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Geochemical, microtextural and petrological studies of the Samba prospect in the Zambian Copperbelt basement: a metamorphosed Palaeoproterozoic porphyry Cu deposit.

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Ever since Wakefield (1978, IMM Trans., B87, 43-52) described a porphyry-type meta-morphosed Cu prospect, the ca 50 Mt, 0.5% Cu Samba deposit (12.717°S, 27.833°E), hosted by porphyry-associated quartz-sericite-biotite schists in northern Zambia, there has been controversy about its origin and significance. This is because it is situated in the basement to the world's largest stratabound sediment-hosted copper province, the Central African Copperbelt, which is hosted by rocks of the Neoproterozoic Katanga Supergroup. Mineralization in the pre-Katangan basement has long played a prominent role in ore genetic models, with some authors suggesting that basement Cu mineralization may have been recycled into the Katangan basin through erosion and redeposition, while others have suggested that the circulation of fluids through Cu-rich basement may have leached out the metals which are found concentrated in the Katangan orebodies. On the basis of ca 490-460 Ma Ar-Ar ages, Hitzman et al. (2012, Sillitoe Vol., SEG Spec. Publ., 16, 487-514) suggested that Samba represents late-stage impregnation of copper mineralization into the basement, and that it was one of the youngest copper deposits known in the Central African Copperbelt. If the Samba deposit really is that young, then it would have post-dated regional deformation and metamorphism (560-510 Ma), and it ought to be undeformed and unmetamorphosed.

The Samba mineralization consists of chalcopyrite and bornite, occurring as disseminations, stringers and veinlets, found in a zone >1 km along strike, in steeply-dipping lenses up to 10m thick and >150m deep. Our new major and trace element XRF geochemical data (14 samples) show that the host rocks are mainly calc-alkaline metadacites. Cu is correlated with Ag (Cu/Ag $\sim$10,000:1) with no Au or Mo. Our study focused on the microtextures and petrology of the Samba ores. We confirm that there is alteration of similar style to that accompanying classical porphyry Cu mineralization, including potassic (biotite+sericite+ quartz), propylitic (clinozoisite+chlorite+saussuritized plagioclase), phyllic (sericite+quartz+ pyrite+hydromuscovite/illite) and argillic (kaolinite+chlorite+dolomite) alteration. The clays were identified with XRD. All the rocks show penetrative deformational textures and fabrics. Our textural studies show that phyllic zone pyrite crystals have quartz-rich pressure shadows, and they predate all phases of deformation. Similarly, in the potassic zone, fracture-controlled biotite stringers in particular orientations are deformed, and partly replaced by chlorite, again showing their pre-deformational, pre-metamorphic origin. Copper sulfide-bearing quartz veinlets are deformed. Many of the alteration assemblages containing biotite or sericite have been deformed into crenulated schists, showing that they were formed early in the deformation history. Coupled with the dating of a Samba metavolcanic rock at 1964$\pm$12 Ma (Rainaud et al., 2005, JAES, 42, 1-31), we regard the Samba deposit as a metamorphosed Palaeoproterozoic porphyry-type Cu deposit, which has undergone deformation, and retrograde metamorphism of its alteration assemblages, during the Neoproterozoic Lufilian Orogeny, followed by post-tectonic cooling, which occurred throughout the Copperbelt at about 480$\pm$20 Ma. Samba, together with the Mkushi deposits, is part of a long-lived (>100 Ma) Palaeoproterozoic porphyry-Cu province in the Zambian Copperbelt basement, and ore genetic theories for the Copperbelt mineralization must now seriously take this into account.