Magnetite texture and major-element geochemistry of BIFs and VHMS mineralization in the Carajás Province, Brazil

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The variation in magnetite chemical composition reflects its formation under different conditions across several geological settings. Chemical variation in magnetite has been used as a petrogenetic indicator and a tool in mineral exploration to constrain the evolution of ore-forming processes. Magnetite has been investigated in three iron deposits from the Carajás Province: S11D in the Serra Sul region, N4WS and GT-57 in the Serra Norte region. The Serra Sul region consists of black shales and magnetite-chert banded iron formations (BIF), whereas in the Serra Norte region andesitic basalt and jaspilite are ubiquitous. Five forms of magnetite (Mag), were distinguished based on their geological context, textures, and major-element chemistry. Mag I and Mag II occur as black bands in the quartz-magnetite BIFs at S11D, with Mag I occupying crystal cores (10 to 600 µm) and Mag II predominantly along the rims (3 to 15 µm). Mag III (4 to 25 µm) occurs along black bands of jaspilite at N4WS. Mag IV (10 to 700 µm) and Mag V (25 to 500 µm) are found in barren BIF breccias at S11D and andesitic basalt breccias host to base metal mineralization at N4WS and GT-57, respectively. In comparison with all magnetite types, Mag I yields the highest MgO content, a positive correlation with SiO_2, and low Al_2O_3. Mag II also displays a positive correlation with SiO_2 but contains lower MgO. Mag III, Mag IV, and Mag V show no variation in MgO which is overall lower when compared to Mag I and Mag II. Mag I and Mag II follow the same pattern on the spidergram being overall markedly less enriched in Al, Mn, and highly enriched in Mg. Mag III is marked by the highest Ca content and intermediate Mg content. Mag IV is less enriched in Mn, Mg and Ni. Mag V displays marked enrichment in Ti, Ca, and Mn. The decrease in MgO and SiO_2 for Mag I and Mag II suggests a drop in fluid temperature and the infiltration of Si-poor fluid. The formation of Mag III, Mag V and Mag IV indicates precipitation under relatively similar lower temperature conditions with fluid composition becoming less siliceous towards the precipitation of Mag IV and Mag V. Si and Ca are enriched in hydrothermal magnetite when compared to magmatic magnetite. Although the enrichment can be observed for all samples, this is specially the case of Mag III and Mag V, which could have derived from the same fluid source that would have become more enriched in Si an Ca

during percolation into jaspilite. High Ti in Mag V suggests higher temperatures and oxygen fugacity, and its Al enrichment indicates extensive fluid-rock interaction.