Hašek, Vladimír; Petrová, Hana; Segeth, Karel

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VLADIMÍR HAŠEK-HANA PETROVÁ-KAREL SEGETH

GRAPHIC REPRESENTATION METHODS IN ARCHAEOLOGICAL PROSPECTION IN MORAVIA

1. INTRODUCTION

For processing of archaeogeophysical data, many different programs have been applied written for primary evaluation of the data, and for their qualitative and quantitative interpretation. Different types of personal computers are used for this purpose, mainly the IBM PC. This topic was previously treated in HAŠEK 1990, HAŠEK et al. 1988, HAŠEK -MĚŘÍNSKÝ 1989, HAŠEK-MĚŘÍNSKÝ-SEGETH 1990, HAŠEK-VENCÁLEK 1989, and HAŠEK-VENCÁLEK-MĚŘÍNSKÝ 1991.

In the present paper, attention is drawn to some new ways of graphic data representation. The results are used by archaeologists in reconnaissance prospection as well in detailed prospection of individual objects.

Application of these methods is demonstrated on an example of location of a primeval double circular object on satellite image of a locality in the vicinity of Brno.

2. THE PROCESSING METHODS APPLIED

Archaeological tasks as e. g. location of sites and drawing of the ground -plans of fortified settlements, etc. are treated using the two principal geophysical methods — magnetometry and the DEMP geoelectric method (HAŠEK 1990, HAŠEK-ZÁHORA 1991). Field data can be plotted on computers either in the classical form of isolines (ΔT, ρ^{DEMP}) — Fig. 1, i. e. derived maps, or in the form of shadow maps, and in axonometric form. It has been found out, that the latter are more useful for archaeologists that the derival maps.

That is why a package of programs was created for the IBM PC, DEC VAX and other computers for solving of these problems of graphic representation of the measured field anomalies.

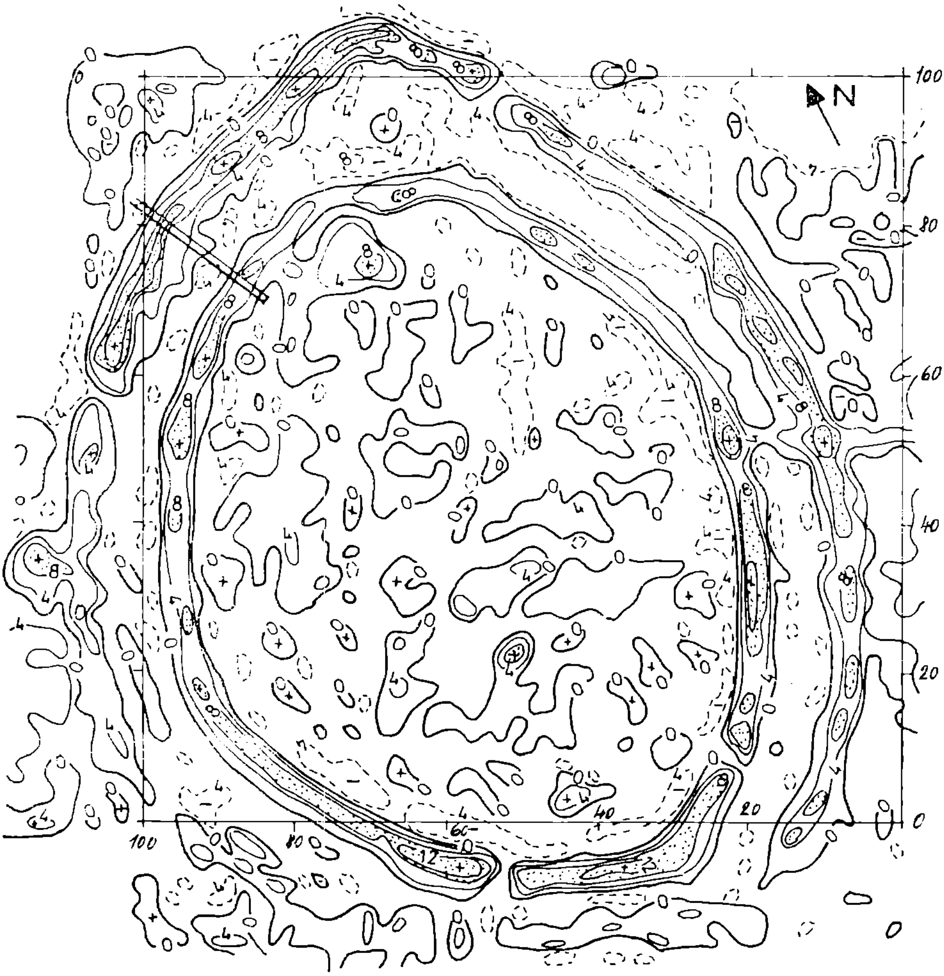


Fig. 1. Šumice, distr. of Znojmo. Map of $\triangle$T isoanomalies.

3. THE GENERAL PROCEDURE

Let us discuss the construction of shadow maps and pictures from perspective representation of the anomalies of the total vector of geomagnetic field by means of different methods.

The data obtained at individual points on profiles was

a) processed into ΔT anomalies,
b) recorded on a diskette in the form of X, Y, ΔT,
c) transformed to the binary file, SIT,
d) smoothed by means of linear interpolation and filtering using the routine ZJEMNI.

Then the graphic representation of the data was performed in the following steps:

1. On the IBM PC the program SURFER ACCESS SYSTEM, Version 4.15 was applied, part GRID for computing the network and part SURF for 3D representation. A figure was printed on the STAR printer and plotted on DIGIGRAF (Fig. 2).

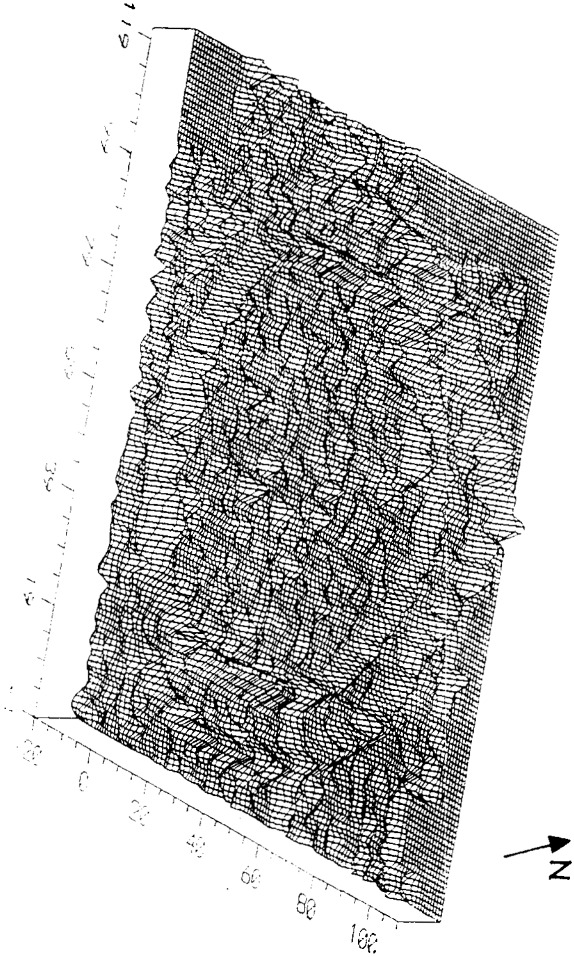


Fig. 2. Šumice, distr. of Znojmo. Axonometric representation of △ T anomalies (view from the south).

2. A figure was generated on the DEC VAX computer using the routine PLOTSIS and recorded on the magnetic tape. Subsequently, a colour map was plotted on the RDS-500 VERSATEC plotter using the routine VERSD. Each value was assigneed colour shade from a scale set in advance.
3. The basic data was processed by means of Fourier transformation and frequency filtering (Fig. 3 and 4) according to the procedure described in the next section.

3. 1. Fourier transformation and frequency filtering

The procedure used for the processing of the data is based on the discrete frequency filtering. The discrete Fourier transform (spectrum) of the data is computed by means of the fast Fourier transform and FFT. Then it is multiplied by the Sampled filter frequency characteristic, and the inverse transform is computer (again by means of the FFT). The processing is fast sue to the properties of the FFT algorithm.

Some false high frequencies could be introduced into the data if its values near the left-hand and the right-hand (or top and bottom) borders are substantially different. To prevent this unfavorable edge effect, the data is smoothed across the borders (BEZVODA-JEŽEK-SEGETH 1990).

Note that the frequency domain filtering is based on the discrete convolution theorem (BEZVODA-SEGETH 1981) expressing the relationship between the discrete data, the discrete filter and their discrete convolution. No discretization (and therefore no aliasing) is involved in the processing.

The most important feature of the frequency domain filtering is the possibility of implementing the discrete and the inverse discrete Fourier transform efficiently by means of the FFT algorithm (COOLEY-TUKEY 1963). The only condition when transforming the $M \times N$ data is that $M = 2^{\mu}$ and $N = 2^{\nu}$ where μ and ν are integers. If M and N are not intergral powers of 2, these numbers can be increased by adding the necessary number of zero rows and zero columns to the data. At the same time, the smoothing of the data near the borders is supported by this enlargement.

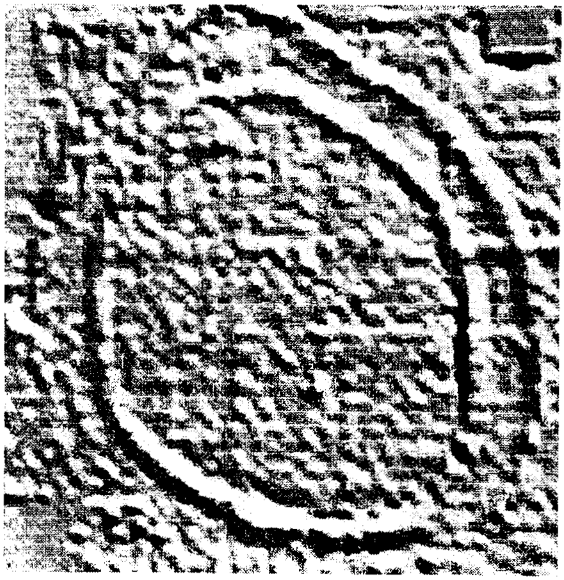
The data presented was processed using the FREDPACK package. The package was run on an IBM-compatible personal computer and is reasonably fast even for the 128×128 data items. It reads the data from the diskette and it can present them on a black-and-white or color display. A half-toned picture (ULICHNEY 1987) or a pseudographic (overprinted) picture (SCOLLAR-WEIDNER-SEGETH 1986) can be printed as well. FREDPACK consists of independent subroutines performing the individual steps of the processing. The detailed user-oriented description of the package as well as its source listing are dealt with in (BEZVODA-JEŽEK-SEGETH 1990).

In the processing, a weak low-pass filter (suppressing noise at high frequencies) was combined with a weak high-pass filter (suppressing the trend of low frequencies). No directional filter was applied since the data has a circular character, and no noise prevailing in any direction is apparent.

4. DISCUSSION

For comparison, magnetic data from the locality Šumice in the surroundings of Brno, an area of 110×120 m, network of 2×2 m was represented in the form of ΔT isoanomalies (Fig. 1), in perspective (Fig. 2), in the form of shadow mapscolour and in different tones of grey by Fourier transformation and frequency filtering (Fig. 3 and 4).

Evaluating the maps from the viewpoint of archeaeological interpretation of ΔT anomalies, we can conclude that almost identical results were obtained from both the colour shadow map and from its black-white version, the latter is more detailed in our case (e. g. the inner structure). The



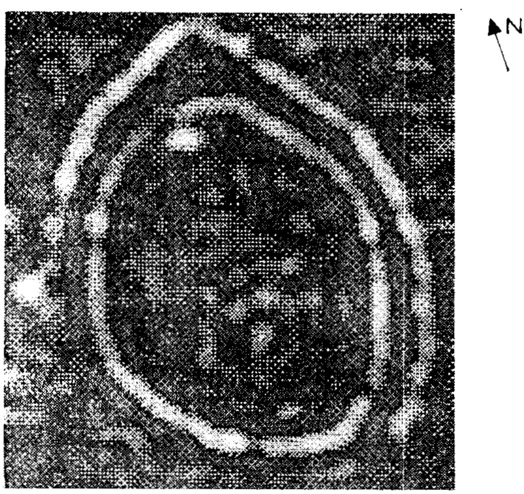


Fig. 3. Šumice, distr. of Znojmo. Shadow map constructed using the obtained data (according Slováková).

Fig. 4. Šumice, distr. of Znojmo. Shadow map-low frequencies partially smoothed, high frequencies-smoothed (approx. 1/2).

perspective 3D representation together with the map of ΔT isoanomalies can be of good use in practice though the intensity and size of the anomaly as well as the angle under which the data is observed are of increased importance.

4. 1. Geophysical interpretation of maps

Using all the maps to locate an archaeological object, we found out that there are two oval moats-inner with semi-axes 90 m and 75 m, striking from NNW to SSE, and outer with semi-axes approx. 120 m and 100 m. While the approx. 5 m wide inner moat is distinct in the geophysical picture (14 nT), the outer, of the same width approximately, (16 nT) is almost illegible on the southern and southwestern side. It cannot be excluded that it was nearly filled up during adaptations, or that it had never been finished.

The orientation and number of inputs in the given area are not regular. In the inner oval, three inputs were detected — on the southern, south -eastern, and north-north-western side. In the outer oval, there were found four inputs, in the NNE, WNW, S and SE direction. The main common input is assumed to be in the southern sector of the area of interest.

Inside the object, magnetic anomalies were found on the southern and south-eastern side (Fig. 4). These anomalies are presumably associated with the strike of a palisade groove (BÁLEK-HAŠEK 1993). It is assumed that the middle part of the object was densely settled.

4. 2. Archaeological evaluation of geophysical processing

Archaeological prospection carried out the north-western part of the interpreted object revealed two approximately parallel trapezoid moats, 5 m in width and 2,2 m in depth. According to the material found in them the object ranges to the Věteřov group of the later stage of the Old Bronze Age (BÁLEK 1991).

5. CONCLUSION

Of the described methods of graphic representation of the data on the IBM PC and on the DEC VAX computer the combination of colour shadow maps by means of Fourier transformation and frequency filtering appears to be the most useful for archaeologists. The representation may be enhanced by platting of results in perspective.

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