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The crustal Architecture and the seismogenic coupling Zone in southern central Chile (38° S) derived from Reflection Seismic Imaging within Project TIPTEQ

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The multi-disciplinary project TIPTEQ (from The Incoming Plate to mega-Thrust EarthQuake processes) investigates the seismogenic coupling zone in Southern Central Chile and the associated subduction zone processes between the Pacific Ocean and the volcanic arc. The reflection seismic component of TIPTEQ encompasses a 110 km long profile which spans from the coast over the down-dip end of the seismogenic coupling zone, crossing the 1960 Valdivia earthquake hypocentre. 180 three-component geophones were deployed (100 m spacing) along an 18 km wide spread whereof 4.5 km were shifted in a daily roll-along. With 100 borehole shots, 1.5 km apart, this up to 8-fold covered line delivers a high-resolution image of the seismogenic coupling zone. 15 additional shots in an expanding spread profiling configuration focussed on the seismogenic coupling zone.

The subducting Nazca plate can be traced from a depth of 25 km below the coast down to a depth of 50 km at the eastern end of the profile. A subduction channel may be interpreted directly above the plate interface with a varying thickness of up to 5 km. The continental crust exhibits highly reflective bands with an average thickness of 2-3 km, dipping at various angles. Broad arching structures argue for basal accretion and subsequent uplift of material, dated by isotope tectonochronology and simulated in analogue sandbox experiments. Between depths of 5 to 25 km several bright reflectivity spots can be seen in the upper plate, which may suggest fluid traps in the accretionary wedge. The tomographic P-wave velocity model reaches approximately 10 km depth and can, therefore, extend surface geology studies towards depth.

The thickness of the sedimentary basins in the Central Valley is approx. 3 km. We can identify prominent fault systems like the sinistral Lanalhue fault zone (LFZ) which divides the forearc into the Western and Eastern series. Two high-velocity bodies with P-wave velocities of 6.8 - 7 km/s are observed. They are ca. 5 x 10 km in size and are found below 5 km depth. These bodies are suggested to have different origins. The body directly west and below the LFZ may be composed of continental mantle material, since i.e. chromites and serpentinites are found farther south of the profile. This material was presumably uplifted at the LFZ along an oblique component of the transpressional fault. The high-velocity body east of the LFZ lies within the granitoids of the Eastern Series and may be of magmatic origin. An S-wave tomographic velocity model is constructed from the recorded data and is also combined with the converted SPOC-South wide-angle model for a migration of the horizontal components.