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A New Ocean Bottom Seismic Node System

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Abstract

New seismic technology aims at imaging the blind spots of conventional methods. One such new technology is Ocean Bottom Station (OBS) nodes. Such nodes record four component (4C) data; the water-borne pressure and the three components of seabed motion.

Oceanographic Research groups have long been using OBS. After testing one of the leading brands of academic type OBS technology in 2002, we developed a commercial system which is deployed using Remotely Operated Vehicles (ROV). We tested the new OBS in 2006 in Louisiana.

Wide azimuth geometry and well sampled common receiver gathers are natural for OBS. These provide better illumination and are suitable for 3D Wave Equation Migration (WEM). Better illumination and WEM enable improved imaging of complex structures under complex overburden such as salt. The P waves are recorded on both the hydrophone and the geophones and enable separation of the data into down- and up-going waves, which in turn enables demultiple and imaging of waves which are conventionally considered multiples and therefore discarded. Given the cost of deep water drilling, such improved imaging and demultiple can make the difference between success and failure when exploring challenging areas.

Shear waves are recorded by geophones on the seabed. Such shear waves are generated by P to S conversion so they do not require special shear sources. The converted PS reflections provide additional information to what is in the PP reflections. The additional information provided by shear waves is useful for improved characterization of lithology and fractures.

We present the engineering, design and field data from the 2002 and the 2006 tests. We used the data to test the coupling for P and S waves and demonstrate imaging with multiples.

Introduction

The world demand for energy is accelerating, while its reserves of energy are diminishing. Producers are compelled to explore and produce in more challenging places and to maximize recovery in existing reservoirs. The application of technology has always been a key to success in such situations. Advances in seismic technology aim at imaging the blind spots of conventional methods and offering new options for reservoir monitoring (4D). One such new technology is from recent developments in ocean bottom seismometers (OBS) or “nodes”.

There are two main methods for acquiring data on the seabed. Ocean bottom cables (OBC) and ocean bottom stations (OBS nodes). Because there are no cables joining the nodes together they are well suited for working in extremely congested waters, even right up to or perhaps under production structures. Seismic monitoring surveys (4D) are practical because the ROV can re-position the units very closely to their previous sites to ensure a high level of repeatability.

OBS and OBC are usually more expensive than conventional streamers but they often provide better data. One reason is that they provide wide azimuth geometry. This is important for imaging structures under complex overburden, such as sub-salt. Salt bodies act like huge lenses distorting seismic waves propagating through them. To image sub-salt targets we need the data processing capability to image through complex overburdens, but even the best imaging technology alone is not enough, we also have to illuminate the targets. Conventional towed-streamer surveys are operated with a single seismic vessel and a fixed source-receiver geometry resulting in a narrow azimuthal coverage. If either the source or the receiver is located above an overburden anomaly, the illumination of the target would be poor. Wide azimuth geometry is much more likely to be successful because we record a dataset well-populated in azimuth and offset. So, if we don't illuminate a target with one azimuth, we still have a good chance to illuminate it with other azimuths. Two techniques that provide wide azimuth geometry offshore are multi-vessel towed-streamer and OBS. Wide azimuth towed-streamer (WATS) surveys are more economical for covering large areas while OBS are more economical for small areas, up to about 400 km². OBS nodes are deployed by ROV, and can be placed very accurately. This makes them more practical to deploy in the presence of obstacles such as production facilities. For the purpose of seismic monitoring with repeat surveys (4D), OBS have better positioning repeatability than