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Experiments to detect clandestine graves from interpreted high resolution geophysical anomalies

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Abstract

This collaborative ongoing project is being used to assist the geophysical search for mass graves in Colombia. This is a pressing problem here. Previous research by colleagues have found optimum geophysical equipment and configurations vary, depending upon target and a host of site specific factors.

Here, we are creating 8 simulated clandestine mass graves in sites with different geography, soil and climate in Colombia. These are the Marengo farm located in the town of Mosquera, Cundinamarca, and the Universidad de los Llanos, located very near of the city of Villavicencio. The graves will contain both pigs and other objects at depths of 0.80 m and 1.20 m below ground level that are average for discovered burials. Near-surface geophysical methods, including ground penetrating radar, electrical resistivity, conductivity and magnetometry, will be used to temporally survey these every 8 days during the first month, 15 days in month 2-3, and monthly from months 4 to 18 post-burial. Data collected will be processed to map the mass graves and the corresponding spectral correlations with favorability indices. The variable depth of the mass graves, burial time, soil texture and rainfall will also be accounted for, to validate the methodology and for results to be compared with other sites and forensic cases.

The project integrated geophysical survey results will support search for mass graves and thus help find missing people who have been illegally buried to bring perpetrators to justice and provide familial closure.

Methodology

This collaborative project will create animal and human mass graves as simulated atrocity victim burials in two sites in Colombia (Figure 3). These have deliberately contrasting bedrock, soil types and climate, and thus will provide some appreciation of the variabilities of potential grave sites in Colombia. There will be mass graves created in different scenarios but at average discovered burial depths (~0.8 m – 1.2 m) to make them consistent with real cases. Mass grave simulations have not been undertaken to-date globally.

The mass graves will be repeatedly surveyed using multi-frequency Ground Penetrating Radar (GPR), fixed-offset (0.2 m) electrical resistivity methods, bulk ground conductivity and gradient magnetometry methods, to determine optimum technique(s) and equipment configuration(s). They will also be surveyed over time, as collaborative colleagues have shown results are temporally variable, which seems to be due to varying conductivity of decompositional fluids and seasonal changes (Figure 2).

Preliminary Results

Results should show the usefulness (or otherwise) of bulk ground conductivity surveys to provide initial datasets to pinpoint anomalous areas for subsequent, more detailed geophysical investigation, optimal GPR detection frequencies, electrical resistivity anomalies that temporally vary and the use of gradient magnetometry results.

Conclusions

Although forensic geophysics has some way to go before being accepted as a standard tool of choice for forensic investigators, this research will continue to improve the knowledge of geophysical methods for searches, and particularly in Latin American depositional environments. Further research is needed to firm up current search workflows (Figure 4) and improve our understanding in different settings (Figure 5).

References

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Introduction

Forensic geophysical research is rapidly evolving to assist forensic and crime investigators to detect a host of illegally buried material (see Pringle et al. 2012a). The successful detection of murdered victim(s) in clandestine graves is often critical to obtaining a successful criminal conviction and to provide familial closure. Sadly, at present successful detection rates are low, with a variety of methods utilised (see Pringle et al. 2012a). Often, poor selection of search technique(s) and/or incorrect sequential procedures can be causes of search failures.

International collaborations between forensic geophysicists is starting to produce results in a variety of cases, from the so-called IRA 'Disappeared' victims found on beaches in Northern Ireland (see Pringle et al. 2012b) to detection of Civil War mass graves in Spain that is currently ongoing. Undertaking long-term geophysical monitoring of simulated clandestine graves is starting to provide both sequential datasets for comparison and to start to understand how the decomposition process affects the geophysical responses (see Figures 1/2 & Pringle et al. 2012c).

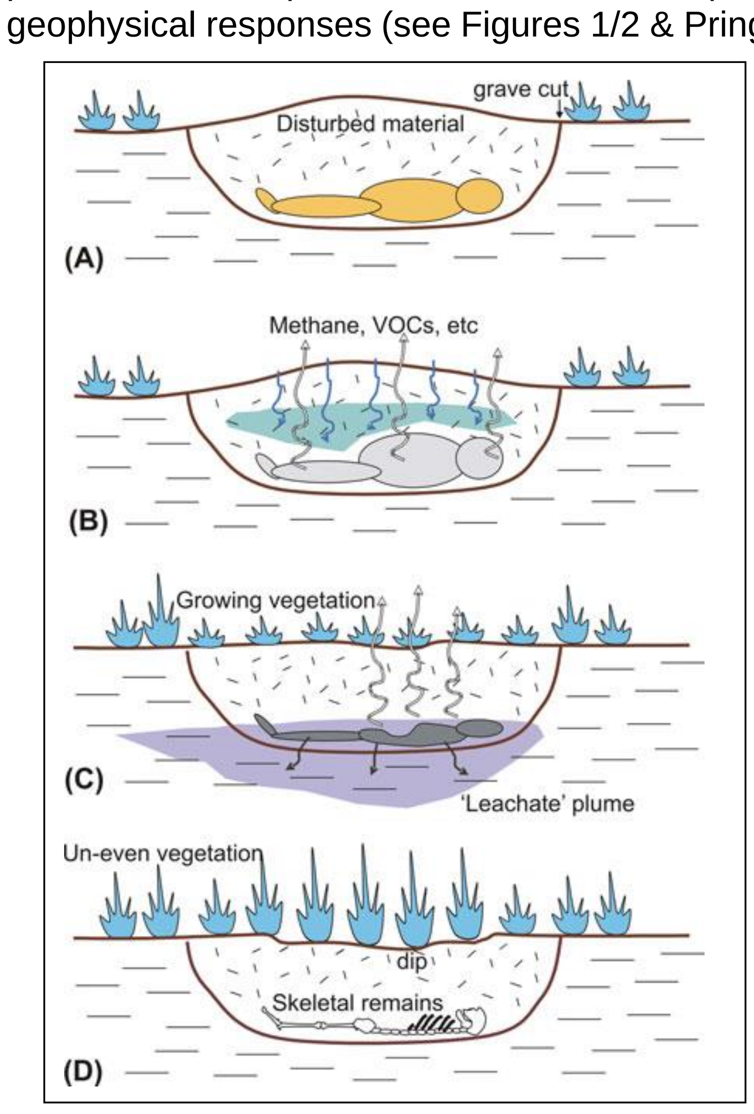

Figure 1. Four sequential stages of clandestine burial. (A) Recent burial, surface expression most obvious. (B) Early decomposition dogs and/or methane probes most useful. (C) Late-stage decomposition with conductive "leachate" plume resolved by electrical methods. (D) Final decomposition state arguably the most difficult to detect. From Pringle et al. (2012c).

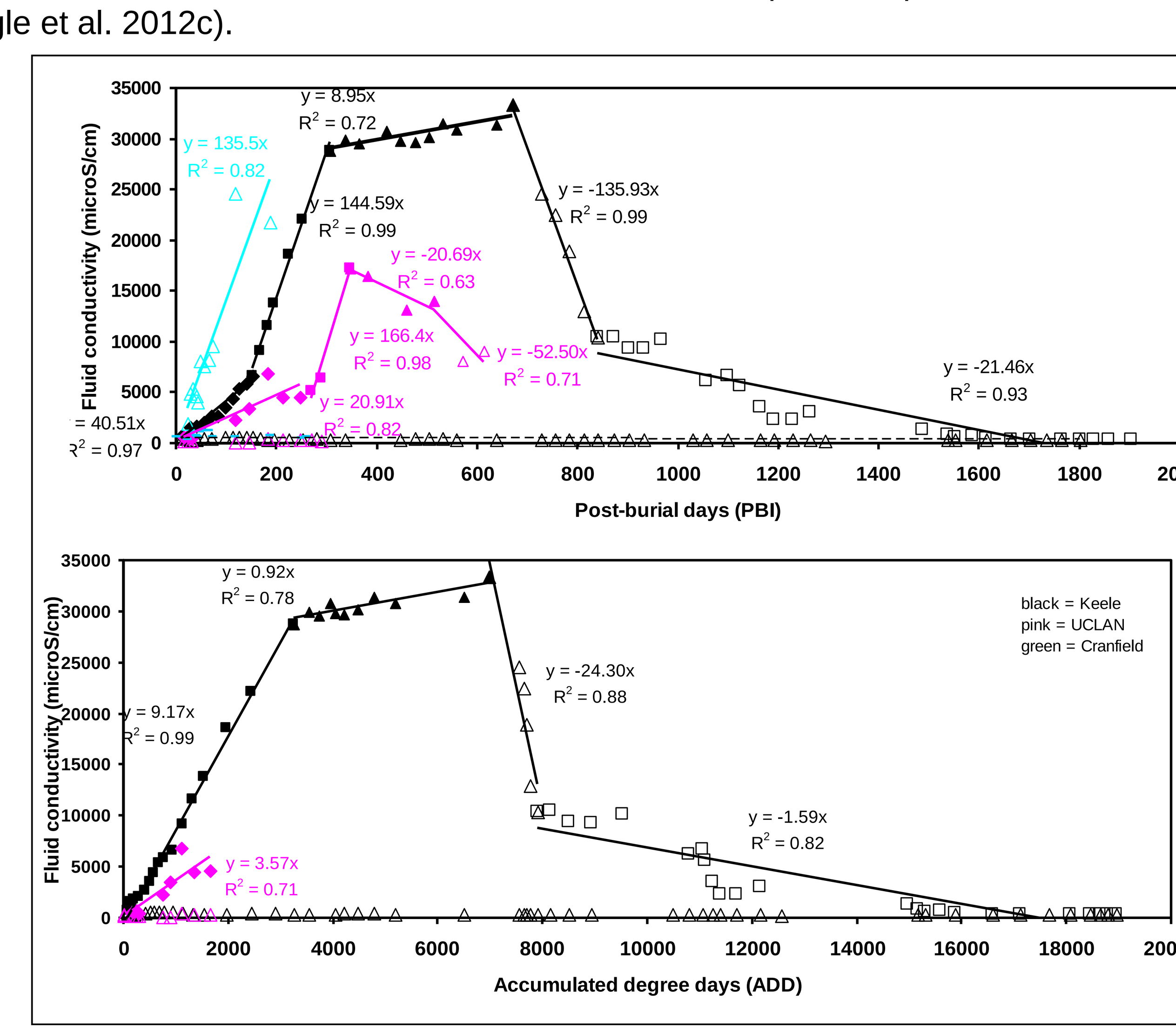

Figure 2. Temporally varying conductivity of decompositional fluids from 3 simulated clandestine grave site using pig cadavers. Note post-burial days have been weighted by their respective average temperatures to correct for temperatures.

Figure 3. The two Colombian sites, (A) Villa Marengo, in Mosquera, Cundinamarca, and (B) University of Los Llanos, Villavicencio, Meta Department, Colombia.

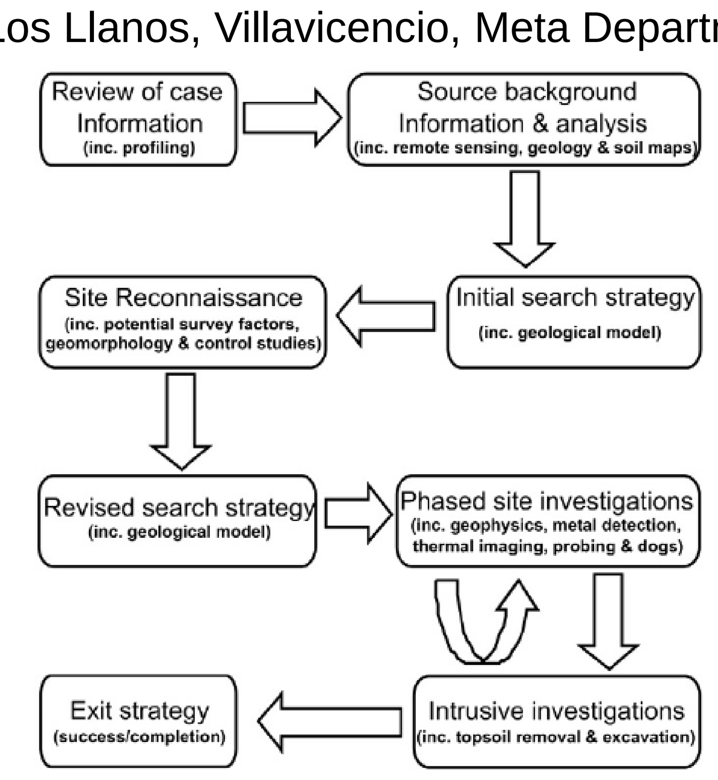

Figure 4. Idealised search workflow. Modified from Pringle et al. (2012a).

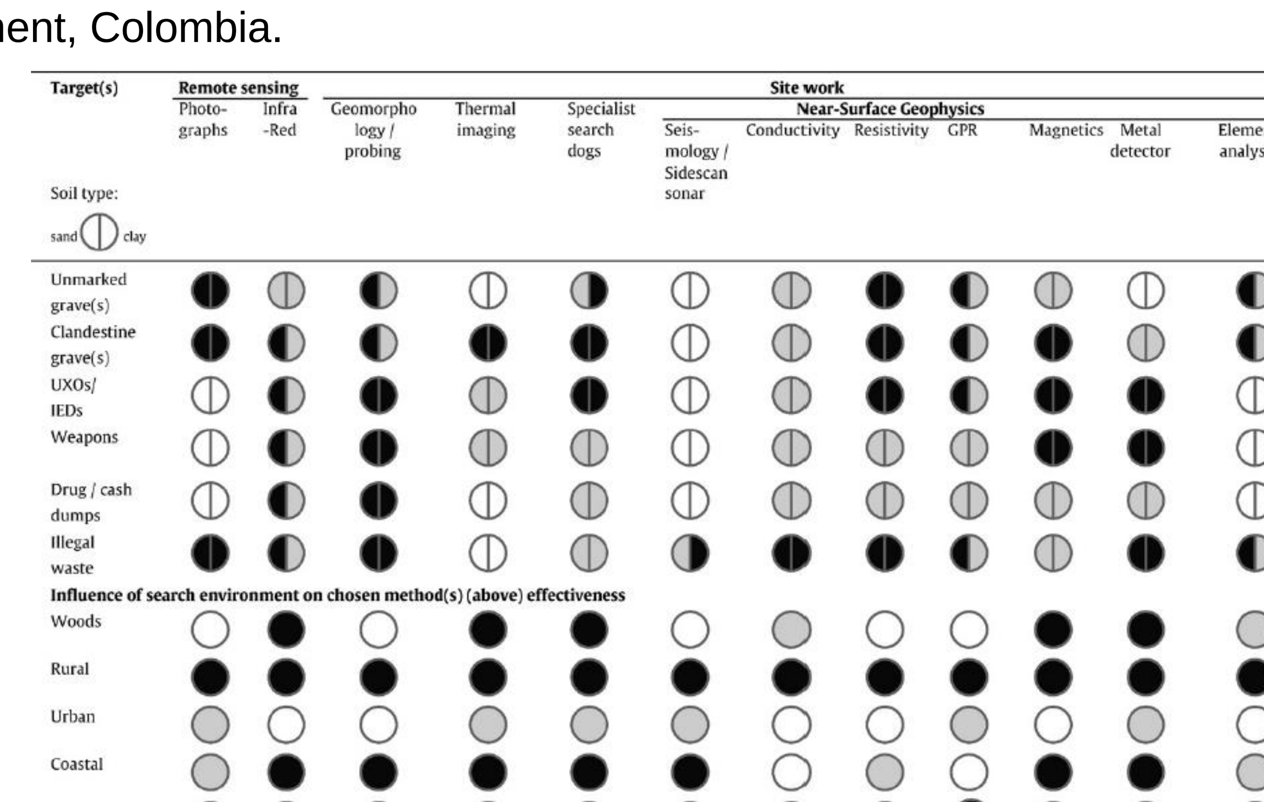

Figure 5. Current search methods. From Pringle et al. (2012a).