

The 2022 Meradalir eruption of the 2021-23 Fagradalsfjall Fires, Reykjanes Peninsula, and associated phenomena.

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The Meradalir eruption began on 3 August 2022 and lasted until 21 August 2022. It was the second of a series of three eruptions to date, bracketed by the 2021 Geldingadalir and 2023 Litli Hrófur eruptions. Together these eruptions make up the Fagradalsfjall Fires.

The eruption was monitored through a combination of time-lapse photography, UAS-borne lidar surveys, and physical sampling. The UAS consisted of a DJI Matrice 300 RTK quadcopter carrying a DJI L1 lidar paired with a DJI D-RTK2 GNSS base-station. Using an electrical generator allowed for recharging of batteries in the field and near-unlimited surveillance of the activity.

The Meradalir eruption started with >8 discrete vents on a single ~250 m-long fissure segment which, over the first days focused onto a single vent which persisted until the end of the eruption. It was a dominantly effusive eruption, covering an area of 1 km² with $5.7 \times 10^6 \pm 7.6 \times 10^5$ m³ (dense rock equivalent, 30% porosity) of lava. The primary volcanic structures of the eruption were the main spatter cone vent, a perched lava pond, four rumbly pāhoehoe lobes, and a significant ropey and slabby pāhoehoe squeeze-out. The final outer dimensions of the vent were 89 m by 105 m and 18 m high with slopes of 25° to 30°. The final internal structure of the vent consisted of two circular pits with diameters of 20 and 27 m. Material forming the vent edifice is primarily dense spatter bombs with lesser quantities of lapilli. The vesicularity of the lapilli covers a wide range from dense, almost vesicle-free, to golden pumice (>95% vesicularity).

The perched lava pond formed within hours of the eruption beginning in response to the vents having opened in a bowl-like depression adjacent to the 2021 Meradalir lava field. The pond formed west of the erupting vents and covered an area of 0.040 km² and was 12 m high by the end of the first day. The second day saw a minor decrease in area (0.036 km²), but the surface of the pond rose by 9 m. On the third day the pond grew to 0.042 km² and a height of 25 m. The pond area barely changed over the following week whilst the height continued to increase up to a maximum of 35 m on day 9. After this the pond drained, reducing in area and height.

The lava field produced by this eruption consisted of four rumbly pāhoehoe lobes. The first lobe reached a length of approximately 1.3 km measuring from the edge of the proximal lava apron and a width of around 250 m. This lobe grew to its maximum length in just two days. Inclement weather prevented on-site observations for the next five days, by which time two additional lobes had been emplaced either side of the first with lengths of approximately 1.4 and 1.3 km and widths of between 200 and 250 m. The similarity of these three lengths suggests that 1.4 km was the critical length of lavas emplaced in this scenario. A relatively minor lobe filled the northern part of Meradalir and began to overflow the third lobe, but the eruption ceased before this lobe could reach its critical length.

The most peculiar product of this eruption was not actually a product of this eruption but rather a result of it. Sometime between day 3 and day 7 of the eruption (the days with stormy weather), ropey and slabby pāhoehoe flows were emplaced along the southern and south-eastern margins of the Meradalir lava field. These flows filled the low between the 2021 lava field and the valley sides, partially covering the former. Upon examination of the surface textures, it became apparent that this new lava had been squeezed out of tumuli cracks within the 2021 lava surface and flooded along the edges of the lava field. Lidar surveys revealed that the surface of the 2021 lava had bulged by 3 m in the south and 3.6 m in the north. The interpretation is that the weight of the 2022 lava had compressed the 2021 lava field enough to squeeze out still-molten 2021 lava which had resided in the Meradalir lava field for the preceding months.