



Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation¹

This standard is issued under the fixed designation D 6432; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 Purpose and Application:

1.1.1 This guide summarizes the equipment, field procedures, and interpretation methods for the assessment of subsurface materials using the impulse Ground Penetrating Radar (GPR) Method. GPR is most often employed as a technique that uses high-frequency electromagnetic (EM) waves (from 10 to 3000 MHz) to acquire subsurface information. GPR detects changes in EM properties (dielectric permittivity, conductivity, and magnetic permeability), that in a geologic setting, are a function of soil and rock material, water content, and bulk density. Data are normally acquired using antennas placed on the ground surface or in boreholes. The transmitting antenna radiates EM waves that propagate in the subsurface and reflect from boundaries at which there are EM property contrasts. The receiving GPR antenna records the reflected waves over a selectable time range. The depths to the reflecting interfaces are calculated from the arrival times in the GPR data if the EM propagation velocity in the subsurface can be estimated or measured.

1.1.2 GPR measurements as described in this guide are used in geologic, engineering, hydrologic, and environmental applications. The GPR method is used to map geologic conditions that include depth to bedrock, depth to the water table (Wright et al (1)²), depth and thickness of soil strata on land and under fresh water bodies (Beres and Haeni (2)), and the location of subsurface cavities and fractures in bedrock (Ulriksen (3) and Imse and Levine (4)). Other applications include the location of objects such as pipes, drums, tanks, cables, and boulders, mapping landfill and trench boundaries (Benson et al (6)), mapping contaminants (Cosgrave et al (7); Brewster and Annan (8); Daniels et al (9)), conducting archaeological (Vaughan (10)) and forensic investigations (Davenport et al (11)), inspection of brick, masonry, and concrete structures, roads and railroad trackbed studies (Ulriksen (3)), and highway bridge scour studies (Placzek and Haeni (12)). Additional

applications and case studies can be found in the various *Proceedings of the International Conferences on Ground Penetrating Radar* (Lucius et al (13); Hannien and Autio, (14), Redman, (15); Sato, (16); Plumb (17)), various *Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems* (Environmental and Engineering Geophysical Society, 1988–1998), and The Ground Penetrating Radar Workshop (Pilon (18)), EPA (19), and Daniels (20) provide overviews of the GPR method.

1.2 Limitations:

1.2.1 This guide provides an overview of the impulse GPR method. It does not address details of the theory, field procedures, or interpretation of the data. References are included for that purpose and are considered an essential part of this guide. It is recommended that the user of the GPR method be familiar with the relevant material within this guide and the references cited in the text and with Guides D 420, D 5730, D 5753, D 6429, and D 6235.

1.2.2 This guide is limited to the commonly used approach to GPR measurements from the ground surface. The method can be adapted for a number of special uses on ice (Haeni et al (21); Wright et al (22)), within or between boreholes (Lane et al (23); Lane et al (24)), on water (Haeni (25)), and airborne (Arcone et al (25)) applications. A discussion of these other adaptations of GPR measurements is not included in this guide.

1.2.3 The approaches suggested in this guide for using GPR are the most commonly used, widely accepted, and proven; however, other approaches or modifications to using GPR that are technically sound may be substituted if technically justified and documented.

1.2.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgements. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.3 Precautions:

¹ This guide is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

Current edition approved June 10, 1999. Published September 1999.

² The boldface numbers in parentheses refer to the list of references at the end of this standard.