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Integration of Ground Remote Sensing Methods for Archaeological Prospections.

Salvatore Piro (1), Daniela Zamuner (1), and Melda Kucukdemirci ()

(1) National Research Council, ITABC-CNR, Monterotondo Sc (Rome), Italy (salvatore.piro@itabc.cnr.it, +39 06 9067-2373), (2) Engineering Dept., Istanbul University. Istanbul, Turkey.

Generally the often limited size and depth of the archaeological remains, the presence of structures made with the same material as the host rocks, soil inhomogeneity and the environmental and anthropogenic disturbances, make difficult to define the position and the extension of archaeological structures in the ground because of the low signal-to-noise ratio (S/N). The enhancement of the processing technique towards the integration of different geophysical methods, enabling one better to define the location, depth and geometry of any archaeological bodies, has been adopted.
Multi-methodological surveys have been employed with the aim of detecting either sharp discontinuities (boundary of the cavity, fractures in the medium, etc) or volumetric variations (bodies with different physical properties) at Aquinum roman archaeological site (Frosinone, Italy). For the survey a combination of passive (Fluxgate Differential Magnetic - FDM) and active (Ground Penetrating Radar - GPR) methods has been employed.
With all methods a high resolution data acquisition method has been adopted with the aim of reconstructing a global vision of the investigated area. Signal processing and time-slice representation techniques were used for the analysis of GPR data. The bi-dimensional cross-correlation technique was applied to enhance the signal-to-noise ratio of the magnetic data.
An extensive geophysical surveys, employing Ground Penetrating Radar (GPR) method, has been made during 2008-2009. The obtained results indicate the good matching between the interpretation of aerial photographs and GPR images at different depths. Some portion of the studied area, investigated with GPR, have been surveyed employing FDM (Fluxgate Differential Magnetic) method with the aim to characterise the located archaeological structures.
A combined approach for modelling and inverted the magnetic data is suggested for high resolution analysis of archaeological targets. The determination of the depth of the (top) of the target, the information on the fall off rate of the magnetic anomaly and the estimate of the magnetic properties of the targets provides for the values of first trial for the modelling and inversion 2D and 3D procedure. We adopted a 3D modelling, based on the classical Talwani approach; the optimisation solver is based on the analysis of the 2D cross-correlation function.
This approach has been successfully tested in the archaeological site of Aquinum, characterised by different archaeological structures with different physical characteristics. This approach presents the advantage to overcome the limits of the interpretation of magnetic data in presence of remnant magnetisation (viscous and thermoremnent) and achieves more refined depth analysis of the targets.
An example of the integration (both qualitative and quantitative) of the results obtained with the two geophysical methods are presented for a portion of the investigated area in the Aquinum site (Frosinone, Italy). Archaeological excavations were made systematically, after the geophysical surveys and interpretations (from 2009 to 2010), which confirmed the location and shape of some structures individuated with geophysical methods.

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