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Oskarshamn site investigation

Drill hole KLX07A

Determination of porosity by water saturation and density by buoyancy technique

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Abstract

The density and porosity has been determined on 5 specimens (each divided in two pieces) from drill hole KLX07A. The specimens were sampled from one level in the drill hole between 340-430 m. The investigated rock type is mapped as Ävrö granite. The results for dry density varied between 2,660 and 2,750 kg/m^3, for wet density the results varied between 2,670 and 2,750 kg/m^3 and the results for porosity varied between 0.4 and 0.7%.

Sammanfattning

Densiteten och porositeten har bestämts på 5 provkroppar (varje provkropp delad i två delar) från borrhål KLX07A. Proverna togs från flera olika nivåer i borrhålet mellan 340-430 m. Den undersökta bergartstypen är karterade som Ävrögranit. Resultaten för den torra densiteten varierade mellan 2 660 och 2 750 kg/m^3, för den våta densiteten varierade resultaten mellan 2 670 och 2 750 kg/m^3 och resultaten för porositeten varierade mellan 0,4 och 0,7 %.

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 KLX07A in the Laxemar area. Thomas Jansson, Tyréns AB, sampled them 10th of August 2005. Specimens were taken from one level in the rock core between 340 and 430 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 13th of October 2005. The testing was started in November 2005 and ended in November 2005.

Figure 1-1. *Location of the drill hole KLX07A at the Oskarshamn site.*

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 KLX07A in Oskarshamn, with a depth of about 340 and 430 m. The samples in this report are taken at one main level.

3 Equipment

Following equipment have been used for the analyses:

- Thermometer (inv no 102080) for measurement of water temperature. Calibrated 2005-10-03. Uncertainty of measurement ± 0.4°C.
- Scale (inv no 102291) for weight measurement. Calibrated in 2005-03-02. Uncertainty of measurement ± 0.2 g.
- Heating chamber (inv no 102284) 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/ and water saturation by /EN 13755/ and in accordance to Activity plan AP PS 400-05-061 (internal controlling document of SKB*)*. The department of Building Technology and Mechanics (BM) at SP performed the test.

4.1 Description of the samples

From the Laxemar area, in Sweden, specimens were sampled from one level in drill hole KLX07A. Level ranged between 340 and 430 m. 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 Boremap overview).

Identification	Sampling depth (adj seclow)	Rock type
KLX07A-90V-1	347.958	Ävrö granite
KLX07A-90V-2	368.963	Ävrö granite
KLX07A-90V-3	388.667	Ävrö granite
KLX07A-90V-4	408.200	Ävrö granite
KLX07A-90V-5	428.120	Ävrö granite

4.2 Testing

The execution procedure followed the prescription in SKB MD 160.002, (SKB internal controlling document), see 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 photographed in JPEG-format.
4	The specimens were weighted in tapwater.
5	The specimens were surface dried with a towel and weighted.
6	The water saturated density was determined.
7	The samples were sent from SP Building and Mechanics to SP Fire Technology for measurement of thermal properties.

Activity no	Activity
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.

5 Results

The main results of the site investigation of KLX07A could be found in SKB´s database SICADA. The data from SICADA should be used for modelling.

Protocols and pictures can be found in appendix 1.

5.1 Description and presentation of the specimen

The temperature of water for water saturation was 21°C and the density of the water was 998 kg/m^3. The specimens were dried in 105°C for one week after water saturation. Table 5-1 shows the identification marks, porosity, dry and wet density.

Table 5-1. Summary of the results for porosity, dry density and wet density of the specimens 340-430 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)
KLX07A-90V-1	347.958	0.4	2,750	2,750
KLX07A-90V-2	368.963	0.4	2,680	2,680
KLX07A-90V-3	388.667	0.7	2,660	2,670
KLX07A-90V-4	408.200	0.6	2,730	2,740
KLX07A-90V-5	428.120	0.4	2,680	2,690

5.2 Results for the entire test series

Results for the entire test series are shown in the Figures 5-1, 5-2 and 5-3 below. They are divided into three diagrams, dry density, wet density and porosity.

5.3 Discussion

The tests were performed in accordance with the method descriptions. The activity plan was followed without deviations.

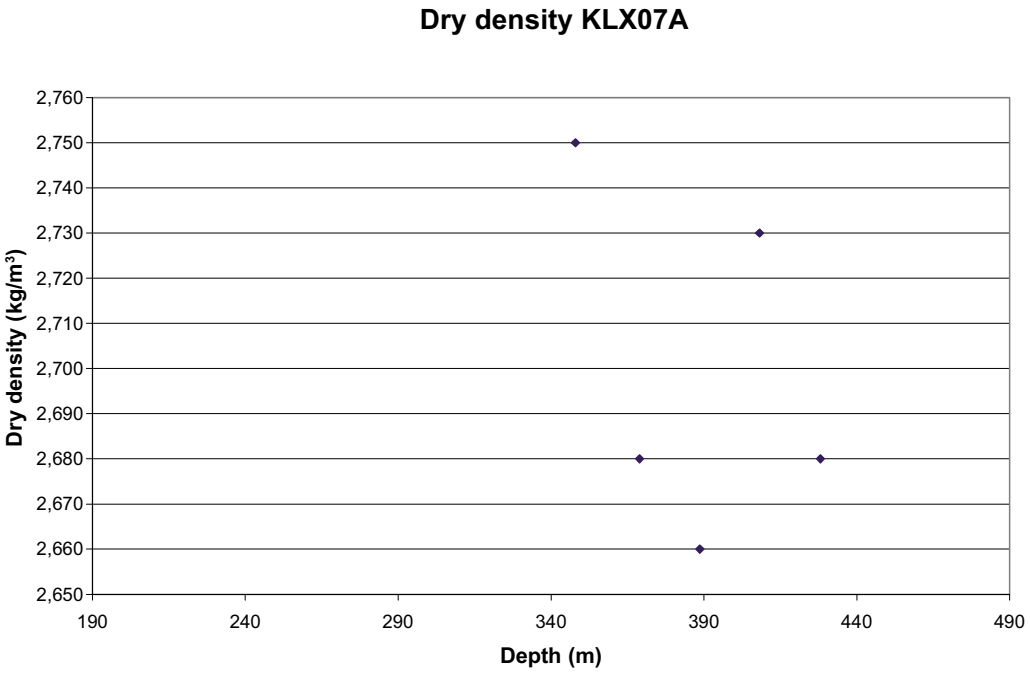

Figure 5-1. *Density (dry) versus depth, depth is where the samples are taken in the borehole.*

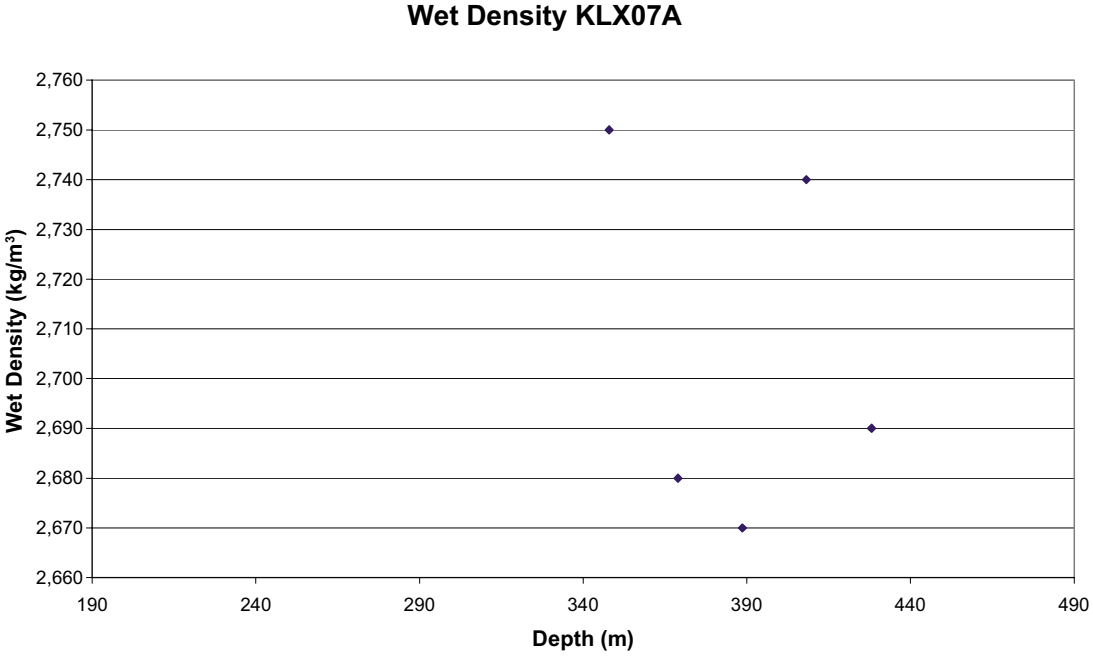

Figure 5-2. *Density (wet) versus depth, depth is where the samples are taken in the borehole.*

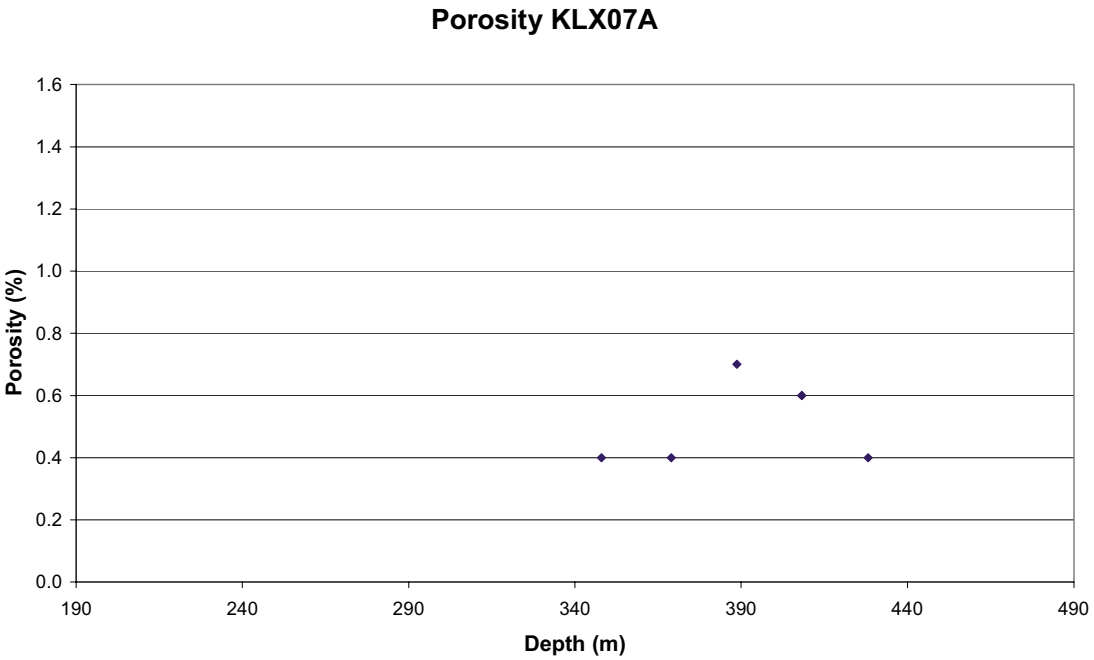

Figure 5-3. *Porosity versus depth, depth is where the samples are taken in the borehole.*

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

Table A-1. Level 340–430 m, Specimen KLX07A-090V-1 to KLX07A-090V-5.

KLX07A-90V-1 (347.958) The dry density for specimen KLX07A-90V-1A was measured to be 2,759 kg/m^3 and the porosity to 0.38% and the dry density for specimen KLX07A-90V-1B was measured to be 2,741 kg/m^3 and the porosity to 0.44%.	***Figure A-1.*** *Specimen KLX07A-90V-1.* 
KLX07A -90V-2 (368.963) The dry density for specimen KLX07A-90V-2A was measured to be 2,683 kg/m^3 and the porosity to 0.40% and the dry density for specimen KLX07A-90V-2B was measured to be 2,675 kg/m^3 and the porosity to 0.39%.	***Figure A-2.*** *Specimen KLX07A-90V-2.* 
KLX07A -90V-3 (388.667) The dry density for specimen KLX07A-90V-3A was measured to be 2,660 kg/m^3 and the porosity to 0.75% and the dry density for specimen KLX07A -90V-3B was measured to be 2,663 kg/m^3 and the porosity to 0.74%.	***Figure A-3.*** *Specimen KLX07A-90V-3.* 

KLX07A -90V-4 (408.200) The dry density for specimen KLX07A-90V-4A was measured to be 2,732 kg/m^3 and the porosity to 0.56% and the dry density for specimen KLX07A-90V-4B was measured to be 2,728 kg/m^3 and the porosity to 0.56%.	***Figure A-4.*** *Specimen KLX07A-90V-4.* 
KLX07A -90V-5 (428.120) The dry density for specimen KLX07A -90V-5A was measured to be 2,683 kg/m^3 and the porosity to 0.34% and the dry density for specimen KLX07A -90V-5B was measured to be 2,681 kg/m^3 and the porosity to 0.43%.	***Figure A-5.*** *Specimen KLX07A-90V-5.*