EGU22-10040
https://doi.org/10.5194/egusphere-egu22-10040
EGU General Assembly 2022

A profile through fast-spreading oceanic crust in the Oman ophiolite: reference frame for the crustal drillings within the ICDP Oman Drilling Project

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The Oman Ophiolite is the largest and best-investigated piece of ancient oceanic lithosphere on our planet. This ophiolite was target of the Oman Drilling Project (OmanDP) within the frame of ICDP (International Continental Scientific Drilling Program) which aimed to establish a comprehensive drilling program in order to understand essential processes related to the geodynamics of mid-ocean ridges, as magmatic formation, cooling/alteration by seawater-derived fluids, and the weathering with focus on the carbonatisation of peridotites.

Over two drilling seasons, the OmanDP has sampled the Samail Ophiolite sequence from crust to basal thrust. The total cumulative drilled length is 5458 m, with 3221 m of which was at 100% recovery. These cores were logged to IODP standards aboard the Japanese drilling vessel Chikyu during two description campaigns in summer 2017 and 2018.

Here we present the main results of the working groups of the Universities Hannover and Kiel, focusing on the magmatic accretion of the Oman paleoridge. During 5 field campaigns these groups established a 5 km long profile through the whole crust of the Oman ophiolite by systematic outcrop sampling, providing the reference frame for the 400 m long OmanDP drill cores. The profile contains 463 samples from the mantle, through gabbros up to the dike/gabbro transition. Identical samples have been analyzed by several methods (bulk rock geochemistry, mineral analysis, Isotope geochemistry, EBSD analysis).

The results allow implication on the mechanism of accretion of fast-spreading lower oceanic crust. Depth profiles of mineral compositions combined with petrological modeling reveal insights into the mode of magmatic formation of fast-spreading lower oceanic crust, implying a hybrid accretion mechanism. The lower two thirds of the crust, mainly consisting of layered gabbros, formed via the injection of melt sills and in situ crystallization. Here, upward moving fractionated melts mixed with more primitive melts through melt replenishments, resulting in a slight but distinct upward differentiation trend. The upper third of the gabbroic crust is significantly more differentiated, in accord with a model of downward differentiation of a primitive parental melt originated from the axial melt lens located at the top of the gabbroic crust. Our hybrid model for crustal accretion requires a system to cool the deep crust, which was established by hydrothermal

fault zones, initially formed on-axis at very high temperatures.