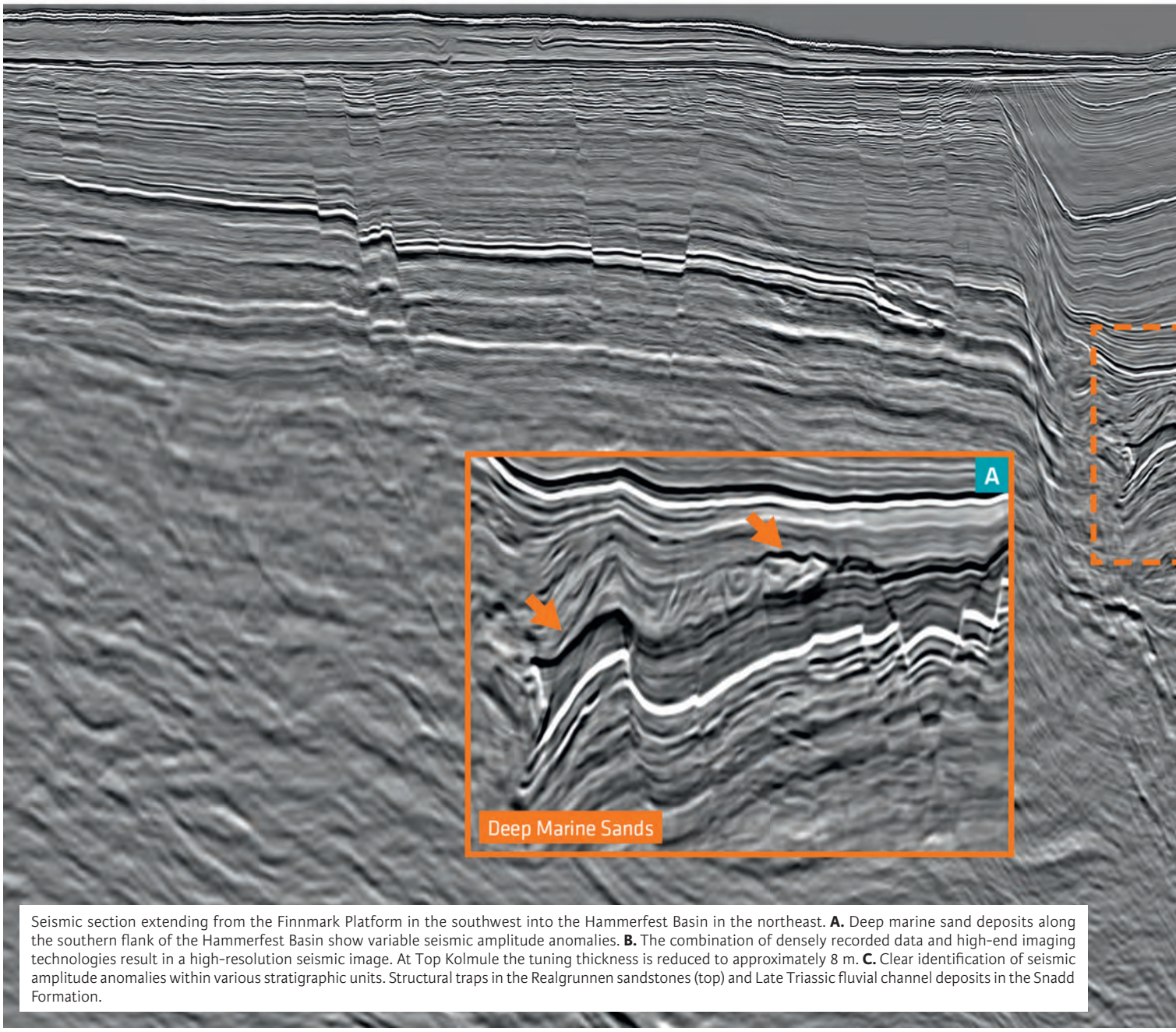
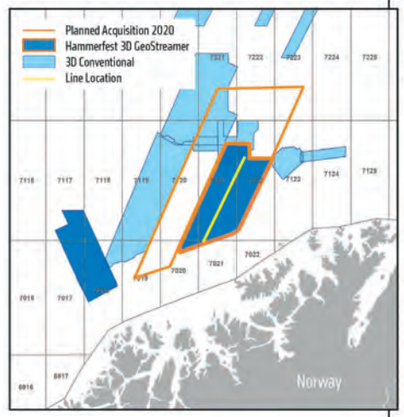
New Prospect Potential

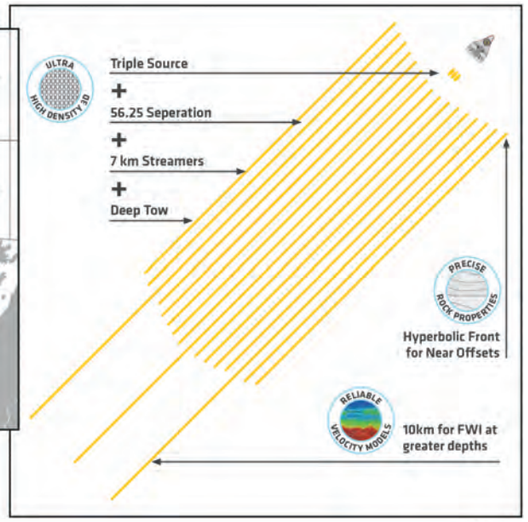
PGS' Hammerfest Basin ultra-high-density high-resolution dataset is now available and will be extended further in 2020. Full integrity data includes open acreage and resolves the challenges in this complex area through an innovative combination of streamer setup and advanced imaging technologies.

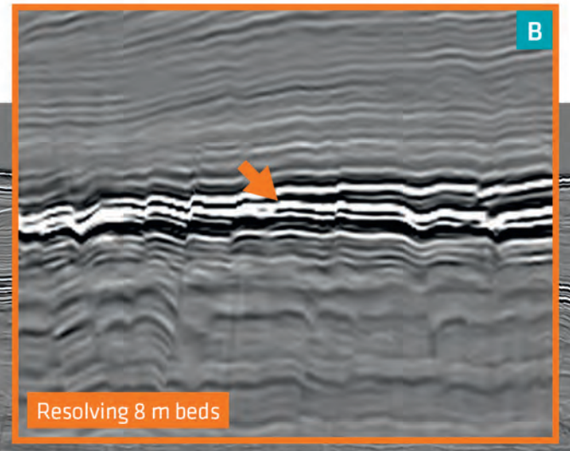


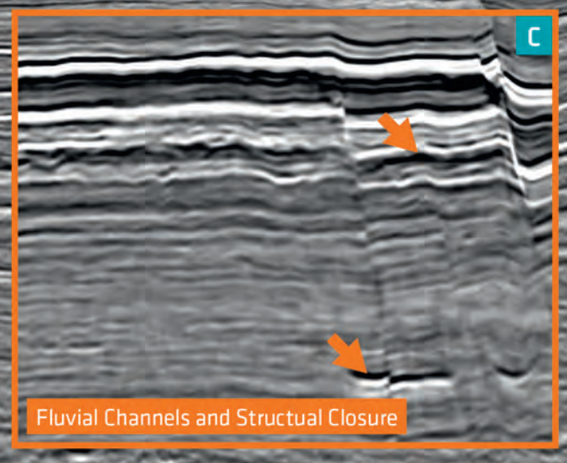
Seismic section extending from the Finnmark Platform in the southwest into the Hammerfest Basin in the northeast. **A.** Deep marine sand deposits along the southern flank of the Hammerfest Basin show variable seismic amplitude anomalies. **B.** The combination of densely recorded data and high-end imaging technologies result in a high-resolution seismic image. At Top Kolmule the tuning thickness is reduced to approximately 8 m. **C.** Clear identification of seismic amplitude anomalies within various stratigraphic units. Structural traps in the Realgrunnen sandstones (top) and Late Triassic fluvial channel deposits in the Snadd Formation.

in Open Acreage in the Barents Sea









PGS

Diving Deeper to Resolve the Challenges of the Barents Sea

An innovative acquisition configuration was designed as the best solution to resolve mixed depth targets in the Barents Sea. It combines novel streamer setup and advanced imaging technologies.

Tekst: SÖREN NAUMANN and RUNE SAKARIASSEN, PGS

In order to fully exploit the exploration potential of the southwestern Barents Sea, the high capacity vessel Ramform Atlas acquired an ultra-high-density 3D seismic dataset over parts of the shallow Finnmark Platform and deeper Hammerfest Basin. The combination of densely recorded data and high-end imaging technologies result in high-resolution seismic imagery, clearly identifying seismic amplitude anomalies within various stratigraphic units and fault complexes and reducing the tuning thickness to resolve beds as thin as 8 m (Figure 1A).

The PGS-TGS joint venture survey was acquired with multisensor GeoStreamer technology. In addition to 16 densely spaced streamers, three streamers were extended from 7 km to 10 km length to capture deeper diving waves (refractions) and thereby enable diving wave FWI to produce accurate velocity updates to greater depths. The unique dataset has been added to PGS' data library and covers an area of approximately 4 100 sq. km.

Open Acreage Opportunities

PGS' planned 2020 survey extension includes open acreage in the Barents Sea (see locator map) and the overall area accounts for around half of the undiscovered resources on the NCS, according to the Norwegian Petroleum Directorate.

Key target areas for hydrocarbon plays in the southwestern Barents Sea are the shallow Kapp Toscana Group sandstones, and deeper, potentially karstified, Carboniferous/Permian carbonates. Proven discoveries made in both geological regimes show the great hydrocarbon potential of this area, but a key challenge in producing an accurate image of the subsurface is creating a reliable velocity model that accounts for the area's complex geological regime.

A Unique 2-for-1 Acquisition Solution

Seismic surveys are often designed for optimum imaging of certain stratigraphic units. In the southwestern Barents Sea several formations have been identified as potential targets, each with its own specific requirement for a seismic survey design. Imaging shallow, thin sedimentary beds relies on densely recorded data whereas deeper strata require long offsets for both imaging and accurate velocity analysis. Until now, there has been a lack of sufficient recorded data which made it difficult to identify porous carbonate facies or thin sand deposits (Figure 1B, previous pages).

To overcome the challenges, a unique acquisition configuration with a variable streamer length is utilized. A triple source configuration in combination with 16 densely spaced streamers results in a nominal bin size of 6.25 x 9.375 m and accurate image frequencies as high as 200 Hz. Three out of 16 streamers were extended from 7 to 10 km, providing long offsets for FWI which are required to record a sufficient number of diving waves from deeper geological layers. This has resulted in an extension of the model update depth from approximately 2.5 to 4 km depth. The multisensor streamers, towed at a depth of 25 m, provide true broadband data with a high signal-to-noise ratio of the low frequencies and further improve FWI and quantitative interpretation (QI).

An example of the FWI velocity model around the Goliat oil field is shown in **Figure 2**. At the reservoir level, the model shows a clear low velocity anomaly, potentially indicating a porous and hydrocarbon-filled sand body (Figure 2A). This is also confirmed when comparing the Goliat field outline with a velocity attribute map extracted around the Top Realgrunnen level (Figure 2B).

The details and large velocity contrasts captured in the depth velocity model allow accurate imaging of the subsurface without being biased by distortion effects caused by the shallow heterogeneous overburden. Both the velocities and the resulting images provide further insights into the reservoir.

Figure 3 shows a FWI velocity depth slice at 900 m which further highlights the benefits that FWI provides, presuming sufficient amount of data is recorded. The transition between the Hammerfest Basin and the Finnmark Platform and its large velocity contrast is well captured and resolves the fault complex and the margin of the basin. Within the basin, several low velocity anomalies can be observed which correlate well with seismic structures.

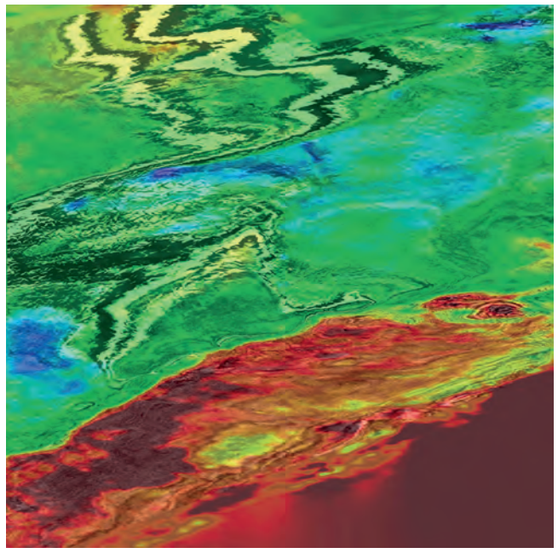


Figure 3. FWI velocity depth slice (900 m) overlaid on the final KPSDM stack. Full integrity data is available now and shows excellent correlation between velocities and prospective structures on the margin of the Hammerfest Basin and on the Finnmark Platform transition zone.

Revealing Hydrocarbon Potential with Updated FWI Velocities

FWI velocity updates provide a migration velocity model to enable accurate imaging of the subsurface. With the ability to capture small-scale features in the model, FWI can help to identify potential areas of hydrocarbon saturated rocks, indicated by low velocity anomalies.

Figure 4 highlights a section around Top Realgrunnen at a depth of around 2.5 km. Within each fault block, low velocity zones are present at the top of the structure. These anomalous velocities correlate well with the seismic amplitude brightening (soft impedance) and highlight areas of potential hydrocarbon fluid accumulation at the structural highs, and therefore potential prospectivity.

Offering flexibility

Tailored acquisition and imaging solutions provide the right seismic data in order to unlock shallow and deep targets in the Barents Sea. Ultra-high capacity vessels, like the PGS Ramform fleet, can operate with highly effective spreads with variable streamer lengths, e.g. including a sparse set of long streamers for FWI-based velocity model building. This acquisition and imaging concept offers the flexibility to address exploration challenges in the Barents Sea, as well as other basins with complex geological regimes around the world, by adding sources or operating with wide-tow source configurations.

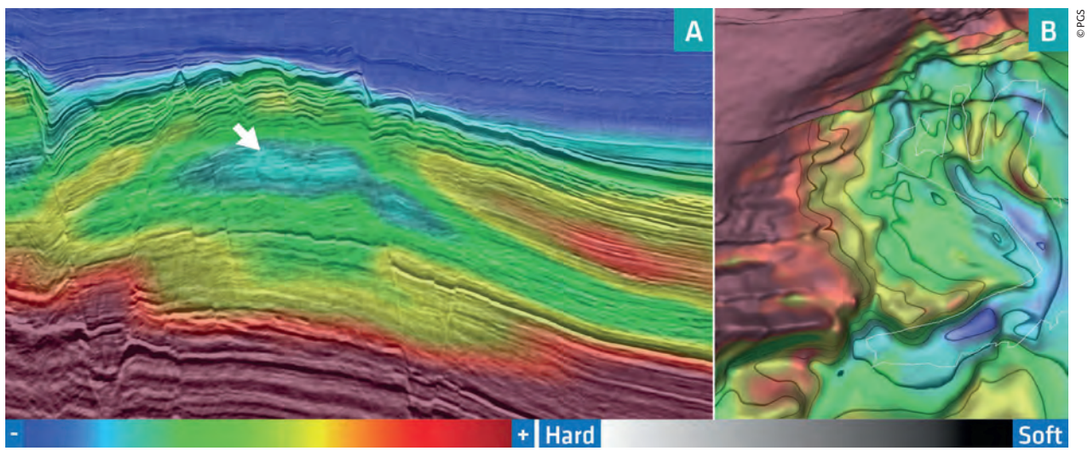


Figure 2. Final KPSDM stack with FWI velocity model overlaid (A) and velocity extraction below the Top Realgrunnen level with the Goliat field outline (B). A clear low velocity anomaly is present at reservoir level (arrow) which correlates well with the field outline.

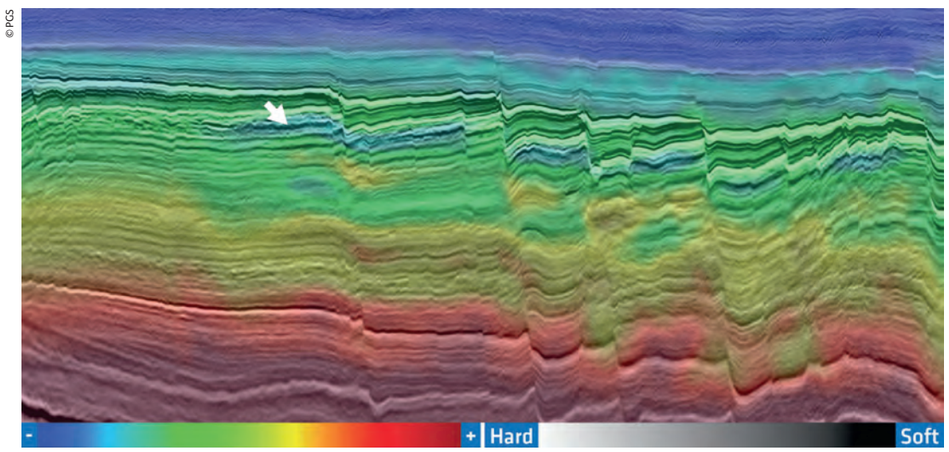


Figure 4. FWI velocity model overlaid on a KPSDM stack. Both amplitude and velocity anomalies correlate well and therefore this can be an indication of hydrocarbon accumulations at the structural highs.