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Station SVIO (VISP ROCK)
Report on active seismic experiment

Introduction
In date 13.04.2011 an active seismic experiment has been performed in Visp (Figure 1) in the vicinity of the strong motion station SVIO, with the aim of mapping the phase velocity dispersion function of the Rayleigh waves at high-frequency (>10Hz). The goal of the experiment is to characterize the uppermost part of the local outcropping bedrock, to model for the seismic response of the nearby reference station.

For the measurement, an array of 7 two-channel seismological stations, with 2m inter-distance was used (Figure 2). Each seismological station was equipped with two three-component velocity seismometers (Lennarz 3C, 5s eigenperiod), for a total of 14 acquisition points, and a 24bit data-logger (Quanterra Q330). Synchronization between stations was assured by standard GPS, while a more accurate differential GPS (Laica Viva system) was used to precisely locate the sensor's coordinates with a tolerance of less than 5cm (nominally 3cm).

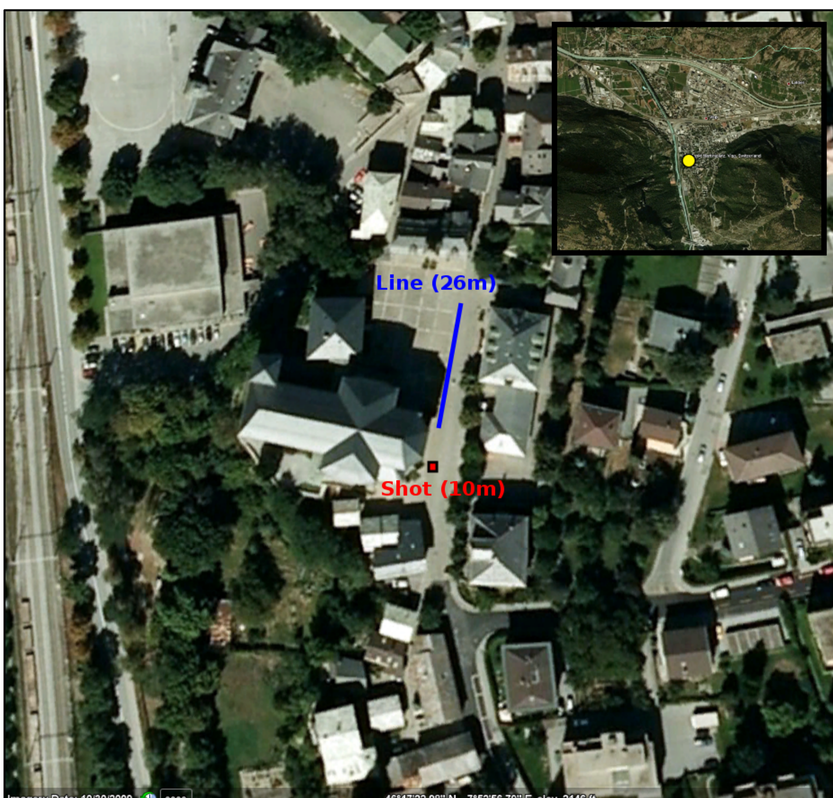


Figure 1. *Location of the seismic line (26m, in blue) and the wave-filed excitation point (source-offset at 10m, in red).*

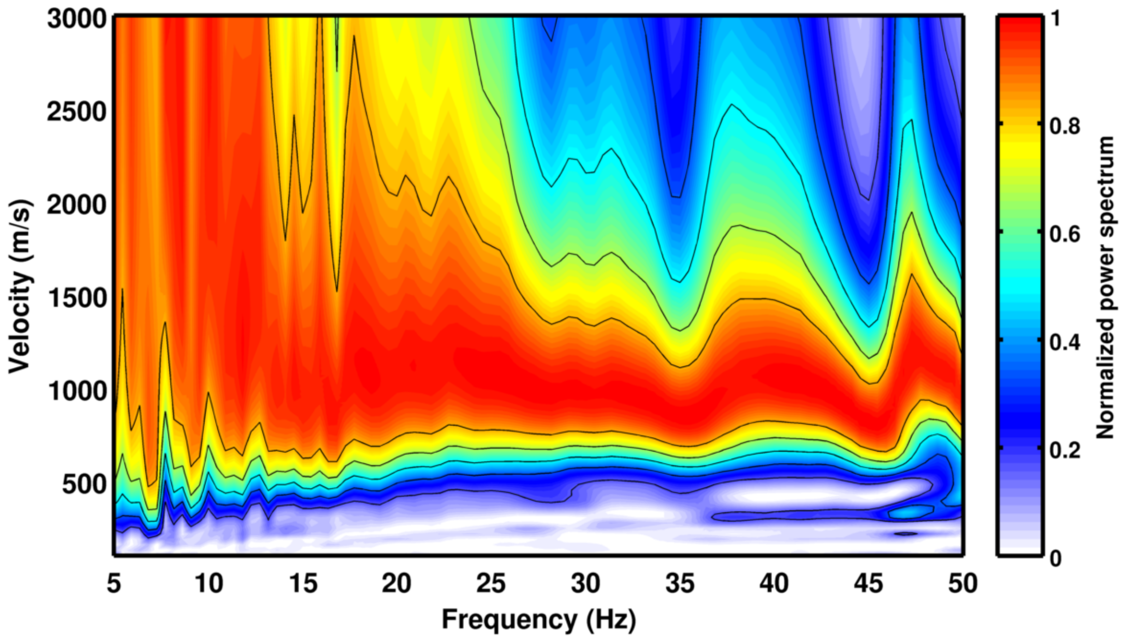
Figure 2. *The array deployment used for the surface-wave survey, consisting of 14 high-resolution three-component seismological stations.*

The acquisition phase

For the experiment, a special device was use as active source, consisting of mass of 120Kg, dropping from a high of 1 and 2m. Two shot-offset distances were tested (10m and 20m) because the distance at which the surface-waves start developing from the source is generally unknown (without some prior knowledge on the local velocity structure). Ten consecutive wave-field excitations have been performed for each source off-set, with the goal of improving the signal-to-noise ratio by stacking in the time (when using classical f-k method) or in the frequency (with the wavelet t-f-k method, Poggi et al. 2012) domain.

The seismological stations recorded continuously, so that a manual selection of the usable part of the recoding had to be performed. It has to be noticed that not all the shots were identically successful during the experiment. Therefore, a further selection on the quality of the performed wave-field excitation has been performed. As such, only the best shots were selected and gathered into a continuous stream.

A)



B)

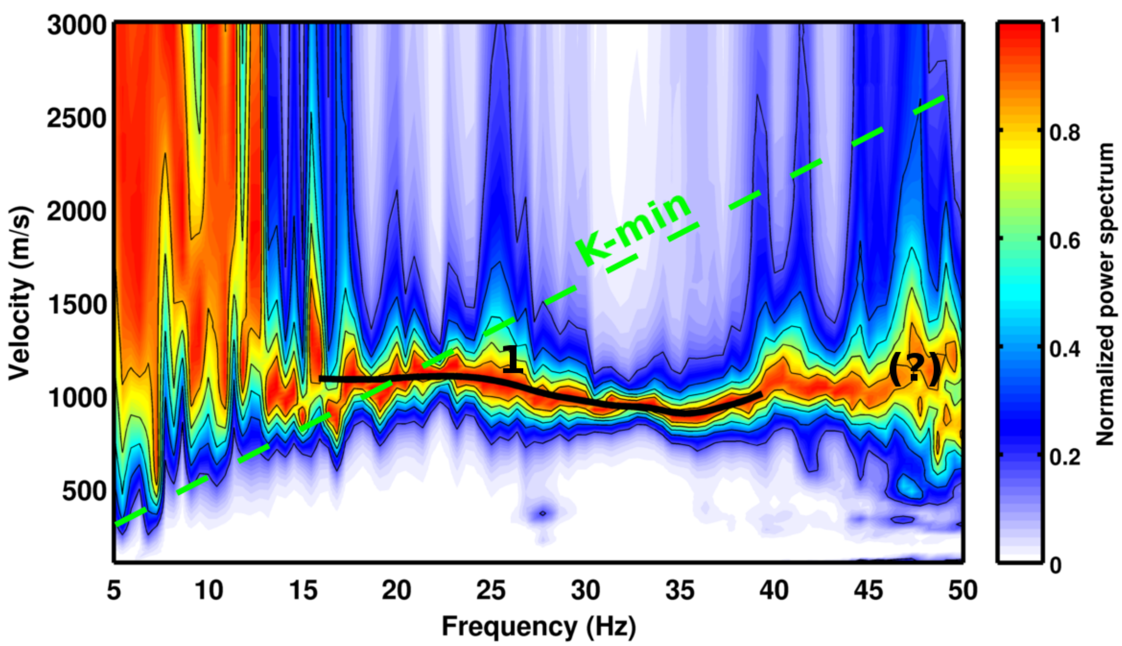


Figure 3. *Results of processing the vertical direction using the Lennartz sensors array. The analysis was performed with the wavelet t-f-k approach, using classical (top) and high-resolution beamforming (bottom) core algorithm. In black, the portion of fundamental mode dispersion curve interpreted as most likely.*

Processing

The recordings have been analyzed using the standard f-k and the most recent wavelet t-f-k analysis (Poggi et al., 2012). Using this last approach, two different setting for the core algorithm have been used; as first, the classical beamforming was tested, which however didn't produce a clear picture of the dispersion pattern (Figure 3A). Following, the high-resolution algorithm was employed, with the result of enhancing the traceability of the fundamental mode of Rayleigh waves in the analyzed frequency range (Figure 3B). Nevertheless, portions of the dispersion curve below 15Hz and above 40Hz have been rejected from the interpretation, being respectively outside the resolution limit of the sensor string and in the non-linear region of the sensor response. This last selection criterion is not generally strict, as some results can also be achieved above the limits. In this case, however, interpreting above 40Hz wouldn't have provided any additional usable information. The Rayleigh-wave fundamental mode identified in this reliability region doesn't show any dispersive behavior, but a constant velocity of about 1000m/s. This can be interpreted as a substantial homogeneity of the uppermost part of the rock velocity profile, which then behaves as homogeneous half-space at this frequency scale. Therefore, assuming the rock material as a Poisson solid, its seismic S-wave velocity can be simplified as:

$$Vs = \frac{VR}{0.919} = \sim 1100 m/s$$

By using the quarter-wavelength approach, is then possible to provide a first-order estimate of the depth sensitivity. Assuming that:

$$z = \frac{Vs}{4f}$$

We might expect a velocity of 1100m/s down to a depth of about 18m (15Hz). Below this depth it is reasonable to assume the seismic velocity to progressively increase.