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Mineralogical Studies and Mineral Chemistry of some Radioactive Mineralizations in Gabal Gattar Area, Northern Eastern Desert, Egypt

A THESIS

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BY

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درجة الماجستير في العلوم (جيولوجيا)

مقدمة من
ناصر مراد مهدي
بكالوريوس العلوم (جيولوجيا و كيمياء)

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ABSTRACT

Gabal Gattar area is bounded by latitudes 26° 52' and 27° 08' N and longitudes 33° 13' and 33° 26' E. It is located to the west of Hurghada town by about 35 kms. All the radioactive occurrences located in its northern parts.

The G. Gattar area is covered by younger granites, metavolcanics, Hammamat sedimentary rocks and older granites. Younger granite is classified into three phases namely, G1, G2 and G3 from older to younger. Two types of structurally controlled ore are known in Gattar area; the uranium-fluorite and molybdenum-bismuth-silver ores. Only information relevant to the distribution and localization of the uranium-fluorite mineralizations are presented here.

The uranium-fluorite (U-F) mineralizations are confined to the margin of the nearly circular-shaped G3 phase where they are controlled by two conjugate fault systems represented by sinistral NNE-SSW faults and the dextral NW-SE faults. Along the faults and sheared planes, the granite is strongly brecciated and fractured. Its colors changes from pink or slightly red to dark or reddish brown.

On a small scale, the U-F mineralizations form centimeter-size steaks, spots and small veinlets in highly jointed granite. In vicinity of these U-F forms, the host granite is strongly affected by hematitization, episyenitization, kaolinitization, fluoritization, and silisification. The size and frequency of uranium-fluorite spots and veinlets correlate positively with the intensity of alteration.

Petrographically, the unmineralized fresh Gattar granite is coarse to medium grained. It exhibits hypidiomorphic equigranular texture, porphyritic and poikilitic textures are also common. Essential minerals comprise K-feldspars (perthites and antiperthites), quartz, plagioclase and biotite. Muscovite, fluorite, calcite and iron oxides (opaque minerals) are minor phases, while zircon and monazite are accessory minerals. Some varieties are mainly composed of perthite and quartz with rare or no plagioclase and ferromagnesian minerals.

In the altered mineralized granite, K-feldspar is highly sericitized and kaolinitized. Due to deformation, quartz grains may show marginal granulation (cataclasses) resulting in a reduction in grain size. Plagioclases occur as scarce interstitial grains. Biotite is very rare or absent. Muscovite occurs as euhedral crystals with iron oxides filling the cleavages planes which may suggest its secondary origin after biotite. Phlogopite is found only in the altered mineralized granite and it is present as elongated or bird eye crystals occupying the interstitial spaces between the other essential minerals. Traces of fluorite grains are interstitial to silicates where their faces are controlled by the surrounding minerals. Zircon is commonly zoned and contains appreciable amounts of uranium. Fluorite occurs in three textural positions: a) as veinlets intersecting between the perthite – quartz groundmass, b) small irregular crystals along the cracks in feldspars, and c) filling cracks and cavities in the host granites. In all these texture, fluorite is commonly unzoned and associated with uranium- and uranium-bearing minerals and iron oxides.

Four phases of uranium minerals were identified by SEM technique, XRD and electron microprobe analyses (EMPA); pitchblende, beta-uranophane, uranophane and kasolite. The U-minerals form large masses, yellow in color, and form a groundmass hosting fluorite and other minerals.

The mineralogical studies and the mineral chemistry revealed that circulation of hydrothermal solutions or fluids produces physico-chemical changes in Gattar granite through which they circulate. This is what is commonly referred to as hydrothermal alteration. These fluids set off chemical reactions, which tend to approach equilibrium through processes of dissolution and precipitation of new mineral assemblages.

The geochemistry (major, trace and rare-earth elements) of fluorite from Gabal Gattar area pointed out that Y/Y*, Ce/Ce* and Eu/Eu* relation patterns show that fluorite clearly records the compositional evolution of the hydrothermal solutions that transported the trace (including U)and REE from the host granite during the fluid-wall rocks interaction in weakly oxidized or reduced conditions.

The above studies and radioactive analyses of Gabal Gattar granite clarified that Gattar granite is rich in uranium because it includes U content more than twice that of the Clark value, accessory mineral bearing uranium such as zircon, uranium minerals and deposition of ore in veins and lenses along shear zones. Consequently, uranium and hydrothermal solutions could not have originated directly from a granite magma differentiation. The source of the uranium must have derived from the consolidated granite itself. The granite acted as a uranium reservoir and uranium underwent double preconcentration with subsequent mobilization. The first preconcecntration of uranium took place during the crystallization of basement rocks with the uranium content increasing, the second during multistage magmatic reworking and differentiation, the uranium content increasing. Then the uranium-rich granite underwent tectono-hydrothermal processes. These alteration processes are mostly responsible for uranium concentration and its redistribution. The mineralizing solutions may be uranium bearing of hypogene and supergene origin fluids which percolate on the granites and leach of uranium. Then, mobilization of uranium within the granite, and deposition of uranium and fluorite mineralizations along the fractures where the planes of these structures provided easy channels for the passage of uranium-bearing solutions and suitable structural trap for uranium accumulations.

CONTENTS

LIST OF FIGURES Page

LIST OF TABLES Page

CHAPTER 1
INTRODUCTION

1.1. General statement

The initiation of the Egyptian nuclear program to produce electrical energy requires big reserve of radioactive raw materials, especially uranium minerals. Most of the basement rocks of Egypt, especially the Younger Granites, are favorable host rocks for uranium mineralizations and notably show higher level of radioactivity. Most of uranium mineralization is structurally controlled, restricted to sheared and fractured zones, and mostly associated with fluorite and iron oxides, e.g. Gabal EL Erediya (El Kassas, 1974), Gabal EL Bakriya (El Amin, 1975), Gabal EL Missikat (Bakhit, 1975), Gabal Um Ara (Abdel Meguid, 1986) and Gabal Gattar (Salman et al., 1986; Roz, 1994; Shalaby, 1995; Moharem, 1997; Esmail, 2002 and Hammoda, 2003). Accordingly, these granites were regarded as a good target for uranium exploration. In the light of such concept, Gabal Gattar at the northern Eastern Desert was chosen as a target area for intensive prospecting, as it is considered the type locality of the Gattarian (younger) granite in Egypt. Most of the radioactive occurrences are located in its northern part.

1.2. Location, accessibility and climate

The area of Gabal Gattar is located in the northern Eastern Desert to the west of Hurghada town by about 35 Kms. It is delineated by latitudes 26° 52' and 27° 08' N and longitudes 33° 13' and 33° 26' E (Fig. 1.1).

Gabal Gattar represents the extreme northeastern part of a pink granite batholith, which is characterized by mild to rough topography and comprises besides Gabal Gattar (1963 m), Gabal Um Dissi (1556 m), Gabal Kehla (1882 m), Gabal Thelma (1733 m), Gabal Abu El Hassan (1550 m), Gabal Abu El Hassan El Ahmar (1234 m) and Gabal Abu Samyuk (1750 m) (Fig. 1.2).

The area of study is traversed by two major wadis trending ENE-