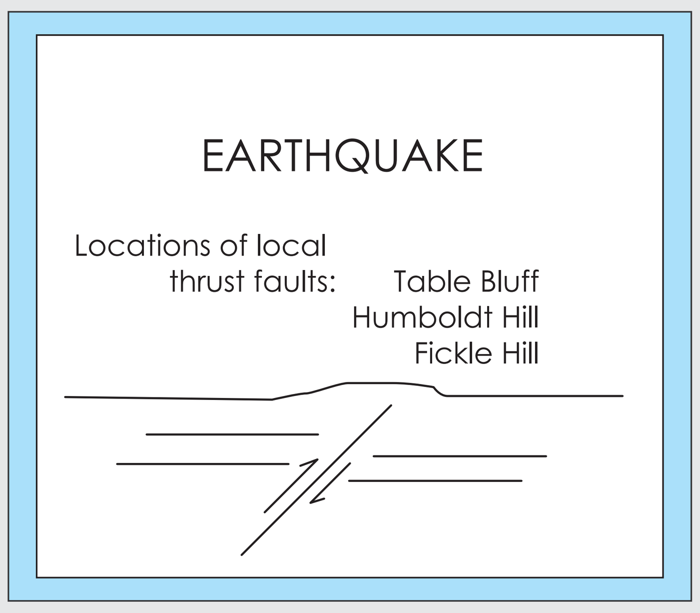
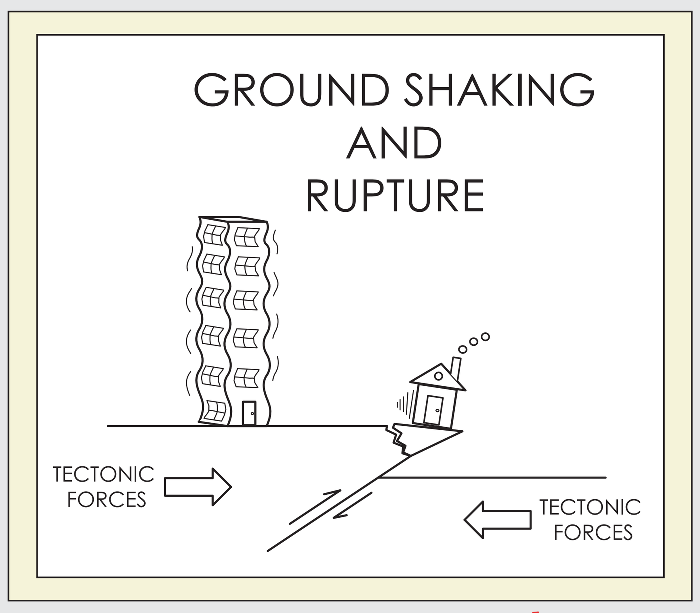
DOOM AND GLOOM ? understanding potential geologic hazards in the Humboldt Bay region

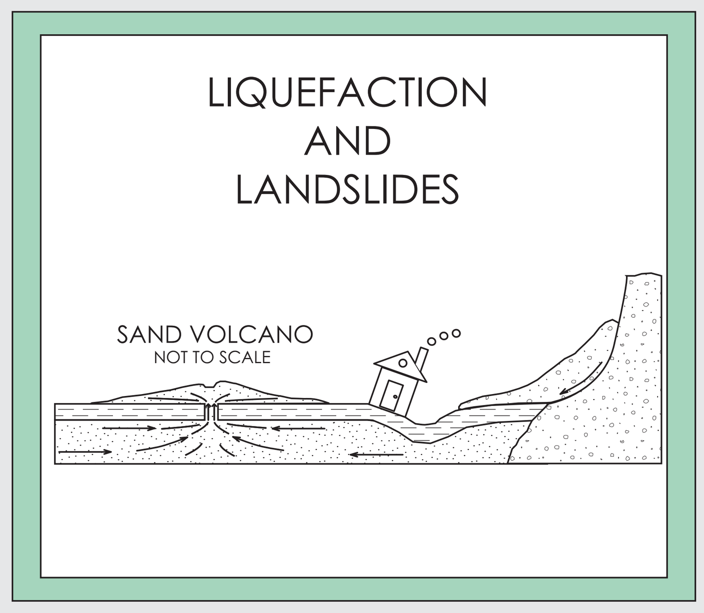
produced by the CASCADIA GEOSCIENCE COOPERATIVE

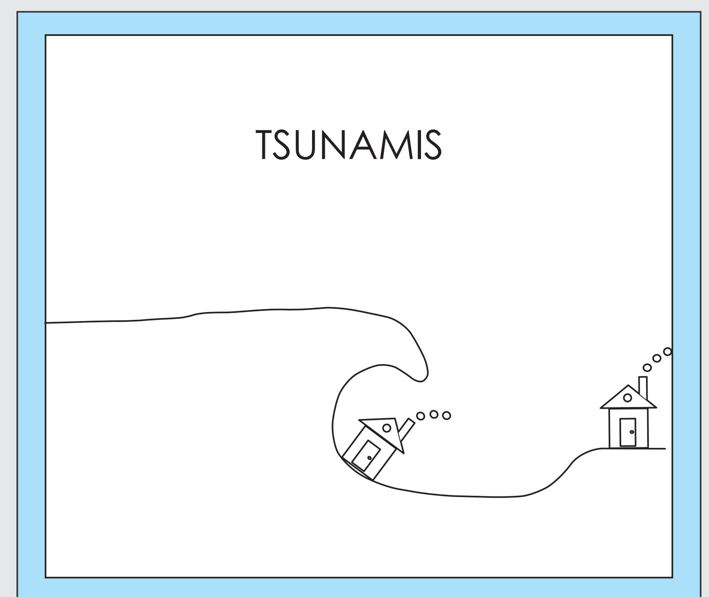
Earthquakes are a significant hazard in Northern California and can be expected to continually affect the Humboldt Bay region. There's nothing we can do about the earthquakes, but **we can inform ourselves about, and prepare for, the effects of these acts of nature.** By having a basic understanding of the hazards associated with earthquakes, we can make better decisions as we construct our future plans for the Humboldt Bay region. There are many potentially damaging effects which are commonly associated with large earthquakes, these include: ground shaking, surface rupture, liquefaction, landsliding, and tsunamis. The purpose of this poster is: 1) to provide a basic understanding of some of the processes and effects of these phenomena, and 2) to mention a few mitigation strategies. We cite a plethora of references to facilitate a better understanding of these phenomena as they relate to the Northern California area.

EARTHQUAKE RELATED HAZARDS IN THE HUMBOLDT BAY REGION

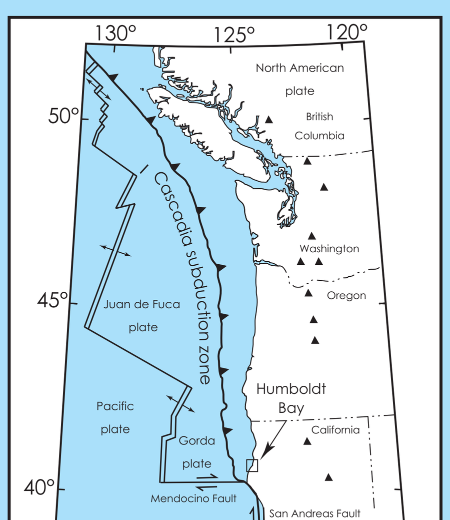






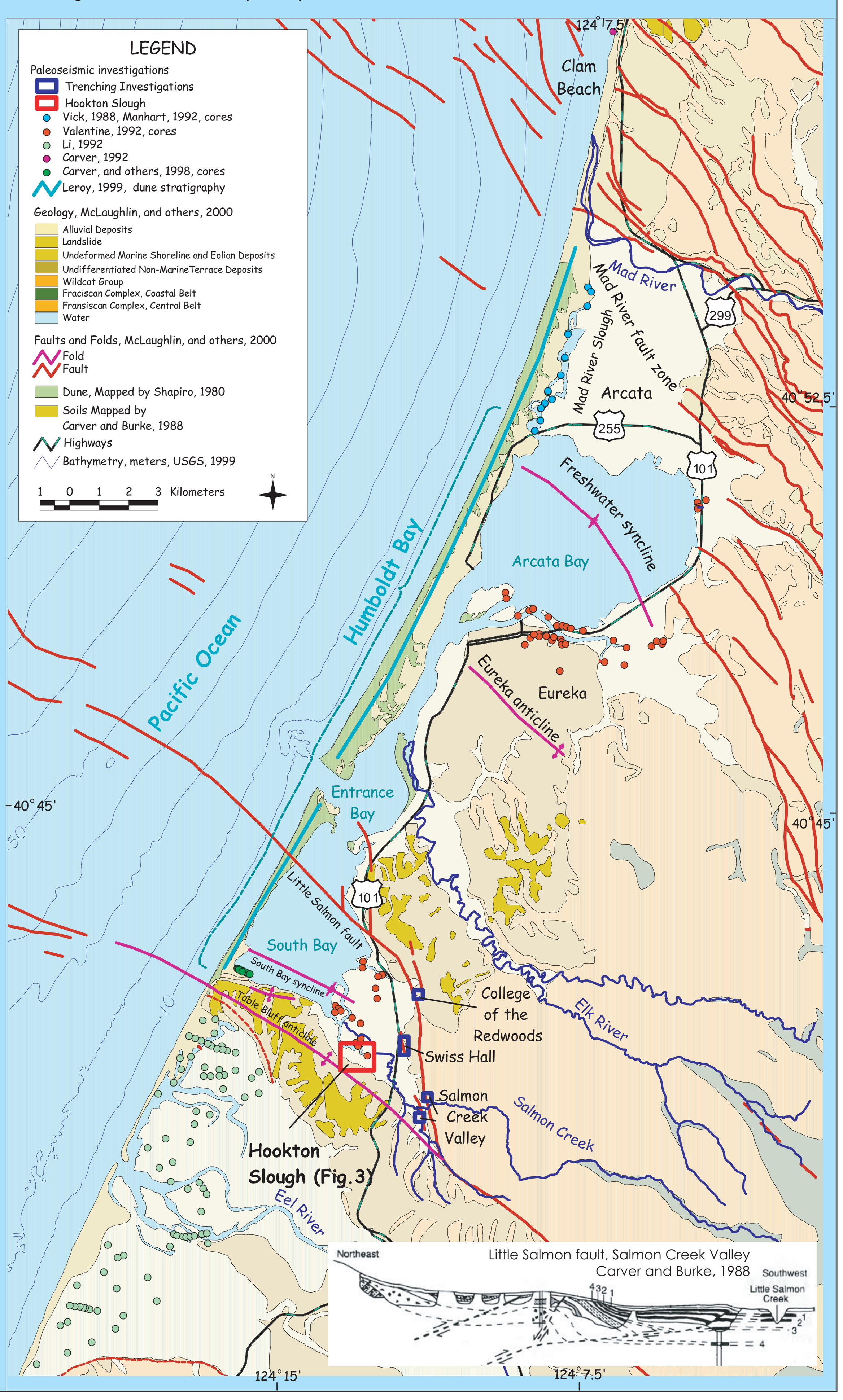


EARTHQUAKES: What earthquake faults are near your house?



The Cascadia subduction zone is a locked convergent plate boundary capable of generating Great (magnitude 8.5 or higher) earthquakes and tsunamis.

Geologic map of Humboldt Bay region showing upper plate **faults and folds.** Geology is from McLaughlin and others (2000). Colored dots show locations of other paleoseismic sites (Shapiro, 1980, Carver and Burke, 1988, Vick, 1988, Carver, 1992, Clarke and Carver, 1992, Li, 1992, Valentine, 1992, Carver and others, 1998, Leroy, 1999). Terraces mapped by Carver and Burke are shown for Table Bluff anticline. Faults were mapped by Carver and Burke (1987) and McLaughlin and others (2000).



local references: EARTHQUAKES

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http://earthquake.usgs.govlocal

SHAKING and RUPTURE

Earthquakes occur when pressure building up in the earth's crust becomes more than the crust can take. . . . . . . and the crust cracks (or ruptures), usually along pre-existing features called faults. This rupture releases energy that had been built up in the crust, some of which we feel and call earthquakes.

Ground shaking and surface rupture are perhaps the most common phenomena people associate with earthquakes although not every earthquake causes surface rupture and for that matter, we don't feel most of the micro-earthquakes that occur almost daily. There are both **regional and local faults** which **are capable of causing hard ground shaking and surface rupture**. Every fault has a different level of activity and potential energy release that occurs during a earthquake. The state of California classifies a fault as active if it shows evidence of activity in the last 11,000 years. (a short time geologically)

There are many **local faults** that show evidence of surface rupture and or deformation in the last 11, 000 years, **these include the Little Salmon fault zone and** faults within the **Mad River fault zone**.

The pictures on the right show some of the effects of hard ground shaking and surface rupture. The upper pictures are from the 1992 Petrolia earthquake, this quake had a magnitude of 7.0. and was centered around the town of...yup you guessed it....Petrolia. Localized effects of the quake included ground cracking, land level changes, and hard ground shaking, especially evident in Ferndale where structure collapse damaged the car below. The two lower pictures are from the Taiwan earthquake on September 21, 1999. This earthquake was from a thrust fault (a fault caused from compression) and was a magnitude 7.5. Many of the faults in the Humboldt Bay region are thrust faults and could exhibit similar damage characteristics if they were to rupture.

Mitigating for ground shaking and surface rupture can be accomplished in many ways including structural engineering and careful site location. **Assessing the potential risks and consequences at future development sites is one of the most important facets of long term community planning.**

Damage in Fenrdale from shaking during the 1992 Petrolia earthquake. A dog inside the car survived this destruction. **Be careful where you park.** Photo credit: http://www.ngdc.noaa.gov

Damage from shaking during the 1992 Mw 7.0 Petrolia earthquake.
Photo credit: http://www.ngdc.noaa.gov

Fault rupture in Taiwan caused this bridge to collapse. Compression during the earthquake squeezed the bridge to peices.
Photo credit: http://earthquake.usgs.gov

Sept. 21, 1999 Mw 7.5 fault rupture in Taiwan caused this running track to buckle. **A destroyed track is better than a destroyed hospital.**
Photo credit: http://earthquake.usgs.gov

local references: GROUND SHAKING AND RUPTURE

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LIQUEFACTION

Liquefaction is a process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in wet sand near water at the beach. This effect can be caused by earthquake shaking. Liquefaction takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking.

Liquefaction occurring beneath buildings and other structures can cause major damage during earthquakes. For example, the 1964 Niigata earthquake caused widespread liquefaction in Niigata, Japan which destroyed many buildings (photo right bottom). Also, during the 1989 Loma Prieta, California earthquake, liquefaction of the soils and debris used to fill in a lagoon caused major subsidence, fracturing, and horizontal sliding of the ground surface in the Marina district in San Francisco.

Areas adjacent to Humboldt Bay are often underlain by soft soils. These soft soils can be susceptible to liquefaction. **Liquefaction susceptibility studies can estimate the potential conditions at specific locations**. (excerpted from: http://earthquake.usgs.gov/image_glossary/liquefaction.html)

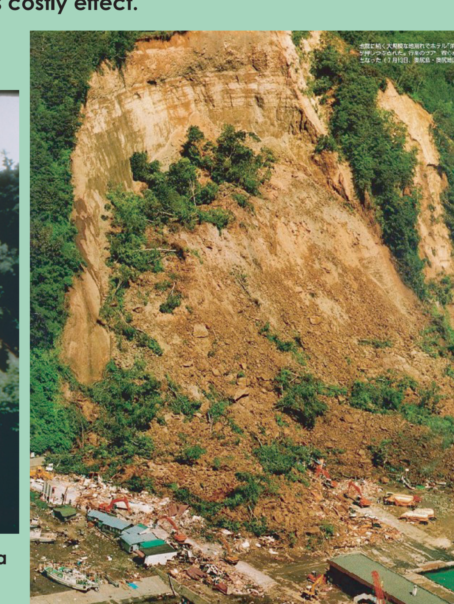
Earthquake fissure filled with intruded sand, formed at the time of the New Madrid earthquake. Mississippi County, Arkansas, 1904.

Photo from the Earth Science Photographs from the U.S. Geological Survey Library, by Joseph K. McGregor and Carl Abston, U.S. Geological Survey Digital Data Series DDS-21, 1995.

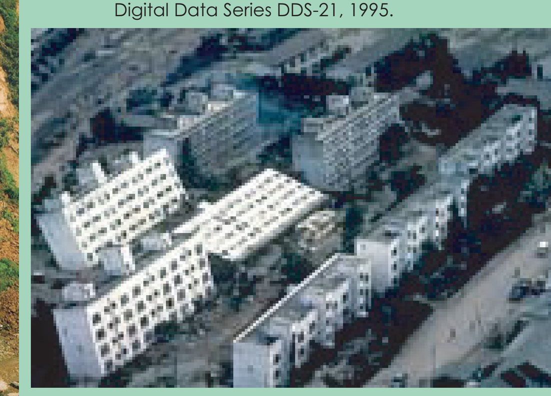
LANDSLIDES

Landslides are common in Humboldt County largely due to the soft bedrock and the high precipitation. Landslides occur when hillslopes are unable to support themselves due to changes in stability. Changes in stability can be influenced by at least three factors: 1) increased ground water in the hillside, 2) undercutting effects, such road building and river scour, and 3) ground shaking. These factors can work independently or in conjunction with each other to enhance the risk of landsliding. Following the 1992 Petrolia earthquake, many landslides were mapped by geologists and local volunteers. **Often well trained geologists can identify sites where instability may be an issue, this can help avoid or mitigate for potential landslide damage and its costly effect.**

Landslide damage as a result from shaking during the **1992 Mw 7.0 Petrolia earthquake.**
Photo credit: http://www.ngdc.noaa.gov



Ground shaking induced landslide near Okus Japan,
Photo credit: Y.Tsuji



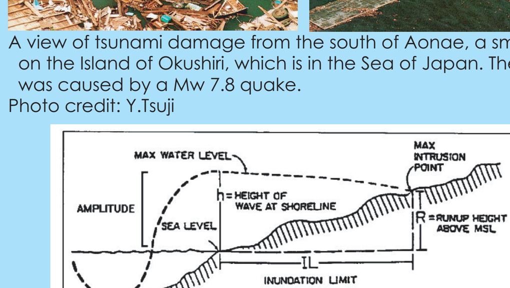
Tilting of apartment buildings at Kawagishi-Cho, Niigata, produced by liquefaction of the soil during the 1964 Niigata Earthquake.
Photo credits:Godden Collection, Earthquake Engineering Research Center, University of California, Berkeley.

TSUNAMI: GET TO HIGH GROUND

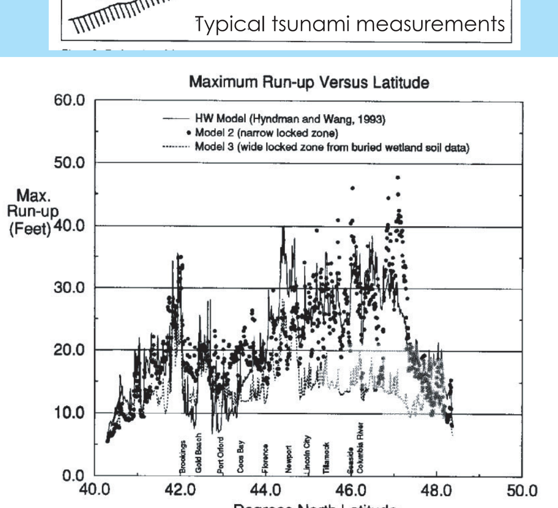
A view of tsunami damage from the south of Aonae, a small town on the Island of Okushiri, which is in the Sea of Japan. The tsunami was caused by a Mw 7.8 quake in 1993. Photo credit: Y.Tsuji

Just the mention of the word tsunami in some regions of the world will bring on tales of survival, tragedy, shock and awe. **Some of the most devastating effects associated with earthquakes come from tsunamis.** Tsunamis are typically generated by earthquakes and submarine landsliding, and they can travel across the entire Pacific Ocean at the speed of a typical passenger jet. Contrary to popular belief, **a tsunami is not like a wave crashing down along the coast, its more like an extremely rapid tidal cycle of unimaginable proportions.** To the north of us, Crescent City has had two long distance tsunamis inundate its coastal zone in the last 50 years. Both the 1960 earthquake in Chile (the largest recorded earthquake ever), and the 1964 Good Friday earthquake in Alaska generated tsunamis that inundated the coast at Crescent City. The figure below shows the extent of the inundation from the 1964 tsunami event at Crescent City. Many **Coastal Marshes between the Smith River and South Humboldt Bay** archive evidence of coastal tsunami inundation. These marshes **contain evidence for tsunamis** as far back as 3500 years before present. Of the many coastal marshes, Crescent City, Lagoon Creek, and South Bay contain the most complete record of tsunami inundation, along with the most detailed site descriptions. Most of these locations are addressed in several Humboldt State University Masters Theses. **The tsunami hazard is being considered by local planners, researchers, and local public representatives.**

A view of tsunami damage from the south of Aonae, a small town on the Island of Okushiri, which is in the Sea of Japan. The tsunami was caused by a Mw 7.8 quake.
Photo credit: Y.Tsuji



Typical tsunami measurements



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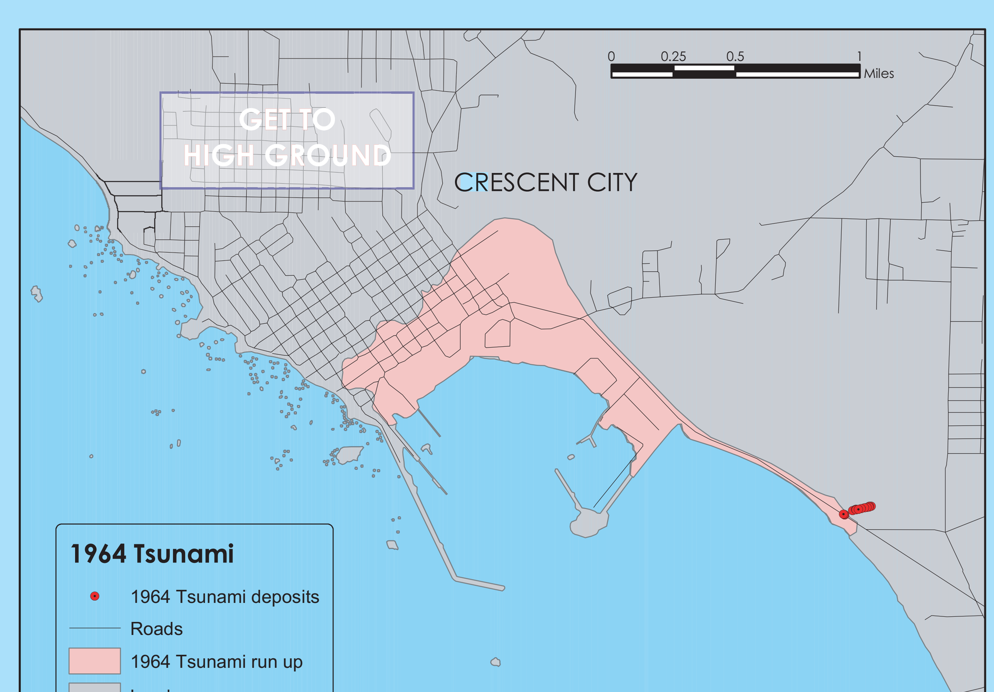

Tsunami inundation from the 1964 Alaska earthquake in Crescent City.

View of tsunami damage from highway to Camaná. Damage from the June 23, 2001 Peru Tsunami.

Photo credits: http://walrus.wr.usgs.gov/peru2/damage.html

local references: TSUNAMIS

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internet resources

http://www.humboldt.edu/~geodept/earthquakes/eqk_info.html HSU Geology earthquake information
http://quake.wr.usgs.gov/ Earthquake hazards program northern California
http://quake.geo.berkely.gov/ Northern California earthquake data center