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A high-resolution seismic survey across the Balmuccia Peridotite, Ivrea Zone, Italy - Project DIVE phase two, site investigation

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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 unravel 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. 3km. Thus, several geological, geochemical and geophysical studies are planned, including the drilling of a 4km deep borehole that will penetrate the Balmuccia Peridotite (Val Sesia, Italy) to approach and possibly cross the crust–mantle transition zone, and provide, for the first time, geophysical in-situ measurements 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 of GFZ Potsdam, Université de Lausanne and Montanuniversität Leoben. First: a deep seismic survey, entitled SEIZE (SEismic imaging of the Ivrea Zone), consisting of two approximately 15km-long seismic lines performed by GFZ Potsdam, that aim to resolve the deeper structure of the IVZ in the area, and second: a static seismic survey at the proposed drill site, entitled HiSEIZE (High-resolution SEismic imaging of the Ivrea Zone), geared towards providing high-resolution seismic images of the uppermost few km at the proposed drill site.

The HiSEIZE survey, the subject of this study, was performed with a fixed spread of 200 vertical geophones and 160 3C-sensors, spaced at ca. 11m along three sub-parallel lines spaced 50-80m apart. Vibroseis source points were at 22m stations along a 2.4km line utilizing a high-frequency (12-140 Hz) 10s linear sweep with 3s listening time. In addition to this, the HiSEIZE receiver spread was active during the deep SEIZE survey, information that may be useful in determination of a velocity model through the Balmuccia Peridotite.

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.

Here we present the data and discuss the challenges of 3D pre-stack-imaging in an area of extreme topography.