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Lava dome emplacement and destruction cyclic process at Popocatépetl volcano, Mexico: The distribution of dome volumes and its consequences on the hazard associated to the current activity

Servando De la Cruz-Reyna (1), Angel Gomez-Vazquez (2), and Ana Mendoza-Rosas (3)

(1) Universidad Nacional Autonoma de Mexico (UNAM), Instituto de Geofisica, Mexico D.F., Mexico (sdelacrr@geofisica.unam.mx), (2) Posgrado en Ciencias de la Tierra, Instituto de Geofisica, UNAM, (3) CONACYT - CIDESI, Querétaro, México

Popocatépetl is a large stratovolcano surrounded by one of the most densely populated areas of the world. Its eruptive history includes a wide range of eruption types, from moderate effusive episodes to Plinian phases and even massive debris avalanches. The historical record of the last 500 years describes several episodes similar to the current one that began in 1994. The current activity is characterized by the cyclic emplacement and destruction of lava domes, with a count of at least 38 between 1996 and 2015. The previous historical episode (1919-1927) probably emplaced around 10 domes. However, 1200 yBP a major Plinian phase affected human settlements, and at least six other major explosive eruptions have been reported in the Holocene. Such eruptive history leads to question the significance of the ongoing activity in the context of a volcano capable to produce extreme eruptions. The analysis of dome parameters characterizing the current activity offers some insight into the underlying physical process sustaining the eruption, and the conditions that may signal an evolution into higher-intensity phases. Although the process is irregular and non-stationary in the time domain, the maximum volumes and thicknesses of the domes estimated from aerial images are well described by an exponential survival distribution N=No*exp(-V/Va), where No is the number of emplaced domes, Va their average volume, and N the number of domes with volumes equal or exceeding V. A variable buoyancy force caused by the variable density contrast between volatile-rich magma and country rock may offer a possible interpretation of the process. The cyclic character of magma ascent may be a consequence of a self-regulating process caused by intense outgassing of magma controlling buoyancy. The proposed scaling law may then be a consequence of the gravitational energy release of the buoyancy force governing the height and volume of the domes. A significant departure from that scaling law in future dome emplacements may signal a failure of the self-regulating nature of the process that could lead to a different type of eruption.