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Localized low-gravity anomalies associated with carbonatites in central Brazil's alkaline complexes and their expression in VOXEL modeling results

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Introduction

This article presents the magnetic and gravity signatures of southeastern Brazil's main alkaline carbonatite complexes and their geophysical modelling performed with Seequent's VOXEL software. These alkaline bodies are typically more magnetic than their host bodies, generating significant magnetic anomalies. They are also denser than their host rocks, resulting in positive, high-amplitude gravity anomalies. These complexes contain several types of rocks, and, in general, Phosphate, Niobium, and rare earth element mineralization are found in the associated less dense carbonatites, which are linked to a negative local gravity anomaly. Overall, all the complexes in this region exhibit significant magnetic anomalies and a positive gravity anomaly, along with a low local gravity associated with the carbonatite body and its associated mineralization.

In this article, we present the magnetic and gravimetric signatures and models of the following carbonatite alkaline complexes: Araxá (MG), Catalão (I and II) (GO), Jacupiranga (SP), Juquiá (SP), Salitre-Serra Negra (MG), and Tapira (MG), a total of eight bodies. Geophysical signatures of these complexes have already been presented for the Juquiá Complex (Slavec et al., 2001), Catalão (Requejo & Mantovani, 2008), Salitre-Serra Negra (Rugenski, 2006), and Tapira (Ribeiro & Mantovani, 2008). An integrated study was presented by Marangoni & Mantovani (2013). All of these studies show the signatures of the complexes in different ways, and some include geophysical models. In this study, we present magnetic and gravimetric anomalies in selected windows in each complex for better color scaling to compare them in a common background. In addition, we applied more recent computational modeling procedures that have evolved dramatically in recent years, allowing for updated models produced by such new technologies.

Method and/or Theory

Potential field methods in geophysics, primarily gravity and magnetics, are used to investigate subsurface geological structures and variations in physical properties (density and magnetization). Magnetic investigations measure the Earth's magnetic field and its anomalies caused by contrasting susceptibility/magnetization lithologies, aiding in the detection of structures and geological formations such as faults and ore bodies. Gravity methods, on the other hand, measure variations in the Earth's gravitational field that are influenced by density variations in subsurface rocks, allowing the mapping of sedimentary basins, intrusions, and other geological features. These methods serve as valuable tools in mineral exploration, oil and gas exploration, and geological mapping. Both methods are passive, meaning they measure naturally occurring fields.

The gravity data come from the USP database, with varied spacing but good sampling of the complexes and associated carbonatites. The magnetic data come from high-resolution airborne geophysical surveys in the public domain, with 500 m line spacing and 10 Hz sampling.

Results and Conclusions

Figure 1 shows the gravity and magnetic anomalies of the eight alkaline complexes in this study.

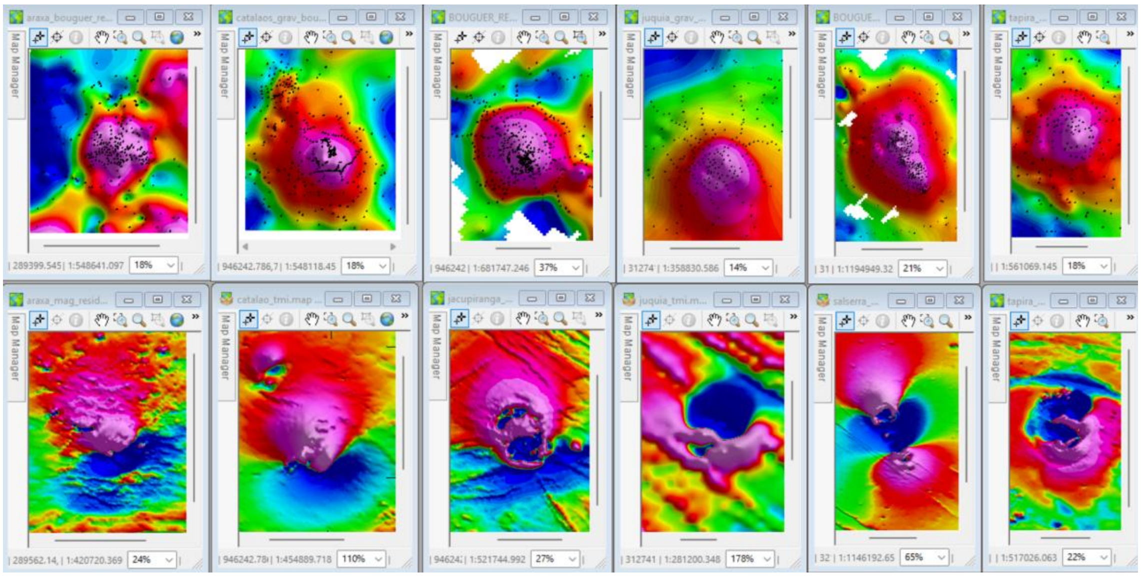

Figure 1: Gravity (top row) and magnetic (bottom) anomalies, from the left to the right: Araxá (MG), Catalão (I and II) (GO), Jacupiranga (SP), Juquiá (SP), Salitre - Serra Negra (MG) and Tapira (MG).

All the complexes' magnetic anomalies are strong and notable. The gravity anomalies are also strong and remarkable, and all but one (Araxa) present a local low from the low density of the associated carbonatite.

Figures 2 to 7 show the gravity profile and the corresponding grid (with cursor in the same position in both) for the six complexes.

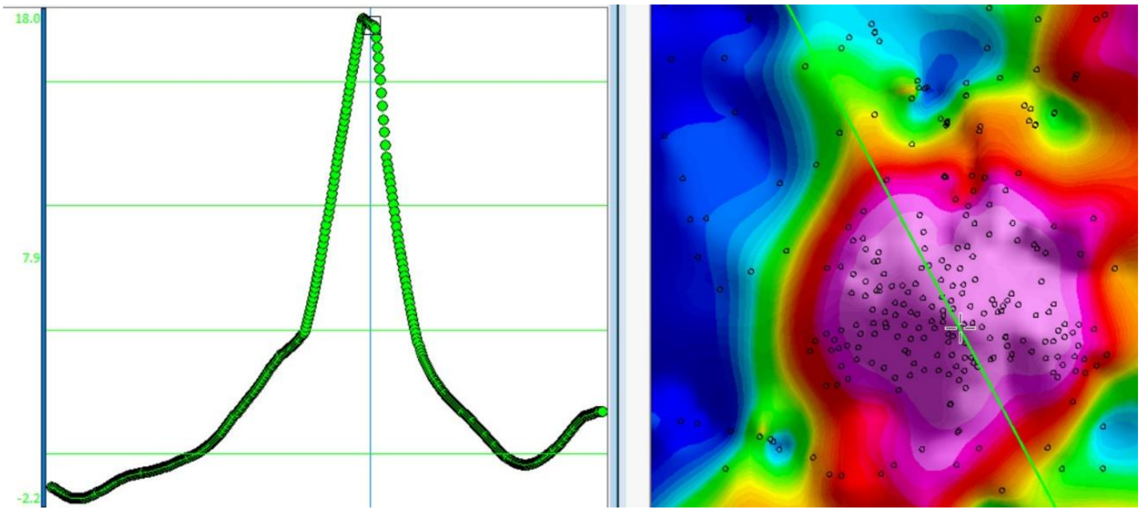

Figure 2: gravity profile (left), gravity grid (right) of Araxá alkaline complex.

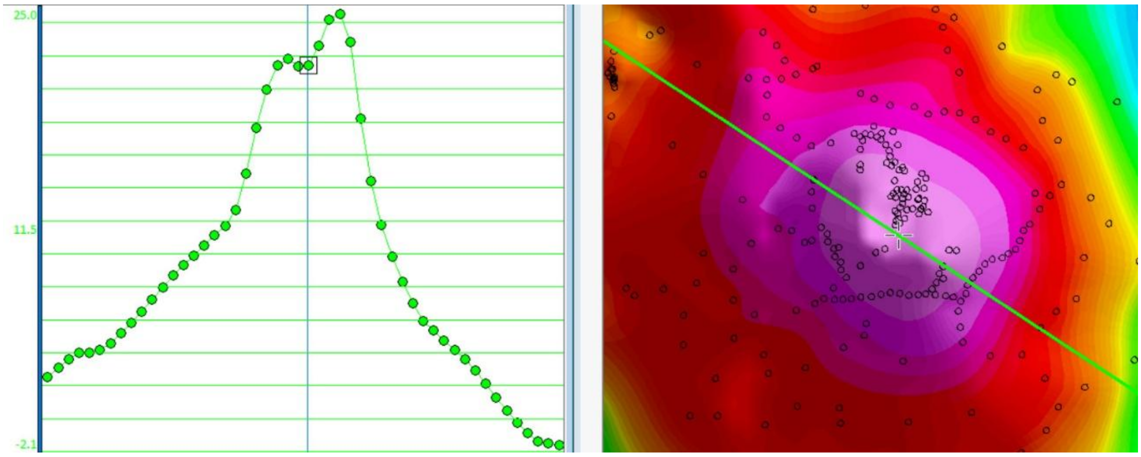

Figure 3: gravity profile (left), gravity grid (right) of Catalão alkaline complex.

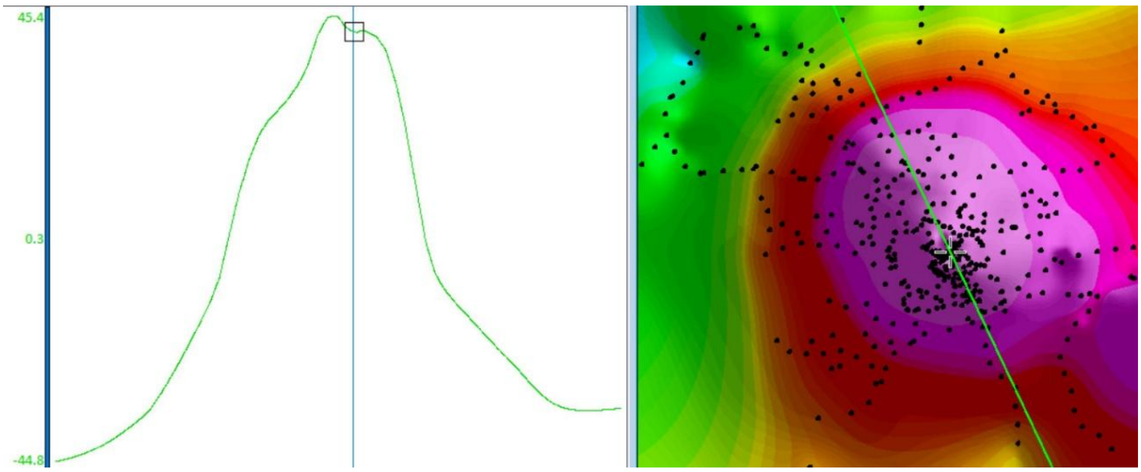

Figure 4: gravity profile (left), gravity grid (right) of Jacupiranga alkaline complex.

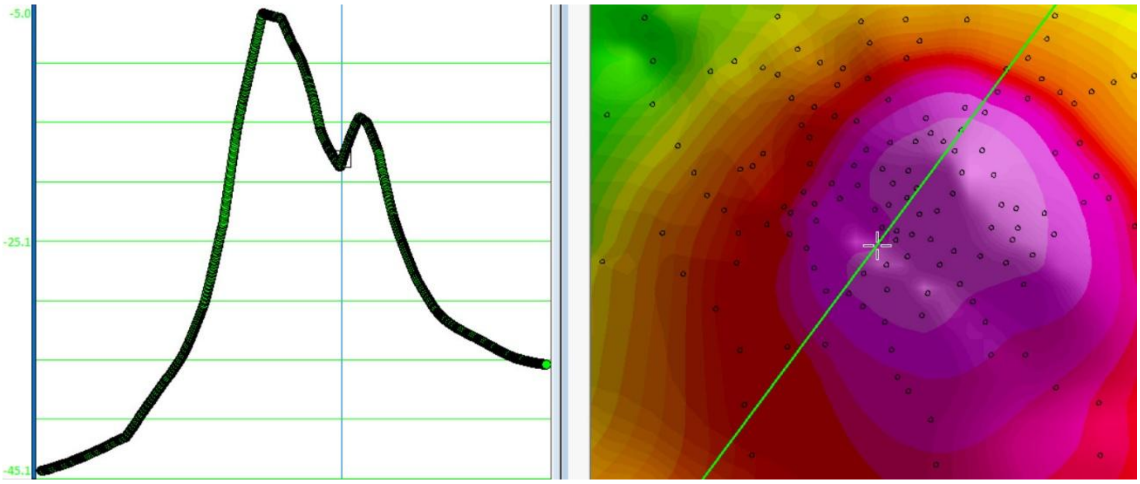

Figure 5: gravity profile (left), gravity grid (right) of Juquiá alkaline complex.

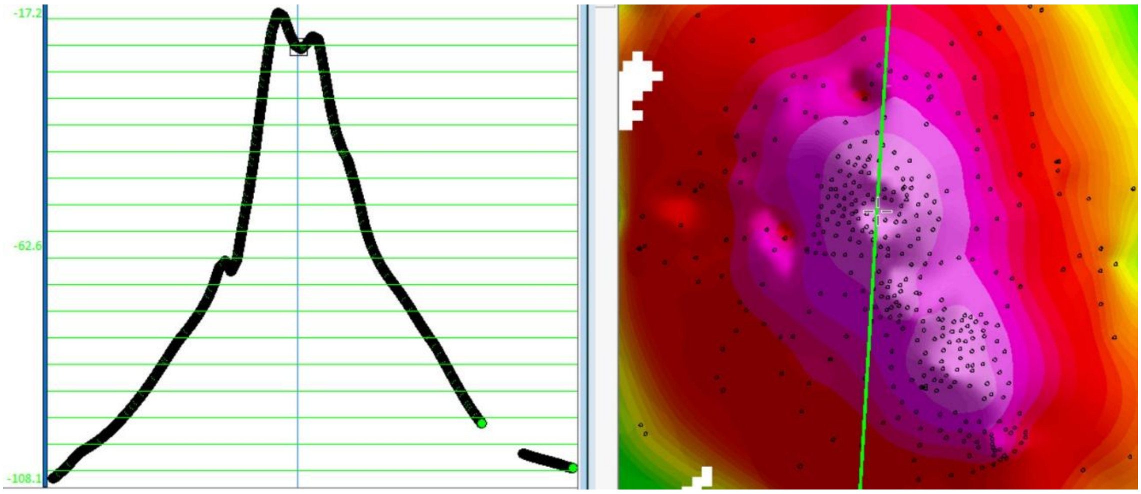

Figure 6: gravity profile (left), gravity grid (right) of Salitre-Serra Negra alkaline complex.

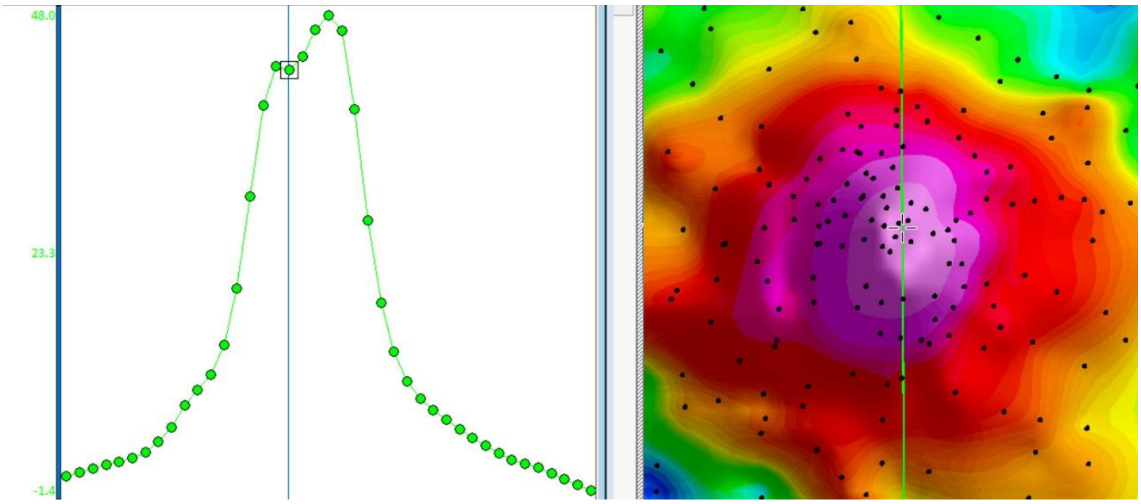

Figure 7: gravity profile (left), gravity grid (right) of Tapira alkaline complex.

All gravity local lows in the positive gravity anomalies of the whole complexes are related to Carbonatites. The final article will present all anomalies (mag-grav) and all Voxy models.