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Structural controls of fluid flow and gold mineralization in the easternmost parts of the Karagwe-Ankole Belt of north-western Tanzania

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ABSTRACT

Gold mineralization in the Biharamulo region of western Tanzania is confined to the sheared, low-angle basement-cover contact between Archaean basement gneisses of the Tanzania Craton and the structurally overlying, low-grade metamorphic metasediments of the Mesoproterozoic Karagwe-Ankole Belt. Regional-scale fluid flow along this detachment is indicated by the pervasive silicification and retrogression of wall rocks to pervasively foliated phyllonites and pyritization of particularly metasediments, commonly graphite-rich, in the hanging wall of the shear zone. Gold mining centres on specific structural sites along the detachment, but also in stratigraphically higher sections in the structurally overlying metasediments. Zones of gold mineralization along the detachment correlate with NE trending ramp structures (dip angles 20°–35°) that are most ideally orientated for slip and reactivation within the low-angle phyllonitic detachment. Repeatedly overprinted auriferous quartz-vein stockworks in quartzofeldspathic gneisses immediately below the detachment indicate brittle fracturing of the competent footwall lithotypes during slip along the weaker detachment. In cases of massive silicification, up to 50 m thick quartz blows are formed along the contacts between detachment phyllonites and footwall gneisses. The multiple overprinting relationships of successive quartz-vein generations in these zones of massive silicification suggests that the quartz blows acted as competent blocks in the weak detachment, causing the repeated overprint of earlier silicification by later fracturing and quartz-veining events. Gold mineralization above the detachment and in stratigraphically higher metasediments is closely associated with fold structures that form part of the low-grade metamorphic fold-and-thrust belt. Veining is particularly abundant in competent lithotypes, such as quartzite and chemically reactive ferruginous mafic sills. Overprinting relationships between quartz vein sets illustrate fluid flow during fold amplification and, importantly, the final lock-up stage of folds, during which much of the mineralization was introduced. Oxygen isotope values for quartz veins indicate fluids were likely derived from clastic, mainly metapelitic sedimentary sequences of the Karagwe-Ankole Fold Belt. The data also implies that the partially reworked Archaean granitoid-greenstone basement of the Tanzania Craton has not contributed to the fluid evolution and possibly gold mineralization. The extent (>100 km) of the basement-cover detachment and associated alteration is indicative for a regional-scale fluid system. Gold mineralization is, however, controlled by local structures and lithological contrasts that require the detailed mapping and sampling of the regional structure.

1. Introduction

Tanzania is Africa's 4th largest gold producer with an annual production of ca. 40 tonne Au (Tanzania Chamber of Minerals and Energy, 2015). Some 90% of the gold production comes from late-Archaean greenstone belts of the Tanzania Craton (TC), mainly from the Lake Victoria region and the Lake Nyanza- and East Lake Victoria Superterranes (Borg and Shackleton, 1997; Borg and Krogh, 1999; Kabete et al., 2012). There have been very few recent gold discoveries on the TC and the apparent maturation of gold exploration on the craton has shifted exploration efforts towards the less explored margins of the TC (Kabete et al., 2012) (Fig. 1). For the most part, the TC is bordered by younger orogenic belts including the Pan-African Mozambique Belt in the east (Fritz et al., 2013) and the Paleoproterozoic Usagaran-, Ubendian-, Rusizian- and Ruwenzori Belts from the southern to north-western margins of the TC (e.g., De Waele et al., 2008, and references therein) (Fig. 1). These are mostly deeply eroded amphibolite- and granulite-facies terrains with somewhat limited potential for hydrothermal gold mineralization compared to the greenschist-facies deposits of the TC. In contrast, low-grade metamorphic, late Paleo- to Mesoproterozoic fold-and-thrust belts and foreland basins unconformably or structurally overlie much of the western parts of the TC. These

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