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

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Iceberg 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 on the plates 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 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 3rd and 3,5th 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 3.5th 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.