A 3D 6C ocean bottom seismic survey at the Breidablikk field.

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Summary

A 3D ocean bottom seismic field trial using using 50 nodes that incorporate a new 6C sensor, where the sensor measures both the translational linear motion of a particle along an axis and the rotational measurement of angular motion about an axis, was performed during the summer of 2025. This field trial was conducted on the Breidablikk field on the Norwegian Continental Shelf (NCS), the results of which will be discussed in this paper.

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Introduction

The results of a new seismic sensor, sensing simultaneously in three orthogonal axes realised through 6 component (6C) measurements, have previously been presented (Pedersen et al., 2023), where the sensor measured both the translational linear motion of a particle along an axis and the rotational measurement of angular motion about an axis. These earlier results demonstrated that the sensor could be deployed and used in an offshore setting and assessed the potential of this single sensor prototype unit to directly measure translational and rotational components. Furthermore, the use of the rotational components to denoise the translational components has also previously been shown (Seher et al., 2024).

Building upon the successes of these previous experiments with the 6C sensors, a 3D field trial, which could also be used as a monitor survey for timelapse (4D) purposes, was performed during the summer of 2025 using 50 ocean bottom seismic nodes that incorporate the new 6C sensor. This field trial was conducted on the Breidablikk field on the Norwegian Continental Shelf (NCS), the results of which will be discussed in this paper.

Breidablikk

During a recent field trial, in the summer of 2025, 50 6C nodes were deployed at the Breidablikk field on the NCS, just over 200km west of Bergen and approximately 10km Northeast of the Grane field (Figure 1). The reservoir, at a depth of approximately 1700m, consists mainly of Palaeocene to early Eocene reservoir sands mainly belonging to the Heimdal Formation, with reservoir properties that have an average porosity of 33–34% and multi-Darcy permeability (Akalin et al., 2024). Above the Heimdal Formation, oil is also present in a sand injectite complex in the shales of Palaeocene and Eocene age in the Lista, Sele and Balder Formations. The field started production in October 2023 and is produced by pressure depletion, assisted by gas lift in the production wells.

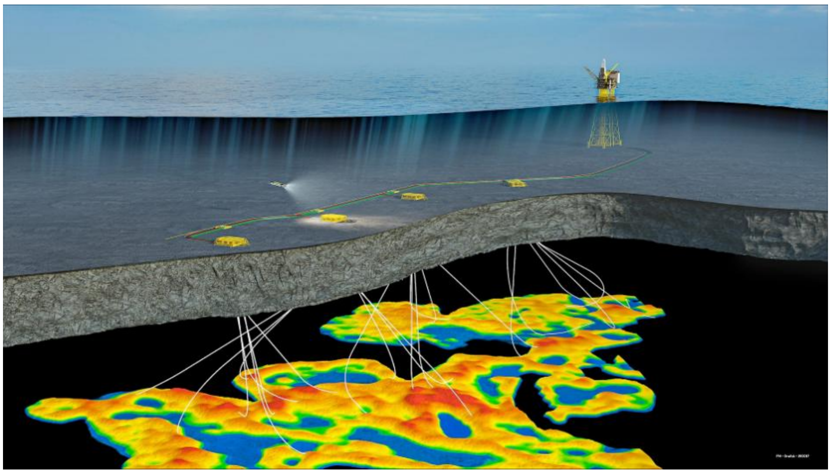
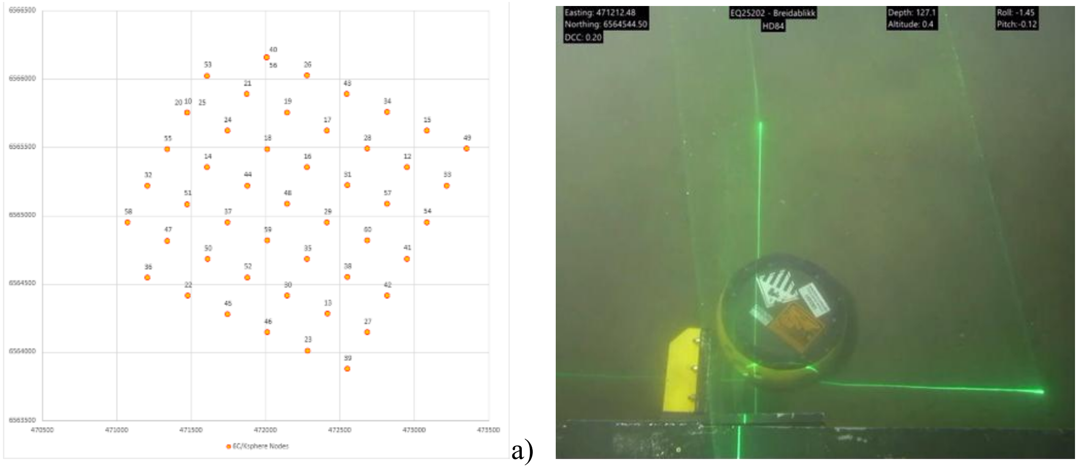


Figure 1 *The Breidablikk field, a subsea development approximately 10km Northeast of the Grane platform, in 130m water depth with a reservoir of Heimdal sands.*

Field Trial

The field trial entailed the deployment of fifty nodes incorporating the 6C sensor, using a Remotely Operated Vehicle (ROV), in 130m of water depth. The nodes were deployed on a grid of 300m by 300m (Figure 2), giving an inline receiver line length of 1800m and a crossline receiver line distance of 1800m, producing a total receiver area of 3,24km^2.



a) b)

Figure 2 *a) Layout of receiver positions, a spread of seven stations in the inline direction and seven stations in the crossline direction with receiver station separation of approximately 300m in both directions. b) An image of receiver station 36 taken from the ROV used for deployment and recovery.*

The seismic source for the field trial was a triple source with a volume of 2660 cu. in. for each array with a source array separation of 37.5m the shot point interval was 12.5m in a flip-flap-flop mode. Approximately 57 source sail-lines were acquired where the sail-line separation was 112.5m with the sail lines acquired parallel to the nominal receiver in-line direction, while the maximum crossline offset acquired was 1500m to the East and 3000m to the West.

Observations

All 50 nodes were successfully deployed and recovered, and initial analysis and imaging of the data have been carried out. An example gather, from node 36 (Figure 3), clearly shows data on both the translational components, acceleration in X, acceleration in Y, acceleration in Z and the rotational components, rotation in X, rotation in Y and rotation in Z.

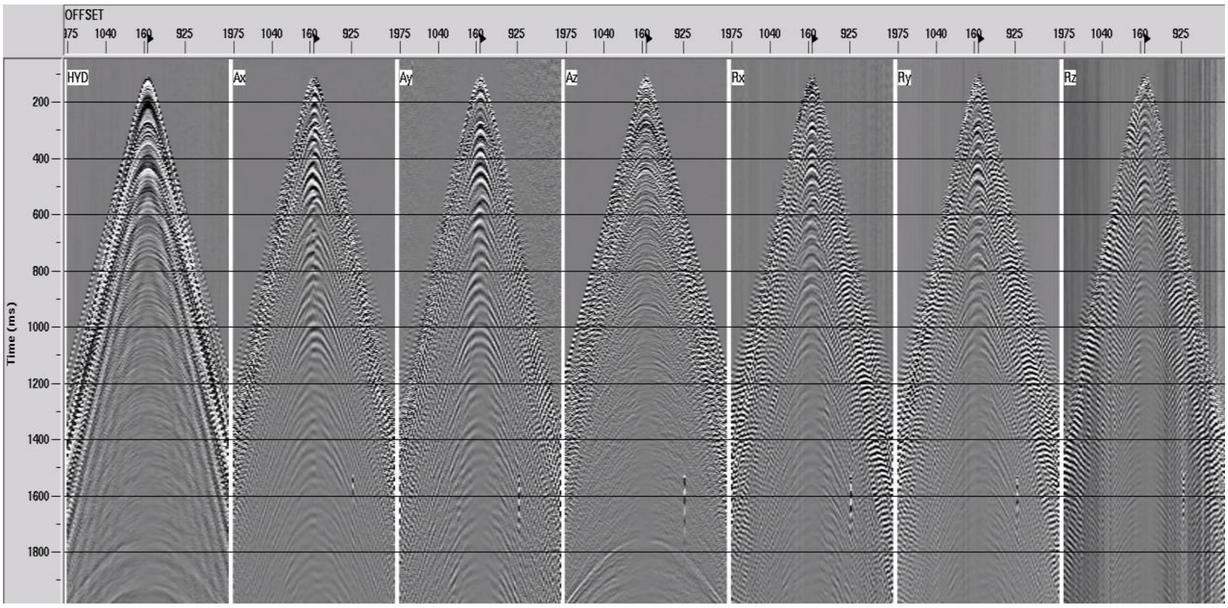


Figure 3 *Common receiver gather from one source line for station 36 showing from left to right, Hydrophone, Acceleration in X, Acceleration in Y, Acceleration in Z, Rotation in X, Rotation in Y and Rotation in Z.*

A simplified fast track processing sequence was applied to the 6C data including denoise, separation of the Up-going and Down-going wavefield, demultiple, and Kirchoff prestack depth migration.

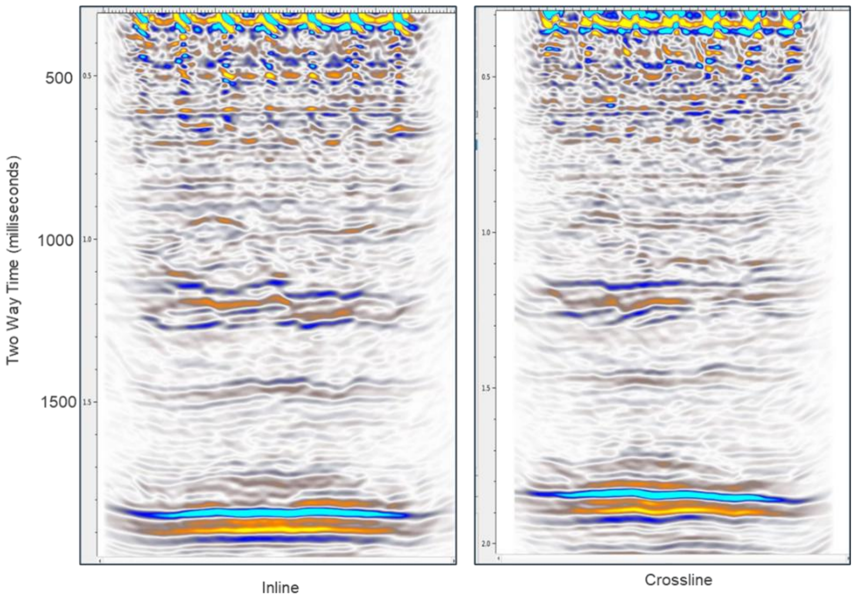


Figure 4 *A central inline (left) and crossline (right) from the early out migrated stack volume after denoise, Up-Down separation, demultiple and PSDM.*

Figure 4 shows well-known structural characteristics of the different formations that comprise the overburden and reservoir. The parallel reflections, in the shallow, of the Nordland clay in the Nordland Group are clearly identifiable. Below the Nordland Group is the Hordaland Group, characterised by the strong chaotic reflections of the Hordaland sands overlaying the weaker reflections of a series of clay units. Further down in the section in the reservoir, the Rogaland Group, the Heimdal sands and enclosing shales of the Balder and Lista Formation are also identifiable, underlain by the strong reflection of the Draupne Formation of the Top Shetland Group.

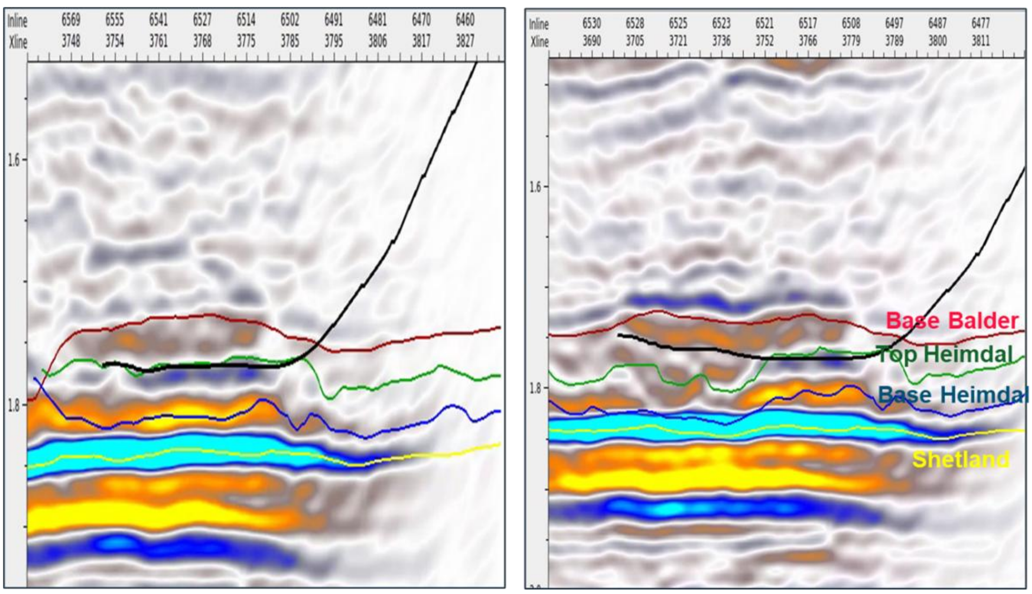


Figure 5 *Two cross sections from the 3D-processed 2025 6C dataset along two separate branches (left and right) of a multilateral well that show details of the Heimdal reservoir section of the well.*

Figure 5 shows cross sections from the 3D-processed 6C dataset along the paths of two branches of a multilateral well that was the focus of the 6C receiver layout and demonstrates that the 6C data has successfully captured the details of the Heimdal reservoir section.

Conclusions

A successful 3D OBS field trial with fifty OBN's equipped with 6C sensors was conducted on the Breidablikk field. Initial analysis indicates successful recording on both translational and rotational data, which is consistent across all fifty nodes. Early 3D seismic processing and imaging results have been able to produce a subsurface image of Breidablikk field, where the known geological features are successfully imaged.

Further work will continue to improve the processing sequence and investigate the potential to fully utilise the extra measurements from a 6C sensor for both 3D and 4D purposes.

Acknowledgements

The authors would like to thank the Breidablikk license partners, Equinor ASA, Vår Energi ASA, ConocoPhillips Scandinavia AS and Petoro AS for permission to present this work. The views and opinions expressed in this paper are those of the authors and are not necessarily shared by the license partners.

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