CHAPTER SIX

VI . SUMMARY AND CONCLUSIONS

This work was carried out to study the geology, structure and radioactivity on both surface and in subsurface levels of G-II uranium occurrence, together with detailed studies on some mineralized zones. The various possible geological and structural factors controlling the distribution of uranium mineralization and affecting its localization are highlighted through the various phases of the present work.

G. Qattar batholith represents the type locality of the younger granite in Egypt. The granite of G. Qattar acquired more interest due to hosting uranium mineralization in more than ten occurrences, namely: G-I, G-II, G-III, G-IV, G-V ...etc

This study deals with G-II uranium occurrence. This occurrence is one of the most important and promising occurrence in the northwestern parts of the batholith. It is situated along a southern tributary of W. Balih and north of G-I uranium occurrence. G-II occurrence is approximately determined by the intersection of latitude 27^0 5' 30"N and longitude 33^0 17' 5" E. It is a small triangular hill of granite bounded by two major faults, striking $N12^0E$ and $N55^0$ W. It is of moderate height, reaches about 720 m above sea level.

Exploratory mining works were performed in two locations in G-II uranium occurrence; one at the western side, namely the western tunnel and the second at the eastern side, namely the eastern tunnel.

The western tunnel (T_2) consists of a main adit, a drift and four crosscuts. The eastern tunnel (T_1) is composed of a main adit and two drifts. The aim of the exploratory mining works is to follow the surface mineralized zones in deeper levels at the subsurface, to prove the continuation of the mineralization and to strike any blind mineralized body.

Detailed geological, structural and radiometrical mapping for the surface uranium mineralized zones of G-II uranium occurrence were constructed, to facilitate the following up these uranium mineralized zones in depth and for comparing the intensity of the mineralization and their uranium content between surface and subsurface as well as to follow up any other features associated to the uranium mineralizations .

The granite of this area, in hand specimens, is pink to reddish pink in color, medium to coarse grained. The studied Qattar granite can be classified as alkali feldspar granite composed of perthite, quartz, minor amount of fine albite laths and biotite as essential minerals while zircon, muscovite, fluorite, iron oxides and opaques are accessories. Chlorite, kaolinite and sericite are secondary minerals. The opaque minerals are mainly represented by hematite and magnetite. The granite of G-II uranium occurrence could be classified as hypersolvus granite.

Hydrothermal alteration features affecting the granite of G-II uranium occurrence either on surface or subsurface, are mainly represented by reddish to brown hematitization, silicification, kaolinitization, fluoritization, and spotty or dendritic manganese oxides.

G-II uranium occurrence is dissected by different faults of the strike – slip and dip-slip types .Both major and minor faults were measured and statistically treated. This study revealed that the NNE-SSW , NW-SE, NE – SW and N-S are the most predominant fault trends.

The secondary structural elements, especially faults and joints, have been recorded in the G-II uranium occurrence, they are considered a sort of ground preparation used by the mineralizing solutions as passways besides hosting the uranium mineralzations. The statistical analyses and the stereographic projection of the poles of surface joints in the G-II uranium occurrence revealed that the most predominant directions of surface non-mineralized joints are striking in the following directions: NE-SW, NW-SE , N-S and E-W.

The measured mineralized surface joints indicate that the NNE-SSW, N-S, WNW–ESE and NW-SE trends are the most predominant sets.

The measured non mineralized joints at the underground mining works demonstrate that the most predominant directions are: NE-SW, NW-SE, WNW–ESE and E-W direction. In addition, the measured subsurface mineralized joints display that the N-S, NNE-SSW , E-W and NW-SE trends are the most predominant sets.

Systematic measurements of the total gamma radioactivity were conducted all over the area of study on surface and subsurface, to establish the relationship between, lithology, structure and gamma-radioactivity. A number of samples were radiometrically analyzed to evaluate the content of the radioelements in the studied rock.

The normal granite (away from the mineralized zones) of G-II uranium occurrence is characterized by high background of gamma radioactivity, uranium ranging from 12 to 23 ppm with an average of 17 ppm while thorium varies from 24 to 33 ppm with an average of 28.4 ppm. Th/U ratio is around 1.76. This indicates that the granite of G-II uranium occurrence could be considered as uraniferous (fertile) granite.

Many surface uranium mineralized zones were discovered. The high gamma radioactivity and uranium mineralized zones are located at the eastern and western sides of G-II uranium occurrence. Visible secondary uranium mineralization of yellow color is recorded on the various topographic levels. These mineralizations occur as discontinuous lenses of different sizes and uranium concentrations.

Ten surface uranium mineralized zones were recorded in the eastern side of G-II uranium occurrence. These mineralizations are undoubtly controlled by certain fracture and fault trends and increase at the zones of intersection of more than one trends. The most obvious intersection are as follows: NE-SW and NNE-SSW with NW-SE and WNW-ESE trends. The concentration of uranium is ranging from 1163 ppm to 6379 ppm, while thorium varies between 300 ppm and 1089 ppm; Th / U ratio reached to 0.24.

At the western side of G-II uranium occurrence, six surface uranium mineralized zones are recorded. These mineralizations are governed by some fracture trends, essentially N-S and NNE-SSW. The uranium mineralization increases when these trends intersected with WNW-ESE and E-W trends. There the uranium content ranges between 2966 ppm and 12150 ppm, while thorium is varying from 624 ppm to 2818 ppm; the ratio Th/U is around 0.23.

Many subsurface uranium mineralized zones were recorded throughout the mining works.These uranium mineralizations include either primary and /or secondary uranium minerals. The primary uranium mineralization is essentially represented by pitchblende. It is located along the left first crosscut (Cc_1 E) in the western tunnel. The pitchblende is of dark black to brownish black color, of metallic luster and occurs in thin smears along minor fractures and as fine disseminations in the host granite around the rock fractures. The secondary uranium mineralization of yellow color occur as thin films or coating microfracture planes with fine radiating fibres.

Three subsurface uranium mineralized zones and four radioactive anomalies were recorded in the western tunnel. These mineralization and radioactive anomalies are controlled by the following trends: N-S, NW-SE, WNW- ESE and ENE-WSW .Uranium content is ranging between 1312 ppm and 13132 ppm, while thorium varies from 100 ppm to 1080 ppm, Th/U ratio around 0.07.

Two subsurface uranium mineralized zones and one radioactive anomaly were recorded in the eastern tunnel. The uranium mineralization are following the NE-SW, NW-SE and E-W trends. The concentration of uranium mineralization is varying from 1388 ppm to11900 ppm while thorium ranges from152 to 980 ppm and Th / U ratio around 0.09.

To identify the uranium minerals in G-II uranium occurrence, pure hand picked grains of the radioactive minerals were collected and examined by X-ray diffraction, which showed the presence of uraninite and pitchblende as a primary uranium minerals associated with secondary uranium minerals mainly uranophane and Beta-uranophane in addition to clarkeite, zippeite, soddyite and kasolite.

The comparative structural studies of both surface and subsurface revealed that the predominant joint and fracture trends recorded at the topographic surface still persistant and possess nearly the same intensities at the subsurface, escorted with the same types of alteration features. The secondary structures, especially fractures and joints acquired their importance as being the passways for the uranium mineralizing solution besides hosting the mineralizations.

G-II uranium occurrence could be classified " as hydrothermal vein-type uranium deposit" which is the most convenient for the following reasons

- Uranium mineralization of the different uranium mineralized zones in both surface and subsurface is mainly localized along some fractures, faults and joints and their intersections. This features assures the typical structural control of uranium mineralization

- The strong hematitization and other intense alteration features associated with the uranium mineralized zones in both surface and subsurface reflect the role of hydrothermal fluids and their effect on the rocks. Hematitization is the major alteration type associated with vein- type uranium deposits (Boyle, 1970).

- The abundance of dark purple, deep violet to black fluorite in intimate association with the uranium mineralization indicates the availability of hydrothermal fluids rich in fluorine. The presence of fluorite associated with uranium mineralization characterizes the complex type of ore deposits or polymetallic type (Rich et al.,1975).

- The mobilization of uranium , which is usually leached from certain parts of the mass and added to other parts, may cause the spotty nature of the mineralization and their presence as disconnected lenses. Its worthy to mention that the spotty nature of uranium mineralization is a significant feature of the uraniferous granite (Hussein et al., 1986)

- The lower Th/U ratio could be attributed to secondary enrichment of uranium in the granite. This was probably due to late stage processes such as hydrothermal activity which may further modify the uranium distribution within this prospect and its enrichment at the expense of thorium.

- The presence of uranium mineralization at differents levels confirm the role of ascending hypogene solutions in the granite.

From the above mentioned discussion, the main geological factors controlling uranium distribution and affecting its localization in G-II uranium occurrence of G. Qattar could be summarized in the following lines:

- The prevailing secondary structures (faults, fractures and joints) act as passways for the uranium mineralizing solutions.

- The host rock type, the Qattar granite, acts as source for both U and Th due to its high magmatic content of these elements. They physical characters (hard, massive, ...) facilitate its response to the acting deformation forces and also its chemical characters facilitate the change of the physicochemical conditions of the hydrothermal solutions (from acidic to alkaline).

- Availability of hydrothermal solutions. The source of these acidic hydrothermal solutions is most probably the residual solutions after the crystallization of G-III granite (Hussein et al, 1982). These solutions dissolved u and Th from the highly sheared fertile Qattar granite and resulted in silicification and kaolinitizaton of these granite and the solutions became alkaline (Bucanan, 1982). These alkaline solutions are rich in Fe, U and Th and resulted in hematitization of the host Qattar granite and redposited the above mentioned elements in the mineralized occurrences.

According to the above mentioned geological, structural, radioactivity and uranium mineralization relationships, G-II uranium occurrence represents a very good uranium prospect area of high economic potentialties.