Catalão I Alkaline Complex: Gravimetric and Magnetic Inversions

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Abstract

The Catalão I Alkaline Carbonatitic Complex is a phosphate mineral deposit located at the central portion of Brazil, in Goiás state (18°08'S, 47°48'N). This intrusive body is the object of this study.

The geophysical potential methods, gravimetry and magnetometry are widely used in mining geophysics and are used here for the Goiás Alkaline Complex study.

The complex is made basically of ultramafic rocks (piroxenites and dunites) with a secondary carbonatitic intrusive phase. The ultramafic phase is denser and more magnetic than the surrounding geology (basically schists); this generates a positive density/magnetic contrast, which allowed a good determination of physical parameters of the complex, such as average density/susceptibility, volume and shape.

The alkaline complex generates a Bouguer anomaly of 24mGal and a magnetic anomaly characterized by a normal dipole with an amplitude of 9000 nT. Both anomalies were inverted using the *UBC Geophysical Inversion Facility*, which generated two 3D models. The inversion results for both methods were very similar in shape, what was expected, since the denser rock is also the magnetic rock.

A less denser/magnetic area was detected inside the complex model. This area probably contains the highest carbonatite concentrations, since the carbonatite is less dense/magnetic then the surrounding rocks of the complex. This shows that these methods are adequate, not only to delimitate and locate the intrusive body, but also to find and delimitate the carbonatite inside the complex, which is the main commercial mineral exploited in this complex.

Introduction

The geophysical potential methods, gravimetry and magnetometry, are vastly used in applied mining geophysics to find mineral deposits with a density/magnetic contrast with the bedrock. That is exactly the case of the Catalão I alkaline complex.

The complex is located at SE of Goiás state, central part of Brazil (18°08'S, 47°48'N, figure 1).

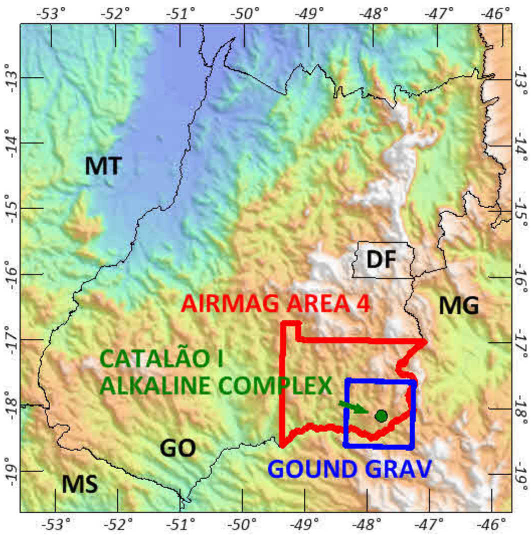


Fig. 1- Air mag survey, ground gravimetric survey and catalão I Alkaline Complex locations.

The intrusion of the alkaline complex of Catalão I (Upper Cretaceous ~ 85mA) deformed the Araxá Group metasediments, quartzite and micaschists (Middle Proterozoic). The body consists of an ultramafic primary phase, composed of dunite and pyroxenite, which have been intensely altered to clinopyroxenite and phlogopititic rocks due to multiple phases of carbonatite intrusion. Ulbrich & Gomes (1981) presented a classification of alkaline complexes, in which Catalão I is included in type III, characterized by the predominance of phlogopitites and carbonatites.

To study this complex 368 ground gravimetric stations were located in the complex region, by GEOLIT study group (IAG/USP), spaced by 300m-500m over the complex and 2km in the surrounding area.

The magnetic data were obtained from an air survey, performed in 2005 by CPRM (The Brazilian Geological Survey) and the Goiás state government.

After the data reduction and the subtraction of the regional gravimetric field, a positive Bouguer gravimetric anomaly was observed over the complex.

The complex also produces a magnetic anomaly, characterized by a normal dipole.

Methods

Ground Gravimetry:

The gravimeter LaCoste&Rombery G model was used to determinate the gravity value in each station. This value was referred to the Brazilian Fundamental Gravimetric Network (ON).

The topography was determined by the fixed base barometry method (Slavec, 2002). In this case we used analog (Thommen) and digital (Intellisensor Air DB) barometers and aspiration psychrometers (Yope). From the barometric measurements at each station corrected by the records at the base station and humidity variation the height of each station is calculated being referred to the IBGE leveling network (Slavec, 2002).

To calculate the gravimetric anomalies, we used the standard free air and complete Bouguer anomaly formulas, using the gravity refence defined by the GR1967 and a crustal density of 2.67g/cm³.

The regional gravimetric field was extracted using the order 5 Robust polynomial fitting.

Air Magnetic Survey

The magnetic data were extracted from an air survey acquired and processed by CPRM (2005), with a line spacing of 500m and a nominal flight height of 100m. The dataset used in this study is that of the total magnetic field intensity.

Reduction to the Magnetic Pole

For the application of the Reduction to the Pole filter to Catalão I magnetic data, initially the software Oasis Montaj 7.0 (GEOSOFT, 1994) was used. However, it is known that the available algorithm produces erroneous results when applied to magnetic anomalies with unknown remnant magnetization (Cooper and COWAN, 2005; MACLEOD et al.).

As an alternative to calculate the reduction to the pole filter of the anomalous magnetic field generated by Catalão I Alkaline Complex, the algorithm developed by Fedi et al. (1994) was used. According to these authors, the total inclination and declination can be calculated from the application of an operator of Reduction To the Pole for different combinations of inclination and declination, and observing the variation of the anomaly as defined in terms of these.
The value of inclination and declination are defined as total index that minimize the negative anomaly reduced to the pole. According to Cordani (2008), by this methodology is based on reduction to the pole, it has the same limitations as the reduction, for example, the instability observed for reductions of anomalies close to the magnetic equator.

Results

After the data reduction, we obtained the complete Bouguer anomaly map (figure 2) and the total magnetic field cut to the gravimetric survey area (figure 3).

In figures 2 and 3, the white square is the area selected for the inversion using UBC. The data used for the inversion were the residual Bouguer anomaly (figure 4) and the Fedi RTP(figure 5).

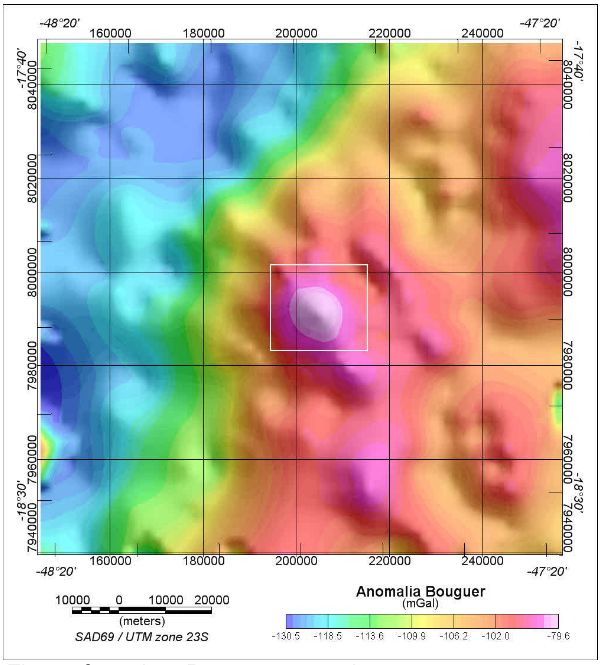


Fig. 2- Complete Bouguer anomaly.

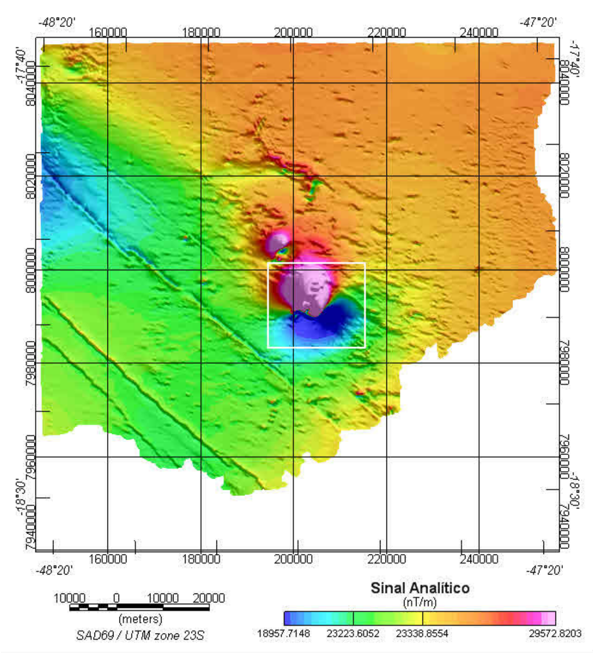
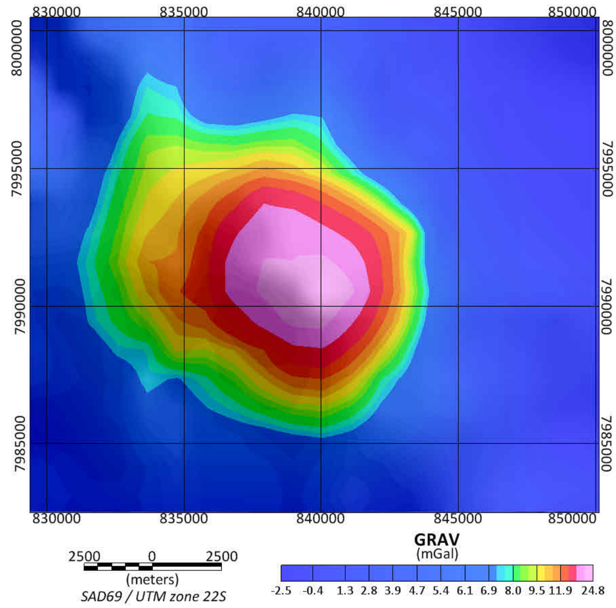
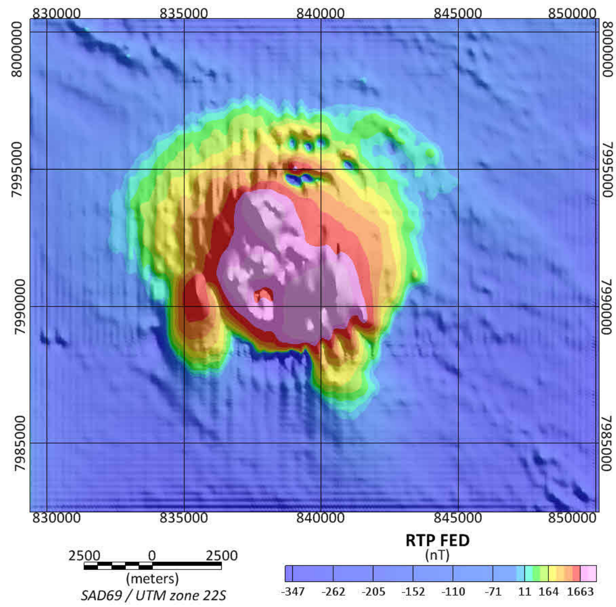


Fig. 3- Total magnetic intensity.

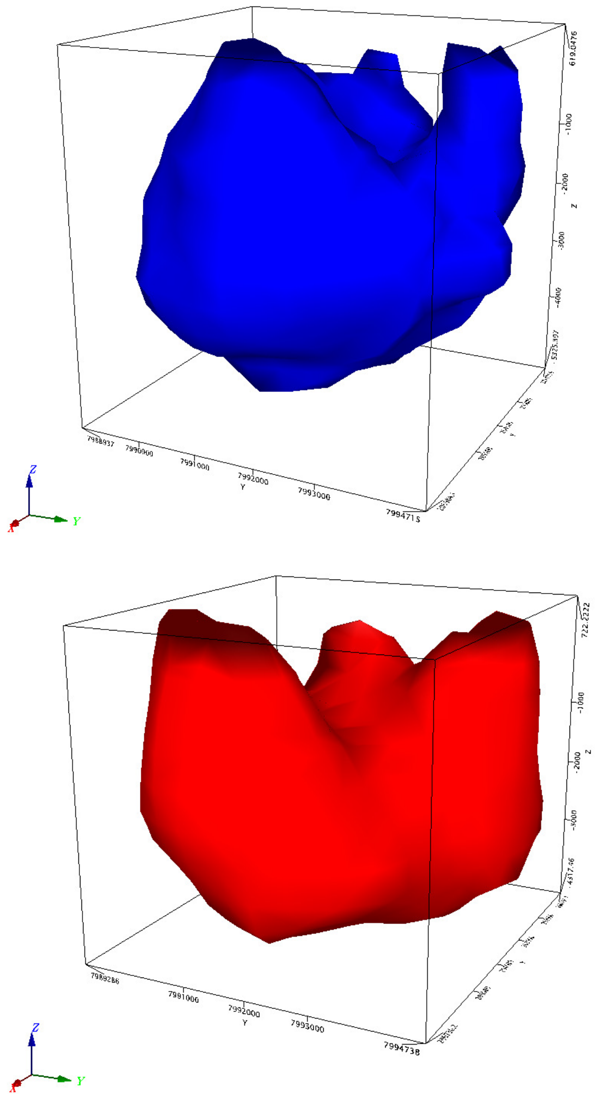


<u>Fig. 4</u> - Residual Bouguer anomaly.



<u>Fig. 5</u> - RTP filter, developed by Fedi, (1994).

Gravimetric (residual Bouguer anomaly) and magnetic data (Fedi RTP) were inverted using the *UBC Geophysical Inversion Facility.* This generated two models that are show in the figure 6.



<u>Fig. 6</u> - Gravimetric inversion (upper, blue) and magnetic inversion (below, red)

As we can see, there is a "hole" in the central portion of the intrusion. This low density/magnetic area is suppose to be the a carbonatite rich area. This area is emphasized in the figure 7.

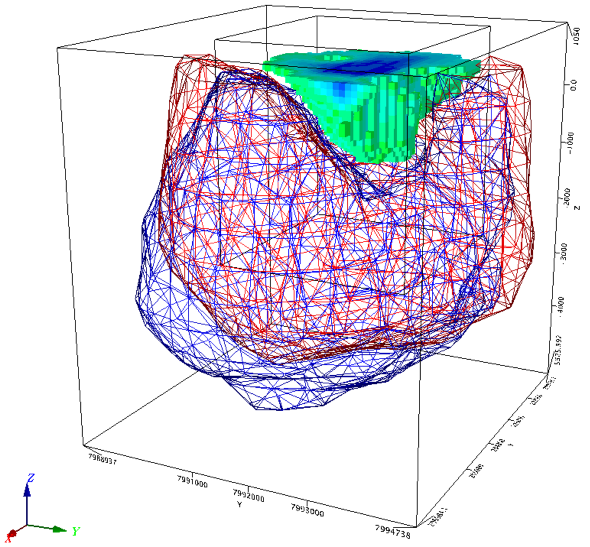


Fig. 7 - Low density/magnetic area (green) with gravimetric model (blue) and magnetic model(red).

Conclusions

Both methods, gravimetric and magnetic, show excellent delimitation of the intrusive body, since the Catalão I Alkaline Complex has a good density/magnetic contrast with the surrounding geology.

The Catalão I have a minor reminiscent magnetization, but it must be considered if we intend to do a detailed inversion. The RTP developed by Fedi et. al. (1994) was the best method, in this case, to minimize the effect of the reminiscent magnetization.

The inversions converged successfully. Both magnetic and gravimetric inversions were very similar in shape.

A low density and magnetic zone was detected inside the alkaline complex. This area is probably the area with higher carbonatite concentration, since it is less denser and magnetic then the ultramafic rocks, which compose the basic rock of the complex.

Geohysics potential methods are a great geologic tool to find, study and delimitate an alkaline complex, as mentioned in various previously published studies of other important alkaline complexes, like, Tapira (Ribeiro, V., 2008), Araxá (Pereira, W., 2009) and Serra Negra (Rugenski, A., 2006).

Acknowledgments

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