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The Guelb Moghrein Cu–Au deposit: Neoarchaean hydrothermal sulfide mineralization in carbonate-facies iron formation

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ABSTRACT

The Guelb Moghrein copper–gold deposit in the Islamic Republic of Mauritania reopened in 2006 and has produced copper concentrate and gold since then. The deposit is hosted in Neoarchaean–Palaeoproterozoic Fe–Mg carbonate-dominated metamorphic rocks interpreted as carbonate-facies iron formation. It forms tabular orebodies controlled by shear zones in the hanging wall and footwall of this meta-iron formation. Copper and gold are hosted in a complex sulfide ore in tectonic breccia replacing Fe–Mg carbonate and magnetite. Hydrothermal monazite dates the mineralization at 2492 ± 9 Ma. Two types of aqueous fluid inclusions suggest fluid mixing at 0.75–1.80 kbar and ~410 °C as the mineralization and precipitation mechanism, which is temporally coincident with regional retrograde metamorphism at 410 ± 30 °C (garnet-biotite). Distal alteration zones are enriched in K, Rb and Cu, whereas orebodies are depleted in K, Rb, Sr and Ba. The copper–gold mineralization at Guelb Moghrein formed during retrograde shearing in metamorphic rocks and contemporaneous hydrothermal alteration. The stable isotope signature of alteration and ore minerals suggest an external crustal fluid source. Fluids were focused in the reactive and competent meta-iron formation. Potassium alteration, magnetite and copper–gold mineralization suggest an IOCG mineral system akin similar deposits in Australia and Brazil.

1. Introduction

The Guelb Moghrein deposit is located 5 km west of Akjoujt and approximately 250 km northeast of Nouakchott, the capital of the Islamic Republic of Mauritania (Fig. 1). This area belongs to the Pan-African Mauritanides belt, that is regarded as a pile of allochthonous terranes thrust eastward onto the West African Craton (Lécorché et al., 1989; Villeneuve, 2005). To the southwest of Akjoujt, basement gneiss, granite and serpentinite are thrust over the lithologies of the Akjoujt area during the Pan-African Orogeny (Martyn and Strickland, 2004). Variscan thrust deformation is recorded to the east and south of Guelb Moghrein, indicating a complex orogenic evolution of the area through time (Clauer et al., 1991; Martyn and Strickland, 2004; Villeneuve, 2005).

Guelb Moghrein was already exploited for copper in Neolithic times and the ancient workings were recognized by the French military in 1931. In 1967, the Société Minière de Mauritanie commenced the exploitation of the oxidized ore, but the mine closed in 1978 due to increased fuel and decreased copper prices. General Gold International SA established the Guelb Moghrein Mines d'Akjoujt (GEMAK) SA in 1995 and completed a feasibility study in April 1997. From 1991 to 1996, approximately 45 kg gold were produced from old mine tailings at 3.08 g/t gold (Strickland and Martyn, 2002). First Quantum acquired an 80% interest in 2004 and increased the ownership to 100% in 2010. Mining in an open pit started in April 2006 and processing of a copper–gold concentrate from the sulfide ore started in July 2006. Commercial production in 2013 was approx. 2.9 Mt ore yielding 37,970 t copper and 58,191 oz. gold. Total reserves are estimated at 31.3 Mt. at 0.92% copper and 0.69 g/t gold, which places Guelb Moghrein into the medium-sized and relatively low grade group of IOCG deposits (Williams and Pollard, 2001; Williams et al., 2005).

In the following, we give a review of the regional geology as well as the copper–gold mineral system based on previous publications. The Guelb Moghrein deposit is an Archaean–Palaeoproterozoic hydrothermal copper–gold deposit that formed during retrograde metamorphism and terrane uplift, and probably belongs to the IOCG class of deposits.

2. Regional geology

2.1. Lithology of the Akjoujt area

The Akjoujt area is underlain by two distinct stratigraphic groups (Martyn and Strickland, 2004; Strickland and Martyn, 2002). The Eizzene Group is exposed about 10 km to the northeast of Akjoujt and is intruded by granodiorite (Fig. 1). The basal Atilis quartzite of the Oumachoueïma Group unconformably overlies the rocks of the Eizzene Group (Strickland and Martyn, 2002; Martyn and Strickland, 2004). The quartzite is overlain by the Sainte Barbe volcanic unit, which is

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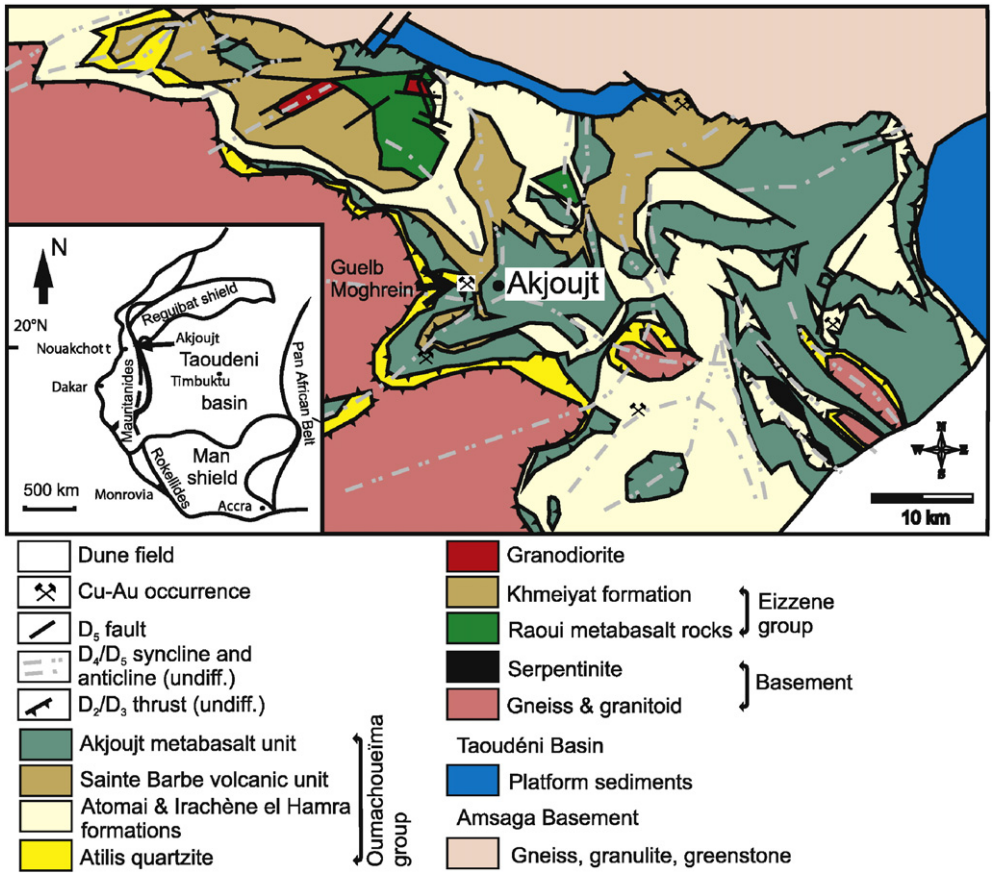

Fig. 1. Schematic geological map of the Akjoujt area.
After Strickland and Martyn (2002).

represented by meta-rhyodacite to meta-dacite and minor meta-sedimentary rocks in Guelb Moghrein (Figs. 1 and 2; Kolb et al., 2008). They are quartz–sericite schists and biotite–garnet–quartz schists, where the former contain quartz porphyroclasts with vitreous inclusions (Kolb et al., 2006). The whole rock geochemistry of these rocks indicates that they are felsic (70 to 75 wt% SiO_2) with trace element patterns similar to a modern continental or island arc setting (Kolb et al., 2008). The Sainte Barbe volcanic unit is overlain by the Lembeitih Formation, a widespread iron formation marker horizon (Fig. 1; Martyn and Strickland, 2004; Strickland and Martyn, 2002), to which the host rock meta-iron formation of Guelb Moghrein belongs (Fig. 2; Kolb et al., 2008). The meta-iron formation is a massive, very coarse-grained rock

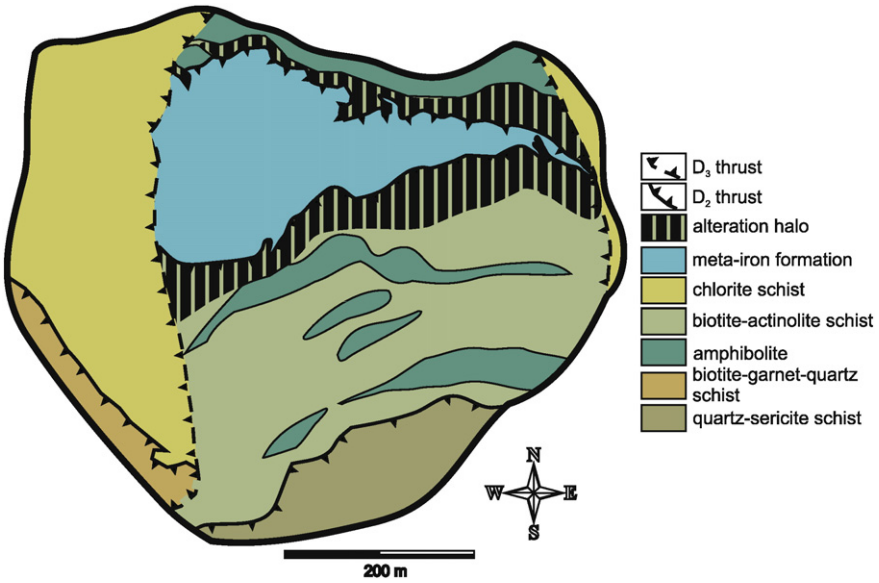

Fig. 2. Geological map of the Guelb Moghrein deposit.
Kolb et al. (2006).