Quaternary Research (2023), **115**, 1–2
doi:10.1017/qua.2023.49

Introduction

Introduction to Thematic Set: Aeolian Processes, Landforms and Chronologies

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Studies of aeolian processes and landforms, especially on millennial to decadal timescales, provide a natural laboratory for understanding their response to forcing factors, including climate change and variability and human impacts, that determine the supply, availability, and mobility of sediment.

This Thematic Set of articles is derived from a Topical Session 136 "Aeolian Processes, Landforms and Chronologies" that was held at the 2021 Geological Society of America annual meeting in Portland, Oregon, USA. The articles in this Thematic Set investigate aeolian system responses at historical to late Pleistocene-Holocene timescales, using a variety of approaches and methods.

In the southern Great Plains, extensive mostly vegetation-stabilized dune systems border west to east flowing rivers. Their morphology and stratigraphy indicate multiple periods of accumulation and stabilization. The boundary conditions of sediment supply and availability that occurred during periods of dune formation and (re-) activation are however debated, as are the regional patterns of aeolian activity and stability (Halfen and Johnson, 2013; Halfen et al., 2015). Forman et al. (2023) show the importance of sediment supply to aeolian accumulation in the Red River valley of Arkansas during the 16th and 17th centuries, in relatively wetter conditions associated with the Little Ice Age, rather than drought conditions, as previously suggested.

Although there is an extensive dataset of OSL chronologies for dune systems in the Great Plains, it is not feasible to date every dune morphological unit. Baldauf et al. (2023) use high-resolution digital elevation models from drone imagery to develop a relative chronology of parabolic dune generations in dune fields in the White River Badlands of South Dakota. Early to Middle Holocene parabolic dunes can be distinguished from Late Holocene parabolic dunes on the basis of slope and roughness (as measured by the terrain ruggedness index). Post-depositional processes of wind erosion, mass wasting and soil formation lead to a reduction in slope angles and lower terrain ruggedness indices. Vegetation cover and soil formation result in reduced sediment availability and preservation of older dune generations, even as new generations of dunes are formed. This approach has wide significance for developing relative dune chronologies elsewhere in the region and for targeting of luminescence dating campaigns. It mirrors similar methodologies applied to coastal dune systems in Australia (Patton et al., 2022) and indicates the global value of this approach.

Cite this article: Lancaster N, Sweeney M (2023). Introduction to Thematic Set: Aeolian Processes, Landforms and Chronologies. *Quaternary Research* **115**, 1–2. https://doi.org/10.1017/qua.2023.49

Historical records of landscape change can provide valuable information on geomorphic responses to changes in boundary conditions. McKeehan and Arbogast (2023) examined the record of changes in blowout occurrence and morphology in dune fields in the on the eastern shores of Lake Michigan, using aerial photographs from three periods: 1938, 1986–1988, and 2018. Using the spatial-temporal analysis of moving polygons (STAMP) model to analyze how each blowout changed in time and space, they showed that the majority of blowouts were reduced in size and/or fragmented over time, largely as dune vegetation increased. It appears that the blowouts are not forming today and are a product of past drier or stormier conditions.

These articles show clearly that innovative techniques of spatial analysis in combination with well-established approaches can provide new insights into how aeolian landforms and processes respond to changes in boundary conditions.

In addition to the articles included in this Thematic Set, this issue of Quaternary Research includes two important articles. Patton et al. (2023) demonstrate the value of dune foot slopes as ecological and sedimentary archives, including a record of fires in the immediate area. Holliday et al. (2023) provide further constraints on the age of the White Sands dunefield – the world's largest gypsum dune area, using the archaeological record of superimposed and stratified artefacts.

Acknowledgements. We thank Randy Schaetzl and Phil Kerr for hosting this Topical Session and the reviewers who provided comments and suggestions on the manuscripts.

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https://doi.org/10.1017/qua.2023.49 Published online by Cambridge University Press