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Extensive palaeo-dunefields on unusually steep slopes in eastern Noctis Labyrinthus, Mars

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Here we report spatial analysis of a large number of bedform patterns in eastern Noctis Labyrinthus (NL), Mars, which occur preferentially on very large, steep (up to $\sim 30^\circ$) slopes, and interpret the features as extensive palaeo-dunefields. We base this aeolian genesis for the features on: i) their frequently oblique orientation to hillslopes, ii) their apparent interaction with topography (consistent with atmospheric transport), and iii) their planform morphology. However, the dunefields also exhibit a number of characteristics that make these dunes highly unusual, viz: i) the dunes preferentially occur not within topographic basins and valley floors, but upon the huge slopes of the valleys of Noctis Labyrinthus, ii) these underlying slopes are in many cases atypically steep for dune formation, with bedforms occurring on slopes of up to $\sim 32^\circ$ and iii) cratering of the dunes confirms their antiquity and induration, and their identity as palaeodunes.

We used data from the HiRISE and CTX sensors on the Mars Reconnaissance Orbiter within a GIS framework to conduct spatial analysis of the palaeodunes. We used an automated crest detection algorithm to derive $\sim 30\,000$ segments of crestline, and slope and aspect were derived from the MOLA DEM. Dunes are found on slopes approaching the angle of repose at around 32° ; the mean slope underlying the bedforms is $\sim 17^\circ$, and around 40% of them are found on slopes in excess of 20° . Using crater-counting methods, we derive a modelled surface age of $4.8\text{ Ma} \pm 0.1\text{ Ma}$. We propose that the dunefields result from past westward transport and result from deposition on unusual accommodation spaces. We consider the possible depositional and subsequent post-induration erosional processes that are consistent with the observed geometries, and propose two models that appear consistent with both fundamental physical principles and present-day observations.

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