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The morphometry of scoria cones as an indicator of their relative age – Results from the Cameroon Volcanic Line

Christoph Schmidt (1), Christian Laag (1), Jörn Profe (2), Tom Richter (1), and Jean Pierre Tchouankoue (3)

(1) Chair of Geomorphology, University of Bayreuth, Bayreuth, Germany, (2) Department of Geography, Justus-Liebig University Gießen, Gießen, Germany, (3) Department of Earth Sciences, University of Yaounde I, Yaounde, Cameroon

For risk assessment and for deciphering the spatio-temporal activity pattern in a specific volcanic field, it is important to establish an eruption chronology. However, Holocene and Late Pleistocene volcanoes often challenge conventional radiometric dating techniques (e.g., 40Ar/39Ar, 14C or luminescence methods) due to absence of datable material or low concentration of radiogenic Ar. Therefore, alternative approaches for chronometric assignment of volcanic activity are required. Previously, it was shown that juvenile scoria cones are characterised by a specific, universal geometry (e.g., Wood, 1980). For a particular climatic zone, it might thus be expected that the morphometry of scoria cones – the most frequent type of volcanic edifice on Earth –changes systematically as a function of their age, driven by erosion. Specifically, it has been proposed that the ratio of height to basal diameter of the cone decreases with age, provided that erosional processes acted uniformly since its formation (e.g., Hooper and Sheridan, 1998; Inbar et al., 2011). A relative assignment of eruption age could thus be attempted based solely on the geometry of scoria cones.

The Quaternary scoria cones along the Cameroon Volcanic Line (CVL) represent an example where this approach of relative age assignment might reveal important information about the origin and time-progression of active volcanism. While pre-Quaternary volcanoes of the CVL are comparatively well-dated by 40Ar/39Ar, no numerical age control is available for the youngest volcanic manifestations. However, information about age is crucial to test hypotheses for the origin of the CVL and to support risk assessment of future eruptions to the local population. We therefore investigated the morphometry of a series of scoria cones in the Mt. Cameroon, Tombel and Manengouba volcanic fields. Based on a digital elevation model with a horizontal resolution of 12.5 m, scoria cones were identified and their basic geometric parameters such as slope inclination as well as basal diameter and elevation were determined using semi-automated GIS procedures. Categorising these geometric parameters allowed us to assign scoria cones to age groups, yielding for the first time a relative chronology for these Quaternary volcanic fields. We can show that a clear relative age scheme emerges, with the scoria cones from the Tombel volcanic field having formed most recently, followed by those on the flanks of Mt. Cameroon and Manengouba. In the future, we intend to apply luminescence methods to those scoria cones that host datable material to 'calibrate' the determined relationships of geometric parameters and age.

References

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