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Four-electrode probe for detection of burial places (forensic and archaeological applications)

In criminology difficulties often arise when it is necessary to find some objects hidden in soil. Search for non-metallic objects hidden in soil, such as buried decomposed corpses, documents, jewelry, and drugs, is troublesome with the conventional police methods. So far only metal objects if buried just below the surface can be found with a help of magnetometers or metal detectors (Murray and Tedrow, 1991). Such techniques, although effective in specific cases, fails to detect non-metallic objects (Murray and Tedrow, 1991). Davenport et al. (1990) conducted research on detection of corpses with ground-penetrating radar (GPR) in Colorado, USA. The GPR method, which utilized the high frequency radio waves, fails if the hidden object is small, buried on higher depth, or in clay/salt rich soil (Liner and Liner, 1997).

We proposed electrical geophysical methods to measure the disturbance of soil together with properties of a hidden object itself. The study was conducted in collaboration with Russian Ministry of Internal Affairs to test methods for fast outlining soil disturbance places to help criminological search The method is based on measurements of soil bulk electrical resistivity and principles of soil formation.

We used LandMapper ERM-01 device with three different equally spaced arrays (*AM=MN=NB*) in Wenner configuration (Kirkham and Taylor, 1949) with distances between AB electrodes equal to 45, 120, and 240 cm. The proposed electrode arrays measured bulk electrical resistivities of soil volume from the surface to the approximate depths 7.5, 20, and 40 cm, respectively.

A number of soil properties, such as humus content, cation exchange capacity, bulk density, structure, and texture, affect soil bulk electrical resistivity. All these properties differ considerably in upper soil horizons from those in lower horizons. Due to digging or mixing of soil materials the resistivity of soils in disturbed places differ significantly from the resistivity of surrounding undisturbed soils. The effect is more pronounced if topsoil and subsoil distinctly different in the electrical resistivity, but some differences can be noted practically in any soil. The importance of such natural soil feature for criminology search is that with infringement of soil the horizons are mixed, hence the place of disturbance shows the different electrical resistivity compared with undisturbed locations. The difference exists for a considerable time, as long as it takes to create the same layered soil profile as at undisturbed locations around, i.e. thousands of years. Therefore, even the disturbance that occurred several years ago can be detected. We measured the bulk electrical resistivity on the soil surface over the former pit and on the surrounding territory (Fig). Even the 27-year old soil pits were easily located with the method.

The criminologist should be aware of the natural variability of soil. If an anomaly in electrical resistivity is detected several measurements should be taken at closer locations to check if they replicate the similar anomaly. The repeated measurements can help to outline the area of disturbance. One should be especially suspected if the disturbance has a size and form of grave (Fig). The smaller sized anomalies can also be important depending on what an expert is looking for. Using different electrode spacing various volumes of soil can be measured. Thus, we can judge whether the potential soil disturbance is at the very surface or goes deeper. The places with deeper disturbance should be given special attention.

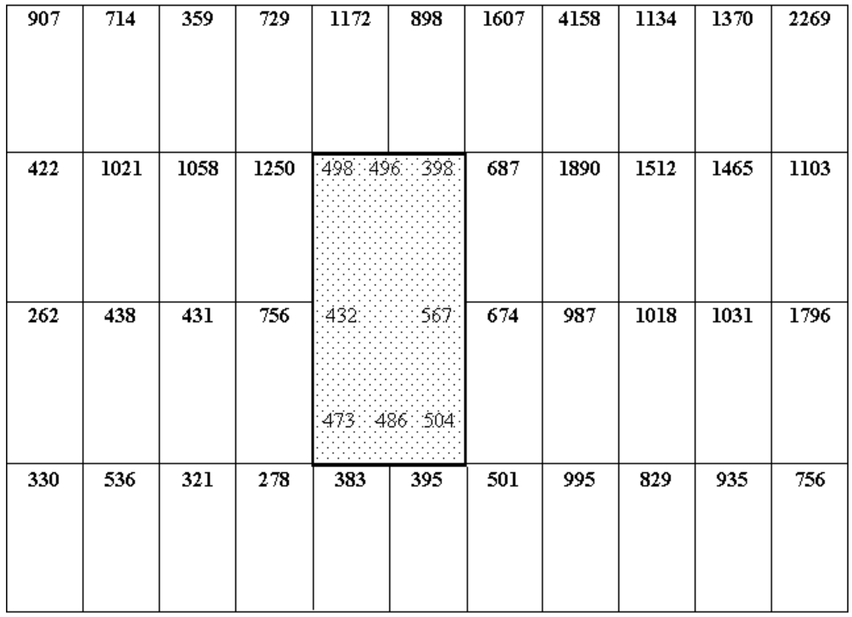

Fig. Spatial variability of electrical resistivity over the disturbed Typic Cryboralf. Rectangular boxes (0.5x1.0 m) indicate the location of filled soil pit; numbers are the values of electrical resistivity (ohm m), and the shaded rectangle outlines the location of former (5 years old) soil pit.

The method of four-electrode probe has been shown to be a successful method for criminology search of some non-metallic objects, primarily corpses, buried in soil. The method outlines the differences in electrical resistivity between disturbed and non-disturbed soils, therefore, does not depend on the properties of the hidden object itself and the properties of bury soil. Although the proposed method is not as quick as metal detectors, magnetometers, or ground penetration radar, the method is free of their drawbacks. The efficiency of the method can be future improved by modifications: combined probes with an automatic switch between different arrays, automatic data logging and calculations of resistivity, and incorporating of a sound signal sensitive to sharp changes in measured electrical resistivity. Although the geophysical techniques employed for criminology search might be not totally successful in finding hidden graves and buried objects, they can be very useful in allowing law-enforcement officers to screen large areas and eliminate many potential targets.

References

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