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Seismic structure of the incoming Nazca plate offshore Southern Central Chile

E. Contreras-Reyes (1), M. Scherwath (1), I. Grevemeyer (1), E.R. Flueh (1) and TIPTEQ Working Group

(1) IFM-GEOMAR, Kiel, Germany (Email: econtreras-reyes@ifm-geomar.de)

Dehydration processes in subduction zones is believed to be an important process controlling earthquakes both in the downgoing plate and in the seismogenesis megathrust fault zone. Water may trigger and nurture rupture propagation. Growing geophysical evidences show that an important input of volatiles into the subducting plate occurrs in the outer-rise area. Here, large stresses and normal extensional faulting induced by the bending plate result in a high degree of alteration, fracturing and hydration of the oceanic lithosphere prior its subduction. To understand the degree of hydration of the incoming plate in the outer-rise area, we studied the velocity structure of the oceanic plate offshore of Southern Central Chile (˜ 43° S). Seismic wide-angle and reflection data are used to derive 2D velocity models of seismic profiles located seaward of the trench axis at 14.5 Ma old oceanic Nazca plate, which was created at the Chile Rise (a fast-intermediate spreading ridge). The data were acquired during RV SONNE cruise SO181 of TIPTEQ (from The Incoming Plate to mega-Thrust EarthQuake processes). Two lines run perpendicular to the Chile Rise and parallel to the Chiloe and Guafo Fracture Zones (Profile P01a and P05). A third profile is parallel to the Chile trench (P03) and hence orthogonal to P01a and P05. P05 approaches to the deep sea trench. Crustal phases (Pg and PmP) and mantle phases (Pn) were inverted using a joint refraction and reflection travel time inversion. Additionally, uncertainties of the velocity-depth model were estimated by applying the Monte Carlo uncertainty analysis. The comparison of the uppermost mantle P-wave velocities at the intersections of crossing profiles reveals a relative low Pn anisotropy (2.5 +/- 1.7 %), which is orientated in the direction of spreading. This degree of seismic anisotropy is interpreted as a preferred orientation of Olivine caused by mantle flow at the spreading centre. In addition, we found P-waves velocities typical for mature fast-spreading crust seaway

from the trench, with uppermost mantle velocities as fast as ~ 8.3 km/s. Approaching the Chile trench seismic velocities are significantly reduced, however, suggesting that the structure of both the oceanic crust and uppermost mantle have been altered, possibly due to a certain degree of fracturing and hydration. Hydration and crustal cracks activated by extensional bending related faulting are suggested to govern the reduced velocities in the vicinity of the trench. Seawater may migrate down to mantle depth causing up to ~ 9% of serpentinization of the uppermost mantle.