

Global Tonnage of Marine FeMn Nodules, Crusts and Associated Metals: Comparisons with Terrestrial Resources

J.R. HEIN^{1*}, S.P. WHISMAN¹, K. MIZELL^{1,2}

¹ USGS, PCMSC, Santa Cruz, CA, 95060, USA

[*correspondence: jhein@usgs.gov]

svhisman@usgs.gov; kmizell@usgs.gov]

² University of California, Ocean Sciences, Santa Cruz, CA, 95060, USA [kmizell@ucsc.edu]

Marine ferromanganese (FeMn) oxide crusts and nodules acquire vast quantities of rare and critical elements from ocean water and also from pore water of sediment for some nodules. These oxide deposits control the concentrations of some elements in seawater, (e.g. Ce, Te) but the full extent of this sequestration and its contribution to the potential metal budget of marine oxides in the global ocean is not known. To partly address these issues, we estimated the total tonnage of crusts and nodules in the global ocean based on the known and inferred distributions, area of occurrence, crust thickness or nodule coverage, and dry bulk density. Crusts and nodules are estimated to have similar total estimated tonnages of 12×10^{10} dry metric tons, and 15×10^{10} dry tons respectively, for a combined total of 27×10^{10} tons. This estimate indicates that typical crust- and nodule-hosted elements (i.e. Mn, As, Bi, Co, Cu, Li, Mo, Nb, Ni, PGM, REE, Sb, Sc, Te, Th, Ti, Tl, V, W, Zr) are more abundant in crusts+nodules than in the Terrestrial Reserve Base (TRB: economic, marginally economic, subeconomic resources). Enrichment factors (EF) for marine mineral estimates over TRB values vary from 1.6 for Cu to 11,800 for Tl. Tl, Sc (EF 150), Te (116), Y (77), Co (65), and As (37) are especially high in marine deposits and can be considered marine mineral deposit-dominant metals. The larger global terrestrial resource for many elements is known for Cu, Co, Mo, Li, Th, and Sc; using these maximum terrestrial metal tonnages, only Cu (EF 3.5), Li (EF 3.4), and PGM (EF 2.0) become terrestrial mineral deposit-dominant elements. These estimates clarify the importance of marine minerals as a potential resource and metals to target.