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(Report, 2 figures and Map 2-1972)

J.A. Heginbottom

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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## ABSTRACT

The whole map-area was ice covered during the Fraser Glaciation. The ice built up in the Coast Mountains and spread northeastwards across the map-area. The ice apparently melted by down-wasting in situ and, in the final stages, consisted of isolated masses of stagnant ice in the river valleys. Most of the area is covered with a variable thickness of unconsolidated deposits, largely resulting from the Fraser Glaciation. No evidence of more than one major glaciation was seen. Valley glaciers were more extensive in the recent past than they are today.

## RÉSUMÉ

La région en question a été entièrement recouverte par les glaces pendant la glaciation Fraser. La glace s'est accumulée dans la région de la chaîne Côtière et s'est répandue, vers le nord-est, de part et d'autre de la zone décrite. Il semble que la glace ait fondu sur place et, dans les derniers stades de la déglaciation, il ne restait plus que des masses isolées de glace stagnante au fond des vallées. La région est couverte, en majeure partie, de dépôts meubles d'une épaisseur variable, provenant dans une large mesure de la glaciation Fraser. On n'a pas trouvé trace de l'existence de plus d'une glaciation importante. Les glaciers de vallée étaient plus étendus dans un passé récent qu'ils ne le sont aujourd'hui.

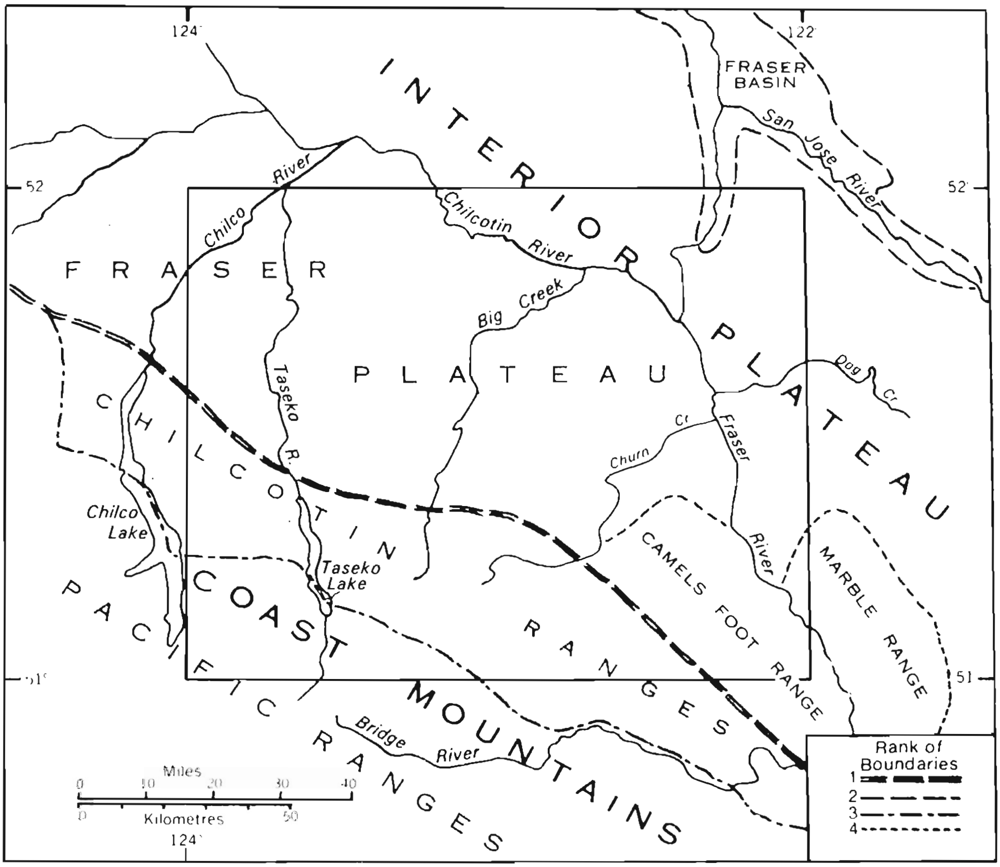


Figure 1. Physiographic divisions of Taseko Lakes map-area (after Holland, 1964).

# SURFICIAL GEOLOGY OF TASEKO LAKES MAP-AREA (92-O) BRITISH COLUMBIA

## INTRODUCTION

This is a final report on Pleistocene geological mapping carried out during parts of the 1968, 1969, and 1970 field seasons, in a 6,000-square-mile area of interior British Columbia. The project was initiated in response to a request from the British Columbia ARDA (Agricultural Rehabilitation and Development Act) Committee. The purpose of the mapping was to provide general, areal information on the Quaternary deposits and landforms of the map-area, with special emphasis on information of use in forest land inventory and ARDA land classification.

The mapping was done primarily by the interpretation of aerial photographs, with field work devoted largely to ground checking and the collection of samples for laboratory examination. The northeastern quarter of the area was mapped in 1968, the southeastern quarter in 1969, and in 1970 the west half was covered. Because of the mountainous nature of the terrain, fieldwork in the southwestern portion of the map-area was restricted to a single helicopter traverse from Williams Lake to the head of the Tchaikazan Valley. In the remainder of the area, some 1,000 miles of traverse were made, mainly along roads and trails. A total of fourteen weeks was spent in the field.

## PHYSIOGRAPHY AND GEOLOGY

The Taseko Lakes map-area lies astride the boundary between the Interior Plateau of British Columbia and the Coast Mountains (Fig. 1). The northern portion of the map-area consists largely of the rolling to level upland of the Fraser Plateau, interrupted by isolated hill masses rising above the general plateau level, and dissected by the deeply incised valleys of the Fraser and Chilcotin Rivers. In the southeast, the plateau gives way to the Camelsfoot Range of the Interior System mountains, and in the southwest to the Chilcotin Ranges of the Coast Mountains (Holland, 1964).

Bedrock (R)* is exposed in the hill and mountain masses and in the steep upper slopes of the deeper valleys. However, over much of the area it is covered by a varying thickness of unconsolidated deposits. The bedrock of the area was studied by Tipper (1963), Jeletzky and Tipper (1968), and Trettin (1961).

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* Numbers and letters in parentheses refer to map-units in the legend of the accompanying map.

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## PREGLACIAL LANDSCAPE

The preglacial landscape cannot have been too different from that of today. The major physiographic units of Coast Mountains, Chilcotin and Camelsfoot Ranges, Fraser Plateau and Fraser and Chilcotin Valleys all existed. The Fraser Plateau was developed on Tertiary volcanic flows, which apparently had a rolling topography not dissimilar to the undulating terrain of the present ground moraine.

## PLEISTOCENE SEDIMENTS

Valley fill: The deep bedrock valleys of the Fraser and Chilcotin Rivers apparently were eroded before the Fraser Glaciation (Armstrong et al., 1965). They were filled with up to 1,800 feet of sediment (1) comprising alternating layers of very hard grey till, diamicton and stratified silt overlying gravel and sand. This valley fill is most extensive at about latitude 51°35'N in the Fraser Valley, where the bedrock valley is over four miles wide. To the north the bedrock valley is much narrower, about one mile wide at latitude 52°N, and the fill is consequently less voluminous. The Fraser Valley also decreases in width to the south, particularly south of Crows Bar, where the river flows in a deep gorge between the Camelsfoot and Marble Ranges. In the Chilcotin Valley the amount of valley fill decreases westward and disappears at longitude 123°00'W, at an elevation of about 2,200 feet.

Ground moraine: The extensive cover of ground moraine (2) varies in thickness from less than one foot to at least 15 feet. It is formed of a greyish brown, stony, sandy to sandy-loam till, with a low clay content. This till is normally firm and compact, but not hard. The upper layers of the till are frequently paler in colour due to a high lime concentration. Representative grain-size distribution curves are shown in Figure 2, while Atterberg limits for ten samples are presented in Table 1.

Table 1. Atterberg limits of representative till samples

| Sample No. | Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|---|
| HGA-7A | 35.2 | 21.0 | 14.2 |
| HGA-113A | 14.7 | 13.8 | 0.9 |
| HGA-243 | 32.5 | 21.5 | 11.0 |
| HGA-563 | 32.7 | 19.4 | 13.3 |
| HGA-69-21 | 27.0 | 15.5 | 11.5 |
| HGA-70-66 | 20.8 | 18.8 | 2.0 |
| HGA-70-119 | 65.9 | 31.2 | 34.7 |
| HGA-70-147 | 23.9 | 16.7 | 7.2 |
| HGA-70-148 | 21.4 | 15.8 | 5.6 |
| HGA-70-149 | 24.0 | 18.5 | 5.5 |

In many areas the surface of the ground moraine is covered with large boulders, commonly of volcanic rock similar to the Tertiary volcanics mapped by Tipper (1963). These boulders are as much as five or six feet long, subangular to subrounded and of low to medium sphericity. Their position varies from being buried almost completely to extremely exposed. Boulder concentrations are not shown on the map as they are not visible on aerial photographs.

The surface form of the ground moraine varies considerably. The simplest form is a near-level featureless plain (2a). Streamlined forms include flutings and grooves (2b) and drumlinoid ridges (2c). The flutings and grooves are difficult to discern on the ground, but show clearly on aerial photographs. Although many of the drumlinoid ridges do not have a distinctive stoss and lee configuration, the direction of ice movement frequently can be determined from the presence of horseshoe-shaped depressions around the nose of many of the ridges.

Ground moraine characterized by transverse minor moraines is restricted to the surface of the valley fill of the Fraser Valley, between latitudes 51°31' and 51°47'N and between elevations of 2,000 and 3,300 feet. The trend of these moraines is shown on the map. Most ridges are between five and ten feet high, between 100 and 300 feet apart, and rarely more than 1,500 feet long. The crests of many ridges are marked by a line of cobbles and boulders.

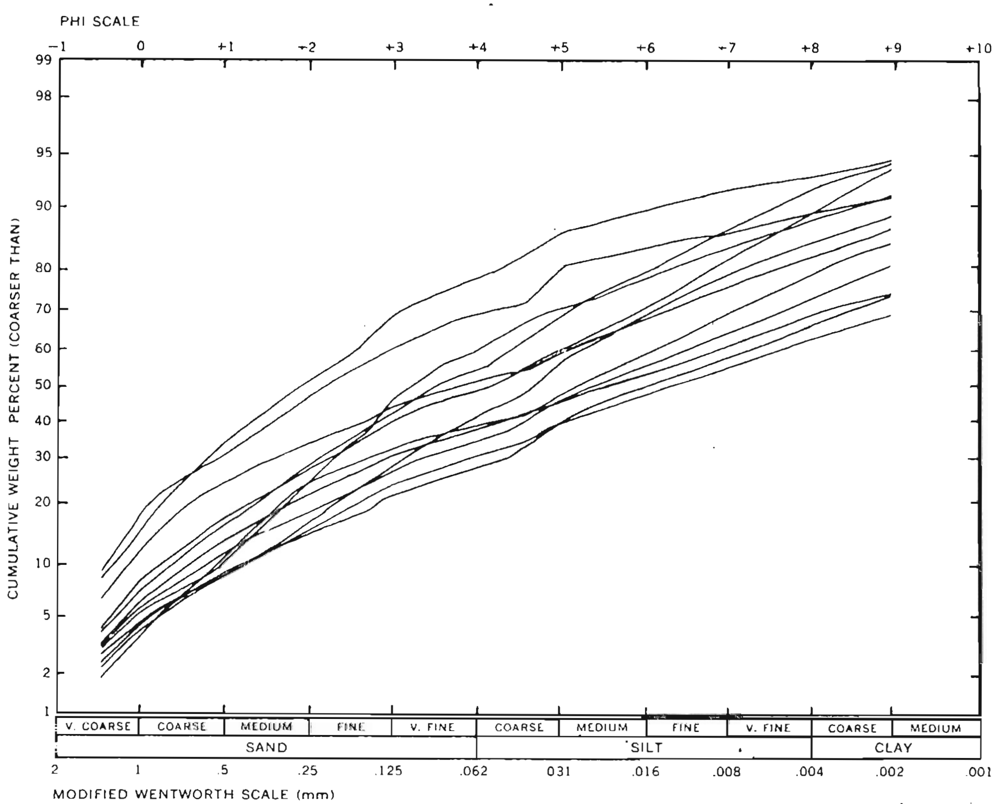


Figure 2. Grain-sized distributions of representative till samples.

Hummocky and ridged ground moraine (2e) is most extensive in the area between upper Big Creek and the Taseko River and immediately north of the Coast Mountains' front range, where the hummocks and ridges are frequently aligned en echelon. The alignment strongly suggests that the ridges and hummocks were formed transverse to the direction of ice movement. This relationship between orientation and direction of ice movement is particularly evident in the area between Anvil Mountain and Tête Hill, where a tongue of ice, moving north down the valley of Taseko Lakes, spread out in a lobate form on reaching the open country of the plateau. In other areas hummocks and ridges are remnants of till situated between kettle holes and/or numerous shallow, discontinuous meltwater channels.

Undifferentiated drift: Within the mountain valleys, and in a few other small areas, patches of till and glaciofluvial deposits are so intermingled that they have been mapped as one unit (3).

Morainal gravels: Esker systems within the map-area are nearly all associated with meltwater channels. Esker ridges generally form part of the other miscellaneous ridges, and hummocks mapped as morainal gravels (4). The main deposit of this type consists of a complex area of meltwater channels, eskers, crevasse fillings, pits, mounds and kames that lies in and beside the Chilcotin River valley upstream from Hanceville. This is interpreted as being the site of a remnant mass of stagnant ice. Meltwater drained along the margins, through and under this ice mass, which gradually shrank into the valley.

Glaciofluvial stream deposits: The numerous, extensive systems of meltwater channels throughout the area fall into two groups; true marginal and submarginal channels, and channels eroded by streams superimposed from a down-wasting ice sheet. In addition to eskers, deposits of glaciofluvial sands and gravels (5) are also associated with these channel systems. Other deposits of glaciofluvial gravels comprise a broad outwash plain around the confluence of the Chilco and Taseko Rivers and terrace deposits in the valleys of modern rivers and creeks, which were used as drainage-ways by meltwater, such as Chilco River, Taseko River and Big Creek.

Glacial lake deposits: Lake deposits (6) occur locally in a few east bank tributary valleys of the Fraser Valley, where they apparently formed behind dams of morainic material. No evidence of an extensive system of proglacial lakes was found.

Alpine glaciation deposits: There are numerous corries (cirques) within the Camelsfoot Range and the Coast Mountains. Most face north and northeast, but there are exceptions. The corries fall into three groups, viz: subdued corries; fresh, sharp corries; and fresh, sharp corries occupied by ice or a glacier. Nearly all the fresh corries are associated with deposits of recent, alpine glaciers (7). The subdued corries are all in lower and more northeasterly positions, and apparently have not been occupied by ice since the Fraser Glaciation, whereas the other corries contained ice during Neoglacial time (Porter and Denton, 1967). A number of glaciers exist in the Coast Mountains. All appear to have retreated in recent years.

Alluvial fan deposits: The main rivers cut into the valley fill, with only a few stillstands (periods of balance between erosion and sedimentation) following the melting of the Fraser Ice Sheet. Extensive alluvial fans (8) were spread over the benches formed during the stillstands. In many areas the fans have coalesced to form bahadas. When river incision was resumed, fan dissection was initiated. Under the present drainage regime, many fans are being eroded at the bottom while deposition continues at the head.

Stream channel and flood plain deposits: Modern stream deposits (9) are not widespread. The major rivers generally occupy steep-sided valleys that exhibit no flood plain development. The only exceptions are four recent meander cut-offs along the Chilcotin River. A broad, open, alluvial plain does occur in the Chilcotin Valley upstream of the Stoney Indian Reserve at the site of the stagnant ice mass described above. In a number of places, the Fraser, Chilco and Chilcotin Rivers have cut through the valley fill, so that their present channels are floored with bedrock.

Swamp and bog deposits: Swamp and bog deposits (10) are restricted largely to closed or poorly drained depressions in the plateau surface. In many cases the swamps owe their existence to beaver activity.

Eolian deposits: A shallow and patchy layer of fine, brown, wind-deposited material, generally about twelve inches thick, but ranging from a few inches to three feet, covers much of the area outside the mountain ranges. This material forms a thin veneer on underlying landforms, and is too patchy and variable in thickness to treat as a mappable unit. No active sand dunes are known within the area. However, narrow lines of fossil lip dunes were seen along the edges of several benches in the Fraser Valley.

Volcanic ash deposits: Several exposures of volcanic ash, assumed to be Bridge River Ash, were seen in the valleys of Tyaughton Creek, Relay Creek and the Yalakom River. Samples positively identified as Bridge River Ash have been collected from the southeast corner of the map-area and volcanic ash referred to as "Mazama" has been reported from Jesmond Bog, just east of the map-area (Nasmith et al., 1967; Westgate et al., 1970).

Landslide deposits: Landslides, slumps, earthflows and their associated deposits are widespread both areally and in time. The deposits are of mixed materials, ranging in age from early Tertiary, and possibly older, to Recent. The landslides themselves are also of various ages. Some may have occurred as the ice melted and ceased to support certain slopes. Most others are apparently the result of stream incision and undercutting. These processes and the consequent slope failures are continuing still. On the map, areas of this unit have been hatched to emphasize the variability of both material and age.

## GLACIATION AND DEGLACIATION

Tipper (1971a) has presented evidence for multiple glaciation in central British Columbia. In the Taseko Lakes map-area no evidence of a pre-Fraser Glaciation was seen, and all the glacial deposits, except for unit 7, are ascribed to the Fraser Glaciation. The deposits of unit 7, alpine glaciation deposits, are considered to be of Neoglacial age.

The early source area for the Fraser Ice Sheet in this area appears to have been the Coast Mountains. The ice moved north and northeast through the valleys of the Chilcotin Ranges and spread into lobes on the Fraser Plateau. These lobes coalesced and the developing ice sheet continued to spread to the north and northeast. Directions of ice movement are well shown by drumlinoid features throughout much of the area. In several areas the details of the flow were controlled by the underlying topography, e.g.: Riske Creek valley, lower Big Creek valley and Churn Creek valley.

In a few places both along and to the east of the Fraser Valley and to the east there is evidence of ice moving in from the northeast. This ice appears to have crossed the Fraser River between Churn Creek and the northern edge of the map-area.

The pattern of deglaciation was the reverse of this pattern of glaciation. In general, the ice front retreated back towards the mountains, and the same flow directions were maintained. However in some areas rapid down-wasting of the ice sheet led to the formation of outliers of stagnant ice, which melted away in situ. One such mass apparently survived much longer in the Chilcotin Valley upstream from Hanceville. This form of deglaciation supports the model proposed by Fulton (1967) and discussed by Tipper (1971b).

The major drainage of meltwater from this area was to the south, via the Fraser River. All the rivers and creeks of this area are direct descendants of meltwater streams. There are no major meltwater channels which are not occupied by modern streams.

## GEOMORPHIC PROCESSES

Exogenous processes at work today in this area comprise both degradational or erosional processes and aggradational ones. The most widespread processes are those of erosion by running water, both as streams and as slope wash. These processes are most active in the spring due to the volume of run-off from melting snow. During the summer, thunderstorms are an important component of the rainfall. In general, stream activity ceases in winter.

The streams of the area are aggrading in a few places. This activity is largely restricted to fans and deltas formed where the streams enter lakes or larger valleys and to scattered gravel bars constructed in the larger creeks and the main rivers.

In certain areas, gully or arroyo cutting was seen. The cause of this was not always obvious but in some instances, it could be ascribed to piping underground (Buckham and Cockfield, 1950) caused by over-irrigation of hay meadows. In other instances, excessive trampling by cattle may be a factor.

In the drier parts of the area, mainly in the Fraser and lower Chilcotin Valleys, the alluvial fans (8) are being built up mainly by mudflows. Fresh flows were seen on many fans, and slightly older flows could be distinguished from very old flows by vegetation differences. The development of alluvial fans in the changing conditions of the postglacial environment of central British Columbia has recently been discussed in some detail by Ryder (1971). In the Fraser and Chilcotin Valleys there are also a number of quite large block flows. These lie below outcrops of the Tertiary volcanics. They are particularly well developed on the northeast side of the Chilcotin River west of Hanceville at what is known as Lee's Corner. The larger block-flows are old and stable, with large, mature Douglas fir growing on them. Present day activity is apparently confined to local scree development.

Landslides in the area fall into three groups, viz: (i) old landslides which are covered with mature vegetation and apparently are quite stable now; for example, the large slide area five miles north of Gang Ranch; (ii) old landslides which are only partially vegetated and are still subject to periodic movement such as a slide on the Empire Valley Road about one mile south of Churn Creek and a slide area on the west bank of the Fraser River about two miles south of Big Bar Ferry; and (iii) fresh, recent landslides where the scar is unvegetated and where slope adjustment is continuing, for example, the August 1964 landslide at Farwell Canyon. The risk of landsliding and slope failure are important factors which must be considered in the design of any engineering project or construction activity in this area. The steep slopes of the Fraser River valley are particularly susceptible to landslides.

In the southwestern part of the map-area, corrie and valley glaciers are active but not particularly effective as either erosional or depositional agents.

Forest fires periodically remove the vegetation from many parts of the area. However, this stripping away of the protective cover does not appear to be responsible for any particularly spectacular erosion. Regrowth of vegetation following fire is quite rapid, and the soil is not unprotected for very long.

The activities of man are noticeable. Gullying and landsliding caused by cattle trampling and over-irrigation have been mentioned. Road construction on the steep slopes of the deeper valleys can cause slope stability problems. Forest harvesting is another fairly serious cause of erosion. The destruction of the ground flora by vehicles and skidding logs coupled with the increased run-off due to decreased raindrop interception and evapotranspiration can lead to serious sheet erosion and gullying problems.

## ECONOMIC GEOLOGY

The surficial deposits in this area are being exploited mainly for agricultural and forestry purposes. Agriculture is largely restricted to cattle ranching, and cultivation is limited to the growing of hay for winter feed. The climate is arid enough that hay cultivation is restricted to naturally moist areas such as the swamp meadows and margins of lakes and creeks or to areas low enough and topographically suitable for irrigation. The original irrigation systems were all gravity fed open ditches and, even today, irrigation is restricted to the terraces and benches of the larger creeks and rivers. The cultivated soils are thus developed on the stream channel and flood plain, fan, lake and, locally, the organic deposits. Till in the lower areas is generally covered by other materials. Where it does outcrop, the surface morphology and stony texture make it generally unattractive for cultivation.

Lumbering is widespread in the northeast half of the area. The most widespread forest-soil parent material is till. These soils have a sandy or loamy texture, with the surface horizons frequently finer than the underlying material due to the addition of windblown silt. Unweathered till is generally compact but friable. On exposure it desiccates and can become strongly cemented and relatively impermeable, often with a carbonate pan between 6 and 18 inches below the surface. In wetter seepage areas the till remains friable, however, and is susceptible to colluvial processes which increase the permeability and the depth to which rooting is possible. Figure 2 indicates the variety in the textural classes of the till, however the mapping was not detailed enough to define areas of specific textural classes. In general, the lithology of the source rock is the primary control on till texture. Thus, till in the area adjacent to the Coast Mountains has a generally sandy texture, as the source material is mainly granite, whereas to the northeast, more clay-rich tills are found over the Tertiary volcanics. Tills derived from other lithologies are largely silty in texture. As noted above, boulders are a common constituent of the tills and a frequent feature of the forest floor where they occasionally present obstacles to the proper use of forestry machinery. Exploitation of the surficial deposits is restricted at present to the localized excavation of till and gravel for road construction. The map-area is well endowed with fill and foundation materials, and long hauls will not be needed in road building, with the possible exception of parts of the mountainous southwestern portion of the area. Foundation conditions are good on most of the materials, with the obvious exception of the organic and lacustrine units and some of the stream deposits. However because the dry climate causes a general absence of near surface water, fine-grained sediment that would be avoided in wetter areas can be used as foundation material with little danger of settlement and consolidation problems.

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