Five, closely related PhD positions in continental drilling of the lower crust – project DIVE

Through funding from the Swiss National Science Foundation, **we invite applications for 5 PhD positions starting in 2022 for a duration of 4 years each**. The research themes are closely related and the doctoral candidates will cooperate with each other within an interdisciplinary team at the University of Lausanne and University of Bern. The research takes place in frame of project DIVE: Drilling the Ivrea-Verbano zone (www.dive2ivrea.org), a multinational, continental drilling project co-funded by ICDP and national funding agencies. In 2022 two 1-km-deep boreholes are to be drilled and cored in the Val d'Ossola, Italy. This area is part of an archetypal lower crust terrane, and the 5 projects presented below propose to close the gaps between observed properties and the processes that shaped the lower continental crust.

Project **A** explores the nature of lower crustal anisotropy and its impact on the interpretation on wide-angle controlled-source seismic data, which provide key constraints with regard to crustal thickness and composition. This is achieved by constructing realistic seismic models of Ivrea-type lower crust through the geostatistical assimilation of diverse datasets ranging from laboratory- and log-based measurements all the way to local- and regional-scale geological maps and cross-sections. This will reveal whether, and to what extent, our current estimates of crustal thickness as well as lower and bulk crustal velocities are systematically biased. The results of this PhD project have direct implications for current and future models of lower crustal composition and evolution. Project lead by Prof. Klaus Holliger, University of Lausanne.

Project **B** investigates the chemical composition of km-long DIVE drill cores of felsic and mafic continental lower crust and rigorously test compositional variability and their uncertainties on different length scales. Realistic bulk chemical models of Ivrea-type lower continental crust will be built that satisfy the petrological and geophysical properties. Fabrics of major rock forming minerals will be investigated to quantify anisotropy of felsic and mafic lower crust. Combined with hydrogen contents in major minerals rheological models of felsic and mafic lower crust will be developed. The models have direct impact on global estimates of crustal composition and rheology. Project lead by Prof. Othmar Müntener, University of Lausanne.

Project **C** focuses on the carbon and hydrogen inventory of the lower crust and investigates how their presence or absence influences the composition and physical properties. Special emphasis will be placed on the devolatilization in the "cratonisation" of metasedimentary rocks during their burial and heating. The quantification will show whether or not felsic lower crust is an important deep carbon reservoir and whether a causal link to electrical resistivity can be established, with direct implications for geophysical investigations of lower crust. Project lead by Prof. Jörg Hermann, University of Bern.

Project **D** will map thermal properties of the DIVE drill-cores and thereby close the spatial gap between petrology and borehole geophysics. By scanning thermal conductivity and densely measuring radiogenic heat producing elements, this project proposes to find new constraints on the thermal properties of rarely characterized metamorphic rocks and on the thermal structure of the deep crust, and assess the spatial variability of thermal properties across scales and their effect on heat flow determination uncertainties. By comparison with results from the other PhD projects, it will establish the relation between thermal, seismic and petrological properties of the deep crust, namely anisotropy, reflectivity and composition. Project lead by Prof. György Hetényi, University of Lausanne.

Project **E** investigates the distribution of radiogenic elements over time. It will target minerals that controls particularly U and Th, their breakdown reactions and solubility in melts, as well as melt transfer responsible for radiogenic heat redistribution. It will target particularly the metasedimentary, felsic crust, where the removal of radioactive elements by melting is required by models, but rarely observed in nature. Chemical and isotopic tracing will be used to translate properties into dynamic processes responsible for radiogenic heat redistribution. Project lead by Prof. Daniela Rubatto, University of Bern.

How to apply

If you are interested in one or more of these projects, please prepare a single PDF file containing:

- a letter of interest, outlining your motivation for undertaking a PhD, and specifying for which project(s) are you applying [max. **1** page];
- your curriculum vitae;
- the names and contact information of at least 2 referees;
- the list of your BSc and MSc classes including the obtained grades.

Please send your application via e-mail to dive2ivrea@unil.ch **no later than March 10th, 2022**. Interviews are planned in April, and the PhD theses to start between May and September 2022. Further inquiries about the projects can be sent to the above e-mail address, or to the responsible persons listed for each project.