Geofísica Internacional (2013) 52-4: 365-373

Original paper

A geostatistical re-interpretation of gravity surveys in the Yagoua, Cameroon region

Philippe Njandjock Nouck*, Chamberlin Kenfack, Ahmad Diab Diab, Kasi Njeudjang, Larissa Jorelle Meli'I and Rodrigue Kamseu

Received: September 28, 2012; accepted: March 13, 2013; published on line: September 30, 2013

Resumen

Desde 1960 se han realizado diversos estudios de gravedad en la región Yagoua del norte de Camerún. Se recabaron datos de gravedad en una área amplia que abarca aproximadamente 11.628 km^2. Estos datos son insuficientes, irregulares, dispersos y no permiten eficientemente continuaciones ascendentes y descendentes del campo gravitatorio, derivadas y otras operaciones que requieren datos reticulados regulares. Algunas anomalías en el mapa Collignon (1968) pueden correlacionarse con la estructura geológica que se conoce, pero no aparecen en los mapas de Louis (1970) y Poudjom *et al*. (1996). Para producir los datos de gravedad reticulares regulares y mejor control de las anomalías, derivadas de estructuras geológicas, se aplicó el método de Kriging a una línea de base de datos-188. Se ensayaron para este propósito varios modelos de variograma. Se encontró que un modelo esférico era la mejor opción; se ha elaborado un nuevo conjunto de datos Kriging con unos 10.100 resultados y un nuevo mapa con los datos Kriged Bouguer. Este mapa contiene anomalías positivas en las zonas Maroua-Mindif y Maga (1968) en el mapa Collignon, que no estaban presentes en los mapas de Louis (1970) y Poudjom *et al*. (1996). Las anomalías positivas de Guibi-Doukoula y Yagoua, que no se encuentran separados en los mapas de Louis (1970) y Poudjom *et al*. (1996), aparecen claramente distintas a como fueron previstas por Collignon (1968). Los nuevos resultados pueden ser utilizados para los estudios gravimétricos posteriores.

Palabras clave: Anomalía Bouguer, datos de gravedad, geoestadística, variograma, Kriging, Yagoua.

Abstract

Since 1960, many gravity studies have been carried out in the Yagoua region of northern Cameroon. Gravity data was collected over a wide area of approximately 11628 km^2. These data are insufficient, irregular, scattered and do not efficiently permit gravity field downward and upward continuations, derivatives and other operations that might require regular gridded data. Some anomalies on the Collignon map (1968), may correlate with known geological structure but do not appear on maps by Louis (1970) and Poudjom *et al*. (1996). To produce regular gridded gravity data and better control anomalies due to geological structures, the kriging method was applied to a 188-data baseline. Several variogram models were tested for this purpose. It was found that a spherical variogram model is the best; it has produced a new kriging dataset of about 10,100 data and a new map of kriged Bouguer data. This map contains positive anomalies in the Maroua-Mindif and Maga areas on the Collignon (1968) map, which were not present on Louis (1970) and Poudjom et al. (1996) maps. The positive anomalies of Guibi-Doukoula and Yagoua, not separated on the Louis (1970) and Poudjom et al. (1996) maps, show up as clearly distinct as previewed by Collignon (1968).The new results can be used for subsequent gravimetric studies.

Key words: Bouguer anomaly, gravity data, geostatistics, variogram, kriging, Yagoua.

P. Njandjock Nouck*
Chamberlin Kenfack
Department of Physics
Faculty of Science
University of Yaoundé I
Cameroon
*Corresponding author:

A. Diab Diab
Department of Physics
Faculty of Science
University of Abeché
Chad

K. Njeudjang
Pecten oil and gas Company
Douala, Cameroon

L. Jorelle Meli'I
Departments of Physics
Advanced Teachers Training College of
Nkolnda-Nsimalen, Cameroon

R. Kamseu
Centre de Formation spécialisée
de Géostatistique MINES-Paris
France

Introduction

Geostatistics is applied in the Earth sciences as an interpolation procedure that uses an available dataset to obtain an optimal, linear and unbiased estimation of a property whose estimation error is minimized (Matheron, 1973). It operates on a random variable for which a set of possible values is known but whose final result requires a measurement. The objective of this study is to re-examine a gravity data set from irregular gridded data. For this operation known as kriging, we make a crucial choice of a variogram. This is a better choice, because more kriged values are closer to reality. The principal difficulty is to find a variogram model that fits the data to be interpolated. In this work, we calculate an experimental variogram from existing gravity data, we evaluate the RMS between the variogram and we use various cross-data validation criteria to ensure that the variogram model chosen is optimal in order to correlate with the experimental variogram. We also offer a new gravity dataset and we propose a new gravity map of the Yagoua region in northern Cameroon.

Study area and Gravity data

Presentation of the study area

Yagoua region (Figure 1), as others in Central-Africa, is the product of a complex period of continental disruption associated to plate tectonic fragmentation of Gondwana (Genik, 1992; Njandjock, 2004). It is characterised by polyphase rifting, separated by tectonic events that can be linked to regional deformation, hiatus of sedimentation and unconformities in seismic sections and outcrops. The region belonging to the Panafrican belt, is bounded to the South by the Doba basin, to the North by Lake Chad basin, to the East by Doseo and Salamat basins, and to the North West by the Mandara Mountains and the Southeast by the Kaele dome. The study area in Cameroon, covers an area of about 11628 km^2 and stretches from latitude 9°45 'N to 10°47'N to longitude 14°20' E to 15°30'E.

Geological context

The Yagoua region is located in the southern part of the Logone Birni Basin (LBB) characterised by Quaternary sediments and belonging to the West and Central African Rift System. The geology of the region (Figure 1) is underlain by a large sedimentary formation and a Precambrian basement. The basement consists of acid and metamorphic formations. gneisses, migmatites, diorites, anatexites, syenites, syn-tectonic to post-tectonic granites, basalts and shales. Rare basalts are observed in the Kaélé region (Maurin, 2002). Among the bedrock outcrops, the Precambrian is dominant. It is characterized by migmatites and anatexites located southwest of the region in Maroua and Kaélé. Some remarkable features include the Mindif intrusion composed of syenites (Eno Belinga, 1984), the North Maroua gabbro hills and the Kaélé hills. The sedimentation in this

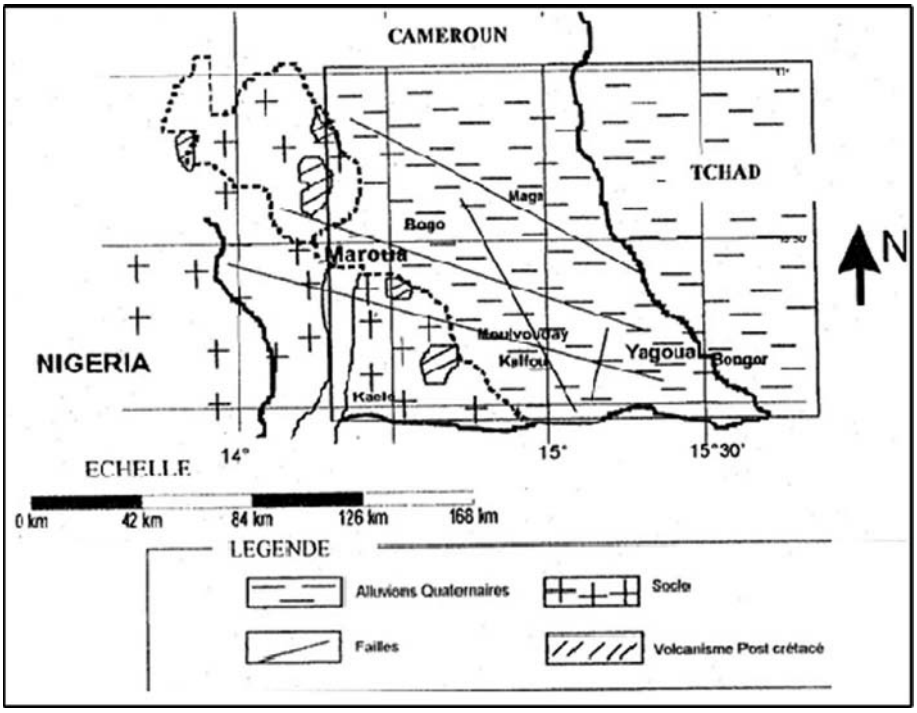

Figure 1. Simplied geology map of the study area.