WIDE-ANGLE SEISMIC MEASUREMENTS DURING THE CINCA95 PROJECT, ON- AND OFF-SHORE CHILE

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EXPERIMENT DESCRIPTION

In the period from 31st July to 22nd August 1995, during the first phase of the CINCA95 (Crustal Investigations off- and on-shore Nazca/Central Andes) experiment the airgun pulses fired from the RV SONNE (cruise no. 104 of the RV SONNE) along the marine seismic lines (SO104-05 - SO104-29, Fig. 1) were recorded by a mobile land array (Wander Array) of 12 seismic stations at Pos1-Pos5 (Fig. 1) along the Chilean coast. The land array consisted of 12 Geotech PDAS 100 recorders deployed about 1.85 km (1' of latitude) apart. The average spacing of the airgun pulses was 50 m in distance (18 s in time) and thus a total of several tens of thousands of pulses were observed by the Wander Array. The first deployment at Pos1 followed immediately after the large Antofagasta earthquake on 30th July and the aftershock data recorded by the array will be of use in the study of the earthquake activity in the region. Unfortunately, however, the strong aftershocks completely masked the airgun signals and thus no useful data from the airgun pulses were obtained during this deployment. However, useful data from the airgun pulses were obtained from the other four deployments at Pos2 to Pos5. Good quality data were often obtained out to about 100-150 km distance.

During the second period of the CINCA95 campaign from August 28th to September 10th 1995, parts of the shot program from the first period (lines SO104-7, 9 and 13, see Fig. 1) were repeated for recordings on OBHs (Ocean Bottom Hydrophones) and wide-angle stations on-shore. The southernmost line was shifted northwards from SO104-5 to SO104-13. This was a prompt reaction to the Antofagasta earthquake of July 30th 1995, which provided the unique occasion for crossing the aftershock area of a recent earthquake with a seismic profile. The short perpendicular lines (203, 303, 403 and 404) were fired additionally. While OBHs were placed along the marine seismic lines, 22 digital (PDAS-100) and 7 analogue (MARS66) recorders were deployed on-shore with an average spacing ranging from 3-6 km along the eastward prolongation of the marine seismic lines (see Fig. 1, lines SO104-7, 9 and 13). In addition to the airgun pulses chemical explosions were used as seismic sources at the eastern- and

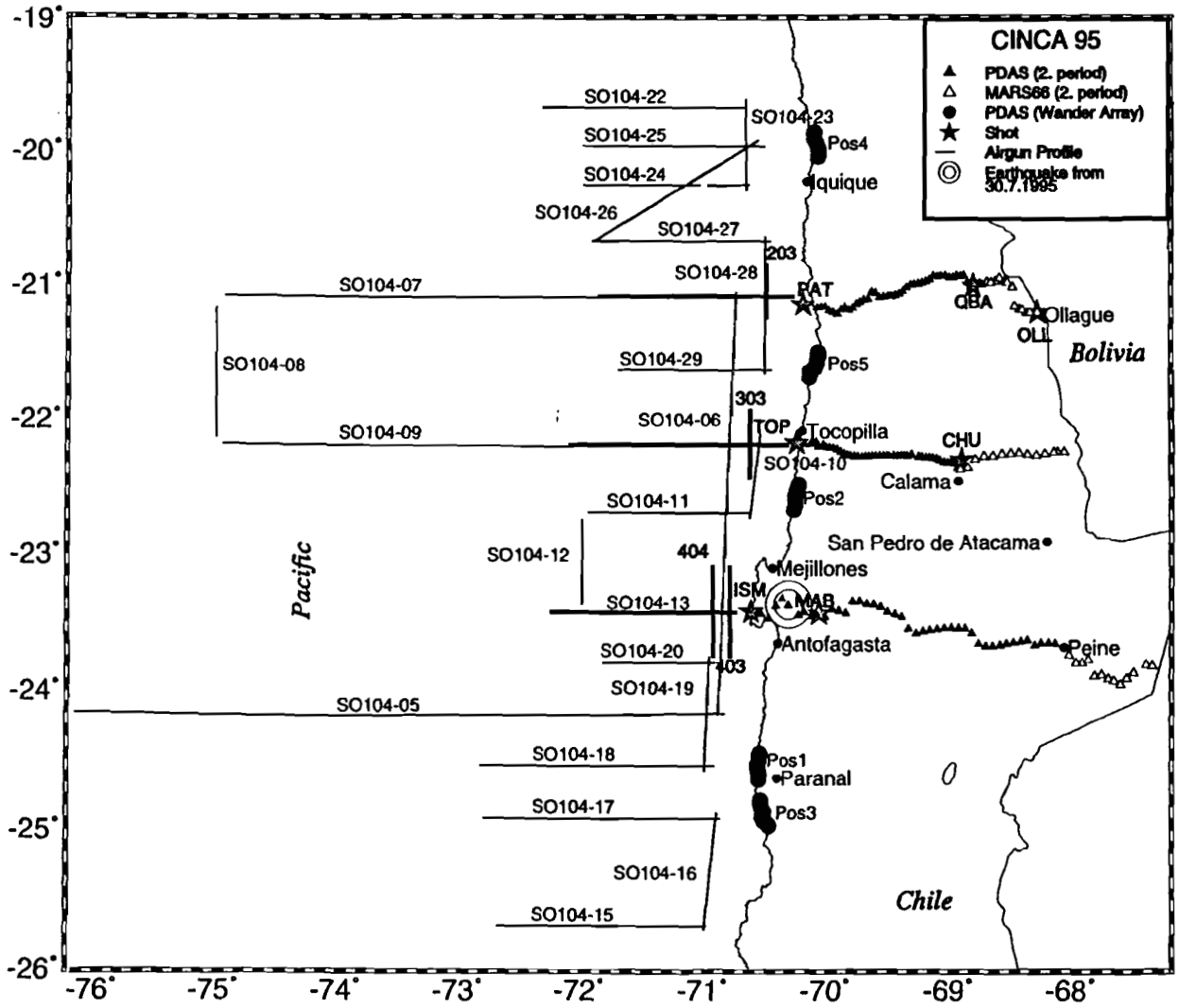

Fig. 1: Location map for CINCA95 on-shore wide-angle seismic experiment. The marine seismic lines SO104-05 - SO104-28 and 203, 303, 403 and 404 are shown together with the positions of the recorders deployed on-shore and the chemical shots and quarry blasts recorded.

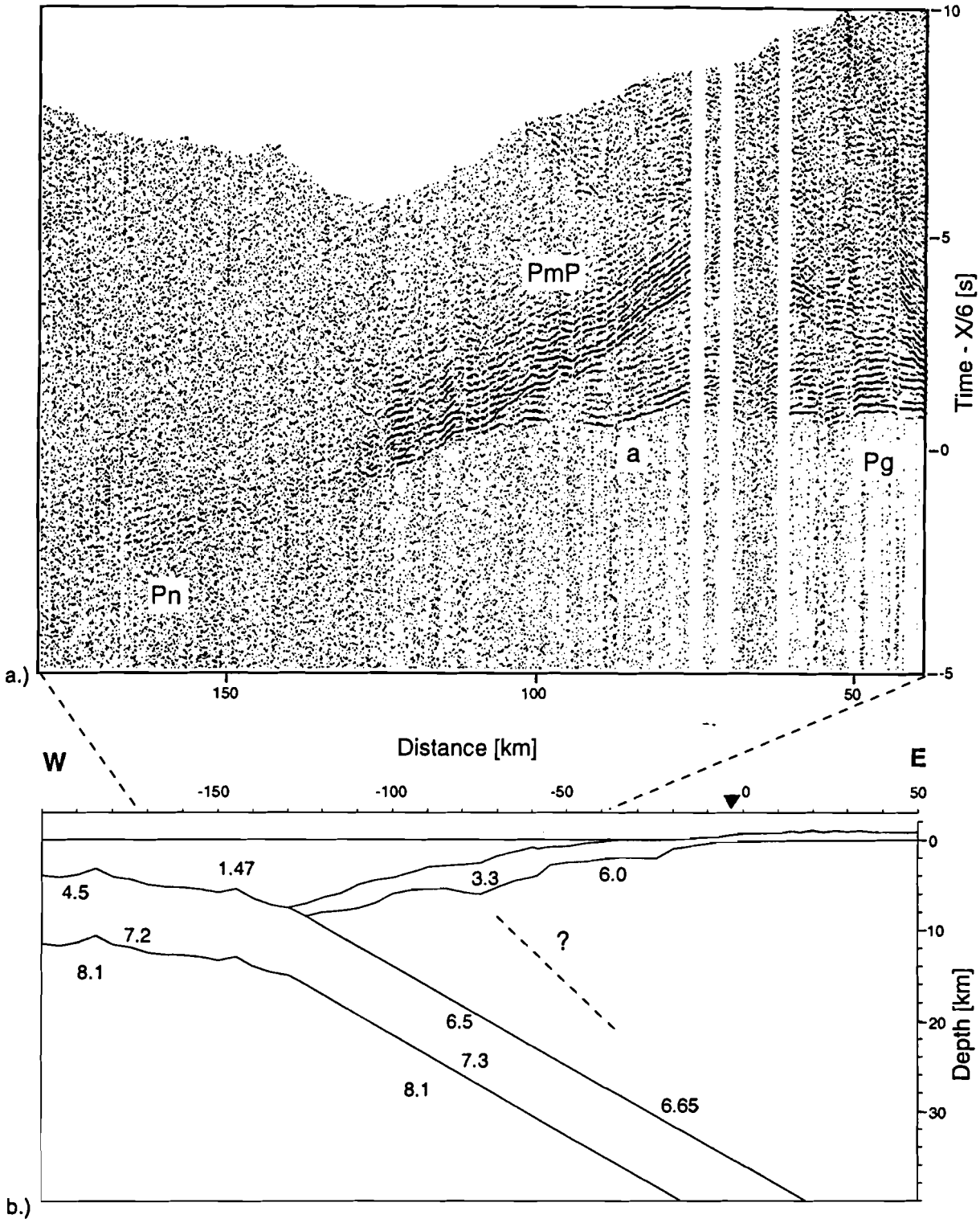

Fig. 2. a) Receiver Gather for receiver no. 2 (nearest to the coast) on seismic line SO104-07. The data have been corrected for water depth and are plotted in the form of a reduced time - distance record section. The 900 traces have been normalized individually and band-pass filtered (3-12 Hz). Reduction velocity = 6 km/s. Key: Pg - refracted phase from the upper crust; PmP - reflected phase from crust-mantle boundary of the Nazca Plate; Pn - refracted phase from the upper-mantle; a - supposed reflection.

b) Two-dimensional velocity cross-section derived from receivers on the land extension of line SO104-07 at 21°S. All velocities are given in km/s.

westernmost ends of the digitally registered lines, providing refraction seismic record sections which give further information on the structure and velocity distribution at the western edge of the south American continent. The average spacing of the airgun pulses was 160 m in distance and the average length of the marine lines was 160 km. The quality of the data in general is good and arrivals can be seen up to a distance of 260 km.

RESULTS

The data example chosen (Fig. 2a) represents a receiver gather of high quality from profile SO104-7. Up to a distance of 68 km the first arrivals are correlated with the refracted phase through the upper crystalline crust (Pg). Its apparent velocity is 6.0 km/s after correction for water depth. From a distance of 68 km up to a distance of 105 km arrivals with large amplitudes can be recognized in the section. They are interpreted as the reflection from the crust-mantle boundary (Moho) of the subducted Nazca plate (PmP). Beyond a distance of 100 km the first arrivals form a refracted phase (Pn) travelling in the uppermost mantle with an apparent velocity averaging 9.5 km/s after water-depth reduction. This high apparent velocity results from the seismic phase travelling up-dip in the subducted Nazca plate. The first arrivals seen between 70 km and 98 km are at this stage of interpretation modelled as Pg arrivals. However, this phase can clearly be interpreted as a reflection from an intra-crustal reflector on some record sections. The correct identification of this phase will require intense examination and modelling of the data.

The resulting velocity model shows the Nazca plate being subducted at an angle of 12° with the Moho reaching a depth of 40 km underneath the coast. Both the dip-angle and depth are in good accordance with the earthquke locations from the CINCA95 seismological experiment and the Moho depth also agrees with the model of Wigger et al. (1994). The uppermost continental crust off-shore is covered by a layer of low velocity material, which thins towards the east near the land, where the sediment layer thickness does not exceed 1 km. The reflections seen in some of the record sections give rise to a steep reflector forming a wedge with the downgoing plate. This reflector could be interpreted as a shear zone separating the wedge from the rest of the crust.

The complete interpretation of all wide-angle data obtained during the CINCA95 project will give a picture of the trench area between 20° and 25° S and help to understand the character of the processes occurring in connection with the subduction of the Nazca plate.

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