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Imaging the subsurface of planetary volcanic analogues using ambient seismic noise data at the Tinguatón Volcano (Lanzarote, Canary Islands)

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Geophysical methods are fundamental tools within the study of subsurface planetary volcanic analogues and the preparation of future planetary subsurface exploration missions [e.g. 1, 2].
Within the recent ESA (European Space Agency) astronaut training campaign extension PANGAEA-X [3] held in the Tinguatón Volcano area (Lanzarote, Canary Islands), the A1TRAP experimental suite, part of the Analog-1 project [4] was aimed at integrating training data collection and analogue field geology procedures with remote sensing methods and geophysical in-situ. Besides drone photogrammetric imagery, static and moving laser scanning, precise positioning of natural features, the geophysical campaign included ambient seismic noise along with active seismic surveys aimed at characterising the shallow subsurface of selected traverses.
Ambient seismic noise recordings were collected along two transversal arrays: traverse A crossed the Tinguaton cone, traverse B passed beside it through two basaltic lava flows and a thick scoria layer.
HVSR (Horizontal-to-Vertical Spectral Ratio) functions were obtained for each recording in compliance with SESAME guidelines [5], using the shear wave velocity of the first seismic layer obtained from active seismic carried out in the same area, as constraint. The set of H/V functions acquired for each traverse was synthetically reproduced as contour plots, providing seismic stratigraphic sections of the two traverses: in these sections, high H/V amplitudes represent high impedance contrasts in the subsurface, allowing identifying the lateral continuity of the seismic reflectors. In this 2-D map of the HVSR patterns, the horizontal axis indicates the distance between the measurement points while the vertical axis indicates the pseudo-depth. Conversion of the processed H/V functions from the frequency domain into the pseudo-depth domain was performed on the basis of the average shear wave gradient measured in the area. Since the H/V functions spanned a frequency range from $\approx$100 Hz to $\approx$0.3 Hz, the contour plots provided pseudo-depths ranging between a few decimeters and $\approx$700 m. The obtained imaging is able to recognize main volcanic units, scoria deposits, different basaltic lava flows up to a depth of $\approx$50 m, and to distinguish the Tinguaton cone from the lava field.
The 2-D map of the HVSR patterns has been proven to be an effective and expeditious approach for the imaging of the subsurface of planetary volcanic analogues.

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