Eruptive Event Determination; Harrat Rahat, Saudi Arabia

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The monogenetic volcanic field of Harrat Rahat in Saudi Arabia is a highly complex volcanic system with 1000+ volcanic cones and craters distributed over 20,000 km2 and with evidence of volcanic activity spanning from >10 Ma to eruptions in 641AD and 1256AD. This record, and a possible recent stalled eruption in 1999, drives a need to quantify the likelihood and possible location and magnitude of future eruptions. This has stimulated research about the controlling subsurface processes influencing distributed alkali-basaltic intraplate volcanism.

Within volcanic fields around the world, particularly in rifting or extensional environments, magma reaches the surface through dykes that may erupt through multiple vents within a brief period (hours to months). This is observed at the surface as temporal and spatial clustering of vents, on a variety of scales as seen by chains of cones/craters, overlapping cones and/or closely clustered structures. From a long term hazards perspective, these multiple vent eruptions should be considered as single eruptive events to avoid overestimation of temporal recurrence rates and/or bias of the hazard, and hence the consequent risk. This definition of an eruptive event, with varying spatial and temporal components, also allows model validation to a greater extent. It is simpler to model the area where a dyke may reach the surface than an exact location at which a vent may appear.

In the absence of detailed site-by-site mapping, few have attempted to disentangle multiple-vent eruptions to develop a field-wide volcanic event/episode record. Here, eruptive events are determined using expert elicitation to obtain a priori event dimension distributions. These were adapted via Bayes to well-informed distributions with the likelihood function based on observed eruptive events in Harrat Rahat.

Probabilities for each vent grouping across the volcanic field were then obtained by comparison of the potential event dimensions with this a posteriori distribution. Results were validated by field mapping and petrographic study for several of the identified events.