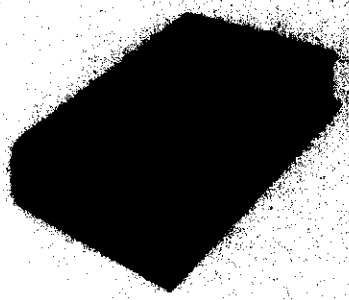
CHAPTER VI

SUMMARY AND CONCLUSIONS



CHAPTER VI

SUMMARY AND CONCLUSIONS

Wadi Abu Maamal area represents a part of the North Eastern Desert of Egypt; it covers about 179 km^2 of crystalline basement rocks. It is bounded by latitudes 27° 09` and 27° 19` N and longitudes 33° 15` and 33° 22` E. According to the field studies, the rock types, of Precambrian age, cropping out in the area are classified into: - (1) Dokhan volcanics (oldest), (2) Hammamat sedimentary rocks, and (3) Younger Granites (youngest).

Dokhan volcanics are represented by a thick sequence of stratified lava flows of intermediate to acidic composition, together with a few intercalations of pyroclastics represented mainly by tuffs with locally distributed volcanic breccia. The lava flows are pale grey to dark grey in colour and range in composition from basaltic andesite to rhyolite. The main alteration processes affected these rocks are chloritization, epidotization, sericitization, and silicification. Silicification may be due to the underlying granitic masses. Dokhan volcanics are intruded by younger granites that are represented by large apophyses and several offshoots. They are unconformably overlain by the Hammamat sedimentary rocks. The contact between the Dokhan volcanics and younger granites is rather sharp intrusive and chilled, dipping 40°-80° to E, SW and NW.

The Hammamat sedimentary rocks or intramountaneous sediments of molasse type are recorded at the southern part of the studied area. They are represented by bedded series of conglomerates, greywackes and

siltstones. The Hammamat sedimentary rocks exposed as relatively low hills and masses compared with Gabal Dokhan volcanics. These sedimentary rocks unconformably overlie the Dokhan volcanics and are intruded by the younger granites. They can be easily distinguished from the country rocks by their distinct bedding. Bedding is expressed in the alternation of conglomerate beds with greywacke and siltstone beds striking NE-SW with variable dips to the southeast. The most common alteration features in Hammamat sedimentary rocks are hematitization, kaolinization, epidotization and silicification. The microfractures of these rocks are sometimes filled with quartz and feldspar veinlets. The presence of volcanic fragments in the conglomerates indicates that these Hammamat sedimentary rocks are younger than the Dokhan volcanics. On the other hand, the Hammamat sedimentary rocks are older than the younger granites that intrude them with sharp intrusive contact.

The younger granites cropping out in the area form a number of medium to relatively elevated outcrops. The younger granites took xenolithes of different shapes and sizes from the Dokhan volcanics and the Hammamat sedimentary rocks. The younger granites are altered in some parts due to secondary processes. The most common alteration features are hematitization, epidotization, chloritization and kaolinization. These alterations are restricted to fault planes and contacts. These rocks are medium to coarse grained, porphyritic or rarely equigrnular, massive, unfoliated and weathered. They become fine grained along the contact with the Dokhan volcanics and become darker in colour due to the assimilation processes of the enclosed volcanic xenolithes in the marginal zone. The microfractures of these rocks are sometimes filled with quartz

and feldspar veinlets. Based on the field investigation, including effect of weathering, grain size, colour and cross-cut relations, the younger granites could be further subdivided into two units. The first unit is of pinkish grey colour. The second unit is of pinkish red colour. The granites of the first unit are coarse grained, sometimes porphyritic with characteristic deep weathering appearance and contain a relative abundance of mafic minerals. They are dissected by a large number of dykes. The granites of the second unit are medium grained, massive with high resistant to erosion, unfoliated and traversed by a small number of mafic dykes. The pinkish red granites intrude the pinkish grey granites with sharp intrusive contact.

Dykes penetrating the mapped rock units are numerous and are variable in mineralogical composition. These dykes are distinguished into felsic and mafic ones. The felsic dykes comprise granites, felsites, rhyolites and aplites. The felsic dykes mostly strike in NE-SW and ENE-WSW directions with vertical or steep dips to the NW and SE. The mafic dykes are greyish green to black in colour, hard, massive, fine to medium grained and porphyritic in texture. They mostly strike in NE-SW direction with vertical or steep dips to the NW and SE.

Veins are represented by quartz and feldspars veins. They mostly strike in E-W and NE-SW trends with vertical or steep dips. Pegmatites are of limited distribution in the studied area. They occur as small pockets, lenses or pegmatitic veins in the various rock types. They are mainly composed of intergrowth of milky quartz and reddish pink K-feldspar with or without mica.

The studied area displays primary and secondary structures. Primary structures comprise volcanic flows, bedding, lamination, graded bedding, and ripple marks. The secondary structures are represented by joints, faults, folds and sheeting.

Faults in the studied area are either concomitant with wadis or cutting through the country rocks. These faults are varying in length from few meters to 20 km and in width from few meters to 500 meters. These faults akin to two main trends, which are the ENE-WSW and the NNW-SSE to N-S, fault trends. The ENE-WSW faulting trend is represented by W.Umm Sidrah and W.Umm Lihaj faults. These faults show dextral sense of movement. The NNW – SSE to NS faulting trend is represented by W. Abu Maamal fault. These faults exhibit a sinistral sense of sheer, proved by displacement of some quartz veins.

Petrography and geochemical studies revealed that, Dokhan volcanics could be subdivided into intermediate (basaltic andesite and andesite, including its special variety Imperial porphery) and acidic volcanics (dacite and rhyolite).

Porphyritc andesite is the dominant rock variety of the Dokhan volcanics in the studied area, while the basaltic andesite is of very limited distribution. Both types of the intermediate Dokhan volcanics are commonly porphyritic and composed of plagioclase and hornblende phenocrysts embedded in fine-grained groundmass. The main accessory and secondary minerals are apatite, opaques, chlorite, epidote and clay minerals. Basaltic andesite is distinguished from porphyritic andesite by the presence of augite as well as dominant amygdales and fractures which are filled, in decreasing order of abundance, with chlorite, carbonates,

epidote and quartz. This mineral association reveals subgreen-schist facies metamorphism. Generally, the intermediate Dokhan volcanics are considered as medium K- rocks originated from calc-alkaline magma. They originated in active continental margin environment.

The acidic Dokhan volcanics are mainly represented by dacite and rhyolite. Dacite is mainly composed of quartz, plagioclase, biotite and rarely hornblende. Zircon and iron oxides are found as accessory minerals. Rhyolite is essentially composed of sanidine, quartz and muscovite. Zircon and iron oxides occur as accessory minerals. They are considered as high K- rocks originated from calc-alkaline magma. They originated in active continental margin environment.

The Hammamat sedimentary rocks are mainly represented by conglomerates, greywackes and siltstones. It is worth to mention that, the Hammamat sedimentary rocks have suffered from low- grade regional metamorphism where chlorite and epidote present at the expense of other silicate minerals. This low-grade metamorphism. The chemical analyses for major oxides and trace elements of siltstones and greywackes in the studied area show great differences reflecting different energies of depositional agents. Siltstones show relatively higher contents of Al_2O_3, TiO_2, Fe_2O_3, MgO, K_2O, Na_2O, Sr, Zr, Ni, Cr, Y, V and Zn but lower contents of SiO_2, L.O.I and Ba than in greywackes. The sources of the studied Hammamat rocks are felsic and intermediate igneous rocks (volcanic and plutonic of island arc and active continental margin tectonic setting) in the continental intramountain basin environment.

The younger granites are identified as monzogranites and syenogranites. Monzogranites is composed of plagioclase, quartz, perthites, biotite and hornblende as essential minerals and zircon, apatite and sphene as accessory minerals but epidote, muscovite and iron oxides as secondary minerals. Syenogranites could be texturally classified as perthitic leucogranites. They are mainly composed of perthites, quartz, plagioclase, biotite and muscovite as essential minerals, while zircon, sphene, epidote and apatite are the accessory minerals. Iron oxides, muscovite and clay minerals are found as secondary minerals. The cracks and fractures in the rock are less common than in monzogranite.

The younger granites are, generally, characterized by their relatively high silica contents with an average value of 73.53 %. They are considered as high calcium granites with an average CaO equal to 1.21%. They are considered as S-type granites originated from a peraluminous calc-alkaline highly fractionated magma. This magma is also rich in Rb and Ba indicating that this granite has originated under low pressure extensional conditions. They could be considered as post orogenic granites (POG), intruded in a crust of thickness greater than 30 km in syenogranites and between 20 and 30 km in monzogranites at water vapour pressure between 2 and 2.5 kb and crystallized at temperatures ranging from 800 to 850° C.

The area of Wadi Abu Maamal was radiometrically surveyed by using the portable gamma-ray spectrometer (UG-130). The prevailing topographic conditions prevented carrying out the field gamma-ray radiometric survey according to a regular pattern traverses. The field background radioactivity levels for W. Abu Maamal area show very wide

range due to lithologic variation, the younger granites show the highest radioactivity level. The radiometric data, of W. Abu Maamal area, expressed in cps are grouped in four zones; Hammamat sedimentary rocks are mainly represented by the zone of radioactivity less than 100 cps, intermediate Dokhan volcanics represented by the zone of radioactivity between 50 and 200 cps, acidic Dokhan volcanics represented by the zone of radioactivity between 200 and 400 cps, while the younger granites are mainly represented by the zone of radioactivity ranging between 300 and 600 cps. Within the acidic Dokhan volcanics, the field background radioactivity levels of rhyolites is more than dacites. Within the younger granites, the field background radioactivity levels of syenogranites is more than monzogranites. It is noticed that the field radioactivity increases along fractures, joints and fault planes as well as in the pegmatite pockets.

The uranium content, in the studied Dokhan volcanics, shows wide variation, range from 1.1 to 10.5 ppm with an average 4.1 and the Th content varies from 3.5 to 20.3 ppm with an average 9.14. The Th/U ratios are ranging from 1.88 to 3.54 with an average 2.57. Generally, the acidic Dokhan volcanics show higher U and Th contents and lower Th/U ratios than those of intermediate Dokhan volcanics.

The uranium content in the intermediate Dokhan volcanics ranges from 1.1 to 2.1 ppm with an average 1.6 ppm and the Th content varies from 3.5 to 6.1 ppm with an average 4.8 ppm. The Th / U ratio is ranging from 2.69 to 3.54 with an average 3. On the other hand, the uranium content in the acidic Dokhan volcanics ranges from 4.7 to 10.5 ppm with an average 7.5 ppm and the Th content varies from 10.5 to 20.3 ppm with

an average 15.1 ppm. The Th / U ratio is ranging from 1.88 to 2.24 with an average 2.

The U content in greywackes, of the Hammamat sedimentary rocks, ranges from 1.1 to 1.4 ppm with an average 1.22 ppm and the Th content varies between 3.4 and 4 ppm with an average 3.68 ppm. The Th/U ratios are ranging from 2.42 to 3.45 with an average 3.01. On the other hand, The uranium content in siltstones ranges from 1.2 to 1.7 ppm with an average 1.5 ppm and the Th content varies from 3.7 to 4.2 ppm with an average 4 ppm. The Th/U ratios are ranging from 2.41 to 3.08 with an average 2.66.

The younger granites posses the highest U and Th contents in the studied area. The uranium content in the studied monzogranites ranges from 9.1 to 11.0 ppm with an average 9.69 ppm and the Th content varies from 19.1 to 21 ppm with an average 20.16 ppm. The Th/U ratios are ranging from 1.92 to 2.09 with an average 2.02. On the other hand, the uranium content in the syenogranites ranges from 17.5 to 21.7 ppm with an average 19.25 ppm and the Th content varies from 35.2 to 43 ppm with an average 38.76 ppm. The Th / U ratio is ranging from 1.98 to 2.06 with an average 2.01, indicating that, the studied younger granites could be considered as uraniferous granites.

The studied younger granites are considered as uraniferous granites, which are characterized by the following items:

1) They are affected by tectonics, which caused fracturing, faulting and shearing; these weak zones are very suitable for the penetrating hypogene and supergene fluids.
2) Petrographically, it is represented as two mica-two feldspar granites.
3) The very high contents of alkali feldspars.
4) The presence of dispersed fluorite in the studied samples.

5) High silica content (more than 73 %).

6) Zr/Sr ratios are greater than 1.65.

7) K/Rb ratios are more than 125.

8) High values of D.I. (more than 88)

9) K_2O/Na_2O ratios are more than 1.

10) Fe_2O_3/FeO ratios are more than 1.

11) L.O.I is always less than 1%.

12) They are considered as S-type peraluminous granites.

13) They are considered as post orogenic granites.

14) Uranium contents are more than twice the Clarke value (4 ppm).

15) Th/U ratios are less than 3.

There are three parameters controlling the U distribution in the studied syenogranites; these parameters are:

1 - The initial U concentration in the magma.

2 - The tectonics which cause fracturing, faulting and shearing; these weak zones are very suitable for the penetrating of hypogene (ascending) fluids.

3 - The types and concentrations of accessory and secondary minerals which causes fixation of U from these fluids.

It is important to mention that it is noticed during this study that the acidic Dokhan volcanics have a relatively high radioactivity (from 4.7 to 10.5 and 7.5 ppm average). In addition, it is noticed also, that syenogranites and monzogranites are rich in magmatic uranium, it reaches 21.7 ppm in syenogranites and 11.0 ppm in the monzogranites. This high uranium content in both acidic Dokhan volcanics and the younger granites could be considered as source rock for uranium. So, this fact is rather important in planning for more detailed uranium exploration in this area or similar one.