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Plate interface properties at the southern central Chilean margin from onshore geophysical images across the seismogenic coupling zone

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One of the main goals in subduction zone research is to understand the structural and petrophysical properties of the seismogenic coupling zone, and especially its down-dip end. Here, mega-thrust earthquakes are suggested to initiate, but the triggering mechanism and processes that shape them are less understood.

We will present the first data and results from the January-October 2005 onshore geophysical experiment components of the project TIPTEQ (from The Incoming Plate to mega-Thrust EarthQuake processes) that concentrated in Chile between 37˚-39˚ S. The surveys were designed to (1) yield a structural image also of physical parameters by s-wave information, (2) reveal the vertical crustal zonation and map active faults, (3) determine the conductivity structure of slab and fault zones including monitoring of transport processes, and (4) result in a 3-D asperity mapping. This should give finally a high-resolution image of the seismogenic coupling zone in the area of the 1960 Chile earthquake hypocentre.

A controlled source seismic experiment took place at 38˚ S. 180 three-component geophones were deployed along an 18 km long spread, moving 4.5 km in a daily roll-along. Explosive shots, with a spacing of 1.5 km, allowed an up to 8-fold CDP coverage. The 95 km long, near-vertical incidence reflection (NVR) seismic profile provides the structural characteristics and an image of the present state of the plate interface ruptured during the 1960 earthquake. Close to the coast the subducting oceanic crust is clearly visible and can be traced further inland down to about 60 km depth with variable reflectivity. A strongly structured forearc and accretionary wedge are identified. Strong reflective bands up to 3 km thick characterise the upper and middle crust of the overriding plate down to at least 35 km depth. These slightly upwardly convex, reflective structures are interpreted as representing the Permo-Triassic accretionary wedge above the subducting Nazca Plate. A major structural element at the plate boundary lies between 18 and 50 km depth. It is interpreted as a subduction channel that is transporting sedimentary material from west to east below the overriding South American plate. The onshore structural image and coastal uplift suggest that basal accretion of parts of this material controls the seismic architecture and growth of the south Chilean crust. Since the presence of a subduction channel requires low coupling in the frontal part of the plate interface, it might not be surprising that there is less seismicity observed along the entire, approximately 130 km-wide, seismogenic coupling zone at c. 38° S, compared to equivalent sites. Local seismicity and teleseismic data, gathered with a temporary seismological network, show that most of the crustal seismicity is concentrated in several clusters close to the coast line between the surface and c. 20 km depth. Benioff seismicity can be found down to a depth of approximately 100 km. An accumulation of seismic events between 20-30 km depth west of $\sim$73° W might be located in the seismogenic coupling zone or in its vicinity. Finally, evaluation of both offshore and onshore MT data postulates a macro-anisotropic layer in upper to middle crustal levels indicating presumably a deeply fractured crust allowing migration of fluids in the entire forearc.

The suggestion that the rheology of the forearc exerts an important control on where extensive rupture and great earthquakes can occur has to be further examined. This will include gravity data and as important task the analysis of the distribution of weakly and strongly coupled segments in the seismogenic coupling zone.