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From local earthquakes tomography to Moho topography beneath the Western Alps

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The Western Alps are the result of the collision between the European margin and the Apulian margin, which started about 35 Ma ago. Nowadays, the lithosphere beneath the Western Alps consists of the subduction of the European plate underneath the Apulian plate. Such geometry implies a complex Moho discontinuity.

Over the past 25 years, several dense seismic networks settled in France, Italy and Switzerland have permitted to locate more than 45,000 local earthquakes. In this study, we used 335 stations spread over a 200,000 km^2 area, and about 35,000 events that have been located with at least 5 stations and 7 P and S–waves picks. The resulting dataset is formed of more than 820,000 data. Most of the Western Alps earthquakes occurred within the first 10 km beneath surface, nevertheless a large part of P and S–waves are refracted waves on the Moho discontinuity.

In order to build up the Moho topography of the western Alps, we used at first this data set to perform a crust and upper mantle tomography based on travel-times analysis. Our model consists of a set of V_P and V_P/V_S values given at each node of a three-dimensional, regularly spaced grid, which constitutes the inversion grid. Transition between crust and mantle is modeled by a continuous change in velocity, as we do not introduce any *a priori* information on the Moho interface. Earthquake locations and site-effect residuals at each station are also determined in the process. The forward computation of travel times in the 3D model is performed by integrating slowness along the rays, which are determined by the Podvin-Lecomte algorithm (basically a finite difference resolution of eikonal equation). Inversion is carried out using a non-linear least-squares approach based on a stochastic description of data and model. The smoothing and damping parameters are adjusted by means of L–curves analysis.

The Moho discontinuity is obtained by matching an isovelocity surface of this tomography model with information on the edge of the area (where our model is poorly resolved) coming from previews studies. We chose a value of about $V_P = 7.5$ km.s^{-1} for this isovelocity surface, which corresponds to an intermediate value between the crust and the upper mantle. This new Moho interface is then used as an *a priori* discontinuity in a new tomography process in which the parameters within the crust and the upper mantle are now decorrelated. Thus, refracted waves are modeled more correctly and the resolution within the crust can be improved.

Finally, we constituted a set of local earthquakes which were accurately relocated by studies involving temporary networks, due to their relatively high magnitude or to the damages they caused. To evaluate the quality of our models, we compared these published locations to the ones we could obtain.