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Coda-wave interferometry and the Marchenko method

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Coda-wave interferometry, introduced by Snieder and co-workers, employs the relative high sensitivity of the scattering coda in an acoustic or seismic response to time-lapse changes of the propagation velocity and/or structure. It has been successfully applied at many scales, ranging from inferring temperature changes in granite samples, via structural health monitoring of bridges, to monitoring the minute changes in the interior of a volcano prior to eruption. Whereas in most situations the velocity changes are assumed to take place in a large region, it has been shown that coda-wave interferometry can also be used to image a local perturbation of the propagation velocity or structure. The latter approach assumes diffuse waves and employs an array of receivers that surrounds the perturbation.

We investigate the application of coda-wave interferometry for monitoring of fluid-flow processes in aquifers, geothermal reservoirs, CO_2-storage reservoirs and hydrocarbon reservoirs. In these applications the velocity perturbation is local, but the medium is probed with deterministic seismic body waves from the surface only. The location of the velocity perturbation is usually reasonably well known, but it is practically impossible to identify events in the coda that are directly related to the local perturbation. Recently we introduced the Marchenko method, which retrieves information about multiple scattering from reflection data at the surface in a data-driven way. Here we propose to use the Marchenko method to remove the response from the areas above and below the local velocity perturbation. In this way we isolate the scattering coda of the local velocity perturbation, which enables the application of coda-wave interferometry to monitor the fluid-flow process.