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A pyroxenic view on major effusive and explosive eruptions at Popocatepetl volcano, Mexico, in the last 2000 years

Martin Mangler^{1,2}, Chiara Maria Petrone¹, Julie Prytulak², Hugo Delgado-Granados³

¹Department of Earth Science, The Natural History Museum, London, UK;

²Department of Earth Science and Engineering, Imperial College, London, UK

³Instituto de Geofísica, Universidad Autónoma de México, Mexico City, Mexico

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Popocatepetl is one of Mexico's most active volcanoes, and with about 20 million people living within 80 km from the crater also one of the most dangerous ones. Continuously active since 1994, Popo has had at least five Plinian eruptions in the last 23 ka, with intercalated phases of effusive to mild explosive activity. Similar whole-rock major, trace and Sr-Nd isotope characteristics for both effusive and explosive eruptions suggest no significant changes in the volcano's feeding system, raising the question which processes control the transition between different styles of activity. In this study, we examine zoned pyroxene phenocrysts from the most recent Plinian eruption (Pink Pumice, 1100 yrs BP) and the preceding effusive Nealticán flank eruption (<2000 yrs BP), to assess the potential role of mafic injections as a primary control on eruptive style. In both rock types, two orthopyroxene populations of distinct core compositions (Mg# 63-68 and 82-88, respectively) imply at least two separate magma storage regions, and common intermediate bands (Mg# 69-83) testify to frequent mixing and hybridisation of the corresponding mafic and evolved melts at depths of 3-6 km and temperatures of 930-990°C. Fe-Mg diffusion modelling of pyroxene crystal stratigraphies indicates that such mixing events occurred days to weeks before both the Nealticán and the Pink Pumice eruption, tracing magma remobilisation by mafic injections at similar timescales for both eruptive types. However, some pyroxenes record a longer and more complex history, with distinct injection events preceding the eruptions by years to decades, suggesting the presence of a stagnant shallow magma body with a complex crystal cargo. In the Pink Pumice, such crystals are significantly more abundant and show longer residence times than in the Nealticán lavas, which indicates that the injection triggering the Pink Pumice eruption remobilised a larger volume of crystals in the storage region.