GEOPHYSICAL METHODS USED IN THE ARCHAEOLOGICAL STUDIES OF THE ANCIENT TOWN OF "ARGAMUM"

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Abstract : In Romania, geophysical methods are normally used to estimate the distribution of cultural relics, before digging. Objects of archaeological interest are usually located within a few meters of the surface. The geophysical studies were carried out within the archaeological site in 2005 as well as in 2006. Geophysical works were conducted using Geometrics equipment (G856 proton precession magnetometers) with a 0.1nT precision, which allowed for a highly detailed local morphology of the geomagnetic field and for the mapping of the magnetic anomaly. The working technology has been chosen to enable to emphasize mainly abnormal effects produced by sources located at depths of 0-5 m. On the south side of the late Roman fortification, outside the precinct wall, an artisanal area including a furnace for manufacturing building materials dated from the late Roman period, was found as well as some Greek furnaces for manufacturing ordinary brick. The south area of the site has been studied within this research project using the magnetometrical method (Fig. 5). Geophysical studies will prove very useful for further archaeological diggings, supplying them with a more clearly defined image on the substratum situation.

Key words : ancient cities, proton precession magnetometers, geomagnetic field, gradient system

INTRODUCTION

Greek colonies in Dobrogea are among the oldest city systems, rightfully considered the oldest towns in Romania (*e.g.* Histria, Tomis, Argamum etc.) During the last period of development of Roman Dobrogea, in IV-VII A.D., fortifications located along the Danube have been strengthened, and other cities were built within (*e.g.* Ulmetum, Petra, Argamum – Fig.1). This latter city is considered the first ancient place settlement within our country quoted in an ancient literary source (Barnea, 1976).

The vestiges of the Roman - Byzantine age discovered by Nicorescu, the student and disciple of Pârvan, are assumed (Popescu, 1994) to constitute proof of the continuity of life in Dolojman Cape and in Bisericuța Island located in the Razelm Lake, in Constantinia settlement.

The study of civilization totally or partially hidden in the soil represents the object of archaeology. The main feature of this humanistic discipline is that it unburies, it preserves and it restores human settlements (Rachet, 1997). Once dug up, and fully exposed to all weather conditions and, also, to adverse human impacts, an archaeological site risks destruction. Depending on the severity of the damage, restoration works are undertaken. Often partial reconstructions are needed, especially of the ancient city walls, although stone which has been treated by using state-of-the art technologies are used.

After a long pioneering period, dominated by great discoveries but also by errors often resulting from the lay works undertaken, archaeology started to become more and more a methodological subject, an accurate and exact one. The change has been possible after understanding the advantages provided by the progress registered lately in the field of engineering.

If aerial photography using different spectral bands, particularly, satellite-based thermal infrared imaging, allow for detection of archaeological structures extending on large areas, the geophysical methods – due to a variety of measuring techniques and studied physical parametres – can safely help in favourable conditions to identify and locate them in the absence of surface indicators, as well as establish their absolute age.

Geophysical methods can provide extremely useful qualitative and quantitative information concerning the form, size, spatial arrangement and certain physical features of investigated structures, limiting the fields of interest in order to perform planned diggings.

THE CURRENT STAGE OF KNOWLEDGE AND ITS MEANING

Magnetometric researches are usually carried out with gradient devices, which implies performing certain simultaneous measurements of the total intensity or of the vertical component of geomagnetic field at two levels, and are usually used within any archaeo-geophysical study. There is a growing involvement lately, in matters related to archaeogeophysics, of electromagnetic methods which also have an extremely high productivity.

Outstanding progress achieved in increasing geophysical equipment sensitivity, more and more sophisticated techniques of processing, interpreting and two and three dimensional shaping of results has enabled approaching using geophysical means a more larger scope of archaeological issues.

Geophysical research of Argamum archaeological site dated from the ancient period, located in Dobrogea, in the area of promontory of the Cape Dolojman has helped to renew collaboration between a series of research centers constantly dealing with the field of geophysical research, as well as archaeology. Another, equally important, advantage derived from the same principle, is that it offers the chance to form and consolidate interdisciplinary research teams which shall gather the best specialists in the research fields - development and academic research so that the results of papers shall be published in specialized magazines like "Geophysics" or "Dacia".

PRELIMINARY SCIENTIFIC RESULTS

Geophysical works have been carried out using Geometrics equipment with a 0.1nT precision, which allowed for highly detailed images of the local morphology of geomagnetic field and drawing of maps presenting the magnetic anomaly. The working technology has been chosen to enable to emphasize mainly abnormal effects produced by sources located at depths of 0-5 m. Under the circumstances, taking into account works carried out in 2005 and the previous experience gained during other archaeo-magnetism contracts, the same equipment and magnetometrical mapping method have been used.

The first works carried out were topographical works, with the help of which the observation networks were transposed

Fig. 1 Argamum archaeological site

within the field, the eye of the network having 1 m, for the three perimeters 20/14 m in size.

This operation was concluded by placing 20 profiles for each perimeter and was performed starting from the self - supporting topographical network of the archaeological site. The geophysical mapping consisted in magnetometrical research works carried out mainly using proton precession magnetometers owned by GeoEcoMar.

The day variation of the geomagentical field was registered in the geomagnetical station set on the sea bank in the Periboina area using Geometrics G856 proton precession magnetometers owned by GeoEcoMar. In this stage a detailed study of petromagentic features of rocks and soil in the research areas was performed. The quick processing of results, carried out starting from the field stage, using data portable acquisition and notation systems of GeoEcoMar allowed for obtaining certain preliminary images of the morphology of the whole geomagnetic field anomaly which were used for directing magnetometric work and for the calibration of the equipment. As regards work in the site of Argamum City there was a need to use micromagnetic techniques, which implies carrying out measurements in rectangular panels of 14/20 m with 1 m equidistance of stations. Magnetometric measurements were performed with 1.5 m distance sensor from the soil.

PROCESSING AND INTERPETING DATA ON LOCATION

Magnetic anomalies emphasized in prospected areas can be explained by the contact of magnetic susceptibility existing between archaeological structures (brick walls, ceramic items, building stones with a certain magnetic susceptibility, etc) with the loess soil.

Thus, within the perimeter 1 we can notice a major anomaly in the Eastern – Western direction, which is continued in the perimeter 2; it can show the existence in the subsoil of certain buried structures making at the sources an effect similar to walls. The stated anomalies are shown in Fig. 2 – blue color.

The direction of anomalies is maintained also in the perimeter 2 (located at 20 m of the perimeter 1 in the same direction) , towards the eastern part of the perimeter; they have the same linearity but are obliquely directed in the southern - eastern part and parallelly directed in the northern part. The third perimeter is characterized by the existence of the types of anomalies shown in Fig. 2.

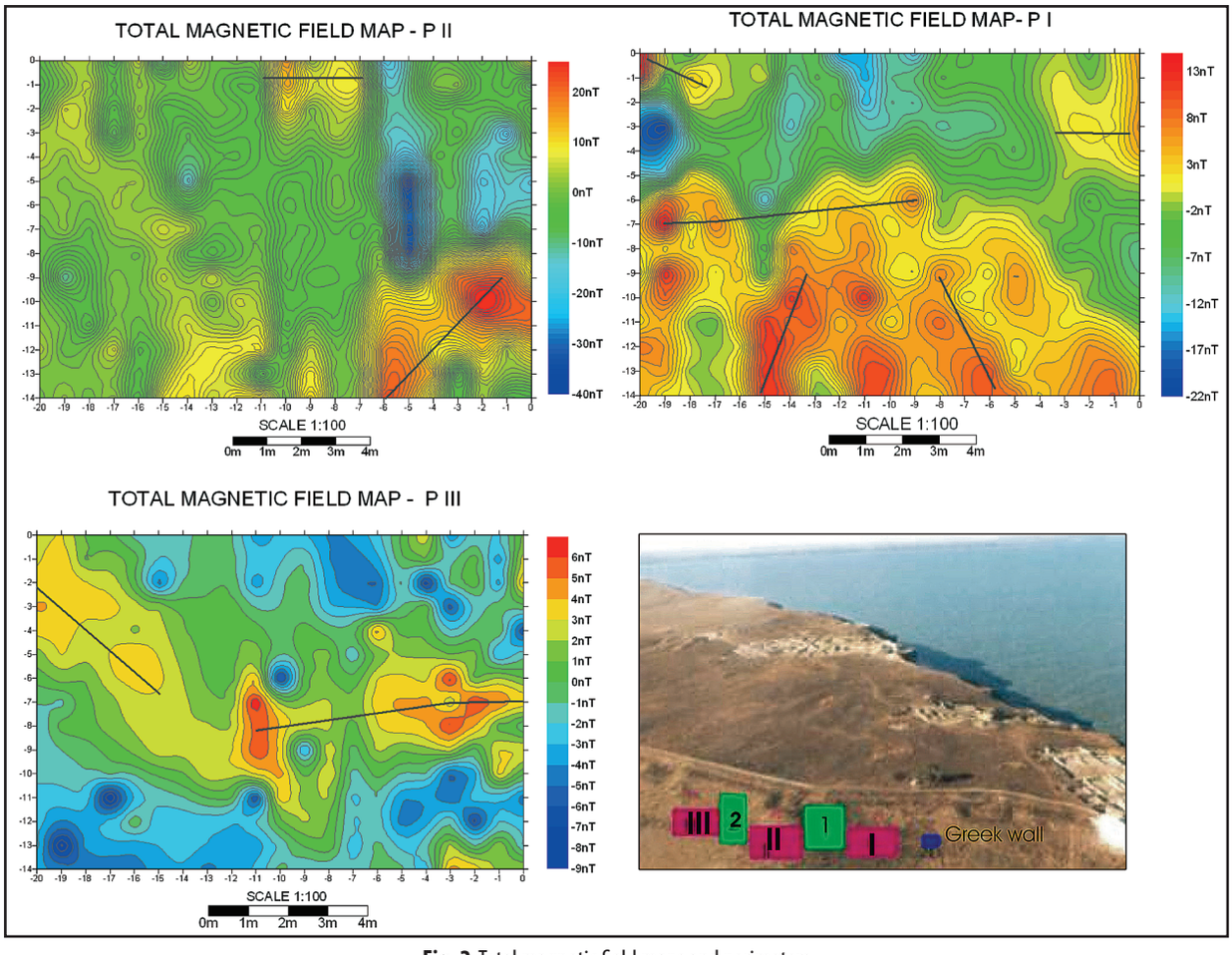

Fig. 2 Total magnetic field maps and perimeters

Fig. 3 Greek Wall

Some of the anomalies are directed towards south-east expanding towards the central part of the perimeter, and one of them is obliquely positioned towards the eastern western direction, having a perpendicularly buried wall on the precinct wall. This wall can be detected due to its perpetual character, whereas obliquely arranged anomalies can outline pieces of rock that can be related to an eroded structure placed at a depth of around 1 m.

The fact that a geological structure in the interval of 0-50 m is extremely heterogeneous, which can be seen in the large variations of the geomagnetic field from profile to profile, can lead to ambiguities. Therefore, the method of correlation among profiles is a possibility of reducing this ambiguity.

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