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Joint receiver function and gravity inversion for new constraints on the Ivrea body structure: a 2D high-resolution view along the Val Sesia profile (N. Italy).

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We present results from a joint inversion study of new seismic and gravity data to constrain a 2D high-resolution image of one of the most prominent geophysical anomalies of the European Alps: the Ivrea geophysical body (IGB). Our work exploits both new data and multidisciplinary a priori constraints, to better resolve the shallow crustal structure in the Ivrea-Verbano zone (IVZ), where the IGB is known to reach anomalously shallow depths and partially outcrop at the surface.

A variety of previous studies, ranging from gravity surveys to vintage refraction seismics and recent local earthquake tomographies (Solarino et al. 2018, Diehl et al. 2009), provide comprehensive but spatially sparse information on the IGB structure, which we aim at investigating at higher resolution, along a linear profile crossing the IVZ. To this purpose, we deployed 10 broadband seismic stations (MOBNET pool, IG CAS Prague), 5 km spaced along a linear West-East profile, along Val Sesia and crossing Lago Maggiore. This network operated for 27 months and allowed us to produce a new database of ca. 1000 seismic high-quality receiver functions (RFs). In addition, we collected new gravity data in the IVZ, with a data coverage of 1 gravity point every 1-2 km along the seismic profile. The newly collected data was used to set up an inversion scheme, in which RFs and gravity anomalies are jointly used to constrain the shape and the physical property contrasts across the IGB interface.

We model the IGB as a single interface between far-field constraints, whose geometry is defined by the coordinates of four nodes which may vary in space, and density and V_s shear-wave velocity contrasts associated with the interface itself, varying independently. A Markov chain Monte Carlo (MCMC) sampling method with Metropolis-Hastings selection rule was implemented to efficiently explore the model space, directing the search towards better fitting areas.

For each model, we perform ray-tracing and RFs migration using the actual velocity structure both for migration and computation of synthetic RFs, to be compared with the observations via cross-correlation of the migration images. Similarly, forward gravity modelling for a 2D density distribution is implemented and the synthetic gravity anomaly is compared with the observations along the profile. The joint inversion performance is the product of these two misfits.

The inversion results show that the IGB reaches the shallowest depths in the western part of the profile, preferentially locating the IGB interface between 3 and 7 km depth over a horizontal distance of ca. 20 km (between Boccioleto and Civiasco, longitudes 8.1 and 8.3). Within this segment, the shallowest point reaches up to 1 km below sea level. The found density and velocity contrasts are in agreement with rock physics properties of various units observed in the field and characterized in earlier studies.