MITT.ÖSTERR.MINER.GES. 145 (2000)

GEOLOGICAL AND GEOCHEMICAL CONDITIONS FOR THE OCCURRENCE OF GOLD IN DUL AREA; WESTERN ETHIOPIA

by

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Dissertation zur Erlangung des Doktorgrades an der
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Wien, Dezember 1999

Dul is located in western Ethiopia, about 800 km from Addis Ababa and 12 km east of Ethio-Sudan border at 34°20' longitude E and 10°20' latitude N. Dul is a part of the Pan-African Orogenic-Belt and lies within the volcano sedimentary rocks of the Arabo-Nubian Shield (VAIL, 1983). Based on rock types, degree of metamorphism and structure, the Basement rocks of Ethiopia are classified into three major complexes: Lower, Middle and Upper complexes. The Lower Complex rocks are high grade granulite facies and are Pre-Panafrican orogeny. Whereas, the Upper Complex rocks are metamorphosed from greenschist to lower amphibolite facies and are constituted in Pan-African Orogeny (KAZMIN, 1979). The contact between Lower and Upper Complex is structurally controlled. It is along this structure that important mineralization are occurring. Two types of tectonic models were forwarded to explain the structural frame work of the basement rocks of Western Ethiopia. The first is by AMENTI, 1989, which is strike slip transcurrent model and the second one is opening and closing of the sea (KAZMIN, 1979; SENBETO & DE WIT 1981, AYALEW & PICCERRILLO, 1998). The lithogeochemistry of the underlying gabrroic intrusion of Dul area favors opening and closing model.

The main rock types that crop out in Dul area include basic metavolcanic and metasedimetary that are deformed, altered and metamorphosed from greenshcist to lower amphibolite (BUCHER et al., 1994). Though not economic, gold is the main mineralization that was seen on the top of mount Dul, associated with pyrite, chalcopyrite, pyrrohotite, scheelite, monazite and magnetite. Gold in Dul area has got different modes of occurrences. It occurs at different depths and horizons as fracture filling in quartz vein, associated with silicified, carbonitized, sericitized and sulfidized rocks.

Fluid inclusion geothermometry investigation from gold bearing quartz vein indicated homogenization temperature of 345°C. Furthermore, calcite-quartz mineral pair oxygen geothermometry showed a temperature of 380°C. Overlap of these facts reveals that the gold mineralization in Dul area has taken place between the temperature ranging from 300°C - 400°C which is hypothermal conditon of hydrothermal deposit.

Sulfur and carbon isotope geochemistry is useful in indicating the physico-chemical condition and the origin of mineralizing fluid (OHMOTO, 1972). The observed isotopic composition of sulfur in gold bearing pyrite, δS^{34} = + 3.2 ± 0.2 per mil and carbon in calcite, δC^{13} = -5.2 ± 0.0089 per mil, indicate magmatic hydrothermal origin with pH around neutral (pH = 7) and intermediate oxidation state, $\log f_{O2}$ = -37 (OHMOTO, 1972). Gold could be transported in different forms of thio-complexes ($AuHS_2^{-1}$, $Au_2HS_2S^{-2}$, $AuHS^{\circ}$) and precipitation of gold could have taken place due to sulfidation of the wall rock (SEWARD, 1973)

One of the uses of alteration zones is determination of the ages of the associated mineralization (EVANS, 1987). The ^{40}Ar-^{39}Ar ages determined from gold bearing sericitized rocks indicate, 565.1 ± 4.6 ma. This age was taken to be the age of the associated gold mineralization. Biotite samples from underlying altered gabbroic intrusion indicate younger ages of 555.7 ± 3.8 ma. The difference between the two ages (sericite and biotite) which is about 10 ma was interpreted to be the time required by the intrusive body (gabbro/diorite) to cool from 350°C ± 50°C to 250° ± 40°C, which are the closure temperatures of sericite and biotite, respectively (FAURE, 1986) Therefore, based on (1) the association of sericite with gold (2) the homoginization temperature of fluid inclusion (345°C), (3) Oxygen isotope geothermometry, (370–380°C) and (4) mineralogical association of gold, scheelite pyrite, pyrrohotite, calcite, tourmaline, gold mineralization in Dul area has taken place at temperatures ranging between 300–400°C, associated with different alteration zones such as, sericitization, silicification, sulfidation and carbonitization around 565.1 ± 4.6 ma, genetically related to the surrounding gabbroic/dioritic intrusion, with contribution from the surrounding country rock.