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Evolution and dynamics of magmatic processes below Gede volcano, East-Java, Indonesia

Daniel Krimer and Fidel Costa
Earth Observatory of Singapore, Singapore (daniel1@e.tu.edu.sg)

Subduction-zone volcanism produces a large variety of compositions and eruption styles, but silica-rich explosive eruptions from arc volcanoes are those that pose the most direct threat for those living on and around the volcanoes. The little known Gede volcano (East-Java, Indonesia) is a composite arc-volcano showing evidences of recurrent silicic explosive eruptions and it is a hazard to its 1 million residences settled on its flank also to the two most populated neighboring metropolises: Jakarta and Bandung. Here we present the results of a detailed petrological and geochemical study of Gede's deposits to untangle its magmatic evolution, the key magma reservoir processes, and try to use this information to better anticipate possible future eruptions at Gede.
After field-work and dating of the main deposits we identified 5 pyroclastic units ranging from basaltic andesite to dacite, and of eruption ages from about 1 ky to > 45 ky. Bulk-rock major and trace element compositions can be explained as a combination of fractional crystallization and magma mixing/mingling. Crystallization trends evolve with time from wet (amphibole present and plagioclase delayed) to 'dry' (olivine and two pyroxenes, and plagioclase). Petrological and geochemical evidence for within-trend mixing/mingling are common and involve high-Si basalt and dacite end-members. Core to rim electron microprobe and LA-ICP-MS trace element analysis of main phenocrysts (amphibole, plagioclase, ortho- and clinopyroxene) record the details of repetitive magma mixing and mingling events. Cores of amphibole, ortho- and clinopyroxene in the Holocene units have low Mg/Fe, high REEs and Eu-anomaly, and are rimmed Mg/Fe, low REEs and no Eu-anomaly zones. These minerals are thus recording the intrusions of mafic, water-richer and crystal-poor magma into an evolved and partly crystallized magma reservoir. Modeling the diffusive re-equilibration between the crystal cores and rims provides the time elapsed since the intrusion of the primitive magmas, interaction between end-member magmas, and eruption, and this is less than a few years.
Our study shows that Gede volcano has evolved in the last 50 ky from a water-rich to a water-poor fractionation series. Many eruptions of both series are probably triggered by injection of mafic magma in evolved magma reservoirs. This suggest that if new unrest occurs below Gede the eruptions are likely to be explosive but the time between new intrusion and eruption would be long enough for proper response for mitigating its potential hazards.