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Laboratory coda wave interferometry for the monitoring of rock property variations

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A significant effort is on-going in the community to continuously monitor deep geothermal reservoirs using ambient seismic noise tomography (e.g. Calo et al, 2013; Lehujeur et al, 2015). It is a method that determines the Green's function between a pair of receivers by correlating sufficiently long seismic noise records. Very small changes of the medium are accessible using this new monitoring technique (significantly smaller than those deduced from direct arrivals). In particular, very small variations of seismic velocities are shown to appear both in time and space during the stimulation of the reservoir. A central question is how to interpret these transient or lateral variations of the seismic velocities for a precise 4D tomography of the reservoir properties. In this study, we address the direct problem of monitoring small variations in seismic velocities when small variations in stress or temperature are slowly applied to the sample. We use a network of piezo-electric sensors on laboratory samples (sandstone and granite from Soultz-sous-Forêts core samples) to perform coda wave interferometry from the multiple scattering of well-controlled seismic pulses (Grêt et al, 2006). The data collected are estimates of the relative variation of travel time. We combine acoustic measurements and strain gauges to differentiate between travel time variations due to seismic velocity changes and those due to deformation effects. We expect this approach to provide useful information for large scale seismic tomography despite the significant difference of considered wavelengths.