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The geodynamics of Sulawesi Island and its structures based on P wave delay time, ray-tracing, and shear wave splitting phenomena

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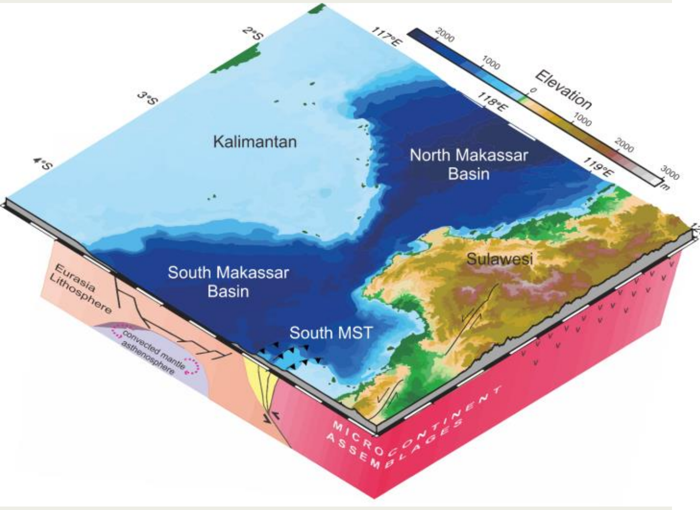
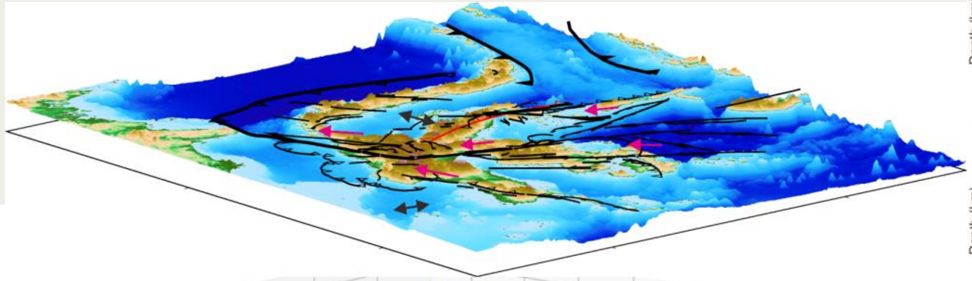
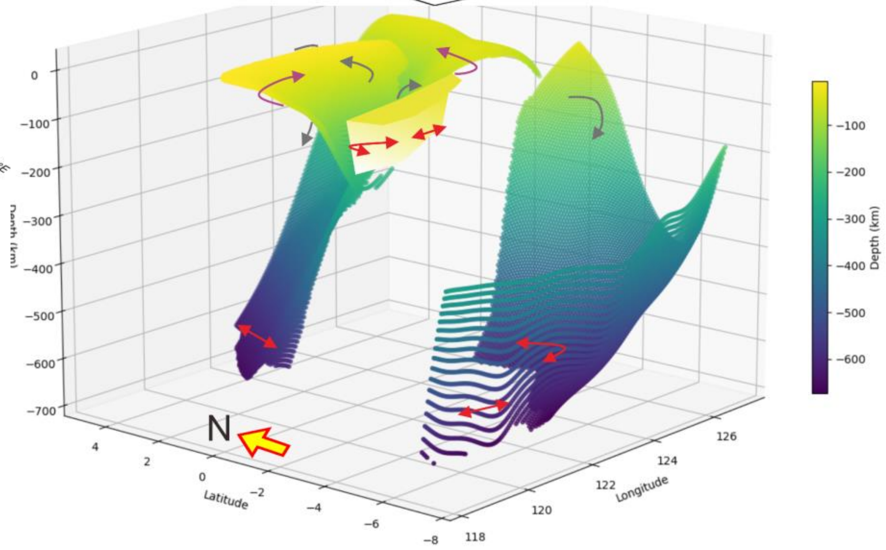
BMKG
國立中央大學 National Central University

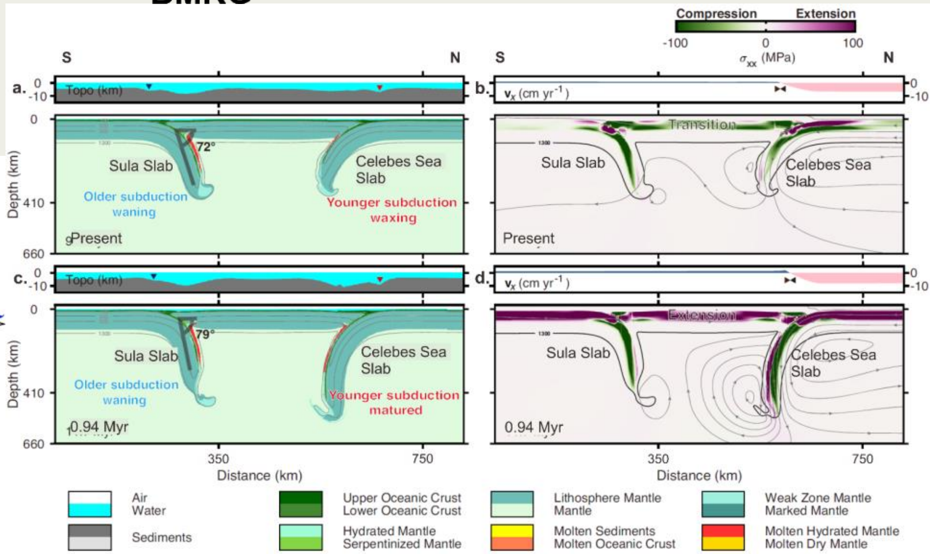
Introduction and Main Results

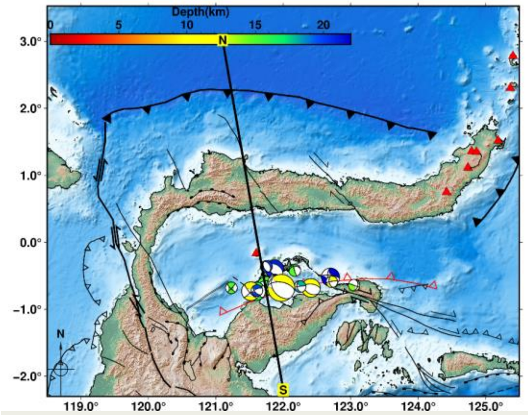
This presentation provides insights related to geodynamics of Sulawesi Island and its structures.











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Introduction

The Indonesia Meteorology Climatology and Geophysics Agency (BMKG) has operated seismic network and we use 69 seismic sensor that have been deployed in Sulawesi Island and its surroundings.

The main objective of deploying seismic network is to detect and identify earthquake that occurred in Indonesia region and big earthquake around the world. However, the data are also extremely valuable for scientific studies e.g., to investigate the shear-wave splitting phenomena. These applications provide a benefit to the main purpose of identifying the geodynamics of Sulawesi Island and its structure, especially anisotropic structures.

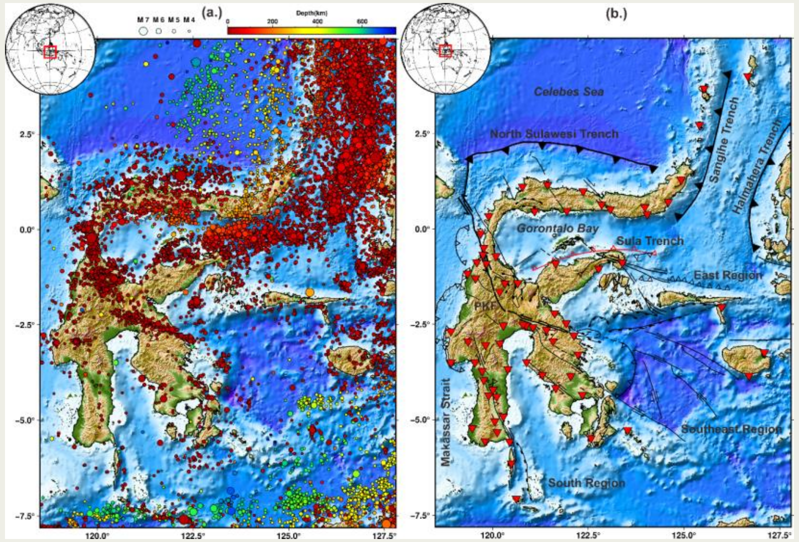

Fig. 1 (a.) Seismicity from BMKG catalog 2009-2024. (b.) The tectonic setting of Sulawesi was compiled by Serhalawan and Chen (2024). The red triangles are seismographs that are used in our study.

Data

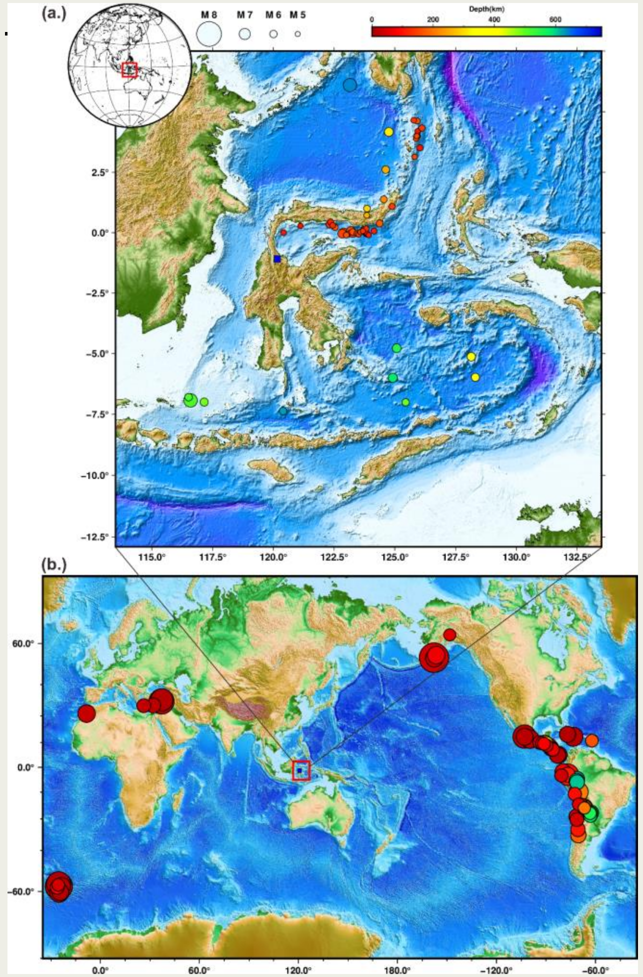

Fig. 2 Earthquakes distribution that are used to identify shear-wave splitting. (a.) Local events have 101.5 km to 638.8 km. (b.) Teleseismic events have 10 km to 623.9 km.

How to observe?

Applications for calculating shear-wave splitting:
https://github.com/TomSHudson/swspy

Methods

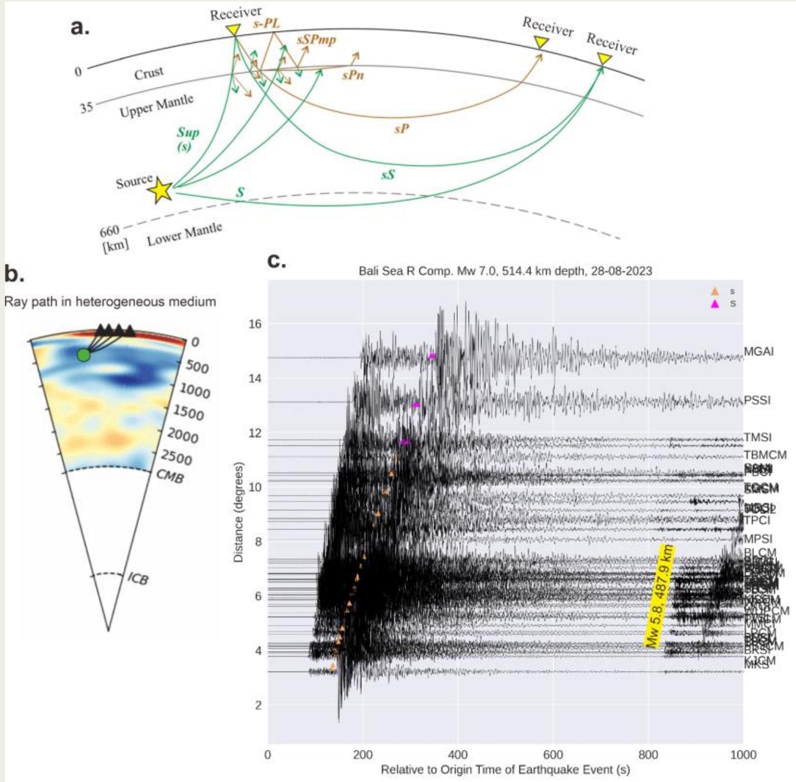

Fig. 3 Earthquakes distribution that are used to identify shear-wave splitting. (a.) Local events have 101.5 km to 638.8 km. (b.) Teleseismic events have 10 km to 623.9 km.

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Methods

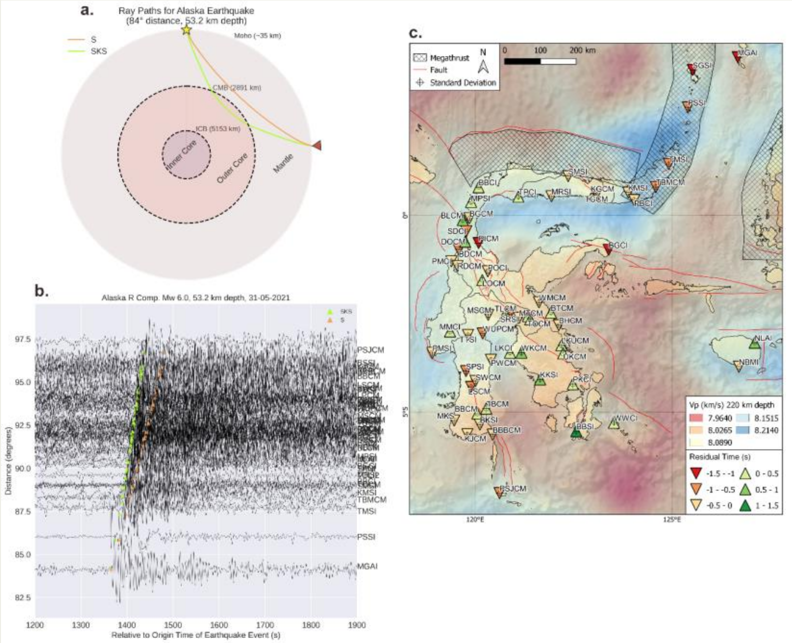


Fig. 4 Plot theoretical arrival time for Alaska Mw 6.0 earthquake. (a.) Schematics S and SKS waves. (b) Theoretical arrival time from AK135 (Kennett, et al., 1995). (c.) The relative residual arrival time is calculated using AIMBAT (Lou, et al., 2013) and overlaid with a 3D-velocity model from Simmons et al. (2012)..

1. Rotate data into the LQT coordinate system.
2. Perform a grid search to find splitting parameters (ϕ,δt) that correspond to minimum eigenvalue-ratio (Silver & Chan, 1991).
3. Repeat for many windows, performing cluster analysis to find overall optimal splitting parameters (Teanby, et al., 2004).
4. Calculate uncertainty in parameters and Wüstefeld's quality factor (Wüstefeld, et al., 2010).
5. Calculate shear-wave source polarization.
6. Convert splitting parameter results from LQT to ZNE.
7. Select the results based on consistency across moving-window results and Wüstefeld's quality.

Results

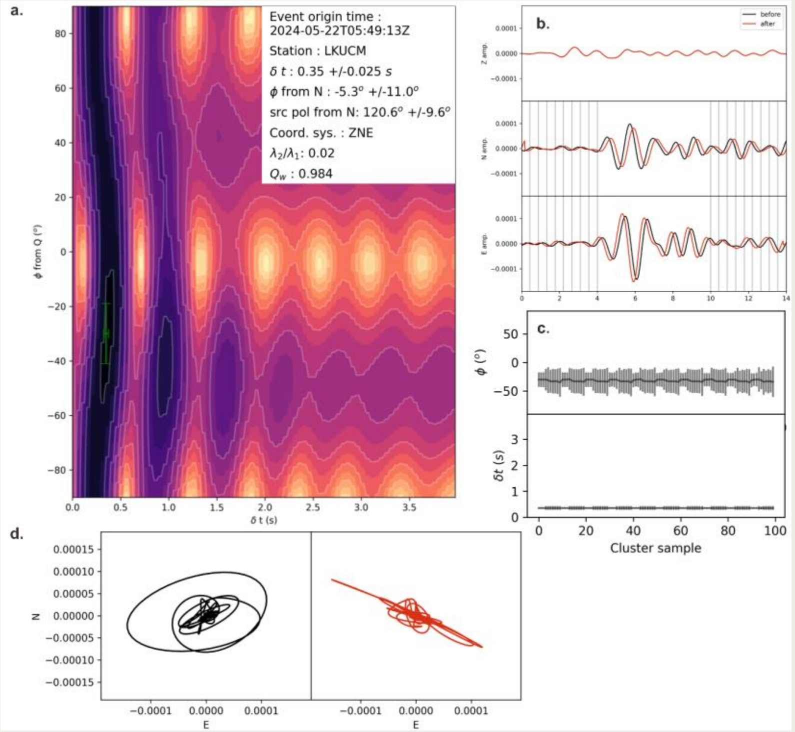


Fig. 5 The result from Minahassa earthquake Mw 5.0 in 127.8 km depth as local event.

Conclusions

Gorontalo Bay exhibits a trench-normal pattern due to the existence of Sula Slab and trench-parallel due to extensional rifting.

The decay pattern of splitting delay time to the east relative to Makassar Strait indicates the presence of mantle flow due to extensional rifting.

Results

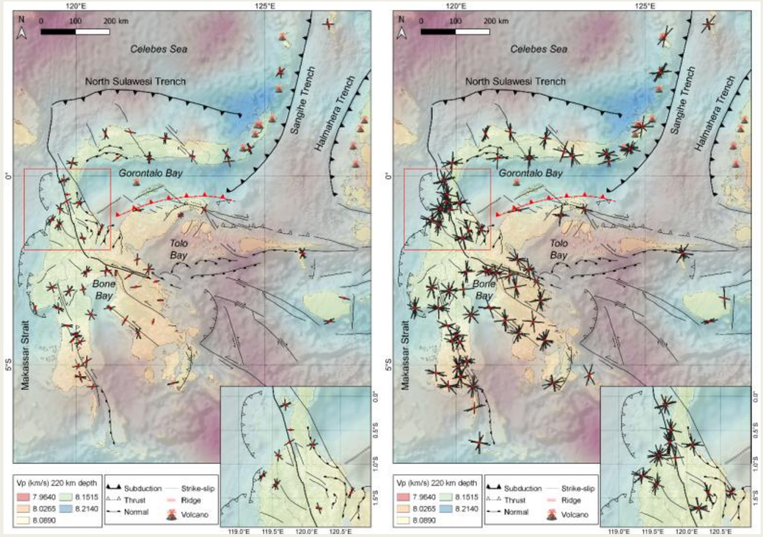
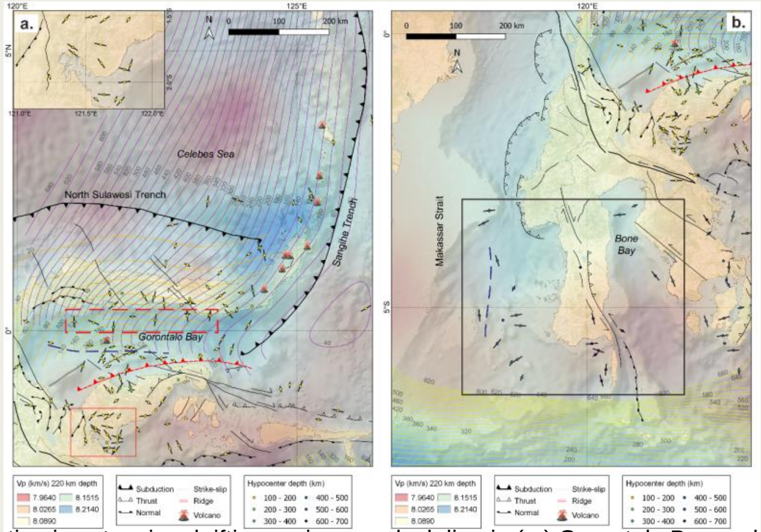


Fig. 6 The shear-wave splitting pattern from local (left) and teleseismic (right) on the stations. Splitting delay time is 0.3-1.9 s and 0.3-3.95 s from local and teleseismic events, respectively.



Fast polarization in extensional rifting regions as dash line in (a.) Gorontalo Bay and (b.) Makassar Strait. The dashed red square shows a normal trench as existing in Sula Slab.