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Research Article

Factors controlling rare earth element plus yttrium enrichment in Fe—Mn crusts from Canary Islands Seamounts (NE Central Atlantic)

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ABSTRACT

Marine minerals are important because concentrate in their structure high contents of strategic and critical elements as rare earth elements. Forty-two samples from eight seamounts of Canary Islands Seamount Province (CISP) have been analyzed in order to evaluate their rare earth elements plus yttrium contents (REY). Highest contents of REY are related to hydrogenetic minerals and essentially Fe-vernadite (on average 3000 μg/g). Diagenetic minerals, on the other hand, show the lowest REY contents with an average content of 260 μg/g. These differences also depend on the growth rates, hydrogenetic minerals with growth rates between 0.5 and 5 mm/Ma allow the incorporation of more REY in their structure. REY contents in studied samples varies depending several factors associated with depth and location, shallowest samples presumably growth near or within the oxygen minimum zone are the most enriched with up to 3800 μg/g due to local enrichment of these elements and the slowest growth rate promoted by the reduced ambient conditions while deeper samples around 3000 m water depth show 2800 μg/g. Location also has a role in REY contents essentially due to the presence of different currents. Samples faced to north are exposed to the more oxygenated waters of the North Atlantic Deep Water and are depleted in REY if compared with deeper samples facing to south to the more oxic Antarctic Bottom Water. Finally, the case of study made on three different seamounts of the CISP show that Fe—Mn crusts from this area could provide on average 130 tons of hydrometallurgical recovered REY (based on 1 km^2 areal crust coverage) together with interesting quantity of several other strategic and base elements as Mn, Co, Ni, Cu, V, Mo between others.

1. Introduction

Rare Earth Elements plus Yttrium (hereafter REY) are a group of chemical elements composed by the lanthanides and yttrium that usually can be found associated in the same ore (Haxel et al., 2002; Long et al., 2010). Scandium, present in most deposits of rare-earth compounds, is also included by the International Union of Pure and Applied Chemistry as a rare-earth element. REY have gained importance in the last 20 years due to their use in the development of new technologies, such as laptops, smartphones and tablets. Probably more important is their use in the development of more efficient electric turbines, e.g. Nd magnets used in windmills or hydro-electric power dams, but also as alloy metals in the development of superconductors, or in the production of better ceramics or glasses. Anyway, more than a half of REY are used as catalysts in the petroleum refinery that comprehend >20% of their consumption (The White House, 2021).

REY are not so rare in the continental crust as their name may suggest, but they are considered rare because they are hardly found in exploitable deposits (Haxel et al., 2002). Currently, the global production is led by China, with >80%, followed by Australia with almost 15%, while the remaining 5% is divided by the rest of producers. Land-based REY deposits are represented by different types like carbonatites,

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