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The Virunga Volcano Province: A new volcano-structural map based on morphological analysis of a high-resolution Digital Elevation Model

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The Virunga Volcanic Province (VVP) is situated at a transfer zone within the Western branch of the East-African Rift system, hosts eight large volcanic edifices, and stretches over D.R.Congo, Rwanda and Uganda. Nyamulagira and Nyiragongo are the most recently active volcanoes, in the Western VVP. The former erupted 30 times since 1900, while the latter is occupied by a semi-permanent crater lava lake, which fed a lava flow flooding large parts of Goma city in 2002.

The Central and Eastern VVP holds six dormant to supposedly inactive central volcanoes, surrounded by tens of eruptive fissures and small satellite cones. The so-called 'Mugogo' eruption, ~11 km North of Visoke volcano, represents a mere exception. Mugogo is a small-volume volcanic cone and adjacent ~1.5 km long lava flow, emitted from an East-West oriented fissure in 1957.

A new volcano-structural map of the VVP has been constructed based on the morpho-structural interpretation of a new Digital Elevation Model (TanDEM-X) at 5 m resolution, supported by colonial-time geological maps and reports, Pleiades, SPOT and SAR satellite imagery and limited field observations (Figure 1). A Geographical Information System (GIS) database was assembled, including the outline of historical and some pre-historical lava flows, the location and boundaries of eruptive cones and fissures, and larger-scale topographic escarpments, interpreted as potential volcano-tectonic structures.

The positions of volcano-structural features in the Central and Eastern VVP exhibit an overall NE-SW to E-W orientation. This is in sharp contrast with the N-S to NNE-SSW dominated orientations observed on and around Nyamulagira and Nyiragongo in the West.

The map evidences varying geomorphological characteristics of the volcanic edifices within the VVP. Sabinyo volcano has a highly eroded profile with deeply incised valleys, which may be the result of deformation by gravitational spreading of the edifice. An extended vertical scarp on Mikeno volcano (Central VVP) and a ~50 m high front of blocky volcanic debris to the East of Muhabura volcano (East VVP) are important evidence of potential voluminous

flank failure during the lifetime of VVP volcanoes. Visoke and Gahinga both exhibit an uneroded topographic profile, suggesting a relatively young age for their volcanic construction. These geomorphological characteristics are consistent with geochronological studies suggesting a Late Pleistocene to Recent age of the Virunga volcanoes but contradict some of the relative chronology between individual volcanoes. Karisimbi volcano at last, is an elevated dome dissected by a pit-crater and caldera, and dominates the Central VVP. Trachytic lava flows on Karisimbi's Southeastern flank witness its most recent volcanism.

The geomorphological study of the VVP reveals that the Eastern and even more the Central VVP volcanoes may be still active, with Karisimbi, Visoke, Gahinga and Muhabura as the most potential candidates. Karisimbi volcano specifically displays a broad differentiation series, implying a broad range of eruptive behavior, in contrast with the typically effusive eruption style of e.g. Nyamulagira. Even in the absence of potential future volcanic activity, volcano instability processes may pose a different type of geo-hazard to the relatively highly populated areas surrounding the VVP volcanoes.

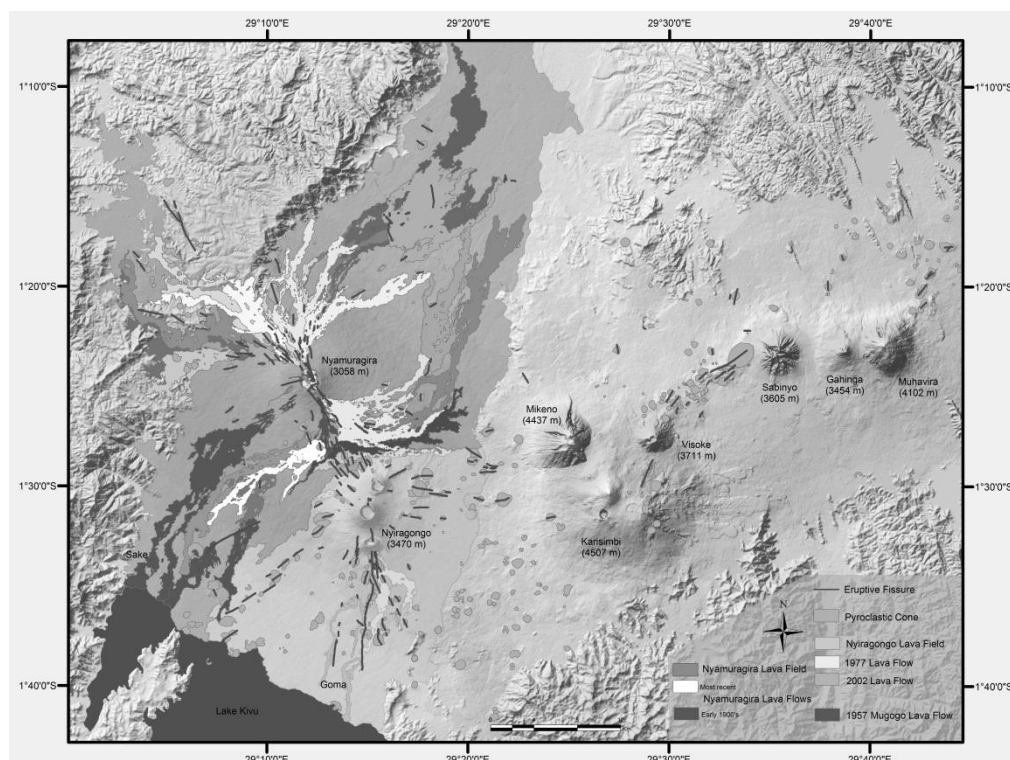


Figure 1: Volcano-structural map of the Virunga Volcanic Province, with eruptive cones and fissures. Historic lava flow boundaries for Nyamulagira and Nyiragongo volcanoes from Smets et al., 2010, *Journ. Afr. Earth. Scie.*