UNDERSTANDING HOW SERPENTINISATION AFFECTS MARINE MAGNETIC ANOMALIES

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Background

Serpentinisation is caused by metamorphic hydration of mafic and ultramafic rocks by seawater. It can fundamentally change the structure and mechanics of the oceanic lithosphere and thereby its response to geodynamic processes. Serpentinisation is known to be more common at slow spreading ridges (<4 cm/yr) like the Mid-Atlantic Ridge, where the detachment-mode seafloor spreading is prevalent. Detachment faults can exhume upper mantle and lower oceanic crust, which may in turn lead to the formation of domal structures known as oceanic core complexes (OCCs). Such structures are commonly serpentinised. Serpentinisation can also occur at subduction zones (Fig. 1).

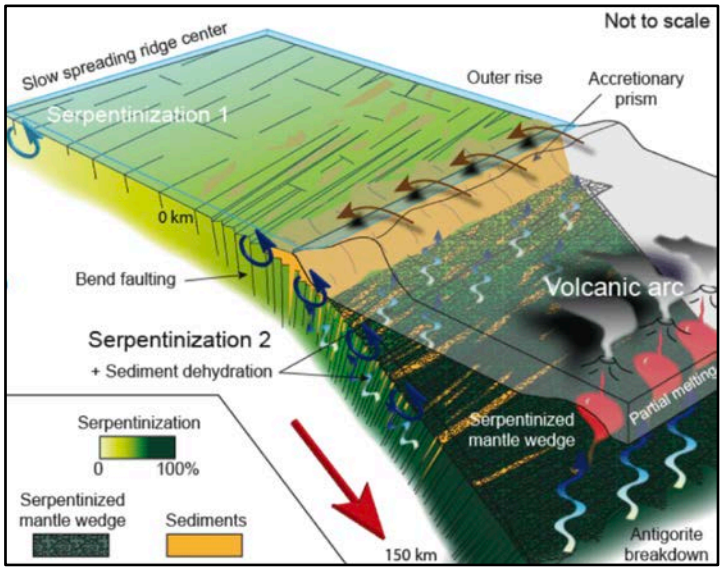

Figure 1. Schematic of serpentinisation at a subduction zone. From Lafay [2013].

Serpentinisation significantly alters many geophysical properties; for example, it reduces the density of the crust giving rise to gravitational anomalies, alters the magnetic signature of the rock and changes the seismic structure. How serpentinisation affects the geophysical properties of these rocks is not fully understood; a better knowledge of these processes is needed to help us resolve the geodynamics of oceanic lithosphere.

Project

The aim of this PhD is to better understand the processes that generate the magnetic signature of serpentinised rocks. Serpentinisation is thought to produced ferromagnetic minerals, in particular magnetite, which both increases the magnetisation of the crust, but also acquires a new magnetic remanence. There have been a few studies that have tried to understand these processes [Maffione et al., 2014], but the exact processes have not been quantified.

This project will collect samples from the serpentinised Troodos Mountains in Cyprus [Nuriel et al., 2009], and from the Atlantic by sampling rocks at the Bremen core facility. By studying the magnetic properties in the laboratory and the samples under the electron microscope we will try to develop a framework that explains the processes of serpentinisation. These findings will then be related back to marine magnetic anomalies that have been studied in the Atlantic.

Student Profile

This project is primarily a field and lab-based project, with the scope to analyse marine magnetic data. Candidates should have a degree in Earth Science.

Lafay, R. (2013). Séquestration des éléments mobiles durant la serpentinisation expérimentale en condition alcaline. PhD Thesis, Université de Montpellier.

Maffione, M., Morris, A., Plumper, O., and van Hinsbergen, D. J. J., 2014, Magnetic properties of variably serpentinized peridotites and their implication for the evolution of oceanic core complexes: Geochemistry Geophysics Geosystems, v. 15, no. 4, p. 923-944.

Nuriel, P., Katzir, Y., Abelson, M., Valley, J. W., Matthews, A., Spicuzza, M. J., and Ayalon, A., 2009, Fault-related oceanic serpentinization in the Troodos ophiolite, Cyprus: Implications for a fossil oceanic core complex: Earth and Planetary Science Letters, v. 282, no. 1, p. 34-46.

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