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TRUFFES DETECTION USING GROUND PENETRATION RADAR

YER RADARI KULLANILARAK TRÜF MANTARININ BULUNMASI

Ali AYDIN[1], Ali KAYA[2], Erdal AKYOL[2]*

[1]Department of Geophysical Engineering, Engineering Faculty, Pamukkale University, Denizli, Turkey.
aaydin@pau.edu.tr

[2]Department of Geological Engineering, Engineering Faculty, Pamukkale University, Denizli, Turkey.
alikaya@pau.edu.tr, eakyol@pau.edu.tr

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* Corresponding author/Yazışılan Yazar
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Abstract

Honaz Mountain (Denizli-SW Turkey) has a mild and humid climate and it produces a rich flora in the area. As a natural consequence thereof, the study area offers a rich mushroom potential that is a rising economic value. In recent years, Ground Penetration Radar (GPR) is a relatively modern and effective and widely utilized technique for shallow subsurface exploration. GPR with 250 Hz antenna was employed to trace the tubers in Honaz Mountain area. To elucidate how the mushroom can reflect the signals, mineral composition of the mushrooms has been analysed. Percentage of K, Na, Ca, Mg, Fe, Al, P, S, Si, Cl minerals were significantly different from that of earth. This difference in element composition seems to cause the reflection of the signals. A large number of mushroom grooving areas have been detected during the study. The observed GPR data have been confirmed by the physical excavation. The study proposes that this method can be effectively employed to detect the natural mushrooms in the ground.

Keywords: Truffle mushroom, GPR, Tuber brumale vittadini

Öz

Honaz Dağı (Denizli-GB Türkiye) ılıman ve nemli bir iklime sahiptir ve bu alanda zengin bir flora oluşmuştur. Bunun doğal bir sonucu olarak, çalışma alanında yükselen bir ekonomik değer olan zengin bir mantar potansiyeli sunmaktadır. Son yıllarda, Yer Radarı (GPR) sığ yeraltı keşif için oldukça modern, etkin ve yaygın olarak kullanılan bir Jeofizik tekniktir. GPR sisteminin 250 Hz anteni ile Honaz Dağı bölgesinde mantar yumrularını izlemek için kullanılmıştır. Mantar sinyallerinin GPR yansımalarını aydınlatmak için, mantar mineral bileşimi analiz edilmiştir. Mantar içindeki K, Na, Ca, Mg, Fe, Al, P, S, Si, Cl minerallerin yüzdeleri, toprak içindeki minerallerden önemli ölçüde farklı idi. Element bileşimi içindeki bu fark, sinyallerin yansımasında farklılık şeklinde görünmektedir. Mantarlar profiler boyunca, çalışma sırasında tespit edilmiştir. Gözlenen GPR verileri üzerindeki mantar yerleri, fiziksel kazı ile teyit edilmiştir. Bu çalışma sayesinde, jeofizik yönteminin etkili bir şekilde toprak altındaki doğal mantarları tespit etmek için kullanılabilir olduğunu önermektedir.

Anahtar kelimeler: Truf mantarı, GPR, Tuber brumale vittadini

1 Introduction

Truffles are a rich source of nutritional benefits including vitamin D and C, iron, zinc, fibre and vegetable protein. Truffle mushrooms have amazingly fragrant and undeniably powerful flavour enhancers which are treasured for their exotic, sensual aroma and powerful flavour. So truffles, at the markets can be sold hundreds of dollars per kilograms and hunting is competitive. In Europe, Asia, Africa and America, truffles have been found association with the roots of specific trees and their fruiting bodies grow underground. They are round, warty and irregular in shape and vary from the size of a walnut to that of a man's fist and their season falls between September and May. Once discovered, truffles can be collected in subsequent years at the same site [1].

Ground penetrating radar (GPR) is a geophysical technique used in different branches of earth sciences, environmental archaeology, civil engineering which has become more accessible since the development of new portable radar technologies. In this study it was characterized firstly the underground tuber brumale, because there is not any record the searching the tubers by using the GPR. The GPR method was used in the study which allows identifying the tubers at the near surface. This geophysical method supports showing and detecting buried tubers distribution elements as well as other buried roots of tree in the study area. There are some studies for mapping shallow subsurface objects, the GPR method has been successfully used by [2]-[7].

This study has focused on applying the GPR technique for investigation of underground mushrooms which are known Tuber Brumale Vittadini in Denizli, Turkey. The selected several GPR profiles were acquired using a RAMAC system with a 250 frequency antenna which penetrates to the ground of about a meter in depth. This study provides a case study of the very practical exploration methods for the determining of the underground tubers buried.

2 Material and Method

2.1 Location Characteristics

The western part of Anatolia, which lies between the Aegean Sea and Central Anatolia, is called Turkish Riviera where the climate favors steppe formation in the inner regions. The mild and humid climate produces a rich flora in West Anatolia [8]. The study has been carried out in Honaz where is the highest mountain in the Aegean region and nearby the small town that is about 20 km from Denizli, Turkey (Figure 1). The average altitude of the study area is about 700 meters. The average annual temperature is 15.9 ^{0}C and the annual precipitation is 505.6 mm [9]. The weather occasionally be very cold with snow on the mountains that surround the city and it is hot in summers. Springs and autumns are rainy, mild climate, warm. In terms of vegetation, Honaz Mountain and its vicinity is called “Mediterranean-Agean Region” according to Walters classification [10]. The Honaz Mountain nestles two of 122 important plant areas of Turkey [11]. The area is also suitable for mushroom growing.

Tuber brumale is a truffle which is usually spherical in shape or a little lobed, with black or dark iron peridium, with very close, evident warts, hollow on the top and with longitudinal grooves. Its gleba is dark brown or greyish black with large white veins. It can easily grow to become larger than a hen's egg (Figure 2). It can be found in autumn and early winter under oaks and hazelnut trees. Its smell and taste are rather powerful but pleasant (in particular its variety moschatum ferry), so that this is the variety that is normally consumed. Tuber brumale; firm, solid, whitish at first, becoming gray-brown or gray-black at maturity, marbled with a few, broad, widely spaced, white veins that do not change colour when exposed to the air. Tuber brumale sometimes have more numerous and thinner veins, but you can distinguish from Tuber melanosporum veins because Tuber brumale veins remain always white. Tuber brumale is a very variable species which has led to the creation of many forms, varieties, subspecies and even new species. Strong, variable, pleasant like Tuber melanosporum odour, musky in Tuber brumale var [1].

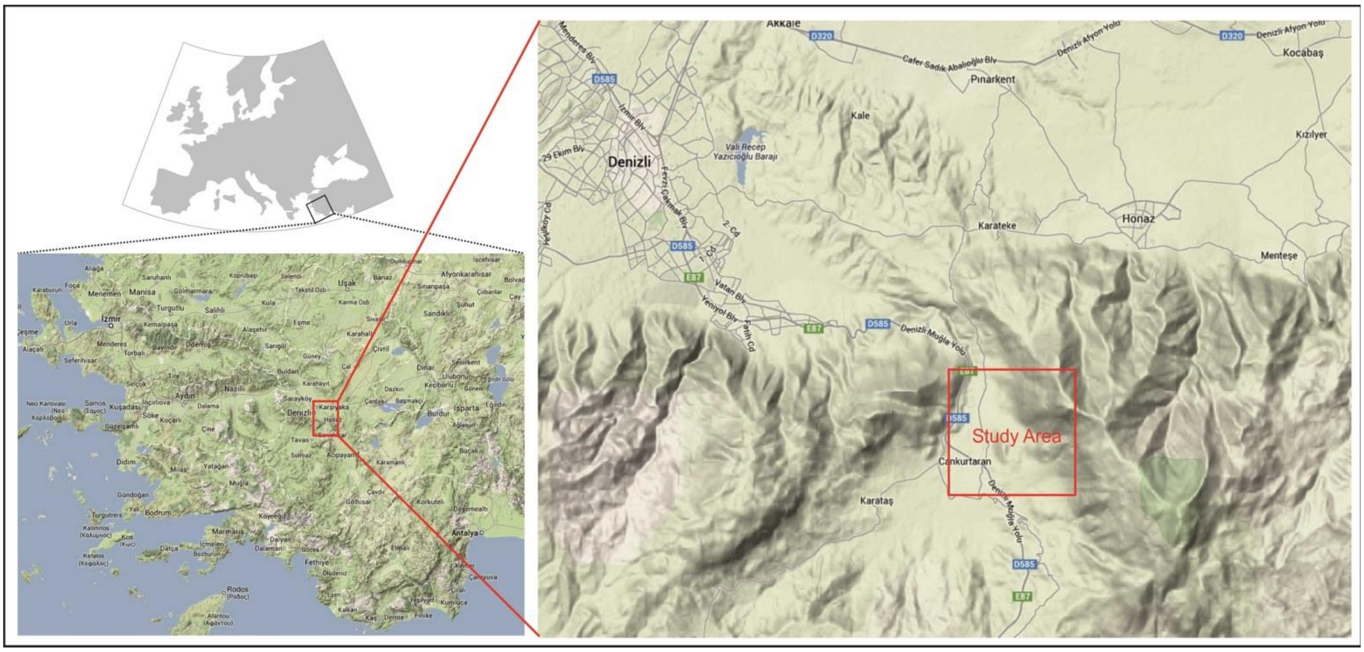

Figure 1: The location map of the study area (Google Maps).

Figure 2: View of the examined mushrooms.

The mushrooms in the study area are mainly characterized by firm, solid, whitish at first, becoming grey-brown or grey-black at maturity, marbled with a few, broad, widely spaced, white veins that do not change colour when exposed to the air, which were buried in the layers of limestone sediments (Figure 3). The dielectric permittivity contrasts between the underground mushrooms and the host media which is limestone sediment are given very useful information in order for possibly significant features identified in GPR sections.

Figure 3: Tuber Brumale Vittadini in the natural ground.

2.2 GPR and Site Description

A geophysical technique based on the propagation and attenuation of electromagnetic energy throughout underground, which is GPR method, is widely used to show the shape of shallow structures and objects. Its penetrations depth is very important and dependent on the dielectrical contrast of the subsoil and also the frequency of electromagnetic pulses. GPR technique designed transmitter antennas and collected after reflection in receiving devices based on the electromagnetic waves which are sent to the underground, and different the dielectric constants of the object or geologic formations will cause anomalies in the GPR records. Therefore the wave energy depends on the value of electrical conductivity of the geological units. GPR is a low cost method, instrumentation is relatively simple to use, and is highly recommended for the first recognition and evaluation to address further explorations.

A transmitter of the GPR system is used to send electromagnetic waves to the ground. Then the waves reflect from geologic interfaces because there is a dielectric contrast between the boundaries of the layers. The reflected energy produces a picture of the reflected waves that reflects the tomography of the underground. The electromagnetic energy is reflected very strongly from prominent dielectric interfaces and these waves are recorded by the receiver and it is used the arrival times and magnitudes of the waves. After the processing of the measurements, the traces are obtained that are from adjacent source locations which are generally plotted side-by-side to form an essentially continuous time-depth profile of the stream bottom and shallow sub-strata. Consequently, GPR records including the velocities of waves can be used to transform the time-depth profile into a depth- profile. The velocities in the sections of GPR are a function of physical properties of ground. GPR method can be used without any processing, but it is suitable for removing unwilling noise and enhancing the amplitude events of interest, after these steps, it can be uses the horizontal filtering, the velocity corrections, the distance normalization, the horizontal stacking, the gain, the migration and the vertical frequency filtering.

A RAMAC system with a 200 frequency antenna is employed for this study on the researching profiles (Figure 4). Data acquisition of each profile was done at 200 scans/m, 1024 samples/scan and 8 bits/sample. We used the filtering processing using an acquisition Infinite Impulse Response vertical filter. The filter was ranged from 200 MHz low pass and 5 MHz high pass with 5 stacking rate. After this processing, the GPR sections are suitable for interpretation (Figures 4 and 5). Two GPR profiles provided by the University of Pamukkale, Department of Geophysics are analyzed using seismic data processing techniques by REFLEX software. Processing operations performed on these data include signal saturation, gain recovery, spiking deconvolution, bandpass filtering, and normal moveout corrections.

Figure 4: GPR profile measurements in the field.

2.3 In-Situ Survey

Two GPR profiles, called Profile-1 and 2, were recorded in the dry season to avoid as much as possible water content and thus affect penetration. The filtered radargrams are shown in Figure 5 and 6. It is possible to distinguish objects very easily even in unprocessing GPR radargrams sections.

The tubers have very important variable electric and electromagnetic properties in sediment soil medium. Using the GPR in the as study is an effective measuring method with high spatial resolution. GPR measurements were carried out on soil and limestone soil surfaces which are classed according to soil properties such as conductivity, dielectric permittivity, electric conductivity and soil electrical properties allows using geophysical exploration to detect the presence of such vegetables under the ground.

Table 1 gives chemical compositions of truff melanosporun and around sediment in which includes element oxides and element ratios. When considering the tuber and sediments ratios, the tuber has higher values of Na, K and P than the sediment. Sediment values give high anomalies at Ca, Fe and Mg. So, the chemical composition differences between two materials are obvious.

GPR radargrams images included noise using of higher frequency sources and some of GPR sections contain discontinuous stratification in the uppermost layers, which contrasts with a rapid signal attenuation below about 0.5 meter depth or 15 ns.

In edition distinctive features in the GPR radargrams present close correspondence with surfaces, we showed the place of the tubers on the radargrams such as cycle.

Table 1: Chemical composition of Truff melanosporun and around sediment are given element oxides and element ratios.

Tuber				Sediment			
Oxide	%	Elements	ppm	Oxide	%	Elements	ppm
K_2O	28.1	K	2.3				
Na_2O	9.1	Na	77.0			Na	10.0
CaO	1.4	K	526.0	CaO	27.3	K	187.0
MgO	2.9	Mg	23.8			Mg	135.0
Fe_2O_3	2.3	Ca	24.0			Ca	6040.0
Al_2O	5.3	Fe	3.5			Fe	24.1
P2O5	34.7	P	62.0			P	1.5
SO_3	3.0	Cl	27.7	NO_2	0.15	Zn	0.8
Si_2O	1.3				Mn		33.1
ClO_2	2.3				Cu		5.0

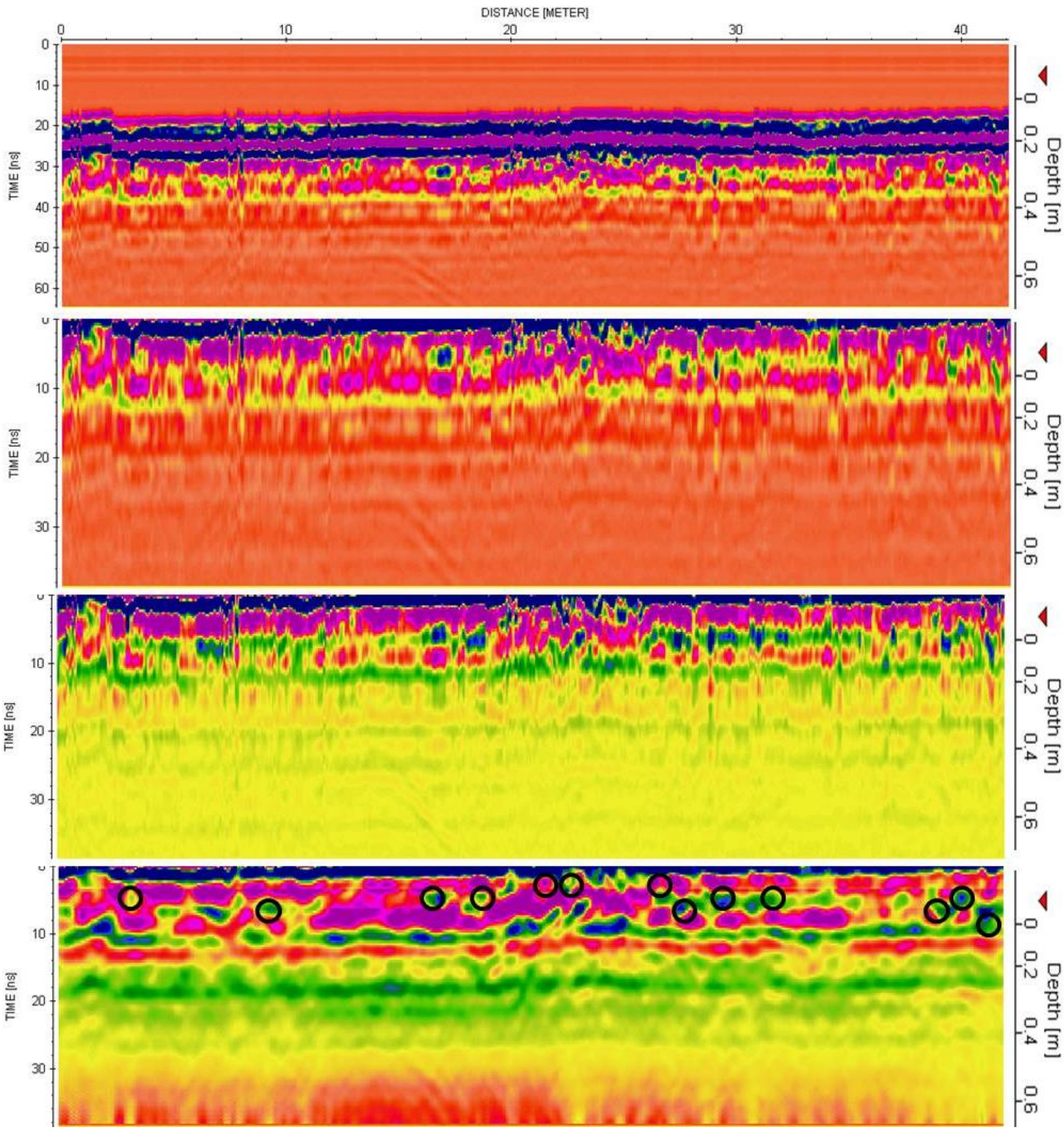

Figure 5: GPR radargram of Profile-1 (fist section) and possible position of the truffles (marked in circle) and data processing techniques from above to below are move smart time, spiking deconvolution, bandpass filtering, and f-k migration.

We selected the only part of the profiles for including tubers. As seen the section of the GPR in Figure 5 the tubers are signed the cycles. The same signs are used on the other radargram sections. Tubers in the Profile-1 were seen on the gramradar section in Figure 5 at 85, 106, 116, 118, 119, 143, 145, 146, 149, 157 and 158 m. In the Profile-2 (Figure 6), the tubers can be traceable at 7, 34, 38, 44, 65, 68, 79 and 89 m. In the gramradar section it was seen very much same size stones along the profile.

GPR data obtained from buried tubers which is identified that: hypogeous, subglobose or irregular in form, tuberiform, lobed, often with a basal depression, 2-5 cm in size, warted, black, sometimes reddish at base of warts. Warts 1-3 mm across, usually smaller than those observed in Tuber melanosporum, pyramidal, 5-6-sided, flattened, often depressed at the apex, vertically fissured. The radar sections have indicated the anomalies characterized by hyperbolic reflections or rings with high amplitude waves where the tubers under the ground. The observed GPR sections were confirmed after the excavation of the area, allowing the identification tubers. GPR is a very effective method for identifying potential and hunting the tubers.

3 Conclusions

The mild and humid climate produces a rich flora in West Anatolia in where Honaz Mountain is located. Consequently, the study area offers a rich mushroom potential that is a rising economic value. In recent years, GPR is a relatively modern and effective and widely utilized technique for shallow subsurface exploration. GPR was employed to trace the structures such as roots and tubers in Honaz Mountain area and its vicinity.

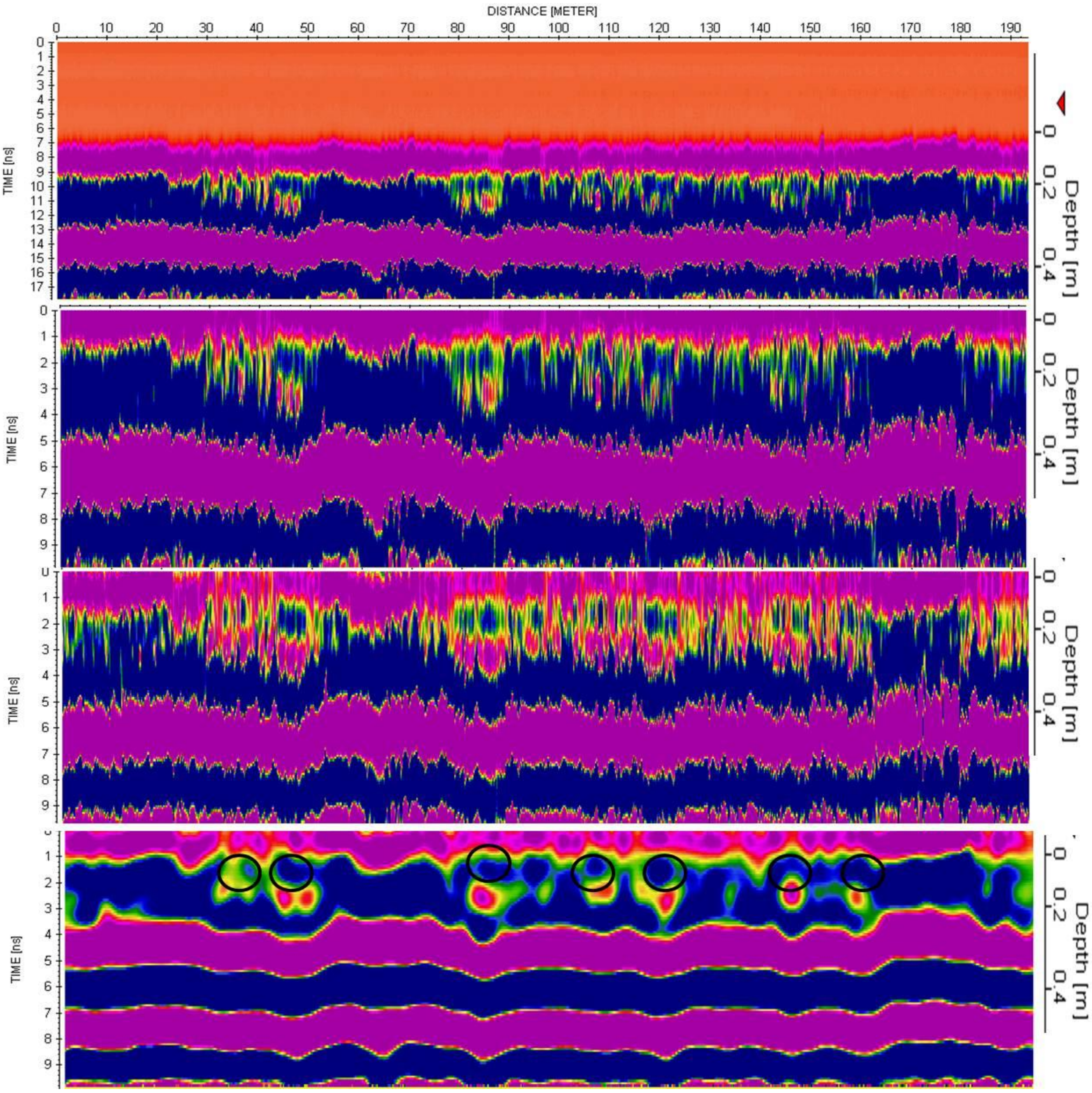

Figure 6: GPR radargram of Profile-1 (fist section) and possible position of the truffles (marked in circle) and data processing techniques from above to below are move smart time, spiking deconvolution, bandpass filtering, and f-k migration.

Mineral composition of the mushrooms have been analysed to clarify how the mushroom can reflects the signals. Percentage of K, Na, Ca, Mg, Fe, Al, P, S, Si, Cl minerals were significantly different from that of earth. This difference in element composition seems to cause the reflection of the signals. In study area, a large number of mushroom grooving areas have been detected. The observed GPR data have been confirmed by the excavation of the area. They are hypogeous, subglobose or irregular in form, and 2-5 cm in size. The study has proved that GPR is a powerful tool to find the locations of the tubers in the ground.

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