P-06-186

# Forsmark site investigation

# Data report from the laboratory investigations of the transport properties of the rock.

## Data delivery for data freeze Forsmark 2.2

Eva Gustavsson, Geosigma AB

September 2006

**Svensk Kärnbränslehantering AB**
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-06-186

# Forsmark site investigation

# Data report from the laboratory investigations of the transport properties of the rock

## Data delivery for data freeze Forsmark 2.2

Eva Gustavsson, Geosigma AB

September 2006

*Keywords:* Transport properties, Porosity, Diffusivity, Batchsorption, AP PF 400-03-58, AP PF 400-06-007.

# Abstract

This report presents data gained from laboratory investigations of diffusivity and sorption characteristics at the time for data freeze Forsmark 2.2. The cored core drilled boreholes concerned in the investigation are: KFM01A, KFM01B, KFM02A, KFM03A, KFM04A, KFM05A, KFM06A, KFM06B, KFM07A and KFM08A. The rock sample collection represents major as well as minor rock types, different fracture types and different kinds of structure elements found in deformation zones at the Forsmark area. The parameters that are determined for the rock materials are: matrix porosity, porosity distribution, matrix diffusivity, BET (specific surface area), CEC (cation exchange capacity) and sorption coefficients. Discussions and interpretations of the results are not included in the present report since some of the diffusion- and batchsorption experiments still are in progress. The laboratory investigations are part of the discipline-specific programme "Transport Properties of the Rock" within the SKB site investigations.

# Sammanfattning

Föreliggande rapport redovisar resultat som erhållits från laboratoriemätningar av diffusions- och sorptionsegenskaper vid tidpunkten för datafrys Forsmark 2.2. Data från följande kärnborrhål presenteras i rapporten: KFM01A, KFM01B, KFM02A, KFM03A, KFM04A, KFM05A, KFM06A, KFM06B, KFM07A och KFM08A. Provurvalet representerar såväl huvudbergarter som sekundära bergarter, varierande spricktyper och olika strukturelement förekommande i deformationszoner inom Forsmarks platsundersökningsområde. De parametrar som bestämts är: matrisporositet, porositetsfördelning, matrisdiffusivitet, BET (specifik ytarea), CEC (katjonbytes kapacitet) och sorptionskoefficienter. Rapporten redovisar inga diskussioner eller tolkningar av resultat då ett antal mätningar av genomdiffusion samt batchsorption fortfarande pågår. Mätning av ovan nämnda egenskaper ingår i programmet för ”Bergets transportegenskaper” inom SKB:s platsundersökningar.

# Contents

# 1 Introduction

This report contains data gained from the laboratory investigations of diffusivity and sorption characteristics within the discipline-specific programme “Transport Properties of the Rock”, which is one of the activities performed within the site investigation at Forsmark. The work was carried out during the period from February 2003 to September 2006, in accordance with activity plans AP PF 400-03-58 and AP PF 400-06-007. In Table 1-1 controlling documents for performing this activity are listed. Both activity plans and method descriptions are SKB’s internal controlling documents.

The rock samples for the laboratory measurements were collected from the core drilled boreholes KFM01A, KFM01B, KFM02A, KFM03A, KFM04A, KFM05A, KFM06A, KFM06B, KFM07A and KFM08A by Eva Gustavsson and Henrik Widestrand, Geosigma AB.

This report includes all data earlier reported in SKB P-05-109, i.e the data report produced for data freeze 2.1, and will concequently replace that report. Data presented have been delivered to SICADA according to AP PF 400-03-58 and AP PF 400-06-007 and are traceable by the activity plan number. The locations of the boreholes are presented in Figure 1-1 below.

**Table 1-1. Controlling documents for performance of the activity.**

| **Activity plan** | **Number** | **Version** |
|---|---|---|
| Provtagning och analyser av borrkärna från kärnborrhål KFM01A-KFM07A för bestämning av bergets transportegenskaper | AP PF 400-03-58 | 1.0 |
| Provtagning och analyser av borrkärnor under 2006 för bestämning av bergets transportegenskaper | AP PF 400-06-007 | 1.0 |
| **Method descriptions** | **Number** | **Version** |
| Metodbeskrivning för genomdiffusionsmätning | SKB MD 540.001 | 1.0 |
| Metodbeskrivning för batchsorptionsmätning | SKB MD 540.002 | 3.0 |

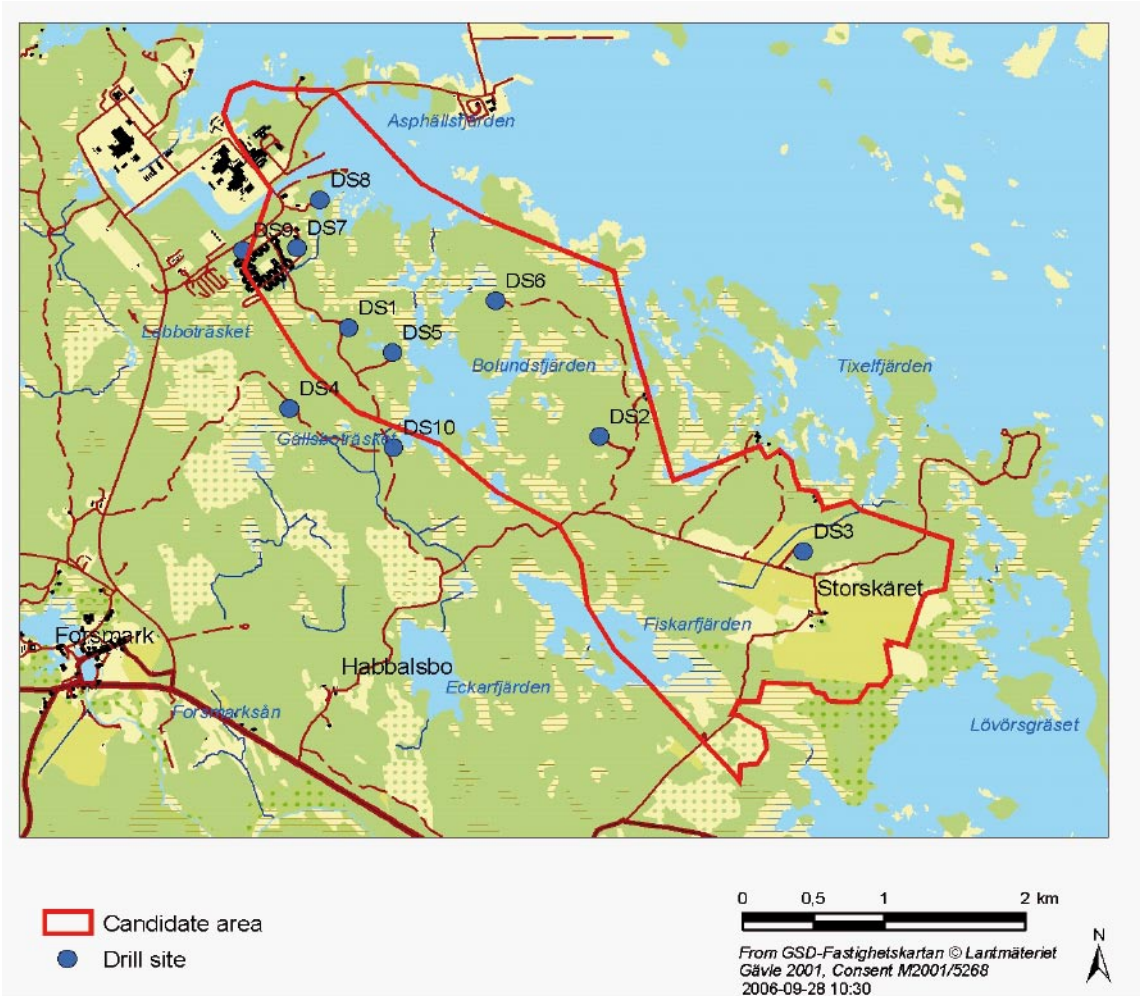


***Figure 1-1.*** *Forsmark site investigation area, including the candidate area selected for more detailed investigations. The boreholes KFM01A–KFM08A are located at drill sites DS1–DS8, respectively.*

# 2 Objective and scope

Laboratory measurements on rock samples and drill cores provide direct information on the retardation properties of the rock matrix and the fracture materials. The laboratory work is performed according to /Byegård et al. 2003/ on rock samples from different parts of the candidate area. Features as major and minor rock types, different fracture types and different kinds of structure elements which are building up deformation zones at the Forsmark area are represented in the total sample collection. The parameters that are determined for the different rock materials are:

- matrix porosity (defined as open porosity in SS-EN 1936),
- porosity distribution,
- matrix diffusivity (equivalent to effective diffusivity),
- BET specific surface area,
- CEC, cation exchange capacity,
- sorption coefficients for a number of combinations of rock materials, radionuclides and groundwater compositions.

The report includes data from cored boreholes KFM01A, KFM01B, KFM02A, KFM03A, KFM04A, KFM05A, KFM06A, KFM07A and KFM08A. Data tables are presented in Appendices 1, 2, 3 and 4. Sorption and diffusivity experiments are very time-consuming and therefore, some of the laboratory works are still in progress. Results from CEC (Cation Exchange Capacity) measurements, performed at the Swedish Geotechnical Institute (SGI), have not yet been obtained. Data from these remaining measurements will be presented in data freeze 2.3 together with a final report including interpretations and discussions of the results from the laboratory investigations of the transport properties of the rock.

Supplementary porosity investigations using the $^{14}$C-PMMA technique have been performed at the Laboratory of Radiochemistry, University of Helsinki (HYRL). The method is used to measure matrix porosity, the two-dimensional distribution of porosity and can also be used to evaluate porosity gradients in altered fracture materials or excavation disturbed materials. The results are documented in a separate report /Ikonen et al. 2006/. Electrical resistivity data, for calculating the formation factor and the effective diffusivity, are presented in two separate reports /Thunehed 2005ab/.

Brief descriptions of the laboratory methods, relevant for the data presentation in this document, are given in Chapter 3.

# 3 Laboratory measurements

## 3.1 General

Sample preparation, water porosity measurements and BET measurements were performed at the Swedish National Testing and Research Institute (SP). Through-diffusion experiments were carried out at the Chalmers University of Technology (CTH). The batch sorption experiments were made at the Royal Institute of Technology (KTH) and the Chalmers University of Technology (CTH).

## 3.2 Matrix porosity

The selected drill core samples were sent to Swedish National Testing and Research Institute (SP) for matrix porosity measurements as supporting data for the diffusion experiments. The porosity of the rock matrix can be determined in several different ways by means of laboratory measurements on slices of drill cores. The most common method is the water saturation technique, in this investigation determined according to standard method SS-EN 1936. The diameter of the core samples is c. 5.0 centimetres and the sample thickness varies from 0.5 to 5 centimetres, although the majorities of the samples are 3 centimetres.

## 3.3 Through-diffusion

Matrix diffusivity measurements are carried out by measuring how quickly an added substance diffuses through a piece of a drill core, so-called through-diffusion measurements /Ohlsson and Neretnieks 1995, Byegård et al. 1998/. The measurement is normally performed on a 1–5 cm thick sawn-out slice of a drill core placed in a measurement cell (Figure 3-1). One side of the core piece is in contact with a synthetic groundwater and the other is in contact with a synthetic groundwater tagged with the radionuclide to be studied (in this case tritiated water, HTO). Samples are then taken on the un-tagged side, and the effective diffusion coefficient, $D$e, for the rock matrix can be calculated based on the concentration increase on the un-tagged side.

The effective diffusivity is related to the water diffusivity, $D_w$, through the formation factor $F$ as:

$$D_e = F \bullet D_w$$

The rock formation factor depends only on the properties of the rock and not on the tracer or solutes properties. The formation factor includes properties such as the tortuous winding of pores (tortuosity), variations in cross-sectional area of pores (constrictivity) and the porosity of the backbone of the pores that are utilised for transport by diffusion in a certain direction (transport porosity). These properties are poorly known and cannot easily be separated from each other in measurements.

A more detailed description of through-diffusion experiments can be found in SKB MD 540.001, SKB internal document.

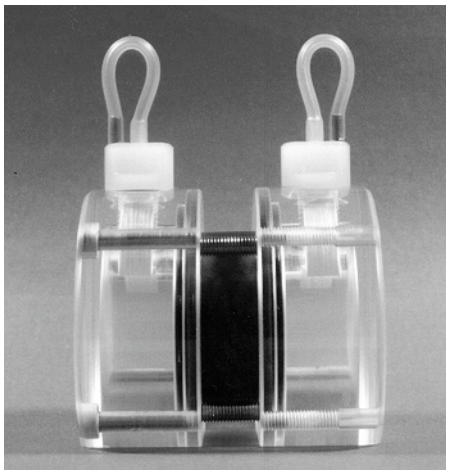

***Figure 3-1.*** *Photograph of a rock sample assembled in a diffusion cell.*

## 3.4 BET

BET (Brunauer, Emmet, Teller, see /Brunauer et al. 1938/) is a method for measuring the specific surface area of a solid material by use of gas adsorption. BET measurements have been performed on site-specific materials from Forsmark according to the ISO 9277 standard method.

The determination of specific surface area does not produce sorption coefficients (*K*d or *K*a), i.e. parameters that are used in the safety assessment calculation to determine the retardation of radionuclides due to adsorption on to mineral surfaces. However, the BET surface area, as well as the CEC, are good diagnostic parameters in order to give rough diagnoses of the sorption capacity of different geologic materials.

BET surface areas in this investigation are measured on the fractions 0.063–0.125 mm and 2–4 mm of crushed and sieved matrix rock samples together with scraped material from fracture fillings and altered bedrock, < 0.125 mm.

## 3.5 Batch sorption

In batch sorption measurements, crushed rock or mineral grains are contacted with groundwater and the distribution of a dissolved species between the aqueous and the solid phase is measured /cf. e.g. Byegård et al. 1998/. Thereby, the mass related sorption coefficient, *K*d, can be calculated from the ratio of the concentration of the species in the solid and aqueous phase. By using several different size fractions, the sorption coefficient for internal rock surfaces (*K*d) and outer surfaces (the surface related sorption coefficient, *K*a) can be estimated.

The batch sorption method is further described in SKB MD 540.002, SKB internal document.

# 4 Results

## 4.1 General

The obtained results are stored in SICADA, according to AP PF 400-03-58 and AP PF 400-06-007. Discussions of the results and evaluation of the methods are left for the future when the final results will be reported.

## 4.2 Matrix porosity

Data gained from the laboratory measurements are presented in Appendix 1. The uncertainty of a single reported porosity value is 0.09%, given with a coverage factor of 2.

## 4.3 Through-diffusion measurements

The obtained matrix diffusivities (or effective diffusivities), are presented in Appendix 2.

The data are presented as a scaled accumulated amount of tracer in the target cell $C_r$ as a function of time. The effective diffusivity $D_e$ ($m^2/s$) and the rock capacity factor α were fitted to the experimental data using Equation 1:

$$C_r = \frac{D_e t}{l^2} - \frac{\alpha}{6} - \frac{2\alpha}{\pi^2}\sum_{n=1}^{\infty}\frac{(-1)^n}{n^2}\exp\left\{-\frac{D_e n^2 \pi^2 t}{l^2 \alpha}\right\}, \quad (1)$$

where $t$ (s) is the experimental time after injection of tracer, $l$ (m) is the length of the rock sample and $n$ is the summation factor.

The latter part of the experimental data is also fitted to a simplified linear form of Equation 1, i.e.

$$C_r = \frac{D_e t}{l^2} - \frac{\alpha}{6}. \quad (2)$$

In Figure 4-1 an example of experimental through-diffusion data is presented together with the result from successful model calculations using Equation 1.

The discussion of the results as well as an evaluation of the method and the diffusion model is left for the future when final results will be reported.

## 4.4 BET measurements

The results of the BET measurements are presented in Appendix 3.

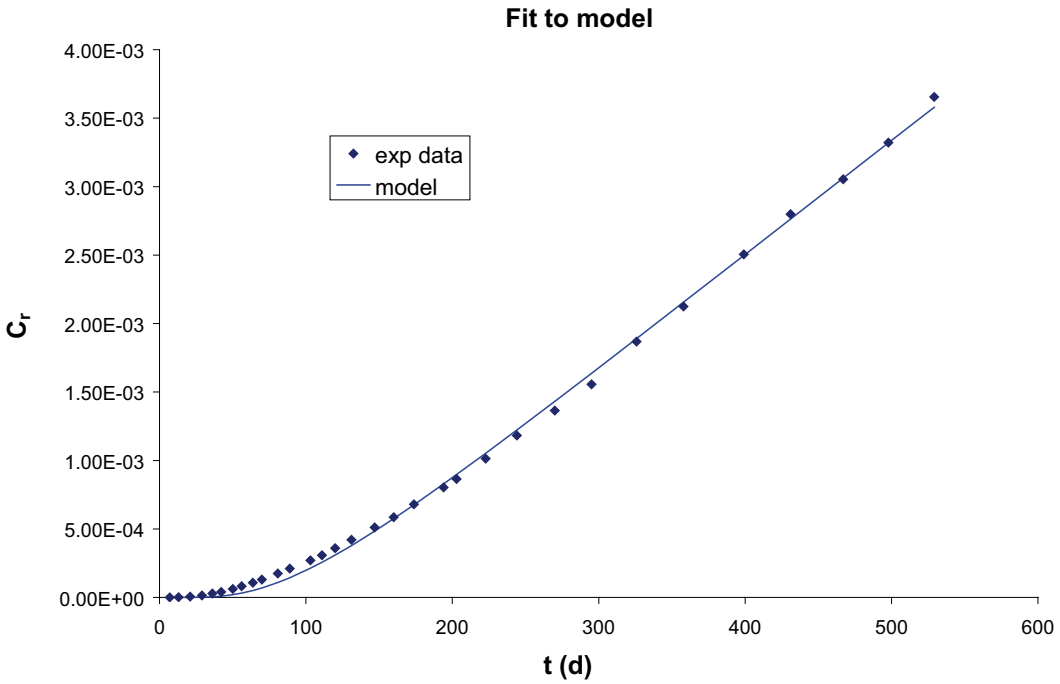


***Figure 4-1.*** *Data of measured Cr values (♦) as a function of time from a HTO through-diffusion experiment on a 5.0 cm thick sample from KFM01A (KFM01A 312.71–312.76). The solid line represents calculated Cr values using Equation 1 with De and α optimized for a fit to the experimental data.*

## 4.5 Batch sorption measurements

The sorption data are summarized in Appendix 4.

The results from the measured distribution of tracer between the rock and water phase will be interpreted as:

- Adsorption of the tracers on the outer surfaces of the rock material, determined by the surface sorption parameter, $K_a$ (m).
- Adsorption of the tracers on the inner surfaces of the rock material, determined by the volumetric sorption parameter, $K_d$ ($m^3$/kg).

The evaluation of the batch sorption experimental results to sorption parameters is done according to:

$$R_d = K_d + \frac{6K_a}{d_p \rho} \qquad (3)$$

where $R_d$ ($m^3$/kg) is the measured tracer distribution between solid and liquid phases, $d_p$ (m) is the average particle diameter, and ρ (kg/$m^3$) is the rock density. A graph of $R_d$ versus $1/d_p$ gives an intercept corresponding to the $K_d$ value, and a slope corresponding to $6K_a/\rho$, see Figure 4-2.

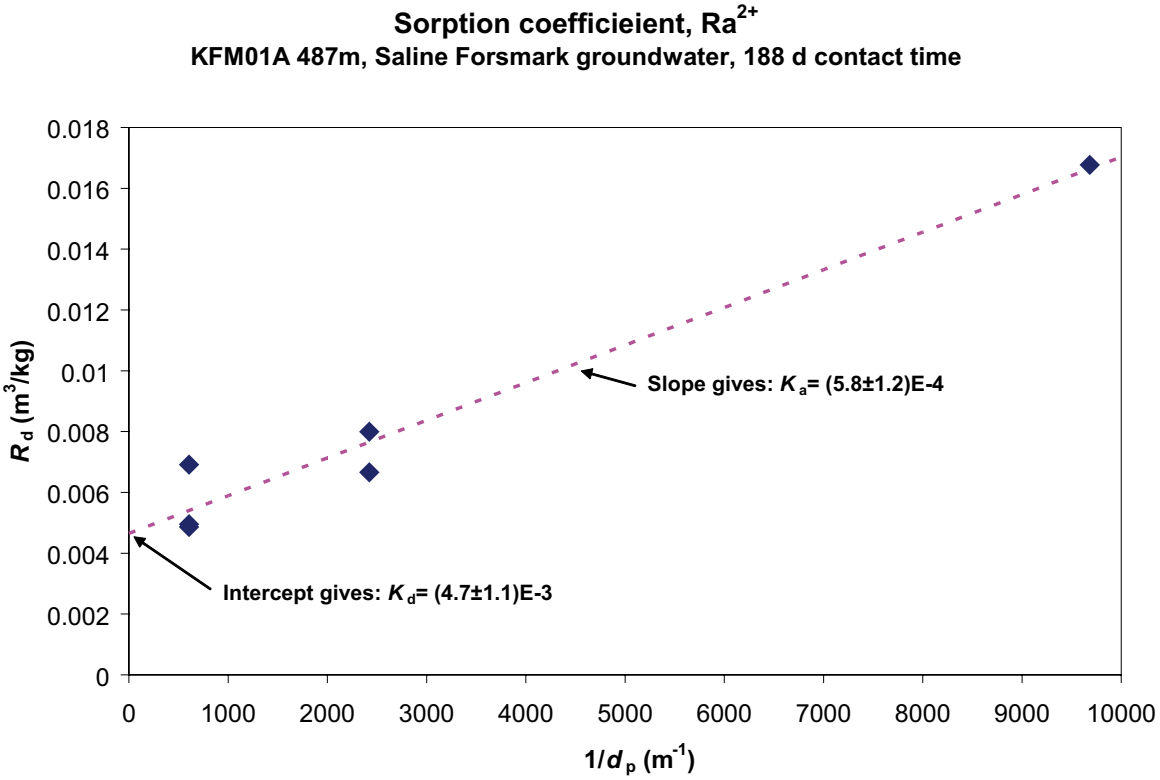


***Figure 4-2.*** *Experimental results and evaluation method from batch sorption experiments on rock sample from KFM01A, 487.10 m.*

## 4.6 Nonconformities

No nonconformities with respect to the activity plan or the method description are reported.

# 5 References

**Brunauer S, Emmet P H, Teller E, 1938.** Adsorption of gases in multimolecular layers. J. Am. Chem. Soc., 60: 309–319.

**Byegård J, Johansson H, Skålberg M, 1998.** The interaction of sorbing and non-sorbing tracers with different Äspö rock types. SKB Technical Report TR 98-18, Svensk Kärnbränslehantering AB.

**Byegård J, Ohlsson Y, Tullborg E-L, Widestrand H, 2003.** Strategy for the use of laboratory methods in the site investigations programme for the transport properties of the rock. SKB R-03-20, Svensk Kärnbränslehantering AB.

**Ikonen J, Penttinen L, Siitari-Kauppi M**, **2006.** Determination of porosity and micro fracturing using the 14C-PMMA technique in samples taken from Forsmark area. SKB P-06-60, Svensk Kärnbränslehantering AB.

**Ohlsson Y, Neretnieks I, 1995.** Literature survey of matrix diffusion theory and of experiments and data including natural analogues. SKB TR-95-12, Svensk Kärnbränslehantering AB.

**Thunehed H**, **2005a**. Forsmark site investigation. Resistivity measurements on samples from KFM01A and KFM02A. SKB P-05-26, Svensk Kärnbränslehantering AB.

**Thunehed H**, **2005b**. Forsmark site investigation. Resistivity measurements and determination of formation factors on samples from KFM03A, KFM04A and KFM05A. SKB P-05-76, Svensk Kärnbränslehantering AB.

# Appendix 1

## Matrix porosity

Appendix 1 contains matrix porosity data presented per drill-site. The uncertainty of a single reported porosity value is 0.09%, given with a coverage factor of 2.

**Table A1-1.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM01B | 23.84 | 23.87 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01B | 23.87 | 23.90 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01B | 23.90 | 23.93 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01A | 101.49 | 101.52 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM01A | 119.99 | 120.02 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.16 |
| KFM01A | 140.01 | 140.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.86 |
| KFM01A | 159.81 | 159.84 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM01A | 199.96 | 199.99 | Amphibolite | 102017 | 0.08 |
| KFM01A | 240.01 | 240.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.25 |
| KFM01A | 259.91 | 259.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.26 |
| KFM01A | 300.01 | 300.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM01A | 312.53 | 312.54 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01A | 312.54 | 312.55 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM01A | 312.56 | 312.59 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.16 |
| KFM01A | 312.59 | 312.64 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM01A | 312.65 | 312.66 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01A | 312.66 | 312.67 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM01A | 312.68 | 312.71 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.16 |
| KFM01A | 312.71 | 312.76 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM01A | 312.76 | 312.77 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.39 |
| KFM01A | 312.77 | 312.78 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM01A | 312.78 | 312.81 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.03 |
| KFM01A | 312.81 | 312.86 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.13 |
| KFM01A | 320.01 | 320.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.13 |
| KFM01A | 340.01 | 340.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.13 |
| KFM01A | 360.01 | 360.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.16 |
| KFM01A | 380.01 | 380.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.12 |
| KFM01A | 420.01 | 420.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM01A | 440.01 | 440.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM01A | 460.01 | 460.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM01A | 480.01 | 480.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM01A | 501.73 | 501.76 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM01A | 520.01 | 520.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.13 |
| KFM01A | 539.99 | 540.02 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.12 |
| KFM01A | 560.01 | 560.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM01A | 580.01 | 580.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM01A | 600.01 | 600.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM01A | 620.01 | 620.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM01A | 640.06 | 640.09 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.13 |
| KFM01A | 659.86 | 659.89 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM01A | 680.01 | 680.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.21 |
| KFM01A | 699.96 | 699.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM01A | 719.96 | 719.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM01A | 740.01 | 740.04 | Amphibolite | 102017 | 0.22 |
| KFM01A | 760.01 | 760.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM01A | 780.01 | 780.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM01A | 800.01 | 800.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.32 |
| KFM01A | 820.01 | 820.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.28 |
| KFM01A | 840.17 | 840.20 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.10 |
| KFM01A | 860.01 | 860.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.16 |
| KFM01A | 880.01 | 880.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM01A | 900.01 | 900.04 | Pegmatite, pegmatitic granite | 101061 | 0.27 |
| KFM01A | 920.01 | 920.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM01A | 940.06 | 940.09 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.33 |
| KFM01A | 960.01 | 960.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM01A | 980.01 | 980.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM01A | 999.96 | 999.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |

**Table A1-2.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM02A | 101.01 | 101.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM02A | 121.01 | 121.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.36 |
| KFM02A | 141.01 | 141.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM02A | 161.01 | 161.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.21 |
| KFM02A | 181.01 | 181.04 | Amphibolite | 102017 | 0.34 |
| KFM02A | 201.01 | 201.04 | Amphibolite | 102017 | 0.10 |
| KFM02A | 221.01 | 221.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM02A | 241.01 | 241.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM02A | 261.01 | 261.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.18 |
| KFM02A | 275.93 | 275.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 9.36 |
| KFM02A | 275.94 | 275.95 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 16.32 |
| KFM02A | 275.95 | 275.98 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 17.22 |
| KFM02A | 275.99 | 276.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 17.94 |
| KFM02A | 276.04 | 276.05 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 10.45 |
| KFM02A | 276.05 | 276.06 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 16.25 |
| KFM02A | 276.06 | 276.09 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 18.42 |
| KFM02A | 276.10 | 276.15 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 18.52 |
| KFM02A | 276.15 | 276.16 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 11.54 |
| KFM02A | 276.16 | 276.17 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 16.84 |

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM02A | 276.17 | 276.20 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 19.33 |
| KFM02A | 276.20 | 276.25 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 19.09 |
| KFM02A | 281.01 | 281.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 11.05 |
| KFM02A | 300.96 | 300.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.21 |
| KFM02A | 321.01 | 321.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM02A | 361.01 | 361.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM02A | 381.01 | 381.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.23 |
| KFM02A | 401.01 | 401.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.29 |
| KFM02A | 420.93 | 420.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.40 |
| KFM02A | 440.96 | 440.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM02A | 460.96 | 460.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.38 |
| KFM02A | 481.01 | 481.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM02A | 500.68 | 500.71 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.42 |
| KFM02A | 521.01 | 521.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM02A | 541.01 | 541.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM02A | 554.59 | 554.60 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.54 |
| KFM02A | 554.60 | 554.61 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.31 |
| KFM02A | 554.61 | 554.64 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.23 |
| KFM02A | 554.65 | 554.70 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.22 |
| KFM02A | 554.70 | 554.71 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.34 |
| KFM02A | 554.71 | 554.72 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.21 |
| KFM02A | 554.72 | 554.75 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.22 |
| KFM02A | 554.76 | 554.81 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.23 |
| KFM02A | 554.81 | 554.82 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.37 |
| KFM02A | 554.84 | 554.85 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.26 |
| KFM02A | 554.86 | 554.89 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.23 |
| KFM02A | 554.90 | 554.95 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.24 |
| KFM02A | 561.01 | 561.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.19 |
| KFM02A | 580.89 | 580.92 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM02A | 601.01 | 601.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.21 |
| KFM02A | 620.96 | 620.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.21 |
| KFM02A | 641.01 | 641.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.28 |
| KFM02A | 661.01 | 661.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM02A | 681.01 | 681.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.19 |
| KFM02A | 701.01 | 701.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM02A | 721.01 | 721.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM02A | 741.01 | 741.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM02A | 761.01 | 761.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM02A | 781.01 | 781.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM02A | 801.01 | 801.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.27 |
| KFM02A | 821.01 | 821.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM02A | 841.01 | 841.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.27 |
| KFM02A | 861.01 | 861.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.30 |
| KFM02A | 881.01 | 881.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM02A | 901.01 | 901.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM02A | 921.01 | 921.04 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.15 |
| KFM02A | 941.01 | 941.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM02A | 961.01 | 961.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.27 |
| KFM02A | 981.04 | 981.07 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM02A | 1001.01 | 1001.04 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |

**Table A1-3.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM03B | 76.74 | 76.77 | Pegmatite, pegmatitic granite | 101061 | 0.24 |
| KFM03A | 242.43 | 242.46 | Tonalite to granodiorite, metamorphic | 101054 | 0.19 |
| KFM03A | 242.46 | 242.49 | Tonalite to granodiorite, metamorphic | 101054 | 0.15 |
| KFM03A | 242.49 | 242.52 | Tonalite to granodiorite, metamorphic | 101054 | 0.17 |
| KFM03A | 311.45 | 311.48 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.15 |
| KFM03A | 367.44 | 367.47 | Pegmatite, pegmatitic granite | 101061 | 0.32 |
| KFM03A | 660.41 | 660.44 | Pegmatite, pegmatitic granite | 101061 | 0.68 |
| KFM03A | 957.67 | 957.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.13 |

**Table A1-4.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM04A | 120.04 | 120.07 | Granodiorite, metamorphic | 101056 | 0.48 |
| KFM04A | 140.03 | 140.06 | Granodiorite, metamorphic | 101056 | 0.19 |
| KFM04A | 180.02 | 180.05 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.31 |
| KFM04A | 199.93 | 199.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.21 |
| KFM04A | 220.00 | 220.03 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.51 |
| KFM04A | 239.70 | 239.73 | Amphibolite | 102017 | 9.95 |
| KFM04A | 260.00 | 260.03 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.89 |
| KFM04A | 300.04 | 300.07 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.21 |
| KFM04A | 319.09 | 319.12 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.72 |
| KFM04A | 339.83 | 339.86 | Felsic to intermediate volcanic rock, metamorphic | 103076 | 0.78 |
| KFM04A | 359.18 | 359.21 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.59 |
| KFM04A | 379.95 | 379.98 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.20 |

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM04A | 399.93 | 399.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM04A | 420.19 | 420.22 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 1.60 |
| KFM04A | 459.93 | 459.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.31 |
| KFM04A | 479.93 | 479.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.12 |
| KFM04A | 499.91 | 499.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |

**Table A1-5.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM05A | 168.34 | 168.37 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.15 |
| KFM05A | 188.03 | 188.06 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.59 |
| KFM05A | 208.82 | 208.85 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM05A | 228.13 | 228.16 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM05A | 249.03 | 249.06 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.33 |
| KFM05A | 269.66 | 269.69 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM05A | 288.85 | 288.88 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM05A | 308.55 | 308.58 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM05A | 348.25 | 348.28 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.23 |
| KFM05A | 369.23 | 369.26 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM05A | 388.93 | 388.96 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM05A | 396.59 | 396.62 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.48 |
| KFM05A | 396.62 | 396.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.58 |
| KFM05A | 396.65 | 396.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.54 |
| KFM05A | 408.75 | 408.78 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM05A | 428.92 | 428.95 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.24 |
| KFM05A | 449.35 | 449.38 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM05A | 469.83 | 469.86 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM05A | 489.36 | 489.39 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM05A | 509.07 | 509.10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.30 |
| KFM05A | 528.72 | 528.75 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.18 |
| KFM05A | 548.54 | 548.57 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.22 |
| KFM05A | 570.04 | 570.07 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.20 |
| KFM05A | 590.05 | 590.08 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.30 |
| KFM05A | 629.30 | 629.33 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.29 |
| KFM05A | 650.42 | 650.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.17 |
| KFM05A | 669.90 | 669.93 | Amphibolite | 102017 | 0.30 |
| KFM05A | 689.69 | 689.72 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.13 |
| KFM05A | 700.28 | 700.31 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.35 |
| KFM05A | 739.82 | 739.85 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.34 |
| KFM05A | 761.07 | 761.10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |

**Table A1-6.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM06B | 56.37 | 56.40 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 9.13 |
| KFM06B | 56.40 | 56.43 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 9.19 |
| KFM06A | 210.13 | 210.16 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.25 |
| KFM06A | 210.16 | 210.19 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM06A | 210.19 | 210.22 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.20 |
| KFM06A | 331.72 | 331.75 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.36 |
| KFM06A | 331.75 | 331.78 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.49 |
| KFM06A | 331.78 | 331.81 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.54 |
| KFM06A | 779.40 | 779.43 | Granite, metamorphic, aplitic | 101058 | 0.18 |

**Table A1-7.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM07A | 608.72 | 608.75 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.27 |
| KFM07A | 608.75 | 608.78 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.29 |
| KFM07A | 608.78 | 608.81 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.29 |

**Table A1-8.**

| Borehole | Secup | Seclow | Rock type | Rock code | Matrix porosity |
|---|---|---|---|---|---|
| KFM08A | 689.96 | 689.99 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.62 |
| KFM08A | 808.70 | 808.73 | Granite, metamorphic, aplitic | 101058 | 0.26 |
| KFM08A | 890.80 | 890.83 | Felsic to intermediate volcanic rock, metamorphic | 103076 | 0.36 |

# Appendix 2

## Matrix diffusivity and rock capacity factor.

Appendix 2 contains results from through-diffusion experiments. Matrix diffusivity, $D_e$, (also denoted effective diffusivity) and α, the rock capacity factor was obtained from least square fits of experimental data to Equation 1 and Equation 2 (the linear form).

**Table A2-1.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | *α* from Equation 1 | *α* from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM01B | 23.84 | 23.87 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 6.92E–14 | 7.02E–14 | 2.29E–03 | 2.37E–03 |
| KFM01B | 23.87 | 23.90 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 8.90E–14 | 8.80E–14 | n.e [1)] | n.e [1)] |
| KFM01B | 23.90 | 23.93 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 5.20E–14 | 5.10E–14 | 2.30E–03 | 2.10E–03 |
| KFM01A | 312.54 | 312.55 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.00E–13 | 2.14E–13 | 9.60E–03 | 1.43E–02 |
| KFM01A | 312.56 | 312.59 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.68E–13 | 2.80E–13 | 6.18E–03 | 7.85E–03 |
| KFM01A | 312.59 | 312.64 | 50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.60E–13 | 2.70E–13 | 3.50E–03 | 4.40E–03 |
| KFM01A | 312.66 | 312.67 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.00E–13 | 3.10E–13 | 1.50E–02 | 2.30E–02 |
| KFM01A | 312.68 | 312.71 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.10E–13 | 3.10E–13 | 5.00E–03 | 5.10E–03 |
| KFM01A | 312.71 | 312.76 | 50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.42E–13 | 2.54E–13 | 4.97E–03 | 6.01E–03 |
| KFM01A | 312.77 | 312.78 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.20E–13 | 3.30E–13 | 1.80E–02 | 2.20E–02 |
| KFM01A | 312.81 | 312.86 | 50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.60E–13 | 1.67E–13 | 3.30E–03 | 3.30E–03 |
| KFM01A | 539.99 | 540.02 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.70E–13 | 1.80E–13 | 1.70E–03 | 2.00E–03 |
| KFM01A | 740.01 | 740.04 | 30 | Amphibolite | 102017 | 6.19E–14 | 6.22E–14 | 3.87E–03 | 3.92E–03 |
| KFM01A | 999.96 | 999.99 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 9.20E–13 | 9.30E–13 | 8.80E–03 | 9.40E–03 |

[1)] Capacity factor not evaluated

**Table A2-2.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | $\alpha$ from Equation 1 | $\alpha$ from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM02A | 181.01 | 181.04 | 30 | Amphibolite | 102017 | 4.90E–14 | 4.82E–14 | 4.40E–03 | 4.10E–03 |
| KFM02A | 275.94 | 275.95 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.60E–11 | 3.50E–11 | 9.00E–02 | 8.40E–02 |
| KFM02A | 275.95 | 275.98 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.10E–11 | 3.00E–11 | 9.80E–02 | 8.40E–02 |
| KFM02A | 276.05 | 276.06 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 4.80E–11 | 4.80E–11 | 8.00E–02 | 8.00E–02 |
| KFM02A | 276.06 | 276.09 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.40E–11 | 3.30E–11 | 1.00E–01 | 9.30E–02 |
| KFM02A | 276.10 | 276.15 | 50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.40E–11 | 3.20E–11 | 8.50E–02 | 6.60E–02 |
| KFM02A | 276.16 | 276.17 | 10 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 4.40E–11 | 4.40E–11 | 8.50E–02 | 8.20E–02 |
| KFM02A | 276.17 | 276.20 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.60E–11 | 3.50E–11 | 9.50E–02 | 8.50E–02 |
| KFM02A | 276.20 | 276.25 | 50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.40E–11 | 2.10E–11 | 8.70E–02 | 6.10E–02 |
| KFM02A | 281.01 | 281.04 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.30E–11 | 1.25E–11 | 6.20E–02 | 5.81E–02 |
| KFM02A | 300.96 | 300.99 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 7.50E–13 | 7.50E–13 | 1.80E–02 | 1.80E–02 |
| KFM02A | 381.01 | 381.04 | 30 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 8.70E–14 | 8.90E–14 | 3.20E–03 | 3.60E–03 |
| KFM02A | 481.01 | 481.04 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 5.50E–14 | 5.80E–14 | 2.50E–03 | 3.00E–03 |
| KFM02A | 554.60 | 554.61 | 10 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.80E–13 | 3.80E–13 | 2.00E–02 | 2.10E–02 |
| KFM02A | 554.61 | 554.64 | 30 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.42E–13 | 3.60E–13 | 1.30E–02 | 1.50E–02 |
| KFM02A | 554.65 | 554.70 | 50 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 2.94E–13 | 2.96E–13 | 6.63E–03 | 6.68E–03 |
| KFM02A | 554.71 | 554.72 | 10 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.20E–13 | 3.20E–13 | 2.00E–02 | 2.10E–02 |
| KFM02A | 554.72 | 554.75 | 30 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.60E–13 | 3.60E–13 | 8.90E–03 | 9.05E–03 |
| KFM02A | 554.76 | 554.81 | 50 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 2.46E–13 | 2.48E–13 | 5.56E–03 | 5.71E–03 |
| KFM02A | 554.84 | 554.85 | 10 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.00E–13 | 3.00E–13 | 2.10E–02 | 2.40E–02 |
| KFM02A | 554.86 | 554.89 | 30 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.10E–13 | 3.00E–13 | 5.50E–03 | 4.40E–03 |
| KFM02A | 554.90 | 554.95 | 50 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 2.34E–13 | 2.41E–13 | 5.36E–03 | 5.97E–03 |

**Table A2-3.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | α from Equation 1 | α from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM03A | 242.43 | 242.46 | 30 | Tonalite to granodiorite, metamorphic | 101054 | 1.75E–13 | 1.76E–13 | 4.28E–03 | 4.36E–03 |
| KFM03A | 242.46 | 242.49 | 30 | Tonalite to granodiorite, metamorphic | 101054 | 1.70E–13 | 1.72E–13 | n.e [1)] | n.e [1)] |
| KFM03A | 242.49 | 242.52 | 30 | Tonalite to granodiorite, metamorphic | 101054 | 1.46E–13 | 1.52E–13 | n.e [1)] | n.e [1)] |

[1)] Capacity factor not evaluated

**Table A2-4.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | α from Equation 1 | α from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM04A | 399.93 | 399.96 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.47E–13 | 3.54E–13 | 3.69E–03 | 4.34E–03 |

**Table A2-5.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | *α* from Equation 1 | *α* from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM05A | 168.34 | 168.37 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 9.80E–14 | 1.00E–13 | 1.60E–03 | 2.20E–03 |
| KFM05A | 369.23 | 369.26 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.20E–13 | 3.2E–13 | 4.60E–03 | 4.80E–03 |
| KFM05A | 396.59 | 396.62 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 4.27E–13 | 4.18E–13 | 9.57E–03 | 8.58E–03 |
| KFM05A | 396.62 | 396.65 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.54E–13 | 3.41E–13 | 4.08E–03 | 2.80E–03 |
| KFM05A | 396.65 | 396.68 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.00E–13 | 1.00E–13 | 5.90E–03 | 5.30E–03 |
| KFM05A | 570.04 | 570.07 | 30 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 3.40E–13 | 3.70E–13 | 2.30E–03 | 4.00E–03 |
| KFM05A | 761.07 | 761.10 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.40E–13 | 3.40E–13 | 4.20E–03 | 4.00E–03 |

**Table A2-6.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | α from Equation 1 | α from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM06A | 331.72 | 331.75 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.62E–12 | 1.61E–12 | 5.13E–03 | 4.52E–03 |
| KFM06A | 331.78 | 331.81 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.20E–12 | 1.20E–12 | 1.85E–02 | 1.82E–02 |
| KFM06A | 779.40 | 779.43 | 30 | Granite, metamorphic, aplitic | 101058 | 1.31E–13 | 1.32E–13 | 1.37E–03 | 1.43E–03 |

**Table A2-7.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | α from Equation 1 | α from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM07A | 608.75 | 608.78 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.42E–12 | 1.40E–12 | 4.74E–03 | 3.53E–03 |

**Table A2-8.**

| Borehole | Secup | Seclow | Sample Length (mm) | Rock type | Rock code | $D_e$ from Equation 1 ($m^2/s$) | $D_e$ from Equation 2 ($m^2/s$) | *α* from Equation 1 | *α* from Equation 2 |
|---|---|---|---|---|---|---|---|---|---|
| KFM08A | 689.96 | 689.99 | 30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 3.06E–13 | 3.00E–13 | 7.07E–03 | 6.57E–03 |
| KFM08A | 808.70 | 808.73 | 30 | Granite, metamorphic, aplitic | 101058 | 6.33E–13 | 6.27E–13 | 7.23E–03 | 6.85E–03 |
| KFM08A | 890.80 | 890.83 | 30 | Felsic to intermediate volcanic rock, metamorphic | 103076 | 1.20E–12 | 1.30E–12 | n.e [1)] | n.e [1)] |

[1)] Capacity factor not evaluated

# Appendix 3

## BET measurements

Measured BET surface area on double samples of the fractions 0.063–0.125 mm and 2–4 mm of crushed and sieved matrix rock samples, or scraped fracture filling material, < 0.125 mm. Tables in Appendix 3 are presented per drill-site.

**Table A3-1.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.937 | | | |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 2.020 | | | |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 3.550 | | |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 3.695 | | |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 3.683 | Fracture filling |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 4.014 | Fracture filling |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.009 | | | |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.040 | | | |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.194 | | |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.209 | | |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.279 | | |
| KFM01A | 312.20 | 312.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | < 0.001 | | | |
| KFM01A | 312.20 | 312.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.005 | | | |
| KFM01A | 312.20 | 312.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.153 | | |
| KFM01A | 312.20 | 312.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.188 | | |
| KFM01A | 475.53 | 475.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.027 | | | |
| KFM01A | 475.53 | 475.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.004 | | | |
| KFM01A | 475.53 | 475.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.030 | | | |

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM01A | 475.53 | 475.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.116 | | |
| KFM01A | 475.53 | 475.68 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.170 | | |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.050 | | | |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.044 | | | |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.198 | | |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.129 | | |
| KFM01A | 520.88 | 521.00 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.005 | | | |
| KFM01A | 520.88 | 521.00 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.023 | | | |
| KFM01A | 520.88 | 521.00 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.120 | | |
| KFM01A | 520.88 | 521.00 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.135 | | |
| KFM01A | 703.25 | 703.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.015 | | | |
| KFM01A | 703.25 | 703.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.009 | | | |
| KFM01A | 703.25 | 703.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.090 | | |
| KFM01A | 703.25 | 703.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.101 | | |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.029 | | | |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.031 | | | |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.156 | | |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.074 | | |



**Table A3-2.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM02A | 118.25 | 118.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.678 | | | fracture filling |
| KFM02A | 118.25 | 118.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 1.657 | | | fracture filling |
| KFM02A | 118.25 | 118.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 5.302 | | fracture filling |

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM02A | 243.50 | 243.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.189 | | | |
| KFM02A | 243.50 | 243.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.202 | | | |
| KFM02A | 243.50 | 243.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.780 | | |
| KFM02A | 243.50 | 243.70 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.763 | | |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.256 | | | episyenit |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.285 | | | episyenit |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 1.573 | | episyenit |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 1.592 | | episyenit |
| KFM02A | 350.00 | 350.27 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.058 | | | |
| KFM02A | 350.00 | 350.27 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.047 | | | |
| KFM02A | 350.00 | 350.27 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.294 | | |
| KFM02A | 350.00 | 350.27 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.286 | | |
| KFM02A | 552.00 | 552.23 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.033 | | | |
| KFM02A | 552.00 | 552.23 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.048 | | | |
| KFM02A | 552.00 | 552.23 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.341 | | |
| KFM02A | 552.00 | 552.23 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.340 | | |
| KFM02A | 711.48 | 711.73 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.026 | | | |
| KFM02A | 711.48 | 711.73 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.018 | | | |
| KFM02A | 711.48 | 711.73 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.224 | | |
| KFM02A | 711.48 | 711.73 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.237 | | |
| KFM02A | 915.53 | 915.70 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.183 | | | |
| KFM02A | 915.53 | 915.70 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.015 | | | |
| KFM02A | 915.53 | 915.70 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.183 | | |
| KFM02A | 915.53 | 915.70 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.162 | | |

**Table A3-3.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM03A | 242.93 | 243.13 | Tonalite to granodiorite, metamorphic | 101054 | 0.049 | | | |
| KFM03A | 242.93 | 243.13 | Tonalite to granodiorite, metamorphic | 101054 | 0.036 | | | |
| KFM03A | 242.93 | 243.13 | Tonalite to granodiorite, metamorphic | 101054 | | 0.290 | | |
| KFM03A | 242.93 | 243.13 | Tonalite to granodiorite, metamorphic | 101054 | | 0.246 | | |
| KFM03A | 311.01 | 311.21 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.024 | | | |
| KFM03A | 311.01 | 311.21 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.020 | | | |
| KFM03A | 311.01 | 311.21 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.321 | | |
| KFM03A | 311.01 | 311.21 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.320 | | |
| KFM03A | 367.52 | 367.72 | Pegmatite, pegmatitic granite | 101061 | 0.025 | | | |
| KFM03A | 367.52 | 367.72 | Pegmatite, pegmatitic granite | 101061 | 0.030 | | | |
| KFM03A | 367.52 | 367.72 | Pegmatite, pegmatitic granite | 101061 | 0.005 | | | |
| KFM03A | 367.52 | 367.72 | Pegmatite, pegmatitic granite | 101061 | | 0.227 | | |
| KFM03A | 367.52 | 367.72 | Pegmatite, pegmatitic granite | 101061 | | 0.239 | | |
| KFM03A | 536.47 | 536.67 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.015 | | | |
| KFM03A | 536.47 | 536.67 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.011 | | | |
| KFM03A | 536.47 | 536.67 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.204 | | |
| KFM03A | 536.47 | 536.67 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.248 | | |
| KFM03A | 643.80 | 644.17 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 10.550 | fracture filling |
| KFM03A | 643.80 | 644.17 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 10.003 | fracture filling |
| KFM03A | 660.18 | 660.39 | Pegmatite, pegmatitic granite | 101061 | 0.055 | | | |
| KFM03A | 660.18 | 660.39 | Pegmatite, pegmatitic granite | 101061 | 0.048 | | | |
| KFM03A | 660.18 | 660.39 | Pegmatite, pegmatitic granite | 101061 | | 0.318 | | |
| KFM03A | 660.18 | 660.39 | Pegmatite, pegmatitic granite | 101061 | | 0.296 | | |

**Table A3-4.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM04A | 141.75 | 141.90 | Granodiorite, metamorphic | 101056 | | | 7.665 | fracture filling |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | | 0.425 | fracture filling |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | | 0.434 | fracture filling |
| KFM04A | 414.14 | 414.34 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | | 2.041 | fracture filling |
| KFM04A | 414.20 | 414.40 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | | 1.172 | fracture filling |
| KFM04A | 694.70 | 694.90 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.012 | | | |
| KFM04A | 694.70 | 694.90 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.023 | | | |
| KFM04A | 694.70 | 694.90 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.158 | | |
| KFM04A | 694.70 | 694.90 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.167 | | |



**Table A3-5.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2-4 mm ($m^2/g$) | BET 0.063-0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM05A | 570.09 | 570.24 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.0194 | | | |
| KFM05A | 570.09 | 570.24 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.034 | | | |
| KFM05A | 570.09 | 570.24 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.290 | | |
| KFM05A | 570.09 | 570.24 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.209 | | |
| KFM05A | 627.85 | 628.02 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 2.867 | altered bedrock |
| KFM05A | 627.85 | 628.02 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 2.450 | altered bedrock |

**Table A3-6.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063-0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM06B | 56.25 | 56.32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 7.505 | altered bedrock |
| KFM06B | 56.25 | 56.32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | | 7.583 | altered bedrock |
| KFM06A | 440.13 | 440.60 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.032 | | | |
| KFM06A | 440.13 | 440.60 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0.038 | | | |
| KFM06A | 440.13 | 440.60 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.264 | | |
| KFM06A | 440.13 | 440.60 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0.274 | | |
| KFM06A | 541.08 | 541.43 | Amphibolite | 102017 | 0.039 | | | |
| KFM06A | 541.08 | 541.43 | Amphibolite | 102017 | 0.038 | | | |
| KFM06A | 541.08 | 541.43 | Amphibolite | 102017 | | 0.304 | | |
| KFM06A | 541.08 | 541.43 | Amphibolite | 102017 | | 0.327 | | |
| KFM06A | 601.86 | 602.26 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.045 | | | |
| KFM06A | 601.86 | 602.26 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.027 | | | |
| KFM06A | 601.86 | 602.26 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.279 | | |
| KFM06A | 601.86 | 602.26 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.296 | | |
| KFM06A | 611.68 | 611.91 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.687 | | | brecciated rock sealed with laumontite |
| KFM06A | 611.68 | 611.91 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | 0.876 | | | brecciated rock sealed with laumontite |
| KFM06A | 611.68 | 611.91 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.667 | | brecciated rock sealed with laumontite |
| KFM06A | 611.68 | 611.91 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | | 0.613 | | brecciated rock sealed with laumontite |

**Table A3-7.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM07A | 387,47 | 387,87 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,026 | | | |
| KFM07A | 387,47 | 387,87 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,038 | | | |
| KFM07A | 387,47 | 387,87 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,212 | | |
| KFM07A | 387,47 | 387,87 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,215 | | |
| KFM07A | 608,92 | 609,32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,027 | | | |
| KFM07A | 608,92 | 609,32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,021 | | | |
| KFM07A | 608,92 | 609,32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,122 | | |
| KFM07A | 608,92 | 609,32 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,189 | | |



**Table A3-8.**

| Borehole | Secup | Seclow | Rock type | Rock code | BET 2–4 mm ($m^2/g$) | BET 0.063–0.125 mm ($m^2/g$) | BET < 0.125 mm ($m^2/g$) | Comment |
|---|---|---|---|---|---|---|---|---|
| KFM08A | 412,04 | 412,30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,335 | | | |
| KFM08A | 412,04 | 412,30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | 0,349 | | | |
| KFM08A | 412,04 | 412,30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,745 | | |
| KFM08A | 412,04 | 412,30 | Granite to granodiorite, metamorphic, medium-grained | 101057 | | 0,732 | | |
| KFM08A | 808,54 | 808,70 | Granite, metamorphic, aplitic | 101058 | 0,049 | | | |
| KFM08A | 808,54 | 808,70 | Granite, metamorphic, aplitic | 101058 | 0,055 | | | |
| KFM08A | 808,54 | 808,70 | Granite, metamorphic, aplitic | 101058 | | 0,182 | | |
| KFM08A | 808,54 | 808,70 | Granite, metamorphic, aplitic | 101058 | | 0,184 | | |
| KFM08A | 890,90 | 891,21 | Felsic to intermediate volcanic rock, metamorphic | 103076 | 0,051 | | | |
| KFM08A | 890,90 | 891,21 | Felsic to intermediate volcanic rock, metamorphic | 103076 | 0,042 | | | |
| KFM08A | 890,90 | 891,21 | Felsic to intermediate volcanic rock, metamorphic | 103076 | | 0,203 | | |
| KFM08A | 890,90 | 891,21 | Felsic to intermediate volcanic rock, metamorphic | 103076 | | 0,207 | | |

# Appendix 4

## Batch sorption measurements

Sorption coefficient, $K_d$, for a number of combinations of rock materials, radio nuclides and groundwater compositions. The different groundwater types used are: fresh water (F), marine water (M), saline water Forsmark (SaF) and Brine water (B).

**Table A4-1.**

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 3.000E–01 | < 6.000E–03 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 3.000E–02 | 5.000E–02 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ra | 4.000E–01 | < 2.000E–02 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ni | 4.000E–01 | < 1.000E–02 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Np | < 6.000E–03 | 6.000E–03 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | U | 3.000E–03 | < 3.000E–04 | F |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 4.000E–02 | < 1.000E–03 | SaF |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 5.000E–04 | < 6.000E–05 | SaF |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ra | 6.000E–02 | < 1.000E–03 | SaF |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ni | 3.000E–01 | 1.000E–02 | SaF |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Np | < 3.000E–02 | 1.000E–02 | SaF |
| KFM01B | 47.72 | 47.82 | Granite to granodiorite, metamorphic, medium-grained | 101057 | U | < 2.000E–01 | < 2.000E–02 | SaF |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 6.000E–02 | | F |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 4.000E–01 | | F |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 4.000E–03 | | M |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 4.000E–04 | | M |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 1.000E–03 | | B |
| KFM01B | 418.80 | 418.94 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 5.000E–04 | | B |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 3.000E–02 | 2.000E–02 | F |

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 4.000E–03 | 5.000E–04 | F |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 6.000E–03 | 9.000E–03 | SaF |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 1.000E–04 | < 1.000E–05 | SaF |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 6.000E–03 | 4.000E–03 | M |
| KFM01A | 103.46 | 103.65 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 3.000E–04 | < 2.000E–05 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 8.000E–03 | 5.000E–03 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 3.000E–04 | 4.000E–05 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ra | 5.000E–03 | 6.000E–04 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ni | 3.000E–02 | 4.000E–03 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Np | < 3.000E–01 | 1.000E–01 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | U | < 2.000E–02 | 1.000E–02 | SaF |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 2.000E–03 | 1.000E–03 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 4.000E–04 | 5.000E–05 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ra | 6.000E–03 | 7.000E–04 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Ni | 2.000E–02 | 2.000E–03 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Np | < 6.000E–02 | 3.000E–02 | M |
| KFM01A | 487.10 | 487.50 | Granite to granodiorite, metamorphic, medium-grained | 101057 | U | < 9.000E–03 | 5.000E–03 | M |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 1.000E–03 | 1.400E–03 | SaF |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 5.000E–04 | < 4.000E–05 | SaF |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 6.000E–04 | 5.000E–04 | M |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 3.000E–04 | < 3.000E–05 | M |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 1.000E–03 | 5.000E–04 | B |
| KFM01A | 908.18 | 908.36 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 2.000E–04 | < 1.000E–05 | B |

**Table A4-2.**

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 4.000E–03 | 5.000E–03 | F |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 5.000E–03 | 2.000E–03 | F |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 3.000E–03 | < 3.000E–04 | M |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 6.000E–04 | 5.000E–05 | M |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 6.000E–04 | 2.000E–04 | B |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 5.000E–04 | < 5.000E–05 | B |

**Table A4-3.**

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 4.000E–01 | | F |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | 7.000E–02 | | F |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 1.400E–01 | | SaF |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 6.000E–04 | | SaF |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 1.800E–02 | | M |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 4.000E–04 | | M |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 4.000E–03 | | B |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 5.000E–04 | | B |

**Table A4-2.**

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 4.000E–03 | 5.000E–03 | F |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 5.000E–03 | 2.000E–03 | F |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | < 3.000E–03 | < 3.000E–04 | M |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | 6.000E–04 | 5.000E–05 | M |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Cs | 6.000E–04 | 2.000E–04 | B |
| KFM02A | 275.22 | 275.45 | Granite to granodiorite, metamorphic, medium-grained | 101057 | Sr | < 5.000E–04 | < 5.000E–05 | B |

**Table A4-3.**

| Borehole | Secup | Seclow | Rock type | Rock code | Tracer | Sorption koefficient Kd | Surface sorption koefficient Ka | Water composition |
|---|---|---|---|---|---|---|---|---|
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 4.000E–01 | | F |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | 7.000E–02 | | F |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 1.400E–01 | | SaF |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 6.000E–04 | | SaF |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 1.800E–02 | | M |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 4.000E–04 | | M |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Cs | 4.000E–03 | | B |
| KFM04A | 377.16 | 377.78 | Granite, granodiorite and tonalite, metamorphic, fine- to medium-grained | 101051 | Sr | < 5.000E–04 | | B |