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The hydrogeology of Fljótsdalsheiði and Eyjabakkar, E-Iceland

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Greinargerð ÁH-99-02

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12. May 1999

Report
ÁH-99-02

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1. Introduction

This paper is an English summary of a report in Icelandic; Vatnafar á Fljótsdalsheiði og Eyjabökkum (The Hydrogeology of Fljótsdalsheiði and Eyjabakkar) by Árni Hjartarson (1999). In it the hydrology and hydrogeology of the catchment area of the Fljótsdalur Hydroelectric Project are discussed. The study area is the watershed of Jökulsá in Fljótsdalur valley just downstream from the Kelduá tributary river. The geology of the area in question is quite well known and geological maps of it are available. The hydrogeology is far less known and no hydrogeological maps have been published, but well established run-off series are available for all the main rivers.

2. Catchment and runoff

The catchment area of Jökulsá downstream of Kelduá is about 1020 km^2 in areal extent of which around 145 km^2 are covered by glacier. The mean runoff of the river and its tributaries is shown in the table below. The annual discharge of the rivers is very variable. Names of places are given in fig. 2.

Gauges, rivers, catchment areas and discharges

Gauge	Place name	Location	Catchment km^2	Discharge m^3/s
vhm 17	Lagarfljót, Lagarfoss	1975-1994	2800	114
vhm 34	Bessastaðaá	1971-1989	127	3
vhm 109	Jökulsá, Hóll	1963-1994	575	28,6
vhm 221	Jökulsá, Eyjabakkavað	1990-1993	315	24,2
vhm 249	Kelduá, Klúka	1994-1994	440	23,9
vhm 205	Kelduá, Kiðafellstunga	1976-1993	314	15,5
vhm 255	Sauðárvatn	1993-1994	25	3,2
vhm 206	Fellsá	1977-1993	126	6,67
vhm 165	Laugará	1972-1982	29	1,13
vhm 106	Grímsá	1975-1984	530	26,5
vhm 93	Gilsá, Skriðdal	1962-1989	29	1,85
vhm 215	Hölkná	1979-1984	50	2,08

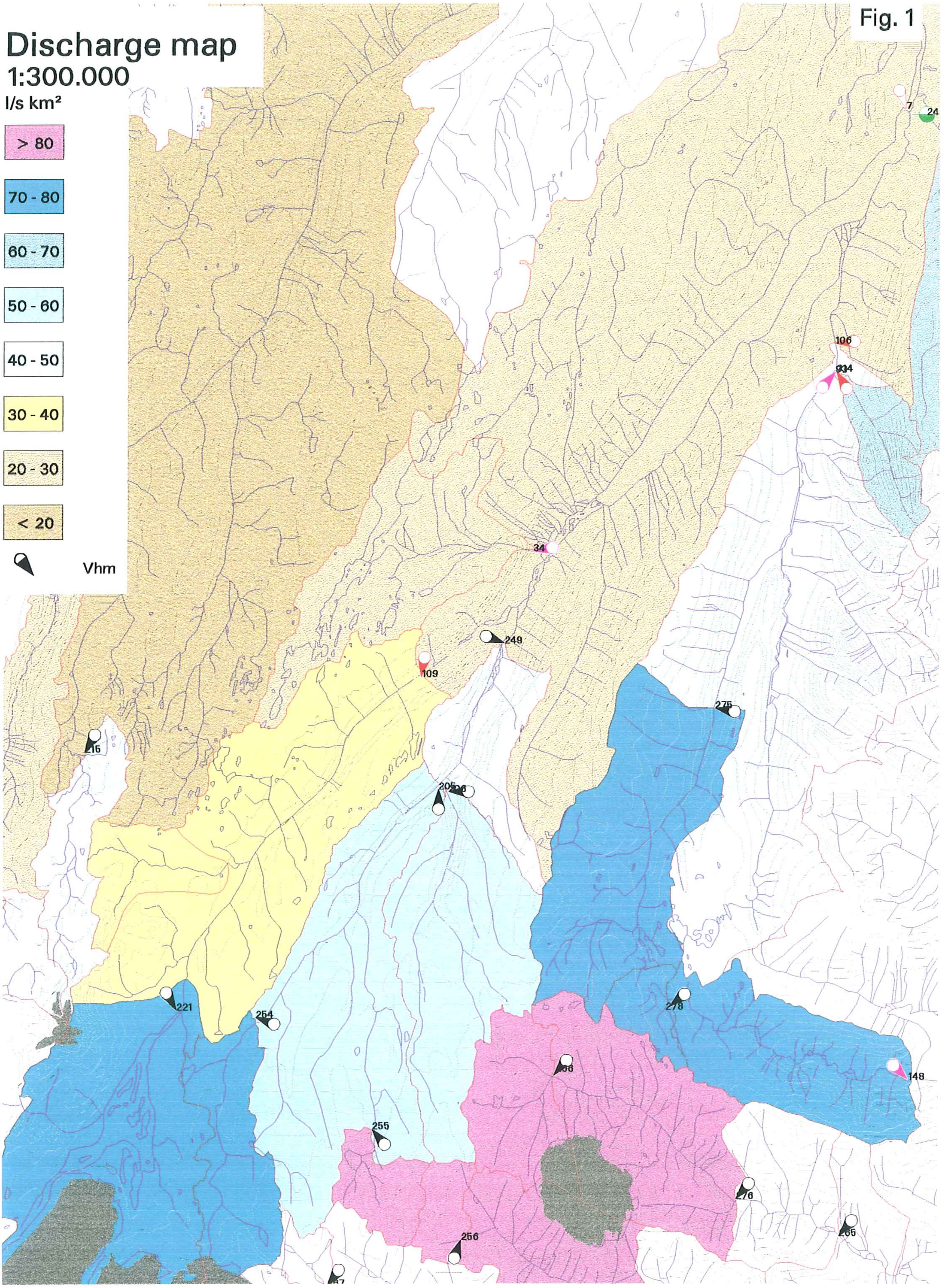
Fig. 1
Discharge map
1:300.000
l/s km²
> 80
70 - 80
60 - 70
50 - 60
40 - 50
30 - 40
20 - 30
< 20
Vhm
7
24
106
34
249
109
275
205
221
254
278
148
255
276
256
266

The map in fig. 1 shows the water divides and the discharge coefficients for the individual catchment areas. The coefficient is determined as the discharge per time unit from a certain area i.e. $l/s/km^2$. It must be kept in mind that the map only gives the average overall discharge coefficient pr. catchment area but not its actual distribution. The gauging network is also shown. The discharge coefficient has been calculated on the basis of the information in table 1 as well as some additional data. The driest area is in Jökuldalur where the discharge coefficient is less than 20 $l/s/km^2$. For the lowland areas of Hérað, around Lagarfljót, the discharge coefficient is 20-30 $l/s/km^2$. In Fljótsdalur it has increased to 30-40 $l/s\ km^2$ and on the upland plateau of Eyjabakkar to 70-80 $l/s/km^2$. The area with the highest precipitation is around the glacier Þrándarjökull. Its discharge coefficient is over 80 $l/s/km^2$.

3. Groundwater and groundwater level

The groundwater level is quite close to the surface in most places. In depressions there are bogs and ponds and in the hills the groundwater level is reached at a few meters depth. Artesian water is rare. Sudden drops in the piezometric surfaces occurred during drilling of boreholes in Fljótsdalsheiði indicating separate aquifers which are divided horizontally by dense sedimentary horizons. These conditions seem to be rather localized.

4. The permeability of the bedrock

The bedrock is of upper Tertiary age except in Snæfell. In the eastern part of the area it is about 5 my. old, but gets younger towards west and in Eyjabakkar it is 2.5 my. old. Although the alteration and zeolitization is low the bedrock has become so dense that very little groundwater flow occurs. Faults and fissures are also impermeable. Springs are small and rare. Rain and melt water flows off on the surface. In general the coefficient of transmissivity (T) obtained from borehole tests in the field is low, ranging between 6 10^{-6} and 6 10^{-8} m^2/s. The storage coefficient (S) is high 0.01-0.3.

The youngest bedrock is found in mount Snæfell. A widespread lava of intermediate composition forms its base. It is about 0.4 my. old and rests unconformably on the Tertiary pile. The bulk of the mountain is made of hyaloclastite formations that have been piled up in subglacial volcanic eruptions. The youngest eruptives might be from the end of the last galciation. Mount Snæfell is a stratovolcano but has been dormant for the last 10000 years.

The permeability of the young bedrock of mount Snæfell is considerably higher than in its surroundings areas and rivers originating in its slopes are characterized by spring and groundwater inflow.

5. Glaciers

Eyjabakkajökull is the main outlet glacier on the catchment area covering about 100 km^2. Its snout reaches down to 700 m elevation in Eyjabakkar plateau. Periodically there occur surges in the glacier. In the year 1890 it invaded the marshlands of Eyjabakkar in a huge surge and reached its Holocene maximum. Spectacular soil moraines, named Hraukar, were formed in this event. Its last surge happened in 1972 as the glacier advanced and moved 2000 m forward. Since then it has retreated about 600 m.

Jökulsá has experienced small jökulhlaups. They originate in the ice lagoon Háöldulón which is formed by an ice dam at the western margin of Eyjabakkajökull glacier. When the lagoon reaches a critical water level the water finds an outlet at the base of the ice and the lagoon is emptied in a short time in a jökulhlaup. The subglacial route is 7 km long and after the event a prominent ice cave has been formed in the ice. No jökulhlaup has occurred since 1995.

6. Geothermal water

On the upland plateau north and east of mount Snæfell geothermal activity is known to occur in a number of places. The warmest spring is at Laugarfell hyaloclastic rise, 52°C issuing 0,5 l/s. The geothermal springs are shown on fig. 2. Carbonate water has been detected in wells and springs around mount Snæfell. The geothermal gradient in the boreholes of Fljótsdalsheiði plateau is 60 - 65 °C/km but around mount Snæfell it is 90 °C/km.

7. The hydrogeolocical impact of Eyjabakkar lagoon

Landsvirkjun holds the power harnessing license for Jökulsá but the maximum water level of a reservoir on Eyjabakkar is limited to 664,5 m elevation. The size of the reservoir will be 43 km^2 and it is going to flood the Eyjabakkar area between the dam and the glacier. The reservoir water level will fluctuate greatly within the year. A minimum water level will be expected in spring but it will rise rapidly in late spring an early summer during the time of snow melting from the highlands and the glacier. The maximum level will be reached in late summer or early autumn. After that the water surface will slowly lower during the winter. After harnessing the stream is going to change radically. Instead of being a powerful glacier river in the rocky canyon of Jökulsá it will turn into a small and peaceful direct runoff river. Many waterfalls and rapids will diminish or disappear but they will reappear in the cases of a full reservoir.

Hydrogeological influences outside the reservoir and the canyon will be limited. The groundwater level is going to fluctuate along with the reservoir level but these fluctuations will only be detectable in the close neighborhood disappearing at a few hundred meters distance from the shore.

Some, but fairly limited, leakage might be expected in the ground below the dam. The unconsolidated superficial deposits are the most permeable layers in the area but it should be easy to prevent leakage. The young intermediate 20 - 30 m thick lava layer at the base of mount Snæfell might cause some extra seepage. The western end of the dam is going to rest on it. The discharge of small springs connected to this layer might increase but this should be easy to handle with grouting. Open fissures or young faults are not known within the reservoir site nor in its surrounding.

No cold water springs, geothermal sites nor carbonate springs will be flooded.

The Sauðárveita diversion will divert water from the rainy plateau of Hraun east of Eyjabakkar which is the southern part of the catchment area of Kelduá river. All its glacier water will be diverted from it and its discharge down in the valley will decrease by 30 - 40%.