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Seismic evidence of a link between subducted oceanic faults and volcanism: A case study from South Central Chile

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The south-central Chilean subduction zone was investigated at 39-40°S by a passive seismic experiment. The investigation area comprises the maximum slip of the great 1960 Mw 9.5 Valdivia earthquake. The incoming Nazca plate is permeated by a number of major fault zones including the Valdivia fault zone and the Mocha fault zone which seem to have behaved as a barriers for the rupture propagation of large earthquakes in the past. The investigated sector is also home to the Villarrica volcano - one of South America's most active volcanoes. In the extension of the Valdiva fault zone we observed a cluster of increased seismicity in the subducting plate at depths between 80 km and 120 km, where dehydration of the subducting plate occurs. The focal plane solutions of this cluster show predominantly strike-slip motion. Tomographic images show decreased P- and S-velocity and increased ratio between the seismic cluster and the volcanic center of Villarrica, Quetrupillán and Lanin, corresponding to an increased content of fluids or melt. Additional geochemical investigations show that the magma of Villarrica volcano has an enhanced fluid signal compared to the other volcanoes of the Southern Volcanic Zone of Chile. It can be assumed that the Valdivia fault zone serves as the source for the fluids. Before the plate subducts, water can penetrate the plate through faults within the Valdivia fault zone. Serpentinization would build the water into minerals. Inside the subduction zone the Valdiva fault zone is reactivated by dehydration reactions at a depth of about 100 km. The released fluids rise towards the volcanic center causing the tomographic anomalies. At the end this leads to an increased degree of melting and a higher activity of Villarrica volcano.