The VORISA project: A novel approach to assessing long-term volcanic hazard in the Kingdom of Saudi Arabia

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The Kingdom of Saudi Arabia has numerous large monogenetic volcanic fields, known locally as 'Harrat'. The northern part of Saudi Arabia's largest such field, the 20,000 km2 Harrat Rahat, extends for 300 km south of the Islamic holy city of Madinah and is called Harrat Al-Madinah. Although basaltic cones and associated lava flow fields dominate, small shield volcanoes and trachytic domes and maars are also present in Harrat Al-Madinah. The most recent eruption took place in 1256 AD through a c. 2 km-long fissure, resulting in the formation of 7 cones, as well as lava flows that travelled within 20 km of Madinah. With over 500 visible vents and periodic seismic swarms indicating stalled eruptions, an understanding of the likelihood, magnitude and style of future eruptions in Harrat Al Madinah is vital.

In order to systematically address the need for long term volcanic hazard assessment in this important region, we developed the VORiSA Project, a 3-year, multi-disciplinary research collaboration between King Abdulaziz University in Jeddah, Saudi Arabia, and the University of Auckland, New Zealand. The project is divided into two scientific themes, a 'Geoscientific' theme and a 'Probabilistic volcanic and volcano-seismic hazard' theme. Both geological and geophysical studies are integrated into the Geoscientific theme. Detailed mapping and geochemical studies will be integrated with new and existing age determinations to determine the style and sequence of events during past basaltic and trachytic eruptions, thus providing insight into possible future scenarios. In order to geophysically characterise the structure and nature of the crust beneath the Harrat, and thus constrain possible physical controls on magma propagation, results from gravity and magnetotelluric (MT) surveys will be combined with microearthquake data from an 8-station borehole seismic research array. Data from the seismic research array will also be used to calculate a new seismic velocity model for this area. In the 'Probabilistic volcanic and volcano-seismic hazard' theme, data such as vent locations; volumes and spatial distributions of past eruptive products; aeromagnetic and seismic interpretations of sub-surface structure; regional tectonic models and geochemistry of erupted products are all being integrated to determine possible relationships between data sets. Thus both existing and new geoscientific data are being synthesised to determine patterns in eruption frequency, magnitude, and style of past activity, as well as the probable location of a future event.

Despite the challenges of working in this isolated and remote area, joint Saudi/NZ geological/geophysical field campaigns and workshops have resulted in a very successful research collaboration that will, in time, lead to a much greater understanding of long term volcanic hazard in Saudi Arabia.