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Chemical mapping and metal zonation in Ferromanganese Crusts from the North Atlantic Ocean and their economic potential

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Several studies indicate the presence of large polimetallic resources on the ocean floor (ferromanganese nodules, ferromanganese crusts and massive sulfide deposits). These resources are known to represent a significant amount of metals essential for modern societies (i.e. Co, Ni and REE) and yet they remain poorly studied. The commodity with more interest in ferromanganese crusts is Co, considered to be a Critical Raw Material for Europe in 2017 (Deloitte Sustainability et al., 2017 and Hein et al., 2000).
Ferromanganese Crusts (Fe-Mn Crusts) cover large areas of the ocean floor, where sedimentations rates are low, as on the flanks of seamounts, being usually found between 400-4000 m. However, the 800-2200 m depth-range is the one with most economic potential (Hein et al., 2000). These deposits normally consist of epitaxial intergrown of amorphous iron oxyhydroxide and ferruginous vernadite (Burns et al., 1977 in Hein et al., 2000).
In order to evaluate the economic potential of these resources in the North Atlantic, Fe-Mn crusts were collected near the East Azores Fracture Zone and in the Atlantis, Plato, Small Hyeres and Great Meteor seamounts (at depths between 1700-2950 m) during the 2007 EMEPC campaign. Geochemical analyses were performed by LA-ICP-MS and preliminary results show that all crusts (n=11) are hydrogenetic (according to the method described by Bau et al. 2014) and mean concentrations in these crusts vary between 0.44-1.41% Co, 0.23-0.58% Ni and 0.04-0.10% Cu. Comparing these results with the average for Atlantic Ocean crusts in Hein et al. 2014 (0.36%, 0.26% and 0.09%, respectively), it is possible to consider the crusts in this study as enriched in these elements. Compositional maps produced with LA-ICP-MS show vertical and horizontal chemical variations that change from sample to sample. For example, occasionally the highest Co concentrations are near the crusts base and other are near the middle or top. The Ni+Cu does not correlate with either Co or Mn, it correlates with Mg. Mn and Fe have opposite behaviors, as expected, and Ti high concentrations normally are near the base/substrate or near the top. As to Ce correlates with the remaining REEs depending on their oxidation state. The horizontal chemical variation is observed in all elements.
The studied crusts show promising results as a potential Co (Ni+Cu) resource at the ocean floor of North Atlantic. Although the exploration of these resources seems to be promising (120 million tons of Co identified in Mn nodule and crusts, according to Shedd, 2018), many questions remain to be answered regarding environmental impacts and economic feasibility of their exploitation.

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