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Microclimatic factors controlling tafoni weathering in Tafraoute, Morocco

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Cavernous tafoni-type weathering is observed in many arid and semiarid regions of the world and the underlying processes, as well as the respective weathering rates, are still not fully understood. Although the conditions of Tafoni formation has been under consideration for approx. 100 years, there is still no unifom view about their formation process. Their distribution pattern is thought to be controlled by distance to shore, duration of the arid season, local fault systems or by the age of the respective exposure. Three possible ways of tafoni genesis are under discussion: (1) mechanical weathering by temperature and volume fluctuations in short periods which are reinforced by micro-circulation of air in the cavities; (2) mechanical weathering by hydration of salts; (3) chemical weathering including case hardening on the surface and "core weathering" of the interior. To understand the tafoni weathering process it boils down to three significant influential factors: temperature fluctuations, rock moisture and salt distribution.
Our study focuses on tafoni weathering in Tafraoute, Morocco, located in the granites of the Kerdouse Massif. We attempt to clarify the formation process using a combination of various micro-climatic and geophysical methods. The most important technique is small-scale 2D-resistivity profiling which allows to look some decimetres inside the rock and to visualise rock moisture and salt concentration patterns. First morphometric analysis and mappings have been conducted in summer 2013, and micro-climatic investigations are carried out in February 2014. Mapping results show that tafoni distribution is influenced by topography and aspect. However, no relation between exposure and depth of the hollows was found; e.g. no significant differences in morphometric parameters were observed between northern and western rock faces. Temperature sensors were installed at different expositions and depths to measure daily temperature changes. These are supplemented by infrared images used to detect subtle spatio-temporal changes in surface temperature. The spatial distribution of rock moisture is derived from the aforementioned 2D-geoelectric profiles which have not been aplied in this context before. The geophysical measurements are complemented by capacitive handheld sensor surveys and borehole humidity measurements. Salt content is determined in a narrow grid using paper pulp poultices; the samples are analyzed in the laboratory for salt types and concentration. The investigations will contribute to understanding the importance of local- and microclimatic conditions, rock parameters and salt concentrations on the occurrence and shape of tafoni.