P-05-130

Oskarshamn site investigation

Drill hole KLX06A

Determination of porosity by water saturation and density by buoyancy technique

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June 2005

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Abstract

The density and porosity has been determined on 7 specimens (each divided in two pieces) from drill hole KLX06A. The specimens were sampled on one level in the drill hole: 200–300 m. The investigated rock types are mapped as Ävrö granite for sample 1–5 and diorite-gabbro for sample 6–7. The results for dry density varied between 2,650 and 2,870 kg/m^3, for wet density the results varied between 2,650 and 2,880 kg/m^3 and the results for porosity varied between 0.3 and 1.1%.

Sammanfattning

Densiteten och porositeten har bestämts på 7 provkroppar (varje provkropp delad i två delar) från borrhål KLX06A. Proverna togs från en nivå i borrhålet: 200–300 m. De undersökta bergartstyperna är karterade som Ävrö granit för prov 1–5 och diorit-gabbro för prov 6–7. Resultaten för den torra densiteten varierade mellan 2 650 och 2 870 kg/m^3, för den våta densiteten varierade resultaten mellan 2 650 och 2 880 kg/m^3 och resultaten för porositeten varierade mellan 0,3 och 1,1 %.

Contents

1 Introduction

The purpose is to determine the porosity and the water saturated and dry density of the samples.

The cores are sampled from borehole KLX06A in the Laxemar area. Thomas Janson and Björn Ljunggren, Tyréns AB, sampled them 8 February 2005. Specimens were taken from 1 level in the rock core between 200 and 300 m. The samples were selected based on the preliminary core logging, and with the strategy to primarily investigate the properties of the dominant rock properties. The rock cores were transported from Oskarshamn and arrived to SP February 2005. The testing was started in March 2005 and ended in May 2005.

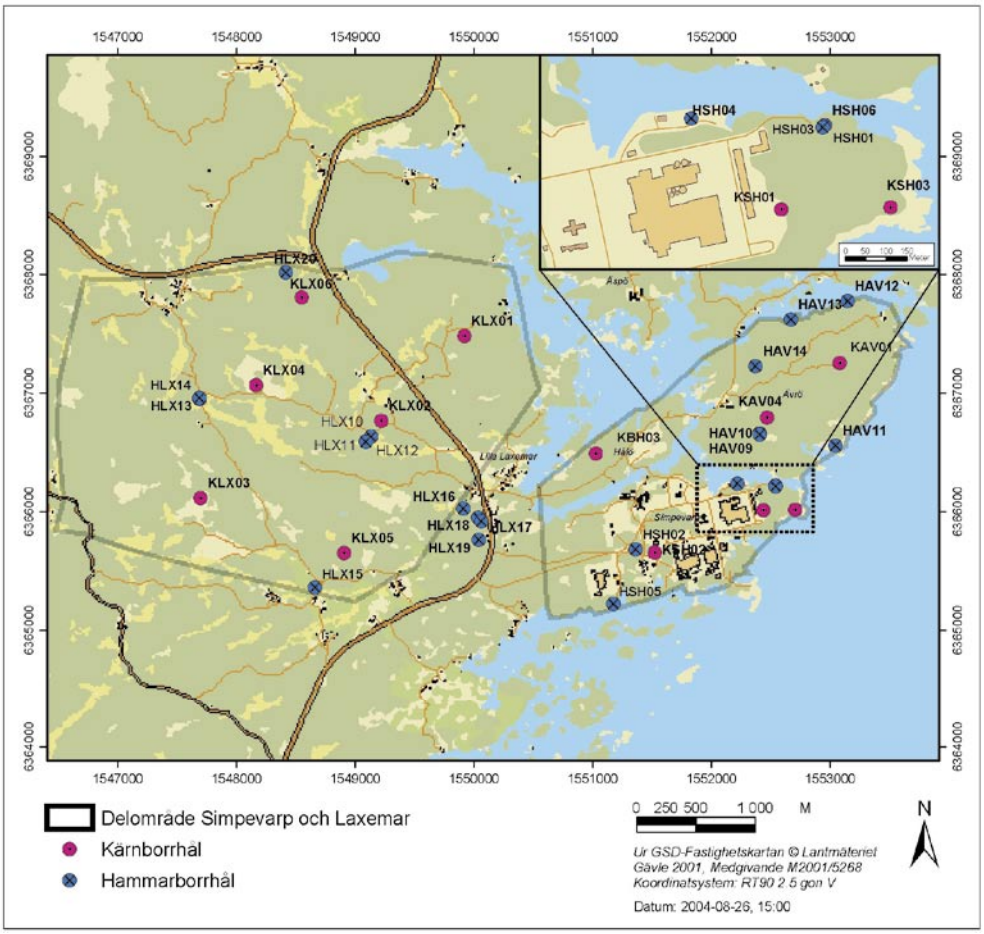


Figure 1-1. *Location of the drill hole KLX06A at the Oskarshamn site investigation area.*

2 Objective and scope

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

The samples are taken from the borehole KLX06A in Laxemar, with a depth of about 199–286 m. The samples in this report are taken from 1 main level.

3 Equipment

Following equipment has been used for the analyses:

- Thermometer (inv no 102185) for measurement of water temperature. Calibrated 2005-02-04. Uncertainty of measurement ± 0.4°C.
- Scale (inv no 102291) for weight measurement. Calibrated in March 2004 and 2005-04-10. Uncertainty of measurement ± 0.2 g.
- Heating chamber (inv no 102289) for drying the specimens. Calibrated 2004-08-31. Uncertainty of measurement ± 5°C.
- A covered plastic box filled with water for water saturation of the samples.
- A dessicator for cooling samples in.

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/, water saturation by /EN 13755/ and in accordance to Activity plan AP PS 400-05-012 (internal controlling document of SKB). The department of Building Technology and Mechanics (BM) at SP performed the test.

4.1 Description of the samples

Specimens were sampled from one level in drill hole KLX06A. The level range between 199 and 286. 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 the overview mapping).

Identification	Sampling depth (Adj Seclow)	Rock type
KLX06A-90V-1	199.31	Ävrö granite
KLX06A-90V-2	221.37	Ävrö granite
KLX06A-90V-3	243.24	Ävrö granite
KLX06A-90V-4	263.60	Ävrö granite
KLX06A-90V-5	285.61	Ävrö granite
KLX06A-90V-6	224.78	Diorite-gabbro
KLX06A-90V-7	224.84	Diorite-gabbro

4.2 Testing

The execution procedure followed the prescription in SKB MD 160.002 (SKB internal controlling document), see Table 4-2. Due to unreasonable results for the porosity, the porosity was tested again; see no 12–18 in Table 4-2.

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

Activity no	Activity
1	The specimens were cut according to the marks on the rock cores. Every specimen was cut in two pieces, marked A and B and about 25 mm thick each. The same specimens were used to test Thermal properties: heat conductivity and heat capacity determing using the TPS method.
2	The specimens were water saturated in normal air pressure for at least seven days.
3	The specimens were weighted in tapwater.
4	The specimens were surface dried with a towel and weighted.
5	The water saturated density was determined. The temperature of water for water saturation was 19.9°C and the density of the water was 998 kg/m^3.
6	The specimens were photographed in JPEG-format.
7	The samples were sent from SP Building and Mechanics to SP Fire Technology for measurement of thermal properties.
8	The samples were sent back from SP Fire Technology to SP Building and Mechanics.
9	The specimens were dried in a heating chamber at 105°C.
10	The specimens were transported to a dessicator for cooling.
11	The dry density and porosity were determined.
Tested density and porosity again:	
12	The specimens were water saturated in normal air pressure for at least seven days.
13	The specimens were weighted in tapwater.
14	The specimens were surface dried with a towel and weighted.
15	The water saturated density was determined.
16	The specimens were dried in a heating chamber at 105°C.
17	The specimens were transported to a dessicator for cooling.
18	The dry density and porosity were determined.

5 Results

Data resulting from activity are stored in the SKB database SICADA. Protocols, calculations and pictures can be found in Appendix 1.

5.1 Summary of results

A summary of the results of the porosity and density determination are presented in Table 5-1, as well as in Figure 5-1, 5-2 and 5-3 below. The results from the second procedure are used, see Table 4-2.

Table 5-1. Summary of the results for porosity, dry density and wet density of the specimens from level 1, seclow 199 to 286 m. The result for each specimen is a mean value of sub sample A and B.

Specimen	Sampling depth, according to the marks on the drill-core boxes (Adj Seclow), (m)	Porosity (%)	Dry density (kg/m^3)	Wet density (kg/m^3)
KLX06A-90V-1	199.31	0.3	2,660	2,670
KLX06A-90V-2	221.37	0.6	2,650	2,650
KLX06A-90V-3	243.24	0.5	2,650	2,650
KLX06A-90V-4	263.60	0.5	2,660	2,670
KLX06A-90V-5	285.61	0.4	2,650	2,660
KLX06A-90V-6	224.78	1.0	2,870	2,880
KLX06A-90V-7	224.84	1.1	2,870	2,880
Mean value		0.6	2,720	2,720
Standard deviation		0.27	102	105

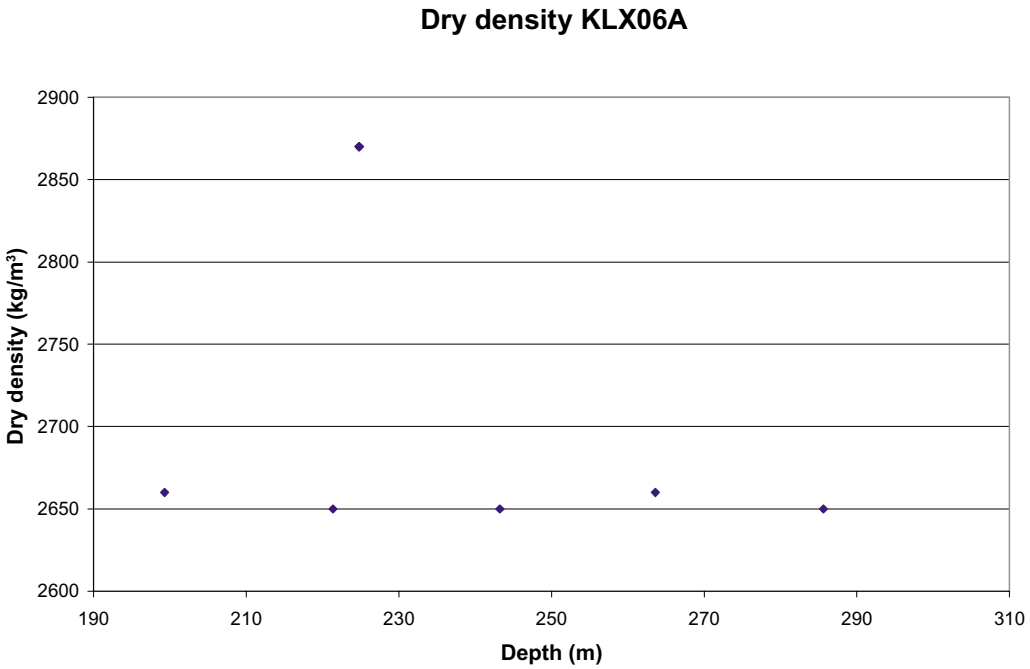


Figure 5-1. *Density (dry) versus depth, depth is where the samples are taken in the borehole.*

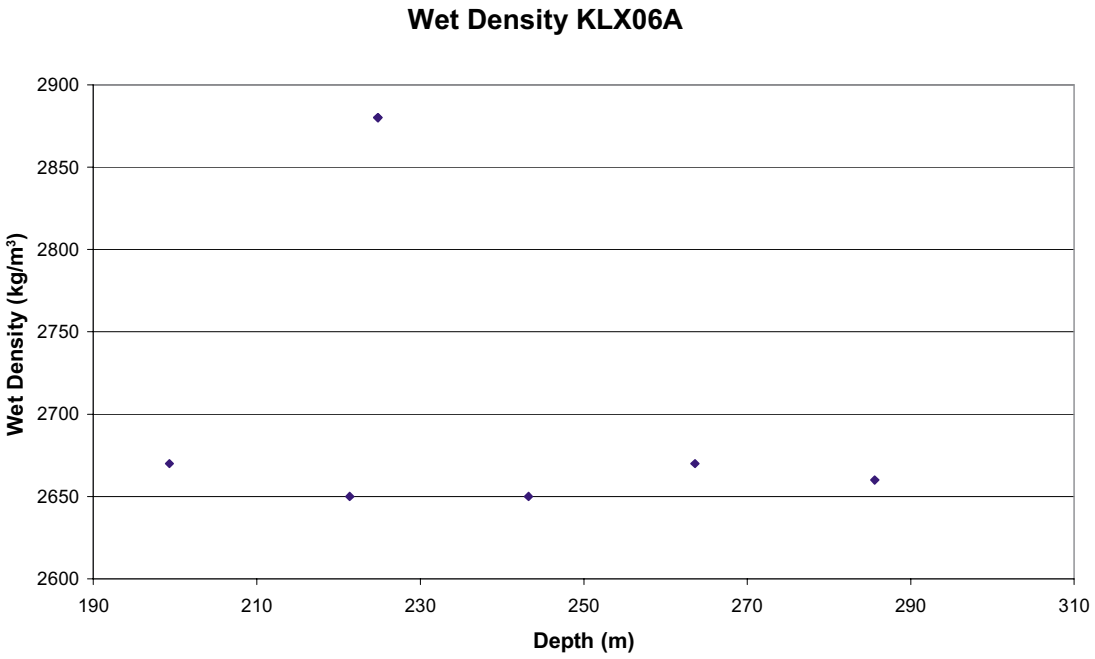


Figure 5-2. *Density (wet) versus depth, depth is where the samples are taken in the borehole.*

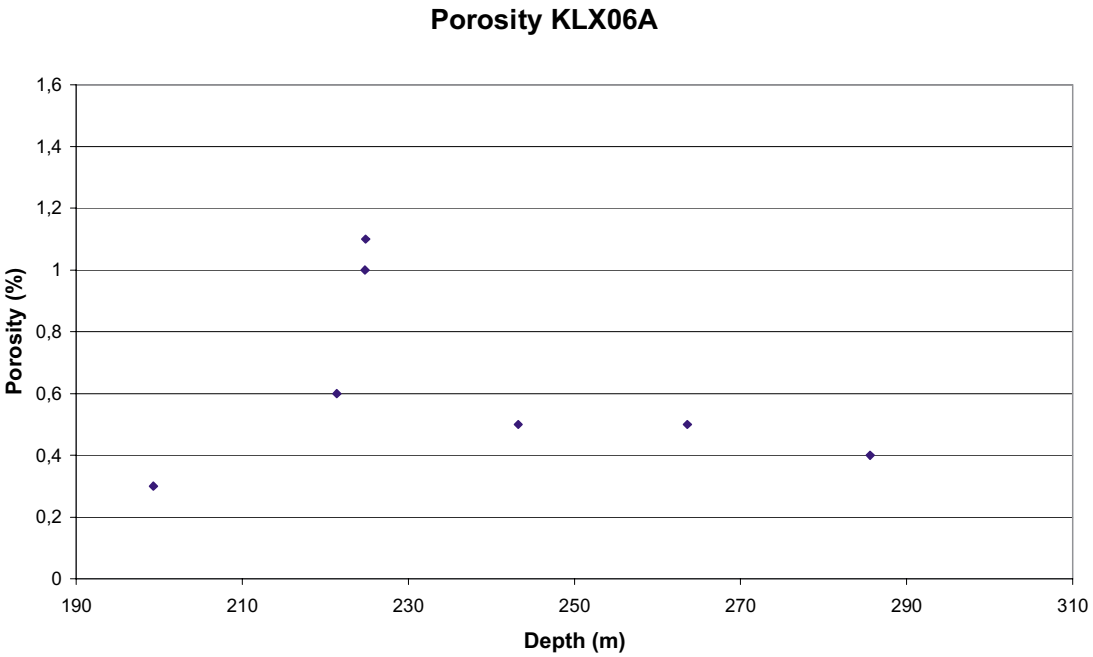


Figure 5-3. *Porosity versus depth, depth is where the samples are taken in the borehole.*

5.2 Discussion

The tests were performed in accordance with the method descriptions.

Due to unreasonable results for the porosity, the porosity was tested again. The new results were more reasonable and are reported.

References

ISRM 1979, Volume 16, Number 2.

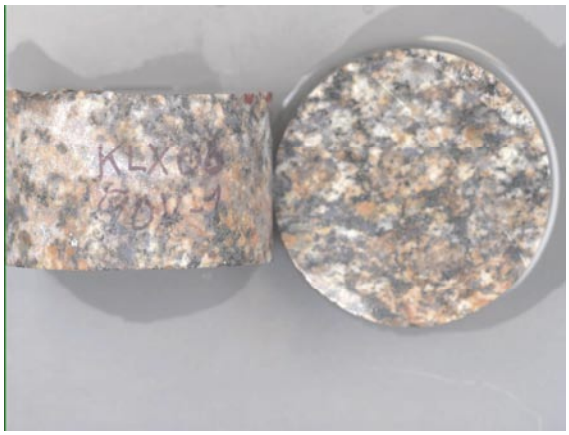
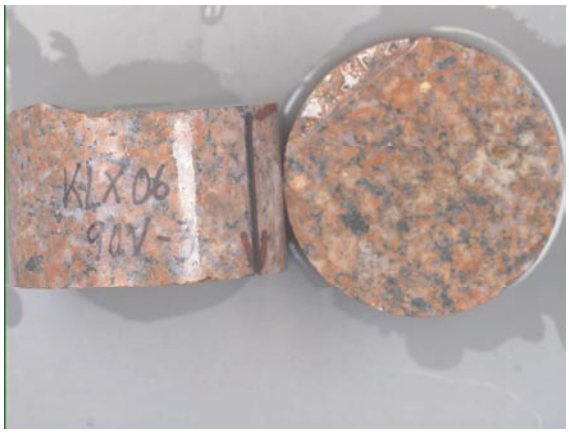
EN 13755, Natural stone test methods – Determination of water absorption at atmospheric pressure.

Appendix 1

Results and pictures

KLX06A: Density and porosity

Table A1. Level 1 199–286 m, Specimen KLX06A-090V-1 to KLX06A-090V-7.

KLX06A-90V-1 (199.31) The dry density for specimen KLX06A-90V-1A was measured to be 2,660 kg/m^3 and the porosity to 0.3% and the dry density for specimen KLX06A-90V-1B was measured to be 2,670 kg/m^3 and the porosity to 0.3%.	***Figure A1-1.*** *Specimen KLX06A-90V-1.* 
KLX06A-90V-2 (221.37) The dry density for specimen KLX06A-90V-2A was measured to be 2,650 kg/m^3 and the porosity to 0.5% and the dry density for specimen KLX06A-90V-2B was measured to be 2,650 kg/m^3 and the porosity to 0.6%.	***Figure A1-2.*** *Specimen KLX06A-90V-2.* 
KLX06A-90V-3 (243.24) The dry density for specimen KLX06A-90V-3A was measured to be 2,650 kg/m^3 and the porosity to 0.5% and the dry density for specimen KLX06A-90V-3B was measured to be 2,650 kg/m^3 and the porosity to 0.5%.	***Figure A1-3.*** *Specimen KLX06A-90V-3.* 

KLX06A-90V-4 (263.60) The dry density for specimen KLX06A-90V-4A was measured to be 2,660 kg/m^3 and the porosity to 0.5% and the dry density for specimen KLX06A-90V-4B was measured to be 2,660 kg/m^3 and the porosity to 0.5%.	***Figure A1-4.*** *Specimen KLX06A-90V-4.* 
KLX06A -90V-5 (285.61) The dry density for specimen KLX06A-90V-5A was measured to be 2,650 kg/m^3 and the porosity to 0.5% and the dry density for specimen KLX06A-90V-5B was measured to be 2,650 kg/m^3 and the porosity to 0.4%.	***Figure A1-5.*** *Specimen KLX06A-90V-5.* 
KLX06A-90V-6 (224.78) The dry density for specimen KLX06A-90V-6A was measured to be 2,900 kg/m^3 and the porosity to 1.1% and the dry density for specimen KLX06A-90V-6B was measured to be 2,850 kg/m^3 and the porosity to 0.9%.	***Figure A1-6.*** *Specimen KLX06A-90V-6.* 

KLX06A-90V-7 (224.84) The dry density for specimen KLX06A-90V-7A was measured to be 2,870 kg/m^3 and the porosity to 1.0% and the dry density for specimen KLX06A-90V-7B was measured to be 2,870 kg/m^3 and the porosity to 1.1%.	***Figure A1-7.*** *Specimen KLX06A-90V-7.*