THE MINERALOGY OF THE SANDS IN THE VICINITY OF VANCOUVER

by

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CONTENTS

LIST OF ILLUSTRATIONS

PLATE I

RUTILE

GARNET

HYPERSTHENE

EPIDOTE

ZIRCON

ALTERED HYPERSTHENE

VOLCANIC GLASS

ZIRCON

FOREWORD

This paper is a statement of the results obtained from the analysis of beach sand from the following localities: Boultbee's Beach, Caulfeild Beach, East Beach, the mouth of Capilano River, Second Beach, Kitsilano Beach and University Beach. These beaches are widely separated, and great lengths of shore intervene whose sands have not been examined. Therefore, it can not yet be determined whether the mineral content of the beach sands in the vicinity of Vancouver show a distinct lateral variation. Before the results of the mineral analysis of the sands can be correctly interpreted, a study must be made of the tides, shore currents and the petrology of the surrounding outcrops of rocks. Because of the lack of time and data, the work recorded here is confined to the identification of the constituent minerals.

INTRODUCTION

The area in the vicinity of Vancouver is characterised by the development of two distinct physiographic types - lowland and highland. The general lowland area extends from the International Boundary to the north shore of Burrard Inlet. It is bounded on the north by the mountains of the Coast Range, and on the east by the Cascades. The monotony of the lowland topography is broken by three relatively high areas of ground - Burrard peninsula, Boundary Upland and Point Roberts Upland.

The Burrard peninsula lies between Burrard Inlet and the north arm of the Fraser River. This area is divided in to two ridges which are separated in the west by False Creek valley, and in the east by the valleys of Still Creek and Brunette River. The ridges are composed of bedrock, glacial drift, interglacial sand and clay and recent marine and delta deposits.

Geologically speaking, all the rocks of the lowland are young. The oldest rocks in the region are the Tertiary sedimentaries. They consist of fairly well consolidated conglomerates, sandstones and shales which have been downwarped and faulted, then uplifted and eroded.

The Prospect Point eruptives are represented by basic dykes, sills, flows and tuffs. The age of these volcanics is post-Eocene and pre-Pleistocene. They therefore furnished some of the material for the glacial deposits.

The Pleistocene deposits are varied in character. Unconsolidated glacial gravel, sands, silts and clays comprise the greater part of the sediments. However, interbedded with these are some interglacial sands, silts and clays.

The highland north of Burrard Inlet is composed of the Jurassic plutonics of the Coast Range Batholith. The narrow strip of lowland area that intervenes between the mountains and the shore is due to the deposition of Tertiary sandstone, glacial drift and the deltas of Capilano River, Lynn Creek and Seymour Creek.

Chapter I

LABORATORY METHODS

The outline of the laboratory methods employed has been included in the hope that it may be of use in any similar work undertaken in the future.

About two pounds of sand were collected at low tide from each beach. Clean sand was obtained by scraping away several inches of surface material. A place on the beach was chosen where there was not likely to be an artificial concentration of heavy minerals by surface irregularities or peculiar wave action.

After the sand had been thoroughly dried, it was put through a fourteen-mesh screen to remove any large rock fragments or shells. Three twenty-five gram specimens were obtained by coning and quartering, and each of these was treated separately in order that the results might be compared.

The carbonates, mostly shell material, were removed by soaking the sand in dilute hydrochloric acid. The percentage was calculated from the loss in weight by the sand.

Bromoform, which has a specific gravity of 2.9, proved a satisfactory medium for concentrating the heavy minerals. About 250 c.c. of this liquid was poured into a one-liter glass separating funnel, and the dry sand was slowly added. The funnel was stoppered, and the mixture allowed to stand for an hour without disturbance. The heavy minerals, which had settled to the bottom of the funnel, were then drawn off. Since the first separation is not always complete, the contents of the funnel were stirred and 20 c.c. of bromoform added. When the remaining heavy minerals had been completely precipitated, they were drained into the beaker containing the first crop. The light minerals were washed from the funnel with bromoform. The light and heavy crops were carefully washed, dried and weighed.

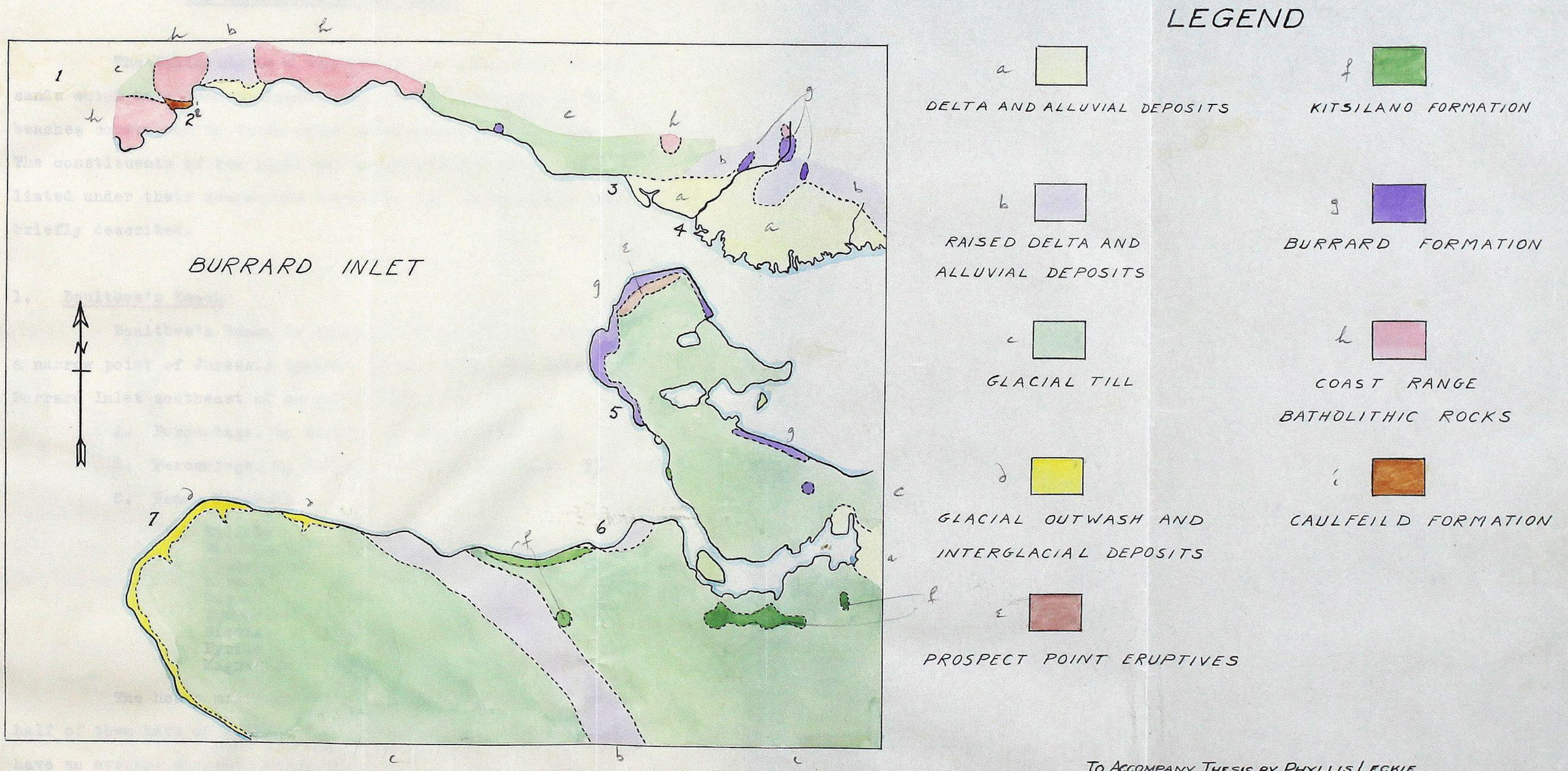
The magnetic material was removed from the heavy concentrate with a small horse-shoe magnet.

The microscope was used to identify the minerals. The light and heavy crops were examined separately. The agglomeration of minerals was spread out on white paper under the binoculars, and the grain singled out for identification was removed on the tip of a camel's-hair brush to a glass slide for examination under the microscope with a low or medium-power lens. The grain was then crushed, and the fragments spread over three or four glass slides. The refractive index of the mineral was determined by immersion in oils of different refractive indices. The other optical properties of the mineral were also obtained. Even very minute flakes of minerals yielded clear interference figures.

Before some of the grains were examined under the microscope, they were dropped into a beaker of methylene iodide which has a specific gravity of 3.3. Therefore a closer approximation to the specific gravity of the mineral was obtained. However, this step usually proved superfluous.

A micrometer eye-piece and a medium-power lens were used to estimate the size of the mineral grains.

The percentage composition of the sand was computed by counting. The minerals were spread on slides, and examined under a low-power lens. The average of several fields was taken as the result. In estimating the percentage composition, the size of the mineral grains was taken into consideration.



VANCOUVER AND VICINITY

To Accompany Thesis by Phyllis Leckie

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Chapter II

THE MINERALOGY OF THE SANDS

The following is a summary of the mineralogy of the sands which have been analysed. The numbers assigned to the beaches correspond to those found on the accompanying map. The constituents of the light and heavy mineral crops are listed under their respective headings, and the minerals are briefly described.

1. Boultbee's Beach

Boultbee's Beach is situated on the eastern side of a narrow point of Jurassic igneous rocks, which juts into Burrard Inlet southeast of Horseshoe Bay.

A. Percentage, by weight, of carbonates: 4%

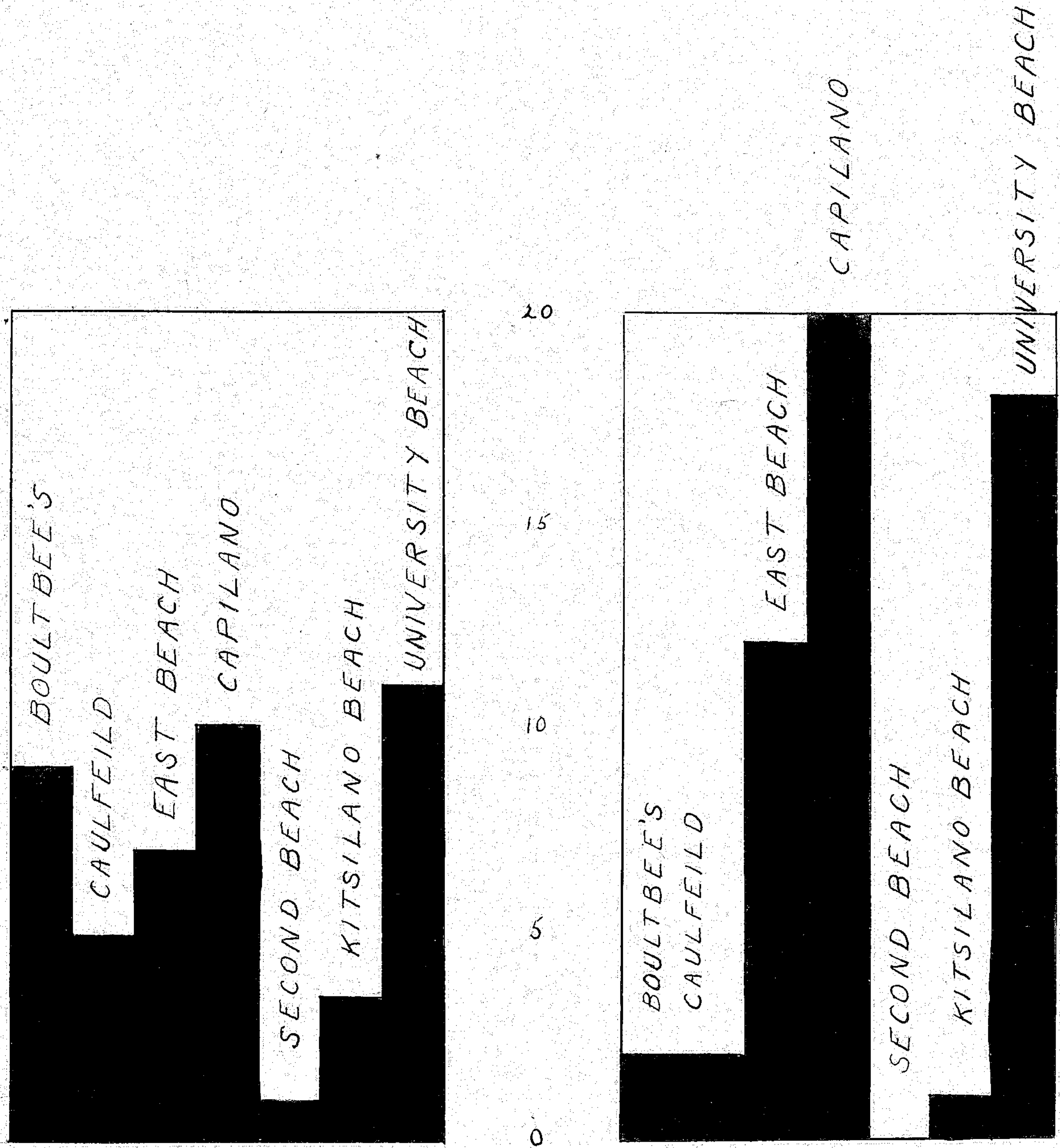
B. Percentage, by weight, of heavy minerals: 9%

C. Heavy Minerals

Epidote	(75% - by counting)
Hornblende	(10% - by counting)
Hypersthene	
Zircon	
Garnet	
Tremolite	
Biotite	
Pyrite	
Magnetite	(2% - by weight) ?

The heavy minerals are of two distinct sizes. One half of them have an average diameter of .4 mm., and the rest have an average diameter of .1 mm.

The largest grains of epidote are pale green to white, sugary and rounded. The small grains are clear, bright



PERCENTAGE of HEAVY MINERALS

PERCENTAGE of MAGNETITE

FIGURE I

green prisms, and may easily be mistaken for olivine.

The hornblende occurs as glossy black prisms.

The small brownish-green prisms of hypersthene are distinctly pleochroic in pink and green tones.

Several minute crystals of brown zircon were found. A number of pale yellow and colorless fragments were also identified as this mineral.

Garnets are rare. They are brown and opaque with rough surfaces.

The tremolite prisms are dark grayish-green.

A few of the biotite flakes show a green tinge.

The pyrite fragments are angular.

D. Light Minerals

Quartz (95% - by counting)
Feldspars
Rock fragments

The light minerals, which are uniform in size, have an average diameter of .5 mm.

2. Caulfeild Beach

Caulfeild Beach lies in a shallow bay about one-third of a mile east of Point Atkinson. The denuded rocks of the Caulfeild formation dip steeply into the sands.

A. Percentage, by weight, of carbonates: 2%

B. Percentage, by weight, of heavy minerals: 5%

C. Heavy Minerals

Epidote	(35% - by counting)
Hornblende	(20% - by counting)
Biotite	
Garnet	
Volcanic Glass	
Pyrite	
Chromite	
Magnetite	(2% - by weight)
Tourmaline ?	

The heavy minerals have an average diameter of .4 mm.

The grains of epidote and hornblende have the same characteristics as those occurring in the sand of Boultbee's Beach.

Some of the biotite flakes are green.

The garnets are brown, opaque and well rounded.

Volcanic glass is rare. It is conspicuous because of the irregular outline of the fragments.

The pyrite fragments are angular.

The chromite grains are rounded.

One deep green grain of sand was doubtfully identified as tourmaline.

D. Light Minerals

Quartz	(95% - by counting)
Feldspars	
Phlogopite	
Rock fragments	

The average diameter of the light minerals is .5 mm.

Most of the quartz grains are rounded. Some of them are pale yellow.

The feldspar fragments are angular.

3. East Beach

East Beach borders the low-lying strip of glacial outwash and interglacial deposits which lie to the east of the West Vancouver Ferry wharf.

A. Percentage, by weight, of carbonate: 3%

B. Percentage, by weight, of heavy minerals: 7%

C. Heavy Minerals

Epidote	(30% - by counting)
Hornblende	(30% - by counting)
Hypersthene	
Garnet	
Magnetite	(12% - by weight)

The heavy minerals have an average diameter of .7 mm.

The epidote grains are rounded.

The hornblende prisms often show an alteration to a micaceous substance.

Brownish-green hypersthene prisms are rare.

The garnets show no crystal form. They are either brown and opaque or pale pink and transparent.

D. Light Minerals

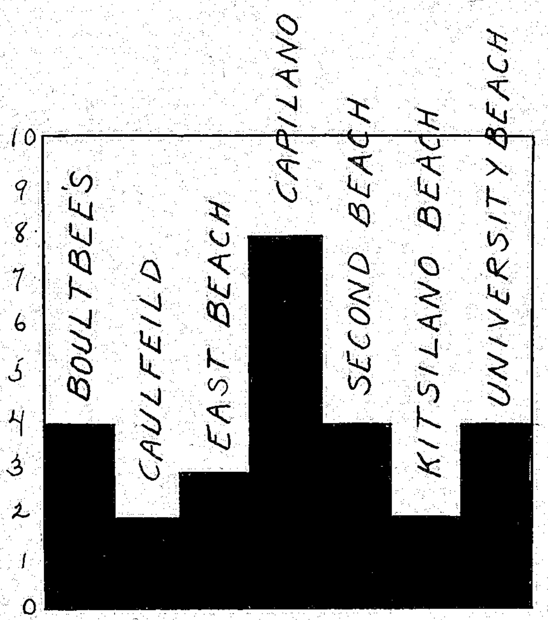
Quartz	(75% - by counting)
Feldspars	
Phlogopite	
Rock fragments	

The light minerals have an average diameter of .8 mm.

The quartz grains are colorless, white or yellow.

The feldspar fragments are angular.

Phlogopite is rare.



PERCENTAGE of CARBONATES

FIGURE 2

4. The Mouth of Capilano River

This sample of sand was taken from the delta of the Capilano River which cuts through both Jurassic and Tertiary rocks.

A. Percentage, by weight, of carbonates: 8%

B. Percentage, by weight, of heavy minerals: 10%

C. Heavy Minerals

Hornblende	(60% - by counting)
Epidote	(20% - by counting)
Hypersthene	(5% - by counting)
Biotite	
Garnet	
Zircon	
Tremolite	
Pyrite	
Magnetite	(20% - by weight)

The heavy minerals are of two sizes. Some of the grains have an average diameter of .1 mm., while others have an average diameter of .5 mm.

The prisms of hornblende are shiny and angular.

The epidote varies from comparatively large, rounded grains to minute prisms.

The hypersthene crystals are olive green prisms. They are pleochroic. Many of them are coated with a red alteration product which makes identification difficult.

The biotite flakes are either black or green.

A few rough brown garnets are present, but the greater number are microscopic, pink dodecahedrons.

The minute zircon crystals are salmon pink. They appear amongst the other sand grains like pin-points of light.

Tremolite is rare. It occurs as grey-green prisms.

The pyrite fragments are very much worn and pitted.

D. Light Minerals

Quartz (75% - by counting)
Feldspars (20% - by counting)
Phlogopite
Rock fragments

The light minerals have an average diameter of .5 mm.

The quartz grains are either colorless or white.

The feldspar fragments are angular.

5. Second Beach

The sand was obtained at the promontory which forms the western boundary of Second Beach. The Burrard formation outcrops here, and the surface of the land is covered by a mantle of glacial till.

A. Percentage, by weight, of carbonate: 4%

B. Percentage, by weight, of heavy minerals: 1%

C. Heavy Minerals

Epidote (45% - by counting)
Hornblende (45% - by counting)
Garnet
Hypersthene
Biotite
Rutile

The heavy minerals have an average diameter of .4 mm.

The epidote and hornblende grains were both slightly rounded.

Minute pink garnets are rare.

Hypersthene is also rare. It is either greenishbrown or coated with a red mineral.

The biotite is black.

One grayish-brown crystal of rutile was found.

D. Light Minerals

Quartz	(75% - by counting)
Feldspars	(15% - by counting)
Rock fragments	

The average diameter of the light minerals is .5 mm.

Several small, clear quartz crystals were identified. The colorless quartz grains from this beach are exceptionally transparent.

Most of the feldspar grains are colorless and angular.

6. Kitsilano Beach

This sample of sand was taken from the point which marks the northern limit of Kitsilano Beach. Delta and alluvial deposits surround the beach, and the Kitsilano formation outcrops to the west.

A. Percentage, by weight, of carbonates: 2.5%

B. Percentage, by weight, of heavy minerals: ^

C. Heavy Minerals

Epidote	(50% - by counting)
Hornblende	(25% - by counting)
Hypersthene	(5% - by counting)
Garnet	
Magnetite	(1% - by weight)

The heavy minerals have an average diameter of .7 mm.

The epidote and hornblende grains are well rounded.

The prisms of hypersthene are small and olive green.

Zircon occurs either as reddish-brown prisms or as minute colorless crystals.

The fragments of garnet are either pale pink or brown.

D. Light Minerals

Quartz	(95% - by counting)
Feldspars	
Rock fragments	

The light minerals have an average diameter of .9 mm.

The quartz grains are colorless, milky or yellowish.

Feldspar fragments are rare.

7. University Beach

University Beach lies at the base of the precipitous cliffs of Point Grey. This western extremity of Burrard peninsula is composed of glacial outwash and interglacial deposits.

A. Percentage, by weight, of carbonate: 4%

B. Percentage, by weight, of heavy minerals: 11%

C. Heavy Minerals

Epidote	(30% - by counting)
Hornblende	(30% - by counting)
Hypersthene	(25% - by counting)
Garnet	(5% - by counting)
Zircon	(1% - by counting)
Apatite	
Biotite	

Muscovite
Magnetite (13% - by weight)

The average diameter of the heavy minerals is .4 mm.

Most of the epidote grains are rounded and sugary, but some are in the form of transparent green prisms.

The hornblende prisms are definitely angular.

Many of the hypersthene crystals are almost completely altered to a red mineral.

This sand is characterised by reddish-brown dodecahedrons of garnet. A few fragments of pale pink garnet are also interspersed amongst the heavy minerals.

Zircon grains are either brown, yellow or pink. The latter color is usually found in minute prismatic crystals.

The pale bluish-green apatite grains are rounded.

Biotite and muscovite are rare.

D. Light Minerals

Quartz (75% - by counting)
Feldspars (20% - by counting)
Rock fragments

The average diameter of the light minerals is .6 mm.

The quartz grains vary in size and shape and are either white, colorless or pink.

The feldspar fragments are angular.

MINERAL OCCURRENCE

	UNIVERSITY	KITSILANO	SECOND BEACH	CAPILANO	EAST BEACH	CAULFEILD	BOULTBEES
APATITE	V						
BIOTITE	V		V	X		V	V
CHROMITE						X	
EPIDOTE	⊗	⊗	⊗	⊗	⊗	⊗	⊗
FELDSPAR	X		X	X	V	V	V
GARNET	⊗	V	X	X	V	V	X
HORNBLENDE	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HYPERSTHENE	⊗	X	X	⊗	X		X
MAGNETITE	⊗	X		⊗	X	X	X
MUSCOVITE	V						
PHLOGOPITE				X	V	V	
PYRITE				V		V	V
QUARTZ	⊗	⊗	⊗	⊗	⊗	⊗	⊗
RUTILE			V				
TREMOLITE				V			V
TOURMALINE						V	
VESUVIANITE	V						
VOLCANIC GLASS						V	
ZIRCON	X			X			V

ABUNDANT - ⊗
PRESENT - X
RARE - V

FIGURE 3

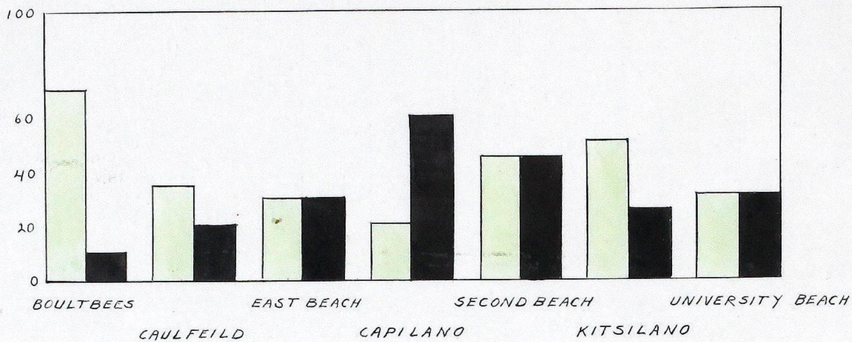
Chapter III

CONCLUSION

The sands of the beaches in the vicinity of Vancouver have been derived from two distributive provinces - the sedimentary lowland and the highland of the Coast Range. Therefore, some of the minerals owe their origin to the re-deposition of pre-existing sediments, while others represent the disintegration of igneous rocks.

The beaches of the north shore of Burrard Inlet lie at the foot of the mountains, and those of the south shore border the sedimentary lowland. The accompanying table (Fig. 3) which records the results of the analyses, demonstrates the fact that the sands of the various beaches differ only in the relative proportions of the mineral constituents. The similarity in the mineral content of the sands may be explained by the fact that the rocks of the Coast Range were laid bare by Tertiary and Pleistocene erosion, and therefore acted as a distributive province for the Tertiary and Pleistocene sediments of which the lowland is composed. Hence, upon erosion, the sedimentary formations of the lowland and the igneous rocks of the highland yield the same minerals. The minerals of the glacial deposits have undergone very little alteration because they were accumulated at a time when chemical weathering was at a minimum.

Epidote and hornblende, which are the most abundant of the heavy minerals, occur in varying proportions in the



PERCENTAGE of EPIDOTE AND HORNBLENDE

IN HEAVY MINERAL CROP

FIGURE 4

different beach sands. From the block diagram (Fig. 4) it may be seen that the percentage of epidote in the sands of the north shore decreases steadily from Boultbee's Beach eastward to the mouth of the Capilano River, whereas the percentage of hornblende increases in this direction.

Both epidote and hornblende are abundantly disseminated throughout the rocks of the Coast Range Batholith. Epidote dykes cut the rocks which lie along the shore east of Caulfeild, and veinlets and masses of this mineral occur in Lynn and Capilano Valleys. Hornblende is an important constituent of the Caulfeild formation, as well as of the epidote dykes mentioned above. According to Burwash[1], hornblende is the principal ferromagnesian mineral in a "dark green, massive porphyrite" which outcrops in the valley of the Capilano River. The erosion of this porphyrite accounts for the high percentage of hornblende in the sand of the delta of the Capilano River.

The number of samples analysed from the south shore of Burrard Inlet was not sufficient to show any persistent lateral variation in the percentages of hornblende and epidote. These minerals both occur in the tuffs which are exposed on the south side of False Creek. Many of the fresh, angular fragments of epidote and hornblende have probably been derived from this source. Hornblende is also plentiful in the Prospect Point eruptives.

Magnetite, which is a common constituent of many

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1. Burwash, E.M.J. - The Geology of Vancouver and Vicinity. 1918. p. 35.

types of rock, is present in appreciable amounts in all the sand analysed except that of Second Beach. The sand of Second Beach is also characterised by having the lowest percentage of heavy minerals. The results show that the greatest percentages of magnetite occur in those sands which have the highest percentages of heavy minerals.

All the beach sands analysed contain large amounts of quartz which commonly occurs as various colored, rounded grains or angular fragments. However, several small quartz crystals were found in the sand from Second Beach. These probably originated in the vesicular cavities of the Prospect Point dyke.

The metamorphosed limestone of Lynn Creek is undoubtedly the source of many of the garnets. However, the dodecahedrons of garnet from the mouth of Capilano River are pale pink, while those from University Beach are reddish brown and larger. Therefore, there must be more than one important source of garnet.

Since hypersthene is a common metamorphic mineral, its presence in the sands is not unusual. The crystals of hypersthene from the sand of Capilano delta show less alteration than those from the other beaches. Therefore, it seems probable that the source of hypersthene lies within the area drained by Capilano River.

Chromite was found only in the sand of Caulfeild Beach. The olivine-bearing dykes which cut the Caulfeild formation are a likely source of the chromite grains.

Volcanic glass is another mineral which was found only in the sand of Caulfeild Beach. The post-Eocene eruptives of Howe Sound are characterised by brown glass. Their erosion offers a plausible explanation for the presence of the glass in the Caulfeild sand.

The rest of the minerals recorded in the table of mineral occurrences are present in the sands in small amounts, and as yet their characteristics have not proved indicative of their source. However, it is the rare heavy minerals with a restricted range which are most useful in the correlation of sediments. Therefore, none of the constituent minerals of the sands should be classed as unimportant until more analyses have been made, and the petrology of the distributive provinces has been more comprehensively studied.

The detrital minerals yield information in regard to the source of the sediments, the direction of drainage and the conditions of transport. The movements of the sea-bed and the subsidence or elevation of the land-masses are also reflected in the mineral composition of the shore sands.

The analyses which are the basis of this report are merely a preliminary effort to disclose the natural history of the sands by determining the qualitative distribution of the minerals and the variation in the proportions of the constituent minerals as the deposits are traced laterally. Hence it is clear that much careful work remains to be done on the sands in the vicinity of Vancouver before any results can be offered as a contribution to the science of geology.

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