GEOL A476/676
Applied Geophysics

Shuvajit Bhattacharya, PhD

Materials to be Covered (Tentative)

Weeks	Topics
1	Introduction to geophysics; geophysical signal and noise; resolution; geophysical surveying techniques; applications
1-4	Borehole geophysics; well logging; vertical seismic profile
5-9	Seismic reflection and refraction survey; seismic wave types; Snell's law ** ** I'm out for Society of Exploration Geophysicists Annual Conference, Houston (September 17th). However, there will be in-class activities and/or guest lectures. Take-home Midterm exam is due by week 8 (October 15)
10-11	Gravity survey; microgravity; gravity anomalies; interpretation; application
12-13	Magnetic survey; magnetic anomalies; interpretation; application
14	Resistivity survey; interpretation; application
15	GPR survey; interpretation; application
16	Final term report and presentations are due.

Week 1 (Overview of Geophysics)

1. What is geophysics? Why do we care?
2. Roles of an applied geophysicist
3. Different types of geophysical surveys
4. Active vs. Passive geophysical methods
5. Fundamentals of geophysical signal
6. Concept of signal and noise
7. Resolution of different geophysical surveys
8. Depth of investigation of geophysical surveys
9. Applications

Week 1-4 (Borehole Geophysics)

1. What is a Well Log ?
2. What do we get from well logs? Rock properties
3. Gamma ray log (measurement principle, applications in petroleum and environmental industry)
4. Resistivity log (measurement principle, different types, applications in petroleum and environmental industry)
5. Porosity logs (density, neuron, and sonic, measurement principles, different types, applications in petroleum and environmental industry)
6. Well log correlation
7. Archie's equation- compute fluid saturation
8. Integrated log analysis for target delineation
9. Introduce Petra software and several hands-on exercise with well logs from the sedimentary basins across the US and world (**1 week**)

Week 5-9 (Seismic survey)

1. What is a seismic survey?
2. Seismic wave generation and propagation
3. Body waves and surface waves
4. Reflection and refraction
5. Seismic wave propagation through multi-layered media (critical distance and cross-over distance)
6. Identification of direct, refracted and reflected seismic waves on raw seismic data
7. Reflection Seismic Data Acquisition (land and marine)
   Conduct field data acquisition (at least one-two times)
8. Basics of seismic processing
9. Calculate Resolution of Seismic Data
10. Calculate Frequency & Wavelength
11. Concept of acoustic impedance, reflectivity, and transitivity
12. Concept of frequency attenuation
13. Multi-component seismic (waveform mode conversion- ***for grad students***)
14. Seismic attributes-concepts and interpretation (structure, stratigraphy, and rock properties)
15. Introduce Petrel software and hands-on activities on 3D seismic data analysis (**~1-1.5 week**)
16. Seismic-well tie, synthetic seismogram, hands-on exercise

Week 10-11 (Gravity survey)

1. Fundamentals of Gravity Survey
2. Gravity anomalies
3. Factors Influencing Gravity
4. Gravity Measurement- gravimeter
5. Gravity data processing or reduction
    a) Instrument drift
    b) Tides
    c) Latitude
    d) Free-air correction
    e) Bouguer correction
    f) Terrain correction etc.
6. Free-air and Bouguer anomaly
7. Examples
8. Gravity Anomaly Interpretation
9. Regional and residual anomaly separation, first-order and second-order derivatives of gravity anomaly
10. Brief concept of micro-gravity survey
11. Applications
12. Hands-on exercise

Week 12-13 (Magnetic Survey)

1. Fundamentals of magnetic survey
2. The Earth's Magnetic Field
3. International Geomagnetic Reference Field Model
4. Total Field Intensity and its variation
5. Magnetic Data Acquisition- magnetometer
6. Airborne and Seaborne Magnetometers
7. Magnetic data processing or reduction
8. Magnetic anomalies- regional and residual
9. Comparison Between Gravity and Magnetic Anomalies
10. Vertical Derivatives of Magnetic Anomaly
11. Applications (basement, hydrocarbons, mineral, and archeology, etc.)

Week 14 (Resistivity Survey)

1. Fundamentals of resistivity survey
2. Series and parallel connections
3. Resistivity of Rocks and Minerals
4. Current Flow in the Subsurface
5. Concept of apparent resistivity and true resistivity
6. Resistivity survey and different designs (e.g., Schlumberger, Wenner, and Dipole-dipole)
7. Resistivity anomaly
8. Concept of geophysical inversion and resistivity modeling (***for grad students***)
9. Applications (e.g., mineral exploration, permafrost, and geotechnical, etc.)

Week 15 (GPR Survey, optional, depends on time)

1. Concept of Electromagnetic Spectrum
2. Fundamentals of Ground Penetrating Radar survey
3. GPR: Interaction with Subsurface
4. GPR Data Acquisition- ***conduct field activities as needed***
5. Basic GPR data processing
6. GPR data interpretation
7. Applications

8. Revision of concepts covered as needed

Week 16 (Finals)