

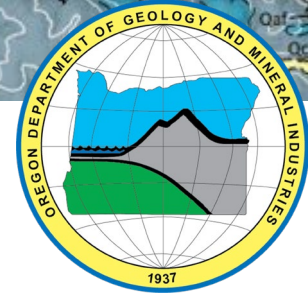
Geologic Hazards in the Gresham Butte Area

Oregon Dept. of Geology and Mineral Industries

Wednesday, January 10th, 2024

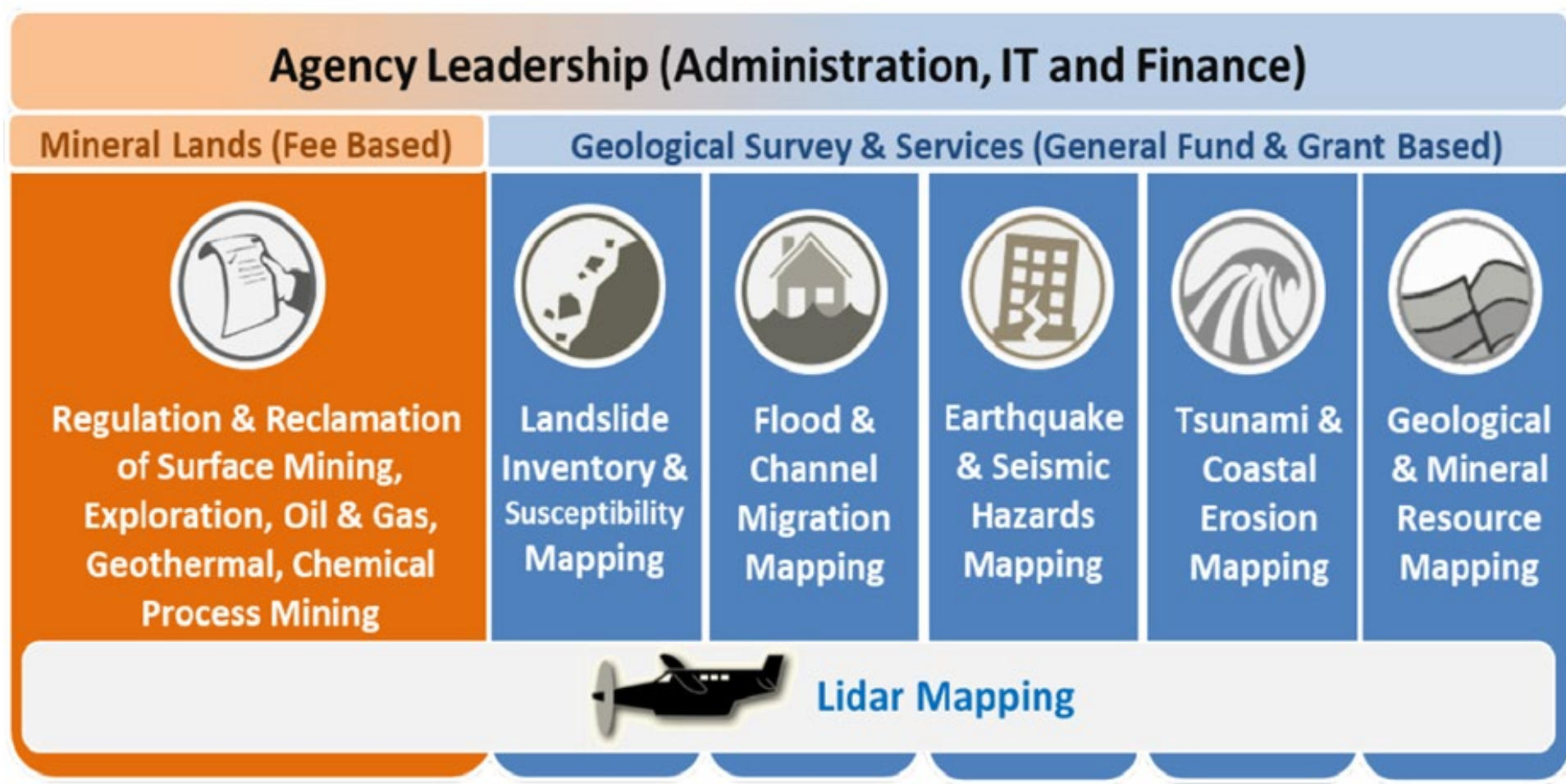
E.F.-Lalo- Guerrero, Ph.D.

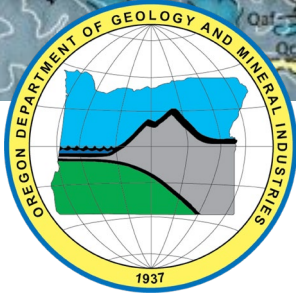
Geology Hazard Specialist



INTRODUCING DOGAMI

MISSION: DOGAMI provides earth science information and regulation to make Oregon safe and prosperous





PRESENTATION OUTLINE

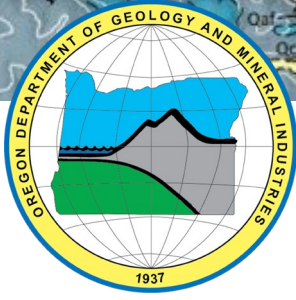
INTRODUCING
DOGAMI

OREGON'S
GEOLOGIC
HAZARDS

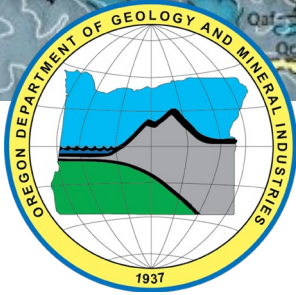
PREPARING
FOR
EMERGENCIES

EARTHQUAKE
LOSS
ESTIMATION
STUDIES

EXPLORING
GRESHAM
BUTTE
HAZARDS



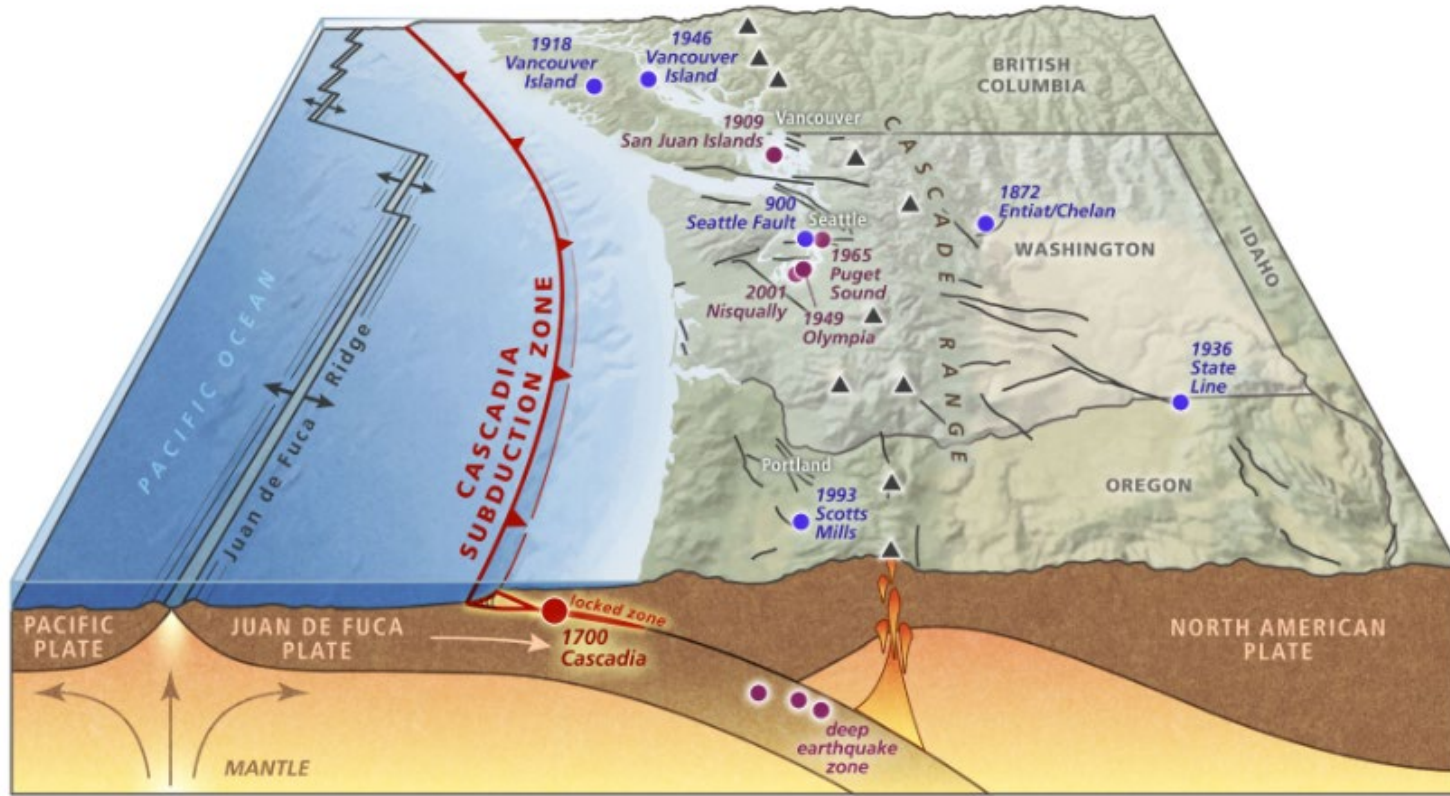
Pacific Northwest Geologic Hazards



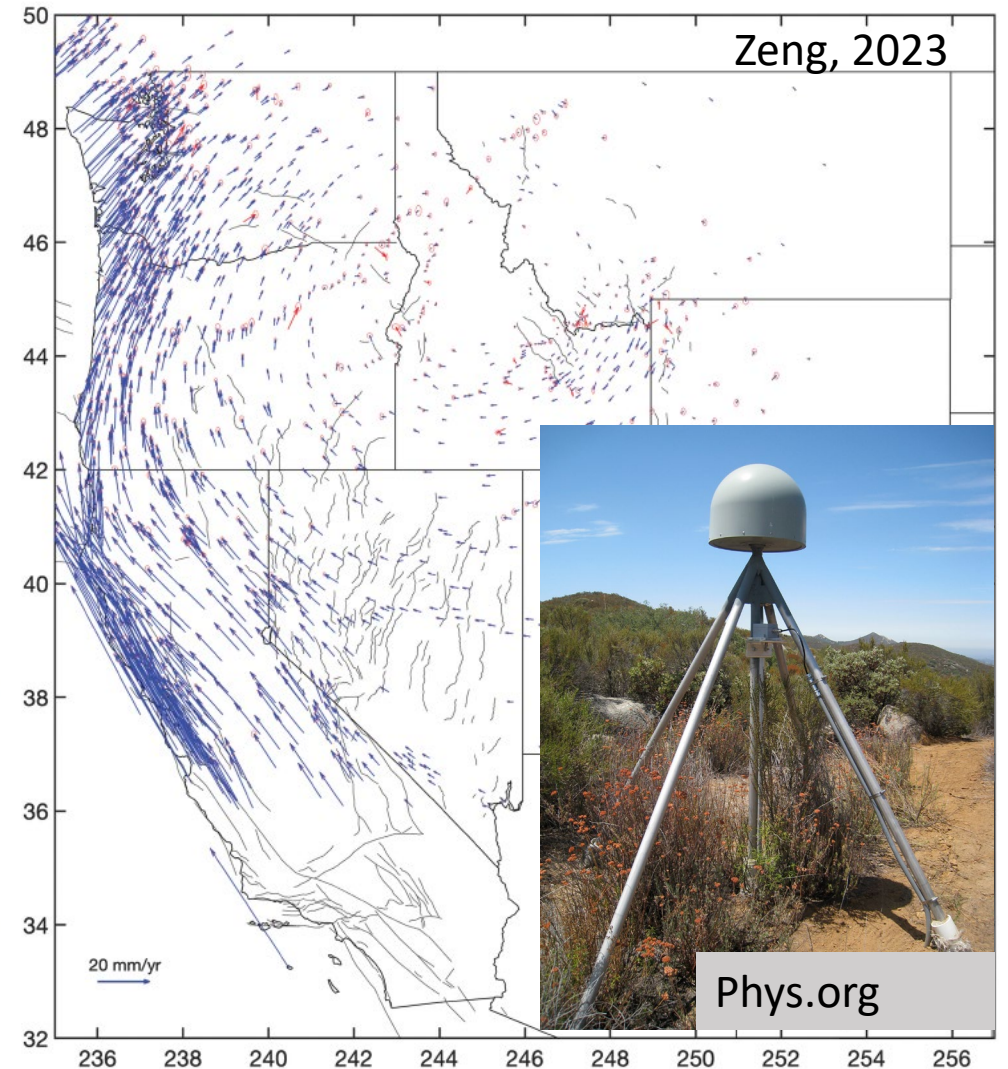
Pacific Northwest Plate Tectonics Overview

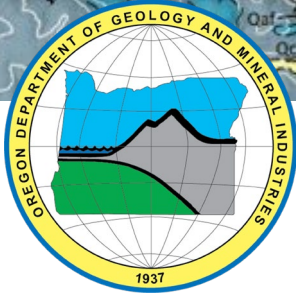
Global Navigation Satellite System

Cross section diagram of the Pacific Northwest

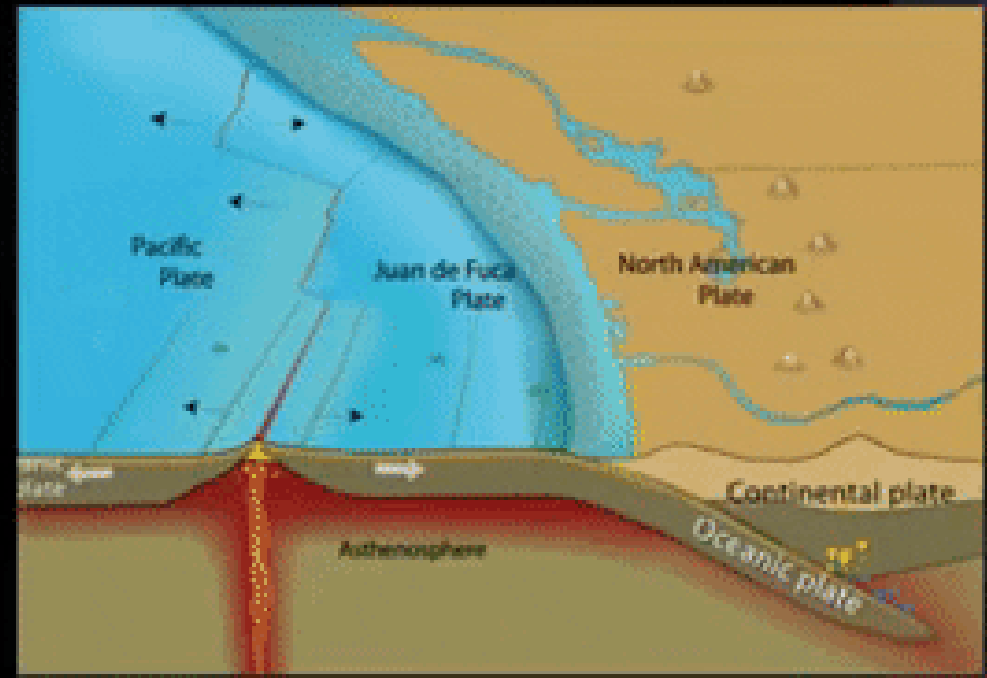


- year 1918 ● crustal earthquake
- deep earthquake
- subduction zone earthquake
- crustal fault
- ▲ major volcano

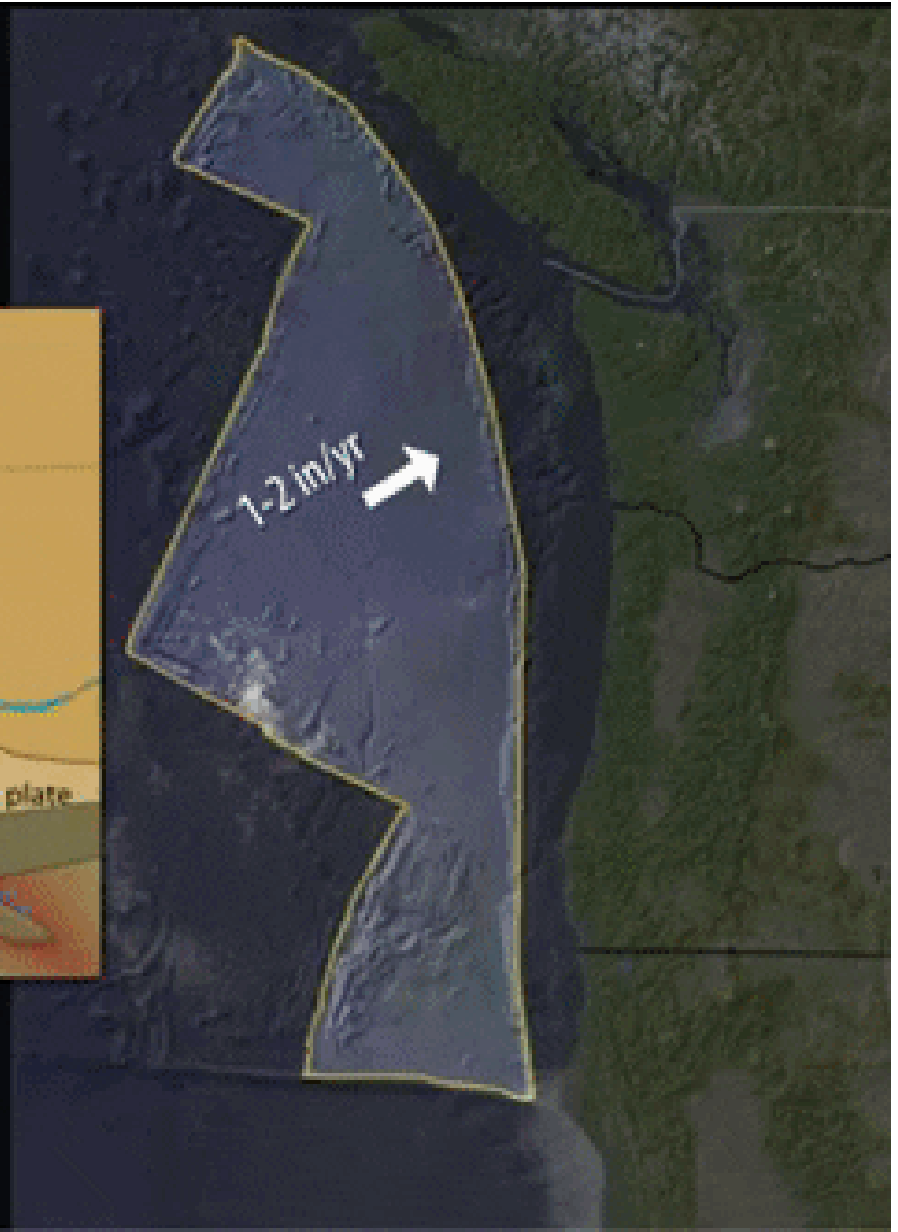


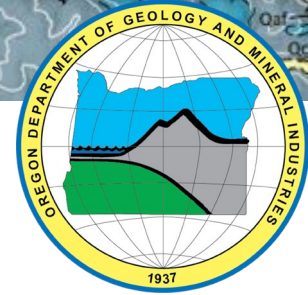


Juan de Fuca Plate



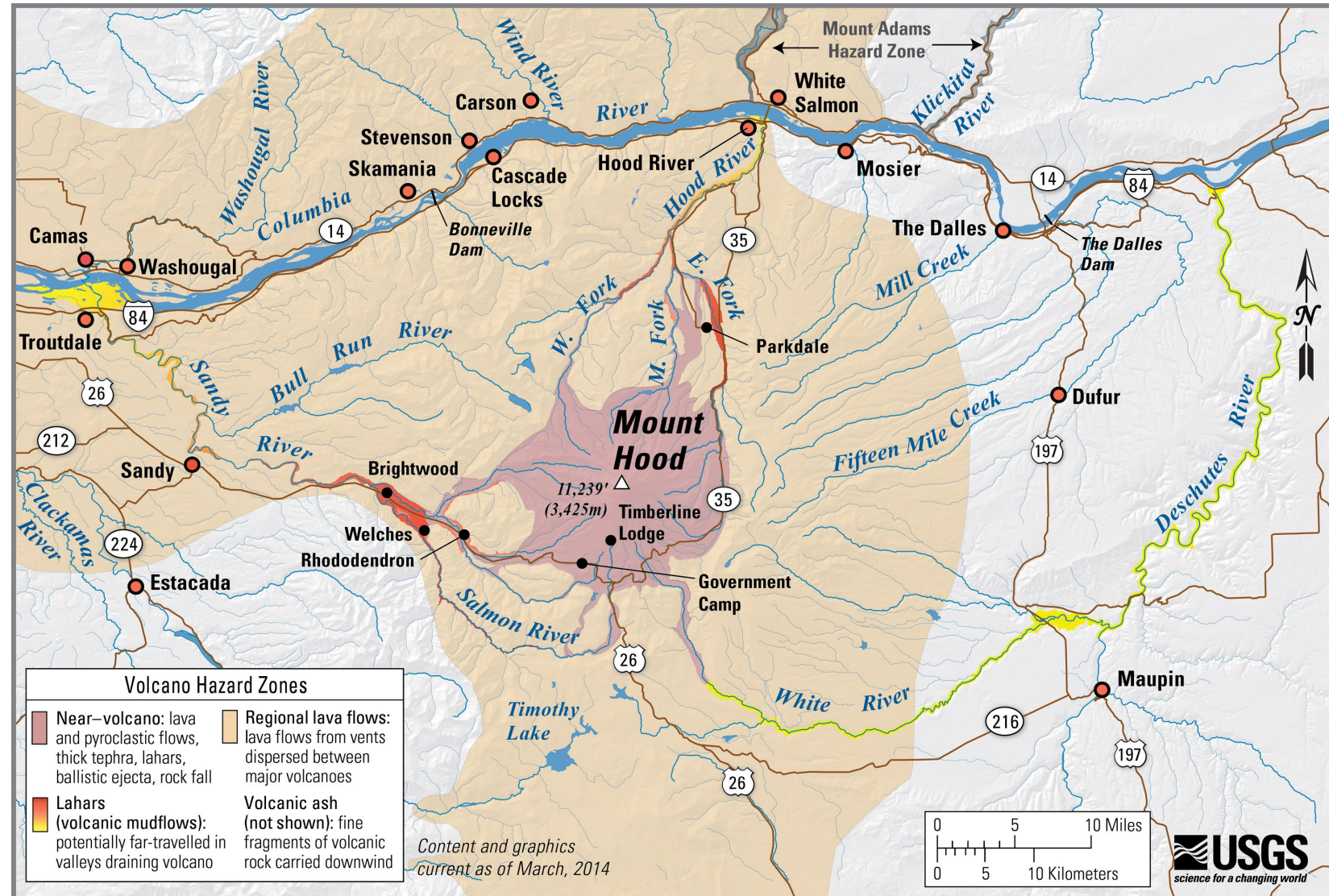
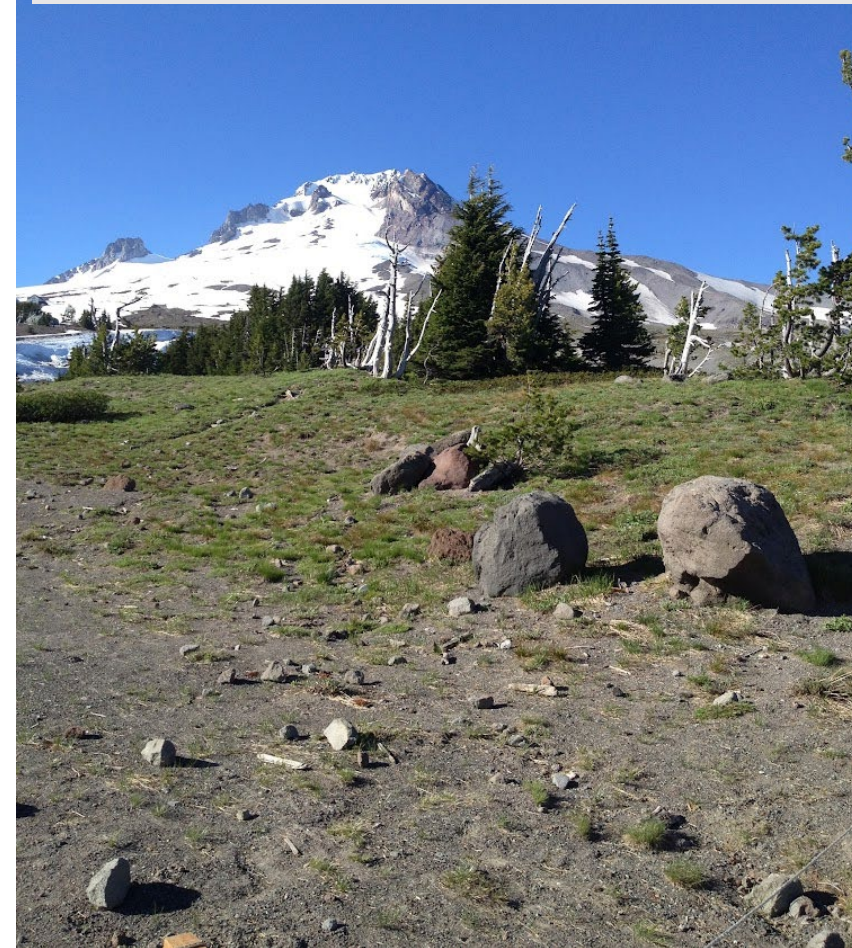
Cross section (Not to scale)





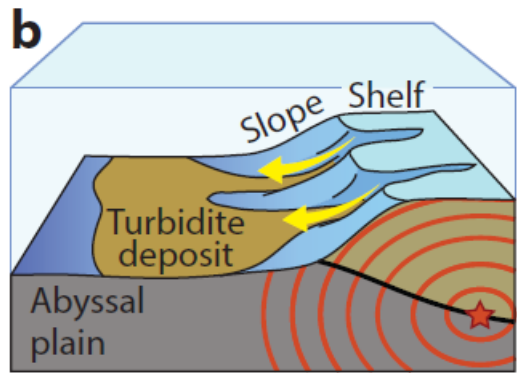
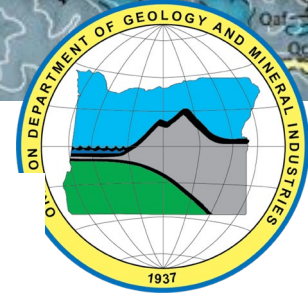
Volcanic Hazards

Mt. Hood/ Wy'east Summit from Timberline Lodge

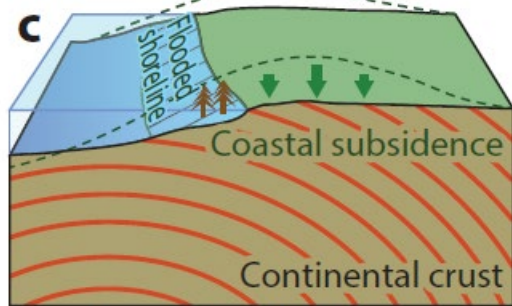


Geologic Hazards in Oregon: Cascadia Subduction Zone

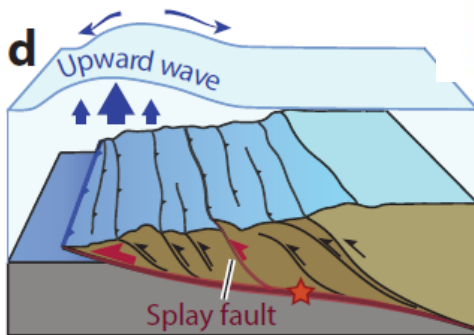
Walton et al, 2021



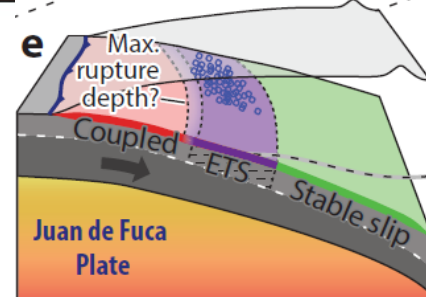
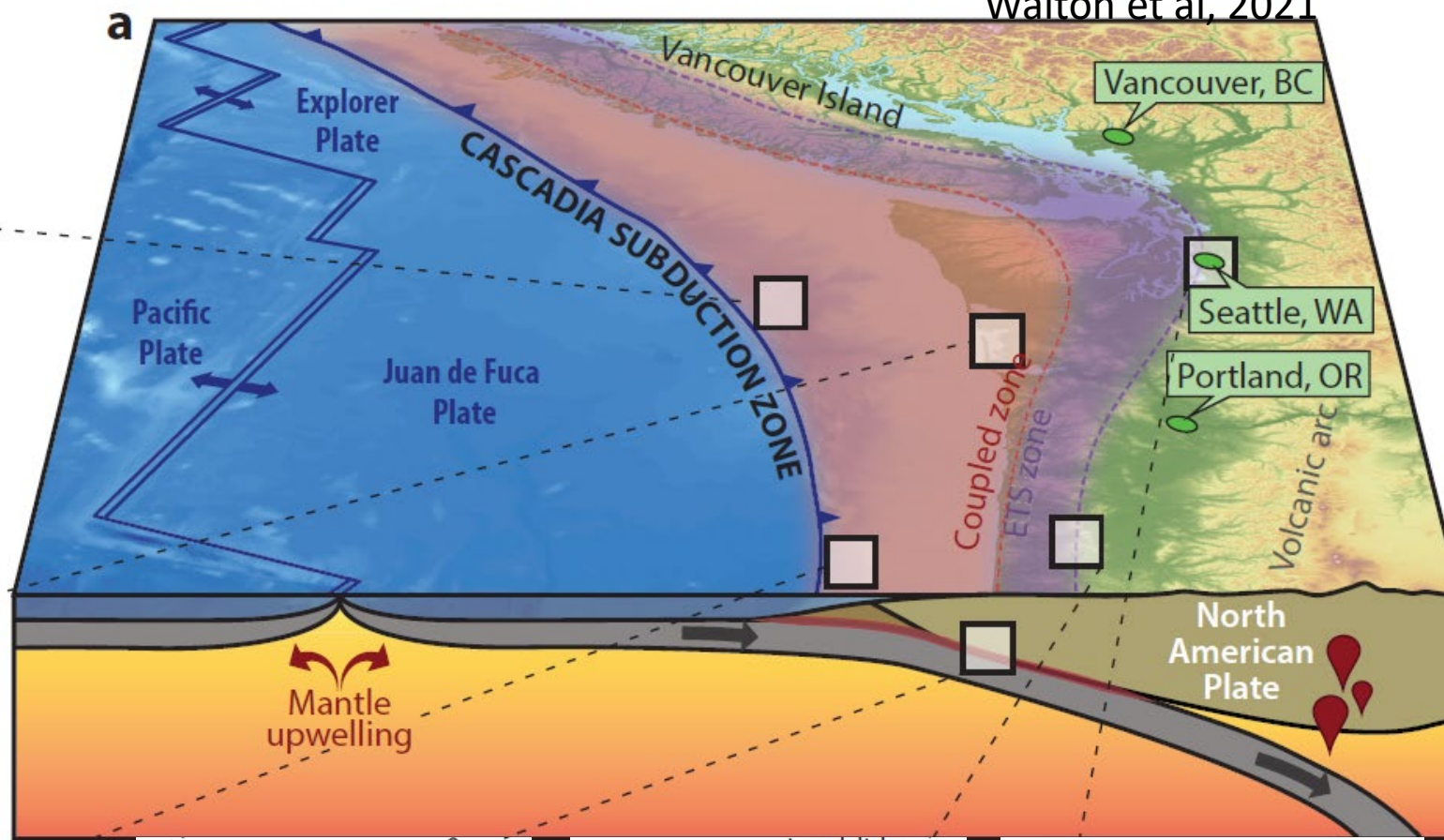
Turbidites



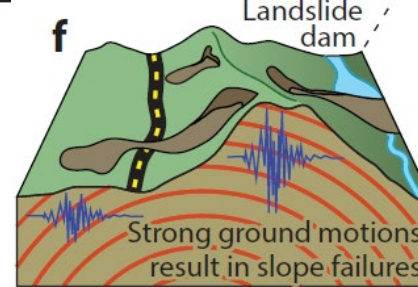
Land-level change



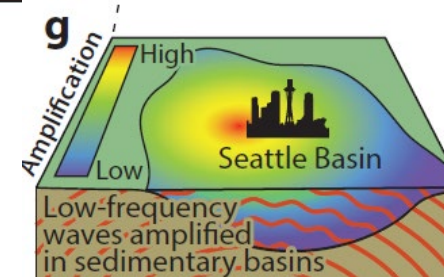
Tsunamis and splays



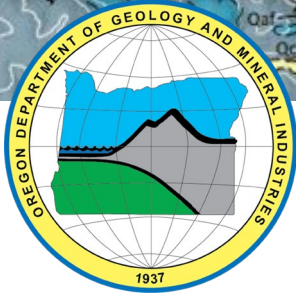
Episodic tremor and slip



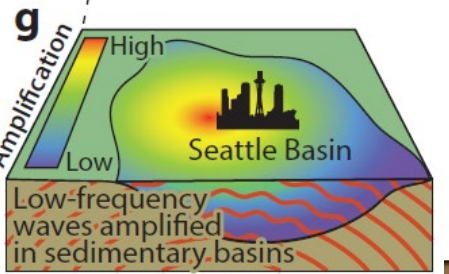
Landslides



Site effects



COSEISMIC HAZARDS



Liquefaction

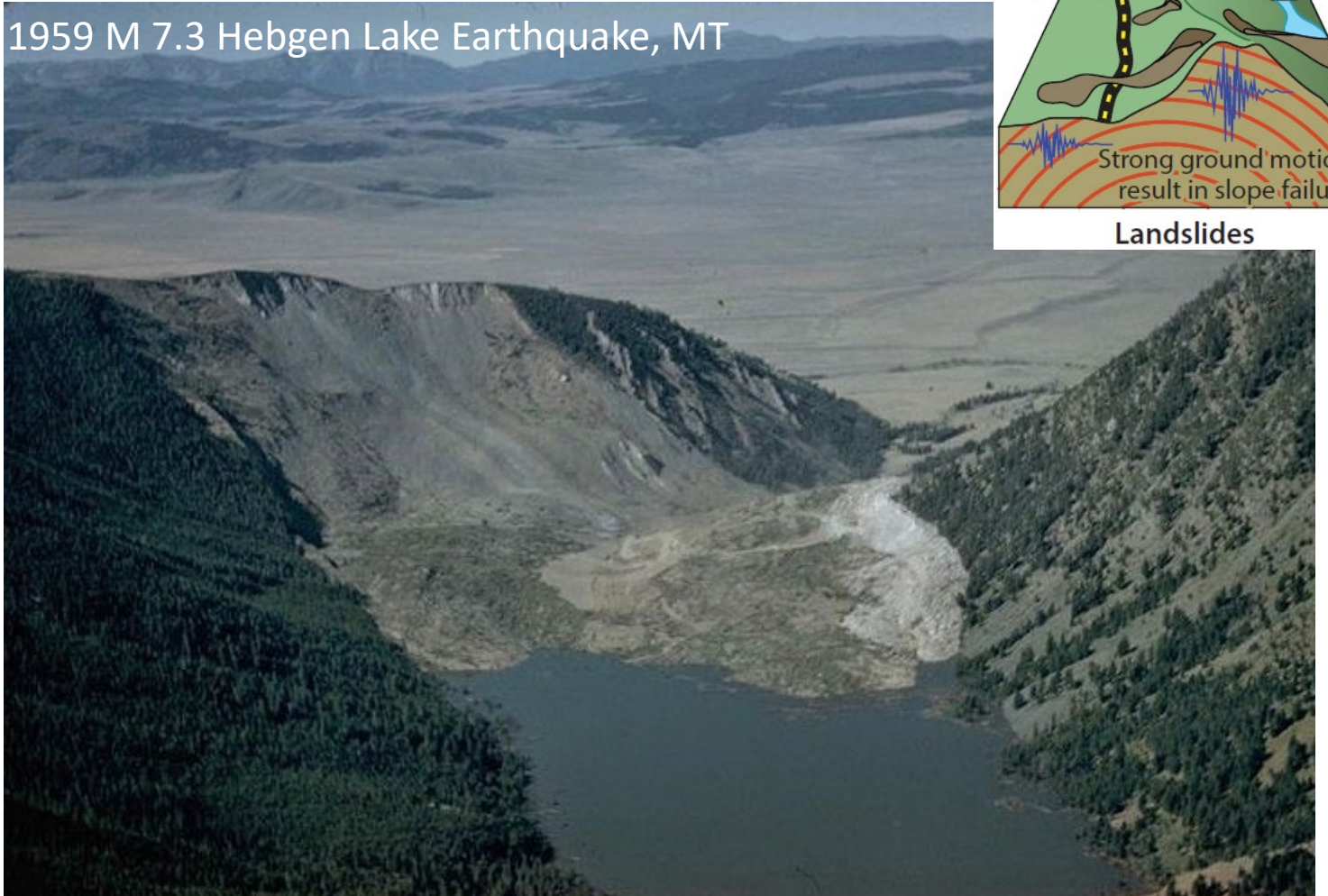


1979 M 6.5 Imperial Valley, CA

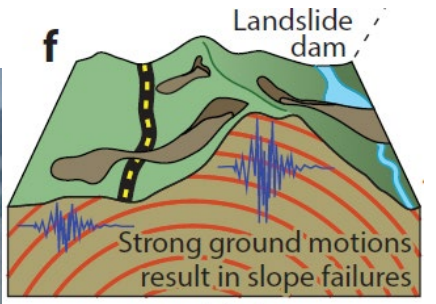


1964 M 7.5 Niigata, Japan

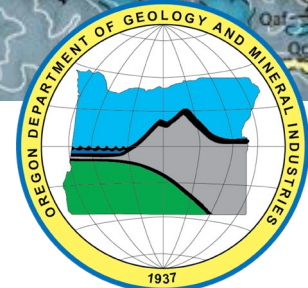
Landslides



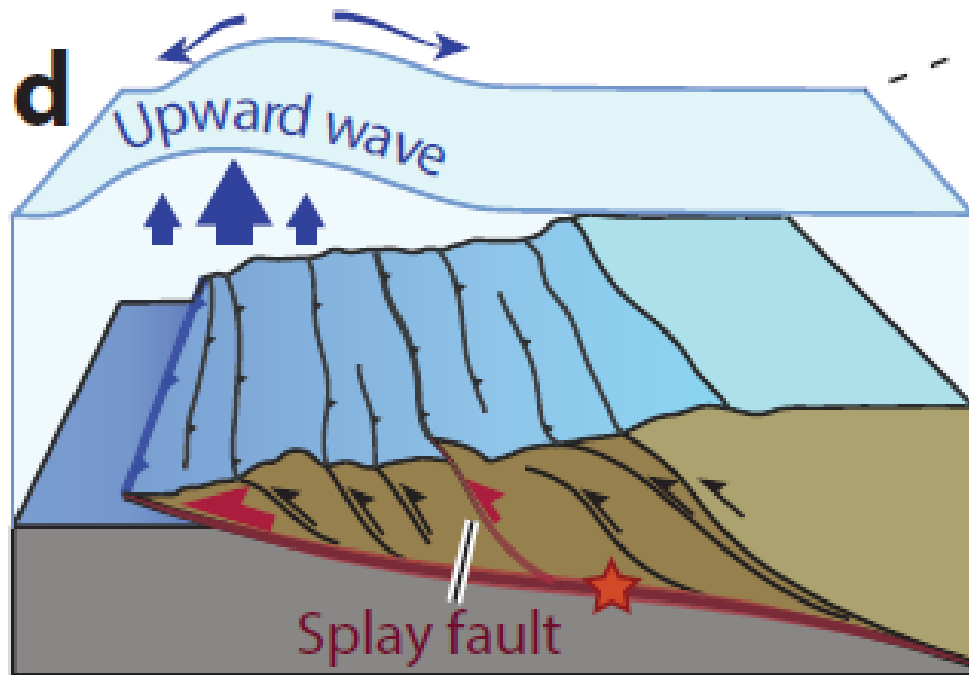
1959 M 7.3 Hebgen Lake Earthquake, MT



Landslides



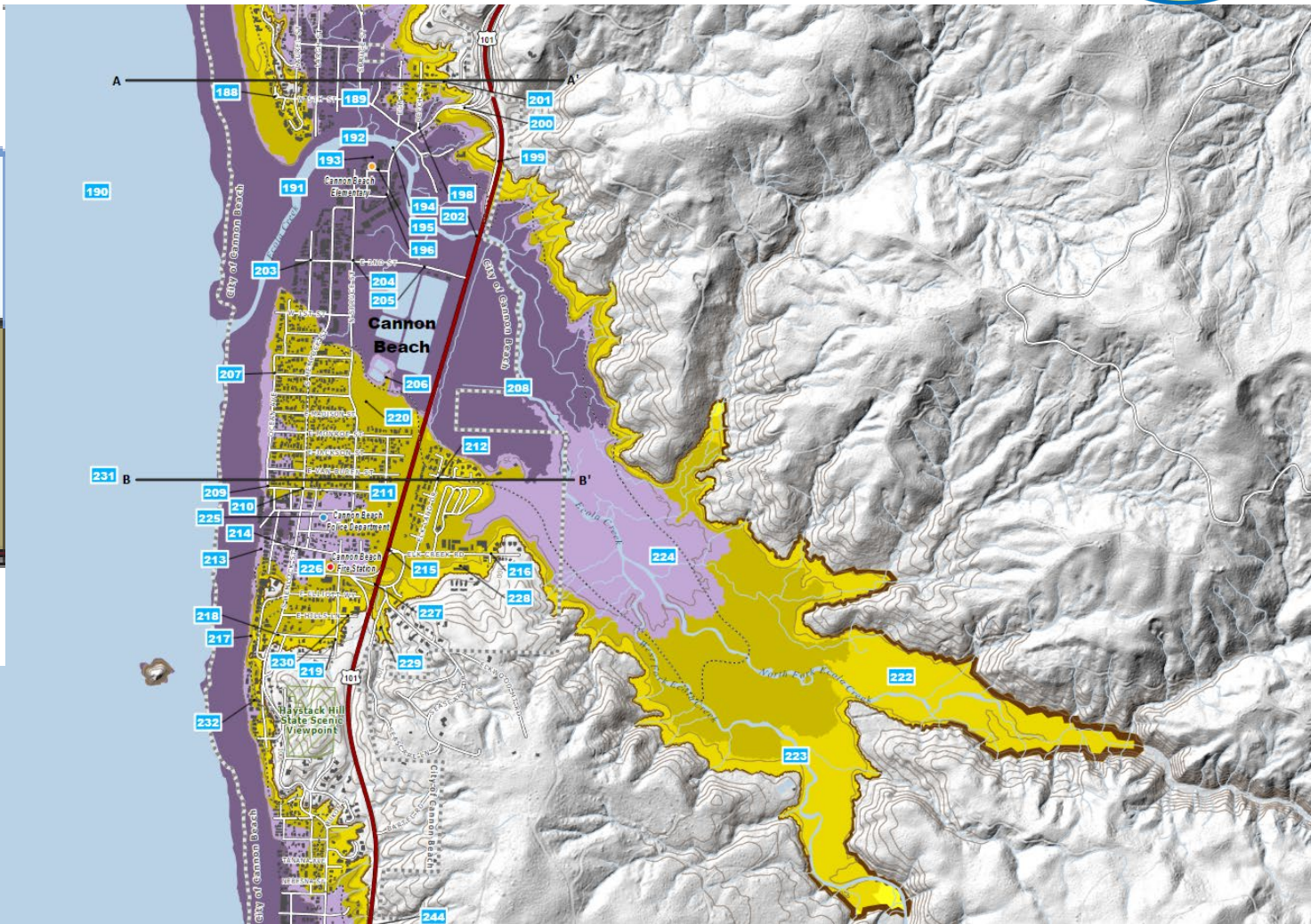
TSUNAMI HAZARDS



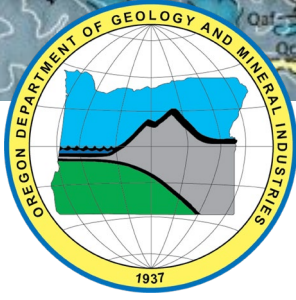
Tsunamis and splays

Local and distal tsunami hazards

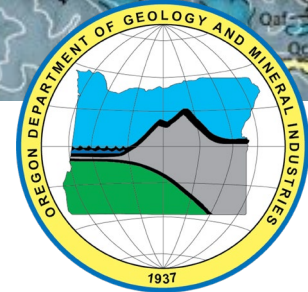
Know your evacuation routes!



<http://Oregon.gov/dogami/Pages/tsunami>

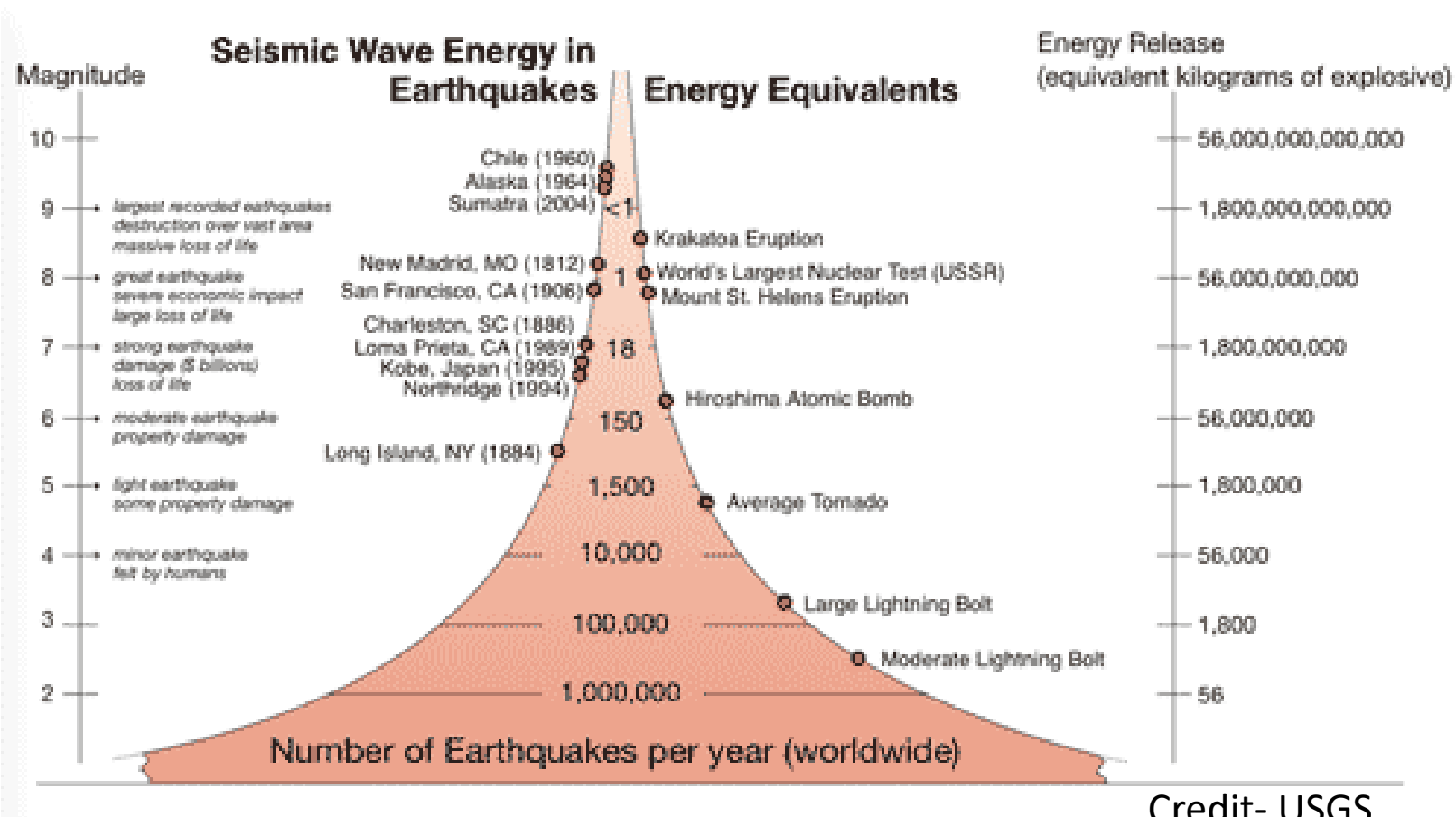


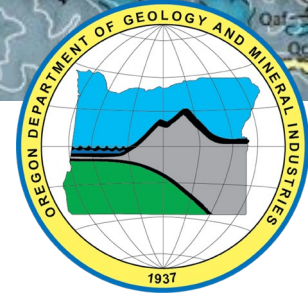
Oregon Earthquake Hazards & How to Stay Safe



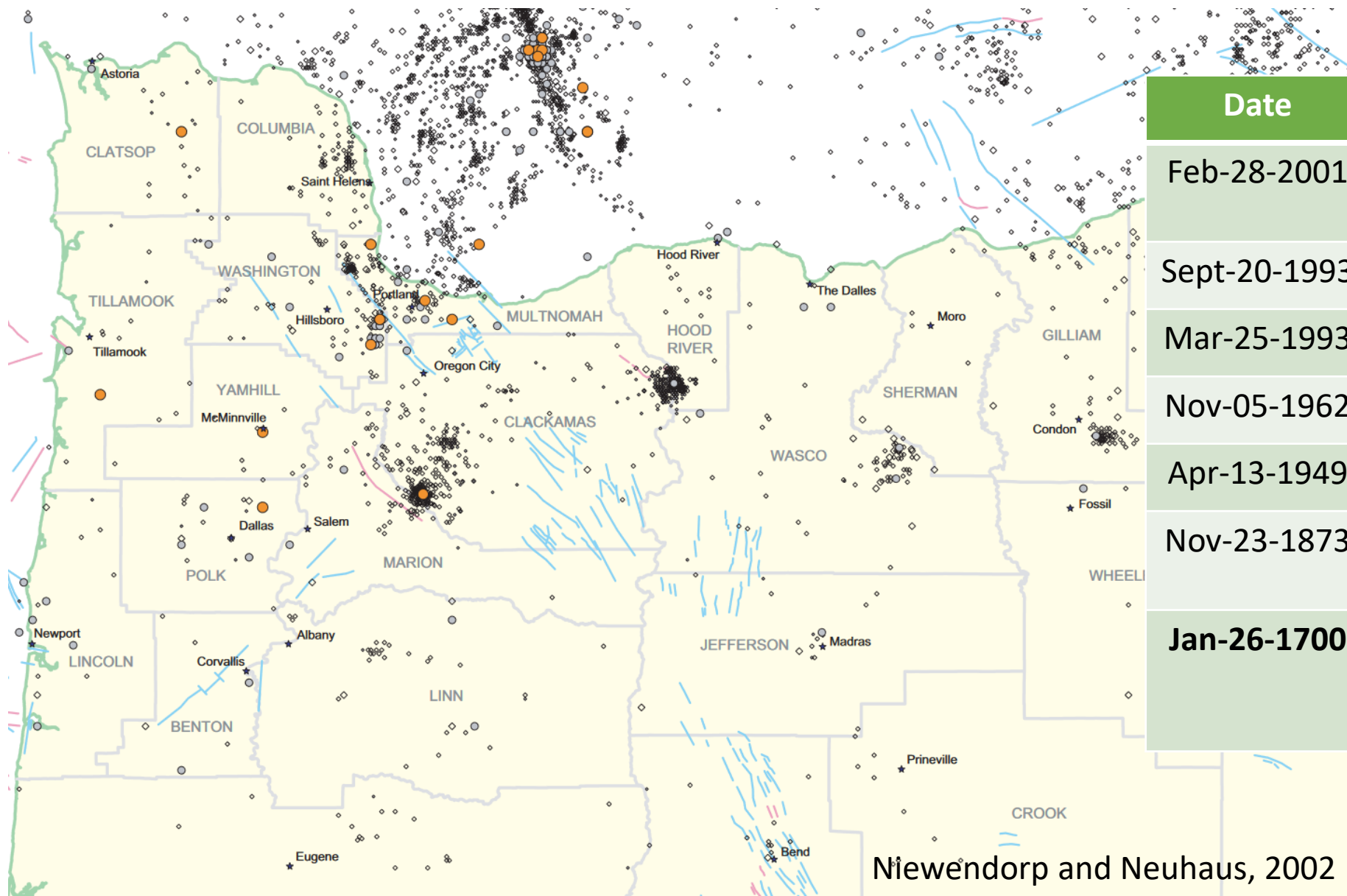
EARTHQUAKE MAGNITUDE

- Measure of the seismic energy released by the earthquake.
- Moment Magnitude Scale (M)
- Measured with seismometers

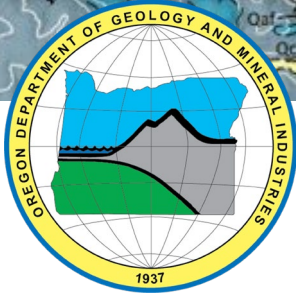




Selection of Historic Regional Earthquakes



Date	Location	Magnitude
Feb-28-2001	Nisqually, WA	6.8
Sept-20-1993	Klamath Falls	5.9; 6.0
Mar-25-1993	Scotts Mills	5.6
Nov-05-1962	Portland	5.5
Apr-13-1949	Olympia, WA	7.1
Nov-23-1873	Offshore of Brookings	6.8
Jan-26-1700	Offshore, Full Margin Rupture	9.0



What happens in an Earthquake?

IRIS

A single seismic station records the arrival of:

- Compressive **P** wave,
- Shearing **S** wave, &
- Rolling **surface** waves

from a distant earthquake

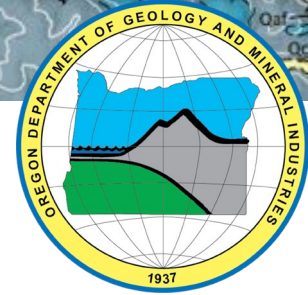
All scales, & building movements will be greatly exaggerated!

Amplitude

Seismogram

TIME, IN MINUTES (since earthquake at time = 0)

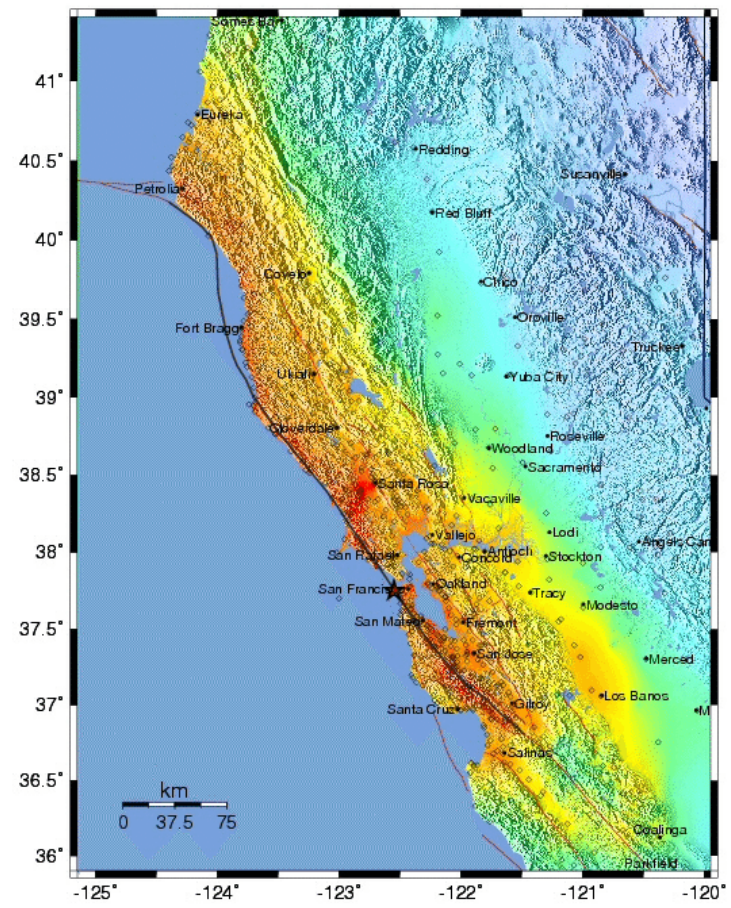
0 10 20 30 40 minutes



EARTHQUAKE INTENSITY

- How the earthquake is felt or experienced at a specific location.
- Modified Mercalli Intensity Scale (MMI)
- Measured with instruments and observations

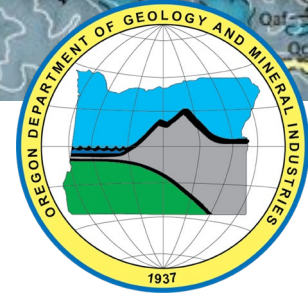
1906 Earthquake, M7.8, Depth 10 km, Epicenter N37.75 W122.55



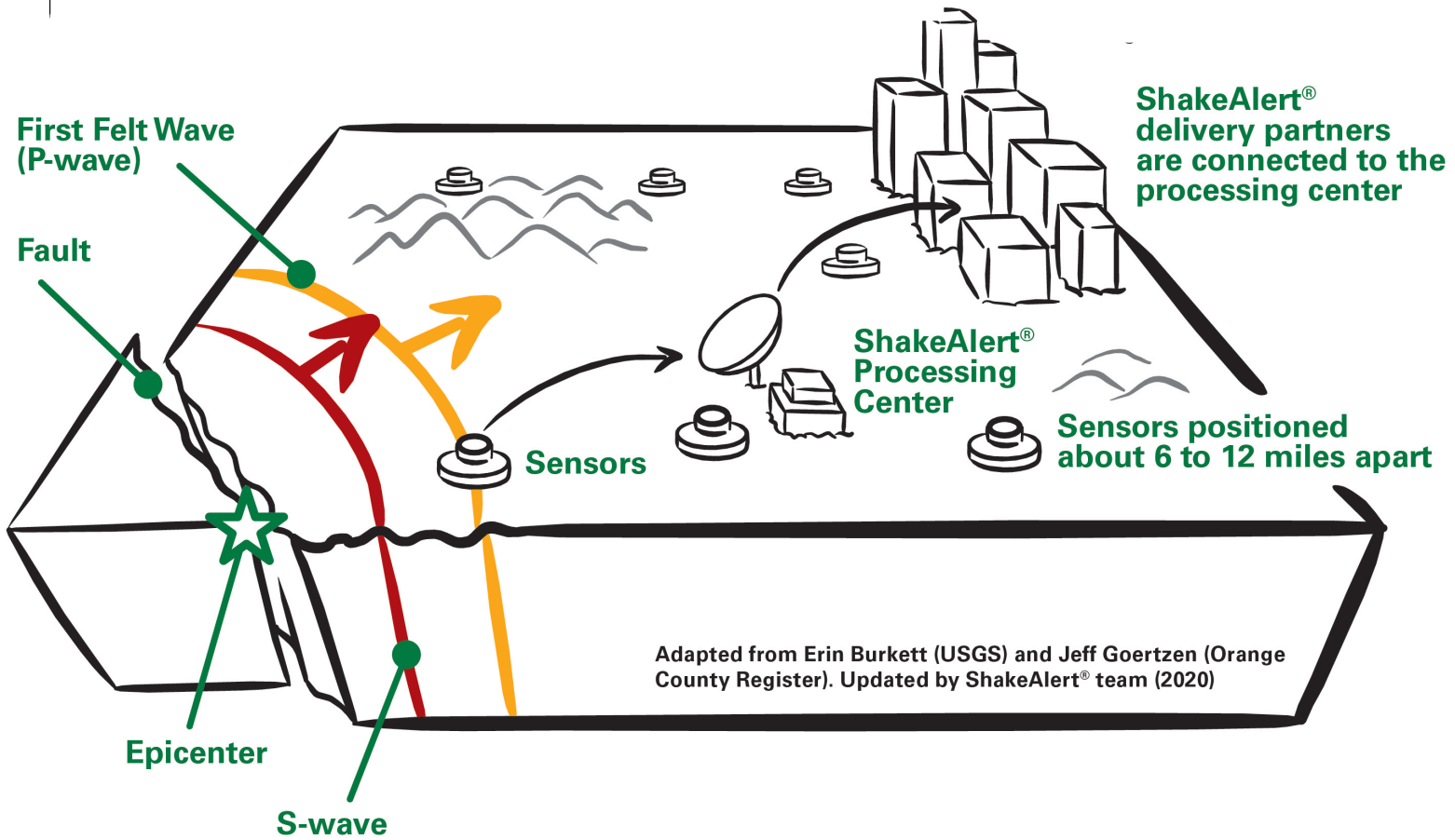
Intensity	Shaking
I	Not felt
II	Weak
III	Weak
IV	Light
V	Moderate
VI	Strong
VII	Very strong
VIII	Severe
IX	Violent
X	Extreme

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

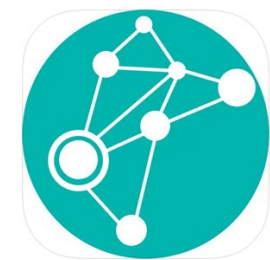
Earthquake Magnitude + Distance + Geology + Soil Type + Water Saturation = Intensity



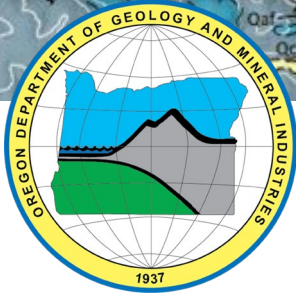
ShakeAlert® EARTHQUAKE EARLY WARNING BASICS



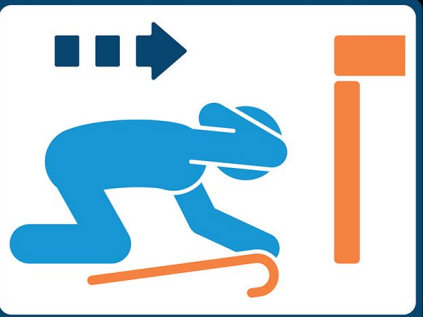
- Sensors detect pressure wave
- Triggers alerts prior to arrival of shear, surface.
- Included in all Android devices.
- iPhone:



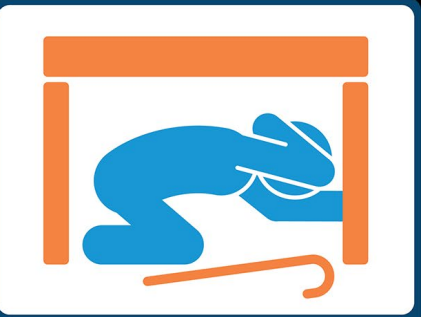
MyShake (4+)
 Earthquake Warning California
 University of California, Berkeley
 Designed for iPhone
 #153 in Education
 ★★★★★ 3.2 • 1.1K Ratings
 Free



DROP!



COVER!



HOLD ON!



DROP!



COVER!



HOLD ON!



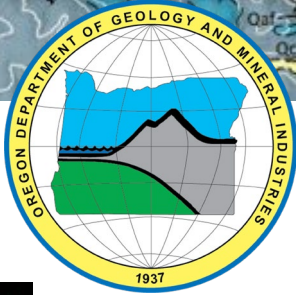
LOCK!



COVER!



HOLD ON!



EMERGENCY PREPAREDNESS

STAY INFORMED

- Learn about hazards
- Enable Wireless Emergency Alerts
- Know evacuation routes in the area



MAKE AN EMERGENCY PLAN

- Resources available to help create plan
- Communicate plan
- Practice



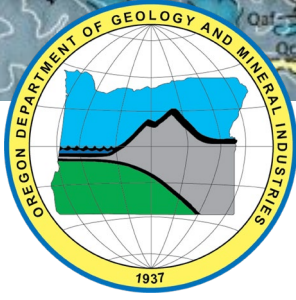
ready.gov

BUILD AN EMERGENCY KIT

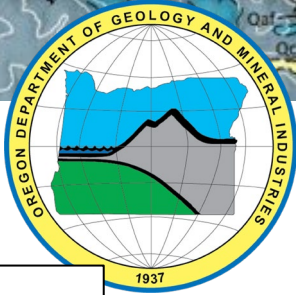
- 2 weeks worth of food, water, and critical supplies



FEMA



Portland Metro & Gresham Butte Area Hazards



Earthquake Loss Estimation for Portland Area

State of Oregon
Oregon Department of Geology and Mineral Industries
Brad Avy, State Geologist

OPEN-FILE REPORT O-18-02

**EARTHQUAKE REGIONAL IMPACT ANALYSIS FOR
CLACKAMAS, MULTNOMAH, AND WASHINGTON COUNTIES, OREGON**

by John M. Bauer¹, William J. Burns¹, and Ian P. Madin¹

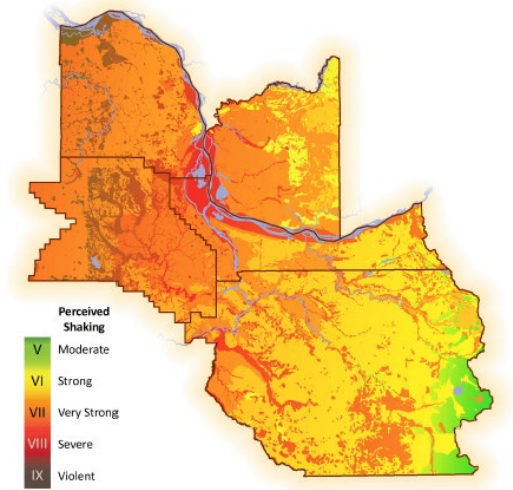
State of Oregon
Oregon Department of Geology and Mineral Industries
Brad Avy, State Geologist

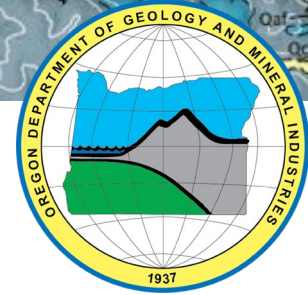
OPEN-FILE REPORT O-20-01

**EARTHQUAKE REGIONAL IMPACT ANALYSIS FOR
COLUMBIA COUNTY, OREGON AND CLARK COUNTY, WASHINGTON**

by John M. Bauer¹, Recep Cakir², Corina Allen², Kate Mickelson², Trevor Contreras²,
Robert Hairston-Porter¹ and Yumei Wang¹

- Regional Disaster Preparedness Organization (RDPO)
- Estimates based on best available data, not predictions.
 - Earthquake scenarios
 - Geology
 - Soil type
 - Geographic information (buildings, census, infrastructure)
- Federal Emergency Management Administration’s HAZUS Model





EARTHQUAKE SCENARIOS

1. M 9.0 Cascadia Subduction Zone

2. M 6.8 Portland Hills Fault

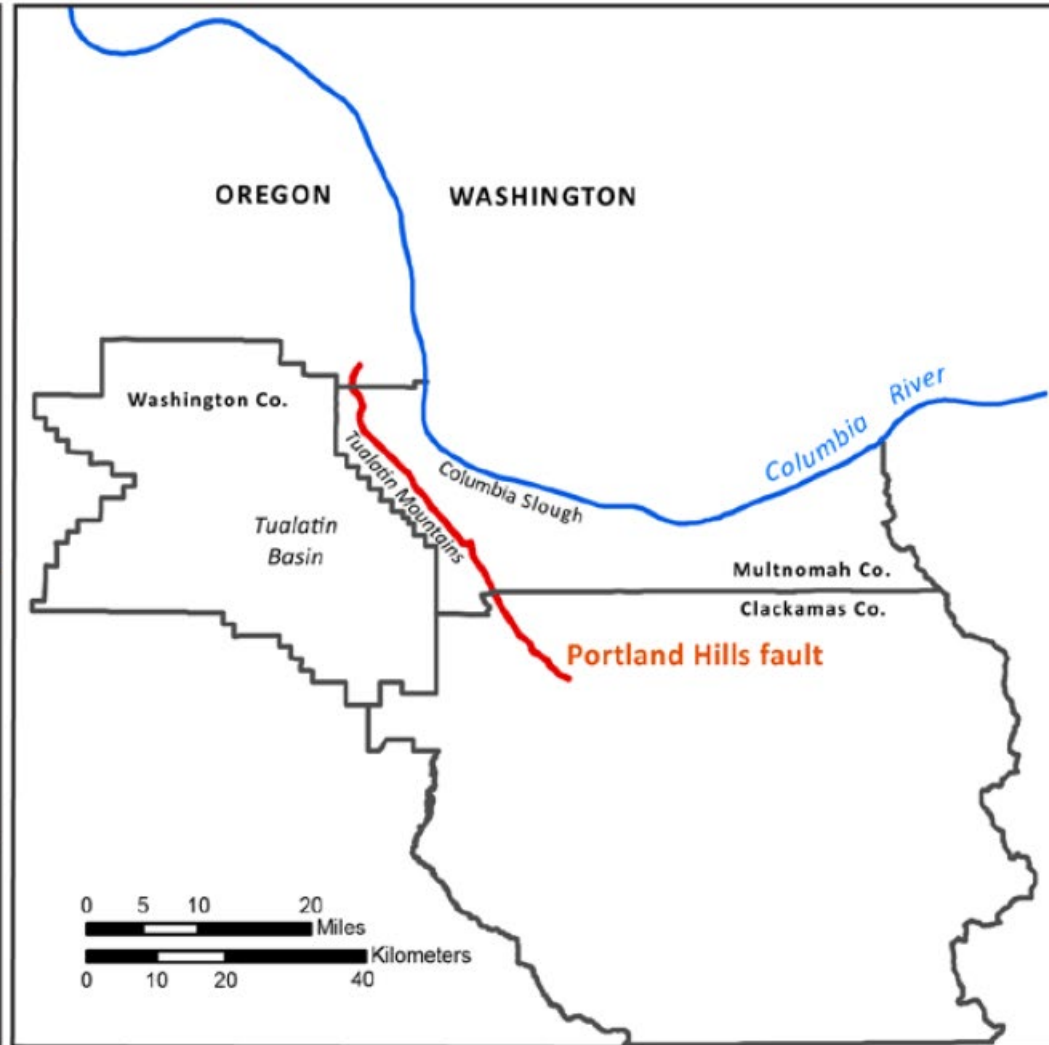
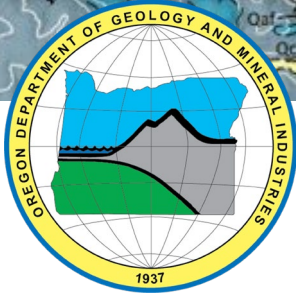


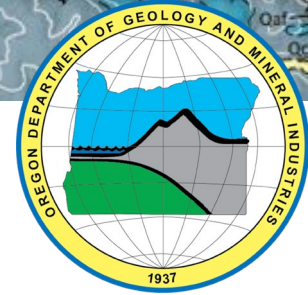
Fig. 1-2. Bauer et al, 2018



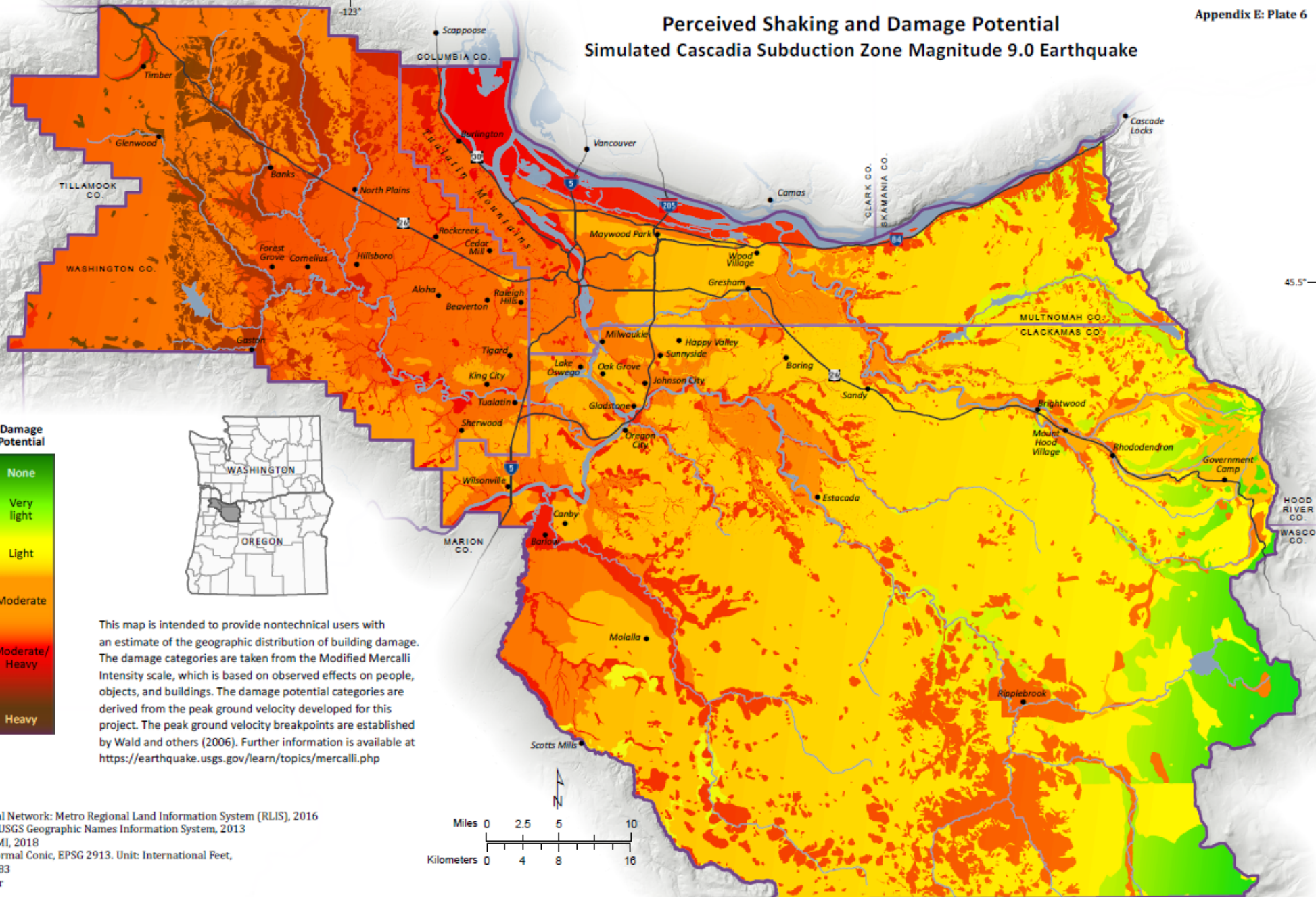
OREGON SEISMIC DESIGN BENCHMARK YEARS

Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	prior to 1976	Pre Code	Interpretation of Judson (2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004–present	High Code	
Manufactured Housing	prior to 2003	Pre Code	Interpretation of Oregon Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2003–2010	Low Code	
	2011–present	Moderate Code	Interpretation of Oregon Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	prior to 1976	Pre Code	Interpretation of Oregon Benefit-Cost Analysis Tool (Business Oregon, 2015, p. 24)
	1976–1990	Low Code	
	1991–present	Moderate Code	

Table 10-2. Bauer et al, 2018



Perceived Shaking and Damage Potential Simulated Cascadia Subduction Zone Magnitude 9.0 Earthquake

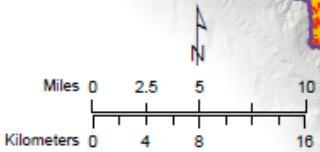


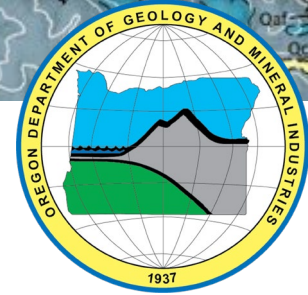
Modified Mercalli Intensity Scale	Perceived Shaking	Damage Potential
IV	Light	None
V	Moderate	Very light
VI	Strong	Light
VII	Very Strong	Moderate
VIII	Severe	Moderate/Heavy
IX	Violent	Heavy



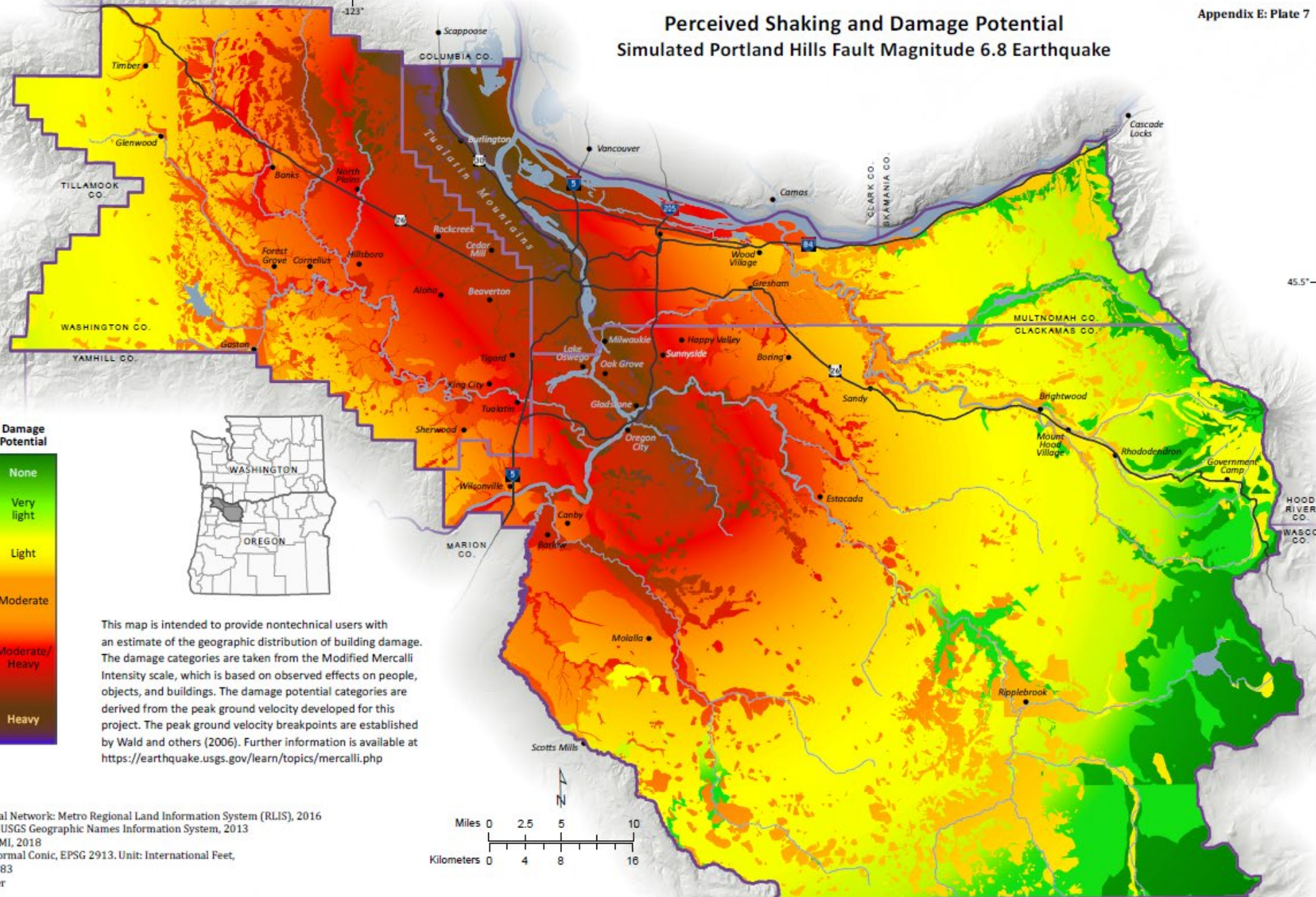
This map is intended to provide nontechnical users with an estimate of the geographic distribution of building damage. The damage categories are taken from the Modified Mercalli Intensity scale, which is based on observed effects on people, objects, and buildings. The damage potential categories are derived from the peak ground velocity developed for this project. The peak ground velocity breakpoints are established by Wald and others (2006). Further information is available at <https://earthquake.usgs.gov/learn/topics/mercalli.php>

Source Data:
 Hydrography, Major Arterial Network: Metro Regional Land Information System (RLIS), 2016
 Cities, Population Centers: USGS Geographic Names Information System, 2013
 Site ground motion: DOGAMI, 2018
Projection: Lambert Conformal Conic, EPSG 2913. Unit: International Feet,
 Horizontal Datum: NAD 1983
Map Author: John M. Bauer
 February 12, 2018





Perceived Shaking and Damage Potential Simulated Portland Hills Fault Magnitude 6.8 Earthquake

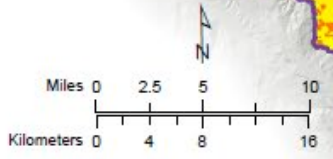


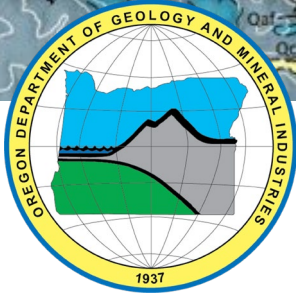
Modified Mercalli Intensity Scale	Perceived Shaking	Damage Potential
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Site ground motion: DOGAMI, 2018
Projection: Lambert Conformal Conic, EPSG 2913. Unit: International Feet, Horizontal Datum: NAD 1983
Map Author: John M. Bauer
February 12, 2018





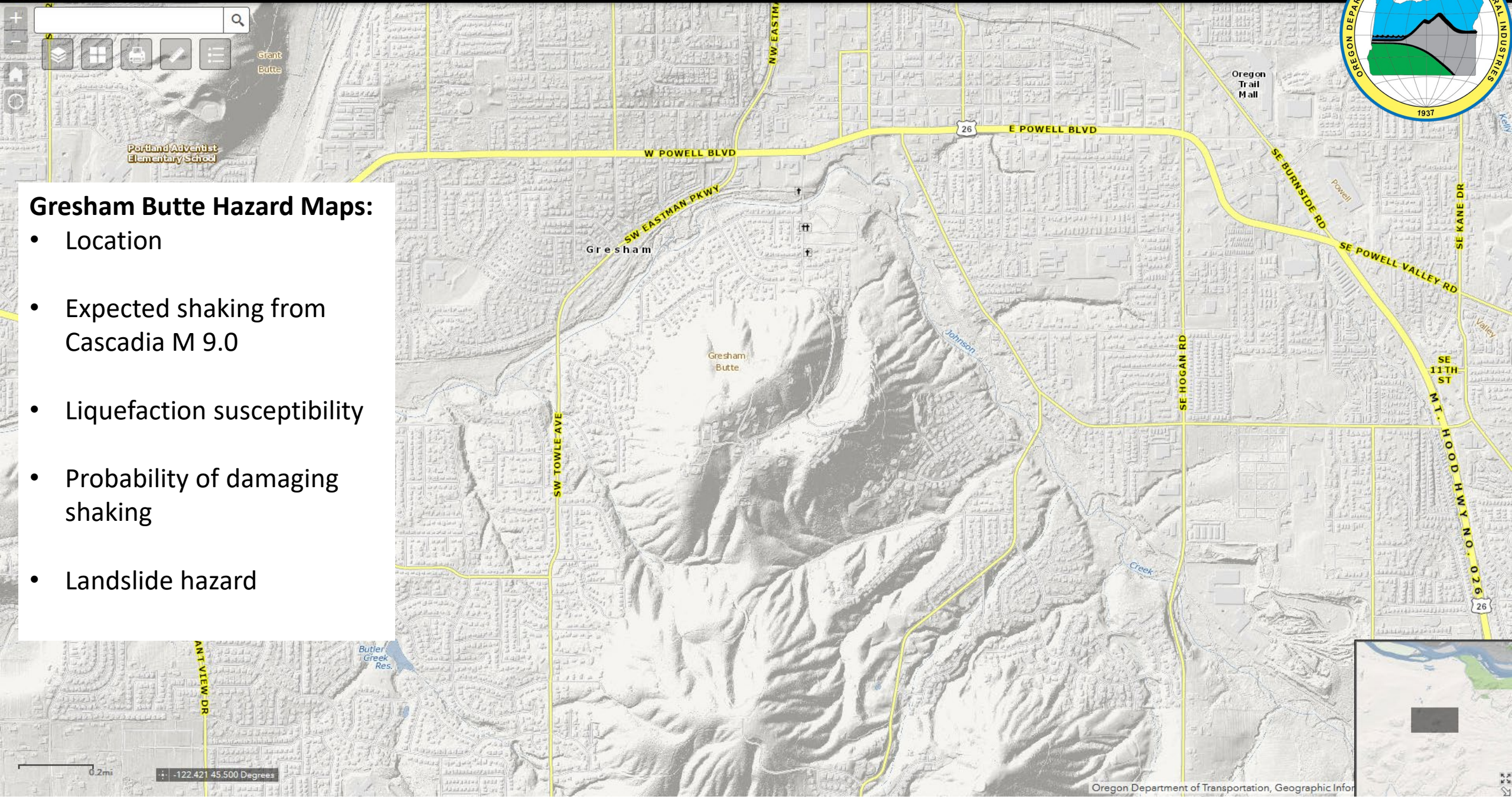
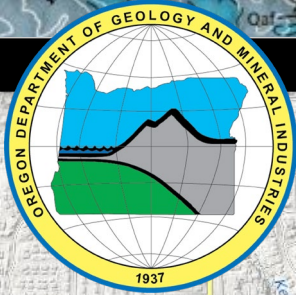
EXPLORING GRESHAM BUTTE GEOLOGIC HAZARDS



Gresham Butte Hazard Maps:

- Location
- Expected shaking from Cascadia M 9.0
- Liquefaction susceptibility
- Probability of damaging shaking
- Landslide hazard

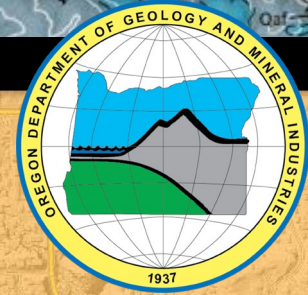
Photo by Jamie Hale (the Oregonian)



- Gresham Butte Hazard Maps:**
- Location
 - Expected shaking from Cascadia M 9.0
 - Liquefaction susceptibility
 - Probability of damaging shaking
 - Landslide hazard

0.2mi

-122.421 45.500 Degrees



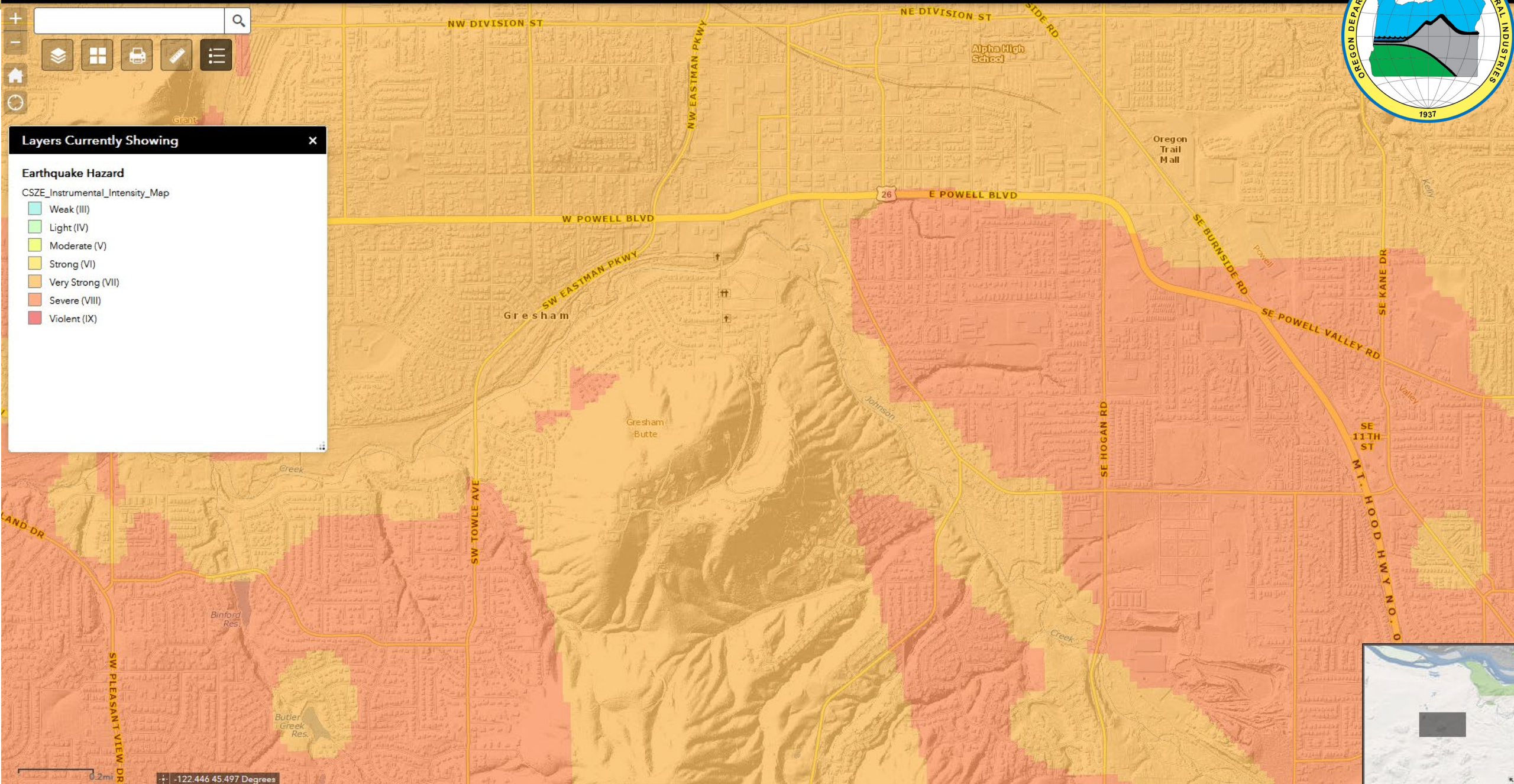
Map navigation controls including a search bar, zoom in (+) and zoom out (-) buttons, a home button, a refresh button, and a layers menu icon.

Layers Currently Showing

Earthquake Hazard

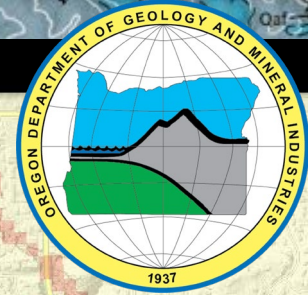
CSZE_Instrumental_Intensity_Map

- Weak (III)
- Light (IV)
- Moderate (V)
- Strong (VI)
- Very Strong (VII)
- Severe (VIII)
- Violent (IX)



0.2mi
-122.446 45.497 Degrees





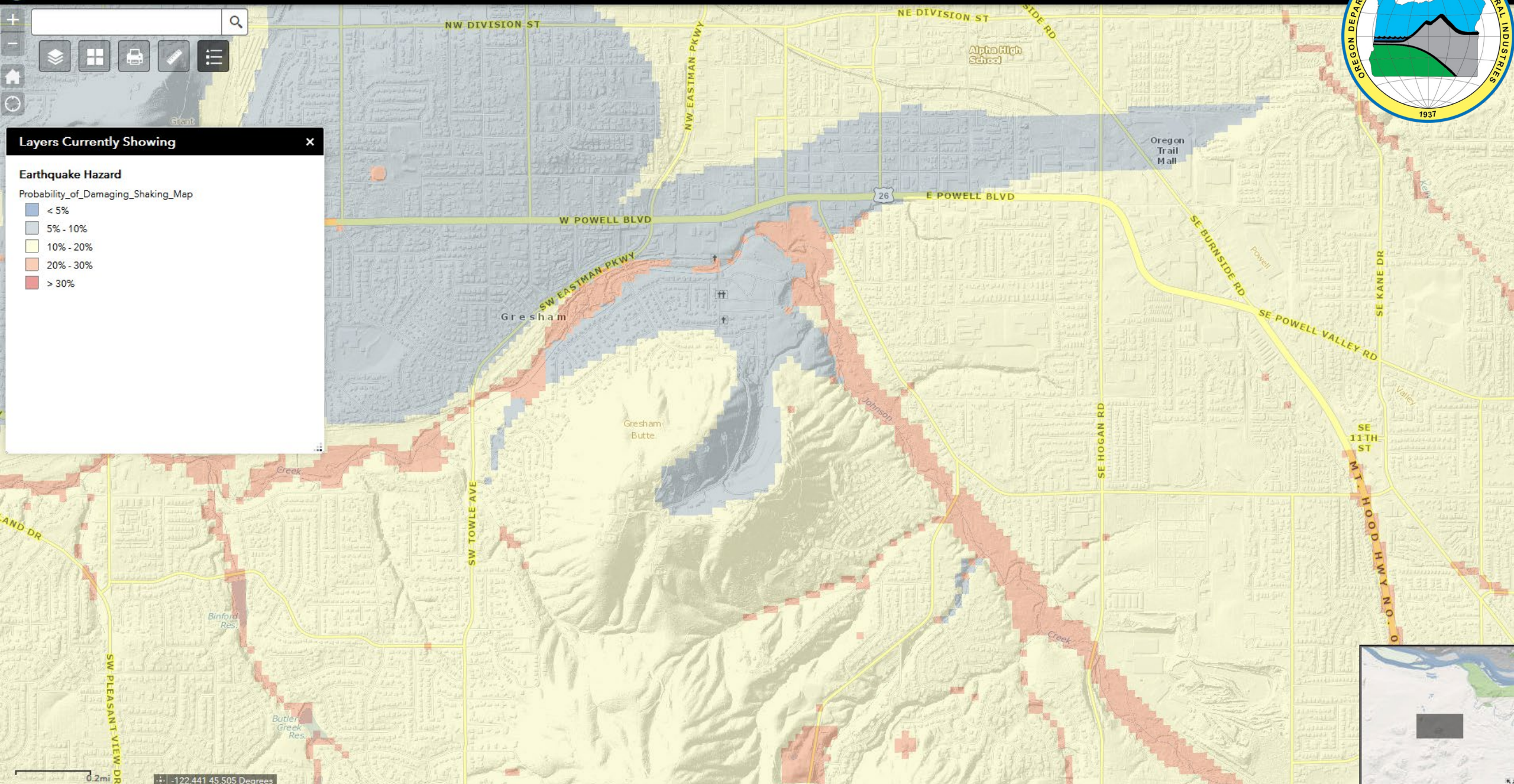
Map navigation controls including a search bar, zoom in (+) and zoom out (-) buttons, a home button, a full-screen button, and a layer management icon.

Layers Currently Showing

Earthquake Hazard

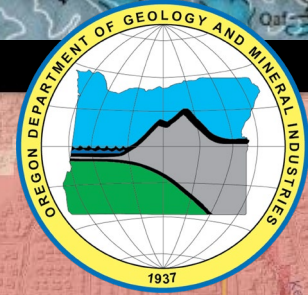
Probability_of_Damaging_Shaking_Map

- < 5%
- 5% - 10%
- 10% - 20%
- 20% - 30%
- > 30%



0.2mi -122.441 45.505 Degrees



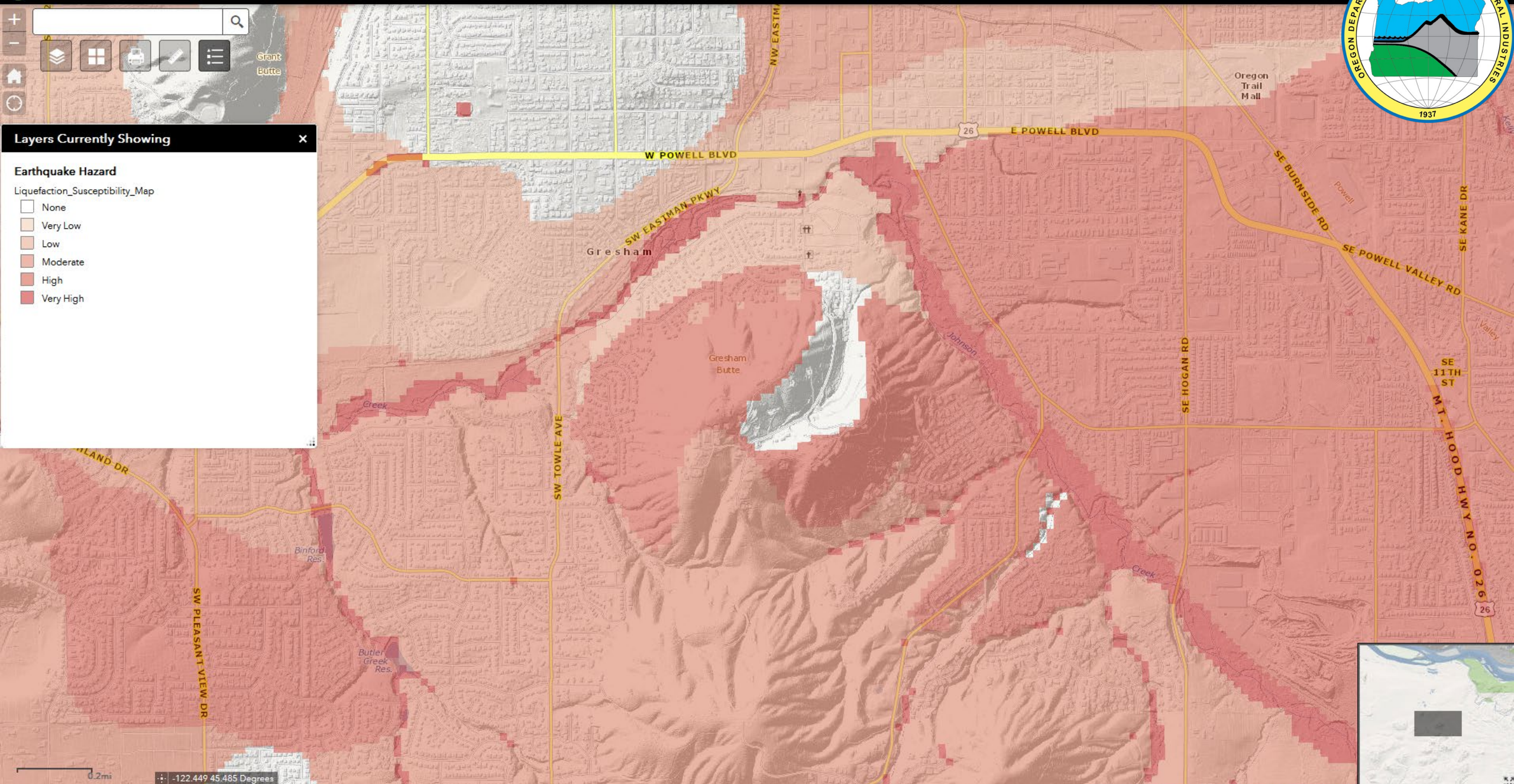


Map navigation controls including a search bar, zoom in (+) and zoom out (-) buttons, a home button, a full-screen button, and a layers menu icon.

Layers Currently Showing

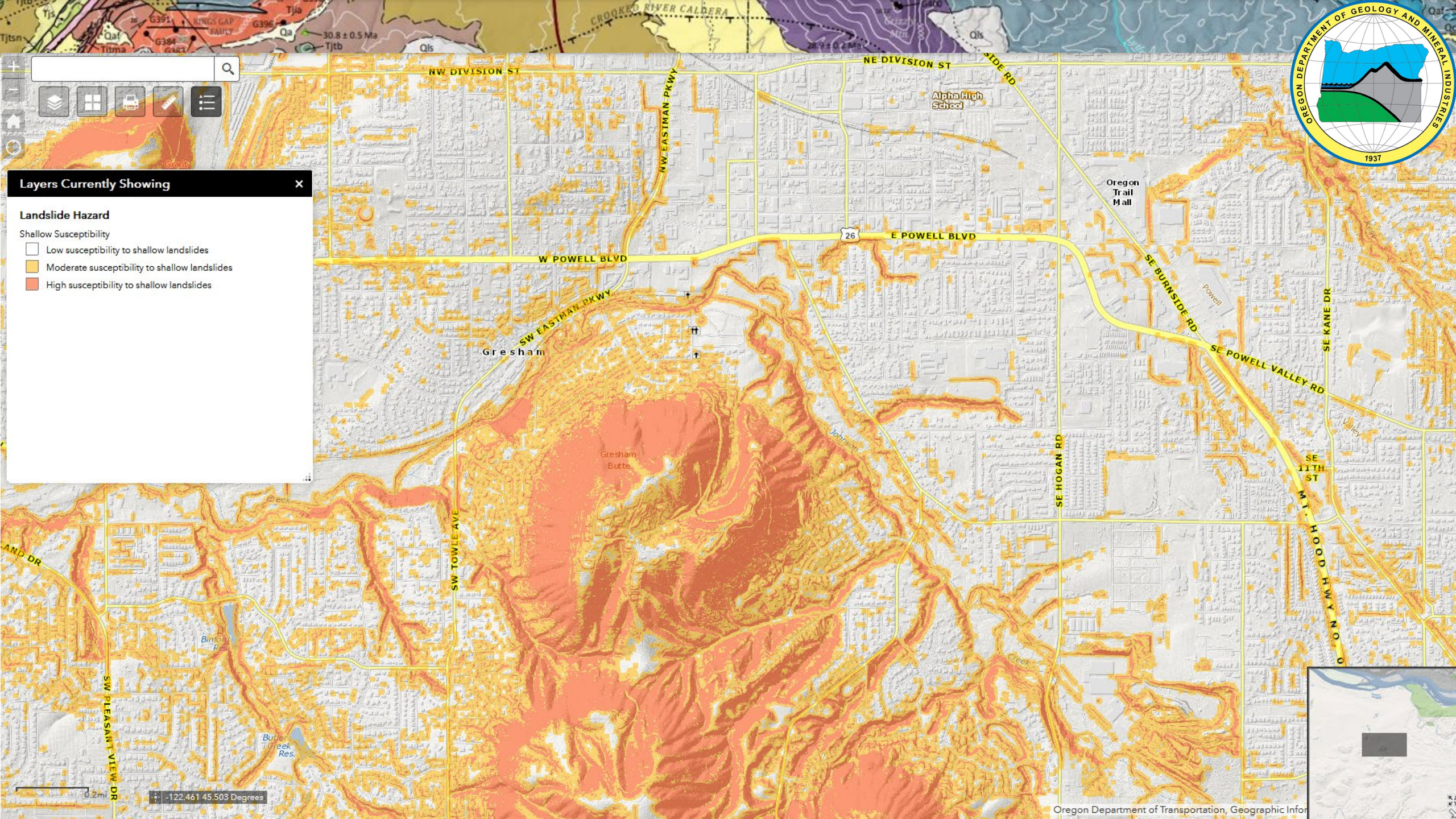
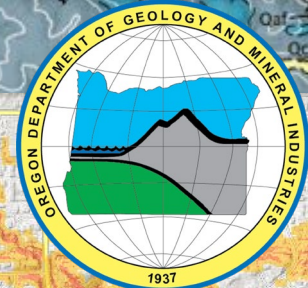
Earthquake Hazard
Liquefaction_Susceptibility_Map

- None
- Very Low
- Low
- Moderate
- High
- Very High



0.2mi -122.449 45.485 Degrees

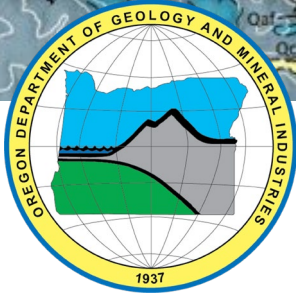




Layers Currently Showing

- Landslide Hazard
- Shallow Susceptibility
- Low susceptibility to shallow landslides
 - Moderate susceptibility to shallow landslides
 - High susceptibility to shallow landslides

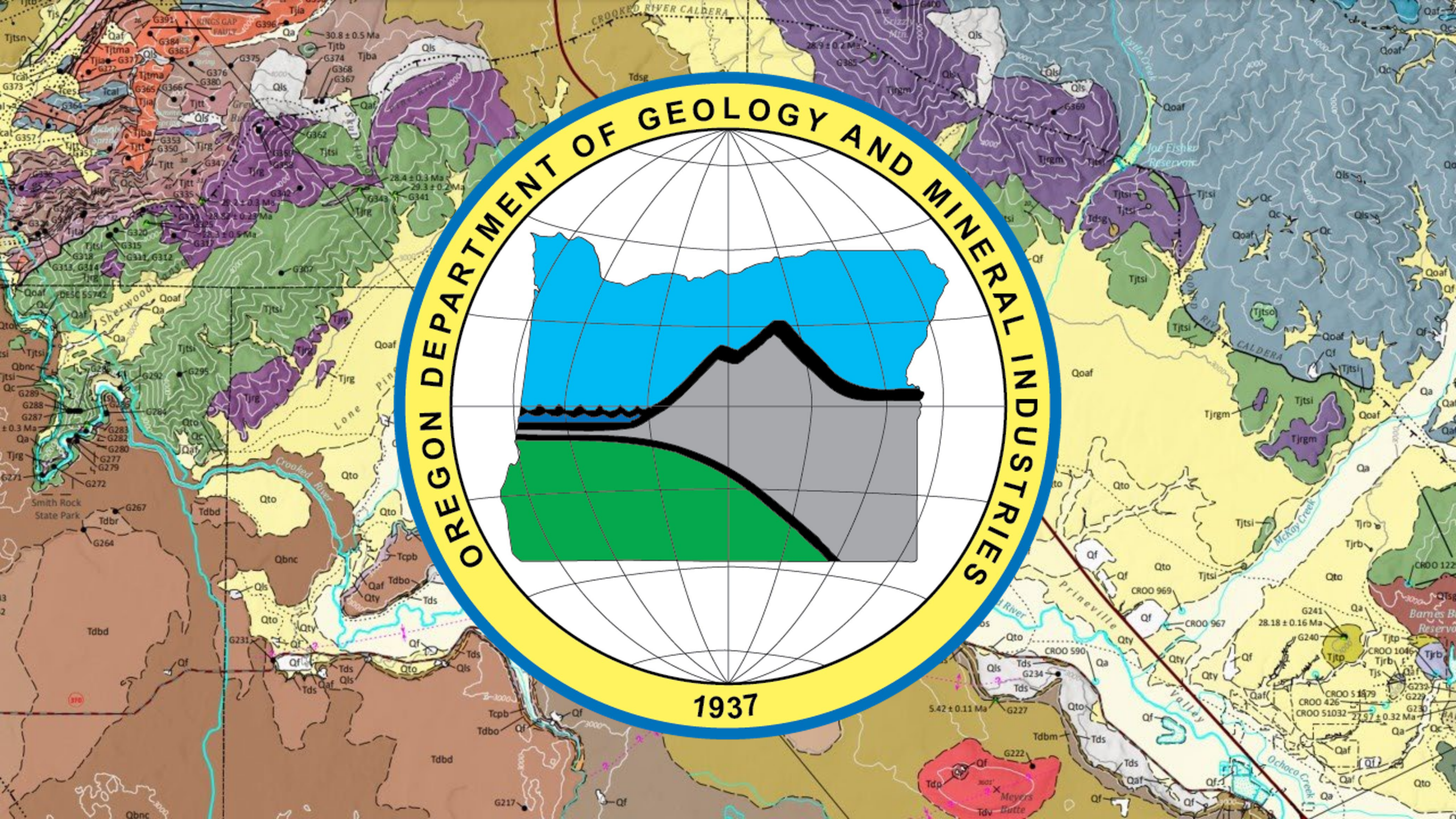
0.2mi
-122.461 45.503 Degrees

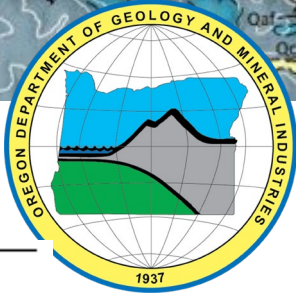


HazVu: Statewide Geohazards Viewer

<https://www.oregon.gov/dogami/hazvu/pages/index.aspx>







CASCADIA M 9.0 SCENARIO SUMMARY RESULTS

County	U.S. Census Population Estimate (2010)	Number of Buildings	Building Value (\$ Billion)	Building Repair Cost (\$ Billion)	Building Loss Ratio	Debris (Millions of Tons)	Long-Term Displaced Population (Thousands)	Total Casualties*	
								Daytime Scenario (Thousands)	Nighttime Scenario (Thousands)
<i>Cascadia Subduction Zone magnitude 9.0 earthquake</i>									
Clackamas	375,992	179,164	62.4	3.2–4.6	5%–7%	1.7–2.1	1.9–10.1	2.0–2.8	0.5–1.1
Multnomah	735,334	255,577	114.0	13.3–20.5	12%–18%	7.7–10.4	9.7–37.5	11.4–16.7	2.8–5.6
Washington	529,710	181,111	82.7	7.0–11.6	8%–14%	3.4–4.8	5.2–37.7	4.9–7.7	1.1–3.7
Total	1,641,036	615,852	259.1	23.5–36.7	9%–14%	12.8–17.3	16.8–85.3	18.3–27.2	4.4–10.4

PORTLAND HILLS M 6.8 SCENARIO SUMMARY RESULTS

Clackamas	375,992	179,164	62.4	12.9–16.4	21%–26%	4.9–6.0	25.2–50.8	8.9–10.9	3.3–5.2
Multnomah	735,334	255,577	114.0	32.3–42.7	28%–37%	15.7–19.3	50.8–120	28.9–36.3	9.3–15.3
Washington	529,710	181,111	82.7	15.4–24.3	19%–29%	6.0–8.6	19.6–86.0	10.0–15.8	3.2–8.5
Total	1,641,036	615,852	259.1	60.6–83.4	23%–32%	26.6–33.9	95.6–257	47.8–63.0	15.8–29.0

Casualty estimates include minor injuries, injuries requiring hospitalization, and fatalities