INTRODUCTION

To study the characteristic features of a geophysical method like the magnetotelluric deep soundings, a model area is to use which is tectonically i.e. geometrically and mineralogically well known. The Köszeg-Rechnitz window (K-R) is one of the characteristic geological structure. It is a graphic (meta-anthracite) conductive body situated at the Austrian-Hungarian border (Fig. 1). Attention can be paid for this specific tectonic formation such a good test area. First pilot measurements were carried out (Adam, et al., 2006) with six MT deep soundings near the research area to prepare a more detailed study. The main objectives of this pilot measurements are as follows:

- indication of the conductor and its lateral-effect (side effect) compared with geological information,
- to analyze the different kinds of MT distortions,
- to determine those extreme MT sounding curves which hold the deepest real information in any correlation with the seismic investigation e.g. indication of the asthenosphere.

GEOL OGY OF THE PENNINIC WINDOW

The Penninic Nappes, which are overlain by thick stack Austro-Alpine Units are exposed in the Eastern end of the Eastern Alps in the tectonic windows of the Köszeg-Rechnitz and Eisenberg (and in two others). This Penninic window contains a reduced metamorphic ophiolite sequence and a meta-sedimentary cover (~3000m) of the former South Penninic Ocean. It is opened during the Early-Middle Jurassic period, subducted and closed in the Late Cretaceous-Early Tertiary. The Upper Nappe in the K-R window – in our study area – consists of calcphyllite, graphite-phyllite and chlorite phylite which overlie by greenish. The Lower Nappe is composed mainly of quartz-phyllite (Ianculescu J., Török K., 2001; Pahir A., 1984). The main rock forming minerals of the chalcopylites often contain small meta-anthracite flakes as inclusion. According to geochemist its amount is about 0.2 % pc.

I. Discussion of the 1D Inversion

In the area of the K-R window the resistivity (Rho minimum) values are under 10 Ohm in the whole period range (10-10² sec) indicating the graphite (meta anthracite) in the phyllites. Outside of the window the resistivity values (Rho minimum) changed to greater than 10 Ohm. At MT site Glasshütten the Rho minimum curve confirms the geological statement of Haas (2001): the graphic phyllites are intercalations in the more resistive quartz-phyllite (see Fig. 2C). MT site Althodis lies just at the boundary of the “conductive” window. Near the edge of the conductive body the electric charges accumulate and consequently the resistivity values increase in the TM mode (similar effect has been discussed by Adam et al. (2000) concerning the outcrop of the Transdanubian Conductivity Anomaly (TCA) in Azófalvi in Hungary).

Generally Rho maximum curves of the TM mode are less sensitive to the small graphic lenses.

II. Direction of the Rho minimum values (TE mode)

The northwest direction inside and nearby K-R window clearly separates from that the other measuring sites having northeast direction (Fig.4). As a special case is the direction of MT site Althodis being north-south (see its explanation under i.). In the points inside the conductor the TE mode (Rho minimum) direction is crossing through to the conductor. The same direction of MT site Unterrabnitz as in MT site Glasshütten could be the indication of the northwest continuation of the conductive window covered by a thin other formation.

DATA

Figure 1: MT sounding curves: outside of the K-R window (Kobersdorf, Katzichen, Kleinmürbish); inside of the K-R window (Glasshütten, Althodis, and the nearby Unterrabnitz).

Figure 2: MT sounding curves: outside of the K-R window (Kobersdorf, Katzichen, Kleinmürbish); inside of the K-R window (Glasshütten, Althodis, and the nearby Unterrabnitz).

Figure 3: Resistivity versus depth diagrams as results of 1D inversion (a - TE mode; b - TM mode).

- A slight resistivity decrease appears in the Rho minimum curves (TE mode) around the seismic crustal discontinuities (Webber et al., 1996). Its depth increases with the distance from the K-R window. Just this tendency can hint at a side-effect of the near surface graphic conductors outside of it. Therefore it is not a real indication of any crustal conductor (see this phenomenon in the 2D inversion also),
- A real deep conductor indication appears on the Rho maximum (TM mode) curves at an averages depth of 140 km (except the strongly distorted Althodis curve – Fig. 3). This depth value of the asthenosphere fits quite well with the seismic data in the area of the Penninicium (see on the map of the asthenosphere of the Pannonian Basin (Horváth et al., 2006).

Figure 4: Distribution of the Rho maximum values.
**IIINDICATION OF META-ANTHRACITE BY MAGNETOTELLURICS IN THE KÖSZEG-RECHNITZ PENNINIC WINDOW**

**DIMENSIONAL ANALYSIS**

The K-R window is a characteristic anisotropic and complex subsurface structure. To define its geometry (dimension) two invariant parameters have been calculated in dimensional analysis: the Bahr-Q (Bahrs, 1988; Bahrs, 1991; Praczer and Starke, 1989; Weaver Agarull Lilley - WAL, Weaver et al, 2000) invariant dimensionality indicators and the phase tensor ellipses (Caldwell et al, 2004; Marti Castells, 2006).

The Bahr-Q (WAL) dimensionality indicators show this area mainly as two-dimensional. At longer period the invariants - beside some 1D and non-classifiable indication - the character is three-dimensional mostly near the K-R window with transition to 3D/2D geometry (Fig. 5).

The phase tensor ellipse is one of the most informative invariant parameters indicating the dimensionality of the structures. It is free of the galvanic distortion and further on it has effect on small subsurface anomalies (Berdichevsky és Dmitriev, 1976). The phase tensor ellipses are in good correlation with the Bahr-Q (WAL) invariants. It indicates the 2D structure where the elongations of the ellipses represent the geological strike. At longer period near K-R window and in the south direction of the area the ellipses change to 3D (by drastic elongation and non-zero values of the βp skew angle) (Fig. 6).

![Figure 5: The Bahr-Q invariants along the MT sites for six frequencies. Symbol of NaN marks the non-classifiable value.](image)

![Figure 6: The phase-tensor ellipses along the MT sites for six frequencies. The fit of ellipses represent by the βp skew angle in degree.](image)

**CONCLUSION**

1. In the Köszeg-Rechnitz window contains graphic intercalation in the upper 10 km layer sequence. Its effect well appears in the magnetotelluric deep soundings as the conductors having resistivities lower than 10 Ohm.m

2. The conductive asthenosphere is indicated at the depth of about 140 km both by 1D (TM mode) and 2D inversion in good correlation with the earlier seismic results.

3. There is not any deep crustal conductor. It appears only as a side-effect of the surface conductors at an increasing depth.

**REFERENCES**


**2D INVERSION**

Nevertheless, the K-R window seems to be a typical 3D geological structure, the dimensional analysis encourage us to make an attempt with 2D inversion and separate the real phenomena from the distortion in the crust and mantle. The near-surface structure has been determined by WinTLink inversion technique (Rodri and Mackie, 2001) and the asthenosphere was approximated by REBOCC inversion (Siripunvaraporn and Gómez, 2000; Siripunvaraporn et al, 2005):

- Inversion of the Rho minimum curves (TE mode) Figure 7 clearly show the near-surface conductors in the central part of the profile and further on south of K-R window in the MT site Kötezhezen which lies near an other small window so called Eisenberg. In the special case of MT site Affodis the conductor almost disappears due to the distortion at the boundary of the K-R window. The inversion results can be seen in another scale (Fig. 7) emphasizing the conductors.

- The inversion of the Rho maximum curves does not show the near-surface conductors.

- The bimodal = TE and TM joint – inversion Fig. 7 can be described with two effects:
  1. The near surface conductors are similar as in case of the TE mode inversion.
  2. The side-effect of the near-surface conductors appears an apparent crustal conductor deepening with the distance from the near surface conductors.

The conductive asthenosphere is well determined by REBOCC inversion in a good accordance with the seismic asthenospheric map at 140-150 km (Fig. 8).

![Figure 7: 2D inversion (bi-modal), TE-transversal electric mode, TM-transversal magnetic mode) along the profile of MT sites for depth of 200 km and 10 km (with WinTLink program, code Rodi and Mackie, 2001). The Root mean square values: BI-4.01%, TE-2.65%, TM-4.7%](image)

![Figure 8: 2D REBOCC code inversion (BL TE and TM) along the profile of MT sites for depth of 200 km and 10 km. Root mean square values: BI-7.73%, TE- 7.06%, TM-4.7%](image)

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