Chapter 4
Earthquakes and Human Activity

Earthquakes
- Earthquakes are caused by abrupt slip on faults.
- Vibrations (seismic waves) propagate out from the focus of the earthquake.

Global Distribution of Earthquakes
- Most earthquakes occur along plate boundaries.
- Intraplate earthquakes often follow ancient plate boundaries.

Seismic Waves
- Body waves, P-waves (primary) and S-waves (secondary) travel through the interior of the earth.
- Surface waves travel along the surface of the earth.
- Difference in arrival time between the P and S waves reveals the distance from a seismograph to an earthquake.
Earthquake Magnitude and Intensity

- Magnitude (Richter or Moment magnitude) estimates the energy released by a fault rupture.
- Intensity (Modified Mercalli) measurement is based on observed damage and people’s perceptions.

Ground Shaking

- Ground shaking caused by shear waves and surface waves causes damage to structures.
- Buildings are designed to withstand vertical loading, not strong horizontal accelerations.

Earthquake Safety

- Seismic Zoning
- Building Codes
- Seismic retrofitting

Landslides

- Earthquake shaking can trigger landslides on unstable or water-saturated slopes.
- Landslide in volcanic debris triggered by a 7.6 earthquake.

Landslide in volcanic debris triggered by a 7.6 earthquake.

Landslide into home at Salmon Beach near Tacoma.
Spider Lake, SE Olympic Mountains

landslide deposit

Rockslide, possibly quake-induced, dammed stream ~1100 yr BP creating lake that drowned forest.

2001 Nisqually eq damage at Tolmie State Park

2/29/01 by Pat Pringle, view is to North.

Nisqually earthquake, 2/28/01. Damaged road at University Place. Photo by Pat Pringle on 2/28/01


Nisqually quake 2001: damage to road around Capital Lake

Liquefaction

Liquefaction caused by quake shaking can weaken water-saturated soil
Sand volcano caused by liquefaction at Nisqually Wildlife Refuge during the 2/28/01 Nisqually quake. The sand is full of pumice and charred wood that had been deposited here by lahar-derived floods from Mount Rainier!

Uplift/Subsidence

- Faulting can produce vertical motion of the ground surface
- Vertical ground rupture can cause catastrophic damage to structures

April 6, 2010 Mg. 7.2 Baja quake; Borrego fault; ~28 km
Locations of subfossil trees (dots) with respect to faults (lavender), volcanic hazard zones (brown), and landslides (green)—were many of these events triggered by earthquakes?

Catfish Lake and Mill Pond are small lakes dammed by the Tacoma fault (Catfish Lake Scarp) on the Kitsap Peninsula.

Dating of the Tacoma Fault at Catfish Lake
Photo and 14C age by Josh Logan, WADNR on subfossil trees in the lake.

~1200 yr BP?

Damage during the 2001 quake!

Tsunamis
- Tsunamis are caused by rapid vertical motion of the seafloor
- Fault rupture or underwater landslides can cause tsunamis
- Tsunamis can travel rapidly across ocean basins
Earthquake Prediction

- Earthquakes cannot be predicted, but seismologists can estimate the chance of an earthquake occurring on a particular fault segment during a given time frame.

Earthquake Recurrence Intervals

- Faults that have not ruptured for a long time and are not creeping are thought to be at high risk for a future earthquake.
- The last great Cascadia subduction zone quake was January, 1700.

A gap in the historic earthquake pattern along the San Andreas Fault south of San Francisco was filled in 1989 by the Loma Prieta earthquake.

This map of the Pacific coast of Mexico shows faulted segments of the subduction zone and recent seismic gaps between faulted segments (ovals).

Groups of migrating earthquakes on the North Anatolian Fault in Turkey from 967 to 1050, 1254 to 1784, and 1939 to 1999.
Fault Creep

- Some faults continually creep, such as sections of the Hayward and Calaveras faults
- Fault creep offsets curbs and Berkeley Memorial Stadium