Geophysical Research Abstracts
Vol. 18, EGU2016-5845, 2016
EGU General Assembly 2016

Quantifying the morphometric variability of monogenetic cones in volcanic fields: the Virunga Volcanic Province, East African Rift

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Volcanic cone fields are generally made up of tens to hundreds of monogenetic cones, sometimes related to larger polygenetic edifices, which can exhibit a wide range of morphologies and degrees of preservation. The Virunga Volcanic Province (VVP) developed itself in a transfer zone which separates two rift segments (i.e. Edward and Kivu rift) within the western branch of the East-African Rift. As the result of volcanic activity related to this tectonic regime of continental extension, the VVP hosts eight large polygenetic volcanoes, surrounded by over 500 monogenetic cones and eruptive fissures, scattered over the vast VVP lava flow fields. Some cones lack any obvious geo-structural link to a specific Virunga volcano.
Using recent high-resolution satellite images (SPOT, Pléiades) and a newly created 5-m-resolution digital elevation model (TanDEM-X), we have mapped and classified all monogenetic cones and eruptive fissures of the VVP. We analysed the orientation of all mapped eruptive fissures and, using the MORVOLC program, we calculated a set of morphometric parameters to highlight systematic spatial variations in size or morphometric ratios of the cones.
Based upon morphological indicators, we classified the satellite cones into 4 categories: 1. Simple cones with one closed-rim crater; 2. Breached cones with one open-rim crater; 3. Complex cones with two or more interconnected craters and overlapping cones; 4. Other edifices without a distinguishable crater or cone shape (e.g. spatter mounds and levees along eruptive fissures). The results show that cones are distributed in clusters and along alignments, in some cases parallel with the regional tectonic orientations. Contrasts in the volumes of cones positioned on the rift shoulders compared to those located on the rift valley floor can possibly be attributed to contrasts in continental crust thickness. Furthermore, higher average cone slopes in the East-VVP (Bufumbira zone) and central-VVP cone clusters suggest a morphologically younger age, which contradicts the previous assumption that the overall VVP volcanic activity shifted over time from E to W. This study thus demonstrates the usefulness of relatively rapid cone morphometry quantification on digital elevation models in volcanic areas where future volcanic hazards are poorly understood.