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Scientific Drilling in the Mediterranean Sea
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Abstract
Nuove idee per la perforazione scientifica

DIVE: Drilling the Ivrea-Verbano zonE

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Abstract (max 4000 caratteri)

There are very few places on Earth where an almost complete cross-section of the continental crust is exposed and even fewer, if any, are the places where the transition between continental crust and upper mantle, the Moho discontinuity, outcrops on the surface. Drilling the Moho is a longstanding goal since the 1950s and there are unresolved scientific questions whether the seismically identified Moho corresponds to the transition between crustal and mantle rocks; to a plagioclase saturation boundary in continental settings; or even to a serpentinization front in parts of the oceanic lithosphere. High-resolution geophysics and outcrop data collectively provide precious insights into the crust-mantle transition, but no tight constraints determine the actual architecture of the continental lower crust and location and thickness of the Moho transition zone. This part of the Earth is a prime target in the field of modern Earth Science because: a) the continental crust holds the only record of most of the Earth’s rich and varied history, and b) understanding the geology of the continents has practical implications to our society.
Amongst the known non-Archean crustal cross-sections with continental and paleo-island arc signature, the Ivrea-Verbano Zone (IVZ) in the Southern Alps (Piemonte, Italy) represents the most complete, time-integrated crust-upper mantle archive in the world. The IVZ is one of the best studied, yet many aspects of its evolution remain enigmatic or are vigorously debated. Historically, the IVZ was the first terrain to have been identified as an exposed cross-section of the continental crust. The IVZ with its pronounced positive Bouguer gravity anomaly (Fig. 1), served as a calibrating benchmark in search of other crustal sections in the world.
The IVZ was and remains an extremely valuable guide to the processes that shape much of the continental crust. The contacts between granulite facies rocks and ultramafic bodies are, however, mylonitic, suggestive of partial removal of the section. Therefore, such contacts do not represent the Moho *sensu stricto*, but they must be viewed as “tectonically modified Moho”. Nevertheless, mantle peridotite slivers in the lower crust may indicate the presence of the Moho transition zone at shallow depth (~3-5 km; Fig. 1). Indeed, a major issue that has sparked worldwide interest is, that the large gravimetric, magnetic, and seismic anomaly of the geophysical Ivrea body indicates dense, mantle-like rocks at fairly shallow crustal levels (Fig. 1). Given the extensive exposure of the crustal section, limited lower crustal removal, and the proximity of the geophysically imaged Moho, the IVZ represents the primary target for assembling data on

the deep continental crust and Moho transition zone, and for testing several hypotheses of formation, evolution, and modification of the continental crust through space and time.

Scientific drilling in the IVZ is therefore the required tool to achieve this target. Drilling will improve our understanding of the processes that form and modify the continental crust and its transition to the mantle. The DIVE project will drill this transition in three different locations in Val Sesia and Val d'Ossola, IVZ, in order to investigate:

- Magmatic and metasedimentary sections of the lower continental crust and its transition to the upper mantle;
- Correlations between the crust-mantle transition zone and the geophysical structure across the scales;
- Extreme niches for hosting microbial life in planetary interiors.

Acquiring data to address such overarching questions will ultimately allow fundamental progress towards understanding the compositions, structure, and evolution of the Earth's crust and the processes that continue to modify it.

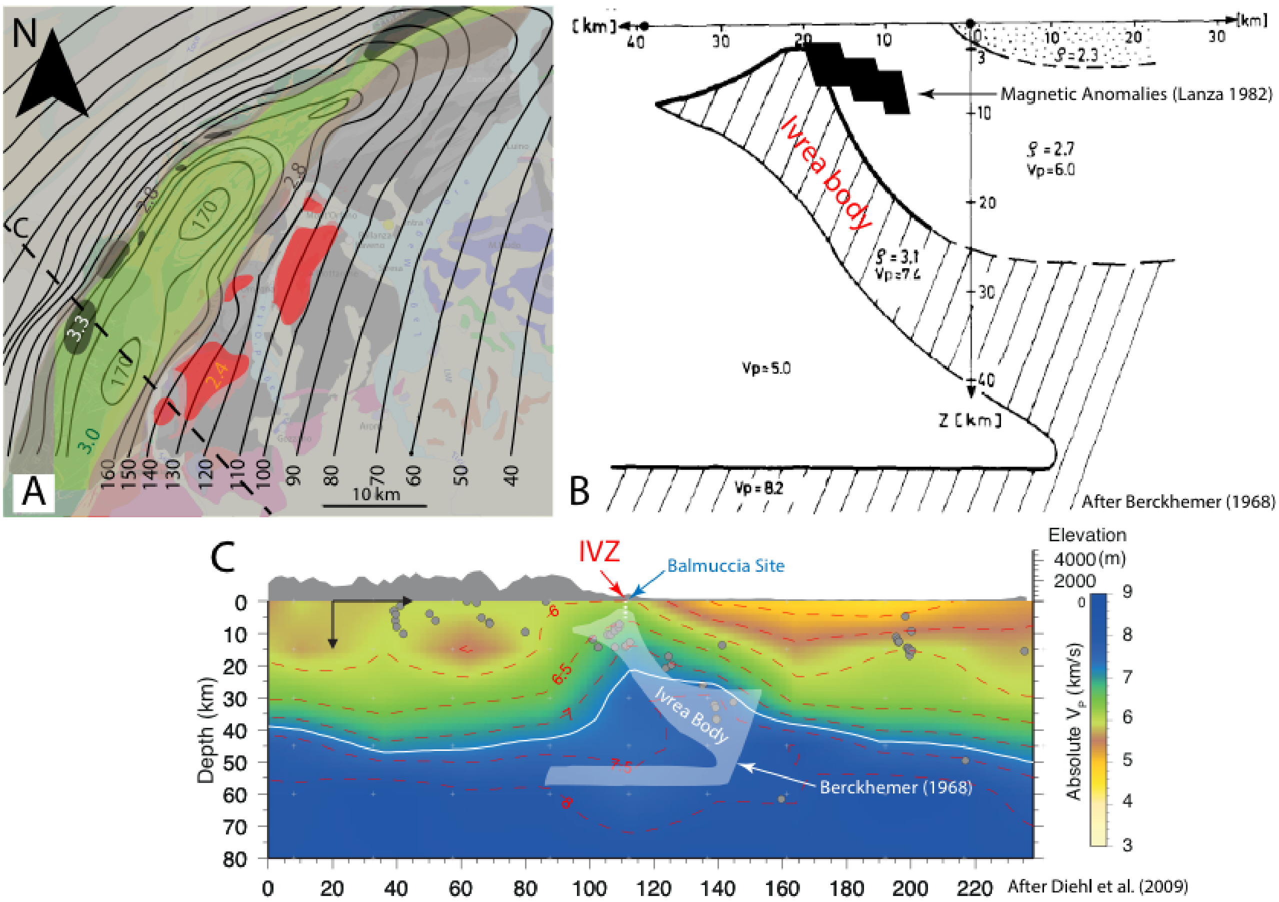

Fig. 1 A) Map showing the bulk density distribution of surface rocks (coloured areas with density values in g/cm^3) and calculated gravity effect of the Ivrea body (black contours with gravity values in mgal) in the IVZ (redrawn after Kissling 1984). B) Cross-section of the Ivrea body ("Bird's Head model"), as determined by

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seismic wave velocities and gravity anomalies (Berckhemer 1968). Black squares are magnetically differentiated rocks with a magnetic susceptibility contrast of $5\cdot10^{-1}$ cgs emu with respect to the surrounding lithologies (Lanza 1982). C) NW-SE seismic profile across the Western Alps (Diehl et al. 2009). The red dashed lines are the final P-wave velocity model contours of Diehl et al. (2009). The vertical white dashed line in (C) indicates the proposed borehole location (up to 4 km depth) at the Balmuccia site. The superimposed white shaded area indicates the best guessed projected position of the Bird’s Head model of Berckhemer (1968).