

Letter from the Desk of David Challinor  
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One of the blessings of longevity is the pleasure of witnessing a familiar landscape change over time. To appreciate the changes, there must be a clear visual or descriptive record of how a site once looked, followed by regular recordings of change. Rarely is humankind aware of the beginnings of an "ecosystem," but in 1963, 20 km off the south coast of Iceland, a submarine volcanic eruption began to create an island later called Surtsey. The site was on the tectonically active mid-Atlantic ridge, which passes north and south across this country and extends almost to Antarctica. The ridge marks the boundary where the new world is moving apart from the old at a rate of a few centimeters a year. In early June of this year, I returned to Iceland for a week's vacation, looking forward to seeing a landscape that had changed since I first saw it almost 40 years ago. This month's letter is about Surtsey Island, its creation, and its sequential colonization by plants and animals since I first visited it in June 1967.

In late June 1965, I and my family (wife and four children) camped along Iceland's south coast. Seaward, the horizon was dominated by a 1,000 m black and white steam cloud where the volcano was erupting off shore. Every time sea water contacted molten lava flowing from a crack in the sea floor, at a depth of about 130m, the resulting explosion forced the instantaneously crystallized lava up through the water column and several hundred meters into the air. Lava in this form looks like fine buff-colored sand and is called tephra. Tephra, falling back into the ocean from the incessant explosions, accumulated enough volume to form Surtsey Island. Once it had broken the surface, Surtsey kept growing until about June 1965 when we first saw it in the distance.

When I was in Iceland for the first Surtsey Research Conference two years later, the lava had ceased to flow on the surface, and the conference attendees were shipped there to see firsthand what had been wrought. It was a memorable moment for me when I gazed down cracks in the solid but rather porous black lava and saw the incandescent molten magma less than a meter below. In fact, the surface rock was still hot enough for me to feel the heat through my shoes.

A major discovery, just above the high tide line of sea wrack, was the island's first flowering plant, a sea rocket (*Cakile arctica*)—about 3cm tall with a tiny white blossom. Since then, the inevitable and fascinating process of converting a barren inorganic island into a living community of plants and animals continues. The succession of plant invaders has been devotedly and precisely monitored by Sturla Fridriksson, one of Iceland's foremost scientists and a renowned botanist. I was fortunate to spend an hour with him on this recent visit going over his photographs so I could follow the greening of this island.

From the sea rocket seen in 1967 to the present, some 54 plant species have been recorded. Initially, colonization was slow with seldom more than one new plant found each year. Then from the 15<sup>th</sup> year of monitoring to the 22<sup>nd</sup> (1979-1987) hardly any new plants became established. During the 1990's, however, approximately three new plants were found each year. This surprisingly rapid succession was triggered by the spread of a critically sized patch of grass that attracted colonies of herring gulls and lesser black-backed gulls to nest. I had not known that these gull species feed their young considerable vegetable matter. Thus seeds pass through the guts of both adults and young. With even the hardest seed coats thus scarified by the stomach acids of both parents and young, the germination rate was high, and subsequent growth was further helped by the fertilizing effect of the birds' droppings. Since 1985, when the first nests were discovered, the small grassy area has spread to about 6.5 ha or about 4% of the total dry area of the island. The presence of the gulls as seed dispersers led Fridriksson and his colleagues to revise their data and estimate the increase in percentage of bird-delivered seed to the island from 62% to 75%, with 11% delivered by ocean currents and 14% by wind.

In addition to the spread of plants the geological character of the islands has altered. As mentioned, tephra is fine-grained and easily moved by wind and waves. In fact, two small islands appeared adjacent to Surtsey during its eruptive phase. However, because their eruptions failed to produce a cone as a source of air-cooled rock-hard lava to cap the tephra, both islands disappeared in winter storms. On Surtsey, however, and on the other Westman Islands a few kilometers north of it, the tephra has hardened over the years and become resistant to wave action. Without describing the geochemical sequence that hardens tephra, hydrothermal activity, common in eruptive areas, actually converts the loose sandy tephra into what is called pelagonite tuff. Perhaps the best analogy to explain what happens is that if conditions are right, with the appropriate temperature and sufficient rain, the sandy tephra congeals into rock much as concrete does when mixed with water and exposed to air. In fact, the first tuff on Surtsey was formed high on its crater in 1969. Since then, more than half of its exposed sandy tephra has converted to tuff. Only a relatively thin layer of tephra is left so that the natural geochemical conversion from sand to rock should ensure the relative permanence of Surtsey. Since its creation, wave erosion has swept away unconsolidated tephra thereby reducing the island's area by about 1/3 to roughly 160 ha (400 ac).

Wisely, the Icelandic government has declared Surtsey off limits to casual visitors. The Icelandic Coast Guard ferries scientists there by helicopter twice a year—one trip for geologists and one for biologists. They can stay in a small hut on the island and each visit is written up and published by the Surtsey Research Society in Reykjavik.

Surtsey should eventually resemble the geologically older islands between it and the mainland, which are covered in grass and surrounded by high tuff cliffs colonized by nesting sea birds. During my 2001 trip I spent a day on Heimaey, the only occupied island in the Westman archipelago, from which Surtsey is clearly visible about 15 km away. Heimaey's current population is about 14,000 and the major industry is fish processing—frozen filets and dried (by steam from thermal vents) fish meal. Only 12 years ago the town was threatened by the eruption of an adjacent, long dormant small volcano. Lava started flowing from it about 2 a.m. one night and the town was quickly evacuated by boat and plane. One whole side of the crater slid off and, floating on the molten lava, moved towards the harbor entrance. Fortunately, powerful water pumps flown to Heimaey by the US Air Force helped stop the flow before it blocked the harbor. The pumps sprayed enough sea water on the advancing lava to solidify it, thereby forming a dike sufficiently large to divert the flowing lava. I climbed the crater and could feel the heat still emanating from the cracks in the rock surface. I toured the island and the town and found much had changed in my 34-year absence. The island is now about 10% larger as a result of the eruption, but the eastern third of the old town remains buried under lava. Replacement houses were built to the west of town where there is now an 18 hole golf course. Tourism is flourishing and replacing the declining fishery. There is a new museum and aquarium and boat rides for tourists that circumnavigate the island allowing people to observe the nesting sea birds at this time of year. Puffins and kittiwakes are the two most prevalent species, but fulmars, murre, and gillimonts also abound.

Although we saw no whales on our trip, four species frequent the area. For those who saw the movie "Free Willy," Keiko, the orca that starred in it, is being trained here for release. He is normally kept in a large net-enclosed cove near the harbor entrance, but during my visit he had gone with his accompanying high-speed motor boat for a two-day excursion in hopes of encountering a pod of local orcas. Keiko was captured here in 1979 at the age of two and stayed in an oceanarium in Iceland for three years before being flown to another facility in Ontario. In 1985 he was sold to a Mexican exhibit, and after 20 years in captivity he was moved to Oregon in 1996, where the Free Willy/Keiko Foundation nursed him to full health. Finally, he was flown to Heimaey in 1998, where he is now being "trained" for release. I question the ethics and efficacy of such a project, but will concede that where certain mammal species are involved, rational human behavior is perhaps an oxymoron.

Heimaey has been a major fishing port for centuries. In 1627, several boatloads of Barbary pirates attacked the island and abducted about 200 inhabitants to sell as slaves on the Barbary Coast. The demand for blond women was particularly high for the Sultans' harems. Among those captured was a young Lutheran priest whom the Sultan released to travel to Denmark, (which was then under Danish rule) and plead for ransom.

After a long journey, he finally saw the king who was indifferent to his plea, so the young priest dejectedly returned to Heimaey, where the citizens eventually raised the ransom to free their enslaved neighbors.

I conclude my account with the happy ending to this Icelandic saga. It is a fascinating place to visit, both culturally and scientifically. It is a geologist's paradise and a place where you can watch a part of the world change continually before your eyes, if you live long enough to witness the landscape's alterations. I am blest to have done so.

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