Figure 1: Map of Iceland with shield volcanoes and fissure marked as circles and lines respectively. The Neovolcanic Zone is also shown as the darker shaded area, and the main ice caps are marked.

Holocene shield volcanoes in Iceland *Poster*

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Introduction

Holocene shield volcanoes (lava shields) are common in Iceland, but they are restricted in space and time. As regards space, most of the shield volcanoes in Iceland occur within two bands in the West and North Volcanic Zones (Fig. 1). There are no shields in the East Volcanic Zone apart from the island of Surtsey. The shields are mostly at the margins of or outside the volcanic systems (Fig. 2). As regards time, many Holocene shield volcanoes formed some 5000–10000 years ago during early postglacial time. Apart from the shield on top of the island of Surtsey, there are no known shields in Iceland younger than about 3500 B.P.

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Formation

The formation of shield volcanoes follows a general pattern. The eruption begins with a fissure that subsequently becomes concentrated at several vents, which generate overlapping shields. A single vent, the last one to remain active, generates a main shield which buries the earlier overlapping smaller shields. The shield volcano itself consists of two main morphological units; a central cone and a lava apron. The cone is generally roughly symmetrical, and the apron roughly a circular shape, though both are affected by topography (Rossi, 1996). There is no caldera collapse associated with Icelandic shield volcanoes, since they are supplied with magma from elongated reservoirs at the boundary between the crust and upper mantle.

Composition

In Iceland, the shield volcanoes are mainly of two compositions, olivine-tholeiite basalt and picrite basalt, both

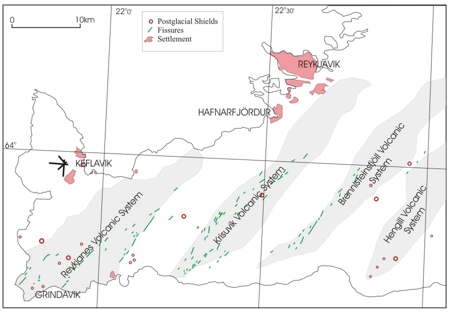

Figure 2: The Reykjanes Peninsula with its volcanic systems and their postglacial shields and fissures shown. Note the location of many shield volcanoes on the outskirts or outside of volcanic systems. Keflavik Airport is also shown along with the main settlements of the peninsula.

Figure 3: Skjaldbreidur shield volcano in the West Volcanic Zone.

of which are primitive basalts. The magma composition is determined by the local pressure and temperature conditions, as well as the composition of the rock undergoing partial melting. Rossi (1996), who documented 40 to 50 Holocene shield volcanoes in Iceland and made a detailed study of 31 found all the shield volcanoes to be monogenetic. Of the 31 shields studied in detail, 24 are olivine-tholeiite basalts and 7 picrite basalts. This indicates that the conditions for the formation of olivine-tholeiite shields are more commonly satisfied than the conditions for picrite shields.

Picrite magma is a primary magma from the mantle. During the waning stages of the last glaciation and the early postglacial period, magma of this composition migrated up under the volcanic zones of the Reykjanes Peninsula at exceptionally high rates. This high rate of migration is attributable to the decrease in lithostatic pressure as a result of the rapid melting of the glaciers. Later in the postglacial period, the picrite magma is thought to have been trapped by the lighter olivine-tholeiite magma that subsequently accumulated in the upper parts of the magma reservoirs (Gudmundsson, 1986).

Shields and Fissures

The volumes of shield volcanoes differ from those of fissure eruptions within the same volcanic system. The average lava volume of Holocene shield eruptions is much larger than the average lava volume of Holocene fissure eruptions. For example, on the Reykjanes Peninsula the mean eruptive volume of 101 volcanic fissures is about 0.1 cubic kilometers, whereas that of 26 shields is about 1 cubic kilometre. A typical large Holocene shield volcano on the Reykjanes Peninsula is Skjaldbreidur, which has a volume of around 15 cubic kilometers (Fig. 3). There is also a correlation between the compositions of the two types of eruption; the fissures produce more-evolved basalts, commonly tholeiite or quartz-tholeiite.

Conclusions

Here we present conceptual and numerical models as to how the stress changes related to the deglaciation may, partly at least, explain four related volcanotectonic features in Iceland. First, how high-density basaltic magmas were able to reach the surface to form the shields. Second, why most of the shields formed in the early part of the postglacial period, with hardly any formed during the past 3500 years. Third, why many of the shields formed at the margins of the volcanic systems to which they are associated rather than at their centres. And, fourth, why the shields became confined to the West and North Volcanic Zones, with essentially no shields in the East Volcanic Zone.

References

Gudmundsson A (1986) Mechanical aspects of postglacial volcanism and tectonics of the Reykjanes Peninsula, Southwest Iceland. Journal of Geophysical Research 91, 12711–12712.

Rossi MJ (1996) Morphology and mechanism of eruption of postglacial shield volcanoes in Iceland. Bulletin of Volcanology 57, 530–540.