Modelling critical element distribution in seamount FeMn crusts for resource estimation

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The expansion in renewable energy technologies is increasing demand for critical elements and driving research into alternative metal resources. Ferromanganese (FeMn) crusts are a potentially significant future source of "E-tech" elements, including cobalt (Co) and tellurium (Te) [1]. Currently, the resource potential of deep-sea FeMn crusts is poorly quantified due to the paucity of data on proven coverage and geochemical variation at high spatial resolutions, in particular at the scale of the prospective mine-site. Here, we focus on the seamount-scale processes controlling FeMn crust formation and composition at Tropic Seamount, NE Atlantic.

Outcrop mapping from high-definition remotely operated vehicle (ROV) videos show that FeMn crust morphologies on the seamount are delineated by a series of "type" environments [2]. These are combined with maps of FeMn crust presence/absence and bulk and surface scrape geochemistry within an R-based generalized additive model (GAM) of distribution to determine trends in crust growth and composition. The interaction and spatial variation of two key features are also considered within the FeMn crust distribution model. These are the bathymetric features of the seamount and the characteristics of the overlying water masses. These grids are used to build an FeMn crust distribution model that utilises the in-situ outcrop observations with environmental predictor variables that are thought to have direct or indirect effects on FeMn crust formation. The model is then evaluated using a resampling method to assess the accuracy of the model in predicting FeMn crust occurrence and composition.

Building predictive models using empirical data allow the assumptions about FeMn crust formational controls to be tested at the scale of the individual seamount. Understanding the controls on the spatial distribution of FeMn crusts and their target metals is key to developing sustainable mining protocols in the future.

[1] Hein et al. (2003) Geochim. Cosmochim. Acta 67, 1117 – 1127. [2] Yeo et al. (2018) Minerals 8, 327.