Reviewed research article

Shallow geothermal and deep seismicity beneath Þeistareykir, NE-Iceland

Juerg Schuler[1,2], Robert S. White[2,3], Bryndís Brandsdóttir[3] and Jon Tarasewicz[2,4]

[1]*Seismological Laboratory, California Institute of Technology, Pasadena, USA*

[2]*Dept. of Earth Sciences, University of Cambridge, Cambridge, UK*

[3]*Institute of Earth Sciences, Science Institute, University of Iceland, Reykjavík, Iceland*

[4]*now at BP, Sunbury on Thames, UK*

Corresponding author email: schuler@cantab.net

Abstract – *The seismicity in the central Þeistareykir volcanic system, NE Iceland, between 2009–2012 consists of spatially clustered earthquakes at 2–5 km depth (b.s.l.) southwest of the main geothermal fields. Deep earthquakes are located in a scattered pattern southeast of Þeistareykir at 8–20 km depth (b.s.l.). Although not associated with detectable surface uplift they may be caused by high strain rates within the plastic regime of the crust in the vicinity of the Húsavík-Flatey transform fault system or due to reduced normal friction caused by melt movements at depth.*

INTRODUCTION

The Þeistareykir volcanic system marks the northwestern boundary of the Northern Volcanic Zone (NVZ) in Iceland. The volcanic system consists of a diffuse central volcano transected by a 7–9 km wide and 70–80 km long fissure swarm, extending from Lake Mývatn to Öxarfjörður at an average azimuth of N27°E (Einarsson and Sæmundsson, 1987; Magnúsdóttir and Brandsdóttir, 2011; Hjartardóttir *et al.*, 2015). The Þeistareykir fissure swarm is characterized by large normal faults with maximum displacements of 200–300 meters along its western rim and numerous rift fissures further east. The volcanic center is dominated by Holocene lava shields (Sæmundsson *et al.*, 2012) and primitive lavas (Maclennan *et al.*, 2003). Surface alterations from geothermal activity are found on the northern slope of the hyaloclastite mountain Bæjarfjall covering an area of about 11 km^2 (Gíslason *et al.*, 1985), although recent results of transient electromagnetic (TEM) soundings suggest an area of geothermally altered crust of up to 45 km^2 at a depth of 800–1000 m below the surface (Karlsdóttir *et al.*, 2012). The study area exhibits relatively low relief (300–500 m elevation) with Bæjarfjall reaching 560 m above sea level. We subsequently refer to depth as depth below the surface whereas we mean depth below sea level when it is followed by the acronym b.s.l.

Geodetic surface deformation measurements and models (e.g., Metzger and Jónsson, 2014) suggest a transient inflation of the Þeistareykir volcano between 1992–2009. A localized uplift at Þeistareykir observed during 2007–2008 was most likely caused by magma accumulation at 8.5 km depth (Metzger *et al.*, 2011; Spaans *et al.*, 2012). The location of the Mogi source used to model the surface deformation is shown by the red cross in Figure 1a. A broad uplift zone within the NVZ has been interpreted as magma accumulating at the crust-mantle boundary at about 21 km depth (Zeeuw-van Dalfsen *et al.*, 2004;