Synmagmatic faulting partly controls fluid-melt-peridotite reaction and lithospheric melts generation at the crust-mantle transition

*Mathieu Rospabe[1], Mathieu Benoit[2], Georges Ceuleneer[2], Mary-Alix Kaczmarek[2]

1. Research Institute for Marine Geodynamics (IMG), Japan Agency for Marine-Earth Science and Technology, 2. Géosciences Environnement Toulouse (GET), Observatoire Midi-Pyrénées, Université de Toulouse, CNRS, IRD

The transition between the upwelling and partially molten peridotitic mantle and the accreting gabbroic lower crust beneath oceanic spreading centres is supposed to be a major interface in terms of chemical and thermal exchanges between the inner part of the Earth and external envelopes. In most ophiolites worldwide as well as at some sites along present-day mid-ocean ridges, the mantle-crust transition is systematically made of dunites developed from reaction between melts and mantle harzburgites and of troctolitic-gabbroic intrusions.

The petrological processes that originate the dunitic mantle-crust transition zone (DTZ) can be studied in the Maqsad area of the Oman ophiolite where is exposed a paleo-mantle diapir that fed with MOR-like melts the former spreading centre. Above the central part of the paleo-diapir, the DTZ reaches 300 to 400 m in thickness. It has been alternatively attributed to a consequence of peridotite reactional melting or to the accumulation of olivine from Mg-rich melts whether a combined origin is also possible (Abily and Ceuleneer, 2013, *Geology*). Variable interstitial minerals fractionation during melt migration between olivine grains (or melt-rock reaction), comprising mainly plagioclase, clinopyroxene, orthopyroxene and pargasitic amphibole, is partly responsible of the high petrological and geochemical variability observed at Moho level (Rospabé et al., 2017, *Geology*; 2018, *Geochem. Cosmochim. Acta*).

The DTZ is frequently cross-cut by faults and minor fractures that seem to have induced a displacement limited to a few meters where measurable. Faults are filled with serpentine and carbonate, and surrounded by a few-meters thick serpentinization aureole. At first glance, it supports a late origin postdating the magmatic accretion of the mantle-crust transition zone. However, the chemical variations observed along the Maqsad DTZ define tendencies with a characteristic vertical scale of few tens of meters, correlated to the distribution of the faults or fracture zones. The fact that (1) not only fluid-mobile elements but also immobile elements (e.g. REE, HFSE) are concerned, and (2) the faults are cross-cut by ridge-trending gabbroic dikes, highlights that the faults were ridge-related and developed at an early, high temperature magmatic stage before the cooling and alteration of this oceanic lithosphere fragment (Rospabé et al., 2019a, *Earth Planet. Sci. Lett.*; 2019b, *Lithos*). In the same area, a well-exposed outcrop of the lowermost oceanic crust likewise recorded strong interplays between ridge-oriented faults and, in the presence of water, crystallizing gabbros (Abily et al., 2011, *Geology*).

We infer that synmagmatic faults may enhance melt migration and extraction from the mantle to the crust and deep hydrothermal fluids introduction down to the Moho level. Faults could be the main places for fluid-melt hybridization and fluid-melt-rock reaction and allowing to the generation of hydrous, lithospheric melts beneath oceanic spreading centres. In other words, synmagmatic faults may directly contribute to the magmatic accretion of the oceanic lithosphere and subsequently significantly impacting the MORB variability and chemical budgets along present-day mid-ocean ridges.

Keywords: Oman ophiolite, dunitic mantle-crust transition zone, synmagmatic faults, fluid-melt-rock reactions

