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Journey from Hot Spring Use to Drilling and Utilizing a Production Well in Laugarvatn Iceland

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INTRODUCTION

Laugarvatn, a lakeside village in South Iceland, has long relied on its abundant geothermal activity. The population of Laugarvatn is about 260 people but during peak season there are many visitors. The village hosts a junior college with a dormitory, hotels, campsite, swimming pool and a spa, and nearby there is an abundance of summer houses. The Laugarvatn hot spring supplies roughly 30 L/s of boiling (100 °C) water for district heating. As the settlement expands and tourism grows, demand for hot water is increasing year-round, prompting the municipality to consider drilling a dedicated production well. To minimize the risk of adverse impacts on natural hot springs, the location of such a well must be chosen carefully. Therefore, a range of exploration activities, including structural mapping, soil temperature surveys and exploration drilling, was carried out to site the production well.

1 HISTORY OF GEOTHERMAL UTILIZATION AND EXPLORATION IN LAUGARVATN

The history of geothermal utilization in the village of Laugarvatn spans almost as long as the history of settlement in Iceland. In 1000 the Icelandic nation reformed to Christianity and historical records indicate that many people were christened in a hot spring called Vígðalaug, which is located next to the shore of lake Laugarvatn. Since then, the locals have benefitted in many ways from the easy access to hot water, such as washing of clothes, bathing and baking of ryebread. The first swimming pool in Laugarvatn was built by students of the junior college in 1930. It was in operation until 1991, but soon after an open-air swimming pool was opened. In 1929 two cabins were built on top of the hottest part of surface manifestations by the lakeside, allowing people to indulge in geothermal steams as in a sauna. This geothermal sauna was famous and a local favourite site to meet and chat. In early 2000 the old cabins were torn down and a new spa built, which is currently being expanded due to popular demand.

The Laugarvatn hot spring is located right at the lakeside and is currently used for district space heating in the village. The spring is artesian and at boiling temperature and discharge measurements conducted on three occasions over recent decades indicate a stable flow of approximately 28–30 L/s (Sveinborg H. Gunnarsdóttir, 2021). A concrete structure was constructed around it decades ago to try to seal it from possible influx from the lake, avoiding persistent scaling problem. Peak winter demand is about 26 L/s, and in light of growing consumption and concerns about the security of supply, the local council sought options to secure additional hot water and engaged ÍSOR, its long-term geothermal consultant.

2 GEOLOGICAL SETTING & GEOTHERMAL MANIFESTATIONS

Laugarvatn is located in South Iceland, near the transition between the Western Volcanic Zone and the Hreppar microplate, just north of the South Iceland Seismic Zone. The village lies on the shore of Lake Laugarvatn, with Mt. Laugarvatnsfjall rising to the northwest. Laugarvatnsfjall forms part of the Western Volcanic Zone, which is characterized by hyaloclastite ridges elongated in a SSW–NNE direction. To the northeast and south of Laugarvatn, the landscape consists of lowlands and hills shaped by glacial processes during the last glacial period. Bedrock ages in the region range from about 3.4 Ma to the present. The tectonic regime is influenced by active rifting in the Western Volcanic Zone and trans-tensional (“bookshelf”) faulting in the South Iceland Seismic Zone (Einarsson, 2008).

Geothermal surface manifestations are widespread in the lowlands from northeast to south of Laugarvatn and are associated with faults and fractures in the bedrock (Sæmundsson, 1986). These structures provide pathways for groundwater to circulate to depth, where it is heated by the elevated geothermal gradient. Due to the complexity of the tectonic stresses in the region, different faults and fracture sets control the permeability at each site making the mapping and characterization of each geothermal system essential (Khodayar et al., 2010).

Gunnarsdóttir et al., 2026.

A regional resistivity survey from the 1970s reveals conductive anomalies that can be linked to known geothermal systems in the southern lowlands, including the Laugarvatn system.

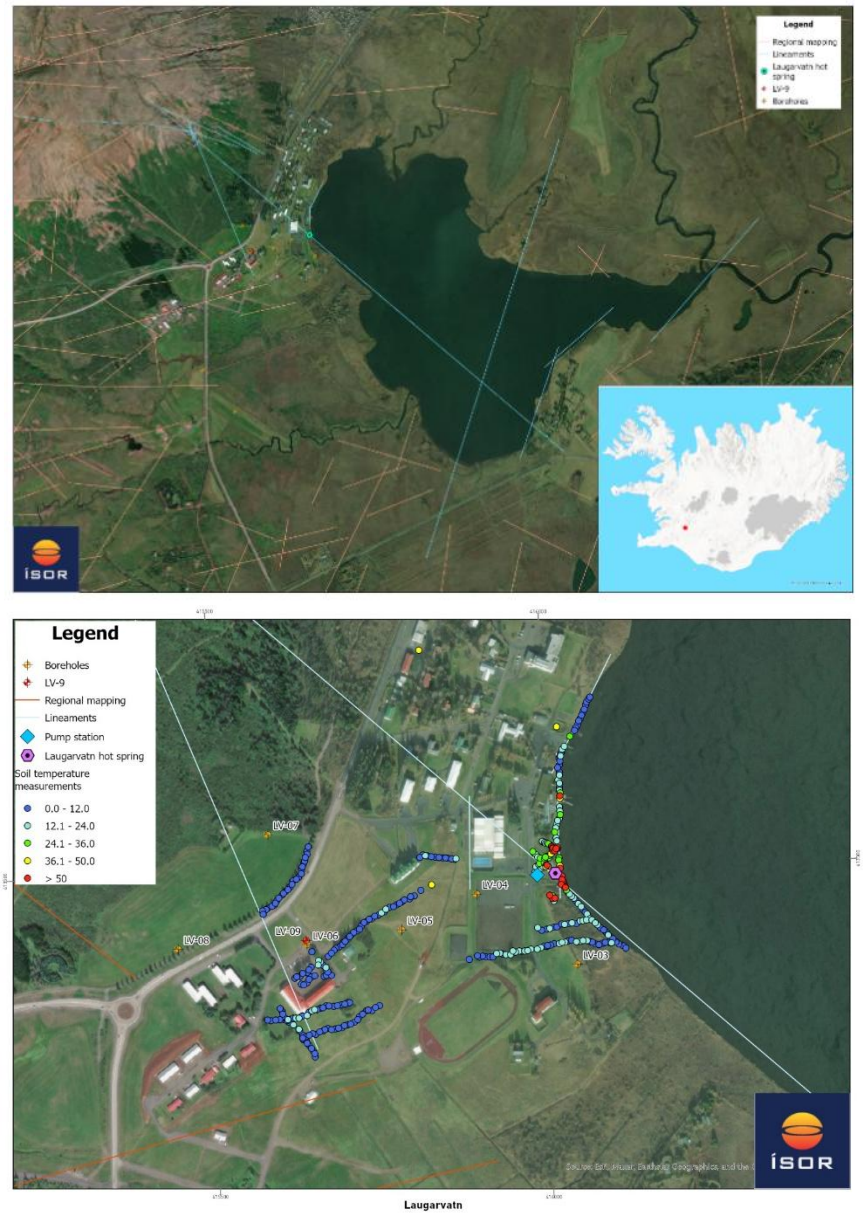


Figure 1. A) The location of Laugarvatn in SW Iceland is shown on the inlet of the upper figure. Regional mapping of lineaments from aerial images is shown in yellow. B) The soil temperature survey points highlight the surface manifestations on a N-S lineament along the shore of lake Laugarvatn. Another anomaly was measured in the parking lot of the junior college. The six exploration wells (LV-3 to LV-08) are shown, and the production well is labeled LV-09.

3 RECENT EXPLORATION IN LAUGARVATN AND SITING OF PRODUCTION WELL

Until now, the Laugarvatn hot spring has been sufficient to meet local demand, which explains the absence of geothermal production wells in or near the village. The closest deep geothermal well is located at Eyvindartunga, approximately 2 km to the south, but there is no indication of hydraulic connection between the two systems. In Laugarvatn, geothermal surface manifestations such as hot springs, altered ground, and fumaroles, are found on a north–south alignment along the lakeshore. The Laugarvatn hot spring is located in the southern part of this alignment. Decades ago, during excavations around the junior college which is located about 500 m west of the lakeshore surface manifestations, fractures and heat were noticed (Benediktsson and Sæmundsson, 1972). More recently during excavations ~100 m west of the lake, hot ground and steam were reported. Chemical analyses of water from the Laugarvatn hot spring show relatively high concentrations of fluoride and hydrogen sulphide, and chalcedony geothermometry suggests reservoir temperatures of about 120°C (Ólafsson, 2019).

Regional mapping of lineaments from aerial images had already been done as seen in figure 1 (Khodayar and Einarsson, 2006). It was evident from regional exploration that structures play an important role in the existence of a geothermal system and as the flow from Laugarvatn hot spring had been consistently high it was regarded as a sign of ample flow in the system.

To characterize the Laugarvatn geothermal system it was necessary to map the structure on a local scale. Unfortunately, vegetation and sediments obscures faults and fractures so few openings are within the village. Some lineaments were mapped in openings in the Laugarvatnsfjall mountain, and alignments were inferred from surface manifestations. To compliment the structural mapping, soil temperatures were measured across likely sites. The results show the main temperature anomaly along the lakeshore on a N-S alignment. The warmest points are found around the Laugarvatn hot spring. Slightly to the north there are hot springs around the spa and even farther north the Vígðalaug hot spring is found. With the results of the soil-temperature survey and inferred fracture lineaments, candidate locations for exploratory boreholes were identified and six exploratory holes were subsequently drilled in 2022.

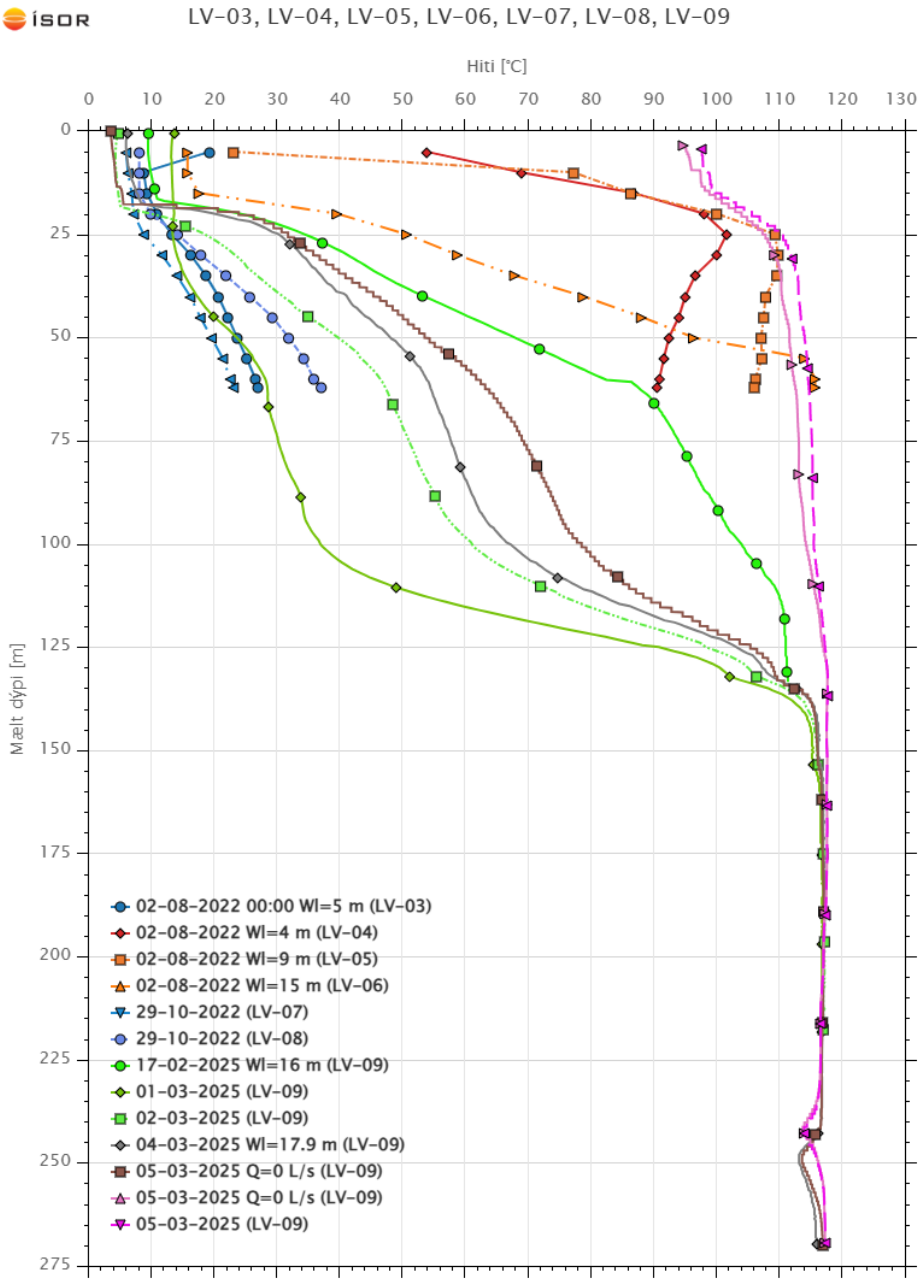


Figure 2. Temperature logs from the exploration wells LV-03 to LV-08 and from the production well LV-09 in Laugarvatn. Wells LV-03, -07 and -08 (blue) are outside the warmest part of the system while LV-04 to -06 are within it. LV-06 reached 115.7°C at 62 m depth. The production well, LV-09, is few meters away and reached a maximum of 117°C.

The results of the temperature logging of all the wells is in figure 2. Wells LV-04 and LV-05 showed high temperatures already at 20 m depth, ~100°C, indicating a horizontal flow at 20-30 m. The well tops are located 19 and 10 m lower than LV-06. LV-06 showed the highest temperature, 115.7°C at 62 m depth. Wells LV-03, LV-07 and LV-08 show much lower temperatures, indicating they are outside of the upflow in the geothermal system. As LV-03 is close to the extension of the N-S alignment of surface manifestations it was presumed that this anomaly does not extend further south. Wells LV-07 and LV-08 provide constraints on the size of the system to the W and NW, however it remains unclear whether the system extends further south from LV-05 and LV-06. As LV-06 was located furthest away from the surface manifestations and the Laugarvatn hot spring and closest to the upflow in the system, the production well, LV-09, was sited next to it. The distance between the surface manifestations and the production well top is 300 m and 24 m in altitude.

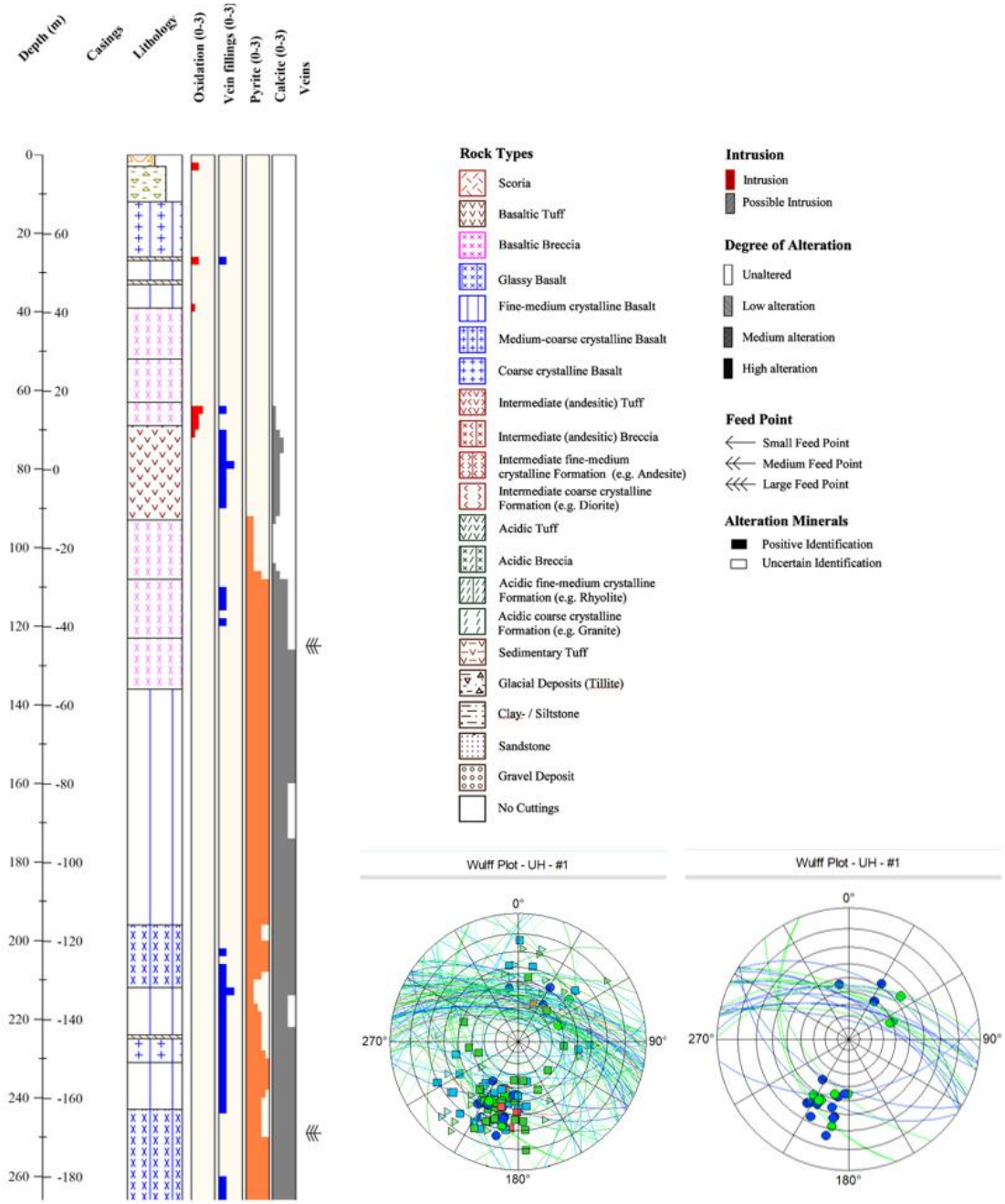


Figure 3. Well LV-09 is 270 m deep. Here shown, are the casings of the well, stratigraphy, alteration, feed points and the structures from the analysis of televiewer logs shown on upper hemisphere (on the left all structures are shown, on the right only structures analyzed with high confidence (Gunnarsdóttir et al., 2025).

Gunnarsdóttir et al., 2026.

4 THE DRILLING OF PRODUCTION WELL LV-09

LV-09 was drilled by a 20 ton rig, Trölli from Iceland drilling, in the winter of 2025. A 14" surface casing was set at 18 m followed by 6 ½" airhammer drilling. At 110 m depth water started entering the well, but at 134 m there was a sudden flow of 85°C water of 10-15 L/s which was too much water for the airhammer to work. Temperature logged in the well after one day of heating up showed 110°C at 110 m. At this point a 10¾" production casing was cemented at 115 m depth. The production section was then drilled with a 6 ¼" bit. At 180 m the flow increased enough to require an additional drainage pipe. Drilling indicated fractured formations. At 221 m a ~25 m high blowout occurred in nearby exploration well LV-05, showing strong hydraulic connection. When air was no longer mixed with the circulation water, the blowout decreased but did not stop, so LV-05 and two additional wells were cemented for safety. At this point the well was obviously hot and permeable but it was decided to continue down to 250 m. When drilling at 249 m there was a loss of circulation, indicating a feed zone, and therefore drilling was continued down to 270 m which was the final depth. Drill cuttings show that the stratigraphy consists of hyaloclastite with basaltic lavas intercalated within (figure 3). The alteration changes at 130 m depth, from where epidote and coarse feathered clays are abundant. This indicates that the temperatures in the reservoir were once higher (>240°C). Laumontite is also present, fitting well with the current temperature conditions in the reservoir, about 120°C. Circulation losses, temperature and televiewer logging confirm that the major feed points are at 125, 230 and 249 m depth (figure 2). The prevailing fracture directions are WNW-ESE towards NW-SE, consistent with, all identified fractures and fractures identified with high confidence (figure 3). The most common dip is towards WSW (50-70°) (Gunnarsdóttir et al. 2025). A production test was conducted in the well by airlifting. The airlift test was done with the drill string first at 52 and then at 100 m depth. Meanwhile a logging tool measuring the temperature and pressure was located at 200 m depth. The depth to the water table was 17.6 m before the testing started. During the first step the total flow from the well was 51 kg/s and 75 kg/s during the second step. The steam proportion is 3%. The results showed that the well is capable of producing about 50 kg/s of 116°C water with only 1.5 m of drawdown (Gunnarsdóttir et al., 2025).

5 CONCLUSIONS & NEXT STEPS

Drilling of six exploration wells was crucial for the location of a production well for the village of Laugarvatn. The locals have relied on the natural hot springs for centuries. The production well, LV-09, is a success, and based on production testing, it should be able to provide ~50 kg/s with minimum drawdown. The feed points in the new well have been correlated with WNW-ESE structures which do not stand out in the limited surface mapping. To better constrain the location of permeable structures in Laugarvatn and the size of the geothermal system, further studies such as structural mapping is needed. Different exploration methods such as using a ground penetrating radar to delineate the structures which are hidden by vegetation and sediments. As soon as the production well is connected to the district heating system, monitoring of the response of the hot spring is essential and will offer insights into field permeability. Monitoring of the fluid chemistry will ensure safe operation. Together, these efforts aim to secure a reliable, safe geothermal supply for Laugarvatn's future and if conditions allow able further development of the resource.

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