



**— University of Mosul —**  
**College of Petroleum & Mining Engineering**

**Geophysical methods:**  
**Lecture-5**  
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It is a physical measurement of subsurface condition made from surface

location. There are three types of methods, which are:

- Gravitational ( gravity survey)
- Magnetic survey
- Seismic survey

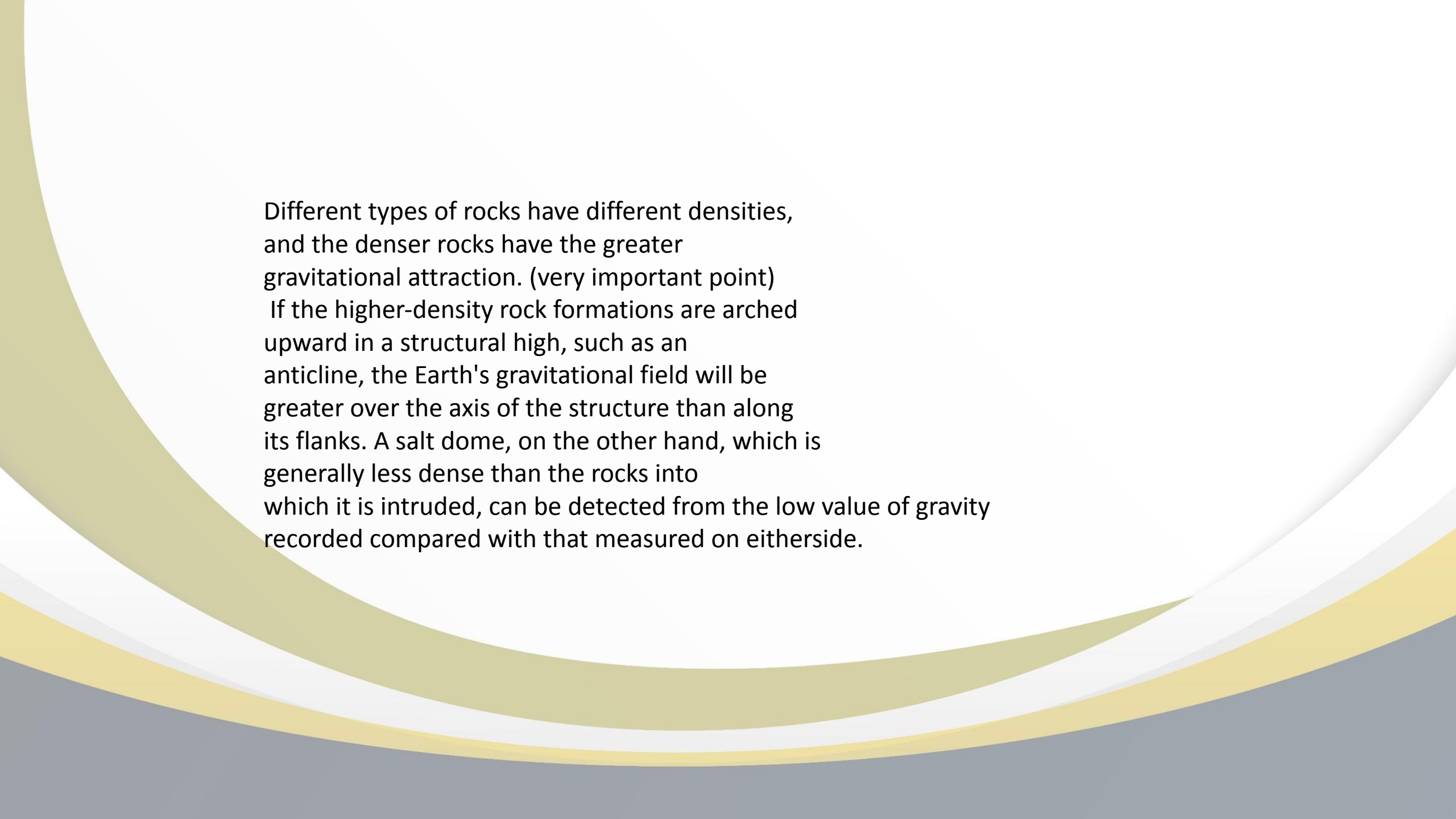
## 1- Gravitational Method:

The Earth's gravitational attraction varies slightly from one place to another on the Earth's surface.

Some of this variation occurs because the Earth is not a perfect sphere, and some is related to differences in elevation on the Earth's surface.

In gravity prospecting, geophysicists measure variations in the force of gravity from rocks up to a few miles beneath the earth's surface (i.e. measures the variation in the acceleration due to gravity).

This method is based on the Newton's hypothesis that every particle in the universe attracts every other particle in the manner, which defined by the equation:



Different types of rocks have different densities, and the denser rocks have the greater gravitational attraction. (very important point)

If the higher-density rock formations are arched upward in a structural high, such as an anticline, the Earth's gravitational field will be greater over the axis of the structure than along its flanks. A salt dome, on the other hand, which is generally less dense than the rocks into which it is intruded, can be detected from the low value of gravity recorded compared with that measured on either side.

Igneous rocks like granite is denser than sedimentary rocks. Gravimeter is used to pick up a reflection of the density of subsurface rock. Previously used instruments were torsion balance and pendulum.

## 2- Magnetic Method:

This method seek to maps anomalies in earth's magnetic field and correlate these with underground structure. In other mean, it used to investigate the subsurface geology by measuring the strength or intensity of the earth's magnetics fields (Measure changes in the Earth magnetic field caused by variations in the magnetic properties of rocks).

Sedimentary rocks generally have a very small magnetic or non magnetic susceptibility compared with igneous or metamorphic rocks, which tend to have a much higher magnetometers (a common magnetic mineral) content.

By conducting a magnetic survey over a given area, a prospector can determine where oil-bearing sedimentary rock is more likely to be found.

The magnetometer is used to measure the magnitude of the earth's total magnetic field over a large area. A magnetometer can be towed behind a ship or an airplane to cover large areas. It transmits data to a device on board which records the information onto paper or magnetic tape.

A development of airborne magnetics is the micro magnetic technique for oil exploration. An airplane tows a micro-magnetometer from a low altitude, normally about 300 ft above the ground. It detects micro-magnetic anomalies, or deviations from the norm.

Any Irregularity spotted is attributed to depth variation of basement rock.

Anomalies in earth magnetic field proportional to the depth of burial of the basement rock. Instruments used in this method vary from dip needle to compass. The geophysicist, by taking the magnetic measurements through an area, can estimate the geological structure of the basement rocks, as well as the thickness of the sedimentary cover rocks (i.e. predict the characteristics of overlying sediment ).



## Seismic Method

it is most successful and widely applied method of determining the type of rock, their relative depth and the location of traps that are suitable for petroleum accumulation and finding good drilling locations .

The word “seismic” refers to vibrations of the earth, including both earthquakes and artificially created sound waves that penetrate into the earth. Sounds measured are in the frequency range of about  $10\text{--}100\text{ cycles.s}^{-1}$  . The depths investigated for a sound to travel into the earth and return are as much as 16 km.

This methods is based on the difference in propagation velocity of artificially induced elastic wave through various subsurface strata (i.e. seismic waves travel with different velocities in different rocks). A sound waves, generated by explosion of dynamite or viber series, which are sending through the earth. A pattern of recording detectors (Geophones) arranged at known distance from the shot points record the arrival time of the reflected and refracted waves.



If wave paths and their velocities are known, then their travelled distances

can be found by the time of arrival at the detectors

Note: variations in depth from a common surface elevation indicate structure.

determining the depth at a large number of points the geophysicist create a profile of the underground layer along the line Data received is recorded on a paper known as seismograph.

Seismograms generate a seismic section, which is a two-dimensional slice from the surface of the earth downward.

The information from a seismic survey indicates the types of rock, their relative depth, and whether a trap is present.

Seismic Method Energy source »

Onshore source are

- Explosives
- Dropping heavy weight
- Vibrating plate

Off shore source are

- Electric sparker (implosion, shallow depths)
- Air gun (bubble of compressed air, up to 5km)