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Abstract

I giovani ricercatori italiani nell'ambito dei programmi internazionali di perforazione scientifica

Titolo dell'abstract: Gravimetry of the Chad basin area: determining the depth of the basement and implication for defining a scientific drilling site (ICDP-CHADRILL project)

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Argomento della ricerca nella perforazione scientifica

The purpose of this work is to investigate the basement depth under Bol city (SE Chad Lake) using the inversion models from gravity-topography regression analysis. The project started from a collaboration between University of Trieste and Institute de Physique du Globe de Strasbourg. The results gave crucial information (depth of the geologic basement, thickness of sediment) for drilling a scientific core onshore of Lake Chad (ICDP-CHADRILL project) of continental Africa over some 10Myr.

Abstract

The Chad basin is one of the largest endorheic basin of the world (2.5 million of km^2) and intracratonic sag-basin located in the North Central Africa and covering 8% of the surface area of the African continent. The detailed geology of the area remains poorly known. Gravity studies in the Chad Basin started in 1959 at the ORSTOM, nowadays IRD (Institut de Recherche pour le Développement). In 1993, Genik gave an overview on petroleum geology of the rift basins located in the area (seismic reflection and well-log data, Exxon 1969-1991).

The main objectives are:

(1) estimation/interpretation of the Bouguer gravity residual anomalies;
(2) estimation of the basement depth under the Chad basin, locally under Bol.

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We used the following methods:

- *The regression analysis*. It is a method particularly suitable for geophysical surveys in areas almost uncovered by data like the Chad basin. The analysis is needed for several scopes: (a) to determine the anomalies due to the crustal mass inhomogeneity. (b) To reduce Bouguer anomaly for the effect of crustal thickness variations; (c) to identify various tectonic features which produce a different correlation between topography and gravity; (d) to invert for the depth of the basement.

- *The inversion modelling* on residual gravity values. We used it for estimating the basement depth under Bol. We used different density contrast between rock basement and sediments. We chose a range of values of density contrast 200-400 kg/m^3 on the base of the lithology observed inside the Basin. The density contrast is an important constrain since the depth of the basement depends on it. Indeed a reduction of this contrast leads to a proportional increase in the basement depth.

The Main results were:

1- *Topography-gravity Regression*: for low topography (<1000m) there is an inverse proportion between the Bouguer gravity anomalies and topography due to isostatic compensation. For higher topography the correlation is loose for the increase of crustal density of the Tibesti volcanic Massif area (the only value of the topography >1000m).

2- *Residual Maps* obtained from the regression analysis. They show gravity signal induced by crustal density variations occurring between the tectonic features after the removal of topography and crustal root effects. The Residual Maps show: (1) a large negative anomaly (<-20 mGal) affecting most of the basin, related to the sedimentary infill. (2) A higher negative anomaly (-30 mGal) with a "U" shape, extending north to the Chad lake probably related with the Termit rift basin, already identified by seismic reflection profiles.(3) Some small positive anomalies (20-30 mGal) inside the basin probably due to some local basalt dykes. (4) A negative gravity anomaly (~ -50 mGal) trending NE-SW, corresponding to the Central African Rift (CAR) around Sarth city. (5) Along the northwestern edge of the basin there is a pattern of positive anomalies (~40 mGal) trending NW-SE, likely corresponding to the volcanic intrusions along the edges of the rifts. (6) A local positive anomaly lineament (~50 mGal) along the southeastern edges of the basin and approximately 1000 m extended.

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3- *Basement depth under the Lake Chad* from the inversion of the residuals. It shows a sharp variation from N to S. In the northern part of Lake Chad, the basement is 4-6 km deep and reaches the depth of ~12 km in the Termit Rifting Basin. This value is consistent with that estimated in the previous study of Genik (1993). In contrast, in the southern part of the Lake Chad, the basement shallows to 2-3 km. The basement depth under Bol ranges 2-4 km. The largest depth of the basement (~ 15 km) is observed 100 km W of the Chad Lake, cannot be connected with a specific tectonic feature because of the poor knowledge of the geology of the area. In the other parts of the study area (e.g., under the city of Mao and Moussoro) the depth of the basement is quite shallow (1-2 km).

In this project, we estimate the depth of the basement under the Chad basin focusing our attention on the city of Bol where, in the framework of the project ICDP, it is planned to drill a borehole for paleo-environmental and anthropological research. The deepening of the basement is connected to the rift basins and the values obtained are compared with previous seismic surveys. The depth of the basement under Bol is 3-4 km but unfortunately, there are no other geological/geophysical constraints to confirm these values. For the drilling purpose, since in the inversion we used a minimum value of the density contrast (200 kg/m^3) among the range defined (200-400 kg/m^3), it is possible to assume that the maximum expected for the basement depth is about 4 km. Furthermore, we suggest an integrative geophysical survey (seismic reflection campaign) to get more detailed information about the basement structure (faults, highs and lows) as well as on the variability of the depth/thickness of the sediment cover.