Reconciling ground deformation and degassing activity at Mt. Etna

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Etna exhibited both steady inflation and persistent degassing between 1993 and early 2001. The source volume increase associated with the inflation was deduced using a Mogi model to fit the observed deformation pattern. The mass of SO2 released in the same period was produced by degassing magma. With knowledge of the original S concentration dissolved in the parental magma it is possible to determine a minimum mass of magma consistent with the observed gas emissions. This mass of degassed magma is more than two orders of magnitude larger than the mass of erupted magma in the same period, implying that the degassed magma was endogenously stored within the volcano. We wish to test the hypothesis that this stored degassed magma was responsible for the observed inflation of the edifice.

An initial comparison of the volume of degassed magma compared with the change in volume associated with the ground deformation reveals that the former is 4 times greater than the latter, suggesting that our hypothesis is incorrect. However, when a combination of magma compression and viscoelastic deformation of hot crustal material heated is taken into account, the deformation source volume changes can, instead, be successfully reconciled with the volume of degassed magma.

Thus, it appears we cannot exclude the hypothesis that during the observation period ground deformation at Etna was controlled by permanent storage of degassed magma in the plutonic zone 5-8 km beneath the surface. In this manner, the constant magma supply indicated by the persistent degassing of the volcano produces a quiescent accumulation of degassed magma at the roots of the volcano, slowly pressurizing and inflating the edifice.

A global volcanic CO_2 flux inventory

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CO_2 degassing from the Earth has played a fundamental role in controlling climate through a series of feedback mechanisms including CO_2 removal through weathering in proportion to the magnitude of greenhouse warming produced by CO_2 in the atmosphere. Constraining CO_2 emission rates from volcanic sources would allow an improved understanding of the relative magnitude of natural and anthropogenic outputs today, shed light on the role of volcanic emissions in the pre-industrial climate and improve our knowledge of carbon recycling though the mantle. Notwithstanding this, the flux of CO_2 from the Earth remains poorly quantified. The uncertainty in our knowledge of this critical input into the geological carbon cycle led Berner and Lagasa (1989) to state that it is the most vexing problem facing us in understanding that cycle.

To date, CO_2 fluxes have been directly measured on approximately 23% of the world's actively degassing subaerial volcanoes. Here we present an updated assessment of the global volcanic CO_2 flux, based on these empirical observations. We use this inventory to extrapolate to an estimate of global volcanic CO_2 emissions, and to investigate rates of carbon recycling though the mantle.

DOI:10.1180/minmag.2013.077.5.2
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