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Linear dunes in the western Sahara, Mauritania: chronology and reconstruction of Late Pleistocene and Holocene wind regimes

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Introduction

The western Sahara in Mauritania is dominated by extensive sand seas that consist largely of linear dunes (Kocurek et al., 1991) that form the western end of sand transport systems that originate in the northern Sahara of Algeria and terminate in the Atlantic Ocean. Previous workers in the region (Fryberger, 1980; Sarnthein and Diester-Haas, 1977) drew attention to the existence of crossing dune trends and superimposition of dunes on different alignments, suggesting that wind regimes in the region have changed over time from one generation of dunes to the next. We targeted one area in the western part of Mauritania between latitudes 18°30' and 20°30' N, in which several dune trends are visible on satellite images, and where three of the sand seas in the region (Azefal, Agneitir, Akchar) are in close proximity.

The sand seas and their component dune elements were mapped on Landsat TM images of the area using their distinctive spectral characteristics. We identified three dune-trend classes that decrease progressively in size: (1) a NE-SW-trending (045°) class of large, degraded linear ridges that appear brown in images, (2) a NNE-SSW-trending (020^0) class of moderate-sized linear dunes, commonly with active crestal areas, which appear yellow in images, and (3) a class of N-S-trending small linear dunes that appear white in images.

Each of the dune-trend classes was selected for OSL dating. Dune sands were sampled by a combination of hand-dug pits (maximum depth 1.5 m) and augering (maximum depth of 5 m). The OSL ages cluster into 3 groups: (1) 24-15 ka, (2) 13-10 ka, and (3) after 5 ka. Each of these periods of eolian activity is associated with a distinct linear dune trend. The oldest ages (24-15 ka) are all associated with the NE-SW dune trend, and are centered around the Last Glacial Maximum. Dunes with an age of 13-10 ka trend NNE-SSW, and span the period of the Younger Dryas event. N-S oriented linear dunes overlie the prominent pedogenic surface developed during the Holocene African Humid Period. The late Holocene ages in our study are associated with local eolian activity in interdune areas, but appear to be representative of a much more widespread period of dune activity that is correlated with the N-S linear dunes and continues to the present day. The ages of these periods of dune construction closely parallel the marine record of increased dust transport in this region (deMenocal et al., 2000).

Assuming that eolian bedforms are aligned to maximize gross sediment transport normal to their crests (Rubin and Ikeda, 1990), it is possible to determine the dune trend that best satisfies the gross-bedform-normal rule in present day wind regimes, as well as to simulate the most likely combination of winds that produced dunes of different trends in the past. Simulations of the dune-forming winds using this approach indicate that wind regimes in this area during the Last Glacial Maximum and the Younger Dryas were characterized by enhanced easterly, northerly, and northwesterly winds. This suggests intensification of the seasonal high pressure cells during periods of dune construction.

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