1D-Joint-Inversion of Radiomagnetotelluric (RMT) and Transient-Electromagnetic (TEM) data: an application for groundwaterprospection in Grundfør, Denmark

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Introduction

In many parts of Europe the resources of ground water are short. A lot of these resources have a risk of contamination through agricultural activity, industry, waste deposits or salt water. For realisation of protection acts it's necessary to improve knowledge of the location and composition of aquifer systems. Solving these questions a large project started in Denmark to resolve aquifer systems from surface measurements with the application of geophysical methods (Sørensen, 1996). A joint interpretation of two methods with different penetration depths like RMT and TEM gives more security about the complete stratification from surface to 200m depth. The results of 1D-joint-inversion of RMT and TEM data from the survey area will be discussed in the following.

Investigations

On an survey area near Grundfør/Denmark (200m x 450m) the University of Cologne realized RMT-measurements with a 10m x 10m grid (Fig.1). About 900 RMT-soundings were obtained during 9 days. The theoretical principle of RMT is the same to VLR-R. As sources civilian and military radio transmitter in the frequency range between 10-240 kHz are used. With four pairs of frequencies perpendicular to each other soundings are realized at one measurepoint. Apparent resistivity and phase data are observed which can be associated to E- and B-polarisation directions giving an information of the conductivity structure till 30 meters depth. On the same survey area the University of Århus, especially the Department of Earth Sciences, Geophysical Laboratory, realized 11 TEM-soundings measured with a commercial Geonics Protem 47 system to derive the depth of the hydrogeological base educated by tertiary clay at a depth of about 130m and some well-logs (Fig.1).

Inversion results

A 1D-joint-inversion program for the interpretation of RMT and TEM data based on a Marquardt-Levenberg algorithm was developed by the institute of geophysics in Cologne which can be also used for

seperate 1D-inversions (Neubauer et al, 1992). A comparison between E- and B-polarisation data shows the justification of the 1D-approximation. Fig. 2 shows the result of a 1D-RMT-inversion of the profile 0 (Fig. 1). A comparison with a 2D-DC-inversion result (Fig. 3) realized from the university of Århus shows a very good conformity especially for the location of the good conductor which is at a very shallow depth beneath measuring the point 240 and after measuring point 370. At the 11 TEM sounding points

Figure 1: The RMT-, TEM- and well-measurepoints: x indicates the position of RMT and TEM stations where 1D-joint-inversion are carried out which is demonstrated in Fig. 5

Figure 2: 1D-RMT-inversion result for profile 0 for the NS-transmitter

joint-inversions of RMT and TEM were carried out. A profile result (see Fig 1) with a simple geological model is shown in Fig. 4. A comparison between resistivity models based on 1D-RMT-inversion, 1D-TEM-inversion, 1D-joint-inversion at the point 30/190 (see Fig. 1) and well 7 is demonstrated in Fig. 5. The RMT-inversion/well comparison shows a good agreement for the thickness of the first and second

layers. The deeper layers could not be resolved. The TEM-inversion/well comparison shows an agreement for the top of the last layer at 30 m depth. The first shallow layers could not be resolved by the TEM-inversion. The joint-inversion/well comparison shows a very good agreement of the thickness for the first and second layers and the layer at 25 m depth could also be resolved.

Figure 3: 2D-DC-inversion result for profile 0

Figure 4: 1D-joint-inversion results of the RMT/TEM-profile

Conclusion

The joint-inversion results e.g. the derived geological model provides a good association about the aquifer system characterized by resistivities of sandy aquifers in the interval 40 -100 Ωm. Although not all layers are resolved the advantages of joint-inversion for the better resolution are demonstrated well.

The combination of RMT and TEM allows a better predication about the stratification instead of a single inversion.

Figure 5: A comparison at point 30/190 (Fig. 1) between resistivity models for RMT, TEM at grnc2 and well 7 (A) and between RMT/TEM-joint-inversion and well 7 (B).

Acknowledgement

Thanks to the university of Århus, Department of Earth Sciences, Geophysical Laboratory, especially to I. Møller, M. K. Lauridsen, K. I. Sørensen and N. B. Christensen for the TEM data, the DC and well-log results, the help for measuring and financial promotion.

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