GEOFIZIKA VOL. 28 2011

Review paper
UDC 550.347.62

Subsurface structural mapping using gravity data of the northern edge of the Congo craton, South Cameroon

Charles Antoine Basseka[1], *Yves Shandini*[2] *and Jean Marie Tadjou*[2,3]

[1] University of Douala, Faculty of Science, Department of Earth Sciences, Douala, Cameroon

[2] University of Yaounde I, Faculty of Science, Department of Physics, Yaounde, Cameroon

[3] National Institute of Cartography (NIC) – Cameroon, Yaounde, Cameroon

Received 28 January 2011, in final form 25 May 2011

In this work, the subsurface structures in a part of the northern edge of the Congo craton in South Cameroon between the latitudes 2° 30' to 4° 30' N and the longitudes 11° to 13° E, has been estimated by the interpretation of gravity data. For quantitative interpretation of the sources of the anomaly, a 3D density model of the upper crust was designed by means of forward modelling and inversion constrained by surface geology and results from Euler deconvolution and spectral analysis methods. The Bouguer anomaly map of the area is characterized by elongated SW–NE trending negative gravity anomaly which correspond to a collapsed structure associated with a granitic intrusion beneath the center of the region and by various gravity highs associated with an uplift of the Pan-African basement in the north and delimited by a strong gradient in relation with the tectonic boundary between the Congo craton and the Pan-African belt. Our result demonstrated that tectonic structures associated to observed gravity anomalies in the region were put in place during a major continental collision.

Keywords: Bouguer anomaly, Congo craton, Euler deconvolution, spectral analysis, 3D gravity modelling

1. Introduction

The Congo craton is one of the areas of the world which has preserved the earliest formed crust. In South Cameroon, the Congo craton which is very well exposed is belted on its northern edge by a pan-African mobile belt (Figure 1). In this region, the evolution is well constrained by the collision between the Congo craton and the mobile belt (Poidevin, 1983; Nzenti et al., 1984; Rolin, 1995; Penaye et al., 1993; Trompette, 1994; Castaing et al., 1994; Abdelsalam et al., 2002; Basseka, 2002; Toteu et al., 2001, 2004, 2006). This collision yields to an overthrusting of the pan-African units onto the craton of about 50 to

150 km (Nédelec et al., 1986; Manguelle-Dicoum et al., 1992; Shandini et al., 2010). A large proportion of older basement in South Cameroon is most likely concealed throughout much of the area by pan-African formations, which obscures most direct geological signatures of the basement architecture. Interpretation of geophysical data can provide indirect insight into the underlying geology. The most relevant geophysical studies were carried out in study area to determine by audio-magnetotelluric investigations the subsurface structure of the schist-granite contact and the Congo craton boundary (Manguelle--Dicoum et al., 1992; Mbom-Abane, 1997) and to define the crustal density across the tectonic and also to identify the important trends and structures in the gravity anomaly field the depths of gravimetric sources (Tadjou et al., 2004, 2009). The later used density modeling restricted mainly to regional 2D direct interpretations and put special interest on the central portion of the study area because of the presence of an elongated gravity low in the complete Bouguer anomaly map. Despite conclusions provided in these studies, there are still uncertainties in the underlying geology structure since the character of the different tectonic units are still debate matters (*e.g*. Toteu et al., 2007).

This paper aims to clarify the structural organization of the area by proposing a comprehensive structural sketch integrating all available surface and subsurface geology together with gravity data. A constrained 3D density model of the upper crust along the transition zone between the Congo craton and the Pan-African belt in south Cameroon area was carried out based on complete Bouguer anomaly data by means of modelling and inversion.

2. Geological setting

The area under study lies in south Cameroon and is made up of two geotectonic units: the Neoproterozoic mobile belt in the northern part that is represented by the Yaoundé group and the Ntem Complex in the southern part, which is the northwestern corner of the Congo craton (Figure 1).

The Ntem complex represents the northwestern part of the Congo craton in Central Africa and is very well exposed in Southern Cameroon (Maurizot et al., 1985; Basseka, 2002). It is divided into two main structural units: the Nyong Unit, to the northwest end, and the Ntem Unit, in the south-central area. The Ntem Unit is dominated by massive and banded plutonic rocks of the charnockite suite and by intrusive tonalites, trondhjemites and granodiorites (TTG). Some of these bodies were dated at ca. 2.9 Ga (Delhal and Ledent, 1975; Lasserre and Soba, 1976; Toteu et al., 1994).

The igneous plutons contain large xenoliths of supracrustal rocks interpreted as remnants of greenstone belts and dated at ca. 3.1 Ga (Tchameni et al., 2004). All these magmatic bodies were intruded by late K-rich granitoids (2.7–2.5 Ga; Tchameni et al., 2000; Shang et al., 2001). Younger metadoleritic dykes are related to the Palaeoproterozoic event (Vicat et al., 1996).

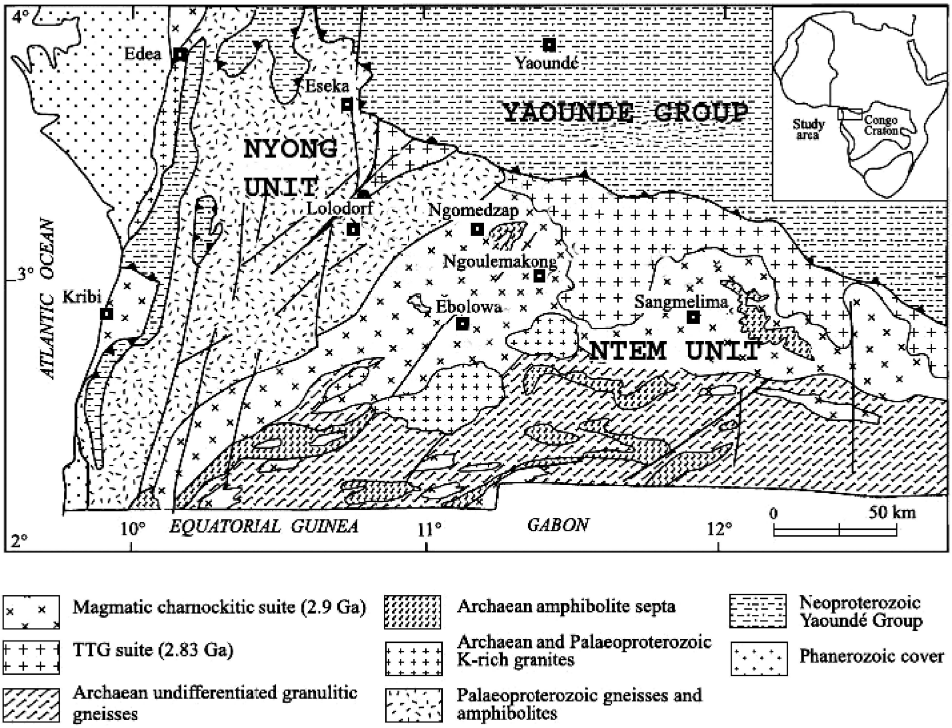

Figure 1. Simplified geological map of southwestern Cameroon (modified after Maurizot et al., 1985).

The Yaoundé group is a huge allochtonous nappe thrusted southward onto the Congo craton at ca. 620 to 600 Ma (Toteu et al., 1994, 2006). It comprises low- to high-grade garnet-bearing schist, gneisses and orthogneisses transformed under a medium- to high- pressure metamorphism reaching the granulite facies (Toteu et al., 2004). The structural data show a definite deformation on the surface, which is characterized by flat structures gently sloping to the North with a generalized tilting towards the South or South-West, indicating a significant overlap of intermediate formations on the basement of the Ntem complex. This deformation is seen by the presence of folds sloping to the North (Maurizot et al., 1985).

3. Gravity data and analysis

Gravity data used in this study were acquired between 1963 and 1968, during a detailed gravity survey of Cameroon and Central Africa undertaken by the "Office de la Recherche Scientifique et Technique d'Outre-Mer" (ORSTOM). Data from other sources were incorporated to achieve a meaningful gravity

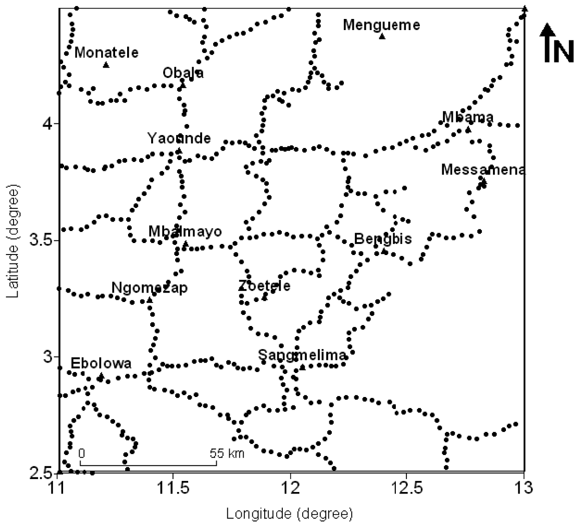

Figure 2. Study area map showing the gravity stations (dots).

data distribution of the region and these include data acquired by Hedberg (1969), Albouy and Godivier (1981), Okereke (1984), US Defense Mapping Agency (1987). In the study area, the data set consists of 617 irregularly spaced gravitational acceleration (Figure 2).

The raw gravity data study was acquired with the Worden or Lacoste and Romberg gravimeters with a resolution of 0.01 mGal. They were collected at 4 km intervals from all gravity stations including base stations, on all available roads and tracks in the area. All gravity measurements are tied to the International Gravity Standardization Network 1971 (IGSN71) datum after correction of luni-solar effect and instrumental drift. The measurement accuracy is about 0.5 mGal. To determine the Free-Air anomaly, the linear vertical gradient of 0.3086 mGal/m was used to approximate free-air correction. Elevation values were obtained with Wallace and Tiernan altimeters. A reduction density of 2670 kg/m^3 was used for the Bouguer correction. The data were then interpolated to regularly spaced grid using a finite element algorithm (Briggs, 1974; Inoue, 1986). The resulting Bouguer anomaly map of the study area is shown in Figure 3. Table 1 shows the raw gravimetric data and the reductions results performed related to section 1 (Figure 5).

The complete Bouguer anomaly map is shown in Figure 3. The map points out mainly three distinctive areas: a predominant gravity low trending SW–NE to E–W in the centre bounded by gravity highs on the north and the south sides. This anomaly is located within areas occupied by the Ntem complex formations to the south as well as by the Yaoundé group formations at the north east. This particular distribution urged us to look for its origin in order to better understand the subsurface geology of the area. It's interesting to observe that

Table 1. Results of the different reductions performed on raw gravity data of section 1 presented in Figure 5.

Latitude (°)	Elevation (m)	Raw gravity (mGal)	Free-air anomaly (mGal)	Bouguer anomaly (mGal)
2.835	709	977822	–3.3	–82.6
3.3567	662	977836	–9.2	–83.3
3.4167	654	977840	–8.0	–81.2
3.445	675	977838	–4.6	–80.1
3.4917	669	977839	–5.6	–80.4
3.52	661	977840	–7.1	–81.0
3.5217	642	977845	–8.0	–79.9
3.5433	683	977836	–5.2	–81.6
3.5633	694	977833	–5.0	–82.6
3.795	703	977851	13.4	–65.3
3.9267	727	977861	29.7	–51.7
4.4633	434	977929	–0.3	–48.9

the main negative anomaly (Figure 2) in the southwest has the shape and occurs over outcrops of the Archean to Paleoproterozoic K-rich granites (known as So'o granites). The central negative zone is surrounding by positive areas. In the northern side, gravity highs, bounded by relatively steep gradients oc-

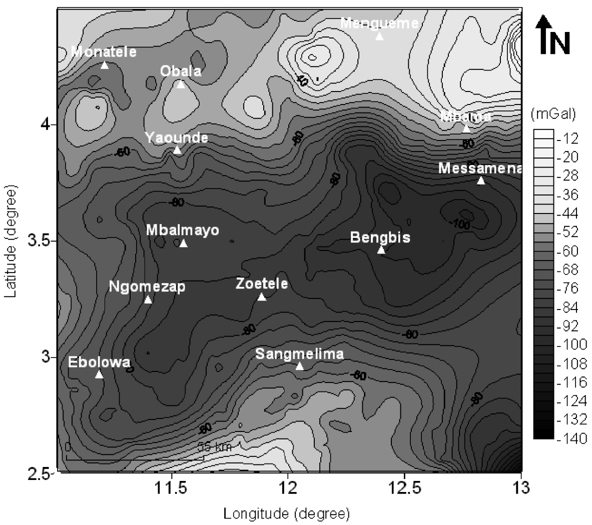

Figure 3. Bouguer anomaly map of the study area.

cur over or near higher metamorphic formations of the Yaoundé group (granulites, migmatites and micaschists). The presence of high gravity gradients, which occur over these basic intrusive rocks, suggests the existence of a suture zone between two blocks of the crust (Kennedy, 1984). The southern positive anomaly trending SW–NE, seems to represent the signature of dense rocks (charnockites) in this zone.

To assess significant local anomalies, separation of regional from residual gravimetric data was performed to enhance localized anomalies. The regional/residual separation was made by polynomial fitting. The regional surface is expressed mathematically as a two-dimensional polynomial of an order that depends on the regional geology complexity.

Figure 4 shows the regional field of the gravity data obtained from the Bouguer gravity field by developing polynomial of the 3rd degree. Meanwhile, the residual component determined by subtracting the regional gravity from the Bouguer gravity is displayed in Figure 5.

The regional structure is characterized by a broad negative gravity in the centre bounded by gradients increasing towards the west and the north. It may be inferred from these observations that the basement is deepening towards the centre of the region. Indeed, using spectral analysis of gravity data, Tadjou et al. (2009) obtained the crustal thickness beneath the northern edge of the Congo craton to vary from 25 km in the west to 32 km in the north and 47 km in the centre of the craton. The regional map must reflect of the thinning of the crust in the central part of the region.

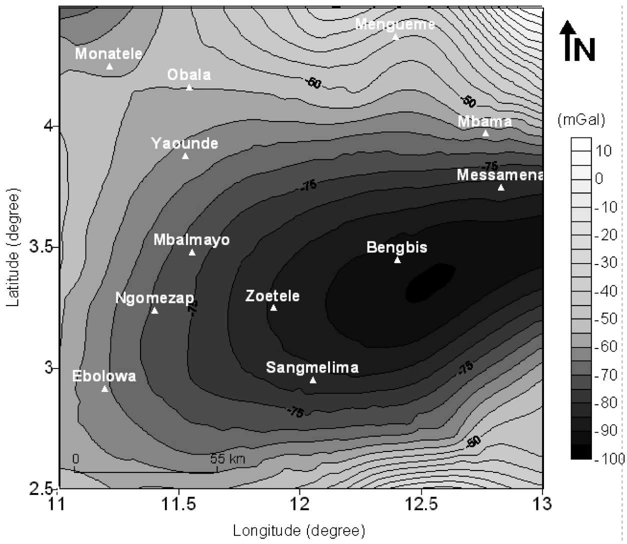

Figure 4. Regional anomaly map of the study area.

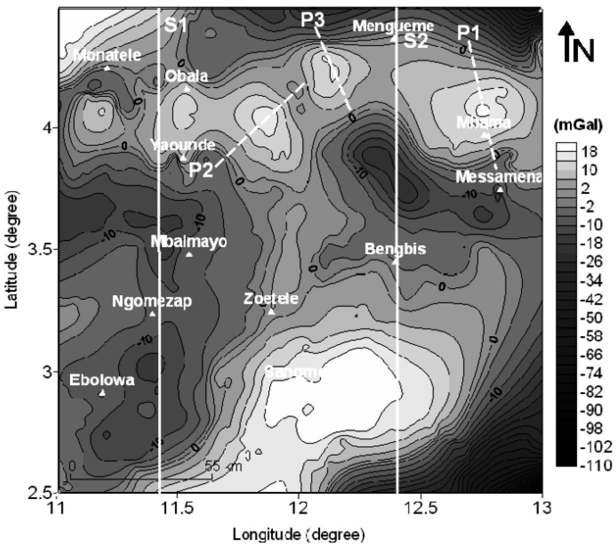

Figure 5. Residual anomaly map of the study area showing studied profiles (P1, P2 and P3) and selected 3-D density model cross sections (S1 and S2).

The residual gravity map is characterized by four sets of negative residual anomalies: starting with an arcuate shaped band west to southwest of the map, a NW–SE trending unit centred at (12.4° E, 3.8° N) in the north of Bengbis, a SE unit and NE band. All the negative residual anomalies in the southern part of the area may be due the So'o granitic rocks, which have a low density contrast with respect to the surrounding rocks in the basement (Mbom Abane, 1997; Tadjou et al., 2004); the NE negative band may be associated to Pan African formations.

4. Method

To delineate the subsurface structure of the area, we have taken two approaches. These approaches are the Euler method to delineate structures and the spectral analysis to constrain depth of perturbing body source. Results of these methods, together with available geological information, are used to build 3D conceptual structural model to help in understanding the subsurface structure of the study area.

4.1. Euler deconvolution

The objective of the 3D Euler deconvolution process is to produce a map showing the locations and the corresponding depth estimations of geologic sources of magnetic or gravimetric anomalies in a two-dimensional grid (Reid et al., 1990). The calculation of the Euler source points is based on Euler's homogeneity equation (1) and results in clusters used to constrain the overall geometry of the model. 3D form of Euler's equation can be defined (Reid et al., 1990) as:

$$x\frac{\partial g}{\partial x} + y\frac{\partial g}{\partial y} + z\frac{\partial g}{\partial z} + \eta g = x_0\frac{\partial g}{\partial x} + y_0\frac{\partial g}{\partial y} + z_0\frac{\partial g}{\partial z} + \eta b \qquad (1)$$

where $\frac{\partial g}{\partial x}$, $\frac{\partial g}{\partial y}$ and $\frac{\partial g}{\partial z}$ are the derivatives of the field in the x, y, and z directions; b is the base level of the field. η is the structural index value that needs to be chosen according to a prior knowledge of the source geometry. By considering four or more neighbouring observations at a time (an operated window), source location (x_0, y_0, and z_0) and b can be computed by solving a linear system of equations generated from equation (1). Then by moving the operated window from one location to the next over the anomaly, multiple solutions for the same source are obtained.

4.2. Power spectrum analysis

Power spectrum analysis was carried out through 2D Fast Fourier Transformation to estimate depths for the structures which cause the measured anomaly. According to this method, as described by Spector and Grant (1970), the depth of a perturbing body source is obtained from the negative slope of the linear relationship between the logarithmic power spectrum and the wavenumber of the gravity field.

4.3. 3D modeling and inversion

For three-dimensional gravity modelling and inversion, we used the interactive computer program Grablox by Pirttijärvi (2004) based on a 3D block model. The program Grablox uses two major inversion methods, namely, singular value decomposition (SVD) and Occam inversion (Hjelt, 1992). In each method three possible ways to parameterise the model (height, density and height + density inversions) are available. As gravity anomalies result from the sum of all the gravity effects in the subsurface, gravity data inversion has a non-unique solution (*e.g.* Skeels, 1947; Chakraborty and Agarwal, 1992; Strykowski, 1998). The way to reduce the instability and to guarantee the uniqueness of the solution is to integrate geological and geophysical constraints into the forward modeling. The geological constraints (density values) used for the study area were determined from the density values published in some recent works (Mbom Abane, 1997; Tadjou et al., 2004). Geophysical constraining focused on direct interpretation of the gravity field by Euler deconvolution and power spectrum analysis results. A starting model was built up by approximate the region by 8 km × 8 km × 1 km blocks. The initial density distribution was progressively changed by means of a trial-and-error procedure using Grablox program to compute the Bouguer anomaly of the model and to compare it to the observed Bouguer anomaly. When the best fitting between the observed and calculated gravity was made as good as possible, inversion was carried. The objective of the 3-D gravity inversion is to optimize the density of the minor blocks so that the difference between the measured and the computed data is minimized. The Grablox program uses a density inversion method based on the old SVD based algorithm.

5. Results and discussion

5.1. Euler method

In this study, we have applied upward continuation with a distance of 0.5 km as a smoothing filter implemented to reduce the effect of noise and enhance signal to noise ratio of the observed data. We are seeking the gravimetric contacts that may delineate the basement in the study area. In the Euler method, the structural index must be assumed as prior information. Thompson (1982) and Reid et al. (1990) showed that the optimum structural index usually yields the tightest clustering of the solutions. Therefore, we have assigned a value of 1.0 as a structural index to locate the possible gravimetric contacts. For this study, we used an overlapping moving window of 2.5 km by 2.5 km for Euler depth estimation. Figure 6 shows the Euler source locations with circles coloured by the estimated depth values.

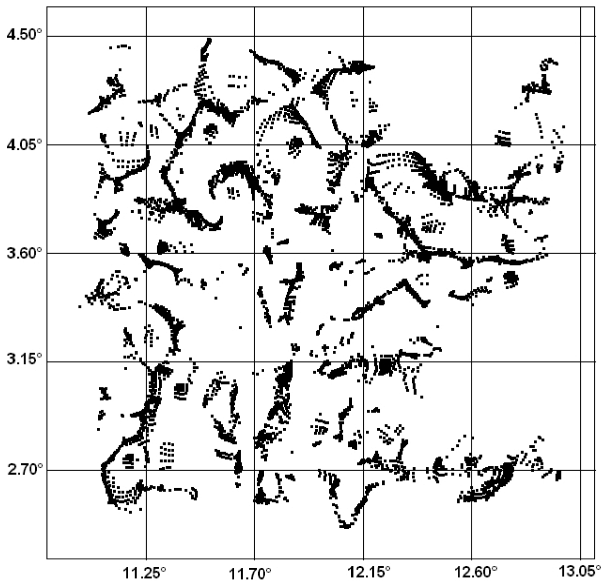

Figure 6. Euler solutions from the residual gravity data.

It is noted that the solutions are generally well clustered. In the northern area, the dense clustering of solutions is observed along the rims of the short--wavelength anomalies, suggesting that it should be associated with small-scale, structural deformation. The basement lineaments associated with positive anomalies in this region represent a combination of NW–SE pattern with a more complex arcuate lineaments style. Such lineaments could be created by crustal faulting during the Pan-African orogeny and could correspond to deep--seated basement structures related to the inferred tectonic boundary separating the Craton and the mobile belt. The two negative anomalies south-west and north-east show clustering of solution predominantly in the NE–SW and NW–SE directions respectively. These structures could be related to faulting associated with the put in place of granitic rocks in the upper brittle crust. In the southern area, the map shows clustering of predominantly NE–SW and NW–SE directions respectively in the south-west and south-east regions.

The brands of anomalies in the north-eastern and south-western parts of the study area are not showing significant solution clusters because of the poor data coverage in these regions.

5.2. Power spectrum analysis

We put the main focus of the spectral analysis on the constraining of the depth of perturbing bodies responsible of the northern positive anomalies. Indeed, the source of these causing masses is not yet clear. Two profiles (P1, P2) were chosen according to the principal directions of the northern positive anomalies. Results show two tendencies for the correlation between energy and wavenumber (Figure 7). The mean depth estimates for the deepest discontinuities obtained for profiles P1 and P2 13.8 km, 14.2 km and respectively.

These depths may be interpreted as inter-basement density variations associated with the northern margin of the Congo craton, or the upflit of the upper mantle in the northern part of the area. These results are consistent with those obtained by Nnange et al. (2000) who determined a major density discontinuity in the crust beneath the Congo craton area at depth 13 ± 1 km using spectral analysis of new gravity data in Cameroon. The shallowest depths obtained for the different profiles are 4.9 km, 4.7 km. These depths can be interpreted as mean depths of bodies responsible for the observed positive gravity anomalies in the northern part of the area.

5.3. 3D modeling and inversion

We put the main focus of the modeling on the shallower structures. The 3D modelling and inversion results are particularly informative for the structure of the study area. The model obtained is shown in two vertical sections (S1 and S2) trending N–S (Figures 8 and 9).

The main features modeled beneath the region in the southern part are lower density bodies (1) with densities ranging from 2600 kg/m^3 to 2650 kg/m^3.

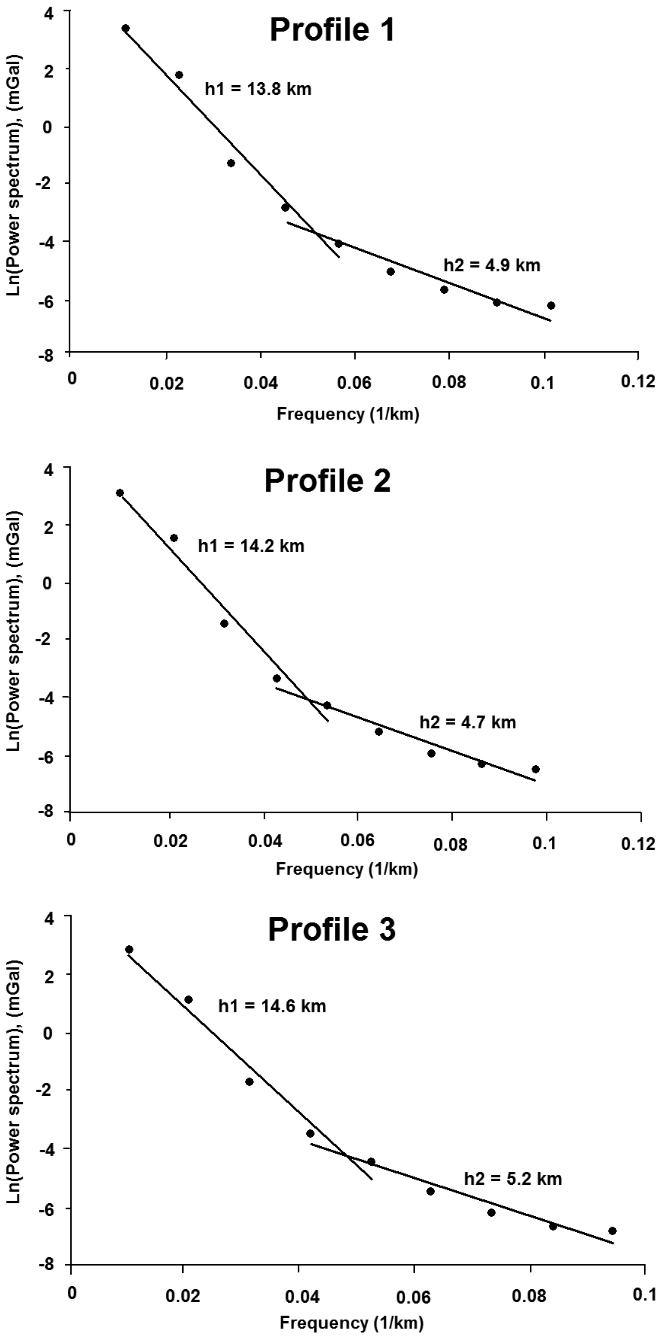

Figure 7. Plots of power spectrum versus the frequency for profiles P1, P2 and P3. h1 – deep density contrast plane; h2 – shallow density contrast plane.

These bodies are correlated to granitic intrusion in the upper crust which can reach 5 km and 7 km for sections S1 and S2 respectively. Such bodies may represent granitic magma intrusion along fractures in the upper, brittle, part of the crust. The negative Bouguer anomalies observed over the entire region can thus be attributed to the thickness of the crust associated with a granitic intrusion with a low density contrast beneath the center of the region. Towards the south, a body with densities between 2800 kg/m^3 and 2900 kg/m^3 was modeled as a basement high extended laterally beneath the So'o granites.

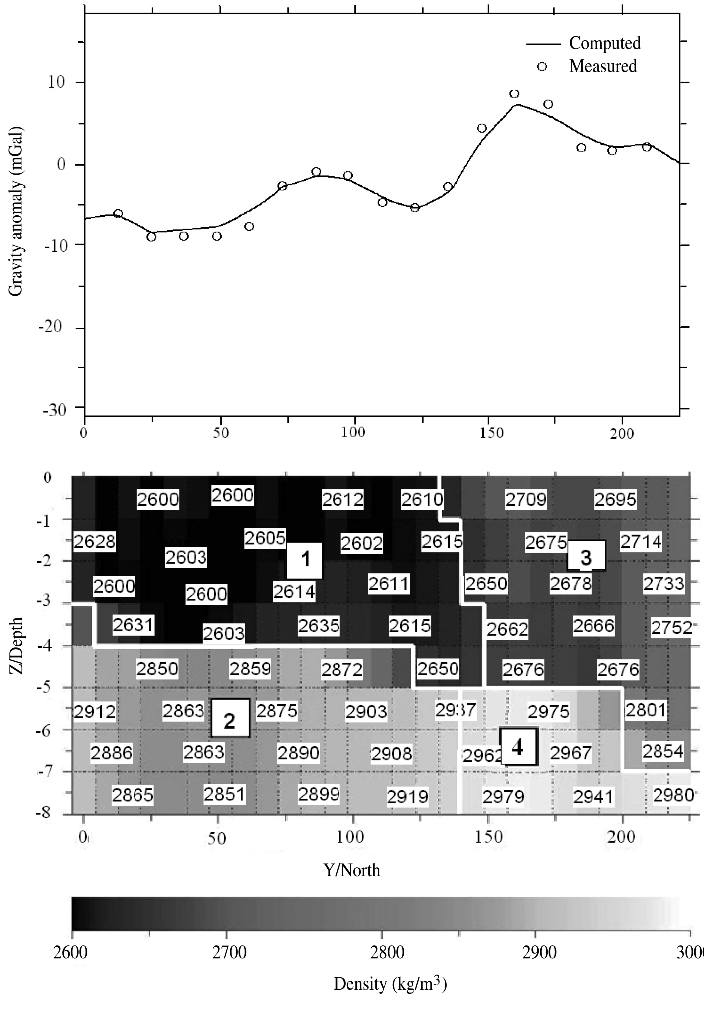

Figure 8. 3D density model cross section (S1). (1) So'o granites; (2) Charnockites; (3) Pan-African formations; (4) Deep structures in Pan-African belt. In the upper box are shown the measured and calculated gravity anomalies.

Its structure follows the trend of Bouguer gravity high in the southern part of gravity maps and represents charnockite formations. Pan-African formations (3) with densities between 2650 kg/m^3 and 2800 kg/m^3 outcrop in the northern border of the model; these formations overlay So'o granites.

Constrained by Euler deconvolution source points obtained for this work as well as the spectral analysis results, high-density bodies were modeled beneath the Pan-African formations. A density ranging of 2900–3000 kg/m^3 was calculated through inversion and assigned to the given body resulting on a

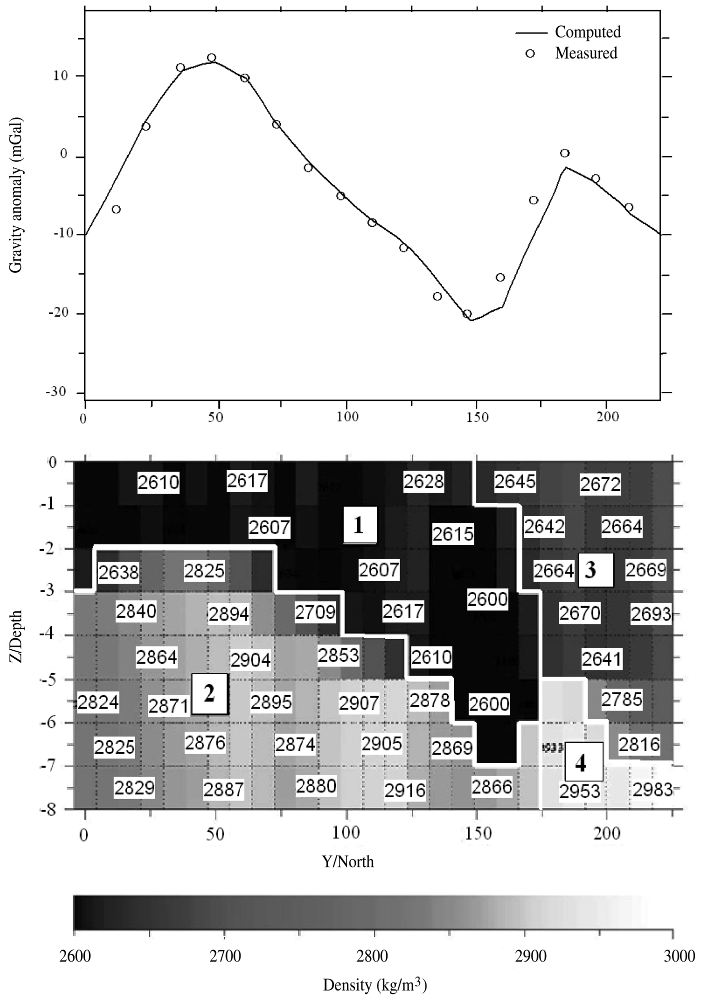

Figure 9. 3D density model cross section (S2). (1) So'o granites; (2) Charnockites; (3) Pan-African formations; (4) Deep structures in Pan-African belt. In the upper box are shown the measured and calculated gravity anomalies.

better fit between measured and calculated gravity. The presence of such material at depths of about 5 km may represent high density heterogeneities in the upper crust brought on by the effects of the Pan-African collision. These effects may be comprised of an important mantle-crust interaction at the vicinity of the northern edge of the Congo craton. The basement high marks the boundary between these two structural units. These bodies thus materialise the suture zone and can be interpreted as granulites rocks to have been put in place at the root of the collision zone. The proposed model put into evidence in the northern margin of the Congo craton a deep structure corresponding to a classical model of collision suture as has been suggested for the western margin of the West-African craton and Pan-African belt (Lesquier and Louis, 1982; Bonvalot et al., 1991).

6. Conclusion

In this paper, we attempted to give a new insight on the structural setting of the northern edge of the Congo craton in south Cameroon area. Two general observations were made concerning gravity anomalies within and at the boundaries of the Congo craton: firstly, anomalies within the craton area are negative relative to those in the adjacent zones; secondly, various anomalies are separated by high gravity gradients, which suggest major fault zones along the boundaries. Based in these observations, the zone is probably a subsided or rifted area in which the subsidence might have been accompanied by intrusion of granitic bodies with assigned density in the range 2600–2650 kg/m^3 and with thicknesses reaching 7 km. The geophysical study suggests that the deep structure of the northern margin of the Congo craton is a product of an active collision margin; this collision has provoked considerable overthrusting of the Pan-African formations onto the Congo craton formations.

References

Abdelsalam, M. G., Liégeois, J. P. and Stern, R. J. (2002): The Saharan Metacraton, *J. Afr. Earth Sci.*, **34**, 119–136, DOI: 10.1016/S0899-5362(02)00013-1.

Albouy, Y. and Godivier, R. (1981): Cartes gravimétriques de la République Centrafricaine, *ORSTOM*, Paris, 80 pp.

Basseka, C. A. (2002): Position tectonique, caractéristiques géophysiques et géochimiques des complexes précambriens au Sud-Cameroun, Thèse de Doctorat / PhD Thesis, Univ. Russe de l'Amitié des Peuples, 119 pp.

Bonvalot, S., Villeneuve, M. and Albouy, Y. (1991): Interprétation gravimétrique de la Sierra-Leone: Mise en evidence d'une suture de collision dans la chaîne panafricaine des Rokelides, *C. R. Acad. Sci. Paris,* **312**, 841–848.

Briggs, I. C. (1974): Machine contouring using minimum curvature, *Geophysics,* **39**, 39–48.

Castaing, C., Feybesse, J. L., Thieblemont, D., Triboulet, C. and Chèvremont, P. (1994): Paleogeographical reconstructions of the Pan-African/Brasiliano orogen: closure of an oceanic domain or intracontinental convergence between major blocks?, *Precambrian Res.*, **67**, 327–344, DOI: 10.1016/0301-9268(94)90095-7.

Chakraborty, K. and Agarwal, B. N. P. (1992): Mapping of crustal discontinuities by wavelenght filtering of the gravity field, *Geophys. Prosp.*, **40**, 801–822, DOI: 10.1111/j.1365-2478.1992.tb00553.x.

Collignon, F. (1968): Gravimetrie et reconnaissance de la République Fédérale du Cameroun, *ORSTOM*, Paris, 35 pp.

Crenn, Y. (1957): Mesures gravimétriques et magnétiques dans la partie centrale de l'A.O.F. interpretation geologique, *Publi. Serie Geophys. ORSTOM,* Paris*,* 43 pp.

Delhal, J. and Ledent, L. (1975): Données géochronologiques sur le complexe calcomagnésien du sud Cameroun. Musée Royal d'Afrique Centrale, Belgique. *Rapp. Annuel*, 71–75.

Hedberg, J. D. (1969): A geological analysis of Cameroon trend, PhD Thesis, Princeton University, New York, USA, 154 pp.

Hjelt, S. E. (1992): *Pragmatic inversion of geophysical data*. Springer-Verlag, Germany, 262 pp.

Inoue, H. (1986): A least-squares smooth fitting for irregularity spaced data: finite element approach using the cubic B-spline basics, *Geophysics*, 51, 2051–2060.

Kennedy, W. Q. (1964): The structural differentiation of Africa in the Pan-African (±500 million years) tectonic episode, in *8th Annual Report*, Research Institute of African Geology, University of Leeds, UK, 48–49.

Lasserre, M. and Soba, D. (1976): Age Libérien des granodiorites et des gneiss à pyroxènes du Cameroun Meridional, *Bull. BRGM, Orleans,* **4**, 17–32.

Lesquier, A. and Louis, P. (1982): Anomalies gravimetriques et collision continentale au Précambrien, *Geoexploration*, **20**, 275–293.

Manguelle-Dicoum, E., Bokosah, A. S. and Kwende-Mbanwi, T. E. (1992): Geophysical evidence for a major Precambrian schist – granite boundary in southern Cameroon, *Tectonophysics*, **205**, 437–446, DOI: 10.1016/0040-1951(92)90447-E.

Maurizot, P., Abessolo, A., Feybesse, J. L., Johan, V. and Lecomte, P. (1985): Etude et prospection miniere du sud-ouest Cameroun. Synthese des travaux de 1978 à 1985, *Rapp. BRGM, Orleans*, **85** CMR 066, 274 pp.

Mbom-Abane, S. (1997): Investigations géophysiques en bordure du craton du Congo (région d'Abong Mbang / Akonolinga, Cameroun) et implications structurales, Thèse de doctorat, Université de Yaoundé I, Cameroun, 180 pp.

Nédélec, A., Macaudière, J., Nzenti, J. and Barbey, P. (1986): Évolution structurale et métamorphique des scihtes de Mbalmayo (Cameroun). Implications pour la structure de la zone mobile panafricaine d'Afrique centrale au contact du craton du Congo, *C. R. Acad. Sci. Paris*, **303**, 75–80.

Nnange, J. M., Ngako, V., Fairhead, J. D. and May Ebinger, C. J. D. A. (2000): Depths to density discontinuities beneath the Adamawa Plateau region, Central Africa, from spectral analyses of new and existing gravity data, *J. Afr. Earth Sci*., **30**, 887–901, DOI: 10.1016/S0899-5362(00)00058-0.

Nzenti, J. P., Barbey, P., Jegouzo, P. and Moreau, C. (1984): Un nouvel exemple de ceinture granulitique dans une chaîne protérozoïque de collision: Les migmatites de Yaoundé au Cameroun, *C. R. Acad. Sci. Paris*, **299**, 1197–1199.

Okereke, C. S. (1984): A gravity study of the lithospheric structure beneath the West Africa rift system in Nigeria and Cameroon, PhD Thesis, University of Leeds, UK, 272 pp.

Pirttijärvi, M. (2004): GRABLOX: Gravity interpretation and modelling software based on 3D block model. Version 1.5a. User's guide. *Archive Report*, *Q 16.2/2004/2*, Geological Survey of Finland, 39 pp.

Penaye, J., Toteu, S. F., Van Schmus, W. R. and Nzenti, J. P. (1993): U–Pb and Sm–Nd preliminary geochronologic data on the Yaoundé series, Cameroon: Re-interpretation of the granulitic rocks as the suture of a collision in the "Centrafrican belt", *C. R. Acad. Sci. Paris*, **317**, 789–794.

Poidevin, J. L. (1983): La tectonique Pan-Africaine à la bordure nord du craton congolais: l'orogenèse des Oubanguides, in *Colloque on the African geology*, **12**, Musée Royal de l'Afrique Centrale, Tervuren, Belgium. Abstract, 75.

Reid, A. B., Allsop, J. M., Granser, H., Millett, A. J. and Somerton., I. W. (1990): Magnetic interpretation in three dimensions using Euler deconvolution, *Geophysics*, **55**, 80–91, DOI: 10.1190/1.1442774.

Shandini, N. Y., Tadjou, J. M., Tabod, C. T. and Fairhead, J. D. (2010): Gravity data interpretation in the northern edge of the Congo craton, South-Cameroon, *Anuário do Instituto de Geociências,* **33**(1), 73–82.

Shang, C. K., Satir, M, Siebel, W., Taubald, H., Nsifa, N. E., Westphal, M. and Reitter, E. (2001): Genesis of K-rich granitoids in Sangmelima region, Ntem complex (Congo craton), Cameroon, *Terra Nostra*, **5**, 60–63.

Skeels, D. C. (1947): Ambiguity in gravity interpretation, *Geophysics,* **12**, 43–56.

Spector, A. and Grant, F. S. (1970): Statistical models for interpreting aeromagnetic data, *Geophysics*, **35**, 293–302, DOI: 10.1190/1.1440092.

Strykowski, G. (1998): Experiences with a detailed estimation of the mass density contrasts and of the regional gravity field using geometrical information from seismograms, *Phys. Chem. Earth*, **23**, 845–856, DOI: 10.1016/S0079-1946(98)00104-9.

Tadjou, J. M.; Manguelle-Dicoum, E.; Tabod, C. T., Nouayou, R., Kamguia, J., Njandjock, N. P. and Ndougsa, M. T. (2004): Gravity modelling along the northern margin of the Congo craton, South-Cameroon, *J. Cameroon Acad. Sci.,* **4**, 51–60.

Tadjou, J. M., Nouayou, R., Kamguia, J., Kande, H. L. and Manguelle Dicoum, E. (2009): Gravity analysis of the boundary between the Congo craton and the Pan-African belt of Cameroon, *Austrian J. Earth Sci.*, **102**, 71–79.

Tchameni, R., Mezger, K., Nsifa, E. N. and Pouclet, A. (2000): Neoarchaean crustal evolution in the Congo Craton: Evidence from K-rich granitoids of the Ntem complex, southern Cameroon, *J. Afr. Earth Sci.,* **30**, 133–147, DOI: 10.1016/S0899-5362(00)00012-9.

Tchameni, R., Pouclet, A., Mezger, K., Nsifa, N. E. and Vicat, J. P. (2004): Monozircon and Sm-Nd whole rock ages from the Ebolowa greenstone belts: Evidence for the terranes older than 2.9 Ga in the Ntem complex (Congo craton, South Cameroon), *J. Cameroon Acad. Sci*. **4**, 213–224.

Thompson, D. T. (1982): EULDPH: A new technique for making computer-assisted depth estimates from magnetic data, *Geophysics*, **47,** 31-37.

Trompette, R. (1994): *Geology of Western Gondwana (2000–500 Ma): Pan-African–Braziliano aggregation of South America and Africa*. Balkema, Rotterdam, 350 pp.

Toteu, S. F., Van Schmus, W. R., Penaye, J. and Nyobé, J. B. (1994): U-Pb and Sm-Nd evidence for Eburnian and Pan-African high-grade metamorphism in cratonic rocks of southern Cameroon, *Precambrian Res*., **67**, 321–347, DOI: 10.1016/0301-9268(94)90014-0.

Toteu, S. F., Van Schmus, W. R., Penaye, J. and Michard, A. (2001): New U-Pb, and Sm-Nd data from north-central Cameroon and its bearing on the pre-Pan African history of central Africa, *Precambrian Res.*, **108**, 45–73, DOI: 10.1016/S0301-9268(00)00149-2.

Toteu, S. F., Penaye, J. and Poudjom, Y. D. (2004): Geodynamic evolution of the Pan-African belt in central Africa with special reference to Cameroon, *Can. J. Earth Sci*., **41**, 73–85, DOI: 10.1139/e03-079.

Toteu, S. F., Penaye, J., Deloule, E., Van Schmus, W. R. and Tchameni, R. (2006): Diachronous evolution of volcano-sedimentary basins north of the Congo craton: Insights from U-Pb ion microprobe dating of zircons from the Poli, Lom and Yaoundé groups (Cameroon), *J. Afr. Earth Sci.*, **44**, 428–442, DOI: 10.1016/j.jafrearsci.2005.11.011.

Toteu, S., Yongue Fouateu, R., Penaye, J., Seme Mouangue, A. C., Van Schmus, W. R., Tchakounte, J., Deloule, E. and Stendal, H. (2007): Reply to the comment by Mvondo et al. on "U-Pb dating of plutonic rocks involved in the nappe tectonics in southern Cameroon: Consequence for the

Pan-African orogenic evolution of the central African fold belt by Toteu et al., 2006" (Journal of African Earth Sciences, **44**, 479-493), *J. Afr. Earth Sci.*, **48**, 53–54, DOI: 10.1016/j.jafrearsci. 2007.03.003.

Vicat, J.-P., Léger, J.-M., Nsifa, E., Piguet, P., Nzenti, J.-P., Tchameni, R. and Pouclet, A. (1996): Distinction, au sein du craton congolais du Sud-Ouest du Cameroun, de deux épisodes doléritiques initiant les cycles orogéniques éburnéen (Paléoprotérozoïque) et panafricain (Néoprotérozoïque), *C. R. Acad. Sci. Paris*, **323** IIa, 575–582.

SAŽETAK

Dubinsko kartiranje na temelju gravimetrijskih podataka na području sjevernog ruba Kongo kratona, južni Kamerun

Charles Antoine Basseka, Yves Shandini i Jean Marie Tadjou

U ovom radu se pomoću gravimetrijskih podataka procjenjivala struktura kore u dijelu sjevernog ruba kratona Konga u južnom Kamerunu, smještenom između 2° 30' i 4° 30' N te 11° i 13° E. U svrhu kvantitativne interpretacije uzročnika anomalije napravljen je 3D model gustoća gornje kore na temelju modeliranja i inverzije. Rezultati inverzije su ograničeni površinskim geološkim podacima i rezultatima Eulerove dekonvolucije i spektralne analize. Kartu Bouguerovih anomalija istraživanog područja karakterizira izdužena negativna gravimetrijska anomalija pružanja SW–NE, koja je uzrokovana urušenom strukturom povezanom s intruzijom granita u središnjem dijelu područja. Različite pozitivne anomalije povezane su s izdizanjem Panafričke podloge u sjevernom dijelu, a omeđene su velikim gradijentom uzrokovanim tektonskom granicom između kratona Konga i Panafričkog pojasa. Rezultati pokazuju da su tektonske strukture koje uzrokuju opažene gravimetrijske anomalije (na istraživanom području) nastale tijekom kolizije (sudara) kontinenata.

Corresponding author's address: Charles Antoine Basseka, University of Douala, Faculty of Sciences Department of Earth Sciences, P. O. Box 24 157 Douala, Cameroon, e-mail: c.basseka@yahoo.fr