

Characterisation of Heterogenite (CoOOH) from oxidized copper-cobalt deposits in the Katanga Copperbelt, D.R.Congo

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The Katanga Province in the Democratic Republic of Congo (D.R.C.) hosts the northwestern part of the Central African Copperbelt, a world class sediment-hosted stratiform copper-cobalt district. Most deposits can be found in weathered siliciclastic or dolomitic sedimentary host rocks of Neoproterozoic age (basal Roan, Katangan Supergroup) that surface in the Lufilian Range, an arcuate fold-and thrust-belt in the southern part of the province.

Due to extensive weathering of the primary sulphide ore and host-rock, a remobilization of the copper and cobalt has taken place. Secondary oxidized ore occurs in a variety of settings: karstic environments, caps and gossans. Heterogenite (cobalt-oxy-hydroxide) is one of the major oxidized cobalt ores found in this secondary mineralization.

Heterogenite samples from 15 different mining sites throughout the Katanga Province have been studied using optical/metallographic microscopy, raman spectroscopy, XRD and chemical analysis (EDS, microprobe, ICP-MS). Heterogenite ore commonly occurs as an impregnation of the host rock. It also forms stalactites, nodular to botryoidal aggregates or banded crusts in open spaces. A wide variety of textures can be observed ranging from earthy coatings, banded masses of amorphous/cryptocrystalline to well crystallized aggregates. Heterogenite coatings enclose relics of the host rock containing phyllosilicates, iron- or manganese oxides and/or quartz. Replacement and boxwork textures show clear evidence of the dissolution of the primary host rock carbonates. Detailed SEM observation shows that the heterogenite ore exhibits distinct micromorphological features that have never been reported before.

Microprobe chemical analysis reveals that common impurities in heterogenite are: Cu, Si, Al, Mn and Fe, and to a lesser extent P, Cl, Ca, Ba, V, Sn, U (and Pb). Other usual trace elements (Ni, Zn, As, Mo) are determined by bulk rock ICP-MS analysis. Previous work suggests that Co substitution by other cations (Cu, Ni, Fe) has an influence on the heterogenite crystallinity (Deliens, 1974). Well crystallized varieties show a lower impurity content, whereas amorphous heterogenite bands usually contain more impurities. Though, until now it remains unsure whether these cations are part of the heterogenite crystal lattice or are present as interstitial or absorbed elements in a heterogenite texture with high microporosity.

Raman spectroscopic investigation shows that well crystallized heterogenite exhibits a distinct raman spectrum (peaks positions at 495, 660 cm^{-1}). In contrast, cryptocrystalline heterogenite yields a markedly different spectrum due to the transformation into a high temperature spinel structure even at low laser power (peaks positions at 180, 460, 500, 600, 660 cm^{-1}). In addition raman spectra surprisingly display no conclusive evidence for the presence of an $(\text{OH})^-$ -group as a structural element in the lattice. Preliminary XRD results show that crystalline heterogenite displays sharp peaks while disordered cryptocrystalline heterogenite displays poorly-defined XRD spectra.

The question of a correlation between the presence of “impurity” cations (chemical composition) and a tendency to transform into a spinel structure due to laser heating remains a matter of debate. Detailed SEM observations suggest that intracrystalline microporosity may be the cause of the bad heat dissipation and consequent high temperature transformation into a spinel structure.

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