Ministry of Economic Affairs and Climate Policy

Shallow Gas

Bright opportunities in the northern Dutch offshore

Explore for shallow gas

Cenozoic sediments in the northern Dutch offshore host abundant seismic amplitude anomalies or **bright spots** at the interval of 300–800 m depth, of which several are proven to be related to the presence of hydrocarbons. **Traps** are generally provided by low relief **4-way dip anticlines** formed by underlying salt diapirs, whereas **intercalating clays** provide the necessary **sealing** capacity. Currently, **4 shallow gas fields** are successfully **producing**, and more fields will come on stream in the coming years.

The shallow gas play has proven to be a valuable resource and with several tens of undrilled shallow leads, largely covered by 3D seismic data, it is worthwhile to further evaluate the development potential of this play.

Key factors for a **successful development** of shallow gas accumulations are:
- Distance to existing infrastructure
- Gas saturation
- Flow and storage capacity

A **challenge** remains in the presence of mobile gas and estimating gas saturation prior to drilling. Seismic attributes do not distinguish between high and low saturation or even lithological effects.

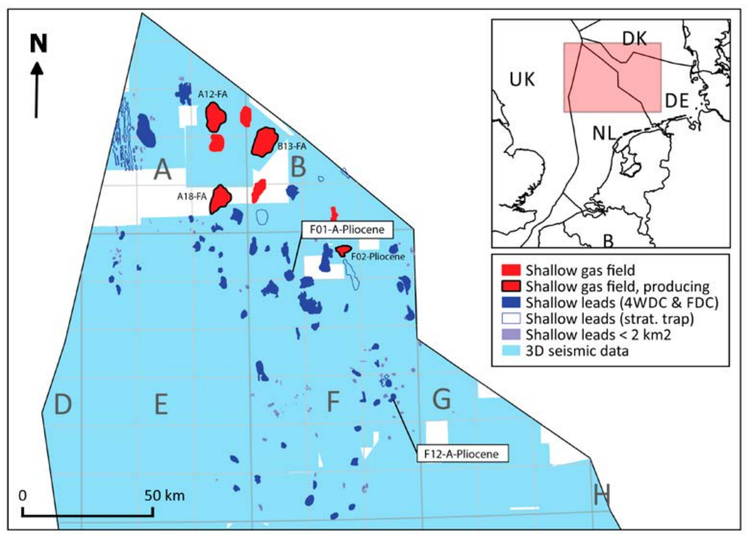

Figure 1.
Shallow gas leads in the northern Dutch offshore identified by bright spots.

High production rates despite modest pressures

The Dutch shallow gas reservoirs produce quicker than initially expected. The **A12-FA field** ranked amongst the best producing gas fields in the Netherlands with production rates around **3 million Nm³/day** from six producers.

The positive effect of production-induced reservoir compaction (rock compressibility)
- The recovery from shallow gas reservoirs is potentially enhanced by production-induced compaction of the unconsolidated sediment reservoir
- The reduction of pore volume as a result of reservoir compaction has a positive impact on the reservoir pressure and therefore the recovery. The potentially negative effect of compaction (reduction in permeability) is negligible

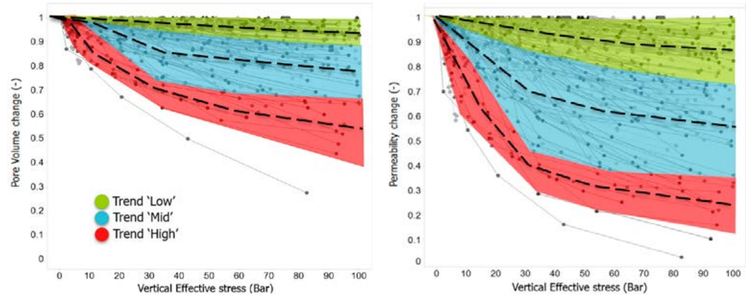

Figure 3.
Representation of rock behaviour during compaction of weakly consolidated to unconsolidated sandstone based on literature.
a. Variation in pore volume (~ porosity),
b. Variation in permeability (based on the Carman-Kozeny equation).
Three different levels of compaction are defined (low-mid-high).

Under-estimation of compaction leads to an initial underprediction of the ultimate recovery.

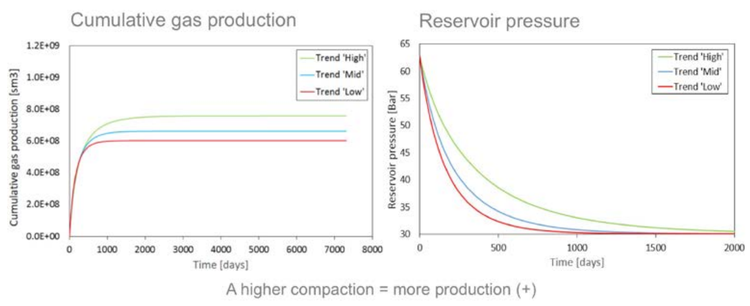

Figure 4.
Results from the reservoir simulation done on a block model with the defined compaction trends. With a higher rock compressibility, more rock compaction, more gas is produced.

Reservoir properties

Based on fields currently in production

- Gas saturation: ~50-80%
- Expected recovery factor: ~70%
- Porosity: 20-25%
- Permeability: good to excellent (100-500 mD)

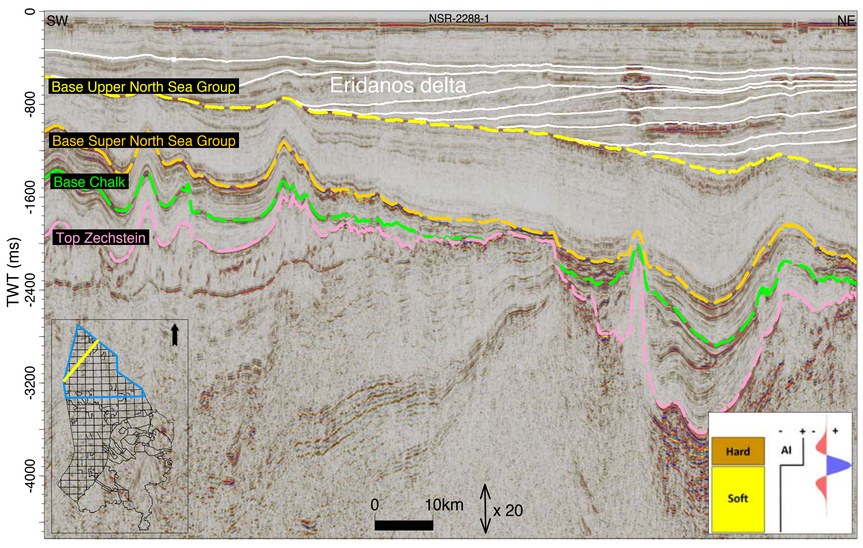

Figure 2. Seismic section through the study area showing the Cenozoic foresets of the Eridanos delta system in white.

Lead F12-A-Pliocene

Licence	Open acreage
Seismic data	3D coverage, seismic data in public domain
Seismic response	Amplitude anomaly conformable to structure, flat-spot, push-down effect and attenuation
Structure	4-way dip closure
Thickness	~50 m (net-to-gross: 85%)
Porosity	> 25%
Gas saturation	± 60%
GIIP	0.5 – 0.8 – 1.1 bcm (P90 – P50 – P10)

Considering the presence of several other shallow gas leads in close proximity and the opportunity to explore for deeper targets, this lead ranks high for further detailed analysis.

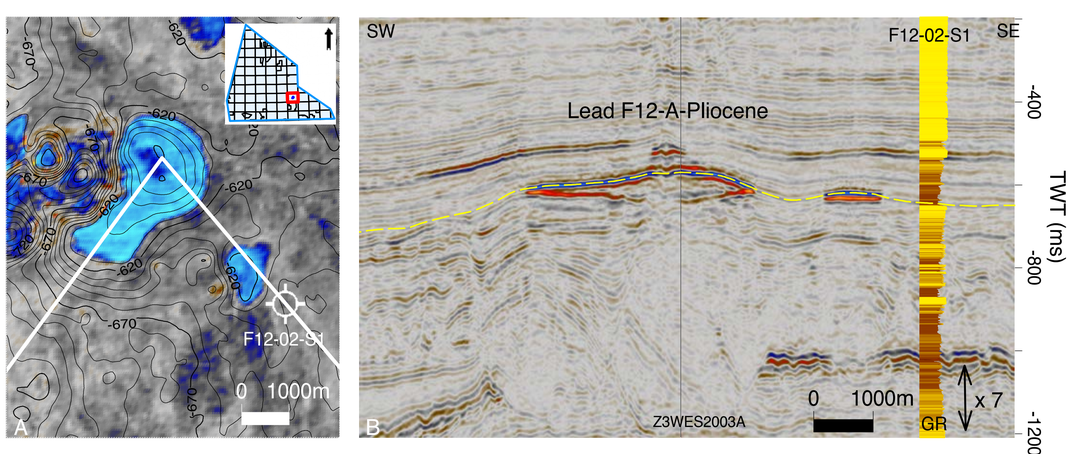

Figure 5a. Time map of the main reservoir in lead F12-A-Pliocene showing seismic amplitudes, b. Seismic line through this faulted dip closure. The top of the main reservoir is indicated by the yellow dotted line.

Lead F01-A-Pliocene

Licence	Exploration (under application)
Seismic data	High quality 3D seismic spec survey (2011)
Seismic response	Several stacked bright spots of which one single sand is considered the main reservoir. Velocity push-down, attenuation and a gas chimney can be observed.
Structure	4-way dip closure with crestal faulting

GIIP calculated by means of Monte Carlo simulation using net-to-gross, porosity and saturation ranges similar to those in the producing shallow gas fields.

GIIP	0.8 – 1.5 – 3.0 bcm (P90 – P50 – P10) Excluding the upside potential of the other sands in the stacked amplitude anomalies.

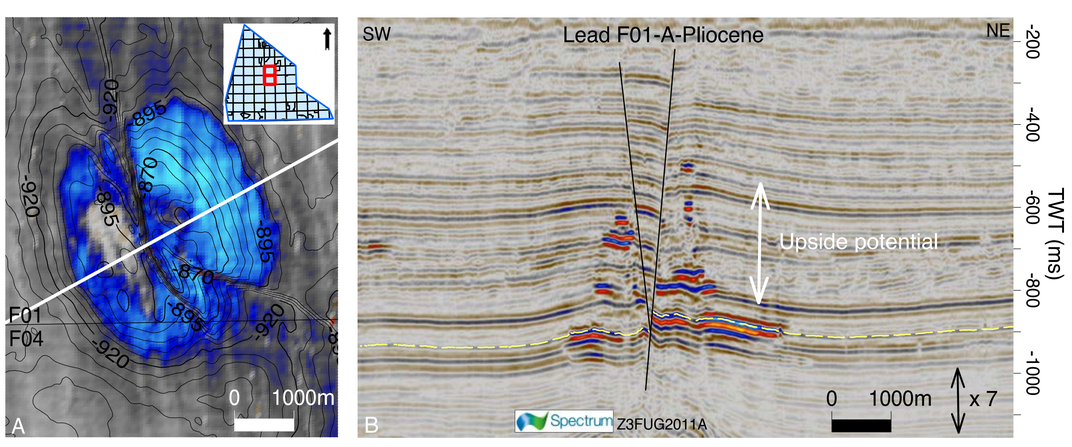

Figure 6a. Time map of the main F01-A-Pliocene lead showing seismic amplitudes, b. Seismic line through this faulted dip closure. The top of the main reservoir is indicated by the yellow dotted line.

For questions contact info@nlog.nl or exploration@ebn.nl