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Continuous monitoring of a magma chamber's pressure changes using geodetic data: Time-dependent inversion with Ensemble Kalman Filter (EnKF)

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Abstract Text:

It is important to monitor pressure changes of a magma chamber to forecast eruptions and mitigate volcanic hazard. The time-dependent inversion of geodetic data such as GNSS and InSAR allows us to continuously monitor a pressure change of a magma chamber if its shape and location are fixed. On the other hand, when a chamber changes its location or shape sequentially, the ordinary time-dependent inversion cannot be directly applied since the pressure non-linearly relate to the deformation. Here we developed a new variant of the time-dependent inversion which involves the Ensemble Kalman Filter (EnKF) instead of linear Kalman filter. We first applied the method to the synthetic GNSS time series generated under the assumption that a tri-axial ellipsoidal magma chamber gradually changes its shape, depth, and pressure (volume) and successfully retrieved parameters such as pressure (volume) changes, depth, and shape factors (axis ratio). Then we applied the method to the observed GNSS data taken at the volcanic crisis in Miyakejima, Japan in 2000. We found that 1) first the change rate of the chamber's pressure exponentially converged to a constant negative value, and then showed sudden increase in response to the caldera collapse, and 2) the chamber migrated upward in response to the caldera collapse. The developed method may easily be adopted to volcano monitoring with real-time/near real-time GNSS data, and in the future may be adopted to eruption prediction if a successful physics-based simulation model is used as a prediction model in the EnKF.

Session Selection:
Under pressure: understanding the storage, activation, and transport processes in magmatic systems

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