PhD Positions at University of Lorraine (FRANCE) – April 2022

Context

The RING team is seeking outstanding PhD candidates to address research questions in integrative numerical geology. These full-time positions are for a three-year term. The PhD topics outlined below can be tailored to the interests and experience of the successful candidates.

The PhD scholarships are sponsored by an international consortium of 10 companies and 114 research institutes. The successful candidates will work in the RING Team[1], a pluridisciplinary group of 12-15 researchers and graduate students working at the interface of geoscience, computer science and applied mathematics. The team is part of Ecole Nationale Supérieure de Géologie in the GeoRessources[2] laboratory, a research lab of Université de Lorraine and CNRS. The research team is driven by passion for developing computer-based methods and theories for geological modeling, serving the geoscience community to address scientific and natural resource managements challenges. It has a strong industry partnership culture.

Location: Nancy, France. Nancy is a UNESCO World Heritage city with a vibrant student life and a rich cultural agenda, only 90 minutes away from Paris, Luxembourg and Strasbourg.

Candidate profile

The ideal candidate is passionate about science, has a solid background in applied mathematics, statistics and physics, and has strong scientific writing skills. An experience in computer programming is required. A background or a proven interest in geoscience is appreciated.

Candidates should hold a MSc in (quantitative) Earth Sciences, Geophysics or Physics, Computer Science, Geostatistics, Porous Media, Applied Mathematics, or related fields.

A strong command of English language is required. French language is preferable, but not necessary.

How to apply

Application files must be sent to jobs@ring-team.org before May 31st and must include:

- A cover letter,
- A CV, including contact information for two or more referees
- A research outcome (Master's thesis or paper) written by the candidate
- A transcript of grades

Possible PhD topics

1. **Stochastic inversion of FWI images for reducing structural uncertainties**

   Owing to the lack and incompleteness of subsurface data, significant uncertainties exist on the position of structural surfaces (faults and horizons). The present project proposes to develop an innovative way of inverting seismic data to reduce uncertainties on these structures. Instead of using seismic recordings and wave propagation simulations, the method will rely on full waveform inversion (FWI) images and the homogenization operator (e.g., HEDJAZIAN ET AL., 2021). To be achieved, the development of efficient

[1] http://ring.georessources.univ-lorraine.fr
[2] http://georessources.univ-lorraine.fr/

computing technology for geomodeling will be necessary. This PhD will be advised by Paul Cupillard and Guillaume Caumon. Timing: The position is open to start between Sept and Dec 2022.

2. **Graph machine learning for geological fault interpretation**
   Graph machine learning (GML) is an important recent area to analyze and forecast the behavior of complex networks. The overall goal of this PhD project is to investigate on the use of GML to associate sparse geological faults observations. This problem has recently been formulated using graph models and relatively simple association rules (GODEFROY ET AL., 2021). In this project, our goal will be to conceptualize and test various GML strategies to solve the association problem from analog structural models or incomplete observations. One particular focus will be put on effectively assessing the higher-order association likelihoods of several observations. This PhD will be advised by Guillaume Caumon and Radu Stoica. Timing: The position is open to start between Sept and Dec 2022.
3. **Unstructured mesh updating: fault editing and it impact on CO2 sequestration forecasting**
   Preliminary studies have shown that geological faults can play a critical role when forecasting the fate of CO2 injected in subsurface reservoirs and the mechanical hazards associated to the injection (SHAO ET AL., 2021; ZHAO & JHA, 2019). However, predicting the fault geometry from the available subsurface data is not always doable, so testing various scenarios is important to mitigate the risks. As building a first simulation mesh can be time consuming, the goal of this PhD it to develop new mesh updating approaches to rapidly insert or edit a fault in an existing mesh. For this, we will extend the implicit surface approach (LEGENTIL ET AL., 2022) and test the impact of the editing on the simulation of CO2 injection. This PhD will be advised by Guillaume Caumon. Timing: the PhD is expected to start after Sept 2023, but some aspects could be addressed in the frame of a M2 internship in 2022-2023.
4. **Assisted borehole interpretation and multi-well stratigraphic correlation for geothermal modeling**
   The characterization of stratigraphic architecture from sparse borehole data is essential to understand the heterogeneity and connectivity of subsurface reservoirs and accurately forecast the performance of CO2 injection or geothermal production (LALLIER ET AL., 2012). This PhD aims at defining a full workflow to bridge the gap between borehole data interpretation, stratigraphic correlation and geomodeling in the presence of a large set of wells. This workflow will be tested on a medium temperature geothermal reservoir. Timing: the PhD is expected to start after Sept 2023, but some aspects could be addressed in the frame of a M2 internship in 2022-2023.

References

HEDJAZIAN N, CAPDEVILLE Y & BODIN T. (2021). Multiscale seismic imaging with inverse homogenization. *Geophysical Journal International 226*(1):676-691. https://doi.org/10.1093/gji/ggab121

GODEFROY G, CAUMON G, LAURENT G & BONNEAU F. (2021). Multi-scenario interpretations from sparse fault evidence using graph theory and geological rules. *Journal of Geophysical Research: Solid Earth 126*(2):e2020JB020022. https://doi.org/10.1029/2020JB020022

LALLIER F, CAUMON G, BORGOMANO J, VISEUR S, FOURNIER F, ANTOINE C & GENTILHOMME T. (2012). Relevance of the stochastic stratigraphic well correlation approach for the study of complex carbonate settings: application to the Malampaya buildup (Offshore Palawan, Philippines). *Geological Society, London, Special Publications 370*(1):265-275. https://doi.org/10.1144/SP370.12

LEGENTIL C, PELLERIN J, CUPILLARD P, FROEHLY A & CAUMON G. (2022). Testing scenarios on geological models: Local interface insertion in a 2D mesh and its impact on seismic wave simulation. *Computers & Geosciences 159*:105013. https://doi.org/10.1016/j.cageo.2021.105013

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