Department of Geophysics
Faculty of Earth Sciences
King Abdulaziz University

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Introduction to Geophysics
EGP 211

Time: 10-10:55 AM (Saturday and Monday)

- Course website address: http://galitzin.mines.edu/INTROGP/
- Course prerequisites and requirements: Phys101, Math 101 , ESR 211, EMR 102

Objective

The aim of the course is to introduce various aspects of geophysics fields and familiarize the student with geophysics as a science specially this course is the first course dealing with geophysics as a science at this level of undergraduate students. The topics that are covered in this course include mainly four methods: seismic (refraction), gravity, magnetic and direct current resistivity methods. the study of the physics of the Earth. Stress and strain, deformation, isostasy, seismic waves, earthquakes, Earth structure, resource exploration, Earth dynamics, plate tectonics, mountain building, gravity and geodesy, magnetic field, and heat flow. Field techniques, instrumentation, data processing, and solid earth applications are surveyed. The course is emphasizing the physical concepts of each method rather than the mathematical derivations. A conceptual review of the governing laws of seismic, gravity, magnetic and DC resistivity methods is provided.

Learning Resources

- The main reference materials for this course is taken from the Colorado School of Mines website. This link is below

Colorado School of Mines, Geophysics Department

✍ The Course Materials that were uploaded from the above address: Seismic Refraction, Gravity, Magnetic and DC Resistivity. You might not to find all the materials that are shown as links due to the capacity of the server. Therefore, each method reference is uploaded as we go through the course to save some space.

✍ Homework:

- HW#1
- HW#2
- HW#3
- HW#4
- HW#5

✍ ***Homework*** are designed to investigate understanding the material concepts, physics and methodology. You are expected to collaborate but each student is asked to submit the homework individually.

✍ Course Content:

✍ **CHAPTER 1:**

Note Outline: Refraction Seismic Methods

Introduction

- Seismic Methods: Refraction and Reflection
- Advantages and Disadvantages of Seismic Methods Versus Other Methods Studied
- Advantages and Disadvantages of Refraction and Reflection Methods
- Elastic Waves
- Types of Seismic Waves
- Wave Propagation: Wavefronts and Raypaths

Seismology and Geology

- Wave Interaction with Boundaries
- Snell's Law
- Velocities and Rock Properties
- Seismic Velocities of Common Earth Materials

Refraction Basics

- Another Simple Earth Model: Low-Velocity Layer Over a Halfspace
- Head Waves
- Records of Ground Motion
- Travel-time Curves for a Simple Earth Model
- First Arrivals
- Determining Earth Structure from Travel Times
- Derivation of Travel Time Equations
- High-Velocity Layer Over a Halfspace: Reprise

Refraction Seismic Equipment and Field Procedures

- Equipment Overview
- Types of Seismic Sources
- Seismometers or Geophones
- Recording Ground Displacement at Several Offsets Simultaneously
- Recording Systems
- Sources of Noise

Interpretation of Seismic Observations

- Picking Times of Arrivals
- Wave Propagation with Multiple Horizontal Layers
- Travel Time Curves from Multiple Horizontal Layers
- Hidden Layers
- Head Waves from a Dipping Layer: Shooting Down Dip
- Head Waves from a Dipping Layer: Shooting Up Dip
- A Field Procedure for Recognizing Dipping Beds
- Estimating Dips and Depths from Travel Time Observations

✍ **CHAPTER 2:**

Note Outline: Geophysical Surveying Using DC Resistivity

Introduction

- Active and Passive Geophysical Methods
- Advantages and Disadvantages of Each Method
- Electrical Methods Overview

Resistivity Basics

- Current Flow and Ohm's Law
- The Fundamental Electrical Property is Resistivity, NOT Resistance
- Resistivities for Common Earth Materials
- Current Density and Electric Field
- A First Estimate of Resistivity
- Current Flow From Two Closely Spaced Electrodes
- A Practical Way of Measuring Resistivity

Resistivity Surveys and Geology

- Sources of Noise
- Depth of Current Penetration Versus Current Electrode Spacing
- Current Flow in Layered Media
- Variation in Apparent Resistivity: Layered Versus Homogeneous Media
- Current Flow in Layered Media Versus Electrode Spacing
- A Second Example of Current Flow in Layered Media

Resistivity Equipment and Field Procedures

- Equipment
- Survey Types Overview: Soundings and Profiles
- Soundings: Wenner and Schlumberger
- Electrode Spacings and Apparent Resistivity Plots

- Advantages and Disadvantages of Each Survey Type
- Profiles

Interpretation of Resistivity Measurements

- Apparent Resistivity Curves for Soundings Over One-Layered Media
- Apparent Resistivity Curves for One-Layered Media: Part 2
- Apparent Resistivity Curves in Two-Layered Media
- Two-Layered Media: Another Example

✍ **CHAPTER 3:**

Note Outline: Geophysical Surveying Using Gravity

Introduction

- Gravitational Force
- Gravitational Acceleration
- Units Associated With Gravitational Acceleration

Gravity and Geology

- How is the Gravitational Acceleration, g, Related to Geology?
- The Relevant Geologic Parameter is not Density, but Density Contrast
- Density Variations of Earth Materials
- A Simple Model

Measuring Gravitational Acceleration

- How do we Measure Gravity
- Falling Body Measurements
- Pendulum Measurements
- Mass and Spring Measurements

Factors that Affect the Gravitational Acceleration

- Overview

- Temporal Based Variations

  - Instrument Drift
  - Tides
  - A Correction Strategy for Instrument Drift and Tides
  - Tidal and Drift Corrections: A Field Procedure
  - Tidal and Drift Corrections: Data Reduction

- Spatial Based Variations

  - Latitude Dependent Changes in Gravitational Acceleration
  - Correcting for Latitude Dependent Changes
  - Variation in Gravitational Acceleration Due to Changes in Elevation
  - Accounting for Elevation Variations: The Free-Air Correction
  - Variations in Gravity Due to Excess Mass
  - Correcting for Excess Mass: The Bouguer Slab Correction
  - Variations in Gravity Due to Nearby Topography
  - Terrain Corrections

- Summary of Gravity Types

Isolating Gravity Anomalies of Interest

- Local and Regional Gravity Anomalies
- Sources of the Local and Regional Gravity Anomalies
- Separating Local and Regional Gravity Anomalies

- Local/Regional Gravity Anomaly Separation Example

Gravity Anomalies Over Bodies With Simple Shapes

- Gravity Anomaly Over a Buried Point Mass
- Gravity Anomaly Over a Buried Sphere
- Model Indeterminancy
- Gravity Calculations over Bodies with more Complex Shapes

✍ **CHAPTER 4:**

Note Outline: Geophysical Surveying Using Magnetics Methods

Introduction

- Historical Overview
- Similarities Between Gravity and Magnetics
- Differences Between Gravity and Magnetics
- Magnetic Monopoles
- Forces Associated with Magnetic Monopoles
- Magnetic Dipoles
- Field Lines for a Magnetic Dipole
- Units Associated with Magnetic Poles

Magnetization of Materials

- Induced Magnetization
- Magnetic Susceptibility
- Mechanisms of Magnetic Induction
- Suseptibilities of Common Rocks and Minerals
- Remanent Magnetism

The Earth's Magnetic Field

- Magnetic Field Nomenclature
- The Earth's Main Field
- Magnetics and Geology - A Simple Example
- Temporal Variations of the Earth's Main Field - Overview
- Secular Variations
- Diurnal Variations
- Magnetic Storms

Magnetometers

- Instrumentation Overview
- Fluxgate Magnetometers
- Proton Precession Magnetomenters
- Total Field Measurements

Field Procedures

- Modes of Acquiring Magnetic Observations
- Assuring High-Quality Observations - Magnetic Cleanliness
- Strategies for Dealing with Temporal Variations
- Spatially Varying Corrections?
- Correcting for the Main-Field Contributions

Magnetic Anomalies Over Simple Shapes

- Comparison Between Gravity and Magnetic Anomalies
- Magnetic Anomaly: Magnetized Sphere at the North Pole
- Magnetic Anomaly: Magnetized Sphere at the Equator
- Magnetic Anomaly: Magnetized Sphere in the Northern Hemisphere

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✍ Related Links:

December 26 Tsunami in Indian Ocean

http://www.freewebs.com/asiadisaster/2004_Indonesia_Tsunami.gif

http://staff.aist.go.jp/kenji.satake/Sumatra-E.html

Sesmic Wave Motion

http://www.wwnorton.com/earth/egeo/flash/8_2.swf

How a Seismograph Works

http://www.wwnorton.com/earth/egeo/flash/8_3.swf

Seismic Mthod (Refraction)

http://duke.usask.ca/~igm852/classes/GEOL335/2004/Lectures/PDF/Refraction_Seismic_Method.pdf

Seismic Waves

http://duke.usask.ca/~igm852/classes/GEOL335/2004/Lectures/PDF/Elasticity.pdf

✍ Course Grading:

- Quizes and Homework 20% Qizes are given every two weeks and the homework is also given every two weeks
- Examination No. 1 20% This exam is given at the end of the seismic and DC resistivity methods
- Examination No. 2 20% This exam is given at t6he end of the gravity and magnetic methods
- Final Examination 40% This exam is a comprehensive exam for all **FOUR** methods

TOTAL 100%

✍ Remarks:

✍ STUDENTS ARE MOST WELCOME AND ENCOURAGED TO ASK QUESTIONS AS I GO THROUGH EACH LECTURE

✍ ATTENDANCE FOR THE FULL DURATION OF ALL LECTURES SESSIONS IS BOTH EXPECTED AND REQUIRED

✍ IT IS PREFERABLE THAT YOU READ THE MATERIAL THAT WOULD BE GIVEN IN THE LECTURE NEXT DAY. SHORT QUIZZES ARE GIVEN TO TEST YOUR KNOWLEDGE ABOUT THE MATERIAL THAT YOU ALREADY TOOK.

- *ACADEMIC HONESTY* IS VERY IMPORTANT. ANY FORM OF ACADEMIC DISHONESTY WILL RESULT IN A ZERO FOR THAT ASSIGNMENT: QUIZ, EXAM, HOMEWORK, ETC. AS WELL AS A POSSIBLE DISCIPLINARY ACTION. SEE YOUR STUDENT HANDBOOK FOR GUIDELINES.