Paleoceanographic and mineral resource applications of Pb and Nd isotope records in Fe-Mn crusts

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Hydrogenetic ferromanganese (Fe-Mn) crusts form condensed stratigraphic records of seawater evolution over millions of years that can be traced by combining isotopic systems (e.g. Nd, Hf, Pb). Core 085_004, recovered from the summit of Tropic Seamount in the north-east tropical Atlantic during the MarineE-Tech project, has been used to study water-mass mixing and provenance of Pb and Nd sources in the region. A high-resolution age model for this sample [1] shows that this core preserves Fe-Mn oxides spanning the last 75 ± 2 Myr. It therefore provides a unique opportunity to study the evolution of the north-east tropical Atlantic over much of the Cenozoic and Late Cretaceous.

The Pb and Nd isotope data obtained by laser-ablation (LA) and solution ICP-MS, indicate that the north-east Atlantic basin has been strongly influenced by various oceanic and continental end-members. This reflects its evolution from a series of restricted and isolated basins in the Late Cretaceous to increasingly well-mixed large-scale basins, with a common deep-water source in the Southern Ocean between the Paleocene and Early Miocene. A strong unradiogenic ƐNd excursion 16 Ma reflects a significant Northern Component Water contribution entering the north-east Atlantic basin. This contrasts with the well-documented variation in the western basin, tracing the recent (2.5–3 Ma) onset of North Atlantic Deep Water, in response to northern hemisphere glaciation.

An additional suite of Pb isotope measurements undertaken by LA-ICP-MS on samples from the flank of Tropic Seamount allows for an assessment of the Fe-Mn crust stratigraphy at the seamount scale. It allows to quantify the growth rate variability in contemporaneous layers, assesses the distribution of hiatuses and the impact of phosphatisation on Pb and Nd isotope records. Establishing a robust stratigraphy also helps to improve understanding of the local-scale processes affecting geochemical variation in Fe-Mn crusts at the seamount scale, which has implications for future mineral resource assessment.

[1] Josso et al., 2019. Chem. Geol 513, 108-119