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Äspö Hard Rock Laboratory

Determination of linear thermal expansion

Samples from borehole KA2599G01. Äspö HRL

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October 2002

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Introduction

This report presents results from investigations of thermal expansion for rock samples from borehole KA2599G01 at Äspö Hard Rock Laboratory. The thermal expansion were correlated to density, water absorption and rock type, in object of finding any relation between the parameters. The work was performed by Geo Innova AB at the request of the Swedish Nuclear Fuel and Waste Management Co (SKB).

The thermal expansion was measured by SINTEF Energy Research. Furthermore, density and water absorption for the rock were measured by the Swedish National Testing and Research Institute. A mapping of the mineralogical composition of the samples was made by Terralogica AB.

Summary

Linear thermal expansion has been determined on 12 samples from borehole KA2599G01, Äspö HRL. The measured linear thermal expansions for samples on Äspö diorite, Ävrö granite and fine-grained granite are about $8 \cdot 10^{-6}$ m/(m×K). No significant difference between the different rock types can be observed for this parameter. There is a rather big dispersion in the results within each rock type which may be caused by lower accuracy in test results than expected. The density for the samples of Äspö diorite is about 2750 kg/m^3 and for the granites almost 100 kg less per cubic metre. The water absorption is about 0.30 % (counted by volume) for all the samples. No clear relation between density and thermal expansion can be observed.

Sammanfattning

Den linjära termiska expansionskoefficienten har bestämts på 12 olika kärnprover från borrhål KA2599G01 beläget i Äspölaboratoriet. Expansionskoefficienten för kärnproverna som bestod av bergarterna Äspödiorit, Ävrögranit och finkornig granit är cirka $8 \cdot 10^{-6}$ m/(m×K). För den termiska expansionskoefficienten har inte någon signifikant skillnad kunnat påvisas mellan de undersökta bergarterna. Resultaten uppvisar en ganska stor spridning inom respektive bergart, vilket kan bero på att mätnoggrannheten är lägre än förväntad. Densiteten för Äspödioriten är cirka 2750 kg/m^3. De mer granitiska bergarterna har en densitet som är cirka 100 kg lägre per kubikmeter. Den volymetriska vattenabsorptionen är cirka 0,30 % för samtliga prover. Inget tydligt samband mellan densiteten och den termiska expansionskoefficienten har gått att finna.

Contents

1 Introduction

As part of the Swedish nuclear waste disposal program a series of site investigations are planned. For each of the studied sites design work will be carried out as a foundation for studies of constructability, environmental impact assessment and safety assessment. The technique for long-term storage of used nuclear fuel is developed at the Äspö Hard Rock Laboratory.

The deposit canisters generate heat due to nuclear fission. The temperature field in the repository depends on thermal properties of the rock and generated heat. A temperature rise causes a change in volume for a rock. This can be measured as coefficient of thermal expansion.

Geo Innova AB has been commissioned by the Swedish Nuclear Fuel and Waste Management Co (SKB) to determine the coefficient of thermal expansion on different rock samples from borehole KA2599G01. Samples from this borehole have earlier been tested in order to determine the thermal properties.

2 Laboratory Investigations

The investigations comprise laboratory measurements of thermal expansion, density and water absorption for the rock samples. The samples have also been ocularly inspected to characterise their mineral composition.

Earlier, investigations have been made to characterise the rock samples. The rock type has been determined along the drill core, KA2599G01. Laboratory tests have been made of the density, porosity and the thermal conductivity of the rock samples. A full-scale thermal response test was made in the borehole and the results were compared to the laboratory results. These results are reported in Sundberg (2002).

A total of 11 samples have earlier been selected from the drill core (diameter about 60 mm) for laboratory investigations. For the investigation of thermal expansion, new samples from the core were selected. The new samples were taken from the same areas along the core as the earlier investigated samples. From one of the 11 samples two sub samples were taken, which makes totally 12 samples. After testing the thermal expansion, density and water absorption were measured on identically the same samples. Finally, the samples were sent for ocular inspection of mineral composition.

Table 2-1 shows where along the drill core the samples for the different investigations were taken. Thus, these tests were not made on identically the same samples as the earlier ones, which can cause differences in the results.

The rock types along the drill core are presented in Table 2-2, from Sundberg (2002) where a more complete mapping of the rock can be found.

Table 2-1. Rock samples taken for laboratory investigations.

Sample no	Core section (KA2599G01)	Chemical and mineralogical *(Report R-02-27)*	Thermal properties, density and porosity *(Report R-02-27)*	Thermal expansion, density and porosity, ocular mineralogical inspection *(Present study)*
1	5.90-5.94 + 6.00-6.04		x	
	5.94-6.00	x		
	6.04-6.24			x
2	14.63-14.67 + 14.58-14.63		x	
	14.67-14.73	x		
	14.85-14.97			x
3	25.32-25.36 + 25.42-25.46		x	
	25.36-25.42	x		
	25.55-25.67			x
4	44.28-44.32 + 44.32-44.36		x	
	44.36-44.42	x		
	44.42-44.55			x
5	50.10-50.14 + 50.20-50.24		x	
	50.14-50.20	x		
a	49.92-50.04			x
b	50.67-50.79			x
6	61.89-61.93 + 61.99-62.03		x	
	61.93-61.99	x		
	61.47-61.59			x
7	70.60-70.64+ 70.64-70.68		x	
	70.68-70.74	x		
	70.74-70.89			x
8	85.10-85.50 + 85.50-85.56		x	
	85.56-85.62	x		
	85.62-85.77			x
9	101.85-101.89 + 101.95-101.99		x	
	101.89-101.95	x		
	102.00-102.15			x
10	120.05-120.09 +120.15-120.19		x	
	120.09-120.15	x		
	120.20-120.32			x
11	126.35-126.39 + 126.45-126.49		x	
	126.39-126.45	x		
	126.29-126.41			x

Table 2-2. Rock type distribution along drill core KA2599G01 according to revised mapping (Sundberg, 2002).

Rock type	Percentage of core	Core section (m)
Äspö QMD	54.6 %	4.0-28.0; 36.0-44.0; 68.9-75.1; 79.6-90.3; 96.6-101.6; 102.9-109.0; 109.6-115.1; 115.4-117.6
Ävrö granite	25.1 %	28.0-36.0; 44.0-45.9; 75.1-79.6; 90.3-96.6; 117.6-126.8; 127.1-128.3
Fine-grained granite	11.0 %	45.9-51.4; 53.8-54.5; 56.0-58.9; 60.4-64.0; 109.0-109.6; 115.1-115.4
Meta-basite	4.3 %	51.4-53.8; 54.5-56.0; 58.9-60.4
Mingled Ävrö granite/Äspö diorite	3.7 %	64.0-68.9
Altered ÄQMD	1.0 %	101.6-102.9
Altered Ävrö granite	0.2 %	126.8-127.1

3 Description of Methods

3.1 Laboratory Measurements of Thermal Expansion

Linear thermal expansion for the samples was analysed according to ISO 4897 and DIN 53752. This method is mainly used for cellular plastic materials, but can also be applied on rock materials.

The length of the samples varied between 108 and 177 mm, which are shorter than the demands in the standard (300 mm). The measurements were carried out mainly in three different temperature intervals; 5-50˚C, 50-105˚C and 5-95˚C, but for a few samples also in the intervals 25-95˚C, 50-95˚C and 5-105˚C.

The original length L_0 of the drill cores was measured with a precision digital sliding calliper (Mitutoyo Digimatic series 500).

The length increase caused by the temperature change was measured with a precision digital dial micrometer with accuracy ±0.003 mm (Mitutoyo Digimatic Indicator 543).

Finally, the coefficient of linear thermal expansion was calculated according to Formula (1).

$$\alpha = [(\Delta L / L_0) \cdot (1/(T_1 - T_2))] \qquad [m/(m \times K)] \qquad (1)$$

Where:

ΔL	=	The change in length of the specimen within the measured temperature limits (between temperature T_1 and T_2)
L_0	=	The original length of the specimen at T_2
T_1	=	The lowest temperature selected
T_2	=	The highest temperature selected

The test specimens were shorter than wanted for this method. Because of the small change in length of the specimen and the equipment in use, the accuracy of the test results is poorer than wanted, which has to be taken in consideration.

The laboratory investigations were performed by SINTEF Energiforskning AS.

3.2 Laboratory Measurement of Density and Water Absorption

Density and water absorption were determined by the Swedish National Testing and Research Institute (SP). The measurements were performed according to DIN 521202-RE, VA and DIN 52103-A, respectively. Both methods have been modified to give a higher accuracy.

The measured water absorption (counted by volume) can be approximated with the porosity of the samples (pore volume in relation to total volume). Any isolated pores in the material will then not be included.

3.3 Ocular Mineralogic Inspection

After the investigations of thermal expansion coefficient, density and water absorption, the samples were sent to Terralogica AB for ocular inspection of the rock types.

4 Results

4.1 Thermal Expansion

Values of linear thermal expansion from the laboratory measurements are presented in Table 4-1, while the complete results are to be found in Appendix 1. A key to the sample numbers is found in Table 2-1. In Table 4-2 the rock types are specified for the samples. Coefficient of thermal expansion for 5-95ºC is shown in Figure 4-1 and for all investigated temperature intervals in Figure 4-2. Note that different numbers of measurement are made for the samples. The mean value for all measurements and highest and lowest values for each sample are presented in Figure 4-3.

Table 4-1. Coefficient of thermal expansion for different temperature intervals.

Sample number	Coefficient of Thermal Expansion (m/(m×K))					
	5-50˚C	5-95˚C	50-105˚C	25-95˚C	50-95˚C	5-105˚C
1	8.06E-06	8.34E-06	7.80E-06			
2	8.96E-06	8.55E-06	6.51E-06	7.82E-06	7.37E-06	
3	7.73E-06	7.48E-06	7.50E-06			
4	6.66E-06	7.24E-06	7.72E-06			
5a	6.73E-06	6.55E-06	6.53E-06			
5b	6.94E-06	6.68E-06	6.23E-06			
6	8.54E-06	7.70E-06	7.41E-06	6.68E-06		
7	7.32E-06	7.80E-06	8.33E-06			
8	6.89E-06	7.28E-06	7.21E-06			
9	9.24E-06	7.25E-06	6.78E-06	6.76E-06		
10	9.68E-06	8.98E-06	6.77E-06			
11	7.64E-06	7.79E-06				7.85E-06

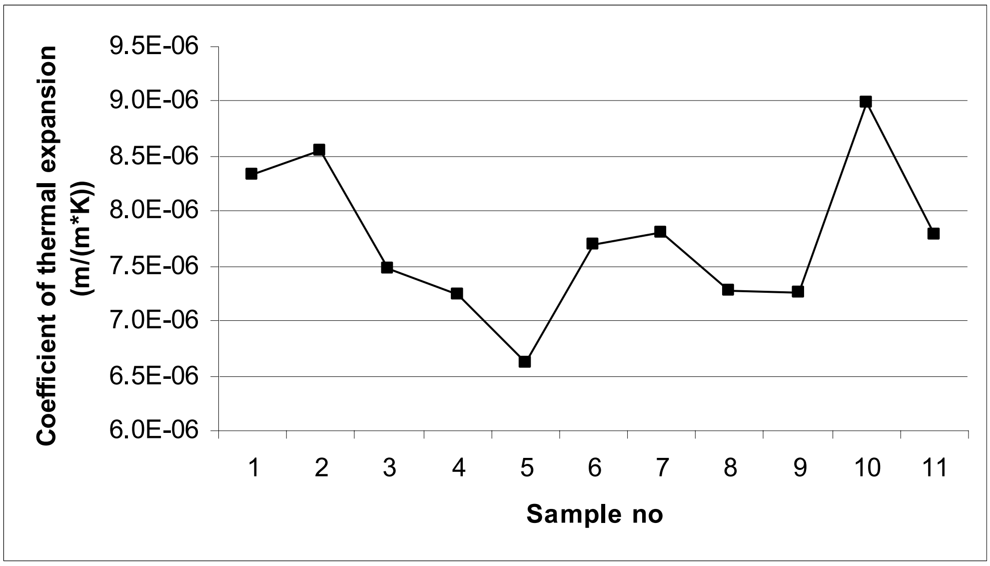

Figure 4-1. *Coefficient of thermal expansion for selected rock samples, measured in laboratory at the interval 5-95ºC. Measurements of sample 5a and b are calculated as mean values.*

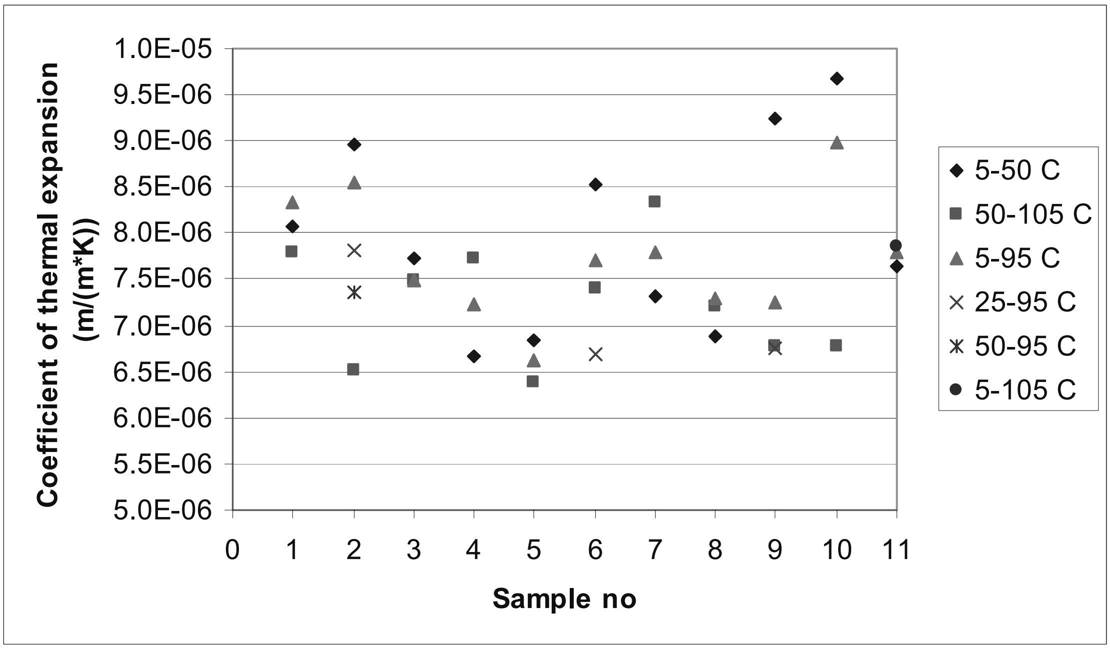

Figure 4-2. *All measurements on coefficient of thermal expansion. Measurements of sample 5a and b are calculated as mean values.*

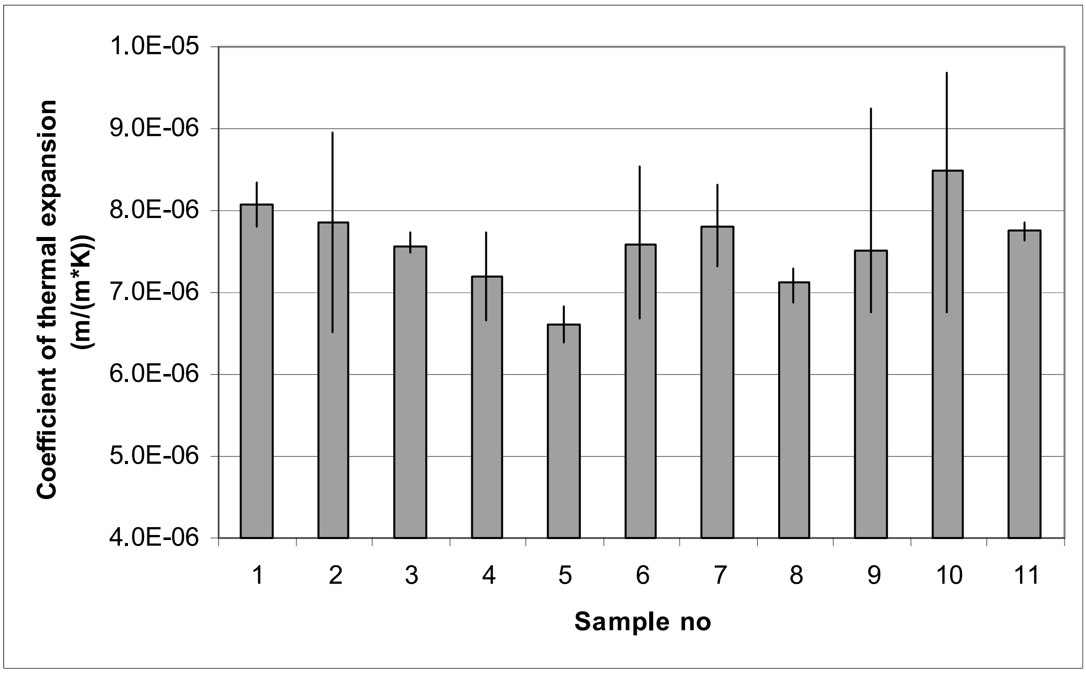

Figure 4-3. *Mean value of coefficient of thermal expansion for all measurements at different intervals of temperature. Highest and lowest values are also indicated. Measurements of sample 5a and b are calculated as mean values.*

4.2 Density and Water Absorption

Density and water absorption for the samples are presented in Figure 4-4 and Figure 4-5. The laboratory report from the determinations is to be found in Appendix 2. The samples with higher density (no 1, 2, 3, 7, 8 and 9) consist mainly of diorite, while the ones with lower density consist mainly of granite.

The porosity of the rock material can be approximated with the water absorption calculated by volume. This approximation excludes the pores that are isolated and not able to absorb any water. From the Figure 4-5 it seems like the porosity is decreasing with depth. For the two samples 5a and 5b there are only very small differences and a mean value is used in the figures.

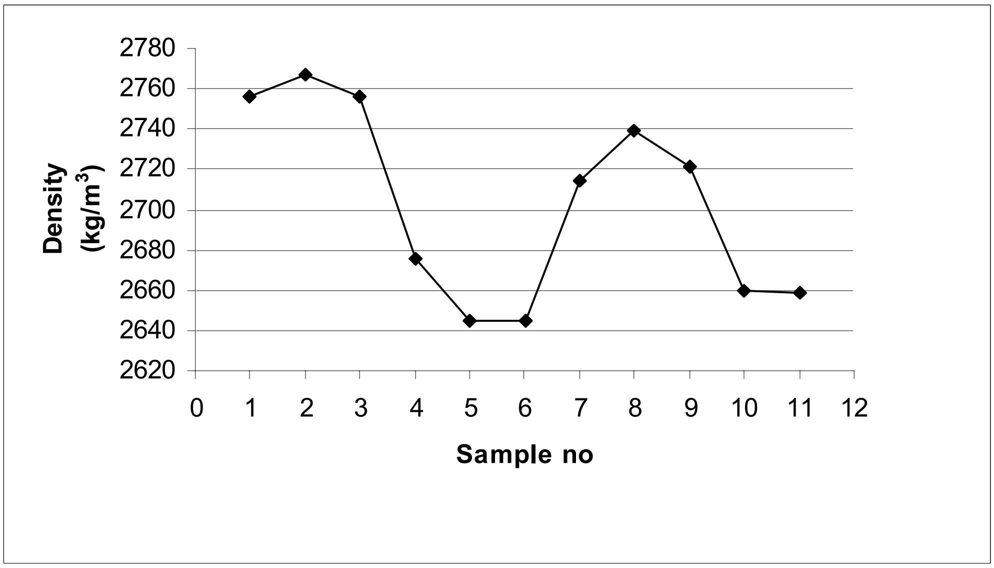

Figure 4-4. *Density of the rock samples. Measurements of sample 5a and b are calculated as mean values.*

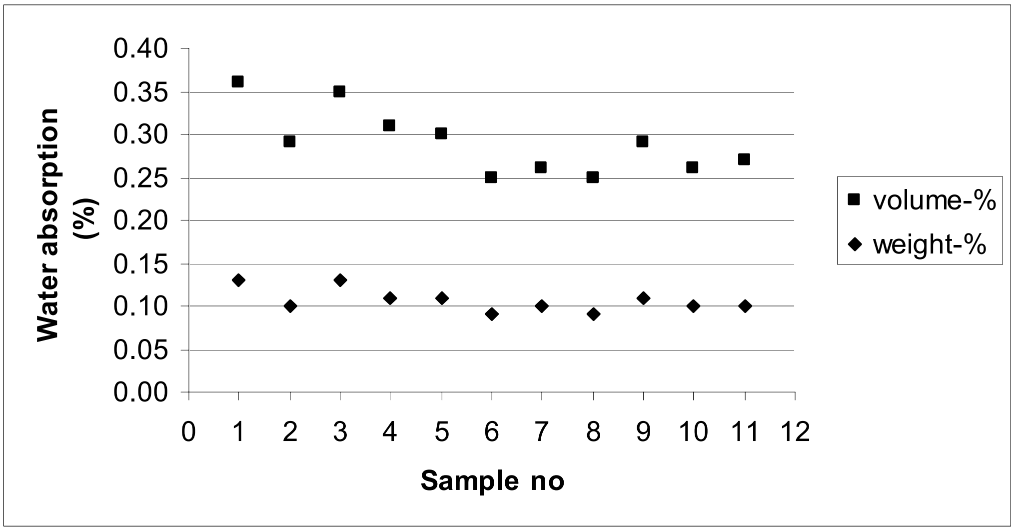

Figure 4-5. *Water absorption for the samples, calculated both by weight and by volume. Measurements of sample 5a and b are calculated as mean values.*

4.3 Ocular Mineralogic Inspection

In the earlier characterisation of the mineral composition the specific 11 samples were investigated with modal analyses and chemical analyses. In the present study samples adjacent to the earlier investigated were picked out for the laboratory tests, in order to have samples with similar rock type, properties and mineralogical composition. The mineralogical composition of the chosen samples was later inspected and compared to the previous characterisation, see Table 4-2. The characterisation of sample 5 differs most from the two investigations.

Table 4-2. Results from mapping of rock type. Please observe that the samples are not identical in the two studies, see Table 2-1.

Sample no	Rock type From Sundberg, 2002	Rock type Present study
1	Äspö diorite	Äspö diorite (with certain grains < 1 cm)
2	Äspö diorite	Äspö diorite (with certain grains < 1 cm)
3	Äspö diorite	Äspö diorite (with more and larger grains > 1 cm)
4	Ävrö granite	Ävrö granite (strongly foliated, mainly parallel to the bore core)
5	Fine-grained granite	Fine-grained mylonite/cataclasite, probably enclosed in fine-grained granite. The samples are very inhomogeneous
6	Fine-grained granite	Fine-grained granite (or fine-grained Ävrö granite)
7	Qz-rich Äspö diorite	Äspö diorite (with more and larger grains > 1 cm, strongly foliated, mainly parallel to the bore core)
8	Qz-rich Äspö diorite	Äspö diorite (with more and larger grains > 1 cm, strongly foliated, mainly parallel to the bore core)
9	Altered Äspö diorite	Altered Äspö diorite/Ävrö granite (probably with biotite transformed to clorite)
10	Ävrö granite	Ävrö granite (strongly foliated, mainly parallel to the bore core)
11	Ävrö granite	Ävrö granite (strongly foliated, mainly parallel to the bore core)

The conclusion from these results, drawn by Terralogica, is that samples 4, 10 and 11 should give similar laboratory results. To some extent, the same should be valid for samples 1 and 2 and for 3, 7 and 8. These are more coarse-grained, and thereby the distribution could be wider.

5 Evaluation

There is a clear relation between density and thermal conductivity for the earlier investigated rock samples (Sundberg, 2002). Higher thermal conductivity was measured in rock types with lower density and vice versa, see Figure 5-1.The relation between thermal expansion and density is not as obvious as the one between density and thermal conductivity, see Figure 5-2. The results subdivided on different rock types are shown in Table 5-1.

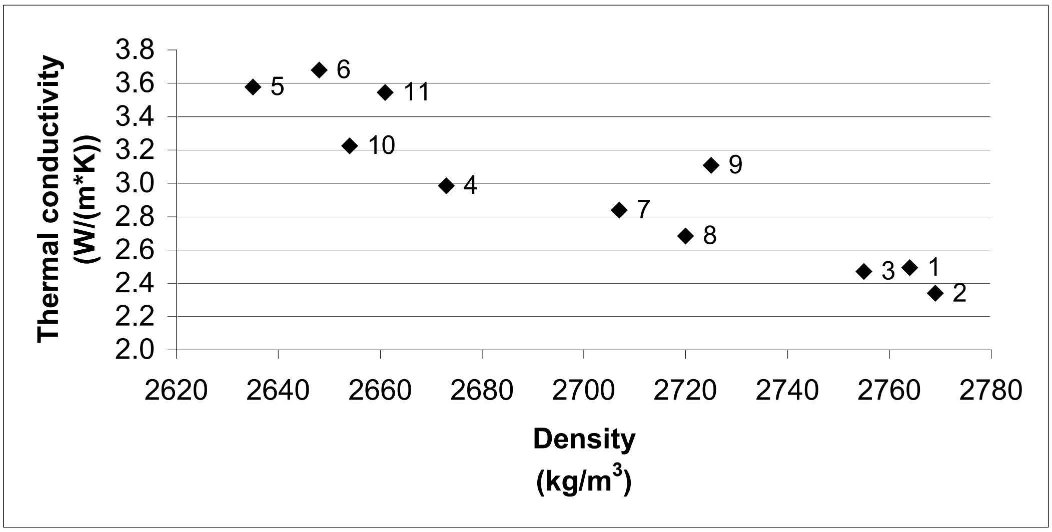

Figure 5-1. Density and thermal conductivity of selected rock samples reported in an earlier investigation (Sundberg, 2002). Sample numbers are given in the graph.

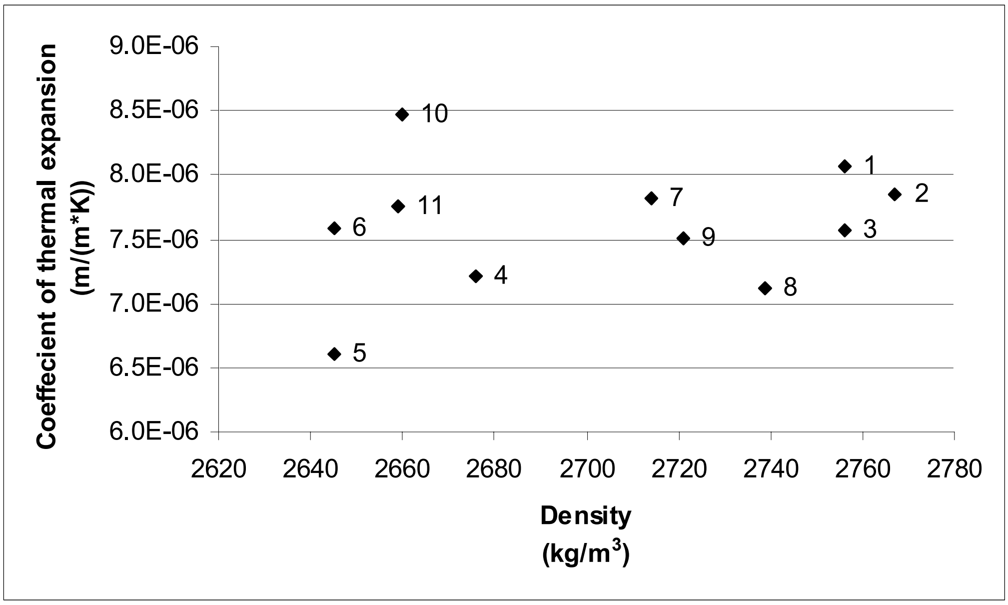

Figure 5-2. Density vs. coefficient of thermal expansion. Results from measurements on identical samples. Mean values calculated from measurements at different temperature intervals are used for coefficient of thermal expansion. Sample numbers are given in the graph.

Table 5-1. Results from measurements on coefficient of linear expansion (m/(m×K)) at interval 5-95ºC subdivided on rock type.

Sample no	Äspö Diorite	Altered Äspö Diorite	Ävrö granite	Fine-grained granite	Fine-grained mylonite/cataclasite
1	8.34E-06				
2	8.55E-06				
3	7.48E-06				
4			7.24E-06		
5					6.51E-06
6				7.70E-06	
7	7.80E-06				
8	7.28E-06				
9		7.25E-06			
10			8.98E-06		
11			7.79E-06		
Mean value:	7.89E-06	7.25E-06	8.00E-06	7.70E-06	6.51E-06

From the ocular inspection of the samples the conclusion is drawn that samples 4, 10 and 11 are very similar in composition and should give similar values from the measurements. This is not the case, as can be seen in Table 5-1 (coefficient of thermal expansion), Figure 4-4 (density) and Figure 4-5 (porosity). Samples 10 and 11 are similar, though for number 10 the values for thermal expansion are widely spread for different temperature intervals. There are small differences in thermal expansion between the two sub-samples 5a and 5b.

Determination of the coefficient of thermal expansion for rock samples from Äspö has earlier been made at Luleå University of Technology by Larsson (2001, unpublished). The samples were taken from a different borehole than in the present investigation. The samples were investigated in laboratory under load (3.8 MPa) and unloaded. Compared with this, our results are higher, both for granite and diorite.

The results in our investigation are slightly lower compared to results reported in Börgesson & Hernelind (1995).

Some results from this investigation can also be compared to results presented in Sundberg (2002). Density and porosity were measured in both investigations. The measurements were made on samples taken close to each other, see Table 2-1. For the density, the differences between the investigations are small, not more than 0.5 %. For the porosity there are differences up to 25 % compared to the older results. The differences seem to be random, no trend towards lower or higher porosity can be seen.

6 Conclusions

- The measured linear thermal expansion for samples on Äspö diorite, Ävrö granite and fine-grained granite are about $8 \cdot 10^{-6}$ m/(m×K). No significant difference between the different rock types can be observed.
- A rather big dispersion can be observed within each rock type and may be caused by lower accuracy in test results than expected, due to smaller length of the specimens then recommended.
- No clear relation between density and thermal expansion can be observed.
- It is recommended to use longer samples or another test standard for further measurements of linear thermal expansion.

References

Börgesson, L. & Hernelind, J., 1995. Decovalex 1- Test case 3, Calculation of the Big Ben experiment, SKB TR95-29.

Sundberg, J., 2002. Determination of thermal properties at Äspö HRL, Comparison and evaluation of methods and methodologies for borehole KA 2599 G01, SKB R-02-27.

LR 2328

Measuring of coefficient of thermal expansion on drill cores of rock

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PROJECT NO.	NUMBER OF PAGES	TEST LOCATION
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TEST OBJECT	TEST OBJECT RECEIVED
12 different drill cores of rock.	2002-08-07
TEST PROGRAM	DATE OF TEST
Standard ISO 4897 and DIN 53752.	2002-09-09

SUMMARY

The coefficient of linear thermal expansion has been measured on forwarded drill cores of rock.
The coefficient has been measured between 5 and 105°C

The test results are shown in Table I

The test results relate only to the items tested

KEYWORDS

SELECTED BY AUTHOR(S)		

TABLE OF CONTENTS

1 INTRODUCTION

On behalf of Geo Innova AB Sweden, mechanical tests have been carried out at SINTEF Energy Research, Trondheim, Norway, to establish values for linear coefficient of thermal expansions on drill cores of rock between 5 to 105 °C.

The test material were forwarded preshaped from customer, some of the test specimens had to be polished at the end surfaces to make them parallel.

2 TEST PROGRAM

The tests are carried out according to **ISO4897 and DIN 53752.**
These standards are used for testing of cellular plastics materials, but can also be used on rock materials.

The original length of the test materials is given in Table I: Test Results.

The test specimens with a length between 108 to 177 mm, were to be tested in 3 different temperature areas, namely 5 to 50 °C, 50 to 105 °C and 5 to 95 °C.

The original length L_0 of the drill cores were measured by mean of a precision digital sliding calliper (Mitutoyo Digimatic series 500). Accuracy ± 0.1mm
The length caused by the temperature change were measured by mean of a precision digital dial micrometer with accuracy ±0.001mm (Mitutoyo Digimatic Indicator 543). Accuracy ± 0.003mm

2.1 Calculations

The coefficient of linear thermal expansion is calculated as follows:

$$\alpha = [(\Delta L / L_0)x(1/(T_1 - T_2))] \quad [m/mK]$$

Where:

ΔL	=	The change in length of the specimen within the measured temperature limits (Between temperature T_1 and T_2)
L_0	=	The original length of the specimen at T_2
T_1	=	The lowest temperature selected
T_2	=	The highest temperature selected

3 TEST RESULTS

The test results are shown in Table I.

The test specimens were very short, because of that the change in length of the specimen within the measured temperature limits (Between temperature T_1 and T_2) was very small.

Table I:

Sample number	ID code	Secup m	Seclow m	Original length mm	ΔL mm	T1 °C	T2 °C	Mean temp. °C	Coefficient of Thermal Expansion
1	KA2599G01	6,04	6,24	176,8	0,068	4,7	52,4	28,6	8,063E-06
		6,04	6,24	176,8	0,131	5,7	94,6	50,2	8,335E-06
		6,04	6,24	176,8	0,075	49,6	104	76,8	7,798E-06
2	KA2599G01	14,85	14,97	108	0,045	5,2	51,7	28,5	8,961E-06
		14,85	14,97	108	0,081	5,3	93	49,2	8,552E-06
		14,85	14,97	108	0,081	48.5	104	76.3	6.507E-06
		14,85	14,97	108	0,037	48,5	95	71,8	7,368E-06
		14,85	14,97	108	0,056	26.7	93	59,9	7,821E-06
3	KA2599G01	25,55	25,67	109,5	0,038	4,8	49,7	27,3	7,729E-06
		25,55	25,67	109,5	0,074	4,7	95	49,9	7,484E-06
		25,55	25,67	109,5	0,044	51,4	105	78,2	7,497E-06
4	KA2599G01	44,42	44,55	114,6	0,037	5,5	54	29,8	6,657E-06
		44,42	44,55	114,6	0,074	5,8	95	50,4	7,239E-06
		44,42	44,55	114,6	0,047	51,9	105	78,5	7,724E-06
5a	KA2599G01	49,92	50,04	108,4	0,034	4,8	51,4	28,1	6,731E-06
		49,92	50,04	108,4	0,064	4,9	94,9	50,0	6,553E-06
		49,92	50,04	108,4	0,037	50,7	103	76,9	6,526E-06
5b	KA2599G01	50,67	50,79	112,9	0,037	4,7	51,9	28,3	6,943E-06
		50,67	50,79	112,9	0,066	4,5	95	48,3	6,681E-06
		50,67	50,79	112,9	0,038	51	105	78	6,233E-06
6	KA2599G01	61,47	61,59	113,7	0,043	5,4	49,7	27,6	8,537E-06
		61,47	61,59	113,7	0,077	5,1	93	49,1	7,704E-06
		61,47	61,59	113,7	0,056	26,5	93	59,8	6,678E-06
		61,47	61,59	113,7	0,041	51	105	78	7,406E-06
7	KA2599G01	70,74	70,89	139,5	0,048	5,1	51,7	28,4	7,321E-06
		70,74	70,89	139,5	0,098	4,9	95	50,0	7,797E-06
		70,74	70,89	139,5	0,064	49,9	105	77,5	8,326E-06
8	KA2599G01	85,62	85,77	141,4	0,048	5,3	54,6	30,0	6,886E-06
		85,62	85,77	141,4	0,093	4,7	95	49,9	7,284E-06
		85,62	85,77	141,4	0,053	52	104	78	7,208E-06
9	KA2599G01	102	102,15	140,3	0,060	4,9	51,2	28,1	9,237E-06
		102	102,15	140,3	0,086	5,7	92,4	49,1	7,070E-06
		102	102,15	140,3	0,064	25,5	93	59,3	6,758E-06
		102	102,15	140,3	0,094	4,7	95	49,9	7,420E-06
		102	102,15	140,3	0,053	49,3	105	77,2	6,782E-06
10	KA2599G01	120,2	120,32	112,2	0,054	4,7	54,4	29,6	9,684E-06
		120,2	120,32	112,2	0,091	4,7	95	49,9	8,982E-06
		120,2	120,32	112,2	0,041	50	104	77,0	6,767E-06
11	KA2599G01	126,29	126,41	116,6	0,044	4,9	54,3	29,6	7,639E-06
		126,29	126,41	116,6	0,082	4,7	95	49,9	7,788E-06
		126,29	126,41	116,6	0,082	5.3	104	54.7	7,560E-06
		126,29	126,41	116,6	0,053	4,2	105	77,1	8,146E-06

RAPPORT

Geo Innova AB
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Handläggare, enhet / *Handled by, department*	Datum / *Date*	Beteckning / *Reference*	Sida / *Page*
Lotta Carlsson, Byggnadsteknik Tel +46 (0)33 16 51 82	2002-09-10	F216154	1 (2)

Provning av natursten - borrkärnor

Uppdrag

Provning av natursten, 12 stycken prov. Beträffande providentifikation och egenskaper som provats, se under rubrikerna ”Provfakta” och ”Provningsomfattning”.

Provtagning och ankomstdatum

Proverna togs ut och skickades till SP genom uppdragsgivarens försorg. SP saknar kännedom om provtagningen. Proverna ankom till SP 2002-08-30. Proverna bestod av borrkärnor av natursten.

Provfakta

Providentitet	Delprovmärkning	Material
KA 25 99 G01	1	Borrkärnor av sten
	2	
	3	
	4	
	5A	
	5B	
	6	
	7	
	8	
	9	
	10	
	11	

Provningsomfattning

Egenskap	Metod	Providentitet	Provningsdatum
Densitet	DIN 52102-RE, VA [1)]	Se tabell ovan	2002-09-02 – 2002-09-06
Vattenabsorption	DIN 52103-A [1)]		

[1)] Se under rubriken ”Kommentar” nedan.

SP 511

RAPPORT

Datum/*Date*	Beteckning/*Reference*	Sida/*Page*
2002-09-10	F216154	2 (2)

Provningsresultat

Densitet och vattenabsorption, DIN 52102-RE-VA, DIN 52103-A

		Provkroppens torra vikt	Densitet	Vattenabsorption, ej kokning	
		(g)	(kg/m³)	(vikt%)	(volym%)
KA 25 99 G01	1	1416,60	2756	0,13	0,36
	2	865,26	2767	0,10	0,29
	3	883,73	2756	0,13	0,35
	4	963,93	2676	0,11	0,31
	5A	897,43	2641	0,12	0,31
	5B	934,76	2648	0,10	0,28
	6	949,90	2645	0,09	0,25
	7	1188,73	2714	0,10	0,26
	8	1209,09	2739	0,09	0,25
	9	1199,27	2721	0,11	0,29
	10	868,55	2660	0,10	0,26
	11	903,30	2659	0,10	0,27

Kommentar

I metoderna för bestämning av densitet och vattenabsorption ska provet torkas respektive vattenmättas till konstant vikt. Konstant vikt vid torkning och vid vattenabsorption definieras i metoderna som en viktändring mindre än 0,1 % per 24 timmar. Vid denna provning har konstant vikt definierats som en viktförändring om 0,01 %, vilket motsvarar ca 0,04 g. Anledningen till detta är att öka precisionen så att skillnaden mellan material med mycket låg vattenabsorption kan detekteras.

Enligt metoden för bestämning av densiteten ska provningsresultatet avrundas till 10 kg/m^3. I denna redovisning har resultaten avrundats till 1 kg/m^3. Anledningen till detta är att tydliggöra små differenser i densitet mellan likvärdiga prov. Metodens (DIN 52102-RE, VA) mätosäkerhet är ej redovisad, angiven avrundning får gälla.

Mätosäkerhet

För information om mätosäkerheten kontakta teknisk handläggare.

SP Sveriges Provnings- och Forskningsinstitut
Byggnadsmaterial

Lotta Carlsson
Tekniskt ansvarig

Marjo Savukoski
Teknisk handläggare

SP 511