DEFORMATION DUE TO MAGMA MOVEMENT AND ICE UNLOADING AT KATLA VOLCANO, ICELAND, DETECTED BY PERSISTENT SCATTERER INSAR

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ABSTRACT

Katla volcano is situated in the south of Iceland, and is largely covered by the Mýrdalsjökull ice cap. Historically, Katla is one of the most active of Iceland's volcanoes, with 20 eruptions in the last 1100 years, the last one being in 1918. The proximity of populated areas and international flight paths makes prediction of the timing and character of any future eruption particularly important. Between late 2000 and early 2005 there was increased seismicity beneath the caldera and west flank of Katla, accompanied by upwards and radially outwards movement of two continuous GPS stations north of Katla caldera. This motion has since ceased, but two continuous GPS sites on the southern flank have been trending upwards and south-southwest since 2000, and this motion continues to the present.

We use both persistent scatterer and combined multiple acquisition InSAR techniques to analyse ENVISAT ASAR data acquired from September 2003 to July 2006, and ERS data acquired between 1995 and 2003, to determine line-of-sight displacements for the area surrounding Katla. The signal we see is consistent with a response to ice unloading, and intrusion of magma or fluids is not required to explain the data. We don't, however, rule out shallow intrusion beneath the caldera causing local deformation that is not visible on the volcano flanks. We also identify possible local landsliding occurring on the volcano flanks.

Key words: InSAR; Persistent Scatterer; Small Baseline; Phase Unwrapping; Katla.

1. INTRODUCTION

Katla volcano is situated in the south of Iceland, at the southern end of the Eastern Volcanic Zone (Figure 1). Most of the upper regions of the volcano, including the caldera, are covered by the Mýrdalsjökull ice cap. Katla is abutted on the west flank by Eyjafjallajökull volcano. Historically, Katla is one of the most active of Iceland's volcanoes, with 20 major eruptions in the last 1100 years, the last one being in 1918 [2]. Eyjafjallajökull volcano is also active and experienced recent intrusive episodes in 1994 and in 1999 to 2000 [3]. The proximity of populated areas and international flight paths makes prediction of the timing and character of any future eruption particularly important.

In July 1999, following bursts of low-frequency seismic tremor, a jökulhlaup was released [4, 5]. The subsequent formation of an ice cauldron implies that the jökulhlaup was caused by a subglacial eruption [5, 6]. Between late 2000 and early 2005 there was a moderate increase in seismicity rate beneath Katla caldera, and a much greater increase in seismicity rate in the Goðabunga area, on the west flank of Katla. The increase in seismicity was approximately coincident with upwards and radially outwards movement of two campaign GPS stations north of Katla caldera [7]. This motion has since ceased, but two continuous GPS sites on the southern flank have been trending upwards and south-southwest, after subtraction of plate-spreading motion, since installation in 2000 [8], and this motion continues to the present.

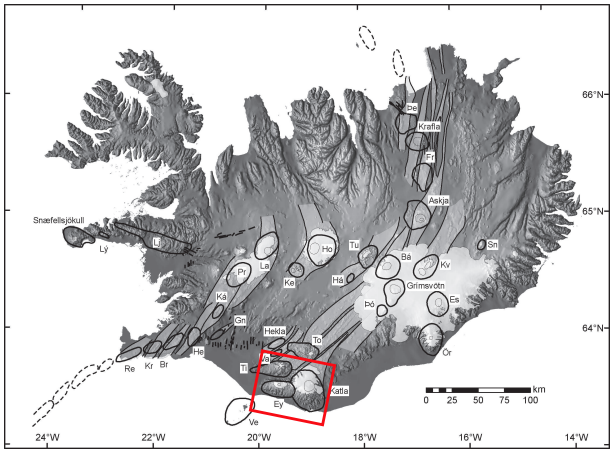

Figure 1. Location of region for which we processed data in Iceland. Katla Volcano is the large volcano on the east side of the processed region and Eyjafjallajökull Volcano is the smaller volcano abutting the west flank of Katla. Background image shows volcanic systems in Iceland plotted on topography in shaded relief, modified from [1].