# 3D subsurface imaging from UAV-based GPR and magnetic data

## A. Barone1, G. Esposito1, F. Mercogliano1,2, F. Accomando1, G. Gennarelli1, R. Castaldo1, P. Tizzani1, I. Catapano1

### 1Institute for Electromagnetic Sensing of the Environment, National Research Council of Italy (CNR - IREA), Via Diocleziano, 328, 80124 Naples, Italy, 2SUniversity of Naples Parthenope, Centro Direzionale Isola C4, 80143 Naples, Italy

### barone.a@irea.cnr.it

Ground Penetrating Radar (GPR) and magnetometric technologies are widely used as they are rapid, cost-efficient, versatile and non-destructive techniques. Thanks to the development of Unmanned Aerial Vehicle (UAV), several UAV-suitable miniaturized/lightweight GPR and magnetometers were released, opening new potentialities but also new challenges. UAV, indeed, allows fast data collection over large and inaccessible areas. However, the acquired data quality may deteriorate because of the UAV electromagnetic disturbances, the limited coupling of electromagnetic energy into the soil, the increased clutter caused by multipath signals and instability of the flight trajectory. Therefore, the use of UAV-based GPR and magnetometric technologies and the effective interpretation of their results is still challenging.

This abstract proposes innovative workflows for the 3D geophysical imaging through commercially available UAV-based GPR and magnetometer. For GPR, the adopted workflow exploits standard time-domain operations, as zero time, time gating, background removal and gain. Thereafter, a specifically designed microwave tomography approach, facing the GPR imaging as a linear inverse scattering problem and accounting for the presence of the air-soil interface, is applied. This approach needs for an accurate UAV positioning data, which are obtained through Differential Global Navigation Satellite System (DGNSS) technique. Magnetic data are processed considering spectral and wavelet analyses, low-pass and directional filtering to mitigate the effect of the heading errors, oscillation artifacts and electromagnetic disturbances. Depth from Extreme Points (DEXP) method is then applied for imaging purposes by considering the scaling laws of potential field sources.

The effectiveness of both the workflows is assessed in real conditions at the test-site of the Altopiano di Verteglia (Southern Italy), where experimental data were collected. The results provided by both the workflows allow the correct identification and reconstruction of buried targets and represent a proof of the potentialities offered by the two UAV-technologies, when their data are properly processed.

**Keywords: UAV, GPR, magnetometry, microwave tomography, imaging methods.**