

ANOMALOUS UPPER MANTLE BENEATH THE CENTRAL ANDES.  
ISOSTASY AND ANDEAN UPLIFT.

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Resúmen: Tres modelos corticales con manto superior "normal" y anómalo en dos secciones gravimétricas (22° S y 25° S) de los Andes Centrales, fueron comparados. Se analiza la elección de uno u otro para evaluar tanto el equilibrio isostático como el levantamiento andino.

Key Words: Central Andes, anomalous mantle, isostasy, andean uplift.

Introduction:

It have been pointed out that below the Central Andes it could exist : (1) significant heating on the lithospheric mantle (Froideveaux - Isacks, 1984; Introcaso - Pacino, 1988; Introcaso, 1988) and (2) cooling produced by the Nazca Plate subduction beneath the continental lithosphere (Grow - Bowin, 1975; Introcaso - Pacino, 1988). We analyze two effects : the one on the gravity and the one on the Andean uplift. Both of them would produce density anomalies from (1) and (2). From (1), we would have lesser gravity and uplift  $\epsilon_{01}$ ; from (2), it would be high gravity and subsidence  $\epsilon_{e1}$ . Our study involves two gravity sections located on 22° and 25° South latitude, with Bouguer anomalies of more than - 400 mGal.

Isostatic compensation. Uplift mechanisms.

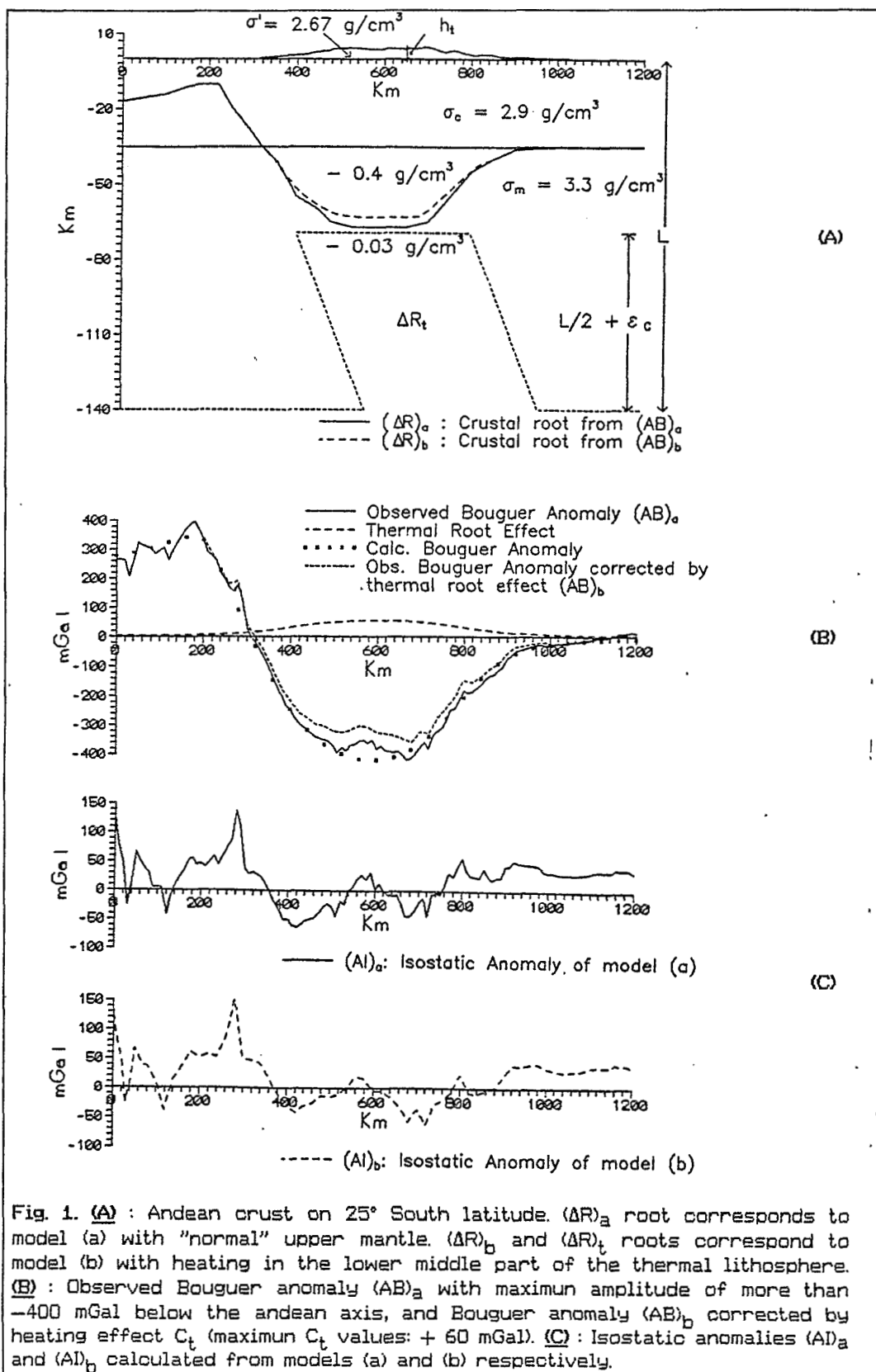
In order to analyze the relationship between the upper mantle processes

to our model, the oceanic plate effect would demand to diminish the crustal thickness defined in (a) in  $8.25 (\epsilon_{C_i} - \epsilon_{E_i})$ . So, the Bouguer anomaly  $(AB)_C$  would be compensated by the following effects: modified crustal root, thermal root and subducted Nazca Plate. We must note that  $\epsilon_{C_i}$  and  $\epsilon_{E_i}$  effects, if they exist together, could be partially cancelled.

The three models present perfect masses balance, but at different depths. Because of this, the addition of the gravimetric effects that originates the compensating masses, is different in each one of them. Nevertheless, by comparing (a) and (b), for example, we show that these differences are not significant. In fact, if we think that the real model is (b), but we do not know the masses distribution below the sea level, it is usual to work with a classical model (like (a)) to evaluate isostasy. The gravity results show that, in general terms, the isostatic equilibrium was reached. In this case, the choice between (a) or (b) models is not critical for evaluating isostasy. But it is critical to find out the crustal characteristics and to explain the Central Andean elevations. So, model (a) explains the uplift by: crustal shortening ( $S_H$ ) or magmatic crustal addition ( $M_A$ ), or by a combination of both mechanisms ( $S_H + M_A$ ). In model (b), the isostatic compensation of the Andean masses is reached from a thermal lithospheric root and a crustal thickening produced by  $S_H$  or  $M_A$  or ( $S_H + M_A$ ). Fig. 1 partially shows one of the two gravity sections analyzed from (a) and (b) models: the one located on  $25^\circ$  South latitude. Fig. 1 A shows the topographic elevation  $h_t$ , the crustal roots  $(\Delta R)_a$  and  $(\Delta R)_b$  and the thermal root  $(\Delta R)_t$ . Fig. 1 B shows the Bouguer anomalies  $(AB)_a$  and  $(AB)_b$ . Fig. 1 C shows the isostatic anomalies  $(AI)_a$  and  $(AI)_b$ .

From  $(AB)_a$  gravity inversion, we found a maximum crustal root of 32 km, while  $(AB)_b$  presents a maximum crustal root of 28 km. This crustal root was obtained from  $(AB)_b$  gravity inversion with:  $(AB)_b = (AB)_a + C_t$  where  $C_t$  is the thermal gravity correction.

We have calculated the isostatic anomalies  $(AI)_a$  that correspond to the (a) model, with an isostatic correction  $(CI)_a$  obtained from  $(\Delta R)_a = 6.675 h_t$ . The isostatic anomalies  $(AB)_b$  that correspond to the (b) model were calculated starting from  $(\Delta R)_b = 6.675 h_t - 8.25 \epsilon_{C_i}$ . Now, the density excess produced by the crustal root diminishes in 5.29 km ( $= 8.25 \epsilon_{C_i}$ ) so balancing the density deficit originated by the thermal root. So,  $(8.25 \times \epsilon_{C_i}) \times 0.4 = 70.6422 \times 0.03$  or, in other words, the Andean masses are compensated at a depth of 140 km, by means of a combination of the crustal root (now diminished) and the thermal lithospheric root. Then, below  $h_t$  we have:  $h_t \times \sigma' = (\Delta R)_b \times (\sigma_m - \sigma_c) + (\frac{h_t}{2} + \epsilon_{C_i}) \times (\sigma_m - \sigma'_m)$ . All densities and thickness of this expression can be found in Fig. 1.



### Conclusions

Different crustal thicknesses from gravimetrical inversions made from  $(AB)_a$ ,  $(AB)_b$  or  $(AB)_c$  have been found. In particular, we can see this in Fig. 1 for (a) and (b) models. Nevertheless, the isostatic anomalies  $(AD)_a$  and  $(AD)_b$  are consistent between themselves.

The choice among (a), (b) or (c) defines the possibilities for the different mechanisms to exist. This choice must be done trying to find the model whose crustal thickness could be consistent with the seismic results. In the 25° South latitude section, model (b) is probable.

This work is based on previous studies, the possibilities of (a), (b) and