



# Morphologic characteristics and migration rate assessment of barchan dunes in the Southeastern Western Desert of Egypt



M.A. Hamdan, A.A. Refaat \*, M. Abdel Wahed

Geology Department, Faculty of Science, Cairo University, Giza, Egypt

## ARTICLE INFO

### Article history:

Received 3 May 2015

Received in revised form 6 December 2015

Accepted 30 December 2015

Available online 31 December 2015

### Key words:

Barchan dune  
dune migration  
dune encroachment hazard  
Western Desert of Egypt

## ABSTRACT

This work explores the morphologic characteristics of aeolian dune sand in the southeastern part of Western Desert of Egypt. It aims to assess the movement of barchan dunes and evaluate their environmental influence on the Toshka Project. Morphometric investigation of barchan dunes in the Toshka area revealed that most barchans have high length/width (a/c) ratios (fat to pudgy), while one-fifth of the studied barchans have lower a/c ratios and so appear normal in their morphologic forms. Statistical analysis of the main parameters of barchan dunes in Toshka and other desert regions in the Kharga (Egypt), Kuwait, Southern Morocco, California and Southern Peru demonstrates that barchans of the Toshka area are distinctive in their appearance. They are characterized by distinct aspect with higher values of length and width and greater growth in height. The high-energy wind environment in addition to the large amount of drifting sand are principal factors responsible for the unique shape of Toshka barchans.

The migration rate of barchan dunes in four chosen test locations, within the central and western Toshka area, ranges from about 3 to 10.82 m/year. The calculated average migration rate of these dunes is about 6 m/year in a SSW direction. Sand encroachment is more extensive in the central and western parts of the investigated Toshka area. Risk evaluation of sand dune movements in the southeastern part of the Western Desert points to medium to high sand encroachment risk values. These may represent serious hazards to the newly-established Toshka Project, threatening roads, as well as cultivated lands in the area.

© 2016 Elsevier B.V. All rights reserved.

## 1. Introduction

Many areas in the Western Desert of Egypt are characterized by high accumulations of wind-blown sand (Fig. 1). Modern aeolian sand of the Western Desert of Egypt has been the subject of scientific interest since the beginning of the 20th century (e.g. Beadnell, 1910; Ball, 1927; Bagnold, 1931, 1941). Numerous geologic, geomorphologic, textural, mineralogical, geochemical and source-area genetic studies of the sand dunes followed (e.g. Embabi, 1970; El-Baz et al., 1979; Besler, 1986, 1998, 2000, 2008; Haynes, 1989; Stokes et al., 1998; Hamdan and Refaat, 1999; Hamdan, 2003; El Gammal and Cherif, 2006; Abou El-Magd et al., 2013; Khedr et al., 2013a, 2013b; Refaat and Hamdan, 2015; Hamdan et al., 2015). Several studies have been concerned with estimating the rate of desert dune movement in many areas of Egypt, especially in the Western Desert (Table 1). Sand dune movements are considered to be a specific threat to roads, irrigation networks, water resources, urban areas, agriculture and infrastructure of the Toshka project (Wahby, 2004).

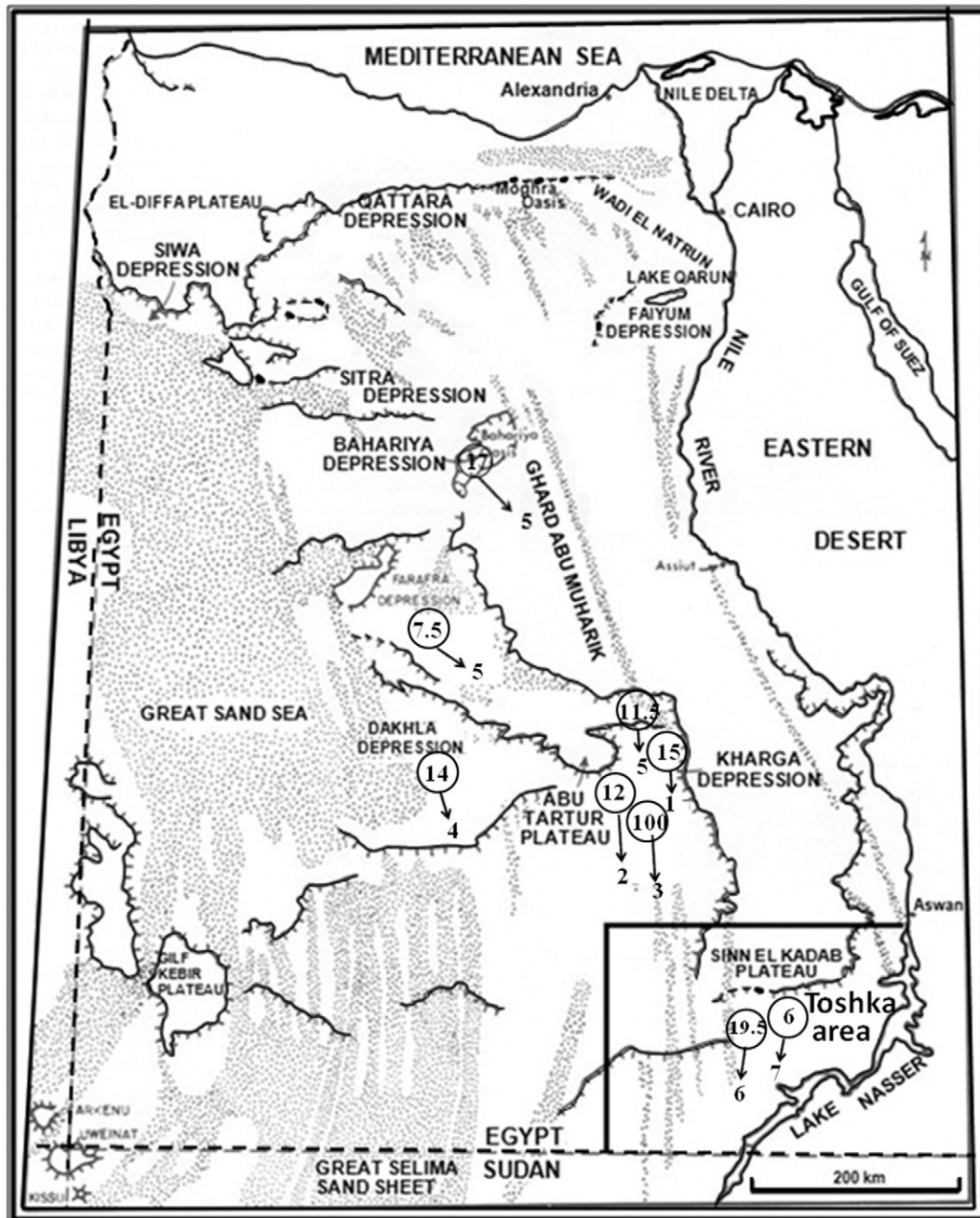
The southeastern part of the Egyptian Western Desert is largely represented by the Toshka area; it covers about 50,000 km<sup>2</sup> and is

characterized by high dune sand accumulation. The area has been chosen to serve as a model for the assessment of dune migration because it is affected mainly by strong trade winds which exert a strong control on the mechanism of dune formation as in the eastern range of the Great Sahara Desert (Besler, 2008). It also represents the focal area of many dune streams and sand accumulations that migrate from other regions of the Western Desert of Egypt into the northern Toshka area (Fig. 1). Hence, the Toshka area is considered to be an ideal region for dune measurements and can be used as a model for other regions in the Western Desert of Egypt and North Africa.

Sand dunes are a common feature of many desert regions all over the world and they may exist in many different types. Barchan dunes are the simplest and most common dune type as it maintains a crescent shape and occurs in areas characterized by steady winds coming from a similar direction throughout the year, providing there is not enough sand to cover the entire regional surface (Sauermaun et al., 2000). Barchan dunes are well developed in many parts of the Egyptian Western Desert, including the Toshka area, as well as in many deserts areas not only on the surface of the Earth (e.g. Bagnold, 1941; Finkel, 1959; Long and Sharp, 1964; Hastenrath, 1967; Hesp and Hastings, 1998; Sauermaun et al., 2000; Parteli et al., 2007) but also on the surface of Mars (e.g. Goudie and Bourke, 2008; Bourke and Balme, 2008). Moreover, several types and forms of barchan exist in these deserts,

\* Corresponding author.

E-mail address: [aaarefaat2000@hotmail.com](mailto:aaarefaat2000@hotmail.com) (A.A. Refaat).



**Fig. 1.** Map of the Western Desert of Egypt showing the distribution of the major sand dune fields (modified after El-Baz, 1979). The study area is located in the southeastern part of the Western desert of Egypt. Numbers inside the circle refer to dune migration rates of the Toshka area and other regions in the Western Desert of Egypt where arrows refer to the direction of dune migration at each area. The number at the head of each arrow refers to the corresponding reference: 1 = Beadnell (1910); 2 = Ashri (1973); 3 = Embabi (1979); 4 = Sharaky et al. (2002); 5 = El Gammal and Cherif, (2006); 6 = Abou El-Magd et al. (2013); 7 = Present study.

depending upon several factors, such as wind strength and direction, amount of drifting sand, topography and vegetation. The current paper is a comparative study that highlights the main morphometric characteristic features of Toshka barchans and other barchan shapes from different deserts of the world. Evaluation of the main factors that control the morphology and existence of these dunes are discussed.

A further aim of this study is to investigate the distribution of aeolian dune sands in the Toshka area and to identify their types using remote sensing and GIS techniques. The study assesses the rate of barchan movement in the Toshka area in comparison with other regions in the

Western Desert of Egypt. Finally, the degree of sand dune encroachment and its effect on the Toshka Project is evaluated.

## 2. Geomorphologic features

The study area is located in the southeastern part of the Western Desert of Egypt between 22° and 24° 00' N and 30° 15' and 33° E (Fig. 2). With the exception of Sinn el Kadab Plateau and its pediments, which lie more than 300 m above sea level and bounding the Toshka Depression from the north, the study area is relatively flat and most of it is

Download English Version:

<https://daneshyari.com/en/article/6431633>

Download Persian Version:

<https://daneshyari.com/article/6431633>

[Daneshyari.com](https://daneshyari.com)