CHAPTER 5

Mineral Resources

INTRODUCTION

The known mineral resources of the Queen Charlotte Islands are important because of their total quantity, their relationship to the development of the islands, and their position in the British Columbia economy. Vague and optimistic statements about the mineral wealth of the islands have been made at intervals for a century, but even preliminary realization has been delayed to the present. In 1966 iron concentrates to the value of approximately $5 million were shipped, and this may be expected to increase sharply and to be joined by copper concentrates when Tasu comes into production. Present reserves are sufficient for more than 20 years’ production. In the future one may expect also some diversification in mineral products produced. Hydrocarbons may be found in economic amounts, and probably industrial rocks and minerals and possibly manganese will some day be exported. Shipments of peat moss, which could be considered a hydrocarbon, started in 1967.

Some idea of the importance of the known mineral wealth can be gained from the following information. The value of ores shipped prior to 1962 was not much more than one-half million dollars at today's metal prices. The value of iron concentrates shipped from the start of operations at Jedway until the end of 1966 was approximately $17 million. The value of reasonably assured ore at Tasu, Jedway, and Burnaby Island is estimated to be of the order of $200 million and an estimate of ultimate potential is about $400 million.

The following discussion and property descriptions were completed in 1965. Only minor revisions have been added since.

HISTORY

Mineral deposits in the Queen Charlotte Islands were first explored more than 110 years ago. Since then repeated cycles of boom and bust with accompanying initial optimism, unreal expectation, and quiet subsidence have followed one another until the recent past. The incomplete and even fanciful record of the early period together with the remote setting and occasional hostility of some of the Haida communities lend that period an exotic and legendary character. The earliest development at Mitchell Inlet in 1852 led directly to the establishment of the Queen Charlotte Islands as a Crown colony the following year. This venture, the first lode-mining in British Columbia, was variously reputed to have yielded $5,000 to $75,000 in gold, which was lost in transit in a wreck near Cape Flattery. The mining on Mitchell Inlet, then called Kupé or Gold Harbour, was under the direction of Captain Mitchell of the brig "Una" of the Hudson's Bay Company, and the vein was reportedly mined out in the short operation. A certain excitement was
created by the news of this venture, which led to succeeding expeditions. These did not recover any quantity of gold, but one, led by a Major William Downie, discovered coal on Skidegate Inlet in 1859. In 1862–63 Francis Poole explored the vicinity of Skincuttle Inlet and discovered the chalcopyrite and magnetite showings near the present mill-site at Jedway and the cupriferous skarns on the Copper Islands and near the orebodies of the Jib (Burnaby Iron Mines Limited). He sank small shafts on chalcopyrite-rich skarn and on a vein both on the present Jib group, but is remembered chiefly for his fanciful account of his adventures (Poole, 1872). About the same time a shaft was sunk by a Mr. Waddington exploring for copper ore on the north side of Copper Bay. Coal exploration started about 1865, and full-scale preparation for mining was made at the Cowgitz "mine" between Kagan Bay and Long Inlet without adequate preliminary exploration or study. This venture closed in 1872 after the waste of much capital, but it did lead to the early investigations of the Geological Survey by Richardson, Billings, and Dawson. After the coal exploration tapered off, activity in general was slight until the beginning of this century.

Beginning in 1900 but particularly during the years 1906 to 1914, prospecting and development were intense and a large percentage of the showings known today were found. About 1900 A. Heino started once again the exploration of the cupriferous skarns of Skincuttle Inlet, which he continued for more than 30 years. Copper exploration was most active about Skincuttle Inlet, Lockeport, and Tasu Sound and led to the successful production from two significant mines and trial shipments from numerous other prospects. Direct shipments from the Lily mine, Ikeda Cove, began in 1907 and continued fairly regularly until 1920, and from the Warwick, now part of Tasu, Tasu Sound, in 1914 with a small production thereafter. Coal exploration was centred on Graham Island about the upper Honna and Yakoun Rivers and at Skonun Point. Once again large sums were invested and optimism was high. Exploration found coal but no significant mineable reserves. Foreclosure by a major investor in one of the companies combined with the start of the Great War finished coal exploration for the time. Once again, however, geological studies by Ells, Clapp, and MacKenzie were successively initiated primarily to aid coal exploration. Oil exploration was centred at Tian Bay on the west coast of Graham Island, where the logistic problems must have been formidable, and yet a 1,600-foot exploratory well was drilled by a standard rig. The exploration philosophy is baffling, for the hole was spudded in volcanic rocks of the Masset Formation remote from any sedimentary rocks. The venture started in 1913 and was abandoned in 1915.

Between 1918 and 1939 exploration was rarely intense, but some exploration and development of lode-gold prospects and beach placers occurred throughout the period, with effort concentrated on the Blue Mule at Kootenay Inlet; Homestake, Cumshewa Inlet; Early Bird, Mitchell Harbour; Southeaster, Skidegate; and placer at Shuttle Island and the northeastern beaches and Bluejacket Creek of Graham Island. Some work was also performed on copper prospects at Harriet Harbour and Louise Island.

Exploration was again at a very low level until the recent developments, which might be said to have started with the acquisition during the mid-1940's of the Crown-granted Ikeda claims by St. Eugene Mining Company (now Falconbridge Nickel Mines Limited). Interest in the skarn deposits of Tasu Sound was shown in 1953 by the purchase of St. Eugene of the key Crown-granted claims of Tasu at a Sheriff's auction and by prospecting by The Consolidated Mining and Smelting Company of Canada, Limited (now Cominco Ltd.). In 1954 Tasu was examined
by Alex Smith of Falconbridge, the Garnet group on Tasu Sound explored by the Consolidated company, and the McMillin (Copper Queen) on Harriet Harbour by R. E. Legg. In 1955 St. Eugene purchased and located more claims at Tasu and continued exploration there and elsewhere. In 1956 activity reached a preliminary peak with drilling at Tasu by a newly formed St. Eugene company subsidiary, Wesfrob, and at the Copper Queen by Silver Standard; by prospecting of the Swede group at Lockeport by New Jersey Zinc; and the Ikeda claims by St. Eugene; and by the acquisition and preliminary investigation of the key claims of Jedway by Dr. J. M. Black and Western Canada Steel. The new Mineral Act in 1957 resulted in uncertainty and a cessation of most activity for the next two years. Meanwhile in 1958 the Department of Mines started geological mapping of Moresby Island as an aid to iron exploration, and in 1959 sponsored an aeromagnetic survey of a 15-minute strip south of 53 degrees. In 1959 and 1960 Silver Standard proceeded with the drilling of a number of properties on Harriet Harbour and had most success on the Jessie Crown-granted mineral claim, which was to become the heart of Jedway. 1961 was another active year, the highlights of which included the purchase by the Granby company of the Jedway property from Silver Standard and the decision to proceed to production, renewal of drilling and engineering studies at Tasu by Falconbridge, and the aeromagnetic survey for Dennison Exploration of a strip of the southeast coast of Moresby in which the Kunga Formation and a number of plutons were outlined on the preliminary geological map. This survey discovered a significant anomaly just off Burnaby Island, the site of the present Jib group. In 1962 Canex and Silver Standard drilled the Iron Duke on Louise Island, and in October Jedway Iron Ore Limited began shipments of iron concentrates to Japan. In 1963 Highland Bell drilled the anomaly off Burnaby Island and proved the existence of a major magnetite body, and Falconbridge completed drilling and exploration and early in 1964 announced sales contracts with Mitsubishi for Tasu iron and copper concentrates with production to start in late 1966.

Oil exploration has been intermittent and as yet unsuccessful. Royalite drilled an exploratory well near Skidegate in the winter of 1949–50. The hole was spudded in the Haida Formation but near a plutonic body which was reached by the drill at 3,300 feet. Little further occurred until Richfield Oil Corporation acquired considerable acreage on northeastern Graham Island and Hecate Strait and drilled five exploratory holes in 1958. After further study in 1961, a 6,000-foot hole was drilled and abandoned at Cape Ball. Exploration in Hecate Strait was continued by Shell Canada in 1963–65 without announced decisions.

CLASSIFICATION

The mineral resources of the Queen Charlotte Islands will be classified in the following discussion and description of properties as follows:—

A. Metallic minerals.
   1. Pyrometasomatic iron-copper deposits.
   2. Massive to disseminated sulphide deposits.
   5. Placer deposits.
B. Industrial minerals and rocks.
1. Limestone.
2. Perlite.
4. Diatomaceous clay.
5. Carving slate.

C. Hydrocarbons.
1. Coal.
2. Lignite.
3. Peat moss.
4. Oil and gas.

DISTRIBUTION

Figure 34 shows the locations, types, and relative sizes of the mineral deposits of the Queen Charlotte Islands. The deposits are numbered from north to south and listed on the margin of the map. Certain geological features of importance are indicated, such as the distribution of plutonic rocks, the Kunga limestone, Masset Formation, and Skonun Formation. The importance of these features in the distribution of the various resources will become increasingly evident in the following discussion.

GENERAL APPRAISAL

Pyrometasomatic iron-copper deposits are by several orders of magnitude the most important mineral deposits now known in the Queen Charlotte Islands. Minable reserves have a gross value approaching $200 million, and the ultimate potential of known economic deposits has a gross value of about $400 million. Not only are these deposits the most valuable, but they are the most numerous. There is really no distinct break between these deposits and those of the second category, massive and disseminated sulphide deposits. For the purposes of the report, the pyrometasomatic deposits are those with significant skarn minerals, magnetite, or both, whereas the others do not have these features. Massive to disseminated sulphide deposits have not been important to date but offer a distinct possibility in the future, for they are known to be present but are considerably harder to find. Gold-bearing veins are not rare, some have good values locally, but no property has yet developed enough tonnage and grade to provide a continuing operation. Only one important manganese "vein" is known, but others, if they exist, probably occur in a relatively unprospected part of the islands where outcrop is minimal. The importance of the known deposit has not been adequately tested. It is possible bedded manganese deposits could occur related to this or other sources. Deposits of placer gold and heavy minerals are found along the northeastern beaches where they are formed by storm action on glacial sands of adjacent sea cliffs. The parent sands are not rich in these minerals, and the concentrations have not proved large enough to support a continuing operation. The industrial minerals and rocks may not be exploited in the near future, but considerable volumes of high-calcium limestone occur near tidewater in sheltered locations, and eventually they may be utilized. Perlite exists on Graham Island, and suitably expansible material might be found by
exploration. Little is known of the diatomaceous clay or bentonite, except of their existence. No mineable reserves of coal are known, and the possibility of developing them at today's economics is not great. Large volumes of lignite occur but not in thick beds near the surface, so that the possibility of exploitation is slight. Peat moss of excellent quality exists in large volume, and production started at a new plant in 1967. No bona fide oil or gas shows are known on the islands, and the results of the Richfield drilling was not encouraging. Nevertheless the considerable Late Tertiary section holds some promise of future discovery.

GENERAL DISCUSSION

A. METALLIC MINERAL DEPOSITS

1. Pyrometasomatic Iron-Copper Deposits

*Nature.*—Pyrometasomatic iron-copper deposits are composed of magnetite and chalcopyrite in a range of relative proportions, usually with pyrite or pyrrhotite, and associated with a partial or complete envelope of skarn. They form a distinct type, characteristic of Vancouver, Texada, and Queen Charlotte Islands, which are united by similar stratigraphic setting, structure, form, and mineralogy. The description that follows is based on Queen Charlotte Islands occurrences but might with few changes be applied to them all. Many of the common features have been noted from the earliest studies, McConnell (1909) and Young and Uglow (1926), but recent studies have noted these features with increasing precision as a result of much greater detailed knowledge of the deposits gained from extensive drilling and development and of the regional geology (Bacon, 1952).

The significant deposits and the great majority of the lesser deposits have the following features:

1. At or within a few hundred feet of the contact of the massive limestone member of the Kunga Formation with altered basalts of the Karmutsen Formation.
2. Near (within 500 feet) a plutonic body.
3. Pre-ore diorite porphyry bodies present.
4. Post-ore dykes abundant.
5. Skarn envelope or partial envelope present—composed of garnet, epidote, tremolite, pyroxene, and chlorite.
6. Pre-ore faulting present.
7. Evidence of brecciation common.
8. Massive bodies of magnetite or magnetite, chalcopyrite, pyrite, and pyrrhotite in variable proportions with variably sharp to gradational boundaries.
9. Shape of the orebodies an interplay of a number of forms concordant or discordant to bedding.
   a. Tabular-lensoid or lensoid swarm conformable with bedding.
   b. Tabular discordant to bedding.
   c. Pipe-like discordant to bedding.

Orebodies may combine these shapes in varying degrees but concordant lensoid shapes are commonest.
| Mineral Claim | Map No. | 15 | 34 | 30 | 11 | 38 | 37 | 29 | 44 | 39 | 51 | 45 | 18 | 16 | 17 | 32 |
|---------------|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| **Type**      |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Pre-ore porphyry |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Present     |        | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Post-ore dykes, important | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Pre-ore faults, important | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Breciolar, important | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Orebodies, massive | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Form**      |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Tabular, concordant | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Tabular, discordant | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Pipe-like    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Oxide       |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Oxide sulphide | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Sulphide oxide | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Metal-content |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Iron         |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Large (> 10^4 tons) | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Medium (> 10^3 tons) | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Small (< 10^3 tons) | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Copper       |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Large (> 10^4 pounds) | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Small (< 10^4 pounds) | |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| **Skarn**    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Important   |        | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Minor       |        | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
These features are shown on Table XX, which is a check list for all the important deposits and selected others. The locations of the deposits are shown on Figure 34, the mineral resource map. Inspection of the table will show how relatively uniform this group of deposits is. Some small massive magnetite bodies or larger disseminated bodies occur in the Karmutsen Formation basalts or minor limestones in this formation, or may occur remote from plutonic rocks. Pragmatic prospectors have considered none of these sufficiently large to be worthy of continuing ownership. All the significant deposits are in the preferred setting. In addition, the larger deposits all seem to have indications of pre-ore porphyry, faulting, brecciation, and normally abundant post-ore dykes. The skarn envelope is commonly better developed in the basalts or diorite porphyry than in limestone, both in regard to completeness and size. In a few deposits in limestone, skarn minerals are limited to the immediate vicinity of the magnetite, or even to the interstices of the magnetite grains.

The mineralogy of skarn and ore is also relatively uniform. Skarn formed from limestone is commonly composed of fairly coarse mid-brown garnet of the andradite-grossularite series. In other rocks, garnet is commonly developed only in the most intense skarns and is either fine or of irregular grain of more variable colour. Skarns formed from Karmutsen rocks are dominantly green rocks of chlorite, actinolite, epidote, and minor anthophyllite and orthoclase. Skarns formed of porphyries are lighter green, epidote, garnet, actinolite rocks. In both Karmutsen rocks and porphyries, remnants of the original texture are common. Minor quartz, calcite, and magnetite are present in almost all skarns. The ore itself is formed of a low titanium magnetite with scattered chalcopyrite, pyrite, or pyrrhotite, and rare high iron black sphalerite. The proportions of sulphide to oxide may be reversed; normally in such a case the ore is replacing limestone. Magnetite may be fine to coarse grained and is commonly coarser where replacing limestone. Replacement of volcanic rocks, porphyry, or diorite is, on the average, not as complete as of limestone, for inclusions of skarn or partly skarned rock of all sizes occur and the boundaries are generally gradational. Ore replacing limestone also commonly has small areas of coarse calcite, the boundaries of which invariably have the coarsest well-crystallized magnetite so that the calcite appears like a vug filling. Scattered or massive garnet may occur within ore in limestone but rarely chlorite, epidote, or amphibole. Sulphides occur as smooth blebs or streaks, as irregular filling of interstices, or as veinlets with clear quartz. Copper and zinc sulphides are commonest in limestone or orebodies replacing limestone and pyrite or pyrrhotite in orebodies replacing igneous rocks.

Origin.—The origin of the pyrometamorphic iron-copper deposits of the coastal islands has received considerable attention but mostly through detailed field and microscopic study (Swanson, 1925; Jeffery, 1961; Stevenson and Jeffery, 1964; Sutherland Brown, 1963; Eastwood, 1966). Geochemical, thermodynamic, and theoretical aspects have had less attention and are still needed (Sangster, 1964; Eastwood, 1965). A consensus has been reached about the ultimate source of iron, although the mechanisms of concentration, conduction, and introduction are not outlined with detail nor confidence.

The nature of the deposits limits the possible origins. A glance at the mineral resources map is enough to reaffirm that the basic setting is not accidental. These deposits are all close to plutons which intrude the Karmutsen Formation, and deposition has generally occurred at or near the basalt-limestone contact. The Karmutsen basalts are abnormally high in iron as well as soda, with total iron oxides
content about 13 per cent (see pp. 46–47). The plutons not only intruded the Karmutsen Formation, offering an opportunity for assimilation, but also seemingly originated by differential melting and mobilization of the Karmutsen Formation (see pp. 145, 161). Therefore, there is an available source of iron that spatial data suggest is the actual source.

The physical conduit system for the metallization is believed to be more nearly akin to hydrothermal processes than was believed in early studies concerned with skarns developed exclusively at intrusive contacts. Most significant deposits are definitely associated with either mineralized pre-ore faults or breccia pipes. Most of the larger deposits are also associated with pre-ore irregular diorite porphyry bodies which are more or less confined to their vicinity. The porphyry bodies provide a great contrast in physical properties to either the limestone or chloritic basalts and behave brittly. Brecciation results in deformation and a permeable, reactive environment. Recent underground development at Texada Mines Ltd., Texada Island, reveals the lower conduit system and the structural relations of porphyry, limestone, volcanics, breccia, intrusive rocks, and skarn orebodies. The orebodies form an upward branching system that follows a zone at the contact of the intrusive rocks in which irregular porphyry bodies and breccia are important. Where the system reaches the gently dipping limestone, both porphyry and orebodies blossom out. The whole system appears to have been a breccia pipe before it was largely replaced by skarn and magnetite (Sutherland Brown, 1964, pp. 146–151). Similarly, the Kingfisher orebodies at Empire mine on Vancouver Island are pipes of circular cross-section which bifurcate upward and are localized along a pre-ore fault (Jeffery, 1960).

The chemical mechanism for the transfer of the iron, alumina, and silica into, and other materials out of, the ore zone is not as obvious. The actual transfer of materials in a pyrometasomatic deposit is large and in replacement of limestone is very obvious. Replacement of basalt and porphyry involves more complicated transfers, such as the net increase in CaO in the skarn zone in contrast to a decrease in limestone skarns. This was suggested by the writer (1962) and demonstrated for the Prescott orebody of Texada Mines Ltd. by Sangster (1964, p. 1/3). On considering the origin of colloform magnetite from the Kingfisher ore pipes replacing limestone, Stevenson and Jeffery (1964) conclude that rapid deposition occurred from a gel that approximates the chlorite solutions proposed by Holser and Schneer (1961). A complete review of these aspects is beyond the scope of this bulletin and has recently been well done by Sangster, who concludes (1964, p. 134):—

"Skarnification, which took place in the temperature range 700–550° C., generally preceded the main stage of magnetite deposition. Conformity to Gibbs Phase Rule and non-appearance of incompatible phases is strong evidence that equilibrium was attained during skarnification. Neutralization of iron chlorite solutions by calcite resulted in precipitation of magnetite in the temperature range 400–550° C. Ore fluids, originally one phase, probably developed into a two-phase system at lower temperatures. These fluids increased in pH by reaction with calcite until they reached at least 7.8, the minimum stability pH of calcite. Magnetite first filled cavities in skarn and brecciated volcanic rocks, then diffusion into, and replacement of, volcanic rocks took place. Where the volume of host rock dissolved exceeded the volume of metasome deposited, cavities were formed, some of which were later filled by magnetite or by post-ore calcite and/or quartz."
2. Massive to Disseminated Sulphide Deposits

These deposits are arbitrarily distinguished from the pyrometasomatic deposits by their lack of magnetite or skarn minerals. It seems clear there is a gradation in character from massive magnetite deposits without significant sulphide, through sulphide-rich deposits with magnetite and skarn, to massive sulphide deposits without these accessories, to disseminated sulphide deposits also without skarn or magnetite. Known massive and disseminated sulphide deposits are not as common as the pyrometasomatic deposits, but are harder to find so may be more abundant than they appear. Whether their relative scarcity is real or apparent, they are not well enough known to treat adequately. The Swede group of disseminated chalcopyrite in Karmutsen basalts with occasional small veins of chalcopyrite forms one type representative of this group, and the Johnson Nickel property of massive sulphides—chalcopyrite and pyrrhotite, with minor bravoite and pentlandite—is representative of the more massive deposits. An additional type common in plutonic and some volcanic rocks is pyritic shear zones which may contain traces of chalcopyrite.

3. Gold Veins

Gold-bearing veins are not rare in the Queen Charlotte Islands, but none have proved large enough to support a continuing operation. Five properties have fairly extensive workings—Early Bird on Mitchell Inlet, Blue Mule on Kootenay Inlet, Cumshewa on Cumshewa Inlet, Southeaster near Skidegate, and Ellen on Shuttle Island. The setting of these deposits is varied, but they are normally in volcanic rocks, either Karmutsen basalts or Yakoun agglomerates or volcanic sandstones. The veins are not distributed in any obvious relation to plutons of either type nor to major fault or fold structures. However, all are stringer vein systems associated with steeply dipping minor faults. In several the amount of quartz present is small, and carbonate, vein breccia, and gouge are as prominent. They are sparsely mineralized with pyrite, traces of chalcopyrite, and some fine free gold. Wallrocks are slightly chloritized and silicified. The Southeaster is in many ways the largest, with a quartz-filled vein 2 to 20 feet wide and about 1,000 feet long which contains lenses of sulphides. In contrast the Early Bird has explored over 200 feet of a ramifying narrow stringer vein system with little quartz or sulphide but occasional concentrations of free gold. No new development has occurred since World War II, so that access to workings on these properties is not generally good.

4. Manganese Veins

Manganese "veins" are represented by one known example, the Shag Rock property near Klashwun Point on the north coast of Graham Island. This is a breccia-filled fault cemented by manganese oxides within the Masset Formation. It is exposed naturally on the tidal zone in an area with few other exposures in a region that is little prospected. The indications are that the fault is a significant structure with continuity over distances much greater than the exposure. The breccia of volcanic fragments is very nearly sealed by the manganese oxides, and ramifying veinlets extend into the fault walls. The mineralogy of the oxides—manganite
with lesser pyrolusite and traces of hausmannite and jacobsite, together with banded textures with open drusy vugs filled with minute crystals of dolomite and adularia (?)—indicate a primary hypogene origin (Hewett, 1964). The setting within layered basalt (and rhyolite) supports this conclusion, and the presence of Cape Knox type porphyry may be an added factor.

5. Placer Deposits

Investigation of placer deposits on the Queen Charlotte Islands has occurred intermittently for a hundred years. Most activity has been on the beaches of the north and east coasts of Graham Island from Tlell to Masset, but one endeavour was on Shuttle Island in Darwin Sound. Until recently all the efforts were to recover gold in heavy mineral concentrates, but in 1957 the iron or titanium content was the chief concern. “Black sand” and gold concentrations were mentioned by Dawson (1878, p. 338) and were known before. The heavy mineral concentrates on the east coast result from reworking during southeast gales of Pleistocene and, possibly at some stages, Skonun sands exposed in cliffs along the coast. On the north coast the situation is similar, but the shore is not currently being eroded and concentrations are smaller. The parent materials are in all respects quite average without abnormal amounts of heavy minerals, and it is only secondary concentration by storms of beach sands that creates local deposits worthy of economic consideration. These sands were studied by Holland and Nasmith (1958) at a time when they were being drilled by Mogul Mining Corporation and investigated by two other companies. Holland and Nasmith state (1958, p. 6):

“Numerous unsuccessful attempts have been made to mine the beach sands for their gold content. Placer-mining took place at Cape Fife, along a 3-mile stretch of beach 5 miles south of Cape Fife, along a stretch south of the mouth of Oeanda River, and in a small area at the mouth of Blue Jacket Creek a mile south of Masset. These are areas where there has been a concentration of magnetite in the normal sand into lenses possibly a few inches thick (from 1 to 8 inches normally), a few tens of feet wide, and possibly 500 or more feet long. The lenses might possibly average 50 per cent magnetite, and consequently represent a fairly high ratio of concentration of the normal beach sand. The small amount of placer gold the lenses contained was never sufficient to support a profitable operation other than for a few individuals.”

On Shuttle Island a small gravel beach has been worked for placer gold on several occasions. Local small gold-bearing veinlets appear to have been eroded with gold concentrated quite locally.

B. INDUSTRIAL MINERALS AND ROCKS

No industrial minerals or rocks have been exploited nor even much studied, yet with the advantage of proximity to the ocean that applies to most of the islands it will be surprising if some are not utilized within the coming few decades. The only exceptions are slate used for carving by the Haida Indians, which has been quarried in a small way for at least 150 years, and suitable rocks quarried for road construction. A brief discussion follows about limestone, perlite, and diatomaceous clay and carving slate. There is no description of properties, but localities are marked on the mineral map (Fig. 34).
1. Limestone

The lower two members of the Kunga Formation represent the main limestone resource of the Queen Charlotte Islands, particularly the basal massive grey limestone member. This unit is the correlative of the main Quatsino or Marble Bay limestone that has been so extensively utilized on Vancouver and Texada Islands. It conformably overlies the Karratun Formation and is widely distributed on the Queen Charlotte Islands. It is rarely cherty or dolomitic, but may contain abundant dykes and sills. Its thickness varies from less than 100 feet to more than 600 feet.

Analyses were made of samples from two localities of the normal basal massive grey limestone member. They were not collected to represent either especially good or even average limestone. At Kunga Island, J. W. McCammon collected chips every 20 feet over 500 stratigraphic feet along the south shore. At Limestone Island the writer collected three samples across separate repetitions representing about 200 stratigraphic feet.

ANALYSES

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<tr>
<th></th>
<th>Limestone Island</th>
<th>Kunga Island</th>
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<tr>
<td>Fe₂O₃</td>
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<td>Ignition loss</td>
<td>42.74</td>
<td>42.03</td>
</tr>
<tr>
<td>H₂O, 105°C</td>
<td>0.01</td>
<td>0.06</td>
</tr>
</tbody>
</table>

1 Average of three.
Analyses by Analytical and Assay Branch.

Thicker than normal sections occur at the following localities: Tasu mine, Kunga Island, southeast Burnaby and Copper Islands, Sandilands Island, Gillatt Arm. Bleached white limestone to marble occurs at Tasu mine, Lockeport, southeast Burnaby Island, and other localities. Good outcrop on sheltered tidewater occurs at Sandilands Island, upper Newcombe Inlet, Tasu mine, Gillatt Arm, Lockeport, Crescent Inlet, and near tidewater at Skidegate and Mosquito Lakes.

2. Perlite

Perlite occurs in dykes and flow-like masses in rhyolitic units of the Masset Formation. Expansible glass in the Queen Charlotte Islands was first reported by Mathews (1949, p. 7) from a locality, Lunch Island, in Juskatla Inlet. This was a vitrophyre, as are many rhyolites of the Masset Formation, but it was not perlitic. True perlites were found at a number of localities by the writer, but none of the samples tested were exceptionally expansible. Better material could likely be found with search. The map shows localities in which perlitic rhyolite was observed. These include localities above Skelu Bay, near Port Louis on Ironside Mountain, the head of Coates Creek, on Blackwater Creek, and at the junction of Gold Creek with the Yakoun River.
3. Bentonite

During the road construction from Juskatla Camp, a quarry was opened on a seemingly solid Masset volcanic rock on Blackwater Creek. It turned out to be a very poor road material, and some was sent to the writer for examination. It was found to be bentonite.

4. Diatomaceous Clay

Diatomaceous clay is exposed in some cutbanks along the lower Yakoun River between Black Bear and Canoe Creeks. These diatomaceous clays are part of the Upper Skonun Formation, presumably uppermost marine Pliocene unit. They are thus the only known marine diatomaceous rocks of British Columbia. One bed is about 10 to 12 feet thick. Sandy Davidson, of Shell Canada Ltd., described them to the writer, who has not seen them.

5. Slate for Carvings

The slate or argillite used for carving by the Haidas is a fairly unique rock composed of silt-sized fragments of kaolinite and less montmorillonite in a macerated very fine carbonaceous clay matrix that forms some 40 to 75 per cent of the rock. There is no detrital quartz, and any detrital feldspar appears to be altered to kaolinite. In addition, crudely barrel-shaped grains of kaolinite with a different texture appear to be porphyroblasts that have grow out of the fine matrix. The rock has a well-developed fine foliation but is compact unless sharply hit. The Haidas have a Crown-granted mineral claim centred on the site of their small quarry near Slatechuck Creek, 1½ miles from Kagan Bay. The quarry is not far from a faulted contact of Masset Formation. Some doubt remains regarding the precise stratigraphic location within the Queen Charlotte Group. It has always been said to be in the Haida Formation and could be in the upper shale member, but the interpretation shown on the map (Fig. 34) places it in the Skidegate Formation. Only detailed work in this region of abundant faults, complex folding, and relatively poor exposure in tangled logging slash could resolve the problem. There is a considerable tonnage of the rock on the claim, although not all is of good quality (that is, some contains detrital minerals). A similar rock without the low-grade metamorphism induced by the folding and metamorphism by the adjacent eruption of the Masset Formation would be unlikely to have the same subtle characteristics that make the rock desirable for carving.

C. HYDROCARBONS

No fossil fuels are currently being exploited, and the potentiality to produce coal or oil and gas remains to be proven. Abundant lignite exists, but economically mineable reserves are not known. Production of peat moss started in 1967.
1. Coal

At various times in the past the coal resources have been stated to be important, but proven reserves are meagre. Clapp (1914, p. 38) calculated the proven reserves as 6,900,000 tons and estimated the probable reserves as large. The writer believes the geological basis on which probable reserves were projected was faulty, so that only a new full-scale exploration programme could produce realistic figures. No significant exploration has occurred since 1914, and developments in the years immediately previous are fully reported by Clapp (1914, pp. 29-39) and MacKenzie (1916, pp. 119-158), both of whom saw workings which are now inaccessible. Hence this account will be concerned primarily with the geological premises on which reserves were projected.

Exploration was concentrated near Slatechuck Creek (Cowgitz and Slatechuck), of the headwaters of Brent Creek (Camp Anthracite and Camp Robertson), on Baddeck Creek near Yakoun Lake (Camp Trilby), and near the Yakoun River on Wilson Creek (Camp Wilson). The quality of the coals evidenced by the analyses (Clapp, 1914, pp. 31-36; MacKenzie, 1916, pp. 125-157) is good for some localities or specimens, but on the average the coals are rather high in ash. They range from low volatile bituminous to sub-anthracite. Unfortunately all except Camp Wilson are from relatively thin seams or aggregates of seams with much intercalated shale. No seam is much more than 2 feet thick. At Camp Wilson a lenticular seam varies from 4 to 18 feet thick within about 50 feet in the workings, and the writer believes pinches out entirely in a few hundred feet. The greatest apparent continuity exists between Camp Robertson and Camp Anthracite; in the former 2½ to 4 feet of coal occurs within 8 feet of beds and at the latter 4½ feet of coal occurs within 9 feet of beds.

The difficulty of correctly distinguishing between sandstones of the Haida and Yakoun Formations has perplexed all geologists concerned, from Dawson to the writer, and this problem is fundamental to the discussion of coal reserves. With experience most individual outcrops can be assigned with confidence to one unit or the other but other outcrops cannot. Fortunately fossils are abundant in the Haida Formation and not rare in the Yakoun. Otherwise, considering the facies changes in the Yakoun, the faults, and the abundant cover everywhere, the problem would be much more difficult. The question is of considerable importance because the coals have been thought to be in the Cretaceous Haida Formation, whereas at least those of Wilson Creek can be proven to be Middle Jurassic Yakoun Formation. By abundant plant microfossils in the coal and by ammonites and other invertebrates in the sandstones, the whole of the “Yakoun Basin” of MacKenzie is apparently Yakoun Formation, not Haida (see p. 75). The writer has not seen the area surrounding Camp Robertson, and it is mapped as Haida Formation following MacKenzie, but the possibility of it being Yakoun Formation overlain by Haida is now considered likely. The Haida Formation is believed to be entirely marine where it is well exposed, but characteristically it contains in its lower part not only carbonized logs, branches, and twigs, but also rounded coal pebbles, which the writer now believes represent eroded Yakoun coal. On the other hand, the writer also has no confidence that the coal of Slatechuck and Cowgitz is within the Haida Formation, and although it is within the Queen Charlotte Group, the structural complexity of this area precludes certainty as to the formation. Whatever the unit, it is apparently non-marine, and this may be explained by being adjacent to the active fault line from which detritus was shed into the basin. The Cowgitz coal is
apparently adjacent to the very large dyke of Masset Formation in the centre of the peninsula, and the contact has been the locus of later faulting.

In conclusion, it looks as if instead of a simple situation of coal existing at about one horizon of the Haida Formation which can be expected to exist over a major part of the basin with attendant large possible reserves, one is actually dealing with coal of at least two periods, in one of which coal was deposited on the flanks of volcanoes in a medium of rapid facies change and in the other in another environment in which not much continuity should be expected.

2. Lignite

There is an abundance of lignite in the Queen Charlotte Islands, but again there is no known economic reserve. Within the Skonun Formation there is much lignite, as shown by surface outcrops of the type locality and by the Richfield wells. In the southern basin, lignites occur in quantity only in the lower non-marine member, which at Cape Ball occurs at 3,500 to 5,000 feet depth, and at Tlèll from 3,250 feet to the total depth of 4,120 feet, and at Gold Creek 2,500 feet to the base of the formation at 3,810 feet (see Fig. 20 and pp. 120-124). This member becomes thinner and appears to be overlapped by younger members as it approaches the basin edge, so that there would be no significant lignites at open-pit mining depths. However, some beds about 1 foot thick outcrop at the mouth of Chinukundl Creek. In the southern basin, lignites appear to occur throughout the section but primarily in the upper non-conglomeratic portion (see Tow Hill well, Fig. 20). The northern basin is disturbed by faults and folds but is really only known from the Tow Hill well and outcrops and the outcrops at Skonun and Yakan Points. The outcrop at Skonun Point is described in some detail on page 121. Thirteen beds of woody lignite occur, of which nine are exposed, with an aggregate thickness of about 20 feet in some 200 feet of shale. The thickest bed exposed is but some 3 feet thick (in an old drill-hole the thickest is 6 feet thick). The beds occur in a faulted west-plunging moderately compressed anticline. An exploration programme might find significant deposits of lignite at relatively shallow depth in the northern basin, although the Skonun locality is not in itself overly interesting. Analyses of lignites from Skonun Point are quoted by Clapp (1914, pp. 38-39) and MacKenzie (1916, p. 157).

3. Peat and Peat Moss

Very large reserves of post-glacial peat and peat moss occur on the Queen Charlotte Lowland, which is in large part organic terrain. The problems of exploitation are not those of reserves but of handling and marketing. The quality of the Queen Charlotte peat moss is reported to be excellent. An operation to mine the peat moss by hydraulic methods started production in 1967.

4. Oil and Gas

The possibility of producing petroleum and natural gas on the Queen Charlotte Islands has received some attention since 1913, when the first exploration hole was drilled near Tian Head. Not until Richfield Oil Corporation conducted their programme from 1958 to 1961 had there been any intensive exploration. Richfield
conducted a geological survey in the summer of 1958, drilled five holes, and ran marine seismic and sparker surveys in Hecate Strait in the winter of 1959, ran further helicopter-supported seismic surveys ashore in 1960, and drilled a 6,000-foot well at Cape Ball in 1961. In 1963 Shell Canada started geological mapping on the islands and offshore studies in Hecate Strait as part of a general offshore programme in British Columbia.

The character of the various units is treated at some length in Chapter II. The older units have not been the target of recent exploration because they are considered too deformed, metamorphosed, and faulted, and most of the arenaceous rocks do not have suitable permeabilities. Perhaps the flaggy carbonaceous upper members of the Kunga Formation and the Haida sandstone-shale interface deserve more study and consideration, the former as an oil shale. MacKenzie (1916, pp. 161–166) treated the tar contained in vesicles in volcanic rocks of the Masset Formation in detail. The writer observed other localities with tar-filled vesicles, including one in the Yakoun Formation. The common denominator of most of these occurrences is that the flows concerned immediately overlie sandstones or shales that contain much woody matter. Hence the tar would seem to be a wood distillate.

Recent search has been concentrated on the Mio-Pliocene Skonun Formation, the correlatives of which have proven productive in California and Alaska. The thick sand member of this formation in the southern basin (see Fig. 20) is very porous and permeable. Unfortunately being almost unconsolidated, it is not well represented in the cores. The underlying member of equivalent thickness contains much lignite and appears to be largely non-marine. Only one slight area of stain was noticed in all the core, in the Tow Hill well at 1,730 to 1,735 feet not far below the sills. The Richfield cores and cuttings are stored at Charlie Lake, British Columbia, and logs are available at the Petroleum and Natural Gas Branch in Victoria. The character of the formation as represented by the cores may be expected to change both basinward and north of the north coast. Only an elaborate and expensive programme can test whether this considerable basin of young sediments has a real possibility of petroleum production.

DESCRIPTION OF PROPERTIES

A1. PYROMETASOMATIC IRON-COPPER DEPOSITS

Northwester (4) The Northwester showings are found at an elevation of about 2,200 feet on the steep south slope at the head of Van Harbour. They were discovered in 1928 by George McRae and Archie Dewall and have been held intermittently by located claims, most recently by Mastodon-Highland Bell Mines Limited with 11 claims of the Magnet group. In 1962 this company carried out geological, magnetometer, and E.M. surveys to explore the area of mineralization.

The Northwester is a pyrometasomatic replacement deposit in the typical setting. The showings occur in the southwest corner of a large pendant that includes Karmutsen to Yakoun and possibly Masset Formations; the pendant is essentially surrounded by various phases of the Kano massif. The showings are at the contact
of Karmutsen greenstones and a band of Kunga grey limestone, and some flaggy black limestone which outcrops along the steep slopes at about 2,100 to 2,400 feet elevation. The Kunga Formation is overlain by Yakoun andesites and volcanic sandstones. Near the showings the sequence strikes about north 60 degrees east, dips steeply to the northwest, and is cut by many andesite and basalt dykes. Faults are numerous nearby but are not definitely identified at the showings. Kano diorite outcrops below the showings to an elevation of about 1,000 feet.

The showings consist of pods of actinolite garnet skarn, and magnetite with chalcopyrite at or near the Kunga-Karmutsen contact and distributed over 1,400 feet along strike. Judged by the surface geology and magnetometer survey, there is no large body of magnetite at or near the surface. Some small lenses contain up to 1 per cent copper, and large float blocks of high-grade chalcopyrite occur down the slope from the showings. A few showings are on inaccessible cliff faces, but none of the accessible ones are of such a size or grade to be copper ore.


Iron Duke

This property consists of 10 Crown-granted claims and fractions and has included a varying number of located claims. The Crown-granted claims are Lots 2331 to 2340. The ownership is dispersed, but Campbell M. Robertson, of New Westminster, one of the owners, has had an agreement with the others that enabled him to explore the property or negotiate regarding it.

The property is on the slope north of Waste Creek, about 2½ miles west of Girard Point on the northeast coast of Louise Island. The elevation of the creek is about 850 feet, the main showings between 1,000 and 1,400 feet, and the ridge top about 1,500 feet. Most of the known ore and the magnetic anomaly are on Iron Duke No. 2 claim, Lot 2333, but both extend uphill onto the southwest corner of Iron Duke No. 1, Lot 2332. The property can be reached by an indifferent trail that climbs steeply from the beach, 4,000 feet west of Girard Point. Much of the servicing of the property during recent exploration was by helicopter.

The property was discovered in 1911 and surveyed and Crown granted in 1921. Most of the physical work on the property other than the recent diamond drilling was done about 1918. The early work included an 80-foot adit and a minor amount of test-pitting. Recent work started with an examination and magnetometer survey by Silver Standard Mines Limited in 1959. During 1961 exploration initiated by Campbell Robertson included a geological examination and an attempt to build a road to the property from the shore near Mathers Creek. In the autumn the property was optioned by Magnum Consolidated Mining Co. Ltd., who made a magnetometer survey of the property and a geological map of the vicinity. Two diamond drills were moved to the Iron Duke late in 1961, and in January and February, 1962, 15 AX holes were drilled totalling 3,054 feet. Later in the year Silver Standard optioned the property and drilled 33 EX holes totalling 4,805 feet.

The claims and area surrounding are largely covered by glacial till and heavily forested, hence outcrop is relatively rare. On the showings, till is generally 10 to 30 feet thick. However, nearly 8,000 feet of short-hole diamond drilling and magnetometer surveys enable one to draw a diagrammatic geological map (Fig. 35) and sections (Fig. 36).
Fig. 36. Iron Duke, cross-sections.
The Iron Duke is a normal pyrometasomatic iron deposit in the typical stratigraphic setting. A thick grey limestone that undoubtedly is the Kunga grey limestone member overlies chloritized basaltic rocks, certainly Karmutsen Formation. These are intruded by contaminated and altered diorite to granodiorite and some diorite to dacite porphyries. The limestone and adjacent Karmutsen greenstones are extensively skarnified and replaced by magnetite and minor iron sulphides. The diorite and porphyry appear kaolinized, chloritized, silicified, pyritized, and even epidotized in varying degree, but they have not been observed highly skarnified or replaced by significant magnetite.

The structure of the host rocks is shown by the plan and sections, Figures 35 and 36. The Kunga limestone overlying the Karmutsen greenstones strikes north to north-eastward and dips gently westward. A minor anticline and syncline are evident at the south, but the orientation of the axes is not. Diorite to dacite porphyry dykes cut the bedded rocks, and diorite to granodiorite intrude the greenstones at relatively shallow depth and outcrop sporadically to the east for one-half mile. The magnetite ore indicated by magnetic anomalies, drill core, and exposure occurs in a dislocated northeast-trending zone that lies adjacent to the limestone along a band that is coincident with the projected limestone-greenstone contact. Judged by position alone, the ore appears chiefly to replace the basal part of the limestone, but other considerations suggest this may not be entirely correct. An alternative explanation that the ore zone is located along a northeast pre-ore fault situated approximately along the western trace of the ore zone has the following to recommend it: (1) There is a major discontinuity in rock types below the ore zone along this line with intrusive rocks appearing at a high level west of the line and volcanic rocks east; (2) minor volcanic rocks occur within the ore zone. If the correct interpretation is a pre-ore fault, then the majority of the ore replaces greenstone that is adjacent to the limestone. In any case the host rocks and the ore zone are cut by three steep post-ore faults trending about north 60 degrees west, with offsets of from 50 to 300 feet. These faults were not encountered in drill-holes but are evident from the plan and from the company magnetometer maps.

The shape of the ore zone is fairly regular in plan, assuming offset by the post-ore faults. It is then about 960 feet long, trending northeastward and up to 200 feet or more wide. In normal cross-sections it is a wedge-like mass with highly digitated margins. The ore consists principally of magnetite and may be quite pure, but commonly has some disseminated skarn minerals and much pyrite. Chalcopyrite is relatively rare. Intercalated within the ore are sections that are formed principally of skarn minerals. Skarn also envelopes the ore zone, has a similar digitated wedge-like form, but extends much farther as wing-like sheets from the ore zone. These appear to follow particular bands in the limestone. The skarn may be characterized as either garnet skarn or epidote skarn. Tan garnet skarn most commonly replaces limestone and may be quite pure garnetite or contain minor amounts of magnetite, epidote, and calcite. Epidote skarn is commonly bright green, less pure, and contains significant garnet, magnetite, and chlorite, and most commonly replaces greenstone.

Reserves calculated by Silver Standard and its consultant geologist, D. D. Campbell, from all drilling are 546,000 tons proven and probable ore of 46 per cent iron as magnetite with an additional possible 36,000 tons. Sulphur may average 2 per cent.

The Tasu mine is located on Tasu Sound, west of the entrance to Fairfax Inlet (see Plate XVIIA). The property consists of 21 Crown-granted claims and 50 recorded claims that stretch from Tasu Peak to Lomgon Islets. The property is held by Wesfrob Mines Limited, a wholly owned subsidiary of Falconbridge Nickel Mines Limited.

The history of the property began in 1908, when the Elliott Mining Company located 20 claims, the Warwick group, on the cupriferous magnetite showings of what is now called No. 3 zone. Over the next six years several options were taken on the property. Exploration and development work included driving a 300-foot-long adit at 1,180 feet elevation on the Tassoo claim, Lot 604, and sinking a 40-foot-deep winze. Over the following four years, mainly in 1914, the property produced 5,180 tons of ore yielding 94 ounces of gold, 1,408 ounces of silver, and 165,566 pounds of copper, from two stopes on the adit. During this period a lower adit at 1,060 feet elevation was driven 200 feet, but not far enough to encounter the ore. The property was thereafter inactive until the two key claims, Tassoo and Warwick, Lot 615, were acquired in 1953 at a tax sale by St. Eugene Mining Corporation, a subsidiary of Falconbridge. Adjacent recorded claims located in 1952 by Albert Jones, of Skidegate village, were purchased in 1955, and in 1956 a new wholly owned company, Wesfrob Mines Limited, was formed to explore and develop the property. In 1956 and 1957 exploration included 22,285 feet of pack sack, EX, and AX diamond drilling. No further work was then done until 1961. Exploration and development thereafter have been continuous, leading to the decision early in 1964 to prepare for production. A total of 132,162 feet of core of all sorts had been drilled to the end of 1964 (see Plate XVIIIA). An expenditure of $25 to $30 million was estimated to be required to bring the property into production at a planned rate of 8,500 tons of ore per day. The mine was officially opened in June, 1967.

The plant produces both sinter- and pellet-feed iron concentrates and a copper concentrate. Production of 855,000 to 1,045,000 metric tons of concentrate per year is contracted to Mitsubishi Shoji Kaisha.

Reserves were stated in December, 1965, to be as follows:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Million Short Dry Tons</th>
<th>Iron</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.66</td>
<td>40</td>
<td>0.14</td>
</tr>
<tr>
<td>2</td>
<td>8.37</td>
<td>38</td>
<td>0.66</td>
</tr>
<tr>
<td>3</td>
<td>7.50</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Sub-totals</td>
<td>27.53</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Not drilled off.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More recent recalculation by computer has not significantly changed these. The various zones referred to above are shown on the plan, Figure 37. Of the known ore, about 20 million tons is expected to be produced by open-pit mining.
Geology

Tasu, like the Jessie, is one of the standards by which other coastal pyrometasomatic iron-copper deposits must be judged. Extensive drilling together with moderately good exposure, considering the forested nature of the area, have led to a fairly detailed knowledge of the deposit. Complete stripping during mining may be expected to revise and clarify concepts to some degree.

The Tasu deposit seems unique in two ways. Its great size in comparison to others and the abundance and importance of pre-ore porphyry. A third feature that may be distinctive is its association with a syntectonic batholith rather than post-tectonic stock.

Figure 37 is a general plan of Tasu, showing the surface geology and the numbered ore zones. The essential structure is a folded and tilted panel of stratified rocks surrounded and underlain in part by the northern termination of the San Christoval Batholith. The stratified succession includes the upper part of the Karmutsen Formation and the three members of the Kunga Formation. Only the two limestone members are closely involved in the ore zones. The stratified panel was repeatedly intruded by igneous rocks from its initial formation to late in the geological history of the area. First, Karmutsen basalts were cut by minor related sills. Next, a complex laccolith of diorite porphyry of considerable importance was emplaced principally between the Karmutsen and the Kunga Formations. Then the San Christoval Batholith was emplaced, followed by skarnification and mineralization. Finally two volumetrically important post-ore dyke swarms, the earlier andesitic and the later basaltic, were intruded. The magnetite ore and associated skarn very largely are found in a stratiform zone some 200 feet thick above the top of the Karmutsen Formation, replacing massive limestone and diorite porphyry.

Petrology

The Karmutsen Formation is largely composed of massive amygdaloidal greenstones that have been subjected to varying degrees of metamorphism or metasomatism. Minor occurrences of what appear to be aquagene tuffs were noted in drill core. The only other rock type is lathy star porphyry greenstone that occurs as a sill about 100 feet below the top of the unit. Where fresh this is composed of 30 per cent labradorite laths up to 2.5 centimetres long and agglomerated laths in a fine sub-ophitic matrix of augite and plagioclase with magnetite and sphene. The Kunga Formation is in all respects normal. However, the basal massive grey limestone member approaches its maximum thickness, about 600 feet, in No. 3 zone, must have been thin in No. 1 zone, and is only about 150 feet thick in a drill-hole at the northwest of No. 5 zone. The massive limestone is largely bleached and slightly recrystallized in outcrop. The flaggy black limestone is of normal thickness and mostly not very bleached or recrystallized, but in some localities it is transformed into a banded garnet tremolite rock. Flaggy argillite is seen in outcrops or in core in a few localities in the west of No. 5 zone, but similar rocks may occur within the flaggy limestone in small amount so there is no assurance that the upper member truly occurs within the ore zones. All suspected occurrences are quite bleached and hornfelsic.

The pre-ore porphyry is highly variable, partly because of minor original differences in phenocryst content or size but mainly because of great variation in
alteration. The least altered specimens are normally composed of about 45 per cent zoned plagioclase phenocrysts (An$_{35\pm5}$), 5 to 10 per cent hornblende phenocrysts, and rare quartz and pigeonite phenocrysts in a finely lathy quartzofeldspathic matrix. In general these rocks seem to contain less than 10 per cent total quartz, so that the name diorite porphyry seems most applicable. An ill-defined elastic texture that pre-dates skarnification is a common feature. The mode of the intrusion of the porphyries has not been fully determined, but it seems as if the emplacement may have taken place in a number of pulses. Minor original differences in phenocryst content and size would be a likely result from multiple intrusion. However, much of the apparent difference in relatively unaltered specimens is only the result of differing colour contrast between phenocrysts and matrix, both of which separately may vary from dark green to white. In addition, the hornblende may be black or light green. These variations may be found in separate localities, in patchy masses, or within hand specimens in a patchy or reticulate form. Even the least altered specimens are far from fresh; the plagioclase is almost completely sericitized and the rock may contain variable amounts of carbonate, chlorite, serpophite, kaolinite, epidote, actinolite, and pyrite. Quite commonly the porphyry is converted to skarn with progressive development of epidote, actinolite, and finally garnet.

The San Christoval Batholith is formed principally of foliated hornblende diorite and quartz diorite (see pp. 129–134). In the vicinity of the mine, exposures are mostly contaminated and/or altered, but are medium-grained rocks originally composed of dominantly unzoned plagioclase (An$_{25\pm2}$) with 15 to 25 per cent hornblende, 5 to 10 per cent quartz, and minor potash feldspar, magnetite, and sphene. Exposures other than those along Fairfax Inlet include a skarnified west-trending dyke near the causeway to Gowing Island and within the conveyor adit below No. 1 zone. Some reported occurrences in drill core No. 5 zone are regarded by the writer as diorite porphyry.

The two main post-ore dyke swarms have definite family characteristics, although individual dykes vary in phenocryst content and crystallinity and hence in superficial appearance. The earlier, andesitic, swarm is characteristically porphyritic greenish-grey rock with phenocryst content varying from 1 to 20 per cent and crystallinity from stony aphanitic to fine grained, yet with few exceptions the rocks belonging to the suite are immediately recognizable. The more porphyritic specimens resemble the diorite porphyries to some degree, and the fine stony specimens which come from small dykes resemble some late basalts superficially. Microscopically all this swarm is very similar with identical alteration. The average composition of eight analysed specimens is as follows:

<table>
<thead>
<tr>
<th>Phenocrysts</th>
<th>Average (Per Cent)</th>
<th>Range (Per Cent)</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plagioclase</td>
<td>8.3</td>
<td>1–20</td>
<td>An$_{30^\pm2}$</td>
</tr>
<tr>
<td>Pyroxene</td>
<td>1.0</td>
<td>0–3</td>
<td>?</td>
</tr>
<tr>
<td>Matrix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plagioclase</td>
<td>46.0</td>
<td>40–55</td>
<td>An$_{28^\pm2}$</td>
</tr>
<tr>
<td>Quartz</td>
<td>6.6</td>
<td>2–15</td>
<td></td>
</tr>
<tr>
<td>Pyroxene</td>
<td>5.7</td>
<td>0–13</td>
<td></td>
</tr>
<tr>
<td>Iron oxides plus sphene</td>
<td>4.5</td>
<td>2.5–10</td>
<td></td>
</tr>
<tr>
<td>Carbonate, chlorite, and sercite</td>
<td>23.1</td>
<td>13–35</td>
<td></td>
</tr>
<tr>
<td>Epidote</td>
<td>4.4</td>
<td>1–20</td>
<td></td>
</tr>
</tbody>
</table>
The plagioclase phenocrysts are zoned, commonly agglomerated, and may be slightly epidotized. They range from 1 to 4 millimetres long. The pyroxene phenocrysts are completely chloritized. Iron ores include sphene and leucoxene. The carbonate, chlorite, and sericite in part probably represent altered glass but, as with the epidote, in part replace original minerals.

The late basalt swarm also varies in phenocryst content and crystallinity. Coarse labradorite phenocrysts may form as much as 25 per cent of the rock, but most dykes are not porphyritic. Crystallinity definitely is closely correlated with the size of dyke. These rocks have been called gabbros, gabbro porphyry, diabase, and basalt. Most actually are fresh diabases with the characteristic ophitic texture, and composed of sub-equal amounts of slightly zoned labradorite and augite with as much as 5 per cent magnetite. The plagioclase is invariably fresh, but pyroxene may be locally altered to chlorite, serpophite, and kaolinite. This swarm is almost certainly related to Early Tertiary Masset volcanism.

A few small dykes seem to be younger than the main basalt swarm. These include small dark-green fine basalt dykes and rare sugary-textured trachytic light-green felsite.

**Structure**

The structure of the Tasu mine area is shown by the regional map (Fig. 5) and the local plan and structural sections (Fig. 37). The plan and sections are compiled from surveys by company geologists augmented by those of the writer. The accuracy is variable, being good in ore zones Nos. 1, 2, and 3, but elsewhere mostly only fair. Only the largest of the great number of dykes are shown. A considerable amount of interpretation is necessary to draw sections through the widely spaced drill-holes of No. 5 zone; therefore, the plan and sections should be regarded as somewhat diagrammatic.

The panel of Karmutsen and Kunga Formations that forms the locus of the ore deposits has been moderately compressed into a synclinorium with two subsidiary anticlines, all with axes striking north 30 degrees west and plunging about 25 degrees northwest. The Tasu ore zones occur along the crest of the eastern subsidiary anticline and extend down the west limb toward the synclinal axis. The diorite porphyry has essentially the same general distribution as the ore. It forms a complex body of dykes and sills which have the over-all form of a flat Christmas tree laccolith with the base along the Karmutsen-Kunga contact. The upper "limbs" actually extend farther into the enclosing strata than do the basal, so that the term "Christmas tree" is not entirely suitable. Extensive alteration and skarn and ore replacement make it difficult to distinguish whether the body was built up with a great number of similar dykes and sills or whether it resulted from a single or a few intrusions.

The San Christoval Batholith surrounds the folded panel of stratified rocks on three sides and underlies it at least in part. The porphyries have a similar composition to the San Christoval and probably represent an early intrusive phase. The folding of the panel was essentially complete before it was engulfed, but the high plunge may result from simple synkinematic tilting. The semiclastic textures in the porphyries may indicate that they were intruded before folding was complete and, being brittler than the limestone or even the greenstone, were extensively
ruptured. Minor sharp folds in the thin-bedded limestone in the southwest part of No. 5 zone strike south 50 degrees west, hence nearly normal to the regional folds. These plunge southwestward toward the synclinorium axis. These folds are parallel to a steep south-dipping fault. The origin of these cross-folds is obscure but may relate to thrusting during emplacement of the San Christoval Batholith, the contact of which is on Mount Tasu (Moody) and is parallel to this orientation.

The structural attitude of dykes of each swarm show a preferred orientation, which rotates with time of intrusion from northwest for diorite porphyry to north for the basalt swarm. More precisely, the majority of dykes of the three swarms have the following orientations:

<table>
<thead>
<tr>
<th>Swarm</th>
<th>Strike</th>
<th>Dip</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Diorite porphyry</td>
<td>North 45 to 60 degrees west</td>
<td>Steeply west</td>
</tr>
<tr>
<td>(2) Andesite</td>
<td>North 35 to 45 degrees west</td>
<td>65 degrees east</td>
</tr>
<tr>
<td>(3) Basalt</td>
<td>North to north 25 degrees east</td>
<td>Vertical steeply east</td>
</tr>
</tbody>
</table>

The ore zones are traversed by a large number of faults in many orientations and of many ages. Most are small and of slight importance, but some are moderate sized with movements of several hundred feet and fundamental importance in regard to metallization. Some important faults are not adequately defined by present exposure and drilling. The most important faults strike north 55 to 85 degrees west and dip more than 75 degrees either north or south. Slightly arcuate traces are common but are partly the result of the interplay of topography. These faults include the important central faults in Nos. 2 and 3 zones and by projection in No. 5 zone. Other only slightly less important faults, such as the central fault in No. 1 zone, strike north 20 to 35 degrees east and dip nearly vertically. The movement of no fault has been determined precisely, but in general the main northwest and northeast faults in effect drop their south blocks 100 to 200 feet. Some horizontal movement is indicated, and the total horizontal movement may exceed vertical. All these faults pre-date the mineralization, but some have been subjected to later movement as brecciated ore is common along them, a primary breccia of skarn cemented by magnetite is evident along some, and the distribution of ore and skarn bears a close spatial relation to them. Thus there is little doubt they were part of the conduit system of the ore-bearing fluids.

In general neither post-ore dyke swarm is cut by the main faults. However, the dykes are cut by a few small northwesterly steep faults.

**Metasomatism**

Skarn is more widespread than magnetite ore and in general forms an envelope that surrounds individual orebodies and may extend well beyond them. The skarn is somewhat selective, affecting massive limestone less than greenstone or flaggy limestone, and these less than porphyry. This is well illustrated in the vicinity of No. 3 zone, where porphyry dykes or sills cutting limestone may be quite highly skarnified, but the limestone is only bleached and recrystallized or apparently unaffected. In contrast, the flaggy limestone is not readily bleached but may be converted into a banded fine garnet-tremolite rock that on weathering may resemble a garnet sandstone. With diorite porphyry and greenstone, the least intense and
earliest stage of metasomatism is a thorough chloritization, followed by growth of epidote, actinolite-tremolite, and less commonly orthoclase and anthophyllite. Anthophyllite has only been observed in some greenstone skarns. Minor magnetite, quartz, and carbonate occur in most intense skarns. Garnet replaces the earlier minerals and commonly shows zonal growth. The first formed or the most remote from intense skarn is commonly pale-cream coloured. The latest, the largest, and the exterior of crystals are a rich cinnamon-brown colour.

The oxide and sulphide minerals have distribution and textures indicating they are the latest in the metasomatic sequence. Magnetite replaces all earlier minerals and is found principally in the core of the skarn areas and as central bands in skarn replacement veinlets. Still younger are the sulphide minerals, pyrite, pyrrhotite, chalcopyrite, and rare sphalerite. Sulphur content of orebodies is fairly uniform at 2 to 3 per cent, regardless whether chalcopyrite is the main sulphide, as in No. 3 zone, or pyrite and pyrrhotite, as in No. 1 and No. 2 zones. The sulphide minerals generally occur as blebs and small masses in magnetite but are also common as veinlets. Some blebs clearly replace interstitial calcite between magnetite crystals. Bladed intergrowths of sulphides and oxides are not rare but are accompanied normally by fine veinlets, so that selective replacement of a bladed actinolite skarn is a more likely explanation of this texture than eutectic crystallization. Bladed textures also occur in essentially pure magnetite that is normally lodestone and generally a replacement of limestone. Quartz veinlets transecting sulphide veinlets occur in selected locales in very minor quantity. A black, very high iron sphalerite occurs in small veinlets in very small amount on the fringes of the skarn area.

Transition from ore to skarn or skarn to country rock may be sharp and commonly is in limestone but not in greenstone and porphyries. The transitional zone includes an outer zone of intense chloritization and minor porphyroblastic growth of epidote or less commonly orthoclase. This zone on approach to intense skarn becomes traversed by an increasing number of joints, commonly in a semi-reticulate pattern, from which skarn minerals have "spread." Commonly the replacement adjacent to the joints shows the order of zoning outward, brown garnet, cream fine garnet, epidote, and finally scattered epidote. Magnetite may occur at the centre of the replacement veinlet, and this is commonest near magnetite orebodies in the core of skarn areas.

Dykes of the andesitic swarm cut skarn and ore but are slightly chloritized and epidotitized themselves. As previously described, the basaltts may be slightly chloritized but normally are fresh.

Orebodies

The Tasu orebodies and their skarn envelope form a tabular panel some 100 to 400 feet thick which conforms to the bedding attitude of the top of the Karmutsen Formation, although it replaces diorite porphyry sills as well as Kunga limestone. This panel extends over a horizontal area at least 3,500 by 4,000 feet. Within the panel there are areas of greater and lesser development of skarn and magnetite, but no area is entirely free from some metasomatism. In effect the major orebodies form linear lenses in plan within the over-all panel. From these ore "build-ups" planar sheets of skarn and ore extend into the less intensely replaced areas. The linear ore "build-ups" occur along pre-ore fault lines. Stratiform lenses and crosscutting sheets or pipes of ore also occur within the Karmutsen Formation, but
although these have not been fully investigated, they seem of minor economic importance. The sections illustrate these concepts substantially.

The various ore zones 1 to 5, used for convenient reference, each largely represent one central "build-up" and fringe area. This is true of all but No. 5 zone, which is a conglomeration of all the areas to the west in which reconnaissance drilling only has been done. The orebodies of No. 3 zone replace limestone, are relatively free of skarn, are copper-rich, and are concentrated just above the contact of the Karmutsen Formation. The orebodies of No. 1 zone replace porphyry, are skarny and on the average less pure, are copper-poor, extend through a greater thickness, and are less concentrated at the Karmutsen contact. No. 2 zone is intermediate in space and characteristics, between No. 1 and No. 3 zones. No. 4 zone is undrilled and is, as far as known, a small zone south of No. 3 with characteristics similar to it. No. 5 zone is not adequately explored but seems to include the continuations of No. 3 and No. 2 zones. No. 2 and No. 3 zones trend about north 65 degrees west, whereas No. 1 zone trends north 20 degrees east.

The ore zones are transected by a very large number of post-ore dykes of the two swarms, and this seriously diluted the grade. In some areas as much as 30 per cent of the ore zones are occupied by post-ore dykes.


Garnet group of nine located claims is situated on the northwestern end of the peninsula between Fairfax and Botany Inlets, Tasu Sound. The property is held under option by Moresby Mines Limited, a company formed in 1965. The property was discovered in 1908 by Messrs. Chapman, Kitson, and Husband and originally called the Ajax. A 70-foot adit dating from this period (the Tommy adit) is on the southern boundary of the claims adjacent to the Tommy claim, which was originally staked by Albert Jones. Five claims, Garnet 1 and 2 and Ruby 1, 2, and 3, were located in 1953 by R. E. Wolverton for Cominco, and explored by trenching by that company over the next few years. The claims were retained by Wolverton after Cominco’s interest terminated. In the winter of 1962 Silver Standard Mines Limited drilled 213 feet of pack sack diamond-drill holes, cleaned out some trenches, and conducted a magnetometer survey. An option was taken in 1964 by Bardale Mining & Development Company and transferred to Moresby Mines Limited when that company was formed.

Geology

The Garnet property is a pyrometasomatic replacement deposit in which iron, copper, and also zinc are important. The surface geology is shown on Figure 38. The setting is the normal one of the metasomatic deposits even though there are some differences in detail. A pad of the Kunga grey limestone member overlies Karmutsen.
greenstone. These rocks are enveloped to the south and east by hornblende quartz diorite of the San Christoval Batholith, dykes of which cut the older rocks in the area of the showings. The limestone appears to form a synclinal keel and to trend north 35 degrees west. Along the shore at the northwest point is another outcrop of limestone that dips steeply northeast. If this is Kunga limestone, as seems probable, there is an anticline overturned to the west between the main limestone pad and the shore. Small faults oriented north to north 30 degrees east are moderately common.

Fig. 38. Garnet group, geological plan.
The showings are dispersed over much of the Garnet No. 1 and No. 2 claims. Exposure is poor, but considerable hand trenching done by Cominco reveals bedrock. Mineralization consists of two types: magnetite skarn with chalcopyrite, found chiefly in the upper part of the Karmutsen Formation, and sphalerite, pyrite, and chalcopyrite, found as vein-like and irregular masses in the limestone. The magnetite ore is found around much of the western and northern periphery of the limestone keel and generally 50 to 100 feet below the contact. Continuous bands up to 500 feet long by 20 feet thick are known. Much is banded with intercalated layers of magnetite and tan garnet, and some is in effect laminated. Pyrite and chalcopyrite may be disseminated in the more massive ore but also occur as vein-like bodies in transecting small faults. The main sulphide mineralization consists of vein-like masses cutting limestone. These may partly be fine fissure fillings along small faults with disseminated replacement of the walls. High-grade masses of sphalerite with pyrite and chalcopyrite are known from the northern nose of the limestone to the southern claim boundary. One “vein” at the northern end with an average mineralized width of 4 feet is continuous for 250 feet. Other areas are known, with rather random masses of sulphides replacing limestone. Float of high-grade sphalerite-chalcopyrite is also widely distributed.

At the time of the writer’s study the property had not received intensive enough exploration to estimate reserves.


These showings are on the old Tasu townsite, on Hunger Old Townsite, Tasu Harbour, Fairfax Inlet. They are on located claims held by Wesfrob Mines Limited as part of the large block of the Tasu mine but are separate from the main Tasu orebodies. Signs of old work indicate the mineralization was probably known about 1910. In 1954 Cominco located the showings and did some stripping and pitting. In the summer of 1964 Wesfrob drilled nine AX holes totalling 2,346 feet at the property.

Geology

These magnetite showings are contained in a synclinal pendant of Kunga limestone with a thin skin of skarn or Karmutsen greenstone engulfed in diorite of the San Cristoval Batholith. The west limb is shown by drilling to continue at a steep attitude to at least 500 feet below sea-level. The core and east limb are irregularly penetrated by a tongue of quartz diorite. The sheath of greenstone and skarn on the west limb varies from 150 to as little as 20 feet thick, and trends north 50 degrees west from the head of the bay south of Hunger Harbour. Within the greenstone and skarny greenstone in the southern 400 feet there are a number of outcrop pits and natural exposures that show scattered magnetite mineralization with some pyrite and chalcopyrite disseminated in skarn. The southernmost exposure shows 35 feet across strike of fairly pure magnetite. Farther north the skarn band is narrow and not well exposed. Wesfrob drilled two fans of diamond-drill holes from set-ups near the southern bay and 400 feet from Hunger Harbour in the north. In some of the drill-holes, diorite porphyry is prominent, although it is not well exposed on the surface. Of the ore encountered, much replaces limestone near the skarn sheath. Proven reserves developed from the limited drilling totalled less than 100,000 tons of relatively low-grade ore.
This property consists of two located claims, Alpine No. 1 and No. 2, held by Wesfrob Mines Limited. The showings are on the ridge between Botany Inlet of Tasu Sound and Anna Lake at an elevation of 2,700 to 2,800 feet. They may be reached by an old trail from the head of Anna Inlet. The showings, originally called the Star, were discovered by Messrs. Davis, Bell, and Harris in 1907.

The mineralization consists of a chalcopyrite-bearing magnetite skarn zone at the base of a small roof pendant in the San Christoval Batholith near its eastern margin. The pendant consists primarily of grey limestone and skarn but includes some skarnified volcanic rock and is cut by late dykes of basalt, granite, and feldspar porphyry. It is oriented northwestward parallel to the nearby margin of the batholith and is about 400 feet long at the somewhat irregular base about 100 to 150 feet below the ridge-top. The walls are fairly planar and steep, and about 200 feet apart. Bedding possibly strikes north 20 degrees west and dips about 70 degrees east. It is not known whether this limestone is a remnant of the Kunga Formation or a member of the Karmutsen Formation. Skarn and magnetite replace limestone and a small amount of volcanic rocks and quartz diorite at the base of the pendant. The profile of the skarny magnetite at the north face is quite irregular but up to 50 feet thick. At the south face it is wedge shaped, about 75 feet thick on the east and a few tens of feet thick on the west. Most of the replacement consists of magnetite, but patches of garnetite and coarse calcite are fairly common and epidote skarn is present, some of the latter clearly replacing original volcanic rocks. Weathered exposure of skarn is stained by malachite, and chalcopyrite is common as blebs in the magnetite and in small vuggy quartz veinlets at the base.

During the early exploration an adit was driven from the south side 50 feet below the pendant and entirely within the quartz diorite. The adit and its ramifying branches include about 200 feet of workings. Recent exploration has included sampling, and in 1963 three packsack holes totalling 320 feet were drilled to confirm the continuity between the two exposures. Assuming this continuity, Young and Uglow calculated the reserves as about 300,000 tons of ore. Calculations based on the drilling indicate somewhat less ore with a grade of close to 50 per cent iron and possibly 1 per cent copper.


This property is on Lyell Bay on the west side of Lyell Island. Lobstalk It is presently held by the Marven group of 10 located claims. The showing is less than 100 feet from the shore. It consists of pyritic magnetite replacing metamorphosed Karmutsen greenstones, adjacent to minor limestone beds striking north 30 degrees west and dipping on the average 50 degrees east. About 150 square feet of surface area is magnetically anomalous or contains exposures of magnetite, and the principal exposure is in a large trench. In 1956 two short packsack holes were drilled by Frobisher (Falconbridge) immediately east of the trench. One bottomed in skarny magnetite at 90 feet; the other ended in greenstone at 74 feet. In 1964 a detailed magnetometer survey was run on the property for Placid Oil Company Limited.
This property on Alder Island, which is just north of Burnaby Island, is held by two recorded claims. The showings are of interest partly because they differ from the normal metasomatic deposits in situation and mineralogy. Alder Island is only a small island but is underlain by complex geology, including folded Kunga Formation, Yakoun volcanic rocks, granitoid dykes related to the Burnaby Batholith, Longarm sandstones, and Masset basalts. The eastern side of the island is a northerly striking fault zone. Adjacent to this, skarn is variably developed in Longarm sandstones. The skarn varies from a pyroxene to garnet skarn to skarny sandstone. Magnetite, pyrrhotite, and chalcopyrite form minor but constant accessories. Some small masses of pyrrhotite occur, and these apparently are nickeliferous. In addition, the skarn contains some late calcite veinlets that carry arsenical allemontite.


The Mac property is 3½ miles southwest of Scudder Point on Burnaby Island and may be reached by a 1½-mile trail along a large creek from an exposed bay 2½ miles south of the point. The property includes a large number of located claims covering much of northeastern Burnaby Island that are held by Merrican International Mines Ltd.

The showings are on the Mac No. 1 claim, north of the creek between 200 and 400 feet elevation. They were discovered by A. Heino about 1906 and are described under the heading “Burnaby Island” by Young and Uglow. Little was done in prospecting other than examination and dip-needle surveys until 1962, when Merrican started a programme that over the next two years included a magnetometer survey, trenching, 11 X-ray drill holes totalling 1,193 feet, and 16 EX drill holes totalling 5,507 feet.

Geology

The Mac magnetite showings are in the normal pyrometasomatic setting at the contact between Karmutsen greenstone and Kunga limestone near the Burnaby Batholith. Alluvium and glacial drift cover much of the area of the showings, although above 400 feet elevation exposure is fair. Moreover, the diamond drilling has been very largely at an acute angle to the stratification, so that there is no certainty about details of the geology. In particular it is difficult to be sure whether the known ore is replacing limestone adjacent to the contact of the Karmutsen Formation or to similar greenstone sills within the Kunga Formation. Such sills are common on Burnaby Island and Copper Island. Below the lowest exposure of magnetite (200 feet), the few outcrops that exist are mostly basaltic greenstone similar to the Karmutsen Formation but include minor limestone. No doubt exists that the main limestone that outcrops on the hill between 200 and 450 feet is the basal member of the Kunga Formation, for Halobia was found in the overlying flaggy limestone member. The stratified rocks generally strike north 45 to 60 degrees east subparallel with the contours of the hill and dip 35 to 55 degrees northwestward into the slope. Fine-grained basic dykes and sills cut the massive and also the flaggy limestone, but with the dearth of outcrop their orientation and continuity are in doubt. No diorite porphyries were observed. Quartz monzonite of the Burnaby Batholith outcrops east of a gully about 350 feet northeast of the main showing. The gully appears to follow a breccia zone along the contact. Post-ore faults are believed to occur and to be oriented northwestward.
The surface showings consist of four magnetite outcrops, two of which are significant. The largest is a sill-like body that outcrops at an elevation of about 275 feet along the hillside. It is about 110 feet long and of variable thickness, 25 feet at the east, where it abuts against a greenstone dyke, and 5 feet at the west. The body appears to replace limestone and to dip parallel to it at about 35 degrees northeast. Some 75 feet northeast of this showing at about the same elevation, a small outcrop of magnetite replaces limestone. The second important showing occurs parallel to the first, with the east end 70 feet southeast of the west end of the main showing. From the east end it is exposed intermittently for 120 feet and is generally 5 feet or less wide. It replaces limestone and appears to dip rather steeply. Quite possibly the two main showings were continuous but are separated by a steep northwesterly trending post-ore fault. If so, the first three showings may represent only one bed. The fourth showing is a minor one in a large basic dyke adjacent to limestone and about 75 feet above and to the west of the western end of the main showing. The large showings consist of almost pure magnetite with rare garnet crystals. Other skarn minerals or sulphides are seemingly absent in the ore, and neither the limestone nor the greenstone show any significant skarnification other than the ore band.

The writer has not had access to the drill results. The company has stated possible reserves of 1,500,000 tons, grading between 40 and 50 per cent iron (George Cross Newsletter No. 102, 1964). Considering the drilling pattern which was largely enforced by topography, and the resulting acute intersections of strata and ore, the results would require caution in interpretation.


The Jib iron-ore deposit is situated at Bluejay Cove on southeastern Burnaby Island (see Plate XVIIa). The major part of the deposit is just offshore. The property is held by Burnaby Iron Mines Limited, a company formed in 1963 and owned jointly by Mastodon-Highland Bell Mines Limited and Leitch Gold Mines Limited. It consists of 47 located claims which cover much of the southeastern peninsula of Burnaby Island south of Poole Point and extends across Skincuttle Inlet to Skincuttle Island of the Copper Islands.

The Jib iron-ore deposit does not outcrop, but cupriferous skarns related to it were first investigated in 1862-63 by Francis Poole. The small adit and shaft near tidewater dating from this period can be seen on the bay south of the main deposit. Some further work was carried out on these copper-rich skarns on the present property both at Poole's original showing and farther to the southeast during the period 1910 to 1916. The history of the discovery of the iron deposit is as follows: In 1961 Denison Mines Limited had an aeromagnetic survey flown of the area from Burnaby Island to Kunghit Island in which the requisite geology was known to occur. A significant magnetic anomaly was discovered over the present deposit and claims located. However, these were allowed to lapse without much further testing, and in the fall of 1962 were relocated by Highland Bell. Drilling started in January, 1963, and continued to September. Eighteen AX holes totalling 12,208 feet were drilled in fans from the shore, the lengths of the longest being nearly 1,000 feet. This preliminary drilling established 2.5 million tons of 50 per cent iron ore and an additional 1.5 million tons of probable ore. In 1965 drilling recommenced in May and continued until September; five new holes were drilled and six deepened for a total of 6,735 feet.