Ain Shams University
Faculty of Science
Geology Department
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A genetic model for Molybdenum and Uranium Mineralizations in Gabal Gattar Granite, Northern Eastern Desert, Egypt

A THESIS

SUBMITTED FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY IN SCIENCE (GEOLOGY)

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To
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2015

APPROVAL SHEET

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Thesis title: A genetic model for Molybdenum and Uranium Mineralizations in Gabal Gattar Granite, Northern Eastern Desert, Egypt.

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Acknowledgment

I wish to express my gratitude to Prof. Dr. Baher A. El Kalioubi, Professor of geology, Geology Depart., Faculty of Science, Ain Shams University, for his kind supervision and critical comments of the manuscript.

My deepest gratitude to Prof. Dr. Mahmoud H. Shalaby, Professor of geology, Nuclear Materials Authority, for planning the work, valuable advices, and reviewing the manuscript.

Special thanks to Prof. Dr. Adel Hassan El-Afandy, Professor of geology, Nuclear Materials Authority, for proposing the present point of research, fruitful discussions and critical comments of the manuscript.

I'm very grateful to Dr. Ehab Korany, Assoc. Professor of petrology, Dr. Mohammed El Dabe, and Dr. Hosam A. Khamis, Nuclear Materials Authority for their help in the field work and petrography, continuous encouragements and advices.

I'm also delighted to express my deep gratitude and thanks to Prof. Dr. Victoria Pease, Professor of magmatism and tectonism, and Head of Petro Tectonics Facility, Stockholm University, Sweden, for her support in finishing the required work in analyzing zircon and reviewing of the manuscript. I am also very grateful to Prof. Dr. Cora C. Wohlgemuth-Ueberwasser, Professor of ore deposits and Head of LA-ICP-MS laboratory, Geochemistry Depart., Petro Tectonics Facility, Stockholm University, Sweden, for her co-supervising of the first part of this thesis and valuable discussion.

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ABSTRACT

Gattar batholith (Latitudes 26° 52' and 27° 08' N and Longitudes 33° 13' and 33° 26' E) in the north Eastern Desert of Egypt as part of the northern region of the Arabian-Nubian Shield (ANS) is geographically, mineralogically and geochemically divided into two distinctive areas. The southern part, mainly consists of syenogranite, while the northern part is dominated by highly evolved alkali-feldspar granite. Uranium and Mo mineralization occurring here is mostly limited to the margin of the highly evolved alkali-feldspar granites. New U-Pb zircon geochronology within this study indicates an age of ~ 620-600 Ma, although high common Pb and discordant age data of many zircon grains reflect alteration by F-rich fluids. Some zircons with distinct older U/Pb ages were considered to be inherited from the wallrocks representing juvenile crust of the ANS. The two different granitic masses are comagmatic in origin and have A-type characteristics generated by partial melting of lower juvenile crust of the ANS. Geochemical data are in good agreement with a magmatic origin of the alkali-feldspar granites, suggesting fractional crystallization of a syenogranitic source as the most favorable process of their formation.

From field relations, petrography, mineral chemistry, U-Pb zircon geochronology, and geochemistry of whole rocks and individual deposits of the Gattar granites, a simple scenario of magma emplacement can be constrained. The sequence of events can be interpreted as follows; 1) fractional crystallization of a magma at depth (syenogranite magma), with enrichment of Mo and U in the residual melts (alkali-feldspar magma), 2) a highly evolved, marginal border phase (G. Gattar granite) developed in the apical parts of the granite after the emplacement, 3) the subsequent development of ore-bearing magma is controlled by fluid differentiation during magma crystallization related to the appearance of a fluid phase and fluid saturation leading to the build-up of hydrostatic pressure. Brecciation occurred as a result of overpressure and tectonism, 4) fluids started to exsolve in equilibrium after tectonism, and 5) the volatiles accumulate in the carapace zone as bubbles causing structurally weakness of the host rocks, which becomes fragile and vulnerable to be fractured and brecciated by any later tectonism or hydrofracturing, leading to the formation of ore deposits.

North of the Gattar batholith including Gattar granite and Hammamat Sedimentary Rocks (HSR) is a considerable place for studying hydrothermal ore system. Gattar granite (A-type character) hosts the U and Mo mineralization, while the HSR rock hosts the Cu mineralization. Although, the three types of deposits are spatially close, structurally controlled and influenced by the same tectonism affected on the area, they are not interlaced and form isolated occurrences. The northern part of the Gattar batholith hosts a numerous shear zones containing all the U and Mo occurrences of the Gattar prospect. These shear zones cut the HSR rocks and contain Cu-mineralization.

The variation of salinity, and alterations related to the Mo and U mineralization of the Gattar granite may indicate that the U- and Mo-bearing fluids were a single phase at magmatic conditions, and then separated into two diverse phases (F-rich acidic for U and F-poor alkaline for Mo) once the solidus has been reached. After fracuring and influx of high input of meteoric waters, the Mo- and U- complexes started to dissociate as a result of alleviating the pressure (depressurization), increasing fO_2 (oxidation state) and decreasing temperature (cooling) resulting in the precipitation of Mo and U deposits. Resurgent magma developed a volatile-rich carapase which produced various textural, geochemical and mineralogical features as a function of the timing and extent of volatiles escape due to degassing and fracturing, as well as later fluid-rock interactions. The volatile components and ore metals could have occurred together within closed vesiculation (bubbling), the bubbles were not interconnected, and hence no extensive permeability resulted. Cu mineralization is important example for reworking deposits formed by leaching of the host HSR rocks as a result of injection of the Gattar granitic magma (advective heat supply) into the HSR rocks and tectonism, as well as high input of meteoric water.

CONTENTS

LIST OF FIGURES Page