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Reconstructing the subsurface of planetary volcanic analogues: ERT imaging of Lanzarote lava tubes complemented with drone stereogrammetry, surface and in-cave LiDAR and seismic investigations

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The study of planetary volcanic analogues through the application of geophysical methods is an important preparatory step towards planetary subsurface exploration [e.g. 1, 2]. Within the recent ESA (European Space Agency) astronaut training campaign extension PANGAEA-X [3] held in Lanzarote (Canary Islands), the Augmented field Geology and Geophysics for Planetary Analogues (AGPA) project [4, 5] was aimed at integrating training data collection and analogue field geology procedures with geophysical in-situ and remote sensing methods.
The geophysical campaign included ERT (Electrical Resistivity Tomography) surveys, drone stereogrammetry [6], surface and in-cave LiDAR (Light Detection and Ranging) and seismic investigations. ERT surveys provided the resistivity imaging of lava tubes in two sites located along the Corona volcano system. ERT has been proven to be successfully in detecting and locating lava tubes and achieving a correct estimation of their size and depth and provided a good definition of the boundaries between different volcanic units. The width of lava tubes varies from 10 to 20 m with depth less than 20 m in the investigated areas. The highest resistivity values (> 800–1000 Ω m) correspond to lava tubes and cavities, intermediate resistivity values (∼ 100–800 Ω m) are related to massive and consolidated materials (mainly lava flows) and the lowest resistivity values (5–50 Ω m) correspond to different types of non-consolidated volcanic deposits (mainly pyroclastic or explosive deposits).
In one test site, the reliability of ERT imaging in detecting lava tubes was verified by comparison with the true imaging obtained from surface and in-cave LiDAR. The resistivity imaging was also compared to the seismic imaging obtained from very light reflection and refraction surveys.
In the other test site, the presence of lava tubes is proven by the evidence of collapsed features (jameos or sinkholes) aligned on the ground surface. Drone stereogrammetry provided the DTM (Digital Terrain Model) of the area used for ERT imaging calibration. An assessment of seismic noise level provided early results on the effectiveness of seismic noise measurements for the detection of lava tubes.
The integrated use of ERT and other geophysical investigations has been proven to be an effective approach for the detection of planetary analogue targets, such as lava tubes, allowing the cross-validation of data and improving the geologic interpretation.

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