

P-Cable: High-Resolution 3D Seismic Acquisition Technology

by

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Abstract

Three-dimensional (3D) seismic data provide unique images of the sub-surface, and are routinely acquired by the industry prior to drilling. However, 3D seismic data are not commonly available for scientific boreholes. This is mainly due to the high acquisition cost of conventional 3D surveys.

We have developed a new cost-efficient technology for acquisition of high-resolution 3D seismic data: the P-Cable system. This system is very well suited for imaging of the sub-surface around scientific boreholes. Small cubes (10 to 30 km²) with high-resolution (50-250 Hz) seismic data can be acquired in 3 to 5 days using existing research vessels.

The analogue P-Cable1 and the digital P-Cable2 prototype systems have been used to acquire 14 cubes from 2004 to 2009. A new third generation system is currently under development.

Rationale

Seismic data are essential for ensuring safety and reaching the scientific goals of deep-water scientific boreholes. Commonly, only a few seismic profiles are available near the proposed drill sites with only two crossing 2D seismic lines being the requirement. A poor coverage of seismic data increases the risk of encountering drilling hazards at shallow sub-bottom depths. More seismic data will often lead to improved site locations where the scientific objectives could more reliably be achieved, e.g. by drilling a structure right in its centre and not in its periphery. For these reasons, 3D seismic data should be acquired routinely before drilling commences.

Over the past eight years we have developed a new technology, the P-Cable, for cost-efficient acquisition of high-resolution 3D seismic data in deep-water areas. The technology is very well suited for site surveys and core-log-seismic integration studies.

The P-Cable system consists of a seismic cable towed perpendicular to a vessel's steaming direction (Figure 1). This configuration allows us to image an up to 150 m wide swath of the sub-surface for each sail line. A 3D image of the subsurface can subsequently be computed by combining the data for each sail line.

Conventional 3D seismic technology relies on very long streamers (several up to 10 km long streamers are common), large sources, and costly operations. In contrast, the P-Cable system is light-weight and fast to deploy from small vessels. Only a small source is required as the system is made for relatively shallow imaging, typically down to sub-bottom depth similar to the water depth.

The P-Cable system is particularly useful for acquisition of small 3D cubes, 10-50 km², in focus areas, rather than extensive mapping of large regions. The rapid deployment and recovery of the system makes it possible to acquire several 3D cubes during one research cruise.

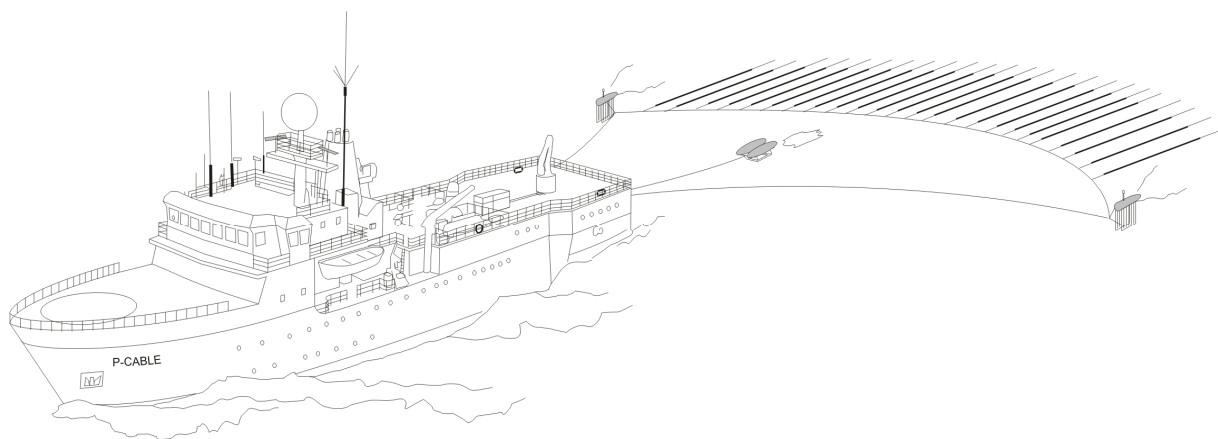


Figure 1. Schematic diagram of the P-Cable 3D seismic system (Planke and Berndt, 2003). A cross-cable is towed perpendicular to the vessel's steaming direction using two paravanes. Up to 24 short seismic streamers are attached to this perpendicular wire.

Development

The P-Cable system is described in the patent by Planke and Berndt (2003). A 12-streamer analogue system, the P-Cable1, was developed by the National Oceanography Center, Southampton (NOCS) in collaboration with the University of Tromsø and industry partners. The P-Cable1 has been used to acquire seven small cubes offshore Svalbard, in the Barents Sea, and in the Gulf of Cadiz (Figure 2). A digital system, the P-Cable2, was subsequently developed in 2006-2007. The P-Cable2 has been used to acquire seven 3D cubes offshore Norway and one in the Mediterranean Sea. The largest cube exceeds 300 km² and was acquired using 24 streamers.

Very high-quality data have been acquired by the P-Cable systems (Figure 3). Typical data characteristics:

- cube size: 5 to 300 km²
- frequency range: 50 to 250 Hz
- water depth: 300 to >3000 m
- imaging above first sea floor multiple
- bin size: 6x6 m
- vertical resolution: ~1.5 m

A new company, P-Cable 3D Seismic AS, was established in 2008 to further develop and commercialize the P-Cable technology. The development is done in collaboration with the three scientific license holders: the University of Tromsø, NOCS, and IFM-GEOMAR.

The main goals of the development of the P-Cable3 are:

- improved operational reliability (more robust cables)
- improved depth control of the streamers (add birds and floatation)
- improved seismic processing data flow (geometry and statics)
- design of a containerized system for easy use on research vessels

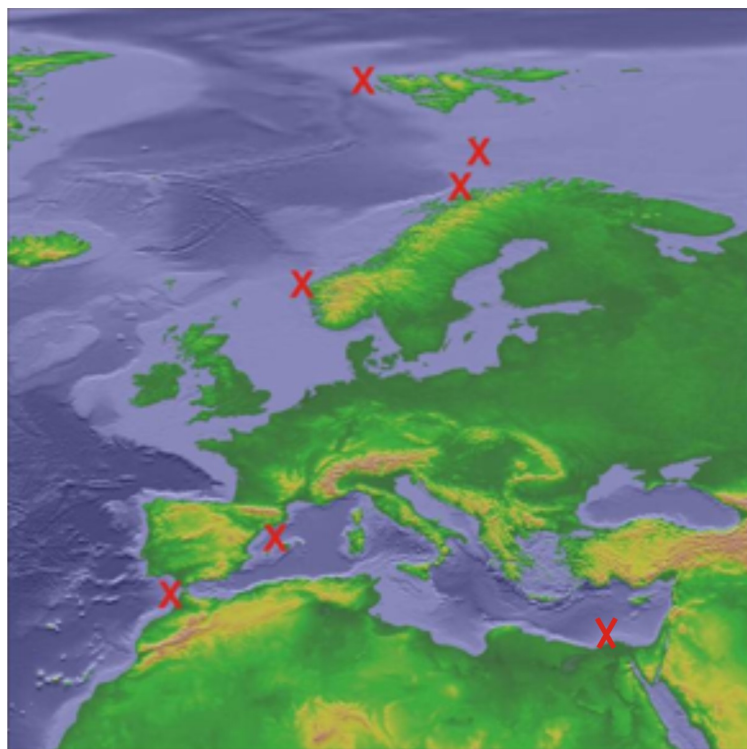
The development and testing of the P-Cable3 system is costly, and requires both research and industry funding. IFM-GEOMAR is currently developing and testing new cables based on industry funding. The Univ. of Tromsø is leading an application for a Norwegian national research infrastructure funding: "Geosystem 3-D Seismic Imaging". P-Cable 3D Seismic AS is working on industrial funding for further development.

The current plan is to complete the design of the P-Cable3 system in 2009. Production and field testing will then be completed during 2010. The technology should be available for INVEST usage by 2011. The actual usage will depend on the level of financial and scientific support from the scientific drilling community.

References

Planke, S. and Berndt, C. (2003) Anordning for seismikkmåling, Norwegian Patent no. 317652 (UK Pat. No. GB 2401684; US Pat No. US7,221,620 B2).

Petersen, C. J., S. Buenz, S. Hustoft and J. Mienert, 2008. 3D seismic imaging of marine gas hydrates in Arctic sediments of the Vestnesa Ridge off the W-Svalbard margin, Proc. 6th International Conference on Gas Hydrates, Vancouver 2008.



Main P-Cable Surveys

Svalbard (2004; UiTø, NOCS)
W Barents Sea (2005; UiTø, NOCS)
Gulf of Cadiz (2006; NOCS)
North Sea (2007; VBPR)
Vestnesa (2007; UiTø)
Nyegga (2008; UiTø)
North Sea (2009; P3S)
Barents Sea (2009; UiTø)
West Nile (2009; IFM-GEOMAR)

Total: 14 cubes (5 to 300 km²)

Figure 2. Summary of P-Cable surveys, 2004-2009.

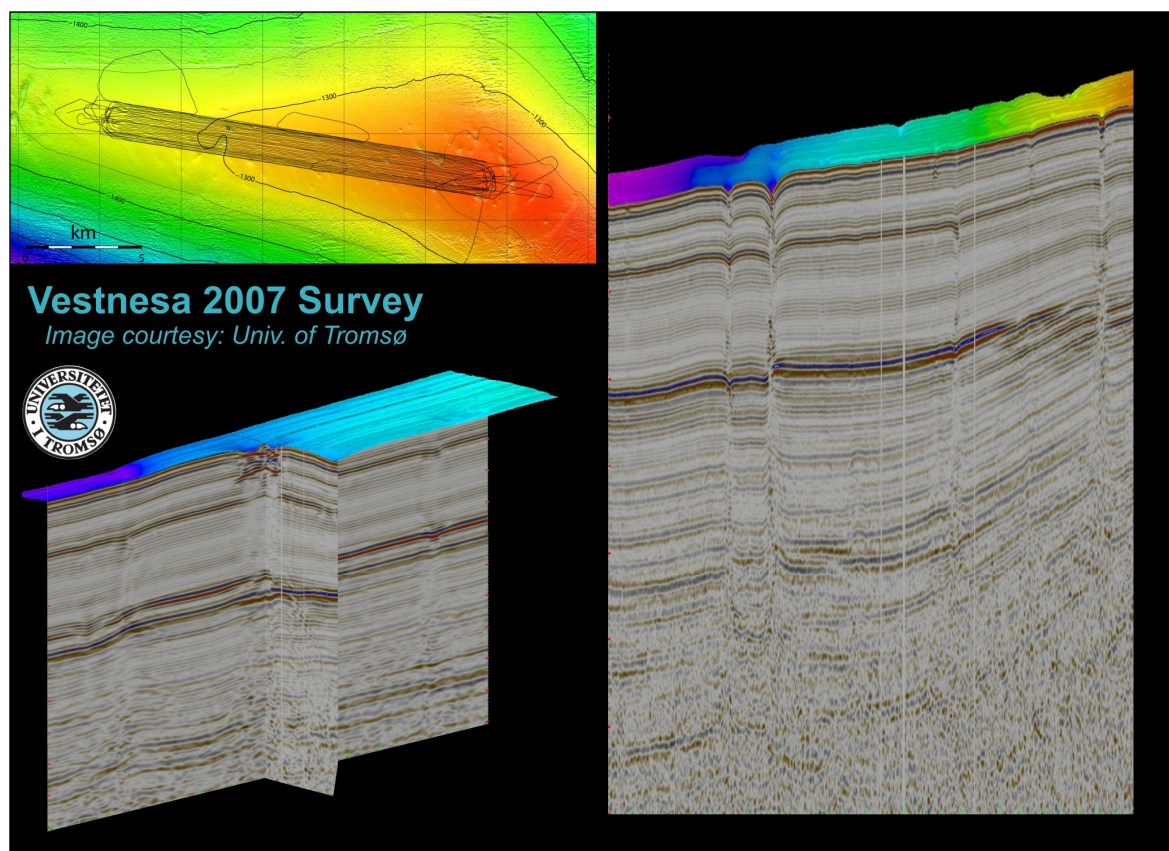


Figure 3. P-Cable data example (Petersen et al., 2008).