Forest Sciences

Prince Rupert Forest Region

Extension Note # 20
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Earthflow Generated Wetlands

Research Issue Groups:

- Forest Biology
- Forest Growth
- **Soils**
- Wildlife Habitat
- Silviculture
- Timber Harvesting
- Ecosystem Inventory and Classification
- Biodiversity
- **Ecosystem Management**
- Hydrology
- **Geomorphology**
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Figure 1. Oblique aerial view of a portion of the Nalbeelah wetland complex. Wetlands occupy the craters of old earthflows.

Introduction

Earthflow scars riddle glaciomarine sediments in the Kitsumkalum-Kitimat trough. Wetlands occupy some of these earthflow craters. These wetlands are unique because of their direct association with earthflows. The organic material (peat) stored in these wetlands can also provide radiocarbon dates for the earthflows.

Deglaciation

The Kitsumkalum-Kitimat trough, particularly the low-lying area between Terrace and Kitimat, was once a fjord, depressed below sea level by the weight of glacial ice. As the glacier retreated, seawater filled the trough and the sea-floor started to rise in response to the decreased load. Glacial retreat from Kitimat to Terrace was relatively rapid,

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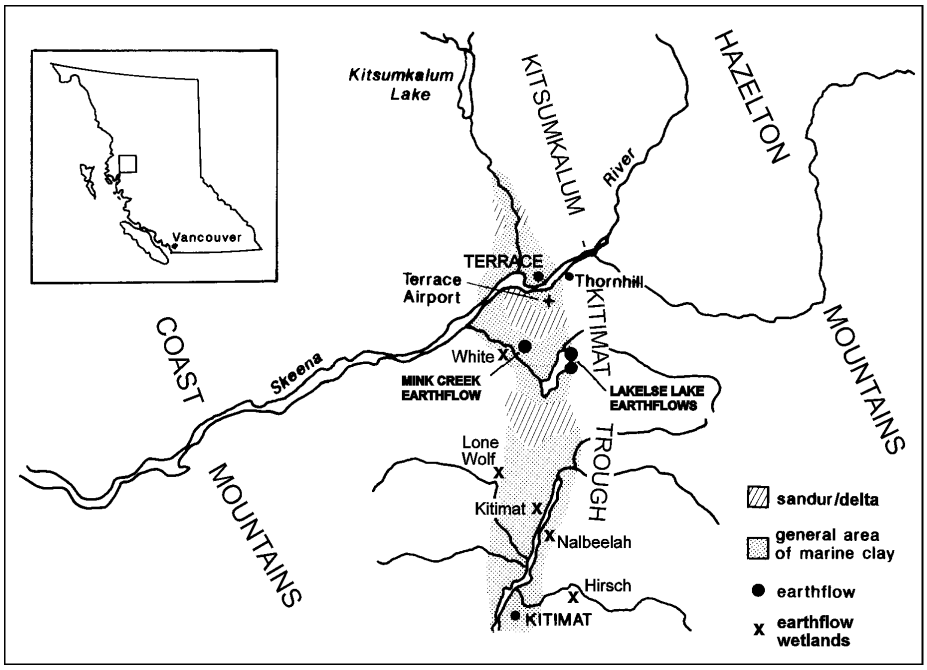

Figure 2. Map of Terrace-Kitimat area showing earthflow wetlands.

occurring between roughly 11,000 and 10,000 years before present (BP).

Elevated delta surfaces in the trough mark previous sea levels, showing that isostatic rebound (uplift of the earth's surface in response to a decreased load) was approximately 200 meters. Uplift occurred rapidly and stopped by about 8,000 BP.

Glacial meltwaters deposited huge amounts of sediment into the glacial fjord. Gravels and sands settled out rapidly against the snouts of the calving glaciers. Present-day kettles, (depressions formed by the burial and subsequent melting of stranded icebergs) like Onion Lake, and the steep ice-contact faces of these deltas, such as along Hwy. 37 as you climb up towards the airport south of Terrace, provide evidence of this contact with the glaciers.

Silt and clay size particles settle out more slowly, and were deposited farther from the ice front.

Conditions for Failure

In most freshwater environments clay particles settle even more slowly than silts and tend to have a plate-like orientation. In salt water, silts and clays form aggregates (small floccules) and settle together in a random pattern. This random alignment of particles (house-of-cards structure) gives the floccular material a higher-than-normal amount of pore space and water content.

When the porewater of such material has a high salt content, interparticle bonds are strong. Leaching by freshwater (whether from groundwater springs or rainfall) gradually lowers the salinity. Certain types of marine clay become prone to structural collapse once the salinity of the porewater falls below a certain threshold. This is because repulsive forces between the particles increase. Clays that exhibit this type of behaviour are often called "quick clays". The most notable characteristic of quick clays is the remarkable difference in strength between an undisturbed and a disturbed soil (where the material loses nearly all of its strength and becomes a flowing liquid slurry).

The clay associated with these earthflows had similar properties to clay at the Mink Creek earthflow (see Ext. Note # 4). The same suite of clay-size minerals was encountered - glacially ground quartz and feldspar, illite, chlorite, and likely some kaolinite. The material had a low porewater salinity - less than 1 g/l. In addition the clay had high natural water contents ranging from 30% to 50%, and low remoulded shear strengths. The above are all properties of quick clays.

We think that bank erosion triggered the Mink Creek earthflow. Earthflows near Nalbeelah Creek and on the foreslope of the raised Onion Lake delta could have been related to channel behaviour and bank erosion of the Kitimat River. We know that the 1964 Turnagain Heights landslide (a large marine clay earthflow) in Anchorage, Alaska was related to seismic activity. Historic earthflows in the Kitsumkalum-Kitimat trough could

Table 1. Depth of peat occupying historic earthflow craters and the earthflows' minimum ages of occurance.

Location	Depth of Peat (m)	Age (years before present)
Hirsch Creek	6.9	9140 +/- 140
Kitimat River	2.0	2750 +/- 90
White Creek	1.4	3300 +/- 70
Nalbeelah Creek #1	2.3	1760 +/- 90
Nalbeelah Creek #2	2.7	2650 +/- 70
Nalbeelah Creek #3	4.0	2470 +/- 70
Nalbeelah Creek #4	2.3	1530 +/- 40
Nalbeelah Creek #5	2.3	1500 +/- 110
Lonewolf Creek	.65	1380 +/- 70

also have been triggered by earthquakes.

Wetland Genesis

After earthflows occurred depressions occupied the landslide sites. Where these depressions were lower than a permanent water table, conditions were right for wetland development.

It is likely that the pioneer wetlands occupying the earthflow craters were base-rich fens, since the pH of the marine clay at depth is high (pH about 8, or mildly alkaline, at the Mink Creek earthflow). As organic material accumulated in the depressions, fens developed into raised acidic bogs.

The pH of clay encountered at the peat-clay interface (Fig. 3) ranged from 4.6 to 5.5 and the soil solution contained no calcium carbonate, while nearby pHs from greater depths ranged from 8.0 to 8.2 and the deep clays did contain calcium carbonate. Acidic pHs typify the soils of coniferous forests and bogs. Low pHs suggest that the landslides are sufficiently old that acids produced by the wetlands have been leached downward in sufficient quantity to neutralize all the carbonate minerals originally present in the marine clay. Lonewolf earthflow was the only one that had an associated high soil pH (8.0) under peat and contained calcium carbonate. This earthflow was also the youngest studied, at 1380 +/- 70 years before present (Table 1).

The most significant cluster of these wetland-filled earthflow scars is the Nalbeelah wetland complex located near the confluence of Nalbeelah Creek and Kitimat River. Peat depth varied between 2 and 4 meters in these wetlands. In other areas, peat was much thicker (6.9 m at a site along Hirsch Creek) or thinner (0.65 m near Lonewolf Creek).

Earthflow/Wetland Ages

We collected radiocarbon samples from the peat/marine clay interface in wetlands occupying earthflow craters. The numbers obtained do not give accurate dates for the earthflows but they do establish dates after which the earthflows could not have occurred. A further caution with using these numbers is that wetlands do not necessarily develop uniformly. The center can be older than the edge, or several pockets could have started earlier than other areas. Nonetheless the oldest date obtained (where multiple samples were collected from a single earthflow) was the date

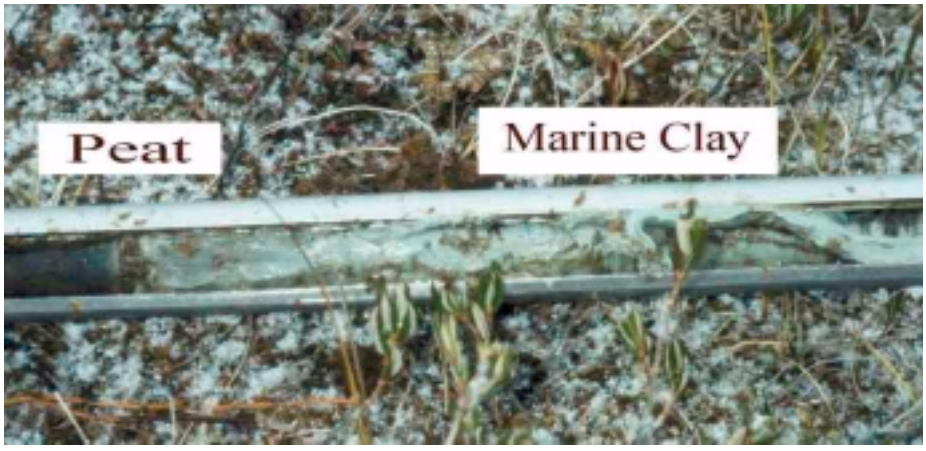

Figure 3. Peat probe showing clay / peat interface.

used to establish the **minimum** age of the landslide.

Related Research

We could examine the possible connection of the dated earthflows with past seismic activity by dating liquefaction features in the Kitimat River delta, or tsunami deposits in local tidal marshes. Establishing whether a connection exists is a key step in the risk assessment of these potentially devastating landslides.

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