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Possibility of star (pyramid) dune development in the area of bimodal wind regime

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Star (pyramid) dunes are the largest aeolian landforms. They can occur in three types – simple, complex and compound. Development of this type of dunes is usually connected with multidirectional or complex wind regimes.

The aim of this study was to verify a hypothesis that the star dunes can also develop by a bimodal wind regime and by local modifications of nearsurface wind flow directions. Field study was performed on Erg Chebbi, in southern Morocco. Several star and transverse dunes were selected for the study of their shape. The star dunes were analysed concerning their type and position in the dune field. This erg contains all of three types of star dunes together with transverse dunes. The regional wind data show that there are two dominant wind directions – NE (Chergui) and SW (Saheli).

To determine the difference in shape of star dunes, we performed topographic surveying by GPS RTK. The results allowed to create 3D models of star dunes. The models were used to determine metric characteristics of star dunes, including area of dune basis, volume, and slope angles.

On the basis of 3D models, primary, secondary and, on the compound dunes, tertiary arms were determined.

Primary arms on each type of star dunes, as well as crestlines of transverse dunes, have dominant orientation NW-SE, perpendicular to two dominant wind directions. This clearly confirms that star dunes of Erg Chebbi develop by a bimodal wind regime

In contrast to primary arms, subsidiary (secondary and tertiary) arms are not connected to general wind regime. The secondary arms of star dunes occur to be differentially developer. There are more subsidiary arms on SW sides in comparison to the E sides of the dunes where inclination of slopes is constant. It can be therefore inferred that sand has been supplied predominantly from SW direction. This is supported by distribution of the dunes on the erg. Most compound star dunes compose a chain along the E margin of the erg.

Comparison of compound star dunes located in E and W parts of the erg allow inferring that there must have been differences in supply of the aeolian sand. Eastern slopes of compound star dunes developed in the W part of the erg are inclined 10-15°. This shows that significant delivery of the sand must have occurred also from NE. Eastern slopes of compound star dunes located in the E part of the erg are inclined 20-30°. It can be therefore inferred that they have functioned mainly as lee slopes and the sand was delivery from SW.

This proves that location of the dunes within the erg plays a significant role in shaping wind directions responsible for delivery of the sand. Orientation of subsidiary arms does not show any relationship with general wind regime, which leads to conclusion that the subsidiary arms develop due to local diversified regime of nearsurface wind flow. This is governed by barriers such as the star dunes themselves and not by other topographic obstacles.