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Seismic noise measurements for the characterisation of Pays de Herve landslides

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The Pays de Herve, located in the eastern part of Belgium, can be characterized as a multiple sections tableland with gentle slopes of less than 15°. It is located in the vicinity of the northern section of the Hockai Fault Zone, a 42 km-long seismogenic fault zone, that is characterized by the presence of fault scarps, multiple dissection elements and the presence of more than 20 paleo-landslides. Among these latter, the Manaihan landslide is the most studied and monitored landslide in the area. From a geological point of view, it developed in a Upper Cretaceous sedimentary setting, i.e., Vaals Clays overlaying Aachen sands. Even today, the slope is affected by instability and subsidence phenomena, likely linked to anthropogenic loading combined with prolonged periods of rainfall and possibly historic seismic events leading to liquefaction in the Aachen sands.

Recently, new geophysical surveys have been carried out using an integrated approach, combining electrical resistivity measurements, active seismic methods (interpreted as P-wave tomography and MASW), and passive seismic techniques (single-station H/V). The key question to address is: How deep is the sliding surface, and is it possible to identify it?

The combination of these surveys allowed the identification of two main layers. The first layer has a variable thickness ranging between 5 m and 20 m. On the electrical resistivity tomography, it corresponds to a more conductive layer with values between 5 and 20 Ωm, and on the seismic tomography, it shows velocities between 500 and 1300 m/s. From the electrical and seismic tomographies, the second layer appears to be more resistive, with values ranging between 30 and 50 Ωm, and P-wave velocities exceed 1500 m/s. Based on the geological map and their physical properties, the identified layers have been attributed to the Vaals clay formation and the Aachen sands, respectively.

The H/V measurements were processed to produce sections showing the variation of H/V amplitude (or the log of H/V) with depth. If multiple H/V measurements can be aligned in a linear array and the surface layer can be assumed to be homogeneous, i.e., shear wave velocity

increasing with depth, the H/V curves along the alignment can be modeled together to create a 2D section. Several H/V sections could be developed for the Manaihan landslide, revealing a similar pattern of contrasts between the before mentioned layers. The main contrast is located at a depth ranging from 15 m to 40 m and corresponds to the interfaces identified by ERT and SRT. This interface is present beyond the landslide and even outside of it, suggesting that it may be associated to the geological contact between the Vaals clays and the Aachen sands. The conductive layer identified in the ERTs can furthermore be associated to very low log H/V amplitudes in the upper range of the H/V sections until 10-20 m depth. The H/V amplitude analysis of all the identified sections suggests that the sliding surface of the Manaihan landslide is located at the contact between the clay and the sand layers.