Abstract

Aeolian processes are a common form of erosion on Iceland due to the vast range of material properties, anthropogenic and environmental processes. Little is, however, known about aeolian erosion of the highly dissected landscapes in Iceland’s interior. Event-driven landscape evolution has created a unique set of conditions near Landmannalaugar in the Torfajökull area. The largest exposure of silicic volcanism on an oceanic crust harbours various subaerial and subglacial eruption edifices. Some of these are characterised by non-cohesive material that is easily eroded and where material properties created by the eruption environments directly contribute to the erosion processes. Following a mapping and inventory of scree deposits in the Grænagil gorge near the Bláhnúkur edifice, samples of scree and overlying parent rock were collected and analysed. Distributional differences between source and deposition areas and auto-organisation processes in these sediments are used to derive dominant erosion processes in an area with relatively young (<11ka) subglacially deposited hyaloclastites. Geomorphological processes in the area of interest, combined with internal stratification, avalanching of dry sediments, and the depletion of fine clay and silty particles with a relative enrichment of larger particles compared to the original parent material indicate that dry processes are favoured over wet erosion. The composition of the deposits is only explained by the combined effects of aeolian transport and sedimentation. A new holistic model is proposed for aeolian-driven scree cone formation where particles are liberated by prevailing winds and gusts. Following detachment, fine particles are carried aloft and down wind while larger particles experience gravity-driven transport and sedimentation in the scree deposits.

The process was split up into the major driving forces to fundamentally understand the contribution of each of the components. A technique was adapted to study each of the two processes with their planetary variable under different conditions. Wind erosion was studied in depth using wind tunnel experiment to obtain the threshold curves of the hyaloclastites and determine important process parameters. Important differences occur in the face of Allen flow dominated entrainment while changing atmospheric pressure. Gravity-driven transport was studied by empirical modelling of avalanches in thin ‘aquarium-like’ Hele-Shaw cells using sediment mixtures that in nature experience auto-organisation process such as stratification (observed in the scree deposits) and segregation. Gravity was changed using state-of-the-art equipment such as the Large Diameter Centrifuge of the European Space Agency and during parabolic flight onboard a Cessna Citation II research jet. Common theory on granular avalanches indicates that angles of repose should not differ with gravity, but the experiments show unambiguously that they do.

The effects of these planetary variables are then taken to the planet Mars where their translation using case studies sheds light on the actual application of these insights on other planets. As processes and landforms on Mars are formed by similar subglacial eruptions, the interpretation of Martian landforms may substantially benefit from the general approach of comparing landforms using planetary variables. These processes may give vital clues for the dominance of dry aeolian and gravity-driven erosion processes at the surface of Mars while simultaneously helping the recognition and identification of similar subglacial landforms on Mars.