

## **Forsmark site investigation**

### **Drill hole KFM01A**

### **Determination of porosity by water saturation and density by buoyancy technique**

M Savukoski

SP Swedish National Testing and Research Institute

January 2004

**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



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*Keywords:* AP PF 400-03-18, Field note no Forsmark 96, Rock mechanics, Petro physics, Density, Porosity.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author and do not necessarily coincide with those of the client.

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## **Abstract**

The density and porosity has been determined on 26 specimens from drill hole KFM01A, Forsmark, Sweden. The specimens were collected from four levels of the drill hole: c 230, 390, 490 and 690 m. The investigated rock types are mapped as medium grained metagranite. The results for dry density varied between 2,650 and 2,660 kg/m<sup>3</sup>, for wet density between 2,650 and 2,660 kg/m<sup>3</sup>, and for porosity between 0.1 and 0.4%.

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# 1 Introduction

The laboratory test program presented in this report for determination of porosity and density of drill core samples from Forsmark, Sweden, was performed in compliance with the activity plan AP PF 400-03-18 (SKB internal controlling document), and is part of the on-going site investigation for a deep repository.

The specimens were sampled from the drill core of borehole KFM01A in the Forsmark area on February 24<sup>th</sup> 2003 by Rolf Christiansson, Swedish Nuclear & Waste Management Co (SKB) and Urban Åkesson, The Swedish National Testing and Research Institute (SP). Specimens were taken from four levels of the rock core: level 1 between 226 and 236 m, level 2 between 389 and 390 m, level 3 between 492 and 495 mm and level 4 between 691–699 m (borehole length). The samples were selected based on the preliminary core logging, and with the strategy to primarily investigate the properties of the dominant rock types. The rock samples were transported by SP from Forsmark and arrived at SP on February 25<sup>th</sup> 2003. The testing was performed during August 2003 and January 2004.

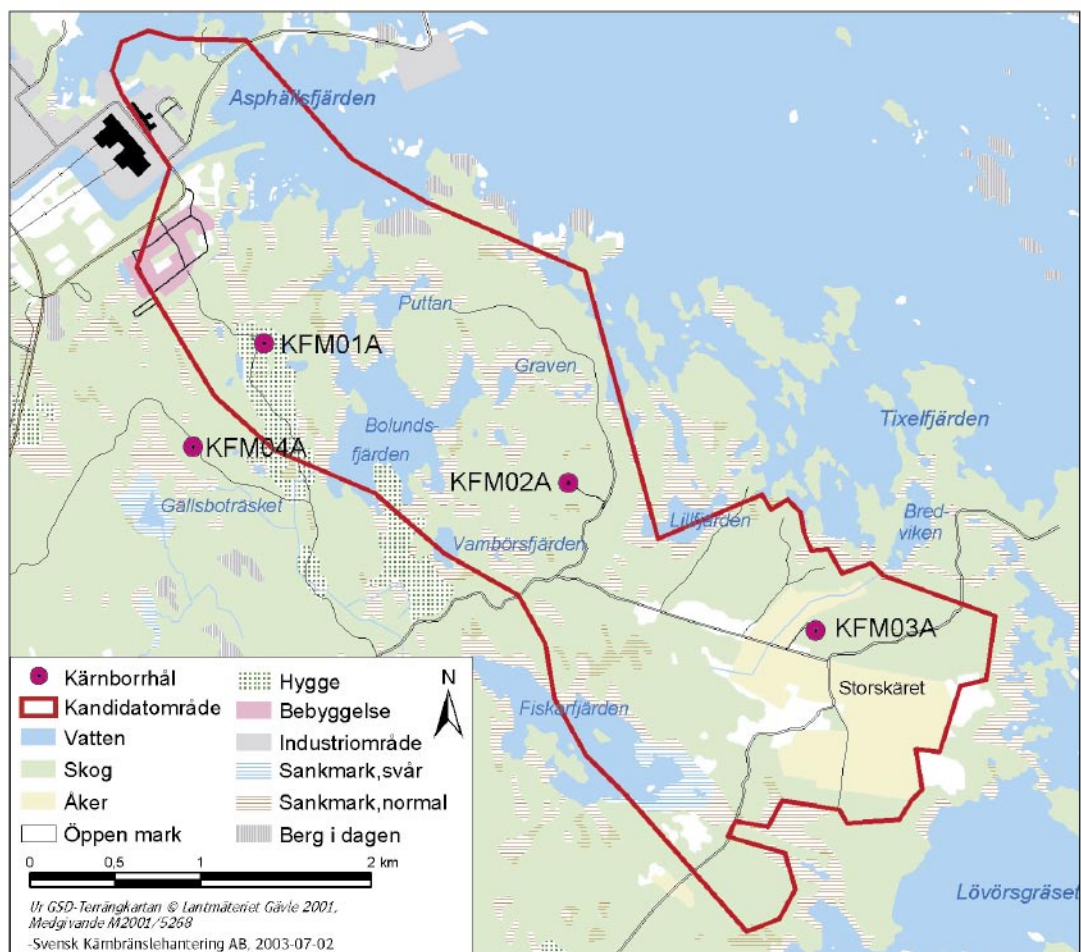


Figure 1-1. Location of drill hole KFM01A at the Forsmark site.

## **2 Objective and scope**

The purpose of the testing is to determine the density and porosity of intact rock core samples. The parameters are used in the rock mechanics and thermal site descriptive model, which will be established for the candidate area selected for site investigations at Forsmark.

The samples originate from borehole KFM01A at Forsmark, which is a near-vertical telescopic borehole of SKB-chemistry type with a borehole length of c 1,000 m. The samples in this report are collected from four different levels.

### 3 Equipment

The following equipment was used for the analyses:

- Thermometer (inv no 102080) for measurements of water temperature. Calibrated 2003-01-07. Uncertainty of measurement  $\pm 0.4^{\circ}\text{C}$ .
- Scale (inv no 102084) for weight measurements. Calibrated 2003-03-19. Uncertainty of measurement  $\pm 0.2$  g.
- Heating chamber (inv no 102065) for drying the specimens. Calibrated 2003-02-21. Uncertainty of measurement  $\pm 5^{\circ}\text{C}$ .
- A covered plastic box filled with water for water saturation of the samples.
- A desiccator for cooling samples.

Uncertainty of method as expanded uncertainty covering factor 2 (95% confidence interval):

Density  $\pm 4$  kg/m<sup>3</sup>

Porosity  $\pm 0.09\%$

Water absorption  $\pm 0.05\%$

## 4 Execution

Determination of the porosity and density was made in accordance with SKB's method description SKB MD 160.002, version 1.9 (SKB internal controlling document). This includes determination of density in accordance with ISRM 1979, volume 16, number 2, water saturation by EN 13755 and in compliance with Activity plan AP PF 400 03 18 (SKB internal controlling document). The department of Building Technology and Mechanics (BM) at SP performed the tests.

### 4.1 Description of the samples

Specimens were sampled from four levels in borehole KFM01A. Core drilling of the borehole started at a borehole length of c 100 m. Sampling level 1 ranges between 226 and 236 m, level 2 between 389 and 390 m, level 3 between 492 and 495 m and level 4 between 691–699 m. Table 4-1 presents the rock type and identification marks of the specimens.

**Table 4-1. Rock type and identification marks (rock-type classification according to Boremap).**

Identification	Sampling depth (Seclow)	Rock type
KFM01A-090V-1	235.23	Meta granodiorite - granite
KFM01A-090V-2	235.35	Meta granodiorite – granite
KFM01A-090V-3	231.28	Meta granodiorite – granite
KFM01A-090V-4	226.80	Meta granodiorite – granite
KFM01A-090V-5	227.02	Meta granodiorite - granite
KFM01A-090V-6	389.04	Meta granodiorite – granite
KFM01A-090V-7	389.15	Meta granodiorite – granite
KFM01A-090V-8	389.27	Meta granodiorite – granite
KFM01A-090V-9	389.38	Meta granodiorite – granite
KFM01A-090V-10	389.68	Meta granodiorite – granite
KFM01A-090V-11	492.51	Meta granodiorite - granite
KFM01A-090V-12	493.85	Meta granodiorite – granite
KFM01A-090V-13	493.97	Meta granodiorite – granite
KFM01A-090V-14	494.09	Meta granodiorite – granite
KFM01A-090V-15	494.20	Meta granodiorite – granite
KFM01A-090V-16	494.32	Meta granodiorite – granite
KFM01A-090V-17	494.43	Meta granodiorite – granite
KFM01A-090V-18	494.62	Meta granodiorite – granite
KFM01A-090V-19	494.74	Meta granodiorite – granite
KFM01A-090V-20	494.94	Meta granodiorite – granite
KFM01A-090V-21	691.79	Meta granodiorite – granite
KFM01A-090V-22	691.90	Meta granodiorite – granite
KFM01A-090V-23	692.02	Meta granodiorite – granite
KFM01A-090V-24	692.14	Meta granodiorite – granite
KFM01A-090V-25	698.47	Meta granodiorite – granite
KFM01A-090V-26	698.58	Meta granodiorite - granite



## 4.2 Testing

The execution procedure followed the prescription in SKB MD 160.002, version 1.0 (SKB internal controlling document) and the activities described in Table 4-2 were performed:

**Table 4-2. The sequence of activities applied for execution of the commission.**

Activity no	Activity
1	The specimens were cut according to the marks on the rock cores. Every specimen was cut in two pieces, marked A and B, about 25 mm thick each. The same specimens as were used to test the thermal properties heat conductivity and heat capacity with the TPS method.
2	The specimens were photographed in JPEG-format.
3	The specimens were water saturated in normal air pressure for at least seven days. The temperature of the water used for water saturation was 21.9 and 18.4°C and the density of the water was 998 respectively 999 kg/m <sup>3</sup> .
4	The specimens were weighed submerged in tapwater (see Appendix 3).
5	The specimens were surface dried with a towel and weighed.
6	The water saturated density was determined (see Appendix 3).
7	The samples were sent from SP Building and Mechanics to SP Fire Technology for measurement of thermal properties.
8	The samples were sent back from SP Fire Technology to SP Building and Mechanics.
9	The specimens were dried in a heating chamber at 105°C during one week after water saturation.
10	The specimens were transported to a desiccator for cooling.
11	The dry density and porosity were determined (see Appendix 3).

## 4.3 Nonconformities

None.

## 5 Results

Data resulting from this activity are stored in the SKB database SICADA under field note no Forsmark 96.

Protocols, calculations and photos are presented in Appendix 1–3.

### 5.1 Summary of porosity, dry density and wet density determinations

A summary of the results of porosity and density determinations is displayed in Tables 5-1, 5-2, 5-3 and 5-4 as well as in the diagrams in Figures 5-1, 5-2 and 5-3 below.

**Table 5-1. Summary of the results of porosity, dry density and wet density determinations of the specimens from 226.80–235.35 m. The result for each specimen is a mean value of subsample A and B.**

Specimen	Sampling depth, according to the marks on the drill-core boxes (Seclow) (m)	Porosity (%)	Dry density (kg/m <sup>3</sup> )	Wet density (kg/m <sup>3</sup> )
KFM01A-90V-1	235.23	0.4	2,660	2,660
KFM01A-90V-2	235.35	0.4	2,660	2,660
KFM01A-90V-3	231.28	0.3	2,650	2,660
KFM01A-90V-4	226.80	0.4	2,650	2,660
KFM01A-90V-5	227.02	0.2	2,660	2,660
<b>Mean value</b>		0.3	2,660	2,660
<b>Standard deviation</b>		0.09	2	2

**Table 5-2. Summary of the results of porosity, dry density and wet density determinations of the specimens from 389.04–389.68 m. The result for each specimen is a mean value of subsample A and B.**

Specimen	Sampling depth, according to the marks on the drill-core boxes (Seclow) (m)	Porosity (%)	Dry density (kg/m <sup>3</sup> )	Wet density (kg/m <sup>3</sup> )
KFM01A-90V-6	389.04	0.1	2,650	2,650
KFM01A-90V-7	389.15	0.2	2,660	2,660
KFM01A-90V-8	389.27	0.2	2,660	2,660
KFM01A-90V-9	389.38	0.2	2,650	2,660
KFM01A-90V-10	389.68	0.2	2,660	2,660
<b>Mean value</b>		0.2	2,660	2,660
<b>Standard deviation</b>		0.04	3	3

**Table 5-3. Summary of the results of porosity, dry density and wet density determinations of the specimens from seclow 492.51 m to 494.94 m. The result for each specimen is a mean value of subsample A and B.**

Specimen	Sampling depth, according to the marks on the drill-core boxes (Seclow) (m)	Porosity (%)	Dry density (kg/m <sup>3</sup> )	Wet density (kg/m <sup>3</sup> )
KFM01A-90V-11	492.51	0.3	2,650	2,660
KFM01A-90V-12	493.85	0.3	2,660	2,660
KFM01A-90V-13	493.97	0.3	2,650	2,660
KFM01A-90V-14	494.09	0.3	2,660	2,660
KFM01A-90V-15	494.20	0.2	2,660	2,660
KFM01A-90V-16	494.32	0.3	2,650	2,650
KFM01A-90V-17	494.43	0.3	2,650	2,650
KFM01A-90V-18	494.62	0.3	2,650	2,660
KFM01A-90V-19	494.74	0.3	2,650	2,660
KFM01A-90V-20	494.94	0.3	2,650	2,660
<b>Mean value</b>		0.3	2,650	2,660
<b>Standard deviation</b>		0.02	3	3

**Table 5-4. Summary of the results of porosity, dry density and wet density determinations of the specimens from 691.79 m to 698.58 m. The result for each specimen is a mean value of subsample A and B.**

Specimen	Sampling depth, according to the marks on the drill-core boxes (Seclow) (m)	Porosity (%)	Dry density (kg/m <sup>3</sup> )	Wet density (kg/m <sup>3</sup> )
KFM01A-90V-21	691.79	0.3	2,660	2,660
KFM01A-90V-22	691.90	0.3	2,660	2,660
KFM01A-90V-23	692.02	0.2	2,660	2,660
KFM01A-90V-24	692.14	0.2	2,660	2,660
KFM01A-90V-25	698.47	0.3	2,650	2,660
KFM01A-90V-26	698.58	0.3	2,650	2,660
<b>Mean value</b>		0.3	2,660	2,660
<b>Standard deviation</b>		0.03	2	2

## 5.2 Discussion

The measurements were performed at two separate occasions. The first ten samples were measured in July 2003 according EN 13755, to compare different methods for density and porosity measurements, see report nr: P-04-93. The rest of the specimens were measured in January 2004 with no deviations.

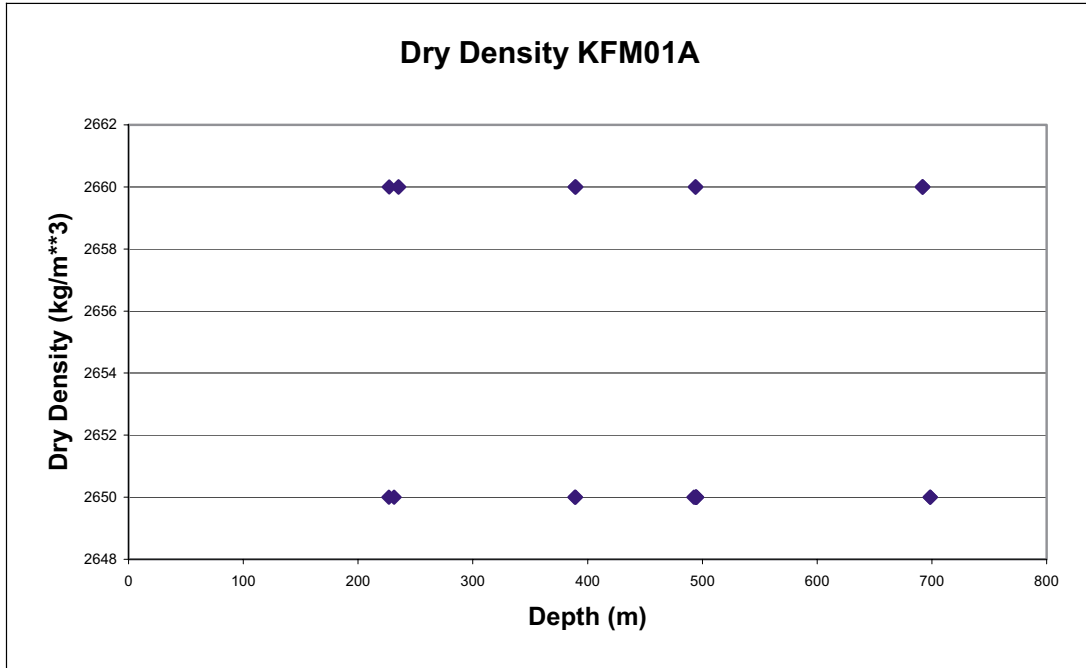


Figure 5-1. Density (dry) versus sampling depth.

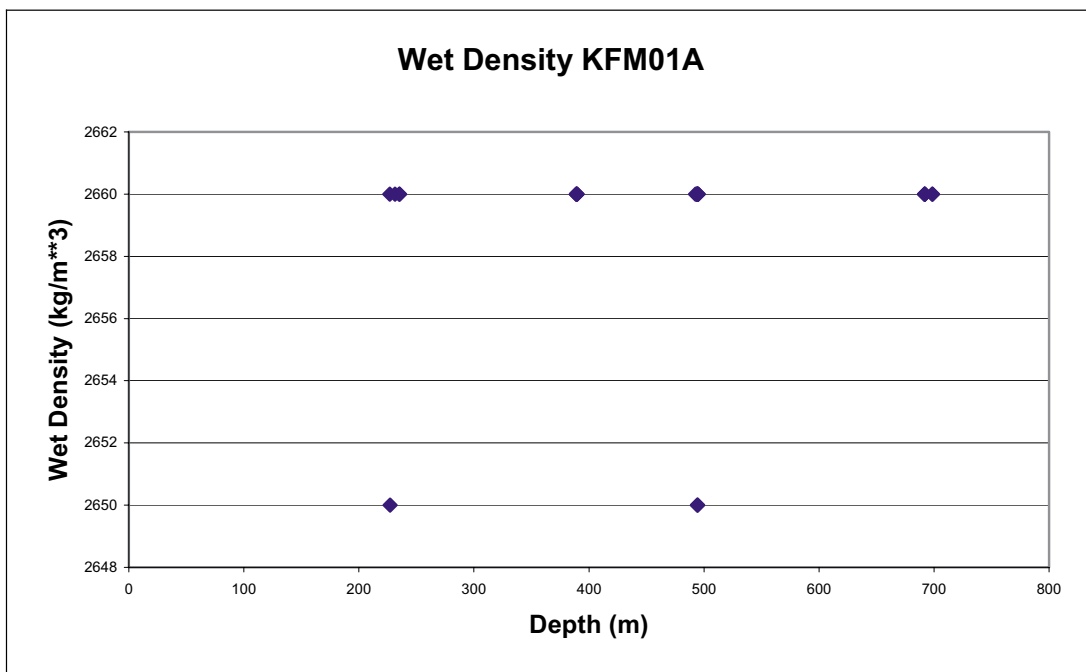
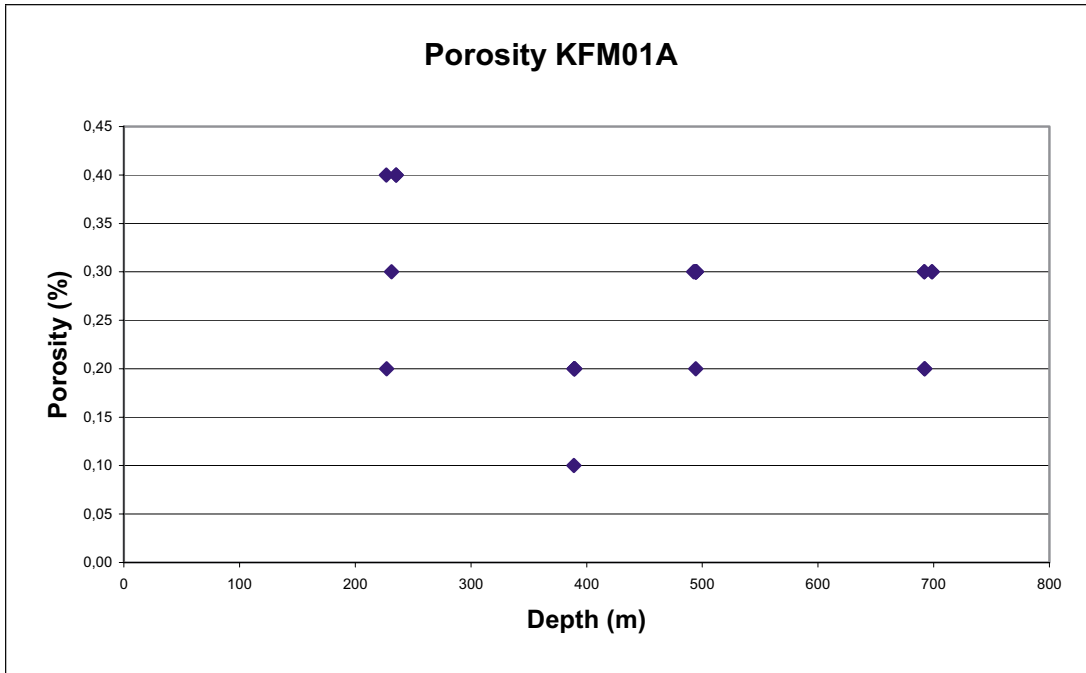


Figure 5-2. Density (wet) versus sampling depth.



*Figure 5-3. Porosity versus sampling depth.*

## References

**ISRM 1979.** Volume 16, Number 2.




**EN 13755.** Natural stone test methods – Determination of water absorption at atmospheric pressure.

**Sandström M, 2003.** Comparison of three test methods for determination of water absorption and wet density of intact rock. Forsmark, drill hole KFM01A. Simpevarp, drill hole KSH01A. SKB P-04-93. Svensk Kärnbränslehantering AB.

**Results and pictures**

**KFM01A: Density and porosity**

**Table 1:** Level 1 226–236 m, specimens KFM01A-090V-1 to KFM01A-090V-5

<p><b>KFM01A-90V-1 (235.23)</b></p> <p>The dry density for specimen KFM01A-90V-1A was measured to be 2,670 kg/m<sup>3</sup> and the porosity to 0.4% and the dry density for specimen KFM01A-90V-1B was measured to be 2,650 kg/m<sup>3</sup> and the porosity to 0.4%.</p>	<p><b>Fig. 1.</b> Specimen KFM01A-90V-1.</p> 
<p><b>KFM01A-90V-2 (235.35)</b></p> <p>The dry density for specimen KFM01A-90V-2A was measured to be 2,660 kg/m<sup>3</sup> and the porosity to 0.4% and the dry density for specimen KFM01A-90V-2B was measured to be 2,660 kg/m<sup>3</sup> and the porosity to 0.3%.</p>	<p><b>Fig. 2.</b> Specimen KFM01A-90V-2</p> 
<p><b>KFM01A-90V-3 (231.28)</b></p> <p>The dry density for specimen KFM01A-90V-3A was measured to be 2,660 kg/m<sup>3</sup> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-3B was measured to be 2,650 kg/m<sup>3</sup> and the porosity to 0.4%.</p>	<p><b>Fig. 3.</b> Specimen KFM01A-90V-3</p> 

**KFM01A-90V-4 (236.29)**

The dry density for specimen KFM01A-90V-4A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.4% and the dry density for specimen KFM01A-90V-4B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.4%.

**Fig. 4.** Specimen KFM01A-90V-4



**KFM01A-90V-5 (227.02)**




The dry density for specimen KFM01A-90V-5A was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-5B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2%.

**Fig. 5.** Specimen KFM01A-90V-5





**Table 2:** Level 2 389–390 m, specimens KFM01A-90V-6 to KFM01A-090V-10

<p><b>KFM01A-90V-6 (389.04)</b></p> <p>The dry density for specimen KFM01A-90V-6A was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.1% and the dry density for specimen KFM01A-90V-6B was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.1%.</p>	<p><b>Fig. 6.</b> Specimen KFM01A-90V-6</p> 
<p><b>KFM01A-90V-7 (389.15)</b></p> <p>The dry density for specimen KFM01A-90V-7A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.1% and the dry density for specimen KFM01A-90V-7B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.2%.</p>	<p><b>Fig. 7.</b> Specimen KFM01A-90V-7</p> 
<p><b>KFM01A-90V-8 (389.27)</b></p> <p>The dry density for specimen KFM01A-90V-8A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.2% and the dry density for specimen KFM01A-90V-8B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.1%.</p>	<p><b>Fig. 8.</b> Specimen KFM01A-90V-8</p> 

**KFM01A-90V-9 (389.38)**

The dry density for specimen KFM01A-90V-9A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-9B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2%.

**Fig. 9.** Specimen KFM01A-90V-9






**KFM01A-90V-10 (389.68)**

The dry density for specimen KFM01A-90V-10A was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-10B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2%.

**Fig. 10.** Specimen KFM01A-90V-10



**Table 3:** Level 3 492–495 m, specimens KFM01A-90V-11 to KFM01A-090V-20

<p><b>KFM01A-90V-11 (492.51)</b></p> <p>The dry density for specimen KFM01A-90V-11A was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-11B was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.3%.</p>	<p><b>Fig. 11.</b> Specimen KFM01A-90V-11</p> 
<p><b>KFM01A-90V-12 (493.85)</b></p> <p>The dry density for specimen KFM01A-90V-12A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-12B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3%.</p>	<p><b>Fig. 12.</b> Specimen KFM01A-90V-12</p> 
<p><b>KFM01A-90V-13 (493.97)</b></p> <p>The dry density for specimen KFM01A-90V-13A was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-13B was measured to be <math>2,650 \text{ kg/m}^3</math> and the porosity to 0.3%.</p>	<p><b>Fig. 13.</b> Specimen KFM01A-90V-13</p> 

**KFM01A-90V-14 (494.09)**

The dry density for specimen KFM01A-90V-14A was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-14B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 14.** Specimen KFM01A-90L-14



**KFM01A-90V-15 (494.20)**

The dry density for specimen KFM01A-90V-15A was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-15B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 15.** Specimen KFM01A-90V-15



**KFM01A-90V-16 (494.32)**

The dry density for specimen KFM01A-90V-16A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-16B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 16.** Specimen KFM01A-90V-16



**KFM01A-90V-17 (494.43)**

The dry density for specimen KFM01A-90V-17A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-17B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 17.** Specimen KFM01A-90V-17



**KFM01A-90V-18 (494.62)**

The dry density for specimen KFM01A-90V-18A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-18B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 18.** Specimen KFM01A-90V-18



**KFM01A-90V-19 (494.74)**

The dry density for specimen KFM01A-90V-19A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-19B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 19.** Specimen KFM01A-90V-19






**KFM01A-90V-20 (494.94)**

The dry density for specimen KFM01A-90V-20A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-20B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 20.** Specimen KFM01A-90V-20



**Table 4:** Level 4 691–699 m, specimens KFM01A-90V-21 to KFM01A-090V-26

<p><b>KFM01A-90V-21 (691.79)</b></p> <p>The dry density for specimen KFM01A-90V-21A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-21B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3%.</p>	<p><b>Fig. 21.</b> Specimen KFM01A-90V-21</p> 
<p><b>KFM01A-90V-22 (691.90)</b></p> <p>The dry density for specimen KFM01A-90V-22A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.2% and the dry density for specimen KFM01A-90V-22B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3%.</p>	<p><b>Fig. 22.</b> Specimen KFM01A-90V-22</p> 
<p><b>KFM01A-90V-23 (692.02)</b></p> <p>The dry density for specimen KFM01A-90V-23A was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.3% and the dry density for specimen KFM01A-90V-23B was measured to be <math>2,660 \text{ kg/m}^3</math> and the porosity to 0.2%.</p>	<p><b>Fig. 23.</b> Specimen KFM01A-90L-23</p> 

**KFM01A-90V-24 (692.14)**

The dry density for specimen KFM01A-90V-24A was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.2% and the dry density for specimen KFM01A-90V-24B was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 24.** Specimen KFM01A-90V-24



**KFM01A-90V-25 (698.47)**

The dry density for specimen KFM01A-90V-25A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-25B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 25.** Specimen KFM01A-90V-25



**KFM01A-90V-26 (698.58)**

The dry density for specimen KFM01A-90V-26A was measured to be  $2,650 \text{ kg/m}^3$  and the porosity to 0.3% and the dry density for specimen KFM01A-90V-26B was measured to be  $2,660 \text{ kg/m}^3$  and the porosity to 0.3%.

**Fig. 26.** Specimen KFM01A-90V-26





# Protokoll checklista densitet och porositet (Protocol checklist density and porosity)

Appendix 2

Kvalitetsmanual  
BMm  
Protokoll – logglista jämförelseprovning  
Densitets vid olika vattenmättning

BTm-QR 53  
Utgåva 1  
Utfärdad 2003-07-08

KFM01A Density and porosity  
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## Logglista prover för jämförelseprovning densitet vid olika vattenmättning

Prov id	Provberedning	Vattenmättning Enl. naturstensmetod	Vattenmättnads densitet	Torr-densitet	Vattenmättning Vakuum (signatur + aktuellt tryck)	Vattenmättnads densitet
FO1A 90V-5	X	X	X	X	11, 11, 11	180/100 MTS
FO1A 90V-6	X	X	X	X	11, 11, 11	1
FO1A 90V-7	X	X	X	X	11, 11, 11	
FO1A 90V-8	X	X	X	X	11, 11, 11	
FO1A 90V-9	X	X	X	X	11, 11, 11	
FO1A 90V-10	X	X	X	X	11, 11, 11	
FO1A 90V-21	X	X	X	X	11, 11, 11	
FO1A 90V-22	X	X	X	X	11, 11, 11	
FO1A 90V-23	X	X	X	X	11, 11, 11	
FO1A 90V-24	X	X	X	X	11, 11, 11	

~~Överlämnat till BR 19/8-03 till MTS~~



Till Dens & Värmetedn

2003-10-17

F01A-90V-1	OK
2	OK
3	OK
4	OK
11	OK
12	OK
13	OK
14	OK
15	OK
16	OK
17	OK
18	OK
<del>19</del>	OK
20	OK
25	OK
26	OK

↑  
METH Dens  
= ABS

LOGGLISTA FÖR PROVVÄXLING:

BMm		Berg art beteckning: F01A-90V	
Provförberedning	Datum	Signatur	Kommentarer
Vattenmättnad	17/10-03	W.S.	
Vät densitet	24/10-03	W.S.	
Vattenlagring			
Prover skickas till BRk			
BMm:s Signatur	BRk:s Signatur	20031027	
<i>W.S.</i>	<i>Björn</i>		
Datum	.....		
BRk			
Termiska egenskaper	Datum	Signatur	Kommentarer
	03-12-19	BRk	
Prover skickas till BMm			
BMm:s Signatur	BRk:s Signatur		
<i>W.S.</i>	<i>Björn</i>		

## Beräkning densitet och porositet (Calculation density and porosity)

### Density and porosity, SKB

Report no: P301334

Method: ISRM (1973), chapter 3 and SKB MD 160.002 version 1.0

Water temperature (°C): 18.4

Scale, inv.no: 102084

Tested by: mhs

Water density (g/cm<sup>3</sup>): 0.9985

Thermometer, inv.no: 102080

Date: 08/01/2004

Sample marking:	Weight in water Msub (g)	Surface dry weight Msat (g)	Dry weight Ms (g)	Bulk volume V (cm <sup>3</sup> )	Pore volume Vv (cm <sup>3</sup> )	Porosity n (%)	Porosity AB n (%)	Dry density pd (g/cm <sup>3</sup> )	Dry Density AB pd (g/cm <sup>3</sup> )	Wet density pd (g/cm <sup>3</sup> )	Wet density AB pd (g/cm <sup>3</sup> )
1	87.20	139.31	139.11	52.19	0.20	0.38	0.38	2.67	2.66	2.67	2.66
2	85.88	137.58	137.39	51.78	0.19	0.37	0.37	2.65	2.65	2.66	2.66
3	86.56	138.61	138.42	52.13	0.19	0.37	0.36	2.66	2.66	2.66	2.66
4	86.17	137.91	137.73	51.82	0.18	0.35	0.35	2.66	2.66	2.66	2.66
5	86.76	138.81	138.65	52.13	0.16	0.31	0.35	2.66	2.65	2.66	2.66
6	86.18	138.16	137.96	52.06	0.20	0.38	0.38	2.65	2.65	2.65	2.65
7	86.21	138.08	137.89	51.95	0.19	0.37	0.36	2.65	2.65	2.66	2.66
8	87.85	140.69	140.50	52.92	0.19	0.36	0.36	2.65	2.65	2.66	2.66
9	86.04	137.85	137.72	51.89	0.13	0.25	0.27	2.65	2.65	2.66	2.66
0	85.66	137.25	137.10	51.67	0.15	0.29	0.29	2.65	2.65	2.66	2.66
1	86.31	138.17	138.01	51.94	0.16	0.31	0.30	2.66	2.66	2.66	2.66
2	86.68	138.78	138.63	52.18	0.15	0.29	0.29	2.66	2.66	2.66	2.66
3	84.43	135.31	135.16	50.96	0.15	0.29	0.29	2.65	2.65	2.66	2.66
4	86.60	138.76	138.61	52.24	0.15	0.29	0.29	2.65	2.65	2.66	2.66
5	86.83	138.88	138.75	52.13	0.13	0.25	0.27	2.66	2.66	2.66	2.66
6	86.43	138.50	138.35	52.15	0.15	0.29	0.29	2.65	2.65	2.66	2.66
7	86.93	139.06	138.94	52.21	0.12	0.23	0.25	2.66	2.66	2.66	2.66
8	86.80	138.90	138.76	52.18	0.14	0.27	0.27	2.66	2.66	2.66	2.66
9	86.45	138.58	138.42	52.21	0.16	0.31	0.31	2.65	2.65	2.65	2.65
0	86.57	138.91	138.75	52.42	0.16	0.31	0.31	2.65	2.65	2.65	2.65

**Density and porosity, SKB**

Report no: P301334

Mehtod: ISRM (1973), chapter 3 and SKB MD 160.002 version 1.0

Water temperature (°C): 18.4

Scale, inv.no: 102084

Water density (g/cm<sup>3</sup>): 0.9985

Thermometer, inv.no: 102080

Tested by: mhs

Date: 08/01/2004

	Sample marking:	Weight in water Msub (g)	Surface dry weight Msat (g)	Dry weight Ms (g)	Bulk volume V (cm <sup>3</sup> )	Pore volume Vv (cm <sup>3</sup> )	Porosity n (%)	Porosity AB n (%)	Dry density pd (g/cm <sup>3</sup> )	Dry Density AB pd (g/cm <sup>3</sup> )	Wet density pd (g/cm <sup>3</sup> )	Wet density AB pd (g/cm <sup>3</sup> )
1	F01A-90V-19A	85.04	136.37	136.23	51.41	0.14	0.27	0.27	2.65	2.65	2.65	2.66
2	F01A-90V-19B	86.92	139.09	138.95	52.25	0.14	0.27	0.27	2.66	2.66	2.66	2.66
3	F01A-90V-20A	86.55	138.69	138.54	52.22	0.15	0.29	0.29	2.65	2.65	2.66	2.66
4	F01A-90V-20B	86.52	138.68	138.53	52.24	0.15	0.29	0.29	2.65	2.65	2.65	2.66
5	F01A-90V-25A	87.04	139.45	139.29	52.49	0.16	0.31	0.30	2.65	2.66	2.66	2.66
6	F01A-90V-25B	87.19	139.58	139.43	52.47	0.15	0.29	0.29	2.66	2.66	2.66	2.66
7	F01A-90V-26A	86.90	139.27	139.10	52.45	0.17	0.32	0.33	2.65	2.65	2.66	2.66
8	F01A-90V-26B	87.16	139.57	139.39	52.49	0.18	0.34	0.34	2.66	2.66	2.66	2.66

**Density and porosity, SKB**

Report no: P301334

Mehtod: ISRM (1973), chapter 3 and SKB MD 160.002 version 1.0

Tested by: mhs

Date: 14/07/2003

Scale, inv.no: 102084

Thermometer, inv.no: 102080

Water temperature (°C): 21.9

Water density (g/cm<sup>3</sup>): 0.9978

Sample marking:	Weight in water Msub (g)	Surface dry weight Msat (g)	Dry weight Ms (g)	Bulk volume V (cm <sup>3</sup> )	Pore volume Vv (cm <sup>3</sup> )	Porosity n (%)	Porosity AB n (%)	Dry density pd (g/cm <sup>3</sup> )	Dry Density AB pd (g/cm <sup>3</sup> )	Wet density pd (g/cm <sup>3</sup> )	Wet density AB pd (g/cm <sup>3</sup> )
1	F01A 90V-5A	84.67	135.53	50.97	0.08	0.16	0.16	2.66	2.66	2.66	2.66
2	F01A 90V-5B	85.21	136.33	51.23	0.08	0.16	0.16	2.66	2.66	2.66	2.66
3	F01A 90V-6A	81.89	131.27	49.49	0.07	0.14	0.14	2.65	2.65	2.65	2.65
4	F01A 90V-6B	82.89	132.81	50.03	0.07	0.14	0.14	2.65	2.65	2.65	2.65
5	F01A 90V-7A	82.81	132.59	49.89	0.07	0.14	0.15	2.66	2.66	2.66	2.66
6	F01A 90V-7B	82.50	132.07	49.68	0.08	0.16	0.16	2.66	2.66	2.66	2.66
7	F01A 90V-8A	83.74	133.94	50.31	0.08	0.16	0.15	2.66	2.66	2.66	2.66
8	F01A 90V-8B	81.94	131.09	49.26	0.07	0.14	0.14	2.66	2.66	2.66	2.66
9	F01A 90V-9A	83.44	133.71	50.38	0.10	0.20	0.21	2.65	2.65	2.65	2.66
10	F01A 90V-9B	83.43	133.57	50.25	0.11	0.22	0.22	2.66	2.66	2.66	2.66
11	F01A 90V-10A	83.44	133.56	50.23	0.11	0.22	0.22	2.66	2.66	2.66	2.66
12	F01A 90V-10B	83.54	133.77	50.34	0.11	0.22	0.22	2.66	2.66	2.66	2.66
13	F01A 90V-21A	84.18	134.59	50.52	0.15	0.30	0.29	2.66	2.66	2.66	2.66
14	F01A 90V-21B	84.09	134.59	50.61	0.14	0.28	0.28	2.66	2.66	2.66	2.66
15	F01A 90V-22A	82.10	131.37	49.38	0.12	0.24	0.25	2.66	2.66	2.66	2.66
16	F01A 90V-22B	83.73	134.01	50.39	0.13	0.26	0.26	2.66	2.66	2.66	2.66
17	F01A 90V-23A	83.74	134.00	50.37	0.13	0.26	0.25	2.66	2.66	2.66	2.66
18	F01A 90V-23B	83.48	133.44	50.07	0.12	0.24	0.24	2.66	2.66	2.67	2.66
19	F01A 90V-24A	83.97	134.21	50.35	0.12	0.24	0.25	2.66	2.66	2.67	2.66
20	F01A 90V-24B	82.84	132.82	50.09	0.13	0.26	0.26	2.65	2.65	2.65	2.65