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Thermo-rheological magma control on the impact of highly fluid lava flows at Mt. Nyiragongo

D. Giordano (1), M. Polacci (2), A. Longo (3), P. Papale, (3), D.B. Dingwell (4), E. Boschi (3), M. Kasereka (5)

(1) Dip.to Scienze Geologiche, Università di Roma Tre, L.go S. Leonardo Murialdo, 1, 00146 Roma, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Italy, (3) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Italy, (4) Earth & Environmental Sciences Dept., Munich University, Munich, Germany, (5) Observatoire Volcanologique de Goma, CRSN, Lwiro, Bukavu, Democratic Republic of Congo. (dgiordan@uniroma3.it)

On 17 January 2002 several lava flows originated along a 10 km fissure system from the summit area of Mount Nyragongo volcano, (DRC), 3649 m a.s.l., to the suburbs of Goma town (ca. 500,000 inhabitants), resulting in the most outstanding case of lava flow impact with a big town ever. Reports by witnesses and field evidence indicate that lava flows from the highest vents were extremely fluid and fast-moving (tens of km/h, by analogy with estimates for the similar 1977 lava flows), instead those in town were more viscous and slowly-advancing (0.1-1 km/h). Accordingly, the threat posed to people was dramatically different. Those living in villages on the flanks of the volcano had little chance to escape, whereas hundreds of thousand people from Goma could flee originating a giant exodus, mostly toward the nearby Rwanda.

To understand the different behavior of lava flows and their menace to people, we undertake a multidisciplinary study involving textural and rheological measurements and numerical simulations of heat transfer during magma ascent. We demonstrate that pre-eruptive cooling and syn-eruptive undercooling of magma determined the different rheological behavior of lava flows erupted from vents at diverse heights. Venting at lower altitudes is expected to produce viscous, slowly advancing lavas, although development of fluid, faster flows should be included among possible future eruptive scenarios.