

# STRUCTURE OF THE WEST CARPATHIANS FLYSCH BELT AND ITS FUNDAMENT

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**Abstract.** The data in this area include results from a number of deep boreholes (up over 6 km deep) and an extensive complex of geophysical measurements. The analysis of frequency characteristics and reprocessing of seismic and gravity data brings the data about composition of density balanced cross-sections of the upper layer of the crust along selected seismic profiles and tracing of tectonic elements.

**Keywords:** tectonics, geodynamic evolution, oil and gas potential, Bohemian Massif, Flysch West Carpathians

## Introduction

The Carpathian Flysch Belt area is on the contact of the Bohemian Massif and the Western Carpathians. Analysis of the frequency of seismic and gravity data belongs to recent geophysical research techniques. This technique makes it possible to identify from the seismic and gravity data rather low-amplitude structural-tectonic features. The method is based on combined analyses of the reflectance image of the derived gravity field and of the changes of the seismic echogenity.

- Methods: - completion of gravity and derived gravity maps;
- calculation of Linsser indications of density contacts;
  - completion of reflectance images of the gravity field;
  - analysis of selected time seismic sections;
  - mapping of tectonic features through combined analysis of seismic and gravity data;
  - examination of the digital model of the topography;
  - composition of density balanced cross-sections along selected seismic profiles.

Several older seismic lines parallel with profiles Brno-Hodonín and Šternberk-Lysá pod Makytou has been newly reprocessed. Those were lines 3/73, 240/79, 240A/80, 3/81, 1P/83, 5/83, 3AP/83, 3BP/83, 4P/83, 5/84, 7A/84F1, 7B/84, 8HR/85, 8AHR/86, 8DHR/86.

The lines were reprocessed using new parameters and procedures and some of them were even put together (for instance 3BP+3P+3AP) and the final outputs were produced both in black and white and coloured versions. This enable fully utilize seismic data information for the geological interpretation. The results will help among others to construct the map of the top of the fundament below younger structures of Carpathians as well as two above meant starting geological-geophysical profiles across the Outer Western Carpathians.

The main aim is the construction of a model of the geological setting of the Bohemian Massif and the Carpathians contact region and the reconstruction of the development of the whole region in space and time. Especially important we consider a further advancement in the knowledge of the structure and development of the nappe units of the Carpathian Flysch Belt. Differences of the Variscan and Alpine tectonic styles are interpreted in respect to the impact of the Carpathian overthrusting on the deformation of the underlying crystalline and its Paleozoic and Mesozoic cover units.

Based on a geological and geophysical synthesis the potential oil and gas plays are shown in the subcrop topographic maps of the crystalline basement, Paleozoic, Mesozoic, Paleogene, Miocene sediments of the Carpathian Foredeep, and Carpathian Flysch Belt.

An example of detail tectonic structure evidenced by new shallow seismic measurements is discussed (interpreted seismic record on Fig. 1).

### **Evidence of strike-slip movements along the Magura thrust fault**

Shallow high-resolution reflection seismics measurements were carried out at profile MS-KB-1/98 across the central part of Kurovice limestone klippe of the Upper Jurassic/Lower Cretaceous age. The Kurovice klippe consists of turbiditic limestones and marlstones and belongs to Magura Group of nappes (partial Rača unit). It is situated near the SE border of the Upper Morava Valley Pliocene basin.

The principle of shallow high-resolution reflection seismics is based on generation of seismic energy in shallow boreholes (till 1 m) and registration of reflected waves by a set of geophone groups. Natural frequency of geophones was 40 Hz, groups spacing 10 m and CMP intervals for the given solution was 5.0 m. The main output of this seismic measurement is final set of

time section in the scale 1:5 000. The range of time section is given by measurement method and is 950 ms two-way travel time.

Older seismic logging measurement result from well Tlumačov-1 (approx. 1 km to the west from section MS-KB-1/98, Fig. 1) were used for the time-to-depth conversion. From this conversion, depth penetration of the measurement is about 1 500 m.

Interpretation of the seismic profile MS-KB-1/98 is based on space analysis of the wavefield, which scans frequency and shape differences in the signal. This allows to divide the seismic profile by different echogenicity of the wavefield.

The main task of the interpretation of the seismic profile M-KB-1/98 was to define the structure of the Kurovice klippe. For it, georadar measurements on profile were also used and added to uppermost part of the seismic section.

The body of Kurovice limestones itself is manifested by distinct group of oblique reflections on the seismic section MS-KB-1/98, dipping southwest and reaching about 400 m depth from the surface. Turning of the lower part of Kurovice klippe to the northwest is interpreted at a depth of 400 - 500 m. Its base is interpreted in the depth of about 800 m, i.e. at the level - 500 m a.s.l. At that level the bottom boundary of the Soláň Formation is interpreted, too, being the base of the Magura Flysch.

We suppose that the turning of lower part of Kurovice klippe is caused by the strike-slip tectonics, the manifestation of which can be followed in the deeper parts of the seismic section, too. The main fault of the tree-formed structure coincides with the northwestern edge of the upper part of Kurovice limestones.

Assumption of the left-handed strike-slip along the main thrust surface of Magura Flysch is supported by the existence of a positive structure (elevation) in the crystalline basement right immediately below the main thrust surface. This structure is well recorded on the older regional seismic section 231/78. The indication of strike slip tectonic phenomena along the main thrust fault of the Magura nappe was supposed at first by Roth (1980). Fodor (1991) confirmed by detail structural measurements this hypothesis. The new seismic investigations of this area brought an evidence for these opinions.

Geophysical survey shows that Kurovice klippe is rather complicated tectonic structure formed in the front of Magura Flysch. Frontal contact of the Soláň Formation and Ždánice units (Outer Flysch) is irregular and can be generally assumed as vertical with the thickness of about 800 m. In the area of the main thrust surface, a distinct strike-slip fault is manifested with numerous deformations of geological units. According to the surface correlation of

geophysical indications, the northwestern edge of the Magura nappe system is limited by SW-NE left lateral strike-slip tectonics of the Middle Miocene age.

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**Figure 1.** Seismic record along the profile MS-KB-1 with intepretation. Time section with depth scale.

Fig.1.

