P-04-163

Forsmark site investigation

Drill hole KFM01A: Extensometer measurement of the coefficient of thermal expansion of rock

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July 2004

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Keywords: AP PF 400-03-18, Field note no Forsmark 96, Rock mechanics, Coefficient of thermal expansion, Temperature change, Density, Porosity.

Abstract

The coefficient of thermal expansion and the wet density have been determined on 21 specimens from drill hole KFM01A. The specimens were sampled on three levels in the drill hole: 230, 490 and 690 m. The investigated rock type is mapped as medium grained metagranite. The coefficient of thermal expansion has been determined within the temperature interval 20-80 ºC and ranges between 5.4 x 10^{-6} and 15 x 10^{-6} mm/mm ˚C. The results indicated that the thermal expansion was almost linear and increased versus depth in the drill hole.

Contents

1 Introduction

This document reports the data collected within the activity “Undersökningar i Forsmarksområdet. KFM01A. Bergmekaniska och tekniska laboratoriebestämningar”, which is one of the activities performed as part of the site investigation at Forsmark. The work was carried out in accordance with activity plan AP PF 400-03-18 (SKB internal controlling document).

The principle of the measurements is to determine the coefficient of thermal expansion at different temperatures.

The cores are sampled from borehole KFM01A in the Forsmark area (Figure 1-1). It was sampled 24 February 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 three levels in the rock core at depths of approximately 230 m, 490 m and 690 m. The rock cores were transported by SP from Forsmark and arrived at SP February 25, 2003. The testing was performed during November 2003 (see Appendix 1).

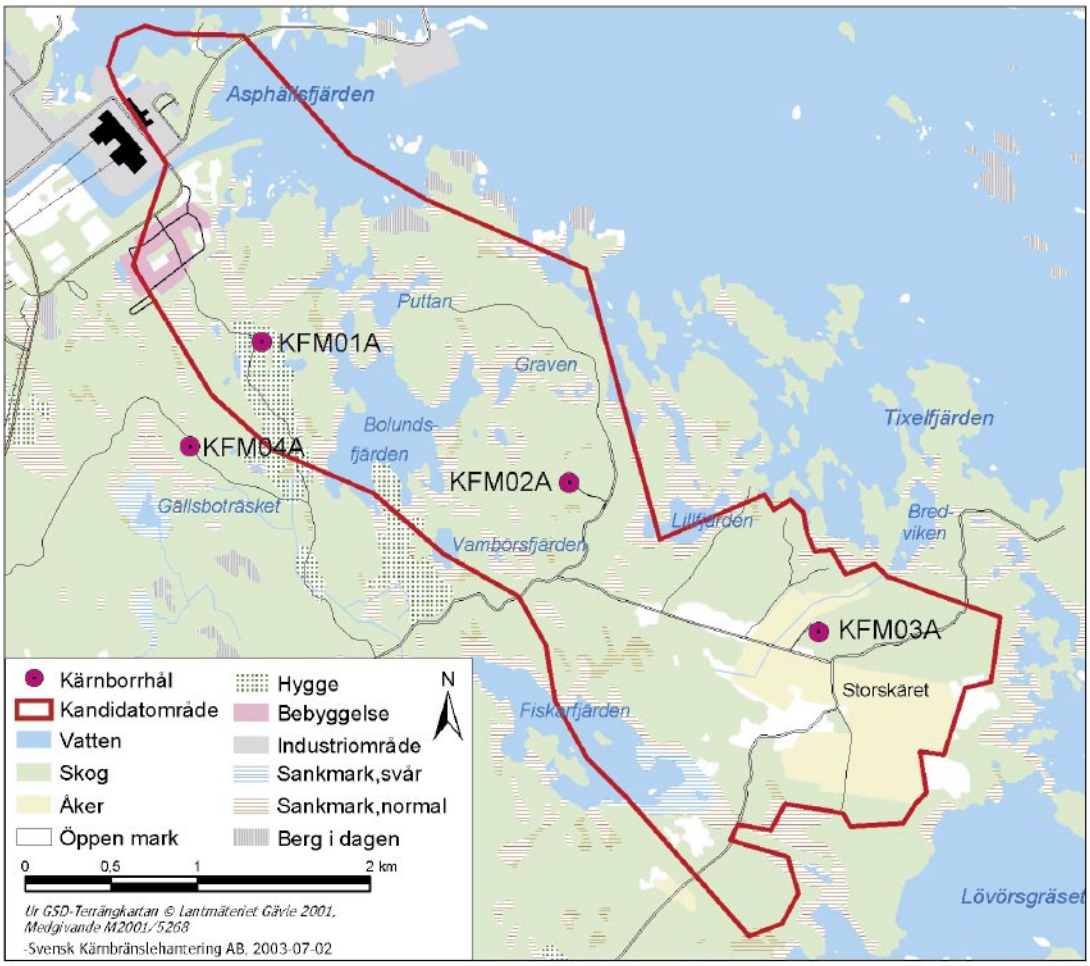

Figure 1-1. *Location of the drill hole KFM01A at the Forsmark investigation area.*

2 Objective and scope

The purpose is to determine the linear coefficient of thermal expansion for rock cores at water-saturated conditions between +20-80 ºC.

These parameters will be included in the site descriptive model of rock mechanics for the Forsmark area, performed by SKB. The specimens and the results will be presented in tables, diagrams and spreadsheets.

3 Equipment

The following equipment has been used for the analyses:

- Extensometer (DEMEC inv no 102266) for measurements of the thermal expansion. Calibration of the instrument was done before the measurements on every new temperature level (see Appendix 1). The uncertainty of the extensometer is ± 3.97 x 10^{-6} mm/mm (strain) which for these samples equals an uncertainty of a single measurement of the coefficient of thermal expansion of ± 0.4 x 10^{-6} mm/mm ^{o}C for a temperature difference of 20 degrees C.
- Reference bar in invar steel for calibration of the extensometer.
- Heating chamber (inv no 102284) with an accuracy of ± 0.7 ºC at 80 ºC for heating up the specimens.
- A covered plastic box filled with water for keeping the specimens water saturated.

4 Execution

Determination of the coefficient of thermal expansion was made in accordance with SKB's method description SKB MD 191.002, version 1.9 (SKB internal controlling document). The department of Building Technology and Mechanics (BM) at SP performed the test.

4.1 Description of the samples

In the Forsmark area, specimens were sampled from three levels in drill hole KFM01A. The core drilled part of the borehole starts at a depth of 100 m and the sampled levels were selected at the approximate depths of 230 m, 490 m and 690 m. 21 specimens, with a length of 250 mm and a diameter of 50 mm, were sampled. The sampled rock type is a medium grained metagranodiorite-granite. Table 4-1 shows 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, according to the marks on the drill-core boxes (Sec up)	Rock type
KFM01A-90L-1	226.50	Metagranodiorite-granite
KFM01A-90L-2	232.83	Metagranodiorite-granite
KFM01A-90L-3	233.11	Metagranodiorite-granite
KFM01A-90L-4	236.29	Metagranodiorite-granite
KFM01A-90L-5	236.56	Metagranodiorite-granite
KFM01A-90L-6	237.24	Metagranodiorite-granite
KFM01A-90L-7	490.72	Metagranodiorite-granite
KFM01A-90L-8	490.98	Metagranodiorite-granite
KFM01A-90L-9	491.25	Metagranodiorite-granite
KFM01A-90L-10	491.51	Metagranodiorite-granite
KFM01A-90L-11	491.84	Metagranodiorite-granite
KFM01A-90L-12	492.12	Metagranodiorite-granite
KFM01A-90L-13	492.38	Metagranodiorite-granite
KFM01A-90L-14	492.85	Metagranodiorite-granite
KFM01A-90L-15	493.47	Metagranodiorite-granite
KFM01A-90L-16	493.73	Metagranodiorite-granite
KFM01A-90L-17	689.07	Metagranodiorite-granite
KFM01A-90L-18	689.33	Metagranodiorite-granite
KFM01A-90L-19	689.59	Metagranodiorite-granite
KFM01A-90L-20	689.84	Metagranodiorite-granite
KFM01A-90L-21	690.22	Metagranodiorite-granite

4.2 Testing

The execution procedure followed the prescription in SKB MD 191.002, version 1.9 and SKB MD 160.002, version 1.9 (SKB internal controlling documents) and the following steps were performed:

Item	Activity
1	The specimens were cut according to the marks on the rock cores.
2	Two measuring points with a distance of 200 mm were glued on the specimens.
3	The specimens were photographed in JPEG-format.
5	The specimens were water saturated for seven days.
6	The dry density was determined (See Appendix 4)
7	The wet density was determined (See Appendix 4)
8	The coefficient of thermal expansion was determined, see Appendix 2. The thermal expansion was measured at 20, 40, 60 and 80 ºC. On each temperature level three to five measurements were done with 24 h intervals in order to ensure that the expansion was completed for each temperature level (see Appendix 1). The coefficient of thermal expansion was determined between 20-80 ºC. The uncertainty in the measurement is ± 3.97 x 10^{-6} mm/mm (strain) which for these samples equals an uncertainty of the coefficient of thermal expansion of ± 0.4 x 10^{-6} mm/mm ^{o}C for a temperature difference of 20 degrees C. Calibration of the instrument was done before the measurements on every new temperature level (see Appendix 1).

5 Results

The results of the extensometer measurements on drill core samples from borehole KFM01A at Forsmark are stored in the database SICADA under field note no Forsmark 96.

5.1 Description of the specimens and presentation of the results

The temperature of water for water saturation was 21.2 ºC and the density of the water was 998 kg/m^3. The coefficient of thermal expansion was determined between +20-80 ˚C.

The coefficient of thermal expansion for specimen KFM01A-90L-1, see Figure 5-1, was measured to be 7.1 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-1 (226.50)

Figure 5-1. *Specimen KFM01A-90L-1.*

The coefficient of thermal expansion for specimen KFM01A-90L-2, see Figure 5-2, was measured to be 6.6 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-2 (232.83)

Figure 5-2. *Specimen KFM01A-90L-2.*

The coefficient of thermal expansion for specimen KFM01A-90L-3, see Figure 5-3, was measured to be 5.7 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-3 (233.11)

Figure 5-3. *Specimen KFM01A-90L-3.*

The coefficient of thermal expansion for specimen KFM01A-90L-4, see Figure 5-4, was measured to be 5.4 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-4 (236.29)

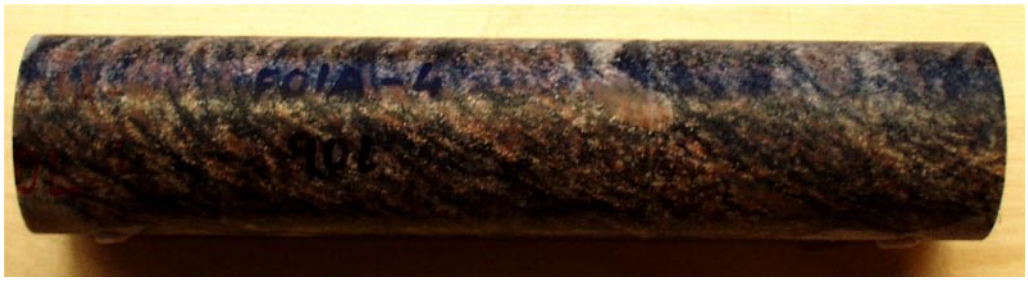

Figure 5-4. *Specimen KFM01A-90L-4.*

The coefficient of thermal expansion for specimen KFM01A-90L-5, see Figure 5-5, was measured to be 5.5 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-5 (236.56)

Figure 5-5. *Specimen KFM01A-90L-5.*

The coefficient of thermal expansion for specimen KFM01A-90L-6, see Figure 5-6, was measured to be 8.5 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-6 (237.24)

Figure 5-6. *Specimen KFM01A-90L-6.*

Table 5-1. Summary of the results for the coefficient of thermal expansion and wet density of the specimens from level 1, 226-237 m.

Specimen	Coefficient of thermal expansion (mm/mm ˚C)	Wet density (Kg/m^3)
KFM01A-90L-1	7.1 x 10^{-6}	2660
KFM01A-90L-2	6.6 x 10^{-6}	2660
KFM01A-90L-3	5.7 x 10^{-6}	2660
KFM01A-90L-4	5.4 x 10^{-6}	2650
KFM01A-90L-5	5.5 x 10^{-6}	2660
KFM01A-90L-6	8.5 x 10^{-6}	2650
Median	6.2 x 10^{-6}	
Maximum value	8.5 x 10^{-6}	
Minimum value	5.4 x 10^{-6}	

The coefficient of thermal expansion for specimen KFM01A-90L-7, see Figure 5-7, was measured to be 8.7 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-7 (490.72)

Figure 5-7. *Specimen KFM01A-90L-7.*

The coefficient of thermal expansion for specimen KFM01A-90L-8, see Figure 5-8, was measured to be 5.6 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-8 (490.98)

Figure 5-8. *Specimen KFM01A-90L-8.*

The coefficient of thermal expansion for specimen KFM01A-90L-9, see Figure 5-9, was measured to be 7.5 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-9 (491.25)

Figure 5-9. *Specimen KFM01A-90L-9.*

The coefficient of thermal expansion for specimen KFM01A-90L-10, see Figure 5-10, was measured to be 6.7 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-10 (491.51)

Figure 5-10. *Specimen KFM01A-90L-10.*

The coefficient of thermal expansion for specimen KFM01A-90L-11, see Figure 5-11, was measured to be 6.7 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-11 (491.84)

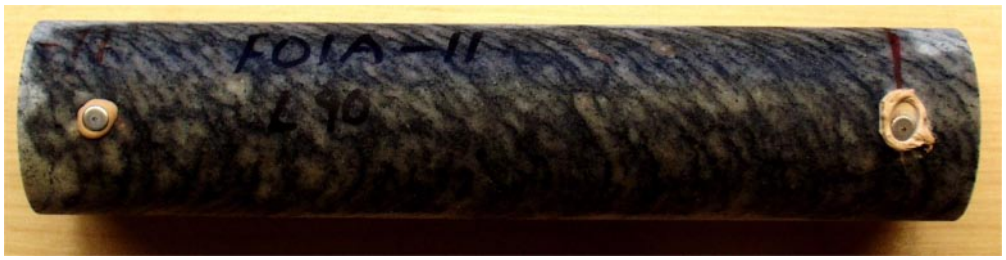

Figure 5-11. *Specimen KFM01A-90L-11.*

The coefficient of thermal expansion for specimen KFM01A-90L-12, see Figure 5-12, was measured to be 6.2 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-12 (492.12)

Figure 5-12. *Specimen KFM01A-90L-12.*

The coefficient of thermal expansion for specimen KFM01A-90L-13, see Figure 5-13 was measured to be 8.9 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-13 (492.38)

Figure 5-13. *Specimen KFM01A-90L-13.*

The coefficient of thermal expansion for specimen KFM01A-90L-14, see Figure 5-14, was measured to be 8.0 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-14 (492.85)

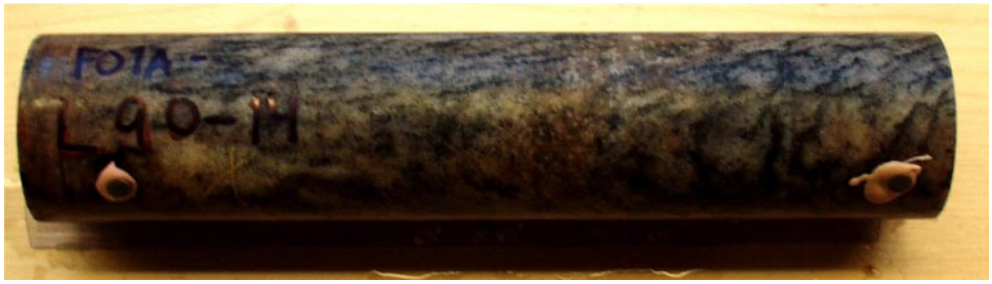

Figure 5-14. *Specimen KFM01A-90L-14.*

The coefficient of thermal expansion for specimen KFM01A-90L-15, see Figure 5-15 was measured to be 7.1 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-15 (493.47)

Figure 5-15. *Specimen KFM01A-90L-15.*

The coefficient of thermal expansion for specimen KFM01A-90L-16, see Figure 5-16, was measured to be 6.7 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-16 (493.73)

Figure 5-16. *Specimen KFM01A-90L-16.*

Table 5-2. Summary of the results for the coefficient of thermal expansion and wet density of the specimens from level 2, 491-494 m.

Specimen	Coefficient of thermal expansion (mm/mm ˚C)	Wet density (Kg/m^3)
KFM01A-90L-7	8.7 x 10^{-6}	2650
KFM01A-90L-8	5.6 x 10^{-6}	2650
KFM01A-90L-9	7.5 x 10^{-6}	2650
KFM01A-90L-10	6.7 x 10^{-6}	2660
KFM01A-90L-11	6.7 x 10^{-6}	2660
KFM01A-90L-12	6.2 x 10^{-6}	2660
KFM01A-90L-13	8.9 x 10^{-6}	2660
KFM01A-90L-14	8.0 x 10^{-6}	2650
KFM01A-90L-15	7.1 x 10^{-6}	2660
KFM01A-90L-16	6.7 x 10^{-6}	2660
Median	6.9 x 10^{-6}	
Maximum value	8.7 x 10^{-6}	
Minimum value	5.6 x 10^{-6}	

The coefficient of thermal expansion for specimen KFM01A-90L-17, see Figure 5-17, was measured to be 10 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-17 (689.07)

Figure 5-17. *Specimen KFM01A-90L-17.*

The coefficient of thermal expansion for specimen KFM01A-90L-18, see Figure 5-18, was measured to be 6.4 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-18 (689.33)

Figure 5-18. *Specimen KFM01A-90L-18.*

The coefficient of thermal expansion for specimen KFM01A-90L-19, see Figure 5-19, was measured to be 15 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-19 (689.59)

Figure 5-19. *Specimen KFM01A-90L-19.*

The coefficient of thermal expansion for specimen KFM01A-90L-20, see Figure 5-20, was measured to be 5.8 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2650 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-20 (689.84)

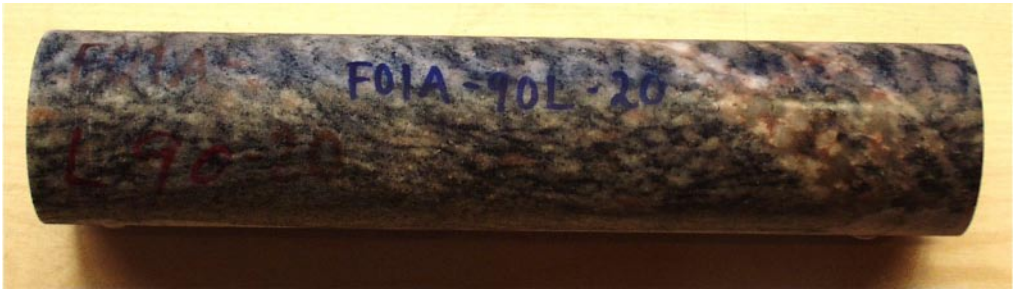

Figure 5-20. *Specimen KFM01A-90L-20.*

The coefficient of thermal expansion for specimen KFM01A-90L-21, see Figure 5-21, was measured to be 9.8 x 10^{-6} mm/mm ˚C and the specimen had a wet density of 2660 Kg/m^3. The diagram for the thermal expansion in the interval 20, 40, 60, 80 ˚C is presented in Appendix 3.

KFM01A-90L-21 (690.22)

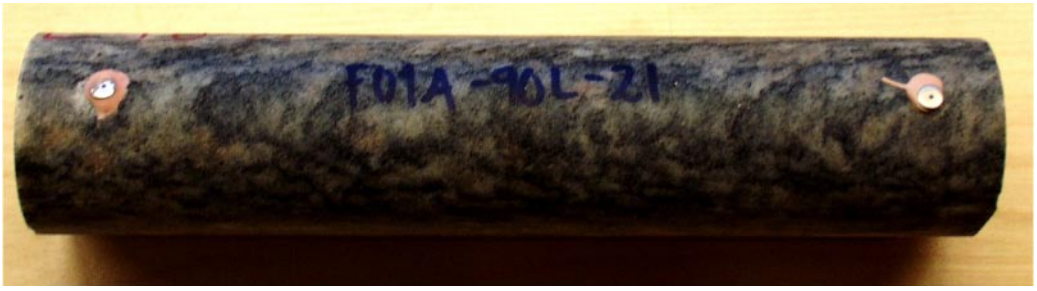

Figure 5-21. *Specimen KFM01A-90L-21.*

Table 5-3. Summary of the results for the coefficient of thermal expansion and wet density of the specimens from level 3, 689-690 m.

Specimen	Coefficient of thermal expansion (mm/mm ˚C)	Wet density (Kg/m^3)
KFM01A-90L-17	10 x 10^{-6}	2660
KFM01A-90L-18	6.4 x 10^{-6}	2660
KFM01A-90L-19	15 x 10^{-6}	2660
KFM01A-90L-20	5.8 x 10^{-6}	2650
KFM01A-90L-21	9.8 x 10^{-6}	2660
Median	9.8 x 10^{-6}	
Maximum value	15 x 10^{-6}	
Minimum value	5.8 x 10^{-6}	

5.2 Results for the entire test series

Figure 5-22 shows the coefficient of thermal expansion plotted versus depth of the drill hole. The results indicate that the coefficient of thermal expansion increases with the depth. Specimen KFM01A-90L-19 shows the largest expansion. This could be due to the strong foliation that strikes parallel to the drill hole axis.

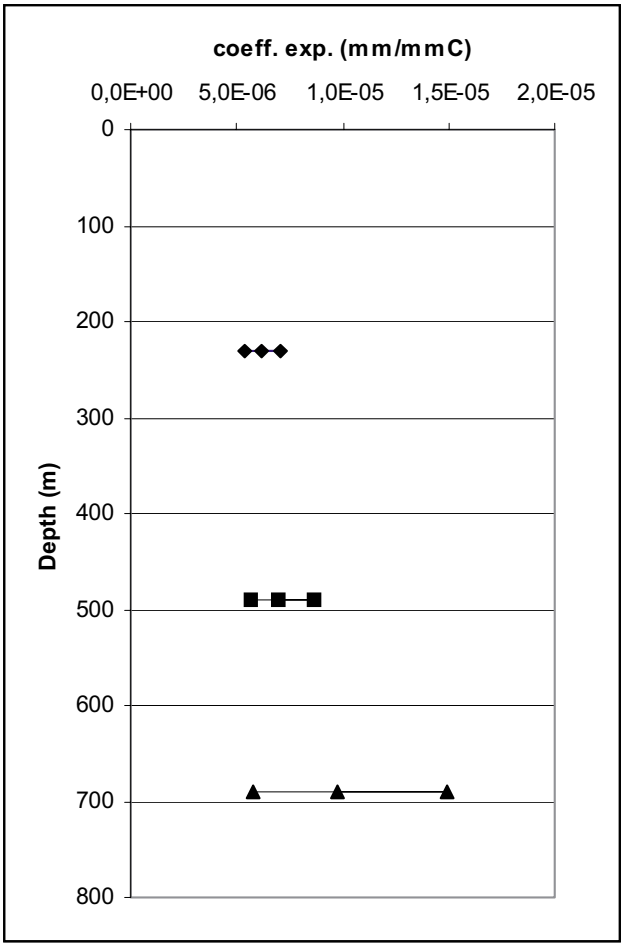

Figure 5-22. *Coefficient of thermal expansion plotted versus depth of the drill hole. The plot shows the minimum, maximum and median values for the specimens on each level.*

5.3 Nonconformities

There were no deviations to the plans.

Provningsprotokoll för längdutvidgningskoefficient

Annex 2
KFM01A
page 1 of 5

Provningsprotokoll längdutvidgningskoefficient								
Borrhål/nivå		KFM01A						
Mättemperatur		20°C						
Kalibrering extensometer (datum)					03-11-14			
Prov ID	Skalvärde/datum		Skalvärde/datum		Skalvärde/datum		Skalvärde/datum	
FO1A -1	-02	03-11-10	01	03-11-11	01	12-11		
-2	024		25		27			
-3	-0449		-447		-446			
-4	04		08		08			
-5	-09		11		12			
-6	020		22		21			
-7	05		08		10			
-8	030		35		35			
-9	042		48		48			
-10	075		77		77			
-11	013		14		15			
-12	788		792		789			
-13	-01		0		1			
-14	-014		-13		-13			
-15	035		38		39			
-16	015		15		15			
-17	010		11		15			
-18	-012		-8		-07			
-19	-054		-52		-53			
-20	01		3		1			
-21	011		14		16			
FO1A -4	24							
FO1A -11	-13							

Annex 2
KFM01A
page 2 of 5

Provningsprotokoll längdutvidgningskoefficient

Borrhål/nivå		KFM01A						
Mättemperatur		40°C						
Kalibrering extensometer (datum)					03-11-13			
Prov ID	Skalvärde/datum		Skalvärde/datum		Skalvärde/datum		Skalvärde/datum	
F01A -1	29	03-11-13	32	03-11-14	32	03-11-17		
-2	61		61		61			
-3	-408		-411		-412			
-4	41		39		39			
-5	46		43		42			
-6	49		51		51			
-7	44	44	~~42~~		44			
-8	65		65		65			
-9	82		83		84			
-10	105		108		109			
-11	41		42		43			
-12	817		818		819			
-13	37		37		38			
-14	15		15		16			
-15	73		73		73			
-16	49		49		49			
-17	48		52		52			
-18	22		20		21			
-19	-10		-10		-10			
-20	27		33		34			
-21	53		53		53			
F01A-4	55		57		59			
F01A-11	16		20		17			

Annex 2
KFM01A
page 3 of 5

Provningsprotokoll längdutvidgningskoefficient

Borrhål/nivå		KFM01A						
Mättemperatur		60°C						
Kalibrering extensometer (datum)					03-11-18			
Prov ID	Skalvärde/datum		Skalvärde/datum		Skalvärde/datum		Skalvärde/datum	
F01A -1	25	03-11-18	71	03-11-19	71	03-11-20		
-2	94		89		89			
-3	-394		-387		-387			
-4	68		66		66			
-5	56		54		54!			
-6	83		93		91			
-7	80	85	~~77~~		88			
-8	98		100		103			
-9	121		130		130			
-10	141		138		139			
-11	70		77		63			
-12	840		850		842			
-13	72		75		76			
-14	51		54		54			
-15	101		105		107			
-16	71		75		75			
-17	96		100		107			
-18	54		53		51			
-19	39		48		46			
-20	61		63		56			
-21	93		103		93			
F01A-4	86		96		91			
F01A-11	43		33		38			

Annex 2
KFM01A
page 4 of 5

Provningsprotokoll längdutvidgningskoefficient

Borrhål/nivå		KFM01A						
Mättemperatur		80°C						
Kalibrering extensometer (datum)					03-11-21			
Prov ID	Skalvärde/datum		Skalvärde/datum		Skalvärde/datum		Skalvärde/datum	
FOIA -1	107	03-11-21	111	03-11-24	108	03-11-25	107	03-11-26
-2	127		127		134		125	
-3	-367		-351		-355		-360	
-4	79		60		66		66	
-5	84		103		95		93	
-6	129		149		149		156	
-7	136		144		144		140	
-8	120		124		125		117	
-9	156		167		161	166	~~178~~	
-10	176		180		185		178	
-11	90		70		70		69	
-12	893		893		883		882	
-13	131		145	141	~~161~~	134	~~159~~	
-14	112		110		106		107	
-15	~~140~~		156		147		140	
-16	110		114		119		118	
-17	163		173		170		164	
-18	88		90		91		86	
-19	148		180		173		173	
-20	88		84		88		88	
-21	154		164		165		164	
FOIA-4	110		105		164			
FOIA-11	78		90		89			

Annex 2
KFM01A
page 5 of 5

Provningsprotokoll längdutvidgningskoefficient

Borrhål/nivå		KFM01A						
Mättemperatur		80°C						
Kalibrering extensometer (datum)								
Prov ID	Skalvärde/datum		Skalvärde/datum		Skalvärde/datum		Skalvärde/	datum
FOIA -1	108	03-11-27						
-2	129							
-3	-364							
-4	62	157						
-5	95							
-6	149							
-7	141							
-8	118							
-9	162							
-10	177							
-11	69							
-12	853							
-13	136							
-14	108							
-15	143							
-16	116							
-17	169							
-18	89							
-19	170							
-20	87							
-21	165							

Beräkning av längdutvidgningskoefficient

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start 20 C	Skalvärde vid mätning 2003-11-13 40C	Differens skaldelar	strain (mm/mm)	Delta l	l	Längdutvidgningskoeff mm/mm per grader C	Längdutv mm/mm
KFM01A-90L-1	1	29	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-2	27	61	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-3	-446	-408	38	0,00015086	0,030172	200,0	0,00000754	0,000151
KFM01A-90L-4	8	41	33	0,00013101	0,026202	200,0	0,00000655	0,000131
KFM01A-90L-5	12	46	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-6	21	49	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-7	10	44	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-8	35	65	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-9	48	82	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-10	77	105	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-11	15	41	26	0,00010322	0,020644	200,0	0,00000516	0,000103
KFM01A-90L-12	789	817	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-13	1	37	36	0,00014292	0,028584	200,0	0,00000715	0,000143
KFM01A-90L-14	-13	18	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-15	39	73	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-16	15	49	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-17	15	48	33	0,00013101	0,026202	200,0	0,00000655	0,000131
KFM01A-90L-18	-7	22	29	0,00011513	0,023026	200,0	0,00000576	0,000115
KFM01A-90L-19	-53	-10	43	0,00017071	0,034142	200,0	0,00000854	0,000171
KFM01A-90L-20	1	27	26	0,00010322	0,020644	200,0	0,00000516	0,000103
KFM01A-90L-21	16	53	37	0,00014689	0,029378	200,0	0,00000734	0,000147
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	55	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-11	-13	16	29	0,00011513	0,023026	200,0	0,00000576	0,000115

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-14 40C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	32	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-2	27	61	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-3	-446	-411	35	0,00013895	0,02779	200,0	0,00000695	0,000139
KFM01A-90L-4	8	39	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-5	12	43	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-6	21	51	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-7	10	44	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-8	35	65	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-9	48	83	35	0,00013895	0,02779	200,0	0,00000695	0,000139
KFM01A-90L-10	77	108	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-11	15	42	27	0,00010719	0,021438	200,0	0,00000536	0,000107
KFM01A-90L-12	789	818	29	0,00011513	0,023026	200,0	0,00000576	0,000115
KFM01A-90L-13	1	37	36	0,00014292	0,028584	200,0	0,00000715	0,000143
KFM01A-90L-14	-13	15	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-15	39	73	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-16	15	49	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-17	15	52	37	0,00014689	0,029378	200,0	0,00000734	0,000147
KFM01A-90L-18	-7	20	27	0,00010719	0,021438	200,0	0,00000536	0,000107
KFM01A-90L-19	-53	-10	43	0,00017071	0,034142	200,0	0,00000854	0,000171
KFM01A-90L-20	1	33	32	0,00012704	0,025408	200,0	0,00000635	0,000127
KFM01A-90L-21	16	53	37	0,00014689	0,029378	200,0	0,00000734	0,000147
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	57	33	0,00013101	0,026202	200,0	0,00000655	0,000131
KFM01A-90L-11	-13	20	33	0,00013101	0,026202	200,0	0,00000655	0,000131

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-17 40C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	32	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-2	27	61	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-3	-446	-412	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-4	8	39	31	0,00012307	0,024614	200,0	0,00000615	0,000123
KFM01A-90L-5	12	42	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-6	21	51	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-7	10	44	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-8	35	65	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-9	48	84	36	0,00014292	0,028584	200,0	0,00000715	0,000143
KFM01A-90L-10	77	109	32	0,00012704	0,025408	200,0	0,00000635	0,000127
KFM01A-90L-11	15	43	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-12	789	819	30	0,0001191	0,02382	200,0	0,00000596	0,000119
KFM01A-90L-13	1	38	37	0,00014689	0,029378	200,0	0,00000734	0,000147
KFM01A-90L-14	-13	16	29	0,00011513	0,023026	200,0	0,00000576	0,000115
KFM01A-90L-15	39	73	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-16	15	49	34	0,00013498	0,026996	200,0	0,00000675	0,000135
KFM01A-90L-17	15	52	37	0,00014689	0,029378	200,0	0,00000734	0,000147
KFM01A-90L-18	-7	21	28	0,00011116	0,022232	200,0	0,00000556	0,000111
KFM01A-90L-19	-53	-10	43	0,00017071	0,034142	200,0	0,00000854	0,000171
KFM01A-90L-20	1	34	33	0,00013101	0,026202	200,0	0,00000655	0,000131
KFM01A-90L-21	16	53	37	0,00014689	0,029378	200,0	0,00000734	0,000147
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	59	35	0,00013895	0,02779	200,0	0,00000695	0,000139
KFM01A-90L-11	-13	17	30	0,0001191	0,02382	200,0	0,00000596	0,000119

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-18 60C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	75	74	0,00029378	0,058756	200,0	0,00000734	0,000294
KFM01A-90L-2	27	94	67	0,00026599	0,053198	200,0	0,00000665	0,000266
KFM01A-90L-3	-446	-394	52	0,00020644	0,041288	200,0	0,00000516	0,000206
KFM01A-90L-4	8	68	60	0,0002382	0,04764	200,0	0,00000596	0,000238
KFM01A-90L-5	12	56	44	0,00017468	0,034936	200,0	0,00000437	0,000175
KFM01A-90L-6	21	83	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-7	10	80	70	0,0002779	0,05558	200,0	0,00000695	0,000278
KFM01A-90L-8	35	98	63	0,00025011	0,050022	200,0	0,00000625	0,000250
KFM01A-90L-9	48	121	73	0,00028981	0,057962	200,0	0,00000725	0,000290
KFM01A-90L-10	77	141	64	0,00025408	0,050816	200,0	0,00000635	0,000254
KFM01A-90L-11	15	70	55	0,00021835	0,04367	200,0	0,00000546	0,000218
KFM01A-90L-12	789	840	51	0,00020247	0,040494	200,0	0,00000506	0,000202
KFM01A-90L-13	1	72	71	0,00028187	0,056374	200,0	0,00000705	0,000282
KFM01A-90L-14	-13	51	64	0,00025408	0,050816	200,0	0,00000635	0,000254
KFM01A-90L-15	39	101	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-16	15	71	56	0,00022232	0,044464	200,0	0,00000556	0,000222
KFM01A-90L-17	15	96	81	0,00032157	0,064314	200,0	0,00000804	0,000322
KFM01A-90L-18	-7	54	61	0,00024217	0,048434	200,0	0,00000605	0,000242
KFM01A-90L-19	-53	39	92	0,00036524	0,073048	200,0	0,00000913	0,000365
KFM01A-90L-20	1	61	60	0,0002382	0,04764	200,0	0,00000596	0,000238
KFM01A-90L-21	16	93	77	0,00030569	0,061138	200,0	0,00000764	0,000306
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	86	62	0,00024614	0,049228	200,0	0,00001231	0,000246
KFM01A-90L-11	-13	43	56	0,00022232	0,044464	200,0	0,00001112	0,000222

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-19 60C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	71	70	0,0002779	0,05558	200,0	0,00000695	0,000278
KFM01A-90L-2	27	89	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-3	-446	-387	59	0,00023423	0,046846	200,0	0,00000586	0,000234
KFM01A-90L-4	8	66	58	0,00023026	0,046052	200,0	0,00000576	0,000230
KFM01A-90L-5	12	54	42	0,00016674	0,033348	200,0	0,00000417	0,000167
KFM01A-90L-6	21	93	72	0,00028584	0,057168	200,0	0,00000715	0,000286
KFM01A-90L-7	10	85	75	0,00029775	0,05955	200,0	0,00000744	0,000298
KFM01A-90L-8	35	100	65	0,00025805	0,05161	200,0	0,00000645	0,000258
KFM01A-90L-9	48	130	82	0,00032554	0,065108	200,0	0,00000814	0,000326
KFM01A-90L-10	77	138	61	0,00024217	0,048434	200,0	0,00000605	0,000242
KFM01A-90L-11	15	77	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-12	789	850	61	0,00024217	0,048434	200,0	0,00000605	0,000242
KFM01A-90L-13	1	75	74	0,00029378	0,058756	200,0	0,00000734	0,000294
KFM01A-90L-14	-13	54	67	0,00026599	0,053198	200,0	0,00000665	0,000266
KFM01A-90L-15	39	105	66	0,00026202	0,052404	200,0	0,00000655	0,000262
KFM01A-90L-16	15	75	60	0,0002382	0,04764	200,0	0,00000596	0,000238
KFM01A-90L-17	15	100	85	0,00033745	0,06749	200,0	0,00000844	0,000337
KFM01A-90L-18	-7	53	60	0,0002382	0,04764	200,0	0,00000596	0,000238
KFM01A-90L-19	-53	48	101	0,00040097	0,080194	200,0	0,00001002	0,000401
KFM01A-90L-20	1	63	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-21	16	103	87	0,00034539	0,069078	200,0	0,00000863	0,000345
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	96	72	0,00028584	0,057168	200,0	0,00001429	0,000286
KFM01A-90L-11	-13	33	46	0,00018262	0,036524	200,0	0,00000913	0,000183

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-20 60C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	71	70	0,0002779	0,05558	200,0	0,00000695	0,000278
KFM01A-90L-2	27	89	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-3	-446	-387	59	0,00023423	0,046846	200,0	0,00000586	0,000234
KFM01A-90L-4	8	66	58	0,00023026	0,046052	200,0	0,00000576	0,000230
KFM01A-90L-5	12	54	42	0,00016674	0,033348	200,0	0,00000417	0,000167
KFM01A-90L-6	21	91	70	0,0002779	0,05558	200,0	0,00000695	0,000278
KFM01A-90L-7	10	88	78	0,00030966	0,061932	200,0	0,00000774	0,000310
KFM01A-90L-8	35	103	68	0,00026996	0,053992	200,0	0,00000675	0,000270
KFM01A-90L-9	48	130	82	0,00032554	0,065108	200,0	0,00000814	0,000326
KFM01A-90L-10	77	139	62	0,00024614	0,049228	200,0	0,00000615	0,000246
KFM01A-90L-11	15	63	48	0,00019056	0,038112	200,0	0,00000476	0,000191
KFM01A-90L-12	789	842	53	0,00021041	0,042082	200,0	0,00000526	0,000210
KFM01A-90L-13	1	76	75	0,00029775	0,05955	200,0	0,00000744	0,000298
KFM01A-90L-14	-13	54	67	0,00026599	0,053198	200,0	0,00000665	0,000266
KFM01A-90L-15	39	107	68	0,00026996	0,053992	200,0	0,00000675	0,000270
KFM01A-90L-16	15	75	60	0,0002382	0,04764	200,0	0,00000596	0,000238
KFM01A-90L-17	15	101	86	0,00034142	0,068284	200,0	0,00000854	0,000341
KFM01A-90L-18	-7	51	58	0,00023026	0,046052	200,0	0,00000576	0,000230
KFM01A-90L-19	-53	46	99	0,00039303	0,078606	200,0	0,00000983	0,000393
KFM01A-90L-20	1	56	55	0,00021835	0,04367	200,0	0,00000546	0,000218
KFM01A-90L-21	16	93	77	0,00030569	0,061138	200,0	0,00000764	0,000306
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	91	67	0,00026599	0,053198	200,0	0,00001330	0,000266
KFM01A-90L-11	-13	38	51	0,00020247	0,040494	200,0	0,00001012	0,000202

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-21 80C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	107	106	0,00042082	0,084164	200,0	0,00000701	0,000421
KFM01A-90L-2	27	127	100	0,000397	0,0794	200,0	0,00000662	0,000397
KFM01A-90L-3	-446	-367	79	0,00031363	0,062726	200,0	0,00000523	0,000314
KFM01A-90L-4	8	79	71	0,00028187	0,056374	200,0	0,00000470	0,000282
KFM01A-90L-5	12	84	72	0,00028584	0,057168	200,0	0,00000476	0,000286
KFM01A-90L-6	21	129	108	0,00042876	0,085752	200,0	0,00000715	0,000429
KFM01A-90L-7	10	136	126	0,00050022	0,100044	200,0	0,00000834	0,000500
KFM01A-90L-8	35	120	85	0,00033745	0,06749	200,0	0,00000562	0,000337
KFM01A-90L-9	48	156	108	0,00042876	0,085752	200,0	0,00000715	0,000429
KFM01A-90L-10	77	176	99	0,00039303	0,078606	200,0	0,00000655	0,000393
KFM01A-90L-11	15	90	75	0,00029775	0,05955	200,0	0,00000496	0,000298
KFM01A-90L-12	789	893	104	0,00041288	0,082576	200,0	0,00000688	0,000413
KFM01A-90L-13	1	131	130	0,0005161	0,10322	200,0	0,00000860	0,000516
KFM01A-90L-14	-13	112	125	0,00049625	0,09925	200,0	0,00000827	0,000496
KFM01A-90L-15	39	156	117	0,00046449	0,092898	200,0	0,00000774	0,000464
KFM01A-90L-16	15	110	95	0,00037715	0,07543	200,0	0,00000629	0,000377
KFM01A-90L-17	15	163	148	0,00058756	0,117512	200,0	0,00000979	0,000588
KFM01A-90L-18	-7	88	95	0,00037715	0,07543	200,0	0,00000629	0,000377
KFM01A-90L-19	-53	148	201	0,00079797	0,159594	200,0	0,00001330	0,000798
KFM01A-90L-20	1	88	87	0,00034539	0,069078	200,0	0,00000576	0,000345
KFM01A-90L-21	16	154	138	0,00054786	0,109572	200,0	0,00000913	0,000548
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	110	86	0,00034142	0,068284	200,0	0,00000569	0,000341
KFM01A-90L-11	-13	78	91	0,00036127	0,072254	200,0	0,00000602	0,000361

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-24 80C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	111	110	0,0004367	0,08734	200,0	0,00000728	0,000437
KFM01A-90L-2	27	127	100	0,000397	0,0794	200,0	0,00000662	0,000397
KFM01A-90L-3	-446	-351	95	0,00037715	0,07543	200,0	0,00000629	0,000377
KFM01A-90L-4	8	60	52	0,00020644	0,041288	200,0	0,00000344	0,000206
KFM01A-90L-5	12	103	91	0,00036127	0,072254	200,0	0,00000602	0,000361
KFM01A-90L-6	21	149	128	0,00050816	0,101632	200,0	0,00000847	0,000508
KFM01A-90L-7	10	144	134	0,00053198	0,106396	200,0	0,00000887	0,000532
KFM01A-90L-8	35	124	89	0,00035333	0,070666	200,0	0,00000589	0,000353
KFM01A-90L-9	48	167	119	0,00047243	0,094486	200,0	0,00000787	0,000472
KFM01A-90L-10	77	180	103	0,00040891	0,081782	200,0	0,00000682	0,000409
KFM01A-90L-11	15	70	55	0,00021835	0,04367	200,0	0,00000364	0,000218
KFM01A-90L-12	789	893	104	0,00041288	0,082576	200,0	0,00000688	0,000413
KFM01A-90L-13	1	145	144	0,00057168	0,114336	200,0	0,00000953	0,000572
KFM01A-90L-14	-13	110	123	0,00048831	0,097662	200,0	0,00000814	0,000488
KFM01A-90L-15	39	156	117	0,00046449	0,092898	200,0	0,00000774	0,000464
KFM01A-90L-16	15	114	99	0,00039303	0,078606	200,0	0,00000655	0,000393
KFM01A-90L-17	15	173	158	0,00062726	0,125452	200,0	0,00001045	0,000627
KFM01A-90L-18	-7	90	97	0,00038509	0,077018	200,0	0,00000642	0,000385
KFM01A-90L-19	-53	180	233	0,00092501	0,185002	200,0	0,00001542	0,000925
KFM01A-90L-20	1	84	83	0,00032951	0,065902	200,0	0,00000549	0,000330
KFM01A-90L-21	16	164	148	0,00058756	0,117512	200,0	0,00000979	0,000588
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	105	81	0,00032157	0,064314	200,0	0,00000536	0,000322
KFM01A-90L-11	-13	90	103	0,00040891	0,081782	200,0	0,00000682	0,000409

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-25 80C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	108	107	0,00042479	0,084958	200,0	0,00000708	0,000425
KFM01A-90L-2	27	134	107	0,00042479	0,084958	200,0	0,00000708	0,000425
KFM01A-90L-3	-446	-355	91	0,00036127	0,072254	200,0	0,00000602	0,000361
KFM01A-90L-4	8	66	58	0,00023026	0,046052	200,0	0,00000384	0,000230
KFM01A-90L-5	12	95	83	0,00032951	0,065902	200,0	0,00000549	0,000330
KFM01A-90L-6	21	149	128	0,00050816	0,101632	200,0	0,00000847	0,000508
KFM01A-90L-7	10	144	134	0,00053198	0,106396	200,0	0,00000887	0,000532
KFM01A-90L-8	35	125	90	0,0003573	0,07146	200,0	0,00000596	0,000357
KFM01A-90L-9	48	161	113	0,00044861	0,089722	200,0	0,00000748	0,000449
KFM01A-90L-10	77	185	108	0,00042876	0,085752	200,0	0,00000715	0,000429
KFM01A-90L-11	15	70	55	0,00021835	0,04367	200,0	0,00000364	0,000218
KFM01A-90L-12	789	883	94	0,00037318	0,074636	200,0	0,00000622	0,000373
KFM01A-90L-13	1	141	140	0,0005558	0,11116	200,0	0,00000926	0,000556
KFM01A-90L-14	-13	106	119	0,00047243	0,094486	200,0	0,00000787	0,000472
KFM01A-90L-15	39	147	108	0,00042876	0,085752	200,0	0,00000715	0,000429
KFM01A-90L-16	15	119	104	0,00041288	0,082576	200,0	0,00000688	0,000413
KFM01A-90L-17	15	170	155	0,00061535	0,12307	200,0	0,00001026	0,000615
KFM01A-90L-18	-7	91	98	0,00038906	0,077812	200,0	0,00000648	0,000389
KFM01A-90L-19	-53	173	226	0,00089722	0,179444	200,0	0,00001495	0,000897
KFM01A-90L-20	1	88	87	0,00034539	0,069078	200,0	0,00000576	0,000345
KFM01A-90L-21	16	165	149	0,00059153	0,118306	200,0	0,00000986	0,000592
			0	0	0	200,0	0,00000000	0,000000
KFM01A-90L-4	24	104	80	0,0003176	0,06352	200,0	0,00000529	0,000318
KFM01A-90L-11	-13	89	102	0,00040494	0,080988	200,0	0,00000675	0,000405

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-26 80C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	107	106	0,00042082	0,084164	200,0	0,00000701	0,000421
KFM01A-90L-2	27	125	98	0,00038906	0,077812	200,0	0,00000648	0,000389
KFM01A-90L-3	-446	-360	86	0,00034142	0,068284	200,0	0,00000569	0,000341
KFM01A-90L-4	8	66	58	0,00023026	0,046052	200,0	0,00000384	0,000230
KFM01A-90L-5	12	93	81	0,00032157	0,064314	200,0	0,00000536	0,000322
KFM01A-90L-6	21	156	135	0,00053595	0,10719	200,0	0,00000893	0,000536
KFM01A-90L-7	10	140	130	0,0005161	0,10322	200,0	0,00000860	0,000516
KFM01A-90L-8	35	117	82	0,00032554	0,065108	200,0	0,00000543	0,000326
KFM01A-90L-9	48	166	118	0,00046846	0,093692	200,0	0,00000781	0,000468
KFM01A-90L-10	77	178	101	0,00040097	0,080194	200,0	0,00000668	0,000401
KFM01A-90L-11	15	69	54	0,00021438	0,042876	200,0	0,00000357	0,000214
KFM01A-90L-12	789	882	93	0,00036921	0,073842	200,0	0,00000615	0,000369
KFM01A-90L-13	1	134	133	0,00052801	0,105602	200,0	0,00000880	0,000528
KFM01A-90L-14	-13	107	120	0,0004764	0,09528	200,0	0,00000794	0,000476
KFM01A-90L-15	39	140	101	0,00040097	0,080194	200,0	0,00000668	0,000401
KFM01A-90L-16	15	118	103	0,00040891	0,081782	200,0	0,00000682	0,000409
KFM01A-90L-17	15	164	149	0,00059153	0,118306	200,0	0,00000986	0,000592
KFM01A-90L-18	-7	86	93	0,00036921	0,073842	200,0	0,00000615	0,000369
KFM01A-90L-19	-53	173	226	0,00089722	0,179444	200,0	0,00001495	0,000897
KFM01A-90L-20	1	88	87	0,00034539	0,069078	200,0	0,00000576	0,000345
KFM01A-90L-21	16	164	148	0,00058756	0,117512	200,0	0,00000979	0,000588
				0	0	200,0	0,00000000	0,000000

Längdutvidgningskoefficient

Provningsmetod: NT BUILD 479

Vattenmättad temperaturintervall 20-80 C
Borrhål/nivå:

1 skaldel motsvarar 3,97 mikrostrain = 3,97x10-6 strain
Delta l = längdförändringen i mm = strain x l

Prov id	Skalvärde start	Skalvärde vid mätning	Differens skaldelar	strain	Delta l	l	Längdutvidgningskoeff	Längdutv
	20 C	2003-11-27 80C		(mm/mm)			mm/mm per grader C	mm/mm
KFM01A-90L-1	1	108	107	0,00042479	0,084958	200,0	0,00000708	0,000425
KFM01A-90L-2	27	129	102	0,00040494	0,080988	200,0	0,00000675	0,000405
KFM01A-90L-3	-446	-364	82	0,00032554	0,065108	200,0	0,00000543	0,000326
KFM01A-90L-4	8	62	54	0,00021438	0,042876	200,0	0,00000357	0,000214
KFM01A-90L-5	12	95	83	0,00032951	0,065902	200,0	0,00000549	0,000330
KFM01A-90L-6	21	149	128	0,00050816	0,101632	200,0	0,00000847	0,000508
KFM01A-90L-7	10	141	131	0,00052007	0,104014	200,0	0,00000867	0,000520
KFM01A-90L-8	35	118	83	0,00032951	0,065902	200,0	0,00000549	0,000330
KFM01A-90L-9	48	162	114	0,00045258	0,090516	200,0	0,00000754	0,000453
KFM01A-90L-10	77	177	100	0,000397	0,0794	200,0	0,00000662	0,000397
KFM01A-90L-11	15	69	54	0,00021438	0,042876	200,0	0,00000357	0,000214
KFM01A-90L-12	789	883	94	0,00037318	0,074636	200,0	0,00000622	0,000373
KFM01A-90L-13	1	136	135	0,00053595	0,10719	200,0	0,00000893	0,000536
KFM01A-90L-14	-13	108	121	0,00048037	0,096074	200,0	0,00000801	0,000480
KFM01A-90L-15	39	143	104	0,00041288	0,082576	200,0	0,00000688	0,000413
KFM01A-90L-16	15	116	101	0,00040097	0,080194	200,0	0,00000668	0,000401
KFM01A-90L-17	15	169	154	0,00061138	0,122276	200,0	0,00001019	0,000611
KFM01A-90L-18	-7	89	96	0,00038112	0,076224	200,0	0,00000635	0,000381
KFM01A-90L-19	-53	170	223	0,00088531	0,177062	200,0	0,00001476	0,000885
KFM01A-90L-20	1	87	86	0,00034142	0,068284	200,0	0,00000569	0,000341
KFM01A-90L-21	16	165	149	0,00059153	0,118306	200,0	0,00000986	0,000592

Sammanställning och diagram										
längdutv (mm/mm)										
Längdutv. koeff (mm/mm C)										

	Prov id	längdutvidgning mm/mm														
		20	**40**	**40**	**40**	**median 40**	**60**	**60**	**60**	**median 60**	**80**	**80**	**80**	**80**	**80**	**median 80**
nivå 1	KFM01A-90L-1	0	0,000111	0,000123	0,0001231	0,0001231	0,000294	0,000278	0,000278	0,000278	0,00042	0,000437	0,000425	0,000421	0,000425	0,000425
nivå 1	KFM01A-90L-2	0	0,000135	0,000135	0,000135	0,000135	0,000266	0,000246	0,000246	0,000246	0,0004	0,000397	0,000425	0,000389	0,000405	0,000397
nivå 1	KFM01A-90L-3	0	0,000151	0,000139	0,000135	0,000139	0,000206	0,000234	0,000234	0,000234	0,00031	0,000377	0,000361	0,000341	0,000326	0,000341
nivå1	KFM01A-90L-4	0	0,000123	0,000131	0,000139	0,000131	0,000246	0,000286	0,000266	0,000266	0,00034	0,000322	0,000318			0,000322
nivå 1	KFM01A-90L-5	0	0,000135	0,000123	0,0001191	0,0001231	0,000175	0,000167	0,000167	0,000167	0,00029	0,000361	0,00033	0,000322	0,00033	0,000330
nivå 1	KFM01A-90L-6	0	0,000111	0,000119	0,0001191	0,0001191	0,000246	0,000286	0,000278	0,000278	0,00043	0,000508	0,000508	0,000536	0,000508	0,000508
nivå 2	KFM01A-90L-7	0	0,000135	0,000135	0,000135	0,000135	0,000278	0,000298	0,000310	0,000298	0,0005	0,000532	0,000532	0,000516	0,00052	0,000520
nivå2	KFM01A-90L-8	0	0,000119	0,000119	0,0001191	0,0001191	0,000250	0,000258	0,000270	0,000258	0,00034	0,000353	0,000357	0,000326	0,00033	0,000337
nivå2	KFM01A-90L-9	0	0,000135	0,000139	0,0001429	0,000139	0,000290	0,000326	0,000326	0,000326	0,00043	0,000472	0,000449	0,000468	0,000453	0,000453
nivå2	KFM01A-90L-10	0	0,000111	0,000123	0,000127	0,0001231	0,000254	0,000242	0,000246	0,000246	0,00039	0,000409	0,000429	0,000401	0,000397	0,000401
nivå2	KFM01A-90L-11	0	0,000115	0,000131	0,0001191	0,0001191	0,000222	0,000183	0,000202	0,000202	0,00036	0,000409	0,000405			0,000405
nivå2	KFM01A-90L-12	0	0,000111	0,000115	0,0001191	0,0001151	0,000202	0,000242	0,000210	0,000210	0,00041	0,000413	0,000373	0,000369	0,000373	0,000373
nivå2	KFM01A-90L-13	0	0,000143	0,000143	0,0001469	0,0001429	0,000282	0,000294	0,000298	0,000294	0,00052	0,000572	0,000556	0,000528	0,000536	0,000536
nivå2	KFM01A-90L-14	0	0,000123	0,000111	0,0001151	0,0001151	0,000254	0,000266	0,000266	0,000266	0,0005	0,000488	0,000472	0,000476	0,00048	0,000480
nivå2	KFM01A-90L-15	0	0,000135	0,000135	0,000135	0,000135	0,000246	0,000262	0,000270	0,000262	0,00046	0,000464	0,000429	0,000401	0,000413	0,000429
nivå2	KFM01A-90L-16	0	0,000135	0,000135	0,000135	0,000135	0,000222	0,000238	0,000238	0,000238	0,00038	0,000393	0,000413	0,000409	0,000401	0,000401
nivå 3	KFM01A-90L-17	0	0,000131	0,000147	0,0001469	0,0001469	0,000322	0,000337	0,000341	0,000337	0,00059	0,000627	0,000615	0,000592	0,000611	0,000611
nivå 3	KFM01A-90L-18	0	0,000115	0,000107	0,0001112	0,0001112	0,000242	0,000238	0,000230	0,000238	0,00038	0,000385	0,000389	0,000369	0,000381	0,000381
nivå 3	KFM01A-90L-19	0	0,000171	0,000171	0,0001707	0,0001707	0,000365	0,000401	0,000393	0,000393	0,0008	0,000925	0,000897	0,000897	0,000885	0,000897
nivå 3	KFM01A-90L-20	0	0,000103	0,000127	0,000131	0,000127	0,000238	0,000246	0,000218	0,000238	0,00035	0,00033	0,000345	0,000345	0,000341	0,000345
nivå 3	KFM01A-90L-21	0	0,000147	0,000147	0,0001469	0,0001469	0,000306	0,000345	0,000306	0,000306	0,00055	0,000588	0,000592	0,000588	0,000592	0,000588
																#########
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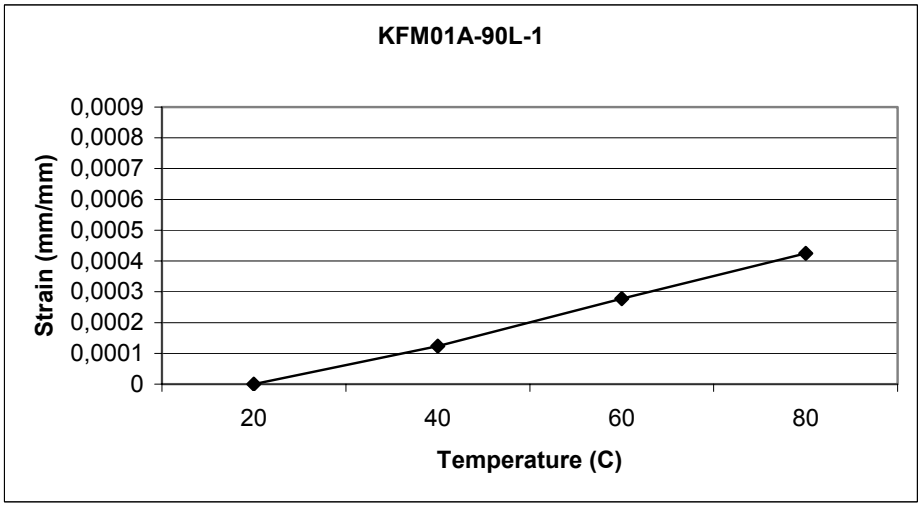
	Prov id	Längdutvidgningskoefficient mm/mmC 20-80 C									
	Nivå 1						**median**	**Median (nivå)**	**max**	**min**	**Depth (m)**
	KFM01A-90L-1	7,01E-06	7,28E-06	7,08E-06	7,014E-06	7,08E-06	7,1E-06	**6,2E-06**			230
	KFM01A-90L-2	6,62E-06	6,62E-06	7,08E-06	6,484E-06	6,749E-06	6,6E-06	7,1E-06			230
	KFM01A-90L-3	5,23E-06	6,29E-06	6,02E-06	5,69E-06	5,426E-06	5,7E-06	5,4E-06			230
	KFM01A-90L-4	5,69E-06	5,36E-06	5,29E-06			5,4E-06				490
	KFM01A-90L-5	4,76E-06	6,02E-06	5,49E-06	5,36E-06	5,492E-06	5,5E-06				490
	KFM01A-90L-6	7,15E-06	8,47E-06	8,47E-06	8,933E-06	8,469E-06	8,5E-06				490
	Nivå 2										690
	KFM01A-90L-7	8,34E-06	8,87E-06	8,87E-06	8,602E-06	8,668E-06	8,7E-06	**6,9E-06**			690
	KFM01A-90L-8	5,62E-06	5,89E-06	5,96E-06	5,426E-06	5,492E-06	5,6E-06	8,7E-06			690
	KFM01A-90L-9	7,15E-06	7,87E-06	7,48E-06	7,808E-06	7,543E-06	7,5E-06	5,6E-06			
	KFM01A-90L-10	6,55E-06	6,82E-06	7,15E-06	6,683E-06	6,617E-06	6,7E-06				
	KFM01A-90L-11	6,02E-06	6,82E-06	6,75E-06			6,7E-06				
	KFM01A-90L-12	6,88E-06	6,88E-06	6,22E-06	6,154E-06	6,22E-06	6,2E-06				
	KFM01A-90L-13	8,6E-06	9,53E-06	9,26E-06	8,8E-06	8,933E-06	8,9E-06				
	KFM01A-90L-14	8,27E-06	8,14E-06	7,87E-06	7,94E-06	8,006E-06	8,0E-06				
	KFM01A-90L-15	7,74E-06	7,74E-06	7,15E-06	6,683E-06	6,881E-06	7,1E-06				
	KFM01A-90L-16	6,29E-06	6,55E-06	6,88E-06	6,815E-06	6,683E-06	6,7E-06				
	Nivå 3										
	KFM01A-90L-17	9,79E-06	1,05E-05	1,03E-05	9,859E-06	1,019E-05	1,0E-05	**9,8E-06**			690
	KFM01A-90L-18	6,29E-06	6,42E-06	6,48E-06	6,154E-06	6,352E-06	6,4E-06	1,49537E-05			
	KFM01A-90L-19	1,33E-05	1,54E-05	1,5E-05	1,495E-05	1,476E-05	1,5E-05	5,7565E-06			
	KFM01A-90L-20	5,76E-06	5,49E-06	5,76E-06	5,757E-06	5,69E-06	5,8E-06				
	KFM01A-90L-21	9,13E-06	9,79E-06	9,86E-06	9,793E-06	9,859E-06	9,8E-06				
						5,00E-06	7,00E-06	9,00E-06	1,10E-05	1,50E-05	

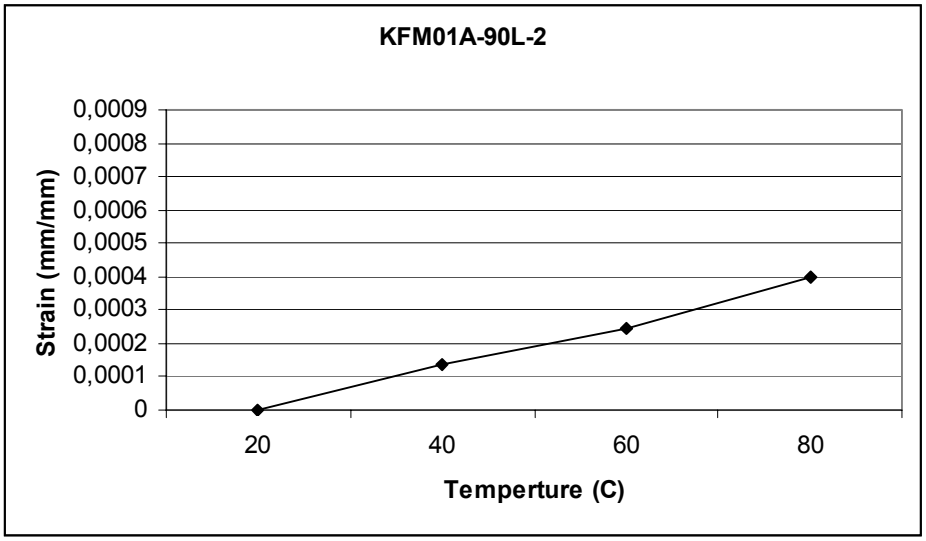
	Prov id				
		20	40	60	80
nivå 1	KFM01A-90L-1	0	0,000123	0,000278	0,000425
nivå 1	KFM01A-90L-2	0	0,000135	0,000246	0,000397
nivå 1	KFM01A-90L-3	0	0,000139	0,000234	0,000341
nivå 1	KFM01A-90L-4	0	0,000131	0,000266	0,000322
nivå 1	KFM01A-90L-5	0	0,000123	0,000167	0,00033
nivå 1	KFM01A-90L-6	0	0,000119	0,000278	0,000508
		20	40	60	80
nivå 2	KFM01A-90L-7	0	0,000135	0,000298	0,00052
	KFM01A-90L-8	0	0,000119	0,000258	0,000337
nivå2	KFM01A-90L-9	0	0,000139	0,000326	0,000453
	KFM01A-90L-10	0	0,000123	0,000246	0,000401
nivå2	KFM01A-90L-11	0	0,000119	0,000202	0,000405
	KFM01A-90L-12	0	0,000115	0,00021	0,000373
nivå2	KFM01A-90L-13	0	0,000143	0,000294	0,000536
	KFM01A-90L-14	0	0,000115	0,000266	0,00048
nivå2	KFM01A-90L-15	0	0,000135	0,000262	0,000429
	KFM01A-90L-16	0	0,000135	0,000238	0,000401
		20	40	60	80
nivå 3	KFM01A-90L-17	0	0,000147	0,000337	0,000611
nivå 3	KFM01A-90L-18	0	0,000111	0,000238	0,000381
nivå 3	KFM01A-90L-19	0	0,000171	0,000393	0,000897
nivå 3	KFM01A-90L-20	0	0,000127	0,000238	0,000345
nivå 3	KFM01A-90L-21	0	0,000147	0,000306	0,000588

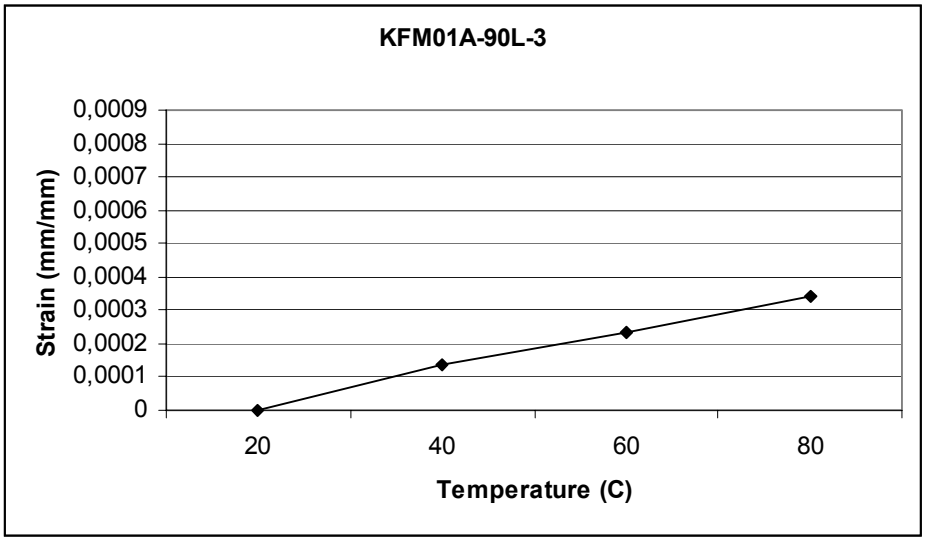
Appendix 3

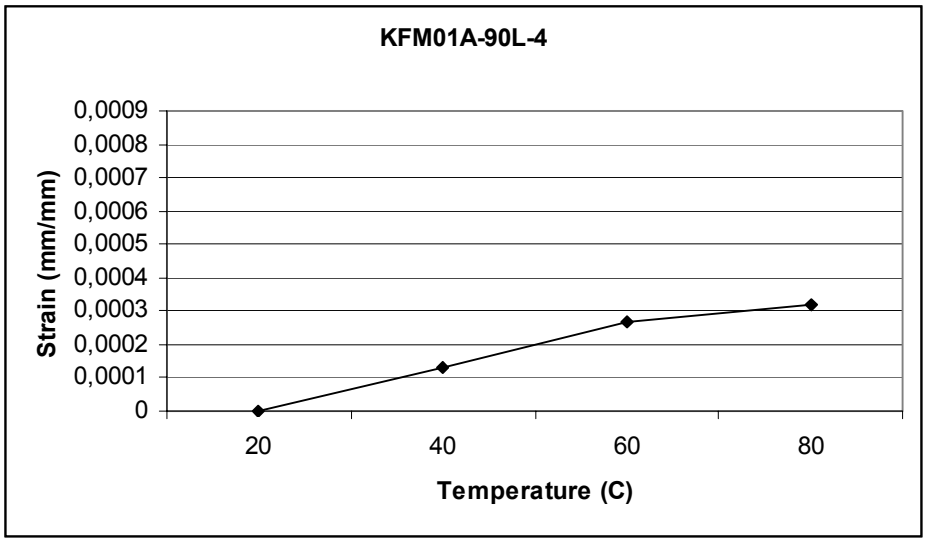
Diagram längdutvidgning mot temperatur

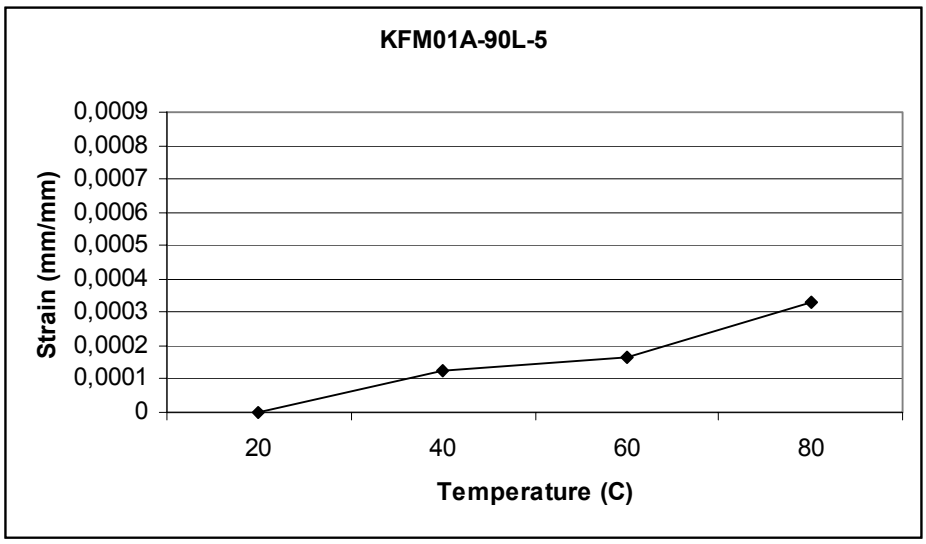
Level 1 226-237 m, Specimen KFM01A-90L-1 to KFM01A-90L-6

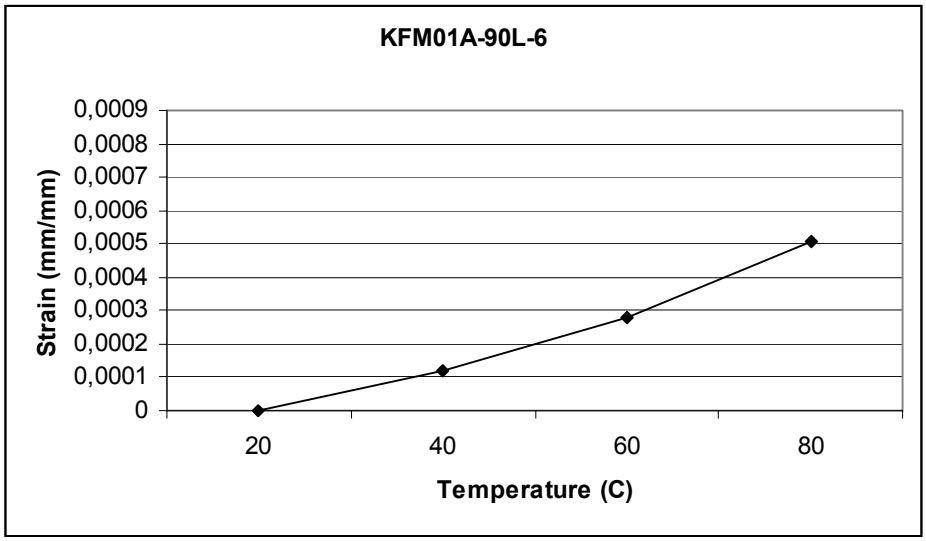




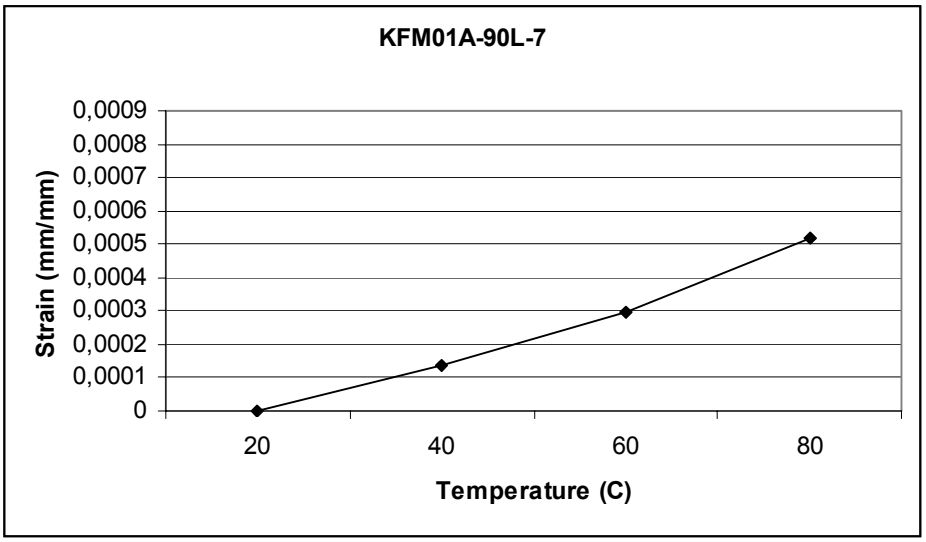


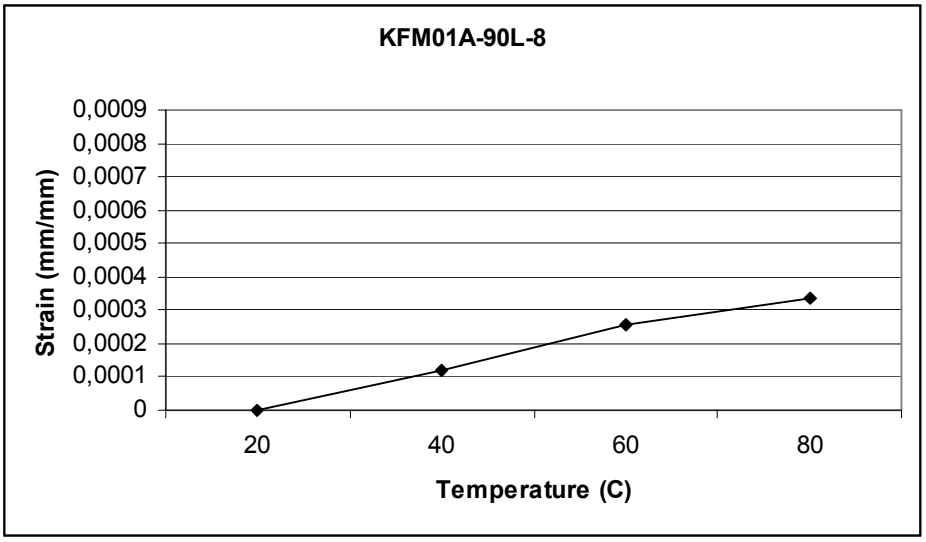

KFM01A-90L-4
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

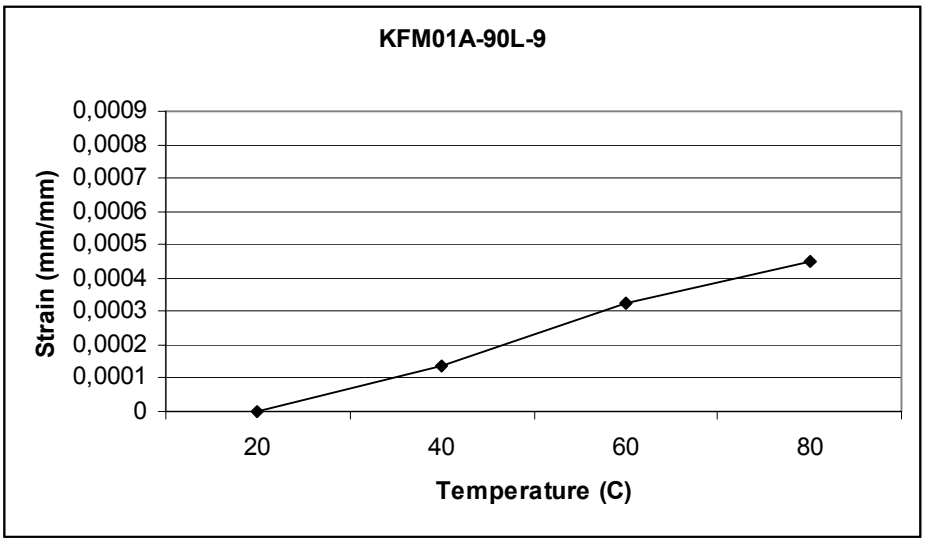

KFM01A-90L-5
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

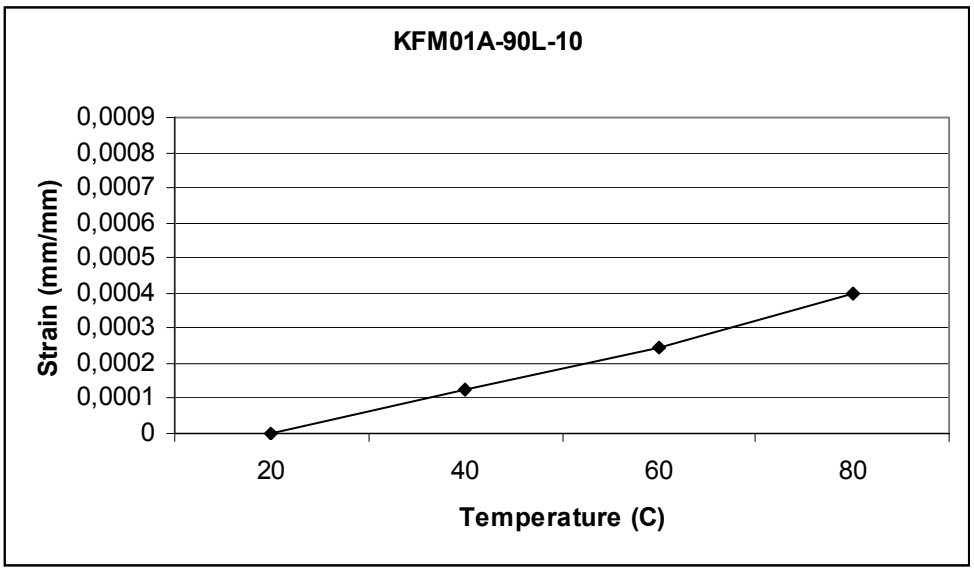

KFM01A-90L-6
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

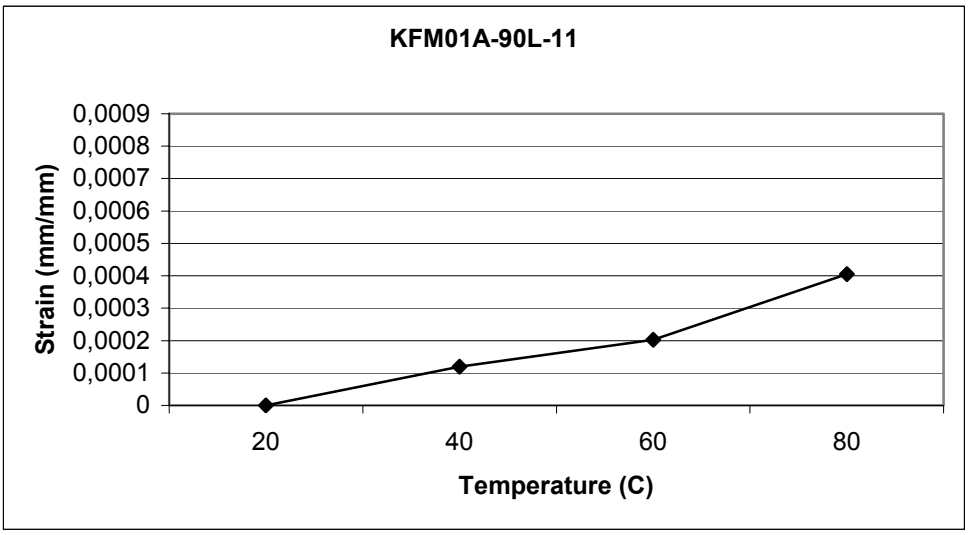
Level 2 491-494 m, Specimen KFM01A-90L-7 to KFM01A-90L-16

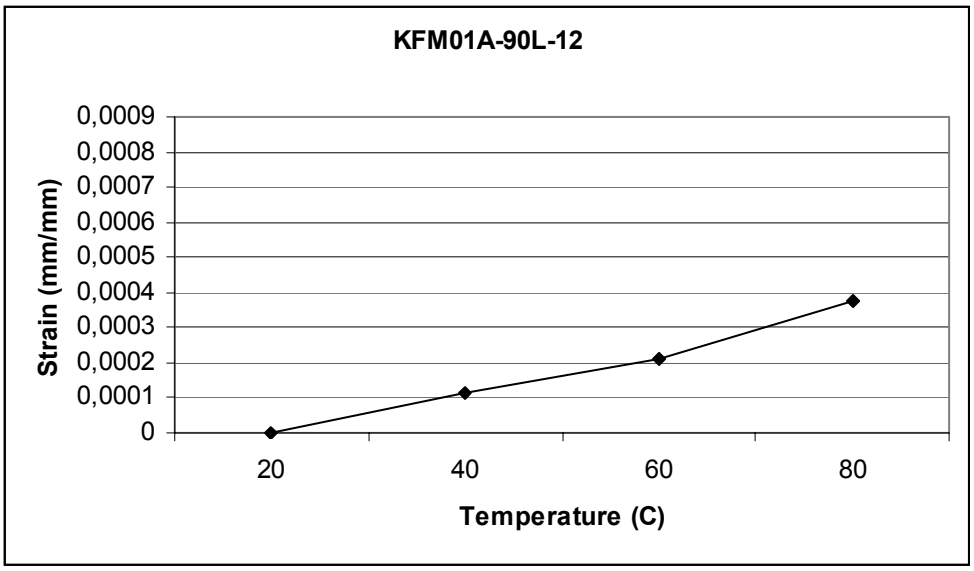


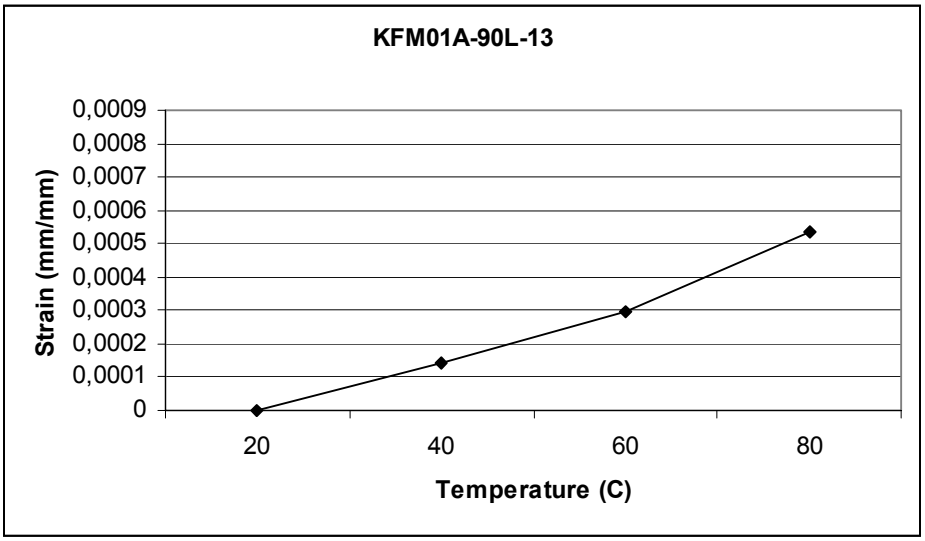


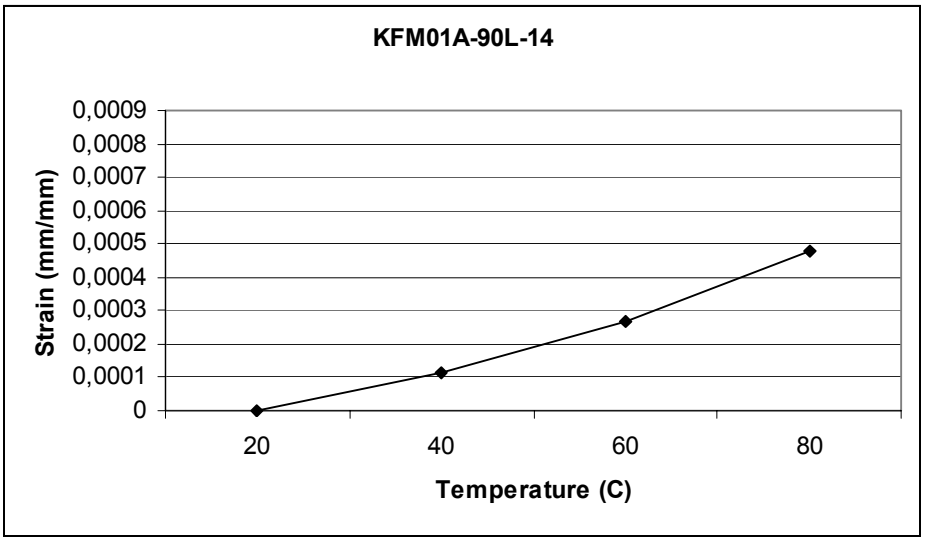


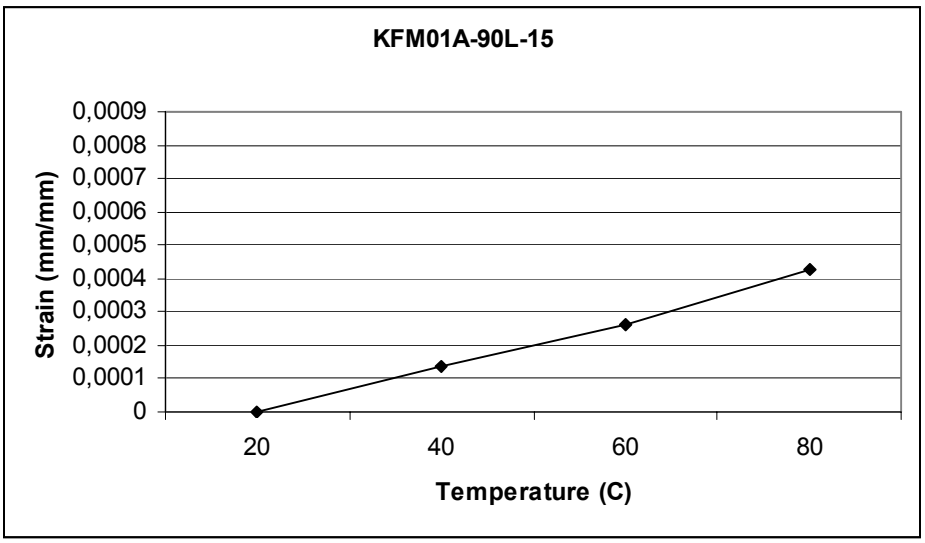

KFM01A-90L-10
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

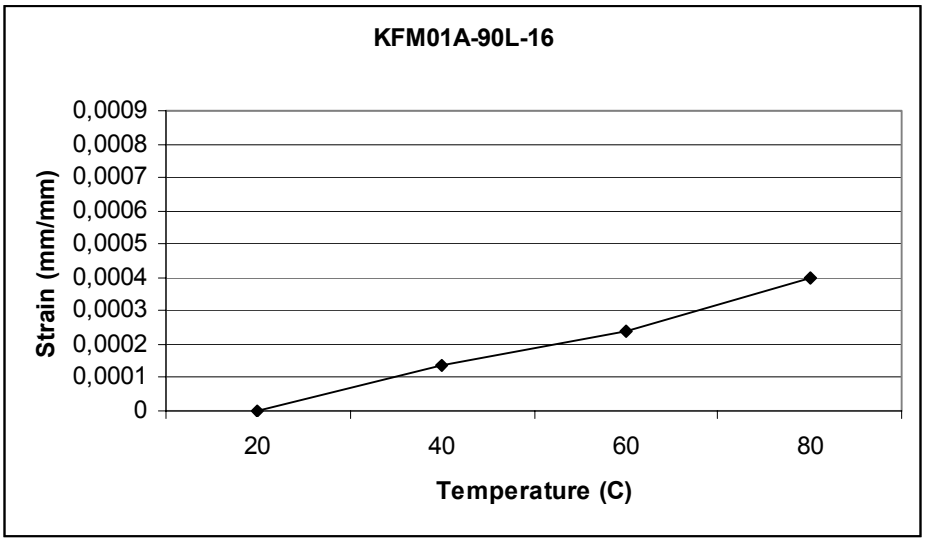

KFM01A-90L-11
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)


KFM01A-90L-12
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

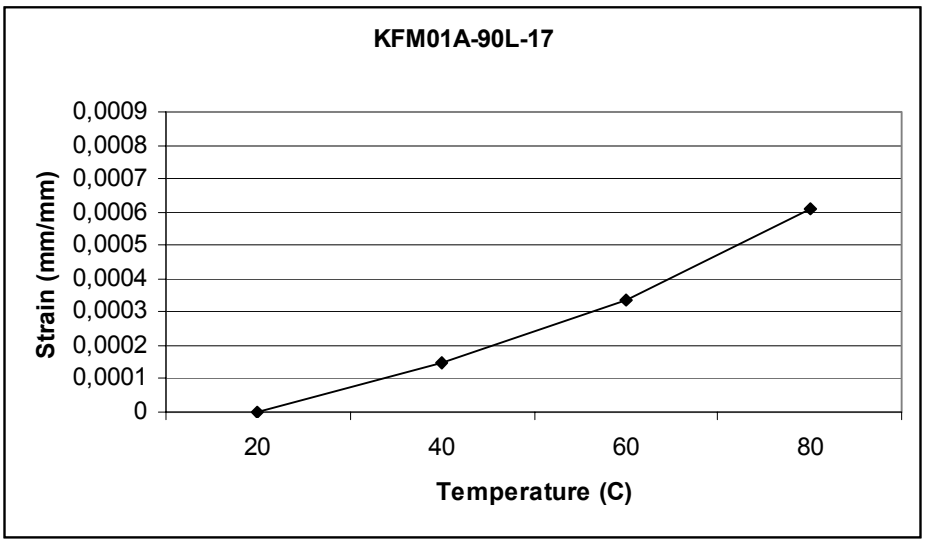

KFM01A-90L-13
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

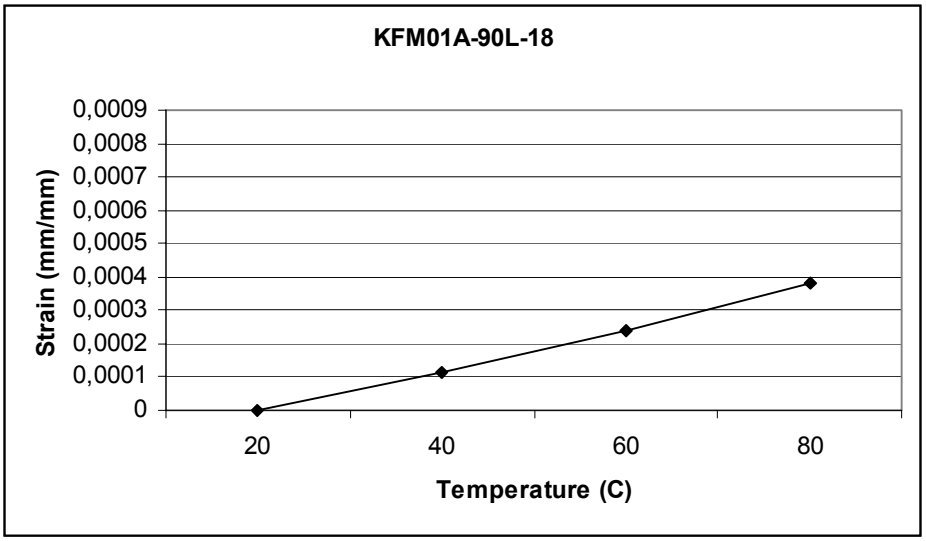

KFM01A-90L-14
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

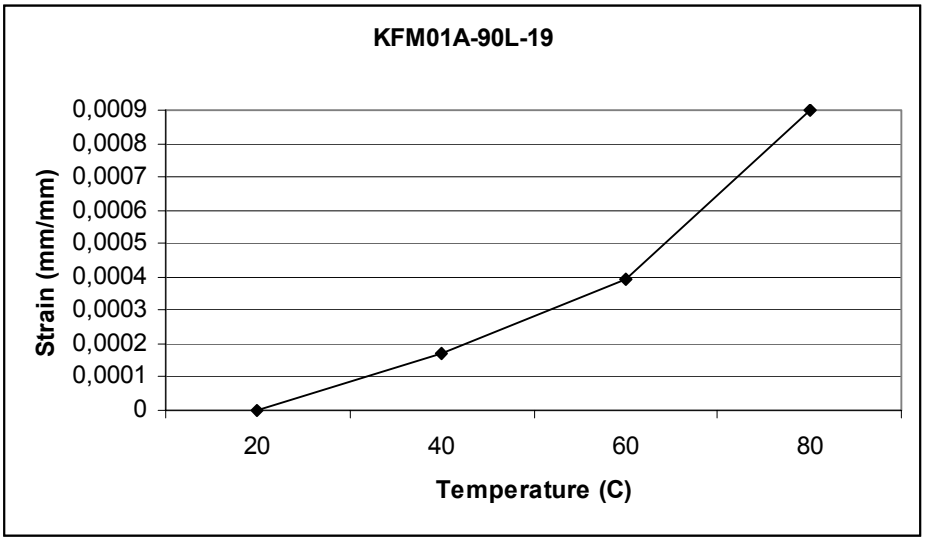

KFM01A-90L-15
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

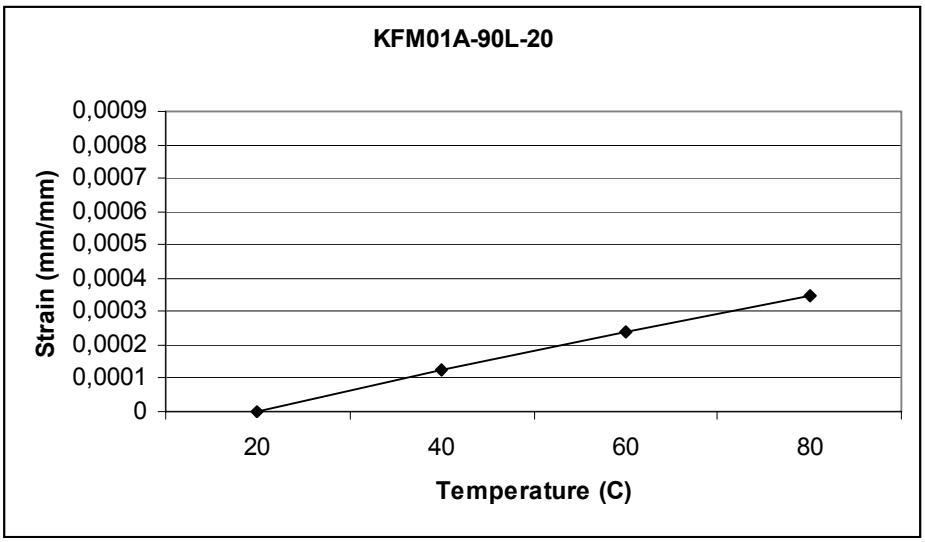


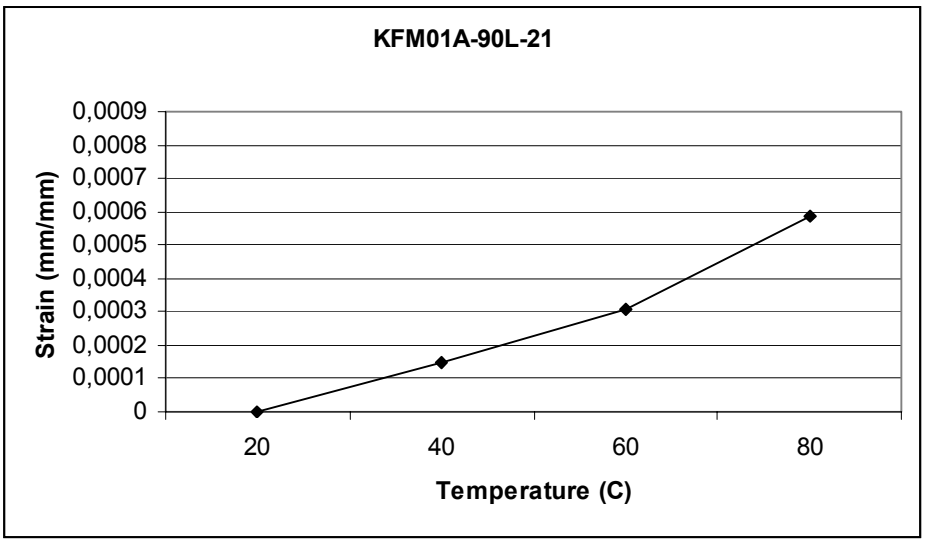
Level 3 689-690 m, Specimen KFM01A-90L-17 to KFM01A-90L-21






KFM01A-90L-19
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)


KFM01A-90L-20
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)


KFM01A-90L-21
Strain (mm/mm)
0,0009
0,0008
0,0007
0,0006
0,0005
0,0004
0,0003
0,0002
0,0001
0
20
40
60
80
Temperature (C)

Beräkning densitet

Vattenmättnadsdensitet

Uppdrags nr: P301334
Metod: EN 13755, ISRM (1973), avsnitt 3 samt SKB MD 160.002 version 1.0
Provad av: mhs
Datum: 2003-11-11

	Provmärkning:	Vikt i vatten, Msub (g)	Yttor vikt, Msat (g)	Yttorr vikt, Ms (g)	Bulk volume, V (cm3)	Pore volume, Vv (cm3)	Porosity, n (%)	Dry density, ρd (g/cm3)	Wet density (g/cm3)
1	KFM01A-90L-1	808,50	1294,23		486,70	1296,82	266,45	0,000	2,659
2	KFM01A-90L-2	807,02	1290,4		484,35	1292,99	266,95	0,000	2,664
3	KFM01A-90L-3	794,08	1269,78		476,65	1272,32	266,93	0,000	2,664
4	KFM01A-90L-4	801,66	1286,53		485,84	1289,11	265,34	0,000	2,648
5	KFM01A-90L-5	805,42	1290,16		485,71	1292,75	266,16	0,000	2,656
6	KFM01A-90L-6	804,50	1289,53		486,00	1292,11	265,87	0,000	2,653
7	KFM01A-90L-7	800,39	1285,45		486,03	1288,03	265,01	0,000	2,645
8	KFM01A-90L-8	805,24	1290,93		486,66	1293,52	265,79	0,000	2,653
9	KFM01A-90L-9	806,02	1291,92		486,87	1294,51	265,88	0,000	2,654
10	KFM01A-90L-10	809,80	1295,86		487,03	1298,46	266,60	0,000	2,661
11	KFM01A-90L-11	812,52	1299,15		487,61	1301,75	266,97	0,000	2,664
12	KFM01A-90L-12	808,36	1293,95		486,56	1296,54	266,47	0,000	2,659
13	KFM01A-90L-13	805,89	1290,61		485,69	1293,20	266,26	0,000	2,657
14	KFM01A-90L-14	805,06	1290,64		486,55	1293,23	265,79	0,000	2,653
15	KFM01A-90L-15	806,25	1291,46		486,18	1294,05	266,17	0,000	2,656
16	KFM01A-90L-16	809,62	1295,21		486,56	1297,81	266,73	0,000	2,662
17	KFM01A-90L-17	816,99	1307,72		491,71	1310,34	266,48	0,000	2,660
18	KFM01A-90L-18	816,37	1307,58		492,19	1310,20	266,20	0,000	2,657
19	KFM01A-90L-19	814,76	1304,16		490,38	1306,77	266,48	0,000	2,659
20	KFM01A-90L-20	811,76	1300,88		490,10	1303,49	265,96	0,000	2,654
21	KFM01A-90L-21	814,75	1304,03		490,26	1306,64	266,52	0,000	2,660
	Medel	807,855	1293,818	#DIVISION/0!	486,937	1296,411	266,238	0,000	2,657
	std avvikelse	5,576	8,546	#DIVISION/0!	3,189	8,563	0,514	0,000	0,005

Vattnets temperatur (‘	21,2
Vattnets desitet (ºC):	0,998

Våg, inv.nr:	102291
Termometer, inv.nr:	102080