P-07-61

Oskarshamn site investigation

Borehole KLX03, KLX05, KLX07A, KLX10 and KLX11A

Determination of porosity by water saturation and density by buoyancy technique

Lotta Liedberg
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Abstract

The density and porosity was determined on 30 specimens (each divided into two pieces) from different boreholes KLX03, KLX07A, KLX10, KLX05 and KLX11A at Oskarshamn, Sweden. The specimens were sampled at different borehole lengths. The investigated rock types are mapped as metamorphic varieties of Ävrö granite (SKB rock code 501044), diorite-gabbro (SKB rock code 501033), quartz-monzodiorite (SKB rock code 501036) and fine-grained diorite-gabbro (SKB rock code 505102). The results for the dry density varied between 2,660 and 2,900 kg/m^3, and for the wet density likewise between 2,670 and 2,900 kg/m^3. Finally, the porosity results varied between 0.2 and 1.3%.

Sammanfattning

Densiteten och porositeten bestämdes på 30 provkroppar (varje provkropp delad i två delar) från borrhål KLX03, KLX07A, KLX10, KLX05 och KLX11A i Oskarshamn. Proverna togs vid olika borrhålslängd. De undersökta bergarterna är karterade som Ävrögranit (SKB bergartskod 501044, diorit-gabbro (SKB bergartskod 501033), kvarts-monzodiorite (SKB bergartskod 501036) och finkornig diorit-gabbro (SKB bergartskod 505102). Resultaten för torrdensiteten varierade mellan 2 660 och 2 900 kg/m^3 och för våtdensiteten likaså mellan 2 670 och 200 kg/m^3. För porositeten, slutligen, varierade resultaten mellan 0,2 och 1,3 %.

Contents

1 Introduction

This document reports performance and results of determination of porosity by water saturation and density by buoyancy technique within the site investigation programme att Oskarshamn, Sweden, /1/. The controlling documents for the activity are listed in Table 1-1. Both Activity Plan and Method Description are SKB's internal controlling documents, whereas the Quality Plan referred to in the table is an SP internal controlling document. The thermal properties conductivity and diffusivity of the specimens were determined within the scope of a parallel activity /2/.

Samples were collected from the drill core of boreholes KLX03, KLX07A, KLX10, KLX05 and KLX11A located within the site investigation area at Oskarshamn, Sweden, see Figure 1-1. Boreholes KLX03, KLX07A, KLX10, KLX05 and KLX11A is a conventional core drilled boreholes.

The samples were selected based on the bore core logging, and with the strategy to primarily investigate the properties of the rock types Ävrögranite (501044), diorite/gabbro (501033), quartz-monzodiorite (SKB rock code 501036) and fine-grained diorite-gabbro (SKB rock code 505102). The samples, which were collected in November 21 and 22, 2006, were transported to SP (Swedish National Testing and Research institute), department of Building and Mechanics, where they arrived in November 27, 2006. Testing commenced in December 2006 and was completed in February 2007.

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

Activity plan	**Number**	**Version**
Selektiv termisk laborationsprovning, Laxemar	AP PS 400-06-141	1.0
Method description	**Number**	**Version**
Determining density and porosity of intact rock	SKB MD 160.002	2.0
Quality Plan		
SP-QD 13.1		

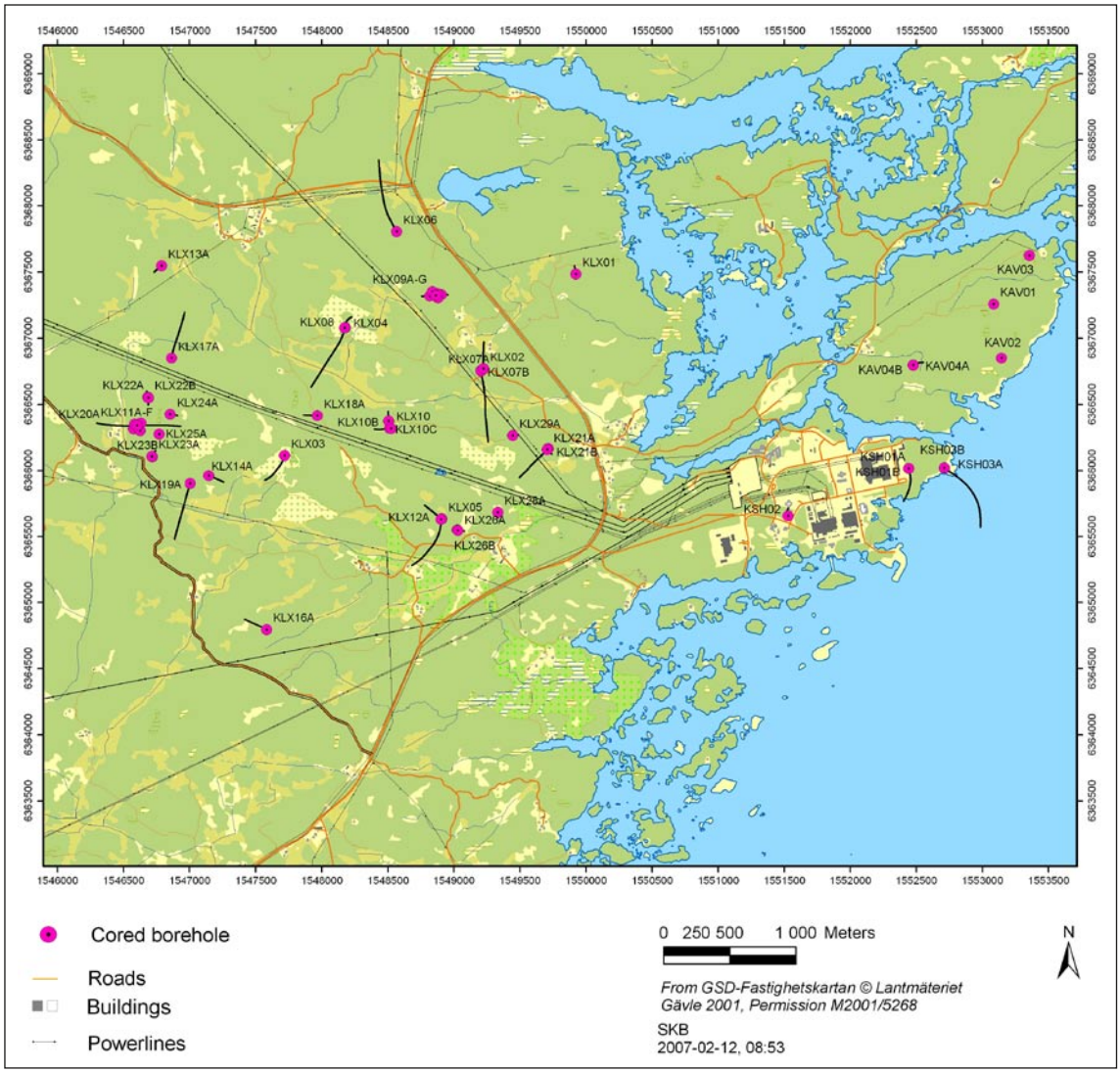

Figure 1-1. *Location of core drilled boreholes up to February 2007.*

2 Objective and scope

The purpose of determining density and porosity of intact rock cores is to use these parameters in the rock mechanics and thermal site descriptive model, which will be established for the candidate area selected for site investigations at Oskarshamn.

The testing comprised 30 rock samples from boreholes KLX03, KLX07A, KLX10, KLX05 and KLX11A collected within different borehole interval.

3 Equipment

The following equipment was used for the density and porosity determinations:

- Thermometer (inv no 102185) for measurement of water temperature. Calibrated 2006-01-17. Measurement accuracy ± 0.4°C.
- Scale (inv no 102291) for weight measurement. Calibrated in 2006-03-21. Measurement accuracy ± 0.2 g.
- Heating chamber (inv no 102289) for drying the specimens. Calibrated 2006-01-17. Measurement accuracy ± 5°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 with covering factor 2 (95% confidence interval):

Density	± 4 kg/m^3
Porosity	± 0.09%
Water absorption	± 0.05%

4 Execution

Determination of the porosity and density was made in accordance with SKB's method description SKB MD 160.002, (SKB internal controlling document). This includes determination of density in accordance to ISRM 1979 /3/ and water saturation by EN 13755 /4/ and in compliance with Activity Plan AP PS 400-06-141 (internal controlling document of SKB). The department of Building Technology and Mechanics (BM) at SP performed the tests.

4.1 Description of the specimens

The specimens from boreholes KLX03, KLX07A, KLX10, KLX05 and KLX11A were sampled at different levels. Table 4-1 shows the identification mark, sampling level and rock type of each specimen.

Table 4-1. Identification mark, sampling level and rock type/occurance of each specimen (rock-type classification according to Boremap).

Identification	Sampling level (m borehole length, Adj seclow)	Rock type
KLX03ST-90V-1	289.94	Ävrögranite (501044)
KLX03ST-90V-2	482.28	Ävrögranite (501044)
KLX03ST-90V-3	527.76	Ävrögranite (501044)
KLX07ST-90V-4	423.22	Ävrögranite (501044)
KLX07ST-90V-5	442.61	Ävrögranite (501044)
KLX07ST-90V-6	559.94	Ävrögranite (501044)
KLX07ST-90V-7	563.14	Ävrögranite (501044)
KLX07ST-90V-8	553.80	Ävrögranite (501044)
KLX10ST-90V-9	454.96	Ävrögranite (501044)
KLX10ST-90V-10	459.83	Ävrögranite (501044)
KLX10ST-90V-11	451.19	Ävrögranite (501044)
KLX10ST-90V-12	706.95	Ävrögranite (501044)
KLX10ST-90V-13	708.72	Ävrögranite (501044)
KLX10ST-90V-14	727.05	Ävrögranite (501044)
KLX05ST-90V-17	502.73	Quartz-monzodiorite (501036)
KLX05ST-90V-18	612.31	Quartz-monzodiorite (501036)
KLX11ST-90V-22	430.14	Quartz-monzodiorite (501036)
KLX11ST-90V-23	442.57	Quartz-monzodiorite (501036)
KLX11ST-90V-24	445.93	Quartz-monzodiorite (501036)
KLX11ST-90V-25	447.60	Quartz-monzodiorite (501036)
KLX11ST-90V-26	449.28	Quartz-monzodiorite (501036)
KLX11ST-90V-27	450.24	Quartz-monzodiorite (501036)
KLX11ST-90V-28	450.63	Quartz-monzodiorite (501036)
KLX11ST-90V-29	451.32	Quartz-monzodiorite (501036)
KLX11ST-90V-30	452.66	Quartz-monzodiorite (501036)
KLX11ST-90V-31	463.12	Quartz-monzodiorite (501036)
KLX11ST-90V-32	486.27	Quartz-monzodiorite (501036)
KLX11ST-90V-33	490.17	Quartz-monzodiorite (501036)
KLX11ST-90V-34	527.11	Fine-grained diorite-gabbro (505102)
KLX11ST-90V-35	524.95	Fine-grained diorite-gabbro (505102)

4.2 Testing

The temperature of the water used for water saturation was 20°C and the density was 998 kg/m^3. The specimens were dried in 105°C for eight days after water saturation. The execution procedure followed the prescription in SKB MD 160.002, see Table 4-2.

The present activity was performed parallel to another activity /2/, conducted by the department of Fire technology respectively Measurement technology at SP, and by which the thermal properties were determined. The following logistic sequence was applied for the three activities.

4.3 Nonconformities

The Activity Plan was followed, except from one minor deviation. The ball bearing of the cutting saw broke down. Therefore additional grinding was necessary during the test and the specimens were weighed in tap water twice.

Subsample A, KLX10ST-90V-13, cracked into two pieces during testing.

The tests were performed in accordance with the Method Description, however with the exception of the statement of significant numbers in Appendix 1. The precision in the method for density gives only three significant digits. The fourth digit given in Appendix 1 is thus not significant. The precision in the method for porosity provides only one significant digit and the second digit given in Appendix 1 is thus not significant. It is important that this is kept in mind when the results are used for further calculation.

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 into two pieces, marked A and B and about 25 mm thick each. The same specimens were used in a parallel activity to determine the thermal properties thermal conductivity and thermal diffusivity by applying the TPS method and the calorimetric method /2/.
2	The specimens were water saturated in normal air pressure for at least seven days.
3	The specimens were weighed in tapwater. The temperature of the water was 20°C and the density 998 kg/m^3.
4	The specimens were surface dried with a towel and weighed.
5	The water saturated density was determined. Some of the samples were sent from SP Building Technology and Mechanics to SP Measurement technology for measurement of thermal properties, calorimetric method /2/.
6	Some of the samples were sent from SP Measurement technology to SP Fire Technology for measurement of thermal properties, TPS method /2/. Some of the samples were sent from SP Building Technology and Mechanics direct to SP Fire Technology for measurement of thermal properties, TPS method /2/.
7	The samples were sent back from SP Fire Technology to SP Building Technology and Mechanics.
8	The specimens were photographed in JPEG-format.
9	The specimens were again weighed in tap water again due to some extra grinding. The temperature of the water was 21°C and the density 998 kg/m^3.
10	The specimens were surface dried with a towel and weighed.
11	The water saturated density was determined.
12	The specimens were dried in a heating chamber for two days at 105°C.
13	The specimens were transported to a desiccator for cooling.
14	The dry density and porosity were determined.

5 Results

The results of the porosity and density determinations of core samples from KLX03, KLX07A, KLX10, KLX05 och KLX11A are stored in SKB´s database SICADA, where they are traceable by the Activity Plan number.

Minutes and photos are presented in Appendix 1.

5.1 Results grouped according to rock type of the specimens and drill hole

Tables 5-1 to 5-6 summarizes the results of the porosity and density determinations divided according to rock type of the specimens and to drill hole.

Table 5-1. Summary of the results for porosity, dry density and wet density of Ävrögranite (501044), drill hole KLX03. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX03ST-90V-1	289.94	0.3	2,790	2,790
KLX03ST-90V-2	482.28	0.5	2,750	2,760
KLX03ST-90V-3	527.76	0.5	2,780	2,780
Mean value		0.4	2,770	2,780

Table 5-2. Summary of the results for porosity, dry density and wet density of Ävrögranite (501044), drill hole KLX07A. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX07ST-90V-4	423.22	0.6	2,680	2,690
KLX07ST-90V-5	442.61	0.5	2,680	2,690
KLX07ST-90V-6	559.94	0.9	2,660	2,670
KLX07ST-90V-7	563.14	0.4	2,690	2,690
KLX07ST-90V-8	553.80	0.4	2,680	2,690
Mean value		0.6	2,680	2,680

Table 5-3. Summary of the results for porosity, dry density and wet density of Ävrögranite (501044), drill hole KLX10. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX10ST-90V-9	454.96	0.7	2,660	2,670
KLX10ST-90V-10	459.83	0.7	2,670	2,670
KLX10ST-90V-11	451.19	0.5	2,680	2,690
KLX10ST-90V-12	706.95	0.6	2,710	2,720
KLX10ST-90V-13*	708.72	1.1	2,720	2,730
KLX10ST-90V-14	727.05	0.5	2,720	2,730
Mean value		0.7	2,690	2,700

* subsample A cracked in two pieces

Table 5-4. Summary of the results for porosity, dry density and wet density of Quartz-monzodiorite (501036), drill hole KLX05. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX05ST-90V-17	502.73	0.2	2,900	2,900
KLX05ST-90V-18	612.31	0.2	2,780	2,780
Mean value		0.2	2,840	2,840

Table 5-5. Summary of the results for porosity, dry density and wet density of Quartz-monzodiorite (501036), drill hole KLX11A. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX11ST-90V-22	430.14	0.2	2,780	2,780
KLX11ST-90V-23	442.57	0.3	2,770	2,780
KLX11ST-90V-24	445.93	0.2	2,790	2,790
KLX11ST-90V-25	447.60	0.2	2,770	2,780
KLX11ST-90V-26	449.28	0.2	2,780	2,780
KLX11ST-90V-27	450.24	0.3	2.780	2,780
KLX11ST-90V-28	450.63	0.3	2,780	2,780
KLX11ST-90V-29	451.32	0.2	2,780	2,780
KLX11ST-90V-30	452.66	0.3	2,770	2,780
KLX11ST-90V-31	463.12	0.2	2,780	2,780
KLX11ST-90V-32	486.27	0.7	2,730	2,740
KLX11ST-90V-33	490.17	1.3	2,680	2,690
Mean value		0.4	2,770	2,770

Table 5-6. Summary of the results for porosity, dry density and wet density of fine-grained diorite-gabbro (505102), drill hole KLX11A. The result for each specimen is a mean value of subsamples A and B.

Specimen	Sampling level (m borehole length), (Adj seclow)	Porosity (%)	Dry density (kg/m³)	Wet density (kg/m³)
KLX11ST-90V-34	527.11	0.2	2,870	2,870
KLX11ST-90V-35	524.95	0.7	2,870	2,880
Mean value		0.5	2,870	2,880

5.2 Results for the entire test series

Results for the entire test series are shown in the diagrams below. They are divided into three diagrams, see Figures 5-1 to 5-3, illustrating dry density, wet density and porosity.

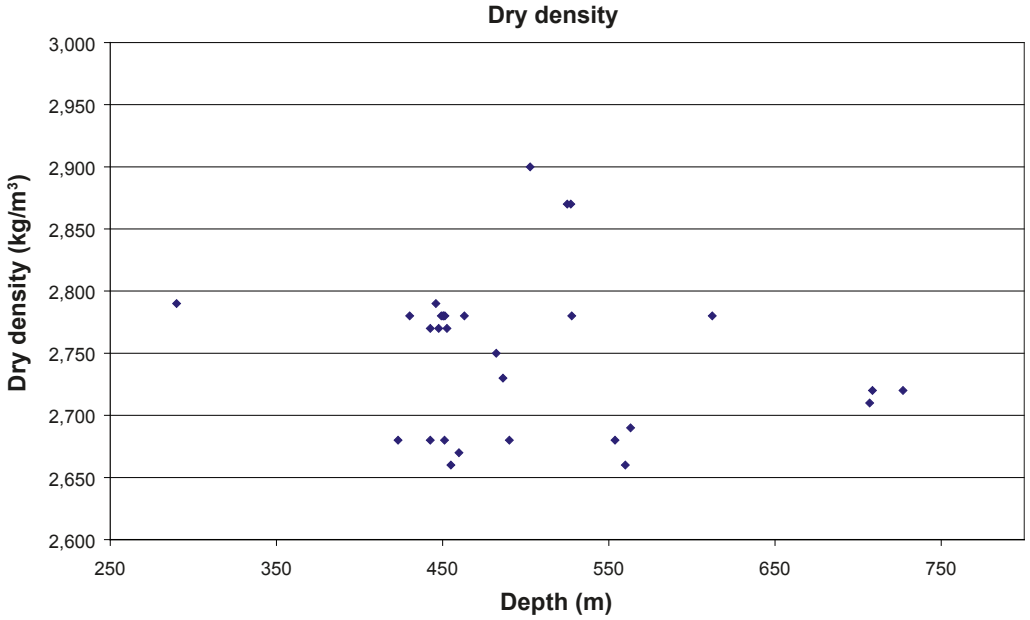

Figure 5-1. *Density (dry) versus sampling level (borehole length).*

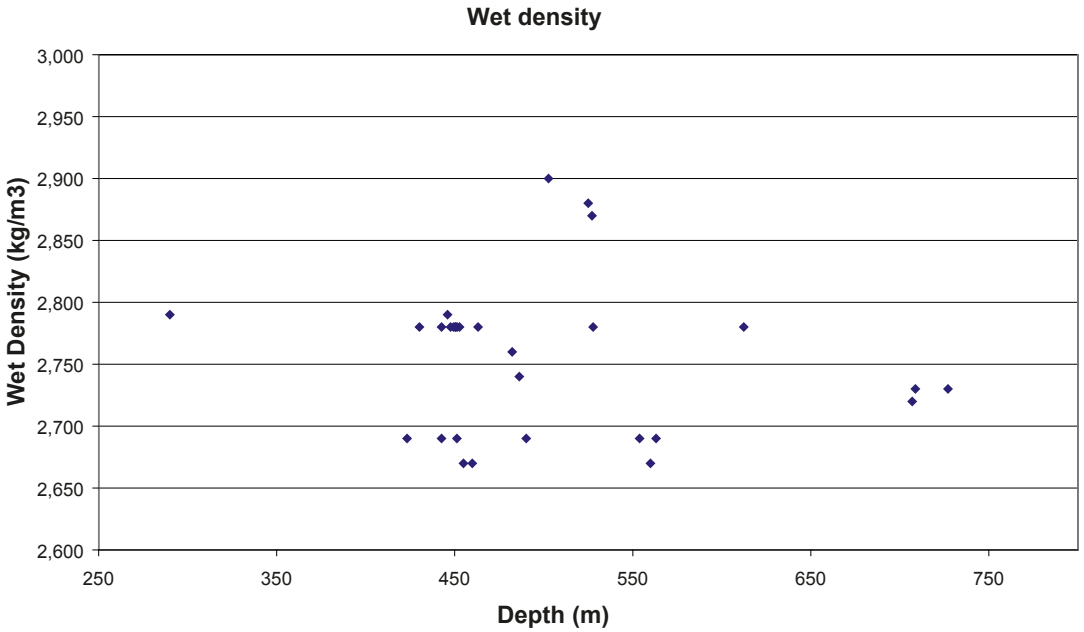

Figure 5-2. *Density (wet) versus sampling level (borehole length).*

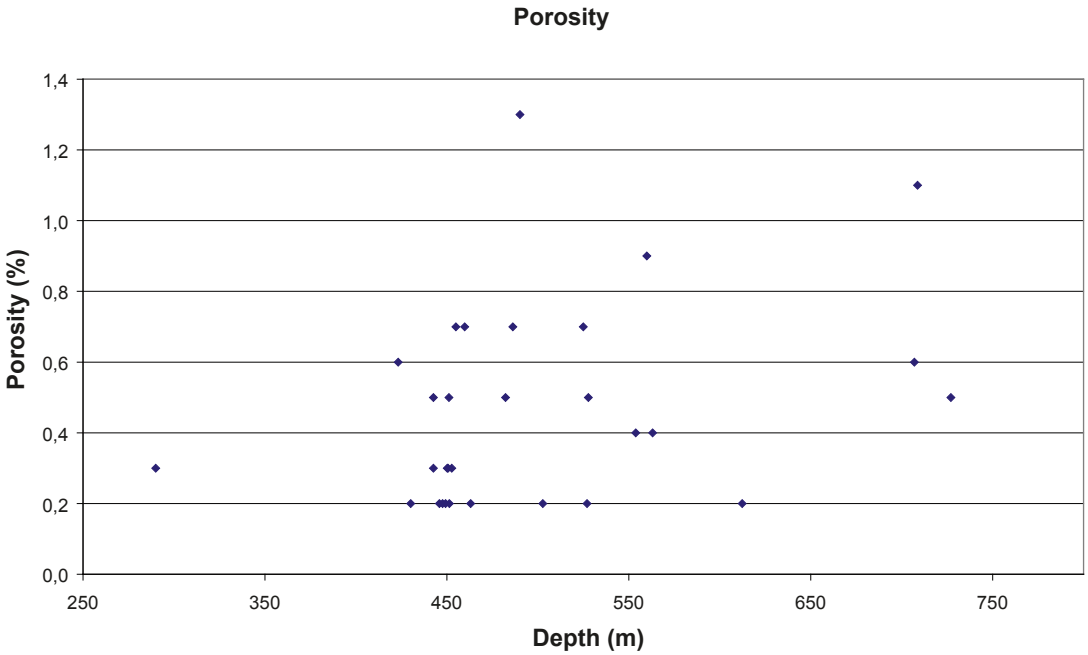

Figure 5-3. *Porosity versus sampling level (borehole length).*

References

/1/ **SKB, 2001.** Site investigations. Investigation methods and general execution programme. SKB TR-01-29, Svensk Kärnbränslehantering AB.

/2/ **Adl-Zarrabi B, 2007.** Borehole KLX03, KLX05, KLX07A, KLX10 and KLX11A. Thermal properties of rock using calirometer and TPS method, and Mineralogical composition by modal analysis. SKB P-07-62, Svensk Kärnbränslehantering AB.

/3/ **ISRM 1979.** Volume 16, Number 2.

/4/ **EN 13755.** Natural stone test methods – Determination of water absorption at atmospheric pressure.

Appendix

Result minutes and photos

Table A-1. KLX03, KLX07A, KLX10, KLX05 and KLX11A at different levels. Specimens KLX03ST-90V-1 to KLX03ST-90V-3, KLX07ST-90V-4 to KLX07ST-90V-8, KLX10ST-90V-9 to KLX10ST-90V-14, KLX05ST-90V-17 to KLX05ST-90V-18 and KLX11ST-90V-22 to KLX11ST-90V-35.

KLX03ST-90V-1 (289.94 m)

Dry density of specimen KLX03ST-90V-1A 2,780 kg/m^3 and porosity 0.22%.

Dry density of specimen KLX03ST-90V-1B 2,802 kg/m^3 and porosity 0.30%.

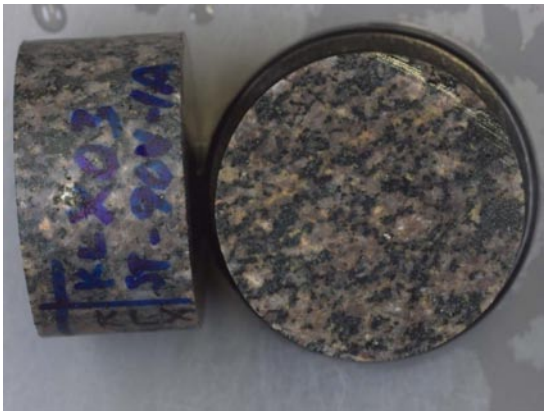

Figure A-1. *Specimens KLX03ST-90V-1 A and B.*

KLX03ST-90V-2 (482.28 m)

Dry density of specimen KLX03ST-90V-2A 2,727 kg/m^3 and porosity 0.54%.

Dry density of specimen KLX03ST-90V-2B 2,775 kg/m^3 and porosity 0.43%.

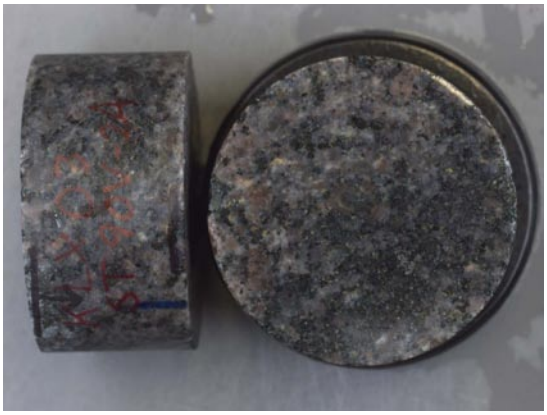

Figure A-2. *Specimens KLX03ST-90V-2 A and B.*

KLX03ST-90V-3 (527.76 m)

Dry density of specimen KLX03ST-90V-3A 2,784 kg/m^3 and porosity 0.48%.

Dry density of specimen KLX03ST-90V-3B 2,773 kg/m^3 and porosity 0.56%.

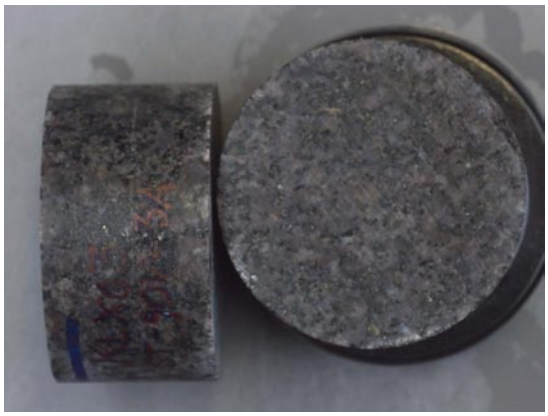

Figure A-3. *Specimens KLX03ST-90V-3 A and B.*

KLX07ST-90V-4 (423.22 m)

Dry density of specimen KLX07ST-90V-4A 2,683 kg/m^3 and porosity 0.59%.

Dry density of specimen KLX07ST-90V-4B 2,683 kg/m^3 and porosity 0.54%.

Figure A- 4. *Specimens KLX07ST-90V-4 A and B.*

KLX07ST-90V-5 (442.61 m)

Dry density of specimen KLX07ST-90V-5A 2,679 kg/m^3 and porosity 0.47%.

Dry density of specimen KLX07ST-90V-5B 2,684 kg/m^3 and porosity 0.43%.

Figure A-5. *Specimens KLX07ST-90V-5 A and B.*

KLX07ST-90V-6 (559.94 m)

Dry density of specimen KLX07ST-90V-6A 2,660 kg/m^3 and porosity 0.93%.

Dry density of specimen KLX07ST-90V-6B 2,652 kg/m^3 and porosity 0.97%.

Figure A-6. *Specimens KLX07ST-90V-6 A and B.*

KLX07ST-90V-7 (563.14 m)

Dry density of specimen KLX07ST-90V-7A 2,689 kg/m^3 and porosity 0.38%.

Dry density of specimen KLX07ST-90V-7B 2,682 kg/m^3 and porosity 0.39%.

Figure A-7. *Specimens KLX07ST-90V-7 A and B.*

KLX07ST-90V-8 (553.80 m)

Dry density of specimen KLX07ST-90V-8A 2,679 kg/m^3 and porosity 0.41%.

Dry density of specimen KLX07ST-90V-8B 2,684 kg/m^3 and porosity 0.45%.

Figure A-8. *Specimens KLX07ST-90V-8 A and B.*

KLX10ST-90V-9 (454.96 m)

Dry density of specimen KLX10ST-90V-9A 2,658 kg/m^3 and porosity 0.68%.

Dry density of specimen KLX10ST-90V-9B 2,663 kg/m^3 and porosity 0.69%.

Figure A-9. *Specimens KLX10ST-90V-9 A and B.*

KLX10ST-90V-10 (459.83 m)

Dry density of specimen KLX10ST-90V-10A 2,664 kg/m^3 and porosity 0.72%.

Dry density of specimen KLX10ST-90V-10B 2,668 kg/m^3 and porosity 0.69%.

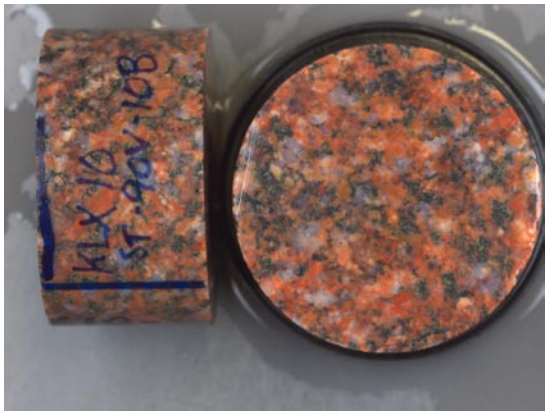

Figure A-10. *Specimens KLX10ST-90V-10 A and B.*

KLX10ST-90V-11 (451.19 m)

Dry density of specimen KLX10ST-90V-11A 2,685 kg/m^3 and porosity 0.44%.

Dry density of specimen KLX10ST-90V-11B 2,684 kg/m^3 and porosity 0.50%.

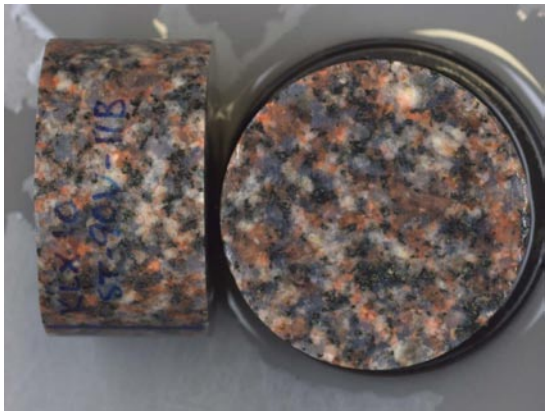

Figure A-11. *Specimens KLX10ST-90V-11 A and B.*

KLX10ST-90V-12 (706.95 m)

Dry density of specimen KLX10ST-90V-12A 2,709 kg/m^3 and porosity 0.63%.

Dry density of specimen KLX10ST-90V-12B 2,710 kg/m^3 and porosity 0.60%.

Figure A-12. *Specimens KLX10ST-90V-12 A and B.*

KLX10ST-90V-13 (708.72 m)

Dry density of specimen KLX10ST-90V-13A 2,719 kg/m^3 and porosity 1.11%.

Dry density of specimen KLX10ST-90V-13B 2,721 kg/m^3 and porosity 1.01%.

Figure A-13. *Specimens KLX10ST-90V-13 A and B.*

KLX10ST-90V-14 (727.05 m)

Dry density of specimen KLX10ST-90V-14A 2,727 kg/m^3 and porosity 0.47%.

Dry density of specimen KLX10ST-90V-14B 2,719 kg/m^3 and porosity 0.48%.

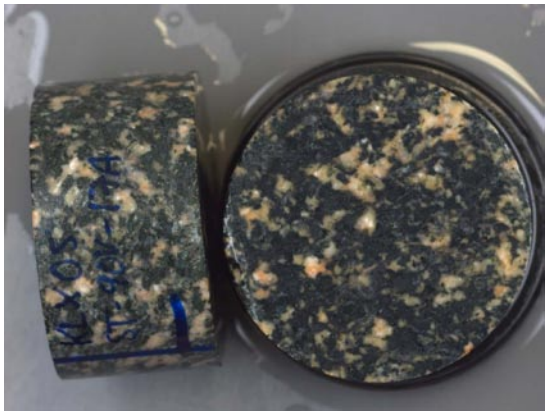

Figure A-14. *Specimens KLX10ST-90V-14 A and B.*

KLX05ST-90V-17 (502.73 m)

Dry density of specimen KLX05ST-90V-17A 2,901 kg/m^3 and porosity 0.21%.

Dry density of specimen KLX05ST-90V-17B 2,900 kg/m^3 and porosity 0.24%.

Figure A-15. *Specimens KLX10ST-90V-17 A and B.*

KLX05ST-90V-18 (612.31 m)

Dry density of specimen KLX05ST-90V-18A 2,779 kg/m^3 and porosity 0.17%.

Dry density of specimen KLX05ST-90V-18B 2,779 kg/m^3 and porosity 0.19%.

Figure A-16. *Specimens KLX05ST-90V-18 A and B.*

KLX11ST-90V-22 (430.14 m)

Dry density of specimen KLX11ST-90V-22A 2,779 kg/m^3 and porosity 0.22%.

Dry density of specimen KLX11ST-90V-22B 2,778 kg/m^3 and porosity 0.26%.

Figure A-17. *Specimens KLX11ST-90V-22 A and B.*

KLX11ST-90V-23 (442.57 m)

Dry density of specimen KLX11ST-90V-23A 2,773 kg/m^3 and porosity 0.26%.

Dry density of specimen KLX11ST-90V-23B 2,775 kg/m^3 and porosity 0.30%.

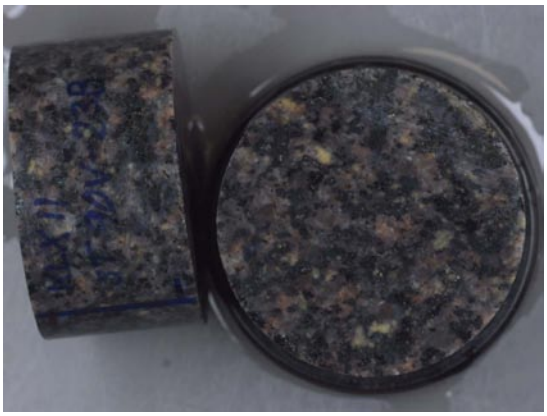

Figure A-18. *Specimens KLX11ST-90V-23 A and B.*

KLX11ST-90V-24 (445.93 m)

Dry density of specimen KLX11ST-90V-24A 2,787 kg/m^3 and porosity 0.19%.

Dry density of specimen KLX11ST-90V-24B 2,793 kg/m^3 and porosity 0.17%.

Figure A-19. *Specimens KLX11ST-90V-24 A and B.*

KLX11ST-90V-25 (447.60 m)

Dry density of specimen KLX11ST-90V-25A 2,774 kg/m^3 and porosity 0.21%.

Dry density of specimen KLX11ST-90V-25B 2,773 kg/m^3 and porosity 0.24%.

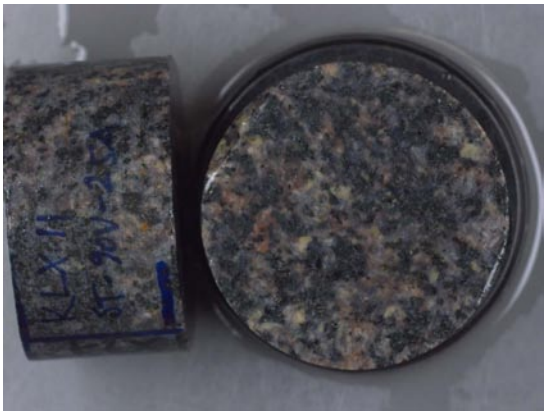

Figure A-20. *Specimens KLX11ST-90V-25 A and B.*

KLX11ST-90V-26 (449.28 m)

Dry density of specimen KLX11ST-90V-26A 2,770 kg/m^3 and porosity 0.22%.

Dry density of specimen KLX11ST-90V-26B 2,780 kg/m^3 and porosity 0.17%.

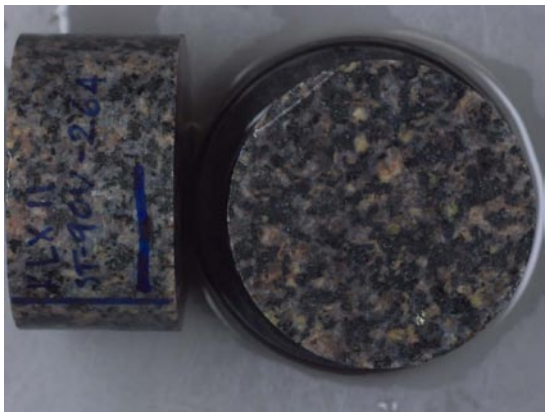

Figure A-21. *Specimens KLX11ST-90V-26 A and B.*

KLX11ST-90V-27 (450.28 m)

Dry density of specimen KLX11ST-90V-27A 2,776 kg/m^3 and porosity 0.30%.

Dry density of specimen KLX11ST-90V-27B 2,777 kg/m^3 and porosity 0.32%.

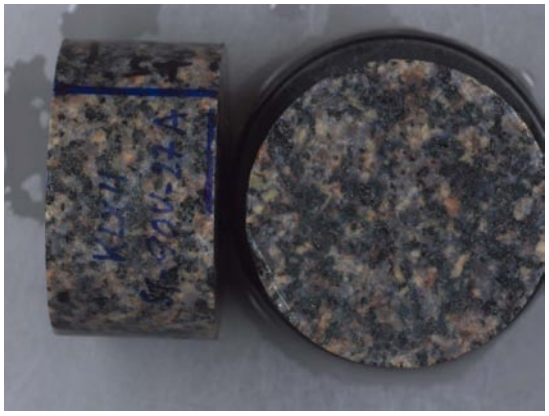

Figure A-22. *Specimens KLX11ST-90V-27 A and B.*

KLX11ST-90V-28 (450.63 m)

Dry density of specimen KLX11ST-90V-28A 2,779 kg/m^3 and porosity 0.32%.

Dry density of specimen KLX11ST-90V-28B 2,779 kg/m^3 and porosity 0.28%.

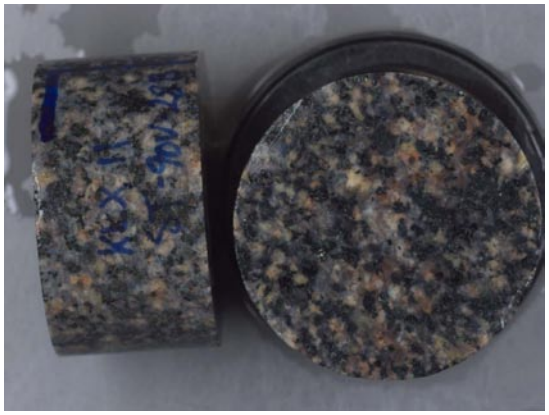

Figure A-23. *Specimens KLX11ST-90V-28 A and B.*

KLX11ST-90V-29 (451.32 m)

Dry density of specimen KLX11ST-90V-29A 2,780 kg/m^3 and porosity 0.23%.

Dry density of specimen KLX11ST-90V-29B 2,781 kg/m^3 and porosity 0.26%.

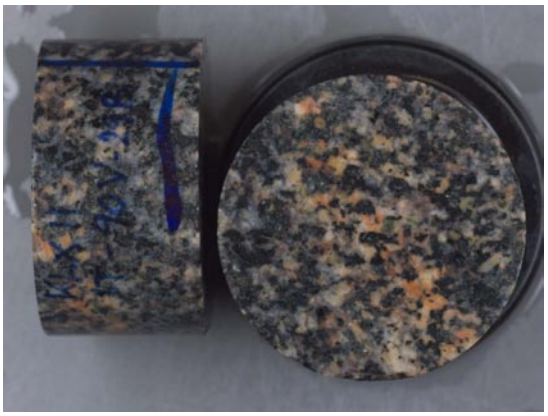

Figure A-24. *Specimens KLX11ST-90V-29 A and B.*

KLX11ST-90V-30 (452.66 m)

Dry density of specimen KLX11ST-90V-30A 2,775 kg/m^3 and porosity 0.22%.

Dry density of specimen KLX11ST-90V-30B 2,773 kg/m^3 and porosity 0.32%.

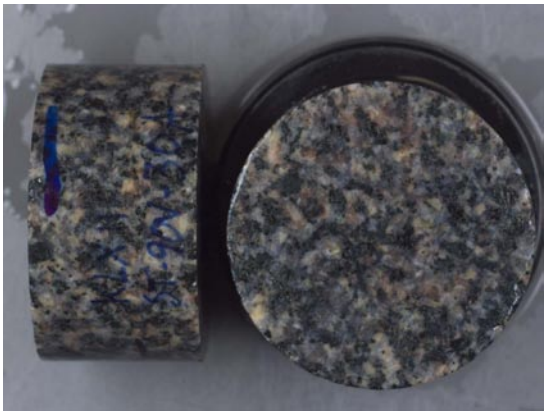

Figure A-25. *Specimens KLX11ST-90V-30 A and B.*

KLX11ST-90V-31 (463.12 m)

Dry density of specimen KLX11ST-90V-31A 2,782 kg/m^3 and porosity 0.21%.

Dry density of specimen KLX11ST-90V-31B 2,782 kg/m^3 and porosity 0.22%.

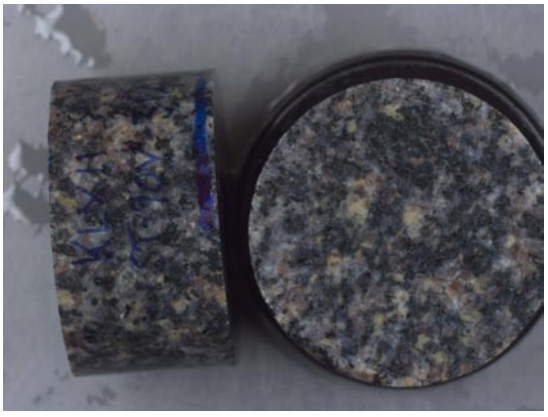

Figure A-26. *Specimens KLX11ST-90V-31 A and B.*

KLX11ST-90V-32 (486.27 m)

Dry density of specimen KLX11ST-90V-32A 2,729 kg/m^3 and porosity 0.67%.

Dry density of specimen KLX11ST-90V-32B 2,731 kg/m^3 and porosity 0.63%.

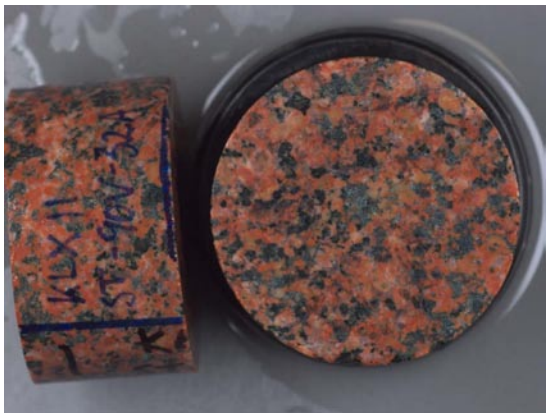

Figure A-27. *Specimens KLX11ST-90V-32 A and B.*

KLX11ST-90V-33 (490.17 m)

Dry density of specimen KLX11ST-90V-33A 2,691 kg/m^3 and porosity 1.06%.

Dry density of specimen KLX11ST-90V-33B 2,660 kg/m^3 and porosity 1.47%.

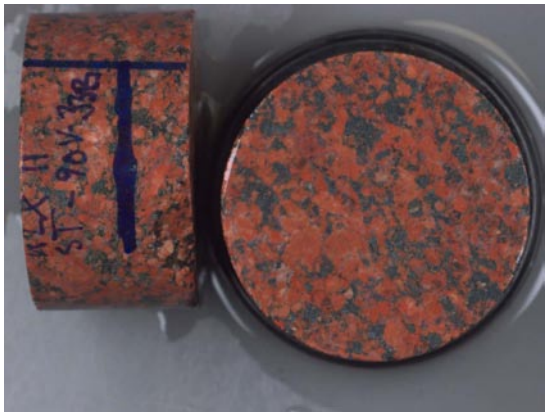

Figure A-28. *Specimens KLX11ST-90V-33 A and B.*

KLX11ST-90V-34 (527.11 m)

Dry density of specimen KLX11ST-90V-34A 2,869 kg/m^3 and porosity 0.21%.

Dry density of specimen KLX11ST-90V-34B 2,877 kg/m^3 and porosity 0.19%.

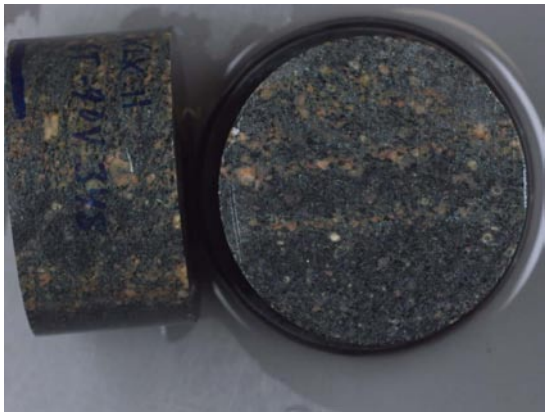

Figure A-29. *Specimens KLX11ST-90V-34 A and B.*

KLX11ST-90V-35 (524.95 m)

Dry density of specimen KLX11ST-90V-35A 2,874 kg/m^3 and porosity 0.61%.

Dry density of specimen KLX11ST-90V-35B 2,868 kg/m^3 and porosity 0.80%.

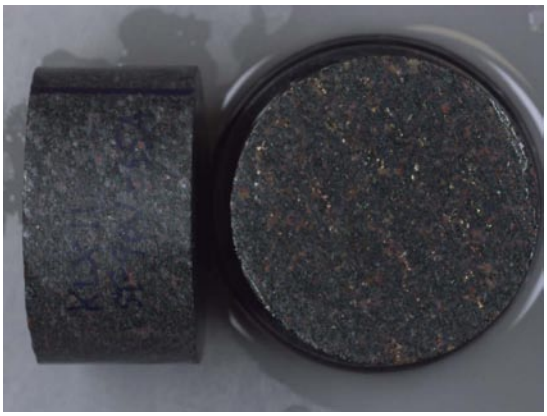

Figure A-30. *Specimens KLX11ST-90V-35 A and B.*