

Trace element and isotopic characterisation of non magmatic dykes in the mantle section of the Oman ophiolite

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We have described recently a new lithology cropping out as dyke-like features in the mantle section of the Oman ophiolite (see Python et al., *Earth Planet. Sci. Lett.*, 2007). It is composed essentially of pure diopside rarely associated with anorthite, forsterite, andradite and hydrous phases like antigorite or tremolite in variable proportions. The texture of these *diopsidites* ranges from medium- to coarse grained assemblages of subhedral, blocky diopside grains to cataclastic. In some samples, ghost of former mantle derived olivines are still present although totally replaced by a mesh of tiny diopside needles. Evidence for metamorphic growth of euhedral diopside in a matrix of antigorite and carbonates is locally preserved. The texture of the diopsidites is similar to the one of skarns in contact metamorphic halos around granite intrusions and to that of rodingite developing at the contact between ultramafic and mafic bodies in ophiolitic complexes.

The chemical composition of the diopsidites was measured with in situ methods (electron microprobe and LA-ICP-MS). The Sr and Nd isotopic compositions of 3 samples from a single dyke were measured on whole rock. The composition of the diopsidites, although rather heterogeneous at all scales presents some systematic characteristics such as strong depletion in Fe, Ti, Al, Cr, Na, and in most trace elements, including REE, compared to common mantle derived or magmatic clinopyroxene. Exceptions concern an unusual enrichment in Eu and Sr. The concentration of Sr, relatively constant from one sample to another and, in the same sample, from one grain to another, suggests that that value was buffered by some process during the diopside crystallisation. The positive Eu anomaly is an intrinsic characteristic of the diopside and is not related to the presence of plagioclase in the mineralogical assemblage.

Texture and composition of these diopsidites are contradictory with a magmatic origin and support an origin by prograde metamorphism of serpentized peridotite in presence of a carbonate-rich fluids. We proposed that these dykes are the result of the interaction between very high temperature hydrothermal fluids and mafic magmas circulating in the shallow mantle. The buffering of Ca, Sr and Eu concentrations to relatively high values likely reflects the fact that hydrothermal fluids have pervasively leached gabbros from the lower crust before reaching the shallow mantle. The preliminary Sr and Nd isotopic data show an isotopic composition in Sr intermediate between the MORB and the cretaceous seawater ($^{87}\text{Sr}/^{86}\text{Sr}$ ranging from 0.7046 and 0.7055, and e_{Sr} from 3.9 to 15.9) and a $^{143}\text{Nd}/^{144}\text{Nd}$ ratio lower than 0.5127 (from 0.5125 to 0.5156, e_{Nd} ranging from 0.0 to 2.9). The Nd and Sr isotopic ratios of diopsidite are not typical values of the mantle beneath a mid-ocean ridge and are quite different from those of Cretaceous or of present-day seawater. They plot away from any other magmatic lithology found in the mantle section of the Oman ophiolite and away from the mantle/seawater interaction line - which involves an evolution of the e_{Sr} from the mantle (MORB) value to the seawater value without any changes of the e_{Nd} until the water/rock ratio reaches 10^6 . The intermediate e_{Sr} and e_{Nd} suggest a very high fluid/rock ratio, that lead to the modification of the e_{Nd} of the protolith of the diopsidite. On the other hand, the *diopsiditisation* process cannot be explained in the frame of a simple interaction between seawater and mantle issued melt, either seawater was contaminated by a fluid of different origin or the metamorphism leading to the formation of the diopsidite dykes involves some phenomenon that strongly modified the e_{Sr} and the e_{Nd} .