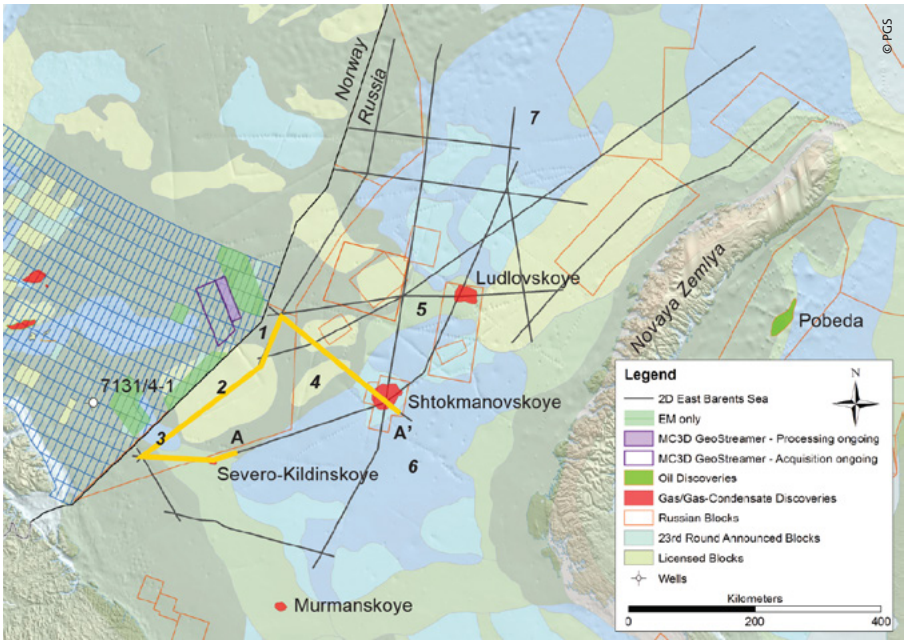
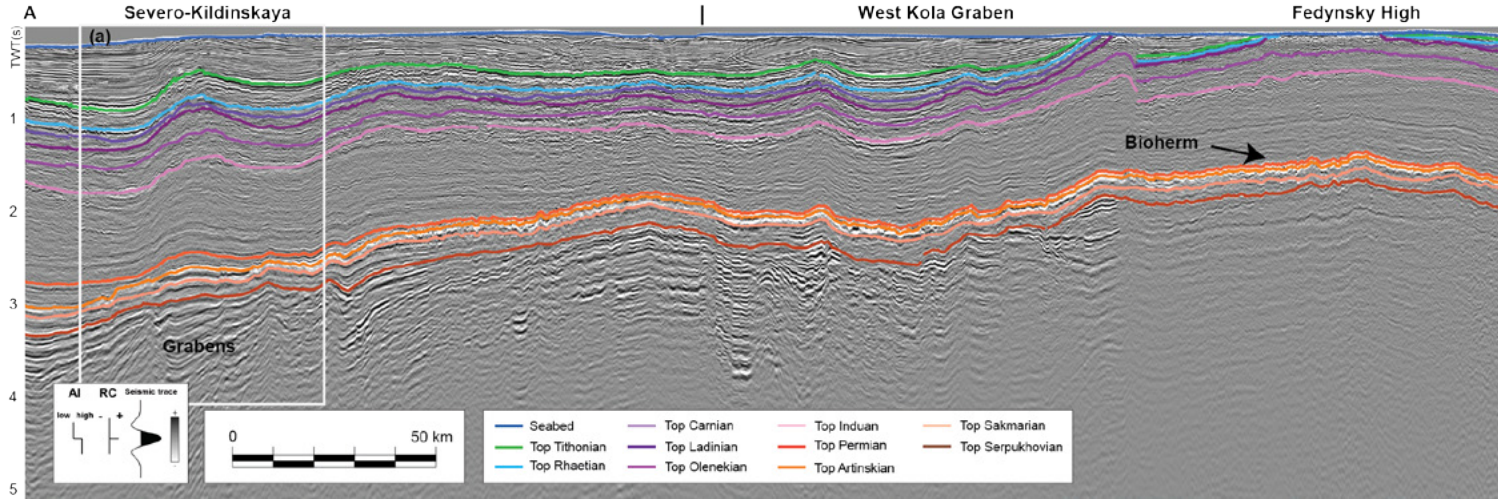
New seismic data enables cross-border correlation

Seismic acquired in the Russian Barents Sea is significantly contributing to understanding the petroleum systems of the Barents Sea Southeast and identifying prospects for the Norwegian 23rd round.



Base map of the East Barents Sea 2D data. Most of the lines are crossing Russian exploration blocks and tie to exploration wells. The BSSE group shoot areas (represented by the EM-data in light green) on the Norwegian side are close to the overview line (A-A', marked in yellow) in seismic section below. Some of the major elements are highlighted: 1 – Demidov Graben, 2– Fedynsky High, 3 – West Kola Graben, 4 – Ivanovskaya High, 5 – Ludlovskaya Saddle, 6 – South Barents Basin, 7 – North Barents Basin.



The exploration blocks available for the 23rd Licensing Round in Norway are located far away from verified geological models on the Norwegian Continental Shelf (NCS). Moreover, few exploration wells have been drilled in the Norwegian Barents Sea South East (BSSE). Any additional geophysical data is therefore of great value in this area.

PGS, in collaboration with Geology Without Limits' (GwL), have acquired 2D seismic surveys in the East Barents Sea. These surveys cross primary structural features, tie to important exploration wells, cross Russian exploration blocks, and extend to the Norwegian border and the edge of the BSSE areas.

The regional 2D data was acquired during two operations and is now available for purchase. Export licenses from Russian authorities have also been obtained, which allowed the data to be legally exported from Russia and to be worked on internationally.

We demonstrate that the East Barents Sea survey data is important in the interpretation of this frontier area, enabling the correlation across the border to potential source and reservoir formations, and in advancing a fuller understanding of the petroleum systems in the BSSE.

FOUR MAJOR DISCOVERIES

The Russian Barents Sea is dominated by two large basins, the **North and South Barents Basins**, both with sediment thicknesses exceeding 12 km. The basins are bordered to the east by Novaya Zemlya Island and to the west by the Finnmark and Bjarmeland Platforms; West Kola/Tiddlybank, Demidov, Malygin and Knipovich Grabens; as well as by the Fedynsky and Fersman Uplifts. The North and South Barents Basins are separated by the Ludlovskaya Saddle.

Exploration began in the 1970s with seismic surveying from which early leads were identified.

By the early 1980s, drilling had commenced and the first gas discovery was confirmed in 1983 (**Murmanskoye**). Several gas/condensate discoveries followed, most notably **Severo-Kildinskoye** in 1984, the largest discovery to date, the **Shtokmanovskoye** discovery in 1988 and **Ludlovskoye** in 1990.

The discoveries vary in hydrocarbon content and geological setting: the Murmanskoye discovery contains gas within Triassic sandstones; Severo-Kildinskoye is a gas discovery within Lower Triassic sandstones; Shtokmanovskoye contains gas and condensate in Middle-Upper Jurassic shallow marine sandstones; and Ludlovskoye is a gas discovery in Middle Jurassic sandstones.

PETROLEUM SYSTEMS IN THE RUSSIAN BARENTS SEA

The evolution of the North and South Barents basins began in the **Devonian-Carboniferous** when rifting created several graben-structures. The basins were filled by **Carboniferous** syn-rift sediments, Top Serpukhovian is equivalent to the Norwegian Billefjorden Group).

The **Permian** was dominated by carbonate deposition with bioherm accumulations on the highs (e.g. the Fedynsky High), and reef structures on the platform and basin margins.

Following the closure of the Uralian Ocean, increased subsidence occurred in the North and South Barents basins during the **Late Permian and Early Triassic**. This subsidence together with the proximity to the main sediment provenance area, Novaya Zemlya, led to a thickening of the **Triassic** in the Russian Barents basins relative to the Norwegian Continental Shelf (NCS) and the BSSE.

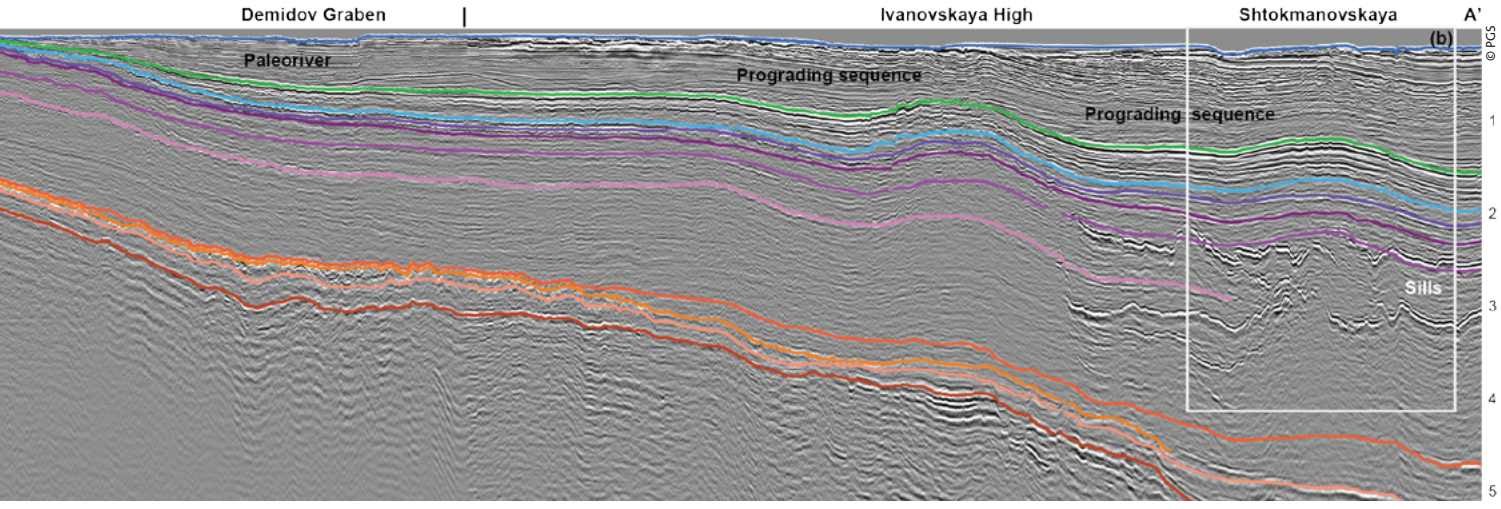
Several westwards prograding sequences are observed in the Lower Triassic succession, coming off the Fedynsky High towards the Demidov Graben – similar to the Havert or Klappmyss formations on the NCS (Top Induan and Top Olenekian, respectively).

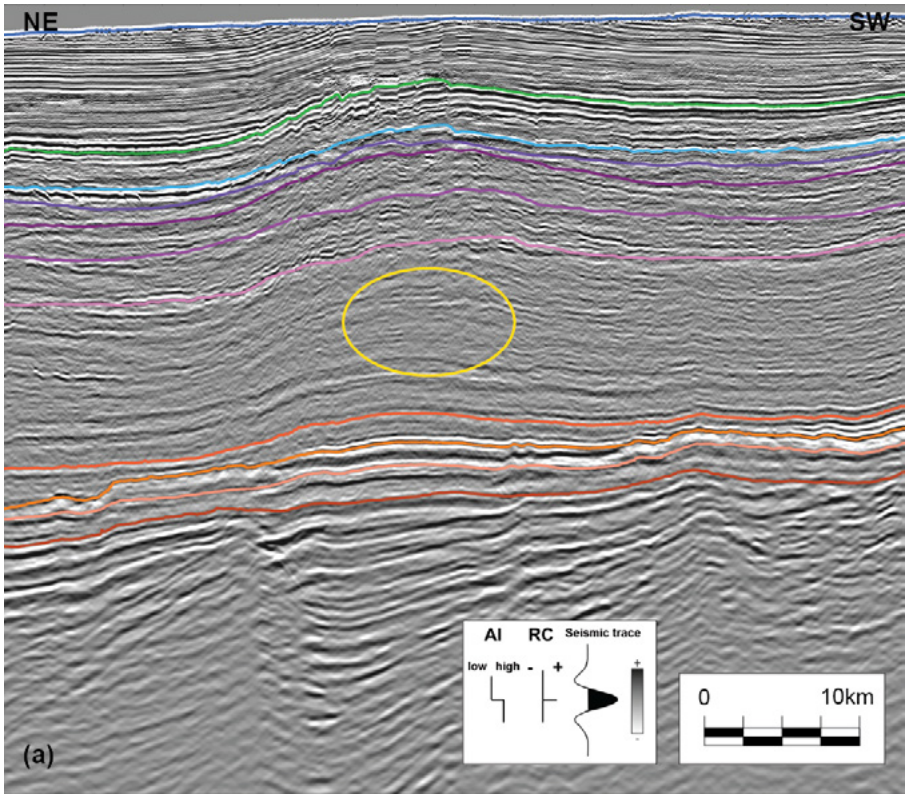
The **Jurassic** sequence is also thicker than what is observed on the NCS, and near the Shtokmanovskoye discovery it is dominated by shallow marine sandstones.

The **Lower Cretaceous** strata consist of several prograding sequences and a large paleo river system. Cretaceous volcanism affected the South Barents Basin, with sills and dikes being intruded into the Triassic strata west of Novaya Zemlya. The post-Mesozoic strata are to a large degree absent as they were eroded and deposited either further west or northwards, beyond the shelf edge into the Kara Sea.

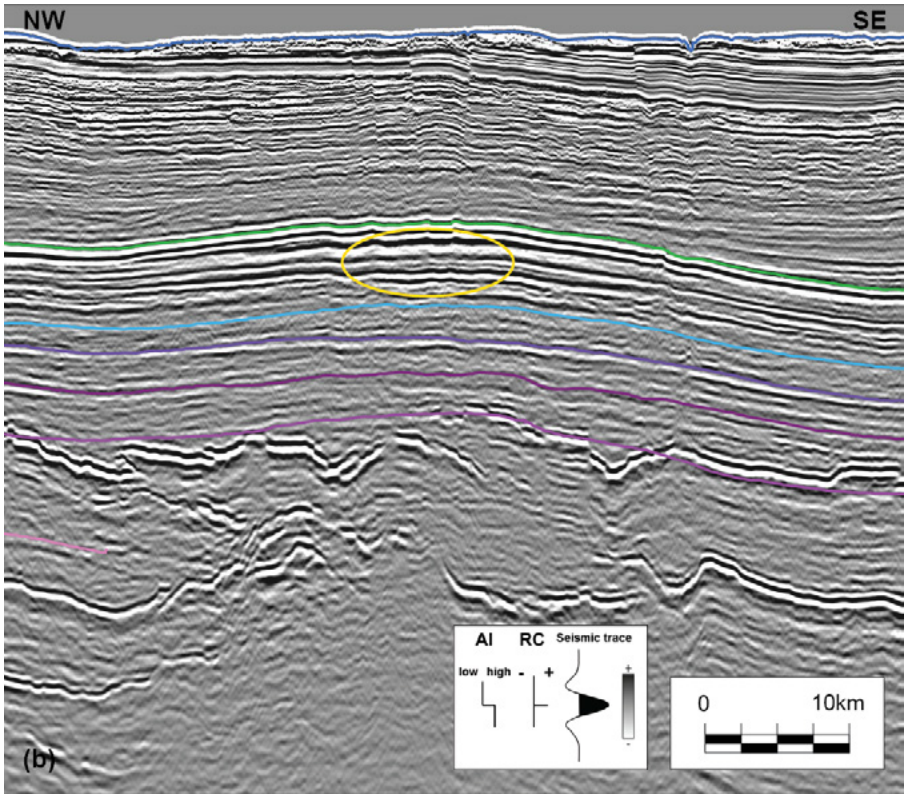
Source rock intervals are present within both the Paleozoic and Mesozoic successions with the Lower to Middle Triassic petroleum system considered the most prolific (Norina, Stupakova, & Kiryukhina, 2014). The Triassic source rocks are considered to be mature

A composite 2D PSTM stack line (See map for location, yellow line A-A') crossing Severo-Kildinskoye (discovery), West Kola Graben, Fedynsky High, Demidov Graben, Ivanovskaya High and Shtokmanovskaya (discovery). The strong events within the Triassic near the Ivanovskaya High and Shtokmanonskaya are the Cretaceous sills. Ten regional horizons from Late Carboniferous to Cretaceous have been interpreted. Boxes indicate location of following close ups (white frames indicate close-up locations on next page).





A zoom-in over the Severo-Kildinskoye gas field. The reservoir level is within Lower Triassic sandstones (yellow circle). (See map for location and wide seismic section on previous pages for legend.)



A zoom in over the Shtokmanovskoye gas and condensate field. The reservoir level is situated within Middle-Upper Jurassic marine sandstones (yellow circle). (See map for location and wide seismic section on previous pages for legend.)

over most of the East Barents region, and are generally gas. The Late Jurassic source rocks ("hot shales") are generally considered immature, but are potentially mature in the center of the South Barents Basin. The Paleozoic in the basinal settings are considered overmature, with potential for mature Paleozoic source rocks on the platforms and highs.

Potential **reservoirs** are situated within Triassic fluvial channels and Jurassic shallow marine sandstones, with further potential in Permian carbonates. In contrast to the NCS, the trapping mechanism in the East Barents consists of anticlines and domes possibly related to the far field stresses due to the late Paleocene – Eocene West Spitsbergen orogeny.

REGIONAL CORRELATION TO NORWEGIAN BARENTS SEA

To understand the cross-border structures and to improve the geological model of the Barents Sea in the BSSE area, the new 2D seismic data has great value.

The easternmost exploration well on the **Norwegian** shelf is the 7131/4-1 drilled in 2005, located on the Finnmark Platform and terminating in the Middle Triassic Kobbe Formation.

Russian exploration wells (e.g. Shtokmanovskoye and Severo-Kildinskoye), were used by GwL in the interpretation work of the East Barents dataset, and give stratigraphic control down to Permian.

The Top Permian and Top Tithonian are good regional markers both in the Norwegian BSSE and the Russian Barents region. The Top Permian represents a shift from mixed siliciclastic-carbonate to pure siliciclastic deposition. The Top Tithonian defines a change from Late Jurassic "hot shales" to Cretaceous clastics. The reflectors are strongly visible on the new data and can easily be correlated to equivalent reflectors on the Norwegian shelf (the Top Tempelfjorden Group and the BCU respectively).

The Russian data will, alongside data from the NCS, aid in the understanding of the prospectivity and quality of the Norwegian leads near the border, with valuable information from the East Barents and potential migration pathways coming from the east, especially important regarding the Fedynsky High area.

MARI SCHJELDSØE BERG AND ØYSTEIN LIE,
PETROLEUM GEO-SERVICES