

Biogenic genesis of the Urucum Mn ores, Brazil

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Urucum Mn deposit of Ediacaran age with more than 600 Mt of Mn-rich rocks form microbialite. Manganese ores are in layers Mn-1, 2 and 3, which are hosted in jaspilites and ironstones, with 27-44% Mn and 12-30% Fe. Based on mineralogy the proto ore sedimentation and also the diagenesis occurred under suboxic-oxic and semi-neutral conditions, where microbial Mn(II) oxidation resulted fine-grained accumulation of Mn oxides and organic matter. The sharp contact between manganese and iron layers represents that horizon, where enzymatic Mn oxidation overwhelms microbial Fe oxidation. High resolution, detailed optical microscopy, cathodoluminescence microscopy, Raman and FTIR spectroscopy showed that the lower Mn-1 is ferruginous and upper Mn-1 consists mainly of 30–75 vol. % braunite, <0.5% aegirine, 3–15% quartz, 5–10% feldspar, 1–5% of clay minerals—apatite—chlorite and organic matter, controlled by homogeneous oxidation and microbial mediation. Kremydilite, a new type of diagenetic, oblate and concentric structure, formed by randomly activated heterotrophic cell colonies generating pores in the microbialite sediment after burial, side by side with lithification and stabilization of minerals. Mn-2 and 3 contain kremydilites, with 77-95 vol.% cryptomelane, 0–23% hollandite, 9–19 % braunite, 7–21% hematite and 0-5% pores originally filled with clay minerals and organic matter, in the midst of fluffy micronodule matrix composed of cryptomelane and hematite in varying proportions. The first syngenetic products of microbial enzymatic oxidation was ferrihydrite, lepidocrocite, on Fe side, and vernadite, todorokite, birnessite, manganite, on the Mn side, formed under obligatory oxic (Mn) and suboxic (Fe) conditions and close to neutral pH. The present deposit is the result of complex diagenetic processes, which include the decomposition and mineralization of cell and extracellular polymeric substance of Fe and Mn bacteria and cyanobacteria. The authors thank the support of National Research, Development and Innovation Office, National Scientific Research Found No. 125060 and the Companies VALE URUCUM.