SnT2025 Conference

# Super-shear rupture and its interpretation for the 2025 Mw7.7 Mandalay, Myanmar Earthquake

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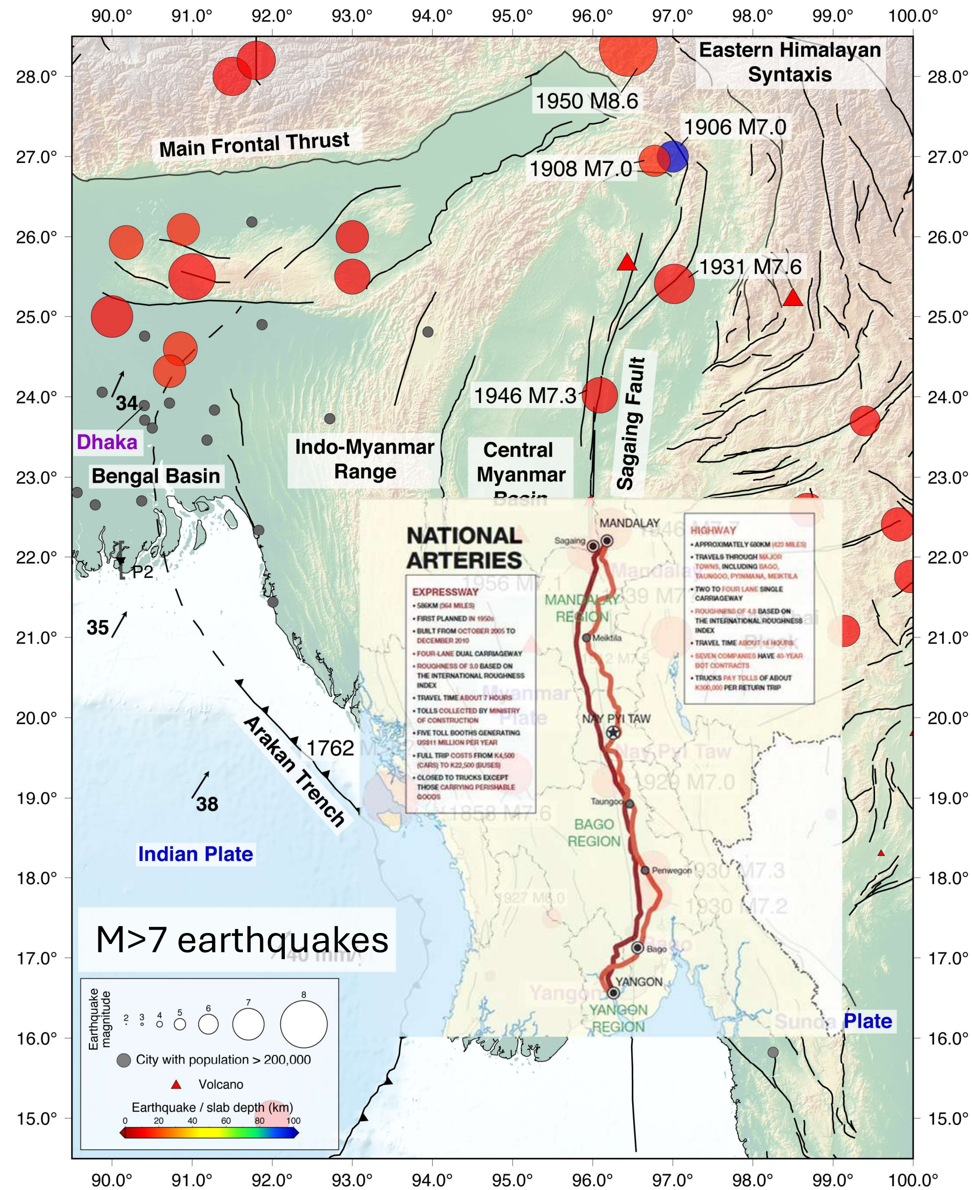
***Wei et al., 2025, Science, in revision***



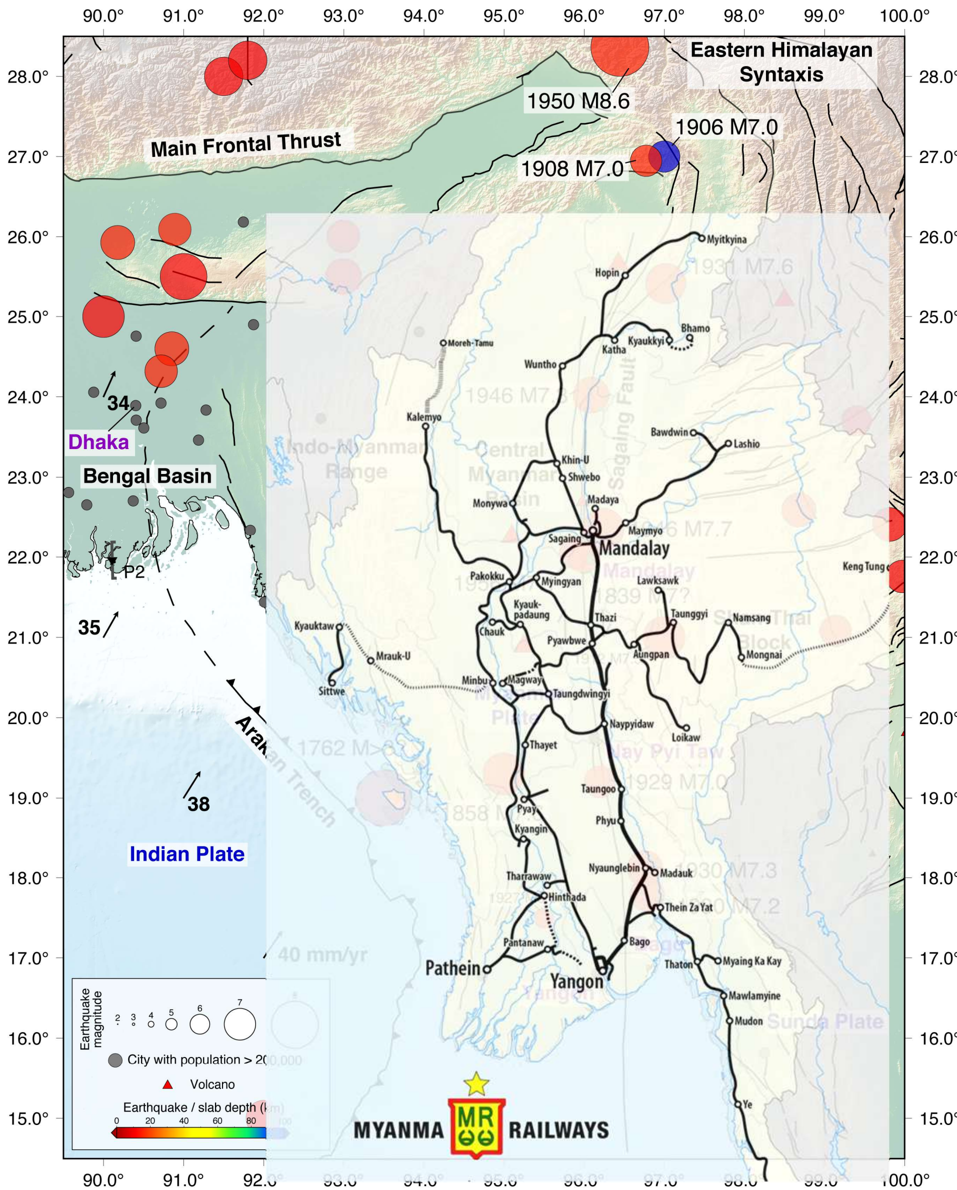

# Tectonics and seismic hazard in Myanmar

Myanmar population
~55 million

Densely populated cities
Yangon, Bago, Nay Pyi Taw,
Mandalay

Major infrastructure
highways, railways

Source: frontier-Myanmar.net



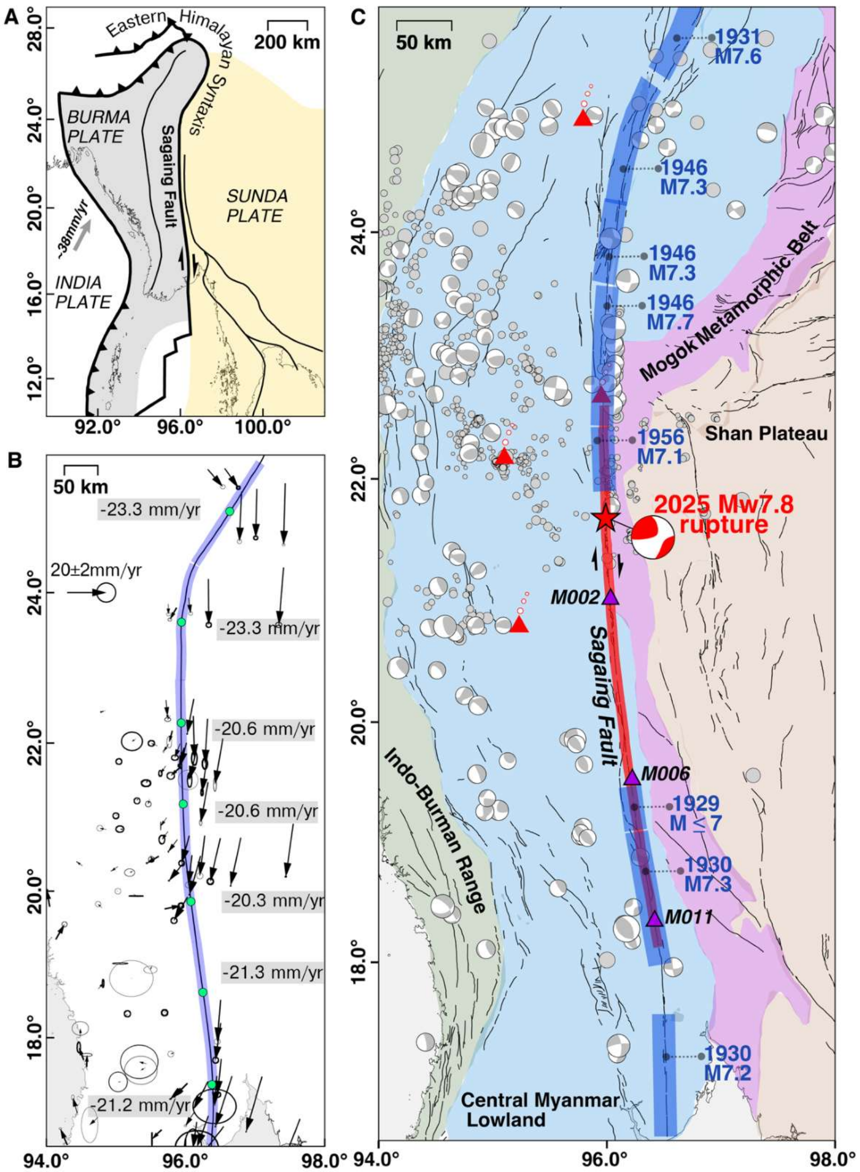

# Tectonics and seismic hazard in Myanmar

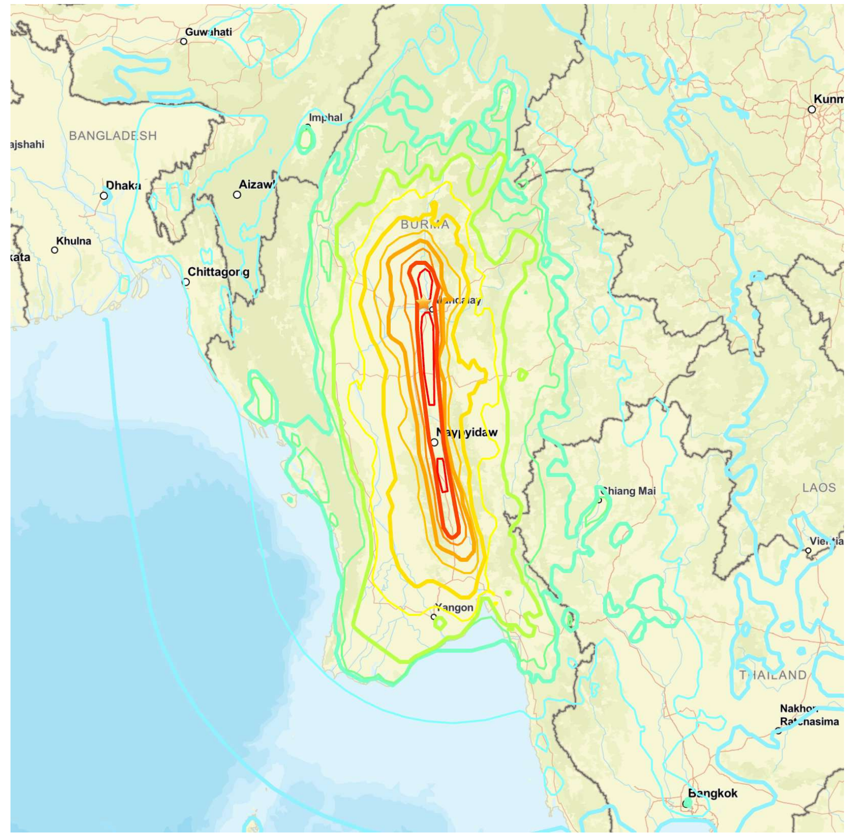
Myanmar population ~55 million

Densely populated cities Yangon, Bago, Nay Pyi Taw, Mandalay

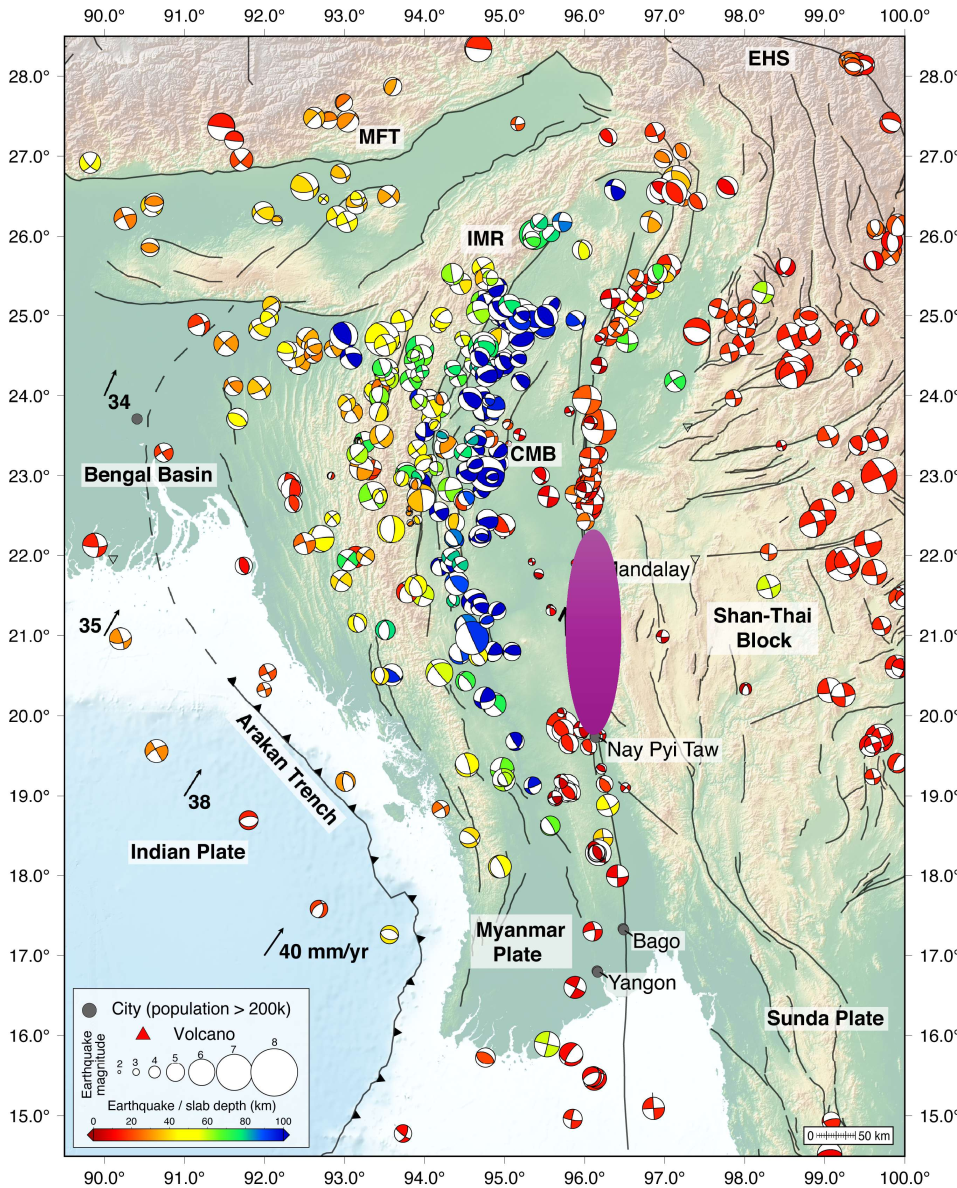
Major infrastructure highways, railways

# Background and tectonic settings



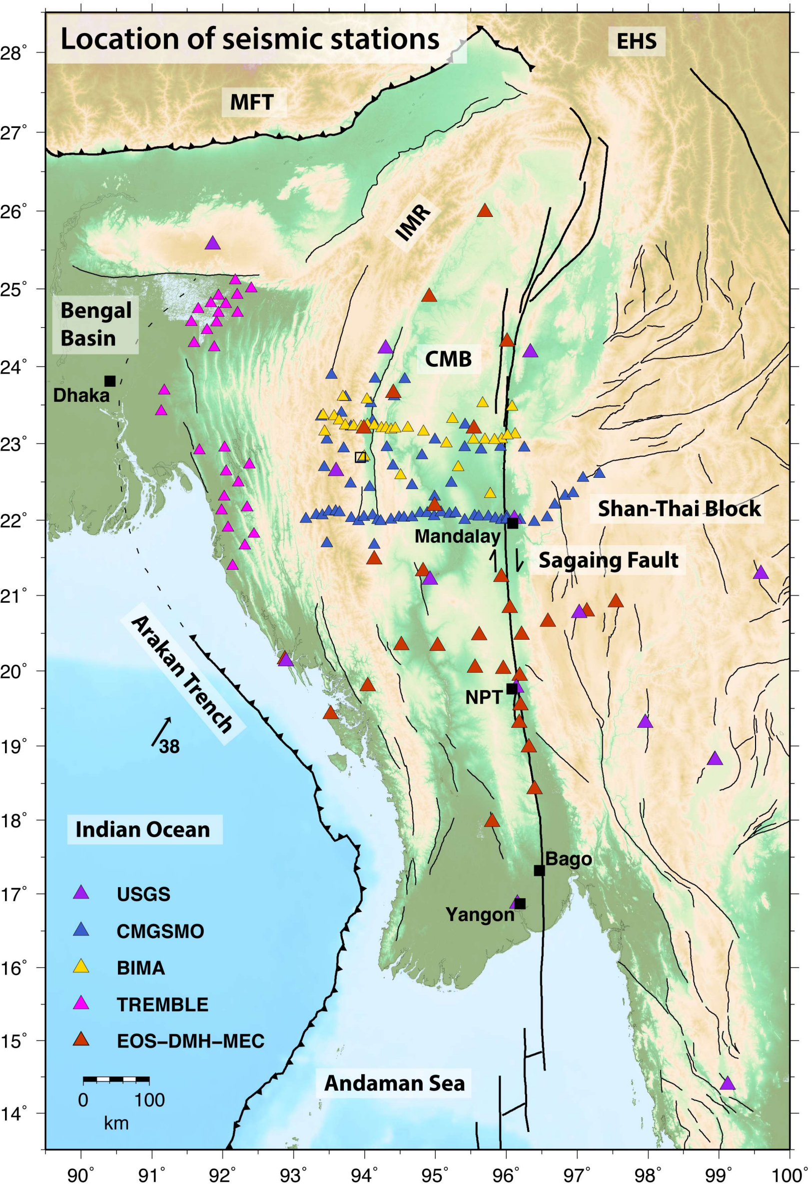

Source: USGS




# 480 focal mechanisms

- New regional 5-year catalog
- GCMT catalog
- 5 published studies:

  Ni et al., 1989
  Chen & Molnar, 1990
  Holt et al., 1991
  Kumar et al., 2015
  Mon et al., 2020



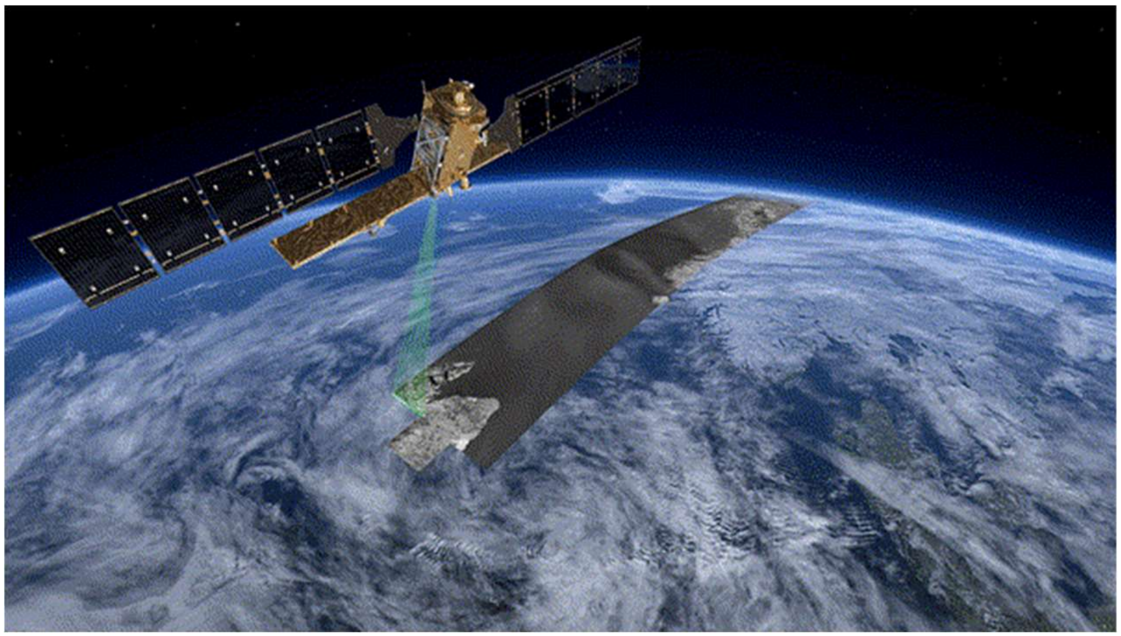

# Regional seismic networks provide a valuable waveform dataset

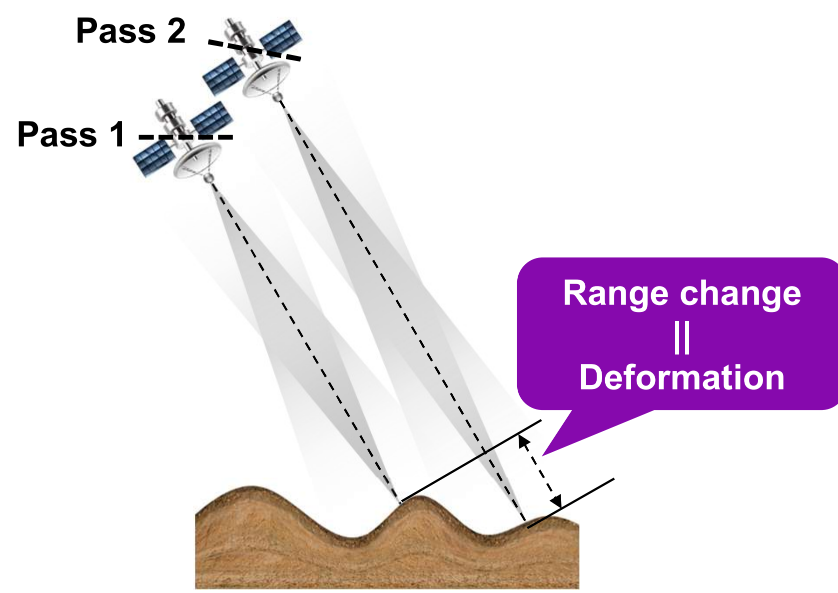
EOS-DMH-MEC network in Myanmar

Source: earthobservatory.sg

# Space geodesy: high-spatial resolution

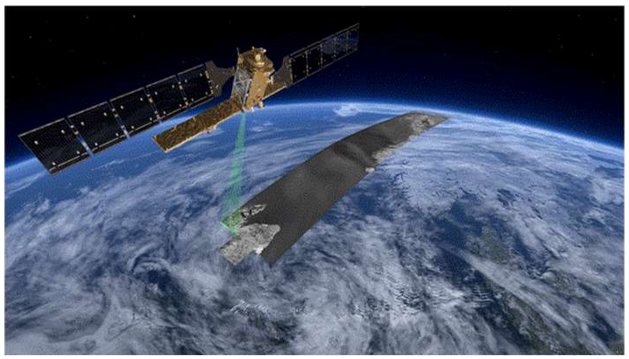
Satellite imaging is a powerful tool to measure surface deformations

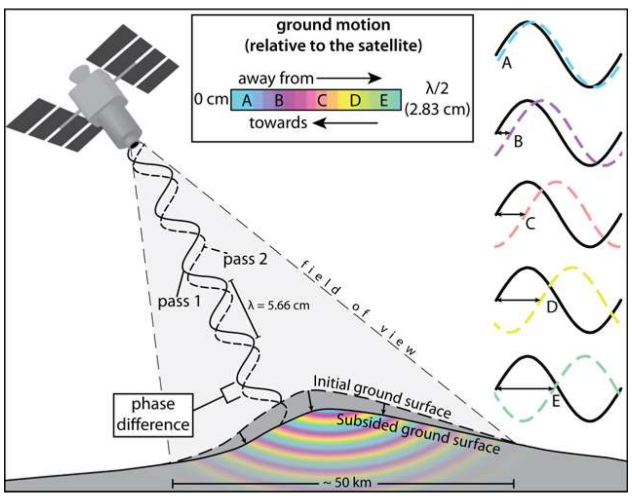




# Space geodesy: high-spatial resolution

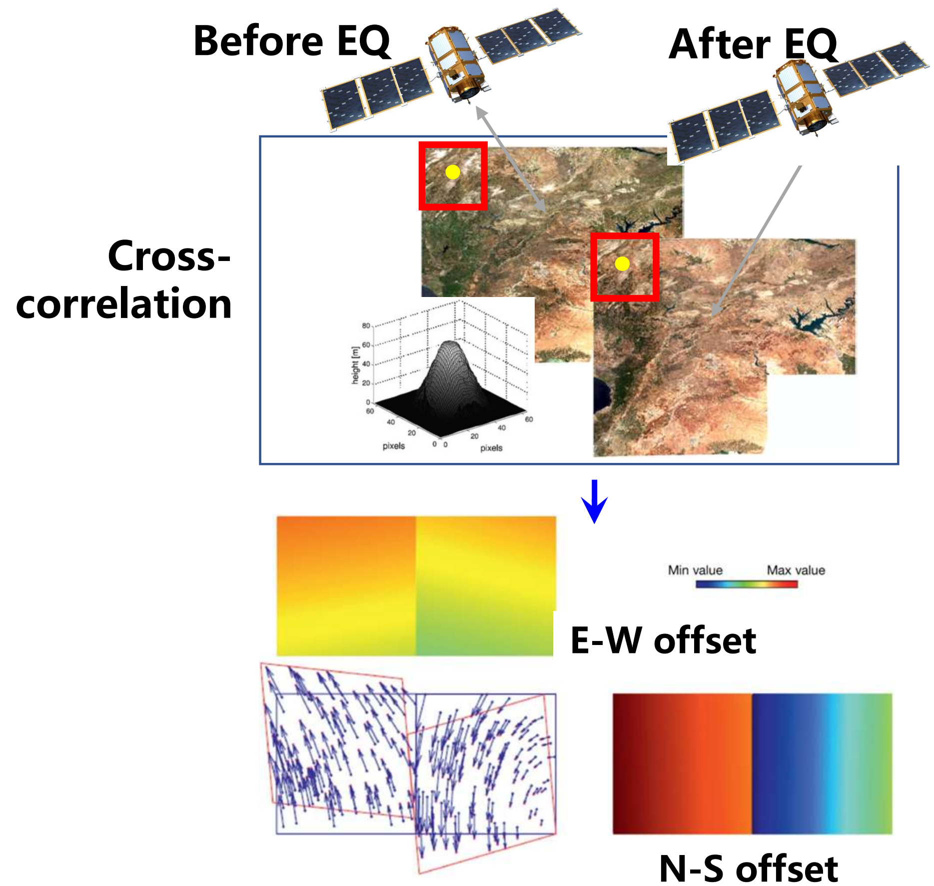
## Interferometric Synthetic Aperture Radar



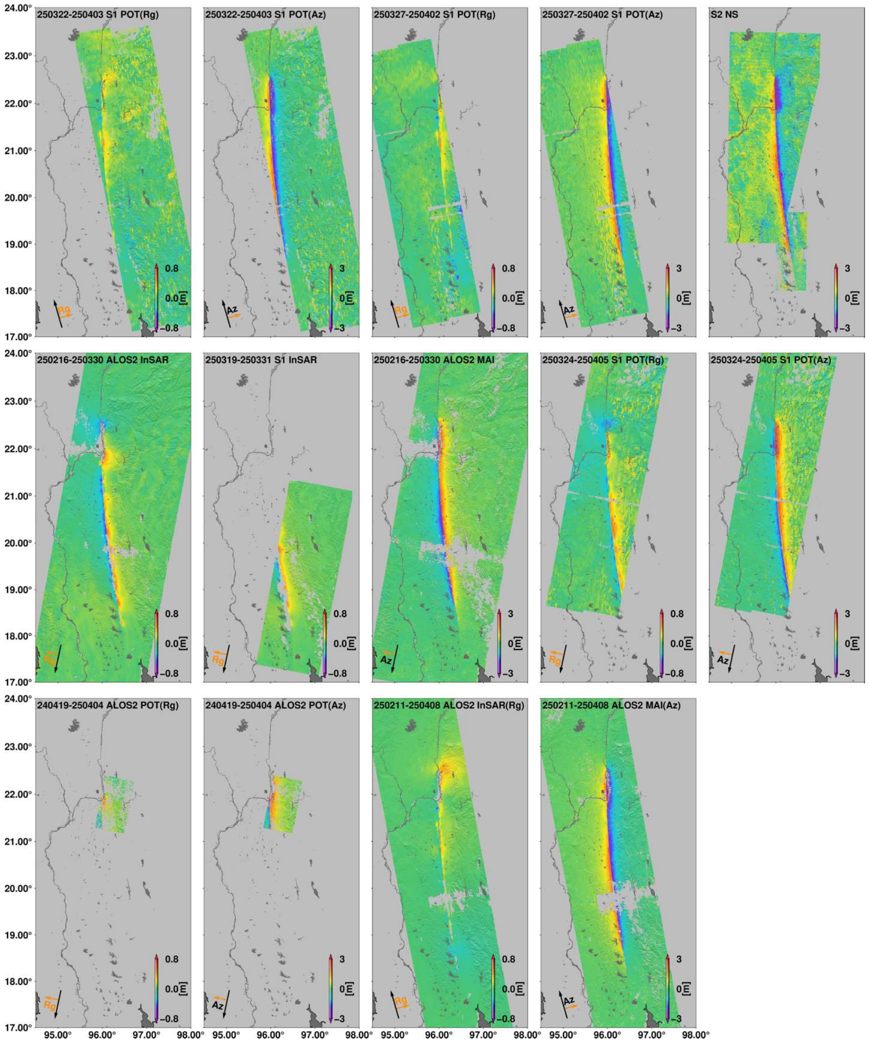



*Source:* volcano.si.edu

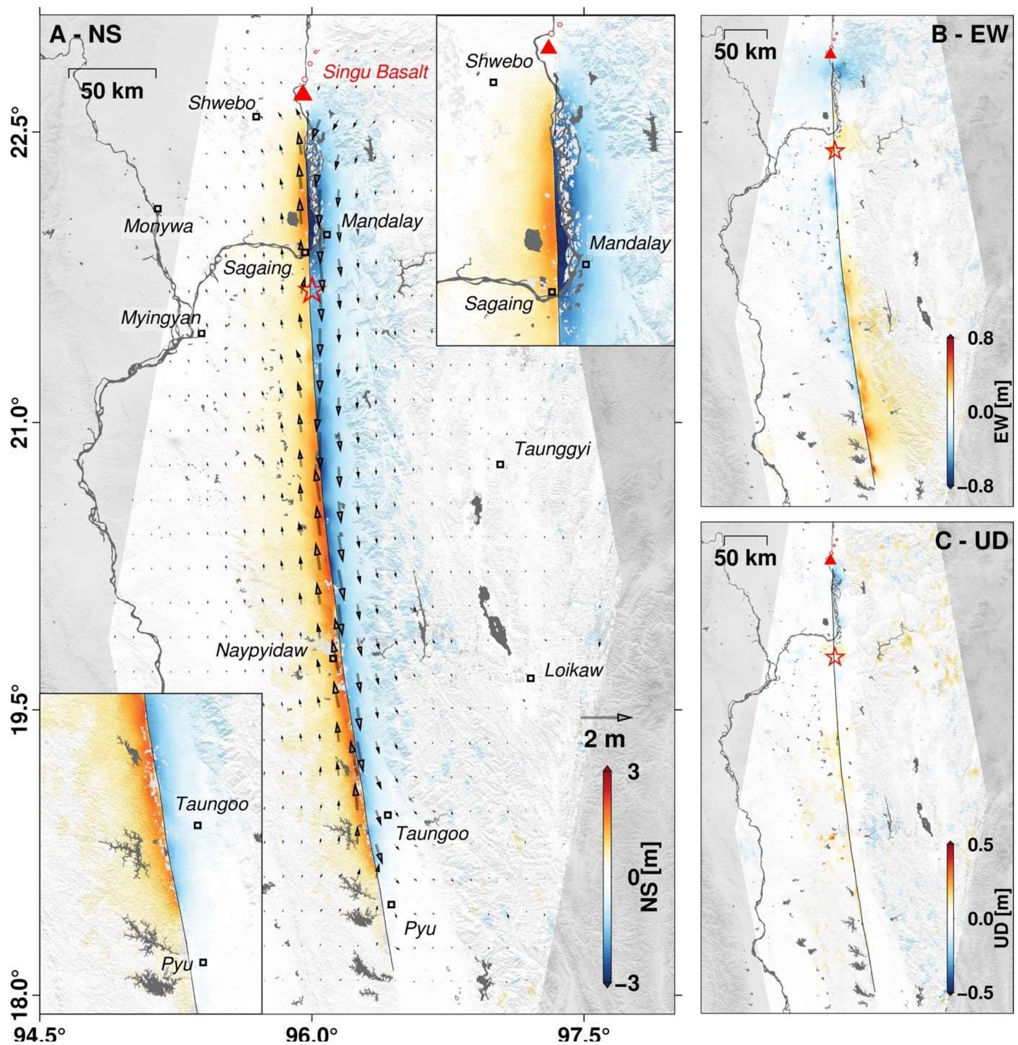
## POT: Pixel Offset Tracking (optical images)

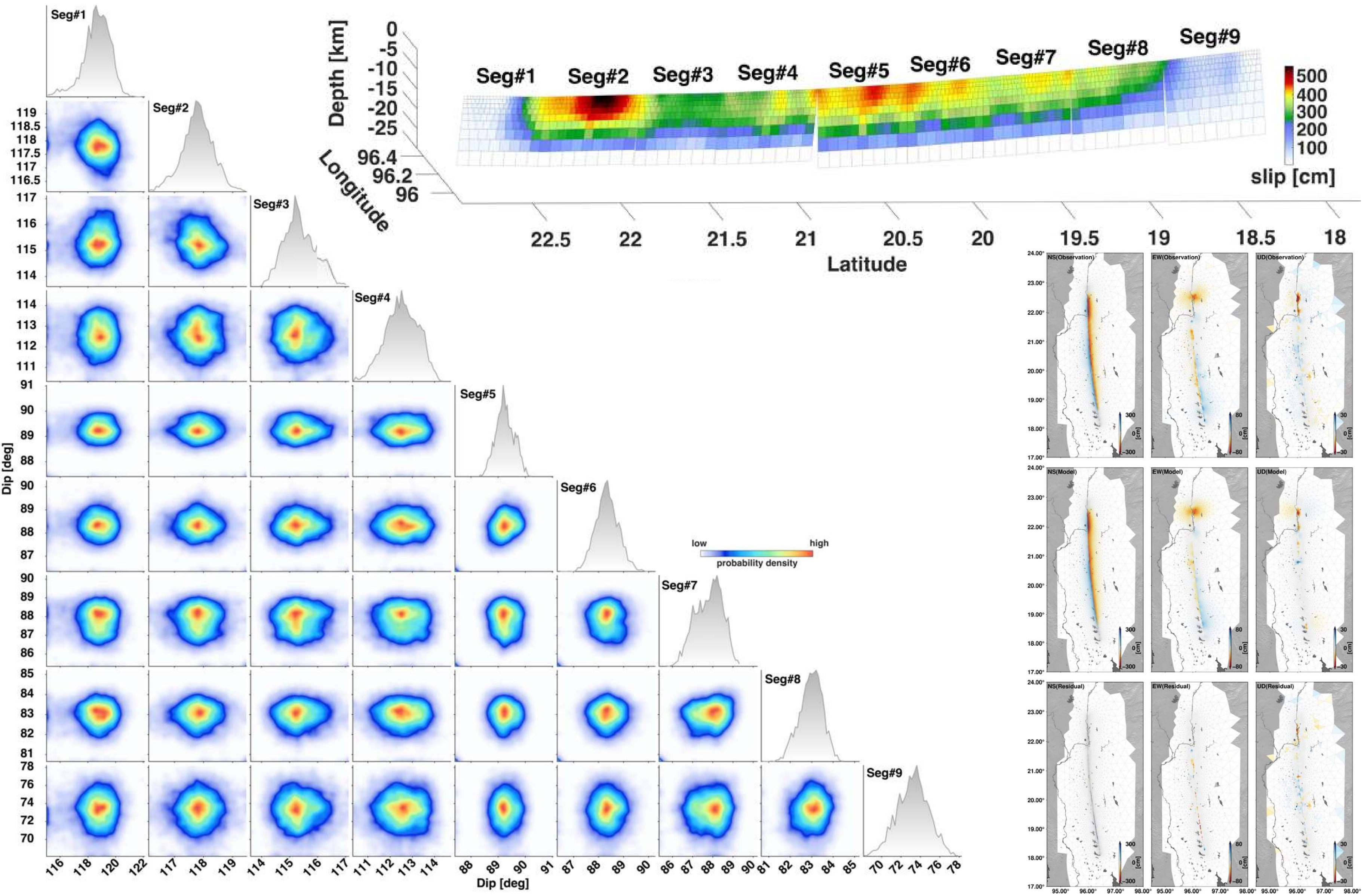


## Interferograms, MAI, and POT results



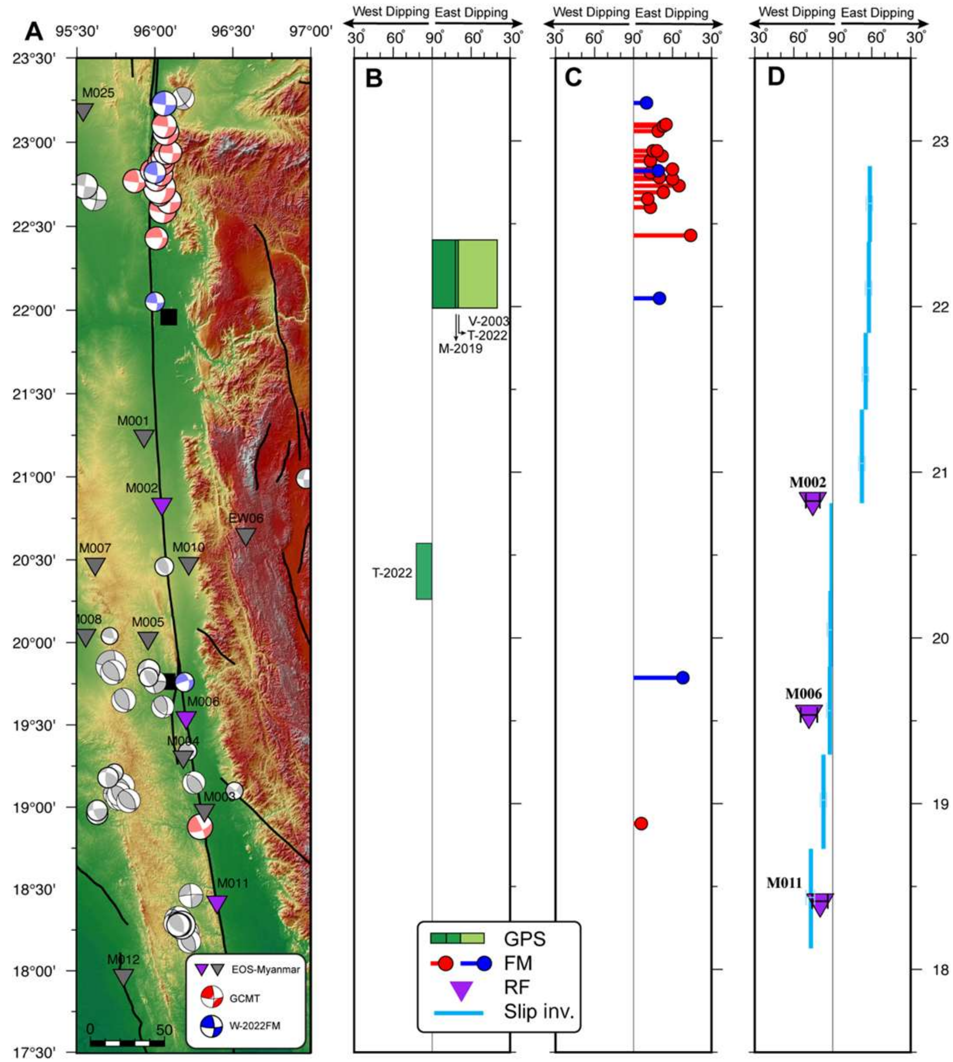

# Coseismic geodetic observations to derive 3D surface deformation





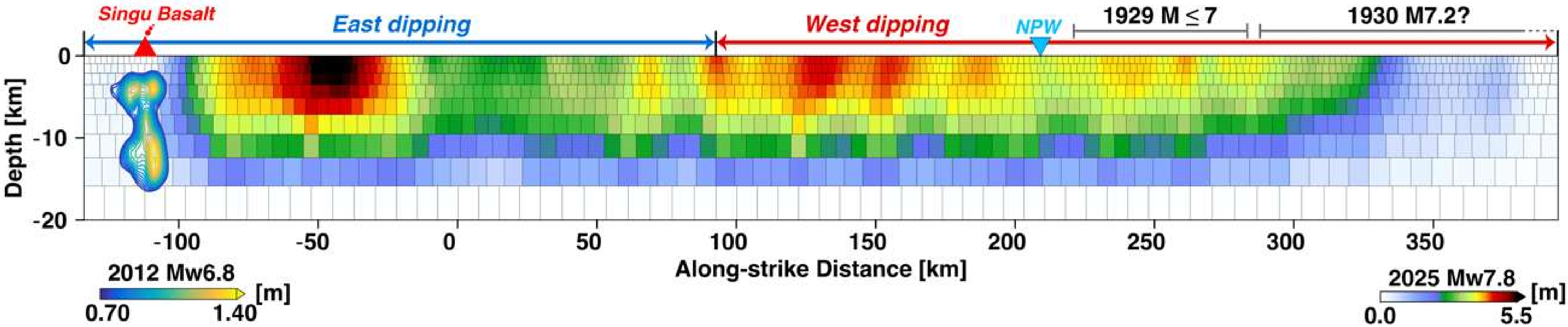

Near Perfect Match!

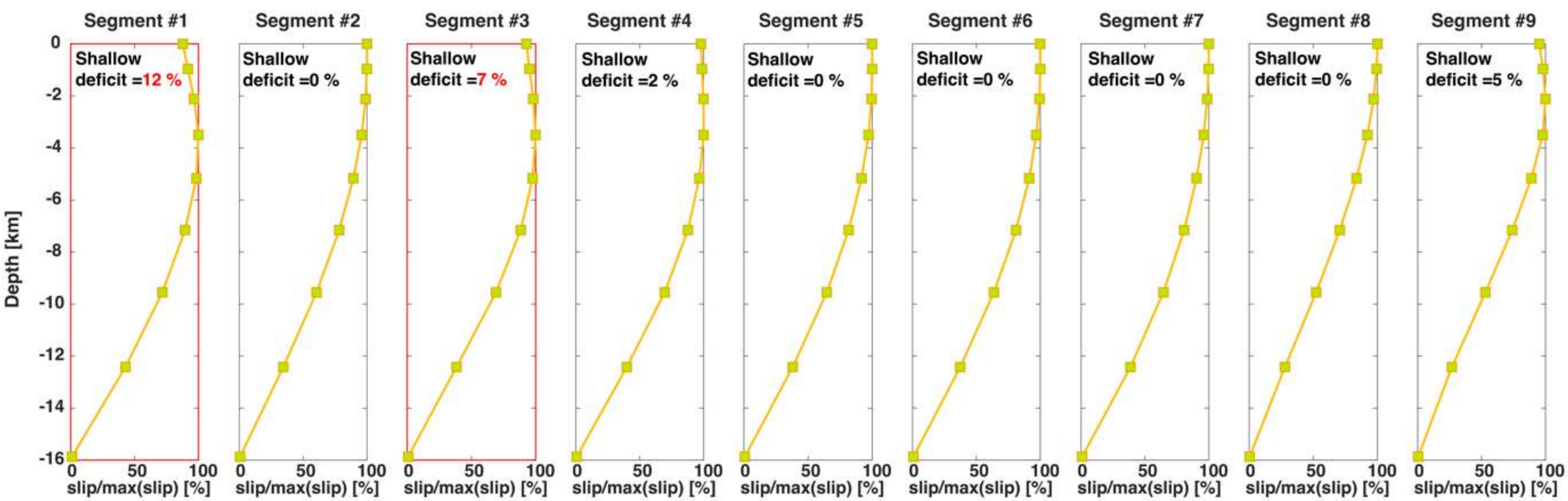
# Consistent Fault Geometry from Different Constraits



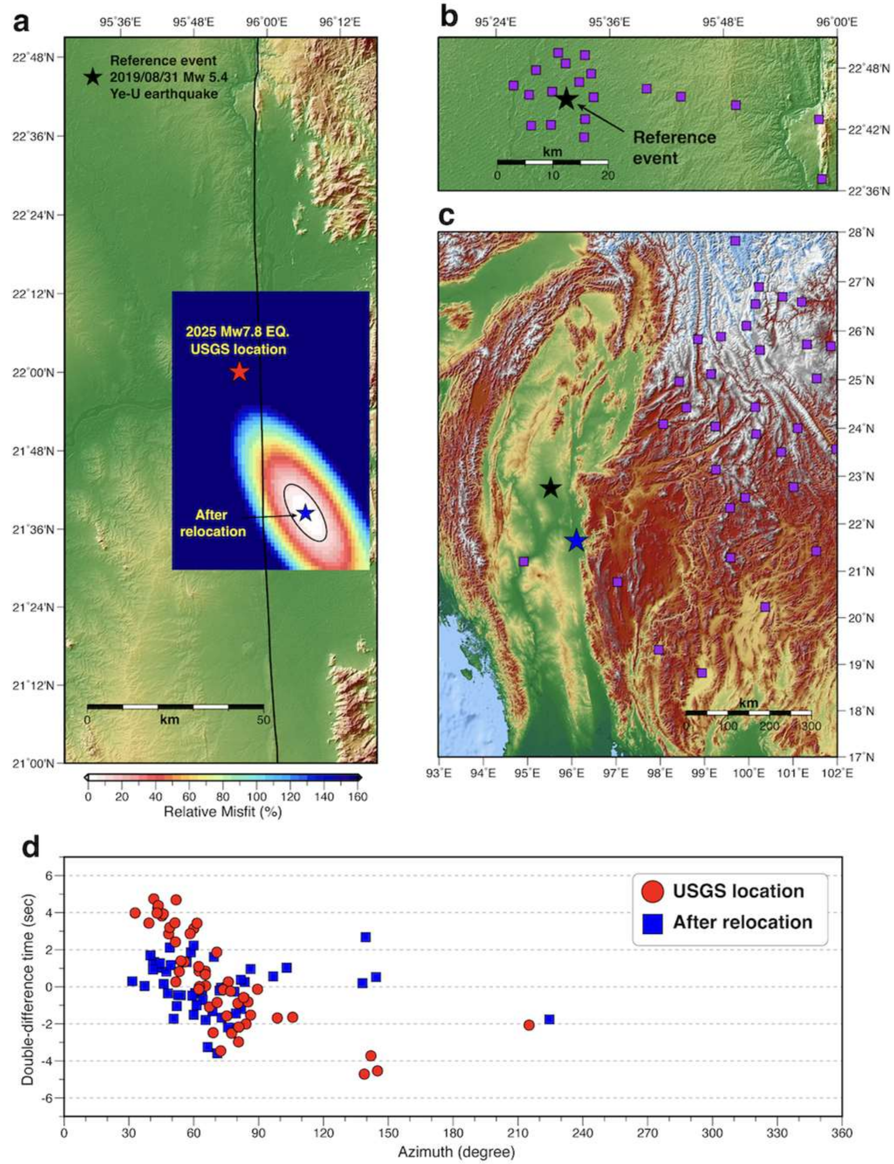

**FM: Focal Mechanism**
**RF: Receiver Function**
**Slip inv: Slip Inversion**

# Static slip model and SSD



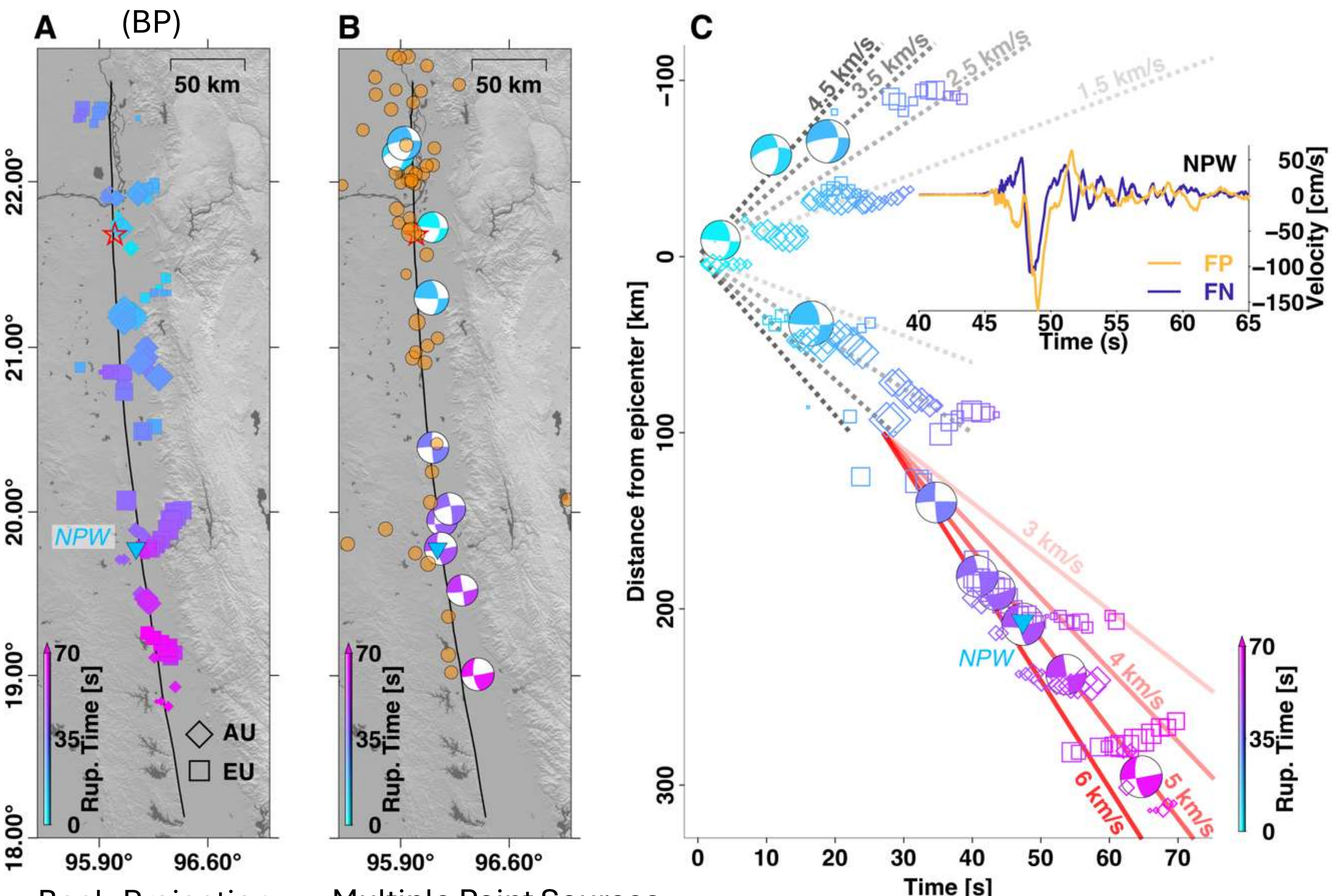



# Epicenter Relocation with Regional Data



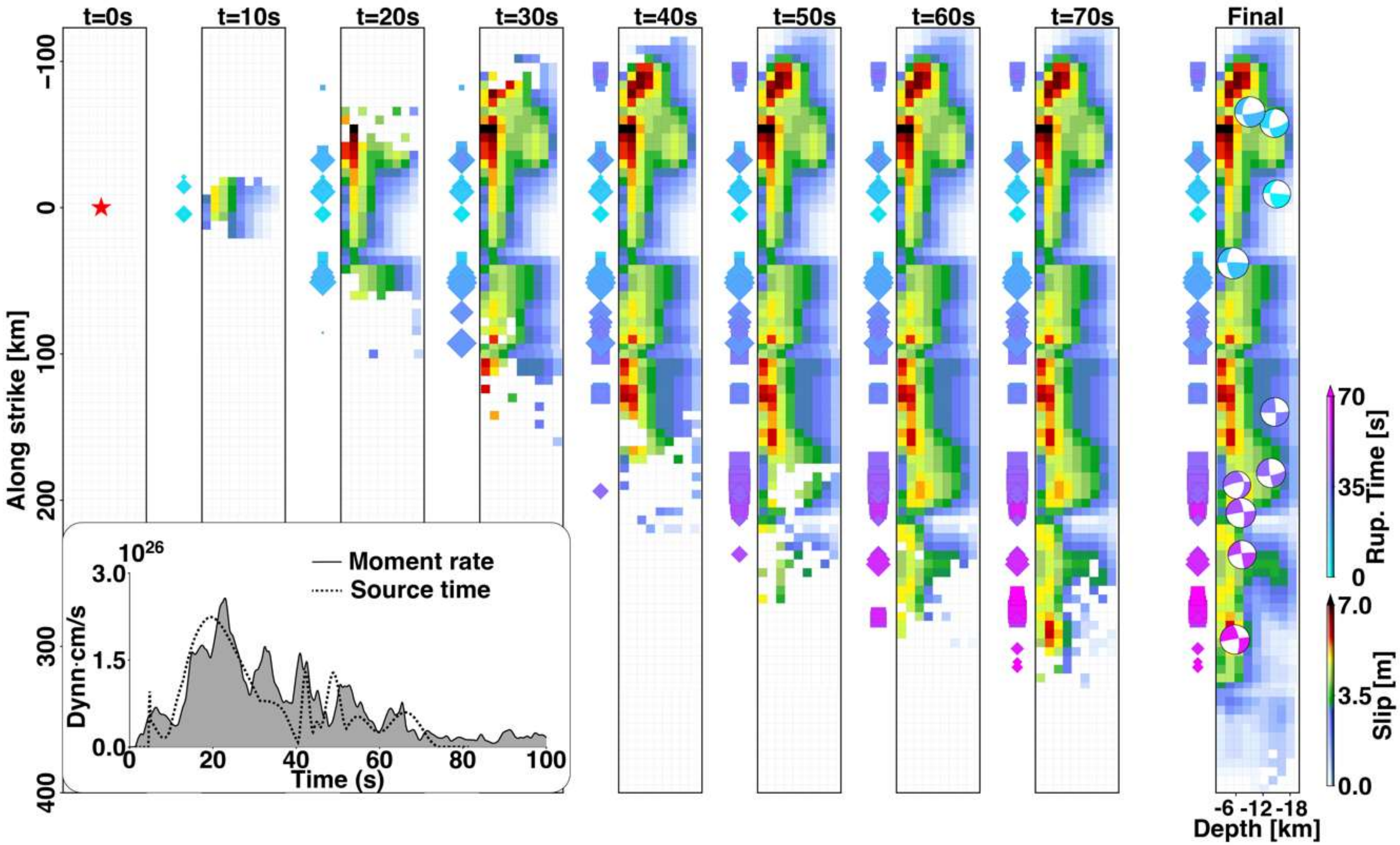
# Coseismic Kinematic Rupture Process and Supershear Rupture

Constrained by
Back-Projection
And
Multiple Point Source
Inversion

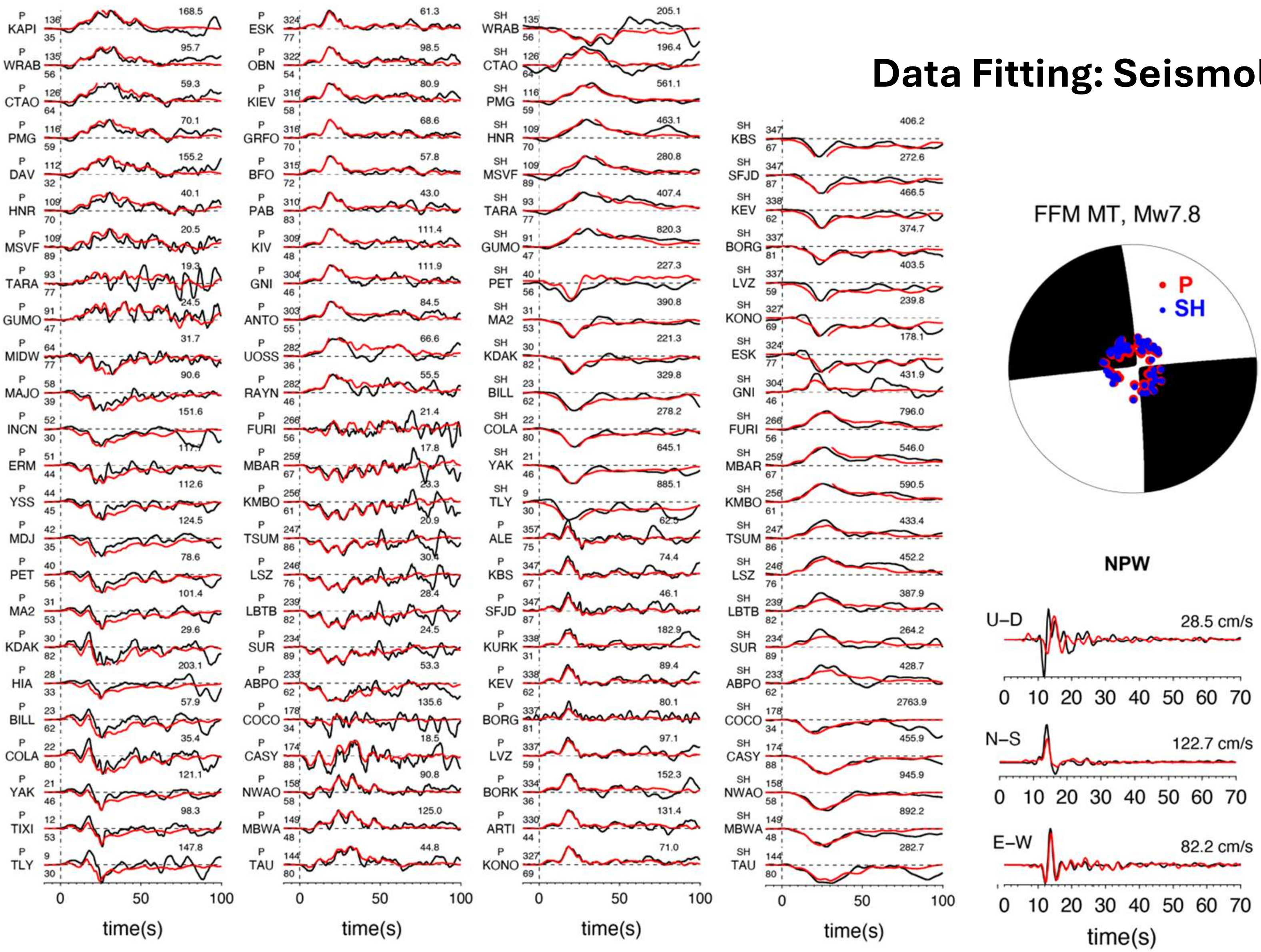



Back-Projection　Multiple Point Sources

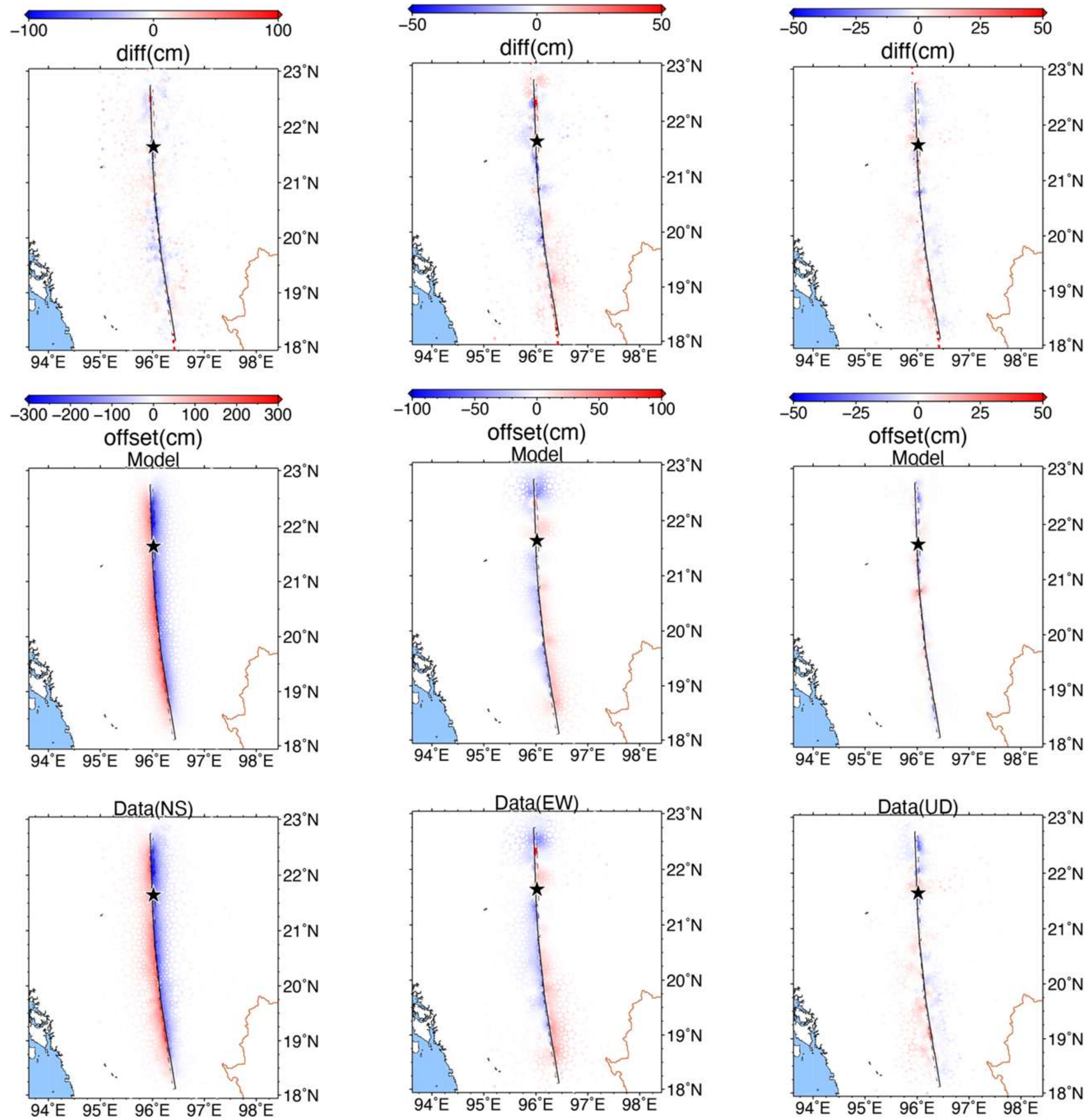
# Finite Fault Model from Joint Inversion of Geodetic and Seismic Observations



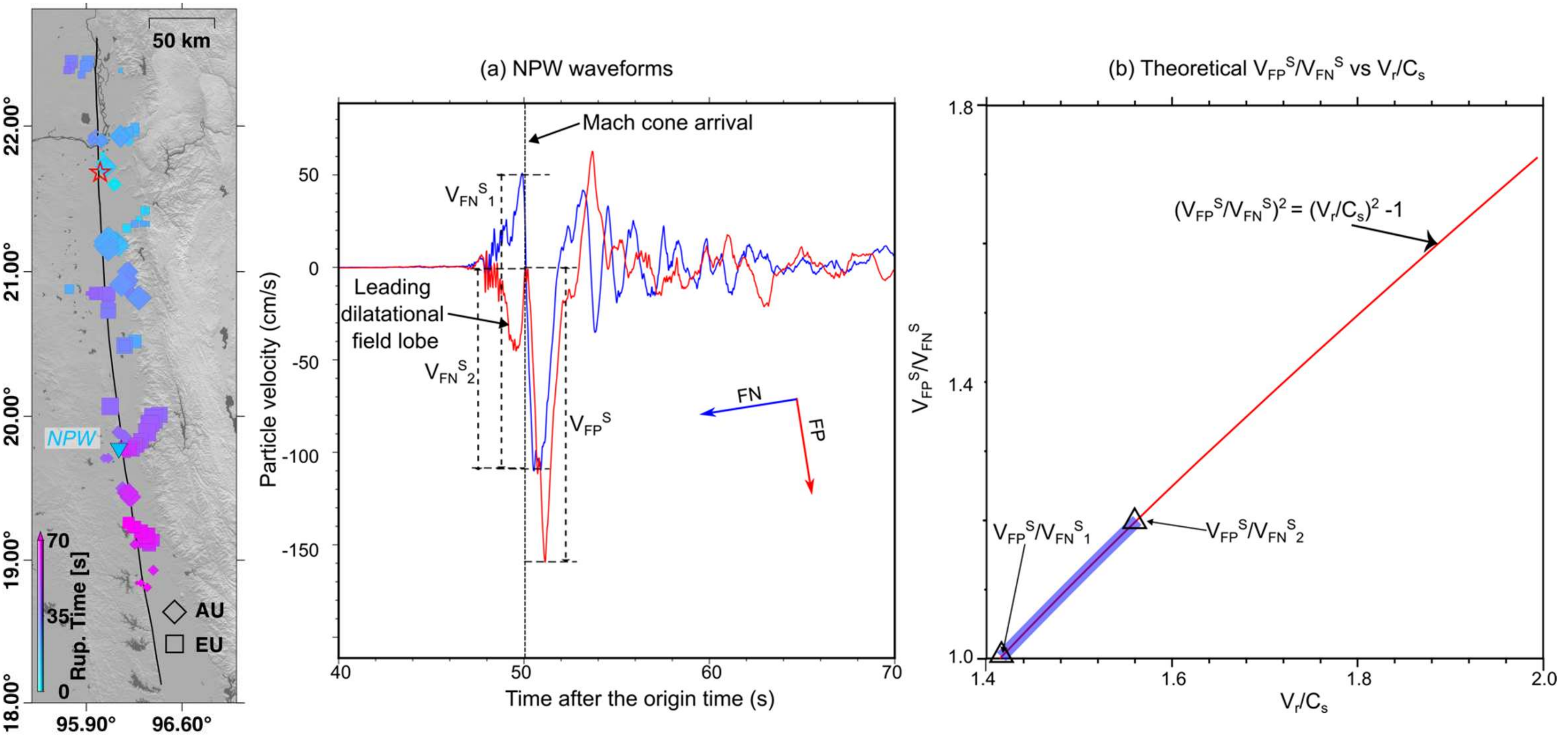
# Data Fitting: Seismological



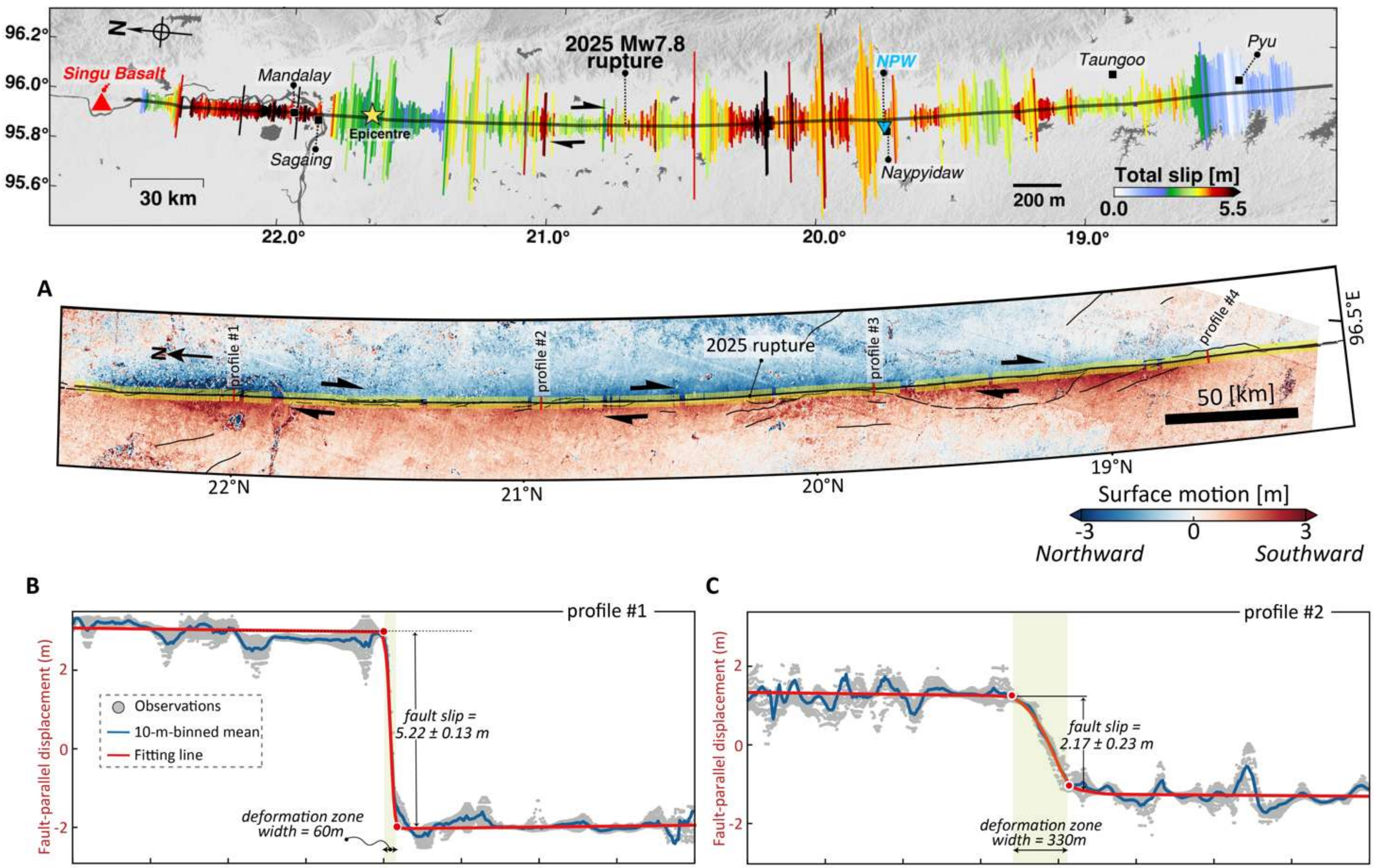
# Data Fitting: Geodetic



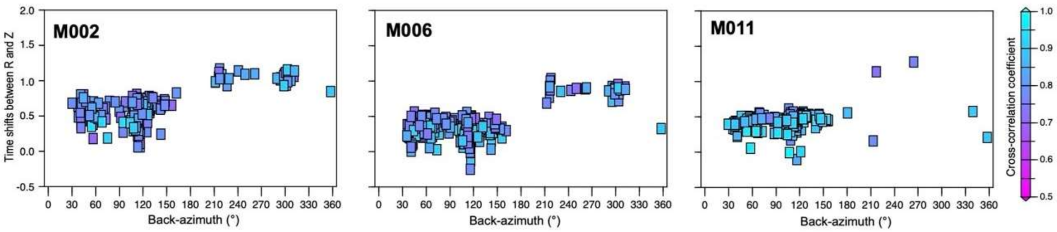
# Super Shear Rupture Speed Constrained by Fault-Parallel/Normal Amplitude Ratio at NPW Station

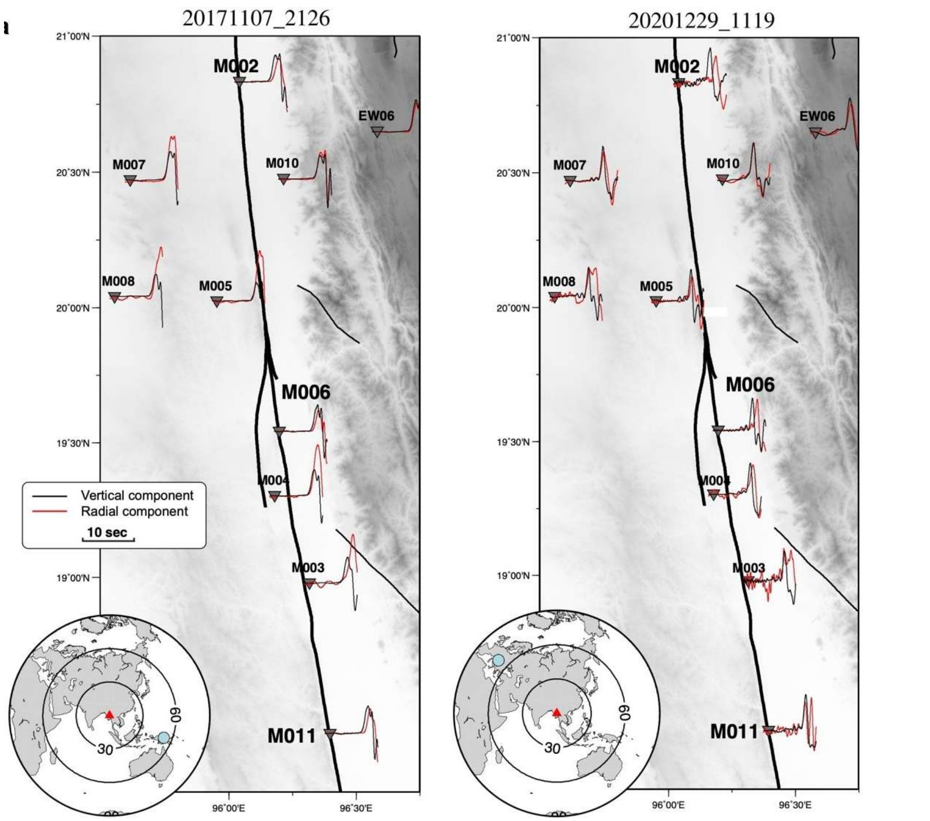


# Coseismic Damage Zone Width Constrained by Optical Imaging

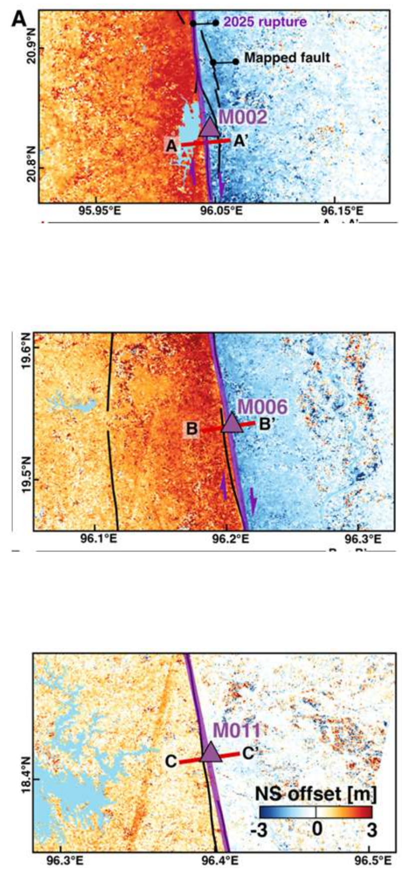


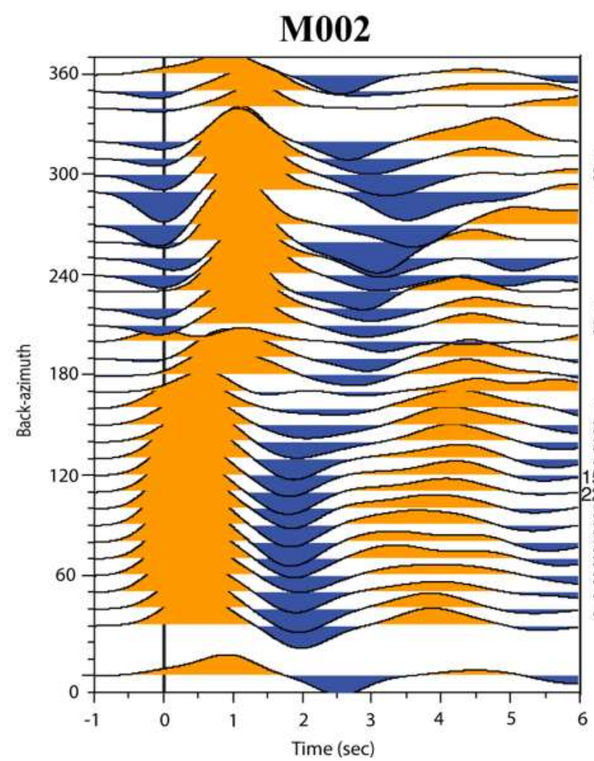
# Fault Zone Revealed by Receiver Function



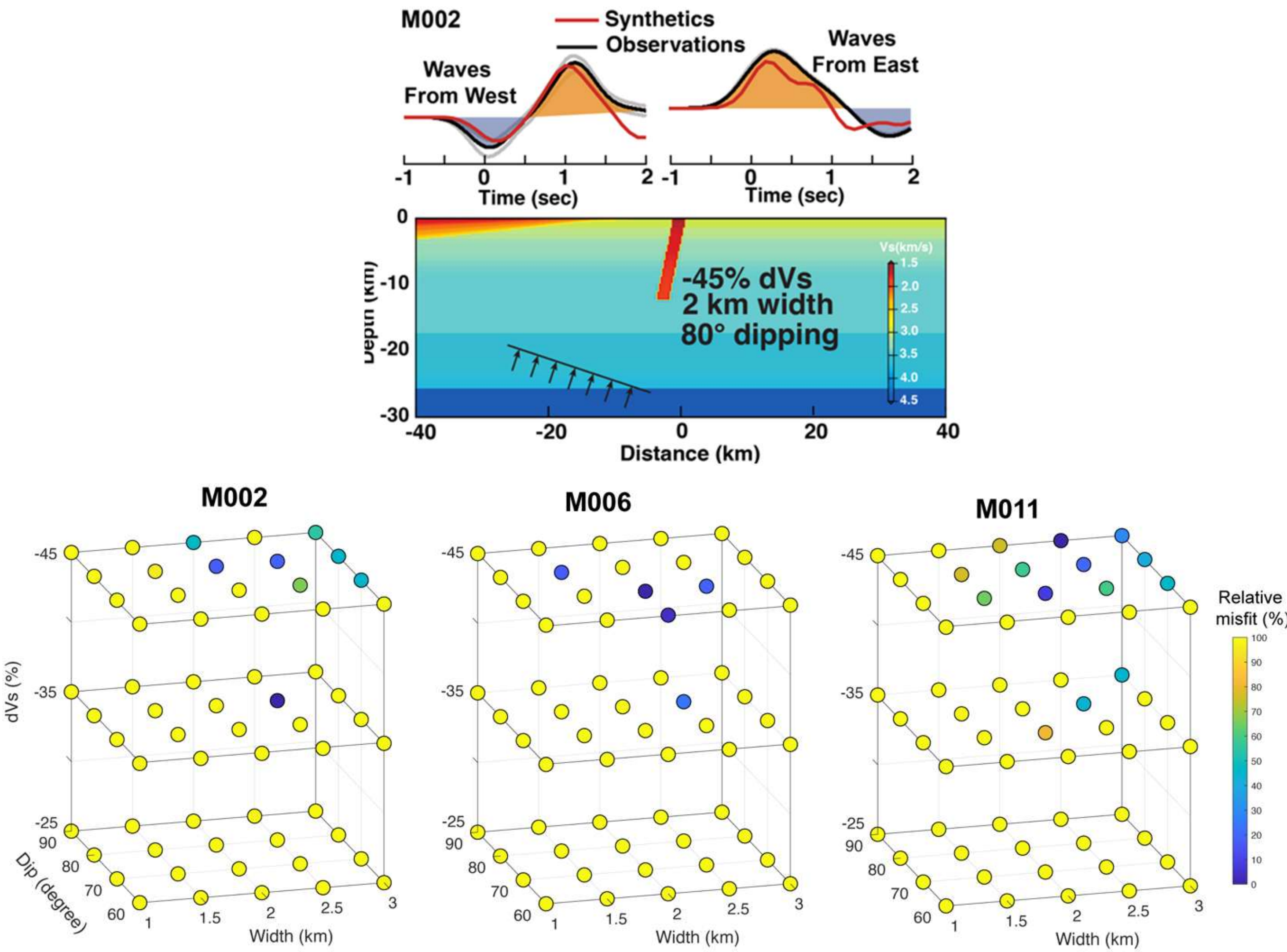




A teleseismic event show different arrival time between Radial and Vertical component

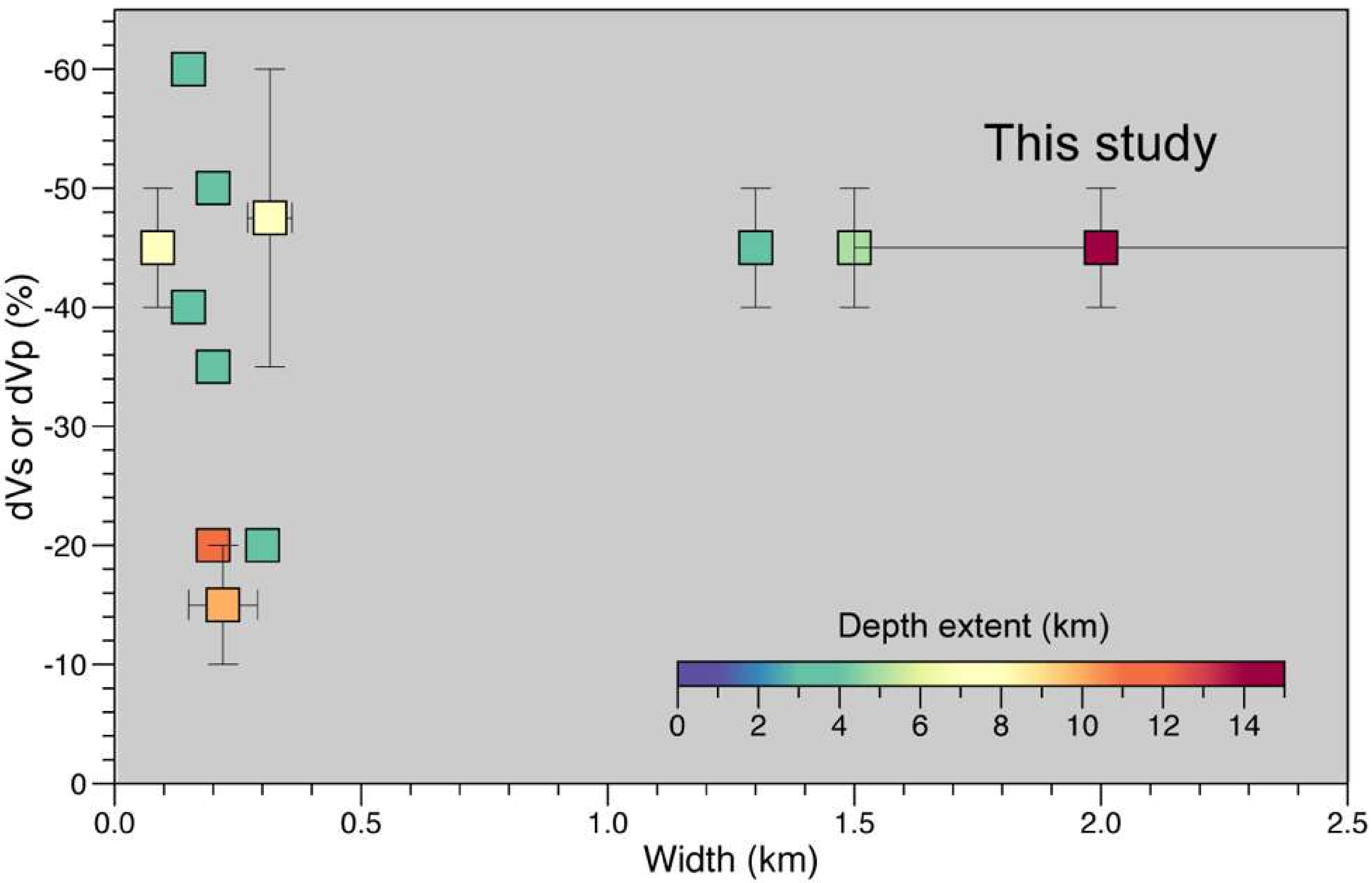


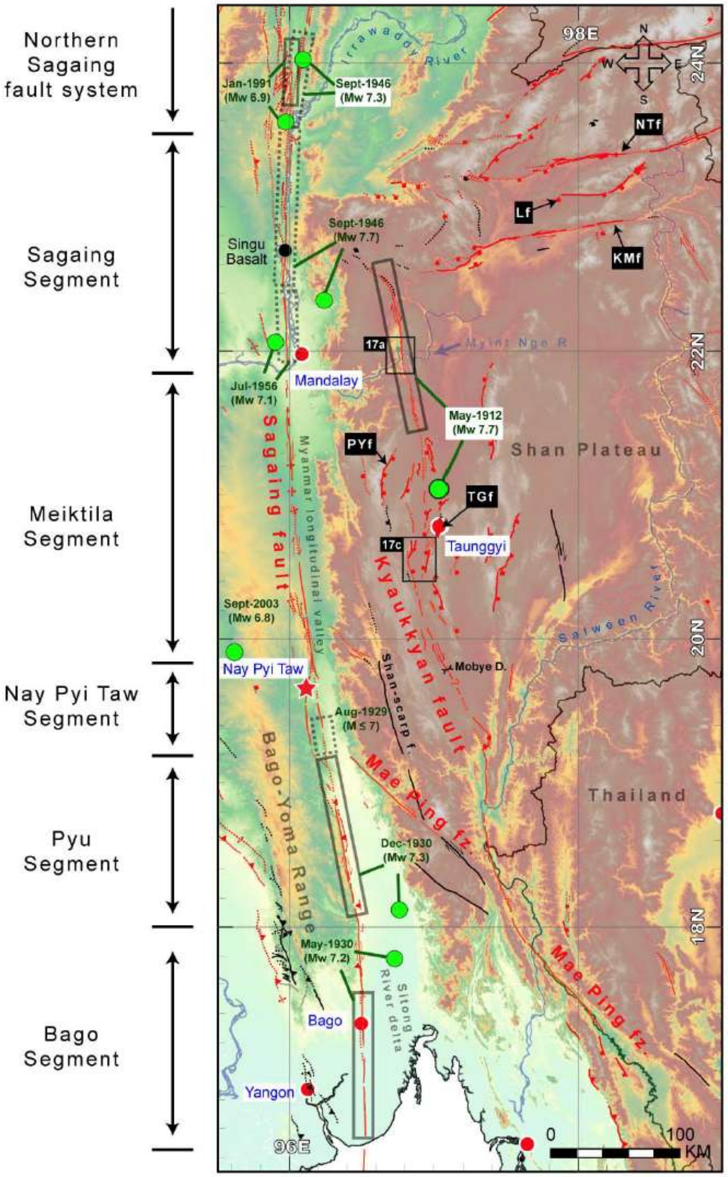
# Grid Search for the Best Fault Zone Model

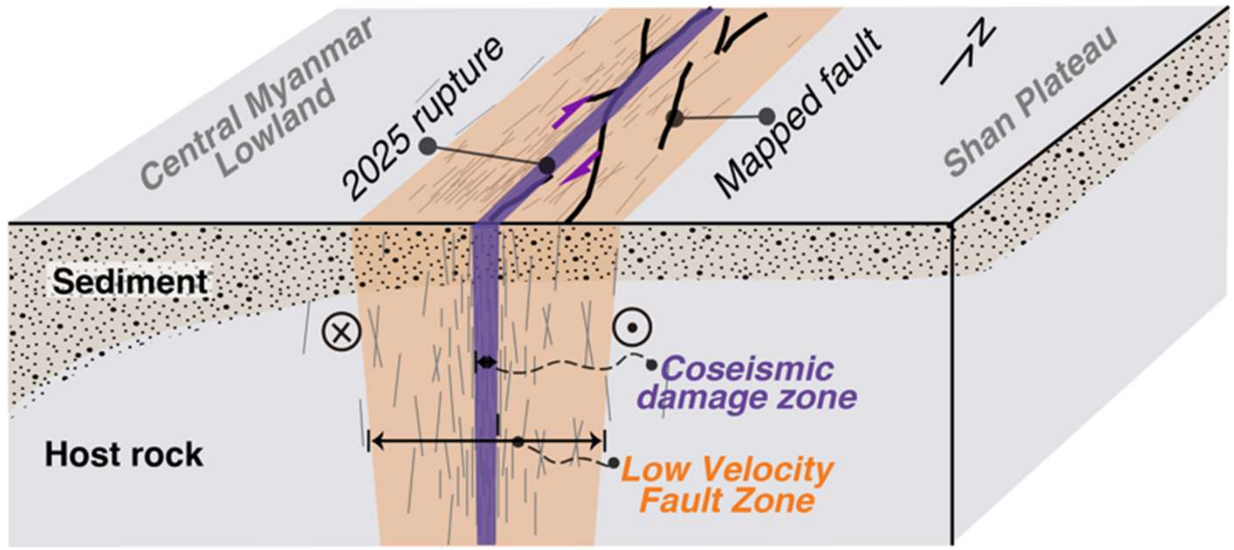


# A Wide Fault Damage Zone of the Sagaing Fault



# Single Event and Cummuative Effects of Past Events




Wang et al, 2014, JGR

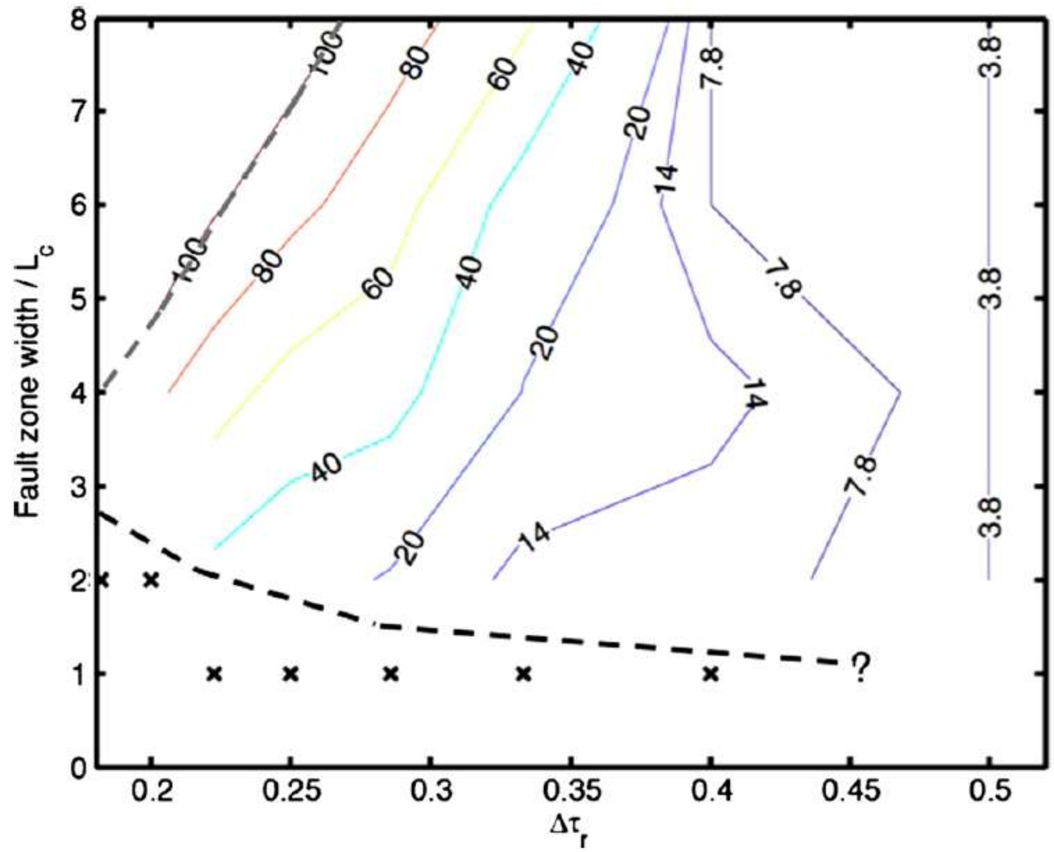
# Thick Fault Zone Impact on Supershear and Its Transition

$$L_c = GD_c/\Delta\tau_s$$

$G$ = 30 GPa, $D_c$= 1 m , $\Delta\tau_s$ = 50 MPa

$$L_c = 600 \text{ m}$$

Critical fault zone width should be at least 2-3 times the critical nucleation size ($L_c$) of earthquakes to facilitate supershear rupture.




Fault geometry (diping direction change) may also play a role.

Huang et al., 2016, EPSL

# Take home message

- Earthquake produced a 480-km-long surface rupture.
- The sub-shear transitioned to supershear (~5.3 km/s) about 100 km south of the epicenter, sustaining this velocity for over 200 km.
- The supershear segment aligns with a ~2 km-thick low-velocity fault zone exhibiting ~45% shear wave speed reduction.
- Thick fault zone facilitate supershear, and its transition matches with observation