

GEOLOGIC HAZARDS

GIANT WAVE IN LITUYA BAY

THE BIGGEST SPLASH IN HISTORY

The highest wave in recorded history splashed up from the ice-scoured tidal inlet called Lituya Bay on the northeast shore of the Gulf of Alaska on July 9, 1958. The enormous wave, which trimmed vegetation to heights of more than 1700 feet, exceeded the tallest seismic sea wave (tidal wave) by more than eight times. It was more than twice as high as the horrifyingly destructive wave set in motion in Vaiont reservoir in Italy in 1963 (see *Mineral Information Service*, July, 1965).

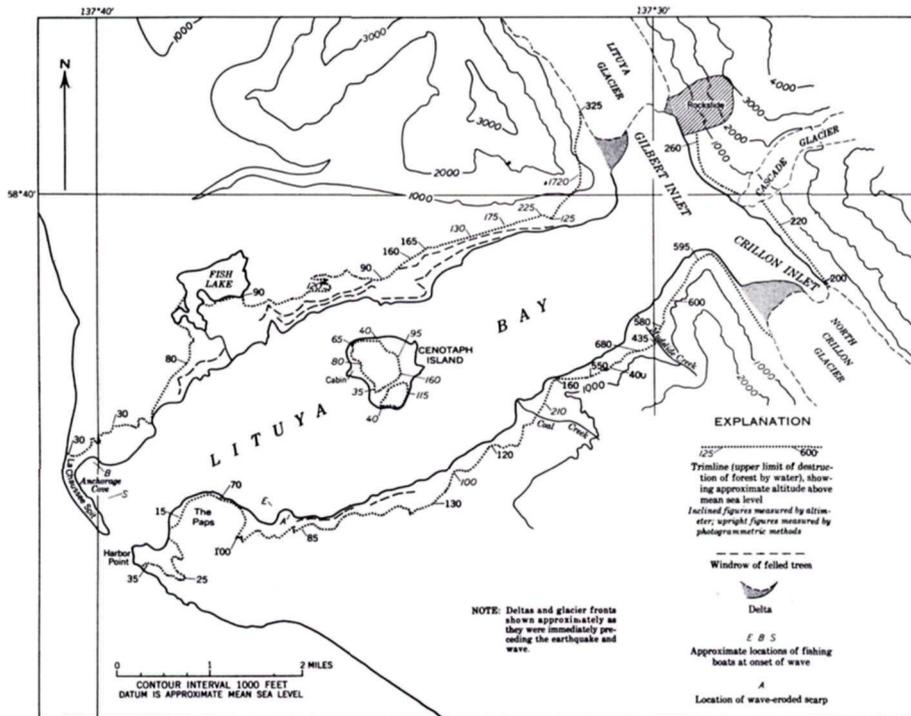
Fortunately, very few people were in or near the bay, so that the loss of life and property was slight compared to Vaiont, which destroyed an entire town, and claimed 2600 lives. The giant wave at Lituya Bay wrecked two of the three fishing boats in the area and killed two people.

The story of the wave was pieced together from eyewitness accounts of the survivors, from on-the-spot study after the wave by geologist Don J. Miller of the

U. S. Geological Survey, and from scale-model experiments by engineer Robert L. Wiegel of the University of California at Berkeley.

Lituya Bay, according to W. H. Dall, who studied the area in 1874, is "a Yosemite Valley, retaining its glaciers and with its floor submerged six or eight hundred feet." The bay lies at the confluence of two major glaciers, North Crillon to the southeast, and Lituya to the northeast, which meet one another almost head on, perpendicular to the long axis of Lituya Bay, so as to give the whole configuration a T shape. Another, smaller glacier, called Cascade, feeds directly into the bay at the top of the T.

In the center of the bay is Cenotaph Island; at its mouth lies La Chaussee Spit, forming a barrier bar partly across the entrance, and a snug cove for anchorage, named, appropriately, Anchorage Cove. On the opposite side of the bay, to the southeast, a headland juts out, providing a smaller anchorage behind it.



Map of Lituya Bay.

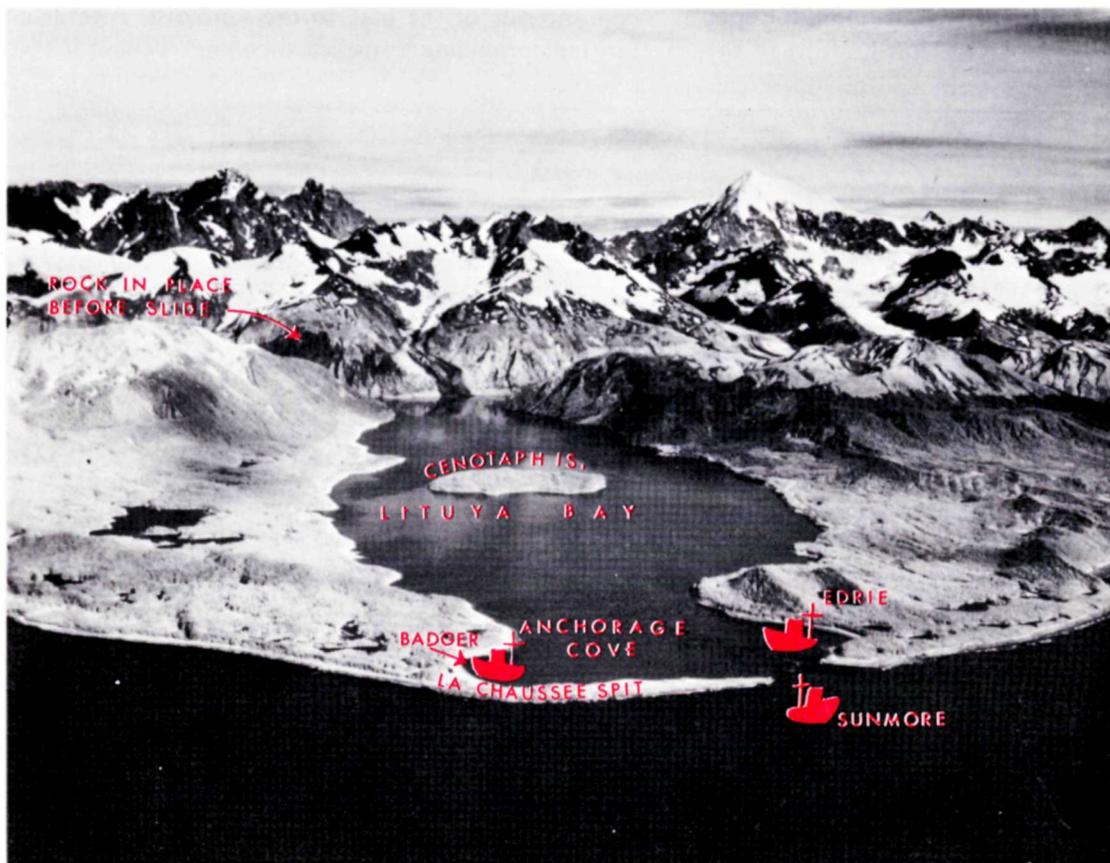
On that fateful day in 1958, three 40-foot trolling boats were in or near the bay. One, the *Edrie*, entered the bay about 8:00 p.m. and anchored in 5 fathoms of water in the small cove on the south shore, behind the headland. Howard C. Ulrich and his 7-year-old son were aboard. At 10:19, Mr. Ulrich was awakened by an earthquake. He went on deck to watch its results. "The wave definitely started in Gilbert Inlet," he stated, "just before the end of the quake. It was not a wave at first. It was like an explosion, or a glacier slough. The wave came out of the lower part, and looked like the smallest part of the whole thing. The wave did not go up 1800 feet—the water splashed there."

For two or three minutes Mr. Ulrich watched, meanwhile starting the boat and letting out the anchor chain, as he was unable to get the anchor loosened enough to pull it up. By the time it reached the *Edrie*, the wave was a wall of water more than 100 feet high. The anchor chain snapped. The boat rose on the crest, rode over the south shore, then was pulled in again with the backwash. Mr. Ulrich—miraculously, it seemed—gained control of the boat after the first great wave struck, and after the following sloshing had

subsided, he sailed out the entrance on the normal ebb tide.

Mr. and Mrs. W. A. Swanson, aboard the *Badger*, entered the bay about 9 in the evening, anchoring in Anchorage Cove in about 4 fathoms of water, near the *Sunmore*. Mr. Swanson, like Mr. Ulrich, was awakened by the earthquake, and hurried to the pilot house. There he saw what he thought was Lituya Glacier, which had "risen in the air and moved forward so it was in sight. . . . It seemed to be solid, but was jumping and shaking. . . . Big cakes of ice were falling off the face of it and down into the water." After a while, "the glacier dropped back out of sight and there was a big wall of water going over the point [the spur southwest of Gilbert Inlet]."

The wave passed Cenotaph Island in about 2½ minutes, and reached the *Badger* in another minute and a half. The boat was still at anchor. It was lifted up by the wave, and thrown across La Chaussee Spit, riding stern first, just below the crest, like a giant surfboard. Mr. Swanson looked down on the trees growing on the spit. He thought, on looking back in calmer times, that he was about 80 feet above the treetops. The wave crest broke just outside the spit, and the boat hit the ocean bottom with a wrenching thud. Mr. Swanson



Before the
giant wave
of
1958

saw, behind him, piles of logs and other debris, pouring over the spit on the crests of the smaller waves. The *Badger* foundered soon, some distance from the shore, but Mr. and Mrs. Swanson abandoned it for a small skiff and were rescued by another fishing boat two hours later, in the dark of the night.

The *Summore* did not fare so well. When the wave hit, it was not at anchor, as were the *Badger* and the *Edrie*, but was underway near the entrance. It was swamped by the great wave, and was lost.

The vegetation suffered severe damage. More than 1700 feet above the level of the water, trees were trimmed, or thrown over and destroyed. Many of them resembled redwood logs trimmed by the "hydraulic barker" used in the lumber mills along the California coast.

Don Miller studied the effects of the wave carefully, in the field. In Berkeley, Robert Wiegel constructed a 1:1,000 scale model, and relived the wave, many times. He experimented with many possible wave sources, in order to discover which means of origin would be most likely to have produced a wave that would have the effects Don Miller found in Alaska. Motion pictures of the model were taken, and analyzed.

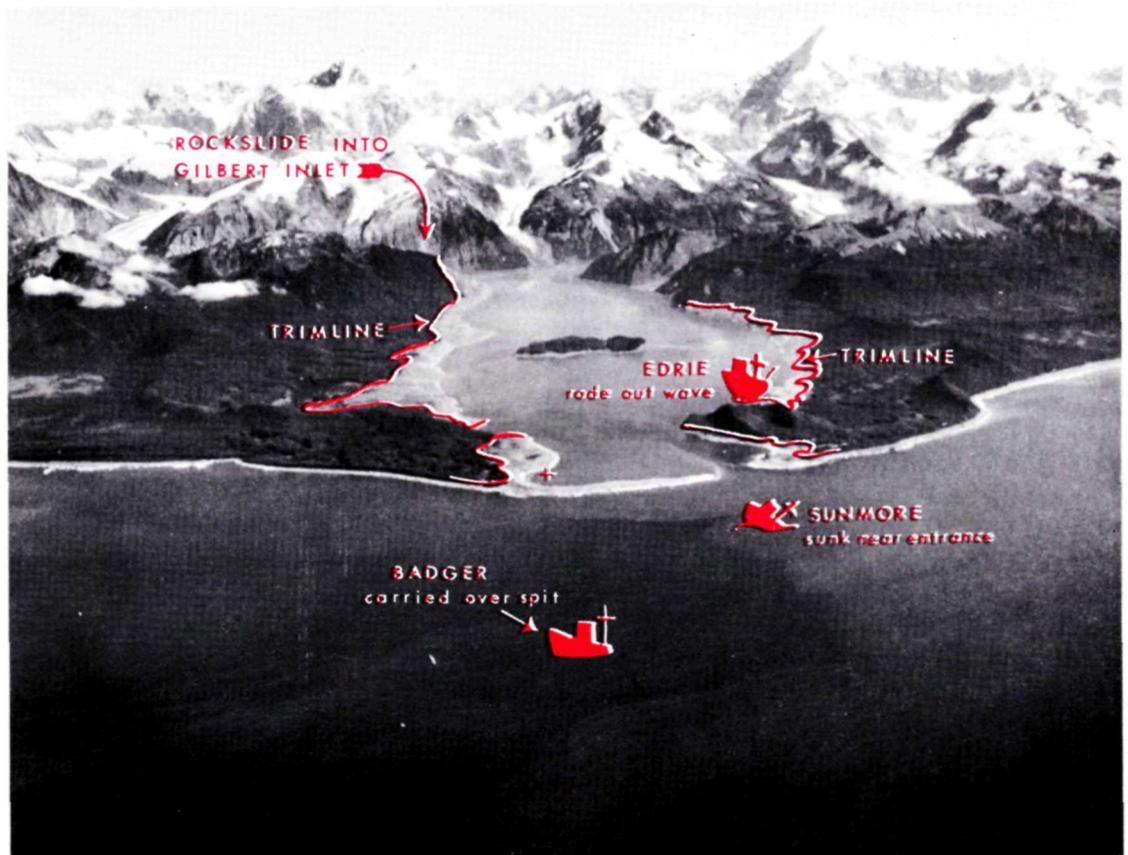
Don Miller's conclusions as to the source of the giant splash and destructive wave were:

"A rockslide triggered either by movement on the Fairweather fault or the accompanying shaking, on July 9, 1958, plunged into Gilbert Inlet, causing water to surge over the opposite wall of the inlet to an altitude of about 1,740 feet and generating a gravity wave that moved out from the head of Lituya Bay at a speed of about 100 miles per hour. Field investigation indicates that this surge and the giant water wave were primarily responsible for the nearly total destruction of the forest up to a sharp trimline. . . . This conclusion is supported by R. L. Wiegel's study of a model of Lituya Bay and his calculations from existing theory and data on wave hydraulics."

It was a remarkable landslide, and a monumental splash. . . . *M. R. H.*

The material for this article was taken largely from "Giant Waves In Lituya Bay, Alaska," by Don J. Miller, published as Professional Paper 354-C of the U. S. Geological Survey, in 1960. Besides this wave, there is considerable information on earlier waves in Lituya Bay, and a consideration of giant waves elsewhere in the world.

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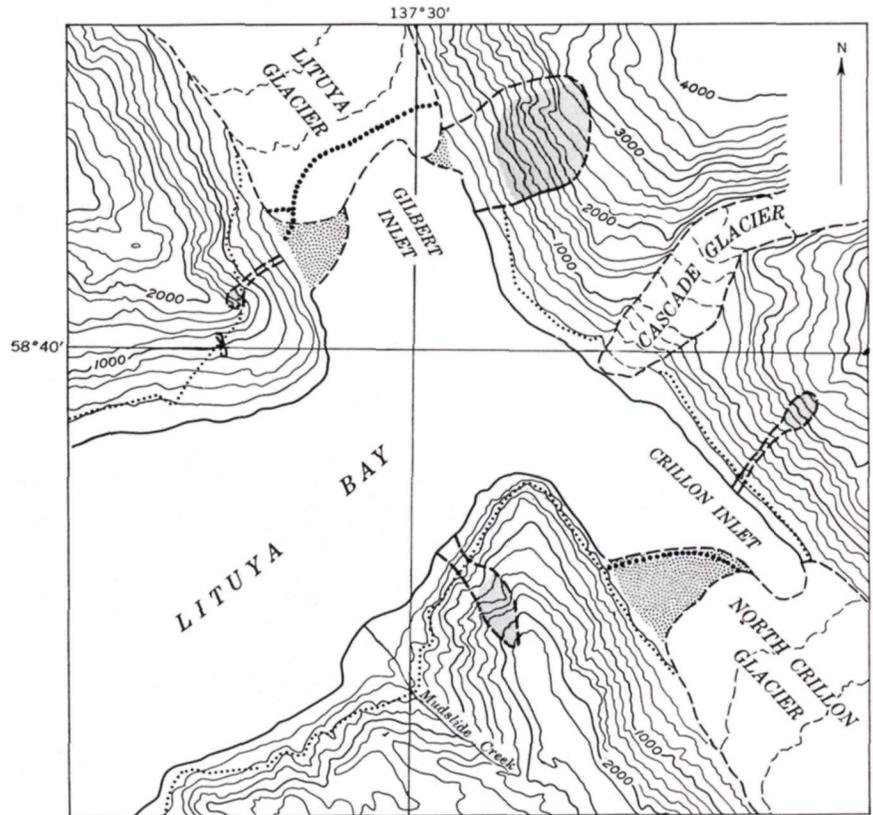




Don J. Miller

In 1961, Don Miller lost his life in the Kiagna River in Alaska. In his honor, the U. S. Geological Survey's oceanographic research vessel bears his name. Elsewhere in this magazine there is a short account of some of the work it has been used for in studying destructive waves from the Alaskan Good Friday earthquake.

Robert L. Wiegel, currently professor of engineering at the University of California, is the author of a new book entitled Oceanographical Engineering, reviewed herein.



EXPLANATION

-  Trimline (upper limit of destruction of forest by water)
-  Slides inferred to be contemporaneous with July 9 earthquake
-  Dashed line outlines entire area of fresh scar; shaded area is main source of slide debris
-  July 7, 1958
-  July 10, 1958
-  Approximate configuration of shoreline, deltas, and glacier fronts
-  0 1/2 1 MILE
-  0 5000 FEET
- CONTOUR INTERVAL 200 FEET
- DATUM IS APPROXIMATE MEAN SEA LEVEL

Detailed map of head of Lituya Bay