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Oskarshamn site investigation

Resistivity measurements on samples from KLX02

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Abstract

This report presents the execution and the results from measurements of electrical resistivity on core samples from the borehole KLX02 at Simpevarp. The formation factor was calculated based on the results of the measurements. A total of 27 core samples were tested. The resitivity was measured after soaking the samples in a 1 M NaCl-solution for 10 (1^{st} quartile: 598 Ωm, 3^{rd} quartile: 1,161 Ωm), corresponding to a median value of the formation factor of 0.136×10^{-3}.

Sammanfattning

Denna rapport presenterar genomförandet och resultaten från mätningar av elektrisk resistivitet på borrkärneprover från KLX02 vid Simpevarp. Formationsfaktorn har beräknats med mätningarna som underlag. Totalt 27 provbitar har undersökts. Resistiviteten mättes efter det att proven legat i 1 M NaCl-lösning i tio veckor. Resistivitetsvärdena var tämligen enhetliga med ett medianvärde på 951 Ωm (första kvartil: 598 Ωm, tredje kvartil: 1 161 Ωm), svarande mot ett medianvärde på formationsfaktorn på 0.136×10^{-3}.

Contents

1 Introduction

SKB performs site investigations for localization of a deep repository for high level radioactive waste. The site investigations are performed at two sites, Forsmark and Simpevarp. This document reports the execution and results gained from resistivity measurements on core samples from the borehole KLX02 at Simpevarp.

The work presented in this report has been performed by GeoVista AB in accordance with the instructions and guidelines presented by SKB in the method description MD 230.001 and the activity plan AP PS-400-03-093 (SKB internal controlling document).

2 Objective and scope

The purpose of resistivity measurements and the calculation of the formation factor are to gain knowledge about the transport properties of the rock mass. The resistivity is a measure of the disability to conduct electric current in the form of ions in the pore space of a rock sample. Low resistivity will thus correspond to a high ability of conduction and vice versa. The resistivity of the water that the sample has been soaked in is often normalised with the resistivity of the sample. The resulting ratio is then referred to as the formation factor.

3 Execution

3.1 Sample preparation and measurements

The measurements were carried out in accordance with the SKB instruction “Metodik för resistivitetsmätningar” (Appendix to AP PS 400-03-093). A summary of the method is given below.

The testing was performed on c 5 cm long core pieces with plane-parallel end surfaces. The samples were dried at a temperature of 110°C for 24 hours. The end surfaces were covered by protective tape and the remaining sample surface was covered by silicon after which the tape was removed. The samples were placed in vacuum for three hours and then placed in a 1.0 M NaCl-solution. The samples were kept in the solution for ten weeks and the resistivity along the sample axis was thereafter measured with an in-house equipment /1/ of Luleå University, Department of Applied Geophysics. The measurements were made with a two-electrode system at the frequencies 0.1, 0.6 and 4.0 Hz. The phase angle between applied current and measured potential difference was retrieved as a by-product during the measurements.

3.2 Data processing

The raw data of the measurements were entered into a MS Excel-file. The formation factor was calculated as the ratio between the resistivity of the soaking water and the resistivity of the samples at 0.1 Hz:

$$Formation\_factor = \frac{\rho_{water}}{\rho_{sample}}$$

The resistivity varied very little between the frequencies and the values can therefore be safely used as an approximation of the true D.C. resistivity.

4 Results

The resistivity values of the samples were fairly uniform. The median value was 951 Ωm (1st quartile: 598 Ωm, 3rd quartile: 1,161 Ωm). The median value of the calculated formation factor was 0.136×10^{-3}. Histograms of the formation factor results can be seen in Figure 4-1.

The phase angle measurements can be used to indicate possible presence of minerals with electronic conduction and also as a quality indicator. All samples show small phase angles (Figure 4-2). The small phase angles of about one to five mrad might be explained by small amounts of magnetite in the samples. The small amounts of magnetite will probably not have any significant effect on the resistivity measurements.

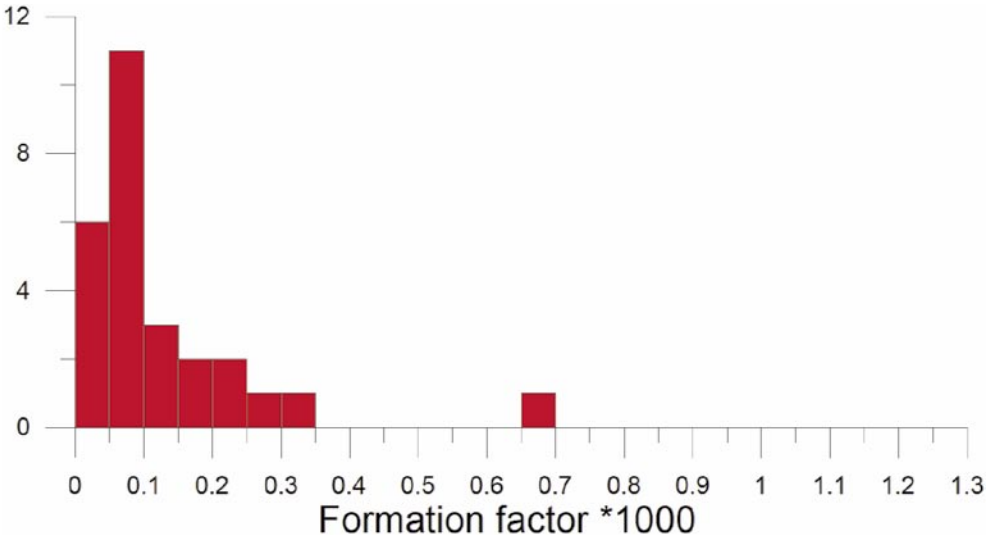

Figure 4-1. *Histogram of calculated formation factor for samples from KLX02.*

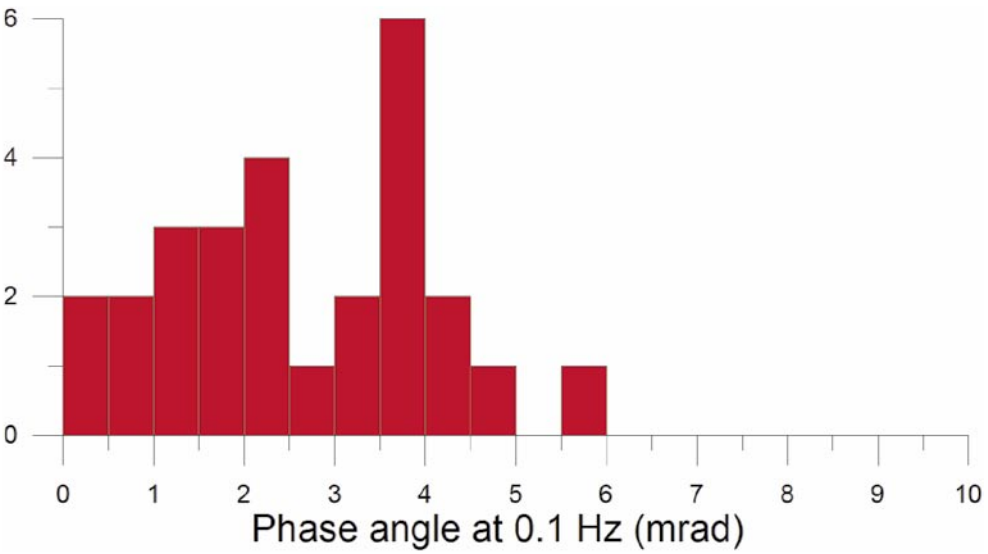

Figure 4-2. *Histogram of measured phase angles for samples from KLX02.*

The formation factor does not show any significant trends with respect to depth (Figure 4-3). The scatter in the data increases for samples below 600 metres depth, but this might be a coincidence.

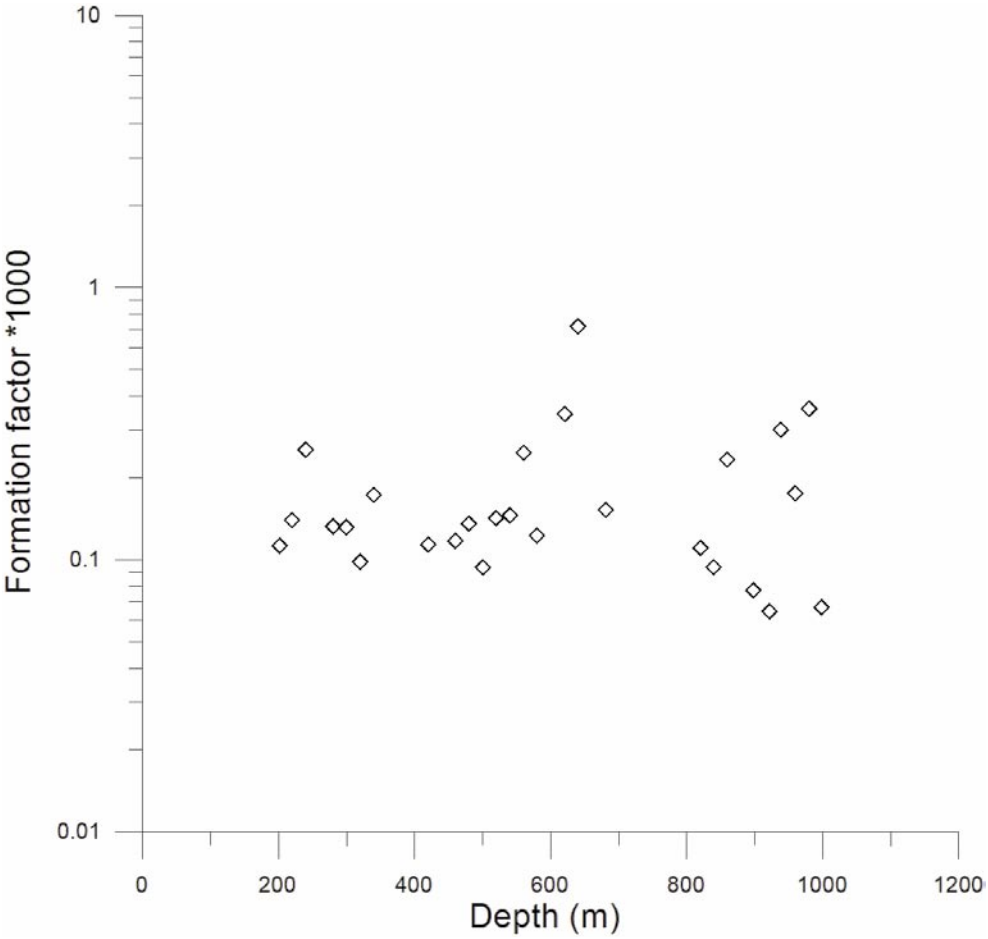

Figure 4-3. *Formation factor plotted as a function of sampling depth along the cores.*

Data delivery

The following data have been delivered to SKB: Measured resistivity and phase angle at 0.1 Hz, calculated formation factor and resistivity of soaking water.

The reference to SICADA is field note no 237.

References

/1/ **Triumf C-A, Thunehed H, Antal I, 2000.** Bestämning av elektriska egenskaper hos vulkaniter från Skellefte- och Arvidsjaurgrupperna. SGU-2000:8