# Slip rates and deep lithospheric deformation along a fault ruptured during the 2012 Mw 8.6 Wharton basin earthquake

(Hunting for active faults in the deep ocean)

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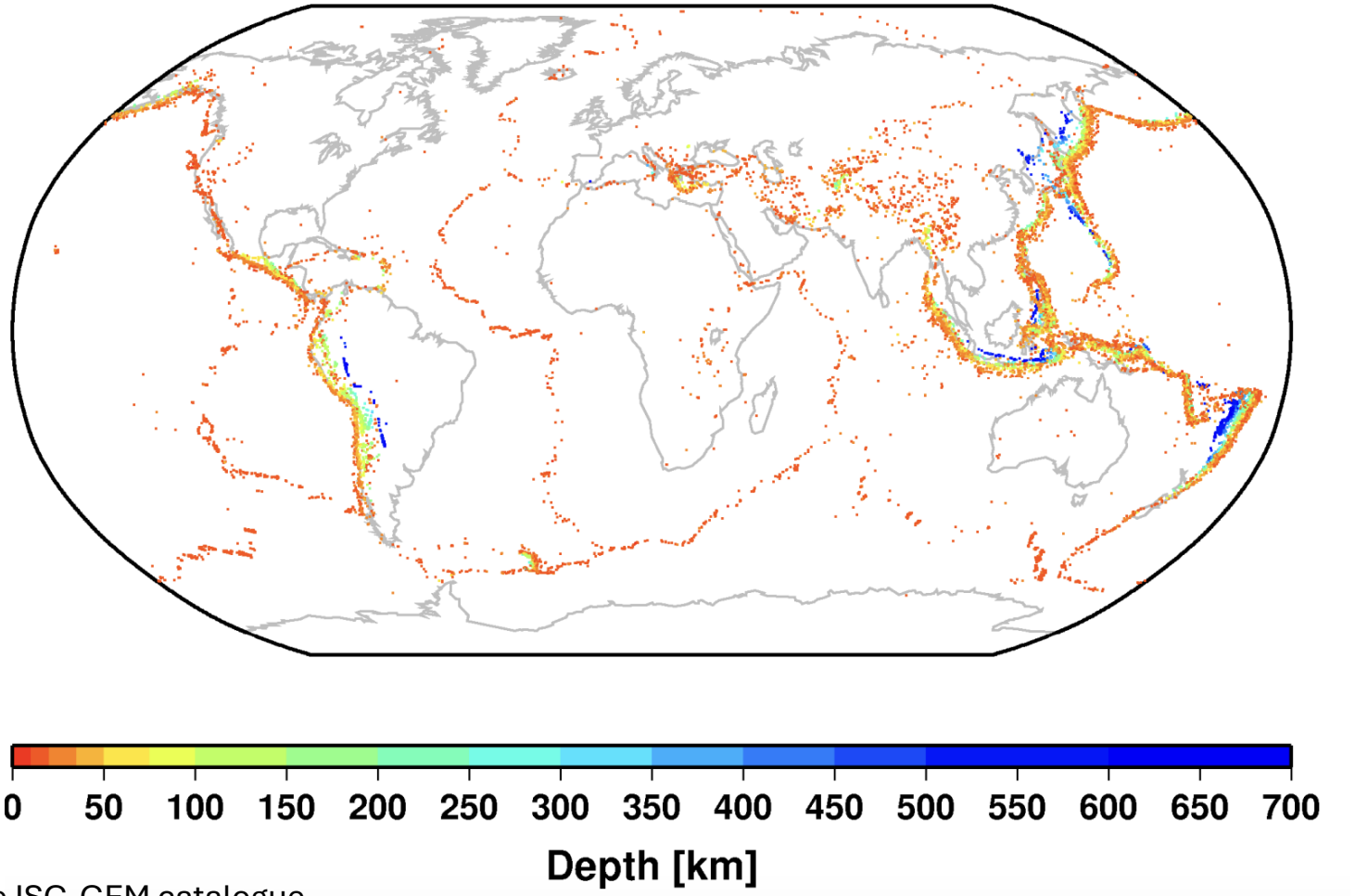
Step'up doctoral congress 2025

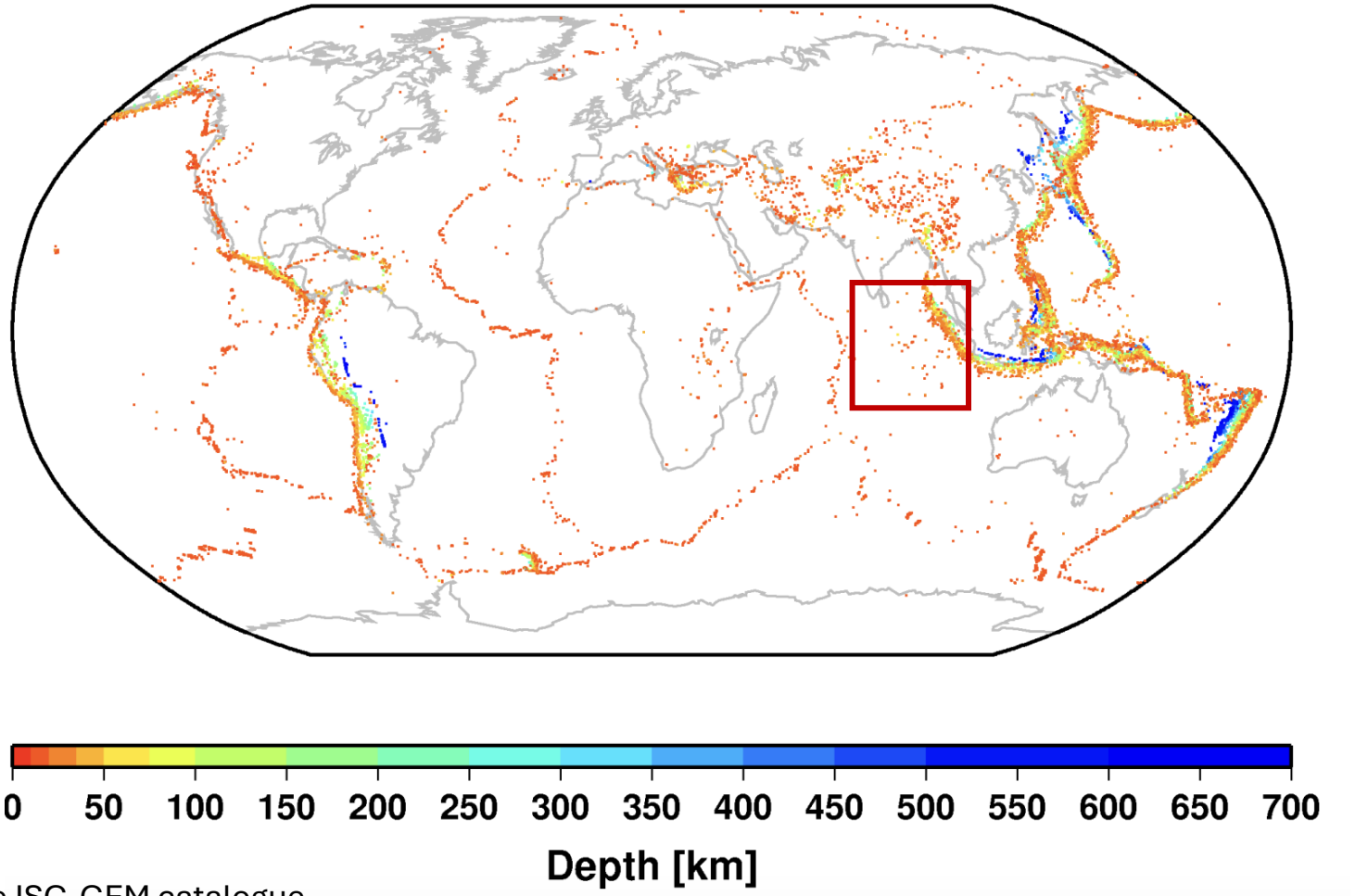
# Tectonic plate boundaries




The ISC-GEM catalogue

Earthquake epicentres define tectonic plate boundaries

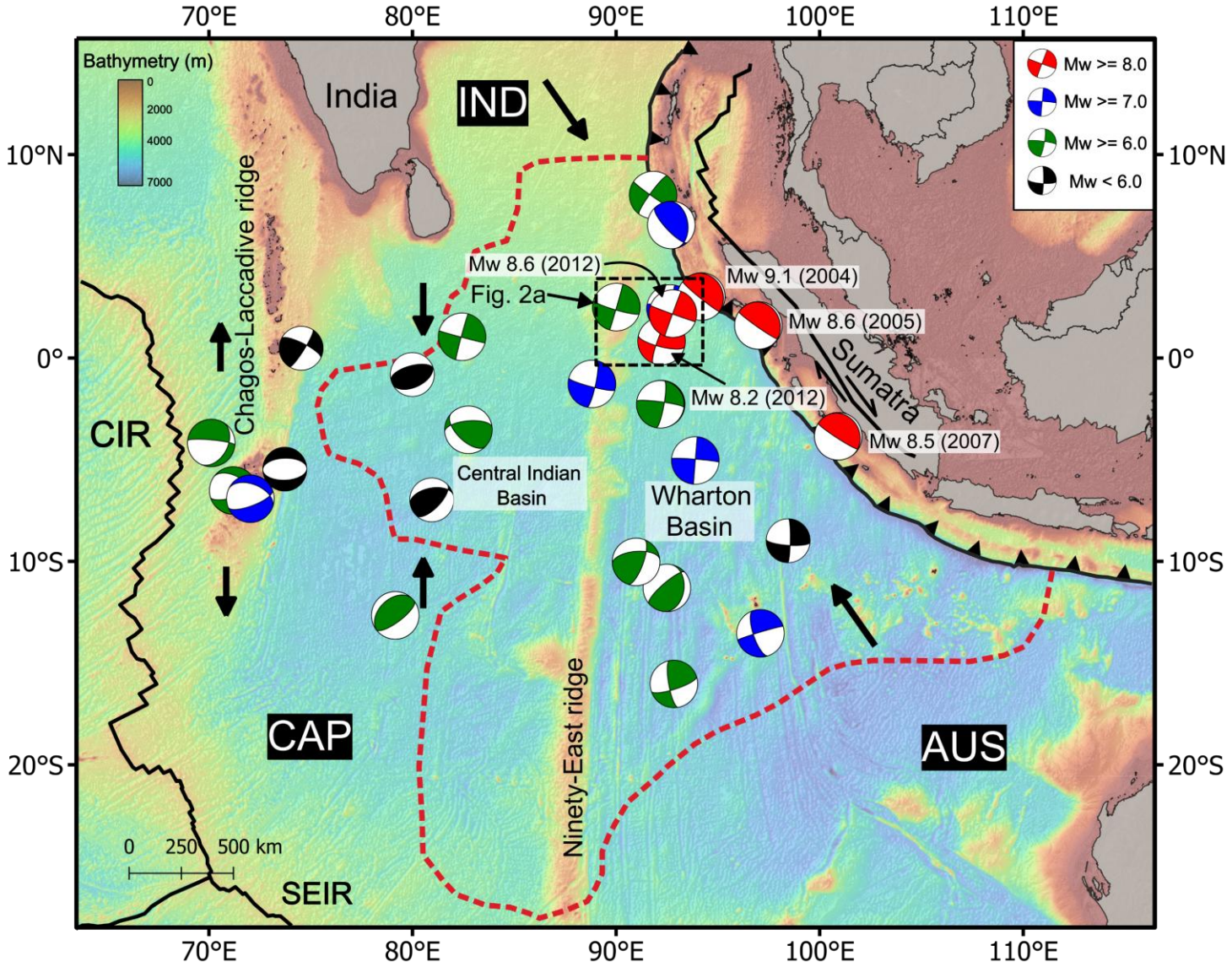
# Tectonic plate boundaries




The ISC-GEM catalogue

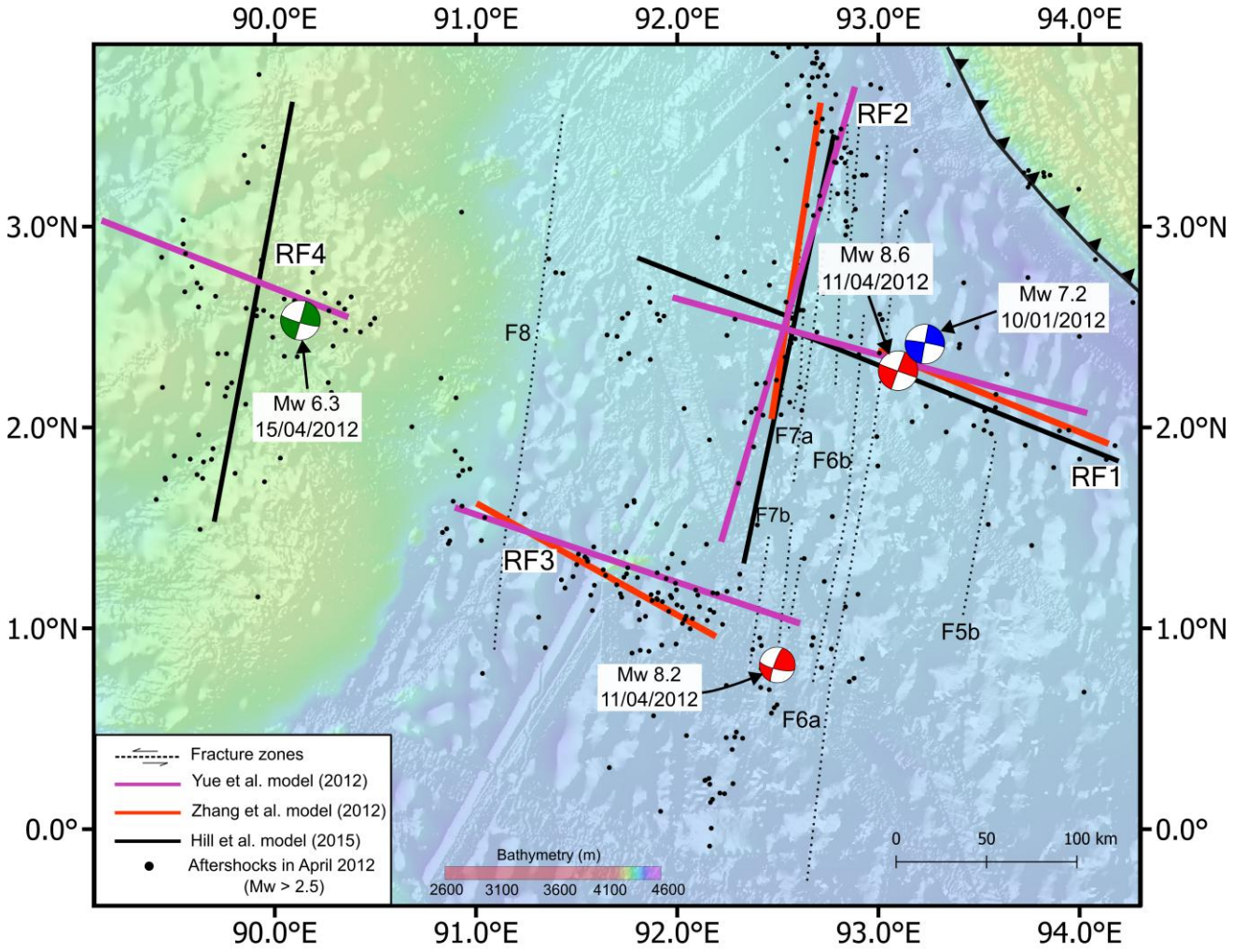
Earthquake epicentres define tectonic plate boundaries

# Indian ocean diffused deformation zone



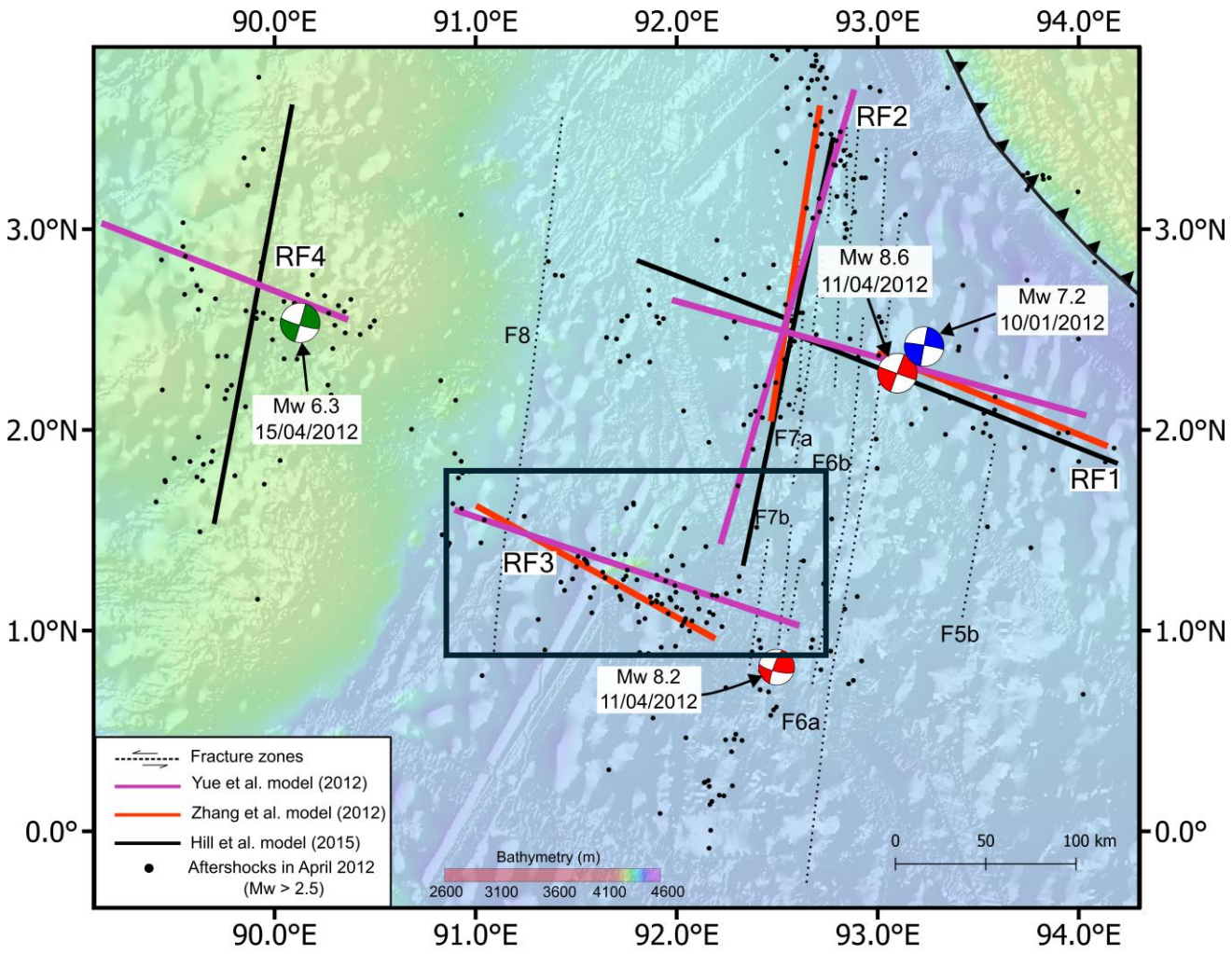

- N-S compression in the Central Indian basin.
- NW-SE compression in the Wharton basin.
- Reactivation of long fossil N-S striking fracture zones as left-lateral strike slip faults.

# Wharton basin earthquake doublet




- Ruptured within the oceanic lithosphere, ~ 400 km SW the Sunda megathrust.
- Activated a complex system of faults (at least 4) at high angle to each other.
- 30 km centroid depth with slip extending to 50-60 km.

# Wharton basin earthquake doublet

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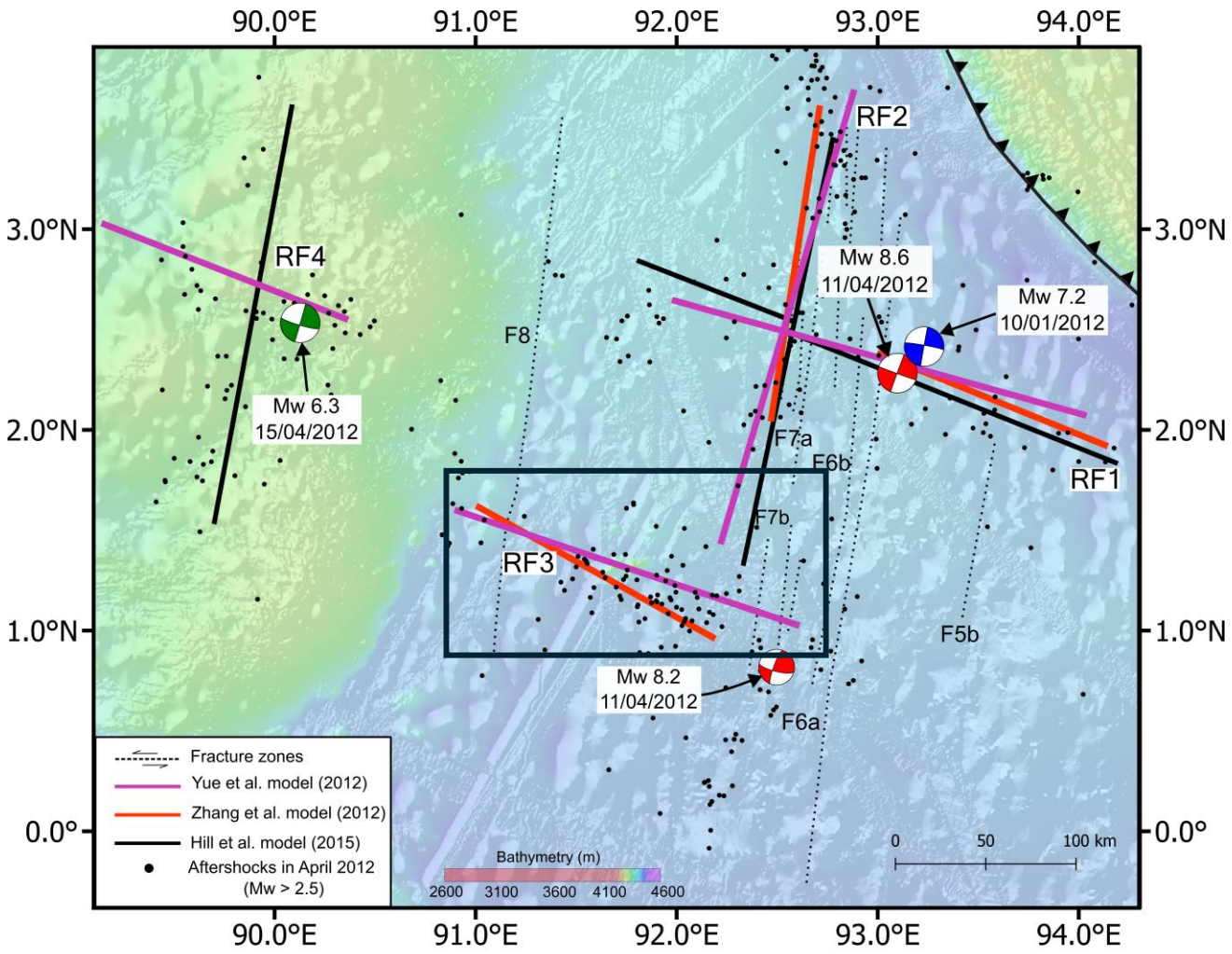
**Fault RF3 (Hill et al. (2015))**

Maximum slip = 20 m
Mw = 8.1
Total rupture length = ~200 km

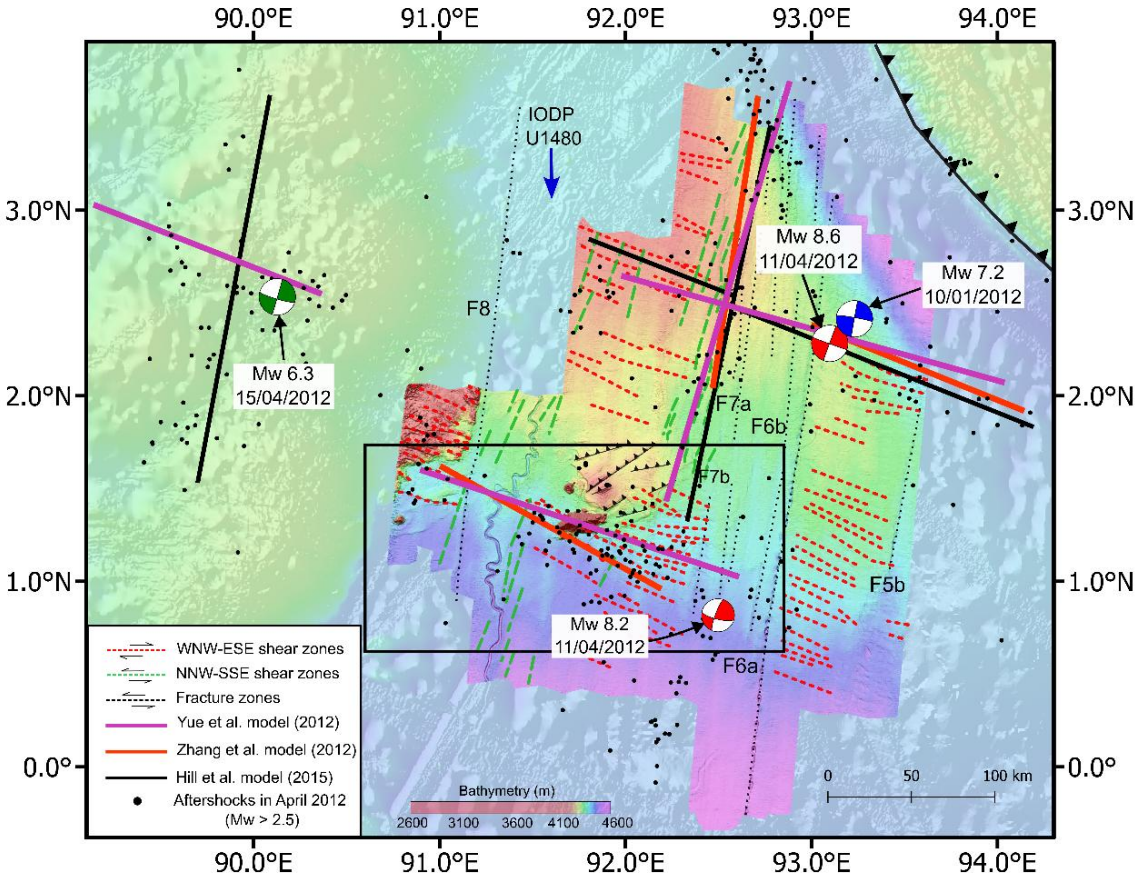
# Objective

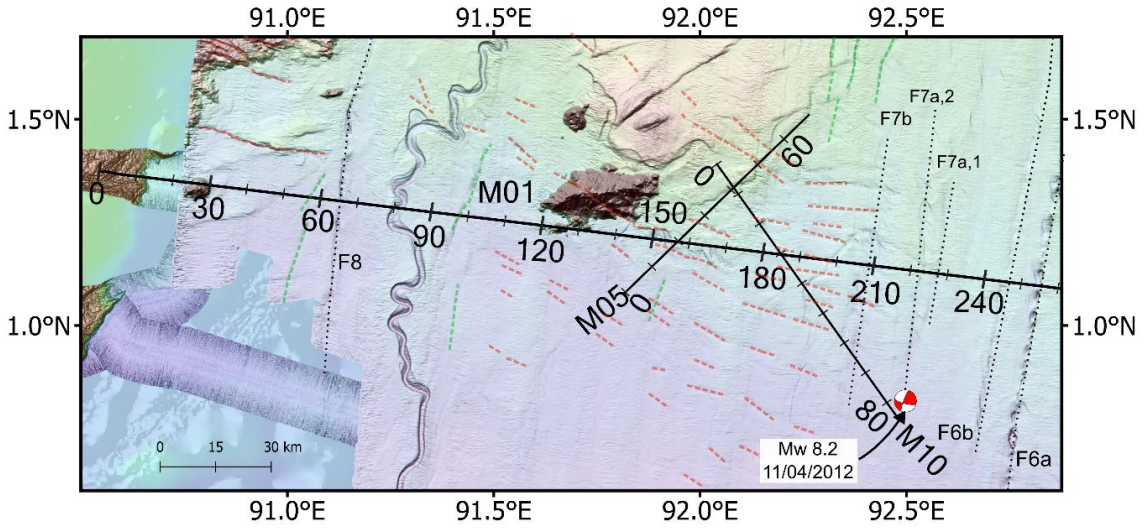



Characterizing the surface and subsurface deformation along the fault RF3

# Marine geophysical data

**M**arine **I**nvestigation of the **R**upture **A**natomy of the 2012 **G**reat **E**arthquakes (MIRAGE) experiment 2016 and 2017



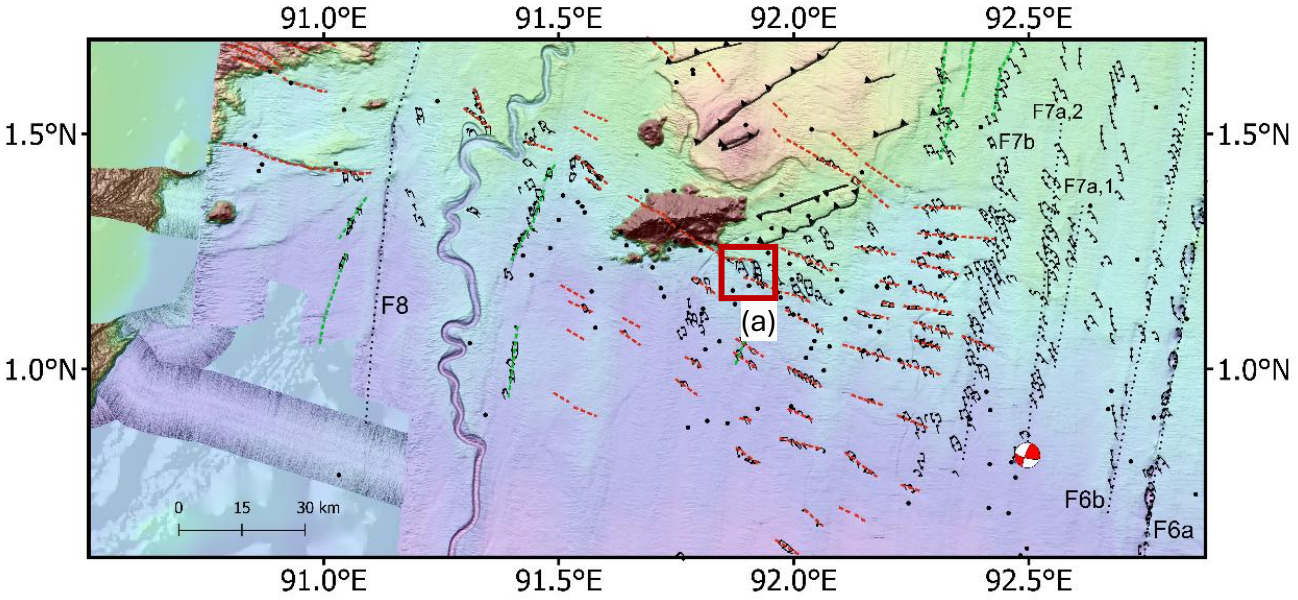



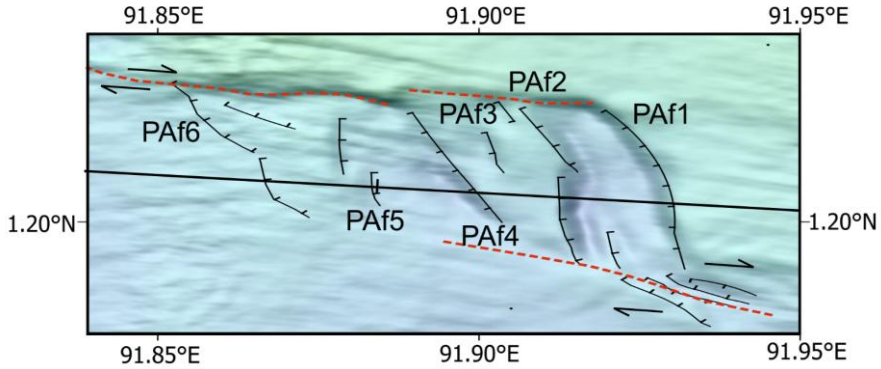

Active source multi-channel seismic data designed to characterize structures deep into the oceanic crust and mantle

High resolution (~ 50 m) bathymetry (90,000 km$^2$) and 3.5 kHz echo-sounder (11,400 km)

Hananto et al. (2018)

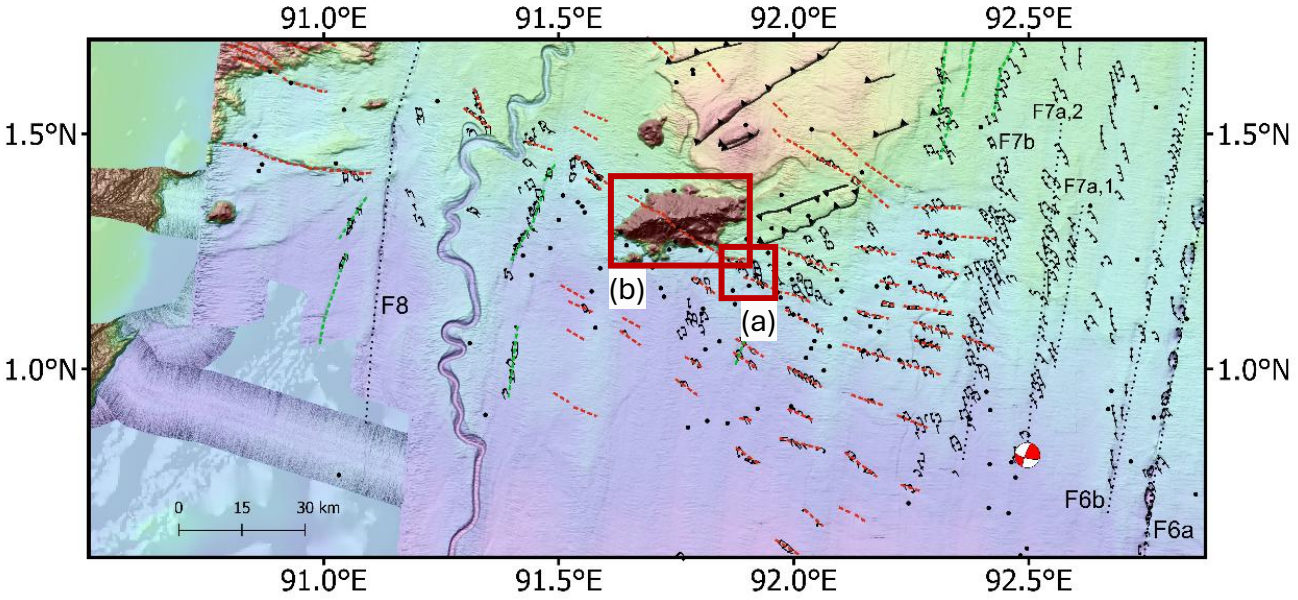
# Results: Surface deformation along RF3

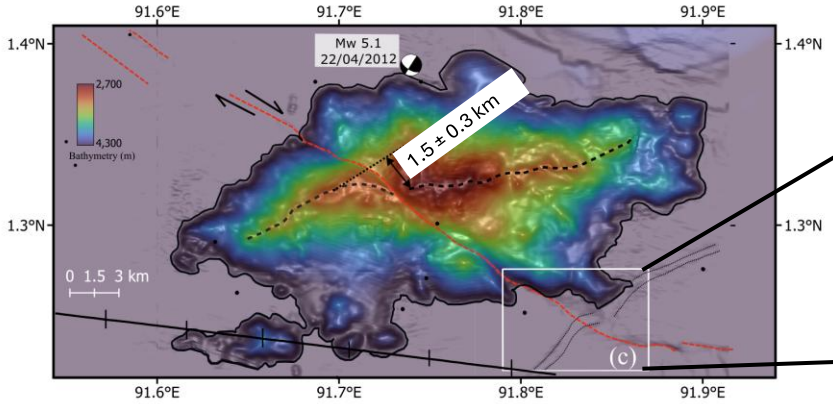


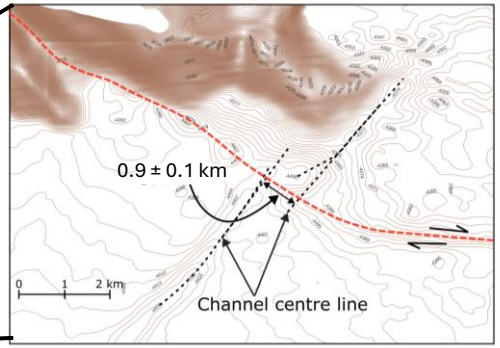

(a) Pull-apart basin

# Results: Surface deformation along RF3

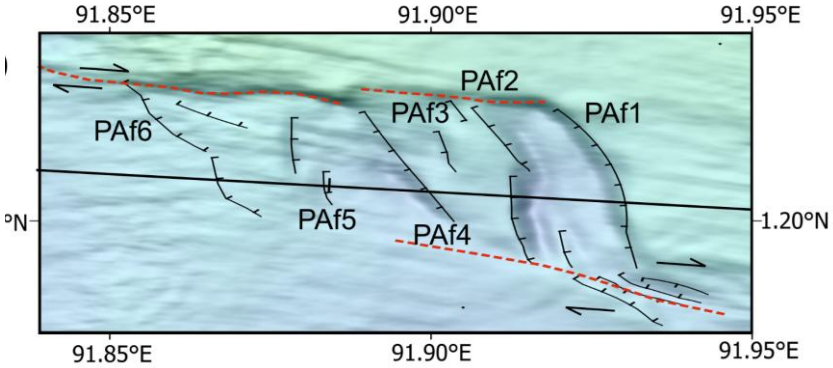



(b) Seamount




Small channel offset




(a) Pull-apart basin

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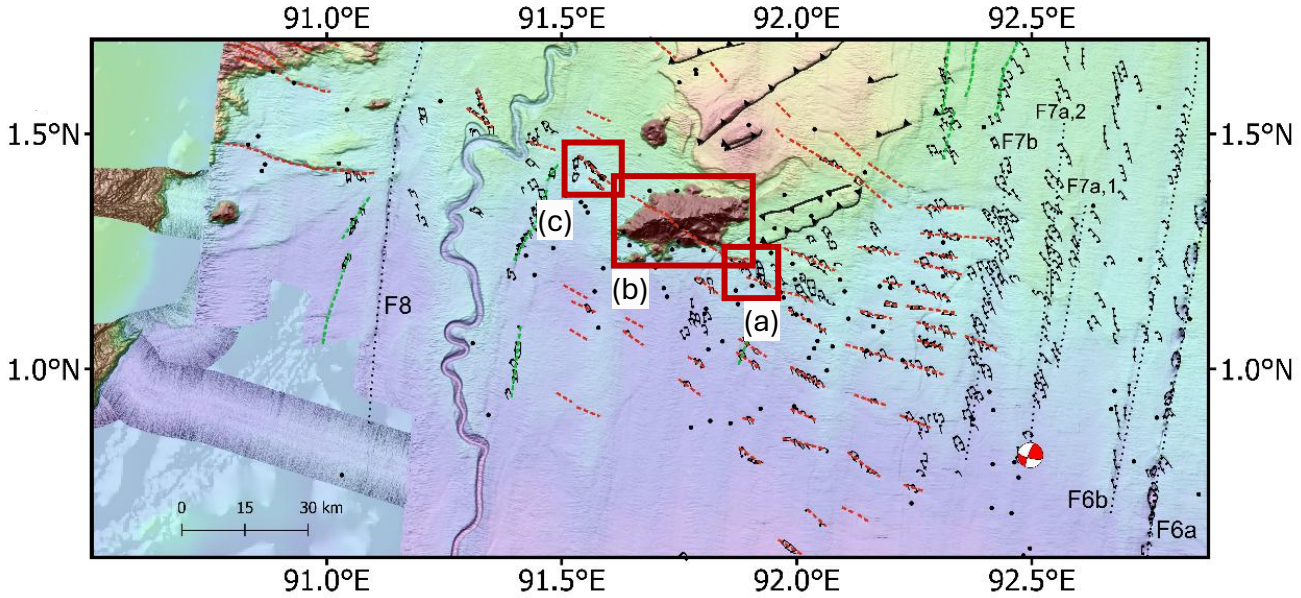
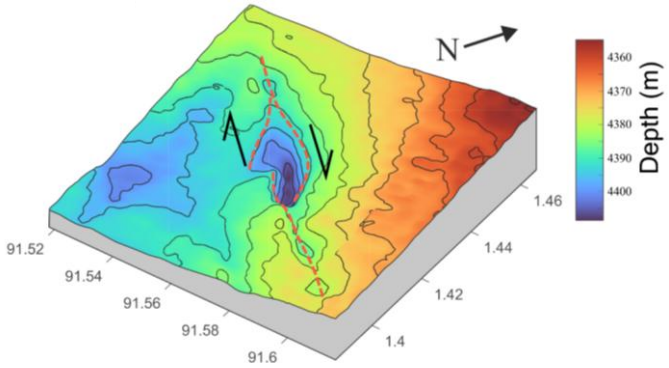
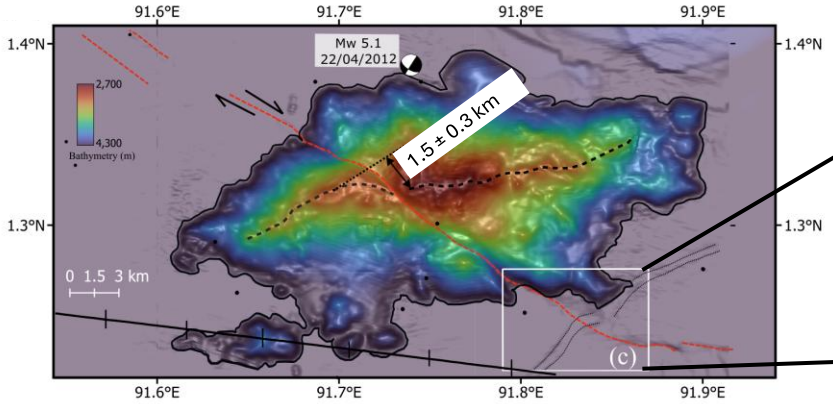
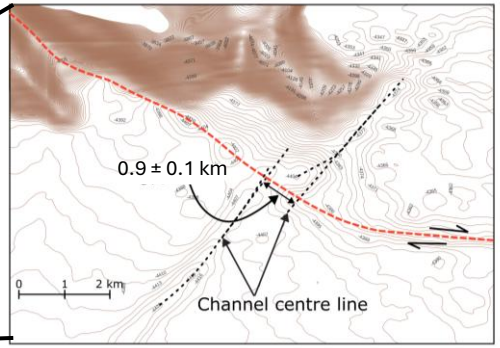


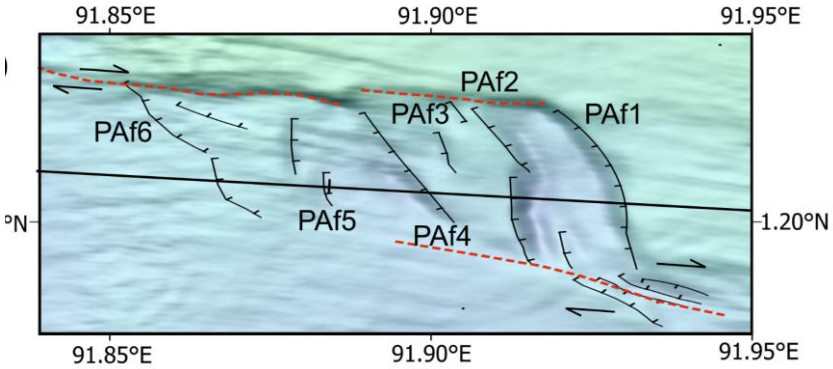

(c) (A lazy) pull-apart basin




(b) Seamount

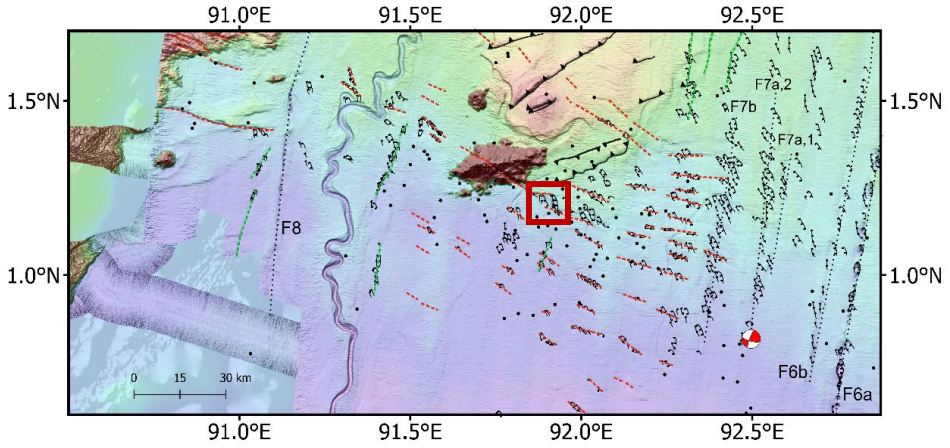


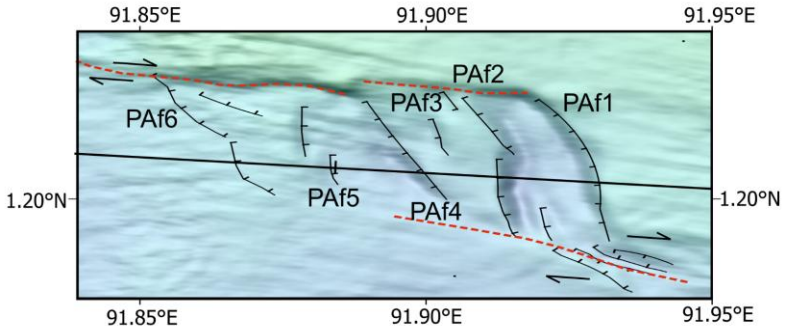

Small channel offset

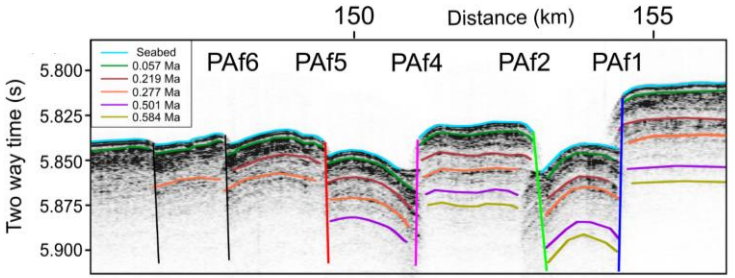


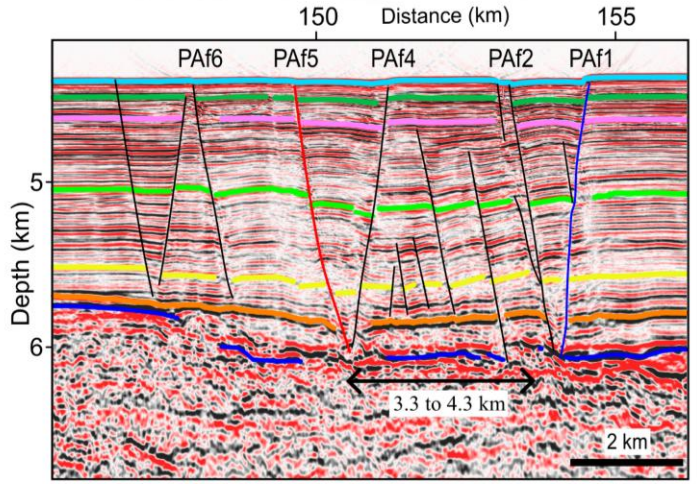

(a) Pull-apart basin

# Results: Subsurface deformation along RF3



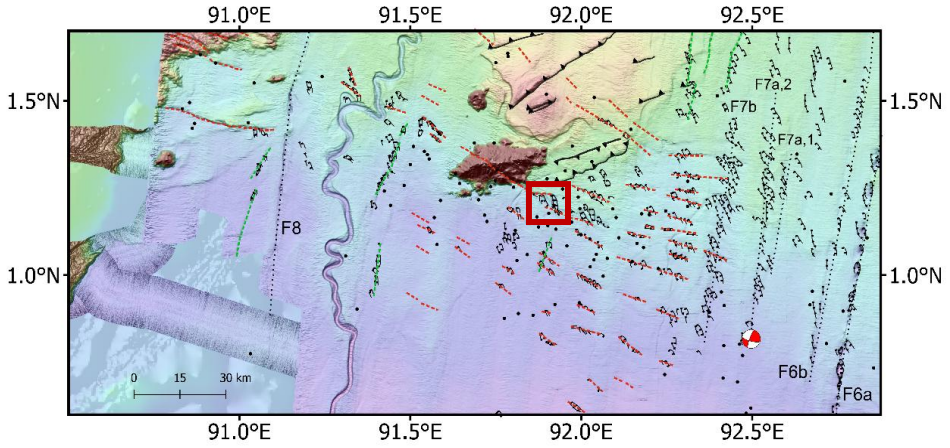



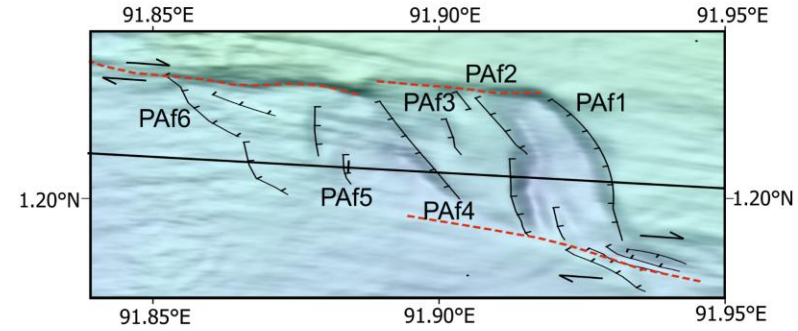



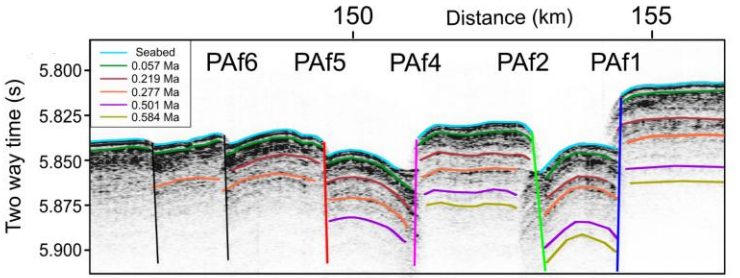

Seabed
1.8 Ma
3.6 Ma
5.5 Ma
7.1 Ma
9.5 Ma
Top Basement

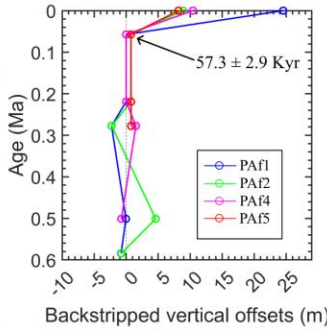
# Results: Subsurface deformation along RF3

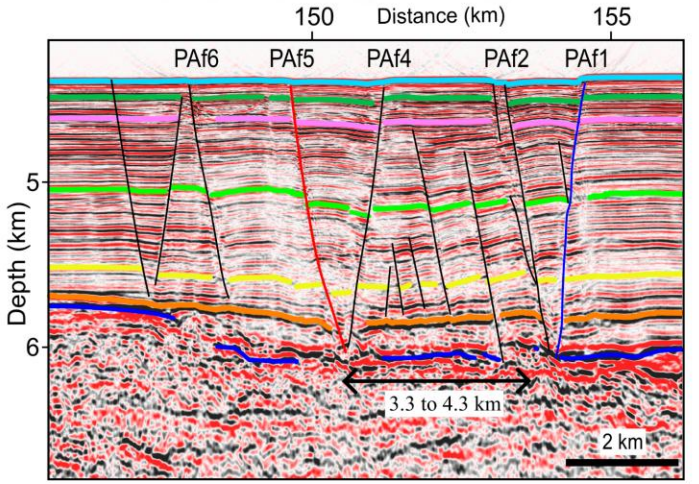


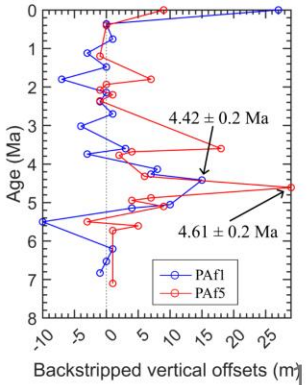

Onset of deformation ~ 4.5 Ma




Seabed
1.8 Ma
3.6 Ma
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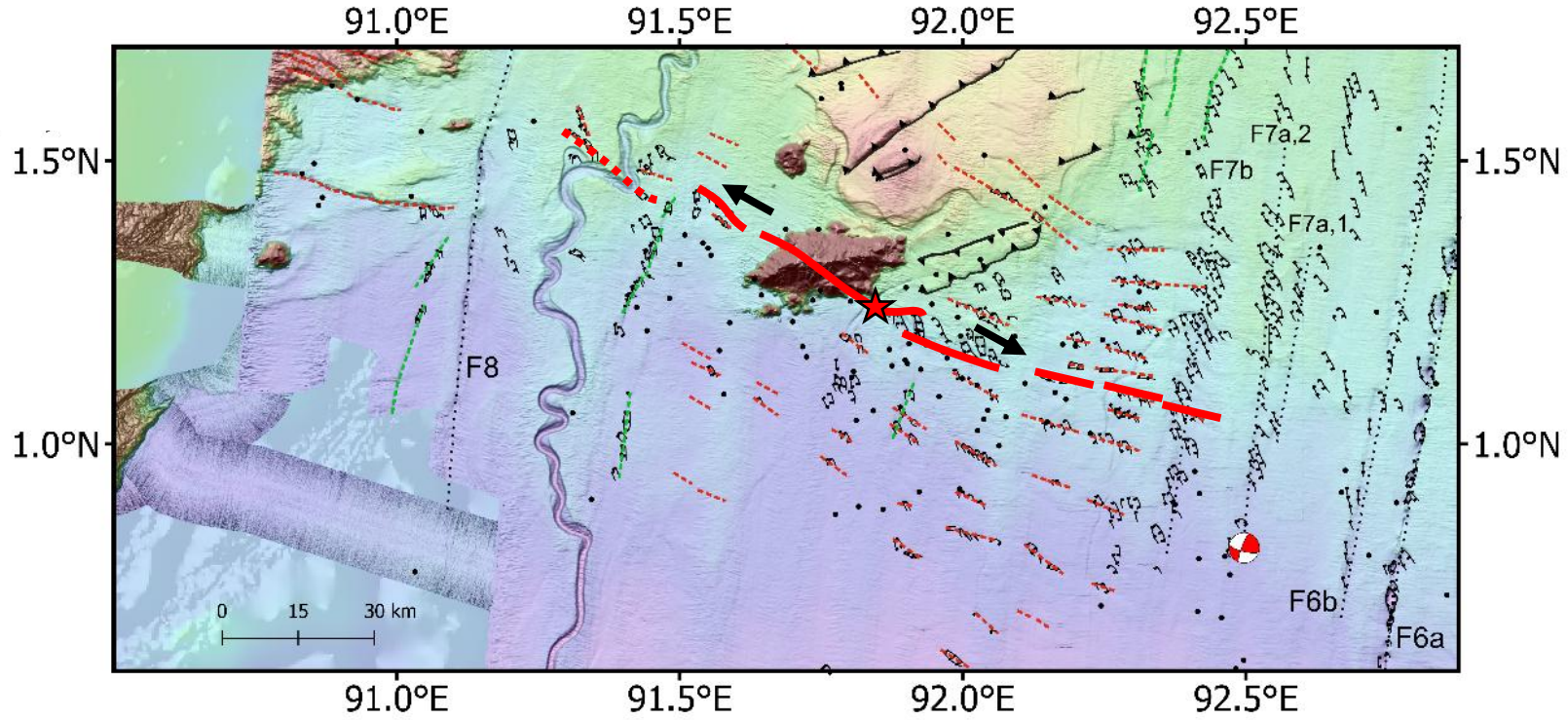
Top Basement

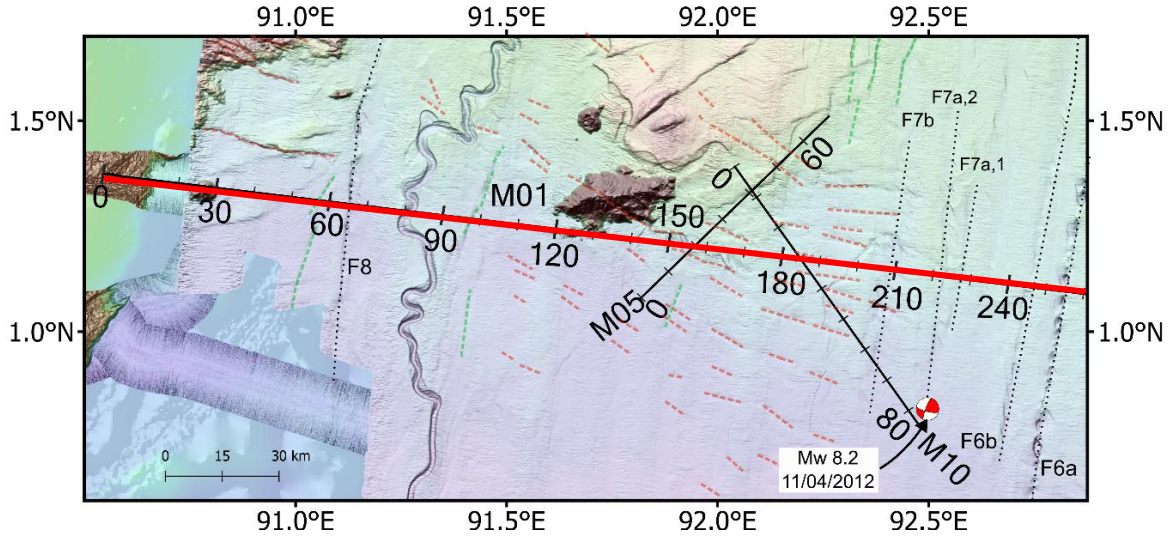
# Results: Surface expression of RF3



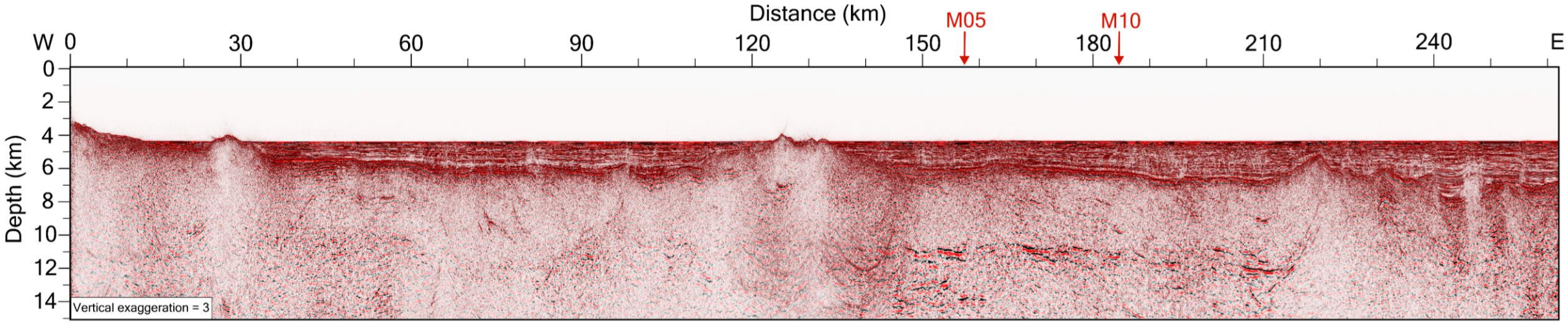

Total length of RF3 = ~130 km

Slip rate along RF3 = 0.3-0.7 mm/yr

# Results: Lithospheric scale deformation along RF3




- Clear vertical offsets in the sediments and the basement due to pervasive faulting.
- Dipping reflections in the crust and the upper mantle.
- Discontinuous moho reflections



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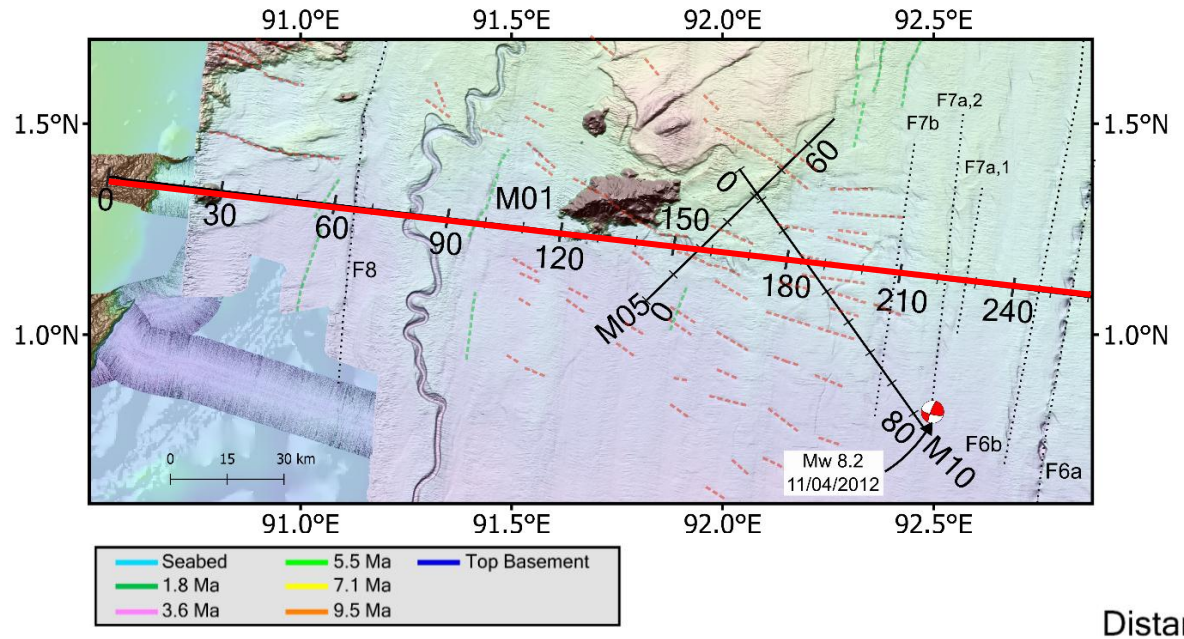
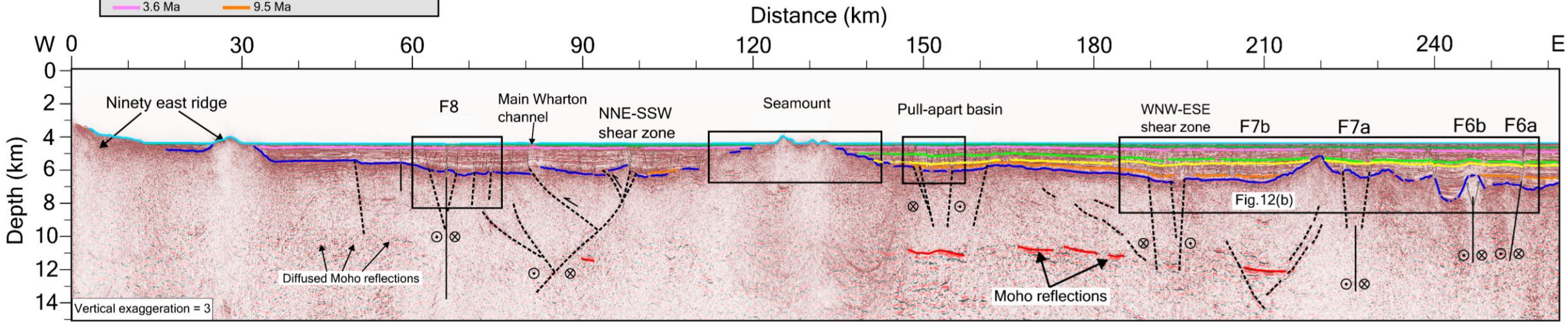



Brittle deformation down to the upper mantle



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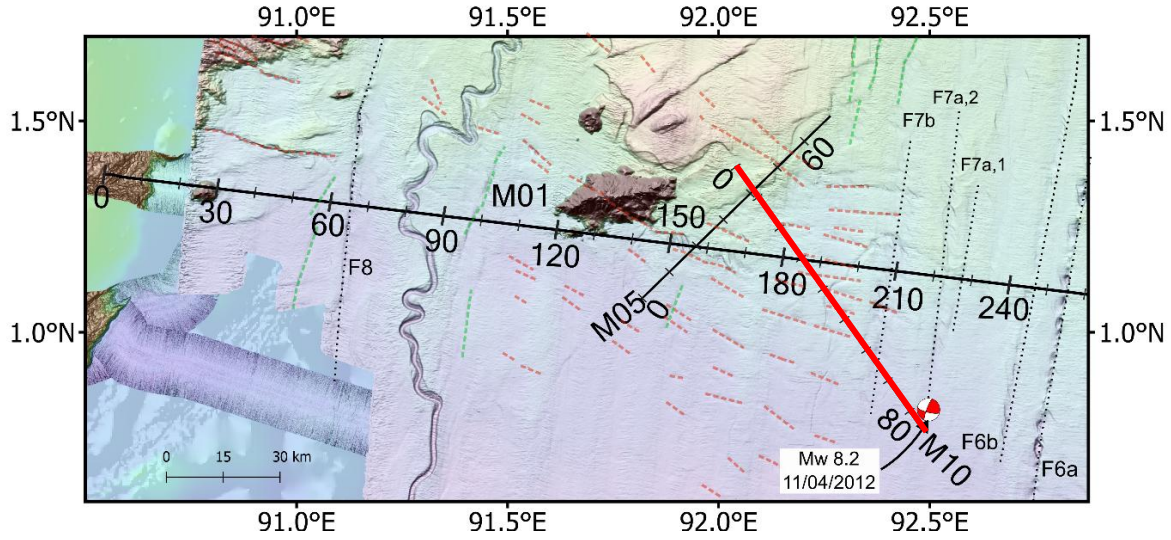


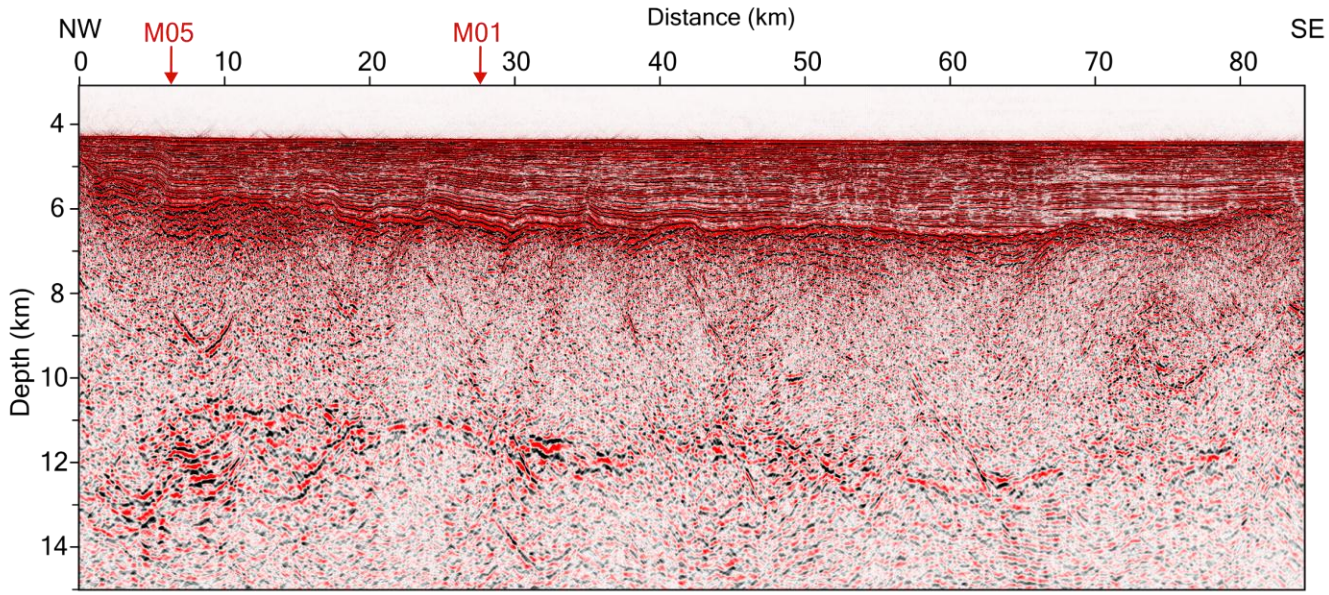

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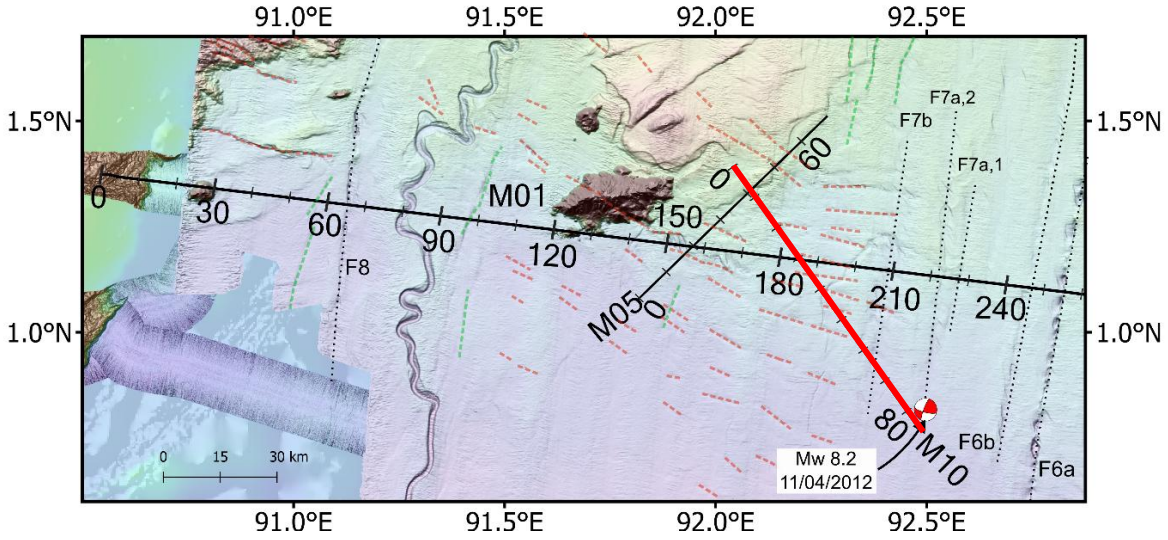
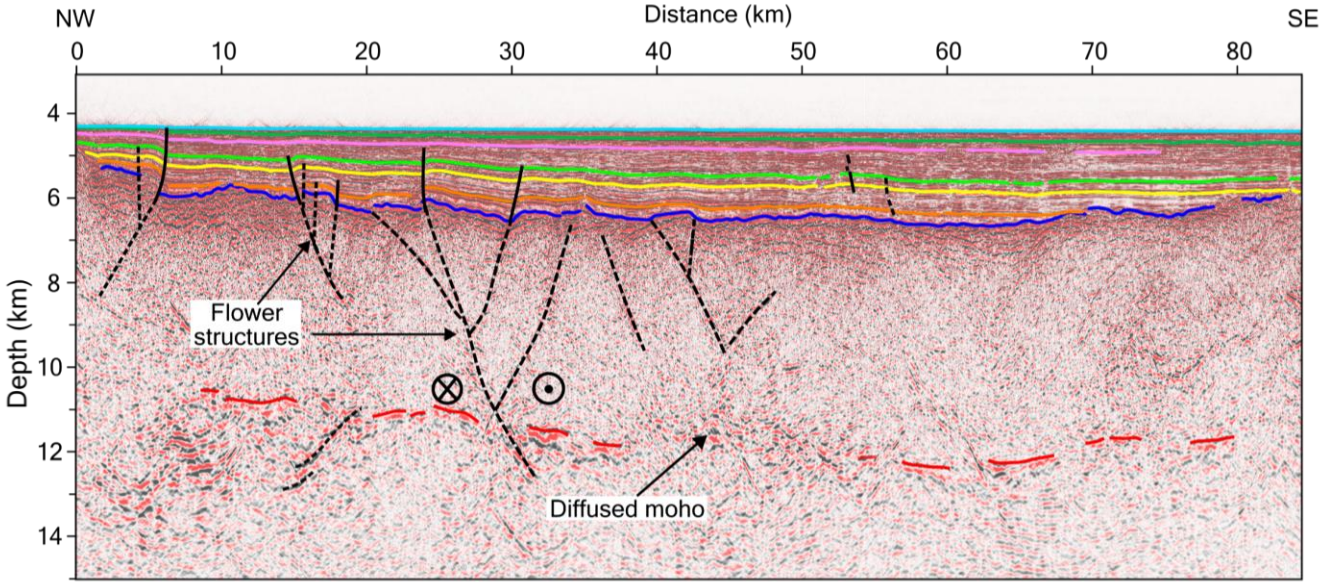
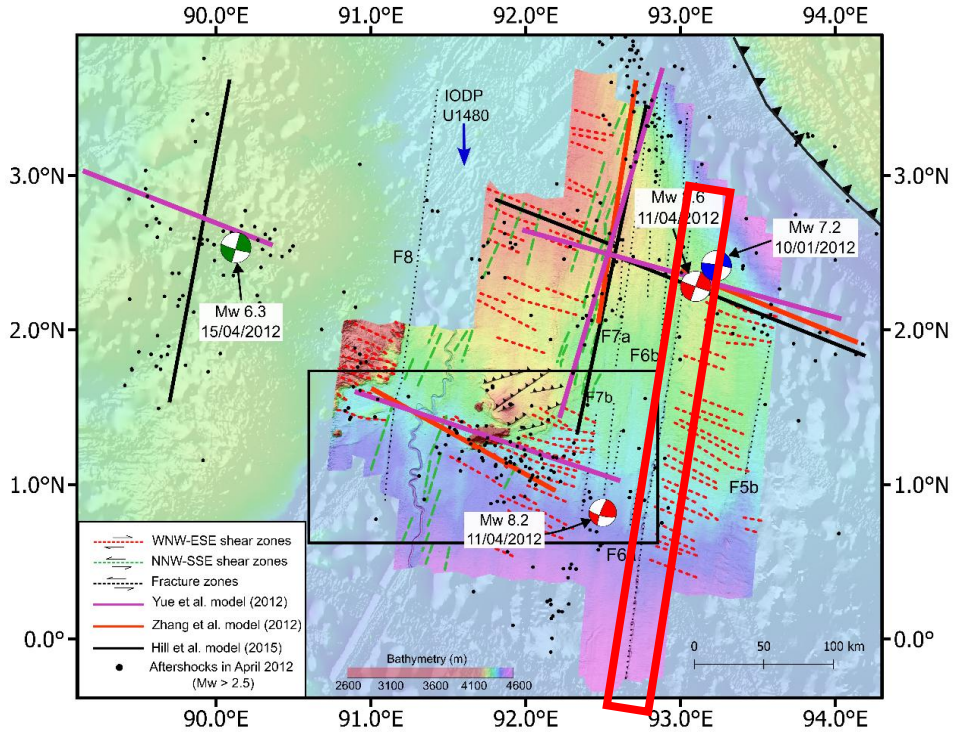


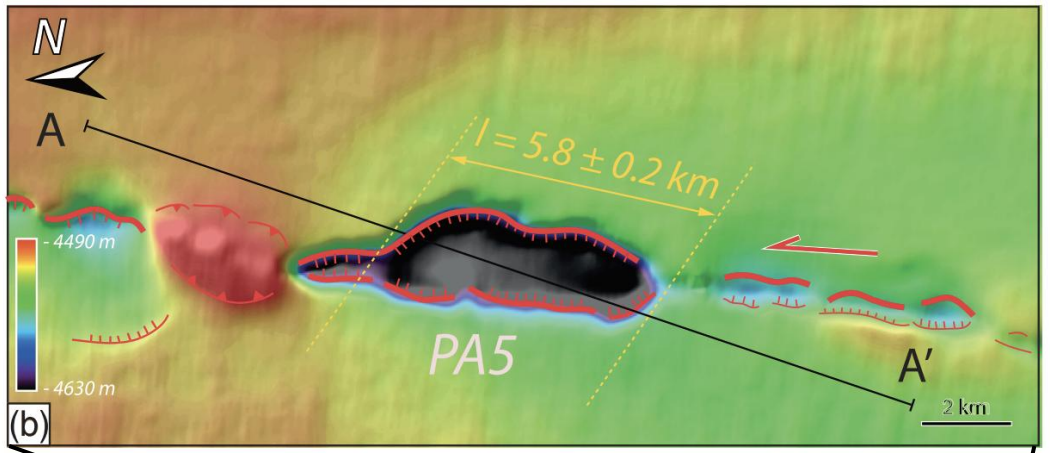



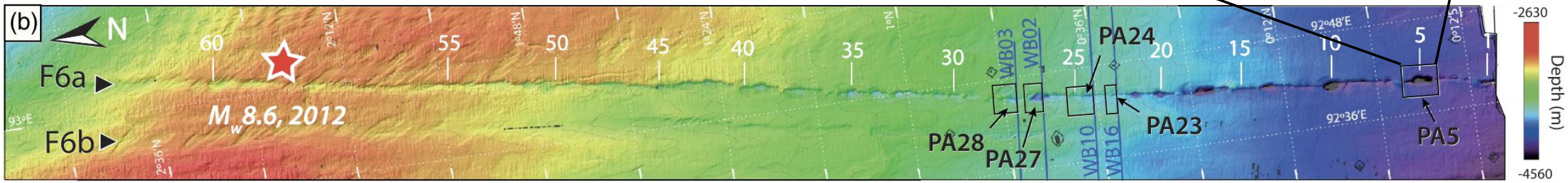
# Rupture of F6a: a nascent plate boundary?




Slip rate along F6a = 0.8 to 2.5 mm/yr

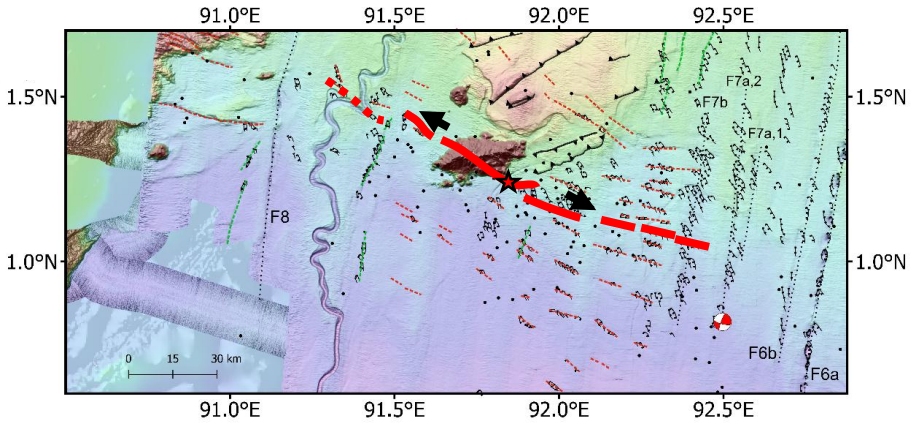
Coudrier-curveur et al. (2021)

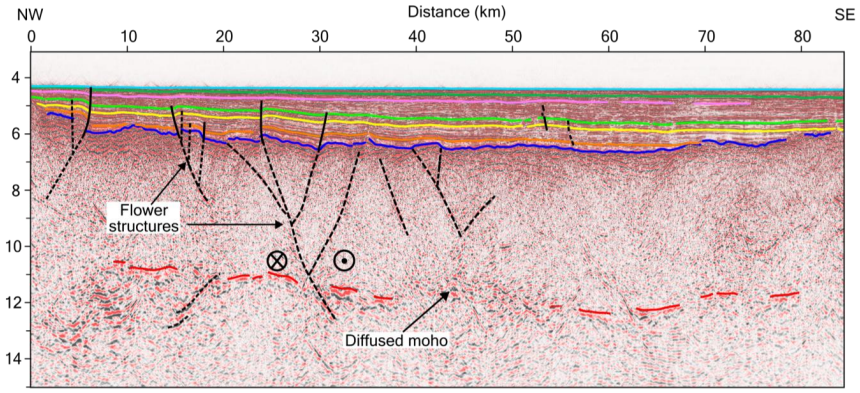


# Conclusions

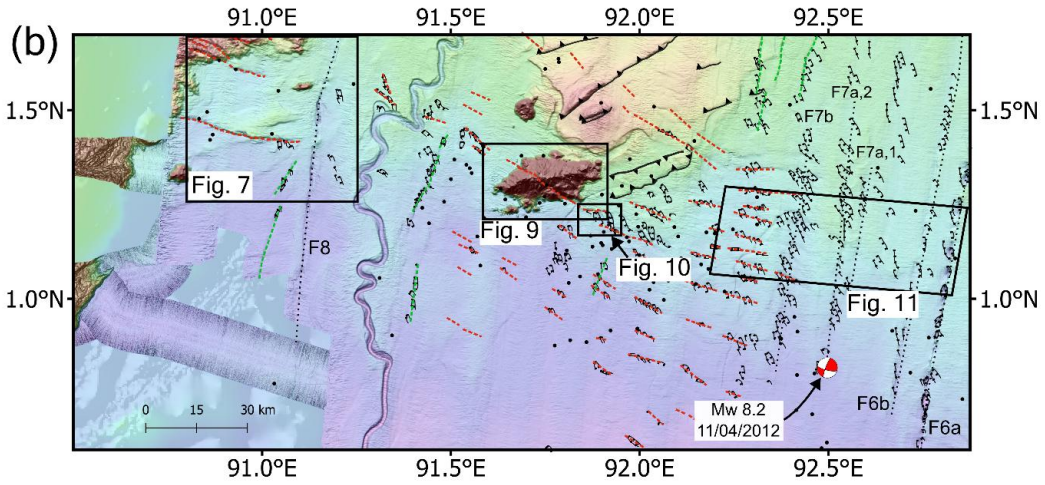
- Very slow long term slip rates (0.3-0.7 mm/yr) along a WNW-ESE fault involved in the 2012 Mw 8.6 Wharton basin earthquake.
- Direct evidence of deep lithospheric scale deformation in Wharton basin along **supposedly younger** WNW-ESE faults.
- Important role of RF3 in the rupture  of the Mw 8.2 event.

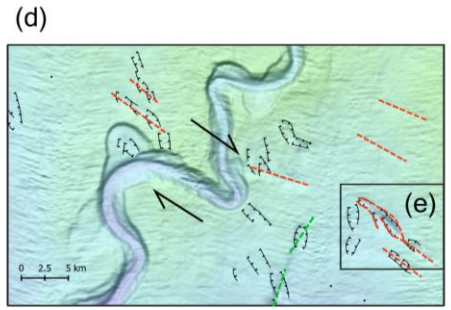


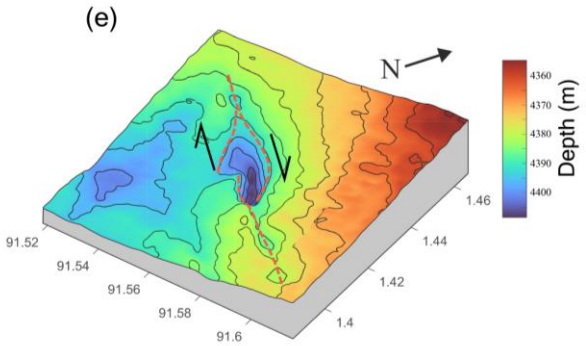



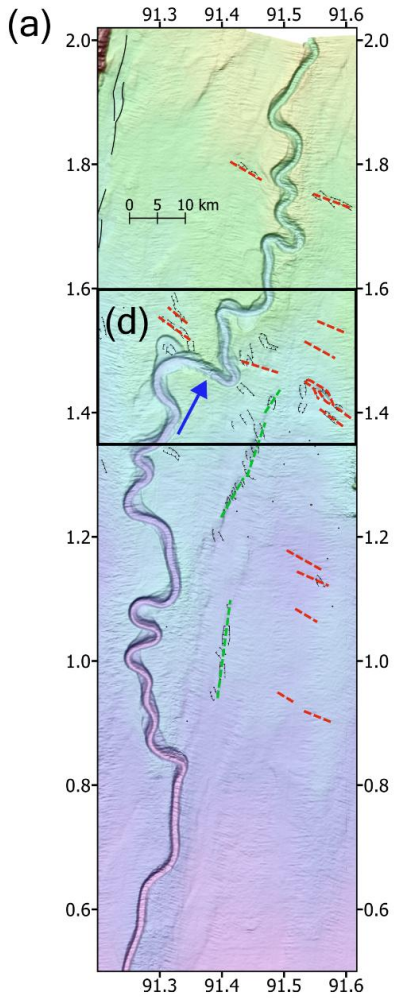
# Thank you

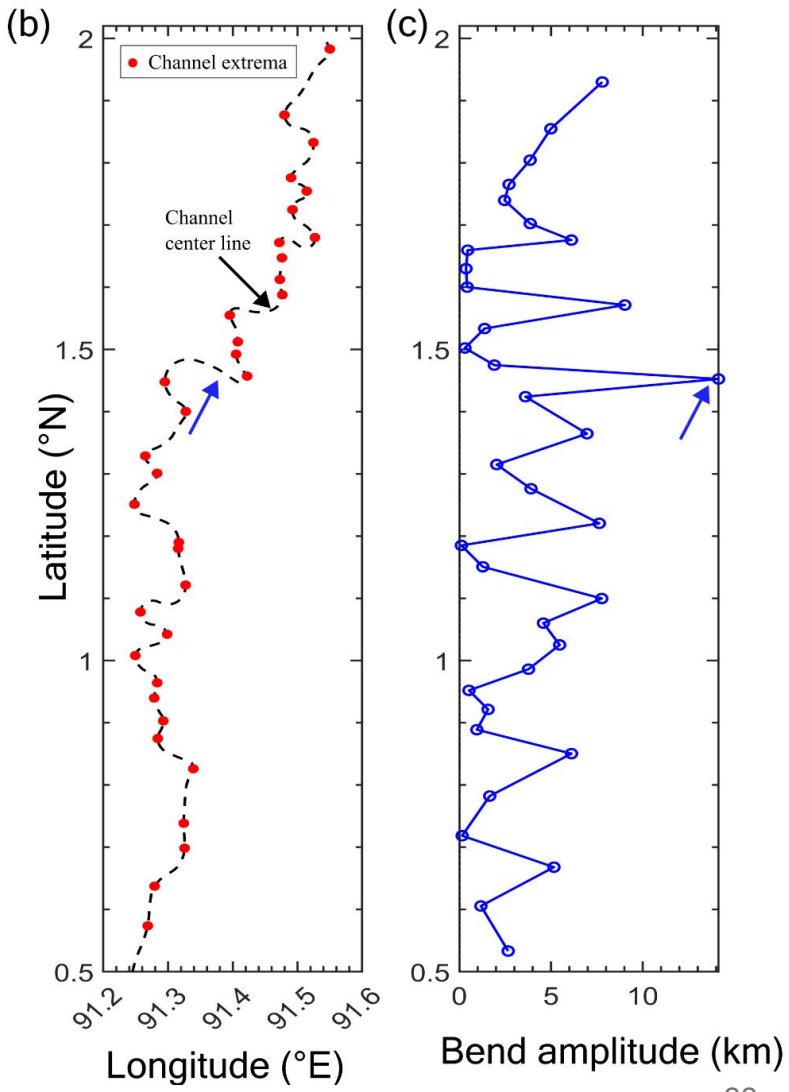
# Results: Surface deformation along RF3



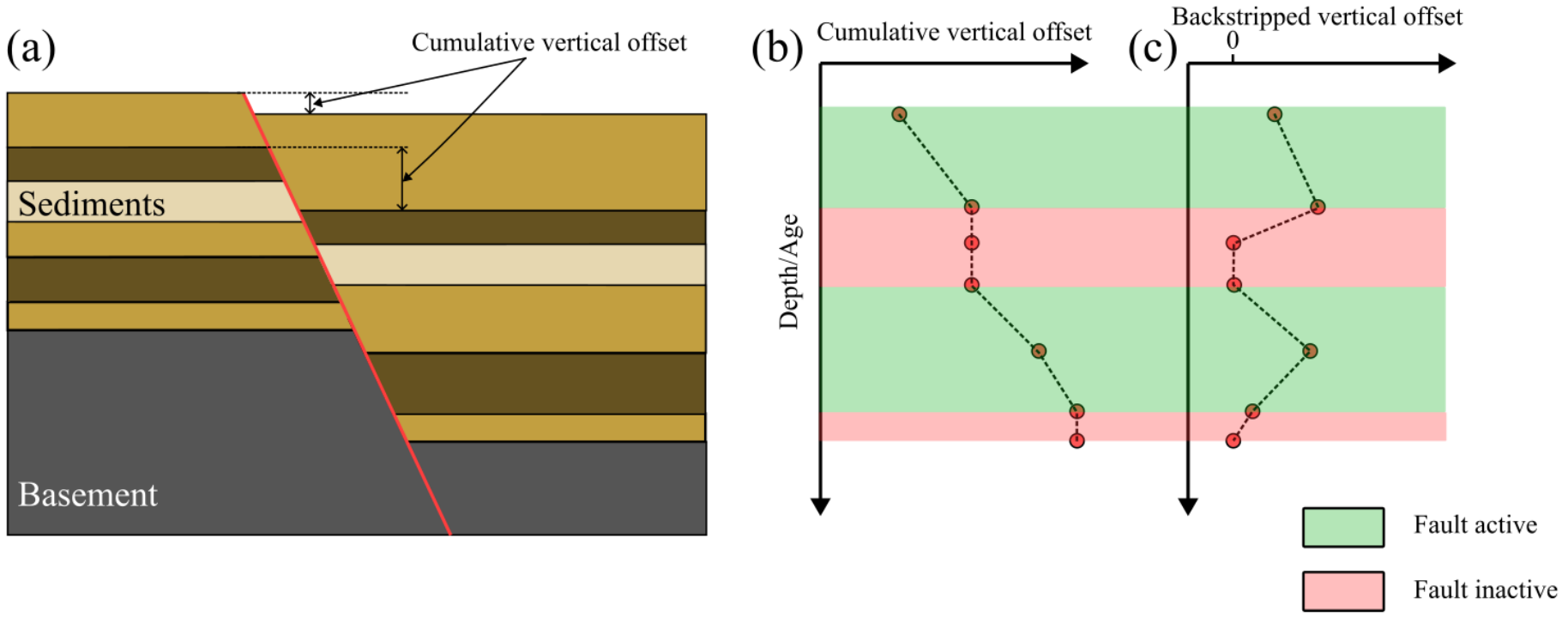



# Throw vs age analysis



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