

# ANAIS



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**A Metalogenia para o  
Desenvolvimento do Setor Mineral  
Brasileiro.**



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# **ANAIS DO VI SIMPÓSIO BRASILEIRO DE METALOGENIA: A Metalogenia para o Desenvolvimento do Setor Mineral Brasileiro**

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## HYDROTHERMAL EVOLUTION OF THE NEOARCHEAN AQW7 REDUCED COPPER SKARN TARGET, AQUIRI HUB, CARAJÁS PROVINCE

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This study presents the first titanite age obtained for the AQW7 Cu-skarn deposit, located in the western portion of the Carajás Mineral Province. The copper mineralization, characterized by chalcopyrite-(pyrrhotite), developed close to the contact between a gabbro intrusion (Cateté Intrusive Suite) and siliciclastic units attributed to the Neoproterozoic Itacaiúnas Supergroup. The gabbro has a typical subophitic texture but locally presents granophyric intergrowths of quartz and K-feldspar. The reduced prograde paragenesis in both endoskarn and exoskarn comprises graphite-marialite and diopside along with apatite, albite, quartz and titanite. In the retrograde stage, hornblende was followed by actinolite-quartz. Chamosite and tourmaline selectively overprint the earlier metasomatic assemblage. Sericite precedes late marialite, calcite, clinozoisite and quartz associated with pyrrhotite and chalcopyrite. Calcite and prehnite veinlets cut earlier alteration stages. In addition to petrographic characterization, we employed Raman spectroscopy, TIMA mineral mapping, and in situ titanite U-Pb-trace element analyses (LA-ICP-MS). Raman analyses enabled the identification of two-phase (liquid-vapor) primary methane bearing fluid inclusions hosted in diopside and the estimation of graphite crystallization temperatures (~724 °C). Titanite was identified in both exoskarn (sedimentary protolith) and endoskarn (gabbro) as pale brown to brown euhedral-subhedral crystals, exhibiting a complex accretive crystallization feature. This feature reflects early euhedral titanite that served as nuclei for subsequent growth. Titanite trace element indicates fluid-rock interaction with redox shifts during the skarn hydrothermal evolution under relatively stable temperature and pressure. The independent Al-in-titanite barometer yielded pressures of ~0.20 GPa, while Zr-in-titanite thermometry indicates temperatures of ~692 °C, consistent with graphite temperature estimates. The *P-T* conditions support the formation of skarn assemblages due to the shallow emplacement of gabbro, as indicated by the presence of granophyre texture. In the endoskarn, chondrite-normalized REE patterns in titanite exhibit a concave-upward shape with pronounced negative Eu anomaly ( $\text{Eu}/\text{Eu}^* = 0.39$ ), possibly related to Eu retention by diopside. The  $\text{Ce}/\text{Ce}^*$  ratios  $< 1$ , accompanied by higher Th/U ratios, indicate reducing conditions, consistent with the prograde mineral assemblage with graphite and the presence of methane-rich fluid inclusions in diopside. In contrast, in the exoskarn, the  $\text{Ce}/\text{Ce}^*$  ratios are greater than 1, and the Th/U ratios are lower, indicating more oxidizing conditions. These patterns, coupled with high REE concentrations, may reflect prolonged fluid-rock interaction with the sedimentary host rocks, resulting in the effective leaching of elements. Titanite U-Pb data reveal a minimum age of the skarn mineralization of ca. 2.58 Ga, which represents an important metallogenic event recorded in IOCG deposits of the Northern Copper Belt of the Carajás Mineral Province. The AQW7 skarn deposit may be part of the regional IOCG mineral system and highlights the significant role of Neoproterozoic mafic intrusions in the copper endowment of the Carajás Mineral Province.