

Acousto-elastic effects in Coda Wave Interferometry

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The use of the ambient seismic noise as a versatile seismic source has led to the development of Ambient Noise Interferometry (ANI), a technique that opened new perspectives for monitoring the time evolution of geological structures using Coda Wave Interferometry (CWI). Among others, temporal variations of wave velocities have been measured in fault zones or volcanoes where seismic velocity decreases are highlighted few weeks prior to eruptions, but also in geothermal reservoirs. Meanwhile, the interpretation of the measurements in terms of disruptive events remains challenging since the measurements usually enclose at once all the contributions of the various physical sensitivities of the scattered waves. Here, we combine laboratory experiments and numerical simulations to perform advanced forward modeling and analyze the causes of these measured temporal variations to discuss their effects on coda waves. We quantify the impact of a mechanical reversible elastic deformation on CWI measurements by comparing experimental results from wave scattering measurements during a uniaxial compression test to the ones obtained from a numerical approach that enables to model wave propagation in complex diffusive media during its elastic deformation. From the numerical modeling, we decipher the different physical effects on the CWI, like the relative contributions of local density changes related to volumetric strain, the impact of the scatter deformation, or the acousto-elastic effects related to non-linear elasticity. We show that the latter are dominant during the elastic deformation. Finally, we compare the spatial variability of the CWI delays to those of the decorrelation signals, i.e. amplitude of the correlation signals.