The EMTESZ project:
Induction vectors, strikes and 2-D modelling

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Introduction

As one of the largest tectonic boundaries in Europe, separating the East European Platform from the Paleozoic mobile belts of central and western Europe, the Trans-European Suture Zone (TESZ) can be traced from the Black Sea through Poland and southern Scandinavia until the North Sea.

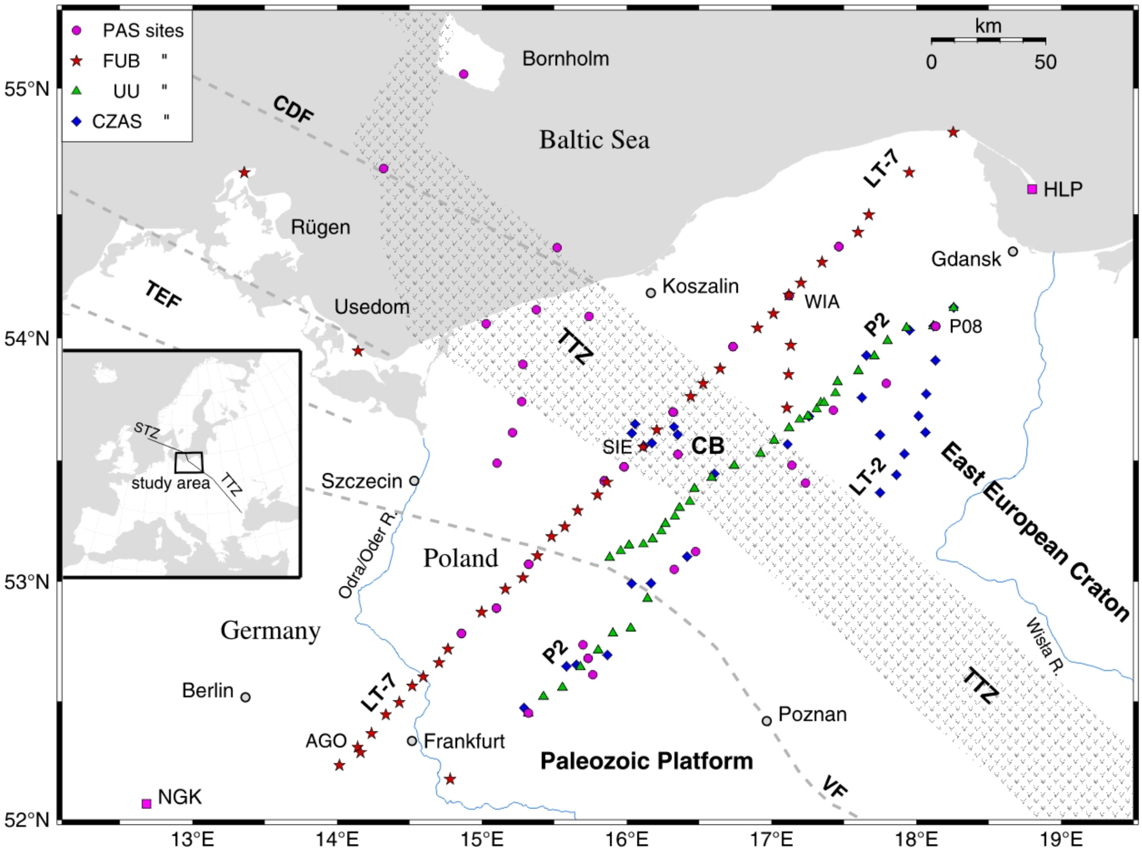

Fig. 1 Distribution of magnetotelluric sites from various institutions in Poland, Germany and the island of Bornholm (Denmark). PAS: Polish Academy of Sciences, FUB: Free University of Berlin, UU: Uppsala University, CZAS: Czech Academy of Sciences. TTZ and STZ are the Teisseyre-Tornquist and Sorgenfrei-Tornquist zones, transitions from the East European Craton (EEC) to the Paleozoic belts of Central Europe. CB: Czaplinek Block, CDF: Caledonian Deformation Front, VF: Variscan Front, TEF: presumed traces of Trans-European Fault system, termed Stralsund and Anklam Faults in NE Germany; its prolongation into Poland is currently unknown.

In central Europe the TESZ coincides with the Tornquist-Tesseyre Zone (TTZ, Fig. 1), which runs in a SE-NW direction through Poland and below the Baltic Sea. Several seismic refraction and reflection experiments have been carried out (POLONAISE and the earlier LT surveys); in the framework of the current proposal the lines P2 and LT7 are of special significance (e.g., Dadlez et al. 2005). Major results include a sedimentary thickness below the TTZ of more than 11 km, sharp lateral boundaries, a deepening Moho from 32-35 km in the SW to 40-45 km in the NE and a reflector below the TTZ at depths of 50-55 km.

To study the electrical conductivity structure of the Trans-European Suture Zone (TESZ) a multi-national research effort (EMTESZ Pomerania, EMTESZ = **E**lectro**m**agnetic Study of the **T**rans-**E**uropean **S**uture **Z**one) has carried out magnetotelluric measurement across the area of interest (see fig. 1). Scientists from 7 European countries (Czech Republic, Finland, Germany, Poland, Russia, Sweden, and Ukraine) participate in this working group.

The measurements have been mainly carried out in the years 2003 and 2004. In 2005 only site AGO was set up and at SAR additional measurement have been made to improve the signal to noise ratio. The main problem were the DC railroads in Poland. Remote reference analyses of the data (WIA as reference site) after Egbert (1986) resulted in useful stable transfer functions in most cases.

Induction vectors

For short periods the vectors are very small. For increasing periods the induction vectors become larger at all sites. On the Precambrian platform in the northeastern part of the profile real vectors reach a maximum length of 0.7 with direction NNE (fig. 2). At the border of the TTZ there is a sharp transition. The vectors are considerably shorter and at the border they rotate to NE and E. In the middle part of the profile the direction of the real vectors changes to NW and further south near the VF they change to SE.

For longer periods length of the real vectors decreases. In the northern part of the profile they are approximately aligned with the profile direction. In the transition zone and in the area of the salt domes they rotate in changing directions and their lengths become very small. In the southwestern part (Paleozoic side) the vectors are also small and show direction SSE.

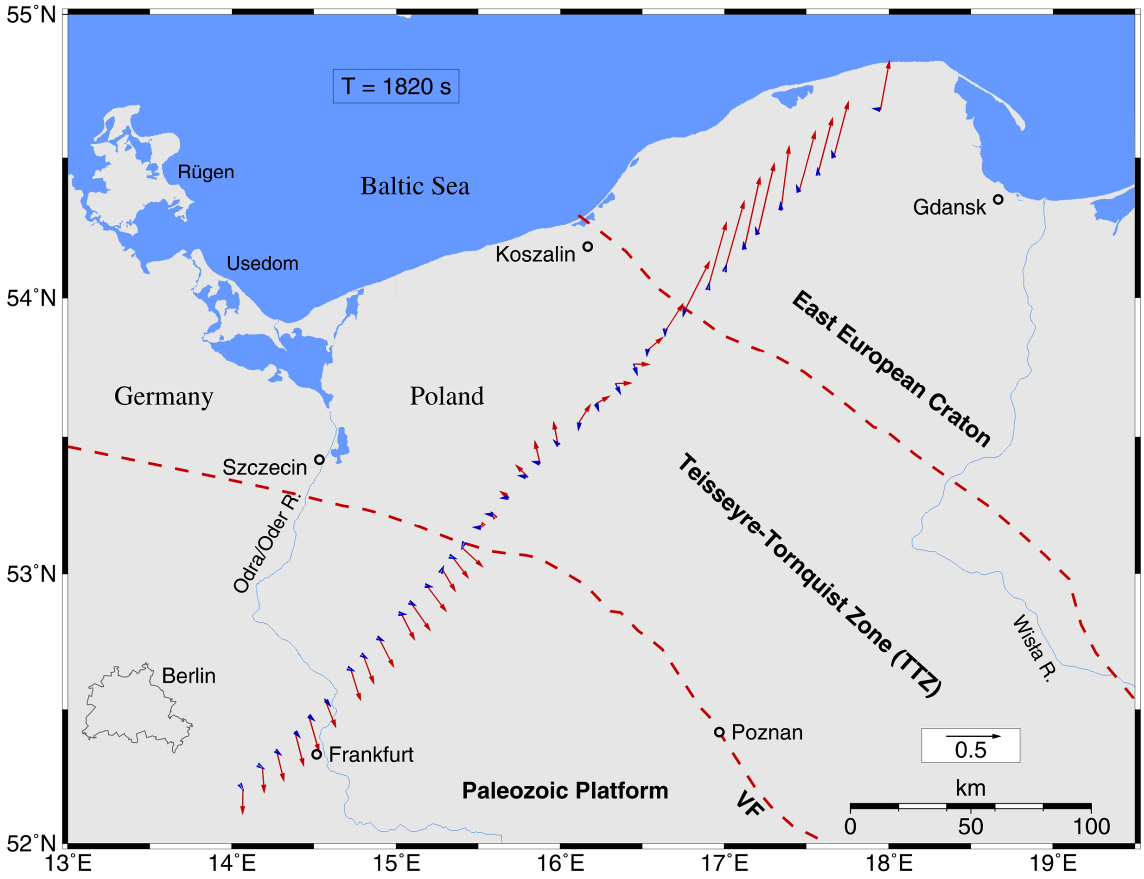

Fig. 2 Induction vectors for profile LT-7 for a period of 1820 s. Real vectors are shown in red, imaginary vectors in blue.

The directions of the vectors compared to the assumed strike of the TTZ and the fact, that the vectors show strong variations in the direction along the profile lead to the conclusion, that this dataset cannot be explained by only 2-D structures.

Strike analysis

Fig. 3 shows the strike angles calculated after the multi-site multi-frequency algorithm of McNeice and Jones (2001) for single sites. For the southern part of the profile (20 sites, DAM – ZOL) the angle varies only slightly with distance and period. From site ZOL to the Northeast the angles jump and in the northern part (GRA – OST) a strong trend is obvious.
Nevertheless, it was possible to calculate a common strike angle of -32° for all sites. For the stated parts in the southwest and northeast the calculated angles are 21° and -25°, respectively.

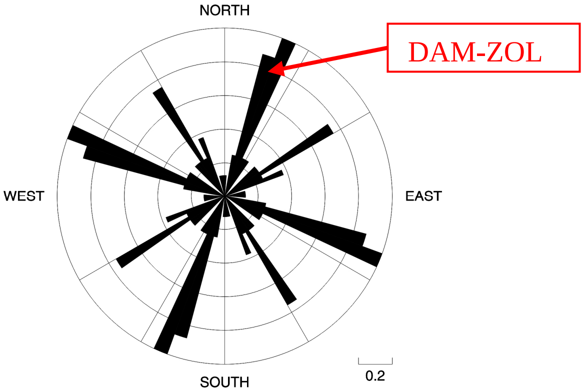

Fig. 3 Strike analyses: Single-site multi-frequency after McNeice and Jones.

Tentative 2-D model

Although the structures beneath the profile seem to change their strike direction and/or show three-dimensional behaviour, in a first attempt the conductivity distribution was interpreted in 2-D. The 2-D models were calculated with the CG-FD inversion algorithm after Rodi and Mackie (2001). First the data were rotated by –60°. This angle does not coincide with the analysis shown above. But due to the three-dimensionality and in consideration of the induction vectors this angle seems the best approximation to fit the 3-D data onto a 2-D model. It was calculated from analysis of horizontal magnetic transfer functions by Varentsov (this volume and pers. comm.).
In a first inversion step TM mode and induction vectors have been inverted. The resulting model was used as the input model for the inversion of all available components: TE, TM, and induction vectors as well as static shift. The models have been tested with different smoothing parameters τ, varying from 5 to 30. In this case τ was set 20, because for lower values the model contains artefacts, i.e. structures not necessary to explain the data. The data fit for $\tau = 20$ is not much worse than for lower values. In the model shown below one can clearly identify the transition zone between the resistent Precambrian shield at the right and the better conducting Paleozoic platform at the left. The area of the TTZ is controlled by local inhomogeneities beneath the upper good conducting zone caused by saline pore water. Beneath the model in fig. 4 typical transfer functions of different parts of the profile and the model fit are shown. North of the TTZ (MIR, right hand side) the curves show an increasing resistivity with period with a splitting of the components. Going southwards across the TTZ the splitting changes sign (GRA). In the middle of the profile (KUZ) an increase of the splitting is obvious with a characteristic TE phase which is probably caused by the local inhomogeneities in the subsurface. Near the southern end of the profile the undulation vanishes again (AGO) but the splitting persists.

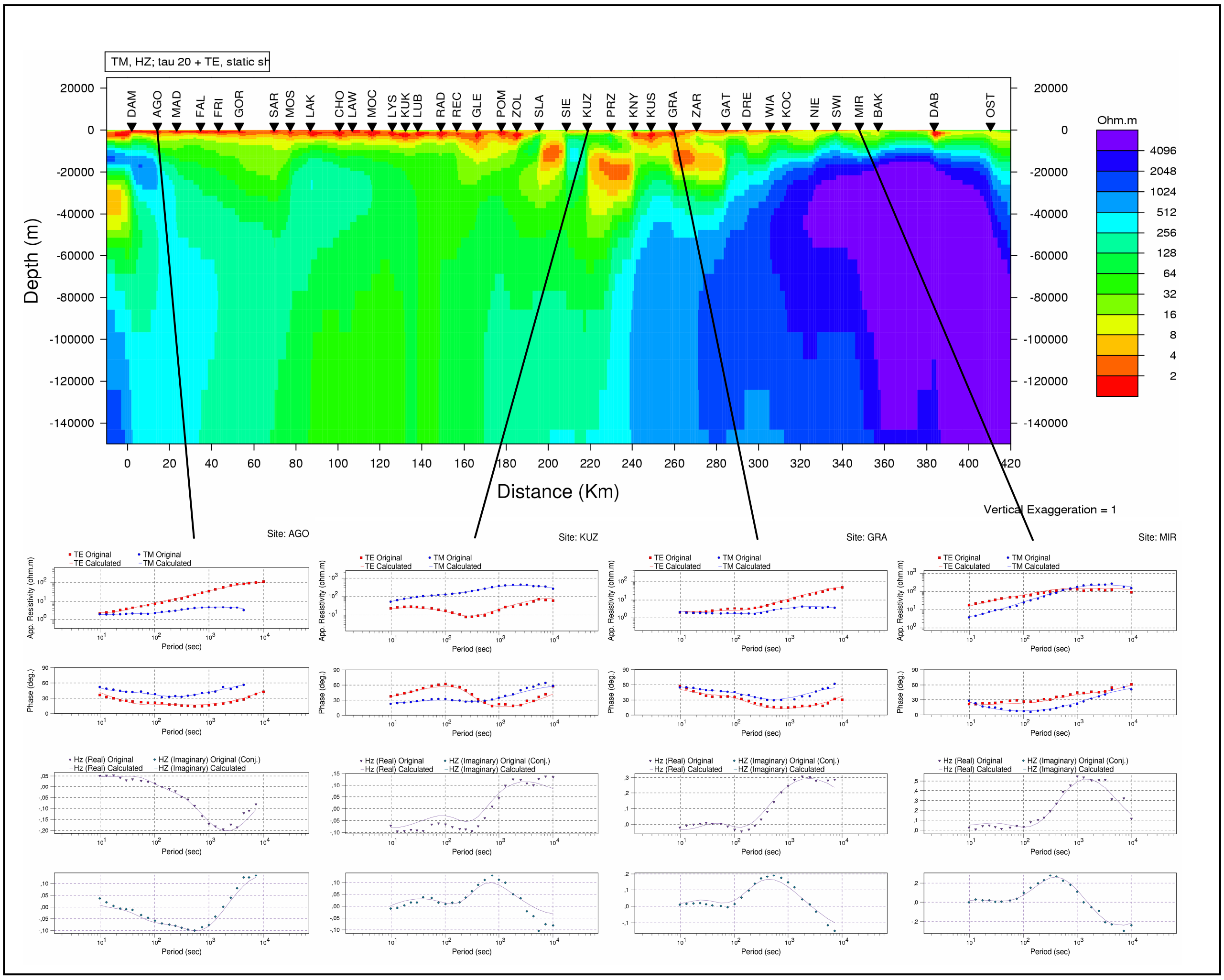

Fig. 4 2-D Model calculated with the algorithm after Rodi and Mackie. Beneath the fit between data and model responses is shown for some representative sites.

References

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