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The near-surface velocity structures of an incipient volcanic flank collapse revealed by geophysical studies (preliminary results)

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The present study aims at the investigation of the large (> 10 km run-out and volume up to 20-50 km3), ancient (176 and 545 ka) coastal and submarine San Andres landslide on volcanic island, El Hierro. The landslide formed, as a result of an aborted giant volcanic flank collapse and represents a rare site where the landslide mass and related failure planes can be studied onshore. The possible triggers of a future massive failure include volcanic activity, large earthquakes, and the rising sea level under future climate change scenarios. Therefore, it is important to analyze possible associated geological hazards based on an extensive site study, as a massive failure could have catastrophic consequences, not only for the population of El Hierro Island, but also for the neighboring islands and even beyond. To that end, we adopted an integrated geophysical approach including horizontal-to-vertical spectral ratio (H/V), seismic array measurements, multi-channel analysis of surface waves (MASW) and seismic refraction tomography (SRT).

The data acquisition phase included campaigns in 2020 (H/V and seismological arrays) and 2021 (H/V, MASW, SRT). The seismic survey (refraction and MASW) was completed with profiles of variable lengths using 48 geophones while ambient noise array and single station measurements were carried out with CMG-6TD broadband velocimeters. Also a mixed scheme combining geophones and seismic stations along longer profiles were tested to increase the investigation depth. Data collected along these profiles were processed both in terms of SRT (providing a 2D P-wave velocity distribution over varying depths) and of MASW (providing S-wave velocity logs through surface wave inversion). Such S-wave velocity logs were also computed by inverting the array seismic noise data (first processed by f-k and cross-correlation techniques, providing a surface wave dispersion curve), which generally provided related information over larger depths.

Denoising of the seismic refraction data was often necessary before picking of the first arrivals as the records were affected by a high level of noise due to the proximity of coastal areas and of windmills. Our approach increased the precision in picking the first arrival and in determining the

depth of the elastic properties of the landslide. Additionally, a geomodeling approach is used for the better presentation of the results in 3D. The latter reveals large variations in the measured physical properties because of the highly heterogeneous conditions marking the volcanic environment. The delineated subsurface information will provide an essential input parameter to be used for further numerical modeling studies of the flank stability and of the potential impact of a collapsing mass on the ocean.