Wide range of magmatic processes leading to monogenetic eruptions and associated seismic unrest

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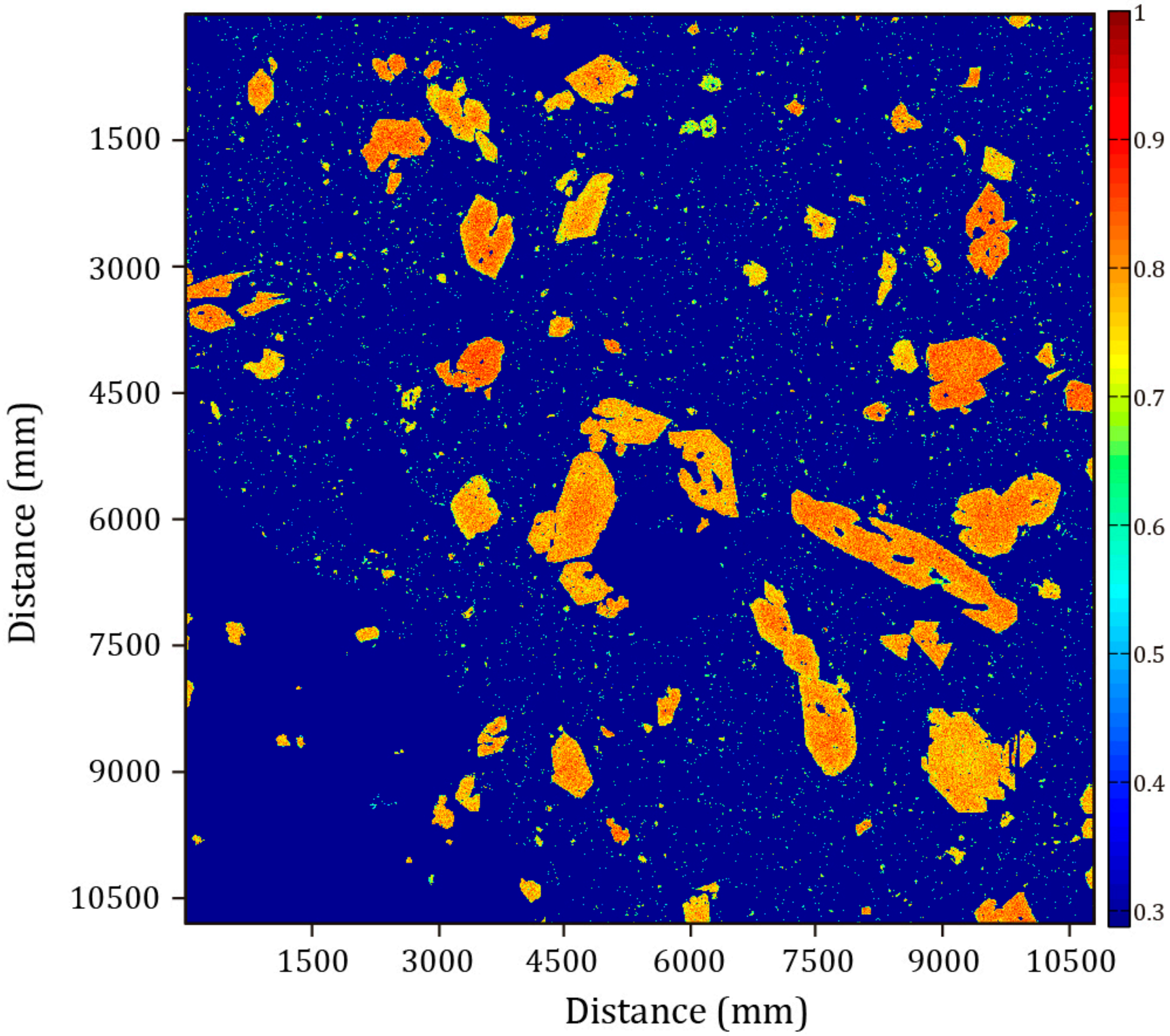
Eruptions in monogenetic volcanic fields are particularly difficult to anticipate since they occur at unexpected locations (e.g. Paricutin, 1943 and El Hierro, 2012). Moreover the factors controlling the precursory activity are still poorly understood, and there is very limited instrumental monitoring data. A review of the available seismic monitoring data and historical documents shows that there is a commonality in the seismic activity preceding monogenetic eruptions with clusters at around one or two years, two or three months, and one or two weeks. The petrological and geochemical characteristics of these eruptions also show that the magmas were affected by mixing in a subvolcanic reservoir and multiple intrusions on similar timescales to the seismicity.

Monogenetic volcanoes sensu stricto have been traditionally interpreted as the result of a single magma batch based on eruption phenomenology; however, recent studies show that a single eruption can display a geochemical evolution and/or variety, which requires multiple magma batches. The study of olivine crystals from different monogenetic volcanos has allowed us to identify different processes and their timescales leading to this type of eruptions. Some eruptions are characterized by the presence of complexly zoned olivine, indicating mixing between different magma pockets at crustal levels rather than a direct ascent from a mantle source. For example, in some historical eruptions from Tenerife (Canary Islands) three mixing event were identify, while in the 2012 submarine eruption in El Hierro (Canary Islands) only one mixing is recorded by the crystals. In contrast, another historical monogenetic eruption in Tenerife present a slightly more evolved magma with olivine crystals normally zoned. The case of Paricutin volcano (Mexico) is an example of geochemical evolution during nine years of eruption. The tephras emitted at the beginning of the eruption contain olivine crystals displaying Mg oscillatory zoning, while later tephras and lavas only contain normally zoned olivine.

We propose a general model where early dike intrusions in the crust do not erupt and create small plumbing systems (i.e. stalled intrusions). These intrusions are probably instrumental in creating a thermal and rheological pathway for later dikes to be able to reach the surface. These observations provide a conceptual framework for better anticipating monogenetic eruptions and should lead to improved strategies for mitigation of their associated hazards and risks.

Keywords: monogenetic, olivine, unrest, timescales, magma mixing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