

Gravimetric study in the northeast portion of Paraná Sedimentary Basin – Southeast Brazil. A preliminary Bouguer anomaly map

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Abstract

This paper presents the results of a geophysical study carried out at Northeast of Paraná Sedimentary Basin. Since the first geological surveys and studies with the aim objective to discover oil reserves the structural highs named Pitanga and Pau D'Alho were at the time the principal targets in subsurface and surface studies and prospecting. Such structural highs are evidences from the tectonic and geological evolution from the Paraná sedimentary basin and its related oil occurrences. Potential geophysical methods such as gravimetry is a valuable tool in the understanding this structural domes and its evolution through the basin evolutionary story. This study is currently in its initial phase but a preliminary Bouguer anomaly map provides a better visualisation and allows new concepts and theories of the polyphasic basin story

Introduction and objectives

A gravity survey in a regional extend allows to identify characteristics between the crustal masses and its relations. These concepts, associated with geological and structural informations and its lithological constituents provides an important background to produce a coherent structural and geological model. A semi-detail gravimetric survey with a preliminary Bouguer anomaly map provides informations to a future gravity modeling based on structural and geological study and promotes information to confirm or elaborate new theories and concepts about the evolution and processes from the structural highs Pitanga, Artemis, Pau Dálho and Jibóia and its related oil formation, migration and its associated reservoirs rocks. The main objective of this study is:

- Terrestrial gravimetric survey (still in acquisition phase), data reduction, processment and gridding of acquired datas.
- Generate a Bouguer anomaly map with the isogalic curves in miliGal determining and correlating its strong gravimetric Bouguer.
- Determine and delineate the strong gravimetric horizontal gradients related to the structural highs and

its uplifted structures (domes) providing subsurface informations to better understand the structural highs, its limits and relations with crustal partitioning and thickness

Geological Settings

The studied area (Figure 1) is located in the middle – east portion from São Paulo State in Brazil, north portion from Paraná Sedimentary Basin.

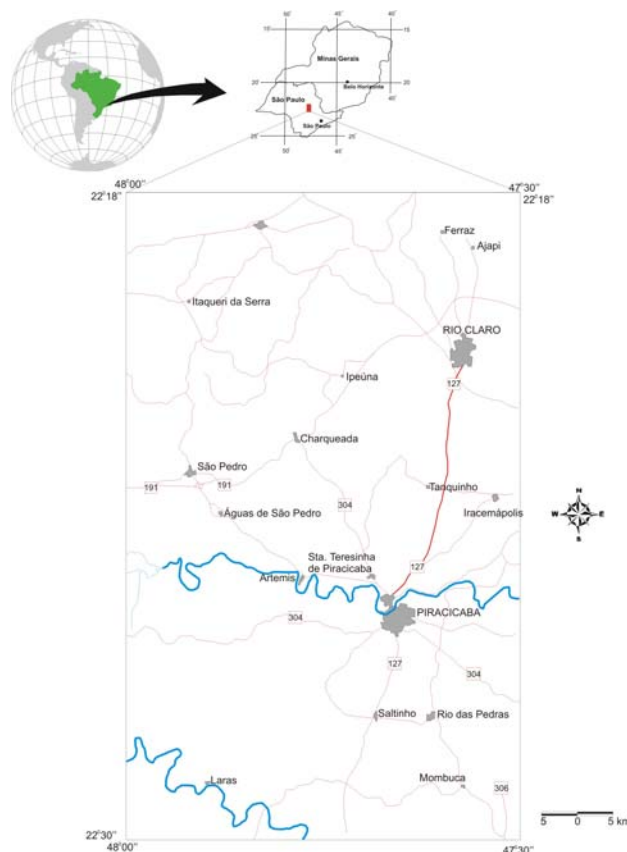


Figure 1 Location Map, main access roads and cities.

It can be described by the basement rocks and the Paraná Basin sedimentary units (Figure 2) with ages from Carboniferous to Permian (Itararé Group-Tatuí and Irati Formation) to upper Cretaceous including basaltic flood rocks intruded in the sedimentary rocks, Pirambóia, Botucatu and Itaqueri Formations and Neocenoic sediments present in the flat surface regions (Souza, 2002).

The rocks units and its respective Formations and Groups are described by authors (Riccomini *et al.*, 1991; Soares & Landim, 1973; Soares, 1974; Souza, 1997; Souza, 2002) as follow:

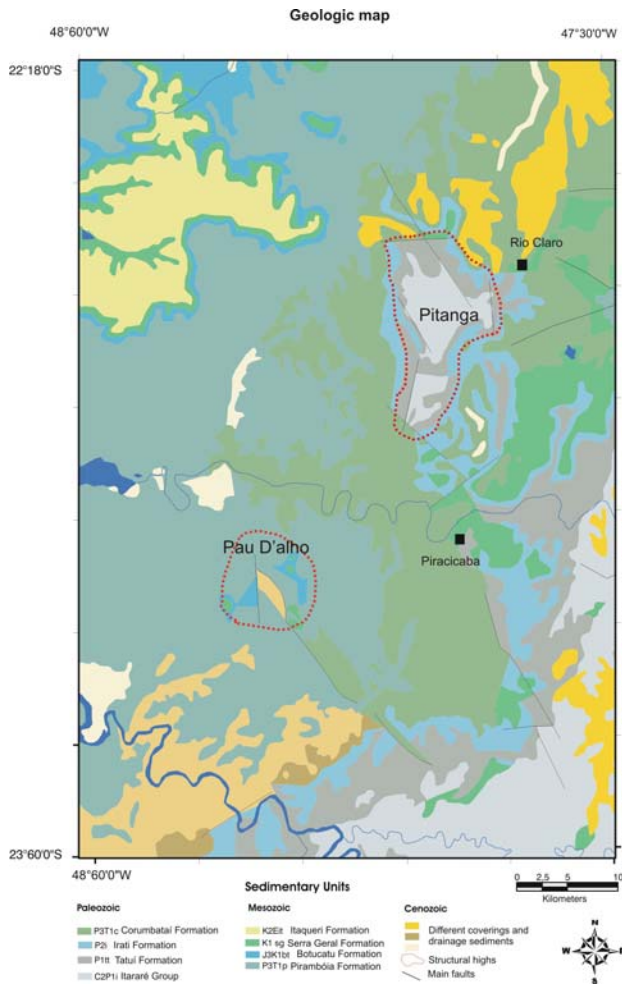


Figure 2 Geologic Map and structural highs present in the study area (red dotted lines). CPRM, 2001

Itararé Group rocks are present in the middle north portion from the study area and it is composed by sandstones, diamictites, siltstones, and argillites. The sandstones presents heterogenic coarsening varying from very fine to conglomeratic. Conglomerates have quartz pebbles, rounded and angular quartzites and granites.

The Tatuí Formation occur in the middle north portion elongated in the study area. Most represented by siltstones mudstones, sandstones and silicites levels.

Irati Formation sediments take place in the northeast portion from the area, near Piracicaba city and in the south portion from the area near Saltinho city. This Formation can present betuminous shales in some parts, with gray dolomites layers intercalated, silicified limestones alternated with betuminous shale presenting otherwise silic nodules.

Corumbataí Formation rocks and its constituents occur along the entire study area. The best outcrops are in the Rio Claro city in its nearness exposed, near Piracicaba

and Laras cities. This Formation presents sandy and muddy siltstones, reddish-purple layered mudstones.

The Pirambóia Formation occur along the north middle west and Southeast from study area. Outcrops with the best expositions are near São Pedro and Águas de São Pedro cities in the region of the structural highs. This Formation presents fine to medium white – reddish to yellow. Occur usually in fine mudstone layers intercalated with siltstones.

Botucatu Formation rocks are in the northwest portion (São Pedro and Itaqueri hills) with well sorted sandstones, brittle or silicified, red coloured with medium to fine coarsness variance.

The Serra Geral Formation occur abundantly in the study area in dykes and sills form. This rocks are well exposed near the Piracicaba and Corumbataí rivers, São Pedro and Itaqueri hills and filling fractures and faults along the entire area specially in the structural highs.

Itaqueri Formation presents poor sorted conglomerates with angular fragments in a sandy matrix, diamictites with a coarsness variance from fragments as quartz, pebbles, compact, poor sorted, muddy or silty sandstones.

Rio Claro Formation and its constituents are sandy, white-yellow-pink coloured, stratified and usually as white mudstones lenses intercalated and conglomeratic levels. Are mostly present in northeast area, near Rio Claro and Ipeúna city.

Superficial recent coverings are represented by conglomeratic materials, pebbles, sand, mudstones river deposits (sediments related to the drainage system in the area). This sediments are mostly sandy-muddy sediments, pebbles in high and intermediary river terraces and also recent sediments.

Structural Highs and its structural and tectonic characteristics

Souza (1997) and Souza (2002) argues that the structural framework is related to stratigraphic units in a up and downlifted blocks arrangement controlled by faulting, considering that the younger units are present side by side near older rocks. In morphostructural terms the area is strongly marked by a NW-EW-NE lineament related to the normal fault zones. The NW-SE faulting characterized by dipping NE and NW tilted blocks promoting such structural dome feature and geometry (Pitanga, Artemis, Pau D' Álho and Jibóia highs).

The morphotectonic in the area can be described as a distension regime product that generated normal faulting (NE –SW) related to the Gondwana partitioning and also the strike – slip faulting regime that reactivated pre – existing discontinuities probably an extended extension from basement fault zones.

Methods and Proceedings

A bibliographic investigation from earlier studies in the area and processment of survey data was initially made. In this study 218 new gravimetric stations were obtained, with a support of a La Coste & Romberg gravimeter model G 987 with a 0.01 mGal precision (Figure 3).

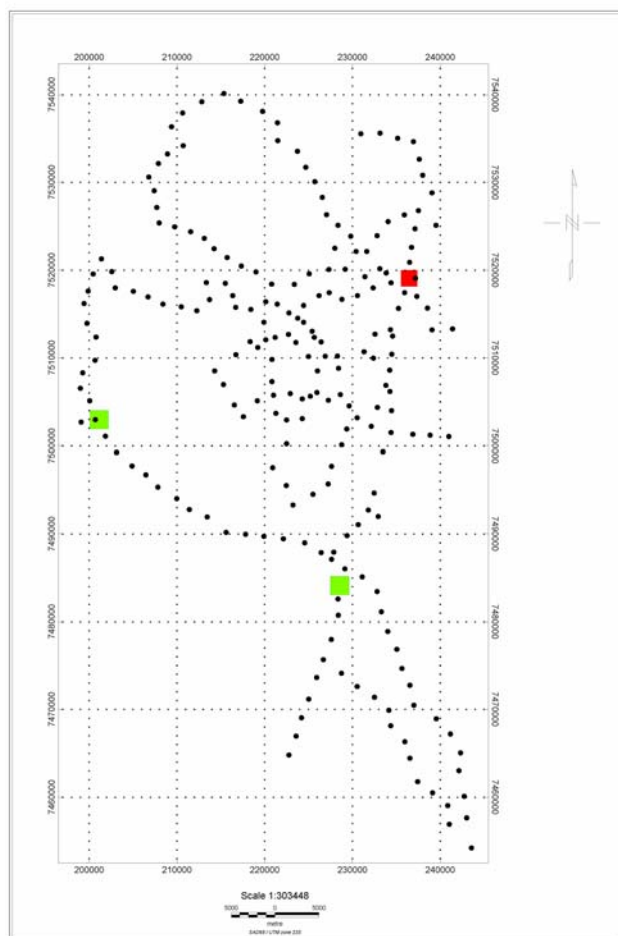


Figure 3 Gravimetric stations acquired in this study. Gravimetric base station Rio Claro (red square) and Piracicaba and São Pedro cities (green squares).

Coordinates X, Y and altitude (Z) values from each gravimetric station in the survey were obtained through a postprocessed Trimble DGPS (Differential Global Position System) model Pathfinder Pro-XR. The X, Y and Z values from each collected point were postprocessed with a known base station in a Pathfinder software package. The gravimetric survey was executed along the main access roads and gravimetric stations were separated 2 km away from each other. The reference base station used for the Bouguer anomaly reduction is located in Rio Claro city and is a base station from the São Paulo Secondary Gravity Net determined by the Instituto Astronômico e Geofísico IAG/USP. This station is referenced to the 1971 IGSN71 (International Gravity Standardization Net). Reduction formulas, latitude, tide and drift corrections as well as the used 1967 reference ellipsoid were performed according Telford (1976) with a AOSIS/MONTAJ software and its executable routine named XCELLERATION GRAVITY (a gravity data processing system).

Bouguer anomaly map characteristics

The Bouguer anomaly map (Figure 4) is product derived from a 19 X 29 (X and Y direction respectively) gridding points and the interpolation method used for the final grid and the isovalues is the minimum curvature adequate for potential geophysical methods such gravimetry.

The acquired gravimetric stations and Bouguer anomaly values have been determined using the OASIS/MONTAJ software. In the Bouguer correction was adopted the mean value of 2.67 g/cm² for the crustal density.

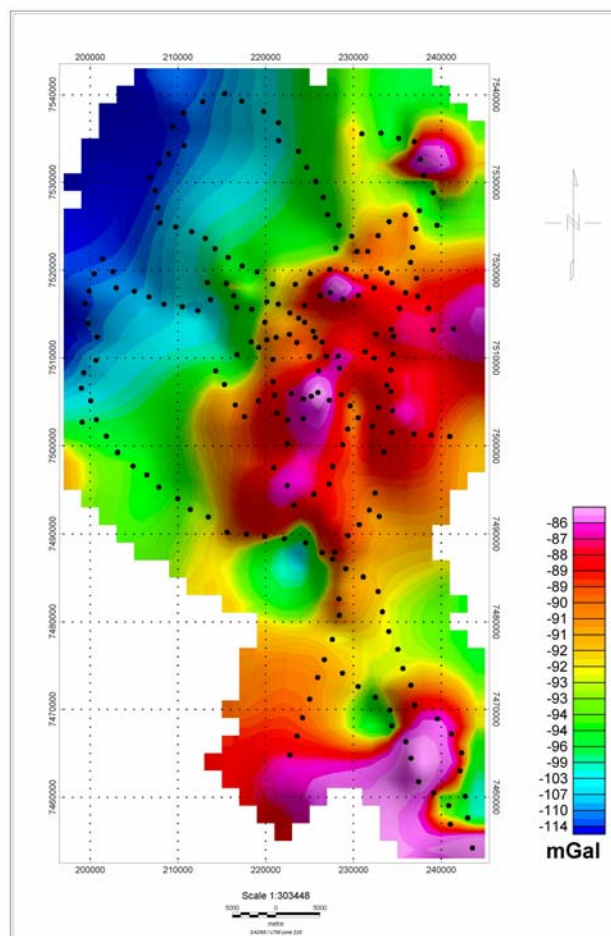


Figure 4 Bouguer anomaly map and gravimetric stations from the studied area

Concluding remarks and final conclusions

In the studied area, Bouguer anomaly values reaching -86 mGal are interpreted as a gravimetric high and are evident in the middle/east and southeast portion of the map. Such values (specially in the middle portion) are concentrated in the structural highs region showing a high density area extending towards east. Bouguer anomaly values (-114 mGal) are distributed along the structural highs respecting its borders limit in the north/northwest portion of the studied area supporting the geologic knowledge where basic rocks intrusions occur

abundantly in the uplifted areas (structural highs) playing however an important role in its evolution.

The presence of this high densities considering that the study is still in its initial phase, points to a direction that the the oil occurrences and its formation in this portion of the Paraná Basin have probably a straight relation with the warping, uplifting and faulting of the original basement (crust) and its sediments contributing for the oil migration and its concentration in the reservoir rocks distributed along the area.

The generated Bouguer anomaly map, its strong gradients interpretation and future correlation with geologic maps, surface profiles with its structural arrangements, allows to predict and elaborate more accurated crustal models contributing to the Paraná basin refinement and understanding .

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