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TITLE: Critical metals in manganese nodules from the Cook Islands EEZ, abundances and distributions

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ABSTRACT:

The Cook Islands (CIs) Exclusive Economic Zone (EEZ) encompasses 1,977,000 km² and includes the Penrhyn and Samoa basins abyssal plains where manganese nodules flourish due to the availability of prolific nucleus material, slow sedimentation rates, and strong bottom currents. A group of CIs nodules was analyzed for mineralogical and chemical composition, which include many critical metals not before analyzed for CIs nodules. These nodules have varying sizes and nuclei material; however all are composed predominantly of γ -MnO₂ and X-ray amorphous iron oxyhydroxide. The mineralogy, Fe/Mn ratios, rare earth element contents, and slow growth rates (mean 1.9 mm/106 years) reflect formation primarily by hydrogenetic precipitation. The paucity of diagenetic input can be explained by low primary productivity at the surface and resultant low organic matter content in seafloor sediment, producing oxic seafloor and sub-seafloor environments. The nodules contain high mean contents of Co (0.41%), Ni (0.38%), Ti (1.20%), and total rare earth elements plus yttrium (REY; 0.167%), and also high contents of Mo, Nb, V, W, and Zr. Compiled data from a series of four cruises by the Japan International Cooperation Agency and the Mining agency of Japan from 1985 to 2000 were used to generate a map that defines the statistical distribution of nodule abundance throughout the EEZ, except the Manihiki Plateau. The abundance distribution map shows a belt of high nodule abundance (19?45 kg/m²) that starts in the southeast corner of the EEZ, runs northwest, and also bifurcates into a SW trending branch. Small, isolated areas contain abundances of nodules of up to 58 kg/m². Six ~ 20,000 km² areas of particularly high abundance were chosen to represent potential exploration areas, and maps for metal concentration were generated to visualize metal distribution and to extrapolate estimated metal tonnages within the six sites and the EEZ as a whole. Grades for Mn, Cu, and Ni are low in CIs nodules in areas of high abundance; however, Ti, Co, and REY show high contents where nodule abundances are high. Of the six areas identified to represent a range of metal contents, one at the northern end of the N-S abundance main belt optimizes the most metals and would yield the highest dry metric tons for Mn (61,002,292), Ni (1,247,834), Mo (186,166), V (356,247), W (30,215), and Zr (195,323). When compared with the Clarion-Clipperton Zone, the CIs nodules show higher nodule abundances (> 25 kg/m² over ~ 123,844 km²), and are more enriched in the green-tech, high-tech, and energy metals Co, Ti, Te, Nb, REY, Pt, and Zr. The CIs EEZ shows a significant resource potential for these critical metals due to their high prices, high demand, and the high nodule abundance, which will allow for a smaller footprint for a 20-year mine site and therefore smaller environmental impact.

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