PRELIMINARY GEOLOGIC REPORT

ON

GLACIAL TILL AND TILL-LIKE SEDIMENTS

BENEATH

PIERS S4 AND S2 OF THE PORT MANN BRIDGE

PORT MANN, BRITISH COLUMBIA

By
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July 1960

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Introduction

Mr. R. A. Spence, consulting engineer, authorized the writer to make a preliminary geologic investigation of the sediments beneath Piers S4 and S2 of the Port Mann bridge.

Field examinations were made on July 4 in company with either Mr. Spence or Mr. McLeod.

Problem

Specifically, the writer was asked to identify glacial till from drill cuttings brought to the surface by the clam bucket of the Benoto rig working on the site of Pile C10, Pier S4. A few of the cuttings from Pile A9, Pier S2 were also examined.

General Discussion of Problem

A brief general discussion of glacial till and till-like deposits is presented first to place the problem in its geologic context and aid those readers who may not be fully informed on this subject.

Glacial Till

The following, generally accepted, definition of glacial till is quoted from Dr. J. E. Armstrong (1957) page 4.

> "Glacial till, as used in this report, refers to a very compact, unsorted mixture of sand, silt, clay, and stones deposited directly beneath glacial ice."

This definition is accepted in this report and any references made herein to glacial till will lie within the confines of this definition.

Glacial till, therefore, will have the following pertinent characteristics:

1. It will normally lack stratification or bedding, but may, in places, exhibit a horizontal fissility, sheeting, or discontinuous bedding.

2. It will be very hard and compact in place, but because, in the Lower Fraser Valley, it usually lacks siliceous or calcareous cement, it will crumble in hand specimen.

3. The matrix surrounding the pebbles, cobbles, and boulders will be composed of angular to sub-angular, interlocked rock and mineral fragments of clay to sand size. In the Lower Fraser Valley, the average composition ranges of the fine fraction of the glacial tills are as follows:

   sand - 57 to 44% (diameter 0.05 to 2 mm)
   silt - 46 to 41% (" 0.002 to 0.05 mm)
   clay - 10 to 2% (" less than 0.05 mm)

   These composition ranges are only guides because local variations will occur as a result of the type of sediment incorporated into the glacier's base and the distance this material is transported by the glacier.

4. A glacial till is a non-marine sediment and, except in special cases, will not contain recognizable marine fossils or sea shells.

5. Except in special cases, a glacial till will not normally separate identical sediments. The two most note-worthy exceptions are

   (a) where a till will overlie and underlie fluvio-glacial outwash sands and gravels.

   (b) where a glacier is in practical equilibrium with its edge or end environment so that minor advances of the glacier will deposit a thin till layer over sediments similar to those deposited on top of it after the glacier retreats.

Till-Like Sediments

Till-like sediments are those which fit, in part, the definition of glacial till. These are unsorted mixtures of sand, silt, clay, and stones

which were not deposited directly beneath glacier ice and therefore have not been loaded by several thousands of feet of ice. The matrix of many of these till-like sediments will not contain the full range of clay, silt, and sand in the same general proportion as glacial till. Their matrix can be practically pure silt or clay.

A typical mechanical analysis of these sediments is quoted from page 4 J. E. Armstrong (1957) to be "about 50% silt, 40% sand, and 10% clay".

Examples of unsorted, till-like sediments are known in various parts of the world and in rock sequences of various geologic ages. The depositional environments associated with such deposits indicate that no glaciers (except, perhaps, distant mountain glaciers) could have existed at the time the till-like sediments were deposited.

Numerous exposures of till-like sediments are present in the Pleistocene of the Lower Fraser Valley. It is beyond the scope of this report to completely describe these sediments or discuss their mode of origin. The reader is referred to the paper by J. E. Armstrong and W. L. Brown (1954) listed in the attached bibliography.

Considerable field evidence and study lead the authors of this paper to conclude that these sediments, although till-like in appearance, were not glacial till. In brief, the following composite theory of their origin explains nearly all of the field characteristics of these deposits:

1. The stones and some of the finer materials were transported by floating ice (in the sea) and the remainder of the fines were transported by meltwater and sea water.

2. The stoney clays were deposited as a result of submarine erosion from the action of submarine slides, slopewash, sea currents and density currents on pre-existing till and till-like sediments.

From the above, it can be seen, that the unsorted nature of a sediment is not a sufficiently diagnostic criterion for the recognition of glacial

till. Whether or not a sediment resembling till in gross aspect, really is glacial till cannot, at times, be determined without regards to its sedimentary context and without at least some idea of the solid geometry of the sediment concerned and its adjacent material.

Observation

The following sediments were examined by the writer:

Pile C10, Pier S4

Depth* (Feet)	Description & Remarks
-70 to -71**	Clay, pebbly and gritty (angular coarse sand) with thin interbeds of fine gravel sand and silt. Broken fragments of sea shells.
-71 to -75	Sand and gravel, boulders up to approximately 3 feet in diameter. Water bearing with almost a 1-inch per minute water rise. Bed judged to be loose and uncompacted based on observed water rise and report that this was an artesian zone during early drilling.
-75 to -86½	Silt, pebbly, with minor fine-grained sand and minor clay. Samples water saturated, soft and jelly-like. Piece of sea shell collected at -86 feet. (Now in custody of Mr. R. A. Spence). This material reportedly called glacial till by some people. It is not.
-86½ to -87	Gravel
-87 to -87½	Silt, pebbly as above.
-87½ to -88	Gravel
	(Pebbly silts, as above, were reportedly encountered to -92 feet.)
-92 to -93½	Till (?). This sediment has all the characteristics of glacial till in hand specimen.
-93½ to -94	Sand and gravel
-94 to (?)	Silt, pebbly as above.

* Depths given in feet below City of Vancouver datum.
** As reported by technician or driller.

Pile A9, Pier S2

Depth	Description & Remarks
(?) to -84	Clay, unctious, impalpable
-84 to -86	Clay, pebbly, gritty with cobbles and boulders. Sea shell pieces present.
-86 to -94	Gravel bed
-94 to (?)	Clays with minor pebbles and grit interbedded with fine to medium sand and silty sand. Bedding contorted by clam bucket. Amount of sand appears to increase with depth, sample at -94 mainly sand.

Conclusion

The only sediment observed by the writer in the drill cuttings that is probably glacial till lies between elevations of -92 to -93½ feet in the hols for Pile C10, Pier S4. In the writer's opinion, none of the other sediments observed by him from either Pile C10, Pier S4 or Pile A9, Pier S2, can be called a glacial till. These opinions are based upon the following considerations:

1. The samples observed indicate, to the writer, that the lithology of the section in place is an interbedded sequence of clays, pebbly gritty clays, pebbly silts, silts, sands and gravels.

2. From megascopic examination, the pebbly silts, observed in Pile C10, Pier S4, are pebbles lying in a matrix of silt containing a minor amount of clay. They are not compact (although reportedly hard to dig with a clam bucket) and are fully saturated with water. This gives them a jelly-like, quick-sand consistency when examined at the surface. These pebbly silts were deposited in the sea, as evidenced by the presence of marine shells.

   The writer is aware of the reported presence of broken sea shells in the glacial tills exposed adjacent to the shores of the Irish Sea in the British Isles. However, to his knowledge, no marine fossils have ever been found in any of the unquestionable glacial tills of the Lower Fraser Valley. Thus, if the pebbly silts were, in fact, a glacial till, they would be very unique within the geologic setting in which they are found.

   From the above, the writer believes that the pebbly silt, called till by some people, is not glacial till. Supporting evidence comes from their appearance in hand specimen which is dissimilar from the glacial tills of the Lower Fraser Valley.

The till (?) observed from -92 to -93½ feet in Pile C10, Pier S4 has all the megascopic characteristics of a true glacial till in hand specimen. However, the writer is suspicious of this sediment, based on the following circumstantial evidence.

(a) It is thin (1½ ft.), not only in the hole where it was observed, but reportedly also across a considerable area of the lowland surrounding Pier S4.

(b) It apparently lies within a sequence of sediments that are the same above and below it.

Therefore, the writer cannot, from evidence on hand, give a definite verdict on this sediment. The fact that he calls it till (?) indicates his preference.

Recommendations

If the differentiation of glacial till and till-like sediments becomes, or is likely to become, of considerable economic importance, then the following should be implemented.

1. The men recording the lithology of the samples from the pier holes should be given a short period of instruction on the local Pleistocene sediments and on the specific things to look for on the job.

   For example, a few moments of diligent examination uncovered the sea shells in the pebbly silts after the writer was repeatedly assured that none existed.

2. Based upon the short time the writer was observing the Benoto rigs (as now being run), he believes that the samples brought to the surface may be considerably disturbed. For this reason, the men logging the holes must be very alert in order to get a reliable log of the sediment in place. This leads to two recommendations:

   (a) A drive core sampler should be available with competent drillers to use it. On a properly set up drilling operation, a drive sample can be called for by a geologist, engineer or technician, and obtained in a very short time at little expense.

   (b) The writer should log at least one more hole from surface to total depth in company with the man responsible for logging. This can be tied in with the instruction period.

Selected References

Armstrong, J. E., (1957) Surficial Geology of New Westminister Map-Area, British Columbia, Geological Survey of Canada. Paper 57-5.

Armstrong, J. E. and Brown, W. L. (1953), Ground-Water Resources of Surrey Municipality, British Columbia, Geological Survey of Canada. Water Supply Paper No. 322.

Armstrong, J. E. and Brown, W. L. (1954), Late Wisconsin Marine Drift and Associated Sediments of the Lower Fraser Valley, British Columbia, Canada, Bulletin, Geological Society of America, vol. 65 pp 349-364.

3. Sieve analyses should be run on some of the samples, and if need be, a microscopic examination made of thin sections, and/or plastic peels.

4. The slow digging in the sands and gravels and in the pebbly silts may be improved by either using an orange peel bucket or an ordinary bailer. However, other than geologic consideration may negate this suggestion.

Respectfully submitted,

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By _____
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