

Trace Element Systematics of Cassiterite From the Bisie Tin Deposit, North Kivu Province (Democratic Republic of Congo)

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The Bisie Tin Deposit is known as the world's highest-grade tin mine with an average grade of 4.5 % SnO₂. Despite its economic importance, the mineralogical characteristics of the ore and geochemical processes controlling tin mineralization remain poorly understood. This study investigates the trace element systematics of cassiterite to better understand the controls and processes responsible for tin mineralization. It compares the trace element composition of cassiterite from the Bisie Tin Deposit with cassiterite from the pegmatite-hosted Uis Tin Deposit, which is associated with the Pan-African-aged Damara Orogen in Namibia. These deposits are genetically different, allowing the trace element systematics of cassiterite to be evaluated across different mineralization environments. Cassiterite is the main ore mineral of tin deposits and can incorporate a range of trace elements during crystallization. This study uses petrography to characterize the cassiterite textures and relationships within the ore assemblage, TIMA to quantify mineralogical distributions within samples, and EPMA to analyze the major and minor element compositions of cassiterite. Petrographically, the cassiterite exists as subhedral to anhedral grains and has a colloform texture. This supports a hydrothermal origin. CL images reveal oscillatory zoning and small mineral inclusions within cassiterite, which reflects variations in element incorporation. EPMA shows that the cassiterite is almost pure SnO₂, with negligible trace element substitution. In contrast, cassiterite from Uis exists as coarse, subhedral-anhedral grains with no zonation reflecting crystallization from pegmatitic melts. These datasets indicate compositional variations in cassiterite, with Bisie cassiterite enriched in Fe and Mn but low in Nb and Ta, whereas Uis cassiterite shows the opposite trend. The integration of mineralogical and geochemical datasets contributes to a better understanding of cassiterite formation and the metallogenic processes responsible for the exceptional grade of the Bisie Tin Deposit, with implications for tin exploration in similar geological environments.