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Drilling a low temperature convective system, Glyvrar, Faroe Islands

The Faroe Islands are a volcanic archipelago in the Nord Atlantic Ocean, located in the triangular area between Iceland, Scotland, and Norway.

Fifteen years ago, the government of the Faroe Islands introduced shallow geothermal heat pump systems for heating private houses around the islands as a greener energy solution instead of oil burners. It took almost 10 years before the people of the Faroe Islands undertook this solution but at present there are more than 1500 buildings being heated with shallow geothermal energy.

The drilling of these shallow geothermal energy systems gave The Faroese Geological Survey (Jarðfeingi) the opportunity to access large amount of information regarding the underground. Information that had not been accessible before. The information was and still is being collected by measuring the depth of the groundwater table and the temperature and the conductivity of the groundwater each five meter down the borehole. With time more advanced logging equipment was acquired such as Optical Televiewer, Caliper log, Gamma ray log, SP log and a Flow log. These new tools have added to the database and have given the possibility of a better geological understanding of the underground.

Based on the collected data a geothermal gradient map was constructed and areas with geothermal gradients up to 140°C/km were discovered. The average geothermal gradient of the Faroe Islands in general around 30°C/km.

In 2021 a hypothesis regarding convection of groundwater in fracture zones was put forward in a test project. An area with a geothermal gradient of approximately 60-70°C/km was chosen close to a school. In addition to the high geothermal gradient the aim is to drill an artesian warm water well. If the test is successful and artesian water found, the energy from the water could be used for heating the school thought an open-loop shallow geothermal system.

Geological mapping of the area commenced with a specific focus on fractures where convection of groundwater was expected to occur. Three large fracture zones were mapped in the area - using 3D topographic maps in Petrel – and all turned out to dip between 30-38° in a northwest to northern direction. The central fracture zone was interpreted in depth closest to the school. Thereafter three wells were planned in the area: one 100 m deep control well north of the school and two 400 m deep wells 25 and 75 m south of the school, respectively. The plan was to reach the fracture zone at approximately 350 and 250 m depth, respectively.

The wells were drilled between the 12th and the 20th of December 2022. Both wells south of the school were artesian but due to water pressure it was only possible to drill the southernmost well, the well farthest away from the school, 275 m deep. The amount and heat of the water running out of the wells was 0.7

m^2/h of 19.5°C and 4.5 m^2/h of 24.5°C warm water, respectively, while the groundwater level in the 100 m deep control well was placed at 7.5 m below surface.

The wells were logged with all available logging tools and on the Optical Televiewer fractures were seen at 228, 356 and 371 in the well closest to the school and at 203 and 245 m depth in the well farthest away from the school. A pump test tells us that the borehole farthest away from the school can manage to provide more than 7 m^2/h of 24.5°C warm water to the system, without affecting the two other boreholes.

So far, only closed loop geothermal heat pump systems are installed in the Faroe Islands. But as 25% of the shallow geothermal wells in the Faroe Islands are artesian well, this is a waste of water and energy. Therefore, the next step of this project is to get funding to install the first open loop geothermal heat pump system in the Faroe Islands. An open loop geothermal heat pump systems is expected to provide 10 times more energy pr. borehole depending on the water amount and temperature.

After the heat is taken out of the water the hope is that the municipality will use the water as drinking water for the inhabitants in Glyvrar or it will be transported to the salmon factory located 400 m north of the school.

The energy of the water is at least four times of what the school needs and the second phase is to connect other surrounding buildings to the same open loop system.