



**A genetic model for Molybdenum and
Uranium Mineralizations in Gabal Gattar
Granite, Northern Eastern Desert, Egypt**

A THESIS

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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 structural 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 fracturing 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

Abstract	I
List of Figures	V
List of Tables	XIII
 Chapter I Introduction	 1
1.1. Uranium as a fuel for future	1
1.2. Location, accessibility and climate	3
1.3. Uranium definition, mineralogy and deposits	5
1.4. Uranium specification and uses	8
1.5. Uranium world resources and production	9
1.6. Uranium deposits in Egypt	10
1.7. Previous literatures on the study area	14
1.8. Aims of the study	19
1.9. Methodology	22
 Chapter II Geological setting and petrography of granitic rocks	 26
2.1. Regional geology of the Arabian Nubian Shield	26
2.2. Field relations and rock types	29
2.2.1. Gattar batholith country rocks	32
2.2.2. Acidic and basic dikes	36
2.3. Gattar younger granites (field features and structure framework)	39
2.4. Petrography of the Gattar younger granites	44
 Chapter III Geochronology of the Gattar granites	 50
3.1. Importance of zircon as a petrogenetic key	50
3.2. Zircon petrography	56
3.3. Zircon typology and alteration	57
3.4. U-Th zircon ages of the Gattar granites	65
 Chapter IV Petrogenesis of U- and Mo-bearing granite	 71
4.1. Objectives	71
4.2. Major oxides, trace- and REE-elements composition	73
4.3. A-type granite and tectonic setting signatures	83
4.4. Fluorine content and REE tetrad effect	86
4.5. Petrogenesis	90
4.5.1. Genetic linkage between the two types of granite	90
4.5.2. Provenance of A-type granite magmas of the Gattar batholith	95
4.6. Parameters controlling the location of ore bodies	96
4.6.1. U-constraints	96

4.6.2. Mo-constraints	101
4.7. Implications for the mode of emplacement	102
Chapter V Ore geology and mineralogy	108
5.1. Structural controlling on the ore deposits	108
5.2. Hydrothermal alteration and mineralization	109
5.2.1. Uranium mineralization	109
5.2.2. Molybdenum mineralization	117
5.2.3 Copper mineralization	127
Chapter VI Characteristics of hydrothermal ore system	132
6.1. Major oxides, trace and REE geochemistry of the ore deposits	133
6.2. Source of the ore fluid	139
6.3. Distribution behaviors of F and Cl in the melt and aqueous fluid	142
6.4. Characteristics and evolution of ore-forming fluids	145
Chapter VII Genetic model of the U and Mo mineralization	153
References.....	160
Arabic Summary.....	

LIST OF FIGURES

Page

Figure 1.1: Landsat image showing the location and desert road passing through Wadi Balih at about 14 kms north of Hurghada town along Hurghada-Cairo asphaltic road to the Gattar batholith.....	4
Figure 1.2: Location map and Landsat image of the Gattar batholith showing the prospect area and the main shear zone entrapment the mineralization.....	5
Figure 1.3: (a) Geological sketch map of NE Africa showing the juvenile Arabian Nubian Shield (ANS), the Saharan Metacraton, and Archean and Paleoproterozoic crust that was mostly remobilized during the Neoproterozoic. (b) Geological map of the Arabian Nubian Shield showing the main mineralized granitic plutons including the studied Gattar batholith, modified from Johnson and Woldehaimanot (2003) and Küster (2009).....	12
Figure 2.1: Model shows the East African Orogeny sandwiched between East and West Gondwana (after Abdelsalam et al., 2008).	27
Figure 2.2: (a) Map of the Arabian-Nubian Shield (ANS) modified after Stern et al. (2006), showing the location of the Eastern Desert of Egypt and regions where pre-Neoproterozoic crust is found. (b) Generalized map of the Eastern Desert, showing the distribution of lithologies, tectonic boundary, U fertile granites and the Gattar granite location modified after Stern and Hedge (1985).....	29
Figure 2.3: Geological map of the Gattar batholith, showing dissimilar granitic phases and surrounding rocks, general structural framework affecting on the batholith and the occurrences of ore deposits at the northern part of the batholith.....	31
Figure 2.4: Field photographs showing. (a) G. Khela (metavolcanics) as a roof pendant covering the red granite type, (b) Red granite sends offshoot into metavolcanics, (c) Roof pendant dipping gently inward the pink granite along W. El Ghoza, and (d) Gattar granites have a higher geographical heights compared to the country rocks.....	34
Figure 2.5: Field photographs explaining. (a) The acidic dike cuts the arc granitoids at the east of the batholith, (b) Red granite sends offshoot into the HSR rocks at the contact, (c) Contact between the HSR rocks and Gattar granite at the northern part of the Gattar batholith through local reverse fault, and (d) Gattar granite hosts xenolith of the HSR rocks with hand size.....	35
Figure 2.6: Field photographs showing. (a) Acidic dike cuts the HSR rocks and stopped in front of the Gattar granite without extension, (b) Huge pegmatite body hosted by pink granite along W. El Ghoza, (c) Swarms of aplite dikes cut the pink granite along W. El Ghoza, arrange parallel and	

extend for few kilometers, and (d) close up view of the aplite dike in the last photograph.....	37
Figure 2.7: Field photographs illuminate. (a) Swarms of basic dikes cut the pink granite along W. El Ghoza, (b) Close up view of basic dike with deep trench and containing fragments and mega-xenoliths of granite during the intrusion.....	39
Figure 2.8: Field photographs show the morphology of granitic phases of the Gattar batholith. (a) Light pink granites with smooth topography and having coarser-grained size; note that the granite looks unaltered and massive, (b) pink granites having coarser-grained size and hosted aplite dike displaced by fault that filled later by quartz veins; note that the granite is slightly altered, (c) Red granite with higher geographical height and showing massive emplacement; note that red granite is silicified and with medium-grained size.....	41
Figure 2.9: Field photographs show the tectonism and shearing affected the granites. (a) Huge granitic shear zone along W. El Ghoza between the red and pink granite and distinctive feature of shearing distinguishing the Gattar granite from the country rocks, (b) Close up view of shear zone, (c) Close up view of shear zone that displaced the main shearing zone along W. El Ghoza.....	43
Figure 2.10: Ternary diagram of modal quartz (Q), alkali feldspar (A), and plagioclase (P) for the studied granite (diagram after Streckeisen, 1976).....	44
Figure 2.11: Textural features of syenogranite (a, b, c), and alkali feldspar granite (d, e, f, g, h, i) of Gattar batholith. a) Zoned crystal of plagioclase with perfect twining, b) Allanite associated with chlorite replacing biotite, c) Assembling of apatite and biotite indicated that they are genetically contemporaneous, d) Anhedral crystal of quartz containing laths of albite and perthite, e) Rounded coarse-grained quartz (resembling snowball texture), note: perthite occurs as interstitial spaces indicated that quartz is present over the other rock-forming minerals , f) Perthite engulfed in quartz, note: quartz containing euhedral crystal of muscovite and zircon with overgrowth, g) zoned hexagonal crystal of quartz, h) Bending of plagioclase rim because of loaded pressure or dragging caused by compression at onset of shearing, note: uranium (insert) mobilized in the developing spaces after extension, and i) Splitting and movement of feldspar crystal next to the quartz vein filling the fissures after shearing process. Abbreviations, Chlorite (Cl), Iron oxides (Ir), Allanite. (Al), Biotite (Bi), Apatite (Ap), Perthite (Pr), Quartz (Qr). Albite (Ab), Plagioclase (Pl), Muscovite (Mu), Zircon (Zr).....	48
Figure 2.12: Secondary mineral selvages that marked the various types of granitic phases of the batholith, a) Fan-shaped muscovite associated with quartz, b) Muscovite produced by hydrolysis of perthite with cracks as a	

passway and trap for hydrothermal solutions that later caused its transformation into muscovite, **c)** Saussuritization of plagioclase, **d)** Muscovite commutating biotite, and **e)** Chlorite replacing biotite..... 49

Figure 3.1: Different growths, sizes and types of zircons for the Gattar granites, **a)** Highly metamict, short prismatic zircon surrounded by pleochroic halo, **b)** Metamict zircon circled by uranium mineralization, **c)** Two metamict zircons show pleochroic halo and glowing zone (thermo luminescence) due to exogenic effects of uranium, **d)** Two types of zircons associated with each other, one is unmetamict and zoned, and the another is metamict, **e)** Cluster of zircons interlaced with iron oxides, and **f)** Overgrowth in zircon included at the edge between quartz and feldspars... 58

Figure 3.2: Cathodoluminescence (CL) images of zircons selected for dating show dark colors due to radiation damage caused by high U and Th contents, they also show obliterated or faint oscillatory zoning..... 60

Figure 3.3: Cathodoluminescence (CL) images of altered zircons show dark colors due to radiation damage caused by higher U and Th contents, they also show obliterated or with no internal zoning. Note: these zircons are with cracks as pathways for solutions, and contain altered domains and have randomly or feathery internal zonings..... 61

Figure 3.4: Plot of U vs. Th based on Hoskin and Schaltegger (2003), clarifies that most of dated zircons are magmatic. It also shows that discordance is mostly owing to the integration between late F-rich fluids and metamictization factors, and not because of zircon type (hydrothermal or magmatic)..... 63

Figure 3.5: Backscattered electron image (BSE) and spectrum of U-rich zircon has much brighter altered zone on its broken rims; green tracing line represents the peripheries of broken altered parts of zircon, dashed blue tracing line represents trace parts of metamict zircon that altered later on its rims (after Mahdy, 2011)..... 64

Figure 3.6: Tera-Wasserburg Concordia diagram for the Gattar granites (samples N7 and G7). Error ellipses are 2σ ; weighted average age errors quoted at 95% confidence. Analytical data are given in Table (3.1)..... 69

Figure 3.7: Frequency plots of dated zircons for the Gattar granites show that peak age or period (600-650 Ma) is more significant as a geological event for the Gattar granite intrusions..... 70

Figure 4.1: Chemical classification diagrams for the studied granites of the Gattar batholith. **(a)** $K_2O + Na_2O$ vs. SiO_2 diagram (Middlemost, 1994), σ is a Rittmann index, defined as $(K_2O + Na_2O)^2 / (SiO_2 - 43)$, **(b)** R1-R2 multicationic classification diagram (De la Roche et al., 1980). Blue diamond (syenogranite), green triangle (alkali feldspar granite)..... 79

Figure 4.2: Plots of **(a)** K_2O vs. Na_2O , **(b)** K_2O vs. SiO_2 diagram with field after Rickwood (1989), and Ewart (1982), **(c)** major element classification

diagram for granitoids ($\text{SiO}_2 > 68\%$), after Sylvester (1989), (d) SiO_2 vs Al [(Na + K)/Al] classification diagram, after Liégeois and Black (1987) for the granites of the Gattar batholith. Symbols as in Fig. 4.1..... 80

Figure 4.3: Plots of (a) A/NK (molar $\text{Al}_2\text{O}_3/(\text{Na}_2\text{O} + \text{K}_2\text{O})$) vs. A/CNK (molar $\text{Al}_2\text{O}_3/(\text{CaO} + \text{Na}_2\text{O} + \text{K}_2\text{O})$) (Maniar and Piccoli, 1989), (b) Zr vs. Th diagram with field after Küster (2009) for the Gattar granites. Symbols as in Fig. 4.1..... 81

Figure 4.4: Trace and REE element data for the samples of granitic phases of the Gattar batholith, plotted as: (a) Rare earth element (REE) patterns of syenogranite and alkali-feldspar granite with M-type tetrad effect, (b) REE patterns for chlorite mineral, barren and mineralized zones from alkali feldspar granite show similar M-type tetrad effect in all segments, (c) REE patterns data for syenogranite and alkali feldspar granites of Katharina pluton after Katzir et al. (2007) for comparison, (d) Primitive mantle normalized trace element diagram for Gattar granites. Normalization values of chondrite and primitive mantle are from Sun and McDonough (1989). Symbols as in Fig. 4.1..... 82

Figure 4.5: Plots of (a) $\text{Na}_2\text{O} + \text{K}_2\text{O}$, and (b) Zr vs. 10,000 Ga/Al discrimination diagrams of Whalen et al. (1987), (c) Rb vs. (Y+Nb) diagram with post-collisional field after Pearce (1996) and A-type granite field after Whalen et al., (1987), and (d) Nb vs. Y diagram with field of A-type granite after Stern and Gottfried., (1989), for the Gattar granites, the last two tectonic discrimination diagrams adopted by Pearce et al., (1984). VAG—volcanic arc granites; ORG—ocean ridge granites; WPG—within-plate granites; Syn-COLG—syn-collision granites; Post-COLG—post-collision granites. Symbols as in Fig. 4.1..... 84

Figure 4.6: (a) Nb–Y–Ce, (b) Nb–Y–3Ga and (c) Rb/Nb–Y/Nb classification diagrams (Eby, 1990, 1992) for the Gattar granites. Symbols are the same as in Fig. 4.1..... 86

Figure 4.7: Plots of (a) Y/Ho vs. Zr/Hf binary diagram with CHARAC field after Bau (1996); (b) K/Ba vs. K/Rb with common range of granite field after Jahn et al. (2001); (c), (d) variation of some key elemental ratios (K/Ba, K/Rb) as a function of the tetrad degree (TE_1 (degree of tetrad effect) of Irber (1999), TE_1 is defined as $(\text{Ce}/\text{Ce}^* \times \text{Pr}/\text{Pr}^*)^{0.5}$, $\text{Ce}/\text{Ce}^* = \text{Ce}_N/(\text{La}_N^{2/3} \times \text{Nd}_N^{1/3})$, $\text{Pr}/\text{Pr}^* = \text{Pr}_N/(\text{La}_N^{1/3} \times \text{Nd}_N^{2/3})$, and is the deviation of the first tetrad (La–Nd) from the smooth connecting line of La and Nd, the fields of common range of granitoids and continental rocks after Jahn et al. (2001), Grey bands refer only to the elemental ratios but not TE_1 , the straight line marks the chondritic value, and the dashed line defines the boundary to clearly visible tetrad effects ($\text{TE}_1 > 1.10$) after Irber (1999); (e) Yb vs. K/Rb diagram for two granitic phases of the Gattar batholith. Symbols as in Fig. 4.1..... 88

Figure 4.8: Al_2O_3 vs. SiO_2 , CaO vs. SiO_2 , Na_2O vs. SiO_2 , Rb vs. SiO_2 , K_2O vs. SiO_2 , K/Rb vs. Rb , Rb/Sr vs. Sr , Y vs. SiO_2 , Nb vs. SiO_2 diagrams for the granites of the Gattar batholith. The diagrams present regular variations as an evidence of the dominant role of fractional crystallization in the evolution of the studied granite magma. Symbols as in Fig. 4.1.....	91
Figure 4.9: (a) $(\text{La/Yb})_{\text{N}}$ vs La (ppm) diagram with fractionation trends for the accessory minerals, (b) Trace element modeling for the petrogenesis of the two granitic varieties of the Gattar batholith. Sample no. (3) is assumed to be the initial melt. Tick marks in fractionation trends indicate percentage of mineral assemblage removed, by 10 intervals. Distribution coefficients of Sr and Ba are from Rollinson (1993). Symbols as in Fig. 4.1.....	94
Figure 4.10: Plots of (a) Zr/U vs. U , (b) Ce/U vs. U , (c) Zr/Th vs. Th , (d) Ce/Th vs. Th , (e) U/Th vs. U , (f) Th vs. U for the Gattar granitic phases. It is notable that the role of magmatic and fluid fractionation leading to enrichment of uranium in the exsolved fluids from the syenogranite to the highly evolved alkali feldspar granite is greatly required. Symbols as in Fig. 4.1.....	98
Figure 4.11: (a) Comparison of zircon-saturation temperatures calculated with calibrations of Watson and Harrison (1983) ($T_{\text{Zircon83}} = 12900/(2.95 + 0.85 \times M + \ln D^{\text{zircon/melt}})$) and Boehnke et al. (2013) ($T_{\text{Zircon13}} = 10108/(0.32 + 1.16 \times M + \ln D^{\text{zircon/melt}})$), whereas, M (cations ratios) = $(\text{Na} + \text{K} + 2 \times \text{Ca})/(\text{Al} \times \text{Si})$, (b) Plot of M against Zr with zircon saturation temperature line (Yang et al., 2013) for the Gattar granites. The temperature diagrams show that the syenogranite is generally higher in temperature than the alkali feldspar granite. Symbols as in Fig.4.1.....	100
Figure 4.12: Plots of (a) $\text{FeO}^{\text{I}}/(\text{FeO}^{\text{I}} + \text{MgO})$ vs. SiO_2 (Frost et al., 2001), (b) Rb/Sr vs. $\text{Fe}_2\text{O}_3/\text{FeO}$ and (c) $\text{Fe}_2\text{O}_3/\text{FeO}$ vs. SiO_2 (Wu et al., 2014) diagrams for the Gattar granites clarify its favorability to form the Mo-deposits. Symbols as in Fig. 4.1.....	103
Figure 4.13: a) Schematic diagram showing the probable accretion style, mechanism of outward building and exsolution of magmatic fluids during the emplacement of Gattar magma, b) 3D representation illustrating the structural relationships controlling ore deposits, most of the mineralization occurs at the north portion of the batholith controlled by strike-slip fault system associated with generation of pull-apart like structures at the uppermost of granite.....	107
Figure 5.1: Geological and structural map of ore prospect area (Gabal Gattar granite and HSR rock) at the northern part of the Gattar batholith explaining the structural control on the mineralization modified after Mahdy et al. (2014).....	110
Figure 5.2: Close up view of the host Gattar granite (a), U mineralized granite (b), Mo mineralized granite (c), and desilicified granite (d), shows distinct color and morphology between the fresh and altered granites	