



Barchan dunes morphology dynamics under different environmental conditions

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The aim of this study was to emphasize significance of diversified dynamics of barchans dune morphology. We analyzed and compared barchans found in two dune fields: Kharga (S Egypt) and Tarfaya-Laâyoune (S-Morocco). These dune fields are characterized by significantly different factors responsible for dunes development e.g. textural and mineralogical composition of dune sand, dune sand moisture, air humidity, inter dune vegetation cover. For each investigated dune field and study period (2008, 2010, 2012 for Kharga and 2007, 2011, 2012 for Tarfaya-Laâyoune dune fields) detailed shape measurement of 20 simple isolated barchans of different dune sizes was made. The ± 10 -2 m horizontal and $\pm 1,5$ 10-2m vertical accuracy was obtained (1 measuring point per 1m² on average). In order to compare barchan dunes morphology and to determine depositional and erosional patterns, the 3D models were created. For better understanding of this processes, sand bulk density of barchan surface was measured (1 measuring point per 2m² on average). The velocity of dunes in relation to dune shape was also analyzed.

The results show that the relationship between typically correlated parameters change during movement of the barchans. Most values change by a few percent per year (slip face height, dune base area and dune volume) or by a dozen or so percent per year (windward side length, horns length and width). We obtain good linear relationship (with 0,05 significant level) between slip face height and the dune base area ($0,77 < R^2 < 0,83$), dune volume ($0,66 < R^2 < 0,72$), windward side length ($0,58 < R^2 < 0,87$), horns length ($0,71 < R^2 < 0,90$) or horns width ($0,79 < R^2 < 0,93$). The linear relationship between displacement rate and the morphological parameters is not strong ($0,54 < R^2 < 0,81$) for Kharga dune field and ($0,41 < R^2 < 0,66$) for Tarfaya-Laâyoune dune field. We noted also good linear relationship between displacement rate and the angle of span of the horns ($R^2=0,73$ on Tarfaya-Laâyoune dune fields).

Comparison of shape change of the same barchan made it possible to determine the depositional and erosional zones. The annual changes of surface altitude do not exceed a few percent of the total sand thickness in analyzed zones (more for small dunes). However, we noted important shape differences between barchans of the same slip face height in two investigated dune fields (up to 20% of sand thickness in the same point). We also found a good correlation between barchans shape and bulk density of dune sand. The highest bulk density of the dune sand is noted at the dune horns (up to 1767kg m⁻³ for Kharga dune field and up to 1644 kg m⁻³ for Tarfaya-Laâyoune dune field). On the windward (stoss) sides the bulk density of the dune sand depends on barchans shape (slope inclination). The lee sides have the value around 1400 kg m⁻³.

Generally our result show relatively small differences in dune morphology dynamics within the same dune field but much greater between the two analyzed areas.