Times Standard

Not My Fault: Iceland is in limbo

Lori Dengler for the Times-Standard
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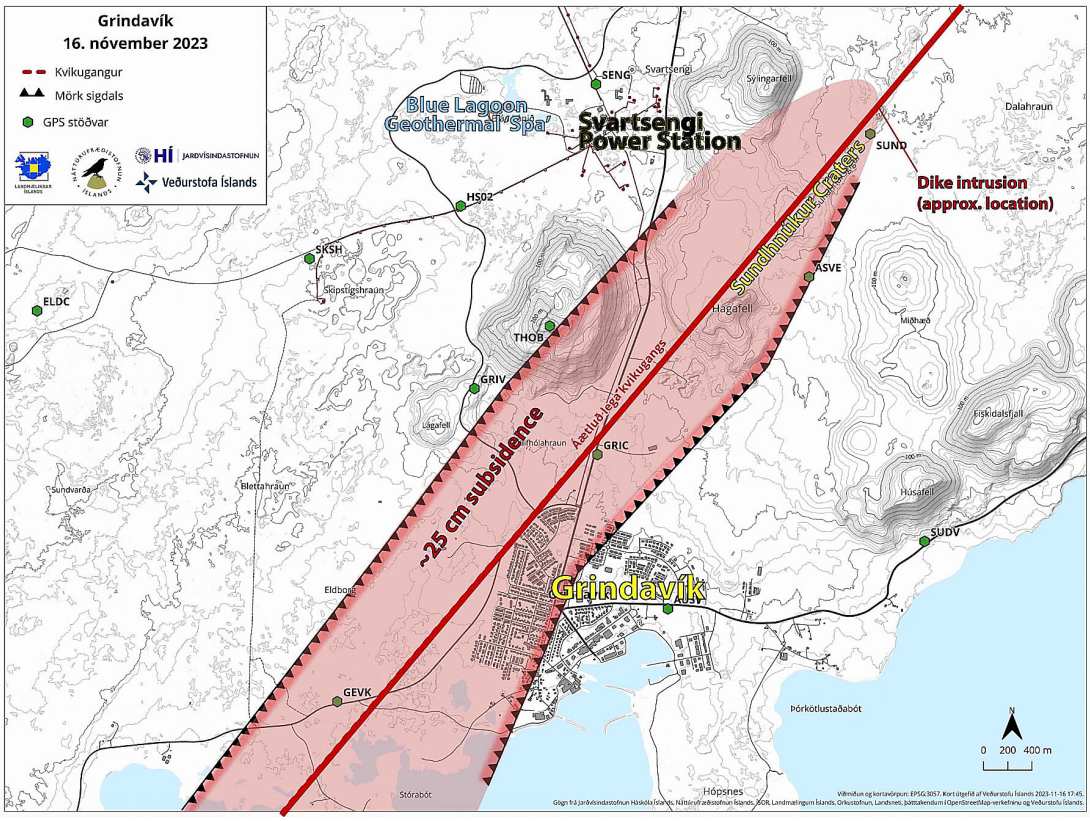

Zone of ground subsidence near Grindavik in pink, bordered by the lines of triangles. The central area has dropped nearly a foot as of November 16. The approximate location of the ten-mile-long magma intrusion is shown by the red line. Illustration courtesy of Iceland Met.

A week ago, I scrambled to keep up with the rapidly changing situation in Iceland. Every time I looked at the Icelandic Meteorological Agency's (Iceland Met) web site, a new piece of data suggested an eruption was imminent. Earthquake activity accelerated and was becoming shallower, the ground was deforming, and cracks opened on the surface. A State of Emergency was declared, the town of Grindavik evacuated and most roads on the southern and western end of the Reykjanes Peninsula closed.

A week later, earthquakes and deformation continue but magma has yet to make it to the surface. What's going on? I'm not a volcanologist and am not privy to discussions of Iceland scientists and authorities, but I've been following Iceland Geology | Seismic & Volcanic Activity in Iceland (Facebook) that contains ongoing discussion of new data by both Iceland geologists and volcanologists from around the world.

Over the past week, the Iceland seismic network has detected at least 8000 earthquakes on the Reykjanes Peninsula. That's an average of over 1000 quakes a day, a number hard to comprehend. But only a few made it into the magnitude 3 range and were large enough to be felt. The previous week a similar number were recorded but 18 were *M* 4.0 or larger, including a 5.2 and 5.3, strong enough to be felt widely and cause minor damage. The rate of quakes over the past three days has picked up again, and a 3.5 was felt by many on Saturday.

The ground surface continues to deform. The first stage of the intrusion was a sill, magma accumulating along a horizontal plane of weakness a few miles below the surface. The ground responded by bulging upwards. Last week, some of this magma began migrating upwards, cutting through the rock layers, and producing a dike. It is now nearly 10 miles long and less than a half mile deep.

The movement of magma beneath the surface can only be inferred from earthquake locations and surface displacements. In the last week a graben has formed, the land sinking along the axis of the intrusion and rising along the sides. A GPS station in Grindavik has recorded nearly a foot of subsidence. Why would the ground sink if magma is still rising? Overall, the region is still inflating, but as the ground bulges outwards, cracks form and the central area drops down. The ground movements are wreaking havoc with pipes and infrastructure. There is no evidence that the intrusion is getting any longer, extending further offshore, but it is still expanding near the middle.

Iceland Met has confirmed the presence of sulfur dioxide gas in a borehole at the Svartsengi geothermal power plant just north of Grindavik, confirming the presence of a shallow magma body in the area. Gas comes out of magma as it nears the surface and the pressure of the surrounding rock diminishes. It doesn't prove an eruption is imminent, but is another sign that magma is nearby.

"High likelihood of volcanic eruption continues," has been on the top of the Iceland Met web site all week. Residents of Grindavik are allowed short access to their homes and businesses under escort to retrieve belongings. A moat and wall are being built around Svartsengi and Blue Lagoon in the hope of deflecting lava flows. Blue Lagoon is not taking any spa reservations until at least December.

The New York Times on Friday described the Iceland situation as "a holding pattern." I disagree. Holding pattern means nothing is changing and all the measurements are detecting change – the intrusion is growing, earthquakes continue, the magma is likely only a third of a mile deep. But when and what will happen next is impossible to state.

The Reykjanes Peninsula is one of the most highly instrumented areas in the world with seismometers, GPS, optic fiber cables, and boreholes providing real time data. All of these sensors are on or near the ground surface. We can't observe what is happening at depth where the action right now is taking place.

Forecasting an eruption is a supply problem. What is the volume of magma, how fast is it accumulating, what are its characteristics (composition, temperature), and what are the barriers to reaching the surface? Magma rises because it is hotter and less dense than the solid rock

around it. That buoyancy force is the primary driver of eruptions. The volume of magma and the strength of the overlying rock are key.

As the magma rises, it expands and cools. It is also cooled by the cold rock it comes into contact with. Many intrusions never reach the surface, but slowly chill in place. Volcanologists in Iceland agree that the outer part of the intrusion has likely solidified, creating a tunnel of sorts. But as long as more magma is still being supplied to the intrusion, the odds are still high it will eventually break through to the surface.

What are the likely scenarios? There are several points authorities and volcanologists agree on. All of the recent eruptions on the Reykjanes Peninsula were basaltic lava flows and not explosive. They have been contained to relatively small areas. The fluid basalt allows gas to readily escape. The plumes I observed last July were composed of steam and gas; no ash involved.

It is unlike the 2010 eruption of Eyjafjallajökull. That eruption, centered 90 miles east of Grindavik, produced voluminous ash. Two factors contributed: location beneath a glacier and a more viscous magma. In 2010, a third factor came into play. The jet stream was directly over Iceland and pointed at Europe. None of these factors apply to the situation near Grindavik.

It is also unlikely this eruption would directly impact Reykjavik. The capitol is about 25 miles away from any eruption site. If the Svartsengi power plant become inoperable, it could affect the power grid, but Iceland has abundant power sources from other geothermal plants and hydroelectric facilities and the greater Reykjavik area should have ample backup.

What about the airport? The international airport at Keflavik is only ten miles from the intrusion. The aviation alert level for the current unrest is Orange, meaning heightened unrest with increased likelihood of eruption. Operations at the airport are currently normal but could be restricted if the situation changes. An eruption similar to those in 2021, 2022, and last July is unlikely to impact travel.

If there is an eruption, surface vents could open at several locations along the intrusion – near Grindavik, near the powerplant or in undeveloped areas to the northeast. The biggest threat is to Grindavik, either directly from lava flows or indirectly from continued ground deformation. There is a small possibility a vent could open in the sea floor just offshore of Grindavik, but current data suggests the intrusion is no longer growing in that direction.

For the Svartsengi power plant, time may be of the essence. Completing the walls and diversion system will take another month. Hollywood to the contrary, humans don't have much ability to control volcanic activity. When Edfell volcano erupted in 1973 on Heimaey, an island off the south coast of Iceland, residents were able to save their harbor by pumping water onto the perimeter of the flows. Thirty-two pumps, each with a capacity of 265 gallons per second managed to slow the advance. It remains to be seen if heroic actions will be required in 2023 and what the results will be.

Want more background? Check out https://temblor.net/temblor/nov-2023-iceland-volcanic-eruption-looms-near-grindavik-15694/

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