PhD position at University of Lorraine (FRANCE)

Stochastic fault and fracture modelling: towards a new model for 3D seismic interpretation.

Topic description

Faults and fractures are dislocations of underground rocks, which play a critical role in many subsurface applications, e.g., when forecasting the fate of CO_2 injected in subsurface reservoirs and the mechanical hazards associated to the injection (SHAO ET AL., 2021; ZHAO & JHA, 2019). Predicting the geometry of faults is often done from 3D reflection seismic images, but the interpretation is challenging because of data coverage and limited seismic bandwidth (BOTTER ET AL., 2017; JULIO, CAUMON & FORD, 2015). Additionally, fault surfaces form complex networks in three dimensions, producing for instance relatively thin relay zones and complex branching patterns (ROCHE ET AL., 2021). Therefore, interpreting fault and fracture networks from seismic images is time-consuming process which may lead to different results depending on the interpreter or the methodology (ALCALDE ET AL., 2017; ROBLEDO CARVAJAL, BUTLER & BOND, 2023). The goal of the proposed PhD is find new ways to automate the 3D seismic interpretation process and to produce fault scenarios that reflect the structural knowledge.

To do this, the idea is to leverage on recent advances in the area of marked point processes. Indeed, some new models been developed specifically to characterize and model fractures and faults in two dimensions with promising results (BONNEAU, CAUMON & STOICA, 2023; BONNEAU & STOYAN, 2022; SHAKIBA ET AL., 2022; TATY-MOUKATI ET AL., 2023). To extend these models to three dimensions, we can use the general framework of the Bisous Model (STOICA, GREGORI & MATEU, 2005). In this context, the integration of geological concepts may rely on the specific choice of the statistical model and also on the choice of parameters. Therefore, the area of investigation for this PhD will also include the issue of parameter inference from incomplete interpretations with approximate Bayesian methods (STOICA ET AL., 2017, 2021).

The methodology will be tested and validated against a natural 3D sample (DOWD ET AL., 2009), publicly available 3D seismic data and possibly also two-dimensional outcrop data.

This PhD will be co-advised by Guillaume Caumon and Radu Stoica.

Context

The successful candidate will join the RING team[1], a pluridisciplinary group of 12-15 researchers and graduate students. The team works in close collaboration with mathematicians, computer scientists and geoscientists. This PhD topic will be jointly advised by Prof. Guillaume Caumon and Prof. Radu Stoica.

The PhD scholarship is sponsored by an international consortium of 8 companies and 90 research institutes. This scholarship offers many opportunities regarding the orientation of the future career of successful candidates (industrial or academic). 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 in the context of the energy transition. It has a strong industry partnership culture and values collaboration and scientific exchange.

The RING team is part of Ecole Nationale Supérieure de Géologie and of the GeoRessources[2] laboratory, a research lab of Université de Lorraine and CNRS. The successful PhD Student will also closely interact with the Institut Elie Cartan de Lorraine (IECL). Both labs are located in Nancy, France. Nancy is a UNESCO World Heritage

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

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 but not mandatory.

Candidates should hold a MSc in Geophysics or Physics, Computer Science, (quantitative) Earth Sciences, Geostatistics, 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

References

ALCALDE J, BOND CE, JOHNSON G, ELLIS JF & BUTLER RWH. (2017). Impact of seismic image quality on fault interpretation uncertainty. *GSA Today*. https://doi.org/10.1130/GSATG282A.1

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