Peridotites beneath the ophiolite: Petrology and chemistry of peridotite bodies located below the metamorphic sole of the Oman ophiolite

Main Tokinaga, Marie Python, Georges Ceuleneer, Tomoya Suzuki and Jean-Paul Breton

*Tokinaga Main[1]

1. Hokkaido University Department of Natural History Science Division of Earth and Planetary Systems Sciences

The Oman ophiolite is a large slab of Tethyan ocean floor obducted onto the Arabic peninsula. It comprises one of the largest pieces of exposed lithospheric peridotites and is a wonderful natural laboratory for mantle science. The emplacement of the ophiolite resulted from intraoceanic subduction in North-northeast direction followed by a period of continental subduction leading to the Oman margin burying. High pressure metamorphic rocks in the northern most Saih Hatat suggest a depth of about 40 km, lower grade metamorphism at the southern border of this massif as well as in Jebel Akhdar show that the subduction slope was rather steep (Breton et al., 2004).

The Oman ophiolite is the last of several nappes thrusted onto the autochtonous units (Saih Hatat and Jebel Akhdar), and then the highest in the general stratigraphic column of Oman (Béchennec, 1989). Although some melange do exist at the base of the ophiolite, with serpentine blocks interbedded within the Hawasina units, tectonic inversion was not observed in Oman up to now.

In this study, we describe the petrological characteristics of several relatively small peridotites bodies found in direct contact with the cretaceous limestones from the Arabic platform and located stratigraphically below the Hawasina units and the metamorphic sole. Those peridotite bodies are mostly located at the northern border of Jebel Akhdar, more rarely at the southern border of Saih Hatat. They crop out as a few meters to a few kilometers-wide massifs, most of the time highly serpentinised or carbonated and deformed. They are characterized by the absence of magmatic veins and dykes, their stratigraphic location below the amphibolite from the metamorphic sole, and when found as ophiolitic melange, by the inclusion of limestone blocks. In these 3 points, they differ from the ophiolite mantle main body, which is located above the Hawasina units and metamorphic sole, contains ubiquitously magmatic dykes and veins, and when observed as ophiolitic melange, contains blocks of amphibolite and/or pelagic sediment from the Hawasina nappes. One of the largest of these peridotites is located near a small village called Taww at the northeastern most border of Jebel Akhdar, so that by contrast to the ophiolite peridotites, we will call these peridotites the Taww peridotites. In order to understand the petrogenesis of the Taww peridotites, we sampled several peridotite bodies from both locations below and above the metamorphic sole and Hawasina units. Only one of our samples taken near Ibra had an unclear stratigraphic position (this sample is called “Ibra” in the present study).

The ophiolitic peridotites are all from the lowermost ophiolite, taken a few meters to a few tens of meter above the metamorphic sole. Their petrological characteristics are similar to what was described for basal peridotite by other researchers: they are mostly high depleted harzburgites containing 1 to 7% of Cpx with granular and porphyroclastic textures. The Taww peridotites seem to contain slightly less Cpx and more Opx but their textures are basically very similar to the usual ophiolite peridotites.

©2020. Japan Geoscience Union. All Right Reserved.

The mineral chemistry shows that the Taww peridotites as well as the ophiolite peridotites are residual harzburgites. However, the Taww peridotites, instead more depleted in Cpx than the ophiolite peridotites, show lower Cr-spinel Cr# and higher Al content in Opx, suggesting a possible lower melting degree than in the ophiolite but also a relatively Al-rich chemical environment. Cpx chemistry in Oman peridotites are difficult to interpret as refertilisation and melt trapping widely occurred during the magmatic history. In our study, Cpx in ophiolite lherzolites and Cpx-rich harzburgites (2 to 5% Cpx) show a Na and Ti-rich chemistry showing that they are mainly from trapped melts and refertilisation processes. By contrast, ophiolite harzburgites and the Taww peridotites, independently of their lithology, show a very depleted chemistry suggesting that they are mostly melting residue.

Keywords: Oman ophiolite peridotite, metamorphic sole, Degree of partial melting

©2020. Japan Geoscience Union. All Right Reserved.