Multiphase serpentinization at the Southwest Indian Ridge (62°-65°E)

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At slow-spreading ridges, fluid-rock interactions cause serpentinization of the peridotites exhumed along detachment faults. The serpentinizing fluids nature and their relations to hydrothermal circulations fueled by magmatic heat remain open questions. Because the easternmost Southwest Indian Ridge (62°-65°E) is nearly a-magmatic it represents an ideal place to study serpentinization in the absence of magmatic overprints. Here we focus on the highly serpentinized peridotites dredged on and off-axis in this region and particularly on a subset of these samples (about 25% in volume) that display textural evidence for a multiphase serpentinization history. Decimeter-sized blocks are zoned, with a typical serpentine mesh texture in the center, rims of recrystallized serpentine and several generations of veins. Increasing spacing of preferential fluid pathways accompany this sequence: from ~60-80-μm-spaced microfractures that form the initial network for fluid penetration in the fresh peridotite, to the 200-500μm-wide polygonal patterns of the mesh texture, then to the decimeter-spaced microfractures and veins that control serpentine recrystallization.

Fluid-serpentine interactions involve the cohabitation of several serpentine polymorphs, from the mesh texture lizardite toward chrysotile-polygonal serpentine assemblages and locally significant amounts of antigorite. $\delta^{18}O$ values decrease from 5.98‰ in mesh texture serpentine to 1.91‰ in the latest recrystallized serpentines, suggesting temperatures of 200-350°C and progressive equilibration with fluid values due to increasing water-rock ratio. Microprobe and LA-ICPMS data indicates that fluid-rock interactions caused local redistribution of some major elements (Al, Fe) and significant enrichments in fluid-mobile trace elements (B, Sr, U, Cu, As, Sb) in the initial mesh textured serpentine minerals compared to primary minerals of the peridotites. Later recrystallization of the mesh is marked by further major element transfers but no significant change in the trace elements contents. REE patterns show non systematic Eu anomalies, inferred to result from variable redox conditions. Significant Ce anomalies are measured in off-axis samples, reflecting seafloor interactions with seawater.