Hybrid parameterization field/object and hybrid full-wave inversion of well seismic data in a subsalt context

PhD position at laboratory “Géosciences et Environnement Cergy” (GEC), University of Cergy-Pontoise (UCP), France

The GEC laboratory is developing research on seismic full-wave inversion methods (FWI). The borehole seismic context of the PhD project implies the use of a (visco)elastic rheology and the introduction of strong constraints in the problem due to its underdetermination by lack of data redundancy. The case study will be the FWI of walkaway of 3D-VSP seismic data in a subsalt context (for instance data from Gulf of Mexico). The practical goals are the delineation of flanks and bottom of the salt body and the improvement of P/S imaging below the salt body.

The theoretical framework is the probabilistic approach of the inversion problem. The multiparameter inversion can be done for elastic or viscoelastic rheology, isotropic or anisotropic (TI). The resolution is performed by optimization base on the L2 norm.

The two specific challenges are:

- **The 3D representation of the medium and the hybrid parameterization:** to constrain the inversion problem using an adequate parameterization for geological a priori information rather than physical parameter fields, particularly by introducing geological objects defined by discontinuities (body salt boundaries for the subsalt context).
- **Taking into account and managing the medium discontinuities in the fullwave inversion,** for instance, how to evaluate and mix the gradient related to discontinuities to the classical field gradient, definition of updated models, etc.

**Program:**
- Study of the different approaches for hybrid representation (bibliography, 2D prototypes).
- Definition of the gradient related to discontinuities and its relationship with the field gradient, check on simple 2D synthetic cases.
- Analysis of impact when modeling and inverting in a 3D medium and when using a model-building software platform to manage objects and associated prior information.
- Check of hybrid inversion on synthetic data using a true model representative of the subsalt context and close to the real well seismic data.
- Analysis of the provided well seismic datasets, walkaway or 3D-VSP, and inversion trials of the data in order to validate the developed methods and implementation on a real case.

**Applicant profile and expected skills:**
Geophysist with a deep knowledge of numerical methods and computing tools.
- Information theory and probabilistic approach of the inverse problem, spatial statistics.
- Numerical methods (SEM, FD), signal processing, data processing.
- Geophysical methods, seismic imaging, reservoir characterization.
- High performance parallel computing, scientific computing, software development.

**PhD supervisors:** Christophe Barnes, Bertrand Maillot

**Place:** Université de Cergy-Pontoise, Laboratoire GEC, Maison Internationale de la Recherche, 1 rue Descartes, 95000 Neuville-sur-Oise (GEC web site).

**PhD Funding:** Standard PhD contract at UCP institute of doctoral studies “Sciences et Ingénierie” (three years including possibly teaching tasks), beginning of fall 2018 (funding from a research contract between the GEC lab and the company TOTAL).