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The basal part of the Oman ophiolitic mantle: a fossil Mantle Wedge?

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Although the Oman ophiolite is classically regarded as being the direct analog of oceanic lithosphere created at fast spreading ridges, the geodynamic context of its formation is still highly debated. The other alternative end-member model suggests that this ophiolite entirely formed in a supra-subduction zone setting. Fluids involved in the hydration of the oceanic lithosphere and in the presence of a secondary boninitic and andesitic volcanism may provide a way to discriminate between these two interpretations: are they descending near-axis hydrothermal fluxes (first model) or ascending from a subducting slab (second model)?

We herein focus on the base of the ophiolitic mantle in order to characterize the origin of fluids and decipher hydration processes. Samples were taken along hecto- to kilometre-long sections across the basal banded unit directly overlying the amphibolitic/granulitic metamorphic sole. We carried out a petrological, structural and geochemical study on these rocks and their constitutive minerals.

Our results show that, unlike the generally refractory character of Oman harzburgites, all the basal mantle rocks display secondary crystallization of clinopyroxene and amphibole through metasomatic processes. The microstructures and the chronology of these secondary mineralizations (clinopyroxene, pargasitic amphibole, antigorite and then lizardite/chrysotile) suggest that these basal rocks have been affected by cooling from mantle temperatures (<1200°C) to low-T serpentinisation (<300°C). Furthermore, major elements required to crystallize these minerals and the observed fluid-mobile elements (FMEs) enrichments in the clinopyroxenes and in the amphiboles (B, Pb, Sr), as well as in the serpentines (B, Sr, Rb, Ba, As), are consistent with amphibolite-derived fluids (Ishikawa et al., 2005) and cannot be easily explained by other sources.

Based on these observations, we propose a geodynamic model in which intense and continuous metasomatism of the cooling base of the ophiolitic mantle is due to the release of fluids coming from the progressive dehydration of underlying amphibolitic rocks. This process is compatible with the progressive subduction of the Arabian margin during the Upper Cretaceous (e.g., HP-LT units history, and tectonic structures observed on top of it). The basal part of the Oman ophiolite would thus represent a fossil incipient mantle wedge.