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Natural hazards mapping of mega sea waves on the NW coast of Egypt

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ABSTRACT

Some boulder fields were deposited by the sea waves during winter storms or by paleo tsunami mega waves and most of these boulders were uprooted from the marine platform and distributed within 90 m of the shoreline, are found up to 4 m above present mean sea level.

The objective of this work is defining systematic characterisation of the high-energy depositional contexts working by storms or paleo tsunami deposit, and to reconstruct the history of mega block deposition along the study area, depends upon extensive field surveying and geomorphic mapping by using GIS and GPS techniques as well as statistical analysis of boulders in order to determine both extreme events using the significant wave height and period of maximum observed storms and historical tsunamis along the study area, as well as geomorphic hazard mapping and samples dating.

The results show that both possible processes (storm and tsunami waves) can deposit these boulders, it attested at Alexandria for example by the archaeological excavations and historical sources. Tsunami waves and storms cause the displacement of huge boulders from sea bottom and submersible marine terraces (platforms) to the beach due to its major power and ability of carving and graving it is also capable of pulling other boulders from the land and redeposit it on the beach or coastline.

1. Introduction

The study area forms a belt about 20 Km deep, which extends for about 500 Km of the NW coast of Egypt on The Mediterranean Sea between Alexandria City and El Sallum town near the borders with Libya "Fig. 1".

The objective of this work is defining systematic characterisation of the high-energy depositional contexts working both on the type of storm or paleo tsunami deposit and the different geomorphological contexts, and to reconstruct the history of mega block deposition along the study area, using chronostratigraphy methodology, it will aid in evaluating the risk of submersion in an area that is affected by storms and tsunamis. The consequences on the occupation of the coastline are important, such as the destruction of Alexandria's ancient lighthouse, as well as dating of mega blocks characteristic of high-energy events (storms or tsunamis) using fixed marine bioconstructions, to evaluate sedimentological impacts and natural hazards associated with these events (submersion, coastal mobility, erosion, high-energy impacts).

2. Setting

2.1. Geology

The coastal plain of the study area is consists of three Pleistocene calcareous ridges parallel to the coast and separated by flat-bottomed depressions. The ridges sediments are composed of well sorted medium grained aragonic ooids sands. The cliffs of the

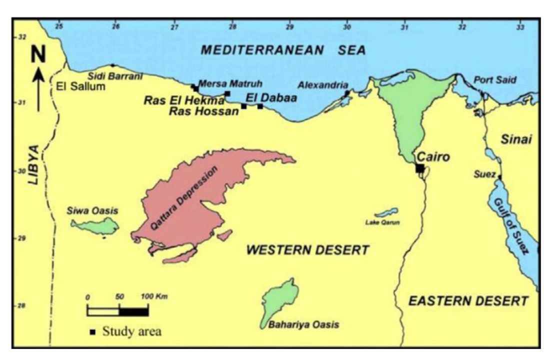

Fig. 1. Location map of the study area.

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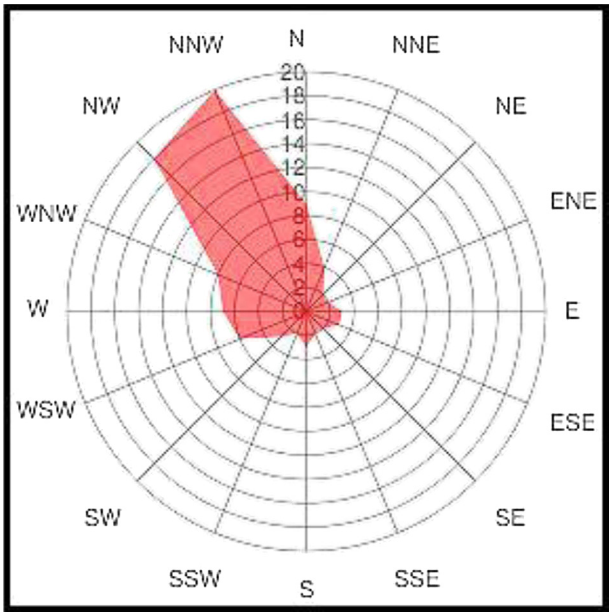

Fig. 2. Average annual wind directions in Marsa Matruh city between 2001/2011. Data source: www.windfinder.com.

Middle Miocene table run parallel to the coast. A discontinuous series of dunes develops at a distance varying from the coast to 2 Km deep. There are some saline depressions and sabkhas in the lower part of the plain, some with outlets to the sea. The escarpment of the plateau is deeply cut by wadis.

2.2. Geomorphology

The previous geomorphologic studies of the northwest coastal plain of Marsa Matruh area as a part of the northwest coastal plain of Egypt show that the origin of the extended calcareous ridges could be grouped under three environmental conditions as follows:

- Continental environment (Hilmy, 1951).
- Marine environment (Anwar et al., 1981).
- Maine/continental environment (El Shazly et al., 1964; Selim, 1974; Torab, 1984).

But sea waves were able to erode the first calcareous ridge in some parts of the study area and therefore the second ridge found on the coastline directly and affected by coastal erosion at the moment.

2.3. Climate

Average annual wind directions graph "Fig. 2" indicates that most wind blow toward the NW coast of Egypt from NW & NNW

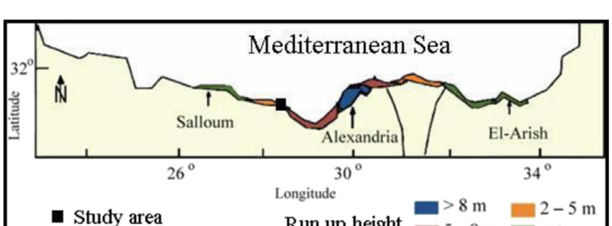

Fig. 3. Run up height along the Egyptian Mediterranean sea coast (After: Hamouda, 2006).

Table 1
Location of selected field work site.

Site #	Sector #	Location	Coordinates	
			Lat. (N)	Long. (E)
1	1.A	El Fyrouz Beach	31°22′01″	27°16′12″
2	2.A	Andalusia Beach	31°22′08″	27°17′49″
	2.B			
3	3.A	Alam El Rom Beach	31°22′18″	27°19′22″
	3.B			
	3.C			
4	4.A	Mina Hasheesh Beach	31°22′22″	27°19′46″
5	5.A	Ras El-Hekma west	31°13′43″	27°51′49″
6	6.A	Ras El-Hekma east	31°13′39″	27°52′27″
7	7.A	Ras Hossan	31°05′37″	28°06′32″
8	8.A	El-Dabaa	31°04′33″	28°28′24″

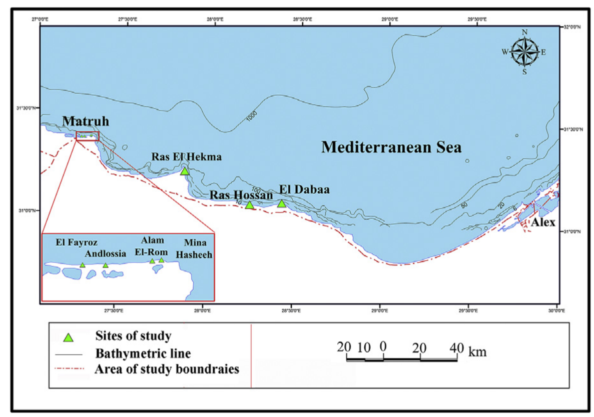

Fig. 4. Location of selected field work sites.

directions. Offshore wind speed at 50 m a.g.l. of Egypt "Fig. 3" show that The NW coast of Egypt is lies in the most offshore wind speed in the Mediterranean region, its speed range between 6 and 7 m/s (determined by meso scale modelling, Wind atlas of Egypt, by Mortensen et al., 2006).

3. Methods

This paper depends upon detailed geomorphological field surveying, 578 boulders have been measured in eight selected sites of the study area, the boulders measurements were chosen on 11 elongated sectors "Table 1 & Fig. 4".

Table 2
Average dimensions of accumulated boulders.

S#	Bn	Average dimensions of boulders			D	L	V	W
		a (m)	b (m)	c (m)				
1.A	57	1.51	1.14	0.51	54.93	0.96	1.02	2.08
2.A	13	1.82	1.61	0.65	26.95	1	2.15	4.58
2.B	85	1.07	0.79	0.36	39.69	3.41	0.41	0.17
3.A	90	1.34	0.94	0.42	29.92	3.43	1.01	2.57
3.B	23	1.42	1.01	1.7	28.2	0	0.65	1.04
3.C	38	1.63	1.21	0.47	21.63	3.60	2.25	7.96
4.A	81	1.22	0.94	0.41	9.49	1.2	0.56	0.89
5.A	38	1.45	0.97	0.40	10.67	0.95	0.74	1.46
6.A	55	1.36	0.97	0.33	14.46	0.37	0.51	0.84
7.A	51	0.85	0.59	0.26	7.04	1.33	0.16	0.18
8.A	47	0.87	0.58	0.17	19.1	1	0.13	0.19
Oa	52.54	1.31	0.98	0.51	23.81	2.02	1.56	2.11

(After: Dalal, 2013), S#: **Sector #**, Bn: Boulders number, D: Distance (m), L: Level (m), V: Volume (m^3), W: Weight (t), Oa: Overall average.