Geophysical Research Abstracts
Vol. 14, EGU2012-384-1, 2012
EGU General Assembly 2012

Geodetic observations at Bezymianny Volcano, Kamchatka: The eruptions from 2005-2010 and long-term, long-wavelength subsidence as seen by the PIRE GPS network

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Bezymianny Volcano in Kamchatka reactivated after a roughly 1000 year hiatus in 1956 with an eruption that culminated into a directed blast due to a flank collapse. About 0.6 km^3 of material were removed from the edifice. Today, eruptive activity occurs roughly every 6 months with a violent explosion lasting for 2 – 20 minutes that creates lava flows and pyroclastic flows. Here, we present the first detailed geodetic study focusing on Bezymianny Volcano in the context of a multi-disciplinary study from 2005-2010 that includes seismology, geology and volcanic gases.

In 2005 the volcano was instrumented with an array of 6 campaign and 8 continuous GPS stations, none of which are telemetered. The campaign sites have been measured during annual summer fieldwork during which we also recovered data of the continuous sites. The first eruption recorded by a partial continuous GPS network was the December 24, 2006, event. Between then and the last data recovery in summer of 2010 six additional eruptions occurred.

We analyze the data in the International Terrestrial Reference Frame (ITRF 2008) using the GIPSY/OASIS II software and find a relatively uniform network wide subsidence of about 7-9 mm/yr for the observation period from 2005 to 2010. This could be induced by continuous depressurization of a deeply seated magma reservoir, likely beneath Kluichevskoy volcano to the north of Bezymianny. We explore other possible sources such as regional surface loading due to deposition of eruptive products in this very productive volcanic region. Surface load effects could be induced by the new dome growing inside Bezymianny's horseshoe shaped crater and other material emplaced during the regular eruptions. Loading effects due to the young Kliuchevskoy volcano, the tallest volcano in Asia, are also considered.

Analysis of daily averages of displacements around times of eruptions shows little to no inflation or deflation signal at distances as close as 1.5 km from the edifice related to the individual explosions. This suggests either a very deep or a very shallow magma source feeding these events. Increasing the temporal resolution of displacements for each eruption by employing a kinematic GPS processing strategy gives similar results.

We invert the GPS time series for a variety of deformation sources including magmatic source models and surface loads to infer an interpretation of the volcanic system and its evolution over time based on geodetic observations in context of results from other disciplines.