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Why longitudinal dunes are rarely recognized in the geologic record

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Until the early 1980s, geomorphologists believed that aeolian dunes were oriented either transverse or longitudinal (relative to a sand-transport vector). Bagnold predicted that linear dunes reverse without migrating and therefore deposit symmetrical, bimodal, zigzag stratification [1]. Rubin and Hunter [2] showed that such stratification, is exceedingly rare in aeolian sandstones, and they considered two hypotheses to explain why: (a) longitudinal dunes migrate laterally, or (b) longitudinal dunes don't leave deposits. Field observations demonstrated that linear dunes commonly do migrate laterally [2], and experiments and theory showed that oblique dunes are more common than perfectly longitudinal dunes [3]. Although lateral migration does prevent many linear dunes from producing the structures that Bagnold predicted, the other hypothesis—that linear dunes might not leave deposits—has remained untested for 3 decades.

In 2015, lab experiments showed that dunes have two modes [4]. On beds that are completely covered with sand, dunes form in the bed-instability mode and follow the alignment described by [3], but on beds that are partially starved, dunes form in the fingering mode and might be more likely to take an orientation that is perfectly longitudinal [4]. Discovery of this second mode reintroduces the question from 3 decades earlier: Do dunes in the fingering mode also migrate laterally (preventing them from leaving deposits), or are these dunes prevented from leaving deposits because they only form on a starved bed (and therefore can not deposit strata without changing to the bed-instability mode)?

We addressed this question using both lab experiments and fieldwork. In the lab experiments, we found it more difficult than we had expected to generate the symmetrical zigzags that Bagnold predicted. In the field (Harris Wash Member of the Page Sandstone in southern Utah) we found a starved (cemented) surface overlain by relatively symmetrical zigzag structures, as well as cross-beds deposited by reversing winds, but we don't know whether these cross-beds were deposited by reversing dunes or by reversing spurs on the lee sides of transverse dunes.

References

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