



A T M E
College of Engineering



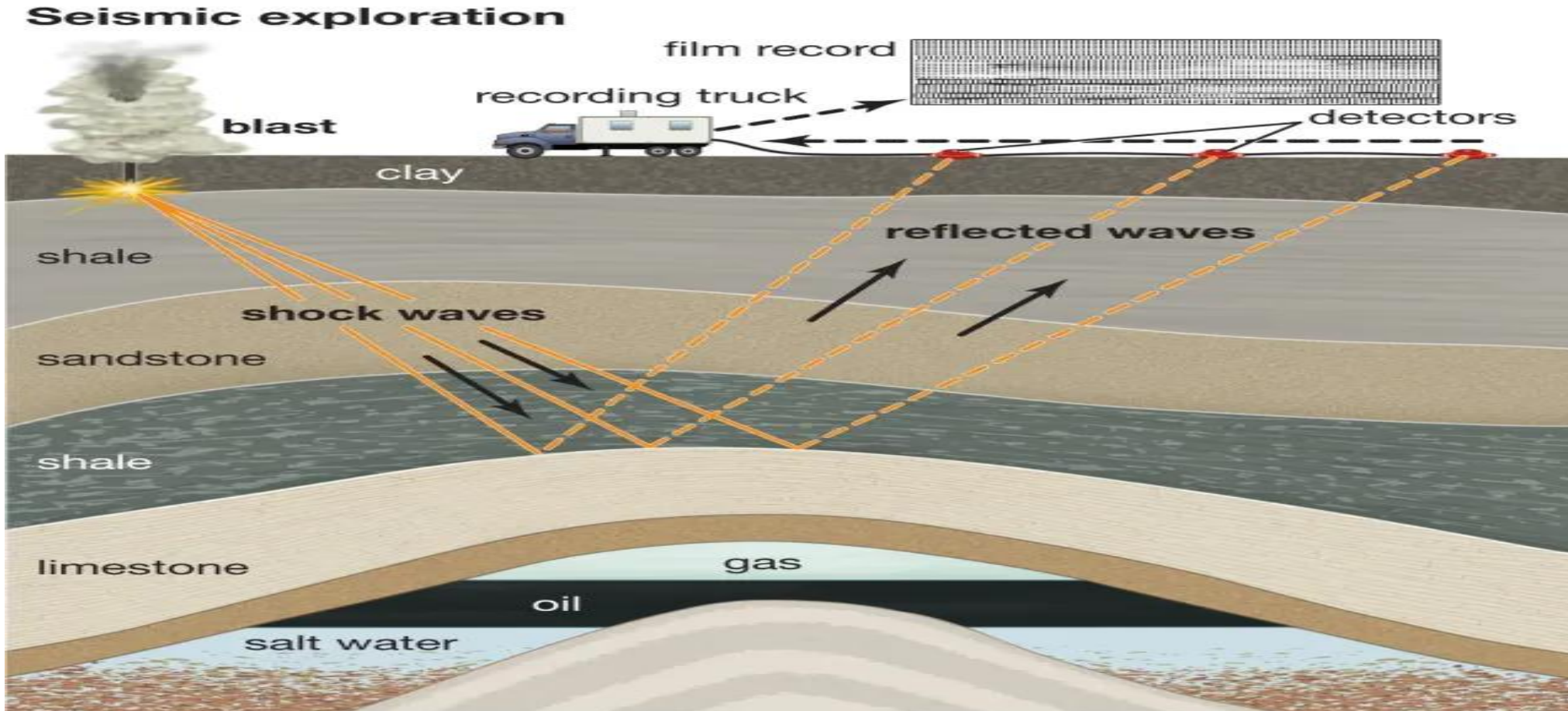
•Module-5



A T M E
College of Engineering



- General, geophysical methods and its importance. Present law regarding water management
- Water footprints- Blue water footprint, green water footprint, grey water footprint. Sustainability
- assessment





A T M E

College of Engineering



- Geophysical methods are important in water studies because they provide non-invasive ways to characterize subsurface conditions, which can be crucial for understanding groundwater resources, identifying potential contamination sources, and monitoring remediation efforts. These methods help determine the presence and extent of aquifers, the depth to bedrock, and the properties of subsurface materials that influence groundwater flow.



A T M E

College of Engineering



- Geophysical methods are crucial for understanding subsurface conditions, particularly in relation to groundwater resources. They help identify aquifers, determine aquifer properties, and locate potential well sites. These methods use physical properties of the Earth, like resistivity and seismic wave velocity, to map the subsurface.



A T M E

College of Engineering



Identifying Aquifers:

- **Electrical Resistivity:**

This method measures the resistance of the Earth to an electric current, which varies based on subsurface materials. Aquifers, with their high porosity and permeability, typically exhibit lower resistivity values.

Seismic Refraction:

- This technique involves sending seismic waves into the ground and measuring their travel time. By analyzing the refraction of waves at different subsurface layers, geophysicists can identify the presence and depth of aquifers.



A T M E

College of Engineering



- Groundwater exploration and characterization involve finding, mapping, and understanding the properties of underground water sources. This process uses various techniques, including geophysical surveys, hydrogeological studies, and water quality analysis, to locate aquifers and assess their suitability for water supply or other uses.



A T M E

College of Engineering



- Exploration Techniques:
- **Geophysical Methods:**
- These methods, like seismic, electrical resistivity, and gravity surveys, help map subsurface structures and identify potential aquifer locations without direct drilling.
- **Hydrogeological Studies:**
- These involve analyzing geological formations, understanding groundwater flow patterns, and evaluating aquifer properties like porosity, permeability, and recharge rates.
- **Remote Sensing:**
- Satellite and aerial imagery can provide information about vegetation, land use, and water bodies, which can be used to infer groundwater conditions.



A T M E

College of Engineering



- **Borehole Logging:**
- Once a potential aquifer is identified, drilling and borehole logging can provide detailed information about its characteristics, such as lithology, fractures, and water quality.
- **Water Quality Analysis:**
- Chemical and biological tests are conducted to assess the suitability of groundwater for different uses, ensuring that it meets quality standards.



A T M E
College of Engineering



- Characterization Aspects:
- **Aquifer Properties:**
- Characterization involves determining parameters like porosity, permeability, hydraulic conductivity, and storativity to understand how much water an aquifer can hold and how easily it flows.
- **Water Quality:**
- Chemical analysis helps identify contaminants, such as heavy metals, organic pollutants, and pathogens, ensuring that groundwater is safe for use.
- **Groundwater Flow:**
- Understanding how groundwater moves through the subsurface is crucial for managing resources and preventing contamination.
- **Recharge and Discharge:**
- Estimating the rate at which groundwater is replenished (recharge) and released (discharge) is essential for sustainable water management.

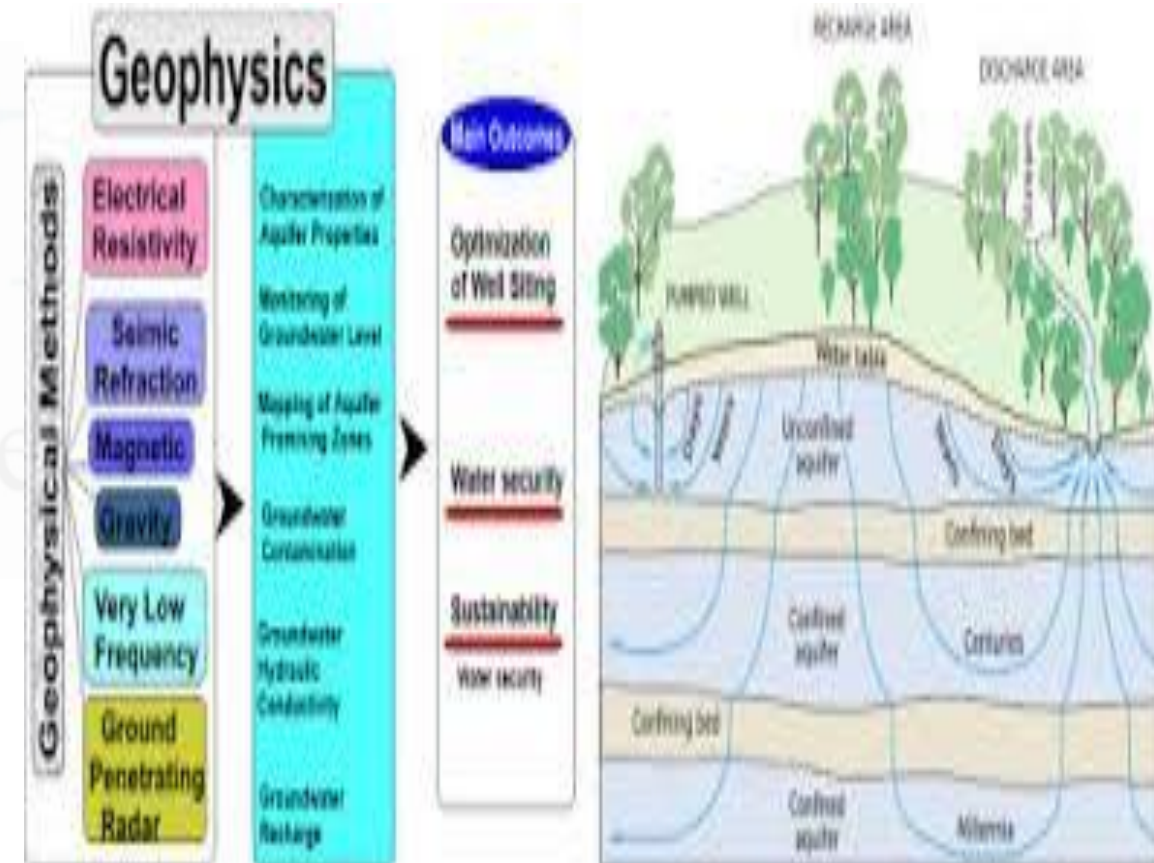
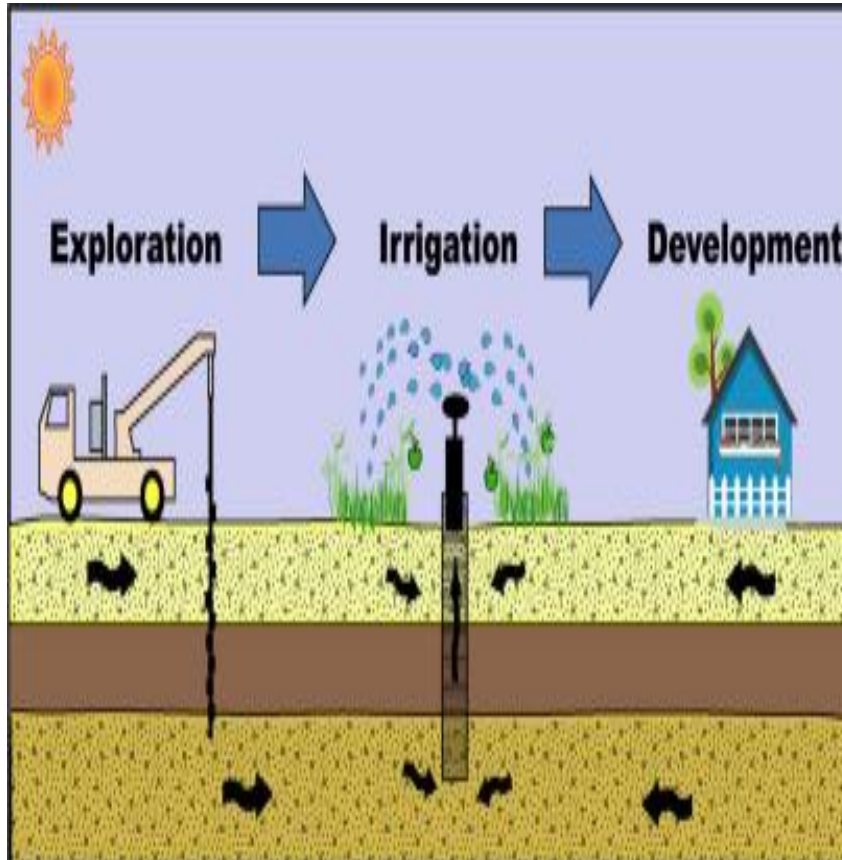


A T M E

College of Engineering



- Tools and Instruments:
- **Geophysical Instruments:**
- These include resistivity meters, magnetometers, gravimeters, and seismic equipment used for surface and borehole surveys.
- **Hydrogeological Tools:**
- These include well logging equipment, pumping test instruments, and water sampling equipment.
- **Analytical Instruments:**
- These include laboratory equipment for chemical and biological analysis of water samples.





A T M E
College of Engineering



- Geophysical surveys are non-destructive methods used to explore the Earth's subsurface by measuring its physical properties, such as density, magnetism, and electrical conductivity. These surveys are crucial for identifying hidden geological structures, mapping subsurface features, and detecting potential hazards like faults or mineral deposits.



A T M E

College of Engineering



- 1. Methods and Techniques:

Seismic Refraction:

- This method uses seismic waves to map subsurface layers by measuring the time it takes for these waves to travel through different materials.

Gravity Surveys:

- Measure variations in the Earth's gravitational field, which can indicate the presence of subsurface mass anomalies like buried structures or mineral deposits.
- Magnetic Surveys:
- Detect variations in the Earth's magnetic field, which can be used to map geological features, such as faults, and also locate buried objects.
- Electrical Resistivity Surveys:
- Measure the resistance of subsurface materials to electrical current, helping to differentiate between different rock types, identify groundwater zones, and locate underground anomalies.
- Electromagnetic Surveys:
- Use electromagnetic waves to map subsurface conductivity, useful for identifying conductive materials like mineral deposits or buried structures.



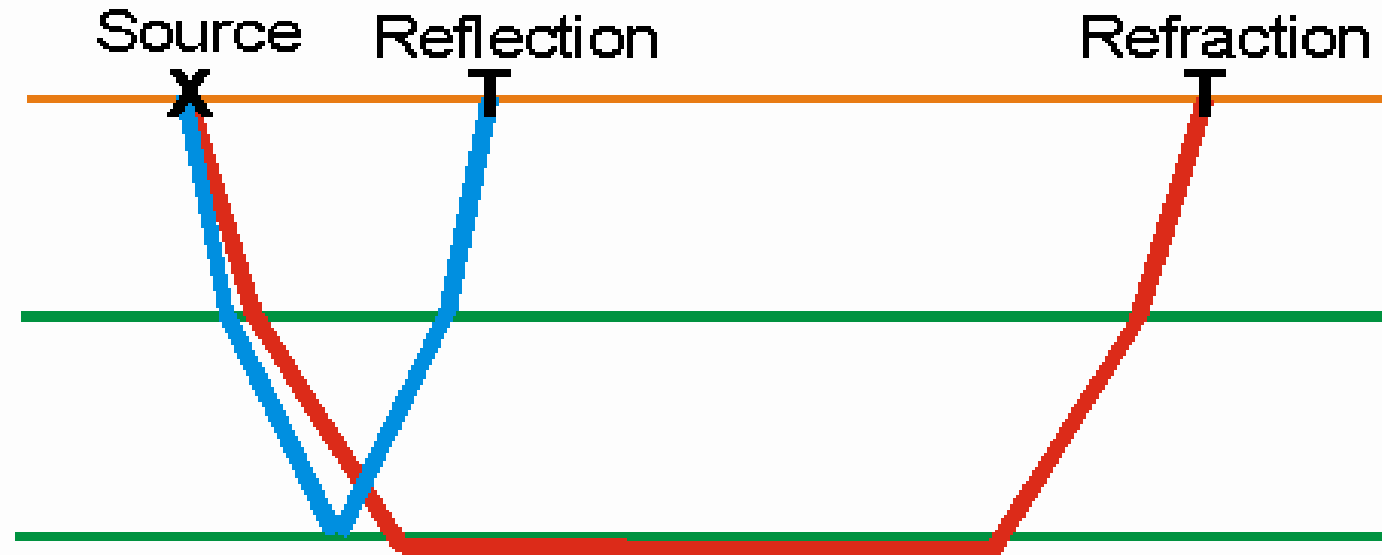
A T M E
College of Engineering



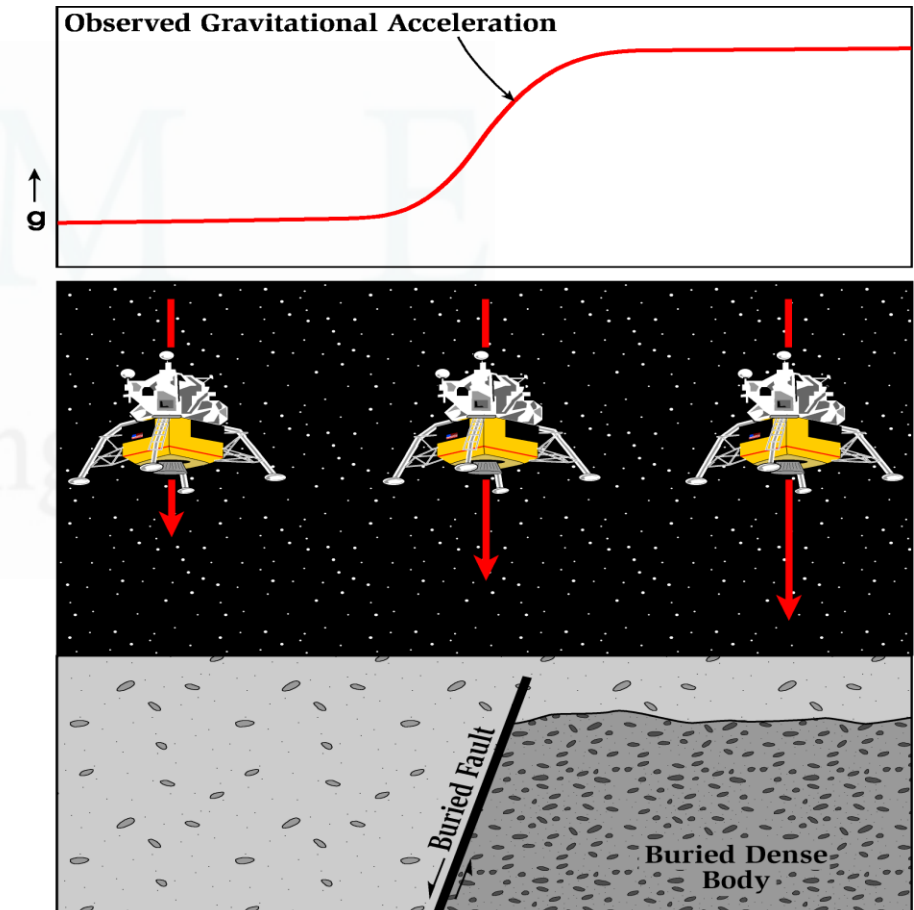
- Seismic refraction is a geophysical method that utilizes the bending (refraction) of seismic waves to study the subsurface structure of the Earth. It works by analyzing the travel times of seismic waves that have traveled along interfaces between different materials of varying densities. By measuring these travel times, geoscientists can determine the depth and thickness of subsurface layers, as well as the velocities of seismic waves within those layers.



A T M E
College of Engineering



- A gravity survey is a geophysical technique that measures variations in the Earth's gravitational field to infer subsurface density variations. It's used to map the distribution of different rock types and structures, helping with mineral exploration, geological studies, and more.





A T M E

College of Engineering



- How it Works:

1. Measuring Gravity:

A gravimeter, a specialized instrument, measures the acceleration due to gravity at different points on the Earth's surface.

2. Identifying Anomalies:

Variations in the measured gravity field (gravitational anomalies) indicate differences in the density of the subsurface rocks.

3. Interpreting the Data:

These gravity anomalies are then interpreted to map out features like faults, mineral deposits, and other geological structures.

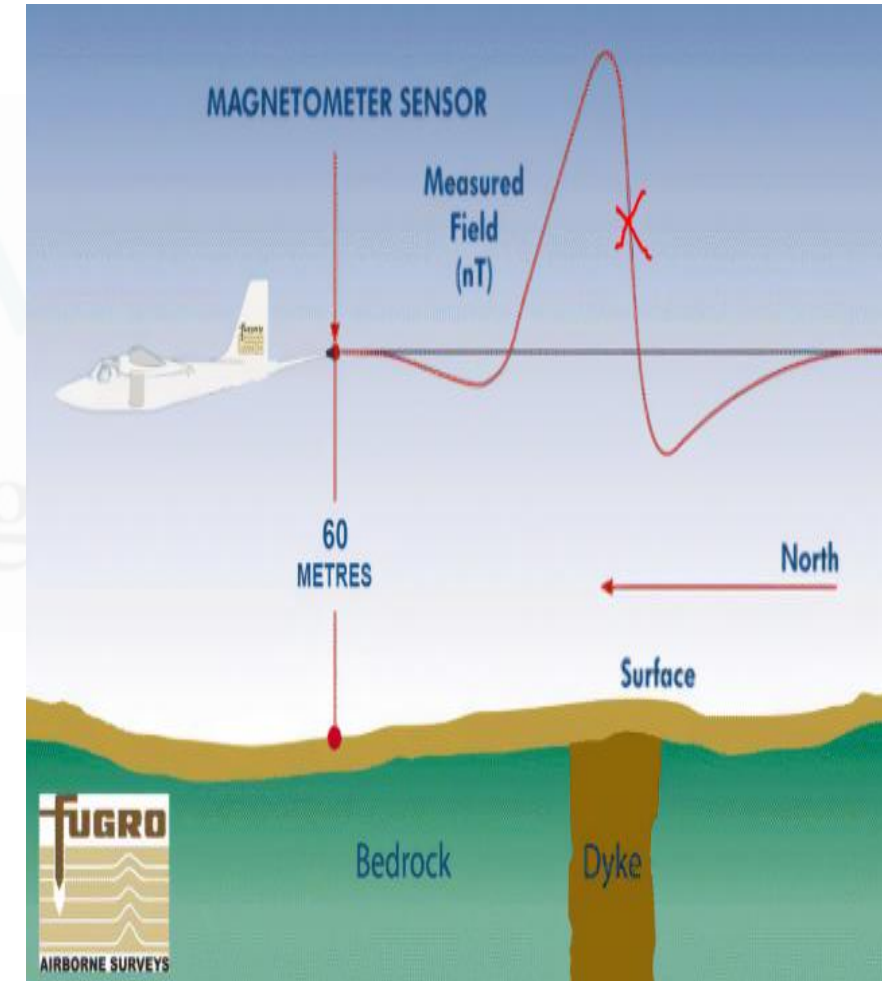


A T M E

College of Engineering

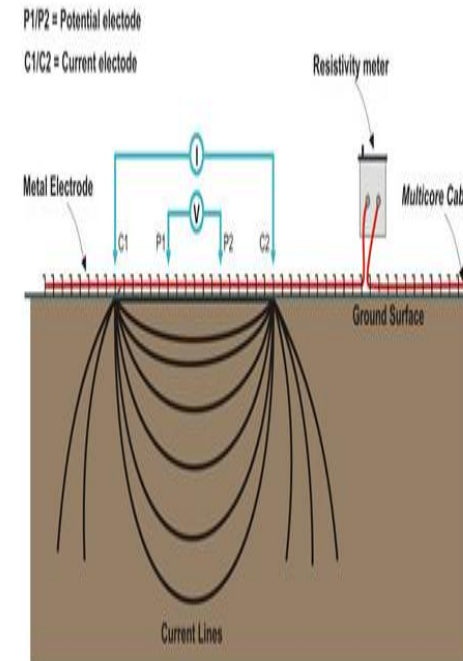


- Magnetic surveys are geophysical exploration methods that map variations in the Earth's magnetic field caused by the magnetic properties of subsurface materials. These surveys are used to detect and locate subsurface features like mineral deposits, buried structures, and changes in rock composition. They are valuable tools in mineral exploration, oil and gas exploration, archaeology, and environmental studies



- Electrical resistivity surveys are geophysical methods that map subsurface structures by measuring the electrical resistance of the ground. They do this by sending an electric current through the ground and measuring the voltage difference between electrodes. This technique is used to determine the distribution of electrical properties, which can provide insights into subsurface geology, groundwater conditions, and even archaeological features

General resistivity principle



Typical field set-up





A T M E

College of Engineering



Electromagnetic (EM) surveys use the principle of inducing electromagnetic fields into the ground and measuring the response to understand subsurface properties. These surveys can be conducted from the ground or from the air, using instruments like electromagnetic induction meters or coils to generate and measure the induced signals. Applications include mapping groundwater, locating buried objects, and exploring for minerals and other resources.





A T M E

College of Engineering



- Importance of Geophysical Methods:
- **Resource Exploration:**
- Geophysical techniques are vital for locating and characterizing mineral, oil, and gas deposits, helping to identify potential economic resources.
- **Geotechnical Engineering:**
- They provide crucial data for foundation design, slope stability assessment, and monitoring of infrastructure projects, ensuring safety and efficiency.
- **Groundwater Exploration:**
- Geophysical methods assist in locating and characterizing groundwater aquifers, assessing recharge rates, and monitoring water quality.
- **Environmental Monitoring:**
- They help track contaminant migration, assess the impact of pollution, and monitor remediation efforts.
- **Geologic Mapping:**
- Geophysical data helps create detailed geological maps, understanding the distribution and characteristics of rock formations and structures.
- **Archaeological Investigation:**
- Geophysical surveys are used to identify and characterize buried archaeological sites and structures, providing valuable insights into past civilizations.
- **Other Applications:**
- Geophysical methods are also used for monitoring volcanoes, assessing the stability of permafrost, and studying other geological phenomena.



A T M E
College of Engineering



- **Effects of Water Pollution**
- The effects of water pollution are as follows:
- **Health Effects**
 - Contaminated water is a major source of waterborne diseases such as cholera, typhoid, hepatitis A, and dysentery.
 - Exposure to toxic chemicals in polluted water can lead to serious health conditions, including cancers, neurological disorders, and reproductive issues.
- **Environmental Effects**
 - Water pollution can disrupt reproductive processes, cause fish kills, and alter aquatic habitats.
 - All these lead to the loss of biodiversity.
 - Excess nutrients from agricultural runoff can cause eutrophication, leading to algal blooms that deplete oxygen levels in water.
 - This process can result in “dead zones” where aquatic life cannot survive.
- **Economic Effects**
 - Water pollution can have significant economic costs, including increased healthcare expenses, loss of tourism revenue, and reduced agricultural productivity.
 - Water pollution affects fish populations, reducing catches and economic losses for the fishing industry.
 - Cleaning up polluted water bodies and restoring affected ecosystems can cause substantial costs.
- **Other Effects**
 - Water Pollution can render freshwater sources unusable, reducing the availability of clean water for drinking, irrigation, and industrial use.
 - This can exacerbate water scarcity issues



A T M E

College of Engineering



- Six essential ways to better locate underground water involve identifying aquifers, determining their properties, locating potential well sites, analyzing subsurface geology and hydrogeology, and employing geophysical surveys.

1. Identifying Aquifers:

- Geophysicists use techniques like electrical resistivity and seismic refraction to map the subsurface and identify areas with high porosity and permeability.
- These methods can help pinpoint areas where groundwater is likely to be found and where it flows, according to IntechOpen and ScienceDirect.com.



A T M E

College of Engineering



- 2. Determining Aquifer Properties:
- Geophysical methods can estimate the hydraulic conductivity, transmissivity, and porosity of aquifers.
- These properties are crucial for understanding how groundwater flows and is recharged,

3. Locating Potential Well Sites:

- By mapping subsurface geology and hydrogeological conditions, geophysical surveys can help pinpoint locations where groundwater wells are likely to be successful, [according to Anco Environmental Services Inc.](#)



A T M E

College of Engineering



- 4. Analyzing Subsurface Geology and Hydrogeology:
- Understanding the geological and hydrogeological conditions of an area is essential for predicting groundwater occurrence and movement.
- This involves mapping the subsurface geology, identifying aquifers, and understanding the hydraulic characteristics of the region.



A T M E
College of Engineering



- Employing Geophysical Surveys:
- Geophysical methods, such as electrical resistivity and seismic refraction, can provide valuable information about the subsurface.
- These methods can be used to identify subsurface structures, map the distribution of aquifers, and assess the suitability of potential well sites, [according to CGWB](#)



A T M E
College of Engineering

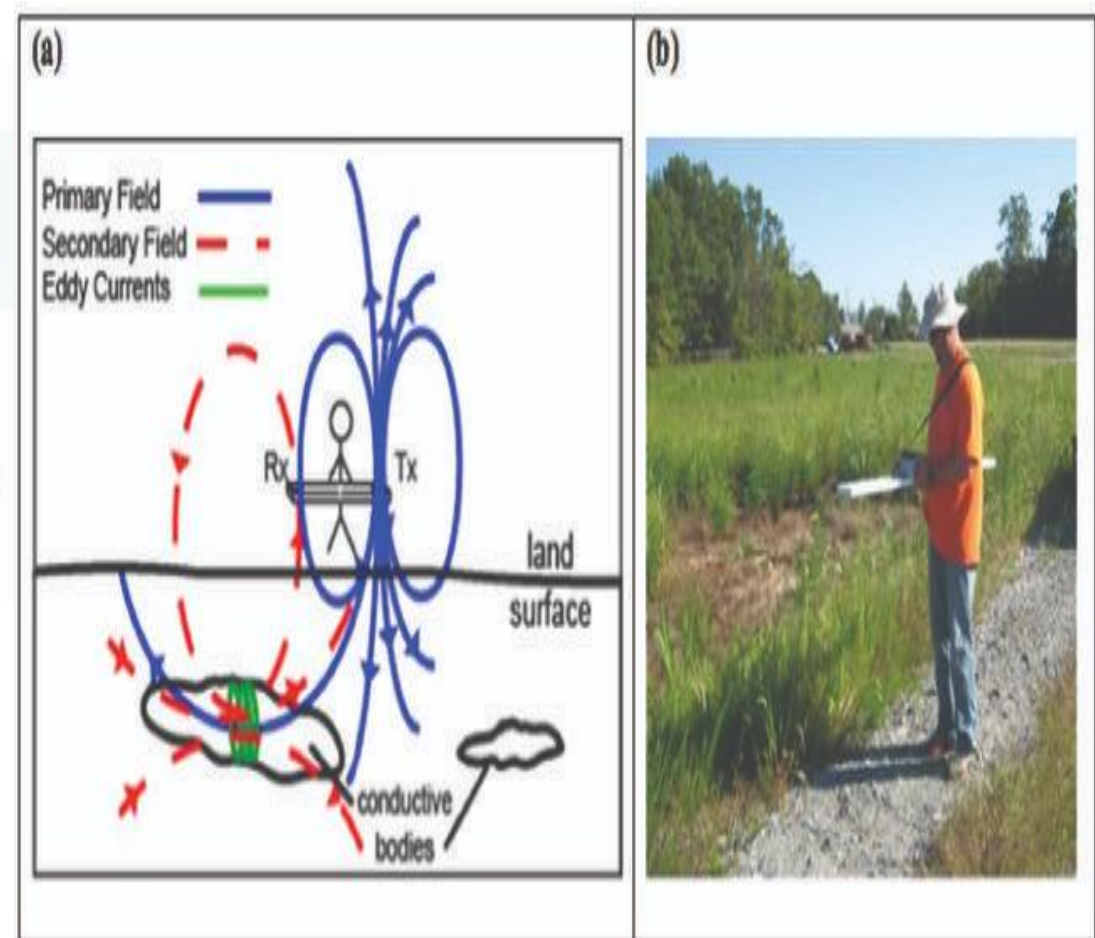
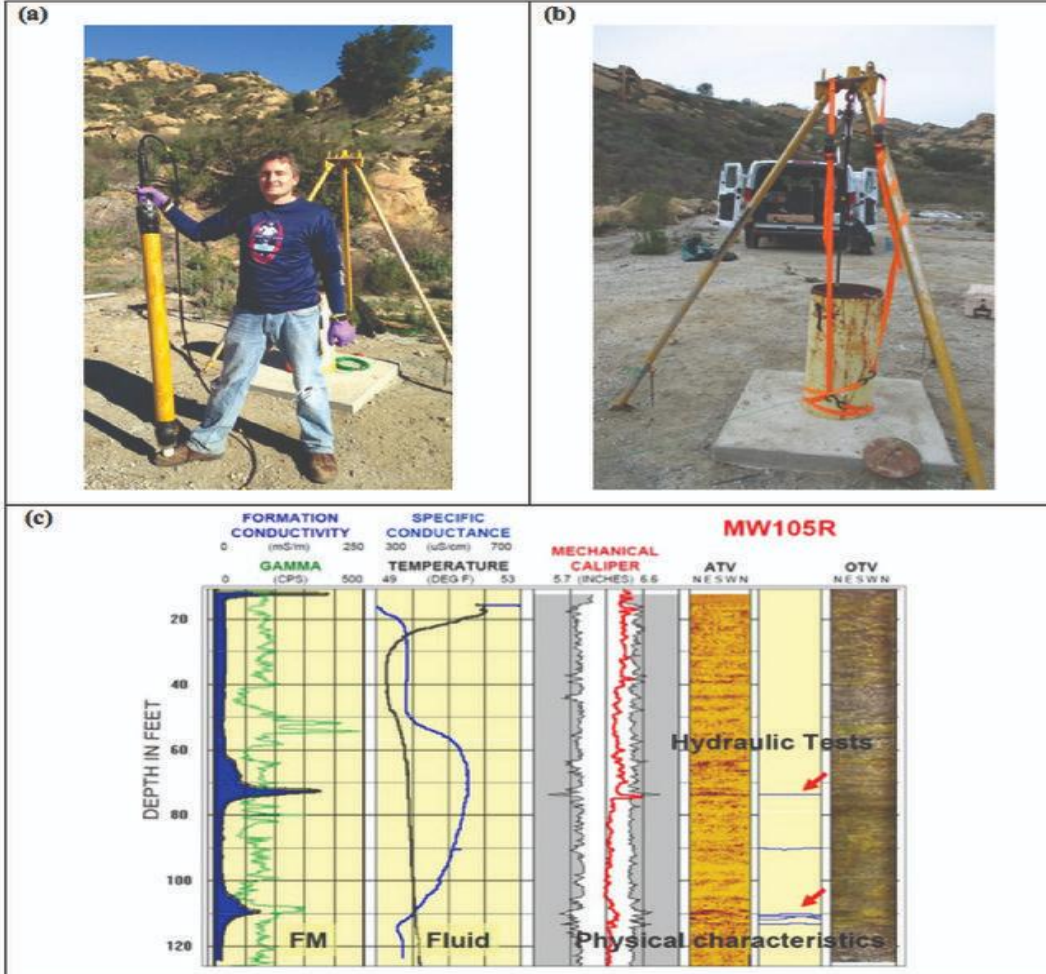


- Utilizing Borehole Logs:
- Borehole logging involves collecting and analyzing data from wells and boreholes to determine subsurface conditions, [according to Anco Environmental Services Inc.](#)
- This information can help in estimating aquifer properties, identifying groundwater flow paths, and assessing the suitability of potential well sites



ATME

College of Engineering





ATME
College of Engineering

