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Petrology and geochemistry of the “Wadi Gideah“ cross section in the Southern Oman Ophiolite: a reference profile for fast-spreading crust

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Ocean crust formed at fast–spreading rates exhibits a relatively uniform seismic stratigraphy and is regarded as layered and relatively homogeneous, in contrast to oceanic crust generated at slow–spreading ridges. Importantly, theoretical models on magmatic accretion of the oceanic crust, thermal models, mass balance calculations for the whole ocean crust, or general alteration models only exist for fast–spreading systems. However, due to the lack of exposures and drilled sections of the deep basement of fast–spread crust, most models for fast–spread crust are not tested up to date by using natural samples. Therefore, it is necessary to perform complementary studies of ophiolites, in particular the Oman ophiolite, which is regarded to present the best example of fast–spreading oceanic crust on land, and which played a vital role in developing crucial paradigms for understanding sea floor spreading.

We undertook a detailed field campaign on the Wadi Gideah, which is located in the Wadi–Tayin Massif in the southern part of the Oman ophiolite in order to sample a complete section through the whole ophiolite. The southern massifs of the Oman ophiolite are regarded as the best area for studying primary "normal" fast-spreading ridge processes, where the so-called "late-stage magmatism" is widely absent. Up to now, our profile contains more than 200 samples from mantle peridotites, gabbros to dikes and lavas. This profile is representative for fast–spread oceanic crust both in terms of completeness of the crust–forming structural components and in coherence of geochemical and petrological data to be obtained, thus well–suited for shedding light on crustal accretion processes and the evolution of primary and secondary geochemical cycles of fast–spreading oceanic crust.

In order to obtain data sets as coherent as possible (major and trace elements, isotopes, and microanalytical results), we will follow a concept to perform all analytical investigations on the same samples. Our study follows an approach of an US working group in the late 1970s to obtain a complete profile through the Oman ophiolite (Pallister & Hopson, 1981, J. Geophys. Res. 86) in the same Wadi.

In this study we present our data obtained so far, in order to present geochemical and petrological logs of the Wadi-Gideah section. Main interest at this stage of the project is to focus on the mineral chemical evolution as well as the bulk major/trace element compositional evolution.

By evaluating the structural data obtained during our field campaign, we were able to reconstruct the layered stratigraphy of a virtually undeformed oceanic crust with a thickness of approximately 6 km. We identified the main lithologies from top to bottom (estimated thickness in parentheses): pillow lava (600 m), sheeted dikes (1300 m), varitextured gabbro (400 m), foliated gabbro (1600 m), layered gabbro (2200 m) resting upon a very thin MOHO transition zone ($<$ 50 m) on the mantle sequence.

First results based on electron microprobe analyses of the constituent mineral phases of the gabbroic section reveal very homogeneous compositions in the layered gabbro section: XMg olivine 0.76 to 0.82; XMg clinopyroxene 0.82 to 0.91; An content plagioclase 79-85 mol%. The mineral compositions of the foliated gabbros show more scattering and are slightly more evolved: XMg olivine 0.65 to 0.74; XMg clinopyroxene 0.74 to 0.87; An content plagioclase 62-82 mol%. In the varitextured gabbro the variation in the compositions are more pronounced with the trend to more evolved compositions (e.g. An content plagioclase 60 to 85 mol%).

Far–reaching goals include to elaborate a complete mass balance and to establish the whole evolution of the hydrothermal alteration cycles (by using Sr, O, S, and other suitable isotopes).

Finally, the Oman reference profile provides scientific support for the "Oman Ophiolite Drilling Project" (lead PI: Peter Kelemen) within the ICDP (International Continental Scientific Drilling Program) and also for the IODP (Integrated Ocean Drilling Program) drilling at Site 1256 (equatorial Pacific) where a complete section from the

lavas through the sheeted dikes down to the uppermost gabbros is available.