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Eruptive history of the youngest Mexican Shield and Mexico's most voluminous Holocene eruption: Cerro El Metate

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Small to medium-sized shield volcanoes are an important component of many volcanic fields on Earth. The Trans-Mexican Volcanic Belt, one of the most complex and active continental arcs worldwide, displays a large number of such medium-sized volcanoes. In particular the Michoacán–Guanajuato Volcanic Field (MGVF) situated in central Mexico, is the largest monogenetic volcanic field in the world and includes more than 1000 scoria cones and about four hundred medium-sized volcanoes, also known as Mexican shields. The Mexican shields nevertheless represent nearly 70% of the total volume erupted since 1 Ma and hence played a considerable role in the formation of the MGVF. However, the source, storage, and transport as well as the physical properties (density, viscosity, volatile content, etc.) of the magmas involved in these eruptions remain poorly constrained.
Here, we focus on Cerro El Metate, the youngest monogenetic andesite shield volcano of the field. New C14 dates for the eruption yield a young age ($\sim$AD 1250), which briefly precedes the initial rise of the Tarascan Empire (AD 1350–1521) in this region. This volcano has a minimum volume of $\sim$9.2 km3 DRE, and its viscous lava flows were emplaced during a single eruption over a period of $\sim$35 years covering an area of 103 km2. By volume, this is certainly the largest eruption during the Holocene in Mexico, and it is the largest andesitic effusive eruption known worldwide for this period. Such a large volume of lava erupted in a relatively short time had a significant impact on the environment (modification of the hydrological network, forest fires, etc.), and hence, nearby human populations probably had to migrate.
Its eruptive history was reconstructed through detailed mapping, and geochemical and rheological analyses of its thick hornblende–bearing andesitic flows. Early and late flows have distinct morphologies, chemical and mineralogical compositions, and isotopic signatures which show that these lavas were fed by two separate magma batches that followed distinct differentiation paths during their ascent. The source for both batches was a subduction-modified heterogeneous lithospheric upper mantle. Mineral thermometry and barometry reveal that after initial ascent through the crust, the first batch became temporarily stalled at a depth of $\sim$7-10 km, allowing for crystallization and fractionation. Then, the second hotter batch ascended, bypassed the first batch without significant mingling or mixing of the two magmas and erupted. Stratigraphic relations between the distinct lava units indicate that this first eruptive episode was followed directly by the eruption of the first batch. The entire eruption was then purely effusive and continuous. The explosive eruption of such a large magma volume was avoided due to efficient and constant passive open-degassing of the magma as it ascended through the uppermost crust and erupted at the surface.