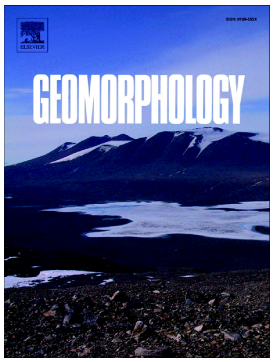

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Parabolic Dune development modes according to shape at the southern fringes of the Hobq Desert, Inner Mongolia, China

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Abstract: Since the 1970s, parabolic dunes at the southern fringe of the Hobq Desert, Inner Mongolia, China have exhibited many different shapes (V-shaped, U-shaped, and palmate) each with a unique mode of development. In the study area, parabolic dunes are mainly distributed in Regions A, B, and C with an intermittent river running from the south to the north. We used high-resolution remote-sensing images from 1970 to 2014 and RTK-GPS measurements to study the development modes of different dune shapes; the modes are characterized by the relationship between the intermittent river and dunes, formation of the incipient dune patterns, the predominant source supply of dunes, and the primary formation of different shapes (V-shaped, U-shaped, and palmate). Most parabolic dunes in Region A are V-shaped and closer to the bank of the river. The original barchans in this region exhibit "disconnected arms" behavior. With the sand blown out of the riverbed through gullies, the nebkhas on the disconnected arms acquire the external sand source through the "fertile island effect", thereby developing into triangular sand patches and further developing into V-shaped parabolic dunes. Most parabolic dunes in Regions B and C are palmate. The residual dunes cut by the re-channelization of river from transverse dune fields on the west bank are the main sand source of Region B. The parabolic dunes in Region C are the original barchans having then been transformed. The stoss slopes of V-shaped parabolic dunes along the riverbank are gradual and the dunes are flat in shape. The dune crest of V-shaped parabolic dune is the deposition area, which forms the "arc-shaped sand ridge". Their two arms are non-parallel; the lateral airflow of the arms jointly transport sand to the middle part of dunes, resulting in a narrower triangle that gradually becomes V-shaped. Palmate parabolic dunes have a steeper stoss slope and height. The dune crest of the palmate parabolic dune is the erosion area, which forms a long and narrow trough between nebkhas by the "funnelling effect". This process forces sand towards lee slopes, which transform from concave (original barchans) into convex, ultimately resulting in the formation of palmate parabolic dunes.

Keywords: Parabolic dunes; dune development; morphological changes

1. Introduction

Aeolian landforms are major landscape features in arid and semi-arid zones. Their formation, evolution, morphology, and spatial inter-relationships are the result of interactions between internal boundary conditions and external forming factors (Greeley and Versen, 1985). The internal boundary conditions include the size of the evolving dune system, mutual feedback effects between topography and near surface flow, and the characteristics of the predominant sand source material (Wilkins and Ford, 2007; Derickson et al., 2008); external forming factors include wind regime, precipitation, vegetation, and extraneous sand sources in the region (Ewing and Kocurek, 2010a; Ewing and Kocurek, 2010b). Different geographical environments create different internal and external conditions, resulting in different modes of the development and ultimate shapes of dunes (Hsu, 1973; Bauer et al., 1990; Wiedemann, 1990; Tsoar and Blumberg, 2002).

Parabolic dunes are an important type of aeolian landform. They are mainly distributed on sandy coasts, on the sides of lakes, on the edges of arid inland deserts, and in semi-arid and sub-humid sandy grasslands (Yan et al., 2010). The initiation of parabolic morphology is commonly linked to transformation from other dune morphologies (Tsoar and Blumberg, 2002; Durán et al., 2008; Wolfe and Hugenholtz, 2009) or elongation of blowout hollows (Cooper, 1958; Pye, 1982). The dune flanks are the first part to be fixed by vegetation due to their proximity to the groundwater table. The middle part continues to move forward, thereby forming a parabolic dune (Zhu et al., 1980; Wasson et al., 1983; Gaylord