CONTROL ID: 1494874

TITLE: Deep Magma Accumulation at Hekla Volcano, Iceland, Insights from Geodetic Data

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ABSTRACT BODY: Most magmatic systems on Earth are located at actively deforming plate boundaries. In cases where the volcanic deformation is subtle, such as from deep (>10 km) plumbing systems, the magmatic and tectonic deformation signals are intertwined and must be deconvolved to properly estimate magma flux and source characteristics of the magma plumbing system. Hekla volcano has shown a distinctive pattern of constant uplift rates interrupted by sudden deformation (deflation and dike formation) accompanying the eruptions. We simultaneously solve for the source parameters of the inter-eruptive volcanic and tectonic deformation in south Iceland using a new ten-year velocity field derived from a dense network of episodic and continuous GPS stations in south Iceland. Specifically, we estimate 1) the location, volumetric rate, and geometry of the inflating magma plumbing system at Hekla; 2) depth and volumetric rate of a deflating source at Torfajökull volcano (~20 km east of Hekla); 3) the location and locking depths of two segments of the plate boundary in Iceland: the Eastern Volcanic rift-Zone (EVZ) and South Iceland Seismic transform-Zone (SISZ). We find that Hekla is located in the SISZ at the inner corner of this rift – non-transform intersection, and the EVZ rift axis bisects Torfajökull caldera. Hekla's magma plumbing system is statistically best described in terms of a horizontal ellipsoidal magma chamber at 24$^{+4}_{-2}$ km depth, aligned with the volcanic system fissure swarm, and increasing in volume by 0.017$^{+0.007}_{-0.002}$ km^3 per year. A spherical magma chamber centered at 24 $^{+5}_{-2}$ km depth with a volume rate of 0.019$^{+0.011}_{-0.002}$ km^3 per year, or a vertical pipe-shaped magma chamber between 10$^{+3}_{-1}$ km and 21$^{+7}_{-4}$ km with a volume rate of 0.008$^{+0.003}_{-0.001}$ km^3 per year are also plausible models explaining the deformation at Hekla. All three models indicate magma accumulation in the lower crust or near the Moho under Hekla. Such deep inflation sources are not commonly found with geodetic methods because the magma influx needs to be high in order to generate detectable signals. The influx rates we estimate for Hekla match the average effusive rate estimated over the past millennium, indicating a constant magma flux rate into the deep magma chamber over long time scales.

KEYWORDS: [1211] GEODESY AND GRAVITY / Non-tectonic deformation, [1209] GEODESY AND GRAVITY / Tectonic deformation, [8434] VOLCANOLOGY / Magma migration and fragmentation.

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