

What are Seismic Surveys?

From the fuel in our cars to the heat in our homes, our lives are intricately dependent on oil and natural gas. In fact, more than 80 percent of global energy consumption, as well as lesser known items such as cosmetics and plastics come from oil and gas. Yet, long before they can be utilized, they must be found deep beneath the ground. That's where seismic surveys play a critical role. Seismic surveys are also used in a variety of ways, from helping to locate ground water, checking the foundations for roads and buildings, to locating potentially recoverable mineral and hydrocarbon resources.

Similar to an ultrasound imaging a human body, seismic surveys generate images below the surface of the earth tens of thousands of feet and accurately image the Earth's subsurface before a single well is drilled. Modern seismic imaging reduces risk by increasing the likelihood that exploratory wells will successfully tap hydrocarbons and decreasing the number of wells that need to be drilled in a given area. Seismic surveys also reduce associated safety and environment risks and the overall footprint of exploration. Because survey activities are temporary and transitory, they are the least intrusive and most cost-effective means to understanding where recoverable oil and gas resources likely exist.

Seismic surveys can be performed onshore or offshore or in what is called "transition zones" (shallow water areas, such as river estuaries and beaches).



Marine Seismic Surveys

By determining geological features below the sea floor, marine seismic surveys are a vital part of exploring for oil and gas. The survey is conducted by sending acoustic waves into the various buried rock layers beneath the sea floor and then recording the time it takes for each wave to bounce back while measuring the various characteristics of each returning wave. In water, the energy source is typically an array of different sized air-chambers, filled with compressed air. The source is towed behind a seismic survey vessel and releases bursts of high pressure energy into the water. The returning sound waves are detected and recorded by hydrophones that are spaced out along a series of cables.

Land Seismic Surveys

Land seismic operations are similar to marine operations in that the energy sources are typically vibrators mounted on trucks, or explosives placed in shot-holes which have been drilled by truck-mounted or portable drills. The receivers are typically geophones, which are like small microphones pushed into the soil to measure the ground motion. Onshore seismic are used in sensitive locations without damaging buildings or the environment.

Benefits of Seismic Surveys

The earliest oil deposits were found by drilling natural oil seeps and large folds in exposed rocks. It was not uncommon to see an entire landscape stacked with one oil well after another all searching for oil and gas reserves—and many resulting in dry holes. After the easiest locations were quickly found and drilled, geologists began using seismic data to more efficiently search out oil and gas. In 1924, a Texas oil field was the first discovery based on the use of seismic data. Seismic technology eliminated exploring with the drill bit.

Today, advancements in seismic technology have helped find, drill and produce oil and natural gas with the least risk and the least possible impact to the earth. As operators explore for oil and gas, the use of geophysical technologies helps to reduce risk in regards to cost, safety and damage to the environment. Seismic information is used to accurately plan locations for wells, reducing the probability of drilling dry wells and consequently the need for further drilling, minimizing the environmental impact of the oil and gas exploration.



This historic postcard of Huntington Beach, California depicts numerous oil wells—an early 20th Century drilling plan. Now seismic surveys can paint a picture of the subsurface in order to better target oil and gas reserves.



Any time we drill a well, either when trying to find oil and gas or when developing a reservoir for production, geophysical technologies can reduce many risks. Images that seismic creates below the earth's surface can illuminate potential hazards for drilling to ensure it is as safe, reliable and efficient as possible.

For example, analysis of a subsurface in advance of drilling is only available through seismic techniques and supports the design of well trajectories that can reach the oil or gas reservoir while avoiding any hazardous highly over-pressured zones that could cause potentially serious issues.

Before picking an exact drilling location, companies utilize seismic to perform hazard surveys to look for geologic hazards on the sea bottom and in the shallow subsurface that could affect the drilling of a well. Features such as a steeply dipping or unstable sea

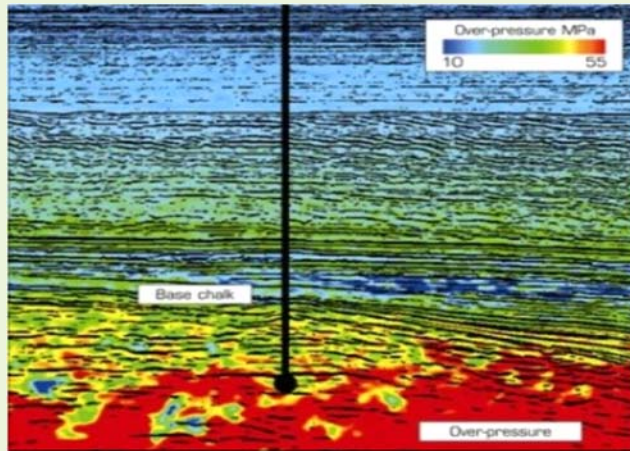
bottom are hazardous and must be avoided in positioning the rig. Likewise, shallow gas pockets, faults, and/or abnormally pressured sands can cause severe problems during the drilling of a well if not known about in advance. To avoid these problems, high resolution seismic surveys are conducted. The resulting data does an excellent job of pinpointing potential hazards.

Geophysical technology enables oil and gas operators to accurately predict the fluid pressures and rock fracture pressures in the subsurface from 3D seismic data and offset well data before a new well is drilled. This information



is critical for the safe drilling of wells with no environmental incidents so that unexpected surges of high-pressure fluids won't get into the well during drilling.

Once oil or gas is found, and a reservoir is being developed and produced, seismic images increase the understanding of the reservoir and optimize development plans. More efficient oil and gas extraction requires fewer wells while increasing the production of hydrocarbons.



This image shows how geophysical technology was used to predict pore pressure for a proposed well in the Central North Sea. The base chalk acts as a seal trapping in the pressure below (seen in red).

Additional Resources on the Benefits of Seismic Surveys

1. Seismic Surveys: <http://www.appea.com.au/oil-gas-explained/operation/seismic-surveys/>.
2. Seismic Surveys: www.geophysicsrocks.com.
3. Canadian Association of Petroleum Producers: <http://www.capp.ca/getdoc.aspx?DocId=234548&DT=PDF>.

IAGC Vision Statement

The International Association of Geophysical Contractors is the most credible and effective voice for promoting and ensuring a safe, environmentally responsible and competitive geophysical industry.