AN INTERPRETATION OF THE KOLÁROVO GRAVITY ANOMALY USING THE TRUNCATION FILTERING METHODOLOGY

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Abstract: A novice approach - the Truncation Filtering Methodology (TFM) – is applied in order to interpret the Kolárovo gravity high. The approach assumes, that this anomaly is produced by a compact body. The interpretation results in determining the centre of mass of the assumed body at the depth of 8.7 km. This result is in agreement with previous interpretations by various authors.

Key words: applied geophysics, Kolárovo gravity high, truncation filtering

Introduction

The Kolárovo gravity anomaly (high) is located in the south-eastern part of the Danube Basin near the village of Kolárovo. Even though the thickness of the overlying Pannonian-Recent sediments reaches more than 3 km , the amplitude of the anomaly is about +28 mGal. The anomaly belongs to one of the largest and most famous gravity highs in the Western Carpathian-Pannonian area. Thus it has been of great interest to geophysicists and geologists.

Based on the geological and geophysical results (Gaža 1966, 1970; Fusán et al. 1971, 1987; Šefara et al. 1987; Škorvanek and Pohánka 1977; Bielik 1984; Bielik et al. 1986; Sitárová et al. 1994), the Kolárovo gravity high indicates the existence of a higher-density anomalous body beneath the pre-Tertiary basement of the southern part of the Danube basin. It is suggested that the apical part of the anomalous body is nearest to the surface in the area of Kolárovo. The quantitative interpretation of this gravity high (Škorvanek and Pohánka 1977; Bielik 1984; Bielik et al. 1986; Šefara et al. 1987; Sitárová et al. 1994) has shown, that the density of the anomalous body varies from 2900 to 3050 kg/m^3, the upper boundary of the anomalous body was interpreted at about 4.5 - 5.0 km. The length of the anomalous body is about 19 km, the width is about 8 km and the thickness was interpreted to be approximately 10 km. The depth of the center of mass of the body was interpreted at about 9.5 km.

In this paper we apply a new method, the TFM, in order to determine the center of mass of the anomaleous body producing the Kolárovo gravity high. The TFM was developed by computer simulations. This is the first time the TFM is applied to real gravity data.

Truncation Filtering Methodology

The Truncation Filtering Methodology (TFM) is a particular way of linear filtering the gravity data to facilitate gravity inversion or interpretation. With the use of integral transforms the gravity anomalies are transformed into new quantities that allow interpretation with the help of pattern recognition. Such filters may be understood as weighted spherical windows moving over the surface, on which the gravity data are defined, the kernel of the transform being the weight function. Truncation filters have one free parameter – the truncation parameter – the size of the window, which allows computing sequences of the transformed quantities while varying the value of the truncation parameter. Instead of the original gravity data, the truncation sequences are interpreted in terms of pattern developments within the sequence. Subjective experience of the interpreter build on computer modelling and case studies makes the bridge between the observed dynamic patterns and the geology generating the gravity data. Depth estimates to some geologic elements result from interpreting the onsets of some patterns. The key feature of the truncation filtering methodology is data enhancement and dynamic (animated) pattern recognition. For more details about the TFM see (Vajda and Vaníček 1997, 1999, 2002).

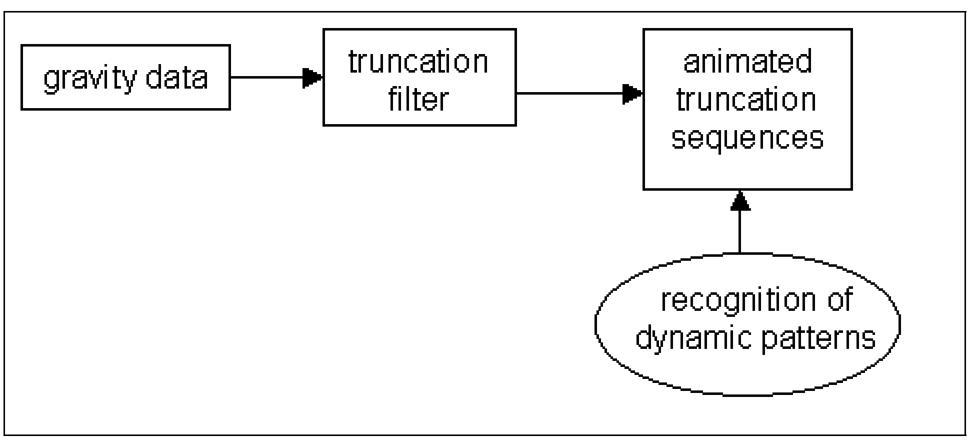

Fig. 1. The Truncation Filtering Methodology

Data

Here we work with the observed g values uncorrected for terrain and reduced to the plane at 110 meters a.s.l. using free air gradient. The gravity data in the Kolárovo region were interpolated to a regular 200 m by 200 m grid.

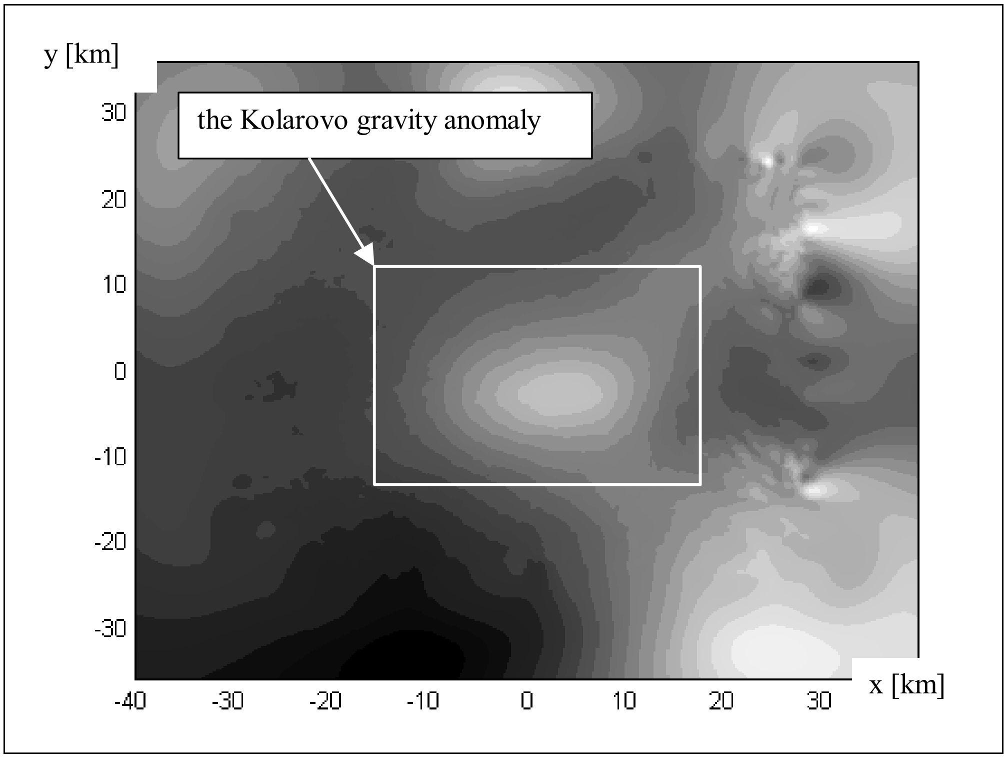

Fig. 2. The Kolárovo gravity high

Interpretation

The TFM has been so far developed only in terms of interpreting synthetic gravity data generated by sets of point masses. Point masses produce dimple patterns in truncation sequences. The depth of a point mass is determined by the TFM from the onset of the dimple pattern. Since the Kolárovo gravity anomaly is a fairly isolated anomaly with the appearance of a gravity anomaly generated by a point mass, we have made an assumption for the sake of its interpretation, that the gravity anomaly is produced by a point mass representing the center of mass of the anomaleous body generating the Kolárovo high. Due to this assumption, the inversion technique based on the TFM for sets of point masses, cf. (Vajda and Vaníček 1997), was applied. The Kolárovo gravity anomaly was transformed into a DZ sequence (cf. Vajda and Vaníček 1997, 1999, 2002) using a truncation filter with a kernel chosen as a constant function. Some snapshots of the animated sequence are presented in the figures below. The DZ sequence displays a dimple pattern in the area of the Kolárovo anomaly. The instant of the dimple onset identifies a point mass located at the depth of 8.7 km. Suppose the body producing the Kolárovo anomaly is fairly compact, its center of mass may be assumed at the depth of 8.7 km.

Conclusions

The TFM designed for interpreting synthetic gravity data generated by point masses was applied to the Kolárovo gravity high. Assuming that the Kolárovo anomaly is produced by a compact body, we interpret its center of mass by means of the TFM at the depth of 8.7 km. This is in agreement with other independent interpretations mentioned in the introduction.

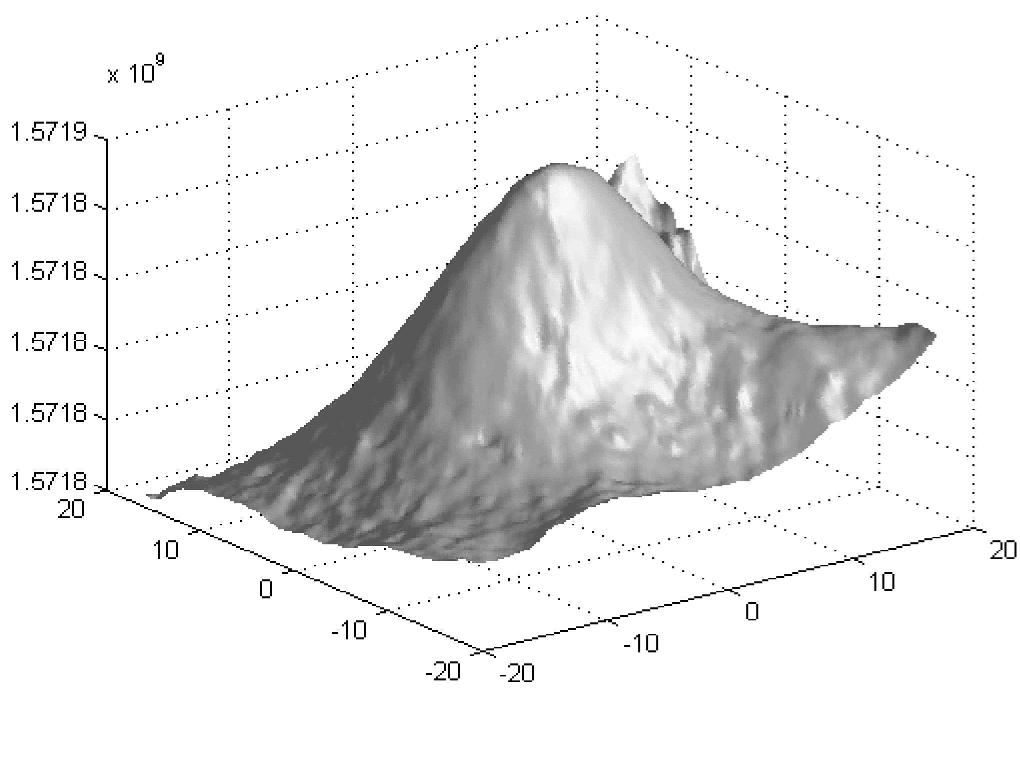

Fig. 3a. Kolárovo, DZ snapshot, s_0 = 0.3 km

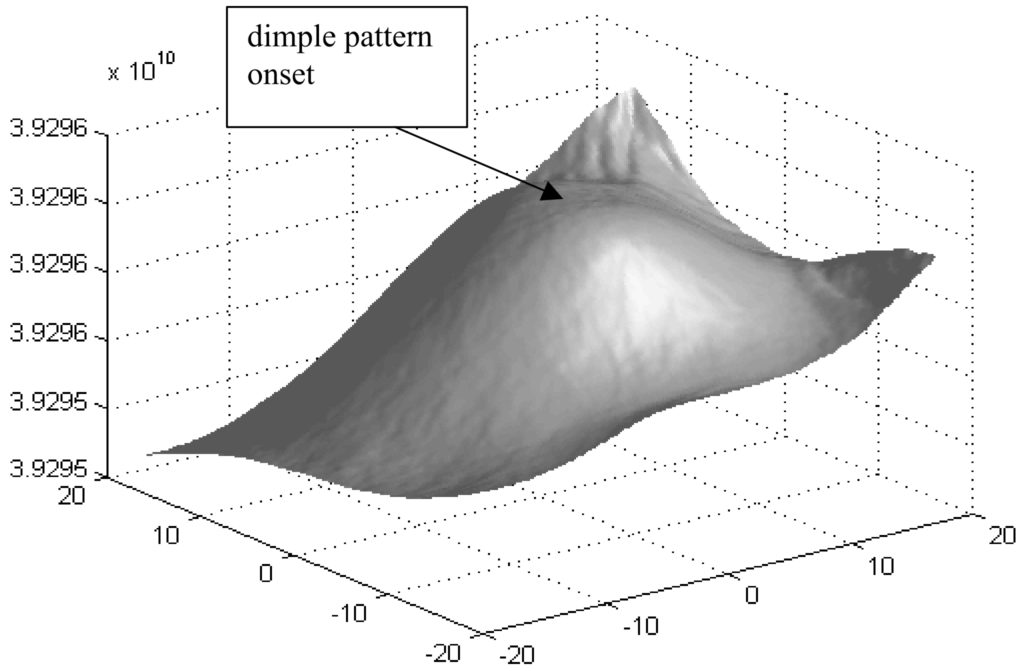

Fig. 3b. Kolárovo, DZ snapshot, s_0 = 7.1 km, instant of the dimple onset

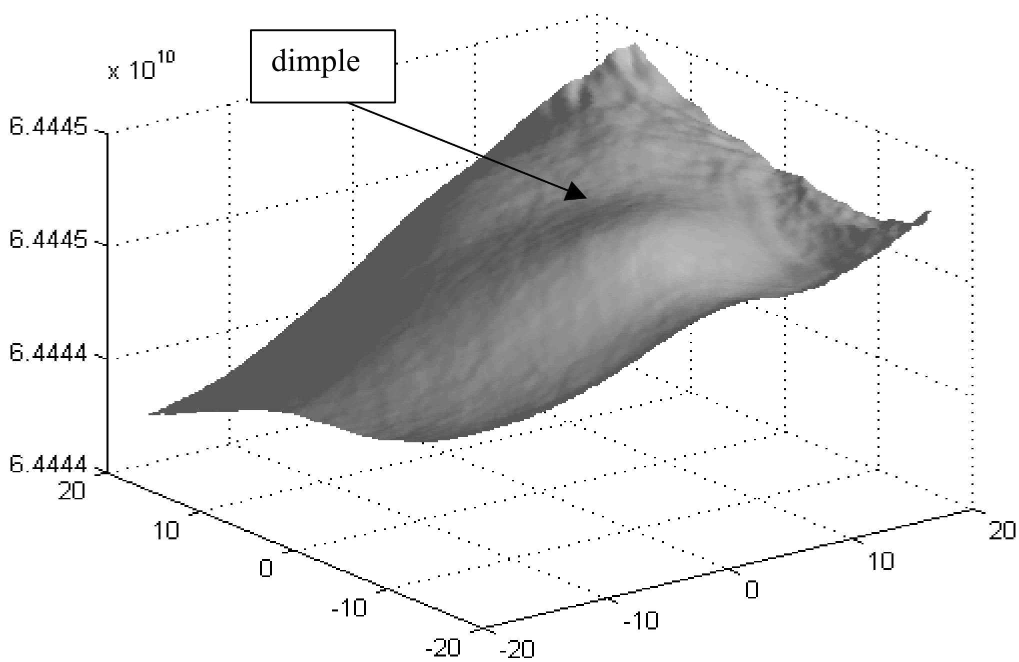

Fig. 3c. Kolárovo, DZ snapshot, s_0 = 10.1 km

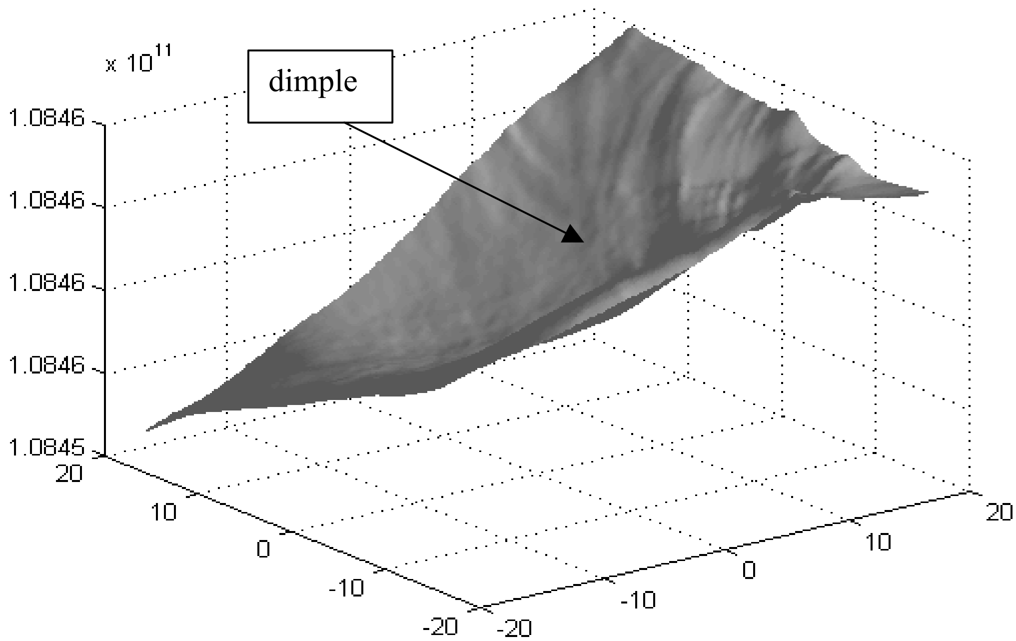

Fig. 3d. Kolárovo, DZ snapshot, s_0 = 18.1 km

References

Bielik, M., 1984: Hlbinné teleso zemskej kôry v oblasti podunajskej panvy. In: Výskum hlubinne geologické stavby Československa. Geofyzika, n.p. Brno, 175-184.

Bielik, M. - Fusán, O. - Plančár, J. - Biela, A. - Túnyi, I. 1986: Some knowledge on deep-seated structure of the Danube basin. Geologické práce, Správy 84, 119-134. (in Slovak)

Fusán, O., Biely, A., Ibrmajer, J., Plančár, J. and Rozložník, L., 1987: Podložie terciéru vnútorných Západných Karpát. GÚDŠ Bratislava, 123.

Fusán, O., Ibrmajer, J., Plančár, J., Slávik, J. and Smíšek, M., 1971: Geologická stavba podložia zakrytých oblastí južnej časti vnútorných Západných Karpát. Zborn. geol. vied, rad ZK 15. Geol. úst. D. Štúra, Bratislava, 1-173.

Gaža, B. 1966: Záverečná vrtne-geologická správa o pionierskom vrte Kolárovo-2. Geofond, Bratislava.

Gaža, B. 1970: Záverečná vrtne-geologická správa o pionierskom vrte Kolárovo-4. Geofond, Bratislava.

Šefara, J., Bielik, M., Bodnár, J., Čížek, P., Filo, M., Gnojek, I., Grecula, P., Halmešová, S., Husák, Ľ., Janoštík, B., Král, M., Kubeš, P., Kucharič, Ľ., Kurkin, M., Leško, B., Mikuška, J., Muška, P., Obernauer, D., Pospíšil, L., Putiš, M., Šutora, A. and Velich, R., l987: Štruktúrno--tektonická mapa vnútorných Západných Karpát pre účely prognózovania ložísk - geofyzikálne interpretácie. SGÚ Bratislava - Geofyzika, n.p. Brno - Uran. priemysel Liberec, 267.

Sitárová, A., Markova, K. N., Bielik, M. and Levashov, S. P., 1994: Interpretation of the Kolárovo gravity anomaly by the option method. Acta Geologica Universitatis Comenianae, 50, 37-43.

Škorvanek, M. and Pohánka, V., 1977: Výpočet gravitačného účinku všeobecného hranola. In: Banícke listy. Mimoriadne číslo. Vydav. Slov. Akad. Vied, 258.

Tomek, Č., Bielik, M., Sitárová, A. 1997: Kolárovo gravity high and its relationship to the Miocene recent extension of the Danube Basin. Abstracts EUG 9,Terra Nova, 9, 159.

Vajda, P. and P. Vaníček, 1997. „On Gravity Inversion for Point Mass Anomalies by Means of the Truncated Geoid“. Studia Geophysica et Geodaetica 41, pp 329-344

Vajda, P. and P. Vaníček, 1999. „Truncated geoid and gravity inversion for one point-mass anomaly.“ Journal of Geodesy 73, pp 58-66

Vajda P., and P. Vaníček, 2002 „The 3-D truncation filtering methodology defined for planar and spherical models: Interpreting gravity data generated by point masses.“ In press in Studia Geophysica et Geodaetic