Petrographic study of gold mineralization in the Karagwe-Ankole belt (Byumba, Rwanda)

Sander WOUTERS[1], Stijn DEWAELE[2], Philippe MUCHEZ[1]

1 KU Leuven, Department of Earth and Environmental Sciences, Celestijnenlaan 200E, B-3001 Leuven, Belgium

2 Ghent University, Department of Geology, Krijgslaan 281, S8, 9000 Ghent, Belgium.

1. Geological setting

The Mesoproterozoic Karagwe-Ankole belt (KAB) is a metallogenetic province in Central Africa which is well known for hosting different types of granite-related rare metal (Nb, Ta, Sn, W) and also gold deposits (Fernandez-Alonso et al., 2012; Pohl & Günther, 1991). It extends from the eastern part of the Democratic Republic of Congo (DRCongo) into Burundi, Rwanda, northwest Tanzania and southwest Uganda. Previous studies demonstrated that the metal source for the Nb-Ta-Sn-W mineralization in pegmatites, greisens and peribatholitic quartz veins, are syn-to post orogenic early-Neoproterozoic leucogranites (Dewaele et al., 2011; Hulsbosch, et al., 2016), while theCentral African orogenic gold mineralization has been related to fold-and-thrust belt formation (Koegelenberg et al., 2016). However, detailed knowledge of the metallogenic source, evolution and age of the Au mineralization in the KAB is largely missing (Pohl et al., 2013). Therefore, the metallogenetic study of KAB Au occurrences forms an excellent opportunity to investigate the contribution of magmatic, metamorphic and water-rock interaction processes related to mineralization in an orogenic belt.

2. Methodology & results

The Byumba gold deposit, situated in the north of Rwanda, was selected for study due to its comparable position in the Mesoproterozoic metasedimentary stratigraphy and structural trend as the well-studied W- and Sn-deposits, allowing a straightforward comparison. From this location, a total of 9 boreholes (± 1800 m) were logged and sampled with the aim to determine the structural setting and timing of ore deposition and the origin and evolution of the mineralizing fluids. Core logging was carried out with special attention to lithological variations, alteration, deformation structures, different vein generations and their relation to the ore grade.

The general lithology is comprised of alternations of sand- to siltstone, with organic-rich shale, which host multiple quartz vein generations. These quartz veins contain varying amounts of chlorite, carbonate and pyrite. Several meter-thick shear zones were identified that are characterized by the occurrence of C'-type shear bands. These shear zones are heavily chloritized and host several deformed quartz veins which are parallel to the foliation. Thin and polished section petrography of the samples reveals the presence of pervasive chloritization, some sericitization, silicification, carbonitization and multiple pyrite generations which are associated with some minor sulfides.

3. Paragenetic sequence of veining and mineralization

A first bedding-parallel quartz vein generation has been folded and is interpreted to predate tectonic deformation. A second and third generation of quartz veins occur in the hinge zones of folds and in faults, respectively. They can be associated with massive pyrite, together with some smaller irregular chlorite-rich veins inside the fold hinges. Quartz veins belonging to a fourth generation developed parallel to the cleavage and are sometimes boudinaged. These quartz veins do not always follow the bedding, but crosscut sandstones at an angle of 45°-60°, giving them a

sigmoidal geometry. At least two distinct sigmoidal vein generations have been recognized. The first generation of these veins is filled with quartz, chlorite and sericite, and is crosscut by a generation consisting of quartz and Fe-rich carbonate. As expressed by these sigmoidal veins and shear zones, a distinct phase of shearing post-dates folding and cleavage development, characterized by silicification and intense chloritization. Preliminary results, based on the ore grade distribution, suggest that gold mineralization at Byumba could have been emplaced during this phase. Finally, cm to m-thick massive quartz veins crosscut the folds, cleavage and all former quartz generations. Often these veins contain fragments of the host-rock and are thus related to a brecciation phase.

Multiple pyrite generations are present in the metasediments. Many of the early pyrite generations are anhedral and contain chalcopyrite blebs. A pre-deformation origin is evidenced by the presence of quartz-filled pressure shadows around these pyrites. Younger, more euhedral, pyrite is associated with pyrrhotite. Many of the later pyrite generations are related to folding and shearing and the associated veining. Notably, a generation of large euhedral pyrites is clearly associated with, but post-dates, the late carbonitization phase associated with shearing.

An important secondary gold enrichment phase is present, as evidenced by the high ore grade associated with oxidation/reduction zone boundaries. The primary gold hosting phases have not yet been directly observed by the used petrographic techniques. However, with the help of different analytical techniques like FEG-EPMA, LA-ICP-MS and ChemScan, the hosting phase(s) of this ‘invisible’ gold will be identified in the future.

References

Dewaele, S., Henjes-Kunst, F., Melcher, F., Sitnikova, M., Burgess, R., Gerdes, A., Fernandez-Alonso, M., De Clercq, F., Muchez, P., Lehmann, B., 2011. Late Neoproterozoic overprinting of the cassiterite and columbite-tantalite bearing pegmatites of the Gatumba area, Rwanda (Central Africa). Journal of African Earth Sciences, 61, 10–26.

Fernandez-Alonso, M., Cutten, H., De Waele, B., Tack, L., Tahon, A., Baudet, D., & Barritt, S. D., 2012. The Mesoproterozoic Karagwe-Ankole Belt (formerly the NE Kibara Belt): The result of prolonged extensional intracratonic basin development punctuated by two short-lived far-field compressional events. Precambrian Research, 216–219, 63–86.

Hulsbosch, N., Boiron, M. C., Dewaele, S., & Muchez, P., 2016. Fluid fractionation of tungsten during granite-pegmatite differentiation and the metal source of peribatholitic W quartz veins: Evidence from the Karagwe-Ankole Belt (Rwanda). Geochimica et Cosmochimica Acta, 175, 299–318.

Koegelenberg, C., Kisters, A. F. M., & Harris, C., 2016. Structural controls of fluid flow and gold mineralization in the easternmost parts of the Karagwe-Ankole Belt of north-western Tanzania. Ore Geology Reviews, 77, 332–349.

Pohl, W., & Günther, M. A., 1991. The origin of Kibaran (late Mid-Proterozoic) tin, tungsten and gold quartz vein deposits in Central Africa: a fluid inclusions study. Mineralium Deposita, 26, 51–59.

Pohl, W. L., Biryabarema, M., & Lehmann, B., 2013. Early Neoproterozoic rare metal (Sn, Ta, W) and gold metallogeny of the Central Africa Region: a review. Applied Earth Science, 122, 66–82.