Abstracts from the gravimetrical workshop *"Bouguer anomaly - what kind of puzzle it is?"*

Bratislava, Comenius University, Faculty of Natural Sciences,

Mlynská dol., room CPS+ (B1-322), 11 - 12th September 2014

Some remarks on the history of the Bouguer anomaly

Ján Mikuška, Roman Pašteka, Pavol Zahorec, Juraj Papčo, Roland Karcol and Ivan Marušiak

Short abstract:

The first question we will briefly comment and discuss in our contribution is the problem of reduction or correction in gravimetry. It will be followed by the question What is "free-air" reduction or correction and how to understand free-air anomaly. Then basic approaches to the problem of approximation of the masses between gravity station and the elevation datum, namely the flat Earth and spherical Earth models, will be discussed. In this aspect it will be interesting to note that all of the founders stood firm on spherical Earth ... We will arrive at the question of the Bouguer correction, i.e. why the simple expression $BC = 2\pi\gamma\sigma h = 0.04193\sigma h$ can serve as first approximation of the gravitational attraction of the topographic masses, but not only of the topographic masses. Regarding the so-called bathymetric correction we have to admit that it is not easy to comprehend its meaning. And finally, how the crust/mantle boundary can contribute to the Bouguer anomaly dependence on height?

Question:

Do we really know why Bouguer anomaly is height-dependent?

The physical meaning of the Bouguer anomaly

Meurers, B.

Short abstract:

The geophysical meaning of gravity anomalies has been debated in several geophysical and geodetic journals. This paper revisits this discussion and picks up the approach of composing synthetically all gravity effects contributing to the gravity observed at the earth's surface, as this aspect enables to determine exactly the physical meaning of Bouguer anomalies (Bouguer gravity disturbance) obtained under certain assumptions (e.g. reference surface, height system, limitation of mass correction area). The problem of applying closed expressions or Taylor series expansions for the normal gravity calculation in areas of negative ellipsoidal heights is discussed. The paper also deals with the consequences of gravity vector transformation into scalar quantities which are commonly used.

Messages/questions:

What is the exact meaning of Bouger gravity and how does it compare to products derived from satellite observations?

Normal Earth gravity field vs. gravity effect of ellipsoidal model

Karcol R., Mikuška J., Marušiak I.

Short abstract:

The discussed question will be as follows: is the present way of normal field calculation the proper one for the applied geophysics/gravimetry? This present form is based on model of rotational biaxial ellipsoid with important property of constant potential on its surface. This condition results in unrealistic density distribution within model. Another problem is the atmosphere. In present form is placed as very thin layer on the surface of the model (or it is "pushed" into the model). In short, the present form does not fit the reality well. Maybe we could to calculate the normal field as effect of rotational layered ellipsoid, i.e. the effect of the system of the homeoids to fit the structure and density distribution within the Earth better. The differences of the effect of these two models is presented, too.

Bouguer anomaly and some distant or global effects

Ján Mikuška, Roman Pašteka, Roland Karcol, Ivan Marušiak, Pavol Zahorec and Juraj Papčo

Short abstract:

In this contribution we will present and briefly comment following distant or global values. Published and unpublished effects of the distant topography and bathymetry, along with the related computational aspects; Published and unpublished values of the gravitational effect of the global Earth atmosphere model, global & local topography taken into account, and its impact on the measured gravity, and, consequently, on the Bouguer anomaly; Unpublished values of the gravitational effect of the global ice; Unpublished values of the gravitational effect of the crust/mantle boundary global 1°x1° model based on an a-priori geological and geophysical information, excluding topography.

Question:

Can gravitational effect of the (complete) topographic masses be negative?

Belated remarks on the important paper „Estimation of distant relief effect in gravimetry" by J.Mikuška, R.Pašteka and I.Marušiak

Jan Švancara

Short abstract:

In the paper Mikuška et al. (2006) the authors have shown, that the gravitational effect of the truncated spherical shell increases with the height of the calculation point until the truncation angle is less than 39 degrees. In this contribution the physical interpretation of this finding is presented. It is demonstrated that in this case the gravity effect of the truncated spherical shell is 1/3 of a complete shell effect.

Next finding of Mikuška et al. (2006), that the gravitational effect of truncated spherical shell exhibits pronounced extreme for inner calculation point and small truncation angles, is discussed. It is demonstrated, that for these truncation angles the gravity effect of the truncated spherical shell is 1/2 of a complete shell effect.

References:

Mikuška J., Pašteka R. and Marušiak I. (2006): Estimation of distant relief effect in gravimetry. *Geophysics*, 71, J59−J69.

Bouguer correction – an old-fashioned concept in the age of satellite gravity?

Ebbing J.

Short abstract:

Satellite mission like GOCE deliver nowadays a homogenous data coverage of the Earth. From such satellite mission spherical harmonic models as well as grids of the gravity field and gravity gradients are available. Geophysical modelling benefits from reduction for the topographic mass reduction, which is classically done by Bouguer and topographic reduction. For satellite data a direct correction for topographic masses can be performed. However, if global data sets are used that are based on downward continuation of satellite data, the omission error in the data and associated with the mass reduction play an important role. Another issue is which role the classical density of 2670 kg/m^3 is playing or is it relevant to use near-surface density models.

Message/question:

How do the classical concepts of Bouguer and topograpohic reduction transfer to modern data acquisition and to data that are defined on various levels and with a resolution specific for their height of measurement?

New perspectives for Bouguer field interpretation using a global spherical harmonic topographic correction

Braitenberg, C., Hirt, C., Bucha, B., Janák, J.

Short abstract:

The definition of a global Bouguer gravity field is the immediate step after the publication of the final spherical harmonic gravity models that incorporate the full GOCE gradient and satellite orbit observations. The spherical harmonic expansion model of the topographic gravity potential is methodologically the closest way to correct the functionals representing gravity and gravity tensor. There are several choices to be taken, as calculation height, exact definition of the functional in case of gravity (gravity disturbance and anomaly, radial derivative, gravity vector amplitude) for the two potentials. The effect of topography is calculated from the spherical harmonic model of the gravity potential of topographic masses model Earth2012 (Claessens and Hirt, 2013; Hirt and Kuhn, 2012). Calculation of the gravity field has been made using the software GrafLab (Bucha and Janak, 2013). For the calculation of the gravity effect of topography some modifications to the program have been necessary. We discuss the choices we have defined as optimal for a global Bouguer field to be used for further geophysical interpretation of the lithospheric density inhomogeneities.

The global calculation has significant differences to Bouguer corrections made on a regional scale with a radius of several hundreds of km. Use of the global Bouguer field implies significant changes in the interpretation of the fields. We show the discrepancies in some sample areas (e.g. Africa, Braitenberg, 2014) and point out the implications in geophysical interpretation of the lithospheric density inhomogeneities.

References

Braitenberg C. (2014). Exploration of tectonic structures with GOCE in Africa and across-continents. International Journal of Applied Earth Observation and Geoinformation, in press doi:10.1016/j.jag.2014.013.

Bucha, B., Janak, J., 2013. A MATLAB-based graphical user interface program for computing functionals of the geopotential up to ultra-high degrees and orders. Computers & Geosciences 56, 186-196, http://dx.doi.org/10.1016/j.cageo.2013.03.012.

Claessens S.J. and C. Hirt (2013) Ellipsoidal topographic potential: New solutions for spectral forward gravity modeling of topography with respect to a reference ellipsoid, Journal of Geophysical Research - Solid Earth, Vol. 118(11), 5991-6002, doi: 10.1002/2013JB010457.

Hirt C. and M. Kuhn (2012) Evaluation of high-degree series expansions of the topographic potential to higher-order powers, Journal Geophysical Research. (JGR) Solid Earth, in press. doi:10.1029/2 2012JB009492.

Message/question:

How can the globally corrected Bouguer field be used in regional forward or inverse modelling?

Computation of global topographic and stripping corrections in spectral form

Peter Vajda, Robert Tenzer, Pavel Novák, Vladislav Gladkikh, Hamayun

Short abstract:

We present a numerical scheme for gravimetric forward modelling of the Earth's global model crustal density structures (topography, oceans, ice, sediments, crust) based entirely on methods for a spherical analysis and synthesis of the gravitational field. This numerical scheme utilizes expressions for the gravitational potentials and their radial derivatives generated by the homogeneous or laterally varying mass density layers with a variable height/depth and thickness given in terms of spherical harmonics.

Message/question:

Spatial vs spectral approach: advantages?

Global vs far zone (truncation).

Modelling with Bouguer anomalies: correct application of observation heights, trend separation and filtering

Smilde P.L., Müller, C., Krieger M.H.

Short abstract:

It is often assumed, that Bouguer reduced gravity data can be modelled by observation points at reduction level. It is shown, that this is not correct: only the (more or less simplified) gravimetric effect of the topography is removed; the observation location is not shifted. This must be taken into account in modelling by (1) either keeping observations in original location or shifting them by vertical field continuation and (2) by removing the same (more or less simplified) gravimetric effect of the topography from the model. Similarly requires removal of trend ("regional") or other long wavelength effects from observed data, that any equivalent long wavelength component is explicitly removed from the modelled gravity effect too.

Message/question:

Free-air and Bouguer reduction do not "shift" observation locations to reduction level as far as small scale (smaller than "normal field") density anomalies are concerned.

Removing long wavelength effects from observed data requires removing long wavelength effects from modelled data too.

Bouguer anomaly in microgravity survey focused on building effects calculation

Pánisová J., Fraštia M., Papčo J., Pašteka R., Kušnirák D.

Short abstract:

Microgravity survey differs from traditional gravity prospecting in several respects. The methodology of data acquisition and processing is adapted for mapping of low amplitude gravity anomalies due to the shallow small scale density inhomogeneities. In the calculation of Bouguer anomalies the most important corrections are free air, planar Bouguer, inner zone terrain and building corrections. On the other hand, latitude, distant zones terrain and Bullard corrections can be neglected. The building correction is crucial in surveys carried out inside large massive edifices. Recently we have developed a new approach to the calculation of building effects based on utilization of photogrammetric methods combined with laser scanning and geodetic measurements. Commonly used models of building walls approximated by a set of simple geometric bodies were replaced by a complex 3D polyhedral bodies described by a triangular irregular network. Our new method provides for high accuracy of calculated building effects, which can contribute to a more precise construction of Bouguer anomaly maps and their interpretation. This is demonstrated on selected illustrative case histories from Slovak churches.

Message/question:

How to estimate the density of construction materials more precisely?

Numerical calculation of terrain correction within the Bouguer anomaly evaluation (program Toposk)

Zahorec P., Marušiak I., Mikuška J., Pašteka R., Papčo J.

Short abstract:

The new software solution Toposk was developed in the frame of a local scientific project "Bouguer anomalies of new generation and the gravimetrical model of Western Carpathians". The program is designed primarily for the calculation of the gravitational effect of the topographic masses and derived terrain corrections, not only within the territory of Slovakia. The computing algorithm was tested on several synthetic models. The real position of the gravity meter sensor with regard to the surrounding terrain (above or below the surface) can be taken into account during the calculation. The choice of arbitrary subzones dividing and coordinate systems is allowed.

Message/question:

How far should we use interpolated elevations of calculated points within the nearest zone?

Generalization techniques to reduce the number of volume elements in terrain effect modeling

J. Benedek, J. Kalmar, G. Papp, E. Szűcs

Short abstract:

Compared to the rectangular prisms the analytical formulas of the polyhedron's gravitational potential and its higher order derivatives are more complicated so their calculation is more time consuming.

The necessary runtime for computing the gravitational potential of the polyhedron and its higher order derivatives is one and half times more than that of rectangular prism computations. Basically it linearly depends on the number of volume elements which is a function of model extension and resolution. The actual polyhedron model of the lithosphere of the Alps - Pannonian basin - Carpathians region containing several million volume elements needs multi processor/core computer systems to obtain the results in reasonable time. With the reduction (i.e. optimization) of the number of elements in the input model the computational time outlined above can be significantly shortened. We started to develop algorithms minimizing the number of model elements defined both in local and global coordinate systems. Common gravity field modelling programs (Tscherning et al. 1991) generates an optimized model for every computation points, contrary to our program, which provides only one optimised model for all computational points. The number of elements of the optimized model depends on a previously chosen threshold, which represents the maximum difference along the Z direction between the initial and optimized model.

We have developed two algorithms. Both start with the native resolution of data describing a density interface (e.g. topography) and generate a new polyhedral surface so that the offset along the Z axis between the two surfaces do not exceed the threshold defined in advance.

The first algorithm is more general than the other one. It may start from e.g. a cloud of scattered data points given in a local rectangular coordinate system (planar approximation) and provides the minimum number of volume elements, according to specific threshold. This process is highly time-consuming, what is exponential function of the number of input points and the previously chosen threshold. The second one starts from a uniform grid of points given in either local or global coordinate systems. The generated model is not guaranteed to be the most optimal one (minimum number of volume elements), but this algorithm is less time consuming. We will present some applications of these algorithms for regional and local gravity field modelling.

Message/question:

How to reduce efficiently the time of forward gravity modelling computations with minimum information loss?

The effect of the differences between terrain and surface models on gravity field related quantities (a case study for Hungary)

E. Szűcs, G. Papp, J. Benedek

Short abstract:

Topographic masses have a strong impact on the medium and short wavelength components of the gravitational signal generated by the mass of the Earth, thus digital terrain models (DTM) are routinely involved in gravity field modelling. Where no high resolution DTM is available the almost global coverage SRTM3 model is routinely applied. Since SRTM is a surface model including all those points which reflected the scanning radar signal (vegetation, buildings, …) thus tree canopy height has been compared to the differences of SRTM and DTM elevations in a hilly test area in Hungary where a local and accurate DTM having 20 m × 20 m horizontal resolution was available. Considerable agreement was indicated between forest height and model differences. Model differences were evaluated to determine their effect synthetically on gravity related quantities.

Message/question:

Could SRTM3 model replace national DTMs in high precision gravity field modeling?

Adaptive calculation of topographical effect with tesseroids and polyhedra

Szwillus W., Holzrichter N.

Short abstract:

We developed two algorithms to calculate the topographical effect using tesseroids or polyhedra. They are adaptive, meaning that the resolution is chosen automatically to speed up the calculation without loss of accuracy. We also discuss how the geostatistical properties of the input topography influence the performance of the adaptive calculation.

Utilization of Bouguer anomalies in determination of heights in geodesy

Ruess D.

Short abstract:

At the BEV the calculation of Bouguer anomalies are used for interpolation and recalculation of gravity values which are needed for orthometric heights and height transformation. The BEV stores all available gravity data for Austria in a database including Bougueranomalies and all the needed correction values. The topographic reduction is calculated using the 50m DTM grid of Austria. The data are also used for geoid calculation and for the height transformation between national heights (MGI, Adria 1875) and orthometric heights respectively ellipsoidal heights. A study of the gravity calculation at the plumbline shows the influence of unknown parameters and gives the upper limit of the uncertainties in height calculation.

A new compilation of Bouguer anomalies in Germany – a brief summary of experiences and results

Gabriel G., Skiba P.

Short abstract:

The Leibniz Institute for Applied Geophysics (LIAG, Hannover) hosts and maintains a gravity database that comprises about 350,000 gravity values for entire Germany (http://www.fis-geophysik.de/). This data was collected over the past 80 years by federal and federal state authorities, universities, research institutes, and the industry; part of the data was also provided by partners from foreign countries.

Up to 2010 the area of Germany was covered by four gravity maps 1: 500,000 (Plaumann 1983, 1991, 1995; Conrad 1994). Due to the non-uniform data processing (e.g. reduction densities, radius of terrain reduction) differences up to 5 mGal appeared at the boundaries of these maps, especially along the former border between East and West Germany. To overcome these limitations LIAG has released a new gravity anomaly map of Germany at a scale of 1:1 million, which is based on all currently available observations. The new map displays detailed and concise Bouguer anomalies in Germany and adjacent areas on one map sheet.

The main goal of the revision was the removal of discrepancies and artifacts caused by erroneous raw data and a uniform and state of the art processing of data originating from different sources. Hence, a detailed quality check was performed before reprocessing, that resulted in the removal of about 5,500 gravity stations. The calculation of terrain corrections utilizes a high resolution digital terrain model with 25 m grid spacing. The reduction procedure involves heights referred to mean sea level (normal heights), as it is common practice since decades. However, due to theoretical considerations, we have calculated a second map which is referred to the WGS84 ellipsoid rather than to the mean sea level. This is possible, since precise national and global geoid models (GCG2005 and EGM2008) are available. We evaluated the quantity and the geophysical significance of the differences.

Message/question:

- accuracy and usability of “old” data.

Regional and detailed gravimetrical database of the Slovak Republic

Pašteka R., Zahorec P., Mikuška J., Szalaiová V., Papčo J., Kušnirák D., Pánisová J., Krajňák M., Vajda P., Bielik M., Marušiak I.

Short abstract:

The existing homogenized regional database of Slovak Republic (212478 points) was enlarged in the frame of a running research project by approximately 107 500 archive detailed gravity measurements. Besides the local errors (due to the wrong positions, heights or gravity of measured points) we have found some areas of systematic errors probably due to the gravity measurement or processing errors. Some of them were confirmed and consequently corrected by field measurements within the frame of current project. Special attention was paid to the recalculation of the terrain corrections - we have used new developed software as well as the latest version of digital terrain model of Slovakia DMR-3. Main improvement of the new terrain correction evaluation algorithm is the possibility to calculate it in the real gravimeter sensor or an interpolated height positions (for inner zones) and involving of 3D polyhedral bodies approximation (accepting spherical approximation of the Earth's curvature). We have also realized several tests by means of the introduction of non-standard distant relief effect evaluation.

Message/question:

Why 167.7 km for the outer zone (Hayford-Bowie O2 radius)?

Do we really need in gravimetry the normal gravity field in its actual form – should we not simply model a density structure of a rotating Earth in its approximation?

Interpretation of gravity: case studies from Central Europe and Western Carpathians

Bielik M., Zeyen H., Grinč M., Makarenko I., Legostaeva O., Starostenko V.I., Pašteka R., Krajňák M., Bošanský M., Hók J., Plašienka, D.

Short abstract:

The main aim of this research is to gain new knowledge about the lithospherical structure and tectonics of the Central Europe and the Western Carpathians. For geophysical study of the lithosphere in Central Europe we applied three different methods: 1D automatic modelling, 2D integrated geophysical modelling and 3D inversion. These methods are similar concerning the used databases but differ by used processing and interpretation. The results show the increasing trend of the lithospherical thickness of the Carpathian Arc from the Western Carpathians toward the Eastern Carpathians, which confirms the previous theories about the propagation of subduction process. It is indicated that the Moesian Platform is bend and underthrusted underneath the Southern Carpathians from north and the Balcanides from south. The results based on 3D inversion show extremely thin lithosphere in the Southern Carpathians area; on the other hand, the results based on 2D integrated modelling do not support such thinning. Based on our modelling we cannot confirm the extreme thinning (less than 70 km) of the Pannonian Basin lithosphere proposed by other authors. New results related to the thickness and density of the sedimentary fill of the Turiec Basin (typical intramontane Neogene depression of the Western Carpathians) allowed us to construct the first original stripped gravity map. Based on this map corrected by regional gravity efect we provided the interpretation of the geological structure and the faults of the pre-Tertiary basement in the Turiec Basin. The results also indicate clearly that the contact of the Turiec Basin with the Malá Fatra Mts and the Veľká Fatra Mts is tectonic.

On capabilities of gravimetric methods in studying magmatic systems

Peter Vajda, Ilya Prutkin, Jo Gottsmann, Miroslav Bielik, Vladimír Bezák, Robert Tenzer, Ladislav Brimich

Short abstract:

We present an inversion methodology by which potential field data can be interpreted in structural or geodynamic studies. The method consists of several steps: removal of regional trend, vertical separation of signal of sources, line segments approximation of sources, and inversion by the method of local corrections yielding star-convex homogenous source bodies and/or contrasting contact surfaces. First we demonstrate a static application of the methodology on a case study devoted to identifying an intrusion in structural tectono-geological investigation in the area of the Kolárovo gravity and magnetic anomalies of the Danube Basin in the Western Carpathian–Pannonian region. Next we demonstrate the capabilities of the methodology in geodynamic studies when studying the movement of magma/hydrothermal fluids in restless volcanic areas on a case of the 2004/5 unrest of Teide volcano, Tenerife, Canary Islands. The presented inversion methodology produces a set of several admissible solutions that all are equally admissible from the viewpoint of observed gravity or magnetic data. Using additional geoscientific con-straints or cognition, these solutions can be discriminated in terms of their geologic or tectonic feasibility.

Message/question:

Non-uniqueness of the inverse gravimetric problem.

Multiple solutions, ambiguities, which solutions are realistic?

Geometric analysis of a digital field of Bouguer anomalies

Hronček S., Ihring P.

Short abstract:

False colors scales used for visualization of Bouguer anomalies do not delineate boundaries of features in the data. Various other methods currently established in the process of Bouguer anomalies analysis such as hillshading or derivatives estimates do not provide stable or useful results and often introduce coherent noise.

Proper analysis of digital data is required in order to investigate features and their properties encoded in the data. Presented Proxima technology uses unique proprietary approach to calculate all morphometric properties for any digital surface as it is defined theoretically by the Differential geometry.

A number of real data examples are provided showing application of this new technology to digital surface analysis including Bouguer anomalies matrices.Multiple solutions, ambiguities, which solutions are realistic?

On the importance of free air anomalies in geodynamics: Carpathian case story

Tomek Č.

Short abstract:

The most conspicuous gravity anomalies on Earth are those with deep sea trenches. Geodynamically, they accompanies sub-ducting oceanic slabs that are bent, pulled and going down into surrounding mantle. Forces responsible for their subduction are slab pull gravity forces due to cold and heavy lithosphere. Oceanic trench anomalies are about 250 km wide as the oceanic downgoing lithosphere is of high effective elastic thickness (EET) of some 40 km and the bending process is not easy due to high strength of the lithosphere. Continental subduction occurrs during final stage of subduction process as e.g. between 17 and 9 Ma ago in the Carpathian arc. We, Reini Zoetemeijer and me, estimated an unusually small EET of subducting continental lithosphere here of some 4 to 8 km. So, responding free air gravity anomalies must be of much shorter wavelength than in the oceans. Active continental subduction exists today only in Vrancea area in the SE Carpathians of Romania where extremely damaging intermediate earthquakes still occur. Elsewhere in the Carpathians, subducting slabs broke off and disappeared in the deeper mantle. Negative free air gravity anomaly with amplitude 90 mGal accompanies the Focsani trench in front of the Vrancea. Local negative geoidal anomaly there has an amplitude of about 4 m. Wavelength of these anomalies is about 60 to 80 km. Everywhere in the Carpathians, past trench was overriden by the upper plate and only negative Bouguer anomaly is present there. Regional Bouguer anomalies are mirror images of topographic maps there as well as in the Alps and are of little use for geodynamic interpretations. Two areas are exceptions on both flanks of the arc – the foredeep of Southern Carpathians in Wallachia and the Vienna basin. Free air and geoidal anomalies are better indicators of active geodynamic processes than previously used isostatic anomalies.

Message/question:

Why exact free air maps are not of use and averaged and weighted maps for large areas of several minutes of length and width are much better? Why Bouguer anomalies with wavelength higher than some 200 km are of no use at all?

Some questions from guests:

- What height system should we prefer – orthometric heights or ellipsoidal ones?

- How to interpret FA anomalies onshore?

- Should we perform density modelling of CBA on the terrain or on a plane and the model will be then deformed due to the terrain?

- Can we produce CBA from GRACE or GOCE satellite data?

Cancelled contributions:

Topographic correction in (really) high mountains - the Central Andes as an example including distant terrain corrections

Sabine Schmidt and Hajo Götze

Short abstract:

BA (up to -480 mGal) are calculated in the Central Andes (20 - 40 deg. S, 70 – 65 deg W) including the steep fore arc region, the high volcano summits (approx. 7 km) and the trench (water depths, up to some 8 km). Spherical calculations including also the distant effect (Mikuška, Pašteka et. al) are necessary. Indirect geophysical effect is around 20 mGal (~4 % of the BA). We describe methods and interpretation due to the dynamic of the active margin.

Messages/questions:

"Should we use orthometrical or ellipsoidal heights in Bouguer anomalies evaluation?"

This depends on the work you are doing, the scientific context and the the information available. In case of research in Europe, Russia, North America and/or Australia we would prefer ellipsoidal heights. In many other parts of the world there are no such data available (Andes, Asia, Africa, etc.)

"How we should correctly interpret free-air anomalies onshore?"

It would be a “dream” to use Free Anomalies because they are not depending on false corrections (correction densities and geometry). However it is hard to construct a real 3D Model for interpretation, which then included also the masses between physical surface and datum.

"How accurately we can construct Bouguer anomalies from GRACE or GOCE satellite data?"

With the new procedure of Nils Holzrichter and Wolfgang Szwillus the calculations of Bouguer anomalies are good enough for any interpretation. The question is: in what height should be calculate the BA: In orbit height or in a height of e.g. 10 Km above ellipsoid/geoid/phys. surface? We would prefer the 10 Km height; however, we have to accept omission errors.

400 meters below the ellipsoid/geoid - the compilation of Bouguer anomalies in the Dead Sea area and surroundings

Sabine Schmidt and Hajo Götze

Short abstract:

The region is unique on Earth, because the gravity stations are positioned some 400 m below the surrounding landscape, ellipsoid and geoid (Eigen-grace02;+ 20 m) lying inside the “ellipsoid”. The common practice is demonstrated and compared with research of Peter Vajda et al., (2008). We became aware of the problem when we conducted a ground gravity survey in the region and a helicopter-borne survey in 2008.