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Can we forecast the failure of magma and how does this help us forecast eruptions?

Jérémie Vasseur (1), Fabian Wadsworth (1), Caron Vossen (2), and Donald Dingwell (1)

(1) Earth & Environmental Sciences, Ludwig Maximilan University, Munich, Germany (jeremie.vasseur@min.uni-muenchen.de), (2) Dept. of Earth Sciences, Utrecht University, Utrecht, the Netherlands

Heterogeneity develops in magmas during ascent and is dominated by the development of bubble populations or pore-network clusters which grow, interact, localize, coalesce, outgas and resorb. Additionally, crystals grow and form solid interacting structures. Alternatively, magmas can arrive at the Earth's surface as relatively homogeneous magmatic liquid phases, forming obsidian domes. Here, we acknowledge this vast spectrum of textural heterogeneity and explore the role it plays in the way magmas break and fracture. We record the acoustic emission associated with fracturing events in the laboratory. Next, we use the temporal evolution of acoustic emission events to test how effective current methods of forecasting failure would be in a simulated real-time situation. Using any method, we find that the accuracy of forecasts depends strongly on the heterogeneity of texture in the sample, such that rupture of homogeneous magmatic liquids cannot be forecast with any reliability. Contrastingly, the failure of magmas with a typical proportional of bubbles or crystals are forecast with prodigious accuracy. Finally, we explore the implications of these results for volcano-scale forecasting by (1) pointing out the difference between host-rock fracturing and magma fracturing in the seismicity produced, and (2) scaling our results to the frequencies and lengthscales of rupture at volcanoes. We find that the success of forecasting results in nature is similar to the accuracy of lab-based forecasting efforts.