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Abyssal serpentinite geochemistry and geodynamics

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The formation of abyssal serpentinites leads to deep changes of the oceanic lithosphere rheology and geochemistry, hence playing a key role on geodynamic and geochemical cycles. However, most abyssal peridotite studies have assessed the role of pre-existing mantle composition, partial melting and/or melt-rock interaction processes affecting peridotite composition prior to their exhumation and serpentinization, and geochemical studies of abyssal serpentinites are limited to regional observations. Hence, there was a significant knowledge gap regarding the role of the serpentinization processes on the geochemical budget of abyssal peridotites worldwide.

In this study, we review the geochemical characteristics of serpentinites collected on abyssal floors (i.e., abyssal serpentinites) by dredging, submersible and drilling during oceanographic expeditions in different geodynamical settings, namely passive margin, forearc and oceanic spreading ridges. The oceanic ridge setting was further divided according to the tectonic context in which the serpentinites were sampled, i.e., slow-spreading centres, ultra-slow spreading centres, fast spreading axis and large transform faults (all spreading rates). This classification allows to better decipher the influence of the geodynamical setting (e.g., structures, tectonic and magmatic activities, thermal regime) on fluid geochemistry and serpentinite composition. On the basis of a comprehensive review of the data available in the literature and of new geochemical data on the serpentinites of the Mid-Atlantic Ridge valley near Kane transform fault (MARK), the Romanche area (Mid-Atlantic Ridge) and the Mariana forearc, we compare the major, volatile, trace and stable isotope (S, C, Fe, Zn and Cu) signatures of abyssal serpentinites. We discuss the role of serpentinization processes in the distribution of volatile and redox sensitive elements within the oceanic mantle lithosphere and highlight the main geochemical heterogeneities between in the different geodynamical settings and tectonic contexts.