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Complex tectono-magmatic interaction in the evolution of the George V Transform Fault, South-East Indian Ridge, 140°E, and implications for mantle dynamics

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The George V Transform Fault (TF) is the westernmost of the major, right-stepping transform faults that offset the South-East Indian Ridge between 140°E and 155°E. The George V TF (140°E) has an offset of about 300 km; the Tasman TF (148°E) an offset of about 600 km, and the Balleny TF (155°E) an offset of about 300 km. All these TFs have multiple shear zones with intra-transform ridge segments (ITRS), mostly unmapped yet. We present the results of the analysis of geophysical and petrological data collected during the STORM cruise (South Tasmania Ocean Ridge and Mantle). The data cover the western shear zone of the 140°E TF and part of two of its ITRSs. They reveal a complex interaction between tectonic processes at the plate boundary and near-axis volcanic activity along and across the transform fault. The western TF shear zone consists of two segments offset by a 50 km-long, 15 km-wide, up to 2000 m-high serpentinite massif. We infer that the massif is a push-up resulting from transpression along the transform, due to the lengthening of the western ITRS, with a mechanism similar to the processes currently uplifting the mylonitic massif along the St. Paul TF in the Equatorial Atlantic (1). The western ITRS is relatively shallow and magmatically robust, which is very unexpected as TF systems are generally associated to low magma supply. The bathymetric and backscatter maps also reveal a series of recent off-axis oblique volcanic ridges. Rocks dredged on one of these ridges consist of picrites (i.e. basalts rich in olivine phenocrysts). These observations suggest that the TF there is not magma starved like many mid-ocean ridge transforms, but is the locus of significant primitive melt supply. Such an unexpected production of high-Mg melt might be related to the presence of a mantle thermal anomaly beneath the easternmost SEIR, and/or to a western flow of mantle across the TF.

(1) Maia et al. 2016 Nature Geo. doi:10.1038/ngeo2759

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