
by

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The Excursion

The principal purpose of this excursion is to provide a general overview of the volcanic environment in a basalt-dominated and ‘hot spot’ related region, with emphasis on lava flow field and sediment associations. This guide is organized such that it gives a brief outline of the Excursion Stops (see Figure 1) along with relevant sketches and photos. A geological overview of Iceland and the geology of the areas covered by the excursion can be found in:


Figure 1. The excursion routes and stops (yellow/red circles). Day 1 is shown in red and Day 2 in green.
Day 1 - Excursion Stops

On the way to Stop 2 we will stop briefly at Hvolsvöllur - break.

Stop 1 Eyjafjallajökull volcano – the 2010 eruption and the glacial lagoon that is no more.

Eyjafjallajökull is a 1666 m-high shield volcano situated near the tip of the propagating Eastern Volcanic Zone. It is crowned by a small caldera and an icecap that reaches down to 1000 m above sea level. It has been active for at least 800,000 years and sits on more than 25 km-thick crust (Figure 1).

Eyjafjallajökull volcano has been relatively quiet in postglacial times, with 14-16 eruptions in the last 11000ka with four in the last 1500 years, AD500, AD1613, AD1821-23 and AD2010.

The 2010 Eyjafjallajökull eruptions: The build up to the 2010 eruption, included a seismic swarm in May 1994 and another one in July 1999. These events have been linked to emplacement of sills emplaced within the volcano’s core. Bout ten years past before the next episode of unrest (May 2009), when an earthquake swarm was accompanied by a significant inflation of the volcano. Six months the volcano’s restlessness picked up and increased steadily in magnitude and intensity over the next three months. On 18th March it was evident that Eyjafjallajökull was heading towards an eruption and at 11:30 pm on 20th March, a 400 m-long fissure opened up on the northeast flanks of Eyjafjallajökull near Fimmvörðuháls (Figure 2). A curtain of fire (= 150 m-high lava fountains) rose from the fissure, feeding a basaltic a'a lava flow advanced over the snow without melting. This event lasted until 12th April and produced 0.026 km³ lava and tephra.
The pause did not last. In early morning of 14th April magma of intermediate composition (i.e. trachyandesite) emerged through 250 m of ice in summit crater of Eyjafjallajökull. This activity produced jökulhlaup (i.e. debris-laden melt water) until late afternoon on the 14th, which cascaded down the outlet glacier Gígjökull, destroyed the glacier lagoon at its front (Figure 3) and completely flooded the sandur plain of the Markarfljót River, including the segments of Highway 1 on either side of the Markarfljót bridge.

In the early hours of the evening a dark coloured, tephra-laden, plume rose from the summit vents, vigorously spewing tephra into the atmosphere (Figure 3, right panel). From this time onwards to the 18th April, the eruption remained explosive initially sending the ash-rich plumes to the southeast (14-15 April) and then south (17 April), directly in over the European forcing a widespread closure of the airspace over Europe that resulted in major disruption to air travel and transport for almost 10 days (April 15 to 24). The eruption intensity dropped on the 18th April and a few days later the European airspace was reopened. The explosive activity became sporadic and lava began to flow from the summit vents. This second phase of the activity lasted until 4th May. On 5th of May the eruption intensity jumped up and explosive activity resumed. Again north-westerly winds carried the ash-rich plumes to Europe, this time resulting in partial closure of the airspace on 4–8 May and 16–17 May. This third eruption phase lasted until the end of the eruption on 22nd May. The summit eruption extruded about 300 million m³ of tephra and 23 million m³ of lava.
Stop 2 Dyrhólaey – an example of a volcano that, like Surtsey, emerged from the sea.

Dyrhólaey (Portland) is the southernmost point of Iceland (63°23’N) and a heavily eroded submarine volcano of the surtseyan type (Fig. 4). The main part of Dyrhólaey is built of well bedded tuff formed by phreatomagmatic explosions and it represents the remains of a larger tuff cone. On the eastern flank of Dyrhólaey the tuff sequence is capped by compound pahoehoe lava, which in places exhibits cube-jointing, indicating water-enhanced cooling of the lava. The lava flows represent the subaerial phase of the eruption when the tuff cone had grown large enough to prevent sea water from accessing the vent. Flowing away from the vent(s), the lava re-entered the sea and cooled rapidly to form the cube-jointed lobes. The Dyrhólaey sequence is typical for Surtseyan eruptions and, if visibility allows, the type-volcano Surtsey can be seen from this location as the southernmost island of the Westman Islands.

Figure 4 (a) Aerial view of Dyrhólaey; (b) simplified cross section showing the structure of the tuff cone.

Stop 3 Mýrdalssandur flood plain and Katla eruptions (section 4.4)

Stop at the visitor rest area on the outwash plain for an outlook of Mýrdalssandur, Katla volcano and the western lava branch (Álftavershraun) of the 934-40 Eldgjá eruption (Figure 5). An overview of historical activity at the Katla volcano (including Eldgjá) and the construction of the Mýrdalssandur outwash plain.

Figure 5. Mýrdalsjökull (Katla) volcano, extending across the photo and capped by glacier and its sandur plain (foreground).

Stop 4 Dalbær and Fjaðrárgljúfur

(a) Dalbær: Impact of Laki lava on the settlement – damming of tributary rivers and farm ruins, Eldgjá lava – penetration of lava under soil confirmed by position of Eldgjá rootless cones and tephra.

(b) Fjaðrárgljúfur: In the last 10000 years the rivers have cut many gorges and gullies into the Síða highlands (i.e. the bedrock = Síða Group, see section, but none as spectacular as the Fjaðrárgljúfur gorge. Here the rather innocent-looking Fjaðrá River has carved out a 100 m-deep ravine into the hyaloclastite flows and other formations of the Síða Group. In early postglacial times a sizeable lake occupied the valley above Fjaðrárgljúfur (the flat-topped benches along the valley side are the strandlines formed by that lake) and was kept a bay by an erosion-resistant threshold. At the time, the gorge did not exist and a much larger river flowed down the gently sloping hills before cascading off the cliffs of the Síða scarp. By sheer power of flow the river rapidly carved out the gorge back into the mountains. Eventually it breached the threshold at the mouth of the valley and in doing so drained the lake, changing the conditions to those of today.

Drive to Hótel Dyrhólaey where we will spend the night.

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Day 2 - Excursion Stops

Stop 5 The Eldgjá Chasm (section 4.5.1)
A short stop to view the spectacular 150 m-deep and 8 km-long Eldgjá chasm (i.e. Eldgjá proper), which occupies the central part of the ~75-km-long Eldgjá vent system. Eldgjá proper is an old tectonic graben that was reactivated in the basaltic flood lava eruption that took place in 934-40 AD. The thick möberg sequence that makes up the walls of Eldgjá is capped by red and black scoria and spatter deposits containing discontinuous lava-like units formed as fountain-fed flows. The scoria and spatter cones at the bottom of Eldgjá are also primary volcanic features.

Fig. 6 Oblique aerial view of the northeastern part of the Eldgjá chasm.

Stop 6 Landmannalaugar (section 3.3)
Landmannalaugar are situated within the caldera of the rhyolitic Torfajökull central volcano where it is cross-cut by the fissure swarm of the basaltic Bárðarbunga-Heidivötn volcanic system. The area features an active geothermal area recent silicic and basaltic lava flows as well as numerous sediment- and lava-filled rift basins. Here we will look at the 870 AD Ljótipollur tuff/scoria cone, the 1477 AD obsidian Laugahraun lava flow as well as the basaltic 1477 AD Stútshraun lava and its spectacular flow inflation structures.

Fig. 7 Landmannalaugar; Laugahraun (centre) and south end of Stutshraun (far right).

Lunch stop at Landmannalaugar.
Stop 7 Lava-sediment successions of the Hreppar Formation (section 3.2)

Stop to view the southern slope of Mt Villingadalsfjall, which at first glance may look like any other mountain slope in the region and certainly its geological significance is not revealed in an instant. The lower part of the slope features large grass-covered terrace-like benches, whereas barren rock is exposed in the steeper upper part, that are in fact large blocks that have been displaced downwards by faulting. For example, the rock formations exposed in the cliffs by the main road at Gaukshöfði, which includes fluvial, coastal and possibly glacial deposits and a lava prograding into pillows, are the same formations as occur at the top of Mt Villingadalsfjall, some 300 m up.

Walking up the lower half of the slope, these formations are repeated each time when one crosses a northeast-trending ravine. The ravines are in fact the fault traces. Occasionally a basaltic dyke pokes up in the ravines. These dykes used the fractures created by the faults to rise towards the surface. The benches were formed by a step-wise displacement of the strata along northeast-trending faults and in all the cumulative downthrow is 200-300 m. These faults mark the northern margins of the East Volcanic Zone.

In the upper half of the slope the original stratigraphy is intact and reveals a rather interesting story. The sequence exhibits distinctive stratification and most of it is composed of fluvial conglomerates and sandstones (Fig. 8). Scattered in between these fluvial deposits are lenticular lava bodies with upper surfaces that show clear evidence of having been modified by fluvial erosion. The fluvial deposits were formed by a braided river system emerging from a glacier situated further inland. In fact it is an old sandur plain, where the debris transported by the ancient rivers and sporadic lava eruption filled in a large paleo-valley. The western slope of this valley was the east side of Mt Hagafjall, where the möberg ridge that forms the mountain core is blanketed by steeply dipping alluvial fan deposits.

![Figure 8. Simplified cross section of the geology of Villingadalsfjall.](image)

Stop 9 Geysir geothermal field

Geysir is perhaps the world’s most famous spouting hot springs and its reputation is such that in many languages such springs are known as geysers. Geysir is situated among other hot springs in a field of silica sinter deposit at the eastern end of the hill Laugarfjall. Most of the springs here are alkaline with clear water. Geysir is by far the largest spring and it consists of a 3 m-wide and 22 m-deep shaft that opens into a 2 m-deep and 15 m-wide bowl-shape basin at the summit of the regular silica sinter dome that surrounds the hot spring. The hot springs are first mentioned in the Geysir area after the south Iceland earthquake in 1294. It is possible that the Great Geysir was rejuvenated by this event, but the 2800-year-old Hekla tephra layer that sits immediately beneath the silica sinter dome indicates a considerably longer lifetime for Geysir.

Geysir eruptions are initiated by superheating of the water column at ~10 m-depth in the shaft and the onset of an eruption is usually indicated by rumbling in the ground, vigorous boiling and periodic inflation of the water in the bowl forming a large cupola-shaped bubble. As the bubble bursts, the eruption begins by sending up a series of water jets, growing in height until the eruption has reached its maximum. In his prime, Geysir produced 30-80 m-high jets in eruptions that lasted 5-10 minutes. In 1750 the Icelandic naturalists, Eggert Ólafsson and Bjarni Pálsson, described a Geysir eruption as follows:

We stayed by Geysir in case he would erupt. Earlier we had thrown several boulders of silica sinter, which lay astray, down into the bowl of Geysir. At first we heard a heavy thump beneath us. It resembled the sound of canon fire from a distance. In all the thumps were five and of increasing intensity, and at the same time the ground jolted, like it was going to be lifted or ripped open. Following the sixth thud/thump the first jet emerged from Geysir. Thereafter the intensity of the eruption increased with each thump and the water was ejected as columns. The boulders we had thrown into the bowl had split into smaller fragments; the largest ones were close to a fist-size. These fragments were ejected with the water and some reached heights greater than their associated water columns. We located ourselves up wind from Geysir so we could best observe the eruption because the steam blocked the
view on the downwind side. This was also done to avoid injuries and burns from the hot water falling down from the columns. From the beginning of this eruption we noticed that not only was the water lifted into the air by each emerging jet, but also simultaneously the total volume of water retained within the crater was inflated and overflowed the banks of the bowl, mostly to the north. … This eruption was equivalent to the highest and greatest eruptions known at Geysir. Although it did not reach the height of Laugafell, a small hill, 70 fathoms [116 m] high, in the neighbourhood of Geysir. In this particular eruption the water columns rose to approximately 60 fathoms [100 m]. According to the inhabitants of Haukadalur, the height of the water column in some Geysir eruptions reaches heights equal to that of Laugafell, but eruptions of such intensity occur only before the arrival of heavy rainstorms. The eruption lasted for 10 minutes, with jets ejected every 3 seconds and the eruption featured around 200 jets in total.

There are many other hot springs in the Geysir area, such as Strokkur (“the churn”) that in his prime erupted jets up to 100-m-high (Fig. 8), Smiður (“the smith”), Óþerrishola (“the drizzly hole”), and Sóði (“the slob”). The most beautiful spring in the area is without doubt Blesi, which consists of two holes, one with bluish and the other greenish crystal clear water. This effect is caused by the presence of colloids in the water.

Stop 10 Þingvellir (The Parliament flats)

No trip to Iceland is complete without a visit to the national park at Þingvellir. This historical site offers not only superb geology but also a glimpse into Iceland’s history. Þingvellir is the original site of the Alþing, the general assembly of the Icelandic commonwealth (930-1262). It was established in 930 and is still operation today, making it the Europe’s oldest operating parliament. In the days of the commonwealth, each year the chieftains and their followers gathered at Þingvellir to settle their debates. The laws of the land were recited by the law speaker from Lögberg – a natural pedestal made of lava – using the walls of Almannagjá to echo is words over the constituency.

Þingvellir is truly the heart of Icelandic culture and it has been the venue for some of the most significant events in the country’s history, perhaps none as significant as the nationwide adoption of Christianity in the year 1000, which came about through political debate at the Alþing. The main reason appears to be that majority wanted to maintain peace and unity throughout the nation and to prevent civil war between the extremists within opposing factions, the followers of the old heathen religion and Christians. The records of the event also offer a rare indication of the contemporary understanding of volcanic eruptions.

As the members of the Alþing were debating the adoption of Christianity, news was brought of an eruption in the Ölfusadistrict, south Iceland. It was apparent that the lava flow would overrun the farm of the heathen priest Þóroddur and the extremists among the heathen followers spoke: "We are not amazed that the heathen gods are enraged at such a decision." Then the heathen chieftain Snorri replied: "At what were the gods enraged when the lava on which we are now standing was formed?" According to the chronicles, this reply was the turning point in the debate and ended the protest by the heathen extremists. It also shows that volcanic eruptions were generally viewed as phenomena of nature rather than punishment from higher authorities. For further information on the other historical aspects of Þingvellir, there is an information centre at the park entrance. We will be viewing the Þingvellir area from the main lookout.

![Figure 9](image)

**Figure 9.** View of the Þingvellir area from the south. The road follows one of the main normal faults in the area and in centre right is Skjaldbreiður, one of Iceland’s largest lava shields (800 m high), formed in single eruption about 9000 years ago that lasted for several hundred years.

Drive to Reykjavik.

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