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Large offset normal faults, ridge obliquity, and the distribution of volcanism at a melt-poor ultra-slow spreading ridge

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We report on an extensive set of off-axis bathymetry, gravity, and magnetic data, providing a 26 myrs-long record of axial tectonic and magmatic processes over a 660 km-long, and very melt-poor portion of the ultra- slow Southwest Indian Ridge (SWIR). 37% of the total mapped area, both on and off-axis, has a smooth seafloor morphology, and appears to have formed with no, or very little axial volcanism. This smooth seafloor terrane is inferred to expose large expanses of mantle-derived peridotites, with minor gabbros and diabases. It locally transitions into corrugated terranes (4% of mapped area). Volcanic seafloor, with numerous volcanic cones and tight, spreading-perpendicular fault scarps, covers the remaining 59% of the mapped area. In this talk, we focus on the transition from smooth to volcanic terranes, showing that while the smooth seafloor forms at minimal melt supply to the ridge, gravity anomalies suggest that the volcanic seafloor forms over a range of crustal thickness and melt supply: from very reduced as in smooth terranes, to about twice the average for this region of the SWIR. Crustal magnetization in volcanic terranes appears to correlate with gravity-derived crustal thickness, and is locally as low as in smooth terranes. Finally, the analysis of seafloor morphology suggests that major ridge-parallel normal faults in smooth terranes also controlled the accretion of adjacent volcanic seafloor. These observations lead us to propose that there is no clearcut change in accretion processes between the two types of seafloor, but rather that beneath the upper volcanic layer, volcanic terranes of the SWIR may display a range of intermediate and lower crust compositions, from dominantly ultramafic, to dominantly basaltic. Ridge obliquity in our study area varies along-axis from more than 30, to less than 10 degrees. In oblique regions, we observe that volcanic terranes are systematically associated with a reorientation of major faults, from oblique to spreading-perpendicular. We propose that this illustrates the role of the magmatic processes associated with volcanic eruptions in creating and maintaining a spreading perpendicular weakness zone in the axial lithosphere of oblique ridges.