Geological Overview of the Carajás Mineral Province (Brazil) and its iron oxide-copper-gold mineralization

Alberto Lobo-Guerrero, LOGEMIN S.A., Bogota, Colombia
ageo@logemin.com, ageo@iname.com

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The Carajás Mineral Province is Brazil's most important mining district. It boasts four well-documented, distinct and overprinted periods of anorogenic ring complex cluster formation; three are Archean (2985-2847Ma, 2803-2675Ma, 2630-2505Ma) and one PaleoProterozoic (1890-1760Ma).

Various types of mineralization are associated to the last three periods. All the world-class, massive iron oxide mineralization took place during the PaleoProterozoic period. Iron ore deposits in the Carajás District - previously considered to be banded iron formations - are hydrothermal replacement IOCG type deposits. Iron mineralization seems to be directly associated with granitoids.

A fifth (collisional?) major tectonothermal event took place during the MesoProterozoic (1760-1575Ma). That amount of geological events and crust rejuvenation has allowed for multiple opportunities of mineralization in the Carajás District. The nearby Rio María Granite-Greenstone Belt Terrain contains two anorogenic ring complex cluster events, and no significant mineralization is attached to them.

In general terms, Carajás granitoids show a tight grouping on the Middlemost modified total alkali versus silica diagram. Granitoids span the subalkaline to midalkaline rock fields. All rocks, except those from the Breves deposit display characteristics of anorogenic granitoids. Limited geochemical evidence shows that all granitoids from the Carajás District contain enough Th to behave as high heat-producing granitoids.

The Breves granitoids seem to have been subject to substantial hydrothermal alteration – depletion in Na, K and Si values.

Main types of mineral deposits identified in the Carajás Mineral Province include: major iron ore (Carajas, N4, N5, S11) and Mn deposits (Antonio Vicente, Azul, Buritirama, Sereno), iron oxide-copper-gold deposits (118, Alemao, Cristalino, Cinzento, Igarape Bahia, Salobo, Sequerinho, Serra Pelada, Sossego), PGE and Ni mineralization related to layered mafic-ultramafic rocks (Formiga, Luanga, Luanga Sur, Serra Leste, Buzios, Fafa, GT34, Jacare, Jacarezinho, Mundial, Puma, Serra da Onca, Vermelho), Ni laterites, Sn related to ring complexes (Velho Guillerme), a few well-defined Cu-Au-(W-Bi-Sn) deposits (Aguas Claras, Breves, Alvo Estrela), a few minor Au veins in shear zones (Babacu, Tucuma, Cumaru, Sapucaia), and various small Cu deposits (Borrachudo, Furnas, Oc. Rio, Raulo, S5, Tarzan, Gameleira, Garimpo Fernando, Serra Verde).

Other main characteristics of the Carajás Mineral Province include: High rainfall regime during most of the year. Many deposits are related to mafic/ultramafic layered complexes. No evidence of sedimentary-hosted Cu mineralization has been identified to date. Rare-earth mineralized mafic/ultramafic dikes and carbonatites are not mentioned in Carajás literature. They may be present, but severe weathering makes the remnants of such ultramafic rocks hard to identify.