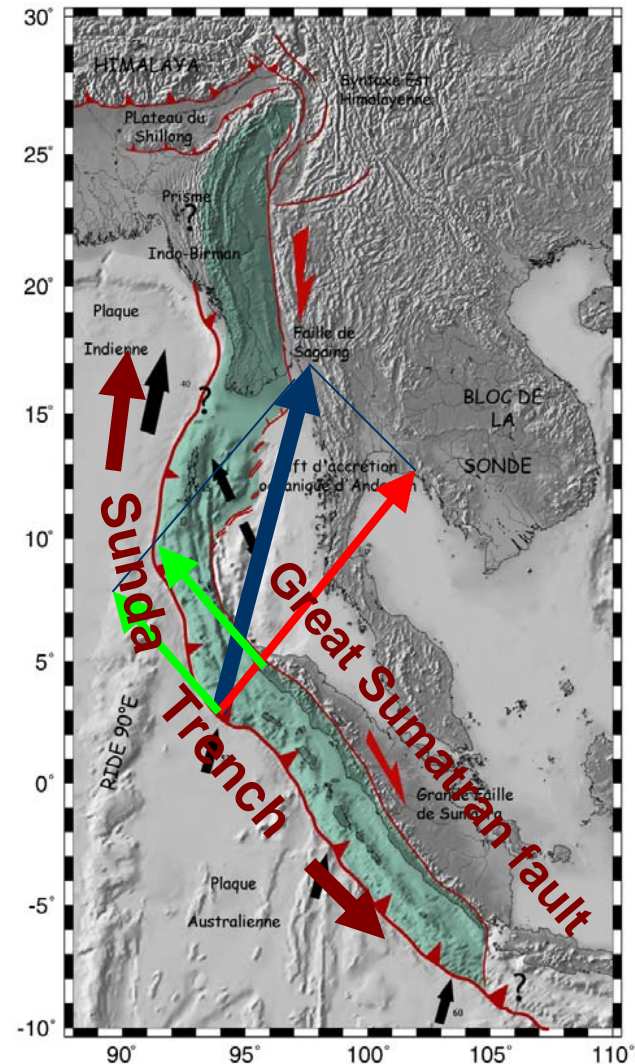
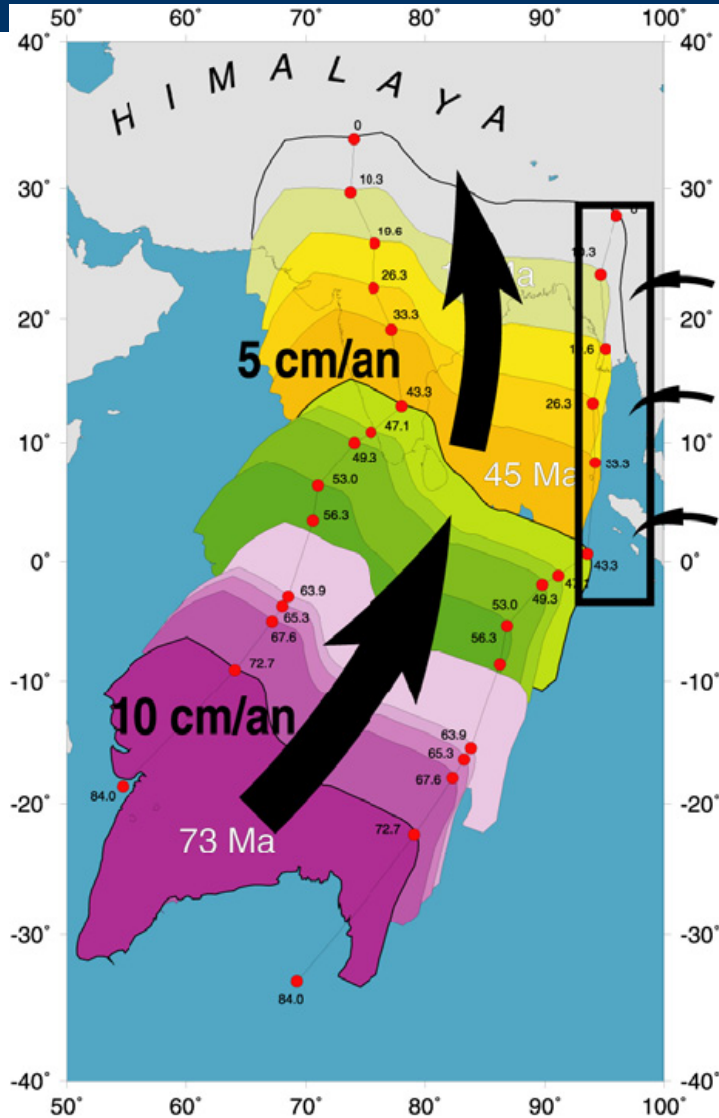


# Sumatra – Andaman 26 December earthquake

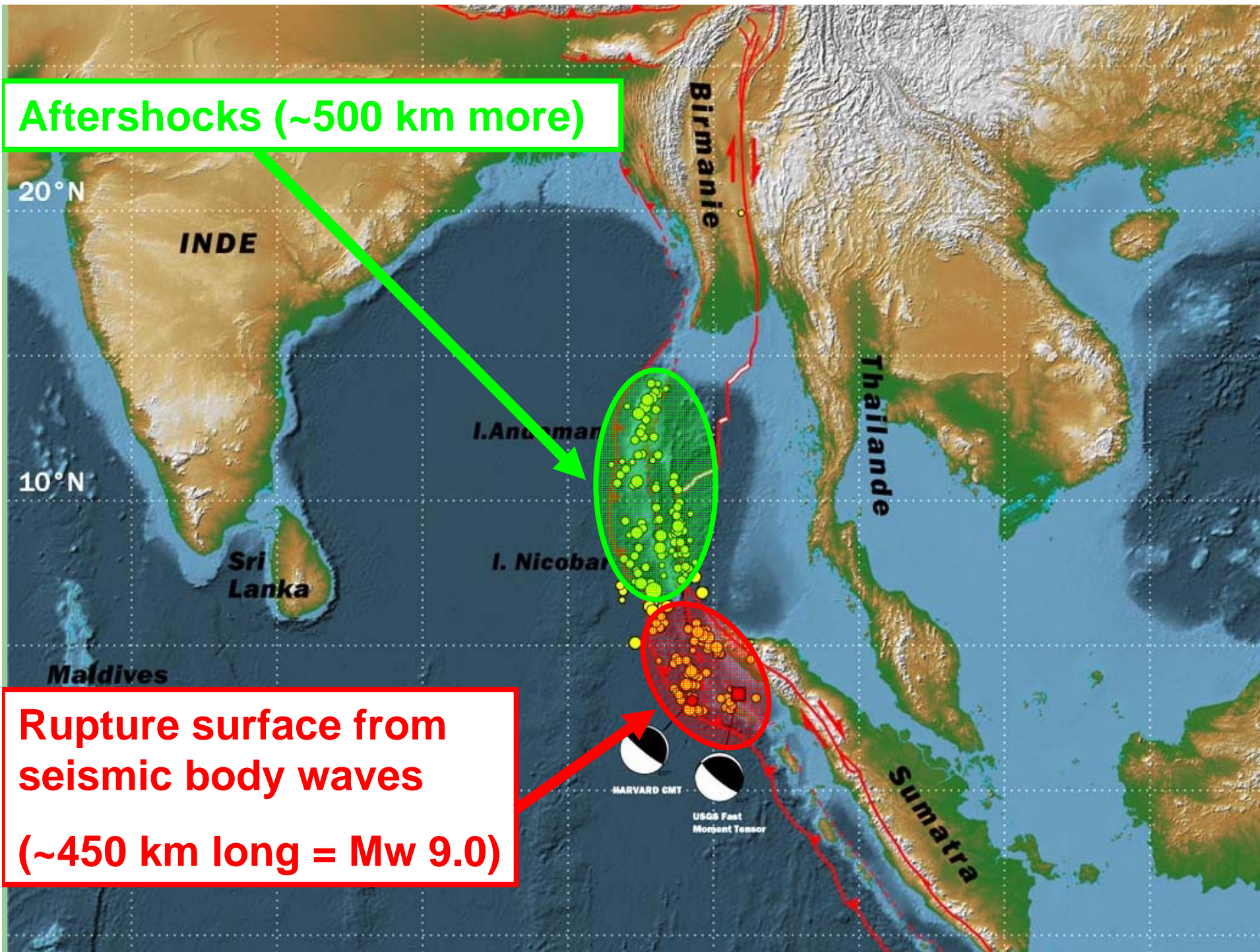
- Sismo tectonic context

# context



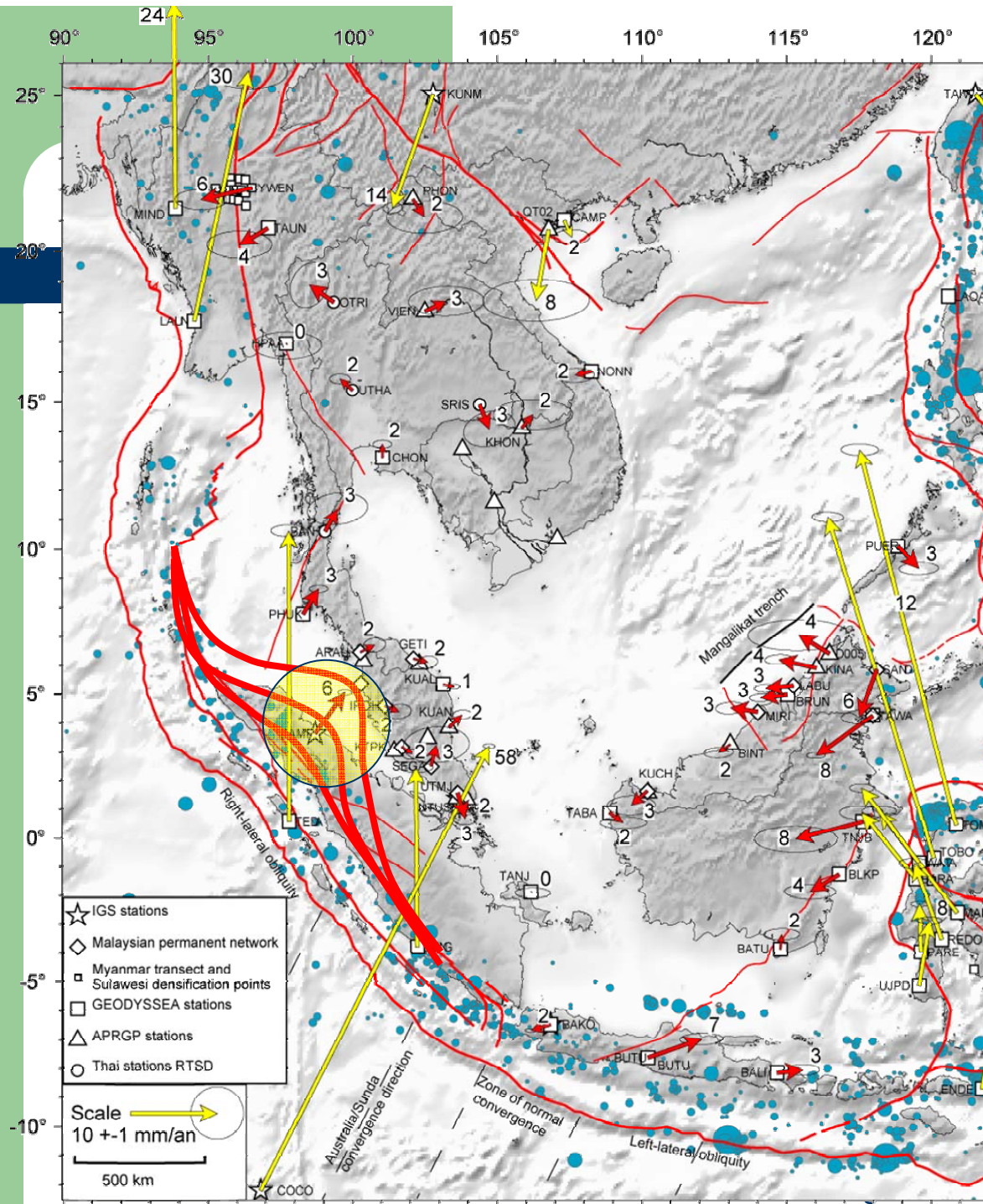


**Aftershocks (~500 km more)**



**Rupture surface from seismic body waves  
(~450 km long = Mw 9.0)**

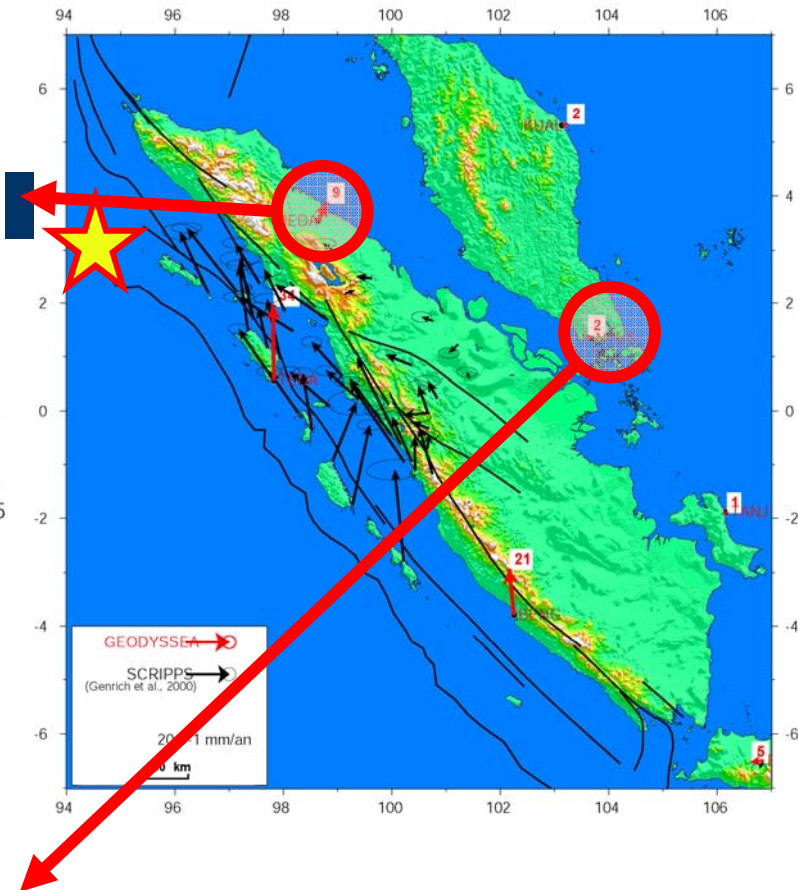
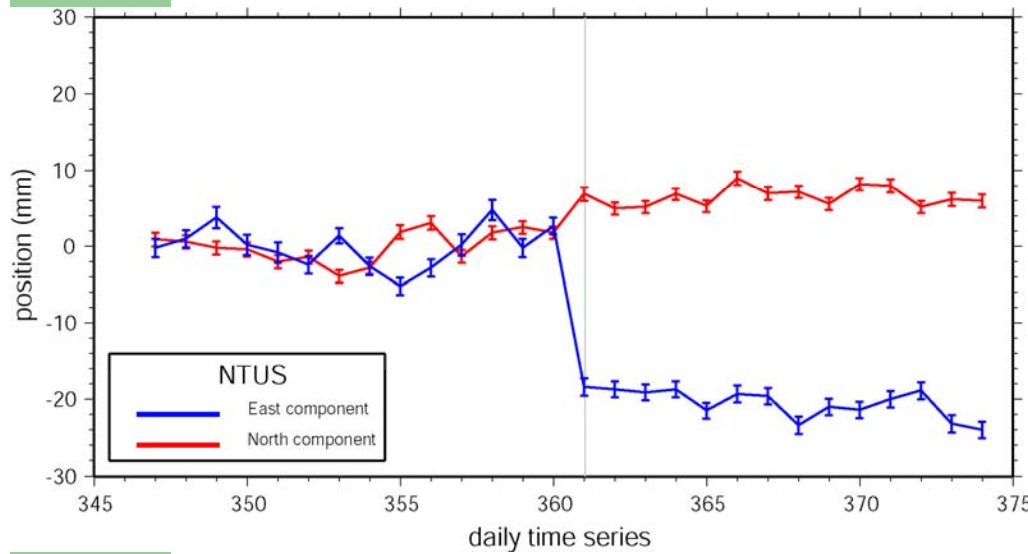
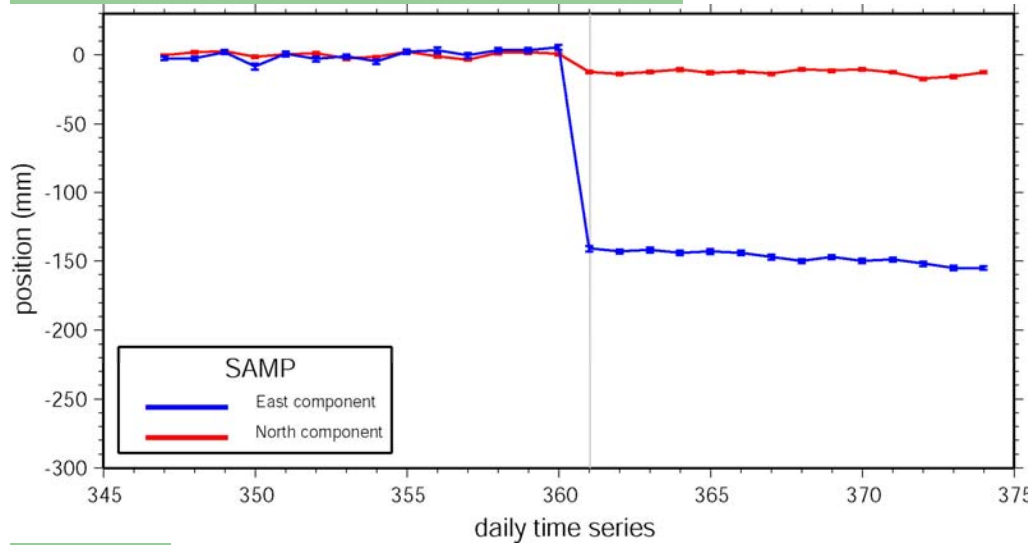


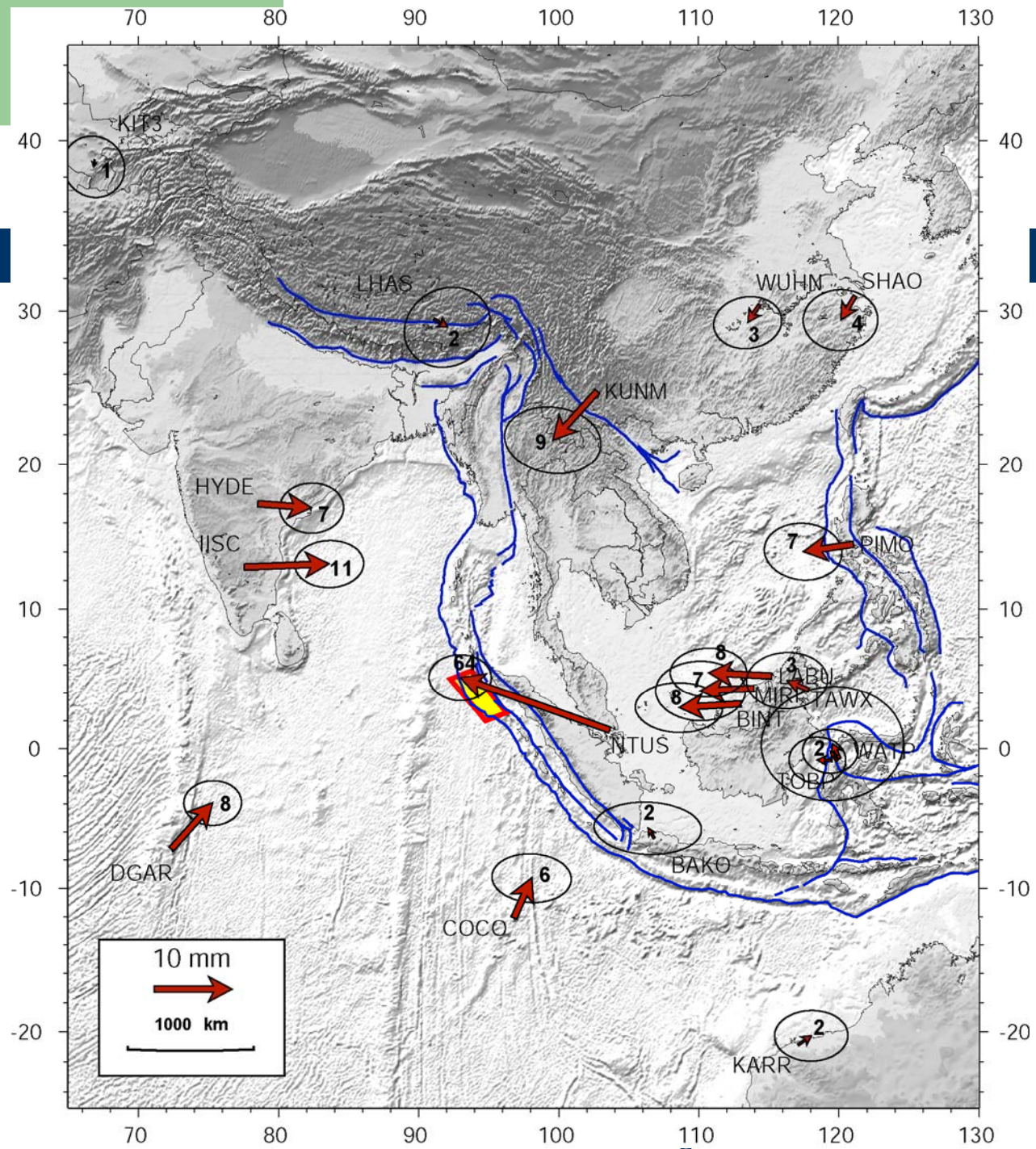


An Earthquake there was not unexpected

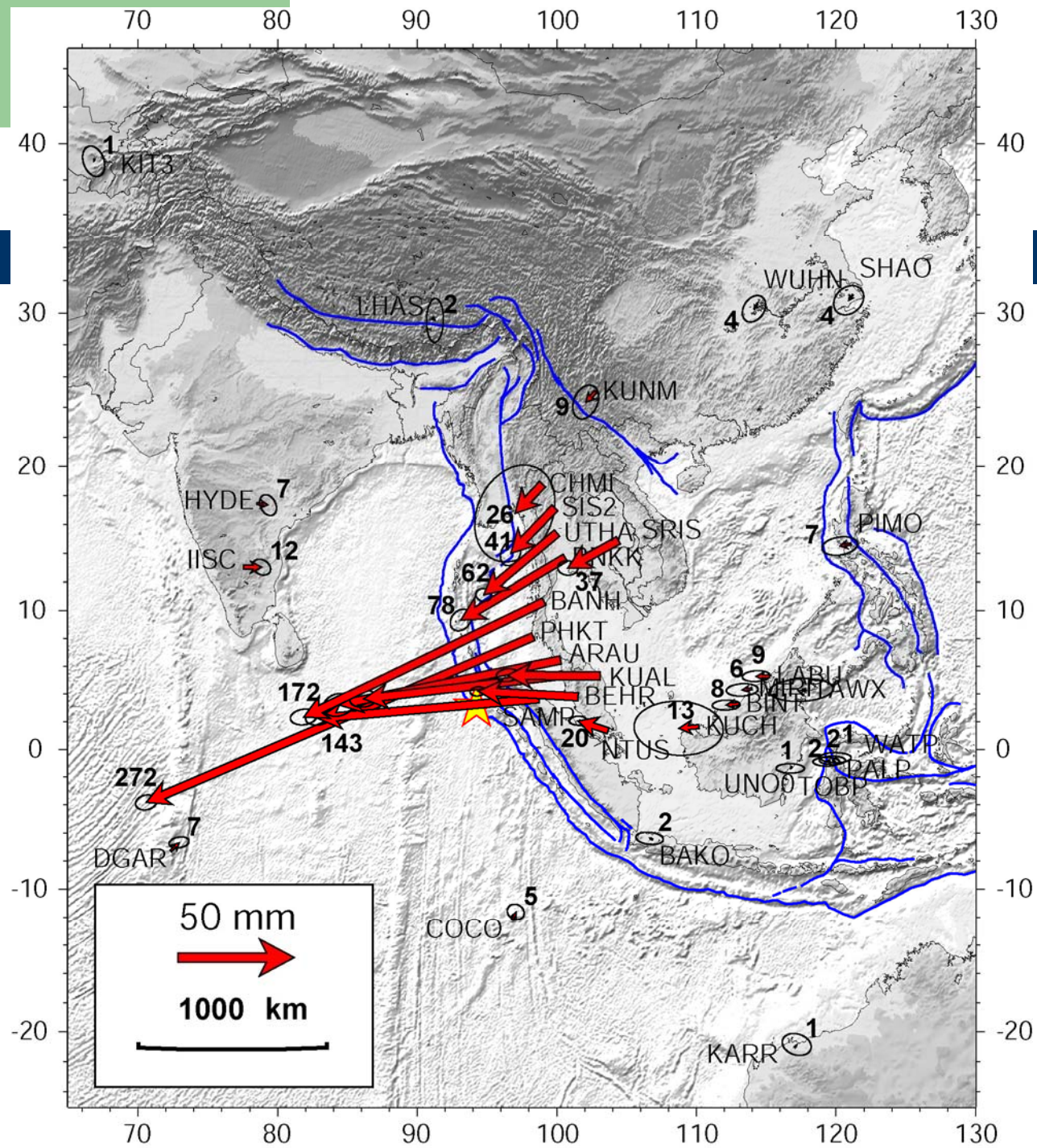


Sumatra 92-94-96-98-00 (ITRF2000)  
ENS solution / ENS Sundaland (59.4,-99.3,0.30)

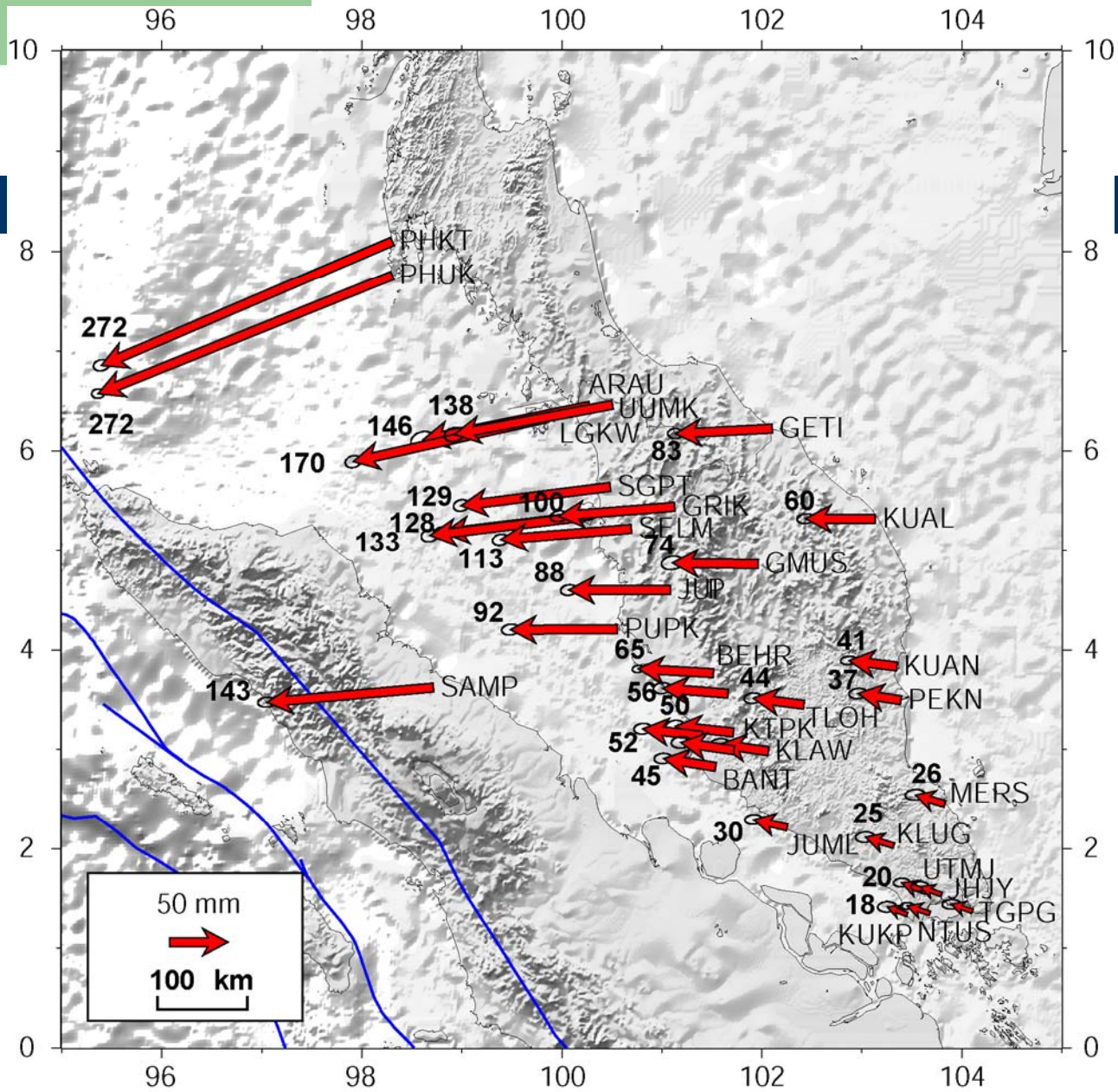






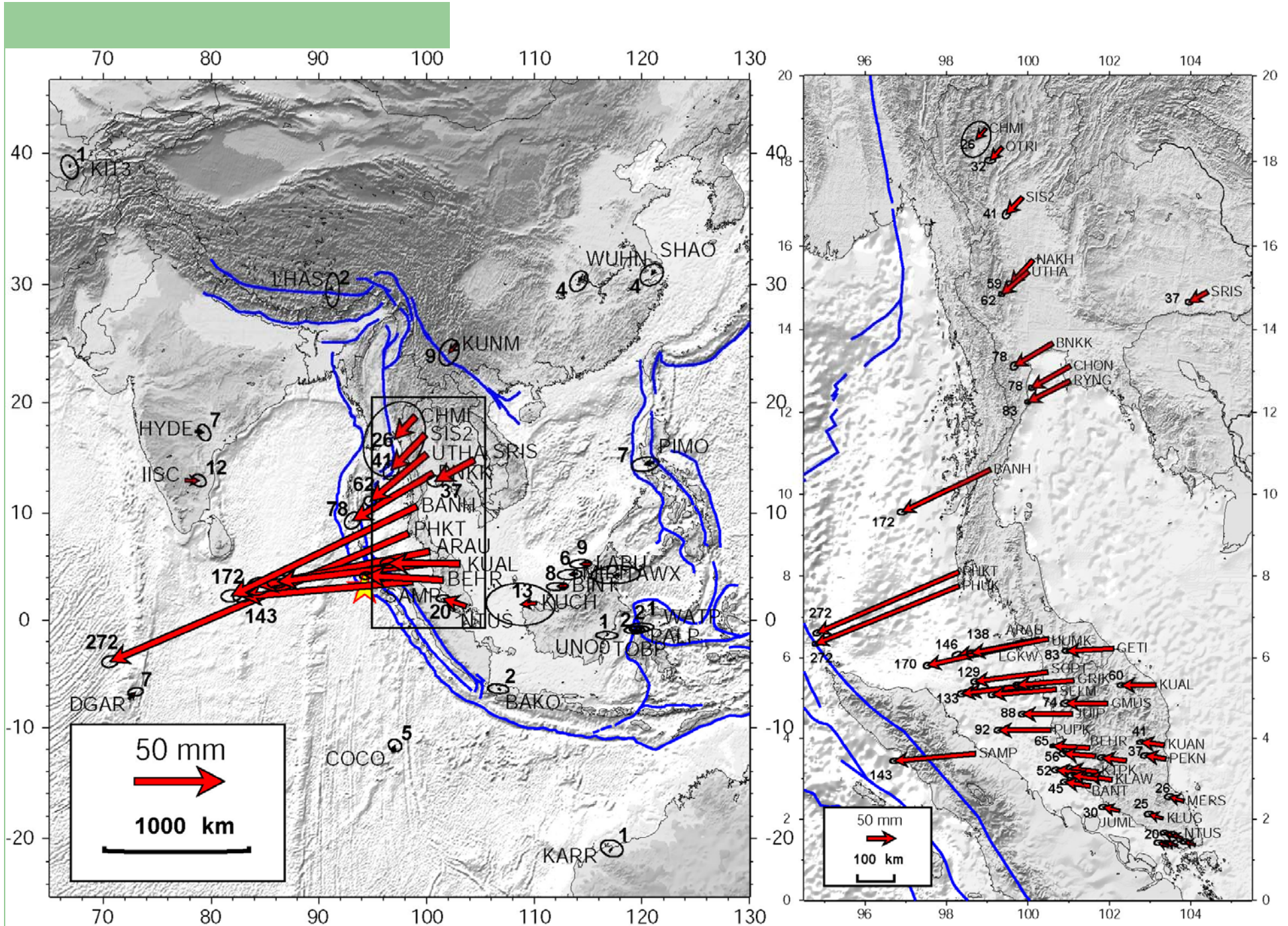






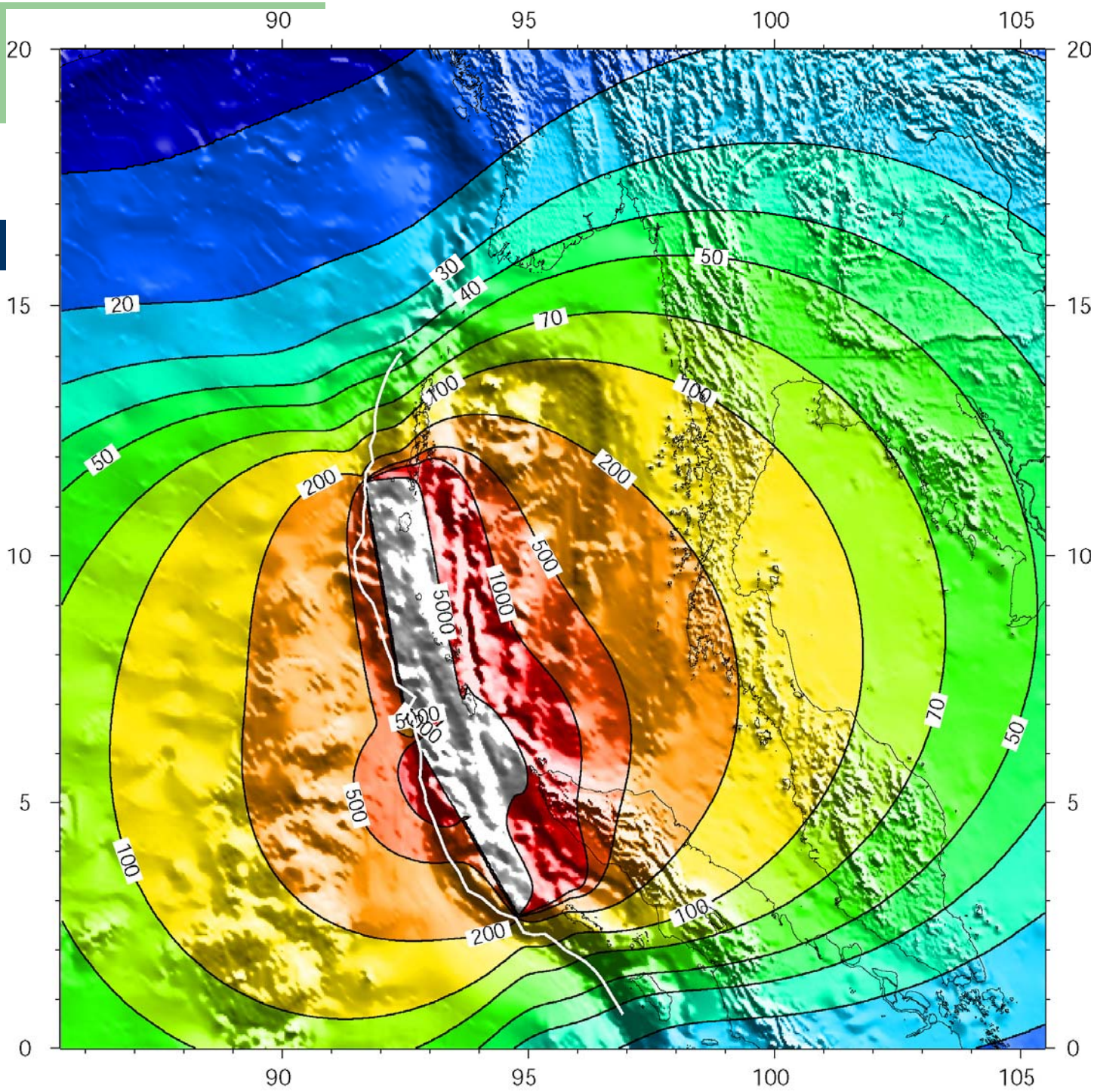
SEAMERGES GPS course - Bandung October 2005





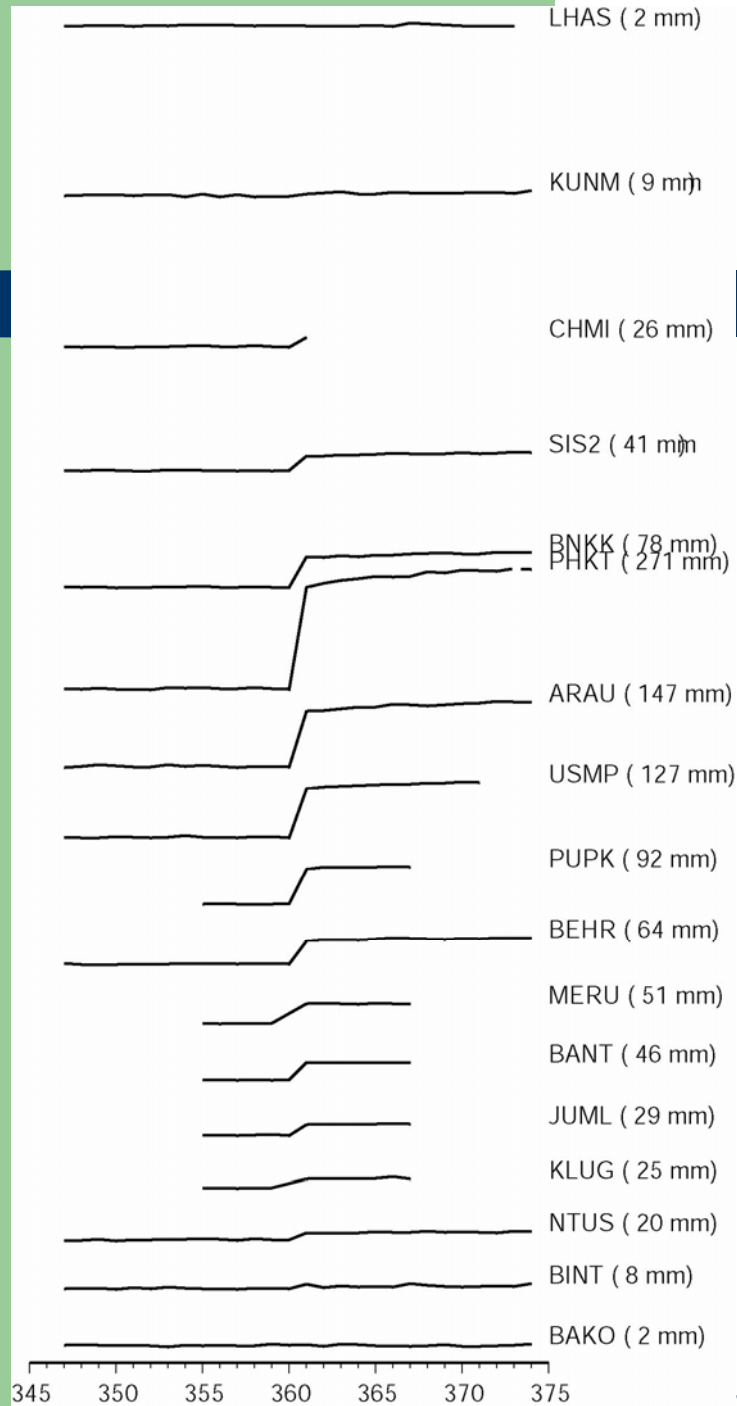
SEAMERGES GPS course - Bandung October 2005



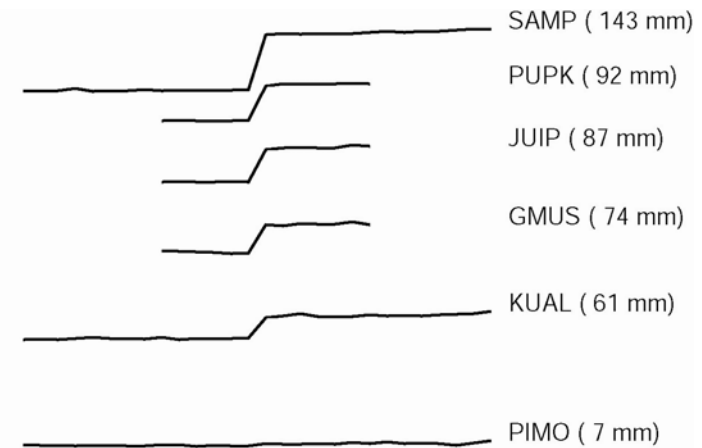




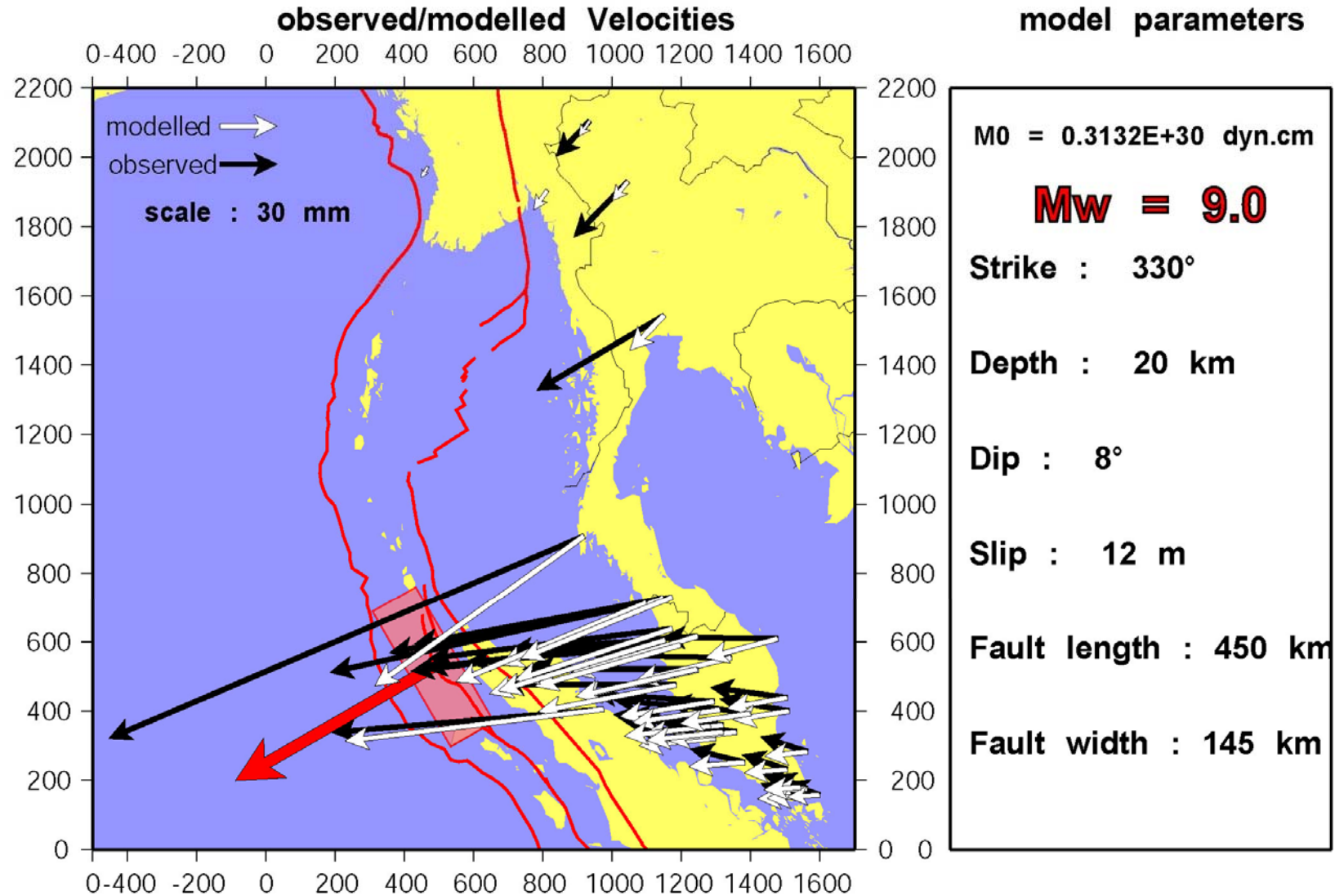
**Co-seismic steps are visible in daily time-series and define a very long**



**North**

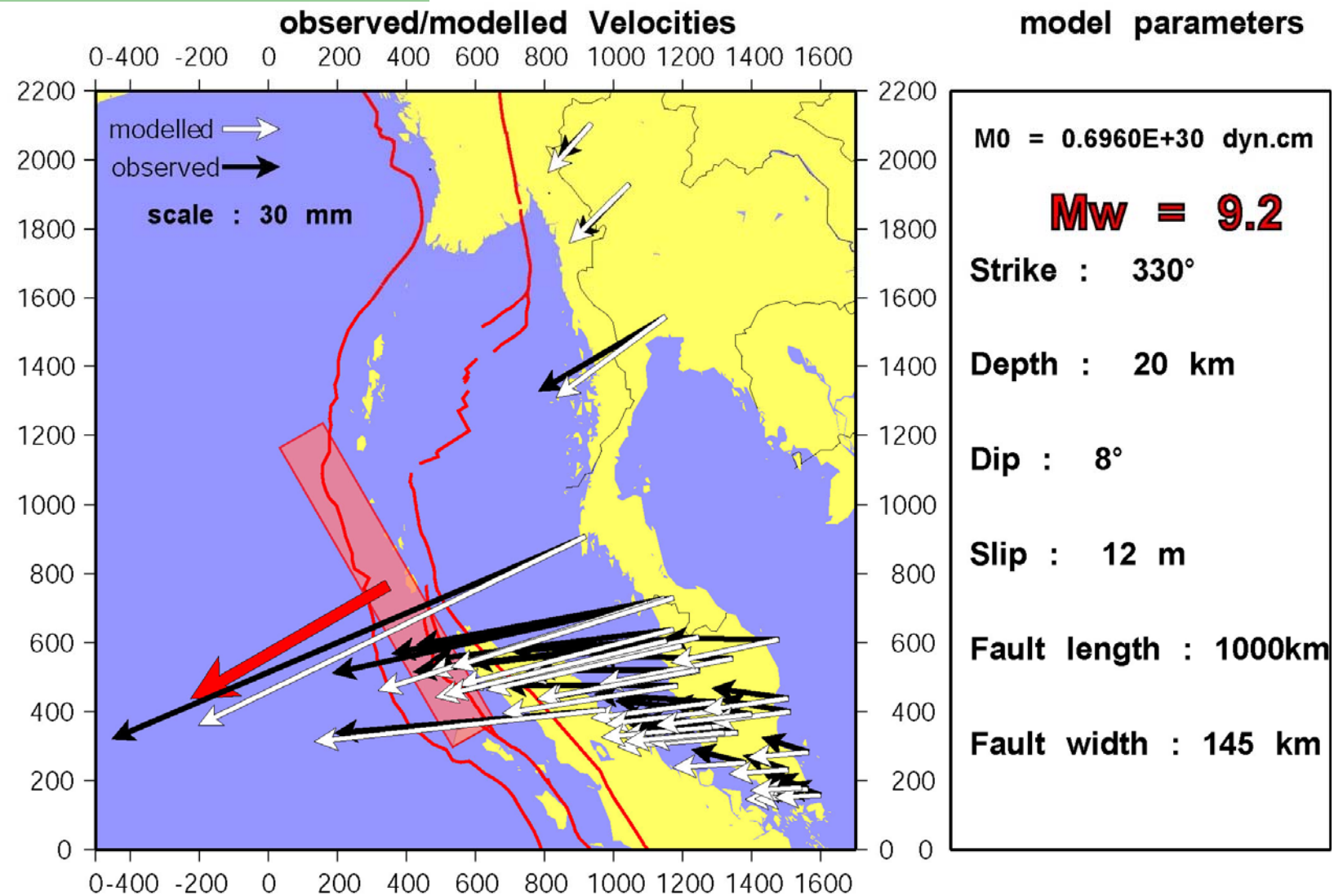


**S course** 345 350 355 360 365 370 375

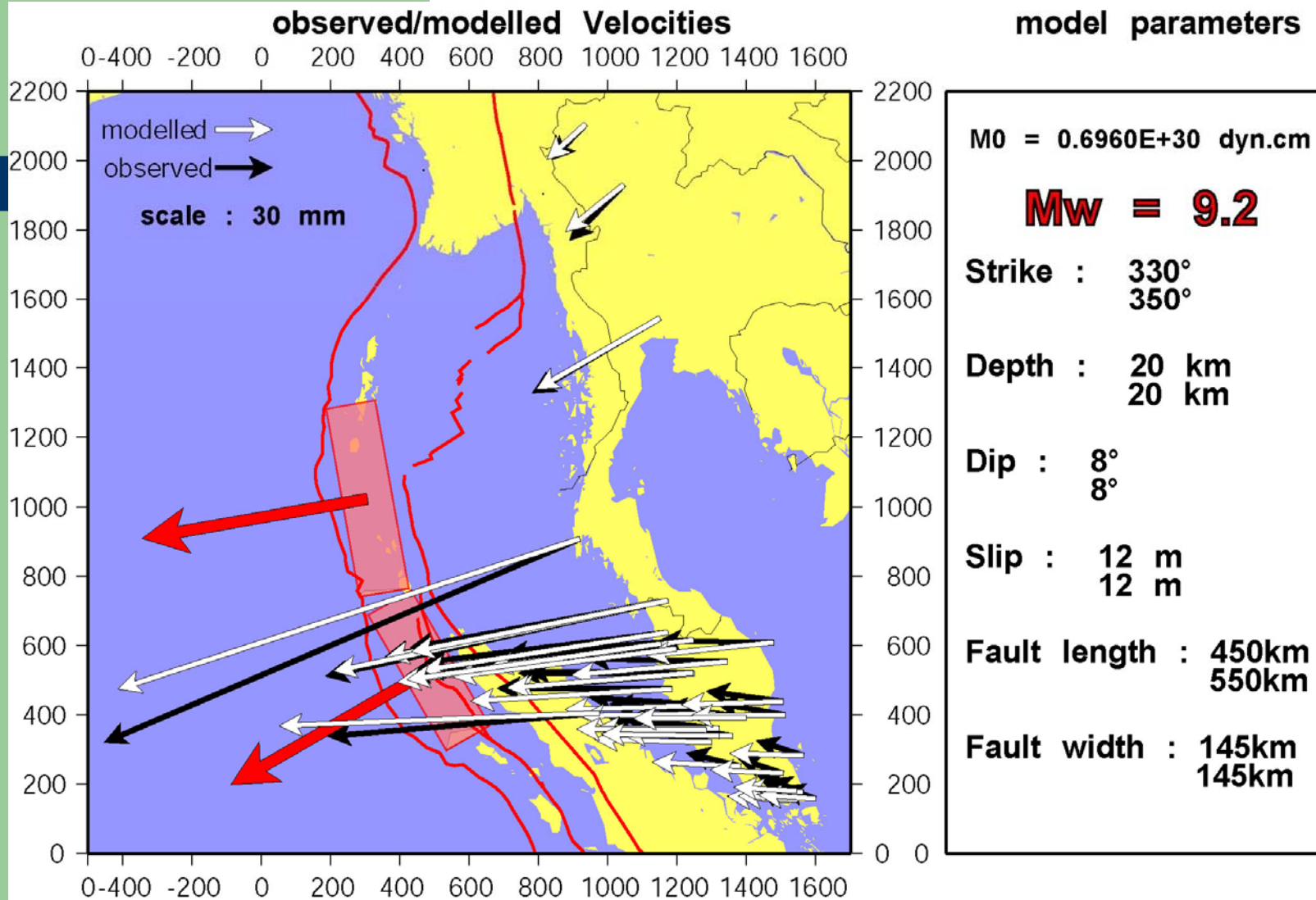


**A rupture of 450 km length gives the reported magnitude ( $M_w=9.0$ )  
but it does not fit the observed deformation**



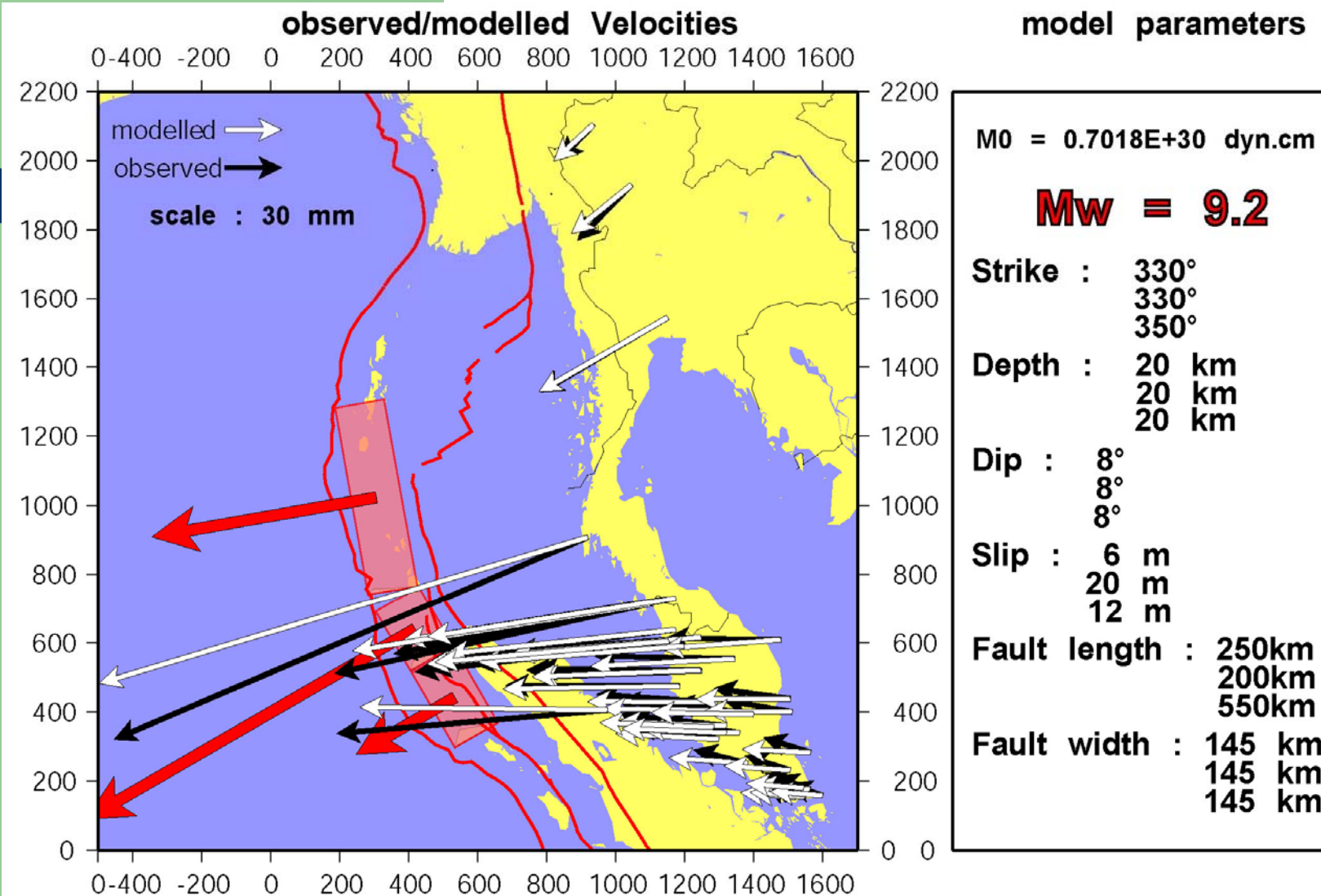


**A rupture of 1000 km length is required to fit far field deformation  
it corresponds to a larger magnitude  $M_w=9.2$**



**Curvature of the trench must be taken into account to fit observed directions in Northern Malaysia**

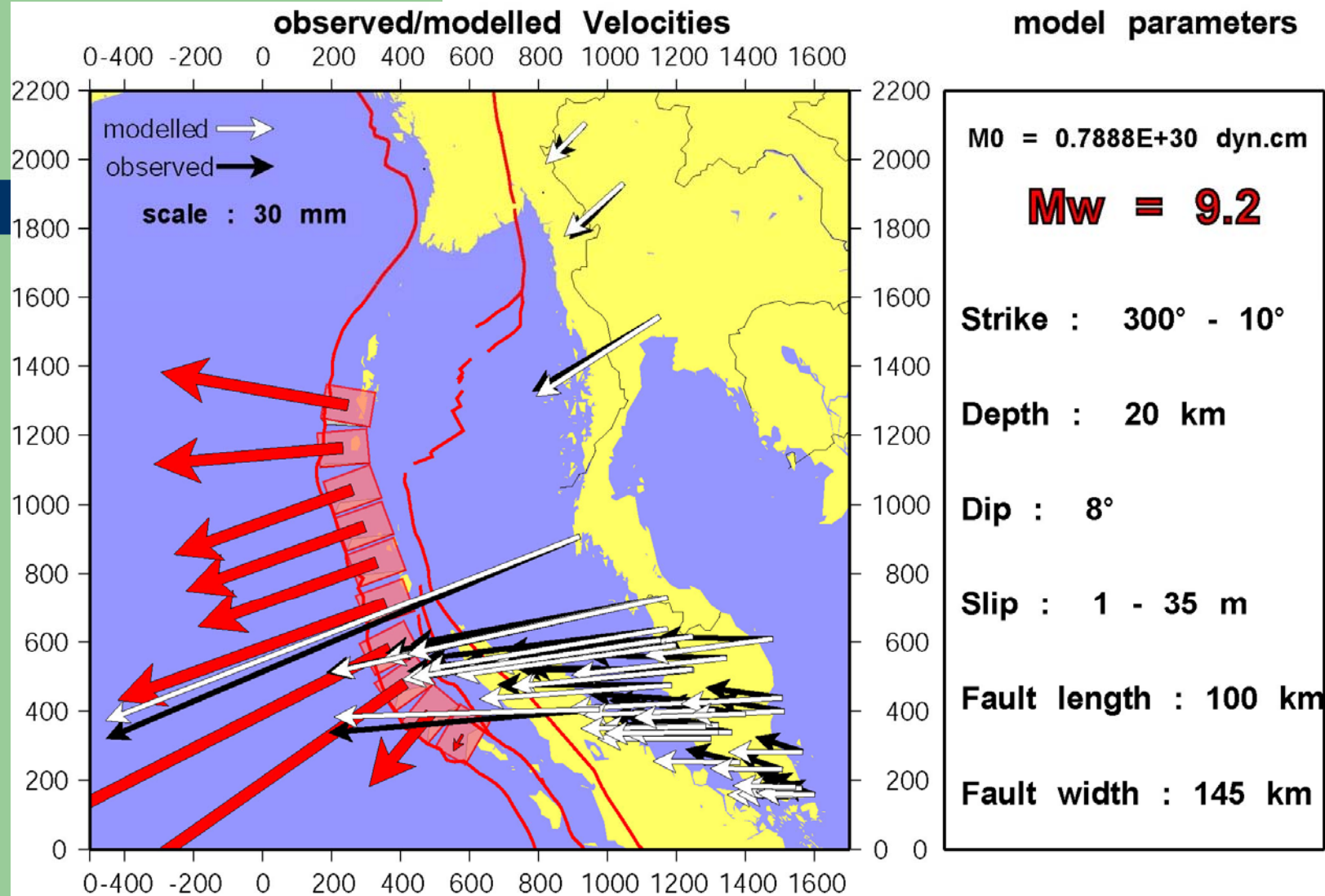




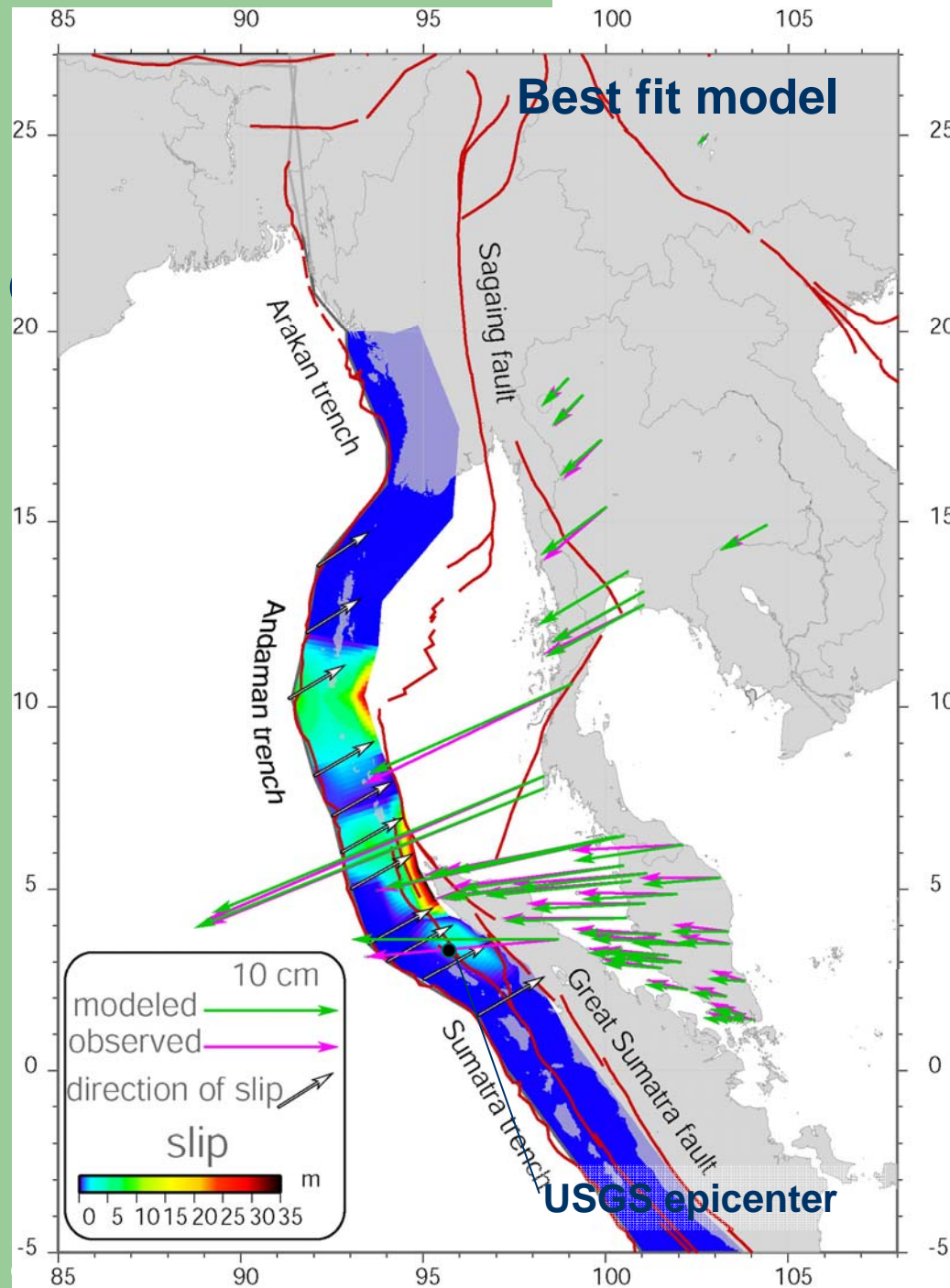
**Non-uniform slip is required on the southern section of the rupture to fit the intense gradient along Malaysia**







**Non-uniform slip + trench curvature give good fit. However, very small deformation in Southern Malaysia request the high slip patch is confined to the shallow part of the rupture plane**



1/ rupture length = 1200 km

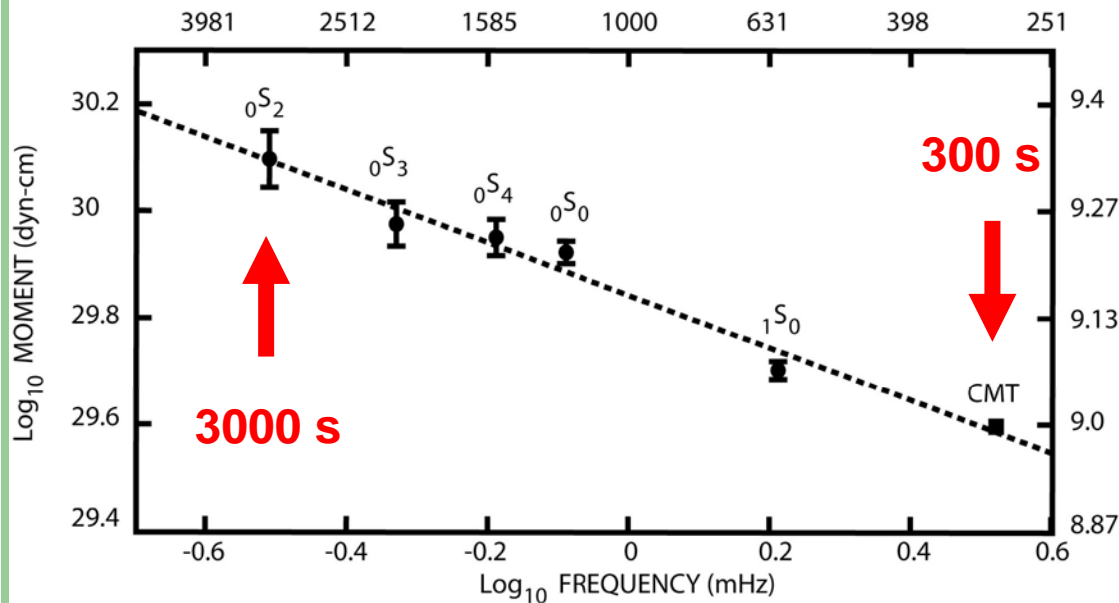
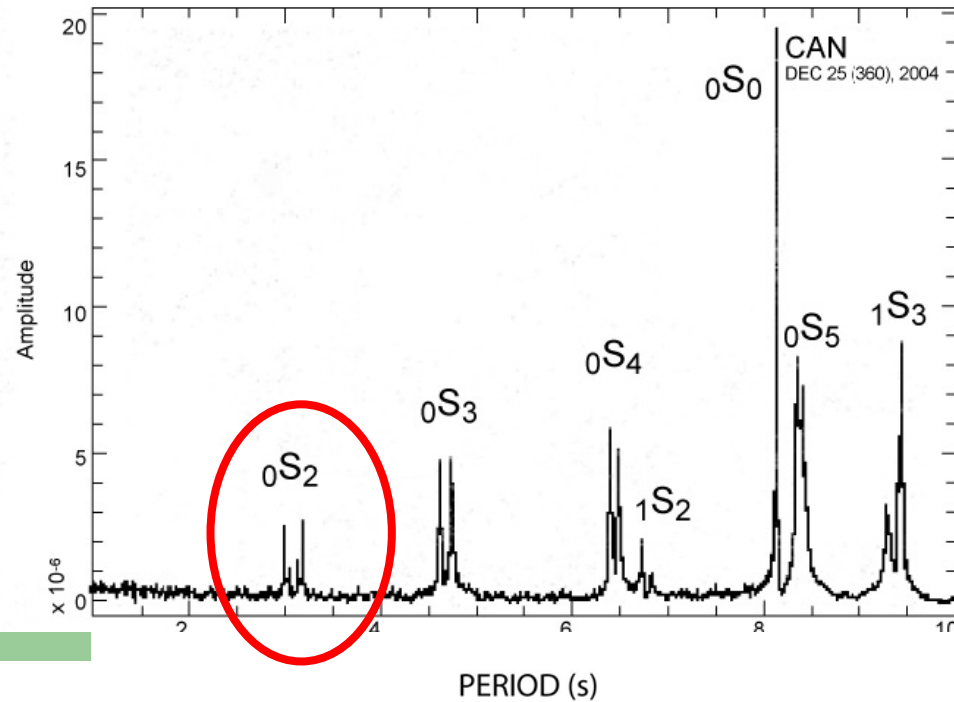
Northward propagation  
from the epicenter

2/ heterogeneous slip

- Almost no slip in the south
- Patch of very large slip at the northern tip of Sumatra (in front of Phuket), 200 km north of the epicenter
- Hardly any slip around 7° North

3/ deep slip

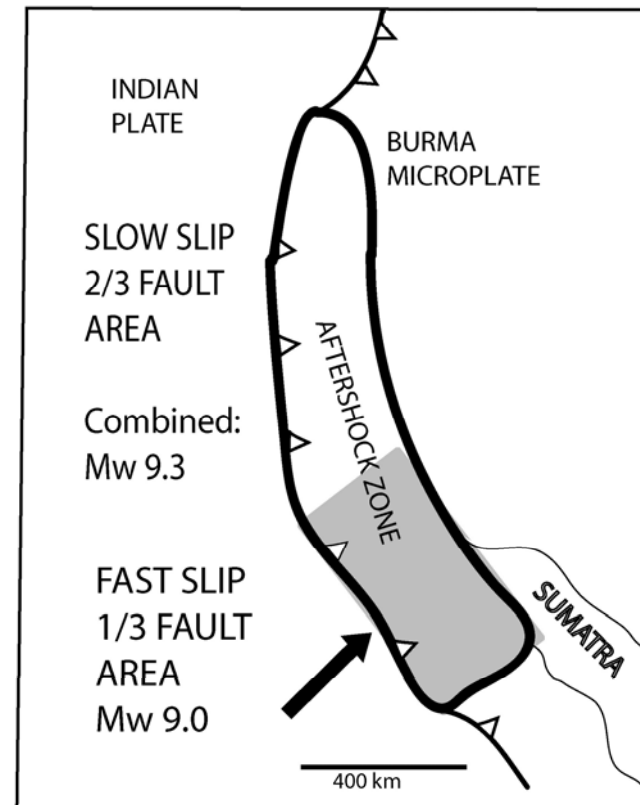


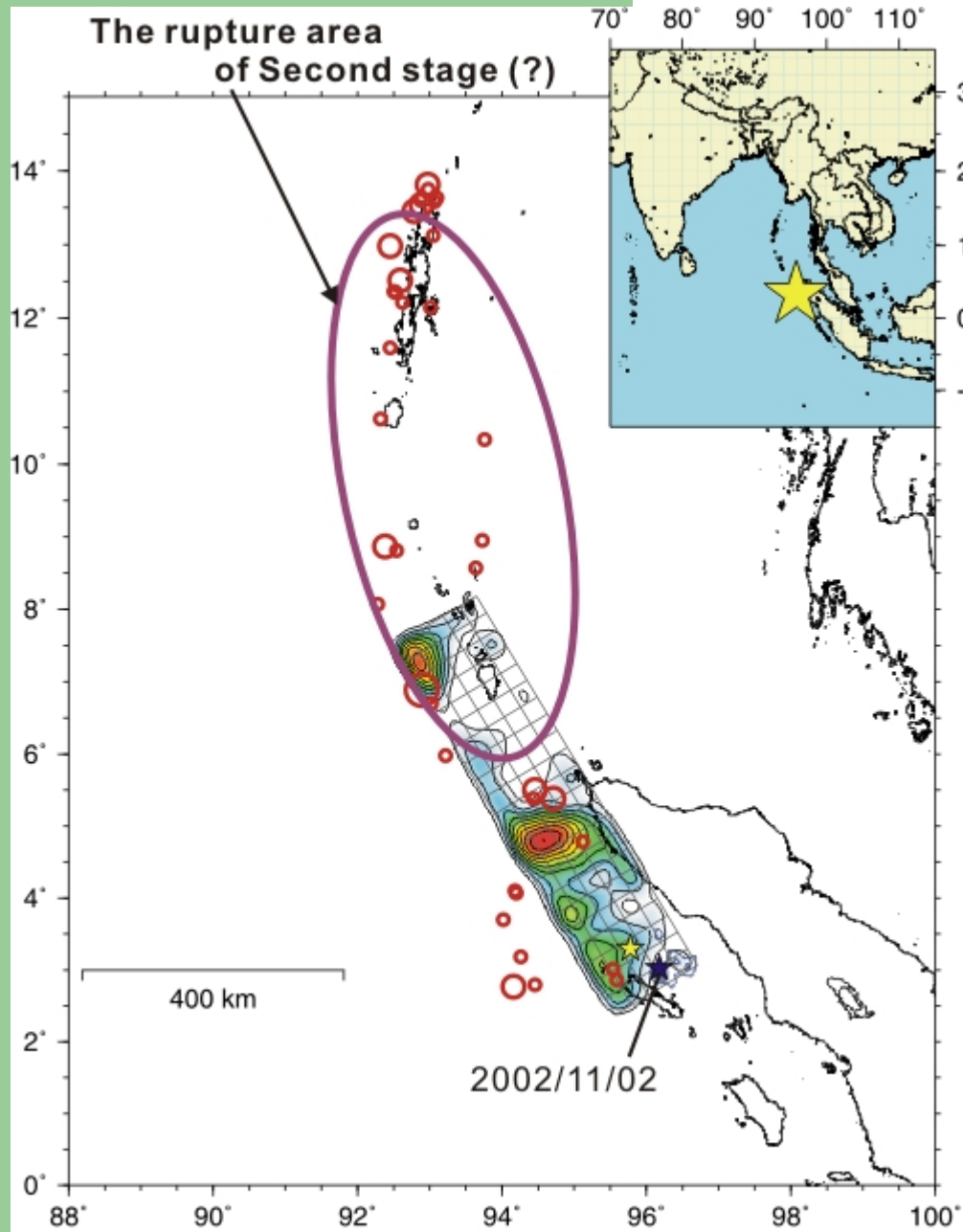


Study of the very low frequencies Earth free oscillations leads to a revised Magnitude

**Mw=9.3**

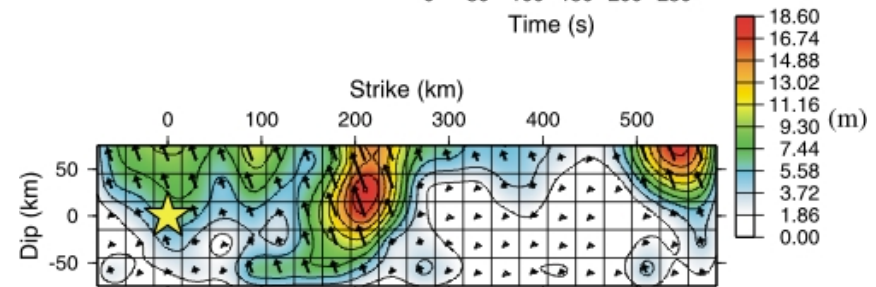
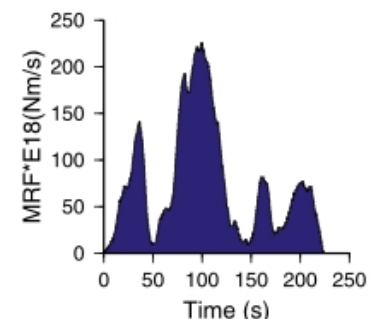
E. Okal, NW Univ. USA





**Inversion of body waves cannot “see” the long rupture but also detect a [redacted] p, with a patch of very high slip (>20 m) 200 km North of the epicenter**

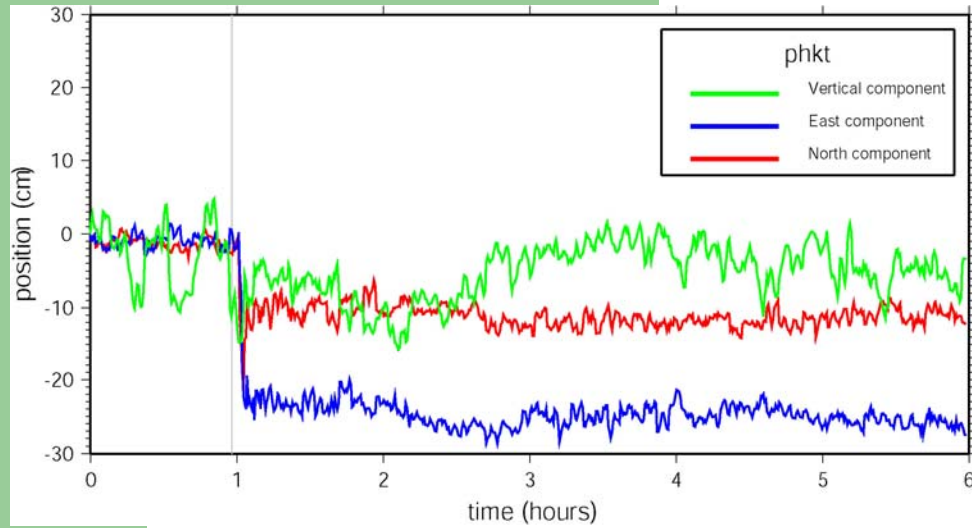
**OFF W COAST OF NORTHERN SUMATRA**  
 Moment = 0.1621E+23(Nm), Mw = 8.7  
 (Strike,Dip,Slip) = (329.0, 10.0, 110.0)



Yagi@IISEE, BRI

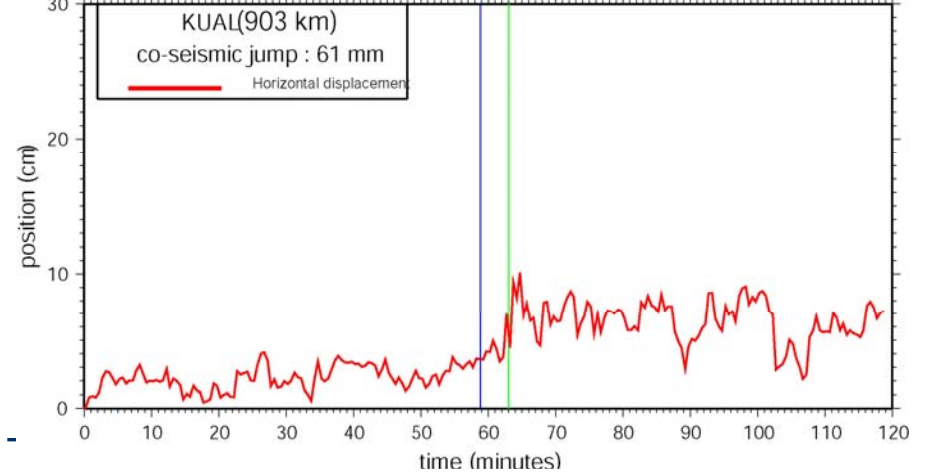
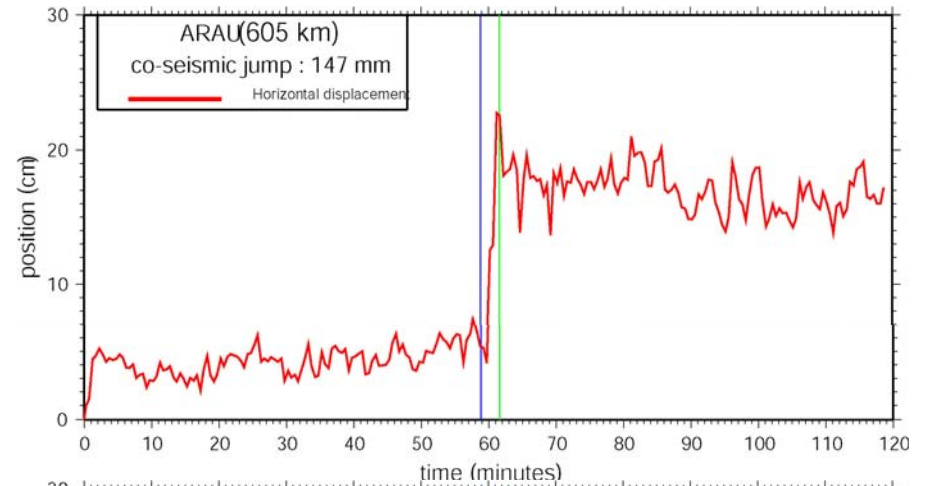
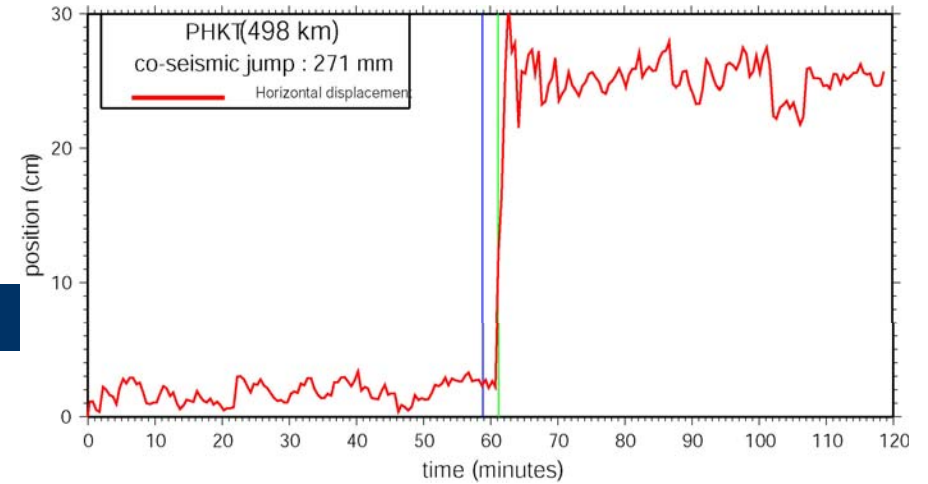
Yagi@IISEE, BRI

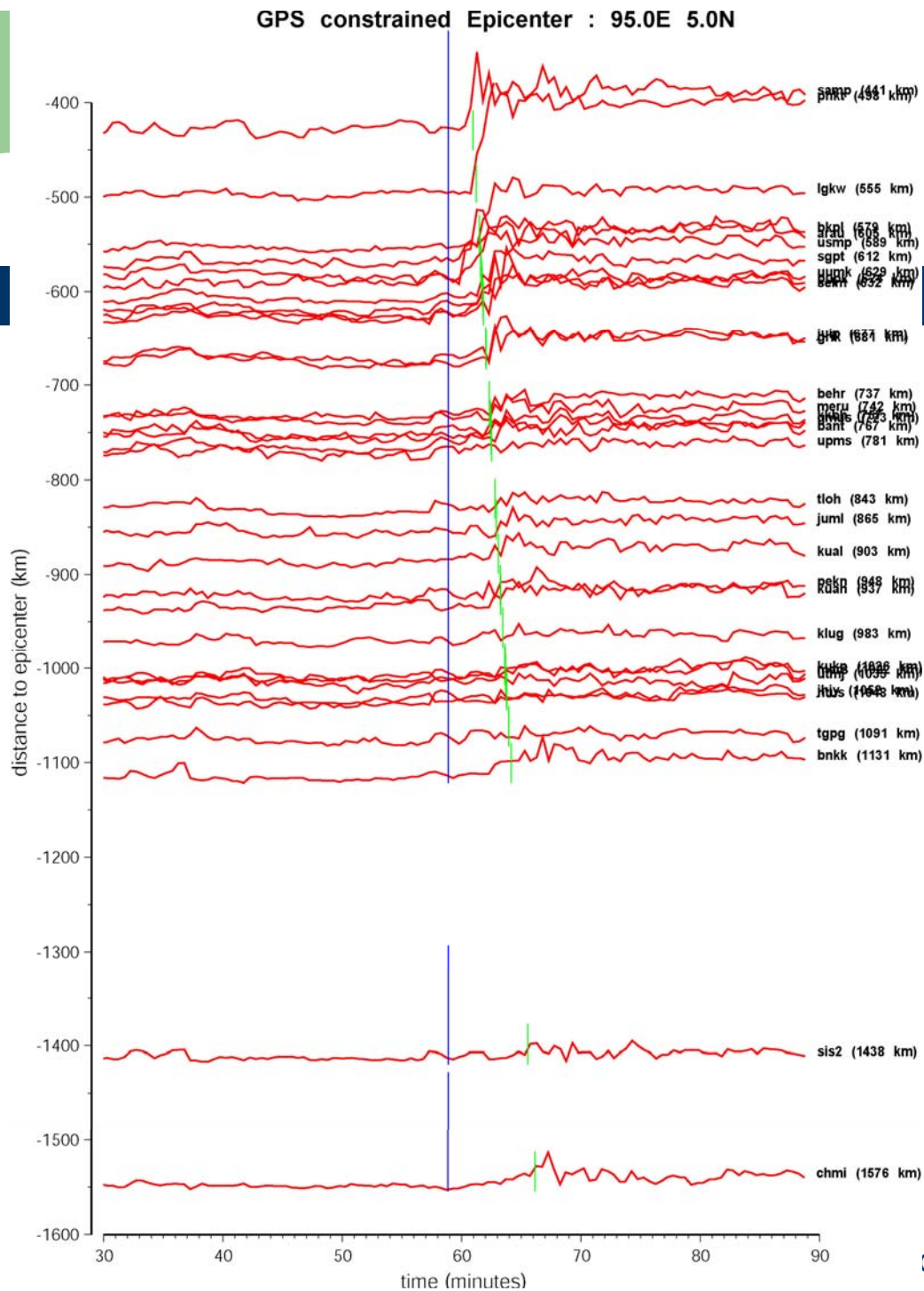




**“Kinematic” (epoch-per-epoch) positioning of the GPS station show the co-seismic step...**

**...and allow to determine the seismic wave arrival time**



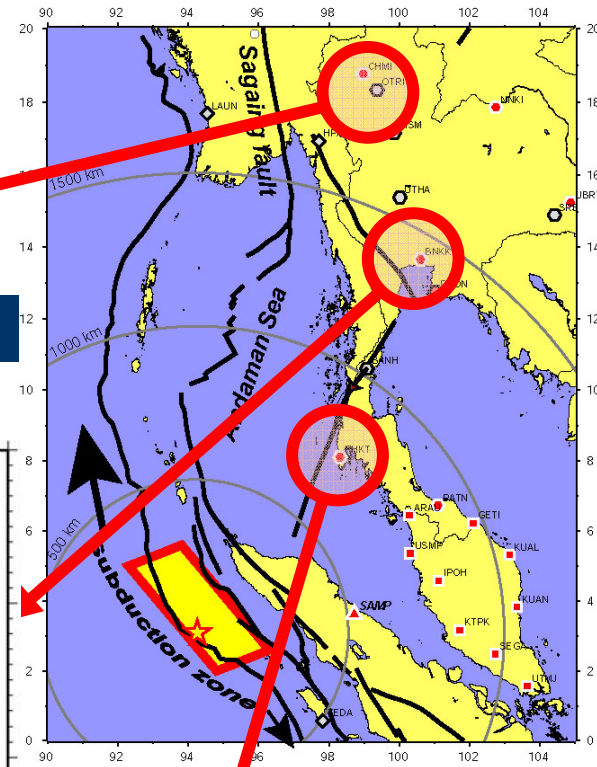
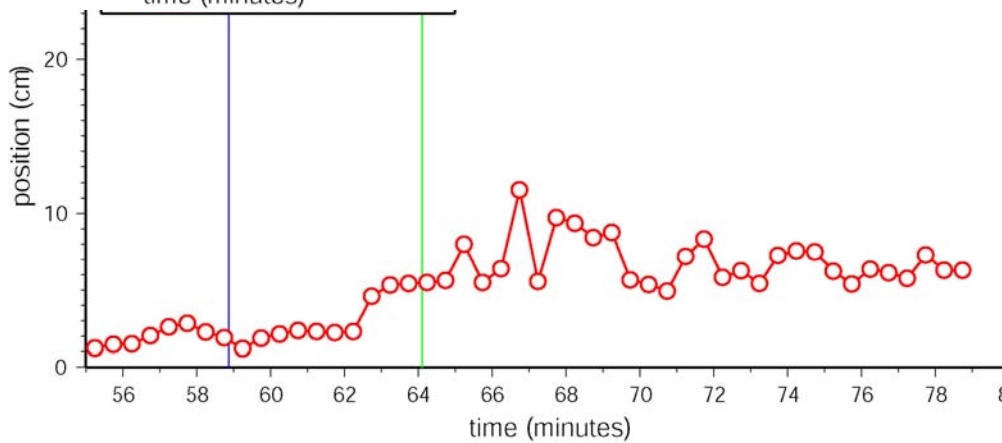
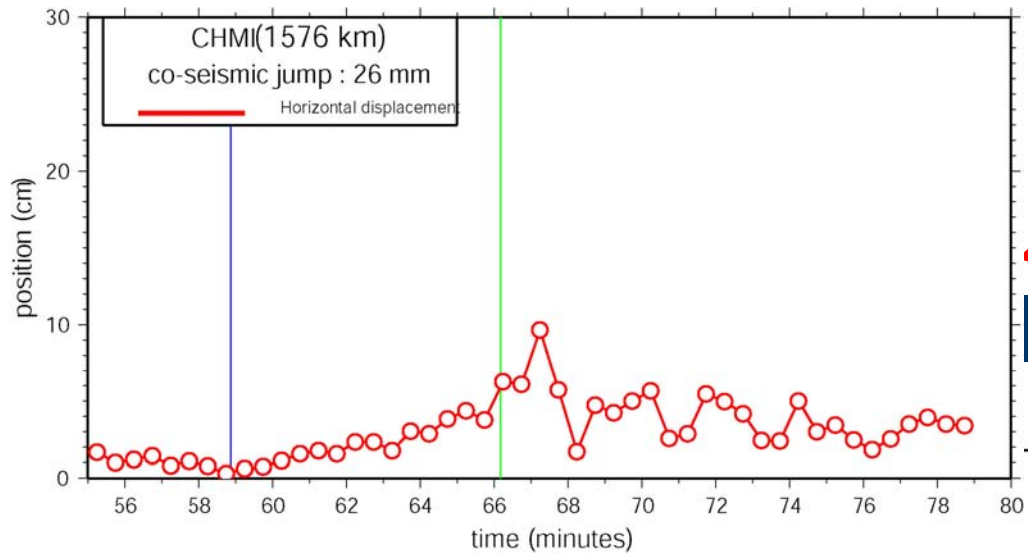


Assuming a  
velocity of 3.6  
km/s for seismic  
waves

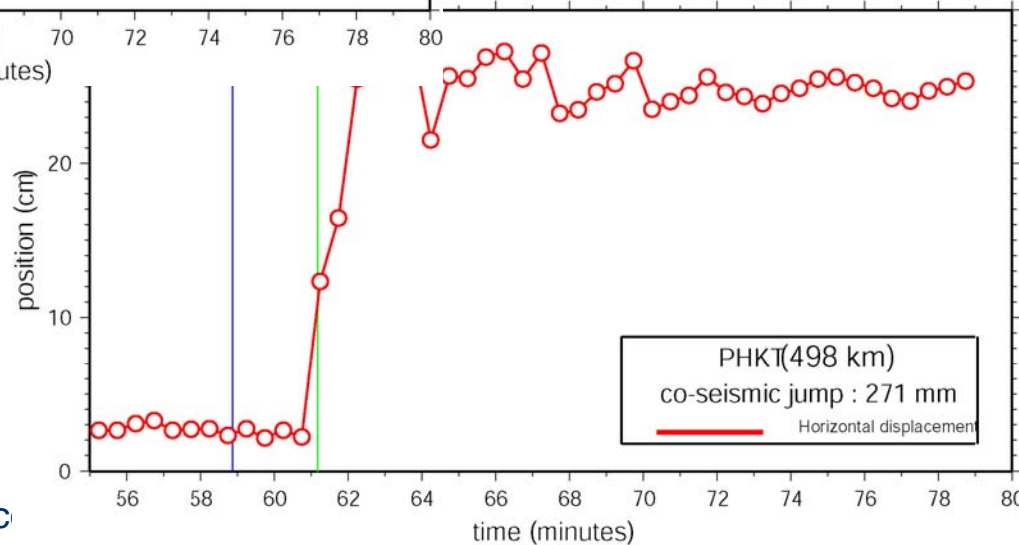
relocation of the  
source of the  
seismic energy is  
needed to match  
and sort arrival  
times at stations

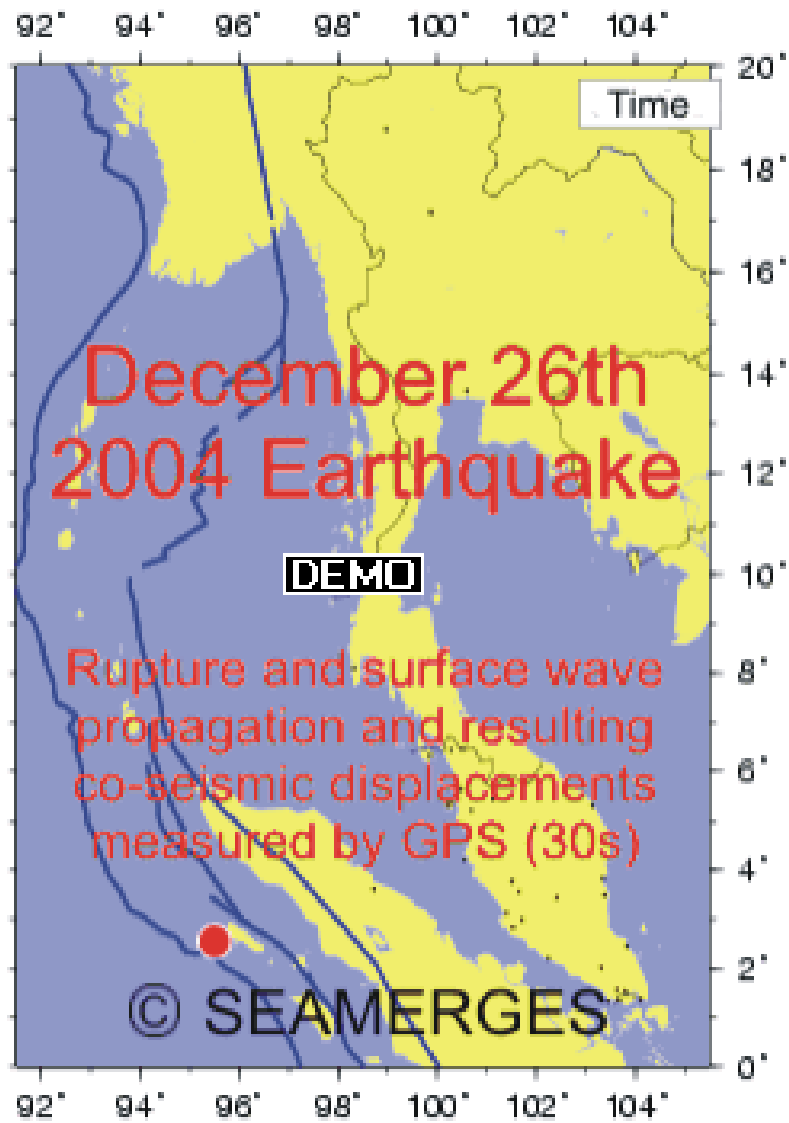
Again, a  
relocation of 200  
km to the north is  
requested





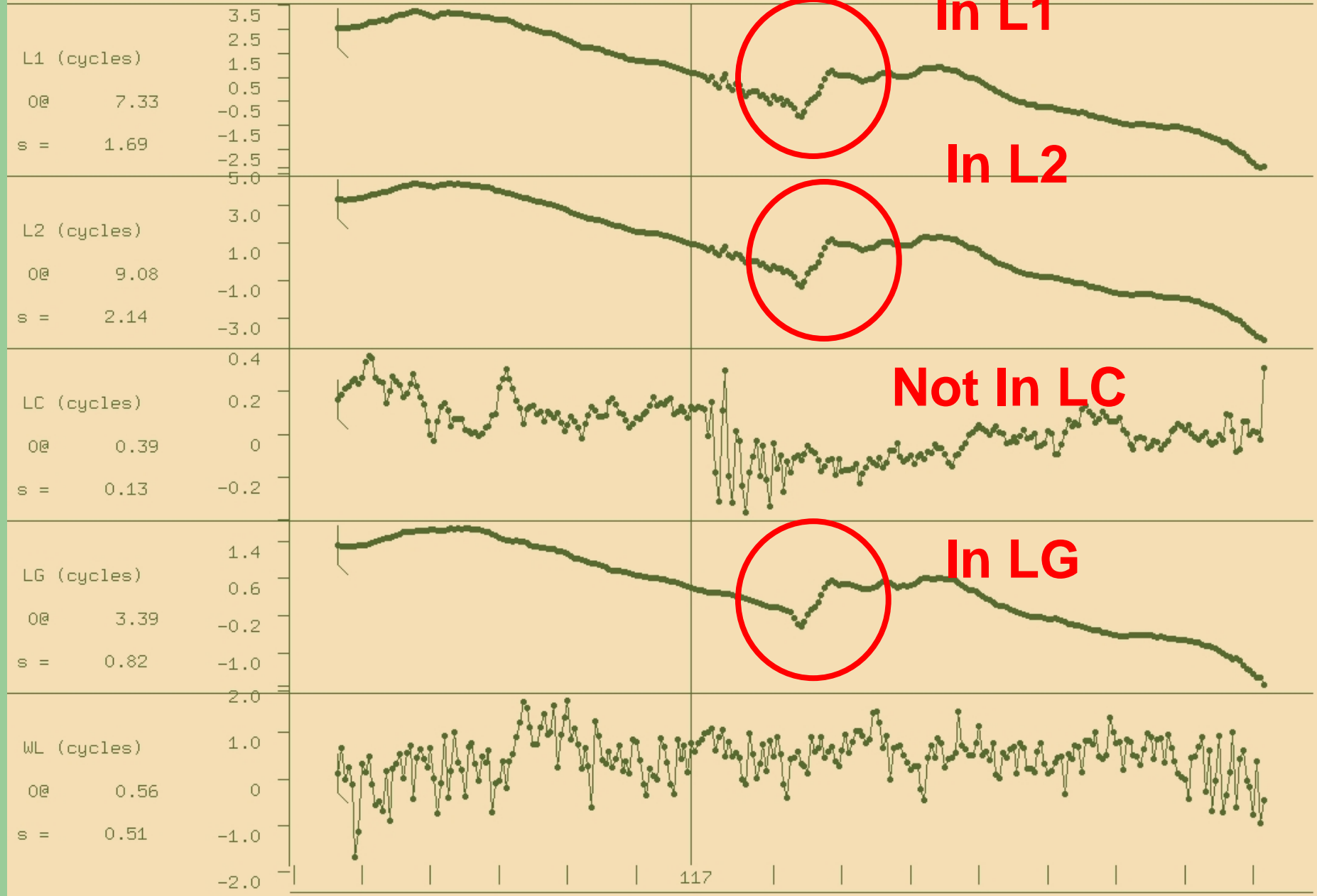
Indication of source directivity is pointed by the fact that the further away from the epicenter the longer it takes for the station to reach its final co-seismic position....This indicates a very slow rupture propagation

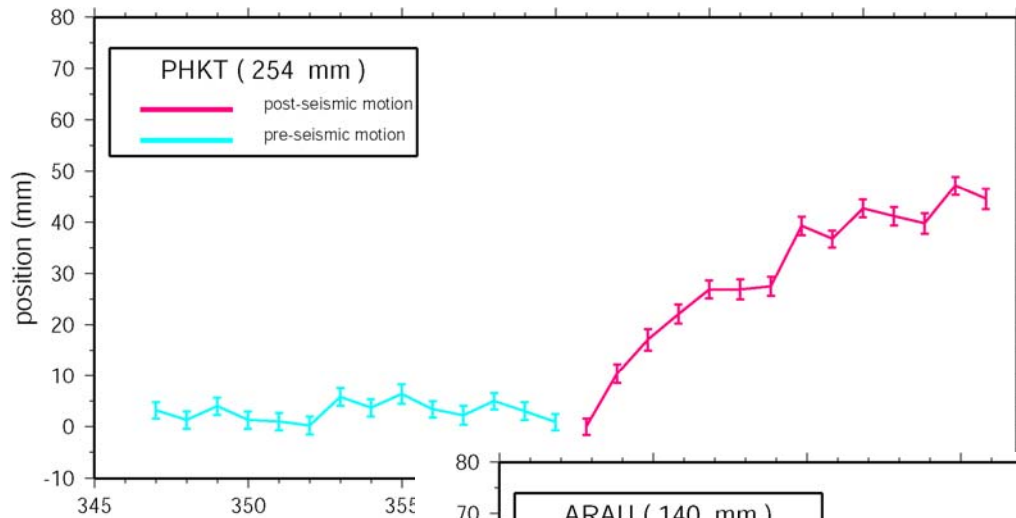




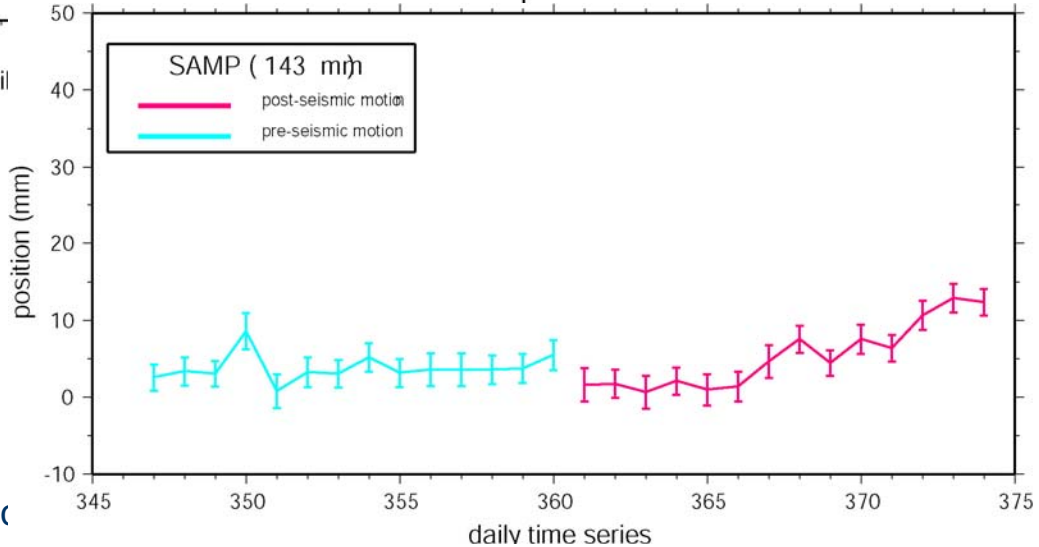
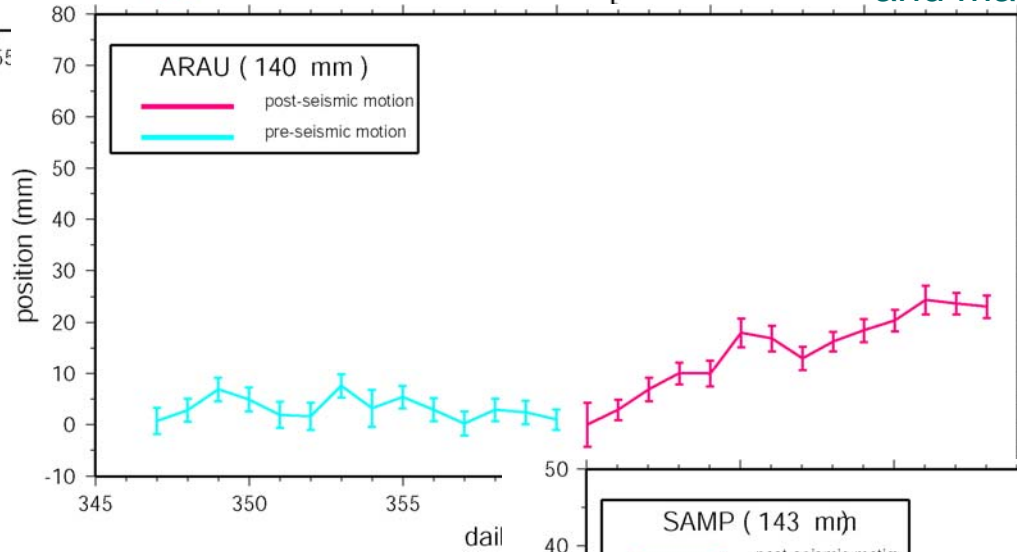
<http://www.deos.tudelft.nl/seamerges>







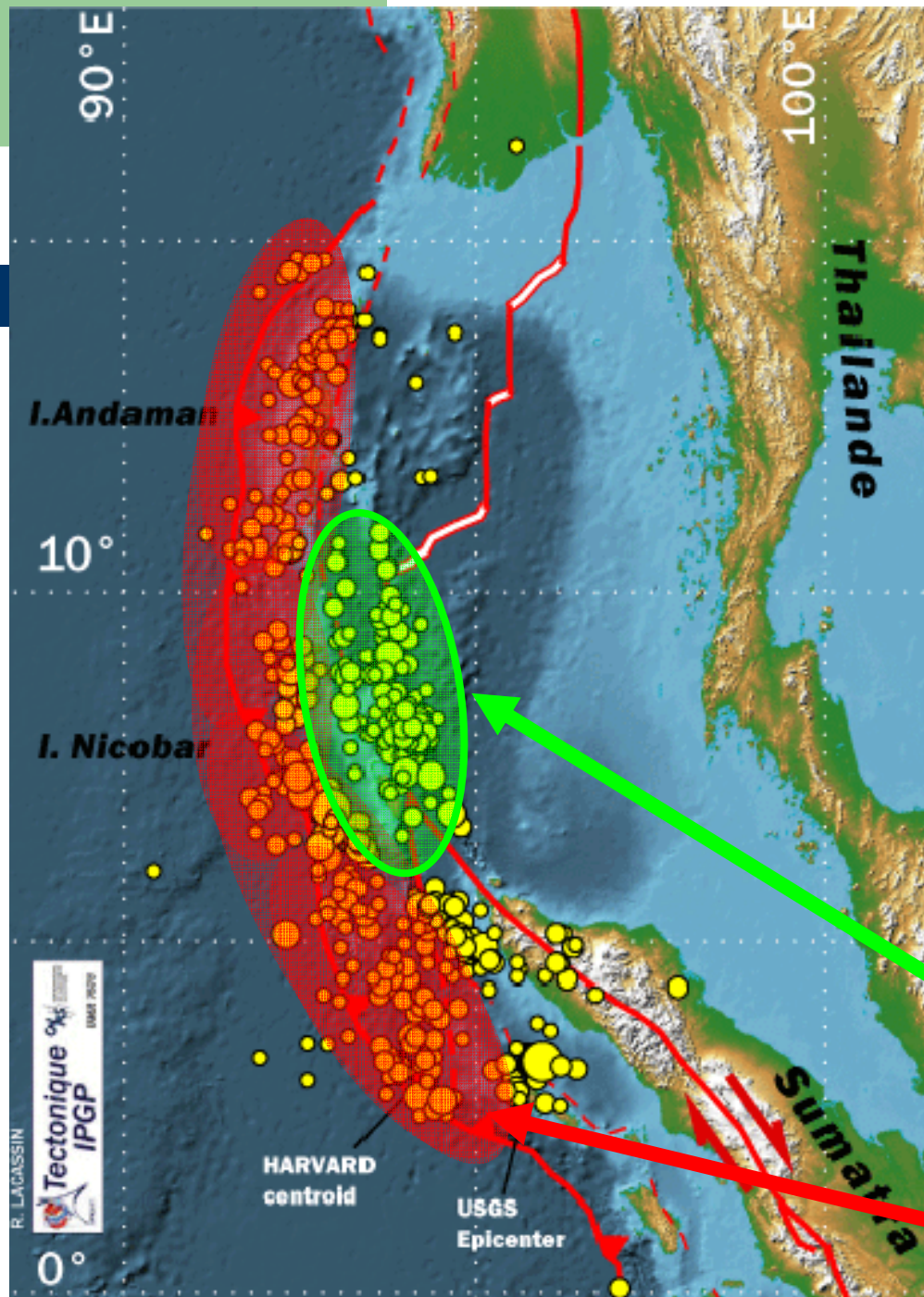
No pre-seismic motion was detected.  
 Post Seismic deformation will go on for years ... and may be for decades





The aftershocks distribution shows :

- The rupture
- The northern tip of the Andaman basin
- The strike slip faults "behind" the subduction were activated in the Andaman basin



Strike-Slip aftershocks

Thrust aftershocks

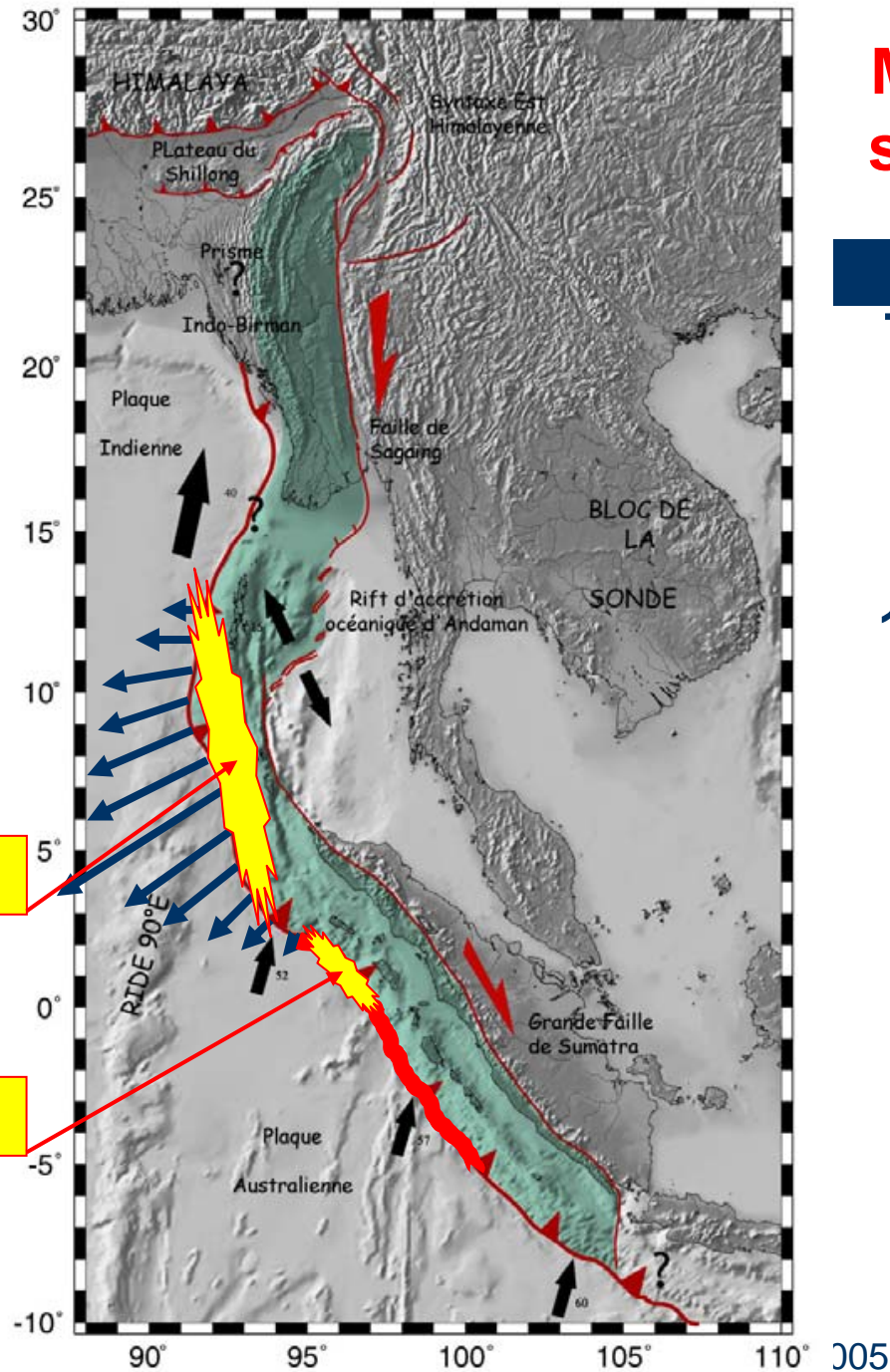
## Modification of seismic hazard in the area

There is a higher risk of a near future events in the vicinity

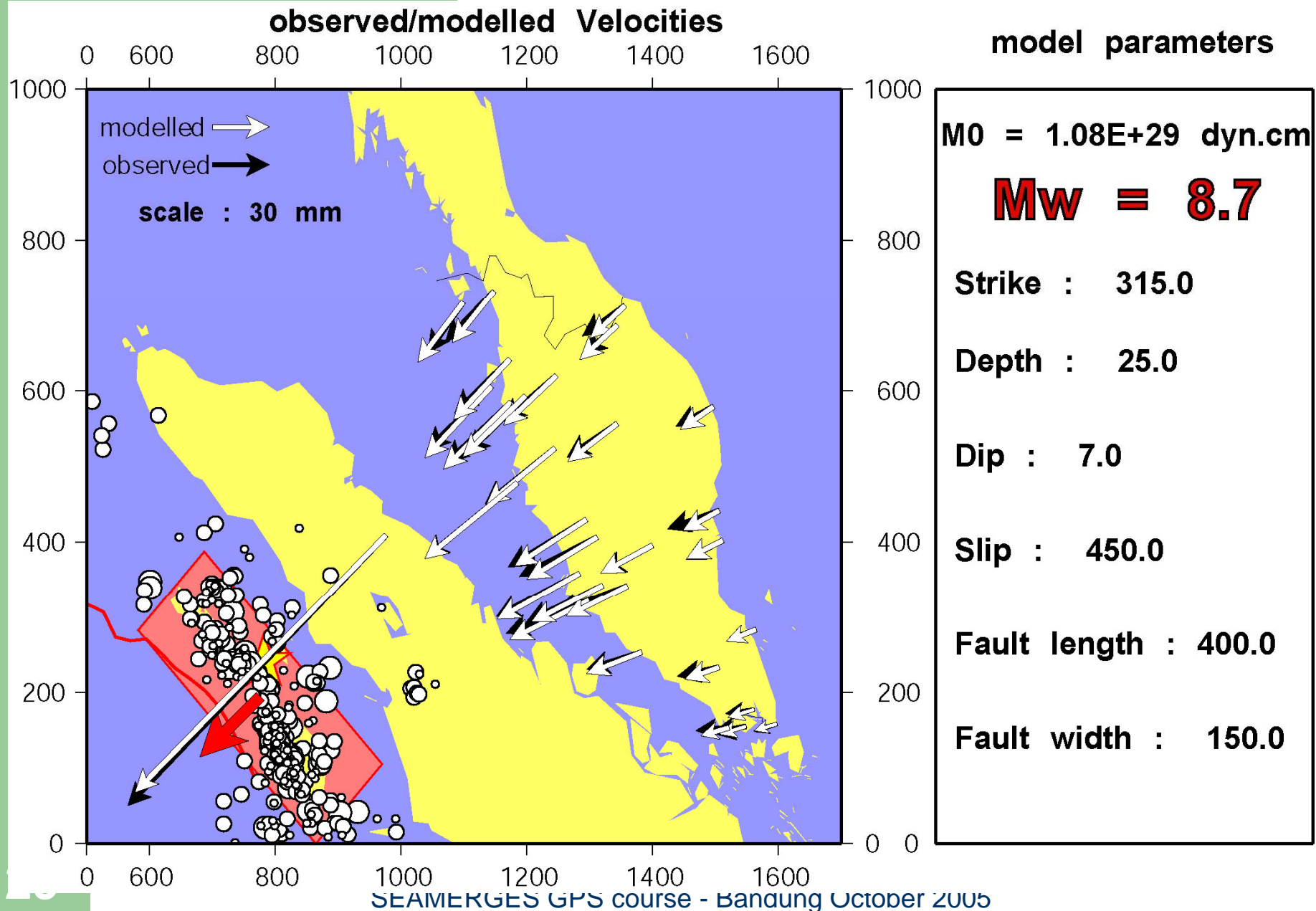
1/ further South on the subduction

26 December 2004

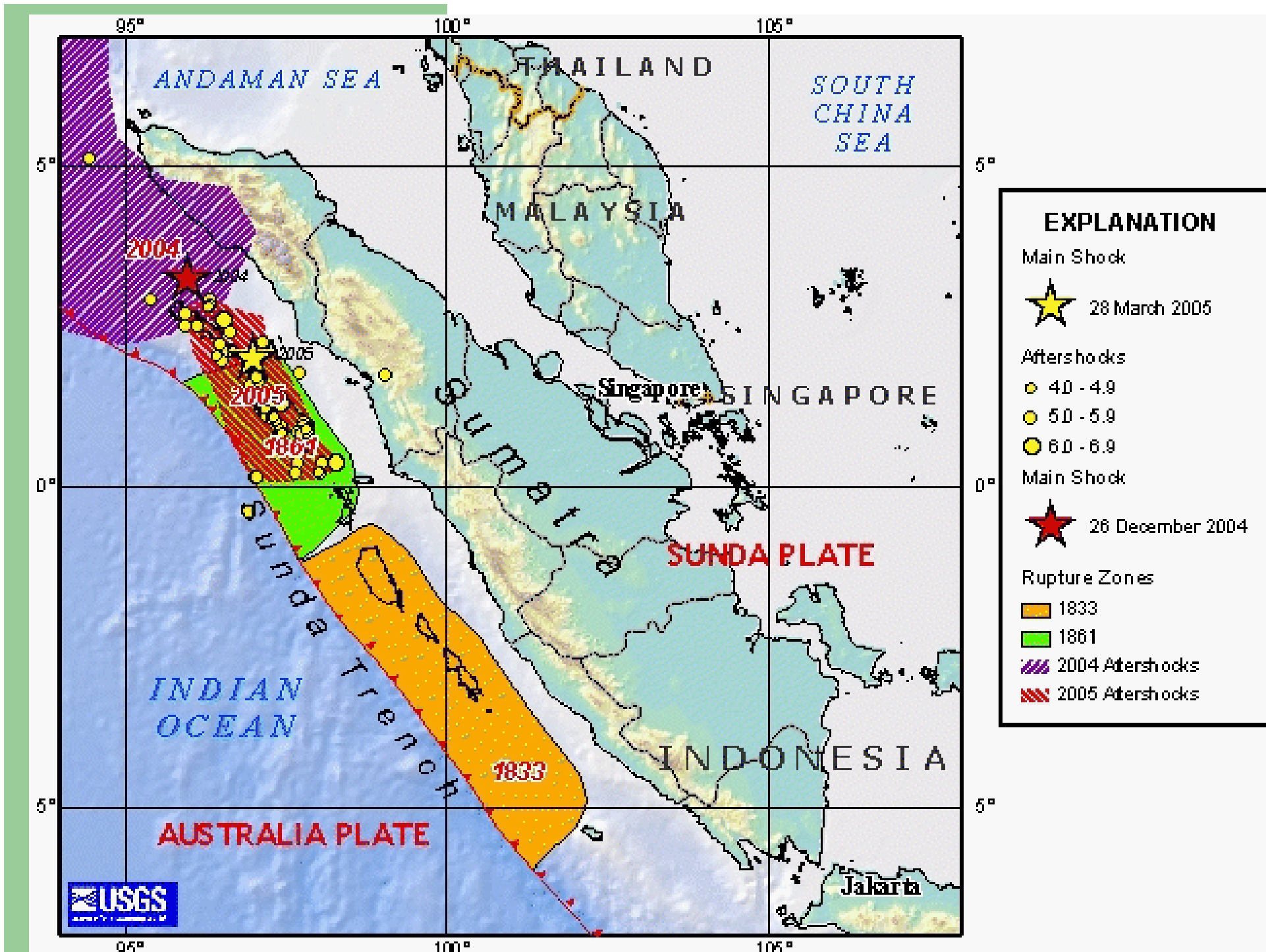
28 March 2005



# Nias Earthquake of March 28th







## Modification of seismic hazard in the area

There is a higher risk of a near future event

1/ further South on the subduction

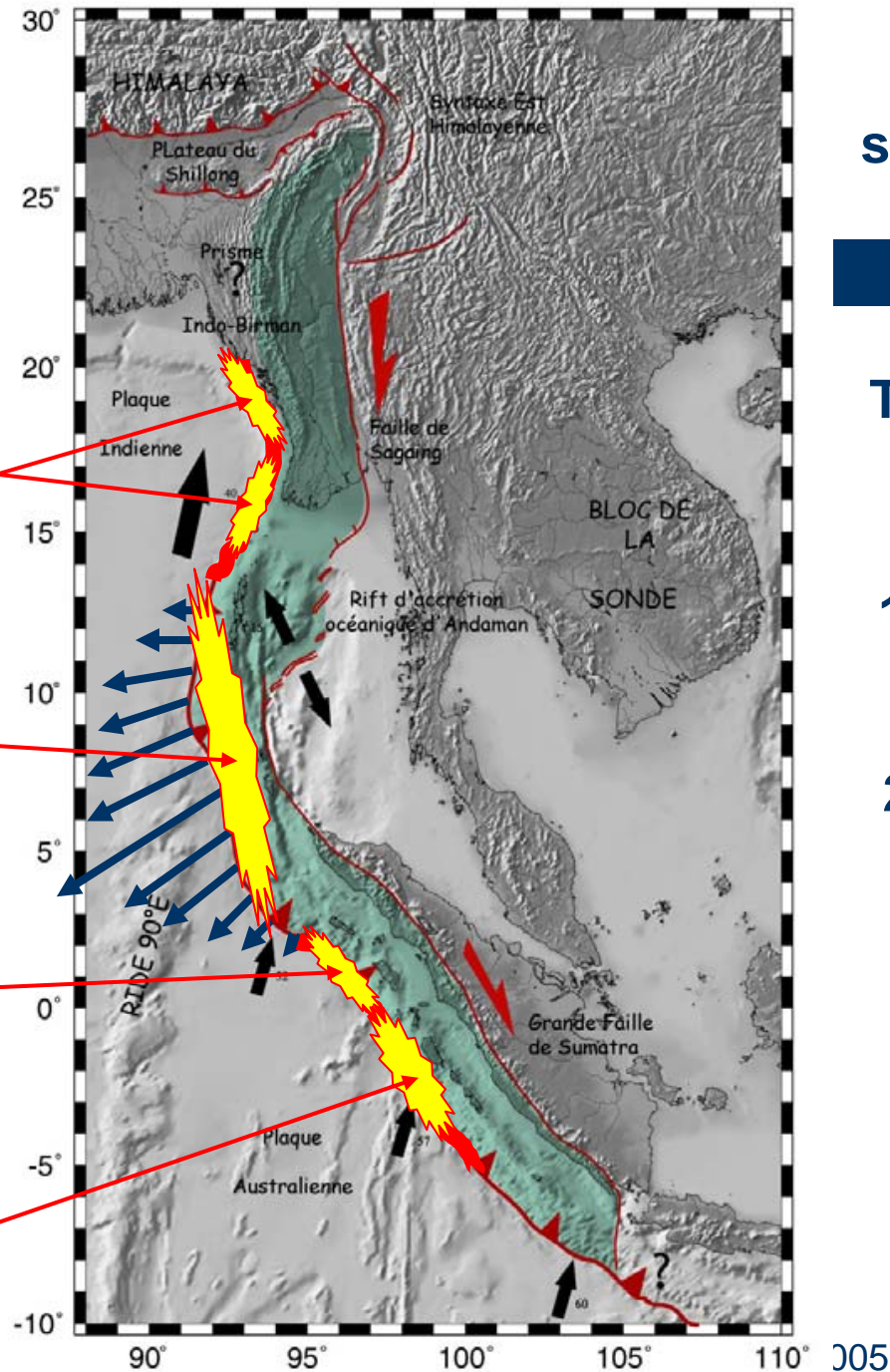
2/ further North on the subduction

1 big or 2 small ?

26 December 2004  
Mw 9.2

28 March 2005  
Mw 8.7

When ?  
Mw 9 ?







## Modification of seismic hazard in the area

There is a higher risk of a near future event

1/ further South on the subduction

2/ further North on the subduction

3/ on the Great Sumatran Fault

4/ on the Sagaing fault

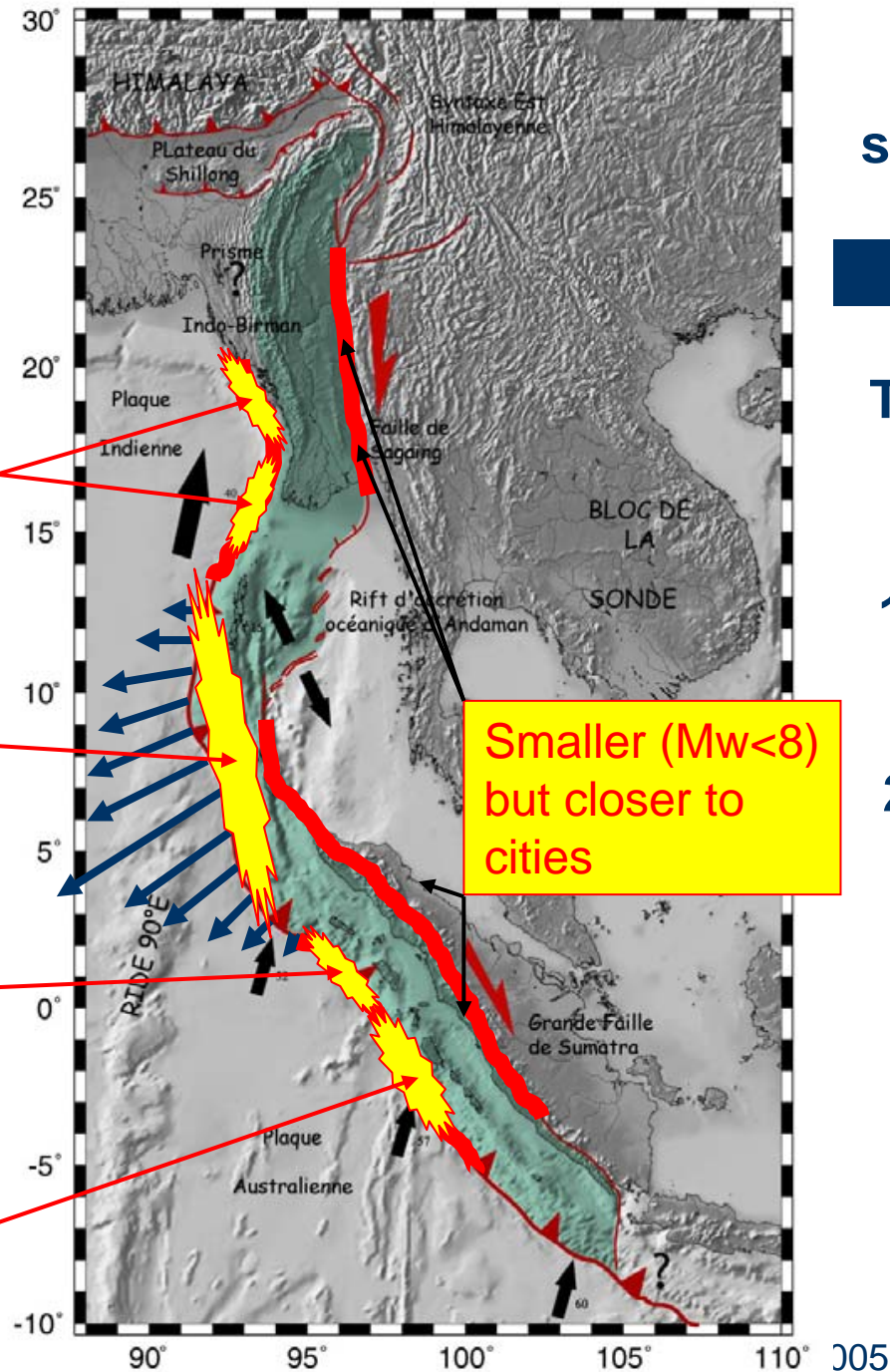
1 big or 2 small ?

26 December 2004  
Mw 9.2

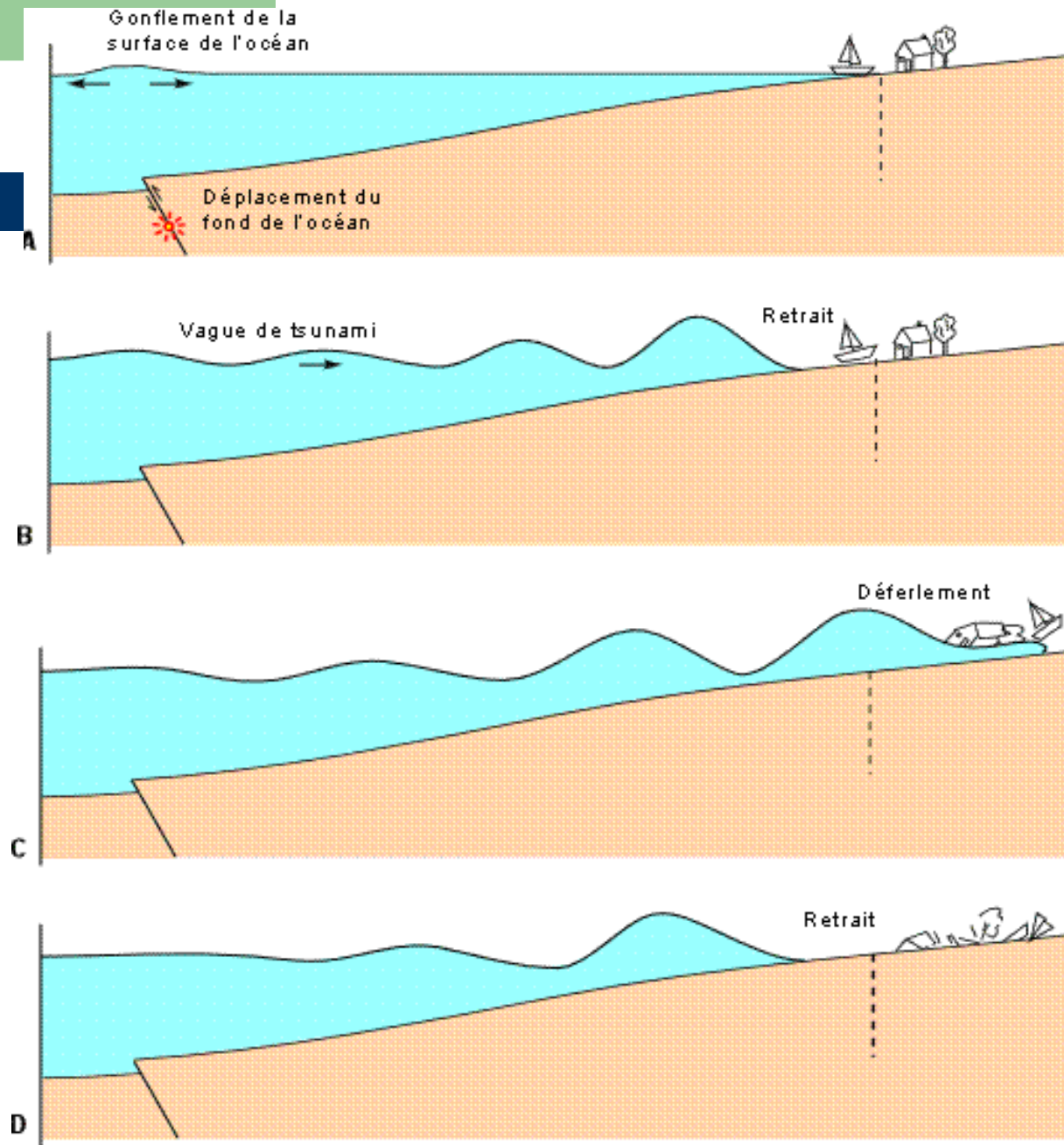
28 March 2005  
Mw 8.7

When ?  
Mw 9 ?

Smaller (Mw<8)  
but closer to cities



# Pourquoi un Tsunami ?



2004 Sumatra Earthquake 300 min

