

Freshwater and seawater on Reykjanes and the Reykjanes Peninsula

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FRESHWATER AND SEAWATER ON REYKJANES AND THE REYKJANES PENINSULA

INTRODUCTION

Ample sources of good and clean freshwater and seawater are found in the proximity of the Reykjanes high-temperature geothermal area. High rainfall and the extremely permeable lavas in the region create this unique geological setting. The freshwater is pumped from shallow wells and seawater can either be taken from the sea or from wells on land. These natural conditions are important for the exploitation of the high-temperature field for power generation or for use in a factory. Extensive hydrogeological studies and mathematical modelling have been used in the past while sources of freshwater and seawater were being sought for the municipalities and fish farms. The results are outlined in this report and attached are several figures from previously published material.

HYDROGEOLOGY

On the western Reykjanes Peninsula freshwater is floating on seawater in the bedrock, in a lens less than 50 - 60 m thick, where 35 - 40 m are submerged below sea level for each 1 m the groundwater level rises above it. This thin lens is due to the very high permeabilities in the geologically young and fissured volcanic rocks in that area. Precipitation in the lowlands of the area is 1.000 - 1.200 mm/y but decidedly higher in the mountainous central and eastern parts of the peninsula. Surface runoff is practically absent, almost all the precipitation being infiltrated.

Groundwater currents and the elevation of the groundwater table are dependent on the hydrogeological structure of the bedrock. The groundwater flow is concentrated in a SW - NE orientated zone across the western peninsula, from Reykjanes proper, its SW - tip, over the extraction area of the Suðurnes District Heating and the Suðurnes District Water Works. On both sides, hyaloclastite mountains and interglacial basalt lavas have somewhat lower permeabilities than the postglacial basalt lavas and fissure zones in the main groundwater zone and have therefore correspondingly relatively higher groundwater elevations. The high-temperature geothermal areas of Reykjanes and Svartsengi create deviations from this pattern, because of the different temperature and salinity of the water and some degree of alteration of the bedrock.

The freshwater conditions on Reykjanes proper are also determined by the above mentioned factors. The present freshwater supply for the local factories is on the northwestern, landward side of the geothermal area, where freshwater is flowing towards the coast from the interior in accordance with the SW-NE orientated geological structures, fissure swarms and hyaloclastite ridges. Increased chemical contents are to be expected on approaching the geothermal area and the coastline. The more promising facilities for freshwater exploitation are farther inland, northeast of the geothermal area, where an extraction of some few hundred litres per second

(l/s) should be possible, so far as it does not collide with other interests. By exploitation care must be taken to avoid overdrought and upconing of seawater in the thin freshwater lens, which can be managed by distributing the extraction wells over a greater area or by some other technical means.

FRESHWATER

The fresh groundwater on the Reykjanes peninsula is considerably more saline than normal for groundwater in Iceland. The chloride concentration is in the range 30-120 mg/l as compared to the normal range of 5-30 mg/l for most places in Iceland. The reason is partly contamination with the underlying saline groundwater and partly sea spray far inland due to low elevation of the part of the country. Tidal effects may also affect the groundwater near to the coast. Runoff from the geothermal fields has been found to affect the chemistry of groundwater in places.

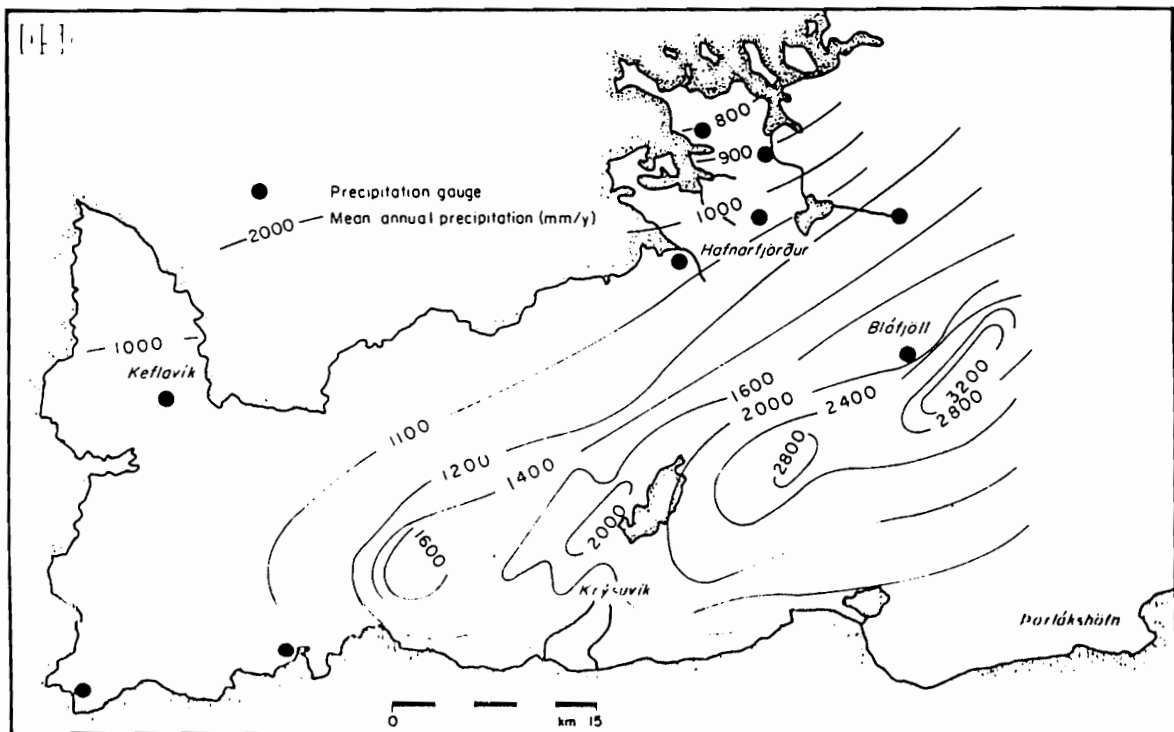
Table 1 shows the chemical composition of freshwater from the well at Sýrfell used by the salt factory at Reykjanes. For comparison the water analysis of the municipal water supply from Lágur is also shown in the table. The freshwater well at Reykjanes has double the salinity, but both sources are of good quality as potable water and the concentration of all components is far below the limits set for drinking water.

SEAWATER

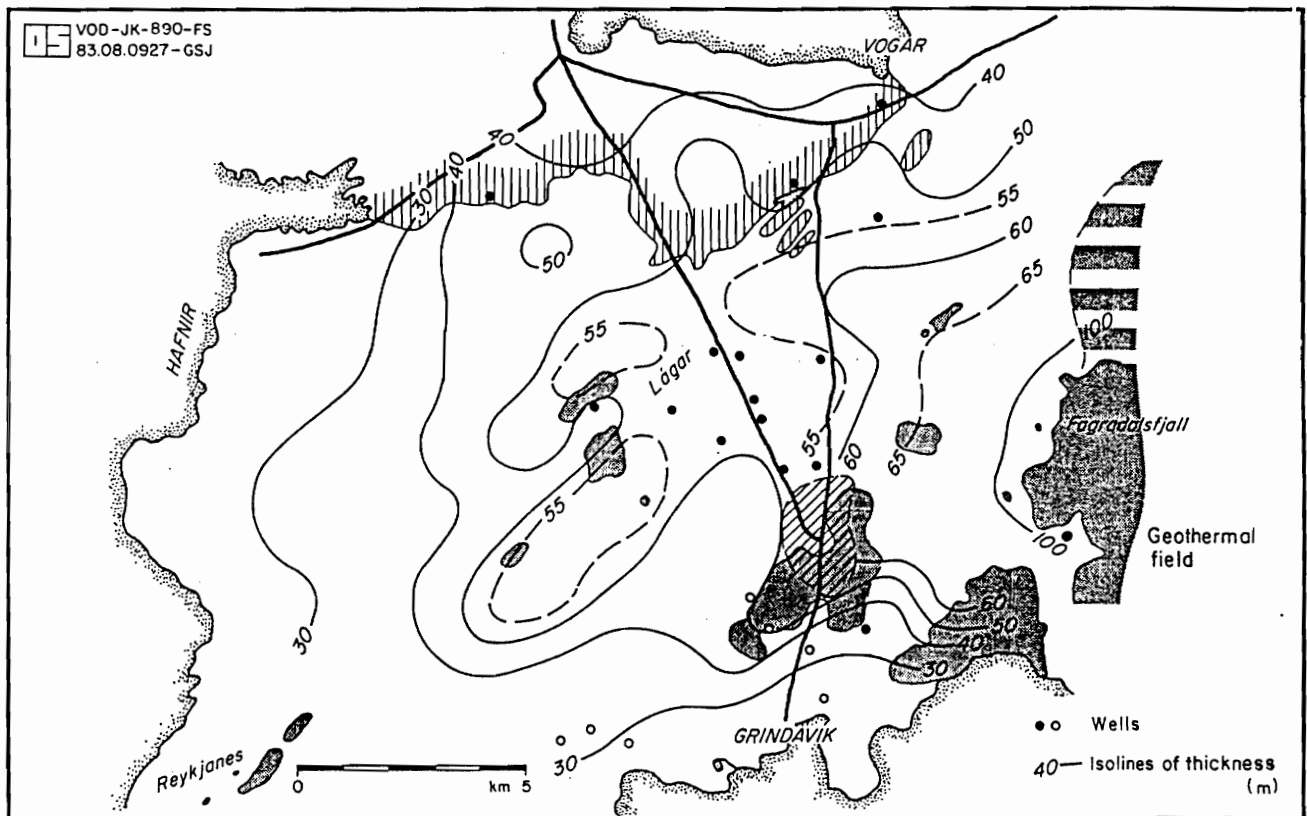
Saline groundwater, having roughly the same salinity as coastal seawater, can be pumped from wells near the shore by casing off the freshwater lens. The water analysis is shown in table 1. Well 5 on Reykjanes containing saline groundwater is near the high-temperature area. The Stóra Sandvík sample is collected from the ocean just north of the geothermal field. The Stadur sample is collected from the ocean by the fish farm situated at the south coast of Reykjanes peninsula. This saline groundwater may show some signs of water-rock reaction whereby the pH is lowered, silica, calcium, potassium, iron and manganese may increase and oxygen, magnesium and sulfate are depleted. In the cold or slightly heated saline groundwater those changes are usually insignificant.

Table 1. Chemical composition of fresh and saline groundwater from the Reykjanes peninsula and seawater offshore

Sample number	959088	921124	900150	959089	959090	849102
Location	Sýrfell well-SY-02	Lágar fiss.	Reykjanes well 5	Reykjanes well 5	Stóra-Sandvík	Stadur Grindavík
Date	July 1995	Nov 1992	July 1990	July 1995	July 1995	Nov 1984
pH / °C	7.84 /22	7.74 /23	7.82 /25	7.81 /23	8.15/23	7.96/22
Tot. Carb. (CO ₂)	17	14	112	111	100	103
Hydr.sulf. (H ₂ S)	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Silica (SiO ₂)	14.4	13.3	14.9	13.9	0.7	1.5
Sodium (Na)	61.2	30.5	10350			9717
Potassium (K)	2.2	1.21	428			415
Calcium (Ca)	7,9	6.68	477			381
Magnesium (Mg)	9.0	6.18	1123			1223
Fluoride (F)		0.072	0.473			0.57
Chloride (Cl)	111	61.3	18700	18300	18400	18037
Bromide (Br)		0.20	64.4			67,9
Sulfate (SO ₄)	15	8.8	2490	2510	2550	2530
Aluminium (Al)		0.007	0.02	0.005	0.001	
Iron (Fe)		0.02	0.021	0.008	0.001	
Manganese (Mn)			0.036	0.003	0.002	
Copper (Cu)			< 0.001			
Zinc (Zn)		0.017	0.085			
Cadmium (Cd)			< 0.001			
Mercury (Hg)			0.000004			
Lead (Pb)			< 0.001			

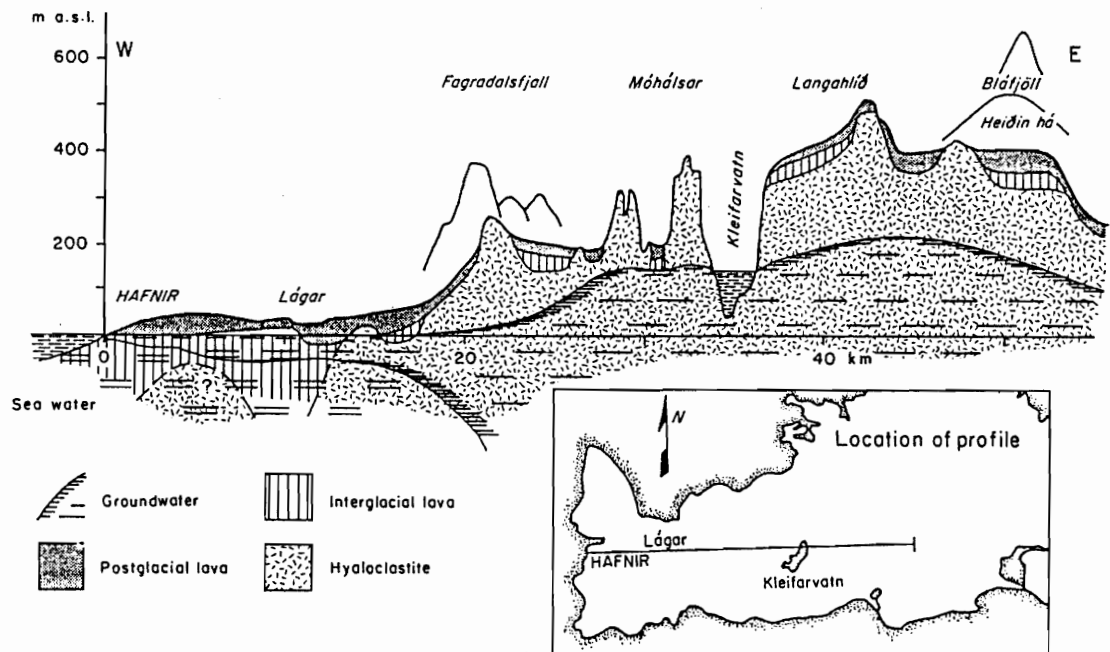


Annual precipitation rates on Reykjanes peninsula. It is extremely high in the eastern, mountainous part of the peninsula.

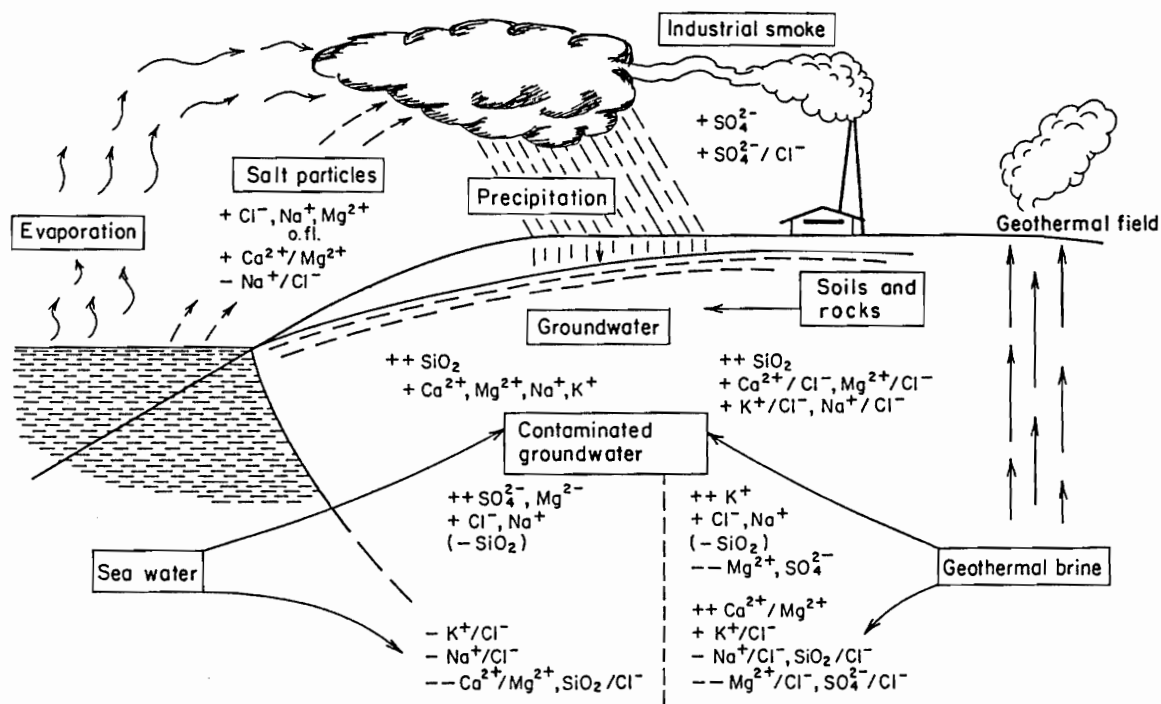


Thickness of the freshwater layer in the western Reykjanes peninsula. The freshwater in the western part of the Reykjanes peninsula floats in a thin layer on the seawater in the bedrock, like oil on water (Sigurðsson 1985).

Groundwater profile of Reykjanes peninsula

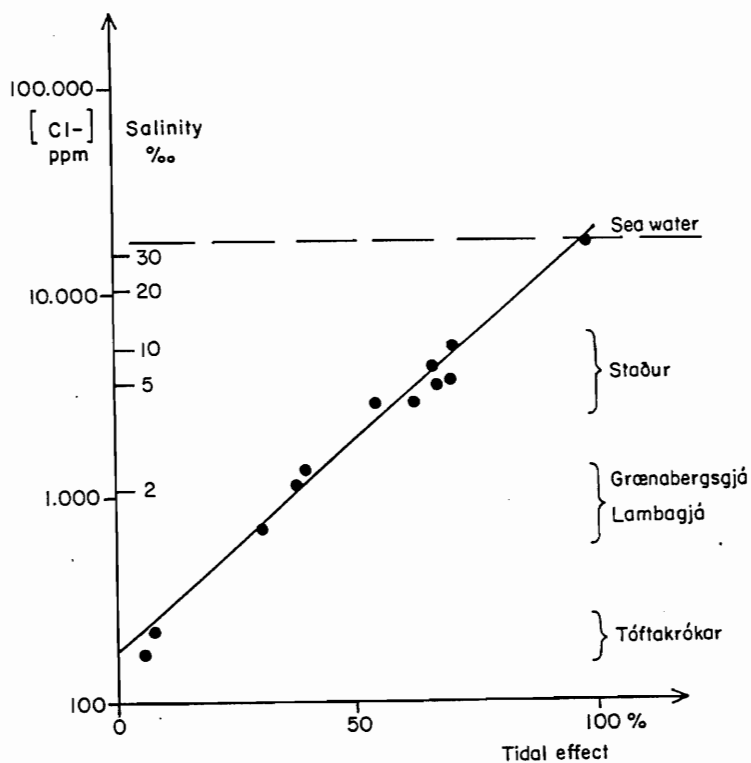


A profile of the groundwater along the Reykjanes peninsula. The groundwater table is much higher in the less permeable hyaloclastite mountains of the eastern peninsula than in the highly permeable lava series in its western part (Sigurðson 1985).



Origin of the chemical contents of the groundwater on the Reykjanes peninsula. Storm carried marine salts, cations and silica from the bedrock and geothermal influx are the chief sources of the chemical contents of the groundwater (Sigurðsson 1985).

SALINATION OF FRESHWATER BY TIDAL EFFECTS



Salination of freshwater through tidal effects. The salinity of the freshwater increases as the flowing groundwater approaches the coast (*Orkustofnun & Vatnaskil* 1986).