Deformation sources at a divergent plate boundary: interplay between volcano deformation, geothermal processes, and plate spreading in the Northern Volcanic Zone, Iceland.

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Iceland is a subearial part of the Mid-Atlantic Ridge, where the divergent plate boundary between the North-American and Eurasian Plates can be studied. The Northern Volcanic Zone (NVZ) of Iceland, divided into volcanic systems, is particularly well suited to study interplay between volcanoes, geothermal areas, and plate spreading as the zone is relatively simple and accommodates the full spreading of the plates (18.6 mm/yr in a direction of 105 degrees according to NUVEL-1A predictions). The most recent volcanic activity in the area was the Krafla rifting episode 1975-1984. Extensive crustal deformation studies have been carried out in the NVZ; we report the results of recent GPS and Interferometric Synthetic Aperture Radar (InSAR) studies focusing on Krafla and Theistareykir volcanic systems at the northern part of the NVZ. A GPS survey in 2012, more extensive than previous measurements, with over 121 stations measured was evaluated together with data from 2010 and 2011 to generate a velocity field for 2010-2012. Three continuous GPS stations have been installed in the area 2011-2012, complementing one previous station. The 2010-2012 GPS velocities can be compared to earlier GPS results, and complementary analysis of InSAR images. The plate spreading is the most significant signal visible with an E-W velocity of about 12 mm/yr over a 30 km wide area. Earlier studies have shown that the Krafla caldera uplifted during 1984-1989 under the influence of a shallow magma chamber in its center and then subsided. Since 1995, the maximum subsidence in Krafla has shifted from directly above the shallow magma chamber towards an array of boreholes (geothermal exploitation) in Leirbotnar. Similar subsidence has been observed around another array of boreholes in Bjarnaflag, 7 km further south. In the 1990s, an uplift was detected at edge of the geodetic network in Krafla. Recent InSAR studies have shown that this deformation took place over a very large area east of Theistareykir with both E-W horizontal as well as vertical displacements. Velocities calculated from the 2010, 2011 and 2012 GPS campaign results show an ongoing pressure decrease in Krafla caldera. The subsidence in Leirbotnar and Bjarnaflag caused by geothermal exploitation is still continuing. However, the broad deformation area east of Theistareykir seems to have changed in shape, with an uplift concentrated on a smaller area situated on the plate boundary. ERS, Envisat, and TerraSAR-X images have been acquired over the NVZ areas of interest for InSAR studies. By combining InSAR and GPS data, an enhanced spatial and temporal resolution of the deformation history within the area is achieved. The planned expansion of geothermal utilization and new power plants in the area may produce additional deformation signals. Continuous monitoring for the upcoming years may deliver information on further magmatic activity as well as the effects of geothermal exploitation on the volcanic systems.