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Geology and hydrogeology of Gvendarbrunnar and Myllulækur east of Reykjavík, Iceland

Kristján Sæmundsson, Kristján H. Sigurðsson, Hrefna Kristmannsdóttir

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GEOLOGY AND HYDROGEOLOGY OF GVENDARBRUNNAR AND MYLLULÆKUR EAST OF REYKJAVÍK, ICELAND

Sól hf. has engaged Orkustofnun (NEA) to provide an expert judgement as to the characteristics of the Gvendarbrunnar drinking water source near Reykjavík. The report is so written as to meet standards set by the "UK Natural Mineral water Regulations S1 1985 No 71", regarding bottling of water.

1. Location of source.

Sól hf. taps the mains of the Reykjavík Municipal Water Works. The water is derived from two borehole fields in the Heiðmörk area SE of Reykjavík at about 80 m above sea level. (See accommpanying map and Fig 1).

The main source is **Gvendarbrunnar**, copious springs that emerge at the edge of a recent lava flow. The average yield of the springs is over 700 l/s. Since 1985 the water is tapped by shallow boreholes (10-20 m) a short distance uphill from the springs. The water is virturally pure and no treatment of it is required.

The smaller source is **Myllulækur** 1.5 km SW of Gvendarbrunnar. There boreholes have also been drilled uphill from copious springs that emerge at the shore of Lake Elliðavatn. The yield of the springs is well over 300 l/s.

2. Geology and hydrogeology of the surrounding terrain

The bedrock of the catchment upwards from and around the Heiðmörk spring area is formed of basaltic rocks (Fig. 1 and 2). **Holocene lava flows** are the youngest unit. They lie generally above the groundwater table. The surroundings of Gvendarbrunnar is a notable exception. **Interglacial lava** forms a bulky unit below the Holocene lavas. Their main occurence in surface exposure is SW of Gvendarbrunnar. There is a thin layer of **moraine and outwash sediment** between the Holocene and interglacial lavas. The layer covers the interglacial lava partly throughout its outcrop area, being thickest in lows. The moraine is of low permeability. The flow of groundwater is mainly associated with the interglacial lava. The primary permeability of the lavas is provided mainly by scoriaceous flow partings. As regards the interglacial lava there is in addition a very effective secondary permeability due to extensional **fissures and faults**. They are part of a NE-SW trending active fissure swarm that passes along the Reykjanes peninsula. **Hyaloclastite** (collective term for pillow lava, breccias and glassy tuffs) is supposed to form irregular mounds below the interglacial lava. Locally it protrudes to the surface. An example is seen 2-3 km E of Gvendarbrunnar. The hyaloclastite was erupted subglacially. Due to the confining environment of the ice the volcanic products accumulated around the vents rather than spreading laterally. The glassy tuffs and breccias are generally poorly permeable.

Precipitation in the catchment of the Heiðmörk area varies from about 1200 mm/y near Lake Elliðavatn at less than 100 m above s.l. to about 3000 mm/y at Bláfjöll in the SE at about 500 m above s.l. (Fig. 3). The water drains directly into the permeable lavas. Surface drainage begins where the Gvendarbrunnar and Myllulækur springs emerge. Fig. 4 shows the groundwater contours around Gvendarbrunnar and Myllulækur during pumping. The groundwater level rises from Lake Elliðavatn (~ 75 m) to the SE and reaches 90 m 1.2 km SE of the lake. The drawdown in the wellfields is kept within safe limits to preclude ingression of lake water. Fluctuations of the groundwater level across the contoured area of Fig. 4 is about 2 m.

The Holocene lavas SE of Gvendarbrunnar, the youngest of which is about 900 years old, are extremely rough surfaced, and mostly barren apart from a thick cover of moss. The roughness is hostile to pedestrians and stray animals alike, thus providing a natural protection.

The zone of interglacial lavas S of Gvendarbrunnar is part of a nature reserve which is being reforested and used for outdoor recreation. It is traversed by roads used during the summer by people enjoying the nature of the reserve by car, on horseback or on foot. There is no other land use within the catchment of the well field that could contaminate the groundwater. The nearest permanent dwellings are in the case of Gvendarbrunnar about 500 m distant laterally with regard to ground water flow (Fig 4). In the case of Myllulækur the nearest permanent dwelling is about 1 km distant downstream from the wellfield.

3. Description of the Gvendarbrunnar and Myllulækur well fields.

The **Gvendarbrunnar well field** is situated at about 80-85 m above sea level 200-400 m SE of the Elliðavatn lakes (~ 75-78 m above sea level). There are two groups of wells situated 300 m apart. They drain a Holocene lava and a gravelly layer beneath it, partly also a fissure in the underlying interglacial lava. The wells of the northeasterly group (Gvendarbrunnar proper) are 10-20 m deep. They tap water from the base of the Holocene lava and from the gravel below it. There are eight wide diameter holes with pumps installed (not all operating simultaneously). The holes are cased to bottom and slotted opposite the aquifer.

The wells of the southwesterly group (Jaðar) are 10-15 m deep. They tap water from the same aquifers as the Gvendarbrunnar group. Boreholes of the Jaðar group, of which there are 6 with pumps installed, are cased to about 8 m depth, but open in the aquifer. At Jaðar water is pumped also from an open fissure in the interglacial lava through pipes sunk into it. The average static water level at Gvendarbrunnar and Jaðar is at about 79 m. The drawdown at pumping of ~ 600 l/s is about 1-2 m (Fig 4).

The **Myllulækur well field** is situated at 80-90 m above sea level 300-500 m SE of lake Elliðavatn. The wellfield lies 1.5-2 km SW of the Gvendarbrunnar well-groups. There are three producing wells 50-100 m deep which tap water from fissured, interglacial lava. The wells are cased to 20 m depth. The static water level is at 78-81 m. The drawdown at pumping of ~ 300 l/s is 2-3 m.

4. **Rate of flow**
The rate of flow of the Gvendarbrunnar and Jaðar spring area is over 700 l/s. Despite pumping of 600-700 l/s from the Gvendarbrunnar and Jaðar wells there is a surplus which emerges in the original springs. The Myllulækur spring area is difficult to assess because the largest springs emerge at the shore and on the lake bottom. It is over 300 l/s, however, because the springs have only partly dried up as a result of pumping of (330 l/s). Seasonal variations in flow rate of the spring area as a whole range between approximately 1000-1500 l/s. There was flood danger at Gvendarbrunnar proper, but by shifting the water intakes from the lake shore several hundred metres uphill of the springs this danger has more or less been eliminated .

5. **Temperature of the aquifers**
Temperature measurements of Gvendarbrunnar show values varying between 3.5-4°C. Water from the Myllulækur wells is stable at 3.5°C.

Protective measures
A 2 km^2 area around Gvendarbrunnar and Myllulækur including both wellfields is surrounded by a 2 m fence to prevent trespassing. Besides, the Heiðmörk recreation area as a whole is fenced off to prevent grazing of domestic animals (see accompanying map).

6. **Water chemistry and hydrogeology**

Analysis of the water
The results of inorganic analysis of tap water from SÓL h.f. are shown in table 1. There were taken two samples :

1. From the main service intake into the building
2. After filtering in the factory

In table 2 are summarized the methods used for analyses, preparation of samples at sampling point and detection limits for each analysis. In the case of sample 2 it was not refiltered.

The radioactivity of the water was not measured, but due to the extremely low concentration of radioactive elements in the icelandic underground rocks it is known to be far below detection limits anywhere in icelandic groundwaters.

Relation to geology
The water used by SÓL is typical for cold deep groundwater in SW Iceland. The crust is built up of volcanics and over 90% of them are basaltic. Those basalts are primitive in the sense that they derive mostly from little evolved magmas and have in accordance low concentrations of radioactive elements and heavy metals in general. This in turn affects the chemistry of the groundwaters such that pH is relatively high and the concentration of dissolved solids is low.

Stability of the source
At the laboratory of Orkustofnun there have been analyzed regularly over a period of 10 years a few of the major components of the tap water from the same sources as

used by SÓL h.f. The range of concentration is shown in table 3. The concentration has proved to be stable over this period of time and the variation is well within the standard deviation for the methods used.

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Topographic map 1:25.000
The well fields of Gvendarbrunnar and Myllulækur are encircled by the dark blue lines. Fences set up for protective measures are marked by heavy blue lines. There is one around each wellfield (dark blue), and one around the Heiðmörk recreation and reforestation area (light blue).

Fig 1. Air-photograph. The photograph (vertical) shows the main characteristics of the surroundings of the Gvendarbrunnar - Myllulækur spring area. The overlay shows the main geological divisions.

Fig 2. Geological sections through the Gvendarbrunnar and Myllulækur well fields.

Fig 3. Annual precipitation across the catchment around the Heiðmörk area.

Fig 4. Groundwater level and flow lines around Gvendarbrunnar and Myllulækur at pumping of 330 l/s at Myllulækur and about 500 l/s at Gvendarbrunnar and Jaðar + excess free flow of 200 l/s at Gvendarbrunnar proper.

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Table 1. Analysis of water used in production by Sól hf.

Table 2. Parameters included in a water analysis.

Table Mean concentration and standard deviation from analyses at Orkustofnun laboratory 1979-1990.

Kristján Sæmundsson

Kristján H. Sigurðsson

Hrefna Kristmannsdóttir