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MESOZOIC IGNEOUS ACTIVITY IN EGYPT

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ABSTRACT

A geochronological sequence of the main phases of igneous activity in Egypt during the Mesozoic is presented in this paper. This is essentially based on scrutinized isotopic age data. New K / Ar ages are also included.

Three main phases are outlined :

1. Early Triassic – Late Permian (230 ± 10 Ma).
2. Late Jurassic – Early Cretaceous (140 ± 10 Ma).
3. Late Cretaceous (90 + 10 Ma).

An attempt is made to relate these phases with tectonic events.

INTRODUCTION

Igneous activity in Egypt during the Mesozoic was extensive and resulted in the intrusion and extrusion of various rock types which are abundant and diversified in size, form and composition. They include basaltic rocks, alkaline ring complexes as well as minor granitic intrusions. These rocks were the subject of several geological, petrological and geochronological studies, especially in the last two decades.

In the light of these studies and the availability of new isotopic age data, a temporal and spatial correlation is attempted in this work. New K / Ar ages obtained by the writer are also included. The rock types, their origin, tectonic setting and ages are presented. The isotopic age data were scrutinized and used to construct a sequence of the main phases of Mesozoic igneous activity. The Geological Time Table compiled by Van Eysinga and published by Elsevier (1978) is used as reference in this work.

THE MAIN ROCK TYPES

The largest Mesozoic volcanic association in Egypt namely that of Wadi Natash, southern Eastern Desert, is of Late Cretaceous age. Several of the ring

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complexes were, at least partly, formed during the Mesozoic (e.g. Abu Khrug, El-Kahfa, El-Naga, El-Mansouri, Nugrub El-Fogani, Nugrub El-Tahtani and Mishbeh). A few small granitic bodies in the Eastern Desert are assigned to the Late Cretaceous. Basaltic dikes, sills, flows and plugs scattered in the Eastern and Western Deserts and in Sinai were intruded or extruded during the Mesozoic. The volcanic rocks of Wadi Araba and Abu Darag are assigned a Lower Cretaceous age.

ISOTOPIC AGE DATA

Available isotopic age data are compiled and carefully examined. Some fifty reliable ages, including new K / Ar ages obtained by the writer are presented in Table 1.

Table : 1 Isotopic determinations yielding Mesozoic ages

No.	Locality	Age (Ma)	Method°	Rock	Reference
1) Early Triassic Ages :					
1.	Farsh El-Azrag, West Central Sinai	238 ± 3 233 ± 3	K/Ar	Olivine basalt	Meneisy (This work)
2.	G. Zarget Naam S.E.D.	247 ± 13	Rb/Sr	Syenite	Hashad & El-Reedy (1979)
3.	Uweinat area S.W.D.	235 ± 5	K/Ar	Dike basaltic	Klerx & Rundle (1976)
4.	El-Gezira S.E.D.	229 ± 5	K/Ar (b)	Gabbro	Serencsits et al. (1979)
5.	G. Bir Um Hebal S.E.D.	223 ± 9	Rb/Sr	Granosyenite	
6.	G. Silaia S.E.D.	221 ± 12	Rb/Sr	Granite	Hashad & El-Reedy (1979)
7.	G. El-Naga S.E.D.	220 ± 20	Rb/Sr	Ne-Syenite	El-Shazly (1977)
2) Late Jurassic – Early Cretaceous Ages :					
8.	G. El-Naga S.E.D.	148 ± 3 146 ± 3 145 ± 3 145 ± 3 146 ± 6	K/Ar(b) " " Rb/Sr	Umptekite " " Ne-Syenite Ne-Syenite	Serenscits et al. (1979) Hashad & El Reedy (1979)

Cont. Table 1

No. Locality	Age (Ma)	Method	Rock	Reference
9. G. Mishbeh S.E.D.	148 ± 12 141 ± 3 141 ± 3	Rb/Sr K/Ar (b)	Syenite Olivine basalt	Serencsits et al. (1979)
10. G. Nugrub El-Fogani S.E.D.	142 ± 3 140 ± 3 135 ± 3	K/Ar (b)	Ne-Syenite Gabbro Gabbro	Serencsits et al. (1979)
11. G. Nugrub El-Tahtani, S.E.D.	140 ± 9	Rb/Sr	Syenite	Hashad & El Reedy (1979)
12. G. El-Mansouri S.E.D.	132 ± 10	Rb/Sr	Syenite	Hashad & El Reedy (1979)
13. W. Araba N.E.D.	126 ± 4 125 ± 4	K/Ar	Olivine basalt	Meneisy & Kreuzer (1974a)
14. W. Abu Darag N.E.D.	113 ± 3 115 ± 3	K / Ar	Olivine basalt	Meneisy & Kreuzer (1974a)
15. W. Natash S.E.D.	104 ± 7	Rb/Sr	Olivine basalt	Hashad & El Reedy (1979)
3) Late Cretaceous :				
16. G. El-Mansouri S.E.D.	95 ± 10	Rb/Sr	Qz-Syenite	El Shazly (1977)
17. G. Zarget Naam S.E.D.	90 ± 10	Rb/Sr	Granite	El Shazly (1977)
18. Um Shilman S.E.D.	93	Rb/Sr	Red Mu-granite	El Shazly (1977)
	90	Rb/Sr	Yellow Mu-granite	

Cont. Table : 1

No.	Locality	Age (Ma)	Method	Rock	Reference
19.	G. El–Naga	86 ± 3	K/Ar	Ne–Syenite	Meneisy &
	S.E.D.	84 ± 3	”	”	Kreuzer (1974b)
20.	G. Abu Khrug	96 ± 2	K/Ar	Ne–Syenite	
	S.E.D.		(b)		Meneisy &
		88 ± 5			Kreuzer (1974b)
		86 ± 15			
		90 ± 2	K/Ar	Gabbro	Serencsits
		89 ± 2	(b)	Ne–Syenite	et al. (1979)
21.	El–Kahfa	90 ± 4	K/Ar	Alk. Syenite	
	S.E.D.	88 ± 2	(b)	”	
		96 ± 2	(b)	Ne–Syenite	
		93 ± 2	(h)	”	Serencsits
		88 ± 4	(b)	Essexite	et al. (1979)
		91 ± 4	(b)	”	
		93 ± 2	(h)	”	
		88 ± 2	(b)	Alk. Syenite	
22.	W. Kareim	92	K/Ar	Trachyte	
	C.E.D.	91		”	Ressetar &
		90		”	Nairn (1980)
	(Younger generation)	74	Rb/Sr isochron	Bostonite	Sayyah et al. (1978)
23.	Darb El Arbain	79 ± 2	K/Ar	Olivine	
	S.W.D.	78 ± 2		basalt	Meneisy &
		78 ± 3			Kreuzer (1974a)
		76 ± 2			

* Notations used : G. = Gabal, W. = Wadi, W.D. = Western Desert, E.D. = Eastern Desert, N. = Northern, S. = Southern, C. = Central.

● Whole rock unless otherwise specified; h = hornblende, b = biotite.

DISCUSSION OF RESULTS

Three main phases of igneous activity are distinguished. These are arranged in chronological order as follows, starting with the earliest :

1) Permo–Triassic (230 ± 10 Ma).

2) Late Jurassic–Early Cretaceous (140 ± 10 Ma).

3) Late Cretaceous (90 ± 10 Ma).

The salient features of each of these phases are outlined in the following :

1) Permo–Triassic Phase (230 ± 10 Ma)

Related to the initial break–up of Pangea and the closure of the Tethys. This period is characterized by rapid polar wandering. Records of volcanicity related to the uplift of the Aswan–Uweinat massif exist.

In the Upper Permian – Lower Triassic, the area between Gabal Uweinat and Bir Safsaf, South Western Desert was uplifted along zones of pre–existing crustal weakness and these reactivated fractures gave way to the intrusion of basaltic dikes around 235 Ma as well as rhyolite subvolcanics around 216 Ma (Schandelmier and Darbyshire, 1984). It is pointed out that a group of K / Ar ages falling in the range of 230 ± 15 Ma is also reported from northeast Sudan (Vail, 1976).

Recently, the writer obtained K / Ar ages indicating a Permo–Triassic age (238 Ma) for an olivine basaltic sheet from Farsh El–Azraq volcanics, West Central Sinai. This sheet (about 70 m thick) overlies the Upper Carboniferous Abu Zarab Formation and is locally covered by Cretaceous (?) Nubian Sandstone. These basaltic rocks subareally erupted along deep seated faults, and were derived from an olivine tholeiitic magma.

2) Late Jurassic – Early Cretaceous Phase (140 ± 10 Ma)

This phase of igneous activity is related to the initial rifting of the South Atlantic and the corresponding Africa–South America compression and Afro–Arabian strike–slip faulting. Many blocks were affected by this event.

Most of the masses which yield isotopic ages in the range of 140 ± 15 Ma are typically alkalic ring complexes and include those of Gabal Mishbeh, Gabal Nugrub El Tahtani, Gabal Nugrub El–Fogani, Gabal El–Naga and Gabal

El-Mansouri, in the south Eastern Desert. The isotopic age data obtained by different methods are remarkably consistent (e.g. Serencsits et al., 1979 and Hashad & El Reedy, 1979). This 140 Ma episode of alkaline magmatism in Egypt coincides with a major episode of similar alkaline magmatism occuring in the areas surrounding the South Atlantic and has been related to initial rifting of Africa from South America. Ring complexes in the same age range (150 - 130 Ma) were reported from northeastern Sudan (Vail, 1976).

The volcanic rocks of Wadi Araba and Abu Darag, western side of the Gulf of Suez, are considered as related to this phase of Early Cretaceous volcanicity. However, a slightly younger volcanic pulse may have followed. The rocks occur mainly as dikes and plugs cutting essentially the Upper Paleozoic sedimentary series which are exposed at the core of Wadi Araba structure and in several localities in Abu Darag area (Abdallah et al. 1973). The K / Ar ages range between 126 and 155 Ma (Meneisy & Kreuzer, 1974a) and are regarded as good minimum ages due to possible argon loss. The petrology and petrochemistry of these volcanics was studied by Meneisy et al. (1976). Petrographically, they are mainly nepheline-bearing and pyroclastic rocks in Wadi Araba.

In Abu Darag, the following volcanic association was recognized: olivine basalt-andesitic basalt and a rhyolitic variety. The Wadi Araba volcanics were extruded into the crest of Wadi Araba anticline. The axis and plunge of which trends from East to West. These alkali basaltic rocks appear to belong to an active continental margin environment, being extruded within uplifted areas (Abdel-Monem & Heikal, 1981). Based on clinopyroxene chemistry, Abdou (1983) suggested that the magma from which the basalts of Abu Darag were derived was transitional in composition between those of within-plate alkaline and within-plate tholeiitic basalts. In Sinai and the Western Desert, it is difficult - as yet - to estimate the extent of volcanicity of this phase due to lack of data.

3) The Late Cretaceous (90 $\pm$ 10 Ma)

This phase is tectonically related to the second major episode of alkaline magmatism and the large scale strike-slip faulting in Afro-Arabia. The Late Cretaceous-Early Tertiary diastrophism referred to as "Laramide" or Syrian arcing system has been the subject of considerable discussion (e.g. Said, 1962 - El

Shazly, 1977). The most obvious folds caused by this movement are the "Syrian arcs" noted in northern Egypt, especially in northern Sinai and the northern Western Desert.

This is parhaps, one of the most documented events of alkalic igneous activity in Egypt. The best record of this event is undoubtedly the volcanic rocks of Wadi Natash about 125 km ENE of Aswan, along the boundary between the Nubian Sandstones and the Precambrian basement complex. The exposed volcanics cover about 600 km^2. A number of workers have studied these volcanics (e.g. Barthoux, 1922 El-Ramly et al., 1971 Sayyah and El Shatoury, 1973, and Abul Gadayel, 1974).

The other important event during this period of igneous activity is the alkaline magmatism giving rise to Gabal El Kahfa, El-Mansouri, Gabal Abu Khrug and partly Gabal El Naga ring complexes. Isotopic ages are fairly consistent, and are roughly around 90 $\pm$ 5 Ma. It is noted that the two ring complexes of El Kahfa and Abu Khrug fall along a northwesterly trending lineament structure called by Brioussov (in El Ramly et al. 1971) the Eriythrean trend. This may imply a tectonic control for their intrusion. These complexes are related to one phase of alkaline igneous activity. Wadi Natash volcanics seem also to belong to this phase and there is evidence which suggests that they were controlled by the same structural trend i.e. north westerly trend. Evidence includes the alignment of the relics of the majority of older volcanics along a N 20° – 30° W trend indicating fissure-type eruptions and the predominance of faults and fracture zones of the same trend which Garson and Krs. (1976) interpreted as surface mainfestation of deep-seated tectonic zones (Fig. 1).

Reference should be made here to the carbonatites in Saini and the south Eastern Desert. The spatial and temporal affinities between African rift valley alkaline magmatism and carbonatites are generally accepted. In south eastern Sinai, the Tarr albitite-carbonatite complex of Wadi Kid was studied by Shimron (1975). The complex comprises albitite masses with closely related explosion breccias, fenite aureoles, intrusive carbonate bodies, olivine dolerite and lamprophyre dikes.

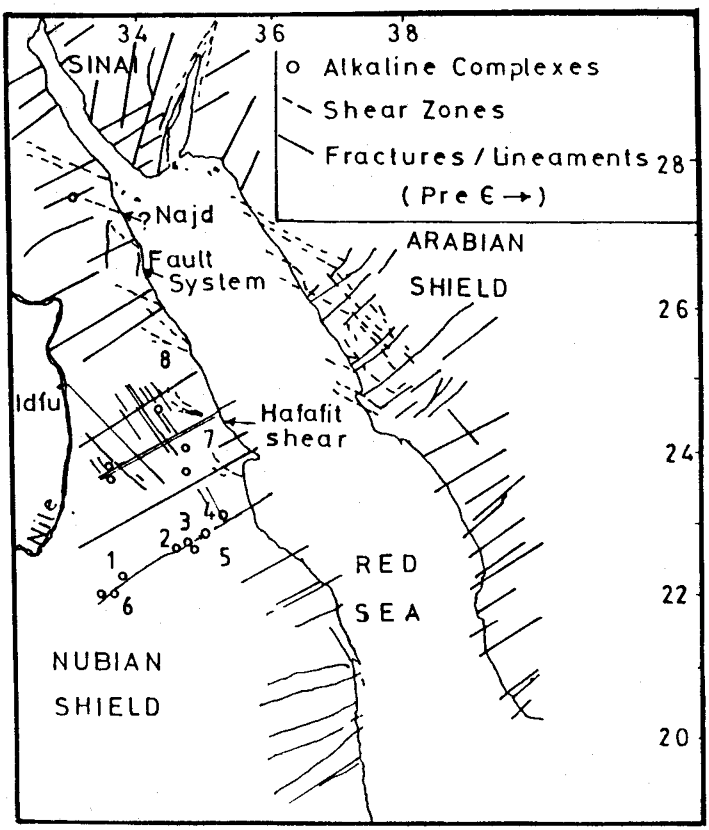

Fig. : 1 Map and tectonic lineaments, (after Garson and Krs., 1976)

Ring complexes yielding Mesozoic ages :

1 – El Gezira (229 Ma).
2 – El Naga (145 Ma).
3 – Mishbeh (142 Ma).
4 – Nugrub El Tahtani (140 Ma).
5 – Nugrub El Fogani (139 Ma).
6 – Mansouri (132 Ma).
7 – El Kahfa (91 Ma).
8 – Abu Khrug (89 Ma).

Another aspect of the late Cretaceous igneous activity is the intrusion of small bodies of granitic composition. These Cretaceous granites came to attention during the last few years. El Shazly (1977) reported Rb / Sr ages around 90 Ma for yellow and red muscovite granite bodies from Abu Sawyel area.

These bodies represent the northward continuation of ring complexes that associate the East African rift system. Garson and Hussein (Personal Communication) suggested that the ring complexes of Nugrub El-Fogani, Nugrub El-Tahtani, Mishbeh, El Naga, Gezeira and Mansouri, together with the carbonatite bodies bordering Mansouri and extending southwestwards into Sudan, all fall on the continental trace of a zone of transform faults that extend to cut across the axis of sea-floor spreading in the Red Sea.

Phil de Gruyter & Vogel (1981) suggested that the origin of these complexes is due to alkaline melts having been formed in the asthenosphere by shear heating, caused by changes in plate motion. These melts were emplaced along reactivated Pan African fractures or pre-existing zones of weakness.

El Ramly & Hussain (1982) discussed the tectonic setting and petrogenesis of the alkaline ring complexes of Egypt. They suggested that under certain favorable geotectonic conditions (e.g. intracontinental hot spots) partial fusion of deeper levels in the upper mantle could produce enough heat, volatiles and mobile elements to melt the overlying parts of the lower crust.

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النشاط الناري في مصر
خلال حقب الميزوزوي

محمد يسري منيسي

يقدم هذا البحث تتابعاً زمنياً للمراحل الرئيسية للنشاط الناري في مصر خلال حقب الحياة المتوسطة (الميزوزوي) ، ويستند هذا التتابع بالدرجة الأولى على نتائج تعيين أعمار الصخور بطرق النظائر المشعة ، ويتضمن البحث نتائج جديدة بطريقة البوتاسيوم - آرجون .

والمراحل الرئيسية التي تم تحديدها هي :

١) نهاية البرمي - الترياس المبكر (٢٣٠ ± ١٠ مليون سنة)

٢) نهاية الجوري - الكريتاوي المبكر (١٤٠ ± ١٠ مليون سنة)

٣) الكريتاوي المتأخر (٩٠ ± ١٠ مليون سنة)

ويتضمن البحث أيضاً الربط بين هذه المراحل والأحداث التكتونية المصاحبة لها .