ALASKA GEOLOGY

Newsletter of the Alaska Geological Society, Inc.

Submarine Landslides and Tsunamis at Seward and Valdez Triggered by the 1964 Magnitude 9.2 Alaska Earthquake

Peter Haeussler, U.S. Geological Survey

Homa Lee & Holly Ryan, U.S.G.S., Menlo Park, CA

Keith Labay, U.S.G.S., Anchorage, AK

E. Suleimani, Geophysical Institute, University of Alaska, Fairbanks

Clark Alexander, Skidaway Institute of Oceanography, Savannah, GA

Rob Kayan, U.S.G.S., Menlo Park, CA

Note: AGS meetings will be at the BP Energy Center for 2008-2009.
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This newsletter promotes the October luncheon talk of the Alaska Geological Society, to be held Thursday, October 23rd at the BP Energy Center.

Submarine-landslide generated tsunamis caused the greatest loss of life and property in the 1964 magnitude 9.2 Great Alaska earthquake. Almost 90% (106/122) of lives lost in the earthquake are attributed to tsunamis, and about 80% of those deaths (85/106) were caused by submarine landslide generated tsunamis rather than tectonically generated tsunamis. Thus, lessons learned about the origin and generation of these submarine landslide-generated tsunamis can be useful to understanding and mitigating the hazard.

Our work uses newly collected high-resolution bathymetry, high-resolution seismic profiling, and coring data to greatly enhance our understanding of the submarine landslides in two fjords – Port Valdez, near Valdez, Alaska, and Resurrection Bay, near Seward, Alaska. In particular, we can better document the location and extent of the 1964 slides and deposits, image pre-1964 mass failure deposits, and model the tsunamis to better understand their physics. This talk will outline our current understanding of the slides in these two fjords. Geologic studies soon after the 1964 earthquake found that the seafloor was much deeper near the communities of Valdez and Seward than before the earthquake, and thus submarine landslides most likely generated the local tsunamis.

Seward, at the north end of Resurrection Bay, was the only town hit by tsunamis generated from both submarine landslides and tectonic sources. Within 45 seconds of the start of the 1964 earthquake, a 1.2-km-long section of waterfront began sliding into the ocean, and soon after,

Alaska Geological Society Luncheon

Date & Time: **Thursday, Oct. 23rd, 11:30 am – 1:00 pm**

Program: **Submarine Landslides and Tsunamis at Seward and Valdez Triggered by the 1964 Magnitude 9.2 Alaska Earthquake**

Speaker: Peter Haeussler, U.S. Geological Survey

Place: **BP Energy Center**

Reservations: **Please make your reservation before noon Tuesday, Oct. 21st, 2008.**

Cost:	**Seminar only, no meal:**	**Free**
	Reserve a box lunch:	**$13**
	Nonmember:	**$15**
	Reserve a hot lunch:	**$20**
	Nonmember:	**$22**

No reservation: add $5 to the above (on an "as-available" basis only)

E-mail reservations: **vp@alaskageology.org**
Or phone (907) 230-1672
(Tom Morahan, AGS VP)

For more information: visit the AGS website:

www.alaskageology.org

~6-8-m high waves inundated the town. Comparison of pre- and post-earthquake bathymetry data allowed us to assess the location and extent of submarine mass failures and sediment transport. To determine the change in the seafloor, we assembled all older soundings from smooth sheets for comparison to a new NOAA multibeam dataset. We gridded the sounding data, applied corrections for coseismic subsidence, post-seismic rebound, unrecovered co-seismic subsidence, sea-level rise (tidal datum shift), and measurement errors. The new comparison shows multiple slides and farther sediment transport than previously thought. We estimate the total volume of slide material to be about 211 million m^3. Most of this material was transported to a deep, flat area, which we refer to as “the bathtub”, about 6 to 13 km south of Seward. Sub-bottom profiling of the bathtub shows an acoustically transparent unit, which we interpret as a sediment flow deposit resulting from the submarine landslides. We use numerical modeling to recreate the mass failures and tsunami waves of the 1964 earthquake to test the hypothesis that the local tsunamis in Resurrection Bay were produced by a number of different slope failures. We find that numerical results are in good agreement with the observational data, and the model could be employed to evaluate tsunami hazard in other Alaska fjords.

The 1964 earthquake caused major damage to the port facilities and town of Valdez, most of it through the process of submarine-landslide generated tsunamis. Also, one of the highest tsunami wave runups ever documented (>60 m) occurred near Shoup Bay in Port Valdez. Post-earthquake assessments of the stability of the old townsite indicated a high likelihood of future failure, and the town was moved to a new location. Based on a comparison of pre- and post-earthquake bathymetry, an estimate of the net volume of landslide debris deposited in the basin is about 400 million m^3. Landslide features include (1) large blocks (up to 40-m high) near the location of the greatest tsunami-wave runup (~60 m) at the west end of Port Valdez, (2) two debris lobes associated with those blocks, (3) a series of gullies, channels, and talus, near the fjord-head delta at the east end of Port Valdez, and (4) the front of a debris lobe that flowed from the east end of the fjord half-way down the fjord. A seismically transparent unit is found above the debris-flow deposits in the deepest part of the fjord and likely represents very fluid sediment flows that occurred shortly following the deposition of the major debris lobes. Integration of the volume of debris flow deposits (mapped according to their acoustic signature) indicates a gross volume of about 1 km^3, showing that the landslides incorporated significant additional sediment from the fjord floor into the debris flows as they translated. Despite the large volume of sediment failures in the eastern part of the fjord, smaller, but more coherent block failures in the western part appear to be the primary cause of the largest tsunamis impacting the shorelines.

The 1964 mass failures in Port Valdez were not unique. We identified 5 additional sets of debris flow deposits, beneath parallel-layered reflectors, which we interpret as paleo-tsunami deposits. Assuming that the first set of debris flow deposits, imaged beneath the 1964 lobes, was deposited at the time of the penultimate megathrust earthquake (dated at 913-808 yrs b.p., Carver and Plafker, in press), we calculated a sediment accumulation rate of about 2 cm/yr for the inter-lobe deposits. This rate is comparable to that determined for post-1964 deposits using ^{137}Cs peaks in gravity cores from Port Valdez. Deposits attributed to submarine failures triggered by the 1964 and penultimate events have a similar distribution across the entire fjord. However, earlier events are not present in western Port Valdez, suggesting that failures related to the Shoup Glacier moraine did not occur until more recently. In addition, the oldest debris flow lobes tend to be thinner and have thinner sedimentary sequences between the lobes than the younger flows. This may be the result of more typical shorter recurrence intervals between megathrust earthquakes and perhaps differences in sediment input at the fjord head.

Speaker’s Biography

Peter Haeussler received his B.S. degree from Michigan State University, his Ph.D. from the University of California Santa Cruz, and he did a post-doc with Dwight Bradley at the USGS in Anchorage before becoming a permanent employee. He has worked on various aspects of the tectonics and neotectonics of southern and southeastern Alaska. Haeussler is now head of the USGS' Alaska earthquake hazards project, where recent work has focused on understanding the paleoseismology and earthquake hazards of the Denali fault system.