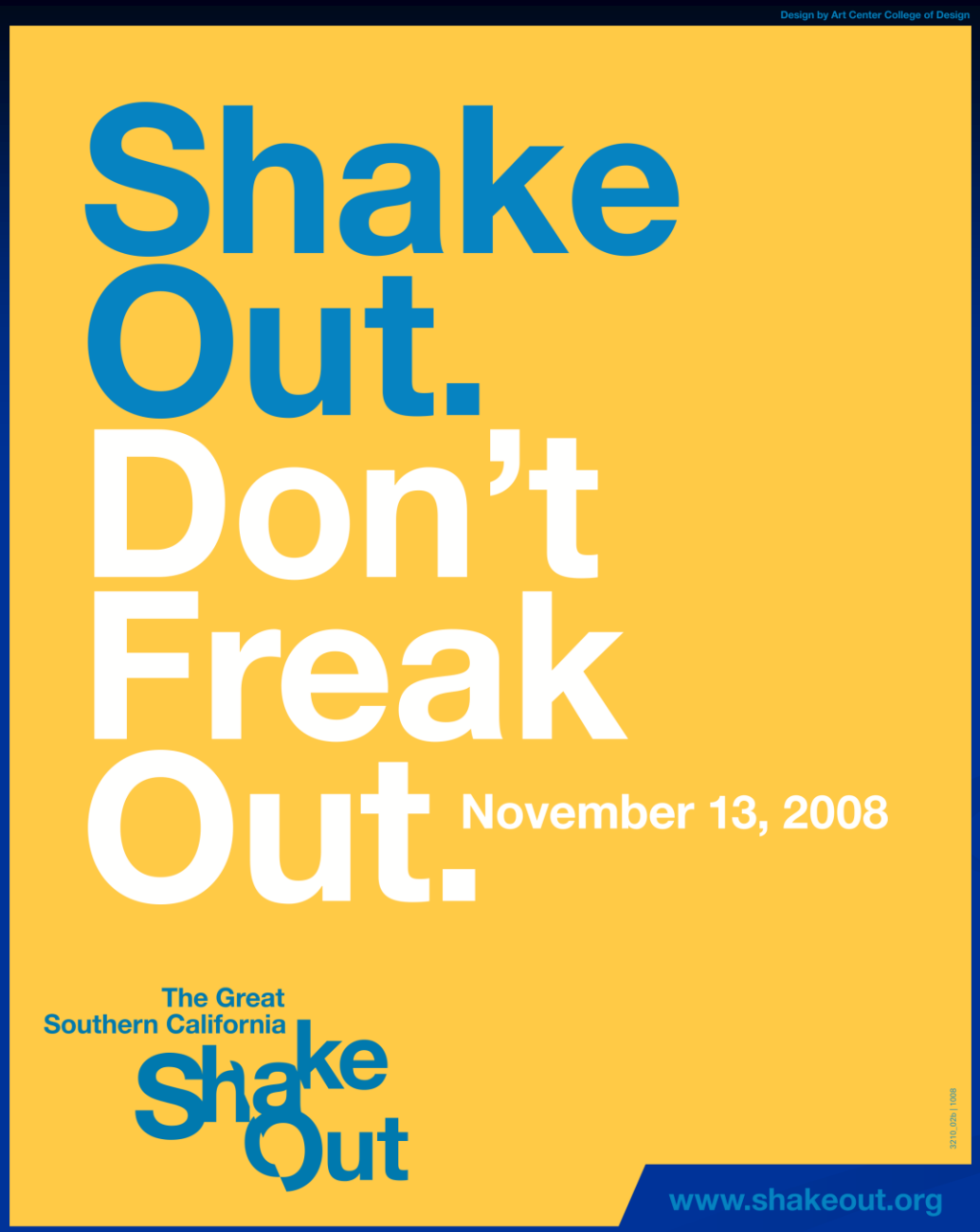
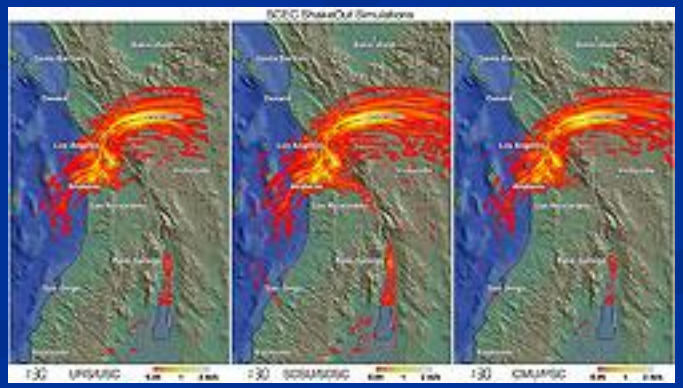


MHDP - increase resiliency to natural disasters southern Calif

Earthquake Scenario 2008

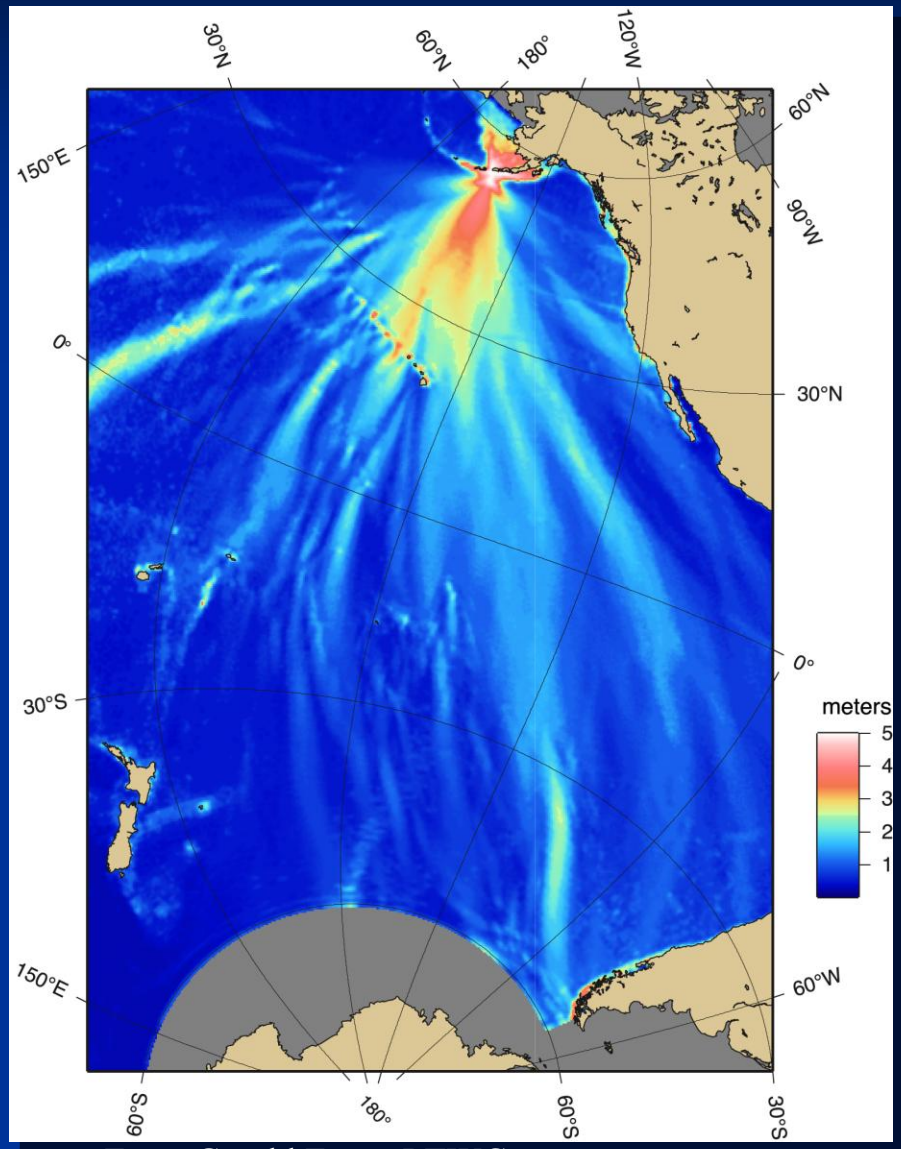


Storm Scenario exercise scheduled for spring 2011

Tsunami Scenario:

PACIFIC WAVE

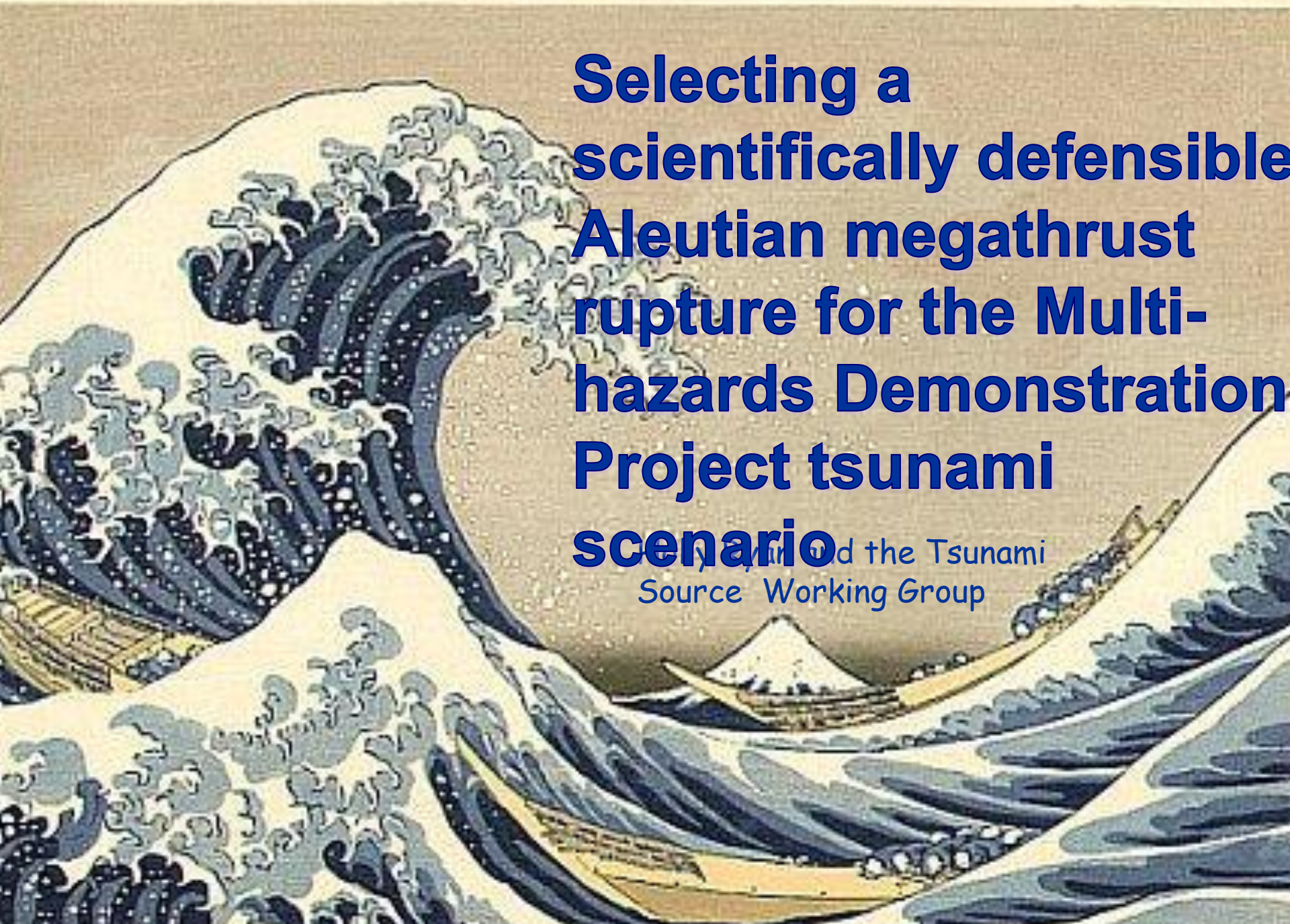
Coming in 2013



From Gerald Fryer, PTWC

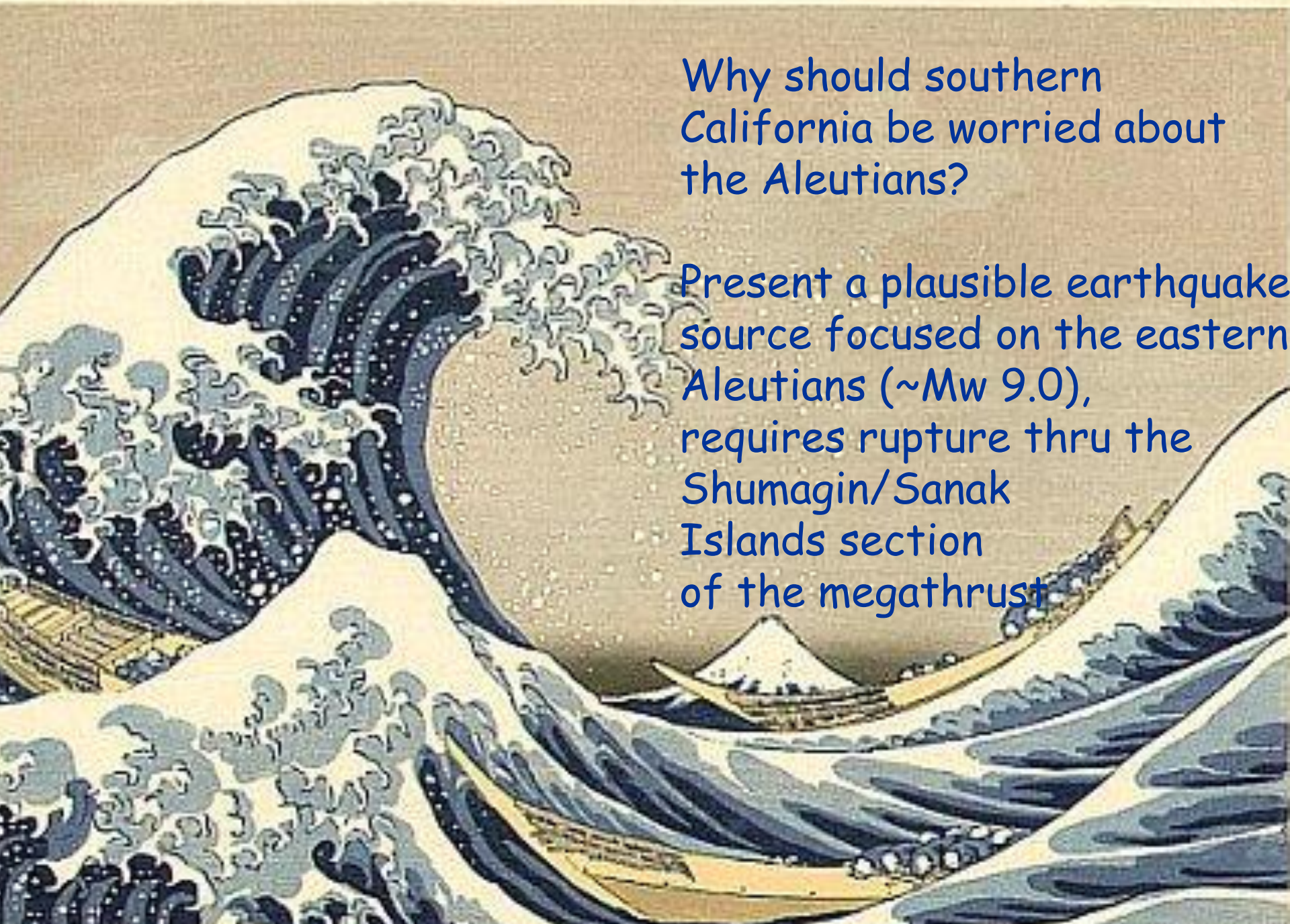
Scotch Cap tsunami, Unimak Island, April 1, 1946. Painting by Darrel Millsap, Alaska Geographic Society, vol. 7, n. 3, p. 25.

1946 SCOTCH CAP TSUNAMI



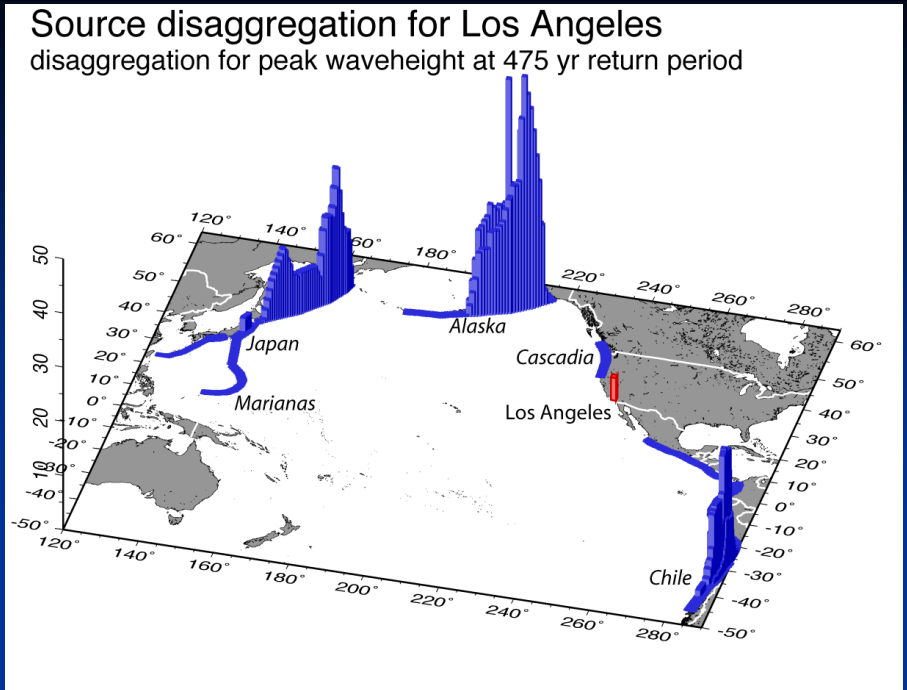
Selecting a scientifically defensible Aleutian megathrust rupture for the Multi-hazards Demonstration Project tsunami scenario

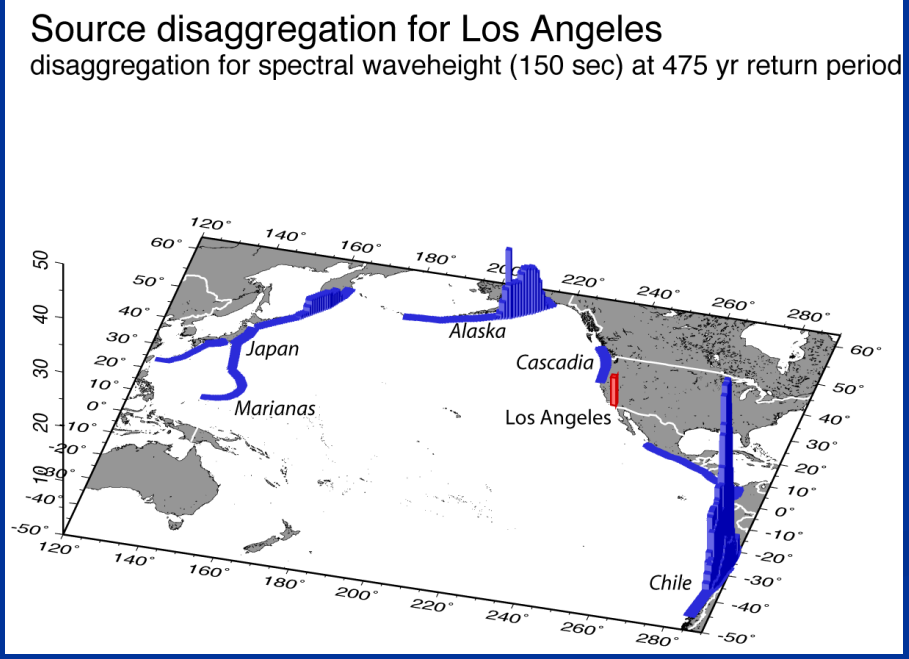
Henry Eyman and the Tsunami Source Working Group



Why should southern California be worried about the Aleutians?

Present a plausible earthquake source focused on the eastern Aleutians (~Mw 9.0), requires rupture thru the Shumagin/Sanak Islands section of the megathrust

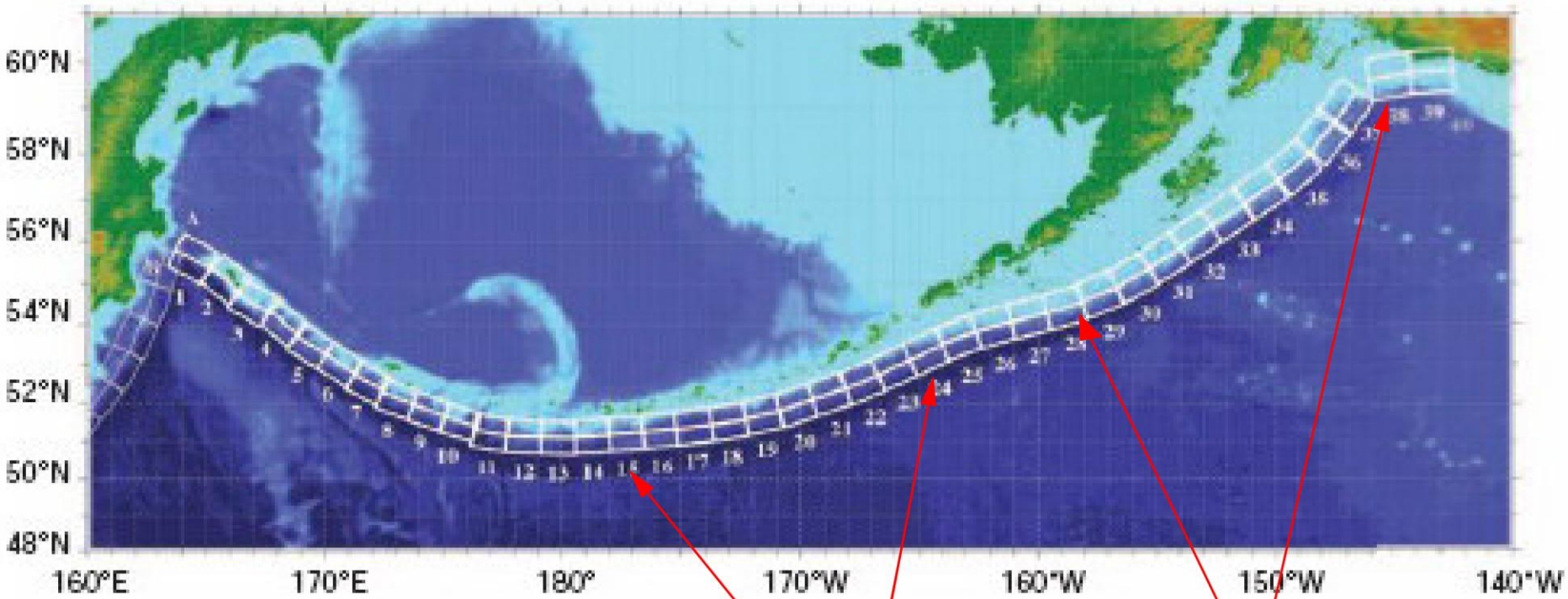




Probability of a tsunami in Los Angeles from a source in the Pacific (a disaggregation plot indicates the predominant source area). Alaska is the most important tsunami source for Los Angeles.

From Honk Kie Thio
URS Group, Pasadena

NOAA/PMEL unit sources for pre-run modeling for LA HARBOR (worst case scenarios)



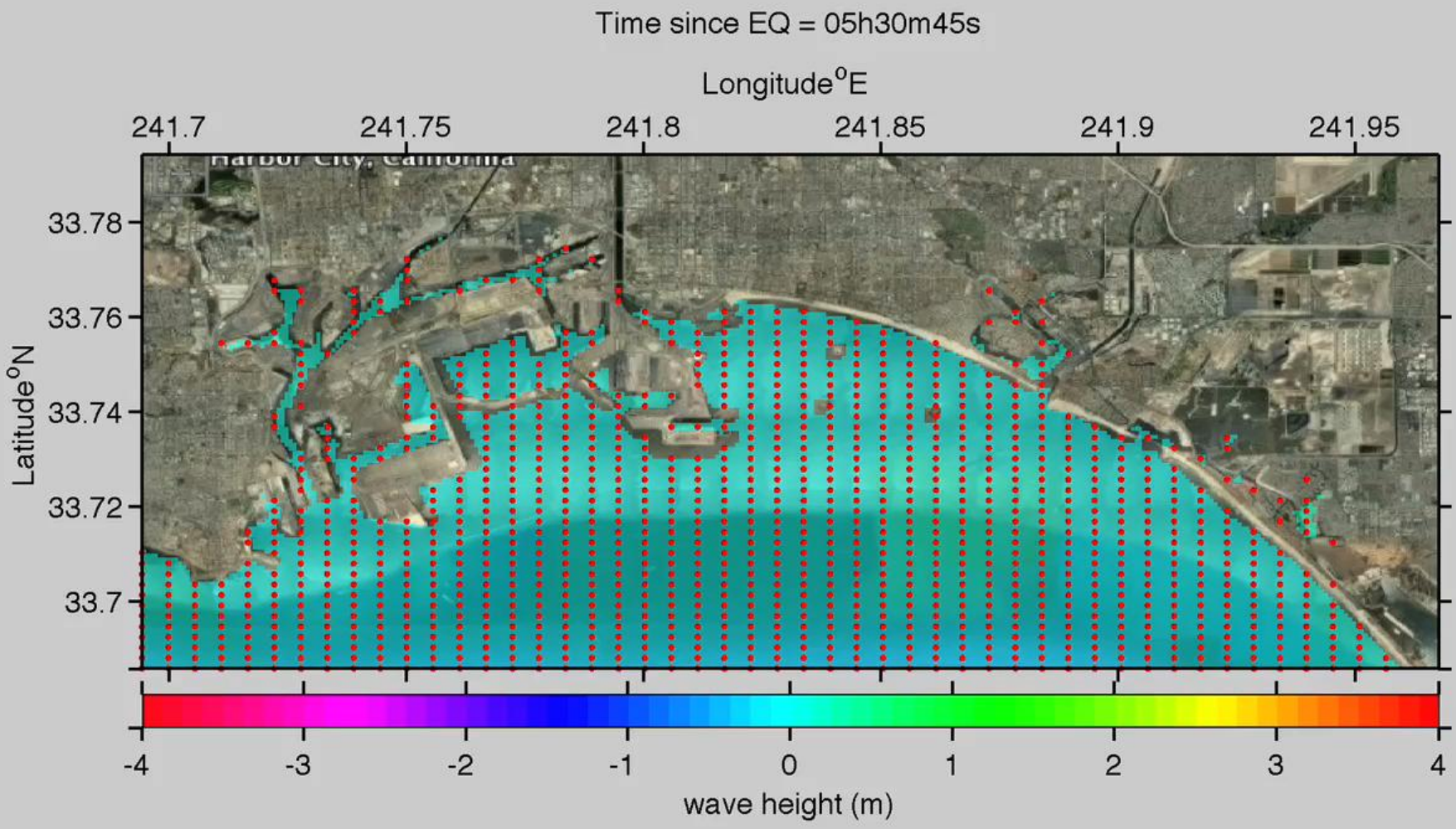
1000 km by 10 km
30 m slip
(Mw 9.3)

AASZ15

AASZ29

from Uslu et al., 2009

Uslu et al., 2009 (simulation begins 5.5 hrs after earthquake)



100 by 100 km blocks aligned along up-dip limit of slab (USGS SLAB 1.0, Hayes and Wald, 2010)

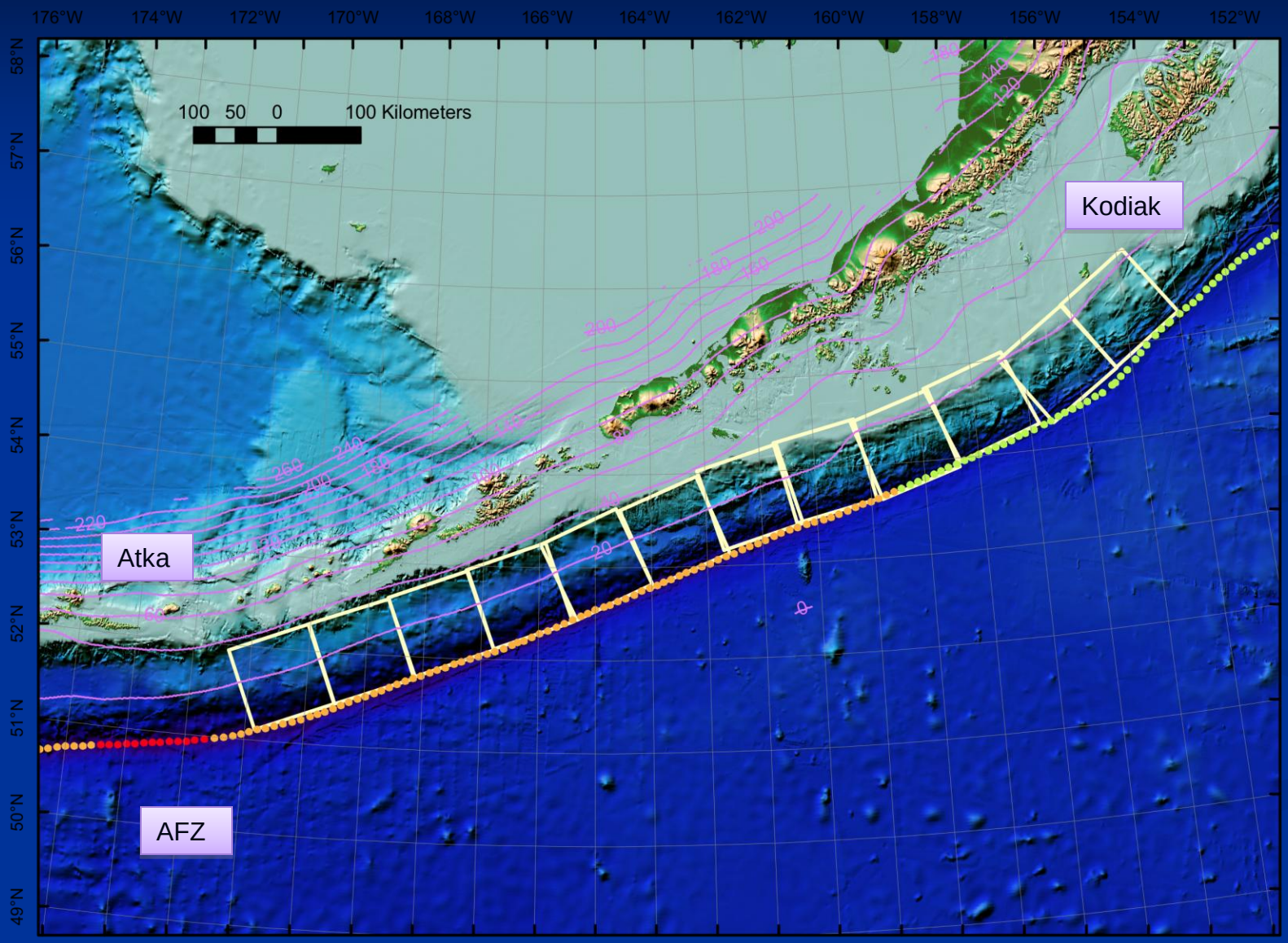
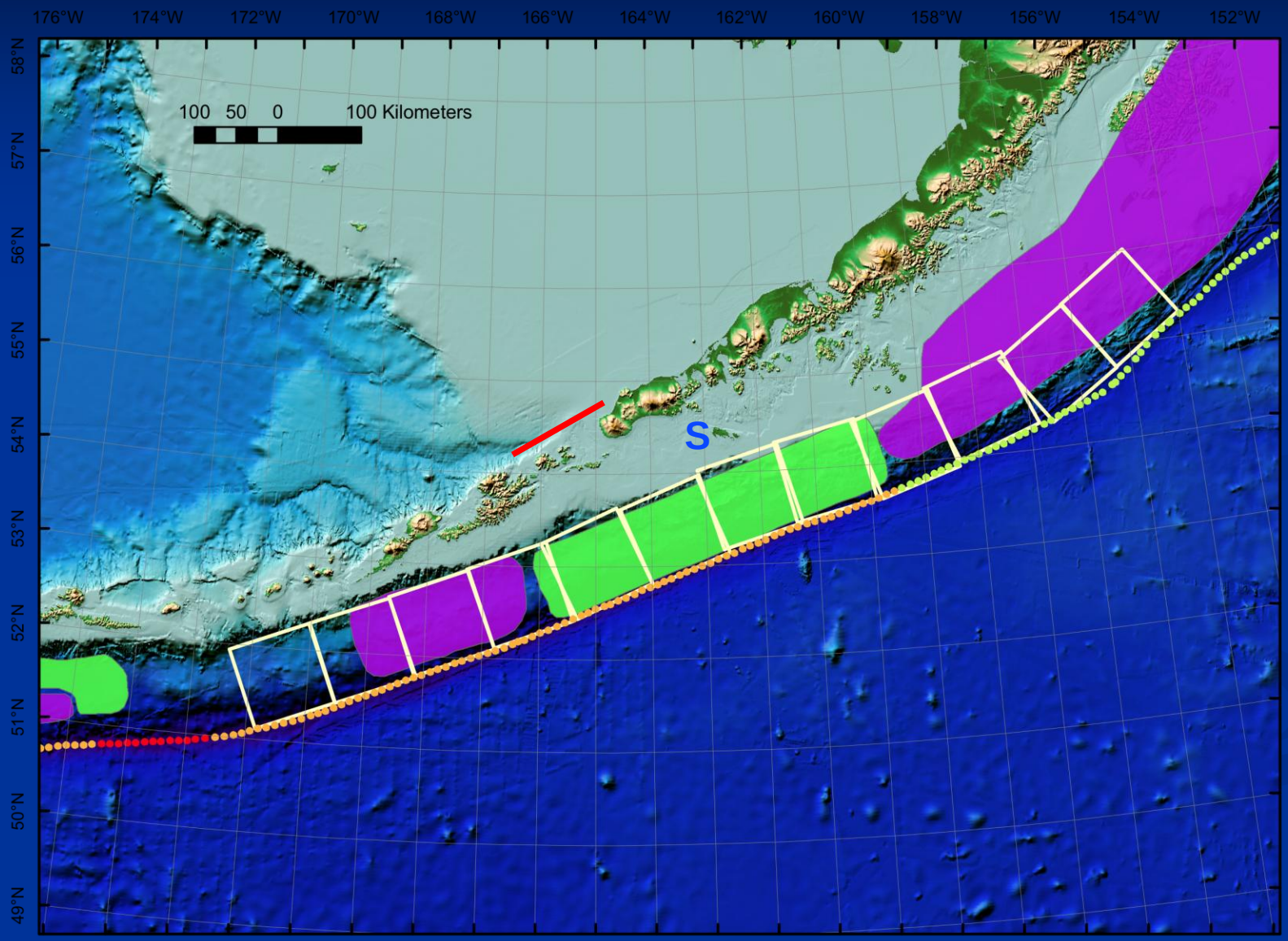
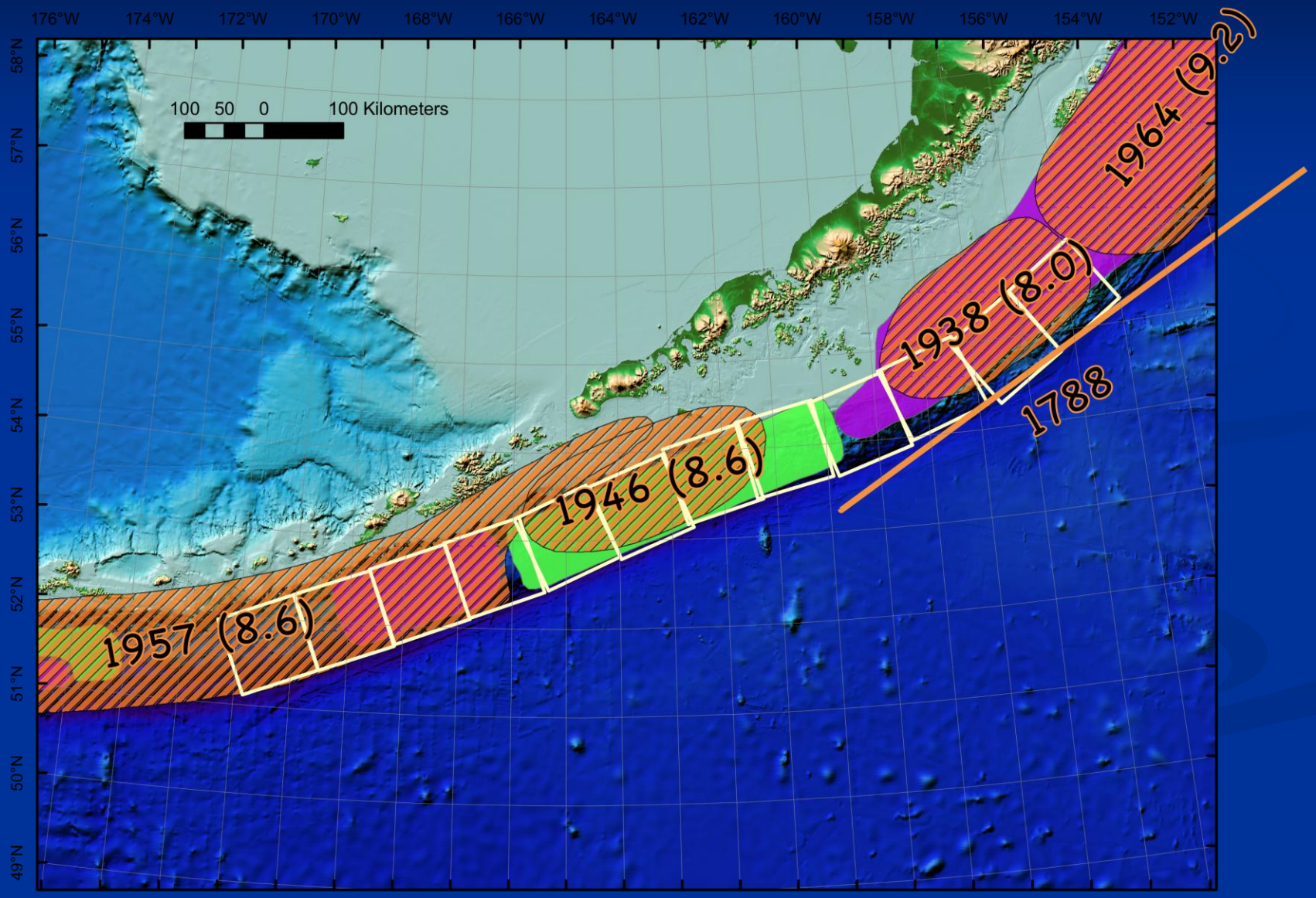


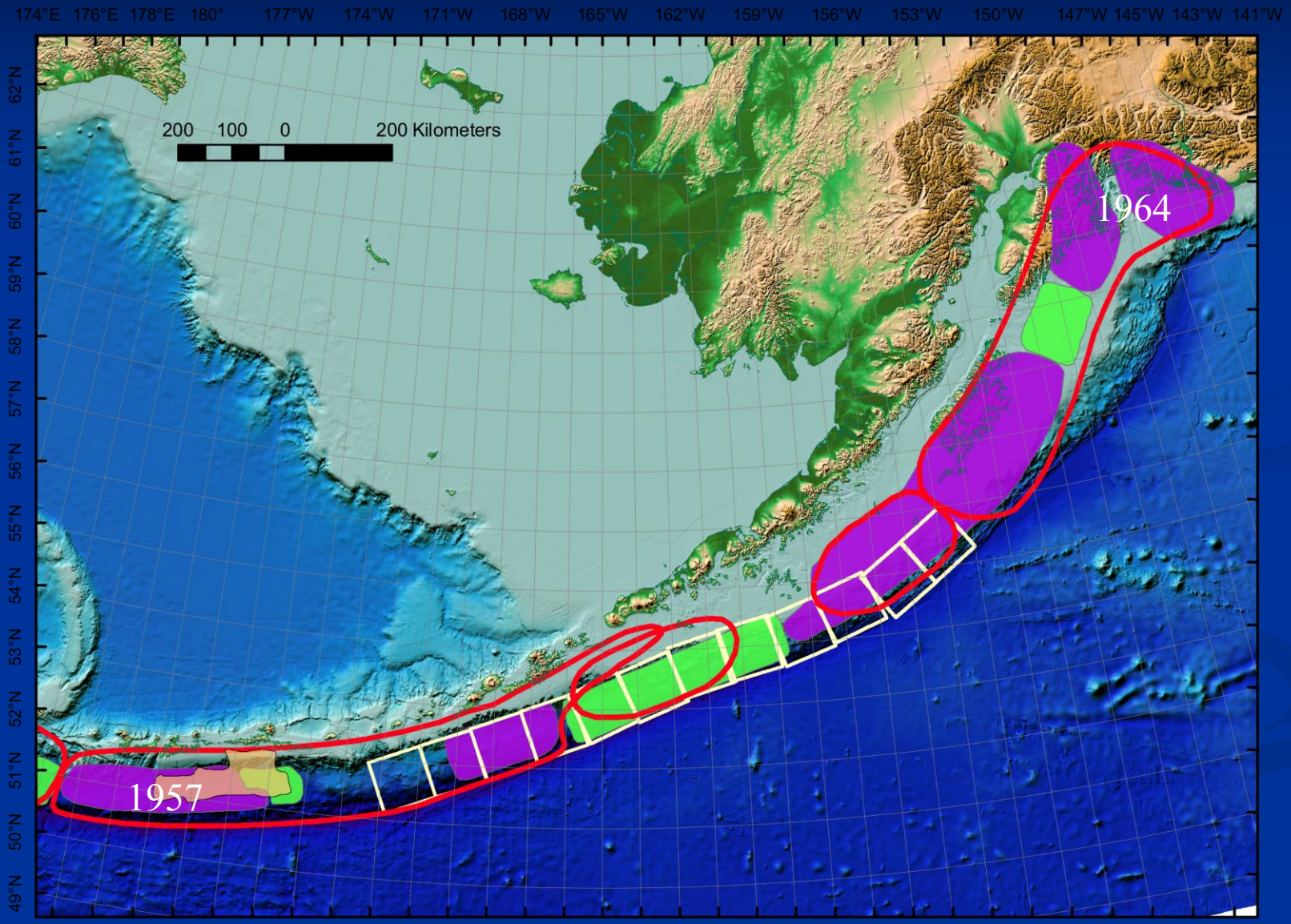
Plate coupling variations along the Aleutian megathrust (Freymueller et al., 2008): purple-locked, green-creeping



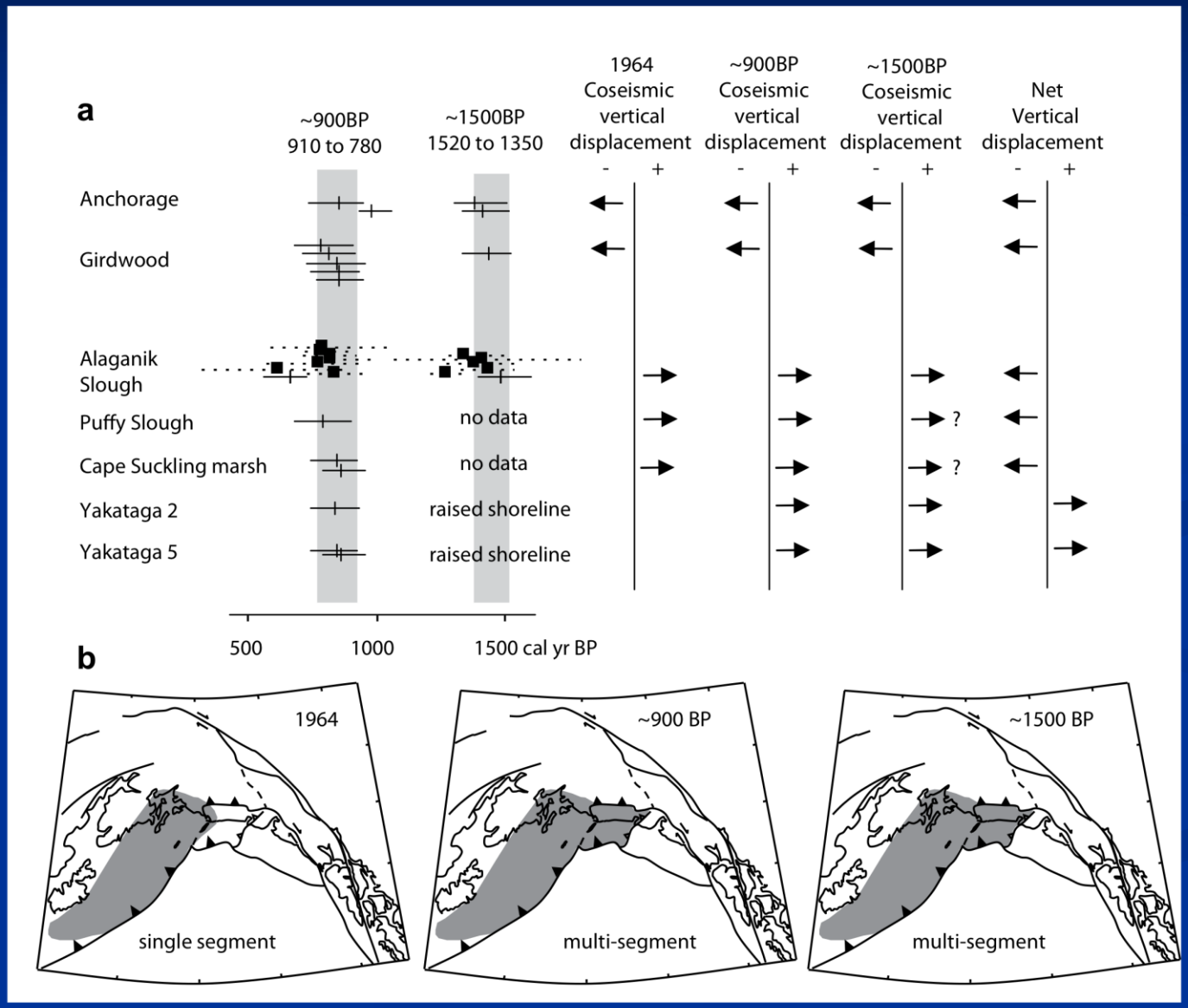
The historic earthquake record indicates that most of the Aleutian megathrust has ruptured in a great earthquake



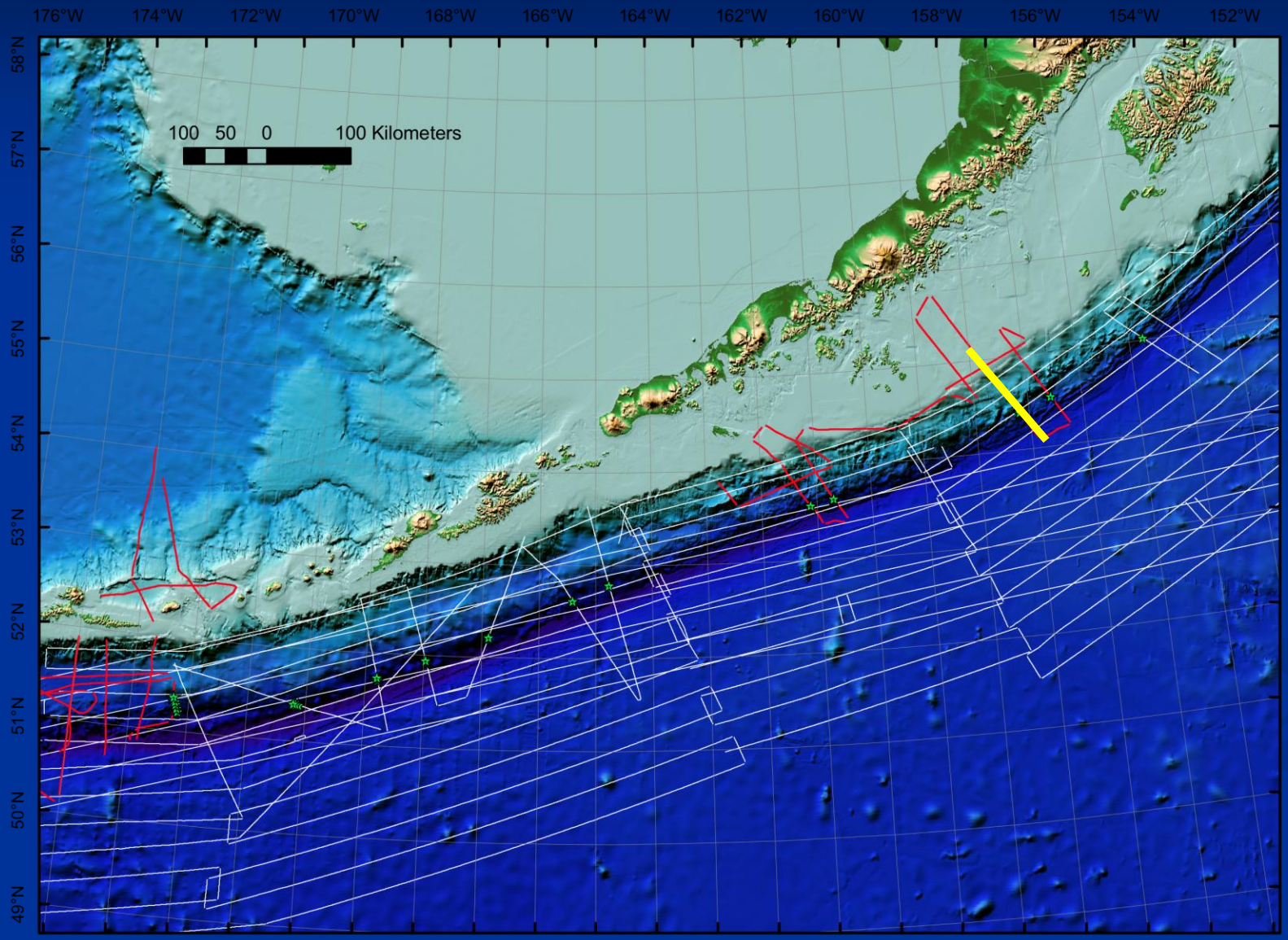
Note that areas of low strain accumulation occur within the rupture zone of both the 1957 and 1964 events.



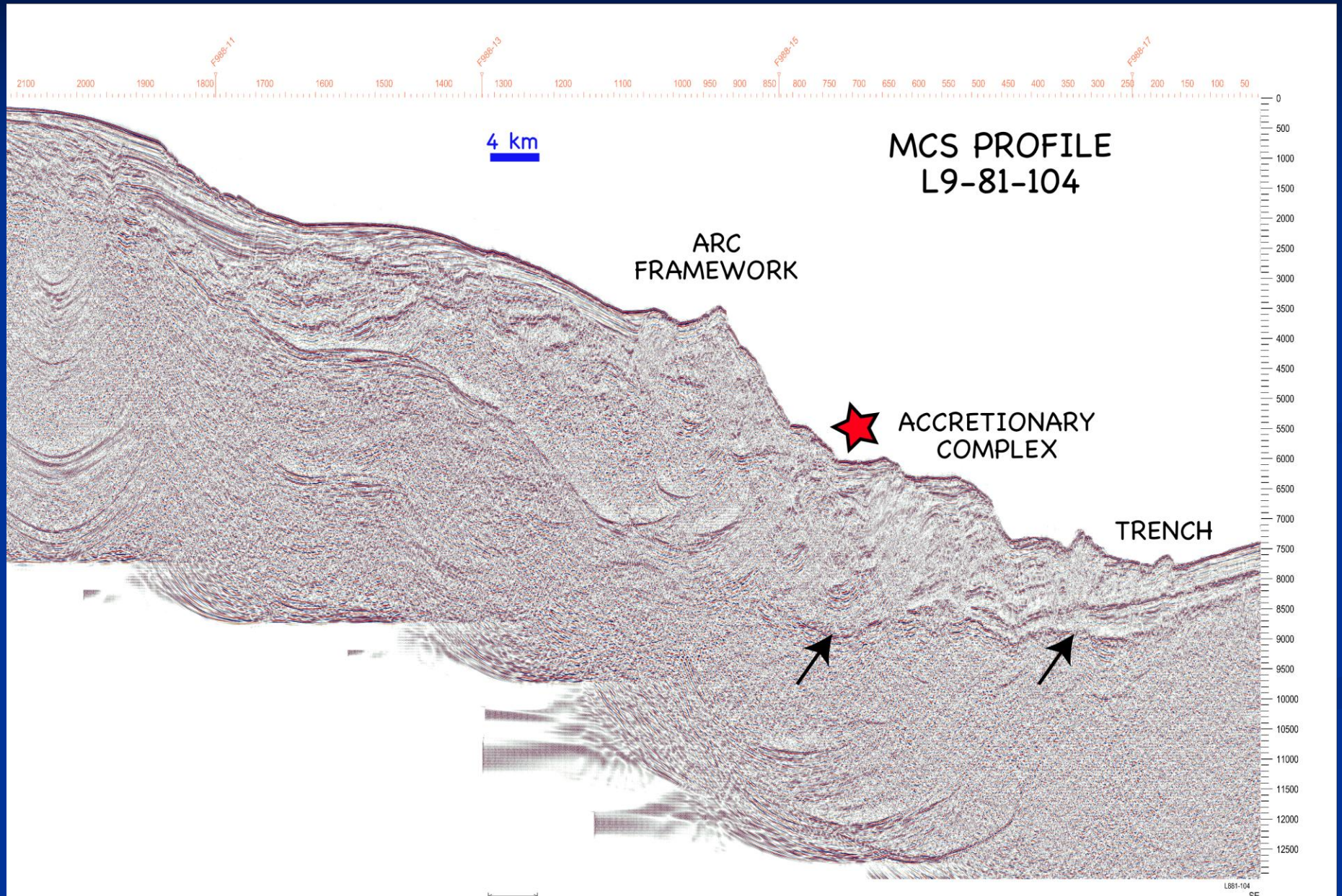
Shennen et al. 2009 use paleoseismic records to show that both the Aleutian megathrust Yakutat microplate have ruptured simultaneously in the past (15% larger earthquake).



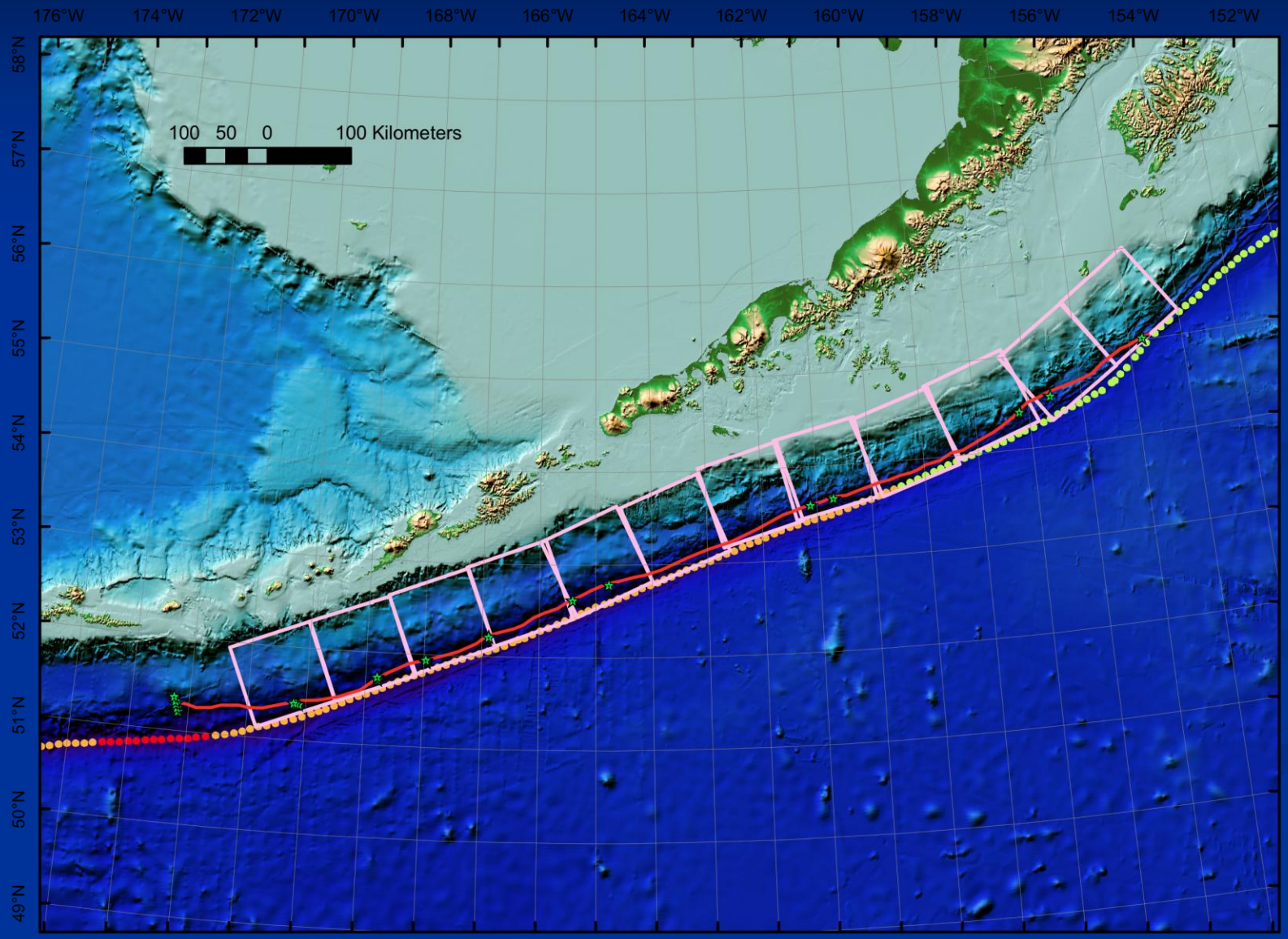
We use seismic reflection profiles to define the seaward edge of the locked zone (landward edge of accretionary complex)



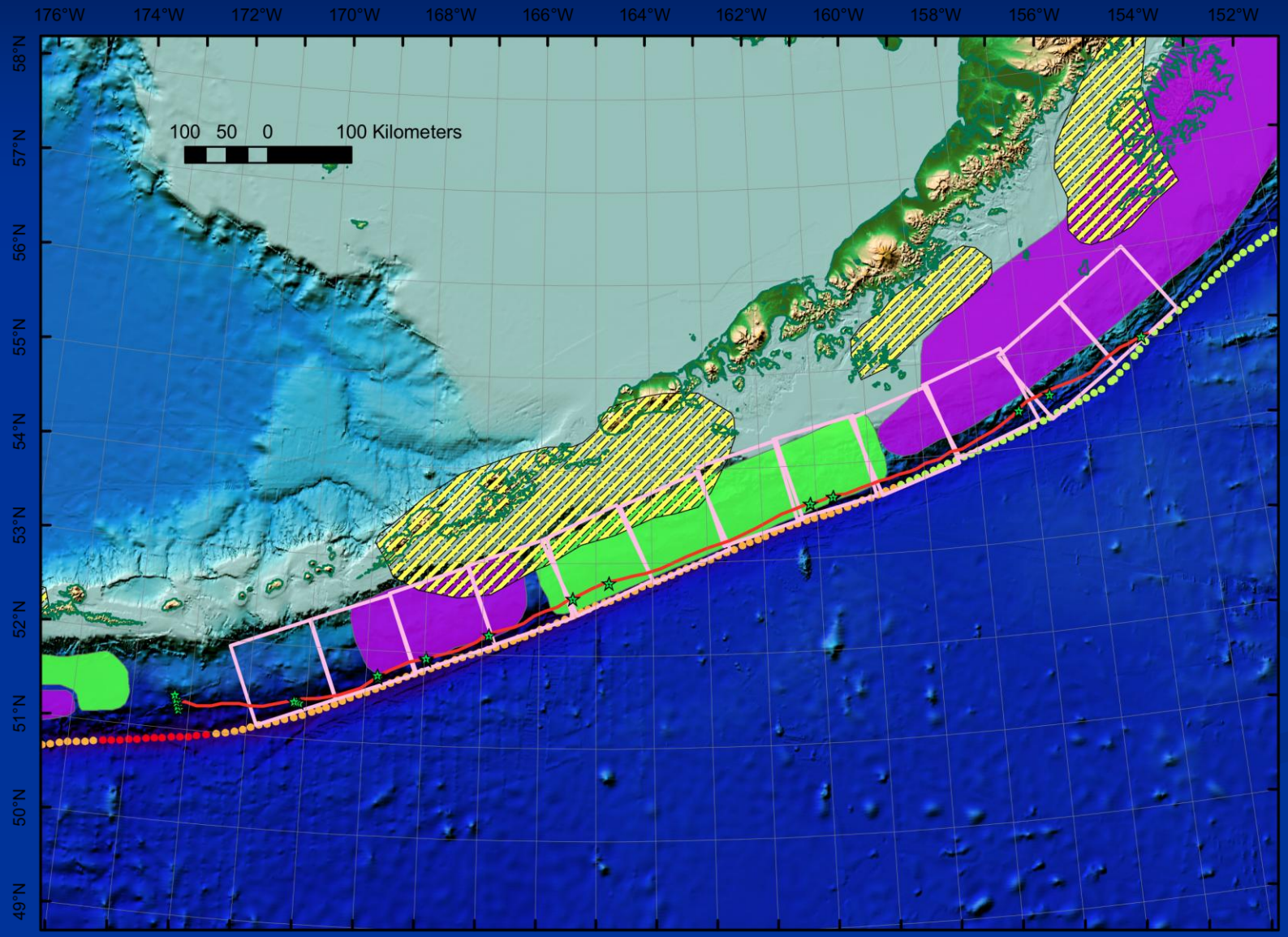
Seaward edge of arc framework rocks defined by steeper slopes and often velocity pull-up of subducting slab.



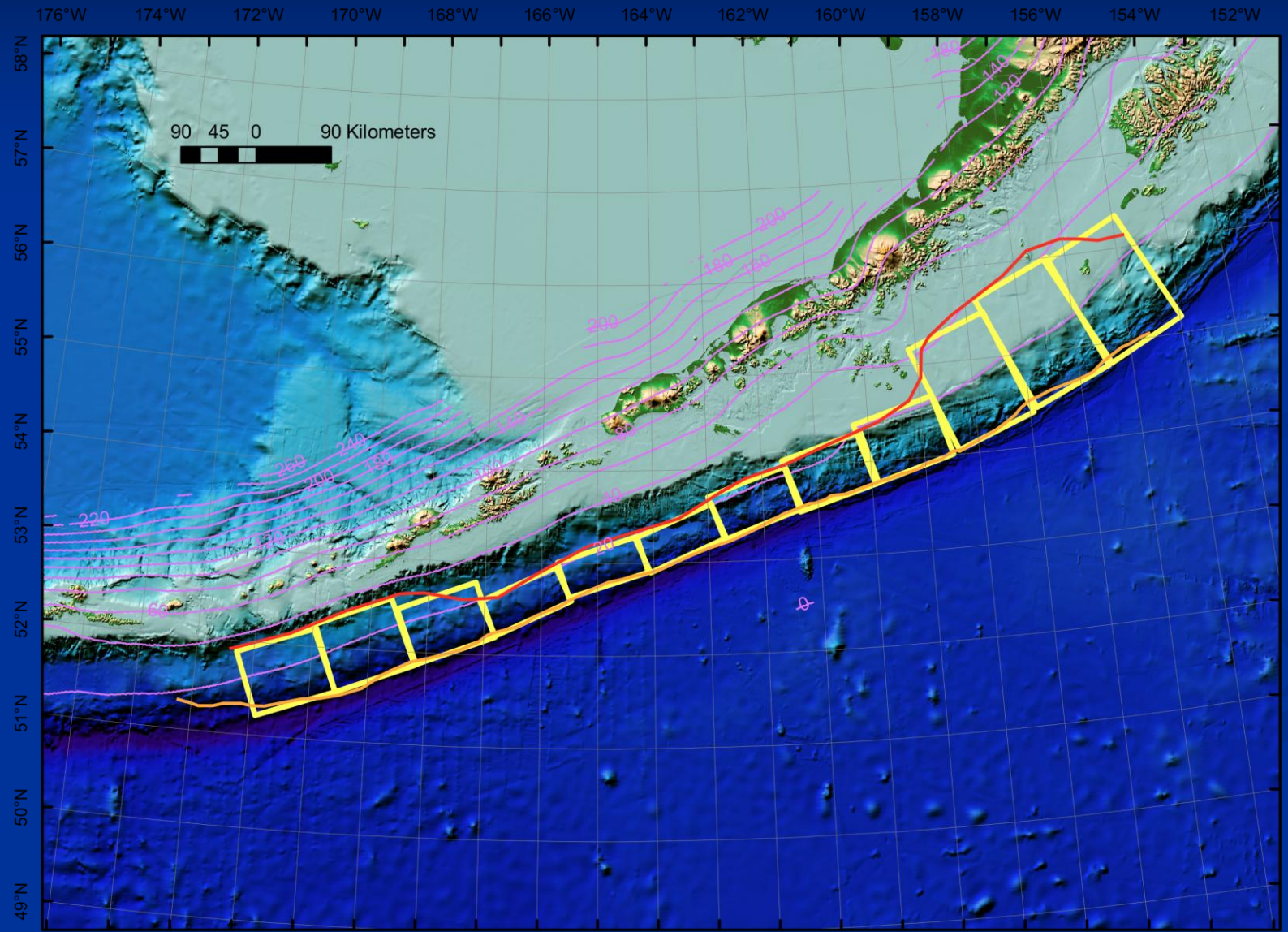
Location of up-dip edge of locked zone offset from Slab 1.0 by 5 to 30 km. (note in west – much wider accretionary complex)



Using the edges of satellite magnetics at mantle depths, location of hydrated mantle (and down-dip edge of locked zone) can be inferred (data from Rick Blakely)

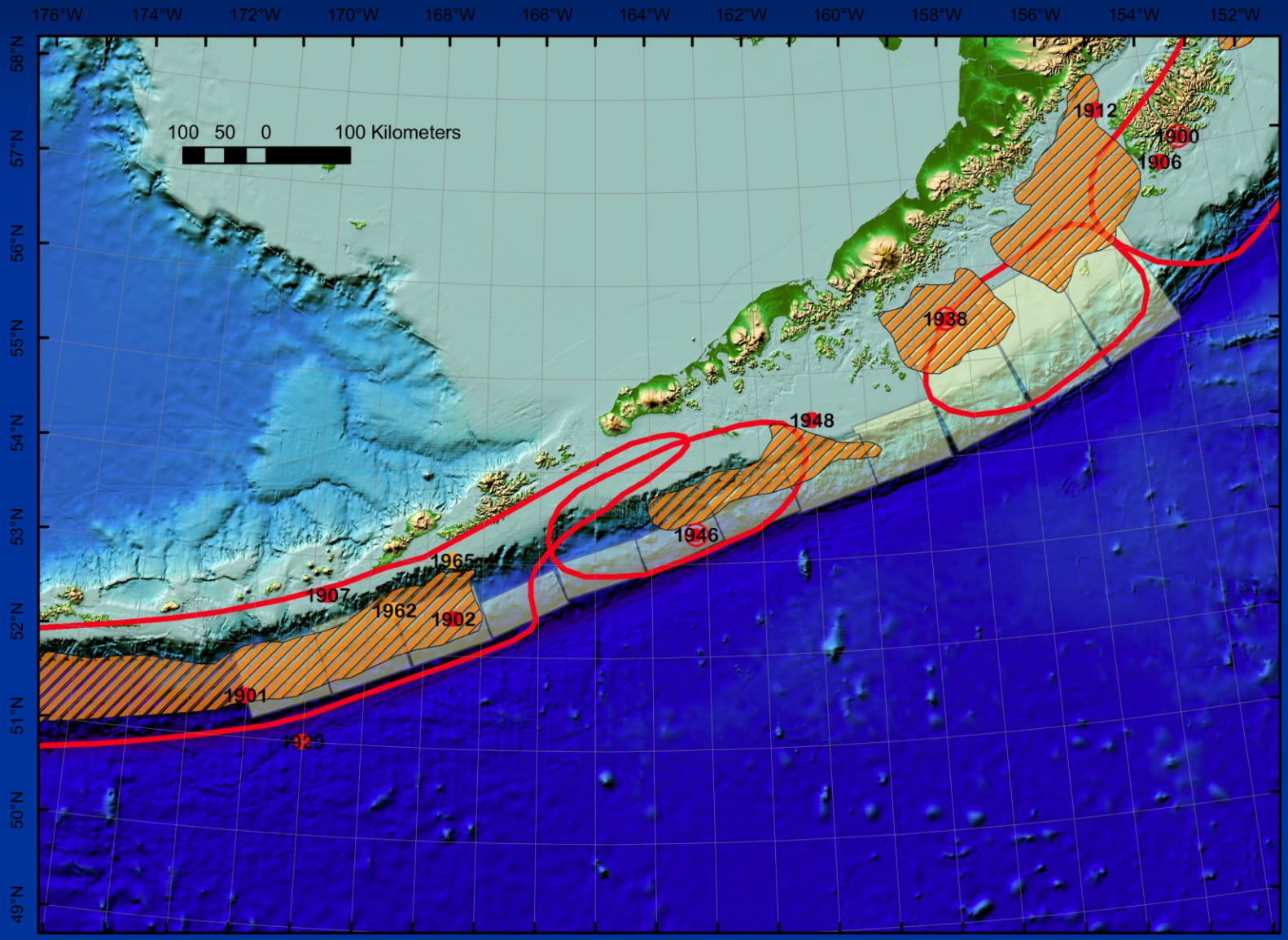


Revised 1 km blocks to reflect up-dip and down-dip limit of locked zone. Based on area of blocks, Mw ~9.2 with average slip of 23 m

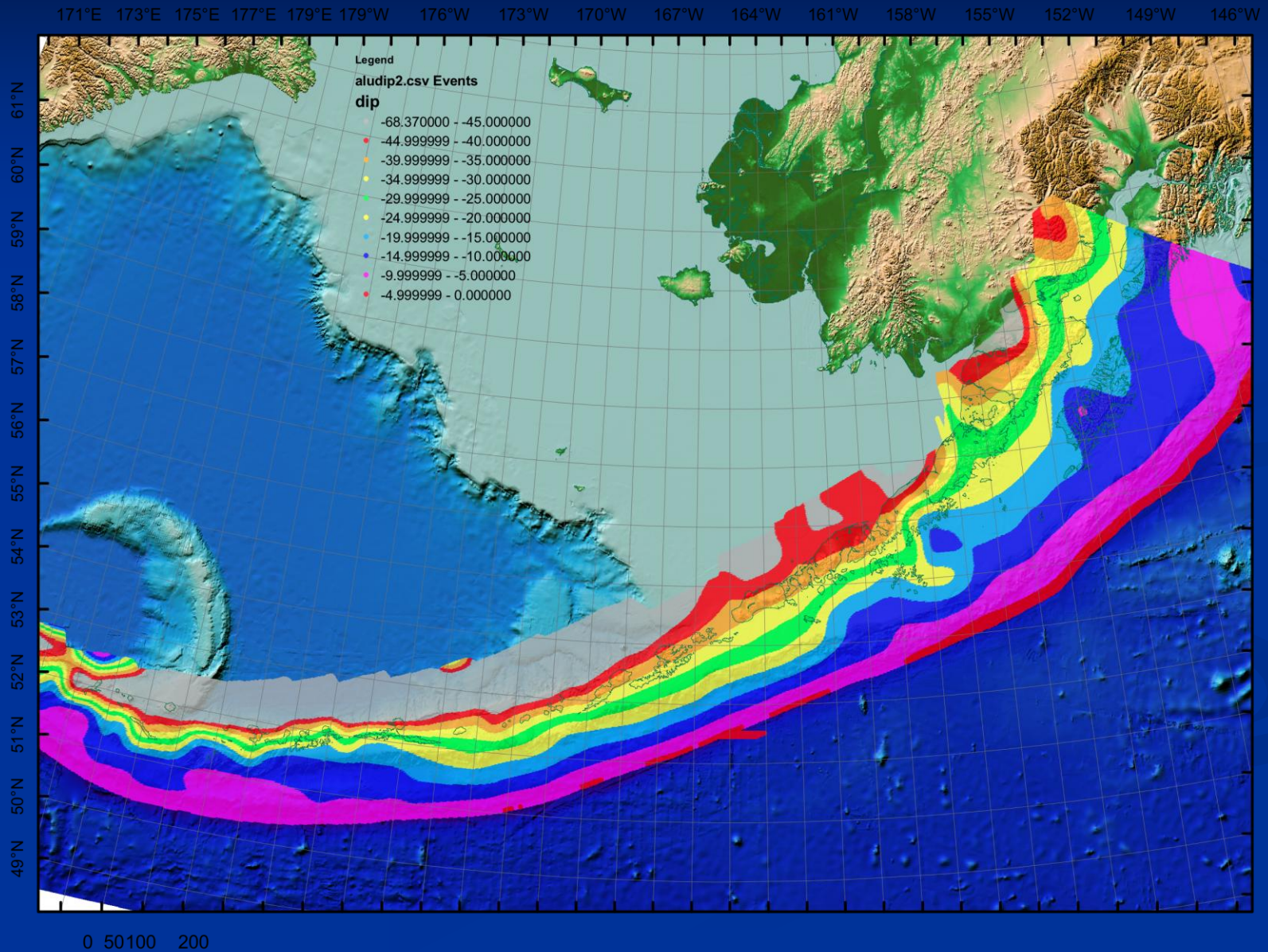


Additional constraints from forearc basin gravity lows as indicators of long-term moment release (Wells et al., 2003).

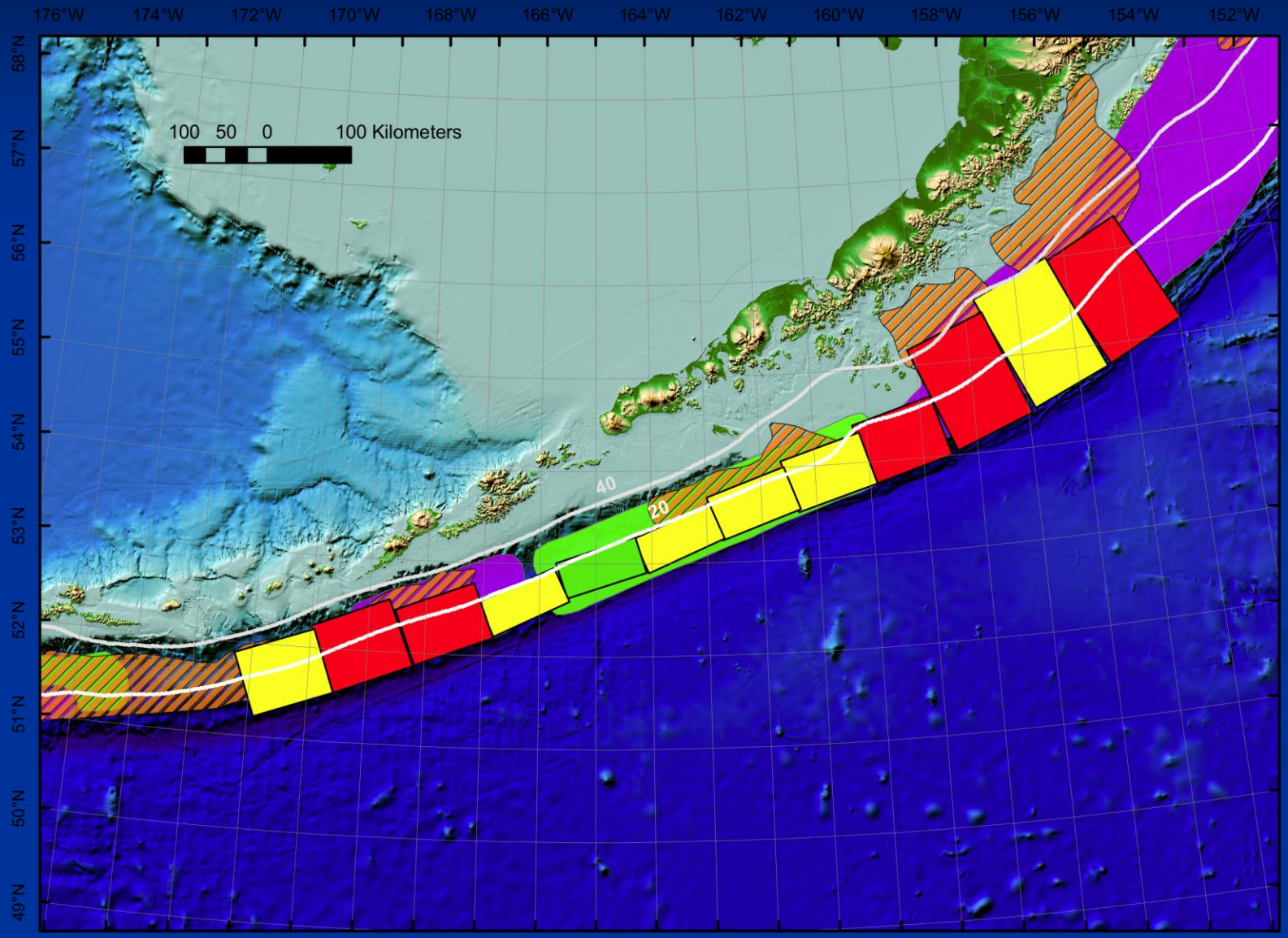
(Note location of gravity lows on shelf east of Shumagins)



Dip of slab in 5° increments from Slab 1.0 (Hayes and Wald, 2010) – note complexities east of Shumagin Islands



Tentative assignment of slip (red-high, yellow-med, green-low) based on GPS, gravity lows and historic record (known patches of high moment release)



The Sediment Records of Tsunami Events are Probably Abundant in the Islands: *E.g.*, Sedanka Island

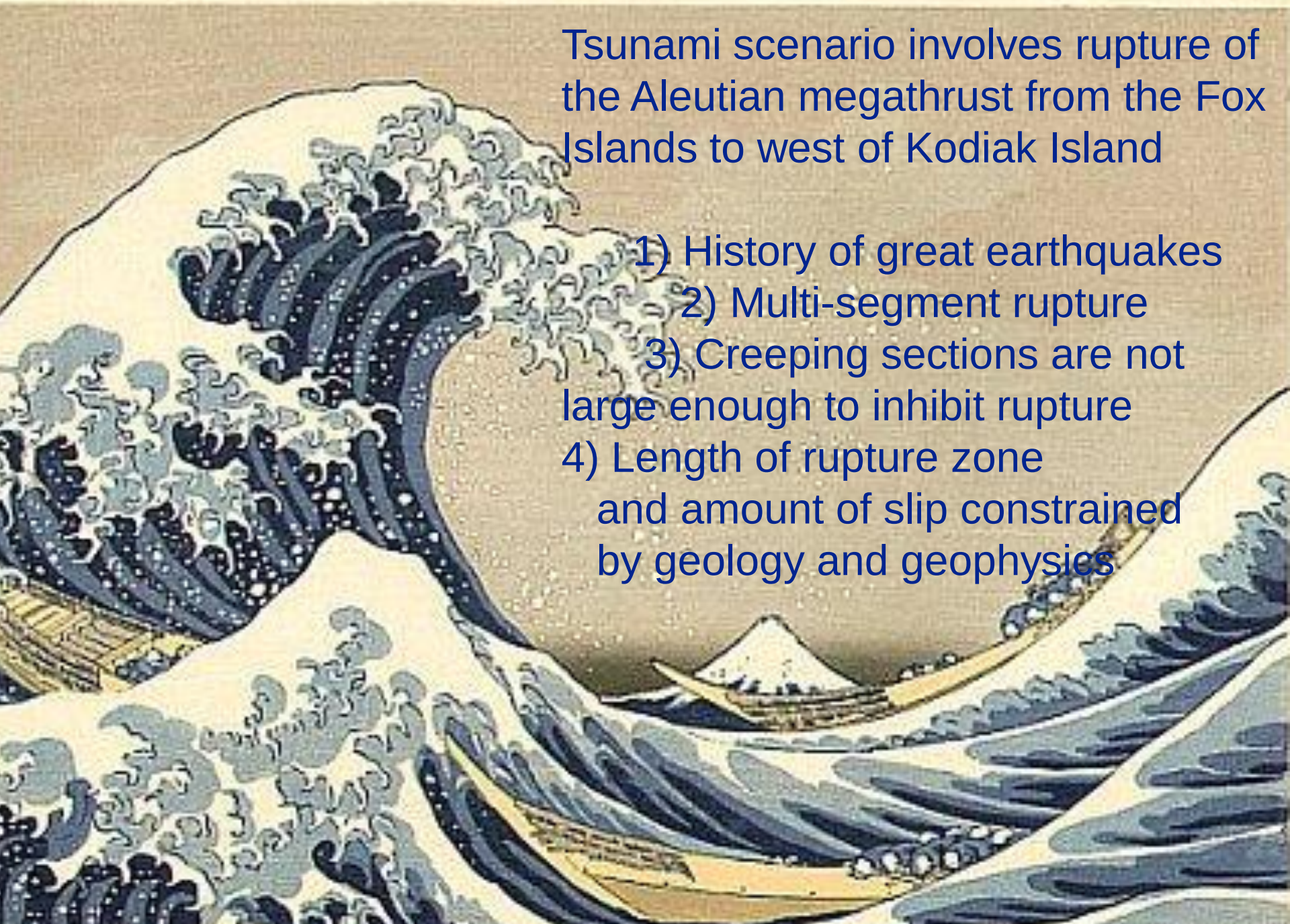
Courtesy of Gary Carver

STARDUST BAY
SEDANKA ISLAND

Soil Pit: Elevation measured 21 m above high tide line at the beach

Paleotsunami sand layers: 6 in 5000 years based on dating of two tephras (ash)

Courtesy: Gary Carver



Tsunami scenario involves rupture of the Aleutian megathrust from the Fox Islands to west of Kodiak Island

1) History of great earthquakes
2) Multi-segment rupture
3) Creeping sections are not large enough to inhibit rupture
4) Length of rupture zone and amount of slip constrained by geology and geophysics

Can there be temporal variability in locking of the plate interface?? (Note the southern Enggano segment of the forearc).

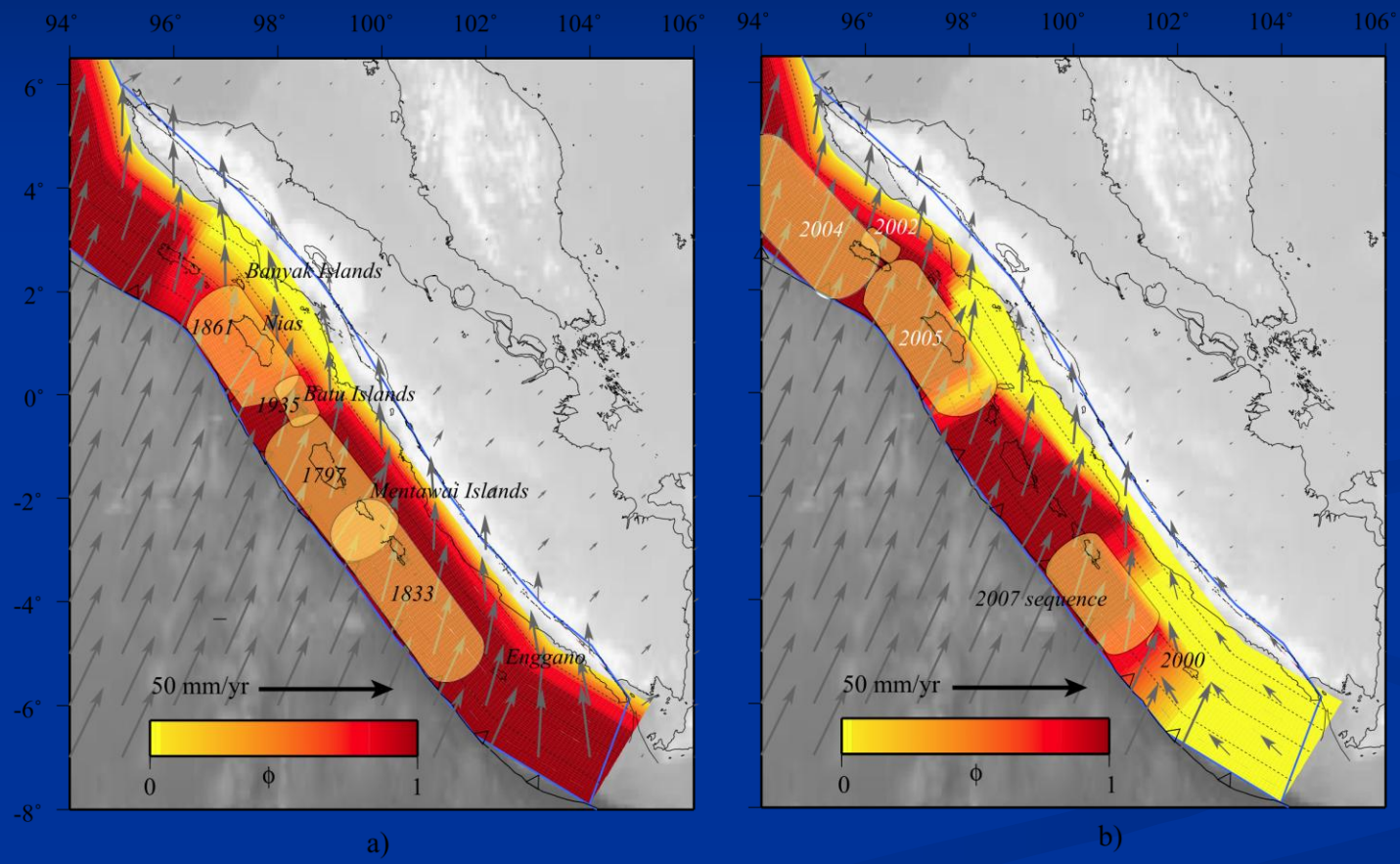
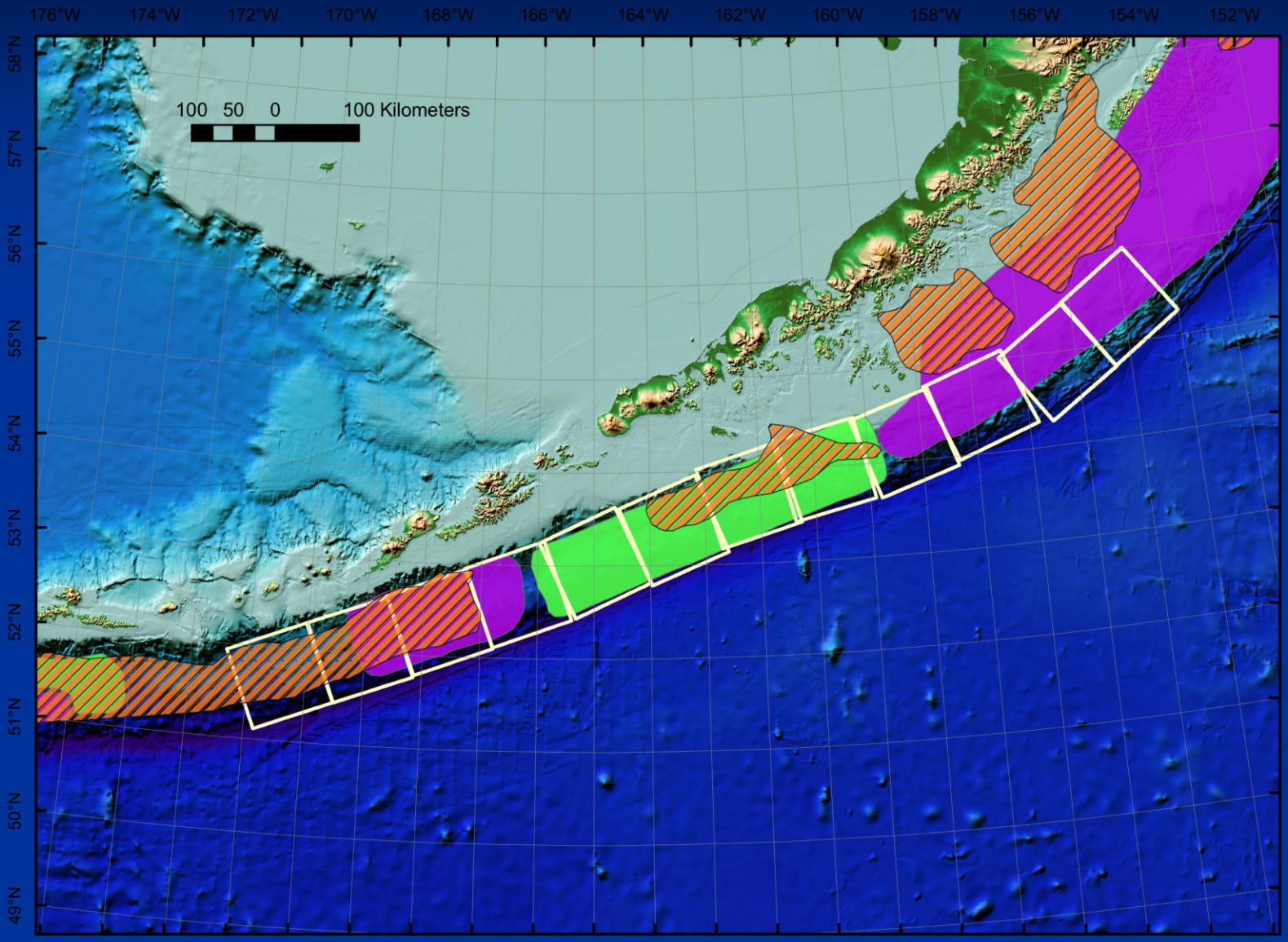


Figure 9. (a) Modeled interseismic velocity field (gray arrows) for period leading up to 21st century. Shading on the fore arc represents the value of the coupling coefficient used in model. Yellow patches show estimated rupture zones of significant subduction earthquakes. (b) Modeled current velocity field (gray arrows). Shading on the fore arc represents coupling coefficient values. Yellow patches show rupture zones of recent subduction earthquakes.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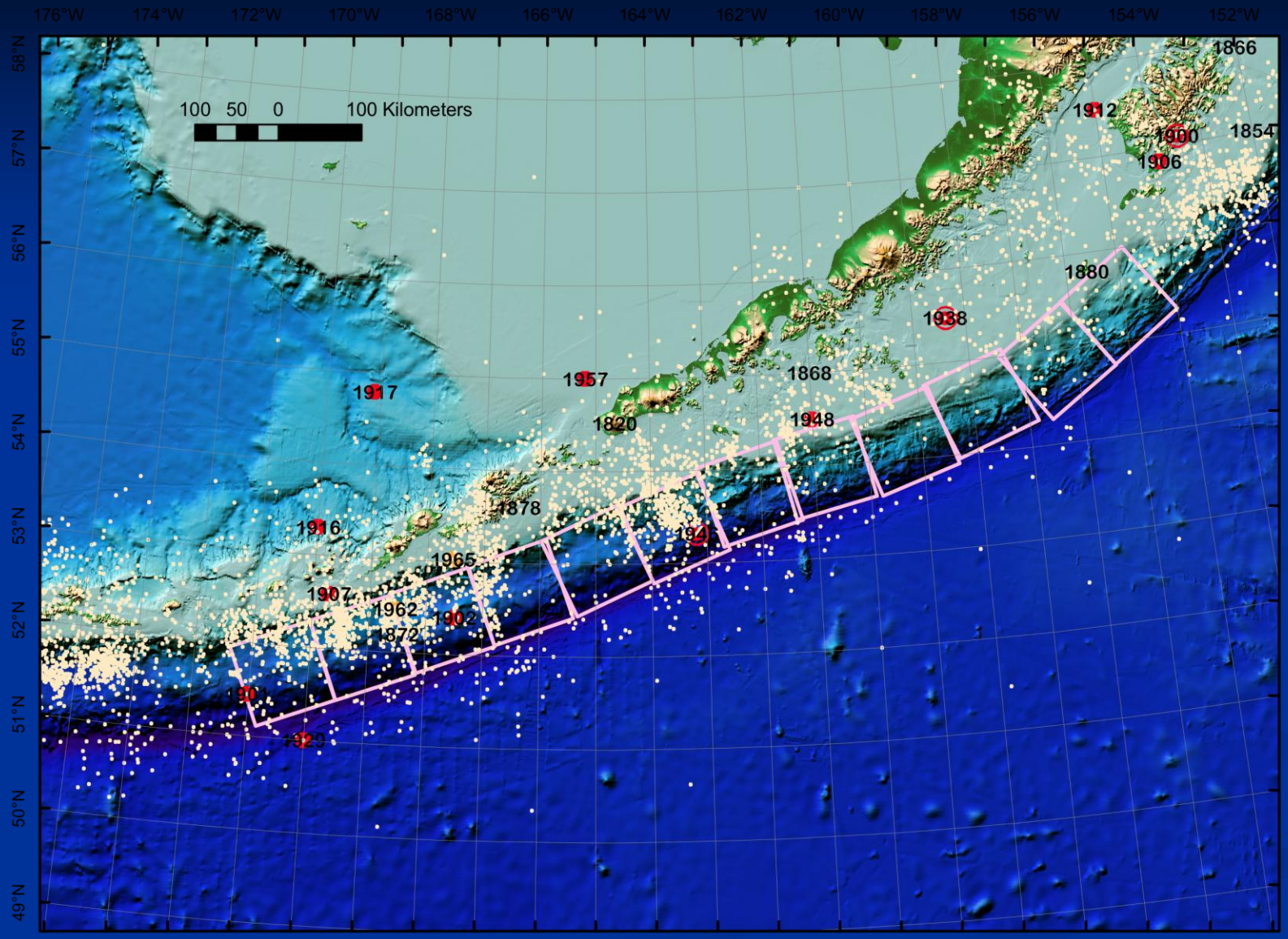
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1946 Tsunami Waves on Hawai'i Island - Worst Tsunami Disaster in U.S. History

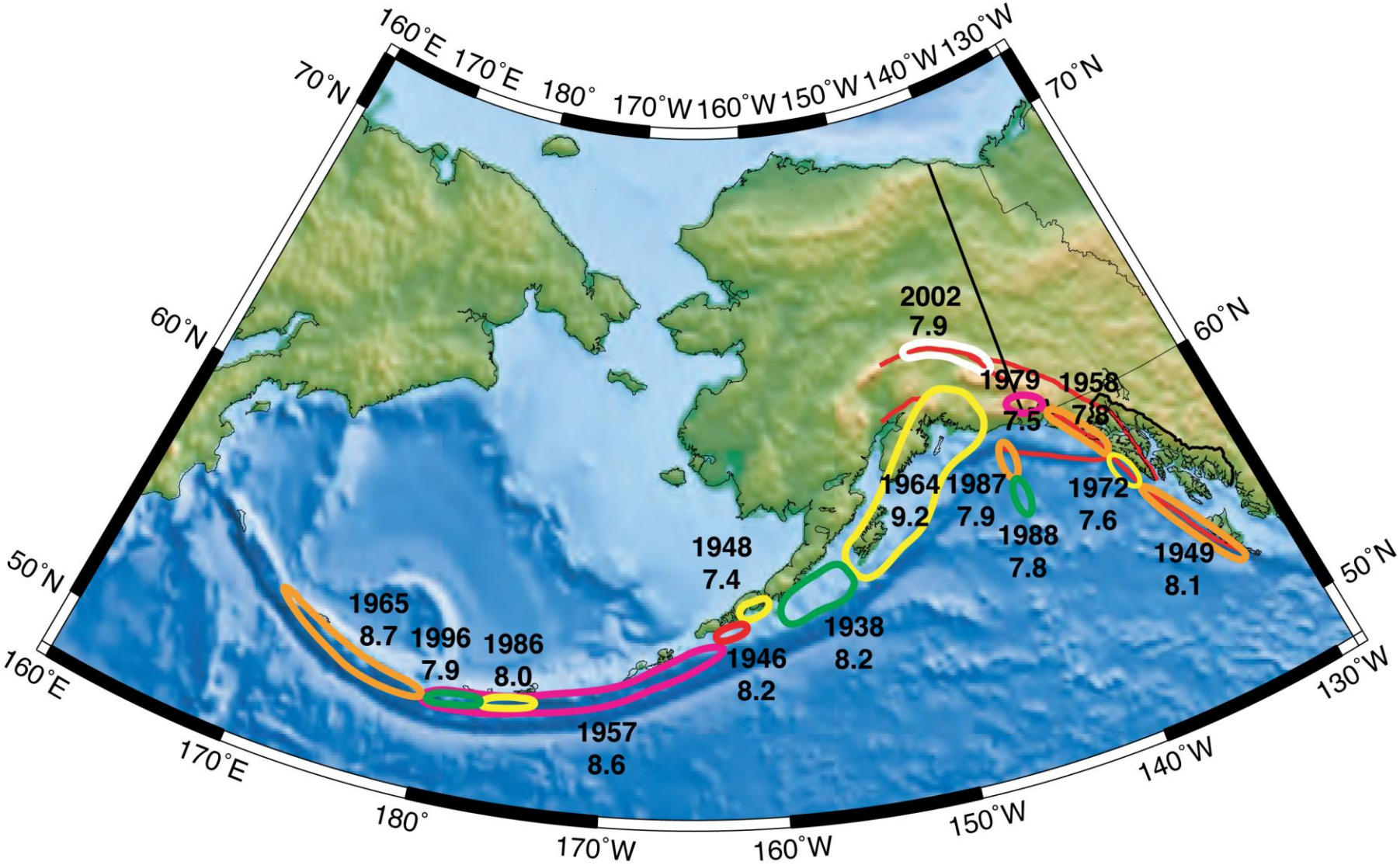
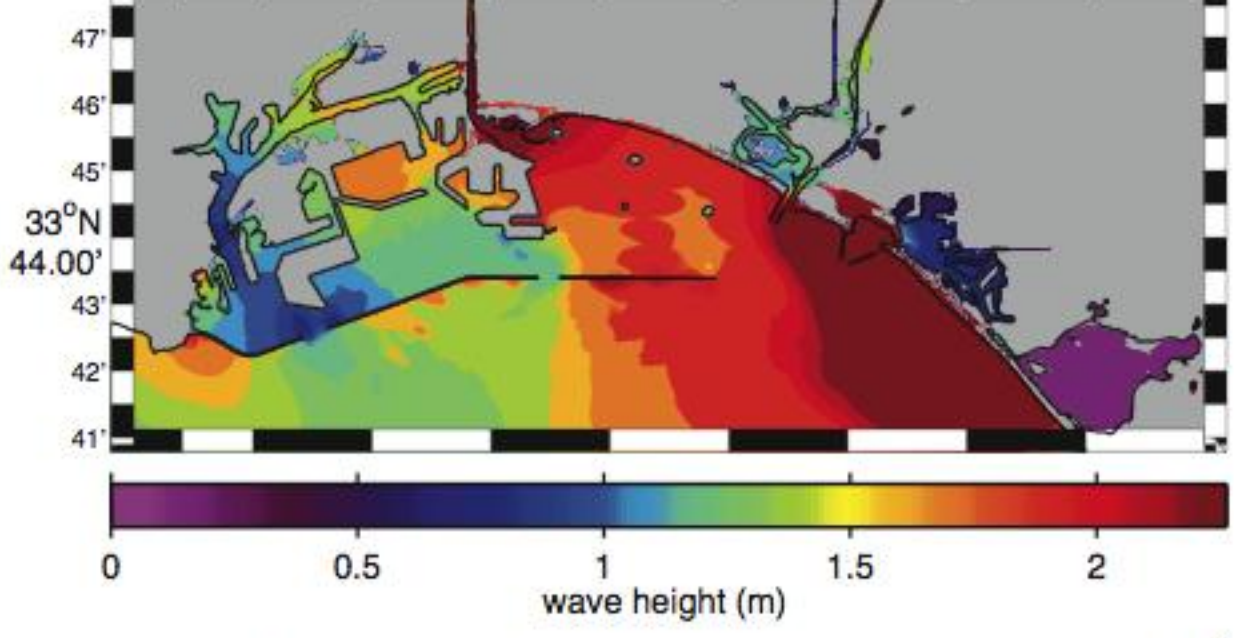
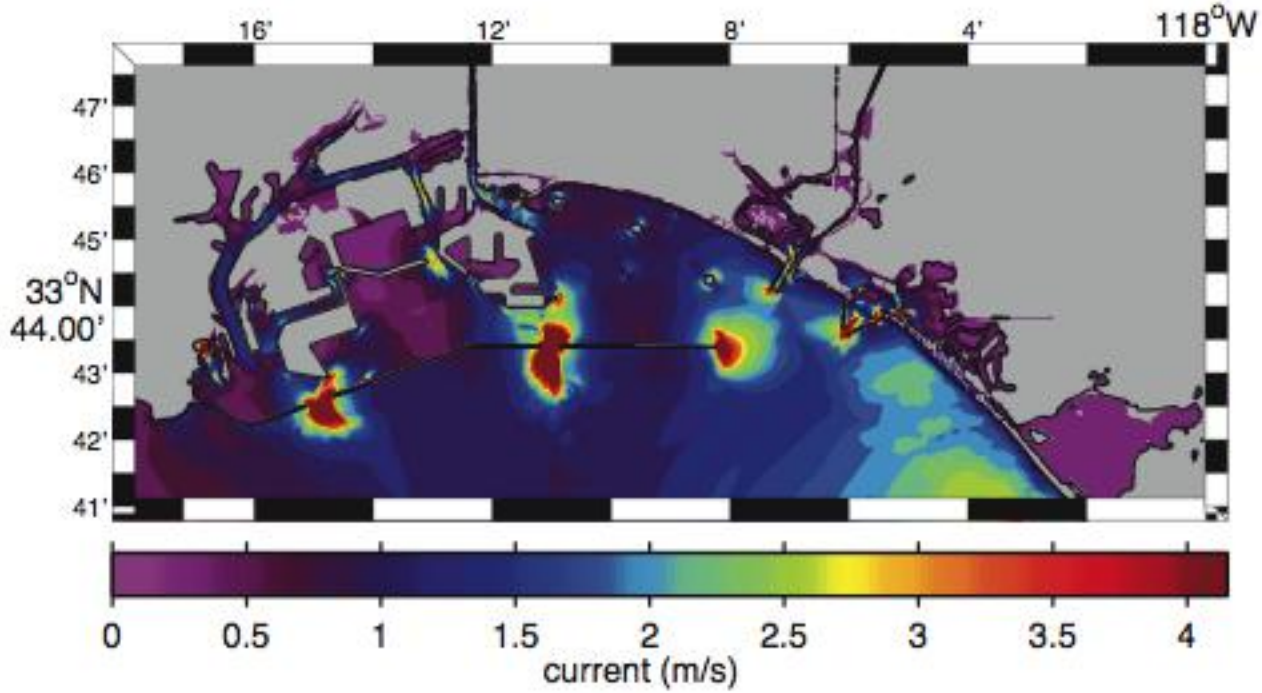


Figure 3. Rupture areas of large earthquakes in Alaska and the Aleutian Islands from 1900 to 2004.



(a)

Uslu, Tito, and Bernard
Draft, October 2009



(b)

re 3.4: Maximum wave height (a) and currents (b) at Port of Los Angeles And

Russian Historical Evidence about two 1788 Great Earthquakes and Tsunamis in the Shumagin Islands and Kodiak

- Two earthquakes and tsunamis: 11 and 27 July 1788
- Russian report estimated the tsunami wave heights at 30 m on Sanak and Unga Islands for the 27 July event
- Shumagin Islands abandoned by eastern Aleut peoples until the 1830's and the Russians abandoned Unga Island by 1799
- Archeological evidence suggests that these islands have been settled and abandoned several times during prehistory, possibly caused by tsunami losses.

Debbie Corbett (USFWS)

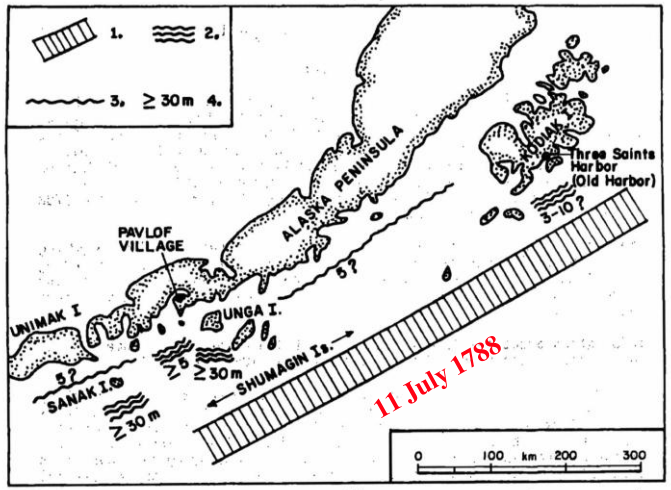


Fig. 1 Scheme of Earthquake and Tsunami of 1788

27 July 1788

1. Presumed location of earthquake rupture zone; 2. doubtless places where tsunami was observed; 3. possible places where occurrences of tsunami was observed; 4. approximate heights of tsunami in meters.

Emile Okal interpetation: 27 July event was a slow-rupture event or a submarine slump

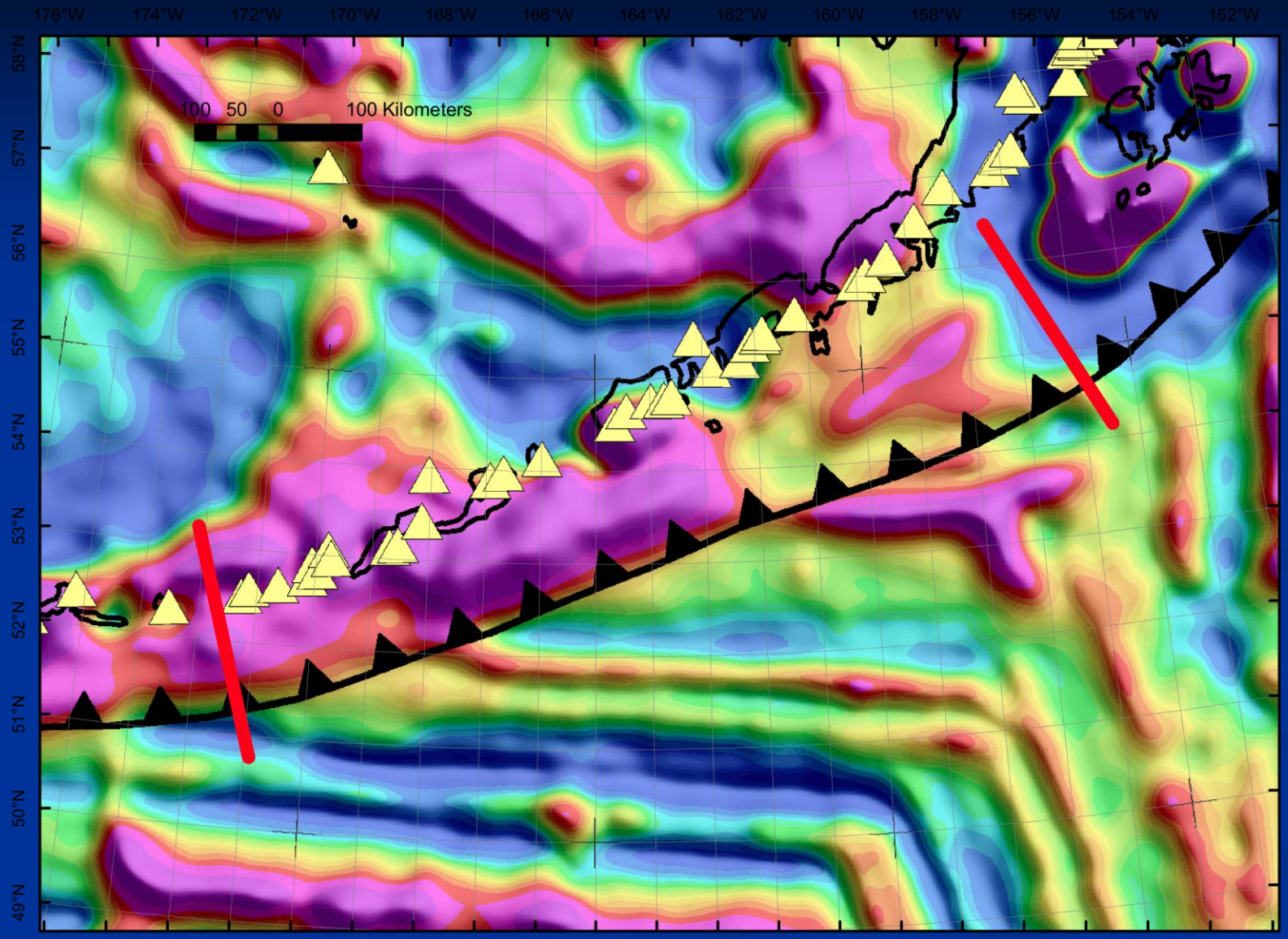
768. Въ 1788 г. 11-го (22) іюля на Унгѣ въ Алеутскихъ островахъ, 16-ю днями позже бывшаго здѣсь наводненія, произошло столь сильное землетрясеніе, что на ногахъ нельзя было стоять и многія горы разсыпались. И. Веніаминовъ замѣчаетъ, что чѣмъ сильнѣе здѣсь горятъ вулканы, тѣмъ рѣже и слабѣе бываютъ землетрясенія и наоборотъ. Землетрясенія здѣсь бываютъ по большей части осенью и всегда при западныхъ вѣтрахъ или послѣ оныхъ, и, начинаются вообще, на всѣхъ островахъ Уналашкинскаго отдѣла на SW и идутъ вдоль гряды къ NO, обыкновенно предшествуемыя болѣе или менѣе сильнымъ шумомъ, похожимъ на шумъ сильнаго вѣтра.

That the sea had [once] been in a state of extraordinary turbulence is confirmed by the Aleut tradition which says that, during the inundation which occurred on Sannakh around 1790, the water advanced in heavy rolling swells at considerable intervals.* I have seen a note in one church book written in an ancient hand, in which it said that, "In the year 1788 on the 27th of July there was a terrible inundation on Unga Island in which many Aleuts perished but God spared the Russians." And the old men say that (at this or some other time) the water rose to a height of 50 sazhen. Such a rise in the water [level] is almost incredible even if one measures not by ordinary but by hand sazhen.**

---

*The description indicates a tsunami. LB.

**The events at Sannakh "around 1790" and those mentioned at Unga in 1788 are close enough to be identical. Baranov established an outpost on Unga for Shelikhov's company soon after he took over in 1790, but independents were there before Baranov, and continued to maintain an outpost there until 1799. LB.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