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Editorial

Geophysical Surveys for Archaeology and Cultural Heritage Preservation

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Abstract: The knowledge that archaeological prospection is shaped by modern attitudes and procedures is important to the future of archaeology. Although geophysical studies have been applied to archaeological and historical sites over time with intermittent success, it is possible to derive great effects when used appropriately. It is most significant when applied in a well-integrated research design where interpretations are established and explored. The representation of survey data involves the knowledge of both archaeological evidence and the way it is stated in geophysical terms. Proper instrumentation, study design, and information processing are important for success, and these must be adapted according to the specific geology and archaeological evidence of each survey location. In this context, the regulation of information quality and spatial quality are important. This Special Issue of the Heritage journal expects to accumulate unique research articles on geophysical surveys for archaeology and cultural heritage preservation.

Keywords: archaeology; cultural heritage; geophysics; preservation; remote sensing; GIS

1. Introduction

Geophysical survey data function as important indirect information for locating archaeological sites and advance new views while investigating existing heritage sites. It can improve early-career geophysicists' understanding of fundamental geophysical procedures through hands-on field-based information acquisition with ground-penetrating radar (GPR), magnetometry (M), and electrical resistivity techniques (DC). In recent years, geophysical investigations have grown impressively in terms of instrumentation, information handling, representation strategies, as well as processing and combined systems. Together with remote sensing (RS) and geographical information systems (GISs), it is being progressively incorporated into archeological examinations as the best arrangement, being quickly pertinent, productive, non-destructive, and requiring minimal intrusive effort.

This Special Issue on Geophysical Surveys for Archaeology and Cultural Heritage Preservation plans to feature the latest advances in geophysics concerning archaeology and heritage around the world, highlighting novelty and advanced works. The use of all the principle procedures of geophysics in a wide scope of archeological targets is considered. Geophysical study is accustomed to making maps of subsurface archaeological characteristics. Geophysical tools may observe buried characteristics when their physical attributes contrast measurably with their surroundings. In some cases, various smaller artifacts may be observed. Interpretations taken in the systematic design turn into a dataset that can be depicted in the form of depth maps. Study results are used to dig, explore, or monitor sites and to give archaeologists insight into the pattern of the non-excavated components of these sites [1].

Unlike other archeological methods, geophysical study is neither invasive nor destructive. For this reason, it is frequently used to prevent the disruption of culturally sensitive sites (e.g., cemeteries) or protected heritage.

In view of the need to create a common platform for the preservation of cultural and archaeological heritage, and arguing that geophysical prospection techniques have to become an inseparable component of the archaeological investigation process, this Special Issue presents recent work, experimental research, case studies, and projects on archaeological prospections, remote sensing, and GIS in archaeology and cultural heritage.

2. Ground-Penetrating Radar Investigation of Corvin Castle (Castelul Corvinilor), Hunedoara, Romania

In this article, Isabel Morris and colleagues have illustrated geophysical research at the Corvin Castle, located in Hunedoara County (Transylvania). This castle is an important Romanian cultural site. Originally a fort constructed in the 14th century, it was first converted into a castle by Ioan de Hunedoara in the 15th century, frequently changing owners (with significant construction in the 15th and 17th centuries) until it was abandoned in the mid-19th century. After undergoing various ill-fated reconstruction attempts in the late 19th century, the castle reopened in the 1950s when the Romanian government renewed its interest in cultural sites and undertook a series of sparsely documented archaeological investigations and conservation projects. Presently, restoration efforts require the renewed investigation of Corvin Castle's construction and history. Ground-penetrating radar (GPR) is a promising tool for investigating the construction phases of heritage structures such as Corvin Castle, where invasive methods are inappropriate and extensive historical modification has left incomplete records. In 2017, a comprehensive GPR survey of the castle was conducted. The survey recognized features mentioned in texts, discovered previously unknown construction phases, located areas of moisture ingress around the courtyard, and identified the extent and composition of the building foundations. Information gained from these scans, especially combined with printed sources, is an asset to the planning of restoration efforts and the understanding of the effects of past modifications [2].

3. Searching for the History of Ancient Basilicata: Archaeogeophysics Applied to the Roman Site of Forentum

Here, Luigi Capozzoli and colleagues have described the results obtained using an archaeogeophysical-based approach for discovering new Roman structures belonging to the ancient settlement of Forentum, which is currently identified by a well-preserved sanctuary that dates back to the third century BC. The investigated area has been affected by invasive human activities that have partially damaged the Roman structures. Extensive geophysical measurements, including detailed ground-penetrating radar (GPR) investigations supported by magnetometric data, have allowed for the identification of an impressive complex of structures comprising various buildings. Magnetometric and electromagnetic anomalies suggest the existence of an "urban" dimension close to the Gravetta Sanctuary, totally buried and unknown until now, organized into regular patterns in a similar manner as the most famous site in the vicinity of Bantia or the famous Apulian archaeological sites of Ordona and Arpi [3].

4. Cultural Routes in Kynouria of Arcadia: Geospatial Database Design and Software Development for Web Mapping of the Spatio-Historical Information

Lampros Boukouvalas and colleagues have used the site of Kynouria (Greece) in order to secure the protection and projection of antiquities and propose a web-based model for highlighting individual monuments and archaeological sites, keeping in mind the historical and archaeological evidence of the region, the topography, the demographic profile, the tourist infrastructure and combining them with the development programs for cultural routes. Therefore, creating suitable databases and mapping the monuments in the area are key prerequisites in the process, as they contribute to an objective assessment of the current situation and aid the making of rational management decisions. In this framework, modern technology provides some important planning tools (GIS, GPS, and OMS) that allow for the recording and mapping of data, viewing the relationships between them in the area where they appear and managing their projection. The complete study of Kynouria's archaeological routes contains the implementation of a website using free or open-source software, which should include all the necessary procedures and the historical and archaeological information material (text, maps, and photographs) [4].

5. Non-Invasive Moisture Detection for the Preservation of Cultural Heritage

In this technical note, Pier Matteo Barone and Carlotta Ferrara have highlighted the relevance of moisture damage. It is the most critical issue in the preservation and integrity of cultural heritage sites. Electromagnetic (EM) sensitivity to the presence of moisture, in both soils and structural materials, is a well-known phenomenon. Thereby, studying the EM response to the presence of moisture, in order to prevent damage to sites of cultural heritage, is a well-established method. This paper discusses the ability of a geophysical non-destructive technique (NDT), present in a ground-penetrating radar (GPR) system, to investigate a very precious building in Rome that is affected by a moisture problem (the Turkish Room at Villa Medici). This geophysical instrument is capable of locating and estimating the extent of water ingression, which can aid the development of restoration plans before permanent damage occurs. The main objective of this paper is to help restorers understand the related hazards caused by the presence of moisture in the wall structures, in real-time, and to rapidly and non-invasively develop strategies for the preservation of cultural heritage sites [5].

6. Bombed Archaeology: Towards a Precise Identification and Safe Management of Dangerous Unexploded Bombs from WWII

In this short communication, Pier Matteo Barone has illustrated a future project related to bombed archaeology. The massive bombings during World War II (WWII) have had a lasting impact across the Italian landscape. The problem of dangerous unexploded bombs is particularly relevant since the bombsites are buried beneath the soil close to inhabited and/or touristic areas. Archaeological sites, such as Pompeii and Vulci, were heavily bombed, and now archaeologists excavate these bombs during their digs. Thus, there is a real risk to people's safety. While the aerial photo collection is a powerful record of the landscapes of wartime Italy, plotting buried unexploded bomb hazard maps remains important in identifying their precise location in the modern landscape. Ground-penetrating radar (GPR)—a non-destructive technique (NDT)—can help detect these bombs buried beneath the soil by providing an accurate horizontal and vertical position. Using aerial photos and NDTs, such as GPR, this future project explores the WWII human experience to preserve and manage the safety of both the archaeological heritage and involved users by using the data to create an open-access WebGIS platform [6].

7. DGPR for the Non-Destructive Monitoring of Subsurface Weathering of Sandstone Masonry

In this article, Brian Johnston and colleagues have analysed how remote sensing techniques, such as LiDAR and photogrammetry, are used by researchers exploring the spatial distribution of weathering features in historic masonry. These well-established tools provide users with a perspective of the processes affecting the surface of masonry blocks. However, they cannot provide information on the alterations occurring subsurface. Geophysical tools are being explored as a potential approach to observe the variation in material properties beneath masonry block surfaces and to examine the patterns of deterioration across wall sections. Applying such techniques informs the development of conceptual models of weathering at the block to building wall scale. In this study, ground-penetrating radar (GPR) was selected to inspect the subsurface condition of the wall section of an historic church wall, where areas of granular disintegration and flaking can be observed. 3DGPR was selected for this task, as its use of regular grids during data collection makes it better suited for detecting features within an area. Three high-frequency antennas, 1.2 Ghz, 1.6 Ghz, and 2.3 Ghz, were run across the study area in a series of 80 cm by 80 cm grids. The data were collated within GIS, where observed features were annotated onto a schematic of the wall surface. The 3DGPR outputs identified anomalies within this structure that could not have been as easily interpreted using a 2DGPR transect. However, as 3DGPR relies upon interpolative techniques to estimate the returns between observation transects, the validity of features detected in these locations needs to be tested. The results of this application of 3DGPR identified variable weathering responses across the wall section, relative to elevation. These observations were used to develop a conceptual model linking these findings to seasonal variations in the capillary rise of groundwater, upward from the base of the church wall. Through these findings, it is possible to see how GPR can assist in developing our understanding of the processes threatening heritage buildings [7].

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