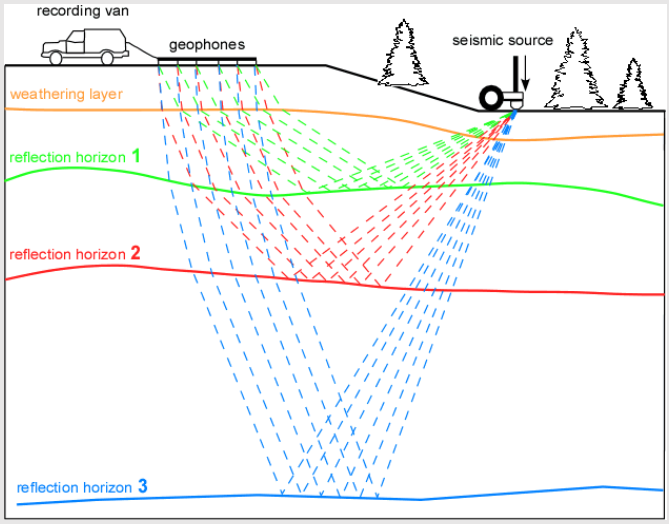
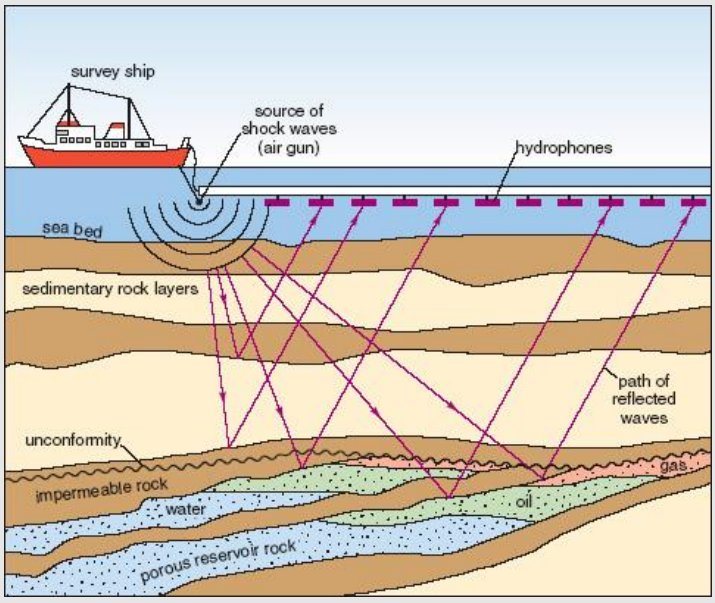
EXPLORATION FOR HYDROCARBONS

GEOPHYSICAL EXPLORATION TECHNIQUES

Seismic reflection surveys: Land or ship-based

1. **Artificial seismic waves** are generated by vibrations on land using a **heavy `thumper'** mounted on a truck. In the sea, **explosions or air guns** may be used on a ship.
2. The artificial seismic waves travel through the Earth and are **reflected as layer boundaries** within a **sedimentary sequence**. They travel back up to the surface and are **detected by an array of geophones** (on land) or **hydrophones** (in water)
3. Their l**ocation** is accurately measured using **GPS.** The **time taken** for the reflected waves to arrive back at the receiver is the travel time and can be used to **calculate distance**s to a **reflective layer** and so a **seismic profile** can be constructed to show **subsurface layering**. **Geophysicists** use this to identify **potential traps.**
4. While vibrotrucks have a limited path on land, ships have unrestricted paths and can two a large array of hydrophones making exploration more efficient.





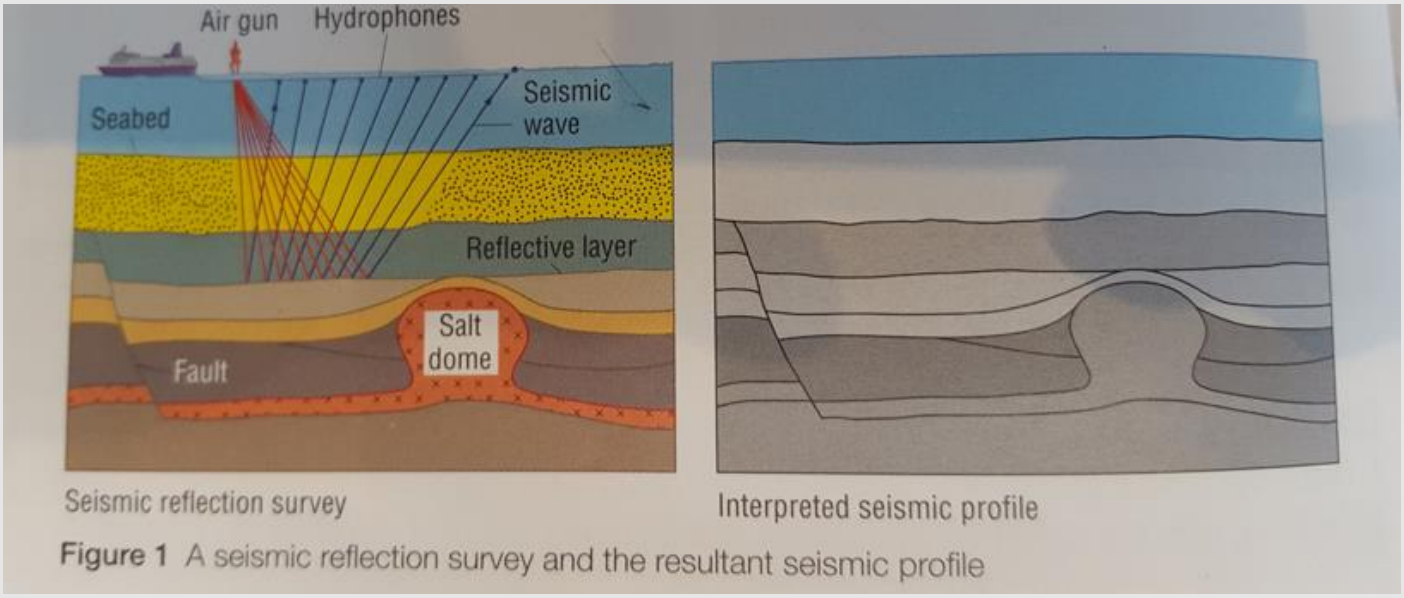


Figure 1 A seismic reflection survey and the resultant seismic profile

Gravity surveys: land or airborne

1. An instrument called a g**ravimeter** measures **small variations** in the Earth's gravitational field strength. The units of measurement are **milligals (mGal).** Gravimeters can be mounted in **road vehicles, helicopters or planes**, allowing a rapid coverage of a wide area.
2. Survey points are located **using GPS** and the **gravity data is corrected** to account for the effects of **latitude, altitude and topography**. This means any **variations are** solely **due to** the underlying **rock** types. A **map is then plotted** with the data points and **lines joining** points of **equal gravitational field** strength are drawn. This makes identification of **anomalies easier.**
3. A **positive gravity anomaly** suggests an **excess of mass**; this could be due to an **anticline or an uplifted** block **bounded by faults** that may represent a **trap** structure.
4. A **negative anomaly** represents a **deficit of mass**, which may be due to the presence of a **low-density salt dome**. In this case, the **exploration target** would be around the **edge of the salt dome** at the **zero milligal line.**
5. They are very useful for identifying reserves of **natural gas, oil and precious metals**

- **A gravity anomaly** is a departure from the normal value and may be positive or negative.

EXPLORATION DRILLING TECHNIQUES

Once potential oil and natural gas traps have been identified, **exploration drilling is used as verification**. Holes are drilled using **cylindrical drill bits studded with diamonds**.

Mud logging

1. **Rock chips** are brought up to the **surface in the drilling mud**. These are **sieved from the mud**, **washe**d and **analysed** under a microscope by geologists called **mud loggers.**
2. Mud loggers identify **microfossils and rock types** present at **different depths down the hole** to build up a picture of the **changing rock types** and **correlate the geology between boreholes**.
3. The **rotating drill bit** is **lubricated and cooled** by **drilling mud containing the mineral barite** to make it **dense enough** to reach the bottom of the hole.
4. **Millimeter-sized rock chips** or a continuous core can be extracted. The latter is more expensive so is only done at **necessary depths.**

Down-hole drilling

1. **A geophysical instrument** called **a sonde** is passed down the drill hole on a cable called a **wireline**. The sonde then **records data** as it **slowly ascends** from the bottom of the hole.
2. **Porosity:** the **higher the porosity**, the higher the **possible natural gas and oil** content of the reservoir rock. It is important to interpret **the type of fluids** present in the pores (**oil, gas, brine**)
3. **Gamma-ray spectroscopy**: this uses a **Geiger counter** to record the count rate of **radioactive decay** of some **unstable isotopes**. Potential source rocks like **black oil shales and mudstones** have **higher gamma ray counts**. **Sandstones and limestones** have a far **lower count** rate.
4. **Resistivity:** measures the **resistance to the flow of electrons** for the rock. **Water is the main conduc**tor present in rocks and gives a lower resistance. The presence of **hydrocarbons,** however, gives a far lower conductance reading.