SUMMARY OF GEOLOGICAL RECONNAISSANCE WORK

NORTHERN VANCOUVER ISLAND

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BRITISH COLUMBIA

OPEN FILE

Prepared For :

TEXACO CANADA RESOURCES LTD.

CALGARY, ALBERTA

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NOVEMBER, 1984

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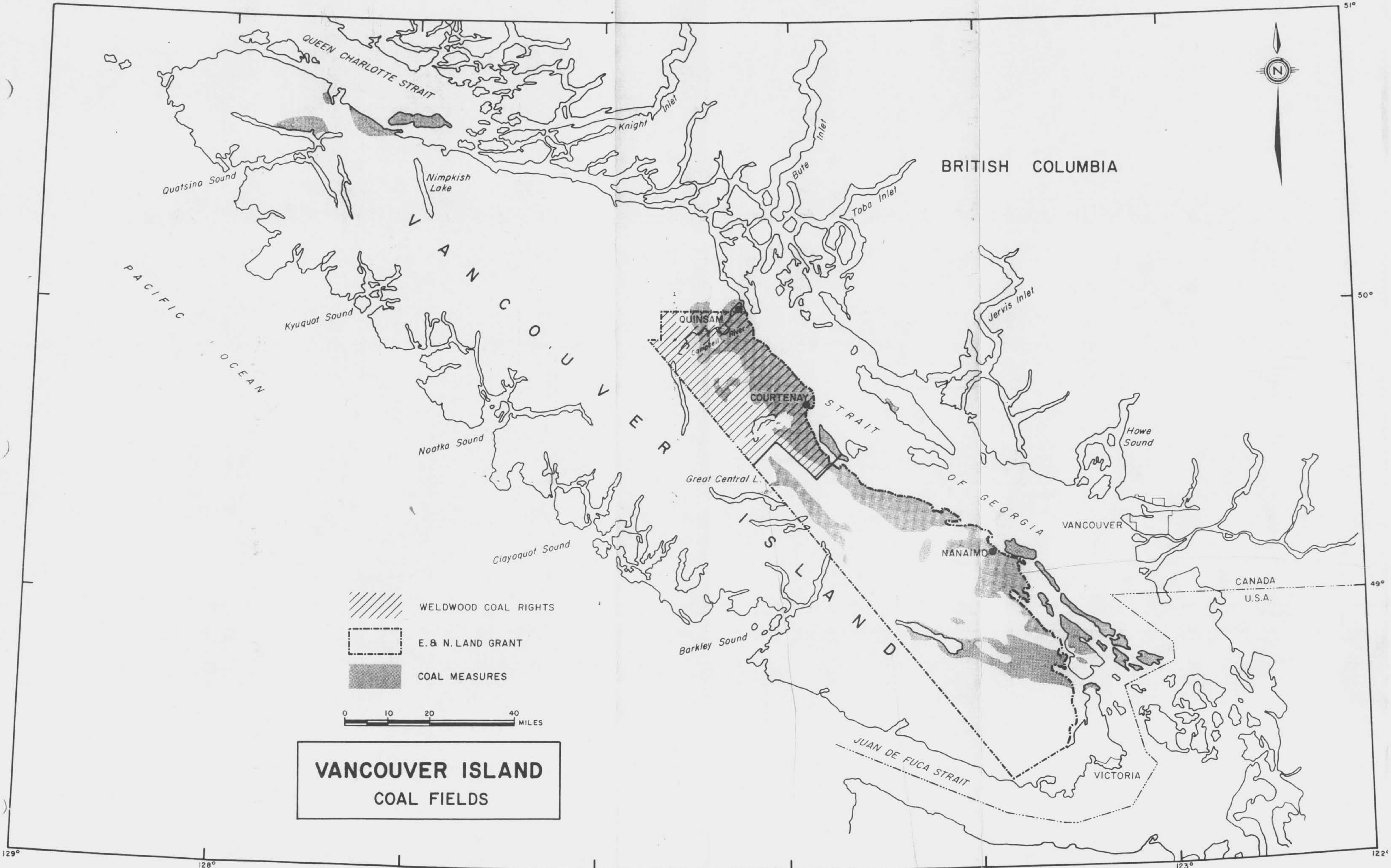

VANCOUVER ISLAND
COAL FIELDS

Chapter 1

INTRODUCTION

This report summarizes field reconnaissance work undertaken during November 5 to 11, 1984 by N. J. Paithouski, P. Eng. of Texaco Canada Resources Ltd. and S. Gardner, P. Geol., under contract to Texaco Canada Resources Ltd.. The area covered during the field work is a large part of northern Vancouver Island.

1.1 Scope of Work

The intent of the field work was to cover as much area as possible in the region in order to determine if any small sedimentary basins with coal potential were missed during the original fieldwork in the spring of 1984. This original work resulted in the acquisition of Coal Exploration Licences in the Hushamu and Cleskaugh Creek areas on the north side of Holberg Inlet.

1.2 Location of Work

The new reconnaissance involved the driving of all accessible logging roads in the area, with some foot traverses where vehicle access was not possible. Three areas were singled out for more concentrated work :

- Northwest and on trend with the Hushamu and Cleskaugh Creek areas on the north side of Holberg Inlet and north and east of the village of Holberg.
- Northwest of the village of Winter Harbour, where sediments had been roughly outlined as a result of the previous work and northwest of the village of Quatsino, between Quatsino Sound and Holberg Inlet.

In addition to these two areas, general reconnaissance work was conducted in the area around Mt. Hansen and the Canadian Forces base at San Josef, the Nahwitti Lake, Kains Lake and Georgie Lake areas, and the large area west of Port McNeill as far west as Alice Lake.

Chapter 2

REGIONAL GEOLOGY

Because of its marginal continental location, the geologic history of Vancouver Island is chiefly related to plate tectonics and massive crustal movements on the Pacific margin of North America. Vancouver Island represents submarine and later terrestrial vulcanism associated with rifting along an ocean floor subduction zone, formed from the Pacific oceanic plate colliding with the western edge of the North American continent and being subducted beneath the continental margin. These crustal movements began in Paleozoic time and have continued to the present. Most of the vulcanism associated with rifting, however, took place in early Mesozoic time[1]. During the Jurassic and Triassic periods, massive outpourings of pillow and flow lavas, and aquagene tuffs formed volcanic island arcs which eventually formed the Insular Mountain Belt, which covers

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1. Muller, J. E., "Evolution of the Pacific Margin, Vancouver Island, and Adjacent Regions", Can. Journal of Earth Science, Vol. 14, 1977

Vancouver Island, the Queen Charlotte Islands, the Alaska panhandle and the Wrangell and St. Elias ranges of Alaska. These volcanic buildups are represented on northern Vancouver Island by the thick basalts of the Triassic Karmutsen Formation, and the major batholiths of the Bonanza Volcanics and the acidic Island Intrusions of Lower to Middle Jurassic. These volcanic complexes form the basement rock upon which later clastic sedimentary wedges of Lower and Upper Cretaceous Age were deposited.

2.1 Sedimentation

Muller[2] describes Upper Jurassic and Lower Cretaceous sedimentation in northwestern Vancouver Island as follows

> ...the eastward onlapping wedge of clastic sediments consists of upper Middle to Upper Jurassic, as yet unnamed sediments, the Lower Cretaceous Valanginian to Barremian Longarm Formation, and the Aptian to Cenomanian Queen Charlotte Group. The lower formations, mainly greywacke and siltstone, only occur in small areas along the west coast and are only a few hundred metres thick. Further east, the upper conglomerate is up to 1000 m. thick and contains cobbles of volcanic rocks and of porphyritic granitoid rocks, presumably derived from high level plutons. Clearly these beds are of a clastic wedge, shed westward from the extinct but still elevated Jurassic volcanic arc.

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2. Muller, J. E., "Evolution of the Pacific Margin, Vancouver Island, and Adjacent Regions", Can. Journal of Earth Science, Vol. 14, 1977

FIGURE 2

TABLE OF FORMATIONS OF VANCOUVER ISLAND*

ERA	PERIOD		STAGE	GROUP	FORMATION	SYMBOL	AVERAGE THICKNESS IN m.±	LITHOLOGY
CENOZOIC					late Tert. volc's of Port McNeill	Tvs		
CENOZOIC			EOCENE to OLIGOCENE		SOOKE BAY	mpTSB		conglomerate, sandstone, shale
CENOZOIC			EOCENE to OLIGOCENE		CARMANAH	eoTC	1,200	sandstone, siltstone, coglomerate
CENOZOIC			EOCENE to OLIGOCENE		ESCALANTE	eTE	300	conglomerate, sandstone
CENOZOIC			early EOCENE		METCHOSIN	eTM	3,000	basaltic lava, pillow lava, breccia, tuff
MESOZOIC		LATE	MAESTRICHTIAN	NANAIMO	GABRIOLA	uKGA	350	sandstone, conglomerate
MESOZOIC		LATE	MAESTRICHTIAN	NANAIMO	SPRAY	uKS	200	shale, siltstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	GEOFFREY	uKG	150	conglomerate, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	NORTHUMBERLAND	uKN	250	siltstone, shale, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	DE COURCY	uKDC	350	conglomerate, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	CEDAR DISTRICT	uKCD	300	shale, siltstone, sandstone
MESOZOIC		LATE	CAMPANIAN	NANAIMO	EXTENSION - PROTECTION	uKEP	300	conglomerate, sandstone, shale, coal
MESOZOIC		LATE	SANTONIAN	NANAIMO	HASLAM	uKH	200	shale, siltstone, sandstone
MESOZOIC		LATE	SANTONIAN	NANAIMO	COMOX	uKC	350	sandstone, conglomerate, shale, coal
MESOZOIC		EARLY	CENOMANIAN ALBIAN APTIAN ?	QUEEN CHARLOTTE	conglomerate unit	lKQC	900	conglomerate, greywacke
MESOZOIC		EARLY	CENOMANIAN ALBIAN APTIAN ?	QUEEN CHARLOTTE	siltstone shale unit	lKQP	50	siltstone, shale
MESOZOIC		EARLY	VALANGINIAN BARREMIAN		LONGARM	lKL	250	greywacke, conglomerate, siltstone
MESOZOIC	JURASSIC	MID to LATE	TITHONIAN CALLOVIAN		Upper Jurassic sediment unit	uJs	500	siltstone, argillite, conglomerate
MESOZOIC	JURASSIC	EARLY	TOARCIAN ? PLIENSBACHIAN SINEMURIAN	BONANZA	volcanics	lJB	1,500	basaltic to rhyolitic lava, tuff, breccia, minor argillite, greywacke
MESOZOIC	JURASSIC	EARLY	TOARCIAN ? PLIENSBACHIAN SINEMURIAN	BONANZA	HARBLEDOWN	lJH		argillite, greywacke, tuff
MESOZOIC	TRIASSIC	LATE	NORIAN	VANCOUVER	PARSON BAY	uTRPB	450	calcareous siltstone, greywacke, silty-limestone, minor conglomerate, breccia
MESOZOIC	TRIASSIC	LATE	KARNIAN	VANCOUVER	QUATSINO	uTRQ	400	limestone
MESOZOIC	TRIASSIC	LATE	KARNIAN	VANCOUVER	KARMUTSEN	muTRK	4,500	basaltic lava, pillow lava, breccia, tuff
MESOZOIC	TRIASSIC	MID	LADINIAN	VANCOUVER	sediment - sill unit	TRds	750	metasiltstone, diabase, limestone
PALEOZOIC	PENN. and ? PERM.			SICKER	BUTTLE LAKE	CPBL	300	limestone, chert
PALEOZOIC	PENN. and ? PERM.			SICKER	sediments	CPSs	600	metagreywacke, argillite, schist, marble
PALEOZOIC	PENN. and ? PERM.			SICKER	volcanics	CPSv	2,000	basaltic to rhyolitic metavolcanic flows, tuff, agglomerate
PALEOZOIC	DEV. or EARLIER							

* Courtesy: Muller, J.E., "Geology of Vancouver Island" G.S.C. No. O.F. 463, 1977

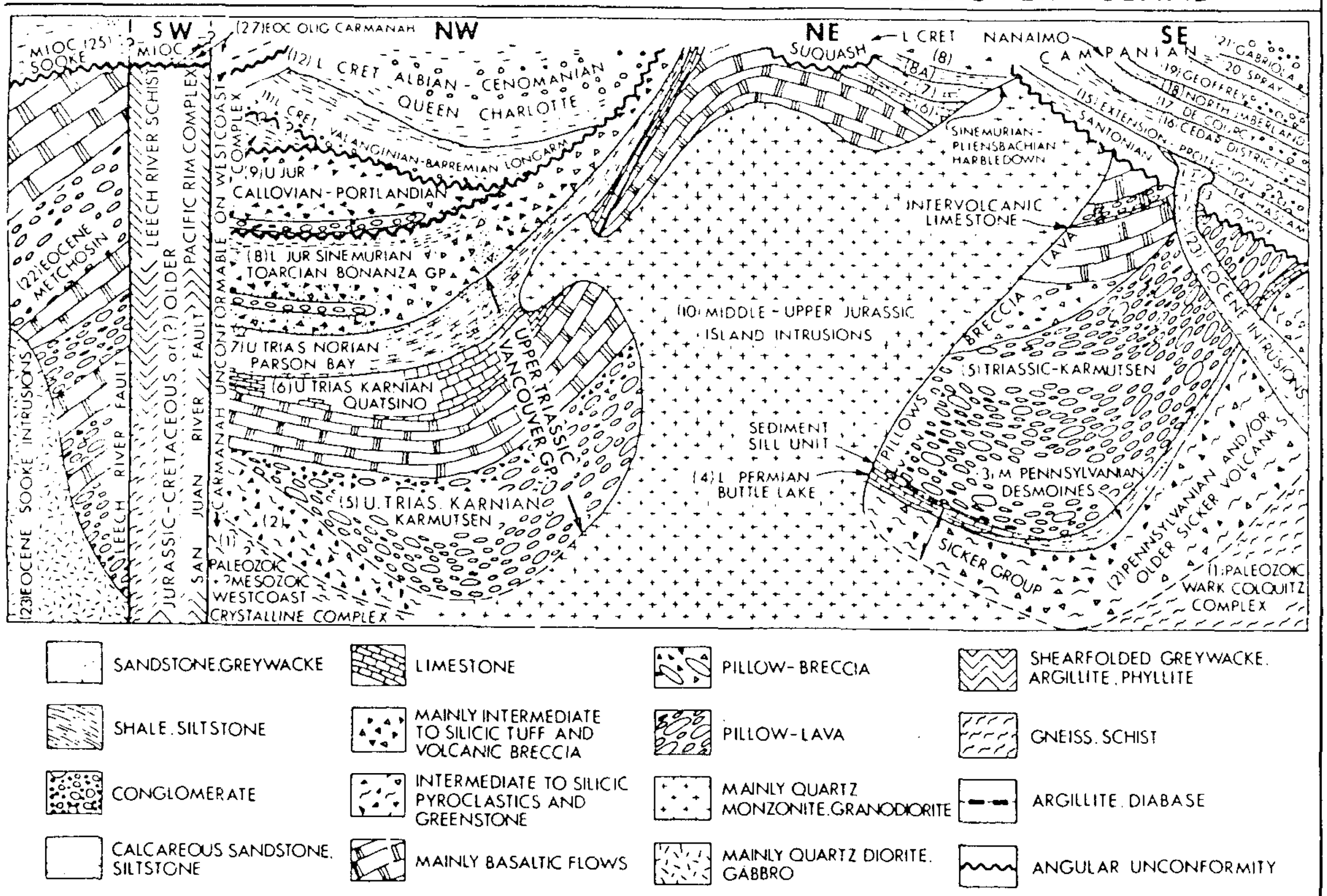
The general range of southwesterly dips measured in the Lower Cretaceous sedimentary sequences around Coal Harbour and the Quatsino Sound area during the current field reconnaissance reinforces Muller's theories of eastward onlap during Lower Cretaceous time. Muller continues:

> The Early Cretaceous shelf sequence of the west coast is succeeded by the Upper Cretaceous Nanaimo Group of eastern Vancouver Island. Only in one place in the central northern part of the island are the two sequences believed to be in stratigraphic contact. Elsewhere Upper Cretaceous sediments overlie with marked unconformity pre-Cretaceous rocks including Jurassic Island Intrusions. The molasse-type coal-bearing marine and deltaic deposits of sandstone, siltstone, shale, and conglomerate contain Santonian to Maestrichian fossils........
>
> .....the Early Cretaceous basin was on a shelf sloping southwestward to the Pacific Rim trench. The Late Cretaceous "Georgia Basin" was inboard of emerging Vancouver Island ranges and deepened to the northeast.

This difference between Lower and Upper Cretaceous sedimentary buildups is clearly evident in the field: in the Late Cretaceous Suquash area, measured dips are predominantly to the northeast and east, as opposed to general southwesterly dips measured in the Lower Cretaceous sediments in the Coal Harbour area. The significance of this can be found in the differing characteristics of the rock types in each of the areas, and more importantly, the characteristics of the coal seams. It also means that observations and conclusions drawn from the Late Cretaceous area can not be inferred for the Lower Cretaceous areas, because the source areas for sedimentation are different.

FIGURE 3

RELATIONSHIPS OF FORMATIONS OF VANCOUVER ISLAND*



*Courtesy: Muller, J.E., "Geology of Vancouver Island", G.S.C. No. O.F. 463, 1977

2.2 Structure

Post-Cretaceous structural deformation in the northern Vancouver Island area is responsible for the preservation of a portion of both the Lower Cretaceous sediments around Coal Harbour, Quatsino and Holberg Inlet, and the Late Cretaceous sediments of the Suquash area on the northeast coast. This structural deformation manifests itself in the form of major normal (gravity) faults which, in many cases, are bounding features of sedimentary areas: the sediments of the Cretaceous are preserved on the downdropped structural blocks. In many cases, this faulting occurs as a number of related 'step' faults. This is best exemplified along the southwest edge of the Suquash area, where two or possibly more sub-parallel normal faults, trending in a northwesterly direction, represent the edge of the basin.

In addition to the predominant faulting, Post-Cretaceous movements have resulted in minor folding. This folding is not clearly evident in surface exposures because the folds are generally gentle and broad with shallow dips, however, drilling in the Suquash area has confirmed their presence.

2.3 Origins of Structural Deformation

The Post-Cretaceous structural deformation evident in the northern Vancouver Island area is chiefly the result of Tertiary Volcanic activity and uplift. However, many workers have attributed fault movements in Tertiary time as occurring along pre-existing fault and fracture planes that originated during the major rifting that occurred during the Triassic.

Muller[3] describes Late Tertiary volcanic rocks near Port McNeill:

> Late Tertiary volcanic rocks are exposed in small areas south of Port McNeill. They are basalt, almost unconsolidated tuff and breccia, volcanic boulder conglomerate and light-coloured dacite tuff.

These are exposed south of O'Connor Lake. Also, they are evident approximately 5.6km southwest of and 6.4 km west of the town of Port McNeill as two peaks, shown on Appendix Map I as Cluxewe Mountain and an unnamed, smaller hill approximately 2.4 km to the northwest. These Tertiary upwellings have decidedly affected the sediments, as a vertical volcanic dyke was observed on the beach south of the Suquash Mine striking at 30 degrees east of north,

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3. Muller, J. E.,"The Geology of Vancouver Island",1977

or directly in line with the smaller peak. This dyke intruded the sediments probably through a joint or fracture plane resulting from stress placed on the sediments as a result of the Tertiary uplift. Frequent parallell joint sets in adjacent sandstones also exhibited similar orientation. It is theorized that additional dykes not exposed occur in a radial fashion from the centres of these Tertiary volcanic occurrences.

2.4 Surficial Geology

The northern part of Vancouver Island has been subjected to glaciation during the Pleistocene and also some earlier period, when glaciation covered the Georgia Strait, the Queen Charlotte Strait and the entire island with a continuous ice sheet originating on the mainland and flowing southwest[4]. During the Pleistocene a number of glacial sequences originated from centres on Vancouver Island, and ice flowed in all directions from these centres, especially down the major valleys such as the Nimpkish Valley, south of Port McNeill.

Glacial erosion and scour occurred on the higher elevations, while varying thicknesses of glacial debris and outwash material

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4. Muller, J. E.,"The Geology of Vancouver Island",1977

were deposited on the lowland areas, in particular the relatively flat-lying sedimentary basins. This glacial deposition has masked the underlying sediments very effectively on northern Vancouver Island, especially in the Suquash area, where unconsolidated overburden is known to be up to 100 metres in thickness. Surface exposures of Cretaceous sediments are thus few in number, and occur along the tideline where the erosive action of the sea has uncovered the bedrock, or along major fault contacts, where scarp lines occur.

Chapter 3

THE HOLBERG AREA

Field work in the Holberg area has isolated the sedimentary occurrences along the north side of Holberg Inlet known as the Hushamu and Cleskaugh Creek areas during the previous reconnaissance work. The new work shows that the sedimentary trend does not occur to the northwest of these areas in such lowlying valleys as the Goodspeed River. The valley of the Goodspeed River, which is separated from Holberg Inlet by a high ridge of volcanics, lies within volcanic terrain which is represented by a series of banded cherts and metamorphosed greywackes, tuff and breccia. These units all dip very steeply in a southwesterly direction. They are part of the Jurassic Bonanza Group, which is chiefly volcanic in nature but contains some elements of marine sediments which indicate a submarine volcanic island arc complex. In only one very confined area on the south side of the Goodspeed valley near its headwaters was Cretaceous conglomerate found. This area, because of its proximity to the top of the southern ridge, is interpreted to be a small remnant of the thick Lower Cretaceous conglomerate unit which is found extending over a large area between Holberg Inlet and Quatsino Sound (see next section). The remainder of the Cretaceous section has been eroded from this uplifted block. Cretaceous sediments were not seen at any location north, east or west of the village of Holberg. It is postulated that the major fault feature running the length of Holberg Inlet is a Pre-Cretaceous feature which created an upland to the north upon which no Cretaceous sediments were deposited, except for very limited areas near the edge of the fault scarp on the north side of Holberg Inlet. Thus the potential for finding coal-bearing Cretaceous sediments to the north on the uplands, which represents a Jurassic or Triassic unconformable surface, is negligible.

Chapter 4

THE WINTER HARBOUR AREA

The Winter Harbour area was demonstrated to contain Lower Cretaceous sediments of the Queen Charlotte Formation during the previous mapping program. The Winter Harbour Area refers to an area of Cretaceous sediments on the north and south shores of Winter Harbour, which also extends to the southeast to include a large area on the north shore of Quatsino Sound, around Koprino Harbour and the Indian village of Quatsino (see Appendix Map I.) The area covers approximately 30 sq. km. on the north shore of Winter Harbour, centering about a low wide valley through which Denaad Creek flows. On the north shore of Quatsino Sound from Koprino Harbour east to Quatsino, and north to almost the south shore of Holberg Inlet, the Cretaceous sediments cover an upland area of approximately 80 sq. km. in extent.

Access to the areas is confined to three private logging roads : the road to Winter Harbour from Holberg, a branch road off this road which follows the south shore of Holberg Inlet for some distance, then swings south to Koprino Harbour, and the Moore

Lake logging road, which follows a valley to the northwest of Winter Harbour up to and beyond Moore Lake (see Appendix Map I). There are some minor secondary logging roads off these main roads but these are very limited.

The area is virtually uninhabited except for Winter Harbour and Quatsino, which are tiny, isolated fishing villages. There are some Indians living on reserve areas close to tidewater, such as the reservation northeast of Winter Harbour at Denaad Creek and the one east of Quatsino.

At Winter Harbour, some sandstones, siltstones and shale beds are evident. These were traced for some miles to the northeast, where at Denaad Creek they assume a very regular, flat-lying structure which would appear to carry through the entire valley. The complete thickness of the Cretaceous section in this vicinity could not be determined, but it is estimated to be at least 300 metres. Due east of Moore Lake, an elongate ridge interrupts the general low-lying nature of the valley. This ridge is currently the site of logging activity - some new roads are being built over and along the southwest side of the ridge, which afforded an examination of approximately 150 stratigraphic metres of the sedimentary section encompassing what is referred to as the Lower Member. These sediments consist of soft, easily erodable brownish to buff-coloured medium grained sandstones overlain by conglomeratic beds. The dips on the formation in this area are steep: the sandstone dips to the southwest at 57 degrees, the overlying conglomerate dips to the northeast at 60 degrees. The ridge is cut in half by a fault which strikes generally north-south. No coal beds were seen in the area and no trace of coal float could be found in any of the creeks.

Northeast of Koprino Harbour, a new road afforded some examination of the conglomerates of the upper member of the Queen Charlotte Formation in an expansion of last spring's field work. This new logging road has progressed in a northeasterly direction for approximately 1 km since the last inspection, however no new formational units were exposed. There are some small thin sandstone interbeds within the massive conglomerate formation, however, there was no indication that the lower member even exists in this area. Near the mouth of the Koprino River on the east side the Triassic Karmutsen unconformable surface is shown in direct contact with the upper member conglomerates, reinforcing the idea that the potential for encountering coal seams in this area is very small.

Further northeast, a road which was in good condition but not passable due to windfalls was traversed on foot to a point approximately 2 km southwest of Jules Bay on the south side of Holberg Inlet. The Karmutsen Formation is exposed on the north side of the new bridge at the end of this road. A branch road to the northeast approximates the contact between the conglomerates of the upper member and the volcanic unconformable surface. No sandstones or traces of coal could be found in this area.

Chapter 5

CONCLUSIONS

As a result of this new work combined with the original reconnaissance, it is this author's opinion that the potential for encountering additional coal deposits other than those that are already known about is very limited. This is chiefly due to volcanic nature of the terrain in most areas. These volcanic areas are readily identifiable in the field from their rugged topographic profiles. The lowlying areas within river valleys have been examined for traces of coal float and sedimentary outcrops and contain, for the most part, deposits of Triassic or older metasediments such as banded cherts, metamorphosed argillite or limestone. No coal occurrences within Triassic or older formations are known about on Vancouver Island.

The lack of exposures on the lowlying areas which are always covered by vegetation and often swampy, and the inaccessibility of many areas, provides some chance that a previously unknown sedimentary deposit will be discovered, however, this discovery will much more likely be the result of logging road construction or other excavation work than reconnaissance mapping.

The sedimentary basins that have been identified as a result of the original survey in the spring of 1984 contain some possibilities for coal resources - this potential has been discussed in the last report. It is the author's opinion, however, that any additional meaningful information gathered in these areas will result from subsurface methods such as drilling. Surface geology in these areas will always be inconclusive due to large areas covered by vegetation and/or glacial till and outwash deposits.

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2. James, A. R. C., "The Coalfields of Vancouver Island", (1969), B.C. Dept. of Mines and Petroleum Resources

3. Muller, J. E., "Port McNeill and Nanaimo Basin", (1967), Geological Survey of Canada Paper 67-1

4. Muller, J. E., "The Geology of Vancouver Island", (1977), Geological Survey of Canada O.F. 463

5. Muller, J. E., "Evolution of the Pacific Margin, Vancouver Island and Adjacent Regions", Canadian Journal of Earth Science, Vol. 14 (1977)


QUEEN CHARLOTTE STRAIT
QUATSINO PROVINCIAL FOREST
VANCOUVER ISLAND
MALCOLM ISLAND
Thick Glacial Cover (no outcrops)
Sedimentary Shelf (Projected Approximate Extent)
(~ 50 fathom water depth)
Area of inferred in-situ coal resources 18.1 million tonnes
SUQUASH MINE underground workings (1922)
Upper Cretaceous Sediments
Triassic Karmutsen Fm. Basalt
Triassic Karmutsen Fm. Basalt & Jurassic Bonanza Group Volcanics
Jurassic Bonanza Grp. Volcanics
Lower Cretaceous Longarm Fm. Sandstone - Shales
Lower Cretaceous Queen Charlotte Fm. Conglomerate
Lower Cretaceous Queen Charlotte Fm. Sediments
Queen Charlotte Fm.
Tertiary Volcanics
Cleskiaugh Creek Coal Area
Hushamu Creek Coal Area
lower coal zone
upper coal zone
UTrQ Lmst
Lmst
IJB
TrKm
BROUGHTON STRAIT
QUATSINO SOUND
VANCOUVER ISLAND RANGES
LEGEND
Formation Strike and Dip
Fault Contact With Indicated Direction of Downthrow
Formational Boundary
Unconfirmed Coal Occurrence
Confirmed Coal Occurrence
Old Borehole
Recent Borehole
Volcanic Terrain (Pre-Cretaceous)
Sandstone
Conglomerate
Limestone
Siltstone
Inferred Subcrop - Outcrop of Coal Seams
Road Traverse
IJB Jurassic Bonanza Group Volcanics
UTrQ Upper Triassic Quatsino Limestone
TrKm Triassic Karmutsen Basalt
0 1 2 3 4 5 6 7 8
kilometres
Scale 1:100,000
APPENDIX MAP I
TEXACO CANADA RESOURCES LTD.
POTENTIAL COAL-BEARING SEDIMENTARY DEPOSITS SUQUASH BASIN AND OUTLIERS
Updated: Nov. 1984
COMPILED BY: S.L.GARDNER
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DATE: MAY 1984
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