

The Surtsey Eruption
Course of events during the year 1966

by

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Introduction

Like in previous years my contribution to the research work connected with the Surtsey eruption during 1966 was to follow the changing habits of the eruption and the morphological changes of Surtsey and adjacent new volcanic islands.

A more comprehensive geomorphological research on Surtsey, which I had planned for 1966 in cooperation with a Danish geomorphologist, had to be postponed for financial reasons.

For reconnoitring flights over Surtsey in 1966 I enjoyed as before the helpfulness of the Director General of Aviation, Mr. Agnar Kofoed Hansen, and some of my trips to Surtsey were made on Coast Guard vessels or with the helicopter of the Coast Guard Service, thanks to its director, Pétur Sigurdsson. Other trips were paid by the Surtsey Research Society.

During 1966 I made 21 reconnoitring flights over Surtsey and the Jólnir island. Two times I landed on Surtsey in helicopter. Nine times I went out by boat and landed seven times by boat on Surtsey and three times on Jólnir, staying on the island(s) sometimes only a few hours, but the longest stay on Surtsey was three days.

The pilot Sigurjón Einarsson has continued to give me valuable information from his numerous flights over Surtsey and Bjarni Herjólfsson and Skarphédinn Vilmundarson of the Control Tower of the Vestmannaeyjar airfield have on my request continued to keep a diary on the behaviour of the volcano.

Cinemaphotographing

Osvaldur Knudsen has continued with my assistance the cinemaphotographing of the Surtsey eruption, using 16 mm colour-film. A new film: Með sviga lævi - The Surtsey eruption continues, has just been finished. It covers the period from August 1965 to Oct. 1966, that is the last months of the first effusive phase of Surtsey and the first months of its second effusive phase, besides the birth, development and disappearing of the adjacent volcanic islands Syrtlingur and Jólnir. It also pictures some of the biological research work that has started on Surtsey.

Aerial mapping

Using the Coast Guard Services aircraft SIF the Icelandic Survey Department aerial-photographed Surtsey and adjacent areas four times in 1966, viz. on Febr. 6, June 14, Oct. 2 and Oct. 20. The first aerial photographing in 1967 was carried out Jan. 3, 1967. The map reproduced here as Fig. 1 is based on aerial photos and should be compared to the maps Fig. 2 and 3 in my report in the Surtsey Research Progress Report II.

My geomorphological material from my 1966-visits in Surtsey and Jólnir has not yet been worked up, and my report will therefore be restricted to a short summary of the course of events and isopach maps of the tephra falls from Syrtlingur and Jólnir as they are of a fundamental influence on the development of life on Surtsey.

Course of events

When my report II ended, Febr. 24, 1966, a new island that had been born as a result of submarine volcanic activity which became visible on Dec. 26, 1965, 0.5 naut. miles WSW of Surtsey. As the rate of production during the first weeks of the visible volcanic activity hardly exceeded one to two m^3/sec , it may have taken one or two months to build up a ridge high enough to

protrude the surface of the ocean. The eruption may thus well have broken through the sea floor at about the same time as the eruption ceased in Syrtlingur in late October 1965.

The new island - later called Jólnir ("Christmas island"), protruded the sea surface for the first time Dec. 28, 1965. The eruption during the first weeks was clearly a fissure eruption as two vents were usually active. The fissure ran about $N25^{\circ}E - S25^{\circ}W$ and the distance between the vents was 50 to 100 metres. After January 20 usually only one crater was in action. During the winter the new island fought a very hard fight for its existence. Jan. 3 the island was about 100 m long and 50 m wide, but its height was only a few metres. Jan. 5 it was washed away for the first time. Jan. 15 it appeared again and Jan. 25 its height was about 35 m and the activity (phreatic explosive) had increased considerably since its visible beginning. Two days later the island had disappeared for the second time. When aerial photographed Febr. 6 there were shoals on an area of about 600 m in length and 150 m wide, cf. fig. 1. Febr. 7 the island had reappeared. Febr. 12 its length was about 200 m, height about 10 m and the black tephra columns reached 250 m height. Febr. 15 the height was 23 m and the length 240 m. Febr. 16 the island was washed away for the third time.

Febr. 28 the length of the island was nearly 500 m. The eruption column rose occasionally to about 300 m height and the vapour columns to 4000 m height. March 3 Jólnir disappeared for the fourth time.

March 18 its height was about 30 m. April 5 Jólnir disappeared for the fifth time to reappear a week later. After that the island on the whole increased in size through the spring and early summer as the sea was now mostly rather calm. May 3 I estimated its height at 45 m. When photographed June 14 the area was 28 hectares (70 acres) and the height of the crater cone, which was situated at its southern end, was at least 50 m. During July and early August the crater cone reached nearly 70 m

height but when the eruption came to an end on Aug. 10, 1966, the area had been reduced to about 16 hectares. September 20 only a reef some tens of metres in length was visible at high tide.

The Jólnir phase of the Surtsey eruption was wholly explosive, similar to the Syrtlingur eruption although with the difference that the continuous uprush activity was more pronounced in Jólnir during the summer months than it ever was in Syrtlingur where the sea had a more easy access to the vent because of the smaller area of that island. On the other hand the Jólnir paroxysms were never as violent as the most violent ones in Syrtlingur. Yet the vapour column at least once (May 20) reached about 6000 m height.

The total volume of tephra produced during the Jólnir phase can at the moment only be roughly estimated. It is of the order of 110 million m^3 , corresponding to an average production rate of 5 m^3 /sec. The production rate was thus of the same order as during the Syrtlingur activity but probably on a somewhat larger scale.

Maps of Jólnir have not yet been worked out except the outline maps shown on Fig. 1, which show how greatly the situation of the island in relation to the vent was affected by the dominating wind direction at various times.

During the summer of 1965 the crater cone on the southern end of the island became nearly separated from the rest of the island by a semicircular tectonic graben containing a shallow lagoon of the same type as the Surtsey lagoon, which no doubt was formed in a similar way in February 1964.

Renewed effusive activity in Surtsey

At about 07 h in the morning of Aug. 19, 1966, effusive activity began again in Surtsey, this time in the older Surtur crater which had been inactive since the end of January 1964,

or more than 2 1/2 year. When first witnessed at close range (by Arni Johnsen about 13h30m) a fissure about 150 m in length, 7 m wide in the middle and about 13 m near each end had opened up in the floor of the crater and lavaflow about 100 m wide had spread 150 - 200 m towards E. From the fissure lava lumps were thrown up to about 50 m height but no crater walls had as yet been built up. About 80 m further south there was a glowing domeshaped patch of lava. It was nearly circular, diameter about 10 m and its height in the middle about 2 m. When visited again at 18 h the lava had begun to flow from this southernmost "crater". When I the following day measured the distance from this crater to the northernmost end of the new fissure where two separate vents were now throwing lava lumps up to 100 m height, I found it to be 220 m. The direction of the fissure was N10°E-S10°W. At 18h40m that day (Aug. 20) the lavaflow reached the sea. The average production of lava until then did not exceed 4 m³/sec, but was gradually increasing and may have reached 5-10 m³/sec the following days. Aug. 20 in the morning there was a lava fountain activity of the Askja type in the northernmost crater and a considerable production of Pelées hair, which means that the fountains then had become Hawaiian. At the end of Aug. the lava production was again down to about 5 m³/sec and the average volume increase of the island and its socle between Aug. 19 and Dec. 31, 1966, is, roughly calculated, 3 ± 0.5 m³/sec. The total volume of lava and tephra produced by the Surtsey eruption until the end of 1966 is about 1 km³. During most of the autumn and winter only one lava crater, the northernmost of the original three, has been active and built up a dome of a similar shape as the dome built up by the younger Surtur crater although still somewhat lower. The 1966 lava covers 82 hectares (cf. fig. 1). It is typical pahoe-hoe lava.

Area changes of Surtsey during 1966

When measured on Aug. 24, 1965, Surtsey had an area of 245 hectares, whereof 135 were covered by lava. During the

autumn and early winter of 1965 the outlines of the island did not change much. When comparing the outlines of Surtsey Aug. 24, 1965, and June 14, 1966, we see that the main difference is that the marine abrasion has cut away a strip of land on the SE, E and NE side of the island and deposited it on its N and W side. This happened mainly in January and during the first five days of February. The changes between Febr. 6 and June 14 were small. By far the most effective assault of the sea was launched during five days of continuous storm from E and SE febr. 1 - Febr. 5, which coincided with full moon (Febr. 5), so that the high tides were extra high towards the end of the storm. Febr. 2 a real hurricane was blowing as the wind velocity was then 90 knots or 45 m/sec. During these days blocks up to 5 tons were wrought up on the flat pahoe-hoe lava plain on the E side of the island, nearly 7 m above the half-tide level. Blocks broken out of the lava on the NE side of the island were transported westwards along the coast during the winter and formed a ridge, 30-50 m broad, of more or less rounded boulders, extending westwards about 600 m. Blocks up to 2 tons were transported about 500 m along the shore. This boulder-ridge protected the lagoon from further flooding by the sea from NE.

When aerial photographed June 14, 1966, the area of Surtsey was 235 hectares, a reduction of 10 hectares since Aug. 24 the previous year. Jan. 3, 1967, the area of the island had increased to 258 hectares, which means an increase of 23 hectares since the lava began to flow again on Aug. 19, thus an average increase of $1700 \text{ m}^2/24$ hours. Fig. 1 shows the outlines of Surtsey and Syrtlingur Aug. 24, 1965, the outlines of Surtsey and Jólnir Febr. 2, June 14, Oct. 2 and Oct. 20, 1966, and the outlines of Surtsey on Jan. 3, 1967.

Tephra fall on Surtsey

Although the activity in Jólnir was purely explosive tephra fall did not affect Surtsey to any degree until the beginning of May 1966. From then onwards there was tephra fall

now and then through May, June and the beginning of July when the wind was from S or SW. After July 5 there was on the whole much less tephra fall. When I walked around the island on July 30 the increase in thickness since July 4 was very little except on a small belt inside the shore on the west side of the island between the 20 cm and 5 cm isopach on Fig. 3, where the thickness had been nearly doubled.

The tephra that fell on Surtsey was mainly medium sandy to coarse sandy. Where the layer was thickest the max. grain diam. was about 5 mm. Fig. 2 is an isopach map of the tephra layer deposited by Syrtlingur 1965. Much of that tephra had been washed or blown away when the tephra fall from Jólnir started.

Fig. 1

The outlines of Surtsey and adjacent new islands at different times

- I. The crater Surtur senior and the craters that opened up on Aug. 19, 1966
- II. The crater Surtur junior.

Vertical and cross striation: areas covered by the 1964/65 lava. Horizontal and cross striation: areas covered by the 1966 lava.

Dotted areas (Jólnir): shoals, more or less visible at low tide.

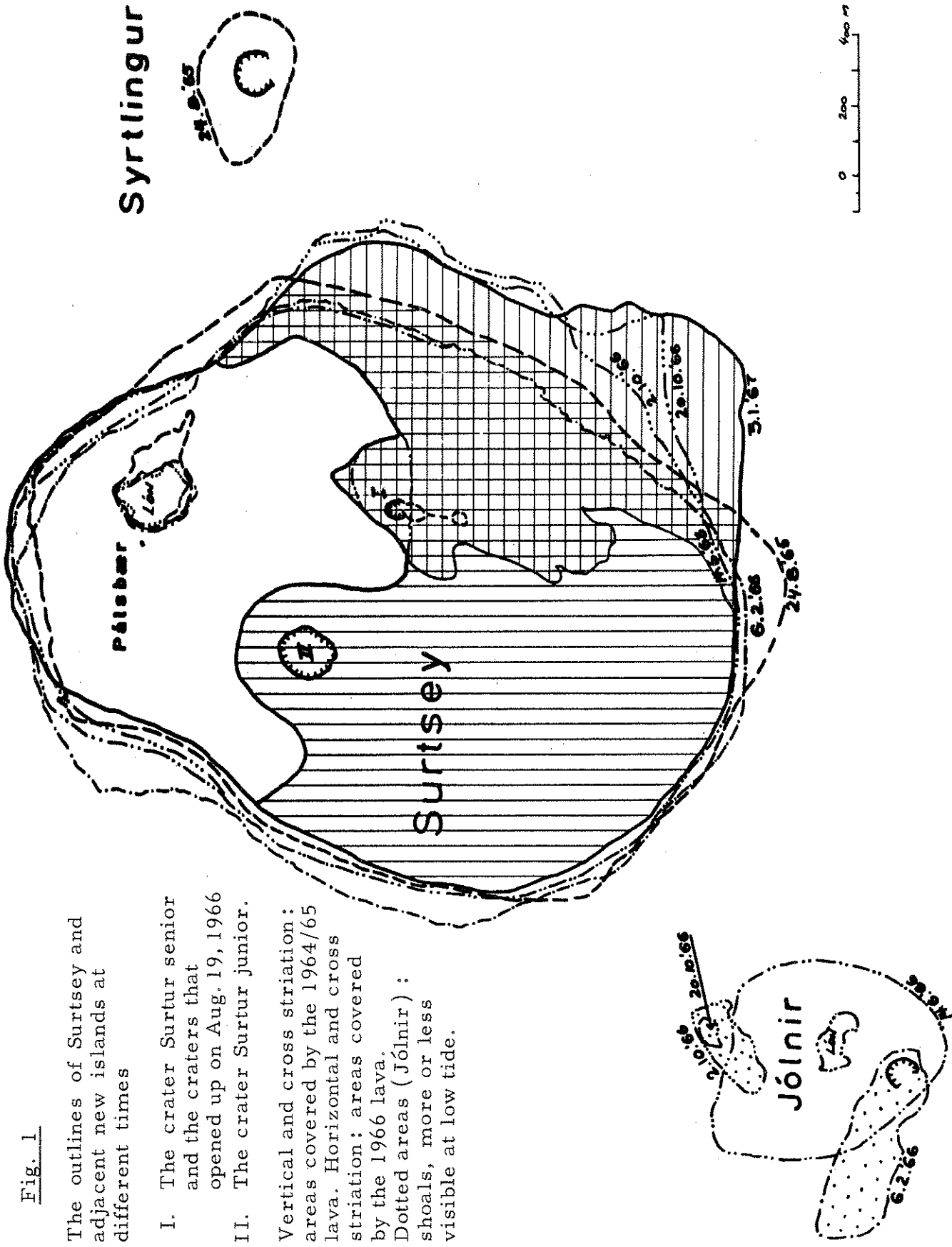
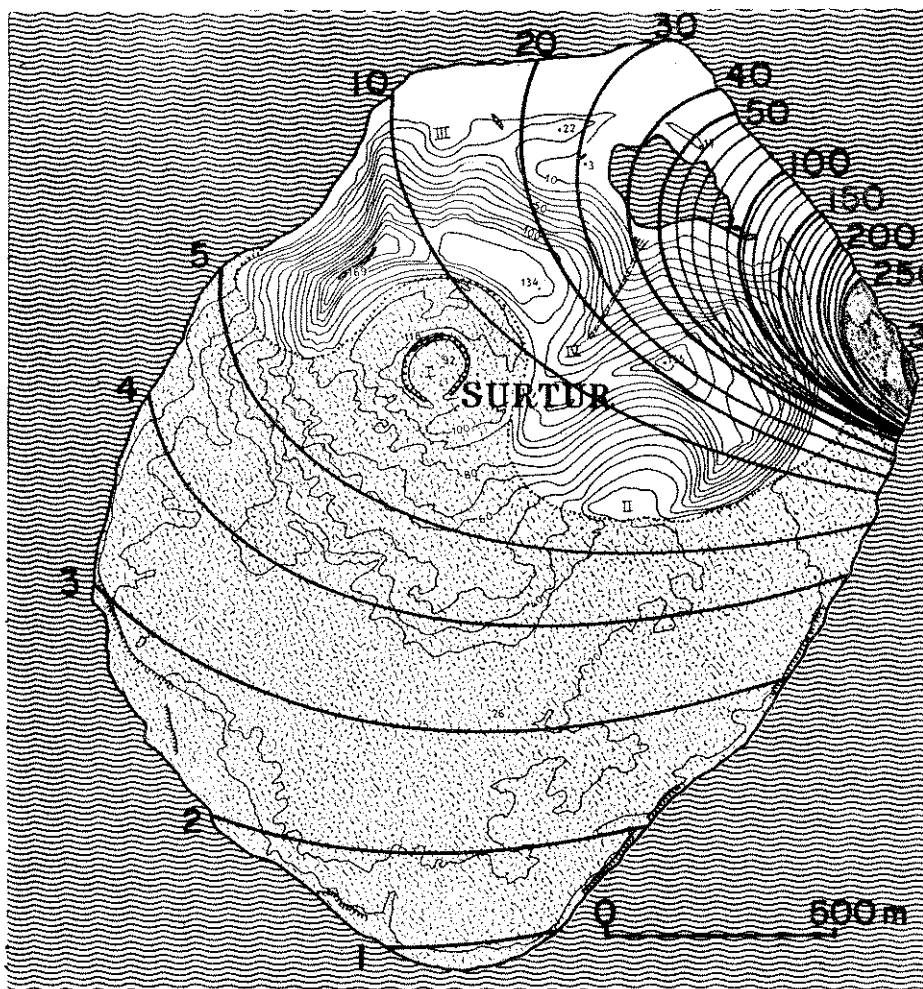


Fig. 2

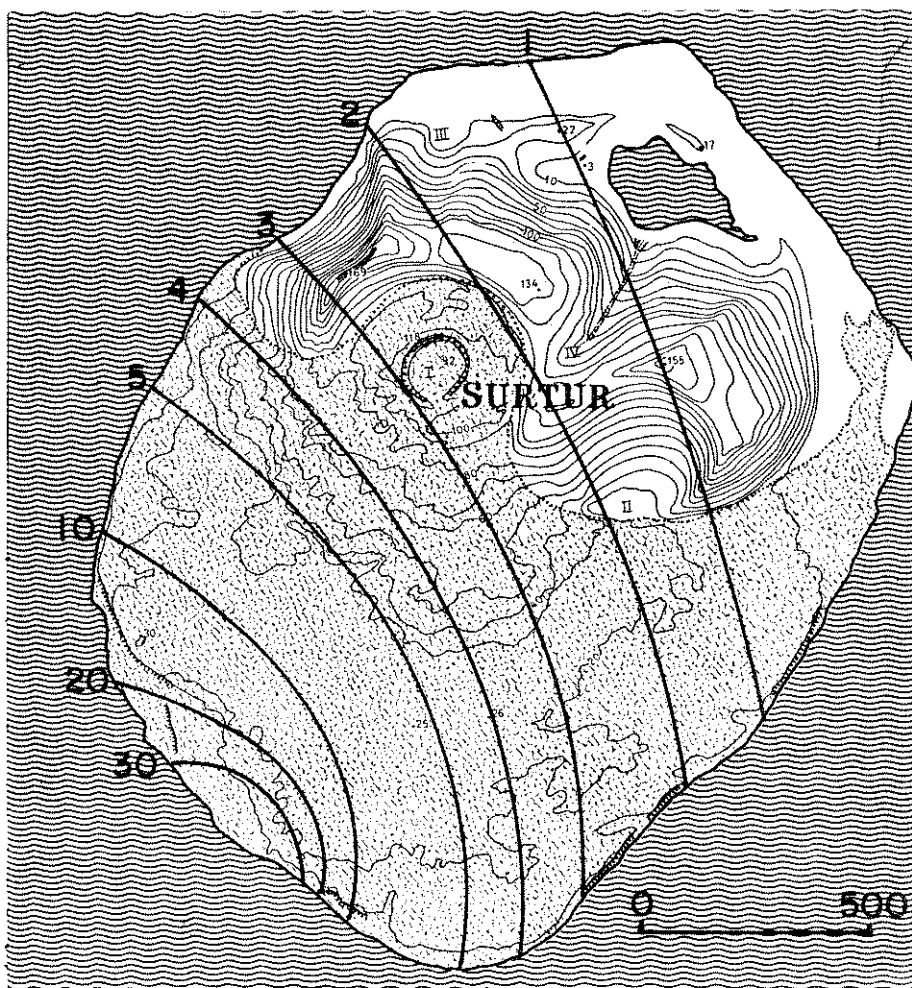
Isopach map of the Syrtlingur tephra on Surtsey according to measurements carried out Sept. 16-17, 1965. Thickness in cm.



17/IX '65

Fig. 3

Isopach map of the Jólnir tephra on Surtsey July 4, 1966. Thickness in cm.



4/VII '66