Geophysical Research Abstracts
Vol. 15, EGU2013-10254, 2013
EGU General Assembly 2013

Characterizing the process and quantifying the rate of subaerial rock weathering on desert surfaces using roughness analysis

Amit Mushkin, Amir Sagy, and Eran Trabelci
Geological Survey of Israel, Jerusalem, Israel (mushkin@gsi.gov.il)

Subaerial weathering of rocks is a common process observed on desert surfaces on Earth and other planetary terrestrial surfaces such as on Mars. On Earth, this weathering process has been previously identified as one of the key erosion agent driving geomorphic surface evolution and the development of desert pavements. And yet, fundamental aspects of the process, such as the relative contribution of the different weathering modes that drive it (e.g., mechanical breakdown of rocks, chemical weathering, aeolian abrasion and exfoliation) as well as the rate by which this weathering process occurs have not been systematically examined. Here, we present a new approach for quantitatively addressing these fundamental aspects of process geomorphology on desert surfaces.

We focus here on co-genetic desert alluvial surfaces of different ages, i.e. alluvial chronosequences, which provide excellent recorders for the evolution of boulder-strewn surfaces into smooth desert pavements through in-situ subaerial weathering of rocks. Our approach combines independent measures of two different surface attributes: High resolution (mm-scale) 3D ground-based laser scanning (LiDAR) of surface micro-topography, and numerical dating of surface age. Roughness analysis of the LiDAR data in power spectral density (PSD) space allows us to characterize the geometric manifestation of rock weathering on the surface and to distinguish between the different weathering modes. Numerical age constraints provide independent estimates for the time elapsed since the process began. Accordingly, we are able to constrain surface roughness evolution on alluvial fan desert chronosequences through time, and present PSD analysis of surface roughness as a new quantitative tool to examine the process of subaerial rock weathering in desert environments.

In this study we present results from two late Quaternary alluvial chronosequences along the Dead Sea Transform in the hyper-arid Negev desert of southern Israel. LiDAR scanning was applied on representative areas (∼30-50 m2) of 10 separate surfaces ranging from rough Holocene surfaces to fairly smooth surfaces with well-developed pavements displaying an OSL age of 87 kyr. We find typical and recurring time-dependent changes in the offset as well as shape of the PSD curves in both chronosequences: PSD offset is continuously reduced over time reflecting the overall reduction in the amplitude of roughness at all wavelengths. The PSD curves display progressive moderation of slopes at the longer wavelengths with the moderation point itself systematically shifted to shorter wavelengths. This characteristic evolution of PSD offset and slope moderation at longer wavelengths reflects the typical break up of boulder-sized clasts through time as the surfaces mature into well-developed desert pavements and points towards mechanical breakdown as the dominant weathering mode. In addition, we are able to determine the rate by which the larger clasts are removed from the system. We build on these new insights into process and rate of rock weathering to propose PSD analysis of surface roughness as a complementary method for constraining the age of desert alluvial surfaces in places where 'conventional' dating cannot be applied.