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The nature of gold-bearing fluids in Atud gold deposit, Central Eastern Desert, Egypt

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ABSTRACT

Electron microprobe analyses of gold and associated ore minerals as well as stable isotope analyses of sulphide and carbonate minerals were performed in order to determine the metal and fluid sources and temperature of the mineralizing systems to better understand the genesis of the Atud gold deposit hosted in the metagabbro–diorite complex of Gabal Atud (Central Eastern Desert, Egypt). The gold can be classified as electrum (63.6–74.3 wt.% Au and 24.6–26.6 wt.% Ag) and is associated with arsenopyrite and As-bearing pyrite in the main mineralization (gold-sulphides) phase within the main mineralized quartz veins and altered host rocks. Based on the arsenopyrite geothermometer, As-contents (29.3–32.7 atom%) in arsenopyrite point to deposition in the Log f_{S2} and T ranges of −10.5 to −5.5 and 305–450°C, respectively, during the main mineralizing phase. Based on the $\delta^{34}S$ isotopic compositions of the sulphides, they are originated from magmatic fluids in which the sulphur is either sourced directly from magma or remobilized from the magmatic rocks (gabbroic rocks). On the other hand, calcite formed from fluids having mainly magmatic mixed with variable metamorphic signatures based on its $\delta^{13}C$ and $\delta^{18}O$ values. This work concluded that the gold-bearing ores at Atud deposit have magmatic sources leaching from the country intrusive rocks during water/rock interactions then remobilized during a metamorphic event. Therefore, the Atud gold deposit is classified as an intrusion-related gold deposit, in which the gabbro–diorite host intrusion acted as the source of metals which were mobilized and deposited as a result of the effects of NW–SE shearing.

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1. Introduction

Genesis of most intrusion related-gold deposits in the Eastern Desert of Egypt remains equivocal, although abundant geological and geochemical data have been published. Atud gold deposit (Central Eastern Desert of Egypt), which represent one of the most important mafic intrusive-related gold deposit in Egypt, has been chosen for a comprehensive mineralogical, microchemical, and stable isotopic investigations in order to define the genesis of its ore-bearing fluids and metal sources.

The intrusion-related gold deposits (IRGDs) are the most important deposits in the Phanerozoic arc settings which have chalcophile metal-bearing porphyry and non-porphyry types (Sillitoe 1991). Based on the metal association, the porphyry type, which related to calc-alkaline to alkaline, intermediate (diorite–monzonite), and I-type intrusions ranges from Cu–Au to Au only (Sillitoe 1991). On the other hand, the non-porphyry type associated with I-type intrusion enriched in Zn, Pb, and Ag rather than Cu (Sillitoe 1991; Richards and Kerrich 1993). Their gold and metals associated with K-silicate alteration assemblages (Sillitoe 1991) have magmatic source (McInnes and Cameron 1994). The IRGDs and orogenic gold deposits in the Egyptian Eastern Desert are located in the Precambrian basement rocks of the Arabian–Nubian Shield (ANS) (Figure 1) (Botros 2002, 2004; Zoheir *et al*. 2011; Zoheir 2012; Zoheir and Moritz 2014). The gold mineralization is mainly confined to quartz-mineralized shear zones. The faulting and shearing represent the most important host to gold mineralization in Egypt (Klemm *et al*. 2001). Gabra (1986) stated that during the Pharaonic time [New Kingdom times (1550–1070 BC) and Roman and Byzantine times based on the existence of the old mining tools at Atud area (Klemm *et al*. 2001)], the Atud gold deposit was first exploited which is located in the Central Eastern Desert of Egypt. This deposit was re-opened between 1953 and 1969 by the Egyptian Geological Survey and Mining Authorities (EGSMA) (Gabra 1986). EGSMA studied the surface and

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