APPLICATION OF THE CONDUCTIVE METHOD IN THE ENGINEERING GEOLOGY - RUCZAJ DISTRICT IN KRAKÓW, POLAND AS A CASE STUDY

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Introduction

The Ruczaj district in Kraków is the potential building area of high flat blocks for inhabitants. This area is built of the gypsum basement covered by the soil and impermeable clay beds with a several meters of thickness. According to the building technology the foundations of the flat blocks must be set on the textured gypsum layer. In the result of the static pressure of the blocks the mineralized water rich in ion SO_4^{2-} outflow from the gypsum into the surround and become the great threat for the flat blocks. To eliminate the phenomena the geological task is to determine precisely the thickness of the soil and impermeable clay as well as the depth of the gypsum basement.

Samples and methods

The conductivity of the soil, impermeable clay and gypsum is equal to near 60, 100 and 10mSm^{-1} respectively. Such the conductivity values and their differences are the good background for the application of the ground conductivity meters (CGM) to determine the thickness of the soil, clay and gypsum layers. The apparent conductivity can be treated as some resultant conductivity of a heterogeneous medium, in which the spatial distribution of real conductivity is imposed by the geological built-up (McNeill, 1980). The measured apparent conductivity σ_a [mS/m] distribution in the ground will be corresponded to the thicknesses of the mentioned layers under earth surface. Apparent conductivity as a function of depth is measured using the horizontal (HD) and vertical (VD) magnetic dipoles with different spacing. The conductivity is measured in the so called near zone or induction zone, which defined as the space surrounding the coil transmitting the electromagnetic waves with a given frequency.
Ground Conductivity Meters: CMD-MiniExplorer and CMD-Explorer, produced by the GF Instruments, s.r.o., are designed for induction profiling (CMD Explorer, 2013). The equipment employs the HD and VD configurations and measures apparent conductivity, with six different options for spacing (S= 0.32, 0.71, 1.18 for MiniExplorer and 1.48, 2.82, 4.49 for Explorer (Fig.1A, C). There are two types of available configuration, which allows regulating the depth of the electromagnetic wave penetration. Measuring at six depth level for HD and VD configuration allows for quantitative interpretation of GCM sounding data (Fig. 1). The GCM measurements were made at the points with 1 meter of distance along the profile with 100 meters of length (Fig. 1 E). Simultaneously the DC soundings were made along the same profile with interval 25 meters. Combined quantitative interpretation of GCM and DC resistivity soundings was made using 1D LMA and 1D Occam algorithms (Constable et al., 1987).

Results

The GCM and DC were carried out at the Ruczaj district in Kraków. The interpreted conductivity of the formations occurring at the study area is similar to that of the typical soil, clay and gypsum published by Kobranova (1989). The 1D LMA inversion of DC sounding (at the point of 25 meters of profile) show that the first interpreted layer is heterogeneous soil of several dozen centimetres of the thickness with conductivity about 60 mS/m. The interpreted low conductivity of the soil near earth surface is often resulted from the characteristics of the GCM method (Fig. 1B, 1D). Under the heterogeneous soil layer there are clays with 100mSm^{-1} of conductivity and near 3 meters of thickness. The next layer there is the gypsum complex with 10 mSm^{-1} of conductivity and thickness of about 12 meters. Below the gypsum formation there is the high-conductive loam Wieliczka layers. The Wieliczka layers were not seen by the GCM method due to its limit of the investigation depth. But the conductivity of the mentioned formation was determined using the DC method and amount to a few hundreds mSm^{-1} (Fig. 1). The GCM profile conductivity cross-section was constructed using 1D Occam inversion of GCM data in VD configuration is presented at the Fig. 1E.

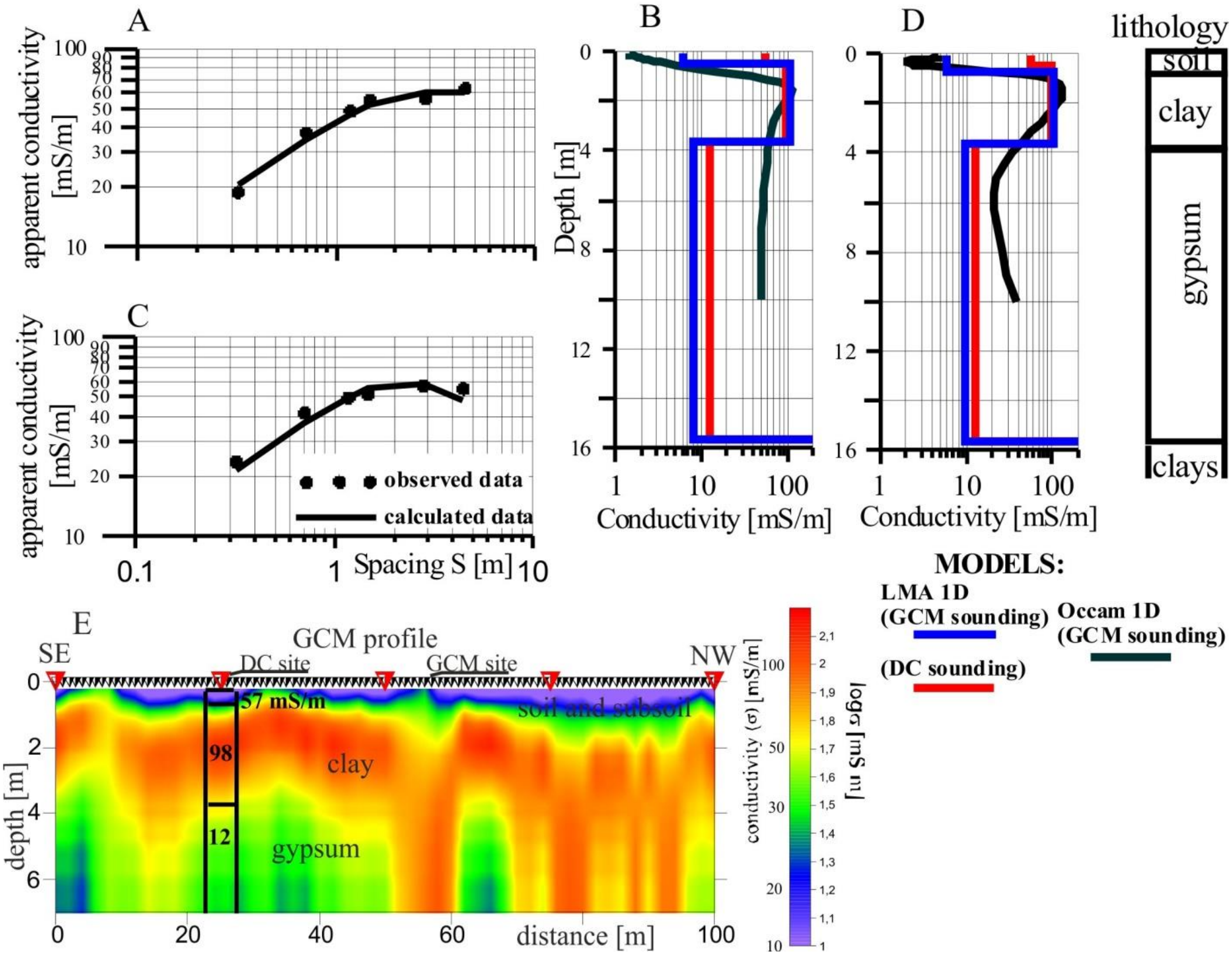

Figure 1. *The results of quantitative interpretation of GCM and DC resistivity soundings, fitting of the observed and calculated GCM data at the site 25 m for HD (A) and VD configuration (C), results of 1D inversion of DC and GCM HD data (B), results of 1D inversion of DC and GCM VD data (D), conductivity cross-section using 1D Occam inversion of GCM VD data (E).*

Conclusions

Based on the obtained results one can state that, the GCM method is effective to determine the conductivity and thicknesses of the rock formations occurring at the Ruczaj district. Regarding on the limitation of the depth investigation of the GCM method the DC sounding was needed to be used. It worth adding the interpreted results of every geophysical method are ambiguous, therefore the more used methods generate the more precise results.

Acknowledgment

Paper was financially supported from the research subsidy nr. 16.16.140.315 at the Faculty of Geology Geophysics and Environmental Protection of the AGH University of Science and Technology, Krakow, Poland, 2019.

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