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Shallow evolution of Santorini volcano constrained by InSAR and GPS measurements

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Santorini, a major caldera volcano in the South Aegean, entered a period of unrest in January 2011. This was characterised by the onset of detectable seismicity and caldera-wide uplift. For the past 360,000 years, the volcano has generated major explosive eruptions every 20,000 to 30,000 years, which are separated by phases during which andesite shields and dacite lava domes are built by multiple smaller effusive eruptions. Since the last major eruption in approximately 1620 BC (Minoan eruption), Santorini has been in a dome-forming phase. Here we present measurements of surface deformation prior to and during the recent period of unrest, using Interferometric Synthetic Aperture Radar (InSAR) and GPS data collected from a network of continuous GPS receivers installed on the caldera complex.

Observations from 1993-2010 using the ERS and Envisat satellites show subsidence on the Kameni islands, which can be interpreted either as loading by recent lava flows or degassing of a shallow magma body. The onset of the unrest was marked by an increase in the rate of micro-seismic activity, beginning in January 2011. At the same time, the coordinates of continuous GPS stations operating on Santorini began to deviate from their longer-term average velocities. To model the temporal evolution of melt supply to the shallow chamber, we have used Envisat and TerraSAR-X data since March 2011, as well as cGPS data since June 2010. We apply a joint inversion technique to convert deformation measurements into sub-surface volume change by treating the displacements as arising from a pressure increase at depth within an elastic crust. We present the best-fit parameters for the spherical source and the variation in volume change associated with a shallow magmatic intrusion during the 2011-2012 period of unrest. Our results indicate that melt is supplied to the shallow chamber as infrequent high-flux batches and that the duration of each intrusive event is short in comparison with the intervening periods of repose.