CHAPTER 5

SUMMARY AND CONCLUSION

The present thesis deals with the geology of the Pan- African basement rocks in Wadi Kreiga – Wadi Kurbiyay area. This area is located in the South Eastern Desert of Egypt between latitudes 22° 45` 00`` and 22° 55` 00`` N and longitudes 35° 00` 00`` and 35 20` 00`` E, covering approximately 690 Kms^2.

This work is an attempt to clarify; the relationships between the different rock units in order to determine their metamorphic grade and to define their petrogenesis and tectonic setting.

The area was mapped on the scale 1 : 50,000 using aerial photographs scale 1 :40,000, photomosaics scale 1 : 50,000 and supported by landsat images. Intrusive and structural relations within the mapped area show the following relative age succession of the exposed rock units. It is more convenient to review the sequence of the rock units and their inferred tectonic setting (see table. 9).

Table (9) : The rock units sequence and their inferred tectonic settings.

Rock Unit	Tectonic Setting
Dykes	The last magmatic activities and filling the fractures of the tensional environment.
Post-tectonic granites	Emplaced during the waning of the Pan-African orogeny (Late orogenic granites): show calc- alkaline affinity and have been formed in an environment of compression, probably belonging to collision-related granites.

Table (9) *Continued*

Rock Unit	Tectonic Setting
Syn-tectonic granitoids	Syn-tectonic, calc-alkaline plutonism, were formed under compressional environment, above subduction zone and pertain to I-type volcanic arc granite.
Syn-tectonic intrusive metagabbros	Syn-tectonic plutonism, they are transitional in composition from calc-alkaline to tholeiitic and pertain to an island arc tectonic setting.
Metavolcanics and volcaniclastic metasediments	These rocks have calc-alkaline nature and similar to island arc lavas evolving in an intra-oceanic environments. The volcaniclastic metasediments were deposited in an oceanic back-arc basins.
Serpentinites and talc carbonate rocks	Dismembered ophiolitic sequence

The serpentinite and talc carbonate rocks occur at the central part of the southern border of the mapped area, where they constitute a huge conspicuous mountainous mass of Gabal Kurbiyay which follow a roughly NW-SE direction. The serpentinite rocks have been emplaced tectonically where they found as allochtonous remnants of an old oceanic crust. They are thrusted over the surrounding island arc metavolcanics and volcaniclastic metasediments. Scattered slices and thrust lenses of serpentinites are tectonically incorporated within the metavolcanic and volcaniclastic metasediments. On the other hand, these serpentinites were intruded by syn-tectonic metagabbros and granitoid rocks.

The mode of occurrence of the present serpentinites and their geological features are quite similar to those pertaining to Fransciscan ophiolites and Bay islands which were described by several authors **(e.g. Loney et al., 1971; Bailey et al., 1970; Coleman, 1971 and 1977).**

" Extreme tectonic dismembering of ophiolites is common within the Fransciscan of California, this produce tectonic blocks of metamorphic peridotite within a melange." **(Loney et al., 1971).**

" Where ophiolites have been incorporated into orogenic zones, their peridotites become serpentinized and are often detached into isolated tectonic lenses separated from the mafic rocks" **(Coleman, 1977).**

Petrographically, the investigated serpentinites consist mainly of antigorite shreds replaced by talc, carbonate, tremolite, magnetite and chlorite.

Geochemical investigations of the present serpentinites were carried by several authors **(e.g. Aly et al., 1995; Zimmer et al., 1995 and Abdel Kariem et al., 2001)** and concluded that they are pertaining to an ophiolitic assemblage within MORB-like affinity.

The mode of occurrence, petrographic criteria and further contributions of geochemical results indicated that these serpentinites are derived from peridotites essentially harzburgite and belonging to an ophiolitic assemblage.

The metavolcanic rocks cover mainly the southwestern part of the mapped area, and surrounding the whole exposure of Gabal Kurbiyay except its northern side. They comprise metamorphosed basic to intermediate rocks including metabasalt, basaltic meta-andesites and predominantly meta-andesites.

In places, these rocks are transformed to actinolite-tremolite-chlorite schists. Meta tuffs and volcaniclastic metasediments are also encountered.

Metavolcanic rocks exhibit tectonic contacts with serpentinites whereas; they are intruded by the syn-tectonic metagabbros and granitoids.

The petrochemical characters of these metavolcanics revealed that, they are predominantly low-potassic in character and mostly calc-alkaline in nature with a few samples having tholeiitic affinity. These metavolcanics follow the Cascade trend that common in island arc environments.

In general, the results reached here indicate that, these rocks are similar to island arc lavas evolving in an intra-oceanic environment, and conformable with the data obtained by **Stern (1981)** on the Egyptian younger metavolcanic rocks.

The present volcaniclastic metasediments occupy small area (south Bir Madi). Detailed field and petrographic investigations revealed that, these rocks including metasiltstones, metagreywackes, spotted phyllite, garnet-biotite schist and garnet-cordierite-biotite schist. These rocks have been subjected to various degree of metamorphism ranging from greenschist to lower amphibolite facies.

In the light of the above mentioned data, the author can proposed that the principle source of the volcaniclastic metasediments is the arc derived material related to the arc volcanism and have been deposited in a back arc basin which floored by an old oceanic crust.

Syn-tectonic intrusive metagabbros are exposed in the central part of the mapped area, where they constitute a huge mountaineous mass of Gabal Meneiga. Along Wadi Atluk and Wadi Shallal El Gharbi small-scattered masses of these rocks are also encountered. They intruded within serpentinites and metavolcanics, while these rocks are intruded by syn-tectonic granitoids.

Petrochemical characters point out that, these rocks are transitional in composition from calc-alkaline to tholeiitic and pertain to an island arc tectonic setting which evolved in oceanic environment prior to cratonization.

Syn-tectonic granitoids are widespread throughout the area and they possess intrusive contacts with the surrounding rocks.

Petrochemical studies revealed that, these rocks are mainly peraluminous, and calc-alkaline in nature. They were formed under an environment of compression above subduction zone and conformable with I-type and volcanic arc granites. Most of their characteristics are comparable with those of G_1 granites of **Hussein et al. (1981).**

Post-tectonic granites are less distributed throughout the study area and occur as small intrusions near Bir Madi. They are considered to be the youngest rock unit in the study area, where they have sharp intrusive contact with the surrounding rocks.

These granites are pink in colour, porphyritic in places and composed of quartz, perthite, plagioclase and minor biotite.

The field relations and the petrographic investigation of these rocks may indicate that, they are belonging to G_2 granite (collision related granites) of **Hussein et al. (1982).**

Several dykes and veins that invade all rock units in the area represent the last magmatic activities in the present area. These dykes are belonging to post granitic dykes and have trending to E-W and NE-SW directions.

The present area was subjected to polyphases of deformation, they are grouped into three major events namely (D_1) including thrusting and F_1 and F_2

folds; (D_2) including F_3 folds and (D_3) resulting in the development of right and left lateral strike-slip faults **(El Amawy et al., 2001).**

Field and petrographic studies indicate that, most of the exposed rocks in the mapped area were subjected to polymetamorphic events including three episodes which are, regional, contact and retrograde metamorphism.

The regional metamorphism is the most widespread and its imprints are quite visible especially, in the volcaniclastic metasediments. It ranges from greenschist to lower amphibolite facies with the mineral assemblages (quartz + albite + chlorite + sericite + epidote) and (quartz + biotite + plagioclase + garnet) respectively.

The contact metamorphism is regarded as the result of the thermal effects of the intrusion of syn-tectonic granitoids and are best recognized along its contact with volcaniclastic metasediments. On closer approach to the contact cordierite-garnet-biotite schist were developed, whereas; the volcaniclastic metasediments in the outer parts are characterized by spotted phyllite.

Actually, it is not known whether the thermal effect of the syn-tectonic granitoids is the reason that produces a new generation of garnet or the garnet, which occurs within the aureole, represents pre-pluton regional metamorphism.

The last stage assemblages of contact metamorphism were obliterated through ***retrograde metamorphism***. Thus pseudomorphs of fine-grained chlorite (pennine) replaced cordierite and transformation of garnet porphyroblasts into chlorite especially along their margins and cracks.

Generally, the field, petrographic, metamorphic and geochemical studies that presented in this thesis and the published geochemical data indicate that, there is no conclusive evidence for the existence of Archaean or even Early-Proterozoic crust in Gabal Gerf area.

Accordingly, a Pan-African age can be assigned to the rocks of the studied area.