3D GRAVITY EFFECTS OF THE SEDIMENTARY COMPLEXES IN THE CARPATHIAN–PANNONIAN REGION

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Abstract: The purpose of this paper is to demonstrate the gravity effects of the sediments of the outer Carpathians, the Pannonian basin and Transylvanian basin. An exclusive approach to 3D gravity modelling has been used to determination of gravity effect of sedimentary filling in the Pannonian basin and Transylvanian basin, outer (flysch) Carpathians and molasse foredeep of outer Carpathians. The gravity effect of the foredeep sediments varies from 0 to –55 mGal. The largest effect of the flysch sediments of the outer Carpathians can be observed in the Western and Eastern Carpathians junction (up to -45 mGal) and in the Eastern and Southern Carpathians junction (up to –25 mGal). The gravity effect of the sediments in the Pannonian (Transylvanian) basin varies from 0 to –50 (-40) mGal. The Danube basin, Békés basin and Makó basin are characterized approximately by the same values (-50mGal). Maximum gravity effect of the Transcarpathian basin and the northern basins in the Great Hungarian basin is about –45mGal. Sáva graben and Drava graben reach maximum of gravity effect about of –40 mGal.

Key words: 3D gravity modelling, sediments, Carpathian-Pannonian region

Introduction

One of the most typical feature of the Carpathian-Pannonian basin results from its evolution is a large thickness of sediment both in the foredeep (outer Carpathians) and in the foreland of the Carpathian orogen (in the inner-Carpathians, Pannonian basin and Transylvanian basin), as well. The outer Carpathians comprise molassic sediments of the Late Tertiary Carpathian foredeep deposited on the southern flanks of the European Platform and the broad Flysch belt that is composed of numerous thrust units (Plašienka et al. 1998). The Flysch belt represents two groups: a) the Silesian-Moldavian

(Krosno-menilite) nappes in the north, and b) the Magura thrust system in the south. Thick flysch sediments of the Jurassic to early Miocene age were scraped off a strongly attenuated continental, in some parts also probably oceanic crust (Plašienka et al. 1998).

The purpose of this paper is to demonstrate the gravity effects of the sediments of the outer Carpathians, the Pannonian basin and Transylvanian basin. These 3D gravity effects of the sediments will used for calculation of the stripped gravity map of the Carpathian-Pannonian-Transylvanian's region (Fig.1) in order to obtain the gravity anomalies which will demonstrate deep-seated anomalous bodies within lithosphere.

An exclusive approach to 3D gravity modelling has been used to determination of gravity effect of sedimentary filling in the Pannonian basin and Transylvanian basin, outer (flysch) Carpathians and molasse foredeep of outer Carpathians. The gravity

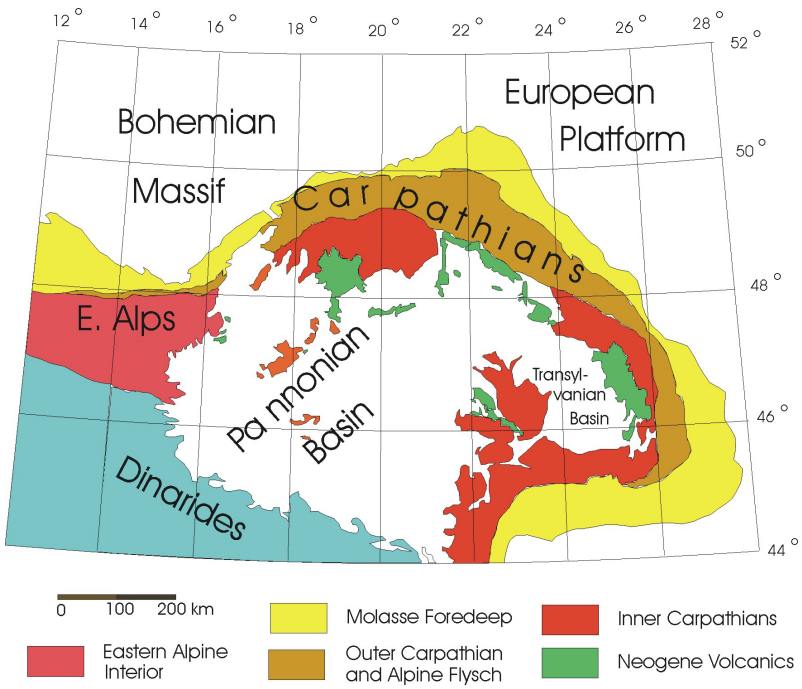

Fig. 1

effects of the mentioned sedimentary layers have been calculated using complex of programs which enables to solve a direct 3D gravity problem within an arbitrarily dense network (grid) from media with a complicated relief of the discontinuities and an arbitrary density distribution in each layer (Starostenko and Legostaeva 1998, Legostaeva 2000). It is especially effective in studying sedimentary basins (Buryanov et al. 2001).

3D density model of the sedimentary filling

3D density model consists of three different tectonic sedimentary complexes: the Pannonian basin and Transylvanian basin, the outer Carpathian foredeep sediments and the outer Flysch Carpathians sediments.

The thickness of the Neogene-Quaternally sediments in the intra-Carpathian region (in the Pannonian basin and Transylvanian basin was compiled by the results published by Bielik (1988), Kilényi and Šefara (1989), Szafián et al. (1997). The resultant map of the thickness of the sediments is illustrated in the Fig. 2. The thickness of the sedimentary basin varies between 0 to 9 km, with average of 2.5 -3.0 km. The filling of the basin mainly consists of sands, clays, shales, sandstones with isolated limestones and evaporites, and also clays and marls in the layers closest to the surface. For estimation of the density model sedimentary basin we used the data from Bielik (1988), Šefara et al. (1987), Szafián et al. (1997), Grasser (1988), Bucha et al. (1994), Šefara and Szabó (1997). Mean density contrasts for the depth intervals are shown in the Table 1.

Depths km	**Grasser (1987)**	**Bielik (1988)**	**Szafian et al. (1997)**	**Bucha et al. (1988)**	**Šefara-Szabó (1997)**	**Average values**
0-1	2,330	2,125	2,000	2,150	2,105	***2,142***
1-2	2,465	2,310	2,200	2,275	2,320	***2,314***
2-3	2,560	2,440	2,365	2,450	2,470	***2,457***
3-4	2,610	2,580	2,415	2,550	2,520	***2,535***
4-5	-	2,660	2,480	2,620	2,570	***2,580***
5-6	-	-	-	-	-	***2,625***
6-7	-	-	-	-	-	**2,670**

Tab. 1

The map thickness of the outer Carpathian foredeep sediments was compiled by using data published by Kováč (2000). The thickness of the molassic sediments of the Late Tertiary Carpathian foredeep (Fig. 2) is the smallest in the outer Western Carpathians (0 - 2 km), then increase in the outer Eastern Carpathians (0 - 4 km) and the largest in the outer Eastern and Southern Carpathians junction (up to 9 km). In the Southern Carpathians it is less then 4 km. Density distributions were taken from Królikowski and Petecki (2001), of whom data were derived from the well-logging (85%) and laboratory tests on drilling cores. The average density of the foredeep sediments in the western (eastern) part of Poland is 2.62 gcm^{-3} (2.42 gcm^{-3}). The density pattern is relatively complicated, however, and for the actual computations a simple, but best-fit density pattern had to be adopted. For

our preliminary 3D gravity modelling we adopted Krolikowski and Petecki's results for the whole outer Carpathian foredeep.

The model of the outer Flysch Carpathians sediments (Fig. 2) were compiled by using data from Krejčí (1997), Rylko (not published data), Mocanu and Radulescu (1994), Matenco (1997), Kováč (2000). Note that the we have only a few available data relate to the thickness of the flysch sediment. Especially, it is in the region where it is supposed the deepest thickness (10-15 km) of these sediments. It is well-known (Tomek 1979, Królikowski and Petecki 2001) that density of the flysch sediments varies extremely fast both vertically and horizontally as well as. In spite of that we unified densities for our calculations based on the results of Królikowski and Petecki (2001).

Gravity effect of sedimentary layers

The gravity effect of the sedimentary layers (Fig. 2) have been calculated using a complex of program, in which the original data (model of the thickness and density of the sedimentary fillings) were introduced in the form of maps and transformed into vector (Starostenko et a. 1997). For 3D gravity modelling was used the method, which was developed by Starostenko et a. (1998). Calculation have been made at the scale of 1 : 4 000 000 on the grid of 4x4 (10x10) km. Therefore the model field reflects all the features of the medium.

The gravity effect of the foredeep sediments varies from 0 to –55 mGal. The largest effect of –55 mGal can be observed in the Eastern and Southern Carpathians junction. In the Eastern Carpathians maximum gravity effect is of about-20 mGal, in the Southern Carpathians attends up to –30 mGal, in the Western and Eastern Carpathians junction it is of –15 mGal and the smallest it is in the Bohemian Massif and the Western Carpathians junction.

The largest effect of the flysch sediments of the outer Carpathians can be observed in the Western and Eastern Carpathians junction (up to -45 mGal) and in the Eastern and Southern Carpathians junction (up to –25 mGal).

The gravity effect of the sediments in the Pannonian (Transylvanian) basin varies from 0 to –50 (-40) mGal. The Danube basin, Békés basin and Makó basin are characterized approximately by the same values (-50 mGal). Maximum gravity effect of the Transcarpathian basin and the northern basins in the Great Hungarian basin is about –45mGal. Sáva graben and Drava graben reach maximum of gravity effect about of –40 mGal.

THICKNESS OF SEDIMENTS IN THE CARPATHIAN-PANNONIAN BASIN REGION

GRAVITY EFFECTS OF THE SEDIMENTS

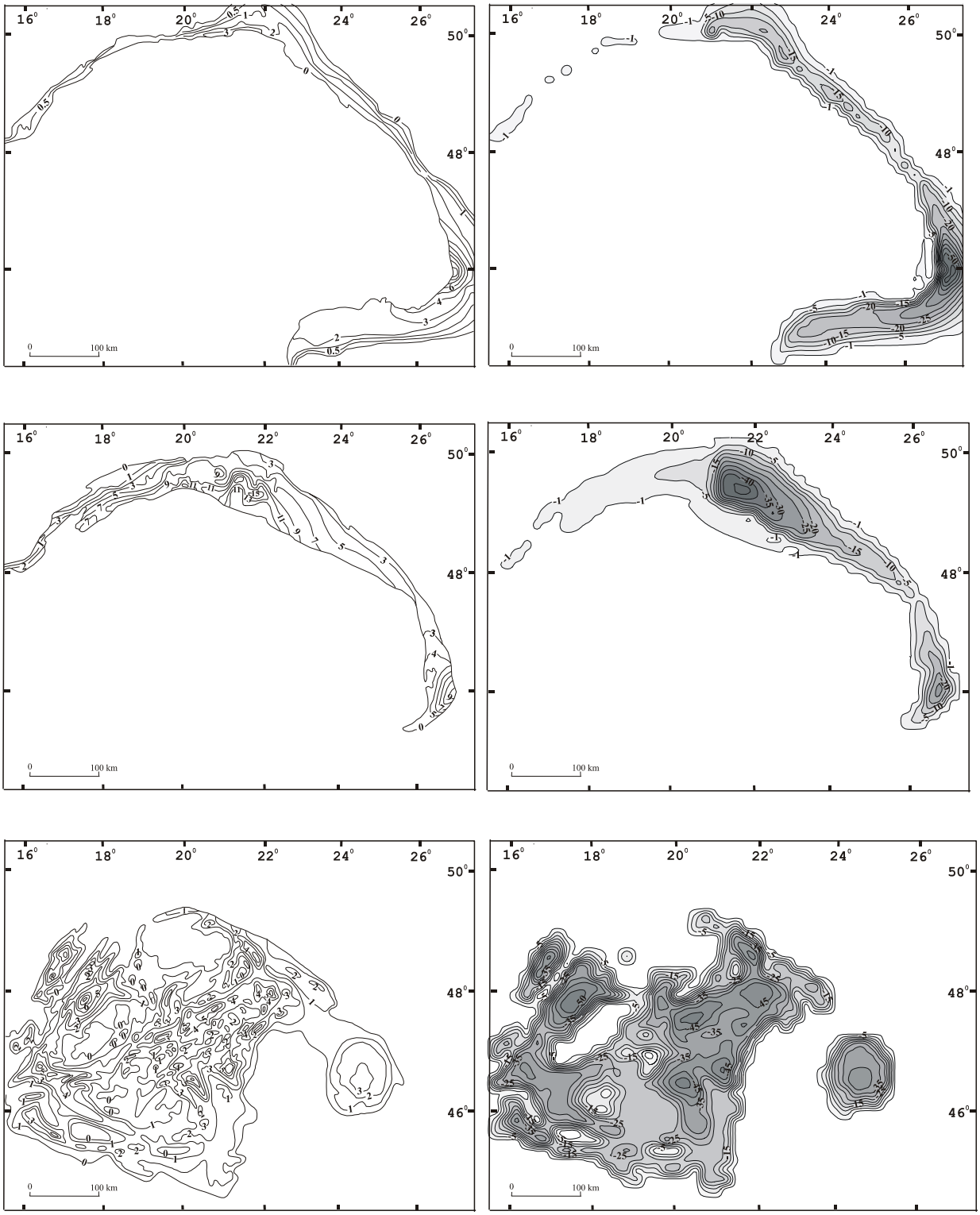

Fig. 2

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