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Dynamic characterization of the Chamousset rock column before its fall

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The rockfall of Chamousset (volume of 21000m3) occurred on November 10, 2007, affecting the 300 m high Urgonian cliff of the southern Vercors massif, French Alps. This event took place when the Vercors plateau was covered by snow. The unstable column was previously detected by observations on the development of a 30 m long fracture back on the plateau. Two aerial Lidar scans of the cliff were acquired before and after the failure, allowing the geometry of the column and of the broken plane to be determined. A temporary seismic array along with two extensometers was installed from July to November 2007. The seismic array consisted of 7 short period seismometers (1 three-components and 6 vertical-component). One vertical seismometer was installed on the column while the other 6 were deployed on the plateau with an array aperture of about 70 m. During the last two months of record, short period seismometers were replaced by 4.5 Hz geophones. The monitoring system recorded in a continuous mode (1000 Hz of frequency sampling) but it stopped to work two weeks before the fall, after the solar panels were covered by snow.

During the running period, the seismic array recorded hundreds of local seismic events, from short (less than 0.5 s) impulsive signals to events with a long duration (a few tens of seconds). Our study was first focused on the dynamic response of the column and on the seismic noise frequency content. Fourier spectra of the seismic noise signals recorded on the column and the corresponding spectral ratios showed the presence of several resonance frequencies of the column. The first resonance frequency was measured at 3.6 Hz in July 2007 and it decreases regularly with time to reach 2.6 Hz two weeks before the fall. In parallel, extensometer measurements show that the fracture aperture increased with time during the same period. The dynamic response of a block which separates from a rock mass was 2D numerically modelled. Finite element computations showed that the progressive block decoupling, resulting from a crack propagation inside the mass, generates a decrease of the natural frequency, as it was measured on the site. These results highlight the interest to study the dynamic response of an unstable column for hazard assessment purposes.

In a second phase, we studied the recorded impulsive signals in which we were able to identify P and S waves. Seismic experiments were performed in September 2008 on the plateau in order to constrain the ground velocity structure. Preliminary event location shows that the signal sources were located along the broken plane and probably result from micro-cracks along rock bridges.