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Geophysics in engineering investigations

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Note

Recent Government reorganisation has meant that DETR responsibilities have been moved variously to the Department of Trade and Industry (DTI), the Department for the Environment, Food and Rural Affairs (DEFRA), and the Department for Transport, Local Government and the Regions (DTLR). References made to the DETR in this publication should be read in this context.

For clarification, readers should contact the Department of Trade and Industry.

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Summary

This report is the result of collaboration between CIRIA, the Engineering Group of the Geological Society, the British Geological Survey, and the Building Research Establishment. It presents a logical sequence through the process of using geophysical investigation methods in site characterisation. Following the introduction about the roles of geophysical methods, Chapter 2 provides the background to geophysics as an investigative tool. Chapter 3 sets out the procurement, management and reporting frameworks for a geophysical investigation and stresses the importance of the involvement of a recognised geophysics specialist adviser. Chapter 4 explains the need for a conceptual ground model in order that appropriate investigative methods are chosen. The underlying science and current practices of the main techniques are explored in Chapter 5. This is followed by an explanation of the processes of data acquisition, handling and presentation. There are separate sections for geological, geotechnical, geo-environmental and structural engineering applications, which consider the different targets determinable by geophysical methods. The report concludes with recommendations for practice.

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Abbreviations

2-D	two dimensional
3-D	three dimensional
AC	alternating current
AGAP	Association for Quality in Applied Geophysics (of France)
ASTM	American Society for Testing and Materials
BGS	British Geological Survey
BRE	Building Research Establishment
BS	British Standard
BSI	British Standards Institution
CAT	cable avoidance tool
CCTV	closed circuit television
CDM	Construction (Design and Management) Regulations
CDP	common depth point
CIRIA	Construction Industry Research and Information Association
DGPS	differential global positioning system
DNAPL	dense non-aqueous phase liquid
EGA	Engineering Geophysics Adviser
EK	Electrokinesis
EKS	Electrokinetic sounding/surveying
EM	Electromagnetic
EN	Euro Norm
ER	electrical resistivity
FFT	fast Fourier transform (analysis)
FMS	formation scanning (tool)
FRF	frequency response function
GA	Geotechnical adviser
GIS	Geographical information system
GPR	ground-probing radar (ground penetrating radar)
GPS	global positioning system
HAC	high alumina cement
IP	induced polarisation
LNAPL	light non-aqueous phase liquid
MGLLS	mobile geomembrane leak location surveying
MT	magnetotelluric
NDT	non-destructive testing
NMR	nuclear magnetic resonance
PC	personal computer
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control

RMR	rock mass rating
RMS	root mean square
RQD	rock quality designation
SASW	spectral analysis of surface waves
SIRT	simultaneous iterated reconstruction techniques
SP	spontaneous potential/self potential
TDEM	time domain electromagnetic systems
TDR	time domain reflectometry
TEM	transient electromagnetic method
TIDEM	time domain electromagnetic system
TRL	Transport Research Laboratory
TRRL	Transport and Road Research Laboratory
UPV	ultrasonic pulse velocity
VES	vertical electrical sounding
VLF	very low frequency
VSP	vertical seismic profiling

COMMONLY USED UNITS AND CONVERSION FACTORS

(commonly used units are highlighted in bold)

Measured parameter or property	Cgs unit	SI unit	Conversion factor
Electrical resistivity	ohm-cm (Ω cm)	ohm-m (Ω m)	1 Wcm = 10^{-2} Ω m
Electrical conductivity	mho/cm	Siemen/m (S/m)	1 S/m = 1 mho/m = $\text{ohm}^{-1}\text{m}^{-1}$
Seismic velocity	cm/s	milliSiemen/m (mS/m)	1 mS/m = 1 mmho/m
		m/s	1 cm s-1 = 10^{-2} ms^{-1}
		km/s	1 km/s = 10^3 ms^{-1}
		m/ms	1 m/ms = 10^3 ms^{-1}
Density	gm/cm ³ (g/cc)	kg/m³	1 kgm-3 = 10^{-3} Mgm ⁻³
		tonne/m ³	1 tm-3 = 1 Mgm ⁻³
		Mg/m ³ / Mgm ⁻³	1kgm-3 = 10^3 gcm ⁻³
Gravitational field strength	Gal	gravity unit (gu)	1 Gal = 1 cms^{-2}
		milliGal (mGal)	1 gu = 10^{-6} ms^{-2} 1 mGal = 10 gu
		microGal (μGal)	1 mGal = 10^{-2} gu
Magnetic field strength	Gamma (γ)	nanoTesla (nT)	1 nT = 10^{-9} T 1 nT = 1 γ = 10^{-4} gauss
Thermal conductivity	—	W/m²K	— — —
Elastic moduli	—	GigaPascal (GPa)	1 GPa = 10^9 Pa
		GN/m ²	= 10^9 Nm-2