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Deep-water seamounts and banks along the Atlantic Spanish continental margin as a potential source of raw materials

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Seamounts and submarine banks are prominent geomorphic features throughout the global ocean, and the target of minerals research and exploration with the goal of future exploitation. Polymetallic ferromanganese deposits and phosphorite are common types of mineralization on seamounts. Co-rich ferromanganese crusts are important as potential resources of Mn and Co, but also Ti, Ni, Tl, REEs, PGEs, and other metals. Many seamounts along the Atlantic Spanish continental margin are known to have mineral deposits but are poorly studied. We present preliminary results of the study of these mineral deposits, including ferromanganese nodules and crusts and phosphate pavements and nodules, which can be considered as potential sources of raw materials. Seamounts and banks in the northern Iberian Atlantic margin (Lat. 42º-44ºN) show extensive areas covered by phosphorite pavements and nodules as well as ferromanganese nodules and crusts from 700 to 1200 m water depths. Ferromanganese nodules and crusts are composed of a large variety of Fe and Mn oxyhydroxides (e.g., vernadite, asbolane, goethite, todorokite, romanechite) depending on the predominant genetic process (hydrogenetic, diagenetic, hydrothermal). High concentrations of metals have been measured in some of these ferromanganese deposits: Mn (up to 45 wt%), Co (up to 1.8 wt%) and Ni (up to 0.8 wt%). Other strategic elements such as Ti, Cu, Mo, REEs, Tl, Ga, and Te are also present in high concentrations with respect to seawater and lithospheric concentrations. Phosphorite, composed mostly of carbonate fluorapatite and ferruginous glauconite and formed by diagenetic processes, shows considerable amounts of P (up to 14 wt%), F (up to 4 wt%), and low concentrations of U and Th.

Seamounts and banks from the Central Atlantic margin (Lat. 23º-26ºN) are largely covered with ferromanganese crusts. We studied crust pavements up to 20 cm thick collected from rock outcrops on several seamounts, at 500 to 2500 m water depths. The crusts have a botryoidal surface texture and colloform, laminar, and massive internal structures formed by vernadite, asbolane, and goethite. The chemical composition shows a predominance of Mn (18.6 wt%) and Fe (24.5 wt%) with considerable amounts of Ti (1.2 wt%), Co (0.67 wt%), Ni (0.27 wt%), REEs (0.3 wt%), Tl, Mo, and Te. The geochemical characteristics indicate a hydrogenetic origin or mixed hydrogenetic and hydrothermal origin for some samples.

The flat top of some seamounts and banks studied shows the most favorable conditions for future mining operations. Many of these seamounts are at ideal depths (800-2500 m) for the occurrence of thick crusts enriched in rare and strategic metals. Some of these metals, including those needed for high-technology applications, may become important by-products of Mn and Co recovery. The selection of mine sites will depend not only on grade, tonnage, and topography of the site but also on the efficiency of the mining system and the impact of the mining activity on the benthic environment, including deep-sea fauna, ecosystems, and the water column. A better understanding of the distribution, abundance, structure, and genesis of these mineral deposits, and their mineralogical and geochemical characteristics, are essential for the selection of viable mine sites and the design of environmentally sound and efficient mining systems for the future.