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The Mass Grave Project

An interdisciplinary approach to the archaeology of mass graves

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ABSTRACT

The shockingly frequent occurrence of mass graves resulting from conflict and mass violence comprises a significant humanitarian and social crisis. In addition to serving as tangible evidence of deep trauma, large-scale criminal acts and violation of human rights, mass graves pose complex and challenging archaeological contexts for investigation. The large numbers of deceased individuals and personal effects found within these graves require specialized forensic archaeological excavation techniques and meticulous documentation methods to safeguard evidence of crimes committed. However, mass graves as archaeological contexts are still poorly understood, with uncertainties surrounding the preservation of remains and the recovery of important evidence. These knowledge gaps affect the identification, documentation and recovery of victims found in mass graves.

The Mass Grave Project is an interdisciplinary experiment simulating clandestine mass and single graves at the outdoor forensic research facility managed by the Forensic Anthropology Center, Texas State University. By enhancing scientific understanding of mass graves as complex and dynamic archaeological contexts, the project seeks to advance the field of forensic archaeology. Specifically, the project aims to advance methods of detection, 3D documentation, and excavation of mass graves, as well as the identification and time-since-death estimation of the deceased individuals within them. Furthermore, the project seeks to provide training opportunities for students and practitioners in excavation and recording techniques, both through fieldwork and the development of innovative 3D Virtual Reality training tools.

Improving scientific understanding of mass graves ensures the preservation of vital evidence of historical events and tragedies. Besides immediate importance for criminal prosecution and humanitarian purposes, such evidence is essential to the development of memorialization practices at conflict sites. Furthermore, improved identification and time-since-death estimation contribute to peacebuilding and reconciliation efforts by providing accurate data on victims of conflict.

Keywords: Forensic Archaeology, Conflict Archaeology, Humanitarian Forensic Action, Mass Graves, 3D Visualisation, Forensic Biology, Forensic Chemistry, Remote Sensing, Actualistic taphonomy.

1. THE MASS GRAVE PROJECT

Globally, there is significant prevalence of clandestine mass graves resulting from gross human rights violations, conflicts, and social and political turmoil (Human Rights Council 2020). The forensic and humanitarian investigation of such sites faces numerous challenges, which impede opportunities for methodological advancements in the forensic archaeological excavation of mass graves. Due to the

evidentiary status of the remains in real forensic cases, along with severe time and money constraints, pursuing scientific innovation during case investigations is limited: using new (unvalidated) methods could negatively affect the acceptance of evidence in court. Furthermore, devising appropriate excavation strategies and interpreting archaeological traces in mass graves requires deep understanding of the variables determining the preservation and spatial patterns of the remains. The numerous factors affecting the condition and position of human remains and personal items recovered from mass graves are poorly understood. The large numbers of deceased individuals and personal effects in such graves require specialized forensic archaeological excavation techniques and meticulous documentation methods to safeguard evidence of criminal acts (Haglund, 2002; Hanson et al. 2023).

Whether (pre)historic or forensic in nature, mass graves invariably are uniquely challenging archaeological contexts to excavate and interpret. Mass graves are complex deposits due to the fact that they contain the remains of multiple individuals, often with a high rate of skeletal disarticulation and commingling of bodies and body parts. This makes identifying which remains belong to each individual and documenting each body a very difficult process (Haglund 2002). The intricate arrangement of human remains and other materials in mass graves results from the human actions and natural processes during and after burial: taphonomic processes. These include all processes that affect the preservation of remains of an organism after death, such as weathering, fragmentation, human and animal activity, as well as body decomposition processes such as putrefaction, skeletonization and disarticulation. These combined natural processes and human actions can modify and bias the archaeological record. Understanding them is therefore essential to accurately interpreting the remains.

The challenges outlined above also hinder the development of practical and efficient training programs in excavating and documenting evidence. Ensuring high-quality training is available to investigators tasked with the recovery of human remains from mass graves is crucial given the complex burial conditions they encounter, and because of the non-replicable nature of the archaeological excavation and documentation process. Without comprehensive documentation, the spatial context of remains and critical evidence will become lost during excavation. There is a pressing need for versatile and research-based training tools that can be rapidly (and remotely) deployed.

The Mass Grave Project is an interdisciplinary research project that aims to advance the development, evaluation, and validation of scientific methodologies for investigating mass graves (Mickleburgh et al. 2022; 2023a; 2023b; 2023c; Mickleburgh & Wescott 2021). Building on this, it also seeks to develop innovative educational opportunities for students and practitioners in forensic archaeological excavation and field recording methods. The project regards mass graves as unique archaeological and evidential contexts shaped by numerous interconnected factors influencing the condition of recovered evidence, such as local soil type and weather conditions, the manner of disposal of bodies by perpetrators, and the number of deceased individuals placed in graves. Its interdisciplinary framework plays an important role in understanding the dynamic interaction of these different variables and their impact on physical evidence. This understanding is essential for determining the most suitable investigation methods and training tailored to mass graves.

Improved expertise in mass grave investigation ensures the preservation of material and immaterial evidence of historical events and tragedies. In addition, the project provides valuable insights into the alterations in landscapes resulting from conflicts and genocides. Beyond the immediate significance for criminal prosecution and humanitarian forensic action, such information and evidence play an important role in shaping memorialization practices at conflict sites (UNESCO 2021).

Figure 1. Preparations for the Mass Grave Project experiments. San Marcos, Texas, May 2021.

1.1. Aims and objectives

The aims and objectives of the Mass Grave Project are organized within the project's four research pillars: Detection, Documentation and 3D Visualization, Identification, and Education and Training.

The results will be used to generate recommendations for excavation, documentation, sampling and analysis protocols. Furthermore, 3D scanned data from experimental graves are being used to create realistic virtual training environments and visualize the unique complexities of mass graves as archaeological contexts. Actualistic experimental forensic research, such as the Mass Grave Project, provides the opportunity to collect data in a safe and secure research environment with strict ethical research review procedures [1], test and validate cutting-edge techniques, and develop realistic, research-based training materials.

1.1.1 Detection

Robust and reliable remote and non-destructive (i.e., without excavating) methods of locating mass graves are important as logistical restrictions and security issues can mean that land-based or destructive techniques are not always feasible or desirable options. The Mass Grave Project contributes to existing research on the (remote) detection of mass graves by monitoring landscape/soil/vegetation changes throughout the experiments using remote sensing and geophysical techniques, and by evaluating the validity and reliability of these methods to detect the presence of a mass grave with human bodies throughout decomposition.

1.1.2. Documentation and 3D Visualization

Mass graves are complex deposits with a large "body mass", disarticulation and commingling of bodies and body parts, and sometimes secondary disturbance, removal and redeposition of remains in attempts to conceal crimes (Barker et al. 2017). These factors can impact the documentation and

[1] Body donations studied at the Forensic Anthropology Research Facility (FARF; the human taphonomy facility managed by FACTS located in San Marcos, Texas) are acquired for scientific research purposes, through the expressed and documented willing of the donors and/or their legal next of kin. The body donation program complies with all applicable legal and ethical standards associated with scientific research on human remains.

interpretation of evidence in mass graves. Digital 3D data capture and 3D visualization methods allow researchers to study complex spatial relationships and provide new ways to reconstruct events leading up to burial, or to simulate hypothesized sequences of events. The Mass Grave Project uses photogrammetric 3D recording techniques to document complex mass grave deposits, with the aim to examine the effects of mass burial on the (commingled) arrangement of human remains and evidence, and to devise protocols for rapid and reliable 3D documentation of deposits with multiple commingled remains.

1.1.3. Identification

Precise and accurate estimation of post-mortem interval (PMI) and age-at-death is crucial in the investigation of unidentified human remains and can assist with identification of the deceased. This project continues the development and test the validity and reliability of biomolecular techniques (proteomics, metabolomics, lipidomics, microbiomics) for PMI and age-at-death estimation, with a specific focus on skeletonized and commingled remains (Mickleburgh et al. 2021). Isotope forensics has been widely applied to establish geographic origin of unidentified deceased individuals and aid identification. Yet, the effects of decomposition and diagenesis on the antemortem isotopic signature of different body tissues (hair, nails, bone, teeth) are not yet fully understood (Kootker et al. 2022; 2023). The Mass Grave Project compares the pre- and post-burial isotopic composition of human tissues and soil from mass and individual graves and examines how diagenesis and sample processing methods affect isotopic ratios.

1.1.4. Education and training

The complex taphonomic environment of mass graves, and the fact that the destructive process of excavation means evidence must be immediately recorded appropriately, requires a high level of training from partners involved in mass grave excavation. The data resulting from the different pillars of this project, in particular “Documentation and 3D Visualization”, will be used to develop a 3D virtual training tool for use in training forensic investigators and university students. This interactive tool will convey 3D information relating to mass grave taphonomy and excavation and will act as a visual teaching aid to demonstrate the complexity of retrieving evidence from contexts with multiple commingled remains. It will include various virtual interactive modules providing guidance on choices that are made in the field, such as decisions on excavation strategy, based on features visible at the surface, expected size of the grave and number of bodies within, information from informants, field surveys, and time and logistical constraints. The virtual tool will provide a safe environment in which users can develop skills to deal with the emotional responses to stressful situations. Moreover, because training in a virtual environment is easily repeatable and scalable, and supports learning and memory retention, it can be deployed to many contexts with fewer logistical hurdles than current learning initiatives. The tool will be developed with sustainable use and straightforward interface in mind, i.e., without dependence on commercial hosting platforms or expensive and logistically cumbersome equipment. It will be developed to be used on common devices including desktop computers, laptops, tablets and smartphones, and will allow the possibility to be expanded in a modular fashion, for example to include a module on managing the protection and restriction of access to the site area.

The tool will be tested in collaboration with the International Commission on Missing Persons (ICMP) Archaeology and Anthropology Division (AAD) and the ICMP Center for Excellence and Learning (CEL), during training of local partners and stakeholders worldwide (e.g., Iraq, Mexico, Libya, Armenia, Ukraine), and will subsequently be made available to other international humanitarian organizations.

1.2. Methods and Approach

The Mass Grave Project uses an interdisciplinary approach to generate a better understanding of the unique physical properties and dynamics of mass graves and harness this information to improve investigation and training related to mass burial locations. The project approach uniquely combines archaeology, forensic taphonomy, soil sciences, remote sensing, and 3D data capture and 3D visualization, to examine the environmental and taphonomic variables in experimental mass graves over the course of multiple years.

Macroscopic changes over time to the burial environment as well as the human remains and objects and materials in the graves are monitored through 3D documentation of body donors (CT scans), graves (photogrammetry), and the environment of the experimental graves (360º and UAV photogrammetry). This provides photorealistic 3D models and surface topology for highly precise analysis of the changes in the spatial arrangement of remains which pose challenges to archaeological excavation and interpretation. These data support the development of protocols for practical, rapid, accurate and reliable 3D documentation of complex burials with multiple commingled remains. In addition, they provide realistic and accurate information for the development of interactive virtual learning environments.

The microscopic changes over time to the burial environment as well as the human remains and objects and materials in the graves are studied through analysis of grave soils and human tissues. Changes or fluctuations in soil chemistry and soil microbiome, as well as temperature, moisture, pH, and other variables associated with body decomposition are studied using methods from soil sciences and molecular sciences. Experimental graves are recorded using remote sensing, including imaging spectroscopy and thermal imaging, as well as geophysical methods, including ground penetrating radar, and electrical conductivity resistivity. These results are compared to other variables to clarify the relation between soil and vegetation changes and spectral and geophysical signatures for detection of graves. Analysis of the isotopic signature of soils and human tissues before and after burial is used to examine the reliability of isotopic signatures derived from deceased individuals for estimation of their geolocation before death. Changes in bone protein, lipid, metabolite and microbiome profiles over time are studied to understand the relation between these profile changes and the time since death.

2. RESULTS TO DATE

While the Mass Grave Project is still ongoing, initial results from the four pillars of the project demonstrate how studying mass graves as unique archaeological and evidential contexts using an interdisciplinary approach provides important information for archaeological surveying, planning of excavations, and wider forensic investigation strategies (Mickleburgh et al. 2023a; 2023c).

Geophysical analysis of the experimental graves, including ground-penetrating radar (GPR), electrical resistivity tomography (ERT), and electromagnetic (EM) techniques, shows that electromagnetic imaging is good at isolating anomalies associated with buried human remains in the first days after burial and electrical resistivity combined with ground penetrating radar is useful for longer timeframes. The findings underscore the effectiveness of geophysical methods in forensic investigations to locate graves and monitor the decomposition process of buried human remains (Doro et al. 2022a; 2022b).

Biomolecular analysis of the human tissues and soil revealed differences in microbial activity between single and mass graves. This could help explain the different rates of body decomposition observed in mass graves, which in turn can improve time since death estimations in mass burials (Procopio et al., 2022). The results also showed higher levels of human DNA preservation in mass graves compared to single graves (Gino et al. 2024; Mickleburgh et al. 2023b).

Preliminary remote sensing results include a distinct thermal signature of 3-4 degrees Fahrenheit difference between the mass grave and its surroundings, in the initial months of the experiments. This heat signal is most visible immediately before dawn before the environment warms up. These findings underscore the importance of finding the correct time window to fly the UAVs to detect graves effectively. Individual graves did not show a similar heat signal initially, suggesting the best time window for detecting these graves has not yet been established or they may not produce a visible heat signal due to the smaller volume of these graves (Mickleburgh & Wescott 2021).

Three-dimensional data capture of the experimental graves was conducted successfully throughout the experiments. Data capture was found to be time efficient and had a limited impact on working procedures during excavations. A description of the data collection protocol is currently in preparation. Furthermore, prototype 3D virtual reconstructions of the experimental graves demonstrate how 3D technology can advance the study of mass graves beyond standard 3D data capture excavation (Mickleburgh 2024).

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