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Low-frequency earthquakes at the Torfajökull volcano, south Iceland

Heidi Soosalu [a,*], Regina Lippitsch [b], Páll Einarsson [c,1]

[a] Nordic Volcanological Center, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland
[b] Bullard Laboratories, Department of Earth Sciences, University of Cambridge, Madingley Road, Cambridge, CB3 0EZ, UK
[c] Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland

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Abstract

Torfajökull is a large rhyolitic volcanic edifice with a 12-km-diameter caldera and abundant high-temperature geothermal activity. It is located in the neovolcanic zone in south Iceland, at the junction of the eastern rift zone and a transform zone with the intraplate volcanic flank zone of south Iceland. The latest eruption at Torfajökull occurred about 500 years ago. Torfajökull is a source of persistent small-scale seismicity, where two types of earthquakes occur. High-frequency events are concentrated in the western part of the caldera and low-frequency events cluster in the south. Small low-frequency earthquakes have been observed at Torfajökull since the installation of a local analogue seismograph station in 1985. They typically occur in swarms; up to 300 earthquakes per day have been observed. The low-frequency events have a frequency content of about 1–3 Hz, and are difficult to locate, because of the emergent nature of their phases. The 160 events located during the years 1994–2000 using the permanent Icelandic seismic network cluster in the southern part of the Torfajökull caldera. A closer study of low-frequency events was carried out between May and October 2002, with a dense network of twenty Güralp 6TD broadband seismometers in the Torfajökull area. No distinct swarm activity was observed during this period, but small low-frequency events occurred almost on a daily basis. About 330 low-frequency events were detected during the study period. They are located in the southern part of the caldera, between two small glaciers. Areas of intensive geothermal activity surround the cluster of low-frequency events. It is argued that these earthquakes are associated with active magma in the south part of the Torfajökull caldera, possibly a rising cryptodome.

Keywords: Torfajökull volcano; Iceland; low-frequency earthquakes; cryptodome

1. Introduction

Iceland is a unique landmass situated astride the Mid-Atlantic ridge. Its geology is characterised by the interplay between spreading at the mid-oceanic plate boundary and a hot spot, which has a centre located in east-central Iceland (Wolfe et al., 1997). The North American and Eurasian plate drift apart with a velocity of approximately 2 cm/year. The plate boundary in Iceland is located within the neovolcanic zone, a chain of active volcanoes, which traverses the central part of Iceland (Fig. 1). In the south it has two branches, the Western and the Eastern volcanic zone, connected by a transform, the South Iceland seismic zone. In the north there is a single Northern volcanic zone. North of Iceland the plate boundary is displaced to the west by the Tjörnes fracture zone (Fig. 1).

* Corresponding author. Present address: Bullard Laboratories, Department of Earth Sciences, University of Cambridge, Madingley Road, Cambridge, CB3 0EZ, UK. Tel.: +44 1223 337 188; fax: +44 1223 360 779.
E-mail addresses: heidi@hi.is (H. Soosalu), palli@hi.is (P. Einarsson).
[1] Tel.: +354 525 4816; fax: +354 552 1347.

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