

Controls on grain-size distribution in an ancient sand sea

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Associate Editor – Subhasish Dey

ABSTRACT

Grain-size distribution in deserts is driven by a combination of autogenic controls such as grain abrasion and sorting due to wind transport, and allo-genic controls such as provenance and spatial changes in wind-direction. Downwind grain-size trends in present day sand seas display contrasting results, with some showing broad downwind fining and sorting (for example, Namib and Hexi) whilst others lack any clear trend (for example, Ténéré, Australian and Sinai). To determine the relative importance of autogenic and allo-genic controls on grain-size distribution in sand seas, this study examines the grain-size distribution along the margins of the Cretaceous Botucatu palaeodesert across an area of >1 000 000 km². To quantify the main controls on Botucatu palaeodesert grain-size distribution, this study compares the spatial distribution of grain-size metrics with: (i) detrital zircon geochronology as a provenance test; (ii) palaeowind patterns as a wind-regime test; and (iii) three transects along the basin palaeomargins as a downwind abrasion test. Grain-size dispersion shows an east to west fining pattern, which agrees with provenance control – in contrast to a north–south trend expected for the predominant wind-regime control. In the north-east region there is good evidence for downwind fining due to aeolian abrasion – of about 0.4 µm by kilometre, indicating that whilst downwind fining due to abrasion does occur, it is limited by the rounded nature of the available sand and possibly by a mix of different provenance sources. The results suggest that the provenance of the available sand is the primary control on the grain-size distribution in the Botucatu sand sea and potentially in most large-scale dune fields.

Keywords Allo-genic controls, autogenic controls, Botucatu, grain-size distribution, palaeoerGs, sand seas.

INTRODUCTION

The construction of dune fields by aeolian systems is ruled by a set of external (allo-genic) and internal (autogenic) forces. Autogenic forces account for the granular self-organization tendency within natural sedimentary systems (Werner, 1995, 1999; Kocurek & Ewing, 2005). Allo-genic controls correspond to external

environmental drivers that are linked to external forces such as tectonism, climate or base-level changes (Jerolmack & Paola, 2010; Rodríguez-López *et al.*, 2014). Jerolmack *et al.* (2011) propose that grain-size distributions in aeolian environments are derived from coupled sorting and abrasion due to the saltation of grains in the downwind direction. Abrasion during transport is inherent to the aeolian system (Bagnold, 1941;