

Georadar test examinations on the place of mass execution - Donja Gradina

Spomenko J. Mihajlovic, Vasilije Belobrkovic, Vladimir Miletic,
Geomagnetski zavod, 11306 Grocka, Yugoslavia
(email: jbabac@yubc.net)

Translated by Gordana Babic

Introduction

Along with archeological searches, geophysical methods are used very often.. Geophysical methods are not destructive and because of this fact they are applied with the aim to define precisely the positions of archeological objects at which excavations were to be done. Georadar or Ground Penetration Radar (GPR) is modern geophysical apparatus that is applied in archeological searches for defining the position of archeological objects. GPR enables scanning under-surface terrain structure and extraction of objects (cultural, archeological, anthropological) which are compound part of examined complex. A great number of georadar examinations of archeological localities in the world can be specified, in our country georadar examinations are applied on archeological locality "Maskare" near Varvarin, there positions of various cultural objects were discovered.

The team of federal public institution the Geomagnetic Institute - Belgrade (*Geomagnetski zavod - Beograd*), in the period of 18th -22nd April, 2000, and in cooperation with the responsive ministry defined by the government of the Republic of Srpska and the Museum of Genocide from Belgrade, did georadar test examinations of mass graves on the area of Donja Gradina.

The application of georadar examinations of soil occupied with mass graves on the location of the place of execution Donja Gradina, has the aim to define morphological and structural characteristics of soil at the positions of marked (discovered) and potential mass graves. By georadar test examinations of soil's constitution of grave fields, mass graves are defined and marked off as the objects with increased concentration of osteological material (organic matter, bones, skulls, ash etc). With these characteristics, they represent environments with various values of electromagnetic field parametres (dialectic constants and electric condutiveness, above all) in relation to the same parametres of the surrounding terrain (substratum).

Georadar test examinations on the grave fields

The examination of composition of grave fields' soil, on location of Donja Gradina, was done by application of georadar system SIR 8, made by American company GSSI. Test measurements were done with the antennas of 500 MHz, 300 MHz and 100 MHz along the profile with the total lenght of 4500 m. Scanning range of 500 MHz antenna was 40 ns and antennas with 300 MHz and 100 MHz had scanning range of 100 ns. The antennas were moved by hand with the speed of 0.5 m/s, that provided obtaining informations about examined semi-space at each of 2 cm (since 25.6 impulses per second - 25.6 scan/s were emitted). During measurements, antennas were positioned directly on the surface of the examined terrain.

The processing and interpretation of measured data were done by application of software package RADAN, that enables digital filtering (FIR, IIR, space filtering, migration, deconvulation, abstract, filtering in domain of frequency, Hilbert's transformation ...), and various display of georadar scans, with the aim to emphasize important informations about composition of the terrain.

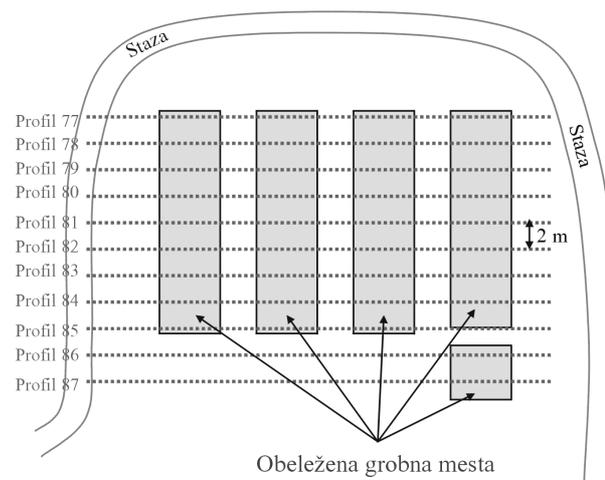
The results of examinations

The results of georadar examinations are shown on georadar profiles which are displayed on the sketches of the examined grave fields. At the vertical axis of georadar profile, on the left side, it is shown the value responding to the period during which electromagnetic wave should pass the way from emitter to some boundary plane (or object), reflects and reaches the emitter on the terrain surface (multiplied period, expressed in nanoseconds). The vertical axis on the right side of each profile represents estimated depth, expressed in meters. Horizontal axis responds to the distance that antenna covers and it is expressed in metres. In order to convert period scale into domain of depth, we should have data with values of speed of electromagnetic waves spreading for concrete, extracted environments. At this case, for average electromagnetic waves spreading it is given tabular value of 8 cm/ns. It is necessary to note that values of speed of electromagnetic waves spreading can be changed according to depth and side, depending on change of compound and saturation of soil by fluid (water or air). That is the reason why estimated depth must be taken with reserve, because it is necessary to do measurements over known objects of similar materials in order to get accurate value.

Georadar test examinations were done at three grave fields: "Jasen", "Topole" and "Orlovace".

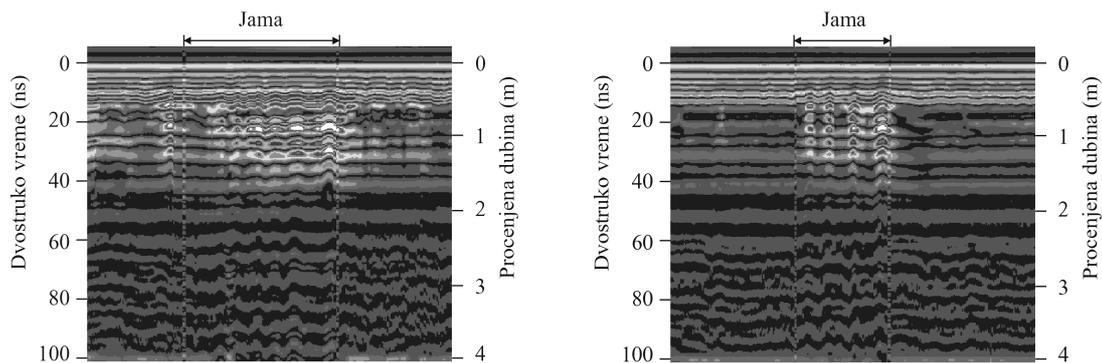
The results of examination on the grave field "Jasen"

The grave field "Jasen" is covered by the net of 10 parallel georadar profiles (situated at each of 2 m), made by antenna of 300 MHz (Scheme 1).



Scheme 1. Schedule of GPR profiles on the grave field "Jasen"

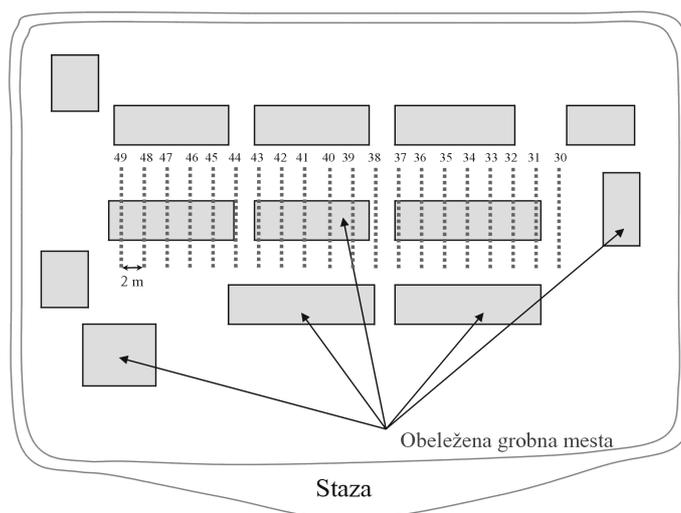
The antennas of 500 MHz and 100 MHz were also tested, but these results were not shown because their level of detectability was weaker at these terrain. On this grave field five graves were marked (their situation is shown at the scheme of grave field "Jasen", along with the situation of georadar profiles). Georadar profiles point at existing of anomaly of registered signal, in the most cases they coincide with content of graves. The density of registered appearances is not equal and it may be concluded that contents of graves are different. It should take into consideration that condition of decay of osteological material, substantially depends on given results. On georadar profiles under the number of 77 to 87, the zones of anomalies, which may respond to osteological material, are framed, so it can be followed their appearance in marked graves (Picture 1). Also it is shown momentary level of underground water.



Picture 1. Details on GPR profile 78 and 85

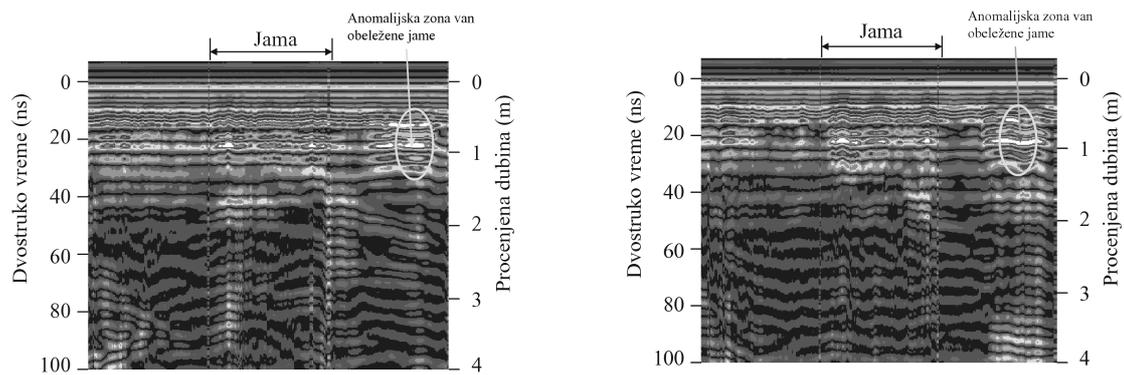
The results of examination on the grave field "Topole"

The grave field "Topole" is covered by the net of 20 parallel georadar profiles (also situated at each of 2m). It was used the antenna of 300 MHz. The processing and interpretation was done at similar way and georadar profiles concerning this grave field are under the number of 30 to 49 (shown at the scheme of grave field "Topola", Scheme2).



Scheme 2. Schedule of GPR profiles on the grave field "Topole"

Georadar profiles of 30 to 37, which cover first marked grave, show the absence of anomalies of high intensity, this is not the case with two other graves (Picture 2). Also, georadar profiles of 30 to 41, show anomaly out of marked grave (at the right side of grave), which should be certainly checked. This zone of anomaly spreads along with marked graves which length is about 24 m.



Picture 2. Details on GPR profile 32 and 33

On the grave field "Orlovaca" test examinations were also done, all of three antennas were tested. The result of those tests show that given data can not be certainly interpreted, because the level of detectability of demanded objects is much lower than on the two former fields. It can be the consequence of decay of osteological material, nearness of embankment of the river Sava, small differences in parameters of conductivity of surrounding area and demanded aims or extempore areas of terrain which ought to be examined. In this case, anomalies induced by moving of antenna over cockles and coarse sod, have similar intensity as the possible anomalies caused by the presence of osteological material.

Conclusion

Georadar test examinations shown that this methodology is applicable to detection of osteological material. Regarding to the period that passed and variety of composition of the examined area's soil, there is no doubt that osteological material is in a condition of decay. That is the reason why georadar examinations sometimes are simple and sometimes are complex, that depends on previously extemporality of terrain for scanning, then the season during which examinations are done (because of the level of underground water), and weather conditions.

Regarding complicity of geological situation of this area and its different condition of decay, suggestion for further examinations is to do detailed geophysical examinations in combination with georadar methods and the methods of geoelectrical scanning. These two methods are compatible and their result recruit each other. Previous experiences in the world and in our country, show that the combination of mentioned methods give the best results when we solve such problems.

Literature

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