

# ELECTRICAL RESISTIVITY TECHNIQUES FOR SUBSURFACE INVESTIGATION

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## ABSTRACT

Geophysical resistivity techniques are based on the response of the earth to the flow of electrical current. With an electrical current passed through the ground and two potential electrodes to record the resultant potential difference between them, we can obtain a direct measure of the electrical impedance of the subsurface material. The resistivity of the subsurface, a material constant, is then a function of the magnitude of the current, the recorded potential difference, and the geometry of the electrode array. Depending upon the survey geometry, the data are plotted as 1-D sounding or profiling curves, or in 2-D cross-section in order to look for anomalous regions. In the shallow subsurface, the presence of water controls much of the conductivity variation. Measurement of resistivity is, in general, a measure of water saturation and connectivity of pore space. Resistivity measurements are associated with varying depths relative to the distance between the current and potential electrodes in the survey, and can be interpreted qualitatively and quantitatively in terms of a lithologic and/or geohydrologic model of the subsurface.

## INTRODUCTION

Geophysical resistivity techniques are based on the response of the earth to the flow of electrical current. In these methods, an electrical current is passed through the ground and two potential electrodes allow us to record the resultant potential difference between them, giving us a way to measure the electrical impedance of the subsurface material. The apparent resistivity is then a function of the measured impedance (ratio of potential to current) and the geometry of the electrode array. Depending upon the survey geometry, the apparent resistivity data are plotted as 1-D soundings, 1-D profiles, or in 2-D cross-sections in order to look for anomalous regions.

In the shallow subsurface, the presence of water controls much of the conductivity variation. Measurement of resistivity (inverse of conductivity) is, in general, a measure of water saturation and connectivity of pore space. This is because water has a low resistivity and electric current will follow the path of least resistance. Increasing saturation, increasing salinity of the underground water, increasing porosity of rock (water-filled voids) and increasing number of fractures (water-filled) all tend to decrease measured resistivity. Increasing compaction of soils or rock units will expel water and effectively increase resistivity. Air, with naturally high resistivity, results in the opposite response compared to water when filling voids. Whereas the presence of water will reduce resistivity, the presence of air in voids should increase subsurface resistivity.

Resistivity measurements are associated with varying depths depending on the separation of the current and potential electrodes in the survey, and can be interpreted in terms of a lithologic and/or geohydrologic model of the subsurface. Data are termed apparent resistivity because the resistivity values measured are actually averages over the total current path length but are plotted at one depth point for each potential electrode pair. Two dimensional images of the subsurface apparent resistivity variation are called pseudo-sections. Data plotted in cross-section is a simplistic representation of actual, complex current flow paths. Computer modeling can help interpret geoelectric data in terms of more accurate earth models.

This paper reviews the working ideas behind basic geoelectric methods. In the following sections we present some of the basic resistivity theory, followed by discussions on resistivity field methods and survey geometry associated with the three main surveying techniques: vertical electric sounding (VES), constant separation traversing (CST), and combined sounding and traversing methods. Comprehensive overviews of resistivity methods are presented in Telford (1976), Ward (1990), Kearny and Brooks (1991), and Burger (1992).

# Electrical Resistivity Techniques For Subsurface Investigation

**University of Alabama. Bureau of  
Engineering Research, C. Howell Mullis**



## **Electrical Resistivity Techniques For Subsurface Investigation:**

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**Geotechnical Engineering Handbook** Braja M. Das, 2011 The Geotechnical Engineering Handbook brings together essential information related to the evaluation of engineering properties of soils design of foundations such as spread footings mat foundations piles and drilled shafts and fundamental principles of analyzing the stability of slopes and embankments retaining walls and other earth retaining structures The Handbook also covers soil dynamics and foundation vibration to analyze the behavior of foundations subjected to cyclic vertical sliding and rocking excitations and topics addressed in some detail include environmental geotechnology and foundations for railroad beds

**On Significant Applications of Geophysical Methods** Narasimman Sundararajan, Mehdi Eshagh, Hakim Saibi, Mustapha Meghraoui, Mansour Al-Garni, Bernard Giroux, 2019-02-13 This edited volume is based on the best papers accepted for presentation during the 1st Springer Conference of the Arabian Journal of Geosciences CAJG 1 Tunisia 2018 This special volume is of interest to all researchers practicing geophysicists seismologists students of PG and UG in the fields of multifaceted Geoscience Major applications with relevant illustrations presented in the volume are from Middle East And therefore this book no doubt would serve as a reference guide to all geoscientists and students in the broad field of Earth Science This volume covers significant applications of gravity and magnetic methods electrical and electromagnetic methods refraction and reflection seismic methods besides a large number of study on earthquakes tectonics and geological settings etc The salient features of this volume are the interpretation and modeling of geophysical data of different nature Main topics include 1 Applications of gravity and magnetic methods 2 Electrical and Electromagnetic methods in mineral and groundwater exploration 3 Case studies on refraction and reflection seismic methods 4 Integrated geoscience applications in the exploration of subsurface resources 5 Hydrocarbon and petrophysical studies 6 Earthquakes and seismic hazard assessment 7 Tectonics

*The Electrical Resistivity Method of Subsurface Exploration* University of Alabama. Bureau of Engineering Research, C. Howell Mullis, 1960

**Improved Subsurface Investigation for Highway Tunnel Design and Construction** Fenix & Scisson, Bruce E. Russell, Robert R. Rommell, 1974

*Geotechnical and Environmental Applications of Karst Geology and Hydrology* B.F. Beck, J.G. Herring, 2001-01-01 This text covers topics such as sinkhole formation and regional studies of sinkholes and karst Issues addressed are taken from the 8th multidisciplinary conference on this subject and chart the characteristics of sinkholes and karst as well as their environmental repercussions

**Soil Mechanics and Subsidence in Mining Engineering** Prof. Dr. Bilal Semih Bozdemir, Soil Mechanics and Subsidence in Mining Engineering Introduction to Soil Mechanics Soil

Composition and Structure Soil Classification Systems Stress Strain Behavior of Soils Shear Strength of Soils Mohr Coulomb Failure Criterion Effective Stress Principle Soil Compaction and Compressibility Consolidation Theory Primary and Secondary Consolidation Settlement Calculations Bearing Capacity of Soils Shallow and Deep Foundations Lateral Earth Pressures Retaining Wall Design Soil Exploration and Site Investigation Sampling Techniques and Methods In Situ Testing SPT CPT Vane Shear Laboratory Testing of Soil Samples Groundwater and Seepage Analysis Darcy's Law and Permeability Seepage Forces and Uplift Pressures Dewatering Techniques in Mining Slope Stability Analysis Infinite Slope and Circular Failure Planar and Wedge Failure Modes Soil Reinforcement and Stabilization Geosynthetics and Soil Nailing Subsidence in Mining Operations Causes and Mechanisms of Subsidence Prediction and Modeling of Subsidence Mitigation Measures for Subsidence Surface Deformation and Tilt Impacts on Structures and Infrastructure Environmental Concerns and Remediation Case Studies of Subsidence in Mining Lessons Learned and Best Practices Conclusion and Future Outlook

Geoelectrical Dar Zarrouk and Hydraulic Parameters Relationships Abdulla Amin, Jassim Thabit, Bakhtiar Aziz, 2026-01-22  
Doctoral Thesis Dissertation from the year 2026 in the subject Earth Science Geography General Basics course Geology language English abstract This book positions electrical resistivity surveying as a decision ready workflow for groundwater characterization in data scarce basins Focusing on the Sharazoor plain in northeastern Iraq it integrates Vertical Electrical Sounding Schlumberger Wenner profiling and targeted well information to build a coherent subsurface model and to operationalize Dar Zarrouk parameters for hydrogeological interpretation Beyond the methodological fundamentals theory acquisition design depth of investigation and interpretation ambiguities the text documents a full field to lab pipeline acquisition strategy across multiple long profiles quality control of curve distortions inversion and curve matching including IPI2Win based workflows and calibration using available wells and pumping test data A dedicated section translates geoelectrical outputs into hydraulically meaningful parameters porosity via Archie's formulation and density based approaches transmissivity and hydraulic conductivity and frames how empirical relationships can be established and validated without over relying on additional drilling campaigns The closing chapters consolidate implications for groundwater exploration planning and provide implementation oriented recommendations for future surveys and resource management

**Terrain Investigation Techniques for Highway Engineers** Olin Wesley Mintzer, 1965

**Hydrogeology Field Manual, 2e** Willis D. Weight, 2008-01-28 Publisher's Note Products purchased from Third Party sellers are not guaranteed by the publisher for quality authenticity or access to any online entitlements included with the product Dramatically Improve Your Hydrogeology Field Skills and Master New Advances in Groundwater Science The Second Edition of Hydrogeology Field Manual provides the latest information on applied applications in groundwater sampling and water quality assessment aquifer characterization contamination issues karst applications and more The book includes actual procedures real world decisions and many examples and case studies to help you understand the occurrence

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*Engineering Experiment Station Bulletin* West Virginia University. Engineering Experiment Station,1968 **Geological and Geotechnical Investigation Procedures for Evaluation of the Causes of Subsidence Damage in Florida** ,2005

Practical Hydrogeology: Principles and Field Applications, Third Edition Willis D. Weight,2019-02-01 Master the latest advances in hydrogeology using this fully updated resource This thoroughly revised guide clearly explains cutting edge hydrogeology techniques that can be applied in the field Featuring contributions from leading experts Practical Hydrogeology Principles and Field Applications Third Edition shows how to plan and conduct site investigations avoid pitfalls in the field interpret a wide array of data types gathered and prepare water quality reports You will get complete coverage of key procedures including aquifer testing groundwater sampling water quality assessment aquifer characterization and tracer tests This third edition has been reorganized and expanded with up to date information a new chapter review questions and real world examples Coverage includes Field hydrogeology The geology of hydrogeology Aquifer properties Groundwater flow Pumping tests Slug testing Aquifer hydraulics Water chemistry sampling Groundwater surface water interaction Vadose zone analysis Karst hydrogeology and tracer tests Drilling and well completion **Engineering and Design** United States. Army. Corps of Engineers,1961 *Proceedings of the Annual Tennessee Highway Conference* ,1958 **Annual Tennessee Highway Conference** ,1958 **Geraghty & Miller's Groundwater Bibliography** Frits Van der Leeden,1983 California Geology ,1978 **ASTM Standards on Environmental Sampling** American Society for Testing Materials,American Society for Testing and Materials,1995 Includes sampling methods for soil and water

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