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Army Snyder Exh. # 5-C

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IDENTIFIED on ______ Witness/Panel ______
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Technology Transfer EPA/625/R-92/007

USE OF AIRBORNE, SURFACE, AND BOREHOLE GEOPHYSICAL TECHNIQUES AT CONTAMINATED SITES: A REFERENCE GUIDE

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Table 2-1 Use of Airborne Sensing Techniques in Hydrogeologic and Contaminated Site Studies

Method	Description	Applications
Visible and near infrared	Aerial photographs (black and white, color, false color, infrared multi-spectral). Imaging limited to surface features.	Air photo interpretation of geologic and surface hydrologic features, fracture trace analysis, soil moisture patterns, and vegetation (infrared).
Photographic ultraviolet"	Aerial photographs using special film and filters for sensing reflected ultraviolet radiation.	Mapping of oil spills on surface water bodies sometimes used for geologic mapping of carbonate formations.
Thermal infrared	Scanners used to detect infrared radiation beyond the range of infrared photography.	Routinely used to detect ground-water discharge into rivers, lakes, and the sea; detects variations in soil moisture content (seepage from leach fields and underground storage tanks), evaporation, and thermal properties.
Side-looking airborne radar (SLAR)	Creates a continuous radar image (reflected radio frequency pulses) of the ground surface.	Similar applications to air photos; can distinguish grain size in alluvium if there is no interference from vegetation. Can also be used for fixture trace analysis.
Low frequency airborne electromagnetic methods (AEM)	Uses a low frequency electromagnetic wave transmitter and receiver that responds to changes in the ground electrical conductivity.	Detects variations in soil and reek types; variations in ground-water salinity; location of shallow subsurface aquifers and deeper brine contaminated aquifers.
Aeromagnetic	Measures the earth's total magnetic field.	Primarily used in petroleum and mineral exploration to assist with geological mapping and structural interpretations. Also used to locate abandoned wells with metallic easings.

* Not mentioned in Ellyett and Pratt (1975).

Source Adapted from Ellyett and Pratt (1975).

Passive microwave sensing systems rely on a lens or antenna that receives energy coming from an outside source and focuses it on a detector. Thermal infrared scanning (see Section 2.2), for example, is a passive microwave sensing system. Active microwave sensing systems involve a transmitter that provides an independent source of energy and a receiver that senses the reflected or echoed signal.

The term **radar** (an acronym derived from the phrase Radio Detection And Ranging) implies the use of an active energy source for sensing. Usually the signal is emitted as short, powerful bursts of energy called **pulses.** Less commonly, a **continuous wave** (CW) signal is used.

6.1.2 Ground Penetrating Radar

Ground penetrating radar (GPR) has been used at contaminated sites since the late 1970s (Table 6-1). The method involves use of a small antenna to radiate short pulses of high-frequency radio waves (ranging from around 10 MHz to 1,000 MHz) into the subsurface and a receiving antenna to record variations in the reflected return signal (Figure 6-1). The principles involved are similar to reflection seismology (see Section 5.2), except that electromagnetic energy is used instead of acoustic energy. Figure 6-2 illustrates the types of lithologic and stratigraphic interpretations that can be made using GPR images.

Dragging the antennae along the ground surface creates a continuous profile that gives the greatest resolution of all the surface geophysical methods discussed in this reference guide. Still, the depth of penetration is generally less than with other methods (1 to 25 meters, although hundreds of meters are possible in certain materials, such as salt domes) and is reduced by fluids, soils with high electrical conductivity, and fine-grained materials. Best overall penetration is usually achieved in dry, sandy, or rocky areas; poorer results are obtained in moist, clayey, or conductive soils. Davis et al. (1984) reported penetration to a depth of 25 meters in dry sandy soil. Attenuation is particularly severe in clay-rich soils and where water content exceeds 40 percent (Horton et al., 1981). Benson et al. (1984) provide more detailed information on the principles and applications of GPR.