ANOMALOUS CRUST IN THE CENTRAL ANDES

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INTRODUCTION

The central Andes, in western Bolivia and northern Chile are the highest and widest mountains associated with regions of ocean-continent convergence. The Andes attain their greatest width in central South America where the Altiplano is bordered on the west by the Cordillera Real (an active volcanic arc) and on the east by the Cordillera Oriental (high mountain range dominated by folding and thrusting) and the Sub-Andean zone (a thin-skin fold and thrust belt). In 1994 and 1995 we deployed two broadband three-component seismic arrays in the central Andean Cordillera of Bolivia and northern Chile with a total of 24 stations (Fig. 1). Our seismic experiment consisted of an east-west transect called the BANJO (Broadband ANdean JOint) experiment and a north-south transect called the SEDA (Seismic Exploration of the Deep Altiplano) experiment. The BANJO experiment consisted of 16 broadband seismic stations along an east-west transect at 19°S to 20°S and extended for nearly 1000 km from near the coast of northern Chile to the Chaco Plain. The SEDA experiment consisted of 7 stations that were deployed in a 350 km north-south transect along the eastern boundary of the Altiplano, between La Paz and Uyuni, Bolivia. We estimated crustal parameters along an east-west transect across the Andes at latitude 20°S and along a north-south transect along the eastern edge of the Altiplano from data recorded on these two arrays.

CONCLUSIONS

Our passive deployment recorded numerous intermediate-depth earthquakes at near-regional distances. Capitalizing on this source-receiver geometry, we have identified and analyzed shear-coupled P waves trapped within the crustal waveguide. We refer to these phases collectively as "sPnl" due to their similarity to the often observed Pnl wavetrain generated by crustal earthquakes. We modeled several

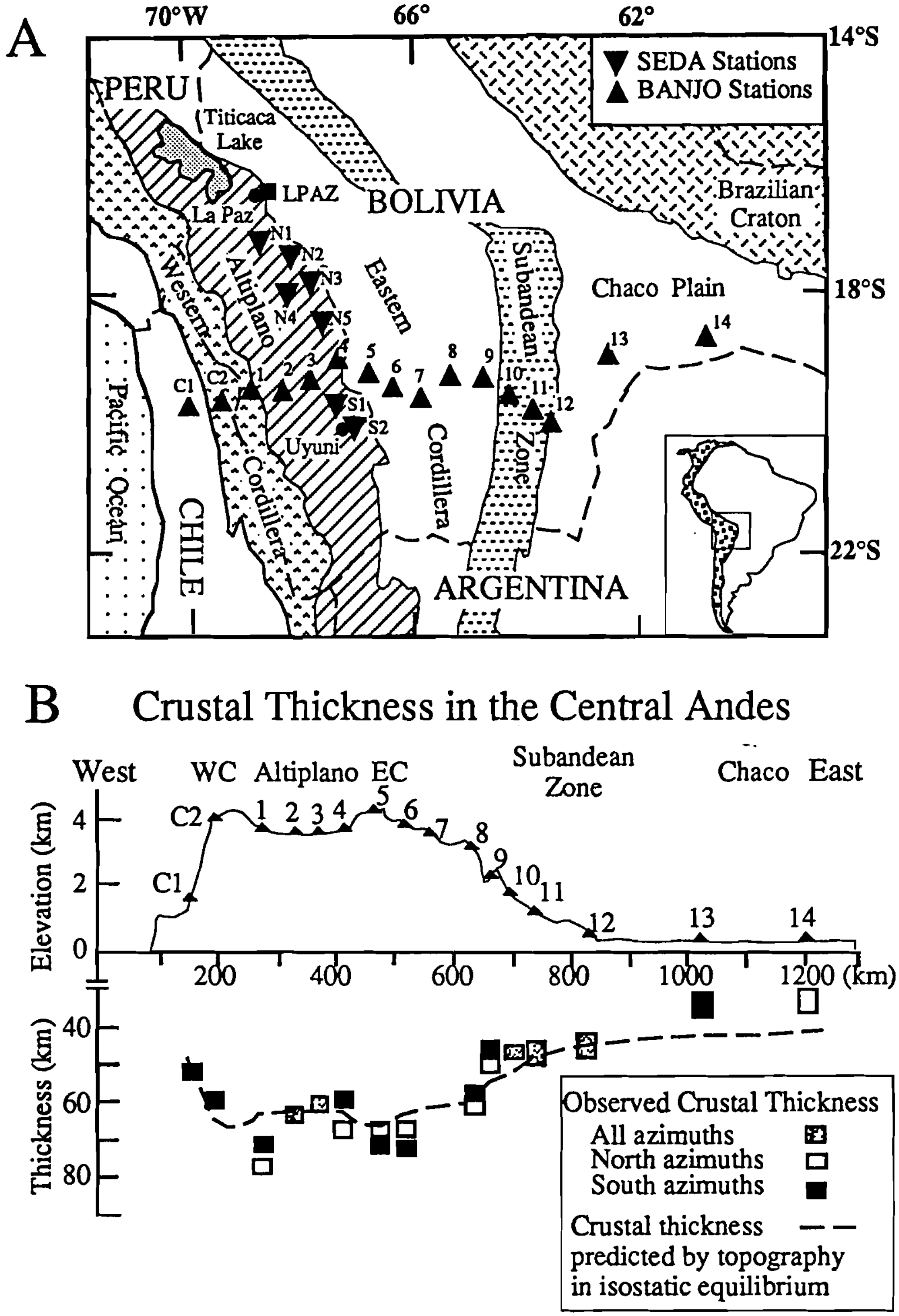

Figure 1: (A) Map showing the station locations in the central Andes. (B) East-west cross-section near 20°S showing topography and estimates of crustal thickness beneath each station.

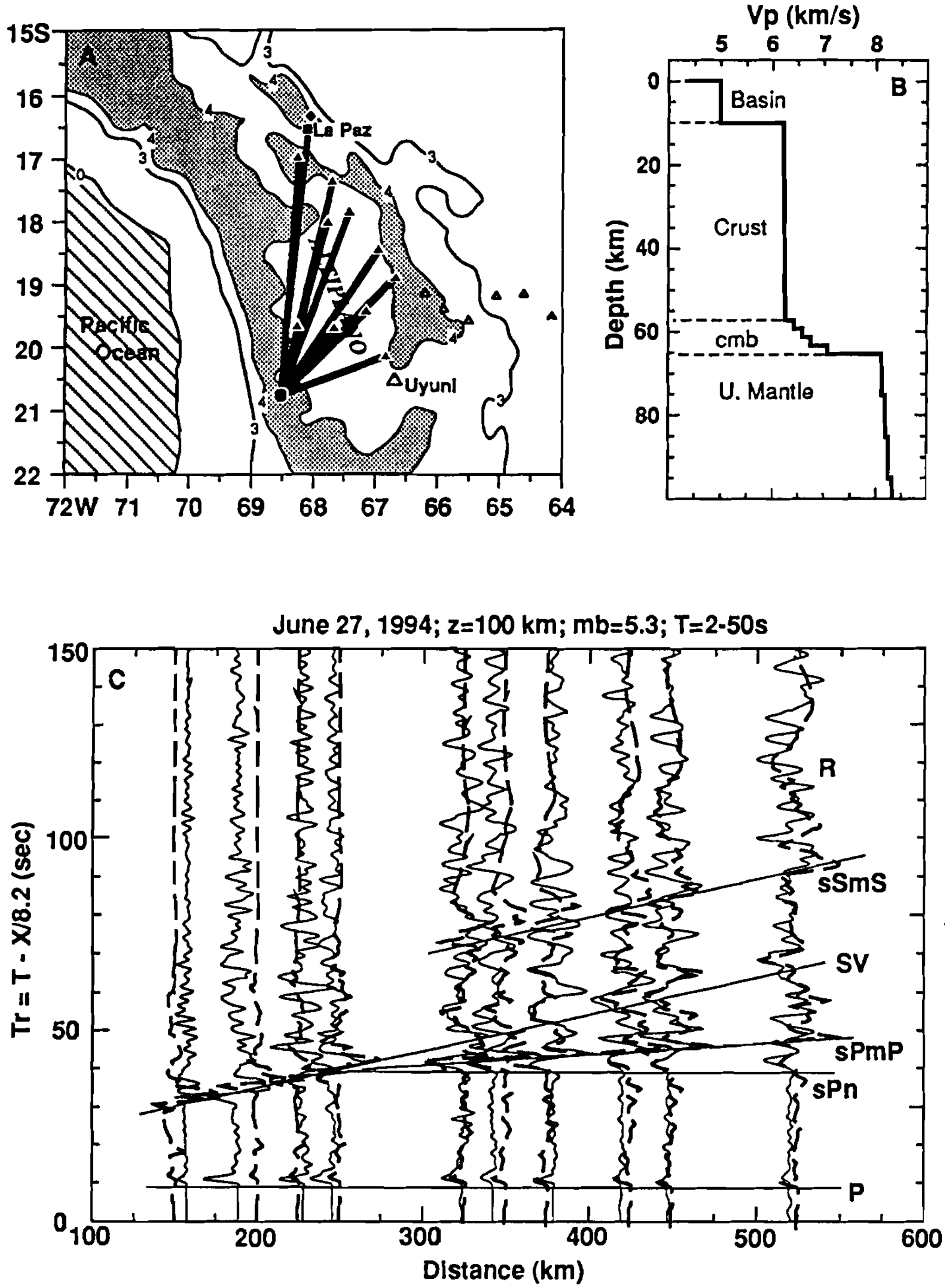

Figure 2: (A) Map showing the location of the stations and the earthquake on June 27, 1994. (B) Best crustal P-wave velocity model determined from the regional waveform modeling. (C) Reduced travel time plot showing the vertical component regional data (thin solid lines) and synthetics (thick dashed lines) for the crustal model shown in B. Major regional phases are shown on the right.

regional distance events to determine average crustal parameters for the Altiplano. The Altiplano crust is characterized by an anomalouly low mean velocity of 6.0km/sec, a Poisson's ratio of 0.25 and a crustal thickness of 65 km (Fig. 2). The combination of low P wave velocities and low Poisson's ratio suggest a thick silicic bulk composition for the crust.

Waveforms of deep regional events in the down-going Nazca slab and teleseismic earthquakes were processed to isolate the P-to-S converted phases from the Moho in order to estimate the crustal thickness. We found crustal thickness variations of nearly 40 km across the Andes, with maximum crustal thicknesses of 70-74 km under the Cordilleras and 32-38 km thick crust 200 km east of the Andes in the Chaco Plain (Fig. 1). The crust also appears to thicken from north (16°S, 55-60 km) to south (20°S, 70-74 km) along the Cordillera Oriental. The Sub-Andean zone crust has intermediate thicknesses of 43 to 47 km. Crustal thickness predictions for the Andes based on Airy-type isostatic behavior show remarkable overall correlation with observed crustal thickness in the regions of high elevation (Fig. 1). In contrast, at the boundary between the Cordillera Oriental and the Sub-Andean zone and in the Chaco Plain, the crust is thinner than predicted, suggesting the crust in these regions is supported in part by the flexural rigidity of a strong lithosphere. The observation of Airy-type isostasy is consistent with thickening associated with compressional shortening of a weak lithosphere squeezed between the stronger lithosphere of the subducting Nazca plate and the cratonic lithosphere of the Brazilian shield.