Observation Project: Tracing Oceanic Asthenosphere Subduction

and Current Status of Japanese BBOBS Projects

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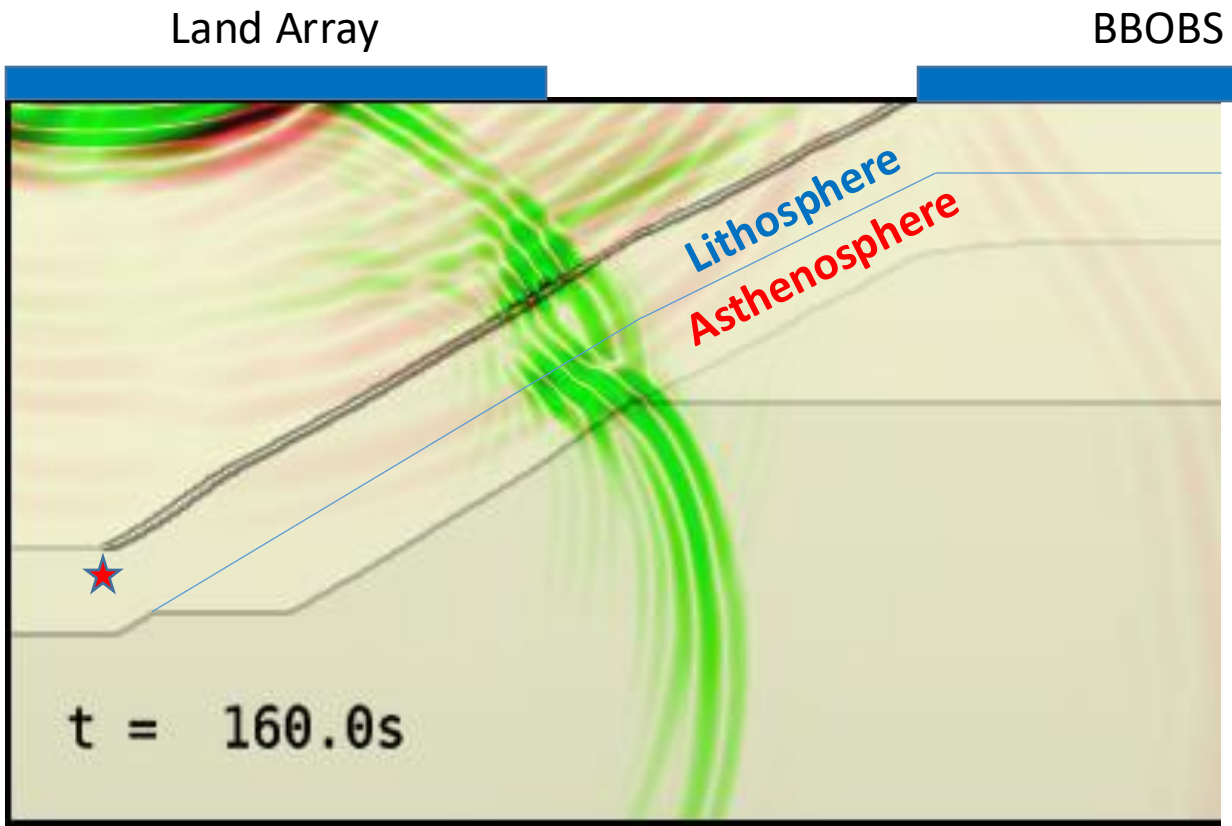
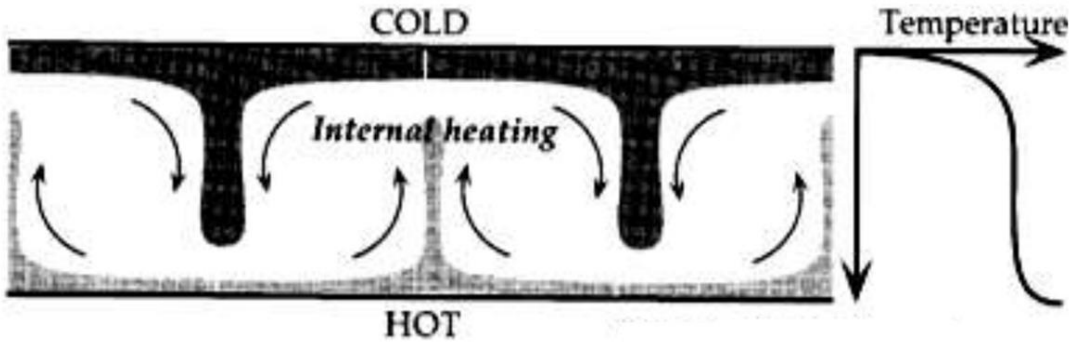


Purpose of the Project

Direct observation of trapped energy in the subducting asthenosphere.

Current Understanding for Mantle Convection
- coupling between lithosphere and asthenosphere -

Plate motion is surface manifestation of mantle convection. However, we still do not understand the relation (coupling) between the lithosphere (surface) and the asthenosphere (internal).



Davies, 1999 (modified)

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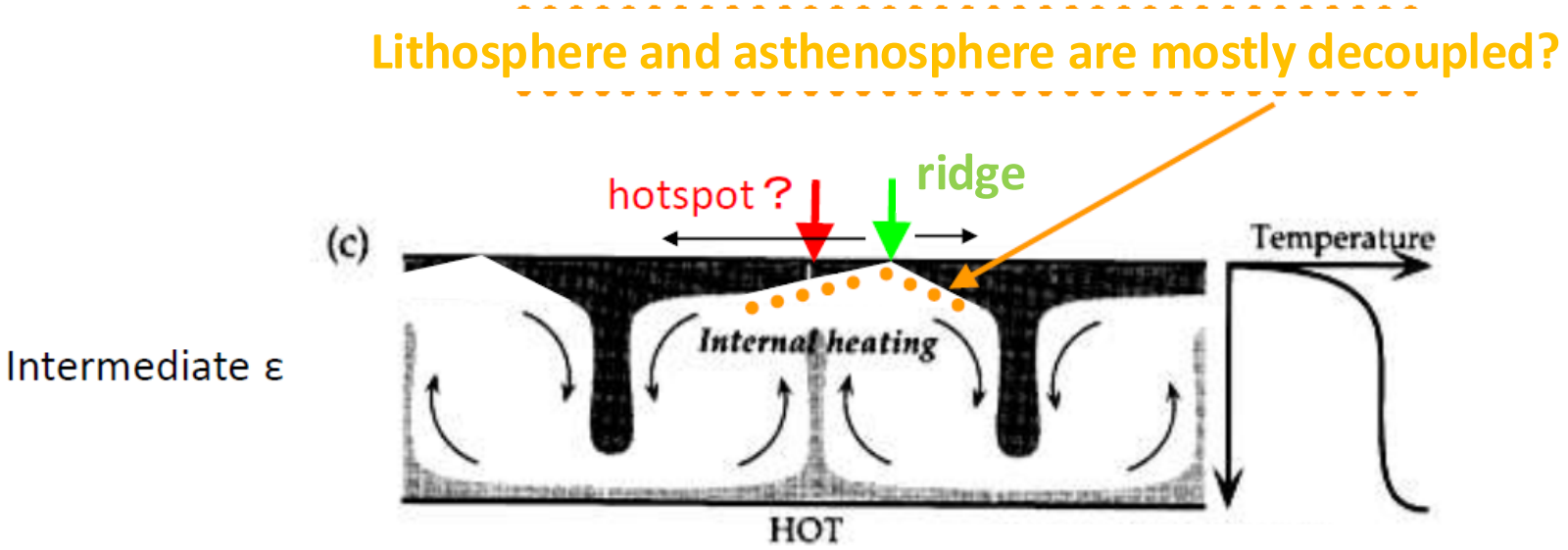
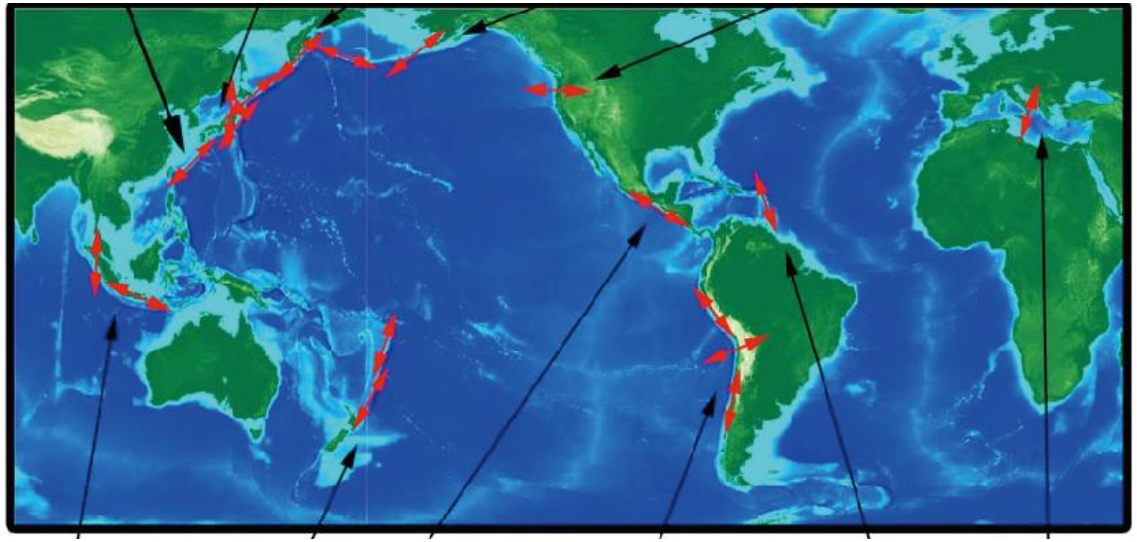


Davies, 1999 (modified)

Motivation

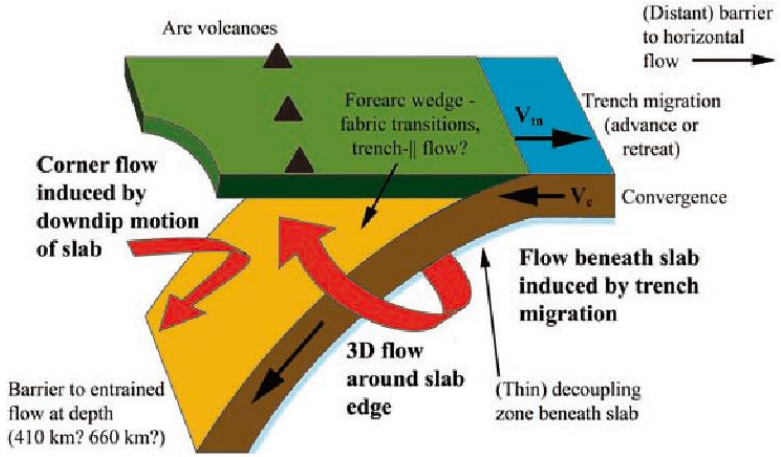
Observations



trench-parallel fast axis in the subslab regions

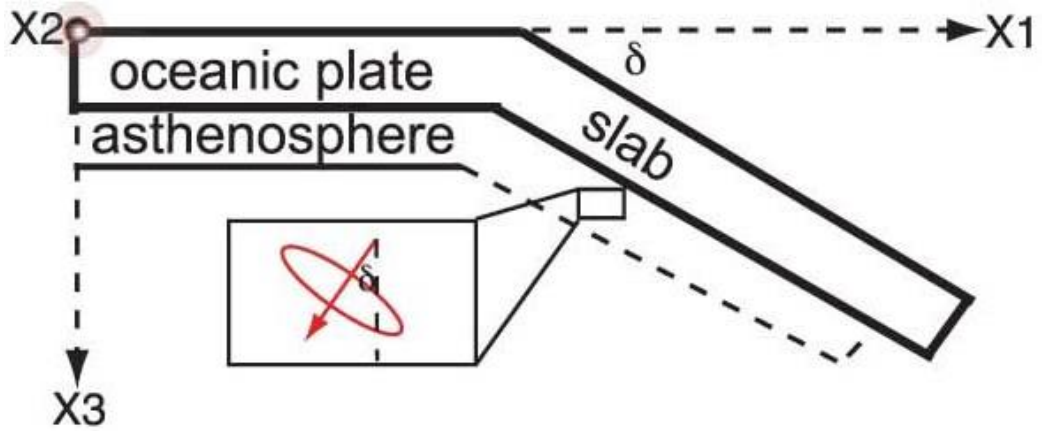
indirect observations and inconsistent interpretations

(1) **Interpretation 1** : trench parallel flow



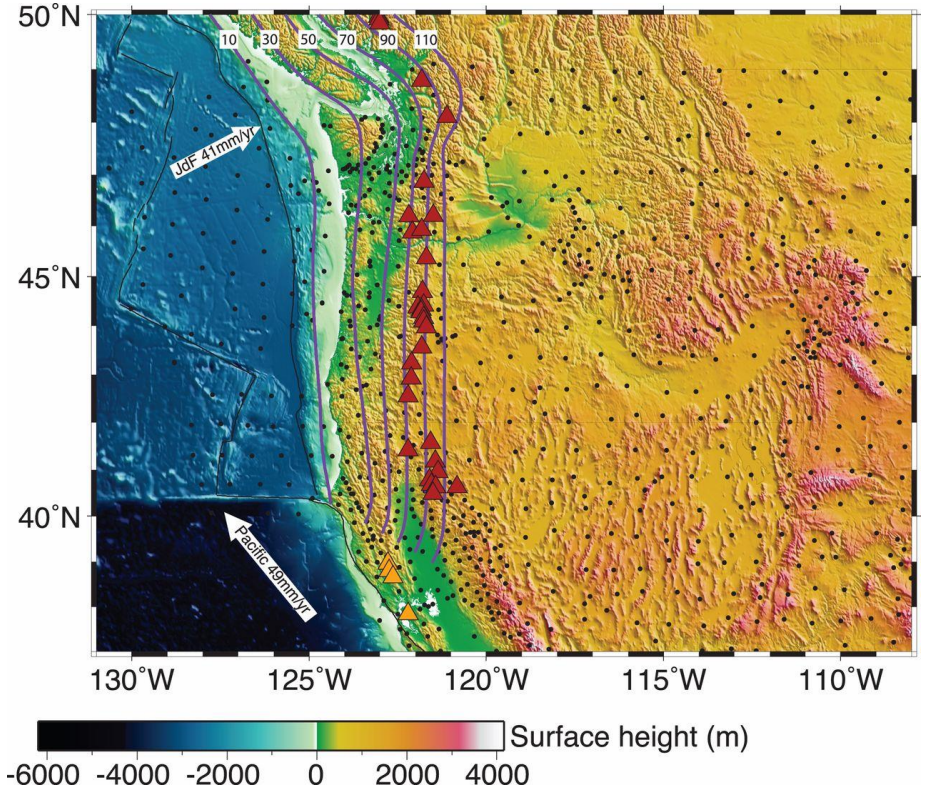
Long & Silver (2008)

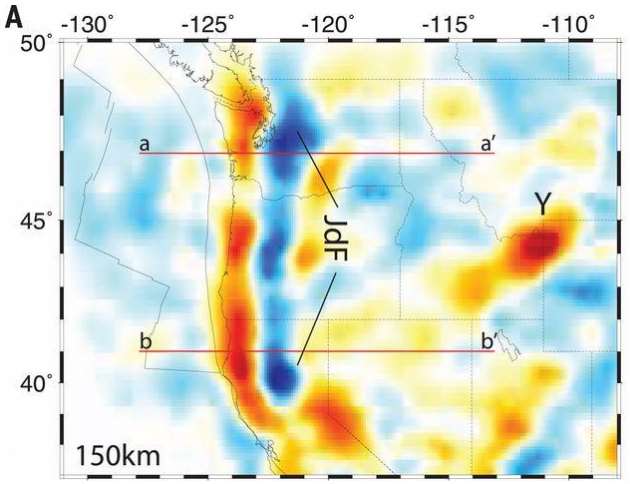
(2) **Interpretation 2** : subduction of anisotropic asthenosphere

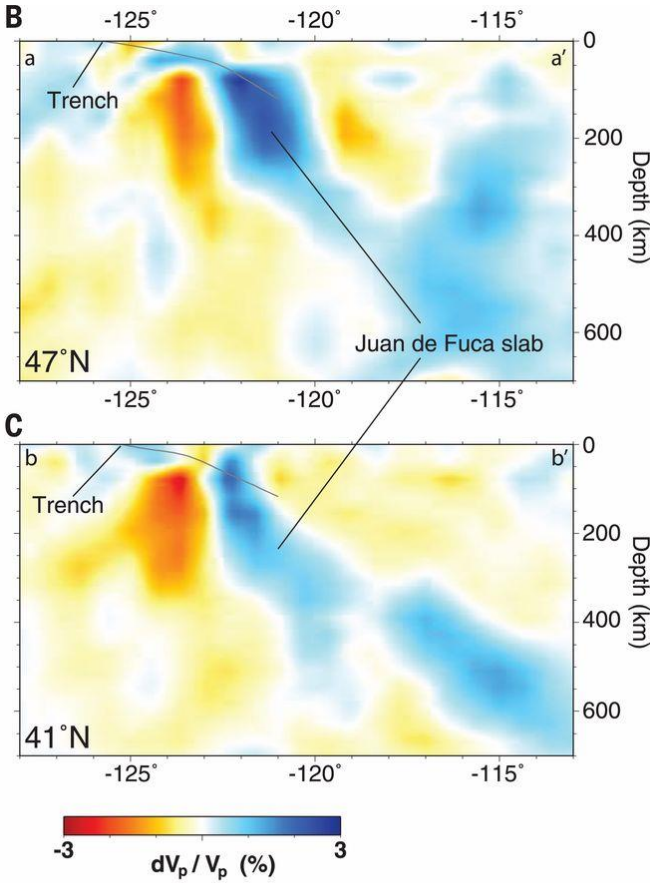


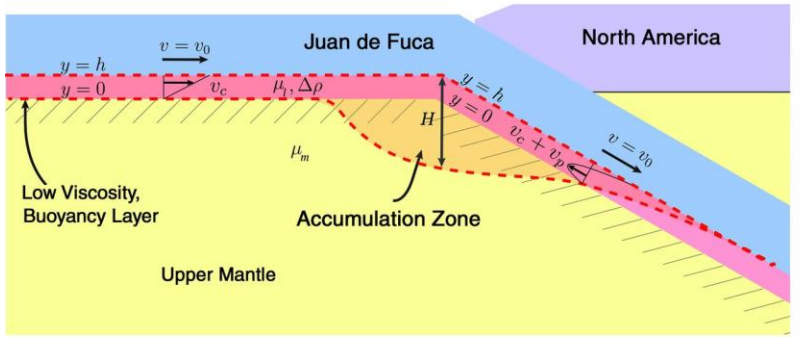
Song & Kawakatsu (2012)

Motivation







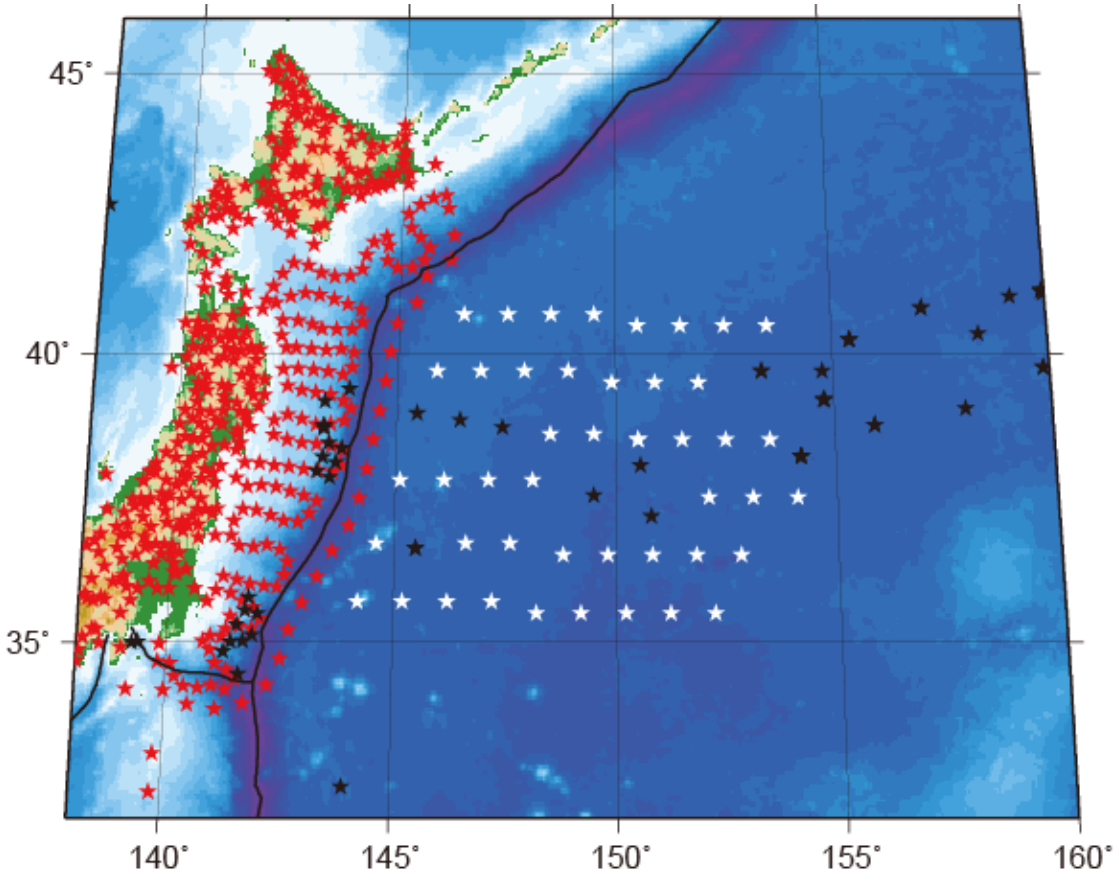


Limited resolution due to lack of deep seismicity.
More pronounced signatures are desired.

Hawley et al. (2016, Science)

New BBOBS Project to Trace the Asthenospheric Subduction

Proposed BBOBS Array



★ "Kiban" Stations ★ Previous BBOBS Stations

☆ New Stations

Extension of the "Kiban" network to the outer-rise

all-purpose geophysical network

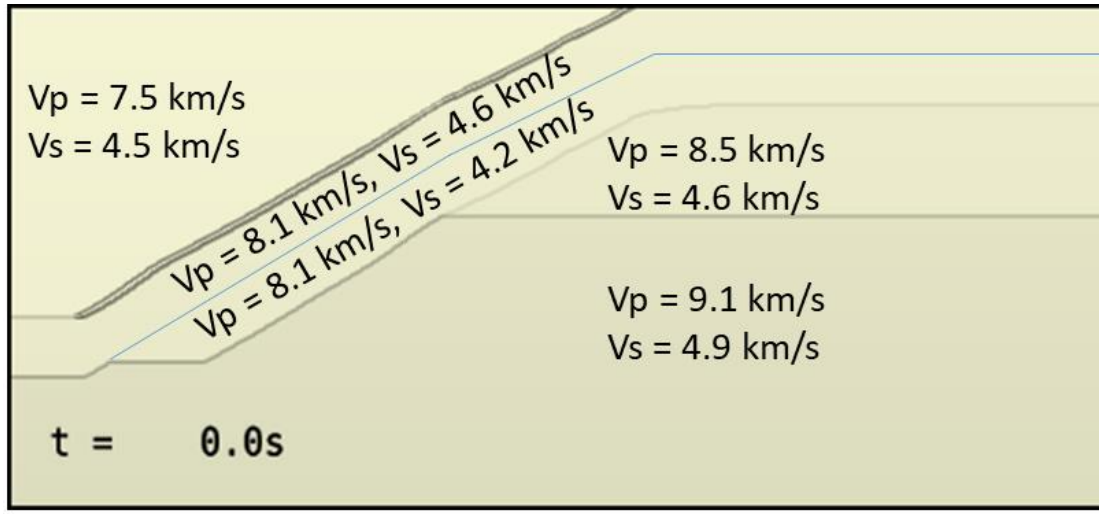
(1) First Japanese geophysical array with larger aperture

(2) Useful for various scientific targets

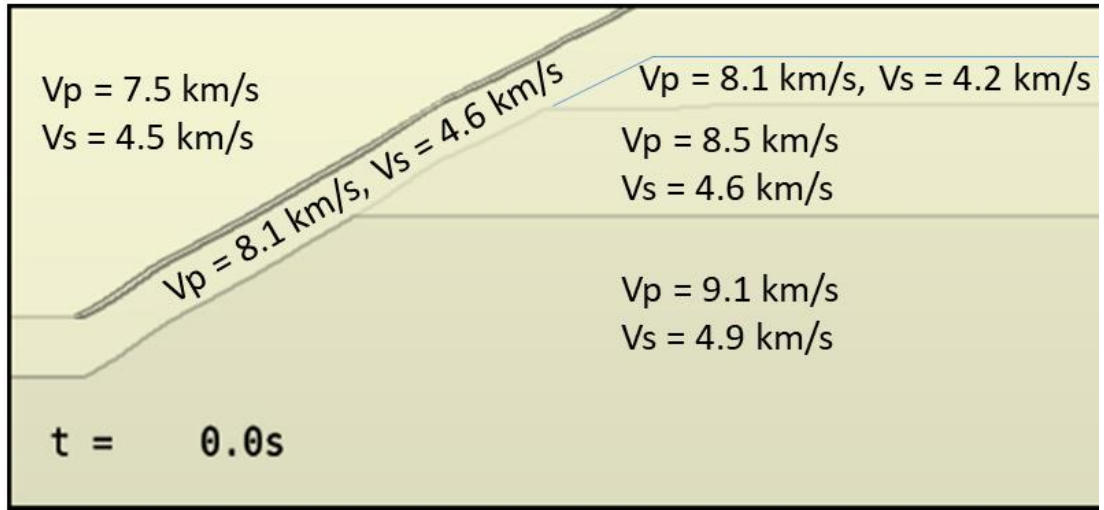
- origin of the land-ocean contrasts
- along-arc heterogeneities and subcution volcanisms
- in-situ seismic/tsunami observations for mega-thrust events

Assumed Structure Model

subducting asthenosphere model



stagnant asthenosphere model



- Modified JSVISM model (Koketsu et al. 2008, 2012)

- Realistic models with several simplifications

  - Mimics the subduction at the Tohoku region

  - stack of homogeneous layers with undulated boundaries

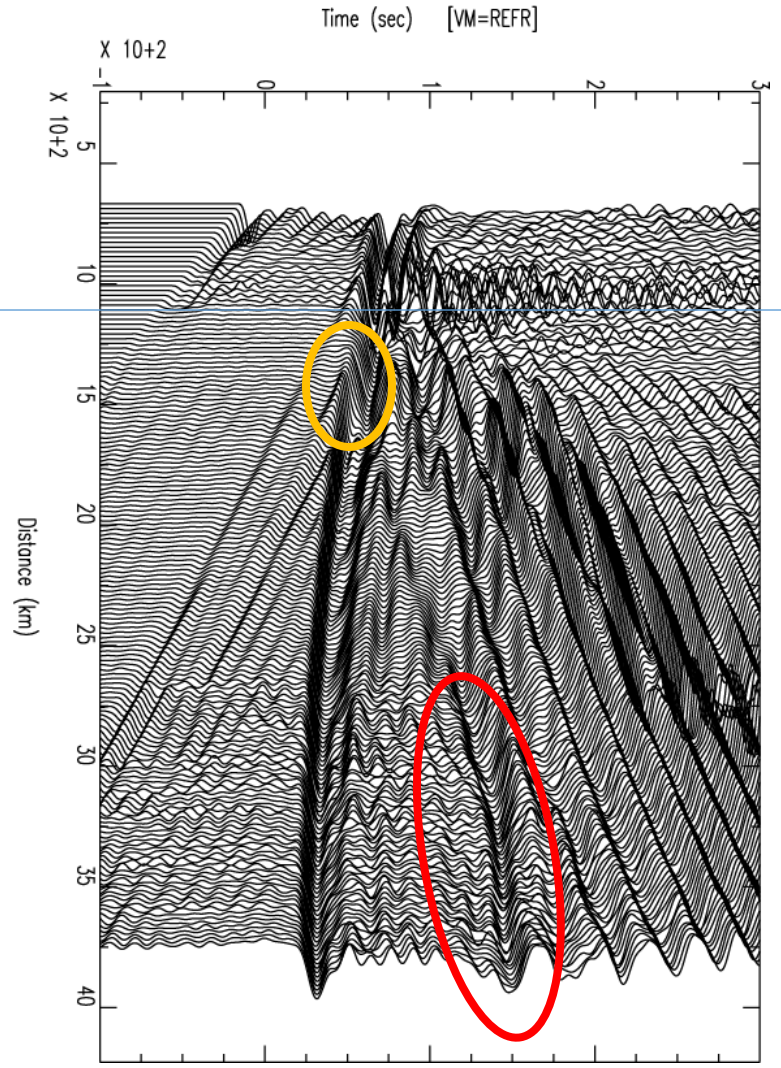
  - sea water layer (5 km thick) with flat bathymetry

  - crust (7 km thick) with flat Moho

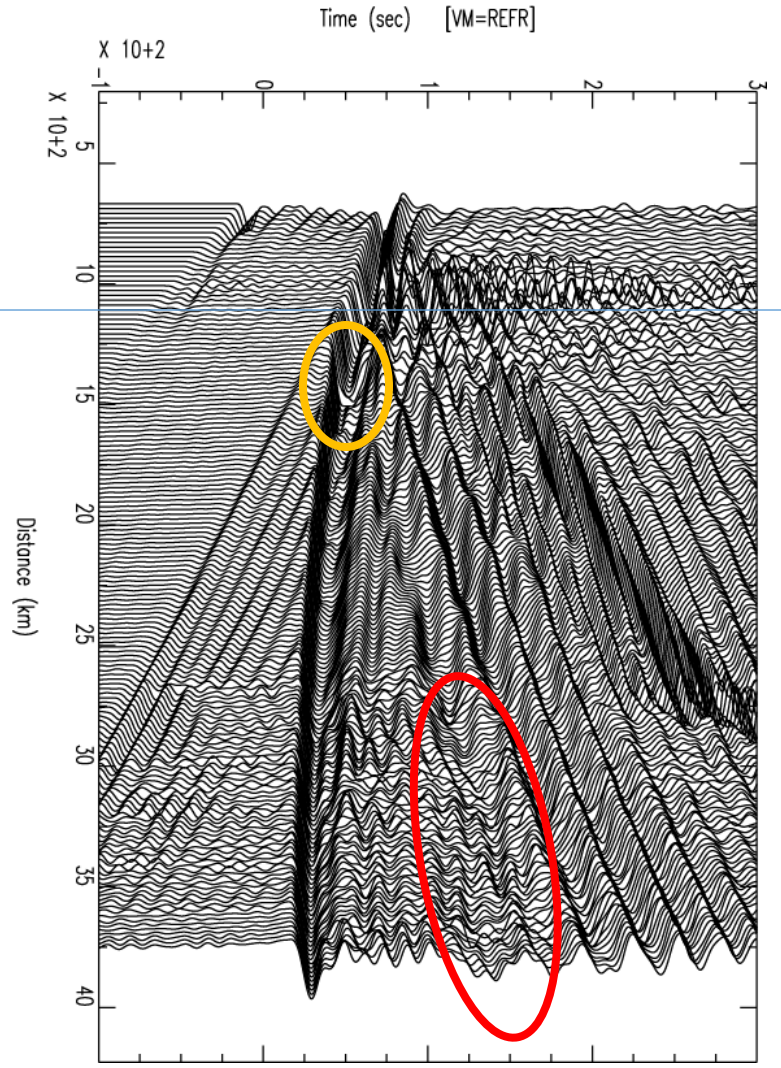
  - subducting oceanic crust into the transition zone

Comparison of the Synthetic Seismograms

Subducting Asthenosphere Model



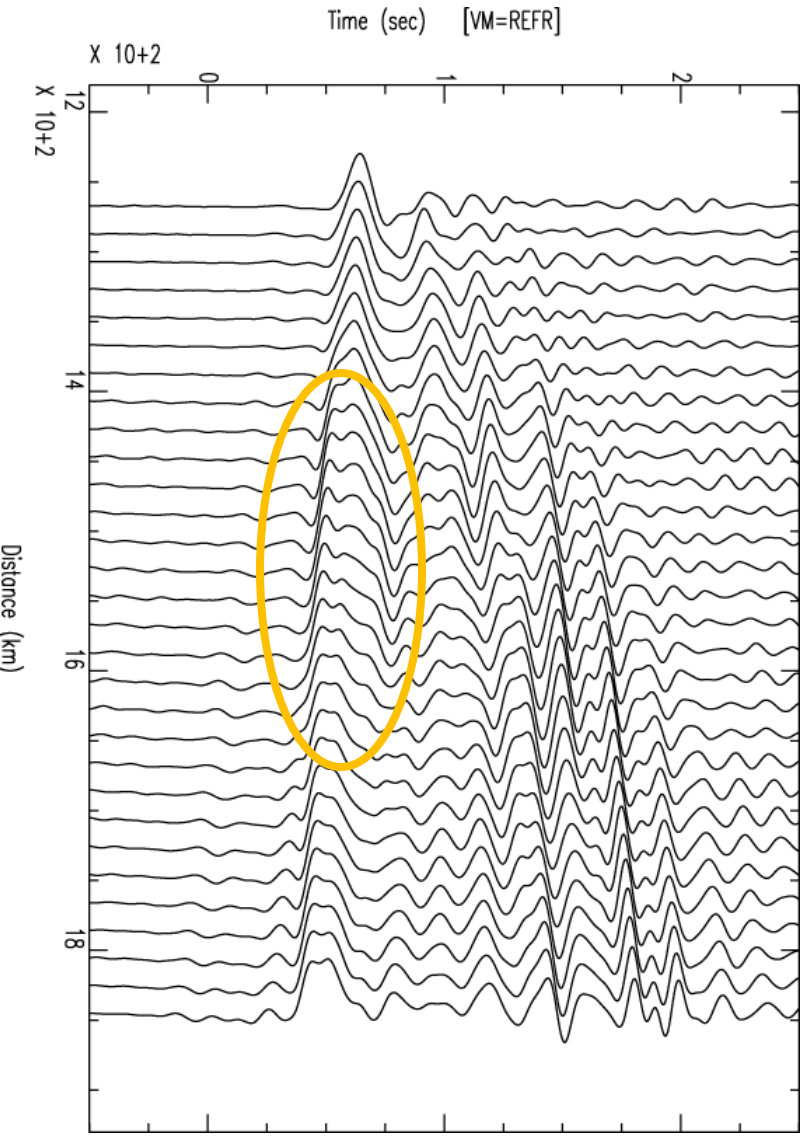
Stagnant Asthenosphere Model



displacement (8 s-)

Comparison of the Synthetic Seismograms

Subducting Asthenosphere Model



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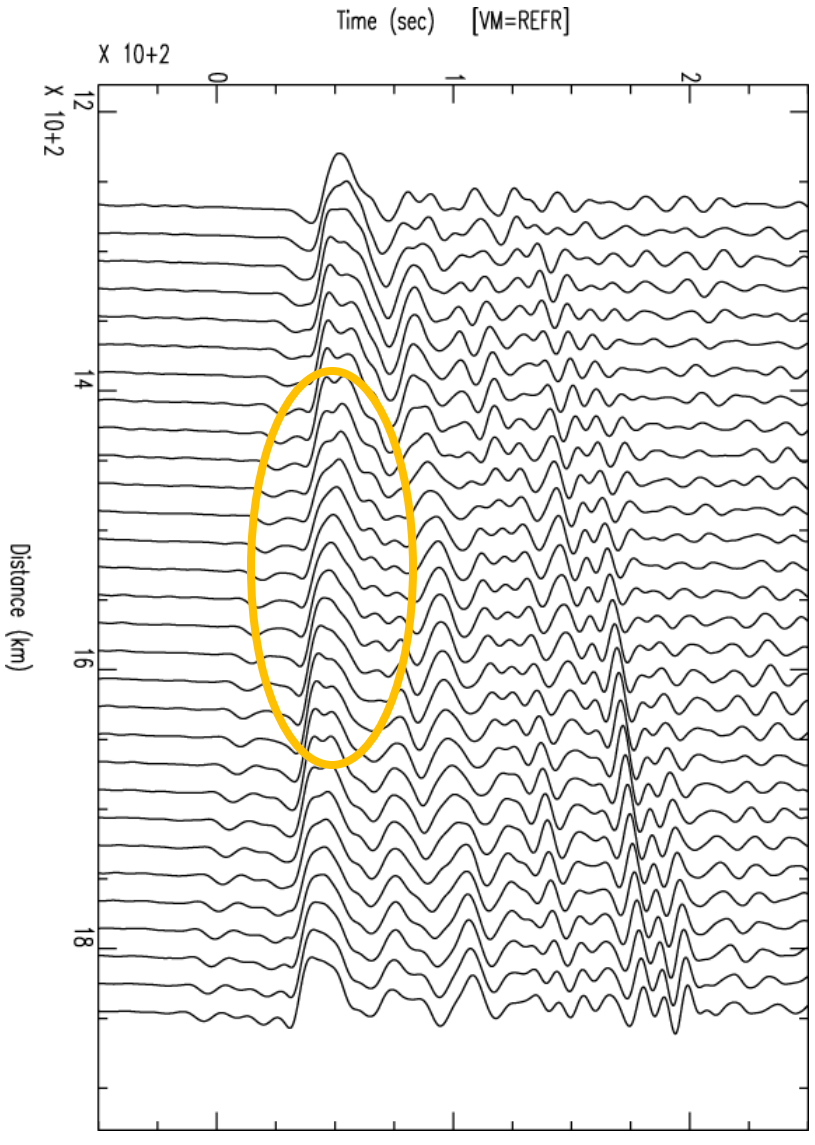
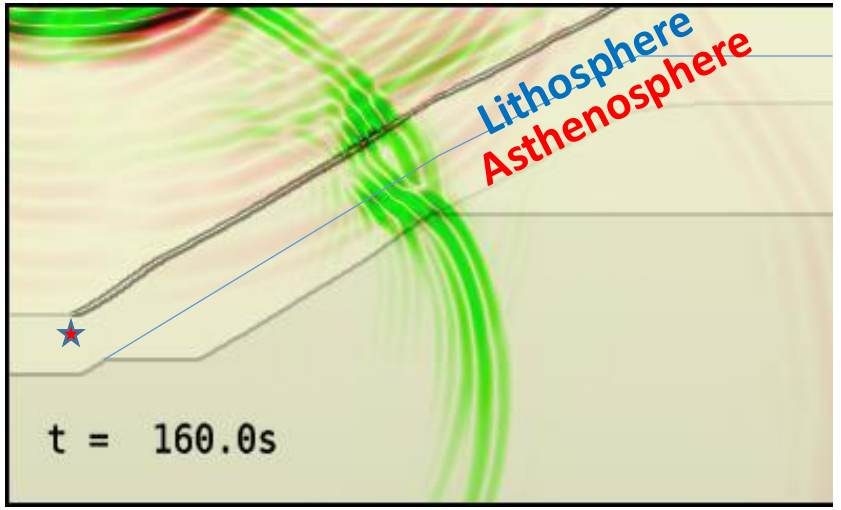
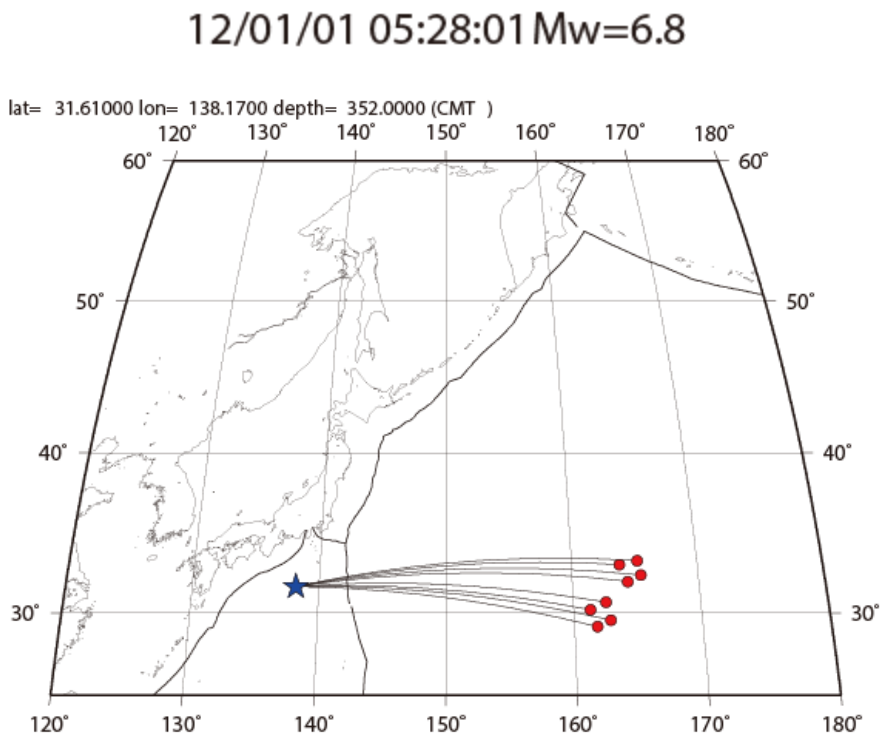
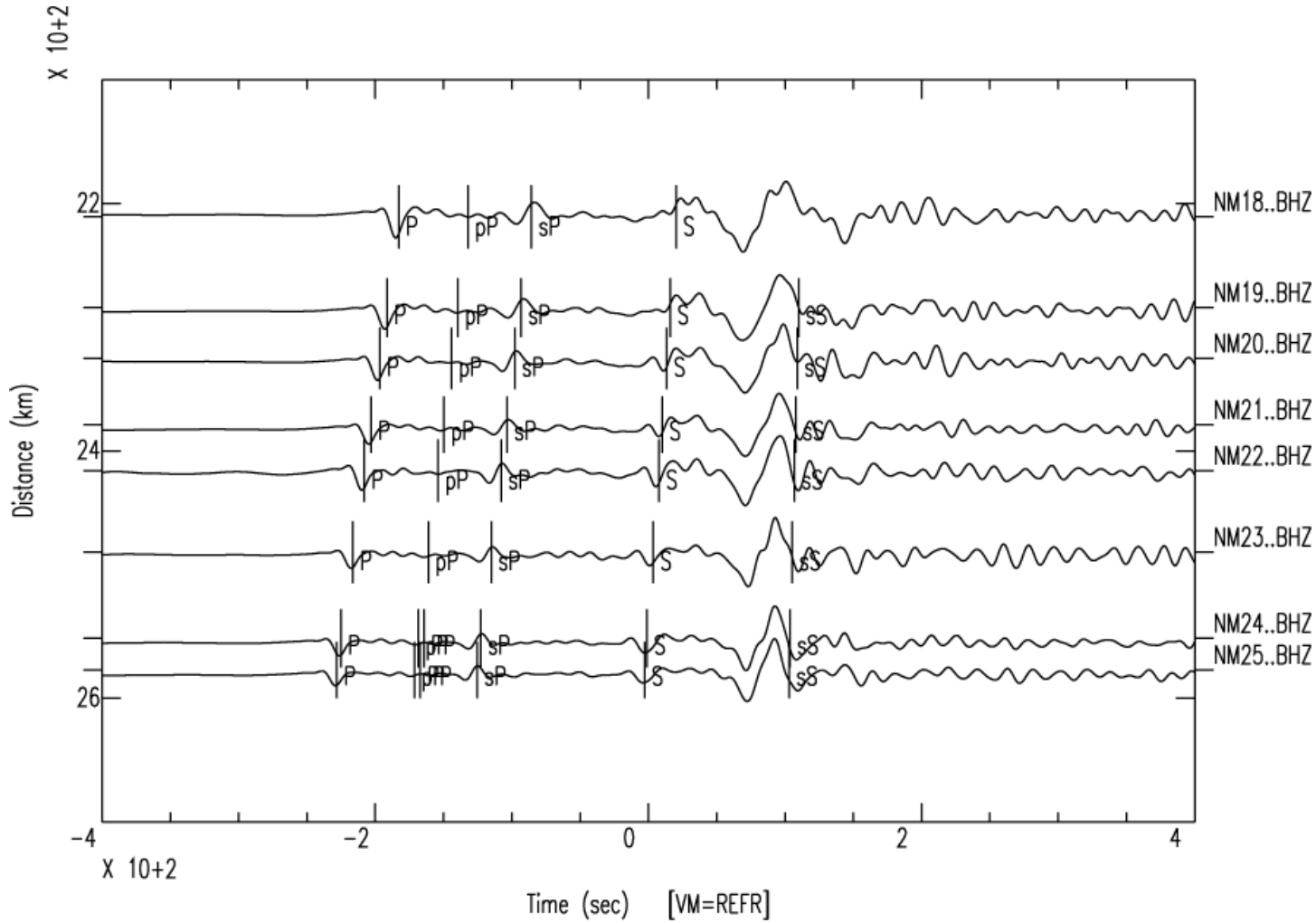


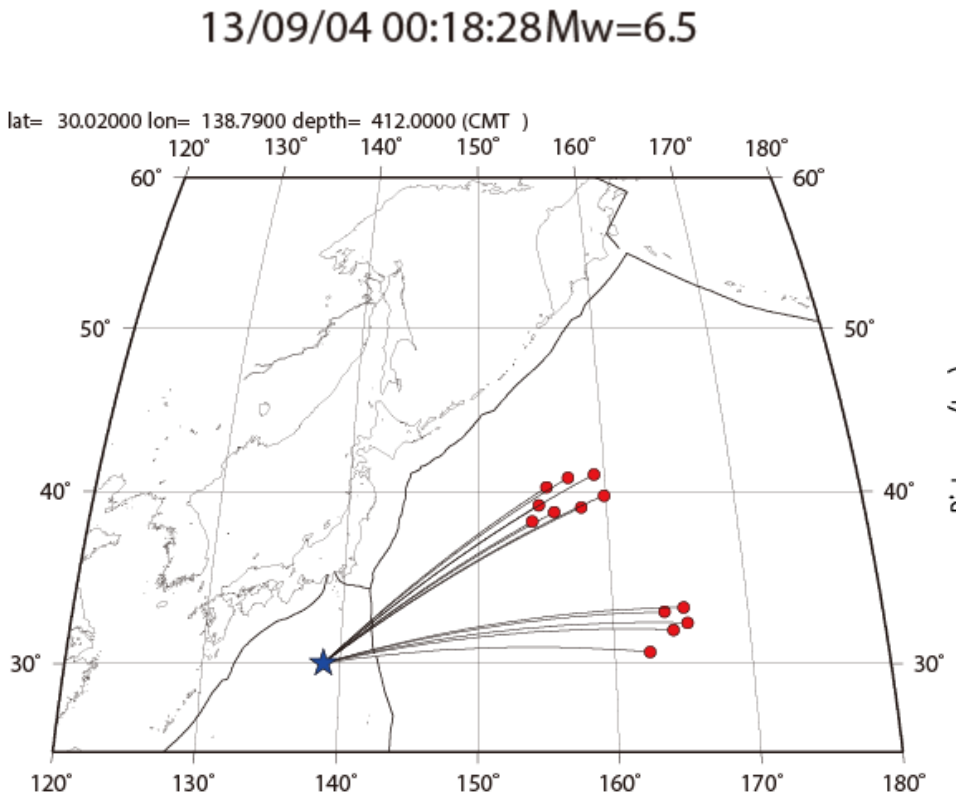


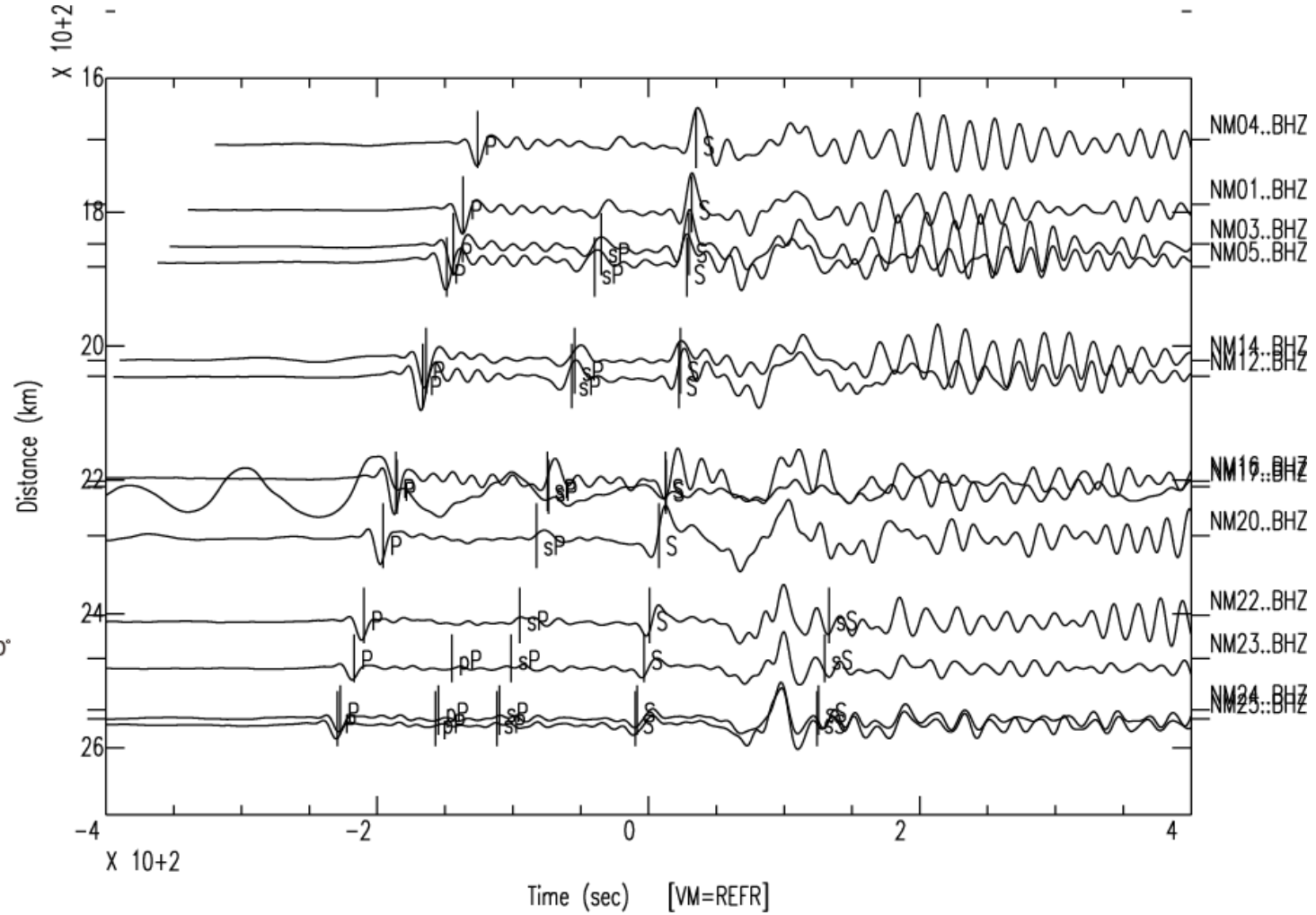
Wave-Front Propagations for the Subducting Asthenosphere Model





displacement (12.5-100 s)





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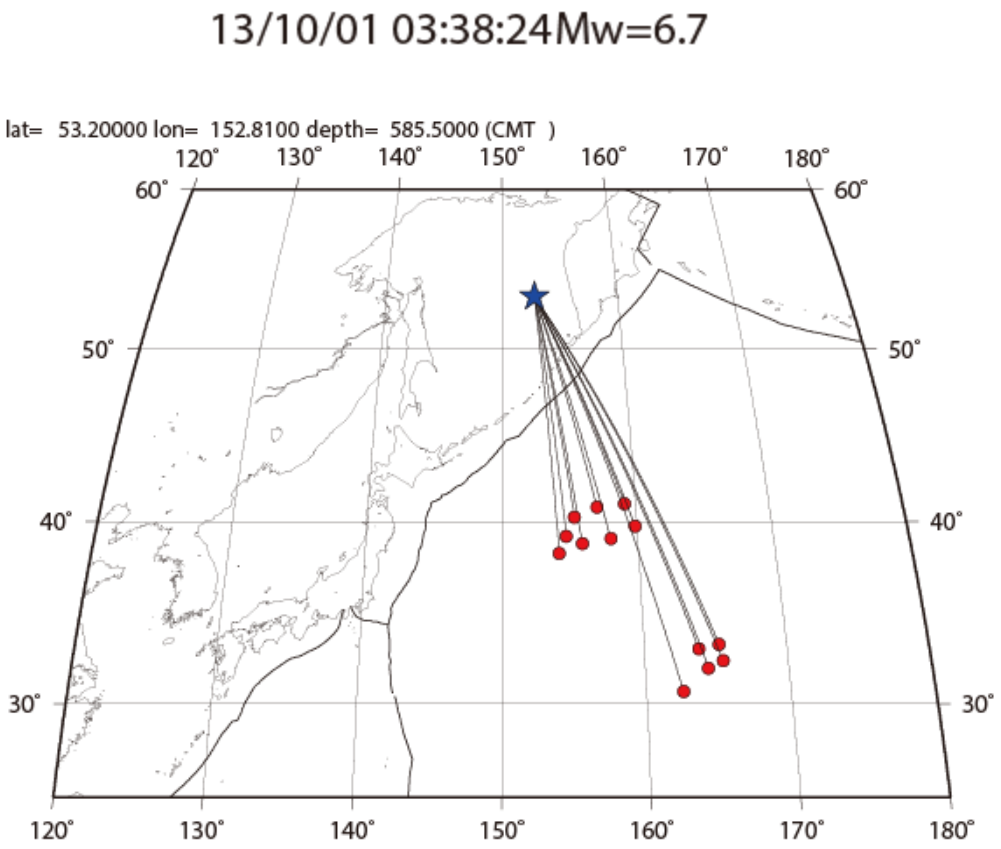

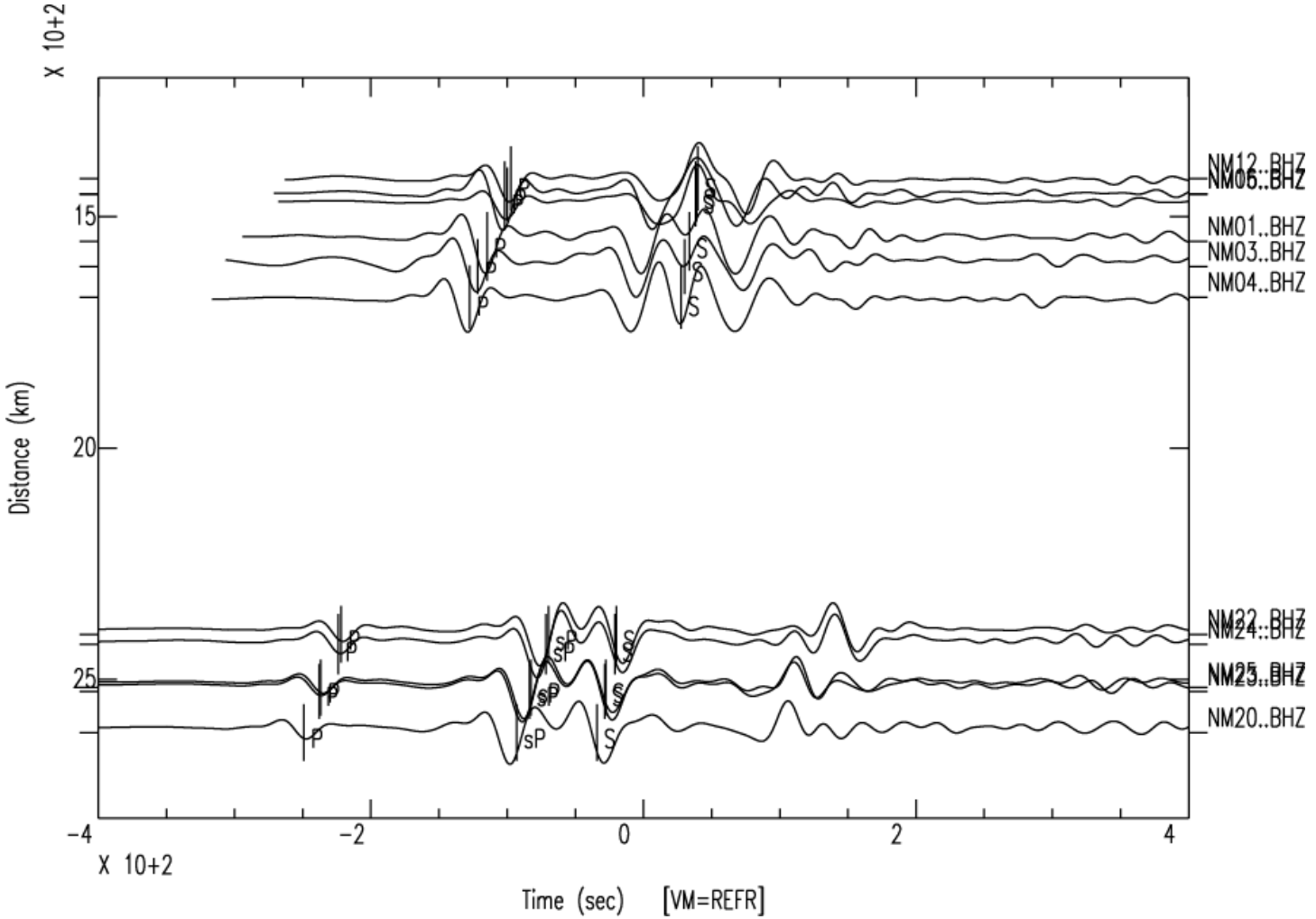

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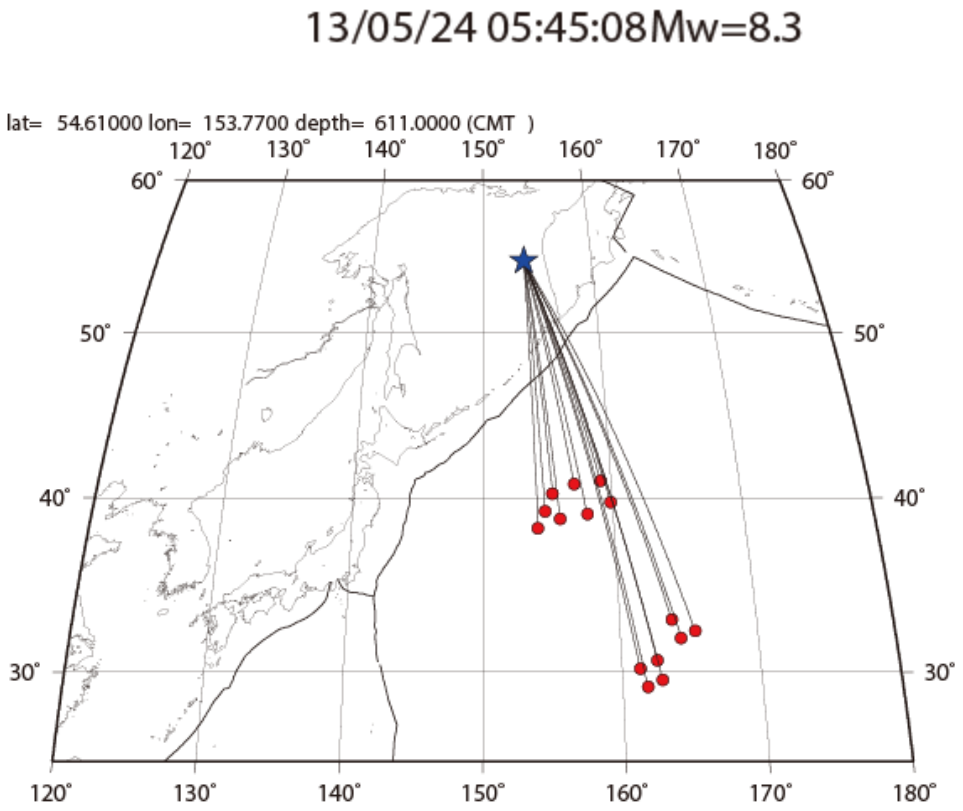
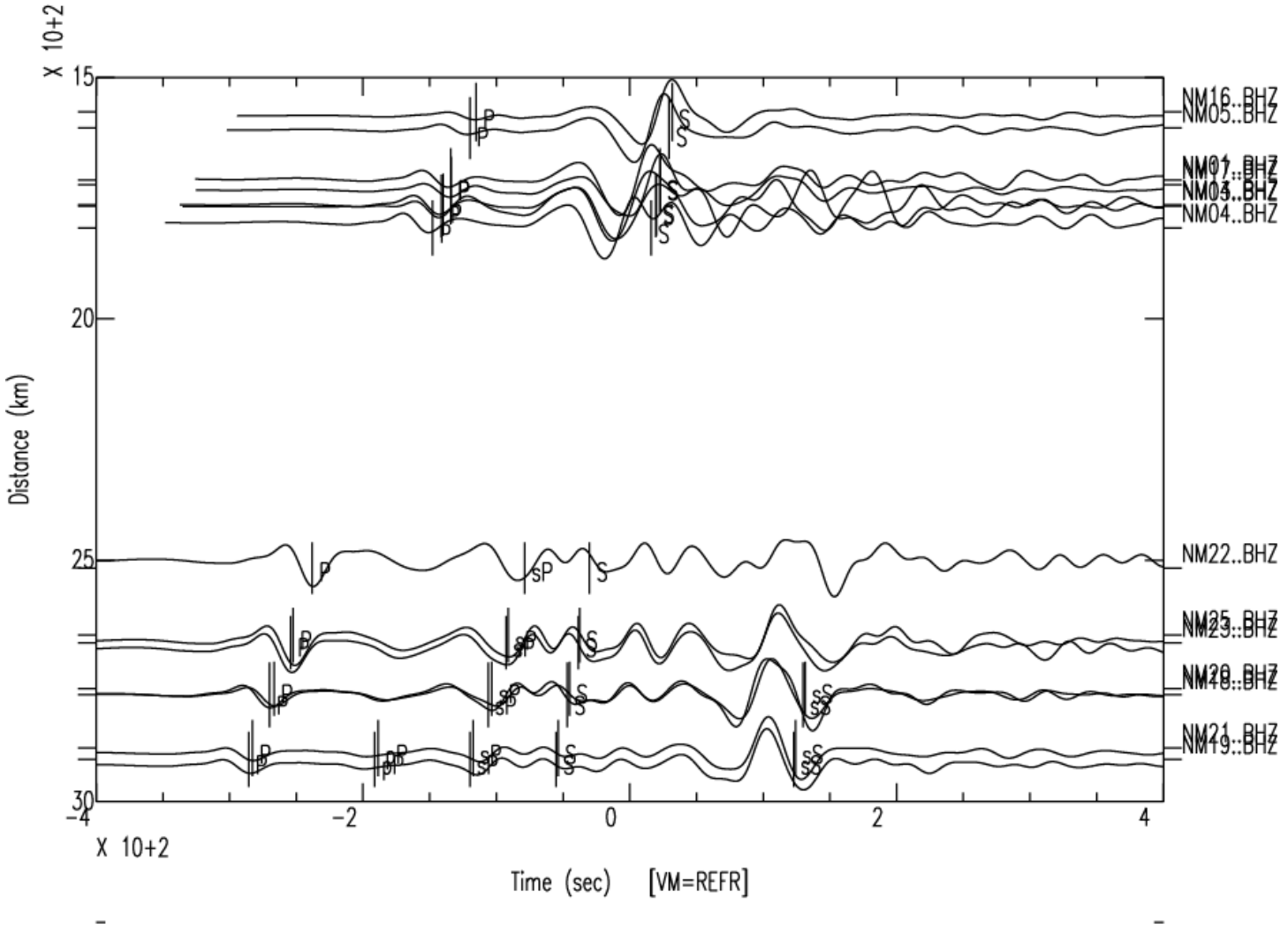
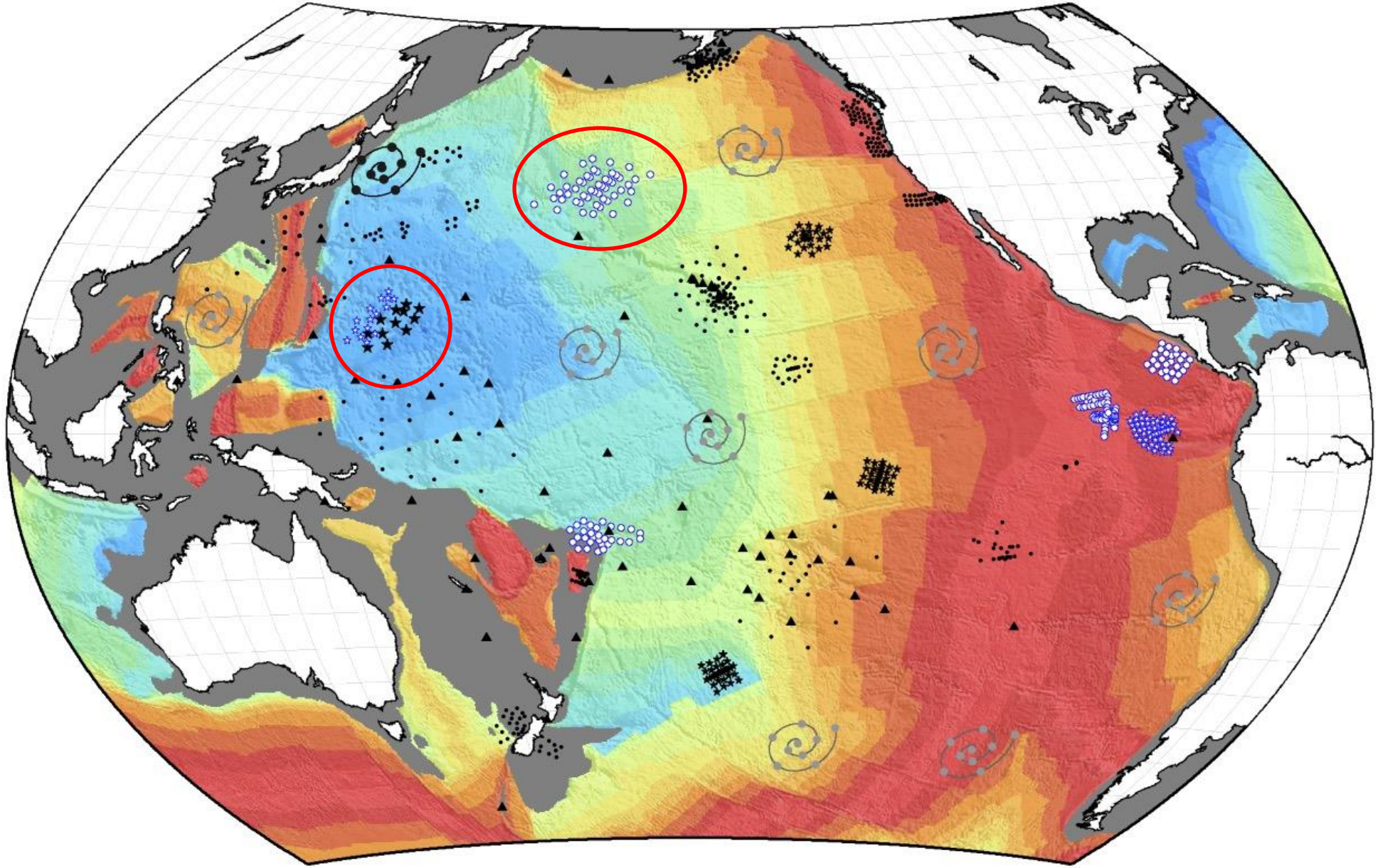




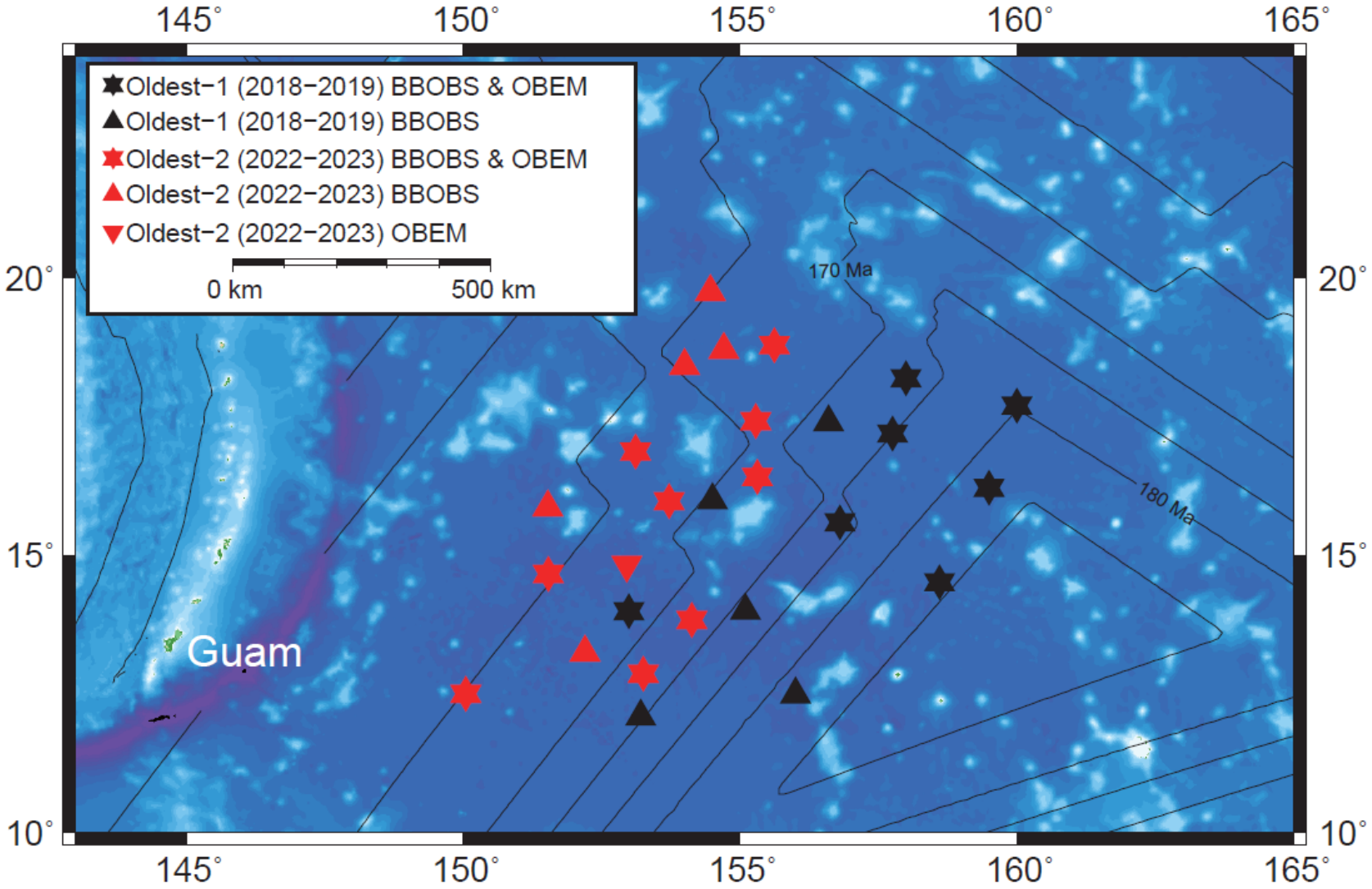
displacement (12.5-100 s)

Pacific Array 2023 spring



○ Funded ☆ Deployed ★ Completed

Oldest Arrays (Oldest-1 & Oldest-2)



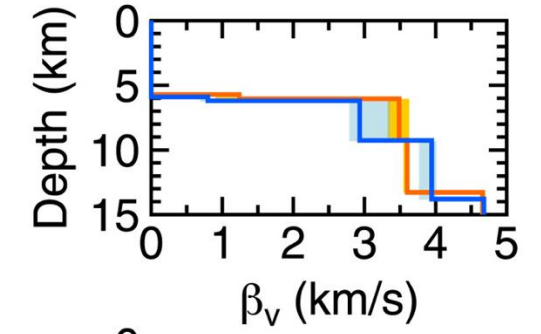
Oldest-1 (2018-2019)
Japan & Korea

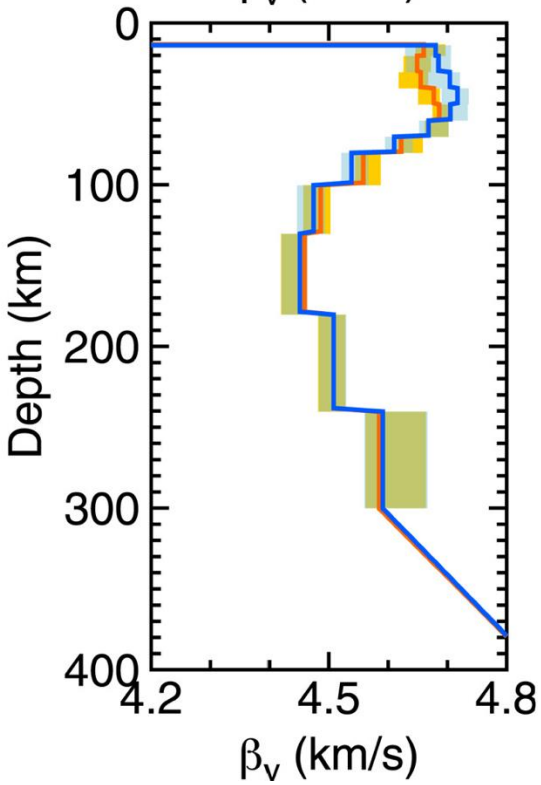
12 stations

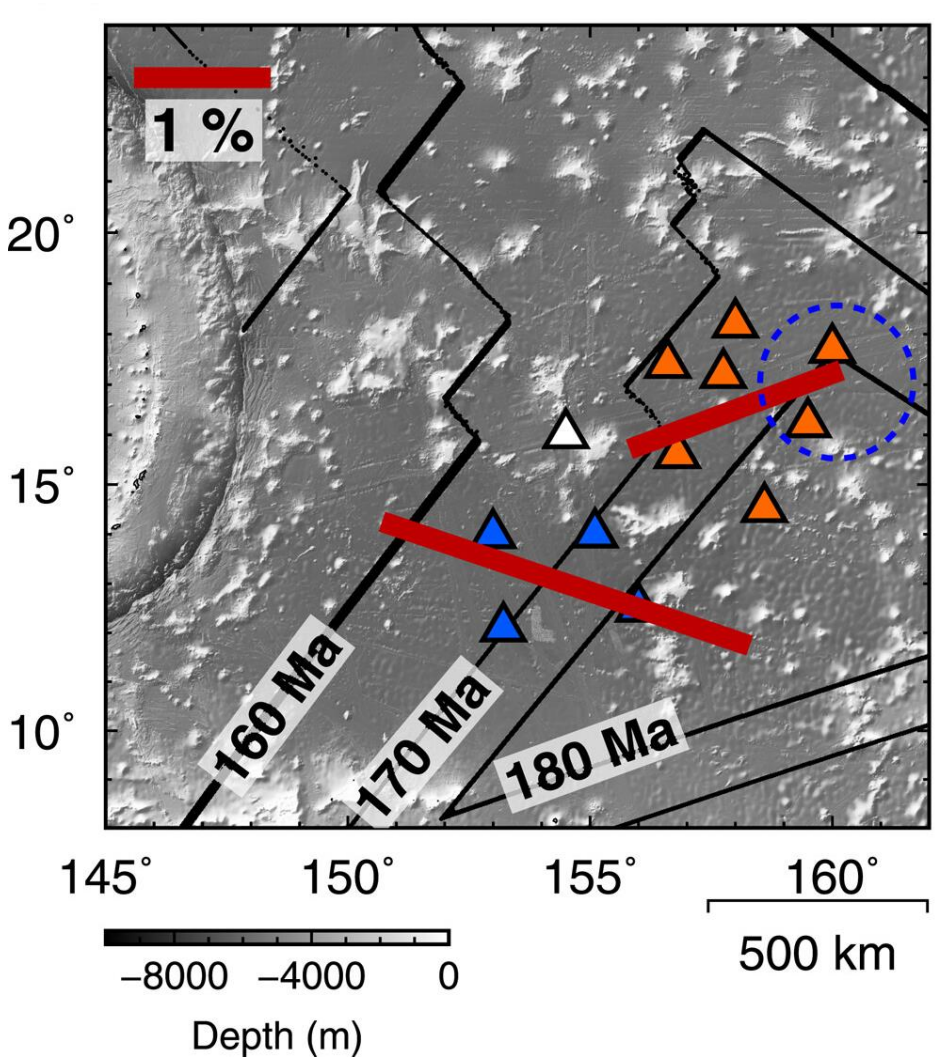
Oldest-2 (2022-2023)
Japan & Taiwan

15 stations

Complex Anisotropy in the Oldest Ocean

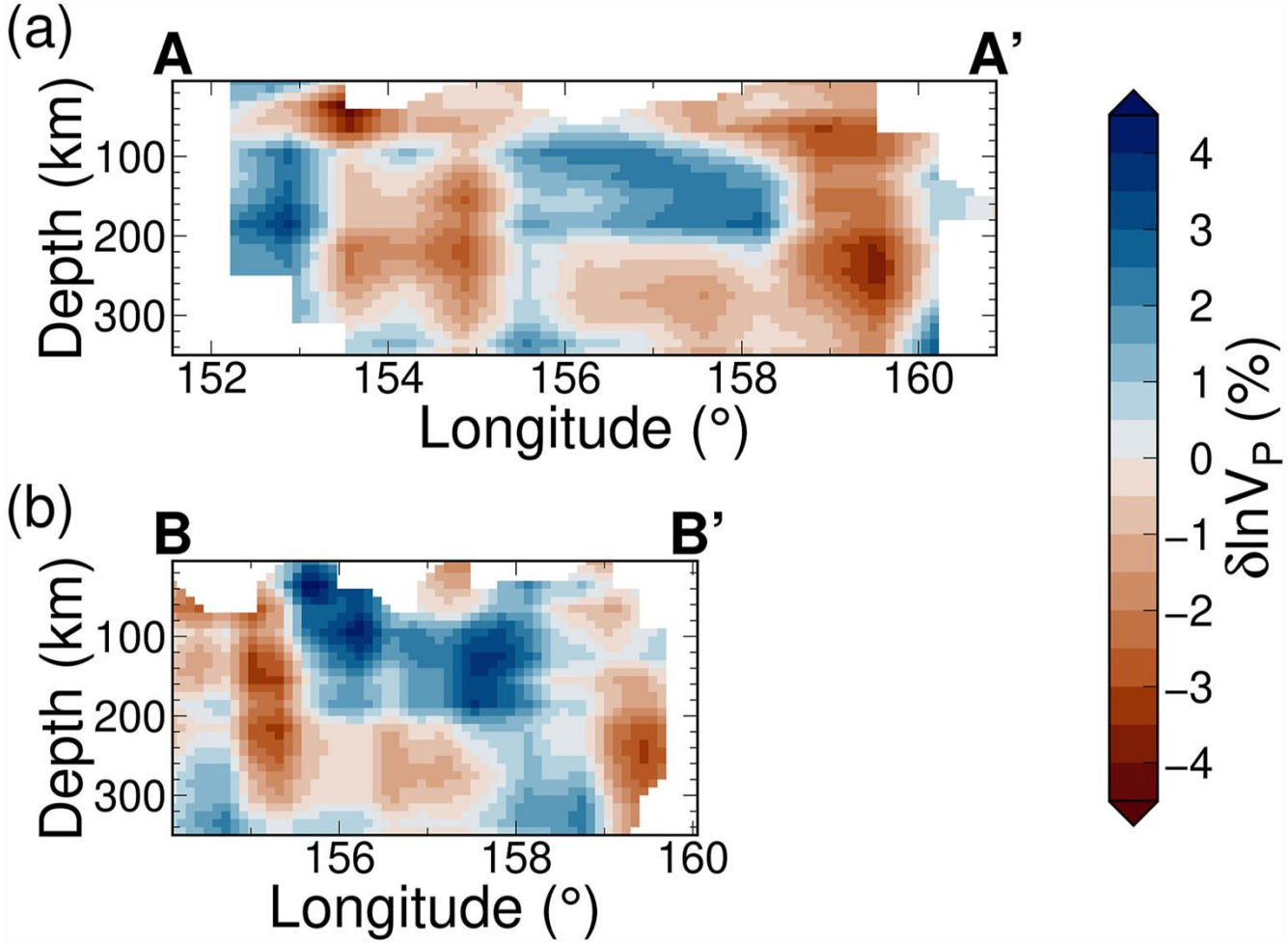


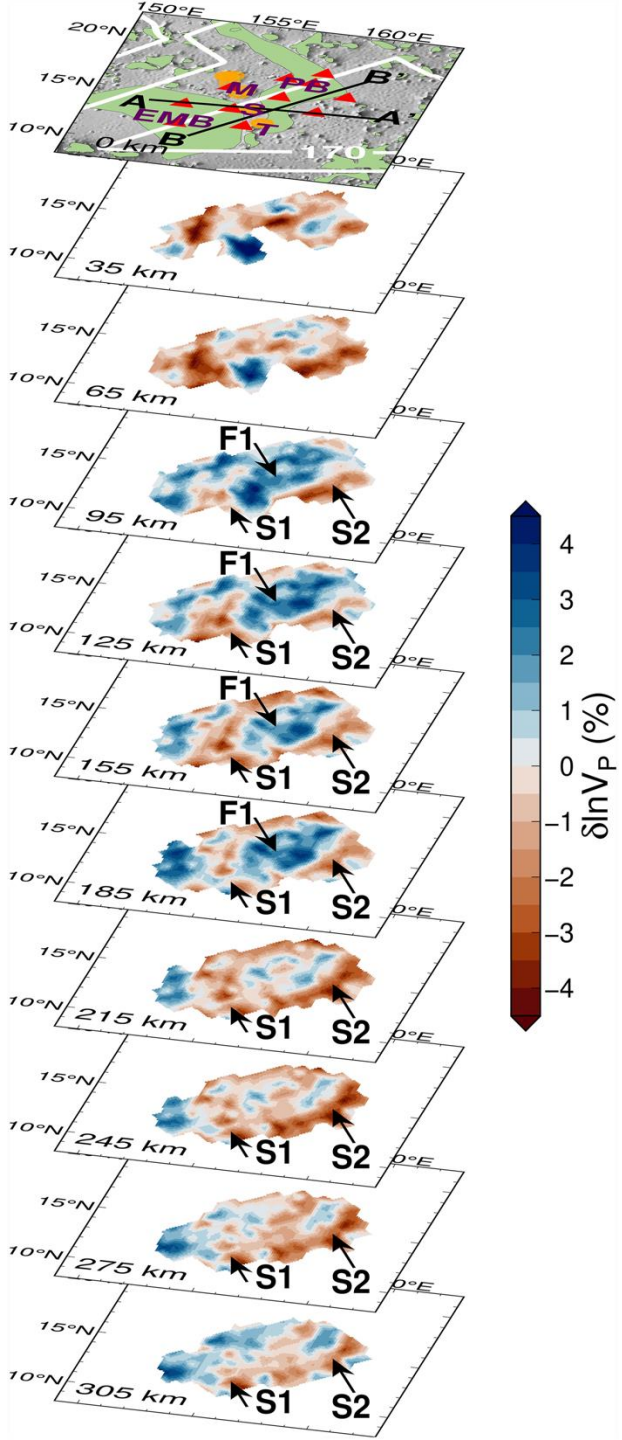




Kawano et al. (2023, JGR)

Heterogeneities in the Asthenosphere





Kang et al. (2023, G-cubed)

Hawaii-Emperor Bend (HEB) project

- Japan-Germany collaborated research
- 50 BBOBSs & 50 OBEMs
- 2025.10 deply. R/V Hakuho-maru
- 2026.04 recover R/V Sonne
- Constrain the viscosity of oceanic asthenosphere from integration of seismological and electromagnetic observations and geodynamic modeling