Research Engineer in Computational Mechanics for Modeling Anisotropy in Geodynamics

Location: Geosciences Montpellier, CNRS & Univ. Montpellier, France
Project: ERC RhEoVOLUTION
Starting date: September 1st, 2025
Duration: 12 months, renewable up to 24 months

Are you passionate about applying machine learning to solve complex physical problems? Join the ERC RhEoVOLUTION team at the forefront of geodynamics research, where we're developing new modelling tools to simulate the dynamics of the solid Earth.

Your Mission

You will develop supervised machine learning models to predict how rocks change their structure and mechanical properties - specifically their **elastic and viscoplastic anisotropy** - as they deform deep within the Earth. This is key to:

- **Imaging Earth's interior** through how seismic waves travel (elastic anisotropy).
- **Accurately modeling mantle flow and plate tectonics** (viscoplastic anisotropy).

At the heart of the problem is **olivine**, the mantle's most abundant mineral. The development of a preferred orientation of the olivine crystals ("texture") during deformation causes both anisotropies. Traditional physics-based models simulating this process are either oversimplified or too computationally expensive for large-scale geodynamic simulations. That's where machine learning comes in.

We've already built a promising framework using neural network surrogates trained on synthetic data generated with state-of-the-art crystal plasticity models. These models can accurately predict, for short deformation histories, how olivine textures and, hence, elastic anisotropy evolve in 2D flow conditions. But challenges remain, especially when chaining predictions over long deformation histories.

What You'll Work On

Your first goal will be to make our machine learning models **robust over long-term recursive use**—a must for simulating realistic geodynamic scenarios. Specific tasks include:

- **Analyzing and expanding the training database** to better represent the diversity of conditions in mantle flows.
- **Exploring new ML architectures**, including physically-informed networks that respect tensor symmetries.
- **Enhancing generalization** to prevent error accumulation during iterative predictions.

Following this, you'll:

- Extend the surrogate models to **3D deformation patterns**.
- Tackle the **viscoplastic anisotropy problem**, drawing on links between texture, elastic and viscoplastic anisotropies.
- Work on integrating the surrogate models into **finite-element geodynamic codes** in collaboration with the RhEoVOLUTION team.
- Explore applications beyond geoscience, such as **ice dynamics** and **material forming in metallurgy**.

Who We're Looking For

We seek a **highly motivated and creative engineer or postdoc** with:

- A degree (PhD or engineering diploma) in **geophysics, physics, mechanics, or applied mathematics**.
- Strong background in **numerical modeling and scientific computing**.
- Knowledge of geophysics and geology is a plus, not a prerequisite.
- Experience with **AI and deep learning**, especially for solving regression problems in physics, and familiarity with **solid mechanics**, particularly **crystal plasticity**, are major plus.
- Experience in using national and regional computing facilities will also be valued.
- Good communication skills in English.

This is an opportunity to contribute to an ERC-funded project addressing fundamental questions in Earth and planetary science—while pushing the boundaries of AI for modeling physical processes.

Interested? Please apply online at https://emploi.cnrs.fr/Offres/CDD/UMR5243-HELOUR-066/ . The application package should include a CV and a cover letter outlining your motivation and relevant research experience and providing the names and contact information for at least two references.

For more information about the position or the RhEoVOLUTION project, please contact Andréa Tommasi (andrea.tommasi@umontpellier.fr).