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A double seismic zone in the Nazca flat slab beneath central Chile (29°-34°S)

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The Nazca plate subducts beneath central Chile and western Argentina (29°-34°S) with a dip angle ∼27° from the trench until ∼100 km depth. North of 32oS the slab becomes sub-horizontal at this depth and continues sub-horizontally for approximately 250 km eastward before resuming sinking with dip angle ∼25°. The location and extent of this "Pampean" flat subduction is very well correlated, seismically and tectonically on the continent, with the continuing subduction of the Juan Fernandez Ridge (JFR). We use the recorded seismicity from three local temporary networks, OVA99 (1999-2000), CHARSME (2002-2003) and CHASE (2005-2006) to characterize the earthquake distribution within the slab in this area. Around 7000 earthquakes were located with magnitude ranging between 1.6 and 5.7, and around 1500 focal mechanisms were calculated.

A double seismic zone (or DBZ) is present in the dipping part of the slab landward from the trench. The lower seismic zone of this Pampean DBZ begins at ∼50 km depth and extends to 100-120 km depth, where it merges with the upper seismic zone. The separation between the two zones is ∼30 km at the shallowest depth. The lower seismic zone shows higher seismic activity relative to the upper zone. Both zones show a similar magnitude distribution, with predominantly tensional focal mechanisms. The Pampean DBZ is best observed within the subducting JFR, which is marked by a dense and thick seismic activity. This seismicity drops substantially outside the JFR ridge limits, making the Pampean DBZ more difficult to detect. Focal mechanisms for earthquakes delineating the DBZ (50-100 km depth) show a strong tendency of the focal planes to strike NS, parallel to the trench axis, suggesting that intermediate-depth earthquakes in the subducting Nazca plate occur on pre-existing reactivated outer rise faults.

The separation distance between the two seismic zones cannot be explained by plate age models which predict a much smaller separation distance given the young age of the Nazca slab (40 Ma). The most probable hypothesis at present is that the large separation distance is a consequence of a combination of factors such as the plate low thermal structure relative to the Nazca plate age, high converge rate, and high degree of hydration. The fact that DBZs are commonly observed in many different kinds of subduction zones suggests that the mechanical and/or chemical processes responsible for producing intraslab seismicity within the oceanic mantle must be linked both to the slab's parameters (composition, internal fabric, and thermal state) and to regional kinematic and dynamic conditions (forces acting on the slab, upper plate convergence, and trench migration).