Arch-geophysical prospecting at Magura Uroiului (Romania)

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ABSTRACT

The archaeological site from Magura Uroiului have a big surface, so it has been decided that the method used for obtaining necessary informations for the archaeological research, is the nagneto-metric prospecting one. The grade-metric invastigation at a big resolution, made on Terrace I (1.65 ha) revealed facts which confirm a human inhabitance coresponding with the archaeological clues already onvious through systematic research.

1. BRIEF LOCATION AND CHARACTERIZATION OF THE AREA

The archaeological site from Magura Uroiului appears as a suspended plateau (terrace), limited by a fortification in the south, south-east and east (Fig. 1). Due to its big surface (approximately 20 ha), it has been decided that the method used for obtaining information necessary to the archaeological research is the magnet-methric prospecting method. The prospecting has been done by a team belonging to Alba Iulia Systemic Archaeology Institute (ArhSis). The arch-physical research pursued the covering of an area 100 m wide and 175 m long, situated in the south and south-east extremity of the plateau and folowing the relief line imposed by the presence of the fortification system, efficiently and meant to replace the archaeological research in progress. In the area under disscusion there has been reported the presence of complex site with deposits dating back to neolithic, Bronze Age, the first and the second part of the Iron Age.

2. DESCRIPTION OF THE ARCH-GEOPHYSICAL RESEARCH PROJECT

The arch-geophysical project consisted of prospecting the available area inside the site, using the magneto-metric method, more exactly the grade-metric one. An area of approximately 1.65 ha was covered with big resolution magnetic data, a number of 31.343 magnetic data spots being collected for each of the three recorded parameters (magnetic field 1 and 2, calculated gradient), using a density of 0.5 m on Y axis and 1m on X axis (area separated by 0.5 m and lines separated by 1 m). This big data density was used for the best possible geophysical record of the existing situation within the areas of archaeological potential, at this stage being searched an area limited by the fortification route and the existence of a location network through GPS spots (Fig. 4).

3. PROSPECTING CONDITIONS. UNDERGONE OPERATIONS, DESCRIPTION OF EQUIPAMENT AND DESIGN USED

The prospected area within the archaeological site proved to be a complex one not only because of the presence of structural anomalies of archaeological interest, but mostly because of the existence of a substantial number of modern defensive systems all over the plateau.

The equipament (Fig. 2) owned by the Syatemic Archaeology Institute consists of a Canadian cesium vapors gradiometer (Scintrex SmartMag SM4G) made up of two very sensitive sensors, a data control and regestering console and capacity batteries. The system sensitivity, of 0.01 nT, perceives tiny variations in the magnetic field values, field which on Romania's territory is situated at an amplitude of approximately 48.000 nT.

The magnetometer is used as *vertical gradiometer* in order to eliminate the effects of the daytime variations or of other phenomena. The magnetic gradiuent is calculated from the values recorded separately by the two sensors used, the distance between them being of 0.5 m. The data are given as magneto-metric maps, using the coordinates system chosen for repporting the plane spots. The amplitutdes registered are direct proportional with the magnetic value of the searched complex and manifest themselves depending on the distance to the source surface – the closer the object is to the surface, the more acute and better positoned the signal is, and the bigger the depth, the bigger the surface on which its magnetic value "dissipates".

The magnetic anomalies encountered on an archaeological site are extremely complex due to numerous factors: the anomaly sources are situated relatively close to the surface, the natural soil variations are stronger, leading to a bigger noise rate, and the pursued characteristics themselves are very strong at the thorough prospecting.

4. COORDINATES SYSTEM USED AND THE CHOSEN PROSPECTING MEANS

The coordinate system chosen for prospecting the potential area is simple and is based on the existence of an E-W line drawn with the help of GPS system. The units had uneven margins due to the terrain pattern. In order to exemplify the means of collecting data in a Cartesian coordinates system (X and Y) and the chosen prospecting means we will use the following scheme:

The tackling sense of the research units; partial units
Square 1, 2, 3... 21
Line I
Partial units due to obstruction
Line II
Disconnected units 22, 23, 24, 25
The coordinates system E 20... E 160

1 m
Data collecting spots
(Y-axis)
Stations
Lines-cross bars
(X-axis)

5. EXPLANATORY REPORT

The chosen prospecting means followed the characterization of the area under disscusion from the point of view of the existing magnetic field anomalies, with a resolution of 0.5/ 1m. The three parameters that can be recorded by the equipament used, namely total field 1, total field 2 and magnetic gradient, can characterize the majority of the situations encountered on such an archaeological site down to a depth of 1.5-2 m through the shape and amplitude of the anomalies generated in the normal values of the local magnetic field. Each of these parameters can be characterize as follows:

- *Total field 1* (tfl, t1) corresponds to the values recorded by sensor 1, the closest to the earth's surface; this location should insure maximum sensitivity, but it also has a major deficit, perceiving with the same precision the "soil noises" characteristic to any surface geological situation;
- *Total field 2* (tf2, t2) corresponds to the second sensor situated 0.5 m higher, identical from the sensitivity point of view with the first one; it is not as sensitive to the "soil noise" as the first, generating a broader image of the anomalies, without clear distinctions; it is used to outline a more general image of the anomalies, but in the same time a "more protected" one against the soil noises;
- *The magnetic gradient* (grade) is a aparameter calculated from the values of tf1 and t2, which has the special quality of being independent form any daily variations which unfortunately affect the other parameters; although it will render only a "" between the two recorded values (t1 and t2), it can help outline the anomalies more accurately.

The whole magneto-metrically searched area is made up of 6 units with siyes of 50/50 m and 2 smaller units of 25/50 m, with variable sides, depending on the terrain structure. The analysis will pursue mainly the characterization of the anomalies encountered, for detailed exemplification existing explanatory maps and corresponding cards. The recorded magnetic field values and their amplitudes show the presence of an archaeologically complex situation in all the investigated units.
The gross magnetic values reveal big amplitudes through the extreme values recorded, this situation being generated by the presence of numerous metallic objects. As a consequence, filters meant to correct this situation were installed, in order to reveal those variations of archaeological importance, of far lower values. For interpretation, were considered archaeologically relevant the data found within the limits -15/+45 nT with a certain linearity, obviuos asociation etc.
Anomalies and anomaly groups were identified which reveal the presence of complexes of archaeological interest in the investigated units. They were interpretated using the most appropriate existing archaeological analogies, mention having to be made that this interpretation trial cannot be considered more than the closest condition revealed by data and not the archaeological situation existing on that location. So as to illustrate the magneto-metric data collected on the site form Magura Uroiului two specialized software programs owned by the Institute were used: Geosoft Oasis Montaj 5.1.2 and Goescan Research Geoplot 3.0. The resulting diagrams are presented under different color specters and graphic methods that distribute the amplitudes of the collected and processed magnetic data in a supervised manner.
From the point of view of the recorded magnetic amplitudes the situation shown by the great majority of the investigated areas is as follows: the general variations are minimal, 3-4 nT (-2 -+2 nT); other values, a lot bigger (over 100 nT) are only scarce, individual and generally belong to modern metallic objects; other variations, vaster and proportions (100 nT or more), but relatively well-shaped, belong either to immediate geology phenomena, or to the relatively recent anthropogenic fittings.

With a view to being interprated, the main alignments/the archaeologically interesting situations magnetically identified were marked on the drawings with red intemittent lines. The identified situation will be described according to the numbers on the eplanatory drawing attached to this report, mention having to be made that tih interpartation is not a final one, but a stage reached by the present possibilities of the processing programs of the data used.
On the complex archaeological site from Magura Uroiului-terrace II, the following magnetic anoamly categories were identified (Fig. 3):

- Anthropogenic anomalies of archaeological interest: a series of anomalies of small amplitudes (+/-10 nT) which have orientations and associations apparently specific to the relatively intense inhabitation of the plateau-red color;
- Anthropogenic anomalies of minimum archaeological interest: groups and vast disposing of magnetic anomalies of relatively big amplitudes (+/-150 nT), specific to the recent metal concentrations of fittings (trenches from World War II) – light green and blue color;
- Anthropogenic anomalies of no interest or which are generated by the site systemati research (archaeological sections and Rom Telecom optic fiber cable, different distinct metallic objects)-blue color.

6. ANOMALIES OF ARCHAEOLOGICAL INTEREST

Mention must be made that the present associations are created according to the existing clues, the presence of a recent strong magnetic answer area preventing the efficient characterization of all anomalies of archaeological interest:

- Anomaly group 1 is made up of positive value associations grouped and with apparently linear limits that would show intense magnetic activity areas corresponding to agglomerations of burnt material, specific to burning residences, etc.
- Group 2 is made up to the same type of variations, positives ones and most probably has the same origin; it was crossed by the optic fibber cable ditch, although the later could have been too superficial;
- Group 3 represents a relatively compact association of positives magnetic anomalies which probably have a source of archaeological interest too, such as a group of burnt residences or annexes, or lots of ceramic material;
- Group 4 is now made up of positive linear anomalies that seem to be describing some sub-constructions boundaries; the existence of positives anomalies shows an origin of archaeological interest; it is remarkable that this positives anomaly area was archaeologically explored; in the very proximity of the first sounding (from the West, the 98th meter of the main line) there are obvious negative anomalies placed in rectangular position, which seem to point out the presence of some complexes of archaeological interest;
- Anomaly group 5 contains positive and negative magnetic associations which could originally be generated by surface complexes with burnt materials and ceramics, a clue being the existence of approximately rectangular limits; it has to be mentioned that the anomaly area between groups 1 and 5 could be generated by the presence of an archaeological section whose location was not obvious at the time of the prospecting.
- Group 6 is made up of positives anomalies within certain spatial limits which seem to point to another burnt material group; the presence of group B values in the proximity does not allow a more detailed interpretation of this group;
- Apart from this groups identified with numbers, the positive value areas located in the North extremity of the investigated surface have to be taken into consideration too, too, together with the ones associated with the earth wave on its entire length; due to the fact that there are no clear limits or clues about their chronological belonging, the present interpretation confines itself to considering them potential inhabited areas or areas affected by the fortification works during the second World War.
- The evidence of the defence wave through the presence of positive anomalies typical to this kind of constructions is to be remarked; the defence wave's doubling towards the interior by the modern trenches is obvious (Fig. 5).

Archaeological soundings and sections from previous campaigns are magnetically visible as negative anomalies with clear rectangular limits. Besides the ones pointed out on the explanatory drawing, somewhere between groups 1 and 5 is suspected another archaeological section.

7. GENERAL CONCLUSIONS REGARDING THE IDENTIFIED ARCHAEOLOGICAL ANOMALIES

The grade-metric investigation of big resolution revealed situations of archaeological interest, which confirm a human inhabitance corresponding the archaeological clues already obvious through systematic research. Of archaeological interest are also considered the complexes that represent, through magnetic characteristics, a possible relatively recent chronological belonging.
The magnetic anomalies considered of archaeological nature consist of positive/negative variations that suppose an associate display, in groups that denote complexes with ceramics agglomerations, burnt adobe and possibly superficial

hearths. Some of these shaped complexes could belong to recent anthropogenic fittings (trenches from World War II etc.), being outlined separately.

The character of the inhabited fortified settlement from this spot cannot be clearly outlined by the present interpretations due to the presence of numerous factors that diminish the possibility of identifying the fine anomalies specific to the settlements under discussion. Thus, this interpretation confined itself only to outlining the areas of interest in the systematic research of the plateau and to mentioning some of the anomaly groups that seems to be most probably generated by the complexes and artefacts of archaeological interest. A sounding of these areas and an evocation of the discoveries corresponding to the magnetic anomalies would help reinterpret the area by extrapolation.

REFERENCES

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ARDEU, A.; BALOS, A. (2002) – Cercetari arheologice la Magura Uroiului (jud. Hunedoara). *Cvmidava 25*, p. 67-81

FIGURES

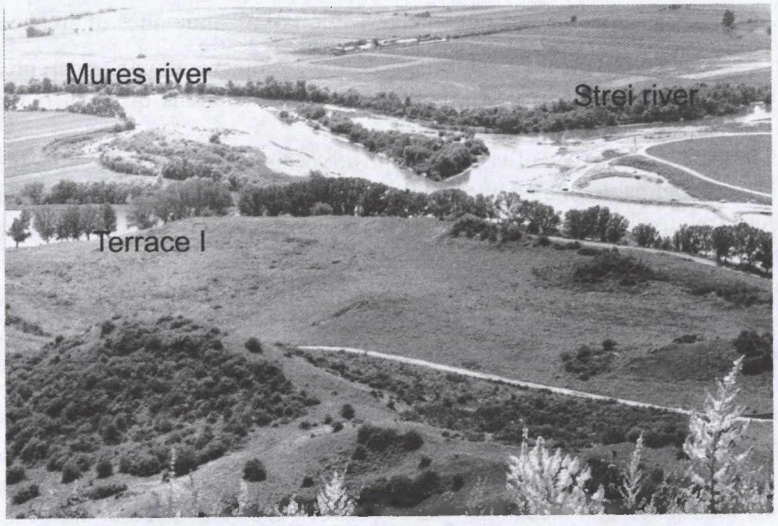

Fig. 1 – Terrace I, The Hallstatt settlement is placed on the terrace I situated at the confluence of Mures river with Strei river.

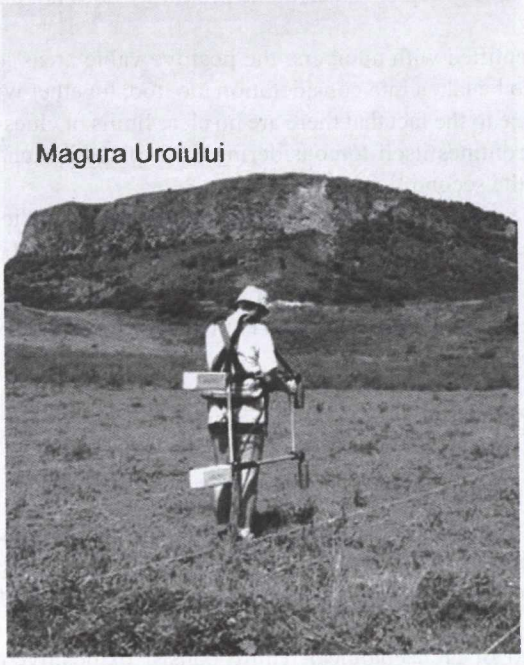

Fig. 2 – Equipment used during the prospecting activity.

Fig. 3 – Terrace I, The magneto-metric map, the magnetic gradient calculated, Alba Iulia Systemic Archaeology Institute.

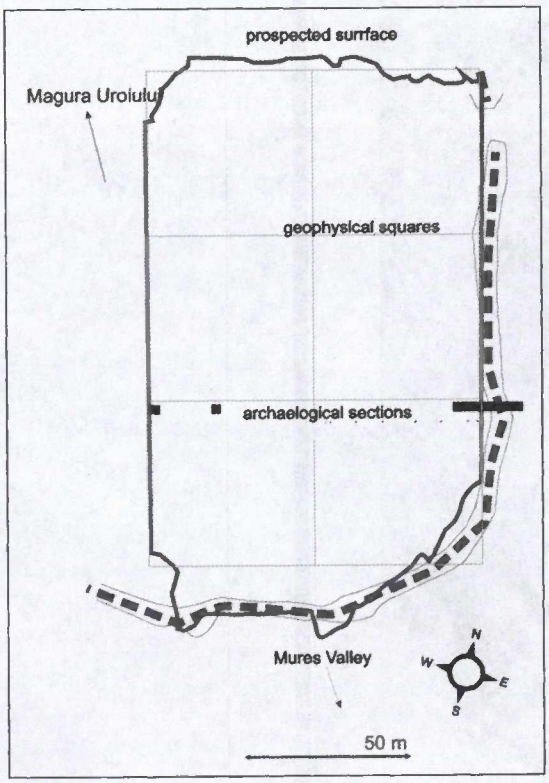

Fig. 4 – The approximate sketch of the prospected surrface within the Hallstatt settlement.

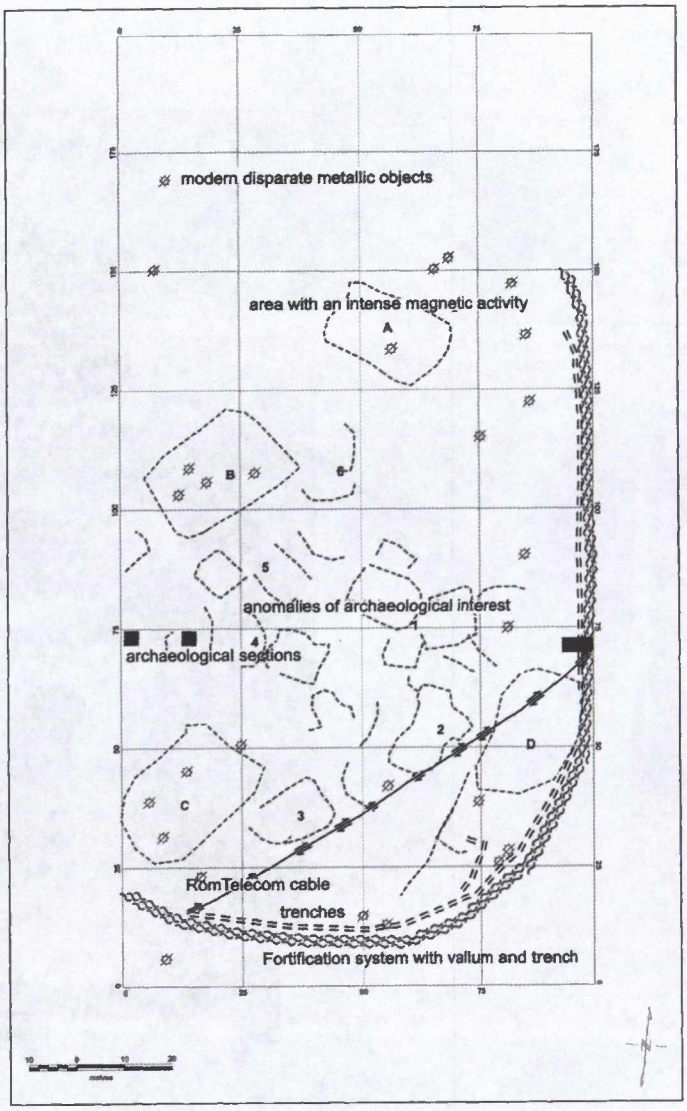

Fig. 5 – Terrace I, The Hallstatt settlement. The magneto-metric map, interpretative sketch. Alba Iulia Sy stemic Archaeology Institute.