University of Genova

Department of Earth, Environmental and Life Sciences

Università degli Studi di Genova

STAT

Dottorato in Scienze e Tecnologie per l'Ambiente e il Territorio

Doctorate Course in Earth and Environmental Science and Technology

Earth Science Curriculum

Research Theme n. 5

Titolo: Idrogeno geologico naturale in ultramafiti alpine
Title Natural Geological Hydrogen in Alpine Utramafic rocks

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Program description including the formation program abroad

The aqueous alteration of peridotites (serpentinization) generates H_2 through redox reactions. Olivine-rich ultramafic rocks are therefore currently considered as the most promising targets for natural hydrogen production in Italy. Serpentinized ultramafic rocks from oceanic and subduction settings not only produce and trap H_2 and CH_4-bearing fluids, but also act as long-term reservoirs, storing and transporting these gases over geological timescales. Upon exhumation to shallow crustal levels, release of the trapped fluids can contribute to the present-day emissions.

The Voltri massif (Western Ligurian Alps) is characterized by the widespread of large slices of serpentinized peridotite, recording a multistage evolution, from early ocean floor conditions to Alpine subduction and exhumation. In the Voltri massif, the Acquasanta spring exhibits high concentrations of abiotic methane (15–20 vol% of dissolved gas), a byproduct of natural H_2 generation, thus providing direct evidence of this energy potential.

Aim of this project is to investigate the peridotite bodies surrounding the Acquasanta sector (including the Erro-Tobbio peridotite) acquiring detailed multiscale textural, chemical and physical data. The study will focus on: (i) the formation processes of natural H_2-CH_4 fluids, their entrapment in inclusions and the geochemical analysis of these fluids; (ii) the identification of the fluid migration pathways through structural and chemical tracers. This investigation will clarify the interplay of processes governing the natural cycle of H_2

The candidate will carry out field work aimed at defining the major meso- to microscale structures responsible for fluid migration in the studied rocks. A selected suite of samples will be analyzed through detailed microstructural, petrologic and geochemical investigations of rock-forming minerals and fluid inclusions. This approach will allow (i) to define the processes and the conditions of H_2-rich fluid release and entrapment, (ii) to determine the H_2 and CH_4 contents of inclusions, (iii) to reconstruct the fluid migration pathways. The results will contribute to constrain the genesis and accumulation of strategic H_2-CH_4 fluids in these Ligurian rocks.

The candidate is expected to spend a period of 3 to 6-months abroad at leading international research institutions (e.g. Njord Centre, University of Oslo, or other European centers), strengthen expertise in rock microstructures and the fluid pathways in fractured rocks.

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Tutor's publications of the last 3 years

Schwarzenbach E.M., Dragovic B., Codillo E.A., Streicher L., Scicchitano M.R., Wiechert U., Klein F., Marschall H.R., Scambelluri M. (2024). Mobilization of isotopically heavy sulfur during serpentinite subduction. Science Advances 10, eadn0641.

Cacciari S., Cannaò E., Toffol G., Scambelluri M., Morales L.F.G., Pennacchioni G. 2025. Fluid infiltration along reactive porosity networks at the subduction interface: Evidence from the eclogite-facies Erro-Tobbio Unit (Ligurian Alps). Lithos 498-499, Art. N. 107950.

Vesin C., Ulrich M., Rubatto D., Hermann J., Scambelluri M. 2025. Chemical and isotopic exchanges in serpentinites 1 during hydration and dehydration events in the Erro-Tobbio Massif (Italy): from ocean to subduction. Journal of Petrology 66, egaf008.

Scambelluri M., Toffol G., Cannaò E., Belmonte D., Campomenosi N., Cacciari S., Pennacchioni G 2025 Hydration and petrologic changes of inner portions of the subducting oceanic lithosphere facilitated by intermediate-depth faulting. Tectonophysics 911 (2025) 230832.