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Analysis of groundwater from deep boreholes in Gideå

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A list of other reports published in this series during 1983 is attached at the end of this report. Information on KBS technical reports from 1977-1978 (TR 121), 1979 (TR 79-28), 1980 (TR 80-26), 1981 (TR 81-17) and 1982 (TR 82-28) is available through SKBF/KBS.

SUMMARY

Groundwater from two boreholes in granitic rock at an investigation site in Gideå has been sampled and analysed. This is part of a larger program of geological, geophysical and hydrogeological investigations aimed at finding a suitable site for a high level radioactive waste repository.

Five water-bearing levels in each borehole down to the deepest at about 500 m in the first and to about 600 m in the second borehole were selected. Prior to sampling, the water-bearing level is isolated between packer sleeves. The water is then pumped to the surface where sensitive parameters such as redox potential, pH, sulphide and oxygen content are measured electrochemically on the flowing water in a system isolated from the air. Water, filter and gas samples are sent to several laboratories for further analysis.

The present report is a presentation of the results of the groundwater analyses. The reliability of the results is discussed but there is no evaluation in relation to geology and hydrogeology. This report presents the basic results from the groundwater analyses to be further evaluated by experts in different fields.

CONTENTS

ANALYSIS OF GROUNDWATER FROM DEEP BOREHOLES IN GIDEÅ

1 INTRODUCTION

Groundwater from two boreholes in Gideå has been sampled and analyzed. GI2 is from an outflow area and GI4 from an inflow area. The sampling levels were chosen on the basis of hydrological measurements in the boreholes. Sampling was carried out by Sveriges Geologiska AB. Personnel from IPK and VIAK performed the field measurements and sampling. Several laboratories participated in the water analysis (see below).

The boreholes were pumped out with an airlift (using nitrogen gas) prior to the hydrological investigation and immediately before the equipment for water sampling was lowered to the first sampling level. On the latter occasion, three such airlift pumpings - also called mammoth pumpings - were performed in a row. Iodide (NaI, 0.01 mmol/l) was added to the drilling water during drilling to enable any residual drilling water to be traced in the groundwater. The selected fracture zones were sealed off by packers spaced at a distance of 2.7 m.

Sampling took place from the middle of May to the middle of September, 1983. Five levels were sampled in each borehole. The depth is given both as vertical depth (depth) and borehole length (length). It is always vertical depth that is given, unless otherwise specified in the table heading. The work was carried out in periods of 14 days. When the supply of water is adequate, a maximum of 4.5 cubic metres of water can be pumped up during one period.

The present report consists primarily of a presentation of the results of the groundwater analyses. The reliability of the results is subjected to some scrutiny. There is, however, no evaluation in relation to geology or hydrology. The material in this report will be further analyzed by experts in different fields.

The geology and hydrology of the test area will be described in KBS TR 83-53.

A general description of the chemistry of groundwater from great depths in granite and gneiss has previously been published by G Jacks (KBS TR 88). The same author has also described the chemistry of groundwater in Blekinge (KBS TR 79-07), where Sternö is situated. The results of analyses of the groundwater composition in Finnsjön are compiled in KBS TR 82-23 and a chemical evaluation of fracture minerals and the relation between fracture minerals and groundwater composition in Finnsjön has been published by E-L Tullborg and coworkers (KBS TR 82-20). The expected groundwater composition and its importance for the final storage of radioactive waste have been discussed in KBS TR 90 and the final report KBS-2 Volume 2 (Handling and Final Storage of Unreprocessed Spent Fuel, Technical Volume). Hydrology and groundwater age are also taken up in the latter report.

The sampling equipment will be described in KBS TR 83-44.

2 SAMPLING

2.1 Drilling water

Some of the drilling water that is used in the core drilling of the sampling holes can penetrate into rock fractures and contaminate the groundwater there. In order to get rid of the groundwater that has been contaminated with drilling water so that the original, undisturbed groundwater can be sampled, three mammoth pumpings (using nitrogen gas) have been carried out immediately prior to sampling in a borehole. The sampling pump is then allowed to work for 3-4 days at the chosen level before sampling begins. Periodic sampling during a pumping period makes it possible to follow changes in the composition of the water that might derive from flushing water or some other source of contamination.

Water from percussion-drilled boreholes has been used as drilling water. The drilling water was filtered through mechanical filters of cellulose (18 CMC 3-2), which are supposed to retain particles with a diameter larger than 5 μm.

The filtered drilling water was then analyzed. The results for the boreholes in question are presented at the bottom of the respective tables (tables 10, 11 and 13).

Before the drilling water was used, it was "marked" by the addition of sodium iodide (0.01 mmol/l in the drilling water). This is done in order to make sure that it will be possible to trace any drilling water that may have contaminated the sampled water. In the light of the analyses performed, the value of this tracer addition must unfortunately be deemed limited, for the following reason:

Unexpectedly high background concentrations of iodide were found in the analysis of three percussion-drilled boreholes within the area.

Percussion borehole	Level, m	I, mg/l
GI 12	90	0.005
GI 13	159	0.030
HBH 24	300	0.017

The above concentrations correspond to a drilling water contamination of 0.04-2.4%. Owing to the degree of uncertainty in the background concentration, iodide concentrations high enough to be of relevance in an analysis of drilling water contamination are found only on levels GI4, 384 and 596 m.

Just these two levels, however, exhibit relatively high chloride concentrations, 100-300 mg/l Cl. The chloride is always accompanied by small quantities of bromide and iodide. If we assume 3×10^{-4} mg I per mg Cl, which is a value that has been observed in connection with water sampling at Stripa, chloride concentrations of 100-300 mg/l correspond to iodide concentrations of 0.03-0.09 mg/l, which in turn would be erroneously interpreted as a drilling water contamination of 2-7%.

The conclusion is therefore that the water samples from levels GI4, 385 and 596 m have drilling water contents of 5-10%. For other levels, drilling water contamination is at least lower than the values calculated from the iodide analyses (see table 13).

2.2 Sampling equipment

A schematic illustration of the equipment is shown in Fig. 1.

The boreholes are core-drilled with a diameter of 56 mm. The 2.7 m long sampling zone is sealed off by rubber packers that are expanded to a pressure that is 0.8-1 MPa above the groundwater pressure. The sampling pump is positioned immediately above the sealed-off zone. The intake is from the upper part of the zone. The pump, which is made of steel and provided with teflon seals, has a maximum capacity of 0.12 l/stroke, equivalent to 330 l/d. The water flow available for sampling decreases if the flow of water in the measured rock is lower than the capacity of the pump.

The water is pumped up through teflon-lined iron pipes to a test chamber of stainless steel on the ground surface. The test chamber is equipped with electrodes and measuring cells for recording pH, Eh (glassy carbon), Eh (platinum), pS, and the oxygen content and conductivity of the water. The test chamber is also equipped with valves for the extraction of different types of water samples.

2.3 Procedure

Work at the boreholes is conducted in periods of 14 days. On the last day of a period, the sampling equipment is set up at the level that is to be sampled during the following period, and the sampling pump is started. The personnel then go home for 4 days off, after which sampling proceeds for 10 consecutive days. There were some disruptions in the programme - usually due to problems with the generators - as is evident from the notes to the table in 2.4.

2.4 Water flow during sampling

The water flow at different levels is shown in the table below. "Prior water volume" refers to the approximate volume of water pumped up from the level before sampling began.

BH	Depth m	Mean flow l/d	Prior water volume cubic meters	Total water volume cubic meters	Notes
GI2	157	275	1.3	7.7	1
	288	325	-	2.6	2
	353	260	0.2	2.3	2
	478	285	0.3	2.0	3
	528	252	1.3	3.5	
GI4	91	209	1.1	2.7	
	212	161	0.5	1.3	4
	385	158	1.0	2.2	
	498	225	1.6	3.2	
	596	1.6	0.013	0.07	5

Note 1 Sampling was conducted during 2 periods, since some equipment was not available at the beginning of the first period.

Note 2 Due to a malfunctioning generator, only an insignificant volume of water was pumped up during the break period before the sampling period.

Note 3 Due to the fact that sampling was delayed by a long-lasting generator malfunction prior to sampling on the 353 m level, sampling was started here on the day after the equipment was lowered.

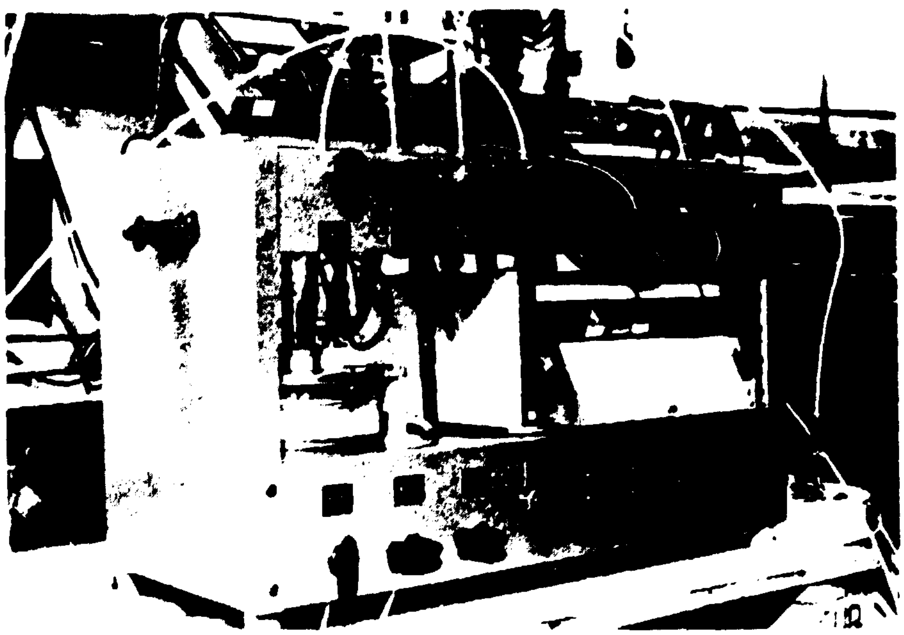
Note 4 Volume calculated up to day 24-7, when a pressure drop in the packers caused water to leak into the sampling section.

Note 5 Since the flow was very low, sampling continued here for a total of 45 days. The flow was about 2.2 l/d at the beginning of the period and about 1.2 l/d at the end of the period.

3 FIELD MEASUREMENTS

The field measurements are recorded in tables 1-8, the E^{o} values obtained from the field calibrations in table 9 and the field values obtained during water sampling in table 10.

The photograph below shows the field equipment with test chamber, measuring equipment and valves for water sampling.



3.1 Calibration

Each calibration has been assigned a calibration number. Measurements made after the calibration have the same number.

During calibration, the different calibration solutions are circulated through the test chamber. All calibration solutions are freshly prepared from concentrate and de-aerated distilled water, except the one used for calibration of the conductivity cell.

Three buffer solutions with pH 4, 7 and 10 are used for calibration of the pH electrode. Quinhydrone is added to the buffer solutions with pH 4 and 7 for simultaneous calibration of the Eh electrodes. Concentrate diluted to solutions that are 0.01 and 0.05 molar with respect to sulphide ion is used for calibration of the sulphide electrode. The E^{o} values obtained are presented in table 9.

The oxygen probe is calibrated against air-saturated distilled water and the conductivity cell against 0.01 and 0.1 mol/l KCl.

3.2 Measurement results

Each measuring occasion is identified with a calibration number, borehole designation, length of borehole (core length) as well as day and time. The vertical depths corresponding to the borehole lengths are shown in the table below.

Borehole	Length m	Depth m	Borehole	Length m	Depth m
GI2	178	157	GI4	96	91
	328	288		227	212
	400	353		404	366
	544	478		512	478
	602	528		616	596

Owing to the fact that it takes some time after each calibration before the water in the test chamber is representative of the borehole water and before the Eh and pS values have stabilized, no measurement results have been included from the calibration days. Nor are values included that have been obtained from obviously unsuccessful measurements owing to operational disturbances in the field.

A pressure drop was obtained in the packers in borehole GI4 on two occasions - days 22-5 and 24-7. Water may then have leaked into the section.

Owing to the extremely low water flow rate in GI4, 596 m, only measurement values from week 33 on have been included. Conductivity measurements from that time show that relatively stable conditions had been achieved. Recalibration was then carried out on day 33-5. Power failures occurred on days 34-5 and 34-7. For more than a week, measurement values were heavily influenced by the calibration and then by the power failures. Measurement results are therefore not reported again until from day 35-2. Owing to a new power failure on day 35-5, days 35-5 and 35-6 have not been included either.

3.3 Temperature measurement

The temperature is measured in the test chamber to permit calibration and calculation of the electrode potentials.

Owing to the relatively slow rate of water turnover in the test chamber, the temperature measured is affected by the air temperature and is therefore not representative of the groundwater.

3.4 Measurement of pH, Eh and pS

The system often seems to need to remain undisturbed for about a week before the Eh and pS values are more or less stable. The pH value stabilizes much faster.

The calibrations show that adjustments must be made fairly frequently, probably because a deposit builds up on electrodes and probes. The optimum time between two calibrations would therefore appear to be between 5 and 10 days. The electrodes were usually cleaned when they were lowered to a new level as well as before calibrations 112, 113, 117 and 154.

3.5 Oxygen measurement with probe

When the oxygen probe was recalibrated, it was found that the measuring error was 5-10% - in the negative direction, as a rule. In some cases, much larger errors (>90%) were found, and the probe had to be cleaned and the membrane changed. Values from such occasions are not reported.

It appears as if the oxygen probe has to be recalibrated more frequently than is possible according to 3.4 in order for meaningful results to be obtained.

3.6 Measurement of conductivity

There are no conductivity values for the beginning of GI2, 157 m owing to the fact that delivery of the measuring equipment was delayed.

Calibration was only done at the beginning of each level. The conductivity measurements were consistently stable.

4 MAIN COMPONENTS OF THE WATER

Each sampling occasion has been assigned a unique sampling number, which is the same for all samples taken on the same occasion ("Nr." in the tables).

The main components were analyzed by SGAB's water laboratory in Uppsala and by Hydroconsult in Stockholm. Some control analyses were performed by IVL (the Swedish Institute for Water and Air Pollution Research) in Stockholm. The analysis results are reported in tables 10-13. The table below shows which laboratory carried out the analyses and which method was used. Where there are two analyses of the same parameter, the mean value is reported.

Drilling water was analyzed by SGAB. The analyses are presented at the bottom of tables 10, 11 and 13.

	SGAB	H-con.		SGAB	H-con.
pH	*	*	HCO_3	g	k
Cond.	*	*	Cl	i	h
Turb.		*	F	n	k
Ca	a	b	SO_4	i	
Mg	a	b	PO_4		f
Na	a	c	NO_3		f
K	a	c	NO_2		f
Mn	a	d	NH_4		f
Fe(II)	e		SiO_2	m	m
Fe-tot	a		S	n	
Al		f	I	o	
Cu	a		TOC	p	q
Sr	a				

* Conventional according to Swedish Standard (SS)

a Optical emission with ICP (own design)

b Titrimetric with EDTA according to SS

c Emission with flame

d Atomic absorption

e Colorimetric with o-phenanthroline according to Standard Methods

f Colorimetric according to SS

g Specially designed titrator

h Titration according to Mohr (SS), high concentrations only

i Ion chromatograph, for chloride, low concentrations only

k Potentiometrically according to SS

m Colorimetrically with methylene blue according to Standard Methods

n Potentiometrically

o Colorimetrically

p Carbon analyzer from Carlo-Erba

q Carbon analyzer from Oceanographic

The field values obtained simultaneously with the water sampling (field) and the laboratory analyses (lab) of the field parameters are presented in table 10. Note that the field values, which are measured during water sampling, are often not representative of the borehole. Sampling may, for example, have been done immediately after a calibration.

"Date sampling" refers to the sampling day and "Date lab" to the day the samples were received at the laboratories. In both cases, the date is given with the number of the week followed by the number of the day of the week. (Day 1 is Monday.)

"Drilling water residue" (table 13) is the fraction of the added iodine concentration in the drilling water (2.1) that has turned up in the groundwater. No correction is made for the water's natural iodide content (2.1).

All determinations of metal ions are presented in table 11, while table 13 shows TOC, turbidity, and the negative ions that do not contain nitrogen. Finally, the parameters that contain nitrogen are compiled in table 12. The analysis results are given both as the concentration of the ion and the concentration of nitrogen.

4.1 Sampling

The water samples were taken through a valve in immediate connection with the test chamber. On each sampling occasion, a new tube, kept well protected from dust, was attached to the valve. The free and untouched end of the tube was inserted down to the bottom of the sample bottle. At least two bottle volumes of sample water were allowed to run over before the bottle was sealed, without any air having been trapped inside. The samples were kept in a refrigerator awaiting transport (4.2).

On level GI4, 596 m, where the water flow was only about 1.5 l/d, one composite sample was taken during the day. It was divided into different samples as specified below. This level is not taken into account in the run-through of individual analysis parameters below (4.4-4.7).

4.1.1 Unpreserved samples for analysis of negative ions etc were taken in bottles of borosilicate glass (1 litre) with a ground, filled stopper held in place with a steel clip.

In order to keep the ground surface moist so that no air can leak through, the bottles were stored and transported upside-down.

4.1.2 Preserved samples for analysis of metal ions were taken in acid-washed polyethylene bottles (250 ml).

The samples were preserved with 2.5 ml of concentrated hydrochloric acid (super-pure). The acid was added through a dispenser below the sample surface immediately before the sample bottle was sealed. Hydrochloric acid was chosen as a preservative because iron(II) was to be determined.

4.2 Transport of samples

The samples were packed in specially-made insulated boxes with frozen blocks. The boxes were mailed "express" on the afternoon of the sampling day and delivered to the laboratory the following morning. No water sampling took place on Fridays and Saturdays, since the samples could then not be received by the laboratory until Monday or Tuesday. The Sunday samples were sent together with the Monday samples.

4.3 Sampling levels

Field analyses representative of the borehole are presented in tables 1-8, while the field analyses in table 10 are only representative of the sampling occasion.

Except for the redox-affected parameters, the analysis results are strikingly consistent within the levels.

4.3.1 Leakage of water into the section due to pressure drop in the packers may have occurred on two occasions: in GI4, 91 m before sampling No. 183 and in GI4, 212 m before sampling No. 189. No appreciable change in the analysis results is noticeable in either case.

No. 183 exhibits the level's lowest pH, conductivity, calcium, magnesium, bicarbonate, chloride, phosphate and ammonia concentrations and the highest concentrations of iron, sulphate and silicic acid, which shows that neither drilling water nor water from the next sampled level can have leaked in. The iodide determination also confirms this.

In the case of sampling No. 189, the changes are even less noticeable. The concentrations of calcium, chloride and sulphate are, however, slightly lower starting with No. 189 and the sodium concentration slightly higher.

At GI4, 596 m, the packers had to be opened on one occasion due to a pump fault. Here we see a very pronounced change of the drilling water concentration according to the iodide analysis starting with sampling No. 206. The natural conclusion is therefore that a heavy inflow of drilling water has occurred from a fracture zone. However, this interpretation is not supported by other analyses.

4.3.2 In GI2, the water from all levels is very similar - dissimilarities between the levels are often of the same magnitude as the precision of the analysis. Significant differences are, however, found in several parameters: potassium is lowest at 353 m, iron lowest at 157 m, sulphate highest at 157 m and lowest at 478 and 528 m and phosphate highest at 528 m.

4.3.3 GI4 has two levels - 212 m and 596 m - with considerably higher salt content (conductivity) than other levels. Other dissimilarities between the levels are also strikingly large here: Levels 91 and 498 m have the highest magnesium concentrations and the lowest concentrations of chloride and fluoride, level 498 m has the lowest sodium and the highest iron concentration measured within the area, and on the salt-containing level 385 m, bicarbonate and sulphate reach their absolutely lowest concentrations, as does silicon on the salt-containing level 596 m. The latter can probably be related to the fact that the pH is also lowest there. The level 498 m is further commented on in section 6.3.

4.4 pH and conductivity

These parameters were determined directly in the field and by both laboratories (table 10). The field values are systematically around 5% higher than the laboratory values. A similar difference has been noted in many groundwaters. There is also a small systematic difference between the laboratories, which may be attributable to the fact that Hydroconsult, which notes the lower value, thermostated its samples at 25°C before measurement.

The differences within the levels are small, as a rule. The pH variation (field) within all of GI2 is only 8.6-8.8, while it is 7.0-9.4 in GI4.

The highest pH values were measured in GI4, 385 m, where the bicarbonate concentration is lowest.

4.5 Organic carbon (TOC)

No parameter exhibits as large differences between the laboratories as TOC - SGAB's results are often more than twice as much as Hydroconsult's. Control analysis at two Swedish laboratories comes closer to verifying SGAB's high results, while analysis at a laboratory in the United States, which specializes in the determination of humic and fulvic acids, confirmed Hydroconsult's low values. The mean value is reported with only one figure (table 13).

The concentrations vary in the two boreholes between 2 and 5 mg/l, which is the same variation as was noted in GI2, 528 m. At level GI4, 385 m, the variation is 2-4 mg/l.

4.6 Negative ions

The negative ions are compiled in tables 12 and 13. The results generally show good consistency within the sampling zones.

The largest difference within the levels is found in the nitrogen-containing parameters (table 12). In some cases, the differences are due to a shift in the redox equilibrium, which is evident from the column "Sum-N".

The ratios between the different anions vary widely in GI4. The differences are often drastic, for example the ratio of Cl/SO_4 in GI4, 91 m is about 1/3, while it is about 1700 in GI4, 385 m.

4.7 Positive ions

The positive ions are compiled in table 11. In GI2, the concentrations differ very little between water samples from the same level as well as between samples from different levels.

In GI4, on the other hand, the differences between the levels are remarkedly large. Most remarkable is the very low sodium concentration in the water from GI4, 498 m compared with other levels.

4.7.1 Lanthanum, neodymium and ytterbium were determined in the same samples as strontium. In all cases, the concentrations were below the detection limit (<0.005 mg/l).

5 PARTICULATE MATTER

The particulate matter was subjected to several different types of analyses (5.1-5.5).

5.1 Chemical composition

The water was filtered through a membrane filter (Millipore, pordiameters 0.45 μm) installed directly after the test chamber. The filtered volume was between 475 and 2300 ml. The larger volume was reached in water with a turbidity of about 1 or lower, whereas only 850 ml was obtained in sample 193 with a turbidity of 0.6.

The total concentration on the membrane was determined by X-ray fluorescence at SGU's (the Geological Survey of Sweden) laboratory in Luleå. The concentrations are presented in table 14 as mg/l of filtered sample. The quantity of copper, strontium, lanthanum, neodymium and ytterbium was always below the detection limit (1, 1, 3, 2 and 2 μg, respectively) on the membrane.

Sulphur could not be determined for samplings Nos. 184 and 188 due to the fact that a membrane without a known background concentration had been used.

The large concentration variations, as well as the variation in the ratios Fe/S and Fe/Al (10-100 and 0.1-5, respectively) are undoubtedly large due to the fact that the particle quantity varied widely between the samplings.

5.2 Turbidity

Turbidity (table 13) was determined for all samples except those from GI4, 596 m. Not unexpectedly, the highest metal concentrations obtained in the chemical analysis (5.1) were measured in samples with high turbidity.

5.3 Particle distribution

The particle distribution within the range 2-80 μm was determined on water from the three lowermost levels in the two boreholes (Fig. 2). The determination was performed by VIAK's water pollution research laboratory in Stockholm.

NOTE! It is the length of the borehole and not its vertical depth that is indicated on the curves.

5.4 Humic and fulvic acids

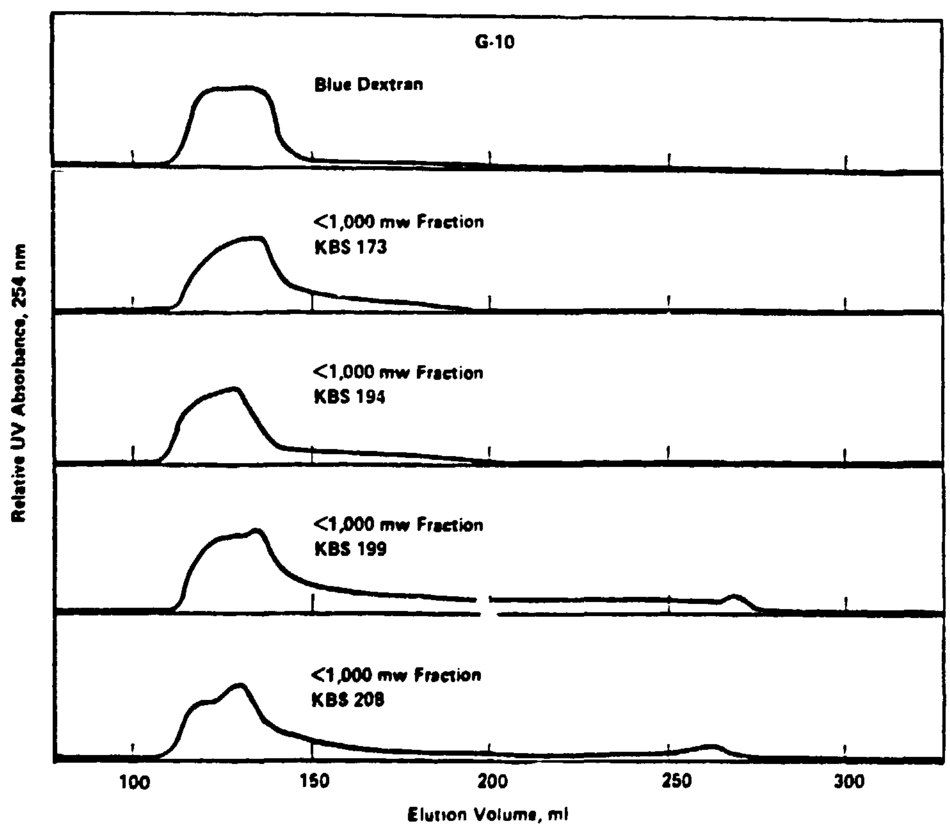
The determination was performed at Batelle, USA, through combined dialysis and gel film chromatography (GFC). The method, which fractions the sample into humic acids and four molecular weight fractions of fulvic acids, is described by Means et al 1977 (Limnol. Oceanogr. 22, 957-965), but sodium tetraborate (pH 9.1) was used on recommendation by Swift Posner 1971 (J. Soil Science, 22, 237-249).

Owing to the samples' low content of organic material, they were first concentrated 10 times before analysis. No loss of volatile organic matter was found in connection with the concentration process.

No humic acids were present in the samples. The samples' contents of different molecular weight fractions of fulvic-acid-like substances are shown in the table below. The eluate's UV absorbance, recorded continuously at 254 nm, is shown in the figure.

Level	Nr	>1000	700-1000	300-700	<300
GI2, 478m	173	43	47	10	0
GI2, 528m	208	55	34	6	5
GI4, 385m	194	21	68	11	0
GI4, 498m	199	29	40	19	12

According to Means, the results strongly indicate that the most important organic constituents are hydrophilic polymer substances with low to medium molecular weights - probably fulvic acids or similar substances, which are the predominant substances in natural waters.



6 ISOTOPE ANALYSIS

Isotope analysis of low atomic weight substances in the water is done mainly to permit calculations of the age and origin of the water. The high atomic weight radioactive substances are determined primarily because the natural background concentrations are of great interest for the KBS project.

The analyses were carried out at the following laboratories:

- Laboratory for Isotope Geology, Stockholm (6.1, 6.3)
- Institute for Radiohydrometry, Neuherberg, West Germany (6.2, 6.4)
- Mass Spectrometry Laboratory, Uppsala University (6.4)
- Studsvik Energiteknik, Nyköping, Sweden (6.5)

6.1 Carbon isotopes

Prior to the determination, which is used for dating by means of the carbon-14 method, the water's contents of carbon dioxide and carbonate have to be concentrated. It is thereby of the utmost importance that the concentrate not be contaminated by air or chemicals.

6.1.1 Sample preparation is done in the field. A polyethylene barrel holding 130 l and filled from the beginning with nitrogen is filled with water. Hydrochloric acid is added to disintegrate carbonates present in the water. A nitrogen gas stream is then used to drive the carbon dioxide over to a wash bottle containing sodium hydroxide.

6.1.2 The age is presented in the table below as "Age BP" and the age after correction for C-13 content as "Age BP, corr".

Bore-hole	Depth m	Nr	Age BP	Age BP corr	C-13 o/oo
GI2	288	164	6355	6445	-19.6
GI2	352	167	6460	6570	-18.1
GI2	478	175	6620	6720	-18.7
GI2	528	208	6360	6435	-20.4
GI4	212	189	11810	11895	-19.6
GI4	498	199	3780	3850	-20.7

Ages are lacking from the uppermost levels owing to a mishap in connection with sample preparation, from GI4, 385 m due to the very low content of bicarbonate in the water and from GI4, 596 m due to an insufficient supply of water.

6.2 Deuterium and oxygen

The analyses have been used in calculations aimed at obtaining a better knowledge of the origin of the water and of the chemical processes that have occurred between the rock and the water. The deuterium concentration also provides information on previous climatic conditions.

The concentrations in the table refer to deviations in per mill from SMOW (Standard Mean Oceanic Water). The analyses were performed in West Germany (D) and in Sweden (S).

Bore-hole	Depth m	Nr	H-2 (D)	O-18 (D)	O-18 (S)
GI2	157	155	-90.9	-12.55	
	157	159	-90.4	-12.62	
	288	164	-90.1	-12.57	
	353	167	-91.4	-12.68	-12.62
	478	175	-89.5	-12.44	-12.71
	528	208	-92.7	-12.73	-12.73
GI4	91	184	-93.4	-12.93	
	212	189	-89.7	-12.55	
	385	194	-99.4	-13.65	-13.67
	498	199	-94.1	-12.94	-13.09
	596	206	-100.8	-13.81	-13.88

6.3 Tritium

Owing to its short half-life (about 12 years), tritium is an important isotope in hydrologic studies. The amount of tritium in the atmosphere has increased drastically due to the tests with nuclear weapons. The tritium content of rainwater has increased by more than 10 times, which makes it possible to determine whether "young" water is present in a groundwater sample.

Bore-hole	Depth m	Nr	Tr TU
GI2	157	155	<3
GI2	157	159	<3
GI2	288	164	<3
GI2	353	167	<3
GI2	478	175	<3
GI2	528	208	<3
GI4	91	184	36
GI4	212	189	5
GI4	385	194	8
GI4	498	199	49
GI4	596	206	10

The tritium concentration is given in the tables in the unit TU, which is the number of tritium atoms per 10^{18} hydrogen atoms.

No tritium determination has been carried out on the drilling water used here. Two other drilling waters (GI12, 90 m and CI13, 159 m) have given results of 13 and 37 TU tritium, respectively.

In GI4, 498m, the unusually high tritium content (49TU), the general water composition and the unexpectedly large water flow (225 l/d) in relation to the low hydraulic conductivity (10^{-11} m/s) indicate a large portion of near-surface water present, probably entering through the borehole.

6.4 Uranium, thorium, radium and radon

The natural concentration of these elements in the groundwater is of great importance for the project. Moreover, the ratio between different uranium isotopes, as well as the uranium/ thorium ratio, are also used in dating.

The analyses are reported in table 15. The concentrations for U, Ra and Rn are given in Bq/l. The following relationships apply:

39.4 μg U per Bq
2.74×10^{-5} μg Ra-226 per Bq
1.76×10^{-10} μg Rn-222 per Bq

7 GAS ANALYSIS

Helium was determined in the gas that spontaneously leaves the water on its passage through a Horst bottle. The analysis was carried out by AGA SpecialGas, Lidingö.

In the table below, besides the percentage content of helium in the gas phase, the amount of water that has passed through the Horst bottle and the obtained gas volume are also given. This enables the reader to form his own rough idea of the quantity of dissolved gases in the water. The helium content of the water has not been calculated, since degassing is dependent on a number of uncontrolled parameters. We know, for example, that temperature variations of >20°C occur in the tent where the borehole opens out and the sampling equipment is located.

BH	Depth m	Nr	Helium %	Water volume l	Gas volume ml	Notes
GI2	157	159		257	c:a 4	1
	288	164	c:a .025	237	" 5	1
	353	167	0.032	420	135	
	478	173	0.046	248	60	
	528	210	0 015	391	45	
GI4	91	184	<.005	289	125	
	212	189	0.16	139	45	
	385	194	0.81	5.8	163	
	498	199	0.006	416		2
	596	205	0.067	0.23	72	

Note 1 Insufficient gas volume for analysis.
Note 2 Data on gas volume lacking.

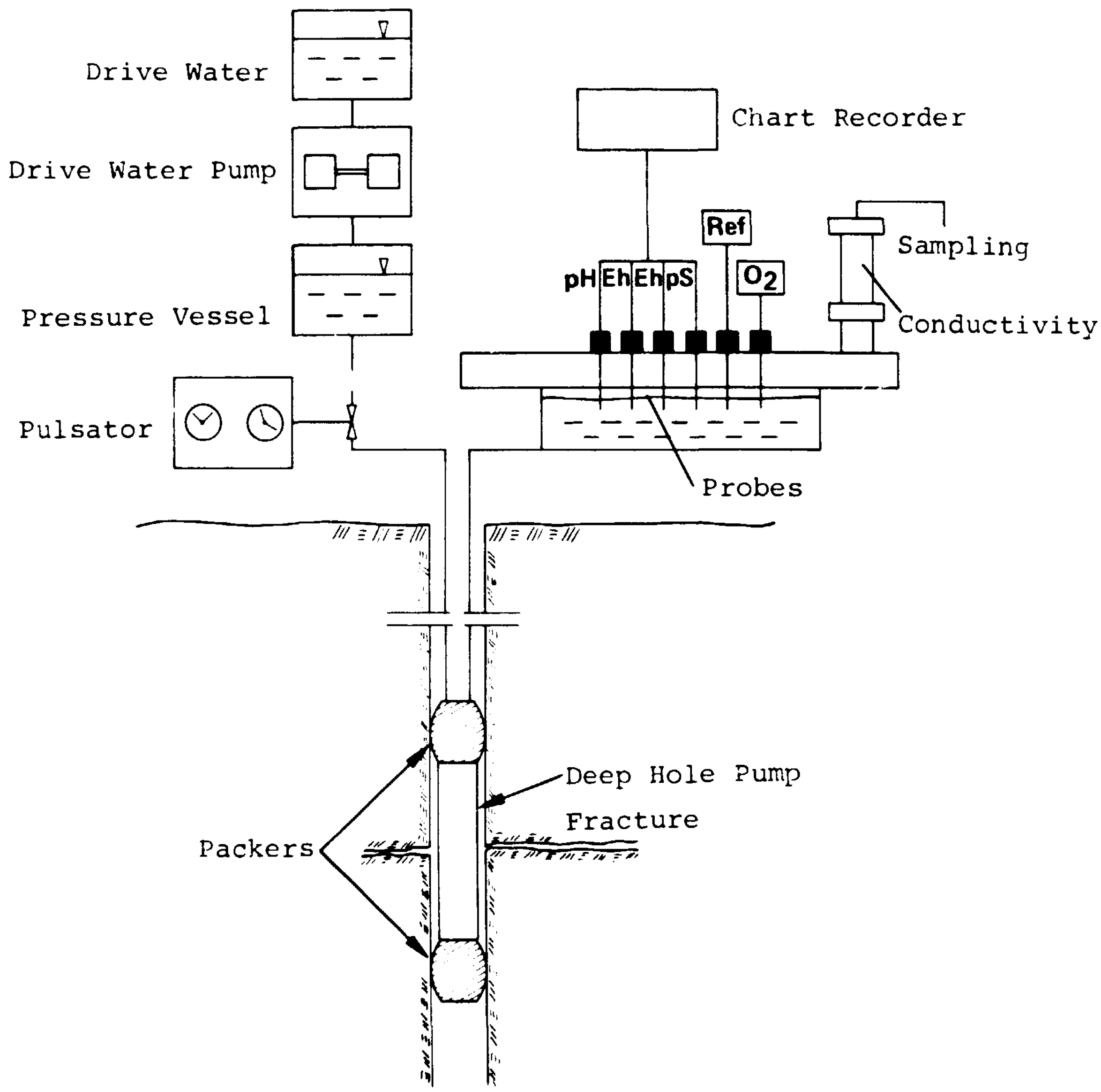


Figure 1. Schematic illustration of sampling equipment

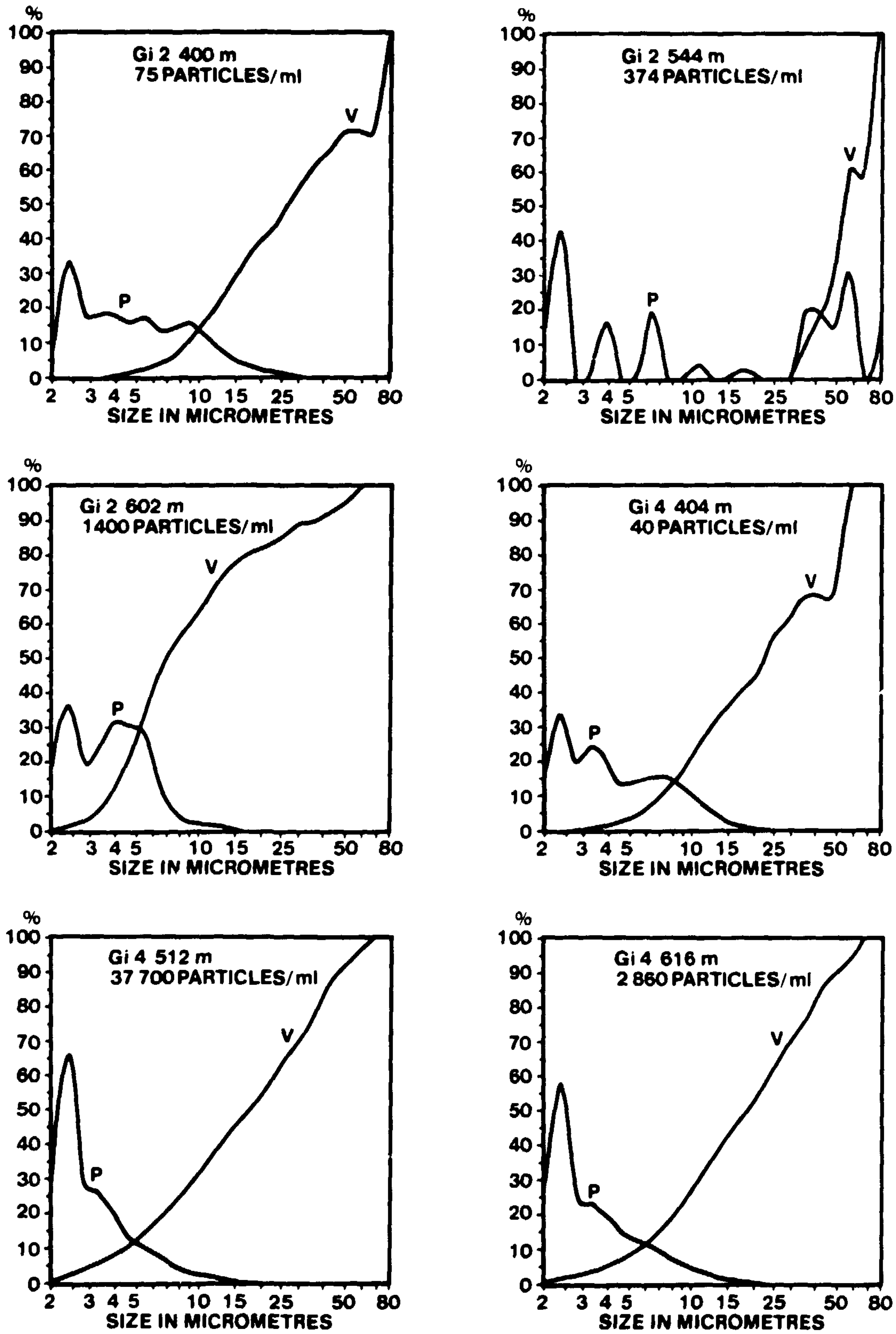


Figure 2. Particle size distribution analysis in the region 2-80 µm. An HIAC PA 500 instrument is used. P represents the percent of the total number of particles with a certain particle size. V represents the percent of the total particle volume less than a certain particle size.

Table 1

GIDEA – Field measurements

Calibration nr	Borehole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh.C mV	Eh.Pt mV	pS	Oxygen mg/l	Conductivity mS/m
102	GI2	178									
			20-3	730	7.0	8.74	-21	-34	15.97	.10	
			20-3	835	7.5	8.72	-25	-37	15.52	.10	
			20-3	1200	8.0	8.71	-35	-47	13.62	.07	
			20-3	1250	8.0	8.71	-36	-50	13.05	.06	
			20-3	1530	7.0	8.77	-37	-53	11.73	.05	
			20-4	715	6.0	8.75	-41	-82	10.98	.01	
			20-4	905	6.6	8.74	-49	-85	10.92	.04	
			20-4	1325	7.1	8.74	-53	-90	10.83	.05	
			20-5	720	5.5	8.77	-44	-108	10.85	.01	
			20-5	820	5.7	8.77	-45	-108	10.84	.02	
			20-5	930	6.0	8.76	-47	-109	10.83	.04	
103	GI2	178									
			20-6	715	5.8	8.79	-22	-41	12.72	.05	
			20-6	815	6.1	8.78	-25	-43	12.16	.05	
104	GI2	178									
			20-7	725	6.1	8.77	-28	-48	11.98	.04	
			20-7	940	6.7	8.75	-32	-52	11.24	.05	
			20-7	1140	6.8	8.75	-33	-57	11.05	.05	
			20-7	1310	6.9	8.76	-37	-61	10.94	.06	
			20-7	1400	6.9	8.75	-37	-61	10.98	.06	
			20-7	1555	6.9	8.75	-40	-66	10.91	.04	
			21-1	720	5.9	8.76	-42	-91	10.69	.00	
			21-1	950	6.5	8.74	-44	-94	10.63	.02	
			21-1	1245	6.6	8.75	-44	-94	10.59	.02	
			21-1	1400	6.4	8.75	-44	16	10.60	.01	
			21-1	1615	6.0	8.78	-44	-98	10.58	.00	
			21-2	715	5.7	8.79	-42	-107	10.59	.00	
			21-2	830	5.8	8.78	-41	-108	10.59	.00	
			21-2	1130	6.0	8.77	-41	-109	10.58	.00	
105	GI2	178									
			22-2	1105	6.9	8.80	55	30	22.64		27.5
			22-2	1315	7.1	8.81	55	29	22.62		27.5
106	GI2	178									
			22-3	735	6.1	8.83	15	9	22.13		27.5
			22-3	820	6.4	8.81	16	12	22.25		27.5
			22-3	915	6.8	8.82	12	4	21.96		27.5
			22-3	1110	7.1	8.80	10	2	21.80		27.5
			22-3	1230	7.2	8.79	11	2	21.79		27.5
			22-3	1430	7.5	8.75	11	2	21.69		27.5
			22-3	1545	7.6	8.75	10		21.61		27.5
			22-4	730	6.8	8.79	-4	-11	21.17		27.3
			22-4	920	7.0	8.77	-4	-13	21.08		27.3
			22-4	1100	7.0	8.75	-1	-10	21.16		27.3
			22-4	1200	7.0	8.77	-6	-16	20.98		27.3
			22.4	1300	7.2	8.75	-6	-17	20.93		27.3
			22-4	1430	7.0	8.78	-3	-16	20.94		27.2
			22-4	1530	7.0	8.78	-4	-17	20.94		27.3
			22-5	725	6.8	8.73	-16	-25	20.52		27.3
			22-5	950	7.2	8.77	-17	-26	20.46		27.2
			22-5	1155	7.6	8.74	-18	-28	20.36		27.2
			22-5	1300	7.7	8.72	-19	-30	20.24		27.2
			22-5	1430	7.9	8.72	-19	-30	20.23		27.2
			22-5	1600	7.9	8.71	-16	-23	20.44		27.2
			22-6	655	6.8	8.79	-27	-38	19.91		27.1
			22-6	815	6.9	8.78	-28	-38	19.87		27.1
107	GI2	178									
			22-7	700	5.8	8.78	14	-1	19.01	20	27.0
			22-7	900	6.0	8.77	12	-2	18.88	20	27.0
108	GI2	178									
			23-1	700	5.7		24	2	18.76		27.0
			23-1	800	6.0		18	-2	18.60		27.0
			23-1	900	6.1		14	-3	18.55		27.0
			23-1	1130	6.2		10	4	18.84		27.0
			23-1	1350	6.2	8.70	46	18	19.41		27.0
			23-1	1445	6.2	8.70	31	13	19.23		27.0
			23-1	1535	6.3	8.69	31	13	19.26		27.0
			23-2	700	5.5	8.72	24	4	18.63		26.9
			23-2	915	5.8	8.71	16	1	18.43		27.0
			23-2	1040	6.0	8.72	13	-1	18.23		27.0
			23-2	1140	6.0	8.73	13	-1	18.31		27.0
			23-2	1400	6.0	8.72	12	-3	18.13		27.0
			23-2	1535	6.1		9	-5	18.01		27.0
			23-3	730	5.2	8.73	8	-10	17.31		26.9

Table 2

GIDEA - Field measurements

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh.C mV	Eh.Pt mV	pS	Oxy-gen mg/l	Conduc-tivity mS/m
111	GI2	328									
			24-3	710	5.8	8.76	-11	3	17.89		26.7
			24-3	800	5.9	8.71	5	19	19.18		27.0
			24-3	1000	6.0	8.77	-18	-5	18.02		26.9
			24-3	1155	6.2	8.75	-20	-11	18.01		26.9
			24-3	1305	6.1	8.77	-20	-14	18.01		26.9
			24-3	1400	6.2	8.71	-17	-10	18.29		26.9
			24-3	1500	6.2	8.75	-15	-9	18.26		27.0
			24-4	655	5.8	8.80	-31	-28	17.85		27.0
			24-4	900	5.8	8.80	-33	-29	17.92		27.0
			24-4	1100	6.1	8.79	-34	-31	17.80		26.9
			24-4	1130	6.1	8.79	-37	-34	17.61		26.9
			24-4	1235	6.1	8.79	-38	-36	17.65		26.9
			24-4	1330	6.2	8.75	-36	-33	17.82		26.9
			24-4	1455	6.2	8.77	-33	-29	17.79		26.9
			24-4	1600	6.2	8.77	-37	-33	17.68		26.9
			24-5	500	5.8	8.82	-44	-44	17.20		26.9
			24-5	700	5.8	8.82	-46	-46	17.09		26.9
			24-5	830	5.9	8.81	-48	-47	16.94		27.0
112	GI2	328									
			24-6	700	5.8	8.80	-52	-47	17.31		26.9
			24-6	830	6.0	8.79	-56	-53	16.90		26.9
113	GI2	328									
			24-7	700	6.0	8.81	-45	-39	17.73		26.9
			24-7	800	6.0	8.81	-47	-42	17.48		26.9
			24-7	910	6.0	8.81	-50	-44	17.30		26.9
			24-7	1005	6.1	8.81	-52	-49	16.86		26.9
			24-7	1200	6.2	8.77	-55	-53	16.49		26.9
			24-7	1410	6.3	8.80	-60	-59	15.87		26.9
			24-7	1500	6.4	8.80	-61	-61	15.68		26.9
			24-7	17	6.3	8.80	-64	-65	15.40		26.9
			25-1	700	5.9	8.90	-77	-80	13.73		26.9
			25-1	900	6.0	8.88	-76	-82	13.61		26.9
			25-1	1105	6.3	8.86	-78	-84	13.49		26.9
			25-1	1315	6.2	8.82	-77	-85	13.42		26.9
			25-1	1500	6.3	8.84	-80	-87	13.35		26.9
			25-1	1600	6.3	8.84	-81	-87	13.31		26.9
			25.2	655	5.9	8.96	-81	-92	13.00		26.9

Table 3

GIDEA – Field measurements

Calibration nr	Borehole	Hole-length m	Date ww-d	Time	Temp °C	pH	Eh,C mV	Eh,Pt mV	pS	Oxygen mg/l	Conductivity mS/m
115	GI2	400									
			26-7	645	6.1	8.63	1	20	20.11	25	[illegible]
			26-7	850	6.1	8.63	-4	22	20.00	26	[illegible]
			26-7	1005	6.2	8.62	-9	15	19.85	26	[illegible]
			26-7	1230	6.2	8.64	-13	8	19.66	24	[illegible]
			26-7	1445	6.2	8.62	-17	1	19.63	22	[illegible]
			26-7	1640	6.2	8.61	-17	-2	19.59	22	[illegible]
			27-1	655	6.2	8.64	-36	-20	18.87	10	[illegible]
			27-1	905	6.8	8.62	-38	-31	18.76	09	[illegible]
			27-1	1100	7.0	8.60	-37	-32	18.67	10	[illegible]
			27-1	1200	7.0	8.60	-43	-36	18.49	09	27.0
			27-1	1445	7.0	8.62	-47	-41	18.10	07	27.0
			27-1	1540	7.0	8.62	-47	-45	17.92	06	27.2
			27-2	650	6.3		-71	-73	15.62	01	27.1
			27-2	950	6.8	8.64	-74	-76	15.23	01	27.1
			27-2	1120	7.1	8.61	-77	-80	15.00	03	27.1
			27-2	1215	7.1	8.60	-78	-81	14.89	.04	27.1
			27-2	1520	7.3	8.59	-80	-85	14.66	04	27.1
			27-3	800	6.3	8.66	-87	-94	13.74	01	27.1
			27-3	1000	6.8	8.66	-84	-94	14.01	01	27.1
			27-3	1110	7.0	8.64	-84	-95	13.71	00	27.1
116	GI2	400									
			28-1	1200	8.2	8.53	-73	-72	15.87	.03	26.5
			28-2	810	6.8	8.57	-76	-76	15.19	00	26.7
			28-2	1150	7.1	8.58	-78	-79	15.03	00	27.2
			28-2	1225	7.2	8.57	-76	-77	15.06	00	27.2
117	GI2	400									
			28-3	800	6.9	8.80	-7	-53	19.18	.06	27.0
			28-3	900	7.0	8.80	-46	-60	18.89	.06	27.0
			28-3	1040	7.5	8.75	-54	-63	18.68	.06	27.0

Calibration nr	Borehole	Hole-length m	Date ww-d	Time	Temp C	pH	Eh,C mV	Eh,Pt mV	pS	Oxygen mg/l	Conductivity mS/m
117	GI2	544									
			28-4	1015	9.3	6.64	117	0	21.59	.07	27.2
			28-4	1115	8.0	6.60	117	-22	20.61	.06	27.2
			28-4	1245	7.9	6.55	63	-36	20.05	06	27.2
			28-4	1325	7.8	6.53	33	-40	19.88	05	27.2
			28-4	1425	8.0	6.51	14	-44	19.61	05	27.2
			28-4	1620	8.1	6.45	-14	-44	19.85	05	27.2
			28-5	750	7.5	6.57	-73	-87	15.59	03	30.5
			28-5	850	7.8	6.55	-76	-90	15.43	01	30.5
118	GI2	544									
			28-6	755	7.2	8.90	-51	-57	19.27		27.5
			28-6	900	7.3	8.88	-32	-35	20.67		27.5
			28-6	1000	7.5	8.87	-26	-33	20.65		27.5
119	GI2	544									
			28-7	820	7.3	8.63	-18	-22	20.70	11	27.1
			28-7	920	7.5	8.57	-17	-10	20.90	11	27.1
			28-7	1120	7.8	8.63	-13	-14	20.92	11	27.1
			28-7	1220	7.8	8.48	-16	-18	20.77	07	27.1
			28-7	1450	7.7	8.58	-22	-22	20.60	05	27.1
			28-7	1605	8.0	8.51	-22	-24	29.86	05	27.1
			29-1	1230	7.2	8.90	-37	-46	19.77	02	[illegible]
			29-1	1400	7.3	8.73	-90	-48	19.08	01	[illegible]
			29-1	1600	7.3	8.77	-83	-69	17.93	00	[illegible]
			29-2	850	7.2	8.79	-72	-89	15.89	00	27.1
			29-2	950	7.1	8.79	-77	-91	15.57	00	27.1
			29-2	1110	7.1	8.81	-81	-92	15.42	01	27.1
			29-2	1345	7.4	8.82	-77	-95	15.23	00	27.1
			29-2	1550	7.3	8.82	-84	-95	15.06	00	27.1
			29-3	650	6.0	8.88	-87	-94	14.59	01	27.1

Table 4

CIDEA – Field measurements

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh.C mV	Eh.Pt mV	pS	Oxy-gen mg/l	Conduc-tivity mS/m
120	G12	602									
			29-4	1050	7.0	8.35	15	12	21.55	.00	30.[illegible]
			30-1	750	7.0	8.81	-61	-61	16.55	.01	26.9
			30-1	1000	7.3	8.81	-62	-63	16.39	.02	26.9
			30-1	1100	7.4	8.80	-62	-63	16.31	.01	26.9
			30-1	1235	7.7	8.81	-63	-64	16.19	.00	26.9
121	G12	602									
			30-2	705	6.5	8.65	-16	-11	20.54	.70	26.6
			30-2	945	7.4	8.60	-12	-9	20.51	.40	26.6
			30-2	1145	7.7	8.60	-18	-13	20.39	.37	26.6
			30-2	1305	7.9	8.61	-14	-11	20.51	.37	26.6
			30-2	1505	8.3	8.60	-19	-15	20.23	.35	26.6
			30-2	1630	8.2	8.62	-21	-16	20.21	.31	26.6
			30-3	655	7.0	8.67	-33	-30	19.54	.25	26.6
			30-3	900	7.2	8.70	-48	-55	18.84	.05	26.6
			30-3	1000	7.5	8.69	-52	-57	18.60	.05	26.6
			30-3	1000	7.5	8.69	-52	-57	18.60	.05	26.6
			30-3	1200	8.0	8.68	-55	-59	18.39	.05	26.6
			30-3	1430	7.9	8.70	-55	-59	18.36	.03	26.6
			30-3	1600	7.9	8.70	-56	-61	18.29	.00	26.7
			30-4	700	7.0	8.74	-63	-69	17.81	.00	26.5
			30-4	900	7.7	8.72	-66	-72	17.62	.00	26.7
			30-4	1100	9.0	8.63	-44	-42	18.40	.00	26.6
			30-4	1310	8.5	8.68	-60	-66	18.04	.00	26.6
			30-4	1510	8.5	8.68	-69	-75	17.54	.01	26.6
			30-4	1620	8.5	8.68	-70	-77	17.39	.01	26.1
			30-5	700	7.2	8.77	-75	-83	16.43	.01	26.5
			30-5	900	8.0	8.71	-76	-84	16.28	.01	26.5
			30-5	1000	8.2	8.69	-75	-84	16.19	.00	26.5
122	G12	602									
			30-6	650	7.5	8.87	-64	-64	17.81	.00	26.6
			30-6	900	8.0	8.86	-69	-70	17.39	.00	26.7
			30-6	1100	8.9	8.83	-75	-76	16.90	.00	26.7
			30-6	1215	9.0	8.82	-77	-79	16.61	.01	26.7
123	G12	602									
			30-7	700	7.8	8.68	-64	-64	17.87	.01	26.5
			30-7	900	8.7	8.65	-69	-70	17.45	.01	26.7
			30-7	1100	9.3	8.64	-74	-76	16.99	.03	26.5
			30-7	1400	10.0	8.63	-83	-86	16.05	.02	26.5
			30-7	1600	9.8	8.66	-86	-89	15.71	.01	26.7
			31-1	600	7.2	8.77	-90	-96	14.20	.00	26.6
			31-1	800	8.5	8.73	-93	-97	13.99	.00	26.7
			31-1	1015	9.0	8.72	-94	-101	13.75	.00	26.6
			31-1	1200	9.0	8.72	-95	-103	13.54	.01	26.6
			31-1	1330	9.0	8.72	-95	-103	13.50	.01	26.6
			31-2	640	7.0	8.81	-93	-105	12.48	.01	26.6
			31-2	840	8.0	8.78	-95	-106	12.30	.02	26.7
			31-2	950	8.2	8.78	-96	-108	12.22	.02	26.7
			31-2	1245	8.8	8.76	-96	-109	11.98	.04	26.7
			31-2	1500	8.5	8.77	-96	-109	11.88	.00	26.7

Table 5

GIDEA - Field measurements

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh, C mV	Eh, Pt mV	pS	Oxy-gen mg/l	Conduc-tivity mS/m
150	GI4	96									
			22-4	745	6.9	7.85	93	88	16.02	.05	23.7
			22-4	840	7.1	7.98	93	86	16.04	.05	23.9
			22-4	1040	7.9	7.82	91	88	16.68	.06	23.9
			22-4	1140	9.0	7.81	81	80	16.83	.05	23.9
			22-4	1335	9.6	7.78	79	74	15.90	.05	23.9
			22-4	1520	8.5	7.81	82	75	15.53	.02	23.9
			22-5	1330	9.8	7.65	76	59	13.00	.02	23.0
			22-5	1520	10.5	7.66	72	51	13.01	.05	23.2
			22-6	735	7.8	7.89	45	20	12.70	.01	23.6
			22-6	830	7.8	7.89	44	19	12.70	.01	23.5
152	GI4	96									
			22-7	1405	9.0	7.75	92	87	22.18	1.40	24.0
			22-7	1530	8.0	7.80	88	82	21.58	.65	23.9
			23-1	755	7.6	7.92	64	22	13.21	.05	24.0
			23-1	845	7.0	7.93		21	13.02	.05	23.9
			23-1	1145	6.8	7.94	63	13	12.64	.04	23.9
			23-1	1330	7.0	7.95	61	8	12.56	.04	23.9
			23-1	1610	7.0	7.95	59	1	12.48	.03	24.0
			23-2	740	7.0	7.97	46	-36	12.23	.00	24.0
			23-2	945	6.5	7.98	45	-48	12.25	.00	24.0
			23-2	1050	6.2	7.99	45	-31	12.23	.00	24.0
			23-2	1145	6.3	8.01	45	-29	12.23	.00	24.0
			23-2	1355	7.0	7.97	41	-32	12.16	.01	24.0
			23-2	1530	7.0	7.99	41	-32	12.13	.00	23.8
			23-3	720	6.1	8.01	32	-53	12.09	.00	24.0

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp C	pH	Eh, C mV	Eh, Pt mV	pS	Oxy-gen mg/l	Conduc-tivity mS/m
153	GI4	222									
			23-4	730	8.2	8.29	12	10	21.07		24.4
			23-4	845	8.8	8.29	10	15	20.88		24.4
			24-1	1050	7.8	8.90	-65	-75	11.37		24.4
			24-2	735	7.9	8.88	-5	-12	19.69		24.4
			24-2	830	7.8	8.90	-4	-13	19.55		24.4
			24-2	925	7.1	8.90	-7	-15	19.42		24.4
			24-2	1055	7.0	9.08	-3	-9	19.79		24.4
			24-2	1240	7.0	8.96	-7	-17	19.28		24.4
154	GI4	222									
			24-3	755	7.8	8.90	12	20	18.40	.50	24.5
			24-3	950	7.0	8.92	12	16	18.28	.45	24.5
			24-3	1150	7.1	8.92	7	13	18.31	.45	24.5
			24-3	1250	7.2	8.92	6	12	18.26	.45	24.5
			24-3	1400	7.3	8.91	5	9	18.15	.40	24.5
			24-3	1500	7.3	8.90	6	11	18.29	.40	24.5
			24-4	750	8.0	8.91	-13	-13	17.53	.24	24.6
			24-4	1000	7.2	8.95	-14	-15	17.51	.20	24.4
			24-4	1200	7.7	8.92	-16	-17	17.37	.20	24.5
			24-4	1255	7.7	8.94	-18	-19	17.19	.20	24.5
			24-4	1400	8.0	8.91	-11	-10	18.14	.25	24.5
			24-4	1445	8.0	8.91	-11	-13	17.39	.20	24.6
			24-5	730	7.6	8.96	-36	-40	15.33	.08	24.7
			24-5	830	7.8	8.95	-36	-41	15.07	.09	24.7
155	GI4	222									
			24-6	730	8.0	8.94	16	20	18.32	.45	24.5
			24-6	845	7.3	8.97	15	19	18.33	.45	24.5
156	GI4	222									
			24-7	730	5.9	8.99	20	6	22.14	.27	24.8
			24-7	830	6.1	8.99	15	-5	17.58	.20	24.8
			24-7	935	6.6	8.97	2	-20	14.70	.15	24.8
			24-7	1045	6.7	9.00	-21	-39	12.35	.05	24.7
			24-7	1235	7.0	8.98	-36	-54	11.37	.05	24.7
			24-7	1400	7.1	9.01	-47	-62	11.22	.05	24.7
			24-7	1520	7.2	9.01	-54	-68	11.15	.05	24.7
			24-7	1630	7.1	8.99	-56	-71	11.15	.05	24.7
			25-1	735	5.5	9.04	-91	-105	11.18	.00	24.7
			25-1	925	6.1	9.02	-94	-108	11.15	.00	24.7
			25-1	1125	7.0	8.99	-96	-111	11.08	.00	24.9
			25-1	1415	6.9	9.02	-104	-116	11.05	.00	24.9
			25-1	1545	7.0	8.99	-107	-118	11.01	.00	24.9
			25-2	705	5.0	9.08	-124	-134	11.05	.00	24.9

Table 6

GIDEA - Field measurements

Calibration nr	Borehole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh,C mV	Eh,Pt mV	pS	Oxygen mg/l	Conductivity mS/m
157	GI4	404									
			25-3	0130	4.9	8.88	- 32	- 26	18.67	.05	36.5
			25-3	700	4.3	9.01	- 56	- 55	16.49	.05	37.5
			25-3	810	6.0	8.97	- 61	- 61	16.07	.05	38.0
			26-1	1000	8.5	9.30	-180	-203	10.49	.02	60.5
158	GI4	404									
			26-2	740	7.8	9.36	95	6	18.94	.25	61.5
			26-2	945	8.8	9.33	78	2	18.34	.26	61.5
			26-2	1045	9.2	9.32	76		18.10	.25	61.5
			26-2	1245	10.4	9.28	68	- 13	17.24	.21	62.0
			26-2	1515	11.9	9.21	55	- 27	15.84	.17	62.5
			26-3	750	8.1	9.39	-139	-172	10.18	.00	64.0
			26-3	955	9.6	9.36	-145	-176	10.05	.01	64.5
			26-3	1055	9.7	9.34	-145	-176	10.08	.01	64.5
			26-3	1255	9.9	9.38	-141	-181	10.01	.03	64.5
			26-3	1355	9.7	9.34	-148	-178	10.16	.02	64.5
			26-3	1530	9.4	9.38	-151	-181	10.10	.01	64.5
			26-4	800	8.6	9.39	-164	-193	10.16	.00	65.5
			26-4	955	9.7	9.34	-165	-193	10.12	.01	65.5
			26-4	1155	10.2	9.36	-168	-195	10.03	.04	64.5
			26-4	1400	11.5	9.31	-165	-192	10.06	.15	65.5
			26-4	1600	11.5	9.28	-166	-193	10.06	.04	65.5
			26-4	1700	11.5	9.30	-166	-193	9.99	.04	65.5
			26-5	800	9.3	9.37	-176	-202	10.13	.00	66.0
			26-5	915	9.8	9.35	-177	-203	10.05	.00	66.0
159	GI4	404									
			26-6	805	8.7	9.32	- 89	-137	9.98	.02	67.0
			26-6	905	9.0	9.31	- 94	-139	9.97	.01	67.5
160	GI4	404									
			26-7	850	8.3	9.31	125	25	19.37	.70	67.0
			26-7	1055	8.8	9.28	88	17	18.95	.27	68.0
			26-7	1300	8.9	9.27	81	12	18.58	.25	67.0
			26-7	1350	8.9	9.29	77	8	18.44	.45	67.5
			27-1	750	8.2	9.33	3	- 65	10.46	.04	67.5
			27-1	905	9.1	9.30	- 6	- 76	10.14	.25	68.0
			27-1	1005	9.4	9.29	- 13	- 84	10.13	.50	67.5
			27-1	1055	9.7	9.30	- 19	- 88	10.08	.30	68.0
			27-1	1600	10.2	9.28	- 41	-112	9.89	.09	68.5
			27-2	910	9.2	9.32	-112	-143	9.75	.05	68.0
			27-2	1100	9.5	9.33	-117	-147	9.66	.02	68.5
			27-2	1255	10.6	9.29	-123	-151	9.59	.08	68.5
			27-2	1530	11.5	9.24	-128	-157	9.49	.05	68.5
			27-2	1835	11.9	9.26	-135	-163	9.37		68.5

Table 7

CIDEA - Field measurements

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh,C mV	Eh,Pt mV	ρS	Oxy-gen mg/l	Conduc-tivity mS/m
161	CI4	512									
			27-3	920	7.1	8.47	- 14	5	19.85	.32	27.5
			27-3	1515	8.2	8.60	- 77	- 86	17.52	.25	18.4
			28-1	1215	10.6	8.44	-166	-177	11.58	.06	22.0
			28-1	1315	10.4	8.46	-165	-177	11.55	.03	22.0
162	CI4	512									
			28-2	750	7.4	7.80	13	32	22.28	.00	22.1
			28-2	950	8.2	7.77	11	26	22.14	.00	22.0
			28-2	1150	8.5	7.73	18	31	22.30	.00	22.0
			28-2	1350	10.2	7.77	1	11	21.49	.01	22.4
			28-2	1550	11.1	7.93	- 30	- 27	19.43	.02	22.4
			28-3	800	7.9	8.48	-104	-111	15.71	.00	22.7
			28-3	1000	8.9	8.45	-107	-114	15.51	.00	22.7
			28-3	1200	9.6	8.43	-109	-117	15.33	.00	22.8
			28-3	1300	9.9	8.44	-112	-118	15.21		22.9
			28-3	1530	10.2	8.43	-115	-120	15.01		22.9
			28-4	800	7.8	8.52	-113	-123	14.78		22.9
			28-4	1005	8.3	8.49	-113	-125	14.68		22.9
			28-4	1205	8.6	8.48	-113	-125	14.63		22.9
			28-4	1400	9.5	8.45	-114	-126	14.51		22.9
			28-4	1615	9.1	8.46	-114	-127	14.50		22.9
			28-5	755	7.6	8.47	-107	-123	14.58		22.9
			28-5	900	8.3	8.45	-109	-123	14.54		22.9
164	CI4	512									
			28-7	825	6.5	7.97	- 12	2	20.04	.00	22.5
			28-7	1030	7.1	8.09	- 39	- 28	18.74	.00	22.5
			28-7	1230	7.8	8.14	- 55	- 46	18.01	.01	22.6
			28-7	1630	9.2	8.18	- 72	- 64	17.14	.03	22.7
			28-7	1815	8.8	8.22	- 77	- 70	16.95	.02	22.8
			29-1	815	10.0	8.26	- 85	- 81	16.09	.00	22.9
			29-1	1050	11.4	8.22	- 90	- 86	15.87	.00	23.0
			29-1	1215	11.8	8.22	- 92	- 88	15.78	.00	23.0
			29-1	1415	13.4	8.16	- 98	- 93	15.51		23.0
			29-1	1620	14.1	8.14	-101	- 97	15.26		23.0
			29-1	1715	13.9	8.18	-100	- 97	15.24		23.1
			29-2	810	10.8	8.27	-102	-100	15.05		23.0
			29-2	1150	9.8	8.34	-102	- 99	15.00		23.0
			29-2	1420	9.9	8.32	-102	-102	14.89		23.0

Table 8

GIDEA - Field measurements

Cali-bration nr	Bore-hole	Hole-length m	Date mm-d	Time	Temp °C	pH	Eh,C mV	Eh,Pt mV	pS	Oxy-gen mg/l	Conduc-tivity mS/m
167	GI4	616									
			33-1	740	13.0	8.23	-278	-285	11.17	00	106.4
			33-1	1130	15.9	7.83	-269	-266	11.12		
			33-1	1640	20.8	7.66	-274	-271	10.87		105.6
			33-2	735	13.8	8.17	-280	-291	10.82		110.2
			33-2	1130	16.4	8.01	-276	-292	10.65		
			33-2	1635	21.9	7.84	-284	-295	10.42		109.8
			33-3	745	16.2	8.26	-290	-308	10.35		113.0
			33-3	1135	16.9	8.27	-290	-307	10.22		
			33-3	1545	20.2	8.19	-295	-314	10.00		111.6
			33-4	740	16.3	8.46	-298	-319	9.68		115.0
			33-4	1200	16.8	8.46	-299	-320	9.80		
			33-4	1610	18.3	8.44	-299	-322	9.68		
			33-5	740	15.0	8.61	-293	-320	9.69		117.2
168	GI4	616									
			35-2	800	14.7	8.58	-285	-315	10.05	.00	
			35-2	1210	16.0	8.52	-282	-310	9.90	.00	108.4
			35-2	1615	18.0	8.48	-296	-315	9.76	.00	60.0
			35-3	800	15.5	8.63	-305	-319	9.64	.00	
			35-3	1300	17.2	8.57	-306	-322	9.48	.00	109.6
			35-3	1720	19.6	8.52	-309	-326	9.37	.00	110.4
			35-4	750	11.8	8.83	-307	-322	9.55	.00	112.4
			35-4	1200	13.1	8.80	-303	-321	9.47	.00	110.0
			35-4	1620	17.5	8.65	-311	-327	9.22	.00	90.0
			35-7	800	6.7	8.93	-237	-309	9.76	.00	115.0
			35-7	1245	9.6	8.79	-226	-303	9.55	.00	
			35-7	1700	13.0	8.61	-232	-307	9.44	.00	
			36-1	800	5.8	8.85	-225	-305	9.94	.00	116.0
			36-1	1100	7.8	8.81	-230	-304	9.79	.00	112.8
			36-1	1600	15.9	8.54	-249	-317	9.35	.00	114.8
			36-2	740	6.3	9.00	-270	-321	9.77	.00	117.8
			36-2	1200	9.3	8.92	-282	-326	9.52	.00	115.8
			36-2	1600	15.8	8.72	-297	-334	9.21	.00	
			36-3	810	11.2	8.84	-292	-329	9.50	.00	119.6
			36-3	1130	12.1	8.82	-300	-329	9.40	.00	119.4
			36-3	1600	13.5	8.79	-309	-336	9.32	.00	120.0
			36-4	745	9.3	8.81	-300	-328	9.60	.00	122.4
			36-4	1200	10.3	8.73	-298	-322	9.53	.00	
			36-4	1630	14.8	8.58	-300	-326	9.38	.00	121.6
			36-5	800	4.2	9.12	-307	-333	9.78	.00	123.6
			36-5	1130	8.4	8.95	-307	-336	9.49	.00	116.8
			36-5	1640	15.0	8.71	-312	-353	9.23	.00	124.0
			36-6	815	11.3	8.73	-300	-349	9.43	.00	
			36-6	1200	12.8	8.78	-314	-356	9.34	.00	124.6
			36-6	1600	15.0	8.71	-317	-362	9.20	.00	125.6
			36-7	820	8.2	8.96	-309	-362	9.53	.00	127.6
			36-7	1200	12.5	8.84	-317	-372	9.21	.00	124.2
			36-7	1630	15.9	8.68	-318	-376	9.03	.00	

Table 9

GIDEA - E°-values

Bore-hole	Length (hole) m	Calibration nr	Date ww-d	Glass pH4 mV	Glass pH7 mV	Glass pH10 mV	C pH4 mV	C pH7 mV	Pt pH4 mV	Pt pH7 mV	Ag₂S 0.01M mV	Ag₂S 0.05M mV
GI2	178											
		102	20-2	410.5	398.7	406.2	242.0	242.7	240.0	239.1	-849.9	-832.8
		103	20-5	397.9	399.2	401.0	249.6	245.2	244.6	243.8	-831.6	-822.2
		104	20-6	399.0	398.1	400.3	248.4	245.8	243.4	244.5	-831.6	-831.2
		105	21-2	397.1	396.7	400.2	249.3	246.1	244.3	244.4	-826.3	-820.6
		106	22-1	391.7	393.4	403.3	250.1	248.0	248.1	247.0	-502.1	-679.9
		107	22-6	393.7	394.6	396.2	247.2	245.7	246.2	243.2	-831.6	-823.1
		108	22-7	387.6	388.3	391.8	256.2	252.5	254.2	249.2	-830.1	-821.5
GI2	328											
		109	23-3	390.5	389.6	392.1	253.3	251.7	249.3	246.3	-834.6	-826.4
		111	24-2	393.1	395.6	392.5	252.3	248.3	247.3	246.3	-902.1	-916.0
		112	24-5	398.7	402.1	400.3	247.1	245.1	245.1	245.1	-840.2	-837.9
		113	24-6	399.5	403.8	409.5	264.3	251.6	250.3	248.6	-838.6	-837.8
GI2	400											
		114	25.2	402.7	404.5	409.6	285.1	255.5	246.1	245.5	-843.2	-850.9
		115	26-6	383.4	382.5	389.0	252.8	251.8	250.8	251.4	-837.3	-836.4
		116	27-3	381.1	384.2	392.8	286.1	255.8	282.1	254.8	-836.8	-837.3
		117	28-2	392.0	401.2	410.0	249.8	250.4	243.8	249.4	-859.3	-861.7
GI2	544											
		118	28-5	400.0	402.1	402.9	246.7	246.4	244.7	246.4	-845.6	-842.8
		119	28-6	388.6	394.7	403.7	261.4	253.2	256.4	253.2	-838.0	-828.9
		120	29-3	361.1	399.0	422.6	304.5	283.7	290.5	281.7	-817.5	-812.1
GI2	602											
		121	30-1	384.6	389.6	397.4	253.3	252.8	252.3	252.8	-827.6	-822.6
		122	30-5	405.1	397.1	412.5	280.3	256.6	274.3	260.6	-824.7	-823.4
		123	30-6	387.1	388.8	391.7	259.3	368.0	258.3	366.0	-934.6	-828.7
GI4	96											
		151	22-6	399.7	401.4	401.1	240.5	238.9	240.5	238.9	-876.1	-859.1
		152	22-7	393.5	399.9	400.5	248.5	240.2	246.5	235.2	-859.8	-847.5
GI4	222											
		153	23-3	394.0	398.2	398.1	244.8	242.3	242.8	240.3	-867.1	-846.9
		154	24-2	395.7	398.2	399.0	243.5	241.8	242.5	239.8	-840.2	-842.8
		155	24-5	394.1	398.9	399.1	246.5	242.6	243.5	238.6	-853.0	-840.0
		156	24-6	393.7	397.9	398.3	248.3	243.2	243.3	240.2	-856.4	-849.5
		157	25-2	392.3	396.3	396.9	250.0	243.2	244.0	241.2	-849.2	-837.9
GI4	404											
		158	26-1	398.2	403.4	401.7	244.4	240.8	240.6	237.8	-851.8	-842.8
		159	26-5	396.9	396.0	395.8	[illegible]	243.6	241.0	242.6	-834.4	-824.3
		160	26-6	392.5	392.3	395.1	243.5	244.8	242.5	243.8	-838.3	-822.4
		161	27-2	394.3	395.7	394.6	242.2	242.5	241.2	241.5	-834.2	-831.5
GI4	512											
		162	28-1	392.4	394.5	393.7	250.1	247.7	248.1	246.7	-837.8	-816.3
		163	28-5	387.7	392.9	392.9	274.4	250.2	283.4	260.2	-811.2	-798.5
		164	28-6	387.5	387.2	390.4	259.7	253.4	265.7	259.4	-820.3	-806.0
		165	29-2	385.0	390.0	391.1	286.8	254.0	310.8	280.0	-823.7	-802.1
GI4	616											
		166	30-3	383.6	386.7	388.5	253.6	252.6	252.6	250.6	-843.9	-835.9
		167	31-2	381.6	384.3	385.2	254.7	254.5	253.7	253.5	-879.1	-862.4
		168	33-5	370.5	374.8	377.9	261.5	260.5	260.5	260.5	-850.7	-822.6
		169	37-1	369.7	373.1	374.9	262.2	261.1	261.2	261.1	-842.3	-823.9

Table 10a

GIDEA – Field measurements and corresponding laboratory values

Bore-hole	Depth m	Hole-length m	Nr	Date sampling yy-ww-d	Date lab ww-d	pH field	pH lab	Eh,C field mV	EH,Pt field mV	pS field	S2- lab mg/l	Cond. field mS/m	Cond. lab mS/m
GI2	157	178											
			154	82-20-7	21-2	8.8	8.4	- 37	- 61	10.9	.02		26
			155	82-21-1	21-2	8.8	8.4	- 44	- 94	10.6	.02		26
			156	82-22-3	22-4	8.8	8.4	12	4	21.9	.03	28	26
			157	82-22-4	22-5	8.8	8.4	- 4	- 13	21.0	.02	27	26
			158	82-22-5	23-1	8.7	8.5	- 19	- 29	20.3	≤.01	27	26
			159	82-23-1	23-2		8.5	18	- 3	10.6	<.01	27	26
			160	82-23-2	23-3	8.7	8.4	13	- 1	18.2	<.01	27	26
GI2	288	328											
			161	82-24-2	24-3	8.8	8.4	84	97	24.5	.03	27	26
			162	82-24-3	24-4	8.8	8.3	- 19	- 10		.01	27	26
			163	82-24-4	24-5	8.8	8.4	- 36	- 33	17.8	.02	27	26
			164	82-24-7	25-2	8.8	8.3	- 60	- 59	15.9	.03	27	26
			165	82-25-1	25-2	8.8	8.4	- 79	- 85	13.4	.03	27	27
GI2	353	400											
			166	82-26-7	27-2	8.6	8.4	- 13	8	19.7	.04	27	27
			167	82-27-1	27-3	8.6	8.4	- 43	- 35	18.5	.04	27	27
			168	82-27-2	27-3	8.6	8.3	- 78	- 61	14.9	.05	27	27
			169	82-27-3	27-4	8.6	8.4	- 84	- 95	13.7	.04	27	27
			170	82-28-2	28-3	8.6	8.4	- 76	- 77	15.1	<.01	27	26
			171	82-28-3	28-4	8.8	8.4	- 54	- 63	18.7	.01	27	26
GI2	478	544											
			172	82-28-4	28-5		8.4				.01	27	26
			173	82-28-7	29-2	8.6	8.2	- 13	- 14	20.9	<.01	27	27
			174	82-29-1	29-2	8.8	8.2	- 83	- 69	17.9	<.01	27	27
			175	82-29-2	29-3	8.8	8.3	- 81	- 92	15.4	.02	27	26
			176	82-29-3	29-5	8.9	8.3	- 82	- 94	14.5	.03	27	27
GI2	528	602											
			177	82-30-1	30-2	8.8	8.1	- 63	- 64	16.9	.03	27	26
			178	82-30-2	30-3	8.6	8.2	- 18	- 13	20.5	.01	27	26
			179	82-30-3	30-4	8.7	8.2	- 55	- 59	18.4	.03	27	26
			180	82-30-4	30-5	8.7	8.2	- 60	- 66	18.0	.03	27	26
			208	82-30-7	31-2	8.7	8.3	- 86	- 89	15.7	.03	27	26
			209	82-31-1	31-2	8.7	8.3	- 95	-103	13.5	.01	27	26
			210	82-31-2	31-3	8.8	8.2	- 96	-108	12.2	.02	27	26
GI2													
			901				6.7						17

Table 10b

GIDEA – Field measurements and corresponding laboratory values

Bore-hole	Depth m	Hole-length m	Nr	Date sampling yy-ww-d	Date lab ww-d	pH field	pH lab	Eh,C field mV	EH,Pt field mV	pS field	S2- lab mg/l	Cond field mS/m	Cond lab mS/m
GI4	91	96											
			181	82-22-3	22-4	7.7	7.4				.02	24	23
			182	82-22-4	22-5	7.9	7.5	92	87	16.3	.03	24	23
			183	82-22-5	23-1	7.6	7.3				.04	23	22
			184	82-23-1	23-2	7.9	7.7	62	11	12.6	<.01	24	23
			185	82-23-2	23-3	8.0	7.6	45	-30	12.2	<.01	24	24
GI4	212	222											
			186	82-24-2	24-3	9.0	8.3	-5	-14	19.5	.01	24	24
			187	82-24-3	24-4	8.9	8.4				.01	25	25
			188	82-24-4	24-5	8.9	8.5	-16	-17	17.4	.02	25	25
			189	82-24-7	25-2	9.0	8.4	-49	-62	11.2	.04	25	25
			190	82-25-1	25-2	9.0	8.5	-98	-111	11.1	.13	25	25
GI4	385	404											
			191	82-26-2	26-3	9.3	8.8	76	1	18.1	.02	62	60
			192	82-26-3	26-4	9.4	8.8	-145	-176	10.1	.18	65	62
			193	82-26-4	26-5	9.4	8.8	-165	-193	10.1	.23	66	63
			194	82-26-7	27-2	9.3	8.7	81	12	18.6	<.01	68	66
			195	82-27-1	27-2	9.3	8.6	-13	-84	10.1	.06	68	66
GI4	498	512											
			196	82-28-2	28-3	7.8	7.3	11	26	22.1	<.01	22	21
			197	82-28-3	28-4	8.4	7.3	-109	-117	15.3	.01	23	21
			198	82-28-4	28-5	8.5	7.4	-113	-125	14.6	.01	23	21
			199	82-28-7	29-2	8.1	7.3	-55	-46	18.0	<.01	23	22
			200	82-29-1	29-2	8.2	7.3	-101	-97	15.3	<.01	23	22
GI4	596	616											
			201	82-31-4	31-4	7.3	7.3	249	260	28.2		50	48
			202	82-31-5	32-3	7.2	7.6	200	150	26.5		56	47
			203	82-32-2	32-3	8.0	7.0	-283	-283	11.5		84	78
			204	82-32-3	32-5	6.8	7.0	-2	2	16.0			90
			205	82-32-4	32-5	6.8	7.0	40	40	23.0			91
			206	82-33-2	33-4	8.0	6.7	-280	-292	10.6		110	104
			207	82-33-4	33-5	8.5	6.8	-294	-321	9.7		115	107
			241	82-34-1		7.0	7.1			28.0		113	107
			242	82-34-4	34-5	7.0	7.1	100	20	22.5		107	100
			243	82-35-2	35-3	8.5	7.1	-285	-313	9.9		108	103
			244	82-35-4	35-5	8.8	7.1	-307	-323	9.4		111	105
			245	82-36-2	36-3	8.9	7.1	-280	-325	9.5		116	100
			246	82-36-7	37-2	8.9	7.1	-317	-374	9.1		128	116
GI4													
			902				7.7						24

Table 11a

GIDEA - Metal ions

Bore-hole	Depth m	Nr	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Mn mg/l	Fe^{2+} mg/l	Fe-tot mg/l	Al mg/l	Cu mg/l	Sr mg/l
GI2	157											
		154	10	2.7	50	2.3	.02	.12	.17	<.02	<.005	.079
		155	10	2.6	50	2.3	.02	.13	.18	<.02	<.005	.081
		156	10	2.3	49	2.3	.01	.10	.16	<.02		
		157	10	2.2	49	2.3	.01	.16	.17	<.02	<.005	.085
		158	10	2.3	50	2.2	.01	.11	.18	<.02		
		159	10	2.7	48	2.2	.01	.18	.18	<.02	<.005	.088
		160	10	3.3	50	2.1	.01	.14	.15	<.02		
GI2	288											
		161	10	3.1	48	2.3	.02	.56	.57	<.02		
		162	10	3.3	48	2.3	.02	.29	.48	.04		
		163	10	2.6	48	2.3	.02	.37	.49	<.02	<.005	.084
		164	10	2.4	49	2.2	.02	.59	.59	<.02		
		165	10	2.4	50	2.2	.02	.64	.60	<.02	<.005	.080
GI2	353											
		166	10	2.3	53	2.0	.02	.32	.66	<.02		
		167	10	2.4	53	2.0	.02	.41	.59	<.02	<.005	.079
		168	10	2.3	54	2.0	.02	.45	.64	<.02		
		169	10	2.4	53	1.9	.03	.54	.67	<.02		
		170	9	2.2	52	1.9	.02	.52	.57	<.02		
		171	9	2.2	51	1.9	.02	.47	.59	<.02		
GI2	478											
		172	10	2.2	49	2.3	.02	.41	.57	<.02	<.005	.080
		173	10	2.1	50	2.3	.02	.28	.66	<.02		
		174	10	2.4	50	2.2	.02	.56	.70	<.02	<.005	.079
		175	10	2.3	51	2.2	.02	.78	.82	<.02		
		176	9	2.2	50	2.2	.02	.24	.77	<.02		
GI2	528											
		177	10	2.3	51	2.3	.03	.35	.82	<.02		
		178	10	2.3	50	2.3	.02	.08	.73	<.02		
		179	10	2.1	51	2.3	.03	.30	.67	<.02		
		180	10	2.0	51	2.3	.03	.42	.70	<.02	<.005	.063
		208	11	1.9	50	2.2	.03	.60	.65	<.02	<.005	.091
		209	11	1.9	50	2.2	.03	.67	.70	<.02		
		210	11	2.0	50	2.2	.02	.63	.71	<.02		
GI2												
		901	19	3.1	12	3.2	.03		.24			

Table 11b

GIDEA - Metal ions

Bore-hole	Depth m	Nr	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Mn mg/l	Fe2+ mg/l	Fe-tot mg/l	Al mg/l	Cu mg/l	Sr mg/l
GI4	91											
		181	31	4.5	9	3.0	.21	1.0	1.6	.04		
		182	32	4.3	10	2.9	.22	1.1	1.3	.04	<.005	.115
		183	31	4.2	10	2.6	.23	1.7	1.8	.04		
		184	33	4.4	11	2.5	.21	.96	1.0	.02	<.005	.115
		185	32	4.6	13	2.5	.19	.75	1.0	.02		
GI4	212											
		186	10	1.4	45	1.2	.02	.18	.26	<.02		
		187	10	1.0	45	1.0	.02	.14	.21	<.02		
		188	10	.9	45	.9	.02	.33	.35	<.02	<.005	.070
		189	9	1.0	49	.9	.01	.13	.24	<.02		
		190	9	.9	50	.8	.02	.25	.28	<.02	<.005	.070
GI4	385											
		191	20	.9	96	1.9	.01	.09	.12	<.02		
		192	20	1.0	100	2.0	.01	.08	.09	<.02		
		193	21	1.1	100	2.1	.01	.06	.11	<.02	<.005	.153
		194	21	1.1	105	1.9	.01	.05	.07	<.02		
		195	21	1.0	105	2.1	.01	.05	.10	<.02	<.005	.163
GI4	498											
		196	30	4.2	5	2.7	.28	6.3	8.0	.04		
		197	30	4.0	5	2.6	.28	7.2	8.4	.06		
		198	31	4.1	5	2.5	.30	7.4	8.6	.02	<.005	.113
		199	30	4.3	5	2.7	.28	7.3	8.5	.04		
		200	29	4.4	5	2.7	.28	6.6	8.7	.04	<.005	.130
GI4	596											
		201	32	2.9	48	7	.12		.9	.02	.02	
		202	33	2.9	48	5	.12		1.1	<.02	.01	
		203	43	2.0	100	3	.21		3.2	<.02	.01	
		204	50	1.7	120	2	.19		1.0	<.02	<.01	
		205	51	2.0	120	2	.20		1.7	<.02		
		206	58	1.5	145	3	.19		5.4			
		207	59	1.2	150	3	.13		3.9			
		241	58	1.0			.10		.3			
		242	56	1.1	145		.10		.5			
		243	55	1.4	150		.05		.9			
		244	56	1.3			.06		.8	.02	.005	.295
		245	59	.8	150		.05		.8			
		246	65	.9	156		.01		.9	.02		
GI4												
		902	43	5.6	16	4.9	.25		.43			

Table 12a

GIDEA - Nitrogen containing ions

Bore-hole	Depth m	Nr	NO2 mg/1	NO3 mg/1	NH4 mg/1	NO2-N mg/1	NO3-N mg/1	NH4-N mg/1	Sum-N mg/1
GI2	157								
		154	<.002	.030	.085	<.001	.007	.066	.073
		155	<.002	.030	.085	<.001	.007	.066	.073
		156	<.002	.020	.085	<.001	.005	.066	.071
		157	.004	.020	.090	.001	.005	.070	.076
		158	<.002	.045	.095	<.001	.010	.074	.085
		159	.004	.020	.105	.001	.005	.082	.087
		160	<.002	.040	.085	<.001	.009	.066	.076
GI2	288								
		161	<.002	.020	.080	<.001	.005	.062	.067
		162	.005	.015	.050	.002	.003	.039	.044
		163	.005	.025	.080	.002	.006	.062	.069
		164	.005	.020	.080	.002	.005	.062	.068
		165	.004	.020	.080	.001	.005	.062	.068
GI2	353								
		166	<.002	.040	.080	<.001	.009	.062	.072
		167	<.002	.030	.075	<.001	.007	.058	.066
		168	.005	.020	.085	.002	.005	.066	.072
		169	<.002	.030	.085	<.001	.007	.066	.073
		170	.004	.040	.075	.001	.009	.058	.068
		171	.005	.065	.080	.002	.015	.062	.078
GI2	478								
		172	.016	.020	.050	.005	.005	.039	.048
		173	.004	.035	.025	.001	.008	.019	.029
		174	.005	.025	.075	.002	.006	.058	.065
		175	.004	.025	.065	.001	.006	.050	.057
		176	.005	.065	.055	.002	.015	.043	.059
GI2	528								
		177	<.002	.045	.030	<.001	.010	.023	.034
		178	.045	.100	.015	.014	.023	.012	.048
		179	<.002	.025	.055	<.001	.006	.043	.049
		180	<.002	.020	.050	<.001	.005	.039	.044
		208	<.002	.035	.070	<.001	.008	.054	.063
		209	<.002	.085	.055	<.001	.019	.043	.063
		210	.004	.035	.025	.001	.008	.019	.029

Table 12b

GIDEA - Nitrogen containing ions

Bore-hole	Depth m	Nr	NO2 mg/l	NO3 mg/l	NH4 mg/l	NO2-N mg/l	NO3-N mg/l	NH4-N mg/l	Sum-N mg/l
GI4	91								
		181	.005	.015	.075	.002	.003	.058	.063
		182	005	.020	.065	.002	.005	.050	.057
		183	.005	.040	.035	.002	.009	.027	.038
		184	.004	.040	.06C	.001	.009	.047	.057
		185	<.004	.045	.065	<.001	.010	.050	.062
GI4	212								
		186	<.002	.020	.015	<.001	.005	.012	.017
		187	.005	.065	.010	.002	.015	.008	.024
		188	.005	.025	.010	.002	.006	.008	.015
		189	.004	.035	.010	.001	.008	.008	.017
		190	.004	.055	.005	.001	.012	.004	.018
GI4	385								
		191	.004	.045	.025	.001	.010	.019	.031
		192	<.002	.035	.015	<.001	.008	.012	.020
		193	<.002	.025	.015	<.001	.006	.012	.018
		194	<.002	.040	.015	<.001	.009	.012	.021
		195	<.002	.040	.020	<.001	.009	.016	.025
GI4	498								
		196	.010	.060	.035	.003	.014	.027	.044
		197	.023	.015	.050	.007	.003	.039	.049
		198	.007	.055	.020	.002	.012	.016	.030
		199	.015	.010	.015	.005	.002	.012	.018
		200	.010	.030	.015	.003	.007	.012	.021

GIDEA - Remaining anions and other parameters

Bore-hole	Depth m	Nr	HCO3 mg/l	Cl mg/l	F mg/l	SO4 mg/l	PO4 mg/l	SiO2 mg/l	TOC mg/l	Turb. NTU	Drilling water residue, I%
GI2	157										
		154	161	4.6	2.7	.8	.015	23	3	.8	.3%
		155	161	4.8	2.7	1.0	.015	23	4	.7	.4%
		156	162	4.8	2.5	.9	.020	21	4	.8	.2%
		157	162	4.8	2.5	1.0	.025	21	4	.7	.2%
		158	161	4.0	2.5	.6	.015	21	4	1.1	.2%
		159	161	4.1	2.5	.6	.030	21	4	1.1	.2%
		160	161	4.0	2.5	.6	.020	21	4	.5	.2%
GI2	288										
		161	164	4.9	2.9	.3	.035	19	4	1.5	.3%
		162	164	4.9	2.9	.3	.030	21	5	1.0	.2%
		163	163	4.9	2.9	.3	.015	20.5	5	.7	.2%
		164	163	4.7	2.8	.5	.010	20.5	5	.5	.2%
		165	163	4.6	2.8	.3	.020	20	5	.6	.2%
GI2	353										
		166	162	5.3	2.6	.6	.025	21	3	1.0	.3%
		167	160	5.4	2.6	.4	.025	21	3	1.2	.4%
		168	163	5.0	2.6	.3	.030	21	3	.9	.4%
		169	163	5.2	2.6	.4	.020	21	3	2.5	.3%
		170	159	5.5	2.6	.4	.010	21	3	1.0	.3%
		171	161	4.9	2.5	.2	.010	21	4	1.0	.3%
GI2	478										
		172	161	5.4	2.4	.2	.030	21		6.9	.4%
		173	161	5.3	2.4	.1	.025	21	2	1.5	.2%
		174	160	5.1	2.4	.1	.030	20	2	1.5	.2%
		175	160	5.0	2.6	.1	.025	20	3	2.2	.4%
		176	159	5.2	2.6	.1	.030	20	3	11.0	.4%
GI2	528										
		177	159	5.1	2.4	.1	.080	20	5	1.2	.2%
		178	160	5.4	2.5	.1	.075	20	4	1.1	.2%
		179	161	5.0	2.4	.1	.070	20	3	1.1	.2%
		180	161	5.1	2.5	.1	.060	20	2	1.2	.2%
		208	158	4.6	2.4	.1	.065	20	2	2.0	.2%
		209	158	4.7	2.4	.1	.070	20	2	1.6	.2%
		210	159	4.6	2.4	<.1	.065	20.5	2		.2%
GI2											
		901	89	1.5	.8	9.9		14			

Table 13b

CIDEA - Remaining anions and other parameters

Bore-hole	Depth m	Nr	HCO3 mg/l	Cl mg/l	F mg/l	SO4 mg/l	PO4 mg/l	SiO2 mg/l	TOC mg/l	Turb. NTU	Drilling water residue, I%
GI4	91										
		181	135	2.1	1.1	7.1	.065	14.5	3	5.7	.2%
		182	137	2.0	1.1	6.3	.065	14	3	4.7	.3%
		183	124	1.4	1.0	9.5	.035	15.5	3	7.9	.2%
		184	141	1.5	1.0	3.9	.085	14	3	4.8	.5%
		185	145	1.4	1.1	3.3	.060	14	3	4.5	.6%
GI4	212										
		186	133	8.2	6.0	.8	.040	14.5	5	1.3	2.0%
		187	133	8.5	6.0	.9	.035	14.5	5	1.2	1.9%
		188	132	8.4	6.0	.8	.030	14.5	5	3.0	1.9%
		189	133	7.9	6.0	.3	.035	14.5	5	1.8	1.5%
		190	133	7.7	6.0	.2	.025	14.5	6	1.2	1.7%
GI4	385										
		191	25	165	3.2	.1	.030	10	4	1.8	13.4%
		192	23	168	3.2	.1	.030	10	4	.8	12.6%
		193	20	174	3.2	.1	.025	10	3	.6	11.8%
		194	18	178	3.2	.1	.025	10	2	1.1	11.0%
		195	18	182	3.5	.1	.015	10	2	.5	10.2%
GI4	498										
		196	119	2.4	.9	10	.045	12	3	95	.2%
		197	119	2.2	.9	9	.045	12	3	48	.2%
		198	121	2.2	.9	7	.045	12	2	92	.3%
		199	121	2.2	.9	8	.025	13	2	101	.3%
		200	121	2.2	.9	8	.015	13	3	116	.3%
GI4	596										
		201	80	100	.9	.6		4.0			4.4%
		202	80	100	.9	.4		4.0			3.9%
		203	60	190	1.3	.2		3.0			11.8%
		204	60	220	1.3	.1		1.5			11.8%
		205	60	220	1.4	.2		1.5			11.4%
		206	50	260	1.4	.1		1.5			29.9%
		207	60	270	1.6	.1		2.0			24.4%
		241	60	270	1.5	<.1		1.5			10.2%
		242	70	260	1.5	<.1		1.5			9.5%
		243	70	250	1.4	.1		1.0			15.0%
		244	70	240		.1		1.0			17.3%
		245	70	270	1.9	.1		1.0			14.2%
		246	70	310	1.9	.7		6.0			16.5%
GI4											
		902	161	2.0	1.1	3.2		22			

GIDEA - Particulate matter

Bore-hole	Depth m	Nr	Sample ml	S, prt mg/l	Fe, prt mg/l	Al, prt mg/l
GI2	157	154	2284	.0004	.025	.011
GI2	157	155	2290	.0004	.014	.008
GI2	157	157	2300	.0004	.011	.014
GI2	157	159	2300	.0004	.004	.014
GI2	288	163	2300	.0004	.041	.015
GI2	288	165	2300	.0004	.006	.008
GI2	353	167	2300	.0013	.032	.021
GI2	478	172	550	.0127	.291	1.291
GI2	478	174	1750	.0034	.035	.030
GI2	528	180	1700	.0012	.118	.028
GI2	528	208	2250	.0009	.012	.013
GI4	91	182	475	.0021	.021	.183
GI4	91	184	925		.011	.092
GI4	212	188	1445		.064	.318
GI4	212	190	1905	.0016	.034	.241
GI4	385	193	850	.0012	.001	.001
GI4	385	195	2100	.0005	.001	.001
GI4	498	198	900	.0022	.092	.244
GI4	498	200	850	.0024	.087	.188

GIDEA - Thorium, uranium, radium and radon

Nr	Bore-hole	Depth m	Th ug/l	U Bq/l	Ra-226 Bq/l	Rn-222 Bq/l
155	GI2	157	(1.2+0.6)E-2	(5.4+3.1)E-3	(7.4+1.0)E-3	(5.41+0.29)E2
159	GI2	157	< 6.1 E-2	(4.6+3.1)E-3	(9.4+1.7)E-3	
164	GI2	288	< 3.0 E-2	(3.4+0.4)E-2	(5.2+0.3)E-3	(3.30+0.07)E2
167	GI2	353	(1.6+1.3)E-1	(6.9+2.9)E-3	(5.0+1.7)E-3	(4.23+0.07)E2
175	GI2	478	< 1.4 E-1	(7.9+2.9)E-3	(5.9+1.1)E-3	(3.16+0.05)E2
208	GI2	528	(2.5+1.9)E-2	(3.9+2.8)E-3	(2.1+0.9)E-3	(2.46+0.05)E2
184	GI4	91	(1.5+0.5)E-2	(2.6+0.4)E-2	(1.6+0.1)E-2	(3.35+0.05)E3
189	GI4	212	< 3.8 E-2	(2.5+0.4)E-2	(1.7+0.1)E-2	(1.26+0.05)E3
194	GI4	385	< 2.8 E-2	< 4.4 E-3	(4.0+0.6)E-3	(8.81+0.37)E1
199	GI4	498	(3.4+2.5)E-2	< 3.6 E-3	(5.7+2.3)E-3	(2.91+0.05)E2
202	GI4	596	< 9.1 E-2	< 3.2 E-3	(2.7+0.2)E-2	4.7+1.5
206	GI4	596	< 2.0 E-1	< 2.5 E-3	(2.3+0.3)E-2	< 5.1

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