Geophysical Research Abstracts
Vol. 21, EGU2019-14464, 2019
EGU General Assembly 2019

Dynamics at the roof of an oceanic magma chamber: Oman Drilling Project GT3 site survey

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Oman Drilling Project (OmanDP) aims at bringing new constraints on oceanic lithosphere formation and evolution, and on ophiolite emplacement and alteration by drilling Holes in the whole ophiolite section (mantle and crust). Among those, operations at GT3 in the Sumail massif drilled 400 m to sample the dike – gabbro transition that corresponds to the top (gabbros) and roof (dikes) of the axial magma chamber, an interface where hydrothermal and magmatic system interacts. Previous studies based on oceanic crust formed at present day fast-spreading ridges and preserved in ophiolites have highlighted that this interface is a dynamic horizon where the axial melt lens that top the main magma chamber can intrude, reheat, and partially assimilate previously hydrothermally altered roof rocks. Here we present the preliminary results obtained in GT3 area that have allowed the community to choose the drilling site.

We provide a geological and structural map of the area, together with new petrographic and chemical constraints on the dynamics of the dike – gabbro transition. Our new results allow us to quantify the dynamic processes, and to propose that 1/ the intrusive contact of the varitextured gabbro within the dikes highlights the intrusion of the melt lens top in the dike rooting zone, 2/ both dikes and previously crystallized gabbros are reheated, and recrystallized by underlying melt lens dynamics (up to 1050°C, largely above the hydrous solidus temperature of altered dikes and gabbros), 3/ the reheating range can be > 200°C, 4/ the melt lens depth variations for a given ridge position is > 200m, 5/ the reheating stage and associated recrystallization within the dikes occurred under hydrous conditions, 6/ the reheating stage is recorded at the root zone of the sheeted dike complex by one of the highest stable conductive thermal gradient ever recorded on Earth (∼3°C/m), 7/ local chemical variations in recrystallized dikes and gabbros are highlighted and used to quantify crystallization and anatectic processes, and the presence of trapped melt, 8/ melt lens cannibalism is attested by numerous assimilation figures close its roof.

Besides providing a general context for future studies at OmanDP GT3 site, those new results allow us to quantify the dynamic processes that govern the layer 2 – layer 3 transition in ocean lithosphere.