
Regional magnetotelluric profile through structures of Polish Lowland

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Introduction

The magnetotelluric survey was made during 2005-2006 years along a regional profile, which runs across Poland from south-west to north-east. The profile crosses major geological structures of Central Poland, including the Variscan Externides and Variscian foredeep, the Transeuropean Suture Zone and the marginal zone of East European Craton. The main objectives of the project include identification of sub-Zechstein sedimentary structures and evaluation of resistivity distribution within the deep crust, especially at the contact of East European Precambrian Craton and Central Europe and Paleozoic structures.

Techniques and methodology of surveys

The length of the profile is about 700 km; 161 deep magnetotelluric sounding sites were designed with a medium spacing of about 4 km. The recording of the components of natural electromagnetic field was made with a broad range of frequencies, varying from 0.0003 Hz up to 575 Hz. This frequency band allowed obtaining the information about geology ranging from a few dozen meters to approximately 100 km, depending on the vertical distribution of the resistivity inside geological medium. To reduce the electromagnetic noise, magnetic and electric remote reference was applied. A remote reference site was located at a distance of over 100 km of the study area.

Data processing and interpretation

Processing of the recorded data included the estimation of the components of impedance tensor (Z_{xx} , Z_{xy} , Z_{yx} and Z_{yy}), with use of robust type procedures. The components of the impedance tensor allowed in a subsequent step for calculation of field curves for two orientations of the measurement system (XY – described further as the TM mode and YX – TE mode) and additional parameters of the medium like skew, strike, pole diagrams etc. Recording of the vertical component of electromagnetic field (H_z) at numerous sounding sites of regional profile allowed calculation of tipper parameter T.

Geophysical interpretation of MT sounding data was made based on 1D and 2D inversion. The upper part of the geological section is built of relatively flat layers, hence a 1D interpretation model could be effectively applied. Starting models for 1D inversion were constructed based on results of electromagnetic well-logging. Some well-documented seismic horizons were taken as constraints in 1D inversion. Initial models for 2D inversion were constructed with the use of results of 1D magnetotelluric sounding inversion and structural model of the upper part of cross-section based on seismic data interpretation. A resistivity distribution model along the measurement profiles was obtained as a result of geophysical interpretation. Of great interest is varied resistivity of the formation resting between the Zechstein evaporate complex, and the crystalline basement and differentiation of the East European Craton basement.

Geological interpretation of upper part of the section was made based on resistivity cross-sections and borehole and reflection seismic data. The main target of that relatively detailed interpretation was recognizing of the structure and lithology differentiation of sub-Zechstein complexes, that are considered as hydrocarbon prospective. The screening of seismic energy by high reflective Zechstein evaporates is the main problem in identifying deeper complexes in the area of Polish Lowland. Interpretation of results of magnetotelluric soundings provide a lot of new information. The main tectonic boundaries were distinguished and location of sediments of different lithology reflected in resistivity differentiation was defined. Deep model of regional structures based on resistivity distribution was suggested as well.

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