

## THE FORMATION OF LOW-ANGLE EOLIAN STRATIFICATION THROUGH THE MIGRATION OF PROTODUNES

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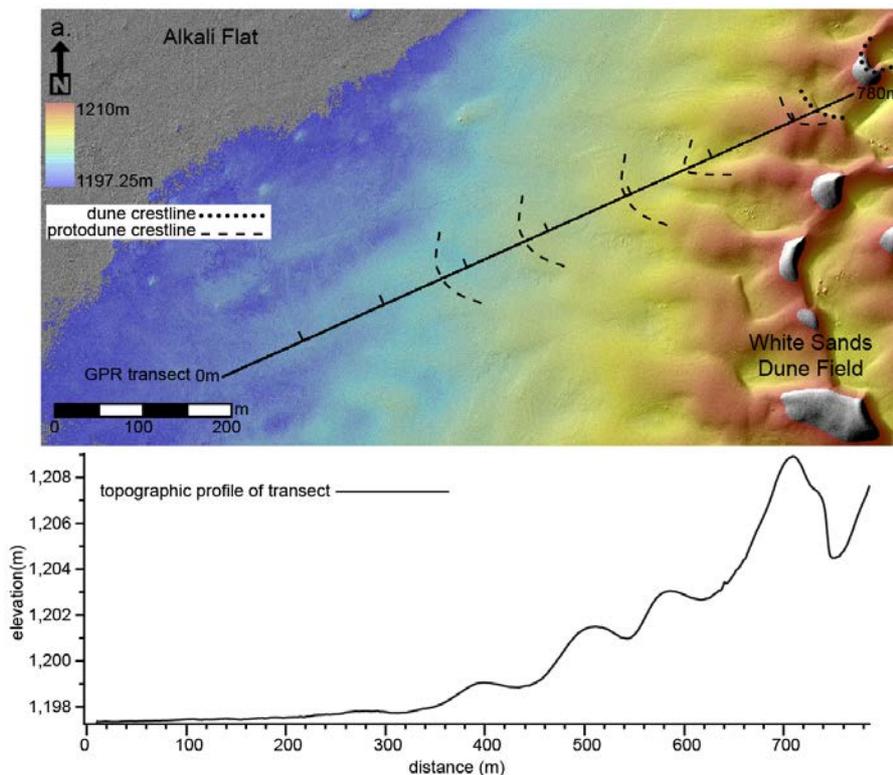
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Protodunes are low-relief, slipfaceless migrating bed forms that represent the emergent form of eolian sand dunes. Protodunes develop as cm-scale topography out of a flat bed of sand and evolve spatially and temporally into dunes with angle-of-repose slipfaces. Protodunes at White Sands Dune Field in New Mexico form at the upwind, trailing margin of the field, on dune stoss slopes, and in interdune areas. Here we analyze protodunes at the upwind margin of White Sands by coupling 200 MHz ground penetrating radar (GPR) with time-series high-resolution topography to characterize the origin and evolution of protodune stratification and the stratigraphic transition into fully developed dunes. We surveyed a 780m transect in the resultant transport direction of the dune field from SW to NE from sand patches through protodunes and into the first dune. We used airborne lidar surveys and structure-from-motion photogrammetry from 2007, 2008, 2009, 2010, 2015, and 2016. We find that protodune stratification forms at angles between 0-10 degrees by protodune migration. Dip angles increase as protodune amplitude increases along the transect. Accumulation of low-angle stratification increases across the first ~650m and ranges from none to subcritical. Nearly aggradational accumulation of low-angle stratification occurs over the last 100m and is a precursor to angle-of-repose slipface formation. The origins of the aggradation and slipface development appear to be linked to protodune merging, dune interactions, and possibly to the development of a dune field-scale boundary layer. Protodunes and the formation of low-angle stratification at the upwind margin of White Sands are a good analog to the initiation of dune field development from sand sheets and the formation of low-angle stratification found at the base of eolian successions in the stratigraphic record.



**Figure 1.** Spatial evolution of protodunes at the upwind margin of White Sands Dune Field, USA