Geophysical Investigation of Subduction Initiation in the Matthew-Hunter Trench

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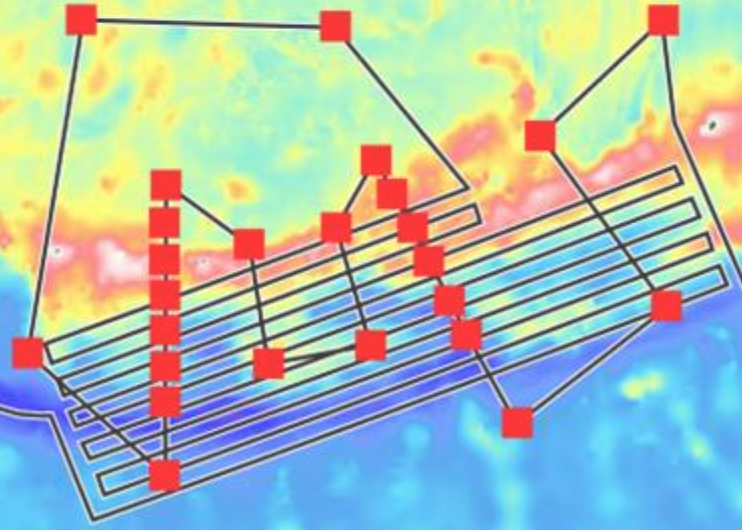
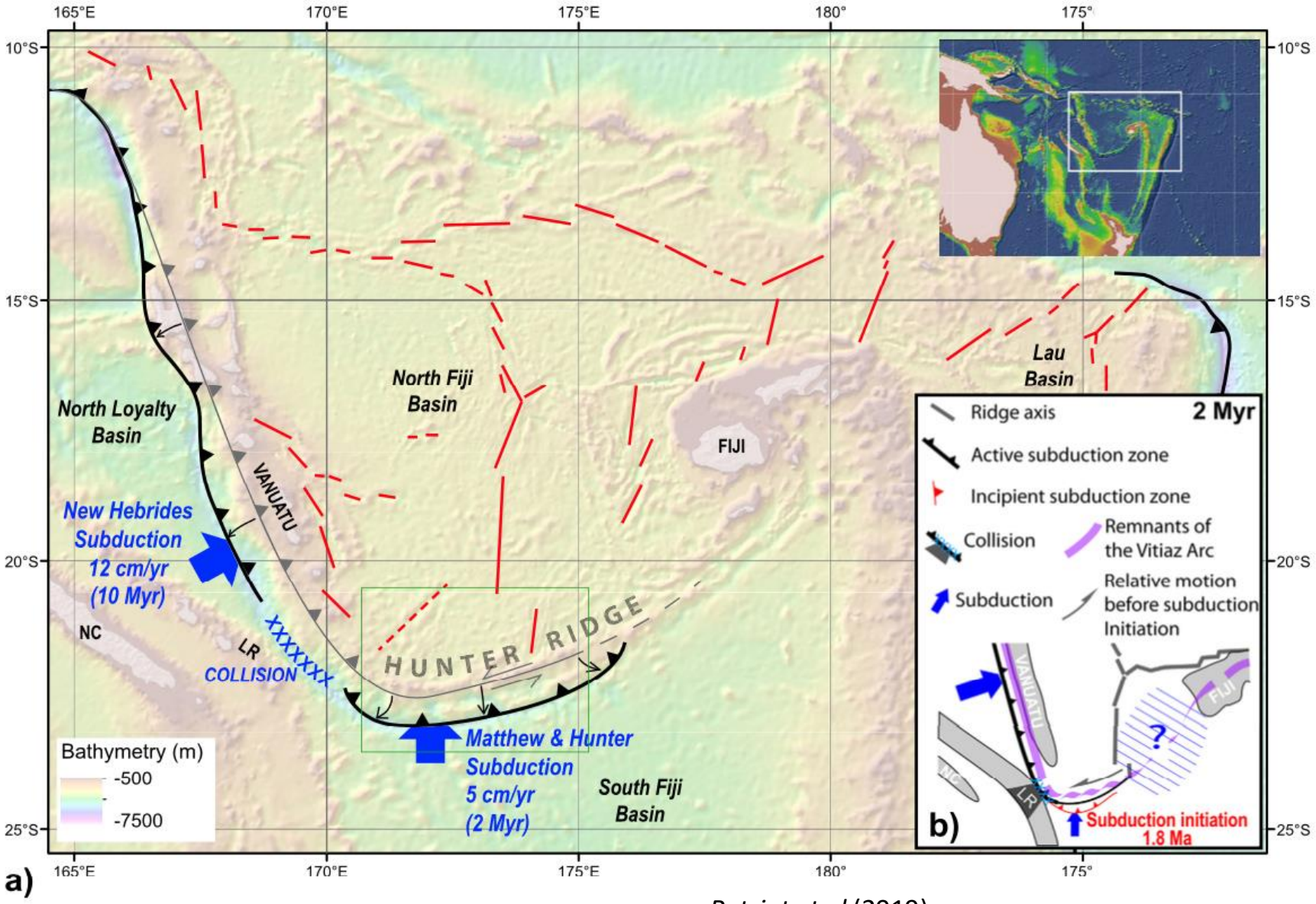


Tectonic Setting – Southernmost Vanuatu (Matthew-Hunter) Subduction Zone

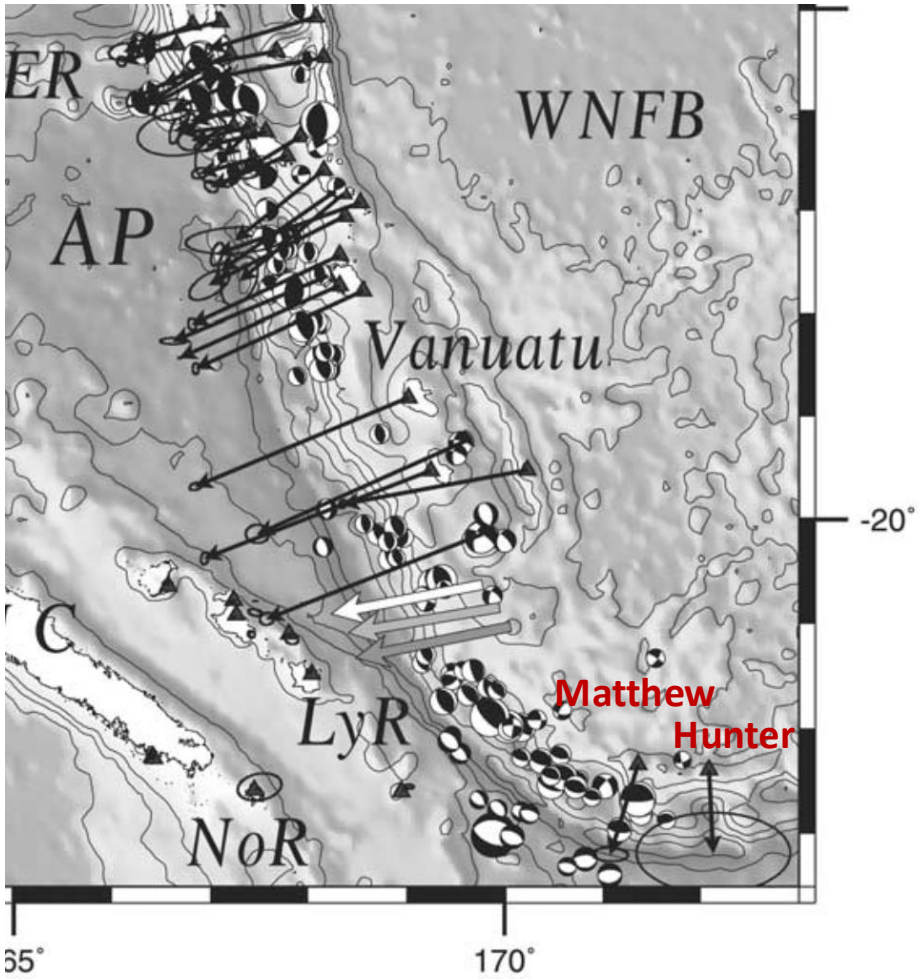


Patriat et al (2019)

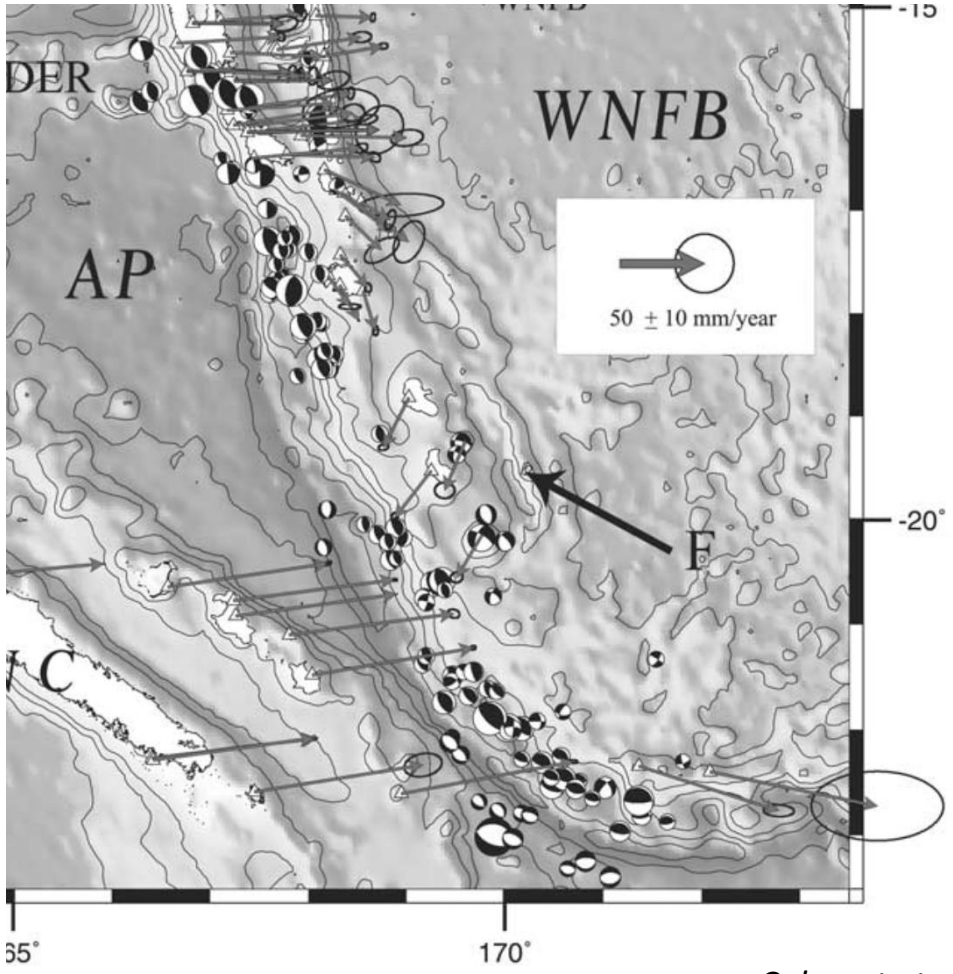
- Complex plate geometry in North Fiji Basin
- GNSS measurements show current subduction at 5 cm/y

GNSS Measurements – Matthew & Hunter Is

Australia Fixed



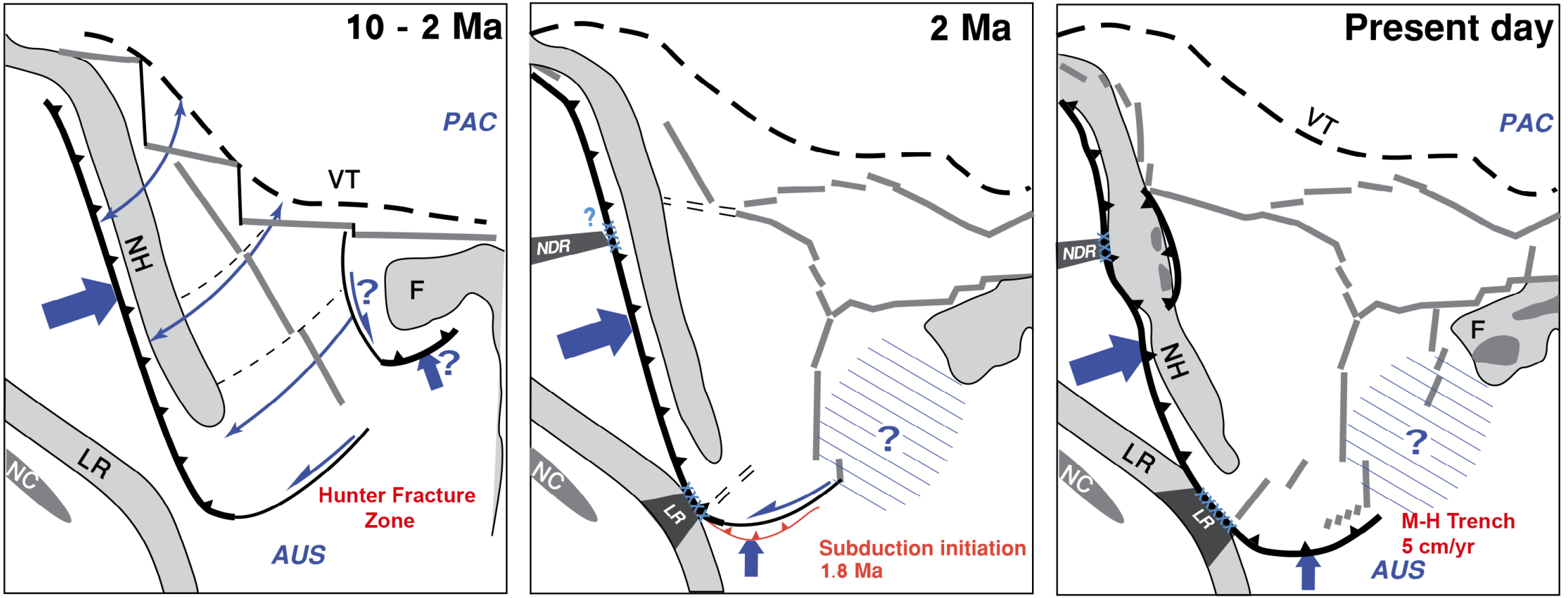
Western North Fiji Basin Fixed



Calmant et al [2003]

- Matthew & Hunter on a separate plate from the rest of South Vanuatu
- Motion is near-orthogonal, 5 cm/yr along the trench

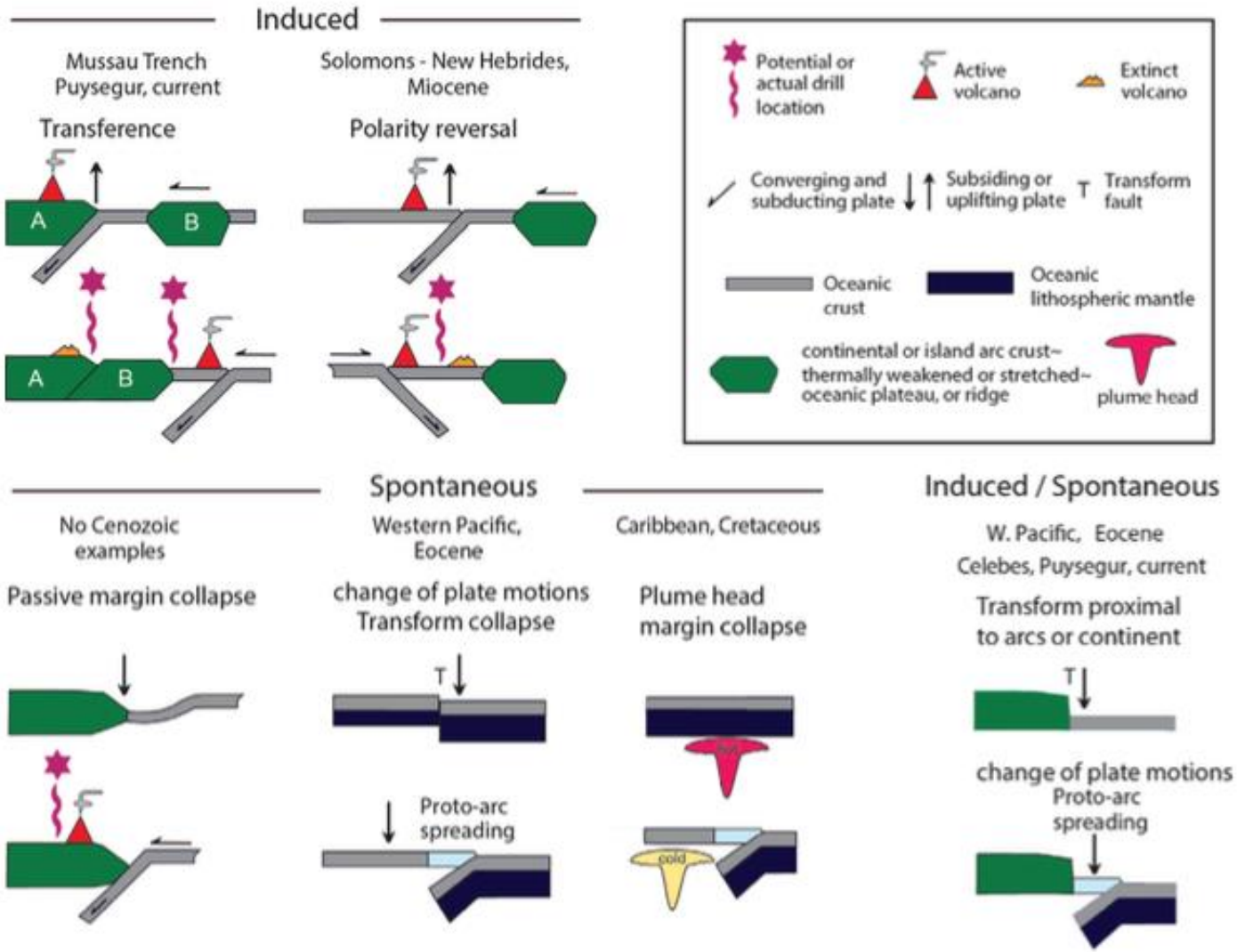
Subduction Initiation – Matthew Hunter Trench



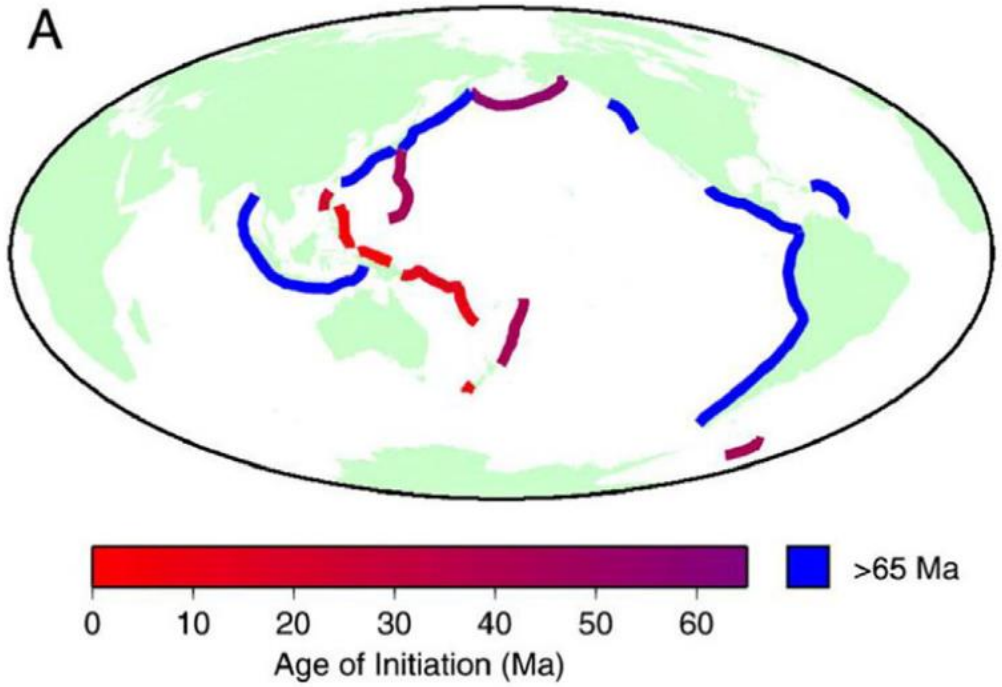
- Convergence started along the Hunter Fracture zone about 1.8 Ma
- Likely due to the collision of the Loyalty Ridge with the Vanuatu Trench
- Led to changes in the motion of backarc microplates

After Patriat et al (2015)

Observed Types of Subduction Initiation



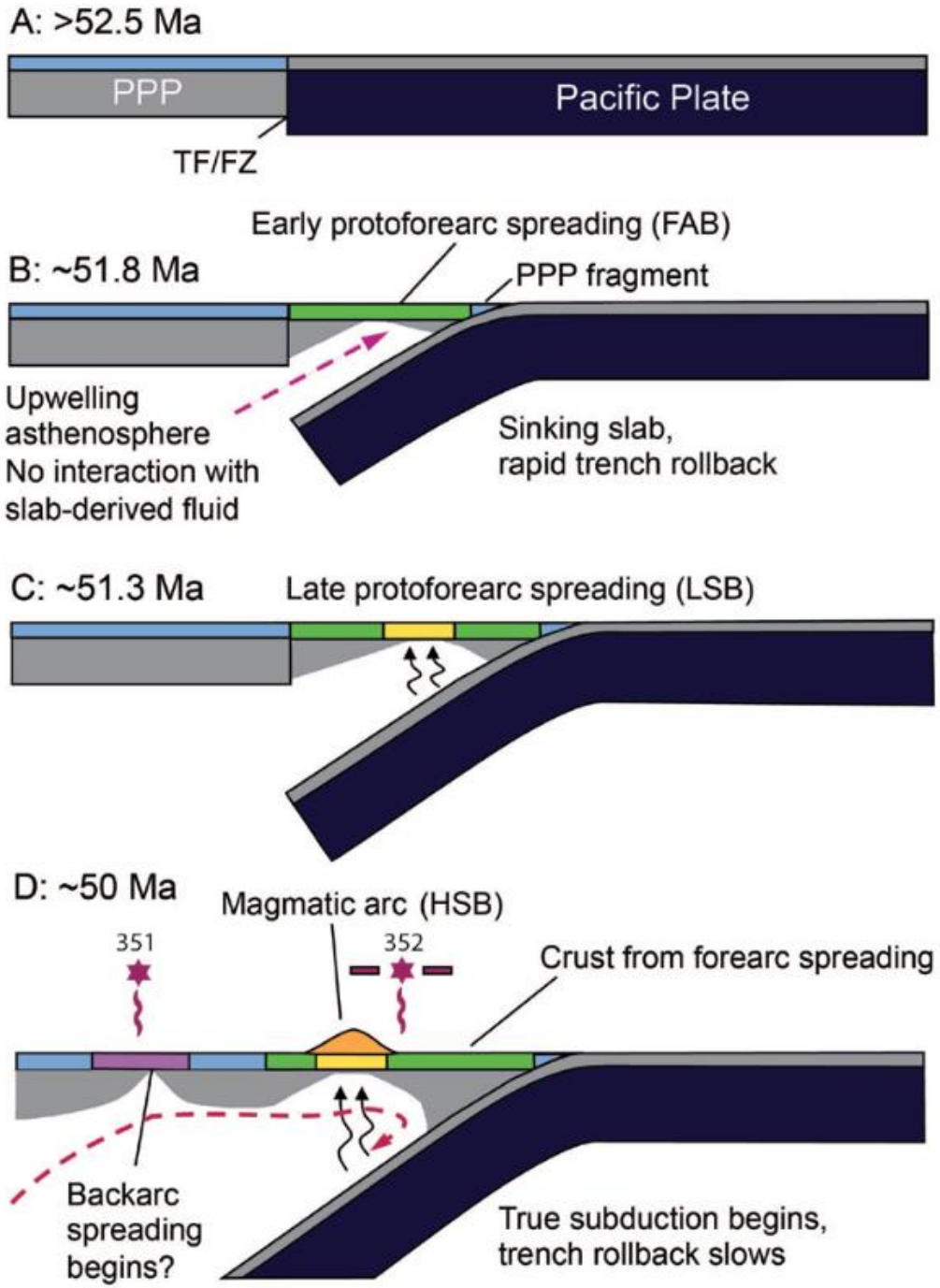
Arculus et al (2019)



Gurnis et al (2004)

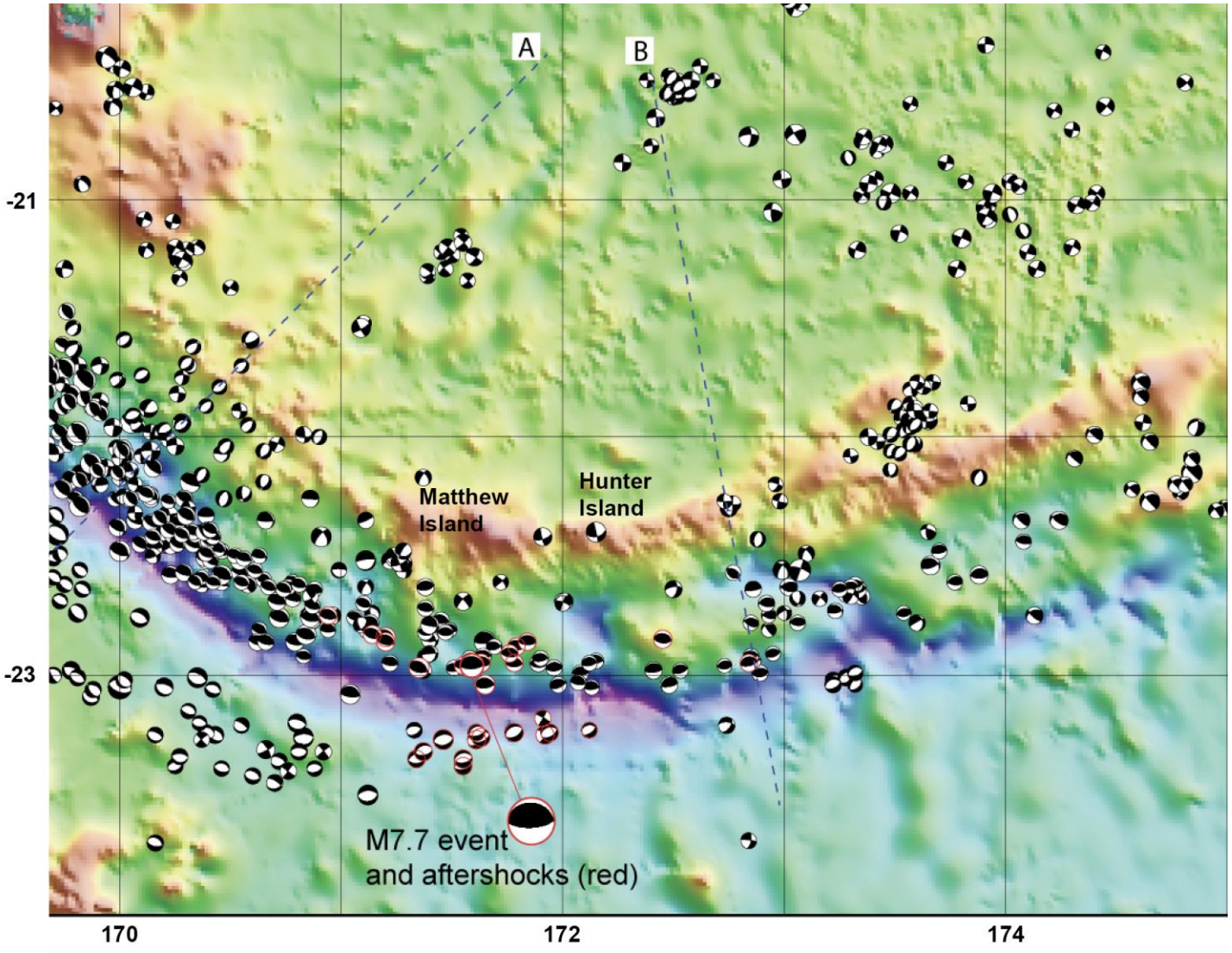
Subduction Initiation along a transform fault - the Mariana example

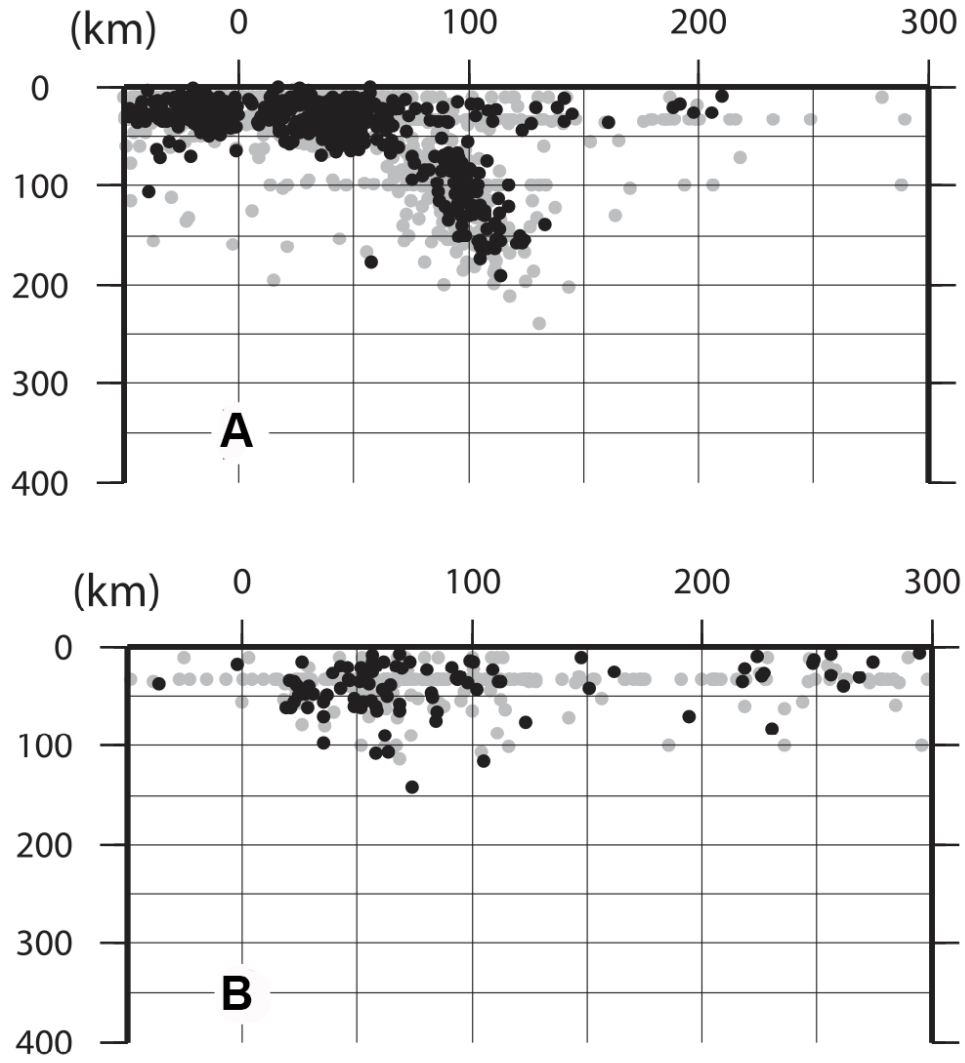
- Likely began as convergence along an oceanic transform
- A modern example of ongoing subduction initiation is needed to better constrain the process
- Matthew-Hunter initiated 1.8 Ma, shows the same petrology (Forearc basalts, boninites)



Reagan et al (2019)

Matthew-Hunter Earthquakes

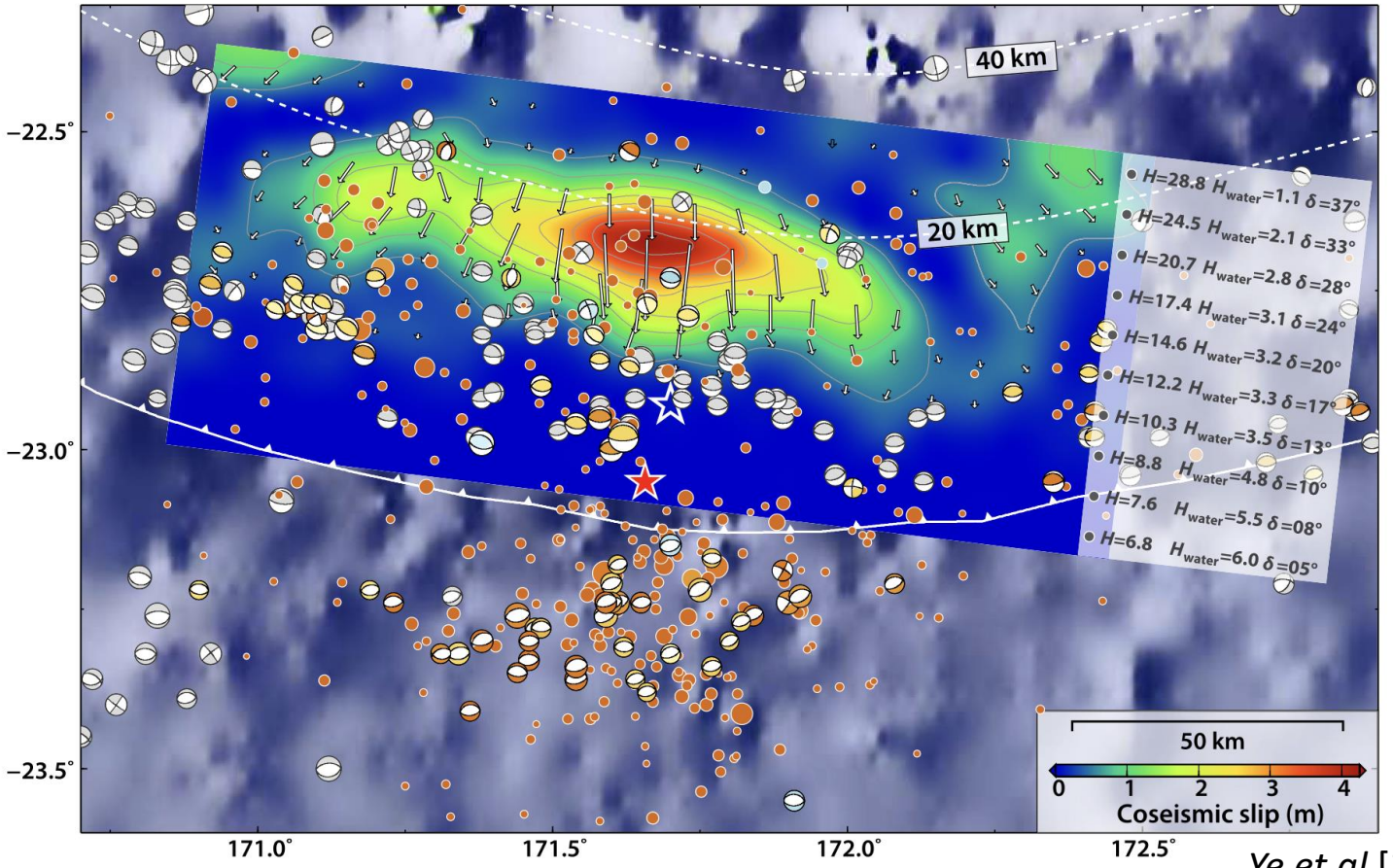




After *Patriat et al* [2015]

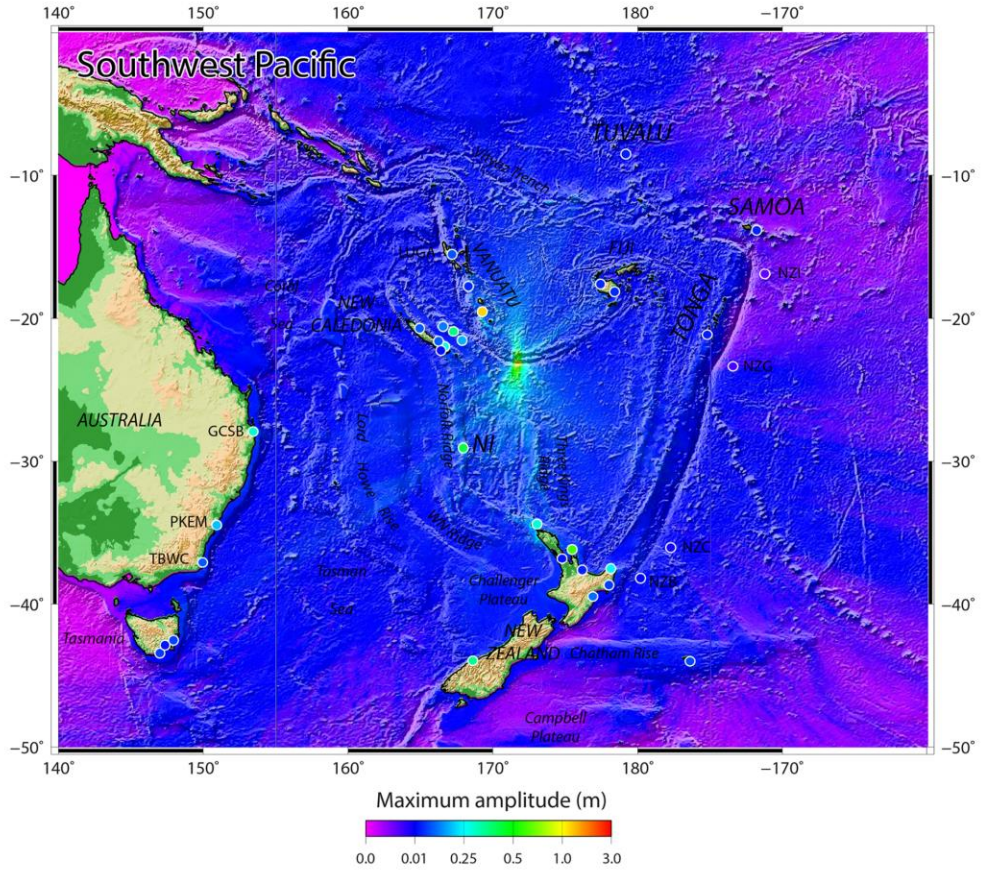
2021 Mw 7.7 Matthew-Hunter Earthquake

Finite-Fault Slip Model



Ye et al [2021]

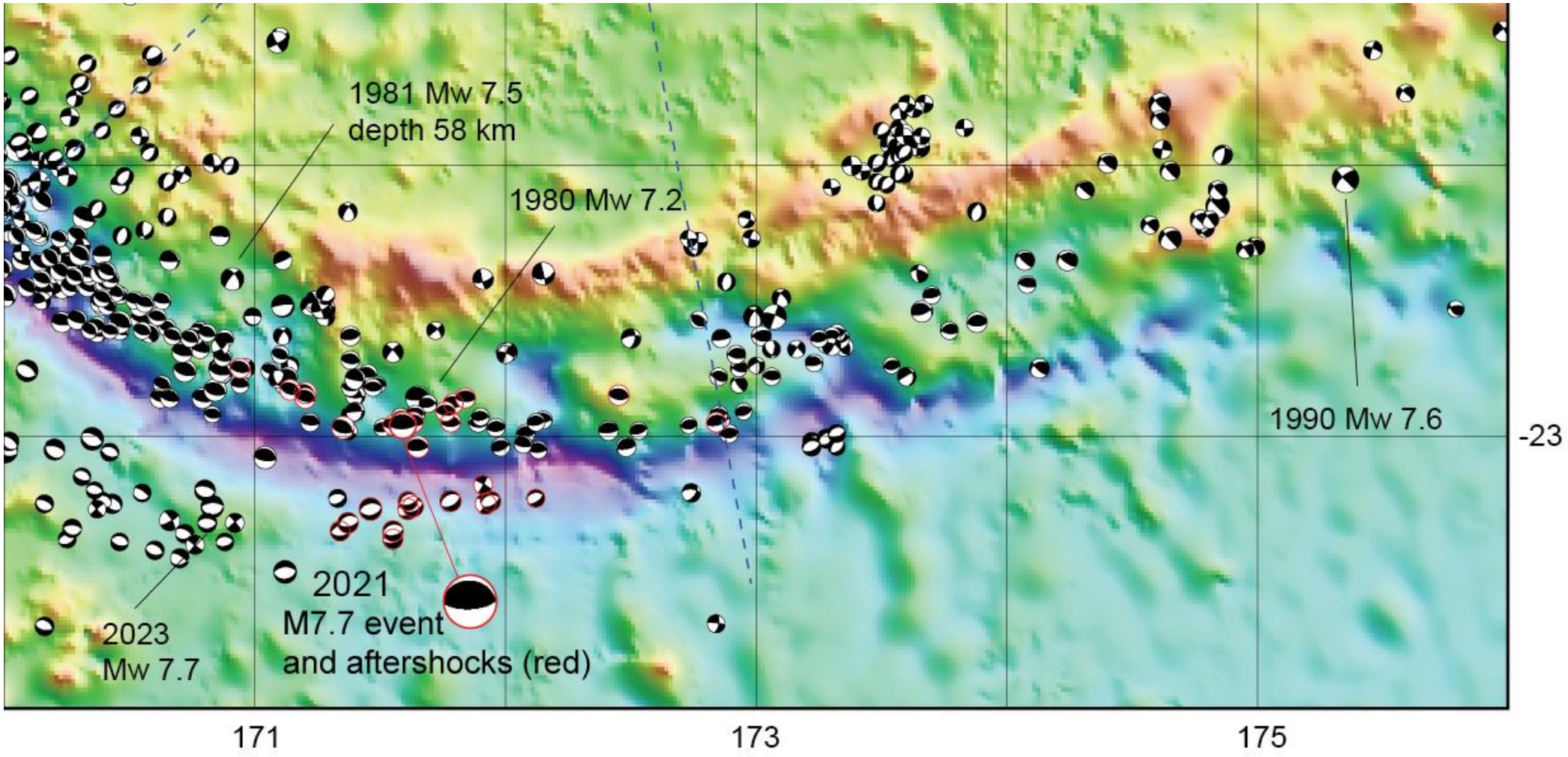
Tsunami Observations and Model



Roger et al [2023]

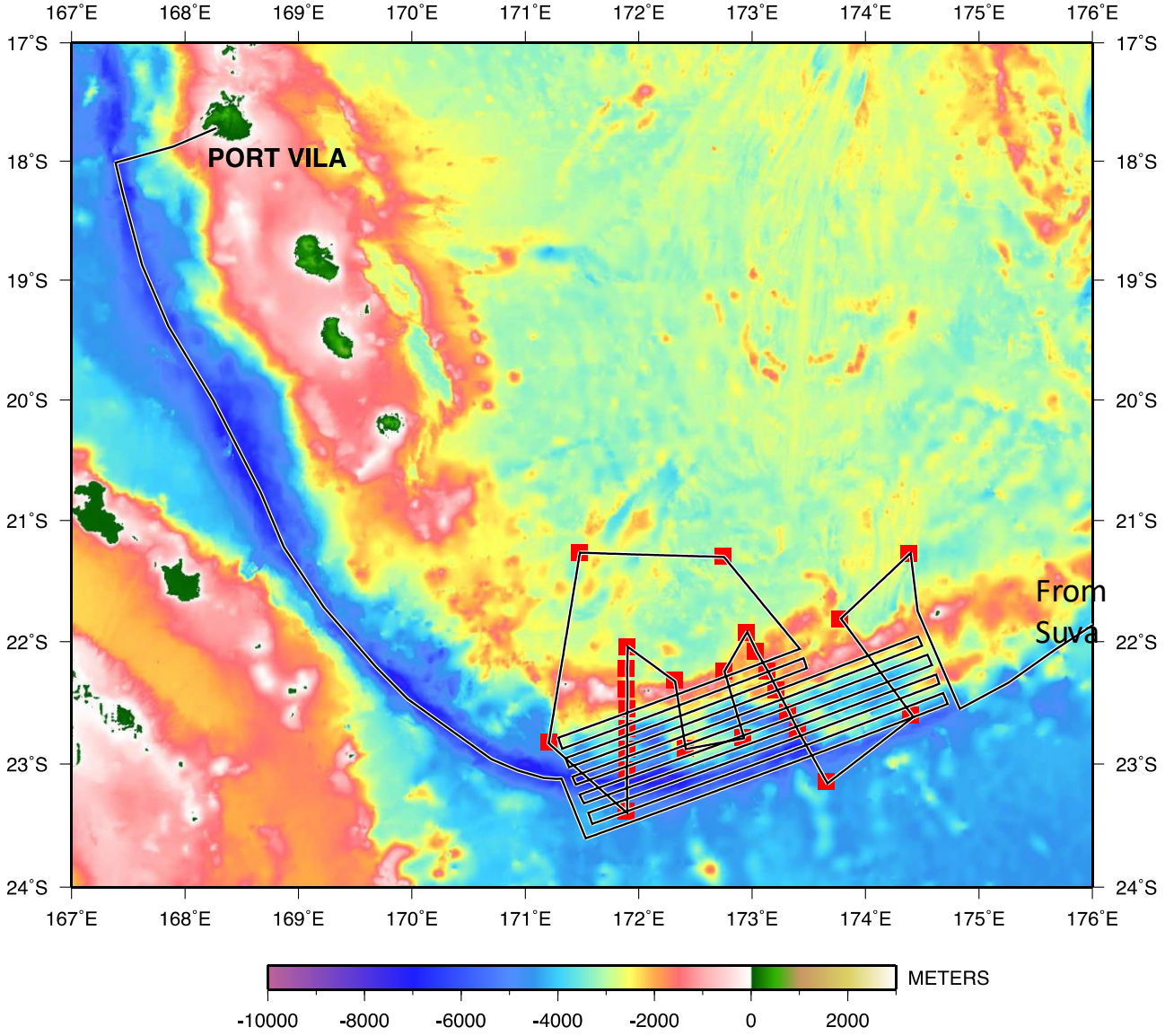
- Slip concentrated at shallow depths along thrust interface
- Produced a tsunami greater than 1 m at Tanna, Vanuatu
- Generated many aftershocks, including in the outer rise

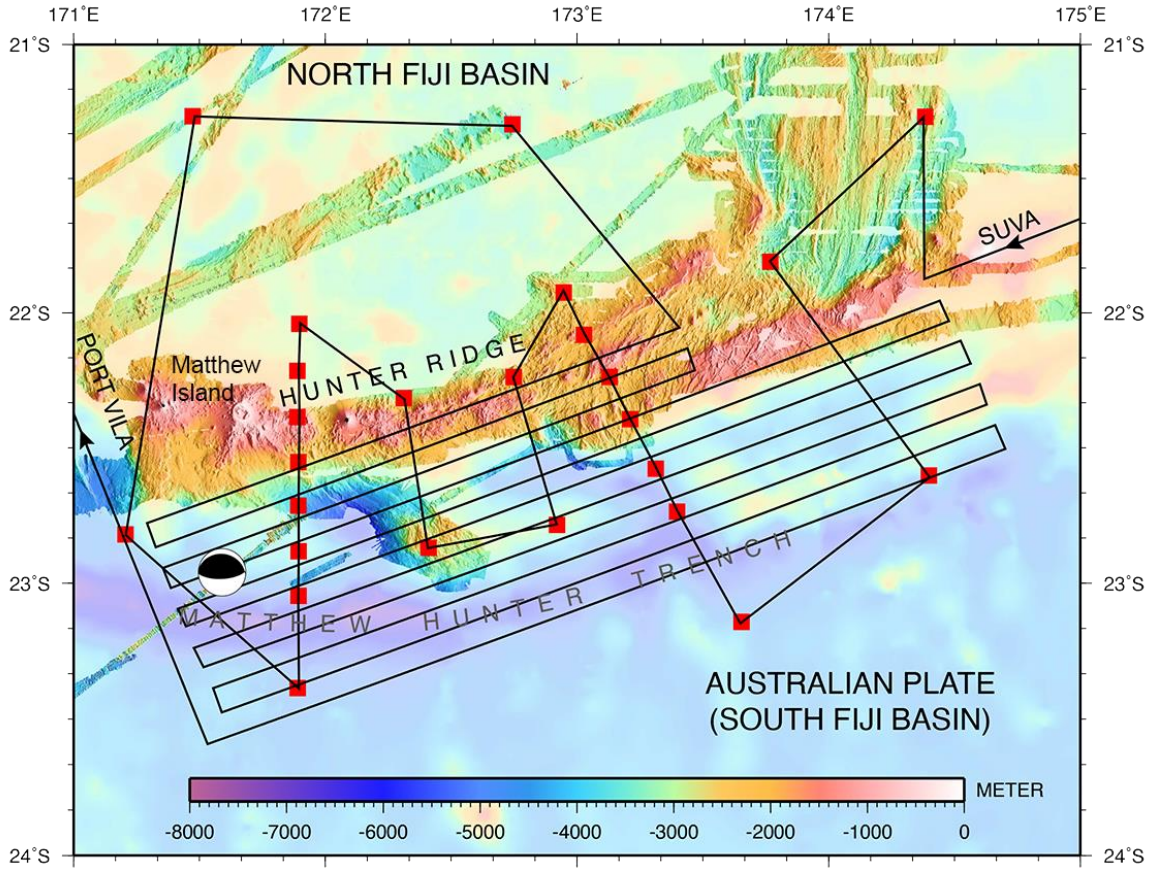
Large Earthquakes along the M-H Trench



- Convergent section of the MHSZ extends to at least 174.5˚ E
- Transition to strike-slip motion seems to be distributed and poorly constrained

Planned OBS deployment and Marine Geophysical Survey

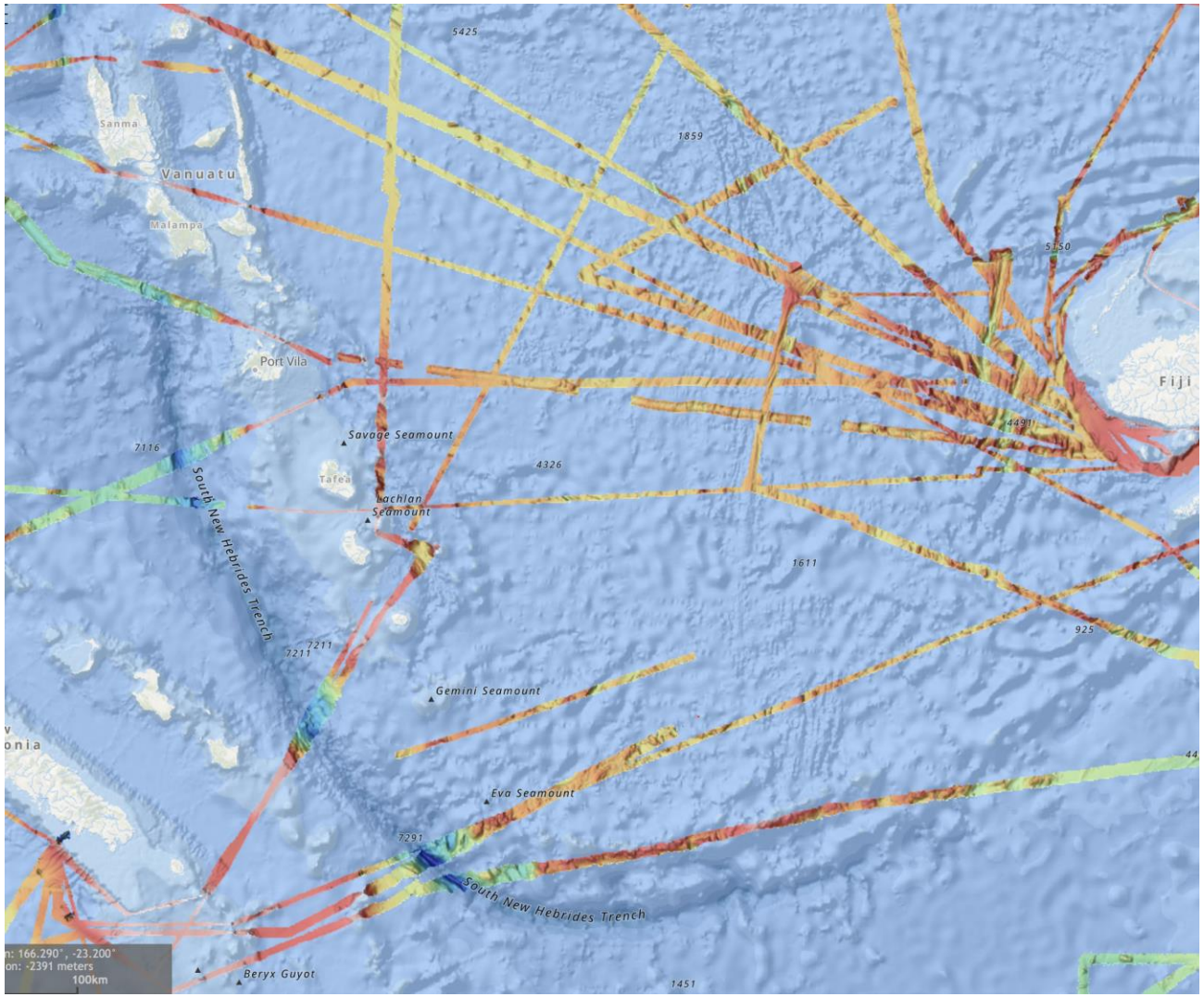




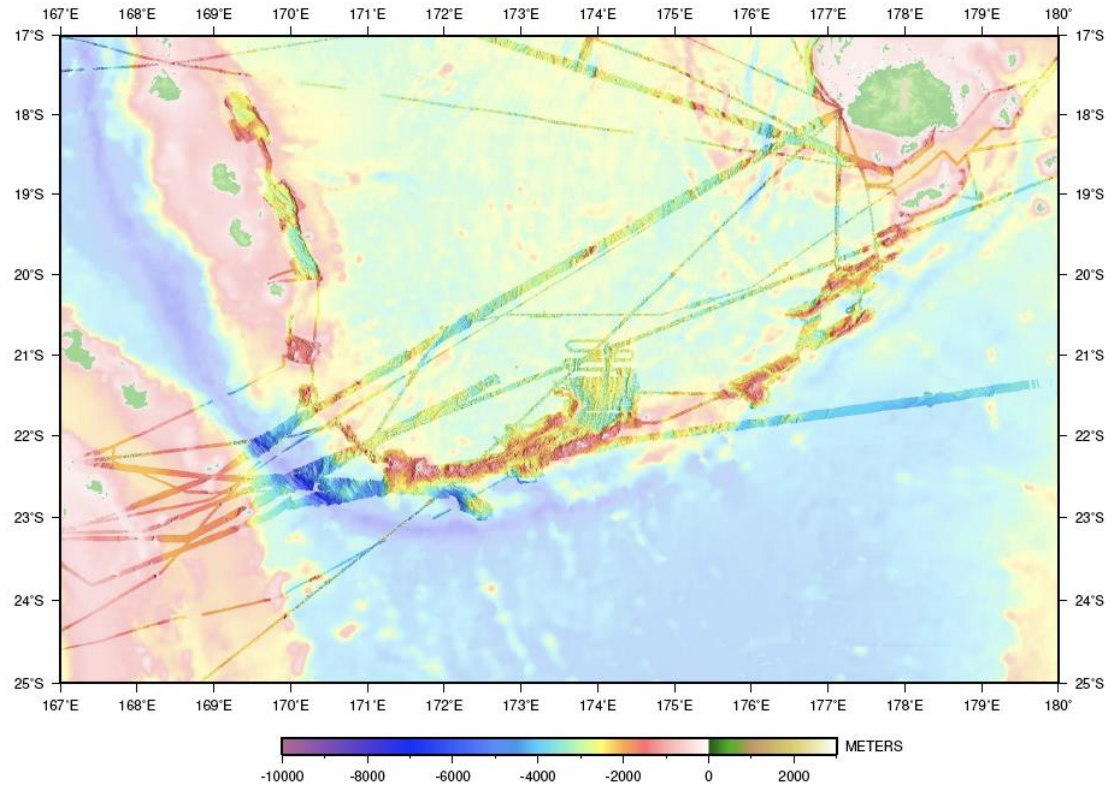
- US-NSF funded project to study subduction initiation along the MHSZ
- Deployment of 20 ocean bottom seismographs for 15 months
- Marine geophysical survey (multibeam bathymetry, gravity, magnetics)
- Will also survey the trench during transits between Port Vila and Suva
- Tentatively scheduled for late 2025 or early/mid 2026

Multibeam Bathymetric Data Available for the Vanuatu Trench

Multibeam data in the US NCEI (NOAA) database



Other Australian and French datasets



Little multibeam data openly available for this region

Our Matthew-Hunter project will expand available datasets

Conclusions

- Subduction Initiated along the Matthew-Hunter Subduction Zone (MHSZ) about 2 Ma
- The MHSZ represents an opportunity to study ongoing subduction initiation
- Earthquakes along the MHSZ pose a significant tsunami hazard
- Bathymetry along the Southern Vanuatu Trench and the MHSZ is poorly surveyed
- Our NSF-funded project will deploy 20 ocean bottom seismographs and carry out marine geophysical surveys to provide much better constraints on the tectonics and hazards of the region.