

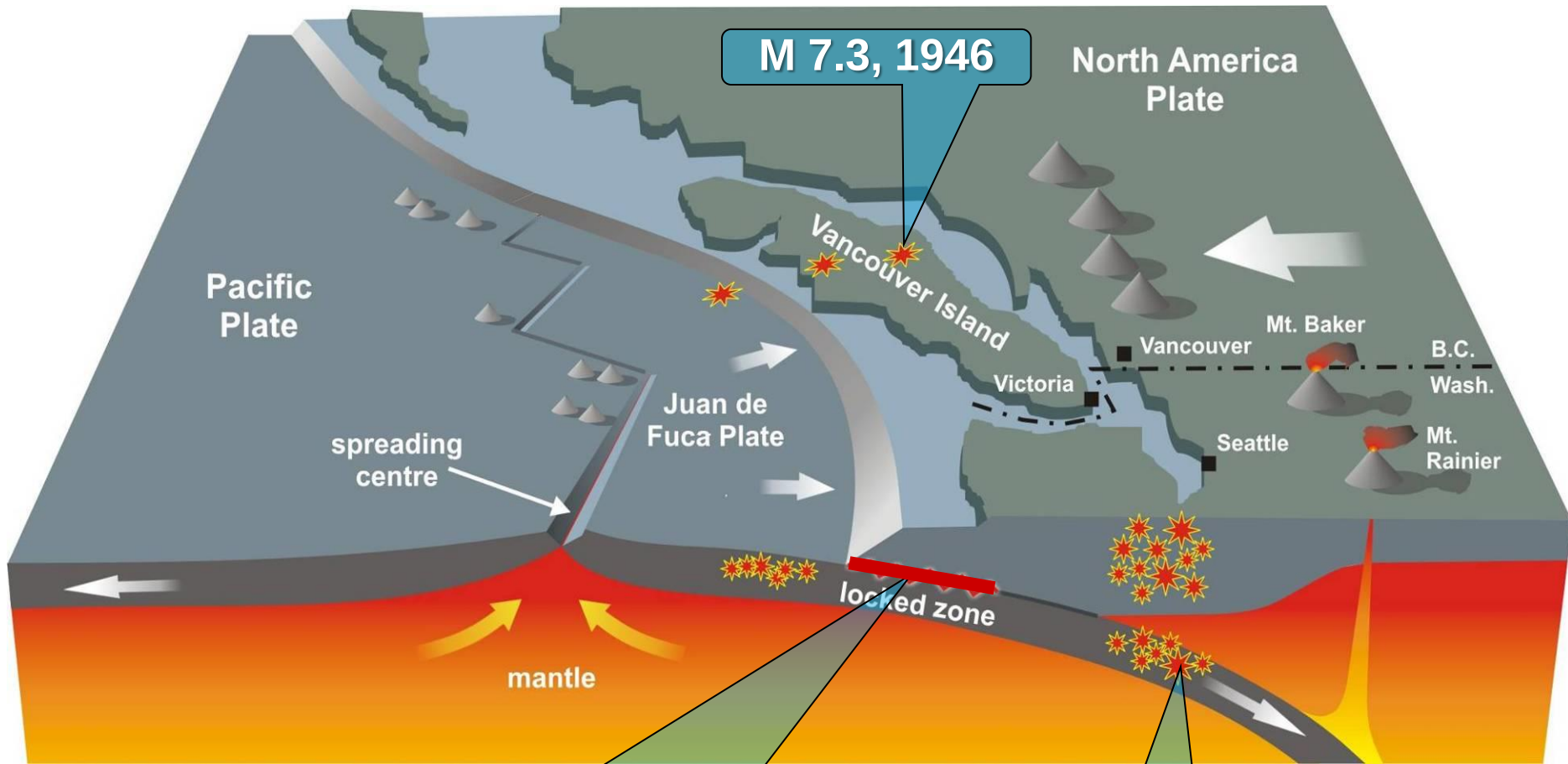
What scientists know and do not know about “the big one” at Cascadia

Kelin Wang

Pacific Geoscience Centre, Geological Survey of Canada
Natural Resources Canada



The Cascadia Subduction Zone



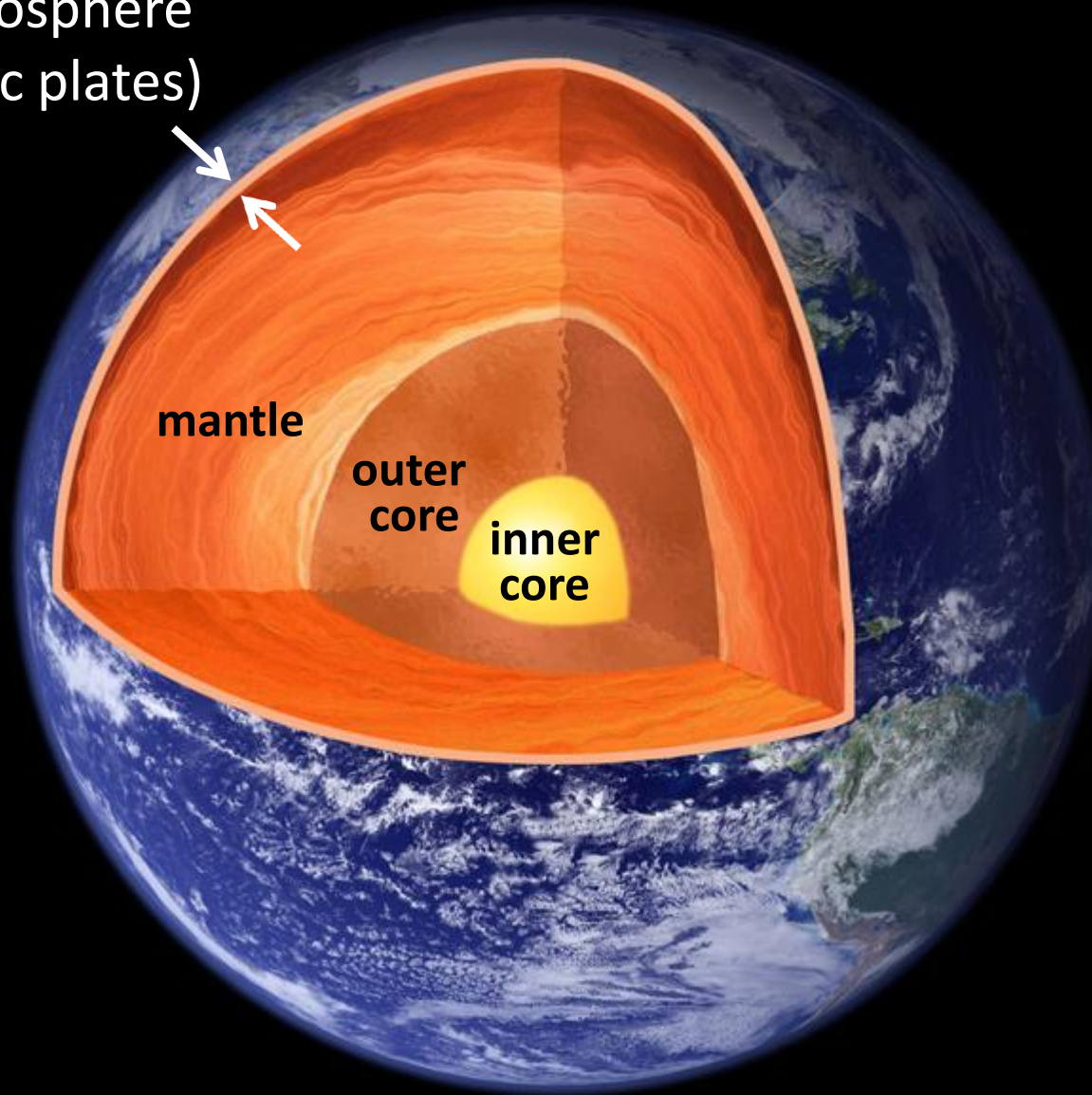
Rupture zone of M ~ 9
Cascadia earthquake, 1700

M 6.8, 2001

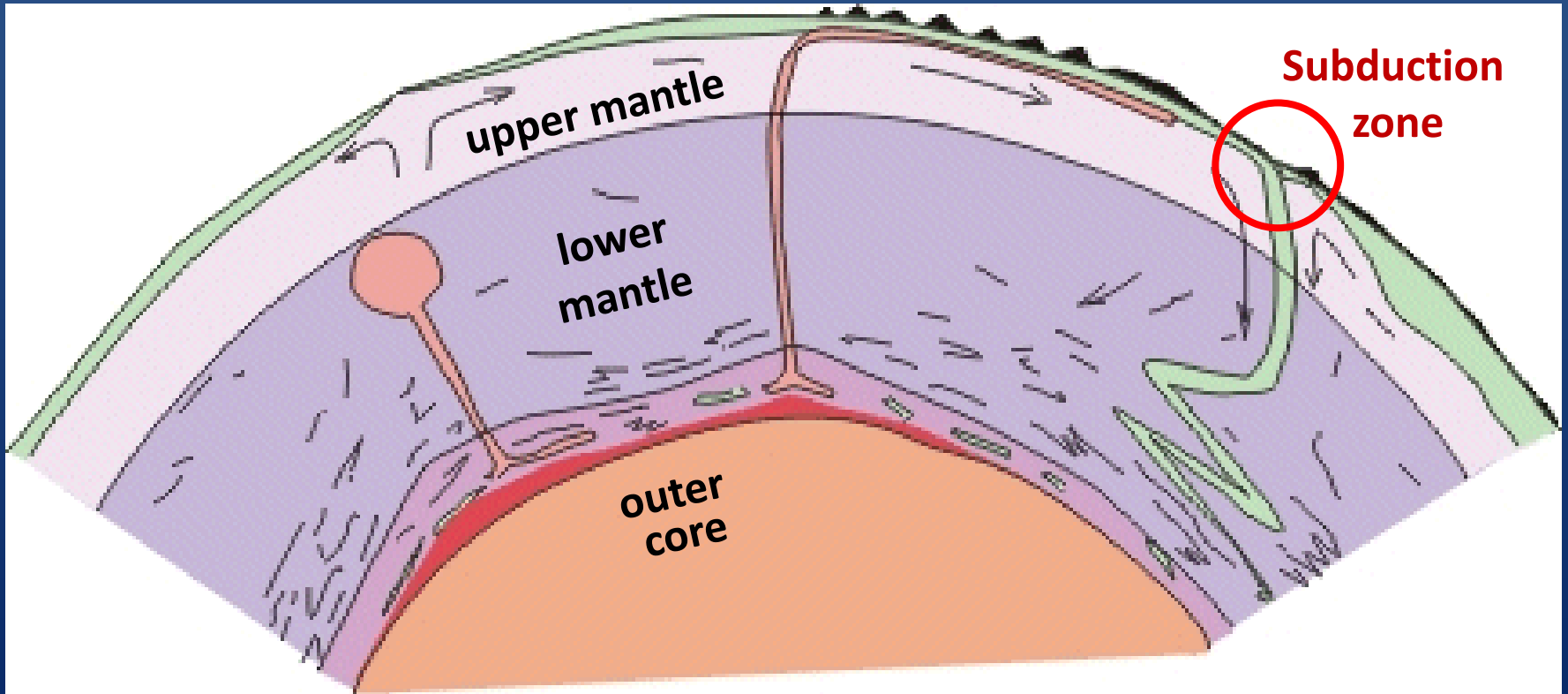
What we know

- Cascadia is a typical place for giant earthquakes
- The last big one occurred in AD 1700
- Similar events occurred every few centuries in the past
- Now the system is building up energy for the next big one

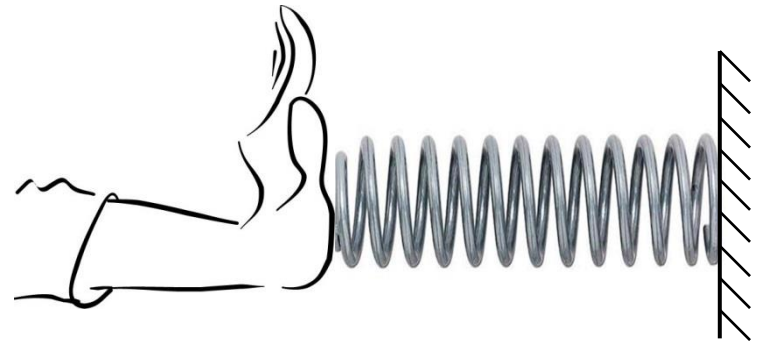
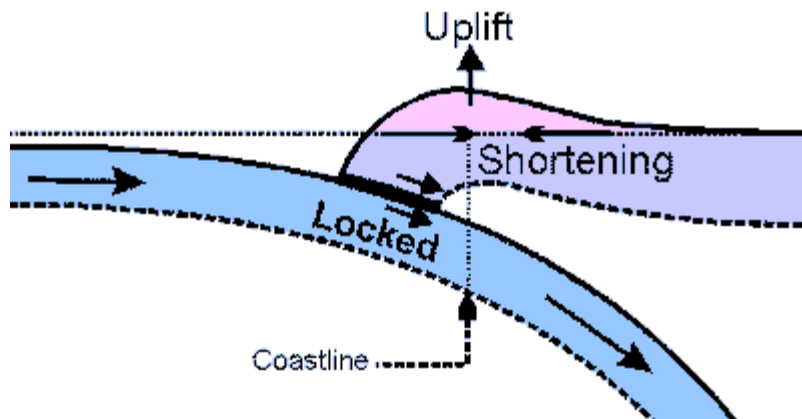
the lithosphere
(tectonic plates)



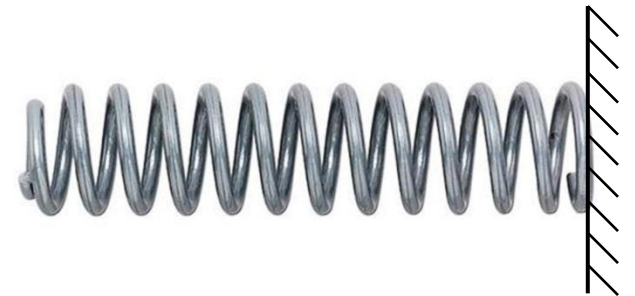
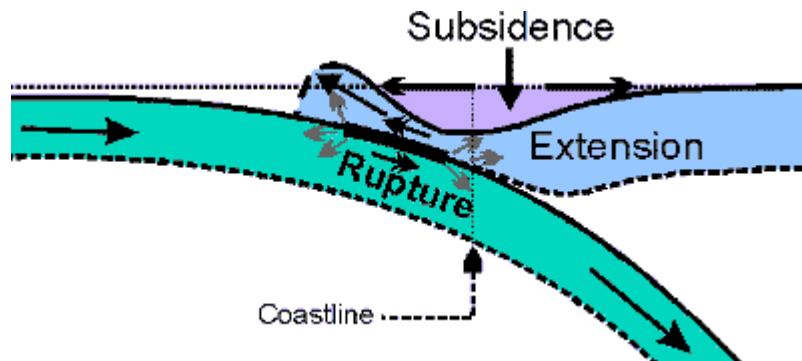
Heat causes the mantle to convect.
Mantle convection causes plates to move.



Between Earthquakes



Earthquake



**The Cascadia
Subduction Zone**

1964 Alaska
(M 9.2)

2011 Japan
(M 9.0)

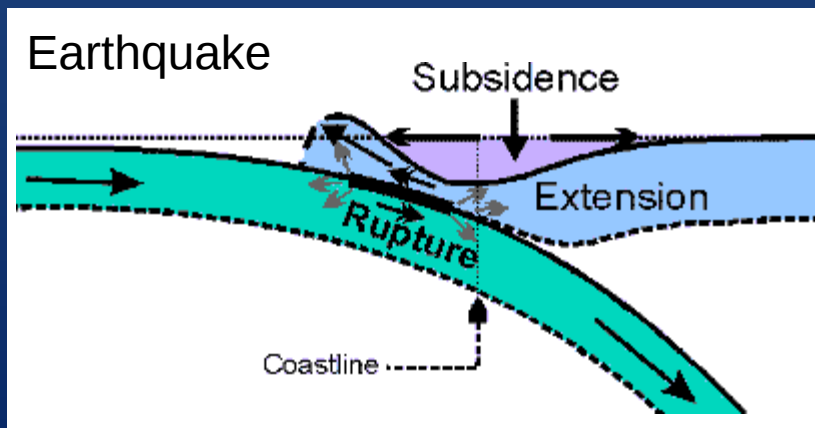
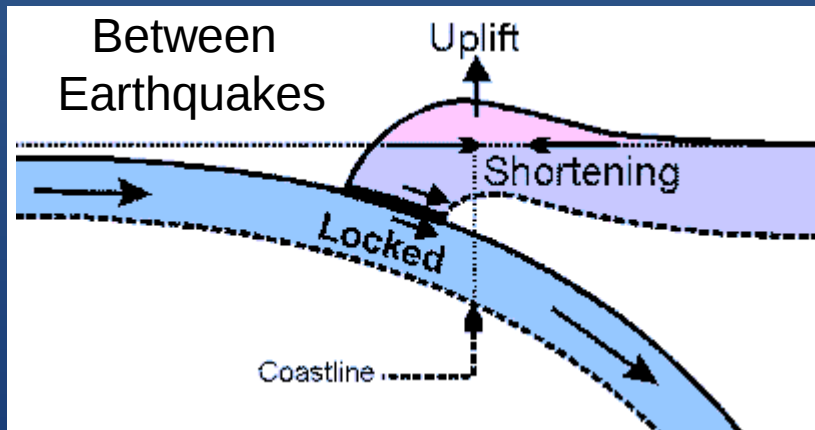
2004 Sumatra
(M 9.2)

1960 Chile
(M 9.5)

What happened in the past?



Great Earthquakes Recorded in Coastal Geology



Great Earthquakes Recorded in Coastal Geology

LAND LOWERED SUDDENLY



Copalis River, WA

- **Dropped during earthquakes**

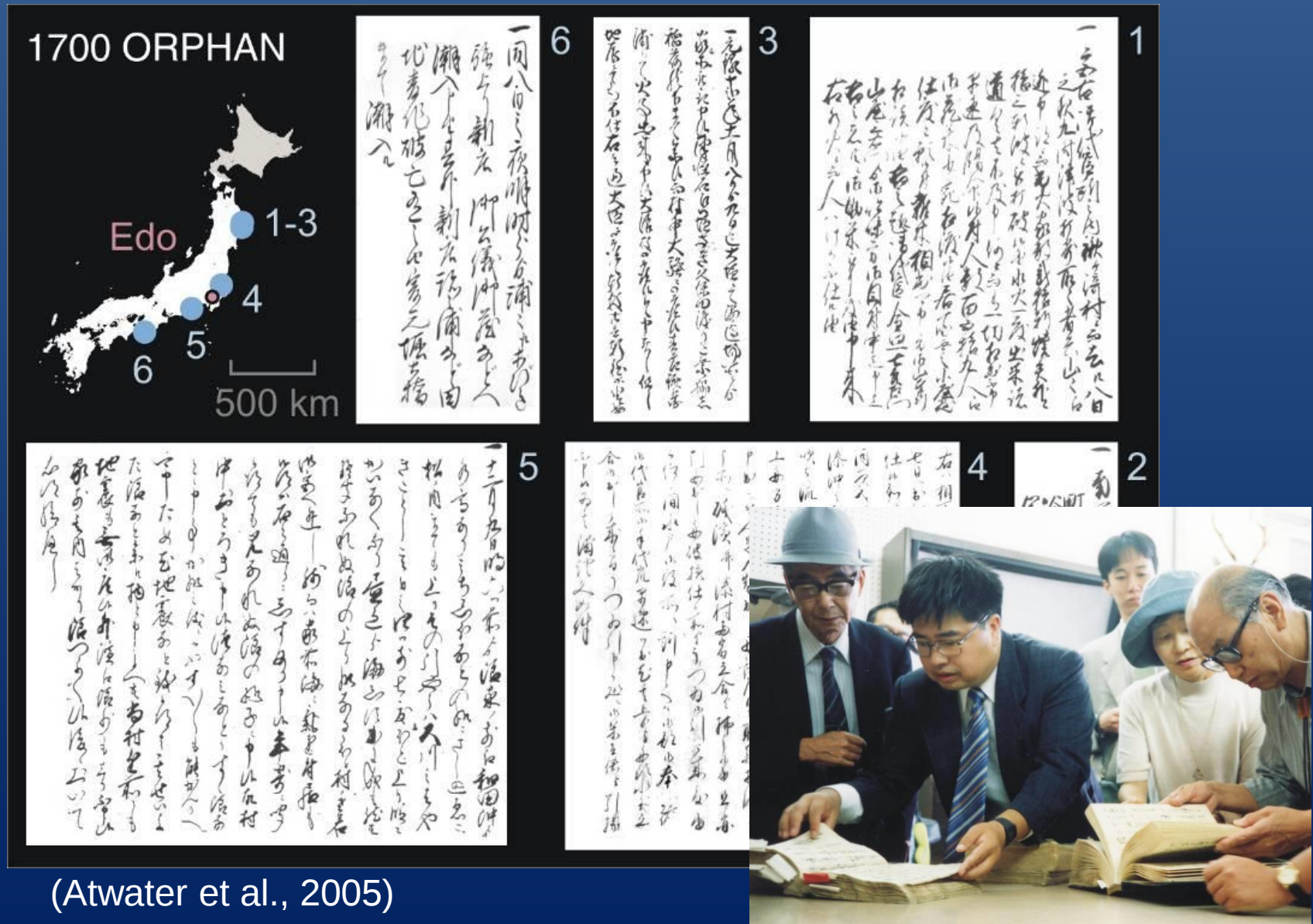
From Brian Atwater

Photo, Brian Smale



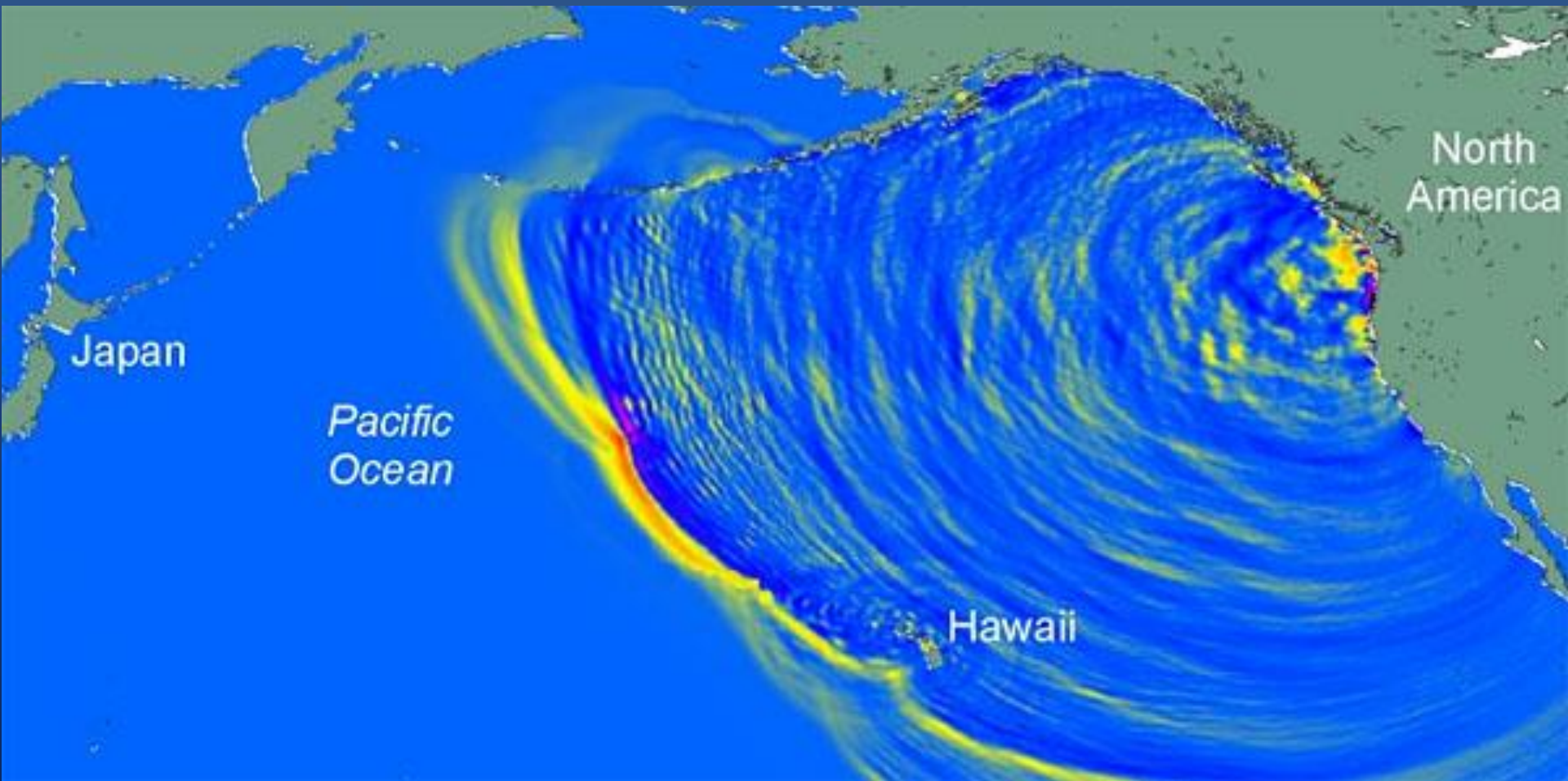
Willapa Bay

Great Cascadia earthquake of Jan. 26, 1700, recorded in Japan



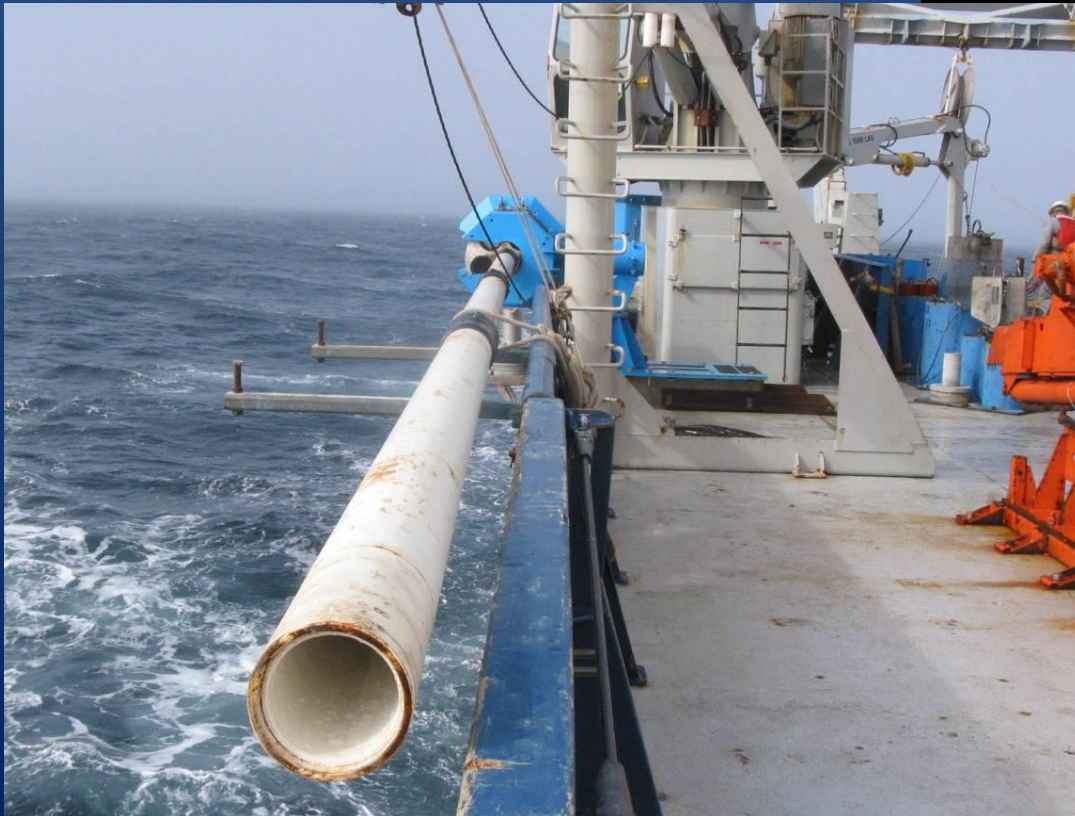
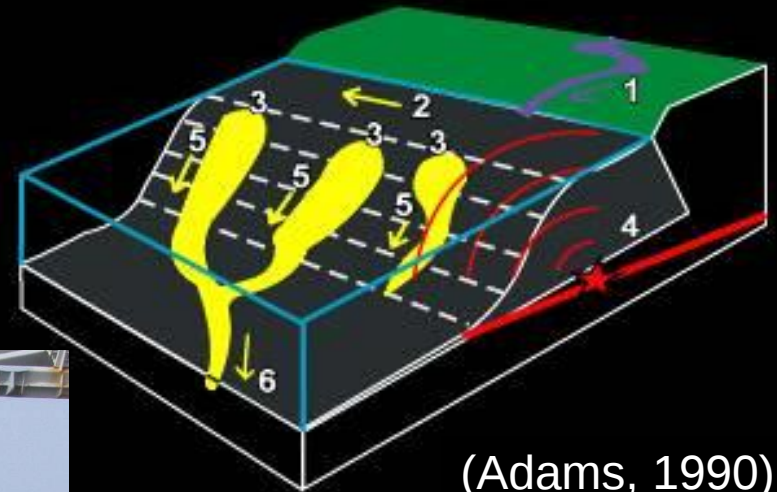
(Atwater et al., 2005)

Great Cascadia earthquake of Jan. 26, 1700, recorded in Japan



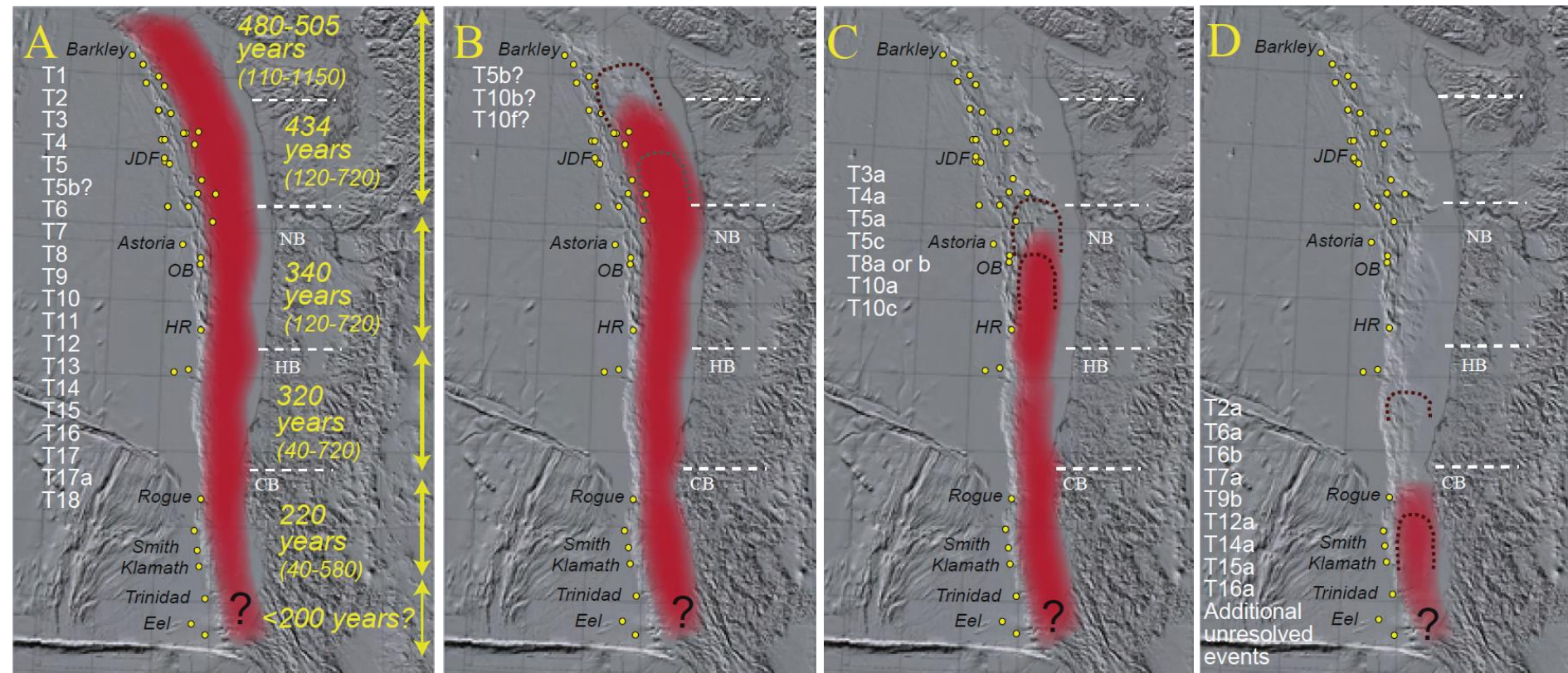
(Satake, Wang, Atwater. 2003 JGR)

Great Earthquakes Recorded in Seafloor Sediment Deposits



(Goldfinger et al., 2005)

Great Cascadia earthquakes recorded in turbidite deposits over the past 10,000 years



M 8.8-9.2
~ 20 events

Many additional
events in the south?

Simplified from Goldfinger et al. (2016 Marine Geology)

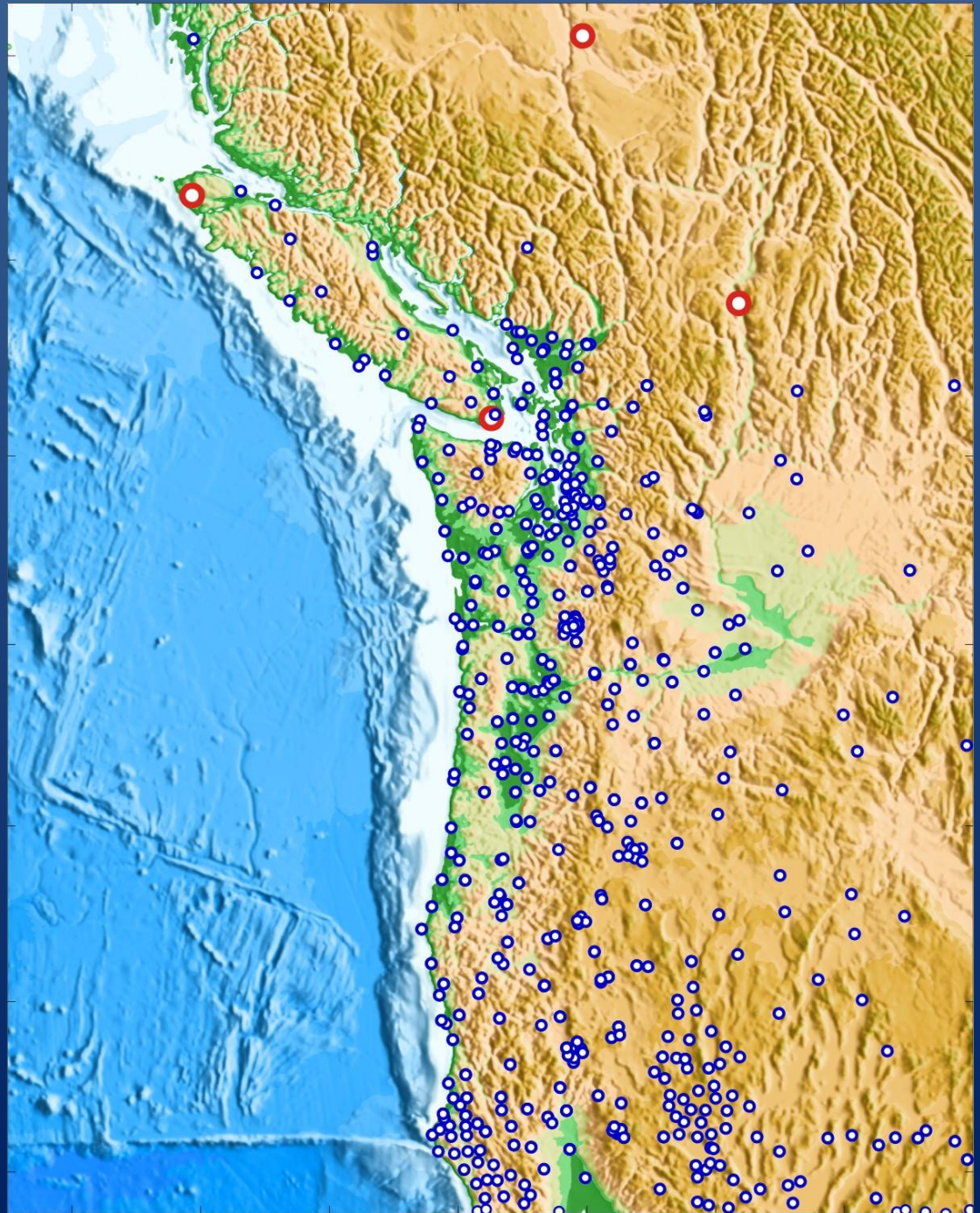
What is happening today?

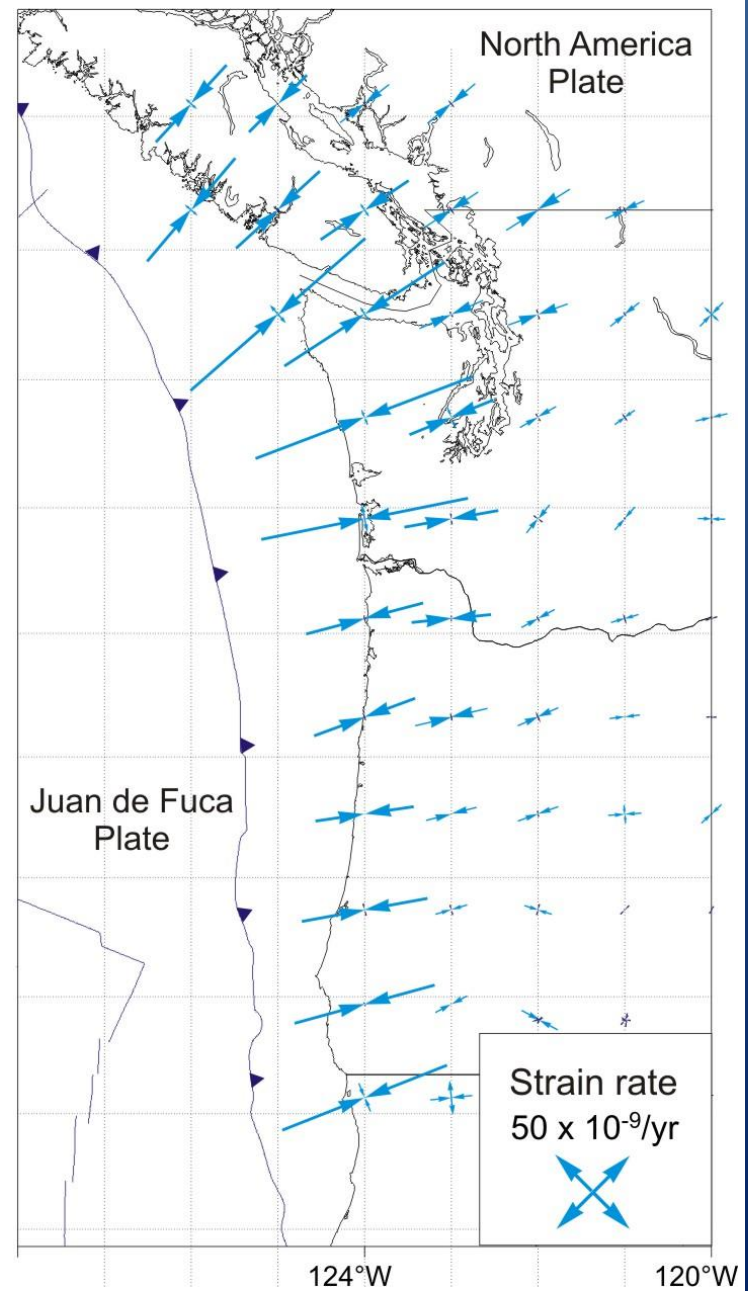
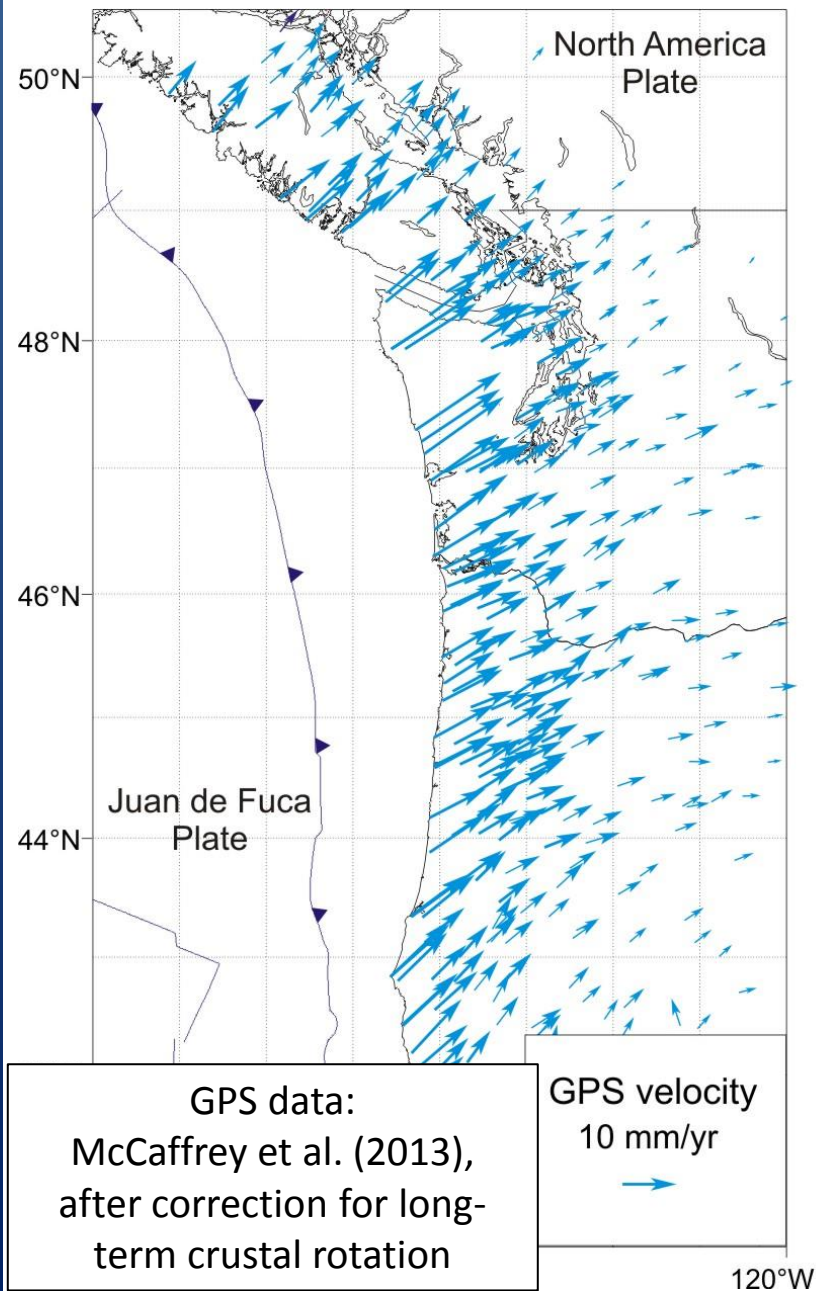


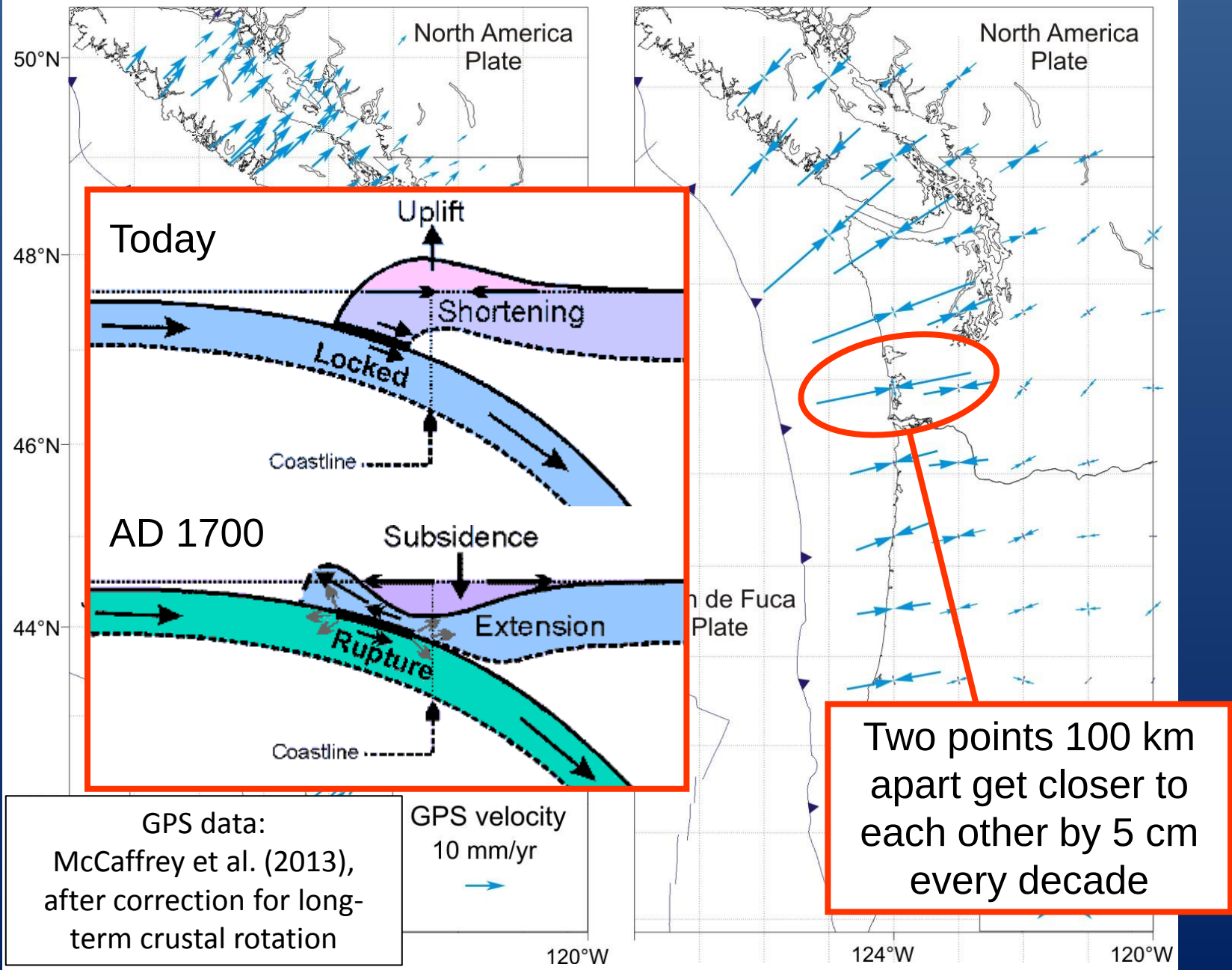
Continuous GPS Stations today:

U.S. Plate Boundary
Observatory (PBO)
and Western Canada
Deformation Array

Plus numerous
temporary GPS sites
and numerous seismic
stations

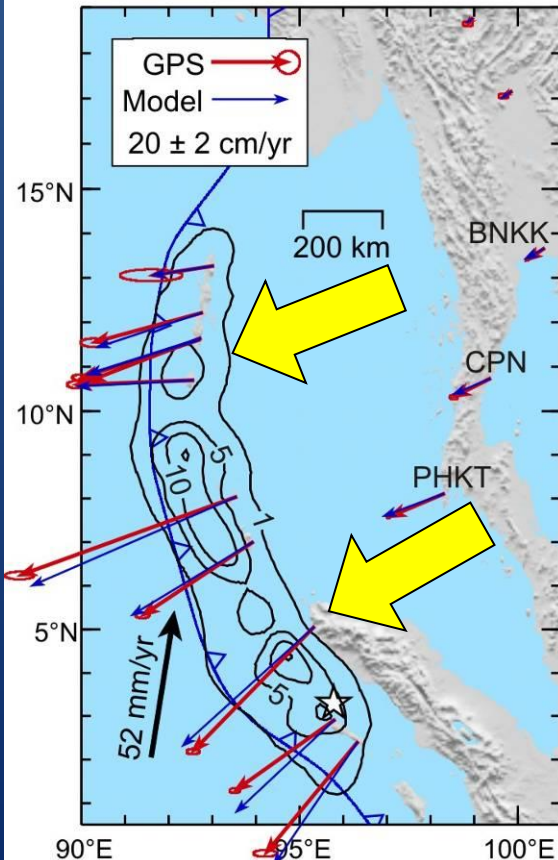






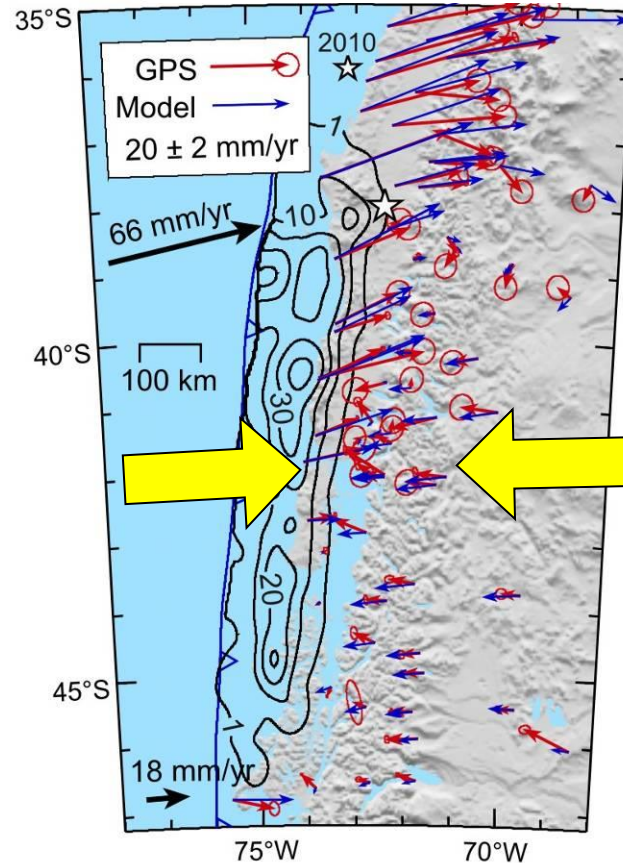
Piecing together the deformation cycle of giant earthquakes

Sumatra (and Japan)



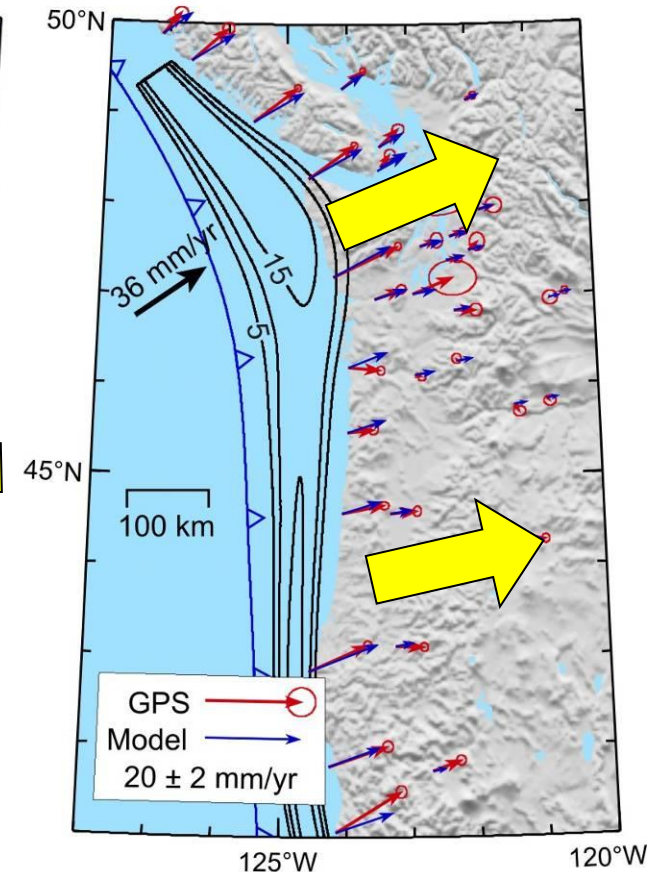
A few years

S. Chile (and Alaska)



Four decades

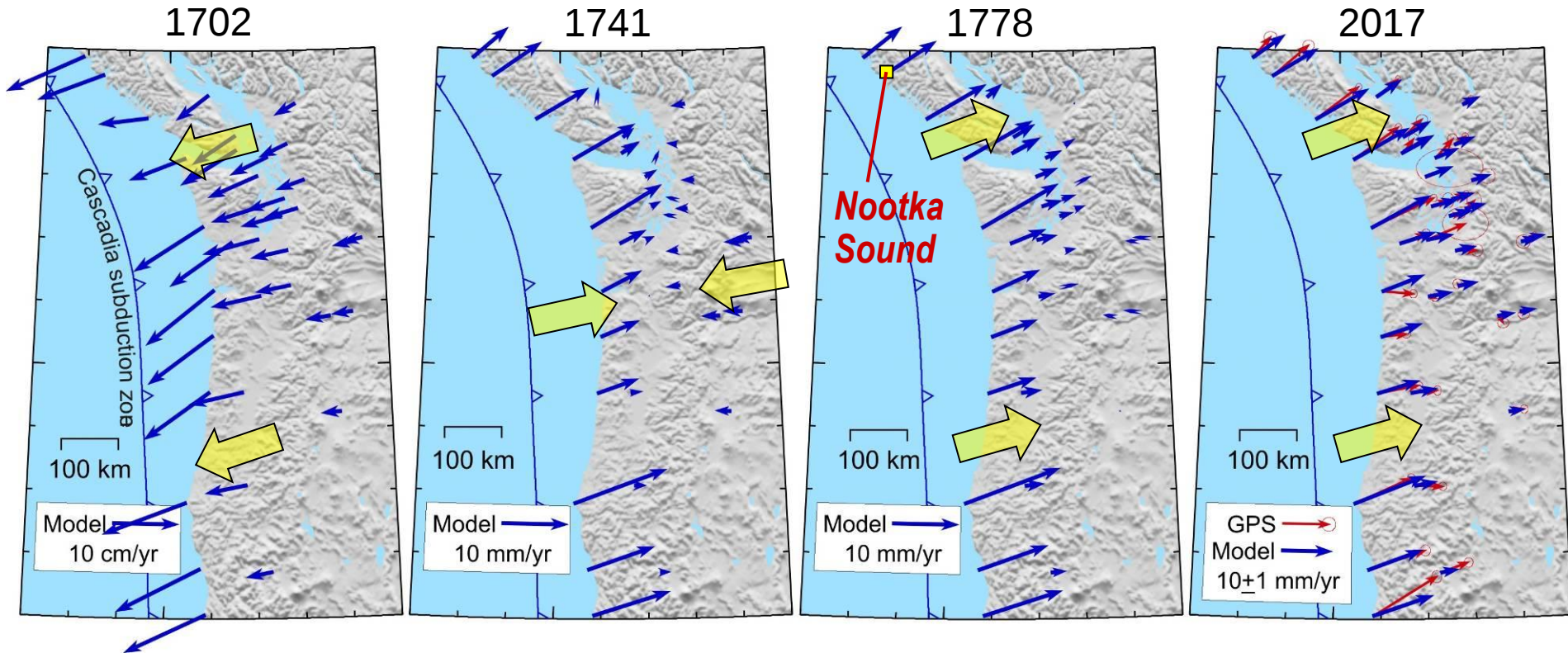
Cascadia



Three centuries

Wang, Hu, He (Nature, 2012)

Cascadia since the 1700 earthquake



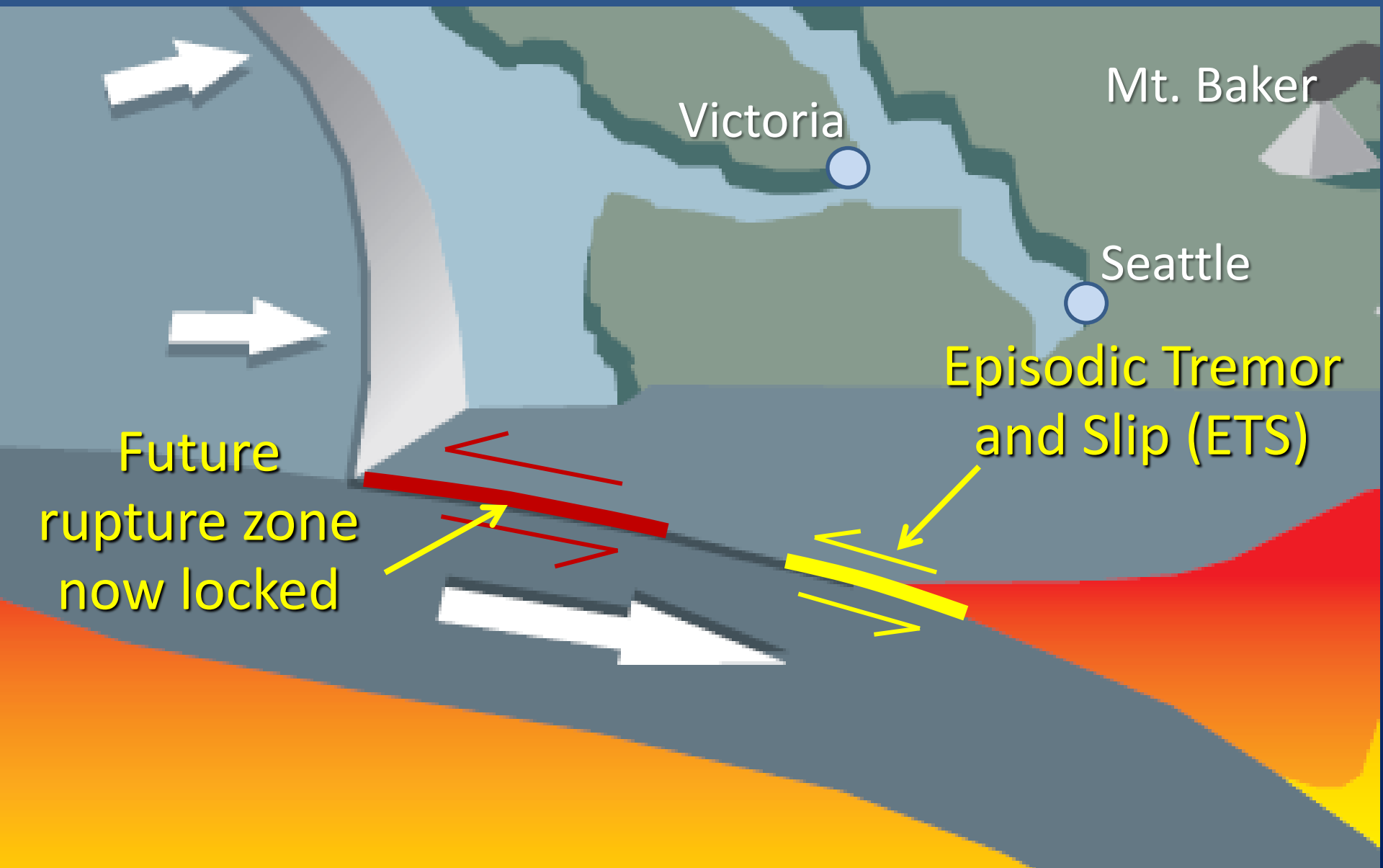
England and France started Queen Anne's War in eastern North America.

Captain Chirikov (Russia) landed on northwest coast.

Captain Cook stayed at Nootka Sound.

Wang and Gombert present webinars.

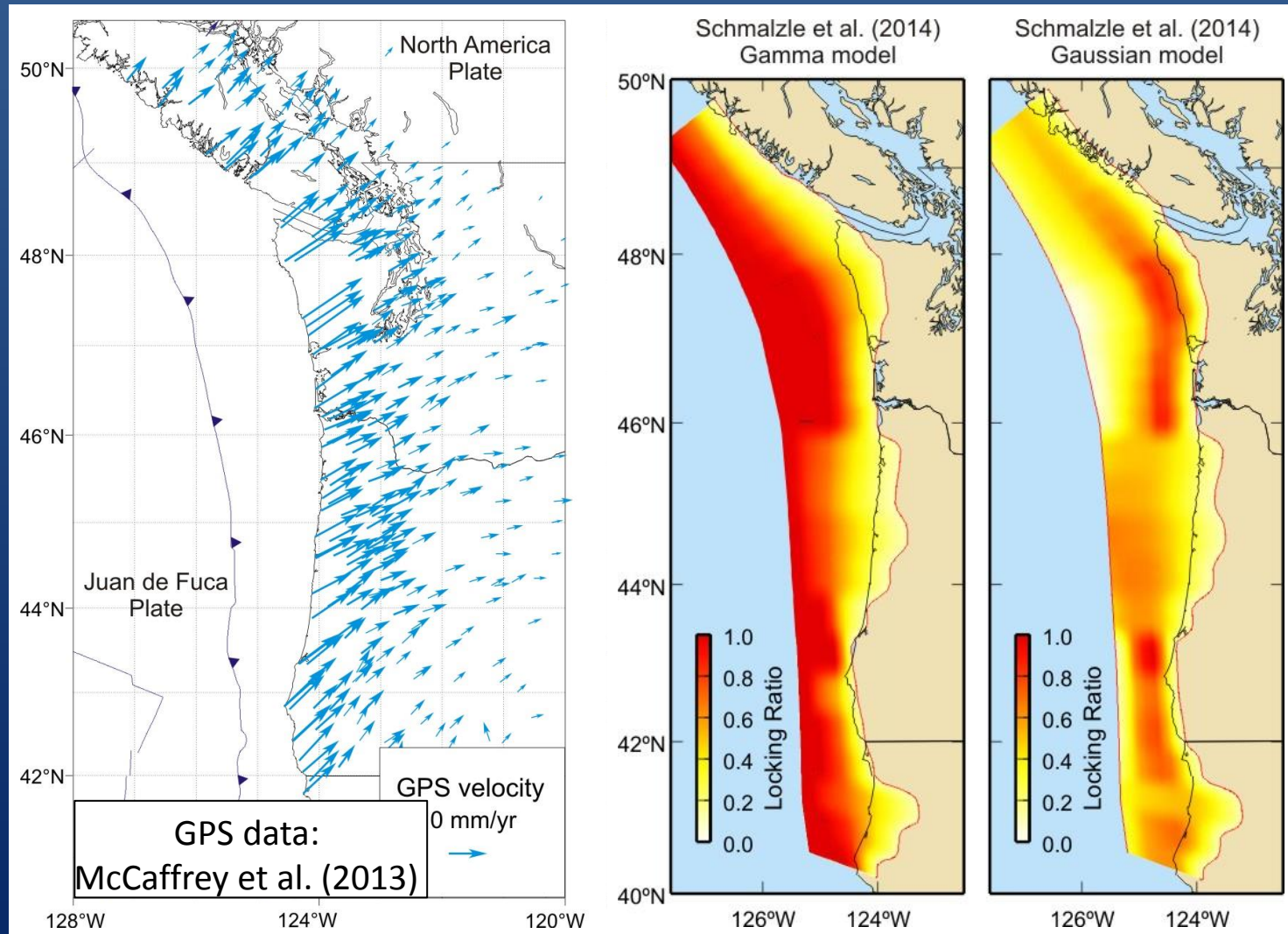
Breathing of a sleeping giant



What we do not know (yet)

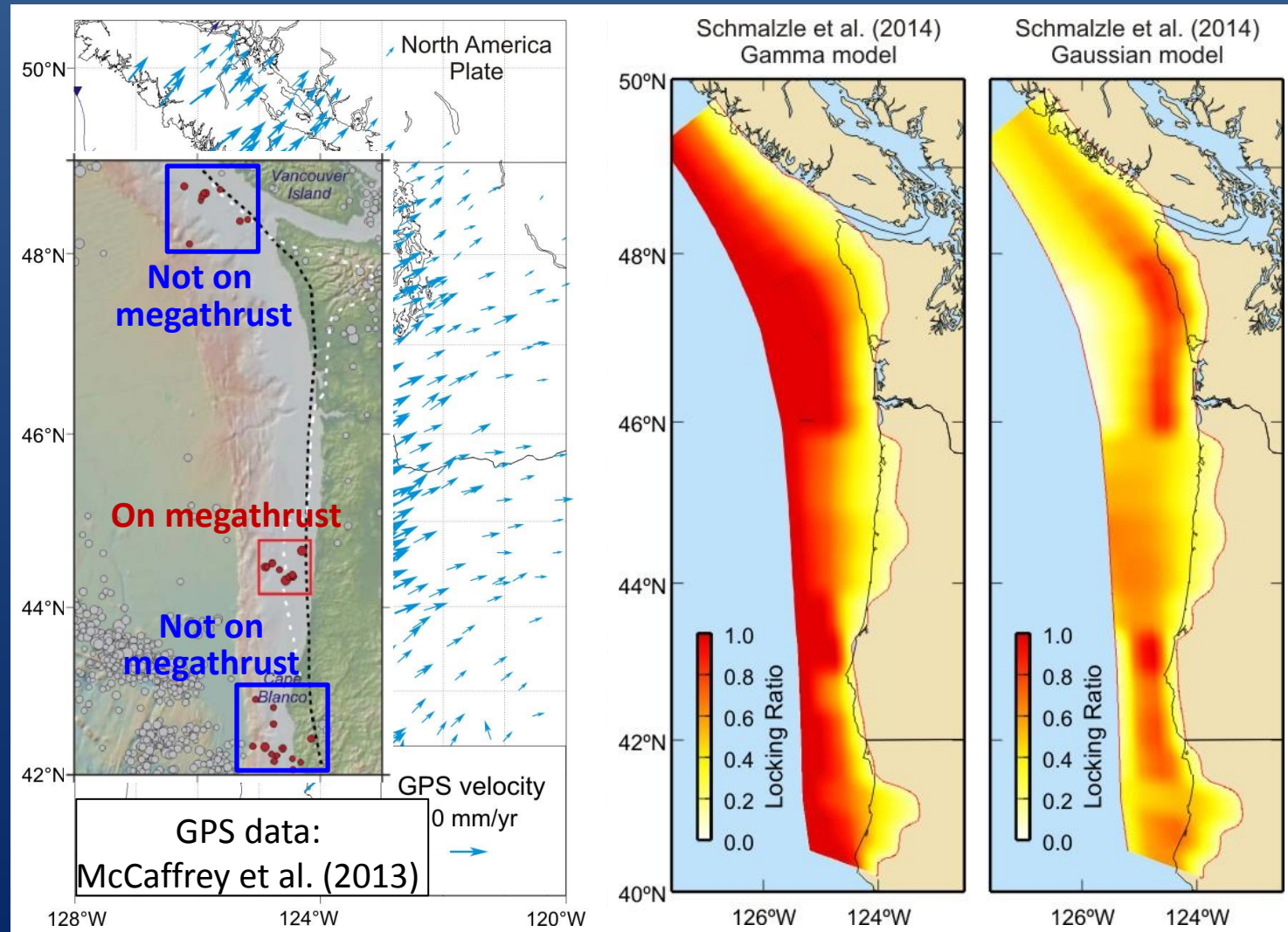
- To what degree (100%?) is the megathrust locked?
- Will the rupture breach the seafloor?
- How does seismic behaviour vary along Cascadia?

Do not know: To what degree (100%?) is the megathrust locked?



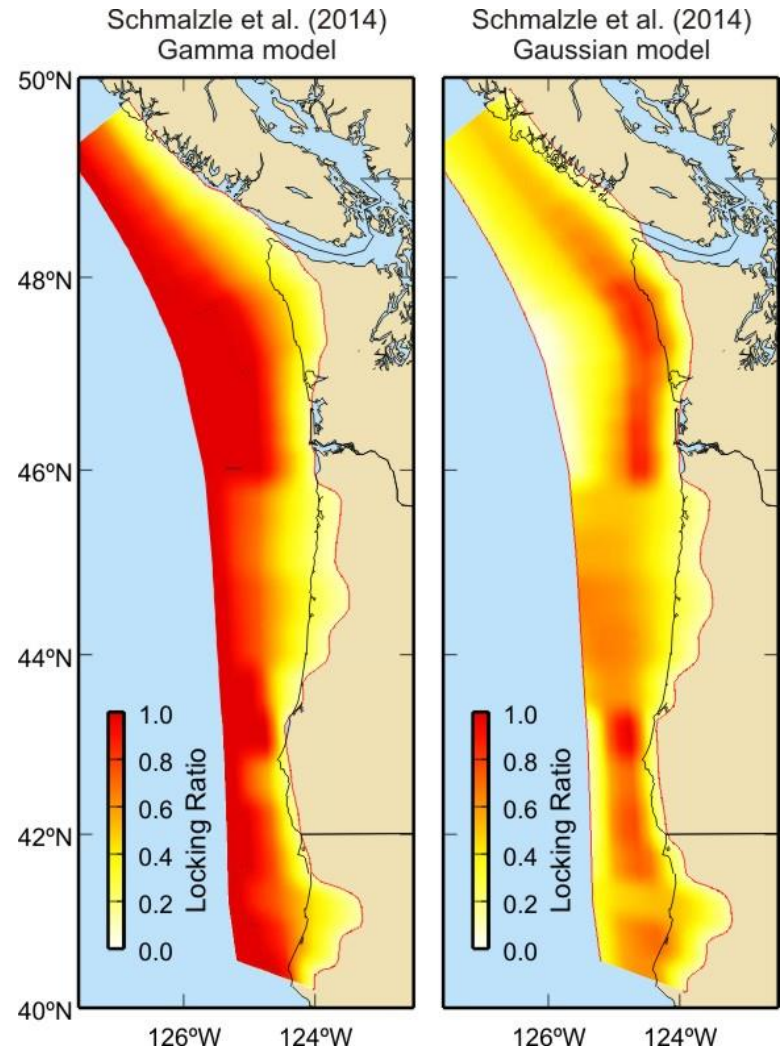
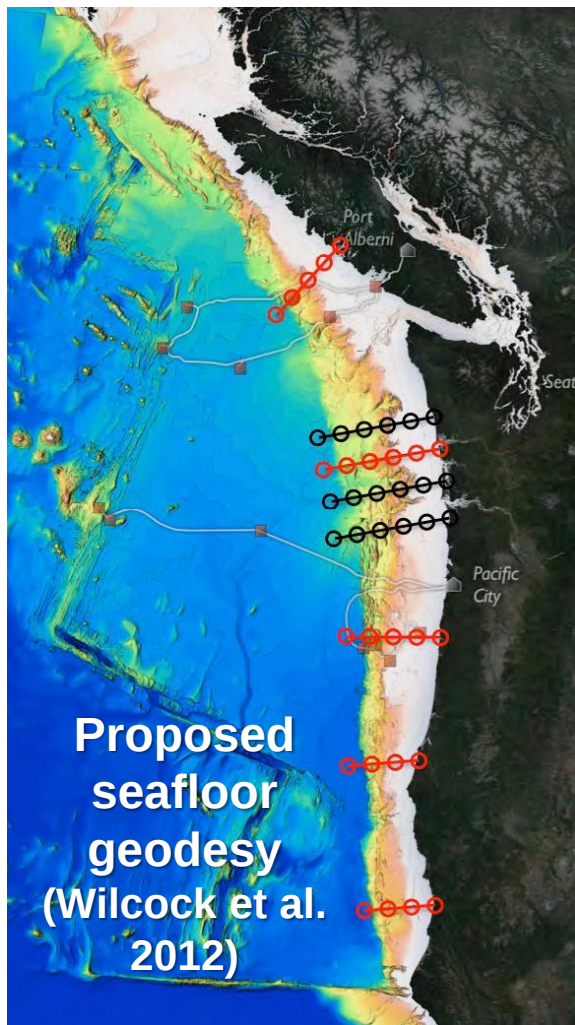
We currently assume full locking of narrow zone because of high temperature and quiet megathrust

Do not know: To what degree (100%?) is the megathrust locked?



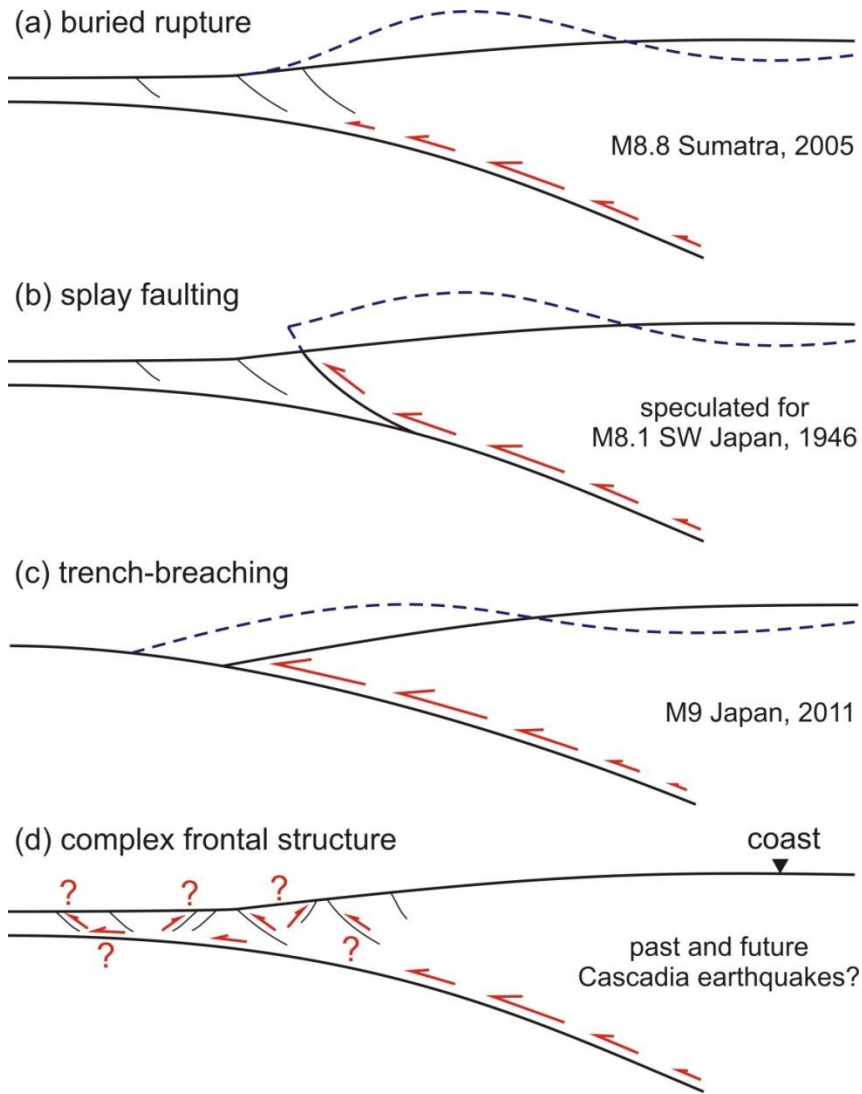
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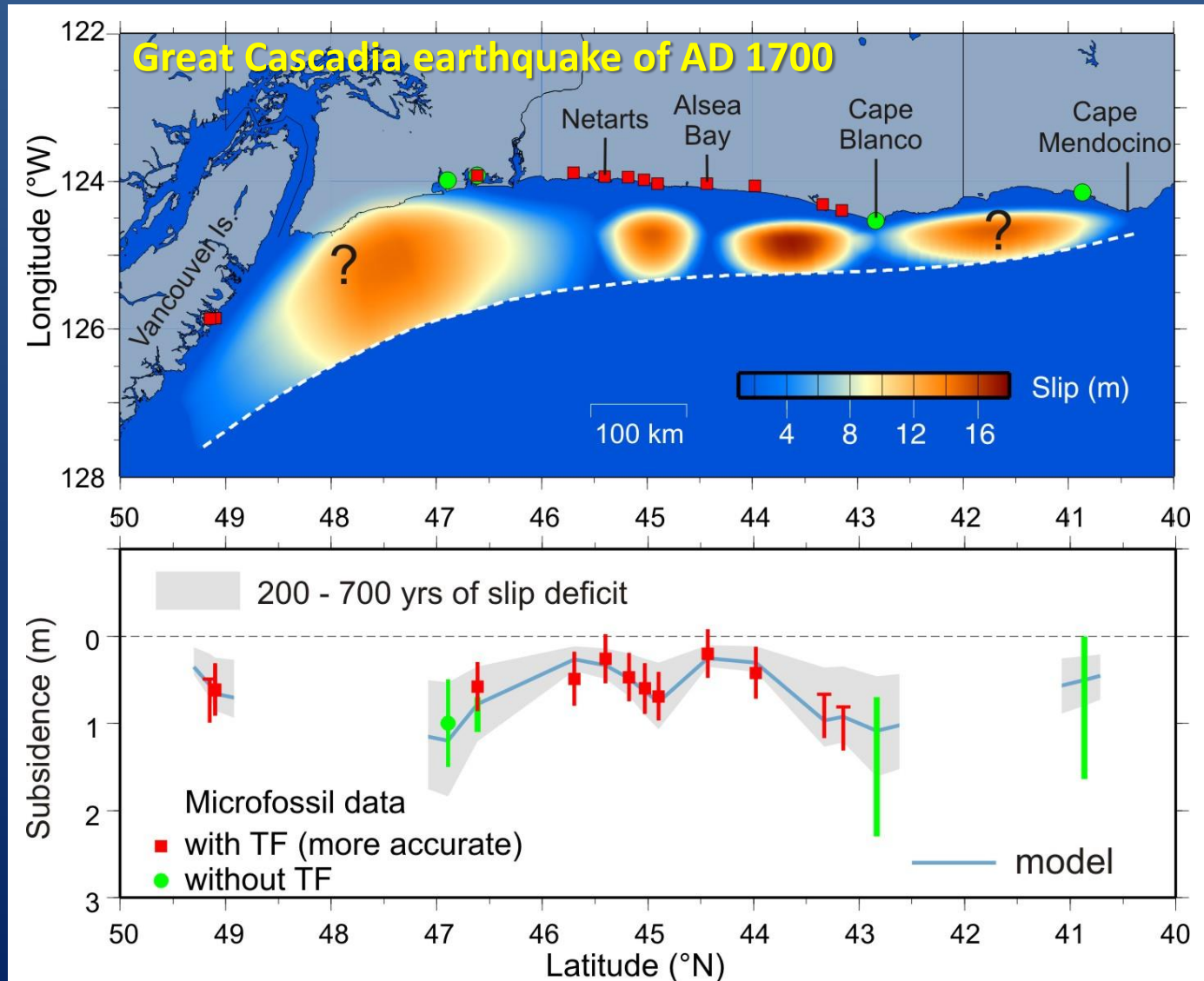
How do we get the true answer? — Seafloor monitoring

Do not know: Will the rupture breach the seafloor?



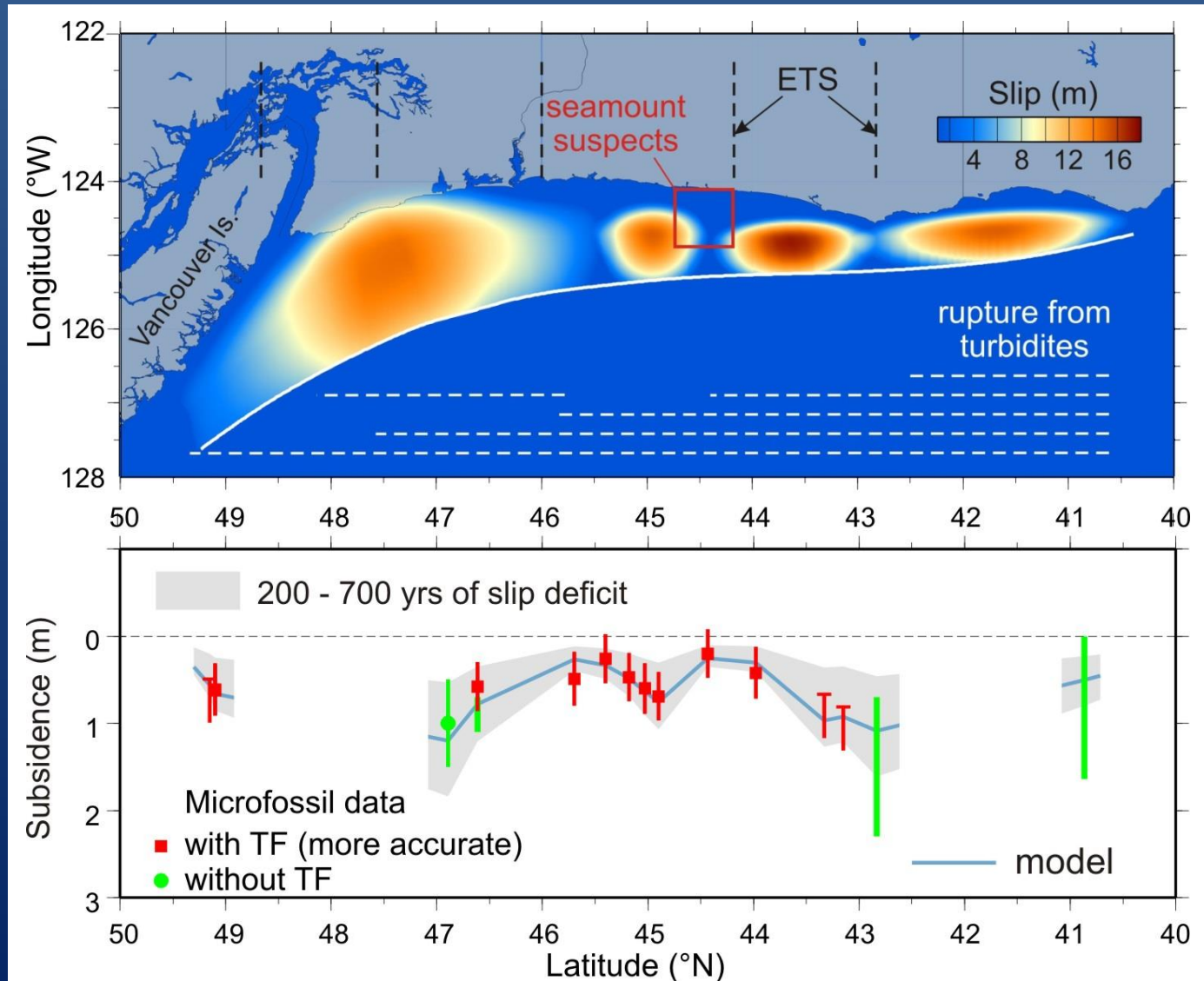
Wang and Trehu (2016 J. Geodyn)

Do not know: How does seismic behaviour vary along Cascadia?



Microfossil data: A. Hawks, S. Engelhart, B. Horton, etc.

Do not know: How does seismic behaviour vary along Cascadia?



Microfossil data: A. Hawks, S. Engelhart, B. Horton, etc.

What we know

- Cascadia is a typical place for giant earthquakes
- The last big one (about M 9) occurred in AD 1700
- Similar events occurred every few centuries in the past
- Now the locked fault is building up energy for the next one

What we do not know but are investigating

- To what degree (100%?) is the megathrust locked?
- Will the rupture breach the seafloor?
- How does seismic behaviour vary along Cascadia?