



A classification scheme for fluvial–aeolian system interaction in desert-margin settings



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ABSTRACT

This study examines 130 case examples from 60 desert regions to propose a generalised framework to account for the diverse types of interaction known to exist between active aeolian and fluvial depositional systems at modern dune-field margins. Results demonstrate the significance of aeolian and fluvial system type, orientation of aeolian versus fluvial landforms, distribution of open versus closed interdune corridors, and fluvial flow processes in controlling the distance and type of penetration of fluvial systems into aeolian dune fields.

Ten distinct types of fluvial–aeolian interaction are recognised: fluvial incursions aligned parallel to trend of linear chains of aeolian dune forms; fluvial incursions oriented perpendicular trend of aeolian dunes; bifurcation of fluvial flow between isolated aeolian dune forms; through-going fluvial channel networks that cross entire aeolian dune fields; flooding of dune fields due to regionally elevated water-table levels associated with fluvial floods; fluvial incursions emanating from a single point source into dune fields; incursions emanating from multiple sheet sources; cessation of the encroachment of entire aeolian dune fields by fluvial systems; termination of fluvial channel networks in aeolian dune fields; long-lived versus short-lived modes of fluvial incursion.

Quantitative relationships describing spatial rates of change of desert-margin landforms are presented. The physical boundaries between geomorphic systems are dynamic: assemblages of surface landforms may change gradationally or abruptly over short spatial and temporal scales. Generalised models for the classification of types of interaction have application to the interpretation of ancient preserved successions, especially those known only from the subsurface.

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1. Introduction

Desert dune fields are not necessarily covered with aeolian bedforms; most are also characterised by other morphological bodies of aeolian-derived or aeolian-related sediment deposits, including interdunes, sand sheets, soils, lacustrine systems, and perennial, intermittent or ephemeral fluvial systems. These geomorphic forms are commonly developed between active aeolian dunes, else they define the limits of dune fields, with sharp or gradational boundaries. Fig. 1 depicts common depositional processes that operate at dune-field margins, many of which control the mechanisms by which successions accumulate to form bodies of preserved strata. Significant diversity in the arrangement and type of interaction of competing depositional sedimentary systems is recognised in modern desert dune fields and their marginal areas, and these give rise to complex yet predictable geomorphological patterns

that commonly vary over space and time (e.g., Lancaster, 1989; Cooke et al., 1993; Bullard and Livingstone, 2002; Al-Masrahy and Mountney, 2013). The record of these interactions is also recognised in the ancient sedimentary record (e.g., Langford and Chan, 1989; Kocurek, 1991; Spalletti and Veiga, 2007), where spatial and temporal changes in the type of interaction between aeolian dune and associated desert sub-environments are known to have resulted in the preservation of complex arrangements of sedimentary deposits and stratigraphic architectures (Mountney, 2006a, 2012).

Permanent, intermittent and ephemeral fluvial systems occur in many dryland regions (Powell, 2009), including in parts of Australia, India, Saudi Arabia, and the Southwestern United States (e.g., Schenk and Fryberger, 1988; Tooth, 2000; Glennie, 1987, 2005; Nanson et al., 2002), and many such systems exhibit complex and long-lived interactions with aeolian dunes. Some fluvial systems serve to generate significant supplies of sediment that are subsequently available for aeolian–dune construction, as in the Kelso dune field, Mojave Desert of California (Sharp, 1966;

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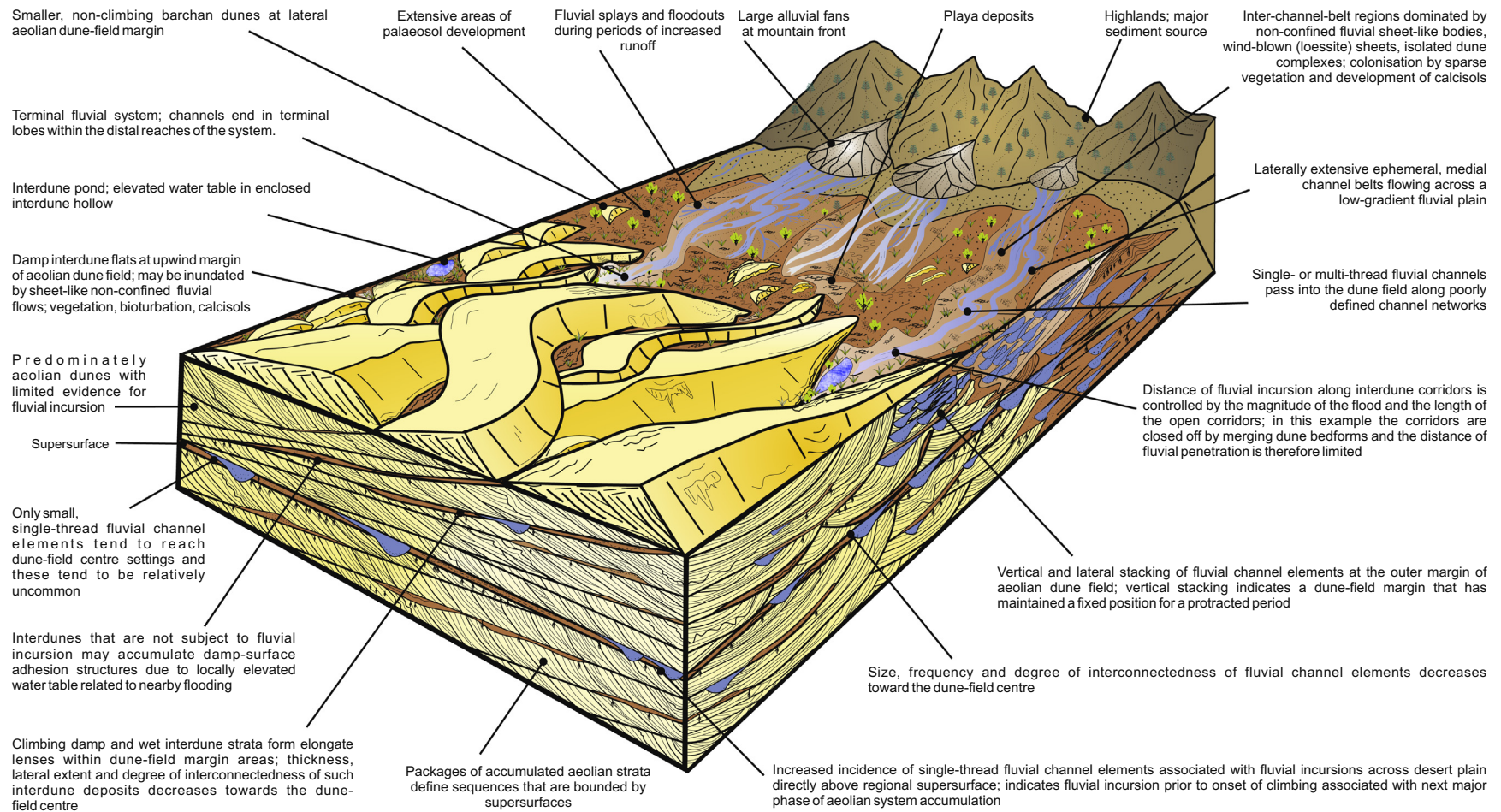


Fig. 1. Schematic model illustrating common depositional processes that operate at dune-field margins, and resultant stratigraphic relationships. No particular scale implied.

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