GRAVIMETRIC MAP OF CHILE

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Abstract

This presentation shows the progress of Chile gravimetric map, scale 1:500,000 being developed by the Military Geographic Institute of Chile (IGM) and Enterprise Services in Mining and Engineering Geophysics (SEGMI). This document corresponds to the Santiago (1), Rancagua - Talca (2) and Concepcion (3) Maps, which are located between latitudes 32° S - 38° S. The main basis of this work is the contribution in knowledge of the potential gravity field of the earth. This information is materialized showing the natural basic field of gravity of Chile through thematic maps of the Bouguer anomaly and isostatic residual scale 1:500,000, which include the mass distribution with different densities, which do not always reflect surface bodies which are important in the genesis of geological bodies that often have economic interest.

Introduction

Knowing the soil structure has always been the goal for geodetics, geophysicals and geologists. Firsts directed to the knowledge of the exact shape of the earth and its parameters that make it up, seconds to the knowledge of the structure, composition and processes that generated it and the third group is directed to study the genesis and distribution of materials and natural resources to locate and quantify economic interests. In this context, expanded studies of global and regional processes have advanced knowledge of the solid earth by connecting the core with the applied field in many cases.

This work is being done by the IGM and SEGMI with gravity data from different sources such as Canuto and Zuñiga (1998), Convention Department of Geophysics, University of Chile IGM-National Geospatial-Intelligence Agency (NGA), Empresa Nacional del Petroleo (ENAP), SEGMI, Colaborative Research Center 267 (SFB 267) Deformation processes in the Andes of Germany and data collected from SEGMI and IGM.

For the preparation of the 3 maps that are presented in this article it is use about 10,930 stations. Figures 1, 2 and 3 show the Bouguer anomaly map in the Chile context.

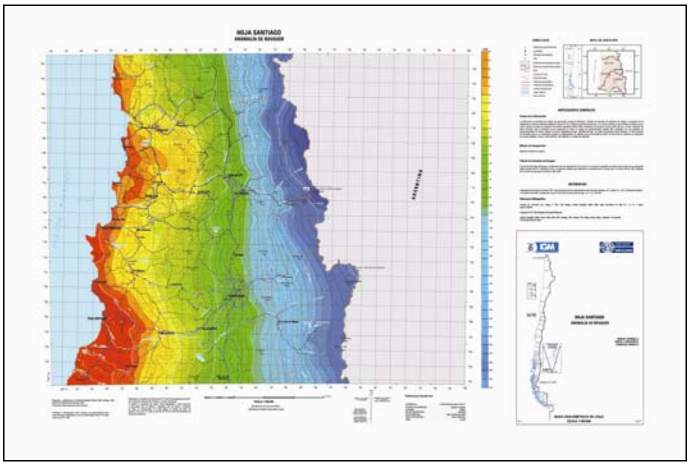

Figure 1 “Santiago Bouguer anomaly”

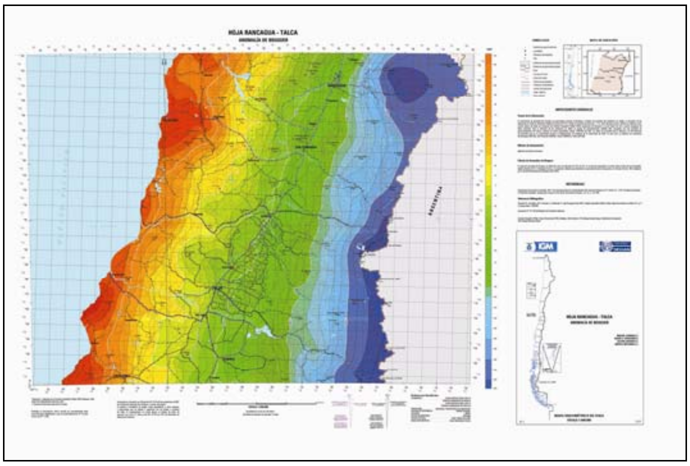

Figure 2 “Rancagua - Talca Bouguer anomaly”

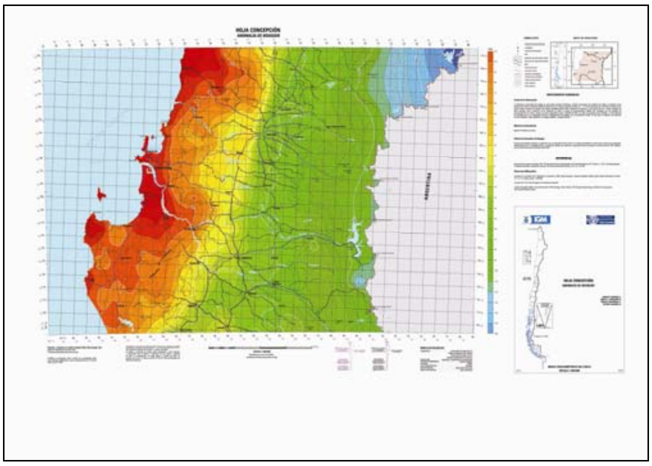

Figure 3 “Concepcion Bouguer anomaly”

Tectonic setting

The importance of subduction processes in active continental margins is generally accepted, but the phenomena associated with them have not yet been fully understood. The Andes offer an excellent opportunity to better understand the relationship between the processes of subduction and continental tectonism. The subduction zone involving Santiago, Rancagua - Talca and Concepcion maps has important tectonic features that are reflected in the potential field of gravity. The subduction zone involving Santiago, Rancagua, Talca and Concepción (32 ° S - 38 ° S) have major tectonic features that are reflected in the potential field of gravity. Among them we mention the transition that occurs in the subduction angle of latitude 32 ° S. To the north of this latitude the subducted slab is subhorizontal, while in the Andes volcanism is absent. To the South of latitude 32 ° S the plate has an angle of about 25 degrees to the east, also began active volcanism and the beginning of the Central Valley. According to the hypothesis of Cahill and Isacks (1992) the change is rapid and steep angle.

In the determination of the angle and thickness of the slab much importance had the study of focal mechanisms of shallow earthquakes and deep, Pardo et al. (2004) in a study of more than 6,000 earthquakes confirmed previous studies related to the subduction angle and thickness of the Benioff zone. For the location of the hypocenters Acevedo (1985) used a two-dimensional model. The longitudinal wave speeds used in the model for the area (32° -38° S) is given in Table I.

Table I

Deep Km	V_p Km/s
0 – 5	5.5
15.5 – 47.9	7.0
> 47.9	8.1

Using gravity Dragicevic (1970) makes a transcontinental profile at latitude 33 ° S, Valparaiso-Buenos Aires, Figure 4, the results are a first attempt to quantify the thickness of the crust in the sector. In Chile he obtains values of 7 km under the sea trench, 25 km under the sector of Valparaíso, Santiago and 35 km under 57 km in the Andean zone. For the model he used densities of 2.84 for the crust and 3.27 for the mantle.

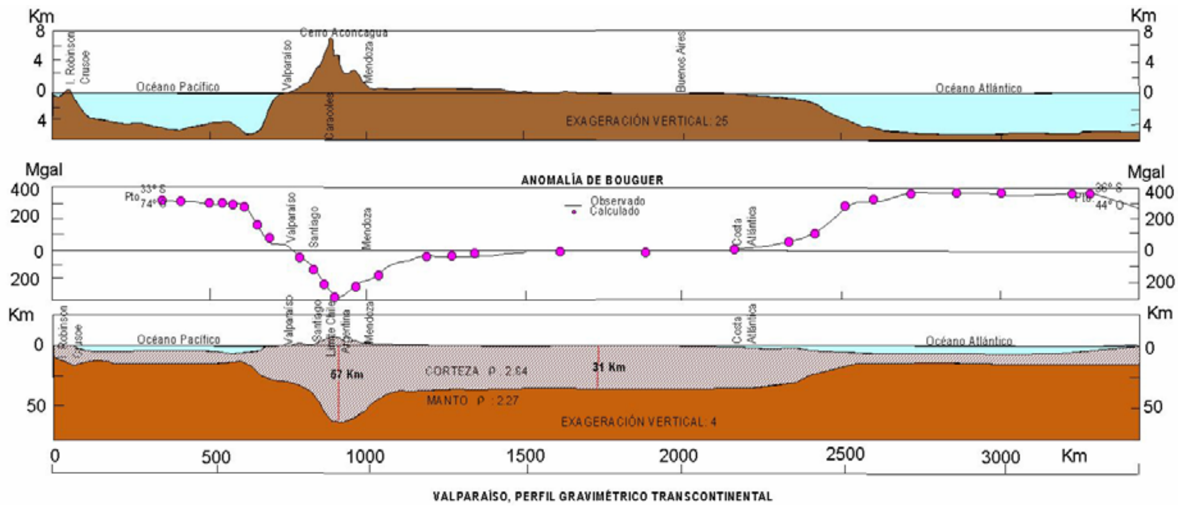

Figure 4 Gravity model transcontinental Dragicevic 1970.

METHODOLOGY

The methodology used was adjusted to normal procedures this type of work often involves; the collection of baseline data, review them, scheduling, field operation, validation and data reduction and presentation of results.

The new measures of gravity, altitude and position held within the framework of the Gravimetric Map of Chile 1:500,000, scale, mainly in the regional road network.

Although in a regional study, the ideal is to have a regular grid of readings, this was not possible given the topography of the regions. In the field work, to improve the coverage of gravity stations we attempt to maintain a separation between measurement stations of no more than 3 km. The total data base incorporated into the final map includes measures largely made through the road network of first and second class. The base maps used to locate the new stations of gravity of the project were topographic maps at 1:50,000 and 1:250,000 scale of the IGM and the road maps of the V to VII regions 1:500,000, scale of the Ministry of Public Works MOP (1999). Stasting with the 1:250,000, scale map, it is prepared the digital topographic base used as the basis for the filing of the gravimetric data. All distances were measured with satellite equipment (GPS), the odometer of the vehicle, road intersections and other unique items. The fieldwork was extended north and south of the area covered by the map in order to eliminate edge effects, at least in those areas during the making of maps.
The normal procedure to unify gravity data is to link them to a common reference system, for which, in this case, we used the International Reference System IGSN 71 (International Association of Geodesy, 1971), which allows comparison of data of the same type at the regional and global levels. The information was linked to the National Network of Gravity which is maintained in the Department of Geophysics, University

of Chile (Avendano and Araneda 1993), updated in the IGM and the Network of Gravity of the Metropolitan Region (Araneda Contreras 1998), which are referred to the datum IGSN 71. To make the maps analyzed in this paper, it is used the National Network compiled by the Department of Geophysics, University of Chile.

FIELD MEASUREMENTS

About 90% of measures were taken by ground gravimeters LaCoste and Romberg model G gravimeters and the remainder by SCINTREX and old Worden (ENAP), whose readings were checked with known data to integrate the total database. Instrumental drift checks, height and coordinates were rigorously tested using existing data and mapping control.

FIELD OF GRAVITY ANOMALIES

In the process the gravimetric map of Chile it is use as reference the 1967 formula, adopted by the International Committee of Geodesy known as Geodesic Reference System (GRS 67, 1967). This is because much of the existing data in Chile and South America are referred to this datum, well-known formula to calculate the theoretical gravity based on the latitude of a station is expressed as follows

$$g_0 = g_{ec}\ (1 + C_1\ Sen^2\ \varphi + C_2\ Sen^2\ 2\varphi)$$

where:

$g_0 =$ Theoretical Gravity (mGal

$g_{ec} = 978031.85$ mGal (value of normal gravity in Ecuador)

$C_1 = 0.005302357$

$C_2 = -\ 0.000005864$

φ = latitude

The values of gravity at any point on the surface of the Earth depend on factors such as latitude, altitude, topographic effects, earth tides and density distribution of subsurface formations (2.67 gr/cm^3). . To isolate the effects of the densities of the subsurface is necessary to correct the other factors that change the gravity.

CALCULATION OF BOUGUER ANOMALY

The value of the Bouguer anomaly it is obtained from the comparison of corrected gravity data for each station, with the theoretical value of gravity to that same point. This is calculated by differentiating the observed gravity and their reductions on gravity theory to the same point relative to a reference level, which is normally the average level of the sea. The formula expressing the Bouguer anomaly is the following:

$$AB = g_{obs} + \Delta g_m - \Delta g_B + \Delta g_{CA} + \Delta g_{top} - g_0$$

Where:

AB: Bouguer anomaly (mGal)

$g_{obs} + \Delta g_m$: Observed gravity + tides correction

Δg_B: Bouguer Correction 2.67 gr/cm^3

Δg_{CA} :Free air correction

Δg_{top} :Topographic correction with density b= 2.67 gr/cm^3

g_0 :Theoretical gravity

CALCULATION OF ISOSTATIC RESIDUAL

The effect of isostatic compensation of topography was calculated assuming an Airy - Heiskanen model programmed into Airyroot of Geosoft software, which calculates the gravitational attraction of sea level whose parameters are: density Mantle 3.2 gr/cm^3, thickness at sea level 33 km, density of sea water 1.03 gr/cm^3, contrast crust density - Moho 0.53 gr/cm^3 and sea water - Moho 2.17 gr/cm^3.

The gravity effect of this model was calculated by the method of Parker (1973), which determines the effect of gravity by a simple model, bordered by a horizontal plane and an interface defined by a grid. This effect is subtracted from the Bouguer anomaly at the station level to get the residual isostatic. Figures 5, 6 and 7 show the maps of isostatic anomalies with gravity the main domains.

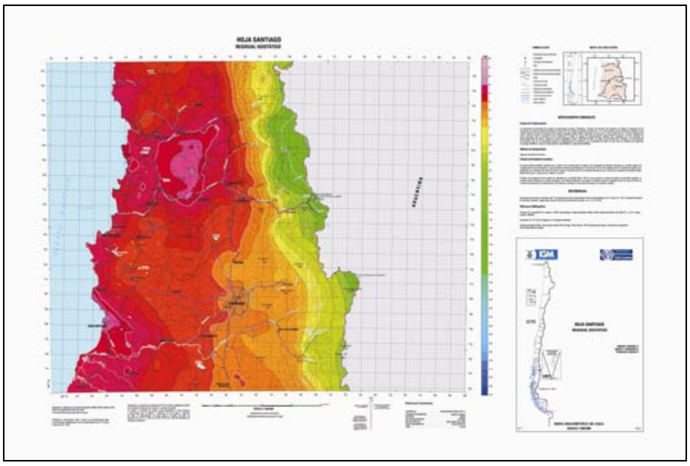

Figure 6 “Santiago isostatic anomalies”

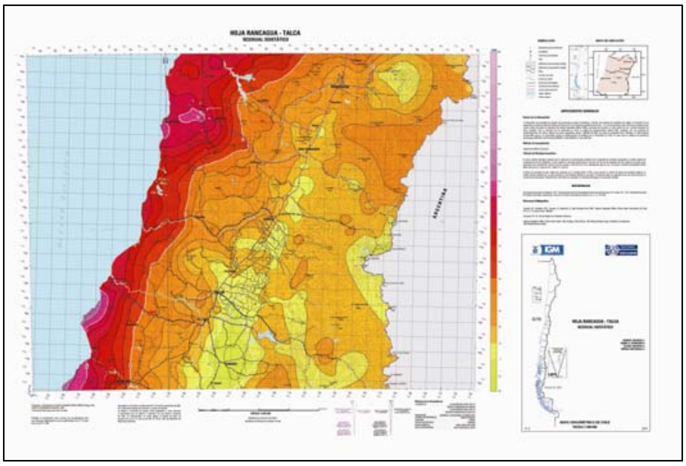

Figure 7 “Rancagua - Talca isostatic anomalies”

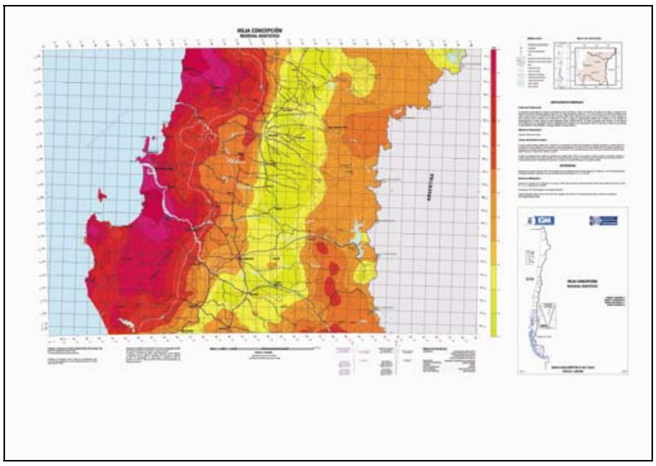

Figure 5 “Concepción isostatic anomalies”

CONCLUSIONS

Due to possible interpretations of the gravimetric potential field that can be generated depending on the densities that are considered a structure as complex as is the Andes, these conclusions are free for those interested authors that surely must have a large collection of geological history and geophysical or other for an interpretation as close to reality.

The similar results presented are the foundation to see more of our planet.

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