

TITLE: Deep-sea mining on the Rio Grande Rise (Southwestern Atlantic): A review on environmental baseline, ecosystem services and potential impacts

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ABSTRACT:

The Rio Grande Rise is an extensive seamount region in the South-western Atlantic, with potential for deep-sea mining activities in the future. Such activities pose significant long-term disturbances and potentially severe impacts to both ecosystem structure and functioning, as well as associated ecosystem services. The Rio Grande Rise presents a severely understudied area, with very little knowledge on either local and regional scales. Most detailed knowledge available is centered on highly localised geological information and interpolated and/or modelled environmental data, while high-resolution data on biogeography, ecosystem processes and functioning are lacking. The Rio Grande Rise is most likely a remnant of the Paraná-Etendeka igneous province, and formed when the African and South-American plates separated to form the Southern Atlantic basin, about 75 million years ago. More recent cruises have generated very local and high-resolution acoustic impedance data on the substrate, showing extremely dense layers, likely to be cobalt-rich crusts and underlying bedrock, interspersed with thick sediment layers. Literature studies revealed that nowadays the Rise appears to be located within a relatively low-productivity oceanic region. Open-database mining yielded large-scale, extrapolated environmental data rasters, which show the Rise to be an oceanic region relatively free of pollution and anthropogenic disturbances, with high geomorphological heterogeneity and potential for high biodiversity. This image was confirmed in a small number of scientific submarine cruises, where a diverse range of seascapes was observed, from soft sediment to carbonate pavement and cobalt crust outcrops. Especially the latter substrata were found to be inhabited by diverse benthic communities, dominated by sessile organisms, presenting three-dimensional structural heterogeneity and with associated vertebrate and invertebrate animals. Cobalt-rich crusts appear to grow at an extremely slow rate of several mm per million years, in the deep ocean where biological and ecological processes such as reproduction, growth and recolonisation are characterised by slow dynamics. The main disturbances posed by deep-sea mining of cobalt-rich crusts on the Rio Grande Rise consist of (1) complete removal of substrate with its particular benthic communities, (2) strong localised increases in suspended particulate matter, causing smothering of breathing apparatus and dilution of food particles, (3) crushing by tailings and overburden and (4) toxicity effects by released metals and other toxic substances, likely to be increased under high pressure. These impacts will likely change the deep-sea ecosystem at the Rio Grande Rise and its functioning for time scales in the order of decades to centuries. State-of-the-art geological, environmental and ecological modelling, complemented with high-quality, fine-resolution data are needed to provide a detailed evaluation of the impacts of cobalt-rich ferromanganese crust mining in the Rio Grande Rise, with the goal to formulate strategic environmental management plans.

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