

On the use of a laser ablation as a laboratory seismic source

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Mimic near-surface seismic imaging conducted in well-controlled laboratory conditions is potentially a powerful tool to study large scale wave propagations in geological media by means of upscaling. Laboratory measurements are indeed particularly suited for tests of theoretical modellings and comparisons with numerical approaches.

We have developed an automated Laser Doppler Vibrometer (LDV) platform, which is able to detect and register broadband nano-scale displacements on the surface of various materials. This laboratory equipment has already been validated in experiments where piezoelectric transducers were used as seismic sources. We are currently exploring a new seismic source in our experiments, a laser ablation, in order to compensate some drawbacks encountered with piezoelectric sources.

The laser ablation source is considered to be an interesting ultrasound wave generator since the 1960s. It was believed to have numerous potential applications such as the Non-Destructive Testing (NDT) and the measurements of velocities and attenuations in solid samples. We aim at adapting and developing this technique into geophysical experimental investigations and produce and explore complete micro-seismic data sets in the laboratory.

We will first present the laser characteristics including its mechanism, stability, reproducibility, and will evaluate in particular the directivity patterns of such a seismic source. We have started by applying the laser ablation source on the surfaces of multi-scale homogeneous aluminum samples and are now testing it on heterogeneous and fractured limestone cores. Some other results of data processing will also be shown, especially the 2D-slice V_P and V_S tomographic images obtained in limestone samples.

Apart from the experimental records, numerical simulations will be carried out for both the laser source modelling and the wave propagation in different media. First attempts will be done to compare quantitatively the experimental data with simulations. Meanwhile, CT-scan X-ray images of these limestone cores will be used to check the relative pertinences of velocity tomography images produced by this newly developed laser ablation seismic source.