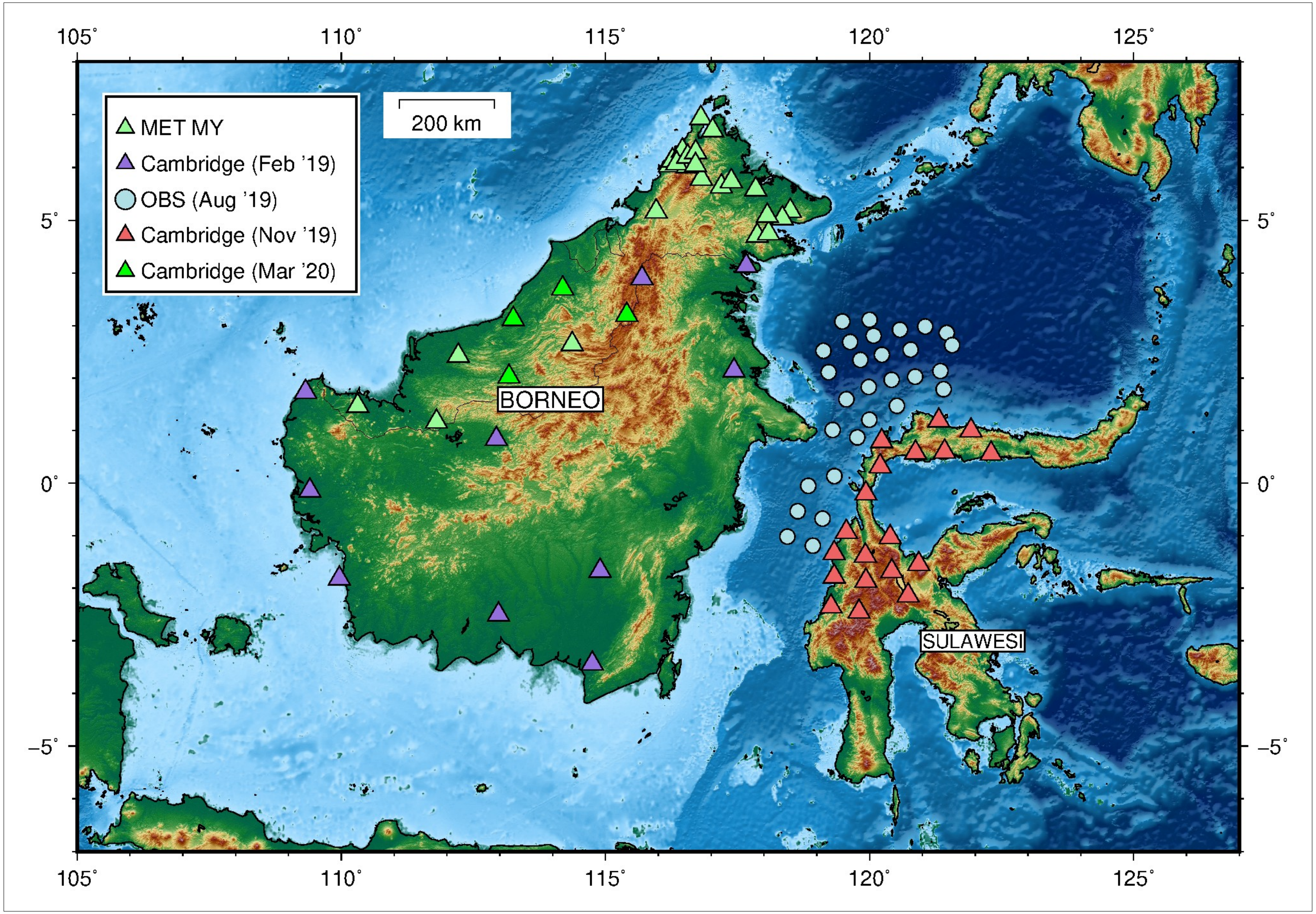
Seismic Structure and Tectonic Evolution of Borneo and Sulawesi

Harry Linang (htal3@cam.ac.uk)[1], A. Gilligan[2], J. Jenkins[1], T. Greenfield[1], N. Rawlinson[1]

1. University of Cambridge
2. University of Aberdeen

D1448
EGU2020-12007

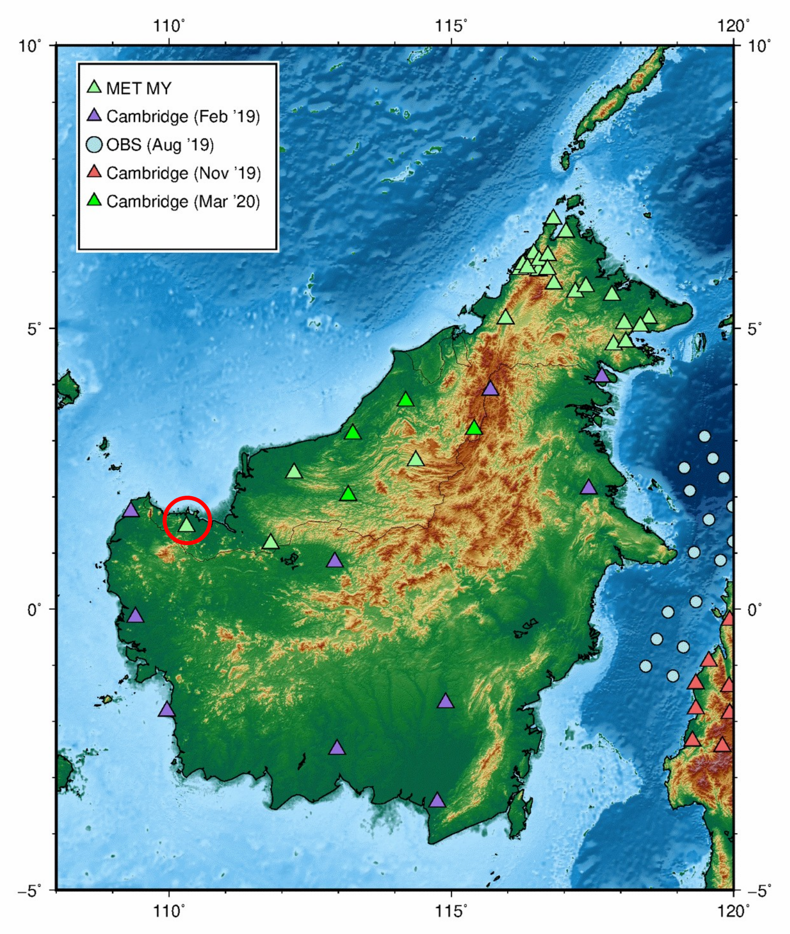
1. Seismic Stations

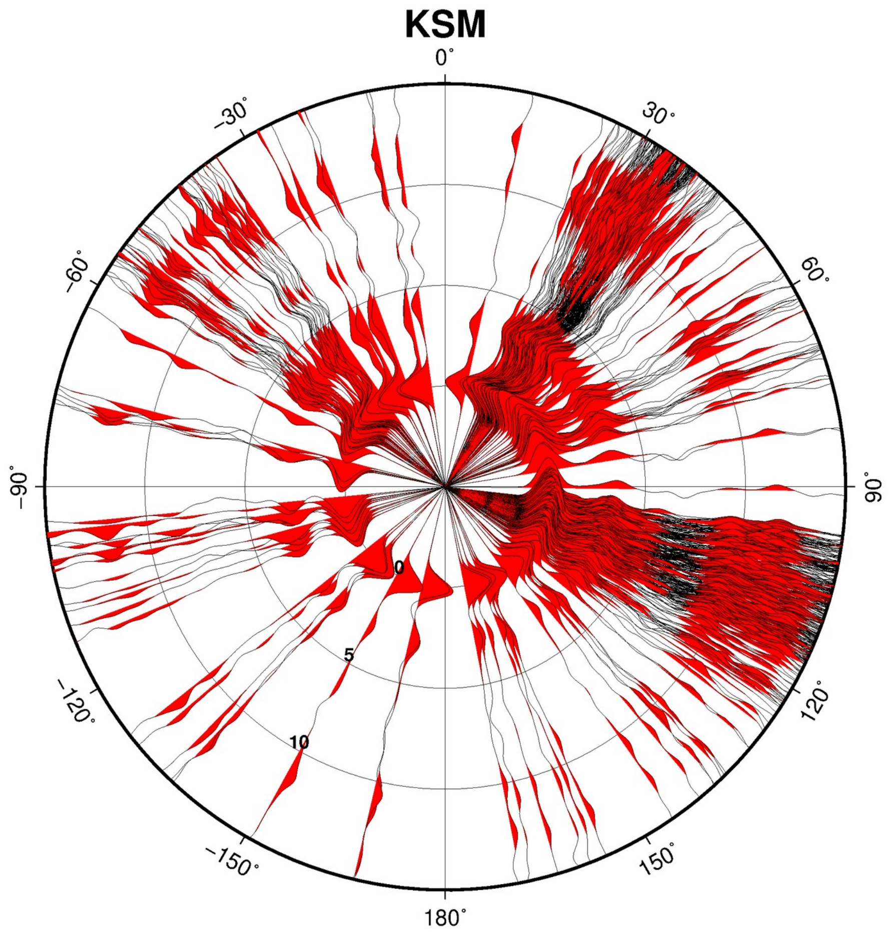


- Map shows the seismic stations currently in place in Borneo and Sulawesi (also OBS) for which data will be ultimately be used in this study
- Current data availability ranges from 6 months to 2 years.
- Setback in data retrieval for stations in Indonesia due to the COVID19 pandemic.

- Methods: Receiver function and Neighbourhood Algorithm Inversion
- Aim: To obtain reliable estimate of crustal thickness.
- To gain an improved understanding of the structure of the crust and mantle lithosphere beneath and across both islands.

2. EXAMPLE RF DATA

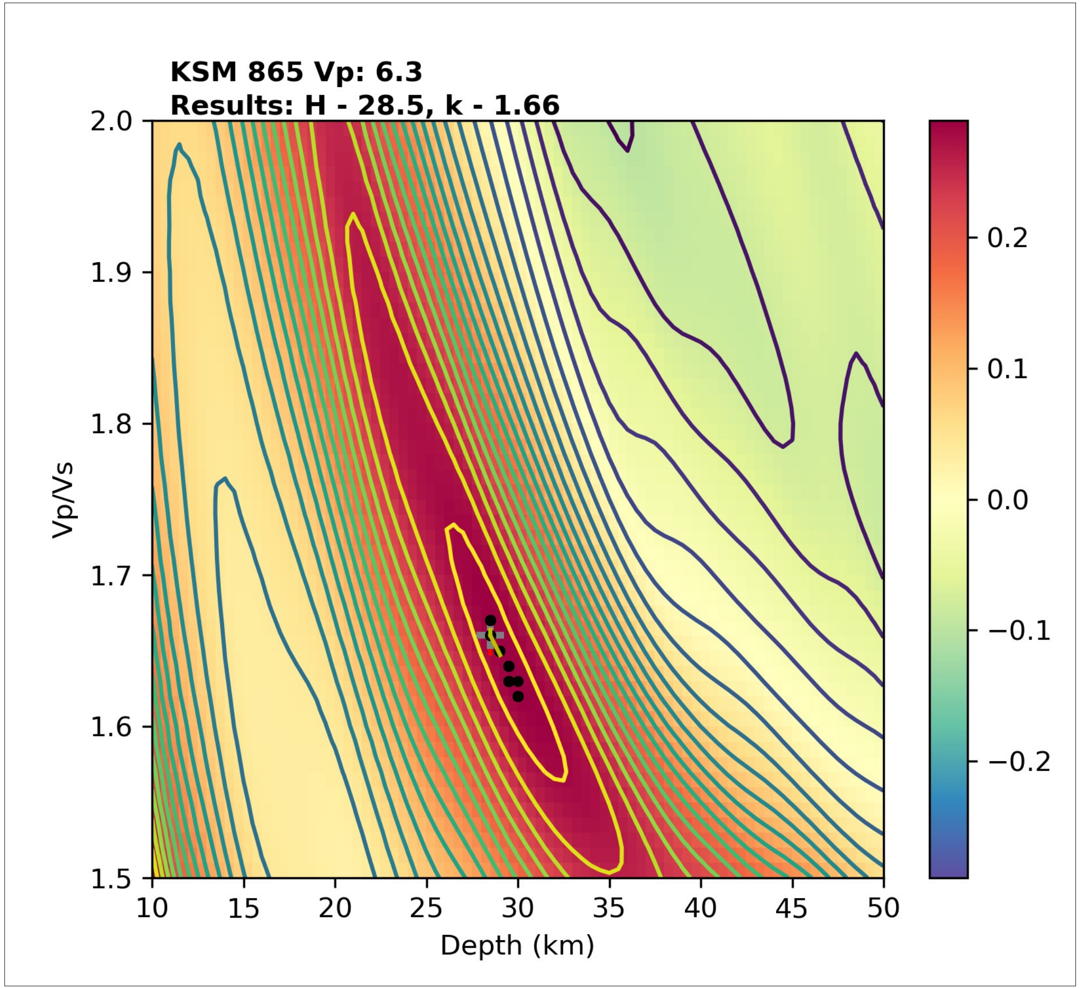




MET Malaysia Station: KSM

- Station KSM is located in West Borneo as shown on the map.
- Figure on the right shows 865 receiver functions (RFs) plotted as a function of back-azimuth (BAZ) from this station. This also shows the back-azimuth data coverage for most seismic stations in this particular region.

3. H-k Stacking Analysis

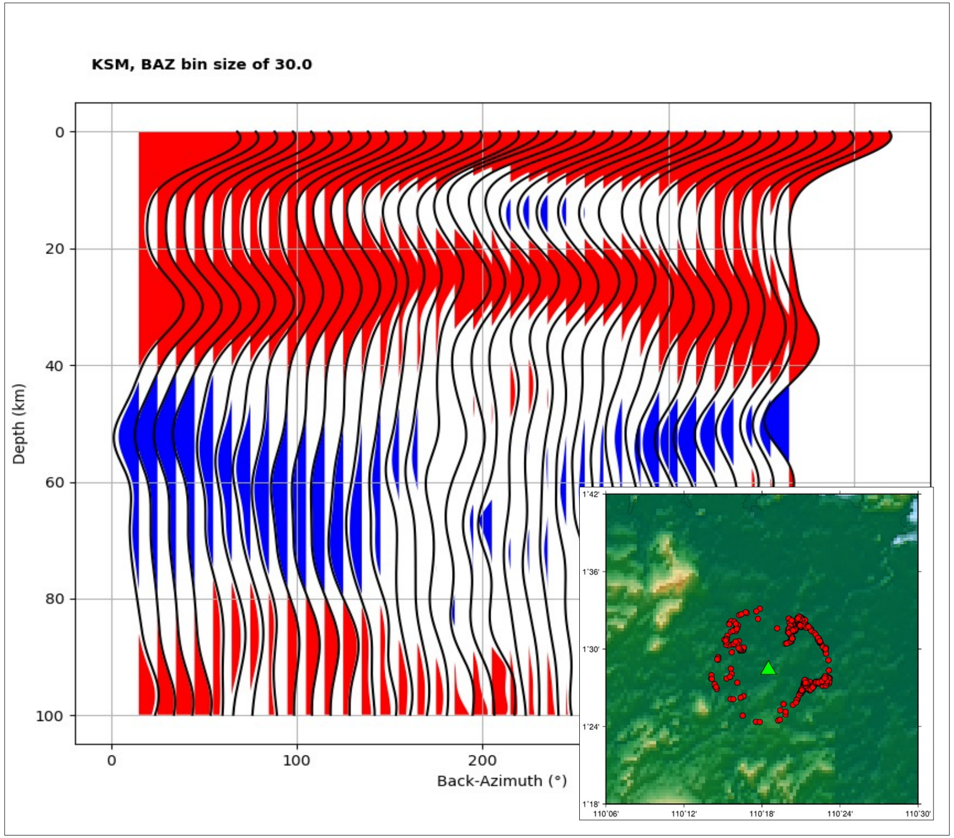


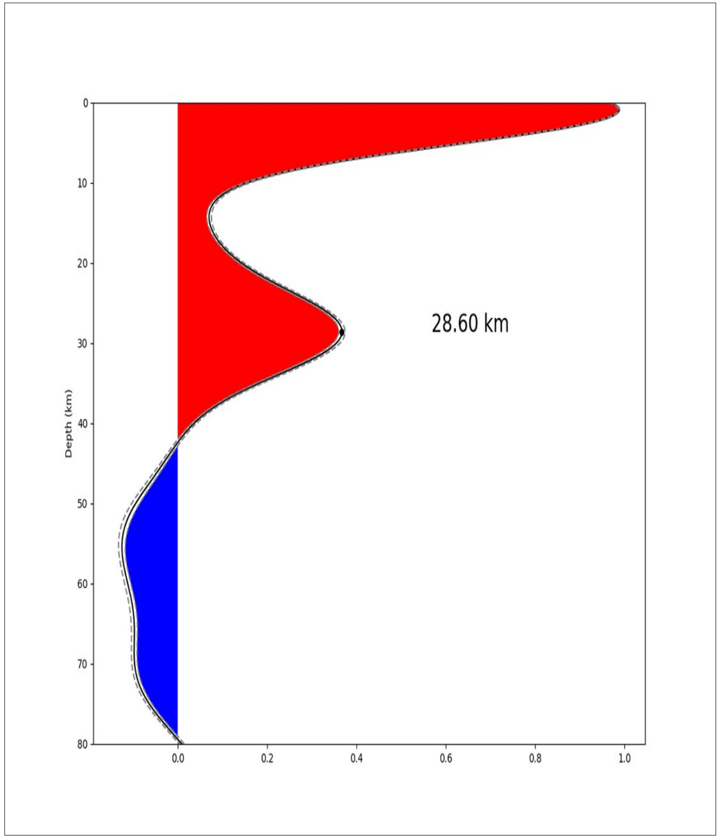
H-k Stacking Method by Zhu and Kanamori (2000)

- Figure shows an example H-k stacking result for station KSM.
- A total of 865 receiver functions (RFs) are used in the stacking from 12 years of data.

- Input:
  - 865 RFs
  - Assumed crustal bulk Vp: 6.3 km/s
- Output:
  - Moho thickness estimate: 28.5 km
  - Crustal bulk Vp/Vs ratio estimate: 1.66
- Black points show bootstrapping solutions for randomly selected and stacked RFs.
- The bootstrapping solutions show that results obtained from the full stacking of RFs are robust, with small error estimates; depth= +- 2km and Vp/Vs= +-0.04.
- This varies from station to station depending on local or regional tectonic complexity.

4. Time to Depth Conversion

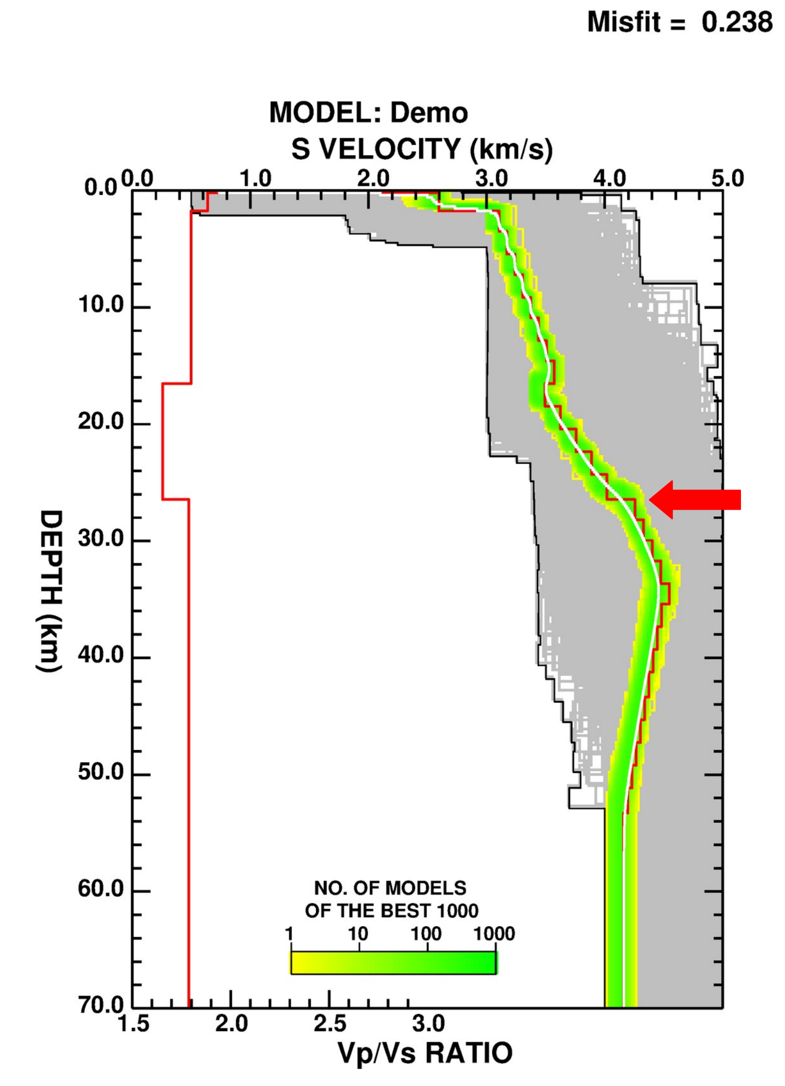


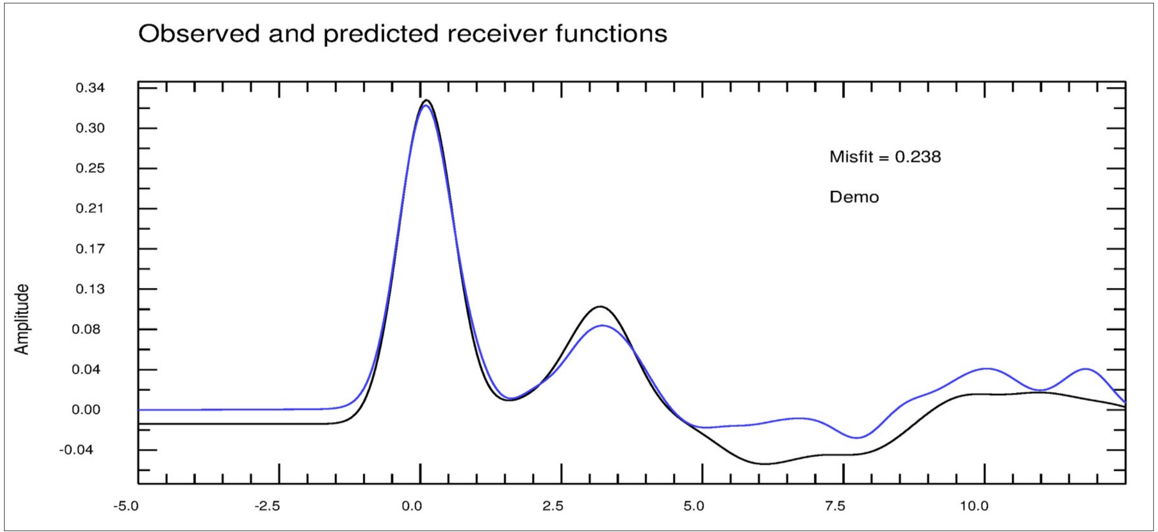


- Figure on the left shows depth converted RFs for station KSM plotted against back-azimuth (BAZ) direction. This was done with time-depth relationship graph produced with information from the H-k stacking result. This plot shows us that there are depth variation in the Moho depth with BAZ beneath the station. Inset figure shows the ray piercing-points of the estimated Moho (red circles) around station KSM.

- Figure on the right is the receiver function produced by the stacking of all the depth converted RFs.

5. NA Inversion

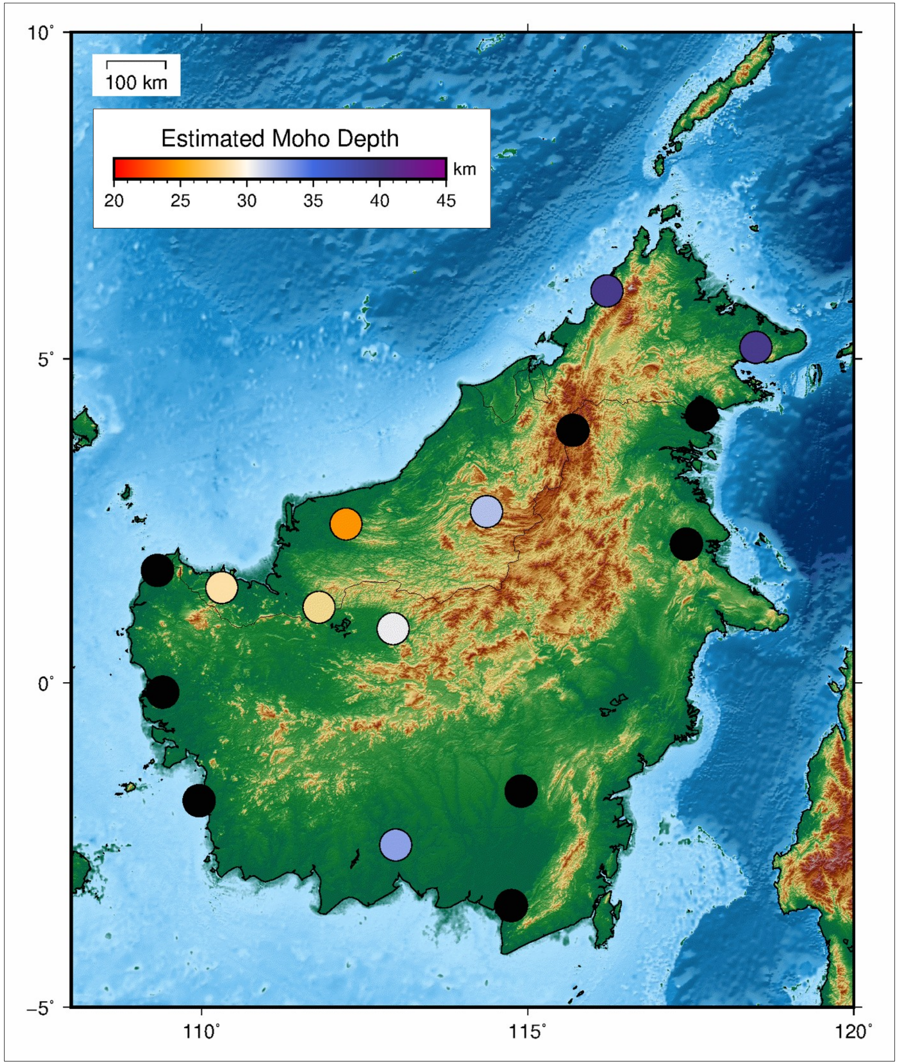




Neighbourhood Algorithm (NA-sampler)

- NA is used to produce seismic velocity profiles by inversion of the RFs; these profiles also help to constrain the depth and transitional nature of the Moho.
- Figure on the left shows S velocity profiles obtained from inversion of RFs from station KSM. Red line (left) shows the Vp/Vs ratio result from inversion and red model (right) is the best fit model. The coloured section shows the best 1000 models and the red arrow shows possible Moho depth.
- The result obtained from the inversion estimated the Moho to be around ~27 km, which is consistent with the H-k stacking method.
- Figure on the top right shows the fit between observed (black) and predicted (blue) receiver function following the inversion.

6. Results



- The map shows average estimated Moho depth beneath a seismic station obtained so far in Borneo, from the receiver function analysis and NA inversion.

- Initial results points to a very thick crust in northern Borneo and relatively thin crust in West Borneo. This is largely consistent with the known tectonic setting, although more data is obviously required before robust interpretation becomes possible.

- Black circles shows station locations where estimation of Moho depth are not yet determined.

- OUTLOOK:
  - Further interpret results obtained from the NA Inversion
  - Continue analysis at additional stations in Kalimantan when more data are available in the coming months. Data from Sulawesi will also be used to examine the change in character of the crust across Makassar Strait.
  - Apply the Virtual Deep Seismic Sounding (VDSS) method to the data recorded at seismic stations in northern Borneo to obtain detailed information on variations in crustal thickness and bulk crustal properties.