Tu SP1 03

Structural Information Inferred from Gravity Data in South-Central Georgia

L.E. Tonita* (University of Bucharest) & C. Badulescu (University of Bucharest)

SUMMARY

The purpose of this paper is to provide a structural interpretation based on the analysis of the gravity field over a study area located in South – Central Georgia, covering a potentially interesting zone in terms of hydrocarbon accumulations. Public Bouguer corrected data was obtained online from The International Gravimetric Bureau. Several processing techniques were applied to the raw Bouguer anomaly (upward continuation, horizontal and vertical derivatives, Gaussian filtering, etc.), in order to extract all possible structural information. Frequency domain processing allowed precise depth analysis of the gravity sources; thus, features like faults could be tracked in-depth and their area of influence could be delimited. Good correlation was found between the filtered maps and the large-scale tectonic features of the area, especially at the junction of the Achara-Trialet orogenic belt. The detailed interpretation provides more insights to the small-scale tectonic features, revealing faults located within the basement and / or the sedimentary formations - different blocks and their relative positions were delimited. The detailed image was also confronted with the geologic map of the area and good correlation was found between them.

Introduction

The purpose of this paper is to provide a structural interpretation based on the analysis of the gravity field over a study area located in South – Central Georgia, covering a potentially interesting zone in terms of hydrocarbon accumulations. Public Bouguer corrected data was obtained online from *The International Gravimetric Bureau*. Aside from the correlation with the large scale tectonic map, a more detailed interpretation was performed, delineating the most interesting structural features.

Tectonic context

Georgian regional tectonic structure has its origin in the Tethyan closure and following subduction between Eurasian and Afro-Arabian lithospheric plates. Rioni, Kura and Kartli foreland molassic basins developed as flexural depressions due to north and south-vergent thrusting of Achara-Trialet and Great Caucasus fold-and-thrust belts respectively which rose under the compressional tectonic events. The basins contain hydrocarbon accumulations in Upper Miocene reservoirs for Rioni and Upper Cretaceous and Middle Eocene for Kura, belonging to the Black Sea and Caspian Sea petroleum provinces. Malm bituminous shales and carbonates source Rioni basin while the Malm, Upper Eocene and Oligocene-Miocene correspond to Kura basin. Both basins developed structural and stratigraphic traps: faulted anticlines, pinch-outs and facies changes (Morariu and Noual 2009).

Figure 1 Large – scale tectonics of Georgia.

Data processing and interpretation

Data was provided as “*Lat, Long, G*”, *G* being the *Bouguer gravity anomaly* value of each point, with a resolution of 2 arc seconds; for the actual analysis, the data was used as provided. *UTM Zone 38* metric coordinates were used, in order to enhance usability. Data points were interpolated over the interest area using a *Minimum Curvature* algorithm, generating a *50m x 50m* grid.

In order to delineate all the identifiable features and isolate specific sources with different sizes and located at different depths, several filters were used over the raw Bouguer grid. *Upward continuation* was first applied (@ 1000m, 2500m and 5000m); the most suggestive for our purpose was found to be the *2500m upward continued map*. A *Fourier transform* was applied to both maps (raw Bouguer and upward continued), in order to perform frequency domain filtering.

The *horizontal gradient* and the *1st horizontal derivative* were computed for both raw Bouguer and upward continued maps; the two types of filtering were correlated, enabling us to identify faults at different depth intervals and transition zones between major blocks. A frequency domain *Gaussian Filter* was applied to the raw Bouguer grid using several cutoff values, corresponding to different depth intervals, providing pairs of *regional / residual* fields for each selected cut-off parameter. The frequency domain Gaussian filter proved to be more reliable and faster than the usual spatial moving average, also allowing us to introduce a *frequency domain low pass filter* in an attempt to reduce the noise level. The obtained results provided the opportunity to follow the development of each feature in terms of depth. The *1st vertical derivatives* of the raw and upward continued Bouguer maps were also computed in order to complement the other filtered data.

The previously discussed processing techniques allowed the identification of different structures and the assessment of their relative depths. Major basement blocks were identified, as well as their relative positions with respect to each other, using the upward continued map and the regional Gaussian map. The major features located in the sedimentary layers were also delineated with the help of the regional

/ residual Gaussian maps. The important faults and contacts of the area were located using the horizontal gradient and the horizontal 1st derivative maps; the use of different parameters in the Gaussian processing allowed us to conclude that the identified faults are mainly comprised within the sedimentary layers, also affecting the upper part of the basement. However, major faulting trends were also identified.

The connections between the gravity sources to actual structural and geological features were possible through precise wavelength-to-depth correlations in the frequency domain.

Conclusions

The obtained interpretative map was confronted with the large scale tectonic map and with the geological map of the area and a pertinent match was found with the major features. Accurate correlation can be observed between the 1st vertical derivative map and the regional tectonics in the western part of the study area (*Figure 2a*) at the conjunction between the Achara-Trialet belt and the Transcaucasian basin; although not visible on the tectonic map, the gravity data clearly states that the Achara-Trialet continues eastwards underneath the Transcaucasian basin. Also, good correlation was found between the filtered gravity maps and the faulting trends over the entire area (*Figure 2*).

Figure 2 (a) 1st Vertical Derivative of the upward continued filed @2500m and (b) Horizontal Gradient of raw Bouguer anomaly / Correlation with large-scale tectonic features.

The detailed interpretative map obtained provides more insights to the actual structural features than the large scale tectonic maps available in this area (*Figure 3*).

References

Morariu, D. and Noual, V. [2009] Cretaceous play - New exploration potential in Eastern Georgia. Нефтегазовая геология. Теория и практика

Figure 3 1st Vertical Derivative of the raw Bouguer filed / Detailed interpretation.

Acknowledgements

The authors would like to thank *The International Gravimetric Bureau* for access to open worldwide gravity data (IAG Geodesist's Handbook, 2012 - Journal of Geodesy, V 86, N 10, Oct. 2012, Springer) – www.bgi.omp.obs-mip.fr