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Trace element enrichments in Pacific ferromanganese crusts as a function of seawater properties

CORALIE RODRIGUEZ[1], KATHERINE KELLEY[1], KIRA MIZELL[2] AND ROBERT BALLARD[1]

[1]University of Rhode Island

[2]United States Geological Survey

Presenting Author: corarodri@uri.edu

Ferromanganese (Fe-Mn) crusts are hydrogenetic deposits composed of iron and manganese oxides that precipitate from the ambient seawater. These crusts are widely distributed throughout Earth's ocean basins, form over millions of years, and are important reservoirs for trace metals, due to their ability to sequester metals from the ocean. Some environmental factors are known to aid in Fe-Mn crust formation (e.g., low sedimentation), but the specific conditions by which they form and the controls on their composition remain ambiguous. Here, we evaluate the concentrations of rare earth elements and transition metals in Fe-Mn crust samples from Pacific seamounts as a function of the water column properties at the depth of collection. Samples for this study were collected by remotely operated vehicle (ROV) during two 2019 cruises of E/V Nautilus to the Line Islands region (NA110) and the Baker/Howland/Johnston atolls (NA114). We conducted bulk analyses of surface scrapes of the top <1 mm of crust (i.e., top scrape), which best represents the currently growing face of each deposit. These top scrapes were analyzed for trace element abundances by inductively coupled plasma mass spectrometry (ICP-MS). We paired each sample with water column data (dissolved oxygen, salinity, temperature, depth) at the point of sample collection using the Conductivity-Temperature-Depth (CTD) sensor aboard ROV Hercules. Our results show that Co enrichments (high Co/Mn) and elevated Ce anomalies (high Ce/Ce*) are associated with lower dissolved seawater oxygen. This Co trend is broadly consistent with previous studies in the Pacific (Mizell et al., 2020; Usui et al., 2019), but extends to the high end of enrichment known for Fe-Mn crusts (0.7 - >2 wt% Co). ROV technology enables high resolution seafloor sampling, paired with continuous sensor data. Together, these afford a highly detailed view of key relationships between Fe-Mn crust composition and associated seawater properties.