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Modeling Moho topography with different seismic methods: application to Alpine-Central Mediterranean region

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The distinct change in chemistry and petrophysical parameters across the crust-mantle boundary expresses itself as a specific feature in all tomographic images obtained by seismic methods. While active and passive refraction seismology image the Moho as the famous first-order discontinuity with near-vertical reflection seismology we see it as a narrow band of reflectivity or simply as the lower limit of the reflective lower crust. In receiver function (RF) seismology Moho signals are generally the most pronounced converted phases and in local earthquake tomography (LET) the Moho expresses itself by characteristic velocities and a strong velocity gradient. Each of these seismic methods has its intrinsic strengths and limitations that prevent continuous and unbiased mapping of Moho topography by any specific seismic method. The specifically designed combination of quality information from controlled source seismology (CSS), RF, and LET, however, allows to compensate limitations in one seismic method by the strength of another method.

The quality of each tomographic information about the Moho not only depends on the seismic method but also on the specific observation and the processing it was derived from. For each seismic method we derive Moho data quality classes and corresponding uncertainty estimates and apply these principles to the available seismic information on the Moho in the Alpine-Central Mediterranean region. We validate our approach by comparing highest quality Moho elements from different seismic methods co-existing in several dozen localities. In all these cases, the derived Moho depths coincide within their individual estimated uncertainty limits. In total we use more than 1000 data points with uncertainty estimates from CSS, RF, and LET to calculate a new Moho map of the Alpine-Central Mediterranean region. The interpolation between data points follows the principle of simplicity: searching for the smoothest three Moho interfaces –representing the three plates Europe, Adria, Corsica-Sardinia-Tyrrhenia- that fit all Moho data points within their individual uncertainty estimates. Compared to previous studies, our new Moho map clearly shows major tectonic structures like suture zones and the high-velocity Ivrea body, and thus allows for a more accurate definition of plate boundaries at Moho level. We attribute this to the larger number of available high-quality Moho data consistently derived from different seismic methods.