ORKUSTOFNUN

Geothermal water from a hot spring in Uunartoq East Greenland

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Sampling

The 1st of June 1996 Sigurður Aðalsteinsson sampled water from the hot spring at Uunartoq, East Greenland. The water was sampled into a gas tube and plastic containers and the water was brought untreated to the chemical laboratorium of Orkustofnun two days later. There the pH, hydrogen sulfide and total carbonate was measured right away and the water from the plastic containers filtered for the analyse of anions and part of it was acidified for the analyse of cations. The delay to filter and acidify the sample may affect the analysis of iron and some other heavy metals so those were not included in the analysis.

Chemical composition

The results of the anlysis are shown in the table below, where results of analyses of samples taken some 25 years ago by danish geologists (GGU report, 1971) are also reported for comparison.

The results of all the analyses are rather similar for the components which are analysed in all of the samples. The scatter observed can be explained by either fluctuation in the composition of the water by time or different treatment of the samples. The main difference between analyses of the samples is probably due to that the older ones have not been analysed for volatiles right away. This is indicated by the fact that total carbonate is much lower in the older analyses, pH varies and hydrogensulfide is not reported in the older ones. Hydrogensulfide is instable and will disappear quickly by storage. It is preferently analysed at the site as any small content of oxygen taken up during sampling will react rather quickly with the hydrogensulfide and transform it to sulfate. This makes this component a very important factor for the production properties of the hot water as it acts as an inbuildt corrosion preventer. The measurements of iron, manganese and aluminium in the older samples are probably not to be trusted as the water was most likely not filtered and acidified during sampling.

Table 1. Chemical composition of geothermal water from Uunarteq.

Sample number	96-2001	98454	98453
Date	96-06-01	71-08-26	71-08-26
Temperature °C	61	61,5	61,5
Rennsli l/s	0,78		
pH/°C	7,22/25	7	7,5
Total carbonate (CO2)	26,2	9,4	15,1
Hydrogen sulfide (H2S)	0,06		
Boron (B) mg/l	0,696		
Silica (SiO2) mg/l	67,5	67	64
Total diss. solids mg/l	10040	9339	9675
Sodium (Na) mg/l	2970	2175	2480
Kalíum (K) mg/l	56,7	61	59
Magnesium Mg) mg/l	11,3	12	9,1
Calsium (Ca) mg/l	1270	1300	1176
Fluoride (F) mg/l	2,73	3,4	2,8
Chloride (Cl) mg/l	5339	5450	5660
Bromide (Br) mg/l	13,5		
Sulfate (SO4) mg/l	249	258	256
Aluminium (Al) mg/l			0,23
Iron (Fe) mg/l		0,1	<0,05
Manganese (Mn) mg/l		0,16	0,22

Type of water

The water is classified as a chloride type geothermal water and according to a special ternary diagram (Giggenbach, 1991) for the classificaton of geothermal water (fig.1) it appears to be a mature type of water.

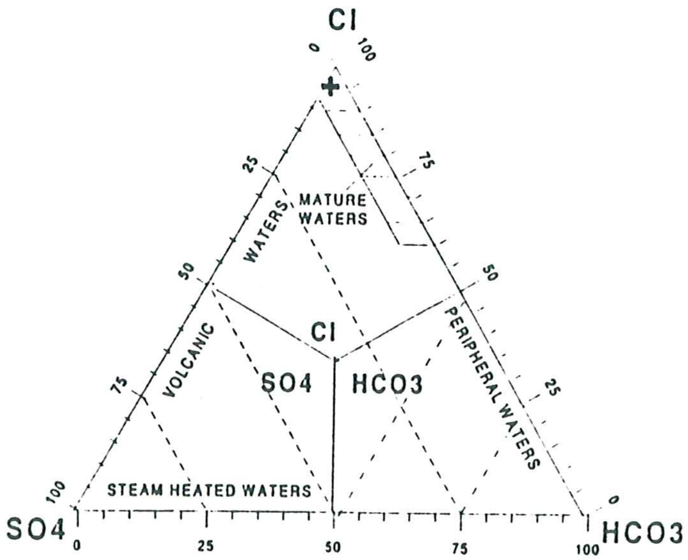

Figure 1. Cl-SO_4-HCO_3 ternary diagram for the geothermal waters from Uunartoq.

This means that the water has gained chemical equilibrium with the underground rocks and the diagram may be used to estimate the prevailing reservoir temperatures.

On figure 2 the data from the Uunartoq waters are plotted on another ternary diagram frequently used for the interpretion of chemical properites of geothermal water.
This plot also indicates that the waters are in quite good chemical equilibrium. The diagram indicates the chemical equilibrium to be attained at temperatures exceeding 100 °C.

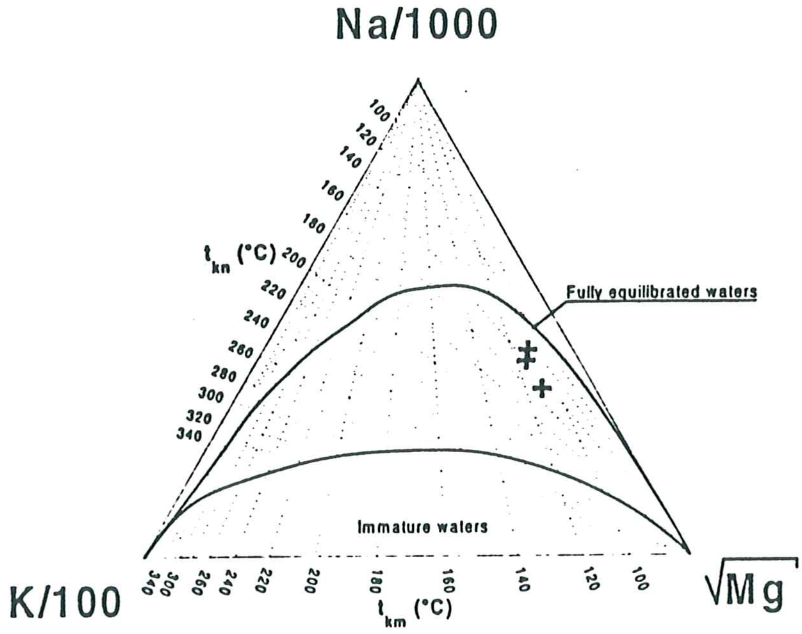

Figure 2. Na-K-Ca ternary diagram (Giggenbach, 1988) for the geothermal waters from Uunartoq.

Estimated reservoir temperature

Values from 70-115 °C are obtained from calculation of geotemperatures from geothermometers based on equilibrium with different alteration minerals likely to be formed in the system and to control the chemistry of the geothermal water. Silica temperature gives 85-115 °C, according to mineral type;115 °C for the quarts geothermometer and 85 °C for the chalcedony geothermometer.

In a basalt basement the chalcedony geothermometer might be a likely choice, whereas in the gneisses the quarts geothermometer would be a more likely one. The alkali geothermometer indicates a temperature of approximately 90 °C, whereas the Mg-K geothermometer gives the lowest one of 70-75 °C. From the different equilibration time those minerals are believed to have it appears rather likely that the original temperature of the water has exceeded 100 °C and then the water has reequilibrated at 70-75 °C.

Origin

The chemistry does not tell anything about the origin of this water is, but a measurement of stable isotopes might possibly indicate a likely origin. Stable isotopes were not analysed in the sample due to cost as the analyse has to be done at the University of Iceland and paid for. The reference data for Greenland are also not very extensive and the groundwater situation complex so one could not be sure to get a reliable informaton about the origin of the water.

Production properties

Regarding the production properties of the water it can be concluded at this point that it is too saline for direct use for heating. It contains free carbondioxide making it highly corrosive and it will become still more corrosive if just a very small content of oxygen will be adsorbed into it. The use of heat exchangers is required for theting purposes and it will probably also be necessary to use heated fresh water for tap water in households. The water is however useable for bathing, but its use in public swimmingpools may cause some technical problems. It may be approriate for "healthbaths" as saline water with not too high pH is considered quite good for the skin and even the cure of skin diseases as phsoriasis. In this matter concentration of some trace elements, not analysed in this study will be of importance.

References:

GGU report, 1971 (Only available as a copy without the front pages)

Giggenbach, W.F., 1988. Geothermal solute equilibria. Deviation of Na-K-Mg geoindicators. Geochim. Cosmochim. Acta, 52,2749-2765.

Giggenbach, W.F., 1991. Chemical techniques in geothermal exploration. In: D´Amore, F. (co-ordinator), Application of geochemistry in geothermal reservoir development. UNITAR/UNDP publication, Rome, 119-142.