High-resolution acquisition solution for cost-effective marine seismic operations

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Introduction

Over the last decades, advances in seismic data acquisition, signal processing and modeling have made subsurface imaging better than ever. Seismic surveys have evolved from 2D to 3D with the introduction of more sophisticated towed and positioning systems. For investigation of both seabed and shallow subsurface fine scale structures, high-resolution (HR) or ultrahigh-resolution (UHR) 3D imaging is needed. Markets such as well de-risking, field development, shallow gas exploration, offshore construction and CO_2 storage fully measure the benefits of using high-resolution techniques. However, they are looking for fit-for-purpose systems and are still keeping a close watch on all improvements that will increase data quality in cost-effective and environmentally responsible approaches.

It is on these key points that research and development efforts have been channeled, in order to integrate conventional field-proven seismic streamers and recording system to a fully new hydrodynamically shaped solution that fulfills the needs of highly detailed mapping in very localized areas. The resulting high-resolution 3D marine seismic solution provides sharp and accurate image of the subsurface in the most efficient way.

Less noise, better signal for enhanced data quality

One of the main challenges in seismic surveys is to limit adverse noise and vibrations that could interfere with the signal and cause poor data quality acquisition.

The system's hydrodynamically shaped design contributes significantly to overcoming these noise and vibration impacts. The main innovation resides in the use of pelagic-type deflectors, part of a specific rigging system to reach greater towing depths and therefore minimize swell noise issues (Figure 1). Extensive work has also been carried out to design a solution as 'integrated' as possible, thereby reducing parasitic effects due to cumbersome cables. In addition, the overall shape of the system itself helps to attenuate cross-cable vibration induced noise.

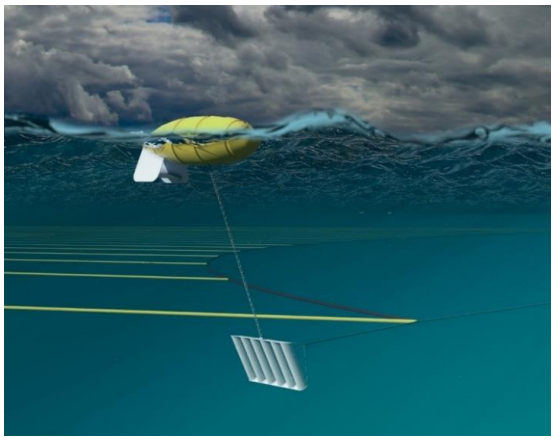

Figure 1: a pelagic-type deflector connected to a surface buoy is used to divert the spread at the desired depth

To complete the picture of noise immunity performance, the system is compatible with state of the art Sentinel solid streamers. These streamers integrate highly isolated hydrophones - each hydrophone element being isolated from the hydrophone carrier, which is itself isolated from the cable. With appropriate robust design and materials, this generation of streamers is less sensitive to noise originating from sea swell effects and provides full immunity to towing equipment induced vibrations. Additionally, this solid cable is much stable in the water compared to smaller diameter cables used in conventional HR systems. This ensures an extra noise reduction. For maximum bandwidth and therefore sharper results, the system is also compatible with the Sentinel MS streamer. Apart from pressure measurements, this multi-sensor streamer integrates two orthogonal vector sensors. These sensors are helpful to reduce the effect of sea surface reflections (the receiver ghost) through a PZ summation process.

Higher productivity for a cost-effective approach

High-resolution surveys are usually shorter in duration compared to conventional seismic surveys. It means that operational downtime can have a much more adverse effect on the cost of the operation, relatively.

Weather is probably one the most important source of downtime for such survey, specifically in the North Sea. The research and development work carried out to minimize adverse noise effects also serves to achieve superior productivity levels. Thanks to the combination of an optimized rigging system with the exceptional noise performance and robustness of solid streamers, towing depths of up to 10 m can be achieved, while conventional systems can only achieve 3 m. Deeper towing enlarges the weather window and facilitates continuous data recording, resulting in better productivity. Another important source of downtime is the reliability of the equipment. It is even more critical when considering a HR3D system, which is obviously more challenging to deploy and recover compared to short HR2D configurations.

Downtime due to maintenance and repair is drastically reduced for two main reasons.

- The system being based on solid cables and a seismic system designed for conventional seismic, it takes full benefit of the recognized robustness of such system and it also takes benefit of the system redundancy (for both telemetry and power).
- Furthermore, to avoid the risks of streamer entanglement and damage, a double deployment process on each side of the boat guarantees easy handling and a smooth launch (Figure 2). This configuration also offers the major advantage of recovering independently one part of the streamers or the other, which is proved to be useful for faster maintenance action.

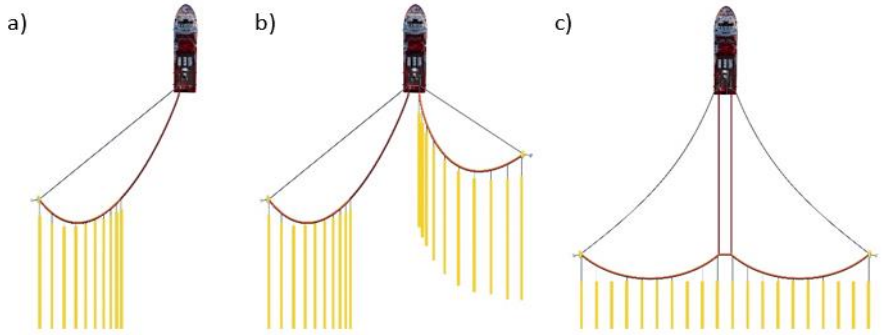

Figure 2: Double deployment process sketch. a) Deployment of the first half, b) Deployment of the second half, c) The full spread as deployed.

Environmentally friendly solution for environmental applications

In the context of HR3D, as it is the case for conventional seismic operations, measures must be adopted to avoid harming cetaceans or even disturbing their life during seismic acquisition work. In response to this need, this innovative high-resolution seismic acquisition system is compatible with QuietSea, a Passive Acoustic Monitoring (PAM) system designed to detect automatically marine mammals during seismic operations. This PAM system is integrated seamlessly within the HR spread. This insures optimal mammal protection while avoiding the risk of deploying extra cables at sea.

Conclusion

A new compact High-Resolution 3D acquisition system is introduced. The drivers for the design of this innovative solution was to enlarge as much as possible the time window for operations, while obtaining the best possible data quality. Based on robust field-proven technologies, it provides the industry with a new productive tool to acquire high-resolution data in the most efficient way. The ease of mobilization and operation of such imaging system may pave the way for new offshore imaging applications.