Cascadia Subduction Zone

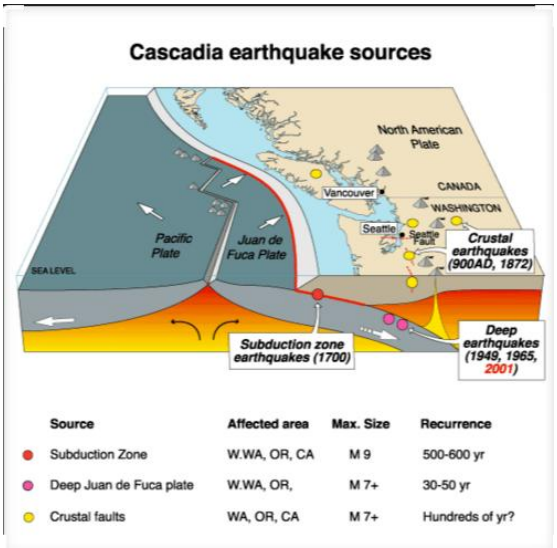
The SBCA hosted Dr. Emily Roland yesterday afternoon for a talk on the earthquake and tsunami risk from the Cascadia Subduction Zone. I added additional information specific to our neighborhood at the end in a section called Preparation.

Background

We sit on the tiny Juan de Fuca Plate with the Juan de Fuca ridge as a spreading center slowly pushing us eastward from Pacific Plate. Meanwhile, the North America plate continues to be pushed westward. In geologic terms, that is a problem as two plates are converging and something has to give. Not unlike a very slow speed head on car wreck, there is some crumpling of the plates causing mountain ranges to uplift and cracks form to accommodate all the deformation. These cracks are faults. But this crumpling and cracking is not enough. The Juan de Fuca place, being smaller and denser, is actually diving below the North America plate. As it descends, it gets hotter and eventually melts. The molten rock comes up as the Cascade volcanoes.

The section of the Juan de Fuca Plate that is starting its dive under the North America Plate is called the Cascadia Subduction Zone. As you might imagine, there is substantial friction as the coastline from Northern California to Southern Alaska is getting shoved under Eastern Washington, Eastern Oregon, and British Columbia. On occasion this movement gets stuck. Eventually the forces become so great that the plate becomes "unstuck" all at once and causes a major earthquake.

Will it happen again? Very likely. Scientists are actively investigating physical evidence of earthquake traces dating back hundreds or thousands of years. Seismic analysis of the Puget Sound, and, specifically, Discovery Bay suggest that major earthquakes occur in this area every 300 to 500 years. Given that the last major earthquake was in 1700, the potential for another major quake is something that needs to be taken seriously. Scientists are working with local officials to raise awareness and create plans.



Risks

The two risks associated with a major earthquake occurring in the Cascadia Subduction Zone are the earthquake itself, and the potential tsunami that it might generate.

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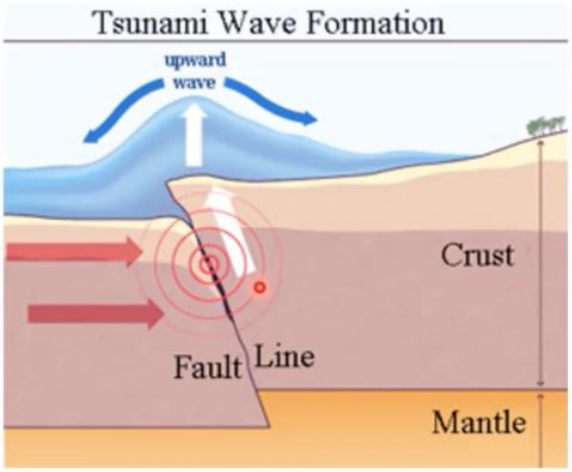
Not all earthquakes generate tsunamis. Many earthquakes occur on "side-slip" faults and the ground shears along the fault line, but there is no vertical movement. Thrust faults, by contrast, frequently include vertical displacement. If that displacement happens under water, the water overhead also is moved vertically, generating an extremely long wavelength wave, known as a tsunami.

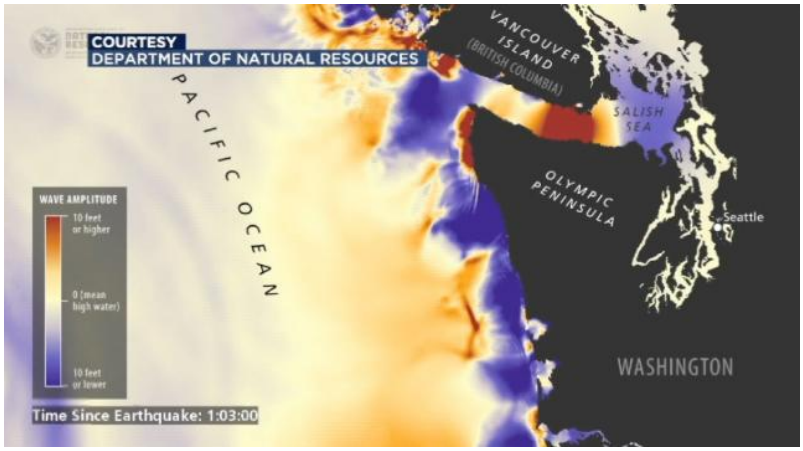


https://www.caloes.ca.gov/EarthquakeTsunamiVolcanoProgramsSite/Pages/Tsunami-About.aspx

Contrary to Hollywood, that tsunami wave in the open ocean is not a monster tipping over ocean liners. It is less than a foot high and no ship would even notice its passing.

Any wave, however, upon getting into shallower water starts to encounter friction with the seafloor below and slows down. As the front of the wave slows, the back of the wave catches up and starts to push up over the front of the wave, building wave height. This is what we see on the beach as surf.

The hideously long wavelength of a tsunami means that the back of the wave just keeps coming even when the front of the wave has already reached the shore. It does not create a massively high wave, but it just keeps coming and coming, pushing farther and farther inland until it reaches an elevation that geologists refer to as inundation height. For example, if your house sits 10 feet above sea level and the inundation height is 15 feet, your house will be under water and likely washed away.



Modeling suggests that the tsunami wave would have an inundation depth of roughly 4m (13 ft) at Port Ludlow some 2 hours after the earthquake. (the image shows the wave at one hour after the quake with the wave passing by Port Angeles).

The damage potential for an earthquake is measured in the US by the Modified Mercalli Intensity Scale, what we see in the news as "magnitude." The chart below shows the potential impact of a magnitude 9 earthquake.

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Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

The actual damage done is dependent on magnitude, distance from the epicenter, depth of the epicenter, home construction and the ground beneath us. Wood frame homes are the safest as the cross-bracing is specifically designed to withstand the forces an earthquake might exert.

Even more critical is the ground we sit on. When the glaciers covered this area 15,000 years ago, they deposited a very thick layer of fine glacial till and sand over most of the Puget Sound region. This stuff is problematic in earthquakes as it provides little stability (known as liquefaction) for any structure sitting on top of it.

Scientists are working with first responders and agencies to prepare plans for the potential for a major earthquake in the Cascadia Subduction Zone. The Puget Sound area will have significant risk of damage in the earthquake, and large parts of the Puget Sound could also suffer inundation from the resulting tsunami.

Preparation

Edgewood Village is somewhat unique for the area. When the glaciers moved south out of Canada and split around the Olympic Mountains, the meltwater also split with one stream carving out the San Juan de Fuca Strait and the other carving out the Hood Canal. One plume of basalt that makes up the Olympic Mountains pushed east. This is called the Crescent Formation and there are a few outcrops of the Crescent Formation basalt beneath us. Edgewood Village sits atop one of these outcroppings. This basalt forms a solid foundation for our houses.

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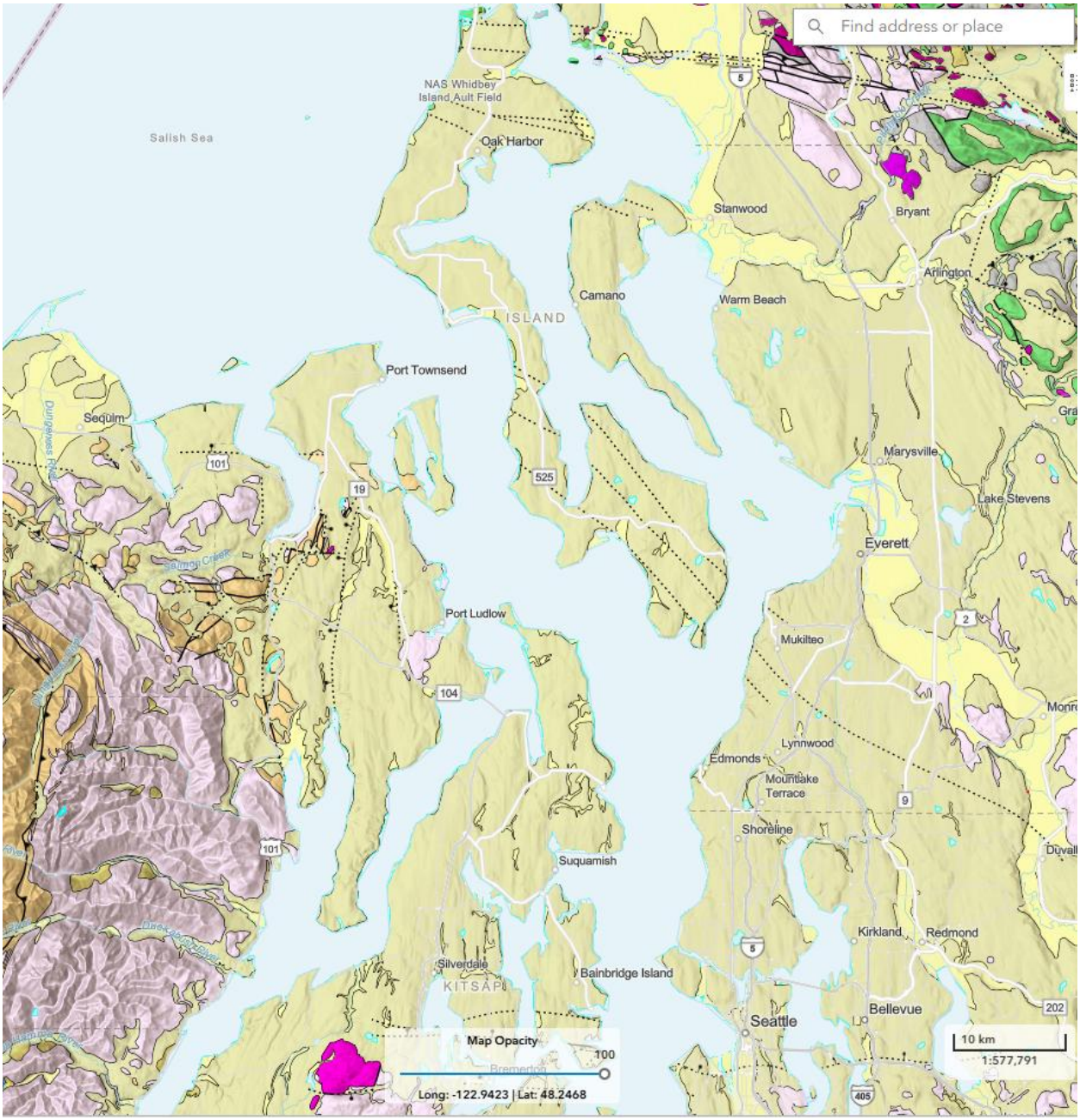
This USGS map show just how unique our area is compared to most of the communities on the Sound. The “pink” is the Crescent Formation basalts. The “tan” is glacial till.



Not only are we situated on rock but above the probable inundation zone of a tsunami generated by a major (magnitude 9) earthquake. That does not mean, however, that we are without risks. Agencies are creating emergency preparedness plans, and it is prudent to have a personal one as well. Some of the considerations include:

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- Falling objects. Although the homes are designed to remain standing through at least a magnitude 8 earthquake, it doesn't mean that things inside the home won't fall off the walls or out of cabinets, and tall pieces may tip over. In an earthquake, getting clonked on the head remains one of the biggest risks. Find shelter under something very solid: a sturdy table, or a door frame away from windows that could shatter.
- Access: The Hood Canal Bridge may be damaged or may well be taken out of service for inspection and repair. The bridge over Ludlow Creek is also at significant risk for damage in an earthquake or tsunami. We may have access to 104 via Teal Lake Road. Emergency rations should be stored as they may become necessary until access is restored.
- Water: The water tank or piping supplying our water might be damaged and out of service. The sewer lines run to the marina treatment plant across the bridge on Ludlow Creek and may be damaged. An adequate supply of drinking as well as laundry, flushing, washing, and cooking water is essential.
- Electricity: The overhead wires along Paradise Bay pose a risk of coming down and cutting off power. Battery backup and food storage options should be considered in your plan.
- Propane: Once it is safe to move again, immediately test the air for any smell of propane. If you smell it, get out instantly. If you don't smell it, go outside and turn off the propane at the tank until you can verify that no damage was done to the piping inside the home carrying propane throughout your house.
- Medical: Getting out to seek medical attention may be challenging. If you cannot get out, it is unlikely first responders can get in to assist. The exception is helicopter evacuation for which insurance is available which might be considered for such eventualities.

Gail Campong and I each have a radio connected to the Jefferson County emergency team. I have put emergency preparedness material on the website. If there is other information that would be helpful to include, please let me know.

The risks are real, but so are the plans in place for responders to act on in the event of this eventuality. Port Ludlow is fortunate as there is water access in the event that all roadways in the area are impassable. Given the potential for region-wide damage, creating a plan for surviving without outside assistance would be prudent. A major earthquake may not happen for another 100 years, but the potential is there. Awareness and planning are key.

Some Resources

- Department of Natural Resources tsunami simulation model (Bing Videos)

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- 2001 Nisqually Earthquake reporting (Bing Videos)
- Get Shake Alerts on your phone (ShakeAlert – Because seconds matter.)
- There is a phone app called MyShake which is a real-time reporting of earthquakes.
- The Emergency Preparedness section of the website.