



GEOLOGY OF THE BROOKS PENINSULA, VANCOUVER ISLAND  
(92L/4)

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INTRODUCTION

A brief reconnaissance of the bedrock geology of the Brooks Peninsula, northern Vancouver Island, was made from August 8 to August 13, 1984. In addition, a stream sediment geochemical survey of most of the drainages on the Peninsula was completed. This work forms the basis of a mineral potential evaluation study of the area undertaken as part of the Ministry's commitment to resource evaluation required for land use planning.

The Ministry of Lands, Parks and Housing have proposed two areas on the north side of the Peninsula totalling 3 833 hectares as Ecological Reserves (Fig. 55). They wish to protect areas of biological importance, believed to have been glacial refugia. If the reserves are approved, the areas would be alienated from mineral exploration and development.

The area is isolated and remote with access limited to boat or aircraft. The two-man party was positioned at Columbia Cove by the Provincial Museum's 50-foot research vessel, the *Nesika*, in conjunction with a four-man party of paleocologists and biologists. The survey utilized a zodiac boat and limited helicopter traverses. It was only partially completed because poor weather forecasts caused the premature departure of the helicopter.

PREVIOUS WORK AND REGIONAL GEOLOGY

Muller published the first description of the geology of the Brooks Peninsula (Muller, *et al.*, 1974). He identified four major geological elements (Fig. 55); from northeast to southwest these are:

- (1) *The Westcoast Fault*. A major fault that separates the Peninsula from Vancouver Island. The adjacent Vancouver Island area is underlain by a sequence of Triassic and Jurassic volcanic and sedimentary rocks of the Vancouver and Bonanza Groups and granitic rocks of the Island Intrusions.
- (2) *The Westcoast Complex*. A variously deformed and metamorphosed mixture of gabbroic, dioritic, and granitic rocks which underlies 95 per cent of the Peninsula.
- (3) *The Cape Cook Fault*. A major northwest-trending structure that juxtaposes the Westcoast Complex and the outboard Pacific Rim Complex.

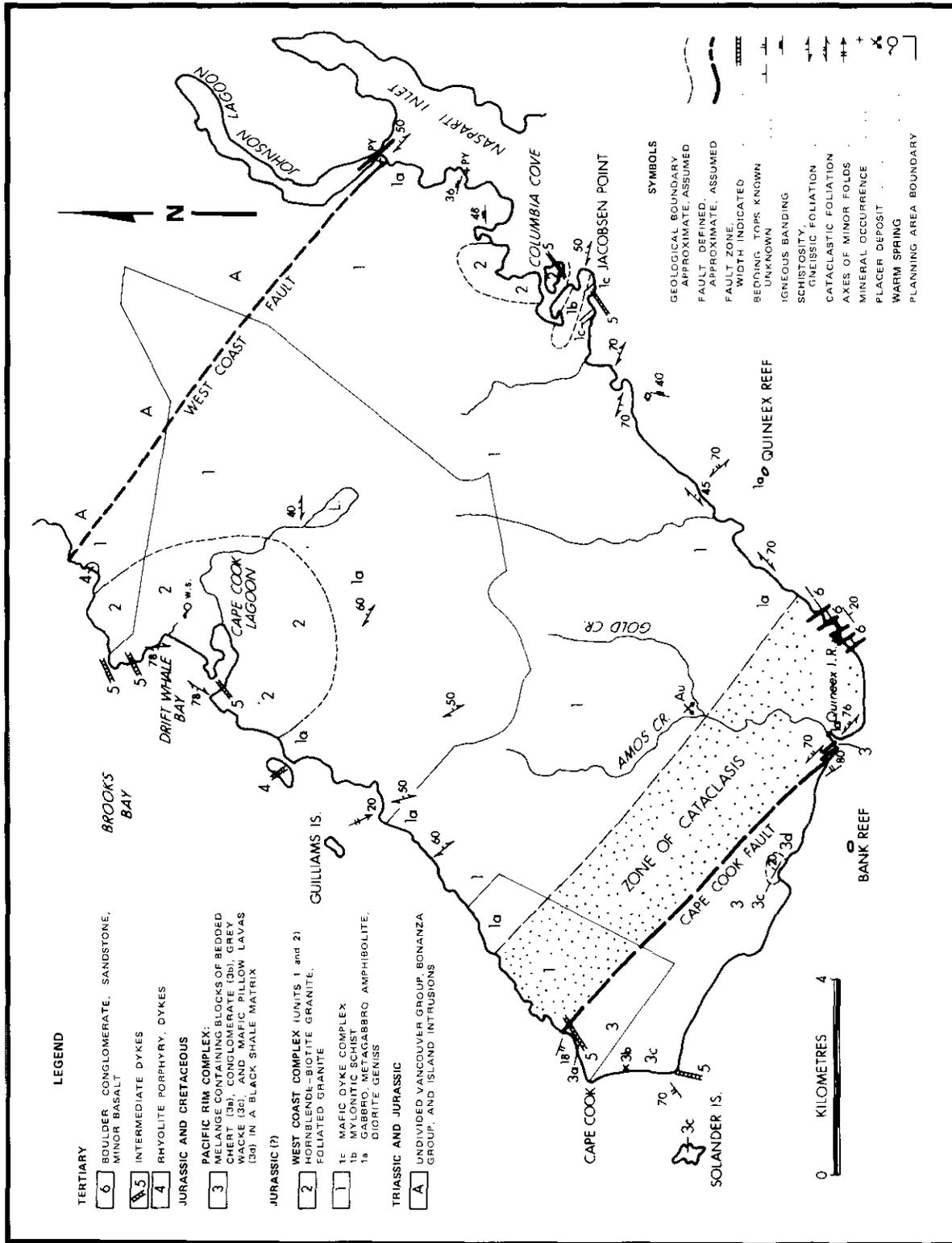


Figure 55. Geological map, Brooks Peninsula, Vancouver Island.

- (4) *The Pacific Rim Complex*. A melange unit that is confined to the outermost part of the Peninsula, but is more extensive than shown on Muller's map (1983).

A fifth element consisting of Tertiary conglomerates and sandstones crops out on the southwest edge of the Peninsula but is not shown on Muller's map (1983).

An area on the southeast corner of the Peninsula shown to be underlain by Bonanza volcanic rocks by Muller (1983) is here interpreted to be underlain by the Westcoast Complex.

## GENERAL GEOLOGY

### WESTCOAST COMPLEX (UNITS 1 and 2)

Westcoast Crystalline Complex is a term proposed by Muller and Carson (1969) for a complex of amphibolite, basic migmatite, and gneissic quartz diorite and gabbro that outcrops on the west coast and in inlets in the Alberni map-area. Muller, *et al.* (1974) subsequently applied the name to similar rocks that outcrop on the Brooks Peninsula. Two main map units (units 1 and 2) were recognized in the complex in this study.

#### **Unit 1 - Gabbro, Metagabbro, Mylonitic Schists, and Mafic Dykes**

Unit 1 consists of the non-granitic rocks of the Westcoast Complex. It comprises three sub-units: 1a - an extensive unit of variably deformed and metamorphosed gabbro, 1b - mylonitic schists, and 1c - mafic dykes.

#### Sub-unit 1a - Gabbro, Metagabbro, Amphibolite Gneiss, and Migmatite

Undeformed to weakly deformed gabbro constitutes less than 10 per cent of this sub-unit. It is exposed mostly on the southeast side of the Peninsula, away from the Westcoast fault. A crude mineralogical banding defined by concentration of mafic minerals on a 3 to 5-centimetre scale is developed locally on the north shore of Nasparti Inlet. The banding is discontinuous over 2 metres and may be the result of magmatic flowage differentiation, not gravity settling.

In most places the unit consists of foliated gabbros and amphibolites. In zones of high strain they are converted to banded amphibolite gneiss, such as south of Williams Island. Migmatite and agmatite are locally developed adjacent to granitic intrusions, for example, south of Cape Cook Lagoon.

Sub-unit 1a is everywhere intruded by granitoid dykes and pegmatites and, in at least two localities, by granitoid intrusions (unit 2) up to 4 kilometres across. Foliated intrusion breccia with aligned xenoliths of gabbro is exposed at the northern contact of the Columbia Cove granite.

#### Sub-unit 1b - Mylonitic Schist

A narrow unit (approximately 350 metres) of banded mylonite outcrops at the southern entrance to Columbia Cove. The mylonite varies in composition from granitic to calc-silicate. Thin amphibolite bands are also present. Isolated, lensoid granitic fragments up to 50 centimetres across occur surrounded in calc-silicate schists. These superficially resemble a metaconglomerate but are more likely highly attenuated and flattened intrusion breccia.

The northern contact of the mylonitic schists is not exposed. The southern contact is obscured by a swarm of mafic dykes (sub-unit 1c) that cut the schists.

#### Sub-unit 1c - Dyke Complex

A narrow unit of fine-grained and porphyritic mafic dykes outcrops on the south shore of Jacobsen Point. The dykes are undeformed to mildly deformed in contrast to the schists that they intrude. They trend 160 degrees and are dark green, grey to black. Rare screens of medium-grained gabbro are present.

The mafic dykes are intruded by a Tertiary(?) dyke (unit 5), which provides an upper age limit for them.

#### Unit 2 - Granitoid Intrusions

Numerous granitic dykes, pegmatites, and two mappable granitoid intrusions cut sub-units 1a and 1b. The intrusions are informally referred to as the Columbia Cove granite and the Cape Cook Lagoon granite.

The Columbia Cove granite is medium and coarse-grained, hornblende-biotite granite. It is massive in the centre but toward the eastern contact with the gabbros a 25-metre-wide zone of intrusion breccia with a strong schistosity is developed.

The Cape Cook Lagoon granite is a deformed hornblende-biotite granite. It contains numerous aligned and flattened inclusions and screens of gabbro, diorite, and pyroxenite, indicating syntectonic intrusion.

Locally, granitoid dykes are more deformed than the gabbro host rocks; they were probably intruded into active shear zones.

#### PACIFIC RIM COMPLEX (UNIT 3)

Muller, *et al.*, (1974) assigned the name Pacific Rim Complex to a highly disturbed and faulted sequence of argillite, greywacke, sandstone,

and quartzite exposed near Cape Cook. The unit is in fact a melange containing exotic blocks or 'knockers' in a matrix of deformed black and green shale. Some of the knockers are so large (up to 50 metres) that they can be distinguished on a 1:50 000-scale map. The complex is much wider than shown by Muller (1983). It forms most of the southwest coast of the Peninsula, and the numerous rocks, reefs, and shoals that extend up to 1 kilometre offshore. Many of these features are isolated, resistant knockers, standing above the eroded shale matrix.

A tectonic slice or block containing bedded ribbon cherts (sub-unit 3a) is well exposed on the coast about 1 kilometre northeast of Cape Cook. The ribbon cherts occur in a sequence of greywacke, chert, breccia, and lesser black shale melange. No tops were determined. The cherts are up to 20 metres thick and are tightly and complexly folded. Individual ribbons are commonly 3 to 5 centimetres thick; they are separated by thin laminae of black argillite. The cherts are light green to grey and weather white.

This sequence is structurally overlain to the northeast by black brecciated argillites (?) which lie adjacent to the Cape Cook fault.

The greywackes (sub-unit 3c), which outcrop adjacent to the ribbon cherts and as knockers throughout the melange, are fine grained, dark green to grey, massive, and indistinctly bedded. Small rip-up clasts of black shale are common. Greywackes also underlie Solander Island (C. Yorath, personal communication), which lies 2 kilometres southwest of Cape Cook.

Knockers consisting of bedded and graded cobble conglomerate and sandstone (sub-unit 3b) occur in the melange 2 kilometres south of Cape Cook. The clasts are subrounded and consist of sandstone, chert, black argillite, quartzite, gabbro, and granite. One large knocker 5 metres across contains a sequence of beds, each up to 1 metre thick, of sandstone, conglomerate, and black shale.

Blocks of mafic pillow lava (sub-unit 3d) occur in the melange on the shore north of Banks Reef. The pillows contain carbonate interpillow material.

The melange also contains a thin wedge of thinly laminated, dark grey, fine-grained, calcareous siltstone toward the southern contact with the Cape Cook fault. The siltstones are extensively brecciated close to the fault.

#### RHYOLITE PORPHYRY AND DYKES (UNIT 4)

Two small, post-tectonic rhyolite porphyry intrusions cut the Westcoast Complex on the northwest coast of the Peninsula. The top of a porphyritic rhyolite intrusion, 5 metres across cuts deformed gabbro south of the Westcoast fault. The rhyolite is compositionally banded parallel to the domed contact. The rhyolite contains phenocrysts of quartz, K-feldspar, and biotite; it weathers white.

A 2-metre-wide, flow-banded porphyritic rhyolite dyke cuts migmatitic gneisses on a small island southwest of Cape Cook Lagoon. It is compositionally similar to the rhyolite intrusion.

The rhyolites postdate major deformation and faulting in the area and are believed to be of Tertiary age.

#### INTERMEDIATE DYKES (UNIT 5)

A number of northeast-trending, intermediate dykes cut both the Westcoast Crystalline Complex and the Pacific Rim Complex. These dykes are unaffected by the intense cataclasis associated with the Cape Cook fault and are assumed to be Tertiary in age. The dykes are dark grey, fine grained to porphyritic; locally they contain rounded quartz phenocrysts or amygdules.

#### BOULDER CONGLOMERATE, SANDSTONE, AND MINOR BASALT (UNIT 6)

A thin sequence of cobble to boulder conglomerate that passes upward into grits and sandstones unconformably overlies cataclastic gabbro of the Westcoast Crystalline Complex in the immediate vicinity of the Quineex Indian Reserve (locally known as Shelter Sheds).

The conglomerates are exposed at low tide level in a narrow graben (approximately 25 metres wide) that defines the Quineex canoe run as well as on islands and headlands 1 kilometre northeast and 0.5 kilometre southwest. The unit is undeformed and beds dip 20 degrees oceanward. Only about 50 metres of strata is exposed.

The unconformity surface is exposed in many places and has a relief up to 1 metre. Boulders of gabbro breccia up to 1 metre across occur on the unconformity surface. The conglomerate contains rounded cobbles and boulders of foliated gabbro, greenschist, granite, and cobbles and pebbles of rounded quartz.

A fine-grained, dark brown basalt flow or sill is interlayered with the basal conglomerate in the Quineex graben. The basalt is exposed at low tide and is at least 2 metres thick; the top is unexposed underwater. The basalt tongues into the underlying conglomerates and isolated conglomerate fragments are caught up in the basalt.

The conglomerate is tentatively correlated with the Eocene/Oligocene Escalante Formation, which occupies a similar lithostratigraphic position in the Nootka Sound map area 75 kilometres to the south (Muller, 1981). These outcrops on Brooks Peninsula are the most northerly known onshore exposures of this formation.

## STRUCTURE

The Cape Cook fault is the major structure in the peninsula. It separates the Pacific Rim Complex and the Westcoast Crystalline Complex and trends northwesterly across the southwest tip of the Peninsula. The fault is exposed northwest of Amos Creek where it is marked by tectonically interleaved thin slices of limestone and chert, which are up to 50 centimetres thick, with brecciated gabbros. At this locality, sedimentary rocks of the Pacific Rim Complex dip steeply to the northwest under the Westcoast Complex and the gabbros of the Westcoast Complex are closely brecciated. Extensive brecciation of the gabbros continues for up to 3 kilometres away from the fault. The breccias consist of angular fragments of gabbro, generally from 3 to 10 centimetres across, in a comminuted groundmass; no veining was noted. This cataclasis is interpreted to have been caused by underthrusting of the Pacific Rim Complex under the Westcoast Complex.

The Westcoast fault also trends northwest and is exposed at the entrance to Johnson Lagoon. It is marked by a 700-metre-wide zone of mylonitized Island Intrusion granite. The mylonite dips moderately to the northwest. Brecciated and foliated gabbros and foliated greenschists of the Westcoast Complex are juxtaposed against the mylonite. The greenschists and the granitic mylonite are openly folded about northwest-trending axes.

The Westcoast fault was not observed on the north coast where it juxtaposes Westcoast Complex and mafic volcanic rocks of the Triassic Karmutsen Formation.

## MINERALIZATION

Mylonites associated with the Westcoast fault at Johnson Lagoon contain thin stringers of pyrite. Assays did not reveal any anomalous gold or silver values.

Large, rusty, pyrite-bearing boulders of fine-grained granite were observed on the headland 1.5 kilometres southwest of Johnson Lagoon.

Disseminated pyrite occurs in volcanic rocks of the Karmutsen Formation 1.6 kilometres northeast of the Westcoast fault at Brooks Bay.

Coarse and fine-grained placer gold has been reported from near the junction of Amos and Gold Creeks (MINFILE 92L/248). This area was worked in the 1910's but there is no record of production. The assessment report (Neave, 1913) describing the work is unfortunately missing from the Ministry's files. The source of the placer gold has not been determined.

## MINERAL POTENTIAL

The metallic mineral potential of the Westcoast Complex and the Pacific Rim Complex appears to be low. The Cape Cook fault shows no evidence of associated hydrothermal activity. The Westcoast fault contains some pyrite and probably deserves closer attention to evaluate its potential.

The small Tertiary rhyolite stock and dykes mapped on the north shore of the Peninsula line up with a belt of Tertiary volcanic rocks that trend northeast across Vancouver Island. This trend was named the Brooks Peninsula Fault Zone by Muller, *et al.* (1974). A warm spring, reported to exist at the source of a small stream that exits at the northeast corner of Drift Whale Bay, also lies on this trend. These data indicate probable Tertiary igneous activity in this area.

Tertiary volcanic and intrusive rocks are favourable metallotects elsewhere on Vancouver Island (Carson, 1969; Muller, *et al.*, 1974). Probably the greatest mineral potential of the Brooks Peninsula lies in discovering mineralized Tertiary igneous rocks in the unexplored interior of the Peninsula.

## LAND USE RECOMMENDATION

A land use recommendation will not be made until the geochemical data is available. Any persons knowing of additional mineral occurrences on the Peninsula are requested to make this information available to the Ministry.

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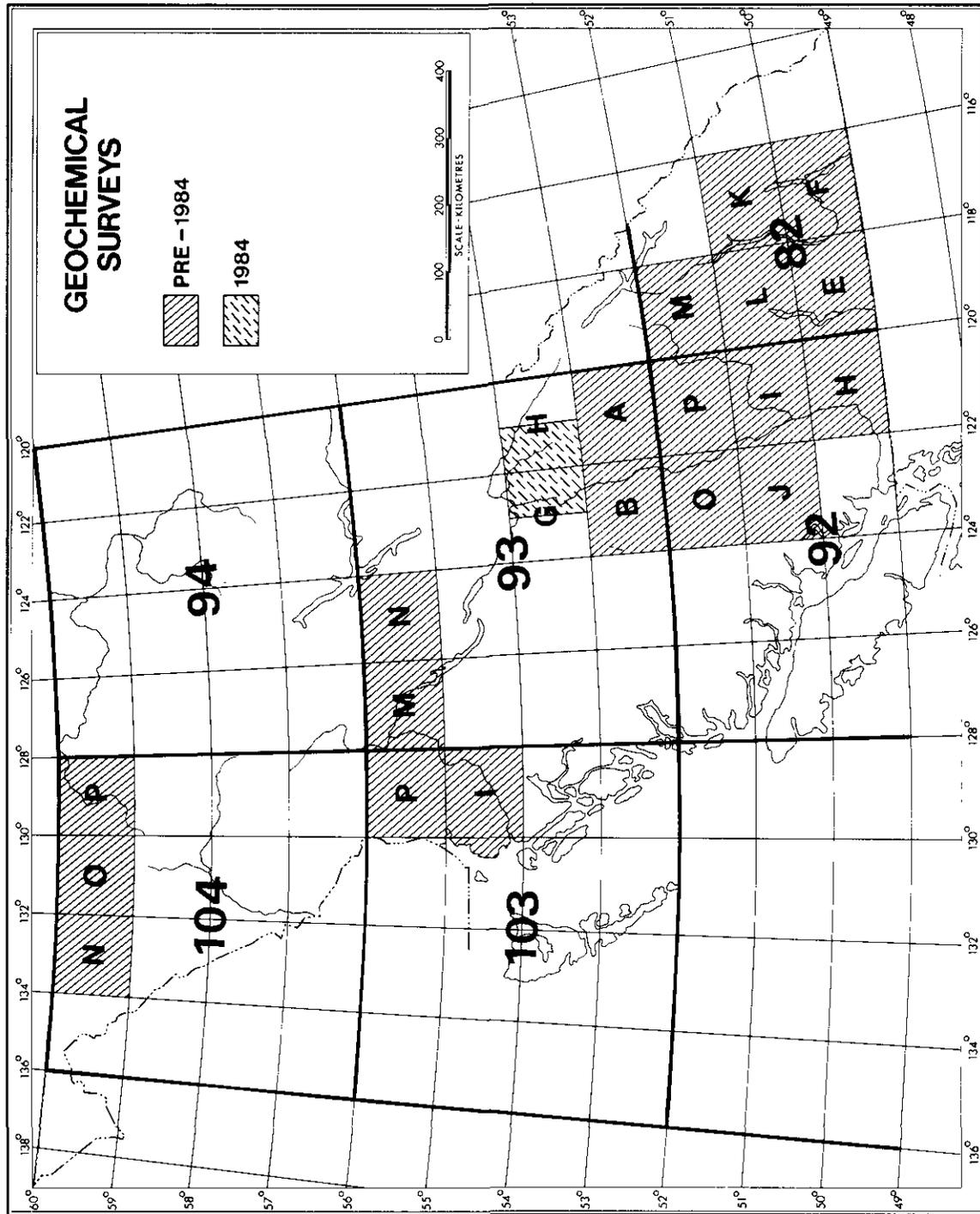


Figure 56. Location map for Regional Geochemical surveys carried out in British Columbia.