

Overlapping rifts in southern Iceland

QUEST field trips: 15 and 17 July 2011

Freysteinn Sigmundsson (fs@hi.is)

The geological map of Iceland gives an excellent overview. The plate boundary is broken up into different volcanic zones and volcanic systems (see figures below).

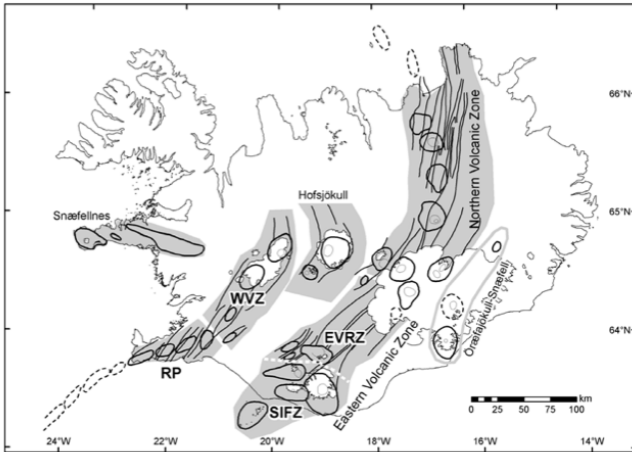


Figure 3.9. Volcanic zones of Iceland. The volcanic rift zones include the Northern Volcanic Zone (NVZ), the Western Volcanic Zone (WVZ), the Eastern Volcanic Rift Zone (EVRZ), and the Reykjanes Peninsula (RP) oblique rift. The volcanic flank zones (with little or no rifting) are the Snæfellsnes, Örfajökull-Snáfell and the South Iceland Flank Zone (SIFZ). Together the SIFZ and the EVRZ are termed the Eastern Volcanic Zone (EVZ).

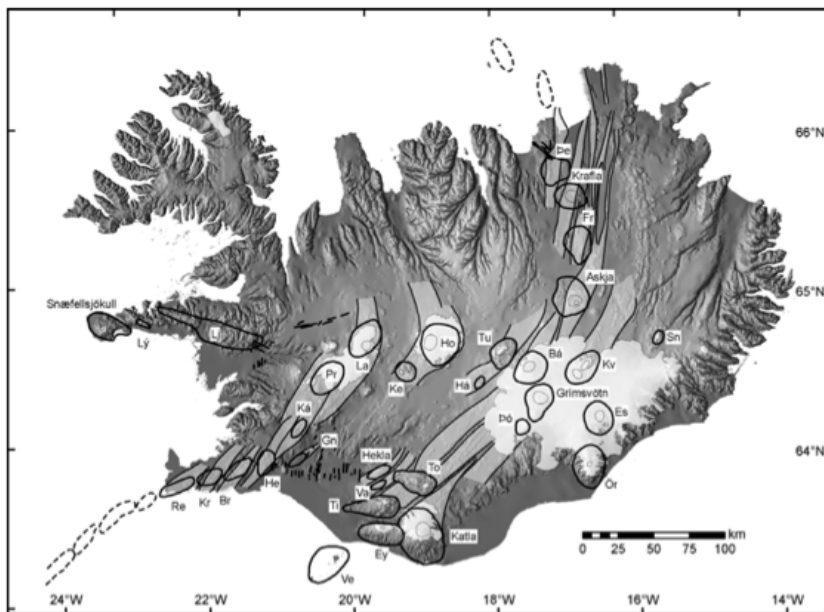
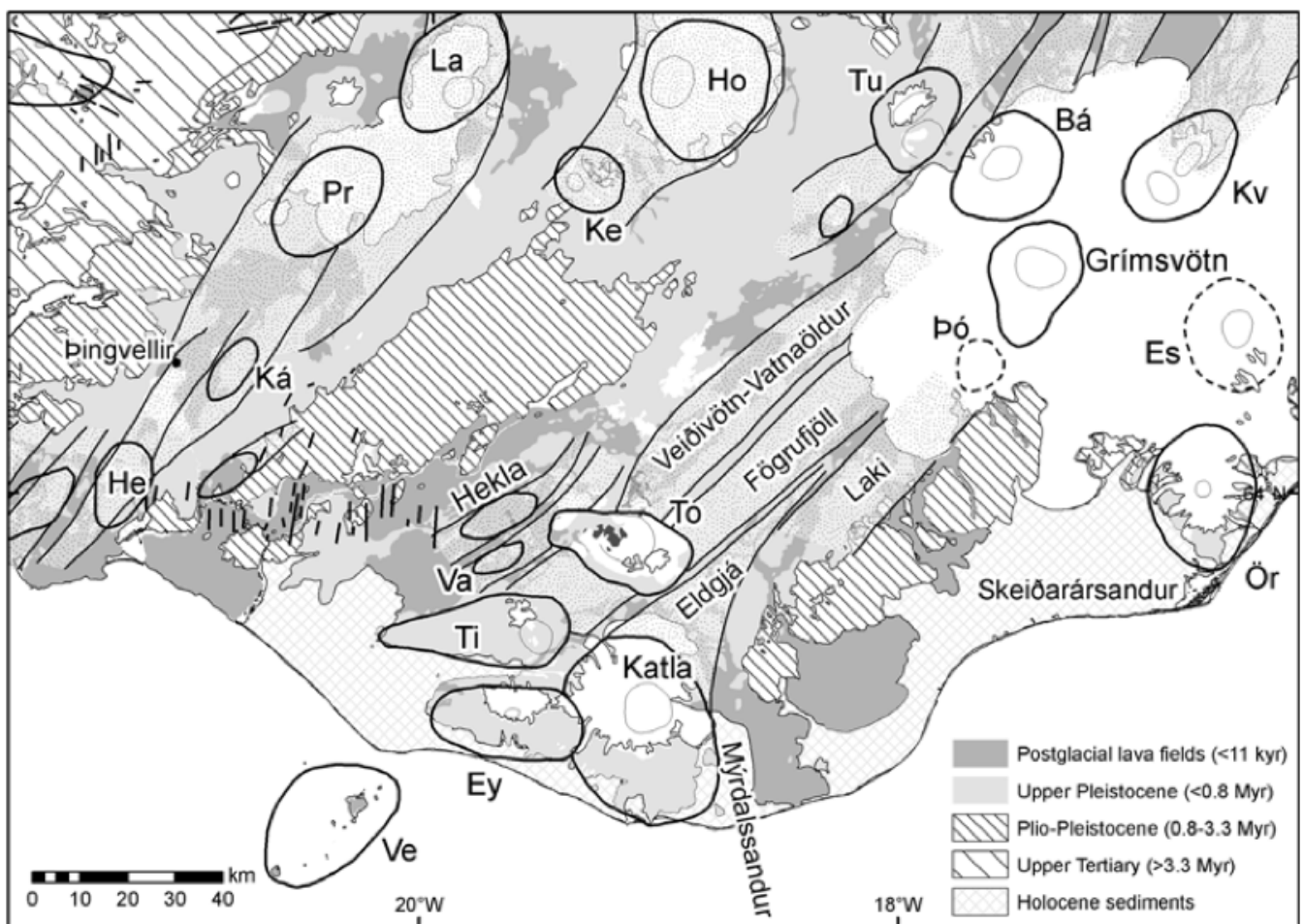


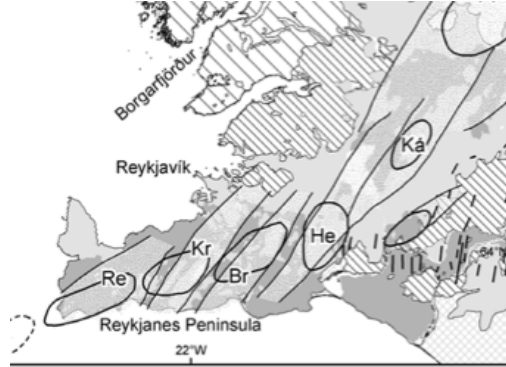
Figure 3.10. Volcanic systems in Iceland as mapped by Einarsson and Sæmundsson (1987). Background map shows shaded topography. The volcanic systems consist of fissure swarms (light shading with outlines), central volcanoes (thick oval outlines), and calderas at some of the central volcanoes (thin oval outlines). The volcanic systems are in alphabetical order: Askja, Bárðarbunga (Bá), Brennisteinsfjöll (Br), Esjufjöll (Es), Eyjafjallajökull (Ey), Fremri Námar (Fr), Grímsnes (Gn), Grímsvötn, Hágöngur (Há), Hekla, Hengill (He), Hofsjökull (Ho), Katla, Kálfstindar (Ká), Kerlingarfjöll (Ke), Krafla, Krísvík (Kr), Kverkfjöll (Kv), Langjökull (La), Ljósufjöll (Lj), Lýsugarð (Lý), Prestahnjúkur (Pr), Reykjanes (Re), Snæfellsjökull, Snæfell (Sn), Tindfjöll (Ti), Torfajökull (To), Tungnafellsjökull (Tu), Vatnafjöll (Va), Vestmannaeyjar-Westman Islands (Ve), Þeistareykir (Þe), Þórðarhyrna (Þó) and Örfajökull (Ör).

We will explore the western and eastern volcanic zones in Iceland, the South Iceland Seismic Zone, and the Hreppar microplate in between the rifts. In the Western Volcanic Volcanic Zone we will explore the Hengill (He) volcanic system and its fissure swarm towards the north (Þingvellir Fissure Swarm). In the Eastern Volcanic Zone we will focus on Hekla and Torfajökull (To) volcanoes.



Western Volcanic Zone, Geysir and Gullfoss

QUEST field trip, 15 July 2011



1. Nesjavellir and the Hengill central volcano

Nesjavellir geothermal area.

The Hengill central volcano.

The Hengill fissure swarm; normal faults and eruptive fissures.

Nesjahraun and the most recent eruptive fissure.

View to the Hrómundartindur volcanic system, the 1994-1999 unrest area.

Þingvellir Lake

2. Þingvellir graben and fissure swarm

Overview of the Western Volcanic Zone

The Almannagjá normal fault

Internal structure of lava flows

Tension fractures

History of Iceland

3. Geysir geothermal area

Geysir geothermal area. This geothermal area hosts the first geyser described, called Geysir or the Great Geyser. Geysir itself is presently not erupting, but frequent eruptions can be seen at the Strokkur Geyser.

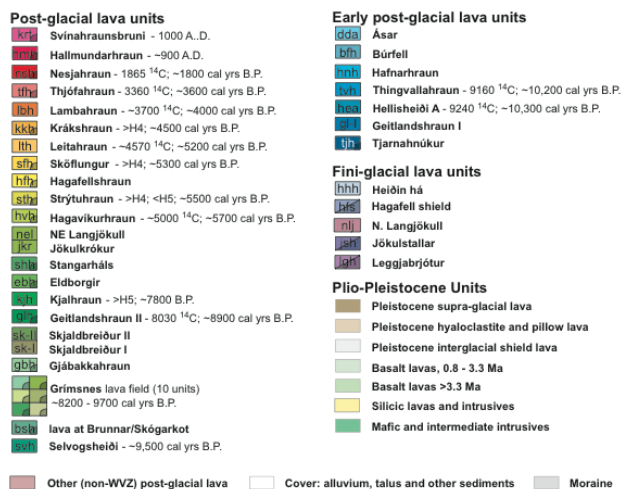
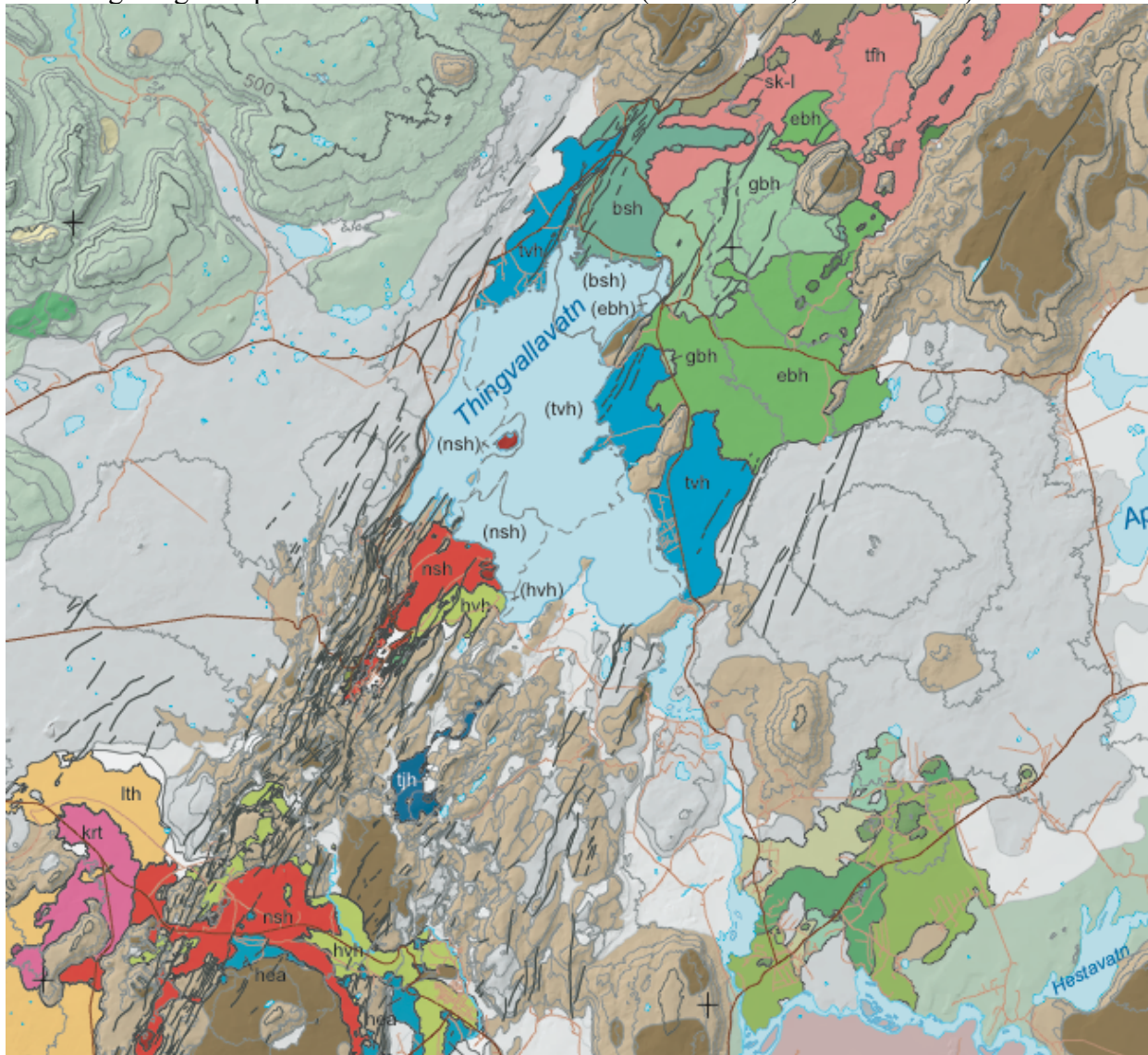
4. Gullfoss water fall

Gullfoss water fall in river Hvítá.

5. Kerið crater (time allowing)

Kerið crater lake in the Grímsnes lava field.

Detailed geologic map of the Western Volcanic Zone (John Sinton, Univ. Hawaii):



John Sinton, Karl Grönvold and Kristján Sæmundsson, Postglacial eruptive history of the Western Volcanic Zone, Iceland, G3, 2005.

QUEST field trip, 17 July 2011

Exploration of the Eastern Volcanic Zone, including Hekla and Torfajökull volcanoes. Beginning with exploration of 1912 fault rupture in South Iceland Seismic Zone.



1. 1912 fault rupture at Selsund.

M7 earthquake in 1912 created surface breaks, typical for those associated with strike slip faulting in the South Iceland Seismic Zone.

2-3. Hekla volcano: tephra and lava

Mt. Hekla (1491 m) is a volcanic ridge and one of three most active volcanoes in Iceland, the others are Katla, and Grímsvötn. Together they are responsible for at least half of all eruptions that have occurred in the last 1100 years. These volcanoes have had profound environmental impact and greatly influenced their surroundings.

The first post-settlement eruption of Mt. Hekla occurred in 1104 A.D. At that time an explosive eruption produced about 2.5 km³ of rhyolitic tephra which blanketed large parts of Iceland and caused complete destruction of nearby inhabited areas. Through historical time one or two major eruptions occurred each century at Hekla until 1947. Thereafter the eruptive pattern changed to more frequent and smaller eruptions. The initial phase of many Hekla eruptions is explosive and has spread tephra over large parts of Iceland, depending on prevailing wind conditions. At Hekla, the length of the repose period between eruptions (known from the historical records) scales with the initial silica content of eruptive products. The longer the repose period, the higher the silica content of the initial eruptive products. In addition to direct effects from tephra, the environmental effects of Hekla eruptions have included effects of soluble fluorine adhering to erupted tephra particles, leading to lethal fluorosis in grazing animals even in areas of minor tephra fallout. An interesting feature of Hekla eruptions is that the volume of eruptive products also scales with the preceding repose period, adding up so that about one cubic kilometre of magma is erupted each century. This is the only volcano in Iceland with such regular pattern.

4. Ljótípollur and view to the Vatnaöldur Veðivötn eruptive fissures

Ljótipollur is an explosive crater

5. Landmannalaugar and Torfajökull volcano

Landmannalaugar and the Torfajökull volcano

At stops 4 and 5 we can see the effects of major rifting episodes (Vatnaöldur 871 AD), Veidivötn (1480), in the eastern volcanic zone and how they have interacted with the Torfajökull rhyolitic volcano.

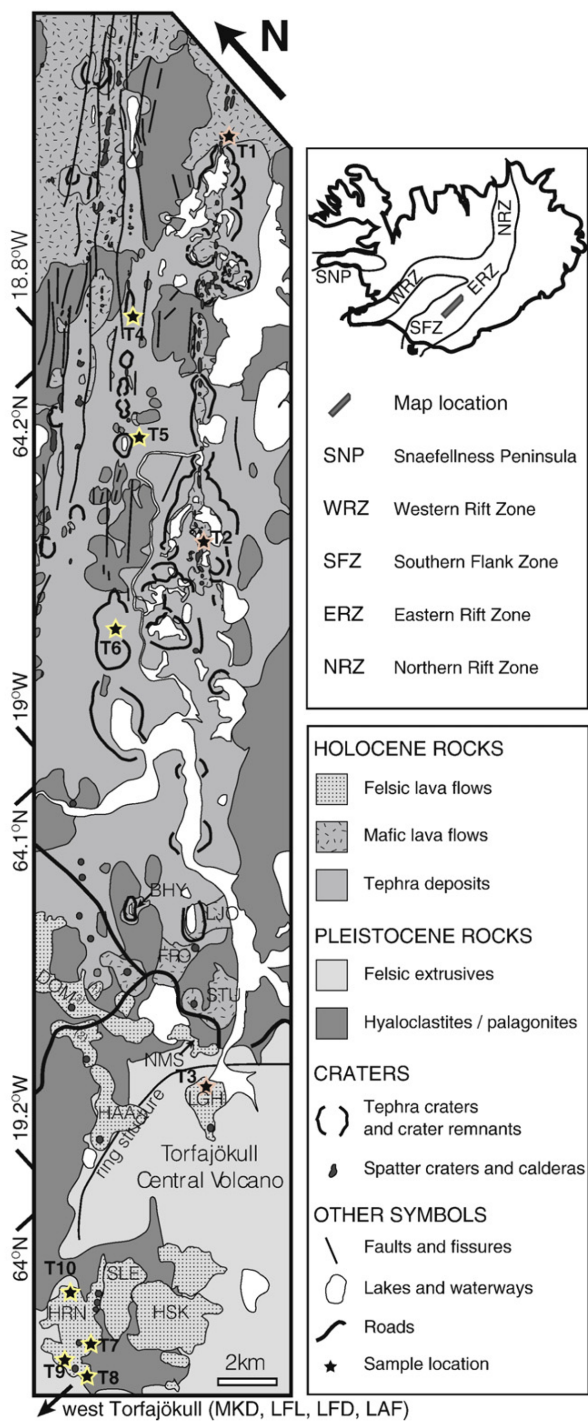


Fig. 1. Outline geological map of the Torfajökull–Veiðivötn area, based on Vilmundardóttir et al. (1988), Jóhannesson et al. (1990) and Ívarsson (1992), and its position with respect to the main rift zones in Iceland. Sampling locations are indicated by stars. Veiðivötn samples T1, T2, T4, T5, and T6 were taken, respectively, from Hrafnót, Breidavatn, Vatnaöldur Inni, Vatnakvísl Creek, and Vatnaöldur Fremri. Place name abbreviations for Torfajökull samples from this study and the literature are adopted from Macdonald et al. (1990), and are the following: For the 1477 AD eruption: FRO – Frostastadahlraun, LGH – Laugahraun, LJO – Ljótípollur, NMS – Namshraun, and STU – Stútshraun basalt flow. For the 871 AD eruption: BHY – Bláhyllur basalt explosion crater, and HRN – Hrafninnuhraun. For older eruptions: DOM⁽³⁾ – Domadalshraun 3 (~150 AD); DOM⁽²⁾ – Domadalshraun 2 (~3100 BP); MKD – Markarfljót domes (~3500 BP); HAA – Haölduhraun lava flow (~6500 BP); LAF – Laufahraun mafic flow, LFD – Laufafell domes, and LFL – Laufafell basalt lavas (~6800 BP); DOM⁽¹⁾ – Domadalshraun 1 (~7000 BP); HSK – Hrafninnuskur (~7500 BP); SLE – Slettahraun lava flow (~8000 BP). See McGarvie (1985) for a discussion of the evidence for, and accuracy of, these ages. Deposits from BHY, LJO, FRO, STU, NMS and LGH are part of the northeast Torfajökull group, as discussed in the text.

Zellner, G.F., K. H. Rubin, K. Grönvold and Z. Jurado-Chichay, On the recent bimodal magmatic processes and their rates in the Torfajökull-Veiðivötn area, Iceland, EPSL, 2008.