A high-resolution seismic survey across the Balmuccia Peridotite, Ivrea Zone, Italy – Project DIVE

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The Ivrea Verbano Zone (IVZ) is one of the most complete crust–upper mantle geological references in the world, and the Drilling the Ivrea-Verbano zone project (DIVE) aims to resolve the uncertainties below this area. Geophysical anomalies detected across the IVZ indicate that dense, mantle-like rocks are located at depths as shallow as ca. 1-3 km. Thus, within DIVE several geological, geochemical and geophysical studies are planned, including the drilling of a 4 km deep borehole that will penetrate the Balmuccia Peridotite (Val Sesia, Italy), a peridotite body that outcrops in the IVZ. The objective of this borehole is to approach, and possibly cross, the crust–mantle transition zone, and provide for the first time geophysical in-situ measurements of the deepest rocks of the IVZ.

One of the primary requirements before drilling is a seismic site characterization, to define with precision the correct positioning and orientation of the borehole, to assess potential drilling hazards and to allow for the spatial extrapolation of the borehole logs. For that goal, two joint geophysical surveys were performed in October 2020 in a collaboration between GFZ Potsdam, Université de Lausanne and Montanuniversität Leoben: (1) a deep seismic survey performed by GFZ Potsdam, entitled SEismic imaging of the Ivrea ZonE (SEIZE), consisting of two approximately orthogonal 15 km-long seismic lines, that aim to resolve the deeper structure of the IVZ in the area, and (2) a smaller seismic survey at the proposed drill site, entitled High-resolution SEismic imaging of the Ivrea ZonE (HiSEIZE), geared towards providing high-resolution seismic images of the uppermost few km. In this study, we focus on the HiSEIZE data.

The area of study is characterized by high-velocity crystalline rocks, which imposes several challenges for reflection seismology: Lithologic impedance contrasts in crystalline crust are usually weaker, the spatial coherence of reflections from faults and fractures is quite limited, steep dips are predominant, and the strong contrast between the weathering layer and the crystalline basement impedes the penetration of the wavefield generated by the source. These problems must be addressed by applying processing approaches that differ from classical imaging of sedimentary structures.

This project will not only provide site characterization for the DIVE project, but also contribute to understanding the structure of the Balmuccia Peridotite, its changes in depth and its relationship with the crustal-mantle transition.