Ferromanganese Crusts and Associated Minerals from the Rio Grande Rise, SW Atlantic Ocean

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The Rio Grande Rise (RGR) is one of the largest oceanic elevations in the South Atlantic Ocean and is known to host ferromanganese crust (FMC) deposits, however, the extent of FMC and types of concomitent mineralization are not well studied. Here, we present the mineralogy and geochemistry of FMC and associated minerals, mainly phosphorites, carbonates, and ironstones, collected on cruise RGR1 onboard the RV Alpha Crucis (University of Sao Paulo) during February 2018. Mineralogy was determined using XRD and chemical composition using a variety of analytical techniques. Growth rate and age of initiation of FMC growth were estimated using the Co-chronometer equation [1]. Sr^{87}/Sr^{86} was used to determine the age(s) of carbonate fluorapatite (CFA) phosphatization. Non-phosphatized, 1 to 9 mm thick FMC layers are composed of δ-MnO_2 and X-ray amorphous FeOOH, while the phosphatized layers consist of δ-MnO_2, asbolane, amorphous FeOOH, CFA, and calcite. Some FMC are pervasively phosphatized. Ironstone layers are composed of predominantly goethite, with minor to moderate calcite and CFA. The mean major element contents of FMC are 16.5% Ca, 15.0% Mn, 9.13% Fe, and 3.89% P, with a Fe/Mn ratio of 0.57. The phosphatized crusts are enriched over non-phosphatized crusts in P, Ca, heavy rare earth elements, Y, Rb, Cr, Cs, Li, Se, and Te, showing the predominance of phosphatization. Ironstones are composed of 40% Fe, 7.01% Ca, and 1.88% P. FMC initiated growth around 23 Myr ago at rates that varied from 4.38 to 0.88 mm Myr^{-1}, while the thin, more recent non-phosphatized crusts, initiated growth at about 5.23 Myr ago. Fe-Mn crusts, carbonates, and ironstones were affected by phosphatization from 20 to 6.8 Myr ago, especially between 17 and 15 Myr ago, although the carbonates were phosphatized during a wider range of time, from 22 to 2 Myr ago. These preliminary data indicate that the FMC from RGR are hydrogenetic, yet have a significant diagenetic CFA component, which strongly affected the crusts since their early growth. FMC and associated minerals from the RGR provide important new information about the evolution of RGR and controls on the formation of the mineral deposits. [1] Manheim and Lane-Bostwick, 1988, Nature, **335**, 59-62.