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Mantle rock carbonation atop the Samail ophiolite metamorphic sole (Oman DP Hole BT1B): The importance of inherited petrography during large scale metasomatism

Romain Lafay (1), Marguerite Godard (1), Andreas Beinlich (2), Michelle Harris (3), Peter Kelemen (4), Katsuyoshi Michibayashi (5), and the Oman Drilling Project Phase 1 Science Party

(1) Université de Montpellier, Géosciences Montpellier, Montpellier, France, (2) Curtin University, The Institute for Geoscience Research, Perth, Australie, (3) University of Plymouth, School of Geography, Earth and Environmental Sciences, Plymouth, United Kingdom, (4) Colombia University, Lamont-Doherty Earth Observatory, New York, United States, (5) Nagoya University, Department of Earth and Environmental Sciences, Japan

The extreme complexity of carbonated (listvenites and ophicarbonates) and hydrated ultramafic (serpentinites) rocks constituting the basal section (lower 200 m) of the Samail ophiolite is investigated by borehole logging, on-board DV Chikyu and post-cruise petrographic and geochemical characterization. Those rocks are the witnesses of CO_2 related metasomatic reactions related to Samail ophiolite obduction.
Large-scale (>100 m) metasomatic processes are evident in all samples and support the hypothesis that the observed lithologies are the result of fluid infiltration into layered mantle peridotite (harzburgite / lherzolite) from the underlying metamorphic sole. However, micro-textural characterisation highlights the intricacy of alteration processes with variable textural, mineralogical, geochemical and petrophysical heterogeneities on the meter to the micrometer scale.
We document that metamorphic sole devolatilization reactions contribute to the carbonation of the overlying obducted ophiolite leading to the development of apparent concentration gradients at the unit scale marked by an enrichment of Ca and Sr and an increase of Fe3+/Fe2+ approaching the metamorphic sole. While the listvenitization (i.e. replacement of mantle rock by carbonate and quartz) is visible throughout the altered section, intercalated serpentinite layers (few cm to few meters in thickness) are observed and the bulk geochemistry reveals distinct domains having a specific compositions (e.g. Al, Cr and LILE enrichment and Ni depletion) unrelated to sole proximity. This is interpreted to reflect an inherited protolith heterogeneity that survived to listvenitization and weathering. This is supported by petrographic observations (distribution of fuchsite and spinel, bastite-like texture) revealing the presence of former harzburgite, dunite or lherzolite intervals. Thus, the trace element composition does not necessarily reflect contamination from an external source.
The combination of SEM (Secondary electron microscopy), X-ray Computer micro-tomography, and electron microprobe (quantitative and mapping) analyses show abundant anastomosing and crosscutting veinlets having heterogeneous compositions interpreted as localized pathway for fluid flow. In addition the transition from listvenites to serpentinites is marked by the formation of zoned (Fe, Mg, Ca, Mn) magnesite dendrites and spherules found in quartz (listvenite) and serpentine mesh matrix. Those textures suggest that mantle rocks were already serpentinized prior to carbonated fluid infiltration and are interpreted to show extensive disequilibrium during carbonation.
These observations question us about the influence of serpentinite layers on metamorphic fluids migrations (permeability / porosity / reactivity) and the processes of serpentinite dehydration/carbonation related to CO_2-bearing metasomatism.