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Desert Pavement Process and Form: Modes and Scales of Landscape Stability and Instability in Arid Regions

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Desert pavements are recognized in arid landscapes around the world, developing via diminution of constructional/depositional landform relief and creating a 1-2 stone thick armor over a "stone free" layer. Surface exposure dating demonstrates that clasts forming the desert pavements are maintained at the land surface over hundreds of thousands of years, as aeolian fines are deposited on the land surface, transported into the underlying parent material and incorporated into accretionary soil horizons (e.g., the stone free or vesicular [Av] horizon). This surface armor provides long-term stability over extensive regions of the landscape. Over shorter time periods and at the landform-element scale, dynamic surficial processes (i.e. weathering, runoff) continue to modify the pavement form. Clast size reduction in comparison to underlying parent material, along with armoring and packing of clasts in pavements contribute to their persistence, and studies of crack orientations in pavement clasts indicate physical weathering and diminution of particle size are driven by diurnal solar insolation. Over geologic time, cracks form and propagate from tensile stresses related to temporal and spatial gradients in temperature that evolve and rotate in alignment with the sun's rays. Observed multimodal nature of crack orientations appear related to seasonally varying, latitude-dependent temperature fields resulting from solar angle and weather conditions. Surface properties and their underlying soil profiles vary across pavement surfaces, forming a landscape mosaic and controlling surface hydrology, ecosystem function and the ultimate life-cycle of arid landscapes. In areas of well-developed pavements, surface infiltration and soluble salt concentrations indicate that saturated hydraulic conductivity of Av horizons decline on progressively older alluvial fan surfaces. Field observations and measurements from well-developed desert pavement surfaces landforms also yield significantly lower infiltration rates, enhanced rates of overland flow characterized by high water:sediment ratios and reduced production of desert ecosystems. Consequently, regionally extensive pavement and significantly decreased infiltration over geologic time have resulted in widespread overland flow, elaborate drainage networks on alluvial and eolian-mantled bedrock landscapes, and channel incision and regional dissection of the pavement-mantled landforms. However, these once stable landscapes become progressively unstable with time, serving as sediment source areas for younger alluvial deposits (i.e. geologic life-cycle). Thus, regional dissection (instability) of these desert landscapes can be influenced by the intrinsic properties of pavement-mantled landscapes and not necessarily to external forces of climate change and tectonics.