A Vulcan Mapping of the Gofar Transform Fault: Understanding the Effect of Porosity Structure on Seismicity Segmentation Using Active Source Marine Electromagnetic Data

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SUMMARY

The oceanic Gofar transform fault (GTF) is situated adjacent to the fast-spreading East Pacific Rise and is a dynamic hub of tectonic activity, including complex patterns of seismicity. In particular, the region displays distinct segmentation of seismicity, with rupture zones hosting quasi-periodic M_w~6 earthquakes alternating with barrier zones that inhibit rupture propagation. As such, the GTF provides an ideal natural laboratory for studying seismic behavior and earthquake genesis. One possible explanation for the observed seismic segmentation is variations in the volume and properties of fluids within the crust. We used controlled-source electromagnetic (CSEM) methods to gain insight into crustal porosity variations throughout the fault system. Our survey was part of a multidisciplinary study aimed at disentangling the complexities of stress evolution, deformation, and pore fluid presence within the GTF. The CSEM system deployed included one deep-towed source transmitting over 300 A of current on a 300 m dipole, and two fixed-offset, three-axis, towed electric field receivers known as Vulcans. The data measured by the Vulcan receivers are influenced primarily by variations in the pore fluid distribution in the uppermost ~500 m of seafloor. We present preliminary 2-D inversion models derived from Vulcan data to delineate the electrical resistivity along the strike of the GTF. Initial results indicate a relatively conductive surface layer suggestive of high porosity extrusive oceanic crust and thus high fluid content. We interpret our initial Vulcan models alongside coincident CSEM data collected on seafloor instruments, seismic data, and water column data collected by the autonomous vehicle SENTRY. This joint-interpretation approach allows us to connect variations in porosity to variations in the behavior of the rupture and barrier zones of the GTF. Our findings offer new insights into the role of fluids in the recurrent, quasi-periodic M_w~6 seismic cycles of the GTF.

Keywords: CSEM, porosity, transform fault, seismicity