COBALT-RICH FERROMANGANESE OXYHYDROXIDE CRUSTS IN THE GLOBAL OCEAN

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Co-rich Fe-Mn crusts are a potential resource for Co, Ni, Pt, Mn, Tl, Te, Ti, and other metals. They occur on topographic highs at water depths of 400-4000 m throughout the ocean basins where currents have swept the rocks clean of sediment for millions of years. Crusts precipitate from cold ambient seawater onto substrates, forming pavements as thick as 25cm. Gravity processes, sedimentation, reefs, and currents control the distribution and thickness of crusts. Crust layers show a variety of textures, including massive, botryoidal, laminated, columnar, or mottled. Characteristic layering sequences are persistent regionally. Most crusts grow at rates of 1-6mm/Ma and are composed of vernadite, Fe oxyhydroxide, and minor quartz and feldspar, with moderate carbonate fluorapatite in thick (6cm) crusts. Older layers of thick crusts were phosphatized during at least two Tertiary global phosphogenic events, which redistributed elements in those layers. Elements associated with vernadite include Co, Ni, Cd, Tl, Te, and Mo, and with Fe oxyhydroxide, As. Co contents range as high as 2.3%, Ni to 1%, and Pt to 3 ppm, with Fe/Mn ratios of 0.6-1.3. Co, Ni, Ti, and Pt are greater in central-Pacific crusts, whereas Fe/Mn, Si, and Al are greater in crusts from continental margins and from the Atlantic and Indian Oceans. Total REEs vary between 0.1% and 0.3% and are derived from seawater, as are Co, Mn, Ni, Tl, and most Pt-group elements. Co, Ce, Tl, and possibly also Ti, Pb, Te, and Pt are more concentrated in crusts than are other metals because of oxidation reactions. Other controls on element abundances in crusts include the concentration of metals in seawater, colloid surface charge, complexing agents, surface area, growth rates, and bacterially mediated reactions.