THEME: GEODYNAMICS (GD)

GD

GD-01

The 2011 Grímsvötn Eruption Observed with High Rate Geodesy

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High rate geodetic measurements at volcanoes can give displacements at sub second interval, revealing surface deformation associated with magma movements. The Grímsvötn volcano lies beneath the Vatnajökull icecap, Iceland, limiting the near field monitoring efforts to a single nunatak, Mt. Grímsfjall, on the southern caldera rim. A 5 Hz GPS station and an electronic tilt meter are located at the nuntak. The colocation of the GPS and tilt station allow us to relate the observed surface deformation to pressure change in a magma chamber assuming simple Mogi source within elastic half space. During the 21-28 May 2011 Grímsvötn eruption a continuous stream of data, despite the eruption plume and lightning, was transmitted to Reykjavík.

The high rate data from the GPS station at Grímsfjall (GFUM) were analyzed using the Track part of GAMIT/GLOBK. We produced kinematic solutions at 5 Hz and 1 Hz intervals using reference stations in 40-120 km distance of the volcano. To minimize multipath effect we used sidereal filtering and stacked solutions to further improve the signal to noise ratio. The deformation suggests a rapid pressure drop starting about 50 minutes prior to the onset of the eruption when over 20 km high plume formed. The characteristics of the GPS and tilt data time series suggests that the main signal is due to a single source of fixed location and geometry throughout the eruption; a shallow magma chamber. Small deviation in displacement direction prior to the onset of the eruption can be explained by influence from the opening of the feeder dike. The GPS station recorded a total displacement of 57 cm in direction N38.5°W and down, suggesting a source depth of ~1.7 km. Majority of the displacement (95%) took place within the first 24 hours.

GD-02

Plate spreading in the North Volcanic Zone, Iceland, constrained by geodetic GPS observations and finite element numerical modeling

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Iceland is located on the Mid Atlantic Ridge (MAR), the only part above sea level, which gives a unique opportunity for research of spreading induct crustal deformation. The aim of this study crustal deformation in the Northern Volcanic Zone (NVZ), by Global Positioning System (GPS) geodetic measurements, and through finite element modelling (FEM) of deformation taking place at spreading plate boundaries. In the NVZ, the volcanic systems are arranged en-echelon and are not aligned perfectly parallel with the plate boundaries. An overlapping of the volcanic systems causes a slightly asymmetrical deformation in the NVZ. Velocities of GPS sites were calculated in Terrestrial Reference Frame 2005 (ITRF2005) and NUVEL-1A reference frame, and presented relative to stable Eurasian plate. The measured full spreading rate between North American and Eurasian plates was to 21.7 ± 3 mm yr^{-1}, projected on a profile striking N1050E (predicted spreading direction in NUVEL-1A). The full deformation zone was identified to be 90 km wide. A half spreading rate was applied on the half deformation zone to construct a two dimensional (2D) symmetrical models using the commercial FEM package Abaqus/CAE 6.11. General pull-push modeling with different geometry between elastic crust and viscoelastic half-space were tested. Advance modeling of cooling oceanic lithosphere and temperature dependent rheology were also studied. In the cooling oceanic model, varied crustal thickness, isotherm and viscosity for viscoelastic half-space were tested to investigate corresponding surface deformation. In the temperature dependent rheology models, temperature distribution for both thin and thick crust models with creep relation where strain is proportional to stress in 3^{rd} and 3.5^{th} power were tested for both wet and dry mantle rheology. The horizontal components resulting from modeling were evaluated with measured spreading rate. However, horizontal displacement in study area was not perfectly symmetrical. This gives, temperature dependent wet mantle rheology with strain proportional to stress in 3.5^{th} power for both thin and thick crust models with best fitted. The vertical deformation is a mix of a spreading generated signal on the general uplift of central Iceland and it could not be well constructed in the plate spreading model.