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Focal mechanism determination of induced micro-earthquakes in reservoir by non linear inversion of amplitudes

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Since these last years, the feasibility of CO2 storage in geological reservoir is carefully investigated. The monitoring of the seismicity (natural or induced by the gas injection) in the reservoir area is crucial for safety concerns. The location of the seismic events provide an imaging of the active structures which can be a potential leakage paths. Besides, the focal mechanism is an other important seismic attribute providing direct informations about the rock fracturing, and indirect information about the state of stress in the reservoir.
We address the problem of focal mechanism determination for the micro-earthquakes induced in reservoirs with a potential application to the sites of CO2 storage. We developed a non linear inversion method of P, SV and SH direct waves amplitudes. To solve the inverse problem, we perfected our own simulated annealing algorithm. Our method allows simply determining the fault plane solution (strike, dip and rake of the fault plane) in the case of a double-couple source assumption. More generally, our method allows also determining the full moment tensor in case of non-purely shear source assumption.
We searched to quantify the uncertainty associated to the obtained focal mechanisms. We defined three uncertainty causes. The first is related to the convergence process of the inversion, the second is related the amplitude picking error caused by the noise level and the third is related to the event location uncertainty.
We performed a series of tests on synthetic data generated in reservoir configuration in order to validate our inversion method.