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Continuous deflation and plate spreading of Askja volcanic system, Iceland: Temperature dependent Newtonian rheological modelling, constrained by GPS measurements and InSAR analysis

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Iceland is a hotspot of volcanic activities in the Mid Atlantic Ridge. These active volcanisms are located mostly at the divergent plate boundary. Askja in the Northern Volcanic Zone, Iceland is such a volcanic system. Askja volcanic system and thus crustal deformation is extensively studied applying geodetic measurement and Mogi source models using elastic and/or elastic-viscoelastic half-space. Therefore, rheology is oversimplified in this case. Our attempt is to study Askja volcano using temperature-dependent Newtonian rheological Finite Element Models (FEM) constrained from Interferometric Synthetic Aperture Radar (InSAR) and Global Position System (GPS) measurement. The model offers continuous variation of rheology in laterally and vertically from rift axis and surface, respectively. In the model, far field is stretched simultaneously to impose plate spreading crossing Askja volcano.

The Askja volcanic system is facing solidification of magma in the magma chamber and post eruption relaxation. Levelling data for long time series show subsidence exponentially. RADARSAT InSAR data 2000-2009 gives average maximum subsidence at the center of caldera to ~20.2 mm yr^{-1}. However this subsidence is slowed down by ~4 mm yr^{-1}. GPS observations 2003-2009 shows average maximum subsidence at OLAF site (next to the magma chamber) of 19±1 mm yr^{-1} relative to the ITRF2005. The MASK is another GPS station at the top of predicted centre of magma chamber correlates well with OLAF site at 500 m distance from MASK. The new data sets of GPS measurement 2009-2013 at MASK give average maximum subsidence of ~23.8 mm yr^{-1}.

A preliminary temperature-dependent non-linear rheological FEM model is conducted where pressure changes at the magma chamber and simultaneously far field stretching by 18.4 mm yr^{-1} (estimated from GPS measurement 2007-2013) as plate spreading is applied. Models are evaluated using InSAR (2000-2010) and GPS data (2003-2009). The optimized pressure in the magma chamber decreases an exponential decay. However ramp pressure drops 4 MPa and rheological relaxation may associated to 4.68 MPa pressure drop during this period (10 years). Models are continued to investigate using new GPS data set during 2009-2013.

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