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The Occurrence of Vein and Matrix Kyanite Hosted in Carbonates of the Menda Prospect of the Congolese Copperbelt

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Kyanite, the high-pressure Al_2SiO_5 polymorph, is traditionally considered a high-pressure, high-temperature mineral. Common kyanite-forming reactions such as pyrophyllite or chlorite dehydration take place at ~400° and >600°C, respectively. In this study, kyanite is observed within low-temperature dolomite-magnesite carbonates and carbonaceous siliciclastic lithologies, hosted in postevaporitic breccia, and associated with abundant chalcopyrite. Kyanite occurs as matrix porphyroblasts as well as coarse-grained, vein-hosted crystals intergrown with quartz, dolomite, chalcopyrite, and monazite. Corroded crystal shapes indicate breakdown of kyanite to Mg-chlorite. The occurrence of kyanite in low-pressure-temperature rocks indicates unusual conditions of kyanite growth. Cathode luminescence and element mapping by laser ablation mass spectrometry are used in this study to unravel the complex vein paragenesis and to characterise the multiple textural generations of kyanite.

The Central African Copperbelt (CACB) is the world's primary source of copper and cobalt, producing about 70% of the metal that is critical for the production of batteries needed to help decarbonise our societies. Highly saline fluids are associated with extensive mineralisation and alteration in the CACB. Intimate association of kyanite-bearing veins and Cu-sulphide mineralisation indicates that the unusual thermodynamic conditions encountered play a role in the understanding of the Copperbelt Cu-Co system. The occurrence of kyanite in Al-poor carbonates and in veins suggests that Al, thought to be relatively immobile, has been transported. The preservation of sedimentary features, indicative of an original grainstone, also suggests that there was a compositional control on kyanite growth. Understanding the paragenesis of kyanite in relation to Cu, Ni, and U mineralisation at Menda, as well as the unusual thermodynamic conditions required for low-temperature kyanite growth and Al-mobilisation, has implications for the interpretation of the kyanite-bearing assemblages in metamorphic assemblages in the Domes region of the Zambian Copperbelt, as well as for metal mobility in highly saline systems.

Figure caption: There are many different textural generations of kyanite which are summarised in the schematic. Generation (i) is distributed along compositional layers which also act as conduits for fluid flow. Generations (ii), (v), and (vi) are related to brittle fractures and vein margins. Generations (iii) and (iv) are found within dolomite, quartz, monazite veins.