Assessing the regional geology of the Rodriguez Triple Junction and associated hydrothermalism

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Ship-based multibeam echosounding is an established method in marine research to remotely explore the ocean floor. Despite the common availability of ship-based multibeam data, its geological interpretation is often limited to individual features or to small areas, where visual observations or ground truthing are available. Further, the resolution of ship-based bathymetry prevents the detection of small structures, such as hydrothermal vent sites and associated massive sulphide deposits. This restricts corresponding exploration to near-seafloor, spatially limited operations, or to active vent sites.

Here, we present a systematic and comprehensive interpretation scheme for producing geological maps of mid-ocean ridges from ship-based bathymetry data to enable statistic assessment of geological occurences and identification of exploration criteria for massive sulphide deposits.

In a case study, we produced a geological map of the Rodriguez Triple Junction (RTJ) in the central Indian Ocean from ship-based multibeam data and verified it with available ground truthing information. The RTJ is a stable, migrating intersection between the ultraslow-spreading Southwest Indian Ridge, the slow-spreading Central Indian Ridge, and the intermediate-spreading Southeast Indian Ridge. The Central Indian Ridge segment of the RTJ hosts two known hydrothermal vent sites: Kairei and Yokoniwa.

The resulting geological map allows us to systematically capture the complexity of the RTJ and to assess the geological environment of both hydrothermal vent sites. This includes the evaluation of lithology, the geodynamic stress field, crustal permeability and deformation dynamics, upper crustal construction and proximity to volcanic centers. Subsequently, this analyses is used to identify areas favourable for hosting hydrothermal vent sites and to guide exploration for yet unknown massive sulphide deposits.