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Deep-tow geophysical survey above large exhumed mantle domains of the eastern Southwest Indian ridge

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The recent discovery of a new type of seafloor, the "smooth seafloor", formed with no or very little volcanic activity along the easternmost part of the ultra-slow spreading Southwest Indian ridge (SWIR) shows an unexpected complexity in processes of generation of the oceanic lithosphere. There, detachment faulting is thought to be a mechanism for efficient exhumation of deep-seated mantle rocks. We present here a deep-tow geological-geophysical survey over smooth seafloor at the eastern SWIR (62-64°N) combining multibeam bathymetric data, magnetic data, geology mapping from sidescan sonar (TOBI) images and results from dredge sampling. We introduce a new type of calibration approach for deep-tow fluxgate magnetometer. We show that magnetic data can be corrected from the magnetic effect of the vehicle with no recourse to its attitude (pitch, roll and heading) but only using the 3 components recorded by the magnetometer and an approximation of the scalar intensity of the Earth magnetic field. The collected dredge samples as well as the sidescan sonar images confirm the presence of large areas of exhumed mantle-derived peridodites surrounded by a few volcanic constructions. We investigate the possibility that magnetic anomalies are either caused by serpentinized peridotites and/or magmatic intrusions. We show that the magnetic signature of the smooth seafloor is clearly weaker than the surrounding volcanic areas. Moreover, the calculated magnetization of a source layer as well as the comparison between deep-tow and sea-surface magnetic data argue for strong East-West variability in the distribution of the magnetized sources. This variability may result from fluid-rock interactions along the detachment faults as well as from the occurrence of small sized and thin volcanic patches and thus questions the seafloor spreading origin of the corresponding magnetic anomalies. Finally, we provide magnetic arguments, as calculation of block rotation or spreading asymmetry in order to better constrain tectonic mechanisms that occur during the formation of this peculiar seafloor.