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Assessing the Multiple Pressure Source Hypothesis for the Sakurajima Volcano and Aira Caldera Magmatic System

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Sakurajima, located on the southern rim of Aira caldera, is one of the most active volcanoes in Japan. From long term deformation trends, the volcano is showing an increased risk of large-scale eruption, emphasizing the need to better understand the magmatic system.

Deformation modelling, primarily using the Mogi method, has dominated the geodetic assessment history of Sakurajima. These methods, however, contain limitations, such as the assumption of a homogeneous crust, and have therefore not accurately depicted the magmatic system. Numerical modelling techniques have reduced this limitation by accounting for subsurface heterogeneity.

Analytical modelling studies have suggested multiple magmatic sources beneath Aira caldera and Sakurajima volcano, whilst the only numerical study undertaken so far indicated a single source. Here, we test the multiple deformation source hypothesis, whilst also incorporating subsurface heterogeneity and topography, using Finite Element (FE) numerical modelling, and geodetic data from Sakurajima.

Using a full 3D model geometry for Sakurajima and Aira caldera, preliminary forward modelling suggests a second deformation source produces our best fit to the measured geodetic data. Optimum results indicate a shallow prolate source 7-10 km below sea level (bsl), in addition to a deeper oblate source at ~13 km bsl. These preliminary findings produce greater shallow storage depths than the previous analytical models (3-6 km) and ties in with the trans-crustal magmatic system hypothesis.

Increasing our understanding of the Sakurajima magmatic system will enable improved interpretations of geodetic data prior to eruptions and will inform models for a range of similar volcanoes world-wide.