High-resolution 3D seismological imaging in the context of high microseismic activity

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Résumé

Knowledge of the subsoil is essential for different economic and societal issues, as well as for understanding the internal dynamics of the globe and its surface deformation such as fluid/seismicity relationships in fractured zones (reservoirs, volcanoes, rifts, subduction zones) or to estimate the risks associated with the activity (natural or anthropogenic) in the subsoil in different geological contexts.
Seismic velocities, being very sensitive to changes in temperature, composition and the presence of fluids, are privileged indicators that are used at different time and space scales (tomography, reflectivity, receiver functions). Active seismic, while effective for high-resolution imaging of interfaces, is still a costly method and is not suitable for the temporal monitoring of reservoirs. Passive methods, with lower spatial resolution and based on the use of natural seismicity, have long demonstrated their ability to locate interfaces, deformation zones and fluids using velocity models (P and S) at the lithospheric and crustal scales. In addition to these structural models, microseismicity, whether caused by the activity of natural active zones, or by induced micro fracturing, makes it possible to locate fault planes and to follow the spatio-temporal evolution of fracturing.
Our goal in this project is to develop a low-cost passive seismic imaging protocol for the analysis of microseismic signals to reach a resolution comparable with the active seismic approaches. The methods based on converted waves combined with tomography can provide information on structures and fluids at the crustal scale. The methodology uses receiver functions applied to local earthquakes to exploit their high frequency content, and signal redundancy is used to amplify the energy of the converted waves. Our preliminary results applied to the dataset from Corinth Rift Basin in Greece show promising results. By making use of full spectrum of microseismic signals (up to 20hz), in theory, the approach can retrieve structural features varying from 60-80m resolution scale which is unprecedented compared to the traditional results. The next steps of the project include forward modelling and inversion of the signals to explain structural and velocity constraints of the obtained results which will be the matter of discussion during the conference.

Mots-Clés: passive seismic imaging, receiver functions, microseismicity, tomography, 3D modelling

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