Persistent Rupture Segmentation along the Sunda Megathrust off Sumatra

SCD Questions Addressed:

- controls on the size, location, and frequency of great subduction earthquakes
- evolution in space and time of deformation across the subduction boundary

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SCD Implementation Workshop
Austin, Texas
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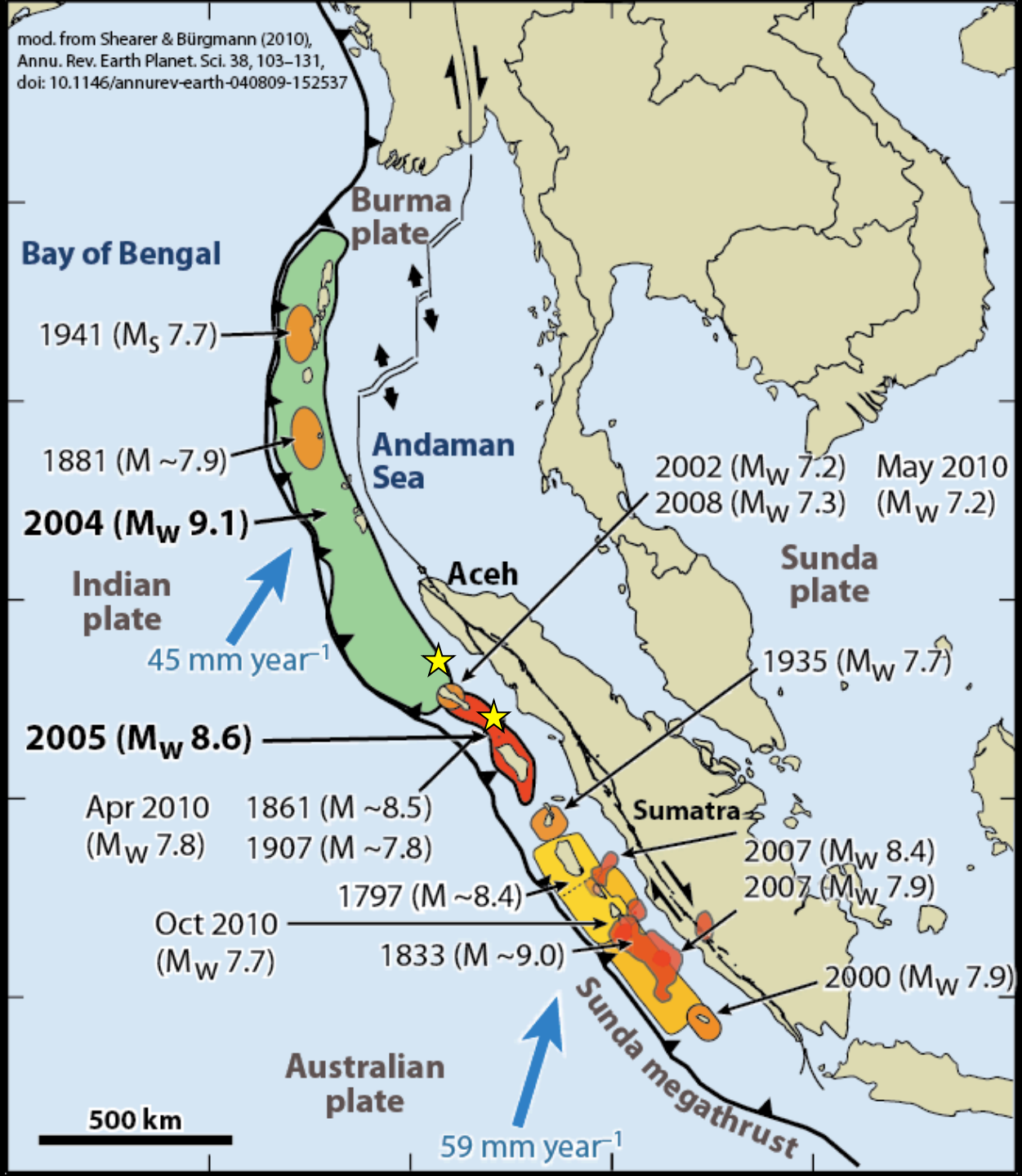
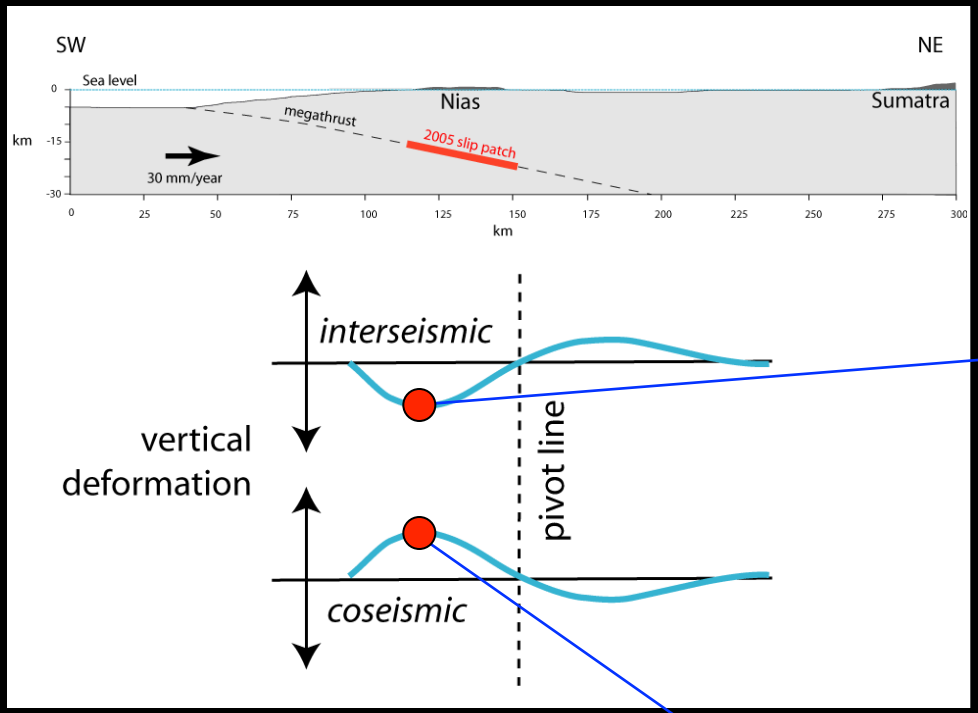


modified from Shearer & Bürgmann, 2010

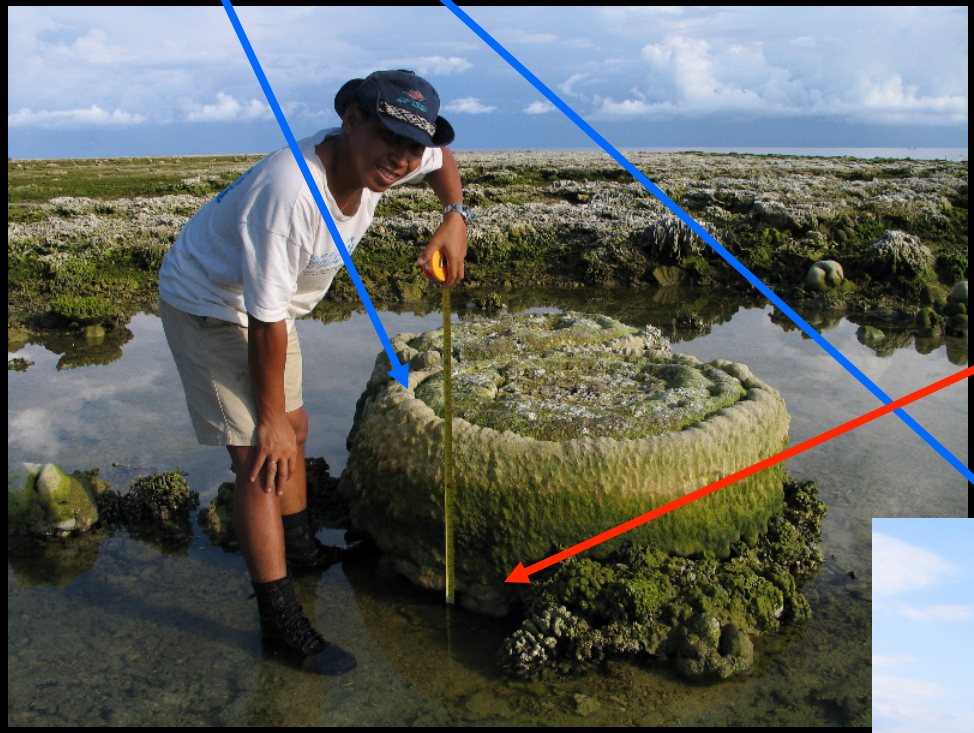
West Coast of Nias Island, Sumatra
(Uplifted March 2005)



Pre-2004 HLG

Post-2004 HLS

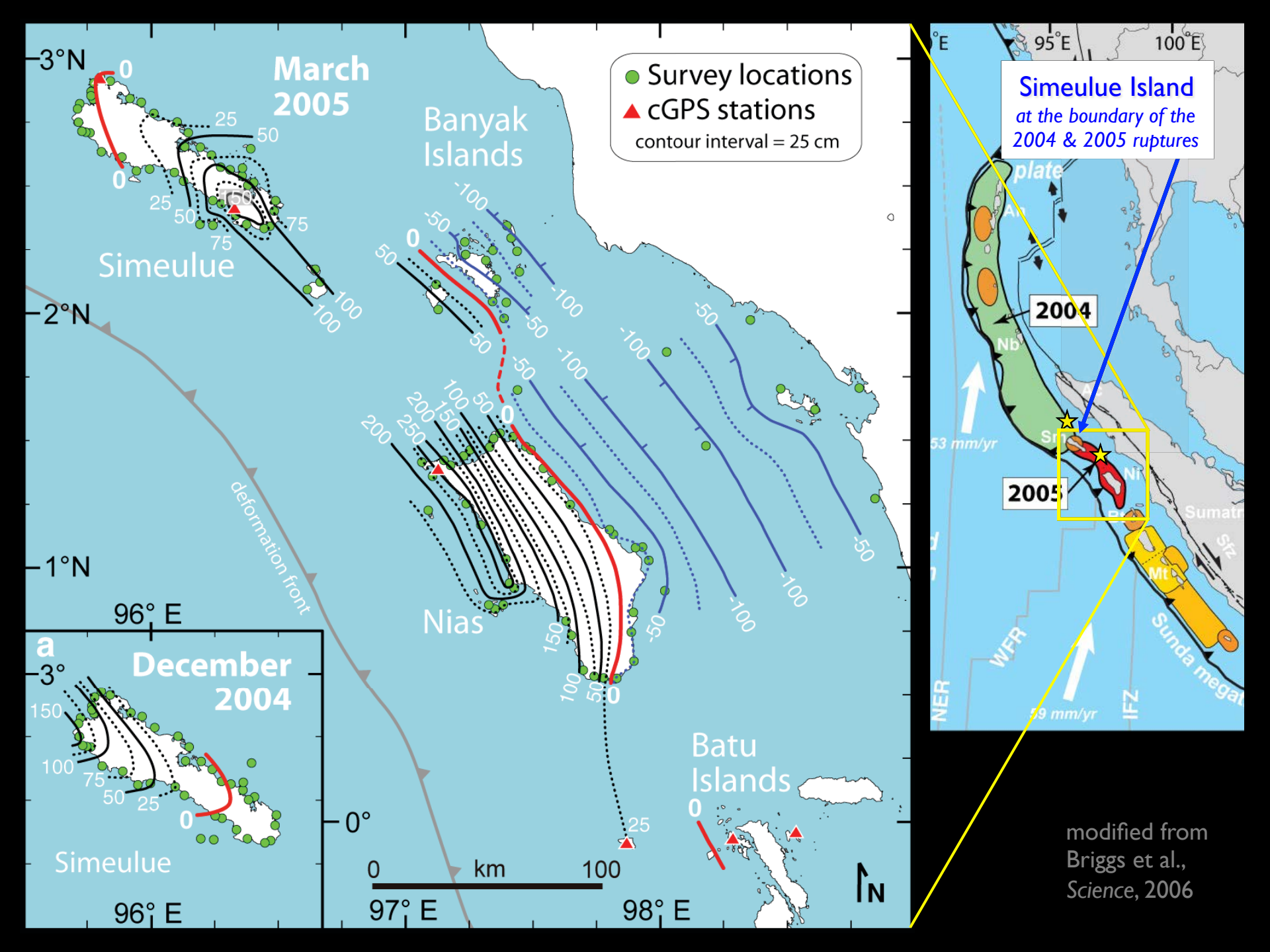
33 cm below pre-2004 HLG



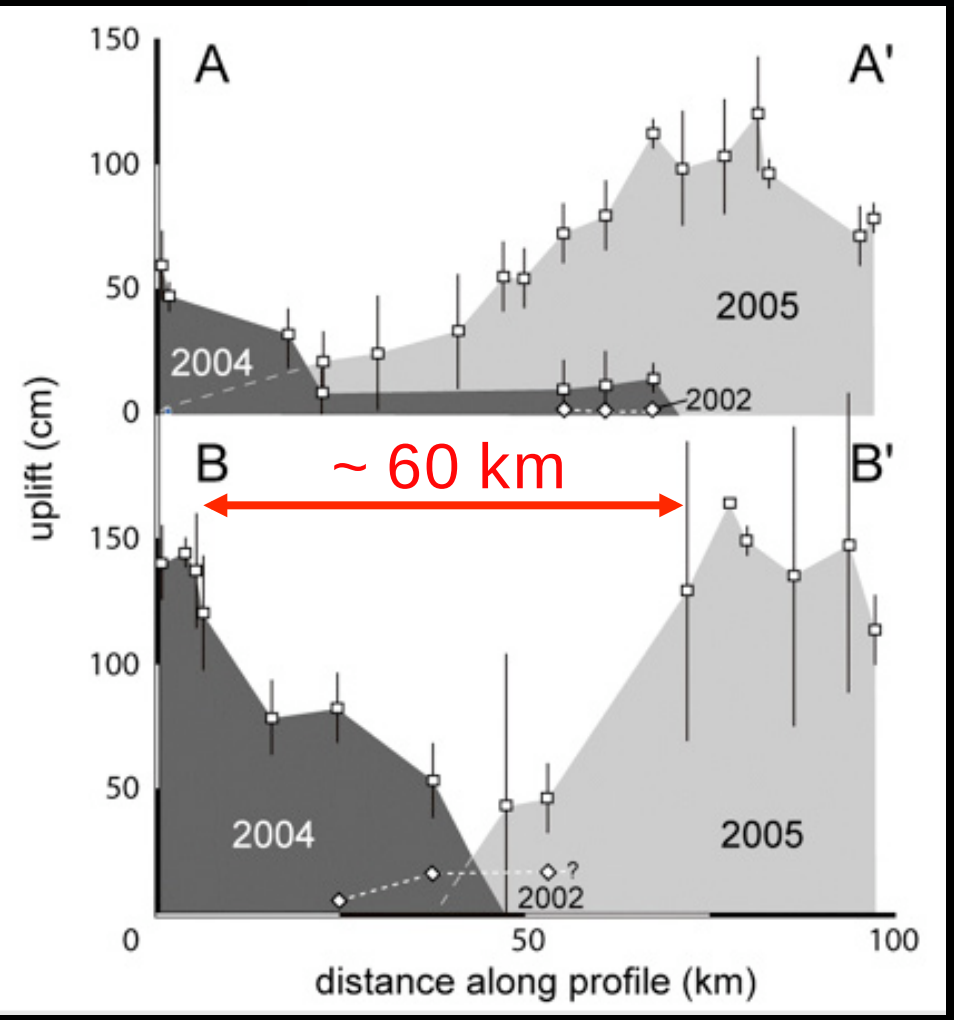
In Sumatra, we can use

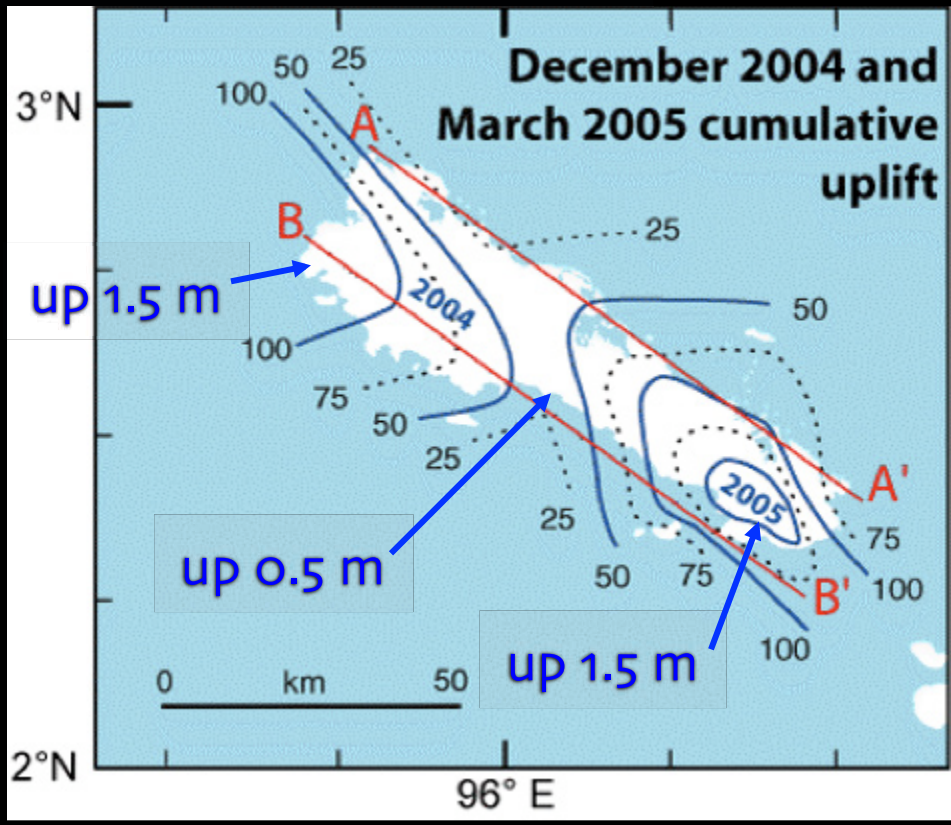
CORAL MICROATOLLS

from John Galetzka


March 2005
Survey locations
cGPS stations
contour interval = 25 cm
Simeulue
Banyak Islands
Nias
Batu Islands
deformation front
3°N
2°N
1°N
0°
96° E
97° E
98° E
0
km
100
a
December 2004
Simeulue
Simeulue Island
at the boundary of the 2004 & 2005 ruptures
2004
2005
95°E
100°E
53 mm/yr
59 mm/yr
WFR
IFZ
NER
Sunda megat
modified from Briggs et al., Science, 2006

The Simeulue Saddle of Uplift

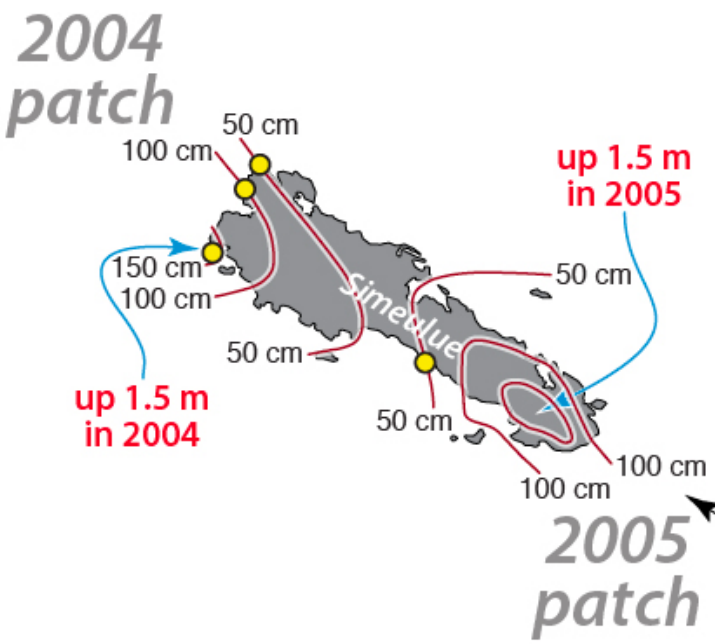




In central Simeulue, only a fraction of the uplift occurred

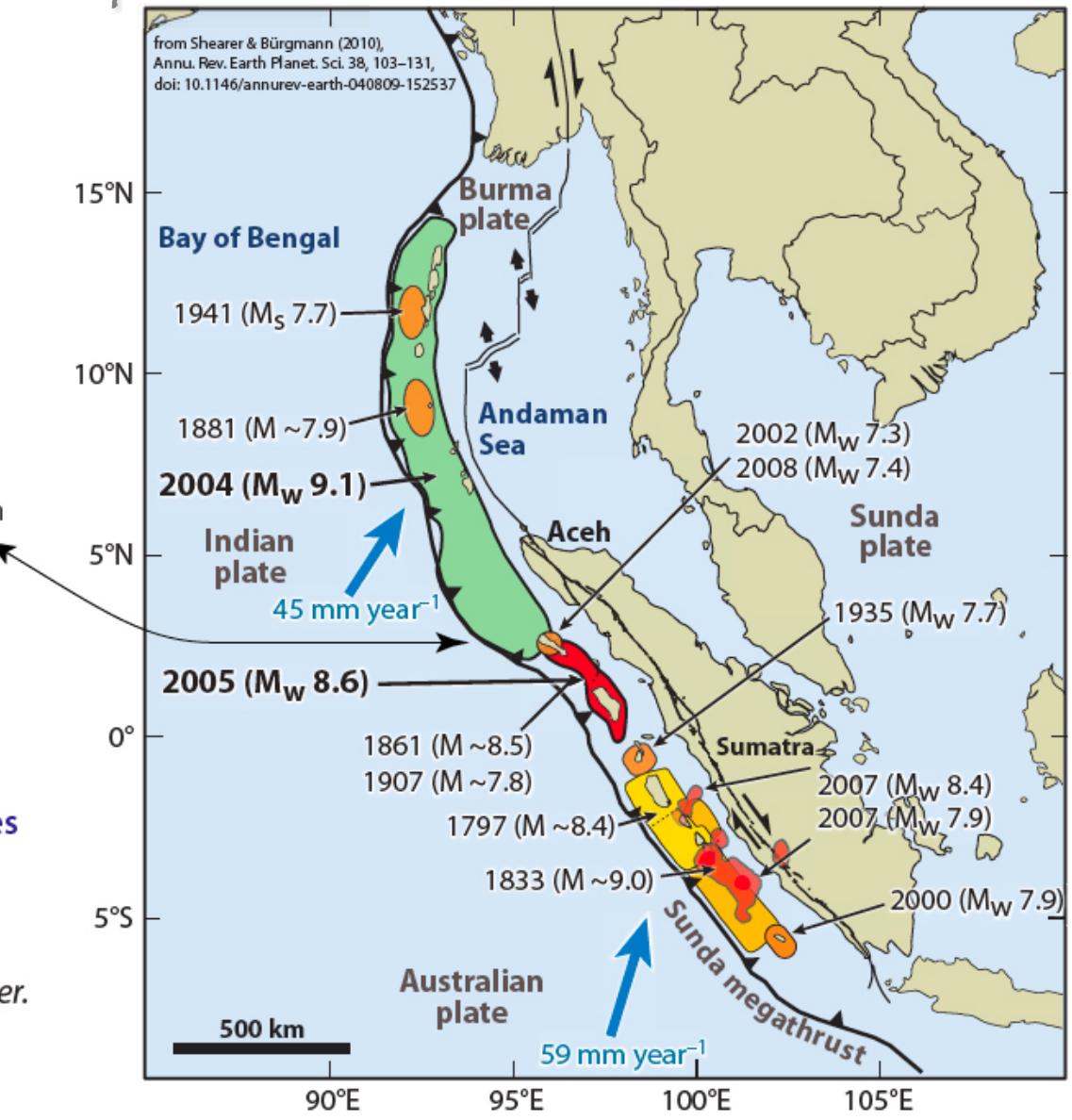
modified from Briggs et al., *Science*, 2006

The 'modern' sequence of ruptures …



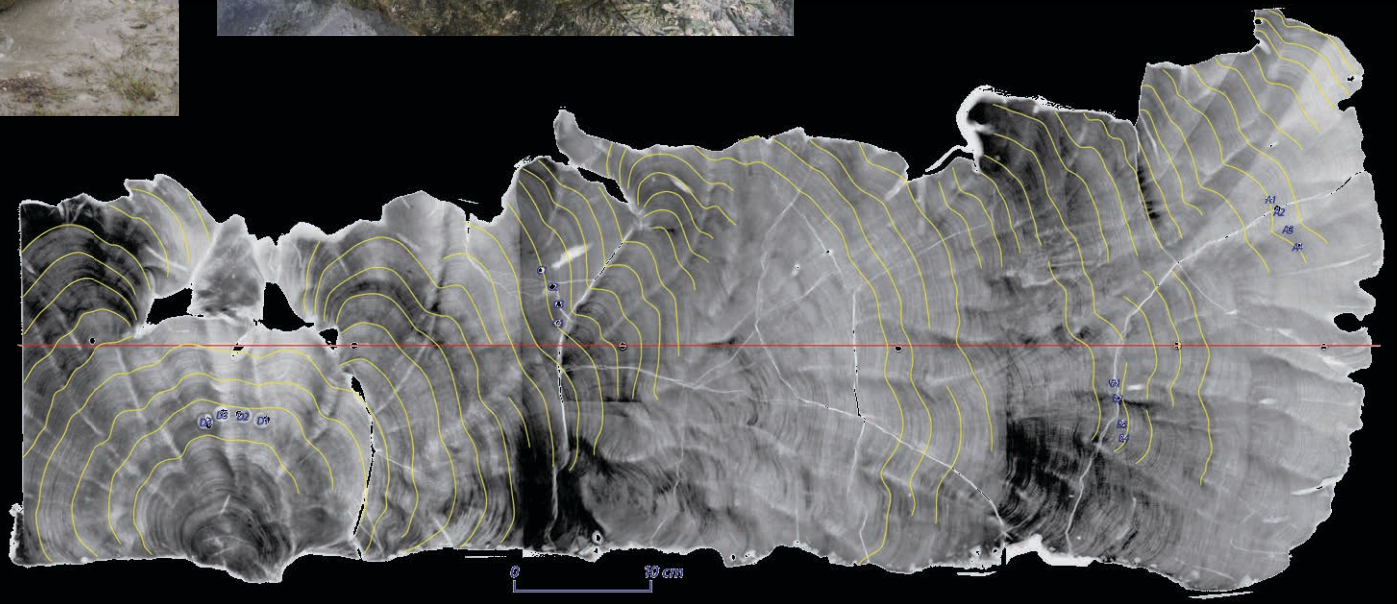
the Simeulue 'saddle' of uplift at the boundary of the 2004 & 2005 patches

Cumulative uplift in 2004 and 2005 was 1.5 m at the NW and SE tips of Simeulue but diminished to 0.5 m or less at the island's center.

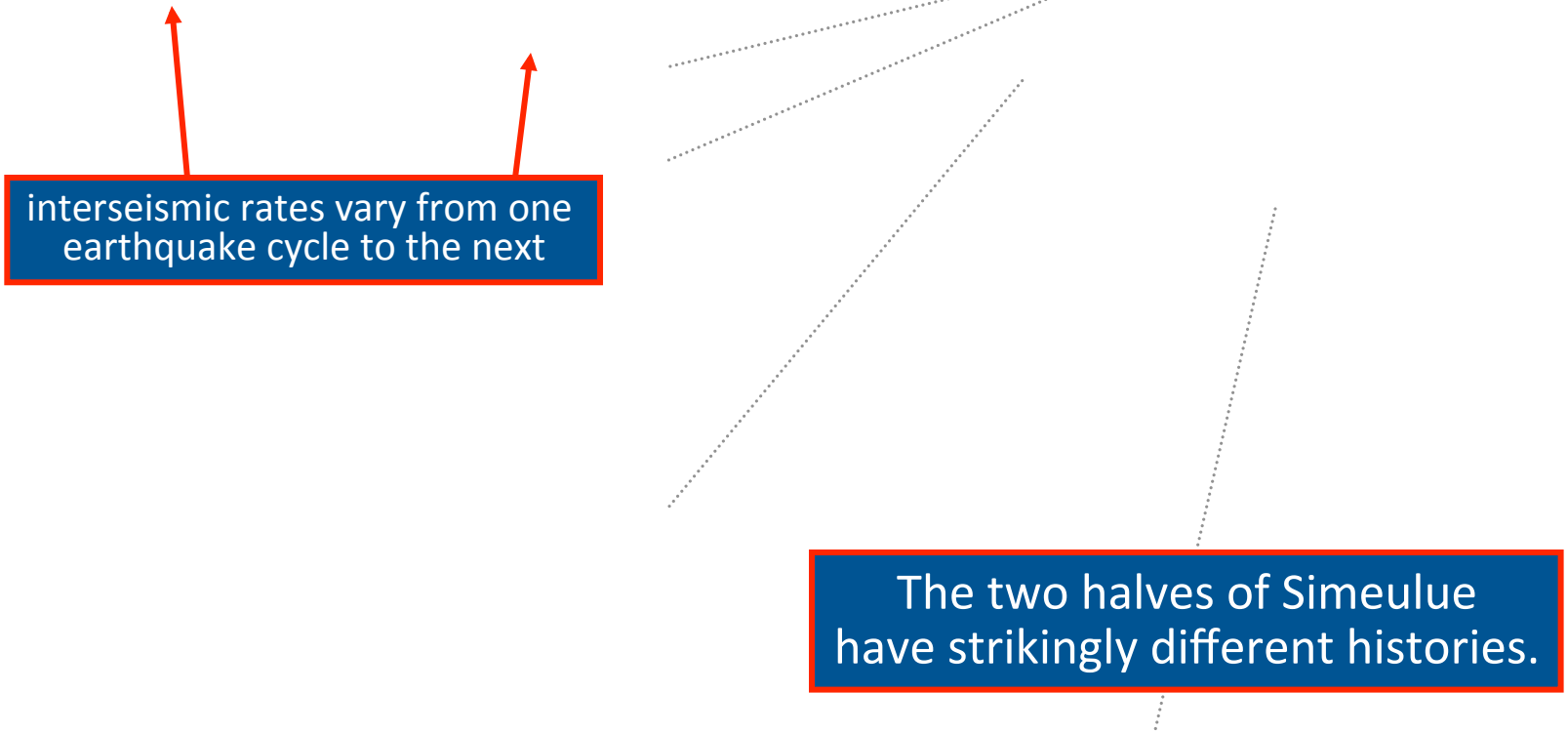


… but what about earlier ruptures?

What about earlier ruptures?



fossil microatoll from Lhok Pauh, northern Simeulue

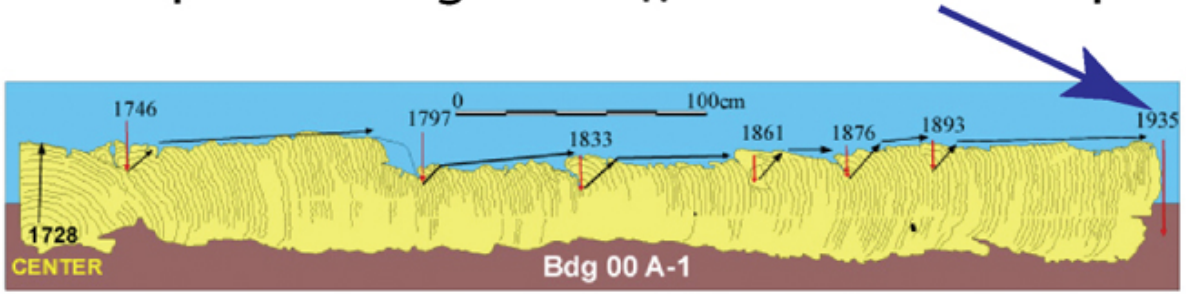


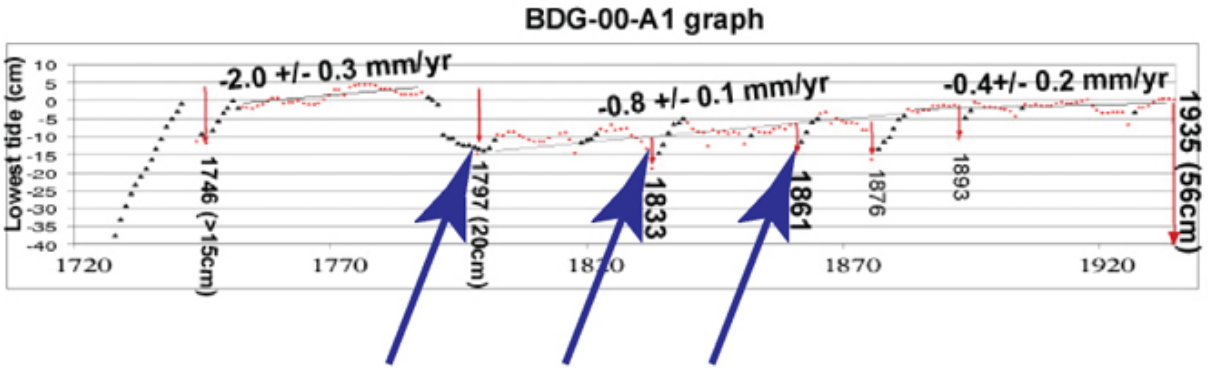
The time series plot showing 14th-15th century uplift and subsidence at sites on northern and southern Simeulue has been removed, as this figure has not yet been published.
You may request this figure directly from the author, at meltzner [at] ntu [dot] edu [dot] sg

Farther south in the Batu Islands …

A 100-km section of the megathrust at the Equator has been a barrier to rupture for at least the past 4 neighboring great earthquakes.

Modest uplift during the M_W 7.7 1935 earthquake

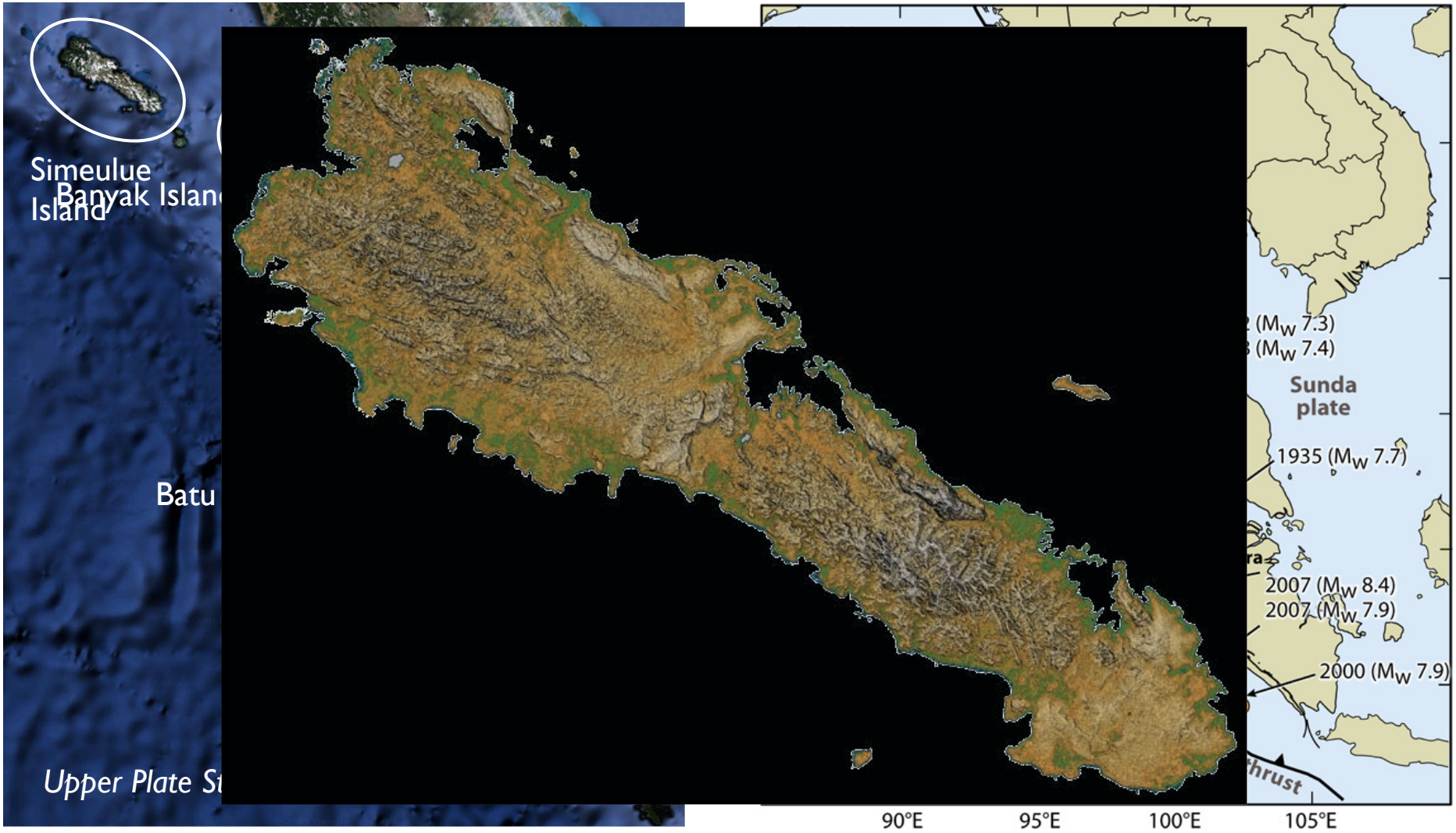




from Kerry Sieh & Danny Natawidjaja

Small uplifts during 3 great earthquakes on neighboring patches ... just as in 2005.

We have thus identified 2 persistent barriers to rupture in Sumatra ... but we can only speculate on their controls



from U. Barckhausen;
after Liu et al. (1983) & Cande et al. (1989)

Conclusions & Questions

- We have identified two persistent barriers to rupture, but do not yet fully understand them or what controls them
- Earthquake clustering and 'supercycles' appear to prevail on at least some segments of the Sunda megathrust
- We have multiple instances of seemingly irrefutable evidence for changes in decades-long subsidence rate at a given site
  - this cannot all be explained by post-seismic deformation
- *Are there advantages to looking in different areas where there are different boundary conditions & different geometries, to see if the same rules apply?*


Thank You!