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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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PAPER 55-40

SURFICIAL GEOLOGY OF VANCOUVER AREA, BRITISH COLUMBIA

(Map and Report)

By

J. E. Armstrong

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INTRODUCTION

This report deals mainly with the geology of the surficial (unconsolidated) deposits, and to a much lesser extent the bedrock geology, of the Vancouver area, British Columbia. The primary aim of this report, geological map, and table of formations is to assemble geological information needed in the future industrial and agricultural development of the area. The general stratigraphic succession and geological history of the Pleistocene and Recent epochs, which are discussed briefly herein, will be dealt with in detail in a later report on the surficial geology of the Lower Fraser Valley.

Field work for this report and map was done intermittently during the years 1949 to 1952. The writer was assisted in the field by W. L. Brown, W. M. Draycot, L. F. Brandon, Rev. R. Sanschagrin, O. M. I., W. Atamanchuk, J. Darker and D. Cooksey. Miss F. J. E. Wagner and W. M. Draycot collected and identified Pleistocene and Recent fossils. Field work consisted of examining all natural and artificial exposures, such as sea-cliffs, stream and river banks, landslides, excavations, gravel and sand pits, drainage ditches, etc. This information was augmented by extensive digging and augering of shallow holes, 3 to 20 feet deep. Wherever possible, information was obtained from holes drilled for ground-water supply, oil and gas exploration, and from foundation and construction work. The writer wishes to thank all those individuals and organizations that supplied drill-hole information, without it he would have been unable to make some of the conclusions and correlations contained in this report. The writer also obtained an advance copy of the detailed soil map of the Fraser Delta from C. C. Kelley, British Columbia Soils Survey, for which he is grateful. All information was plotted on maps on the scale of 1 inch to 1/2 mile with a contour interval of 25 feet, and interpolated to construct the accompanying geological map.

The geological boundaries on the map are mostly gradational and are accurate only to within 1/4 mile. Furthermore, map units are to some extent generalized so that a pattern representing a certain type of deposit may contain small areas of another related type of deposit shown elsewhere by a different pattern. No attempt has been made to study the detailed physical and chemical properties of the various materials discussed.

PHYSICAL FEATURES

The area may be divided into four distinct parts, differing in physical features: (1) the Coast Mountains, (2) Burrard Peninsula, (3) the delta of Fraser River, and (4) the present and raised marine deltas of Capilano, Seymour, and Lynn Creeks. The last three divisions form part of the Lower Fraser Valley lowland, which is the area bordering Fraser River and extending from the Strait of Georgia 80 miles eastward, and from the International Boundary northward to the Coast Mountains.

The Strait of Georgia, which occupies the area between Vancouver Island and the British Columbia mainland, is 10 to 15 miles wide and varies in depth in its central part from 600 to 1,350 feet. Burrard Inlet extends eastward from the Strait of Georgia and separates Vancouver city from the Coast Mountains. The lower part of the Inlet has a maximum depth of about 200 feet between First and Second Narrows.

Only the southwest fringe of the Coast Mountains is included in the area mapped. They rise abruptly several thousand feet from deep U-shaped valleys, which, in the area, are occupied by Howe Sound and Capilano, Seymour, and Lynn Creeks.

Burrard Peninsula, bounded on the north by Burrard Inlet and on the south by the North Arm of Fraser River extends from Point Grey to Pitt River. In the area it consists of two easterly trending ridges separated by False and Still Creek Valleys. The northern ridge is formed mainly of Tertiary bedrock overlain by a thin mantle of surficial deposits, except on the south slope of the ridge where these deposits may be 100 feet or more thick. Burnaby Mountain, elevation 1,135 feet, lies several miles to the east of the area and is the highest point on the ridge. The southern ridge is more continuous than the northern and is of more uniform height, averaging nearly 300 feet and nowhere exceeding 425 feet. Tertiary bedrock is at or near the surface on the northern slope of this ridge between Jericho Beach and Boundary Road, also on Little Mountain. On parts of the southern slope of the ridge surficial deposits exceed 700 feet in thickness.

The delta of the Fraser River is in the process of formation, and its upstream limit is where the first distributary is given off at New Westminster, 19 miles west of the Strait of Georgia. This delta is mostly below the level of extreme high tide and is dyked to prevent flooding.

Present and raised marine deltas rise in a series of terraces from Burrard Inlet north along Capilano, Seymour, and Lynn Creeks to elevations of about 1,000 feet.

GENERAL GEOLOGY

TYPES OF PLEISTOCENE AND RECENT DEPOSITS

Before describing the stratigraphy and historical geology of the area some of the terms to be used will be defined and some information regarding the types of Pleistocene and Recent deposits found will be given.

The term Pleistocene refers to that epoch in the earth's geological history when large areas of the earth's surface were periodically covered by great glaciers many thousands of feet thick. The epoch is estimated to have started about one million years ago and to have continued in the Vancouver area up to about five to ten thousand years ago. The term Recent is used to refer to the post-glacial time.

The deposits formed during the Pleistocene and Recent periods consist of clay, silt, sand, gravel, varved clay and silt, stony, clayey silt and related till-like mixtures, and till. The terms clay, silt, and sand as used in this report are based on the diameter of the constituent particles as follows: clay, less than 0.002 mm.; silt, 0.002 to 0.05 mm.; and sand 0.05 to 2 mm. The clays and silts of the Vancouver area are composed chiefly of rock flour produced by mechanical abrasion by glaciers, and only to a very minor extent of clay minerals formed by chemical decomposition of rock. The sands are mainly quartz, but contain in addition many feldspar and rock fragments.

Varved silt and clay are glacial lake deposits consisting of alternating light and dark coloured layers from a fraction of an inch to several inches thick.

The stony, clayey silt and related till-like mixtures are in a large part glacio-marine and to a lesser extent normal marine deposits that were laid down in the sea during and following the advance and retreat of an ice-sheet and during the subsequent uplift of the land. The glacio-marine deposits are marine drift; that is, the stones and part of the fine material were transported by floating ice and the remainder of the fine material carried by meltwater and sea water. The somewhat similar deposits of normal marine origin are mainly reworked till and marine drift resulting from submarine erosion as the land rose above the sea. Mechanical analyses of stony, clayey silts similar to those found in the map-area show that, exclusive of the stones, they comprise about 50 per cent silt, 40 per cent sand, and 10 per cent clay. Many of these deposits are very similar in appearance to true till and in mapping the area it was feasible in only a few places to separate them.

The term glacial till as used in this report indicates a very compact, unsorted mixture of sand, silt, clay, and stones deposited directly beneath glacial ice. Mechanical analyses of the fine fraction of representative samples of tills from lowland areas within and adjoining the map-area yielded the following average results: Surrey till, 57 per cent sand, 41 per cent silt, and 2 per cent clay; Semiamu till, 47 per cent sand, 45 per cent silt, and 8 per cent clay; and Seymour till, 44 per cent sand, 46 per cent silt, and 10 per cent clay. Tills in the mountain valleys have a greater proportion of sand than tills at the same age in the lowlands.

Outwash consists of sediments deposited by streams issuing from glaciers.

STRATIGRAPHY AND HISTORICAL GEOLOGY OF PLEISTOCENE AND RECENT DEPOSITS

The unconsolidated materials of the Pleistocene and Recent epochs vary in thickness from a few feet in parts of downtown Vancouver to a maximum of 2,300 feet in the Boundary Bay area. In the preceding section the general nature of these materials has been described but no reference was made to their complex interrelations and age. Accompanying this paper is a table of formations that shows these interrelations graphically. The oldest deposits are shown at the bottom of the table and the youngest at the top. Deposits shown alongside one another indicate that they are of the same general age but were laid down in different environments.

All ages are relative except in the case of the Capilano and Quadra deposits, where radio-carbon age determinations were made on wood collected from them outside of the field area. These determinations were made at Columbia University, New York. Wood from the base of the till which was deposited by post-Vashon valley ice and hence a part of the Capilano group, was dated as 11,500 $\pm$ 500 years old. Wood from the Quadra group inter-till sediments was dated as greater than 30,000 years. Deposits correlated from area to area may vary somewhat in age as glaciation is a relatively slow process.

Study of the table indicates that the area was subject to at least three major glaciations, namely, Seymour, Semiamu, and Vashon. The Seymour and Vashon glaciations reached ice-sheet proportions during their maxima at which time they were probably 7,500 or more feet thick over the valleys. At these times the ice moved in a general southerly direction off the Coast Mountains. The Semiamu ice was possibly, also, of ice-sheet proportions, but, due to later erosion, deposits of this group are

so poorly preserved that a reliable history of this ice-advance cannot be pieced together. Post-Vashon valley ice advanced westward across the Lower Fraser Valley lowland to within about 25 miles of the Vancouver area.

During each major glaciation the land was depressed relative to the sea, possibly 1,000 feet or more. At the maximum of Vashon glaciation the ice rested on the sea floor. During the retreat of the Vashon ice, largely by wasting, the ice thinned and floated and the glacio-marine Newton stony clay deposits were laid down. After the Vashon ice melted and as the land rose above the sea, the offshore marine Cloverdale sediments and the marine-shore Sunnyside sand and Bose gravel deposits were laid down, and many terraces were formed. For example, along the Capilano Valley, fourteen well-marked terraces occur between sea-level and 1,000 feet. Undoubtedly similar conditions prevailed during the retreat of earlier ice-sheets as is indicated by some evidence obtained from drill records and from exposures outside the area.

Up to the end of 1953 a total of 42 species of fossil marine shells had been collected and identified from Newton stony clay and Cloverdale sediments. They were collected from 50 localities ranging from 5 to 575 feet above sea-level within the Vancouver and adjoining areas. Marine shells similar to these assemblages are now found in the sea in latitudes ranging from 60° to 63° north; that is 760 to 950 miles north of Vancouver.

As shown in the table of formations one probable interglacial period, the Quadra, has been recognized between the Seymour and Semiamu ice-sheets. Apparently climatic conditions existing then were somewhat similar to those at present, as is indicated by a study of the pollen and plants from the Point Grey peat beds. Some of the Capilano group deposits are probably interstage in age.

Two major erosion intervals are shown in the table of formations separating the Semiamu group from the Quadra group below and the Vashon group above. The hills in the Lower Fraser Valley lowland were shaped during the latter interval and were mantled by Vashon group deposits. Surrey till conforms to the slopes of the hills truncating underlying deposits. In post-Vashon time the hills have been subjected to marine action resulting in the development of beach terraces and the deposition of a thin mantle of marine deposits. The overall topography has been much subdued as a result of extensive filling (several hundred feet) of the intervening valleys with marine and alluvial deposits.

DISTRIBUTION OF PLEISTOCENE AND RECENT DEPOSITS

The distribution of the Vashon and younger deposits is fairly obvious from a study of the geological map accompanying this paper, and they are therefore discussed only briefly here. Most of this section deals with the distribution of pre-Vashon deposits. These are dealt with as a single unit on the map in view of their very limited surface expression.

Pre-Seymour group deposits are not exposed in the area, but deep drill holes in the Marpole district of Vancouver, on Lulu Island, and in the Boundary Bay area intersect unconsolidated and semi-consolidated sediments below what the writer believes to be the equivalent of Seymour till. These pre-Seymour deposits, which are up to 1,000 or more feet thick, consist of clay, silt, sand, gravel, and till. The Seymour till is identified in drill holes from its stratigraphic position, which is determined from the fact that it is below recognizable interglacial deposits or is the third distinct till from the surface. The latter correlation may admittedly lead to errors, as in places good evidence has been obtained of local advances and retreats of Vashon ice, each depositing a till, but in general when applied over a wide area the premise seems safe. In most of the area north of 49°15' Seymour till or younger deposits rest directly on bedrock.

Seymour group sediments are exposed in the valleys of Capilano, Seymour, and Lynn Creeks, and as mentioned above have also been intersected in deep drill holes elsewhere. Along the Capilano Canyon Park road bedrock is overlain by an 80-foot section of Seymour group till and varved silts (Seymour till and Sisters varved clay). These are overlain by Lynn outwash consisting of coarse gravel. Somewhat similar sequences are found farther north in Capilano Valley and near Lynn Creek and Seymour Creek canyons. Varved silts and clays were observed in all these areas from elevations of about 200 to 1,400 feet. Similar deposits of probably the same age were encountered in drill holes in the Marpole area, several hundred feet below sea-level.

Quadra interglacial deposits are exposed in sea-cliffs at Point Grey and Boundary Bay, along the valleys of Capilano, Seymour, and Lynn Creeks, and in Vancouver city on the southern slope near the Fraser golf course and on the northern slope between Granville and Oak Streets near 16th Avenue. Peat and wood were observed in these sediments in all the above localities except on the southern slope in Vancouver city. The deposits south of Burrard Inlet are in a very large part sand and silt with minor clay and gravel. North of Burrard Inlet gravel is more abundant but does not predominate.

Colebrook gravel is exposed in the gravel pit at Boundary Bay.

Semiamu till and sediments may be positively identified only in the section at Englishman's Bluff in the Boundary Bay area. Till and sediments believed to be Semiamu are exposed along southwest Marine Drive, Vancouver, about 1 1/2 miles west of the city limits. Similar deposits were encountered in drill holes in the Point Grey and Marpole areas of Vancouver. Till believed to be Semiamu occurs in the Capilano Canyon area. There is a good possibility that some of the till at the surface mapped as Vashon is really Semiamu, the Vashon till having been removed by post-Vashon marine erosion.

Richmond delta deposits are up to 700 feet thick on Lulu Island. On Sea Island the top sands are 50 to 65 feet thick and are underlain by a relatively thick clay and silty clay section. Along the South Arm of Fraser River and throughout much of Lulu Island the top sands are much thicker.

APPLICATION OF THE GEOLOGICAL STUDIES

The geological study and mapping of the Pleistocene and Recent unconsolidated deposits of the Lower Fraser Valley and Greater Vancouver area were undertaken as an aid to the future development of the area. The proper realization of the influence of geological conditions on industrial and agricultural development is essential in intelligent planning and may result in saving considerable sums of money. Application of geological information in the planning stage may indeed prevent floods, slides, and other disasters.

The work upon which this report is based consisted of obtaining all information available on the physical nature, origin, and extent of the surficial deposits, and bedrock, and from this attempting to unravel the stratigraphy and geological history of the area. For this reason it was necessary to do considerable work in parts of the area where it had no immediate practical application. A knowledge of the stratigraphy and geological history is essential, however, to the proper utilization of the geological information obtained in the field.

Some of the present and future applications of this basic geological information are discussed in the sections below.

ENGINEERING GEOLOGY

Adequate data on the kind and distribution of geological materials aid the engineer and contractor to solve many problems pertaining to foundation materials, sewage disposal, flood control, slides and washouts, and construction materials.

Foundation Materials

Although in the past it has often been disregarded, it is now apparent that a knowledge of the properties of foundation materials is particularly desirable wherever the stability and durability of structure may be affected by the nature of underlying materials. The more important properties are permeability and drainage, stability and shearing strength, and workability. Information on these properties is valuable in the design and location of buildings, roadways, airport runways, bridges, dams and playing fields.

In areas of clay, silty clay, stony silty clay, glaciomarine till-like mixtures, till, and bedrock most of the drainage is by surface runoff, as these materials are nearly impervious and permit very little downward percolation of water. Areas of sand and gravel are, however, rather pervious and allow much downward drainage, except where the water-table is at or near the surface, as is the case in much of the Fraser River delta. Although the tills contain relatively little clay and a high percentage of sand, their compact nature tends to make them nearly impervious. The compaction is due to the angularity of the fine materials and to the weight of glacial ice beneath which the till was deposited. Even when excavated, broken up, and used for fill or other purposes the till soon becomes impervious due to the fines washing into and sealing the channels or cracks, and if loaded it readily becomes quite compact. There are many examples in Vancouver of drainage problems involving tills, one of the more recent being at Empire Stadium.

Of particular interest is the fact that the Surrey till and older deposits have been pre-loaded by at least 7,500 feet of ice, whereas the post-Surrey deposits have only been pre-loaded by the weight of the sediments above them. Consequently the Surrey till and Newton stony clay, although very similar in appearance, react very differently to load; except perhaps for bedrock, the former is the best foundation support available and the latter, because it undergoes considerable compaction under load, is poor. The very different reaction to load of similar appearing materials is readily explainable when their origins are considered. The till was deposited under a great weight of ice whereas the till-like

stony clay was dropped from floating ice. Fortunately for builders in the Greater Vancouver area, in most places the glacio-marine sediments are less than 25 feet thick and rest directly on till. The larger areas where these deposits are probably thicker and may constitute a problem are indicated on the map. East of the Vancouver area the glacio-marine and related marine deposits are up to 500 feet or more thick.

The peat bogs of the Fraser River delta and to a lesser extent in the uplands, present probably the most obvious foundation problems of any of the deposits mapped. They undergo extreme compaction when loaded and are very difficult to drain. Hard surfaced roads laid across these bogs tend to develop alternating swells and depressions and deteriorate very rapidly unless the peat is excavated and, where necessary replaced by fill before building the road.

All the unconsolidated deposits found in the area are easy to excavate, except the tills and, to a much lesser extent, the glacio-marine sediments. In the tills, high cohesion in places necessitates blasting before excavation and in both tills and glacio-marine sediments large stones may have to be broken to be removed.

Sewage Disposal

Wherever sewage disposal is dependent on septic tanks a knowledge of drainage and sub-soil conditions is necessary. Most of the uplands are covered by nearly impervious to impervious Surrey till and Newton stony clay glacio-marine deposits at or within a few feet of the surface. For all practical purposes these materials permit no downward drainage. Where these are not at the surface they are overlain by thin deposits of Bose beach gravel and Sunnyside sand, deposits that permit downward drainage to the impervious materials underlying them. These sands and gravels are so thin, however that in the rainy season, the water-table is close to or at the surface even in these permeable deposits. It is therefore evident that much of the overflow from septic tank absorption fields in the uplands must eventually drain down the slopes by surface or near surface runoff.

The impervious tills and glacio-marine deposits nearly everywhere overlie either impervious bedrock or permeable interglacial sediments, and in the latter case, especially on the higher parts of the uplands, some downward drainage could be brought about by sinking drainage holes through the overlying impervious material. This procedure is practical only where contamination of the ground-water supply does not matter. If septic tanks must be used under the unfavourable conditions

outlined above they should be placed so far apart that the development of adjacent lots will not be affected.

Septic tank sewage disposal systems will not operate satisfactorily where the ground-water level is up to, or nearly up to the absorption tile, or in areas that are periodically flooded. These conditions exist in much of the Fraser River delta lowlands especially during the rainy season.

Flood Control

To combat flooding effectively along rivers by means of dyking and dredging, the nature of the river-bank and bottom deposits must be known. Most of the dyking troubles along the Fraser River are due to the dykes being built on permeable sand. Consequently, when the river is in flood and the water level is higher than the land behind the dyke, the hydrostatic head forces some of the water through the sand beneath the dyke and dyke failures have resulted from such seepage.

The streams that flow off the Coast Mountains occasionally reach flood stages and bring destruction, and continued erosion in the mountains and continued floods into the valleys are to be expected. Except for raised delta deposits along some of the streams most of the slopes have impervious till or bedrock at the surface, which allows an extremely fast surface run-off, especially where the vegetative cover has been removed. In this way serious flooding occurred in North and West Vancouver in November 1955 following excessive rainfall. Protection by vegetative cover, check dams, and other expedients are designed to minimize the destructive effect of these natural forces. The maintenance of the Greater Vancouver watershed north of Vancouver with regulations preventing removal of forest growth has certainly helped to prevent more serious flooding on Seymour and Capilano Creeks.

Slides and Washouts

Over the years large slides and washouts have occurred in the lower mainland area. These always occur on steep slopes where the soil conditions are rendered unstable by heavy rainfall and generally excessive clearing of the land. One of the best examples of a large washout took place near the University of British Columbia in 1935. There the sea-cliffs reveal about 150 feet of Quadra sands and related deposits overlain by about 10 feet of Surrey till. Following an exceptionally heavy rainfall, a small stream, whose banks had been cleared of most vegetation, cuts through the till into the underlying sands.

Great quantities of these sands were eroded and carried away and by undercutting, much of the overlying impervious till also.

In other places the disturbance of the angle of repose of the sediments, combined with geological conditions somewhat similar to the above, have caused slides. A knowledge of the geology would not prevent all such slides and washouts, but it would enable many to be foreseen, and if necessary precautions were taken, most of them could be prevented.

Construction Materials

The production of gravel and sand is an important industry in the Vancouver area. At present twelve companies are operating gravel and sand pits and produce over a million yards a year with a value of more than one-half million dollars before crushing, washing, and sizing. The value of the finished products exceeds a million dollars. The bulk of these materials are used for concrete aggregate, for fill, and for base course or surfacing of roads. Eleven of the pits are on the north shore of Burrard Inlet and the twelfth is on the Boundary Bay upland.

Geologically, the deposits in which the pits are located may be classified as follows: (1) marine deltaic and channel deposits formed by present-day mountain streams (7 pits); (2) Capilano gravel raised marine delta and channel deposits (4 pits); and (3) Colebrook gravel of Quadra interglacial deposits (1 pit).

Gravel and minor sand is being deposited in the intertidal deltas at the mouths of Capilano, Seymour, and Lynn Creeks, and also along the bars on these creeks. All the above are torrential mountain streams capable of transporting gravel of cobble, and occasionally of boulder size. The outer edges of the deltas drop off steeply, partly because of the coarse materials forming the deltas and partly because of the strong tidal currents at First and Second Narrows, which tend to carry away the fine material. Steep foreset beds are well developed in the deltas. This present-day stream gravel is well-sorted, clean, and up to 50 feet thick. It consists mainly of well-rounded granitic pebbles.

The Capilano gravel deposits were laid down in the same way as the present-day stream deposits and later elevated to their present positions, 25 to 1,000 feet or more above sea-level, when the land rose above the sea following the retreat of the Vashon ice sheet. They now form raised terraced deltas along Capilano, Seymour and Lynn Creeks. These raised delta deposits overlie Vashon group and older deposits, some of which are gravel and sand, and in places, lie directly on pre-Vashon

gravel and sand, the intervening till having been removed by erosion. The raised deltaic deposits are very similar to the present-day stream deposits except that they contain more interbedded sand. In many places most of the deposit consists of foreset delta beds dipping at 10 to 35 degrees outward from the face of the deposit. In all the operating pits the foreset beds are overlain by up to 10 feet of topset beds consisting of poorly sorted and bedded cobble gravel.

The Colebrook interglacial deposits underlying part of the Boundary Bay upland contain one gravel pit. The deposit exposed consists of 30 feet of horizontally bedded pebble gravel and sand. Granitic rocks comprise about 50 per cent of the pebbles. Most of the deposit is overlain by 10 to 15 feet of Surrey till and Newton stony clay.

In most of the smaller operations, pit-run gravel and sand only are produced. This material, without crushing or screening is loaded by gasoline or Diesel-driven shovels (3/8 to 3/4 cu. yd.) directly from the workings into trucks for transport to the place of use. At most of the medium-sized and larger pits shovels up to one cubic yard and draglines are used at the face, and the pit-run materials are hauled in trucks to crushing plants, generally at or near the pits. The Deeks-McBride operation, at the mouth of Seymour River, is using a dragline shovel to depths of 40 feet below sea-level to take gravel out of the delta of the river. This gravel is loaded on a conveyor belt 1,500 feet long for transport to the crushing plant. Road Materials, Limited uses hoe-type scrapers to drag gravel from the pit face to trucks for transport to the crushing plant. All the large pits crush part or all of their gravel. The common range of products includes fine and coarse sand, gravel in various size ranges from less than 3/8-inch to more than 2 1/2-inch, 'mulch' (pit-run crushed gravel for road material), and 'navy jack' (a mixture of sand and gravel).

The most common difficulties encountered in the operation of gravel and sand pits that may be attributed to geological conditions are as follows:

(1) Excessive overburden of glacial till or stony clay, both of which are difficult to handle with a shovel and hard to dispose of.

(2) The 'lensy' nature of many of the gravel beds, which results in a pit-run product containing much sand, for which the market is limited.

(3) The large size of some of the boulders, which in many places are from 4 to 12 feet in diameter, cannot be handled by the equipment without blasting.

(4) The occurrence of interbedded thin strata of silt or clay, materials that cannot be handled satisfactorily in the washing and sizing.

(5) The presence at the base of the deposits of ridges of varved clay or glacial till which, when wet form mud-holes. Indeed, if these ridges are high, they make the overlapping gravel and sand deposit too thin to mine economically.

(6) The presence of high ground-water tables, a particularly troublesome problem to the small operator using only shovels and not washing or crushing.

Vancouver is fortunate in the abundance of good gravel and sand deposits close to the city and, as a result, enjoys some of the lowest-cost gravel and sand products in North America.

AGRICULTURAL APPLICATIONS

The information contained in this report aids in the study of agricultural soils, in problems concerning drainage and irrigation, and in outlining a source of agricultural peat.

Agricultural Soil

Modern soil classification is based upon the nature of the soil profile, which reflects the influence of the various factors of soil development including parent material, climate, topography, organisms, time, and geological environment. The last factor is not normally considered in discussions on agricultural soils, but some writers believe that the factor has not been emphasized sufficiently, especially the stratigraphy and geological structure in and around a particular soil. Each of the factors in soil development mentioned above is in itself dependent on geological history.

The geologist is most able to help the soil scientist in his interpretation of soils by indicating the role played by parent material and geological environment. The soil profiles in the Vancouver area, for instance, are poorly developed and the texture and composition of the parent material is still dominant. The writer believes that when the agricultural soils of the area are re-mapped the broad divisions of the completed soil map will show a very marked similarity to the geological map accompanying this paper.

Undoubtedly very significant soil differences are to be found in soils developed from similar parent materials but in

different geological environments. A very important factor is differences in the deposits underlying the parent material. For example, as shown on the map, in the Fraser River delta the top 15 feet may consist of any one of the following: all peat, all silty clay and clay; all sand; silt above peat above silty clay and clay; peat above silty clay and clay; peat above silty clay and clay above sand; silty clay and clay above sand; and silt above sand. The clay, silty clay and silt are impermeable; the sand is permeable; and the peat has a very high absorptive value, that is, it will store as much as twenty-six times its own weight of water. Obviously the drainage pattern encountered will vary greatly depending on which of the combinations described above is found and therefore the moisture and other soil-climate conditions in the soil may show very significant differences.

Differences in materials underlying the upland soils also play an important role in their development. Furthermore, variation in surface drainage conditions may result in differences in the kind of upland soil developed from a single parent material.

The geological history of the Vancouver area has greatly affected the nature of many of the upland soils particularly those developed on till, on glacio-marine stony silty clays and on till-like mixtures. Following the retreat of the Vashon ice the land rose above the sea and during this uplift, that part of the uplands now below 600 feet underwent marine erosion. As a result much of the fine material was washed out leaving a mantle of boulders, gravel, and sand (Bose gravel).

Drainage and Irrigation

Drainage has been discussed briefly above, and the principles laid down there are broadly applicable.

Some investigations have been made regarding the feasibility of large scale irrigation in the Fraser River delta. The geological environment will have to be fully appraised before final plans are formulated. The water for these planned irrigation systems would have to be drawn from the Fraser River, as groundwater supplies in this area would not be adequate.

Agricultural Peat

The largest peat operations in Canada, accounting for more than one-half of the Canadian production, are in the delta of the Fraser River. The output in 1948 was in excess of 45,000 tons with a value of $1,500,000; the present production and value is probably higher.

Five bogs are partly or entirely in the map-area. They are: (1) Burnaby Lake Bog, of which only the western part lying along Still Creek, is in the area; (2) Byrne Road Bog, along Marine Drive near the eastern border of the area; (3) Small Lulu Island Bog in the eastern part of Lulu Island; (4) Large Lulu Island Bog in the central part of Lulu Island, and (5) Delta Bog in Delta Municipality, only the western part of which is in the map-area.

The only production from the Burnaby Lake Bog is as top-soil and no further discussion of it is necessary here.

The Byrne Road Bog covers approximately 1,500 acres, of which more than half are under cultivation. The bog varies in depth from 2 to 15 feet. The small Lulu Island Bog covers about 3,500 acres, of which only a few hundred acres are under cultivation. Much of the bog has been badly burnt. It varies in depth from 2 to 20 feet. The large Lulu Island Bog covers about 5,500 acres and varies in depth from 1 to 20 feet. At least 500 acres of this bog are under cultivation, mainly for the blueberry crop. The Delta Bog underlies an area in excess of 10,500 acres. The margins of the bog are under cultivation and a very considerable part of the bog has been destroyed by fire. It varies in thickness from 2 to 25 feet.

All the peat produced from these bogs is sphagnum moss peat. The stratum of moss of high enough quality to produce moss of acceptable commercial grade varies greatly in thickness. In some places it is as much as 7 feet thick, but averages nearer 4 feet. The top layer is referred to as unhumified peat. This is dead sphagnum moss only slightly humified. It is fibrous, elastic, light greyish green, or yellowish to light brown in colour, becoming somewhat darker on drying. It has an absorptive value of up to twenty-five times it own weight of water and is light in weight and porous. Humified peat in its natural state is dark brown to black, colloidal, plastic, homogeneous, and somewhat elastic. It dries into a hard solid mass with specific gravity higher than water. It has almost no absorptive value. A piece of dried humified peat may be under water for weeks without absorbing any water. Unhumified peat left in its natural state will humify in the course of time and all fibrous matter eventually disappears. From descriptions of the peat moss bogs mentioned above it is clear that the lower peat strata are darker and consist of intermixtures of humified and fibrous peat with a bottom stratum of well humified peat.

GROUND-WATER GEOLOGY

During the course of field work ground-water information was gathered wherever available. Indications are that water may be found in the Boundary Bay upland in limited quantities for domestic and farm use. In the Fraser River delta ground water occurs in the Richmond delta sands underlying the top silty clay and clay, but much of this water is salty or contaminated and not fit for use. On the Fraser River side of Burrard Peninsula artesian water has been found in considerable quantity. At least three wells are in use in the Marpole area for industrial water, each producing 50,000 or more gallons a day. About 40 years ago the old Municipality of South Vancouver had in use at least twelve artesian wells producing upwards of a million gallons of water a day. One well was 500 feet deep and all the others were less than 140 feet deep. Ground water has been found only in very limited quantities on the north slope of Burrard Peninsula and no water has been developed in the Tertiary bedrock. Several large wells were in use in North Vancouver 40 years ago, and in one the flow exceeded 300,000 gallons a day. These wells were in the Capilano gravel and older deposits.

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