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REGIONAL SITING OF EL DABAA NUCLEAR POWER PLANT EGYPTIAN NATIONAL PROJECT

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ABSTRACT

The area is located on the Northern Western Desert of Egypt from latitudes 30°N to 32°N and from longitudes 27°E to 30°E. The area includes Ras El Dabaa location, the first candidate site to receive the national project in the nuclear power plant, where it is directly located on the Mediterranean Sea shore.

In seeking a site for a Nuclear Power Plant (NPP) a utility must balance the engineering and economic factors with the special requirement to minimize the radiological risk.

This work will provide some insights into the issues involved in siting a nuclear power plant, from the perspective of both the utility and regulator. Among these we will present the general factors associated with the siting of large electrical generating plants; the special factors associated with selection and approval of El Dabaa site for nuclear power plant through studying its geology, fracture lineaments and topography at regional scale (1:500,000).

Results of this integrated study show that Ras El Dabaa location satisfies the safety standards of the IAEA 2002, 2003 and 2012 as well as the NRC 2006 and 2014, where it exhibits low topography, very low seismic activity, and low radioactivity while surface fracture lineaments density and trend analyses indicate a NE-SW predominant fracture trend with densities within the safe levels. These factors support and facilitate the security plans, emergency measures and evacuation plans if needed, while the direct location on the Mediterranean guarantees the continuous, easy and sufficient supply of water. Thus, Ras El Dabaa area could be considered to be the first candidate site to receive the nuclear power plant national project of Egypt.

INTRODUCTION

The requirement for siting of NPP would be different for every country where they are controlled by their own regulatory bodies (Khattak et al., 2017). An important stage in the development of a nuclear power project is the selection of a suitable site to establish the site-related design inputs for Nuclear Power Plant (NPP). The main objective in site evaluation for nuclear installation in terms of nuclear safety is to protect the public and environment from the radiological consequences of radioactive releases due to accidents as well as due to normal operation (IAEA, 2003). The uncertainties of various factors involved in the nuclear power plant site selection influence on the ultimate practical power generation as well as imposing a threat on the safety and stable operation of equipment units (Yun-na Wu et. al., 2012). A regulatory consideration for (NPP) site selection process includes geologic/seismic, hydrologic, and meteorological characteristics of proposed sites (Atomic Energy Licensing Board, 2011). NPPs shall be designed to prevent the loss of safety-related functions. Generally, the most restrictive safety-related site characteristics considered in determining the suitability of a site are: 1) Geologic-related hazard; 2) Capable tectonic structures and surface faulting and deformation; 4) Seismicity; 5) Environmental factors; 6) Population considerations; 7) Emergency planning; 8) Security plans; 9) Industrial, military and transportation facilities; 10) Land use and aesthetics; 11) socioeconomics (NRC, 2014). These site characteristics increase the importance of the siting (investigation and evaluation) especially that it will hold the national project of nuclear power plant.

Egypt is located within a zone of the plate boundaries, from the eastern side, the Red Sea Rift which is a zone of plate separation along which sea-floor spreading separates the African plate and Arabian plates apart, from the northeastern part, the Gulf of Aqaba–Dead Sea transform fault, which is a major left-lateral strike slip fault, from the north Egypt is bounded by a subduction zone, where the African plate subducts beneath the Eurasian plate at the Cyprean and Hellenic Arcs (Mohamed et. al., 2012). This site characteristics increase the importance of the siting (investigation and evaluation) especially that it will hold the national project of nuclear power plant.

The main purpose of the present work is to study the El Dabaa site at the regional scale to establish its suitability to hold the Egyptian nuclear power plant national project. This work has been achieved through the integration of the geological, regional seismicity and earthquake history, airborne radiometric and topographic data sets as well as Landsat images and the extracted fracture lineaments of the area.

LOCATION OF THE AREA

The study area is located on the Northern Western Desert of Egypt from latitudes 30°N to 32°N and from longitudes 27°E to 30°E (Fig. 1), while Ras El Dabaa location is directly located on the Mediterranean Sea shore.

REGIONAL INVESTIGATIONS

Geological Outlines

A nuclear power plant involves large sized buildings which require sound foundation, so the site should provide coherent lithology as well as stable geological structures, whilst the potential for liquidification, as may be caused by an earthquake, should be evaluated and avoided (Boyd, 1997).

Lithologically (Fig. 2), the area under investigation is covered by plate form Cenozoic sedimentary rocks belonging to both Tertiary and Quaternary (Said, 1990). The Tertiary rocks are classified into Pliocene, Middle Miocene and Lower Miocene.

- ***Pliocene*** rocks in the area are represented by El Hagif Formation, white shallow marine limestone with interbedded marl, grading into pink marly limestone towards El Dabaa in the west.

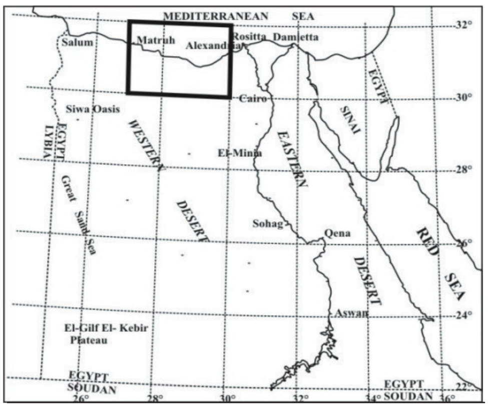


Fig. 1 : Location map of Ras El Dabaa area environs

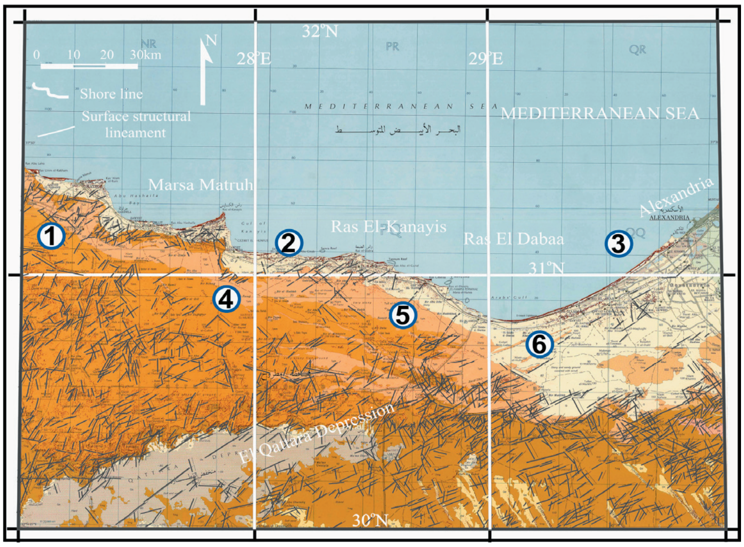


Fig. 2 : Geological map of Ras El Dabaa area environs, after Conoco, 1987. Circled numbers represent the studied sectors

- ***Middle Miocene*** rocks are represented by Marmarica Formation; Fossiliferous shallow marine platform limestone with few marly intercalations.

- ***Lower Miocene*** in the area is represented by Moghra Formation. Comprising continental to shallow marine clastic sequence including shale and white sandy carbonate beds, vertebrates, silicified wood, and marine echinoids. Intercalations of shallow marine sediments increase in frequency from east to west. Uppermost carbonate layer transitional to Marmarica Fm. in the west.

- ***Quaternary*** rocks sequence in the area represented from the younger to the older by: Nile Sill, Sand sheet, Sand dunes, Stabilized dunes, Wadi deposits, Sabkha deposits, silt, clay, evaporites, Gravel, Calcarenite bars of Pleistocene age (Alexandria Fm), Chalky, marly, arenaceous oolitic beach ridges, Undifferentiated Quaternary deposits, Ducricrusts, sand, gravel, recent coastal deposits. Thus, the study area shows almost coherent lithologic characters that could fit the NPP requirements.

Fracture Lineaments Analyses

Remote sensing sensors and aerial photography continuously provide an unintermittent flow of images and photos from which lineaments maps can be prepared. These surface features when properly identified, can usually be assumed to reflect subsurface formations and the structural framework of an area. The preparation of lineament density maps is important, especially when integrated them with other maps for mineral, oil and ground water exploration (Mostafa and Qari, 1995 and Mostafa and Bishta 2005) as well as for preparing seismic risk maps necessary for site investigations (Zakir et. al. 1999).

The area has been examined for surface fractures which enabled the setting of a fracture lineaments map (Fig. 4) through tracing the fracture lineaments from the geological map of Conoco (Fig. 2) and the Land Sat image of the area (Space Atlas of Misr) (Fig. 3), exhibiting 1797 fracture lineaments with 8441km total length. In the present study three analyses of surface fracture lineaments

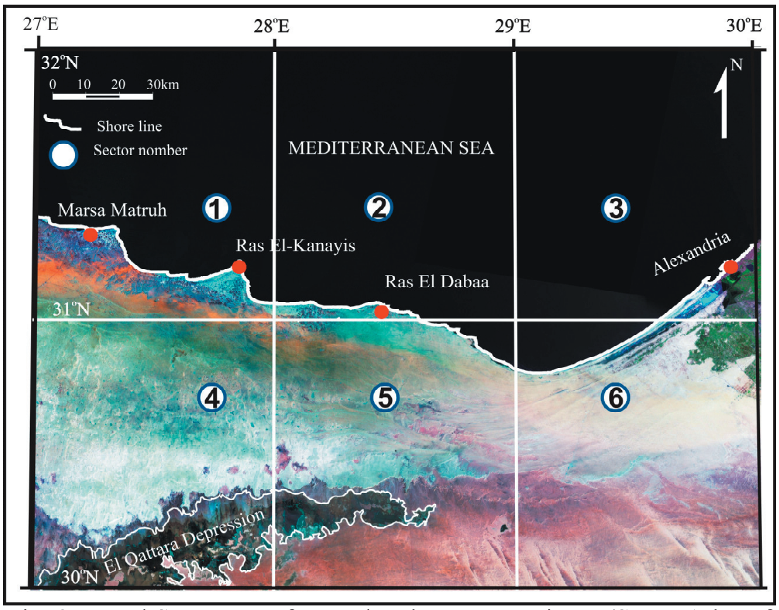


Fig. 3 : Land Sat Image of Ras El Dabaa area environs (Space Atlas of Misr, 1990)

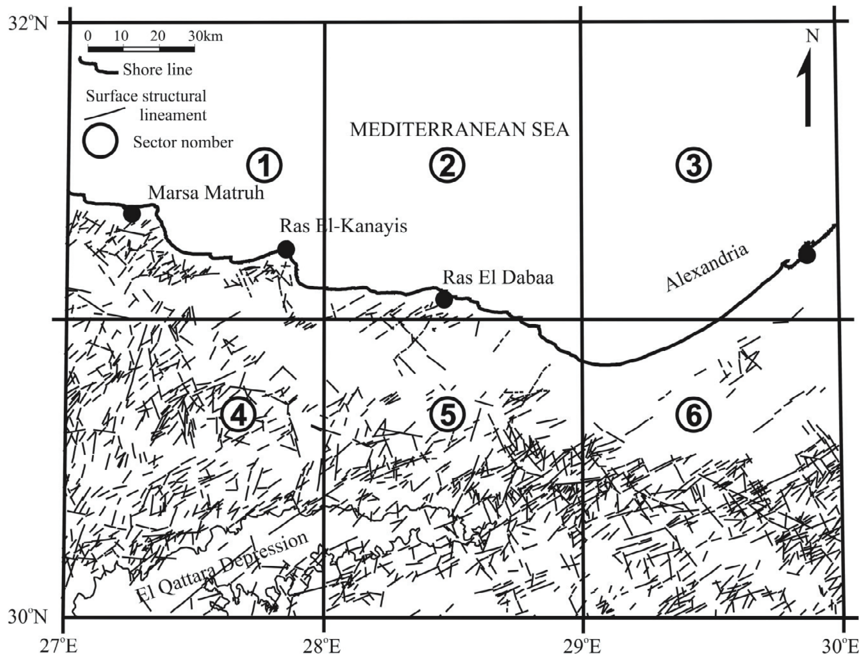


Fig. 4 : Fracture lineaments map of Ras El Dabaa area environs

evaluation were presented including (1) density analysis, (2) length analysis, and (3) orientation analysis.

The investigated area is divided in this work into six sectors each of them occupy 1°latitude and 1° Longitude (Figs. 2 & 3). The lineaments trends analyses are carried out on the lineaments on the area totally and then on each sector according to number and length. The fracture lineaments of sector number 3 could not be traced due to the earthworks and land uses in different human activities. The emerged land areas in sectors 1 and 2 are calculated and only taken in consideration on the analyses excluding the areas covered with the Mediterranean Sea water.

The analyses indicates that the study area is affected by multi-directional sets of surface fractures and considered as stable geological structures, where the potential for liquidification that may be caused by an earthquake didn't recorded among its seismic history.

The trend analyses of the lineaments affecting the area (Table 1) indicate that their distribution according to the number and length percentages are the same exhibiting that the NE-SW is the most predominant trend followed by the ENE-WSW, NNE-SSW, NNW-SSE, N-S, NW-SE, E-W and WNW-ESE in descending order.

The length analysis of the lineaments in the area is carried out according to the classification of El-Etr, 1974. This analysis (Table 2) indicates that the brachy lineaments are the most abundant in both number (99.25%) and length (99.33%), while the mezo lineaments represent the second in number and the third in length, whilst the macro lineaments are the third in number and the second in length. This dis-agreements between the number and length abundances is attributed to the segmentation of the fractures. The analysis indicates

Table 1 : Total lineaments trends distribution in Ras El Dabaa area environs

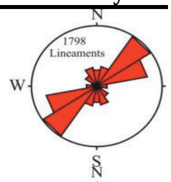
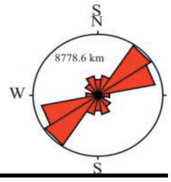
Distribution parameter	Lineaments Trends								
	N-S	NNE-SSW	NE-SW	ENE-WSW	E-W	NNW-SSE	NW-SE	WNW-ESE	Lineaments analyses
N%	8.7	10.4	31.2	25.1	5.1	10.1	6.7	2.7	
L%	8.12	9.82	29.7	27.1	5.54	9.7	7.01	3.01	

Table 2 : Lineaments length analysis in Ras El Dabaa area environs

Mezo.		Brachy.		Macro.		Miga.	
N%	L%	N%	L%	N%	L%	N%	L%
0.58	0.2	99.25	99.33	0.17	0.46	00	00

the absence of the mega fracture lineaments.

The length analyses of fracture lineaments on each of the sectors (Table 3) exhibit that same distribution as that of the whole area, where the brachy lineaments are the most abundant and the mezo fracture lineaments are the second in number and third in length, while the macro fracture lineaments are the third in number and the second in length, and the absence of the mega fracture lineaments from all sectors as well as the absence of the macro fracture lineaments from sector 2.

The analyses of fracture lineaments intensities (Table 4, Fig. 5) as lineaments number per square kilometer area and lineaments length in meter per square kilometer area on each of the sectors indicate that the area is affected by low intensities of lineaments number per square kilometer ranging between 0.04 and 0.1, where the intensities of fracture lineaments length range from 215 to 295 meter lineaments per square kilometer area.

The geometric trend distribution analyses of the fracture lineaments according to number percentage on each trend indicate that in sector 1 the NE-SW is the predominant trend and the ENE-WSW is the second followed by the NNW-SSE, E-W, NNE-SSW, WNW-ESE, NW-SE, N-S in descending order. In sector 2 the most dominant trends are the NE-SW and ENE-WSW, then the NNW-SSE, NNE-SSW and NW-SE, that represents the less dominant trend. In sector 4 the most abundant trend is the NE-SW and then the ENE-WSW, NNE-SSW, NNW-SSE, N-S, E-W and the less abundant trends are the NW-SE and WNW-ESE. In sector 5 the NE-SW trend is the predominant and the ENE-WSW is the second, then the NNE-SSW, NNW-SSE, N-S, NW-SE, E-W and WNW-ESE trend in descending order. In sector 6 the most abundant trend is the ENE-WSW, while the second trend is the NE-SW then the NW-SE, NNE-SSW, NNW-SSE, N-S, E-W reaching the WNW-ESE trend as the less abundant (Table 5, Fig. 6).

The geometric trend distribution analyses of the fracture lineaments according to length percentage on each trend indicate that in sector 1 the NE-SW is the predominant trend and the ENE-WSW is the second followed by the WNW-ESE, E-W, NNW-SSE, NW-SE, NNE-

Table 4 : Distribution of lineaments densities in the studied sectors

Sector	N	Lm	N/Km^2	Lm/Km^2
1	**173**	**658.6**	**0.065**	**246.32**
2	**29**	**95.2**	**0.1**	**295.0**
3	**---**	**---**	**---**	**---**
4	**572**	**2832.7**	**0.048**	**237.6**
5	**545**	**2621.9**	**0.046**	**219.9**
6	**478**	**2570.2**	**0.040**	**215.5**

N: number of lineaments, Lm: lineaments length in meters

Table 3 : Distribution of lineaments according to the length in the studied sectors

	Mezo.		Brachy.		Macro.		Miga.	
Length	**N%**	**L%**	**N%**	**L%**	**N%**	**L%**	**N%**	**L%**
Sector-1	**11.6**	**4.75**	**84.4**	**83.25**	**4**	**12**	**00**	**00**
Sector-2	**24**	**11.6**	**76**	**88.4**	**00**	**00**	**00**	**00**
Sector-3	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
Sector-4	**5**	**1.5**	**92**	**90.3**	**3**	**8.2**	**00**	**00**
Sector-5	**8.8**	**2.8**	**87.9**	**88.8**	**3.3**	**8.4**	**00**	**00**
Sector-6	**5.44**	**1.54**	**89.75**	**87.46**	**4.81**	**11**	**00**	**00**

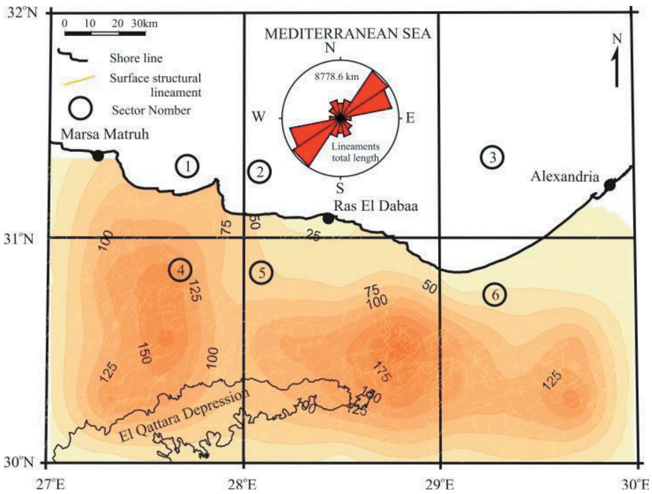


Fig. 5 : Fracture lineaments length density contour map of Ras El Dabaa area environs

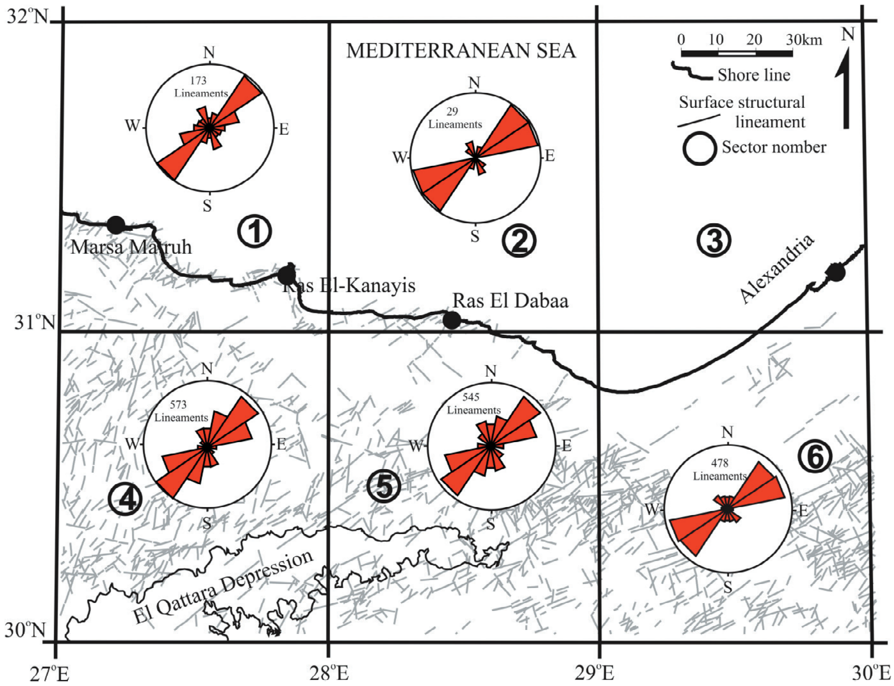


Fig. 6 : Fracture lineaments geometric distribution map of Ras El Dabaa area environs according to number percentage

Table 5 : Distribution of lineaments trends according to the Number percentage in the studied sectors

sectors	Lineaments Trends							
	N-S	NNE-SSW	NE-SW	ENE-WSW	E-W	NNW-SSE	NW-SE	WNW-ESE
Sector-1	**5.80**	**8.70**	**34.75**	**16.80**	**8.7**	**12.1**	**6.3**	**6.9**
Sector-2	**00**	**6.9**	**38**	**38**	**00**	**10.3**	**6.8**	**00**
Sector-3								
Sector-4	**9.3**	**17.8**	**29.5**	**21.8**	**4.5**	**9.4**	**4**	**3.7**
Sector-5	**10.3**	**14**	**27.7**	**21.6**	**5.9**	**11.7**	**7**	**1.8**
Sector-6	**6.7**	**7.32**	**31.38**	**32.42**	**3.14**	**7.11**	**9**	**2.93**

SSW and N-S. In sector 2 the most dominant trends are the ENE-WSW and NE-SW, then NNW-SSE, NW-SE and NNE-SSW, that represents the less dominant trend, while the N-S, E-W and WNW-ESE are not recorded.

In sector 4 the most abundant trend is the NE-SW and then the ENE-WSW, NNE-SSW, NNW-SSE, N-S, E-W and the less abundant trendsare the NW-SE and WNW-ESE. In sector 5 the NE-SW trend is the predominant and the ENE-WSW is the second, then the NNE-SSW, NNW-SSE, N-S, NW-SE, E-W and WNW-ESE. In sector 6 the most abundant trend is the ENE-WSW, while the second trend is the NE-SW then the NW-SE, NNW-SSE, NNE-SSW, N-S, WNW-ESE, reaching the E-W trend as the less abundant (Table 6, Fig.7).

The geometric trend distribution analyses according to length percentage and according to number percentage indicate that the distribution of the fracture lineaments according to length percentage is mostly the same as that of the number percentage in sectors 1, 2 and 6, while in sectors 4 and 5 they are exactly the same.

Regional Seismicity and Earthquake History

The hazards of ground motion and faulting associated with earthquakes and geological phenomena shall be investigated for every nuclear power plant. Investigations in this area form the basis for technical judgments in the site evaluation for a plant for all levels of exposure to seismic hazards. The general approach to seismic hazard evaluation should be directed towards reducing the uncertainties at various stages of the process. Experience shows that the most effective way of achieving this is to collect a sufficient amount of prehistorical, historical and instrumentally recorded reliable and relevant data. The ultimate purpose of the data compilation and seismic hazard analysis is to determine the ground motion and fault displacement hazards for a nuclear power plant site (IAEA, 2002).

Egypt is located at the northeastern part of the African Continent, which is considered as a stable region with exception of the East African Rift which runs through Mozambique, Kenya, and Ethiopia. The African Continent collides with the Eurasian continent at the Mediterranean. The East African Rift branches in northern Ethiopia into two rifts along the Red Sea and along the Gulf of Aden. At the most northern part of the Red Sea Rift, it branches into the Gulf of Suez and Gulf of Aqaba.

A revised earthquake catalogue for Egypt and its surroundings during the period from 2200 BC to 2009 AD with magnitude equal or greater than three is compiled using information from several international and local seismic catalogues (Fig. 8). This catalogue delineated that the Gulf of Aqaba region is of relatively highest seismic hazard in the country, which is characterized by moderate seis-

Table 6 : Distribution of lineaments trends according to the Number percentage in the studied sectors

Sectors	**Lineaments Trends**							
	N-S	**NNE-SSW**	**NE-SW**	**ENE-WSW**	**E-W**	**NNW-SSE**	**NW-SE**	**WNW-ESE**
Sector-1	**5.8**	**8.1**	**33**	**16.1**	**9.7**	**8.6**	**8.3**	**10.4**
Sector-2	**00**	**3.6**	**36.8**	**48**	**00**	**7.6**	**4**	**00**
Sector-3			**100**					
Sector-4	**9**	**19.4**	**29.7**	**20.4**	**5.7**	**9.2**	**3.3**	**3.3**
Sector-5	**9.3**	**13.2**	**26.4**	**24.1**	**5.6**	**11.8**	**7.6**	**2**
Sector-6	**5.79**	**6.55**	**27.82**	**36.05**	**3.72**	**6.94**	**9.28**	**3.85**

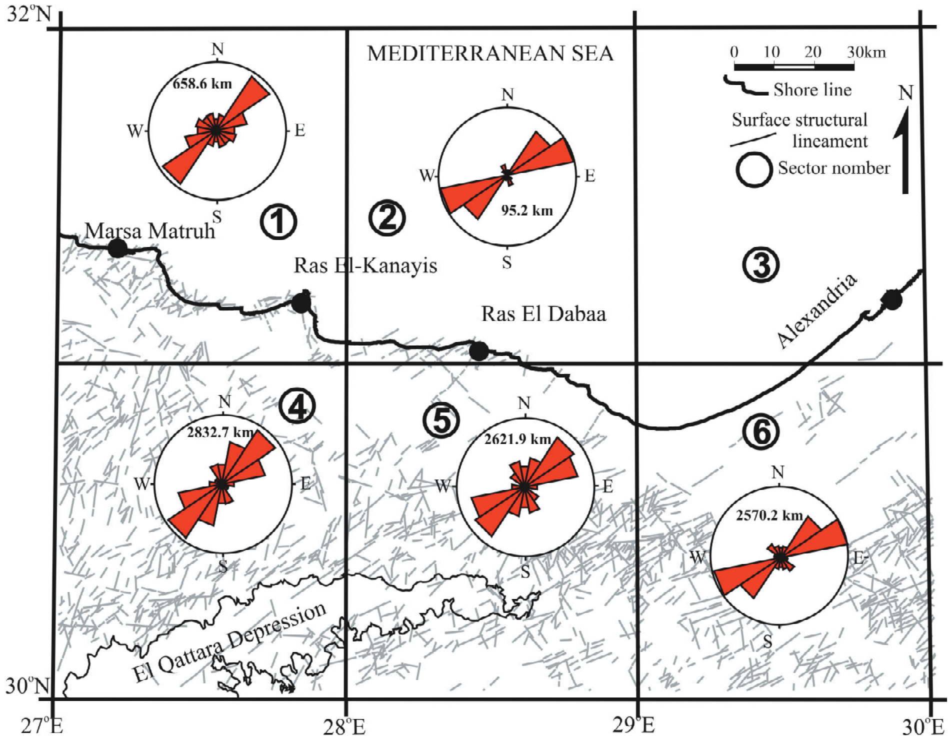


Fig. 7 : Fracture lineaments geometric distribution map of Ras El Dabaa area environs according to length percentage

mic activity. The second active area is the entrance of the Gulf of Suez. In the southern part of Egypt high seismic activity is noticed around Aswan area. Also there are some areas with noticed relatively higher seismic activity than their surroundings as Dahshour area, the area of Cairo Suez District, Beni-Suef area, and Abou-Dabbab area. Generally the acceleration values within the Eastern Desert are higher than those of the Western Desert, which is characterized by very low seismic activity (Mohamed et. al., 2012).

The compilation of the seismicity data from the Egyptian National Seismological Network (ENSN), (Fig. 9) database during the period

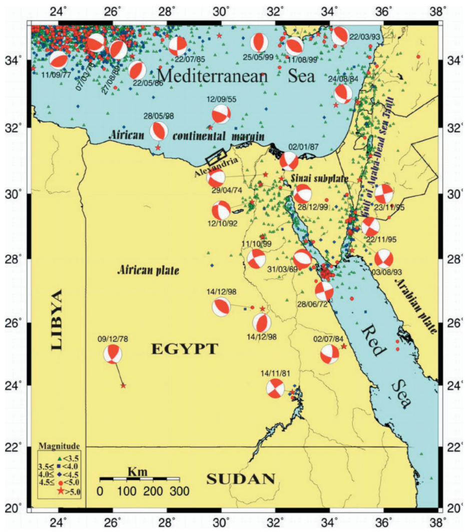


Fig.8 : Seismicity of Egypt based on the compiled earthquake catalogue during the period from 2200 BC to 2009 AD (after Abuo El-Ela et. al., 2012)

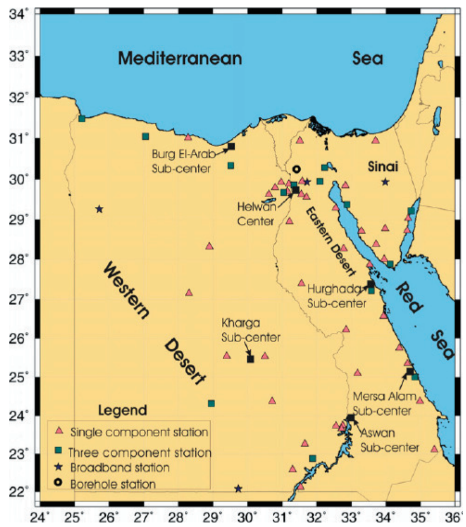


Fig. 9 : Geographic distribution of the Egyptian National Seismic Network (ENSN), the International Data Center (IDC) and the locations of the 36 seismic events. (Abdelazim et. al., 2016)

from 2004 to 2011 enabled the setting of the seismotectonic catalogue during that period.

This catalogue divided Egypt into thirteen seismic source regions (Fig. 10) observed from the earthquakes spatial distribution and mechanisms. These source regions exhibit the Gulf of Suez, Gulf of Aqaba, Red Sea, Cairo-Suez District, Abu- Dabbab, Dahshour, Aswan, Sinai Peninsula, Suhag-Assiut, the zone to the south of Cairo-Suez District and the zone between Barnes and Nasser Lake in the Eastern Desert and Idfu zone (Abdelazim et. al., 2016).

Radioactivity

The background level A term that usually refers to the presence of radioactivity or radiation in the environment. A site is considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation does not exceed 25 mrem/year (0.25mSv/year) for the occupational workers and members of the general public., "the Total Effective Dose Equivalent" (TEDE), (NRC, 2006).

The radioactivity of the area (Fig. 11) is studied using the data of the Nuclear Materials Authority (1984), which exhibits that the area has low background level ranging between 0.5 and 5.5μR/h (100 to 1100 cps), while the Ras El Dabaa location exhibits 3μR/h. This low radioactivity guarantees a good ecological conditions and protection of the biota in the area.

Topography

The study of the topography of the area is carried out for the suitability criteria, which are defined by the IAEA, 2012, as the factors that affect the relative suitability of developing the site, but do not have 'unacceptable' levels. Examples would include ease of site access and transport costs, closeness to load centers, cost of cooling water systems.

The SRTM data is used to study the regional topography of the area. The SRTM is a

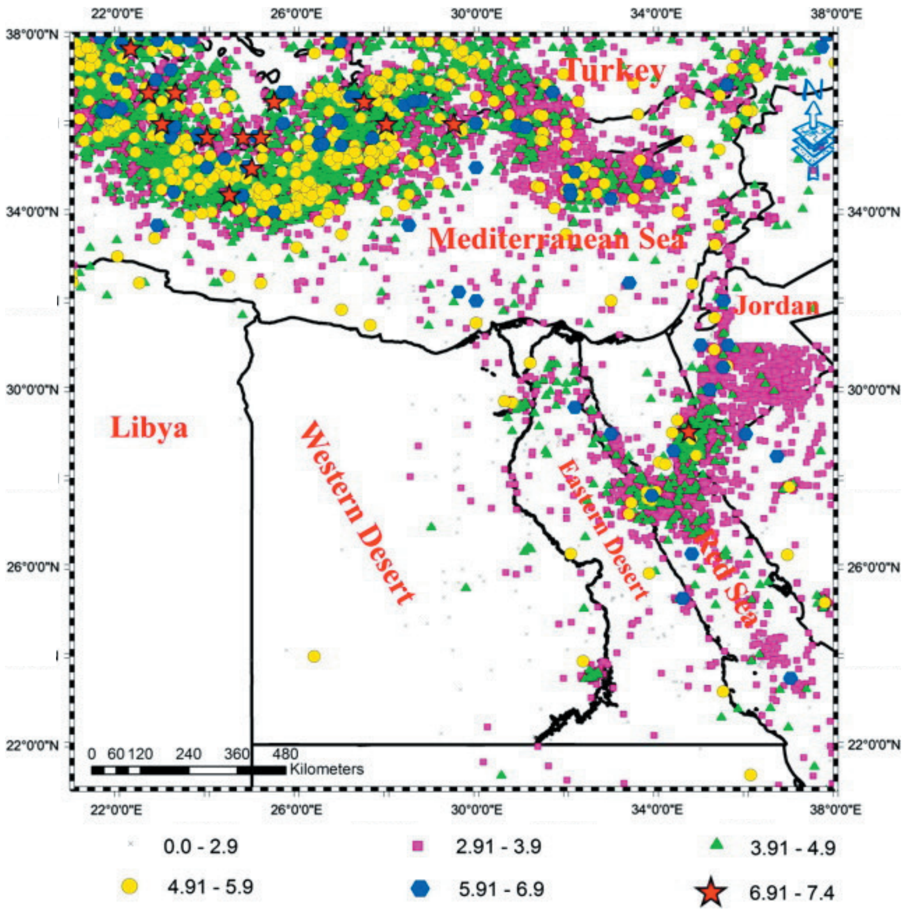


Fig. 10 : Distribution of the earthquake epicenters during the period from 2004 to 2011 and the different seismic source regions in Egypt are represented by numbers, (Abdelazim et. al., 2016)

digital elevation data for Africa, the island of Madagascar and the Arabian Peninsula. The SRTM is a digital elevation data for Africa, the island of Madagascar and the Arabian Peninsula acquired and released by the Shuttle Radar Topography Mission (SRTM) aboard the Space Shuttle Endeavour, launched on February 11th, 2000 by the National Aeronautics and Space Administration (NASA).

The area is characterized by low topography (Fig. 12) with elevations ranging between 20m above sea level (a.s.l) and 160m a.s.l., with the exception of the Qattara Depression which reaches to -120m (120m b.s.l.). The Ras El Dabaa itself is located directly on the Mediterranean Sea shore line at 20m a.s.l. with a gentle gradual increase southwards. This low topography supports and facilitates the security plans, emergency measures and evacuation plans if needed, while the direct location on the Mediterranean guarantees the continuous, easy and sufficient supply of water.

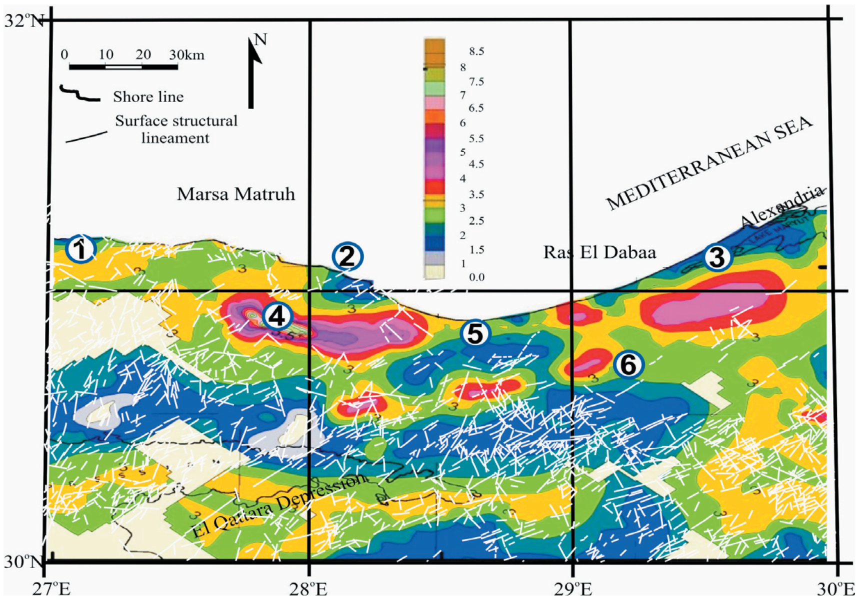


Fig. 11 : Radiometric map according to Nuclear Materials Authority (1984). Circled numbers represent the studied sectors

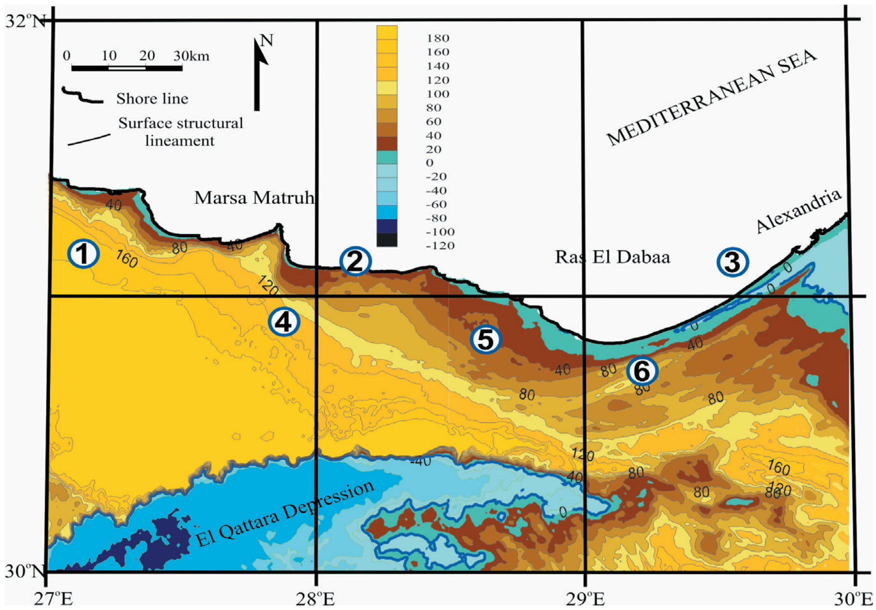


Fig. 12 : Topographic map of Ras El Dabaa area environs (SRTM data, 2000). Circled numbers represent the sectors

DISCUSSION

Egypt is located at the North Eastern part of the African Continent, which is considered as a stable region with exception of the East African Rift which runs through Mozambique, Kenya, and Ethiopia. The African Continent collides with the Eurasian continent at the Mediterranean. The East African Rift branches in northern Ethiopia into two rifts along the Red Sea and Gulf of Aden. At the most northern part of the Red Sea Rift, this is branching into the Gulf of Suez and the Gulf of Aqaba.

The trend analyses of the lineaments affecting the area indicate that their distribution according to the number and length percentages are the same exhibiting that the NE-SW is the most predominant trend followed by the ENE-WSW, NNE-SSW, NNW-SSE, N-S, NW-SE, E-W and WNW-ESE in descending order.

The length analysis of the lineaments all over the area; 1797 fracture lineaments exhibiting 8778.6 km length; indicates that the bracHy lineaments are the most abundant in both number (99.25%) and length (99.33%), while the mezo lineaments represent the second in number and the third in length, whilst the macro lineaments are the third in number and the second in length. This dis-agreements between the number and length abundances is attributed to the segmentation of the fractures. The analysis indicates the absence of the mega fracture lineaments.

The analyses of fracture lineaments intensities exhibit that the area has low intensities of lineaments number ranging between 0.04/km^2 and 0.1/km^2, where the intensities of fracture lineaments length range from 215m/km^2 to 295m/km^2.

A revised earthquake catalogue for Egypt and its surroundings during the period from 2200 BC to 2009 AD with magnitude equal or greater than three delineated that Egypt is characterized by moderate seismic activity, while the Gulf of Aqaba region is of relatively highest seismic hazard in the country, while the entrance of Gulf of Suez isthe second active area. The high seismic activity is noticed around Aswan area also there are some areas with relatively higher seismic activity than their surroundings as Dahshour, the Cairo-Suez District, Beni-Seuf, and Abou-Dabbab areas. Generally the acceleration values within the Eastern Desert are higher than the acceleration values of the Western Desert, which is characterized by very low seismic activity.

The seismotectonic catalogue during the period from 2004 to 2011 divided Egypt into thirteen seismic source regions exhibit the Gulf of Suez, Gulf of Aqaba, Red Sea, Cairo-Suez District, Abu- Dabbab, Dahshour, Aswan, Sinai Peninsula, Suhag-Assiut, the zone to the south of Cairo-Suez District and the zone between Barnes and Nasser Lake in the Eastern Desert and Idfu zone, excluding the Western Desert from the seismic source regions during this period.

The area has a low background level ranging between 0.5 and 5.5μR/h (100 to 1100 cps), while the Ras El Dabaa location exhibits 3μR/h. This low radioactivity background level guarantees a good ecological conditions and protection of the occupational workers and members of the general public as well as the biota in the area.

The area is characterized by low topography with elevations ranging between 20m a.s.l and 160m a.s.l., with the exception of the Qattara Depression which reach to -120m.b.s.l. The Ras El Dabaa itself is located directly on the Mediterranean Sea shore line at 20ma.s.l. with a gentle gradual increase southwards. This low topography supports and facilitates the security plans, emergency measures and evacuation plans if needed, while the direct location on the Mediterranean guarantees the continuous, easy and sufficient water supply.

CONCLUSIONS

The Ras El Dabaa site satisfies the safety standards of the IAEA 2002 and 2003, where the analyses of surface geology and fracture lineaments delineates that area is affected by low intensities of multi-directional surface fractures and considered as stable geological structures, where the potential for liquidification that may be caused by an earthquake didn't recorded among its seismic history. The analyses of the prehistorical, historical and instrumentally recorded reliable and relevant seismotectonic data from 2200 BC to 2011 AD indicate that the Western Desert of Egypt is characterized by very low seismic activity.

The area has low radioactivity, which meets the NPP regulatory requirements of the NRC 2006. The location and low topography of the area supports and facilitates the transportation, security plans, emergency measures and evacuation plans if needed, as well as guarantees the continuous, easy and sufficient water supply, which satisfies the suitability criteria of the IAEA, 2012. The site also satisfies the socioeconomics of the NRC, 2014, where the project will save more jobs for the local labors. Thus, Ras El Dabaa could be considered to be the first candidate site to safely receive the nuclear power plant national project of Egypt.

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دراسة إقليمية لموقع المشروع القومي المصري لإنشاء محطة نووية بالضبعة

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تقع المنطقة في الصحراء الغربية الشمالية من مصر وتمتد من خط العرض ٣٠° إلى ٣٢° شمالاً ومن خط الطول ٢٧°إلى ٣٠° شرقاً وتشمل المنطقة موقع رأس الضبعة وهو الموقع الذي سينفذ به المشروع الوطني النووي المصري، حيث يقع مباشرة على شاطئ البحر الأبيض المتوسط.

تم إجراء تحليلات الإتجاه والكثافة على خطوط الصدوع التي تم رسمها من الخريطة الجيولوجية وصورة الأقمار الصناعية للمنطقة، مما مكن من رسم ١٧٩٧ من خطوط الصدوع التي يبلغ طولها ٨٤٤١ كم .تم تحليل خطوط الصدوع في المنطقة ثم قسمت المنطقة إلى ستة قطاعات يتم تحليلها بشكل فردي. تشير تحليلات الاتجاهات لخطوط الصدوع المؤثرة في المنطقة كلها إلى أن توزيعها وفقا لنسب العدد والطول هو نفس الترتيب الذي يشير إلى أن اتجاه شمال شرق-جنوب غرب هو الاتجاه السائد يليه اتجاهات شرق شمال شرق-غرب جنوب غرب، شمال شمال شرق-جنوب جنوب غرب، شمال شمال غرب- جنوب جنوب شرق، شمال-جنوب، شرق-غرب ثم غرب شمال غرب- شرق جنوب شرق مرتبين ترتيباً تنازلياً.

تم دراسة إقليمية لتاريخ الزلازل والتاريخ الزلزالي للمنطقة من البحوث المنشورة التي وضعت فهرساً منقحاً للزلازل لمصر خلال الفترة من عام ٢٢٠٠ قبل الميلاد وحتى عام ٢٠٠٩ ميلادية، و الذي يدل على أن مصر تتميز بالنشاط السيزمي المعتدل وتتميز الصحراء الغربية بنشاط زلزالي منخفض جدا، كما تم دراسة الفهرس السيزموتكتوني لمصر عن الفترة من ٢٠٠٤ إلى ٢٠١١ م من البحوث المنشورة أيضاً والذي قسم مصر إلى ثلاثة عشر منطقة مصدر زلزالي مستثنياً الصحراء الغربية من هذه المناطق.

يشير التحليل الإشعاعي للمنطقة إلى أن انخفاض النشاط الإشعاعي بها حيث يتراوح بين ٠,٥ و٥,٥ مايكرو رونتجن/ ساعة (١٠٠ إلى ١١٠٠ cps)، في حين أن موقع رأس الضبعة يظهر ٣ مايكرو رونتجن/ ساعة. ويضمن هذا النشاط الإشعاعي المنخفض ظروف بيئية جيدة وحماية للكائنات الحية في المنطقة. في حين أن دراسة تضاريس المنطقة يبين أنها ذات تضاريس

منخفضة مع ارتفاعات تتراوح بين ٢٠ إلى ١٦ متر فوق مستوى سطح البحر باستثناء منخفض القطارة الذي يصل إلى -١٢٠ متر تحت مستوى سطح البحر ويقع رأس الضبعة نفسه على شاطئ البحر المتوسط مباشرة على ارتفاع ٢٠ متر فوق مستوى سطح البحر مع زيادة تدريجية إلى الجنوب. وتدعم هذه الطوبوغرافيا المنخفضة تسهيل الإجراءات الأمنية وتدابير الطوارئ وخطط الإجلاء إذا لزم الأمر، في حين أن الموقع المباشر على البحر الأبيض المتوسط يضمن إمدادات المياه المستمرة والسهلة والكافية إلى المحطة.