Imaging 3D structure around the Gofar oceanic transform fault with magnetotellurics

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SUMMARY

The seismic behavior and structure of the Gofar transform fault, which offsets the East Pacific Rise near $5°$S, have been well studied over the course of several expeditions. Patches of the fault rupture periodically in $M_w \sim 6$ earthquakes, while nearby patches host only small earthquakes. Magnetotelluric and controlled source electromagnetic data were collected in 2022 to better constrain the distribution of fluid in the subsurface as it relates to variations in fault behavior from section to section. We present a magnetotelluric model revealing a strong conductor in the lower crust, primarily south of the fault scarp. The conductor corresponds spatially to the seismogenic zone of the fault and likely extends deeper near the rupture barrier than in the adjacent asperity zone. Little structure is visible below the conductor, despite high quality data to 4000s.

We discuss two possible interpretations of this feature. Conductivity could be elevated by the presence of pore fluid, consistent with the spatial correlation between conductivity and seismicity. At the observed bulk rock conductivities, the pore fluid would be substantially more conductive than seawater, potentially indicating very high salinity. This interpretation is complicated by seismic tomography from this area, which shows no observable velocity anomaly in the lower crust. Conductive mineral phases, which could be less visible to seismic tomography than elevated porosity, provide an alternative explanation. Chromite and associated minerals are often present near the Moho in ophiolites, and have been found in association with fossil transform faults. However, the presence of chromite does not provide an obvious mechanism for the correlation between high conductivity and seismicity. Additionally, the conductor is centered in the lower crust, whereas chromite tends to occur in the uppermost mantle. It is possible that the conductor reflects both fluid in the fault zone and conductive minerals.

Keywords: oceanic transform fault, magnetotellurics, earthquake mechanics, porosity