COMPARISON BETWEEN THE GENETIC PROCESSES AND COMPOSITION OF MASSIVE NODULES FROM THE URUCUM MANGANESE ORE DEPOSITS AND MODERN MANGANESE NODULES

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ABSTRACT: The Urucum manganese and iron district is located in the Mato Grosso do Sul state, next to the city of Corumbá, in Brazil. Their rocks belong to the Neoprotezoic to Cambrian Santa Cruz Formation of the Jacadigo Group. The Santa Cruz Formation contains tons of manganese and massive iron ores that have been mined since the beginning of the last century. The iron ore occurs as layers of jaspilite and iron formations that host three massive manganese ore layers called Mn1, Mn2 and Mn3. Nodular structures occur in Mn2 and Mn3, and the aim of this research is to study the characteristics of these structures and compare them with the modern manganese nodules. The current deep-sea nodules, also known as polimetallic nodules, are composed by approximately 20% of Fe, 20% of Mn and 1% of Ni + Cu + Co (Mo, Li). Understanding the formation processes of polymetallic nodules is important because in the near future deep-ocean nodules will be exploited to obtain these metals, as it is already done on the ocean platforms of Japan and New Zealand. However, the access to these nodules is difficult, and the study of fossils nodules, as the ones in Urucum, is easier and can be helpful in the understanding of the modern nodules genesis and assist in the prospection of new submarine nodules deposits. For this purpose, bibliographic review, chemistry analyses and SEM-EDS imaging were carried out. Aggregations of micrometric micronodules, and prismatic crystallite meshes of carbonaceous cryptomelane, interpreted as microbialites generated by microorganisms, were found inside the Urucum manganese ore. These ores are enriched in Mn, P and Co, and depleted in Al, K, Ca and Na, which suggests bacterial mediation during their genesis and the absence of terrigenous sediments during the deposition of the layers. Plotted on the Mn-Fe-(Cu+Ni+Co) *10 triangular diagram, the samples from Urucum show low values of trace elements (0-0,0512%) and high manganese concentrations (37,3-51,8%), identifying the processes that have developed these nodules by hydrothermal followed by diagenetic modifications. Moreover, they show discrete negative anomalies of Ce and enrichment in HREE (heavy rare earth elements), except for the samples Mn3 from the MCR mine, which has positive anomalies of Ce. These characteristics suggest they were formed in reducing environments under the influence of hot fluids. Briefly, this research allowed the following conclusions: (1) The Urucum nodules are morphologically similar to the modern manganese nodules, but microbialites were not found in the modern nodules, although the presence of bacteria had been reported by many authors. (2) The Urucum nodules are compositionally similar to the nodules from modern continental margin environments. (3) The iron and manganese from Urucum nodules come from distal hydrothermal vents and the nodules have formed under sub-oxide conditions. The Mn3-layer samples from the MCR mine are exceptions, because they were likely generated on the floor of Urucum sedimentary basin, closer to hydrothermal vents; (4) the enrichment in bio-essential elements and the presence of microbialites suggest that microorganisms mediated the formation of the Urucum nodules.

Key words: URUCUM, MANGANESE NODULES, NEOPROTEROZOIC