

Taking a geological approach to regional exploration

Acquiring seismic data with an eye toward geology and combining it with nonseismic measurements brings new understanding to frontier areas.

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In the current competitive environment E&P companies must take greater financial risks to access frontier areas and new prospective plays. Between block award signing bonuses and work commitments, oil companies can spend hundreds of millions of dollars before drilling the first well in an exploration program. In frontier areas where seismic and well data do not exist or are lacking, the perceived risk is even greater.

Although no commercial wells have been drilled, northeast Greenland is believed to be highly prospective with resource estimates of 31 Bboe. Exhumed oil deposits to the southwest in the Traill Ø area and a conjugate margin connection to the highly productive North Sea suggest evidence of an active petroleum system. Yet there are no regional ties between these potential end members that can reduce exploration uncertainty in this untested area.

A regional understanding of basins and petroleum systems can provide the geological context to help reduce uncertainty of play types and high-grade the most prospective areas. To deliver this kind of information, ION introduced BasinSPAN regional 2-D programs to help E&P companies focus in the most prospective areas.

Using this kind of exploration framework, E&P companies can mitigate exploration risk by placing all play types within a calibrated regional framework that enables them to compare their portfolio of opportunities.

Exploring the Arctic

ION's ArcticSPAN programs are taking a first look at new exploration frontiers. The three phases of the northeast Greenland program were designed to deliver a more comprehensive understanding of the geologic structure, providing a basin-scale 2-D seismic framework of the entire petroleum province. The geophysical objectives were achieved by defining image requirements and then working back through the seismic workflow to define the appropriate acquisition and processing technologies and methodologies. The company first employed its new proprietary under-ice arctic technology, acquiring 17,500 km (10,658 miles) of data in areas previously inaccessible because of heavy ice coverage.

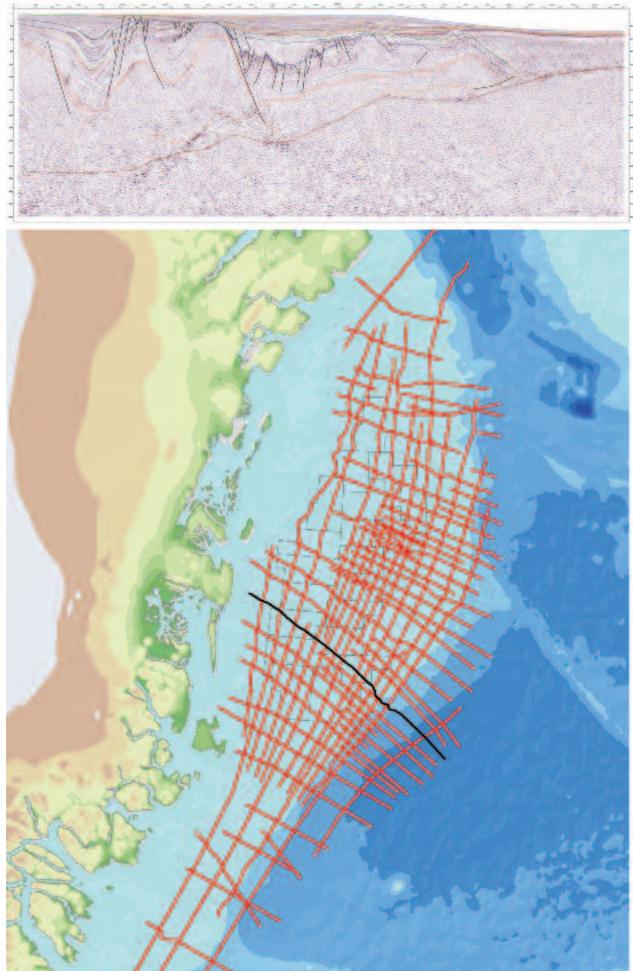


FIGURE 1. The base map shows the regional distribution of lines designed to image key geologic features. (Images courtesy of ION)

Rather than using a conventional symmetrical grid, the surveys take a geological approach designed to cross geologic structures and tie key data points. The lines purposely intersect wells and recent discoveries to provide stratigraphic calibration wherever possible. Global and regional geologic models are incorporated to design and set limits for acquisition. Critical building blocks of this process include understanding basin crustal geometry and sedimentary architecture and the implications to the thermal history and maturity within a basin.

Because of the depth and stratigraphic resolution provided by these surveys, it is possible to understand and reconstruct a basin's tectonic evolution at a crustal scale. Interpretation reports illustrate the geometry and nature of stratigraphic horizons from the water bottom to Moho. Crustal thickness and sediment isopach maps created from these data provide a regional context for defining exploration play fairways.

Basin-scale depth imaging also provides a basis for studying and gaining insight from conjugate margins globally. Understanding basin evolution at the regional scale requires imaging both margins within the basin. Programs are designed and oriented to consider the paleogeography as the basin formed, providing the most accurate data to explore both sides of a basin.

Greenland

The northeast Greenland Shelf is the conjugate margin to the Lofoten and Vøring margins of Norway prior to continental breakup. The new data provide evidence of a continent-ocean transition that occurred closer to the Greenland coastline than previous interpretations allowed for. This interpretation impacts the breakup history of both the Greenland and conjugate Norwegian margins and has led to a revised plate reconstruction model of the North Atlantic (Figure 2).

In large geographic areas with limited data, nonseismic methods are integrated with seismic data to cost-effectively develop higher resolution 3-D images. Combining gravity and seismic data gives a more complete picture of fault geometry, salt distribution, and crustal type.

As part of the Northeast GreenlandSPAN program, ION partnered with ARKeX to acquire the world's largest offshore 3-D multiclient airborne full-tensor gravity gradiometry (FTG) survey spanning 50,000 sq km (19,305 sq miles). The integration with existing 2-D seismic data has led to an improved understanding of fault linkages, basement composition, and the geometry and continuity of salt bodies. The section shown in Figure 3 shows how

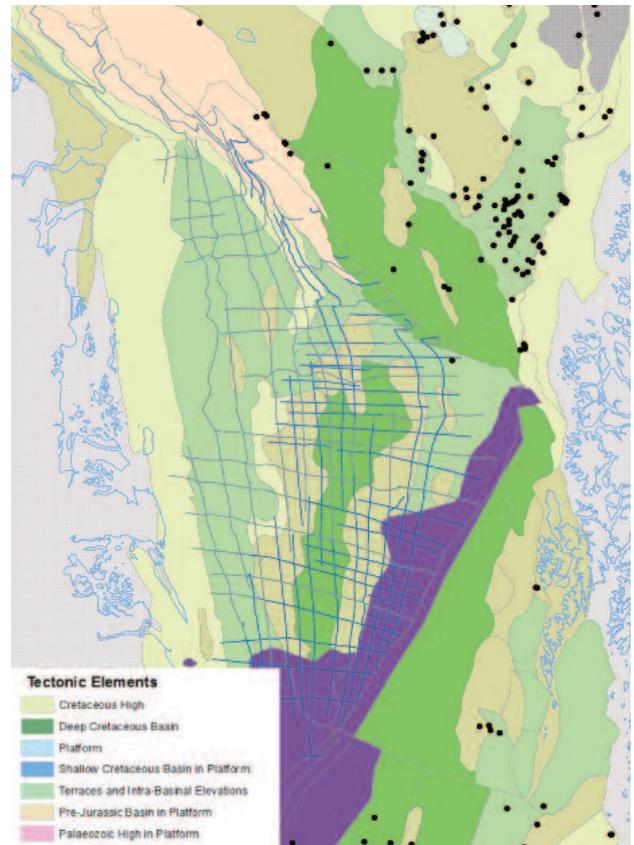


FIGURE 2. The Northeast GreenlandSPAN data provided new insights, resulting in a revised plate reconstruction model of the North Atlantic 55 million years ago.

high-resolution gravity gradiometry is integrated with regional 2-D seismic to improve the architectural understanding of salt geometries within a basin.

Integrating gravity also provides constraints in velocity model-building by revealing density contrasts within a given area. Iterating between seismic, magnetic, and gravity data makes it easier to identify densities of subsurface layers to achieve the best match.

The data revealed new insights into the subsurface, identifying play types and structural leads and suggesting that oil-prone Jurassic source rocks are present over much of the area. These interpretations, coupled with the observations on the conjugate Mid-Norway margin, indicate that the area has excellent hydrocarbon potential. **ESP**

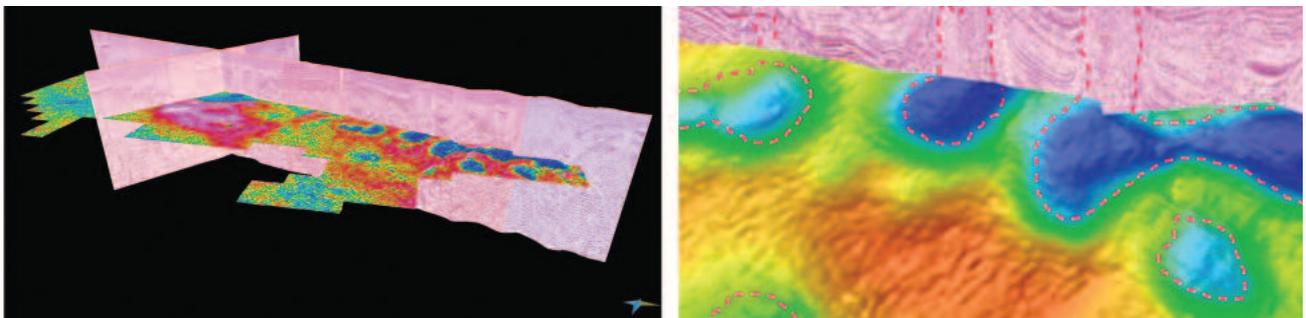


FIGURE 3. Integrating 2-D seismic with full-tensor gravity gradiometry improves understanding of salt amount and shapes.