Two-year postdoc position (full time) at University of Lorraine (France)

Accurate and efficient geophysical potential field response on implicit structural geological models.

Objectives

The integration of multi-modal geological and geophysical data is an essential task to gain knowledge on subsurface heterogeneity and sustainably manage the associated resources (heat, H_2 or CO_2 storage capacity, mineral resources, groundwater, etc.). To this end, three-dimensional numerical representation and simulation have undergone significant development and now make it possible to solve joint inverse problems, see for instance (MOORKAMP ET AL., 2016; WELLMANN & CAUMON, 2018). However, a compromise often needs to be made between the representational accuracy of geological features, the accuracy of the geophysical computation and the computational speed. For example, geological structural models are typically converted to gridded models in potential field inversions (GIRAUD, CAUMON ET AL., 2024; GIRAUD, LINDSAY & JESSELL, 2021; GUILLEN ET AL., 2008; WELLMANN ET AL., 2017; ZHEGLOVA, LELIÈVRE & FARQUHARSON, 2018). This induces geometric approximations which may raise problems in the presence of sharp variations caused by geological faults and rugged topography. The goal of this postdoc is to improve the accuracy of potential field response computation on realistic and accurate rock unit geometries while keeping acceptable performance.

Several numerical and computational techniques will be tested and compared to assess and maximize the efficiency / accuracy ratio in practical inversion tasks. This will be addressed by testing different numerical schemes and parallel implementations, starting from an existing in-house CPU / GPU C++ code. These methods will be tested first on synthetic models for which analytical solutions exists, before considering more complex 3D geological models. After this, the successful candidate may extend the approach to other geophysical problems (e.g. electromagnetics) or consider advanced geometric-based inversion techniques combining multiple level sets geomodel updating and transdimensional techniques (GIRAUD, FORD ET AL., 2024; HERRERO ET AL., 2023).

Context

The postdoctoral researcher will be based at Université de Lorraine and will work in a multidisciplinary environment with numerical geologists, geophysicists and mathematicians. The scientist will join the GeoRessources Laboratory in the RING team[1], a pluridisciplinary group of 12-15 researchers and graduate students, which has a broad academic and industrial collaboration network. She/he will collaborate closely with Prof. Guillaume Caumon and Dr. Ayoub Belhachmi (UL), Dr. Modeste Irakarama (Independent researcher based in the USA), Dr. Jeremie Giraud (University of Western Australia), and Dr. Frédéric Dubois (BRGM - French Geological survey). The successful candidate will join the network of researchers involved in the Digital Earth project[2] of the PEPR *Sous-sol, Bien Commun*.

The postdoctoral scholarship (2600 to 3500 EUR monthly depending on experience) includes full salary, social benefits (incl. 44 days of paid leave annually), and budget to attend national and international conferences. The goal of the postdoc is to produce, present and publish innovative methodologies and the associated open-source software. Particular attention will be put on the professional development of the successful candidate and on establishing connections both with industrial and academic partners.

[1] http://ring.georessources.univ-lorraine.fr
[2] https://www.soussol-bien-commun.fr/fr/terre-numerique-une-plateforme-unique-pour-connaissance-du-sous-sol

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 holds a PhD in numerical geophysics or applied mathematics. Experience in **computer programming is required**. A background or a proven interest in geoscience is appreciated but not mandatory. She/he has strong scientific writing and communication skills. Proficiency in English is required; knowledge of French is desirable, but not necessary.

The contract is expected to start during Q1 of 2025, but may be shifted to Q2 or Q3 depending on the successful candidate's availability.

How to apply

Application files must be sent to jobs@ring-team.org before Jan 5, 2025 and must include:

- A cover letter
- A CV, including list of publications and contact information for two or more referees
- The PhD thesis
- If available, the PhD review and defense reports.

References

GIRAUD J, CAUMON G, GROSE L, OGARKO V & CUPILLARD P. (2024). Integration of automatic implicit geological modelling in deterministic geophysical inversion. *Solid Earth 15*(1):63-89. https://doi.org/10.5194/se-15-63-2024

GIRAUD J, FORD M, CAUMON G, OGARKO V, GROSE L, MARTIN R & CUPILLARD P. (2024). Geologically constrained geometry inversion and null-space navigation to explore alternative geological scenarios: a case study in the Western Pyrenees. *Geophysical Journal International*:ggae192. https://doi.org/10.1093/gji/ggae192

GIRAUD J, LINDSAY M & JESSELL M. (2021). Generalization of level-set inversion to an arbitrary number of geologic units in a regularized least-squares framework. *GEOPHYSICS 86*(4):R623-R637. https://doi.org/10.1190/geo2020-0263.1

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HERRERO J, CAUMON G, BODIN T & LACHEUX M. (2023). Transdimensional Sampling of Two-Dimensional Layered Geological Models with Variable Slope: a Proof of Concept. *Fifth EAGE Conference on Petroleum Geostatistics*:1-5. https://doi.org/10.3997/2214-4609.202335016

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WELLMANN F & CAUMON G. (2018). 3-D Structural geological models: Concepts, methods, and uncertainties. *Advances in Geophysics 59*:1-121. https://doi.org/10.1016/bs.agph.2018.09.001

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ZHEGLOVA P, LELIÈVRE PG & FARQUHARSON CG. (2018). Multiple level-set joint inversion of traveltime and gravity data with application to ore delineation: A synthetic studyMultiple level-set joint inversion. *Geophysics 83*(1):R13-R30. https://doi.org/10.1190/geo2016-0675.1