الإستكشاف الكهربائي والجاذبي والمغناطيسي

ELECTRICAL, GRAVITY AND MAGNETIC EXPLORATION

المقرر : مبادىء الجيوفيزياء (371 جيو)

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قسم الجيولوجيا – كلية العلوم

جامعة الملك سعود

1428هـ

PRINCIPLES OF GEOPHYSICS (GEO 371)
SYLLABUS OF THE SECOND PART OF THE COURSE

FIRST SEMESTER, 1428

I ELECTRICAL METHOD (5 HOURS)

- Electrical properties of rocks
- Apparent & True resistivity
- Electrode configurations
- Electrical soundings & Profiling
- Applications in groundwater exploration

MIDTERM EXAM…….. (SATURDAY , 2 / 12 / 1427)

II GRAVITY PROSPECTING (6 HOURS)

- Fundamental principles
- Measurements
- Data reduction
- Isostasy and crustal thickness
- Interpretation & Applications

III MAGNETIC METHOD (4 HOURS)

- Basic concepts
- Description of the magnetic field
- Source of magnetic anomalies
- Interpretation & Applications

GRADING :

Midterm exam.	**10**	**%**
Final exam.	**30**	**%**

TEXT :

Sharma , P. (1976). ***Geophysical Methods in Geology*****. Elsevier. Amsterdam.**

Lowrie, W. (1997). Fundamentals of Geophysics. Cambridge University Press.

INSTRUCTOR : ABDULLAH M. S. AL-AMRI

OFFICE HOURS : SAT & MON 11 - 12

الإستكشاف الـكهـربائـي وتطبيقاته

1427هـ

ELECTRICAL RESISTIVITY TECHNIQUES

Geophysical methods are divided into two types : Active and Passive

1. **Passive methods** (Natural Sources): Incorporate measurements of natural occurring fields or properties of the earth. Ex. SP, Magnetotelluric (MT), Telluric, Gravity, Magnetic.
2. **Active Methods** (Induced Sources) : A signal is injected into the earth and then measure how the earth respond to the signal. Ex. DC. Resistivity, Seismic Refraction, IP, EM, Mise-A-LA-Masse, GPR.

Position of Electrical Methods in:

(1) Petroleum Exploration.

The most prominent applications of electrical techniques in petroleum expl. Are in well logging. Resistivity and SP are standard Logging techniques.
The magnetotelluric method has found important application for pet. Exploration. In structurally complex region (EX. Rocky Mountains).

(2) Engineering & Groundwater

D C. Resistivity and EM have found broad use in civil Engineering and groundwater studies. Saturated / Unsaturated, Saltwater / freshwater

(3) Mineral Expl.

Electrical methods interpretation difficult below 1000 to 1500 ft. Electrical exploration methods are the dominant geophysical tools in Mineral Expl.

Ohm's Law

Ohm's Law describes the electrical properties of any medium. **Ohm's Law, V = I** R, relates the voltage of a circuit to the product of the current and the resistance. This relationship holds for earth materials as well as simple circuits. **Resistance(R)**, however, is not a material constant. Instead, resistivity is an intrinsic property of the medium describing the resistance of the medium to the flow of electric current.

Resistivity ρ is defined as a unit change in resistance scaled by the ratio of a unit cross-sectional area and a unit length of the material through which the current is passing (Figure 1). **Resistivity** is measured in ohm-m or ohm-ft, and is the reciprocal of the conductivity of the material. Table 1 displays some typical resistivities.

$(\rho = \delta A\, \delta R / \delta L)$

Figure 1. Resistivity is defined based on the change in resistance δR for a given change in length δL and cross-sectional area δA of material.

Table 1

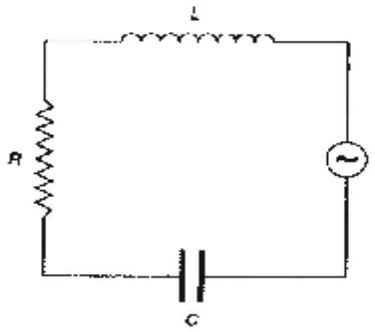
Common Resistivities (ohm-m)

Material	Resistivity range	Typical Value
Igneous & Metamporphic rocks	10^2 - 10^8	10^4 10^3
Sedimentary rocks	10 - 10^8	10^3
Unconsolidated	10^{-1} - 10^4	10^3
Groundwater	1 - 10	5
Pure water		10^3

Note that, in Table 1, the resistivity ranges of different earth materials overlap. Thus, resistivity measurements can not be directly related to the type of soil or rock in the subsurface without direct sampling or some other geophysical or geotechnical information. Porosity is the major controlling factor for changing resistivity because electricity flows in the near surface by the passage of ions through pore space in the subsurface materials. The porosity (amount of pore space), the permeability (connectivity of pores), the water (or other fluid) content of the pores, and the presence of salts all become contributing factors to changing resistivity. Because most minerals are insulators and rock composition tends to increase resistivity, it is easier to measure conductive anomalies than resistive ones in the subsurface. However, air, with a theoretical infinite resistivity, will produce large resistive anomalies when filling subsurface voids.

Electric circuit has three main properties:

- **Resistance (R):** resistance to movement of charge
- **Capacitance (C):** ability to store charge
- **Inductance (L):** ability to generate current from changing magnetic field arising from moving charges in circuit



Resistance is NOT a fundamental characteristic of the metal in the wire.