BOEM Bureau of Ocean Energy Management | FACT SHEET

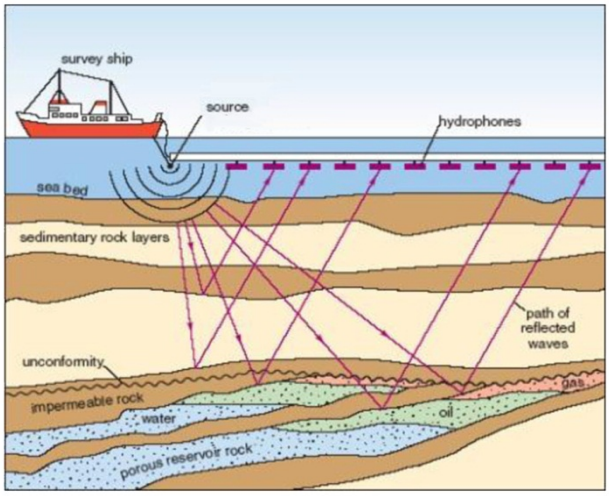
GEOPHYSICAL SURVEYS
DEEP PENETRATION SEISMIC USING AN AIRGUN ACOUSTIC SOURCE

WHAT ARE DEEP PENETRATION AIRGUN SURVEYS USED FOR?

- Geoscientists use state-of-the-art computer mapping systems that utilize the seismic data acquired to make detailed subsurface maps showing geological structures and features.
- This data is used for
    - oil and gas exploration and production
    - scientific research

HOW DOES A DEEP PENETRATION SEISMIC SURVEY WORK?

- A survey vessel or multiple vessels tow an acoustic source (airgun(s)) and multiple acoustic receivers (hydrophones).
- The airgun(s) creates a pressurized air bubble.
- The expansion of the air bubble creates a low frequency, high energy sound that penetrates into the ocean floor. This energy reflects off of sediment layers back to the surface.
- The towed hydrophones receive the reflected sound back from the seafloor and subsurface.
- This information is recorded, processed and used to create subsurface maps



(Geomatic Solutions)

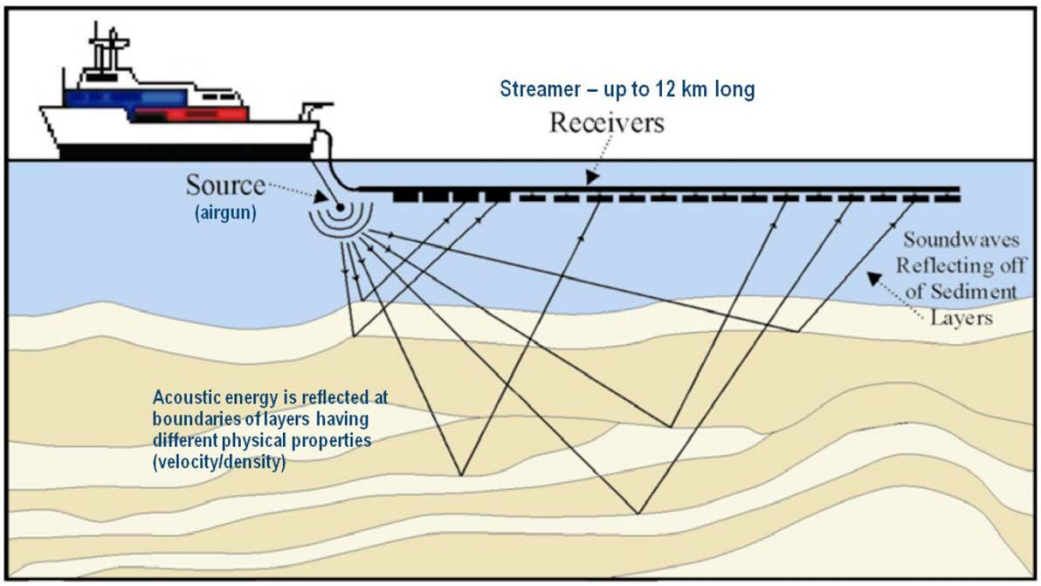
ARE THERE DIFFERENT TYPES OF DEEP PENETRATION SEISMIC SURVEYS?

Yes, there are different types of deep penetration surveys to meet different data needs:

- **2D** – used to learn about regional geology and hazards.
- **3D** – used to target oil and gas reservoirs and formations below salt *(multiple streamers of hydrophones and acoustic source arrays towed behind a survey vessel, typically 2 to 6 survey vessels).*
- **4D** – used in production areas to monitor reservoirs, time-lapse surveys *(3D surveys are duplicated, as exactly as possible, over oil and gas production field at intervals sufficient to monitor changes in reservoir fluids).*

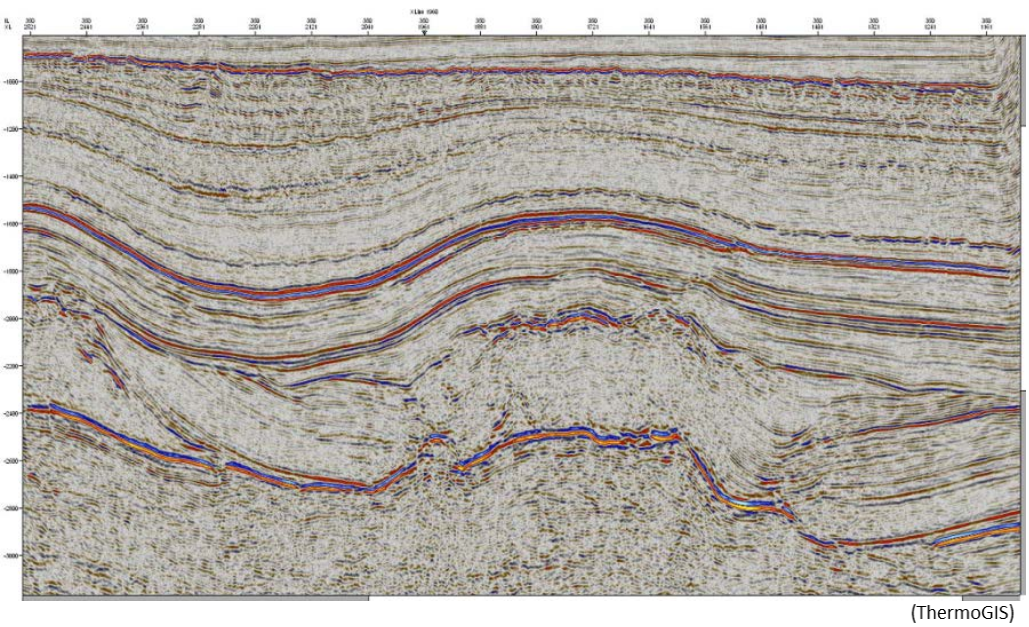
DEEP PENETRATION SURVEYS:

- **2D:** Used to study regional geology (*single streamer of hydrophones and single airgun array towed behind a survey vessel, typically 1 vessel).* Seismic Data is collected in a grid pattern. The grid square sizes can vary widely depending on what the data is to be used for (e.g. 1 mile x 1 mile to many miles x many miles). When a dense data grid is not needed, these surveys are advantageous because they can cover large areas (very large data grid) in a short time and the data is acquired at a lower cost.



(Geomatic Solutions)

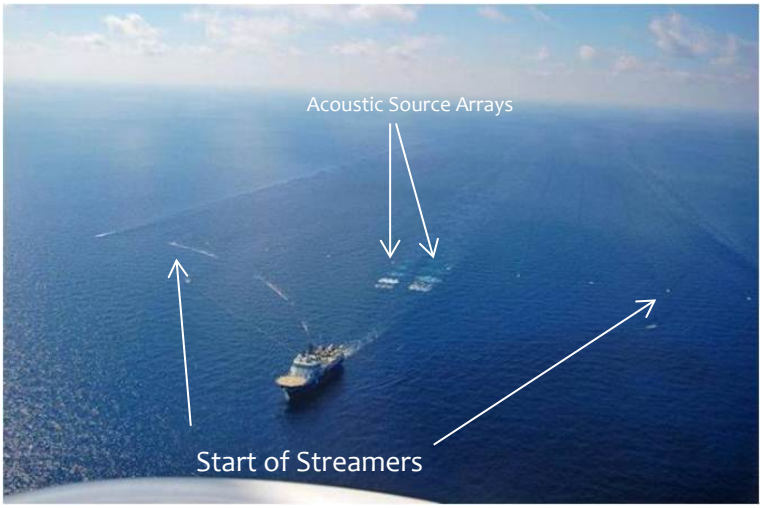
Schematic of a Typical 2D Data Acquisition



(ThermoGIS)

Example of a Typical 2D Seismic Line

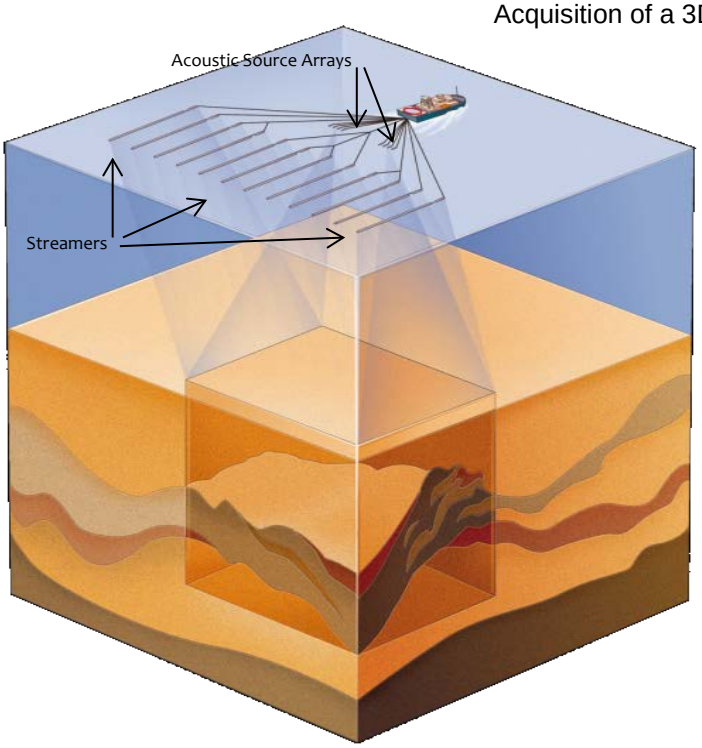
- **Three-Dimensional (3D) Surveys:** Used for research, locating potential oil and gas reservoirs and monitoring reservoir changes over time. Advanced types of 3D surveys are particularly well suited for imaging the subsurface below salt formations in the Gulf of Mexico *(multiple streamers of hydrophones and airgun arrays towed behind a survey vessel, typically 1 to 6 survey vessels).* 3D surveys acquire a volume of data. The 3D seismic data have enabled industry to identify, with greater precision, where the most economical prospects may be located. The 3D technology is also used to identify previously overlooked hydrocarbon-bearing zones and new productive horizons. However, because 3D modeling requires much denser data coverage (i.e., closer line spacing) than 2D seismic surveys, areas already covered using 2D techniques *may be resurveyed*. The basic 3D Narrow Azimuth (NAZ) survey uses a dual purpose vessel pulling both acoustic source arrays and streamers.

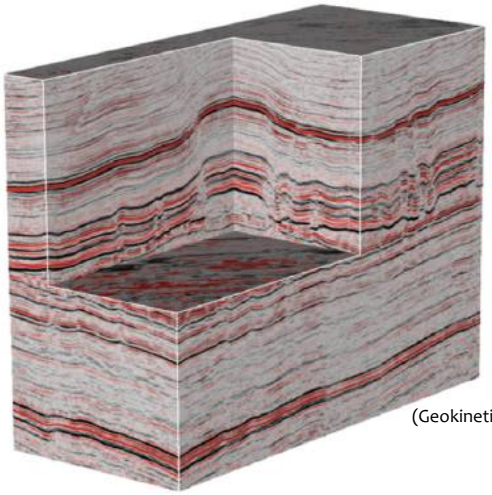


(CGG)

Aerial View of a Typical 3D Survey Using One Vessel

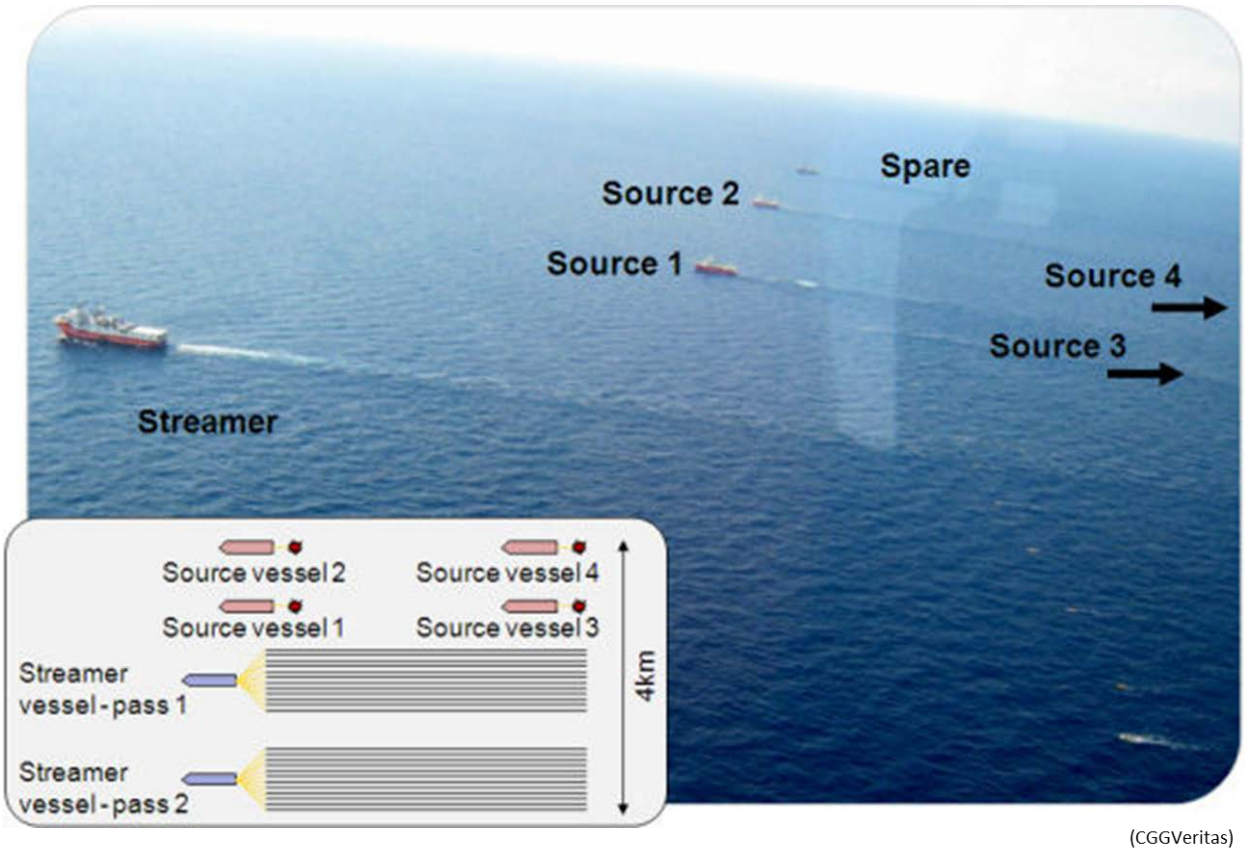
Acquisition of a 3D Data Volume



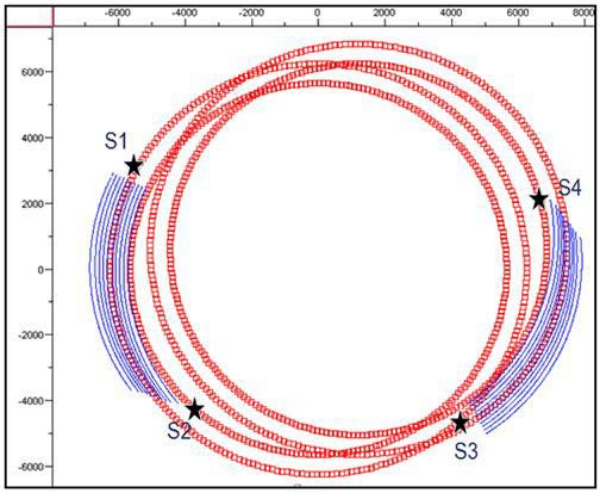


3D Data Volume – During interpretation on a workstation, this data can be "sliced" and viewed from many different angles and directions to aid in interpretation.

- Variations on the basic single vessel 3D survey:
  - Wide Azimuth (WAZ)/Coil Multi-Vessel Surveys provide a more robust illumination over a larger subsurface area than the "standard" 3D single vessel survey. These surveys typically use multiple source and receiver vessels in various geometries.



(CGGVeritas)



Coil Survey Configuration

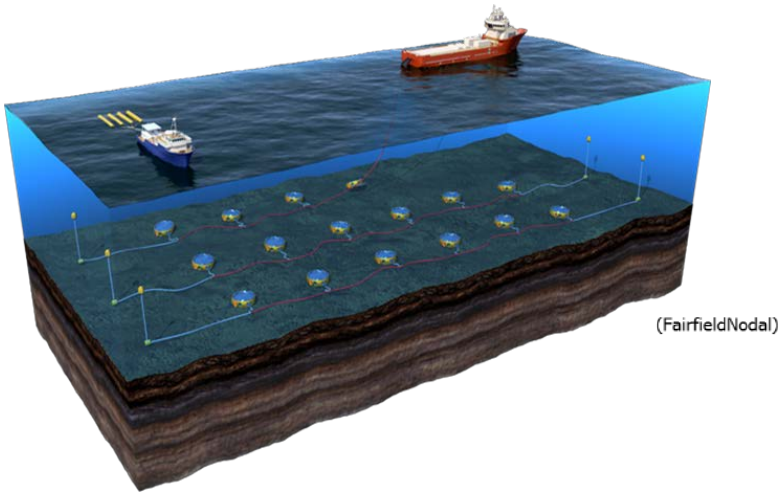
(WesternGeco)

- Another variant of the 3D survey is the 4D survey. The 4D surveys are time-lapse 3D surveys that are repeated over producing fields to characterize production reservoirs. Because of this, these surveys usually only cover a limited area. The 4D surveys are used predominantly as a reservoir monitoring tool to observe reservoir changes over time. This permits the production company to produce the reservoir in the most efficient manner and recover the maximum oil or gas from the reservoir.

- Nodal surveys are another type of 3D survey. In the previously discussed 3D surveys, the receivers (hydrophones) were pulled (streamed) through the water behind the survey vessel. In nodal surveys, the nodes (receiver) are laid on the sea floor. The acoustic source arrays are towed by the surface vessel (as before) over the seafloor nodes which collect the seismic data.

    - The Z700 and Z3000 are typical of the nodes use. The Z700 nodes are 17 inches in diameter, 6 inches high and weigh 65 lbs. dry or 40 lbs. in water. The Z3000 nodes are 21 inches in diameter, 11 inches tall and weigh 213 lbs. dry or 110 lbs. in water.

    - Tethered Node Surveys: In this type of nodal survey, the nodes are tethered together by a cable and deployed on the seafloor in a grid pattern. While one vessel deploys and retrieves the tethered nodes, the source vessel is actively emitting acoustic signals that reflect off the subsurface layers and are received by the nodes. The nodes store the data for later downloading after they are retrieved.



- Autonomous Node Surveys: These surveys use nodes that are completely autonomous; as such they are not connected to anything. They are deployed by a Remotely Operated Vehicle (ROV). After the seismic is collected the nodes are then collected by the ROV and bought to the surface for data download. This survey type is typically for 4D surveys.