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

PhD project at the 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 or 3D-VSP seismic data in a subsalt context (for instance data from Gulf of Mexico). The practical goals are the delineation of the flanks and bottom of the salt body and the improvement of P- and S-wave 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. The resolution is performed by optimization based on least squares.

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 (the boundaries of the salt body for the subsalt context).
- **Taking into account and managing the medium discontinuities in the fullwave inversion:** how to evaluate and mix the gradient related to discontinuities to the classical field gradient, how to define updated models, etc.

Program:

- Study of the different approaches for hybrid parameterization (bibliography, 2D prototypes).
- Definition of the gradient related to discontinuities and its relationship with the field gradient, trials with simple 2D synthetic cases.
- Adaptation of 3D tools to take into account geological objects and associated *prior* information. Efficiency and scalability tests.
- Check of the hybrid inversion on synthetic data using a reference model representative of the subsalt context and close to that of the real well seismic data.
- Analysis of the provided well seismic datasets, and inversion trials of the data in order to validate the developed methods and implementation on a real case.

Searched profile and expected skills:

A **Numerical modeling** specialist with knowledge on mechanical wave propagation (elastic) and geosciences, or a **Geophysicist** with a deep knowledge of numerical methods and computing tools.

- Information theory and probabilistic approach of the inverse problem, spatial statistics.
- Numerical methods of PDE discretization (SEM, FD), signal processing, data processing.
- Geophysical methods, elastic wave propagation, seismic imaging, reservoir characterization.
- High performance parallel computing (HPC), scientific computing, software development.

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

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