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Tropic Seamount (NE Atlantic) as a Natural Laboratory for the Exploration and Environmental Impact Monitoring of Seabed Mineral Resource Exploitation

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Tropic Seamount is an extinct submarine volcano located southwest of the Canary Islands in the Northeast Atlantic Ocean. Rising from depths greater than 4,000 meters to a flattened summit about 1,000 meters below sea level, it is classified as a guyot-type seamount. Formed during the Mesozoic, it represents a well-preserved ancient volcanic edifice that has since accumulated significant mineral deposits and records of long-term oceanographic change.

The seamount, intensively investigated since 2010 by the Geological Survey of Spain, is especially notable for its extensive cobalt-rich ferromanganese crusts that coat its summit and flanks. These crusts contain high concentrations of critical raw materials, including cobalt, tellurium, rare earth elements, platinum, and other strategic metals. Tellurium is particularly important for high-efficiency photovoltaic technologies, making Tropic Seamount strategically relevant in the context of renewable energy and the growing global demand for critical minerals. Beneath many crusts, phosphorite deposits composed mainly of carbonate fluorapatite occur, enriched in phosphorus as well as fluorine and yttrium, reflecting complex paleoceanographic and diagenetic processes. In addition, polymetallic nodules enriched in manganese, nickel, and copper are distributed across the summit and upper flanks, sometimes forming carpet-like pavements [1].

These overlapping mineralization processes make Tropic Seamount a unique natural laboratory for studying seabed resource formation and environmental impact. It provides opportunities to investigate the origin and distribution of cobalt-rich crusts, nodules, and phosphorites, while also reconstructing Atlantic Ocean paleoenvironmental evolution since the Cretaceous. Equally important is its ecological significance: mineral substrates host diverse deep-sea ecosystems, including microbial communities, cold-water corals, sponges, and deep-sea fishes, which are tightly linked to biogeochemical cycling.

Potential mining activities, such as the removal of crusts or nodules, could cause habitat destruction, sediment plume dispersion, biodiversity loss, and disruption of seafloor processes. Therefore, Tropic Seamount is an ideal site to develop environmental baseline studies, predictive impact models, and adaptive management strategies. Advanced monitoring technologies, including autonomous and remotely operated underwater vehicles, seabed observatories, and environmental DNA sampling, support habitat mapping, real-time plume tracking, and long-term ecosystem assessment, promoting science-based and responsible seabed resource management.

[1] González et al. (2023): https://doi.org/10.1144/SP526-2022-150