Tsunamis

Abstract

A tsunami is a sea wave or series of waves produced by large disturbances of the sea floor that are of relatively short duration. Such disturbances cause the water column to move vertically and the resulting wave energy to spread outwards across the ocean surface at high speed. Although tsunami occurrences in Canada are rare, they do occur and can cause major damage and loss of life. Since the beginning of the twentieth century, there has been one tsunami reported about every fifteen to twenty years in Canada. This map shows the location of the major tsunami events in Canada including earthquake and landslide events that triggered tsunamis.

Canadian Tsunami Events

Tsunamis are rare in Canada (average historical recurrence of 1 per 15 years), but they have had devastating impacts on the Canadian population and infrastructure. The tsunamis that have impacted our shorelines have been triggered by either an earthquake or a landslide. The following are descriptions of some tsunami events that have affected Canadians.

Burin Peninsula, Newfoundland, November 18, 1929

On November 18, 1929, a magnitude 7.2 earthquake, with an epicentre about 250 kilometres south of Newfoundland, generated an extremely large submarine landslide. This slide triggered a tsunami that struck the southern coast of Newfoundland. Later studies by seismologists confirmed that the tsunami was not generated by the earthquake, but rather was triggered by the subsequent large submarine landslide.

Tsunami waves, varying in height between 3 and 7 metres, travelled at a speed of 140 kilometres per hour. The horizontal run-up, which is the distance travelled in-land, measured as much as 1 kilometre. The tsunami was recorded as far south as North Carolina and as far east as Portugal. Twenty-eight lives were lost on Burin Peninsula in Newfoundland (see Figure 1).

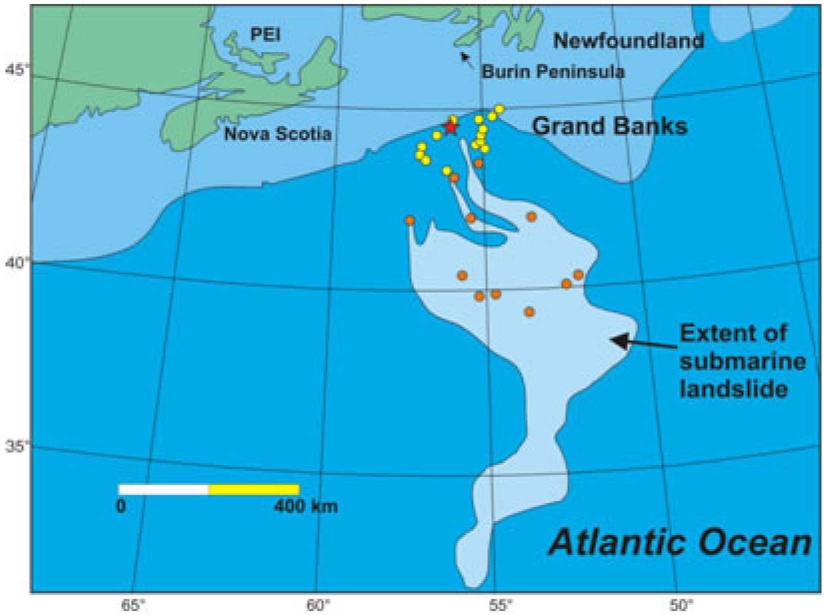

Figure 1. Extent of the submarine landslide south of the island of Newfoundland that caused the tsunami of November 18, 1929. The red star shows the epicentre of the magnitude of 7.2 earthquake. The yellow and orange dots indicate locations where telegraph cables were severed by the submarine landslide. Yellow dots are locations of cables that were severed immediately and orange dots are locations of cables that were severed progressively through time. It took 13 hours for the last cable (farthest east) to break.
Source: EarthNet/Geonet Virtual Resource Centre for Earth Science Educators/Un centre virtuel de matériel pédagogique pour les enseignants en sciences de la Terre (http://www.earthnet-geonet.ca/)

Forty communities on the south coast of Newfoundland were affected, with about 10 000 people left homeless (see Figure 2).

Figure 2. Aftermath of the November 18, 1929 Tsunami, Newfoundland. The home of S.H. Isaacs of Port au Bras, which was towed back to shore after being swept out to sea by the tsunami and anchored to the fishing schooner Marian Belle Wolfe.
Source: The Rooms Provincial Archives of Newfoundland and Labrador, A2-149, Tidal Wave Disaster, Newfoundland, November 1929 (postcard no. 351) / S.H. Parsons and Sons, Parsons family funds. Handwritten text on reverse: "House nearly submerged after Burin Tidal Wave, Nov. 1929". Photograph courtesy of The Rooms Provincial Archives, A2-149 / S.H. Parsons and Sons.

At the time, all transatlantic telegraph cables from the east coast of Canada to Europe passed through the Laurentian Channel, just south of Newfoundland. It was there that the submarine landslide occurred. Consequently, the cables were severed, cutting off communication to Europe. Total damage from the tsunami was estimated at $1 million in 1929 dollars (about $20 million today).

Port Alberni, British Columbia, March 28, 1964

On March 27, 1964, the magnitude 9.2 Alaska earthquake, the second largest earthquake reported at the time, triggered a tsunami that travelled to areas along the Pacific Northwest, Japan, Hawaii and Australia. In Canada, waves struck portions of the Queen Charlotte Islands and Vancouver Island. The worst hit area was Port Alberni, where the tsunami caused about $5 million in damage (1964 dollars; $25 million in 2006 dollars). The community was struck by three main waves (see Figure 3) between 00:20 and 3:30 (Pacific Standard Time) on March 28. No one was killed in Canada, but 130 people lost their lives elsewhere across the Pacific Ocean.

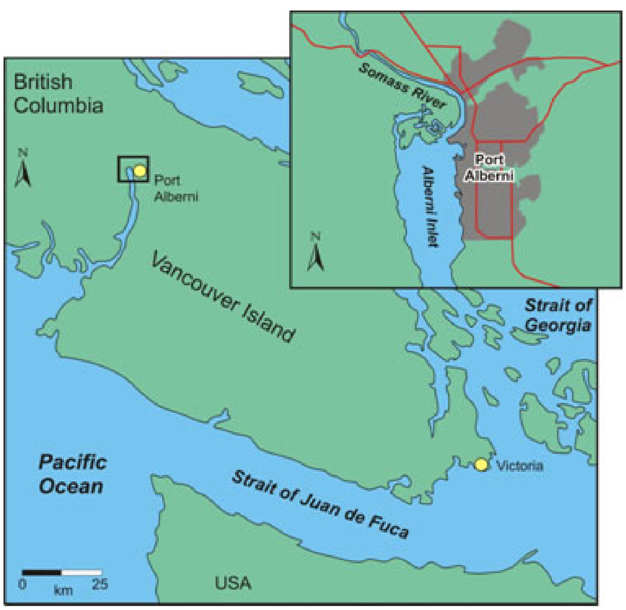

Figure 3. Port Alberni, West Coast of Vancouver Island
Source: Geological Survey of Canada

In the open ocean, waves travelled at speeds of 830 kilometres per hour. When the tsunami entered Port Alberni Inlet, the waves had slowed to about 50 kilometres per hour. The sea surged up the Somass River, with the highest wave being 4.3 metres and a wave run-up of 1 kilometre inland. It destroyed houses and automobiles, and buildings were dragged seaward. A total of 260 houses were damaged (see Figure 4).

Figure 4. Damage in Port Alberni caused by the tsunami triggered by the magnitude 9.2 earthquake in Alaska, March 28, 1964
Source: Geological Survey of Canada

Kitimat, British Columbia, April 27, 1975

Between 1952 and 1975, several submarine landslides occurred near Kitimat in northwestern British Columbia. The most recent and most damaging occurred on April 27, 1975 — most damaging because it triggered a tsunami in the Moon Bay area of Kitimat arm (see Figure 5). More than 25 million cubic metres of marine mud slumped and generated a tsunami with waves up to 8.2 metres in height. Damage to a wharf and other coastal structures were estimated at about $600 000 (1979 dollars). Fortunately, no one was hurt. Detailed studies have been carried out to generate computer models for tsunami hazard assessment for fjords along the northwestern coast of British Columbia.

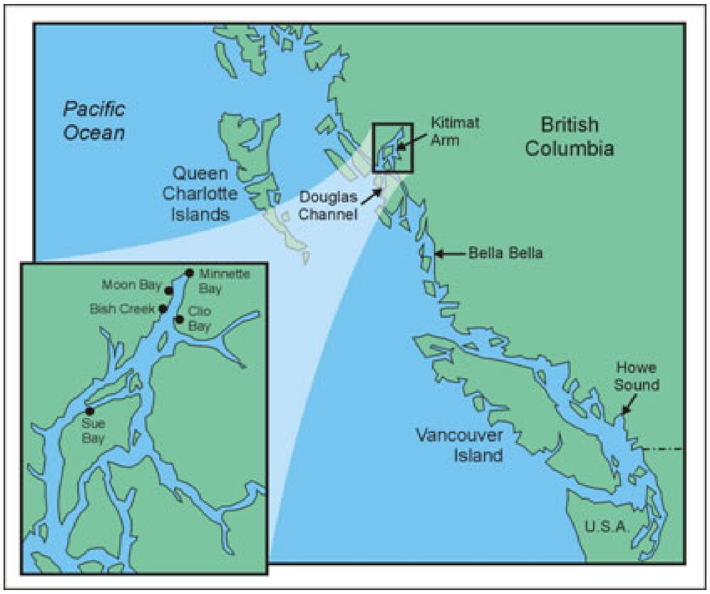

Figure 5. Kitimat, Northwestern British Columbia
Source: Geological Survey of Canada

Troitsa Lake, October 6, 1998

Tsunamis can occur in large lakes, as exemplified by the 1998 Troitsa Lake tsunami in north-central British Columbia. The effects can be amplified when the lake is funnel-shaped. On October 6, 1998, a tsunami was generated in Troitsa Lake by the collapse of a fan delta where a stream entered the lake (see Figures 6 and 7), following large amounts of sedimentation resulting from intense precipitation. The first wave measured 1.5 metres and travelled to the opposite shore of the lake, damaging trees. It also reached the north end of the lake, 10 kilometres away, where it damaged wharves and boats. A second backwash wave, measuring 2 metres, travelled back to the head scarp of the slope failure, damaging trees as much as 300 metres inland. Fortunately, this area is remote and no one was hurt. Furthermore, a series of uprooted trees, lying flat, was discovered at the head scarp of the collapse. Their age, determined by radiocarbon dating, revealed that they were roughly 700 years old. This suggested that at least one other tsunami event had been generated in the past in Troitsa Lake.

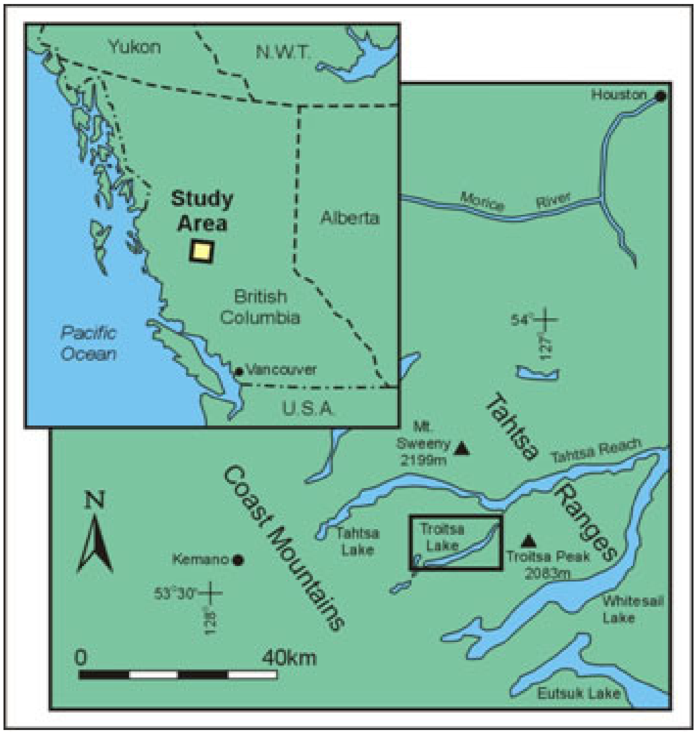

Figure 6. Troitsa Lake, North-central British Columbia
Source: Geological Survey of Canada

Figure 7. Aerial Photograph of the Fan Delta at Troitsa Lake, British Columbia. The outline of the fan delta is shown by the thick dashed-dotted line. The area that collapsed and triggered the tsunami represented only a fraction of the fan (thinner dashed line).
Source: Government of British Columbia. Photo number BC77737-131

Highest Tsunami ever Recorded

This event is mentioned because it was so spectacular and occurred in a fjord off the Alaska Panhandle, close to British Columbia.

Sometimes, a combination of triggers generates a very high wave called a "mega-tsunami", which is usually higher than 40 metres. For example, Lituya Bay, Alaska, is known for having been exposed to the world's highest tsunami ever recorded at 524 metres. In comparison, the height of the CN tower in Toronto is 553 metres. On July 9, 1958, at around 10:00 (Pacific Standard Time), a powerful magnitude of 8.3 earthquake with an epicentre at about 20 kilometres south of the bay, shook the area along a nearby fault, that is located underneath two glaciers (Lituya and North Crillon glaciers) going into Lituya Bay (see Figure 8).

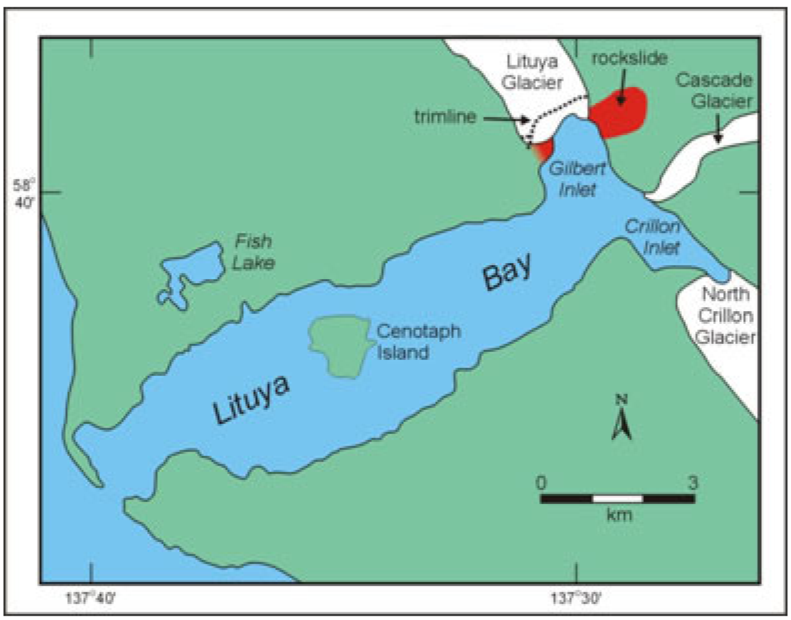

Figure 8. Lituya Bay, Alaska. Red indicates the site of the rock slide. Trim line indicates the amount of ice that was sheared off.
Source: Geological Survey of Canada

This earthquake triggered a 43 million cubic metre rock slide and, consequently, a very large tsunami. It is thought that a combination of factors, including the earthquake, the impact of the rock slide (like a meteorite), the movement along the fault, collapse of about 400 metres of ice from one of the glaciers, and sudden drainage of a lake beneath one of the glaciers, was responsible in creating this mega-tsunami. After the initial 524 metre high splash wave, secondary tsunami waves measured more than 230 metres in height. This was determined by the height of the trim line in the southern part of the bay (see Figure 9).

That night in August 1958, three fishing boats were anchored at the entrance of the bay. One boat disappeared along with the two people on board, while the other two rode the waves. Four people lived to tell the story.

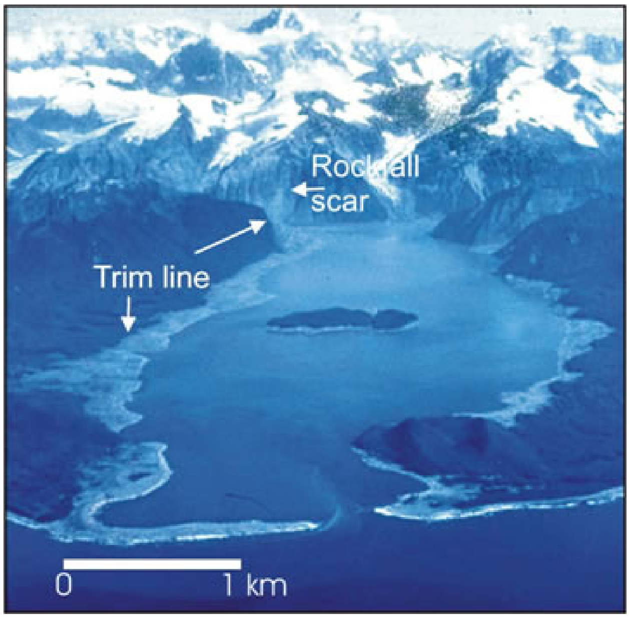

Figure 9. Oblique aerial photograph of Lituya Bay, Alaska, taken soon after the tsunami of July 9, 1958. The trim line indicates the maximum height where trees were destroyed by the tsunami waves. The rock fall scar is also shown in the background.
Source: Photo S1356, Karl V. Steinbrugge Collection, Earthquake Engineering Research Center, University of California, Berkeley.

Map Sources

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Tsunami
This map shows a selection of 6 tsunamis and 4 related earthquake events that have impacted Canada and Alaska since 1929. Tsunami events are located in the area of significant impact. Earthquake events are located at their epicentre. Data from: Geological Survey of Canada, United States Geological Survey and British Columbia Ministry of Forests and Range.

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http://earthquakescanada.nrcan.gc.ca/historic_eq/20th/1929/1929tuttleresearch.php

Public Safety Canada. Is your family prepared?
http://www.getprepared.gc.ca/index-eng.aspx

Provincial/Territorial Government

British Columbia Provincial Emergency Preparedness Program, Coastal Communities at Risk and Local Warning Capabilities
http://www.pep.bc.ca/hazard_plans/tsunami2001/Tsunami_Risk_Map-2001.pdf
Tsunami hazard map of coastal British Columbia (from British Columbia Tsunami Warning and Alerting Plan 2001)

Government of British Columbia. Ministry of Public Safety and Solicitor General. Provincial Emergency Program. Tsunami Preparedness
http://www.pep.bc.ca/hazard_preparedness/tsunami_preparedness.html
The Provincial Emergency Program, as an essential part of the public safety network of British Columbia, will be the leader in emergency management, helping people to prepare for, respond to and recover from emergencies and disasters.

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