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# ANCORP'96 - DEEP SEISMIC REFLECTION/REFRACTION EXPERIMENT ILLUMINATES CENTRAL ANDEAN SUBDUCTION ZONE

**ANCORP-Research Group* (Potsdam, Berlin, Antofagasta, Santiago, La Paz, Santa Cruz)**

Very deep-reaching seismic reflection and refraction profiling using the explosive source technique was performed for imaging and modelling the deformation processes of the collision of the South American continent (Central Andes) with the subducting oceanic Nazca plate. Following more than 10 years of interdisciplinary research in the Central Andes by the universities of Berlin and their partners in South America, the German DEKORP program (German Continental Reflection Seismic Program), operated by the GFZ Potsdam, defined this area as one of its major targets. In contrast to previous deep crustal DEKORP surveys in the German Variscan Mountains and the North German Plains as well as the Ural Mountains in Russia, where the seismic data acquisition was mainly done by an industrial contractor, the financial and geographical constraints constituted the main reason to operate mostly with our own equipment and personnel. The target area at 21°S was chosen because of open questions of crustal growth (tectonic stacking versus magmatic underplating) and because of the results of pilot studies with similar design in the area of Calama in 1994.

The survey was conducted from Sept 15 to Nov 20 in 1996 by cooperating institutions from Germany, Chile and Bolivia. It was linked to previously acquired off-shore reflection data (CINCA'95 project) at 21°S and extends E-W from the coast for about 400 km across the Coastal Cordillera, the Longitudinal Valley, the Precordillera, the Western Cordillera and the Altiplano. It is expected that this transect will be prolonged towards the east crossing the Eastern Cordillera into the Bolivian Subandean Belt under the leadership of Cornell University (U.S.A.) in 1998 or 1999. This will result in a seismic transect from the Pacific Ocean to the Brasilean Craton with a length of nearly 1000 km.

Field parameters of the near-vertical reflection profiling were especially designed to image the deep lithosphere. Profiles imaging the shallower crust are available through industrial contributions by ENAP (Chile) in the off-shore shelf area and the Longitudinal Valley and by YPFB (Bolivia) in the Altiplano. Therefore, for the near-vertical profiling in this survey a wide shot spacing of 6 km was chosen. Each shot was fired twice into 252 recording channels 100 m apart resulting in a 50 km long split spread. The resulting sub-surface coverage was 4-fold. Drilling and shooting was done by Chilean and Bolivian contractor companies. The shots were fired in 20 m deep boreholes with 90 kg explosive charges. The wide-angle measurements, mainly for velocity control, were integrated in this program by repeating shots at a number of points, about every 50 km, up to 9 times with increasing charges, after each complete move-up of the recording spread. Thus wide-angle seismic record sections with maximum recording distances of 230 km were obtained. Of these wide-angle shotpoints, one was off-shore, operated by the Chilean Navy, and one was at the mine Quebrada Blanca using regular quarry blasts. Both these

shotpoints turned out to be extremely useful. The experiment was accompanied by geological mapping, gravimetric measurements and seismological monitoring of local and teleseismic earthquakes, which was completed in March 1997.

Fig. 1 presents a location map of the ANCORP line. Shown here are the 65 shotpoints of the near-vertical reflection survey with an average spacing of 6 km. The big symbols mark the eight shotpoint locations which were used for wide-angle measurements. Fig 2 presents a compressed section for the shotpoint Quebrada Blanca showing near-vertical as well as wide-angle recordings. At the top of the section, the P-wave and subsequent S-wave arrivals of the direct waves will be inverted for a velocity-depth section of the upper and middle crust. At about 10 s two-way traveltime below the source a very bright reflection is discernible, corresponding to a depth of about 30 km. This bright spot is located at the western rim of the recent volcanic arc and thus could be related to magmatic processes. At nearly 30 s, corresponding to about 90 km depth, another zone of reflections is recognized, dipping to the east. These deep reflections, among the deepest ever observed in seismic reflection surveys, are discussed in the context of the subducting Nazca plate.

The most remarkable feature of the near-vertical recordings is an eastward dipping band of reflections, seen at about 10 s TWT (approx. 30 km) beneath the coast dipping towards the east to 28 s TWT (approx 85 km) beneath the bright spot mentioned above at about 170 km distance from the coast. Its relationship to the Wadati-Benioff-Zone, defined by the location of subduction-related earthquakes, is under discussion. The reflectivity of the Bolivian Altiplano is less pronounced, although the deepest reflections at about 20-22 s TWT can be clearly recognized. This confirms the previously postulated enormous crustal thickness of about 60 km for the Altiplano.

* Onno Oncken, Ewald Lüschen, James Mechie, Albrecht Schulze, Christoph Gaedicke (GeoForschungsZentrum Potsdam);
Peter Giese, Peter Wigger, Michael Schmitz, Stefan Lüth, Ekkehard Scheuber (Freie Universität Berlin);
Guillermo Chong, Hans Wilke, Gabriel Gonzalez, Arturo Jensen (Universidad Católica del Norte, Antofagasta);
Manuel Araneda (Universidad de Chile, Santiago);
SERNAGEOMIN (Servicio Nacional de Geologíca y Minería, Santiago);
Hugo Vieytes, ENAP (Empresa Nacional de Petroleo, Chile);
Girardo Behn , CODELCO(Compañia del Cobre, Chile);
Armada de Chile;
Minera Quebrada Blanca;
Compañia Minera Punta de Lobos;
Eloy Martinez, YPFB-GXG (Yacimientos Petrolíferos Fiscales Bolivianos, Bolivia);
Reinhard Rößling, José Amador, SERGEOMIN (Servicio Geológico de Boliva, Bolivia);
Edgar Ricaldi (Universidad Mayor de San Andres, La Paz)

Fig.1: ANCORP location map.

Fig.2: Near-vertical and wide-angle section of the shotpoint Quebrada Blanca (Western Cordillera.

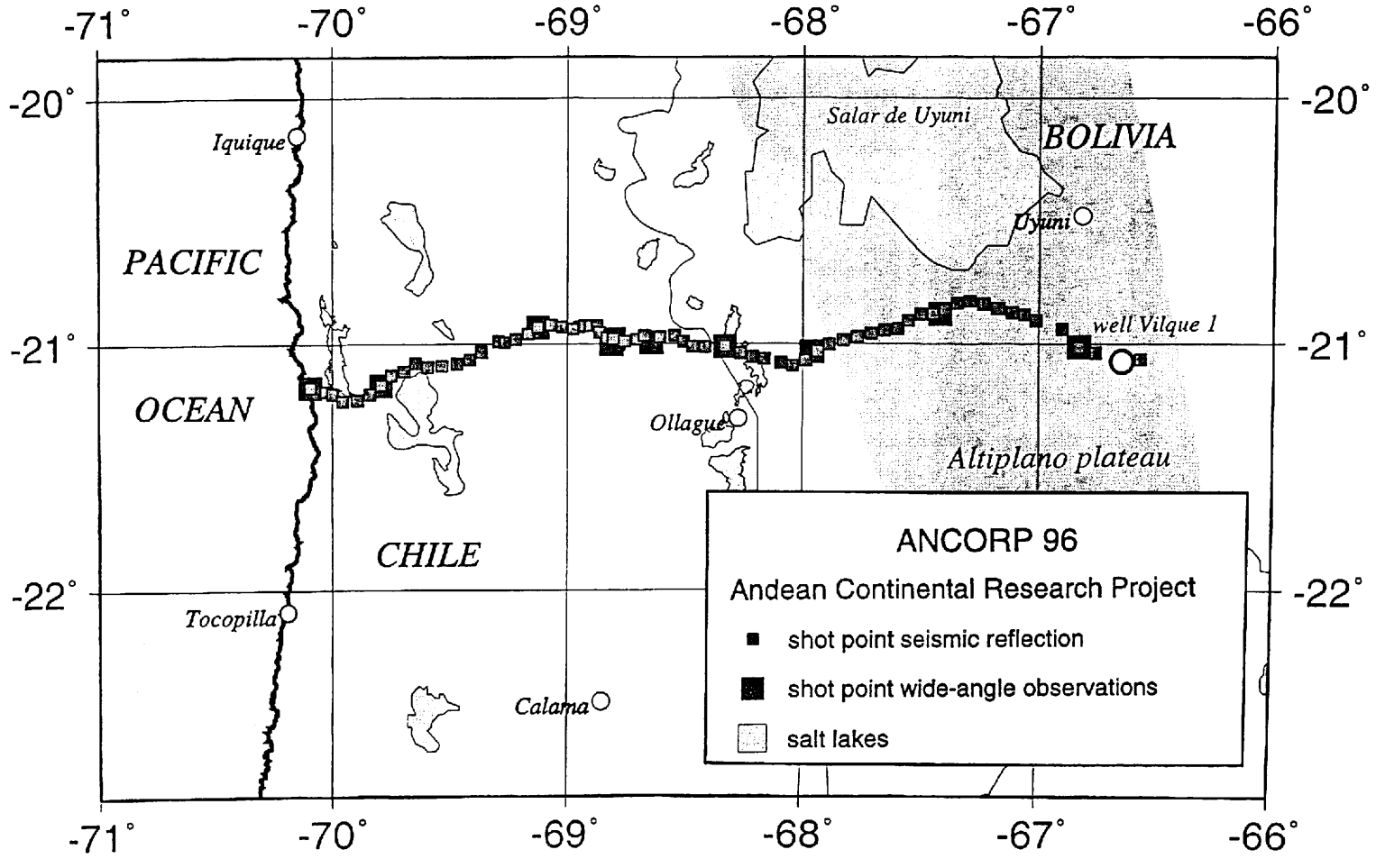
-71°
-70°
-69°
-68°
-67°
-66°
-20°
-21°
-22°
Iquique
PACIFIC
OCEAN
CHILE
Tocopilla
Calama
Salar de Uyuni
BOLIVIA
Uyuni
well Vilque 1
Ollague
Altiplano plateau
ANCORP 96
Andean Continental Research Project
shot point seismic reflection
shot point wide-angle observations
salt lakes

Fig. 1

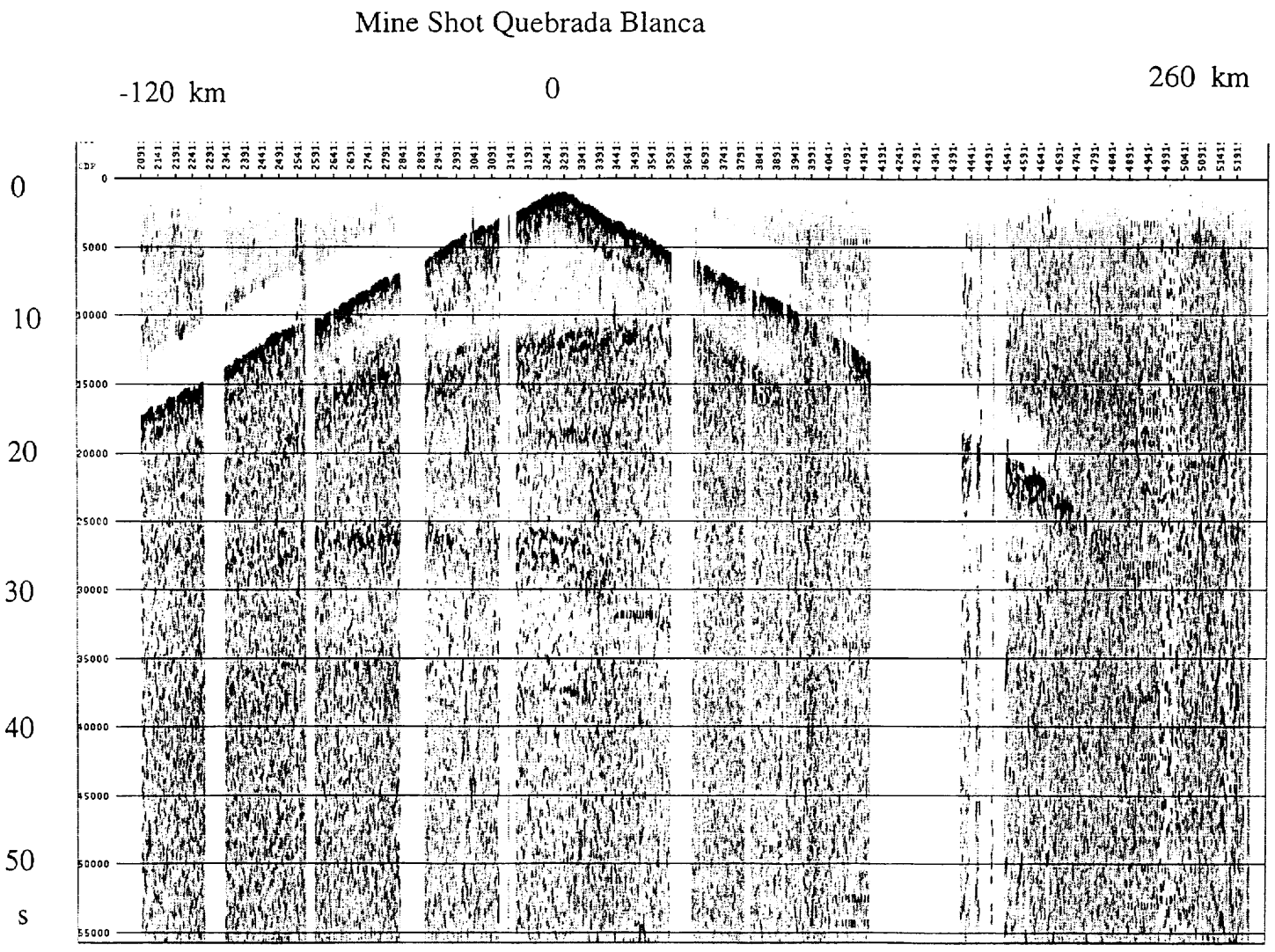


Fig. 2