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Using cGPS to estimate the magma budget for Soufrière Hills volcano, Montserrat, West Indies

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For over 20 years, Soufrière Hills Volcano, Montserrat has been in a state of volcanic unrest. Intermittent periods of dome building have been punctuated by explosive eruptions and dome collapse events, endangering the lives of the inhabitants of the island. The last episode of active magma extrusion was in February 2010, and the last explosive event (ash venting) in March 2012. Despite a lack of recent eruptive activity, the volcano continues to emit significant volumes of SO_2 and shows an ongoing trend of island inflation as indicated by cGPS.

Through the aid of three-dimensional numerical modelling, using a finite element method, we model the cGPS data to explore the potential sources of the ongoing island deformation. We consider both magmatic (dykes and chambers) and tectonic sources which result in entirely different interpretations: Whilst a magmatic source suggests the possibility for further eruption, a tectonic source may indicate cessation of volcanic activity. We investigate the effects that different sources (shapes, characters and depths) have on the surface displacement.

We demonstrate that whilst a tectonic contribution cannot be completely discounted, the dominant source is magmatic. Consequently, we define a best-fit model which we use to assess the source volume change, and therefore, the potential current magma budget. Based on the similarity in the relative displacement between the cGPS stations at every episode of the eruption, we assume that the displacement for all Phases and Pauses can be explained by the same basic source. Therefore, we interpret the cGPS data with our source model for all the preceding Pauses and Phases to estimate the magma budget feeding the entire eruption. Subsequently, we derive important insights into the potential future eruptive behaviour of the volcano.