= Surtsey =

Surtsey (" Surtr 's island " in Icelandic , pronounced ?s?r ? tsei) is a volcanic island located in the Vestmannaeyjar archipelago off the southern coast of Iceland . At 63 @.@ 303 ° N 20 @.@ 605 ° W ? / 63 @.@ 303 ; -20.605 , Surtsey is the southernmost point of Iceland . It was formed in a volcanic eruption which began 130 metres (426 ft) below sea level , and reached the surface on 14 November 1963 . The eruption lasted until 5 June 1967 , when the island reached its maximum size of 2 @.@ 7 km2 (1 @.@ 0 sq mi) . Since then , wave erosion has caused the island to steadily diminish in size : as of 2012 , its surface area was 1 @.@ 3 km2 (0 @.@ 50 sq mi) . The most recent survey (2007) shows the island 's maximum elevation at 155 m (509 ft) above sea level .

The new island was named after Surtr , a fire jötunn or giant from Norse mythology . It was intensively studied by volcanologists during its eruption , and afterwards by botanists and other biologists as life forms gradually colonised the originally barren island . The undersea vents that produced Surtsey are part of the Vestmannaeyjar submarine volcanic system , part of the fissure of the sea floor called the Mid @-@ Atlantic Ridge . Vestmannaeyjar also produced the famous eruption of Eldfell on the island of Heimaey in 1973 . The eruption that created Surtsey also created a few other small islands along this volcanic chain , such as Jólnir and unnamed other peaks . Most of these eroded away fairly quickly .

= = Geology = =

= = = Formation = = =

The eruption was unexpected , and almost certainly began some days before it became apparent at the surface . The sea floor at the eruption site is 130 metres (426 ft) below sea level , and at this depth volcanic emissions and explosions would be suppressed , quenched and dissipated by the water pressure and density . Gradually , as repeated flows built up a mound of material that approached sea level , the explosions could no longer be contained , and activity broke the surface .

The first noticeable indications of volcanic activity were recorded at the seismic station in Kirkjubæjarklaustur , Iceland from 6 to 8 November , which detected weak tremors emanating from an epicentre approximately west @-@ south @-@ west at a distance of 140 km (87 mi) , the location of Surtsey . Another station in Reykjavík recorded even weaker tremors for ten hours on 12 November at an undetermined location , when seismic activity ceased until 21 November . That same day , people in the coastal town of Vík 80 km (50 mi) away noticed a smell of hydrogen sulphide . On 13 November , a fishing vessel in search of herring , equipped with sensitive thermometers , noted sea temperatures 3 @.@ 2 km (2 @.@ 0 mi) SW of the eruption center were 2 @.@ 4 ° C (4 @.@ 3 ° F) higher than surrounding waters .

= = = = Eruption at the surface = = = =

At 07 : 15 UTC on 14 November 1963 , the cook of Ísleifur II , a trawler sailing these same waters spotted a rising column of dark smoke southwest of the boat . The captain thought it might have been a boat on fire , and ordered the vessel to investigate . Instead , they encountered explosive eruptions giving off black columns of ash , indicating that a volcanic eruption had begun to penetrate the surface of the sea . By 11 : 00 the same day , the eruption column had reached several kilometres in height . At first the eruptions took place at three separate vents along a northeast by southwest trending fissure , but by the afternoon the separate eruption columns had merged into one along the erupting fissure . Over the next week , explosions were continuous , and after just a few days the new island , formed mainly of scoria , measured over 500 metres (1640 ft) in length and had reached a height of 45 metres (147 ft) .

As the eruptions continued , they became concentrated at one vent along the fissure and began to

build the island into a more circular shape . By 24 November , the island measured about 900 metres by 650 metres (2950 by 2130 ft) . The violent explosions caused by the meeting of lava and sea water meant that the island consisted of a loose pile of volcanic rock (scoria) , which was eroded rapidly by North Atlantic storms during the winter . However , eruptions more than kept pace with wave erosion , and by February 1964 , the island had a maximum diameter of over 1300 metres (4265 ft) .

The explosive phreatomagmatic eruptions caused by the easy access of water to the erupting vents threw rocks up to a kilometre (0 @.@ 6 mi) away from the island , and sent ash clouds as high as 10 km (6 mi) up into the atmosphere . The loose pile of unconsolidated tephra would quickly have been washed away had the supply of fresh magma dwindled , and large clouds of dust were often seen blowing away from the island during this stage of the eruption .

The new island was named after the fire jötunn Surtur from Norse mythology (Surts is the genitive case of Surtur , plus -ey , island) . Three French journalists representing the magazine Paris Match notably landed there on 6 December 1963 , staying for about 15 minutes before violent explosions encouraged them to leave . The journalists jokingly claimed French sovereignty over the island , but Iceland quickly asserted that the new island belonged to it .

= = = = Permanent island = = = =

By early 1964 , though , the continuing eruptions had built the island to such a size that sea water could no longer easily reach the vents , and the volcanic activity became much less explosive . Instead , lava fountains and flows became the main form of activity . These resulted in a hard cap of extremely erosion @-@ resistant rock being laid down on top of much of the loose volcanic pile , which prevented the island from being washed away rapidly . Effusive eruptions continued until 1965 , by which time the island had a surface area of 2 @.@ 5 km2 (0 @.@ 97 sq mi) .

On 28 December 1963 , submarine activity 2 @.@ 5 km (1 @.@ 5 mi) to the northeast of Surtsey caused the formation of a ridge 100 m (328 ft) high on the sea floor . This seamount was named Surtla , but never reached sea level . Eruptions at Surtla ended on 6 January 1964 , and it has since been eroded from its minimum depth of 23 m (75 ft) to 47 m (154 ft) below sea level .

= = = = Subsequent volcanic activity = = = =

In 1965 , the activity on the main island diminished , but at the end of May that year an eruption began at a vent 0 @.@ 6 km (0 @.@ 37 mi) off the northern shore . By 28 May , an island had appeared , and was named Syrtlingur (Little Surtsey) . The new island was washed away during early June , but reappeared on 14 June . Eruptions at Syrtlingur were much smaller in scale than those that had built Surtsey , with the average rate of emission of volcanic materials being about a tenth of the rate at the main vent . Activity was short @-@ lived , continuing until the beginning of October 1965 , by which time the islet had an area of 0 @.@ 15 km2 (0 @.@ 058 sq mi) . Once the eruptions had ceased , wave erosion rapidly wore the island away , and it disappeared beneath the waves on 24 October .

During December 1965 , more submarine activity occurred 0 @.@ 9 km (0 @.@ 56 mi) southwest of Surtsey , and another island was formed . It was named Jólnir , and over the following eight months it appeared and disappeared several times , as wave erosion and volcanic activity alternated in dominance . Activity at Jólnir was much weaker than the activity at the main vent , and even weaker than that seen at Syrtlingur , but the island eventually grew to a maximum size of 70 m (230 ft) in height , covering an area of 0 @.@ 3 km2 (0 @.@ 12 sq mi) , during July and early August 1966 . Like Syrtlingur , though , after activity ceased on 8 August 1966 , it was rapidly eroded , and dropped below sea level during October 1966 .

Effusive eruptions on the main island returned on 19 August 1966 , with fresh lava flows giving it further resistance to erosion . The eruption rate diminished steadily , though , and on 5 June 1967 , the eruption ended . The volcano has been dormant ever since . The total volume of lava emitted during the three @-@ and @-@ a @-@ half @-@ year eruption was about one cubic kilometre (0

@.@ 24 cu mi) , and the island 's highest point was 174 metres (570 ft) above sea level at that time .

Since the end of the eruption , erosion has seen the island diminish in size . A large area on the southeast side has been eroded away completely , while a sand spit called Norðurtangi (north point) has grown on the north side of the island . It is estimated that about 0 @.@ 024 km3 (0 @.@ 0058 cu mi) of material has been lost due to erosion ? this represents about a quarter of the original above @-@ sea @-@ level volume of the island . Its maximum elevation has diminished to 155 m (509 ft) .

= = = Recent development = = =

Following the end of the eruption , scientists established a grid of benchmarks against which they measured the change in the shape of the island . In the 20 years following the end of the eruption , measurements revealed that the island was steadily subsiding and had lost about one metre in height . The rate of subsidence was initially about 20 cm (8 in) per year but slowed to 1 ? 2 cm (0 @.@ 4 ? 0 @.@ 8 in) a year by the 1990s . It had several causes : settling of the loose tephra forming the bulk of the volcano , compaction of sea floor sediments underlying the island , and downward warping of the lithosphere due to the weight of the volcano .

The typical pattern of volcanism in the Vestmannaeyjar archipelago is for each eruption site to see just a single eruption , and so the island is unlikely to be enlarged in the future by further eruptions . The heavy seas around the island have been eroding it ever since the island appeared , and since the end of the eruption almost half its original area has been lost . The island currently loses about 1 @.@ 0 hectare (2 @.@ 5 acres) of its surface area each year .

= = = Future = = =

This island is unlikely to disappear entirely in the near future . The eroded area consisted mostly of loose tephra , easily washed away . Most of the remaining area is capped by hard lava flows , which are much more resistant to erosion . In addition , complex chemical reactions within the loose tephra within the island have gradually formed highly erosion resistant tuff material , in a process known as palagonitization . On Surtsey this process has happened quite rapidly , due to high temperatures not far below the surface .

Estimates of how long Surtsey will survive are based on the rate of erosion seen up to the present day . Assuming that the current rate does not change , the island will be mostly at or below sea level by 2100 . However , the rate of erosion is likely to slow as the tougher core of the island is exposed : an assessment assuming that the rate of erosion will slow exponentially suggests that the island will survive for many centuries . An idea of what it will look like in the future is given by the other small islands in the Vestmannaeyjar archipelago , which formed in the same way as Surtsey several thousand years ago , and have eroded away substantially since they were formed .

= = Biology = =

= = = Settlement of life = = =

A classic site for the study of biocolonisation from founder populations that arrive from outside (allochthonous) , Surtsey was declared a nature reserve in 1965 , while the eruption was still in active progress . Today only a few scientists are permitted to land on Surtsey ; the only way anyone else can see it closely is from a small plane . This allows the natural ecological succession for the island to proceed without outside interference . In 2008 , UNESCO declared the island a World Heritage Site , in recognition of its great scientific value .

= = = = Plant life = = = =

In the spring of 1965 , the first vascular plant was found growing on the northern shore of Surtsey , mosses became visible in 1967 , and lichens were first found on the Surtsey lava in 1970 . Plant colonisation on Surtsey has been closely studied , the vascular plants in particular as they have been of far greater significance than mosses , lichens and fungi in the development of vegetation .

Mosses and lichens now cover much of the island . During the island 's first 20 years , 20 species of plants were observed at one time or another , but only 10 became established in the nutrient @-@ poor sandy soil . As birds began nesting on the island , soil conditions improved , and more vascular plant species were able to survive . In 1998 , the first bush was found on the island ? a tea @-@ leaved willow (Salix phylicifolia) , which can grow to heights of up to 4 metres (13 ft) . By 2008 , 69 species of plant had been found on Surtsey , of which about 30 had become established . This compares to the approximately 490 species found on mainland Iceland . More species continue to arrive , at a typical rate of roughly 2 ? 5 new species per year .

= = = = Birds = = = =

The expansion of bird life on the island has both relied on and helped to advance the spread of plant life . Birds use the plants for nesting material , but also continue to assist in the spreading of seeds , and fertilize the soil with their guano . Birds first began nesting on Surtsey three years after the eruptions ended , with fulmar and guillemot the first species to set up home . Twelve species are now regularly found on the island .

A gull colony has been present since 1984 , although gulls were seen briefly on the shores of the new island only weeks after it first appeared . The gull colony has been particularly important in developing the plant life on Surtsey , and the gulls have had much more of an impact on plant colonisation than other breeding species due to their abundance . An expedition in 2004 found the first evidence of nesting Atlantic puffins , which are extremely common in the rest of the archipelago .

As well as providing a home for some species of birds , Surtsey has also been used as a stopping @-@ off point for migrating birds , particularly those en @-@ route between Europe and Iceland . Species that have been seen briefly on the island include whooper swans , various species of geese , and common ravens . Although Surtsey lies to the west of the main migration routes to Iceland , it has become a more common stopping point as its vegetation has improved . In 2008 , the 14th bird species was detected with the discovery of a common raven 's nest .

According to a 30 May 2009 report , a golden plover was nesting on the island with four eggs .

= = = = Marine life = = = =

Soon after the island 's formation , seals were seen around the island . They soon began basking there , particularly on the northern spit , which grew as the waves eroded the island . Seals were found to be breeding on the island in 1983 , and a group of up to 70 made the island their breeding spot . Grey seals are more common on the island than harbour seals , but both are now well established . The presence of seals attracts orcas , which are frequently seen in the waters around the Vestmannaeyjar archipelago and now frequent the waters around Surtsey .

On the submarine portion of the island , many marine species are found . Starfish are abundant , as are sea urchins and limpets . The rocks are covered in algae , and seaweed covers much of the submarine slopes of the volcano , with its densest cover between 10 and 20 metres (33 to 66 ft) below sea level .

= = = = Other life = = = =

Insects arrived on Surtsey soon after its formation , and were first detected in 1964 . The original arrivals were flying insects , carried to the island by winds and their own power . Some were believed to have been blown across from as far away as mainland Europe . Later insect life arrived

on floating driftwood , and both live animals and carcasses washed up on the island . When a large , grass @-@ covered tussock was washed ashore in 1974 , scientists took half of it for analysis and discovered 663 land invertebrates , mostly mites and springtails , the great majority of which had survived the crossing .

The establishment of insect life provided some food for birds , and birds in turn helped many species to become established on the island . The bodies of dead birds provide sustenance for carnivorous insects , while the fertilisation of the soil and resulting promotion of plant life provides a viable habitat for herbivorous insects .

Some higher forms of land life are now colonising the soil of Surtsey . The first earthworm was found in a soil sample in 1993 , probably carried over from Heimaey by a bird . However , the next year earthworms were not found . Slugs were found in 1998 , and appeared to be similar to varieties found in the southern Icelandic mainland . Spiders and beetles have also become established .

= = Human impact = =

The only other significant human impact is a small prefabricated hut which is used by researchers while staying on the island . The hut includes a few bunk beds and a solar power source to drive an emergency radio and other key electronics . All visitors check themselves and belongings to ensure no seeds are accidentally introduced by humans to this ecosystem . It is believed that some young boys tried to introduce potatoes , which were promptly dug up once discovered . An improperly handled human defecation resulted in a tomato plant taking root which was also destroyed . In 2009 a weather station for weather observations and a webcam were installed on Surtsey .