**Analysis of Leachate, fatty acids and Mineralogy**

**Following the Discovery of a Homicide Grave: Potential Implications for Police Led Open Area Ground Searches for Burials**

Donnelly, L.J.1, Cassella, J.2, Pirrie, D.3, Dawson, L.4, Harrault, L.4, Blom, G.2, Davidson, A.2, Arnold, P.5 and Harrison, M.6

1Chair IUGS, IFG Manchester and Arup, UK,

2Staffordshire University, Stoke-on-Trent, UK

3Helford Geoscience, Cornwall, UK

4James Hutton Institute, Aberdeen, UK

5Area Forensic Manager, Yorkshire UK

6Australian Federal Police & University of Canberra, Australia

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Police and law enforcement ‘Open Area Ground Searches’ may take place in a variety of geographical settings and over large tracts of land. These often can cover several tens to hundreds of square kilometres. Searches of this type are usually carried out to locate; unmarked graves, drugs, weapons, firearms and other items related to homicide, organised crime and terrorism. These types of searches may require significant resources in term of search assets, tactical support, finance and time. Any reconnaissance techniques that can reduce substantially the search area bring numerous benefits to policing where typically search activity is required to be intelligence informed and decisions of search area priority have an evidence basis informed from research, science or witness testimony. This ensures search activity can be justified as reasonable, proportionate and necessary and the police can be confident in expending time, resources and funds with a high probability of success especially where there are high levels of community oversight or expectation and or where there are time critical elements to an active investigation where the offender(s) are still at large. Past and recent investigations and research has shown that leachate and organic compound analyses may be potentially generated at a homicide grave. However, the migration and detectability of the organic compounds and leachate are dependent on several factors, such as the groundwater, geology, geomorphology of the burial site, and circumstances of the burial (e.g. was the deceased wrapped in plastic which could have impeded leachate and flows of organic compounds). A shallow, unmarked, homicide grave was detected, located and recovered by the Police at a remote location in Northern Europe. This grave contained the body of victim who had been buried more than a decade earlier. Following the recovery of the body soil samples were collected using using a 30mm diameter soil auger (window sampler) and transferred into 40ml, glass vials containing a screw cap and a polypropylene septa. The soil samples were taken at and beneath, the floor of the grave, along strike (slope) of the grave, up to 100m downslope and 75m upslope. A control sample was also collected at approximately 250m from the grave, at a higher elevation and in an area of similar geology, but which could not have been influenced by the grave’s contents. The geology predominantly comprised strong, well-jointed, coarse grained, feldspathic sandstones of Namurian age, overlain by Periglacial deposits and organic peat soils. The grave was located above the water table, but was influenced by surface run off and shallow groundwater flows within the soil profile and weathered strata. Three soil samples were taken at each locality from the top and bottom of the soil profiles, at a maximum depth of approximately 0.75mbgl. The leachate, organics and mineralogy were analysed and results compared to the equivalent control sample. Experimental techniques were developed to extract anions and bio-amines from the soil samples. The data showed elevated levels of putrescine, at nearly 150 ppb at the grave, downslope and for several meters upslope at localities where victim recovery dogs showed an ‘interest’ before the grave was discovered. The mineralogical analysis, using integrated automated mineralogy and petrology (QEMSCAN), detected the presence of digenetic calcite in the soil profile beneath the grave, while mineralogy by XRD did not detect differences due to limits of resolution. Additionally, the organic analysis detected the presence of elevated stanols at the grave site and downslope. The preliminary results are interesting and further research is required to test whether this approach can be reliably applied operationally to ‘Open Area Searches’ for burials. The authors recommended further sampling at experimental grave sites and following the recovery of homicide graves, in Europe and beyond, in different geological settings and contrasting crime scene scenarios.