

Palaepaphos, Cyprus: The contribution of Geographical Information Systems and Geophysical Prospection in the study of the archaeological topography and settlement patterns

**A. SARRIS¹, G. STAMATIS¹, N. PAPADOPOULOS², E. KOKKINO¹, S. TOPOUZI¹, E. KOKKINAKI¹,
E. MOISSI¹, M. IACOVOU², V. KASSIANIDOU², G. PAPASSAVAS², G. PAPANTONIOU², M. DIKOMITOU²,
E. STYLIANIDIS³**

¹ Laboratory of Geophysical – Satellite Remote Sensing & Archaeo-environment, Institute for Mediterranean Studies, Foundation for Research & Technology, Hellas (F.O.R.T.H.), stamatgiorgos@students.phl.uoc.gr asaris@ret.forthnet.gr]

² Research Unit, Department of History-Archaeology, University of Cyprus, maria@ucy.ac.cy, v.kassianidou@ucy.ac.cy, georgep@ucy.ac.cy]

³ GEOIMAGING, LTD., CYPRUS, stratos@geoimaging.com.cy

ABSTRACT

A large number of monuments in the wider region of Palaepaphos, Cyprus (known as Kouklia today) have been excavated since the late 19th and the mid-20th centuries. These archaeological monuments are dated from the Late Bronze Age to the Venetian Domination and the Turkish Rule. Specifically, the monuments that have been systematically excavated include the Sanctuary of Aphrodite, parts of the fortification of the ancient city, houses with mosaics, "administrative" residences, two historical industrial installations of cane sugar refinery and a number of tombs, either single graves or extended cemeteries.

For the aforementioned reasons, the design of an interactive tool which utilizes the G.I.S. technology has been proposed for the monitoring of the development plans of the region, emphasizing the registration, conservation and protection of the cultural and environmental monuments of the area. The continuous recording of the archaeological and cultural material of the area under examination can be used as a basis for the confrontation of significant problems concerned with the heritage management, such as the modern development and the changing land-use patterns.

A relational database was constructed for the registration of the monuments distributed in the wider region of Palaepaphos, together with those finds located at the local Archaeological Museum. An extensive high accuracy DGPS survey was conducted for the spatial registration of the monuments to the local topographic system. Digitization techniques were used for the georeferencing of the aerial images and the digital topographic and geological maps. Geophysical prospection techniques, including magnetic and soil resistance surveys, were carried out in order to provide additional information regarding the subsurface relics in relation to the excavated or surface monuments. Finally, the superposition of the above information layers allowed a further spatial analysis through the use of GIS tools. Statistical correlations of the monuments with slope and aspect, viewshed analysis and least cost path calculations were employed in an effort to reconstruct the fortification wall of the ancient city and recover parts of the fragmentary record of the town plan.

The application of the above technologies has already established a rigid research framework upon which the archaeological material of Palaepaphos can be studied, evaluated, brought into prominence and protected.

1. INTRODUCTION

The city of Palaepaphos, which extends to the south-west end of Cyprus, has been one of the most significant settlements of the island with a constant human presence from the Chalcolithic period to recent times (Maier and Karageorghis, 1984; Maier and Wartburg, 1985a). Both the city's continuous presence and its notable prosperity throughout its history provided the stimulus for the intensive study of the area. Palaepaphos was one of the two cities of ancient Cyprus (the other being Kition), about which archaeological data confirmed a peaceful transition from the Late Bronze Age to the Iron Age, an evolution that has not been noticed in any other known city of the island (Iacovou, 1994, p. 157-8; Iacovou, 1999, p. 148; Maier, 1999, p. 82). Furthermore, since the Iron Age, Palaepaphos emerged to one of the ten blooming kingdoms of Cyprus, namely the kingdom of Paphos.

Although the historic significance of the area has been widely recognised, as it can be also confirmed by the establishment of a protection zone by UNESCO and the Department of Antiquities of Cyprus, past archaeological research did not provide the appropriate attention to the cultural landscape of the region. Only a small number of excavations were conducted at a limited extent, revealing a restricted amount of the archaeological record, as it is shown by the absence of a synthetic study and publication of the area's archaeological monuments.

2. DESIGN OF A NEW APPROACH TOWARDS THE RECONSTRUCTION OF THE ARCHAEOLOGICAL TOPOGRAPHY OF PALAEPAPHOS

After the establishment of the priorities of the research project, a number of actions have been considered and carefully planned in order to approach the two basic goals of the project, namely the reconstruction of the archaeological

topography of the area and the study the temporal variations of the settlement patterns. The specific approach, consisting of both geographical databases and fieldwork modules, was considered as the most appropriate. One aiming towards the construction of a digital archive management system of the existing cultural records, the geophysical mapping of specific areas of interest in order to enhance the existing archaeological evidence, and the spatial modelling of complementary data.

The initial steps of the project included a number of fieldwork activities such as the GPS mapping of the visible monuments and the geophysical surveying of specific areas of interest in the vicinity of existing monuments or recent excavations. More than 120 points related to known monuments were mapped through a set of Ashtech CGRS (Continuous Geodetic Reference System) GPS receivers (Z-12 double frequency). All measurements were taken to the Local Transverse Mercator (LTM) System, according to the parameters provided by the National Cadastral Department of Cyprus. It has to be mentioned that all cartographic data were digitized and registered to the same projection system.

Geophysical prospection methods included soil resistivity measurements with a Twin probe configuration and vertical magnetic gradient measurements covering a total area of 43.600m². Processing of the geophysical data included the creation of mosaics, grid and line equalization techniques, compression of dynamic range and the application of directional filters. Laboratory measurements of the soil magnetic susceptibility (high and low frequency and frequency dependent susceptibility) were carried out at selected parts of the site in order to verify the results of the rest geophysical techniques.

A relational database was constructed for registering the existing archaeological records related to the monuments and finds accompanied by the corresponding references and photographic material. The database consists of four main information modules related to toponyms, local cadastral parcels (coding, declaration, declaration documentation, etc.), monuments (coding, description, location, references, photos, chronology, GPS fieldwork, usage, etc.) and finds (inventory number, atlas monument code, description, references, photos, etc.).

Cartographic material, consisting of aerial ortho-rectified photographs, topographic and land-registry maps and geological maps, was digitized, coded and entered to the GIS software (ArcGIS 9.0), and it was linked to the archaeological database. Intensive photo-interpretation of the aerial photos was carried out in conjunction to the processing of the geological maps in order to identify continuities and possible links to the visible monuments.

3. ANALYZING THE CULTURAL LANDSCAPE OF PALAEPAPHOS

3.1. FORTIFICATION WALL

In order to reconstruct the cultural landscape of Palaepaphos, it is important to investigate the extent of the settlement (as it can be suggested by the course of the fortifications walls of the city) and study the enclosed architectural remains and their density. Processing and cross-correlation of the geophysical data in addition to the results of the spatial analyses (such as viewshed and least-cost-path calculations) provided indications which were further investigated through a ground-truthing survey on May 2004.

Previous archaeological research, which revealed parts of the fortification wall of the city at the sites of Marchello, Kaminia and Hadji Abdullah (dating from the Cypro-Archaic and Cypro-Classical period), suggests that the wall follows the area's topography and, in the largest part of the town's eastern section, it is founded on an edge of plateau, being the offset of shallow vales descending towards the modern Kouklia community (Fig. 1). This assumption was reinforced through Least Cost Path Analysis and it was consecutively confirmed with a local inspection at the site on May 2004. In several areas, the direction of the wall was also confirmed with the geophysical mapping techniques (Fig. 2).

Contrary to the eastern section of the town, at the southern and western parts of the settlement, the direction of the wall remains vague. The only assumption about the course of the wall originates by the results of the least-cost-path analysis, which was based on the well-known burial practices of particular period, namely the development of the cemeteries (after the Bronze Age) within the town limits (Fig. 1).

3.2. TOWN PLAN

Merging the above conclusions together with the results of the geophysical survey and the evidence originating from previous excavation work in the wider area of Palaepaphos we can also enhance the information context of the town plan of the city. From the Late Bronze Age to the Late Classical period, the main housing plan was extended east of the modern Kouklia community. In the Late Bronze Age, the centre of the settlement was located in the areas of Evreti, Asproyi and Mantissa. From the Cypro-Geometric to the Late Cypro-Classical period, the city extends to the east, as far as the sites of Marchello and Hadji Abdullah, which constitute the eastern limit, as it is suggested by the extensive sections of the fortification wall which have been discovered at the specific location. During the Hellenistic and Roman periods, the extent of the city diminishes, while its centre is displaced along the hill circumference of the Sanctuary of Aphrodite, in the areas of Alonia, Phones and Kato Alonia. Cemeteries, which are an inextricable part of an organized social practice, were a main source of information concerning the settlement's extent.

Among the sections which were investigated through magnetic techniques, the area close to the "House of Leda" has indicated a dense distribution of candidate targets in accordance to the visible architectural remains found in there (Fig. 3). Possibly this area, west of the Sanctuary of Aphrodite, was evolved to a central part of the organized space of the settlement. This suggestion is also confirmed by the sophisticated decorative attributes of three roman houses, containing mosaic floors and other surface findings located during the ground truthing campaign.

Equally interesting results emerged from processing the geophysical measurements at the site of Evreti, close to the northern and eastern part of the excavation (Fig. 4). Taking as feedback the results of past excavations in the region, which among others confirmed the co-existence of the habitation area and the cemetery in the Late Bronze Age, geophysical anomalies can be correlated with tombs, pits or even wells. Furthermore, a number of linear anomalies may also suggest the existence of a dense network of houses.

Further evidence originated from the soil resistivity measurements in the area west of the excavated building at Hadji Abdullah (by F. G. Maier), where linear elements probably belonging to architectural remains seem to coincide with the projection of the excavated structural walls.

3.3. VISIBILITY STUDIES

Having collected a number of data regarding the extent of the settlement and the diachronic evolution of the town plan, research was focused on the locality selection process of specific structures. Taking the example of the structural remains of Hadji Abdullah, which was assumed to be the residence of the commandant of the Persian guard, which was installed in Palaepaphos in 498/7 B.C. (Maier and Karageorghis, 1984, p. 208; Maier and Wartburg, 1985b, p. 106-7; Maier, 1989, p. 17), visibility analyses were carried out in order to study this hypothesis (Fig. 5).

The results of the viewshed analysis, confirmed that the particular location satisfied the requirement for the maximum surveillance of the surrounding space, covering a large part of the settlement and of the coastal area.

Further work on the visibility analysis from selected spots of the region produced some interesting results about the exploitation of the natural settings of the settlement. Mutual visibility was indicated among the Sanctuary of Aphrodite, the buildings at the localities of Evreti and Hadji Abdullah and the wall section with the N-E Gate located on the Marchello hill. Moreover, the built (king?) tomb of "Rigaina" seems to have a direct visual contact with the Sanctuary of Aphrodite, a fact that can be associated with the assumption that the Kings of Paphos were considered as the first priests in rank of the goddess Aphrodite (Maier and Karageorghis, 1984, p. 14-5).

4. GENERAL CONCLUSIONS

The above sections have demonstrated the contribution of Geographical Information Systems and geophysical prospection in the study of the archaeological topography and settlement patterns of Palaepaphos. Least-cost-path and viewshed analysis were the most successful, compared with the statistical correlation of other geomorphological attributes, such as slope, aspect, elevation and geology, in suggesting the way of usage of the landscape in terms of the different phases of the settlement. In addition, geophysical prospection offered a further verification of the GIS analysis and provided a valuable record of the existence of potential archaeological targets, which can be used for the guidance of the future excavations.

The above approach has set the framework for the future study of Palaepaphos and has created the necessary tools for the better management of the archaeological monuments of the area, which are under a severe threat due to contemporary developmental works (national road construction, golf courts, resort areas etc. Iacovou, 2001, 2004).

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FIGURES



Fig. 1 – Suggested course of fortification wall based on GIS analysis and ground truthing of May 2004.

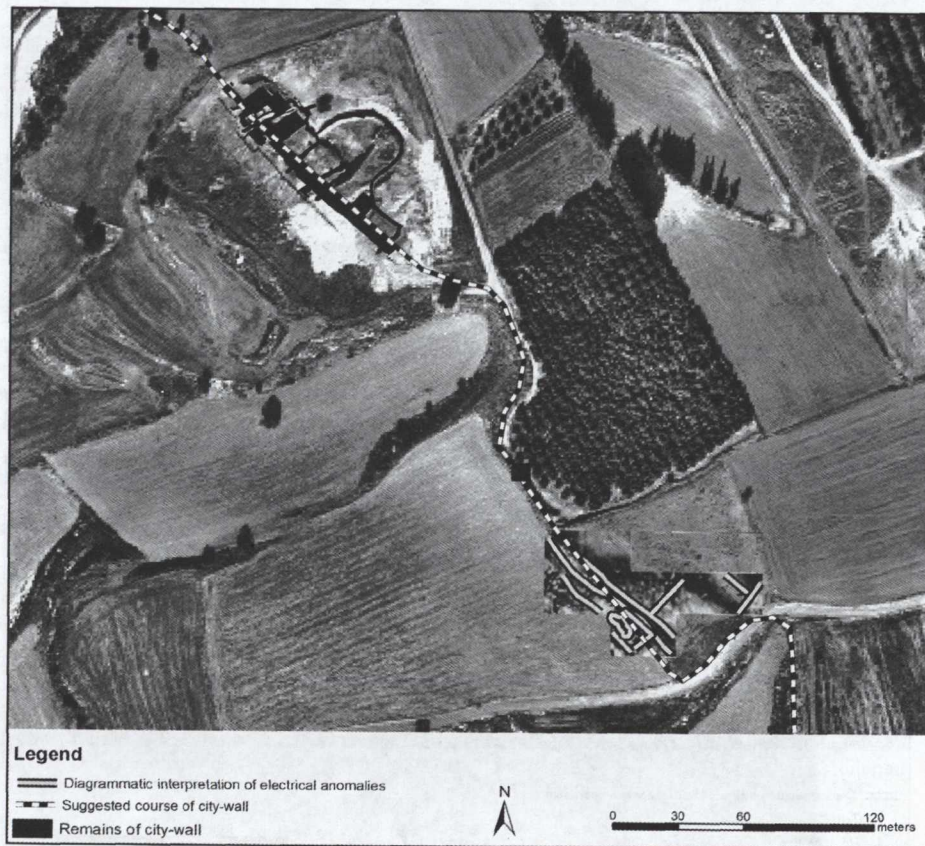


Fig. 2 – Marchello hill. Overlay of the results of geophysical survey.

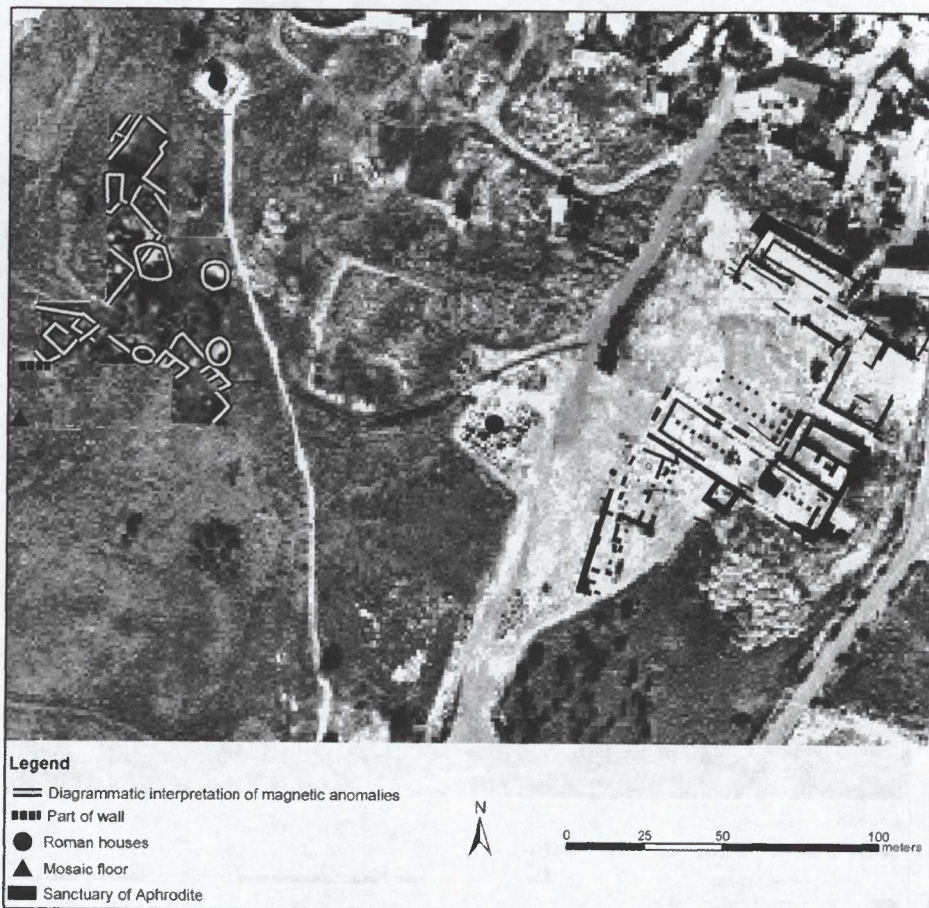


Fig. 3 – Area west of Sanctuary of Aphrodite. Overlay of geophysical anomalies and plan of the excavated relics.

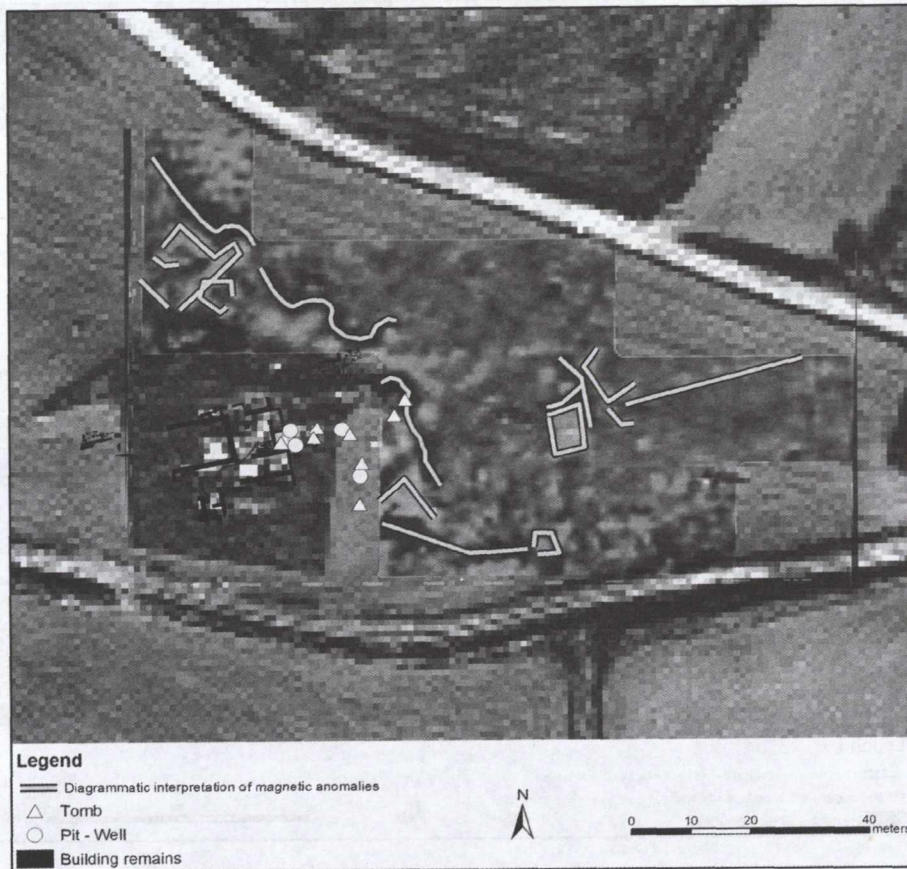


Fig. 4 – Evreti. Overlay of results of geophysical survey and correlation of them with the excavated monument.

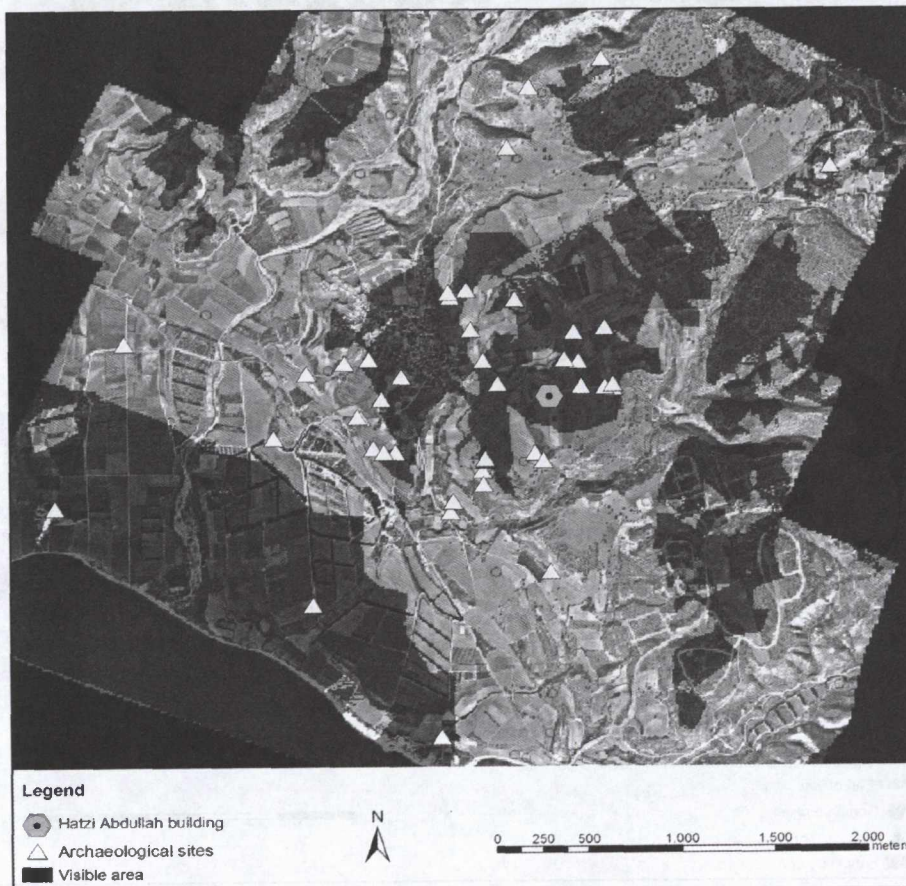


Fig. 5 – Viewshed Analysis from Hatzi Abdullah building.