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Flat vs. Normal subduction, Central Chile: insights from regional seismic tomography and rock type modeling

Marianne Marot (1), Tony Monfret (1), Muriel Gerbault (1), Guust Nolet (1), Giorgio Ranalli (2), and Mario Pardo (3)

(1) , UNSA, IRD, CNRS, OCA, (UMR 7329), 250 Albert Einstein, 06560 Valbonne, France, (2) Department of Earth Sciences, Carleton University, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, Canada , (3) de Geofisica, Universidad de Chile, Blanco encalada 2002, Santiago, Chile

The Central Chilean subduction zone (27-35°S) is host to a multitude of unexplained phenomena, all likely linked to one another. Here, the 35 Ma oceanic Nazca plate is subducting beneath South America with a well developed, highly seismic flat slab, very well correlated with the subducting Juan Fernandez seamount Ridge (JFR) track, and also with the absence of volcanism at the surface. The upper plate, currently under compression, is composed of a series of accreted terranes of various origins and ages.
Although no general consensus on the formation of this flat slab has been yet achieved, there may have been influence of overthickened oceanic crust, delayed eclogitization and consequent fluid retain within the slab, and slab suction due to the high convergence rate with the thick Rio de Plata craton.
Therefore, the main questions we address are: Does the slab dehydrate along the flat subducting segment? If so, how hydrated is the slab, at what depth does slab dehydration occur, where are the fluids transported to, and where are they stored? Is magmatism still active beneath the now inactive arc? Are accreted terranes and suture zones important attributes of this subduction zone? Do they possess their own mantle entities?
To answer these questions, we analyzed recorded local seismicity and performed regional 3D seismic tomography for Vp and Vs. Combining seismic tomography with 2D instantaneous thermo-mechanical modeling for the regions of flat and normal subduction, we predict rock compositions for these two regions based on published mineral and rock elastic properties.
Here, we present a comparison between the normal subduction zone to the south, reflecting typical and expected features, and the flat slab region to the north, exhibiting heterogeneities. Our results agree with other studies for a dry and cold continental mantle above the flat slab. We distinguish the Cuyania terrane with overthickened crust and/or abnormal mantle beneath it. We notice that the inactive volcanic arc crust carries an ongoing thermal signature of past magmatism with high fluid content. The downdip extent of the interface zone has seismic properties indicative of fluid saturation. The aftershock region of the Punitaqui slab earthquake (z=70 km, Mw 7.1) as well as the mantle wedge corner above the flat slab are two areas of anomalous seismic properties (particularly pronounced directly above the Punitaqui earthquake), which are unexplained by normal rock compositions or temperature variations. In addition, we observe a double seismic zone (DSZ) along the JFR track and the occurrence of a reactivated fault plane at intermediate-depth following a mainshock event.