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Petrogenesis at the southernmost Central Indian Ridge: Fluid flow in the oceanic lithosphere at the Rodriguez Triple Junction

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In October-November 2011 the cruise INDEX 2011 explored the intermediate to slow spreading southern Central Indian Ridge to reinvestigate the bathymetry, structural geology, and petrology of the area, with the main focus on the petrogenesis and hydrothermal processes. This study focuses on the region north of the Rodriguez Triple Junction. The active Kairei hydrothermal vent field is located on the eastern rift valley wall in the first ridge segment. For detailed petrological and geochemical studies a large variety of rock samples were collected using dredge and TV-guided grab. The rock suite includes basalts, gabbros and ultramafic lithologies. Massive sulfide ores were recovered from the Kairei vent field. This study presents the geochemical and mineralogical composition of the different rock suites and the copper ores from the Kairei oceanic lithosphere.

The recovered rock samples are best classified as tholeiitic basalts, olivine-gabbros, olivine-norites and serpentinized harzburgites and dunites. The tholeiitic basalts are represented by sheet flows and pillow basalts with dispersed vesicles up to cm-sizes. They display an aphyric to porphyric texture with large mm-sized plagioclase, olivine and minor clinopyroxene phenocrysts in a fine-grained to glassy groundmass. The basalts are relatively Fe-rich with a high amount of fine-grained magnetite in the groundmass. Monosulfide solid solution phases show exsolution to pyrrhotite, chalcopyrite and pentlandite. Gabbros show variable clino- and orthopyroxene contents and locally represent norite compositions. They are geochemically characterized by different trace element signatures and may be grouped into differentiated and cumulate varieties. The serpentinite suite represents variable degrees of altered harzburgites and dunites. It is evident that the serpentinisation process occurred during the exhumation as evidenced by serpentine slickensides. A characteristic mesh texture with replaced olivine by serpentine and magnetite can be noticed.

Samples of the massive copper ores consist of major chalcopyrite and minor sphalerite and marcasite. In rim areas and fractures, the chalcopyrite is replaced by secondary copper phases such as chalcocite and covellite. Accessory pyrite inclusions occur in the large chalcopyrite grains. Overall the massive copper ores display a relatively consistent chemical composition with significant concentrations of Cu, Au, Ag, Se, Mo, Bi and Te. Analyses of specific minerals show inclusions of silver sulfide mineral phases in chalcopyrite.

The study aims at the interrelationships between fluid flow, petrogenesis deep in the crust and upper mantle and the relationship to hydrothermal processes.