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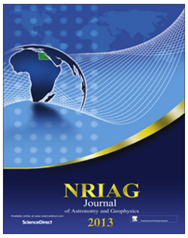

Magnetization of three Nubia Sandstone formations from Central Western Desert of Egypt

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Abstract A total of 198 oriented cores (from 16 sites) have been sampled from three Cretaceous Nubia sandstone formations distributed around the Kharga–Dakhla and Dakhla–Uwainat roads in the Western Desert for paleomagnetic studies. Two of these formations are of the Early Cretaceous (the Six Hills, Abu Ballas formations) and the third one is of the Late Cretaceous (Maghrabi formation). The studied rocks are subjected to rock magnetic measurements as well as demagnetization treatment.

Rock magnetic experiments reveal that the presence of hematite is the main magnetic mineral in the three formations. Therefore, present study relies mostly on thermal demagnetization.

Two magnetic components have been isolated from the studied rocks. The first component has been isolated from the Six Hills and Abu Ballas formations and is carried by hematite with $D = 347.1°$, $I = 41.6°$ with $\alpha_{95} = 7.8°$ and the corresponding pole lies at lat. = 78.2° N and long. = 294.1° E. The second component has been isolated from the Maghrabi formation and is carried also by hematite with $D = 22.7°$, $I = 28.4°$ with $\alpha_{95} = 9.9°$ and pole position lies at lat. = 66.3° N and long. = 140.6° E.

The first magnetic component obtained from the two older formations is considered primary, as the corresponding pole reflects the age when compared with the previously obtained Cretaceous poles for North Africa. On other hand, the second pole obtained from the Maghrabi formation (the younger) is inconsistent with the Cretaceous pole positions for North Africa, but falls closer to the Eocene pole indicating that the rocks of this formation could have suffered remagnetization during the late Eocene time.

1. Introduction

The Nubia sandstone is a clastic sequence composed mainly of sandstones intercalated with mudstones and characterized by the absence of marine fossils. It extends for several degrees of latitude and longitude beyond the border of Egypt into Libya and Sudan. In Egypt, the Nubia sandstone is exposed

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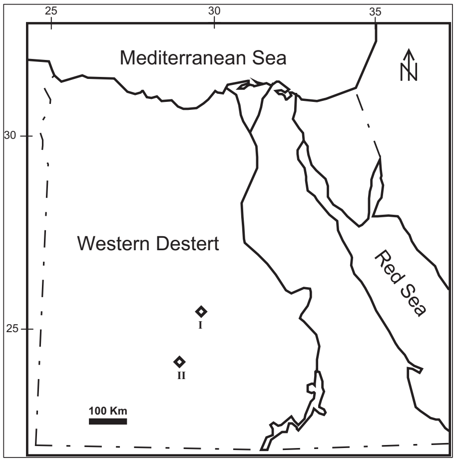

Fig. 1 Map of Egypt showing sampling locations. (I) Abu Ballas and Maghrabi formations. (II) The Six Hills formation.

on both sides of the Nile Valley in the southern part of the Egypt, northern Red Sea coast and central Sinai, forming horizontal or slightly dipping (1–15°) strata. There is no formal stratigraphic nomenclature for the Nubia sandstone formations along their broad extension because of the difficulty of the stratigraphic correlation (El-Khoriby, 2003).

Magnetization of these rocks could play an important role in the stratigraphic correlation of the Nubia sandstone formations. Although, the Nubia sandstone rocks were studied paleomagnetically by many authors (e.g. El-Shazly and Krs, 1973; Hussain et al., 1976; Schult et al., 1978, 1981; Ibrahim, 1993), the majority of these previous studies treated all Nubia formations as a single unit.

The use of magnetization of these rocks as a new tool for the correlation process requires an intensive paleomagnetic investigation for each formation separately. This will produce a paleomagnetic database for the Nubia sandstone formations that could help (with other geologic tools) in solving this problem.

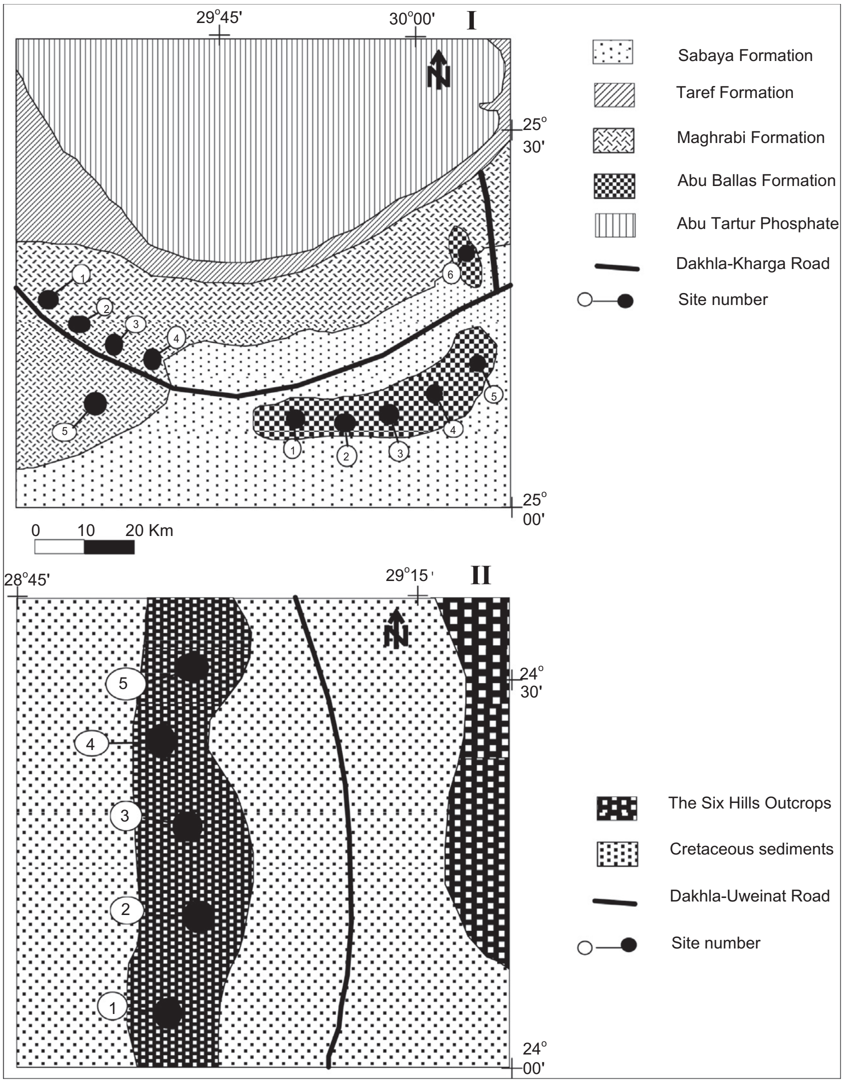

Fig. 2 (I) Sampling location map of Abu Ballas and Maghrabi formations (simplified after EGPC/CONOCO map sheet Dakhla, 1987). (II) Sampling location map of the Six Hills formation (simplified after Hendriks and Kallenbach, 1986).

The Nubia sandstone formations in the Western Desert of Egypt represent an interesting target to begin such studies, as this area is a part of the stable shelf (Said, 1962).

The purpose of this study is to investigate the magnetization carried by these rocks and to use paleomagnetism in dating its magnetization. It will be valuable, on the light of the obtained results, to try understanding the postdepositional processes that may have influenced the magnetization of these formations.

The results of the present study may produce a new Cretaceous paleomagnetic pole(s) that will enrich the proposed data base.

1.1. Nubia sandstone in the Western Desert

Klitzsch (1978) and Klitzsch et al. (1979) divided the Nubia sandstone deposits in the Western Desert into five formations ranging in age from Neocomian to Aptian. These are, from older to younger, the Six Hills formation (Basal Clastic Unit), Abu Ballas formation (Lingula Shale Unit), Sabaya formation (Desert Rose Unit), Maghrabi formation (Plant Bed Unit of marine environment) and the youngest Taref formation (Taref Sandstone Unit).

In the present studies, the authors choose three sedimentary formations from the central Western Desert of Egypt for paleomagnetic studies. Two of these formations are of the Early Cretaceous age (the Six Hills and Abu Ballas formations) represent the oldest deposits in this area and the third (Maghrabi formation) is of the Late Cretaceous composed of Marine deposits.

1.2. The Six Hills formation (Neocomian–Barremian)

The Six Hills formation reaches up to 500 m in thickness in its type area (24° 10′ N, 29° 15′ E) at about 100 km south of Mut in Dakhla. It is generally assigned to the late Jurassic-early Cretaceous age (Klitzsch and Lejal-Nicol, 1984). In the subsurface based upon pollen investigations, Helal (1965) and Soliman (1977) referred the lower part of The Six Hills formation to the late-Jurassic.

1.3. Abu Ballas formation (Aptian)

The Abu Ballas formation was divided by Bottcher (1982) into seven units, three of which consist of claystones and four of siltstones and sandstones. This formation is of shallow marine to deltaic origin (Bottcher, 1985; Klitzsch, 1978). This formation is thought to be of Aptian age (Bottcher, 1982; Schrank, 1982), basing on comprehensive paleontological and paleocological studies.

1.4. Maghrabi formation (Cenomanian)

The rocks of this formation consist of interbedded claystones, siltstones and sandstones. The basal flaser-bedded sandstone at the base of this formation is of the Cenomanian age (Klitzsch and Lejal-Nicol, 1984), while the overlying shale, siltstone and sandstone are less fossiliferous. Glauconitic sand layers contain poorly preserved remains of lamellibranches and fish teeth from shallow marine to tidal flat sedimentation and was correlated with the fluviomarine sediments of the Cenomanian Bahariya formation by Dominik (1985).

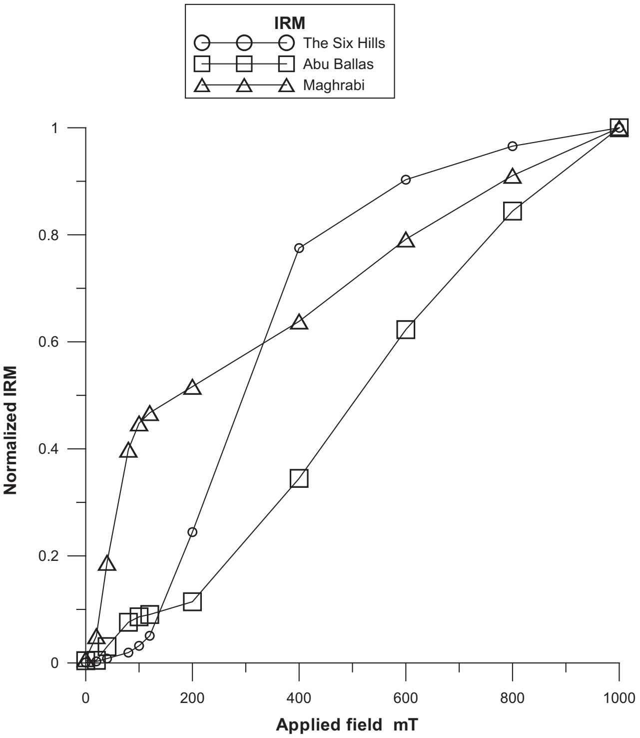

Fig. 3 Examples of IRM acquisition curves for the studied formations.

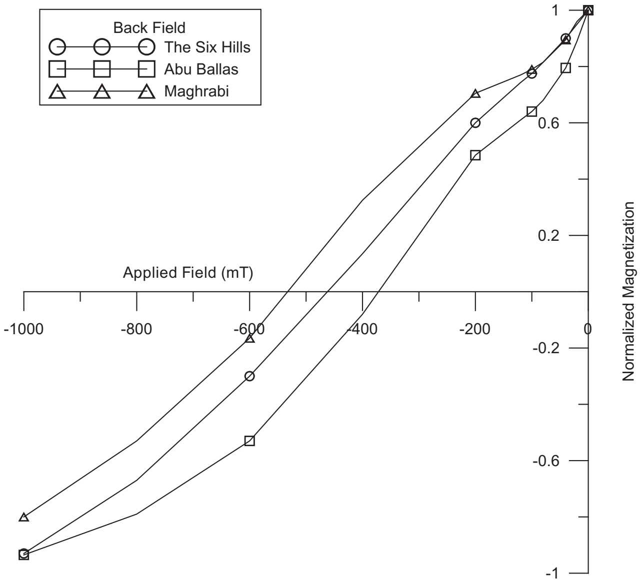

Fig. 4 Examples of back field curves for representative samples from the studied formations.

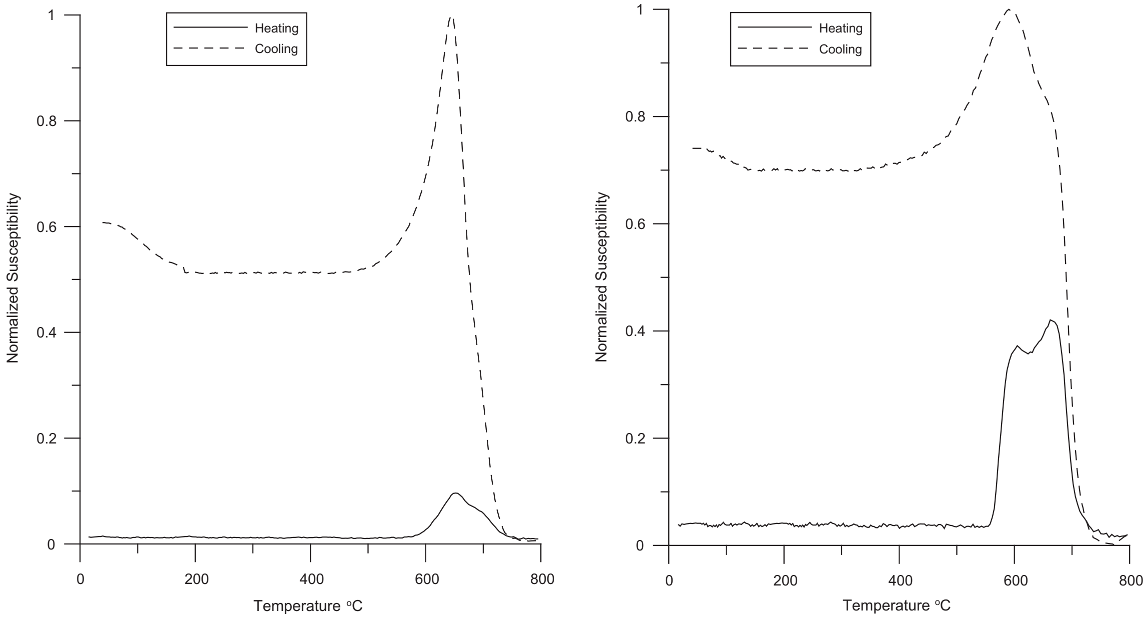

Fig. 5 Susceptibility vs temperature curve for the Six Hills formation on the left and for Abu Ballas formation on the right.

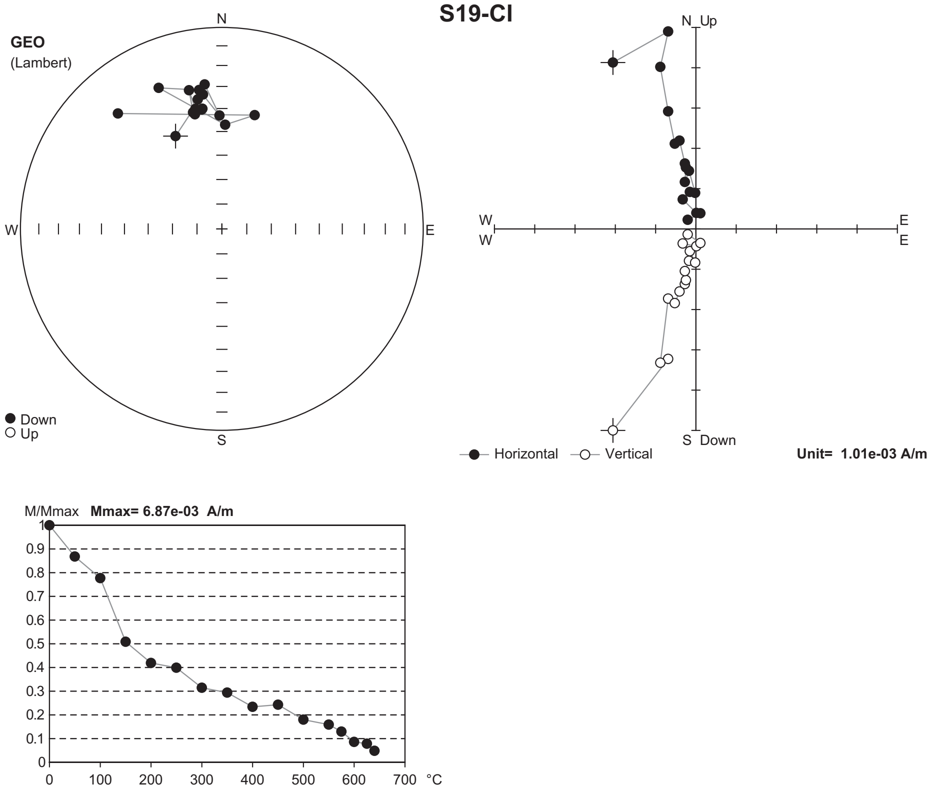

Fig. 6 Thermal demagnetization plots [Stereonet, Zijderveld diagram (Zijderveld, 1967) and intensity decay curve] for a representative specimen from the Six Hills formation.

2. Sampling

A total of 198 oriented specimens from sixteen sites have been collected from surface outcrops of the three investigated formations (Fig. 1) within an area between longitudes 29–30.5° E and latitudes 24–26° N. The samples have been collected from an area around the Kharga–Dakhla and Dakhla–Uwainat roads from which 67 specimens are collected from 5 sites from the Six Hills formation, 73 specimens at 6 sites from the Abu Ballas formation and 58 specimens are taken from 5 sites from the Maghrabi formation (Fig. 2I and II). Sampling is performed using a portable drilling machine and the orientation is carefully done using magnetic compass.

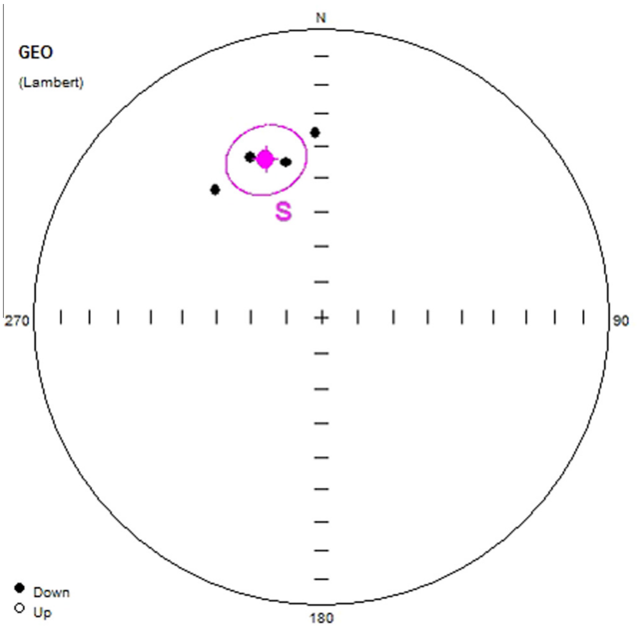

Fig. 7 Stereographic projection of site mean direction for the Six Hills formation.

Table 1 Demagnetization results of the Six Hills formation.

Site No.	*N*	*D* (°)	*I* (°)	α_{95} (°)	*K*	VGP	
						P_Lat. (°N)	P_Long. (°E)
S1	9	347	44	5.3	56	78.3	303.2
S2	9	336	39	7.1	50	67.8	295.1
S3	8	358	36	11.2	52	84.2	227.8
S4	7	320	42	4.8	53	53.8	305.8
S5	9	340	42	5.5	54	71.8	299.3
Mean (S)	42	340.5	41.3	10.6	57.5	72.2	297.4

Key: N, number of specimens (sites in mean) exhibit the specific component; *D*, declination; *I*, inclination, α_{95}, radius of 95% circle of confidence (Fisher, 1953) for mean direction; *K*, precision parameter (Fisher, 1953); P_Lat., P_long., latitude and longitude of the Virtual Geomagnetic Pole.

3. Rock magnetism

The identification of the magnetic minerals existed within the studied rocks, which may represent the magnetic carriers, has been done using several rock magnetic experiments. These experiments include construction of IRM acquisition curves, back field curves and behavior of susceptibility during heating.

The isothermal remanent magnetization (IRM) acquisition curve is constructed for several samples representing all sampled sites using pulse magnetizer of MM9P type. Fig. 3 represents an example of the constructed IRM curves for the studied formations. The constructed curves show that the studied samples did not reach the saturation state until 1000 mT, revealing the presence of hard magnetic mineral(s).

Back field curves constructed for the same samples show that the existing magnetic mineral is of high coercivity values, ranging in general from 350 to 570 mT (Fig. 4). This coercivity values range from 350 to 550 mT for the Six Hills formation, 370–560 mT for Abu Ballas formation and from 330 to 520 mT for the Maghrabi formation. This hard magnetic mineral of high coercivity could be hematite and/or goethite.

The behavior of magnetic susceptibility during continuous heating for representative samples has been performed using MFK1 KAPPABRIDGES of AGICO. The obtained thermomagnetic curves (Fig. 5) reveal that the Curie temperature of the existing magnetic mineral ranges in values from 620 to 680 °C. Such high values of coercivity and Curie temperature characterize the hematite mineral. This mineral could carry a stable magnetization within the investigated samples.

4. Demagnetization

Demagnetization processes have been performed on the sampled specimens to isolate the magnetic component(s) carried by these samples, using both thermal and alternating field (AF) demagnetization. Thermal demagnetization has been done using non-magnetic thermal demagnetizer of Magnetic Measurements (MMTD80). In addition, AF demagnetization has been carried (within a magnetically shielded room) using the Degausser attached with the 2-G SQUID at the Paleomagnetic Lab., University of Montpellier, France. The magnetic remanence of the specimens has been measured using both Spinner and Cryogenic magnetometers.

The presence of hematite (high coercive mineral) as the magnetic mineral carrying the magnetization within the studied rocks, makes the AF technique not to be an effective one. Therefore the stepwise increasing thermal technique up to 690 °C is mainly used in the present work.

An analysis of the demagnetization data has been done, using the Remasoft 3.0 computer program, to separate the characteristic magnetic components carried by each specimen. After getting the mean direction of each site and the site means, the mean of the corresponding Virtual Geomagnetic Poles (VGPs) has been calculated using Fisher statistics (Fisher, 1953), representing the paleomagnetic pole position for the studied formations.

4.1. The Six Hills formation

This formation has low intensities of remanence ranging from 0.2 to 8.2×10^{-3} A/m. The susceptibility values of the studied specimens are very low, ranging from −2 to 9×10^{-6} SI units. These values reflect the dominance of diamagnetic and paramagnetic materials.

Example of thermal demagnetization data for a representative sample from the Six Hills formation is shown in Fig. 6. This example shows the presence of a stable single magnetic component of high unblocking temperatures (>650 °C), revealing that the hematite is the carrier of this magnetization.

All magnetic components isolated from The Six Hills formation show a normal polarity (Fig. 7).

The obtained mean direction is Dec. = 340.5°, Inc. = 41.3°, and α_{95} = 10.6° and the corresponding paleopole lies at Lat. = 72.2° N and Long. = 297.4° E (Table 1).

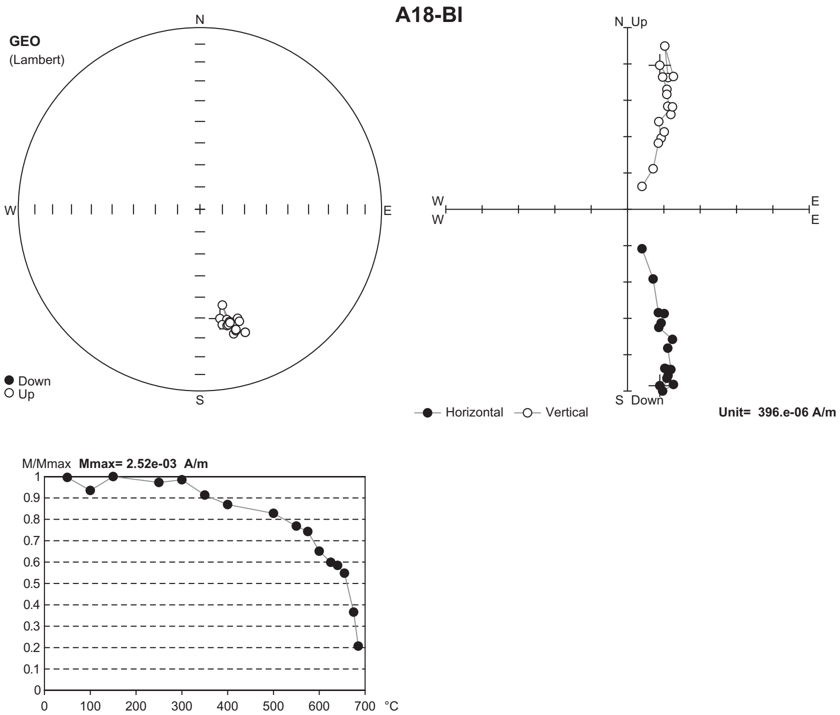

Fig. 8 Thermal demagnetization plots for a representative specimen from Abu Ballas formation (reverse polarity).

Table 2 Demagnetization results of Abu Ballas formation.

Site No.	*N*	*D* (°)	*I* (°)	α_{95} (°)	*K*	VGP	
						P_Lat. (°N)	P_Long. (°E)
A1	9	165	–40.4	5.8	55	76.1	292
A2	9	169	–41	6.2	64	79.8	290
Mean(Ar)	2	167	–40.7	6.7	374	78.4	290.6
A3	8	356	47	6.8	30	85.5	337
A4	7	342	43	8.2	32	73.7	301.1
A5	9	358	39	7	26	86.1	237.3
A6	10	359.4	40.6	9.6	34	87.6	222.5
Mean(An)	4	354	42.5	7.8	139.5	84.5	291
Mean(A)	6	350.5	41.7	24.0	12.1	81.2	291.2

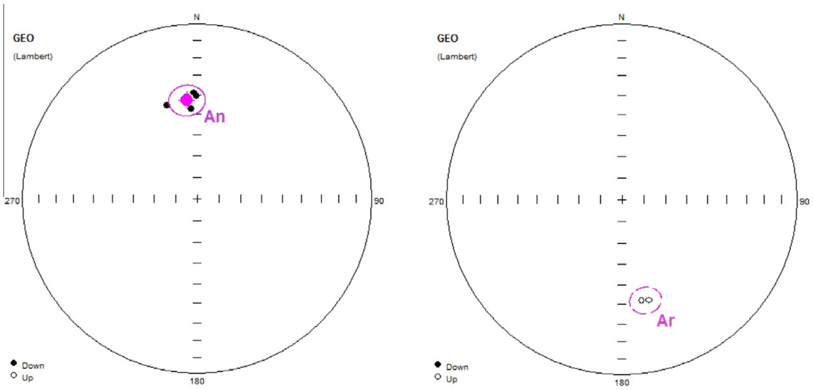

Fig. 9 Stereographic projection of the Abu Ballas formation site mean direction (normal polarity on the right and reverse polarity on the left).

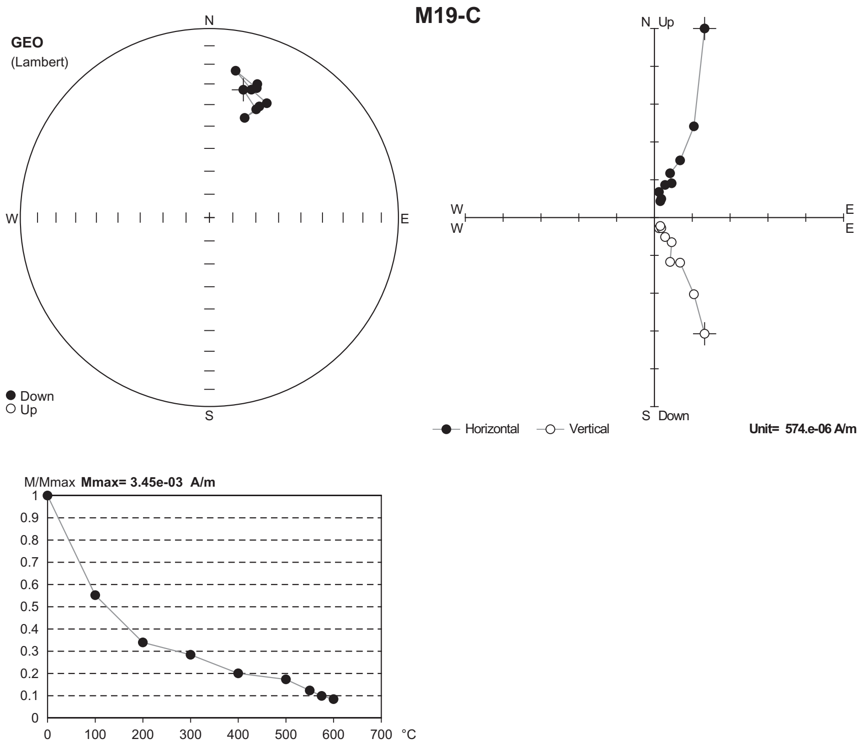

Fig. 10 Thermal demagnetization plots for a representative specimen from the Maghrabi formation.

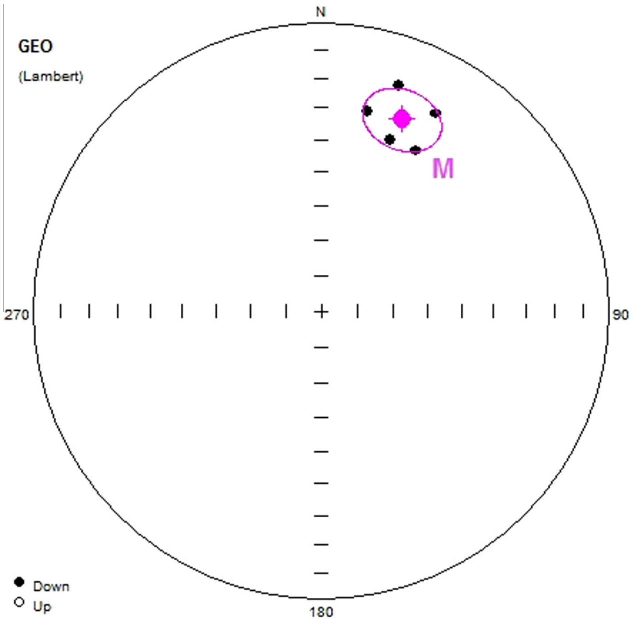

Fig. 11 Stereographic projection of the Maghrabi formation site mean direction.

4.2. *Abu Ballas formation*

The intensity values of natural remanent magnetization of this formation are relatively low, ranging from 0.6 to 35.4×10^{-3} A/m. Also the values of the magnetic susceptibility of these specimens are very low, ranging between −2 and 5×10^{-6} SI units. This reflects the predominant effect of the diamagnetic and paramagnetic materials.

Table 3 Demagnetization results of the Maghrabi formation.

Site No.	N	D (°)	I (°)	α_{95} (°)	K	VGP	
						P_Lat. (°N)	P_Long. (°E)
M1	7	30	21.7	7.5	33	58.3	140.1
M2	7	21.8	36	6.7	42	69.2	129.9
M3	8	30.5	35.5	5.8	34	61.3	124.5
M4	9	12.8	29.5	8	42	74.6	155.6
M5	7	18.9	18.3	6	43	65.9	157.5
Mean (M)	5	22.7	28.4	9.9	61	66.3	140.6

Key: see Table 2.

Table 4 Mean directions and pole positions for the Six Hills and Abu Ballas formations.

Formation	N	Dec°	Inc°	Pal_lat	α_{95}	VGP	
						P_lat. (°N)	P_long. (°E)
The Six Hills	5	340.5	41.3	23.7	10.6	72.2	297.4
Abu Ballas	6	350.5	41.7	24.0	12.1	81.2	291.2
Mean	11	347.1	41.6	24.0	7.8	78.2	294.1

Key: N, number of sites from each formation; *D*, mean declination; *I*, mean inclination, P_lat. and P_long., latitude and longitude of the paleopole; Pal. Lat., paleolatitude.

Table 5 Pole positions obtained for the Egyptian Nubia sandstone.

Pole No.	Location	Paleopole		References
		Lat. (°N)	Long. (°E)	
1	N.S.S and lava, Egypt	66.5	217.9	El-Shazly and Krs (1973)
2	W. Natash, Egypt	69.0	258.0	Schult et al. (1981)
3	Qena, N.S.S., Egypt	76.0	265.0	Hussain et al. (1976)
4	N.S.S. and iron ores, Egypt	80.0	227.0	Schult et al. (1978)
5	Idfu-Mersa Alam N.S.S, Egypt	80.0	252.0	Schult et al. (1978)
6	W. Natash N.S.S., Egypt	82.0	230.0	Schult et al. (1981)
7	East Owienat N.S.S., Egypt	77.0	258.0	Hussain and Aziz (1983)
8	N.S.S., G. El Minsherah, Egypt	84.0	257.0	Ibrahim (1993)
9	N.S.S., G. El Halal, Egypt	78.0	288.0	Ibrahim (1993)
10	N.S.S. Central Eastern Desert, Egypt	74.0	244.0	El-Hemaly et. al. (2004)
11	Nubia S.S.W. Desert, Egypt	78.0	294.0	This study

Table 6 Selected Cretaceous paleopole positions of Africa.

	Rock Unit	Age	Paleopole		References
			Lat. (°N)	Long. (°E)	
1	North Sudan Volcanic Field	61–82	56	274	Saradeth et al. (1989)
2	Melilite basalts, S. Africa	64–77	85	243	Duncan et al. (1978)
3	Qusier Trachytes, Egypt	63–92	63	252	Ressetar et al. (1981)
4	East El Oweinat Vol., Egypt	65–97	68	296	Hussain and Aziz (1983)
5	Gebel El Kahfa Ring Complex, Egypt	74–95	61	238	Ressetar et al. (1981)
6	Abu Khrug Ring Complex, Egypt	87–91	59	266	Ressetar et al. (1981)
7	Group I Kimberlites, S. Africa	81–100	64	226	Hargaraves (1989)
8	Wadi Natash Volcs., Egypt	86–100	69	258	Schult et al. (1981)
9	Wadi Natash ss.&volcs., Egypt	78–111	64	218	El-Shazly and Krs (1970)
10	Wadi Natash Intrusions, Egypt	78–111	76	228	Ressetar et al. (1981)
11	Kars Souk Red beds, Morocco	65–145	66	227	Martin et al. (1978)
12	Lupata Volcanics, Mozambique	109–113	64	257	Gough and Opdyke (1963)
13	Kaoko Basalts, Namibia	120–140	56	264	Gidskehaug et al. (1975)
14	Beni Mellal Intrusive, Morocco	110–130	46	258	Westphal et al. (1979)
15	Infra Cenomanian seds., Morocco	98–144	75	227	Hailwood (1975)
16	Mlanje Synite, Malawi	119–131	64	258	Briden (1967)
17	Group II Kimberlites, S. Africa	113–145	56	268	Hargaraves (1989)
18	El Naga Ring Complex, Egypt	~ 140	69	268	Abd El-All (2004)
19	Wadi Abu Shait Dikes, Egypt	65–200	51	272	Hussain et al. (1979)
20	Nubia S. S. W. Desert, Egypt	113–124	78	294	This study

Demagnetization processes performed on the studied samples from this formation reveal the presence of a stable single component carried by hematite. Both intensity and direction of the magnetization seems to be stable till the unblocking temperature (650–675 °C), after which a drop of about 90% of the intensity is noticed (Fig. 8). This indicates that this magnetization is carried by coarse grain hematite.

The components isolated from this formation show both normal and reverse polarity. Components of reverse polarity have been isolated from two sites (A1 and A2), with the mean value being Dec. = 167.0°, Inc. = 40.7°, and $\alpha_{95} = 6.7°$, with corresponding paleopole lying at Lat. = 78.4° N and Long. = 290.6° E ("Ar" Table 2 and Fig. 9).

The normal polarity components have been isolated from four sites (A3–A6) and the mean of these normal polarity components has Dec. = 354.5°, Inc. = 42.5°, and $\alpha_{95} = 7.8°$, with corresponding paleopole lying at Lat. = 84.5° N and Long. = 291° E ("An" Table 2 and Fig. 9).

The mean direction obtained for the two groups after inverting the reversed polarity to normal polarity is, Dec. = 350.5°, Inc. = 41.7°, and $\alpha_{95} = 12.1°$, with corresponding paleopole lying at Lat. = 81.2° N and Long. = 291.2° E ("A" in Table 2).

The presence of normal and reversed polarity (Fig. 9 and Table 2) carried by coarse grained hematite in this formation indicates the primary origin of that component.

4.3. Maghrabi formation

The samples from this formation also show low intensity values of NRM ranging from 0.13 to 4.52×10^{-3} A/m, and low susceptibility values ranging from -2 to 2×10^{-6} SI units.

Demagnetization processes for the studied samples from this formation show that these samples carry a single stable component of normal polarity with high unblocking temperature carried by hematite. Fig. 10 shows demagnetization plots

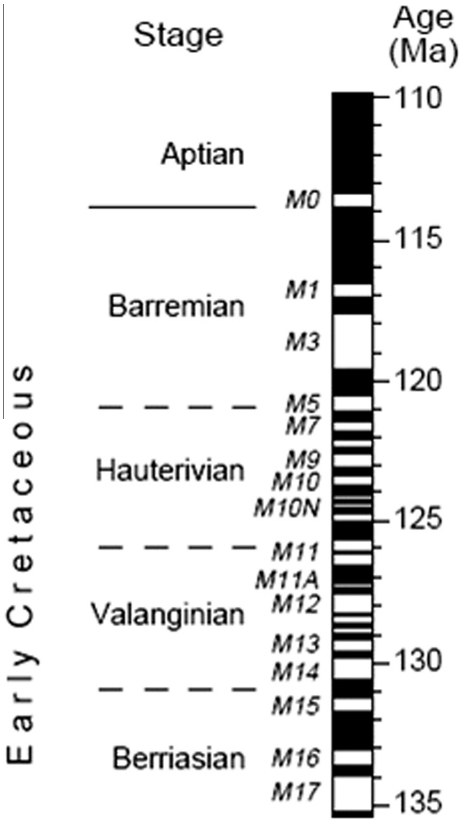

Fig. 12 The geomagnetic polarity time scale of Lowrie and Ogg (1986) for the Late Jurassic and Early Cretaceous. Geologic time divisions are shown to the left of the polarity column, and the absolute age scale is given to the right of the column; "M anomaly" designations of reversed polarity chrons are given in italics at the left of the polarity column. Redrawn from Lowrie and Ogg (1986).

for one sample from the Maghrabi formation. In this figure, the intensity of magnetization is gradually decreased with the increase of temperature losing about 90% of its initial value at 650 °C. This reflects stable magnetization carried by fine grained hematite.

The mean direction obtained from this formation is, Dec. = 22.7°, Inc. = 28.4° (Fig. 11), and α_{95} = 9.9° and the corresponding paleopole lies at Lat. = 66.3° N and Long. = 140.6° E (Table 3).

5. Discussion

The rock magnetic investigations of the studied samples from the three formations prove that hematite is the main carrier of magnetization. The low susceptibility values obtained for these rocks indicate the dominant effect of the diamagnetic and paramagnetic minerals, as well as the low content of the magnetic minerals.

Thermal demagnetization is mainly used in this study. According to demagnetization results, the three studied formations carry stable single magnetic components of high unblocking temperature carried by hematite. Tables 1–3 summarize the mean values of the obtained components.

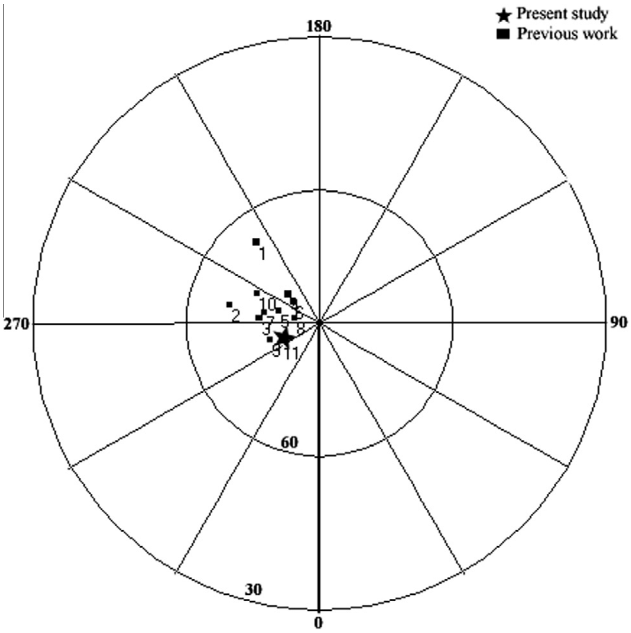

Fig. 13 The previous obtained Nubia sandstone poles with the pole of the present study (star). Number of poles see Table 5.

5.1. The Six Hills formation

The magnetic components isolated from the Six Hills formation have a mean direction (S) with Dec. = 340.5°, Inc. = 41.3° and the corresponding pole lies at Lat. = 72.2° N and Long. = 97.4° E (Tables 1 and 4). Comparing this pole with the corresponding published Cretaceous poles for Africa and other poles obtained for the Nubia sandstone Tables 5 and 6, respectively, reveals a good agreement with poles of similar age. This gives an indication of the primary origin of this magnetization. Unfortunately, fold test could not be applied in the present study, as these rocks are dipping in the same direction.

5.2. Abu Ballas formation

Demagnetization of the studied samples from Abu Ballas formation shows a single and stable component with normal and reverse polarity. The presence of normal and reversed polarity in this formation can be understood in the light of the geomagnetic polarity time scale (Fig. 12) of Lowrie and Ogg (1986) for the same age of this formation (Aptian). This figure shows reverse geomagnetic field during the lower most part of the Aptian (M0) and the rest is of normal polarity. This gives an indication that the obtained component could be a real component of primary origin.

There is good agreement between the obtained pole from Abu Ballas formation and other published poles (Tables 5 and 6), revealing that the pole obtained from Abu Ballas formation reflects its age and also confirms that its magnetization is primary Fig. 13.

According to the similarity of the two poles obtained from the Six Hills formation and Abu Ballas formation, a mean pole is calculated from the two poles (Table 4), to represent the Paleomagnetic pole of the Lower Cretaceous Nubia sandstone in the Western Desert.

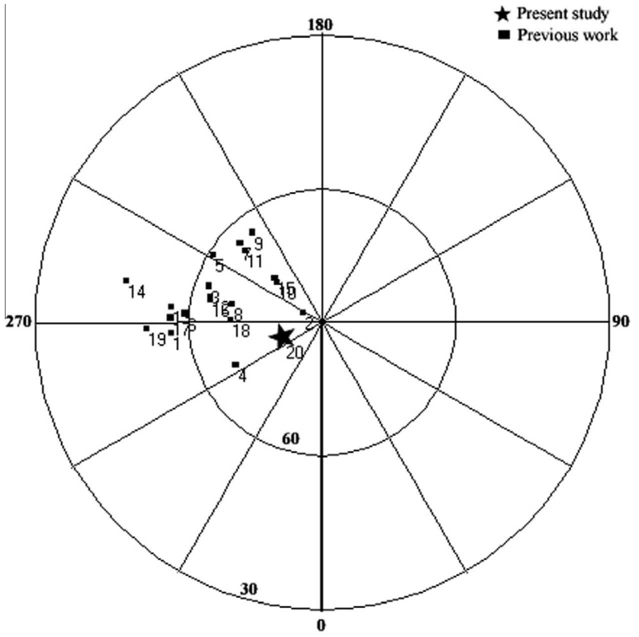

Fig. 14 The previous obtained poles of Africa with the pole of the present study (No. 20). Number of poles see Table 6.

Table 7 Some selected Eocene pole positions of Egypt.			
Rock unit, location	Paleopole		References
	Lat. (°N)	Long. (°E)	
1 Mokattam limestone	73	147	Kafafy et al. (1995)
2 Maadi limestone	75	150	Kafafy et al. (1995)
3 Mokattam limestone	78	163	Abdeldayem (1999)
4 Maghrabi formation	66.36	140.6	This study

5.3. Maghrabi formation

Samples from the Maghrabi formation also possess stable single component magnetization carried by fine grain hematite (Table 3). The pole obtained from this formation is inconsistent with the Cretaceous pole positions for North Africa (Table 6), but falls closer to the Eocene (40 Ma age) pole (Table 7 and Fig. 14), indicating that the studied rocks of the Maghrabi formation could have suffered a complete remagnetization postdepositionally, most probably during the late Eocene time Fig. 15.

This means that the hematite mineral carrying this magnetization in the Maghrabi formation is of secondary origin and seems to be precipitated within these rocks due to the weathering and hydrothermal activities that characterize several areas of Egypt (Van Houten et al., 1984).

The hypothesis of the remagnetization processes for this formation seems to be a regional phenomenon. Remagnetization process for the Nubia sandstone rocks from the Western Desert (Bahariya formation) was also reported by Odah (2004). Also El-Hemaly et al. (2004) find a similar remagnetization process of the Nubia sandstone rocks from the Eastern Desert.

Such hypothesis could be accepted as it came combatable with the available geologic information. El Kammar and El Kammar (2002) claimed that the Nubia sandstone rocks have been subjected to diagenetic changes by the act of meteoric water and thermal activities. One of these phases of diagenetic changes, which occurred during the Late Eocene and Early Oligocene caused the oxidation and dissolution of the primary iron bearing minerals and precipitated the iron in the form of hematite. Moreover, Issawi et al. (1999) stated that there were periods of heavy rain fall and activity of surface water during Oligocene that could lead to the addition and precipitation of secondary magnetic minerals, more probably hematite. This agrees with the rock magnetic results that indicate the fine grain hematite is the main carrier of magnetization in this formation.

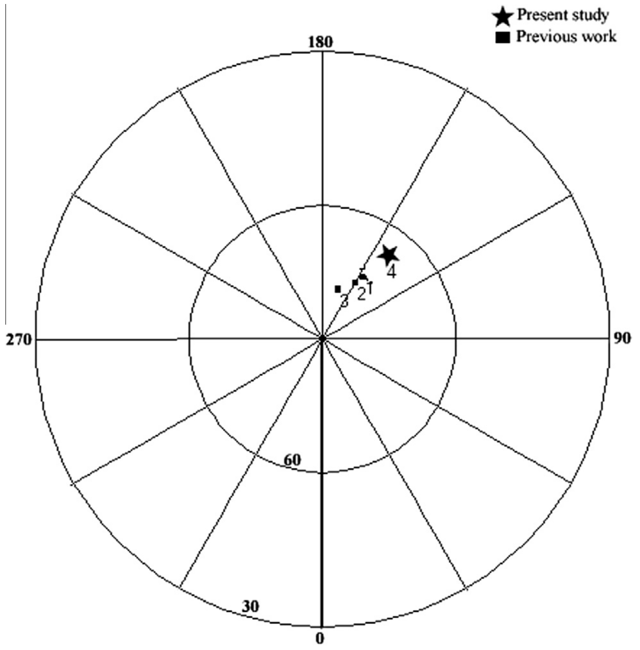

Fig. 15 Selected Eocene poles with the pole of the present study (No. 4). Number of poles see Table 7.

6. Conclusion

Magnetization carried by the two Lower Cretaceous Nubia sandstone formations (the Six hills and Abu Ballas formation), is of primary origin carried by coarse grain hematite.

The magnetization of the Abu Ballas formation is of mixed polarity that could be used in correlation process.

The magnetization of the Maghrabi formation (of Upper Cretaceous age) is of secondary origin carried by fine grained hematite. This postdepositional magnetization was acquired in this formation due to the late diagentic process at Eocene time.

The remagnetization of this formation seems to be a regional phenomenon for the upper Cretaceous Nubia formations. It has been reported from other localities in the Eastern and Western Desert of Egypt. This phenomenon also could be used in the correlation processes.

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