Field Trip

The Outdoor Classroom on the Sea-to-Sky Highway:

Earth Science of the Howe Sound area

Prepared by: **Bob Turner and John Clague**
GEOLOGICAL SURVEY OF CANADA (GSC)

This is the original guide to the geology of the Sea to Sky corridor. Since the early 1990s the GSC, through Bob Turner, has developed *Geoscape Vancouver, Vancouver, City on the Edge*, and, in 2010, the *Sea to Sky GeoTour* guide which provides many beautiful illustrations to help explain the stops along the Sea to Sky highway.

The Outdoor Classroom on the Sea-to-Sky Highway: Earth Science of the Howe Sound area

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This field trip introduces you to earth science issues along Highway 99 between Horseshoe Bay and Squamish (Figure 1). The highway route provides an outdoor classroom to study issues such as debris and rockfall hazards for communities and the highway, glacial landforms, mining history and metal contamination from an abandoned mine, the workings of an estuary, and volcanoes and their hazards. All these bear on decisons regarding land use.

Directions from Vancouver

Drive through Vancouver, cross the Lions Gate bridge, follow the signs to West Vancouver onto Marine Drive (going west); cross the Capilano River; turn right (north) at the first lights onto Taylor Way; turn left past just past underpass to Highway 99 (Upper Levels Highway. Follow signs to Squamish. At the Eagleridge exit (Exit 2; one west the Caulfeild exit) set your trip odometre at zero. All distances in this guide are measured from here.

Stop #1: Living with Debris Flow Hazard

Harvey Creek bridge, Lions Bay village (12.1 km)

Directions: Take the Lions Bay exit at 12.1 km (Oceanview Rd., Lions Bay Rd). Stay right at fork onto Oceanview Rd. Turn left at the T-junction (Crosscreek Rd.), cross the bridge over Harvey Creek, and park on the far side. Walk back to bridge. To return to Highway 99 continue north on Crosscreek Rd. Turn left at first stop sign. Road leads to Highway.

Purpose of stop: To view the engineering structures built to protect the residences and the bridges (highway, muncipal, railway) of Lions Bay, from debris torrents travelling down Harvey Creek.

What You See

Looking upstream from the bridge, you can see the armoured channel and dam built on Harvey Creek. The catch basin behind the dam is designed to retain the "design torrent" (the debris torrent with a recurrance interval of 200 years), but allow normal floods to pass (Figure 2a). After the capture of a debris torrent, the material is excavated with bulldozer and truck so that the basin doesn't lose capacity.

The channel floor of Harvey Creek is armoured with cemented boulders; at bends in the stream the outer channel walls are cement. These protective walls are built to contain debris flows and floods that pass the dam. The rough channel floor slows stream flow in the steep channel.

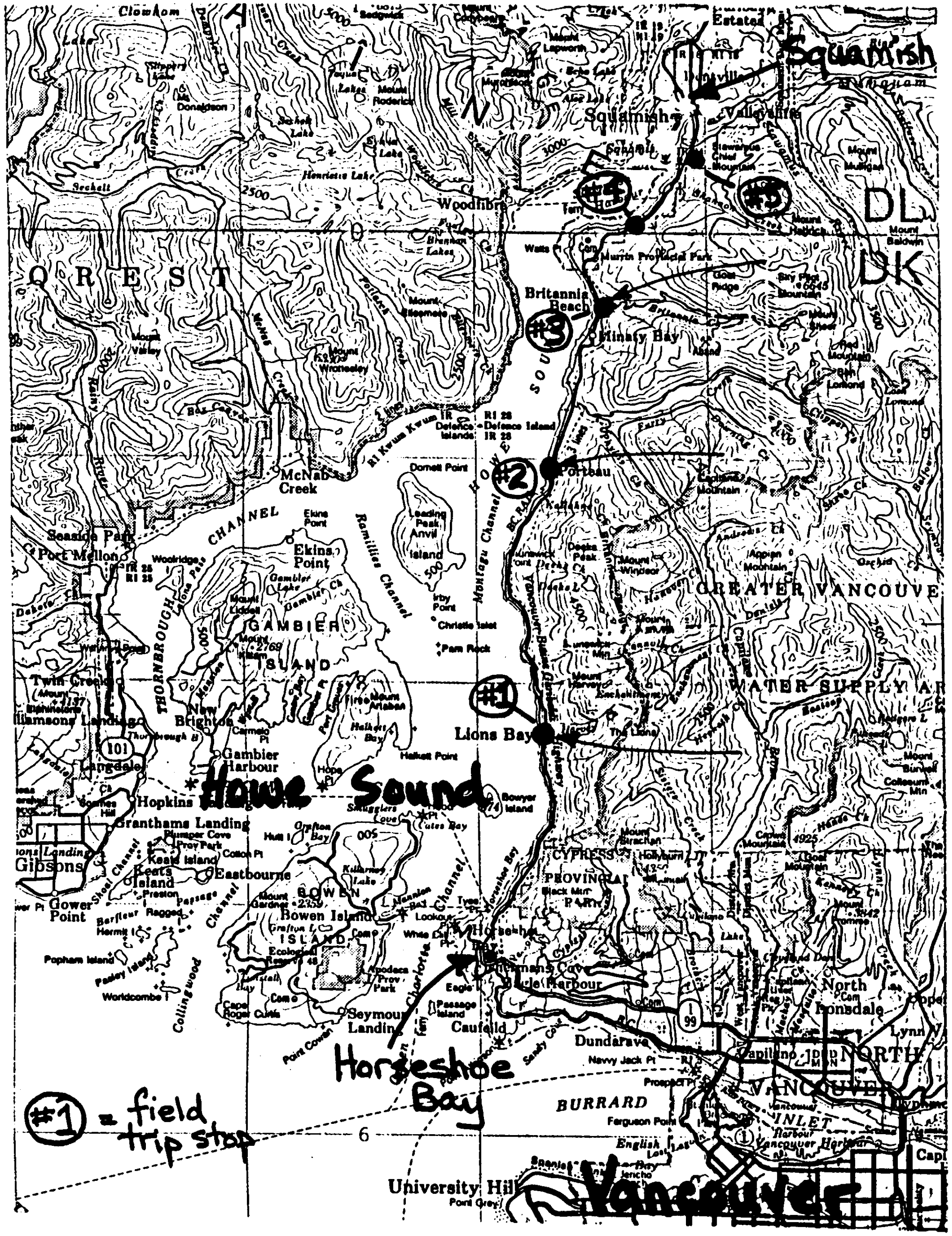
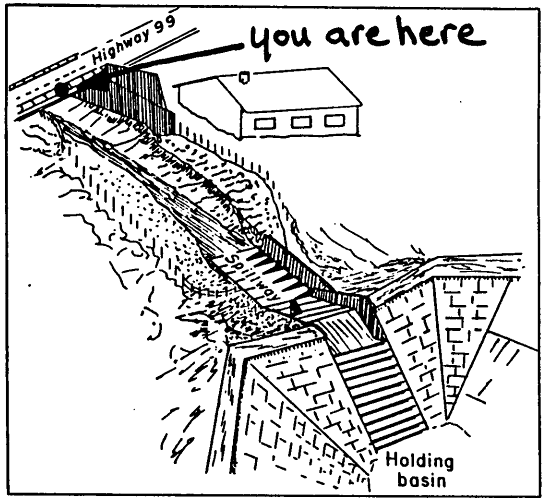


Figure 1 Map of field trip route with stops.



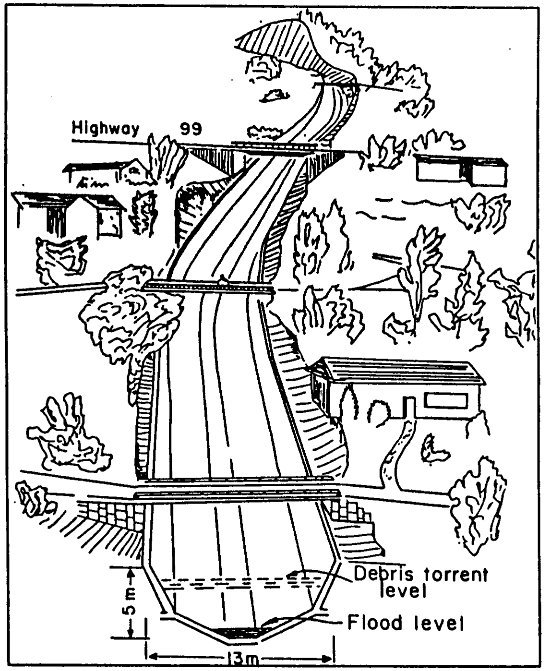


Figure 2 **(a)** Dam, holding basin and spillway (looking downstream) on Harvey Creek, designed to prevent debris flow damage to the community of Lions Bay.

(b) Concrete lined channel of Alberta Creek through community of Lions Bay. From Armstrong, 1990.

Debris Flows on Highway 99

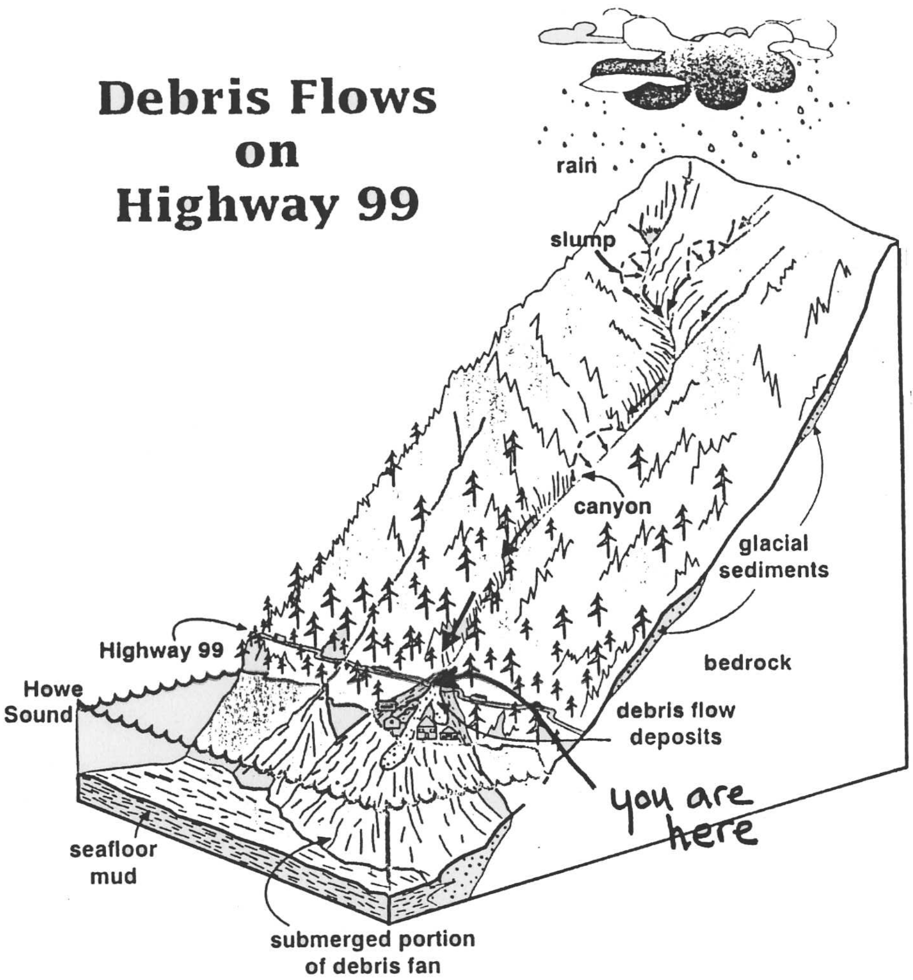


Figure 3 Schematic view of the evolution of a debris flow on a steep valley wall of Howe Sound (From Turner, Clague and Groulx, 1997).

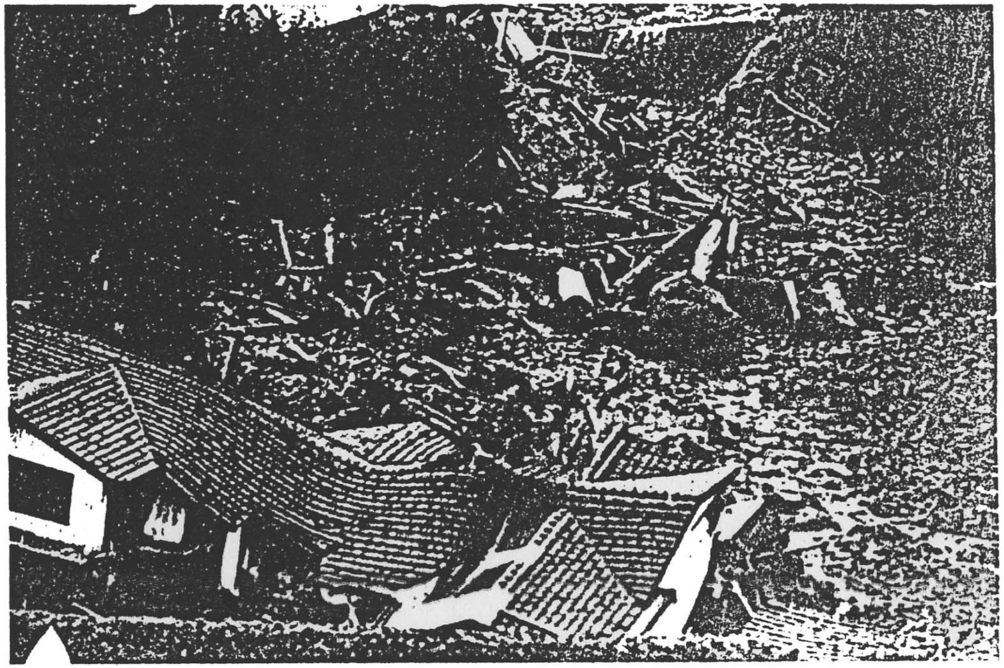


Figure 4 Damage in Lions Bay along Alberta Creek after the February 1983 debris flow (Vancouver Sun photo).

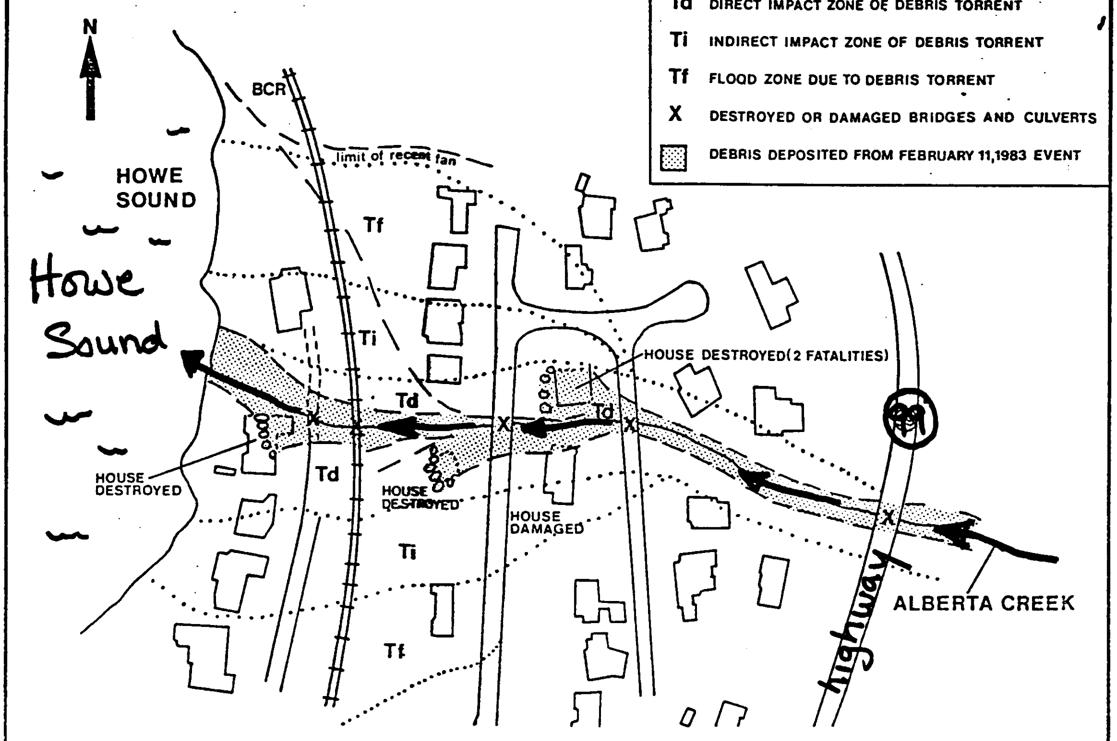


Figure 5 Alberta Creek debris fan, showing hazard assessment and 1983 debris flow deposits. From Jackson et al. (1985).

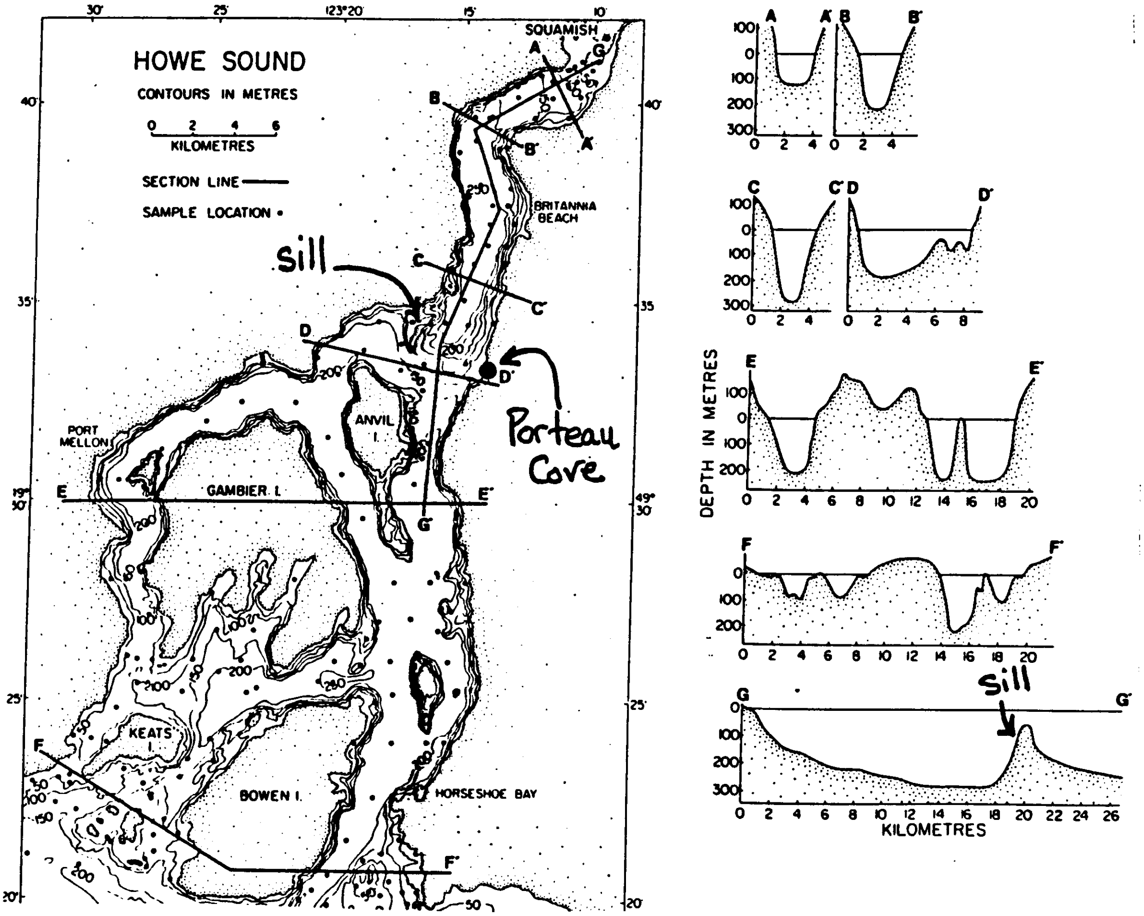


Figure 6 Bathymetric chart of Howe Sound and topographic profiles (From Syvitski and Luternauer, 1982).

As we leave Lions Bay on Highway 99, visible upslope (east) is the steep walled cement channel of Alberta Creek (Fig. 2b). This second protective strategy is to build a deep, straight walled channel with necessary clearance for any bridges so that the torrent can pass through the community without obstacle. Bends or obstructions cause the torrent to pile up and overflow the banks.

The Making of a Debris Flow

Channelized debris flows in steep drainages along the east side of Howe Sound have caused serious damage to Highway 99 and various settlements along its route (Figure 3). A debris flow is a moving mass of rock fragments, soil, and mud. A debris torrent is a special case of debris flow with very high water content that develops within the confines of a steep channel. A debris torrent may originate as a slide from adjacent hillslopes which enter a steep channel and move downstream, or by the mobilization of debris within a steep channel. As the debris torrent moves downstream, it incorporates organic debris, trees, soil, and channel sediments (sand, gravel, boulders) from the channel, often scouring the channel to bedrock. As the debris torrent looses momentum on a flattening slope, there is deposition of a tangled mass of vegetation debris in a matrix of sediment and fine organic material.

Lions Bay Disaster

The village of Lions Bay is built on and adjacent to a steep cone or fan of alluvium deposited by Harvey and Alberta creeks. The entire fan complex has been built during the last 10,000 years since the retreat of the last glaciers. Residential development has taken place here because of the greater ease of building on the shallower slopes of the fan surface relative to the adjacent steeper mountain slopes. The community began to develop in 1957 after the construction of Highway 99. The depostional processes that have built the alluvial fan are the same processes that put the community at risk, and in hindsight it is clear that such alluvial fans are dangerous sites for residential development.

Major debris torrents occurred in both Alberta and Harvey Creeks during the 1930's. The catalyst for the construction of the control structures we see today was an event on February 11, 1983 that followed three days of heavy rain. A debris torrent descended Alberta Creek destroying the highway bridge, several village bridges, and five homes adjacent to the channel (Figures 4, 5). The debris flow moved in a series of surges with flow velocities of 2 to 9m/sec down Alberta Creek (slope ~16 degrees), transporting a total volume of 20,000m^3 of debris. Log and boulder tongues were forced out of the channel and into residential neighbourhoods at bends in the channel and obstructions. These tongues froze after a few meters progress but nonetheless caused significant damage.

Defending Against Debris Flows

To mitigate debris torrent hazard, the torrent has to either be stopped and ponded by a dam structure before entering the vulnerable area (e.g Harvey Creek, Figure 2a), or structures need to be built to allow passage of the debris torrent safely through the village (Alberta Creek, Figure 2b). Such required structures along Highway 99 were designed by Thurber Consultants and built by the Department of Highways from 1984 to 1989.

Logging and Debris Flows

Studies in the Pacific Northwest have shown that the frequency of debris flows is often higher on logged slopes versus unlogged slopes. The highest incidence of slope failure occurs several years after logging when root systems of cut trees start to break down, decreasing the strength of the slope soils, and before new growth root systems are developed. Poorly constructed logging roads can also provide unstable embankment material that can fail as a landslide. Roads also

intercept dispersed drainage on a slope, and channelize it in roadside ditches. If not carefully engineered, during heavy rains this concentrated flow can destabilize slope material.
Logged areas and associated logging roads occur in the drainages of Harvey and Alberta Creeks. A significant amount of the debris in the the destructive debris torrent of February, 1983 on Alberta Creek was derived from the area where a logging road crosses Alberta Creek at the 610 m elevation.

13.5 km: Evidence for a Higher Ancient Sea Level
Magnesia Creek gravel quarry

Highway 99 swings west to skirt a large gravel body on the mountain side about a kilometre north of Lions Bay. Cliffs above the highway expose beds of gravel, some rusty, that slope toward Howe Sound. Just past the gravel body is Magnesia Creek. This gravel body is similar to gravels that form a flat peninsula (delta) where Magnesia Creek enters Howe Sound and deposits its gravel load. These gravels are also interpreted to be formed where ancient Magnesia Creek met the ocean. However, as the elevation of these gravels is as much as 150 m above sea level, this requires that sea level must have been 150 m higher than it is today. Similar evidence is used to interpret a much higher sea level in the Vancouver and Howe Sound area about 9,000 to 10,000 years ago following the end of the Ice Age. An explanation for this higher sea level is that the landscape was depressed by the weight of 1500-2000 m of glacier. As the glaciers retreated, the sea flooded this landscape. Gravel deltas such as Magnesia Creek formed during this period. However removal of the ice load caused the land to rebound, stranding old shoreline features high up on mountain slopes.

14.8 km: Deadly Debris Flows
M Creek bridge

During the night of October 28, 1981, a debris torrent destroyed the M Creek bridge and nine people were killed when their cars drove into the creek. The trigger slide occurred within a logged area in the upper M Creek drainage basin. To create more clearance between the stream bed and the highway bridge, the road has since been moved out from the mountain slope on a concrete wall.

15.4 km Steep Mountain Slopes
Tunnel Point Rest Area

Turn west into parking lot. Rest rooms are available here. The view to south looks back along the steep mountain wall that forms the south side of Howe Sound. Note the elevated delta deposits of Magnesia Creek sitting high above sea level, and the setting of Lions Bay village on the debris cone at the base of the mountain front. Construction and maintenance of a safe highway near the base of such a steep slope is at signficant cost. From south to southwest to west the islands of Howe Sound are respectively Bowyer, Bowen and Gambier.

Stop #2: The Making of Howe Sound
Porteau Cove Provincial Park (25 km)

Directions : Turn west at Porteau Cove Provincial Park exit, cross railway tracks, turn into large parking lot along water, and part at west end near ferry dock and boat launch.
Purpose of stop : Discuss: (1) character and glacial history of Howe Sound; (2) slope hazards along Highway 99, and (3) origin of beaches.

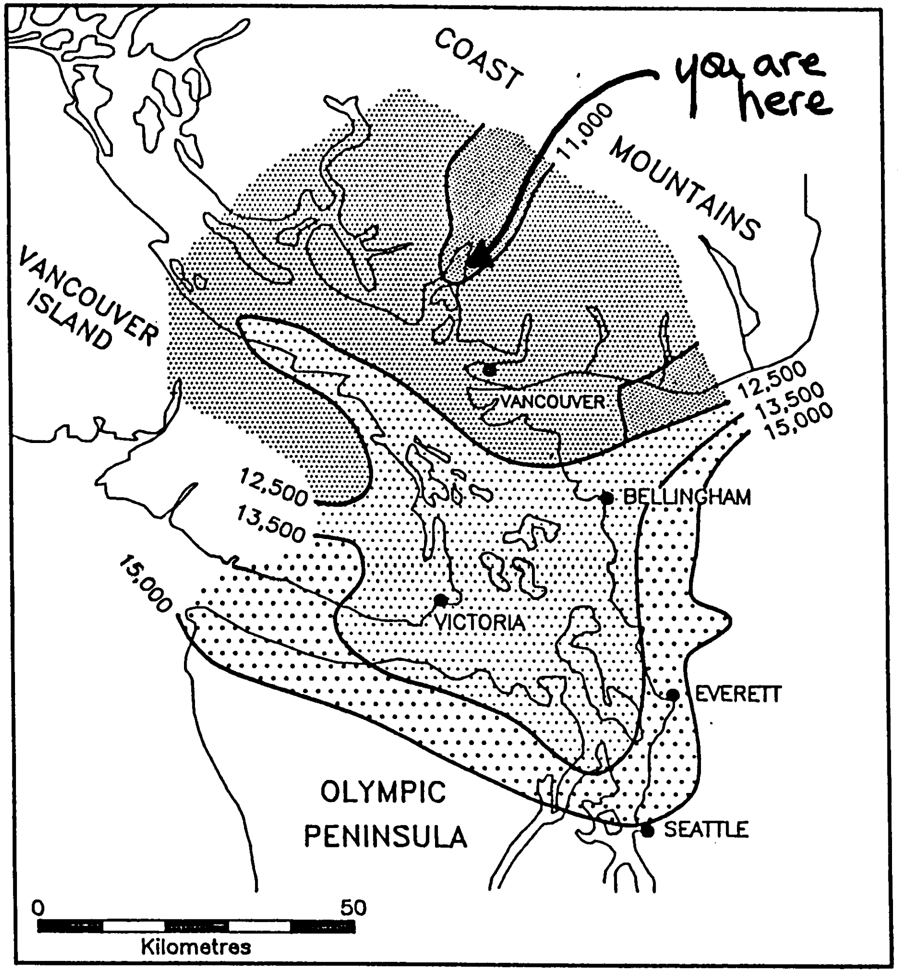


Figure 7 The extent of Fraser Glaciation ice at varous points in time during its retreat between 15,000 and 11,000 years ago. Since then, the area formerly covered by ice has been rising, in a process called "isostatic rebound" (from Armstrong, 1990).

Howe Sound Area During The Ice Age

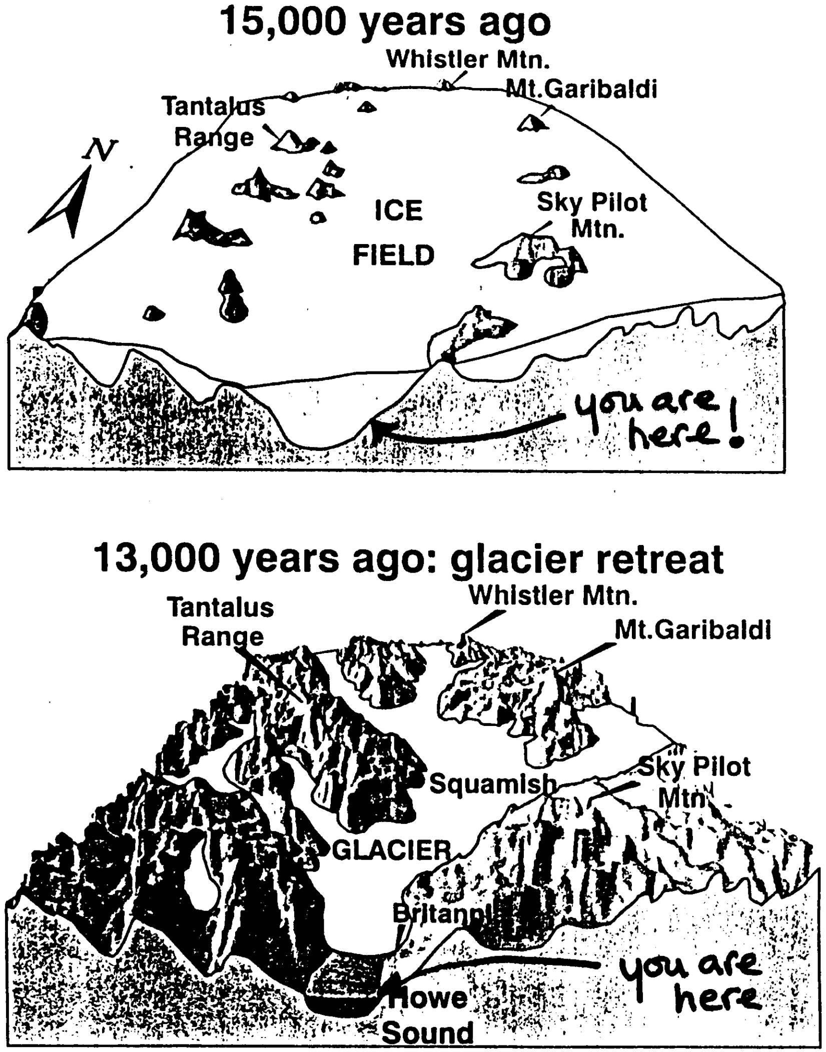


Figure 8 Artist's impression of the Howe Sound area during the Ice Age (from Turner, Clague and Groulx, 1997).

What You See

To the west is the steep western slopes of the Howe Sound fiord. To the north the high rugged and craggy peaks of the Tantalus Range are visible above lower rounded peaks and ridges. The Woodfibre pulp mill sits where a U-shaped tributary valley meets Howe Sound. To the southwest are the steep and ice-sculpted slopes of Anvil Island. Across the highway to the northeast the steep cliffs of granitic rock (100 million year old quartz diorite) are cut by seaward sloping fractures.

The parking lot is built on blasted rock fill. The fill near the boat launch is predominantly granitic rock and lessor metamorphic volcanic rocks, the major rock types of the Howe Sound area. Granitic rocks are distinctive by a "salt and pepper" texture of intergrown grains of light (feldspar, quartz) and dark (mica, amphibole) mineral grains. Volcanic rocks are typically grey to greenish grey colour, and individual minerals are too fine to be seen by the unaided eye.

The low shoreline area of Porteau Cove is not typical of the steep Howe Sound shorelines; submarine slopes offshore are also shallow due to a submerged ridge of glacial sediment that extends across Howe Sound. These shallow waters allowed construction of the large parking lot you are standing on. The lower slopes behind the train station to the southeast are underlain by gravels and sands. Some of these are exposed in a quarry just south of the railway station and represent old shoreline deposits formed when sealevel was higher. A ridge of Ice Age sediment extends west under the waters of Howe Sound from Porteau Cove. Floats offshore to the north mark a popular dive area for scuba diving. A vessel has been sunk here to enhance habitat for marine life.

Geography of a Fiord

Howe Sound is a representative fiord of the British Columbia coastline. In its upper reach it is a narrow, steep-walled trough 3 km wide and up to 1700 m from seafloor to mountain peaks (Figure 6). Porteau Cove sits at the transition between a narrow "true fiord" to the north and a broader seaward "sound" up to 15 km wide with numerous islands. The Squamish River drainage enters the head of the fiord; small, steep streams drain down its steep walls. The present topography of Howe Sound reflects glacial scour during the Ice Age (Pleistocene Epoch). During glaciation, glaciers streamed southward down the valley, deepening and widening it. At the end of the Ice Age, Howe Sound was deeper and extended further inland than it does today. Sediment from rivers and streams have partly filled the submerged basins, and southward advance of the Squamish River delta and floodplain has shorted the fiord.

Mountains on the Rise

The Coast Range is a rugged mountain chain extending from Vancouver to Alaska. In southwestern British Columbia its peaks range from 2500 to 3500 m elevation. Studies suggest that about 2 km of uplift has occurred during the last 10 million years to form the Coast Range, and that uplift continues today at the rate of 1-2 millimetres a year. It is a general rule that rugged mountain landscapes are typically rising landscapes where uplift is outpacing erosion.

Legacy of the Ice Age

The Coast Range, along with most of northern North America, was affected by a series of glaciations from about 1.6 million years ago to as recently as 11,000 years ago (Figure 7). Modern glaciers are relicts of this ice sheet and still cover high parts of the Coast Ranges. During the last ice advance (Fraser Glaciation) 25,000 to 11,000 years ago, glacier ice up to 2000 m thick filled what is now Howe Sound and flowed over all the present peaks south of the Britannia Beach area. The rounded character of the peaks on the islands of Howe Sound, and the west slopes of Howe Sound attest to the sculpting by this southward flow of ice. However, the highest peaks at the head of Howe Sound protruded above this great glacier and are not glacier-

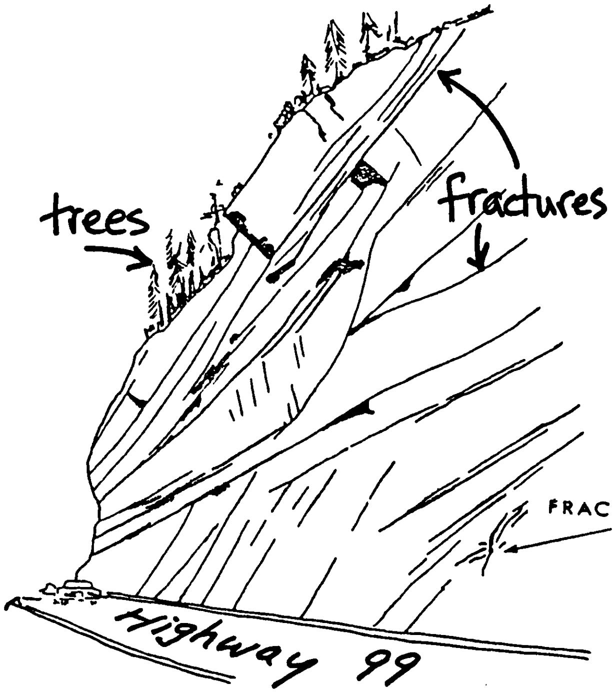


Figure 9 View of cliffs across Highway 99 from Porteau Cove illustrating the seaward-sloping fracture sets cutting the granitic bedrock.

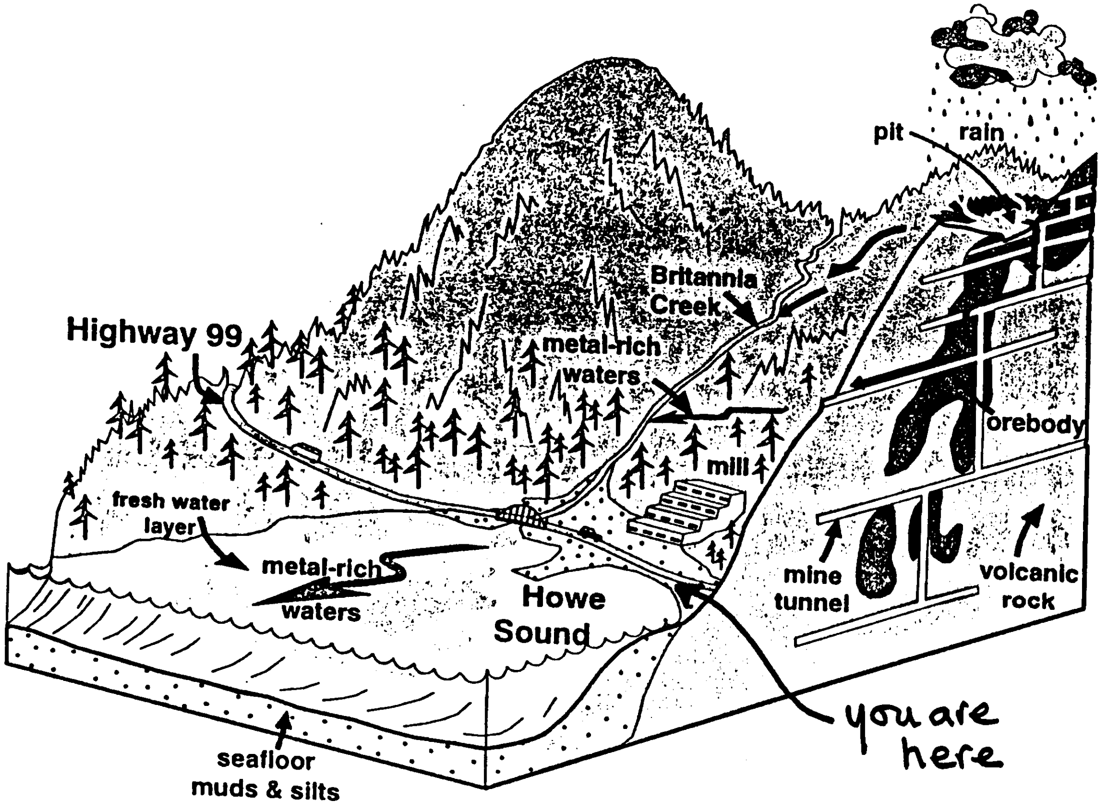


Figure 10 Schematic block diagram of the area of the Britannia mine and Britannia Beach (from Turner, Clague and Groulx, 1997).

sculpted; the craggy peaks of the Tantalus Range to the north remained as nunataks during the peak of glaciation (Figure 8a). The height of the glacier is marked by the transition between the craggy summits and lower smooth ridges of the Tantalus Range.

Howe Sound is a U-shaped valley, now flooded by the sea. Glacier flow has steepened, widened and deepened what was a river valley prior to glaciation.

Withdrawal of the last ice advance 13,000 years ago (Figure 8b) has left a record of uplift due to isostatic rebound (uplift of lithosphere due to removal of weight of ice). The corollary of uplift in coastal areas is the fall of the local sea level. Sands and gravels that formed as shoreline deposits such as those exposed in pits south of the train station, and at Magnesia Creek (see previous discussion) are evidence of a past sea level higher than present.

Giant Hidden Ridge

Porteau cove lies at the eastern margin of a cresent-shaped submarine ridge or sill across Howe Sound (Figure 6). The shallowest portion of the ridge rises to within 13 m of the surface and separates deeper, flat bottomed basins to the north ("inner basin, average depth 280m) and to the south (average depth 240m). The sill is composed of glacial till (poorly sorted mud, sand and boulders) and is interpreted to an end moraine deposited at the snout of a glacier during the close of the Fraser glaciation. The seafloor north and south of the sill is covered with greenish-grey silty muds with local deposit of coarser sediment derived from the margins of the fiord.

Falling Rock and the Highway

Across the highway from the beach is a steep granite face, part of the ice-carved valley wall (Figure 9). Fractures (joints) in the rock occur as two parallel sets roughly parallel to the land surface and sloping toward the Sound. This type of fracture is naturally formed and common in many rocks. Blasting the highway and rail route has further steepened these slopes and removed support for slabs of rock above the uppermost fractures. Highway vibration and freeze-thaw cycles loosen rock slabs bound by joint surfaces and numerous rock falls have occurred here. Rock falls in 1969 and 1970 from this cliff resulted in human deaths. An extensive program of rock bolting has been conducted on these cliffs to increase their stability.

Why Beaches?

The gravelly beaches north and south of the parking lot are similar to many small pocket beaches along the shore of Howe Sound. The coarse nature of the beaches reflects the coarse sediment transported by the high gradient creeks that drain the walls of the Sound and provide material to the shoreline zone. Exposure of these beaches to vigorous wave action during storms removes the finer sands and deposits them in deeper water.

When the tide is low, you will notice an abundance of golden colour rockweed, dark mussels, and white barnacles along the intertidal zone of the rock fill of the parking lot. This typical intertidal community is absent at Britannia Beach, our next stop, due to metal contamination.

Stop#3: The Legacy of a Giant Mine

Britannia Beach (33.2 km):

Directions : Highway 99 enters Britannia Beach. Pass the restaurants and large paved parking area on the east side of the road. Turn west on gravel road opposite entrance to Britannia Beach and BC Mining Museum. Cross tracks, pass through gate in chain link fence and park at north end of large parking area adjacent to shorefront. Walk to shoreline near gate.

Purpose of stop : To discuss the history of the Britannia mine and observe the impact of a major mine development on its environment.

What You See

To the west are the waters of upper Howe Sound fiord confined within a narrow, steep-walled valley. To the northwest across the sound is the Woodfibre pulpmill at the mouth of a U-shaped tributary valley (Mill Creek).

Across the highway, the community of Britannia Beach and buildings of the Britannia mine are built on a shallowly sloping gravel alluvial fan and delta of Britannia Creek. Britannia Creek comes out of a bedrock canyon at the upper end of the fan to the east. Mine buildings of Britannia Mine now house the BC Museum of Mining. The museum (tel. 688-8735) provides a range of tours for groups and individuals. The large, terraced building on the steep slope is the old concentrator building for the mine.

The natural shoreline of the fan and delta to the north and south has been extended with fine pyritic rock waste from the mine; this fill has been armoured against wave erosion along the shoreline with coarse granitic rock blocks. Note the rusty colour of these shoreline rocks that indicates abundant iron and other metals in the intertidal zone. Note also the rusty ledge (visible at lower tide levels) below the granitic blocks; the ledge is composed of rock fragments, and mine debris such as wood, steel pipes and even clothing held together by a rusty cement. This debris is fill used to extend the shoreline; iron-rich (and other metals) groundwaters flowing through this fill have precipitated iron hydroxide (rust), turning the loose debris into a solid mass. At lower tides there is a striking absence of expected intertidal life (e.g. rockweed, barnacles, mussels) attached to these rocks due to toxic levels of metals (to marine organisms that is) in the intertidal waters.

A Mine Worth Billions

The Britannia mine was a major producer of copper, zinc, lead, silver and gold from 1905 to 1974. At its peak it employed over 2000 people and produced over its lifetime metals worth more than $1.3 billion. Britannia Beach developed as the mill site, town site and port facility for the mine.

The Britannia ores are a natural concentration of over 50 million tons of iron sulphide-rich rock containing 1% copper, 0.6% zinc and trace (but economic!) amounts of gold and silver. The orebodies are located about 5 km to the east within the mountain ridge on the south side of Britannia Creek (Figure 10). The common sulphide minerals are pyrite (FeS_2), pyrrhotite (FeS), chalcopyrite ($CuFeS_2$), sphalerite (ZnS) and galena (PbS). The first mining was from surface pits at 1700 m elevation near the top of the mountain. Subsequent mining developed deeper ore bodies in the mountain; by 1974 the deepest mine working were several hundred meters below sea level.

The ore was brought to the mill across the highway by a variety of techniques over the years: aerial tram, underground tunnel, switch backed electric railway. Within the old concentrator building of the Britannia mine, broken rock was crushed to a fine powder and the copper and zinc rich component (i.e. concentrate) was recovered. The residue of finely ground rock (tailings) containing anomalous quantities of copper, zinc, lead, silver, was disposed of in the intertidal zone or deeper water of Howe Sound. Concentrate was shipped from the Britannia docks to smelters in Tacoma, Washington and Butte, Montana for recovery of copper, zinc, silver and gold metals.

Living with Disasters

The Britannia area is the site of two of the largest natural disasters in BC history. In 1915, early in the development of the mine, a rock slide destroyed a bunkhouse at the Jane Basin camp high on the mountain, killing more than 50 mine workers. In 1921, flooding waters from Britannia Creek destroyed half of the 170 houses in Britannia Beach and killed 37 people.

The flat area that Britannia Beach is built on is the gravel alluvial fan and delta of Britannia Creek. Damaging floods of Britannia Creek occurred in 1906, 1921, 1933 and on four occasions during the 1960's. The fan flooded most recently in September 1991, blocking the highway and damaging homes and property. The October 21, 1921 flood followed 146 mm of rainfall in 24 hours. A flood surge was caused by the failure of a railway embankment that released a sudden surge of water that jumped the stream banks and flowed through the settlement. Homes were washed into Howe Sound. It is likely that activities related to the mine development such as logging in the watershed, logging debris in the creek channel, water supply dams on the creek and other interference with the stream channel, contributed to the disaster.

Environmental Legacy: Metals on the Move

Metals from old Britannia mine contaminate Britannia Creek and nearby Howe Sound. Rainwater and snowmelt enters the top of the mine through old pit workings at the top of the mine (Figure 10). Waters containing dissolved atmospheric oxygen flow through the network of mine tunnels, reacting with metal sulphide minerals exposed on the tunnel walls. This reaction results in acidification of the waters and dissolution of metals. These mine waters with their metal load flow out of the mine and enter Britannia Creek. Copper measured in Britannia Creek can be at levels toxic to aquatic animals. The waters of Britannia Creek spread as a layer over denser sea water of Howe Sound, flowing along the intertidal zone before being diluted by mixing with seawater.

Mine wastes are another source of metal contamination. The shoreline of Britannia Beach was extended by the dumping of sulphide-rich material. Today waters percolating through the gravelly sediment of Britannia Beach flow seaward through these wastes, acidifying the groundwaters and transporting metals to the intertidal zone. Other mine wastes were dumped in the intertidal zone and shallow waters just offshore. Theses seafloor waste are continually remobilized by wave energy, allowing continued reaction with seawater and creating a seafloor "desert", lacking life. Some wastes hav collapsed by landslides into deep waters of the central Sound. These metal-rich wastes appear to pose the least threat to life as they are being buried by fine sediment from the Squamish River and the metallic minerals are not dissolving into overlying seawater due to a lack of oxygen in the seafloor sediment.

Stop #4: River meets Sea in the Shadow of a Volcano

Viewpoint of Squamish estuary and Mount Garibaldi (37.9 km)

Directions : A kilometre north of the turnoff to Murrin Provincial Park, the road swings east and starts a long descent. Turn left half way down the hill onto a large gravelled parking area with a monument to Giuseppe Garibaldi and overlook to the north. The best viewpoint is near the intersection with a gravelled road.

Purpose of stop : (1) to discuss the general aspects of Squamish River and its estuary; and (2) volcanic history and hazards of Mount Garibaldi volcano.

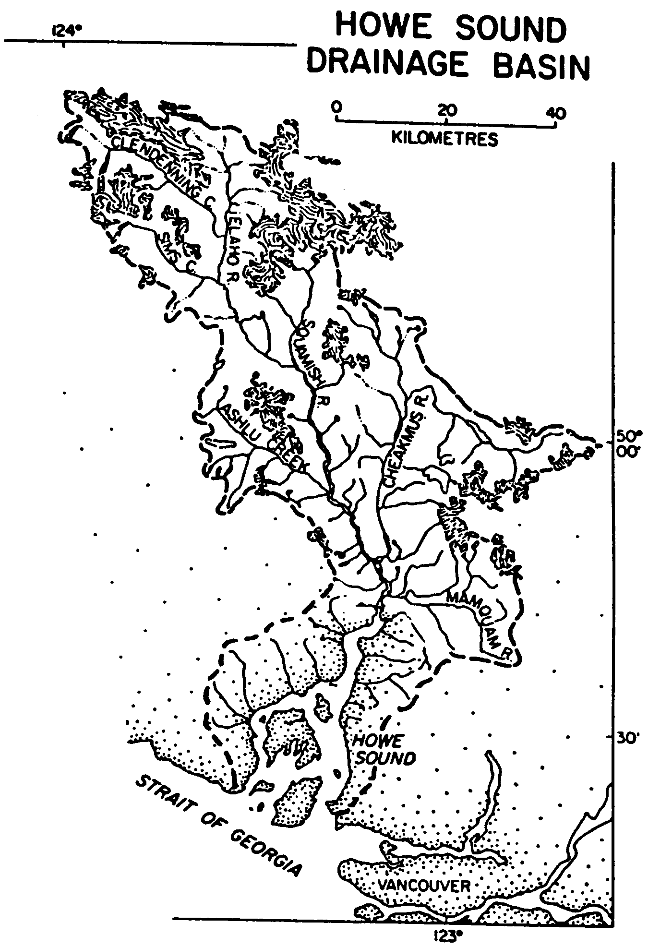


Figure 11 Map of the Howe Sound drainage basin. The wavy-lined pattern is glacier. (From Syvitski and Luternauer, 1982).

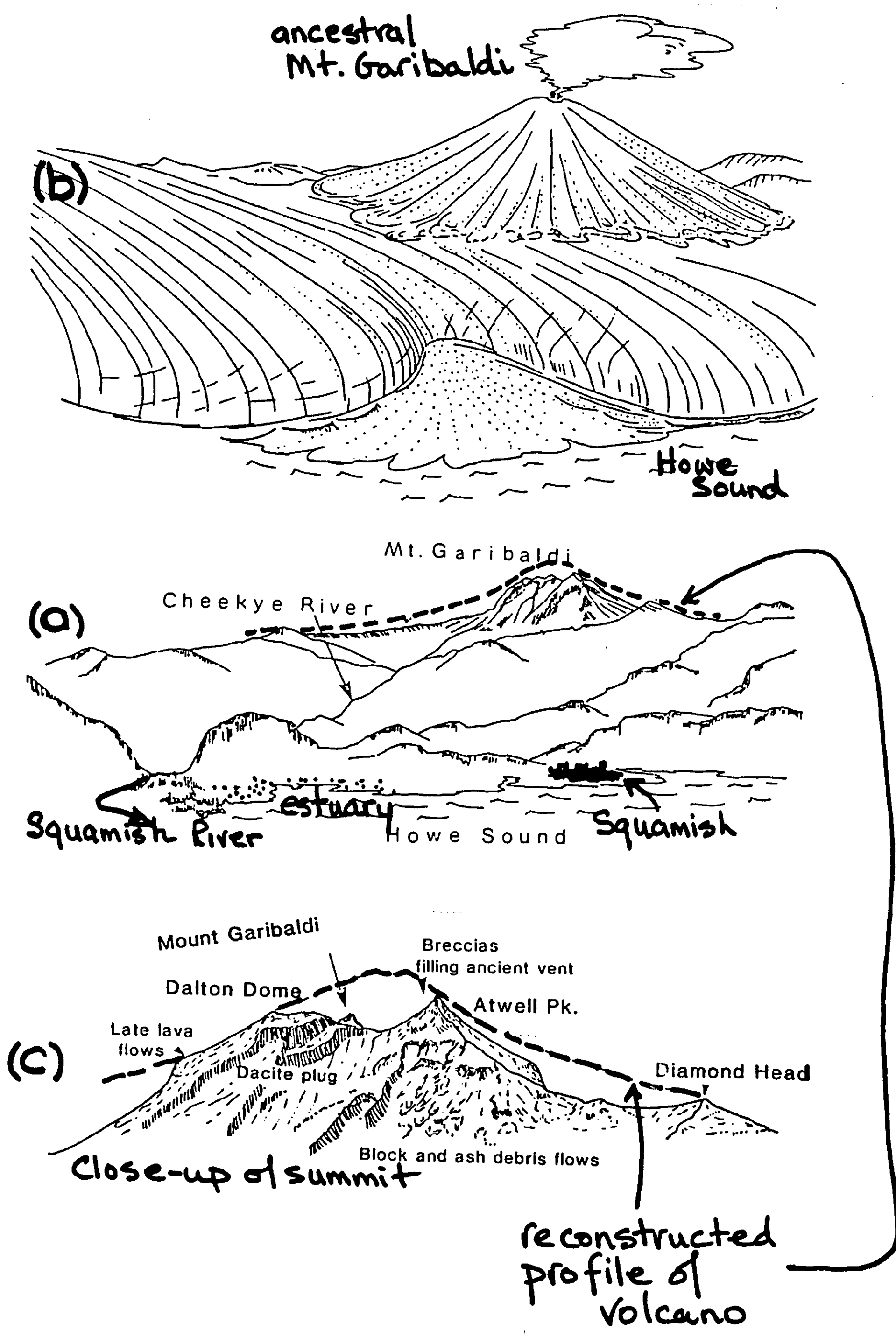


Figure 12 **(a)** Panorama of the Squamish area and Mt. Garibaldi from Stop 4. **(b)** Cartoon of the late Ice Age Mt. Garibaldi erupting over the remnants of the retreating glaciers, from the position of Stop 4. (From Souther and Matthews, 1983). **(c)** detailed interpretation of Mt. Garibaldi summit area relative to original volcano surface

What You See

To the north is the northernmost extent of Howe Sound and the estuary of the Squamish River. The western side of the estuary is largely in a natural state; the eastern estuary has been developed as a port facility, industrial land, and the downtown area of the Municipality of Squamish. The estuary is confined by steep valley walls of glacier-sculpted granitic rock. The famous climbing cliffs of the Stawamus Chief form a distinctive promontory in the eastern wall of the valley.

The Squamish River flows along the western side of the valley. Above and northeast of Squamish is the ice covered summit of Mount Garibaldi, an eroded volcano, that was last active during the end of the Ice Age.

Where River Meets the Sea

Here the Squamish River meets the ocean waters of Howe Sound. Here the river deposits its load of sediment, fresh water mixes with salt water, and a rich marshland grows on sand and silt flats. Ongoing addition of river-borne sediment is causing the shoreline to advance seaward. Slowly, the river is converting Howe Sound into the Squamish Valley.

The abrupt slowing of Squamish River current where it enters the sea causes deposition of its sediment load of sand and silt to form a broad plain near sea level. This accumulation of sand and silt largely occurs during high summer flows and during autumn floods; flooding of the estuary distributes sand across its surface. Construction of a dike in the early 1970's now confines the river to the western side of the estuary and relatively little river water flushes through the eastern side of the estuary. The channel on the eastern side of the estuary (Mamquam Blind Channel; Highway 99 crosses just south of the turn off to Squamish) was once the mouth of the Mamquam River. Prior to 1921 the Mamquam River emptied directly into the ocean here; during a major flood in that year the river changed its course to flow into the Squamish River, 5 km upstream from the sea.

Vegetation on the delta is zoned seaward from coniferous and deciduous forest above the high tide line to shrubs and grasses straddlling the high tide range, and intertidal marshes sedges and rushes.

Changing Flow, Changing Colour

The Squamish River and its tributaries drain about 4000 square kilometers of rugged Coast Range characterized by extensive glaciers and icefields (Figure 11). Highway 99 to Whistler north of Squamish follows the Cheakamus River valley, a major tributary of the Squamish. Whistler sits at the drainage divide between the Squamish River watershed and the Lillooet River watershed to the north.

During the winter when most precipitation within the basin falls as snow, the flow in the Squamish River is very low and clear. Snow melt in the spring swells the river; erosion of its banks by this higher water turns the river colour greenish brown. By July and August, glaciers are also melting, creating high flows (freshet) on the river. Finely ground glacial rock flour from this glacier melt gives the water an opaque greenish grey colour. In spring and summer, the grey colour of the river water is distinct from ocean water and the plume of river water within upper Howe Sound is very visible. As river water is less dense than seawater, this turbid plume floats as a thin layer over underlying seawater. Major floods on the Squamish River commonly occur in the autumn, when major warm air storms cause rain to fall on early snows, resulting in runoff from both rain and snowmelt.