# BASIC STRUCTURES OF THE CARPATHIAN BASEMENT AS A RESULT OF MAGNETOTELLURIC SOUNDING INTERPRETATION

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**Abstract:** The pattern of main structures of the Carpathian basement obtained as a result magnetotelluric data interpretation is presented. Two generations of magnetotelluric data were applied. Regional resistivity cross-sections and structural map of the basement roof were made. Two overthrusts modifying structures of the basement were distinguished. A strong differentiation of basement resistivity was observed.

**Key words:** Carpathians, basement structure, magnetotellurics

## Introduction

The interpretation of the deep structure of the Carpathian orogen and its basement is difficult because of its complexity and limited borehole data available. The flysch orogen built of strongly folded series of shale and sandstone layers with diverse physical properties and cut by faults and overthrusts, generates a very complicated wave field pattern that makes the seismic data interpretation difficult. Therefore, other geophysical methods, including the magnetotellurics, are employed there. Magnetotelluric investigations have been conducted for over twenty years in the Polish Carpathians (Jankowski et al. 1991, Stefaniuk 1995,2001). A new magnetotelluric survey with use of MT-1 system has been made by Geophysical Exploration Company since 1998, in the framework of “The project of magnetotelluric survey in the Carpathians”. Nine magnetotelluric profiles were located in the eastern part of Polish Carpathians. Seven of them were transverse and two parallel to the major orogen axis. The main objective of magnetotelluric data interpretation was to recognize the structure of the sub-flysch or sub-Miocene basement and the deep structure of the flysch cover. Results of investigation are presented as depth cross-sections (fig.1) and a structural outline of the top of consolidated basement (fig.3)

## Data recording and processing

Several different generations of equipment were used for data recording. Older measurements (1975-1995) were made with the use of five-component systems with Bobrov magnetometers as magnetic field detectors. Variations of magnetotelluric field were recorded over a frequency range of 0,0002-1,0Hz. Different data processing methods were used in relation to applied techniques of time series recording (Stefaniuk 2001). New magnetotelluric measurements were made using MT-1 magnetotelluric system of Electromagnetic Instruments Inc., Richmond, USA. Data were recorded over a frequency range of 0,0005-300,0 Hz. The remote magnetic reference was applied to eliminate the effects of electromagnetic noise (Stefaniuk et al. 1998). Data processing was made by a software included in the MT-1 system.

## Main results of magnetotelluric data interpretation

Magnetotelluric data interpretation was based on 1-D automatic inversion (Stefaniuk 2001, Czerwiński, Stefaniuk, 2001) with the use of different algorithms and programs. The method of apparent velocity of electromagnetic wave was applied to interpretation of some older, analogue data (Miecznik and Tomaszkiewicz, 1980, Stefaniuk 2001). 2-D forward and inverse modelling was also applied.

Two large structures, likely of overthrust type may be distinguished in the basement (fig.2). They divide the basement into three zones. In the outermost zone the high-resistivity horizon related with the sub-flysch or sub-Miocene basement top occurs at a relatively shallow depth (3-8 km), and generally subsides toward the orogen axis (Stefaniuk 2001). South of the outermost zone, the high-resistivity basement elevates and then slopes steeply to the most buried zone that occurs at a depth of 15-25 km. On the southern margin of the area a third zone of the relatively elevated basement is observed.

## Some remarks on geological interpretation of magnetotelluric data

Of great importance to magnetotelluric data interpretation is the geological identification of geoelectric horizons. Based on author’s analysis it may be concluded that the high-resistivity horizon corresponds generally to the top of the Mesozoic, Paleozoic or Precambrian basement (Stefaniuk 1995, 2001, Borczuch et al.1998). This holds for the outermost zone and has been proved by deep borehole data and reflection seismic. Geological identification of the high-resistivity horizon in these two zones is not verified because of lack of deep boreholes crossing the flysch cover.

Still, geological identification of the low-resistivity rock complex is a key problem. There are different interpretations and hypotheses on the origin of this complex. According to them, the complex is connected with deep oceanic sediments saturated with mineral water (Jankowski *et al.* 1985, Woźnicki 1985), or graphitized shales or graphites (Żytko 1997). The analysis of resistivity of flysch complexes and basement, made by the author for some twenty boreholes drilled near the orogen margin, shows that resistivity of the Miocene clayey sediments falls in a range of 1 to 5 omm, thus being the same as that of the low-resistivity layer (Stefaniuk 2000, 2001). W. D. Stanley states that resistivity anomalies in the Western Carpathians are generated by black shales similar to those Miocene sediments (Stanley 1989). It may be concluded that a depression in the southern part of the study area is a filled with molasse-type sediments and covered by the Carpathian overthrust, or the conductivity anomaly is caused by a thick complex of deep marine sediments. Geophysical data are insufficient to confirm this, however the hypothesis can be verified by analyzing the tectonic development of the Carpathian orogen.

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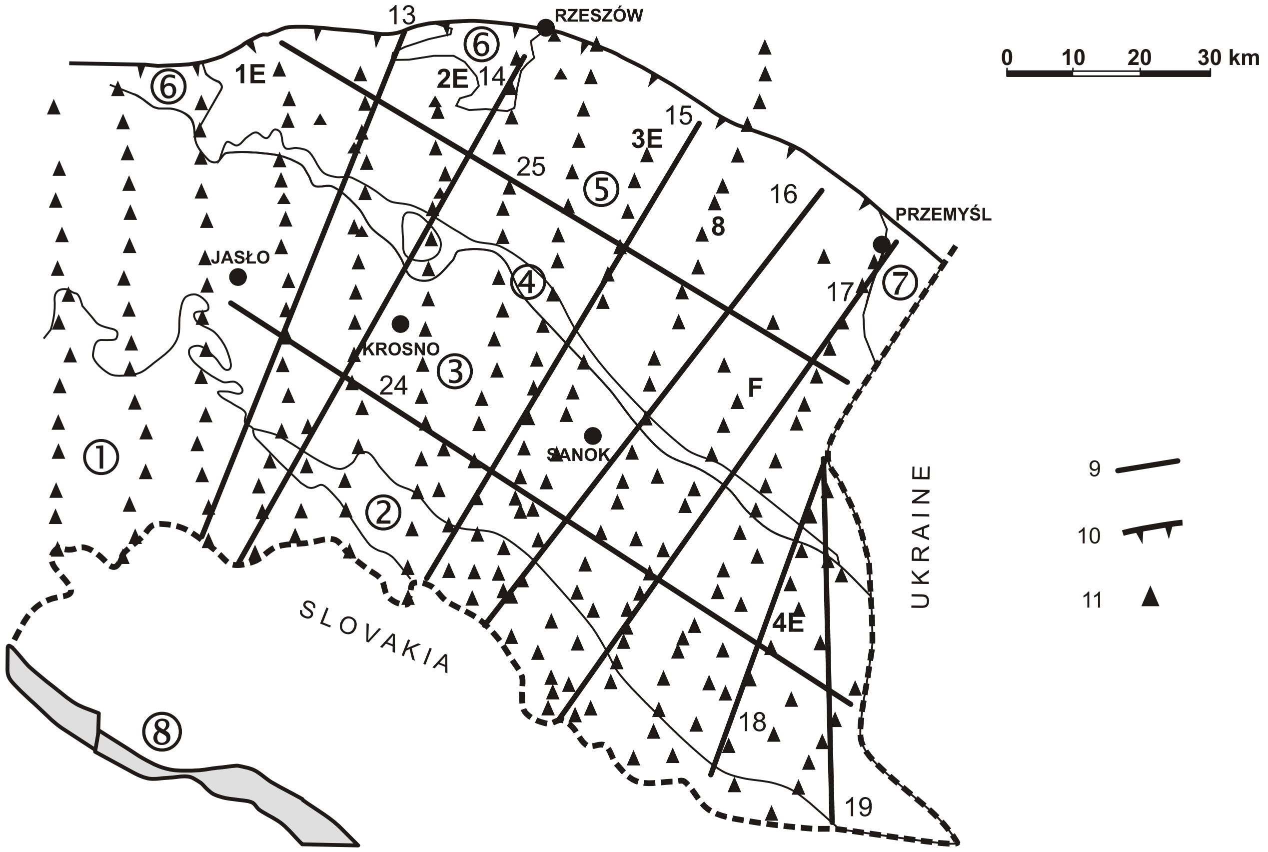
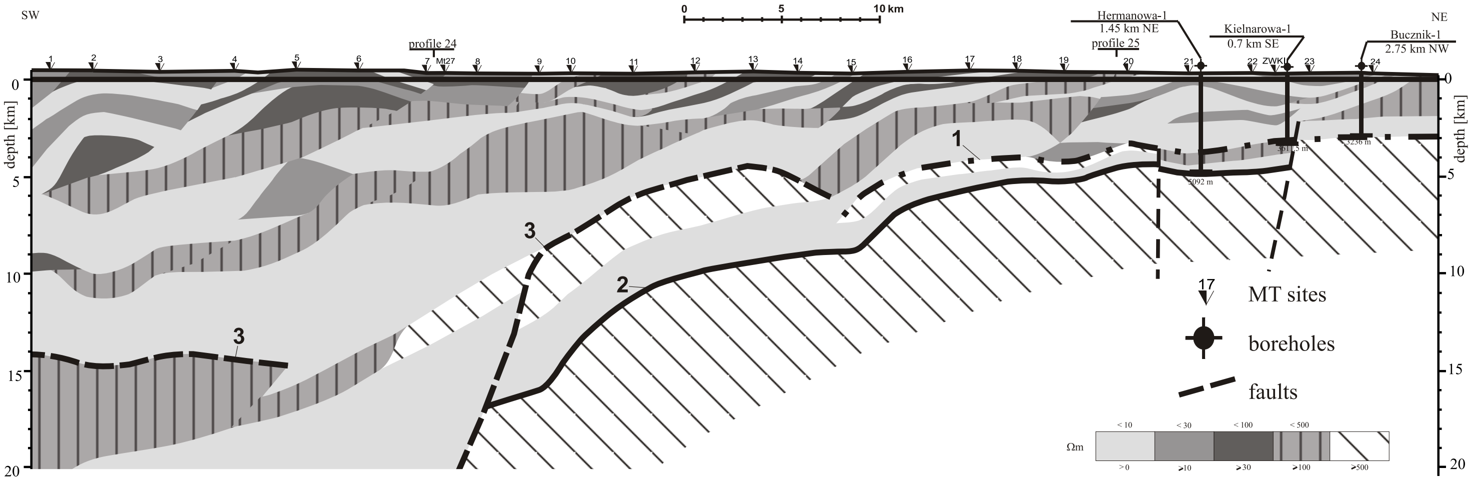
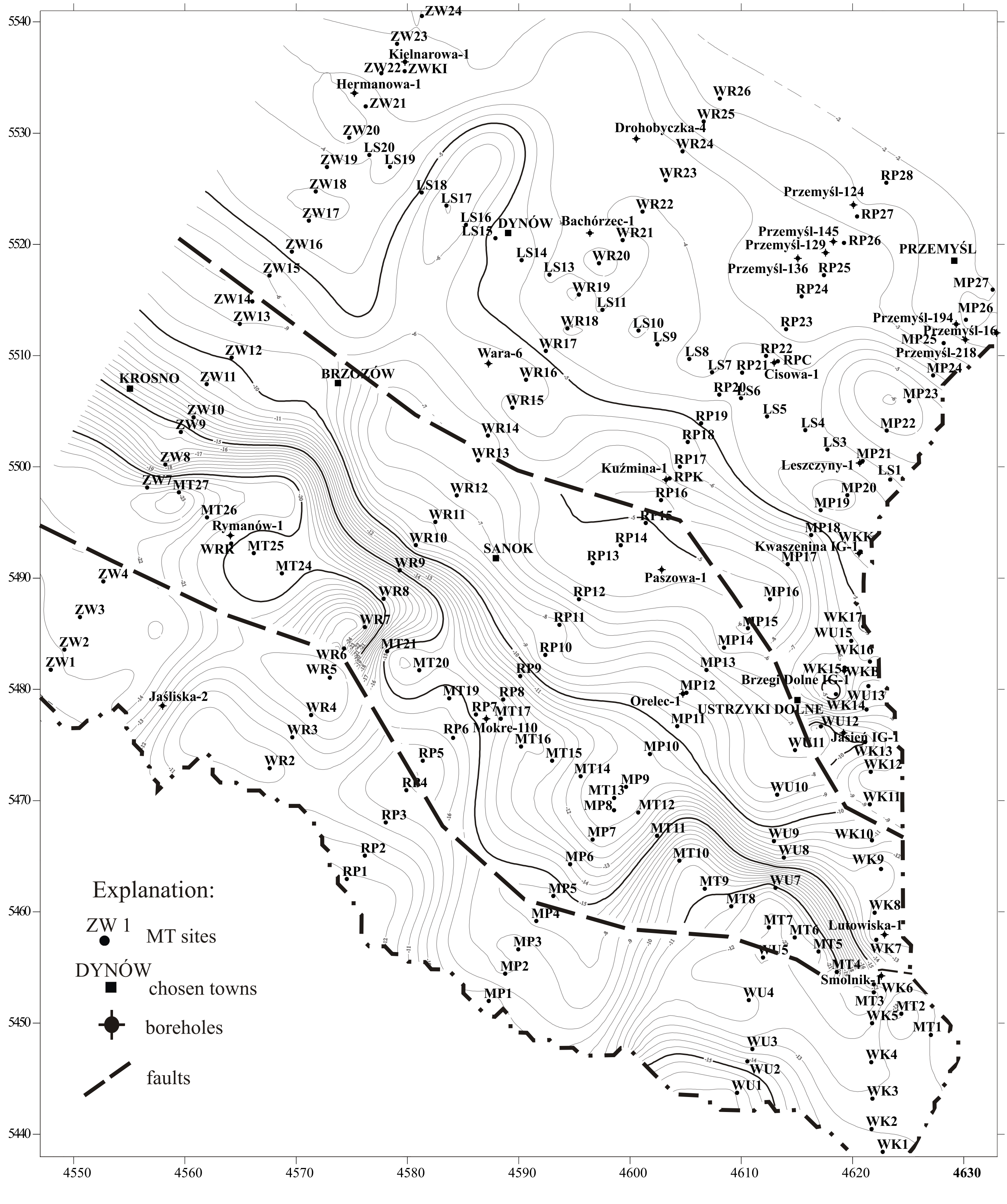



1- Magura Unit, 2- Dukla Unit, 3- Silesian Unit, 4- Subsilesian Unit, 5- Skole Unit, 6- transgressive Miocene, 7- Stebnik Unit, 8- Pieniny Klippen Belt, 9- new magnetotelluric profiles, 10- Carpathian overthrust, 11- older magnetotelluric soundings




1- the top of the sub-flysch / sub-miocene basement, 2- the top of crystalline basement
3- the top of hypothetical Carpathian basement



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Explanation:
ZW 1
MT sites
DYNÓW
chosen towns
boreholes
faults