CRUSTAL THICKENING IN THE CENTRAL ANDES - RESULTS FROM SEISMIC REFRACTION AND CRUSTAL BALANCING

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RESUMEN: Las estructuras tectónicas de sobrecorrimiento y el espesor actual de la corteza derivados de los resultados de sísmica de refracción han sido modelados por medio de un balanceo tectónico con un acortamiento cortical de 320 km desde el Cretasico superior con un espesor inicial de 35 km. El volumen de la corteza inferior en el antearco y debajo del arco magmático, aproximadamente el 20% del volumen cortical actual, no puede ser explicado por este acortamiento. La litósfera subcortical debe haber sufrido un acortamiento en el mismo rango que exige un transporte de material hacia el manto más profundo.

KEY WORDS: Central Andes; crustal balancing; seismic refraction; crustal doubling.

INTRODUCTION

The Central Andes are part of the convergence system between the oceanic Nazca plate and the South American plate. Elevations of about 7000 m above sea level in the central parts of the mountain belt are observed where the crustal thickness reaches about 70 km. The importance of tectonic shortening for the

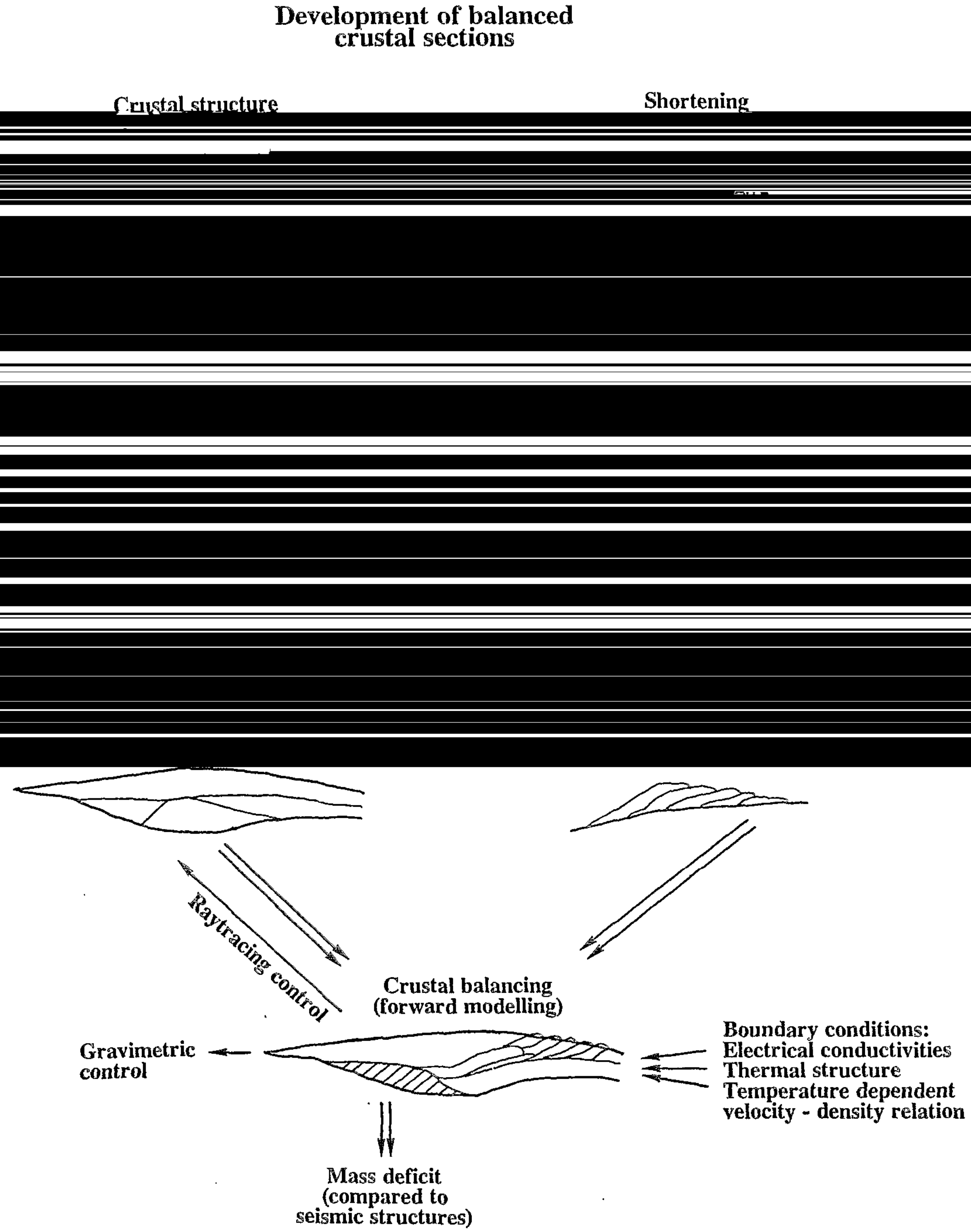


Figure 1. Development of the balanced crustal section from the crustal structure (derived from seismic refraction) and shortening from cross-section balancing.

The aim of the study was to develop an areal balanced model that should be able to explain the velocity model and the seismic discontinuities at 21°S. The program THRUSTBELT II does not allow the modelling of different rheological characteristics of the distinct crustal units. As the program only permits faults with the same vergency, no backthrusts were introduced exept in the forearc, using a "pin-line" on the Altiplano.

GROSS CRUSTAL STRUCTURE FROM SEISMIC REFRACTION

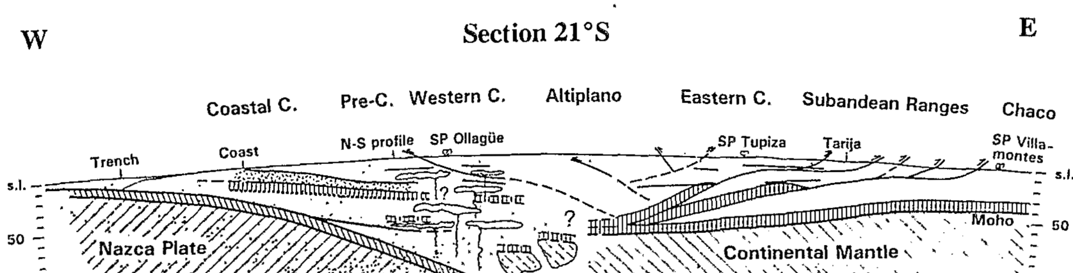
The velocity structure was derived by observations of 4 shotpoints along a profile at 21°S with corresponding N-S profiles in the Coastal Cordillera and in the Precordillera (position map see Wigger et al., this volume). A clear discontinuity at 40 km depth in the Coastal Cordillera is interpreted as Moho of the Eastern Cordillera, where Cretaceous rifting took place (Marquillas & Salfity 1988). The starting point for the calculation of the modelled shortening is the onset of the strong compressional phases at Upper Cretaceous at 90 Ma (Scheuber et al. 1993).

Cross-section balancing was done for different profiles in the Central Andean backarc and the derived shortening values vary between 210 and 230 km for the Eastern Cordillera and Subandean Ranges (Roeder 1988; Sheffels 1990) at about 18°S and 140 km for the Subandean Ranges and a transition zone (Kley & Reinhardt 1993) at 21°S. In the area of the Altiplano and the recent magmatic arc the determination of tectonic shortening is somewhat more difficult because of the young sedimentary and volcanic cover. Shortening values of 55 km (Baby et al. 1990a) and 42 km (Baby et al. 1990b) for the Altiplano are reported. In the forearc region shortening is most evident in the Precordillera (Chong & Reutter 1985).

An amount of 320 km is taken for the shortening between the trench and the Andean foreland since Upper Cretaceous (Schmitz 1993), modelled mainly for two tectonic phases, the Incaic Phase in the Altiplano/Eastern Cordillera area and the Quechua Phase in the Subandean Ranges. The detachments are located at the base of the younger sediments, on top of the middle crust and at the base of the lower crust.

CRUSTAL DOUBLING IN THE BACKARC

A crustal thickening from 40 km in the Subandean Ranges to about 70 km in the Eastern Cordillera is observed, representing a crustal doubling in the backarc. Material with high seismic velocities (6.8 km/s) was found in 20 to 25 km depth in the Eastern Cordillera. This can be explained by lower crustal material detached from the crustal base and overthrusted to the east (figure 2). The modelled structures of the Subandean fold- and thrust belt are in good coincidence with balanced cross-sections (Kley & Reinhardt 1993). Zones of high electrical conductivities might have acted as detachments.



The lower crust of the forearc as well as of the magmatic arc region, which represents together about 20% [redacted]