Understanding geomorphic data of monogenetic scoria cones

Gabor Kereszturi, Karoly Nemeth

Volcanic Risk Solutions, Massey University, Palmerston North, New Zealand

E-mail: kereszturi_g@yahoo.com

The definition of a scoria (or cinder) cone traditionally refers to any kind of volcanic landform that has conical geometry, is dominantly composed of fragmented rocks (coarse ash to lapilli) of low silica content of any type (e.g. basalt) and that is small in edifice volume (e.g. 0.1 to 0.00001 cubic km). Geomorphic data of scoria cones are often used for understanding eruptive and degradation processes quantitatively and as discrimination factors for relative age dating. One of the most common interpretations of scoria cones' geomorphic data is that these geomorphic parameters gradually decrease with age as the erosion processes smooth the cone morphology away from the Earth surface. Recently, an increasing number of studies have found evidence for a significant eruptive-control on the morphology of scoria cones. This study aims to give a summary of the possible interpretations of the geomorphic data of scoria cones in the light of the findings of new studies. Morphometric data extracted from any source (e.g. Digital Elevation Models) carry information about both syn-eruptive and post-eruptive processes. Therefore, the traditional morphology-based discrimination of edifice degradation stages and relative age groupings of volcanic cones should be avoided; a distinction should be made between the syn-eruptive contribution and the post-eruptive contribution before any further interpretation is carried out. For discrimination purposes, known absolute ages should be used, thus the likely effect of erosion on the primary, syn-eruptive morphology can be quantified. Here we suggest that prior to any detailed morphological study on a cone-dominated field, a preliminary assessment of the cone (e.g. eruption history) needs to be performed and cones grouped following their genetic (syn-eruptive) origin. If the grouping of edifices is based on eruptive similarities, then the initial morphologies should be similar to each other and their subsequent degradation will likely follow the same pattern over time. Here we provide numerous examples to support the syn-eruptive controls on scoria cone morphology and their long-term effect on degradation rates and patterns under different climatic settings. A theoretical degradation model, by the combination of long-term (e.g. rain splash erosion) and short-term (e.g. debris flow) mass wasting processes, is established to help the interpretation of geomorphic data. Due to the coupling mechanism between the eruptive diversity and the degradation path of individual volcanoes, it is proposed that volcano degradation is not only the consequence of age and climate, but of many other processes, such as number of 'event' degradations and the erosion-resistance of pyroclastic materials exposed to the environment.