ID: W2029647685

TITLE: Deep-ocean mineral deposits as a source of critical metals for high- and green-technology applications: Comparison with land-based resources

AUTHOR: ['James R. Hein', 'Kira Mizell', 'Andrea Koschinsky', 'T. A. Conrad']

ABSTRACT:

Ferromanganese (Fe?Mn) crusts are strongly enriched relative to the Earth's lithosphere in many rare and critical metals, including Co, Te, Mo, Bi, Pt, W, Zr, Nb, Y, and rare-earth elements (REEs). Fe?Mn nodules are strongly enriched in Ni, Cu, Co, Mo, Zr, Li, Y, and REEs. Compared to Fe?Mn crusts, nodules are more enriched in Ni, Cu, and Li, with subequal amounts of Mo and crusts are more enriched in the other metals. The metal ions and complexes in seawater are sorbed onto the two major host phases, FeO(OH) with a positively charged surface and MnO2 with a negatively charged surface. Metals are also derived from diagenetically modified sediment pore fluids and incorporated into most nodules. Seafloor massive sulfides (SMS), especially those in arc and back-arc settings, can also be enriched in rare metals and metalloids, such as Cd, Ga, Ge, In, As, Sb, and Se. Metal grades for the elements of economic interest in SMS (Cu, Zn, Au, Ag) are much greater than those in land-based volcanogenic massive sulfides. However, their tonnage throughout the global ocean is poorly known and grade/tonnage comparisons with land-based deposits would be premature. The Clarion?Clipperton Fe?Mn Nodule Zone (CCZ) in the NE Pacific and the prime Fe?Mn crust zone (PCZ) in the central Pacific are the areas of greatest economic interest for nodules and crusts and grades and tonnages for those areas are moderately well known. We compare the grades and tonnages of nodules and crusts in those two areas with the global terrestrial reserves and resources. Nodules in the CCZ have more Tl (6000 times), Mn, Te, Ni, Co, and Y than the entire global terrestrial reserve base for those metals. The CCZ nodules also contain significant amounts of Cu, Mo, W, Li, Nb, and rare earth oxides (REO) compared to the global land-based reserves. Fe?Mn crusts in the PCZ have significantly more Tl (1700 times), Te (10 times more), Co, and Y than the entire terrestrial reserve base. Other metals of significance in the PCZ crusts relative to the total global land-based reserves are Bi, REO, Nb, and W. CCZ nodules and PCZ crusts are also compared with the two largest existing land-based REE mines, Bayan Obo in China and Mountain Pass in the USA. The land-based deposits are higher grade but lower tonnage deposits. Notably, both land-based deposits have < 1% heavy REEs (HREEs), whereas the CCZ has 26% HREEs and the PCZ, 18% HREEs; the HREEs have a much greater economic value. Radioactive Th concentrations are appreciably higher in the land-based deposits than in either type of marine deposit. A discussion of the differences between terrestrial and marine impacts and mine characteristics is also presented, including the potential for rare metals and REEs in marine deposits to be recovered as byproducts of mining the main metals of economic interest in nodules and crusts.

SOURCE: Ore geology reviews

PDF URL: None

CITED BY COUNT: 690

PUBLICATION YEAR: 2013

TYPE: article

CONCEPTS: ['Geology', 'Ferromanganese', 'Nodule (geology)', 'Geochemistry', 'Crust', 'Mineralogy', 'Metallurgy', 'Manganese', 'Materials science', 'Paleontology']