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A Fluid Inclusion Study of the Auriferous Quartz Veins in the Mesoproterozoic Karagwe-Ankole Belt (Byumba, Rwanda): Petrography, Microthermometry, and Raman Spectroscopy

Sander Wouters[1], Stijn Dewaele[2], Philippe Muchez[1]
1. KU Leuven, Leuven, Belgium, 2. Ugent, Gent, Belgium

Despite a resurgence of mineral deposit research in the area, gold deposits in the Central African Mesoproterozoic Karagwe-Ankole belt (KAB) still have many unanswered questions concerning their genesis. Central African orogenic gold mineralization has been linked to fold-and-thrust belt formation accompanied by shear movement. However, a genetic link between the auriferous quartz veins and early-Neoproterozoic post compressional magmatism (G4 granites) is still under debate. The aim of this research is to characterize the quartz vein mineralizing fluids at Byumba (Rwanda) in order to help resolve this long lasting discussion. In order to achieve this, fluid inclusions from the different quartz vein generations at the Byumba deposit were studied by petrography, microthermometry, and Raman spectroscopy. A previous study at the Byumba deposit identified distinct phases of folding and shear deformation of the metasediments, associated with three main phases of quartz veining (pre-[V1], syn[V2], and post-folding[V3]). Primary gold mineralization is identified within post-folding chlorite-rich quartz veins (V3), primarily in the form of sub-micron gold. Petrography of the different vein generations shows the presence of many leaked/decrepitated inclusions in all vein types. Three main fluid types are identified in the Byumba quartz veins (see Figure 1). Type I are primary H_2O-CO_2-X fluid inclusions which consist of an aqueous and a liquid carbonic phase (Lw-Lc) and other gasses (X). Type II primary CO_2-H_2O-X fluid inclusions are dominantly carbonic liquid with a rim of H_2O (Lc-Lw). Type III are aqueous inclusions (Lw-V) found inside secondary trails and have not been studied. Fluid inclusions inside a V1 quartz vein show many resemblances with the V3 quartz veins, but contain more secondary trails. Syn-folding V2 quartz vein inclusions were not suited for further microthermometric analysis. They are too small to be measured or have been leaked/decrepitated. Auriferous V3 quartz veins show large cloudy clusters of primary inclusions. Microthermometric data of primary fluid inclusions of Type I and II is similar in the pre- and post-folding quartz veins. Melting temperatures of CO_2 (Tm_{CO2}) are on average between -61.0 and -59.0°C, with a higher average for Type I inclusions. These temperatures indicate the presence of other gasses inside the carbonic phase, verified by subsequent Raman spectroscopy, which shows significant amounts of N_2 and CH_4. Homogenization of the carbonic phase (Th_{CO2}) is variable within a single assemblage, mostly between 3.5 and 9.5°C. Within Type I fluid inclusions it was often not possible to see the formation of frozen CO_2 because it was completely used up in clathrate formation. Clathrate melting temperatures (Tm_{CLATH}) are mostly between 10.5 and 11.0°C. The primary fluids present in the post-folding auriferous quartz generation have a H_2O-CO_2-CH_4-N_2 composition, which is often associated with a metamorphic origin. However, in a next step, a more detailed analysis of the major and trace element composition of the inclusions will be performed to determine the possible influence/mixing with other likely fluid types, such as magmatic hydrothermal fluids.

Figure 1: Overview of the different fluid types inside an auriferous V3 quartz vein at Byumba.