ESTIMATE THE THICKNESS OF THE SEDIMENTARY DEPOSITS IN ICA – PERU BY THE GRAVIMETRIC METHOD

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Abstract

In this study used gravimetric data for determining the thickness of the sedimentary layer below of Ica city and evaluating its dynamic behavior.

The gravimetric data collected in the field were used for estimating the Anomaly Bouguer with values between -17.72 and -24.32 mGal and its filtrate allowed to separate the regional, residual anomaly and the content of noise. The spectral analysis of the values of Bouguer corrected allowed to estimating the thickness of quaternary deposits in 150 meters. The gravimetric profile found in this study corresponds to the final phase of integrating of geological, seismic and gravimetric information.

Keywords: Gravimetry, Ica, Spectral analysis, Residual anomaly and Regional anomaly.

1. Introduction

The city of Ica is located in the department of the same name and is located between the Coastal Plain and SO of the Western Cordillera (Figure 1).

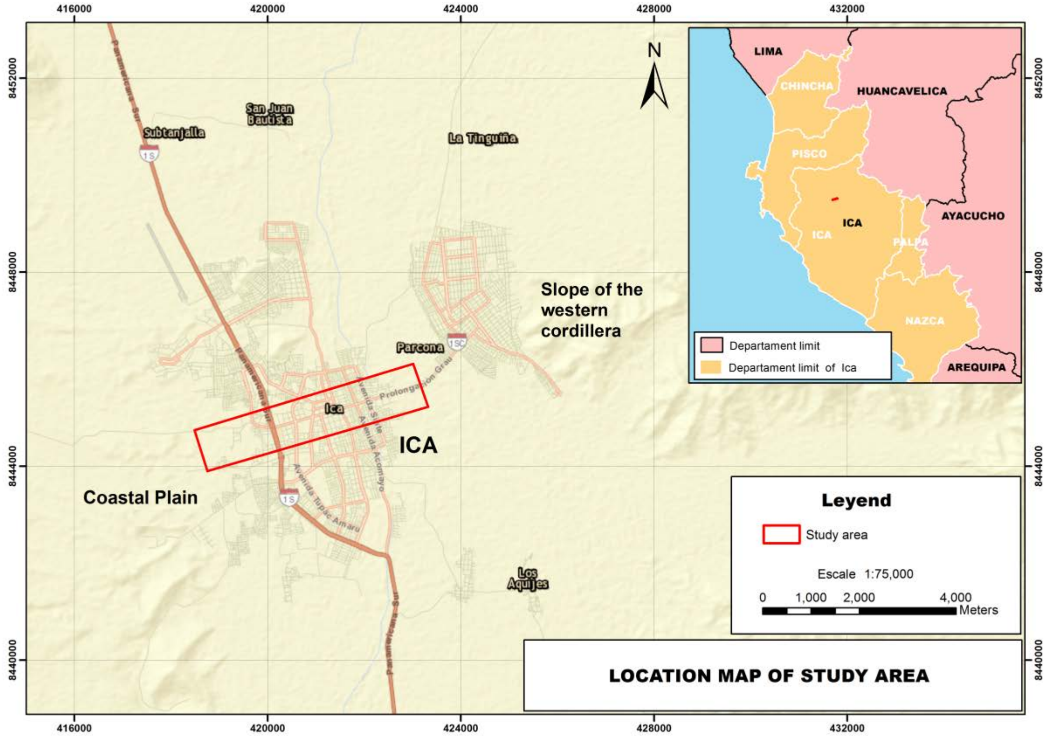

Fig. 1 – Location map of study area.

Historically the city of Ica, has been affected by several earthquakes as the occurred in 1924, 1942, 1996 and most recently in 2007. For the 2007 earthquake, with its epicenter 125 km west of Ica were produced structural damage associated with the quality of the soil on which it resides.

Historically the city of Ica has been affected by several earthquakes, for example, those that occurred in 1924, 1942, 1996 and most recently in 2007. For the 2007 earthquake, with its epicenter located 125 km west of Ica caused structural damage that were associated to quality of the soil on which it is.

According to the local geology, the study area is above alluvial deposits composed for blocks with matrix of sandy and silty (Leon and Torres, 2001). These deposits are above the mozonitas, to andesitic, pyroclastic rocks and the Quilmana and Copara formations that outcrop to eastern of the Ica city. In the same way, in the west end is the aeolian deposits that form the great Tablazo. According to the type and quality of soils, it will expected that these contribute to damage in surface by product of earthquakes. In this regard, the knowing the thickness of the sedimentary layer is very important in order to evaluating its dynamic behavior.

In Figure 2, shown the local geological map of the study area and spatial distribution of gravity measurement points.

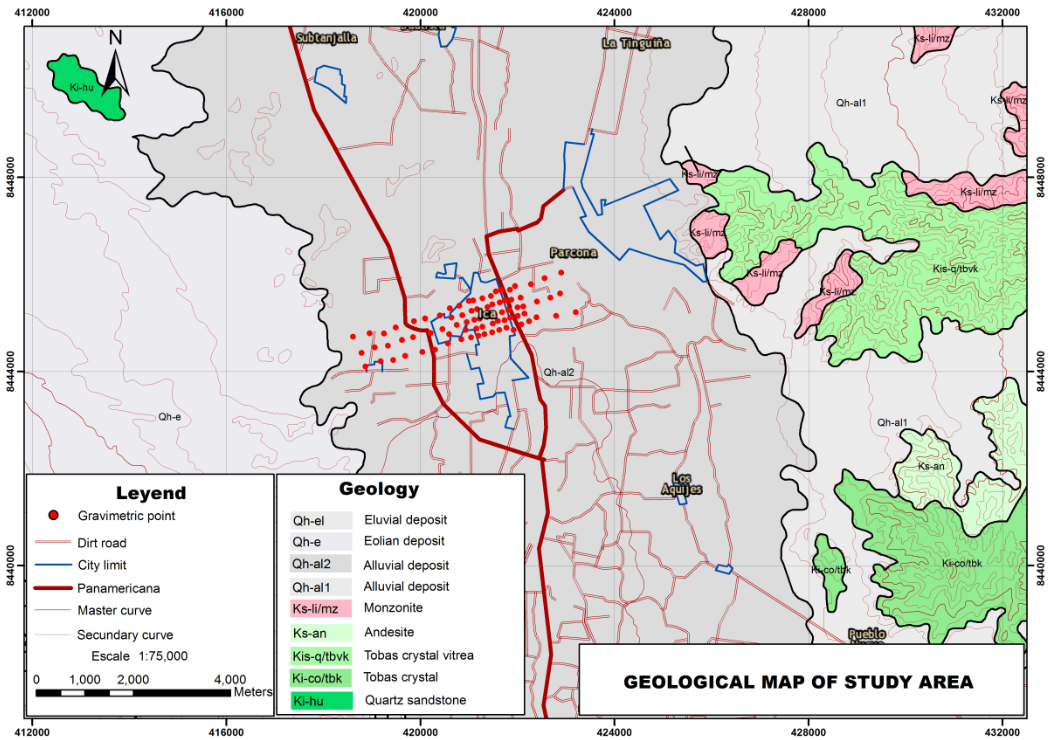

Fig. 2 – Geological map of study area and the location of gravimetric measurement points.

In the study area, it has made three linear arrays, and each one it was considered combining two seismic methods; MASW (Multichannel Analysis of Surface Waves) and MAM (Multichannel Analysis of Microtremor), in order to obtain results of the variation of shear wave velocity (Vs) in depth. The results of velocity and depth were obtained from models in one dimension with the SeisImager software.

The seismic array LS01 located east of the study area, was made in the Vista Alegre ranch, the profile of velocity shows that the depth of the rock basement is 60 meters. Also, the seismic array LS02 located in the Ica River (bridge height Puno); the result shows that the rock basement is 55 meters deep. On the other hand, the seismic array LS03 located in Santa Rosa association (west of the study area); shows that until to the depth of 100 meters, there isn't the presence of the rock basement.

2. Methodology

For this study 80 gravimetric data were acquired and distributed in 5 parallel lines; between these: 3 lines of 4.5 kilometers and 2 with 1.5 kilometers long, all with direction SW - NE; the lines were separated by a distance of 300 meters on average. The distance between each measurement point is 200 meters on average. The gravity values were obtained with the gravimeter LaCoste & Romberg with an accuracy ± 0.01 mGal. The gravity values were corrected to value of absolute gravity located in the Rio Grande tunnel (978215.134 mgal), located south of Ica.

Traditionally the heights move to the surface of the geoid, but the new standards recommend to work with ellipsoid reference, because it doesn't produce significant differences in the calculation of gravity anomaly (Li and Götzez, 2001). At each gravimetric station were determined the height of ellipsoid refered to WGS84 using a total station NIKON DMT-322.

Processing . - The observed gravity data contain the effect of all bodies spread around and below the point of gravimetric measurement. After doing the corrections of Free Air, Bouguer and topographical is obtained the Bouguer anomaly with terrain correction.The processing and calculation of Bouguer anomaly is done in the Oasis Montaj software of Geosoft. The average rocks density selected is 2.67 g / cm3 (Hinze et al., 2005).

The topographic correction allows to eliminate the effects produced by hills and valleys in each point of gravimetric measurement, for them, the models of digital elevation of topography regional and local are used; the first obtained since Shuttle Radar Topographic Mission (SRTM) and the second, the elevation values measured at each point of gravimetry, both with a grid of 50m x 50m resolution.

The topographic correction developed by Kane (1962) and Nagy (1966) bring as results a grid of topographic correction, which, through a sampling operation assigns the value of correction to each gravimetric point. The interpolation of Bouguer anomaly values is shown in Figure 3.

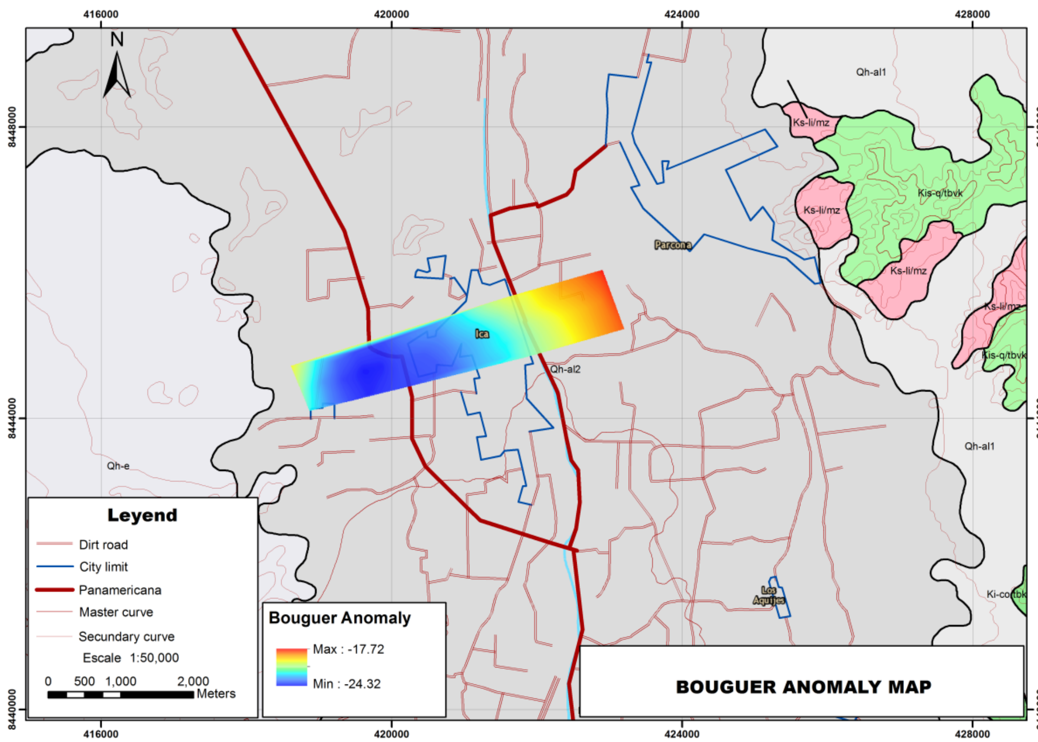

Fig. 2 – Bouguer anomaly map.

Culminating with processing, the Bouguer anomaly is the result of different sources and gravimetric effects that corresponding to regional structures (regional anomaly), plus the gravimetrical effect of local and superficial character (residual anomaly).

Spectral Analysis .- Spector (1968) and Spector & Grant (1970) developed the method for determining the depth of the anomalies from the spectral analysis. The method consists to transform the grid of Bouguer anomaly in the space domain, to frequency domain, as shown in Figure 4.

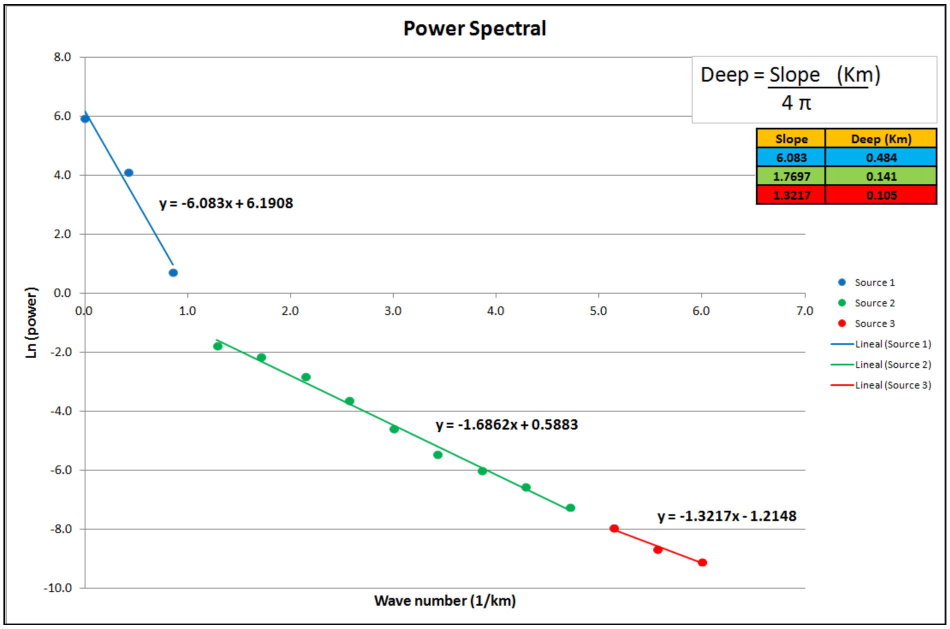

Fig. 2 – Spectral analysis since Bouguer anomaly map.

In this Figure is shown the sequence of three slopes for the spectrum, whose value divided 4π, allows to know the average depth of the center of mass of each anomaly. The line of higher slope is associated with the depth of the masses that generate the regional anomaly, the second with the depth of the intermediate sources and the third with the most superficial sources.

3. Gravimetric profile

A gravimetric profile (A- A') with SW -´NE direction, in order to understand the variation of thickness of the sediments. The profile of 4.6 kilometers in length, corresponding to the middle part and parallel the gravimetric lines (see Figure 2 and 3). For the generation of profile was used the GM- SYS module of Oasis Montaj and considers as input information: the map of Bouguer, the results of spectral analysis, the deeps calculated since seismic method and the local topography of the area. The gravimetric profile is shown in Figure 5.

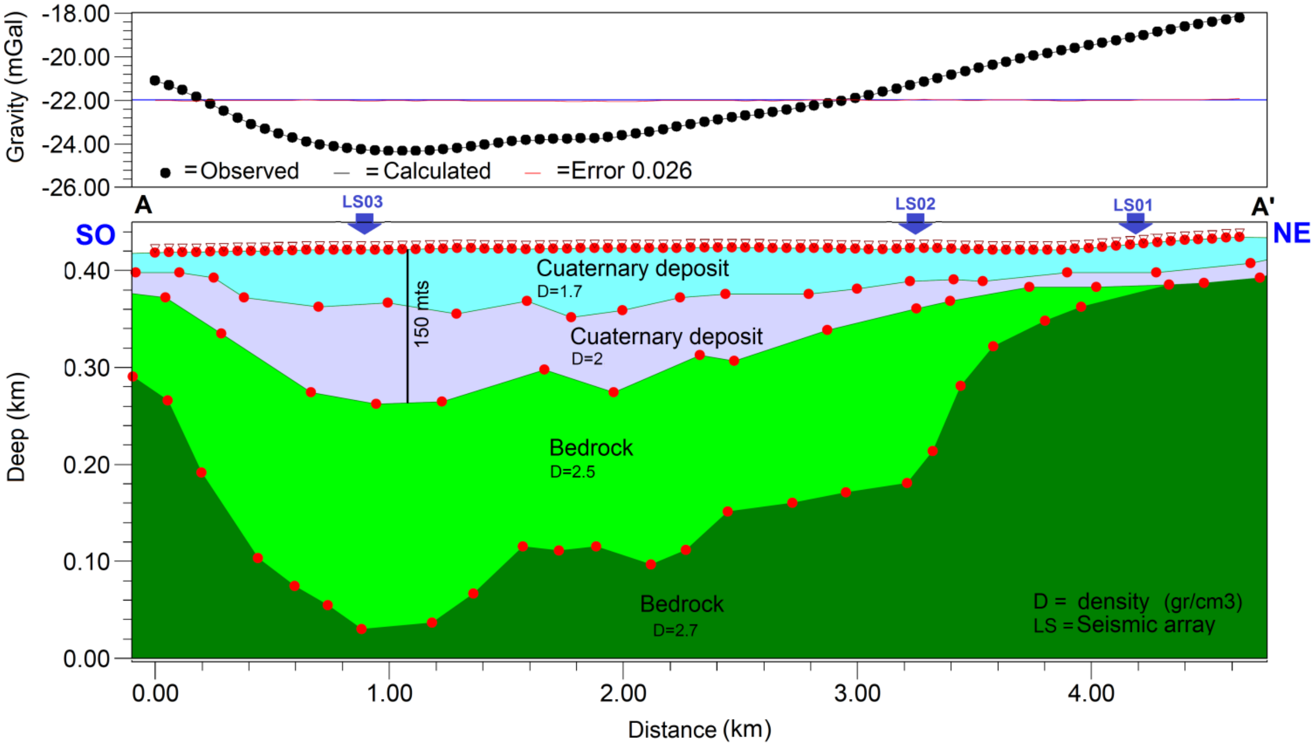

Fig. 2 – Gravimetric profile of sedimentary deposits and bedrock. (A- A ') indicates the orientation of the line according to Figure 4.

In Figure 5, is shown the variation in thickness of the sediments, specifically in the area located at the SW end of the profile is observed (from 0.4 to 2.4 km) have greater thicknesses (150 meters) and while increasing the topographic altitude decreases the thickness (< 60 meters).

4. Conclusions

According to gravimetric study, the thickness of the sediments is variable in the study area, the maximum thickness located in the West end (150 meters) and minimum thickness in the east (60 meters).

The sediments are constituted by eolian, alluvial and pluvial deposits, which expands throughout the study area and the bedrock consists of andesites and pyroclastic rocks, altered by intrusions of monzonites.

The radial average of thickness of the sedimentary deposits found through spectral analysis is consider as surface sources.

The result of sediments thickness are essential data for calculating of the dinamic response of soil and the definition of microzones in the Ica city.

4. Acknowledgements

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5. Copyrights

5. References

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