Geophysical Research Abstracts
Vol. 14, EGU2012-2659, 2012
EGU General Assembly 2012

An approach to better understanding of salt weathering on stone monuments - the "petraSalt" research project

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Salt weathering is known as a major cause of damage on stone monuments. However, processes and mechanisms of salt weathering still can not be explained satisfactorily. From the experts′ point of view, better understanding of salt weathering deserves further comprehensive in-situ investigation jointly addressing active salt weathering processes and controlling factors. The ‘petraSalt’ research project takes this approach.

The rock-cut monuments of Petra / Jordan were selected for studies, since stone type and spectra of monument exposure regimes, environmental influences, salt loading and weathering damage are representative for many stone monuments worldwide. The project aims at real-time / real-scale weathering models that depict characteristic interdependencies between stone properties, monument exposure regimes, environmental influences, salt loading and salt weathering damage. These models are expected to allow reliable rating and interpretation of aggressiveness and damage potential of the salt weathering regimes considering their variability under range of lithology, monument exposure scenarios, environmental conditions and time.

The methodological approach systematically combines assessment of weathering damage (type, extent, spatial distribution and progression of damage), assessment of monument exposure characteristics and environmental influences acting on the monuments (monument orientation / geometry, lithology, rain impact, water run-off, rising humidity, wind impact, insolation, heating-cooling and drying-wetting behaviour, etc.), engineering geological studies (structural discontinuities and related failure processes) and investigation of salt loading (type, concentration, spatial distribution and origin of salt, salt crystallization / dissolution, phase transitions, etc.).

Besides established methods, very innovative technologies are applied in the course of investigation such as high-resolution 3D terrestrial laser scanning (TLS) and wireless sensor network (WSN), facilitating improved steps of evaluation. The 3D models, images and cross-sections of the monuments derived from laser scanning contributed, for example, to the assessment of the monuments′ original geometry, thus providing the basis for precise quantification of apparent weathering damage on the monuments, in particular loss of stone material. An autonomously operating wireless sensor network was developed for continuous temporal and spatial high-resolution monitoring of environmental conditions affecting stone surface and stone interior of the monuments and acting as driving forces for the salt weathering processes. The extraordinary data output is to provide the basis for a differentiated numerical analysis of partial or complete salt crystallization / salt dissolution cycles, considering diurnal and seasonal variation.

Methodological approach and results of the ‘petraSalt’ research project are presented.