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Feedbacks between deformation and fluids in mantle shear zones recording the late stades of rifting in the Red Sea

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Peridotites in the Zabargad island, Red Sea, record different stages of lithospheric thinning and asthenospheric upwelling during rifting. Field mapping highlights a pervasive high-temperature NW-SE, subvertical foliation with lineations pluning 50°NW. This foliation is overprinted by a series of lower-temperature mylonitic zones with slightly oblique foliations and subhorizontal lineations, which record progressive strain localization under retrogressive conditions during the final exhumation of the peridotites (Nicolas and Boudier, JGR 1987). We performed a petrostructural study of ca. 50 samples collected by A. Nicolas and F. Boudier in the 80s from the different deformation facies. This study highlights: (1) progressive strain localization associated with decreasing temperature conditions, (2) a rather pervasive, but highly heterogeneous distribution of the LT deformation and (3) strong feedbacks between deformation and fluid flow. The HT deformation is recorded in medium grained plagioclase- and spinel-peridotites by a homogeneous foliation and lineation marked by a shape-preferred orientation of plagioclase and olivine and a consistent CPO of all major-rock forming phases. The LT temperature deformation is recorded in a large number of meters to cm-scale shear zones. It is characterized by a marked grain size reduction by dynamic recrystallization of olivine, remobilization of orthopyroxene by dissolution- precipitation, and crystallization of amphibole. Increasing finite strain is associated with an increase in the volume of the fine-grained material and in the amphibole proportion. The latter may attain in totally recrystallized cm-wide ultramylonite bands up to 30%. This together with the strong amphibole SPO and CPO corroborate fluid focusing and enhanced reaction rates into active shear zones. On the other hand, outside the LT shear zones static replacement of pyroxenes by amphibole with no associated LT deformation is observed, indicating that the presence of fluids does not suffice to trigger strain localization.