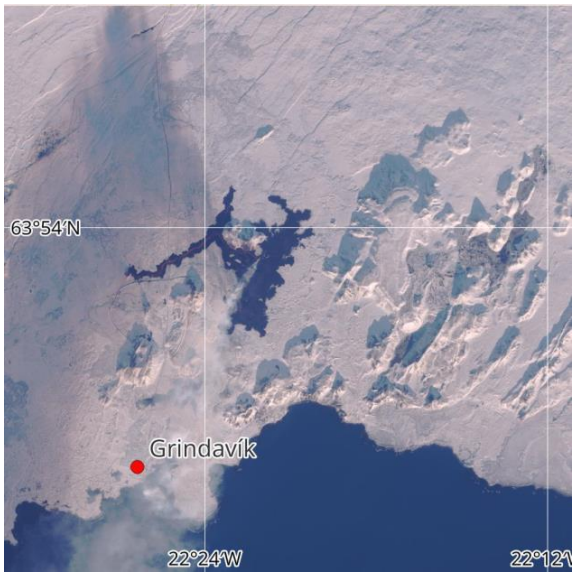
LIT06.3
Grindavík – Volcanism

2023-10-29, Sentinel-2 – Grindavík before the eruptions.



2024-02-08, Sentinel-2 – after the first series of eruptions.

2024-10-05, Sentinel-2 – lava fields around Grindavík.

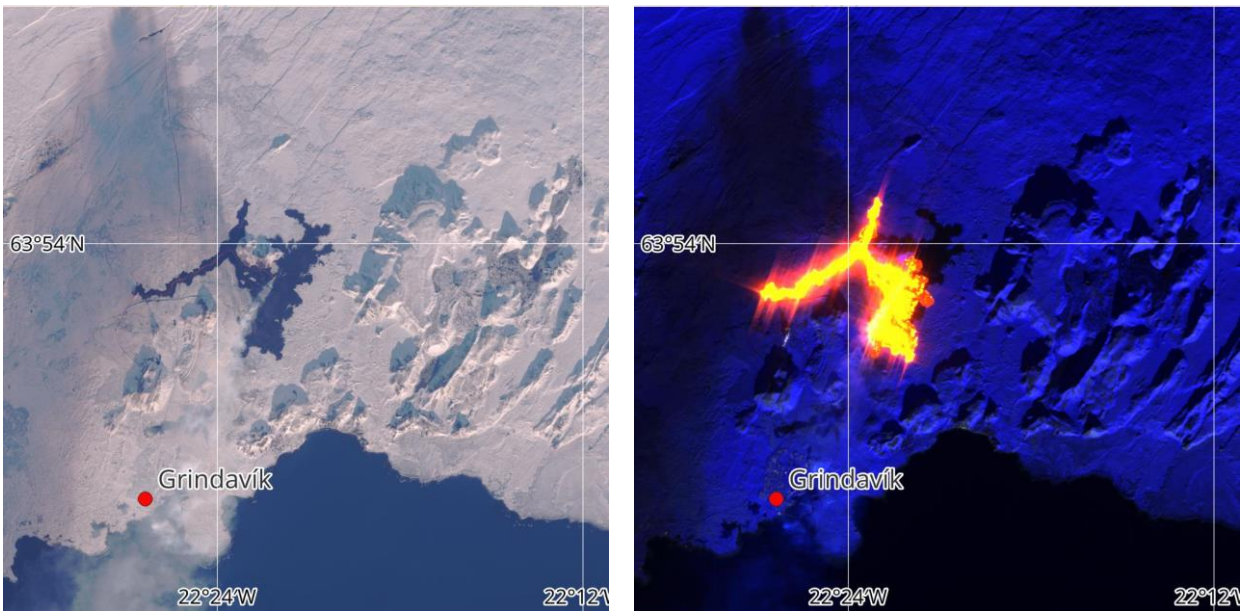
Iceland lies at the Mid-Atlantic Ridge, where the Eurasian and North American tectonic plates diverge, causing frequent volcanic events. Since 2023, the region around Grindavík, a town on Reykjanes Peninsula in the southwestern part of Iceland, has experienced increased volcanic activity.

After eruptions in 2021 and 2022 at Fagradalsfjall, increased seismic activity began in 2023. By November, over 15,000 earthquakes were detected in the area within a week, some of them exceeding magnitude 5.0. The quakes indicated magma movement beneath the surface, a precursor to potential eruptions. Near Grindavík a land uplift of up to 15 centimetres confirmed magma accumulation.

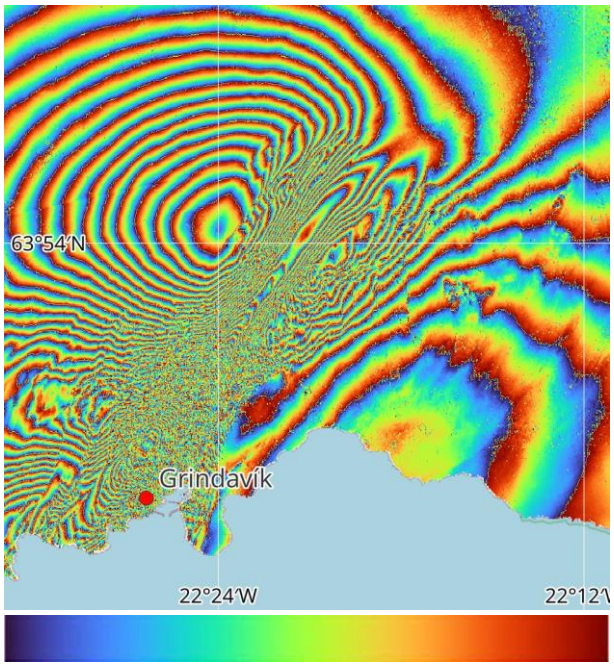
The so-called Sundhnúkur eruptions started on November 13, 2023, when a fissure eruption began just a few kilometres from Grindavík. The fissure extended about 1 kilometre, releasing lava at an initial rate of 20 cubic meters per second. No lava reached Grindavík, but toxic gases such as sulphur dioxide (SO_2) posed health risks. Authorities evacuated around 4,000 residents and restricted access to the area. By early 2024, new eruptions occurred, with lava spouting up to 50 meters high. An eruption in May 2024 sent lava flows toward the town, destructing several homes. Emergency response teams built protective barriers. August and November 2024 saw further series of eruptions

Iceland's geothermal energy industry, producing over 25% of its electricity, benefits from volcanic activity. Additionally, eruptions have become a major draw for tourists witnessing the dramatic landscapes. The Reykjanes Peninsula is densely populated with infrastructure critical to Iceland, including geothermal power plants and the nearby Keflavík International Airport. Damage to these facilities would have economic and energy consequences.

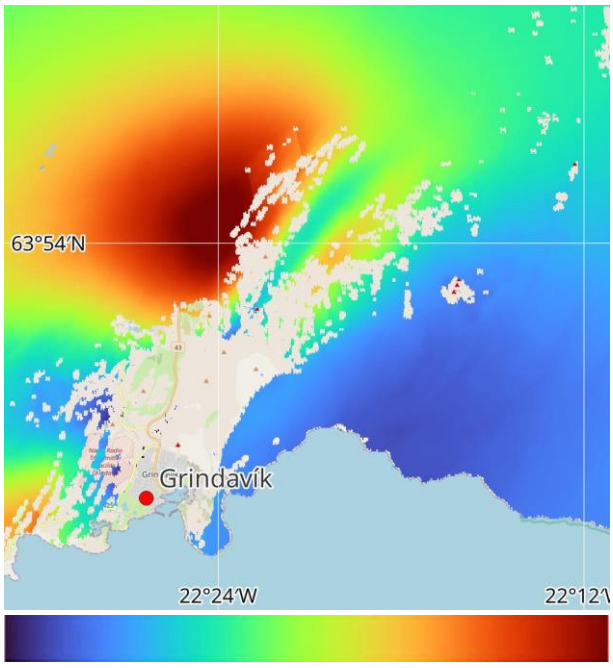
The Icelandic Meteorological Office (IMO) tracks volcanic activity using seismic stations, satellite data, and gas measurements. A monitoring system has been established to allow timely evacuations and minimize risks to human life during these events.



2024-02-08, Grindavík – Sentinel-2 image in true colours (left) and in false colour infrared (right). In the winter images the lava field is well visible both in the true colour image and in the false colour infrared image.



Oct.31-Nov.12, 2023 – Sentinel-1 Interferogram, phase (one cycle from blue to red corresponds to a phase between -180 and +180°).



Oct.31-Nov.12, 2023 – Sentinel-1 Interferogram, unwrapped – the colours indicate a displacement of the surface between 0 (blue) and 700 mm (red).

Exercises

- Look at the series of Sentinel-2 satellite images taken between Oct. 2023 and Oct. 2024 and try to identify the different land cover classes. Take the different seasons into account. What changes are caused by the eruption and the lava flow?
- Concentrate on the region north of Grindavík. Which changes can you see?
- Look at the lava field and try to estimate the area directly covered by lava.
- Look at the true colour and false colour infrared images from Feb. 2024. Why does the lava field appear in bright colours in the infrared image, while the snow-covered areas appear in dark blue? Think about the relation between infrared and thermal radiation.
- For advanced readers: Look at the Sentinel-1 interferograms from November 2023. One cycle of the colour fringes (from red via blue to red again) corresponds to a terrain shift according to a phase difference from -180° to +180° of the used radar waves.

Additional Material

View of Grindavík and the nearby eruptions (photograph: Almannavarnadeild ríkislögreglustjóra)

Links and Sources

- https://en.vedur.is/about-imo/news/volcanic-unrest-grindavik-older-updates - changes monitored during the Grindavík eruptions
- https://www.esa.int/ESA_Multimedia/Images/2024/05/Earth_from_Space_Changing_Iceland_in_colour - Grindavík lava fields in an Sentinel-1 radar image
- https://www.esa.int/ESA_Multimedia/Images/2024/01/Icelandic_lava - hot lava near Grindavík in a Sentinel-2 infrared image
- https://sentiwiki.copernicus.eu/web/s1-mission#S1Mission-InterferometryS1-Mission-Interferometry – background information about Sentinel-1 radar interfernometry