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The structure of the Calabrian subduction system from the fore-arc to the back-arc: new insights from wide-angle seismic data

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The Calabrian subduction system is characterized by the subduction of the Ionian Lithosphere under Calabria. The SE migration of this system, triggered by slab rollback, caused the opening of the Tyrrhenian back-arc basin. The large-scale lithospheric structure of the subduction system is mostly imaged by regional earthquake tomography studies. The limited resolution of these studies, however, hinders the definition of smaller-scale details on the location, nature, and transition of different lithospheric domains (e.g. Arc - back-arc transition), which are crucial to understanding the geodynamic evolution of the system.
Here we perform travel-time tomography of offshore and onshore active-source wide-angle seismic data to define the 2D Vp structure of the entire Calabrian subduction system. The data were acquired along a 550 km-long transect that extends from the Tyrrhenian back-arc domain to the fore-arc in the Ionian Sea, across Calabria.
From NW to SE, the tomographic model shows abrupt variations of the velocity structure. In the back-arc system, particularly in the Vavilov and Marsili basins, OBS sections lack PmP-like arrivals and the velocity structure shows a continuous and strong vertical velocity gradient of $\sim$1 s-1. These results together with previous tomographic models, analysis of Vp/Vs and basement rock sampling strongly supports the exhumation of the mantle along > 200 km long section in the back-arc region. Between the Vavilov and Marsili basins, a relatively thick, low-velocity block is interpreted to be of continental affinity.
The transition between Marsili Basin and Calabria is marked by a steep Moho geometry that shallows from SE to NW, revealing a dramatic crustal thinning along the N Calabrian margin. The lower crust of the margin has localized Vp of $\sim$7 km/s under the submarine volcanic arc. The vertical velocity structure of this young arc (< 2Ma) reveals a thinner and more mafic crust than older Island arcs in the Pacific, suggesting that crustal growth by magmatic addition and differentiation is still at an early stage in the Calabrian volcanic arc.
SE Calabria, the model shows a strong horizontal velocity gradient that is interpreted as the backstop of the subduction. In the Ionian, a 3-5 km thick sedimentary wedge thickens towards the NW. The frontal part of the wedge shows sub-vertical low-velocity anomalies indicating the presence of fluid-saturated large thrusts faults.