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Amphibolitization of eclogites in a subduction channel (Sistan belt, E. Iran): Monitoring changes in fluid composition during exhumation and tectonic implications

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Fluids released from subducting slabs are important for improving our understanding of mass transfer within subduction zones. Eclogites from the Sistan ophiolitic suture zone (eastern Iran) have a well preserved structure and a rather simple metamorphic history, making them an interesting target to monitor changing in fluid composition throughout their journey from eclogite-facies conditions towards the surface. The Sistan suture formed by the closure of a branch of the Neotethys during Cretaceous times. It comprises a stack of tectonic slices detached from various depths of this paleo-subduction complex. One of these slices is made of 10-meter sized blocks of eclogite wrapped by serpentinite schist (Angiboust et al., 2013). The eclogite assemblage (∼550°C, 2.4 GPa), only visible in exposed block cores, has been strongly retrogressed by an amphibolite-facies paragenesis (∼650°C, 1.2 GPa). The thermal overprint during exhumation has been ascribed to the juxtaposition of this unit to the overlying sub-continental serpentinized mantle. In the present study, one of the eclogitic blocks has been investigated for chemical changes associated with the amphibolitisation of the eclogite, in order to get an idea about the geochemical signature of retrograde fluids. Petrographic and geochemical observations point to high element mobility and multiple fluid-rock interaction events, visible in the sample as dissolution textures, mineral chemical oscillations and pervasive replacement by amphibolite-facies minerals. Whole-rock mass balance calculations and LA-ICP-MS measurements reveal at least two successive metasomatic events associated with the retrograde metamorphic overprint of the eclogitic block. Deep fluids (1.5–2.0 GPa) were apparently rather enriched in Mg, Cr, and Ni, indicating the presence of serpentinite-derived fluids, while later fluids associated with the climax of amphibolitization were clearly carriers of large ion lithophile elements (such as K, Ba, Sr). This later event likely witnesses interaction with fluids derived from metasediments, as the eclogite unit ascended in the subduction channel and finally reached the bottom of the accretionary wedge. These results highlight the combined use of thermobarometry and detailed monitoring of mineral composition as a valuable source of information for tracking fluid composition evolution through burial and exhumation in convergent settings.