PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP04c Data Report – Porewater Extraction and Analysis and Petrographic Analysis for IG_BH01

APM-REP-01332-0233 **September 2019**

Golder Associates Ltd. and Hydroisotop

nwmo
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REPORT

PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP4C Data Report – Porewater Extraction and Analysis and Petrographic Analysis for IG_BH01

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WP4C REPORT – POREWATER EXTRACTION AND ANALYSIS AND PETROGRAPHIC ANALYSIS FOR IG_BH01

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1.0 INTRODUCTION

The Initial Borehole Drilling and Testing project in the Wabigoon and Ignace Area, Ontario is part of Phase 2 Geoscientific Preliminary Field Investigations of the NWMO's Adaptive Phased Management (APM) Site Selection Phase.

This project involves the drilling and testing of the first of three deep boreholes within the northern portion of the Revell batholith. The first drilled borehole, IG_BH01, is located a direct distance of approximately 21 km southeast of the Wabigoon Lake Ojibway Nation and a direct distance of 43 km northwest of the Town of Ignace. Access to the IG_BH01 drill site is via Highway 17 and primary logging roads, as shown on Figure A.

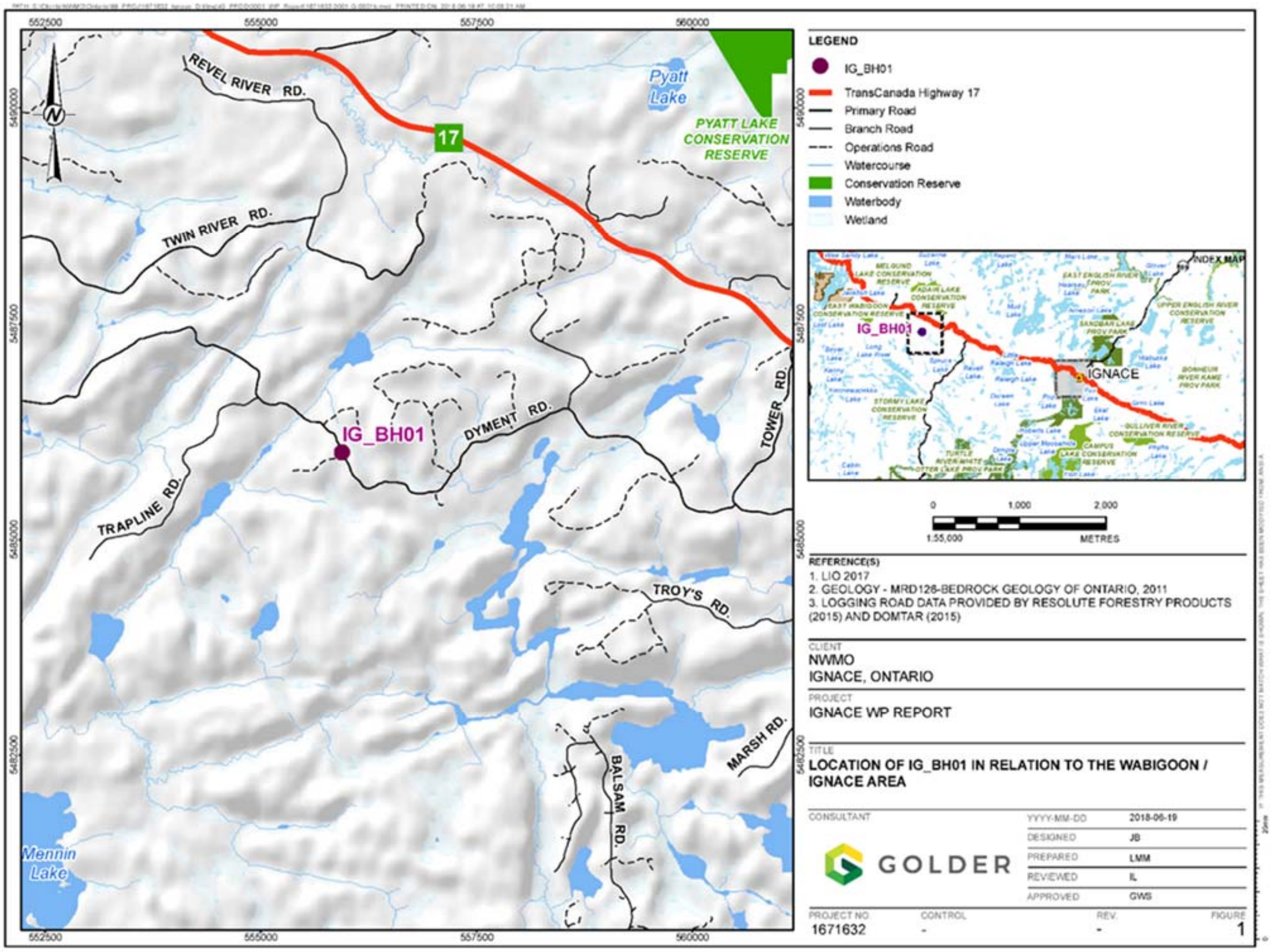


Figure A: Location of IG_BH01 in relation to the Wabigoon / Ignace area

The project was carried out by a team at Hydroisotop GmbH, subcontracted by Golder Associates Ltd. (Golder) on behalf of the NWMO. This report describes the testing methodology and results for Work Package 4C (WP4C): Porewater Extraction and Analysis and Petrographic Analysis for IG_BH01. Porewater in low-permeability crystalline bedrock resides in the connected inter- and intragranular pore space of the rock matrix and forms a significant water reservoir within bedrock suites, which interacts by diffusion with fracture groundwater.

1.1 Geological Setting

The approximately 2.7 billion year old Revell batholith is located in the western part of the Wabigoon Subprovince of the Archean Superior Province. The batholith is roughly elliptical in shape trending northwest, is approximately 40 km in length, 15 km in width, and covers an area of approximately 455 km^2. It is likely that the batholith is approximately 2 km to 3 km thick through the center of the northern portion (SGL, 2015). The Revell batholith is surrounded by the Raleigh Lake (to the north and east) and Bending Lake (to the southwest) greenstone belts (Figure B).

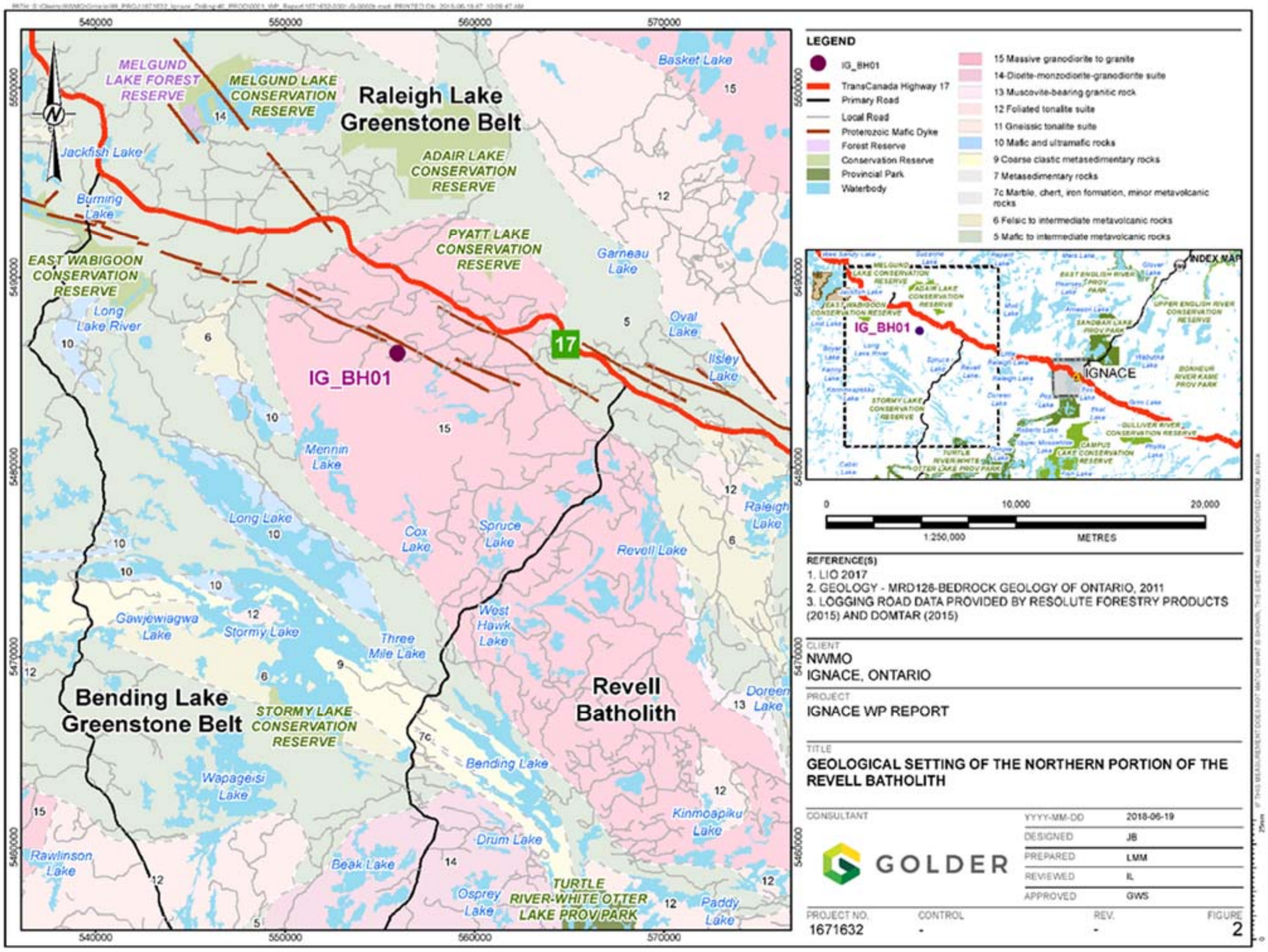


Figure B: Geological setting of the northern portion of the Revell Batholith

Borehole IG_BH01 is within an investigation area of approximately 19 km^2 in size situated in the northern portion of the Revell batholith. Bedrock exposure in this area is very good due to minimal overburden, few water bodies, and relatively recent logging activities. Ground elevations generally range from 400 to 450 m above sea level. The ground surface broadly slopes towards the northwest as indicated by the flow direction of the main rivers in the area (Revell and Mennin rivers). Local water courses within the investigation area tend to flow to the southwest towards Mennin Lake.

The northern portion of the Revell batholith is composed mainly of granodiorite and tonalite, which together form a relatively homogeneous intrusive granitoid complex. The granodiorite and tonalite are massive to weakly foliated.

Overall, the tonalite transitions gradationally into granodiorite and no distinct contact relationships between these two rock types are typically observed. There is also a younger granite intrusion, which is observed southeast of the investigation area and primarily in the central portion of the Revell batholith. The granite, which is massive to weakly foliated, post-dates and intrudes into the granodiorite-tonalite intrusive complex (Golder and PGW, 2017). In the centre of the investigation area, a west-northwest trending mafic dyke is interpreted from aeromagnetic data and observed during detailed mapping to be approximately 15-20 m wide (Figure B). This dyke is associated with a similarly-orientated mafic dyke that stretches along the entire northern limit of the investigation area. Both dykes, along with others in the northern portion of the Revell batholith, have a similar character and are interpreted to be part of the Wabigoon dyke swarm. It is assumed based on surface measurements that these mafic dykes are sub-vertical (Golder and PGW, 2017).

Long, narrow valleys are located along the western and southern limits of the investigation area (Figure A). These local valleys host creeks and small lakes that drain to the southwest and may represent the surface expression of structural features that extend into the bedrock. A broad valley is located along the eastern limits of the investigation area and hosts a more continuous, un-named water body that flows to the south. The linear and segmented nature of this waterbody’s shorelines may also represent the surface expression of structural features that extend into the bedrock.

Details of the lithological units and structures found within the investigation area are provided in (Golder and PGW, 2017).

1.2 Technical Objectives

The technical objectives of the porewater testing program are to assess the key chemical and transport properties of the crystalline host rock with depth and within the repository horizon (presently assumed to be between depths of approximately 400 and 600 m). The geochemical results will provide information about the paleohydrogeological evolution of the bedrock system. Thin section petrographic analyses will be carried out at all sampling depths in order to characterize mineralogy and support the evaluation of the porewater chemistry (obtained by indirect extraction methods, which requires the determination of the in situ water content and connected porosity). The evaluation of petrophysical parameters requires correlation with the petrographic and mineralogical characteristics of the rock samples.

The associated work tasks include:

- Aqueous extraction experiments to determine initial estimates of pore fluid composition and Total Dissolved Solids (TDS);
- Isotope diffusive exchange experiments, for the determination of stable water isotopes ($\delta^{18}O$ and $\delta^{2}H$);
- Out-diffusion experiments, for determination of porewater stable ion concentrations (Cl and Br), as well as the determination of effective diffusion coefficients, D_e, for Cl and Br;
- $\delta^{37}Cl$ analyses;
- Bulk petrography; and
- Determination of density, water content and porosity for the various subsamples used in the above-listed analytical suites.

The characterization of the porewater composition and the solute transport processes in the rock matrix contribute important information for the long-term safety assessment of deep geological repositories for radioactive waste. Thus, knowledge of the porewater composition will allow better constraints on the processes affecting the near-field of a repository. In designs where repository construction is restricted to bedrock of low permeability, the first water to interact with the repository barrier materials (e.g., bentonite, Cu-canister) will be the porewater. This interaction could result in changes of the physical and chemical properties of the various barrier materials. Knowledge of the porewater composition and its evolution over recent geological time – particularly during the last thousand to hundreds of thousands of years, in accordance with the expected lifespan of a geologic repository – is considered to be of high importance.

In combination with the knowledge gained about solute transport in the rock matrix, the characterization of porewater also contributes to a better understanding of processes related to the far-field environment around the repository. Thus, it provides valuable information about matrix diffusion as a potential retardation factor for radionuclides, and allows better constraints to be placed on the palaeohydrogeological history of a repository site. Due to the exchange by diffusion between fracture groundwater and matrix porewater, released radionuclides may be temporally immobilized by matrix diffusion, and possible subsequent sorption on mineral surfaces. For radionuclides susceptible to sorption, the accessible surface areas are greatly enhanced by matrix diffusion when compared to the accessible surface area on fracture surfaces alone. Matrix diffusion has the potential to increase solute transport times to the biosphere from the repository.

In contrast to fracture groundwater, porewater cannot be sampled by conventional groundwater sampling techniques. The chemical and isotopic composition of porewater has, therefore, to be derived by indirect extraction techniques based on rock material. In most of these indirect extraction techniques – especially in case of rocks of a porosity below about 2 vol.% – the original porewater concentrations are diluted and need to be back-calculated to in-situ concentrations. This requires a well-defined value for the connected porosity – accessible to different solutes under in-situ conditions. The derivation of such porosity values, as well as solute concentrations, is prone to various perturbations during drilling, core sampling, storage and experiments in the laboratory. The obtained data have to be carefully evaluated for potential perturbations induced by drilling activities, rock stress release and sample treatment in the laboratory in order to derive values that are representative of in-situ conditions. This requires detailed knowledge about the rock composition, the rock texture, and the local stress field, because porewater composition is dependent on these factors as well.

Matrix porewater of ten core samples taken from 220 m to 920 m depth in the borehole IG_BH01, drilled as part of the Phase 2 Initial Borehole Drilling and Testing programme in the Ignace Area for the Nuclear Waste Management Organization (NWMO), was investigated for its chemical and isotopic composition using different methods. Additionally, the crystalline rock core samples were characterised for their petrophysical and mineralogical properties, including water content, water-loss porosity, bulk density, pore diffusion coefficient and mineralogical composition.

The results of the porewater investigations are compiled and presented in this report.

2.0 SAMPLING AND SAMPLE PREPARATION

A total of 30 samples from ten depth intervals were taken from borehole IG_BH01 between November 26, 2017 and January 12, 2018 for the characterization of porewater (Table 1). Sampling was conducted by Golder Associates Ltd. (Golder) according to the instructions provided by Hydroisotop GmbH (Hydroisotop) via personal on-site training. After recovery from the borehole, the individual core sections (three per depth interval, ten intervals in total) were photographed and immediately packed in a plastic bag, evacuated and sealed airtight. This procedure was repeated for a second plastic bag and a final Al-coated plastic layer. The samples were stored in a refrigerator on site and then sent to Hydroisotop, Germany, in a cooler.

The samples arrived in the lab between December 4, 2017 and January 28, 2018. All samples were well packed and arrived in the lab with preserved vacuum in all three layers. At Hydroisotop the samples were stored in the fridge at 4°C and prepared between December 14, 2017 and January 28, 2018.

The assigned samples were unpacked and immediately wrapped into Parafilm™ and cut by dry-sawing into full-diameter sections. After sawing, the surfaces of the obtained pieces were cleaned with paper towels and again wrapped into Parafilm™. The entire sample preparation was conducted as rapidly as possible (within 10 minutes) after opening the sealed bags, in order to minimize evaporation.

One of the three core sections taken from each depth interval was stored and sealed as a retained sample at 4°C in the fridge. The analytical program conducted on each sample is summarized in Table 2. Photos of the samples on-site and in the lab are provided in Appendix I.

Table 1: Overview of the core samples taken from IG_BH01 for porewater investigations

		Depth								
Sample ID	Hydro Lab Nr.	from	to	ave	Length	Date sampled	Time drilled	Time recovered	Date sent	Date arrived
		m	m	m	m		hh:mm	hh:mm		
IG_BH01_PW001	307818	221,71	222,05	221,9	0,34	26. Nov	14:35	14:55	27.11.2017	04.12.2017
IG_BH01_PW002	307819	222,05	222,17	222,1	0,12	26. Nov	14:35	14:55	27.11.2017	04.12.2017
IG_BH01_PW003	307820	223,05	223,45	223,3	0,40	26. Nov	14:35	14:55	27.11.2017	04.12.2017
IG_BH01_PW004	307971	321,05	321,41	321,2	0,36	29. Nov	22:10	22:33	30.11.2017	07.12.2017
IG_BH01_PW005	307972	321,41	321,56	321,5	0,15	29. Nov	22:10	22:33	30.11.2017	07.12.2017
IG_BH01_PW006	307973	321,56	321,92	321,7	0,36	29. Nov	22:10	22:33	30.11.2017	07.12.2017
IG_BH01_PW007	308051	420,38	420,73	420,6	0,35	03.Dec	13:30	13:49	02.12.2017	11.12.2017
IG_BH01_PW008	308052	420,73	421,08	420,9	0,35	03.Dec	13:30	13:49	02.12.2017	11.12.2017
IG_BH01_PW009	308053	421,08	421,19	421,1	0,11	03.Dec	13:30	13:49	02.12.2017	11.12.2017
IG_BH01_PW010	308243	455,98	456,08	456,0	0,10	05.Dec	17:40	18:10	06.12.2017	14.12.2017
IG_BH01_PW011	308244	456,08	456,42	456,3	0,34	05.Dec	17:40	18:10	06.12.2017	14.12.2017
IG_BH01_PW012	308245	456,42	456,77	456,6	0,35	05.Dec	17:40	18:10	06.12.2017	14.12.2017
IG_BH01_PW013	308278	531,59	531,71	531,7	0,12	09.Dec	09:20	09:37	10.12.2017	15.12.2017
IG_BH01_PW014	308279	530,88	531,23	531,1	0,35	09.Dec	09:20	09:37	10.12.2017	15.12.2017
IG_BH01_PW015	308280	531,23	531,59	531,4	0,36	09.Dec	09:20	09:37	10.12.2017	15.12.2017
IG_BH01_PW016	308365	582,30	582,41	582,4	0,11	11.Dec	12:24	12:58	11.12.2017	18.12.2017
IG_BH01_PW017	308366	582,41	582,76	582,6	0,35	11.Dec	12:24	12:58	11.12.2017	18.12.2017
IG_BH01_PW018	308367	582,76	583,13	582,9	0,37	11.Dec	12:24	12:58	11.12.2017	18.12.2017
IG_BH01_PW019	308544	632,43	632,53	632,5	0,10	13.Dec	10:10	10:52	13.12.2017	21.12.2017
IG_BH01_PW020	308545	632,53	632,88	632,7	0,35	13.Dec	10:10	10:52	13.12.2017	21.12.2017
IG_BH01_PW021	308546	632,88	633,23	633,1	0,35	13.Dec	10:10	10:52	13.12.2017	21.12.2017
IG_BH01_PW022	308820	720,41	720,79	720,6	0,38	18.Dec	20:35	21:03	19.12.2017	27.12.2017
IG_BH01_PW023	308821	720,79	721,20	721,0	0,41	18.Dec	20:35	21:03	19.12.2017	27.12.2017
IG_BH01_PW024	308822	721,20	721,34	721,3	0,14	18.Dec	20:35	21:03	19.12.2017	27.12.2017
IG_BH01_PW025	309002	820,25	820,62	820,4	0,37	08. Jan	10:25	10:55	09.01.2018	12.01.2018
IG_BH01_PW026	309003	820,62	820,98	820,8	0,36	08. Jan	10:25	10:55	09.01.2018	12.01.2018
IG_BH01_PW027	309004	820,98	821,09	821,0	0,11	08. Jan	10:25	10:55	09.01.2018	12.01.2018
IG_BH01_PW028	309344	920,27	920,64	920,5	0,37	12. Jan	01:10	01:50	12.01.2018	22.01.2018
IG_BH01_PW029	309345	920,64	921,00	920,8	0,36	12. Jan	01:10	01:50	12.01.2018	22.01.2018
IG_BH01_PW030	309346	921,00	921,13	921,1	0,13	12. Jan	01:10	01:50	12.01.2018	22.01.2018

Table 2: Overview of the analytical porewater program conducted on core samples from borehole IG_BH01

				Experimental and analytical programme															
				Aqueous Extraction			Isotope diffusive exchange experiments			Out-diffusion experiments							Grav. WC	Thin section petrography	
Sample ID	Hydro Lab Nr.	Ave. Depth	Date prepared	Exp. Set-Up	Chemical analyses	Grav. WC	Exp. Set-Up	Isotope Analyses	Grav. WC	Exp. Set-Up	Time Series	Analyses ions	Analyses δ^{37}Cl	Grav. WC	Density	Modelling Dp	Extra Pieces	Preparation	Microscopy
		m BHL																	
IG_BH01_PW001	307818	221,9	14.12.2017																
IG_BH01_PW002	307819	222,1	14.12.2017	X	X	X											X		
IG_BH01_PW003	307820	223,3	14.12.2017				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW004	307971	321,2	14.12.2017																
IG_BH01_PW005	307972	321,5	14.12.2017	X	X	X											X		
IG_BH01_PW006	307973	321,7	14.12.2017				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW007	308051	420,6	14.12.2017				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW008	308052	420,9	14.12.2017																
IG_BH01_PW009	308053	421,1	14.12.2017	X	X	X											X		
IG_BH01_PW010	308243	456,0	14.12.2017	X	X	X											X		
IG_BH01_PW011	308244	456,3	14.12.2017																
IG_BH01_PW012	308245	456,6	14.12.2017				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW013	308278	531,7	22.12.2017	X	X	X											X		
IG_BH01_PW014	308279	531,1	22.12.2017																
IG_BH01_PW015	308280	531,4	22.12.2017				X	X	X	X	X	X	X	X	X	X		X	X
IG_BH01_PW016	308365	582,4	22.12.2017	X	X	X											X		
IG_BH01_PW017	308366	582,6	22.12.2017																
IG_BH01_PW018	308367	582,9	22.12.2017				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW019	308544	632,5	09.01.2018	X	X	X											X		
IG_BH01_PW020	308545	632,7	09.01.2018				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW021	308546	633,1	09.01.2018																
IG_BH01_PW022	308820	720,6	09.01.2018																
IG_BH01_PW023	308821	721,0	09.01.2018				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW024	308822	721,3	09.01.2018	X	X	X											X		
IG_BH01_PW025	309002	820,4	29.01.2018				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW026	309003	820,8	29.01.2018																
IG_BH01_PW027	309004	821,0	29.01.2018	X	X	X											X		
IG_BH01_PW028	309344	920,5	29.01.2018																
IG_BH01_PW029	309345	920,8	29.01.2018				X	X	X	X	X	X	X	X	X	X	X	X	X
IG_BH01_PW030	309346	921,1	29.01.2018	X	X	X											X		

3.0 EXPERIMENTAL SET-UPS AND ANALYTICAL METHODS

Porewater investigations were performed on different types of samples that were subjected to different types of extraction and exchange experiments. This included aqueous extraction and out-diffusion experiments to characterise porewater using chemical tracers, isotope diffusive exchange experiments for the porewater $\delta^{18}O$ and $\delta^{2}H$ composition, and the determination of the water content and water-loss porosity on the respective samples.

Unless otherwise specified, the analytical work has been conducted at Hydroisotop GmbH, Germany.

3.1 Mineralogy and Petrography

Mineralogical and petrographic investigations were performed on rock material from ten samples taken along the borehole profile (Table 2). The samples were characterised using thin section microscopy. Modal mineralogy was determined by point counting.

End pieces of the core sections used for out-diffusion experiments (cf. Section 3.3.2) were first weighed and dried to determine the water content of the individual sections. After stable weight was reached (= ± 0.002 g for 14 days), thin sections (with a size of 32 x 20 mm) were produced by standard methods at Geotec Consult, Germany. Petrographic and mineralogical evaluation, description and documentation were performed using transmitted light microscopy.

The modal composition of the individual core samples represented by the thin sections was determined by point counting. The entire 32 x 20 mm thin section was screened with 400 points (25 x 16 steps), which correlates to a mesh size of 1.3 x 1.3 mm. The point distance and hence the number of counting points was defined by an estimation of the average grain size of the rock forming minerals.

During the determination of the modal composition of the rock forming minerals, a distinction was made between altered and unaltered plagioclase. Plagioclase crystals showed only one type of alteration (i.e., sericitization), which is caused by hydrothermal fluids with elevated potassium concentrations, whereby plagioclase is replaced by fine grained mica (sericite). A plagioclase crystal was named altered if the point count hit a sericitized part of the grain.

Biotite crystals show varying fs/pleochroism from dark brown to reddish-brownish and light green, and some crystals are weakly altered at the rim. The occurrence of weakly altered biotite, together with sericitized plagioclase, was observed in all samples. During the coupled alteration reaction, potassium is released from biotite and is incorporated into sericite. Calcium is released from the anorthite component of plagioclase and is consumed by the formation of epidote/clinozoisite (Eggleton & Banfield 1985).

The transition from sericite to muscovite, which are more or less the same minerals but with different grain sizes, is not clearly defined in the literature. In the following petrographic description, light mica minerals are named muscovite and/or epidote/clinozoisite (continuous solid solution) if mineral shapes of vibrant interference colours are observable. Epidote/clinozoisite can be distinguished from mica crystals by their higher relief. Sericite is present as very fine-grained aggregates, mostly in the core of altered plagioclase, and no clear interference colours are observable.

3.2 Water content and water-loss porosity

The water content was determined on core material used for aqueous extraction experiments and out-diffusion experiments, as well as on the core pieces used for the isotope diffusive exchange technique. Water contents also were determined on extra pieces of core available from those used for the out-diffusion experiments.

The degree of sample saturation upon arrival in the laboratory was assessed by the condition of the sample bags and of the core surface (wet vs. dry).

For water content measurements, drill-core pieces were placed in a crystallization dish, weighed and subsequently dried at 45°C and later at 105°C until stable weight conditions. Before taking the initial wet weight of the full diameter core sections, the surface was allowed to dry on the balance until stable weight was achieved for ≈10 sec. During the following drying process, weighing was carried out weekly until the sample weight remained constant (±0.002 g) for at least 14 days.

Water contents were determined on core pieces used for out-diffusion experiments, with weights between 1209 – 1419 g. The comparison of the weights of the samples before and after the experiment delivered additional information about the saturation state of these samples. Drying times for out-diffusion cores varied between 55 and 69 days.

Water contents also were determined on core samples used for aqueous extraction experiments (Table 2). Therefore, one half of the full disc core (199 – 329 g) was broken by a mortar to an edge length of approximately 1 cm, placed in a crystallization dish, weighed and put in the oven at 105°C for drying. Additionally, the two cut uneven head pieces (for one sample, three pieces) with weights between 89 and 316 g were also weighed and put in the oven to determine the water content. Drying times varied between 65 and 78 days for crushed pieces, and 77 to 133 days for full disc cores.

An extra piece of the core sample used for out-diffusion and isotope exchange experiments also was taken for the determination of the water content. These sections had weights between 139 and 663 g, and drying times varied between 78 and 133 days.

Gravimetric water contents were determined on crushed core sections used for the single isotope diffusive exchange experiments after equilibration. Potential evaporation and transfer of water from the reservoir to the rocks, or vice versa, were controlled by taking the weights of the rock, filled crystallization dish and entire closed experiments before and after equilibration. The rock masses were between 283 and 365 g, and drying times varied between 30 and 90 days.

Weights and drying time series of the individual sub-samples are shown in Appendix II.

The calculation of the water-loss porosity (i.e., the connected porosity) from the gravimetric water content requires a measure of the grain density. In rocks of low porosity, the bulk wet density can be used as a proxy for the grain density. A measure for the bulk wet density of the rocks used for out-diffusion and aqueous extraction experiments was obtained from volume and saturated mass of the core samples. The volume was calculated from measurements of height and diameter of the core samples using a Vernier Caliper, with an error of ± 0.01 mm.

Core lengths varied between 3.0 and 4.7 cm for aqueous extraction cores, and between 15.6 and 18.1 cm for out-diffusion cores, with core diameters of 6.07 – 6.15 cm. This results in core volumes between 87 and 136 cm^3 for aqueous extraction and between 460 and 530 cm^3 for out-diffusion.

From known sample volume and wet mass, the bulk, wet and dry density is obtained by

$$\rho_{bulk,wet} = \frac{m_{rock,wet}}{V_{rock}}, \qquad \rho_{bulk,dry} = \frac{m_{rock,dry}}{V_{rock}} \qquad \text{eq. 1}$$

and the water-loss (connected) porosity, ϕ_{WL}, can be calculated according to

$$\phi_{WL} = WC_{wet} * \frac{\rho_{bulk,wet}}{\rho_{water}} \quad = \quad \phi_{WL} = \frac{m_{pw} \times 100}{r^2 \times h \times \pi \times \rho_{water}}, \qquad \text{eq. 2}$$

where WC_{wet} is the water content based on the wet weight of the rock sample and $\rho_{bulk,wet}$ the bulk wet density of the rock. In a first approximation, the density of water, ρ_{water}, is assumed to be 1 g/cm^3. Due to the low water content of the investigated crystalline rocks, the water content and water-loss porosity determined by the wet weight and bulk, wet density of the sample is essentially equal to those values calculated using the dry weight and bulk, dry density.

As shown by Gaussian error propagation (cf. Appendix III) the error of the water content and the water-loss porosity depends predominately on the accuracy of the determination of the mass of porewater measured after unpacking (i.e., on the measured initial wet weight) and the final dry weight of the cores.

3.3 Porewater extraction methods

3.3.1 Aqueous extraction experiments

Aqueous extraction experiments were conducted prior to out-diffusion and isotope exchange experiments to estimate the salinity of the investigated porewaters.

Saturated full disc core sections were crushed by a mortar to a maximum edge length of 0.3 mm and 195 to 390 g of rock material were put in a PE bottle, where 165 to 592 ml of deionized water were added. Subsequently the bottle was gently shaken for 24 h. Afterward, the elution was decanted, filtered (0.45 µm) and immediately analysed for their alkalinity, pH and sp. electrical conductivity (using a Metrohm Titrino 785 and WTW LF 325 system). Subsequently, the main anion and cation concentrations were analysed by IC using a Dionex ICS 1500 system. The analytical error of the ion concentration analyses is ± 5 %.

The porewater Cl-concentration was further calculated according to

$$C_{i,pw} = \frac{C_{i,sol} \times V_{sol} \times 0.001}{m_{pw}} \qquad \text{eq. 3}$$

where $C_{i,pw}$ = porewater elemental concentration, $C_{i,sol}$ = analyzed elemental concentration in the aqueous extraction solution, V_{sol} = Volume of aqueous extraction solution and m_{pw} = mass of porewater.

Experimental data and analytical raw data are listed in Tables 8-15 and lab reports in Appendix II.

3.3.2 Out-diffusion experiments

Out-diffusion experiments were performed on intact full disc core samples of 15.6 to 18.1 cm in length by immersion into ultrapure water. The volume of test water varied between 400 and 451 ml. During the experiments the two water reservoirs, i.e., porewater and test water, were allowed to exchange until equilibrium. Equilibrium with respect to chloride is reached, when the Cl concentration has been constant within the analytical error range (= ±5 %) over a minimum of 14 days.

After placing the core sample in the PE-vessel, the vessel was sealed and put in a vibrating water bath (40 rpm) at a constant temperature of 45°C to accelerate diffusion. The PE-vessels were covered by a vapour-tight lid, which is equipped with two swagelock^{TM} valves and PEEK^{TM} sampling lines. The core, the experiment container and the test water were weighed before and after the experiment to ensure that no loss of test water occurred during the entire experiment. At specific time intervals of initially a few days, and later a few weeks, 0.5 ml of solution were sampled using a PVC-syringe to determine the chloride concentration as a function of time. The experimental time depended on the equilibration grade in the individual experiments. All out-diffusion experiments were ended after 212 days.

After equilibrium with respect to chloride was achieved, the vessels were removed from the water bath and cooled to room temperature. Subsequently, the core was weighed and the supernatant solution was filtered (0.45 µm) and analysed immediately for pH and total alkalinity, and later for major cation and anion concentrations.

The chloride contents of the 0.5 ml time-series samples from the out-diffusion experiments, and the major cations (Na, K, Ca, Mg, Sr) and anions (F, Cl, NO_3^-, Br, SO_4^{2-}) of the final test solutions were analysed by ion chromatography using a Dionex ICS 1500 system. The relative analytical error of these analyses is ±5 % based on multiple measurements of external check standard solutions (1σ). The alkalinity titration, pH and specific electrical conductivity (EC) measurements were performed using a Metrohm titration systems and a WTW LF 325 probe.

Boron, aluminium and silica concentrations of out-diffusion test solutions were analysed at Görtler analytical services GmbH, Germany, using a Thermo Fischer ICP-MS system with a detection limit of 0.0001 mg/l and an analytical uncertainty of 5%.

The $^{37}Cl/^{35}Cl$ isotope ratio, expressed as $\delta^{37}Cl$ relative to SMOC, was measured by a GC-MS-IRMS system (Thermo Fischer Delta S). Analytical errors were determined by the standard deviation of triplicate analyses of every sample.

Strontium isotope signatures were analysed at Iso Analysis UG, Germany, by a Thermo Fischer MC-ICP-MS system with an analytical uncertainty of 0.0005.

Chloride and bromide concentrations of the experiment solution can be converted to porewater concentrations by applying mass balance calculations if equilibrium between test water and porewater is achieved. With knowledge of the mass of porewater in the rock sample, the chloride and bromide concentration of the porewater can be calculated according to:

$$C_{pw} = \frac{(m_{pw} + m_{TWi} - \sum^{n} m_s) * C_{TW\infty} - (m_{TWi} * C_{TWi}) + \sum^{n} m_s * C_s}{m_{pw}} \qquad \text{eq. 4}$$

where C_{pw} = porewater concentration; m_{pw} = mass of porewater; m_{TWi} = initial mass of test water; C_{TWi} = initial Cl-concentration of test water; m_s = mass of sub sample used for time series; C_s = Cl concentration of sub sample used for time series.

The term $\sum m_s * C_s$ (equation 4) describes the amount of Cl removed from the initial experiment solution for Cl time-series samples. A correction for chloride and bromide in the initial experiment solution ($m_{TWi}*C_{TWi}$) is necessary if this solution is not entirely free of chloride and bromide.

The unit for the porewater concentration is given in mg/kg_{H2O} (and not mg/l) because it is derived on a mass basis rather than a volumetric basis. This is due to the fact that the density of the porewater is not known beforehand, because it depends, inter alia, on the in-situ salinity of the water, which is unknown.

3.3.3 Isotope diffusive exchange technique

The isotope diffusive exchange technique to determine the water isotope composition, $\delta^{18}O$ and $\delta^{2}H$, of the porewater and the mass of porewater was originally developed by Rogge (1997) and Rübel et al. (2002) for sedimentary rocks and later adapted for crystalline rocks by Waber and Smellie (2005, 2006) and Eichinger et al. (2006). In this method, initially saturated rock material is placed into two vapour-tight containers together with different test waters of known isotope composition. The porewater and test water is then allowed to isotopically equilibrate via the vapour phase without any direct contact between the core material and the test water. The porewater isotope composition and the water content of the rock sample can then be derived by isotope mass balance relationships. It has been shown that the uncertainty of the derived isotope composition largely depends on the ratio of porewater to test water used in the experiments (e.g., Rübel et al. 2002). For crystalline rocks, this ratio was optimised by using larger volumes of rock and smaller volumes of test water in the experiments (e.g., Waber and Smellie 2005, 2006; Eichinger et al. 2006).

For the present samples, 1.8 ml of test water were placed in a Petri dish in the centre of a glass vessel and surrounded by hand crushed core pieces of 4-6 cm^3 in size and with a total mass of 284 to 365 g. After an equilibration time of 60 days, the two test waters were removed and analysed by Cavity Ring Down Spectroscopy using a Picarro L 2130-I Analyser. The results for the test waters are reported relative to the V SMOW standard with a precision of $\delta^{18}O$ and ± 1.5 ‰ for $\delta^{2}H$.

Test water and core material were weighed before and after the experiment to assess if test water was lost on the container walls and/or rock material due to evaporation and/or condensation. To minimise condensation, about 0.6 mol of NaCl were dissolved in the test water to lower its water vapour pressure. For every sample, two experiments were performed, one using test water with an isotope composition close to that expected in the porewater ("LAB-sample”) and one using test water with an isotope composition far from that expected for the porewater ("SSI-sample”).

The test water used for the LAB-sample was normal laboratory tap water ($\delta^{18}O$ = -9.61 ‰ V-SMOW; $\delta^{2}H$=-67.5 ‰ V-SMOW), while that for the SSI-sample was water from an ice core drilled in Greenland ($\delta^{18}O$ = -30.10 ‰ V-SMOW; $\delta^{2}H$=-236.8 ‰ V-SMOW). The equilibration time in the three reservoirs – rock porewater, test water and the air inside the container as a diaphragm – depends on the volume of the container, the size of the rock pieces and the distance of the rock pieces to the test water (see Rogge 1997). Based on the estimations of the minimum time period required for complete isotopic equilibration (cf. Eichinger et al. 2006), an experimental time of 60 days was chosen.

The isotope diffusive exchange technique delivers the $\delta^{18}O$ and $\delta^{2}H$ values and the mass of the porewater present in the connected pore space of the rock sample. These parameters are calculated from the analytical results obtained for the two test water solutions using mass balance relationships according to:

$$m_{pw} * c_{pw}\Big|_{t=0} + m_{tw} * c_{tw}\Big|_{t=0} = (m_{pw} + m_{tw}) * c_{tw}\Big|_{t=\infty} \qquad \text{eq. 5}$$

where *m* = mass, *c* = isotope ratios expressed in the δ notation, *pw* = porewater, *tw* = test water; *t = 0* means the isotope concentrations at the beginning, and *t* = ∞ at the end of the experiment.

The water content of the applied samples is calculated by transformation of equation 5 to

$$WC_{IsoEx} = \left[\frac{m_{TW(Std2)} \times m_{Rock(Std1)} \times (C_{TW^0(Std2)} - C_{TW\infty(Std2)}) + m_{TW(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std1)} - C_{TW^0(Std1)})}{m_{Rock(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std2)} - C_{TW\infty(Std1)})} \right] \times 100 \quad \text{eq. 6}$$

where m_{Rock} = mass of rock, *Std 1* = test solution 1 and *Std 2* = test solution 2.

Equation 6 can be set up for oxygen and hydrogen isotope ratios of the test water, resulting in two independent values for the mass of porewater.

The $\delta^{18}O$- and δ^2H- values of the porewater are calculated by transformation of equation 5 to

$$C_{PW} = \frac{C_{TW\infty(Std1)} \times m_{TW(Std2)} \times m_{Rock(Std1)} \times (C_{TW\infty(Std2)} - C_{TW^0(Std2)}) - C_{TW\infty(Std2)} \times m_{TW(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std1)} - C_{TW^0(Std1)})}{m_{TW(Std2)} \times m_{Rock(Std1)} \times (C_{TW\infty(Std2)} - C_{TW^0(Std2)}) - m_{TW(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std1)} - C_{TW^0(Std1)})} \quad \text{eq. 7.}$$

The errors of the calculated $\delta^{18}O$, δ^2H and the mass of porewater are computed for each sample using Gauss' law of error propagation (Appendix III).

4.0 PETROGRAPHY AND MINERALOGY

The interpretation of porewater derived by indirect methods using rock material requires knowledge about the rock composition and the physical properties of the rock. The petrographic and mineralogical investigations provide information about:

- The structure and texture of the rocks, which place constraints on pathways for solute migration.
- The type of pore space where porewater resides (intergranular versus intragranular), and a correlation of the experimentally determined petrophysical properties (porosity, density) with the petrography of the rocks.

Petrographic and mineralogical investigations were conducted on ten core samples taken from borehole IG_BH01 at depths between 220 and 920 m below surface (b.s.). Thin sections were produced from the cut-off end pieces of core sections used for porewater out-diffusion experiments. The macroscopic and microscopic petrographic descriptions of the cores, minerals and rock textures were classified according to Bas & Streckeisen (1991) and Le Maitre et al. (2002). The nomenclature and mineral abbreviations, which are compiled in Table 3, were taken from Siivola & Schmid (2007). The mineral sizes are defined according to Schmid et al. (2007). The dimensions of the individual grain sizes are listed in Table 4. Alteration grades of rock forming minerals are defined based on the estimated altered area on individual grains (Table 5).

Table 3: Abbreviations of mineral names recommended by IUGS (Siivola & Schmid 2007)

Mineral name	Abbreviation
Alkali feldspar	Afs
Apatite	Ap
Biotite	Bt
Clinozoisite	Czo
Epidote	Ep
Muscovite	Ms
Sericite	Ser
Opaque mineral	Op
Plagioclase	Pl
Quartz	Qtz
Titanite	Ttn
Zircon	Zrn

Table 4: Definition of grain sizes recommended by IUGS (Schmid et al. 2007)

Size	Description
>16 mm	Very coarse grained
4-16 mm	Coarse grained
1-4 mm	Medium grained
0.1-1 mm	Fine grained
0.01-0.1 mm	Very fine grained
<0.01 mm	Ultra-fine grained

Table 5: Definition of alteration grades of rock forming minerals

Proportion of crystal area	Degree of alteration
0 %	Unaltered
<40 %	Weakly altered
40-70 %	Moderately altered
>70 %	Highly altered

4.1 General macroscopic and microscopic description of core samples from borehole IG_BH01

The crystalline rock samples of borehole IG_BH01, which were sampled between 220 and 920 m b.s. and examined in this study, consist of macroscopically homogenous, unaltered granodiorite and tonalite. All samples show an equigranular and phaneritic structure. The core samples are not intersected by open fractures. No foliation is observed in any sample. Quartz, feldspars and biotite are distinguishable macroscopically.

Microscopically, the individual samples consist predominately of quartz, plagioclase and biotite and minor amounts of alkali feldspar and muscovite in different modal compositions.

The pore space between quartz grains is open and no alteration products are observed, which appears to reflect natural conditions. Intergranular grain boundaries can also be artefacts of drilling, sawing and stress release. In the investigated samples, there are no clear indications about the formation of new pore space by above mentioned processes. Nevertheless, they cannot be excluded by the conducted investigations.

Alteration of alkali feldspar crystals could not be observed, and muscovite is only present in micro fissures of alkali feldspar in some samples. The individual core samples show variable degrees of alteration, mainly in the plagioclase and biotite crystals. Plagioclase crystals are moderately to highly sericitized. Only few crystals are unaltered or weakly altered. Fine grained muscovite and epidote/clinozoisite, and very fine grained sericite, are present as alteration products in the core of sericitized plagioclase. Fine grained muscovite and epidote/clinozoisite crystals are also present at the rim of weakly altered biotite crystals. The colour/pleochroism of biotite varies strongly within each thin section and ranges from dark brown to reddish-brownish and green. The light green(ish) biotite crystals frequently show sutural alteration at the rim, whereas dark brown biotite crystals show less alteration products. It is assumed that biotite crystals from two different generations of growth are observed in the thin sections. In all samples, the intergranular pore space between the individual rock-forming minerals is open and not filled with alteration products. In general, sutural altered biotite grains did not show clear grain boundaries in thin sections.

4.2 Modal composition of individual core samples from borehole IG_BH01

The modal composition of the individual samples was determined by point counting, which screened the entire thin section.

The core samples consist mainly of quartz, plagioclase, alkali feldspar, biotite and muscovite + epidote/clinozoisite in different modal compositions (Table 6). Opaque minerals, apatite, zircons and titanite are present as accessories (Table 6). The individual samples have varying proportions of altered plagioclase and biotite. The grade of alteration of these two minerals also varies within the individual thin sections (Table 6).

Plagioclase is the most abundant mineral in all investigated rock samples with varying contents between 46 and 54 Vol.% (Table 6). The normalized proportion of altered plagioclase areas varies between 18 and 35 Vol.% of the detected plagioclase grains. However, the real proportion of altered plagioclase is higher because only points that hit a sericite grain are defined as altered plagioclase. The proportion of quartz and alkali feldspar varies between 28 and 35 Vol.% for quartz and between 4 and 17 Vol.% for alkali feldspar (Table 6). Alteration of alkali feldspar could not be observed in any sample. However, it cannot be excluded that alkali feldspar is altered, as albitization is difficult to observe using transmitted light microscopy. The proportion of biotite is between 6 and 14 Vol.% in the investigated samples (Table 6). Minerals showing abnormal (“vibrant”) interference colours are summarized as muscovite and epidote/clinozoisite in Table 6 and are present in the range between 1 and 4 Vol.% in the investigated samples.

According to the modal composition determined by point counting, which is consistent with visual observations of the core in hand specimen, the individual core samples can be classified after Bas & Streckeisen (1991) and Streckeisen (1974) as phaneritic granodiorite to tonalite. The classification/nomenclature is specified by the modal mineral content of quartz (Q), plagioclase (P) and alkali feldspar (A) (Q + A + P = 100 Vol.%). After Streckeisen (1974), core samples containing 20-60 Vol.% quartz are defined as granodiorite with a proportion of 65-90 Vol% plagioclase of total feldspar (A + P = 100 Vol.%) and tonalite with a proportion of 90-100 Vol.% plagioclase of total feldspar (A + P = 100 Vol.%) (Table 7). The more current classification/nomenclature of Bas & Streckeisen (1991) used in this report differs from the classification/nomenclature of Streckeisen (1974). After Bas & Streckeisen (1991) the modal mineral contents of quartz, plagioclase and alkali feldspar of the individual core samples are plotted in a simplified ternary diagram (Figure 1). The percentage of alkali feldspar, determined by point counting in samples IG_BH01_PW007, IG_BH01_PW012, IG_BH01_PW025 and IG_BH01_PW029 is in the range of 9.3-18.4 Vol.% of the total proportion of quartz, plagioclase and alkali feldspar (Q + A + P = 100 Vol.%, Table 7). These samples lie within the classification field of granodiorite (Figure 1). In the other samples (IG_BH01_PW003, IG_BH01_PW006, IG_BH01_PW015, IG_BH01_PW018, IG_BH01_PW020 and IG_BH01_PW023), the percentage of alkali feldspar varies between 4.9 Vol.% and 7.2 Vol.% of the entire proportion of quartz, plagioclase and alkali feldspar (Table 7). These samples lie within the classification field of tonalite (Figure 1). For the calculation of the proportions of quartz, plagioclase and alkali feldspar in the samples the sericitized portion of plagioclase was added to the unaltered plagioclase.

Table 6: Modal composition (Vol.%) of the occurring minerals obtained using point counting; Modal compositions of accessories were not determined (The modal percentage of accessories is <1 Vol.%)

Sample	Depth	Qtz	Pl	Altered Pl	Afs	Bt	Ms + Ep + Czo	Accessories
	m b.s.	Vol.%	Vol.%	Vol.%	Vol.%	Vol.%	Vol.%	Minerals
IG_BH01_PW003	223.25	34	38	8	5	12	2	Op, Ap, Zrn, Ttn
IG_BH01_PW006	321.74	35	31	15	6	11	3	Op, Ap, Zrn
IG_BH01_PW007	420.56	28	37	12	17	6	1	Op, Ap, Zrn
IG_BH01_PW012	456.60	34	31	17	9	8	2	Op
IG_BH01_PW015	531.41	33	40	14	5	8	1	Op, Zrn
IG_BH01 _PW018	582.95	35	35	11	5	12	4	Op, Ap, Zrn
IG_BH01_PW020	632.71	31	38	13	4	12	2	Op
IG_BH01_PW023	721.00	33	35	12	6	11	4	Op, Ap, Zrn, Ttn
IG_BH01_PW025	820.44	28	36	13	8	14	2	Op, Ap, Zrn
IG_BH01_PW029	920.82	30	36	12	8	13	1	Op, Ap, Zrn

Table 7: Normalized modal composition (Vol.%) of quartz, plagioclase and alkali feldspar obtained using point counting and classification of rock types

Sample	Depth	Qtz	Pl + altered Pl	Afs	Rock type[1)]	Proportion Afs of total feldspar	Rock type[2)]
	m b.s.	Vol.%	Vol.%	Vol.%		Vol.%	
IG_BH01_PW003	223.25	40.2	53.9	5.9	Tonalite	9.8	Tonalite
IG_BH01_PW006	321.74	40.4	52.4	7.2	Tonalite	11.6	Granodiorite
IG_BH01_PW007	420.56	29.9	51.7	18.4	Granodiorite	26.0	Granodiorite
IG_BH01_PW012	456.60	36.9	52.8	10.3	Granodiorite	15.8	Granodiorite
IG_BH01_PW015	531.41	35.7	58.6	5.7	Tonalite	8.5	Tonalite
IG_BH01_PW018	582.95	40.5	53.4	6.2	Tonalite	9.9	Tonalite
IG_BH01_PW020	632.71	35.8	59.3	4.9	Tonalite	7.3	Tonalite
IG_BH01_PW023	721.00	38.3	55.0	6.7	Tonalite	11.3	Granodiorite
IG_BH01_PW025	820.44	32.9	57.6	9.5	Granodiorite	14.2	Granodiorite
IG_BH01_PW029	920.82	34.6	56.1	9.3	Granodiorite	14.2	Granodiorite

according to [1)]Bas & Streckeisen (1991) and [2)]Streckeisen (1974)

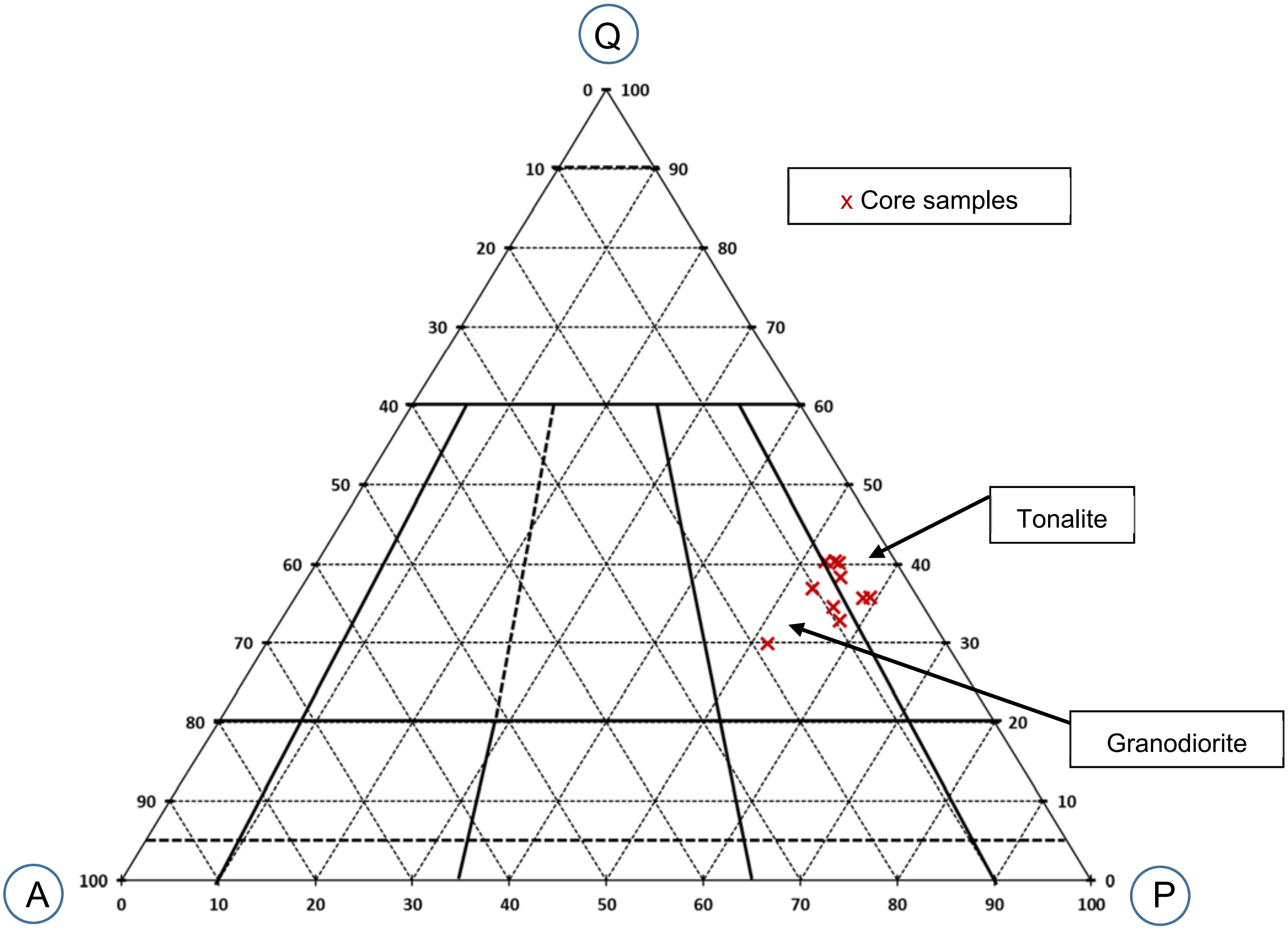


Figure 1: Classification/nomenclature according to the modal mineral content (Q + A + P = 100 Vol.%) of the individual core samples plotted in a simplified ternary Streckeisen diagram after Bas & Streckeisen (1991).

4.3 Microscopic petrographic description of individual core samples from borehole IG_BH01

Sample IG-BH01-PW003 (223.25 m b.s.)

Sample IG-BH01-PW003 is a homogenous, equigranular, phaneritic tonalite. Macroscopically, medium to coarse grained feldspars, quartz and biotite can be distinguished (Figure 2a). Fine grained sericite, muscovite and epidote/clinozoisite are observed microscopically as alteration products in plagioclase and around undefined grain boundaries of plagioclase and biotite (Figure 2c,d). Quartz and alkali feldspar are free from alteration products. Very fine grained apatite, zircon, titanite and opaque minerals are present as accessories.

Plagioclase (46 Vol.%) is mainly present as xenomorphic-hypidiomorphic medium (1-4 mm) to coarse (4-16 mm) grained crystals, which are weakly to highly altered. Few crystals are very coarse (>16 mm) grained. Plagioclase of varying alteration degrees is present in the sample. Some crystals are highly sericitized (Figure 2d-g): sericite (fine grained mica) is a common alteration product in feldspars. The main group of plagioclase contains sericite in the core of the crystals and is associated with fine grained bladed muscovite and epidote/clinozoisite, whereas the rim is free of alteration products (Figure 2f). Few weakly altered crystals show a strong zonation and are crazed with fine cracks partially filled with muscovite (Figure 2d,e). Lamellar twinning is only observed in weakly altered crystals.

Quartz makes up to 34 Vol.% of the rock. Xenomorphic, medium to coarse grained crystals frequently appear as clusters in Figure (2b,h). Quartz grains within the clusters are mainly coarse grained, whereas the grain size is frequently medium at grain boundaries between quartz and plagioclase or biotite.

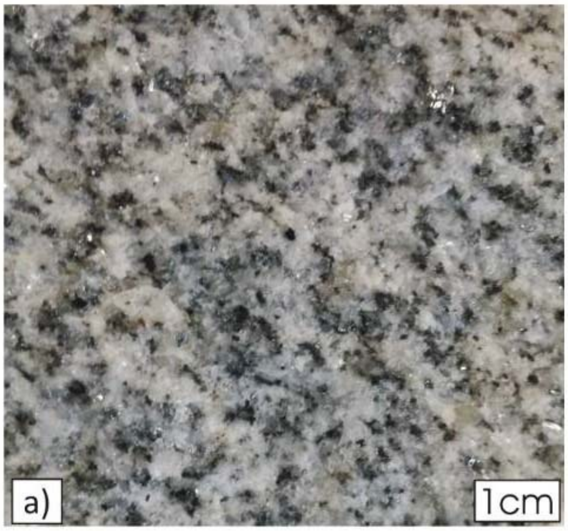
The main group of biotite (12 Vol.%) is present as xenomorphic, medium to coarse grained bladed crystals showing mainly dark reddish-brownish colours/pleochroism. Few crystals show light brown and greenish colours/pleochroism (Figure2c-f). Microfissures are frequently filled with needle-like muscovite and the margin of weakly altered crystals also shows fine-grained muscovite and epidote/clinozoisite (Figure 2d,f,g). Very fine grained opaque minerals, apatite and zircons with pleochroic haloes can be observed as inclusions in the minor group of weakly chloritized crystals.

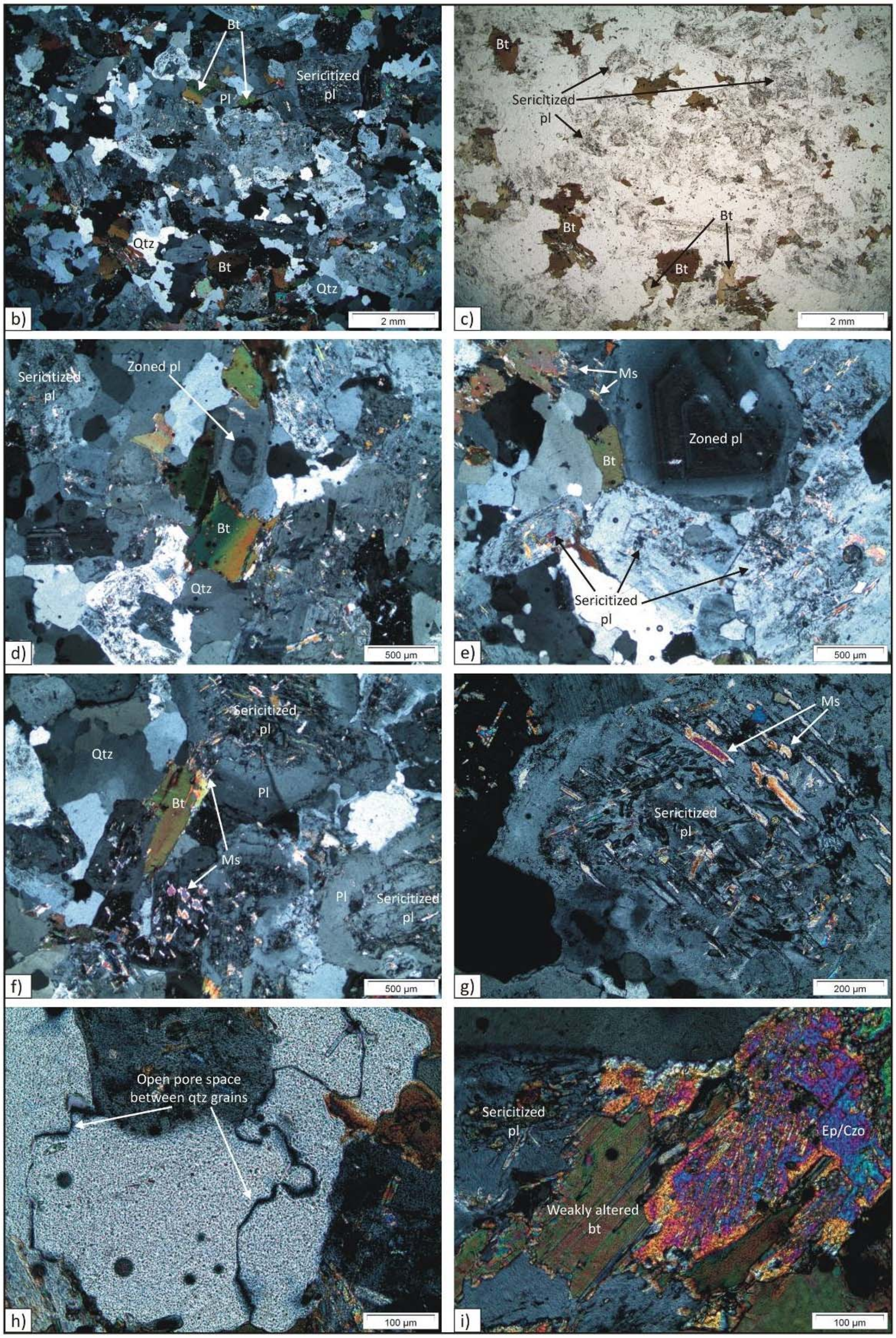
About 5 Vol.% is alkali feldspar occurring as xenomorphic-hypidiomorphic coarse grained crystals and showing microcline twinning (grating-like structure). The crystals are unaltered. Fine grained muscovite can be observed in microfissures of some alkali feldspar crystals.

Muscovite and epidote/clinozoisite make up to 2 Vol.%. Muscovite is mainly present as fine grained needle-like inclusions in moderately to highly sericitized plagioclase (Figure 2b,e). In association with biotite, muscovite frequently forms a sutural texture at the grain boundaries or replaces biotite in the shape of fine grained (rarely medium grained) bladed crystals (Figure 2d-f,i). Epidote/clinozoisite occurs as fine grained crystals in the core of sericitized plagioclase, and along with biotite and plagioclase crystals with undefined grain boundaries.

The intergranular pore space between quartz and feldspar minerals is open and not filled with alteration products (Figure 2h), which appears to reflect natural conditions. Along sutural weakly-altered biotite grains, a clear grain boundary is generally not observed. In the vicinity of altered minerals, the intergranular pore space is also open.

Figure 2: Sample IG-BH01-PW003 (223.25 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Quartz, sericitized plagioclase, biotite and zoned plagioclase under transmitted, cross-polarized light, e) Sericitized plagioclase and unaltered zoned plagioclase with biotite under transmitted, cross-polarized light, f) Plagioclase sericitized in the core with biotite and unaltered quartz under transmitted, cross-polarized light, g) Sericitized plagioclase containing needle-like muscovite under transmitted, cross-polarized light, h) Open pore space between quartz grains under transmitted, cross-polarized light, i) Weakly-altered biotite with epidote/clinozoisite under transmitted, cross-polarized light.

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Sericitized pl
g)
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Open pore space between qtz grains
h)
100 µm
Sericitized pl
Ep/Czo
Weakly altered bt
i)
100 µm

Sample IG-BH01-PW006 (321.74 m b.s.)

Sample IG-BH01-PW006 is a homogenous, equigranular, phaneritic tonalite. It is mainly composed of medium to coarse grained feldspar, quartz and biotite (Figure 3a). Plagioclase and alkali feldspar can be distinguished in the thin section. Minor amounts of muscovite, sericite and epidote/clinozoisite occur as alteration products. Apatite, zircon and opaque minerals are present as accessories.

Plagioclase makes up to 46 Vol.% and occurs as xenomorphic–hypidiomorphic, medium to coarse grained crystals. Two different types of plagioclase crystals can be distinguished: most crystals are moderately or highly altered and contain fine grained sericite and muscovite and/or epidote/clinozoisite mainly in the core of the crystal (Figure 3b,c,e). Some crystals are even fully sericitized. A few crystals are less altered and contain muscovite fillings in microfissures. Lamellar twinning is observed independent of alteration grade in few crystals (Figure 3e,f).

Quartz crystals (35 Vol.%) are xenomorphic and medium to coarse grained. Few crystals of hypidiomorphic or idiomorphic shape are found as inclusions in alkali feldspar crystals (Figure 3b). Quartz frequently occurs in the form of clusters (3b,d).

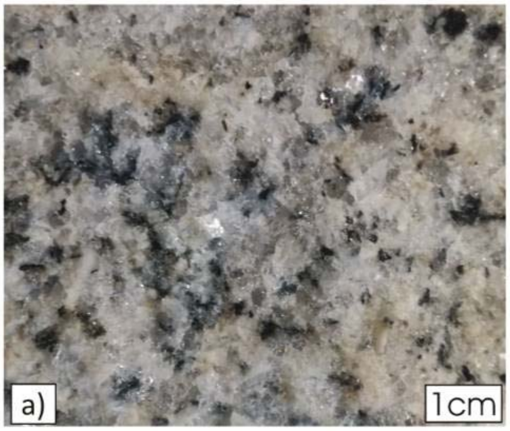
Biotite (11 Vol.%) occurs as xenomorphic to hypidiomorphic medium to coarse grained plates with varying colours/pleochroism (Figure 3c,f). Biotite is often associated with highly-sericitized plagioclase and fine grained epidote/clinozoisite. Fine grained muscovite and sericite are present as a rim around biotite (Figure 3f). Very fine grained opaque minerals, apatite and zircons with and without pleochroitic haloes, can be observed as inclusions in weakly altered biotite.

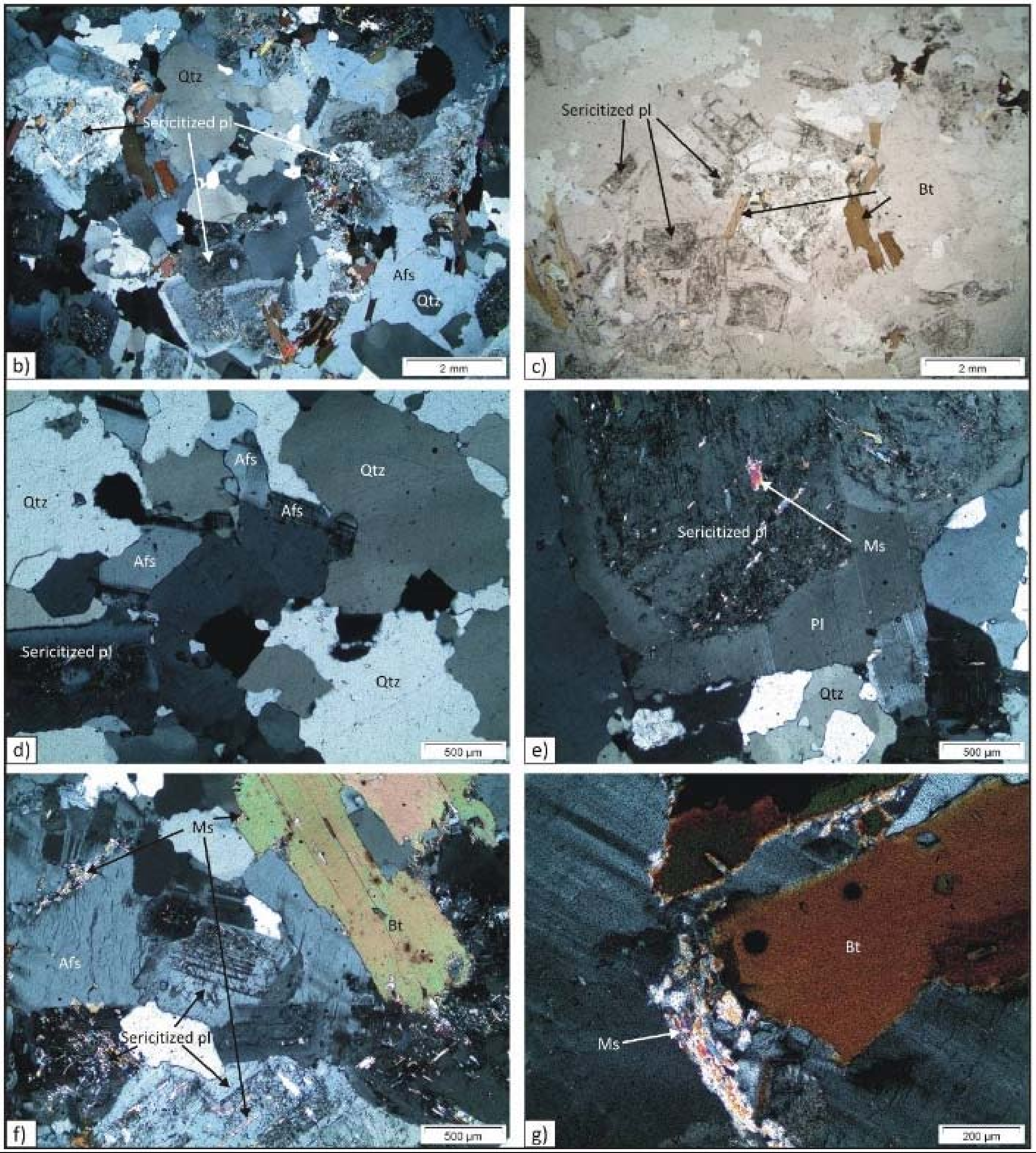
Alkali feldspar (6 Vol.%) is present as xenomorphic-hypidiomorphic medium to coarse grained crystals which are unaltered. In association with chloritized biotite, fine grained needle-like muscovite is rarely present in microfissures. Some crystals show lamellae of albite (microcline-perthite) or microcline twinning (Figure 3d). Twins, as per the Carlsbad law, occur in few columnar crystals.

Muscovite and epidote/clinozoisite (3 Vol.%) occur as fine grained needle-like or bladed inclusions in moderately to highly sericitized plagioclase (Figure 3f). In association with weakly altered biotite, muscovite frequently forms a sutural texture at the grain boundaries (Figure 3e-g). Epidote/clinozoisite is mainly present as fine grained crystals in sericitized plagioclase.

The pore space between quartz and feldspar grains is open and free from alteration products (Figure 3d,e). Along sutural altered biotite grains a clear grain boundary is generally not observed (Figure 3f,g). In the vicinity of altered minerals, the intergranular pore space is open.

Figure 3: Sample IG-BH01-PW006 (321.74 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Unaltered quartz and alkali feldspar with weakly sericitized plagioclase under transmitted, cross-polarized light, e) Plagioclase sericitized in the core with fine grained bladed muscovite under transmitted, cross-polarized light, f) Sericitized plagioclase, biotite and unaltered alkali feldspar under transmitted, cross-polarized light, g) Biotite with muscovite under transmitted, cross-polarized light.





Sample IG-BH01-PW007 (420.56 m b.s.)

Sample IG-BH01-PW 007 consists of a homogenous, equigranular, phaneritic granodiorite (Figure 4a). Macroscopically, no alteration is observed and medium to coarse grained feldspar, quartz and biotite can be distinguished. Minor amounts of muscovite, epidote/clinozoisite and sericite are observed microscopically as alteration products. Apatite, zircon and opaque minerals are present as accessories. The biotite content (6 Vol.%) is low compared to the other samples, whereas the alkali feldspar content (17 Vol.%) is significantly higher.

Plagioclase (49 Vol.%) occurs as xenomorphic-hypidiomorphic medium to coarse grained crystals, which are moderately to highly altered. Moderately altered crystals contain fine grained sericite, needle-like muscovite and/or epidote/clinozoisite, mainly in the core of the crystal (Figure 4e,g). In association with biotite they are frequently fully sericitized. Few crystals are unaltered or weakly altered. Lamellar twinning can be observed in some crystals.

Quartz (28 Vol.%) is present as xenomorphic, medium to coarse grained crystals. Few crystals are very coarse grained (Figure 4b,d). Very fine grained spherical opaque minerals are observed between quartz grains.

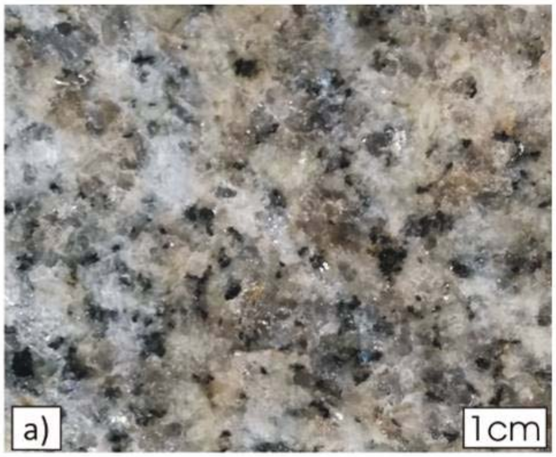
Biotite (6 Vol.%) appears as xenomorphic-hypidiomorphic medium to coarse grained bladed crystals which are unaltered or weakly altered and show varying colours/pleochroism (Figure 4c). Fine grained needle-like muscovite and sericite are present at sutural grain boundaries of weakly-altered biotite (Figure 4f,g). Xenomorphic-hypidiomorphic fine grained epidote/clinozoisite, in association with sericitized plagioclase, can be observed at undefined grain boundaries of biotite.

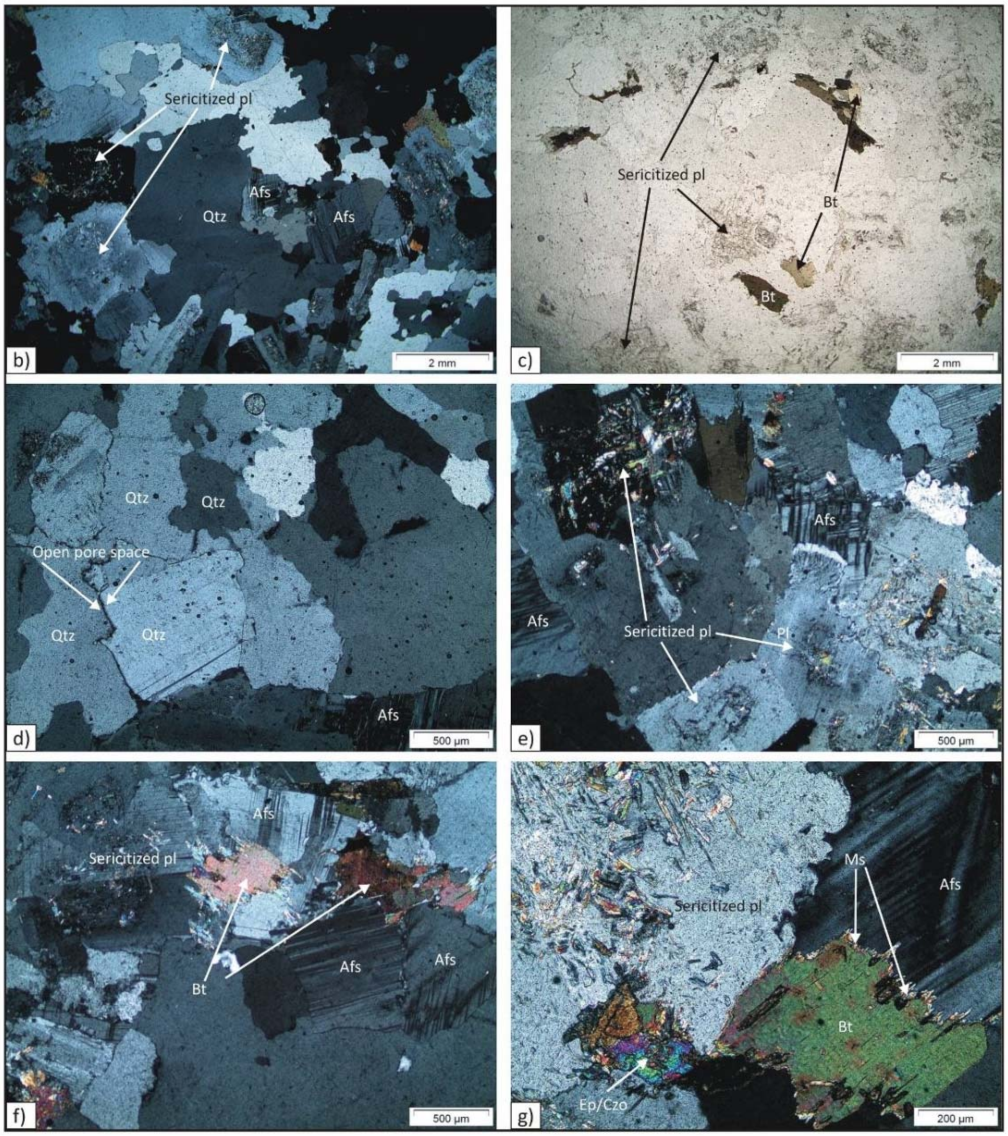
Alkali feldspar (17 Vol.%) occurs as xenomorphic-hypidiomorphic medium to very coarse grained crystals, which are unaltered. Crystals showing microcline twinning are medium to coarse grained (Figure 4b,e-g). Few coarse to very coarse grained crystals have lamellae of albite (Microcline-perthite). In association with biotite, microfissures are filled with muscovite.

Minor amounts of muscovite and epidote/clinozoisite (1 Vol.%) occur as fine grained inclusions in moderately to highly sericitized plagioclase (Figure 4b,e-g). In association with weakly-altered biotite, muscovite frequently forms a sutural texture at the grain boundaries (Figure 4f,g). The low amount of muscovite in this sample is associated with the low amount of biotite in this sample, as muscovite is formed as alteration product under increased potassium supply. The main group of minerals showing multiple vibrant interference colours are present as fine-grained epidote/clinozoisite crystals in sericitized plagioclase. Few hypidiomorphic crystals are observed at undefined grain boundaries of weakly altered biotite and sericitized plagioclase (Figure 4g).

The pore space between grain boundaries of quartz and feldspar is open and not filled with alteration products (Figure 4d). Along sutural altered biotite grains, no clear grain boundary can be observed. The pore space also is open if no alteration minerals are present.

Figure 4: Sample IG-BH01-PW007 (420.56 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Unaltered quartz and alkali feldspar with open pore space under transmitted, cross-polarized light, e) Plagioclase sericitized in the core and unaltered alkali feldspar under transmitted, cross-polarized light, f) Sericitized plagioclase, weakly altered biotite and unaltered alkali feldspar under transmitted, cross-polarized light, g) Sericitized plagioclase, weakly altered biotite with rim of muscovite and epidote/clinozoisite under transmitted, cross-polarized light.





Sample IG-BH01-PW012 (456.60 m b.s.)

The texture of the granodiorite sample IG-BH01-PW012 is homogenous, equigranular and phaneritic. Macroscopically, medium to coarse grained feldspar, quartz and biotite form the bulk of the rock (Figure 4a). Minor amounts of muscovite, sericite and epidote/clinozoisite are observed microscopically as alteration products (Figure 5b-g). Opaque minerals appear as accessories.

Plagioclase (48 Vol.%) occurs as xenomorphic-hypidiomorphic medium to coarse grained crystals, which are moderately to highly altered. Few crystals are very coarse grained. Moderately altered crystals contain fine grained sericite and needle-like muscovite mainly in the core of the crystal (Figure 5g). Also, bladed fine to medium grained muscovite and fine grained epidote/clinozoisite appear as inclusions in some highly altered plagioclase crystals (Figure 5d,f). Few crystals are unaltered or weakly altered and show lamellar twinning.

Quartz (34 Vol.%) is present as xenomorphic, medium to coarse grained crystals. Quartz crystals are frequently arranged in the shape of coarse grained clusters surrounded by medium grained crystals (Figure 5d).

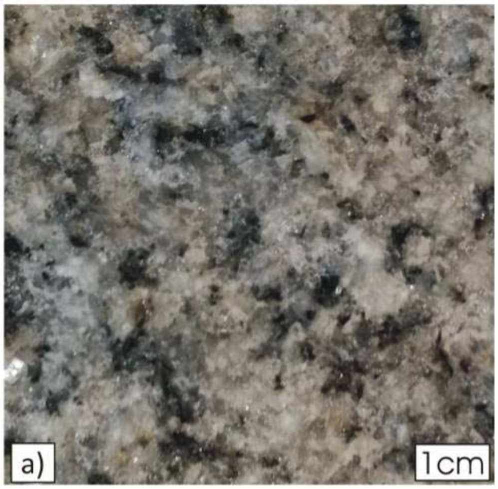
Biotite (8 Vol.%) is present as xenomorphic-hypidiomorphic medium to coarse grained bladed crystals with varying colours/pleochroism (Figure 5c). Few crystals are weakly altered. In association with highly sericitized plagioclase, fine grained needle-like and bladed muscovite and fine grained epidote/clinozoisite crystals are present. Few crystals show a rim of epidote/clinozoisite (Figure 5e,f).

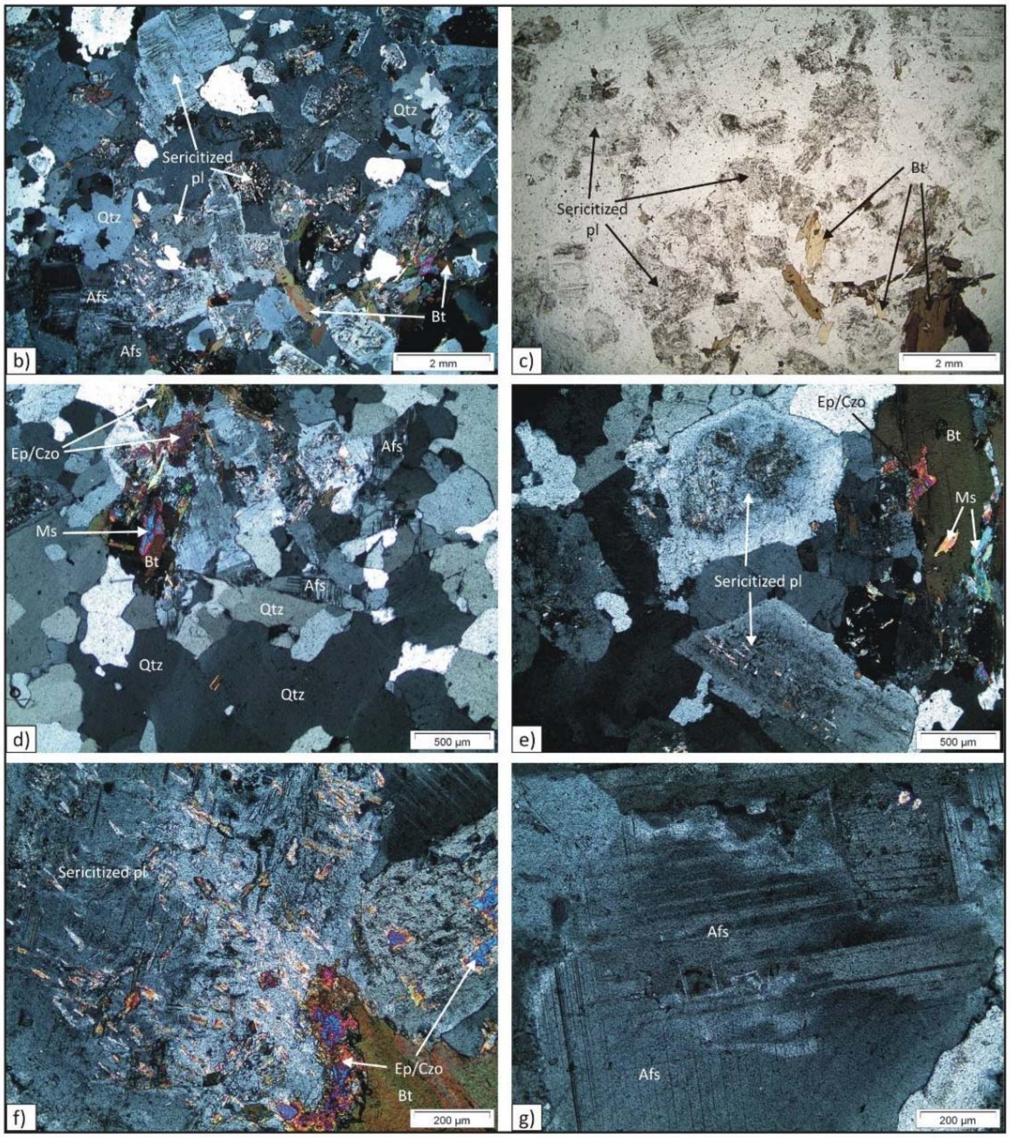
Alkali feldspar (9 Vol.%) occurs as xenomorphic-hypidiomorphic medium to coarse grained unaltered crystals. Microcline twinning and lamellae of albite in some coarse grained crystals are observed (Figure 5d,g). In some crystals microfissures are filled with muscovite.

Muscovite and epidote/clinozoisite (2 Vol.%) occur together with sericite as fine grained inclusions in moderately to highly sericitized plagioclase (Figure 5e,f). In association with weakly altered biotite, muscovite and/or epidote/clinozoisite is present at sutural grain boundaries of biotite or replaces biotite in the shape of fine grained (rarely medium grained) bladed crystals (Figure 5d-f).

The grain boundaries between quartz and feldspar crystals are open and no alteration product is present in the pore space (Figure 5d,g). Along sutural altered biotite grains, a clear grain boundary is generally not observed (Figure 5e,f). In the vicinity of altered minerals, the intergranular pore space also is open.

Figure 5: Sample IG-BH01-PW012 (456.60 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Unaltered quartz cluster, alkali feldspar, biotite, bladed muscovite and epidote/clinozoisite under transmitted, cross-polarized light, e) Plagioclase sericitized in the core, biotite with muscovite and epidote/clinozoisite under transmitted, cross-polarized light, f) Highly sericitized plagioclase and biotite with rim of epidote/clinozoisite under transmitted, cross-polarized light, g) Unaltered alkali feldspar under transmitted, cross polarized light.





Sample IG-BH01-PW015 (531.41 m b.s.)

Sample IG-BH01-PW015 is a homogenous, equigranular and phaneritic tonalite. Macroscopically, medium to coarse grained feldspar, quartz and biotite form the bulk of the rock (Figure 6a). Microscopically, muscovite, sericite and low amounts of epidote/clinozoisite are observed as alteration products (Figure 6b-e,g). Opaque minerals and hypidiomorphic-idiomorphic fine grained zircon crystals appear as accessories.

The composition is dominated by xenomorphic-hypidiomorphic, medium to very coarse grained plagioclase (54 Vol.%) crystals. Few crystals are highly sericitized (Figure 6e). The main group of plagioclase crystals shows fine grained sericite and needle-like muscovite in the core of the crystals, whereas the rim is mainly free from alteration products (Figure 6g). In association with weakly altered biotite, the grain boundaries are not defined due to a margin of fine grained needle-like muscovite (Figure 6b,d). Lamellar twinning is observed in weakly altered crystals.

Quartz makes up to 33 Vol.% of the rock. Xenomorphic, medium to coarse grained crystals frequently appear as clusters (Figure 6f). Quartz crystals are arranged in the form of clusters and fine grained opaque minerals are present as accessories between quartz grains.

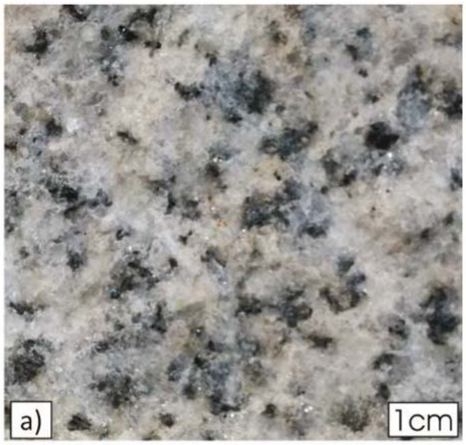
Biotite (8 Vol.%) is mainly present as xenomorphic, medium to coarse grained bladed crystals with varying colours/pleochroism (Figure 6b-e). Weakly altered crystals are associated with fine grained needle-like muscovite and epidote/clinozoisite and are present as a margin around weakly altered biotite and at sutural grain boundaries (Figure 6b,d).

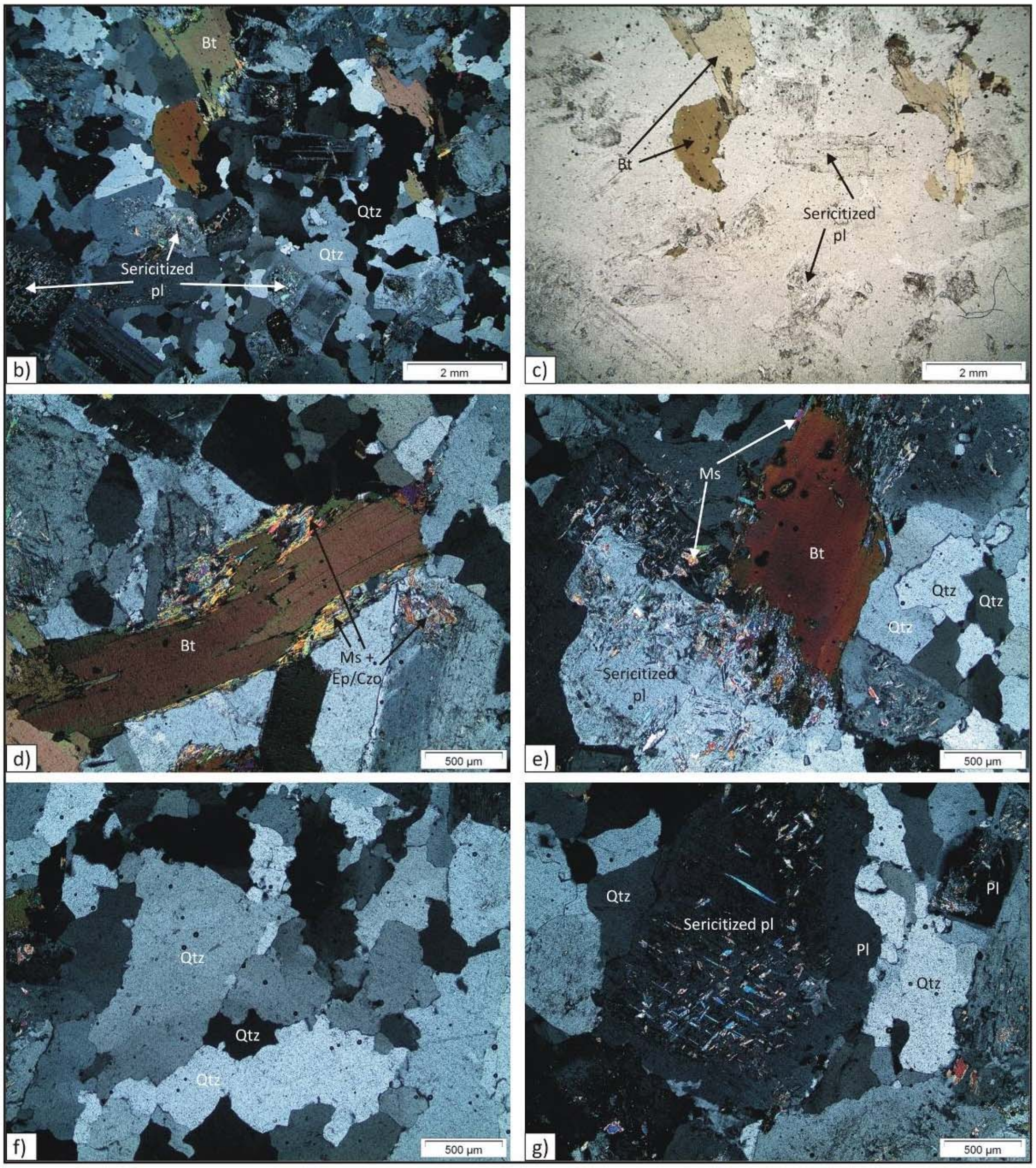
Alkali feldspar (5 Vol.%) occurs as xenomorphic medium to coarse grained crystals showing microcline twinning. The crystals are unaltered; microfissures are filled with sericite/muscovite.

The content of muscovite and epidote/clinozoisite (1 Vol.%) in this sample is low. Muscovite occurs as fine grained needle-like inclusions in moderately to highly sericitized plagioclase (Figure 6b,c,e,g). In association with weakly-altered biotite, muscovite is present at sutural grain boundaries of biotite (Figure 6b,d,e). Minor amounts of epidote/clinozoisite are associated with weakly altered biotite, muscovite and plagioclase (Figure 6d).

The pore space between quartz and feldspar crystals is open and not filled with alteration products (Figure 6e-g). Along sutural altered biotite grains, a clear grain boundary is generally not observed (Figure 6b,d,e). In the vicinity of altered minerals, the intergranular pore space also is open (Figure 6g).

Figure 6: Sample IG-BH01-PW015 (531.41 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Weakly altered biotite with fine grained needle-like muscovite under transmitted, cross-polarized light, e) Quartz, sericitized plagioclase with muscovite and biotite under transmitted, cross-polarized light, f) Open pore space between quartz grains under transmitted, cross-polarized light, g) Quartz and plagioclase sericitized in the core under transmitted, cross-polarized light.





Sample IG-BH01-PW018 (582.95 m b.s.)

Sample IG-BH01-PW018 is a homogenous, equigranular, phaneritic tonalite (Figure 7a). Macroscopically, no alteration is observed and medium to coarse grained feldspar, quartz and biotite can be distinguished. Minor amounts of muscovite, sericite and epidote/clinozoisite are observed microscopically as alteration products. Apatite, zircon and opaque minerals are present as accessories.

Plagioclase (46 Vol.%) occurs as xenomorphic-hypidiomorphic medium to very coarse grained crystals which are weakly to highly altered. Some moderately sericitized crystals contain fine grained needle-like muscovite inclusions, and microfissures along the cleavage are frequently filled with muscovite (Figure 7e). Few crystals show sericite and muscovite in the core, whereas the rim is free of alteration products (Figure 7d,g). Also, highly sericitized plagioclase is present in the sample. In association with weakly altered biotite, fine grained epidote/clinozoisite is present at undefined grain boundaries. Lamellar twinning is present in the main group of plagioclase crystals (Figure 7g).

Quartz (35 Vol.%) occurs as xenomorphic-hypidiomorphic medium to coarse grained crystals. Quartz is frequently arranged in the shape of clusters (Figure 7b,f). Quartz grains within the clusters are mainly coarse grained whereas the grain size is frequently medium at grain boundaries between quartz and plagioclase or biotite.

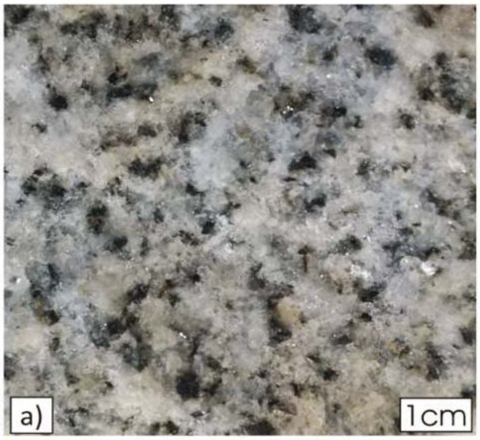
The main group of biotite (12 Vol.%) is present as xenomorphic-hypidiomorphic medium to coarse grained crystals with varying colours/pleochroism (Figure 7b-d,f). Weakly altered light green biotite crystals are frequently associated with fine grained muscovite and little epidote/clinozoisite (Figure 7f), whereas brown(ish) biotite crystals show no alteration products (Figure 7f). Some biotite crystals contain inclusions of very fine grained apatite and zircons with pleochroic haloes.

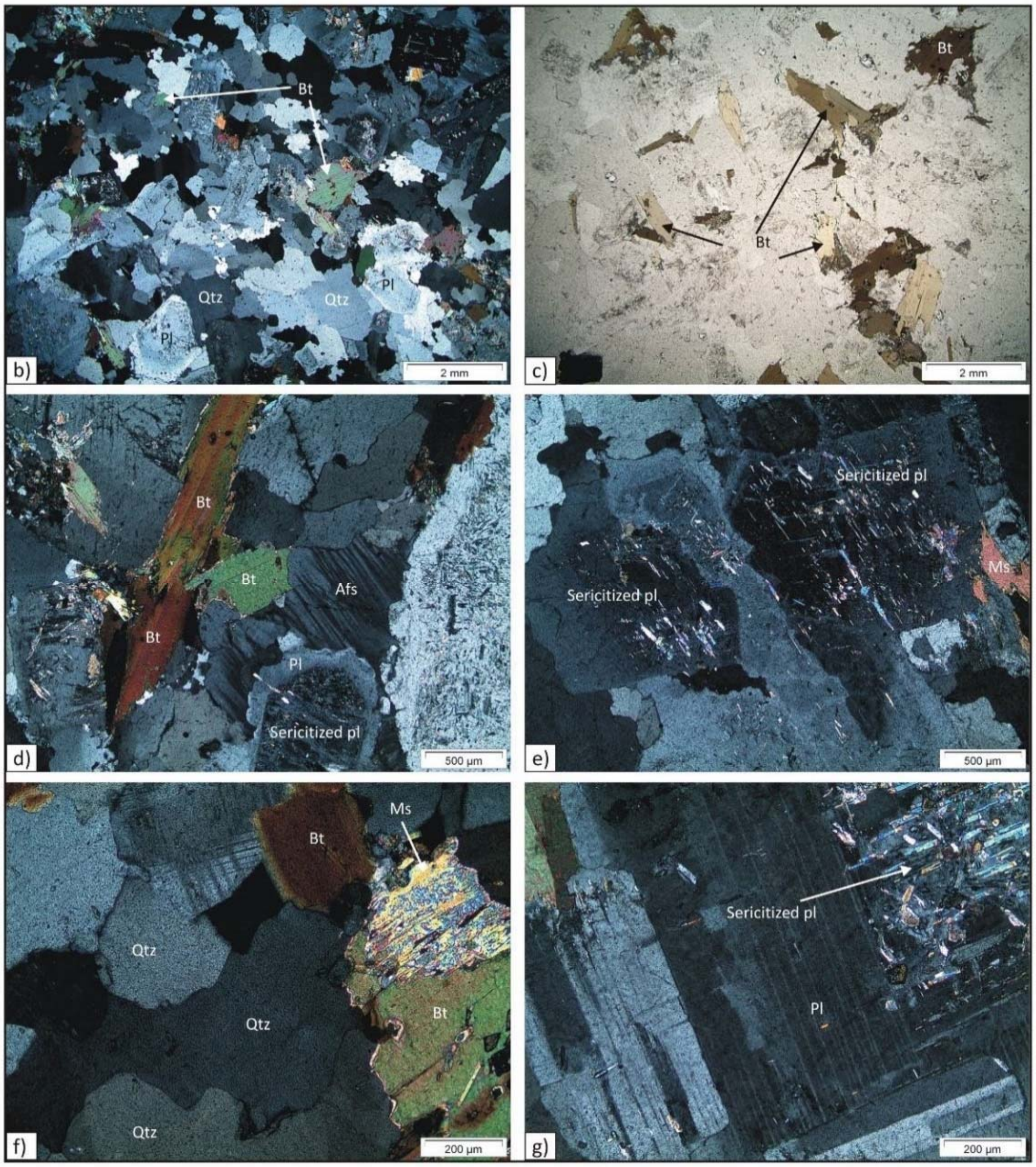
Alkali feldspar (5 Vol.%) occurs in minor amounts in the sample. Alkali feldspar crystals show a xenomorphic shape and are medium to coarse grained. They are free from alteration products, show microcline twinning and lamellae of albite (Figure 7d,f).

Fine grained needle-like muscovite and little fine grained epidote/clinozoisite (4 Vol.%) occur as alteration products in moderately to highly sericitized plagioclase and in association with biotite (Figure 7d-g). In association with weakly altered biotite, muscovite is present at sutural grain boundaries of biotite or replaces biotite in the shape of fine grained (rarely medium grained) bladed crystals (Figure 7f).

The pore space between quartz grains is open and not filled with alteration products (Figure 7f). In association with highly chloritized biotite, the grain boundaries are not defined due to a margin of fine grained needle-like muscovite (Figure 7b,d,f).

Figure 7: Sample IG-BH01-PW018 (582.95 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Weakly altered biotite with sericitized plagioclase and unaltered alkali feldspar under transmitted, cross-polarized light, e) Moderately sericitized plagioclase under transmitted, cross-polarized light, f) Weakly altered biotite with muscovite and unaltered quartz under transmitted, cross-polarized light, g) Plagioclase sericitized in the core under transmitted, cross-polarized light.





Sample IG-BH01-PW020 (632.71 m b.s.)

Macroscopically, sample IG-BH01-PW020 is a homogenous, equigranular and phaneritic tonalite containing mainly medium to coarse grained feldspar, quartz and biotite (Figure 8a). Microscopically, muscovite, sericite and epidote/clinozoisite are observed as alteration products (Figure 8b-f). Opaque minerals are present as accessories.

The composition is dominated by xenomorphic-hypidiomorphic medium to very coarse grained plagioclase crystals (51 Vol.%) showing variable degrees of alteration. Plagioclase is frequently moderately to highly sericitized in the core of zoned crystals and contains fine-grained needle-like muscovite, whereas the rim is free of alteration products (Figure 8b,c,e). In association with weakly altered biotite, needle-like fine to medium grained muscovite and/or epidote/clinozoisite is noticeable (Figure 8e). Lamellar twinning is only observed in few weakly sericitized zoned crystals.

Quartz (31 Vol.%) occurs as xenomorphic, medium to very coarse grained unaltered crystals. Quartz frequently is arranged in the shape of a quartz grain network/cluster (Figure 8b,e,g). Medium grained quartz mainly is present at grain boundaries to plagioclase and biotite, whereas coarse grained crystals occur mostly within the cluster.

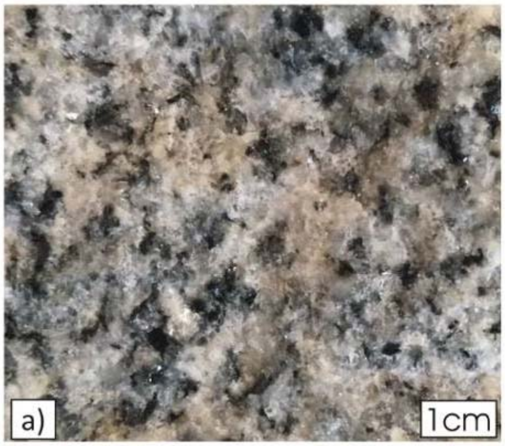
Biotite (12 Vol.%) is mainly present as xenomorphic, medium to coarse grained crystals showing colours/pleochroism in the range of dark brown(ish) to light green(ish). Fine grained needle-like muscovite is present at sutural grain boundaries of weakly altered biotite crystals (Figure 8d,e). In association with highly sericitized plagioclase, fine to medium grained needle-like muscovite and fine grained epidote/clinozoisite are present.

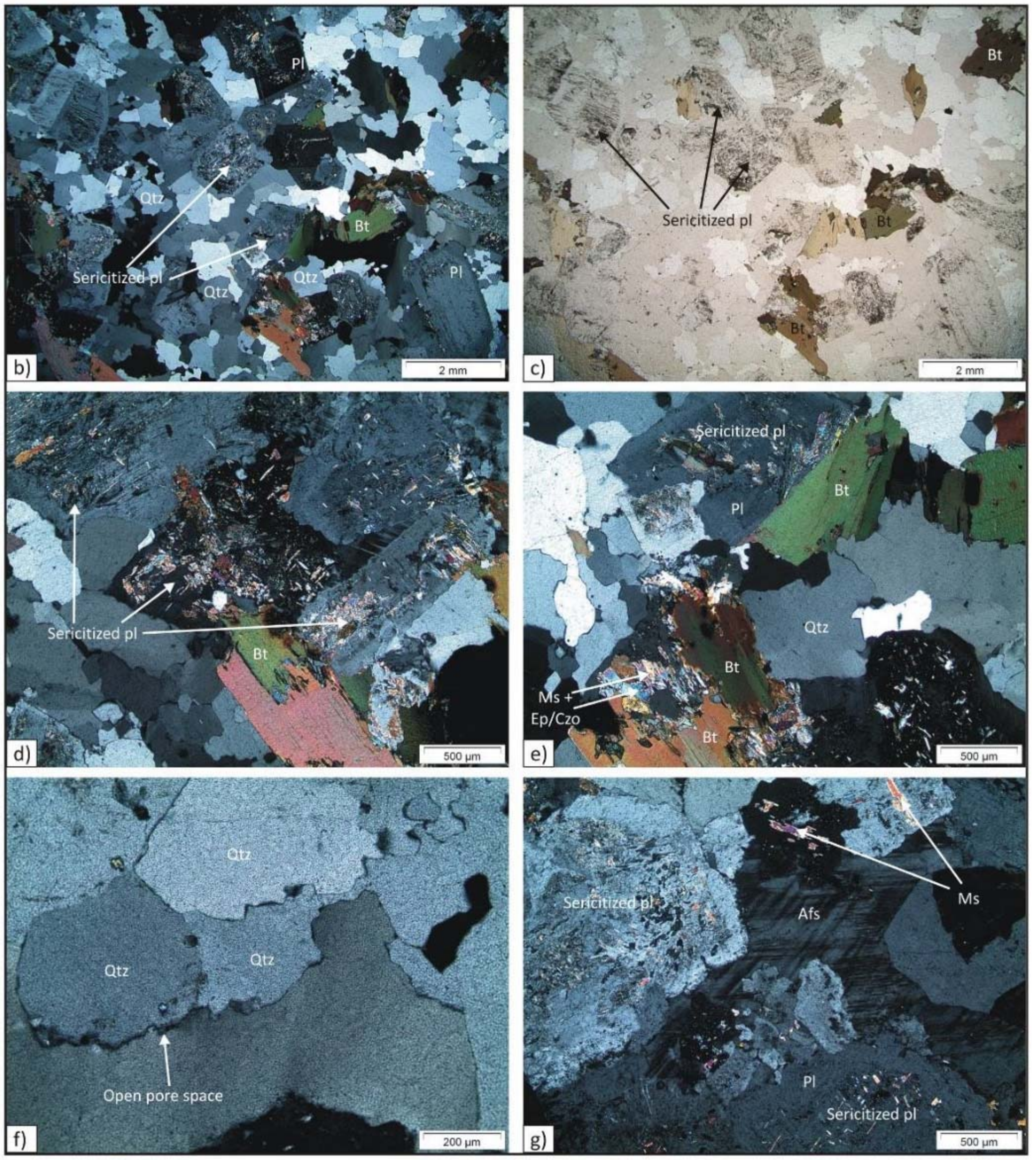
Minor amounts of alkali feldspar (4 Vol.%) are present as xenomorphic medium grained unaltered crystals showing microcline twining (Figure 8g).

Muscovite and epidote/clinozoisite (2 Vol.%) are present as fine grained alteration products, together with moderately to highly sericitized plagioclase and biotite (Figure 8d,e,g). Muscovite frequently occurs with weakly altered biotite in the form of a sutural grain boundary of biotite or partially replaces biotite (Figure 8d,e). Epidote/clinozoisite is mainly present at undefined grain boundaries between sericitized plagioclase and biotite (Figure 8e).

The pore space between quartz grains is open and no alteration products are observed (Figure 8f). Along sutural altered biotite grains a clear grain boundary is generally not observed. The intergranular pore space also is open if no alteration minerals are present (Figure 8g).

Figure 8: Sample IG-BH01-PW020 (632.71 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Weakly altered biotite with highly sericitized plagioclase under transmitted, cross-polarized light, e) Quartz, sericitized plagioclase and weakly altered biotite with muscovite and/or epidote/clinozoisite under transmitted, cross-polarized light, f) Open pore space between quartz grains under transmitted, cross-polarized light, g) Highly sericitized plagioclase with muscovite inclusions and unaltered alkali feldspar under transmitted, cross-polarized light.





Sample IG-BH01-PW023 (721.00 m b.s.)

Macroscopically, sample IG-BH01-PW023 is a homogenous, equigranular, phaneritic tonalite (Figure 9a). No alteration is observed and medium to coarse grained feldspar, quartz and biotite can be distinguished. Minor amounts of muscovite, sericite and epidote/clinozoisite are observed microscopically as alteration products. Very fine grained apatite, zircon, titanite and opaque minerals are present as accessories.

Plagioclase (47 Vol.%) is present as xenomorphic-hypidiomorphic medium to coarse grained crystals showing variable degrees of alteration. Weakly altered plagioclase crystals that are not associated with biotite only contain fine grained needle-like muscovite as inclusions or filled in microfissures (Figure 9g). The main group of plagioclase is highly sericitized and is associated with weakly altered biotite and contains fine grained bladed muscovite and/or fine grained epidote/clinozoisite inclusions (Figure 9b-d,f).

Quartz (33 Vol.%) is present as xenomorphic, medium to coarse grained unaltered crystals. Quartz frequently forms clusters with few coarse grained and mainly medium grained crystals (Figure 9b,g).

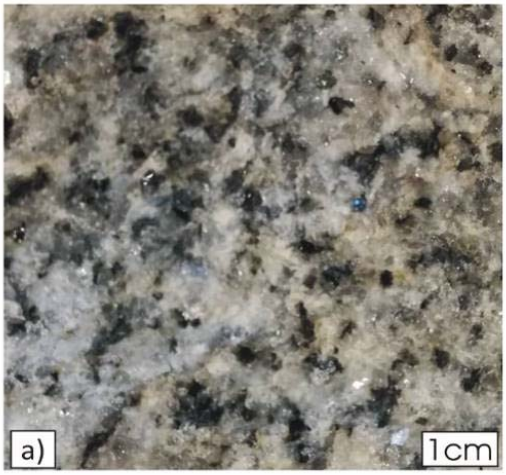
Biotite (11 Vol.%) is present as xenomorphic-hypidiomorphic medium to coarse grained crystals with varying colours/pleochroism (Figure 9b,c,g). Frequently, fine grained epidote and needle-like muscovite is observed at grain boundaries to sericitized plagioclase. Very fine grained zircon and titanite crystals are observed as inclusions in weakly altered biotite.

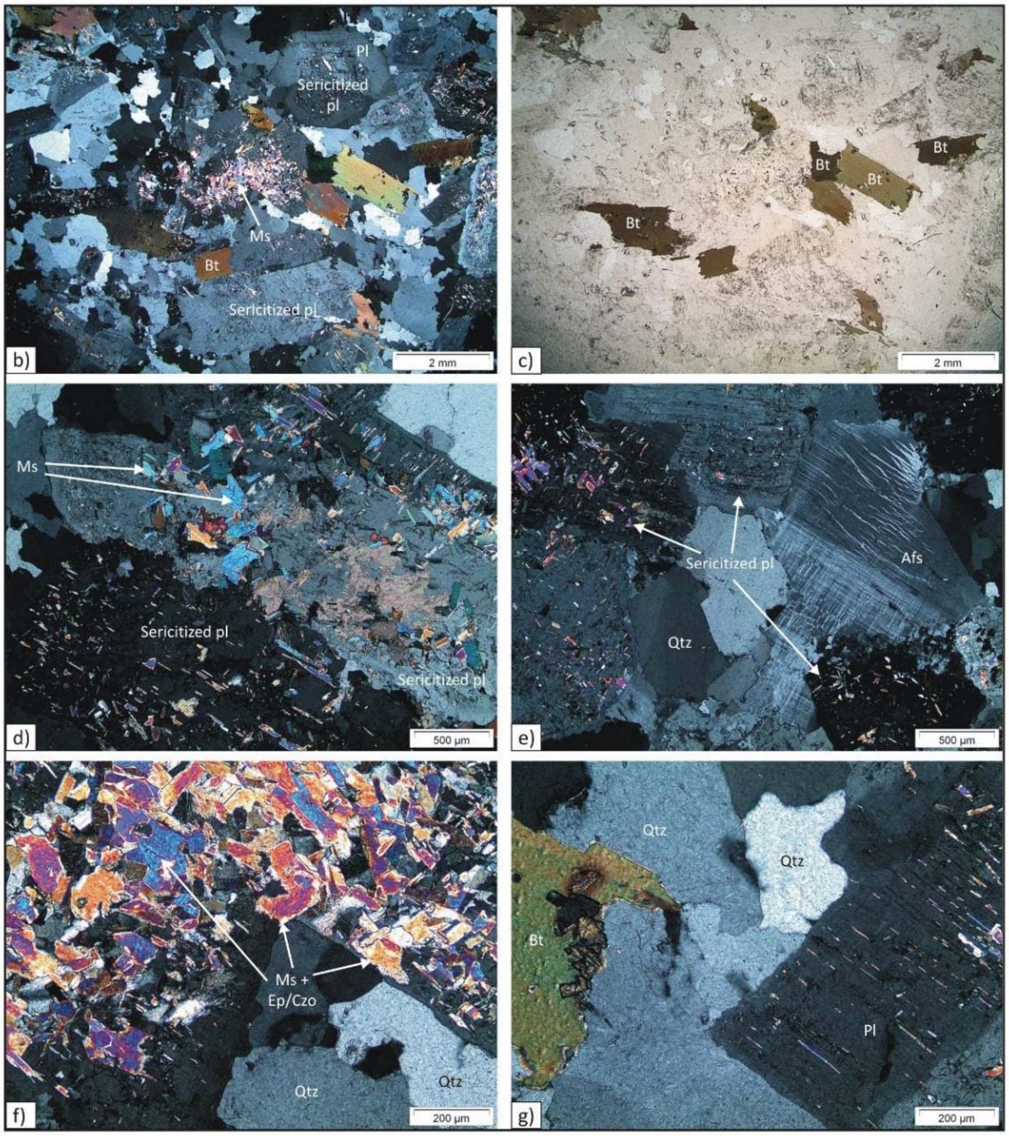
Minor amounts of alkali feldspar (6 Vol.%) are present as xenomorphic medium grained crystals. Alkali feldspar is unaltered and frequently shows microcline twining or lamellae of albite (Figure 9e).

Muscovite and epidote/clinozoisite (4 Vol.%) are mainly present as fine grained inclusions in sericitized plagioclase (Figure 9b,d-f). Few weakly altered biotite crystals show a sutural grain boundary of fine grained muscovite. Fine grained bladed muscovite is frequently concentrated in highly sericitized plagioclase. Few weakly sericitized plagioclase crystals contain muscovite-filled microfissures (Figure 9g). Epidote/clinozoisite is also present between grain boundaries of sericitized plagioclase and biotite.

The pore space between quartz and feldspar grains is open and no alteration products are observed (Figure 9e,g). Along sutural altered biotite grains, a clear grain boundary generally is not observed (Figure 9g). In the vicinity of altered minerals, the intergranular pore space also is open (Figure 9g).

Figure 9: Sample IG-BH01-PW023 (721.00 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Highly sericitized plagioclase with needle-like and bladed muscovite under transmitted, cross-polarized light, e) Unaltered quartz and alkali feldspar with sericitized plagioclase under transmitted, cross-polarized light, f) Highly sericitized plagioclase with bladed muscovite and/or epidote/clinozoisite inclusions under transmitted, cross-polarized light, g) Quartz, biotite and weakly sericitized plagioclase with muscovite filled microfissures under transmitted, cross-polarized light.





Sample IG-BH01-PW025 (820.44 m b.s.)

Sample IG-BH01-PW025 is a homogenous, equigranular, phaneritic granodiorite (Figure 10a). Macroscopically, no alteration is observed and medium to coarse grained feldspar, quartz and biotite can be distinguished. Minor amounts of muscovite, sericite and epidote/clinozoisite are observed microscopically as alteration products. Very fine grained apatite, zircon and opaque minerals are present as accessories.

Plagioclase (49 Vol.%) occurs as xenomorphic-hypidiomorphic medium to very coarse grained crystals. Most crystals are highly sericitized and are associated with biotite and fine grained muscovite and/or epidote/clinozoisite as alteration products (Figure 10b,e,g). Weakly sericitized plagioclase contains muscovite inclusions in the form of fine grained needle-like muscovite.

Quartz makes up 28 Vol.% of the rock. The crystals are xenomorphic, unaltered and medium to coarse grained. Quartz crystals are arranged in the form of clusters (Figure 10d) and fine grained opaque minerals are present as accessories between quartz grains.

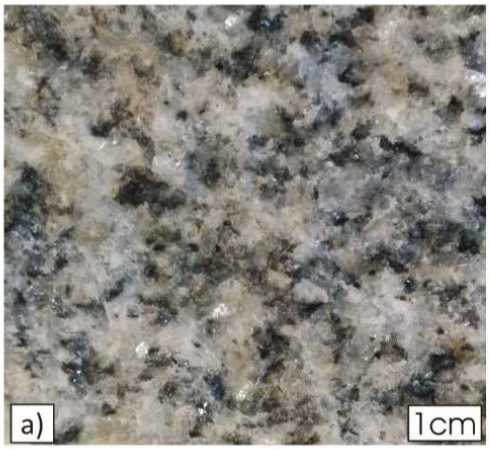
Biotite (14 Vol. %) is present as xenomorphic medium to coarse grained crystals with varying colours/pleochroism (Figure 10b-e). Most grain boundaries show a sutural texture associated with fine grained needle-like muscovite. Fine grained epidote/clinozoisite is frequently observed at biotite-sericitized plagioclase grain boundaries. Very fine grained zircons with pleochroitic haloes are present as inclusions in few crystals.

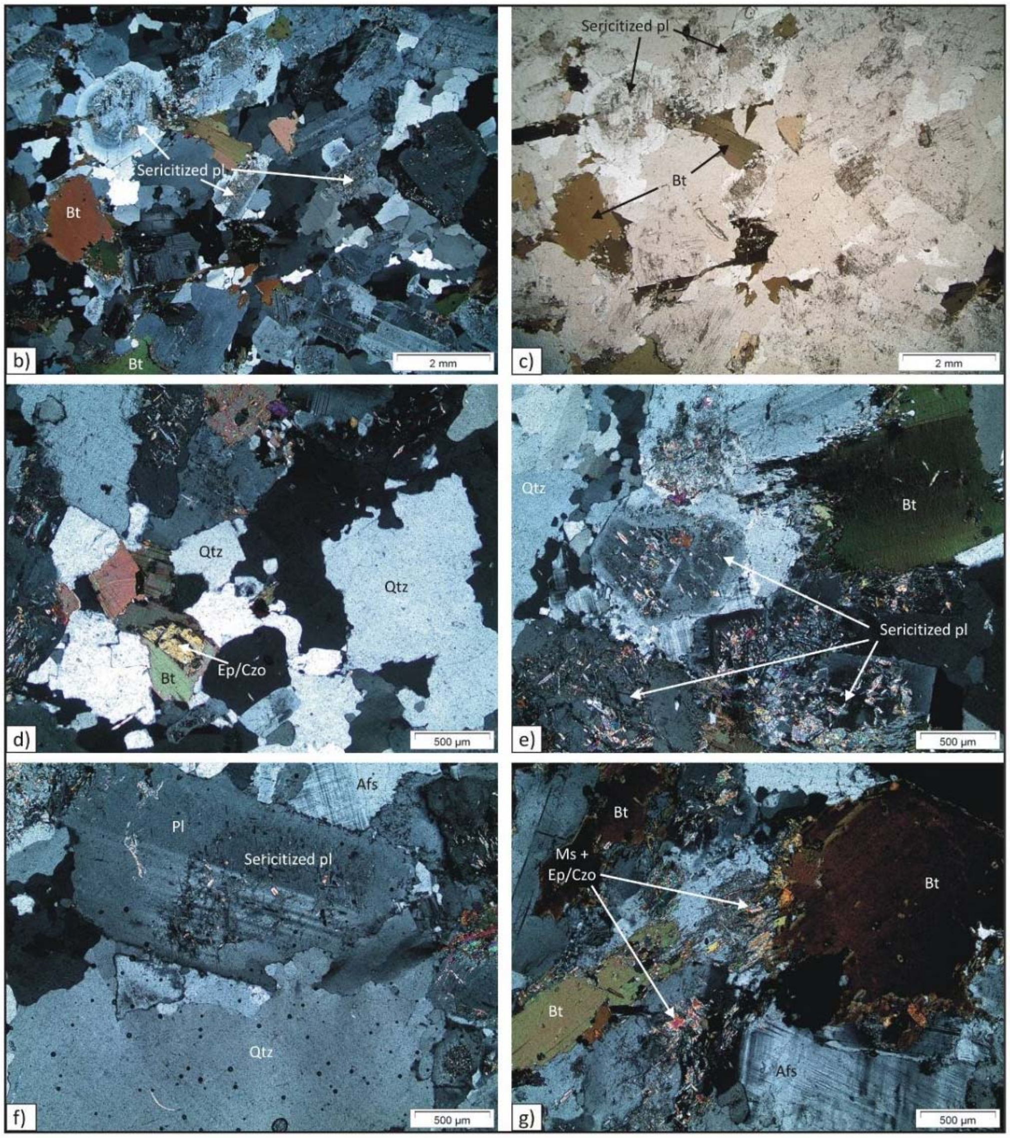
Alkali feldspar (8 Vol.%) occurs as xenomorphic medium to coarse grained crystals. They are free from alteration products, show microcline twinning or lamellae of albite (Figure 10d,f).

Muscovite and epidote/clinozoisite (2 Vol.%) occur as fine grained needle-like inclusions in moderately to highly sericitized plagioclase (Figure 10b,d). Frequently, fine grained muscovite is present as a rim at the grain boundary of biotite (Figure 10e,g). Both alteration products occur at grain boundaries of biotite-sericitized plagioclase (Figure 10g).

The pore space between quartz and feldspar grains is open and no alteration products are observed (Figure 10e,f). Along sutural altered biotite grains, a clear grain boundary generally is generally observed (Figure 10e,g). In the vicinity of altered minerals, the intergranular pore space also is open.

Figure 10: Sample IG-BH01-PW025 (820.44 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Quartz and light green(ish) weakly altered biotite with epidote/clinozoisite under transmitted, cross-polarized light, e) Highly sericitized plagioclase with biotite and quartz under transmitted, cross-polarized light, f) Weakly sericitized plagioclase with unaltered quartz and alkali feldspar under transmitted, cross-polarized light, g) Brown(ish) and green(ish) biotite with muscovite and/or epidote/clinozoisite as alteration products under transmitted, cross-polarized light.





Sample IG-BH01-PW029 (920.82 m b.s.)

Sample IG-BH01-PW029 (920.82 m b.s.) is a homogenous, equigranular, phaneritic granodiorite (Figure 11a). Macroscopically, no alteration is observed and medium to coarse grained feldspar, quartz and biotite can be distinguished. Minor amounts of muscovite, sericite and epidote/clinozoisite are observed microscopically as alteration products. Very fine grained apatite and zircon crystals and opaque minerals are present as accessories.

Plagioclase (48 Vol.%) occurs as xenomorphic-hypidiomorphic medium to very coarse grained crystals, which are weakly to highly altered. The main group of sericitized plagioclase crystals shows muscovite and/or epidote/clinozoisite in the core, whereas the rim is free of alteration products (Figure 11b,c,f,g). Some crystals contain fine grained needle-like muscovite inclusions, and microfissures along the cleavage are frequently filled with muscovite (Figure 11e-g). Few weakly altered and/or zoned crystals also are observed.

Quartz (30 Vol.%) is present as medium to coarse grained crystals. Medium grained quartz is mainly present at grain boundaries to plagioclase and biotite, whereas coarse grained crystals occur mostly within the cluster.

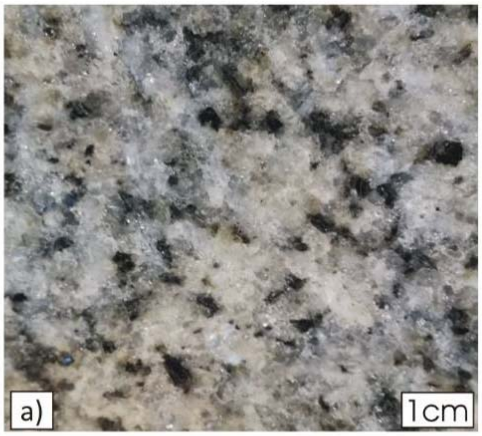
Biotite (13 Vol.%) occurs as xenomorphic medium to coarse grained crystals showing variable colours/pleochroism (Figure 11b,c,e,f). Fine grained muscovite and/or epidote/clinozoisite are present as a rim around weakly altered biotite grains (Figure 11b,c,f).

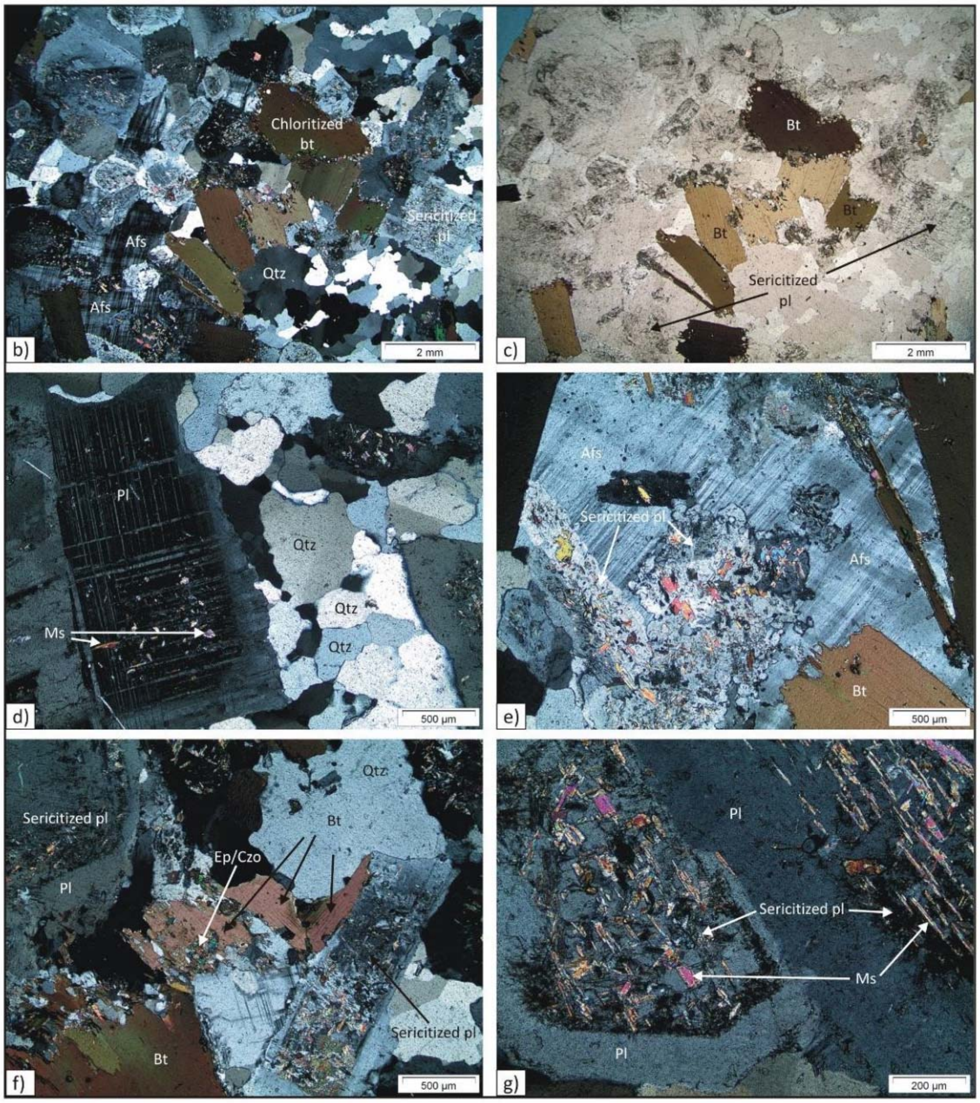
Alkali feldspar (8 Vol.%) occurs as xenomorphic medium to coarse grained crystals. They are free from alteration products and frequently show microcline twinning (Figure 11e).

Muscovite and epidote/clinozoisite (1 Vol.%) occur as fine grained inclusions in moderately to highly sericitized plagioclase (Figure 11b,d-g). In association with sericitized plagioclase, the alteration products muscovite and epidote/clinozoisite are present as a rim around weakly altered biotite (Figure 11b,c,f).

No alteration products are observed in the open pore space of grain boundaries between quartz and feldspar (Figure 11b,d). Along sutural altered biotite grains, a clear grain boundary generally is not observed (Figure 11e,f). In the vicinity of altered minerals, the intergranular pore space also is open.

Figure 11: Sample IG-BH01-PW029 (920.82 m b.s.): a) Macroscopic appearance, b) Overview of the mineral assemblage under transmitted, cross-polarized light, c) Overview of the mineral assemblage under transmitted plane-polarized light, d) Quartz and weakly sericitized plagioclase with muscovite inclusions under transmitted, cross-polarized light, e) Highly sericitized plagioclase, biotite and unaltered Alkali feldspar under transmitted, cross-polarized light, f) Plagioclase sericitized in the core and weakly altered biotite with muscovite and/or epidote/clinozoisite under transmitted, cross-polarized light, g) Plagioclase sericitized in the core with needle-like and bladed muscovite inclusions under transmitted, cross-polarized light.





5.0 WATER CONTENT AND WATER-LOSS POROSITY

Water content, bulk density and water-loss porosity were determined on originally saturated segments of the core samples from borehole IG_BH01. The water content was determined by two independent methods, i.e., gravimetrically by drying rock sections at 45°C and later 105°C to stable weight conditions, and by using the isotope diffusive exchange technique (see Section 3). The gravimetric water content (WC_{grav}) was determined on different segments of the core samples, used for the individual experiments. The initial saturated weight of all these samples was recorded directly after unpacking and preparation of the samples in the laboratory. This ensures that the calculation of the porewater mass is not affected by any possible changes induced during the experiments. Such possible changes were monitored as well by recording the sample weight right after termination of the experiment and before the drying process began. The water loss was calculated using the initial wet weight measured in the lab and the final weight after drying.

The exact determination of the in-situ mass of porewater is of particular importance when using indirect extraction methods, because porewater tracer concentrations are calculated by mass balance equations using the mass of porewater (cf. Section 3). Knowledge of the water-loss porosity (calculated from the water content and density) is further required for the derivation of diffusion coefficients (cf. Section 7).

Drying time series of the individual sub-samples are shown and summarized in Appendix II.

5.1 Water contents

Gravimetric water contents were determined on different segments used for individual experiments (cf. Section 3, Appendix II). The individually determined water contents were weighted, taking the weight of the single sub-samples and the total weight, resulting in a weighted gravimetric water content ($WC_{grav,weighted}$), which represents core samples with weights between 2260 and 2993 g.

The gravimetric water contents ($WC_{grav,weighted}$) of the core samples taken between 220 and 920 m b.s. vary between 0.12±0.01 wt.% and 0.21±0.03 wt.% (Table 8, Figure 12). This covers the value range of the individual sub-samples (Table 8, Figure 12). The weighted gravimetric water contents of the core samples for aqueous extraction and for out-diffusion/isotope exchange experiments, which are taken next to each other, agree well and are within the measurement uncertainties (Table 8, Figure 12).

For all sub-samples the gravimetric water contents were calculated taking the wet and dry mass into account. Due to the low water contents of the crystalline core samples taken from borehole IG_BH01 the gravimetric water contents determined using the wet weight of the cores (WC_{wet}) and using the dry weight of the samples (WC_{dry}) are similar within two decimal places for all sub-samples.

With increasing depth along the borehole, a decrease of the water content can be observed from 0.21 wt.% at 200 m b.s. to 0.14 wt.% at 580 m b.s., followed by a slight increase to 0.16 wt.% at 630 m b.s. At the bedrock zone between 630 and 920 m b.s., the water contents remain constant between 0.15 and 0.17 wt.% (Figure 12), except for the sample at 820 m. The sample taken at 820 m b.s. shows the lowest detected water content (0.12 wt.%).

Differences in the water contents can be caused by mineralogical and textural differences between the granodiorite/tonalite core samples. Varying alteration grades of rock forming minerals, such as feldspars and micas, can cause different proportions of intragranular saturated porosity, however, a correlation of water content to mineral modal composition and alteration grades is not observed in the core samples tested (cf. Table 9). The core sample with the highest gravimetric water content (IG_BH01_PW003, 0.21 wt.%) for example has the lowest proportion of altered plagioclase and a low proportion of muscovite, epidote and clinozoisite compared to the other core samples. In contrast the samples with the lowest gravimetric water content (IG_BH_01_PW025, PW015, PW018, WC = 0.12-0.14 wt.%) show higher proportions of altered plagioclase and muscovite, epidote and clinozoisite proportions in the same range as sample IG_BH01_PW003 (Table 9).

Table 8: Gravimetric water content of the individual core sections used for aqueous extraction experiments (AqEx), isotope diffusive exchange experiments (IsoEx), separate pieces for WC determination (extra) and out-diffusion experiments (out-diff); the gravimetric water contents are weighted with respect to the weight of the individual sub-samples (Appendix II). Water contents are additionally determined by the isotope diffusive exchange technique (Iso Diff Ex) according to equation 6 (cf. Section 3.3.3). The errors are calculated by Gaussian error propagation (Appendix III). The gravimetric water contents are determined using the wet and dry weight of the individual core pieces; due to the low water content the values are similar within two decimals.

		Gravimetric Water Content					Water Content by Iso Diff Ex
Sample	**Depth**	WC_{AqEx}	WC_{extra}	WC_{IsoEx}	$WC_{out\text{-}diff}$	$WC_{grav,weighted}$	WC_{IsoEx}
	m b.s.	wt.%	wt.%	wt.%	wt.%	**Wt.%**	wt.%
IG_BH01_PW002	222.2	0.21±0.02				**0.21±0.02**	
IG_BH01_PW003	223.3		0.23±0.03	0.18±0.02	0.21±0.02	**0.21±0.03**	0.17±0.01
IG_BH01_PW005	321.6	0.19±0.01				**0.19±0.01**	
IG_BH01_PW006	321.7		0.20±0.01	0.19±0.01	0.18±0.02	**0.19±0.01**	0.21±0.01
IG_BH01_PW007	420.6		0.19±0.01	0.19±0.01	0.18±0.01	**0.19±0.01**	0.16±0.01
IG_BH01_PW009	421.2	0.19±0.03				**0.19±0.03**	
IG_BH01_PW010	456.1	0.16±0.02				**0.16±0.02**	
IG_BH01_PW012	456.6		0.19±0.01	0.18±0.01	0.16±0.01	**0.17±0.02**	0.17±0.01
IG_BH01_PW015	531.4		0.16±0.01	0.13±0.01	0.13±0.01	**0.14±0.02**	0.13±0.01
IG_BH01_PW013	531.7	0.13±0.02				**0.13±0.02**	
IG_BH01_PW016	582.4	0.14±0.02				**0.14±0.02**	
IG_BH01_PW018	582.9		0.16±0.01	0.13±0.01	0.14±0.01	**0.14±0.01**	0.12±0.01
IG_BH01_PW019	632.5	0.16±0.01				**0.16±0.01**	
IG_BH01_PW020	632.7		0.17±0.01	0.15±0.01	0.15±0.01	**0.15±0.01**	0.15±0.01
IG_BH01_PW023	721.0		0.19±0.02	0.17±0.01	0.16±0.01	**0.17±0.02**	0.15±0.01
IG_BH01_PW024	721.3	0.16±0.03				**0.16±0.03**	
IG_BH01_PW025	820.4		0.13±0.01	0.13±0.01	0.10±0.01	**0.12±0.01**	0.10±0.01

		Gravimetric Water Content					Water Content by Iso Diff Ex
Sample	**Depth**	**WC_{AqEx}**	**WC_{extra}**	**WC_{IsoEx}**	**$WC_{out\text{-}diff}$**	**$WC_{grav,weighted}$**	**WC_{IsoEx}**
IG_BH01_PW027	821.0	0.12±0.03				**0.12±0.03**	
IG_BH01_PW029	920.8		0.16±0.01	0.14±0.01	0.15±0.02	**0.15±0.01**	0.13±0.01
IG_BH01_PW030	921.1	0.16±0.02				**0.16±0.02**	

Table 9: Gravimetric weighted water contents of core samples from borehole IG_BH01 compared to their mineral composition (abbreviations are explained in Table 3).

Sample	Depth	$WC_{grav,weighted}$	Qtz	Pl	Altered Pl	Afs	Bt	Ms + Ep + Czo
	m b.s.	Wt.%	Vol.%	Vol.%	Vol.%	Vol.%	Vol.%	Vol.%
IG_BH01_PW003	223.25	**0.21±0.03**	34	38	8	5	12	2
IG_BH01_PW006	321.74	**0.19±0.01**	35	31	15	6	11	3
IG_BH01_PW007	420.56	**0.19±0.01**	28	37	12	17	6	1
IG_BH01_PW012	456.60	**0.17±0.02**	34	31	17	9	8	2
IG_BH01_PW015	531.41	**0.14±0.02**	33	40	14	5	8	1
IG_BH01 _PW018	582.95	**0.14±0.01**	35	35	11	5	12	4
IG_BH01_PW020	632.71	**0.15±0.01**	31	38	13	4	12	2
IG_BH01_PW023	721.00	**0.17±0.02**	33	35	12	6	11	4
IG_BH01_PW025	820.44	**0.12±0.01**	28	36	13	8	14	2
IG_BH01_PW029	920.82	**0.15±0.01**	30	36	12	8	13	1

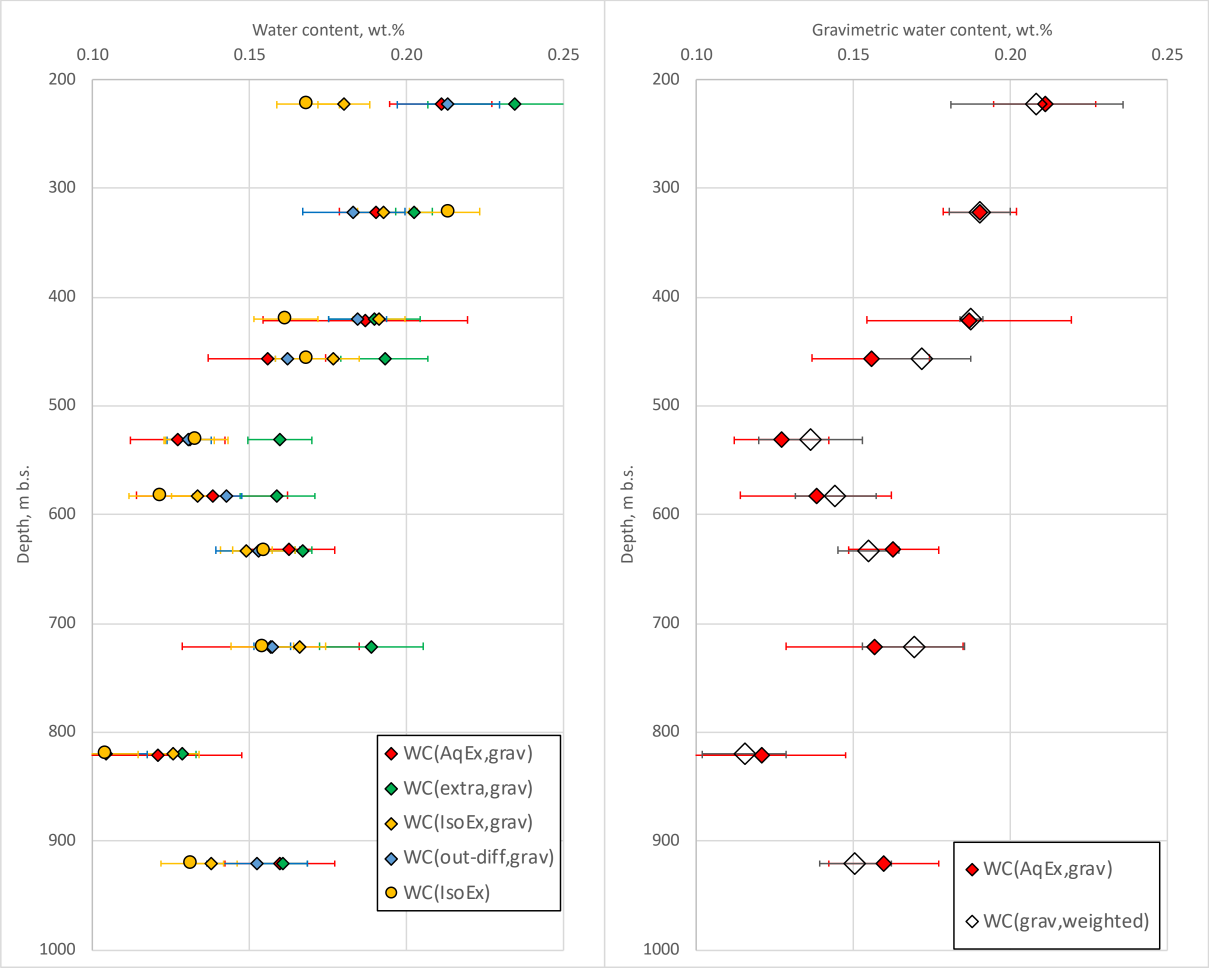


Figure 12: Left, gravimetric water contents and water contents determined by isotope diffusive exchange for core sections used in different experiments versus sample depth; Right, weighted gravimetric water contents versus depth.

5.1.1 Effects on water content observed during out-diffusion experiments

The low mass of porewater in the crystalline rocks from IG_BH01 makes the determination of the water content sensitive to any processes that might cause a mass change of porewater in a core sample. Such processes are, for example, stress release during and after drilling, the generation of a drilling disturbed zone (DDZ) during the drilling process, and desaturation during sample packing and preparation in the laboratory. As shown in previous porewater studies, the latter can be successfully minimised by applying an adequate sampling and packing procedure (cf. Section 2). The influence of drilling fluid due to stress release and a disturbed zone is limited to the (short) time the core is in contact with the drilling fluid (cf. Waber et al. 2011; Meier et al. 2015).

During immersion in test water for several months, the mass of eight of ten large-sized core samples increased between 0.002 and 0.158 g during the out-diffusion experiments (Table 9). Relative to the original mass of porewater before the experiment this corresponds to an increase in porewater mass of 0.1 to 8.1 % (Table 10, Figure 13). Two samples (IG_BH01_PW003 and PW023) showed a slight weight decrease of -0.04 and -0.03 g after out-diffusion experiments. This results in a porewater mass difference of -1.5 % (Table 10, Figure 13).

The influence of evaporation – and thus artificially decreased initial sample weight – in the time interval from sample recovery to experimental setup was successfully minimised because the samples were well-sealed, and the core surfaces were wet upon arrival in the lab.

The uptake of water during the long-term diffusion experiments, which might be caused by the creation of a DDZ or stress release, is < 10 % for all samples (Table 10, Figure 14). A correlation between water uptake and sampling depth cannot be observed.

The mass of porewater determined from the initial sample mass before the experiment and after drying to stable weight conditions reflects the in-situ mass of porewater. Therefore, the initial mass of porewater was used for the calculation of porewater tracer concentrations and further interpretation of the water contents and water-loss porosity.

Table 10: Weight of core samples from borehole IG_BH01 before and after the out-diffusion experiments and the corresponding calculated mass of porewater and water content; the mass of water uptake (Δm_{PW}) is obtained by difference of the sample mass before and after the out-diffusion experiments

Sample	Depth	$m_{core,wet}$ b.e.	$m_{core,wet}$ a.e.	$\Delta m_{core,e}$	m_{PW} m_{core}b.e.	m_{PW} m_{core}a.e.	WC m_{core}b.e.	WC m_{core}a.e.	Δm_{PW}
	m b.s.	g	g	G	g	g	wt.%	wt.%	%
IG_BH01_PW003	223.3	1289.140	1289.100	-0.040	2.749	2.709	0.21	0.21	-1.47
IG_BH01_PW006	321.7	1209.408	1209.554	0.146	2.213	2.359	0.18	0.20	6.18
IG_BH01_PW007	420.6	1244.479	1244.545	0.066	2.295	2.361	0.18	0.19	2.79
IG_BH01_PW012	456.6	1253.103	1253.105	0.002	2.032	2.034	0.16	0.16	0.10
IG_BH01_PW015	531.4	1225.818	1225.854	0.036	1.600	1.636	0.13	0.13	2.20
IG_BH01_PW018	582.9	1280.967	1280.981	0.014	1.827	1.841	0.14	0.14	0.76
IG_BH01_PW020	632.7	1234.663	1234.779	0.116	1.884	2.000	0.15	0.16	5.79
IG_BH01_PW023	721.0	1418.334	1418.300	-0.034	2.228	2.194	0.16	0.15	-1.55
IG_BH01_PW025	820.4	1297.555	1297.674	0.119	1.350	1.469	0.10	0.11	8.09
IG_BH01_PW029	920.8	1302.956	1303.114	0.158	1.984	2.142	0.15	0.16	7.37

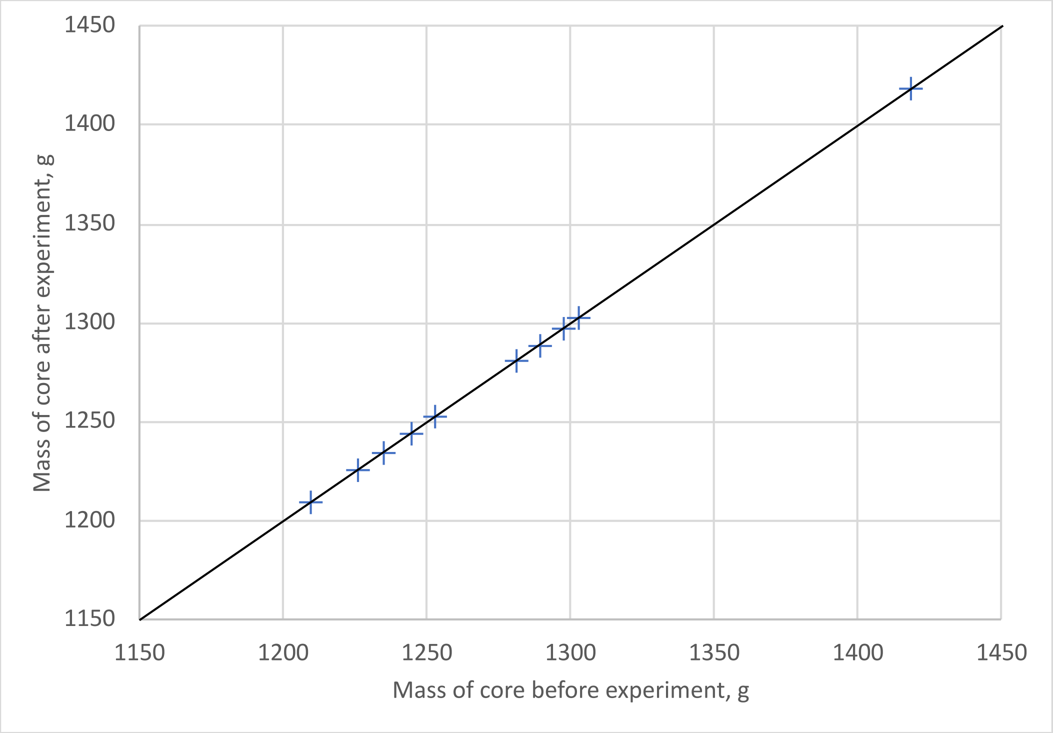


Figure 13: Mass of samples from borehole IG_BH01 before and after the out-diffusion experiments; the uncertainty of the core mass is ±0.02 g.

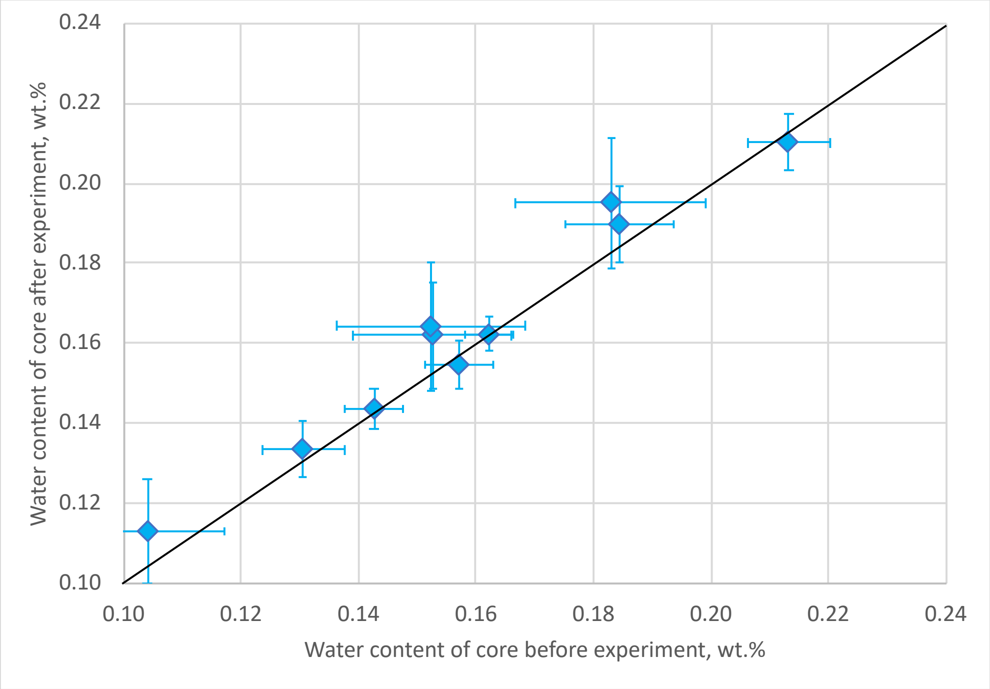


Figure 14: Water content calculated from the wet mass before and after the out-diffusion experiments of core sections from borehole IG_BH01; the error of the water content is determined by Gaussian error propagation (Appendix III)

5.1.2 Comparison of water contents determined gravimetrically and by isotope diffusive exchange

The water content determined by the isotope diffusive exchange technique (WC_{IsoEx}) for granodiorite/tonalite core samples from borehole IG_BH01 varies between 0.10±0.01 and 0.21±0.01 wt.% and show the same depth trends as the gravimetric water contents (Table 8, Figure 12).

The water contents determined by the isotope diffusive exchange technique are, for most samples, similar to and within the error range of the gravimetric values determined on the same core pieces (Table 8, Figure 12 and 15). Two samples show slightly higher, one sample slightly lower, gravimetric water contents than those determined by isotope exchange. A correlation to any experimental or analytical artefacts cannot be observed.

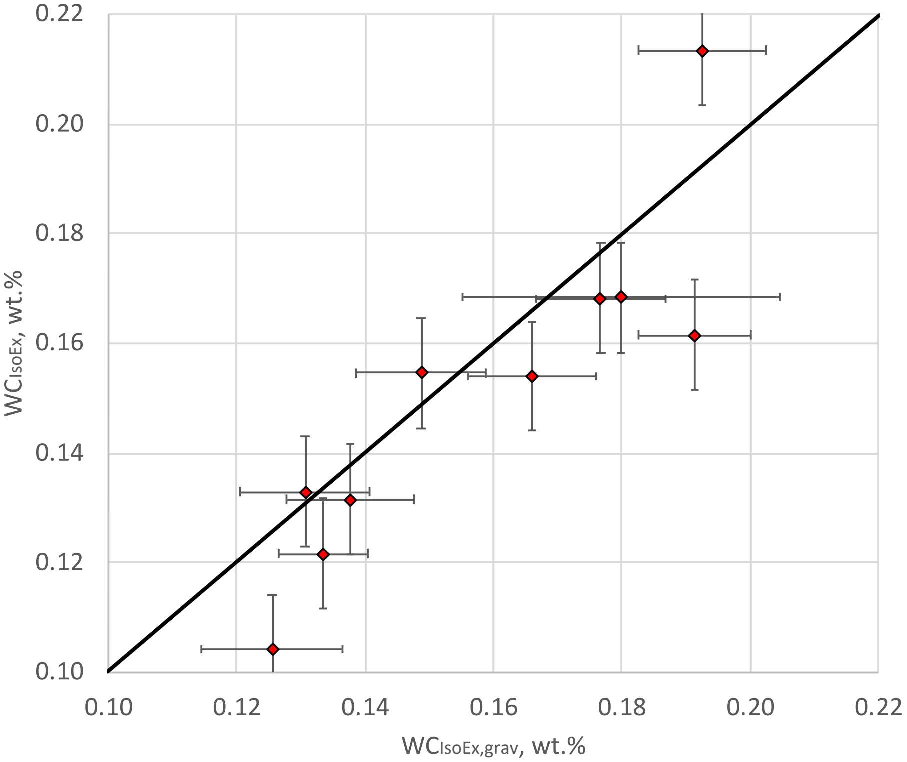


Figure 15: Comparison of water contents determined by isotope diffusive exchange and gravimetrically (by wet weight) on the same core pieces; the error of the water content is determined by Gaussian error propagation.

5.2 Bulk dry/wet density and water-loss porosity

The bulk dry and wet density is calculated according to equation 1 (Section 3.2) using the dry and wet mass of the full diameter cylinders and the volume of the core samples determined by measuring the height and core diameter by a Vernier caliper. Bulk dry and wet densities were determined for the cores used for out-diffusion and aqueous extraction experiments before crushing.

Bulk dry and wet density values of the granodiorite/tonalite samples from borehole IG_BH01 are similar, differing by a maximum of 0.01 vol.%, due to the low water content of the samples and vary between 2.57 and 2.69 g/cm^3 (Table 11). Bulk dry and wet densities determined on adjacent out-diffusion and aq. ex. samples are mostly in good agreement.

The water-loss (connected) porosity was calculated according to equation 2 (Section 3.2) using the water content calculated by the dry and wet weight and the bulk dry/wet density of the samples. Water content porosities are calculated for core sections used for the out diffusion and aqueous extraction experiments, for which the water content and the bulk dry/wet density were determined. Water-loss porosities calculated using the wet mass and density do not differ (within two decimal places) from those determined by the dry mass and density. The only exception is sample IG_BH01_PW020, which shows a higher (0.01 vol.%) wet water-loss porosity (Table 11).

Water-loss porosity values of core samples taken between 200 and 920 m b.s. from borehole IG_BH01 vary between 0.31±0.04 and 0.56±0.03 Vol.% (Table 11, Figure 16). Samples taken adjacent to each other mostly show equal WL-porosities within the uncertainty range (Table 11, Figure 16). The trends of the porosity values of the single samples follow the same trends as described by the water contents.

Table 11: Bulk wet and dry density and water-loss (=WL-) porosity determined by water contents calculated for dry ($\Phi_{WL,dry}$) and wet core samples ($\Phi_{WL,wet}$) of rock core samples from borehole IG_BH01; the errors are determined by Gaussian error propagation (Appendix III)

Sample	Depth	$WC_{grav,weighted}$ (wet weight)	$WC_{grav,weighted}$ (dry weight)	Bulk, wet density	Bulk, dry density	Water-loss Porosity $\Phi_{WL,wet}$	Water-loss Porosity $\Phi_{WL,dry}$
	m b.s.	wt. %	wt. %	g/cm³	g/cm³	Vol.%	Vol.%
IG_BH01_PW002	222.2	0.21±0.02	0.21±0.02	2.66	n.d.	0.56±0.03	0.56±0.03
IG_BH01_PW003	223.3	0.21±0.03	0.21±0.03	2.67	2.67	0.56±0.03	0.56±0.03
IG_BH01_PW005	321.6	0.19±0.01	0.19±0.01	2.57	n.d.	0.49±0.02	0.49±0.02
IG_BH01_PW006	321.7	0.19±0.01	0.19±0.01	2.66	2.66	0.51±0.05	0.51±0.05
IG_BH01_PW007	420.6	0.19±0.01	0.19±0.01	2.63	2.62	0.49±0.03	0.49±0.03
IG_BH01_PW009	421.2	0.19±0.03	0.19±0.03	2.60	n.d.	0.49±0.03	0.49±0.03
IG_BH01_PW010	456.1	0.16±0.02	0.16±0.02	2.61	n.d.	0.41±0.02	0.41±0.02
IG_BH01_PW012	456.6	0.17±0.02	0.17±0.02	2.65	2.64	0.45±0.02	0.45±0.02
IG_BH01_PW015	531.4	0.14±0.02	0.14±0.02	2.66	2.65	0.36±0.02	0.36±0.02
IG_BH01_PW013	531.7	0.13±0.02	0.13±0.02	2.63	n.d.	0.33±0.04	0.33±0.04
IG_BH01_PW016	582.4	0.14±0.02	0.14±0.02	2.61	n.d.	0.36±0.03	0.36±0.03
IG_BH01_PW018	582.9	0.14±0.01	0.14±0.01	2.68	2.68	0.39±0.02	0.39±0.02
IG_BH01_PW019	632.5	0.16±0.01	0.16±0.01	2.67	n.d.	0.43±0.04	0.43±0.04
IG_BH01_PW020	632.7	0.15±0.01	0.16±0.01	2.68	2.68	0.42±0.04	0.43±0.04
IG_BH01_PW023	721.0	0.17±0.02	0.17±0.02	2.67	2.67	0.45±0.02	0.45±0.02
IG_BH01_PW024	721.3	0.16±0.03	0.16±0.03	2.69	n.d.	0.42±0.03	0.42±0.03
IG_BH01_PW025	820.4	0.12±0.01	0.12±0.01	2.69	2.69	0.31±0.04	0.31±0.04
IG_BH01_PW027	821.0	0.12±0.03	0.12±0.03	2.58	n.d.	0.31±0.02	0.31±0.02
IG_BH01_PW029	920.8	0.15±0.01	0.15±0.01	2.67	2.69	0.40±0.04	0.40±0.04
IG_BH01_PW030	921.1	0.16±0.02	0.16±0.02	2.67	n.d.	0.43±0.02	0.43±0.02

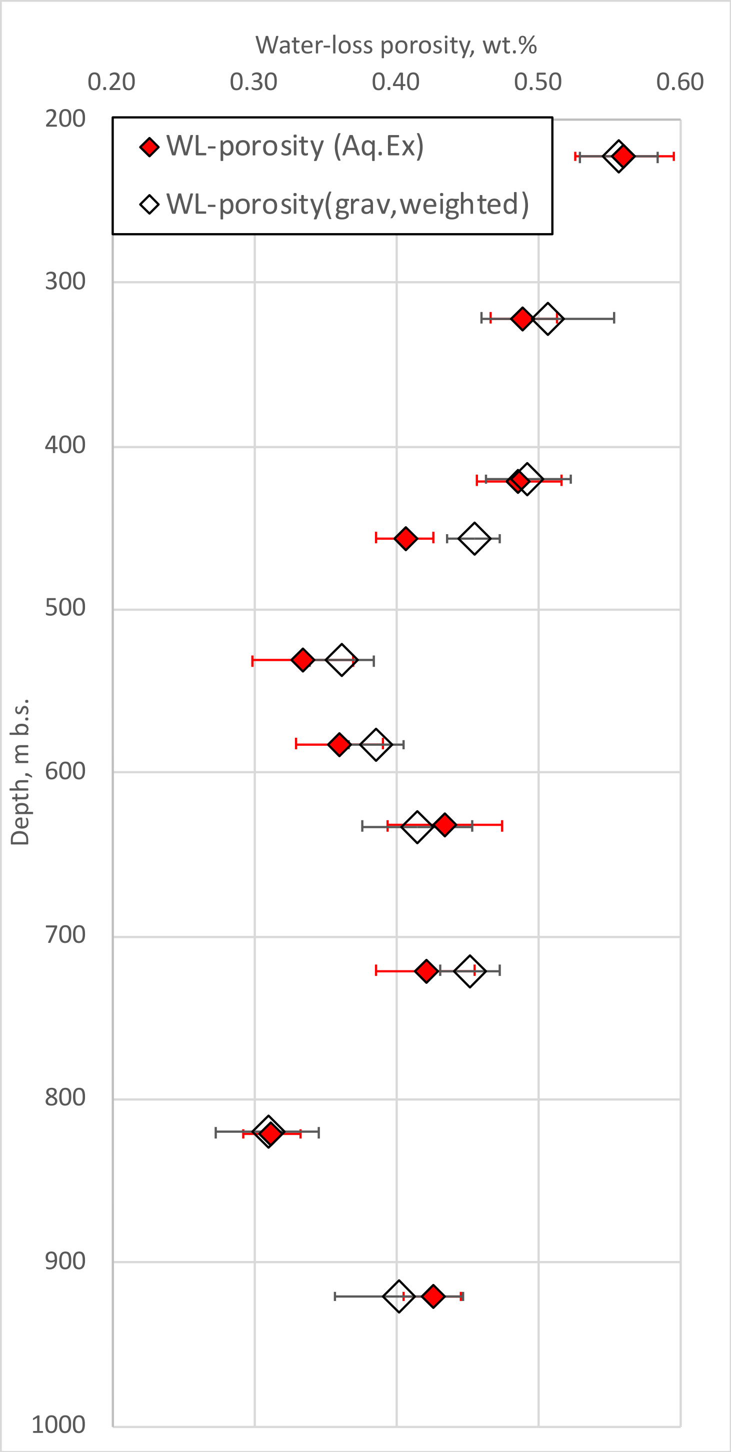


Figure 16: Water-loss porosity of core samples from borehole IG_BH01; the errors are determined by Gaussian error propagation (Appendix III)

6.0 CHEMICAL COMPOSITION OF EXPERIMENT SOLUTIONS OF AQUEOUS EXTRACTION AND OUT-DIFFUSION EXPERIMENTS

Out-diffusion and aqueous extraction experiments were performed on ten core samples taken from borehole IG_BH01. In both experiments the investigated rock samples were immersed in test water. The concentrations of dissolved constituents in the test solutions originate from:

a) porewater, which exchanges and mixes with test water,

b) water-rock interactions, releasing reactive elements in the test water

c) fluid inclusions (only aqueous extractions), which are liberated during crushing of the rocks.

In contrast, non-reactive elemental concentrations can be converted to porewater concentrations, because porewater is the only source in the system.

6.1 Chemical composition of aqueous extraction solutions

The purpose of aqueous extraction experiments is to obtain an initial estimate of the porewater salinity, which is necessary for the adjustment of the ion concentration in the test waters for the indirect porewater extraction methods.

Crushing and grinding of the rock material additionally liberates fluid trapped in mineral fluid inclusions. During leaching, all salts will become dissolved in addition to the limited dissolution of the original mineral assemblage. The mineralization of a leach solution is therefore the sum of: (i) the constituents originally dissolved in the pore water, (ii) the constituents present in fluid inclusions, and (iii) water-rock interactions during the leaching process. Thus, aqueous leach solutions represent a complex composition in rocks with abundant fluid inclusions and/or rapidly reacting mineral phases.

The aqueous extraction solutions produced by the immersion of crushed cores from borehole IG_BH01 in deionized water (procedure cf. Section 3.3.1) have pH values between 8.50 and 9.45, and a mineralization between 44.8 and 184 mg/l (sp. electrical conductivity = 50 – 183 µS/cm, Table 12). The dissolved constituents consist predominately of Na, K, Ca, HCO_3^- and Cl in different concentrations and proportions (Table 12, Figure 17). Further, minor concentrations of Mg, F, Br and SO_4^{2-} could be detected. Concentrations of Sr were below detection limit (Table 12). Silica and aluminum could be detected in concentrations between 3.9 and 55 mg/l (Si) and between 0.25 and 9.8 mg/l (Al).

Table 12: Analytical results of the aqueous extraction solutions of crushed core samples from borehole IG_BH01; Test solution types are classified after Jäckli et al. 1971

Sample		**IG-BH01-PW002**	**IG-BH01-PW005**	**IG-BH01-PW009**	**IG-BH01-PW010**	**IG-BH01-PW013**	**IG-BH01-PW016**	**IG-BH01-PW019**	**IG-BH01-PW024**	**IG-BH01-PW027**	**IG-BH01-PW030**
Hydroisotop Nr.		308246	308247	308248	308249	308757	308758	308759	309999	310000	310001
Interval	m.b.s.	222.2	321.6	421.2	456.1	531.7	582.4	632.5	721.3	821.0	921.1
Water:Rock ratio	g/g	1.6	2.0	1.4	1.8	0.7	0.5	0.9	1.0	1.2	0.8
MISCELLANEOUS PROPERTIES											
pH-value (lab)	-log(H$^+$)	9.25	9.27	9.45	9.29	8.50	9.53	9.21	9.27	9.18	9.18
Spec. electr. conductivity (lab)	µS/cm	50	63	81	56	135	183	110	104	111	144
Sample Temperature	ºC	23.0	24.7	24.1	24.9	21.4	21.1	21.3	24.6	24.8	23.2
DOC	mg/l	1.5	1.1	1.8	1.2	4.3	14.8	5.8	12.3	2.2	1.9
DISSOLVED CONSTITUENTS											
CATIONS											
Sodium (Na$^+$)	mg/l	3.5	5.1	7.4	5.8	19	22.6	12.5	8.6	10.0	12.0
Potassium (K$^+$)	mg/l	3.2	7.5	9.4	7.7	15.9	18	12.8	16.9	19.7	18.1
Magnesium (Mg^{2+})	mg/l	0.13	0.19	0.18	0.11	0.18	0.35	0.22	0.41	0.55	0.29
Calcium (Ca^{2+})	mg/l	4.4	3.1	2.8	1.1	1.9	0.86	0.6	2.3	1.4	3.7
Strontium (Sr^{2+})	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silicon (Si)	mg/l	5.9	5.9	5.0	10.5	10.0	55.0	7.6	5.3	3.9	4.7
Aluminium (Al)	mg/l	0.47	0.37	1.2	0.57	1.3	9.8	0.25	0.88	1.4	0.34
ANIONS											
Fluoride (F$^-$)	mg/l	0.13	0.06	0.06	0.06	0.17	0.31	0.14	0.11	0.23	0.12
Chloride (Cl$^-$)	mg/l	1.4	1.4	4.5	2.5	11.2	19.6	9.5	9.9	10.0	22.4
Bromide (Br$^-$)	mg/l	0.02	<0.02	0.04	0.04	0.68	1.08	0.26	0.18	0.21	0.42
Sulfate (SO$_4^{2-}$)	mg/l	0.27	0.26	0.47	0.23	1.7	1.4	1.6	0.65	0.78	0.83
Nitrate (NO$_3^-$)	mg/l	0.1	0.06	0.21	0.08	0.28	0.13	0.22	-	-	-
Alkalinity (pH 4,3)	meq/l	0.4	0.6	0.6	0.4	1.8	2.3	1.3	0.7	0.8	0.6
Alkalinity (pH 8,2)	meq/l	0.2	0.3	0.3	0.3	0.1	0.4	0.3	0.5	0.4	0.3
PARAMETERS CALCULATED FROM ANALYTICAL DATA											
Sum of analysed constituents	mg/l	19.7	24.2	31.6	29.0	62.5	129.6	46.0	45.7	48.5	63.2
Charge balance	%	0.76%	2.73%	1.53%	0.28%	0.96%	0.11%	0.40%	0.41%	1.07%	1.96%
Test solution type		Ca-Na-(K)-HCO_3	Na-K-Ca-HCO_3	Na-K-Ca-HCO_3-(Cl)	Na-K-(Ca)-HCO_3-(Cl)	Na-K-HCO_3-Cl	Na-K-HCO_3-Cl	Na-K-HCO_3-Cl	K-Na-(Ca)-HCO_3-Cl	K-Na-HCO_3-Cl	Na-K-(Ca)-Cl-HCO_3

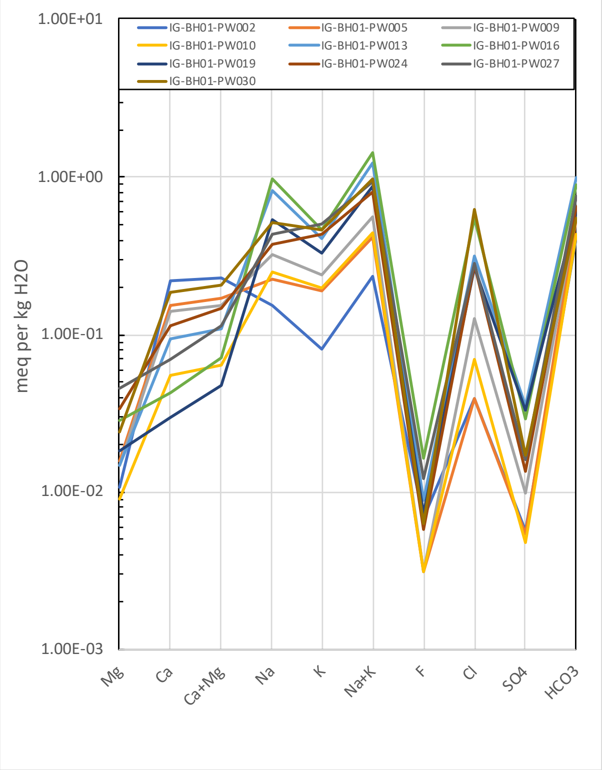


Figure 17: Schoeller diagram of experiment solutions from aqueous extraction experiments conducted with core samples from borehole IG_BH01

6.2 Chemical composition of out-diffusion experiment solutions

Out-diffusion experiments were performed on ten core samples from borehole IG_BH01 to derive the porewater chloride and bromide concentrations. The intact core sections varied in diameter between 60.8 mm and 61.2 mm with a length between 156 mm and 181 mm. The corresponding volume of the sections varied between 454 cm^3 and 530 cm^3 and the saturated mass was between 1209 g and 1418 g. In the out-diffusion experiments, the mass ratio of experiment solution to rock samples was between 0.300 and 0.368 (Appendix II).

During the out-diffusion experiments, a continuous exchange between porewater and test water takes place until equilibrium conditions with respect to conservative compounds, and steady-state conditions with respect to non-reactive compounds, are achieved. The exchange appears to occur mainly by diffusion (cf. Section 7). For chemically conservative elements such as chloride and bromide, for which the porewater is the only source, the porewater concentration can be calculated using the gravimetrically determined porewater mass in the rock sample. For reactive elements and compounds such as Ca, Mg, Na, K, Sr, Si, Al, Fe, SO_4^{2-} and HCO_3^-, the contribution of mineral dissolution reactions during the experiment has to be taken into account.

Chemical modelling of the water-rock interaction processes in out-diffusion experiments conducted on granitic rock samples from Sweden showed that the influence of mineral dissolution on the concentration of alkali- and earth alkali elements, Al and Si, of the equilibrated test solution is low (Waber et al. 2009 a, b). This hypothesis has yet to be tested on samples from Ignace.

In parallel to the out-diffusion experiments, a blank set-up containing only test water, which was sampled at the same frequency as the normal experiments and also finished after 212 days, was conducted. After the experimental period, the “Blank” water, with a pH of 4.8 and an sp. electrical conductivity of 10 µS/cm, contained 1.4 mg/l dissolved constituents, mainly composed of Na, Ca and HCO_3^- (Table 13, Figure 18).

The pH of the experiment solutions varies between 7.2 and 7.7 with a total mineralization between 50 and 111 mg/L (sp. electrical conductivity between 74 and 217 µS/cm, Table 13). It should be noted that the total mineralization obtained for the experiment solutions depends on the water content of the sample and the water/rock ratio used in the experiment (Table 12) and does not directly reflect differences in porewater salinity.

The experiment solutions contain mainly Na (5.6 – 11.2 mg/L), Ca (5.9 - 21.1 mg/l), K (1.9 – 11.2 mg/l), Cl (2.4 – 42.3 mg/l) and HCO_3^- (24.5 – 52.5 mg/l) in varying proportions and concentrations (Table 13, Figure 18). Silica is also present in concentrations between 4.2 and 6.2 mg/l, sulphate between 0.8 and 3.7 mg/l. Strontium, aluminium, boron, fluoride, and bromide are present in low or trace concentrations (Table 13).

In the experiment, the carbon system of the test water – porewater system is influenced by in- and/or out-gassing of atmospheric CO_2. For all out-diffusion solutions, the CO_2 partial pressure was estimated using the chemical composition and pH-values of the out-diffusion solutions. The estimated log pCO_2 range between -3.1 and – 2.7 and are higher than that of the atmosphere (log pCO_2 ~ -3.5). At the beginning of the experiments the test water was in equilibrium with atmospheric CO_2 and contained only a small amount of dissolved carbon (~0.32 mmol/L as HCO3-). Therefore, the additional carbon must have been derived from the rock and/or the porewater during the experiment.

The strontium $^{87}Sr/^{86}Sr$ isotope ratios of the out-diffusion test solutions vary between 0.723777 and 0.746162 (Table 13).

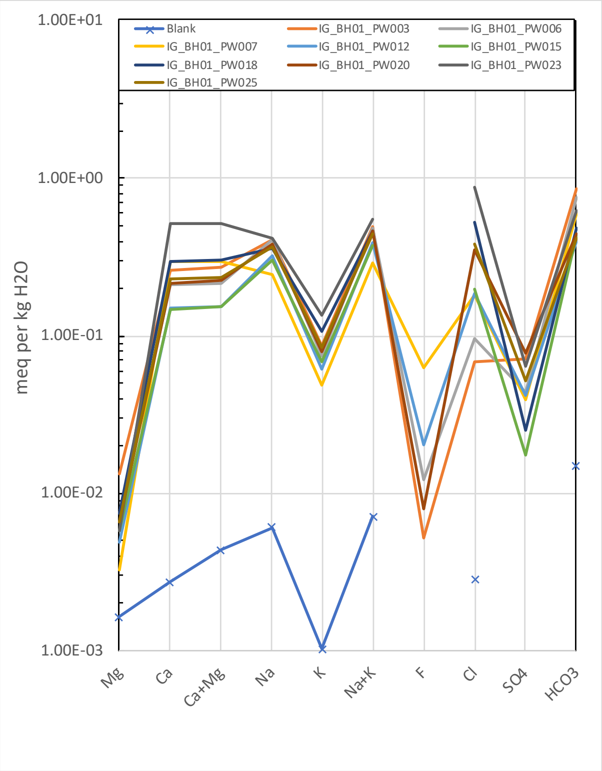


Figure 18: **Schoeller diagram of experiment solutions from out-diffusion experiments including the "Blank" set-up conducted with core from borehole IG_BH01**

Table 13: Analytical results of test solutions of out-diffusion experiments using core samples from borehole IG_BH01; Test solution types are classified after Jäckli et al. 1971

Sample	Unit	Blank	IG_BH01_PW003	IG_BH01_PW006	IG_BH01_PW007	IG_BH01_PW012	IG_BH01_PW015	IG_BH01_PW018	IG_BH01_PW020	IG_BH01_PW023	IG_BH01_PW025	IG_BH01_PW029
Hydroisotop Nr.		317595	317596	317597	317598	317599	317600	317601	317602	317603	317604	317605
Interval	m.b.s.	-	223.3	321.7	420.6	456.6	531.4	582.9	632.7	721.0	820.4	920.8
Ratio Exp.Water : Rock	g/g	-	0.329	0.330	0.339	0.352	0.368	0.313	0.326	0.300	0.329	0.337
Ratio TW:PW	g/g	-	154	181	184	217	282	219	214	191	316	222
MISCELLANEOUS PROPERTIES												
pH (lab), UniBe	-log(H$^+$)	4.8	7.6	7.7	7.5	7.4	7.3	7.2	7.4	7.5	7.5	7.3
Spec. Electr. Conductivity (lab.)	µS/cm	10	107	95	97	77	74	128	108	189	107	217
Sample Temperature	ºC	24.0	23.9	24	24.1	24.2	24.3	24.5	25	24.6	24.6	24.8
DOC	mg/l	4.9	3.6	3.7	3.6	3.6	3.9	4.5	3.8	4.0	3.3	4.0
DISSOLVED CONSTITUENTS												
CATIONS												
Sodium (Na$^+$)	mg/l	0.14	9.3	9.4	5.6	7.5	7.0	8.3	8.9	9.5	8.4	11.2
Potassium (K$^+$)	mg/l	0.04	3.4	2.9	1.9	2.4	2.7	4.2	3.1	5.3	3.3	6.5
Calcium (Ca^{2+})	mg/l	0.11	10.5	8.4	11.8	6.0	5.9	11.9	8.7	20.6	9.2	21.1
Magnesium (Mg^{2+})	mg/l	0.02	0.16	0.09	0.04	0.06	0.07	0.09	0.08	0.07	0.08	0.14
Strontium (Sr^{2+})	mg/l	<0.05	0.05	0.07	0.07	0.05	0.05	0.11	0.10	0.18	0.09	0.27
Aluminium (Al)	mg/l	<0.01	0.1	0.13	0.24	0.07	0.10	0.04	0.06	0.14	0.11	0.05
Silicon (Si)	mg/l	<0.1	4.7	4.2	5.2	4.8	5.3	5.8	5.5	5.5	6.2	5.6
Boron (B)	mg/l	0.014	0.053	0.093	0.039	0.057	0.033	0.025	0.068	0.044	0.030	0.049
ANIONS												
Fluoride (F$^-$)	mg/l	<0.01	0.10	0.23	1.2	0.39	<0.01	<0.01	0.15	<0.01	<0.01	<0.01
Chloride (Cl$^-$)	mg/l	0.1	2.4	3.4	6.4	6.6	7.1	18.9	12.6	30.9	13.6	42.3
Bromide (Br$^-$)	mg/l	<0.01	0.04	0.05	0.14	0.15	0.42	0.89	0.34	0.63	0.34	0.78
Nitrate (NO$_3^-$)	mg/l	<0.01	0.27	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
Sulphate (SO$_4^{2-}$)	mg/l	<0.01	3.4	2.1	1.9	2.0	0.84	1.2	3.7	3.1	2.5	2.4
Alkalinity (pH 4,3)	meql/l	0.016	0.86	0.76	0.6	0.4	0.43	0.49	0.45	0.62	0.42	0.43
PARAMETERS CALCULATED FROM ANALYTICAL DATA												
Sum of analysed constituents	mg/l	1.4	82	73	66	50	50	75	65	108	63	111
Charge balance	%	-11.14%	1.22%	-0.01%	-0.04%	3.07%	1.43%	0.76%	0.96%	0.62%	3.26%	1.13%
Water type		Na-Ca-(Mg)-HCO$_3$-(Cl)	Na-Ca-(K)-HCO$_3$	Na-Ca-(K)-HCO$_3$-(Cl)	Ca-Na-HCO$_3$-Cl	Na-Ca-(K)-HCO$_3$-Cl	Na-Ca-(K)-HCO$_3$-Cl	Na-Ca-(K)-Cl-HCO$_3$	Na-Ca-(K)-HCO$_3$-Cl	Ca-Na-(K)-Cl-HCO$_3$	Na-Ca-(K)-HCO$_3$-Cl	Ca-Na-(K)-Cl-HCO$_3$
ISOTOPE RATIOS												
^{87}Sr/^{86}Sr		-	0.732147	0.729832	0.746162	0.738629	0.740456	0.737503	0.723777	0.728989	0.726570	0.726485
error ^{87}Sr/^{86}Sr		-	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050

7.0 CHLORIDE TIME SERIES AND PORE DIFFUSION COEFFICIENT OF CHLORIDE

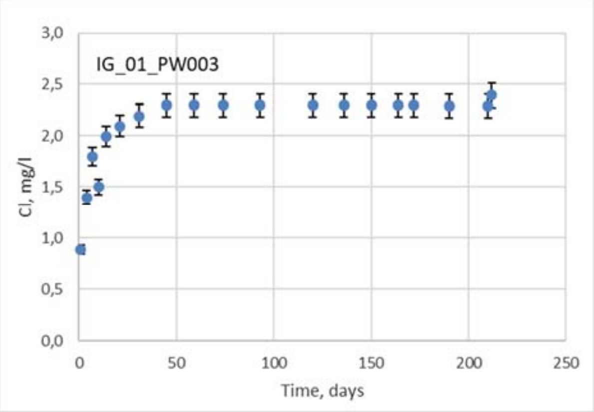
7.1 Chloride and bromide elution curves

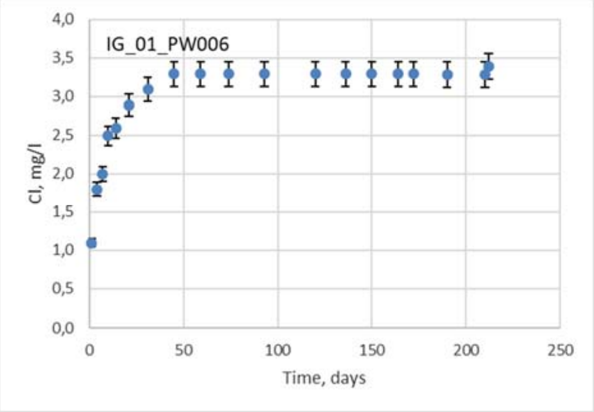
Porewater chloride and bromide concentrations are calculated based on the final concentrations in the out-diffusion test solutions and the water content of the individual core samples (cf. Section 2). The approach to equilibrium was monitored by periodically taking sub-samples and analysing them for their Cl and Br concentrations. The criterion for attainment of equilibrium conditions is defined by a difference of less than 5 % in Cl and 10 % in Br concentrations between the last sub-sample and the final test solution at the end of the experiment. This corresponds to the analytical uncertainty of the Cl and Br measurements. Sub-samples were collected as a function of time during all conducted out-diffusion experiments.

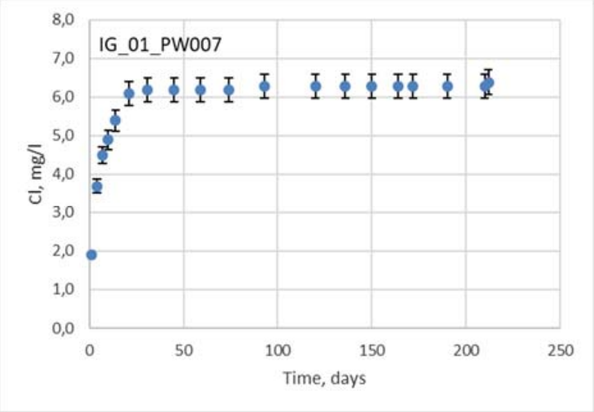
All out-diffusion experiments were run for 212 days. Equilibrium with respect to Cl and Br was attained for all samples with respect to the above-mentioned criteria (Figure 19, 20). In three experiments (IG_BH01_PW003, PW006 and PW007) the Br concentrations of the majority of sub-samples were below the detection limit (< 0.1 mg/l for 0.5 ml sub-samples) and so elution curves could not be set-up. The final Cl and Br concentrations in the experiments were achieved after about 45 to 136 days for Cl and 31 to 150 days for Br, respectively (Figure 19, 20).

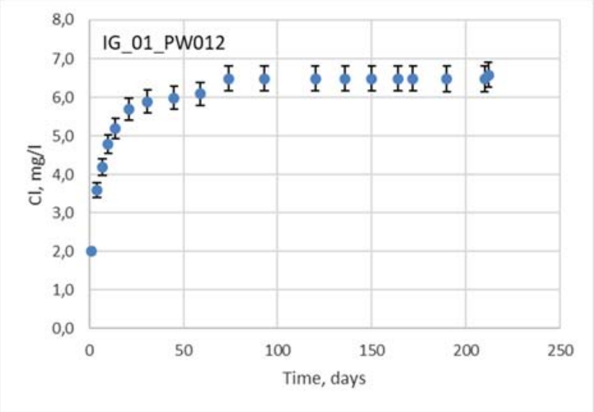
Two chloride (IG_BH01_PW015, PW023) and three bromide time series (IG_BH01_PW15, PW18, PW20, PW25) show a sharp concentration increase at apparent equilibrium after 93 to 150 days. After this sharp concentration increase, concentrations remained constant again (Figure 19, 20).

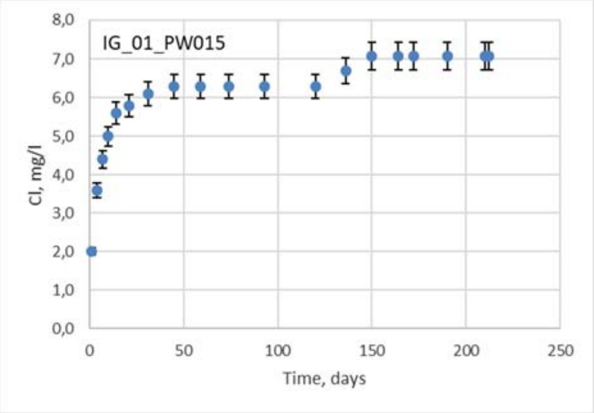
Sub-samples were also taken from the “Blank” set-up at the same intervals as in the out-diffusion experiments. Chloride concentrations of the “Blank” sub-samples vary between 0.01 and 0.10 mg/l and show an increasing trend with experimental time (Figure 19). Bromide concentrations were below the detection limit (<0.1 mg/l) for all “Blank” sub-samples.

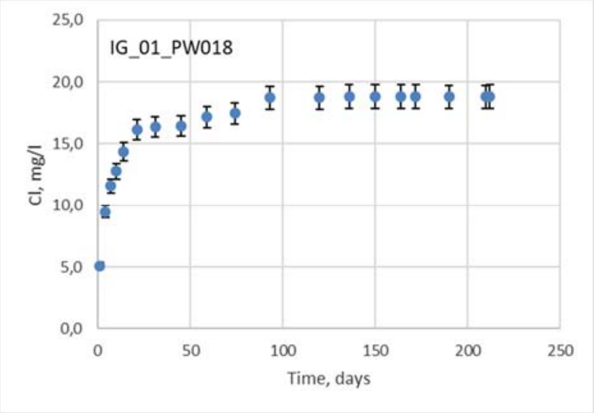

IG_01_PW003
Cl, mg/l
0,0
0,5
1,0
1,5
2,0
2,5
3,0
0
50
100
150
200
250
Time, days


IG_01_PW006
Cl, mg/l
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
4,0
0
50
100
150
200
250
Time, days


IG_01_PW007
Cl, mg/l
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,0
8,0
0
50
100
150
200
250
Time, days


IG_01_PW012
Cl, mg/l
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,0
8,0
0
50
100
150
200
250
Time, days


IG_01_PW015
Cl, mg/l
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,0
8,0
0
50
100
150
200
250
Time, days


IG_01_PW018
Cl, mg/l
0,0
5,0
10,0
15,0
20,0
25,0
0
50
100
150
200
250
Time, days

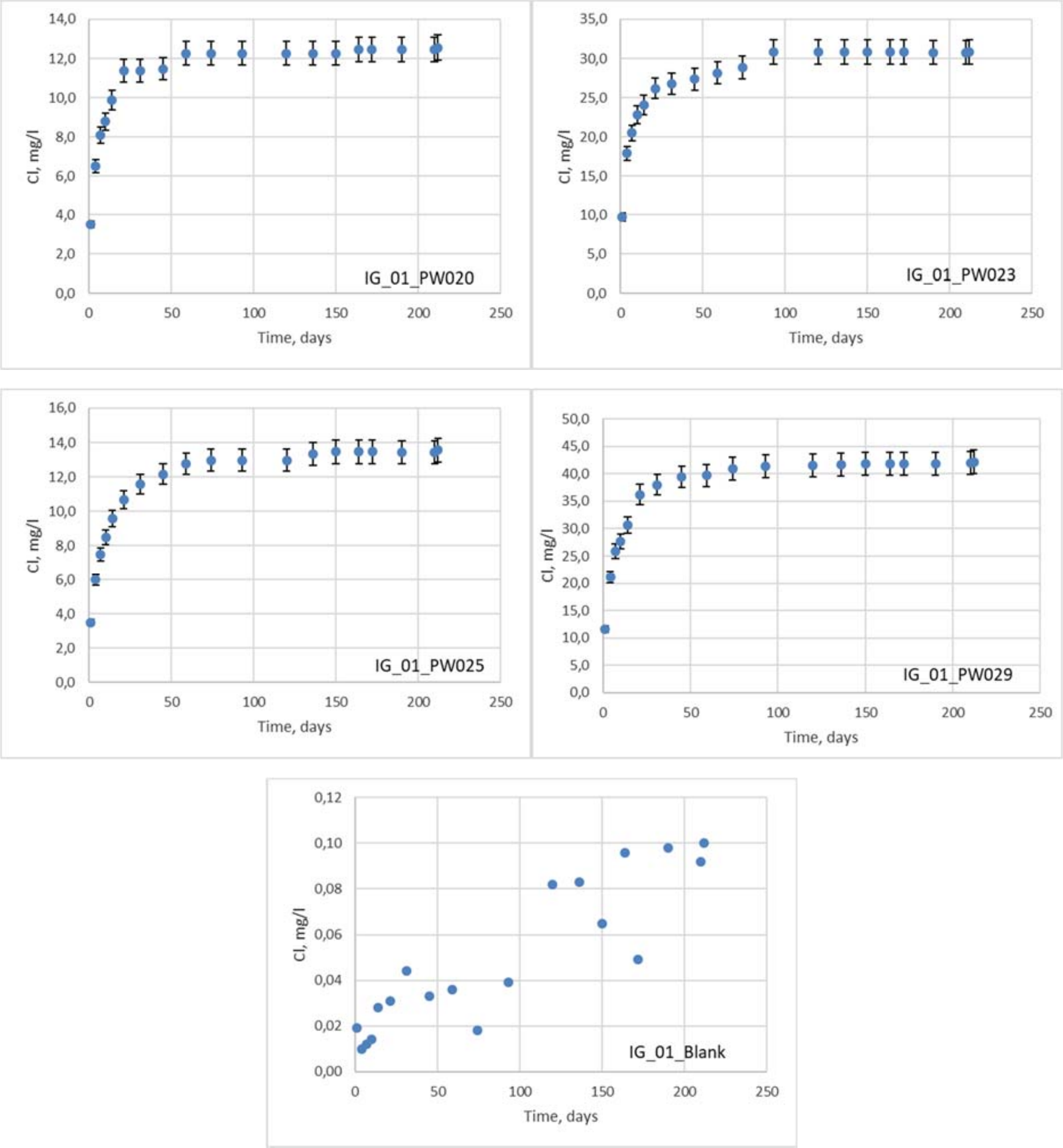


Figure 19: **Chloride out-diffusion curves of core samples from borehole IG_BH01; the errors are the analytical uncertainty of ± 5 %**

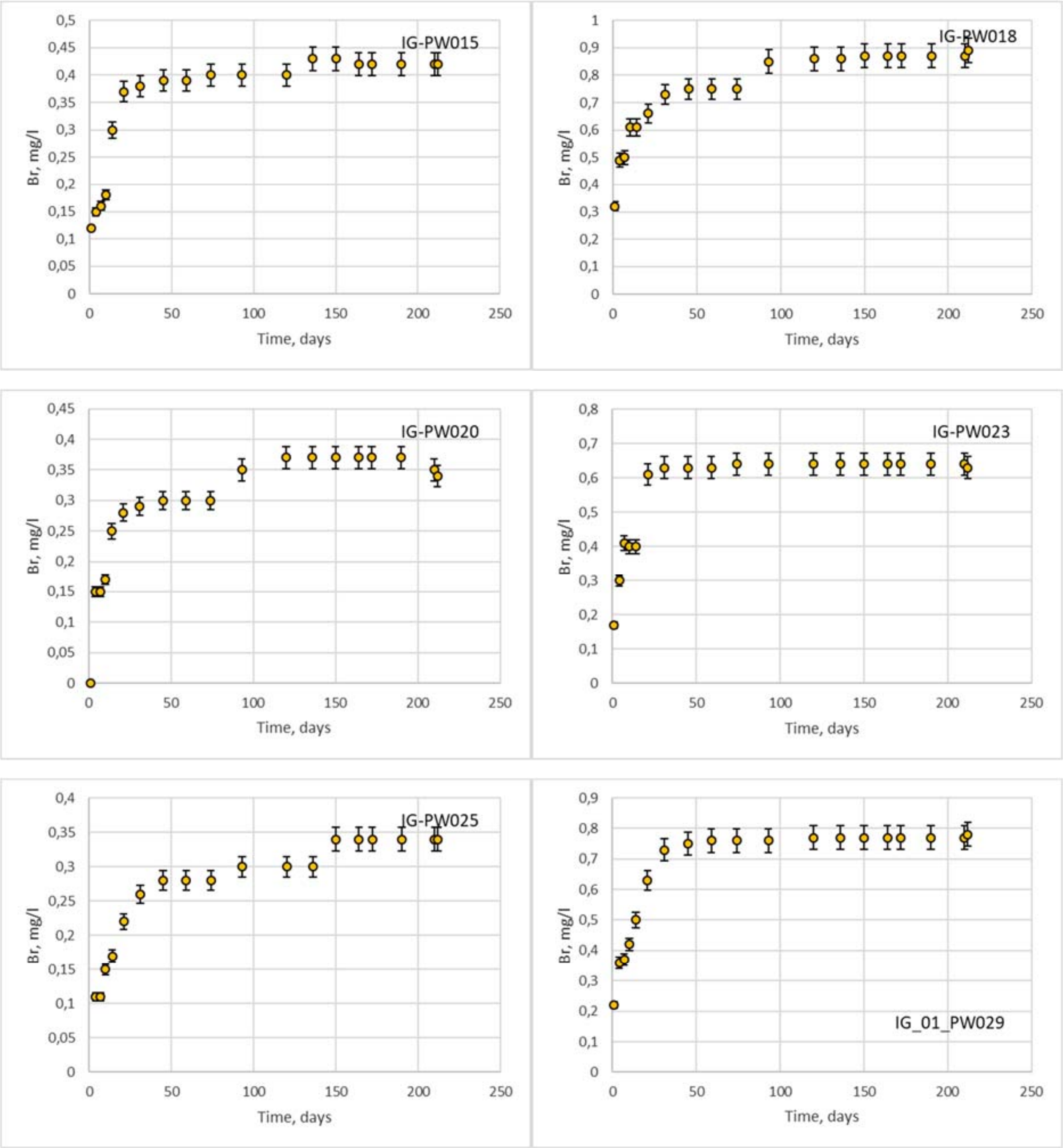


Figure 20: **Bromide out-diffusion curves of core samples from borehole IG_BH01; the errors are the analytical uncertainty of ± 10 %**

7.2 Modelling of pore diffusion coefficients

Chloride pore diffusion coefficients were derived by modelling the chloride breakthrough curves obtained from the out-diffusion experiments of all ten samples from borehole IG_BH01. The chloride breakthrough curves are deduced from the Cl contents in the small-sized subsamples that were collected periodically during the out-diffusion experiments (cf. Section 3.3.2, 7.1). The pore diffusion coefficient is obtained by fitting the observed data with an analytical solution for one-dimensional radial diffusion out of the cylinder into a well-mixed solution reservoir (Crank 1975). The applied model (T. Gimmi, RWI, University of Bern) is restricted to homogeneous hydraulic properties (porosity, diffusion coefficient) across the core cylinder, and cannot consider heterogeneous properties due to rock anisotropy and possibly induced effects such as a disturbed zone caused by stress release and the drilling process.

The pore diffusion coefficient, D_p, of a solute in a geological media mainly depends on the shape and size of water conducting pores (constrictivity) and on the pathways given by the connected pore network (tortuosity, cf. e.g., Ohlsson and Neretnieks 1995). It can be defined as:

$$D_p = D_w \frac{\delta_D}{\tau^2} \qquad \text{Eq. 8}$$

where D_P = pore-diffusion coefficient in m^2/s; D_W = diffusion coefficient in pure water in m^2/s; δ_D = constrictivity; τ = tortuosity; the term δ_D/τ^2 is called the geometry factor.

In a first assumption the pore diffusion coefficient of a given species, D_P, can be converted to the effective diffusion coefficient of this species, D_e, according to:

$$D_e = D_p \Phi_{WC} \qquad \text{Eq. 9}$$

where D_e is the effective diffusion coefficient in m^2/s and Φ_{WC} the species-accessible porosity.

For solutes such as ^3H, for which the species-accessible porosity is equal to the water-accessible porosity, D_e describes the mobility of the dissolved substance in the water filled pores, considering the porosity, tortuosity and constrictivity.

The shape of the Cl elution curves obtained for all core samples from borehole IG_BH01 suggests a heterogeneous hydraulic system from the rim to the centre of the core (Figure 21). The curves show an initial steep slope in the transient state during the first five to ten days. The slope then proceeds to change until the concentrations reach a plateau, which is indicative for an attained equilibrium between Cl in the solution surrounding the core and Cl in the pore space of the core. The shapes of the curves therefore suggest an initial fast out-diffusion from a small rim zone followed by a slower diffusion from the central part of the core. It seems that this rim zone represents the zone most influenced by the drilling process (and possibly also by stress release).

To account for these apparent heterogeneous conditions, several runs were performed for each sample to derive a best-fit pore diffusion coefficient, D_P. In these runs, all parameters remained equal except D_P, which was varied by weighting the fit to the data points produced in the first 5 to 10 days of out-diffusion (steep slope), and to those produced later during out-diffusion until the end of the experiment (moderate slope).

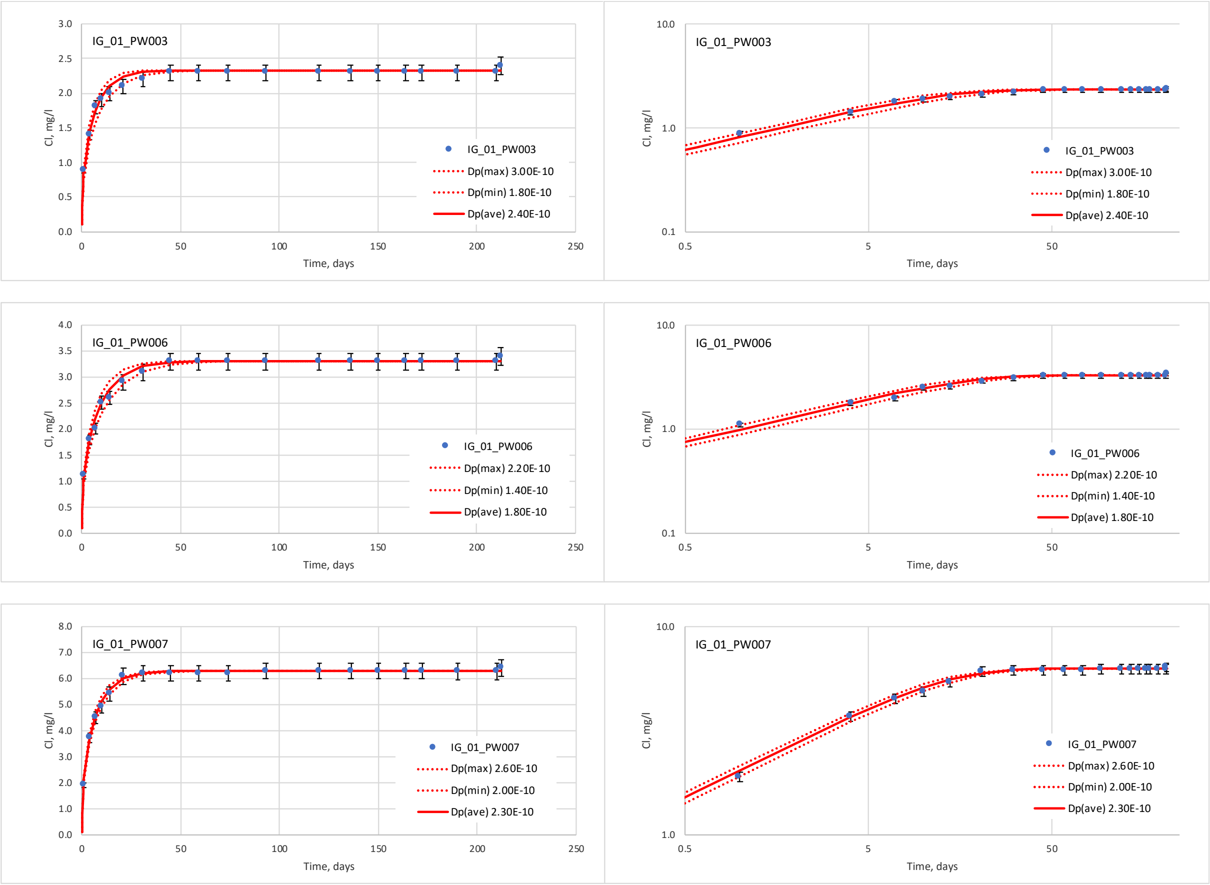
The quality of the D_P fits is controlled by the difference ($\Delta_{meas\text{-}mod}$) of the measured and modelled Cl concentration at equal time and shown by logarithmic plots (Figure 21). To determine the lowest $\Delta_{meas\text{-}mod}$ values, a stepwise adjustment of the single points was conducted and the $\Delta_{\text{meas-mod}}$ values were calculated for every measured point. The determination of the best fits per sampling point indicates a gradual decrease of the modelled pore diffusion coefficients with proceeding diffusion into the cores.

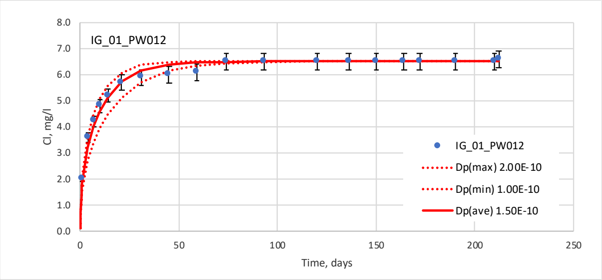
The modelled D_P values, which were determined at 45°C, are additionally converted to 10°C by the Stoke-Einstein equation (Lide 1994).

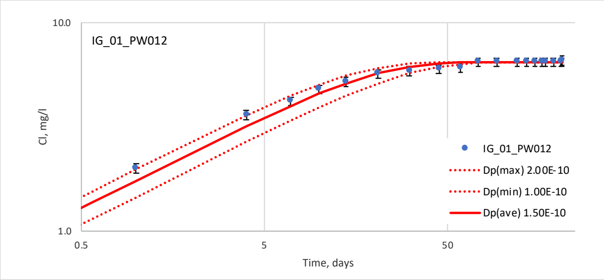
For the investigated core samples, the influence of the disturbed zone results in a pore diffusion coefficient that is a factor 1.3 to 4 higher than that of the undisturbed inner zone of the core cylinders (Table 14, Figure 21).

The average pore diffusion coefficients (D_P) of the ten granodiorite/tonalite core samples vary between 0.4 and $1.0*10^{-10}$ m^2/s (10°C), resulting in effective diffusion coefficients (D_e) between 0.1 and $0.6*10^{-12}$ m^2/s (10°C, Table 14, Figure 22).

Considering the depth profile, pore and effective diffusion coefficients of chloride show a decreasing trend between 200 and 600 m b.s. and subsequently remain almost constant with increasing depth down to 920 m b.s.




IG_01_PW012
Cl, mg/l
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Time, days
0
50
100
150
200
250
IG_01_PW012
Dp(max) 2.00E-10
Dp(min) 1.00E-10
Dp(ave) 1.50E-10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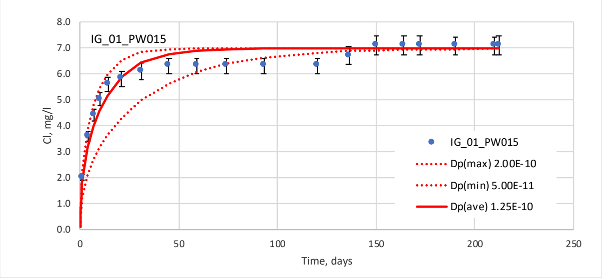
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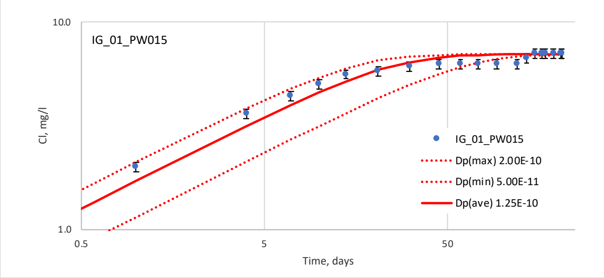
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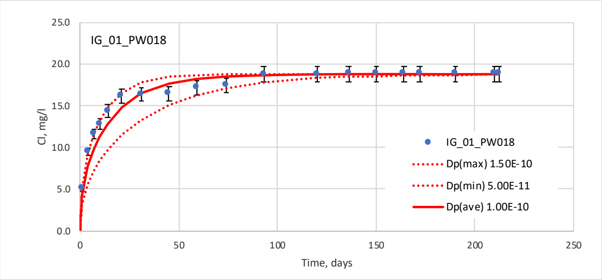
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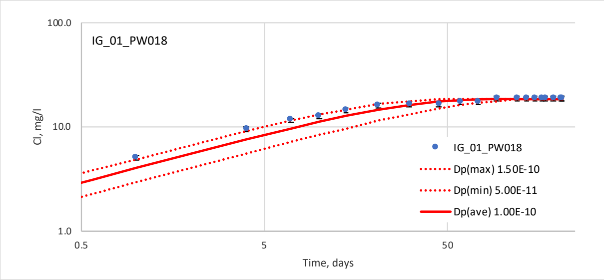
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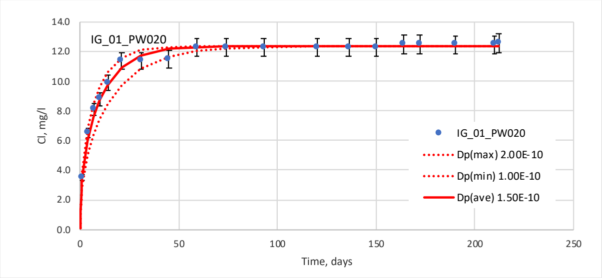
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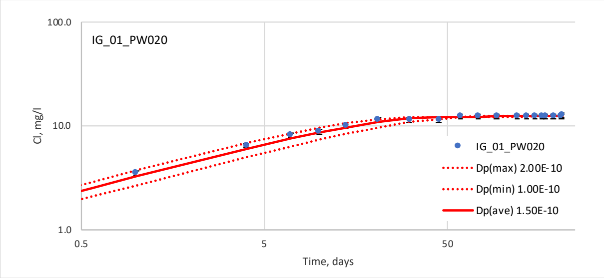
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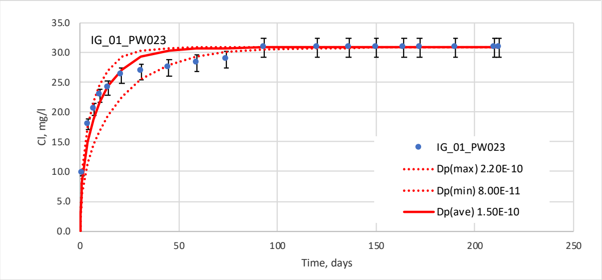
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30.0
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100
150
200
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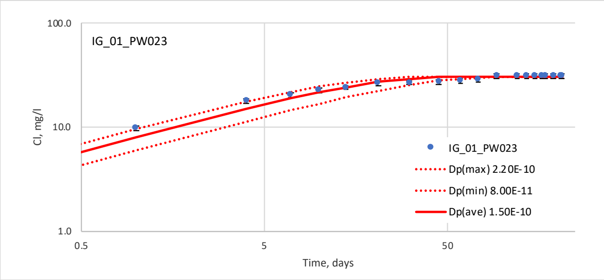
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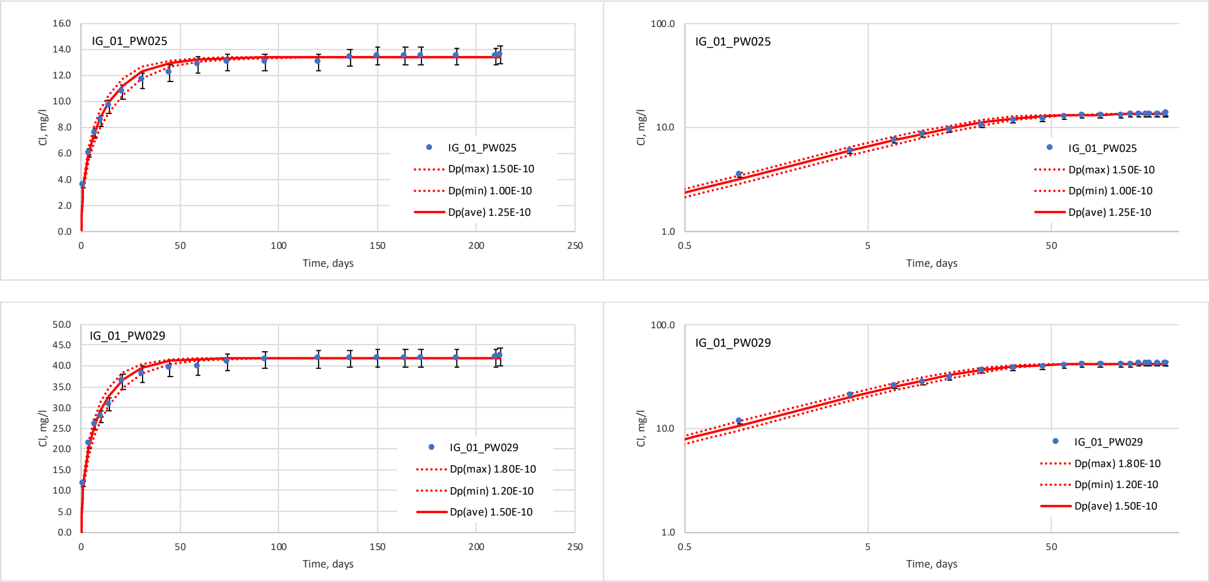

Figure 21: Maximum and minimum pore diffusion coefficients determined by a best-fit of Cl elution curves in linear and logarithmic time and concentration scale; the solid lines mark the average diffusion coefficients

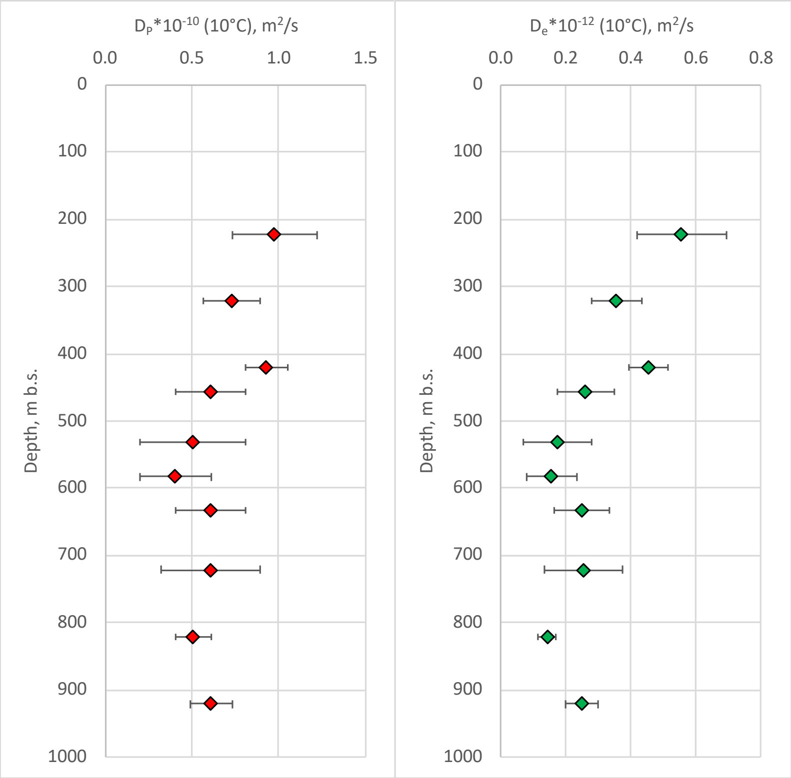

Figure 22: Average pore (left) and effective (right) diffusion coefficients (10°C) of core samples from borehole IG_BH01 versus depth; the errors are the difference between the average and maximum/minimum values

Table 14: Minimum (min), maximum (max) and average (avg) pore and effective diffusion coefficients determined by 1-dimensional modelling of Cl-elution curves of out-diffusion experiments conducted on core samples from borehole IG_BH01 at 45°C and 10°C

			D_P*10^{-10} m^2/s (45°C)			D_P*10^{-10} m^2/s (10°C)			D_e*10^{-13} m^2/s (45°C)		
Sample	**Depth**	**WL-Porosity**	**max**	**min**	**avg**	**max**	**min**	**avg**	**max**	**min**	**avg**
	m b.s.	**Vol.%**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**	**m^2/s**
IG-BH01-PW003	223	0.57	3.0	1.8	2.4	1.2	0.7	1.0	7	4	6
IG-BH01-PW006	322	0.49	2.2	1.4	1.8	0.9	0.6	0.7	4	3	4
IG-BH01-PW007	421	0.48	2.6	2.0	2.3	1.1	0.8	0.9	5	4	5
IG-BH01-PW012	457	0.43	2.0	1.0	1.5	0.8	0.4	0.6	3	2	3
IG-BH01-PW015	531	0.35	2.0	0.5	1.25	0.8	0.2	0.5	3	1	2
IG-BH01-PW018	583	0.38	1.5	0.5	1.0	0.6	0.2	0.4	2	1	2
IG-BH01-PW020	633	0.41	2.0	1.0	1.5	0.8	0.4	0.6	3	2	2
IG-BH01-PW023	721	0.42	2.2	0.8	1.5	0.9	0.3	0.6	4	1	3
IG-BH01-PW025	820	0.28	1.5	1.0	1.25	0.6	0.4	0.5	2	1	1
IG-BH01-PW029	921	0.41	1.8	1.2	1.5	0.7	0.5	0.6	3	2	2

8.0 CHLORIDE, BROMIDE AND CHLORIDE ISOTOPES IN POREWATER OF BOREHOLE IG_BH01

Chloride and bromide concentrations of porewater were determined by aqueous extraction experiments (cf. Section 3.3.1) and out-diffusion experiments (cf. section 3.3.2). Aqueous extraction experiments were conducted prior to the other longer lasting experiments to obtain information about porewater salinities.

8.1 Porewater chloride concentrations estimated by aqueous extraction experiments

Aqueous extraction experiments were conducted for 10 core samples from the individual sampled depth intervals. Approximate estimates of porewater Cl concentrations were calculated according to equation 3 (cf. Section 3.3.1). During crushing of the rock samples, saline fluids from fluid inclusions in quartz and feldspar are released, which contribute to the Cl and Br inventory of the samples. This means that the chloride concentrations determined by aqueous extraction overestimate the actual porewater Cl concentrations.

Estimated porewater Cl concentrations for core samples from borehole IG_BH01 determined by aqueous extractions vary between 1.08 and 9.16 g/kg H_2O and show the same variations with depth as those observed for the out-diffusion experiments (Table 15).

Estimated porewater Cl concentrations determined by aqueous extraction are, besides those samples taken at 820 m (IG_BH01_PW024/025) and 920 m b.s. (IG_BH01_PW029/030), 1.2 to 3 times higher than those determined by out-diffusion (Table 15). Two samples show almost identical Cl concentrations.

8.2 Porewater chloride, bromide and δ^{37}Cl isotope ratios determined by out-diffusion experiments

The conservative behaviour of chloride and bromide, the absence of Cl and Br bearing minerals in the rock, and the non-destructive character of the out-diffusion method make the porewater the only source for dissolved Cl and Br in the experiment solution. This allows calculation of the Cl and Br concentration in the porewater using mass balance calculations according to equation 4 (cf. Section 3.3.2), given that equilibrium in the out-diffusion experiment is achieved. As shown by their chloride and bromide elution curves, this latter condition is fulfilled for all samples within the applied constraints (cf. Section 7.1).

The ratio of the two conservative elements, Cl and Br, serves as a valuable tracer of the origin of Cl and Br in porewater and fracture groundwater. The δ^{37}Cl ratio measured for the experiment solutions directly corresponds to the porewater Cl isotope signature. This is because the attained equilibrium in the out-diffusion experiment with respect to total Cl is also expected to result in equilibrium with respect to the Cl isotopes (Gimmi and Waber 2004).

Chloride concentrations of porewaters taken between 220 and 920 m b.s. from borehole IG_BH01 vary between 360 and 9350 mg/kg H_2O (Table 15, Figure 23). Considering the depth profile, the porewater chloride concentrations increase continuously from 360 mg/kg H_2O at 223 m b.s. to 4120 mg/kg H_2O at 583 m b.s., before they decrease to 2670 mg/kg H_2O at 633 m b.s. (Table 15, Figure 23). At further depths in the borehole, the Cl concentrations increase again to 9350 mg/kg H_2O at 921 m b.s.. An exception is the sample IG_BH01_PW025 (820 m b.s.), which has 4240 mg/kg H_2O, a slightly lower Cl concentration as the sample taken above at 720 m b.s..

Porewater bromide concentrations of core samples from borehole IG_BH01 vary between 5.9 and 190 mg/kg H_2O (Table 15, Figure 23). Along the depth profile, the Br concentrations show a similar trend to the porewater Cl concentrations. Porewater Br concentrations increase slightly from 5.9 mg/kg H_2O at 223 m b.s. to 32 mg/kg H_2O at 457 m b.s and show at greater depths a strong increase to 190 mg/kg H_2O at 583 m b.s. (Table 15, Figure 23). Below that, the porewater Br concentrations decrease again to 70 mg/kg H_2O at 633 m b.s. and then increase with depth to 170 mg/kg H_2O at 921 m b.s. (Table 15, Figure 23).

The Br*1000/Cl mass ratios (=Br/Cl ratio) of porewater from borehole IG_BH01 vary between 14.7 and 59.2 (Table 15, Figure 23). From 223 m b.s. to 457 m b.s. porewater Br/Cl mass ratios increase slightly from 16.7 to 22.7 and show, in the following 75 m, a strong increase to 59.2 at 531 m b.s.. Below that depth porewater Br/Cl ratios decrease continuously to 27.0 at 633 m b.s. and remain almost constant between 18.4 and 25.0 down to 921 m b.s. (Table 15, Figure 23).

In the bromide versus chloride diagram, porewaters extracted from borehole IG_BH01 cores plot significantly above the seawater dilution line (Br*1000/Cl of seawater = 3.4, Figure 24). Chlorine isotope signatures of porewater of core samples from borehole IG_BH01 vary along the depth profile between -0.61 and 0.85 ‰ SMOC (Table 15, Figure 23). The correlation of δ^{37}Cl porewater values with the porewater Cl concentrations shows no dependency of the Cl isotope signature to the determined Cl concentrations (Figure 25).

Porewater δ^{37}Cl signatures are almost constant within the analytical uncertainty between 223 and 583 m b.s. ranging between 0.07±0.35 and 0.46±0.12 ‰ SMOC. In this bedrock section only the sample taken at 421 m b.s. (IG-BH01-PW007) has a higher δ^{37}Cl signature of 0.82±0.32 ‰ SMOC (Table 15, Figure 23). In the following bedrock zone between 633 and 921 m b.s., δ^{37}Cl concentrations decrease from -0.09±0.10 to -0.61±0.14 ‰ SMOC. An exception of this trend is the porewater extracted from the sample taken at 721 m b.s., which has the highest δ^{37}Cl signature (0.85±0.24 ‰ SMOC, Table 15, Figure 23).

Table 15: Porewater Cl and Br concentrations, Br*1000/Cl mass ratios and δ^{37}Cl isotope signatures. Cl concentrations are determined by out-diffusion (o.d.) and estimated using aqueous extraction experiments (aq. ex.); The errors of porewater Cl (o.d.) and Br concentrations, Br*1000/Cl mass ratios are calculated by Gaussian error propagation (cf. Appendix III); the errors of δ^{37}Cl values are the standard deviation of triplicate analyses

Sample	Depth	Cl_{PW} (o.d.)	Estimated Cl_{PW}(aq.ex.)	Br_{PW}	Br*1000/Cl	δ^{37}Cl
	m b.s.	mg/kgH2O	mg/kgH2O	mg/kgH2O	mg/mg	‰ SMOC
IG-BH01-PW003	223.3	360±25		5.9±0.4	16.7±1.5	0.22±0.11
IG-BH01-PW006	321.7	600±40		8.8±0.6	14.7±1.4	0.07±0.35
IG-BH01-PW007	420.6	1160±80		25±2	21.9±2.1	0.82±0.32
IG-BH01-PW012	456.6	1410±100		32±2	22.7±2.3	0.15±0.36
IG-BH01-PW015	531.4	1970±160		120±10	59.2±6.8	0.39±0.13
IG-BH01-PW018	582.9	4120±310		190±20	47.1±5.0	0.46±0.12
IG-BH01-PW020	632.7	2670±200		70±5	27.0±2.8	-0.09±0.10
IG-BH01-PW023	721.0	5890±410		120±10	20.4±2.0	0.85±0.24
IG-BH01-PW025	820.4	4240±380		110±10	25.0±3.2	-0.15±0.05
IG-BH01-PW029	920.8	9350±670		170±10	18.4±1.9	-0.61±0.14
IG-BH01-PW002	222.2		1080			
IG-BH01-PW005	321.6		1410			
IG-BH01-PW009	421.2		3150			
IG-BH01-PW010	456.1		2220			
IG-BH01-PW013	531.7		3930			
IG-BH01-PW016	582.4		4990			
IG-BH01-PW019	632.5		4360			
IG-BH01-PW024	721.3		5033			
IG-BH01-PW027	821.0		5830			
IG-BH01-PW030	921.1		9160			

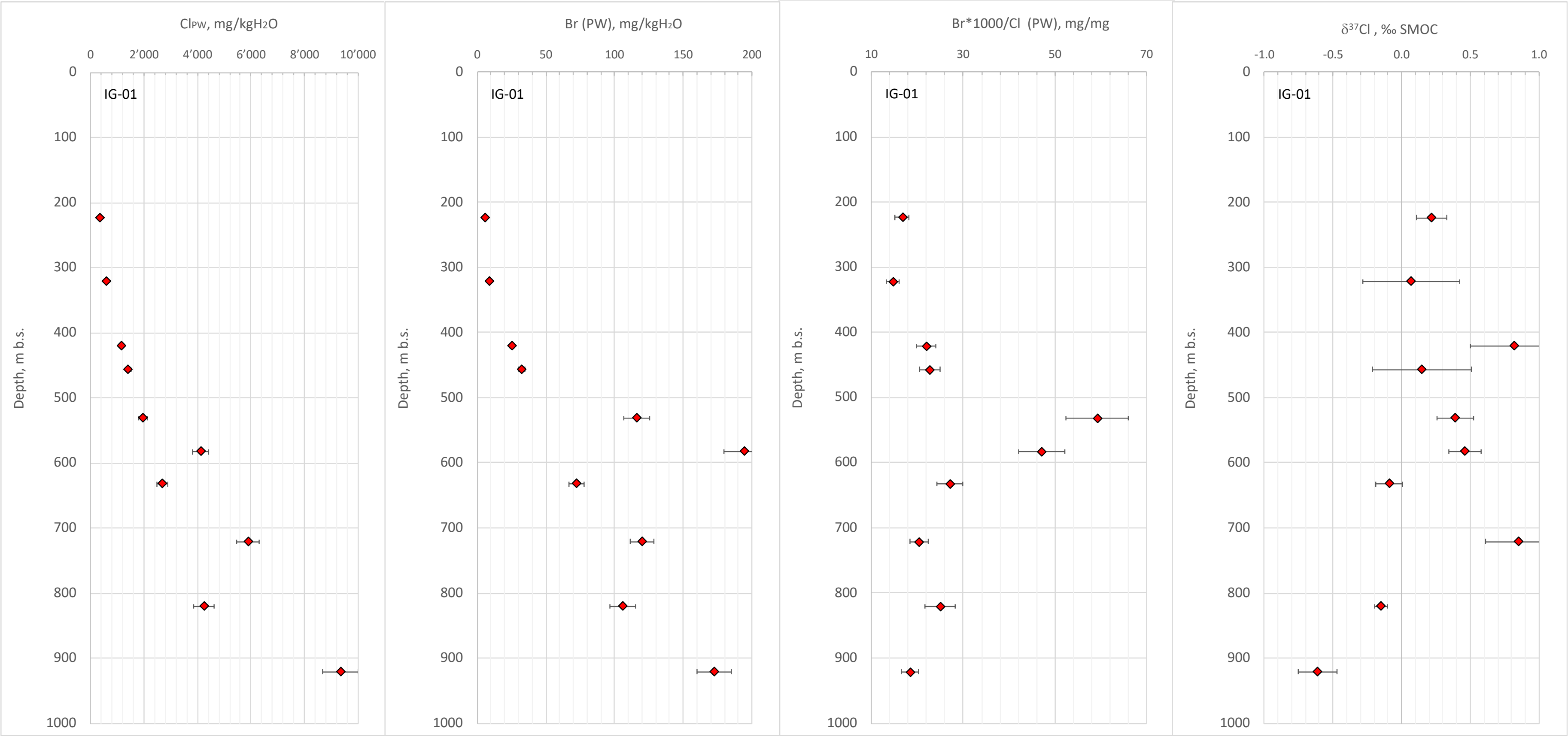

Figure 23:Porewater chloride and bromide concentrations (out diffusion only), Br*1000/Cl mass ratios and δ^{37}Cl ratios extracted from cores from borehole IG_BH01 as function of depth. Errors of Cl and Br porewater concentrations determined by out-diffusion and Br*1000/Cl mass ratios are determined by Gaussian error propagation, those of δ^{37}Cl values are the analytical error; The uncertainty of Cl concentrations estimated by aqueous extraction are assumed to be ±10 %

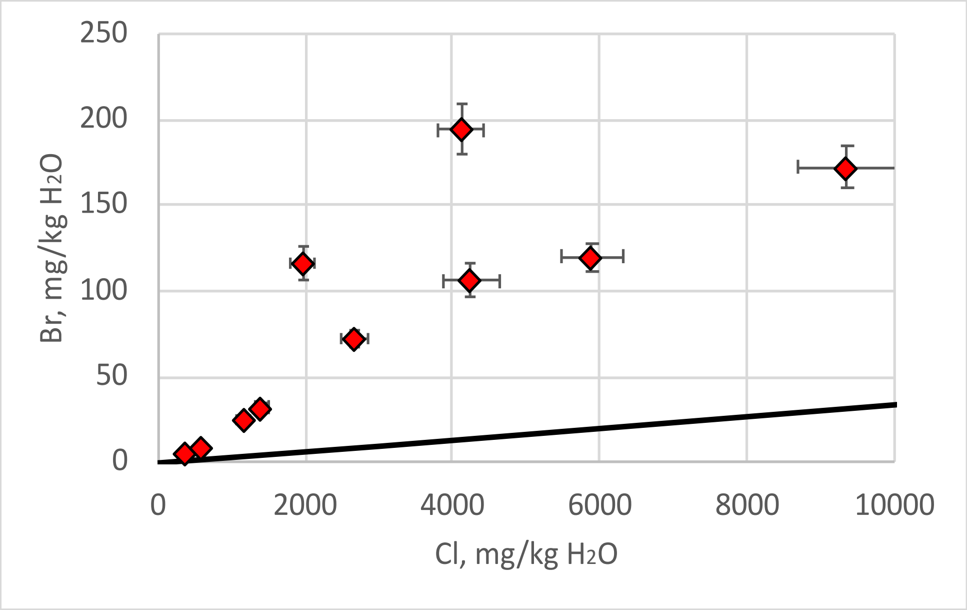

Figure 24: **Chloride versus bromide concentrations of porewater from cores from borehole IG_BH01; the black line indicates the seawater evaporation line. The errors of porewater Cl and Br concentrations are calculated by Gaussian error propagation (Appendix III)**

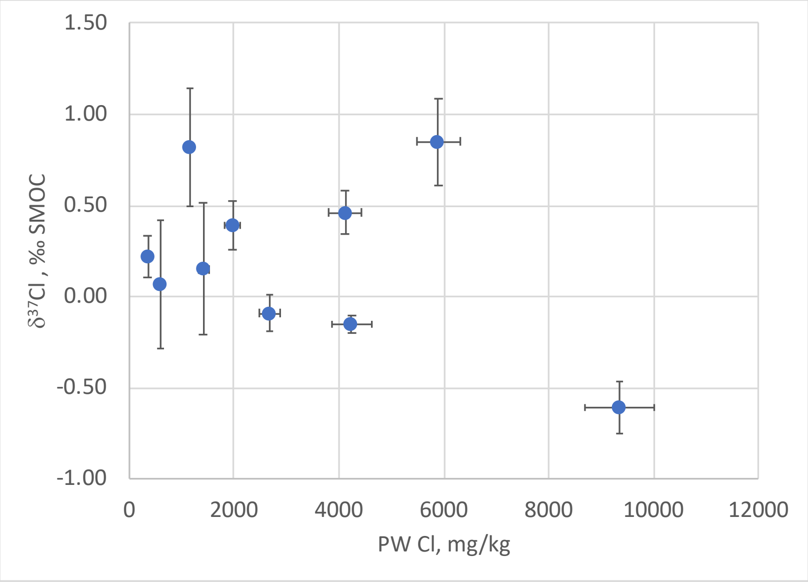

Figure 25: **δ^{37}Cl isotope ratios versus Cl concentrations of porewater extracted from core samples taken from borehole IG_BH01.**

9.0 δ^{18}O AND δ^{2}H OF POREWATER OF CORE SAMPLES FROM BOREHOLE IG_BH01

Isotope diffusive exchange experiments have been carried out on ten core samples (20 individual experiments) from borehole IG_BH01. The δ18O and δ2H values of porewater are calculated according to equation 7 (cf. Section 3.3.3), expressed relative to the standard V SMOW, and are listed in Table 15 and graphically shown in Figure 25. The calculated porewater isotope signatures, which are based on the isotope analyses of the test waters, are carefully evaluated for potential artefacts, mainly due to evaporation of test water during the experiment, test water storage and handling. Evaporation of porewater during storage and handling was minimized by careful handling of the core samples (cf. Section 3.3.3).

These processes might result in large discrepancies between the gravimetric water content and that calculated from isotope mass balance or isotope signatures that are out of any natural range and/or a large error on the calculated porewater isotope signatures. Such differences were not observed in this study (cf. Section 5.1.1, Table 8, Figure 14).

Evaporation within the experiment was monitored by keeping track of all individual weights before and after the experiments. None of the experiments suffered evaporation > 5 % of the total water mass in the experiments (= mass of porewater determined gravimetrically + mass of test water) during the time of equilibration. Measured weights and isotope signatures of test solutions after equilibration are listed in Appendix II.

The maximum Cl concentration determined by aqueous extraction prior to the set-up of the isotope diffusive exchange experiments is 9.2 g/kg H_2O, which relates to 0.26 mol $NaCl_{eq}$. Based on this, it was decided to adjust the salinity of the test solutions to 0.3 mol NaCl to prevent mass transfer from the test water reservoir to the rocks.

Stable oxygen and hydrogen isotope signatures of porewater extracted from core samples from borehole IG_BH01 vary between -10.84 and -6.63 ‰ for δ^{18}O and between -83.6 and -57.7 ‰ for δ^{2}H (Table 16, Figure 26). Along the depth profile encountered by borehole IG_BH01, stable water isotope signatures continuously increase between 223 and 583 m b.s. from -10.84 to -6.63 ‰ for δ^{18}O and -83.6 to -57.7 ‰ for δ^{2}H, respectively. The next sample taken at 633 m b.s. shows a depletion in ^{18}O and ^{2}H (δ^{18}O = -9.01 ‰, δ^{2}H = -69.6 ‰) compared to the sample above, followed by a slight enrichment to -7.89 ‰ and -58.2 ‰ within the further course of the profile down to 921 m b.s. (Table 16, Figure 26).

Porewaters from borehole IG_BH01 all plot on, or slightly to the right of, the global meteoric water line on the δ^{18}O - δ^{2}H diagram (Figure 27). Samples taken below 400 m b.s. plot above the samples taken between 223 and 322 m b.s. (Figure 27).

Table 16: Porewater δ^{18}O and δ^{2}H values of porewater of core samples from borehole IG_BH01; the errors are calculated by Gaussian error propagation (cf. Appendix III).

Sample	Depth	δ^{18}O	Error δ^{18}O	δ^{2}H	Error δ^{2}H
	m b.s.	‰ V-SMOW	‰ V-SMOW	‰ V-SMOW	‰ V-SMOW
IG_BH01_PW003	223.3	-10.84	0.70	-83.6	5.8
IG_BH01_PW006	321.7	-10.81	0.62	-80.0	5.3
IG_BH01_PW007	420.6	-8.39	0.92	-69.6	7.0
IG_BH01_PW012	456.6	-8.50	0.97	-69.8	7.5
IG_BH01_PW015	531.4	-7.41	1.06	-62.4	8.2
IG_BH01_PW018	582.9	-6.63	1.29	-57.7	9.5
IG_BH01_PW020	632.7	-9.01	0.95	-69.6	7.7
IG_BH01_PW023	721.0	-7.84	1.04	-66.0	8.0
IG_BH01_PW025	820.4	-7.45	1.39	-61.9	10.4
IG_BH01_PW029	920.8	-7.89	1.07	-58.2	8.8

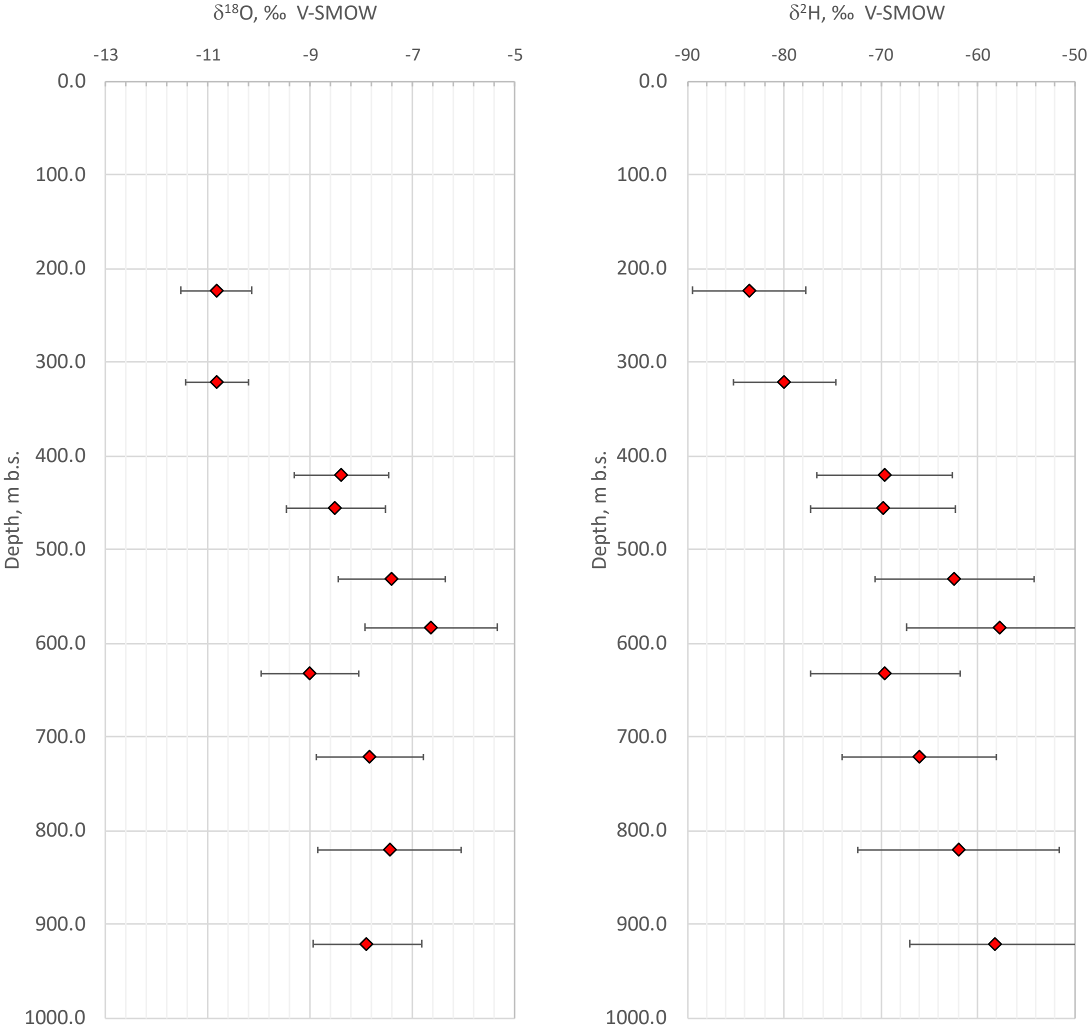

Figure 26: $\delta^{18}O$ and $\delta^{2}H$ porewater signatures as function of depth along borehole IG_BH01; the errors are calculated by Gaussian error propagation (cf. Appendix III)

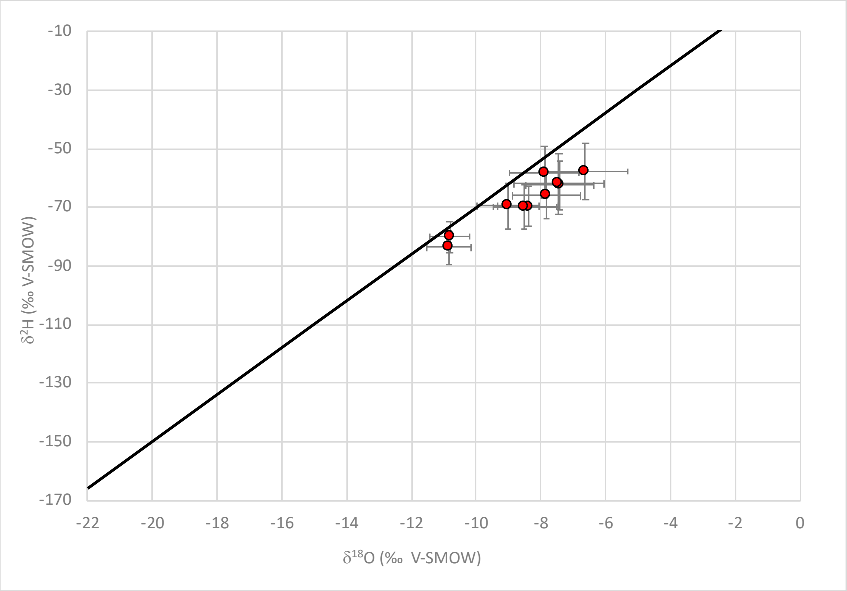

Figure 27: δ¹⁸O versus δ²H values of porewater; the black line marks the global meteoric water line; the errors of the porewater stable isotope ratios are calculated by Gaussian error propagation (Appendix III)

10.0 SUMMARY

Porewater investigations applying different indirect methods were successfully conducted on crystalline core samples taken between 220 and 920 m b.s. from borehole IG_BH01 drilled in the Revell batholith (RE-B at Ignace, Ontario).

Potential major sampling-, preservation-, preparation-, experimental- and analytical artefacts, were carefully monitored during the investigation, and none were observed.

The investigated ten core samples consisted of macroscopically homogeneous, equigranular granodiorite and tonalite with quartz, plagioclase and biotite as main components, with variable degrees of alteration.

The gravimetrically determined water contents vary along the depth profile between 0.12 and 0.21 wt.%, corresponding to water-loss porosities between 0.31 and 0.56 Vol.%. Gravimetrically determined water contents agreed well with those determined by isotope diffusive exchange experiments. The bulk, wet density values are between 2.59 and 2.69 g/cm^3.

Pore diffusion coefficients were determined by 1-dimensional diffusion modelling based on the fitting of Cl-elution curves, set up by taking periodic sub-samples from out-diffusion experiments. Elution curves could not be fitted by a single pore diffusion coefficient. All cores showed a faster diffusion in the outer rim of the cores and a slower diffusion in the inner parts. The average pore diffusion coefficients (10°C) vary between $0.4*10^{-10}$ and $1.0*10^{10}$ m^2/s, corresponding to effective diffusion coefficients between $0.1*10^{-12}$ and $0.6*10^{-12}$ m^2/s.

Aqueous extraction experiments were conducted prior to the set-up of the long-term experiments to obtain first information about porewater salinities, which are necessary for the applied test water concentrations for isotope diffusive exchange experiments.

Out-diffusion experiments ran for more than 200 days. The analyses of time series samples showed that all experiments were in equilibrium with respect to Cl before they were terminated. Test water chemistries are mainly dominated by sodium, calcium, potassium, hydrogen carbonate and chloride in varying proportions and concentrations.

Porewater Cl and Br concentrations were calculated using out-diffusion concentrations and the gravimetrically determined mass of porewater. They vary between 360 and 9350 mg/kg H_2O for Cl, and 5.9 and 190 mg/kg H_2O for Br, resulting in Br*1000/Cl mass ratios between 16.7 and 59.2.

Chlorine isotope signatures of porewater vary along the profile between -0.61 and 0.85 ‰ SMOC and show no correlation to porewater Cl concentrations.

Porewater stable water isotope signatures were determined by isotope diffusive exchange experiments. Along the depth profile encountered by borehole IG_BH01, porewater $\delta^{18}O$ signatures vary between -10.84 and -7.41 ‰ V-SMOW, and $\delta^{2}H$ signatures between -83.6 and -57.7 ‰ V-SMOW.

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APPENDIX I

Photo Documentation

Figure A-1: On site documentation of core samples for porewater characterization sent to Hydroisotop (photos provided by Golder); Core samples are packed in the first evacuated and sealed plastic bag

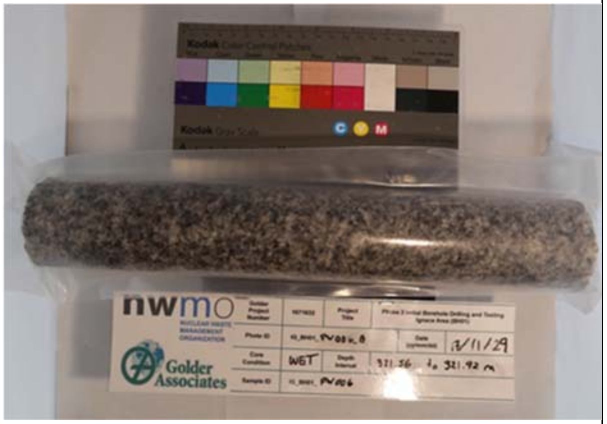
IG_BH01_PW001: 221.71-222.05 m

IG_BH01_PW002: 222.05–222.17 m

IG_BH01_PW003: 223.05–223.45 m

IG_01_PW004: 321.05 – 321.41 m

IG_01_PW005: 321.41 – 321.56 m



IG_BH01_PW006: 321.56 – 321.92 m

IG_BH01_PW007: 420.38 – 420.73 m

IG_BH01_PW008: 420.73 – 421.08 m

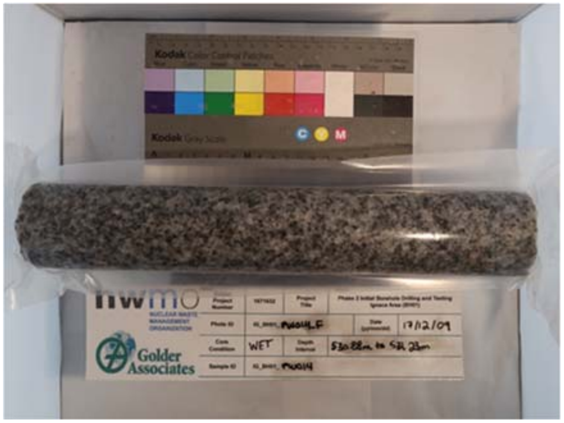
IG_BH01_PW009: 421.08 – 421.19 m

IG_BH01_PW010: 455.98 – 456.08 m

IG_BH01_PW011: 456.08 – 456.42 m

IG_BH01_PW012: 456.42 – 456.77 m

IG_BH01_PW013: 531.59 – 531.71 m



IG_BH01_PW014: 530.88 – 531.23

IG_BH01_PW015: 531.23 – 531.59 m

IG_BH01_PW016: 582.30 – 582.41

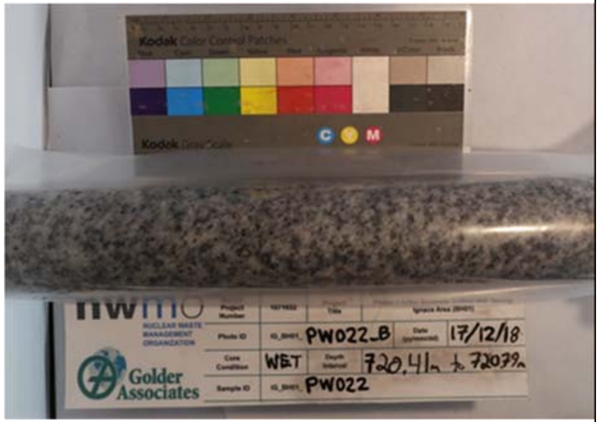
IG_BH01_PW017: 582.41 – 582.76 m

IG_BH01_PW018: 582.76 – 583.13 m

IG_BH01_PW019: 632.43 – 632.53 m

IG_BH01_PW020: 632.53 – 632.88 m

IG_BH01_PW021: 632.88 – 633.23 m



IG_BH01_PW022: 720.41 – 720.79 m

IG_BH01_PW023: 720.79 – 721.20 m

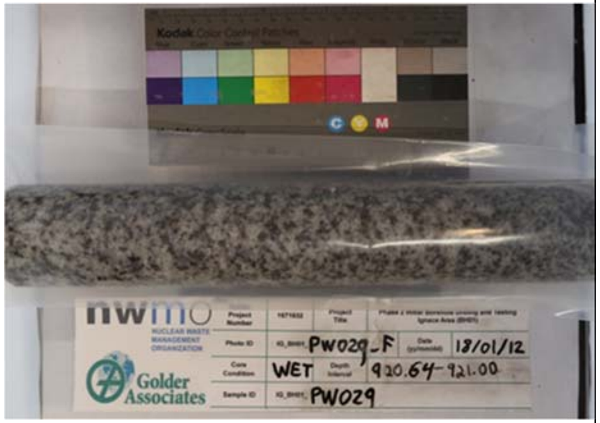
IG_BH01_PW024: 721.20 – 721.34 m

IG_BH01_PW025: 820.25 – 820.62 m

IG_BH01_PW026: 820.62 – 820.98 m

IG_BH01_PW027: 820.98 – 821.09 m

IG_BH01_PW028: 920.27 – 920.64 m



IG_BH01_PW029: 920.64 – 921.00 m

IG_BH01_PW030: 921.00 – 921.13 m

Figure A-2: Laboratory documentation of core samples for porewater characterization sent to Hydroisotop; photos were taken right after unpacking

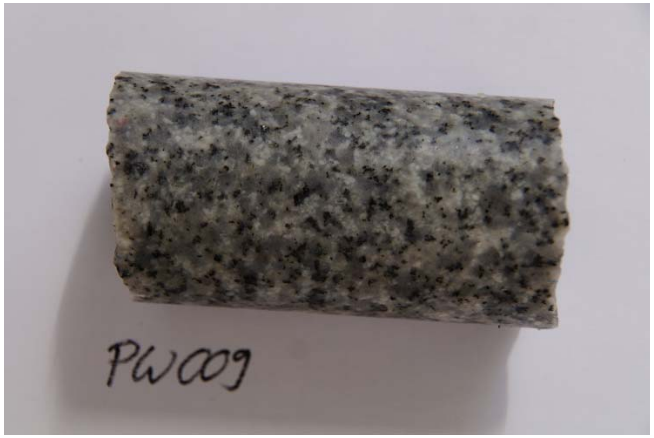
IG_BH01_PW002: 222.05 – 222.17 m

IG_BH01_PW003: 223.45 – 223.45 m

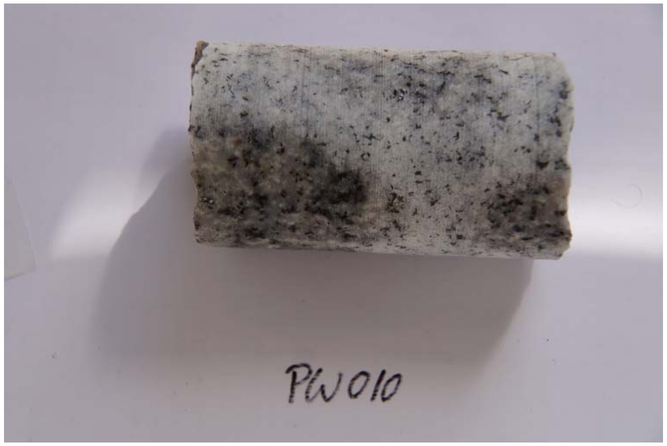
IG_BH01_PW005: 321.41 – 321.56 m

IG_BH01_PW006: 321.56 – 321.92 m

IG_BH01_PW007: 420.38 – 420.73 m



IG_BH01_PW009: 421.08 – 421.19 m

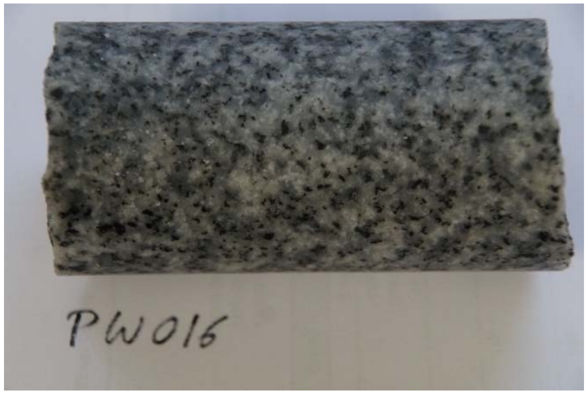


IG_BH01_PW010: 455.98 – 456.08 m

IG_BH01_PW012: 456.42 – 456.77 m

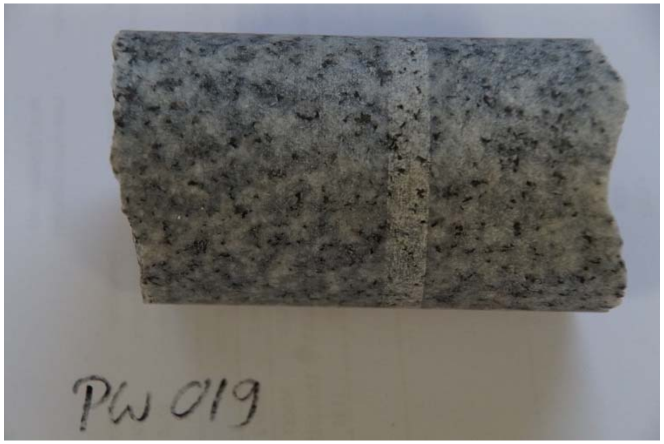
IG_BH01_PW013: 531.59 – 531.71 m

IG_BH01_PW015: 531.23 – 531.59 m



IG_BH01_PW016: 582.30 – 582.41

IG_BH01_PW018: 582.76 – 583.13 m

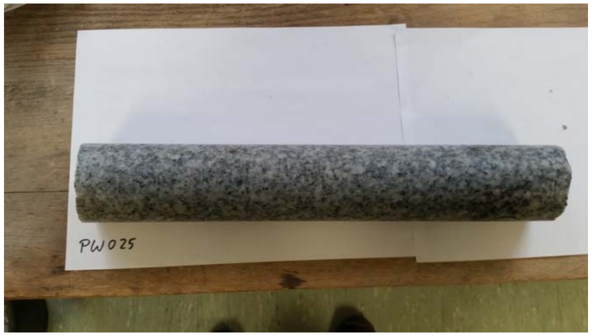


IG_BH01_PW019: 632.43 – 632.53 m

IG_BH01_PW020: 632.53 – 632.88 m

IG_BH01_PW023: 720.79 – 721.20 m

IG_BH01_PW024: 721.20 – 721.34 m

 IG_BH01_PW025: 820.25 – 820.62 m	 IG_BH01_PW027: 820.98 – 821.09 m
 IG_BH01_PW029: 920.64 – 921.00 m	 IG_BH01_PW030: 921.00 – 921.13 m

APPENDIX II

Analytical Raw Data

Hydroisotop

Hydroisotop GmbH · Woelkestraße 9 · D-85301 Schweitenkirchen·

Golder Associates Ltd.
6925 Century Avenue, Suite 100

Mississauga, Ontario, Canada

Durch die DAkkS nach DIN EN ISO/IEC 17025
akkreditiertes Prüflaboratorium

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17315-01-00

Nach § 15 Abs. 4 TrinkwV 2001 zugelassene
Trinkwasseruntersuchungsstelle

Schweitenkirchen, 11.03.2019
FE / CG

Report No. 308246 - 310001

page 1 of 9

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Hydroisotop
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG_BH01_Pw 002 Aqueous extraction**	**IG_BH01_Pw 005 Aqueous extraction**	**IG_BH01_Pw 009 Aqueous extraction**	
Lab. no.	308246	308247	308248	
Sampling date	14.12.2017	14.12.2017	14.12.2017	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	50	63	81	µS/cm
pH value Lab.	9.3	9.3	9.5	
Temperature Lab.	23.0	24.7	24.1	°C
Alkalinity (pH 4,3) Lab.	0.41	0.55	0.58	mmol/l
Alkalinity (pH 8,2) Lab.	0.22	0.30	0.30	mmol/l

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Hydroisotop
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter	**Result**			**Unit**	
SAMPLE NAME	**IG_BH01_Pw 002 Aqueous extraction**	**IG_BH01_Pw 005 Aqueous extraction**	**IG_BH01_Pw 009 Aqueous extraction**		
Lab. no.	308246	308247	308248		
Sampling date	14.12.2017	14.12.2017	14.12.2017		
CATIONS					
Sodium (Na^+)	3.50	5.10	7.40	mg/l	
Potassium (K^+)	3.20	7.50	9.40	mg/l	
Calcium (Ca^{2+})	4.40	3.10	2.80	mg/l	
Magnesium (Mg^{2+})	0.13	0.19	0.18	mg/l	
ANIONS					
Chloride (Cl^-)	1.40	1.40	4.50	mg/l	
Sulphate (SO_4^{2-})	0.27	0.26	0.47	mg/l	
Nitrate (NO_3^-)	0.10	0.06	0.21	mg/l	
TRACE COMPOUNDS					
Bromide (Br^-)	0.02	< 0.02	0.04	mg/l	
Fluoride (F^-)	0.13	0.06	0.06	mg/l	
Silicon	5.90	5.90	5.00	mg/l	
Strontium (Sr^{2+})	< 0.1	< 0.1	< 0.1	mg/l	
METALS					
Aluminium	0.47	0.37	1.20	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	1.50	1.10	1.80	mg/l	

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Hydroisotop
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG_BH01_Pw 010 Aqueous extraction**	**IG_BH01_Pw 013 Aqueous extraction**	**IG_BH01_Pw 016 Aqueous extraction**	
Lab. no.	308249	308757	308758	
Sampling date	14.12.2017	23.12.2017	23.12.2017	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	56	135	183	µS/cm
pH value Lab.	9.3	8.5	9.5	
Temperature Lab.	24.9	21.4	21.1	°C
Alkalinity (pH 4,3) Lab.	0.43	1.81	2.28	mmol/l
Alkalinity (pH 8,2) Lab.	0.30	0.14	0.43	mmol/l
CATIONS				
Sodium (Na^+)	5.80	19.0	22.6	mg/l
Potassium (K^+)	7.70	15.9	18.0	mg/l
Calcium (Ca^{2+})	1.10	1.90	0.86	mg/l
Magnesium (Mg^{2+})	0.11	0.18	0.35	mg/l
ANIONS				
Chloride (Cl^-)	2.50	11.2	19.6	mg/l
Sulphate (SO_4^{2-})	0.23	1.70	1.40	mg/l
Nitrate (NO_3^-)	0.08	0.28	0.13	mg/l

Project: **Ignace Borehole 1, Porewater**
Customer: **Golder Associates Ltd.**
Sample: Liquid sample Sampling: Hydroisotop
Lab. entry: 14.12.2017 - 05.02.2018 Analysis start: 14.12.2017
Analysis finish: 14.05.2018

Parameter	**Result**			**Unit**	
SAMPLE NAME	**IG_BH01_Pw 010 Aqueous extraction**	**IG_BH01_Pw 013 Aqueous extraction**	**IG_BH01_Pw 016 Aqueous extraction**		
Lab. no.	308249	308757	308758		
Sampling date	14.12.2017	23.12.2017	23.12.2017		
TRACE COMPOUNDS					
Bromide (Br^-)	0.04	0.68	1.08	mg/l	
Fluoride (F^-)	0.06	0.17	0.31	mg/l	
Silicon	10.50	10.00	55.00	mg/l	
Strontium (Sr^{2+})	< 0.1	< 0.1	< 0.1	mg/l	
METALS					
Aluminium	0.57	1.30	9.80	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	1.20	4.30	14.80	mg/l	

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Customer
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG_BH01_Pw 019 Aqueous extraction**	**IG_BH01_Pw 024 Aqueous Extraction**	**IG_BH01_Pw 027 Aqueous Extraction**	
Lab. no.	308759	309999	310000	
Sampling date	23.12.2017	05.02.2018	05.02.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	110	104	111	µS/cm
pH value Lab.	9.2	9.3	9.2	
Temperature Lab.	21.3	24.6	24.8	°C
Alkalinity (pH 4,3) Lab.	1.31	0.66	0.75	mmol/l
Alkalinity (pH 8,2) Lab.	0.30	0.46	0.35	mmol/l
CATIONS				
Sodium (Na^+)	12.5	8.60	10.0	mg/l
Potassium (K^+)	12.8	16.9	19.7	mg/l
Calcium (Ca^{2+})	0.60	2.30	1.40	mg/l
Magnesium (Mg^{2+})	0.22	0.41	0.55	mg/l
ANIONS				
Chloride (Cl^-)	9.50	9.89	10.0	mg/l
Sulphate (SO_4^{2-})	1.60	0.65	0.78	mg/l
Nitrate (NO_3^-)	0.22	-	-	mg/l

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Customer
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter		**Result**		**Unit**	
SAMPLE NAME	**IG_BH01_Pw 019 Aqueous extraction**	**IG_BH01_Pw 024 Aqueous Extraction**	**IG_BH01_Pw 027 Aqueous Extraction**		
Lab. no.	308759	309999	310000		
Sampling date	23.12.2017	05.02.2018	05.02.2018		
TRACE COMPOUNDS					
Bromide (Br^-)	0.26	0.18	0.21	mg/l	
Fluoride (F^-)	0.14	0.11	0.23	mg/l	
Silicon	7.60	5.30	3.90	mg/l	
Strontium (Sr^{2+})	< 0.1	< 0.1	< 0.1	mg/l	
METALS					
Aluminium	0.25	0.88	1.40	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	5.80	12.30	2.20	mg/l	

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter	**Result**	**Unit**
SAMPLE NAME	**IG_BH01_Pw030 Aqueous Extraction**	
Lab. no.	310001	
Sampling date	05.02.2018	
PHYSICAL-CHEMICAL PARAMETER		
Spec. electr. conductivity (25 °C) Lab.	144	µS/cm
pH value Lab.	9.2	
Temperature Lab.	23.2	°C
Alkalinity (pH 4,3) Lab.	0.56	mmol/l
Alkalinity (pH 8,2) Lab.	0.29	mmol/l
CATIONS		
Sodium (Na^+)	12.0	mg/l
Potassium (K^+)	18.1	mg/l
Calcium (Ca^{2+})	3.70	mg/l
Magnesium (Mg^{2+})	0.29	mg/l
ANIONS		
Chloride (Cl^-)	22.4	mg/l
Sulphate (SO_4^{2-})	0.83	mg/l
Nitrate (NO_3^-)	-	mg/l

Project:	**Ignace Borehole 1, Porewater**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	14.12.2017 - 05.02.2018	Analysis start:	14.12.2017
		Analysis finish:	14.05.2018

Parameter	**Result**	**Unit**	
SAMPLE NAME	**IG_BH01_Pw030 Aqueous Extraction**		
Lab. no.	310001		
Sampling date	05.02.2018		
TRACE COMPOUNDS			
Bromide (Br^-)	0.42	mg/l	
Fluoride (F^-)	0.12	mg/l	
Silicon	4.70	mg/l	
Strontium (Sr^{2+})	< 0.1	mg/l	
METALS			
Aluminium	0.34	mg/l	*
SUM AND SINGLE PARAMETER			
DOC	1.90	mg/l	

Project:	**Ignace Borehole 1, Porewater**
Customer:	**Golder Associates Ltd.**

Parameter	**Method**	
pH value Lab.	DIN EN ISO 10523 (C5): 2012-04	
Temperature Lab.	DIN 38404-C4: 1976-12	
Spec. electr. conductivity (25 °C) Lab.	DIN EN 27888 (C8):1993-11	
Alkalinity (pH 4,3) Lab.	DIN 38409-H7:2005-12	
Alkalinity (pH 8,2) Lab.	DIN 38409-H7:2005-12	
Sodium (Na^+)	DIN EN ISO 14911 (E34): 1999-12	
Potassium (K^+)	DIN EN ISO 14911 (E34): 1999-12	
Calcium (Ca^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Magnesium (Mg^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Chloride (Cl^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Sulphate (SO_4^{2-})	DIN EN ISO 10304-1 (D20): 2009-07	
Nitrate (NO_3^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Fluoride (F^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Bromide (Br^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Aluminium	DIN EN ISO 17294-2 (E29), ICP-MS	*
DOC	DIN EN 1484 (H3): 1997-08	
Strontium (Sr^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Silicon	Merck Spectroquant 1.14794: 2016-07	

Legend

*	Analysis in cooperation with accredited resp. qualified extern labs
n.m.	not measured, concentration too small
<	not detectable
-	not ordered
x	qualified method with pending accreditation

Notes

The results relate only to the measured samples.
Each presentation of the results needs a written permission of Hydroisotop GmbH.
The terms and conditions of Hydroisotop GmbH are applied.
Hydroisotop does not take responsibility for the correctness of sampling by a third party.

Dr. Eichinger
(Managing Director)
11.03.2019

Hydroisotop

Hydroisotop GmbH · Woelkestraße 9 · D-85301 Schweitenkirchen·

Golder Associates Ltd.
6925 Century Avenue, Suite 100

Mississauga, Ontario, Canada

Durch die DAkkS nach DIN EN ISO/IEC 17025
akkreditiertes Prüflaboratorium

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17315-01-00

Nach § 15 Abs. 4 TrinkwV 2001 zugelassene
Trinkwasseruntersuchungsstelle

Schweitenkirchen, 11.03.2019
Dr. FE / CG

Report No. 309690 - 317605

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Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**3-A**	**6-A**	**7-A**	
Lab. no.	309690	309691	309692	
Sampling date	30.01.2018	30.01.2018	30.01.2018	
CATIONS				
Sodium (Na^+)	10.0	8.20	7.30	mg/l
Potassium (K^+)	2.10	1.40	1.00	mg/l
Calcium (Ca^{2+})	5.00	3.80	6.30	mg/l
Magnesium (Mg^{2+})	1.20	0.22	0.25	mg/l
ANIONS				
Chloride (Cl^-)	0.89	1.10	1.90	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.51	< 0.5	mg/l
Nitrate (NO_3^-)	0.39	< 0.2	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**3-A**	**6-A**	**7-A**	
Lab. no.	309690	309691	309692	
Sampling date	30.01.2018	30.01.2018	30.01.2018	
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**12-A**	**15-A**	**18-A**	
Lab. no.	309693	309694	309695	
Sampling date	30.01.2018	30.01.2018	30.01.2018	
CATIONS				
Sodium (Na^+)	9.50	8.10	8.30	mg/l
Potassium (K^+)	1.50	1.30	2.10	mg/l
Calcium (Ca^{2+})	4.50	5.40	8.60	mg/l
Magnesium (Mg^{2+})	0.13	0.17	0.14	mg/l
ANIONS				
Chloride (Cl^-)	2.00	2.00	5.10	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.50	< 0.5	mg/l
Nitrate (NO_3^-)	0.20	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.12	0.32	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**20-A**	**23-A**	**25-A**	
Lab. no.	309696	309697	309698	
Sampling date	30.01.2018	30.01.2018	30.01.2018	
CATIONS				
Sodium (Na^+)	7.80	9.20	8.20	mg/l
Potassium (K^+)	1.70	2.70	1.70	mg/l
Calcium (Ca^{2+})	6.80	12.7	6.40	mg/l
Magnesium (Mg^{2+})	0.09	0.10	0.09	mg/l
ANIONS				
Chloride (Cl^-)	3.50	9.70	3.50	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.17	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**29-A**	**IG-Blank-A**	**3-B**	
Lab. no.	309699	309700	309932	
Sampling date	30.01.2018	30.01.2018	02.02.2018	
CATIONS				
Sodium (Na^+)	9.20	7.40	9.60	mg/l
Potassium (K^+)	3.00	0.25	2.20	mg/l
Calcium (Ca^{2+})	14.1	9.00	15.5	mg/l
Magnesium (Mg^{2+})	0.13	0.10	1.20	mg/l
ANIONS				
Chloride (Cl^-)	11.6	0.02	1.40	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.27	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.22	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-B**	**7-B**	**12-B**	
Lab. no.	309933	309934	309935	
Sampling date	02.02.2018	02.02.2018	02.02.2018	
CATIONS				
Sodium (Na^+)	9.30	9.10	10.0	mg/l
Potassium (K^+)	1.50	1.40	1.50	mg/l
Calcium (Ca^{2+})	12.5	11.2	8.30	mg/l
Magnesium (Mg^{2+})	0.36	0.12	0.09	mg/l
ANIONS				
Chloride (Cl^-)	1.80	3.70	3.60	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**15-B**	**18-B**	**20-B**	
Lab. no.	309936	309937	309938	
Sampling date	02.02.2018	02.02.2018	02.02.2018	
CATIONS				
Sodium (Na^+)	10.1	10.9	9.70	mg/l
Potassium (K^+)	1.80	3.00	2.30	mg/l
Calcium (Ca^{2+})	6.60	13.0	13.2	mg/l
Magnesium (Mg^{2+})	0.08	0.10	0.09	mg/l
ANIONS				
Chloride (Cl^-)	3.60	9.50	6.50	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	0.59	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.15	0.49	0.15	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**23-B**	**25-B**	**29-B**	
Lab. no.	309939	309940	309941	
Sampling date	02.02.2018	02.02.2018	02.02.2018	
CATIONS				
Sodium (Na^+)	11.6	9.20	11.8	mg/l
Potassium (K^+)	3.20	2.00	3.70	mg/l
Calcium (Ca^{2+})	18.9	14.2	19.5	mg/l
Magnesium (Mg^{2+})	0.08	0.08	0.11	mg/l
ANIONS				
Chloride (Cl^-)	17.9	6.00	21.1	mg/l
Sulphate (SO_4^{2-})	0.59	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.30	0.11	0.36	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-B**	**3-C**	**6-C**	
Lab. no.	309942	309988	309989	
Sampling date	02.02.2018	05.02.2018	05.02.2018	
CATIONS				
Sodium (Na^+)	7.10	9.40	8.50	mg/l
Potassium (K^+)	0.24	2.40	1.60	mg/l
Calcium (Ca^{2+})	6.70	8.60	10.7	mg/l
Magnesium (Mg^{2+})	0.05	1.30	0.49	mg/l
ANIONS				
Chloride (Cl^-)	0.01	1.80	2.00	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.63	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	0.39	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-C**	**12-C**	**15-C**	
Lab. no.	309990	309991	309992	
Sampling date	05.02.2018	05.02.2018	05.02.2018	
CATIONS				
Sodium (Na^+)	8.00	8.90	10.0	mg/l
Potassium (K^+)	1.50	1.70	2.00	mg/l
Calcium (Ca^{2+})	12.9	10.3	8.30	mg/l
Magnesium (Mg^{2+})	0.15	0.12	0.10	mg/l
ANIONS				
Chloride (Cl^-)	4.50	4.20	4.40	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.10	< 0.1	0.16	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**18-C**	**20-C**	**23-C**	
Lab. no.	309993	309994	309995	
Sampling date	05.02.2018	05.02.2018	05.02.2018	
CATIONS				
Sodium (Na^+)	10.9	9.60	11.1	mg/l
Potassium (K^+)	3.30	2.70	3.60	mg/l
Calcium (Ca^{2+})	14.8	13.3	21.0	mg/l
Magnesium (Mg^{2+})	0.08	0.09	0.07	mg/l
ANIONS				
Chloride (Cl^-)	11.6	8.10	20.5	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.56	0.59	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.29	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.50	0.15	0.41	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / Hydro
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**25-C**	**29-C**	**IG-Blank-C**	
Lab. no.	309996	309997	309998	
Sampling date	05.02.2018	05.02.2018	05.02.2018	
CATIONS				
Sodium (Na^+)	8.90	11.2	7.20	mg/l
Potassium (K^+)	2.40	4.30	0.20	mg/l
Calcium (Ca^{2+})	14.7	22.6	7.80	mg/l
Magnesium (Mg^{2+})	0.10	0.13	0.05	mg/l
ANIONS				
Chloride (Cl^-)	7.50	25.9	0.01	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.61	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.11	0.37	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**3-D**	**6-D**	**7-D**	
Lab. no.	310263	310264	310265	
Sampling date	08.02.2018	08.02.2018	08.02.2018	
CATIONS				
Sodium (Na^+)	7.40	7.10	7.30	mg/l
Potassium (K^+)	2.70	2.20	1.70	mg/l
Calcium (Ca^{2+})	10.5	10.4	11.5	mg/l
Magnesium (Mg^{2+})	0.23	0.15	0.06	mg/l
ANIONS				
Chloride (Cl^-)	1.50	2.50	4.90	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	0.52	mg/l
Nitrate (NO_3^-)	0.22	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**12-D**	**15-D**	**18-D**	
Lab. no.	310266	310267	310268	
Sampling date	08.02.2018	08.02.2018	08.02.2018	
CATIONS				
Sodium (Na^+)	7.90	8.60	9.40	mg/l
Potassium (K^+)	1.90	2.20	3.50	mg/l
Calcium (Ca^{2+})	10.0	9.60	13.5	mg/l
Magnesium (Mg^{2+})	0.10	0.09	0.09	mg/l
ANIONS				
Chloride (Cl^-)	4.80	5.00	12.8	mg/l
Sulphate (SO_4^{2-})	< 0.5	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.18	0.61	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**20-D**	**23-D**	**25-D**	
Lab. no.	310269	310270	310271	
Sampling date	08.02.2018	08.02.2018	08.02.2018	
CATIONS				
Sodium (Na^+)	8.50	9.90	8.50	mg/l
Potassium (K^+)	2.70	3.70	2.70	mg/l
Calcium (Ca^{2+})	13.0	20.3	14.0	mg/l
Magnesium (Mg^{2+})	0.10	0.08	0.10	mg/l
ANIONS				
Chloride (Cl^-)	8.80	22.8	8.50	mg/l
Sulphate (SO_4^{2-})	0.66	0.74	0.56	mg/l
Nitrate (NO_3^-)	< 0.2	0.26	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.17	0.40	0.15	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	JK / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**29-D**	**IG-Blank-D**	**3-E**	
Lab. no.	310272	310273	310367	
Sampling date	08.02.2018	08.02.2018	12.02.2018	
CATIONS				
Sodium (Na^+)	10.1	5.00	9.70	mg/l
Potassium (K^+)	4.70	0.23	2.60	mg/l
Calcium (Ca^{2+})	21.9	5.00	24.6	mg/l
Magnesium (Mg^{2+})	0.10	0.04	1.00	mg/l
ANIONS				
Chloride (Cl^-)	27.7	0.01	2.00	mg/l
Sulphate (SO_4^{2-})	0.79	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.42	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-E**	**7-E**	**12-E**	
Lab. no.	310368	310369	310370	
Sampling date	12.02.2018	12.02.2018	12.02.2018	
CATIONS				
Sodium (Na^+)	9.40	9.90	9.50	mg/l
Potassium (K^+)	1.60	1.70	1.90	mg/l
Calcium (Ca^{2+})	21.0	16.2	11.9	mg/l
Magnesium (Mg^{2+})	0.90	0.34	0.26	mg/l
ANIONS				
Chloride (Cl^-)	2.60	5.40	5.20	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.64	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**
Customer:	**Golder Associates Ltd.**
Sample:	Liquid sample
Sampling:	FE / HY
Lab. entry:	30.01.2018 - 12.02.2018
Analysis start:	30.01.2018
Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**15-E**	**18-E**	**20-E**	
Lab. no.	310371	310372	310373	
Sampling date	12.02.2018	12.02.2018	12.02.2018	
CATIONS				
Sodium (Na^+)	9.90	11.3	10.3	mg/l
Potassium (K^+)	2.20	3.80	2.80	mg/l
Calcium (Ca^{2+})	11.4	16.8	14.2	mg/l
Magnesium (Mg^{2+})	0.21	0.15	0.14	mg/l
ANIONS				
Chloride (Cl^-)	5.60	14.4	9.90	mg/l
Sulphate (SO_4^{2-})	0.61	< 0.5	0.80	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.30	0.61	0.25	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	30.01.2018 - 12.02.2018	Analysis start:	30.01.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**23-E**	**25-E**	**29-E**	
Lab. no.	310374	310375	310376	
Sampling date	12.02.2018	12.02.2018	12.02.2018	
CATIONS				
Sodium (Na^+)	12.1	10.0	11.8	mg/l
Potassium (K^+)	3.90	2.70	5.70	mg/l
Calcium (Ca^{2+})	23.9	16.9	26.7	mg/l
Magnesium (Mg^{2+})	0.12	0.11	0.11	mg/l
ANIONS				
Chloride (Cl^-)	24.1	9.60	30.7	mg/l
Sulphate (SO_4^{2-})	0.79	0.51	0.68	mg/l
Nitrate (NO_3^-)	0.20	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.40	0.17	0.50	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-E**	**3-F**	**6-F**	
Lab. no.	310377	310534	310535	
Sampling date	12.02.2018	19.02.2018	19.02.2018	
CATIONS				
Sodium (Na^+)	6.70	13.9	14.8	mg/l
Potassium (K^+)	0.46	2.60	1.70	mg/l
Calcium (Ca^{2+})	9.30	10.9	12.6	mg/l
Magnesium (Mg^{2+})	0.07	0.41	0.17	mg/l
ANIONS				
Chloride (Cl^-)	0.03	2.10	2.90	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.54	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	0.43	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-F**	**12-F**	**15-F**	
Lab. no.	310536	310537	310538	
Sampling date	19.02.2018	19.02.2018	19.02.2018	
CATIONS				
Sodium (Na^+)	13.7	13.5	14.5	mg/l
Potassium (K^+)	1.80	1.90	2.10	mg/l
Calcium (Ca^{2+})	14.9	12.1	11.0	mg/l
Magnesium (Mg^{2+})	0.35	0.17	0.10	mg/l
ANIONS				
Chloride (Cl^-)	6.10	5.70	5.80	mg/l
Sulphate (SO_4^{2-})	0.67	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.14	< 0.1	0.37	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**18-F**	**20-F**	**23-F**	
Lab. no.	310539	310540	310541	
Sampling date	19.02.2018	19.02.2018	19.02.2018	
CATIONS				
Sodium (Na^+)	16.2	14.9	17.1	mg/l
Potassium (K^+)	4.10	2.80	4.00	mg/l
Calcium (Ca^{2+})	14.8	16.0	21.8	mg/l
Magnesium (Mg^{2+})	0.09	0.11	0.07	mg/l
ANIONS				
Chloride (Cl^-)	16.2	11.4	26.2	mg/l
Sulphate (SO_4^{2-})	< 0.5	0.86	1.20	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.23	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.66	0.28	0.61	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**25-F**	**29-F**	**IG-Blank-F**	
Lab. no.	310542	310543	310544	
Sampling date	19.02.2018	19.02.2018	19.02.2018	
CATIONS				
Sodium (Na^+)	14.7	17.6	10.9	mg/l
Potassium (K^+)	2.60	5.30	0.11	mg/l
Calcium (Ca^{2+})	16.6	27.0	8.10	mg/l
Magnesium (Mg^{2+})	0.09	0.12	0.15	mg/l
ANIONS				
Chloride (Cl^-)	10.7	36.3	0.03	mg/l
Sulphate (SO_4^{2-})	0.69	1.40	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.22	0.63	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**3-G**	**6-G**	**7-G**	
Lab. no.	310752	310753	310754	
Sampling date				
CATIONS				
Sodium (Na^+)	11.2	10.9	9.80	mg/l
Potassium (K^+)	3.40	2.00	1.90	mg/l
Calcium (Ca^{2+})	17.8	11.9	15.5	mg/l
Magnesium (Mg^{2+})	0.89	0.24	0.07	mg/l
ANIONS				
Chloride (Cl^-)	2.20	3.10	6.20	mg/l
Sulphate (SO_4^{2-})	2.30	2.50	0.81	mg/l
Nitrate (NO_3^-)	2.80	1.50	3.00	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**12-G**	**15-G**	**18-G**	
Lab. no.	310755	310756	310757	
Sampling date				
CATIONS				
Sodium (Na^+)	10.1	10.7	12.6	mg/l
Potassium (K^+)	2.30	2.40	4.10	mg/l
Calcium (Ca^{2+})	10.5	12.7	18.4	mg/l
Magnesium (Mg^{2+})	0.08	0.10	0.09	mg/l
ANIONS				
Chloride (Cl^-)	5.90	6.10	16.4	mg/l
Sulphate (SO_4^{2-})	0.70	0.62	1.00	mg/l
Nitrate (NO_3^-)	2.40	1.70	1.10	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.38	0.73	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**20-G**	**23-G**	**25-G**	
Lab. no.	310758	310759	310760	
Sampling date				
CATIONS				
Sodium (Na^+)	11.6	13.1	11.5	mg/l
Potassium (K^+)	3.00	4.20	3.00	mg/l
Calcium (Ca^{2+})	16.2	24.9	18.5	mg/l
Magnesium (Mg^{2+})	0.12	0.08	0.08	mg/l
ANIONS				
Chloride (Cl^-)	11.4	26.8	11.6	mg/l
Sulphate (SO_4^{2-})	1.10	1.10	0.94	mg/l
Nitrate (NO_3^-)	2.20	1.30	0.70	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.29	0.63	0.26	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**29-G**	**IG-Blank-G**	**3-H**	
Lab. no.	310761	310762	311308	
Sampling date			15.03.2018	
CATIONS				
Sodium (Na^+)	13.4	6.70	10.8	mg/l
Potassium (K^+)	5.80	0.58	2.80	mg/l
Calcium (Ca^{2+})	29.5	12.4	15.0	mg/l
Magnesium (Mg^{2+})	0.14	0.07	0.14	mg/l
ANIONS				
Chloride (Cl^-)	38.1	0.04	2.30	mg/l
Sulphate (SO_4^{2-})	1.40	< 0.5	0.75	mg/l
Nitrate (NO_3^-)	1.20	0.47	0.35	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.73	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-H**	**7-H**	**12-H**	
Lab. no.	311309	311310	311311	
Sampling date	15.03.2018	15.03.2018	15.03.2018	
CATIONS				
Sodium (Na^+)	14.7	9.50	10.9	mg/l
Potassium (K^+)	2.60	1.60	2.00	mg/l
Calcium (Ca^{2+})	13.5	15.4	11.4	mg/l
Magnesium (Mg^{2+})	0.24	0.05	0.05	mg/l
ANIONS				
Chloride (Cl^-)	3.30	6.20	6.00	mg/l
Sulphate (SO_4^{2-})	1.30	0.65	0.72	mg/l
Nitrate (NO_3^-)	13.7	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**15-H**	**18-H**	**20-H**	
Lab. no.	311312	311313	311314	
Sampling date	15.03.2018	15.03.2018	15.03.2018	
CATIONS				
Sodium (Na^+)	10.8	12.8	11.5	mg/l
Potassium (K^+)	2.20	3.90	2.80	mg/l
Calcium (Ca^{2+})	10.7	15.1	13.5	mg/l
Magnesium (Mg^{2+})	0.06	0.07	0.07	mg/l
ANIONS				
Chloride (Cl^-)	6.30	16.5	11.5	mg/l
Sulphate (SO_4^{2-})	0.66	0.71	1.70	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.39	0.75	0.30	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**23-H**	**25-H**	**29-H**	
Lab. no.	311315	311316	311317	
Sampling date	15.03.2018	15.03.2018	15.03.2018	
CATIONS				
Sodium (Na^+)	13.3	11.4	14.8	mg/l
Potassium (K^+)	4.30	2.90	5.70	mg/l
Calcium (Ca^{2+})	24.2	14.4	27.8	mg/l
Magnesium (Mg^{2+})	0.06	0.06	0.10	mg/l
ANIONS				
Chloride (Cl^-)	27.4	12.2	39.5	mg/l
Sulphate (SO_4^{2-})	1.40	0.99	1.30	mg/l
Nitrate (NO_3^-)	0.27	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.63	0.28	0.75	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**
Customer:	**Golder Associates Ltd.**

Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-H**	**3-I**	**6-I**	
Lab. no.	311318	312031	312032	
Sampling date	15.03.2018	29.03.2018	29.03.2018	
CATIONS				
Sodium (Na^+)	5.90	9.70	9.30	mg/l
Potassium (K^+)	0.20	3.30	2.50	mg/l
Calcium (Ca^{2+})	6.30	20.0	16.7	mg/l
Magnesium (Mg^{2+})	0.04	1.10	0.35	mg/l
ANIONS				
Chloride (Cl^-)	0.03	2.30	3.30	mg/l
Sulphate (SO_4^{2-})	< 0.5	1.40	0.95	mg/l
Nitrate (NO_3^-)	< 0.2	0.35	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-I**	**12-I**	**15-I**	
Lab. no.	312033	312034	312035	
Sampling date	29.03.2018	29.03.2018	29.03.2018	
CATIONS				
Sodium (Na^+)	8.50	9.30	11.2	mg/l
Potassium (K^+)	1.90	3.30	2.70	mg/l
Calcium (Ca^{2+})	18.5	14.0	11.1	mg/l
Magnesium (Mg^{2+})	0.08	0.08	0.09	mg/l
ANIONS				
Chloride (Cl^-)	6.20	6.10	6.30	mg/l
Sulphate (SO_4^{2-})	0.77	0.67	0.70	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	0.39	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**18-I**	**20-I**	**23-I**	
Lab. no.	312036	312037	312038	
Sampling date	29.03.2018	29.03.2018	29.03.2018	
CATIONS				
Sodium (Na^+)	11.2	10.4	11.8	mg/l
Potassium (K^+)	4.10	3.10	4.50	mg/l
Calcium (Ca^{2+})	18.7	17.8	26.1	mg/l
Magnesium (Mg^{2+})	0.09	0.11	0.07	mg/l
ANIONS				
Chloride (Cl^-)	17.2	12.3	28.2	mg/l
Sulphate (SO_4^{2-})	0.76	1.80	1.80	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.75	0.30	0.63	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**25-I**	**29-I**	**IG-Blank-I**	
Lab. no.	312039	312040	312041	
Sampling date	29.03.2018	29.03.2018	29.03.2018	
CATIONS				
Sodium (Na^+)	10.0	13.1	4.70	mg/l
Potassium (K^+)	3.10	6.10	0.19	mg/l
Calcium (Ca^{2+})	18.2	29.6	7.10	mg/l
Magnesium (Mg^{2+})	0.09	0.12	0.04	mg/l
ANIONS				
Chloride (Cl^-)	12.8	39.8	0.04	mg/l
Sulphate (SO_4^{2-})	1.10	1.50	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.28	0.76	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**3-K**	**6-K**	**7-K**	
Lab. no.	312465	312466	312467	
Sampling date	13.04.2018	13.04.2018	13.04.2018	
CATIONS				
Sodium (Na^+)	9.50	8.90	7.90	mg/l
Potassium (K^+)	2.90	2.10	1.70	mg/l
Calcium (Ca^{2+})	14.2	13.4	15.4	mg/l
Magnesium (Mg^{2+})	0.33	0.18	0.12	mg/l
ANIONS				
Chloride (Cl^-)	2.30	3.30	6.20	mg/l
Sulphate (SO_4^{2-})	1.10	1.10	0.79	mg/l
Nitrate (NO_3^-)	0.29	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**12-K**	**15-K**	**18-K**	
Lab. no.	312468	312469	312470	
Sampling date	13.04.2018	13.04.2018	13.04.2018	
CATIONS				
Sodium (Na^+)	9.10	13.7	10.8	mg/l
Potassium (K^+)	2.10	1.70	3.80	mg/l
Calcium (Ca^{2+})	12.1	17.8	16.9	mg/l
Magnesium (Mg^{2+})	0.09	0.09	0.05	mg/l
ANIONS				
Chloride (Cl^-)	6.50	6.30	17.5	mg/l
Sulphate (SO_4^{2-})	0.93	0.67	0.85	mg/l
Nitrate (NO_3^-)	< 0.2	0.28	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.40	0.75	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**20-K**	**23-K**	**25-K**	
Lab. no.	312471	312472	312473	
Sampling date	13.04.2018	13.04.2018	13.04.2018	
CATIONS				
Sodium (Na^+)	10.2	11.8	9.40	mg/l
Potassium (K^+)	2.90	4.50	3.00	mg/l
Calcium (Ca^{2+})	15.5	24.1	16.4	mg/l
Magnesium (Mg^{2+})	0.09	0.08	0.07	mg/l
ANIONS				
Chloride (Cl^-)	12.3	28.9	13.0	mg/l
Sulphate (SO_4^{2-})	2.00	2.10	1.10	mg/l
Nitrate (NO_3^-)	< 0.2	0.27	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.30	0.64	0.28	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**29-K**	**IG-Blank-K**	**3-L**	
Lab. no.	312474	312475	312963	
Sampling date	13.04.2018	13.04.2018	02.05.2018	
CATIONS				
Sodium (Na^+)	12.3	4.60	12.5	mg/l
Potassium (K^+)	5.90	0.09	3.50	mg/l
Calcium (Ca^{2+})	27.5	8.90	20.1	mg/l
Magnesium (Mg^{2+})	0.08	0.03	0.34	mg/l
ANIONS				
Chloride (Cl^-)	41.0	0.02	2.30	mg/l
Sulphate (SO_4^{2-})	1.60	< 0.5	1.50	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.32	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.76	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-L**	**7-L**	**12-L**	
Lab. no.	312964	312965	312966	
Sampling date	02.05.2018	02.05.2018	02.05.2018	
CATIONS				
Sodium (Na^+)	12.9	11.1	11.9	mg/l
Potassium (K^+)	2.70	1.90	2.20	mg/l
Calcium (Ca^{2+})	19.2	21.5	17.0	mg/l
Magnesium (Mg^{2+})	0.15	0.10	0.09	mg/l
ANIONS				
Chloride (Cl^-)	3.30	6.30	6.50	mg/l
Sulphate (SO_4^{2-})	1.60	0.70	1.00	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**15-L**	**18-L**	**20-L**	
Lab. no.	312967	312968	312969	
Sampling date	02.05.2018	02.05.2018	02.05.2018	
CATIONS				
Sodium (Na^+)	15.5	13.7	13.1	mg/l
Potassium (K^+)	2.60	4.00	2.90	mg/l
Calcium (Ca^{2+})	16.1	21.5	19.6	mg/l
Magnesium (Mg^{2+})	0.16	0.09	0.14	mg/l
ANIONS				
Chloride (Cl^-)	6.30	18.8	12.3	mg/l
Sulphate (SO_4^{2-})	0.58	0.68	2.50	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.40	0.85	0.35	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	12.02.2018 - 02.05.2018	Analysis start:	12.02.2018
		Analysis finish:	11.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**23-L**	**25-L**	**29-L**	
Lab. no.	312970	312971	312972	
Sampling date	02.05.2018	02.05.2018	02.05.2018	
CATIONS				
Sodium (Na^+)	15.0	12.9	15.6	mg/l
Potassium (K^+)	4.80	3.10	6.10	mg/l
Calcium (Ca^{2+})	30.0	20.8	32.2	mg/l
Magnesium (Mg^{2+})	0.11	0.10	0.15	mg/l
ANIONS				
Chloride (Cl^-)	30.9	13.0	41.5	mg/l
Sulphate (SO_4^{2-})	2.40	1.20	1.60	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.64	0.30	0.76	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-L**	**3-M**	**6-M**	
Lab. no.	312973	313911	313912	
Sampling date	02.05.2018	29.05.2018	29.05.2018	
CATIONS				
Sodium (Na^+)	6.70	12.8	11.6	mg/l
Potassium (K^+)	0.15	3.50	2.90	mg/l
Calcium (Ca^{2+})	11.5	24.9	19.7	mg/l
Magnesium (Mg^{2+})	0.07	0.89	0.28	mg/l
ANIONS				
Chloride (Cl^-)	0.04	2.30	3.30	mg/l
Sulphate (SO_4^{2-})	< 0.5	2.30	1.20	mg/l
Nitrate (NO_3^-)	< 0.2	0.78	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-M**	**12-M**	**15-M**	
Lab. no.	313913	313914	313915	
Sampling date	29.05.2018	29.05.2018	29.05.2018	
CATIONS				
Sodium (Na^+)	9.10	10.4	10.6	mg/l
Potassium (K^+)	1.80	2.30	2.50	mg/l
Calcium (Ca^{2+})	20.9	16.3	15.3	mg/l
Magnesium (Mg^{2+})	0.15	0.15	0.09	mg/l
ANIONS				
Chloride (Cl^-)	6.30	6.50	6.30	mg/l
Sulphate (SO_4^{2-})	0.72	0.65	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	0.40	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**18-M**	**20-M**	**23-M**	
Lab. no.	313916	313917	313918	
Sampling date	29.05.2018	29.05.2018	29.05.2018	
CATIONS				
Sodium (Na^+)	12.1	11.5	12.8	mg/l
Potassium (K^+)	4.10	3.10	4.80	mg/l
Calcium (Ca^{2+})	21.0	19.3	29.1	mg/l
Magnesium (Mg^{2+})	0.11	0.20	0.13	mg/l
ANIONS				
Chloride (Cl^-)	18.8	12.3	30.9	mg/l
Sulphate (SO_4^{2-})	< 0.5	2.40	2.00	mg/l
Nitrate (NO_3^-)	< 0.2	0.20	0.25	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.86	0.37	0.64	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**25-M**	**29-M**	**IG-Blank-M**	
Lab. no.	313919	313920	313921	
Sampling date	29.05.2018	29.05.2018	29.05.2018	
CATIONS				
Sodium (Na^+)	10.9	13.9	4.80	mg/l
Potassium (K^+)	3.20	6.30	0.20	mg/l
Calcium (Ca^{2+})	20.5	32.3	10.6	mg/l
Magnesium (Mg^{2+})	0.09	0.21	0.09	mg/l
ANIONS				
Chloride (Cl^-)	13.0	41.7	0.08	mg/l
Sulphate (SO_4^{2-})	1.20	1.30	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.29	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.30	0.77	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**3-N**	**6-N**	**7-N**	
Lab. no.	314494	314495	314496	
Sampling date	14.06.2018	14.06.2018	14.06.2018	
CATIONS				
Sodium (Na^+)	14.7	14.3	12.5	mg/l
Potassium (K^+)	3.00	2.40	1.70	mg/l
Calcium (Ca^{2+})	18.2	18.0	20.9	mg/l
Magnesium (Mg^{2+})	0.33	0.18	0.14	mg/l
ANIONS				
Chloride (Cl^-)	2.30	3.30	6.30	mg/l
Sulphate (SO_4^{2-})	1.30	1.00	1.30	mg/l
Nitrate (NO_3^-)	0.37	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**12-N**	**15-N**	**18-N**	
Lab. no.	314497	314498	314499	
Sampling date	14.06.2018	14.06.2018	14.06.2018	
CATIONS				
Sodium (Na^+)	14.1	13.7	15.4	mg/l
Potassium (K^+)	2.30	2.40	3.90	mg/l
Calcium (Ca^{2+})	15.8	15.7	21.2	mg/l
Magnesium (Mg^{2+})	0.15	0.08	0.13	mg/l
ANIONS				
Chloride (Cl^-)	6.50	6.70	18.9	mg/l
Sulphate (SO_4^{2-})	0.80	< 0.5	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.43	0.86	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**20-N**	**23-N**	**25-N**	
Lab. no.	314500	314501	314502	
Sampling date	14.06.2018	14.06.2018	14.06.2018	
CATIONS				
Sodium (Na^+)	14.9	16.4	14.1	mg/l
Potassium (K^+)	2.90	4.70	3.00	mg/l
Calcium (Ca^{2+})	19.0	29.2	19.8	mg/l
Magnesium (Mg^{2+})	0.14	0.14	0.15	mg/l
ANIONS				
Chloride (Cl^-)	12.3	30.9	13.4	mg/l
Sulphate (SO_4^{2-})	2.20	1.90	1.00	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.37	0.64	0.30	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**29-N**	**IG-Blank-N**	**3-O**	
Lab. no.	314503	314504	315443	
Sampling date	14.06.2018	14.06.2018	28.06.2018	
CATIONS				
Sodium (Na^+)	17.1	7.90	14.3	mg/l
Potassium (K^+)	6.10	0.08	3.20	mg/l
Calcium (Ca^{2+})	31.5	11.1	12.5	mg/l
Magnesium (Mg^{2+})	0.21	0.09	0.17	mg/l
ANIONS				
Chloride (Cl^-)	41.8	0.08	2.30	mg/l
Sulphate (SO_4^{2-})	1.30	< 0.5	2.00	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	1.90	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.77	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-O**	**7-O**	**12-O**	
Lab. no.	315444	315445	315446	
Sampling date	28.06.2018	28.06.2018	28.06.2018	
CATIONS				
Sodium (Na^+)	15.3	11.3	12.6	mg/l
Potassium (K^+)	2.60	1.60	2.00	mg/l
Calcium (Ca^{2+})	8.60	11.2	6.80	mg/l
Magnesium (Mg^{2+})	0.06	0.05	0.06	mg/l
ANIONS				
Chloride (Cl^-)	3.30	6.30	6.50	mg/l
Sulphate (SO_4^{2-})	1.10	0.98	0.75	mg/l
Nitrate (NO_3^-)	0.50	0.68	1.10	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**15-O**	**18-O**	**20-O**	
Lab. no.	315447	315448	315449	
Sampling date	28.06.2018	28.06.2018	28.06.2018	
CATIONS				
Sodium (Na^+)	16.9	13.2	13.5	mg/l
Potassium (K^+)	2.80	3.70	2.80	mg/l
Calcium (Ca^{2+})	7.80	12.2	9.80	mg/l
Magnesium (Mg^{2+})	0.08	0.07	0.08	mg/l
ANIONS				
Chloride (Cl^-)	7.10	18.9	12.3	mg/l
Sulphate (SO_4^{2-})	0.97	< 0.5	2.20	mg/l
Nitrate (NO_3^-)	4.50	0.20	0.27	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.43	0.87	0.37	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**23-O**	**25-O**	**29-O**	
Lab. no.	315450	315451	315452	
Sampling date	28.06.2018	28.06.2018	28.06.2018	
CATIONS				
Sodium (Na^+)	14.2	12.9	15.4	mg/l
Potassium (K^+)	4.60	3.00	5.90	mg/l
Calcium (Ca^{2+})	20.4	10.3	22.5	mg/l
Magnesium (Mg^{2+})	0.08	0.07	0.12	mg/l
ANIONS				
Chloride (Cl^-)	30.9	13.5	41.9	mg/l
Sulphate (SO_4^{2-})	2.10	1.00	1.50	mg/l
Nitrate (NO_3^-)	0.32	0.29	0.36	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.64	0.34	0.77	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-O**	**3-P**	**6-P**	
Lab. no.	315453	315946	315947	
Sampling date	28.06.2018	12.07.2018	12.07.2018	
CATIONS				
Sodium (Na^+)	8.60	14.4	14.6	mg/l
Potassium (K^+)	0.59	2.50	2.10	mg/l
Calcium (Ca^{2+})	1.90	10.8	8.80	mg/l
Magnesium (Mg^{2+})	0.18	0.09	0.09	mg/l
ANIONS				
Chloride (Cl^-)	0.07	2.30	3.30	mg/l
Sulphate (SO_4^{2-})	< 0.5	2.20	1.70	mg/l
Nitrate (NO_3^-)	1.20	0.27	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Customer
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-P**	**12-P**	**15-P**	
Lab. no.	315948	315949	315950	
Sampling date	12.07.2018	12.07.2018	12.07.2018	
CATIONS				
Sodium (Na^+)	12.0	13.8	16.4	mg/l
Potassium (K^+)	1.30	1.90	3.30	mg/l
Calcium (Ca^{2+})	11.6	6.80	8.70	mg/l
Magnesium (Mg^{2+})	0.05	0.07	0.28	mg/l
ANIONS				
Chloride (Cl^-)	6.30	6.50	7.10	mg/l
Sulphate (SO_4^{2-})	1.80	1.40	1.10	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	0.42	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Customer
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**18-P**	**20-P**	**23-P**	
Lab. no.	315951	315952	315953	
Sampling date	12.07.2018	12.07.2018	12.07.2018	
CATIONS				
Sodium (Na^+)	14.6	14.9	16.2	mg/l
Potassium (K^+)	3.40	2.60	4.30	mg/l
Calcium (Ca^{2+})	12.0	10.1	20.9	mg/l
Magnesium (Mg^{2+})	0.07	0.09	0.08	mg/l
ANIONS				
Chloride (Cl^-)	18.9	12.5	30.9	mg/l
Sulphate (SO_4^{2-})	1.00	3.20	2.90	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.87	0.37	0.64	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Customer
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**25-P**	**29-P**	**IG-Blank-P**	
Lab. no.	315954	315955	315956	
Sampling date	12.07.2018	12.07.2018	12.07.2018	
CATIONS				
Sodium (Na^+)	14.4	18.0	8.30	mg/l
Potassium (K^+)	2.60	5.60	0.65	mg/l
Calcium (Ca^{2+})	10.7	22.6	4.00	mg/l
Magnesium (Mg^{2+})	0.06	0.13	0.05	mg/l
ANIONS				
Chloride (Cl^-)	13.5	41.9	0.10	mg/l
Sulphate (SO_4^{2-})	1.90	2.20	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.34	0.77	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**3-Q**	**6-Q**	**7-Q**	
Lab. no.	316510	316511	316512	
Sampling date	20.07.2018	20.07.2018	20.07.2018	
CATIONS				
Sodium (Na^+)	18.6	18.1	15.7	mg/l
Potassium (K^+)	3.10	2.70	1.70	mg/l
Calcium (Ca^{2+})	12.7	10.8	12.9	mg/l
Magnesium (Mg^{2+})	0.11	0.17	0.09	mg/l
ANIONS				
Chloride (Cl^-)	2.30	3.30	6.30	mg/l
Sulphate (SO_4^{2-})	2.60	2.10	1.90	mg/l
Nitrate (NO_3^-)	0.23	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project: **Ignace Borehole 1, Porewater Out-Diff TS**
Customer: **Golder Associates Ltd.**
Sample: Liquid sample
Sampling: Kreitmayr / HY
Lab. entry: 02.05.2018 - 20.07.2018
Analysis start: 02.05.2018
Analysis finish: 07.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**12-Q**	**15-Q**	**18-Q**	
Lab. no.	316513	316514	316515	
Sampling date	20.07.2018	20.07.2018	20.07.2018	
CATIONS				
Sodium (Na^+)	15.3	16.3	16.9	mg/l
Potassium (K^+)	2.20	2.50	3.80	mg/l
Calcium (Ca^{2+})	8.40	8.00	13.4	mg/l
Magnesium (Mg^{2+})	0.08	0.07	0.10	mg/l
ANIONS				
Chloride (Cl^-)	6.50	7.10	18.9	mg/l
Sulphate (SO_4^{2-})	1.70	0.79	1.20	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.42	0.87	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	02.05.2018 - 20.07.2018	Analysis start:	02.05.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**20-Q**	**23-Q**	**29-Q**	
Lab. no.	316516	316517	316518	
Sampling date	20.07.2018	20.07.2018	20.07.2018	
CATIONS				
Sodium (Na^+)	48.4	18.2	19.3	mg/l
Potassium (K^+)	19.8	5.10	6.30	mg/l
Calcium (Ca^{2+})	12.1	20.8	21.4	mg/l
Magnesium (Mg^{2+})	0.38	0.07	0.11	mg/l
ANIONS				
Chloride (Cl^-)	12.5	30.9	41.9	mg/l
Sulphate (SO_4^{2-})	4.60	3.40	2.60	mg/l
Nitrate (NO_3^-)	0.94	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.37	0.64	0.77	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-Q**	**25-Q**	**3-R**	
Lab. no.	316519	316926	316941	
Sampling date	20.07.2018	06.08.2018	07.08.2018	
CATIONS				
Sodium (Na^+)	8.60	16.6	12.3	mg/l
Potassium (K^+)	0.18	3.10	3.50	mg/l
Calcium (Ca^{2+})	3.90	11.4	12.4	mg/l
Magnesium (Mg^{2+})	0.04	0.05	0.22	mg/l
ANIONS				
Chloride (Cl^-)	0.05	13.5	2.30	mg/l
Sulphate (SO_4^{2-})	< 0.5	1.90	2.30	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	0.34	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**6-R**	**7-R**	**12-R**	
Lab. no.	316942	316943	316944	
Sampling date	07.08.2018	07.08.2018	07.08.2018	
CATIONS				
Sodium (Na^+)	12.3	9.40	10.8	mg/l
Potassium (K^+)	3.40	1.60	2.30	mg/l
Calcium (Ca^{2+})	10.4	13.1	8.30	mg/l
Magnesium (Mg^{2+})	0.20	0.07	0.09	mg/l
ANIONS				
Chloride (Cl^-)	3.30	6.30	6.50	mg/l
Sulphate (SO_4^{2-})	2.00	1.90	1.50	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**15-R**	**18-R**	**20-R**	
Lab. no.	316945	316946	316947	
Sampling date	07.08.2018	07.08.2018	07.08.2018	
CATIONS				
Sodium (Na^+)	12.0	12.2	11.8	mg/l
Potassium (K^+)	3.40	3.90	3.00	mg/l
Calcium (Ca^{2+})	7.30	13.3	10.8	mg/l
Magnesium (Mg^{2+})	0.17	0.09	0.12	mg/l
ANIONS				
Chloride (Cl^-)	7.10	18.9	12.5	mg/l
Sulphate (SO_4^{2-})	1.30	1.00	3.60	mg/l
Nitrate (NO_3^-)	1.90	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.42	0.87	0.37	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**23-R**	**25-R**	**29-R**	
Lab. no.	316948	316949	316950	
Sampling date	07.08.2018	07.08.2018	07.08.2018	
CATIONS				
Sodium (Na^+)	13.1	11.6	14.0	mg/l
Potassium (K^+)	5.00	3.10	6.30	mg/l
Calcium (Ca^{2+})	20.3	11.1	22.2	mg/l
Magnesium (Mg^{2+})	0.08	0.09	0.18	mg/l
ANIONS				
Chloride (Cl^-)	30.9	13.5	42.0	mg/l
Sulphate (SO_4^{2-})	3.20	2.10	2.40	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.64	0.34	0.77	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**IG-Blank-R**	**3-S**	**6-S**	
Lab. no.	316951	317490	317491	
Sampling date	07.08.2018	27.08.2018	27.08.2018	
CATIONS				
Sodium (Na^+)	5.20	11.7	9.30	mg/l
Potassium (K^+)	0.88	3.60	2.90	mg/l
Calcium (Ca^{2+})	4.90	15.0	12.8	mg/l
Magnesium (Mg^{2+})	0.21	0.13	0.18	mg/l
ANIONS				
Chloride (Cl^-)	0.10	2.30	3.30	mg/l
Sulphate (SO_4^{2-})	2.70	2.20	2.00	mg/l
Nitrate (NO_3^-)	0.71	0.27	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**7-S**	**12-S**	**15-S**	
Lab. no.	317492	317493	317494	
Sampling date	27.08.2018	27.08.2018	27.08.2018	
CATIONS				
Sodium (Na^+)	6.50	7.20	8.10	mg/l
Potassium (K^+)	2.00	2.40	2.70	mg/l
Calcium (Ca^{2+})	16.0	9.70	9.50	mg/l
Magnesium (Mg^{2+})	0.10	0.08	0.10	mg/l
ANIONS				
Chloride (Cl^-)	6.30	6.50	7.10	mg/l
Sulphate (SO_4^{2-})	1.50	1.40	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	< 0.1	< 0.1	0.42	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**18-S**	**20-S**	**23-S**	
Lab. no.	317495	317496	317497	
Sampling date	27.08.2018	27.08.2018	27.08.2018	
CATIONS				
Sodium (Na^+)	12.2	9.00	10.1	mg/l
Potassium (K^+)	4.10	3.00	5.10	mg/l
Calcium (Ca^{2+})	16.1	12.7	24.5	mg/l
Magnesium (Mg^{2+})	0.12	0.11	0.08	mg/l
ANIONS				
Chloride (Cl^-)	18.9	12.5	30.9	mg/l
Sulphate (SO_4^{2-})	0.93	3.00	2.70	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.87	0.35	0.64	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	Kreitmayr / HY
Lab. entry:	20.07.2018 - 27.08.2018	Analysis start:	20.07.2018
		Analysis finish:	07.03.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**25-S**	**29-S**	**IG-Blank-S**	
Lab. no.	317498	317499	317500	
Sampling date	27.08.2018	27.08.2018	27.08.2018	
CATIONS				
Sodium (Na^+)	8.10	11.2	3.20	mg/l
Potassium (K^+)	3.20	6.40	0.40	mg/l
Calcium (Ca^{2+})	13.2	25.6	3.70	mg/l
Magnesium (Mg^{2+})	0.08	0.15	0.51	mg/l
ANIONS				
Chloride (Cl^-)	13.5	42.1	0.09	mg/l
Sulphate (SO_4^{2-})	1.50	2.10	< 0.5	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	0.23	mg/l
TRACE COMPOUNDS				
Bromide (Br^-)	0.34	0.77	< 0.1	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter	**Result**			**Unit**
SAMPLE NAME	**Blank**	**PW003**	**PW006**	
Lab. no.	317595	317596	317597	
Sampling date	29.08.2018	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	10	107	95	µS/cm
pH value Lab.	4.8	7.6	7.7	
Temperature Lab.	24.0	23.9	24.0	°C
Alkalinity (pH 4,3) Lab.	0.02	0.86	0.76	mmol/l
CATIONS				
Sodium (Na^+)	0.14	9.30	9.40	mg/l
Potassium (K^+)	0.04	3.40	2.90	mg/l
Calcium (Ca^{2+})	0.11	10.5	8.40	mg/l
Magnesium (Mg^{2+})	0.02	0.16	0.09	mg/l
ANIONS				
Chloride (Cl^-)	0.10	2.40	3.40	mg/l
Sulphate (SO_4^{2-})	< 0.5	3.40	2.10	mg/l
Nitrate (NO_3^-)	< 0.2	0.27	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter		**Result**		**Unit**	
SAMPLE NAME	**Blank**	**PW003**	**PW006**		
Lab. no.	317595	317596	317597		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
TRACE COMPOUNDS					
Boron	0.014	0.053	0.093	mg/l	*
Bromide (Br^-)	< 0.02	0.04	0.05	mg/l	
Fluoride (F^-)	< 0.01	0.10	0.23	mg/l	
Silicon	< 0.1	4.70	4.20	mg/l	
Strontium (Sr^{2+})	< 0.01	0.05	0.07	mg/l	
METALS					
Aluminium	< 0.01	0.10	0.13	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	4.90	3.60	3.70	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	n.m.	0.732147 ± 0.00005	0.729832 ± 0.00005		*
Chlorine-37 (*37Cl)	-	0.22 ± 0.11	0.07 ± 0.35	‰	
REMARKS					
Remark	Chlorid concentration too low for analysis of Chlorine-37	-	-		

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**PW007**	**PW012**	**PW015**	
Lab. no.	317598	317599	317600	
Sampling date	29.08.2018	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	97	77	74	µS/cm
pH value Lab.	7.5	7.4	7.3	
Temperature Lab.	24.1	24.2	24.3	°C
Alkalinity (pH 4,3) Lab.	0.60	0.40	0.43	mmol/l
CATIONS				
Sodium (Na^+)	5.60	7.50	7.00	mg/l
Potassium (K^+)	1.90	2.40	2.70	mg/l
Calcium (Ca^{2+})	11.8	6.00	5.90	mg/l
Magnesium (Mg^{2+})	0.04	0.06	0.07	mg/l
ANIONS				
Chloride (Cl^-)	6.40	6.60	7.10	mg/l
Sulphate (SO_4^{2-})	1.90	2.00	0.84	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter		**Result**		**Unit**	
SAMPLE NAME	**PW007**	**PW012**	**PW015**		
Lab. no.	317598	317599	317600		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
TRACE COMPOUNDS					
Boron	0.039	0.057	0.033	mg/l	*
Bromide (Br^-)	0.14	0.15	0.42	mg/l	
Fluoride (F^-)	1.20	0.39	< 0.01	mg/l	
Silicon	5.20	4.80	5.30	mg/l	
Strontium (Sr^{2+})	0.07	0.05	0.05	mg/l	
METALS					
Aluminium	0.24	0.069	0.10	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	3.60	3.60	3.90	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.746162 ± 0.00005	0.738629 ± 0.00005	0.740456 ± 0.00005		*
Chlorine-37 (*37Cl)	0.82 ± 0.32	0.15 ± 0.36	0.39 ± 0.13	‰	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter		**Result**		**Unit**
SAMPLE NAME	**PW018**	**PW020**	**PW023**	
Lab. no.	317601	317602	317603	
Sampling date	29.08.2018	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	128	108	189	µS/cm
pH value Lab.	7.2	7.4	7.5	
Temperature Lab.	24.5	25.0	24.6	°C
Alkalinity (pH 4,3) Lab.	0.49	0.45	0.62	mmol/l
CATIONS				
Sodium (Na^+)	8.30	8.90	9.50	mg/l
Potassium (K^+)	4.20	3.10	5.30	mg/l
Calcium (Ca^{2+})	11.9	8.70	20.6	mg/l
Magnesium (Mg^{2+})	0.09	0.08	0.07	mg/l
ANIONS				
Chloride (Cl^-)	18.9	12.6	30.9	mg/l
Sulphate (SO_4^{2-})	1.20	3.70	3.10	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter	**Result**			**Unit**	
SAMPLE NAME	**PW018**	**PW020**	**PW023**		
Lab. no.	317601	317602	317603		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
TRACE COMPOUNDS					
Boron	0.025	0.068	0.044	mg/l	*
Bromide (Br^-)	0.89	0.34	0.63	mg/l	
Fluoride (F^-)	< 0.01	0.15	< 0.01	mg/l	
Silicon	5.80	5.50	5.50	mg/l	
Strontium (Sr^{2+})	0.11	0.10	0.18	mg/l	
METALS					
Aluminium	0.04	0.056	0.14	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	4.50	3.80	4.00	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.737503 ± 0.00005	0.723777 ± 0.00005	0.728989 ± 0.00005		*
Chlorine-37 (*37Cl)	0.46 ± 0.12	-0.09 ± 0.1	0.85 ± 0.24	‰	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter	**Result**		**Unit**
SAMPLE NAME	**PW025**	**PW029**	
Lab. no.	317604	317605	
Sampling date	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER			
Spec. electr. conductivity (25 °C) Lab.	107	217	µS/cm
pH value Lab.	7.5	7.3	
Temperature Lab.	24.6	24.8	°C
Alkalinity (pH 4,3) Lab.	0.42	0.43	mmol/l
CATIONS			
Sodium (Na^+)	8.40	11.2	mg/l
Potassium (K^+)	3.30	6.50	mg/l
Calcium (Ca^{2+})	9.20	21.1	mg/l
Magnesium (Mg^{2+})	0.08	0.14	mg/l
ANIONS			
Chloride (Cl^-)	13.6	42.3	mg/l
Sulphate (SO_4^{2-})	2.50	2.40	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	06.02.2019

Parameter	**Result**		**Unit**	
SAMPLE NAME	**PW025**	**PW029**		
Lab. no.	317604	317605		
Sampling date	29.08.2018	29.08.2018		
TRACE COMPOUNDS				
Boron	0.030	0.049	mg/l	*
Bromide (Br^-)	0.34	0.78	mg/l	
Fluoride (F^-)	< 0.01	< 0.01	mg/l	
Silicon	6.20	5.60	mg/l	
Strontium (Sr^{2+})	0.12	0.27	mg/l	
METALS				
Aluminium	0.110	0.046	mg/l	*
SUM AND SINGLE PARAMETER				
DOC	3.30	4.00	mg/l	
ISOTOPES				
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.72657 ± 0.00005	0.726485 ± 0.00005		*
Chlorine-37 (*37Cl)	-0.15 ± 0.05	-0.61 ± 0.14	‰	

Project: **Ignace Borehole 1, Porewater Out-Diff TS**
Customer: **Golder Associates Ltd.**

Parameter	Method	
pH value Lab.	DIN EN ISO 10523 (C5): 2012-04	
Temperature Lab.	DIN 38404-C4: 1976-12	
Spec. electr. conductivity (25 °C) Lab.	DIN EN 27888 (C8):1993-11	
Alkalinity (pH 4,3) Lab.	DIN 38409-H7:2005-12	
Sodium (Na^+)	DIN EN ISO 14911 (E34): 1999-12	
Potassium (K^+)	DIN EN ISO 14911 (E34): 1999-12	
Calcium (Ca^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Magnesium (Mg^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Chloride (Cl^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Sulphate (SO_4^{2-})	DIN EN ISO 10304-1 (D20): 2009-07	
Nitrate (NO_3^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Fluoride (F^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Bromide (Br^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Aluminium	DIN EN ISO 17294-2 (E29), ICP-MS	*
Boron	DIN EN ISO 17294-2 (E29), ICP-MS	*
DOC	DIN EN 1484 (H3): 1997-08	
Chlorine-37 (*37Cl)	QMA 504-2-30; GC-IRMS	
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	Thermal ionisation mass spectrometry (TIMS) after decomposition and element-matrix separation	*
Strontium (Sr^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Silicon	Merck Spectroquant 1.14794: 2016-07	

Legend

*	Analysis in cooperation with accredited resp. qualified extern labs
n.m.	not measured, concentration too small
<	not detectable
-	not ordered
x	qualified method with pending accreditation

Notes

The results relate only to the measured samples.
Each presentation of the results needs a written permission of Hydroisotop GmbH.
The terms and conditions of Hydroisotop GmbH are applied.

Dr. Eichinger
(Managing Director)
12.03.2019

Hydroisotop GmbH · Woelkestraße 9 · D-85301 Schweitenkirchen·

Golder Associates Ltd.
6925 Century Avenue, Suite 100

Mississauga, Ontario, Canada

Durch die DAkkS nach DIN EN ISO/IEC 17025
akkreditiertes Prüflaboratorium

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17315-01-00

Nach § 15 Abs. 4 TrinkwV 2001 zugelassene
Trinkwasseruntersuchungsstelle

Schweitenkirchen, 01.03.2019
Dr. FE / CG

Report No. 310716 - 312060

page 1 of 3

Project:	**Ignace Borehole 1, Iso Ex**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	26.02.2018 - 03.04.2018	Analysis start:	26.02.2018
		Analysis finish:	07.05.2018

Lab. no.	**Sample name**	**Oxygen-18 ($\delta^{18}O$) ‰**	**Deuterium ($\delta^{2}H$) ‰**	**Deuterium-excess ‰**
310716A	IG_BH01_TW LAB_A	-9.61	-67.5	9.66
310716B	IG_BH01_TW LAB_B	-9.62	-67.5	9.66
310717A	IG_BH01_TW SSI_A	-30.04	-237.1	3.22
310717B	IG_BH01_TW SSI_B	-30.17	-233.5	3.40
310718	IG_BH01_PW03 LAB	-9.92	-71.5	8.18
310719	IG_BH01_PW03 SSI	-25.16	-198.6	2.90
310720	IG_BH01_PW06 LAB	-9.95	-71.0	8.92
310721	IG_BH01_PW06 SSI	-24.61	-193.3	3.80
310722	IG_BH01_PW07 LAB	-9.34	-68.0	7.10
310723	IG_BH01_PW07 SSI	-25.25	-198.8	3.46
310724	IG_BH01_PW12 LAB	-9.38	-68.0	7.94
310725	IG_BH01_PW12 SSI	-25.55	-201.5	2.96

Project:	**Ignace Borehole 1, Iso Ex**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	26.02.2018 - 03.04.2018	Analysis start:	26.02.2018
		Analysis finish:	07.05.2018

Lab. no.	Sample name	Sampling date	Oxygen-18 ($\delta^{18}O$) ‰	Deuterium ($\delta^{2}H$) ‰	Deuterium-excess ‰
311177	IG_BH01_PW015 LAB	13.03.2018	-9.17	-66.5	7.26
311178	IG_BH01_PW015 SSI	13.03.2018	-25.43	-201.5	2.42
311179	IG_BH01_PW018 LAB	13.03.2018	-9.09	-65.7	7.42
311180	IG_BH01_PW018 SSI	13.03.2018	-25.96	-204.7	3.22
311181	IG_BH01_PW020 LAB	13.03.2018	-9.49	-67.9	8.40
311182	IG_BH01_PW020 SSI	13.03.2018	-25.64	-202.1	3.60
312055	IG_BH01_PW023 LAB	03.04.2018	-9.26	-67.2	6.70
312056	IG_BH01_PW023 SSI	03.04.2018	-25.67	-201.8	3.86
312057	IG_BH01_PW025 LAB	03.04.2018	-9.28	-66.6	7.82
312058	IG_BH01_PW025 SSI	03.04.2018	-26.62	-208.4	4.86
312059	IG_BH01_PW029 LAB	03.04.2018	-9.28	-65.7	9.00
312060	IG_BH01_PW029 SSI	03.04.2018	-25.78	-201.9	4.88

Project: **Ignace Borehole 1, Iso Ex**
Customer: **Golder Associates Ltd.**

Parameter	Method
Deuterium-excess	calculated
Deuterium (δ^2H) (s)	QMA 504-2/23: 2012-02; Cavity-Ringdown-Spectrometry (CRDS); related to standard VSMOW: 1σ= ± 1,5 ‰
Oxygen-18 ($\delta^{18}O$) (s)	QMA 504-2/23: 2012-02; Cavity-Ringdown-Spectrometry (CRDS); related to standard VSMOW: 1σ= ± 0,15 ‰

Legend

*	Analysis in cooperation with accredited resp. qualified extern labs
n.m.	not measured, concentration too small
<	not detectable
-	not ordered
x	qualified method with pending accreditation

Notes

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Dr. Eichinger
(Managing Director)
01.03.2019

Hydroisotop GmbH · Woelkestraße 9 · D-85301 Schweitenkirchen·

Golder Associates Ltd.
6925 Century Avenure, Suite 100

Mississauga, Ontario, Canada

Durch die DAkkS nach DIN EN ISO/IEC 17025
akkreditiertes Prüflaboratorium

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17315-01-00

Nach § 15 Abs. 4 TrinkwV 2001 zugelassene
Trinkwasseruntersuchungsstelle

Schweitenkirchen, 11.03.2019
FE / CG

Report No. 317596 - 317605

Project: **Ignace Borehole 1, Porewater Out-Diff TS**
Customer: **Golder Associates Ltd.**
Sample: Liquid sample
Sampling: FE / HY
Lab. entry: 29.08.2018
Analysis start: 29.08.2018
Analysis finish: 02.11.2018

Parameter		**Result**		**Unit**
SAMPLE NAME	**PW003**	**PW006**	**PW007**	
Lab. no.	317596	317597	317598	
Sampling date	29.08.2018	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	107	95	97	µS/cm
pH value Lab.	7.6	7.7	7.5	
Temperature Lab.	23.9	24.0	24.1	°C
Alkalinity (pH 4,3) Lab.	0.86	0.76	0.60	mmol/l
CATIONS				
Sodium (Na^+)	9.30	9.40	5.60	mg/l
Potassium (K^+)	3.40	2.90	1.90	mg/l
Calcium (Ca^{2+})	10.5	8.40	11.8	mg/l
Magnesium (Mg^{2+})	0.16	0.09	0.04	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter		**Result**		**Unit**	
SAMPLE NAME	**PW003**	**PW006**	**PW007**		
Lab. no.	317596	317597	317598		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
ANIONS					
Chloride (Cl^-)	2.40	3.40	6.40	mg/l	
Sulphate (SO_4^{2-})	3.40	2.10	1.90	mg/l	
Nitrate (NO_3^-)	0.27	< 0.2	< 0.2	mg/l	
TRACE COMPOUNDS					
Boron	0.053	0.093	0.039	mg/l	*
Bromide (Br^-)	0.04	0.05	0.14	mg/l	
Fluoride (F^-)	0.10	0.23	1.20	mg/l	
Silicon	4.70	4.20	5.20	mg/l	
Strontium (Sr^{2+})	0.05	0.07	0.07	mg/l	
METALS					
Aluminium	0.10	0.13	0.24	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	3.60	3.70	3.60	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.732147 ± 0.00005	0.729832 ± 0.00005	0.746162 ± 0.00005		*
Chlorine-37 (*37Cl)	0.22 ± 0.11	0.07 ± 0.35	0.82 ± 0.32	‰	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter		**Result**		**Unit**	
SAMPLE NAME	**PW012**	**PW015**	**PW018**		
Lab. no.	317599	317600	317601		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
PHYSICAL-CHEMICAL PARAMETER					
Spec. electr. conductivity (25 °C) Lab.	77	74	128	µS/cm	
pH value Lab.	7.4	7.3	7.2		
Temperature Lab.	24.2	24.3	24.5	°C	
Alkalinity (pH 4,3) Lab.	0.40	0.43	0.49	mmol/l	
CATIONS					
Sodium (Na^{+})	7.50	7.00	8.30	mg/l	
Potassium (K^{+})	2.40	2.70	4.20	mg/l	
Calcium (Ca^{2+})	6.00	5.90	11.9	mg/l	
Magnesium (Mg^{2+})	0.06	0.07	0.09	mg/l	
ANIONS					
Chloride (Cl^{-})	6.60	7.10	18.9	mg/l	
Sulphate (SO_4^{2-})	2.00	0.84	1.20	mg/l	
Nitrate (NO_3^{-})	< 0.2	< 0.2	< 0.2	mg/l	
TRACE COMPOUNDS					
Boron	0.057	0.033	0.025	mg/l	*
Bromide (Br^{-})	0.15	0.42	0.89	mg/l	
Fluoride (F^{-})	0.39	< 0.01	< 0.01	mg/l	
Silicon	4.80	5.30	5.80	mg/l	
Strontium (Sr^{2+})	0.05	0.05	0.11	mg/l	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter		**Result**		**Unit**	
SAMPLE NAME	**PW012**	**PW015**	**PW018**		
Lab. no.	317599	317600	317601		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
METALS					
Aluminium	0.069	0.100	0.040	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	3.60	3.90	4.50	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.738629 ± 0.00005	0.740456 ± 0.00005	0.737503 ± 0.00005		*
Chlorine-37 (*37Cl)	0.15 ± 0.36	0.39 ± 0.13	0.46 ± 0.12	‰	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter		**Result**		**Unit**
SAMPLE NAME	**PW020**	**PW023**	**PW025**	
Lab. no.	317602	317603	317604	
Sampling date	29.08.2018	29.08.2018	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER				
Spec. electr. conductivity (25 °C) Lab.	108	189	107	µS/cm
pH value Lab.	7.4	7.5	7.5	
Temperature Lab.	25.0	24.6	24.6	°C
Alkalinity (pH 4,3) Lab.	0.45	0.62	0.42	mmol/l
CATIONS				
Sodium (Na^+)	8.90	9.50	8.40	mg/l
Potassium (K^+)	3.10	5.30	3.30	mg/l
Calcium (Ca^{2+})	8.70	20.6	9.20	mg/l
Magnesium (Mg^{2+})	0.08	0.07	0.08	mg/l
ANIONS				
Chloride (Cl^-)	12.6	30.9	13.6	mg/l
Sulphate (SO_4^{2-})	3.70	3.10	2.50	mg/l
Nitrate (NO_3^-)	< 0.2	< 0.2	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter		**Result**		**Unit**	
SAMPLE NAME	**PW020**	**PW023**	**PW025**		
Lab. no.	317602	317603	317604		
Sampling date	29.08.2018	29.08.2018	29.08.2018		
TRACE COMPOUNDS					
Boron	0.068	0.044	0.030	mg/l	*
Bromide (Br^-)	0.34	0.63	0.34	mg/l	
Fluoride (F^-)	0.15	< 0.01	< 0.01	mg/l	
Silicon	5.50	5.50	6.20	mg/l	
Strontium (Sr^{2+})	0.10	0.18	0.12	mg/l	
METALS					
Aluminium	0.056	0.140	0.110	mg/l	*
SUM AND SINGLE PARAMETER					
DOC	3.80	4.00	3.30	mg/l	
ISOTOPES					
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.723777 ± 0.00005	0.728989 ± 0.00005	0.72657 ± 0.00005		*
Chlorine-37 (*37Cl)	-0.09 ± 0.1	0.85 ± 0.24	-0.15 ± 0.05	‰	

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter	**Result**	**Unit**
SAMPLE NAME	**PW029**	
Lab. no.	317605	
Sampling date	29.08.2018	
PHYSICAL-CHEMICAL PARAMETER		
Spec. electr. conductivity (25 °C) Lab.	217	µS/cm
pH value Lab.	7.3	
Temperature Lab.	24.8	°C
Alkalinity (pH 4,3) Lab.	0.43	mmol/l
CATIONS		
Sodium (Na^+)	11.2	mg/l
Potassium (K^+)	6.50	mg/l
Calcium (Ca^{2+})	21.1	mg/l
Magnesium (Mg^{2+})	0.14	mg/l
ANIONS		
Chloride (Cl^-)	42.3	mg/l
Sulphate (SO_4^{2-})	2.40	mg/l
Nitrate (NO_3^-)	< 0.2	mg/l

Project:	**Ignace Borehole 1, Porewater Out-Diff TS**		
Customer:	**Golder Associates Ltd.**		
Sample:	Liquid sample	Sampling:	FE / HY
Lab. entry:	29.08.2018	Analysis start:	29.08.2018
		Analysis finish:	02.11.2018

Parameter	**Result**	**Unit**	
SAMPLE NAME	**PW029**		
Lab. no.	317605		
Sampling date	29.08.2018		
TRACE COMPOUNDS			
Boron	0.049	mg/l	*
Bromide (Br^-)	0.78	mg/l	
Fluoride (F^-)	< 0.01	mg/l	
Silicon	5.60	mg/l	
Strontium (Sr^{2+})	0.27	mg/l	
METALS			
Aluminium	0.046	mg/l	*
SUM AND SINGLE PARAMETER			
DOC	4.00	mg/l	
ISOTOPES			
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	0.726485 ± 0.00005		*
Chlorine-37 (*37Cl)	-0.61 ± 0.14	‰	

Project: **Ignace Borehole 1, Porewater Out-Diff TS**
Customer: **Golder Associates Ltd.**

Parameter	Method	
pH value Lab.	DIN EN ISO 10523 (C5): 2012-04	
Temperature Lab.	DIN 38404-C4: 1976-12	
Spec. electr. conductivity (25 °C) Lab.	DIN EN 27888 (C8):1993-11	
Alkalinity (pH 4,3) Lab.	DIN 38409-H7:2005-12	
Sodium (Na^+)	DIN EN ISO 14911 (E34): 1999-12	
Potassium (K^+)	DIN EN ISO 14911 (E34): 1999-12	
Calcium (Ca^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Magnesium (Mg^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Chloride (Cl^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Sulphate (SO_4^{2-})	DIN EN ISO 10304-1 (D20): 2009-07	
Nitrate (NO_3^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Fluoride (F^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Bromide (Br^-)	DIN EN ISO 10304-1 (D20): 2009-07	
Aluminium	DIN EN ISO 17294-2 (E29), ICP-MS	*
Boron	DIN EN ISO 17294-2 (E29), ICP-MS	*
DOC	DIN EN 1484 (H3): 1997-08	
Chlorine-37 (*37Cl)	QMA 504-2-30; GC-IRMS	
Strontium isotope ratio ($^{87}Sr/^{86}Sr$)	Thermal ionisation mass spectrometry (TIMS) after decomposition and element-matrix separation	*
Strontium (Sr^{2+})	DIN EN ISO 14911 (E34): 1999-12	
Silicon	Merck Spectroquant 1.14794: 2016-07	

Legend

*	Analysis in cooperation with accredited resp. qualified extern labs
n.m.	not measured, concentration too small
<	not detectable
-	not ordered
x	qualified method with pending accreditation

Notes

The results relate only to the measured samples.
Each presentation of the results needs a written permission of Hydroisotop GmbH.
The terms and conditions of Hydroisotop GmbH are applied.

Dr. Eichinger
(Managing Director)
11.03.2019

APPENDIX II-1

Calculation of Water Content Values: Raw Data

Table A-1: Determination of gravimetric water content; sample weights, drying times and calculated water contents of core pieces used for aqueous extraction experiments

Sample	Date prepared	m (cryst.dish)	m (cryst+ rock)		18.12.2017	01.02.2018	16.02.2018	01.03.2018					Sample	m(rock, wet)	m (rock, dry)
Drying times	days				5	50	65	78						g	g
PW002-AqE	13.12.2017	87,187	286,29		285,906	285,902	285,904						PW002-AqE	199,103	198,715
PW005-AqE	13.12.2017	86,928	285,996		285,654	285,652	285,653						PW005-AqE	199,068	198,724
PW009-AqE	13.12.2017	88,912	312,836		312,48	312,472	312,479						PW009-AqE	223,924	223,56
PW010-AqE	13.12.2017	92,887	322,464		322,146	322,142	322,151						PW010-AqE	229,577	229,255
PW013-AqE	22.12.2017	86,341	359,187			358,872	358,871						PW013-AqE	272,846	272,53
PW016-AqE	22.12.2017	86,251	359,359			359,038	359,031	359,033					PW016-AqE	273,108	272,78
PW019-AqE	22.12.2017	85,349	342,092			341,693	341,694						PW019-AqE	256,743	256,344
PW024-AqE	29.01.2018	87,59	416,579			416,077	416,035	416,038					PW024-AqE	328,989	328,445
PW027-AqE	29.01.2018	86,993	372,157			371,903	371,871	371,869					PW027-AqE	285,164	284,876
PW030-AqE	29.01.2018	83,833	343,687			343,361	343,309	343,309					PW030-AqE	259,854	259,476
		m (wet surf)	**m(dry surf)**		**18.12.2017**	**01.02.2018**	**16.02.2018**	**28.02.2018**	**14.03.2018**	**28.03.2018**	**09.04.2018**	**25.04.2018**			
Drying times	days				5	50	65	77	91	105	117	133			
PW002-AqE A	13.12.2017	145,973	145,933		145,623	145,608	145,603	145,602					PW002-AqE A	145,933	145,602
PW002-AqE B	13.12.2017	162,147	162,127		161,798	161,782	161,779	161,776	161,777				PW002-AqE B	162,127	161,776
PW005-AqE A	13.12.2017	101,805	101,793		101,601	101,594	101,593	101,593					PW005-AqE A	101,793	101,593
PW005-AqE B	13.12.2017	111,313	111,307		111,104	111,099	111,095	111,095					PW005-AqE B	111,307	111,095
PW005-AqE Extra	13.12.2017	316,733	316,724		316,139	316,106	316,099	316,094	316,095				PW005-AqE Ext	316,724	316,094
PW009-AqE A	13.12.2017	101,454	101,401		101,188	101,175	101,172	101,170					PW009-AqE A	101,401	101,17
PW009-AqE B	13.12.2017	99,315	99,294		99,112	99,100	99,098	99,096					PW009-AqE B	99,294	99,096
PW010-AqE A	13.12.2017	92,892	92,836		92,684	92,676	92,674	92,673					PW010-AqE A	92,836	92,673
PW010-AqE B	13.12.2017	123,154	123,136		122,941	122,932	122,929	122,928					PW010-AqE B	123,136	122,928
PW013-AqE A	22.12.2017	89,141	89,111			88,995	88,993	88,990	88,990				PW013-AqE A	89,111	88,99
PW013-AqE B	22.12.2017	125,8	125,783			125,607	125,602	125,600					PW013-AqE B	125,783	125,6
PW016-AqE A	22.12.2017	124,864	124,839			124,658	124,657	124,649	124,648				PW016-AqE A	124,839	124,648
PW016-AqE B	22.12.2017	105,644	105,604			105,439	105,435	105,432	105,429	105,428			PW016-AqE B	105,604	105,428
PW019-AqE A	22.12.2017	138,194	138,173			137,963	137,960	137,957	137,955				PW019-AqE A	138,173	137,955
PW019-AqE B	22.12.2017	133,838	133,805			133,574	133,569	133,562	133,562				PW019-AqE B	133,805	133,562
PW024-AqE A	29.01.2018	102,107	102,1			101,991	101,987	101,982	101,981				PW024-AqE A	102,100	101,981
PW024-AqE B	29.01.2018	130,692	130,666			130,463	130,451	130,449					PW024-AqE B	130,666	130,449
PW027-AqE A	29.01.2018	90,247	90,234			90,124	90,109	90,102	90,101				PW027-AqE A	90,234	90,101
PW027-AqE B	29.01.2018	131,558	131,542			131,402	131,388	131,384	131,381	131,376	131,351	131,350	PW027-AqE B	131,542	131,35
PW030-AqE A	29.01.2018	117,086	117,075			116,902	116,886	116,884					PW030-AqE A	117,075	116,884
PW030-AqE B	29.01.2018	158,174	158,135			157,880	157,861	157,850	157,850				PW030-AqE B	158,135	157,85

Table A-2: Determination of gravimetric water content; sample weights, drying times and calculated water contents of rim core pieces of samples used for out-diffusion and isotope diffusive exchange experiments

Sample										
	Set-up date	m (wet surf)	m(dry surf)	02.02.2018	16.02.2018	01.03.2018	14.03.2018	28.03.2018	09.04.2018	25.04.2018
Drying time (days)				51	65	78	91	105	117	133
PW003 A	13.12.2017	361,94	361,916	361,036	361,021	361,021				
PW003 B	13.12.2017	182,554	182,53	182,153	182,150	182,150				
PW006 A	13.12.2017	329,676	329,647	328,976	328,970	328,968				
PW006 B	13.12.2017	270,208	270,202	269,674	269,669	269,668				
PW007 A	13.12.2017	280,666	280,605	280,072	280,065	280,053	280,049	280,048		
PW007 B	13.12.2017	204,239	204,216	203,860	203,854	203,853				
PW012 A	13.12.2017	294,091	294,036	293,528	293,520	293,516	293,511	293,505	293,452	293,450
PW012 B	13.12.2017	139,809	139,78	139,537	139,530	139,529				
PW015 A	13.12.2017	258,712	258,66	258,247	258,241	258,231	258,231			
PW015 B	22.12.2017	205,712	205,678	205,379	205,368	205,366				
PW018 A	22.12.2017	406,64	406,525	405,881	405,867	405,860	405,858			
PW018 B	22.12.2017	188,592	188,54	188,268	188,263	188,262				
PW020 A	22.12.2017	290,516	290,478	290,003	289,998	289,999				
PW020 B	22.12.2017	243,423	243,386	243,005	242,980	242,976	242,974			
PW023 A	29.01.2018		149,22	148,967	148,951	148,945	148,937	148,934	148,903	148,902
PW023 B	29.01.2018		166,314	166,039	166,017	166,009	166,005			
PW023 C	29.01.2018		663,473	662,446	662,399	662,389	662,386	662,380	662,254	662,253
PW025 A	29.01.2018		316,672	316,317	316,257	316,246	316,246			
PW025 B	29.01.2018		280,752	280,461	280,401	280,393	280,391			
PW029 A	29.01.2018		220,13	219,799	219,760	219,754	219,752			
PW029B	29.01.2018		313,311	312,873	312,818	312,808	312,808			

Sample		
	m wet	m dry
	g	g
PW003 A	361,916	361,021
PW003 B	182,530	182,15
PW006 A	329,647	328,968
PW006 B	270,202	269,668
PW007 A	280,605	280,048
PW007 B	204,216	203,853
PW012 A	294,036	293,45
PW012 B	139,780	139,529
PW015 A	258,660	258,231
PW015 B	205,678	205,366
PW018 A	406,525	405,858
PW018 B	188,540	188,262
PW020 A	290,478	289,998
PW020 B	243,386	242,974
PW023 A	149,220	148,902
PW023 B	166,314	166,005
PW023 C	663,473	662,253
PW025 A	316,672	316,246
PW025 B	280,752	280,391
PW029 A	220,130	219,752
PW029B	313,311	312,808

Table A-3: Determination of gravimetric water content; sample weights, drying times and calculated water contents of core pieces used for isotope diffusive exchange experiments

Sample	Date start drying	Drying times (days)	m (cryst.dish)	m (cryst+ rock)	02.03.2018	15.03.2018	28.03.2018	09.04.2018	25.04.2018	08.05.2018	24.05.2018	04.06.2018	18.06.2018	02.07.2018		Mass dry	m rock wet	m rock dry
PW03-LAB	26.02.2018	58	91,123	456,407	455,838	455,808	455,795	455,733	455,731							455,731	365,284	364,608
PW03-SSI	26.02.2018	30	86,222	447,485	446,878	446,868	446,868									446,868	361,263	360,646
PW06-LAB	26.02.2018	58	94,258	423,51	422,958	422,947	422,938	422,869	422,870							422,869	329,252	328,611
PW06-SSI	26.02.2018	30	86,027	416,58	415,962	415,947	415,947									415,947	330,553	329,920
PW07-LAB	26.02.2018	58	88,434	415,178	414,732	414,709	414,688	414,629	414,629							414,629	326,744	326,195
PW07-SSI	26.02.2018	71	97,33	417,258	416,750	416,727	416,704	416,652	416,620	416,619						416,619	319,928	319,289
PW12-LAB	26.02.2018	58	93,394	377,192	376,835	376,808	376,783	376,735	376,733							376,733	283,798	283,339
PW12-SSI	26.02.2018	58	88,238	376,597	376,146	376,131	376,136	376,056	376,055							376,055	288,359	287,817
PW15-LAB	13.03.2018	43	85,726	434,021		433,667	433,64	433,565	433,563							433,563	348,295	347,837
PW15-SSI	13.03.2018	43	92,964	441,974		441,491	441,474	441,390	441,390							441,390	349,01	348,426
PW18-LAB	13.03.2018	43	93,451	416,386		416,008	415,991	415,914	415,914							415,914	322,935	322,463
PW18-SSI	13.03.2018	43	88,612	411,064		410,537	410,519	410,440	410,441							410,440	322,452	321,828
PW20-LAB	13.03.2018	43	88,293	396,899		396,495	396,425	396,380	396,378							396,378	308,606	308,085
PW20-SSI	13.03.2018	43	92,284	400,991		400,486	400,481	400,409	400,410							400,409	308,707	308,125
PW23-LAB	03.04.2018	62	83,83	382,962				382,510	382,500	382,617	382,622	382,621				382,500	299,132	298,670
PW23-SSI	03.04.2018	62	92,873	389,858				389,333	389,324	389,446	389,439	389,437				389,324	296,985	296,451
PW25-LAB	03.04.2018	62	87,588	417,154				416,768	416,756	416,873	416,877	416,879				416,756	329,566	329,168
PW25-SSI	03.04.2018	51	86,236	415,491				415,052	415,019	415,153	415,152					415,019	329,255	328,783
PW29-LAB	03.04.2018	90	87,172	419,766				419,197	419,186	419,308	419,313	419,308	419,302	419,303		419,303	332,594	332,131
PW29-SSI	03.04.2018	51	85,336	418,283				417,578	417,561	417,688	417,688					417,688	332,947	332,352

Table A-4: Determination of gravimetric water content; sample weights, drying times and calculated water contents of core pieces used for out-diffusion experiments

Sample	Date start drying	m dry surface, at receipt	m dry surface, before experiment (b.e.)	m wet surf, after experiment	m dry surf, after experiment (a.e.)	12.09.2018	25.09.2018	09.10.2018	23.10.2018	06.11.2018	m (dry)	m(PW), (b.e.)	m(PW), (a.e.)
		g	g	g	g	g	g	g	g		g	g	g
Drying time (days)						**14**	**27**	**41**	**55**	**69**			
IG_BH01_PW003	29.08.2018	1289,140	1288,94	1289,285	1289,1	1286,452	1286,407	1286,397	1286,391	1286,390	1286,390	2,750	2,710
IG_BH01_PW006	29.08.2018	1209,408	1209,334	1209,62	1209,554	1207,248	1207,215	1207,201	1207,195	1207,201	1207,195	2,213	2,359
IG_BH01_PW007	29.08.2018	1244,479	1244,212	1244,785	1244,545	1242,258	1242,209	1242,196	1242,184	1242,186	1242,184	2,295	2,361
IG_BH01_PW012	29.08.2018	1253,103	1252,91	1253,388	1253,105	1251,137	1251,092	1251,08	1251,071	1251,073	1251,071	2,032	2,034
IG_BH01_PW015	29.08.2018	1225,818	1225,721	1226,098	1225,854	1224,279	1224,221	1224,231	1224,218	1224,217	1224,217	1,601	1,637
IG_BH01_PW018	29.08.2018	1280,967	1280,81	1281,238	1280,981	1279,214	1279,15	1279,149	1279,14	1279,145	1279,140	1,827	1,841
IG_BH01_PW020	29.08.2018	1234,663	1234,512	1234,886	1234,779	1232,831	1232,788	1232,782	1232,779	1232,779	1232,779	1,884	2,000
IG_BH01_PW023	29.08.2018	1418,334	1418,12	1418,644	1418,3	1416,174	1416,132	1416,109	1416,106	1416,107	1416,106	2,228	2,194
IG_BH01_PW025	29.08.2018	1297,555	1297,49	1297,837	1297,674	1296,299	1296,242	1296,212	1296,205	1296,200	1296,200	1,355	1,474
IG_BH01_PW029	29.08.2018	1302,956	1302,836	1303,3	1303,114	1301,048	1300,996	1300,977	1300,972	1300,972	1300,972	1,984	2,142

APPENDIX II-2

Determination of Bulk Wet and Dry Density: Raw Data

Table A-5: Determination of bulk wet and dry density; sample dimensions, weights and density results

Sample	m (core) wet surface	m (core) dry surface	diameter core	height core	Volume core	bulk, wet density	bulk, dry density
	g	g	cm	cm	cm^3	g/cm^3	g/cm^3
IG_BH01_PW002	342.104	342.074	6.09	4.42	128.75	2.66	2.66
IG_BH01_PW005	237.015	236.994	6.09	3.16	92.05	2.57	2.57
IG_BH01_PW009	266.209	266.166	6.09	3.51	102.24	2.60	2.60
IG_BH01_PW010	247.206	247.183	6.07	3.27	94.63	2.61	2.61
IG_BH01_PW013	319.864	319.823	6.09	4.17	121.47	2.63	2.63
IG_BH01_PW016	305.946	305.923	6.12	3.99	117.37	2.61	2.61
IG_BH01_PW019	233.782	233.763	6.11	2.99	87.67	2.67	2.67
IG_BH01_PW024	366.035	365.987	6.10	4.66	136.19	2.69	2.69
IG_BH01_PW027	306.908	306.882	6.15	4.00	118.82	2.58	2.58
IG_BH01_PW030	348.503	348.471	6.10	4.47	130.63	2.67	2.67

Sample	m (core a.e.) wet surface	m (core a.e.) dry surface	diameter core	height core	Volume core	bulk, wet density	bulk, dry density
	g	g	cm	cm	cm^3	g/cm^3	g/cm^3
IG_BH01_PW003	1289.285	1288.978	6.08	16.6	481.95	2.67	2.67
IG_BH01_PW006	1209.62	1209.554	6.09	15.6	454.41	2.66	2.66
IG_BH01_PW007	1244.785	1244.545	6.08	16.3	473.24	2.63	2.63
IG_BH01_PW012	1253.388	1253.105	6.08	16.3	473.24	2.65	2.65
IG_BH01_PW015	1226.098	1225.854	6.08	15.9	461.63	2.66	2.66
IG_BH01_PW018	1281.238	1280.981	6.11	16.3	477.93	2.68	2.68
IG_BH01_PW020	1234.886	1234.779	6.11	15.7	460.33	2.68	2.68
IG_BH01_PW023	1418.644	1418.3	6.11	18.1	530.70	2.67	2.67
IG_BH01_PW025	1297.837	1297.674	6.12	16.40	482.43	2.69	2.69
IG_BH01_PW029	1303.3	1303.114	6.10	16.7	488.05	2.67	2.67

APPENDIX II-3

Aqueous Extraction Experiments: Raw Data

Table A-6: Experimental data of aqueous extraction experiments

Sample	Depth	m (bottle)	m (bottle + rock)	m (rock)	m (H_2O)	m (tot)	water:rock
	m a.b.	g	g	g	g	g	
IG-BH01-PW002	222.2	91.171	452.090	360.919	591.945	1044.05	1.64
IG-BH01-PW005	321.6	86.359	316.337	229.978	463.642	779.971	2.02
IG-BH01-PW009	421.2	88.714	419.739	331.025	463.333	883.062	1.40
IG-BH01-PW010	456.1	86.662	347.677	261.015	464.401	812.078	1.78
IG-BH01-PW013	531.7	85.537	455.343	369.806	259.676	715.106	0.70
IG-BH01-PW016	582.4	91.406	416.065	324.659	165.434	581.502	0.51
IG-BH01-PW019	632.5	46.356	241.093	194.737	178.603	419.688	0.92
IG-BH01-PW024	721.3	77.43	460.019	382.589	389.374	849.371	1.02
IG-BH01-PW027	821.0	79.628	348.103	268.475	312.849	660.929	1.17
IG-BH01-PW030	921.1	79.152	512.288	433.136	354.134	866.416	0.82

APPENDIX II-4

Isotope Diffusive Exchange Experiments: Raw Data

Table A-7: Experimental data of isotope diffusive exchange experiments

Sample	Test water (TW)	Date Experiment Start	Date Experiment End	Standard	Weight container	Weight container and rock	Cryst. dish	Cryst Dish + H2O	Total weight container	Weight rock	Weight test solution	Total weight container after experiment	Weight test solution after experiment	Weight container and rock after experiment	Weight test solution after experiment	Weight rock after experiment	mass (PW)	mass TW+PW after exp.	Δ total weight before & after	Δ weight rock before & after	Δ weight test solution before & after	Δ weight rock and test solution	Δ weight rock and test solution - Δ total weight before and after	Δ weight rock and test solution	Δ water loss (total weight)	remaining water fraction
					g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	% of TW	% of TW+PW	
PW003	LAB	14.12.2017	26.02.2018	IG01-LAB	520.666	886.399	14.818	16.630	903.000	365.733	1.812	903.007	16.641	886.354	1.823	365.688	0.676	2.499	0.007	-0.045	0.011	-0.034	-0.041	1.9	-0.3	1.00
PW006	LAB	14.12.2017	26.02.2018		521.232	852.591	14.912	16.723	869.289	331.359	1.811	869.288	16.667	852.602	1.755	331.370	0.641	2.396	-0.001	0.011	-0.056	-0.045	-0.044	2.5	0.0	1.00
PW007	LAB	14.12.2017	26.02.2018	0.3 n NaCl	523.811	853.458	14.690	16.521	869.956	329.647	1.831	869.956	16.578	853.362	1.888	329.551	0.549	2.437	0.000	-0.096	0.057	-0.039	-0.039	2.1	0.0	1.00
PW012	LAB	14.12.2017	26.02.2018		525.363	809.596	14.802	16.633	826.213	284.233	1.831	826.200	16.629	809.553	1.827	284.190	0.459	2.286	-0.013	-0.043	-0.004	-0.047	-0.034	2.6	0.6	0.99
PW015	LAB	22.12.2017	13.03.2018		523.333	872.289	14.788	16.620	888.890	348.956	1.832	888.908	16.602	872.282	1.814	348.949	0.458	2.272	0.018	-0.007	-0.018	-0.025	-0.043	1.4	-0.8	1.01
PW018	LAB	22.12.2017	13.03.2018		522.673	845.960	15.731	17.556	863.494	323.287	1.825	863.510	17.502	845.985	1.771	323.312	0.472	2.243	0.016	0.025	-0.054	-0.029	-0.045	1.6	-0.7	1.01
PW020	LAB	22.12.2017	13.03.2018		523.414	832.238	14.291	16.122	848.349	308.824	1.831	848.356	16.034	832.300	1.743	308.886	0.521	2.264	0.007	0.062	-0.088	-0.026	-0.033	1.4	-0.3	1.00
PW023	LAB	29.01.2018	03.04.2018		525.120	824.636	15.001	16.811	841.437	299.516	1.810	841.408	16.770	824.606	1.769	299.486	0.462	2.231	-0.029	-0.030	-0.041	-0.071	-0.042	3.9	1.3	0.99
PW025	LAB	29.01.2018	03.04.2018		523.202	852.945	15.002	16.816	869.751	329.743	1.814	869.696	16.736	852.955	1.734	329.753	0.398	2.132	-0.055	0.010	-0.080	-0.070	-0.015	3.9	2.6	0.97
PW029	LAB	29.01.2018	03.04.2018		524.808	857.498	15.024	16.833	874.289	332.690	1.809	874.154	16.643	857.494	1.619	332.686	0.463	2.082	-0.135	-0.004	-0.190	-0.194	-0.059	10.7	6.5	0.94
PW003	SSI	14.12.2017	26.02.2018	IG01-SSI	523.985	885.962	14.273	16.078	901.995	361.977	1.805	901.997	15.975	885.993	1.702	362.008	0.617	2.319	0.002	0.031	-0.103	-0.072	-0.074	4.0	-0.1	1.00
PW006	SSI	14.12.2017	26.02.2018		523.736	855.046	14.651	16.463	871.386	331.310	1.812	871.370	16.330	855.039	1.679	331.303	0.633	2.312	-0.016	-0.007	-0.133	-0.140	-0.124	7.7	0.7	0.99
PW007	SSI	14.12.2017	26.02.2018	0.3 n NaCl	523.327	849.028	14.741	16.553	865.550	325.701	1.812	865.537	16.452	849.075	1.711	325.748	0.639	2.350	-0.013	0.047	-0.101	-0.054	-0.041	3.0	0.6	0.99
PW012	SSI	14.12.2017	26.02.2018		525.142	814.242	14.751	16.574	830.806	289.100	1.823	830.804	16.501	814.275	1.750	289.133	0.542	2.292	-0.002	0.033	-0.073	-0.040	-0.038	2.2	0.1	1.00
PW015	SSI	22.12.2017	13.03.2018		524.559	873.770	14.817	16.632	890.388	349.211	1.815	890.402	16.467	873.908	1.650	349.349	0.584	2.234	0.014	0.138	-0.165	-0.027	-0.041	1.5	-0.6	1.01
PW018	SSI	22.12.2017	13.03.2018		523.014	845.628	14.832	16.651	862.257	322.614	1.819	862.268	16.408	845.838	1.576	322.824	0.624	2.200	0.011	0.210	-0.243	-0.033	-0.044	1.8	-0.5	1.01
PW020	SSI	22.12.2017	13.03.2018		523.617	833.424	14.631	16.445	849.841	309.807	1.814	849.852	16.282	833.547	1.651	309.930	0.582	2.233	0.011	0.123	-0.163	-0.040	-0.051	2.2	-0.5	1.00
PW023	SSI	29.01.2018	03.04.2018		523.294	820.768	14.673	16.477	837.218	297.474	1.804	837.189	16.362	820.804	1.689	297.510	0.534	2.223	-0.029	0.036	-0.115	-0.079	-0.050	4.4	1.3	0.99
PW025	SSI	29.01.2018	03.04.2018		522.963	852.348	14.894	16.714	869.045	329.385	1.820	869.014	16.509	852.381	1.615	329.418	0.472	2.087	-0.031	0.033	-0.205	-0.172	-0.141	9.5	1.5	0.99
PW029	SSI	29.01.2018	03.04.2018		522.325	855.374	15.064	16.866	872.225	333.049	1.802	872.089	16.540	855.520	1.476	333.195	0.595	2.071	-0.136	0.146	-0.326	-0.180	-0.044	10.0	6.6	0.93

Table A-8: Analytical raw data of isotope diffusive exchange experiments

Sample	Test water (TW)	Initial $\delta^{18}O$ TW	Initial $\delta^{2}H$ TW	Final $\delta^{18}O$ TW	Final $\delta^{2}H$ TW
		‰ VSMOW	‰ VSMOW	‰ VSMOW	‰ VSMOW
IG_BH01_PW003	LAB	-9.61	-67.5	-9.92	-71.5
IG_BH01_PW006	LAB	-9.61	-67.5	-9.95	-71.0
IG_BH01_PW007	LAB	-9.61	-67.5	-9.34	-68.0
IG_BH01_PW012	LAB	-9.61	-67.5	-9.38	-68.0
IG_BH01_PW015	LAB	-9.61	-67.5	-9.17	-66.5
IG_BH01_PW018	LAB	-9.61	-67.5	-9.09	-65.7
IG_BH01_PW020	LAB	-9.61	-67.5	-9.49	-67.9
IG_BH01_PW023	LAB	-9.62	-67.5	-9.26	-67.2
IG_BH01_PW025	LAB	-9.62	-67.5	-9.28	-66.6
IG_BH01_PW029	LAB	-9.62	-67.5	-9.28	-65.7
IG_BH01_PW003	SSI	-30.04	-237.1	-25.16	-198.6
IG_BH01_PW006	SSI	-30.04	-237.1	-24.61	-193.3
IG_BH01_PW007	SSI	-30.04	-237.1	-25.25	-198.8
IG_BH01_PW012	SSI	-30.04	-237.1	-25.55	-201.5
IG_BH01_PW015	SSI	-30.04	-237.1	-25.43	-201.5
IG_BH01_PW018	SSI	-30.04	-237.1	-25.96	-204.7
IG_BH01_PW020	SSI	-30.04	-237.1	-25.64	-202.1
IG_BH01_PW023	SSI	-30.17	-236.5	-25.67	-201.8
IG_BH01_PW025	SSI	-30.17	-236.5	-26.62	-208.4
IG_BH01_PW029	SSI	-30.17	-236.5	-25.78	-201.9

APPENDIX II-5

Out-diffusion Experiments: Raw Data

Table A-9: Experimental data of out-diffusion experiments

Sample		IG_BH01_PW003	IG_BH01_PW006	IG_BH01_PW007	IG_BH01_PW012	IG_BH01_PW015	IG_BH01_PW018	IG_BH01_PW020	IG_BH01_PW023	IG_BH01_PW025	IG_BH01_PW029	Blank
Depth	m	223.3	321.7	420.6	456.6	531.4	582.9	632.7	721.0	820.4	920.8	
start experiment		29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018	29.01.2018
Initial Rock Mass (as received, +/- mountain wet)	g	1289.140	1209.408	1244.479	1253.103	1225.818	1280.967	1234.663	1418.334	1297.555	1302.956	
Initial Rock Mass (start experiment)	g	1288.940	1209.334	1244.212	1252.910	1225.721	1280.810	1234.512	1418.200	1297.490	1302.836	
Final Rock Mass (resaturated)	g	1288.978	1209.554	1244.545	1253.105	1225.854	1280.981	1234.779	1418.300	1297.674	1303.114	
Uptake of water	g	-0.16	0.15	0.07	0.00	0.04	0.01	0.12	-0.03	0.12	0.16	
Saturation	%	100.013	99.988	99.995	100.000	99.997	99.999	99.991	100.002	99.991	99.988	
Core Diametre	cm	6.08	6.09	6.08	6.08	6.08	6.11	6.11	6.11	6.12	6.10	
Core Length	cm	16.6	15.6	16.3	16.3	15.9	16.3	15.7	18.1	16.40	16.7	
Volume of Rock Sample	cm^3	481.95	454.41	473.24	473.24	461.63	477.93	460.33	530.70	482.43	488.05	
Density (calculated from volume & mass)	g/cm^3	2.67	2.66	2.63	2.65	2.66	2.68	2.68	2.67	2.69	2.67	
Mass of Rock (calculated from volume and density)	g	1289.14	1209.41	1244.48	1253.10	1225.82	1280.97	1234.66	1418.33	1297.56	1302.96	
Masses before experiment	g	1288.94	1209.33	1244.21	1252.91	1225.72	1280.81	1234.51	1418.12	1297.49	1302.84	
Mass cylinder	g	339.141	336.590	337.922	336.454	334.406	340.440	337.072	338.314	339.627	338.037	337.792
Mass cylinder + core	g	1628.053	1545.913	1582.118	1589.333	1560.106	1621.217	1571.569	1756.423	1637.116	1640.882	
Mass cylinder + core + H_2O	g	2052.577	1945.512	2003.943	2030.306	2010.945	2021.836	1974.209	2182.000	2063.494	2080.585	1192.271
Mass tot start	g	2230.800	2124.188	2182.572	2208.773	2189.395	2200.661	2152.760	2360.700	2242.000	2259.000	1370.813
Initial Water Mass	ml	424.524	399.599	421.825	440.973	450.839	400.619	402.640	425.577	426.378	439.703	854.479
Ratio Exp.Water : Rock		0.329	0.330	0.339	0.352	0.368	0.313	0.326	0.300	0.329	0.337	
End Experiment		29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018	29.08.2018
Final Water Mass (measured, not all recoverable)	ml	410.42	385.85	408.15	427.81	437.56	387.63	389.69	412.11	412.55	426.86	
Time Experiment	days	212	212	212	212	212	212	212	212	212	212	212
Volume of samples for Cl-measurements												
sample A	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample B	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample C	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample D	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample E	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample F	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample G	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample H	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample I	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample K	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample L	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample M	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample N	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample O	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample P	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample Q	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample R	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
sample S	ml	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
total volume subsamples	ml	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Mass of cylinder wet	g	520.28	517.628	518.59	517.41	514.355	521.233	517.597	519.558	520.221	518.36	
mass of cylinder dry	g	517.97	515.676	515.68	515.505	513.254	519.711	516.128	517.46	518.786	516.786	
mass of residual water in cylinder	g	2.31	1.952	2.91	1.905	1.101	1.522	1.469	2.098	1.435	1.574	
mass of core wet	g	1289.285	1209.62	1244.785	1253.388	1226.098	1281.238	1234.886	1418.644	1297.837	1303.3	
mass of surface water	g	0.307	0.066	0.240	0.283	0.244	0.257	0.107	0.344	0.163	0.186	
Final Mass of Experiment-Solution (calculated)	g	412.91	388.58	409.68	429.79	440.49	389.84	392.06	414.14	415.78	428.94	
Final Mass of Experiment-Solution (measured)	g	410.42	385.85	408.15	427.81	437.56	387.63	389.69	412.11	412.55	426.86	
Difference in water mass	Dif (ml)	2.48	2.73	1.53	1.97	2.93	2.21	2.37	2.03	3.23	2.08	
Water loss in % of ini water mass	Dif (%)	0.6	0.7	0.4	0.5	0.7	0.6	0.6	0.5	0.8	0.5	

Table A-10: Chemical composition of time series samples taken during out-diffusion experiments

Sample			IG01-PW003							
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Preparation		29.01.2018								
A	1	30.01.2018	10.0	2.10	5.00	1.20	0.89	<0.5	0.39	<0.1
B	4	02.02.2018	9.60	2.20	15.5	1.20	1.40	<0.5	0.27	<0.1
C	7	05.02.2018	9.40	2.40	8.60	1.30	1.80	0.63	0.39	<0.1
D	10	08.02.2018	7.40	2.70	10.5	0.23	1.50	<0.5	0.22	<0.1
E	14	12.02.2018	9.70	2.60	24.6	1.00	2.00	<0.5	<0.2	<0.1
F	21	19.02.2018	13.9	2.60	10.9	0.41	2.10	0.54	0.43	<0.1
G	31	01.03.2018	11.2	3.40	17.8	0.89	2.20	2.30	2.80	<0.1
H	45	15.03.2018	10.8	2.80	15.0	0.14	2.30	0.75	0.35	<0.1
I	59	29.03.2018	9.70	3.30	20.0	1.10	2.30	1.40	0.35	<0.1
K	74	13.04.2018	9.50	2.90	14.2	0.33	2.30	1.10	0.29	<0.1
L	93	02.05.2018	12.5	3.50	20.1	0.34	2.30	1.50	0.32	<0.1
M	120	29.05.2018	12.8	3.50	24.9	0.89	2.30	2.30	0.78	<0.1
N	136	14.06.2018	14.7	3.00	18.2	0.33	2.30	1.30	0.37	<0.1
O	150	28.06.2018	14.3	3.20	12.5	0.17	2.30	2.00	1.90	<0.1
P	164	12.07.2018	14.4	2.50	10.8	0.09	2.30	2.20	0.27	<0.1
Q	172	20.07.2018	18.6	3.10	12.7	0.11	2.30	2.60	0.23	<0.1
R	190	07.08.2018	12.3	3.50	12.4	0.22	2.30	2.30	<0.2	<0.1
S	210	27.08.2018	11.7	3.60	15.0	0.13	2.30	2.20	0.27	<0.1
Final	212	29.08.2018	9.30	3.40	10.5	0.16	2.40	3.40	0.27	0.04

Sample			IG01-PW006							
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Preparation		29.01.2018								
A	1	30.01.2018	8.20	1.40	3.80	0.22	1.10	0.51	<0.2	<0.1
B	4	02.02.2018	9.30	1.50	12.5	0.36	1.80	<0.5	<0.2	<0.1
C	7	05.02.2018	8.50	1.60	10.7	0.49	2.00	<0.5	<0.2	<0.1
D	10	08.02.2018	7.10	2.20	10.4	0.15	2.50	<0.5	<0.2	<0.1
E	14	12.02.2018	9.40	1.60	21.0	0.90	2.60	<0.5	<0.2	<0.1
F	21	19.02.2018	14.8	1.70	12.6	0.17	2.90	<0.5	<0.2	<0.1
G	31	01.03.2018	10.9	2.00	11.9	0.24	3.10	2.50	1.50	<0.1
H	45	15.03.2018	14.7	2.60	13.5	0.24	3.30	1.30	13.7	<0.1
I	59	29.03.2018	9.30	2.50	16.7	0.35	3.30	0.95	<0.2	<0.1
K	74	13.04.2018	8.90	2.10	13.4	0.18	3.30	1.10	<0.2	<0.1
L	93	02.05.2018	12.9	2.70	19.2	0.15	3.30	1.60	<0.2	<0.1
M	120	29.05.2018	11.6	2.90	19.7	0.28	3.30	1.20	<0.2	<0.1
N	136	14.06.2018	14.3	2.40	18.0	0.18	3.30	1.00	<0.2	<0.1
O	150	28.06.2018	15.3	2.60	8.60	0.06	3.30	1.10	0.50	<0.1
P	164	12.07.2018	14.6	2.10	8.80	0.09	3.30	1.70	<0.2	<0.1
Q	172	20.07.2018	18.1	2.70	10.8	0.17	3.30	2.10	<0.2	<0.1
R	190	07.08.2018	12.3	3.40	10.4	0.20	3.30	2.00	<0.2	<0.1
S	210	27.08.2018	9.30	2.90	12.8	0.18	3.30	2.00	<0.2	<0.1
Final	212	29.08.2018	9.40	2.90	8.40	0.09	3.40	2.10	<0.2	0.05

Table A-10: continued

Sample			IG01-PW007							
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Preparation		29.01.2018								
A	1	30.01.2018	7.30	1.00	6.30	0.25	1.90	<0.5	<0.2	<0.1
B	4	02.02.2018	9.10	1.40	11.2	0.12	3.70	<0.5	<0.2	<0.1
C	7	05.02.2018	8.00	1.50	12.9	0.15	4.50	<0.5	<0.2	0.10
D	10	08.02.2018	7.30	1.70	11.5	0.06	4.90	0.52	<0.2	<0.1
E	14	12.02.2018	9.90	1.70	16.2	0.34	5.40	0.64	<0.2	<0.1
F	21	19.02.2018	13.7	1.80	14.9	0.35	6.10	0.67	<0.2	0.14
G	31	01.03.2018	9.80	1.90	15.5	0.07	6.20	0.81	3.00	<0.1
H	45	15.03.2018	9.50	1.60	15.4	0.05	6.20	0.65	<0.2	<0.1
I	59	29.03.2018	8.50	1.90	18.5	0.08	6.20	0.77	<0.2	<0.1
K	74	13.04.2018	7.90	1.70	15.4	0.12	6.20	0.79	<0.2	<0.1
L	93	02.05.2018	11.1	1.90	21.5	0.10	6.30	0.70	<0.2	<0.1
M	120	29.05.2018	9.10	1.80	20.9	0.15	6.30	0.72	<0.2	<0.1
N	136	14.06.2018	12.5	1.70	20.9	0.14	6.30	1.30	<0.2	<0.1
O	150	28.06.2018	11.3	1.60	11.2	0.05	6.30	0.98	0.68	<0.1
P	164	12.07.2018	12.0	1.30	11.6	0.05	6.30	1.80	<0.2	<0.1
Q	172	20.07.2018	15.7	1.70	12.9	0.09	6.30	1.90	<0.2	<0.1
R	190	07.08.2018	9.40	1.60	13.1	0.07	6.30	1.90	<0.2	<0.1
S	210	27.08.2018	6.50	2.00	16.0	0.10	6.30	1.50	<0.2	<0.1
Final	212	29.08.2018	5.60	1.90	11.8	0.04	6.40	1.90	<0.2	0.14

Sample			IG01-PW012							
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Preparation		29.01.2018								
A	1	30.01.2018	9.50	1.50	4.50	0.13	2.00	<0.5	0.20	<0.1
B	4	02.02.2018	10.0	1.50	8.30	0.09	3.60	<0.5	<0.2	<0.1
C	7	05.02.2018	8.90	1.70	10.3	0.12	4.20	<0.5	<0.2	<0.1
D	10	08.02.2018	7.90	1.90	10.0	0.10	4.80	<0.5	<0.2	<0.1
E	14	12.02.2018	9.50	1.90	11.9	0.26	5.20	<0.5	<0.2	<0.1
F	21	19.02.2018	13.5	1.90	12.1	0.17	5.70	<0.5	<0.2	<0.1
G	31	01.03.2018	10.1	2.30	10.5	0.08	5.90	0.70	2.40	<0.1
H	45	15.03.2018	10.9	2.00	11.4	0.05	6.00	0.72	<0.2	<0.1
I	59	29.03.2018	9.30	3.30	14.0	0.08	6.10	0.67	<0.2	<0.1
K	74	13.04.2018	9.10	2.10	12.1	0.09	6.50	0.93	<0.2	<0.1
L	93	02.05.2018	11.9	2.20	17.0	0.09	6.50	1.00	<0.2	<0.1
M	120	29.05.2018	10.4	2.30	16.3	0.15	6.50	0.65	<0.2	<0.1
N	136	14.06.2018	14.1	2.30	15.8	0.15	6.50	0.80	<0.2	<0.1
O	150	28.06.2018	12.6	2.00	6.80	0.06	6.50	0.75	1.10	<0.1
P	164	12.07.2018	13.8	1.90	6.80	0.07	6.50	1.40	<0.2	<0.1
Q	172	20.07.2018	15.3	2.20	8.40	0.08	6.50	1.70	<0.2	<0.1
R	190	07.08.2018	10.8	2.30	8.30	0.09	6.50	1.50	<0.2	<0.1
S	210	27.08.2018	7.20	2.40	9.70	0.08	6.50	1.40	<0.2	<0.1
Final	212	29.08.2018	7.50	2.40	6.00	0.06	6.60	2.00	<0.2	0.15

Table A-10: Continued

Sample			IG01-PW015								
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-	Br/Cl
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Preparation		29.01.2018									
A	1	30.01.2018	8.10	1.30	5.40	0.17	2.00	0.50	<0.2	0.12	60
B	4	02.02.2018	10.1	1.80	6.60	0.08	3.60	<0.5	<0.2	0.15	42
C	7	05.02.2018	10.0	2.00	8.30	0.10	4.40	<0.5	<0.2	0.16	36
D	10	08.02.2018	8.60	2.20	9.60	0.09	5.00	<0.5	<0.2	0.18	36
E	14	12.02.2018	9.90	2.20	11.4	0.21	5.60	0.61	<0.2	0.30	54
F	21	19.02.2018	14.5	2.10	11.0	0.10	5.80	<0.5	<0.2	0.37	64
G	31	01.03.2018	10.7	2.40	12.7	0.10	6.10	0.62	1.70	0.38	62
H	45	15.03.2018	10.8	2.20	10.7	0.06	6.30	0.66	<0.2	0.39	62
I	59	29.03.2018	11.2	2.70	11.1	0.09	6.30	0.70	<0.2	0.39	62
K	74	13.04.2018	13.7	1.70	17.8	0.09	6.30	0.67	0.28	0.40	63
L	93	02.05.2018	15.5	2.60	16.1	0.16	6.30	0.58	<0.2	0.40	63
M	120	29.05.2018	10.6	2.50	15.3	0.09	6.30	<0.5	<0.2	0.40	63
N	136	14.06.2018	13.7	2.40	15.7	0.08	6.70	<0.5	<0.2	0.43	64
O	150	28.06.2018	16.9	2.80	7.80	0.08	7.10	0.97	4.50	0.43	61
P	164	12.07.2018	16.4	3.30	8.70	0.28	7.10	1.10	<0.2	0.42	59
Q	172	20.07.2018	16.3	2.50	8.00	0.07	7.10	0.79	<0.2	0.42	59
R	190	07.08.2018	12.0	3.40	7.30	0.17	7.10	1.30	1.90	0.42	59
S	210	27.08.2018	8.10	2.70	9.50	0.10	7.10	<0.5	<0.2	0.42	59
Final	212	29.08.2018	7.00	2.70	5.90	0.07	7.10	0.84	<0.2	0.42	59

Sample			IG01-PW018								
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-	Br/Cl
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Preparation		29.01.2018									
A	1	30.01.2018	8.30	2.10	8.60	0.14	5.10	<0.5	<0.2	0.32	63
B	4	02.02.2018	10.9	3.00	13.0	0.10	9.50	<0.5	<0.2	0.49	52
C	7	05.02.2018	10.9	3.30	14.8	0.08	11.6	<0.5	<0.2	0.50	43
D	10	08.02.2018	9.40	3.50	13.5	0.09	12.8	<0.5	<0.2	0.61	48
E	14	12.02.2018	11.3	3.80	16.8	0.15	14.4	<0.5	<0.2	0.61	42
F	21	19.02.2018	16.2	4.10	14.8	0.09	16.2	<0.5	<0.2	0.66	41
G	31	01.03.2018	12.6	4.10	18.4	0.09	16.4	1.00	1.10	0.73	45
H	45	15.03.2018	12.8	3.90	15.1	0.07	16.5	0.71	<0.2	0.75	45
I	59	29.03.2018	11.2	4.10	18.7	0.09	17.2	0.76	<0.2	0.75	44
K	74	13.04.2018	10.8	3.80	16.9	0.05	17.5	0.85	<0.2	0.75	43
L	93	02.05.2018	13.7	4.00	21.5	0.09	18.8	0.68	<0.2	0.85	45
M	120	29.05.2018	12.1	4.10	21.0	0.11	18.8	<0.5	<0.2	0.86	46
N	136	14.06.2018	15.4	3.90	21.2	0.13	18.9	<0.5	<0.2	0.86	46
O	150	28.06.2018	13.2	3.70	12.2	0.07	18.9	<0.5	0.20	0.87	46
P	164	12.07.2018	14.6	3.40	12.0	0.07	18.9	1.00	<0.2	0.87	46
Q	172	20.07.2018	16.9	3.80	13.4	0.10	18.9	1.20	<0.2	0.87	46
R	190	07.08.2018	12.2	3.90	13.3	0.09	18.9	1.00	<0.2	0.87	46
S	210	27.08.2018	12.2	4.10	16.1	0.12	18.9	0.93	<0.2	0.87	46
Final	212	29.08.2018	8.30	4.20	11.9	0.09	18.9	1.20	<0.2	0.89	47

Table A-10: Continued

Sample			IG01-PW020								
Sub-samples	Time	Date	Na$^+$	K$^+$	Ca^{2+}	Mg^{2+}	Cl$^-$	SO$_4^{2-}$	NO$_3^-$	Br$^-$	Br/Cl
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Preparation		29.01.2018									
A	1	30.01.2018	7.80	1.70	6.80	0.09	3.50	<0.5	<0.2	<0.1	
B	4	02.02.2018	9.70	2.30	13.2	0.09	6.50	0.59	<0.2	0.15	23
C	7	05.02.2018	9.60	2.70	13.3	0.09	8.10	0.56	<0.2	0.15	19
D	10	08.02.2018	8.50	2.70	13.0	0.10	8.80	0.66	<0.2	0.17	19
E	14	12.02.2018	10.3	2.80	14.2	0.14	9.90	0.80	<0.2	0.25	25
F	21	19.02.2018	14.9	2.80	16.0	0.11	11.4	0.86	<0.2	0.28	25
G	31	01.03.2018	11.6	3.00	16.2	0.12	11.4	1.10	2.20	0.29	25
H	45	15.03.2018	11.5	2.80	13.5	0.07	11.5	1.70	<0.2	0.30	26
I	59	29.03.2018	10.4	3.10	17.8	0.11	12.3	1.80	<0.2	0.30	24
K	74	13.04.2018	10.2	2.90	15.5	0.09	12.3	2.00	<0.2	0.30	24
L	93	02.05.2018	13.1	2.90	19.6	0.14	12.3	2.50	<0.2	0.35	28
M	120	29.05.2018	11.5	3.10	19.3	0.20	12.3	2.40	0.20	0.37	30
N	136	14.06.2018	14.9	2.90	19.0	0.14	12.3	2.20	<0.2	0.37	30
O	150	28.06.2018	13.5	2.80	9.80	0.08	12.3	2.20	0.27	0.37	30
P	164	12.07.2018	14.9	2.60	10.1	0.09	12.5	3.20	<0.2	0.37	30
Q	172	20.07.2018	48.4	19.8	12.1	0.38	12.5	4.60	0.94	0.37	30
R	190	07.08.2018	11.8	3.00	10.8	0.12	12.5	3.60	<0.2	0.37	30
S	210	27.08.2018	9.00	3.00	12.7	0.11	12.5	3.00	<0.2	0.35	28
Final	212	29.08.2018	8.90	3.10	8.70	0.08	12.6	3.70	<0.2	0.34	27

Sample			IG01-PW023								
Sub-samples	Time	Date	Na$^+$	K$^+$	Ca^{2+}	Mg^{2+}	Cl$^-$	SO$_4^{2-}$	NO$_3^-$	Br$^-$	Br/Cl
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Preparation		29.01.2018									
A	1	30.01.2018	9.20	2.70	12.7	0.10	9.70	<0.5	<0.2	0.17	18
B	4	02.02.2018	11.6	3.20	18.9	0.08	17.9	0.59	<0.2	0.30	17
C	7	05.02.2018	11.1	3.60	21.0	0.07	20.5	0.59	0.29	0.41	20
D	10	08.02.2018	9.90	3.70	20.3	0.08	22.8	0.74	0.26	0.40	18
E	14	12.02.2018	12.1	3.90	23.9	0.12	24.1	0.79	0.20	0.40	17
F	21	19.02.2018	17.1	4.00	21.8	0.07	26.2	1.20	0.23	0.61	23
G	31	01.03.2018	13.1	4.20	24.9	0.08	26.8	1.10	1.30	0.63	24
H	45	15.03.2018	13.3	4.30	24.2	0.06	27.4	1.40	0.27	0.63	23
I	59	29.03.2018	11.8	4.50	26.1	0.07	28.2	1.80	<0.2	0.63	22
K	74	13.04.2018	11.8	4.50	24.1	0.08	28.9	2.10	0.27	0.64	22
L	93	02.05.2018	15.0	4.80	30.0	0.11	30.9	2.40	<0.2	0.64	21
M	120	29.05.2018	12.8	4.80	29.1	0.13	30.9	2.00	0.25	0.64	21
N	136	14.06.2018	16.4	4.70	29.2	0.14	30.9	1.90	<0.2	0.64	21
O	150	28.06.2018	14.2	4.60	20.4	0.08	30.9	2.10	0.32	0.64	21
P	164	12.07.2018	16.2	4.30	20.9	0.08	30.9	2.90	<0.2	0.64	21
Q	172	20.07.2018	18.2	5.10	20.8	0.07	30.9	3.40	<0.2	0.64	21
R	190	07.08.2018	13.1	5.00	20.3	0.08	30.9	3.20	<0.2	0.64	21
S	210	27.08.2018	10.1	5.10	24.5	0.08	30.9	2.70	<0.2	0.64	21
Final	212	29.08.2018	9.50	5.30	20.6	0.07	30.9	3.10	<0.2	0.63	20

Table A-10: Continued

Sample			**IG01-PW025**								
Sub-samples	**Time**	**Date**	**Na$^+$**	**K$^+$**	**Ca^{2+}**	**Mg^{2+}**	**Cl$^-$**	**SO$_4^{2-}$**	**NO$_3^-$**	**Br$^-$**	**Br/Cl**
	days		**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	
Preparation		29.01.2018									
A	1	30.01.2018	8.20	1.70	6.40	0.09	3.50	<0.5	<0.2	<0.1	
B	4	02.02.2018	9.20	2.00	14.2	0.08	6.00	<0.5	<0.2	0.11	18
C	7	05.02.2018	8.90	2.40	14.7	0.10	7.50	<0.5	<0.2	0.11	15
D	10	08.02.2018	8.50	2.70	14.0	0.10	8.50	0.56	<0.2	0.15	18
E	14	12.02.2018	10.0	2.70	16.9	0.11	9.60	0.51	<0.2	0.17	18
F	21	19.02.2018	14.7	2.60	16.6	0.09	10.7	0.69	<0.2	0.22	21
G	31	01.03.2018	11.5	3.00	18.5	0.08	11.6	0.94	0.70	0.26	22
H	45	15.03.2018	11.4	2.90	14.4	0.06	12.2	0.99	<0.2	0.28	23
I	59	29.03.2018	10.0	3.10	18.2	0.09	12.8	1.10	<0.2	0.28	22
K	74	13.04.2018	9.40	3.00	16.4	0.07	13.0	1.10	<0.2	0.28	22
L	93	02.05.2018	12.9	3.10	20.8	0.10	13.0	1.20	<0.2	0.30	23
M	120	29.05.2018	10.9	3.20	20.5	0.09	13.0	1.20	<0.2	0.30	23
N	136	14.06.2018	14.1	3.00	19.8	0.15	13.4	1.00	<0.2	0.30	22
O	150	28.06.2018	12.9	3.00	10.3	0.07	13.5	1.00	0.29	0.34	25
P	164	12.07.2018	14.4	2.60	10.7	0.06	13.5	1.90	<0.2	0.34	25
Q	172	20.07.2018	16.6	3.10	11.4	0.05	13.5	1.90	<0.2	0.34	25
R	190	07.08.2018	11.6	3.10	11.1	0.09	13.5	2.10	<0.2	0.34	25
S	210	27.08.2018	8.10	3.20	13.2	0.08	13.5	1.50	<0.2	0.34	25
Final	212	29.08.2018	8.40	3.30	9.20	0.08	13.6	2.50	<0.2	0.34	25

Sample			**IG01-PW029**								
Sub-samples	**Time**	**Date**	**Na$^+$**	**K$^+$**	**Ca^{2+}**	**Mg^{2+}**	**Cl$^-$**	**SO$_4^{2-}$**	**NO$_3^-$**	**Br$^-$**	**Br/Cl**
	days		**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	
Preparation		29.01.2018									
A	1	30.01.2018	9.20	3.00	14.1	0.13	11.6	<0.5	<0.2	0.22	19
B	4	02.02.2018	11.8	3.70	19.5	0.11	21.1	<0.5	<0.2	0.36	17
C	7	05.02.2018	11.2	4.30	22.6	0.13	25.9	0.61	<0.2	0.37	14
D	10	08.02.2018	10.1	4.70	21.9	0.10	27.7	0.79	<0.2	0.42	15
E	14	12.02.2018	11.8	5.70	26.7	0.11	30.7	0.68	<0.2	0.50	16
F	21	19.02.2018	17.6	5.30	27.0	0.12	36.3	1.40	<0.2	0.63	17
G	31	01.03.2018	13.4	5.80	29.5	0.14	38.1	1.40	1.20	0.73	19
H	45	15.03.2018	14.8	5.70	27.8	0.10	39.5	1.30	<0.2	0.75	19
I	59	29.03.2018	13.1	6.10	29.6	0.12	39.8	1.50	<0.2	0.76	19
K	74	13.04.2018	12.3	5.90	27.5	0.08	41.0	1.60	<0.2	0.76	19
L	93	02.05.2018	15.6	6.10	32.2	0.15	41.5	1.60	<0.2	0.76	18
M	120	29.05.2018	13.9	6.30	32.3	0.21	41.7	1.30	<0.2	0.77	18
N	136	14.06.2018	17.1	6.10	31.5	0.21	41.8	1.30	<0.2	0.77	18
O	150	28.06.2018	15.4	5.90	22.5	0.12	41.9	1.50	0.36	0.77	18
P	164	12.07.2018	18.0	5.60	22.6	0.13	41.9	2.20	<0.2	0.77	18
Q	172	20.07.2018	19.3	6.30	21.4	0.11	41.9	2.60	<0.2	0.77	18
R	190	07.08.2018	14.0	6.30	22.2	0.18	42.0	2.40	<0.2	0.77	18
S	210	27.08.2018	11.2	6.40	25.6	0.15	42.1	2.10	<0.2	0.77	18
Final	212	29.08.2018	11.2	6.50	21.1	0.14	42.3	2.40	<0.2	0.78	18

Table A-10: Continued

Sample			IG01-Blank							
Sub-samples	Time	Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NO_3^-	Br^-
	days		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Preparation		29.01.2018								
A	1	30.01.2018	7.40	0.25	9.00	0.10	0.019	<0.5	<0.2	<0.1
B	4	02.02.2018	7.10	0.24	6.70	0.05	0.010	<0.5	<0.2	<0.1
C	7	05.02.2018	7.20	0.20	7.80	0.05	0.012	<0.5	<0.2	<0.1
D	10	08.02.2018	5.00	0.23	5.00	0.04	0.014	<0.5	<0.2	<0.1
E	14	12.02.2018	6.70	0.46	9.30	0.07	0.028	<0.5	<0.2	<0.1
F	21	19.02.2018	10.9	0.11	8.10	0.15	0.031	<0.5	<0.2	<0.1
G	31	01.03.2018	6.70	0.58	12.4	0.07	0.044	<0.5	0.47	<0.1
H	45	15.03.2018	5.90	0.20	6.30	0.04	0.033	<0.5	<0.2	<0.1
I	59	29.03.2018	4.70	0.19	7.10	0.04	0.036	<0.5	<0.2	<0.1
K	74	13.04.2018	4.60	0.09	8.90	0.03	0.018	<0.5	<0.2	<0.1
L	93	02.05.2018	6.70	0.15	11.5	0.07	0.039	<0.5	<0.2	<0.1
M	120	29.05.2018	4.80	0.20	10.6	0.09	0.082	<0.5	0.29	<0.1
N	136	14.06.2018	7.90	0.08	11.1	0.09	0.083	<0.5	<0.2	<0.1
O	150	28.06.2018	8.60	0.59	1.90	0.18	0.065	<0.5	1.20	<0.1
P	164	12.07.2018	8.30	0.65	4.00	0.05	0.096	<0.5	0.25	<0.1
Q	172	20.07.2018	8.60	0.18	3.90	0.04	0.049	<0.5	<0.2	<0.1
R	190	07.08.2018	5.20	0.88	4.90	0.21	0.098	2.70	0.71	<0.1
S	210	27.08.2018	3.20	0.40	3.70	0.51	0.092	<0.5	0.23	<0.1
Final	212	29.08.2018	0.14	0.04	0.11	0.02	0.100	<0.5	<0.2	<0.02

APPENDIX III

Error Calculations

APPENDIX III-1

Gravimetric Water Content

The water content is calculated according to $WC_{grav} = \frac{m_{pw}}{m_{core,wet}}$

Where WC_{grav} = gravimetric water content, m_{pw} = mass of pore water, $m_{core,wet}$ = mass of the wet core sample

Error calculation after Gaussian error propagation

$$\sigma(WC_{grav}) = \sqrt{\left(dWC_{grav}dm_{PW} \times \sigma(m_{PW})\right)^2 + \left(dWC_{grav}dm_{core,wet} \times \sigma(m_{core,wet})\right)^2}$$

Analytical errors (error of measurement)

s(m_{pw}) = difference between $m_{core,dry\ surface}$ before and after drying + 0.05 g (=variations at end of drying); The constant of 0.05 g is the empirically derived uncertainty associated to the drying process of the surface, i.e. loss of water from the core surface.

s($m_{core,wet}$) = difference between $m_{core,dry\ surface}$ before and after experiment

Both uncertainties include the mass difference of the individual cores before and after the experiments (cf. Appendix II).

Derivations

$$dWC_{grav}dm_{pw} = \frac{100}{m_{core,wet}}$$

$$dWC_{grav}dm_{core,wet} = \frac{-100 \times m_{pw}}{(m_{core,wet})^2}$$

APPENDIX III-2

Water Loss Porosity

The water-loss (connected porosity), ϕ_{WL}, is calculated according to

$$\phi_{WL} = WC_{wet} \times \frac{\rho_{bulk,wet}}{\rho_{water}}$$

where *WC*$_{wet}$ is the water content based on the wet weight of the rock sample and $\rho_{bulk,wet}$ the bulk wet density of the rock. The density of water, ρ_{water}, is assumed to be 1 g/cm^3.

The conversion of the formula leads to

$$\phi_{WL} = \frac{m_{pw} \times 100}{r^2 \times h \times \pi \times \rho_{water}}$$

where *r* = radius of the core pieces, *h* = height of the core.

Error calculation after Gaussian error propagation

$$\sigma(\phi_{WL}) = \sqrt{\begin{array}{l}\left(d\phi_{WL}dm_{PW} \times \sigma(m_{PW})\right)^2 + \left(d\phi_{WL}dr \times \sigma(r)\right)^2 + \\ \left(d\phi_{WL}dh \times \sigma(h)\right)^2 + \left(d\phi_{WL}d\rho_{water} \times \sigma(\rho_{water})\right)^2\end{array}}$$

Analytical errors (error of measurement)

s(m$_{pw}$) = difference between m$_{core,dry\ surface}$ before and after drying + 0.05 g (=variations

at end of drying)

s(r) = 0.02 cm

s(h) = 0.2 cm

s(r$_{water}$) = 0.03 g/cm^3

Derivations

$$d\phi dm_{pw} = \frac{100}{r^2 \times h \times \pi \times \rho_{water}}$$

$$d\phi dr = \frac{-m_{pw} \times 100 \times 2r \times h \times \pi \times \rho_{water}}{(r^2 \times h \times \pi \times \rho_{water})^2}$$

$$d\phi dh = \frac{-m_{pw} \times 100 \times r^2 \times \pi \times \rho_{water}}{(r^2 \times h \times \pi \times \rho_{water})^2}$$

$$d\phi dh = \frac{-m_{pw} \times 100 \times r^2 \times \pi \times h}{(r^2 \times h \times \pi \times \rho_{water})^2}$$

APPENDIX III-3

Porewater Cl- and Br Concentration

Calculations

$$C_{PW} = \frac{(m_{PW} + m_{TWi} - \sum^{n} m_s) \times C_{TW\infty} - (m_{TWi} \times C_{TWi}) + \sum^{n} m_s \times C_s}{m_{PW}}$$

where C_{pw} = porewater concentration; m_{pw} = mass of porewater; m_{TWi} = initial mass of test water; C_{TWi} = initial Cl-concentration of test water; m_s = mass of sub sample used for time series; C_s = Cl concentration of sub sample used for time series.

Error calculation after Gaussian error propagation

$$\sigma(C_{PW}) = \sqrt{\begin{array}{l} \left(dC_{PW} dm_{PW} \times \sigma(m_{PW})\right)^2 + \left(dC_{PW} dm_{TWi} \times \sigma(m_{TWi})\right)^2 + \\ + \left(dC_{PW} dC_{TW\infty} \times \sigma(C_{TW\infty})\right)^2 + \left(dC_{PW} dC_{TWi} \times \sigma(C_{TWi})\right)^2 + \\ (\sigma(\sum m_S))^2 + (\sigma(\sum m_S \times c_S))^2 \end{array}}$$

Analytical errors (error of measurement)

$\sigma(m_{PW})$ = difference between $m_{core,dry\ surface}$ before and after drying + 0.05 g (=variations at end of drying

$\sigma(m_{TWi})$ = difference between $m_{TWi} - m_S - m_{TW\infty}$-2ml (2 ml = remaining water in the cylinder

$\sigma(C_{TWi})$ = 5% (Cl) and 10 % (Br) of the analysed concentration

$\sigma(C_{TW\infty})$ = 5% (Cl) and 10 % (Br) of the analysed concentration

$\sigma(m_S)$ = 0.05 ml

$\sigma(C_S)$ = 5% (Cl) and 10 % (Br) of the analysed concentration

Derivations

$$dC_{PW} dm_{PW} = \frac{C_{TW\infty} * m_{PW} - \left[C_{TW\infty} * (m_{PW} + m_{TWi}) - C_{TW} * m_{TWi}\right]}{{m_{PW}}^2}$$

$$dC_{PW} dm_{TWi} = \frac{(C_{TW\infty} - C_{TWi}) * m_{PW}}{{m_{PW}}^2}$$

$$dC_{PW} dC_{TW\infty} = \frac{(m_{PW} - m_{TWi}) * m_{PW}}{{m_{PW}}^2}$$

$$dC_{PW} dC_{TWi} = \frac{-m_{TWi} * m_{PW}}{{m_{PW}}^2}$$

$$\sigma\left(\sum (m_s)\right) = \left(Nr_S \times \sigma(m_S)\right)$$

$$\sigma\left(\sum (m_S \times C_S)\right) = \left(Nr_S \times C_{S,ave} \times \sigma(m_S)\right) + \left(Nr_S \times m_S \times \sigma(C_S)\right)$$

APPENDIX III-4

Br*1000/Cl Mass Ratio of Matric Ore Water

Br*1000/Cl porewater mass ratio = R

Error calculation after Gaussian error propagation

$$\sigma(R) = \sqrt{\left(dRdC_{Br} \times \sigma(C_{Br})\right)^2 + \left(dRdC_{Cl} \times \sigma(C_{Cl})\right)^2}$$

Analytical errors (error of measurement)

$\sigma(C_{Cl})$ = Error of porewater Cl concentration calculated according to AIII-3

$\sigma(C_{Br})$ = Error of porewater Br concentration calculated according to AIII-3

Derivations

$$dRdC_{Br} = \frac{1000}{C_{Cl}}$$

$$dRdC_{Cl} = \frac{-1000 \times C_{Br}}{C_{Cl}^2}$$

APPENDIX III-5

Calculation of Isotopic Signatures of Matrix Porewater

Calculation

$$C_{PW} = \frac{C_{TW\infty(Std1)} \times m_{TW(Std2)} \times m_{Rock(Std1)} \times (C_{TW\infty(Std2)} - C_{TW^0(Std2)}) - C_{TW\infty(Std2)} \times m_{TW(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std1)} - C_{TW^0(Std1)})}{m_{TW(Std2)} \times m_{Rock(Std1)} \times (C_{TW\infty(Std2)} - C_{TW^0(Std2)}) - m_{TW(Std1)} \times m_{Rock(Std2)} \times (C_{TW\infty(Std1)} - C_{TW^0(Std1)})}$$

m_{PW} = mass of porewater (g)

m_{TW} = mass of test water (g)

C_{TW} = isotopic signature of test water at the beginning of the experiment (‰)

$C_{TW\infty}$ = isotopic signature of test water after equilibration (‰)

Std 1 = Experiment 1 applying standard 1

Std 2 = Experiment 2 applying standard 2

Error calculation after Gaussian error propagation

$$\sigma(C_{PW}) = \sqrt{\begin{aligned} &\left(dC_{PW}\,dm_{TW(Std1)} \times \sigma(m_{TW(Std1)})\right)^2 + \left(dC_{PW}\,dm_{TW(Std2)} \times \sigma(m_{TW(Std2)})\right)^2 + \\ &+\left(dC_{PW}\,dC_{TW(Std1)} \times \sigma(C_{TW(Std1)})\right)^2 + \left(dC_{PW}\,dC_{TW(Std2)} \times \sigma(C_{TW(Std2)})\right)^2 + \\ &+\left(dC_{PW}\,dC_{TW\infty(Std1)} \times \sigma(C_{TW\infty(Std1)})\right)^2 + \left(dC_{PW}\,dC_{TW\infty(Std2)} \times \sigma(C_{TW\infty(Std2)})\right)^2 \end{aligned}}$$

Analytical errors (error of measurement)

$\sigma(m_{TW(Std1)})$ = 0.002 g

$\sigma(m_{TW(Std2)})$ = 0.002 g

$\sigma(C_{TW(Std1)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW(Std2)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW\infty(Std1)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW\infty(Std2)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

Derivations

$$dC_{PW}dm_{TW(Std1)} = \frac{\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)}}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)} -$$

$$- \frac{\left(\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)} \times m_{TW(Std1)} - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)} \times m_{TW(Std2)}\right) \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right)}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)^2}$$

$$dC_{PW}\,dm_{TW(Std2)} = \frac{-\left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)}}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)} +$$

$$+ \frac{\left(\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)} \times m_{TW(Std1)} - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)} \times m_{TW(Std2)}\right) \times \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right)}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)^2}$$

$$dC_{PW}\,dC_{TW(Std\,1)} = \frac{C_{TW\infty(Std\,2)} \times m_{TW(Std\,1)}}{\left(m_{TW(Std\,1)} \times \left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times m_{TW(Std\,2)}\right)} -$$

$$- \frac{\left(\left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) \times C_{TW\infty(Std\,2)} \times m_{TW(Std\,1)} - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times C_{TW\infty(Std\,1)} \times m_{TW(Std\,2)}\right) \times m_{TW(Std\,1)}}{\left(m_{TW(Std\,1)} \times \left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times m_{TW(Std\,2)}\right)^2}$$

$$dC_{PW}\,dC_{TW(Std\,2)} = \frac{-C_{TW\infty(Std\,1)} \times m_{TW(Std\,2)}}{\left(m_{TW(Std\,1)} \times \left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times m_{TW(Std\,2)}\right)} +$$

$$+ \frac{\left(\left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) \times C_{TW\infty(Std\,2)} \times m_{TW(Std\,1)} - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times C_{TW\infty(Std\,1)} \times m_{TW(Std\,2)}\right) \times m_{TW(Std\,2)}}{\left(m_{TW(Std\,1)} \times \left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) - \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times m_{TW(Std\,2)}\right)^2}$$

$$dC_{PW}\,dC_{TW\infty(Std1)} = \frac{-\left(C_{TW\infty(Std2)} \times m_{TW(Std1)} + \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)} +$$

$$+ \frac{\left(\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)} \times m_{TW(Std1)} - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)} \times m_{TW(Std2)}\right) \times m_{TW(Std1)}}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)^2}$$

$$dC_{PW}\,dC_{TW\infty(Std1)} = \frac{-\left(C_{TW\infty(Std2)} \times m_{TW(Std1)} + \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)} +$$

$$+ \frac{\left(\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)} \times m_{TW(Std1)} - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)} \times m_{TW(Std2)}\right) \times m_{TW(Std1)}}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)^2}$$

$$dC_{PW}\,dC_{TW\infty(Std2)} = \frac{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) + C_{TW\infty(Std1)} \times m_{TW(Std2)}\right)}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)} -$$

$$- \frac{\left(\left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) \times C_{TW\infty(Std2)} \times m_{TW(Std1)} - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times C_{TW\infty(Std1)} \times m_{TW(Std2)}\right) \times m_{TW(Std2)}}{\left(m_{TW(Std1)} \times \left(C_{TW(Std1)} - C_{TW\infty(Std1)}\right) - \left(C_{TW(Std2)} - C_{TW\infty(Std2)}\right) \times m_{TW(Std2)}\right)^2}$$

APPENDIX III-6

Calculation of Mass of Porewater by Isotope Diffusive Exchange Technique

Calculation

$$WC_{IsoEx} = \left[\frac{m_{TW(Std\,2)} \times m_{Rock(Std\,1)} \times (C_{TW^0(Std\,2)} - C_{TW\infty(Std\,2)}) + m_{TW(Std\,1)} \times m_{Rock(Std\,2)} \times (C_{TW\infty(Std\,1)} - C_{TW^0(Std\,1)})}{m_{Rock(Std\,1)} \times m_{Rock(Std\,2)} \times (C_{TW\infty(Std\,2)} - C_{TW\infty(Std\,1)})} \right] \times 100$$

m_{PW} = mass of porewater (g)

m_{TW} = mass of test water (g)

C_{TW} = isotopic signature of test water at the beginning of the experiment (‰)

$C_{TW\infty}$ = isotopic signature of test water after equilibration (‰)

Std 1 = Experiment 1 applying standard 1

Std 2 = Experiment 2 applying standard 2

Error calculation after Gaussian error propagation

$$\sigma(m_{PW}) = \sqrt{\begin{array}{l} \left(dm_{PW} dm_{TW(Std\,1)} \times \sigma(m_{TW(Std\,1)})\right)^2 + \left(dm_{PW} dm_{TW(Std\,2)} \times \sigma(m_{TW(Std\,2)})\right)^2 + \\ + \left(dm_{PW} dC_{TW(Std\,1)} \times \sigma(C_{TW(Std\,1)})\right)^2 + \left(dm_{PW} dC_{TW(Std\,2)} \times \sigma(C_{TW(Std\,2)})\right)^2 + \\ + \left(dm_{PW} dC_{TW\infty(Std\,1)} \times \sigma(C_{TW\infty(Std\,1)})\right)^2 + \left(dm_{PW} dC_{TW\infty(Std\,2)} \times \sigma(C_{TW\infty(Std\,2)})\right)^2 \end{array}}$$

Analytical errors (error of measurement)

$\sigma(m_{TW(Std1)})$ = 0.002 g

$\sigma(m_{TW(Std2)})$ = 0.002 g

$\sigma(C_{TW(Std1)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW(Std2)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW\infty(Std1)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

$\sigma(C_{TW\infty(Std2)})$ = 0.1 ‰ for ^{18}O and 1.0‰ for ^{2}H

Derivations

$$dm_{PW} dm_{TW(Std\,1)} = \frac{\left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right)}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)}$$

$$dm_{PW} dm_{TW(Std\,2)} = \frac{-\left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right)}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)}$$

$$dm_{PW} dC_{TW(Std\,1)} = \frac{m_{TW(Std\,1)}}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)}$$

$$dm_{PW}dC_{TW(Std\,2)} = \frac{-m_{TW(Std\,2)}}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)}$$

$$dm_{PW}dC_{TW\infty(Std\,1)} = \left(\frac{-1}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)} - \frac{\left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right)}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)^2}\right) \times m_{TW(Std\,1)} + \left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right) \times m_{TW(Std\,2)}$$

$$dm_{PW}dC_{TW\infty(Std\,2)} = \left(\frac{\left(C_{TW(Std\,1)} - C_{TW\infty(Std\,1)}\right) \times m_{TW(Std\,1)}}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)^2} + \frac{1}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)^2} - \frac{\left(C_{TW(Std\,2)} - C_{TW\infty(Std\,2)}\right)}{\left(C_{TW\infty(Std\,1)} - C_{TW\infty(Std\,2)}\right)^2}\right) \times m_{TW(Std\,2)}$$

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