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Monitoring deep fractured reservoirs with ambient noise correlation: importance of acousto-elastic effects

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An emerging technique for a continuous and low cost geophysical monitoring of deep reservoirs like Enhanced Geothermal Systems (EGS) is based on ambient seismic noise correlation and in particular Coda Wave Interferometry (CWI) from temporal stacks of ambient noise cross-correlation functions (or ANCCFs). We present here a forward numerical model simulating the propagation of scattered waves through a reservoir during its deformation, including non-linear acousto-elastic effects. Our approach is based on the case study of the Rittershoffen geothermal reservoir (France). We validate the numerical model by reproducing seasonal variations of the relative changes in seismic velocity observed from ANCCFs and provide a physical interpretation of this seismic signal. We extend our modelling to the in-situ deformation of the reservoir by considering either a hydraulic pressure increase or an aseismic shear of an embedded fault. The sensitivity of the scattered waves to small strain perturbations enables to detect small travel time changes as $dt/t \sim 10^{-5}$, which opens perspectives for the application of ambient noise based techniques to the continuous monitoring of local mechanisms in deep geothermal reservoirs.