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Tectonic conditions favouring the formation of shield volcanoes in Iceland

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Formation of shield volcanoes (lava shields) has occurred throughout the geological history of Iceland. For example, there are many large shield volcanoes buried within the Tertiary and Pleistocene lava pile. The best studied shield volcanoes in Iceland, however, are those formed during the early Holocene. There are two distinctive voclanotectonic features of the Holocene shields, namely (1) their distribution in time, and (2) their distribution in space. As regards time, most of the shields formed during early postglacial times. In fact, during the past 3500 years, only one shield has formed in Iceland. This is the shield that forms the top of the island of Surtsey, off the south coast of Iceland. It was formed in an eruption that lasted from 1963 to 1967. As regards space, the Holocene shield volcanoes are confined to two marked areas, namely the West Volcanic Zone and the North Volcanic Zone. Apart from the shield on top of the island of Surtsey, there are no shield volcanoes in the East Volcanic Zone. Furthermore, many of the large shields are not located at the centres of the volcanic systems to which they belong but rather at their margins.

The shield volcanoes generally differ from fissure eruptions in the same volcanic systems as regards volume and composition. The average lava volume of Holocene shield eruptions is much larger than that of Holocene fissure eruptions. For example, on the Reykjanes Peninsula the mean eruptive volume of 101 volcanic fissures is about 0.1 cubic kilometres, whereas that of 26 shields is about 1 cubic kilometre. As regards composition, most shields are of primitive basalt, either olivine tholeiite or picrite. By contrast, most lava flows issued from volcanic fissures are more evolved basalts, commonly tholeiite or quartz-tholeiite.

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. First, how high-density 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. 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.