

Mesoarchean tectono-magmatic and hydrothermal events recorded by in situ U-Pb titanite geochronology at the Hades and Hades Nordeste copper deposits, SW Carajás Domain

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The Hades and Hades Nordeste copper deposits are situated in the extreme southwest sector of the Carajás Domain, along a WNW-ESE regional shear system almost 20Km long, likely associated with the Canaã Shear Zone. The deposits are hosted by metagranodiorite (Hades deposit), metamonzogranite (Hades Nordeste deposit) and amphibolite that are cut by dykes of mafic and felsic volcanic rocks. This work provides in situ LA-ICP-MS U-Pb geochronological data obtained in titanite crystals from thin sections of host rocks and hydrothermal zones of these deposits. The metagranodiorite and metamonzogranite are medium-grained and have a spaced to continuous foliation (S_n) defined by segregation of chlorite grains into the incompetent domains, quartz ribbon, and feldspar subgrains orientation. Euhedral titanite in equilibrium with igneous quartz and feldspar yielded a Concordia age at 3377 ± 14 Ma (MSWD=8.4; n=5) for the Hades metagranodiorite and at 3296 ± 8 Ma (MSWD=4.5; n=16) for the Hades Nordeste metamonzogranite. In the Hades metagranodiorite, titanite also occurs with chlorite in pressure shadows around feldspar porphyroclasts and yielded a Concordia age at 2944 ± 23 Ma (MSWD=8.2; n=4). The amphibolite is dark green, fine-grained, and has nematoblastic texture with spaced to continuous foliation (S_n). In the amphibolite, titanite occurs as subgrains with intense ilmenite-rutile replacement along cleavage plans and yielded a lower intercept age in the Tera-Wasserburg diagram at 2900 ± 125 Ma (MSWD=1.6; n=9). In both deposits, early pervasive hydrothermal sodic and potassic alteration are marked by chessboard Ab I, and Mc I-Or I at the mineral interstices, respectively. In the Hades deposit, these initial alterations are followed by Ca-rich veins (Act-Ep I±Cal±Ttn I±Ap I) associated with Ab II-Mc II-Or II halos related to mineralization I (Ccp I-Py I-Gn I-Pn ±Mag I). Hydrothermal titanite occurs mainly in the alkaline halos or along the contact between epidote-actinolite and yielded a Concordia age at 2888 ± 8 Ma (MSWD=5.8; n=23). The Hades Nordeste deposit exhibits Ca-Fe veins (Act-Ep I-Mag I±Cal I), which are associated with Ab II-Or II halos and mineralized veins (Ccp I-Mag I-Py I-Mo I-Gn). These alteration stages are crosscut by chlorite-quartz-rich veins and fronts associated with quartz recrystallization during foliation (S_{n+1}) development, which is related to the main ore stage. The latter at Hades is represented by the Ccp II-Py II-Gn II-Mo related to Chl-Qtz±Cal II-Ap II-Ttn II veins and breccias. In the Hades Nordeste deposit, the ore zones comprise Ccp II-Py II-Mag II-Mo II stockwork and breccias with Chl-Bt-Qtz-Ep II±Cal II. Overall, the LA-ICP-MS U-Pb geochronological data suggests a magmatic crystallization event as old as ca. 3.3 Ga in the southwest sector of the Carajás Domain. It also constrains nearly coeval deformation and

hydrothermal episodes at ca. 2.9 Ga, which coincide with a regional deformation event at late Mesoarchean (2.89-2.85 Ga) related to the collision between the Rio Maria and Carajás domains.