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Imaging of an incipient volcanic flank collapse by passive seismic methods: El Hierro, Canary Islands

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The proposed research aims at the investigation of large mass movements on volcanic islands, like the San Andres landslide on El Hierro island (Canary Islands, Spain). These coastal and submarine landslides are extremely large (with run-out exceeding tens of km) and voluminous (up to hundreds of km^3). They represent therefore a major geological hazard with direct consequences for the population of the islands. Volcanic activity and large earthquakes, as well as factors unrelated to the growth of the island like heavy precipitations and sea level change must be considered among the important triggering factors. Recent studies also evidenced that these large instabilities and failure mechanisms are linked to the geomechanical characteristics of the volcanic rocks, especially the formation of low strength and high deformability rocks.

San Andres landslide, formed between 176 and 545 ka, has been interpreted as the result of an aborted giant collapse and it represents one of the rarest sites where it is possible to investigate the landslide mass and fault planes of a volcanic collapse structure onshore. While several studies have been performed for the surface characterization, there is still a lack of knowledge about the subsurface properties of the San Andres landslide. For this purpose we conducted a seismological survey on El Hierro island in October 2020 aimed at the characterization of the internal properties of the terrestrial part of the landslide through seismological measurements.

Three temporary seismic arrays and two seismic profiles were deployed in order to retrieve the elastic properties of the subsurface through the analysis of seismic ambient noise. We applied the f-k analysis and cross-correlation techniques to measure the dispersion of the surface waves, the features of which were successively inverted to retrieve 1D shear-wave velocity profiles. Furthermore we analysed 3D signals to investigate the site resonance frequencies and thus identified impedance contrasts at depth. We therefore determined the degree of (de)-consolidation of the sliding mass itself estimated and and then compared it to the surrounding rocks of the volcanic island. During the aforementioned campaign, we also performed UAV flights to establish a 3D model of the investigated site. These recent investigations contributed to the construction of a 3D-geomodel by including existing geological information.

In prospect, the estimation of the landslide geometry will contribute to the evaluation of the flank stability as well as to the assessment of the risks associated to any possible reactivation.