SOUTH CENTRAL ANDES GRAVITY, NEW DATA BASE

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ABSTRACT

From 1993 to 1998 approximately 3.927 gravity stations were taken in the Central Southen Andes, comprising the southern central zone of Chile and the central western part of Argentina, between latitudes 37.50ºS to 42.5ºS and 69ºW as far as the coast of the Pacific Ocean. To this information, 9.123 old stations were included, which were reprocessed and when in some doubt, were remeasured. Now the the database contains 13.050 gravity stations available which can be used along with other geophysical and geological information for an interdisciplinary interpretation to be able to understand some structural aspects and evolution of the Southern Central Andes. In this paper, we present the new data base by means of maps of Bouguer anomaly and isistatic anomaly, together with a very preliminary interpretation.

OLD DATABASE

The first gravity measurements taken in a systematically in the area were carried out by the present National Imagery Agency (NIMA) under the sponsorship of the Instituto Geográfico (IGM). Later, the Geophysical Department of the University de Chile (DGF) took control of the systematization of the information, updating the National Gravity Network and incorporating over 85% of the new basic sations in Chile. Of the systematization, Dragicevic (1970) made the interpretation of the Central Andes. Although with scarce data he obtained general features of the Andes, showing a strong gradient of the regional from the coast as far as the Chilean Andes. The distribution of the gravity stations do not allow to to see short waves, which can indicate anomalous structures in the crust that can be significant for the evlolution of the Andes.

NEW DATA BASE

Within the academic activities carried out between the DGF and the Frieie Universität of Berlin the project 'Integrated Study of the Seismic risk zone of the Southern Central Andes 38-42ºS under the auspices of the Volkswagen Foundation of Germany, Araneda and Avendaño (1998). This project had as the objective the construction of a new gravimetric database in the southern-central zone of Chile and central-west zone of Argentina, through a recopilation and updating of the existing measurements, complemented with additiional explorations and interpretationos of the gravity data, with the help of the available geophysical information.

FIELD WORK AND CORRECTION

The file of the authors'measurements was composed by 3.927 gravity stations, out of which 2.997 were taken in Chile and 1.000 in Argentina. The 3 km distance was established to carry out the measurements, regardless the fact that the distances were minor as it happened with the data of Empresa Nacional del Petróleo (ENAP) that were located each 1 km and the ones of the study of the Ofqui-Liquiñe Fault each 0,2 km. This procedure allowed to use almost all the available and reliable information of the region. The additional sources that contributed with gravity data were the following: ENAP (8.000 stations), the Project of the National Imagery Agency (NIMA) (180 stations) and Moreno Project (1996) contributed with 283 stations. All the measurements are linked to IGSN 71 gravity *datum.* The distribution of the gravity stations are shown in figure 1. Fortunately, most of the base stations used in the region correspond to The National Graqvity Network of Chile. The base stations established in Argentina were linked to IGSN 71 station of Puerto Montt and whose parametes are the following:

Station	Gravity (mGal)	Latitude	Longitude	Height (m)	Location
47612J	980282.26	41º 25.9' S	73º 05' W	81	BM Field El Tepual

Below are the parameters of the base stations used in Argentina and Chile:

Station	Gravity (mGal)	Latitude	Longitude	Height (m)	Location
8H91	979913.45	40º42.17'S	71º56.50'W	1306.7	Chile-Argentina border
Bariloche	980015.95	41º08.66'S	71º09.71'W	846.0	Bariloche Airport
Nodal 244	979926.95	39º57.20'S	71º04.17'W	774.84	Plaza Junín de los Andes
Nodal 63	979785.65	38º54.09'S	70º03.81'W	1011.44	Plaza Zapala
9309 TE	980013.58	38º43.60'S	72º38.21'W	92.96	Plaza Temuco
93VALD	980130.86	39º48.61'S	73º14.58'W	9.60	Plaza Valdivia
93OSOR	980251.06	40º34.74'S	73º07.44'W	31.30	Plaza Osorno
12H20C	980382.79	42º28.75'S	73º45.72'W	40.70	Plaza Ancud

The control of the instrumental derift was carried out rigurously in the initial and intermediate stations of each circuit. These values were all the time in the permitted ranges, though the circuits were carried out by third class roads. The instrument drift used hardly exceded 0,1 mGal (1 mGal=10^5 ms^2).The gravimeters used were Lacoste & Romberg G411 and G64.
For the height controls 2 altimeters were used: Wallace and Tiernan models FA181 with a measurement range of 5,000 m and height precision of 1 m. These were calibrated in levelling lines with a height difference of 3,000 m. The height control was rigurous. For that, all those points of elevation known, mainly levelling lines of the IGM in Chile and Argentina, Railways stations, water lake mirrors, singular points and medium sea level with its respective corrections by tides was used.
The determination of the geographic coordinates was carried out through the satellite positioning GPS and the help of cartography at scale 1:50.000 and 1:250.000 of IGM in Chile and the map scale 1:500-000 of the Argentinian Automobile Club. It is estimated that the positioning error was 0,25 km which corresponds to an error in the gravimetric anomaly of 0.13 mGal, effect caused by taking an imprecise latitude.

BOUGUER ANOMALY

Figure 2 shows the Bouguer anomaly obtained. This anomaly mainly corresponds to terrestrial data. As usual**,** in the offshore area the Bouguer anomaly is replaced by the Free Air anomaly. To obtain the Bouguer anomaly the following formula was used:

$$AB= g_{obs} - g_o - \Delta g_B + \Delta g_{CA} + \Delta g_{top} + \Delta g_M$$

Where

AB= Bouguer anomaly

Δg_{obs} = gravity observed

g_o = theoretical gravity

Δg_B = Bouguer correction (ρ= 2.67 gr/cm^3)

Δg_{CA} = free air correction

Δg_{top}= topographic correction (ρ= 2.67 gr/cm^3)

Δg_M= tidal correction

ISOSTATIC ANOMALY

The topographic isostatic compensation effect was calculated assuming a Vening Meineiz regional compensation mode, that considers the topography as a load over a continous crust, flexibly deformable with flexural rigidity of 1E+23 Nm, crust density of 2.67 gr/cm^3, water density of 1.03 gr/cm^3, mantle density of 3.2 gr/cm^3 and a crust thickness at sea level of 33 km. The gravity effect of this model was calculated by the Parker method (1973), which permits a calculation of the gravity effect through a simple model confined by a horizontal plane and an interface defined by a grid. The result can be explained as a Taylor series in the frecuency domain. Later, this effect is substracted from the Bouguer anomaly at the levelled station.

RESULTS

The Bouguer anomaly in the continental part has a maximum regional of 120 mGal in the 38-42ºS segment. South of parallel 39º, the regional diminishes to 100 mGal. Those effects are closely bound with the crust. Thickness due to the isostatic compensation, there appear numerous unknown anomalies, *e.g.,* the positive anomaly in the 40-42ºS and the 73-74ºW segment that can be extended much farther south. This anomaly appears just in the Central Valley, beginning approximately in the proximities of La Unión as far as south of Maullín. The most symptomatic characteristic of this anomaly is that it is found pracatically all over Quaternary sediments. The medium value of this anomaly is +50 mGal.
The gravimetric minimum of the Andes is found in Argentina with a value of –80 mGal, and in north-south direction.
This minimum would be indicating that the maximun thickness of the Andes is approximately 40 km. This minimum is approximately in the Sierra of Catan-Lil, seen mainly in front of the cities of Aluminé and San Martin de los Andes.

According to the magnitude of this anomaly, it extends far south and north of the region indicated above.
The most interesting characteristics of the isostatic residual are the following:

1) The coast range fundamentally composed of metamorphic rock of Paleozoic age show in general negative anomalies.
2) The Central Valley in Chile, covered with 2,000 to 4,000 m of Quaternary sediments, shows positive anomalies.
3) The major values of isostatic residuals are located approximately between latitudes 40.5ºS and 42ºS under Quaternary sediments of the Central Valley and this is likely due to the existence of a minor abnormal thickness of the crust in the zone. This would infer that the high densities of the materials that make up the upper mantle are reflected in the residual anomalies.
4) In general, the isostatic residual shows a general pattern of south-north orientation in which the major values are located in the Central Valley in a segmented way.

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