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The relevance of diffusion processes for desert pavement dynamics - the experimental view

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Desert pavements are a widespread feature of arid landscapes. Their evolution has been commonly attributed to the trapping of eolian fines and their subsequent relocation beneath the pavement's clasts. Thus, desert pavements rise vertically on a continously thickening sedimentary layer and therefore have been assumed to be stable landforms, useful for relative and numerical age estimations. The recognition of the importance of unconcentrated overland flow is now challenging the accuracy of such age estimates as it allows recovery of disturbed patches, burial of clasts and formation of new surficial layers. Here, we explore a further lateral process that possibly indicates desert pavements to be a dynamic rather than a stable landform. Rain water infiltration causes soil air pressure to increase. Air cannot escape through the puddled surface but through the still dry patches below stones. This air escape lifts stones parallel to the slightly inclined surface. Subsequent settling results in downslope displacement and/or rotation. Here we present first results of a scaled experiment in which we explore the physics and boundary conditions of this process. A 0.5 m^2 inclined (2°) metal box, equipped with pressure, moisture and temperature sensors, was filled with eolian sediment and loaded with clasts whose positions were tracked photogrammetrically. The material was cyclically wetted by a rain nozzle and subsequently dried (32 cycles). Sediment volume increased by ca. 15%, due to the formation of vesicular structure. After each wetting cycle the pressure inside the sediment rose to max. 10 hPa, eight times more than necessary to lift clasts. Besides rising, clasts were also embedded in the fine grained matrix. With time, due to the fine texture, a cutan started developing, which increasingly prevented stones from becoming mobile. A reorganisation of the experiment setup will now add a fine sandy layer on top of the fine material, which will bring the experiment closer to natural conditions, where this sand layer is almost ubiquitously present. After 20-30 additional cycles we aim to quantify the average downslope displacement and rotation rates, and their dependence on stone size and geometry. We also test the efficacy of the process to diffuse an agglomeration of rocks into a monolayer of clasts, i.e., a stone pavement sensu stricto.