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The 16 ka eruption of Sete Cidades volcano, São Miguel Island (Azores, Portugal): Hazard assessment from mapping and simulation of tephra fall

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São Miguel, the biggest island of the Azores archipelago, accommodates three presently quiescent central volcanoes (Sete Cidades, Fogo, Furnas), connected by basaltic fissure systems. Sete Cidades volcano, located in the western part of the island, is nearly 900 m asl high, has a basal diameter of approx. 15 km (at sea level), and hosts a summit caldera of 5 km across. We studied the last caldera-forming event (CFE) of Sete Cidades (ca 16 ka BP) in detail, including morpho-tectonic analysis, deposit mapping, establishment of the stratigraphy, and grain-size distribution (GSD). Due to the restricted size of the volcanic edifice, abundant post-16 ka deposits, and a generally humid climate (fast weathering and dense vegetation), outcrops related to the last CFE are fairly sparse. The presence of magmatic mafic enclaves in juvenile pumice clasts is a characteristic feature of this eruption and unique to São Miguel.

The 16 ka eruption started with a phreatic/phreatomagmatic phase producing several units of layered fall deposits. The eruption then shifted to a mostly magmatic regime, generating quasi-steady but variably energetic pyroclastic density currents (PDC) that deposited massive, unwelded ash-lapilli tuffs on all flanks of the volcano. The eruption culminated in a (sub)plinian phase and produced a well-sorted tephra fall layer that shows a slight fining upward and attains up to 4 m of thickness. Thin, discordant, ash-rich layers with rounded pumice clasts in the top of this unit indicate the simultaneous occurrence of small-scale PDC. As the fall layer is only found in a narrow sector on the N and NE flanks of the volcano, a reliable analysis of eruptive conditions (volume, VEI, magnitude, column height etc.) based on changes in GSD or isopachs is impossible. Field work furthermore identified the existence of a well sorted fall deposit (up to 50 cm thick) related to the 16 ka eruption of Sete Cidades volcano on the N-coast of Fogo volcano, at a distance of approx. 25 km.

Here, we present how important eruptive parameters may be constrained by numerical simulations, trying to fit the distribution and thickness of the 16 ka (sub)plinian fall deposit. Usually, volume, vent location, column height, meteorological conditions etc. are input parameters for tephra fall models. As none of these parameters are known, we assumed a wind pattern as of today and estimated the eruptive conditions in order to achieve the best fit of the found deposit distribution. We consider that this approach can be used to better constrain the eruptive conditions in cases where these parameters can not be obtained from the geologic record. The results show that Sete Cidades volcano possibly imposes a big threat to São Miguel Island as proximal and distal deposits are likely to affect the entire island. We believe that this approach is a simplified but promising way to assess the possible hazard of explosive volcanoes, even if the deposit distribution is limited, either primarily or due to erosion.