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GEOCHEMISTRY AND MINERALOGY OF NEOPROTEROZOIC BANDED IRON-FORMATIONS AND SOME SELECTED, SILICEOUS MANGANESE FORMATIONS FROM THE URUCUM DISTRICT, MATO GROSSO DO SUL, BRAZIL

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Abstract

This study characterizes the precursor mineralogy and geochemistry of the Neoproterozoic iron ore deposits as well as some associated Na-containing manganese assemblages of the Urucum district, Mato Grosso do Sul, Brazil. It is based on ten mineralogically well characterized samples (six of banded iron-formation (BIF), three of manganese formations, and a sample of a veinlet that crosscuts the manganese assemblage), which were carefully selected so as avoid as much as possible supergene enrichment and secondary alteration (weathering), both of which are pervasive in the Urucum district. The six BIF samples are representative of the extensive Urucum BIF sequence from which the rich iron ores were developed by supergene enrichment and are considered to be precursors to the iron ore. The manganese-rich samples are part of unusual siliceous manganese horizons that contain complex silicate assemblages with braunite, cryptomelane, some pyrolusite, and authigenic aegirine.

The Urucum BIF sequence is distinctive because it consists almost entirely of hematite and chert (jasper) with almost all of the iron present as only Fe_2O_3. This is in sharp contrast to the iron chemistry of much older (Archean and Early Proterozoic) BIF, in which a very large proportion of the iron occurs as ferrous iron in magnetite, carbonates, and silicates. As such, the Urucum BIF are essentially identical to those of the Neoproterozoic Rapitan sequence (755–730 Ma) of the Yukon and Northwest Territories of Canada. The Urucum sequence contains abundant dropstones, whereas the Rapitan sequence is set among diamictites but also contains dropstones. The $\delta^{13}C$ values of carbonates at Urucum are low, ranging from –5.2 to –7.0 per mil, which reflects their deposition in a glaciomarine setting. The REE concentrations of the BIF, as well as three Mn formation samples, are very similar and are almost completely lacking positive Eu anomalies (relative to NASC). This is in sharp contrast to the pronounced positive Eu anomalies of Archean and Early Proterozoic iron-formations. The general trend of the REE profiles (in NASC plots), with some enrichment of the heavy REE, is qualitatively very similar to that of modern seawater. The source of the Fe, Mn, and Si is concluded to be from typical ocean water with some deep-sea hydrothermal component. The reappearance of the Neoproterozoic Urucum sequence with BIF and interlayered manganese formations, together with the Rapitan sequence of similar Neoproterozoic age, after an absence of such sedimentary sequences in the geologic record for about 1.1 billion years, is considered to reflect ocean stagnation (with anoxic conditions), which may have been caused by a near-global ice cover, referred to as "snowball Earth."

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