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Determining dyke-propagation paths at Santorini volcano, Greece

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The volcanic Island of Santorini constitutes a complex of collapse calderas which has experienced a range of explosive and effusive volcanic eruptions and is still active. Numerous stratigraphic horizons which constitute the upper part of the volcano have widely different mechanical properties, resulting in local stresses that may act as dyke-traps, preventing the dykes from reaching the surface to erupt. Several caldera collapses (<3.6 ka) have exposed part of the stratigraphy and a dyke swarm (composed of at least 63 dykes, many arrested and some feeders) within a section of the northern caldera wall, allowing detailed examination.

This ongoing study will (1) document the petrological and structural characteristics of feeder and non-feeder (arrested) dykes and estimate their frequency; (2) determine the physiochemical and mechanical conditions that control dyke arrest/dyke penetration at contacts between layers; (3) explore the fluid and mechanical conditions of the associated magma chamber(s) that must be satisfied for chamber rupture and dyke injection to occur; (4) make numerical and probabilistic models as to the likely dyke paths in heterogeneous and anisotropic crustal segments/volcanoes (such as Santorini), including the likelihood of injected dykes reaching the surface during an unrest period in a volcano of a given type; (5) compare the data collected from Santorini with existing data on dykes worldwide, particularly those on dykes in Tenerife and Iceland.

The principal aim of the study is to provide models that, during an unrest period in Santorini and other similar volcanoes, allow us to forecast (a) the condition for magma-chamber rupture and dyke injection, and (b) the likely path of the resulting dyke. The latter includes assessment of the likelihood as to dyke arrest versus dyke propagation to the surface, the latter resulting in an eruption. For dyke-fed eruptions, the study will also provide methods for forecasting the likely volumetric flow rates and eruption magnitudes.