Postdoc position: Bridging the dynamic frictional behavior of fault gouges to earthquake ruptures via concurrent multi-scale modeling

We are seeking a full-time postdoctoral researcher with research interests in geomechanics, geophysics, multiphysics, and multi-scale methods (e.g., discrete element method and finite element method) to join the University of Twente (Netherlands). You will work on multi-scale modeling of coupled thermo-hydro-mechanically processes in fault gouges.

The post-doc position is part of the "FastSlip" project funded by the DeepNL programme of the Dutch Research Council (NWO). You will join a multidisciplinary team of leading experts in the fields of Granular Mechanics, Earth sciences, and Tribology from the University of Twente (UT) and Utrecht University (UU).

Background and aim:

The strength of geological faults drastically reduces at near-seismic slip rates, leading to large co-seismic displacements in fault zones. The observed weakening has been attributed to several multiphysical mechanisms, involving rapid frictional heating and temperature change, leading to high pore fluid pressures. While these phenomena originate at the microscale, current earthquake simulators often use continuum approaches, that typically require empirical rate and state friction models, without addressing the discontinuous, coupled multi-physical processes within the fault gouges and their coupling to fault reactivation at the larger length scales.

Accurate prediction of highly dynamic fault slip requires the development of comprehensive and experimentally validated models across different length scales: microscale, where friction between grains generates heat in fault gouges; mesoscale, featuring the fault microstructure, including pore networks that dominate the generation and dissipation of fluid overpressure; and macroscale, where thermal and stress waves attenuate and propagate across multiple faults. Based on the development of predictive models at these scales, a multiscale, multiphysical understanding of fault frictional phenomena will be obtained to help constrain estimates of hazards due to induced seismicity. In particular,

We aim to simulate **coupled thermo-hydro-mechanical processes** within fault gouges to investigate loading conditions inaccessible in laboratory and **upscale** their effects on fault reactivation using a concurrent **multi-scale modeling** approach recently developed at the University of Twente.

Your tasks:

- Extend the multi-scale methods already implemented in the open-source code Kratos Multiphysics from mechanical to coupled thermo-hydro-mechanical problems.
- Implement a thermal-hydro-mechanically coupled discrete element method (DEM) model for dynamic friction phenomena in fault gouges, in collaboration with a PhD student from the Surface Technology and Tribology group at UT.
- Couple the micro-scale (DEM) of the fault gouges and the macro-scale (FEM) models for fault reactivation within the same computational domain, in collaboration with a postdoctoral researcher at UU.

- Compare the simulation results with laboratory data from the High Pressure and Temperature Lab of UU.

Your profile:

- Obtained a PhD degree in a relevant field such as geotechnical engineering, applied geophysics, granular mechanics, computational mechanics, or related areas;
- Previous experience in coupled geomechanical processes;
- Sound programming skills in C/C++, Fortran, Python or equivalent;
- Previous experience with finite element method codes and/or discrete element method codes will be advantageous;
- You are an excellent teammate, able to collaborate intensively with academic parties in regular meetings and work visits ;
- An appropriate qualification in the English Language together with excellent communication and organizational skills.

We are an equal opportunity employer and value diversity at our company. We do not discriminate on the basis of race, religion, colour, national origin, gender, sexual orientation, age, marital status, or disability status. Women are explicitly asked to apply for this position. This is part of the University of Twente's strategy to increase the proportion of women among its faculty and to create a working environment that is diverse and inclusive and supportive of excellence in research and education.

Our offer

We offer you a very exciting position in an inspiring multidisciplinary environment. The university offers a dynamic ecosystem with enthusiastic colleagues in which internationalization is an important part of the strategic agenda.

- A two-year Postdoc position, with the possibility of extending the appointment to a third year.
- Collaborations with a dedicated, dynamic research team at University of Twente and University of Utrecht and external parties from several Dutch universities in the NWO-funded DeepNL programme.
- A gross salary between € 4.020 – € 5.278 per month, depending on experience and qualifications;
- A minimum of 232 leave hours (29 days) in case of full-time employment based on a formal workweek of 38 hours.
- A full-time employment in practice means 40 hours a week, therefore resulting in 96 extra leave hours on an annual basis.
- Excellent fringe benefits including a holiday allowance of 8% of the gross annual salary, an end-of-year bonus of 8.3%, a solid pension scheme, free access to sports facilities and a family-friendly institution that offers parental leave (both paid and unpaid).

The University of Twente is situated on a green and lively campus with lots of facilities for sports and other activities.

Information and application

If interested, please submit your application before 22 November, 2024 via the link below, including:

- A motivation letter (no more than 1 A4), explaining your motivation for the application, and why you qualify for this project;
- A detailed Curriculum Vitae, including contact information for two academic references;
- A half A4 page summary of your PhD research;
- A half A4 page summary of your experience and expertise in numerical modeling and simulations;
- Two selected publications.

For more information, contact dr. Hongyang Cheng (h.cheng@utwente.nl) or prof. dr. Vanessa Magnanimo (v. magnanimo@utwente.nl).

The first round of (online) selection interviews are scheduled for the first two weeks of December. A second round of interviews may be scheduled if necessary.
The expected starting date is February 2025.

Link to the application page: https://utwentecareers.nl/en/vacancies/1943/postdoc-position-bridging-the-dynamic-frictional-behavior-of-fault-gouges-to-earthquake-ruptures-via-concurrent-multi-scale-modeling/