Mantle petrological mapping in the Oman ophiolite reveals large scale heterogeneities possibly in relation with mantle source variation

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Long debate have been hold about the tectonic setting of the Oman ophiolite. Some researcher outlining the MORB affinity of most magmatic features in favour of a mid-ocean ridge setting and other insisting on the ultra-depleted nature of the mantle and the petrological and chemical characteristics of the metamorphic sole as support for a supra-subduction zone setting. Recent studies have suggested that the tectonic settings may have switched from an open ocean to a subduction zone, explaining most of the characteristics of the ophiolite as well as that of the metamorphic sole.

Magmatic dykes present within the mantle section show that several type of magma may have circulated in the Oman ophiolite: a MORB-like end-member melt and more a more depleted end-member melt, richer in Si with possible andesitic affinity. Only little mixing between these two end-members is observed in the mantle dykes and the geographical distribution is non random with MORB-like melts concentrating in the South-eastern massifs while andesitic melts are dominant in the north-western massifs. The same distribution can be observed for other ophiolitic features, like the chemistry of chromitite pods, the chemistry of chromian-spinels in pyroxenite dykes (richer in Ti and lower in Cr in the south-eastern massifs for both features), and the presence or absence of pyroxene-rich concordant layers in the mantle (abundant only in the north-western massifs).

In this study, we put an additional piece to this edifice by showing that the mantle chemistry, in particular its chromian spinel chemistry show basically the same type of variation. If the silicate chemistry was mostly buffered by mantle processes and do not show any significant difference all along the ophiolite, Cr# in Cr-pinels is on average 15% lower in the south-eastern massifs, in particular the Wadi Tayin massif, than in the north-western ones. This could suggest that the melting degree was significantly lower (about 4%) in the Wadi Tayin massif compared to the north-western part of the ophiolite, however the structure of the Wadi Tayin massif is in contradiction with this hypothesis. A partial melting degree about 4% lower would lead to a 10 to 20% decrease in the magma amount and then in a significantly thinner crustal section, which is not the case in the Oman ophiolite where all the massif a a similar crustal thickness.

On the other hand, Cr# in mantle Cr-spinel could be influenced by other processes than only partial melting and possibly reflects other petrographical properties. It is reasonable to think that the Wadi Tayin mantle melted at the same degree than in the other massifs of the Oman ophiolite. The lower Cr# can be explained in the frame of mantle heterogeneities and mantle sources variations. All well studied magmatic features showed that melts were richer in Al, Ti and lower in Cr, Si in the south-eastern massifs compared to the north-western part of the ophiolite. We conclude then that the mantle below the ophiolite presented large scale (70 to 150 km wide) heterogeneities and that mantle sources were basically different in the various part of the ophiolite. Crust and mantle dykes chemistry was strongly influenced by their mantle sources and cannot be interpreted only in the frame of tectonic settings. Our study cannot bring any definitive answer about the tectonics settings of the Oman ophiolite but show that the presence

of certain petrographical or chemical characteristics have to be considered with great caution.

Keywords: Oman ophiolite, Mantle heterogeneity, Mantle source

