Using Turbidite and On-Shore Data to Update Logic Tree for Recurrence of Great Cascadia Earthquakes for the U.S. National Seismic Hazard Maps

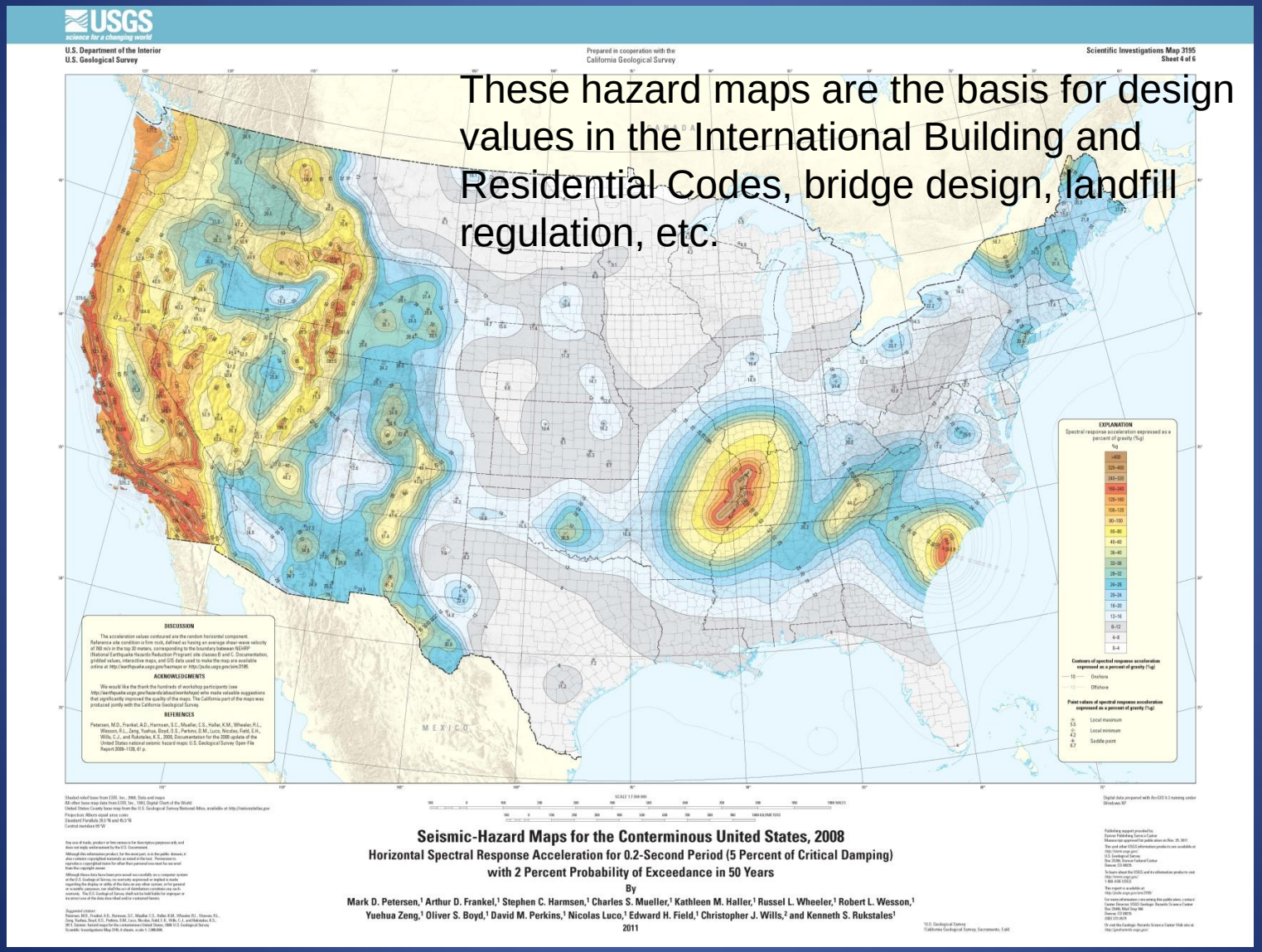
Art Frankel
U.S. Geological Survey
Seattle, WA
afrankel@usgs.gov

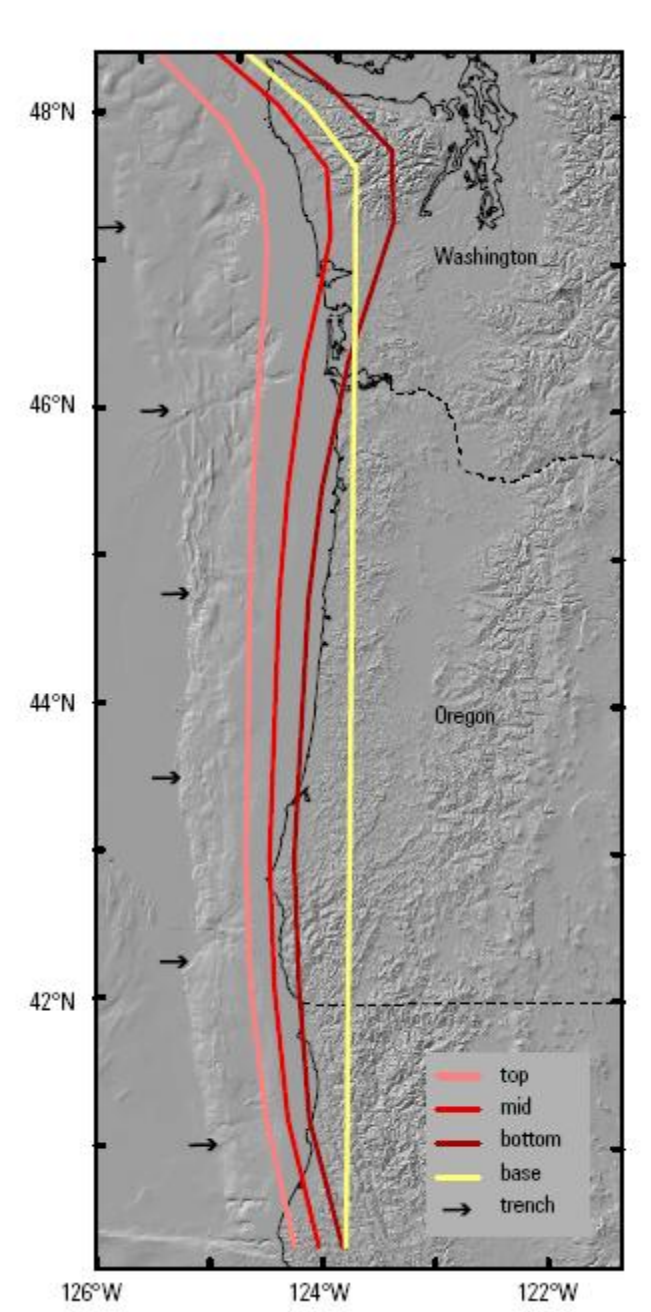
National Tsunami Hazard/Risk Analysis Workshop
Seattle, WA

July 25, 2012

USGS
science for a changing world

The USGS has started the process of updating the National Seismic Hazard Maps for release in 2014





Great earthquakes on Cascadia Subduction Zone included in NSHM's since 1996 based on paleoseismic studies (e.g., Atwater, 1992)

Figure shows different models for eastern edge of rupture used in 2002 and 2008 maps

2008 maps have two sets of scenarios: M8.8-9.2 that rupture entire length of CSZ With average recurrence of 500 yr

M8.0-8.7 rupture zones distributed along entire CSZ, rupture under any point with average of 500 yr

USGS science for a changing world

Recent and Future Workshops for the NSHM Update

- November 18-19, 2010, Corvallis, to evaluate turbidite data for constraining CSZ recurrence rates and magnitudes (USGS OFR 2011-1310)
- December 15, 2011, Eugene, to evaluate models for eastern edge of CSZ rupture zones
- March 21-22, 2012, Seattle, to gather inputs and feedback for the update for the PacNW
- December 13, 2012, Berkeley (with PEER) to discuss WUS ground-motion prediction equations including those for Cascadia great earthquakes

USGS science for a changing world

Turbidite Workshop, OSU, Nov 18-19, 2010

2010

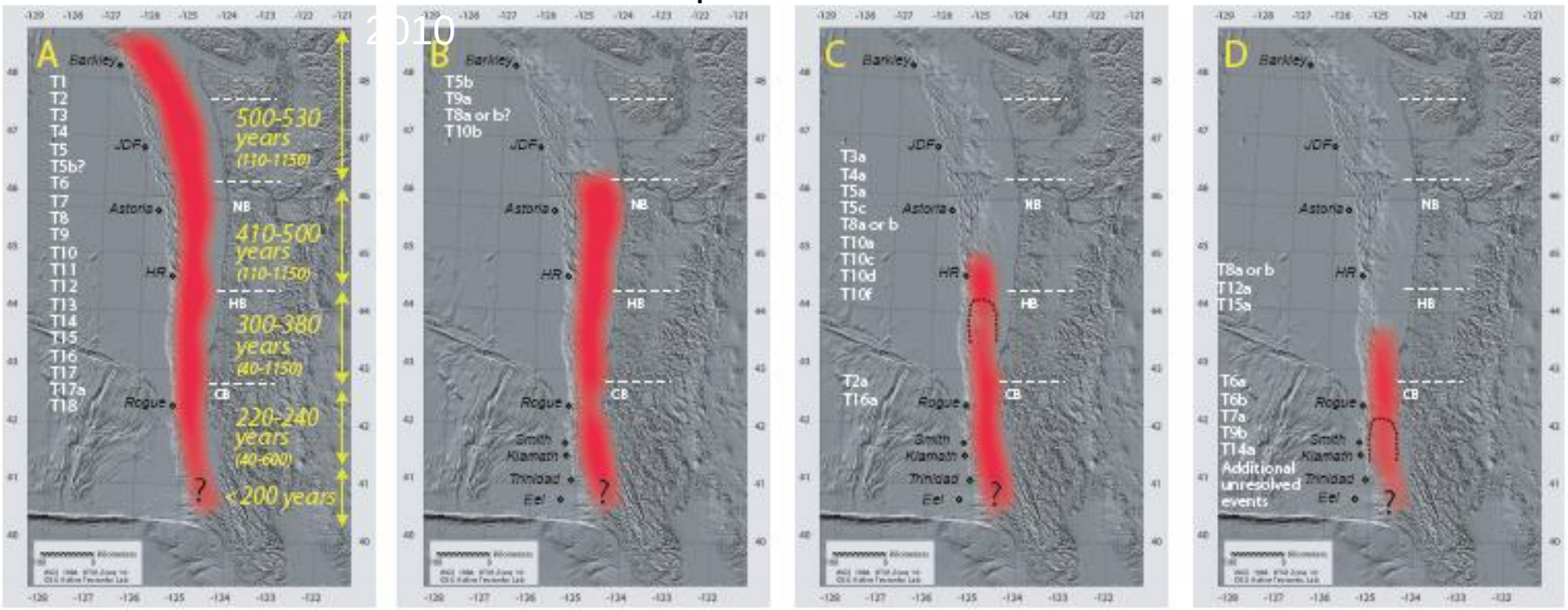
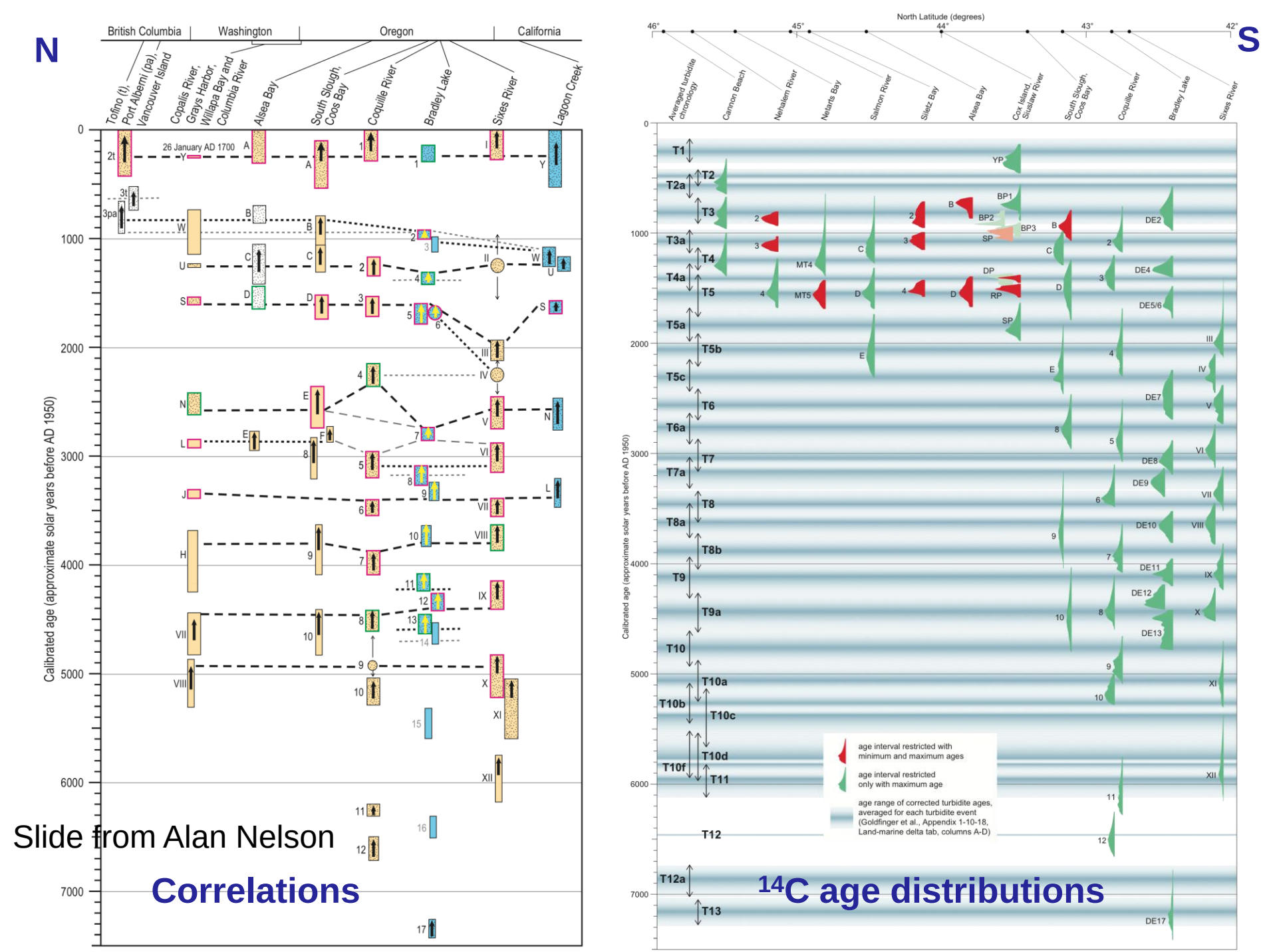


Figure from Goldfinger et al. (2012); great earthquake ruptures inferred from turbidites over past 10,000 years

We convened workshop at OSU on Nov 18-19, 2010 to evaluate turbidite data for constraining recurrence models for CSZ

1) Consensus on M9 whole CSZ rupture events with ave. recurr. time of 500-550 yr (or serial M8's in some cases)



Slide from Alan Nelson

Correlations

^{14}C age distributions

2) workshop consensus on southern CSZ

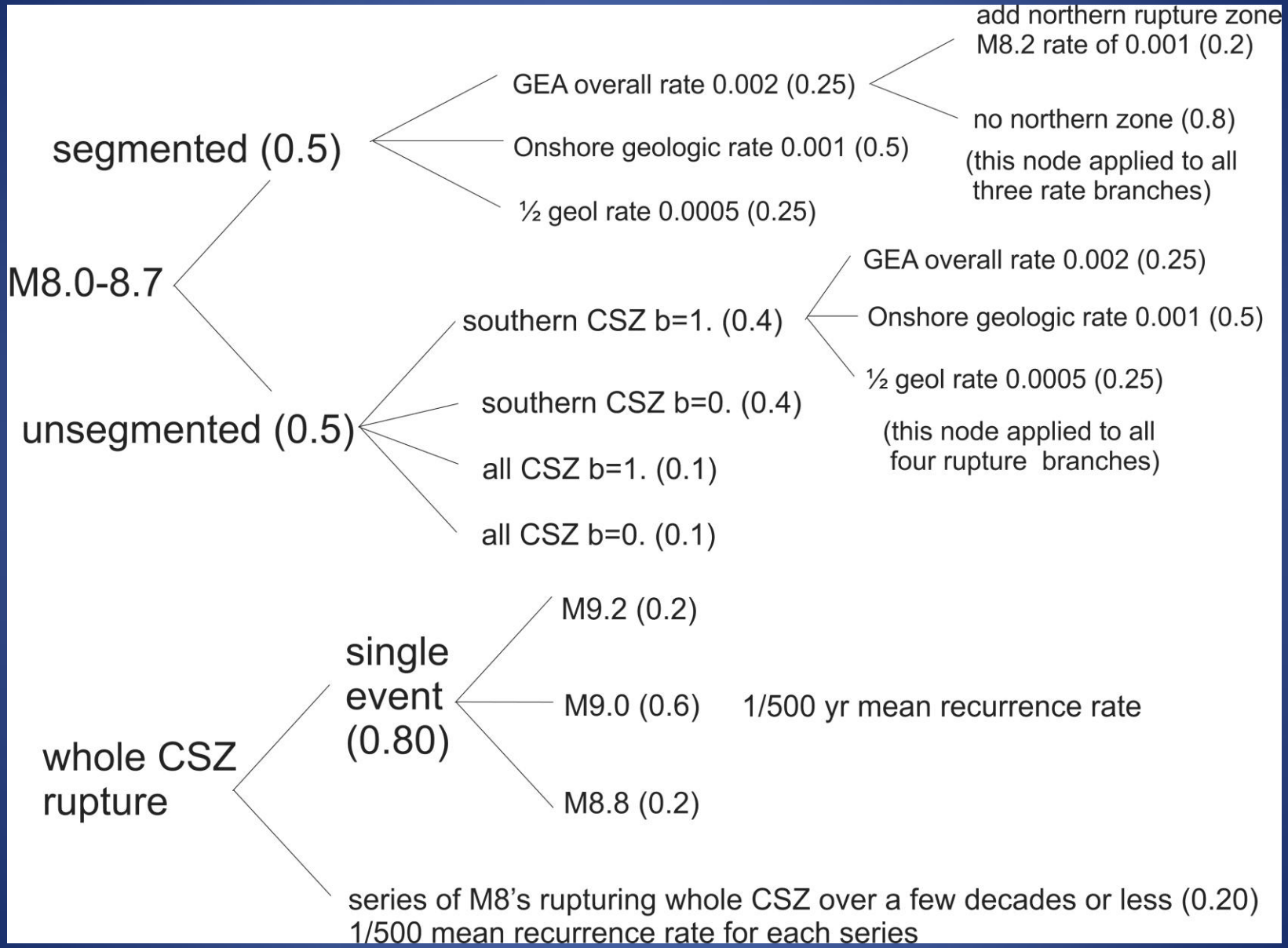
- About 10 partial rupture events in past 10,000 years (half of number in Goldfinger et al., 2012). Most participants thought the rough correspondence of rates between turbidites and on shore data (Bradley Lake, Sixes River) was indicative of M8+ earthquakes that ruptured only the southern CSZ
- Implies recurrence time of about 340 years in southern CSZ for earthquakes of M8 or larger (including M9 events with average recurrence time of 500 yr)
- Note that we already have M8.0-8.7 partial CSZ rupture events in current model, but they are distributed along whole zone)

3) Northern CSZ

- No consensus on rates of earthquakes that just rupture northern CSZ
- Atwater suggests zone north of Neah Bay may be as active for M8's as southern CSZ (based on "extra events" at Discovery Bay, Saanich Inlet) , but others at workshop disagreed
- More extensive discussion given in Atwater and Griggs (USGS OFR 2012-1043)

USGS
science for a changing world

Proposed Logic Tree for CSZ Great Earthquake Recurrence



GEA= Goldfinger et al. (2012) Northern zone proposed by Atwater and Griggs (2012)

Future work needed to improve logic tree for CSZ recurrence

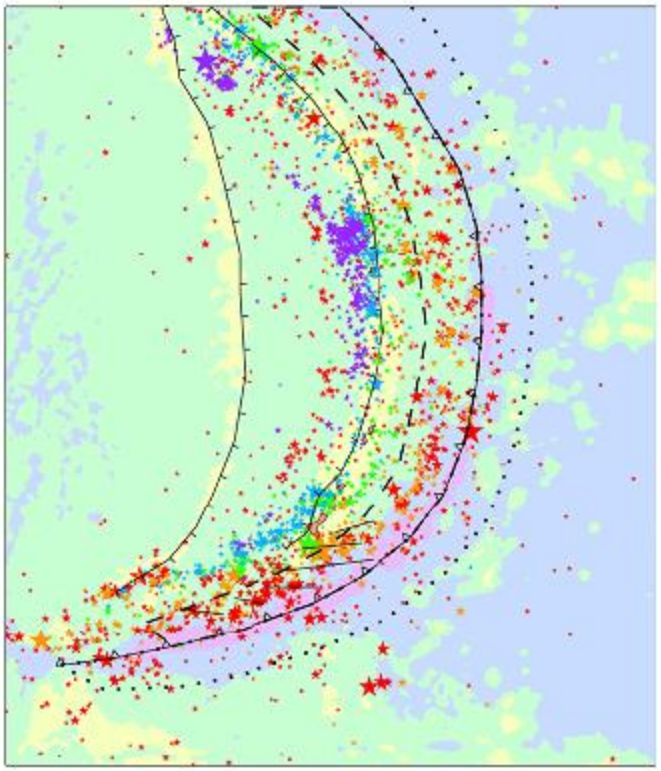
- More paleoseismic and paleotsunami studies to determine recurrence rates and locations of M8 earthquakes, including possible northern zone
- Examine turbidite case histories from recent earthquakes to better understand origin of mud turbidites; use of chirp data to track turbidites between cores is promising

USGS
science for a changing world

USGS
science for a changing world

Seismic Hazard Assessment for Guam and the Northern Mariana Islands

By Charles S. Mueller, Kathleen M. Haller, Nicholas Luco, Mark D. Petersen, and Arthur D. Frankel



Open-File Report 2012–1015

U.S. Department of the Interior
U.S. Geological Survey

Also: USGS Open File Report on seismic hazard maps for American Samoa will be out soon (Petersen et al., 2012)

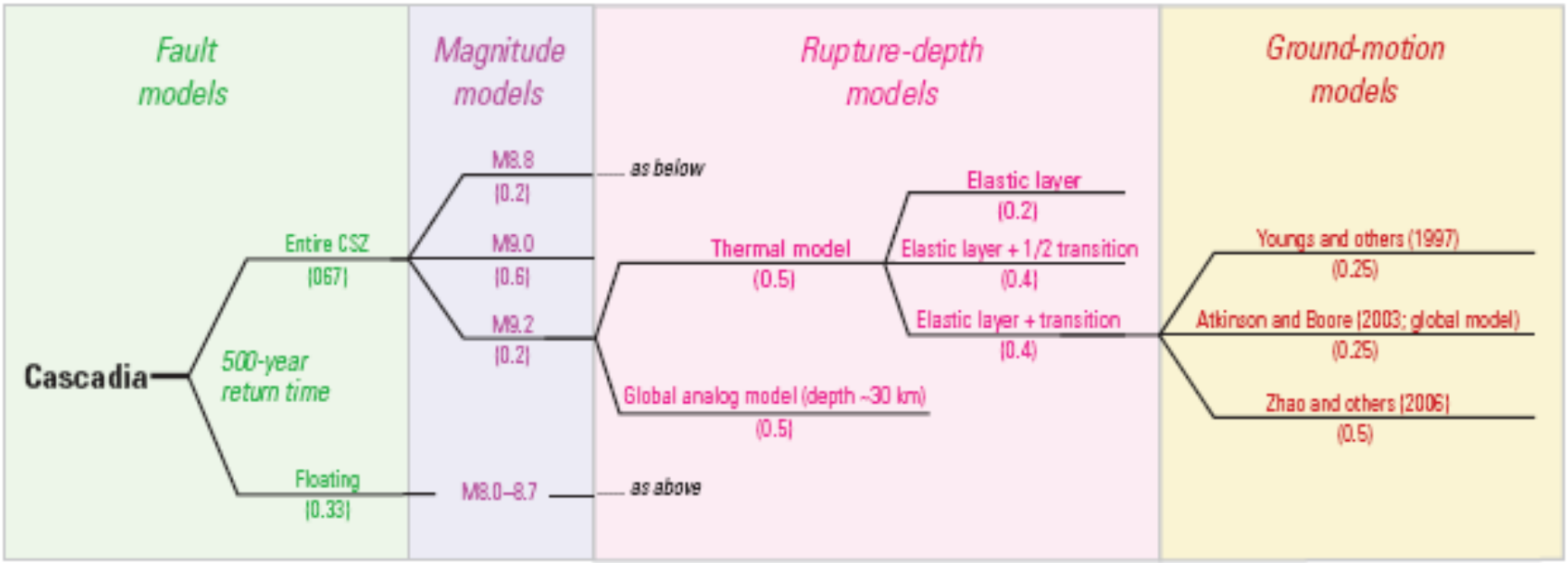
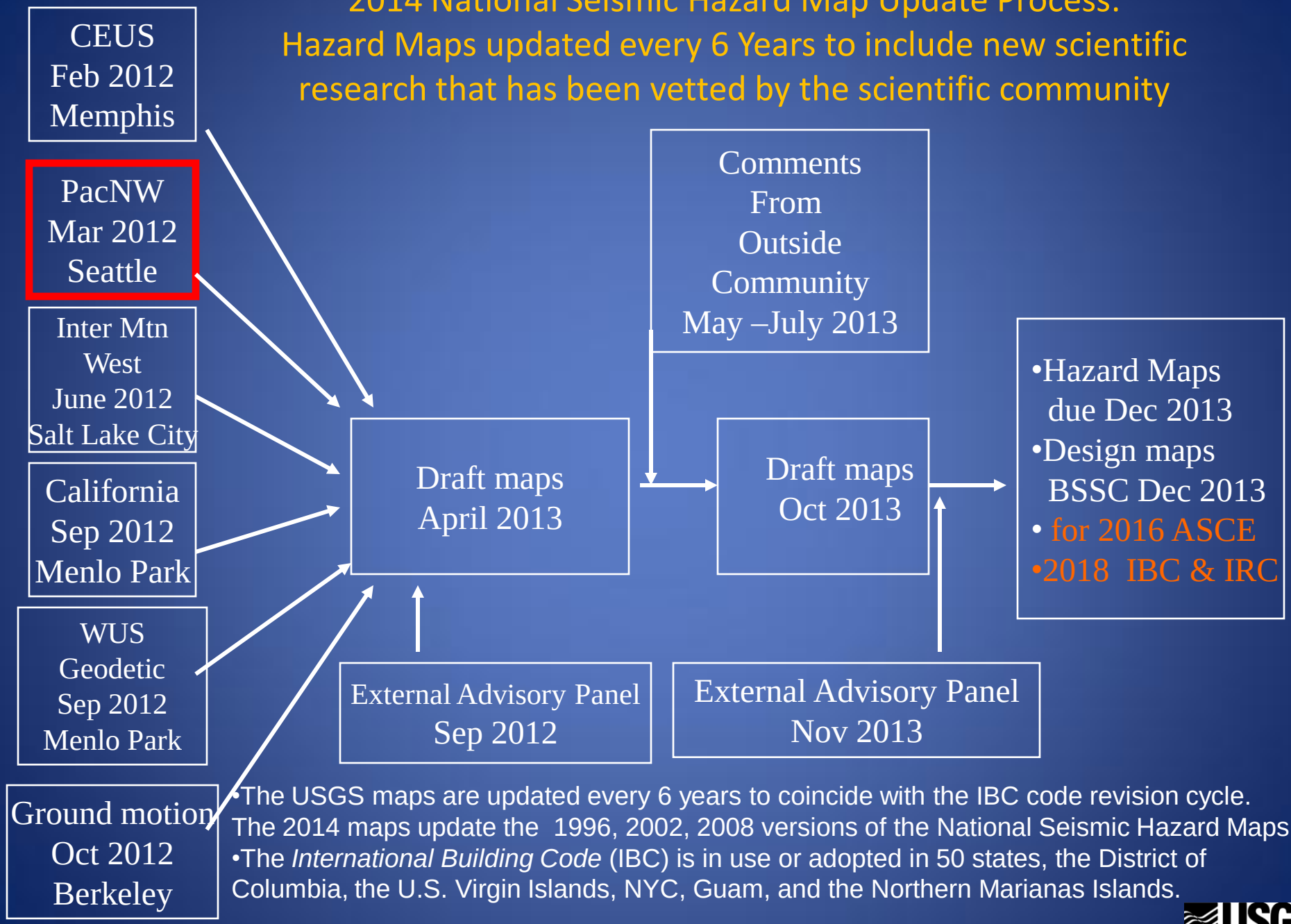


Figure 20. Logic tree for Cascadia subduction zone (CSZ). Parameters in this figure include some aleatory variability as well as depicted epistemic uncertainty. Additional aleatory variability shown in table K-1 in Appendix K.

From 2008 NSHM Documentation (Petersen et al., 2008)

USGS science for a changing world

2014 National Seismic Hazard Map Update Process:
Hazard Maps updated every 6 Years to include new scientific research that has been vetted by the scientific community



•The USGS maps are updated every 6 years to coincide with the IBC code revision cycle. The 2014 maps update the 1996, 2002, 2008 versions of the National Seismic Hazard Maps.

•The *International Building Code* (IBC) is in use or adopted in 50 states, the District of Columbia, the U.S. Virgin Islands, NYC, Guam, and the Northern Marianas Islands.

USGS science for a changing world