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Testing the hydraulic and case hardening hypotheses of honeycombs origin

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Cavernous weathering is a global phenomenon occurring in porous rocks all around the world. Honeycombs (also called alveoli or lacework), together with tafoni, are the most common forms of cavernous weathering. Honeycombs are generally described as numerous tightly adjoining pits of several centimeters in size at the outcrop surface. Despite their common occurrence, origin and evolution of honeycombs are yet not fully understood. Most often, the two formation hypotheses – hydraulic and case hardening – are assumed. According to the hydraulic hypothesis, weathering is controlled by a hydraulic field and its boundary conditions that dictate where the damaging soluble salts will crystallize from the pore water (Huinink et al., 2004). The case hardening hypothesis emphasizes that the lips between honeycomb pits become hardened by mineral crystallization in rock pores and thus weather at a slower rate compared to the pits. We conducted several field and laboratory experiments to test these two hypotheses. Tensile strength, drilling resistance and porosity in the honeycombs lips and pits are not significantly different, and thus do not support the case hardening hypothesis. On contrary, the hydraulic hypothesis was clearly supported by field and laboratory measurements of hydraulic suction within the pore space and the study of water flow. The use of fluorescein dye enabled us to observe the capillary zone, vapor zone and the evaporation front in sandstone surface and subsurface and demonstrated that under low water flux, the evaporation front reaches the honeycombs pits and the honeycombs lips remain dry. The places of evaporation correspond to the places of potential salt weathering. Therefore, the experiments demonstrated that it is the spatial distribution of the capillary and vapor zones, not the rock hardness that controls the formation of honeycombs.

References:
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