Paper Number: 5009

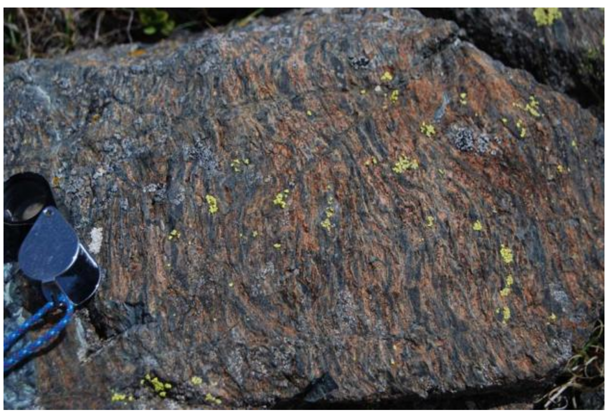
Interaction of melt and deformation at the lithosphere-asthenosphere boundary

Kaczmarek, M.-A.[1]

[1] ISTE, University of Lausanne, Switzerland. mary-alix.kaczmarek@unil.ch

---

The lithosphere–asthenosphere boundary (LAB) represents the transition from a hot and convecting asthenospheric mantle to an overlying cold and rigid lithosphere. Chemical, thermal and mechanical processes happening at this boundary are critical to our understanding of the geodynamic and geochemical evolution of the Earth. Results from geophysical and numerical modelling studies suggest the presence of melt within this boundary to explain the change the seismic wave velocity [e.g. 1] and the LAB could represent a 10 km thick melt- and water-rich shear zone [2]. The temperature, the presence of melt/fluid and/or decrease in grain size of minerals may have a strong influence important role in chemical and physicals processes at this boundary.



This study focuses on mantle rocks sampled by volcanoes (as xenoliths) or exposed in orogenic peridotitic massifs. These samples offer a direct window into melt / deformation interaction processes. The Lanzo (Italy) and Platta-Totalp (Switzerland) massifs are remnants of an ocean continent transition and represent a section from deep sub-continental mantle to shallower inherited and infiltrated sub-continental mantle. In the OCT, from the continent toward the ocean, the peridotite changes from spinel-peridotite to plagioclase peridotite as a result of infiltration and interaction of melts originating from the asthenosphere. The presence of melt during mantle exhumation leads to the localization of deformation with the formation of kilometric scale to micrometric scale shear zones [e.g. 3]. The study of crystallographic preferred orientation of minerals (olivine, pyroxenes and amphibole) combined with the chemical composition of the phases helps to understand how the rock deforms in the presence of fluid/melt. Results show that the presence of melt/fluid will change the chemical composition of the minerals, but will also change the mineral proportion which is an important parameter (high proportion of amphibole), not very often considered, to take into account as it will change the rock rheology and the activated slip systems in the minerals. For instance, the major slip in the olivine could be different for a high proportion of clinopyroxene or for a high proportion of orthopyroxene.

Generation of melt is easily envisaged when the LAB is shallow in the mantle, such as below oceanic crust or during mantle exhumation in an OCT, but it becomes difficult when it is deeper. However, rare mantle xenoliths sampled by petit-spot volcanoes coming from both the garnet and the spinel facies show the first direct evidence for metasomatism in this deep part [4].

This work is in collaboration with Reddy S., Vonlanthen P., Muntener O., Pilet S., Rochat L., Abe N.

Figure 1: Sheared peridotite, Platta massif, Switzerland

References:

[1] Naif S et al. (2013) Nature 495: 356-359

[2] Stern T A et al. (2015) Nature 518: 85-88

[3] Kaczmarek M-A and Tommasi A (2011) G3 12(8): Q0AG06

[4] Pilet S et al. (submitted) Nature