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Non-eruptive unrest at the caldera of Alcedo Volcano (Galápagos Islands) revealed by InSAR data and geodetic modelling

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Understanding volcanic unrest is crucial to forecasting eruptions. At active mafic calderas, unrest usually culminates in eruption, and does so more frequently than at felsic calderas. However, the mafic caldera of Alcedo Volcano (Ecuador) has experienced repeated episodes of unrest without erupting, since at least 1992, when geodetic monitoring began. Here, we investigate the unrest occurred between 2007 and 2011 performing a multi-temporal InSAR analysis of ENVISAT and ALOS-1 data, using the Small Baseline method. Then, we inverted ALOS-1 data to constrain the sources of deformation, using the GBIS software. We observe an initial asymmetric uplift of the caldera (∼30 cm of vertical motion) from 2007 to 2009, followed by subsidence of the uplifted area and contemporary uplift of the north-western caldera rim between January and June 2010. Finally, from June 2010 through March 2011, caldera uplift resumed. The first uplift episode is best explained by inflation of a sill and the activation of an inner ring fault. Successive caldera subsidence and rim uplift are compatible with the withdrawal of magma from the previously inflated sill and its north-western migration. The resumption of uplift is consistent with the re-pressurization of the sill. This evolution suggests episodic magma emplacement in a shallow reservoir beneath the caldera, with aborted lateral magma migration, probably due to the discontinuous supply from depth. This short-term deformation pattern matches well geological observations showing a longer-term (hundreds of years at least) asymmetric uplift of the caldera floor, culminating in a weak resurgence of ∼30 m. We propose that the monitored episodes of uplift represent short-term stages of the rarely observed incremental growth of a resurgent basaltic caldera.