EGU22-4993
https://doi.org/10.5194/egusphere-egu22-4993
EGU General Assembly 2022
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A new model for the evolution of oceanic transform faults based on 3D PSDM Seismic observations from São Tomé and Príncipe, eastern Gulf of Guinea.

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Oceanic Transform faults are one of the three major tectonic plate boundaries and yet their evolution and deformational mechanism is not well understood. They are broadly considered to be dominated by strike-slip displacement along simple planar vertical faults and to be conservative in nature with no magmatic addition. Observations from Pre-Stack depth-migrated (PSDM) 3D seismic of Cretaceous-aged transforms in the eastern Gulf of Guinea allow complex internal architectures to be described, including crustal scale detachments and rotated packages of volcanics.

These insights demonstrate additional complexity previously only predicted in numerical simulations of spreading ridge-transform interaction, namely intra-transform extension at a high angle to the spreading orientation, and the addition of significant extrusive volcanic material. In the study area of São Tomé and Príncipe, several Oceanic Fracture Zones (OFZ) are identified, consisting of a broad deformational zones that can be described from top to base crust. OFZ scarps are observed to connect at depth with zones of low angle reflectivity which dip into the OFZ and perpendicular to the spreading orientation. At depth they detach onto the Moho below, necking the adjacent crust along the length of the OFZ in the manner of extensional shear zones. Thickly stacked and tilted reflectors, interpreted as extrusive lava flows, are common above the shear zones and infill up to 75% of the crustal thickness. The entire OFZ stratigraphy is overlain and sealed by late-stage lavas that are continuous from the abyssal hills of the trailing spreading ridge. This constrains a process of oblique extension at a high angle to the spreading orientation along a low angle shear zone which also acts as a conduit for decompression related melt.

We demonstrate that transforms in São Tomé and Príncipe were both non-conservative and not a simple strike slip fault zone, contradicting the current understanding of modern systems. This style of deformation has similarities with anomalously deep and smooth nodal basins which form at slow spreading inside-corner crust. Our model adds strong observational constraints to complement recent numerical models that predict oblique extension within transform zones.