Gravity prospecting for carbonatite at the Jacupiranga Alkaline Complex, Brazil

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Abstract

A detailed gravity survey was successfully used at the Cajatí mine to confirm the continuation of the carbonatite orebody beyond it's presently recognized northern limits. The results of the modeling and interpretation of the gravity data imply the presence of a carbonatite body at a shallow depth with an extension of about 200 m in the E-W direction and of about 500 m in the N-S direction.

The knowledge of the size and position of the orebody is of a great value as it contributes to the cost reduction in the planning of borehole drilling and future mining exploration in the area.

Introduction

The Jacupiranga Ultramafic-Alkaline Complex, first described by Melcher (1954), is located in southeastern Brazil, at 230 km from the São Paulo State capital.

As a part of the Alkaline Complex, there exists an important occurrence of carbonatite, being currently mined for low grade phosphate carbonatitic ore by the Bunge Fertilizantes S/A company.

According to Gaspar (1989), the carbonatitic orebody was formed as a sequence of at least five magmatic intrusion phases into the jacupiranguite host rocks, resulting in an internal organization as illustrated in figure 1.

It has been hypothesized for some time that the orebody continues to the north beyond the limits shown in figure 1, as suggested by data from a few boreholes.

A detailed gravity survey was performed aiming at a better understanding of the subsurface structure of the orebody, as an aid to the evaluation of the feasibility of mining exploration in this area.

Methodology

The gravity method was selected taking into account the large mass density difference between the carbonatite and the jacupiranguite host rock, as shown in table 1, based on borehole core density measurements.

Gravity was measured by a Lacoste & Romberg model G gravity meter at 422 gravity stations located on a 25x25 meter regular grid, covering the area to the north of the Cajati mine.

SAMPLE	DENSITY RANGE (kg/m^3)
Carbonatite	2840 - 2860
Carbonatite with xenoliths	2900 - 3060
Jacupiranguite	3370 - 3420

Table 1. Density ranges for borehole core samples.

The measured gravity values were referred to the International Gravity Standardization Network (IGSN72) and to the Geodetic Reference System of 1969. Bouguer anomaly values were computed at each station by the application of the Bouguer and Faye corrections.

Gravity terrain corrections were applied in order to compensate for the effects of the nearby topography and of the Cajati mine pit.

The contribution to the gravity values caused by the ultramafic rocks was removed by the subtraction of a 5th degree polynomial computed by the robust estimation method of Beltrão et al. (1991). The resulting residual Bouguer anomaly is shown in figure 2.

Results

The conspicuous elongated negative anomaly in figure 2 implies the presence of a low density subsurface structure with a width in excess of 200 m in the E-W direction and with an extension of about 500 m in the N-S direction. This structure is probably the continuation of the carbonatite orebody to the north of the Cajatí mine.

The strong N-S elongation of the negative residual Bouguer anomaly makes it suitable for 2.5 D subsurface modeling. The modeling was performed by the use of the GRAVMAG forward modeling program (Pedley et al., 1994). Based on table 1, the density contrast between the carbonatite and the Jacupiranguite was assumed as -450 kg/m^3.

The results of the subsurface modeling along the two profiles shown in figure 2 can be seen in figures 3 and 4. They are interpreted as the indication of the occurrence of a carbonatite body at a shallow depth, which extends at least to a depth of 250 m below sea level.

Conclusions

The gravity survey confirmed the continuation of the orebody to the north of the Cajatí mine, as emphasized by figure 5. The subsurface modeling indicates the occurrence of carbonatite at a shallow depth, which is in good agreement with the existing borehole data.

The gravity prospecting methodology applied at the Cajatí mine is suitable for application to other carbonatite occurrences, provided there is a significant mass density contrast relative to the host rock.

Acknowledgments

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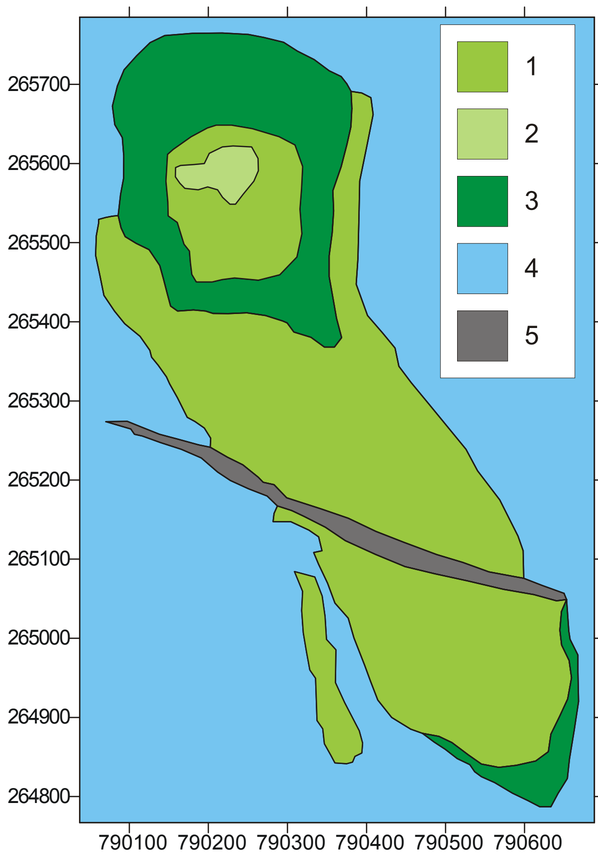

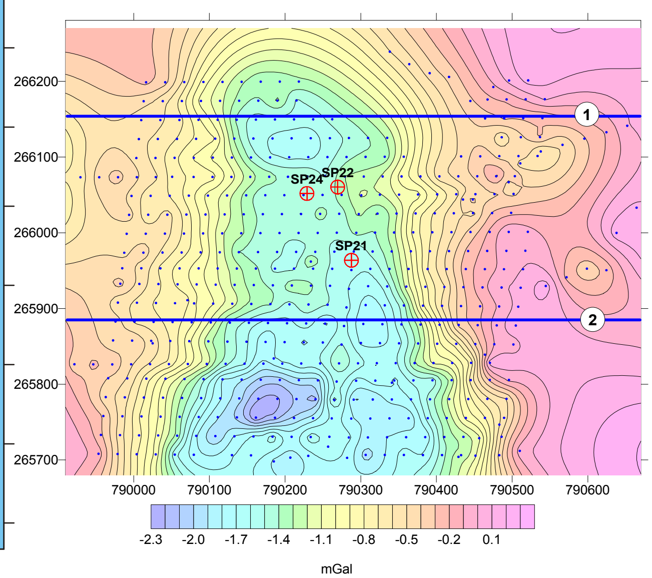

Figure 1. Carbonatite orebody internal structure, according to the geological modeling currently used by the mining company. Modified from Sant'Agostino et al. (2001). 1- Calcitic carbonatite; 2- Dolomitic carbonatite; 3- Xenolithic zone; 4- Jacupiranguite; 5- Faulting zone.

Figure 2. Residual Bouguer anomaly in the area to the north of the Cajatí mine, with the location of the gravity stations, the location of existing boreholes and two profiles used in the subsurface modeling.

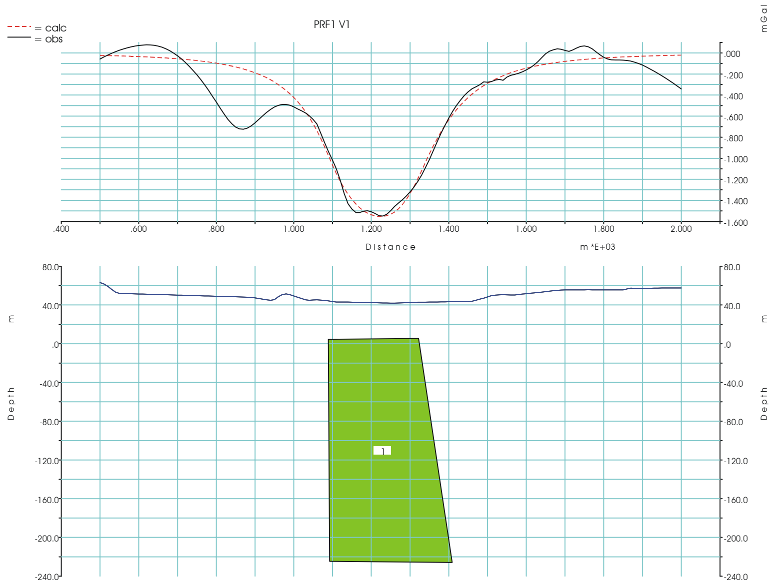

Figure 3. Subsurface model along the profile 1, showing very good agreement between the observed and computed gravity anomaly values.

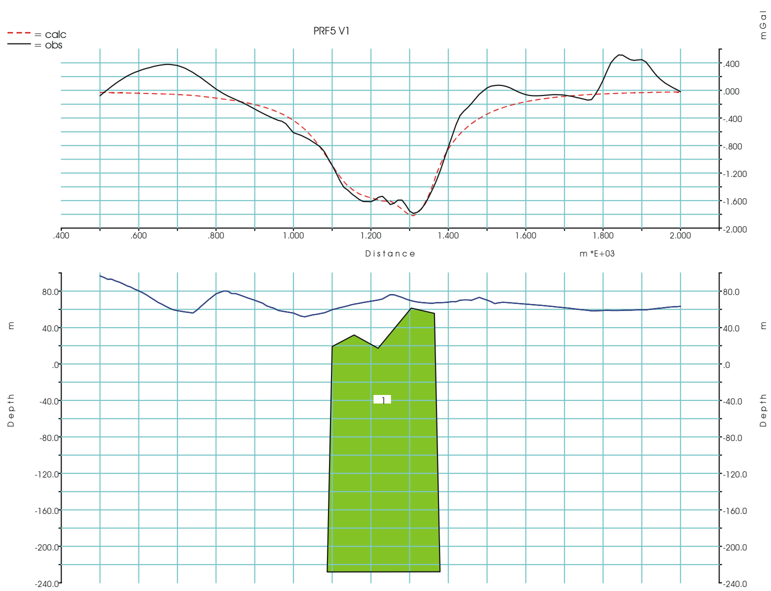

Figure 4. Subsurface model along the profile 2, showing an excellent agreement between the observed and computed gravity anomaly values.

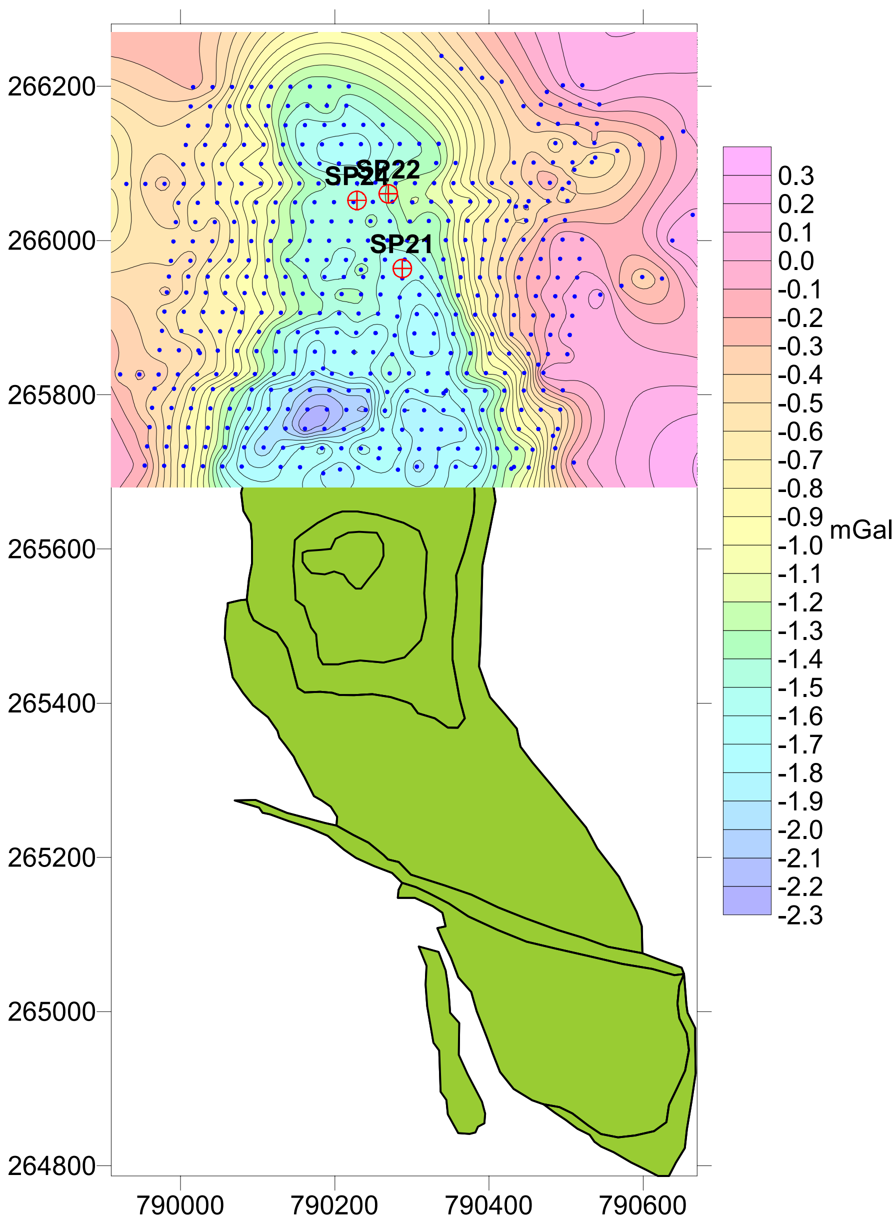

Figure 5. Superimposition of the residual Bouguer anomaly, of the location of the gravity stations and of the location of existing boreholes onto the geological model of the orebody.