Improved Seismic Imaging

Local characterization of the Dutch offshore

Zechstein diapirism (figure 1)

- Complex morphologies with high & variable Acoustic Impedance (AI) contrasts
- Surrounded by deformed anisotropic sediments
- Distortion of propagated wavefields
- Typically flanks and underlying stratigraphy are poorly illuminated/imaged
- Accurate salt extent and hence velocity model derivation often challenging

Poorly imaged Carboniferous and Rotliegend (figure 1)

- Seismic imaging hampered by signal penetration through complex overburden and high AI contrasts (Top and Base Zechstein)

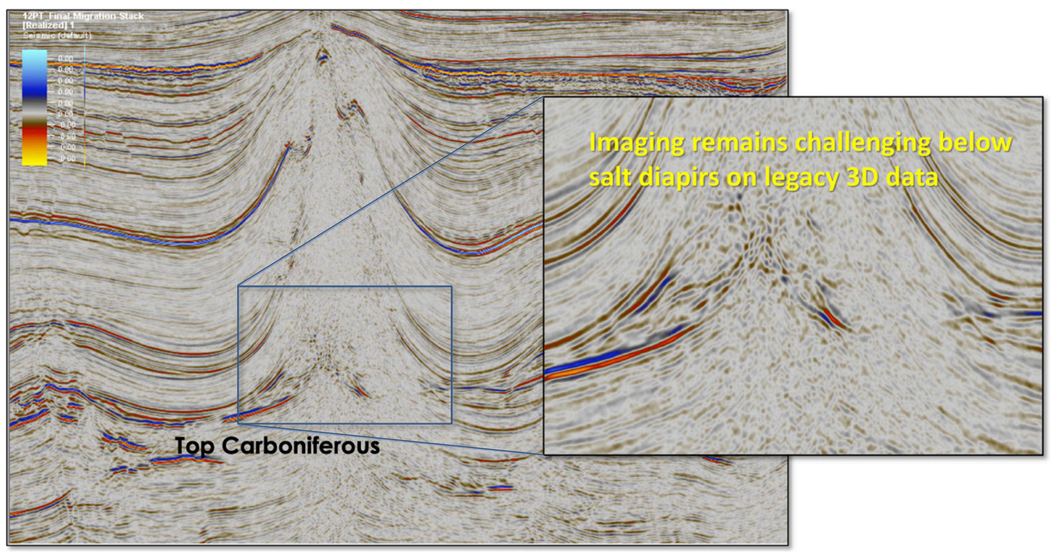


Figure 1. Example of Zechstein diapirism and associated poor imaging.

OBN acquisition combined with FWI and RTM is deemed necessary to address imaging issues sub-salt offshore The Netherlands

Project premise: In areas exhibiting severe diapirism, the reprocessing of legacy NAZ 3D is unable to provide the imaging needed in pre-Zechstein to enable identification and maturation of exploration opportunities. Ocean Bottom Node (OBN) acquisition combined with the latest velocity model and imaging technology is deemed necessary to successfully image these areas.

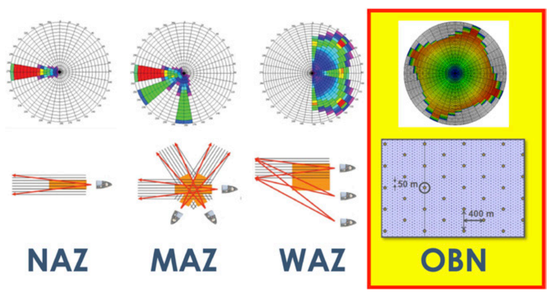
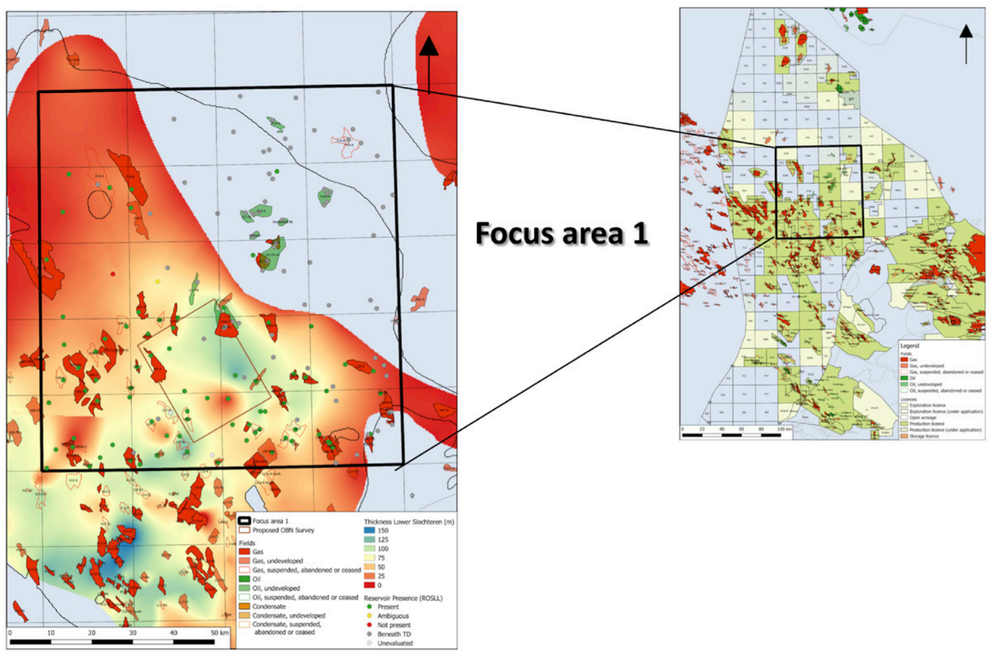


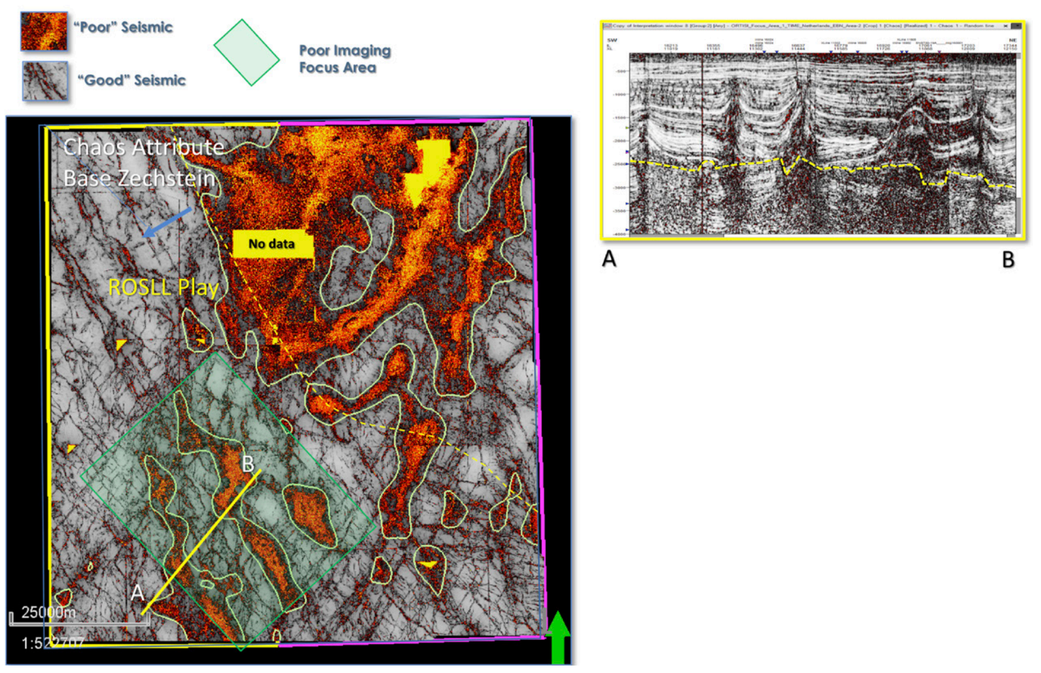
Figure 2.
Azimuth distribution for various acquisition techniques.

- Underexplored regions: Prospective and undrilled areas offshore The Netherlands and coincide with a poorly imaged pre-Zechstein section
- OBN acquisition should be considered in poorly imaged areas large enough to contain possible economic traps AND coincide with prospective areas on the basis of proximity to known hydrocarbon accumulations and/or a positive Play Based Exploration assessment (figures 3-6)
- OBN acquisition is inherently broadband and provides the azimuth and offset data needed to improve illumination (figure 2). OBN acquisition provides data that supports effective application of FWI (velocity model derivation) and RTM (imaging) algorithms



Play Based Exploration: Area distribution of the Lower Slochteren play in focus area 1

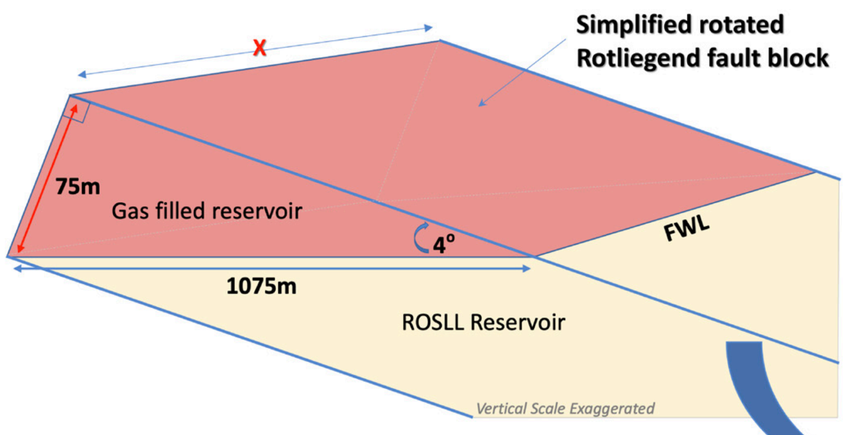
Figure 3. Lower Slochteren play extent and reservoir thickness.



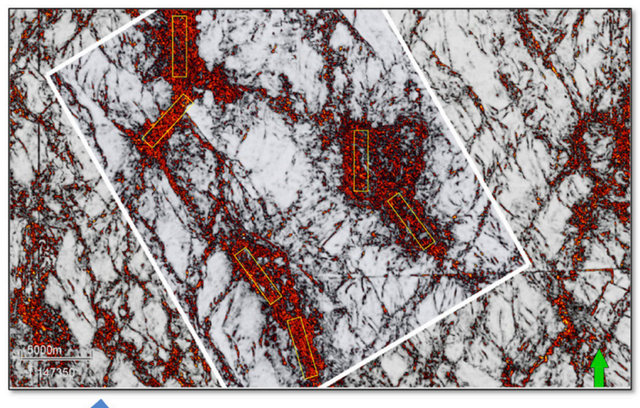
Chaos attribute extracted along Top Rotliegend to illustrate areas of poor imaging. Poor imaging within the green (figure 4 left) rectangle due to halite diapirism

Figure 4. Chaos attribute highlighting faults and lateral variations in seismic data quality.

Can an economic gas field fit within poorly imaged areas?



Reservoir thickness	75 m
Cross Section Area	40220 m2
Length?	4350 m
GRV	174957000 m3
n/g	60%
Porosity	10%
Av. Gas saturation	60%
Gas Expansion factor	320
GIIP	2,02 bcm



Assuming reasonable volumetric parameters –
What length X is needed to achieve 2 bcm GIIP?

Notional 2 bcm structures located in areas where poor imaging precludes identification and maturation of exploration opportunities

Figure 5. Sketch of Rotliegend fault block trap used to calculate geometry needed to contain 2 bcm.

Figure 6. Sketch of how economic 2 bcm structures might fit in poorly imaged areas.

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