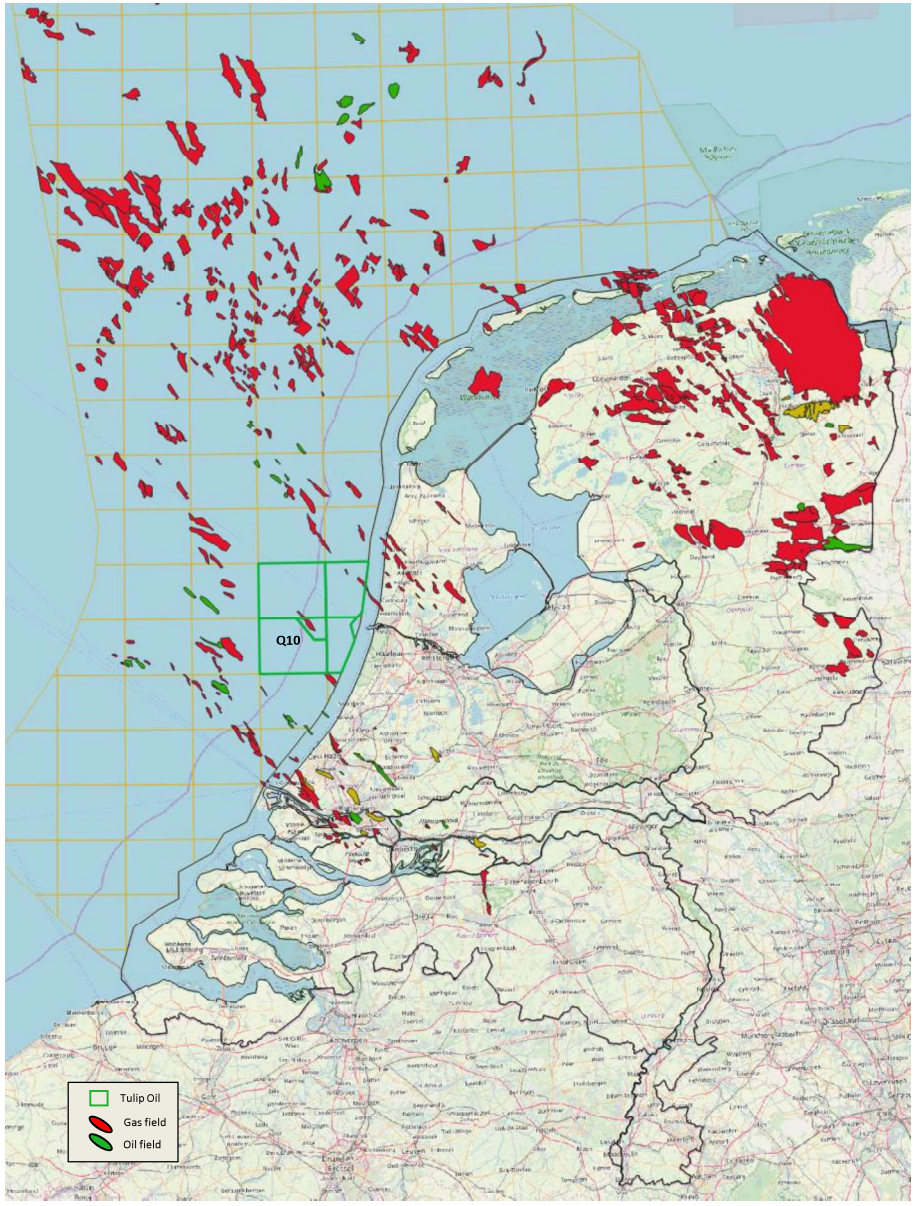
Tulip Oil
Exploration and Production

Revival of the central Q blocks

EBN exploration Day 20 Nov 2019
Kike Beintema

Tulip Oil
Exploration and Production

Central Q-blocks: an empty corridor



Q blocks:

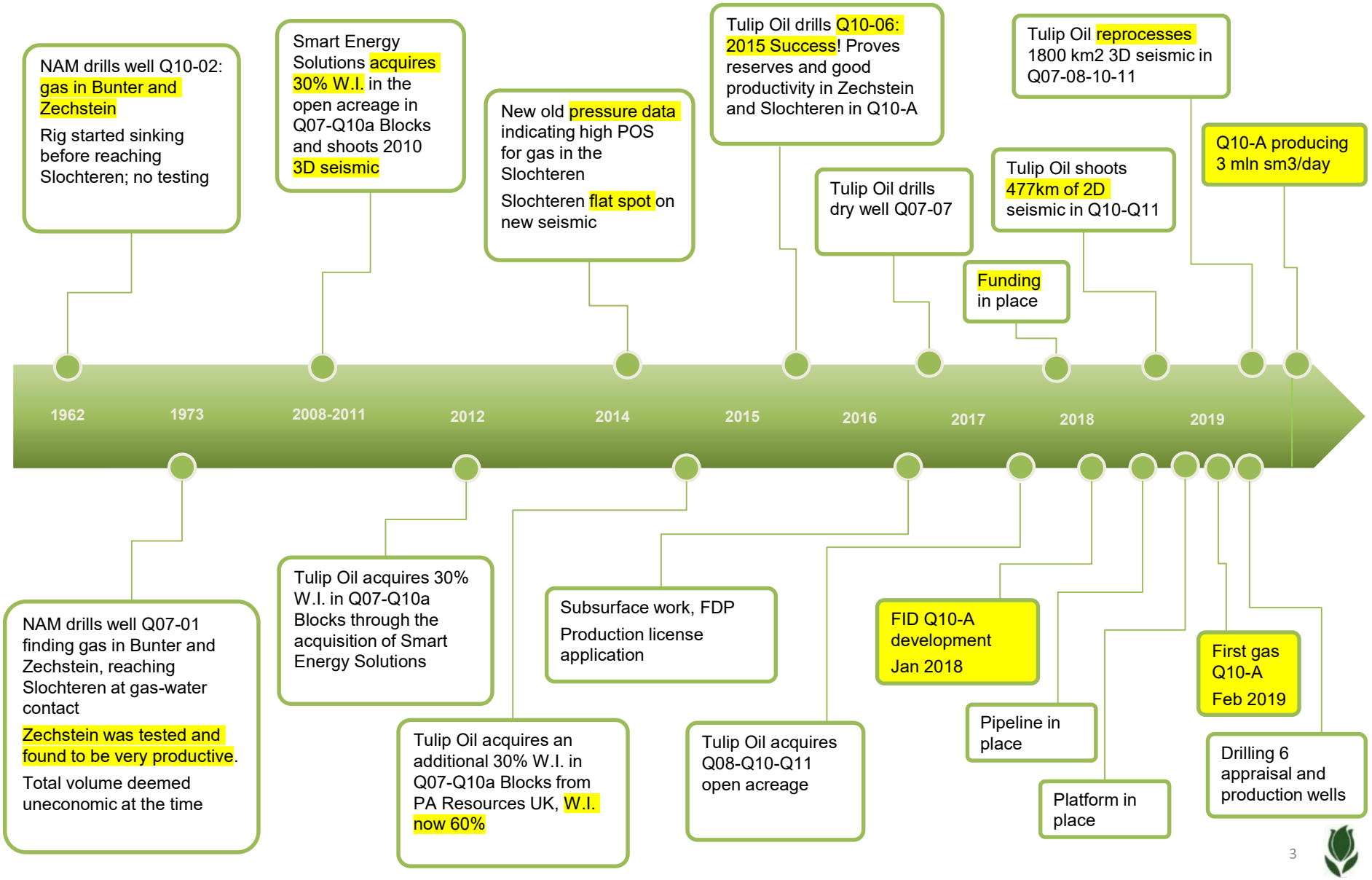
- Several dry wells were drilled in the 60's – 70's
- Several uneconomic discoveries
- Revival of the area in the 80's not successful

Historically underexplored plays:

- Slochteren was perceived tight (Weissliegend)
- Perceived high risk top seal (no salt)
- Zechstein Carbonate and Fringe Sands were perceived unproductive or risky.
- Vlieland and Delfland oil underexplored.

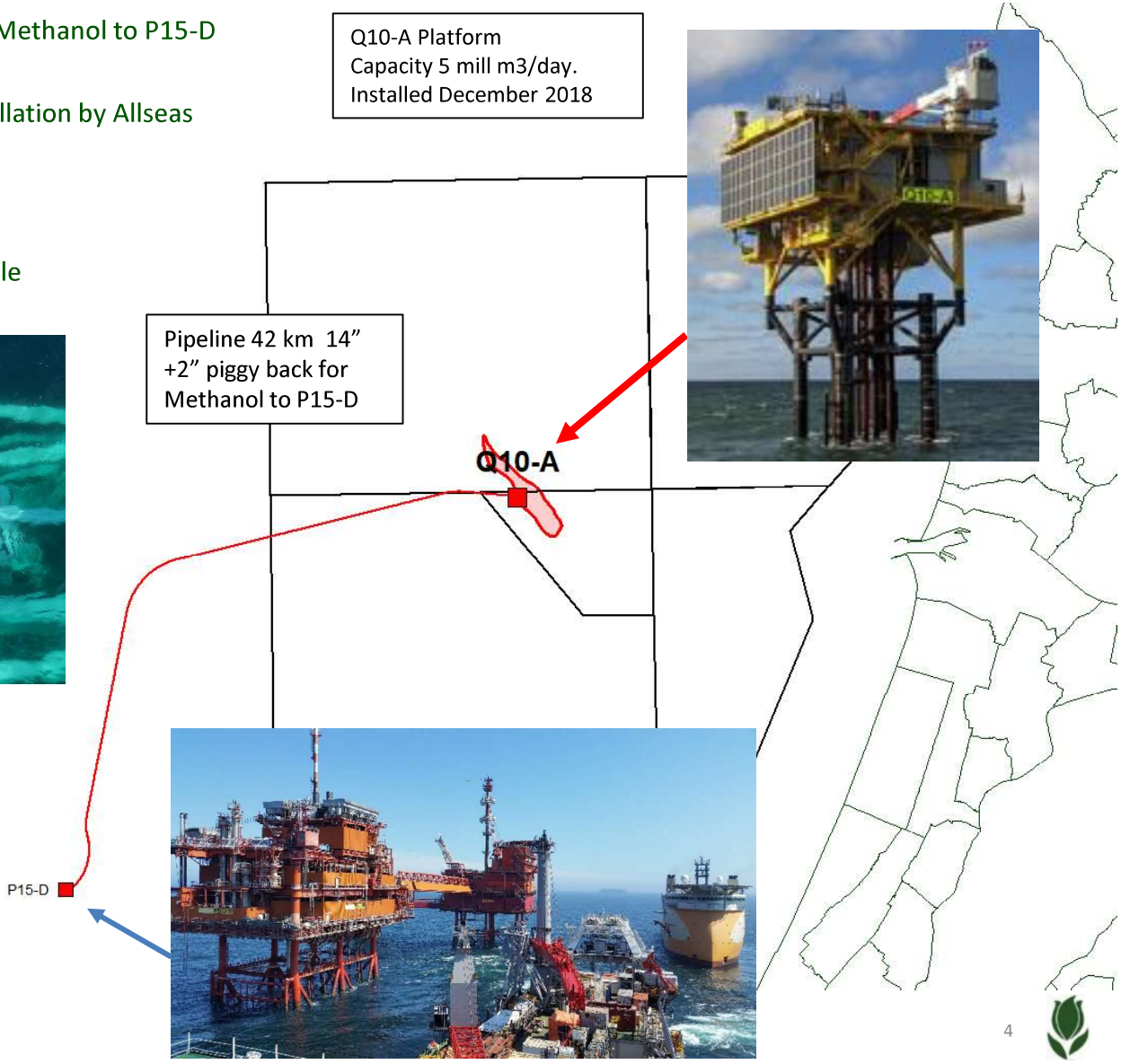
Tulip Oil
Exploration and Production

Q7-FA …. Q10-A history



Pipeline Q10-A

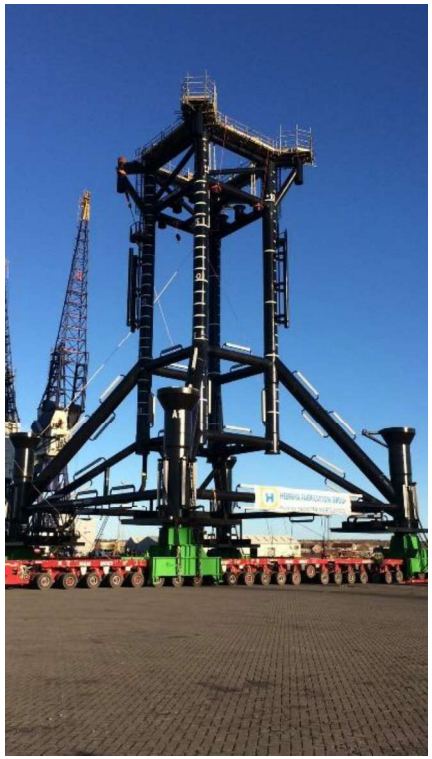
- Pipeline 42 km 14” +2” piggy back for Methanol to P15-D
- FID: January 2018
- Engineering, Material delivery and installation by Allseas Delft NL
- Installed June 2018
- First Gas Feb 2019
- Incident free, within budget and schedule



Platform Q10-A

Jacket and Topside

- FID: January 2018
- Topside construction at Heerema in Zwijndrecht NL
- Jacket construction in Hartlepool UK
- Installed December 2018
- First Gas Feb 2019



Q10-A production wells - Drilling

Rig Prospector 1

On contract 25 December 2018

- Tie-back of Q10-06
- Drilling of 4 production and 2 appraisal wells

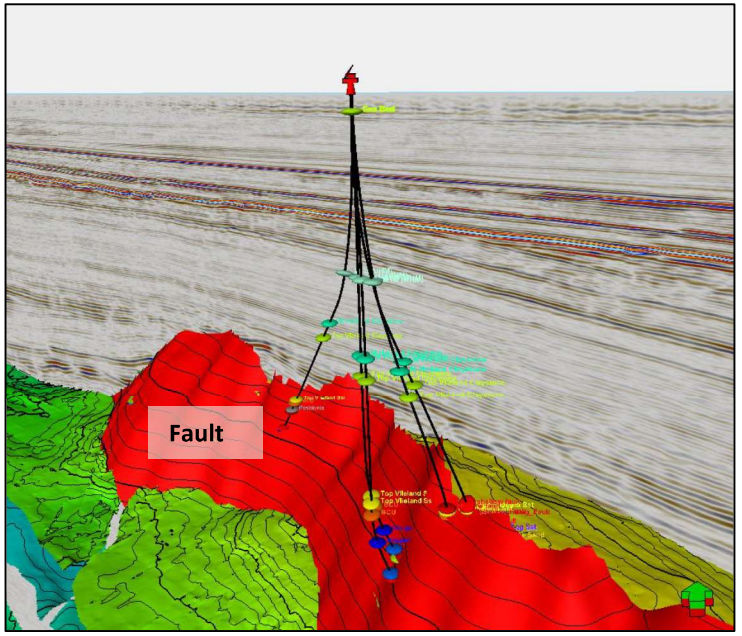
Off contract 1 October 2019

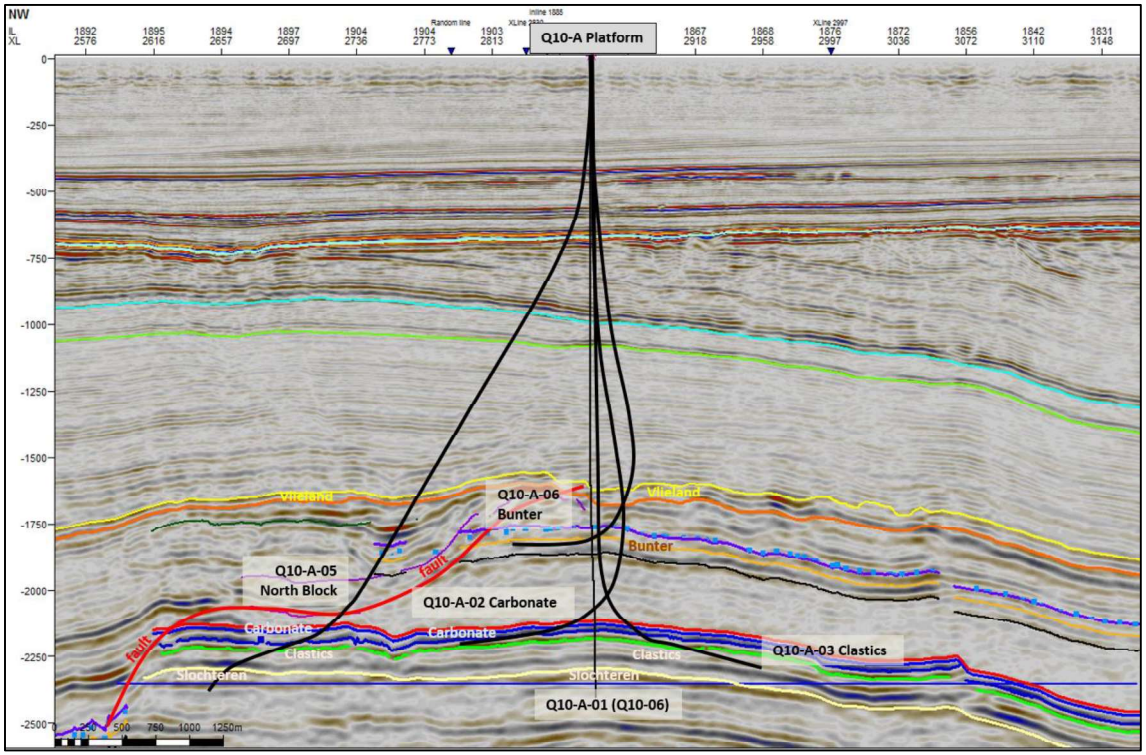
- Conductor hammering and Tophole drilling (17.5'') in batch
- Tie-back of Q10-06: now Q10-A-01
- Drilling and completion of 4 production and 2 appraisal wells
- Data acquisition
  - Mostly by LWD
  - Wireline sonic, pressures and samples
  - Coring

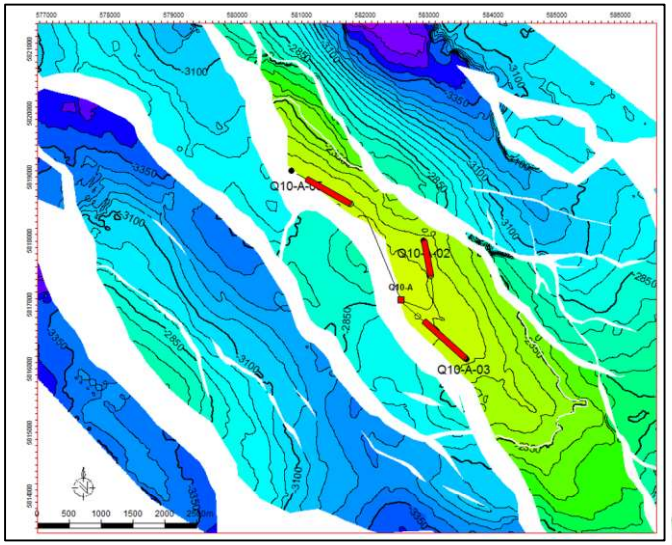
Tulip Oil
Exploration and Production

Q10-A production wells – all unique

- Q10-A-02 Zechstein Carbonate horizontal well + acid stimulation
- Q10-A-03 Zechstein Clastics slanted well + multi frac
- Q10-A-03A Pilot hole, Vlieland and Bunter evaluation
- Q10-A-04 West-block deep appraisal well
- Q10-A-05 North block slanted Clastics & Slochteren
- Q10-A-04 Bunter horizontal development well



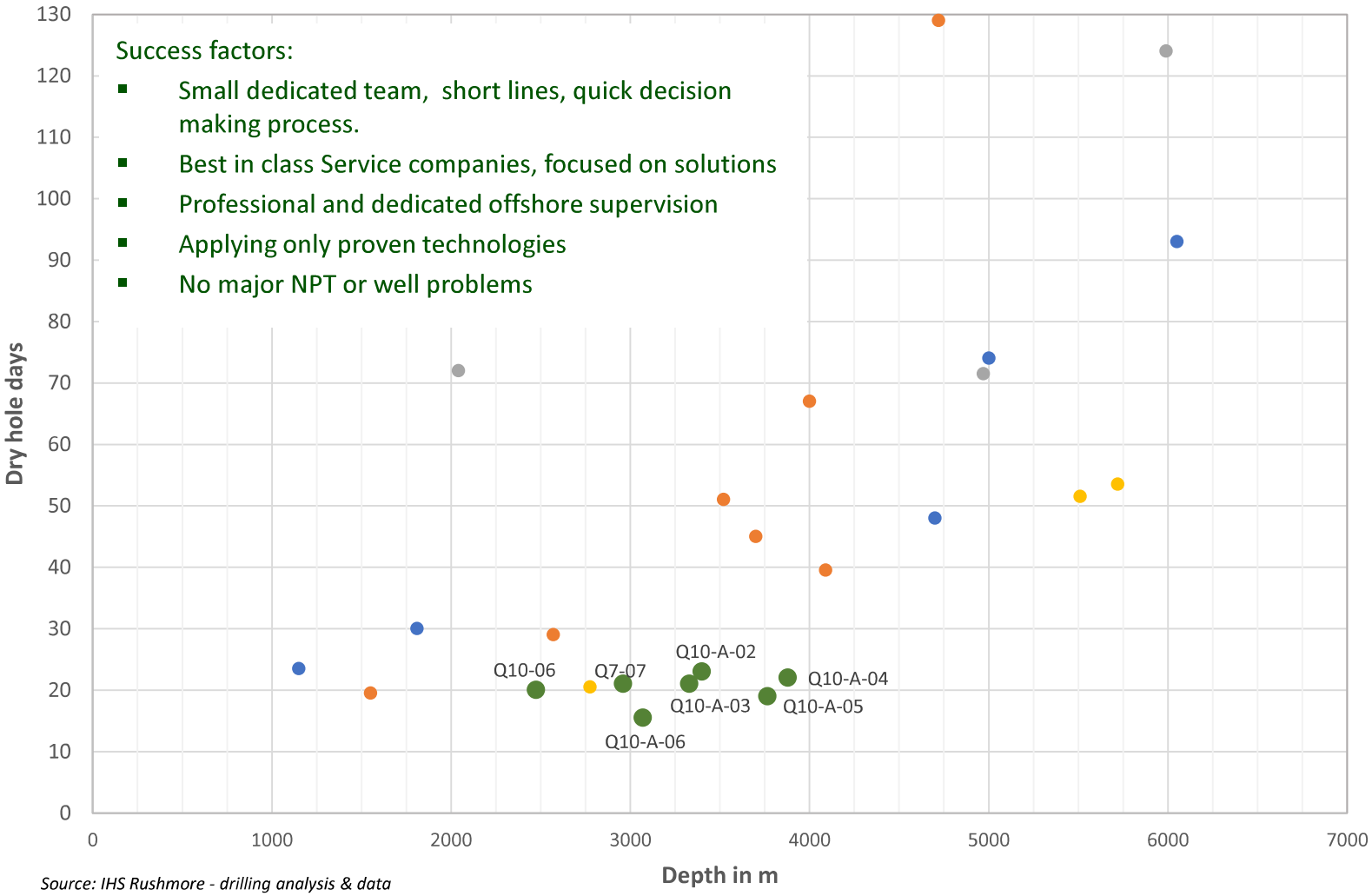




Tulip Oil
Exploration and Production

Q10-A production wells – Drilling performance

Drilling days vs final depth from Offshore wells in the NL



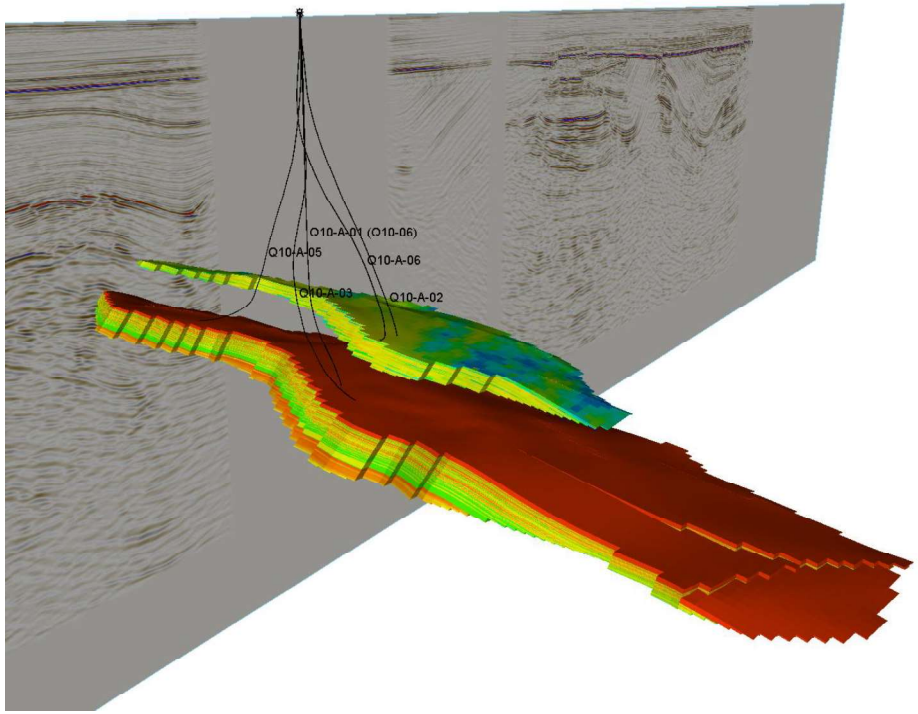
Source: IHS Rushmore - drilling analysis & data

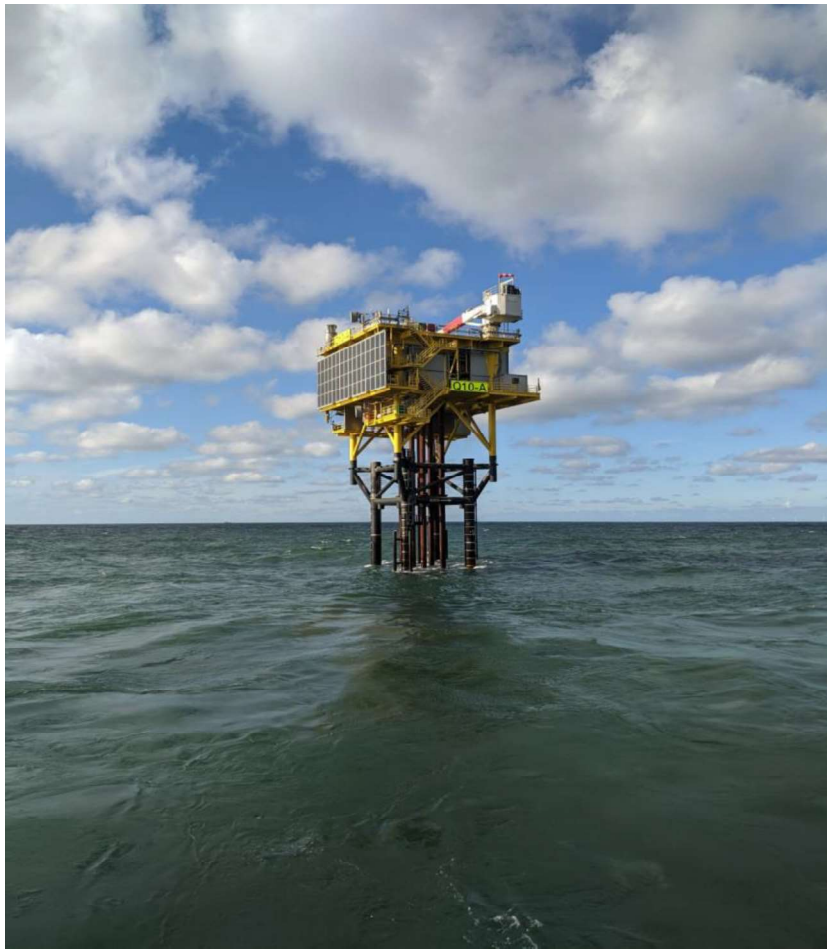
Q10-A on stream

Start production Feb 2019

Nov 2019:

- Daily production 3 mln Sm3/day
- Produced > 500 mln Sm3 to date





Exploration - opportunities

Regional picture

- 3 gas plays and 2 oil plays
- 3D and 2D Seismic coverage of variable quality

Opportunity

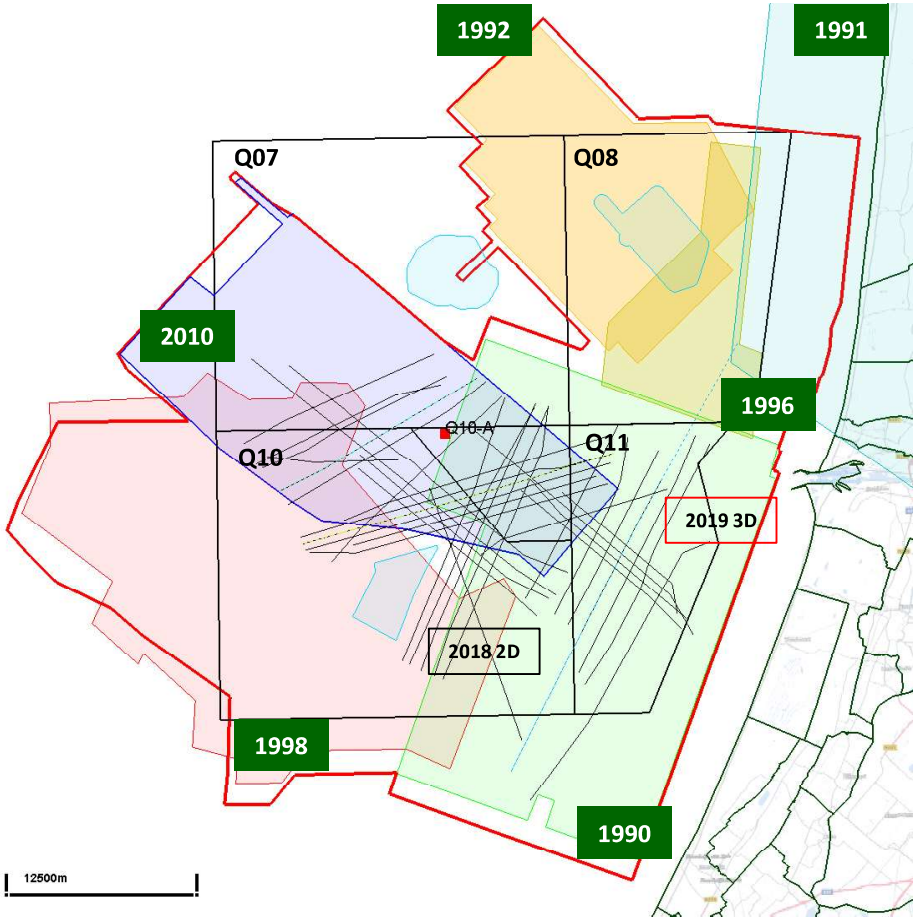
- 'Dry' wells on the map – are they really dry??
- Data mining and archaeology
- Undrilled structures
- Missed pay

Seismic Program

- 2D lines planned and acquired in 2018, processing delivered in Feb 2019
- 3D reprocessing of 1880km^2 input, started early 2019, PreSDM delivered in September
- 3D interpretation ongoing
- QI studies ongoing

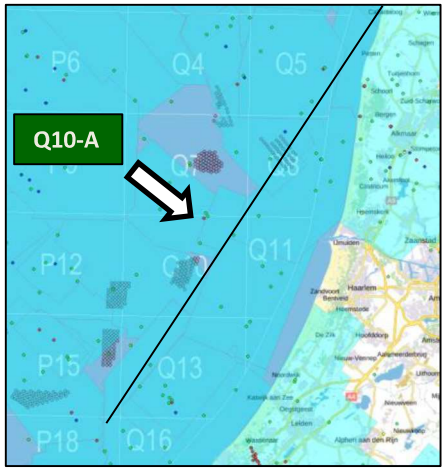
Well program

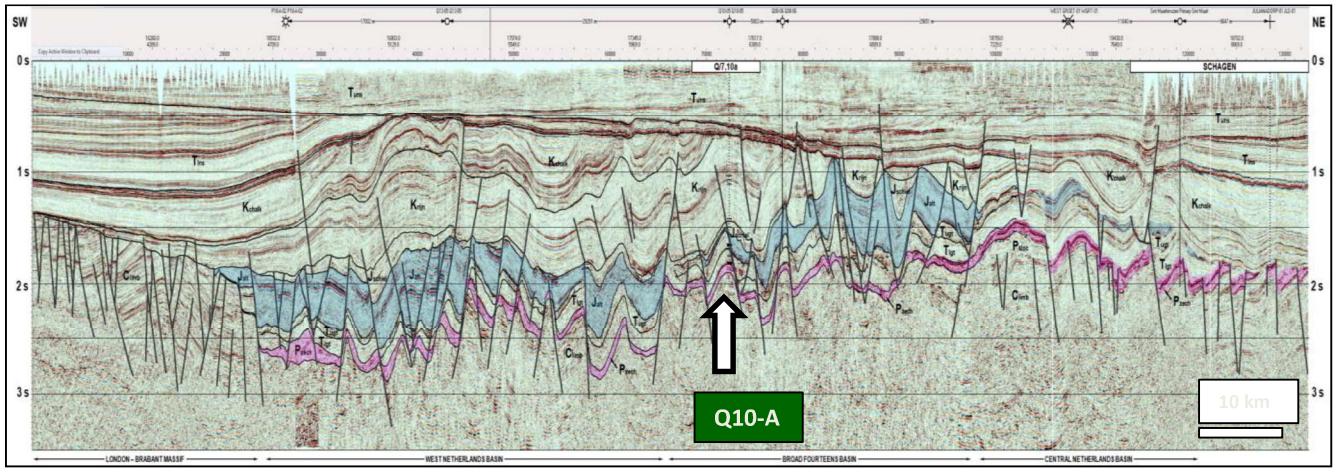
- Three drilling targets identified for 2020 campaign
- Subsurface, well planning and BoD ongoing
- Surface locations agreed and site surveys done
- Permitting done

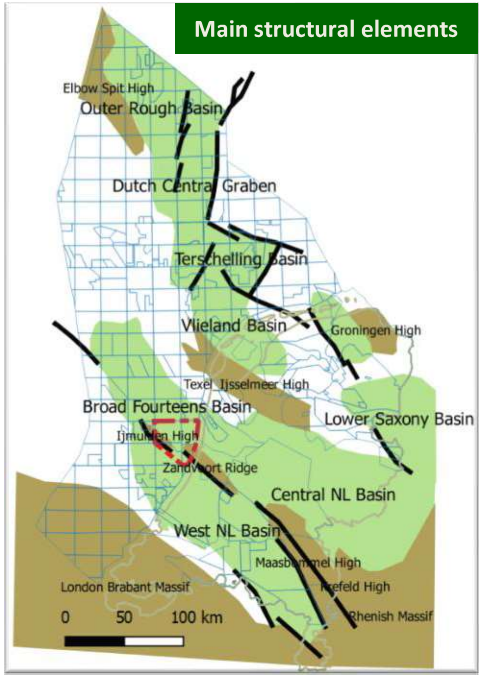


Tulip Oil
Exploration and Production

Southern North Sea context



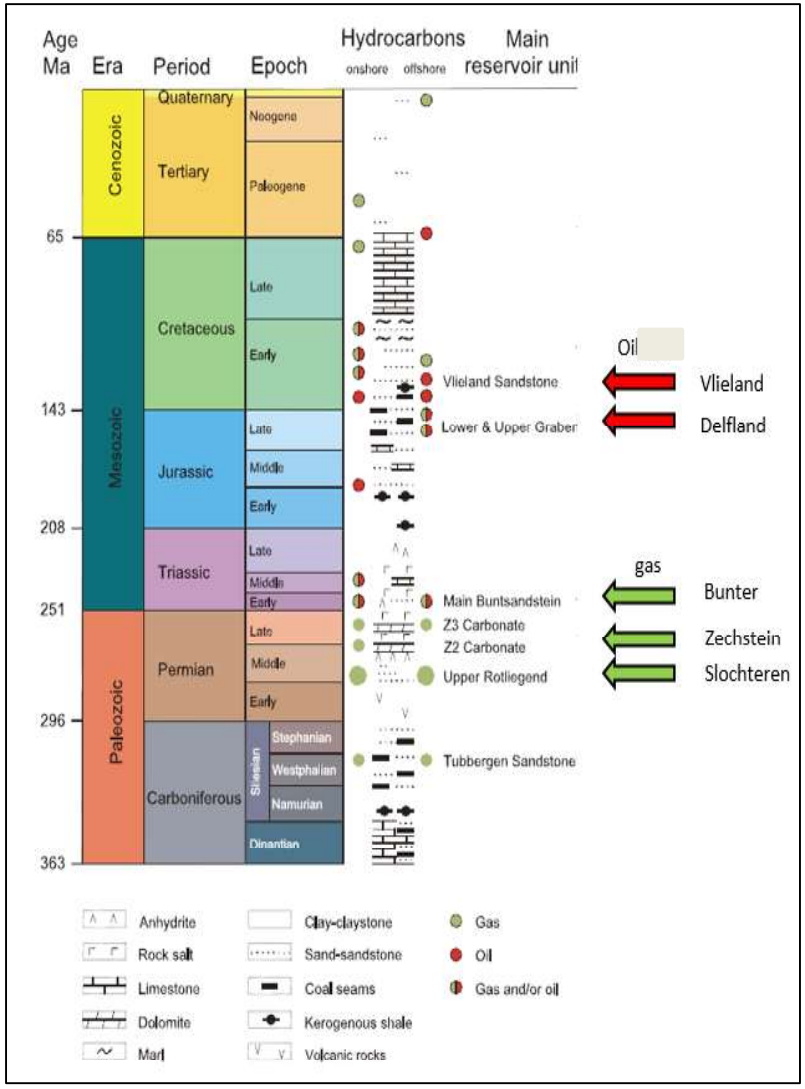




- Dominant NW-SE trending lineaments defining Permo-Triassic Horsts and Grabens
- Located at Southern edge of the Broad Fourteens Basin: on IJmuiden high – western continuation of the onshore Zandvoort ridge and Maasbommel high
- Rotliegend aeolian Slochteren overlying Carboniferous source rocks
- Lower Zechstein (Fringe) Sandstone reservoirs and Upper Zechstein Carbonate reservoirs (No salt and no halokinesis in this area)
- Jurassic Graben fill includes the Posidonia shale as oil source rock
- Schieland Group pockets with reservoir sands
- Followed by Cretaceous Marine deposition and Chalk (mostly eroded in Q07)
- Cretaceous Alpine inversion decreasing to the North
- North Sea Group sand deposition during the Tertiary

Tulip Oil
Exploration and Production

Hydrocarbon plays



Plays:

Cretaceous Vlieland Sandstone. Known oil producer in the area.

- All wells drilled to date on structural highs have oil shows and high oil saturations on logs
- Q07-06-S1 tested oil to surface
- Q10-A-03A oil sample

Triassic Bunter Sandstone (gas). Historically major focus.

- Known producer in the P-blocks, Q04, Q05, Q08
- Known to be tight in other areas and onshore

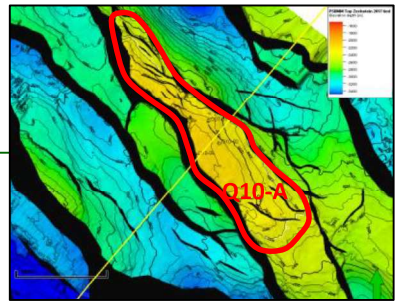
Permian Zechstein (gas) consists of three reservoir intervals:

- Z3 fractured Carbonate; widespread producer in the area
- Z1 and Z2 sandstones: regional sweet spot at the edge of the Broad Fourteens Basin

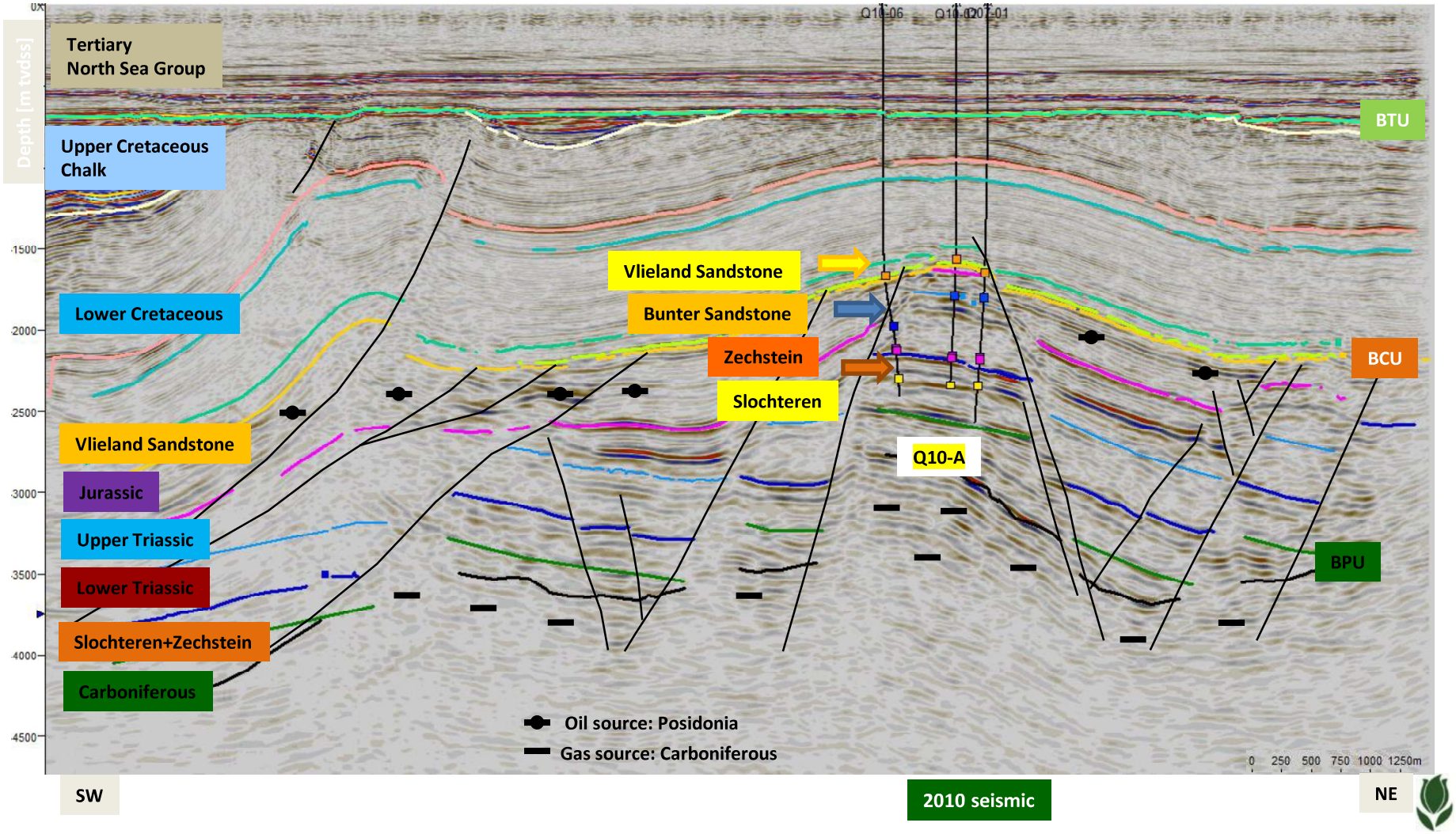
Permian Rotliegend Slochteren formation (gas): thick aeolian sandstone package in the Q-blocks.

Tulip Oil
Exploration and Production

Q10 section SW-NE

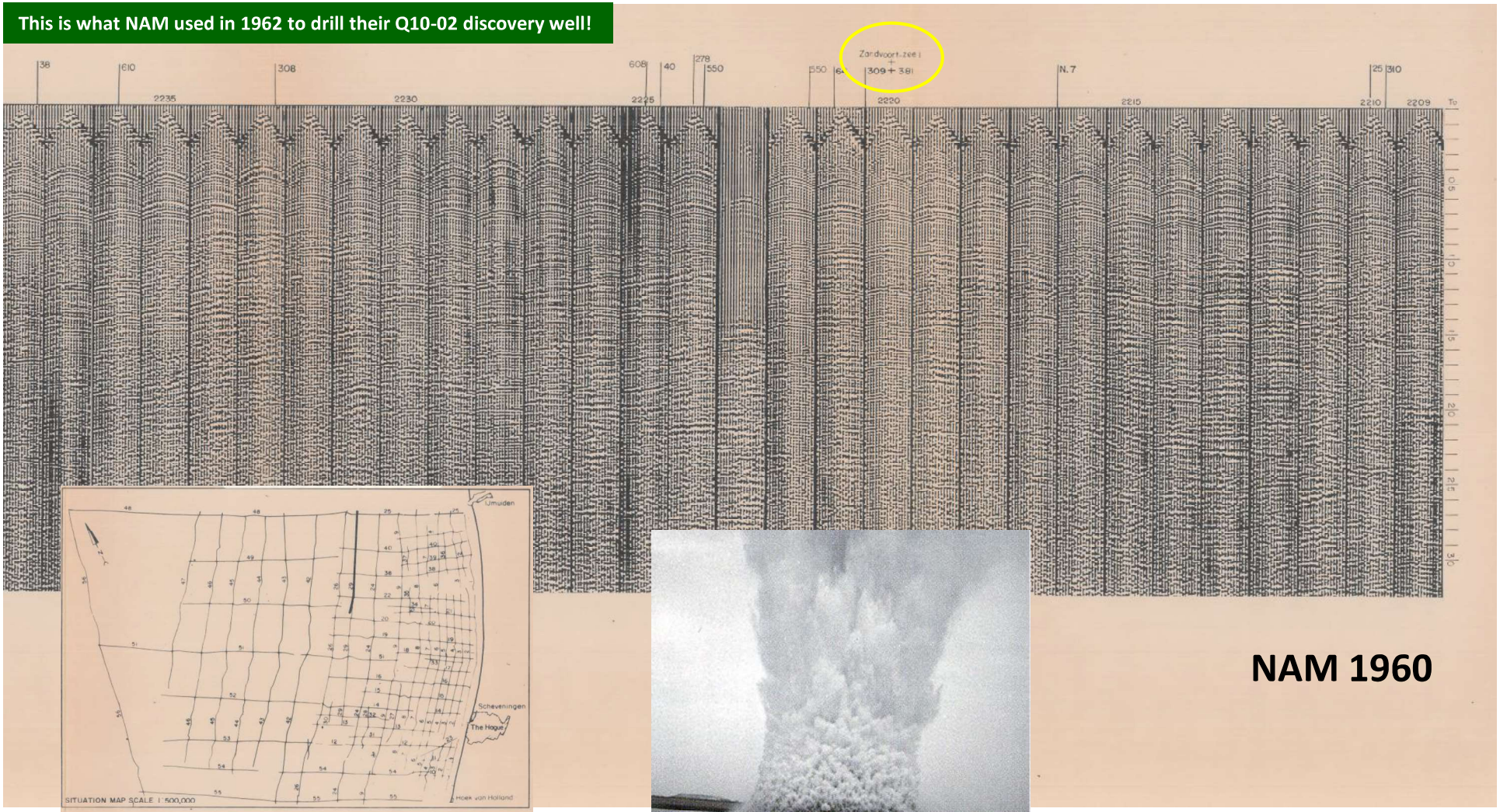


- All the hydrocarbon plays in perspective



Q10 section SW-NE

This is what NAM used in 1962 to drill their Q10-02 discovery well!



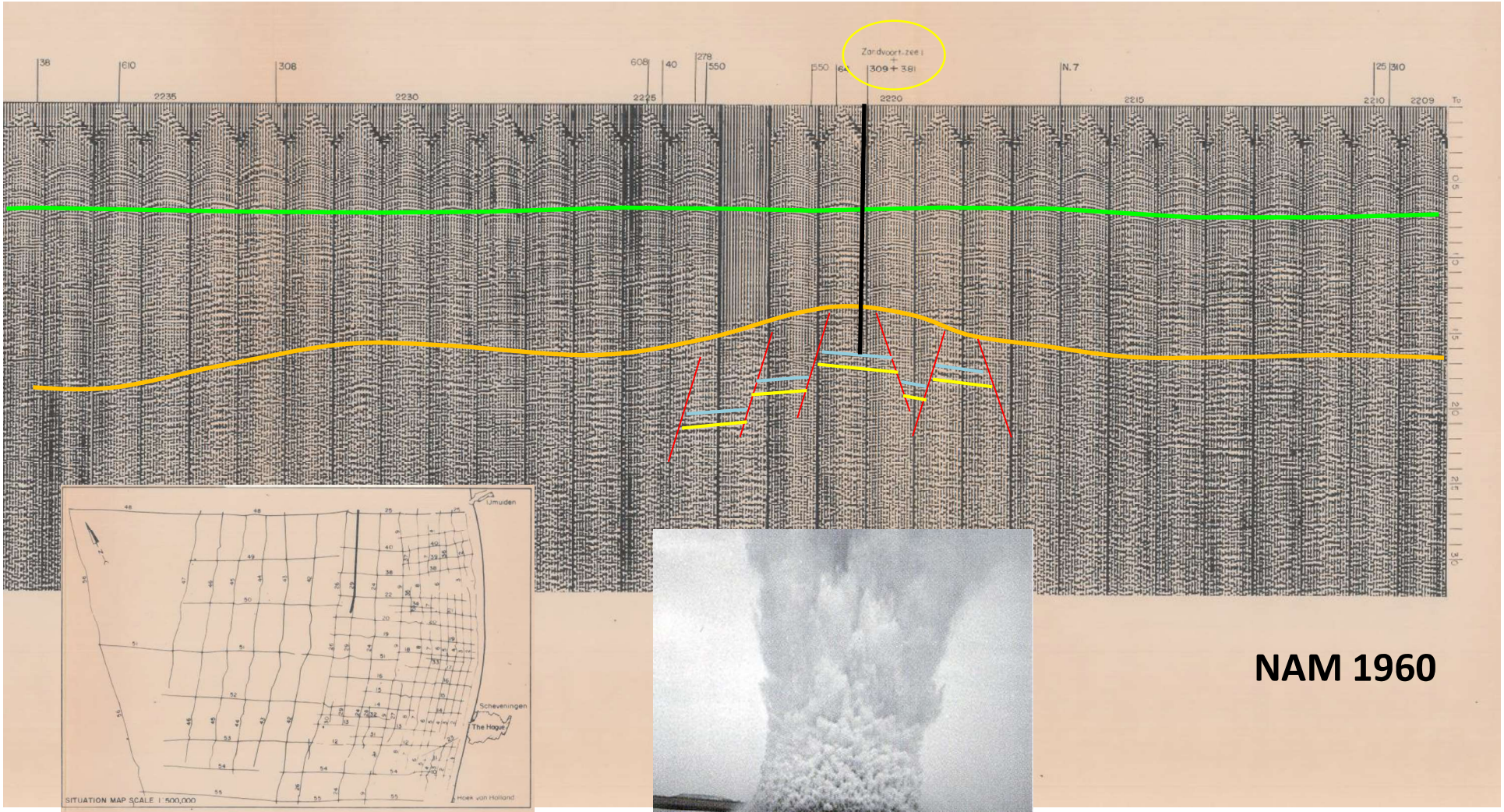
NAM 1960

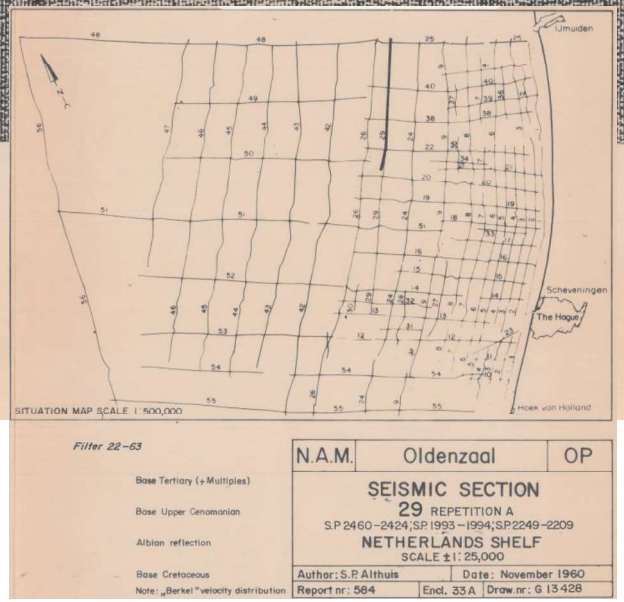
1958
Marine dynamite source
Dual vessel acquisition

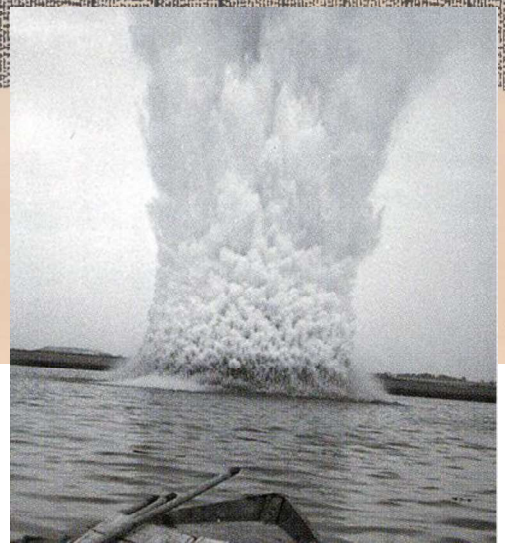
Source: CGG website

Tulip Oil
Exploration and Production

Q10 section SW-NE



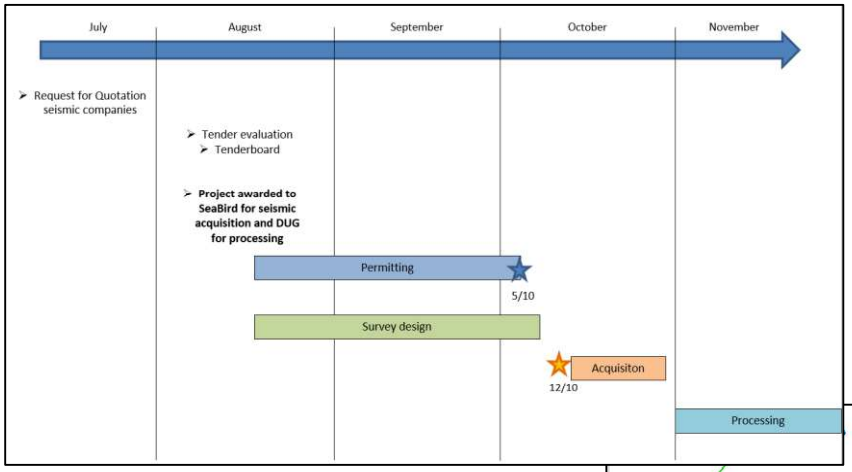




1958
Marine dynamite source
Dual vessel acquisition

Source: CGG website

2D seismic acquisition Q10-Q11

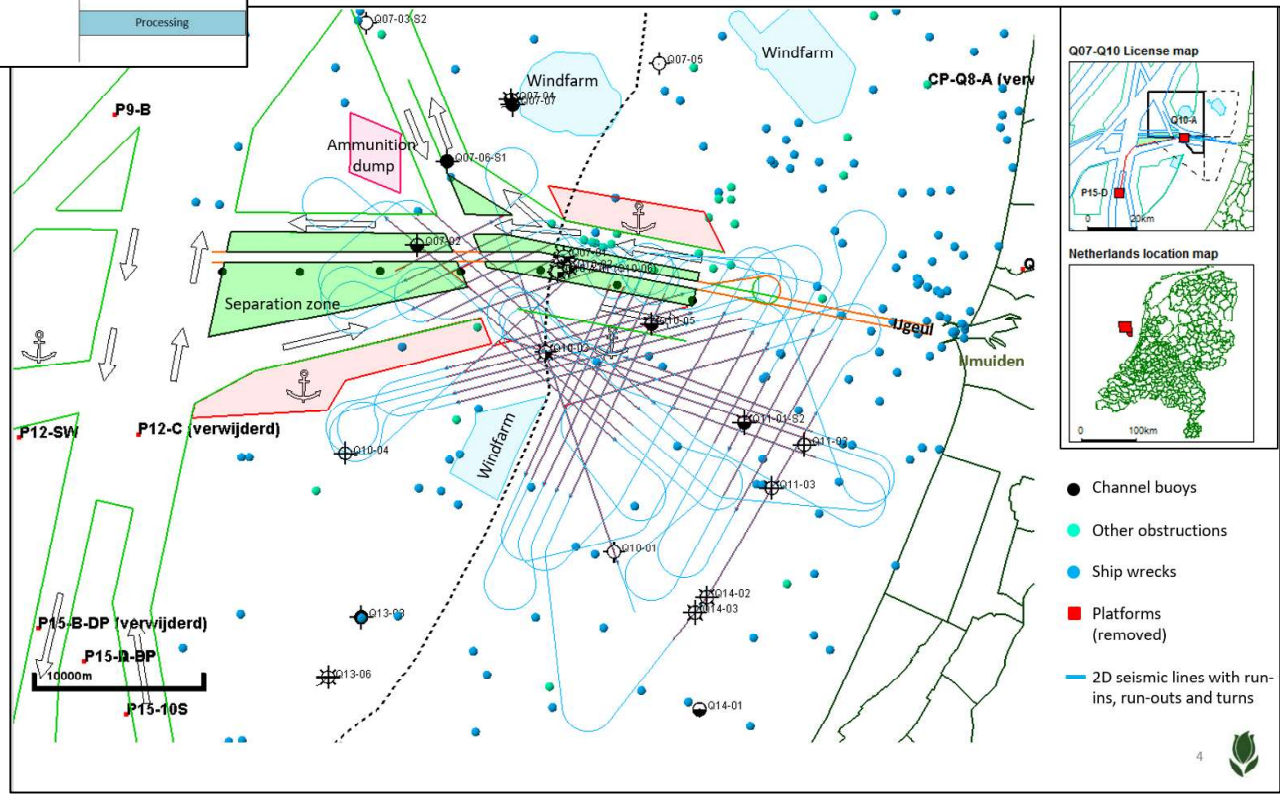


Targets and Objective

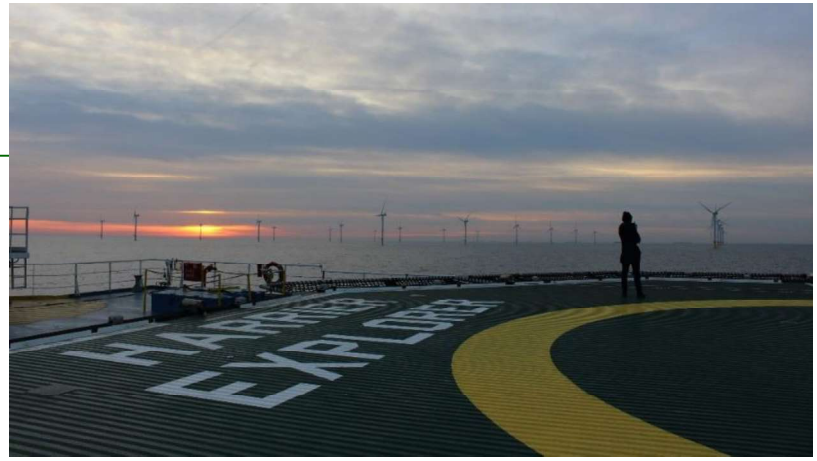
- Fill data gap near windfarm ENECO Q10
- Allow better (fault) imaging – positioning for well placement on primary 2020 exploration targets
- Derisk prospects by reducing volumetric uncertainty
- Acquire long-offset data for quantitative work

477 km full fold lines

- Permitting started June 2018
- Tendering July-Aug 2018
- Acquisition Oct 2018 by SeaBird, 8 days
- Efficient communication: issues with
  - Shipping
  - Tide
  - Feathering
  - Concurrent operations Q10
- Processed by Feb 2019 by DUG



Execution



Critical success factor:

Excellent communication with all stakeholders, through coordination by Royal Haskoning DHV

Before applying for permits:

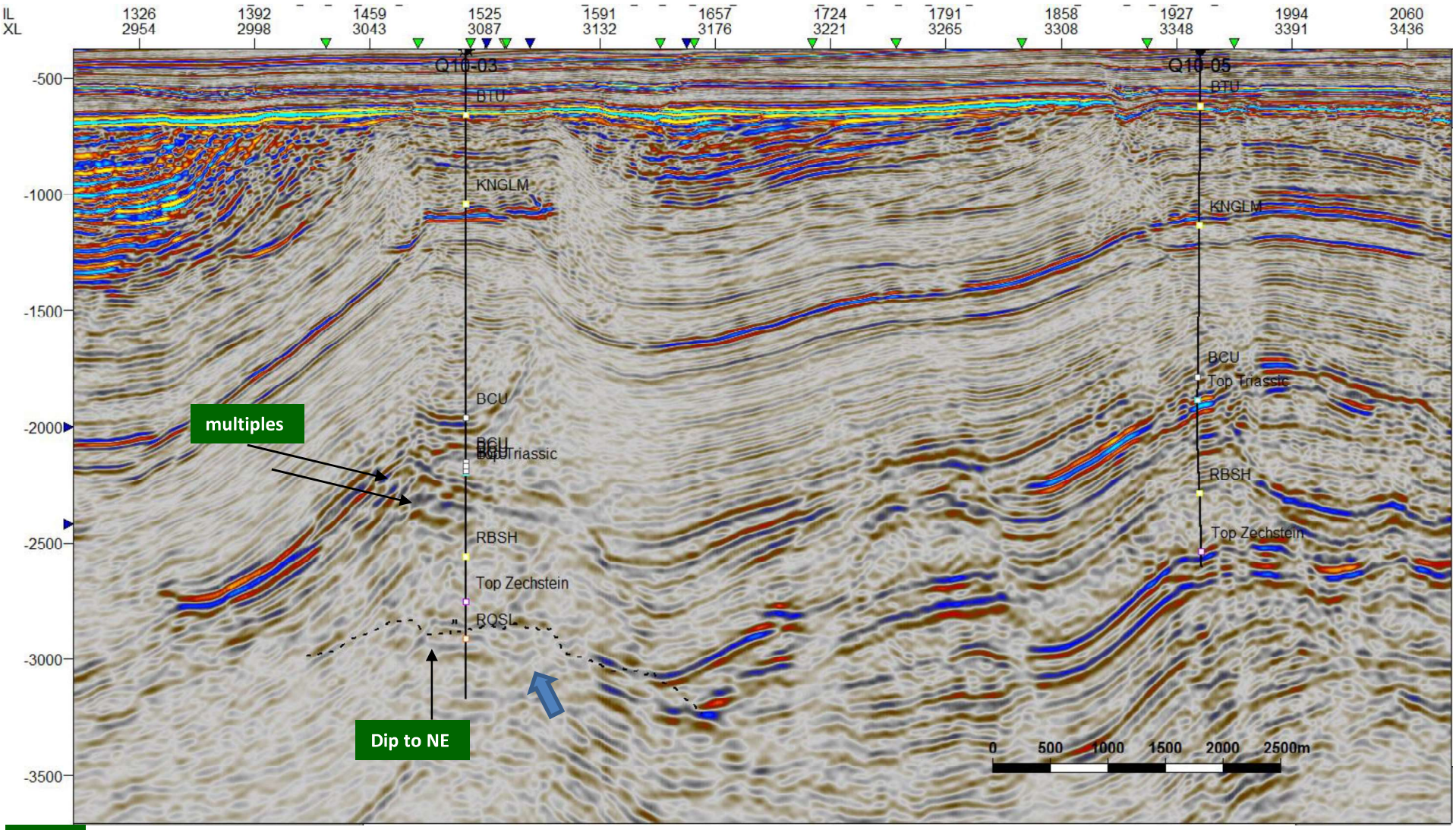
- Meetings with Port of Amsterdam, VTS pilots
- Meetings with Kustwacht, Rijkswaterstaat
- Preparation with MinEZK, MinLNV, SodM, RVO
- Arranging marine mammal observation
- Seabird survey design; quick turnaround

During acquisition:

- Seabird: efficient and flexible execution
- Tulip representative on board
- Hourly support from Port of Amsterdam
- 2 guard/chase vessels

Tulip Oil
Exploration and Production

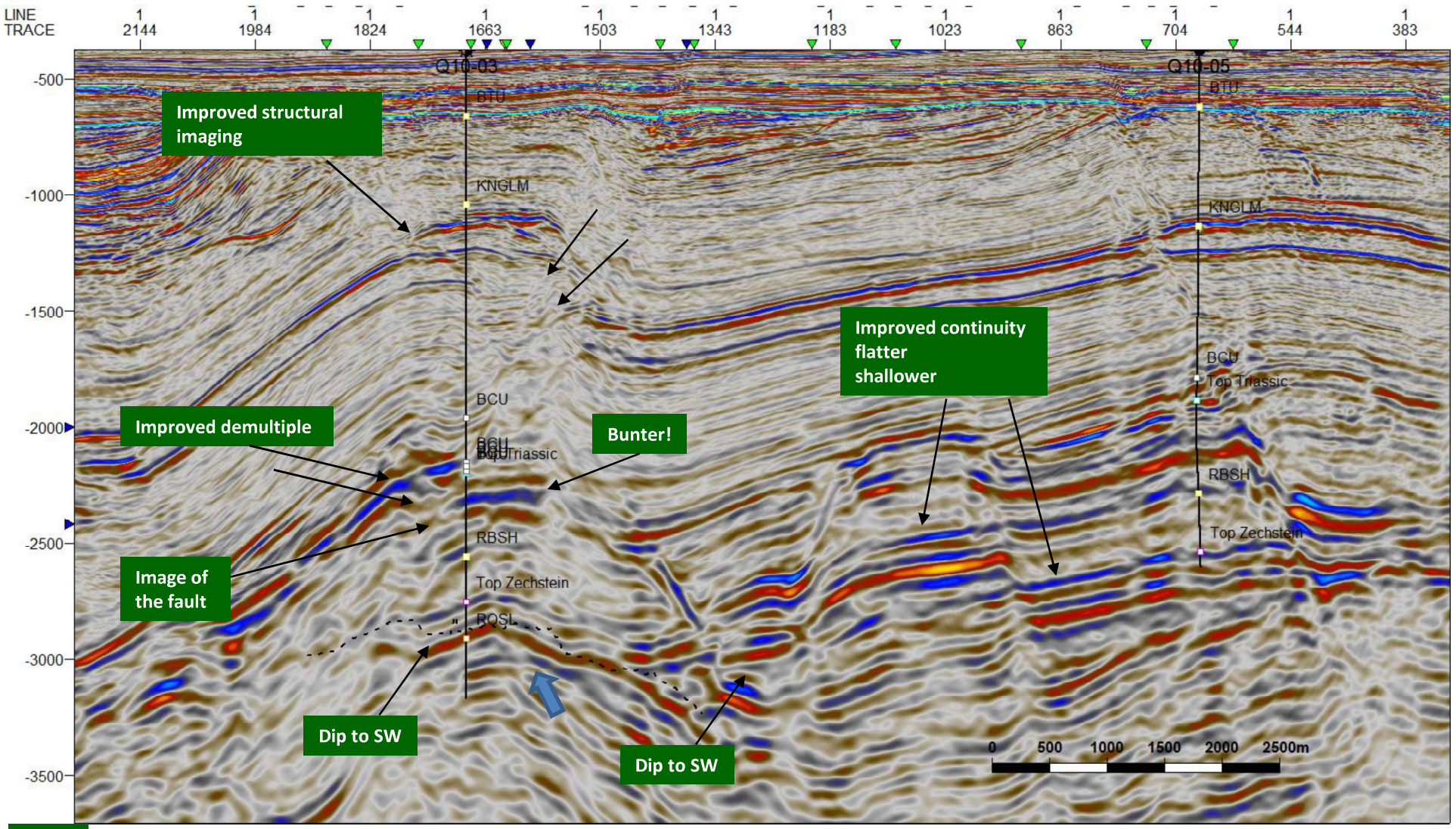
2D line - example



2010 final 3D PreSDM depth

Tulip Oil
Exploration and Production

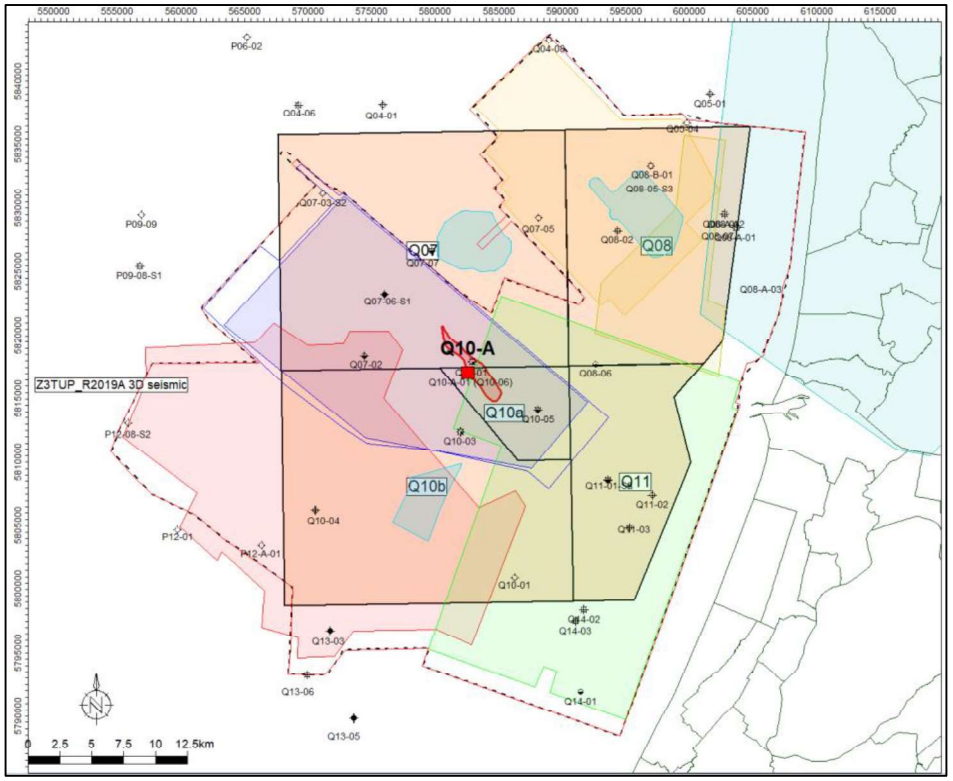
2D line - example

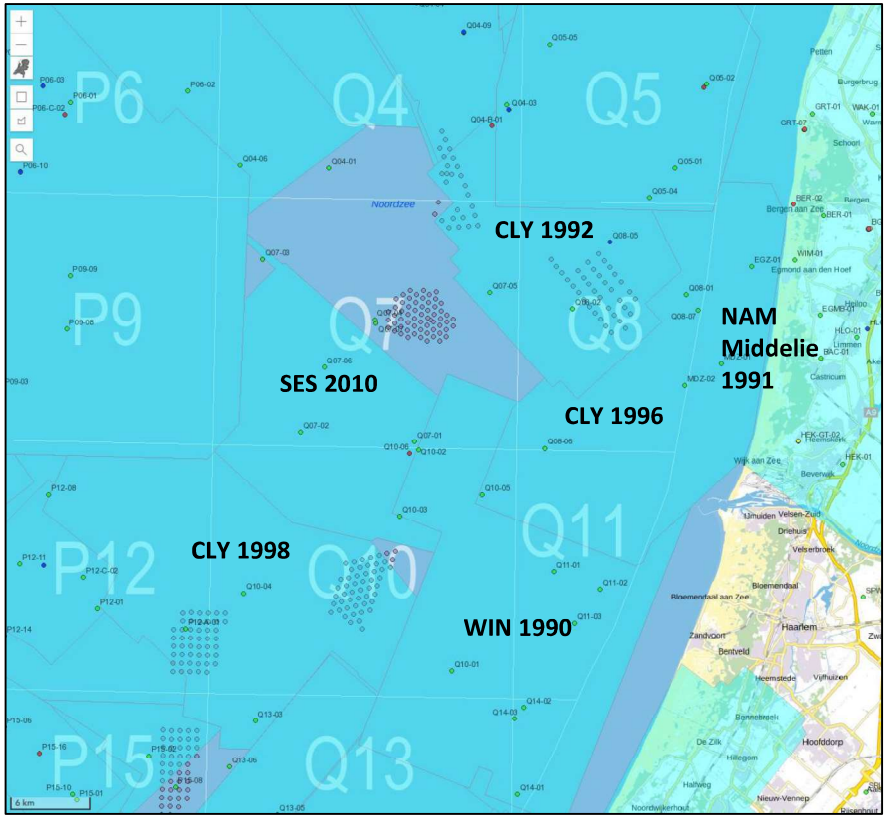


New Line 204 2D final PreSDM depth

3D reprocessing Z3TUP_R2019A

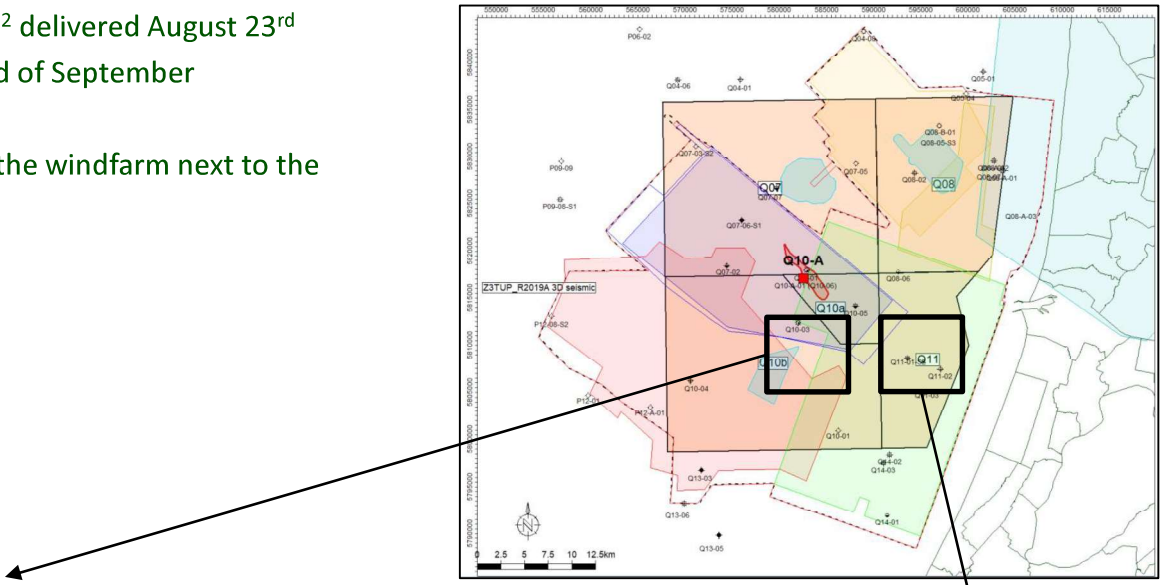
- Tendering Nov 2018, awarded to DUG
- Field/nav data collection: Nov 2018-Feb 2019
  - Great cooperation by WINZ
  - Great support from TNO for NAM data
- Workflow started Jan 2019
- PreSTM delivered in May 2019
- PreSDM delivered in Sept 2019



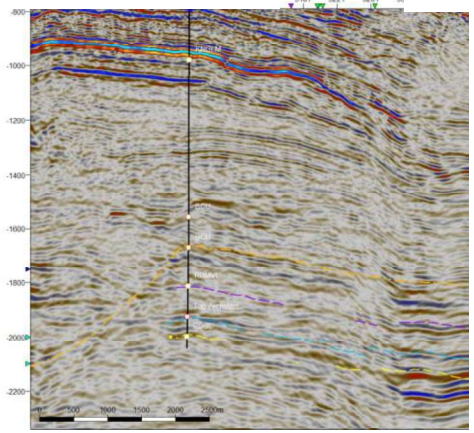


3D seismic reprocessing

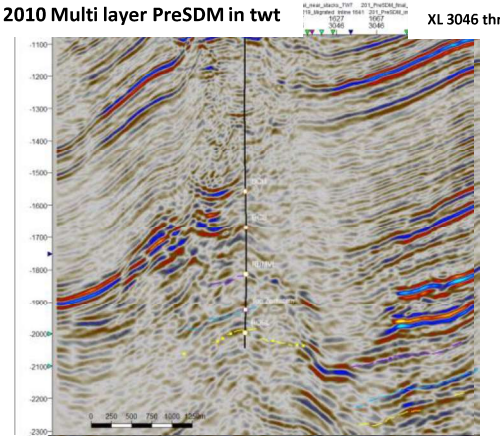
- 1880 km^2 input: First raw volume of 1645 km^2 delivered August 23rd
- All final stacks (twt, tvd, angles) delivered end of September
- Good structural improvements
- Used new 2D data to interpolate the hole of the windfarm next to the Q10-Beta prospect to improve the migration

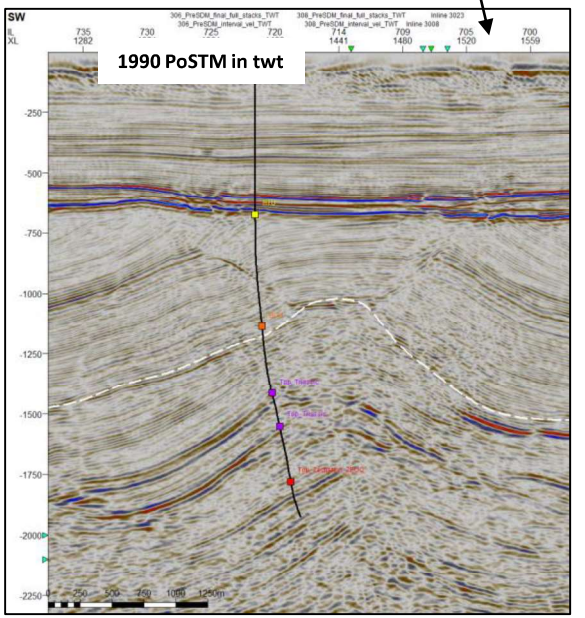


2010 Multi layer PreSDM in twt IL 2534 through well Q10-03



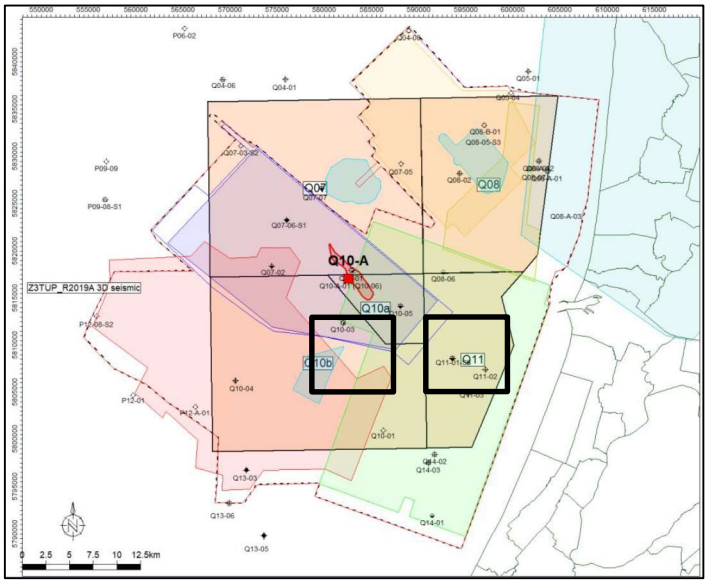
2010 Multi layer PreSDM in twt XL 3046 through well Q10-03



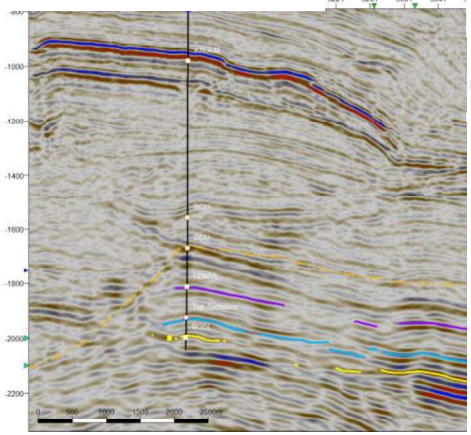


3D seismic reprocessing

- 1880 km^2 input: First raw volume of 1645 km^2 delivered August 23rd
- All final stacks (twt, tvd, angles) delivered end of September
- Good structural improvements
- Used new 2D data to interpolate the hole of the windfarm next to the Q10-Beta prospect to improve the migration

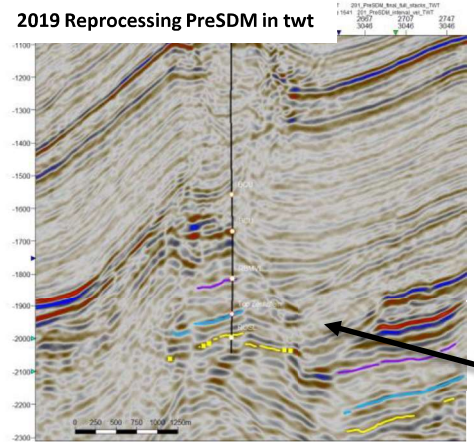


2019 Reprocessing PreSDM in twt



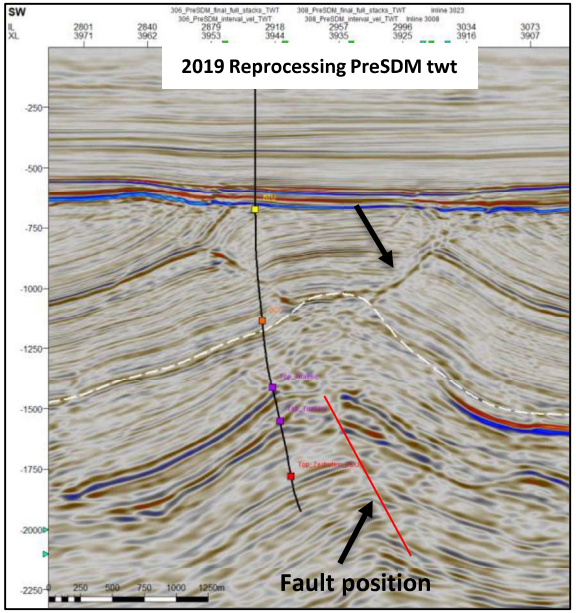
Improved continuity
Better multiple attenuation

2019 Reprocessing PreSDM in twt



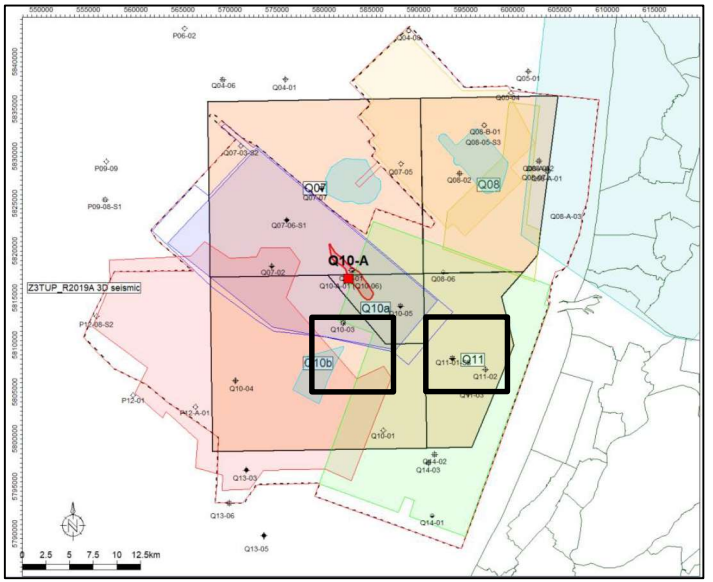
- In the 1990 area the 2D is better because the legacy 3D input is of poor quality
- In the 2010 area the 3D repro gives the best result

Improved imaging because of better velocity model

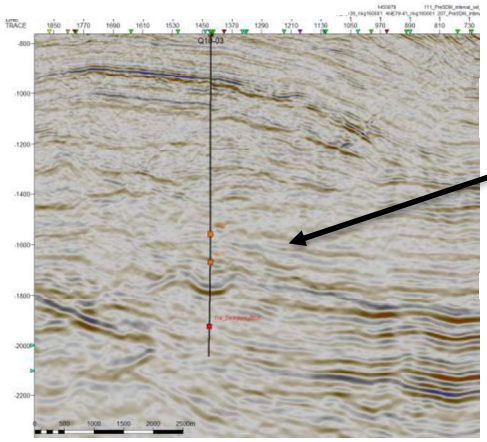


3D seismic repro vs 2D

- Final 3D
- Comparison with the 2018 2D

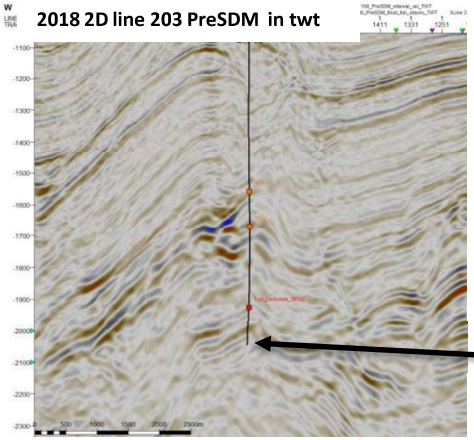


2018 2D line 303 PreSDM in twt



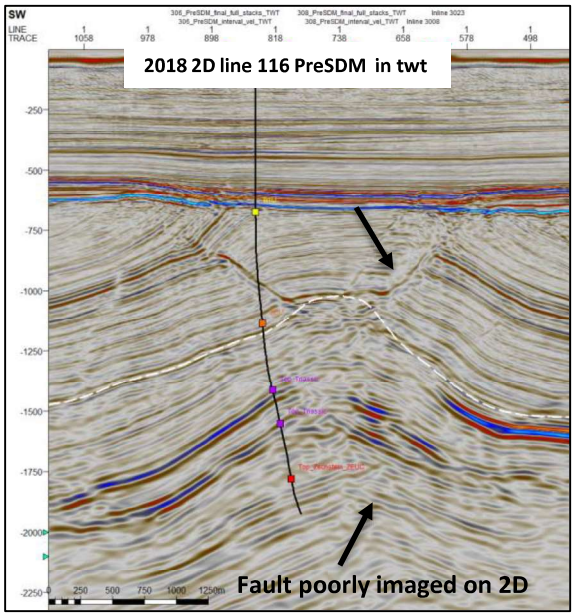
Poor imaging, lots of out-of plane energy due to complex overburden

2018 2D line 203 PreSDM in twt



Structural dips are correct on the W-side. E-side poorly imaged

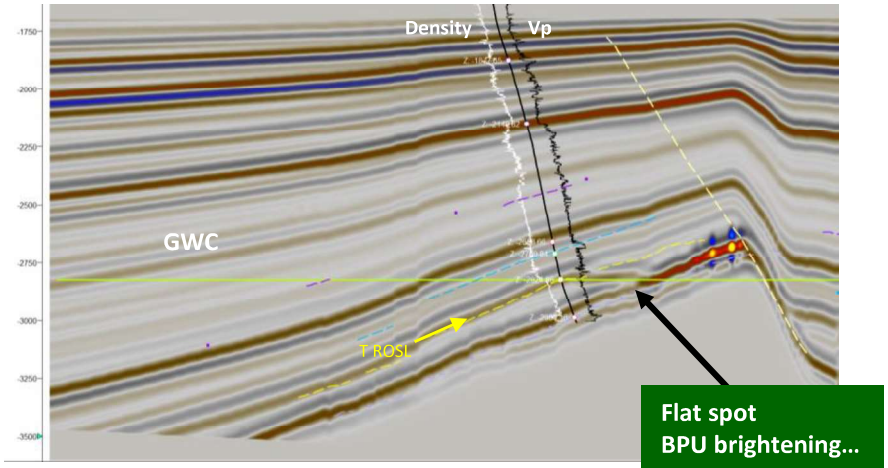
- In the 1990 area the 2D is better because the legacy 3D input is of poor quality, except in the deeper targets



QI on Q10 field and propspects

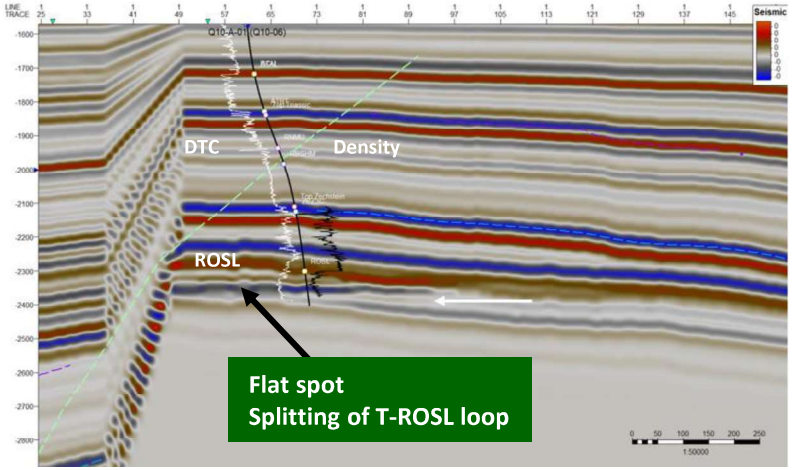
- Follow-up of the successful feasibility / petrophysical study
- Known QI potential in the area
- Flat spot on Q10-A field in Slochteren Fm on 2010 data – led to drill decision 2015 for Q10-06
  - Well developed on far stack and even full stack
- Flat spot Q10-A field on 2019 repro more difficult to see
  - Broadband, lower resolution
  - Can be brought out by filtering and high frequency boost
  - Can be reproduced very well in synthetic wedge model
- Test on near-field prospects: works in theory, looks promising for de-risking

Prospect: works in theory



Synthetic model with gas in Slochteren Fm

Q10-A field: works in theory

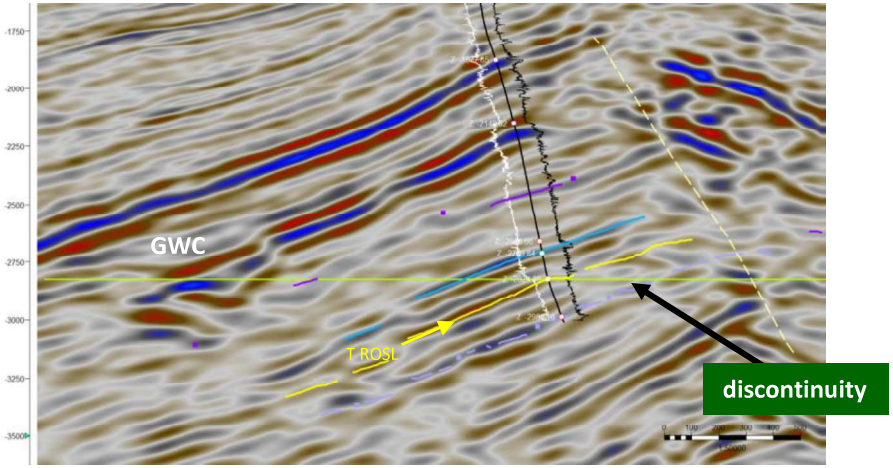


2D line model with gas in Slochteren Fm

QI on Q10 field and propspects

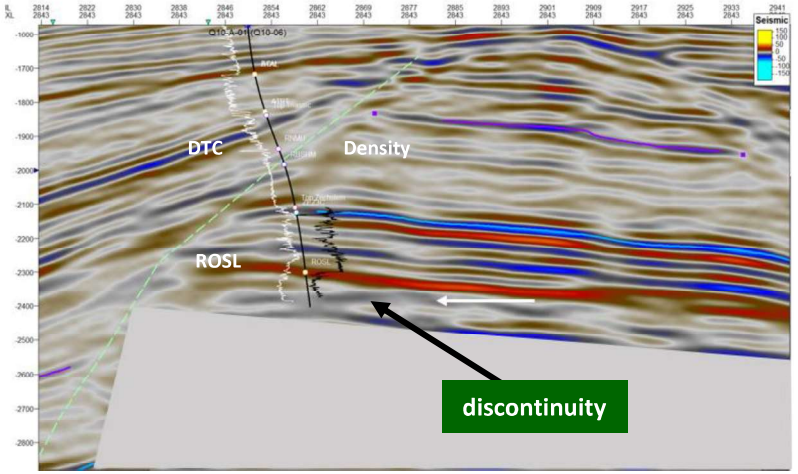
- Follow-up of the successful feasibility / petrophysical study
- Known QI potential in the area
- Flat spot on Q10-A field in Slochteren Fm on 2010 data – led to drill decision 2015 for Q10-06
  - Well developed on far stack and even full stack
- Flat spot Q10-A field on 2019 repro more difficult to see
  - Broadband, lower resolution
  - Can be brought out by filtering and high frequency boost
  - Can be reproduced very well in synthetic wedge model
- Test on near-field prospects: works in theory, looks promising for de-risking

Prospect: works in practice??



3D PreSDM

Q10-A field: works in practice! We know, it is producing.



3D PreSDM

Looking ahead

Lots of remaining potential and opportunities in the North Sea

- Don’t stop looking because others did

Nothing is impossible:

- Re-interpret old well reports (pick the cherries)
- Reprocess and improve old seismic (choose your battles)
- Shoot new seismic (make some new friends)

Keep it simple, do it quickly

- Efficient drilling
- Simple developments

Our job is not done:

We’ll need clean gas during the energy transition.

Chez Beauvardia