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Comparisons of the growth and composition of seamount-hosted ferromanganese nodules and crusts

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Ferromanganese mineral precipitation in the global oceans occurs in the form of both crusts and nodules at a broad range of depths and seafloor landscapes. Although crusts and nodules are both composed of ferromanganese minerals, they are different mineral occurrences based on their morphology and their compositional variation observed on regional scales. However, most published compilations compare nodules forming on abyssal plain sediments to crusts forming on seamounts. Seamounts and abyssal plains experience different water masses, current regimes, redox conditions, fauna, and other environmental conditions. These stark differences in seafloor setting do not allow for evaluation of whether crust versus nodule formation processes may affect ferromanganese growth and composition. We hypothesize that co-located crusts and nodules have similar compositions. To address this hypothesis, we gathered a set of co-occurring hydrogenetic (seawater sourced) open-ocean ferromanganese crust and seamount-hosted nodules from multiple locations in the Pacific and Atlantic Oceans. We measured bulk mineralogy and geochemistry of crust and nodules from each region and combine this with microanalyses across the stratigraphy of co-located crust and nodule pairs to investigate general similarities in their formation as well as fine scale variation. Bulk geochemistry data show that while crusts tend to have a broader range of concentrations than nodules for manganese, iron, cobalt, copper, nickel, and cerium, median crust and nodule concentrations within each location are similar. Growth rates estimated from $_{230}Th_{ex}/_{232}Th$ ratios are also similar for co-located crust and nodules pairs. Thus, regional variation in element concentrations and growth rates is more evident than crust vs nodule variation at a single site. In contrast, eighty percent of the samples that contain 10 angstrom vernadite peaks measured by x-ray diffraction are nodules, indicating that mineralogy can differ between co-located crusts and nodules. In addition, micro-XRF data show that some patterns in Mn and Co can be seen, but exactly similar layer formation over the same mineral thickness is not observed. Additional work to produce time-calibrated growth horizon alignment is planned to further investigate micro-scale differences in co-located crust and nodule formation.