Gold-Bearing Black-Sand Deposits of Graham Island, Queen Charlotte Islands

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INTRODUCTION

THE Queen Charlotte islands, of which Moresby and Graham are the largest, form the most westerly section of the Province of British Columbia. The mineral occurrences of the islands were among the first in northern British Columbia to receive attention. In 1852, the first discovery of lode-gold in the Province, and probably the first chronicled gold discovery in the Dominion of Canada, was made at Thetis cove (Gold harbour), on the west coast of Moresby island. Since that time, lode-gold has been found at other places on the islands, and in certain sections geological conditions are known to be favourable for gold deposition.

Considered from the aspect of placer-gold deposits and their relationship to glacial erosion, however, the geographical situation of the area is, in general, quite unfavourable. Nevertheless, some remarkably interesting deposits of very fine gold occurring in beach sands, and originating from the re-working of extensive morainic deposits by wave and wind action, occur along the shores of some sections of Graham island. Over a long period of years, the lure of these deposits has attracted the attention of a host of machine and process inventors, dreamers, romancers, and artful promoters with chimerical calculations, but no important gold recovery has yet been made from them. On the other hand, some patient and hardworking individuals, using primitive hand-methods, have won small, profitable returns.

Interest in the possible profitable recovery of gold from these beach-sand concentrates, especially those of the east coast of Graham island, by individuals, syndicates, and companies, has recently increased very materially. In view of this and the haze beshrouding the general conception of these deposits, the following notes are offered.

LOCATION, TOPOGRAPHY, AND GENERAL GEOLOGY

Graham island, some 2,500 square miles in area, is the largest of the Queen Charlotte Island group. Its east coast is about sixty miles west of

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Prince Rupert. The east shore and the easterly third of the north shore is low-lying, with sand beaches extending for many miles. The western shore, on the other hand, is rocky and generally precipitous, with only a few small shingle beaches. The topography of the island is in general comparatively flat, in contrast to that of Moresby island, which nearly adjoins it on the south. The rocks are mainly Cretaceous and Tertiary sediments, deposited unconformably on metamorphosed Jurassic and Triassic volcanic and sedimentary rocks. These two series are intruded by numerous dykes and sills up to late Tertiary in age, and in a few sections small bosses of granitic rocks, related to the Coast Range batholith, are exposed. On the east coast quadrant, Pleistocene and post-Pleistocene clays, sands, and gravels are widely distributed and are especially well exposed along the shore-line of the east coast between Tlell and Rose Spit and along the west shore of Massett inlet. It is in these sections, and also along the north-shore beach between Rose Spit and Massett inlet, that the black-sand deposits occur.

ACCESSIBILITY AND CLIMATE

The area of black-sand concentrations is best reached from the settlement of Massett, *via* Tow Hill, a distance of about 45 miles by road and beach to the mouth of Oeander river. Of this distance, about 30 miles can be covered by automobile and the remainder by waggon-road. An alternative route is by trail along the beach from Tlell, a distance of about 25 miles to the mouth of the Oeander river. The Rose Spit and Cape Fife areas are about 30 miles from Massett.

The climate of Graham island is generally mild. Extremes of heat and cold are infrequent, and in winter heavy clothing is seldom essential. The central and eastern parts of the island have considerable rain, possibly about sixty inches annually. In the early summer, the weather is frequently cloudy but is interspersed with many sunshiny days. The driest period of the year occurs at about August, and the autumn months are the wettest. Snow does not lie on the ground for any length of time in the winter. With these general conditions, mining and prospecting operations can be carried on uninterruptedly throughout the year.

Deer, rabbits, ducks and geese, clams, and fish abound, and vegetables of many varieties thrive well.

PLACER GOLD ASPECTS

The Queen Charlotte islands have been intensely glaciated. During the Glacial period, ice-sheets and glaciers advancing west and southwest destroyed and scattered what pre-Pleistocene river and creek gold-concentrations may have existed. In depressed outwash areas, however, such as that in the northeasterly quadrant of Graham island, partial inter-glacial re-concentrations of morainic deposits may have given rise to low-grade

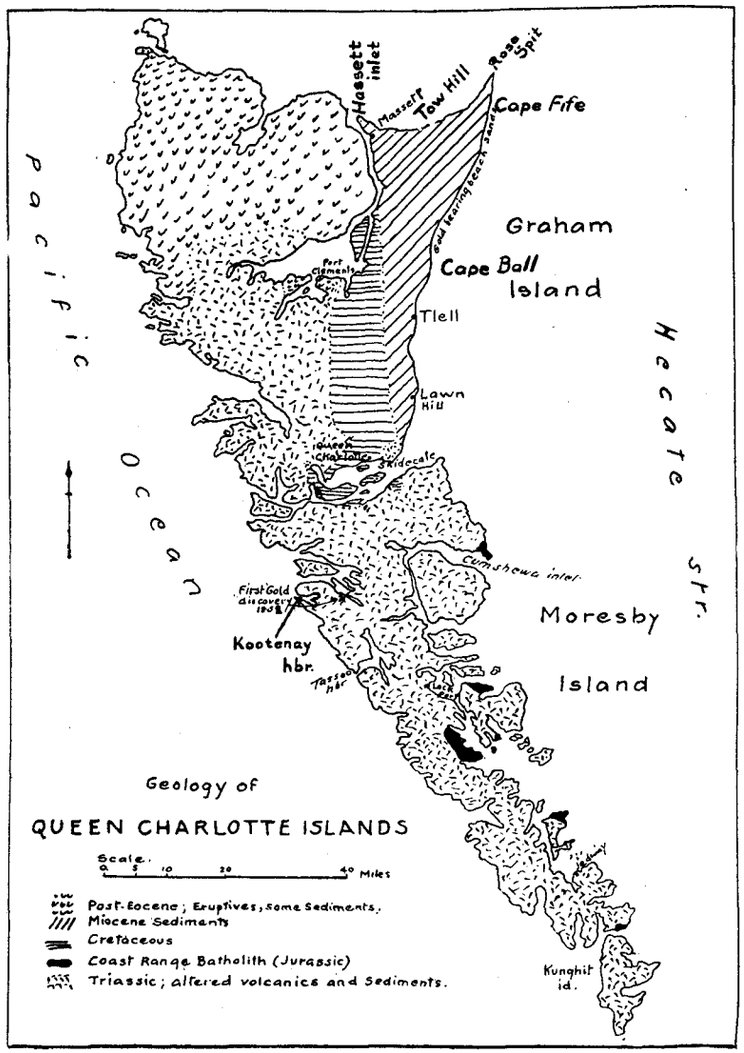

Figure 1.

placer-gold enrichments in lenticular, semi-stratified gravel streaks. Such gravel streaks may be seen in the beach area of the northerly half of Graham island continguous to and along the east coast. Some fine gold has been found in these, but they have not been prospected for pay values.

A more widely-spread and continued re-concentration of these outwash deposits has occurred in recent times, however, and is still continuing. This

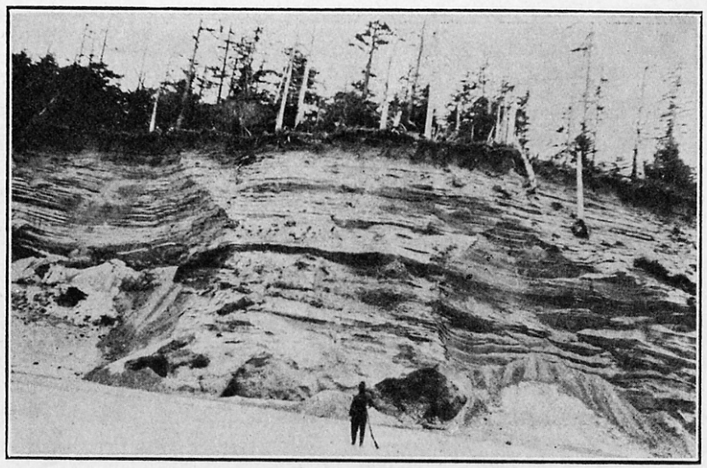

Figure 2.—East coast, Graham island. Interglacial, stratified sand and gravel, underlain by glacial clay. Lake creek, at 12 miles south of Oeander river.

is attendant upon wave and wind action on the bluffs formed of this outwash material, and the result is the beach black-sand concentrations of the northeasterly quadrant of Graham island. These are to be found in several localities along the north shore, from Rose Spit to Massett inlet, but they are best developed along the east coast between Rose Spit and Cape Ball.

Between Rose Spit and Cape Ball the beach and bordering bluffs consist of Pleistocene to recent superficial deposits of unconsolidated to semi-consolidated sands, clays, sandy clays, gravels, and conglomerates. The basal formation is a blue-grey glacial clay, which undulates in gentle folds from about sea-level at Tlell to well above sea-level in the bluffs of Cape Ball. From this point northward, the basal clay continues with gentle folds at about sea-level until it gradually plunges north to just below sea-level at Rose Spit. In places along the bluffs bordering the beach, lenticular layers up to several feet in thickness of stratified, unconsolidated to semi-consolidated, rusty gravels occur. These are inter- and post-Glacial products resultant from water-wash derived from the receding ice. In some localities, very definitely stratified marine deposits with layers of shells, representing raised beaches, compose the low bluffs bordering the beach. There is a splendid example of this about three miles south of Cape Fife and another extending for about two miles north of the Oeander river on the east coast of the island. Along the east coast of Massett inlet, at Blue Jacket creek and in its vicinity, a raised beach constitutes the bordering shore.

The occurrence of raised beaches, together with the structural condition of the shore-line and its topography, indicates recurring and sectionally distributed uplift and depression of the coast accompanied by relatively

distributed invasion and retreat of the sea during comparatively recent times. The present periodically varying condition of the beach shows that this process is continuing and that the island is still in a more than average condition of static unrest. It is of interest to note, in this regard, that this condition is suggested in legends of the local Haida Indians, according to which the domicile of the great and horrible 'Earthquake Spirit' and his family of shivering little 'Earthquakes' is located somewhere in the plutonic abyss beneath the Queen Charlotte islands.

The black-sand deposits have a lenticular and varying distribution along the base of the bordering bluffs and have been derived from disintegration of the material constituting these and its re-concentration by wave-action on the bluffs and at their base. As would be expected from the wave-action process which causes this deposition, the best period for the formation of concentrates is in the winter storm months, with a subdued deposition during the summer.

The extent, distribution, and location of these black-sand concentrates varies greatly and changes rapidly and frequently. Especially during the winter months, and sometimes during other periods of the year, this coastline is subjected to southeasterly and easterly gales and storms and their accompanying heavy seas. These vary greatly in intensity and duration, and the direction from which the wind blows and the waves come has a distinct bearing on the character and conformation of the beach line and the sand-deposits on it. After a gale or storm, the entire condition of the beach may be changed. What, before, showed black-sand may be covered by a thick layer of white sand, or the white sand may be removed, leaving the black-

Figure 3.—East coast, Graham island. Black-sand operation at two miles west of Cape Fife.

Note sand-bar building between new and old high-tide mark, outlined by two lines of drift-logs.

sand, or the positions and locations of the black and white sands may be interchanged. A remarkable characteristic of the heavy black-sand streaks and lenses is that they do not lie on any impervious bed such as clay, but form a layer of distinct concentration on top of white sand, mixing very little into it. The extent and location of the deposits is also largely affected by the direction of the wind and its influence on the direction of wave-action in correlation with the strike of the shore-line and the accumulation and removal of protecting or breakwater sand-bars. It can be readily seen that these allied and varying influences can only culminate in extremely varying results over long and short time limits. For a period of years, one stretch of beach may be especially favoured with black-sand deposits, and in this stretch one strip may be especially favoured one year and ignored the next, or the deposits may be here today and gone tomorrow.

Black-sand concentrate lenses from one to over six inches thick are distributed in sections up to 300 and 400 feet long and 40 to 50 feet wide, extending from the base of the bluffs through the high-water drift-log fringe and down the gently sloping beach. The richest lenses are about 5 feet wide and 10 to 50 feet long. A typical characteristic of the deposits is a marked and picturesque gradation from concentrated magnetite black-sand in the upper or high-water fringe, through brownish-red and pink garnetiferous sand, to greenish epidote or peridote sand, and then to the yellow sand strip down to the low-tide breaking surf. The magnetite-sand lenses have been found to carry values varying from a few cents to over $10 in gold to the cubic yard.

Although, in some of the black-sand patches, particularly those collected behind drift-logs, some of the characteristically fine gold-colours could be recognized with the naked eye or with the aid of a magnifying glass after gently scraping away the top layer of the damp sand, no gold was actually recognized in the pinkish garnet or greenish epidote section. In all cases where gold could be recognized, the colours are charactertisically fine, probably from 60 to over 100 colours constituting one cent.

During an examination of this area in 1931, the section best adapted for the deposition of gold-bearing concentrates was a stretch about three miles in length locally known as 'Bull swamp', situated about six miles south of Cape Fife, commencing at about one mile south of Martel creek and extending to the vicinity of Lake creek (about four miles south of Martel creek). In this section, which is a topographical depression in the bluffs fronting the beach, several small ravines representing the eroded beds of small creeks are noted. These creeks, dependent upon the rainfall for their water supply and cutting down to the basal clay on the beach, offer an additional means for re-concentration or natural sluicing of the already formed lenses, and in one of them, from which a small amount of water was trickling in veinings across the beach, numerous fine specks of gold could be readily seen. At

that time, probably about an ounce of gold could have been recovered from this little trickle in two days' shovelling and washing.

EXPLOITATION OF THE DEPOSITS

Considered from the standpoint of individual workers, the character of the deposits is such that their exploitation is not recommended to 'greenhorns'. However, given the ability for continuous work, intelligence, applied study of the peculiarities of the deposits, and the application of suitable methods, it would be possible for individuals to earn expenses or small wages.

From the standpoint of an appreciable-yardage operation, it must be stressed that this would seemingly be dependent for success, not upon the exploitation of spasmodic superficial depositions and lenticular occurrences of the high-grade streaks and patches, but upon the location and careful appraisal of a sufficient yardage of low-grade, permanently-situated formerly-deposited sands, and the application of a suitable method of concentration and gold-extraction. Such deposits would take the form of buried black-sand concentrate-lenses interbedded with layers of non-pay grey-sands, the whole making up sufficient grade for profitable treatment by the method selected. Provided a successful method can be applied to the treatment of such material, it is quite possible that detailed and careful prospecting of the extensive stretch of beach along the east coast of the island, from Rose Spit to Cape Ball, might disclose a sufficient yardage of such sands to warrant an operation.

METHODS FOR RECOVERY

Hitherto, in appreciable-yardage operations, concentration followed by amalgamation in specially constructed machines has been the most popular procedure. Unfortunately, most of the large-scale operations attempted have been on superficial, naturally concentrated lenses only. These are evanescent as the dew, and the ventures have failed through lack of opportunity for continuous operation. The most recent attempt was by means of the Lorensen centrifugal force amalgamator, manufactured in Vancouver. A good gold extraction can be made with this machine, but the operation could not cope with the usual and very apparent problem of machine capacity and available yardage of the required grade of concentrates contiguous to the machine.

Requirements for such an operation are preliminary concentration of low-grade material followed by a suitable and efficient method of gold extraction from the type of black-sand concentrate delivered. To determine a sufficient yardage of permanently located material to warrant such an operation, the extensive stretch of beach requires careful and systematic sampling. Dependent on the results of this, a mobility of the plant to the pay-

areas, or some cheap method of transporting the pay-sand to the plant, would have to be worked out. Other problems relative to such an appreciable-scale operation are matters of water supply and tailings disposal. Treated magnetite black-sands may form a possible by-product or would have to be disposed of in such a way as not to endanger the grade of workable deposits by dilution.

APPLICATION OF FLOTATION PROCESS

Recent metallurgical progress has pointed to the possibility for the successful application of the flotation process in the extraction of the fine or flour gold occurring in these sand-deposits. In this respect, A. W. Fahrenwald, Professor of Metallurgy and Ore Dressing, School of Mines, University of Idaho, has carried out exhaustive experiments on this type of material. Regarding the treatment of these sands, Professor Fahrenwald, in a letter to the author, states:

> "Rather a large number of placer and black-sand samples have come to this laboratory and have been tested for flotation. We have had very good results Small gold particles float readily, and I have no doubt that the material in which you are interested would respond satisfactorily to the flotation process It is, of course, a matter of economics. From considerable study of the problems and calculations that I have made, I believe any sand running 50 cents or more a yard can be handled at a profit by the flotation process".

The following is quoted from a further communication from Professor Fahrenwald:

> "Metallic gold is one of the most easily floatable of all natural substances. The requirements are as follows:
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> "(1) Sand coarser than about 14 or 20 mesh must be screened out before putting the sand in the flotation cell.
>
> "(2) A mechanical-agitation-type flotation machine is necessary The so-called air-agitation-type will not hold the heavy sand in suspension.
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> "(3) Particles larger than the ordinary type-writer period (.) may or may not float. All sizes finer than this size, including 'flour' gold, float readily.
>
> "(4) The reagents required are, sometimes, but not always, a small amount of sodium carbonate, a pound or so per ton, or, in other terms, about as much as the tin-end of a pencil (rubber removed) will hold, for each pound of sand; sodium amyl xanthate or sodium aerofloat in amount about equal to a grain of wheat for each pound of sand; pine oil in quantity to give voluminous froth, adding a drop at a time and stirring between additions. Four or five drops off the end of a wire usually are sufficient. Sometimes a minute amount of cyanide (about like xanthate) helps.
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> "In the case of black-sands, the gold comes up in a clear foam on top of the pulp and is skimmed off. Minus 14 or 20 mesh river-sand gives a more dirty froth and the ratio of concentration is not as great as for the black-sand concentrate. Much of the dirt can be eliminated by a retreatment in another or in the same cell. The concentrate assays from $100 to $1,000 or more a ton
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> "In many tests, the recovery has ranged from 90 to 98 per cent of the gold.
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> "If coarse gold is present in the sand to be treated, it should be removed by tabling or panning, or by some gravity method. Amalgamation always must be done ahead of any attempt at flotation, because the flotation reagents foul the gold and it cannot thereafter be caught by mercury.
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> "Flotation may be continuous or done in batches. The miner wishing to clean black-sand should do so in batches, using about two or three times as much water as ore. The reagents are added, and from 15 to 20 minutes are required to froth off the gold values.
>
> "Machines and reagents can be purchased from the well known manufacturers of milling equipment. Care should be taken in the selection of a machine for this work".

For individual operations to meet efficiently the varying occurrence of the black-sand concentrates, it would be necessary to evolve some mobile system whereby the richest concentrates could be gathered at the time they were formed. One apparent difficulty in connection with gold recovery from these deposits is the scarcity of water, particularly during the drier summer season. To overcome this, it is suggested that a conveniently situated locality with a sufficient and permanent supply of water be selected as a base for operations. The base could, of course, be changed from time to time to suit conditions and the distance of transportation of the concentrated sands. In some locations, where only a limited amount of water would be available, this could be used for a rough concentration, and the concentrated material then 'packed' to a sufficient supply of water at base headquarters for final cleaning. To facilitate the transportation of material, it is suggested that a pack-horse or an ox could be utilized in conjunction with a waggon, go-devil, or other suitable equipment.

Washing of the beach concentration by individuals necessitates careful, skilled, and experienced operation for a satisfactory recovery. The hand-method that has so far given best results is shovelling into sluice-boxes with the recovery-box carried at a steep grade, say about 18 inches to the

12-foot box, so as not to allow the riffles to become clogged with heavy magnetite, and the gold-saving boxes lined with blankets into which narrow and shallow cleat-riffles are sewn. A combination with this of trap or plate amalgamation might be useful for increased recovery. The necessary grade of the recovery-box would have to be determined by experiment and the panning of the tailings. The sands would be shovelled into a sluice-box without riffles, ahead of the recovery-box. This facilitates an even feed to the recovery-box. The alteration of the grade of the recovery-box to suit the material could be easily accomplished by blocking it up at the top end and suspending it at the tailings end on a rope half-hitched on two stakes driven into the ground at either side of the box. To alter the grade, the rope-hitches could be quickly and easily moved either up or down the stakes as required. By this method, probably from 50 per cent to 60 per cent of the gold values in the sand, and also some platinum, could be recovered.

It is not known whether long-toms have been tried on the Graham Island beaches, but it would seem that this method, with the introduction of a steep gradient and amalgam plates, might be applicable to the richer patches. In such an operation, the plates should be protected from scouring with a screen, and sea-water could be baled with a large dipper. Recovery in rockers adapted to the peculiarities of the sands should also be possible from the rich patches. This method would have the advantage of easy transportation from place to place and the utilization of sea-water baled with a dipper from a well, pool, or lagoon. It is estimated that one man could handle about three cubic yards of sand per 10-hour shift in a long-tom or rocker. With a two-man combination, the duty per man would be proportionately increased.

Where a fresh-water flow is not handy, the surf washer which was used with success on the Nome beach, Alaska, might also be applicable, at some periods and localities, to the richer patches of the Graham Island beaches. This device is similar to a long-tom but it is wider and shorter and could be mounted on wheels for easy shifting from place to place. The black-sand could be transported to the washer in buckets or wheelbarrows. The device is placed at the edge of the surf, and the sand dumped into the hopper. The surf rushes up the sluice to the hopper and, on flowing back down the sluice, carries sand from the hopper back over the riffles and amalgam plates. Two surf washers could be operated by one man and from five to ten cubic yards of sand handled in a 10-hour shift.

In considering hand-operations by individuals on these black-sand concentrations, it must be stressed that the nature of these deposits would necessitate more or less intermittent operation on small, rich lenses, with the best periods occurring after storms. Such operations would naturally not be suitable nor profitable to transient seasonal operators, whose comings and goings would consume the small wage-recovery made.