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Direct modeling of coda wave interferometry: comparison of numerical and experimental approaches

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The sensitivity of coda waves to small changes of the propagation medium is the principle of the coda waves interferometry, a technique which has been found to have a large range of applications over the past years. It exploits the evolution of strongly scattered waves in a limited region of space, to estimate slight changes like the wave velocity of the medium but also the location of scatterer positions or the stress field. Because of the sensitivity of the method, it is of a great value for the monitoring of geothermal EGS reservoir in order to detect fine changes. The aim of this work is thus to monitor the impact of different scatterer distributions and of the loading condition evolution using coda wave interferometry in the laboratory and numerically by modelling the scatter wavefield.

In the laboratory, we analyze the scattering of an acoustic wave through a perforated loaded plate of DURAL. Indeed, the localized damages introduced behave as a scatter source. Coda wave interferometry is performed computing correlations of waveforms under different loading conditions, for different scatter distributions.

Numerically, we used SPECFEM2D (a 2D spectral element code, (Komatitsch and Vilotte (1998)) to perform 2D simulations of acoustic and elastic seismic wave propagation and enables a direct comparison with laboratory and field results. An unstructured mesh is thus used to simulate the propagation of a wavelet in a loaded plate, before and after introduction of localized damages. The linear elastic deformation of the plate is simulated using Code Aster. The coda wave interferometry is performed similarly to experimental measurements.

The accuracy of the comparison of the numerically and laboratory obtained results is strongly depending on the capacity to adapt the laboratory and numerical simulation conditions. In laboratory, the capacity to illuminate the medium in a similar way to that used in the numerical simulation deeply conditions among others the comparison. In the simulation, the gesture of the mesh and its dispersion also influences the rightness of the comparison and interpretation. Moreover, the spectral elements distribution of the mesh and its relative refinement could also be considered as an interesting scatter source.