Reflection seismic surveys to site the Drilling the Ivrea Verbano zonE (DIVE) proposed drill-holes, Val Sesia and Val d’Ossola, Italy.

Andrew Greenwood1,2, Ludovic Baron1, Yu Liu1, György Hetényi1, Klaus Holliger1, Mattia Pistone1,3, Alberto Zanetti4, Luca Ziberna5, and Othmar Müntener1

1University of Lausanne, Switzerland.
2Montanuniversität Leoben, Austria.
3University of Georgia, United States of America.
4Università degli studi di Pavia, Italy.
5Università degli studi di Trieste, Italy.

The Ivrea-Verbano Zone in the Italian Alps represents one of the most complete and best-studied cross-sections of the continental crust. Here, geological and geophysical observations indicate the presence of the Moho transition zone at shallow depth, possibly as shallow as 3 km in the location of Balmuccia in Val Sesia. Correspondingly, the Ivrea-Verbano Zone is a primary target for assembling data on the deep continental crust as well as for testing several hypotheses regarding its formation and evolution.

Within the context of a project submitted to the International Continental Scientific Drilling Program (ICDP), the Drilling the Ivrea-Verbano zonE (DIVE) team proposes to establish three drill holes across pertinent structures within the Ivrea-Verbano Zone. Two of the planned drill holes, each with a length of ~1000 m, are within Val d’Ossola and target the Pre-Permian lower and upper section of the lower crust. The third proposed drill hole, with a length of ~4000 m, is targeting the lowermost crust of the Permian magmatic system of the Ivrea-Verbano Zone in the Val Sesia, close to the Insubric Line. Combined, the three drill holes will compose a complete section of the lower crust and the Moho transition zone, and will reveal the associated structural and composition characteristics at different scales.

To bridge across the range of spatial scales and to support the drilling proposal, we have carried out active seismic surveys using an EnviroVibe source in the Val d’Ossola. These surveys combined 2D transects (in-line) with the simultaneous collection of short cross-lines, and spatially varied source points, to collect sparse 3D data with a preferential CMP coverage across strike. This survey geometry was largely controlled by environmental considerations and access for the vibrator. Accordingly, 2D profiles, both in-line and cross-line, have been processed using crooked-line geometries, which include CMPs from the 3D infill.

The very high acoustic impedance contrast of the Quaternary valley infill sediments with respect to the predominant metapelitic and gabbroic lower crustal rocks, as well as the highly attenuative nature of the sediments, were both beneficial and problematic. The former enables mapping of
the valley structure, while the latter largely prevents the detection of low-amplitude reflections from within the underlying lower crustal rocks.

Here, we present the latest results of these seismic reflection surveys and discuss the observations with respect to the prevailing structure and the planning of the drilling operations. Beyond the specific objectives pursued in this study, our results have important implications with regard to the acquisition and processing of high-resolution seismic reflection data in crystalline terranes and their capacity for resolving complex, steeply dipping structures.