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Investigating the War Traces With Near Surface Geophysical Methods: Anzac Bay (Çanakkale)

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Abstract
The Çanakkale Land and Naval Battles are of great importance in terms of the intensity of the war, the size of the geography in which it took place and its duration. During the landing at Anzac Bay on April 25, 1915 and their retreat, the Allied Powers left behind their ammunition and equipment without taking them with them, either by burying them or destroying them. For this reason, the locations of all the traces and remains of the battle are still not clearly known today. Thanks to the technological innovations developing today, the detection of war remains buried underground is determined by near surface geophysical studies to be carried out in the determined regions. In the study area, traces of the war, such as trenches, buried underground, were detected with GPR, in 5 different regions, over a total area of 32000 m². In addition to geophysical studies, UAV flights were used to detect many structural remains of war (such as trenches, pits) that cannot be detected visually from the ground, and the UAV method applied with RTK-GPS was also used as a base for GPR measurements. As a result of all these processes, the anomalies detected during the measurements in the study area were identified and marked as on the map.

Keywords: *Çanakkale Wars, Anzac Bay, GPR, UAV, War Archaeogeophysics.*

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I. INTRODUCTION

The Arıburnu Landing was the landing made by the Anzac Corps on April 25, 1915 on the Aegean Sea coast of the Gallipoli Peninsula, on and around the beach that would become known as "Anzac Bay" (Figure 1a). The approximate locations of the battles that took place after this landing are indicated on maps drawn by Şevki Paşa (Figures 1b and 1c). In order to examine the locations shown on these maps in detail and to determine their current and actual locations and to form a basis for geophysical studies, images (Figure 1d) and a general view of the aerial photograph of this region (Figure 1e) were created with UAV (Unmanned Aerial Vehicle) for its high resolution image.

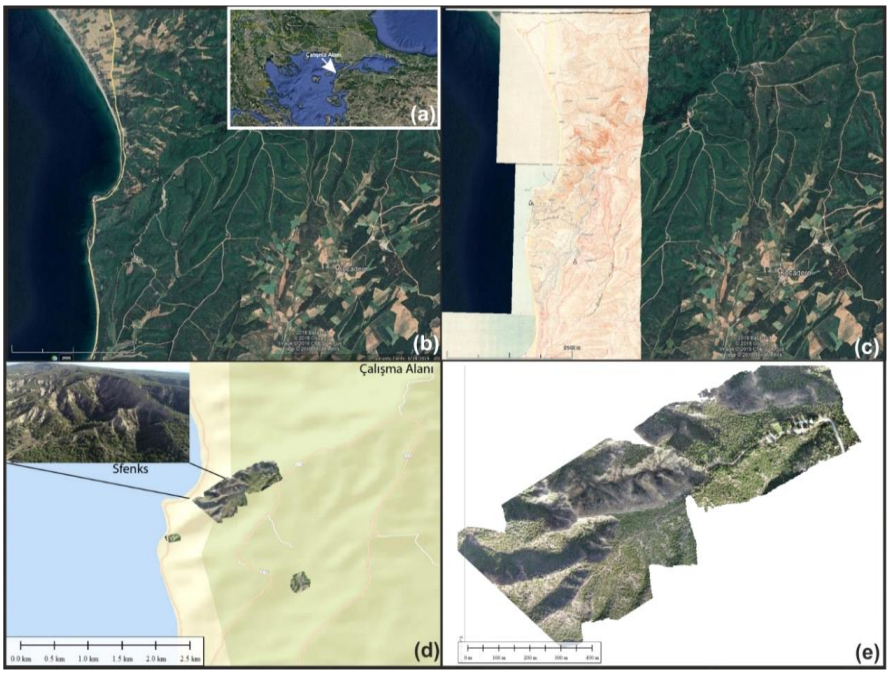

Figure 1: (a-b) Location of the study area on Google Earth image (c) Şevki Paşa map overlaid on current aerial photograph (d) Study area around Anzac Bay and Sphinx Cliffs (e) UAV orthophoto around Anzac Bay and Sphinx Cliffs.

II. MATERIALS AND METHODS

First of all, detailed topography of the land was created digitally by comparing aerial and satellite photographs with topographic maps. In support of this, very high-resolution topography and orthophoto of the measurement areas were created with the photogrammetric studies applied with UAV (Unmanned Aerial Vehicle). In this way, the locations of the geophysical measurements to be applied were clearly processed in the digital environment. The GPR Method, which is one of the near surface geophysical methods, provides a significant advantage in areas requiring investigation without damaging the measured area. Ground penetrating radar (GPR) is a highly effective and widely used geophysical method in archaeological sites and cultural heritage research [2 -6]. The GPR method is used in many fields today due to its easy applicability, high sensitivity and non-destructive effect on the measured ground [1]. In order to obtain high-resolution images up to a depth of approximately 6 m, scans were performed with the MALA 450 MHz HDR PRO and high resolution RTK-GPS device with measurements applied in both horizontal and vertical directions (Figure 2).

Figure 2: GPR measurement applied in the study area.

III. RESULTS

In the study area, GPR measurements were carried out in 5 different regions, in a total of 15 locations and on a total area of 32,230 m² (Table 1). High resolution UAV (Unmanned Aerial Vehicle) images of the surveyed areas are shown in Figure 3.

Table 1. List of all measured regions and areas

		X (m)	Y (m)	Area (m²)
Zone 1	Area 1	40	15	600
	Area 2	6	35	210
	Area 3	9	45	405
	Area 4	7	68	476
	Area 5	10	40	400
	Alan 6	7	34	238
	Alan 7	7	112	784
	Alan 8	5	34	170
	Total			**3283**
Zone 2	Area 1	8	238	1904
	Area 2	10	238	2380
	Area 3	10	263	2630
	Total			**6914**
Zone 3	Area 1	47	30	1410
	Area 2	8,5	100	850
	Total			**2260**
Zone 4	Area 1	1	5589	5589
	Total			**5589**
Zone 5	Area 1	1	14184	14184
	Total			**14184**
General Total				**32230**

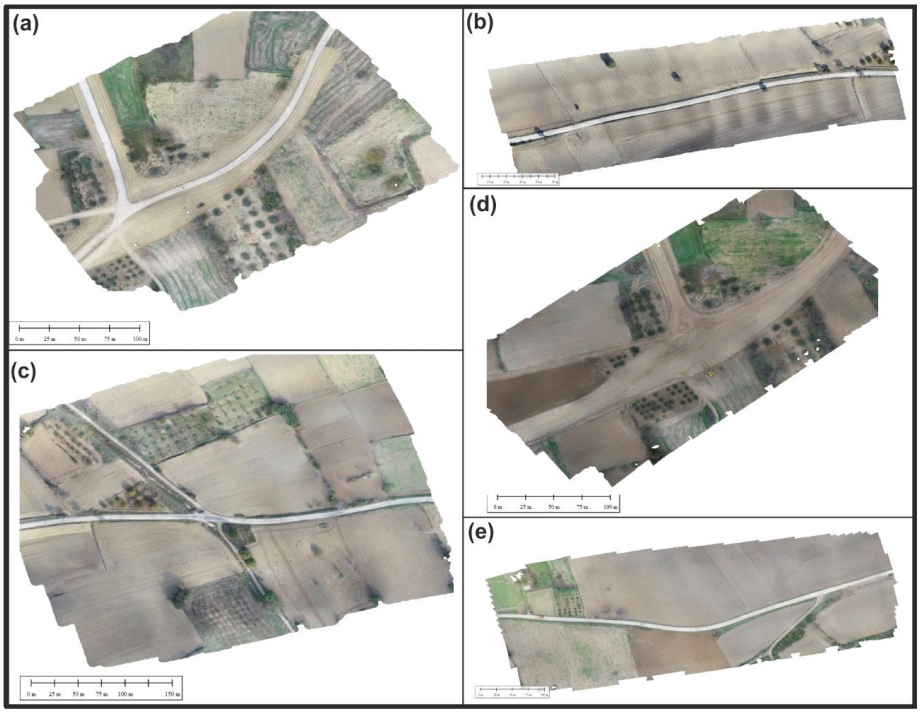

Figure 3: Drone images obtained from 5 different locations in the study area

In Zone-1, a total of 8 different areas were measured and prepared as depth slices (Figure 4 a-h). In the depth slices, the depth at which the trench structure is best visible is given as a plan view (Figure 4 a′-h′).

In Zone-2, measurements made in 3 different areas were prepared separately as depth slices (Figure 5 a-c). In the depth slices the depth at which the trench structure is best seen is given as a plan view (Figure 5 d-f).

In Zone-3, measurements made in 2 different areas were prepared separately as depth slices (Figure 6 a, b). In the depth slices, the depth at which the trench structure is best visible is given as a plan view (Figure 6 c, d).

Measurements made in one different area in Zone-4 were prepared as separate depth slices (Figure 7a). In the depth slices, the depth at which the trench structure is best seen is given as a plan view (Figure 7b).

Measurements made in one different area in Zone-5 were prepared as separate depth slices (Figure 8a). In the depth slices, the depth at which the trench structure is best seen is given as a plan view (Figure 8b).

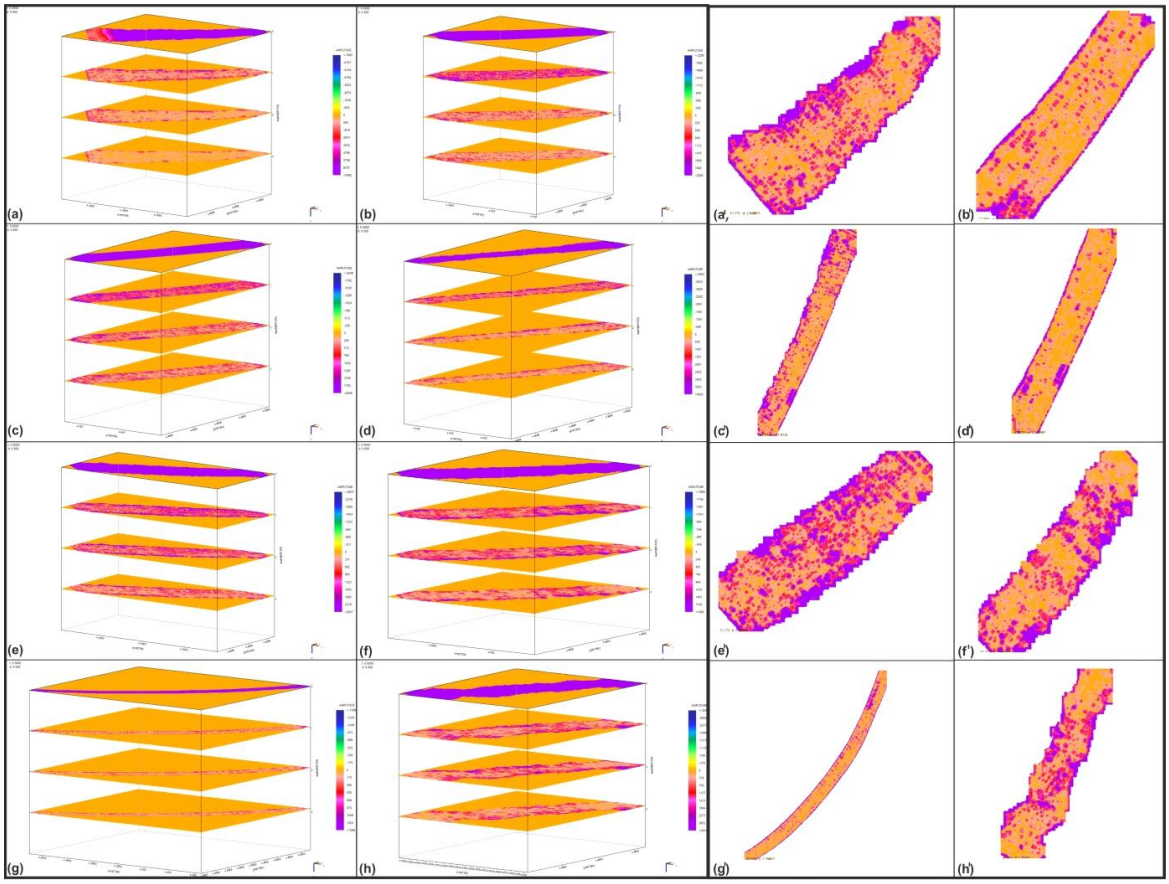

Figure 4: (a-h) Depth slices prepared for the measurements carried out in a total of 8 different areas in Zone-1 and (a′-h′) optimal depth sections selected for the measurements). (a-a′) Zone-1 area 1, (b-b′) Zone-1 area 1, (c-c′) Zone-1 area 3, (d-d′) Zone-1 area 4, (e-e′) Zone-1 area 4, (e-e′′) Zone-1 area 1. zone 2, (c-c′) zone 1 area 3, (d-d′) zone 1 area 4, (e-e′) zone 1 area 5, (f-f′) zone 1 area 6, (g-g′) zone 1 area 7, (h-h′) zone 1 area 8 (dark areas correspond to anomaly).

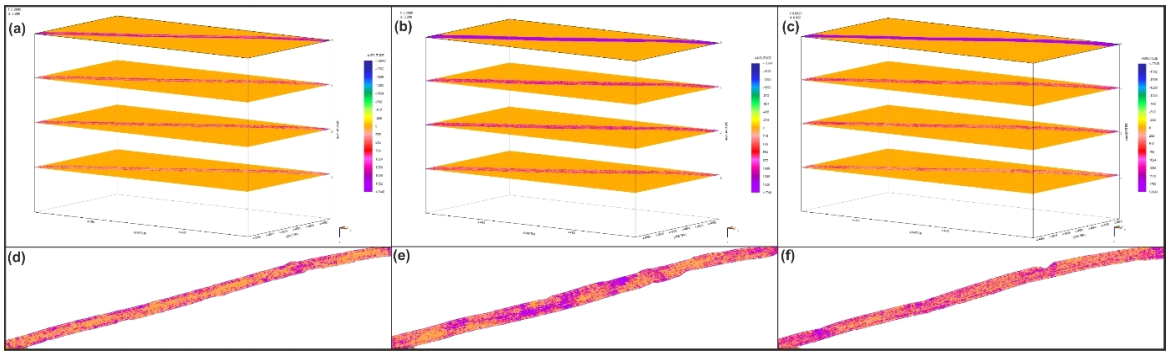

Figure 5: Depth slices prepared for measurements in 3 different areas in Zone-2 (a) Zone 1, Area 1, (b) Zone 1, Area 2, (c) Zone 1, Area 3. Selected best-fit depth slices (d) Region 1 Area 1, (e) Region 1 Area 2, (f) Region 1 Area 3 (dark areas correspond to anomaly)

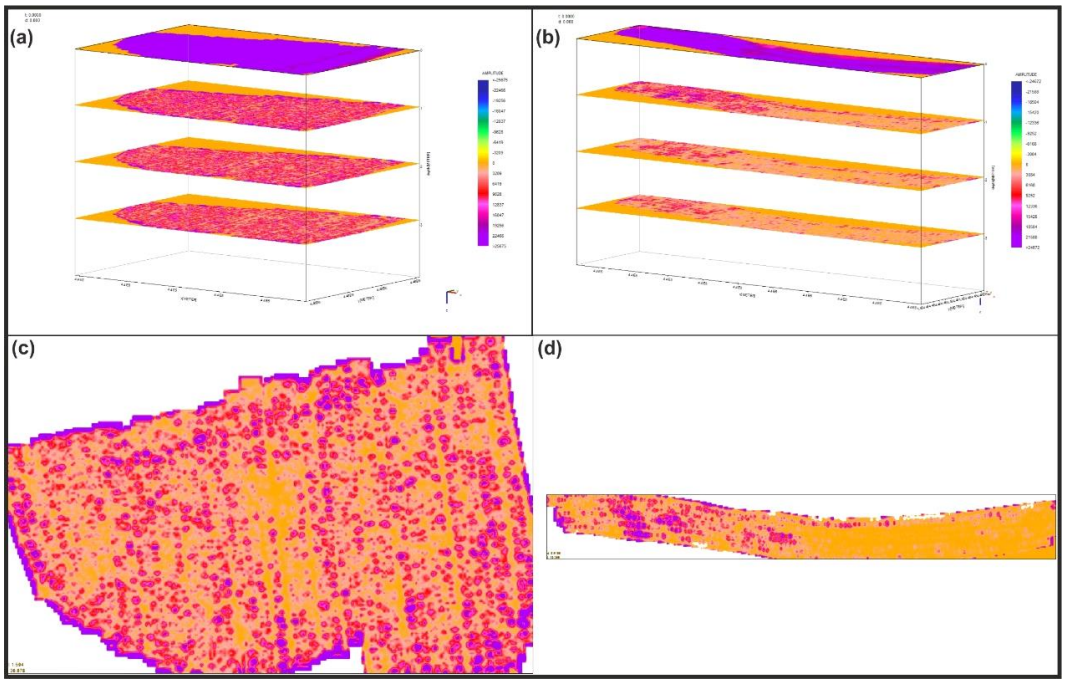

Figure 6: Depth slices prepared for measurements in 2 different areas in Zone-3 (a) Zone 1, Area 1, (b) Zone 1, Area 2. Selected best-fit depth sections (a) Region 1, Area 1, (b) Region 1, Area 2 (dark colored areas correspond to anomaly)

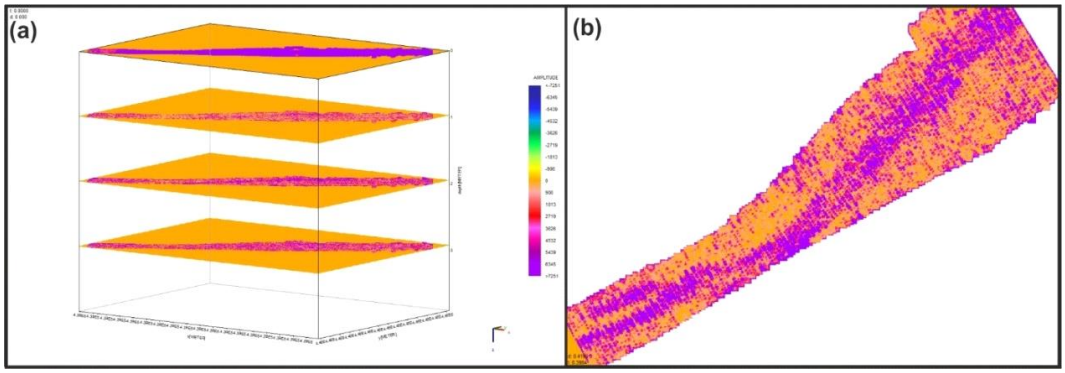

Figure 7: In Zone-4, (a) depth section prepared for the measurement (b) selected optimal depth slice (dark areas correspond to anomaly)

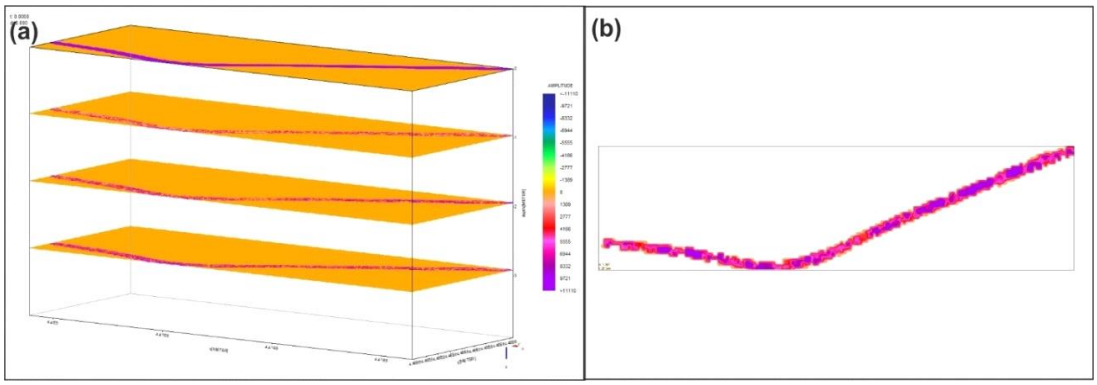

Figure 8: In Region-5, (a) depth slices prepared for the measurement performed (b) selected optimal depth section (dark areas correspond to the anomaly)

IV. DISCUSSION AND CONCLUSION

Nowadays, with the effect of developing technology, the importance of near surface geophysical studies in the detection of structures buried underground is increasing. In this study, in and around Anzac Bay, where the Çanakkale Land and Naval Wars were intensively fought, GPR was used to identify the buried structures of the war, such as trenches. These studies were carried out in 5 different regions over a total area of 32000 m².

The anomalies obtained from the measurements made in five different zones were mapped coordinately together with drone photos and GPR data (Figure 9). The results obtained are as follows;

The anomalies detected during the measurements in all regions were identified and marked as trenches.

The depths of the possible trench structures identified were around 220 - 260 cm on the existing road and 170 - 210 cm in the fields off the road.

Especially in the locations called Zone 1 and Zone 4, the anomaly depth from the existing ground is around 150 - 170 cm even though the stripping work of the new road to be constructed has been carried out.

Since the soil structure on the anomalies detected in the depth slices is loose in the form of vegetation and fill, it is thought that the trench areas were filled in time for field-style use and used for agricultural activities.

In the light of all these data, indications that can be defined as "Possible Martyrdom" around Şahindere Martyrdom were obtained at a depth of approximately 240 cm. The studies conducted in the area called Lone Pine were carried out to investigate the locations of the tunnel structures thought to be used in the communication of the trenches. As a result, the structures thought to be tunnel structures were identified at a depth of 150 cm.

In this study, high-precision geophysical and UAV studies carried out within the borders of the Gallipoli Peninsula, where the Çanakkale battles took place, shed light on issues that were previously little or no information about. Due to the large size of the study area, the targeted goal was achieved with the studies carried out in only 2 different locations. In the continuation of this coordinated multi-disciplinary study, it will be possible to shed light on more unknowns by investigating new areas.

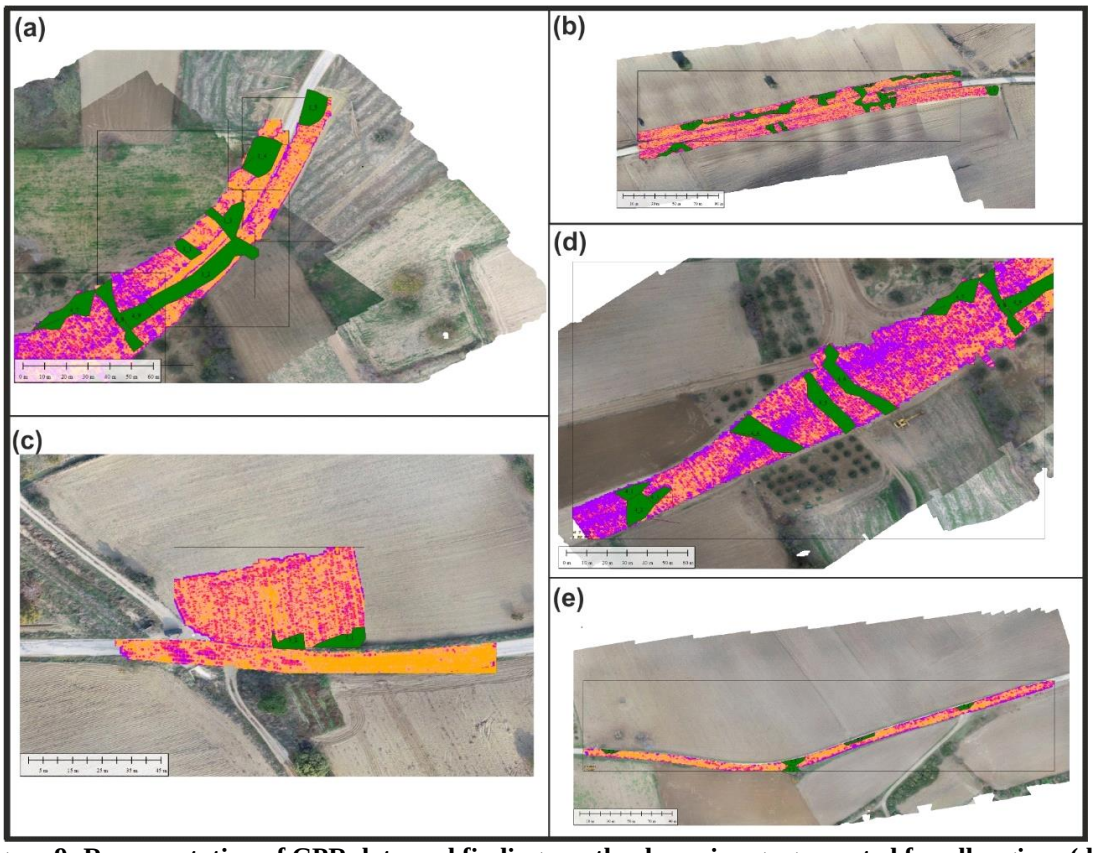

Figure 9: Representation of GPR data and findings on the drone image generated for all regions (dark green areas correspond to anomalies).

ACKNOWLEDGEMENT

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