ACKNOWLEDGEMENTS

Thanks are always to **Allah**.

I would like to express my deepest sincere gratitude to my dear professor and mentor, **Prof. Dr. Ahmed Gaber Shided**, Professor of Geology, Geology Department, Faculty of Science and vice president for higher education and research, Fayoum University, for his kind supervision, and guidance during the course of research work.

I would like also to express my deepest sincere gratitude to professor, **Prof. Dr. Maher Dawoud Ibrahim Dawoud**, Professor of Geology, Geology department, Faculty of Science, Menoufiya University, not only for suggesting and planning the subject of the work of this thesis, but also for his kind advices, supervision, continuous, valuable, and enlightened help, fruitful criticism and encouragement throughout this piece of research work.

The author also wishes to express his thanks to **Prof. Dr. Mohamed Abd El-Fatah**, Vice dean of the Faculty of Science, Fayoum University, for his valuable help.

Also I would like to appreciate the effort introduced to me from the head of the geology department **Prof. Dr. Sobhi Ahmed Helal** for his compassionate help during the course study.

I wish to express my sincere appreciation to **Ass. Prof. Mohamed Abu El-Ghar** for encouragement on the various phases of this study.

A special word of thanks is to **Dr. Ahmed Wajih** and **Dr. Mohamed Ali Agha** for their kind advices.

I am also grateful to the laboratories of Egyptian Geological Survey authority especially **Dr. Mohamed Abd El-Aty** for his kind and gentle treatment and some facilities throughout the SEM work.

Special thanks to my mother, father, wife, brothers, sister, colleges and my daughter for their encouragement, help and patience during my work in thesis.

Abd El-Halim Shokry Montser

ABSTRACT

Zircon as an indicator to the genesis and evolution of some gneisses from Egypt

This thesis encompasses the study of zircon crystals from gneisses and some associated rocks in three main exposures from Egypt. They are Migif - Hafafit (South west Marsa Alam-Central Eastern Desert), Meatiq (West Quseir-central Eastern Desert) and Feiran (Central south Sinai). Zircon is studied in thin section using the polarized microscope to examine its relationship with the associated minerals. It is separated using the different covenantal techniques such as heavy liquid and magnetic separation. The morphological properties of the zircon have been studied under a stereo microscope and polarized microscope and the various species of zircon are plotted on Pupin 1980 varietal diagram. Internal structures of zircon are studied using a scanning electron microscope imaging with energy dispersive X-ray (EDX) spectroscopy analysis. The main objective of this investigation is to try to resolve the controversy of the variable estimated ages of these gneisses.

Firstly: Gneissic rocks from Migif-Hafafit area

The metamorphic succession from Migif-Hafafit area can be distinguished into (starting from top to bottom): psammitic gneiss, hornblende biotite gneiss, mylonitic gneiss and mylonites. Migif gneisses are tentatively correlated but later modification and secondary imprints lead to prominent differences among them. The zircon population from the psammitic gneiss which is characterized by the presence of both rounded and euhedral morphologies. The lower parts show higher percentage of subhedral and anhedral broken zircon grains. The investigated samples of psammitic gneiss show downward decrease in grain size of zircon crystals. It is

suggested that the lower parts exposed to higher levels of strain. Agglomerating morphology enhance this explanation. The psammitic gneiss represents metamorphosed loose sediment inherited from locally weathered igneous rock on hill slopes that experienced little transport. Its lower parts with hornblende biotite gneiss were washed into the basin during the energetic environment of deposition. After that they exposed to higher levels of strain, such as those formed in mylonitic shear zones. The separated zircons from hornblende biotite gneiss are mainly fracture-truncated fragments or rounded grains with abraded surface. At least a part of hornblende biotite gneiss developed at the expense of sediments more intensely reworked by sedimentary processes. However, there is evidence that some disintegration features developed during the tectonic deformation and contemporaneous metamorphic recrystallization of the rocks. Absence of compositional zoning and internal textures supports the sedimentary origin of the rock. Metamorphism results in the formation of homogenous rims on preexisting zircon. The zircon population shows typological characteristics nearly similar to population of tholeiitic series granite. Zircon grains from the mylonitic gneiss are dominantly euhedral in shape. The rock expresses a large number of twinned zircon crystals. As experienced from literature the high proportion of zircon xenocrysts in the melt could induce early zircon crystallization leading to the formation of parallel growth. All zircon characteristics from mylonitic gneiss indicate magmatic phase protolith and reflect slow normal crystal growth from the melt during the cooling of the pluton. Zircon population contains high proportion of zircon xenocrysts but after excluding xenocrysts, the population is typical of zircon from alkaline granitoids.

Secondly: Gneissic rocks and some associated rocks from Meatiq area

Meatiq dome is composed of gneissose granite core (Umm Ba'anib gneissose granite) surrounded by a suite of metasedimentary (Pelitic schist, quartzofeldspathic schist, muscovite schist and garnet muscovite schist) and metavolcanic rocks and is intruded by many types of granitic stocks (Abu Fannani tonalite and Arieki granite). Zircon typology from the Umm Ba'anib gneissose granite and the pelitic schist indicate a genetic kinship for these two units, while zircons in the older granite are distinct, suggesting that the origin of this unit is different. The collected samples from Umm Ba'anib pluton show prominent variations in mineralogy, petrography and zircon characteristics. The Umm Ba'anib pluton exposed to high degree of deformation appears prominent in zircon features near to shear zone at pluton eastern edge. Abundance of different growth phenomena gives evidence of discontinuities in the growth history of grains. Opaque and milky grains (metamictic zircon) have been observed in the hand backed separated zircon. Internal structures of some zircons are weaker due to a higher degree of metamictization. Zircon population shows bimodality which may be attributed to presence of amphibolite xenoliths; we suggest these xenoliths formed along the pluton border at the end of crystallization process. The resultant morphology and internal structures of zircon not only take place under magmatic conditions, but also controlled by post magmatic and metamorphic conditions. Many factors responsible for age disturbances including: metamictization, inherited older magmatic zircon, zircon xenocrysts, post-magmatic recrystallization, action of external forces during or after metamorphism and abundance of inclusions. Zircon from pelitic schist is mainly euhedral and short prismatic thus resistant to destruction. Many morphological features and surface textures are developed along the grain surface. The zircons examined are interpreted to originate from local sources, presumably washed into

the basins in the energetic environment during or after deposition of thick sediments. It is concluded that the major part of zircon coming from an igneous source by in situ extraction from close basement; probably from Umm Ba'anib gneissose granite. Zircon typology indicates the alkaline nature of the rock with similar characteristics of Tholeiitic series granitoids of mainly mantle origin. Most grains exhibit no zoning with dark BSE patchy alteration zones appear in most zircon grains with CL-bright overgrowths. Zircon grains of Abu Fannani tonalite are mostly euhedral with multi-facet character with completely absence of rounded zircons. Zircon population is similar to intrusive aluminous monzogranites and granodiorites of essential crustal origin. Some grains show large CL-dark, inherited core overgrown by oscillatory zones. Small part inherited from the crustal component during mixing with magma as experienced from the presence of xenocrystic cores. The Abu Fannani tonalite zircon differs from zircons of the other rock units of the area in many respects thus far does not appear to have the same origin and probably formed in different period.

Thirdly: Gneissic rocks from W. Feiran area

From zircon study it appears that almost all types of gneissic rocks from W. Feiran could have developed from the same source rocks. The abundance of the inherited components (inherited cores and xenocrystic grains) among the zircons from Feiran gneisses and migmatites indicate an important role of crustal contamination of pre-Pan African rocks in the formation of these rocks. It also solves the problem of the variable estimated ages of the gneissic rocks of the Feiran area. Zircons occur in biotite gneiss mainly as either inherited from the tonalite protolith or formed due to metamorphism. The presence of zircons with inherited cores supports this idea. The zircon population is characterized by very long prismatic crystals indicating its formation from a highly

saturated melt under low velocity of crystallization. Also, the zircon exposed to anatectic melting-precipitation appears clear in the subhedral to subrounded shape of the grains. Zoning patterns, absence of cracks and inclusions of apatite and quartz suggest that this zircon come from an igneous source. Zircon population is similar to the zircon population of subalkaline granite of hybrid origin (crustal + mantle). Zircon from migmatites exhibit signs of resorption can be due to the onset of anatexis. The presence of very long prismatic crystals with abundance of growth phenomena as parallel to sub-parallel twinning, overgrowth and outgrowth indicates that the crystal growth was performed slowly in supersaturated liquid along discontinuous intervals. Many crystals are characterized by three successive shells: an inherited core, inner resorption rim, and a thin overgrowth rim. This population is nearly typical of zircon from calc-alkaline granitoids of hybrid (crustal + mantle) origin. The poorly-facetted external form (rounded crystal edges) of the zircon from hornblende biotite gneiss reflects partial resorption. A special feature of the hornblende biotite gneiss is intergrowths of twins and compound twins parallel or subparallel to the c-axis. Many features indicate xenocrystic origin of the expected including: zircon subtypes separate from the zircon population, the development of fractures around possible xenocrystic cores and the abundance of simple and compound twins. Typological investigations indicate that these morphological types are more typical of zircon from calc-alkaline granitoids of hybrid (crustal + mantle) origin.

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