyrite, chalcopyrite, sphalerite and a little galena in a gangue of barite, quartz and calcite; and a quartz ore consisting of mainly quartz and chalcopyrite.

The two main orebodies, known as the North orebody and the South orebody, are long, lenticular bodies lying along two main dragfolds in the band of sediments. The North orebody measures about 500 metres along strike, 37 metres downdip and from 0.3 to 3 metres in thickness. The South orebody, which is 46 metres from the North, and has its upper limit 45 metres higher, measures 640 metres along the strike, 45 metres downdip and is about 6 metres in thickness. Two main faults, striking east and nearly vertical, displace the orebodies. A fracture zone is manifested by vertical silicified zones on the south sides of both the North and South orebodies.

The Richard III mine operated in three years between 1903 and 1907, producing 22 830 grams of gold, 522 714 grams of silver and 113 604 kilograms of copper from a total of 4903 tonnes of ore mined (Mineral Policy data). See Lenora (092B 001) for the combined production and reserve figures that were derived after the three mines were amalgamated as the Twin J mine. Zinc, lead and cadmium are also reported in the Twin J production records.

MINFILE NUMBER: 092B 004 **NAME: VICTORIA (L.21G)**
NORTHING: 5412825 EASTING: 440750 STATUS: Past Producer

CAPSULE GEOLOGY:

The Victoria past-producer is located on the east bank of the Chemainus River, west of, and along the strike of, the Lenora-Tyee volcanogenic massive sulphide past-producers on Mount Sicker (see 92B 001).

The deposit is located within the Cowichan uplift, one of three geanticlinal uplifts that expose rocks of the Paleozoic Sicker and Buttle Lake groups on Vancouver Island. Cretaceous sediments of the Nanaimo Group unconformably overly the Paleozoic rocks; the contact is marked by a basal conglomerate containing volcanic fragments derived from the Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally known as the Mount Hall Diorite) that are coeval with the Upper Triassic Karmutsen Formation.

The Sicker Group rocks mainly comprise felsic volcanic tuffs of the McLaughlin Ridge Formation. The rocks in the mine, and nearby, include graphitic schists and cherty sediments and tuffs which form a band within the rhyolitic volcanics. This is the same band of sediments which hosts the massive sulphides of the Lenora-Tyee deposit to the east. The strike of the sediments along the Chemainus River is about 080 degrees and the dip is 70 degrees south.

On the property a tunnel has been driven in for 46 metres at 110 degrees. From the end of the tunnel a crosscut has been run to the south for about 8 metres ending in diorite. Another crosscut was made to the north for about 11 metres in the schist, of which about 3 metres is mineralized with pyrite and chalcopyrite. A sample of this assayed 17.1 grams per tonne silver and trace copper and gold (Minister of Mines Annual Report 1902, page 253). On the steep banks of the river, outcrops of massive iron sulphides with a small amount of copper were exposed and tested by adits. Small pits have exposed quartz veins and stringers up to 75 centimetres wide mineralized with iron sulphides and chalcopyrite.

The mine has a combined production from 1904, 1905 and 1907 totalling 115 tonnes of ore, from which was recovered 124 grams of gold, 3452 grams of silver and 4346 kilograms of copper (Mineral Policy data). Details of the deposit and workings were not reported after 1902.

MINFILE NUMBER: 092B 016 **NAME: MELORE**
NORTHING: 5406200 EASTING: 431750 STATUS: Showing

CAPSULE GEOLOGY:

The Melore showing occurs near the west-northwest trending geological contact of the Devonian Nitinat Formation (Sicker Group) and the Mississippian to Pensylvanian Fourth Lake Formation (Buttle Lake Group), (Open File 1988-8). Several hundred metres to the north, Fourth Lake Formation rocks form a west-northwest trending contact with granodiorite of the Early to Middle Jurassic Island Plutonic Suite (formerly called Island Intrusions).

Two rhodonite/pyrolusite "veins", striking 040 to 045 degrees and dipping 60 to 65 degrees west, occur within bedded andesite tuffs (Nitinat Formation?) some 20 metres apart. The veins are 2 and 3 metres wide and extend approximately 5 metres each between two 120- degree striking, 30-degree north dipping shear zones. Approximately 25% of each vein is rhodonite and the remainder is pyro- lusite.

Another rhodonite occurrence is located about 1 kilometre to the north-northwest of the above showing in an area of dacitic rock. It occurs mostly as jagged boulders between 0.5 and 1 metre in diameter. This area has been disturbed by the construction of a forest access road.

MINFILE NUMBER: 092B 027 **NAME: HILL 60**
NORTHING: 5408305 EASTING: 428334 STATUS: Past Producer

CAPSULE GEOLOGY:

The Hill 60 manganese deposit, mined by open pit in 1919 and 1920, is underlain by cherty tuffs of the Mississippian to Penn- sylvanian Fourth Lake Formation, Buttle Lake Group (formerly the upper part of Muller's Myra Formation (Sediment-Sill Unit)). Several hundred metres to the north of the deposit, the Fourth Lake rocks form a west-northwest trending contact with granodiorite of the Early to Middle Jurassic Island Plutonic Suite (formerly called the Island Intrusions). To the south, several hundred metres, they form a west-northwest trending geological contact with volcanics of the Devonian Nitinat Formation (Sicker Group), (Open File 1988-8). The cherty tuffs are intruded by large masses of gabbro (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group.

The rocks associated with the manganese occurrence are thinly banded, green, cream, and red cherty tuffs locally containing lenses of massive red jasper. These rocks are cut by a few mafic dikes near the Hill 60 workings. The ore outcropped for a distance of 33 metres along the crest of the hill having a strike of 080 degrees (magnetic) and a dip of about 70 degrees to the southeast. Both strike and dip of the ore conform with the bedding of the country rock. The ore consisted mainly of a mixture of hard, compact oxides of manganese (pyrolusite), grading from highly siliceous material along the walls (rhodonite) to a relatively pure oxide at the centre of the ore body. The central portion of highly oxidized ore was about 6.5 metres across and 4.6 metres in depth. An average sample of the deposit was reported to contain 37.5% manganese (Minister of Mines Annual Report 1918, page 297).

The rhodonite varies in colour from pink to watermelon red. It is predominantly massive with minor irregular shaped masses of quartz and the yellow manganese garnet, spessartite. Toward the periphery of the deposit these three minerals occur in parallel bands, with quartz predominant. Rare fragments of green chert occur in the rhodonite. Chalcopyrite and bornite occur as disseminations in the rhodonite and jasper. Numerous veins of quartz and fracture-fillings of paler pink rhodonite cut the rhodonite lens. Fault gouge occurs along the contact between the rhodonite and the country rock. Thin section and x-ray diffraction analysis confirm the presence of calcite, rhodochrosite, quartz and rhodonite in the gouge.

Thin lenses of rhodonite are present in the cherty tuffs, approximately along strike from this deposit but not continuous with it.

The deposit was discovered in 1918, and in 1919 and 1920, 480 and 530 tonnes of ore, respectively, were shipped (Bulletin 37, page 67). From this ore a total of 1 058 679 kilograms of manganese was recovered.

MINFILE NUMBER: 092B 028 **NAME: ROSE**

NORTHING: 5414650 EASTING: 440400 STATUS: Showing

CAPSULE GEOLOGY:

The Rose occurrence is located in an area underlain mainly by volcanic rocks of the Late Devonian McLaughlin Ridge Formation (Sicker Group) and by sediments of the Mississippian to Pennsylvanian Fourth Lake Formation (Buttle Lake Group). The local stratigraphy is disrupted by folding, faulting, (pre-Triassic as well as Late Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation.

Most of the original rock textures and structures have been obliterated by extensive faulting, shearing and polyphase deformation, resulting in the formation of cataclastic schists. About 70 metres of sericite and graphitic schists, as well as non-schistose argillite have been exposed along the north side of a road. In the rocks a strongly developed schistosity strikes 065 degrees and dips 79 degrees north (Minister of Mines Annual Report 1965, page 268).

MINFILE NUMBER: 092B 029 **NAME: LADY A (A ZONE)**

NORTHING: 5419250 EASTING: 430300 STATUS: Developed Prospect

CAPSULE GEOLOGY:

The Lady A deposits are underlain by cherty sediments of the Upper Devonian McLaughlin Ridge Formation, Sicker Group. Locally, the sediments strike northwest and dip to the northeast at 50 to 60 degrees.

The Lady A (A zone) deposit is a stratabound taconite deposit composed of grey chert and red jasper hosting bands of very fine grained magnetite with minor specularite. The deposit consists of two lenses which outcrop along strike for a distance of 105 metres, attaining widths of up to 18 metres. An average thickness, determined from drilling, is less than 9 metres. The estimated reserves are 366 000 tonnes with an average grade of 25% iron (Minister of Mines Annual Report 1956, page 135).

MINFILE NUMBER: 092B 030 **NAME: MESABI**

NORTHING: 5402200 EASTING: 460500 STATUS: Showing

CAPSULE GEOLOGY:

The Mesabi taconite deposit occurs on the west slope of Mount Sullivan. The area is underlain by schistose metasediments of the Mississippian to Pennsylvanian Fourth Lake Formation, Buttle Lake Group. Bedding and schistosity in the rocks are essentially parallel; the strike is northwest and the dip 70 to 80 degrees southwest.

The mineralized zone strikes intermittently along a hillside for about 150 metres. It consists of lenticular bands of jasper, interlayered with schist containing streaks, bands and lenses of magnetite and smaller amounts hematite. Some of the ore masses are up to 45 metres long and 3 to 6 metres wide. The deposit is cut by irregular veins and stringers of white quartz. A sample of the ore assayed 30.0% iron, 53.3% silica and 0.2% phosphorus (Minister of Mines Annual Report 1918, page 299).

MINFILE NUMBER: 092B 033 **NAME: LADY A (C ZONE)**

NORTHING: 5418900 EASTING: 430750 STATUS: Prospect

CAPSULE GEOLOGY:

The Lady A (C zone) deposit is underlain by cherty sediments of the Upper Devonian McLaughlin Ridge Formation, Sicker Group. Locally the sediments strike northwest and dip to the northeast at 50 to 60 degrees. Intruding the strata are dikes and sills of gabbro and diabase (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group.

The deposit is a stratabound taconite lens composed of grey chert and red jasper hosting bands of very fine-grained magnetite with minor hematite. The deposit outcrops along strike for a distance of 42 metres, having an apparent thickness of 12 metres. Drilling has revealed a downdip extent of at least 48 metres. A conservative estimate of reserves based on four drill holes put down in 1953 is 2.4 million tonnes grading 18% iron (Buckham, 1953)

MINFILE NUMBER: 092B 037 **NAME: ANITA**

NORTHING: 5417400 EASTING: 430000 STATUS: Showing

CAPSULE GEOLOGY:

The Anita occurrence lies within the Cowichan uplift, in which the Paleozoic Sicker and Buttle Lake groups are exposed. The occurrence is underlain by felsic and mafic volcanics of the Upper Devonian McLaughlin Ridge Formation, of the Sicker Group, that trend northwest and dip steeply. The volcanic rocks are flanked on the north side by the Mississippian to Pennsylvanian Fourth Lake Formation, Buttle Lake Group (formerly the Sediment-Sill Unit of Muller). These rocks are intruded by gabbro bodies (informally known as the Mount Hall Gabbro), varying from 1 to 300 metres thick, that are coeval with the Upper Triassic Karmutsen Formation (Vancouver Group). To the south, the Sicker Group rocks are unconformably overlain by the Upper Cretaceous Nanaimo Group sediments.

The "Anita Active Tuff" is a pyritic and quartz phyric felsic ash and lapilli tuff that occurs along the southern edge of a sericitic felsic tuff package that has an outcropping exposure width of 400 to 1300 metres. A major thrust fault that is probably a splay of the Fulford fault occurs immediately north of the Anita Active Tuff. Drilling in 1987 to 1990 revealed polymetallic sulphide mineralization within 10 metres of a felsic-mafic contact within the Anita Active Tuff. The southern contact of the Anita Active Tuff with mafic tuffs is called the "Anita Horizon". The Anita Horizon has been traced discontinuously by drilling over a length of 3.5 kilometres. From its western end, where it is terminated by a fault, the horizon trends southeast for 1.4 kilometres after which the remaining 2.1 kilometres is occupied by the "Anita Gabbro". This gabbro is a sill to dike-like body that is also present to the west where it is adjacent to the 1.4 kilometre length of the horizon.

Mineralization consists of pyrite, sphalerite and chalcopyrite occurring as sparse veinlets, stringers and as polymetallic bands. The best drill intersections to date tested a strike length of 300 metres. Assay results of true widths are as follows (Stewart, 1990):

Hole	Length (metres)	Copper (%)	Lead (%)	Zinc (%)	Silver (g/t)	Gold (g/t)
87-37	2.5	2.37	0.73	2.73	46.0	0.72
88-49	4.9	2.30	0.49	3.66	73.9	1.90
88-76	4.8	0.93	0.10	3.81	20.5	0.37

The original Anita showing, which occurs along the Anita Horizon, consists of quartz lenses in schist traceable for at least 60 metres in an easterly direction. The "vein" is up to 4.5 metres wide and carries chalcopyrite and pyrite. A sample assayed 10.28 grams per tonne silver and 3.3% copper (Minister of Mines Annual Report 1917, page 270).

The western end of the Coronation zone of the Lara deposit (092B 129) occurs about 1.5 kilometres southeasterly (120 degrees) from the eastern end of the Anita Horizon. The two deposits are almost along strike from each other but significant differences in their settings suggest that the horizons are not identical.

MINFILE NUMBER: 092B 038 **NAME: CORNUCOPIA**
NORTHING: 5410000 EASTING: 451600 STATUS: Past Producer

CAPSULE GEOLOGY:

The area of the Cornucopia occurrence is underlain by a belt of schists, originally volcanics, of the Upper Devonian McLaughlin Ridge Formation, Sicker Group. Intruding the country rocks is quartz feldspar porphyry of the Late Devonian Saltspring Intrusive Suite (formerly the Saltspring Intrusions).

The belt is very much sheared and fissured with some of the fissures filled with quartz carrying copper minerals. Around 1917, a prospect hole was sunk 3.6 metres deep, 3 metres long and 2.4 metres wide. A sample taken from the dump assayed 2.1% copper, 27.43 grams per tonne silver and a trace of gold (Minister of Mines Annual Report 1917, page 269). About 60 metres west of the prospect hole there is a short adit driven in schist and quartz. About 120 metres west of the adit is an extensive outcropping of quartz carrying "low values".

Twenty-three tonnes of ore were produced from the Cornucopia deposit in 1960. From this production, 1058 grams of gold and 93 grams of silver were recovered.

MINFILE NUMBER: 092B 039 **NAME: YREKA**
NORTHING: 5410000 EASTING: 451850 STATUS: Showing

CAPSULE GEOLOGY:

The Yreka showing consists of copper mineralization, probably in a shear zone. Two shafts, one 64 metres deep and the other 43 metres, were sunk on the property in the early 1900s. The area is underlain by volcanics of the Upper Devonian McLaughlin Ridge Formation, Sicker Group, reported to be altered to schists in the area. Intruding the country rocks is quartz feldspar porphyry of the Late Devonian Saltspring Intrusive Suite (formerly the Saltspring Intrusions). Gold and silver values are also reported.

MINFILE NUMBER: 092B 040 **NAME: SHARON COPPER**
NORTHING: 5413950 EASTING: 439700 STATUS: Prospect

CAPSULE GEOLOGY:

Several past-producers are located on Mount Sicker in the Cowichan uplift, one of three geanticlinal uplifts that expose Paleozoic Sicker and Buttle Lake Group rocks on Vancouver Island. Cretaceous sediments of the Nanaimo Group unconformably overlie the Paleozoic rocks; the contact is marked by a basal conglomerate containing volcanic fragments derived from the Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of diabase and gabbro sills (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation (Vancouver Group). The target of exploration activity has been the volcanogenic, polymetallic massive sulphides that are hosted within felsic volcanic tuffs of the McLaughlin Ridge Formation (Sicker Group) and restricted to a belt running from Chipman Creek to Mount Richards, in the hangingwall of the Fulford fault.

There are four main units underlying the Sharon area: andesitic feldspar porphyry, tuff breccia and rhyolite porphyry of the McLaughlin Ridge Formation intruded by a dike or sill of metadiorite. The stratigraphic sequence is poorly exposed. Textures and assemblages indicate that the area has undergone regional greenschist metamorph- ism.

Most of the original rock textures and structures have been obliterated by late shearing and extensive faulting. Structural styles are different between the lower volcanics and the upper sediments of the Paleozoic rock. The volcanics exhibit polyphase deformation, resulting in cataclastic schists. Adjacent sediments, interbedded cherts, siltstones and cherty tuffs, appear undeformed with only tilting or broad open folding. A major portion of the volcanic rocks exhibit strong, steeply dipping axial plane cleavage. Severe alteration has removed most indications of bedding, but isoclinal folding can be inferred from fold structures and extension joints perpendicular to lineations. An additional phase of folding, or a continuation of the first phase, is shown by small, tight isoclinal folding of axial plane cleavage. A possible third phase is indicated by box folds displayed by well foliated units in Copper Canyon.

Sulphides are hosted by extremely sheared chlorite-sericite schist. Slabbed and polished rock surfaces have revealed that the schists were coarse lapilli tuffs. The sulphides are concentrated in two 10-metre wide horizons, forming the core of an antiform. Adjacent to the chlorite schists is the intrusive quartz-albite porphyry, which appears to be conformable. Sulphides, pyrite with very minor chalcopyrite, are generally semi-massive to coarsely disseminated. The sulphides are recrystallized after deformation but appear to have undergone some later shearing. Similar sulphides are also encountered in fractures and quartz stringers in chlorite schist and in white quartz veins in gabbro.

The Sharon prospect is believed to have originally been covered by the Pauper Crown grant (Lot 31G), a Crown grant that was issued in 1903. Underground development over the years has included three parallel adits 46 metres, 1.5 metres and 11 metres in length, respectively. The longer adit also has two crosscuts, totalling about 23 metres. The crosscuts averaged 1.45% copper over 11 metres, 0.71% over 7 metres and 0.92% over 5.5 metres (Property File - Sharon Copper Mines, Plan of workings and drill holes, 1963). In 1985, Kidd Creek Mines Limited drilled the property, intersecting 9.2 metres (4.6 metres true width) of 0.55% copper, with up to 1.44% copper over 2 metres (Assessment Report 14411).

MINFILE NUMBER: 092B 041 **NAME: WATER POWER-BRENTON**
NORTHING: 5414350 EASTING: 440100 STATUS: Showing

CAPSULE GEOLOGY:

The Water Power-Brenton occurrence, within the Cowichan uplift, is located in an area underlain mainly by andesitic to rhyolitic volcanics of the McLaughlin Ridge Formation, Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation (Vancouver Group). The showing is in the vicinity of the Lenora-Tyee (092B 001) and Lara (092B 110) volcanogenic massive sulphide deposits and may be considered to be of related origin.

The Sicker rocks on the Mildred Crown grant (Lot 96) have been locally metamorphosed to sericitic and chloritic schists which have a general northwest trending strike and foliation. Pyrite, with minor chalcopyrite, occurs as stringers, elongate masses or as dissemin- ations within the schistose units. Sulphide content varies within the units but is generally between 2 and 5% . Lenses of massive sulphides up to 2 metres thick occur throughout some of the schistose units.

On the old Water Power-Brenton claims on Holyoak Creek, down- stream from the Mildred claim, a selected sample assayed 20.5% copper, 103 grams per tonne silver and a trace of gold (Minister of Mines Annual Report 1923, page 274).

MINFILE NUMBER: 092B 047 **NAME: CROFTON SLAG**
NORTHING: 5412052 EASTING: 453546 STATUS: Past Producer

CAPSULE GEOLOGY:

The slag dump from the old Crofton smelter has been mined for use as an aggregate.

MINFILE NUMBER: 092B 049 **NAME: IRONCLAD**
NORTHING: 5412200 EASTING: 450250 STATUS: Showing

CAPSULE GEOLOGY:

The Ironclad property is located in the vicinity of Mount Richards, about 2.0 kilometres southwest of Crofton. Access is easily attained by roads from Crofton, or from the Westholme road to the west.

The area is underlain by metavolcanics of the McLaughlin Ridge Formation (Sicker Group). These are intruded by quartz-feldspar porphyries of the Late Devonian Saltspring Intrusive Suite (formerly the Saltspring Intrusions) and gabbro (informally called the Mount Hall Gabbro) that is coeval with the volcanics of the Karmutsen Formation (Vancouver Group). The Sicker rocks are in unconformable contact with the Cretaceous Nanaimo Group to the north, and cut off to the south by the northwest trending Fulford thrust fault. A younger, left-lateral strike-slip fault, trending north-northeast, offsets the generally east trending rocks on the west side off Mount Richards (Massey, N.W.D., 1988).

The Ironclad workings consist of two shafts and an incline. The main working is a 30-degree incline 36 metres long. The material on the dump shows heavy pyrite mineralization in a strongly sheared and silicified gabbroic country rock, with minor patches of chalcopyrite.

Talc is found in shear zones, with the sulphide mineralization in the schists where they are cut by quartz-feldspar porphyries. The talc is up to one metre thick and contains calcite and quartz as impurities. One of the Ironclad shafts is claimed to have intersect- ed a one-metre thick band of talc at the 10-metre level (Geological Survey of Canada Summary Report 1909, page 101).

A quartz vein, up to 30 centimetres in width, occurs in gabbro a few hundred metres to the west of the Ironclad workings. The vein is reported to contain malachite, chalcocite, tetrahedrite and minor bornite (Assessment Report 7233, page 4, Figure 2).

The old Tidal (Tital?) Wave showing is located on the summit of the ridge above Westholme, apparently on Land Lot 93. This lot is located to the immediate east of the Ironclad workings. A pit up to 6 metres in depth exposes a 1-metre wide quartz vein trending west through gabbro. The vein is virtually barren except for an occasional speck of malachite (Notes by Wright, 1969).

MINFILE NUMBER: 092B 072 **NAME: BOOTH BAY**
NORTHING: 5412866 EASTING: 460072 STATUS: Past Producer

CAPSULE GEOLOGY:

A quarry on Saltspring Island was developed in sandstone of the Upper Cretaceous Nanaimo Group, Cedar District Formation. The stone is medium-grained (0.06 to 2 millimetres), has a uniform texture and a moderate light to dark brown colour. Exposed surfaces of stone are prone to disintegration. The worked face extends intermittently for 150 metres along a vertical bedding plane and is cut by steeply dipping north-northeast striking joints. Vertical joints are widely spaced (up to 16 metres) while flat-lying bedding planes are regularly spaced between 2 to 4 metres.

Saltspring sandstone was used to construct a portion of the main Victoria Post Office. Potential reserves of sandstone extend 20 metres north and east of the worked face. A developed residential lot immediately east of the quarry will restrict expansion.

MINFILE NUMBER: 092B 076 **NAME: LADY D**
NORTHING: 5417750 EASTING: 441500 STATUS: Showing

CAPSULE GEOLOGY:

The Lady D area is underlain by volcanics of the Devonian Nitinat Formation, Sicker Group. An exhalative iron formation is associated with a jasper unit. The unit is mapped at the contact of cherty tuffs above, and intermediate volcanics below. It appears to pinch and swell, with observed thicknesses up to 10 metres.

In 1986, massive magnetite up to 8 metres thick was intersected in a drill hole by Utah Mines Limited. Up to 2.5% pyrite was present along fractures. An old adit and dump in the same area showed samples of massive magnetite breccia containing up to 20% pyrite with traces of chalcopyrite. Assay values were up to 0.05% copper and 0.74 grams per tonne gold (Assessment Report 15749, page 14). Another nearby drill hole intersected similar mineralization. Moderate quartz veining with pyrite is present in the footwall andesite.

Work done on the showing in 1953 by Ladysmith Development Ltd. indicated that the iron zone extended along strike for 540 metres (Buckham, 1953, Map A).

Zones of crackle brecciation occurring in the andesite contain magnetite, pyrite, chalcopyrite and malachite. One of these masses (probably to the northwest of the iron zone?) assayed 8.6% copper, 42.86 grams per tonne silver and 3.22 grams per tonne gold (Assessment Report 15749, page 11).

MINFILE NUMBER: 092B 084 **NAME: JANE**
NORTHING: 5411850 EASTING: 449600 STATUS: Prospect

CAPSULE GEOLOGY:

The Jane prospect is underlain by metavolcanics of the McLaugh- lin Ridge Formation, Sicker Group. The strata are intruded by gabbro, (informally known as the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Vancouver Group), and by quartz- feldspar porphyries of the Late Devonian Saltspring Intrusive Suite (formerly known as the Saltspring Intrusions), (Massey, N.W.D., Personal Communications, 1991). The Sicker rocks are in unconformable contact with the Cretaceous Nanaimo Group to the north, and cut off to the south by the northwest trending Fulford thrust fault. A younger, left-lateral strike-slip fault, trending north-northeast, offsets the generally east trending rocks on the west side off Mount Richards (Massey, N.W.D., 1988).

The workings consist of two short adits and several opencuts. Lenses of sulphides in schistose quartz-feldspar porphyry are exposed. The porphyry forms a dike-like body about 140 metres wide trending 110 degrees parallel to the strike of the schistosity. It is bounded on both sides by massive-grained diorite that appears to intrude the porphyry.

Mineralization in the adit consists of lenses of fine-grained, dense, massive sulphides lying parallel to the schistosity of the porphyry. Pyrrhotite, sphalerite, chalcopyrite and pyrite are the principal sulphides, and small amounts of quartz and calcite form the only gangue material. The largest lens is about 45 centimetres wide and up to 1.5 metres long. A sample taken across 91 centimetres assayed 16.1% zinc and 0.05% copper (Minister of Mines Annual Report 1949, page 225)

MINFILE NUMBER: 092B 085 **NAME: REGAL**
NORTHING: 5410350 EASTING: 433250 STATUS: Showing

CAPSULE GEOLOGY:

The Regal occurrence comprises of shale of the Cedar District Formation, Nanaimo Group. Tests done by Shalex Resources Limited in 1986 are reported to have shown that this shale is expandable and suitable as lightweight aggregate for use in the making of light- weight cement.

The shale is medium to dark brownish grey, soft, friable and thinly laminated, containing minor amounts of siltstone.

MINFILE NUMBER: 092B 086 **NAME: COPPER CANYON (L.22G)**
NORTHING: 5412800 EASTING: 440600 STATUS: Showing

CAPSULE GEOLOGY:

The Copper Canyon showing is located on the west bank of the Chemainus River, west and along strike of the volcanogenic-type Victoria (092B 004) past-producer, located on the opposite bank of the river.

The area is underlain mainly by felsic volcanic tuffs of the McLaughlin Ridge Formation, Sicker Group. The rocks at the showing include graphitic schists and cherty sediments and tuffs which form a band within the rhyolitic volcanics. This is the same band of sediments which host the massive sulphides at the Lenora-Tyee (092B 001) deposit to the east. The strike of the sediments along the Chemainus River is about 080 degrees and the dip is 70 degrees south.

An adit has been driven on a quartz vein which varies in width from 2.5 to 46 centimetres, averaging about 33 centimetres. The tunnel follows the vein for 41 metres at which point it stops (Minister of Mines Annual Report 1902). The vein is reported to contain mostly pyrite with some chalcopyrite and traces of sphalerite and galena. Gold values are reported to be low. A 91 metre shaft was later put down on the Copper Canyon group (presumably on the claim of the same name) with drifts driven off it. Some attractive copper showings were reported. Assessment Report 4626 (Figure 3) shows a shaft on the claim near the Chemainus River.

MINFILE NUMBER: 092B 087 **NAME: KEY CITY (L.37G)**
NORTHING: 5412750 EASTING: 441750 STATUS: Prospect

CAPSULE GEOLOGY:

The Key City occurrence is located within the Cowichan uplift; one of three geanticlnal uplifts that expose Paleozoic Sicker and Buttle Lake Group rocks on Vancouver Island. Cretaceous sediments of the Nanaimo Group unconformably overlie the Paleozoic rocks; the contact is marked by a basal conglomerate containing volcanic fragments derived from the Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally known as the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation.

The Sicker Group rocks mainly comprise felsic volcanic tuffs of the McLaughlin Ridge Formation. The rocks in the area include graphitic schists and cherty sediments and tuffs which form a band within the rhyolitic volcanics. This is the same band of rock which hosts the massive sulphides on the Lenora-Tyee mines (092B 001) to the immediate east.

The property was first explored by an adit run from south to north for about 160 metres in order to intersect the projected extension of the Lenora orebody. Overall the adit cuts about 60 metres of diorite and 100 metres of schist. A shaft runs 30 metres from the surface to intersect the adit about 100 metres from the portal. The shaft then continues down to the 60 metre-level where a crosscut is made 60 metres to the south. There are several places in the schists where a small amount of pyrite and chalcopyrite show in small stringers or disseminations but no orebody was intersected.

MINFILE NUMBER: 092B 088 **NAME: QUEEN BEE (L.100G)**
NORTHING: 5413637 EASTING: 442560 STATUS: Showing

CAPSULE GEOLOGY:

The Queen Bee occurrence on Mount Sicker is located within the Cowichan uplift and is underlain mainly by andesitic and rhyolitic volcanics of the McLaughlin Ridge Formation, Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally known as the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation. The showing lies 1 kilometre to the north of the Lenora-Tyee volcanogenic massive sulphide deposit (092B 001) and is of related origin.

In 1986, Corporation Falconbridge Copper (Minnova) drilled two holes on the old Queen Bee Crown grant, in order to test the "Mine Package". Both holes (MTS-25,26) intersected a mineralized, chloritized and locally barium enriched package consisting of well- bedded dacitic ash, tuff and chert. The package contained up to 20% pyrite and 6% chalcopyrite. One sample assayed 0.99% copper and 1.18% zinc over 1.45 metres (Assessment Report 15719). Pyrite-pyrrhotite-chalcopyrite stringer mineraliza- tion was encountered in epidotized andesitic volcaniclastics stratigraphically above the "Mine Package" in both holes.

By 1898, a 20-metre tunnel had been driven into a reef (quartz vein) that contained free milling gold. Two shafts were reported in 1900; one 21 metres deep with 37 metres of drifting and the other almost 11 metres deep with 24 metres of opencut.

MINFILE NUMBER: 092B 089 **NAME: BELLE (L.55G)**
NORTHING: 5413650 EASTING: 442600 STATUS: Showing

CAPSULE GEOLOGY:

The Belle occurrence on Mount Sicker is located within the Cowichan uplift and is underlain mainly by andesitic to rhyolitic tuffs of the McLaughlin Ridge Formation, Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Late Cretaceous) and the intrusions of gabbro and diabase sills and dikes that are coeval with the Upper Triassic Karmutsen Forma- tion. The showing lies about 1 kilometre to the north of the Lenora-Tyee volcanogenic massive sulphide deposit (092B 001) and is of related origin.

In 1980, Serem Limited drilled four diamond-drill holes in order to test a package of variably siliceous schists that originated as tuffs and flows and which are similar in nature to the package hosting the Lenora-Tyee deposit. The schists, locally chlorite and sericite altered, appear to form a south dipping panel having a hanging wall and footwall of gabbro. North of the drill holes there is a transition to andesitic rock.

Pyrite and chalcopyrite occur as disseminations or in association with quartz-calcite veins. It is common to see the sulphides concentrated along the schistosity as fine to coarse grains. In drill hole SRM 18 an average grade of 0.37% copper occurs over 4.6 metres (Assessment Report 8264).

In 1897, it was reported that two very large veins 6 to 12 metres in width occur about 30 metres apart in dioritic rock. No work was done on them at that time.

MINFILE NUMBER: 092B 090 **NAME: BREEN LAKE**
NORTHING: 5411500 EASTING: 450350 STATUS: Showing

CAPSULE GEOLOGY:

The Breen Lake occurrence area is underlain by east-northeast striking, steeply dipping andesitic and rhyolitic volcanics and volcaniclastics of the Upper Devonian McLaughlin Ridge Formation, Sicker Group. Large irregular gabbroic bodies (informally known as the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Sicker Group), intrude the volcanics. Also intruding the stratigraphy are quartz-feldspar porphyry bodies of the Late Devonian Saltspring Intrusive Suite (formerly the Saltspring Intrusions).

Over 3,000 metres of drilling in 10 holes tested the strata in the area of Breen Lake (Assessment Report 17007). Bands and beds of massive pyrite less than 0.4 metres thick are common. A 0.8-metre long sample of semi-massive pyrite-chalcopyrite in silicified mafic ash tuff assayed 0.97% copper. Sulphides including pyrrhotite also occur in chlorite-carbonate altered felsic lapilli tuff, andesitic tuff and quartz feldspar porphyry.

The best drill assays are: 1.14% zinc over 1.2 metres, 1.29% zinc over 0.5 metres, 1.04% copper over 0.4 metres, 2.08% copper over 0.1 metre, 0.82% copper over 1.0 metres and 0.94 per copper over 0.5 metres (Assessment Report 17007).

MINFILE NUMBER: 092B 091 **NAME: LUCKY STRIKE**
NORTHING: 5411400 EASTING: 449750 STATUS: Showing

CAPSULE GEOLOGY:

The Lucky Strike copper showing occurs in a rock cut of the Mount Sicker narrow gauge railway, along the northwestern slopes of Mount Richards. The area is underlain by volcanic rock of the Upper Devonian McLaughlin Ridge Formation, Sicker Group and by gabbroic to basaltic dikes and sills (informally known as the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group. The deposit was reported to occur in Sicker Group rocks.

MINFILE NUMBER: 092B 092 **NAME: SALLY 2**
NORTHING: 5412250 EASTING: 449000 STATUS: Showing

CAPSULE GEOLOGY:

The area is underlain by gabbro (informally knopwn as the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Vancouver Group), which is intrusive into Upper Devonian Sicker Group volcanics of the McLaughlin Ridge Formation.

A 14 metre long adit follows a fracture in diorite (gabbro?) and contains a few small quartz lenses from 0.5 metres wide to 2 metres in length. Locally, clusters of sulphides, mainly pyrite and chalco- pyrite, are present in the quartz, especially where northwest trend- ing fractures intersect the main fracture. A sample of high-grade material assayed 5.6% copper and nil in silver and gold (Minister of Mines Annual Report 1949, page 225).

MINFILE NUMBER: 092B 093 **NAME: MYRA**
NORTHING: 5409950 EASTING: 429600 STATUS: Showing

CAPSULE GEOLOGY:

The Myra occurrence is underlain by the Mississippian to Pennsylvanian Fourth Lake Formation of the Buttle Lake Group (formerly the upper sediment package of Muller's Myra Formation). Rhodonite occurs within a belt of cherts, cherty siltstones and cherty argillites. These beds are folded into a broad synform with the limb striking 175 degrees and dipping 60 degrees southwest at the occurrence. A quartz diorite contact lies about 20 metres southwest of the showing and it's possible that the rhodonite is a contact metamorphic product of a manganese-rich sediment.

A 1.5-metre thick horizon of rhodonite occurs discontinuously in lenses over a 45 metre length. The lenses are typically composed of massive blue-black manganese oxide with irregular patches of pale pink, massive, fine-grained crystalline rhodonite up to a few centi- metres in diameter. Manganese oxide also occurs along the many frac- tures of the host grey cherts. The rhodonite itself is relatively unfractured and probably formed after the deformation which caused the fracturing in the host cherts.

MINFILE NUMBER: 092B 095 **NAME: NEVER SWEAT**
NORTHING: 5431200 EASTING: 431000 STATUS: Showing

CAPSULE GEOLOGY:

The deposit is underlain by the Mississippian to Pennsylvanian Fourth Lake Formation of the Buttle Lake Group (formerly the upper sediment package of Muller's Myra Formation). These sediments have been folded into a broad synform with a fold axis trending at approximately 127 degrees. Bedding in the sediments strike between 090 and 140 degrees and dip moderately to steeply to the southwest. A large body of quartz diorite of the Early to Middle Jurassic Island Plutonic Suite (formerly called the Island Intrusions) is exposed to the west of the showing, outcropping within 800 metres.

Rhodonite occurs in massive pale pink bands up to 2 centimetres wide interlayered with thinly laminated dark brown chert, cherty siltstone and jasper. The rhodonite is highly fractured and contains up to 25% manganese oxide. A sample of this material contained 15.62% manganese (Assessment Report 16200). The width and lateral extent of the showing has not been determined.

It is thought that the rhodonite is a contact metamorphic product of a manganese-rich sediment which came in contact with the quartz diorite.

MINFILE NUMBER: 092B 099 **NAME: NORTHEAST COPPER ZONE**
NORTHING: 5413350 EASTING: 444450 STATUS: Showing

CAPSULE GEOLOGY:

The Northeast Copper Zone (Fortuna) on Mount Sicker is located within the Cowichan uplift and is underlain mainly by andesitic to rhyolitic volcanics of the McLaughlin Ridge Formation, Sicker Group. The local stratigraphy is disrupted by folding, faulting (pre-Triassic as well as Tertiary) and the intrusions of gabbro and diabase sills and dikes (informally known as the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group. The showing lies 2 kilometres east-northeast of the Lenora-Tyee (Twin J) volcanogenic massive sulphide deposit (092B 001).

The zone consists of at least 3 bands of very siliceous rock (chert) lying north of a large body of gabbro and contains 1 to 5% pyrite as disseminations or as small pods. Small amounts of chalcopyrite occur as disseminations, with or without pyrite. The mineralized area measures approximately 12 by 5 metres. Selected specimens assayed as high as 2% copper and 10.28 grams per tonne silver (Assessment Report 7875).

About 50 metres to the northwest of the zone is what is thought to be the old Fortuna adit which was driven into sericite schist. By 1898, a 40-metre adit was reported to have been excavated, cutting up to 2 metres of copper ore.

MINFILE NUMBER: 092B 104 **NAME: CORONATION MOUNTAIN**
NORTHING: 5425100 EASTING: 429300 STATUS: Showing

CAPSULE GEOLOGY:

Near the western boundary of the Ladysmith batholith of the Early to Middle Jurassic Island Plutonic Suite (formerly called the Island Intrusions), a large quartz vein occurs cutting the granodiorite. The vein strikes about 090 degrees and in places is 18 metres wide. The vein consists of coarse-grained quartz with pyrite, chalcopyrite and a little pyrrhotite and molybdenite. A 91-metre adit has been driven on the vein and a crosscut developed at the end. The vein was not considered of sufficient grade to be of interest as an ore.

A large mafic dike carrying some chalcopyrite is reported to occur about 1.2 kilometres to the southeast of the adit, on the east side of a road.

MINFILE NUMBER: 092B 110 **NAME: HOPE**

NORTHING: 5413550 EASTING: 437100 STATUS: Showing

CAPSULE GEOLOGY:

The Hope occurrence is underlain by volcanic rocks of the Upper Devonian McLaughlin Ridge Formation (Sicker Group) intruded by gabbroic bodies (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group (Massey, Personal Communication, 1991). See Lara (092B 129) for a discussion of the regional geology.

Mineralization consists of pyrite, sphalerite, pyrrhotite(?), and chalcopyrite in a narrow quartz vein. The vein occurs at the sheared contact between andesite-rhyolite tuffs and a gabbro sill. Disseminated pyrite also occurs along the foliation within volcanics.

The tuffs are reported to be cherty and baritic, containing up to 0.2% copper, 0.85% lead, 2.95 grams per tonne gold, 25.03 grams per tonne silver; barium averages about 2% (Assessment Report 11123, page 18).

MINFILE NUMBER: 092B 112 **NAME: ORN 3**

NORTHING: 5419277 EASTING: 435149 STATUS: Showing

CAPSULE GEOLOGY:

The area of the Orn occurrence is underlain by gabbro sills (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group. A west trending horizon of sediments, about 125 metres thick, occurs along the northern flanks of Mount Hall and Coronation Mountain and is encompassed by the gabbro. These sediments, belonging to the Mississippian to Pennsylvanian Fourth Lake Formation (Buttle Lake Group), comprise siltstone, cherty siltstone and minor sandstone.

Gabbro to the north of the sediment horizon is divisible into medium-grained and coarse-grained horizons. The coarse-grained variety is about 30 metres thick with hornblende crystals up to 1 centimetre in length. This rock contains up to 15% medium- grained magnetite, 5% disseminated and fracture filled pyrite and traces of chalcopyrite. The medium-grained magnetite is equi- granular, massive and contains up to 5% magnetite. Two samples of the gabbro assayed 0.18 and 0.15 grams per tonne palladium (Assessment Report 17351).

The gabbro is cut by abundant east-northeast to east-south- east trending, vertical to north dipping shears and quartz veins, up to 20 centimetres wide. Many of these structures are mineralized with pyrite and rarely chalcopyrite and contain anomalous levels of gold (up to 0.13 grams per tonne), silver (up to 6 grams per tonne) and copper (up to 1.03%), (Assessment Report 17351, page 27).

MINFILE NUMBER: 092B 113 **NAME: SALT SPRING ISLAND**

NORTHING: 5410500 EASTING: 462827 STATUS: Showing

CAPSULE GEOLOGY:

On Saltspring Island, shale of the Haslam and Cedar District (formerly Ganges) formations, both of the Upper Cretaceous Nanaimo Group, are reported to bloat fairly well when heated. The resulting product may be of use as a lightweight aggregate in the building industry.

MINFILE NUMBER: 092B 120 **NAME: SKUTZ FALLS**

NORTHING: 5400050 EASTING: 429210 STATUS: Showing

CAPSULE GEOLOGY:

The Skutz Falls showing is located 4.5 kilometres south of the falls on the Cowichan River, 19 kilometres west-southwest of Duncan. The showing consists of an area containing cavernous, crinoidal limestone pods of the Upper Pennsylvannian to Lower Permian Mount Mark Formation, Buttle Lake Group (previously Buttle Lake Formation, Sicker Group).

MINFILE NUMBER: 092B 126 **NAME: DUNCAN CLAY**
NORTHING: 5407000 EASTING: 447000 STATUS: Past Producer

CAPSULE GEOLOGY:

The Duncan Clay occurrence is composed of Recent clays of the Capilano Sediments (formerly known as Puyallup Interglacial deposits). The clays of this type are described as being somewhat sandy and yellowish to bluish grey in colour and in most places contain fairly abundant pebbles. The clay is fairly plastic, dries with moderate shrinkage and burns hard and red at low temperature. A sample of this surficial clay contained 67.6% silica, 13.6% alumina, 8.8% iron oxide, 3.6% lime, 0.2% magnesia and 5.6% water and loss upon ignition (Geological Survey of Canada Bulletin 96, page 308).

These clays are suitable for the manufacture of common brick and drain-tile, and for the manufacture of portland cement. Prior to 1917, bricks were made from this material at Somenos.

MINFILE NUMBER: 092B 128 **NAME: RANDY NORTH**
NORTHING: 5416500 EASTING: 433050 STATUS: Showing

CAPSULE GEOLOGY:

The Randy North zone is an anomalous package of felsic rocks of the Upper Devonian McLaughlin Ridge Formation, Sicker Group. The zone consists of 3 to 6 zinc-rich weakly polymetallic horizons over a stratigraphic thickness of about 150 metres. These horizons consist of laminated light brown sphalerite and pyrite with subordinate chalcopyrite and trace tetrahedrite hosted by a strongly schistose quartz-eye rhyolite tuff (sericite-quartz schist).

Ten diamond-drill holes have intersected the zone trend over a distance of 2 kilometres and downdip from surface to a depth of 180 metres. A 0.74-metre drill section assayed 0.052% copper, 0.08 cent lead, 0.95% zinc, 2 grams per tonne silver and 0.05 grams per tonne gold (Assessment Report 17857).

MINFILE NUMBER: 092B 129 **NAME: LARA**
NORTHING: 5414600 EASTING: 433750 STATUS: Developed Prospect

CAPSULE GEOLOGY:

The Lara prospect is a volcanogenic polymetallic massive sulphide deposit located in the Cowichan uplift, one of three geanticlinal uplifts that expose Paleozoic volcanic and sedimentary rocks on Vancouver Island. The Paleozoic rocks are intruded by mafic sills (informally called the Mount Hall Gabbro) that are coeval with overlying basaltic volcanics of the Upper Triassic Karmutsen Formation, Vancouver Group. All of these sequences have been subsequently intruded by granodioritic stocks of the Early to Middle Jurassic Plutonic Suite (formerly the Island Intrusions). Late Cretaceous sediments of the Nanaimo Group lie unconformably on the older sequences. The geology of the Paleozoic rocks has recently undergone reinterpretation and the stratigraphy has been reassigned to several new formations of a redefined Sicker Group and to the new Buttle Lake Group (formerly the upper part of the Sicker Group).

The new Buttle Lake Group consists of: (1) the Lower Permian(?) St Mary's Lake Formation composed of volcanic sandstone, conglomerate, argillites and turbidites; (2) the Upper Pennsylvanian to Lower Permian Mount Mark Formation (formerly Buttle Lake Formation) consisting of massive crinoidal limestone, bedded limestone, marble, chert and argillite; and (3) the Mississippian to Pennsylvanian Fourth Lake Formation (formerly Cameron River Formation, and equivalent to the upper parts of the Myra Formation of Muller) made up of mostly thinly bedded, often cherty sediments which include ribbon chert, argillite, crinoidal limestone, intercalated sandstone, siltstone and argillite, epiclastic sandstone and conglomerate, thickly bedded tuffite, lithic tuffite, laminated cherty tuff, heterolithic lapilli tuff and breccia.

The Sicker Group, from youngest formation to oldest, consists of: (1) the Upper Devonian McLaughlin Ridge Formation (the equivalent of lower parts of the Myra Formation of Muller) consisting of thickly bedded tuffite and lithic tuffite, feldspar-crystal tuff, heterolithic lapilli tuff and breccia, rhyolite, dacite, laminated tuff and chert; (2) the Devonian Nitinat Formation comprising pyroxene-feldspar phyric agglomerate, breccia and lapilli tuff, massive and pillowed flows, massive tuffite and lithic tuffite, laminated tuff and chert; and (3) the Devonian Duck Lake Formation (ascribed to the Karmutsen Formation by Muller) made up of pillowed and massive basaltic flows and, monolithic basalt breccias and pillow breccias, chert, jasper and cherty tuff, felsic tuffs and lapilli tuff, massive dacite and rhyolite.

The geology of the Duncan area differs, however, in that the McLaughlin Ridge Formation is dominated by volcanics with only minor tuffaceous sediments. The volcanics are predominantly intermediate to felsic pyroclastics, commonly feldspar-crystal lapilli tuffs and heterolithic lapilli tuffs and breccias. A thick package of quartz- crystal, quartz-feldspar-crystal and fine dust tuffs is developed in the Chipman Creek-Mount Sicker area and are host to the massive sulphides. This package thins to the west where it interfingers with andesitic lapilli tuffs and breccias. It appears to be stratigraphically high within the formation. A distinctive maroon schistose heterolithic breccia and lapilli tuff forms the uppermost unit within the McLaughin Ridge Formation and is seen in the Chipman Creek-Rheinhart Creek area. Most contacts with overlying sediments are faulted.

Southern Vancouver Island has undergone a complex tectonic history involving at least 6 major deformational events, often rejuvenating previous structures (Fieldwork 1987, page 87). The area is dominated by the effects of Tertiary west-northwest trending thrusting which have cut the Cowichan uplift into several slices. Where exposed these are high-angle reverse faults which dip between 45 and 90 degrees to the north-northeast paralleling earlier formed axial foliation in the Sicker Group rocks. Slip planes are relatively sharp and narrow, though wide schistose zones have formed in receptive lithologies. The thrusts generally place older rocks over younger and become listric at mid-crustal depth. Displacements along the faults are unknown but are probably small, on the order of 1 to 10 kilometres. Direction of motion is also unknown.

The metamorphic grade is generally quite low, but increases with age and structural position of the rocks. Nanaimo Group sediments are essentially unmetamorphosed. Basalts of the Karmutsen Formation show characteristics and alteration assemblages typical of the prehnite- pumpellyite facies. Intrusive rocks are unaltered. Sediments of the Fourth Lake Formation are essentially unmetamorphosed except where involved in intense shearing. Volcanic rocks of the McLaughlin Ridge Formation and Nitinat Formation in the Chipman Creek to Maple Mountain belt, however, show the effects of greenschist facies metamorphism. The felsic volcanic rocks develop sericite, talc and chlorite along foliation planes and are interbedded with minor chlorite schists. Intermediate to mafic rocks have chloritic schistose matrixes with epidote alteration of feldspars. Lithic lapilli may show almost complete replacement by epidote.

The Lara property is underlain by the McLaughlin Ridge Formation which has been thrust over younger rocks of the Fourth Lake Formation and the Nanaimo Group on the Fulford fault, a regional west-northwest trending fault that dips at about 47 degrees and crosscuts bedding in the volcanic rocks at a shallow angle. The McLaughlin Ridge Formation consist of northerly dipping, west-northwest striking rhyolitic to andesitic rocks. Bedding in the rocks generally dips steeply at 60 to 75 degrees north, although dips of between 30 and 45 degrees are common between Humbird and Silver creeks.

The Fourth Lake 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 series with siltstone and chert interbeds. The Nanaimo Group, which unconformably overlies the Fourth Lake Formation includes basal conglomerates, sandstone, and fossil bearing mudstone.

The strata on the property is cut by a number of mafic intrusions which are probably feeders to the Karmutsen Formation. The intrusions are composed of medium to coarse-rained diabase, gabbro and leucogabbro with minor diorite. They are commonly porphyritic with feldspar phenocrysts often forming glomero- porphyritic clusters up to 3 centimetres in diameter. Mafic phenocrysts are generally absent. Equigranular gabbros are also common. The intrusive bodies also vary in form. Sill-like bodies are generally subconcordant with bedding, but also may follow foliation where this is strongly developed. As a result of this they can show a variety of attitudes from shallow dipping to vertical. They may range in thickness from a few metres to 200 metres. Discordant dikes are also common, varying from 10 to 20 centimetres in width.

Also occurring are a number of quartz-feldspar porphyry dikes. These dikes, related to the Upper Devonian Saltspring Intrusive Suite (formerly Saltspring Intrusions and Tyee Intrusions), are coeval with the felsic volcanics of the McLaughlin Ridge Formation. The porphyries are usually well foliated and sometimes difficult to distinguish from crystal tuffs.

The package of rocks which hosts the Lara deposits has been tested by over 150 drill holes. It consists of an andesitic sequence referred to as the "Green Volcaniclastic Sequence", overlying rhyolite which are host to the massive sulphides. The rhyolite has been subdivided into two units which are referred to as the "Rhyolite Sequence" and the "Footwall Sequence", the latter underlying the lowermost sulphide sequence.

The Green Volcaniclastic Sequence is greater than 250 metres thick and dominated by fragmental rocks of intermediate composition. The sequence grades from coarse-grained locally silicified 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, locally greater than 1 metre thick occurs in the transition zone from andesite to dacite. 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 which may indicate a splay off the Fulford 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 (less than 2 millimetres) and comprise less than 10% of the rock. These rocks are usually siliceous and cherty. Black argillite and buff coloured volcanic mudstone beds are a common constituent of the sequence typically ranging from less than 1 millimetre up to several millimetres in thickness. Argillite beds up to about a metre thick occur locally in the immediate footwall of the Coronation zone.

The Footwall Sequence, like the Rhyolite Sequence, is dominated by light grey rhyolites, but is characterized by the presence of coarse-grained massive quartz porphyries units up to 40 metres thick. These rocks are texturally variable but are distinguishable by the presence of abundant large quartz eyes. Feldspar porphyry dikes, rhyolite dikes, rhyolite breccia and mudstone and argillite beds are also present.

The Lara 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 actually 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 thickest, most extensive of these deposits is the Coronation zone which occurs primarily to the west of Solly Creek. 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 and is clearly at a different stratigraphic level than the other two. Although the zone locally attains ore grade it is somewhat sporadic. The Coronation deposits occur in the Rhyolite Sequence immediately north of the Fulford fault. The deposits strike west-northwest, dip to the north at 60 degrees and exhibit considerable variation in both thickness and grade. Intercepts are up to 16 metres thick and average about 6 metres. One massive sulphide lens exposed by trenching in the Coronation zone graded 24.58 grams per tonne gold, 513.60 grams per tonne silver, 3.04% copper, 43.01% zinc and 8.30% lead over 3.51 metres (Bailes et al., 1987).

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, 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 characteristic of the other facies.

The massive sulphide facies is a relatively coarse-grained massive intergrowth of sulphide minerals and gangue (predominantly calcite). 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 to 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 the massive pyrite sections.

The predominant facies of the Coronation deposits is the banded and laminated facies which consist of sulphide laminae and bands up to a few centimetres thick in a siliceous host. The host rock varies from a silicified rhyolite to very fine-grained siliceous mass with various amounts of felsic tuffaceous debris. The mineralization is broadly conformable, however crosscutting features are common within the conformable zones. Crosscutting 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 pronounced cataclastic overprint. 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.

The banded and laminated facies varies up to about 16 metres true thickness. Although not as high grade as the massive sulphide facies, laminated and banded sulphides can achieve significant grade. Diamond-drill hole 85-36 for example, intersected 4.18 metres grading 9.91 grams per tonne gold, 82.63 grams per tonne 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 suphides. Intersections usually contain from 3 to 5% pyrite but concentrations of 10 to 15% are not uncommon.

The stringer facies, which is restricted, is best developed in the Hanging Wall zone. The facies consists of narrow sulphides, generally less than 1 or 2 millimetres, in a silicified rhyolite host. It is generally low grade but may be thick and is commonly rich in precious metals relative to base metals. A 10.52-metre diamond-drill hole interval graded 0.96 grams per tonne gold, 43.89 grams per tonne silver, 0.06% copper, 0.90 per zinc and 0.29% lead (Bailes et al., 1987).

These zones have been traced over a strike length of about 2 kilometres and to a depth of 440 metres downdip from surface. Drill indicated (probable) reserves to date stand at 529,000 tonnes grading 1.01% copper, 1.22% lead, 5.87% zinc, 100.11 grams per tonne silver and 4.73 grams per tonne gold (George Cross News Letter, February 23, 1990).

MINFILE NUMBER: 092B 130 **NAME: QUAMICHAN LAKE**

NORTHING: 5406000 EASTING: 453000 STATUS: Showing

CAPSULE GEOLOGY:

Thirty to sixty centimetres of impure, gritty diatomite, high in alumina, occurs over an area of 2.4 hectares adjacent Quamichan Lake. The diatomite in this region is of Recent age and mainly unconsolid- ated. The area is underlain by sedimentary rock of the Upper Cretaceous Nanaimo Group.

MINFILE NUMBER: 092B 131 **NAME: BJ**

NORTHING: 5422406 EASTING: 436956 STATUS: Showing

CAPSULE GEOLOGY:

At the BJ occurrence mineralization occurs in the northeast contact zone of an Early to Middle Jurassic Island Plutonic Suite (formerly the Island Intrusions) body, and rocks of the Devonian Nitinat Formation, Sicker Group. The rock immediately adjacent the stock is black amphibolite cut by many small granitic dikes and pegmatitic vein-dikes. It passes northeastward through migmatite to somewhat schistose and recrystallized pyroxene basalt (Nitinat Formation). To the southeast the basalt is in contact with gabbro (informally known as the Mount Hall Gabbro) which, like the amphibolite, is cut by many small granitic dikes.

The amphibolite and migmatite contain wispy zones, 30 to 60 centimetres wide, of disseminated and seam pyrite accompanied by less chalcopyrite. These zones are exposed only in one place, and only scattered occurrences of sparsely disseminated pyrite were found in the basalt and gabbro.

A quarry was reported to have been opened up in the contact zone in order to provide rock-facing for dams at each end of Holland Lake.

MINFILE NUMBER: 092B 133 **NAME: VV**

NORTHING: 5423100 EASTING: 431400 STATUS: Showing

CAPSULE GEOLOGY:

The VV showing occurs in an area underlain by a contact of the Early to Middle Jurassic Island Plutonic Suite (formerly called the Island Intrusions) and rock of the Devonian Nitinat Formation, Sicker Group. In 1979, a single drill hole was completed in order test a magnetic anomaly. The hole encountered a minor amount of graphitic argillite at bedrock and then passed into a sequence of very siliceous tuffs which have been variably altered to garnet skarn. A zone of heavily altered skarn breccia was penetrated containing up to 15% pyrite, pyrrhotite, minor chalcopyrite and traces of molybdenite.

A 1.7-metre drill section contained 0.117% copper and 0.007% molybdenite. Another section assayed 0.028% copper and 0.015% molybenite over 1.1 metres (Assessment Report 7323).

MINFILE NUMBER: 092B 137 **NAME: POLY 2**

NORTHING: 5411350 EASTING: 434225 STATUS: Showing

CAPSULE GEOLOGY:

The Poly 2 occurrence is hosted by sediments of the Mississippian to Pennsylvanian Fourth Lake Formation (previously the upper part of Muller's Myra Formation), Buttle Lake Group. The sediments consist of interbedded laminated chert, argillite and siltstone with beds of fine to coarse-grained tuff. Bedding strikes northwest with a moderate to steep northeast dip. The unit, particularly the cherty intervals, is locally cut by quartz veins and veinlets.

A feldspar porphyritic diabasic to basaltic sill (informally called the Mount Hall Gabbro), likely coeval with the Upper Triassic Karmutsen Formation, is exposed over several hundred metres in the area. The contact of the sediments and the sill strikes 335 degrees and dips 30 degrees northwest.

Mineralization is reported to comprise manganese oxides in quartz veins and manganese-rich chert or greenish grey to pink rhodonite in close proximity to the vein. The quartz vein is up to 0.7 metres in width and is clear to whitish with a greasy luster. Up to 10% manganese oxide minerals, including pyrolusite and psilomelane, and associated limonite staining occurs. The vein assayed 1.82% manganese across 0.7 metres and adjacent manganiferous wallrock with quartz veinlets sampled on either side of the vein, assayed 9.24 and 7.16% manganese (Assessment Report 16906). Silver assays up to 1.3 grams per tonne were also obtained from these samples.

MINFILE NUMBER: 092B 138 **NAME: POLY**

NORTHING: 5412950 EASTING: 432850 STATUS: Showing

CAPSULE GEOLOGY:

The Poly occurrence is hosted by sediments of the Mississippian to Pennsylvanian Fourth Lake Formation (previously the upper part of Muller's Myra Formation), Buttle Lake Group. The sediments consist of interbedded laminated chert, argillite and siltstone with beds of fine to coarse-grained tuff. The unit, particularly the cherty intervals, is locally cut by quartz veins and veinlets. A feldspar porphyritic diabasic to basaltic sill, likely coeval with the Upper Triassic Karmutsen Formation, invades the strata.

Argillite interbedded with a foliated tuff strikes west- northwest with a moderate northerly dip. Foliation has the same strike but has a steep northerly dip. The argillite contains finely disseminated pyrite and minor chalcopyrite. Limonite staining occurs locally. Samples from this zone assayed up to 1.0 gram per tonne silver and 0.056% zinc (Assessment Report 16906).

MINFILE NUMBER: 092B 139 **NAME: MAPLE MOUNTAIN**

NORTHING: 5410000 EASTING: 454500 STATUS: Showing

CAPSULE GEOLOGY:

The Maple Mountain occurrence area is underlain by basaltic andesites of the Devonian Nitinat Formation, Sicker Group. These are intruded by gabbroic rock (informally called the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Vancouver Group), and by quartz-feldspar porphyry of the Late Devonian Saltspring Intrusive Suite (formerly the Saltspring Intrusions), (Massey, N.W.D., Personal Communication, 1991).

A massive, milky white quartz vein occurring on the northwest flank of Maple Mountain contains 1% disseminated chalco- pyrite. A grab sample assayed 0.35% copper (Assessment Report 16029, page 14).

MINFILE NUMBER: 092B 140 **NAME: QUARRY**
NORTHING: 5412000 EASTING: 450850 STATUS: Showing

CAPSULE GEOLOGY:

The Quarry area is underlain by pyritic silicified metasediments of the Upper Devonian McLaughlin Ridge Formation (Sicker Group) and a gabbro intrusive (informally called the Mount Hall Gabbro) that is coeval with the Upper Triassic Karmutsen Formation, Vancouver Group, (Massey, N.W.D., Personal Communication, 1991).

Two small quarries are reported to exist about 400 metres north of Crofton Lake. Some of the more heavily pyritized rocks in the area contain chalcopyrite along with malachite and bornite. In the lower quarry, where gabbro is in contact with the metasediments, extensive pyritization occurs in silicified sediments 20 metres north of the contact, along with minor amounts of copper minerals. The pyrite occurs as disseminations and as masses in fractures. At the contact is an altered chloritic schist with quartz veining confined mainly to bedding. Chalcopyrite and minor amounts of pyrite are found in the quartz.

The Phoenix showings are located in the vicinity of the quarries on the eastern slope of the ridge northwest of Crofton Lake, and overlooking Crofton. A pit, 6 metres wide and 1.5 metres deep, exposes a 1-metre wide quartz vein trending west through sheared gabbro. The vein is virtually barren except for an occasional speck of malachite (Notes by Wright, 1969).

MINFILE NUMBER: 092B 141 **NAME: WEST 2**
NORTHING: 5411000 EASTING: 451500 STATUS: Showing

CAPSULE GEOLOGY:

The West 2 occurrence area is underlain by trachyte, and minor areas of argillite and quartz mica schist of the Upper Devonian McLaughlin Ridge Formation (Sicker Group). The strata is intruded by gabbroic rock (informally known as the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Vancouver Group), and by quartz-feldspar porphyry of the Late Devonian Saltspring Intrusive Suite (formerly called the Saltspring Intrusions), (Massey, N.W.D., Personal Communication, 1991).

Chalcopyrite was noted as disseminations near the contacts of the sediments and trachyte, and in quartz veins up to 50 centimetres in width cutting the trachyte and sediments.

MINFILE NUMBER: 092B 142 **NAME: TIDAL WAVE**
NORTHING: 5412350 EASTING: 450500 STATUS: Showing

CAPSULE GEOLOGY:

The area is underlain by rocks of the Upper Devonian McLaughlin Ridge Formation (Sicker Group). The strata is intruded by gabbroic rock (informally known as the Mount Hall Gabbro) that is coeval with the Upper Triassic Karmutsen Formation (Vancouver Group)

The old Tidal (Tital?) Wave showing is located on the summit of the ridge above Westholme, apparently on Land Lot 93. This lot is located to the immediate east of the Ironclad workings (092B 049). A pit up to 6 metres in depth exposes a 1 metre wide quartz vein trending west through gabbro. The vein is virtually barren except for an occasional speck of malachite (Notes by Wright, 1969).

MINFILE NUMBER: 092B 143 **NAME: COW 10**
NORTHING: 5414000 EASTING: 429000 STATUS: Showing

CAPSULE GEOLOGY:

The Cow 10 deposit is underlain by the Mississippian to Pennsylvanian Fourth Lake Formation of the Buttle Lake Group (formerly the upper sediment package of Muller's Myra Formation). These sediments form a northwest trending succession of interbedded argillite, cherty sediment, siltstone and sandstone, with minor conglomerate, crystal tuff and marble. A northwest trending, 30-metre wide gabbroic dike (informally known as the Mount Hall Gabbro), coeval with the Upper Triassic Karmutsen Formation (Vancouver Group), intrudes the strata northwest of the showing. A stock of quartz diorite and diorite of the Early to Middle Jurassic Island Plutonic Suite (formerly the Island Intrusions) is present to the southwest of the showing.

An approximately 10-metre thick ferruginous chert (iron formation) horizon has been traced for 700 metres. This bed is generally composed of blue-grey cryptocrystalline quartz (sporadically jasperoidal) with up to 5% each of pyrite and specular hematite and a few% magnetite. A sample of this material assayed 0.3 grams per tonne gold (Assessment Report 16053, pages 23,47,53).

A siliceous, magnetite and pyrite-rich boulder was found a few hundred metres to the northeast of the ferruginous chert. Sulphides and magnetite occur in bands up to 5 centimetres thick. A sample of this material contained up to 4.80 grams per tonne gold. Another siliceous boulder from the same area contained up to 40% sulphide-rich bands, consisting of pyrite, chalcopyrite and sphalerite. A sample of brecciated, hematitic, cherty sediment float found a few hundred metres to the northwest of the iron-rich chert exposure assayed 1.44 grams per tonne gold (Assessment Report 16053).

MINFILE NUMBER: 092B 144 **NAME: ORN 1**

NORTHING: 5417800 EASTING: 434100 STATUS: Showing

CAPSULE GEOLOGY:

The Orn 1 showing occurs in a gabbro sill (part of the informally called Mount Hall Gabbro) that is coeval with the Upper Triassic Karmutsen Formation, Vancouver Group. A 5-cent- imetre wide quartz vein is hosted in a 10-centimetre wide shear zone that strikes 009 degrees and dips 80 degrees to the southeast. The quartz is limonitic, fractured and contains irregular lenses, up to 5 millimetres wide by 2 centimetres long, of chalcopyrite, specular hematite and malachite. A sample of this material contained 0.07 grams per tonne gold, 16.4 grams per tonne silver and 0.42% copper (Assessment Report 17351, page 36).

MINFILE NUMBER: 092B 145 **NAME: LADY C**

NORTHING: 5420150 EASTING: 437900 STATUS: Showing

CAPSULE GEOLOGY:

The Lady C occurrence area is mapped as being underlain by diorite and granodiorite of the Early to Middle Jurassic Island Plutonic Suite (formerly called the Island Intrusions).

An iron ore deposit (the Lady C) was located in the area in the early 1950s and is probably similar to the jasper-hosted Lady D deposit (092B 076) which occurs on strike several kilometres to the southeast. The Lady D is an exhalative-type iron ore deposit, consisting primarily of magnetite, occurring in the Devonian Nitinat Formation, Sicker Group

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MINFILE NUMBER: 092B 146 **NAME: LADY B**

NORTHING: 5421100 EASTING: 428600 STATUS: Showing

CAPSULE GEOLOGY:

The Lady B iron ore deposite is underlain by rock of the Mississippian to Pennsylvanian Fourth Lake Formation, Buttle Lake Group. These are intruded by Late Triassic gabbro (informally knowm as the Mount Hall Gabbro (Massey, N.W.D., Personal Communication, 1991). Except for a map indicating the location no other details are available (Buckham, 1953).

MINFILE NUMBER: 092C 074 **NAME: COW**

NORTHING: 5416875 EASTING: 425990 STATUS: Prospect

CAPSULE GEOLOGY:

The Cow showing is located 27 kilometres northwest of Duncan. Several showings occur in the area; the Pogo showing was the initial discovery.

The property is underlain by Mississippian to Pennsylvanian Fourth Lake Formation (Buttle Lake Group) cherty argillite and by Upper Devonian McLauglin Ridge Formation (Sicker Group) volcani- clastics. These rocks are intruded by granodiorite and quartz diorite of the Early to Middle Jurassic Island Plutonic Suite and Triassic gabbro (informally called the Mount Hall gabbro). Sulphide mineralization occurs in rusty shear zones as disseminations, and/or stringers along bedding, cleavage or crosscutting fractures. Miner- alization is hosted in laminated sediments and volcaniclastics spatially associated with the gabbroic dikes. Pyrite and minor chalcopyrite are finely disseminated throughout the rocks.

The Pogo showing, near the centre of the Cow property on the Cow 15 claim, consists of pyrrhotite, pyrite (up to 5%), chalco- pyrite (less than 1%), sphalerite and galena. Spahlerite and galena have not been confirmed for the Pogo showing and if present would be rare. Mineralization occurs disseminated, along fracture planes and in quartz-carbonate stringers (up to 2 centimetres wide) in a fractured-medium grained gabbroic dike which intrudes black cherty argillites of the Fourth Lake Formation (previously known as the "Sediment-Sill Unit" of the Paleozoic Sicker Group). Mineraliz- ation occurs at a synclinal fold axis where the sill is "pinched" as it crosses from the west limb to the east limb. The best assays are 0.42% zinc over 3 metres, 0.48% lead, 0.09% copper and trace silver from different 1.5 metre samples (Assessment Report 14462).

The area of the main quartz carbonate vein, on the Cow 14 claim, is underlain by pyroclastic and sedimentary rocks of the McLaughlin Ridge Formation adjacent to a gabbro dike (130 metres to the east).

The rocks trend west-northwest, are tightly folded and contain 3 to 5% pyrrhotite. The vein occurs in a east trending shear zone, several metres wide, in silty, sandy and lapilli tuffs. The vein, exposed along strike for 20 metres, strikes 94 to 100 degrees and dips 85 degrees south. The vein, 5 to 20 centimetres wide, is well- mineralized with pyrite (2 to 10%) and lesser amounts of pyrrhotite, galena and sphalerite (up to 3%) and chalco- pyrite. The highest assay from a sample (#14024) of vein material was 13.03 grams per tonne gold over 5 centimetres (Assessment Report 16097).

On the Cow 12 claim, several mineralized shears hosted in northwest trending fine-grained sediments of the Fourth Lake Formation are exposed along a road. These define a 100 metre wide zone of sporadic mineralization. The shears are up to 0.20 metres wide, gougy, limonitic and contain up to 5% each of pyrite and chalcopyrite. A few pyrite and chalcopyrite bearing shear zones adjacent to gabbroic rocks carry weakly elevated gold values and up to 28 grams per tonne silver (Assessment Report 16097).

APPENDIX 3

SUMMARY OF ASSESSMENT REPORT WORK RECORDED WITHIN THE DUNCAN MAP AREA

Data is abstracted from the Ministry's ARIS database which should be consulted for more complete information and for assessment reports filed after December 1989.

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
19	449869	5410972	VICT	Bobs	McLellan W.	1948	GEOL
				Lucky Strike	Dolmage V.		
				New Ironclad			
				Peter			
936	437924	5414427	VICT	Lot	Cominco	1966	GEOP
				Rum	Tikkanen G.		
				Tot			
1104	443660	5413625	VICT	Lenora	Mt. Sicker Mines	1967	GEOL
				Richard III	Sheppard E.		
				Tyee	Basco D.		
1714	443660	5413625	VICT	Lenora	Mt. Sicker Mines	1968	GEOP
				Richard III	Sheppard E.		
				Tyee			
2397	450968	5410777	VICT	Sirius	Canpac Min.	1970	GEOL
					Douglas D.		GEOP
					MacFarlane P.		
2914	442573	5414933	VICT	Dawn	Mt. Sicker Mines	1970	PHYS
					Brooks J.		
3099	441083	5412726	VICT	Copper Canyon	Kinneard L.	1971	GEOP
				Elmore Fr.	Whittles A.B.L.		GEOC
				Susan			
				Victoria			
3741	443660	5413625	VICT	Alliance Fr.	Ducanex Res.	1972	PHYS
				Margie			
				Mollie			
				Yankee			
3950	443660	5413625	VICT	CF GR.	Ducanex Res.	1972	GEOL
				Dawn	Watson I.M.		
				M.L. 13			
3951	443660	5413625	VICT	B	Ducanex Res.	1972	GEOP
				CF GR.	Walcott P.E.		
				DAWN			
				M.L. 13			
4626	441083	5412726	VICT	Copper Canyon	Viva Ventures	1973	GEOL
				Elmore Fr.	Whittles A.B.L.		GEOP
				Muriel Fr.			
				Susan			

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
4904	443660	5413625	VICT	CF	Mt. Sicker Mines	1973	GEOP
				CPOG	Nielsen P.		
				Golden Rod	Gutrath G.		
				Moline Fr.			
5164	443660	5413625	VICT	CF	Dresser Ind.	1974	DRIL
				Lenora	Carter J.		
				Richard III			
				Tyee			
6216	439995	5413849	VICT	Mildred	Deighton J.R.	1976	GEOL
					Deighton J.R.		
6518	437713	5417394	VICT	Nonsuch	Deighton J.R.	1977	GEOL
					Deighton J.R.		
6548	437924	5414427	VICT	Holy	Imperial Oil	1977	GEOP
				VV	Doborzynski Z.		PHYS
				YY	Somerville R.		GEOC
				ZZ			
6599	441083	5412726	VICT	Susan	Deighton J.R.	1977	GEOC
				Victoria	Deighton J.R.		
6600	441083	5412726	VICT	Elmore Fr.	Deighton J.R.	1977	GEOL
					Deighton J.R.		
6602	441083	5412726	VICT	Margie	Deighton J.R.	1977	GEOL
				Mollie	Deighton J.R.		
				Mollie Fr.			
				Yankee			
6698	436095	5414819	VICT	Hope	BHP-Utah Mines	1977	GEOL
					Deighton J.R.		GEOP
					Vyselaar J.		GEOC
6699	443660	5413625	VICT	Faith	BHP-Utah Mines	1977	GEOL
					Deighton J.R.		GEOP
					Vyselaar J.		
6807	444404	5414730	VICT	Twin G	Union Miniere Ex.	1978	GEOC
					Pauwels A.M.		
6972	441083	5412726	VICT	Copper	Kinneard G.E.	1978	GEOL
				Klondyke	Whittles A.B.L.		GEOP
				Victoria			
6996	443660	5413625	VICT	CF	Serem	1978	PHYS
				Richard	Ronning P.		
				Rocky			
				Tyee			
7183	441083	5412726	VICT	Charity	Union Miniere Ex.	1979	GEOP
				Coppermint I	Pauwels A.M.		
				Susan			
				Victoria Fr.			
7233	451082	5409850	VICT	Croft	Serem	1979	GEOL
					Grette J.		GEOC

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
7273	439995	5413849	VICT	Mildred	Union Miniere Ex.	1979	GEOC
					Pauwels A.M.		
7323	439901	5416444	VICT	Brent	Esso Res. Can.	1978	DRIL
			NIMO	Oak	Somerville R.		
				QQ			
7384	431226	5416359	VICT	Bear	Union Miniere Ex.	1978	GEOC
				Deer	Pauwels A.M.		
				Elk			
				Pika			
7434	443660	5413625	VICT	Faith	Union Miniere Ex.	1979	GEOC
				Nonesuch	Pauwels A.M.		
7435	441083	5412726	VICT	Charity	Union Miniere Ex.	1979	GEOC
				Coppermint	Pauwels A.M.		
				Hope			
				Susan			
7714	443660	5413625	VICT	Alliance Fr	Serem	1979	GEOL
				Morley-Jane	Ronning P.		PHYS
				Patricia-Jan	Allen G.J.		GEOC
				Peggy Fr.			
7875	443660	5413625	VICT	Acme	Serem	1979	GEOL
				Margaret	Allen C.		GEOC
				Rocky	Ronning P.		
8168	443660	5413625	VICT	CF	Serem	1980	GEOP
				Rocky	Ronning P.		PHYS
							GEOC
8264	446355	5414340	VICT	Belle	Serem	1980	DRIL
				Chemainus	Ronning P.		
				Dunsmuir			
				Little Nugget			
10116	436449	5413703	VICT	Silver	Laramide Res.	1981	GEOP
					Belik G.		GEOC
					DiSpirito F.		
10171	432480	5408932	VICT	Al	SMD Min.	1982	GEOC
				And	Chan D.		
				Bar			
				Jac			
				Roy			
10837	432368	5399669	VICT	Al	SMD Min.	1982	GEOP
				Bar	Chan D.		
				Jac			
				Roy			
10838	442019	5408639	VICT	Len	SMD Min.	1982	GEOP
				Tine	Chan D.		
				Val			

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
11123	436449	5413703	VICT	Fang	Aberford Res.	1982	GEOL
				Silver	Smee B.		GEOP
				Solly	Cartwright P.		GEOC
				TL			PHYS
11166	439901	5416444	VICT	Brent	Esso Res. Can.	1982	GEOP
					Cooper W.G.		
11328	443152	5411778	VICT	Margie	Cominco	1983	GEOL
				Mollie	Sorbara J.P.		PHYS
				Yankee			GEOC
11329	440125	5414589	VICT	Mildred	Cominco	1983	GEOL
				Nonesuch	Sorbara J.P.		PHYS
				Nugget			GEOC
11345	429516	5416380	VICT	Chip	Esso Res. Can.	1983	GEOP
					Everett C.		PHYS
					Cooper W.G.		GEOC
11433	451346	5412071	VICT	West	Bilquist R.	1983	PROS
					Bilquist R.		
11563	428464	5420100	VICT	Hart 3-5	Cominco	1983	GEOL
					Freeze A.		GEOC
11841	447069	5412295	VICT	Geo	Lieberman P.	1982	DRIL
				Sicker	Lonsdale R.		GEOC
12048	444458	5420102	VICT	JJ	Joyce J.	1982	PROS
					Joyce J.W.		
12172	442560	5413637	VICT	Seattle	Falconbridge Copper	1984	DRIL
					Davidson A.J.		
12315	440165	5418294	VICT	Ermelina 13-14	BHP-Utah Mines	1984	GEOP
			NIMO	JJ	Witherly K.		
				JJ 1-4	Holland G.		
				JRM			
				JRM 1-12			
				Sheila B1			
				Sheila B2			
12317	442560	5413637	VICT	Herbert	Falconbridge Copper	1984	DRIL
				XL	Davidson A.J.		
12379	437071	5414622	VICT	Brent 1	Esso Res. Can.	1984	GEOL
				Oak 1-3	Britten R.		GEOC
12525	431633	5419689	VICT	Lady 1-2	Lode Res.	1984	GEOC
					Schorn T.F.		
12678	424367	5424045	NIMO	Imp J	Imperial Metals	1983	GEOP
				Imp K	Quin S.		
				Imp L	De Carle R.J.		
				Imp M			
12788	440165	5418294	VICT	Ermelina	BHP-Utah Mines	1984	GEOL
			NIMO	JJ	Holland G.		PHYS
				JRM			GEOC
				Sheila B1			

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
12917	427715	5399912	VICT	Skutz 1	Noranda Ex.	1984	GEOL
					Stewart C.		GEOC
13375	463244	5399566	VICT	Bruce 1-2	Kidd Creek Mines	1984	GEOL
				Mus	Mallalieu D.		GEOP
				Musgrave 1-2	Hendrickson G.A.		PHYS
				Salt 1			GEOC
				Salt 2-3			
				Sul 1-2			
13468	425611	5425882	NIMO	Imp J	Imperial Metals	1984	GEOP
				Imp L	Clark A.M.		
				Imperial H	Walcott P.E.		
13532	451098	5411702	VICT	West 1-8	Falconbridge	1985	GEOP
					Chandler T.		
					Martyn D.		
13655	436460	5414629	VICT	Fang	Aberford Res.	1985	GEOP
				Flat	Blackadar D.W.		GEOL
				Jennie	LeBel J.L.		PHYS
				Klondyke			
				Nero			
				Silver I-II			
				Solly			
				Susan			
				T.L.			
				Tintoview			
				Ugly			
13744	438903	5414602	VICT	Brent 1	Kidd Creek Mines	1985	GEOP
				Oak 1-3	Hendrickson G.A.		PHYS
13853	451106	5412629	VICT	West 2	Falconbridge	1985	DRIL
					Chandler T.		GEOC
					Lear S.R.		
13907	446208	5411747	VICT	Lawarance	Falconbridge Copper	1985	GEOL
				Sicker 1-2	Lefebure D.		GEOC
13996	463244	5399566	VICT	Bruce 1-2	Kidd Creek Mines	1985	GEOL
				Musgrave 2	Mallalieu D.		GEOP
				Salt 1	Hendrickson G.A.		PHYS
							GEOC
14008	441386	5418281	VICT	JRM 3	BHP-Utah Mines	1985	PHYS
			NIMO	JRM 7	Holland G.		GEOC
14267	429246	5423981	NIMO	Thriller	Canamin Res.	1985	PROS
					Specogna E.		GEOL
14411	439504	5413669	VICT	Brent 1	Kidd Creek Mines	1986	DRIL
				Oak 1-2	Enns S.		GEOC
14462	426345	5416792	VICT	Cow 12-16	J.B.L. Res.	1986	GEOL
					Neale T.		GEOC
					Hawkins T.		

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
14492	433647	5414477	VICT	Silver 1	Aberford Res.	1986	DRIL
				Solly	Blackadar D.W.		GEOC
14497	454132	5408897	VICT	Crof 1	Canamax Res.	1986	PHYS
					Fleming D.B.		GEOC
					Bruce D.		
14669	440295	5419034	VICT	JRM 1-3	BHP-Utah Mines	1986	GEOP
			NIMO	JRM 7-8	Holland G.		PHYS
					Ord R.S.		GEOC
14712	430373	5416555	VICT	Chip 1-5	Kidd Creek Mines	1986	GEOP
				Chip 8	Hendrickson G.A.		PHYS
14735	442560	5413637	VICT	Bonnie III	Falconbridge Copper	1986	DRIL
				Rocky 5	Lefebure D.		
14793	425574	5423102	NIMO	Imp J	Imperial Metals	1986	GEOL
				Imp K	Clark A.		GEOP
				Imp L			GEOC
				Imp W			PHYS
14919	433974	5411137	VICT	Poly	Specogna E.	1986	PROS
				Poly 2	Specogna E.		PHYS
							GEOC
14929	444880	5413428	VICT	Acme	Falconbridge Copper	1986	DRIL
				Acme Fr.	Davidson A.		
				Blue Bell			
				CF Group 13-18			
				Dixie Fr.			
				Donagan			
				Estelle			
				Golden Rod			
				Moline Fr.			
				Nellena			
				Rocky 2			
				Rocky 5			
				Rocky 6 Fr.			
				Tony			
15013	426152	5411421	VICT	Cow 7	Int. Cherokee Dev.	1986	GEOL
				Cow 9-11	Neale T.		GEOC
					Hawkins T.		
15136	430648	5418960	VICT	Ermelina 5-11	Rafael Res.	1986	GEOP
				Lady 2	Green K.		GEOC
15389	430816	5412843	VICT	Myra	Int. Cherokee Dev.	1986	GEOL
				Never Sweat	Getsinger J.S.		GEOP
							GEOC
15442	440784	5419029	VICT	JRM 3	BHP-Utah Mines	1986	DRIL
				JRM 7-8	Holland G.		GEOC

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
15504	429770	5417118	VICT	Chip 1-5	Kidd Creek Mines	1987	GEOP
				Chip 7-8	Hendrickson G.A.		
				Chip 11 Fr.			
				Chip 13 Fr.			
15556	445234	5412127	VICT	Sicker 1	Falconbridge Copper	1986	GEOP
				Rocky 1-2	Burge C.M.		PHYS
15719	443772	5412698	VICT	Queen Bee	Falconbridge Copper	1986	GEOP
				Key City	Gibson H.L.		DRIL
				Tony			GEOC
				Sicker 1			
				Rocky 2			
				Estelle			
				XL			
				Herbert			
				Morley-Jayne			
15737	436460	5414629	VICT	Silver 1-2	Abermin	1986	DRIL
				Fang	McLaughlin A.D.		GEOL
				Tooth	Kapusta J.D.		GEOC
				Touche	Blackadar D.W.		PHYS
				Cavity			
				Solly			
				T.L.			
				Jennie			
				Ugly			
				Wimp			
				Nero			
				Face			
				Plant			
				Cor 1-7			
				Susan			
15749	440334	5418817	VICT	JRM 3	Utah Mines	1986	DRIL
				JRM 7-8	Holland G.		GEOP
							PHYS
							GEOC
15823	432763	5412078	VICT	Poly	Specogna E.	1987	DRIL
							PHYS
15881	430408	5419334	VICT	Ermelina	Lode Res.	1987	GEOC
				Ermelina 1-11	Laanela H.		GEOP
				Lady 1-2			GEOL
				Optimus			PHYS
				Prime			

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
16029	453525	5409458	VICT	Beatrice I-IV	Falconbridge	1987	GEOC
				Crof 1	Booth K.		GEOL
				John Travers			PHYS
				John Travers I-IV			
				PF			
				P.F. III			
				P.F. V			
				Peggy I-IV			
16053	429121	5414162	VICT	Cow 7	Int. Cherokee Dev.	1987	DRIL
				Cow 9-11	Allen G.J.		GEOC
							GEOP
							GEOL
							PHYS
16097	425971	5416241	VICT	Cow 12-16	Int. Cherokee Dev.	1987	DRIL
					Allen G.J.		GEOC
							GEOP
							GEOL
							PHYS
16163	444402	5414544	VICT	Plum	Falconbridge Copper	1987	GEOL
					Gray M.J.		GEOC
16164	440308	5408843	VICT	Bob	Consort Energy	1987	PROS
					Hayes T.		GEOC
16200	430811	5412473	VICT	Never Sweat	Int. Cherokee Dev.	1987	GEOC
					Allen G.J.		GEOP
							GEOL
							PHYS
16201	428992	5403972	VICT	Bick 1-5	BP Min.	1987	DRIL
					Wong R.H.		GEOC
							GEOL
16217	435808	5411116	VICT	Murial 1	Decker J.	1987	PROS
16237	428832	5410645	VICT	Cow 5-6	Int. Cherokee Dev.	1987	GEOC
				Cow 8	Allen G.J.		GEOL
				Namiko			PHYS
				Namiko 1 Fr.			
				Namiko 2 Fr.			
16289	435043	5418907	NIMO	Orn 1-4	Hayes E.	1987	GEOC
			VICT		Neale T.		GEOL
16319	452303	5409654	VICT	PF	Kidd Creek Mines	1987	DRIL
					Money D.P.		GEOC
16330	442384	5408450	VICT	Bet 1-8	Int. Field Services	1987	GEOC
					Hainsworth W.		
16350	432142	5411345	VICT	Ryan	Decker J.	1987	PROS
16351	434206	5410023	VICT	Bud 3-6	Decker J.	1987	PROS
					Decker J.		
16452	437363	5418881	VICT	Brenton	Vancouver Venture	1987	GEOC
					Wahl H.J.		PROS

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
16453	428739	5422505	VICT	Ridgestake Ridgestake I	Vancouver Venture Wahl H.J.	1987	PROS
16710	431550	5416170	VICT	Chip 1 Chip 12 Fr.	Kidd Creek Mines Enns S. Pattison J.M.	1987	DRIL
16716	440247	5412642	VICT	Sicker 1 Copper Canyon Coppermint 1-3	Minnova Wells G.S.	1987	DRIL
16825	431550	5416170	VICT	Chip 1	Kidd Creek Mines Enns S. Pattison J.M.	1987	DRIL GEOC
16871	440557	5413009	VICT	Copper Canyon	Minnova Wells G.S.	1987	DRIL
16906	433972	5410952	VICT	Poly Poly 2	Canamin Res. Hawkins T.G. Thomae B.	1987	GEOL GEOC
16999	433950	5409100	VICT	Helga 1-3	Decker J. Decker J.	1987	PROS
17007	451106	5412629	VICT	West 1-2	Falconbridge Money D.P. Pattison J.M.	1988	DRIL GEOC
17138	427355	5408378	VICT	Josh 1-3	Rajala D.F. Rajala D.F.	1988	PROS GEOP
17231	432131	5410388	VICT	Gold Tusk	Int. Cherokee Dev. Allen G.J.	1988	GEOL GEOC
17351	435413	5419212	NIMO VICT	Orn 1-4	Avondale Res. Hawkins T.G.	1988	GEOL GEOC GEOP PHYS
17649	438903	5414602	VICT	Holyoak 2	Falconbridge Esso Res. Can. Clemmer S.G.	1988	DRIL
17834	442915	5412521	VICT	Richard III	Minnova Wells G.S.	1988	DRIL
17836	440843	5413099	VICT	Victoria	Minnova Wells G.S.	1988	DRIL
17857	433464	5414479	VICT	Solly T.L. Jennie	Abermin Kapusta J.D.	1988	DRIL
18293	432794	5414672	VICT	Chip 1-3 Chip 16 Fr.	Falconbridge Esso Res. Can. Clemmer S.G.	1989	DRIL
18520	443561	5411959	VICT	Westholme	Minnova Baxter P.	1989	DRIL GEOC

ASSESSMENT REPORT NO.	EASTING	NORTHING	MINING DIVISION*	CLAIM(S) WORKED ON	OPERATOR(S)/ AUTHOR(S)	REPORT YEAR	WORK TYPE**
18561	430281	5409144	VICT	Cassey	Rajala D.F.	1989	PROS
				Rajala D.F.			GEOP
							PHYS
18755	428002	5422144	VICT	SB	Vancouver Venture	1989	GEOC
					Ven Huizen G.L.		
18859	442550	5412710	VICT	Nellena	Minnova	1989	DRIL
				Westholme	Wells G.S.		GEOC
				Bluebell			
				Key City			
				Herbert			
				Tyee			
18871	425413	5411060	VICT	Cow 1-6	Int. Cherokee Dev.	1989	GEOL
				Cow 8	Lorenzetti G.M.		GEOC
				Namiko			GEOP
				Namiko 1			
				Namiko 2 Fr.			
18908	433928	5407247	VICT	Melore	Pardek M.M.	1989	PROS
				Ellen	Wood D.H.		
				Sulphide			

** Mining Division*

NIMO: Nanaimo
VICT: Victoria

***DRIL: Drilling*
GEOC: Geochemistry
GEOL: Geological mapping
GEOP: Geophysics
PHYS: Physical (trenching, etc.)
PROS: Prospecting

APPENDIX 4

CORONATION ZONE, LARA PROPERTY*

The discovery trench of the Coronation Zone of the Lara massive sulphide lens was sampled in the fall of 1986. Ten chip samples were taken, over a true thickness of 3.2 metres from the footwall into the hangingwall. Trace and major element analyses are presented below. In general, the highest copper value occurred in the centre of the lens and the highest lead value at the top, consistent with typical zoning patterns of volcanogenic massive sulphide lenses.

The lens consists predominantly of massive to laminated sphalerite with pyrite, galena, minor chalcopyrite and high precious metal values. It is within a tuffaceous quartz-eye rhyolite unit in the McLaughlin Ridge Formation of the Sicker Group. Other mineralized zones within the Coronation and Coronation Extension zones include a silicious facies, comprising various amounts of sulphides in a chert-quartz unit, minor massive pyrite or chalcopyrite facies and massive white quartz veins with high gold-silver values.

TABLE 1
TRACE ELEMENTS, BASE METAL AND OXIDE ANALYSES OF SURFACE CHIP SAMPLES, CORONATION ZONE, LARA PROPERTY

NO.	LAB	TYPE	WIDTH	Au ppm	Ag ppm	Cu %	Pb %	Zn %	Co ppm	Ni ppm	Mo ppm	As ppm	Sb ppm
LARA 1	32561	fw	70	0.063	<10	0.01	0.017	0.18	16	6	<5	470	23
2	32562	fw/ms	60	0.283	16	0.01	0.02	0.02	15	6	<5	365	17
3	32555	ms	40	1.46	342	1.30	3.90	9.5	42	7	230		
4	32556	ms	65	3.48	283	1.73	3.50	43.00	10	26	220		
5	32557	ms	40	12.86	154	7.67	2.67	43.00	6	14	206		
6	32558	ms	37	3.67	365	2.40	4.53	45.00	5	17	133		
7	32559	ms	53	5.00	312	4.47	3.90	51.00	6	15	167		
8	32560	ms	58	17.80	381	4.33	8.03	40.00	15	24	320		
9	32563	hw	53	0.989	140	0.12	0.52	0.95	18	5	15	306	453
10	32564	hw	70	0.442	14	0.04	0.15	0.45	18	7	<5	97	82

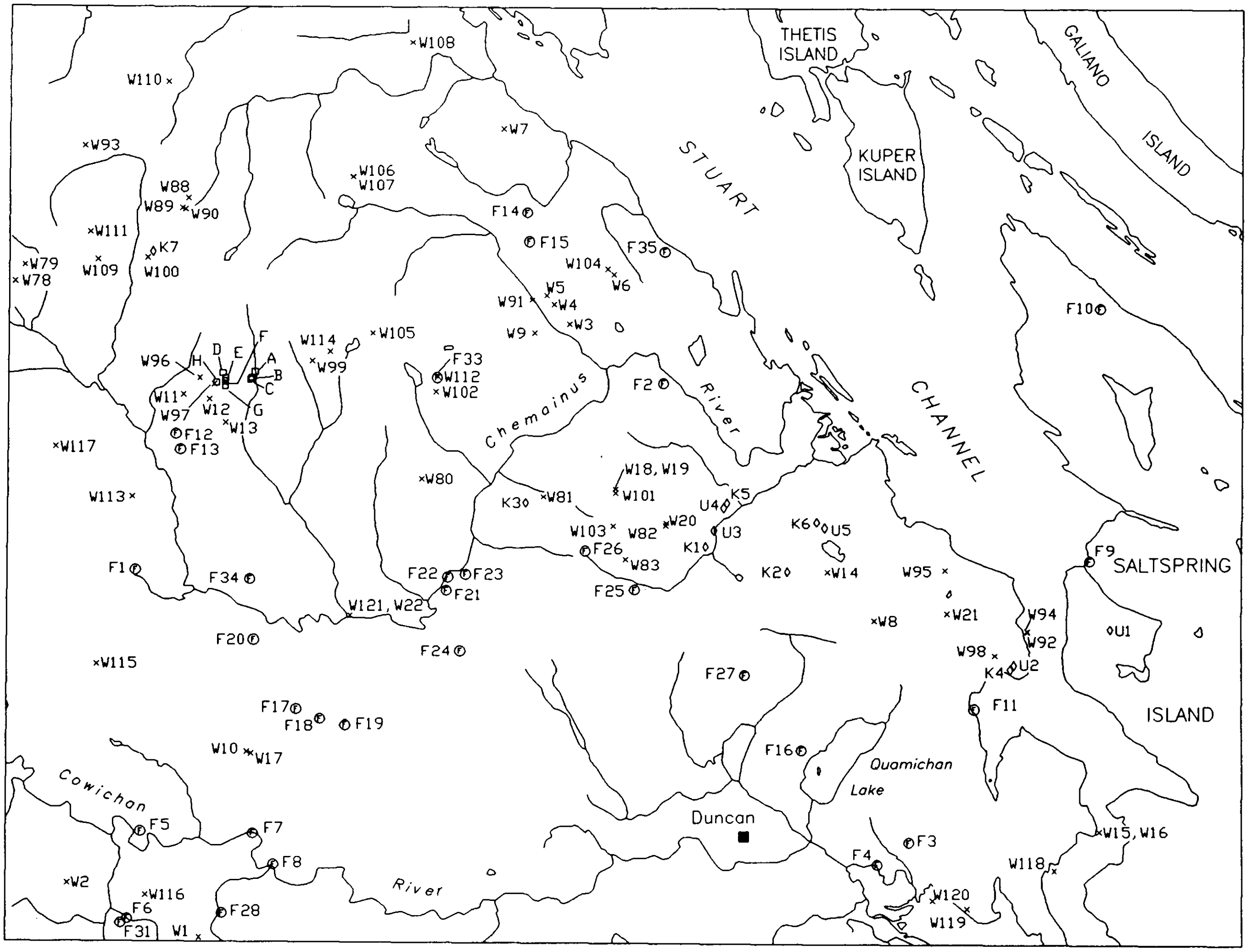
NO.	LAB	TYPE	SiO_2	TiO_2	Al_2O_3	FeO_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Loi
LARA 1	32561	fw	67.57	0.30	16.76	1.79	0.02	1.07	1.40	0.00	5.47	0.09	3.82
2	32562	fw/ms	65.95	0.28	15.59	2.14	0.03	1.09	2.66	0.00	5.15	0.04	4.58
9	32563	hw	60.87	0.26	13.01	3.37	0.02	0.94	5.26	0.77	3.96	0.01	7.63
10	32464	hw	73.16	0.24	14.55	1.96	0.03	0.75	0.31	3.03	3.41	0.06	2.07

fw - footwall of massive sulphide zone
ms - massive sulphides
hw - hanging wall of massive sulphide zone

*based on notes and data supplied by T. Höy

APPENDIX 5

TABULATED ISOTOPIC AGE SAMPLE DATA, WHOLE-ROCK GEOCHEMICAL ANALYSES



Whole rock geochemical samples (A5-3, A5-4)................... ×
K-Ar isotopic age samples (A5-1).. K◊
U-Pb isotaoic age samples (A5-2)... U◊
Fossil locations (A6).. ⓕ

APPENDIX 5 - TABLE 1
POTASSIUM-ARGON ISOTOPIC AGE DETERMINATIONS
IN THE DUNCAN MAP AREA (92B/13)

MAP NO.	SAMPLE NO.	UTM (Zone 10) EASTING	NORTHING	ROCK TYPE	MINERAL	K (%)	40*Ar (x10-6cc/gm)	40Ar (%)	Age ± 1δ (Ma)	REFERENCE
K1	Sicker 3	447305	5411367	Pyroxene crystal tuff (Nitinat Fm)	Uralite				421±36**	1
K2	E80-77 #24517M	449744	5410603	Pyroxene crystal tuff (Nitinat Fm)	Uralite				288±28**	1
K3	GSC/66-34	441939	5412717	Schist (McLaughlin Ridge Fm)	Whole Rock				167±20**	2
K4	GSC/80-21	456448	5407768	Quartz porphyry (Saltspring Int.)	Muscovite				180±8**	3
K5	SIC 1AM	447929	5412658	Gabbro	Hornblende	0.346±0.007	2.689	49.2	190±7	4
K6	E80-24 #24566M	450613	5412078	Mafic intrusiona	Uralite				363±26**	1,5
K7	NMA87-36-1-2	430872	5420166	Hornblende-feldspar porphyry dike (Minor Int.)	Hornblende	0.383±0.001	3.205	93.8	203±7	

* = Radiogenic argon; ** Age±2δ
Decay constants: 40Ke = 0.581 x 10-10 year-1; 40Kb = 4.96 x 10-10 year-1; 40K/K = 1.167 x 10-4.
Potassium determined at The University of British Columbia, Geochronology Laboratory.
Argon determination and age calculation by J.E. Harakal, The University of British Columbia.

Notes: (a) Sample was from drill core and identified as mafic intrusion (?Triassic), though age suggests it may be Sicker Group

References: (1) Geochronology data file of R.L. Armstrong (University of British Columbia) as quoted by Brandon et al. 1986; (2) Wanless et al. 1968; (3) Stevens et al. 1982; (4) Armstrong et al. 1986; (5) Eastwood, 1983

APPENDIX 5 - TABLE 2
URANIUM-LEAD ISOTOPIC AGE DETERMINATIONS IN THE DUNCAN MAP AREA (92b/13)

MAP NUMBER	SAMPLE NUMBER	MAP SHEET	EASTING	NORTHING	LOCATION	FORMATION	LITHOLOGY	MINERAL	DATE	COMMENT	REFERENCE
U1	MEZ-77-1	92B/13	459392	5408950	Mount Maxwell, Saltspring Island. On powerline, 3/4 mi N of west tip of Lake Maxwell.	Ds	meta-quartz porphyry	zircon	393 +25/-10** UI 92 +120/-130** LI	Discordant; 5 points on good linear array.	1,2
U2	WN-19-74	92B/13	456448	5407768	Arbutus Point, NW of Maple Bay.	Ds	quartz porphyry	zircon	>370	Discordant; 4 points with poor dispersion. Pb-Pb ages of 361 - 395 Ma.	1,2
	MEZ-76-3	92B/14	467431	5403061	Lake Stowell, Saltspring Island. Roadcut on road from Fulford Harbour to Beaver Point.	Ds	granodiorite	zircon	>370	Discordant; 4 points with poor dispersion. Pb-Pb ages of 357 - 379 Ma.	1,2
	84925-1	92B/14	472774	5402291	Southern Saltspring Island, on south side of cove just N of Beaver Point.	Ds	quartz-feldspar porphyr	zircon	366 ± 2	Concordant; 5 points	3
U3	85225-2	92B/13	447637	5411981	Highway 1, 2.25 km south of Chemainus River, west side of road.	Ds	quartz-feldspar porphyr	zircon	363 ±2	Concordant; 4 points	3
U4	SIC-1AM	92B/13	447929	5412658	Highway 1, 1.4 km south of Chemainus River, west side of road.	Tri	gabbro	zircon	217 - 222	Concordant; 2 points K-Ar age = 190 ± 14 Ma	4,2
U5	84822-1C	92B/13	450931	5412038	N of Mt Richards, W of Crofton. dirtroad off Shasta St.	Tri	gabbro	baddeleyite	227 ± 3	Concordant; 1 point Best estimate of age	3,2
								zircon	233, 285	Discordant; Pb-Pb ages interpreted as xenocrysts K-Ar age = ?363 ± 26 Ma	
	85626-1	92B/11	476255	5395328	Moresby Island, 1 km southeast of Seymour Point.	JI	quartz diorite	zircon	168 ± 2	Slightly discordant; 5 points, age from lower intercept. Upper intercept suggests Paleozoic (?Sicker Group) inheritance.	3

All analyses performed at Geological Survey of Canada except SIC-1AM, analysed at the University of British Columbia

* Error limits are ±1 sigma as Ma except where ** in which case error limits are ±2 sigma as Ma

UI = upper intercept

LI = lower intercept

References:
1: Muller (1980)
2: Brandon et al (1986)
3: Parrish (1991)
4: Armstrong et al (1985)

Formations:
Ds: Saltspring Intrusive Suite
Tri: Mount Hall Gabbro
JI: Island Plutonic Suite

APPENDIX 5 - TABLE 3
WHOLE ROCK GEOCHEMICAL DATA FOR ROCKS FROM THE DUNCAN MAP AREA

MAP NUMBER	SAMPLE NUMBER	FORMATION	LITHO-LOGIC CODE	EASTING	NORTHING	SiO_2 %	TiO_2 %	Al_2O_3 %	Fe_2O_3 %	FeO %	MnO %	MgO %	CaO %	Na_2O %
Sicker Group:														
W1	SFR87-56-2	Duck Lake Fm: suite 1	BSLT	432263	5399988	43.54	1.37	16.86	3.16	11.17	0.16	9.57	2.65	3.35
W2	SFR87-57-2	Duck Lake Fm: suite 1	BSLT	428354	5401662	52.86	0.88	14.73	3.85	6.94	0.19	4.70	6.30	5.43
W3	NMA87-31-2	Nitinat Fm: suite 1	PXPP	443367	5418115	48.62	0.74	14.28	3.30	6.49	0.18	8.29	11.16	2.22
W4	NMA87-31-4	Nitinat Fm: suite 1	BSLT	442907	5418691	49.76	0.64	11.64	2.87	6.85	0.19	10.40	12.39	1.99
W5	NMA87-31-5	Nitinat Fm: suite 1	BSLT	442689	5418971	52.60	0.78	16.78	3.39	6.21	0.17	4.93	5.92	5.07
W6	NMA87-33-6-5	Nitinat Fm: suite 1	PXPP	444687	5419567	48.92	0.78	16.90	3.64	6.28	0.18	5.00	8.41	2.00
W7	NMA87-38-6-3	Nitinat Fm: suite 1	BSLT	441422	5423941	49.86	0.99	18.52	3.61	7.80	0.14	5.47	6.43	4.50
W8	NMA87-41-9	Nitinat Fm: suite 1	BSLT	452410	5409251	50.43	0.75	17.08	3.39	5.31	0.31	5.61	6.82	4.28
W9	NMA87-42-4	Nitinat Fm: suite 1	BSLT	442320	5417862	48.69	0.74	16.20	1.91	6.20	0.14	3.82	11.01	2.49
W10	SFR87-18-3-3	Nitinat Fm: suite 1	PXTF	433711	5405476	49.21	0.74	14.05	2.31	7.67	0.22	8.78	9.92	1.81
W11	NMA87-21-9	McLaughlin Ridge Fm	FQXTF	431915	5416136	71.90	0.21	13.01	0.86	1.43	0.06	1.53	2.54	1.91
W12	NMA87-27-5	McLaughlin Ridge Fm	FQXTF	432672	5415984	71.16	0.27	15.02	1.25	1.57	0.05	1.34	1.70	2.94
W13	NMA87-27-11	McLaughlin Ridge Fm	FXTF	433148	5415298	72.34	0.33	14.46	0.90	1.29	0.02	1.59	0.25	4.89
W14	NMA87-40-7	McLaughlin Ridge Fm	QFXTF	451027	5410708	73.45	0.25	14.29	0.62	1.00	0.02	0.70	0.95	6.72
W15	NMA87-47-3-3	McLaughlin Ridge Fm	FSAND	459037	5402971	51.89	0.92	18.75	5.15	2.71	0.18	2.45	10.56	2.75
W16	NMA87-47-3-3	*duplicate analysis*	FSAND	459037	5402971	51.73	0.93	18.80	5.03	2.83	0.18	2.43	10.57	2.83
W17	SFR87-18-3-2	McLaughlin Ridge Fm	DCIT	433835	5405420	58.11	0.66	16.37	3.04	3.70	0.10	3.08	5.14	4.13
W18	SFR87-26-2-5	McLaughlin Ridge Fm	QXTF	444701	5413245	70.24	0.31	12.91	3.43	3.80	0.06	2.19	0.06	0.01
W19	SFR87-26-2-5	*duplicate analysis*	QXTF	444701	5413245	70.08	0.32	12.97	3.56	3.87	0.07	2.17	0.07	0.00
W20	SFR87-28-5	McLaughlin Ridge Fm	FXTF	446212	5412207	53.49	0.70	17.84	4.01	4.40	0.15	5.36	6.85	2.97
W21	SFR87-42-8-2	McLaughlin Ridge Fm	QFXTF	454569	5409457	76.01	0.18	13.56	0.68	0.57	0.01	0.90	0.91	5.23
W22	LARA-118-27.22	McLaughlin Ridge Fm	QXTF	432882	5416471	78.97	0.17	13.23	0.59	1.07	0.00	0.22	0.20	0.20
W23	LARA-118-49.15	McLaughlin Ridge Fm	LAMTF	432882	5416471	69.42	0.29	14.66	2.17	0.29	0.11	1.66	2.73	0.45
W24	LARA-118-71.10	McLaughlin Ridge Fm	QXTF	432882	5416471	69.45	0.25	13.55	0.90	1.81	0.09	1.32	3.63	0.68
W25	LARA-118-80.90	McLaughlin Ridge Fm	CHTTF	432882	5416471	47.98	0.61	13.61	0.80	6.83	0.25	3.54	9.08	0.70
W26	LARA-118-99.14	McLaughlin Ridge Fm	QXTF	432882	5416471	75.19	0.16	11.92	0.32	1.23	0.07	0.89	2.31	1.58
W27	LARA-118-117.52	McLaughlin Ridge Fm	FQXTF	432882	5416471	74.89	0.17	13.26	0.23	1.31	0.03	1.59	1.20	2.05
W28	LARA-118-128.15	McLaughlin Ridge Fm	FQXTF	432882	5416471	74.63	0.17	12.87	0.94	1.47	0.02	2.25	1.40	1.44
W29	LARA-118-135.12	McLaughlin Ridge Fm	QXTF	432882	5416471	75.05	0.16	12.56	0.77	0.93	0.05	0.63	2.56	0.87
W30	LARA-118-136.55	McLaughlin Ridge Fm	FQXTF	432882	5416471	74.27	0.18	13.93	0.49	1.28	0.03	1.89	1.21	1.89
W31	LARA-118-139.87	McLaughlin Ridge Fm	QXTF	432882	5416471	75.17	0.17	13.06	0.60	0.39	0.05	0.23	2.15	2.50
W32	LARA-121-27.45	McLaughlin Ridge Fm	QXTF	433140	5416369	72.61	0.27	15.20	0.99	1.03	0.07	0.68	1.79	0.26
W33	LARA-121-57.82	McLaughlin Ridge Fm	QXTF	433140	5416369	76.27	0.21	13.81	0.82	1.88	0.00	0.79	0.80	0.50
W34	LARA-121-64.62	McLaughlin Ridge Fm	LAMTF	433140	5416369	70.23	0.25	13.71	1.63	1.04	0.10	1.48	3.16	0.43
W35	LARA-121-93.70	McLaughlin Ridge Fm	QFXTF	433140	5416369	64.76	0.18	14.52	0.40	1.84	0.13	1.96	4.23	1.12
W36	LARA-121-104.98	McLaughlin Ridge Fm	QXTF	433140	5416369	72.17	0.16	12.90	0.83	0.36	0.07	1.07	3.56	0.27
W37	LARA-121-104.98	*duplicate analysis*	QXTF	433140	5416369	64.38	0.25	19.27	1.05	1.21	0.03	1.84	1.43	1.69
W38	LARA-121-116.86	McLaughlin Ridge Fm	QXTF	433140	5416369	72.14	0.17	12.89	0.80	0.39	0.07	1.06	3.55	0.28
W39	LARA-121-122.06	McLaughlin Ridge Fm	FQXTF	433140	5416369	74.36	0.18	13.80	0.55	1.16	0.03	1.66	1.96	2.40
W40	LARA-127-26.93	McLaughlin Ridge Fm	QXTF	433131	5416493	68.02	0.21	11.95	1.76	1.28	0.23	2.37	3.82	0.11
W41	LARA-127-37.39	McLaughlin Ridge Fm	QXTF	433131	5416493	72.85	0.22	12.65	0.99	1.11	0.09	1.32	2.53	0.19
W42	LARA-127-68.54	McLaughlin Ridge Fm	QXTF	433131	5416493	67.69	0.21	12.32	0.59	1.91	0.14	1.85	5.26	0.24
W43	LARA-127-79.03	McLaughlin Ridge Fm	QXTF	433131	5416493	67.52	0.25	13.23	0.96	1.87	0.10	1.74	4.89	0.38
W44	LARA-127-98.43	McLaughlin Ridge Fm	QXTF	433131	5416493	73.02	0.17	13.37	0.48	0.96	0.08	1.13	2.51	0.24
W45	LARA-127-130.54	McLaughlin Ridge Fm	LAMTF	433131	5416493	66.28	0.25	14.22	0.69	1.97	0.11	2.03	4.34	0.44
W46	LARA-128-20.36	McLaughlin Ridge Fm	FXTF	433151	5416599	63.44	0.38	14.24	0.78	3.24	0.15	1.74	4.84	0.95
W47	LARA-128-58.13	McLaughlin Ridge Fm	QXTF	433151	5416599	77.58	0.15	13.48	1.49	1.71	0.01	0.48	0.06	0.27
W48	LARA-128-80.00	McLaughlin Ridge Fm	QXTF	433151	5416599	68.74	0.27	14.04	0.81	2.11	0.10	1.71	3.24	0.31
W49	LARA-128-97.53	McLaughlin Ridge Fm	QXTF	433151	5416599	73.79	0.26	13.67	1.66	0.74	0.06	0.95	1.55	0.24
W50	LARA-128-163.41	McLaughlin Ridge Fm	QXTF	433151	5416599	68.95	0.24	13.45	0.73	1.48	0.11	1.90	3.38	0.21
W51	LARA-128-181.73	McLaughlin Ridge Fm	QXTF	433151	5416599	70.84	0.23	13.84	1.22	0.76	0.09	0.82	3.50	0.27
W52	LARA-128-207.85	McLaughlin Ridge Fm	QXTF	433151	5416599	69.13	0.22	13.62	1.20	1.63	0.11	1.42	3.69	0.20
W53	LARA-128-216.62	McLaughlin Ridge Fm	ANDS	433151	5416599	43.05	0.60	12.52	0.50	7.49	0.18	7.80	12.07	-0.10
W54	LARA-150-39.32	McLaughlin Ridge Fm	CHTTF	433069	5416737	77.13	0.25	6.09	0.92	4.71	0.10	1.52	4.22	-0.10
W55	LARA-150-73.83	McLaughlin Ridge Fm	LAMTF	433069	5416737	64.48	0.46	16.77	0.87	2.45	0.06	1.33	3.85	3.25
W56	LARA-150-87.50	McLaughlin Ridge Fm	LAMTF	433069	5416737	69.22	0.38	13.74	1.52	1.61	0.10	0.54	4.14	2.85
W57	LARA-194-151.33	McLaughlin Ridge Fm	FSPPP	433929	5416599	68.81	0.24	15.48	1.01	1.78	0.05	2.80	1.86	2.01
W58	LARA-194-170.63	McLaughlin Ridge Fm	RYLT	433929	5416599	72.53	0.18	12.71	0.55	1.61	0.05	0.87	2.05	0.92
W59	LARA-197-11.35	McLaughlin Ridge Fm	FXLTF	433895	5416537	52.01	0.63	15.40	2.84	6.00	0.25	4.55	8.57	2.44
W60	LARA-197-25.79	McLaughlin Ridge Fm	FXTF	433895	5416537	67.79	0.20	13.30	0.64	1.30	0.08	1.85	3.36	3.31
W61	LARA-197-43.00	McLaughlin Ridge Fm	QXTF	433895	5416537	72.49	0.21	14.26	0.74	0.81	0.02	0.51	1.46	3.25
W62	LARA-197-56.38	McLaughlin Ridge Fm	QXTF	433895	5416537	71.66	0.20	13.57	0.57	1.09	0.06	0.76	1.57	2.61
W63	LARA-197-69.50	McLaughlin Ridge Fm	QFXTF	433895	5416537	65.85	0.32	14.95	1.39	1.63	0.04	1.66	2.74	1.55
W64	LARA-197-75.20	McLaughlin Ridge Fm	QFXTF	433895	5416537	61.47	0.19	12.64	0.49	2.64	0.06	2.57	5.73	1.51
W65	LARA-197-79.43	McLaughlin Ridge Fm	QFXTF	433895	5416537	67.59	0.22	14.49	1.09	2.64	0.10	3.24	2.27	1.63
W66	LARA-197-85.33	McLaughlin Ridge Fm	RYLT	433895	5416537	72.93	0.22	14.57	0.63	0.86	0.03	0.75	1.31	3.48
W67	LARA-197-90.20	McLaughlin Ridge Fm	FQXTF	433895	5416537	68.96	0.23	15.21	1.08	1.75	0.05	2.99	1.32	1.67

(APPENDIX 5 - TABLE 3 Continued)

MAP NUMBER	K_2O %	P_2O_5 %	LOI %	CO_2 %	S %	Ba ppm	Sr ppm	Rb ppm	La ppm	Ce ppm	Ni ppm	Cr ppm	V ppm	Cu ppm	Zn ppm	Sc ppm	Y ppm	Zr ppm	Nb ppm
Sicker Group:																			
W1	0.79	0.12	5.26	0.10	0.02	198	208	10	15	17	28	-10	515	161	135	35.3	32	70	15
W2	0.02	0.09	2.90	0.33	0.38	49	132	10	15	27	30	-10	351	111	95	32.8	21	56	10
W3	1.35	0.28	1.79	0.10	0.01	577	486	19	20	42	47	79	296	213	79	36.9	20	63	10
W4	0.75	0.21	1.33	0.14	0.01	328	428	10	22	45	113	532	284	167	85	49.2	19	56	11
W5	1.36	0.29	1.36	0.10	0.02	246	571	10	15	48	31	68	297	53	107	26.2	36	104	19
W6	3.41	0.37	3.45	1.81	0.01	1514	943	72	20	53	28	27	305	117	112	27.9	25	94	13
W7	0.44	0.09	1.26	0.32	0.02	103	280	10	15	27	27	32	376	150	107	33.0	23	61	9
W8	0.09	0.19	4.77	2.13	0.53	82	373	10	19	46	15	14	279	151	299	28.3	21	73	9
W9	1.54	0.29	6.37	4.13	0.01	400	565	28	16	53	34	61	272	85	84	28.6	24	68	9
W10	1.62	0.36	2.32	0.10	0.04	539	570	38	17	47	46	164	329	131	100	42.5	22	56	9
W11	2.46	0.03	4.06	2.18	0.01	887	142	19	15	26	-5	-10	30	21	68	3.7	16	111	8
W12	2.21	0.05	2.31	0.63	0.01	1143	234	25	15	33	-5	-10	36	26	50	3.4	19	132	8
W13	1.46	0.05	1.52	0.42	0.01	762	143	10	15	29	-5	-10	35	27	49	3.0	23	142	14
W14	0.14	0.04	0.79	0.10	0.01	187	168	10	15	25	-5	-10	28	13	21	3.0	16	118	11
W15	0.25	0.35	3.63	1.48	0.01	99	664	10	18	47	-5	-10	169	125	100	25.3	37	97	13
W16	0.27	0.34	3.70	1.54	0.01	100	668	10	19	37	9	-10	166	119	102	26.3	37	101	9
W17	2.36	0.34	1.72	0.42	0.03	1461	652	33	28	55	23	24	151	-10	62	14.2	18	118	14
W18	3.02	0.04	3.44	0.10	1.51	1806	14	25	15	16	7	-10	83	723	46	5.0	19	105	14
W19	3.02	0.04	3.49	0.10	1.51	1855	16	29	15	26	7	-10	78	606	47	5.0	17	104	13
W20	0.42	0.11	3.24	0.10	0.01	150	318	10	15	26	16	-10	279	26	56	27.3	25	67	10
W21	0.98	0.02	0.97	0.35	0.01	618	134	10	15	27	-5	-10	20	18	21	3.0	25	123	19
W22	3.15	0.02	2.38	0.21	0.97	nd	38	54	nd	nd	-3	-10	nd	5	33	nd	19	107	6
W23	2.77	0.05	5.30	3.35	0.28	nd	66	54	nd	nd	-3	-10	nd	9	42	nd	18	129	6
W24	2.57	0.04	6.00	4.05	0.14	nd	107	40	nd	nd	-3	-10	nd	21	31	nd	16	109	-5
W25	2.03	0.26	12.89	11.10	0.55	nd	157	30	nd	nd	13	-10	nd	37	86	nd	16	57	5
W26	2.51	0.02	4.01	2.65	0.02	nd	112	34	nd	nd	-3	-10	nd	3	18	nd	20	100	5
W27	2.04	0.02	2.50	0.70	-0.01	nd	209	29	nd	nd	-3	-10	nd	-2	32	nd	17	101	-5
W28	2.16	0.02	2.51	0.28	-0.01	nd	256	29	nd	nd	-3	-10	nd	3	34	nd	19	101	-5
W29	3.40	0.02	3.25	1.68	0.01	nd	190	52	nd	nd	-3	-10	nd	-2	18	nd	18	95	6
W30	2.33	0.02	2.45	0.42	0.01	nd	242	41	nd	nd	-3	-10	nd	-2	31	nd	19	112	6
W31	2.76	0.02	2.85	1.54	0.03	976	197	31	-15	-15	-3	-10	11	9	20	nd	16	98	5
W32	3.33	0.05	3.24	2.48	0.46	1063	55	62	-15	9	-3	-10	28	9	53	4.0	20	134	8
W33	1.79	0.04	2.77	1.72	0.27	1333	48	28	-15	24	-3	-10	16	5	28	-3.0	17	91	-5
W34	2.60	0.05	5.11	0.28	0.94	1289	69	45	-15	23	-3	-10	31	19	31	5.0	17	113	-5
W35	3.80	0.02	7.25	5.53	0.02	914	157	61	-15	27	-3	-10	12	10	35	5.0	22	121	6
W36	3.52	0.03	4.80	3.63	0.36	1464	162	86	15	24	-3	-10	14	-2	44	3.0	21	155	-5
W37	5.14	0.03	3.53	0.64	-0.01	1105	135	57	-15	15	-3	-10	10	6	8	4.0	19	109	9
W38	3.51	0.02	4.76	3.24	0.39	1105	132	61	-15	-15	-3	-10	9	5	7	4.0	20	109	7
W39	0.79	0.02	2.21	0.28	-0.01	nd	448	14	nd	nd	3	-10	nd	-2	31	nd	19	108	-5
W40	2.96	0.04	5.44	4.06	1.21	1260	41	55	-15	-15	-3	-10	20	20	85	6.0	16	104	7
W41	2.86	0.04	4.32	3.86	0.52	2595	45	51	-15	22	-3	-10	27	7	29	5.0	19	111	5
W42	2.42	0.04	7.27	3.79	0.14	843	66	47	-15	18	-3	-10	22	8	34	7.0	15	109	6
W43	2.29	0.05	6.20	2.96	0.33	894	81	41	-15	-15	-3	-10	22	7	58	7.0	19	112	5
W44	3.21	0.02	4.80	2.34	0.15	914	50	55	-15	19	-3	-10	12	-2	18	3.0	18	105	-5
W45	2.81	0.04	6.88	4.54	0.12	1089	72	46	-15	23	-3	-10	25	9	86	6.0	20	121	-5
W46	2.32	0.11	7.89	3.80	-0.01	820	98	34	-15	20	-3	-10	36	-2	42	10.0	27	112	-5
W47	2.56	0.02	2.33	0.83	0.66	1065	37	37	-15	-15	-3	-10	13	-2	29	0.0	15	88	-5
W48	2.89	0.05	5.64	2.21	0.16	1147	89	61	-15	21	-3	-10	30	4	46	6.0	18	123	7
W49	3.02	0.04	3.10	1.38	0.90	1253	64	55	-15	-15	-3	-10	35	5	46	5.0	18	113	-5
W50	3.16	0.04	5.59	2.28	0.48	1227	47	51	-15	24	3	-10	26	7	50	5.0	18	112	-5
W51	3.24	0.04	4.40	2.69	0.55	996	67	63	-15	22	-3	-10	18	29	51	5.0	21	135	9
W52	3.08	0.04	4.86	2.14	0.54	927	52	49	-15	20	-3	-10	20	16	134	5.0	20	122	-5
W53	0.76	0.08	14.06	5.18	0.03	267	71	18	-15	-15	57	302	255	32	146	44.0	15	32	6
W54	0.87	0.15	3.89	1.66	0.24	942	17	10	-15	-15	15	26	89	47	45	8.0	12	39	-5
W55	1.05	0.11	4.30	2.21	0.68	1142	268	10	-15	25	-3	-10	43	7	56	10.0	28	135	6
W56	0.97	0.08	3.69	2.21	0.70	477	189	15	-15	18	5	-10	30	4	23	8.0	26	116	8
W57	2.95	0.05	2.72	1.74	0.02	926	223	45	-15	27	-3	-10	20	3	48	3.0	18	124	7
W58	6.34	0.03	2.37	1.38	0.67	968	106	54	-15	-15	-3	-10	15	6	44	3.0	16	97	-5
W59	0.39	0.16	6.48	3.30	0.10	65	229	-10	17	33	15	65	237	3	66	29.0	22	68	8
W60	2.79	0.05	5.42	4.69	0.02	802	161	33	-15	-15	-3	-10	19	-2	42	4.0	18	114	9
W61	4.23	0.05	1.94	0.71	0.16	1054	90	36	-15	-15	-3	-10	19	3	23	-3.0	17	109	-5
W62	5.31	0.04	2.28	1.27	0.20	1433	159	43	-15	18	-3	-10	17	10	92	-3.0	15	101	-5
W63	3.92	0.05	4.85	3.38	0.54	2575	141	55	-15	17	5	-10	47	139	264	7.0	19	130	7
W64	3.00	0.04	9.30	7.73	0.10	697	274	39	-15	19	-3	-10	22	17	79	6.0	14	96	-5
W65	2.69	0.04	3.79	0.98	0.04	709	130	44	-15	-15	3	-10	17	10	76	-3.0	17	107	6
W66	4.22	0.06	1.24	0.21	0.10	905	112	38	-15	16	-3	-10	14	3	16	-3.0	19	110	6
W67	3.76	0.05	2.63	0.07	0.04	561	148	63	-15	26	-3	-10	19	-2	40	3.0	18	121	10

(APPENDIX 5 - TABLE 3 Continued)

MAP NUMBER	SAMPLE NUMBER	FORMATION	LITHO-LOGIC CODE	EASTING	NORTHING	SiO_2 %	TiO_2 %	Al_2O_3 %	Fe_2O_3 %	FeO %	MnO %	MgO %	CaO %	Na_2O %
W68	LARA-204-12.80	McLaughlin Ridge Fm	QFXTF	434020	5416771	62.80	0.37	15.80	1.54	2.81	0.08	3.56	2.17	2.43
W69	LARA-204-24.80	McLaughlin Ridge Fm	QFXTF	434020	5416771	65.04	0.35	13.89	1.01	2.47	0.06	4.33	2.38	3.16
W70	LARA-204-34.50	McLaughlin Ridge Fm	QXTF	434020	5416771	70.28	0.33	13.58	1.11	2.00	0.06	2.44	1.78	1.56
W71	LARA-204-57.05	McLaughlin Ridge Fm	QXTF	434020	5416771	72.96	0.23	13.82	0.80	1.06	0.03	1.87	1.00	2.14
W72	LARA-204-82.87	McLaughlin Ridge Fm	QXTF	434020	5416771	73.84	0.24	13.91	1.32	0.80	0.06	2.27	0.44	-0.10
W73	LARA-204-247.65	McLaughlin Ridge Fm	TF	434020	5416771	55.13	0.60	15.75	2.46	5.95	0.28	6.61	4.62	3.76
W74	LARA-204-290.58	McLaughlin Ridge Fm	QXTF	434020	5416771	71.88	0.28	12.97	0.83	1.78	0.09	4.13	0.82	0.51
W75	LARA-204-299.85	McLaughlin Ridge Fm	FQXTF	434020	5416771	53.49	0.60	15.63	1.72	6.25	0.33	7.59	3.06	2.51
W76	LARA-204-332.30	McLaughlin Ridge Fm	FXLTF	434020	5416771	52.93	0.57	15.10	2.92	5.78	0.28	6.69	5.43	2.42
W77	LARA-204-345.75	McLaughlin Ridge Fm	PXTF	434020	5416771	50.10	0.63	12.92	3.60	7.56	0.53	7.95	10.58	1.55
W78	NMA87-13-7	Older Dikes	BSLT	426829	5419510	47.78	1.95	13.57	5.52	7.71	0.23	6.82	11.07	1.30
W79	NMA87-15-1-2	Older Dikes	BSLT	427200	5420000	47.33	1.88	12.74	3.09	9.71	0.22	7.73	10.73	1.66
W80	NMA87-26-2-2	Older Dikes	BSLT	438939	5413580	49.52	1.80	13.80	6.11	5.58	0.20	6.07	12.46	0.10
W81	SFR87-25-3	Older Dikes	FBAS	442555	5413028	48.81	2.30	15.33	4.98	7.01	0.20	4.37	11.26	0.98
W82	SFR87-28-4	Older Dikes	FBAS	446206	5412126	49.26	1.84	14.20	3.55	8.42	0.21	5.88	11.01	1.92
W83	SFR87-29-6	Older Dikes	BSLT	444996	5411131	49.20	1.77	13.40	3.72	8.28	0.21	6.74	11.36	1.58
W84	LARA-121-84.20	?Older Dikes	MFDYK	433140	5416369	44.97	0.80	16.17	0.99	7.72	0.16	2.74	10.75	1.59
W85	LARA-127-96.60	?Older Dikes	MFDYK	433131	5416493	52.47	1.04	14.75	1.38	9.21	0.18	3.07	6.77	0.00
W86	LARA-127-115.13	?Older Dikes	MFDYK	433131	5416493	43.65	1.75	11.85	0.70	10.47	0.20	6.37	10.92	-0.10
W87	LARA-150-61.34	?Older Dikes	MFDYK	433069	5416737	45.71	0.49	11.98	1.74	6.59	0.16	10.81	9.53	1.35
W88	NMA87-37-2	Fourth Lake Fm: Coronation Mt suite	BSLT	432089	5421935	50.00	2.35	15.88	2.32	8.78	0.19	3.55	9.87	4.01
W89	NMA87-37-5-1	Fourth Lake Fm: Coronation Mt suite	BSLT	431911	5421653	51.49	1.95	15.50	2.82	8.18	0.28	1.99	7.89	2.27
W90	NMA87-37-5-3	Fourth Lake Fm: Coronation Mt suite	BSLT	432003	5421609	51.91	2.26	14.58	4.63	8.06	0.24	4.21	6.85	4.80
W91	NMA87-42-6-2	Fourth Lake Fm: Coronation Mt suite	BSLT	442249	5418834	44.38	2.07	13.59	1.73	9.00	0.17	8.71	11.39	2.28
W92	TPO87-18-4-2	Fourth Lake Fm: Coronation Mt suite	ANDS	456952	5408889	49.43	2.33	14.03	6.06	6.85	0.22	4.13	7.93	2.82
W93	SFR87-40-1-2	Fourth Lake Fm: Mt Whymper suite	PLLV	429032	5423543	43.55	3.52	13.49	0.76	10.72	0.57	8.22	12.31	0.79
Saltspring Intrusive Suite:														
W94	TPO87-18-4	granodiorite	GRDR	456946	5408909	70.29	0.38	14.54	1.91	1.66	0.03	0.86	2.06	5.75
W95	SFR87-43-1	granodiorite	GRDR	454514	5410744	66.62	0.49	15.28	2.72	2.00	0.14	1.50	4.34	4.48
W96	NMA87-27-2-3	quartz porphyry	QZFPP	432391	5416611	75.79	0.15	12.52	0.48	0.31	0.02	0.16	1.05	0.22
W97	NMA87-28-4-2	quartz porphyry	QZPP	432814	5416422	77.03	0.14	11.24	0.57	0.21	0.05	0.30	3.37	1.92
W98	SFR87-45-9	quartz porphyry	QZFPP	455973	5408184	72.37	0.26	13.99	1.06	1.19	0.04	0.79	2.73	4.66
Late Triassic:														
W99	NMA87-34-3	Mt Hall Gabbro: standard suite	DORT	435718	5417080	49.24	1.16	15.29	2.49	7.42	0.18	7.27	12.38	1.91
W100	NMA87-36-1	Mt Hall Gabbro: standard suite	GBBR	430872	5420166	48.47	4.14	11.11	4.90	12.87	0.27	3.89	8.99	2.06
W101	SFR87-26-2-2	Mt Hall Gabbro: standard suite	DIAB	444700	5413124	48.25	2.50	13.69	3.19	9.81	0.22	6.33	9.26	2.18
W102	PTE87-21-8	Mt Hall Gabbro: standard suite	DIAB	439373	5416144	49.56	1.52	15.55	2.09	8.57	0.19	6.41	12.01	2.05
W103	TPO87-8-3	Mt Hall Gabbro: standard suite	GBBR	444633	5412127	50.76	2.01	14.21	6.31	3.58	0.13	2.56	17.61	0.01
Early to Middle Jurassic:														
W104	NMA87-33-8-2	Island Plutonic Suite	PXDRT	444512	5419739	57.76	0.58	17.31	2.69	4.07	0.00	3.18	3.65	5.30
W105	NMA87-34-5	Island Plutonic Suite	GRDR	437505	5417887	69.01	0.33	15.51	1.47	1.57	0.07	1.16	3.54	3.43
W106	NMA87-35-8-2	Island Plutonic Suite	GRDR	436946	5422537	71.51	0.25	14.78	1.00	1.14	0.06	0.70	2.73	3.53
W107	NMA87-35-8-4	Island Plutonic Suite	GRDR	436952	5422529	65.23	0.45	16.47	1.70	2.37	0.08	1.86	4.93	4.02
W108	NMA87-38-2	Island Plutonic Suite	QDORT	438729	5426536	58.87	0.70	16.74	2.87	4.17	0.16	2.66	6.09	2.92
W109	SFR87-38-4-2	Island Plutonic Suite	GRDR	429400	5420130	60.32	0.46	17.35	2.97	3.30	0.12	2.44	4.59	3.05
W110	SFR87-40-5	Island Plutonic Suite	GRDR	431519	5425441	64.34	0.50	15.95	2.55	2.14	0.11	1.87	4.56	3.39
W111	SFR87-38-8-2	Minor Intrusions: basalt Dike	MFDYK	429181	5420949	42.79	0.73	12.14	1.69	7.97	0.21	11.91	10.18	1.04
W112	PTE87-21-14	Minor Intrusions: hornblende porphyry	HBFPP	439423	5416591	44.72	0.97	16.93	1.65	8.43	0.23	5.12	11.00	2.31
W113	NMA87-17-2-2	Minor Intrusions: feldspar porphyry	QZFPP	430379	5413132	69.54	0.24	14.92	0.56	2.05	0.11	0.78	3.15	3.74
W114	NMA87-34-2-2	Minor Intrusions: feldspar porphyry	QZFPP	436240	5417353	63.37	0.51	16.24	1.87	3.07	0.08	2.59	5.26	3.43
W115	SFR87-19-8	Minor Intrusions: feldspar porphyry	FSPPP	429281	5408120	61.39	0.76	18.47	0.95	4.00	0.13	1.76	3.52	5.05
W116	SFR87-56-4	Minor Intrusions: feldspar porphyry	FSPPP	430693	5401275	65.40	0.38	16.46	2.10	1.69	0.08	1.01	3.66	4.20
W117	PTE87-13-7-2	Minor Intrusions: feldspar porphyry	QZPP	428106	5414631	57.81	0.56	17.41	1.87	3.28	0.11	2.70	6.38	3.90
W118	NMA87-46-6-2	Minor Intrusions: dacite	DCIT	457696	5401828	55.88	0.56	19.03	2.17	4.98	0.15	2.19	6.09	4.19
W119	NMA87-48-9-2	Minor Intrusions: dacite	DCIT	455110	5400700	63.35	0.43	17.29	1.00	3.06	0.09	1.48	3.45	4.04
W120	NMA87-48-10-2	Minor Intrusions: dacite	QZPP	454080	5400940	41.27	0.58	10.82	0.20	7.58	0.27	9.78	13.34	0.10
Age uncertain:														
W121	NMA87-26-7-2	dacite Dike, post-Sicker	DCIT	436797	5409505	62.84	0.35	18.87	2.21	3.42	0.06	1.27	0.84	3.58
W122	NMA87-26-7-2	*duplicate analysis*	DCIT	436797	5409505	62.89	0.35	18.92	2.18	3.41	0.06	1.28	0.83	3.66

(APPENDIX 5 - TABLE 3 Continued)

MAP NUMBER	K_2O %	P_2O_5 %	LOI %	CO_2 %	S %	Ba ppm	Sr ppm	Rb ppm	La ppm	Ce ppm	Ni ppm	Cr ppm	V ppm	Cu ppm	Zn ppm	Sc ppm	Y ppm	Zr ppm	Nb ppm
W68	2.94	0.06	5.06	2.50	-0.01	973	101	37	-15	22	3	-10	39	-2	57	8.0	27	149	6
W69	1.93	0.07	4.80	2.91	-0.01	577	136	30	-15	17	3	-10	60	4	122	8.0	29	134	10
W70	3.25	0.06	3.34	1.04	0.07	1180	104	36	-15	-15	4	-10	51	36	99	8.0	24	122	6
W71	3.10	0.04	2.43	0.41	0.19	1020	89	36	-15	-15	-3	-10	20	18	45	-3.0	18	114	-5
W72	4.27	0.04	2.70	0.28	0.60	2481	25	52	-15	-15	-3	-10	26	7	68	-3.0	18	119	8
W73	0.63	0.10	3.05	0.28	0.15	269	129	-10	-15	15	31	97	243	48	144	31.0	20	56	5
W74	3.15	0.04	3.14	0.21	0.18	1506	24	39	-15	23	-3	-10	23	6	60	4.0	24	140	-5
W75	1.09	0.10	5.84	0.48	0.35	493	98	19	-15	17	29	95	228	10	208	27.0	18	59	9
W76	0.69	0.09	6.24	1.80	0.04	222	104	-10	15	19	30	90	219	132	94	29.0	18	54	-5
W77	0.01	0.09	3.16	0.69	0.71	29	228	10	-15	17	54	287	305	170	141	48.0	17	40	-5
W78	0.13	0.15	2.98	0.10	0.01	176	226	10	14	16	95	213	442	116	124	43.5	33	122	21
W79	0.23	0.14	3.25	0.63	0.01	298	261	10	20	17	114	282	474	150	120	46.1	34	123	24
W80	0.00	0.15	3.45	0.10	0.31	18	342	10	17	17	86	123	421	301	94	41.2	34	115	20
W81	0.10	0.20	3.32	0.42	0.04	49	332	10	25	16	44	29	457	241	126	34.8	34	153	24
W82	0.26	0.15	2.15	0.14	0.02	125	227	10	18	24	81	105	398	198	113	38.7	29	119	17
W83	0.08	0.15	2.37	0.35	0.03	51	232	10	18	15	99	141	390	212	108	39.7	26	110	15
W84	1.41	0.12	11.60	7.87	0.02	286	189	23	-15	-15	11	33	310	97	93	32.0	21	47	-5
W85	1.43	0.49	7.97	2.96	0.25	634	52	27	33	53	-3	-10	6	17	338	23.0	72	203	41
W86	0.19	0.13	12.35	4.48	0.02	78	43	-10	-15	29	81	202	352	168	143	39.0	24	100	11
W87	0.01	0.09	10.29	4.28	0.02	690	274	-10	-15	-15	210	791	212	57	45	35.0	16	43	7
W88	0.79	0.34	0.85	0.10	0.01	2355	218	10	28	36	10	-10	481	19	116	33.3	41	144	15
W89	5.32	0.36	0.68	0.10	0.01	4176	273	37	34	36	13	-10	323	30	131	23.3	39	125	14
W90	0.93	0.33	0.30	0.10	0.01	1913	516	10	35	33	9	-10	426	10	126	28.3	40	148	16
W91	0.58	0.36	4.55	2.47	0.03	148	457	14	39	42	277	392	278	75	109	30.0	23	180	31
W92	0.34	0.35	4.69	2.33	0.10	251	269	10	36	37	12	-10	385	34	124	29.8	45	194	21
W93	1.60	0.75	1.74	0.14	0.01	2408	720	30	68	76	200	258	300	21	143	24.8	26	367	67
Saltspring Intrusive Suite:																			
W94	0.53	0.07	1.67	0.92	0.01	261	210	10	15	44	-5	-10	33	12	24	8.1	55	223	31
W95	0.30	0.12	1.51	0.10	0.20	222	311	10	15	27	6	-10	68	33	75	10.0	37	154	13
W96	7.66	0.02	1.56	0.84	0.01	1289	138	54	15	34	-5	-10	16	112	28	3.0	15	92	7
W97	1.86	0.02	3.19	2.16	0.01	973	199	28	15	30	-5	-10	12	23	18	3.0	16	98	11
W98	0.80	0.04	1.71	0.99	0.04	580	209	10	15	33	-5	-10	39	34	22	3.9	17	120	11
Late Triassic:																			
W99	0.26	0.09	1.15	0.35	0.07	208	213	10	15	29	102	134	315	59	84	39.7	19	65	13
W100	0.67	0.30	0.31	0.10	0.01	153	261	25	40	15	28	-10	644	371	133	42.5	48	218	30
W101	0.12	0.20	2.28	0.10	0.02	97	218	10	28	28	89	172	470	266	139	38.0	34	151	23
W102	0.18	0.13	0.81	0.10	0.01	322	242	10	15	15	94	158	333	133	100	37.6	26	96	16
W103	0.01	0.19	2.10	0.92	0.01	17	825	10	28	17	35	60	350	129	56	39.6	29	148	21
Early to Middle Jurassic:																			
W104	1.32	0.31	3.40	1.67	0.05	1105	520	15	23	64	11	11	147	24	136	10.6	26	132	15
W105	2.71	0.11	0.54	0.10	0.01	1032	585	86	22	55	7	-10	78	18	37	5.8	25	142	38
W106	3.05	0.08	0.54	0.10	0.02	1219	530	99	15	69	-5	-10	42	23	40	3.2	29	164	38
W107	1.81	0.17	0.65	0.10	0.04	819	776	51	17	60	13	25	83	42	48	8.3	16	146	24
W108	3.24	0.27	0.74	0.10	0.01	680	644	117	25	67	6	-10	169	69	87	14.4	27	170	25
W109	2.45	0.28	2.27	0.10	0.01	776	692	68	15	42	12	11	142	52	57	19.8	25	117	10
W110	2.90	0.19	0.75	0.35	0.01	972	610	51	24	62	11	14	102	39	60	8.9	17	129	18
W111	0.24	0.20	9.03	4.79	0.06	103	270	10	19	29	314	525	266	70	99	34.3	17	31	11
W112	1.25	0.34	5.38	3.73	0.64	776	678	19	18	29	38	28	332	60	117	26.3	23	54	10
W113	2.56	0.09	2.11	0.46	0.08	1223	555	58	15	32	-5	-10	47	20	52	3.0	22	121	41
W114	1.71	0.18	1.05	0.10	0.06	757	613	29	16	53	23	43	108	23	48	11.3	16	117	20
W115	1.35	0.18	1.71	0.21	0.04	2560	885	13	26	45	6	14	71	53	113	15.2	43	163	14
W116	2.39	0.17	2.34	0.97	0.01	1117	1167	28	24	58	7	-10	62	33	56	5.6	15	120	10
W117	1.24	0.29	4.20	2.00	0.08	683	833	33	24	47	23	45	101	16	85	12.4	14	118	29
W118	1.00	0.31	2.91	0.64	0.01	459	474	21	15	49	-5	-10	127	11	86	11.2	22	93	16
W119	1.35	0.19	3.60	1.69	0.01	805	497	23	18	52	6	-10	69	17	75	4.7	14	129	35
W120	0.01	0.17	14.91	9.69	0.03	27	108	12	36	15	309	668	214	52	122	39.9	16	42	19
Age uncertain:																			
W121	3.11	0.19	2.64	0.10	0.01	2193	181	64	15	38	-5	-10	89	32	85	4.8	21	83	15
W122	3.20	0.19	2.63	0.14	0.01	2122	180	67	15	43	-5	-10	840	27	86	4.8	18	82	12

(APPENDIX 5 - TABLE 3 Continued)

Analyses performed by B.C. Geological Survey - Analytical Sciences Laboratory.
Majors and traces by XRF; LOI by gravimetry; CO_2 and S by LECO induction furnace; FeO by titration
Negative values indicate sample is below the stated detection limit
Major element data has been resumed to 100% following correction of XRF Fe_2O_3 (total iron) for FeO

*Lithologic codes:

ANDS -	andesite
BSLT -	basalt
CHTTF -	cherty tuff
DCIT -	dacite
DIAB -	diabase
DORT -	diorite
FBAS -	feldspar basalt
FQXTF -	feldspar-quartz-crystal tuff
FSAND -	feldspar andesite
FSPPP -	feldspar porphyry
FXLTF -	feldspar crystal lappili tuff
FXTF -	feldspar crystal tuff
GBBR -	gabbro
GRDR -	granodiorite
HBFPP -	hornblende-feldspar porphyry
LAMTF -	laminated tuff
MFDYK -	mafic Dike
PLLV -	pillow lava
PXDRT -	pyroxene diorite
PXPP -	pyroxene porphyry
PXTF:	pyroxene tuff
QDORT -	quartz diorite
QFXTF -	quartz-feldspar crystal tuff
QXTF -	quartz crystal tuff
QZPP -	quartz porphryr
RYLT -	rhyolite
TF -	tuff

APPENDIX 5 - TABLE 4
REE, Sc, Hf, Ta and Th DATA FOR ROCKS FROM THE DUNCAN MAP AREA

MAP NUMBER	SAMPLE NUMBER	FORMATION	LITHOLOGIC CODE	EASTING	NORTHING	La ppm
W2	SFR87-57-2	Duck Lake Fm: suite 1	BSLT	428354	5401662	3.9
W4	NMA87-31-4	Nitinat Fm: suite 1	BSLT	442907	5418691	12.6
W5	NMA87-31-5	Nitinat Fm: suite 1	BSLT	442689	5418971	18.0
W10	SFR87-18-3-3	Nitinat Fm: suite 1	PXTF	433711	5405476	11.8
W20	SFR87-28-5	McLaughlin Ridge Fm	FXTF	446212	5412207	6.4
W80	NMA87-26-2-2	Older Dikes	BSLT	438939	5413580	8.1
W82	SFR87-28-4	Older Dikes	FPMV	446206	5412126	7.6
W88	NMA87-37-2	Fourth Lake Fm: Coronation Mt suite	BSLT	432089	5421935	13.5
W90	NMA87-37-5-3	Fourth Lake Fm: Coronation Mt suite	BSLT	432003	5421609	14.0
W93	SFR87-40-1-2	Fourth Lake Fm: Mt Whymper suite	PLLV	429032	5423543	42.3

MAP NUMBER	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Sc ppm	Hf ppm	Ta ppm	Th ppm
W2	10	6	1.9	0.64	0.4	1.78	0.27	28	1.2	-0.3	0.6
W4	26	13	3.1	0.93	0.5	1.28	0.18	41	1.1	-0.3	1.6
W5	39	19	4.0	1.25	0.7	2.06	0.31	19	1.9	-0.3	2.9
W10	28	16	3.7	1.22	0.6	1.65	0.22	36	1.3	-0.3	1.5
W20	15	8	2.0	0.72	0.4	1.83	0.27	23	1.5	-0.3	0.9
W80	22	14	3.9	1.25	0.9	2.35	0.35	31	2.8	0.4	0.8
W82	20	13	3.5	1.25	0.7	2.05	0.31	30	2.7	0.4	0.8
W88	34	19	4.8	1.62	0.9	3.01	0.44	24	3.3	0.5	1.9
W90	34	20	4.9	1.63	0.9	2.94	0.44	22	3.4	-0.3	1.8
W93	89	40	7.6	2.55	0.9	0.98	0.11	12	6.7	3.2	3.3

Analyses by Activation Laboratories Ltd., Ancaster, Ontario.
negative Ta values are below the detection limit (0.3ppm)
Lithological codes are the same as for Appendix 5, Table 3

APPENDIX 6

FOSSIL SAMPLES FROM THE DUNCAN AREA

The following tabulation of fossil identifications combines data extracted from published literature as well as samples collected during the present mapping project. Locations of the samples are plotted on map included in Appendix 5, page 97.

References for already published data:

1: Clapp, C.H. and Cooke, H.C. (1917): Sooke and Duncan Map-area, Vancouver Island with Sections on the Sicker Series and the Gabbros of East Sooke and Rocky Point; Geological Survey of Canada, Memoir 96, 445 pages.

2: Mueller, J.E. (1980): The Paleozoic Sicker Group of Vancouver Island, British Columbia; Geological Survey of Canada, Paper 79-30, 24 pages.

3: Ward, P.E. (1978): Revisions to the Stratigraphy and Biochronology of the Upper Cretaceous Nanaimo Group, British Columbia and Washington State; Canadian Journal of Earth Sciences, Volume 15, pages 405-423.

4: Usher, J.L. (1952): Ammonite Faunas of the Upper Cretaceous Rocks of Vancouver Island, British Columbia; Geological Survey of Canada, Bulletin 21, 182 pages.

New material was submitted to the Geological Survey of Canada for identification and archiving. Identifications were made by:

JWH	J.W. Haggart; GSC-Cordilleran Section, Vancouver
MJP	M.J. Orchard; GSC-Cordilleran Section, Vancouver
EM	E. Melver; University of Saskatchewan, Saskatoon
EWB	E.W. Bamber; Institute of Sedimentary and Petroleum Geology, Calgary

DUNCAN FOSSIL DATA

MAP NUMBER: F1 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: CLAPP-17-1
EASTING: 430459 NORTHING: 5410918
LOCATION: On the north bank of the Chemainus river, about 2.8 km upstream (west) of the confluence with Boulder Creek
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Anomia vancouverensis* (Gabb)
Ostrea sp.
Rhynconella cf. suciensis (Whiteaves)
AGE: Late Cretaceous
IDENTIFIED BY: REFERENCE: 1

MAP NUMBER: F2 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: CLAPP-17-2
EASTING: 446141 NORTHING: 5416353
LOCATION: About 1.2 km west of Fuller Lake
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Ostrea* sp.
Ostrea congesta (Conrad)
Rhynconella sp.
AGE: Late Cretaceous
IDENTIFIED BY: REFERENCE: 1

MAP NUMBER: F3 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: CLAPP-17-3
EASTING: 453388 NORTHING: 5402672
LOCATION: West of Tzuhalem Mt.
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Trigonia tryoniana* (Gabb)
AGE: Late Cretaceous
IDENTIFIED BY: REFERENCE: 1

MAP NUMBER: F4 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: CLAPP-17-4
EASTING: 452445 NORTHING: 5402023
LOCATION: On Indian reserve about 0.8 km southeast of Mt. Tzuhalem
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Axinea veatchii* (Gabb)
AGE: Late Cretaceous
IDENTIFIED BY: REFERENCE: 1

MAP NUMBER: F5 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: CLAPP-17-5
EASTING: 430549 NORTHING: 5403168
LOCATION: On the Cowichan River, south of Falls and west of Copper Canyon
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Anomia vancouverensis* (Gabb)
Lima multiradiata (Gabb)
Ostrea sp.
Astarte sp.
AGE: Late Cretaceous
IDENTIFIED BY: REFERENCE: 1

MAP NUMBER: F6 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: 79-42H
EASTING: 430137 NORTHING: 5400567
LOCATION: 3 km south of Skutz Falls, logging road S5K
STRATIGRAPHIC UNIT: MPf
FOSSIL TYPE: radiolaria
AGE: Early to early late Mississippian
(middle Kinderhookian to early Meramacian)
IDENTIFIED BY: REFERENCE: 2

MAP NUMBER: F7 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: McM132
EASTING: 433879 NORTHING: 5403079
LOCATION: Cowichan River, approximately 750 m upstream of Marie Canyon railroad bridge
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Canadoceras yokoyami*
Canadoceras multisulcatus
Inoceramus schmidti
AGE: Lower Campanian (I. schmidti zone)
IDENTIFIED BY: REFERENCE: 3

MAP NUMBER: F8 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: McM133
EASTING: 434481 NORTHING: 5402145
LOCATION: Cowichan River, downstream 500 m from Marie Canyon railroad bridge
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Canadocera yokoyami*
Canadoceras multisuclcatus
Inoceramus schmidti
Baculites bailyi
AGE: Lower Campanian (I. schmidti zone)
IDENTIFIED BY: REFERENCE: 3

MAP NUMBER: F9 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: USHER-52-283
EASTING: 458800 NORTHING: 5411000
LOCATION: South shore of Booth Bay, Saltspring Island. 170 m north of small stream (Maxwell Creek) that enters sea north of Erskine Point
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: ammonites
Diplomoceras? subcompressum
Bostrychoceras elongatum
AGE: Late Cretaceous (Santonian)
IDENTIFIED BY: REFERENCE: 4

MAP NUMBER: F10 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: USHER-52-284-A
EASTING: 459140 NORTHING: 5418481
LOCATION: North end, east shore of Saltspring Island
STRATIGRAPHIC UNIT: uKcd
FOSSIL TYPE: ammonites
AGE: Late Cretaceous (Santonian)
IDENTIFIED BY: REFERENCE: 4

MAP NUMBER: F11 **NTS MAP: 92B/13**
SAMPLE NUMBER: USHER-52-524
EASTING: 455350 NORTHING: 5406600
LOCATION: Maple Bay
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: ammonites
Bostrychoceras elongatum
(GSC 5837, GSC 5837a, GSC 5837b, GSC 5837c)
AGE: Late Cretaceous (Santonian)
IDENTIFIED BY: REFERENCE: 4

MAP NUMBER: F12 **NTS MAP: 92B/13**
SAMPLE NUMBER: NMA87-20-08
EASTING: 431679 NORTHING: 5414972
LOCATION: Chipman Creek
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Acila (Truncacila)* sp.cf. sp.D of Schenk (1943)
echinoid fragment
small bivalve fragments, indeterminate
(GSC C154169)
AGE: Late Cretaceous, probably Santonian to Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F13 **NTS MAP: 92B/13**
SAMPLE NUMBER: NMA88-20-10-1
EASTING: 431809 NORTHING: 5414512
LOCATION: Chipman Creek
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: small bivalve fragments, indeterminate
juvenile gastropod, indeterminate
infaunal burrows, indeterminate
(GSC C154170)
AGE: Indeterminate
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F14 **NTS MAP: 92B/13**
SAMPLE NUMBER: NMA87-33-01
EASTING: 442120 NORTHING: 5421423
LOCATION: Powerline south of Ladysmith
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Didymoceras (Eubostrychoceras) elongatum* (Whiteaves, 1903), juv.
Sphenoceramus? naumanni (Yokohama, 1890)?
Glycymeris? sp.
Perissitys? sp.
ammonite, flattened and compressed, indeterminate
brachiopod fragments indeterminate
gastropod fragment, indeterminate
veneriid bivalves, indeterminate
bivalves, indeterminate
(GSC C158223)
AGE: Late Santonian, D. (E.) elongatum Zone of Jeletzky (1970)
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F15 **NTS MAP: 92B/13**
SAMPLE NUMBER: NMA87-33-04
EASTING: 442177 NORTHING: 5420562
LOCATION: Powerline south of Ladysmith
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: gastropod, juv., indeterminate
(GSC C158224)
AGE: Indeterminate
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F16 **NTS MAP: 92B/13**
SAMPLE NUMBER: NMA87-51-06
EASTING: 450206 NORTHING: 5405410
LOCATION: Quamichan Lake
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Sphenoceramus orientalis ambiguus* (Nagao & Matsumoto, 1940)
possible ammonite fragment
bivalve fragments, indeterminate
brachiopod? fragments
(GSC C158239)
AGE: Late Santonian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F17 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-20-01-1
EASTING: 435177 NORTHING: 5406733
LOCATION: Hill 60 Ridge
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Didymoceras (Eubostrychoceras) elongatum* (Whiteaves, 1903)
Sphenoceramus orientalis ambiguus (Nagao & Matsumoto, 1940)
ammonite fragment, *Glyptoxoceras*? sp.
Acila (Truncacila) sp.
Inoceramus prisms, some pyritization
small plant fragments
(GSC C158202)
AGE: Late Santonian, D. (E.) elongatum Zone of Jeletzky (1970)
IDENTIFIED BY: JHW REFERENCE:

MAP NUMBER: F18 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-20-02-1
EASTING: 435881 NORTHING: 5406442
LOCATION: Hill 60 Ridge
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Sphenoceramus? naumanni* (Yokohama, 1890)?
bivalve fragments, indeterminate
plant material: order *Coniferales cf. Geinitzia* sp.
(GSC C158201)
AGE: Probably late Santonian
IDENTIFIED BY: JWH, EM REFERENCE:

MAP NUMBER: F19 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-20-03-1
EASTING: 436617 NORTHING: 5406251
LOCATION: Hill 60 Ridge
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Sphenoceramus orientalis ambiguus* (Nagao & Matsumoto, 1940)
pachydiscid ammonite fragment
(GSC C158213)
AGE: Late Santonian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F20 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-21-02-1
EASTING: 433939 NORTHING: 5408803
LOCATION: Hill 60 Ridge
STRATIGRAPHIC UNIT: uK?e
FOSSIL TYPE: *Perissitys*? sp.
Teredolites sp.
Inoceramus prisms
shell fragments, indeterminate
unidentified woody axes and debris
(GSC C158203)
AGE: Late Cretaceous, possibly Santonian Campanian
IDENTIFIED BY: JWH, EM REFERENCE:

MAP NUMBER: F21 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-22-01-1
EASTING: 439661 NORTHING: 5410236
LOCATION: Copper Canyon, west of Mount Prevost
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Sphenoceramus* ex gr. *schmidti* (Michael, 1899)
Baculites sp.cf. *capensis* (Woods, 1906)
ammonite fragment, indeterminate
Acila (Truncacila) sp.
(GSC C158204)
AGE: Latest Santonian to earliest Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F22 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-22-02-1
EASTING: 439707 NORTHING: 5410627
LOCATION: Copper Canyon, west of Mount Prevost
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Baculites* sp.indeterminate
(GSC C158205)
AGE: Late Cretaceous (Late Turonian to Maastrichtian)
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F23 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-22-04-1
EASTING: 440238 NORTHING: 5410710
LOCATION: Copper Canyon, west of Mount Prevost
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Sphenoceramus* ex gr. *schmidti* (Michael, 1899)
bivalves, indeterminate
Didymoceras (Eubostrychoceras) elongatum?, juv.
pachydiscid? ammonite, juv.
echinoid
(GSC C158206)
AGE: Latest Santonian to earliest Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F24 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-22-05-1
EASTING: 440054 NORTHING: 5408420
LOCATION: Copper Canyon, west of Mount Prevost
STRATIGRAPHIC UNIT: uKe
FOSSIL TYPE: *Sphenoceramus* ex gr. *schmidti* (Michael, 1899)
Pinna? sp.
wood fragment
(GSC C158207)
AGE: Latest Santonian to earliest Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F25 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-23-06-1
EASTING: 445266 NORTHING: 5410210
LOCATION: Mount Prevost
STRATIGRAPHIC UNIT: uKe
FOSSIL TYPE: *Sphenoceramus* ex gr. *schmidti* (Michael, 1899)
Baculites? sp.
(GSC C158208)
AGE: Latest Santonian to earliest Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F26 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-24-05-1
EASTING: 443792 NORTHING: 5411386
LOCATION: Mount Sicker
STRATIGRAPHIC UNIT: uK?h
FOSSIL TYPE: *Sphenoceramus* ex gr. *schmidti* (Michael, 1899)
Baculites? sp.
bivalves, indeterminate
(GSC C158231)
AGE: Latest Santonian to earliest Campanian
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F27 **NTS MAP: 92B/ 13**
SAMPLE NUMBER: SFR87-48-01-1
EASTING: 448532 NORTHING: 5407648
LOCATION: Between Maple Bay and Duncan
STRATIGRAPHIC UNIT: uKh
FOSSIL TYPE: *Glycymeris*? sp.
Acila? sp.
ammonite fragment, possibly *Didymoceras (Eubostrychoceras)*? sp.
nuculid bivalves, indeterminate
bivalve, indeterminate
Inoceramus prisms
(GSC C154178)
AGE: Possibly late Santonian, D. (E.) elongatum Zone of Jeletzky (1970)
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F28 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-52-01
EASTING: 432946 NORTHING: 5400709
LOCATION: Fairservice
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Sphenoceramus orientalis ambiguus* (Nagao & Matsumoto, 1940)
Sphenoceramus sp.
anomiid bivalves
bivalves, indeterminate
lowspired gastropod, indeterminate
(GSC C154179)
AGE: Probably late Santonian, D. (E.) elongatum zone
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F29 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-55-01-1
EASTING: 436613 NORTHING: 5399439
LOCATION: Fairservice Ridge
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Sphenoceramus? naumanni* (Yokohama, 1890)?
Inoceramus sp.
(GSC C158235)
AGE: Late Santonian, D. (E.) elongatum Zone of Jeletzky (1970)
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F30 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-55-03-1
EASTING: 435334 NORTHING: 5399637
LOCATION: Fairservice Ridge
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: *Sphenoceramus? naumanni* (Yokohama, 1890)?
brachipods, indeterminate
nuculid bivalves, indeterminate
(GSC C158234)
AGE: Probably late Santonian, D. (E.) elongatum zone of Jeletzky (1970)
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F31 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-56-07-1
EASTING: 429935 NORTHING: 5400435
LOCATION: Mt. Fairservice
STRATIGRAPHIC UNIT: MPf, chert
FOSSIL TYPE: conodonts, ramiform fragment
spumellarian radiolarian
(GSC C158237)
AGE: Ordovician - Triassic
IDENTIFIED BY: MJO REFERENCE:

MAP NUMBER: F32 **NTS MAP: 92B/13**
SAMPLE NUMBER: SFR87-57-08-1
EASTING: 429430 NORTHING: 5399242
LOCATION: Mt. Fairservice
STRATIGRAPHIC UNIT: PPm, Limestone
FOSSIL TYPE: conodonts, indeterminate fragments
ichthyoliths
(GSC C158240)
AGE: Ordovician - Triassic
IDENTIFIED BY: MJO REFERENCE:

MAP NUMBER: F33 **NTS MAP: 92B/13**
SAMPLE NUMBER: PTE87-21-11
EASTING: 439413 NORTHING: 5416557
LOCATION: Holyoak Lake
STRATIGRAPHIC UNIT: MPf
FOSSIL TYPE: echinoderm ossicles, indeterminate
poorly preserved bryozoans, indeterminate
(GSC C158215)
AGE: No age determination possible
IDENTIFIED BY: EWB REFERENCE:

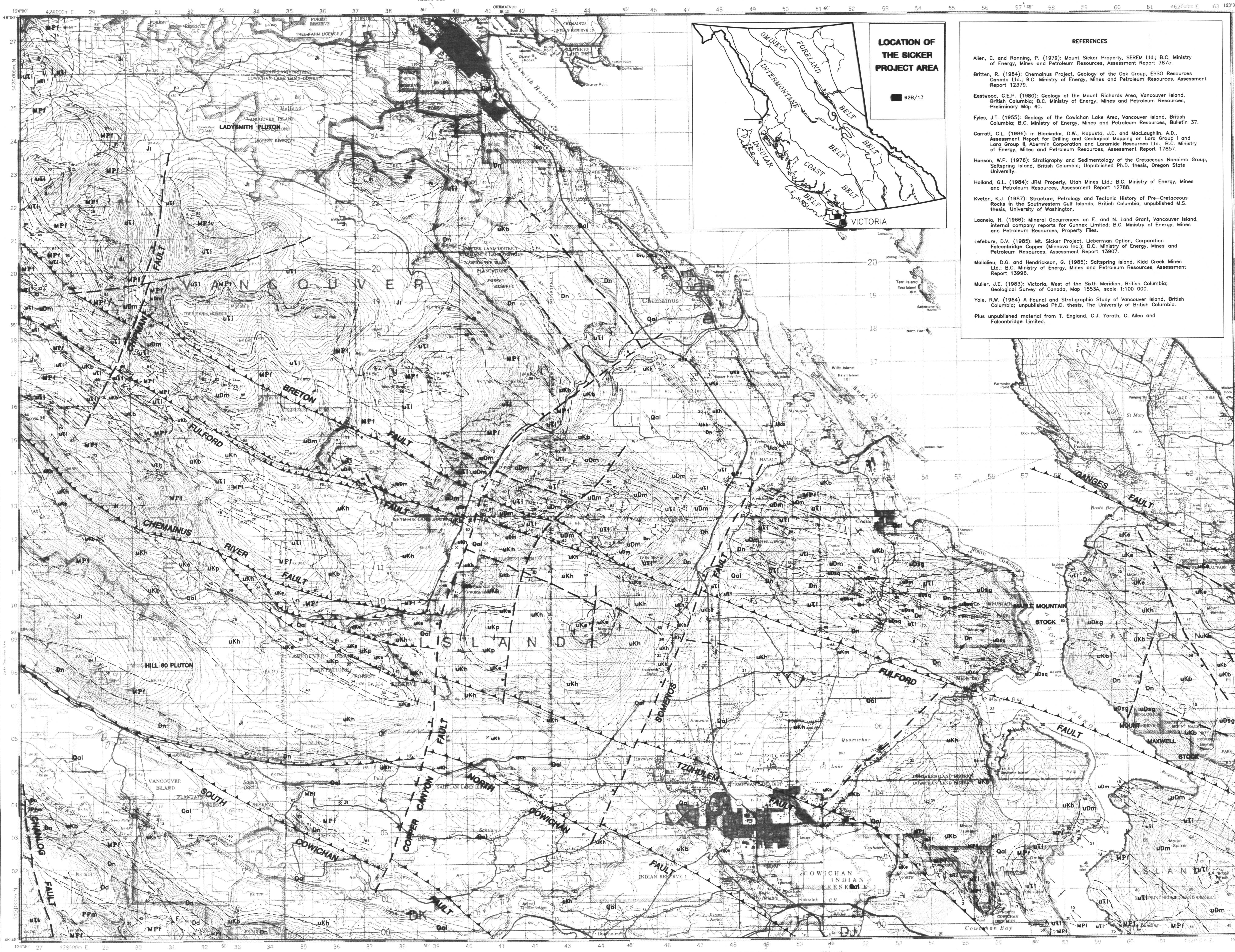
MAP NUMBER: F34 **NTS MAP: 92B/13**
SAMPLE NUMBER: TPO87-06-06
EASTING: 433835 NORTHING: 5410615
LOCATION: North side of Chemainus River, west of power-lines
STRATIGRAPHIC UNIT: uK?e
FOSSIL TYPE: *inoceramid*? bivalve fragments
juvenile ammonite mold, indeterminate
bivalve fragments, indeterminate
infaunal burrows, indeterminate
(GSC C154175)
inoceramid bivalve, indeterminate
bivalve mold, possibly *Acila*? sp.
inoceramid? bivalve fragments, indeterminate
Inoceramus prisms
crinoid ossicle?
(GSC C154176)
AGE: Indeterminate, probably Late Cretaceous
IDENTIFIED BY: JWH REFERENCE:

MAP NUMBER: F35 **NTS MAP: 92B/13**
SAMPLE NUMBER: TPO87-22-03-1
EASTING: 446209 NORTHING: 5420229
LOCATION: Chemainus Road
STRATIGRAPHIC UNIT: uKb
FOSSIL TYPE: ostreid bivalve fragments, indeterminate
venerid bivalve fragments, indeterminate
bivalve fragments, indeterminate
brachiopod fragments, indeterminate
common fragmentary shell debris
(GSC C154177)
AGE: Indeterminate
IDENTIFIED BY: JWH REFERENCE:

Energy, Mines and Resources Canada

BC Province of British Columbia

This project is a contribution to the Canada/British Columbia Mineral Development Agreement, 1985–1990.



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BC Ministry of Energy, Mines and Petroleum Resources

BRITISH COLUMBIA GEOLOGICAL SURVEY

GEOSCIENCE MAP 1991-3

GEOLOGY OF THE DUNCAN AREA

NTS 92B/13

GEOLOGY BY N.W.D. MASSEY, S.J. FRIDAY, P.E. TERCIER AND T.E. POTTER (1987)

COMPILATION BY N.W.D. MASSEY

SCALE 1:50 000

KILOMETRES 0 1 2 3 KILOMETRES

LEGEND

INTRUSIVE ROCKS

JURASSIC(?)
MINOR INTRUSIONS

F	Feldspar, quartz–feldspar porphyry (several smaller bodies of feldspar porphyry, hornblende–feldspar porphyry and aphyric dacite intrude older rocks but are not shown on the map)

EARLY TO MIDDLE JURASSIC
ISLAND PLUTONIC SUITE

Ji	Diorite, granodiorite, quartz diorite often with abundant xenoliths, aplite

LATE TRIASSIC
MOUNT HALL GABBRO

uTi	Sills and dikes coeval with the Karmutsen Formation: diabase, gabbro and flower gabbro

LATE DEVONIAN
SALTSPRING INTRUSIVE SUITE

uDs	Granodiorite and feldspar porphyry (g), quartz–feldspar porphyry (q)

VOLCANIC AND SEDIMENTARY ROCKS

QUATERNARY

Qal	Unconsolidated glacial till and poorly sorted alluvium

UPPER CRETACEOUS
NANAIMO GROUP

uKp	PROTECTION FORMATION: argillite, siltstone
uKe	EXTENSION FORMATION: boulder and pebble conglomerate, sandstone
uKh	HASLAM FORMATION: argillite, siltstone, shale and minor sandstone
uKb	BENSON FORMATION: boulder and pebble conglomerate, sandstone and minor siltstone

UPPER TRIASSIC
VANCOUVER GROUP

uTk	KARMUTSEN FORMATION: pillowed and massive basaltic flows, hyaloclastite and hyaloclastite breccia

MISSISSIPPIAN TO LOWER PERMIAN
BUTTLE LAKE GROUP
UPPER PENNSYLVANIAN TO LOWER PERMIAN

PPm	MOUNT MARK FORMATION: massive crinoidal limestone, bedded limestone, marble, chert, cherty argillite and siltstone

MISSISSIPPIAN TO PENNSYLVANIAN

MPf	FOURTH LAKE FORMATION: Ribbon chert, cherty tuff, graphitic argillite, intercalated thinly bedded sandstone siltstone and argillite, epiclastic sandstone, conglomerate, argillite and crinoidal limestone
MPfv	Massive and pillowed basalt with intercalated cherty sediment

MIDDLE(?) TO UPPER DEVONIAN
SICKER GROUP

uDm	MCLAUGHLIN RIDGE FORMATION: thickly bedded tuffite and lithic tuffite, feldspar–crystal tuff, heterolithic lapilli tuff and breccia, quartz–feldspar crystal tuff (porphyry in part), rhyolite, dacite, laminated tuff, jasper and chert
Dn	NITINAT FORMATION: pyroxene–feldspar phyric agglomerate, breccia and lapilli tuff, massive and pillowed flows, massive tuffite and lithic tuffite, laminated tuff, and chert
Dd	DUCK LAKE FORMATION: pillowed and massive basaltic flows, monolithic basalt breccias and pillow breccias

SYMBOLS

Geological contact (defined, approximate, assumed, transitional)

Limit of drift covered area

Bedrock outcrops within drift covered area

Bedding (horizontal, inclined, overturned)

Bedding estimated from pillows (inclined)

Schistosity and cleavage (inclined, vertical)

Secondary schistosity (inclined, vertical)

Lineation (plunge indicated)

Axis of minor folds (plunge indicated)

Fault; downthrown side and dip indicated (defined, approximate, assumed)

Reverse and thrust faults with dip indicated; teeth indicate upthrust side (defined, approximate, assumed)

Anticline (with plunge indicated)

Syncline (with plunge indicated)