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Exposing the Urban Plan of the ancient city of Hyettos, Boeotia, Greece

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Both surface surveying and remote-sensing techniques were applied for recording structures and reconstructing the road network of the ancient city of Hyettos in central Boeotia, Greece. A geophysical survey focused on areas of the archaeological site with the highest recorded ceramic density as well as other sections that were hypothesized as the boundaries of the ancient city. The surface survey and the study of the pottery and architecture were carried out previously by the University of Leiden.

Ground penetrating radar (GPR), electrical resistivity tomography (ERT), electrical resistance mapping, magnetic gradiometry and magnetic susceptibility methods were used comple-

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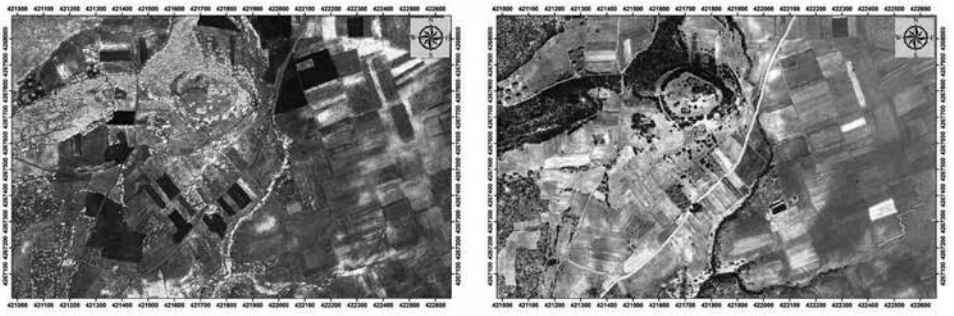

Fig. 1. Results from satellite remote-sensing image processing. Left: Intensity–Hue–Saturation (HIS) filtering; right: Decorrelation Stretch

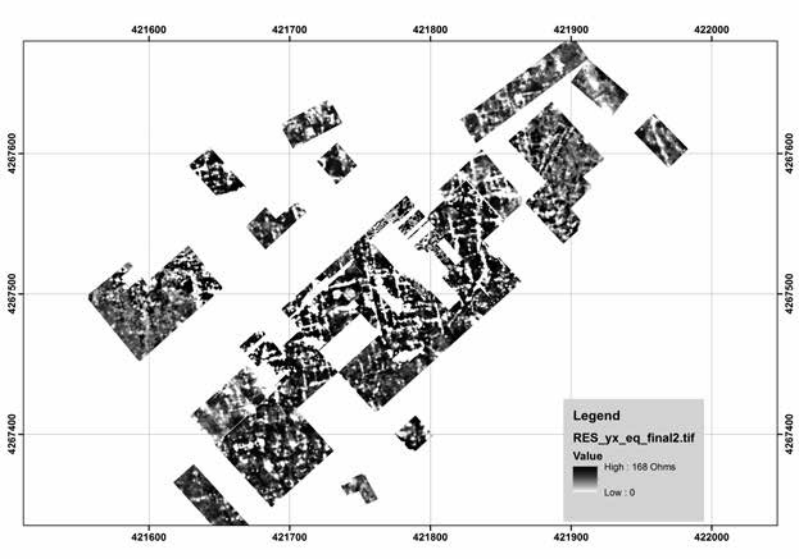

Fig. 2. Combined results of soil resistance mapping and ERT surveying at Hyettos

mentarily for the prospection of various sectors of the archaeological site. Satellite remote-sensing images were also employed in an effort to capture any potential anthropogenic features in the broader landscape of the archaeological site (Fig. 1).

All the resulting maps were rectified to the Greek geodetic topographic system (GGRS 87) and they were overlaid on an aerial photo of the area, together with the rest of the available topographic maps and plans of the area depicting some of the surface architectural remains, like the scattered tombs to the northwest and the agora in the central part of the investigated area. The synthesis of the geophysical results clearly demonstrated the importance of the manifold geophysical strategy

Fig. 3. Integrated diagrammatic interpretation of the geophysical anomalies registered by geophysical surveying methods at Hyettos and reconstruction of the ancient urban street grid based on the results

to survey the area of Hyettos. Each one of the methods applied has been able to suggest specific targets in terms of the physical quantity measured and the properties of the subsurface.

Despite the fact that the GPR provided more details of the stratigraphic extent of some of the architectural buildings, its signals were severely affected by the geological and local environmental setting. High concentrations of iron oxides in the soil similarly affected the magnetic data. Two extensive (6–8 m by 65 m) and outstanding magnetic anomalies were located to the north of the surveyed area, right below the acropolis of the site. These were caused most probably by magnetic ores known to exist in the region and mined in the past. Electrical resistivity and induced polarization tomographic measurements above these anomalies indicated that they were caused by highly magnetized bodies with chargeability of more than 20 mV/V, buried at depths of 0.9–2 m below ground surface.

The enrichment of soils in highly magnetic minerals is obvious also in the magnetic susceptibility values. Magnetic susceptibility variation along the three different transects studied does not indicate any clear fall-off pattern corresponding to the settlement limits. Increased values of magnetic susceptibility were manifested at the centre of the settlement, where architectural relics were revealed by the resistivity, and towards the riverbed to the southeast, suggesting that ancient urban occupation could have extended in this direction.

A number of rectangular buildings were revealed by the GPR survey, mainly in the central area of the settlement. The buildings were of a similar orientation as the rest of the urban street grid and their strong signal indicates satisfactory preservation. Large architectural complexes appear also on the plateau to the south of the acropolis. These appear in good correlation to linear anomalies (possibly ancient streets) found in the same area, extending E–W or N–S and suggesting that the city had reached the acropolis. A few more GPR reflectors were identified above the asphalt road and

the area of the churchyard to the south. More specifically, an architectural complex seems to extend to the east and southeast of the church, and it probably runs under the church foundations. The structure has a similar orientation as the rest of the ancient city and measures more than 7 m by 7 m. In general, the GPR signals were relatively strong in cases where preservation of the structures was good and in areas where there was no collapsed building material collected in bulk.

The electrical resistivity method proved to be the most suitable for reconstructing the urban network of Hyettos. A standard twin-probe resistance mapping technique and electrical resistivity tomography (ERT) in a dipole–dipole configuration were jointly applied to map the subsurface resistivity properties of the site within a depth of more than one meter. A total area of more than 40,000 m^2 was covered by the two techniques combined (Fig. 2).

The resistivity map clearly outlined a number of structural remains that extended mainly over the central part of the surveyed region below the acropolis and to the north of the modern road. Most of the architectural remains represented building complexes, consisting either of simple rectangular walls or more complicated divisions. All of them, with very few exceptions, were aligned almost exactly N–S/E–W. Some sectors exhibited a much more complicated plan with interior walls dividing the buildings into smaller compartments.

The N–S roads appear to have been 5.7–6.0 m wide, some of them narrowing at the eastern and western ends of the city. To the south, the N–S streets were about 38 m apart, but they started to deviate as they ran northward, toward the slopes of the acropolis. Some of the long linear street sections were traced for more than 93 m and corresponded to the main pathways leading to the entrances to the acropolis. Traces of about 8 longitudinal roads are evident, and only six E–W streets, which seem to be narrower and harder to reconstruct based on the geophysical signals.

Geophysical techniques facilitated a rough plan of the urban street grid (Fig. 3). It is evident that the city reached the foot of the acropolis and covered an area of at least 300 m by 300 m, whereas the magnetic susceptibility measurements indicated a further expansion of the habitation to the east and south.

The geophysical surveys carried out in the different seasons were accompanied by a hands-on training module for students and theoretical seminars. The workshops on "Geophysics, Remote Sensing Techniques and Ground-Based Digital Recording Methods for Archaeological Sites and Cultural Landscapes" were able to provide a thorough and in-depth training to graduate, PhD and Postdoc students.

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