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Long regional magnetotelluric profile crossing geotectonic structures of central Poland

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Introduction

The magnetotelluric survey was made along a regional profile, which runs across Poland from south-west to north-east during 2005-2006 years. The profile crosses major geological structures of Central Poland, including the Variscan Externides and Variscan 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 Paleozoic structures. The length of the profile is about 700 km; 161 deep magnetotelluric sounding sites were made with a medium spacing of about 4 km.

Data acquisition and processing

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 with use of MT-1 system of Electromagnetic Instruments Incorporation. 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 field sites.

Processing of the recorded data included the estimation of the components of impedance tensor (Zxx, Zxy, Zyx and Zyy), 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 (Hz) allowed calculation of tipper parameter T.

Magnetotelluric soundings interpretation

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 and some well-documented seismic horizons. 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. 2D inversion was performed in two steps with use of NLCG and SBI algorithms. At first step of inversion high-frequency range of data was used and constraints based on borehole data was applied. Inversion in second step was made with starting model constructed based on results of first one and with stabilizing resistivity distribution in upper part of cross-section.

Of great interest is varied resistivity of the formation resting between the Zechstein evaporate complex, and the crystalline basement. 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. Some new deep tectonic elements were recognized at the zone of Fore-Sudetic Block and Fore-Sudetic Monocline. Substantial differentiation of resistivity of crystalline massif of the East European Craton basement was discovered. Zones of low resistivity are probably connected with development of metamorphic processes or reflects location of big faults. Geological cross- section based on resistivity dis-

tribution was constructed. Deep model of regional structures based on resistivity distribution was suggested as well.

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