THE ARGENTINA-CHILE ANDES. CRUSTAL THICKNESSES, ISOSTASY, SHORTENING AND ANOMALY PREDICTION FROM GRAVITY STUDIES

Antonio Introcaso(1), María Cristina Pacino(1) and Fernando Guspí(1)

(1) IFIR (INSTITUTO DE FISICA ROSARIO) - (CONICET - U.N.R.)
FACULTAD DE CIENCIAS EXACTAS, INGENIERIA Y AGRIMENSURA (U.N.R.)
Av. Pellegrini 250 - 2000 - Rosario - ARGENTINA

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INTRODUCTION, RESULTS AND CONCLUSIONS

We present the results of a comprehensive study made over 14 E-W sections of the Andes across Argentina and Chile, starting at the Pacific Ocean and reaching most the Atlantic Ocean. Isostatic gravity anomalies, crustal models and shortening estimates were analyzed at all them. Particularly at 22°, 25° and 32° S latitude, seismo-gravity models performed indicate that the equilibrium of these Andean sections behaves "grosso modo" as an Airy isostatic system. In all the studied sections, a good correlation is observed between the Andean masses and the regional Bouguer anomalies, and Andean roots calculated by inverting those anomalies also strongly resemble the isostatic roots. Elastic or visco-elastic models under vertical loads, even with complicated hypotheses (e.g. Burov and Diament, 1995), always yield shallower and smoother roots, and therefore they seem not to be adequate for the present situation. Some narrow gravity peaks observed on certain sections, however, may suggest a flexo-compressional deformation; this investigation could be the subject of future work.

Crustal models are better determined on those sections at which deep seismic data are available. Thus, at both 22° and 25° S latitudes, where the Nazca plate subducts with "normal" angle, seismic models render a crust about 60 km deep. (Schmidt et al., 1993; Schmidt, 1994). Our gravity models are consistent with the former as long as one assumes a lithospheric mantle heating of the area, as proposed by Isacks (1988). No significant influence of the plate on the determination of the crustal thicknesses is observed. At 32° S, the seismo-gravity model yields approximately an Airy system (Introcaso et al., 1992). The plate subducts horizontally here, with probable influence of positive sign over the gravity anomalies. From seismic analyses, Regnier et al. (1994) report crustal depths beneath Precordillera and Sierras Pampeanas of San Juan exceding significantly those calculated by gravity inversion without seismic support. This fact seems to suggest that a gravity balance could be developed between the positive effect of the Nazca plate and the negative effect of the deeper roots.

Summarizing, both "normal" and "flat" subduction would produce heterogeneity in the upper mantle, and they would play a role in the determination of the Andean crustal thicknesses.

Table 1 and Fig. 1 report maximum Bouguer anomaly and derived maximum crustal thickness and shortening at each section. Shortening, which indicates a decreasing from N to S in the degree of compression of the Cordillera axis, is undoubtely the main mechanism of the Andean uplift.

Our institute developed last year complete Argentine Bouguer and free-air gravity anomaly charts with a separation of 5' x 5' between grid points (Guspí et al., 1995). They include Chilean anomalies from a SERNAGEOMIN data base. We also prepared charts which represent: (1) Free-air anomalies, (2) Bouguer anomalies, (3) Isostatic corrections, (4) Thermal correction for the central Andes (Pratt), (5) Moho depths (Fig. 2). The observed coherence between (2), (3), (5) and a digital terrain model, and furthermore between (5) for latitudes greater than 22° S and the chart of James (1971) for latitudes less than 22° shows undoubtely isostatic compensation in a wide regional scale, and it comfirms the results obtained for each section. (5), along with the seismo-gravity models at 22°, 25° and 32° S illustrates that gravity models without seismic constraints are also able to define reasonably the crustal thicknesses.

Finally, from all these available sources, four predictive equations were derived. B is mean Bouguer anomaly in mGal and H is mean altitude in km (Fig. 3).

Complete Argentina and Chile: $B = 14 - 71.2\ H$
Northern area (22 - 30° S): $B = 25 - 76\ H$
Central area (30 - 39° S): $B = 10 - 66\ H$
Southern area (> 39° S): $B = 2.6 - 69\ H$

LOCATION	MAXIMUM BOUGUER ANOMALY mGal	MAXIMUM CRUSTAL THICKNESS Km	SHORTENING Km
22°S	-410	66	
25°S	-400	60-65	>300 to 220
27°S	-370	68	
30°S	-340	66-70	150
32°-33°S	-300	65	130
35°S	-225	57	
36°S	-164	48	
37°S	-120	44	
39°S	-110	43	90,70 and 23
41°S	- 90	42	
44°S	- 82	41	
46°S	- 70	42	
50°S	- 78	45-47	

Table 1.- Location, maximum Bouguer anomaly, maximum crustal thickness and shortening of the Chile-Argentina sections studied in this work, Outcropping Andean masses keep the expected concordance with the compensating subterranean masses (roots).

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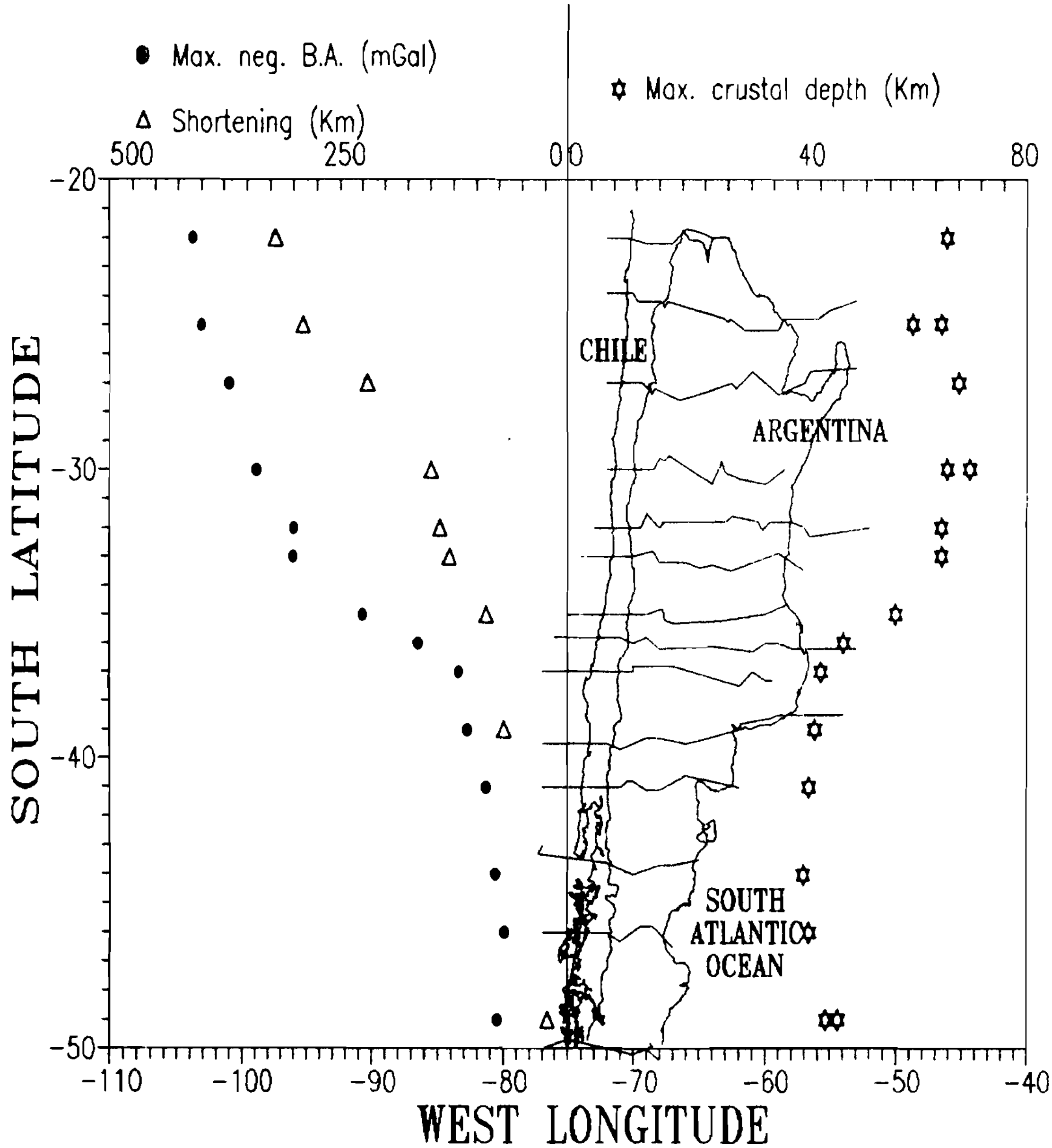
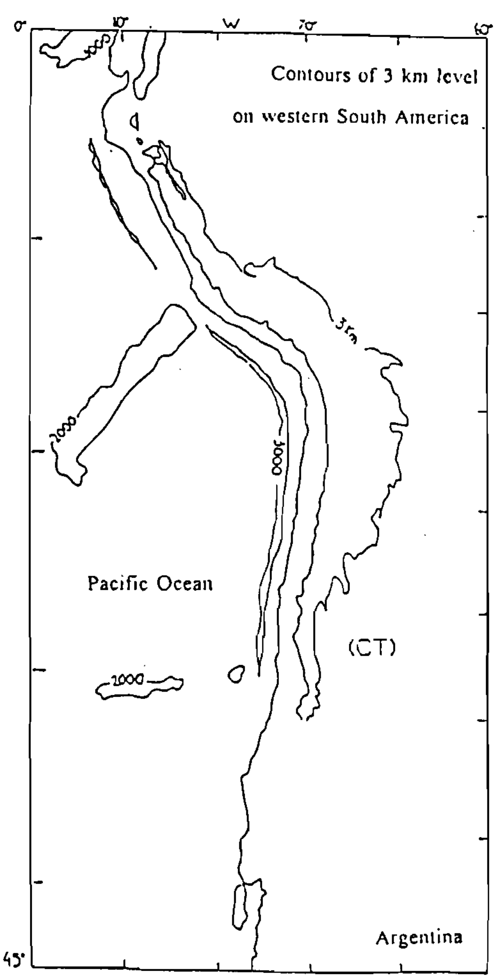


Fig.1: Maxima Bouguer Anomaly (●); Shortening (Δ) and maxima crutal thickness (✡) on 14 E-W Andean gravity sections on Argentina-Chile.



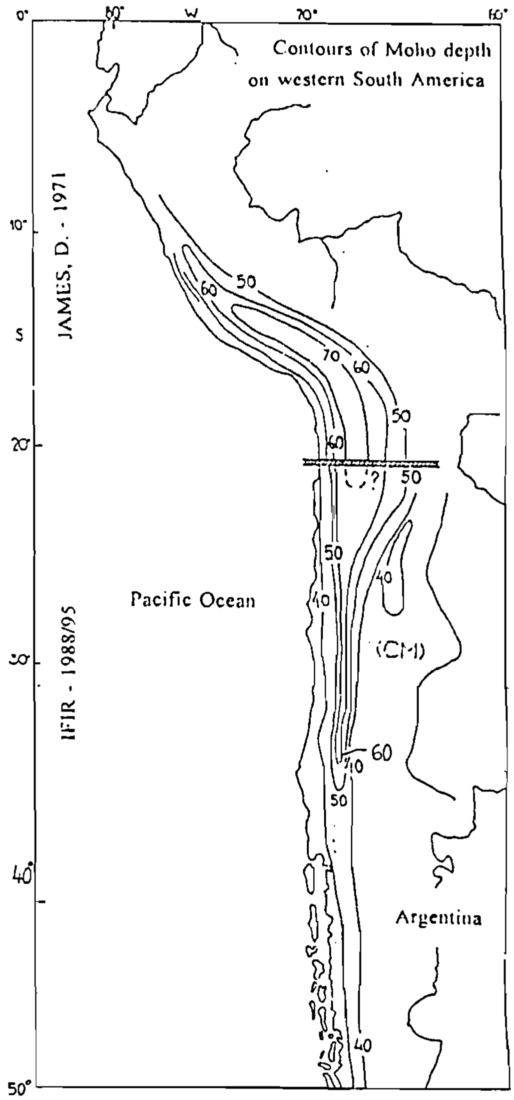


Fig.2: Left: 3000m altitude contour (Cordillera Andina) Right: Moho depth contour over 22°S latitude from seismic results(James, 1971) and at 22°-50° S latitudes from gravity data (this work).

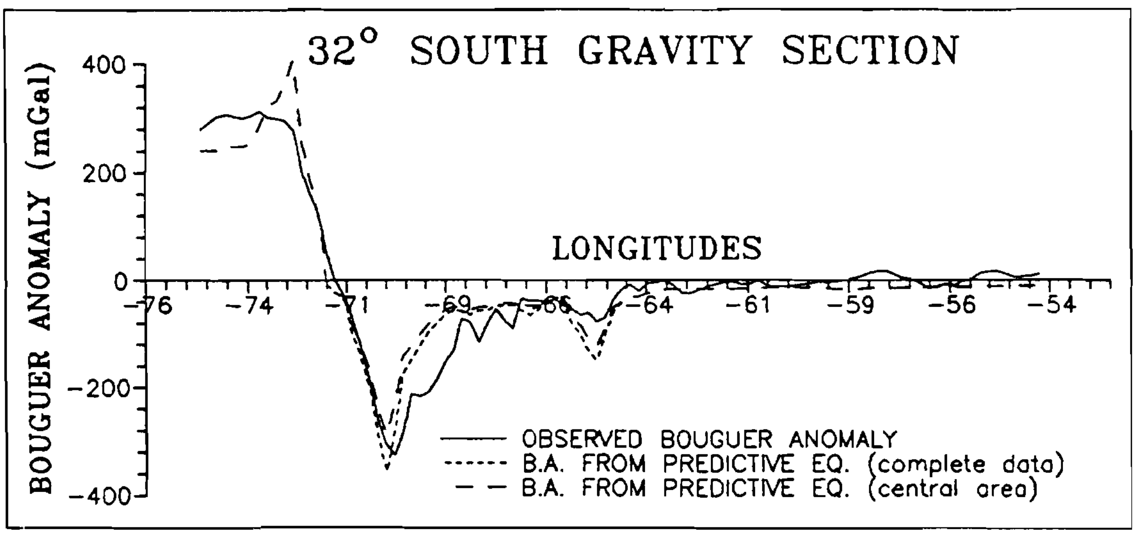


Fig.3: Relations between predicted Bouguer anomalies at 32°S latitude (by means of altitudes H) and observed Bouguer anomalies.