Postdoctoral Researcher in Metamorphic Petrology, Petrochronology & Numerical Modelling

FWF Project: PAT1459025 – Decoding Thermal Histories: Uncoupling Chemical and Mechanical Heat Production
Principal Investigator: Simon Schorn
Host Institution/work location: NAWI Geocenter, Karl-Franzens University of Graz (Austria)
Duration: 36 months, fixed-term contract
Weekly work load: 36 hours/week (90% employment)
Gross total salary: €196.522,95 (Postdoc-level B1)
Preferred starting date: Early 2027 (latest by 01.03.2027)
Project information: https://www.fwf.ac.at/en/research-radar/10.55776/PAT1459025

Project background

Metamorphic rocks preserve information about the thermal and tectonic evolution of the Earth's crust. However, their mineralogical and isotopic records may be modified by short-lived thermal perturbations associated with fluid-rock interaction and deformation. Latent heat released during exothermic hydration reactions and mechanical heat generated by deformation may perturb temperature-time paths, promote mineral diffusion, and partially reset geochronological systems. Despite their potential importance, these transient heat sources are rarely quantified explicitly in reconstructions of metamorphic and geodynamic evolution. The project *Decoding Thermal Histories: Uncoupling Chemical and Mechanical Heat Production* aims to identify and quantify the respective contributions of hydration-related and deformation-related heating to the metamorphic rock record. It combines field-based petrology, mineral chemistry, petrochronology, thermodynamic calculations, and numerical modelling. High-resolution observations from natural samples will be directly integrated with forward and inverse models to constrain the magnitude, duration, and spatial distribution of transient thermal perturbations.

The Koralpe-Saualpe region of the Eastern Alps is chosen as testing ground for this research. Its polymetamorphic units preserve variable degrees of rehydration during the Cretaceous Eoalpine overprint, while the region also contains the Plattengneiss Shear Zone, one of the largest high-grade shear zones in the Alps. These features make it possible to investigate chemical and mechanical heat production within a single, well-constrained tectonometamorphic setting.

Research objectives

The project will test two central hypotheses:

1. **Latent heat released during hydration perturbs the cooling paths of exhuming metamorphic rocks and partially resets mineral-compositional and isotopic systems.**
2. **Shear heating within major deformation zones produces short-lived thermal perturbations that cannot be explained by conductive cooling or exhumation alone and leaves detectable signatures in the petrochronological record.**

To address these hypotheses, the successful candidate will integrate mineral-scale observations with quantitative models of crustal-scale thermal evolution. Garnet zoning, titanite petrochronology, and ^{39}Ar–^{40}Ar data will provide complementary records with different sensitivities to temperature and time. These natural constraints will be compared with simulations of hydration, shear heating, mineral diffusion, and isotopic production–diffusion.

The goal is to establish a quantitative framework for evaluating transient heat sources in metamorphic systems and to determine how these processes affect interpretations of pressure–temperature–time histories and orogenic evolution.

The position

We invite applications from a highly motivated, independent, and proactive postdoctoral researcher who will take a leading role in the scientific development and implementation of the project.

The position combines data from natural samples with numerical modelling. The successful candidate will contribute to all stages of the workflow, from sample collection and petrographic characterization to analytical work, model development, inversion, interpretation, and publication. The precise balance between analytical and computational activities may reflect the candidate's expertise and scientific interests while remaining aligned with the objectives of the funded project.

The postdoctoral researcher will have substantial intellectual freedom to develop research questions and methodological approaches within the project framework. Close cooperation with the project partners will support the integration of petrology, geochronology, and numerical modelling. The position can begin in early 2027 and must start no later than 1 March 2027.

Main activities

The successful candidate will contribute to:

- Fieldwork and campaign-style sampling of rehydrated metamorphic units and the Plattengneiss Shear Zone in the Koralpe-Saualpe region (Austria).
- Petrographic and microstructural characterization of metapelites, amphibolites, calc-silicate rocks, and associated lithologies.
- Electron-microprobe analysis, including high-resolution compositional maps and transects of garnet, titanite, mica, and other relevant minerals.
- Trace-element analysis and in situ U–Pb dating of titanite by LA-ICP-MS.
- Investigation of Zr zoning in titanite and its application to thermometry and diffusion modelling.
- ^{39}Ar–^{40}Ar analysis of mica and amphibole, including step-heating and in situ laser-ablation approaches.
- Identification of diffusion-controlled mineral and isotopic patterns and their distinction from fluid-assisted dissolution-reprecipitation and recrystallization.

- Thermodynamic modelling of stable and metastable mineral assemblages and calculation of hydration-related changes in mineral-bound water, enthalpy, and other relevant rock properties.
- Development and application of thermokinematic models incorporating latent heat of hydration, shear heating and heat advection–diffusion.
- Coupling of calculated pressure–temperature–time paths with models of multicomponent diffusion in garnet and titanite, and K–Ar production–diffusion in mica and amphibole.
- Design of model–data misfit functions using mineral-compositional and geochronological observations.
- Forward exploration and inversion of model parameters such as latent heat release, exhumation rate, convergence rate, deformation duration, and shear-zone thickness.
- Application of probabilistic inversion methods, including Markov Chain Monte Carlo and Hamiltonian Monte Carlo approaches, to quantify uncertainty and address model non-uniqueness.
- Integration and interpretation of petrological, geochronological, and numerical results.
- Preparation of scientific publications and presentation of results at national and international conferences.
- Participation in project meetings, research visits, and the scientific activities of the host institute and partner institutions.

Candidate profile

The ideal candidate will have:

- A PhD in Earth Sciences or a closely related discipline.
- A strong background in metamorphic petrology and thermodynamics.
- Demonstrated experience in numerical modelling using environments such as MATLAB, Python, or Julia.
- Experience with thermodynamic, thermal, diffusion, thermokinematic, or inverse modelling, preferably using finite-difference or finite-element methods.
- The ability to integrate observations from natural samples with quantitative, process-based models.
- Strong analytical and problem-solving skills.
- The ability to work independently, organize complex research activities, and take scientific initiative.
- An interest in working across disciplinary boundaries.
- Strong communication skills and a collaborative approach to research.

Experience in geochronology, petrochronology, diffusion chronometry, petrography, mineral chemistry, electron-microprobe analysis, or LA-ICP-MS would be advantageous. Particularly relevant analytical methods include U–Pb titanite petrochronology and ^{39}Ar–^{40}Ar geochronology of mica and amphibole.

Candidates are not expected to have prior experience with every analytical and modelling method used in the project. Preference will be given to candidates with a strong background in thermodynamics, quantitative metamorphic petrology, and numerical modelling. Familiarity with finite-difference or finite-element methods, diffusion modelling, thermokinematic modelling, or inverse methods will be particularly valuable. Candidates with this quantitative background should demonstrate an interest in applying their skills to natural petrological and petrochronological datasets and in developing the necessary analytical expertise during the project.

Analytical and computational approach

The project will draw on a suite of established numerical methods and publicly available modelling codes. Thermokinematic models will be used to calculate pressure–temperature–time paths that explicitly incorporate latent heat release and shear heating. These paths will subsequently be coupled with models of:

- Multicomponent diffusion in garnet and titanite.
- Zr-in-titanite temperatures.
- K–Ar production–diffusion and apparent ^{39}Ar–^{40}Ar ages in mica and amphibole.

Measured mineral zoning profiles, temperatures, and age distributions will serve as quantitative constraints for forward and inverse modelling. Joint inversion of several independent mineral and isotopic systems will be used to reduce non-uniqueness and identify geologically meaningful combinations of transient heat input and tectonic parameters.

Research environment and collaborations

The project is based at the NAWI Geocenter of the University of Graz and is embedded in an international network combining expertise in metamorphic petrology, analytical geochemistry, petrochronology, thermochronology, and numerical modelling.

The successful candidate will collaborate with:

- **Simon Schorn, University of Graz:** metamorphic petrology, reaction energetics, thermodynamic and numerical modelling.
- **Jesse Walters, University of Graz:** titanite petrochronology, fluid–rock interaction, LA-ICP-MS, and high-resolution electron-microprobe analysis.
- **Christoph Hauzenberger, University of Graz:** metamorphic petrology, mineral chemistry, thermobarometry, and analytical infrastructure, including electron microprobe, LA-ICP-MS, and XRF facilities.
- **Evangelos Moulas, Johannes Gutenberg University Mainz:** numerical modelling of metamorphic and geodynamic processes, thermo-mechanical coupling, diffusion modelling, shear heating, and inversion methods.
- **Richard Spikings, University of Geneva:** thermochronology, isotope geochemistry, and step-heating and in situ ^{39}Ar–^{40}Ar methods.

Research visits are planned at the University of Geneva for ^{39}Ar–^{40}Ar analyses and data reduction and at Johannes Gutenberg University Mainz for the development and application of advanced inversion and uncertainty-quantification methods.

What the position offers

- A fully funded three-year postdoctoral position.
- An interdisciplinary project connecting field geology, metamorphic petrology, geochronology, thermodynamics, and numerical modelling.
- Access to established analytical infrastructure for electron-microprobe, LA-ICP-MS, and XRF work.
- Collaboration with an international network of specialists in petrochronology, thermochronology, and computational petrology.
- Planned research stays at partner institutions in Mainz and Geneva.
- The opportunity to work with established and benchmarked thermal, thermokinematic, and diffusion-modelling tools.
- Scope to develop and apply advanced forward and inverse modelling approaches.
- Substantial scientific autonomy within the objectives of the funded project.
- Support for publication in international peer-reviewed journals and presentation at major scientific conferences.
- Opportunities to develop an independent research profile at the interface between natural observations and quantitative process modelling.

Application

Please submit the following documents:

- A curriculum vitae, including a publication list.
- A motivation letter describing your research interests, relevant experience, and fit with the project.
- Contact details for two to three referees.

Applications and requests for further information should be sent by 15.10.2026 to:

Simon Schorn
Email: simon.schorn@hotmail.com

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