5. Finding Oil and Gas: Exploration

- Oil and gas exist in reservoirs located thousands of feet below the earth's surface and ocean floors. These reservoirs would exist only in certain locations depending on the geologic history of the earth.
- Therefore, determining the location of petroleum reservoirs is a very difficult task and probably is the most challenging aspect of the petroleum industry.
- The main goal of exploration operations is to obtain an image of the reservoir prior to drilling. By using exploration techniques, geological information data are collected on subsurface conditions to evaluate the potential for the presence of oil and natural gas.
- The collected information helps a decision to be made as to whether there is a hydrocarbon reserve or not and where more intensive exploration activities should take place.
- Petroleum exploration operation methods can be divided into two different categories. The first are **land-based operations** and the others are **aquatic**, which might be conducted in river and offshore environments.
- Finding or discovering a petroleum reservoir involves three major activities: **geologic surveying**, **geophysical surveying**, and **exploratory drilling activities**.

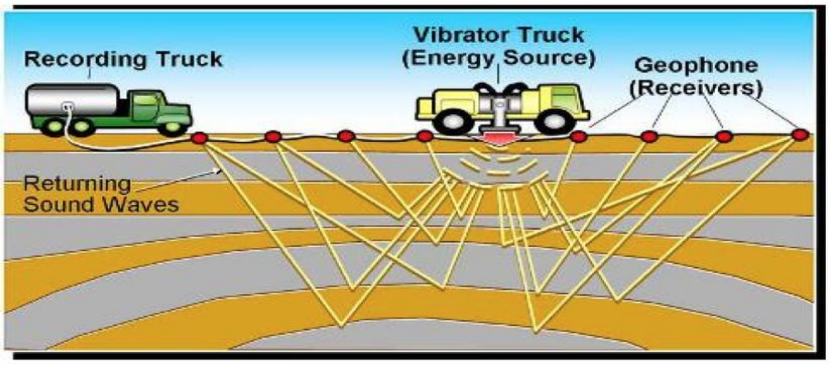
1. Geologic Survey

- Geologic surveying is the oldest and first used tool for determining potential locations of underground petroleum reservoirs.
- It involves examination of the surface geology, formation outcrops, and surface rock samples.
- The collected information is used in conjunction with geologic theories to determine whether petroleum reservoirs could be present underground at the surveyed location.
- The results of the geologic survey are not conclusive and only offer a possibility of finding petroleum reservoirs.

2. Geophysical Surveys

❖ There are mainly four types of geophysical surveys used in the industry: **gravity survey**, **magnetic survey**, **seismic survey**, and **remote sensing**.

- **The gravity survey** involves the use of an instrument, a gravimeter, which picks up a reflection of the density of the subsurface rock. For example, because salt is less dense than rocks, the gravimeter can detect the presence of salt domes, which would indicate the presence of an anticline structure. Such a structure is a candidate for possible accumulation of oil and gas.
- **The magnetic survey** involves measurement of the magnetic pull, which is affected by the type and depth of the subsurface rocks. The magnetic survey can be used to determine the existence and depth of subsurface volcanic formations, or basement rocks, which contain high concentrations of magnetite.
- **The seismic survey** involves sending strong pressure (sound) waves through the earth and receiving the reflected waves off the various surfaces of the subsurface rock layers. The sound waves are generated either by using huge land vibrators or using explosives. The very large amount of data collected, which include the waves' travel times and characteristics, are analyzed to provide definitions of the subsurface geological structures and to determine the locations of traps that are suitable for petroleum accumulation. Sensors on land are called **geophone**. The sensors on lakes and seas are called **hydrophones**. This type of survey is the most important and most accurate of all of the geophysical surveys.
- **Remote sensing** is a modern technique that involves using infrared, heat-sensitive color photography to detect the presence of underground mineral deposits, water, faults, and other structural features. The sensing device, normally on a satellite, feeds the signals into special computers that produces maps of the subsurface structures.



Land Seismic Acquisition

3. Exploratory Drilling

- The data collected from the geologic and geophysical surveys are used to formulate probable definitions and realizations of the geologic structure that may contain oil or gas.
- However, we still have to determine whether petroleum exists in these geologic traps, and if it does exist, would it be available in such a quantity that makes the development of the oil/gas field economical? The only way to provide a definite answer is to drill and test exploratory wells.
- The exploratory well is drilled in a location determined by the geologists and geophysicists.
- The well is drilled with insufficient data available about the nature of the various rock layers that will be drilled or the fluids and pressures that may exist in the various formations.
- As this exploratory well is drilled, samples of the rock cuttings are collected and examined for their composition and fluid content.
- The data are used to identify the type of formation versus depth and to check on the presence of hydrocarbon materials within the rock.
- Whenever a petroleum-bearing formation is drilled, the well is tested while placed on controlled production.
- After the well has been drilled, and sometimes at various intervals during drilling, various logs are taken that are used to gather information about the drilled formations. These tools are lowered into the well on a wireline (electric cable).

- The exploratory well will provide important data on rock and fluid properties, type and saturation of fluids, initial reservoir pressure, reservoir productivity, and so forth.
- These are essential and important data and information that are needed for the development of the field.
- In most situations, however, the data provided by the exploratory well will not be sufficient.
- Additional wells might need to be drilled to provide a better definition of the size and characteristics of the new reservoir.
- Of course, not every exploratory well will result in a discovery. Exploratory wells may result in hitting dry holes or they may prove the reservoir to be an uneconomical development.