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The genesis of fluorite veins in Gabal El Atawi granite, Central Eastern Desert, Egypt

Khairiya M. Fawzy

Geology Department, Faculty of Science, Aswan University, Egypt

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ABSTRACT

Quartz-fluorite-calcite veins were deposited by hydrothermal solutions along structures in Gabal El Atawi granitic pluton. The present investigation aims to study the geochemical characteristics and petrogenesis of Gabal El Atawi fluorite veins. Micro-inclusions data in fluorite veins were obtained and integrated with the available geological, mineralogical and geochemical data to yield information on the genesis of the mineralization as well as the evolution of the mineralizing fluids. Fluid inclusions studies reveal that the fluorite precipitated from saline (up to 22 equiv. wt % NaCl) H_2O–NaCl-$CaCl_2$ solutions at homogenization temperatures (T_h up to 220 °C). The close spatial relationship between fluorite veins and the granitic rocks, the structural control of the veins, the presence of fluorite and tourmaline as accessory minerals in the granite, the high fluorine concentration in the granite, the REE normalized pattern and the formation conditions of fluorite imply a magmatic origin of hydrothermal fluids which formed the fluorite veins. The source of the fluorite veins is the same magma chamber that supplied the granitic magma i. e. co-magmatic. The ore fluids were released as a result of late-stage differentiation, forming fluorite veins along faults and shears.

1. Introduction

Fluorite mineralizations are common as veins cutting the younger granites of Egypt. Numerous geological and geochemical data on the fluorite veins in the Eastern Desert were obtained (e.g. Yonan, 1990; Mohamed and Bishara, 1998; Fawzy, 1994, 1999, 2001; Salem et al., 2001; Fawzy et al., 1993, 1996; Fawzy and Abdel Rahman, 2002; Omar, 2010; Mohamed, 2013; Mahdy et al., 2014; El Hadek et al., 2016).

Gabal El Atawi granitic pluton is located at the eastern part of the Central Eastern Desert of Egypt between latitudes 25° 32′ and 25° 38′ N and longitudes 34° 6′ and 34° 14′ E (Fig. 1). It is occurring ≈45 km to the west of Quseir-Marsa Alam asphaltic road. El Atawi granitic pluton is roughly oval shaped elongated in the ENE direction with 5 × 9 km^2 and dissected by Wadi El Miyah.

Several studies have been carried out on El Atawi area (Ragab, 1971; Hashad et al., 1972; Sabet et al., 1975; El Manharawy, 1977; Meneisy and Lenz, 1982; Yonan, 1990; Fasfous et al., 1992; Obeid, 1996; Sadek, 2007; Salman, 2014; Fawzy, 2017).

El Atawi area is covered, from oldest to youngest, by serpentinite and talc-carbonates, metasediments, metavolcanics, older granites, Hammamat Group, younger granites, post granite dykes, trachytes and veins. Quartz-fluorite-calcite veins are cutting the western part of the younger granite mass.

Fluid inclusions in minerals are tiny blebs of fluid, usually <50 μm, that found trapped within single crystals. They are considered the direct evidence for the pressure, temperature, density and composition of the mineral-forming fluids. Their study provides important tools for understanding the genesis of hydrothermal mineral deposits (Roedder, 1984; Roedder and Bodnar, 1997; Robb, 2005; Pirajno, 2009). One of the advantages bestowed on workers in the hydrothermal ore deposits is that veins commonly record a series of stages of mineral growth, the sequence of which or paragenesis, can be resolved utilizing careful microscope petrography (Wilkinson, 2001). The relative timing of the types of fluid inclusions in relation to stages of mineralizations may be established by taking into account the petrographic and microthermometric data (Beurlen et al., 2001).

The present investigation aims to study the geochemical characteristics, petrogenesis of Gabal El Atawi fluorite veins. Micro-inclusions data in fluorite veins were obtained and integrated with the available geological, mineralogical and geochemical data to yield information on the genesis of the mineralization as well as

E-mail address: fawzik20@gmail.com.

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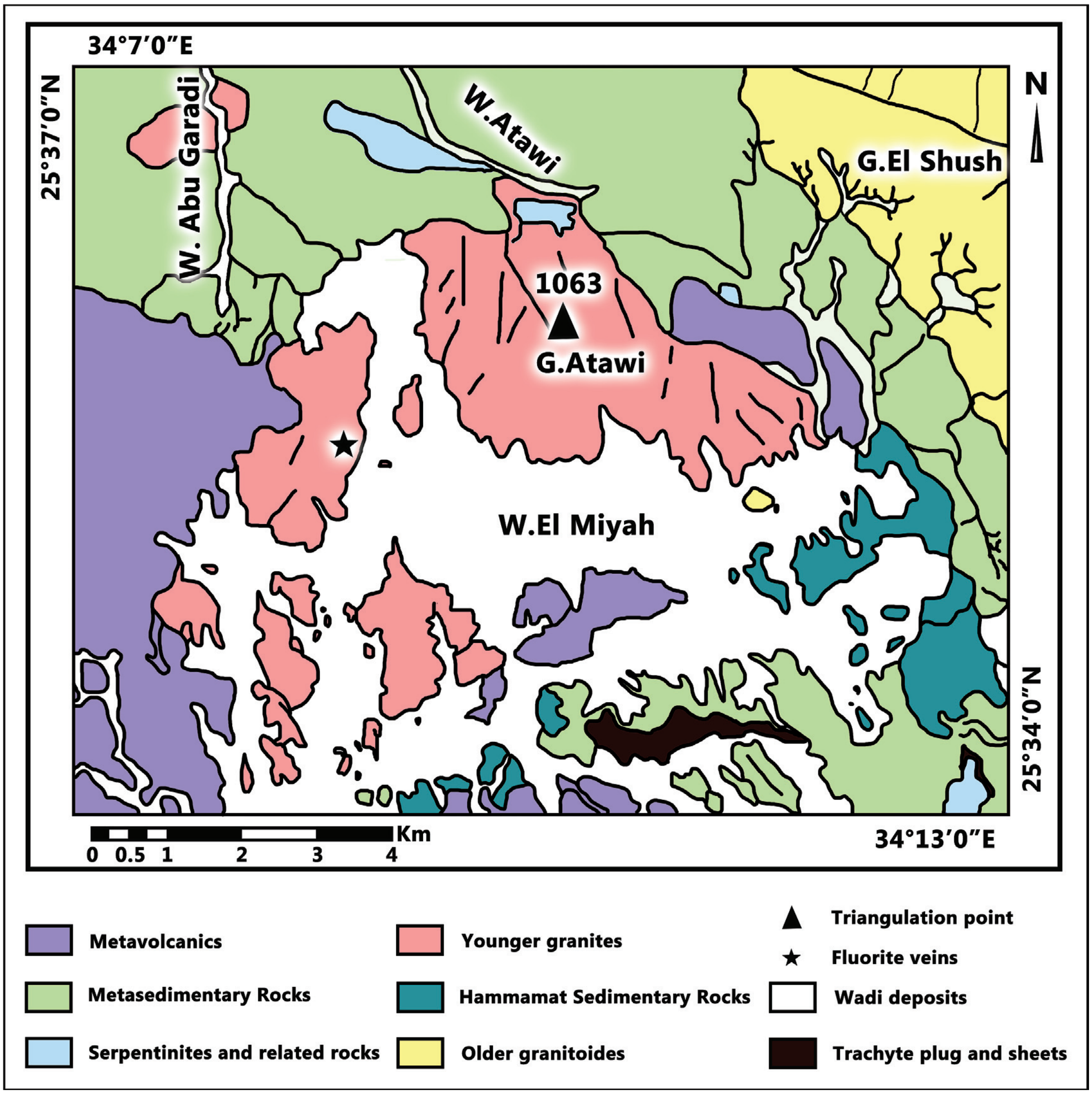

Fig. 1. Geological map of Gabal El Atawi (G. Atawi) area (after Obeid, 1996).

the evolution of the mineralizing fluids.

2. Geologic setting

The younger granites occur as highly elevated lensoidal mass intruding the meta-sedimentary and metabasalts in the central part of mapped area. They are medium to coarse-grained with light pink color. They display sharp intrusive contacts with the country rocks.

The younger granites are traversed by a group of faults trending mainly NW and NE and crossed by several post granite basic, intermediate and acidic dykes exhibiting various lengths and thickness trending in the NW-SE and E-W directions. Quartz-fluorite-calcite veins trending N-S and dipping $\approx 80^\circ$ to the east are cutting the western part of the younger granite mass (Fig. 1). They represent fissure fillings developed mainly along the fault planes. The main fluorite vein is about 30 m long and 1 m thick. The vein is crustified where fluorite and calcite form layers occupying the central parts while quartz occupies the borders of the vein. The fluorite forms coarse-grained cubic crystals and grades in color from honey to green while calcite is black. The veins contain brecciated quartz and wall rock fragments. Fluorite also forms intersected veinlets forming stockwork up to 8 m width as well as disseminated crystals in the wall zone. An alteration zone associating the main vein is represented by very friable highly altered greenish white kaolinitic rock. The alteration gradually fades away from the vein passing to slightly altered granite still preserving its original texture. The most characteristic alteration processes affecting the G. El Atawi younger granites are kaolinization, sericitization and chloritization.

3. Methodology

Bed rock samples from the vein fluorite, the altered granite close to the vein as well as the unaltered granite away from the vein were collected. Representative samples were selected for petrographic, chemical analysis and micro inclusions studies. The bulk samples were chemically analyzed for major oxides, trace elements and REE. The analysis was done using the XRF Philips PW2400 X-ray fluorescence spectrometer. Trace elements analysis was conducted on the Pressed powder whereas fused samples used for the major elements. The REEs were determined by inductively coupled plasma