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Understanding volcanoes and society: the key for risk mitigation

Timescale of magma mixing processes at the effusive to explosive transition at Popocatépetl Volcano (Mexico)

C.M. Petrone¹, R. Pellegrino¹, C. Rengifo-Castillo¹ And H. Delgado-Granados²

¹The Natural History Museum, Department of Earth Sciences, Cromwell Road, London, UK,

¹Departamento de Volcanología, UNAM, Mexico

The timescales over which an explosive stratovolcano switches from low-to-moderate explosive activity to cataclysmic Plinian eruption are fundamental in understanding the eruptive behaviour and thus contributing to volcanic hazard assessment. Popocatépetl volcano in Mexico ranks high both in terms of explosivity and threatened population (> 20 million, including Mexico City). It has had at least five major Plinian eruptions in the last 23 ky. These highly explosive events punctuate periods of quiescence and interplinian activity with effusive and Vulcanian eruptions – a pattern shown by many arc volcanoes.

El Fraile lavas erupted between 23 and 14 ky BP, prior to the Pumice with Andesite (PwA) Plinian eruption, the most powerful eruption at Popocatépetl. Macroscopic evidence of magma mingling are abundant both at El Fraile, with red and black lavas, and in the PwA, which shows mingled deposits and banded pumices. However, each eruptive sequence is very homogenous in terms of whole rock chemistry. All samples have similar paragenesis (phenocrysts of plagioclase, ortho- and clinopyroxene \pm amphibole). A complex population of pyroxene textures is found in both eruptive events, namely: (i) single banded pyroxene with evolved cores and rims and mafic bands (El Fraile Mg# 64-86, PwA Mg# 73-86), and (ii) mafic and patchy cores surrounded by evolved rims. These pyroxene textures testify pulsatory intrusions of new mafic magma carrying mafic crystals and/or antecrysts. We applied the NIDIS chronometry (Petrone et al., 2016 *Nat Comms*) to suitable ortho- and clinopyroxene to constrain the timescale of refilling events at El Fraile and PwA. An order of magnitude difference in timescales between interplinian and Plinian events is evident. El Fraile interplinian activity points to a rapid/short magma resident time (days/months), whereas the building up of the PwA Plinian eruption occurred over longer magma storage timescales (decades to hundred years).