

# West Coast Earthquake Early Warning

# Earthquake Early Warning

- ✦ **Advance warning of strong shaking**
  - » **Soon - minutes of warning of M9 coastal earthquakes**
  - » **(Later - 10s of secs for Puget Sound earthquakes)**
- ✦ **In contrast to the PNSN's existing products**
  - » **ShakeMap, ShakeCast, ENS**
  - » **Delivered 5-15 minutes after earthquake**
- ✦ **Will be a prototype in about a year**
  - » **Delivered to a few companies**
  - » **Plus whoever can handle it - (Seattle OEC?)**
  - » **Exists now in California**
  - » **Not yet supported for the long term**

# "Rebuilding seismology" – Lessons Learned - 12 May 2011 *Nature*



## "Integrate all available data..."

The Tohoku earthquake clearly shows that 400 years is too short a time period to evaluate seismic activity--a great tsunami inundated the Sendai area in AD 869."

"...the second lesson...strive to integrate observational information with different temporal and spatial scales..."

## Rebuilding seismology

Two months on from the earthquake and tsunami that hit their country on 11 March, five Japanese seismologists reflect on what they have learned from it so far.

Integrate all available data

## "Warnings work, but must be better..."

"The overall performance of the system was not satisfactory, mainly because of the complex character and relatively small amplitude of the beginning of the rupture."

MASUMI YAMADA  
Warnings work, but must be better

The system underestimated ground motion and tsunami heights, so the large population in the greater **Tokyo** region, where many areas experienced strong and damaging shaking, **received no warning...**"

"The system has the potential to work well for the next great earthquake...if technical improvements are made to recognize great earthquakes quickly."

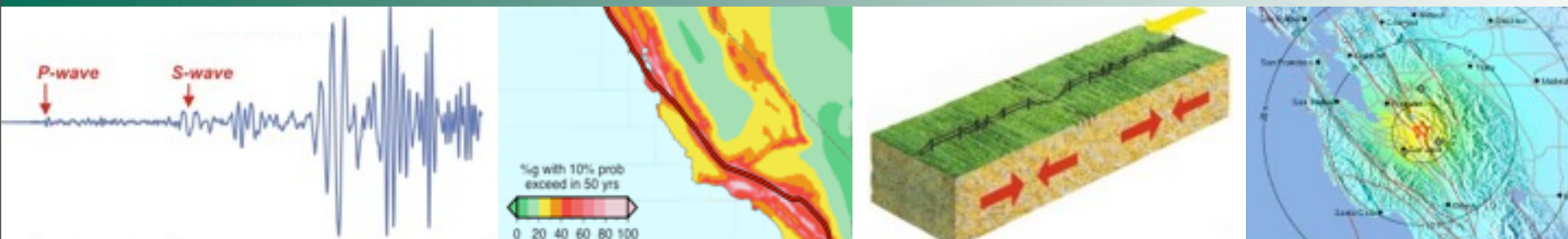
# Workshop at Berkeley in April 2011



# Seismology Funding Research Opportunity for Science Program

Presented to Moore Foundation Science Advisory Board  
May, 2011

Presented to Moore Foundation Board of Trustees  
early October, 2011  
approved, started 1/1/2012



## 2012-2014 – Moore Foundation gave \$6M

Caltech Seismology Lab

Berkeley Seismology Lab

Pacific Northwest Seismology Network (U. Washington)

USGS

### Outcome:

Further develop and implement state-of-the-art seismological techniques into a prototype system that, under USGS oversight, can be transformed into a full end-to-end system that is paid for and beta-tested by the USGS and a suite of early funders.

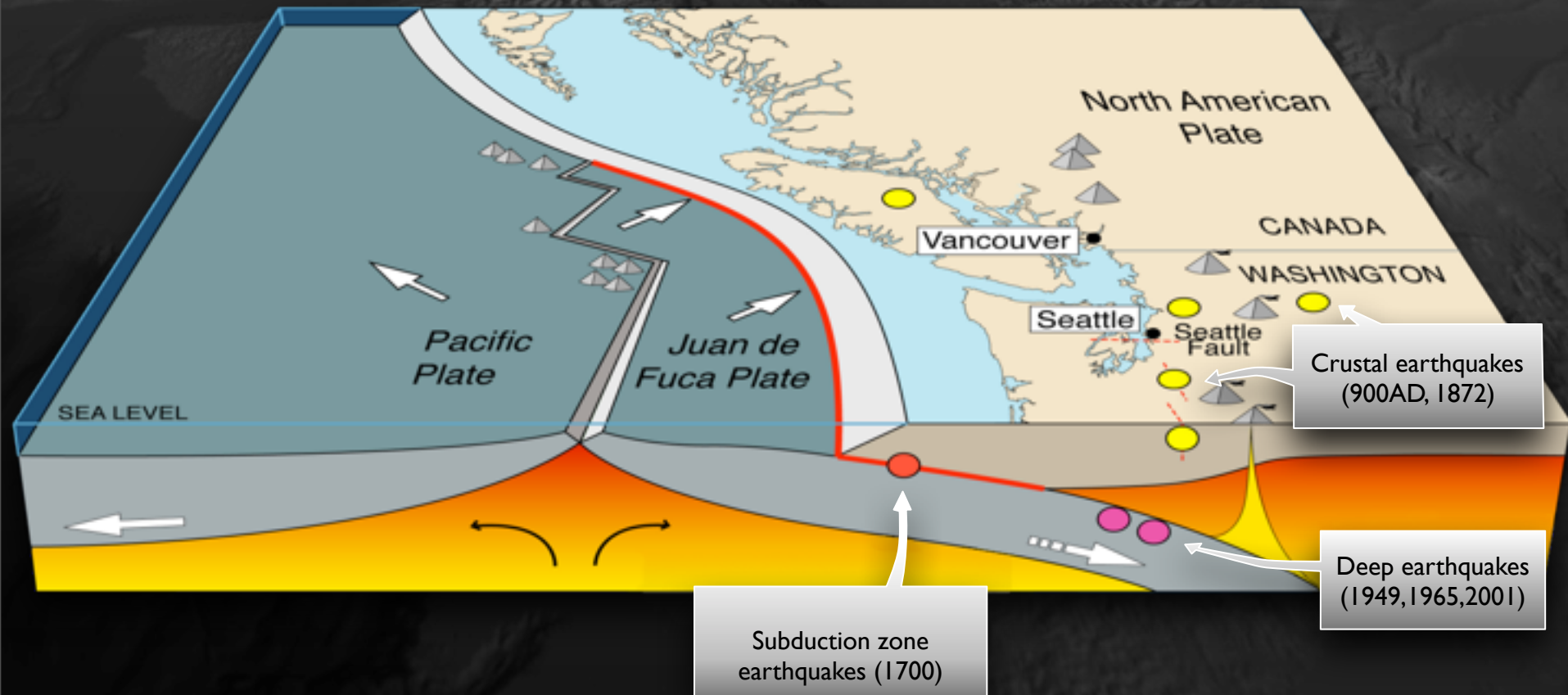
For PNW, this means at least a crude system to warn of coastal M9s.

# UW proposal - 3 years, \$1.85M

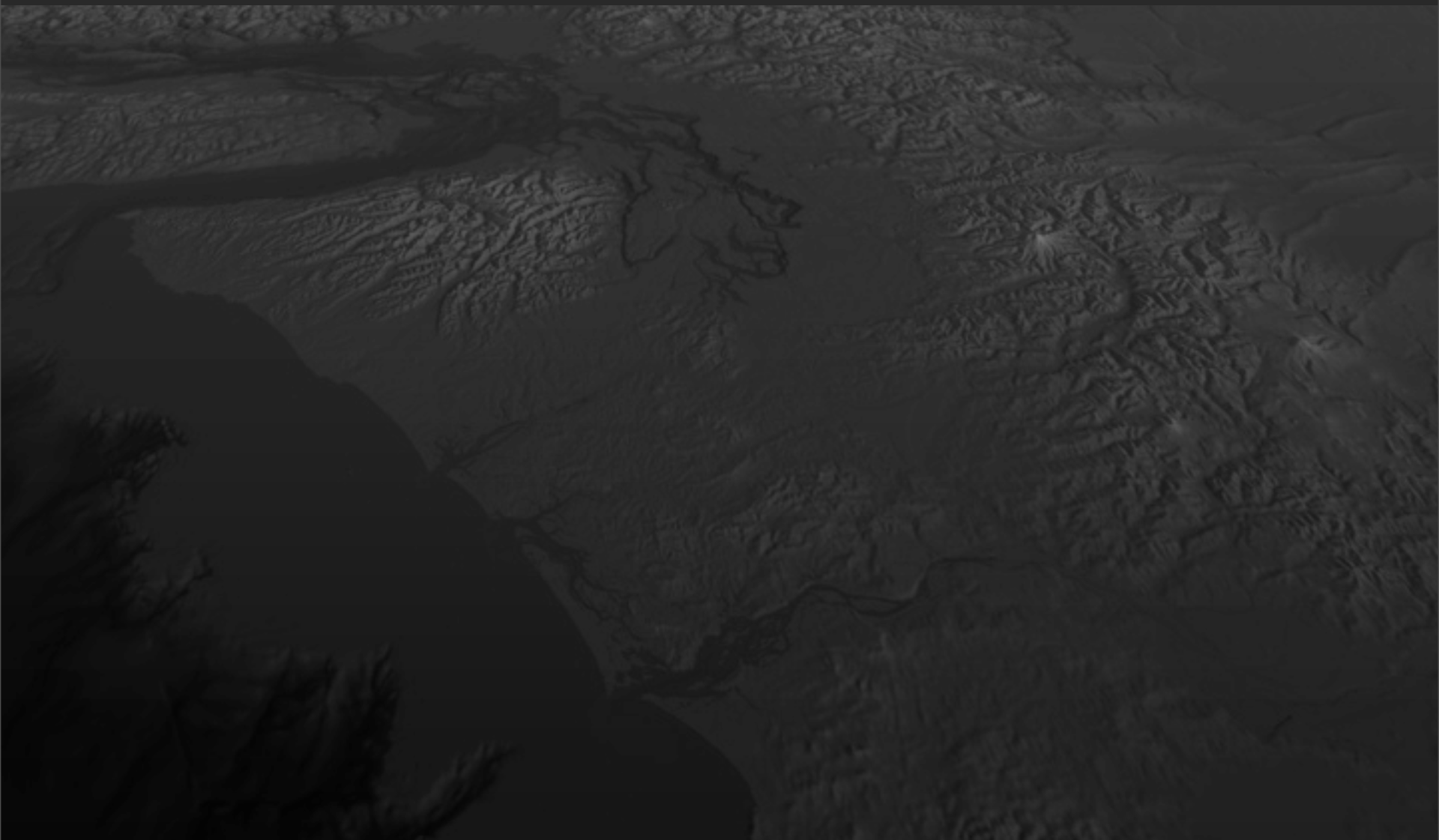
**Goal-** provide warning within tens of seconds that large earthquakes are developing along the coast, and send warning to a handful of corporations, such as Microsoft, Boeing, Intel, and HP, and EMs (if desired).

1. add 24 strong motions stations to existing GPS stations on coast.
2. hire a geodesy faculty member at UW, interviewing this month.
3. a scientist to study geodesy, Cascadia subduction, and plug geodetic information into PNSN and EEW.
4. a programmer at UW, 1/2 technician/scientist at CWU to make it happen.

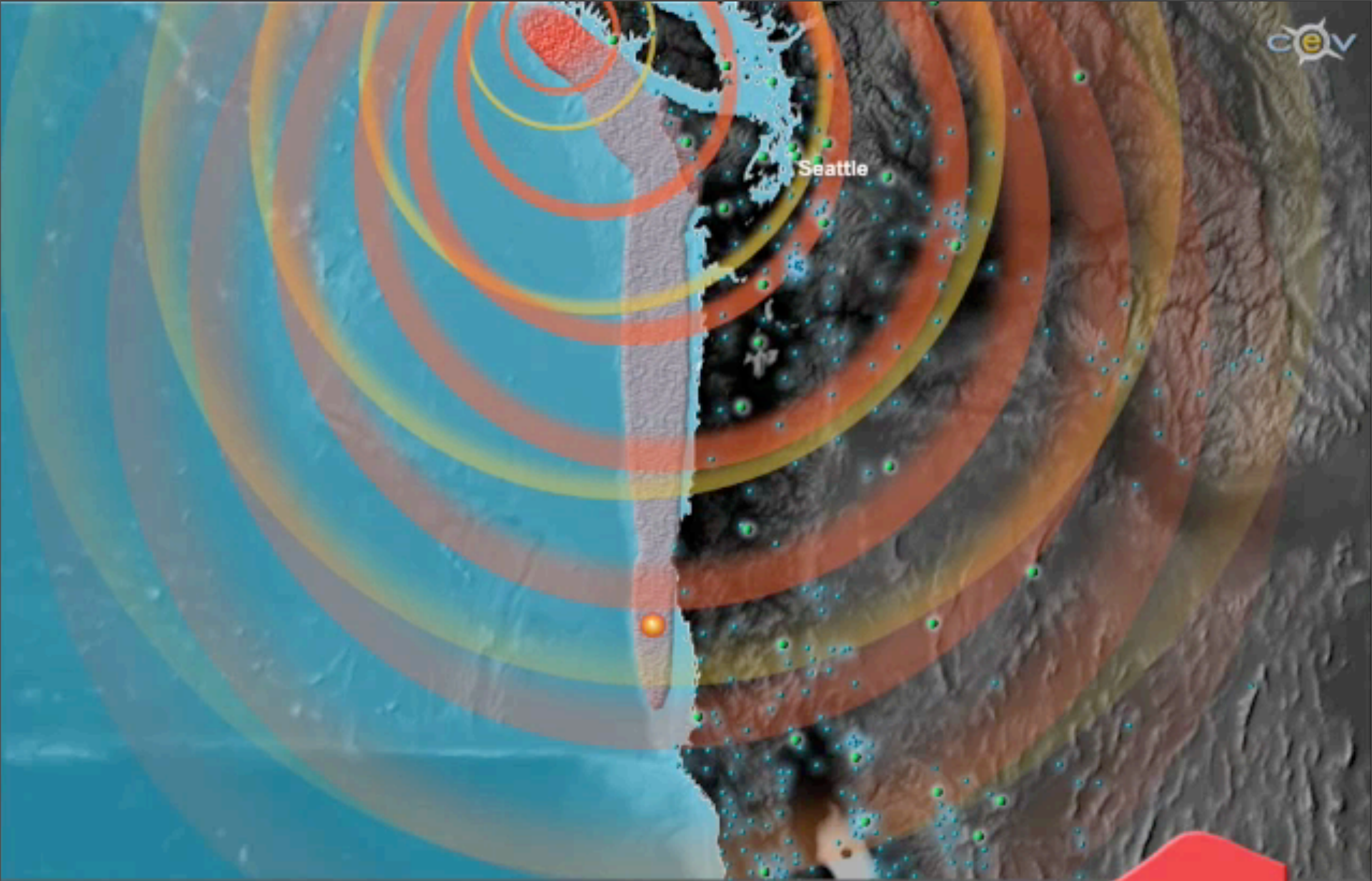
# Cascadia megathrust fault







Wednesday, May 9, 12



# Earthquake Early Warning

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  - » **Peace of mind and just being modern**

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### » Peace of mind and just being modern

» Most times, system will just reassure people that no earthquake has happened.

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» If a quake happens, one has time to gather one's wits.

# Earthquake Early Warning

Wednesday, May 9, 12

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- » Accurate results before chaos sets in.
- » Needs GPS, strong motion sensors, broadbands.

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... and has a high value with society

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an opportunity for broad earth science education and  
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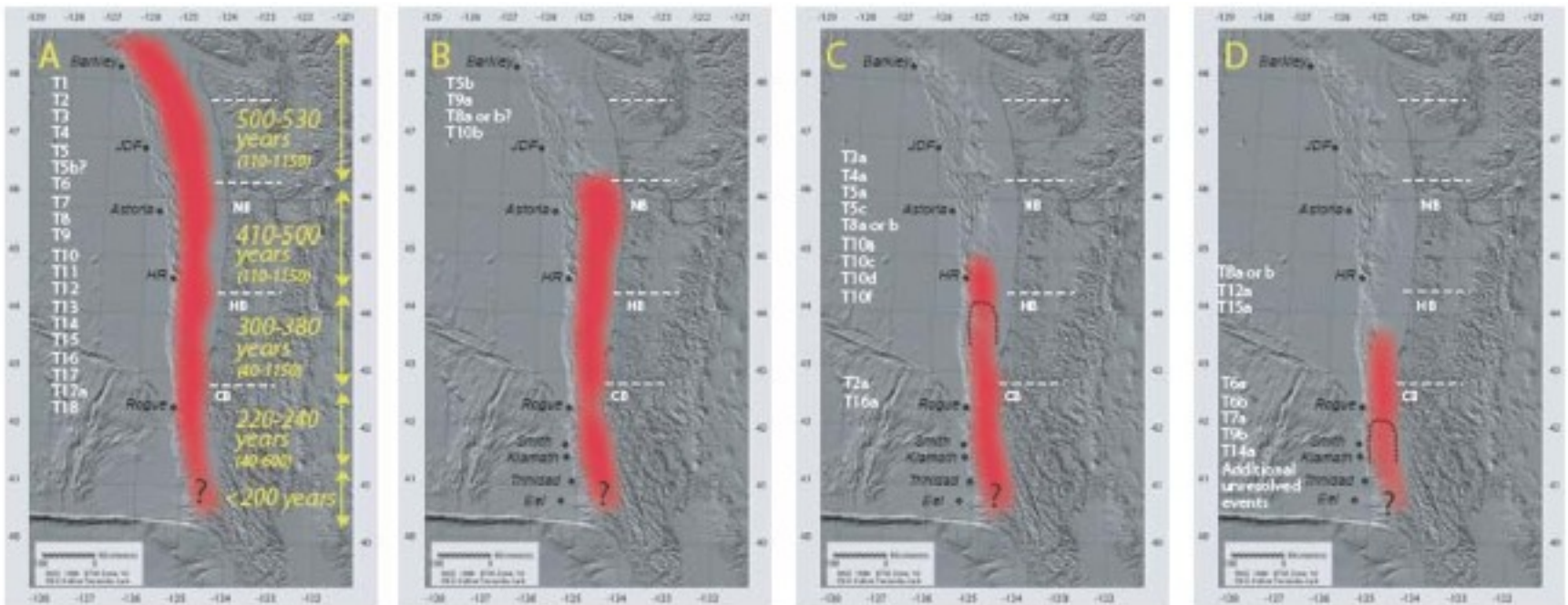
**307 respondents: 176 UC Berkeley students – “not a scientific study”**

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# Recent analysis could help predict OR/WA "big ones"

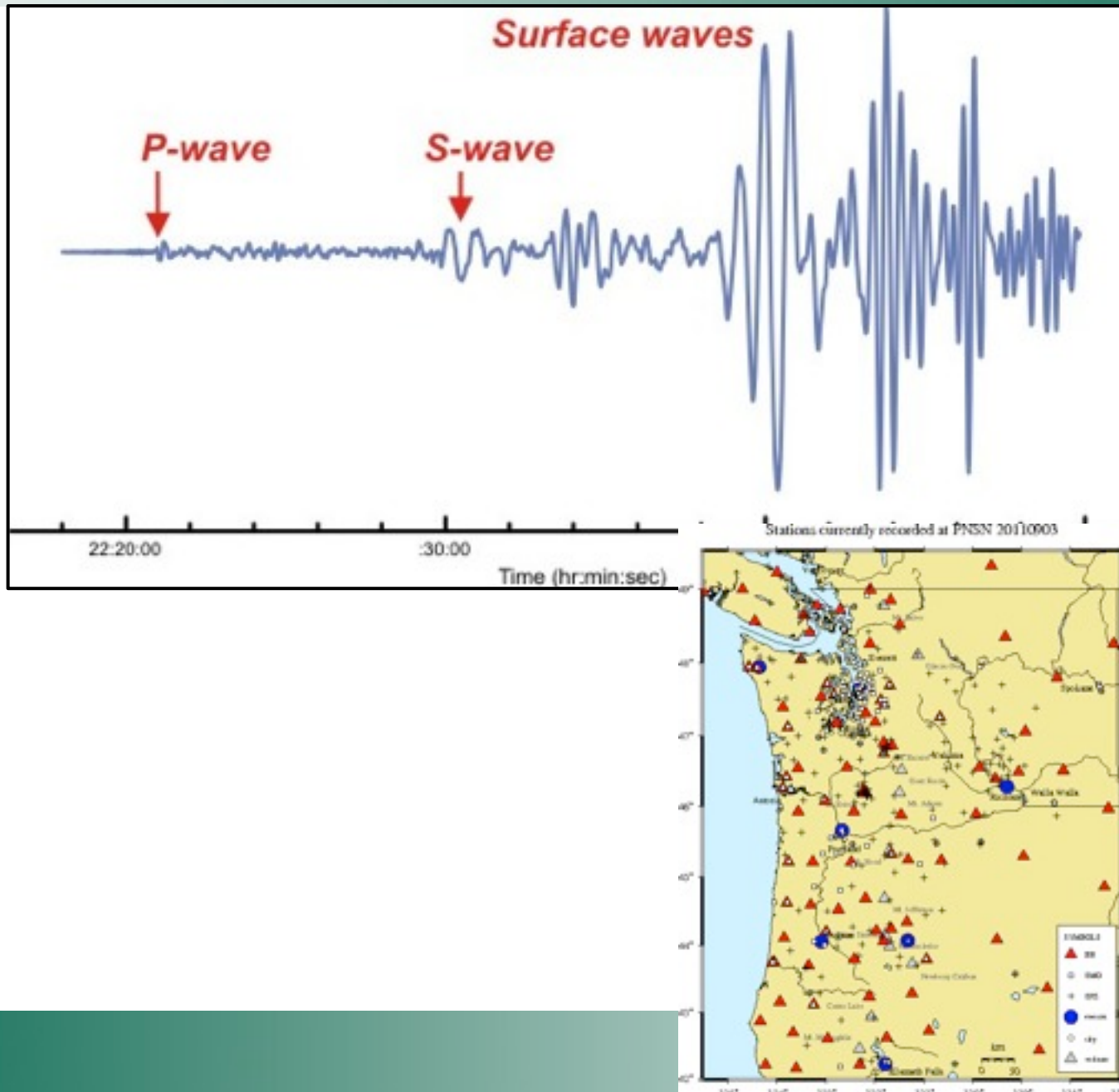
Scientists analyzed 10,000 years of Cascadia oceanic turbidities  
40 largest earthquakes occurred via 4 rupture paths

Implementing this, and similar results, into models would greatly improve their early prediction capabilities



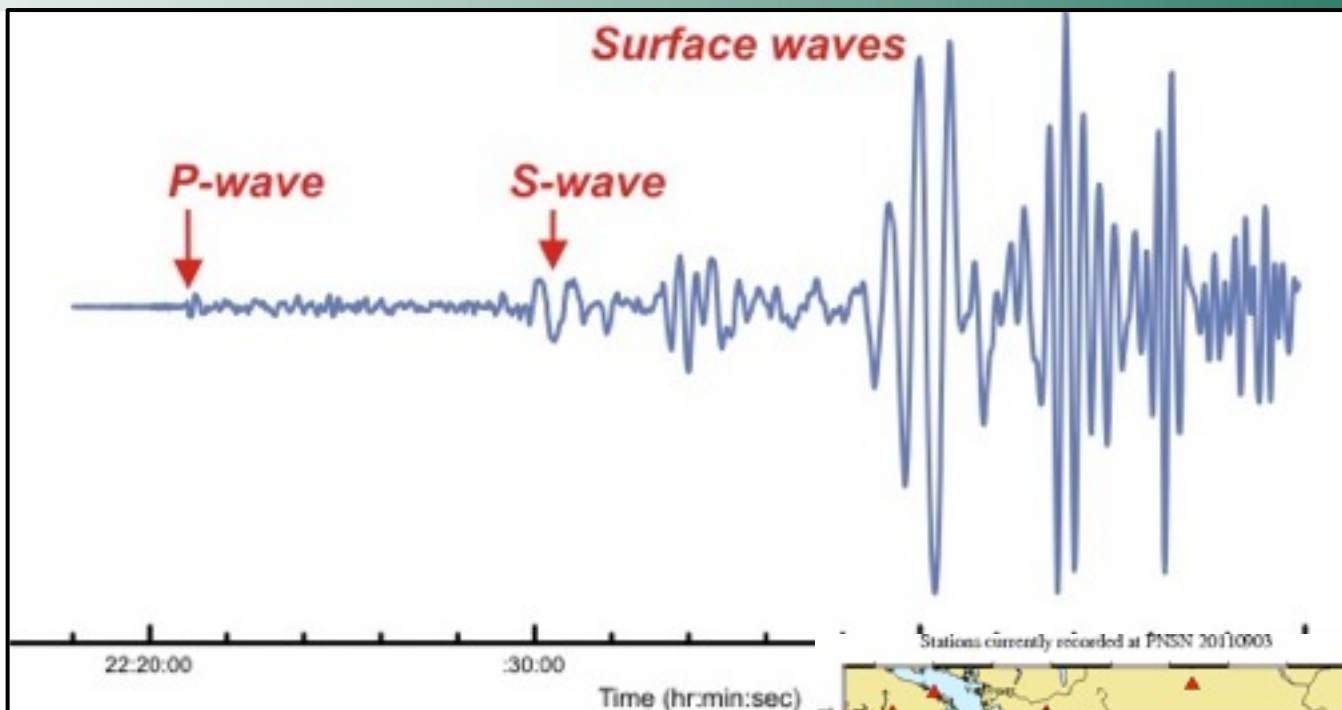
(Goldfinger et al., 2008, Bull, Seis. Soc. Amer)

# What is required to detect earthquakes early?



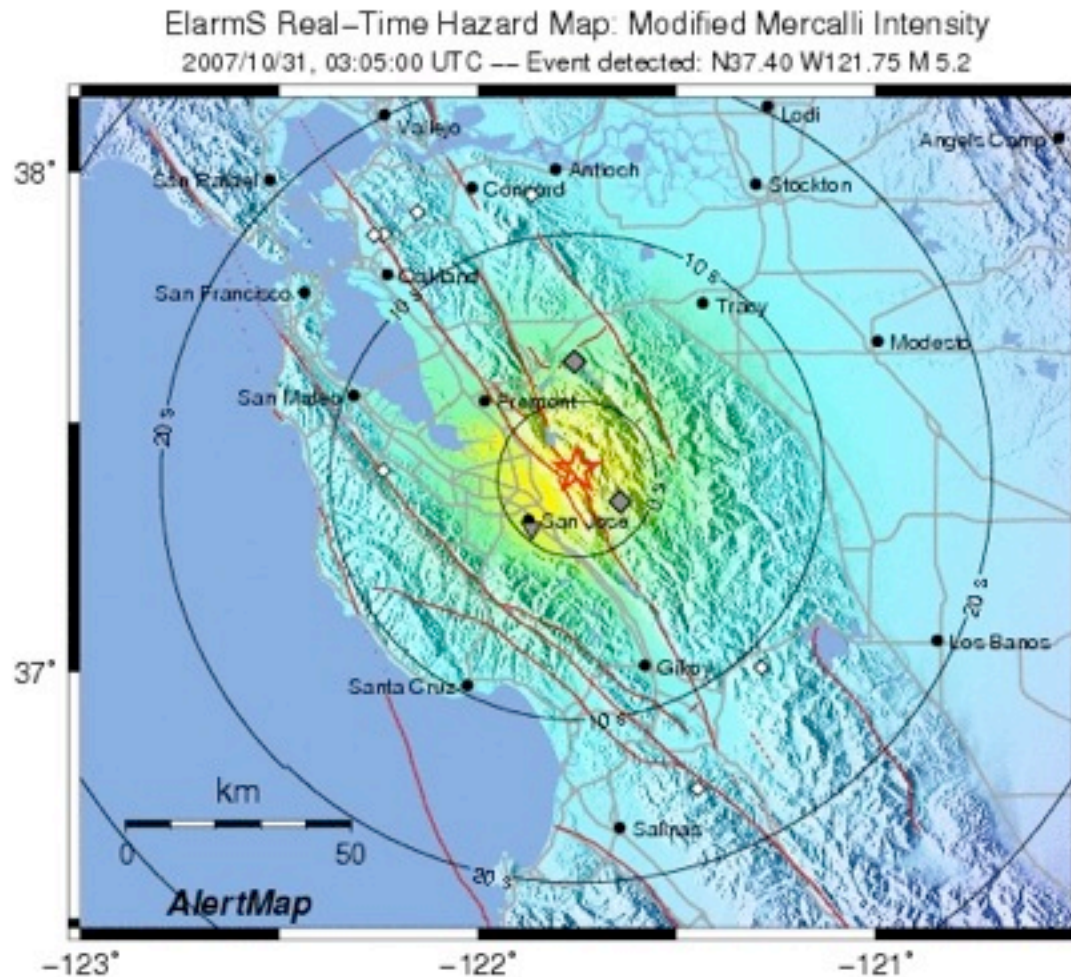


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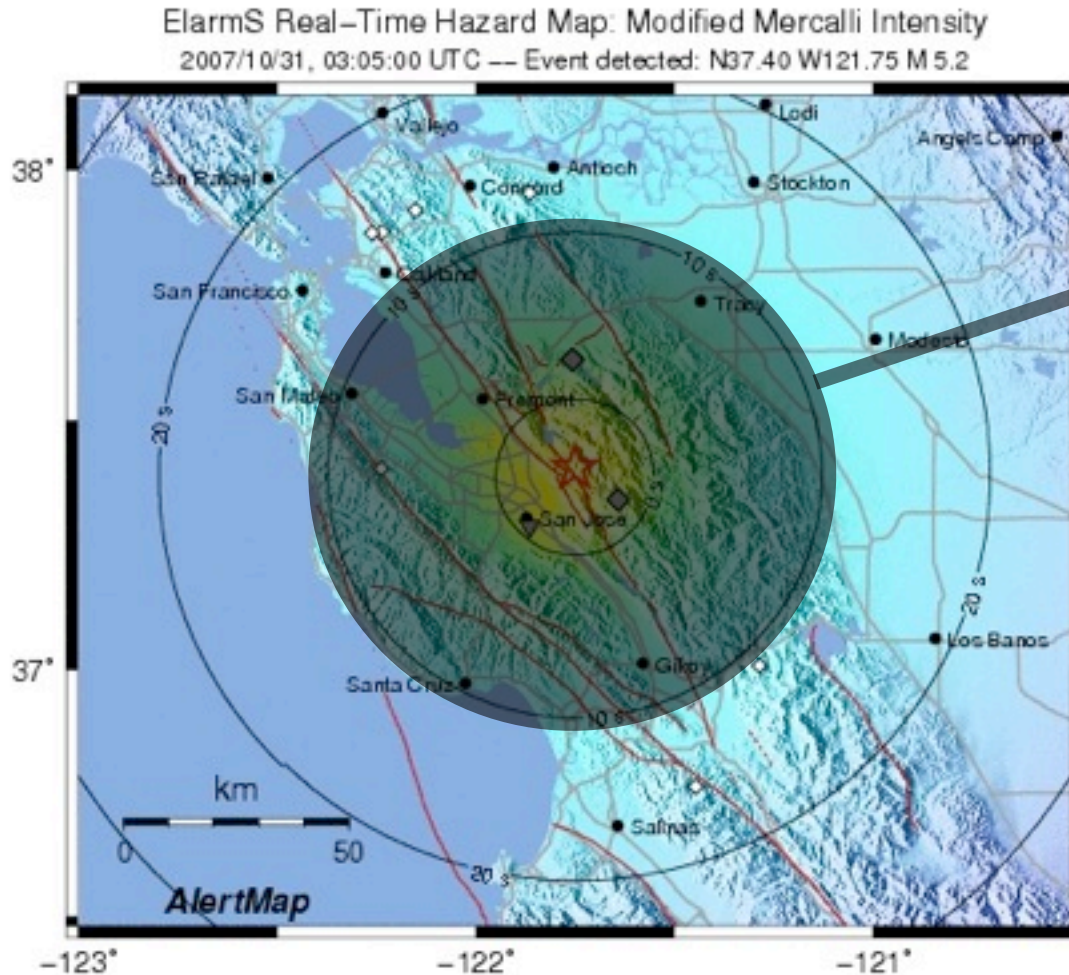
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The region close to the epicenter where telemetry and processing delays prevent warning



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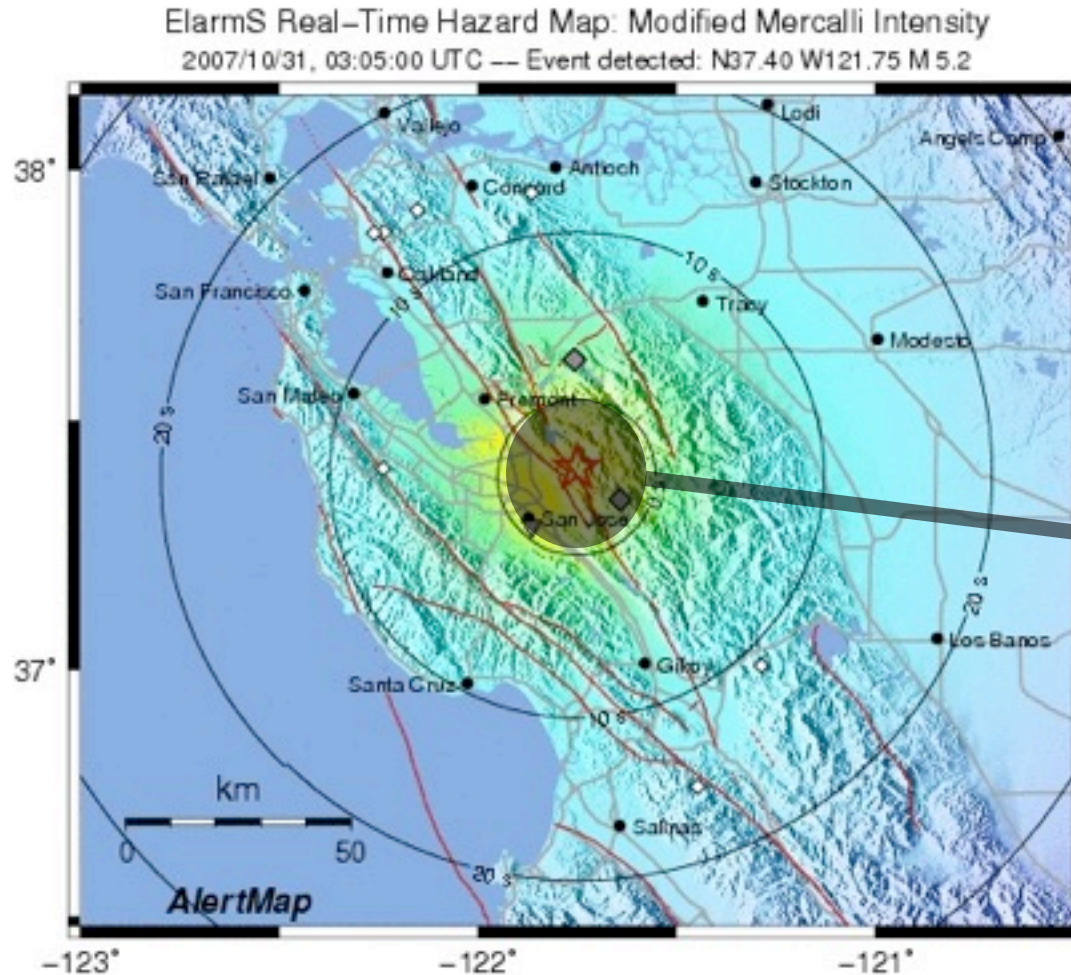
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**2007:**  
**Blind zone for Alum  
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**15 sec delay**

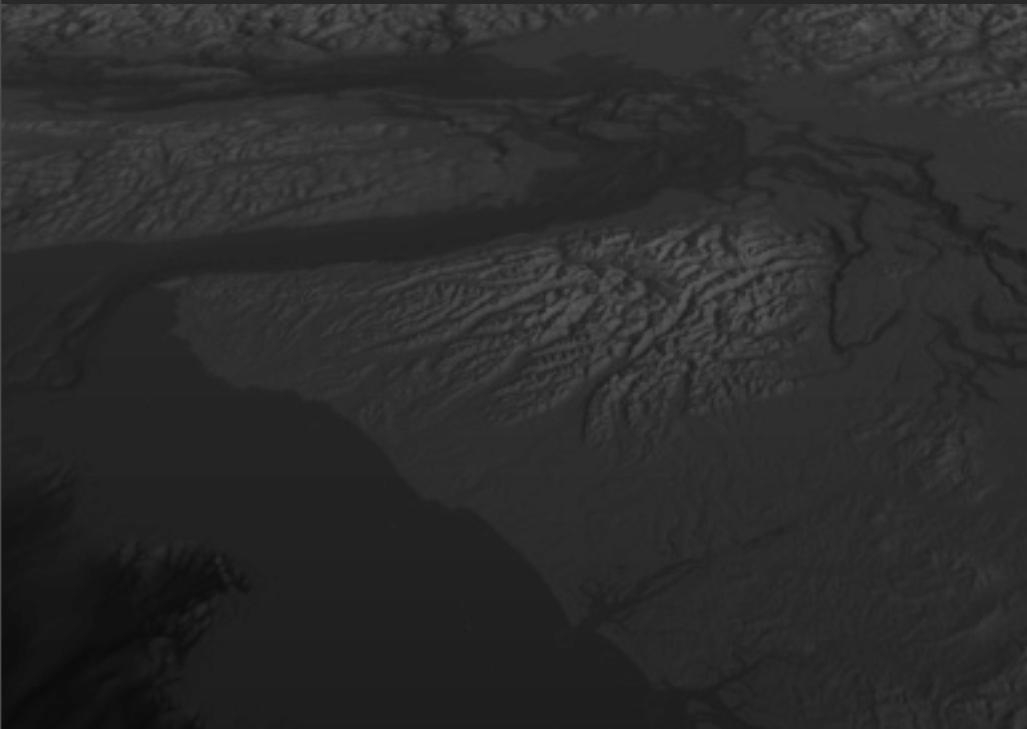
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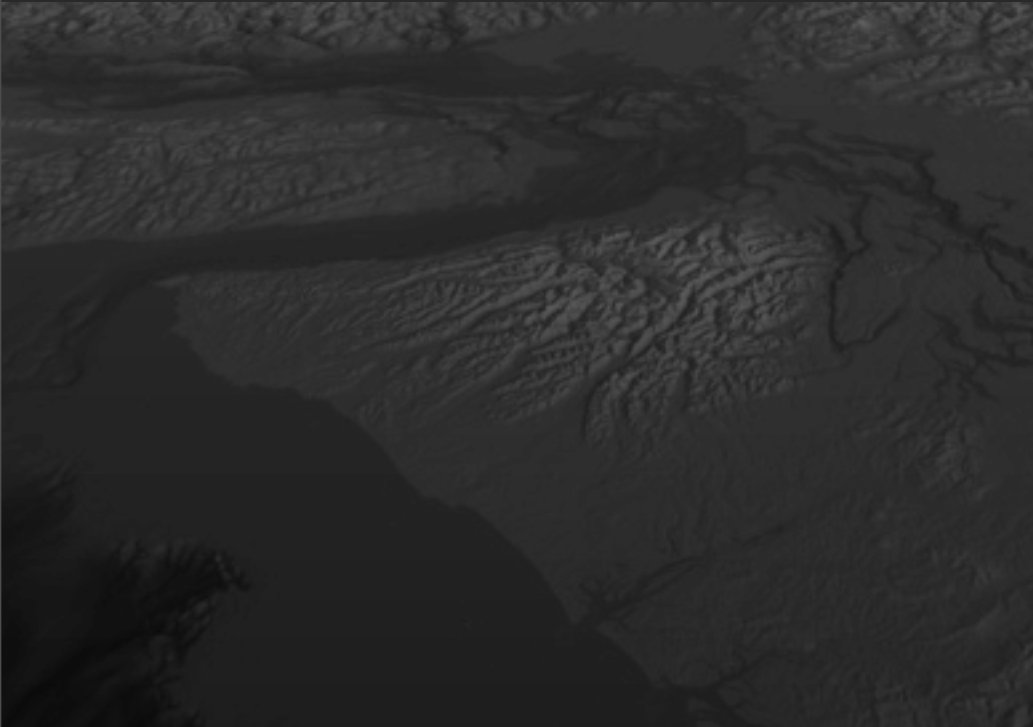


**2007:**  
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**15 sec delay**

**Goal:**  
Blind zone for  
**5 sec delay**  
3 sec latency  
+ 2 sec processing



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# Earthquake Early Warning

- ✦ **Earthquake early warning and fast response**
  - » Minutes of warning for earthquakes on the coast
  - » Puget Sound infrastructure along Columbia R.
  - » Immediate shut-down of viaduct, bridges
  - » Slowing traffic, trains, airports
  - » Hospitals, jump-starting emergency operations
  - » Warning delicate industrial operations
  - » Allows Shakemaps to be made before communications go down
- ✦ **No new physics necessary**

# Peace of mind in earthquake country?

