Shallow Gas: An overlooked resource opportunity – examples of the Netherlands

G. Hoetz, M. van den Boogaard, EBN
Shallow Gas: An overlooked resource opportunity – examples of the Netherlands

Hazard?

Opportunity?
Outline

1. Introduction
2. New play rather than hazard
3. Lead characterization using seismic attributes
4. Summary
Drilling hazard…..

- Blow-out in Het Haantje on 1.12.1965
- No injuries but the drilling rig and portacabins sank into the ground
- Unexpected gas accumulation encountered at 1950m leading to over-pressures that exceeded mud-weight selection.
- Once pressure exceeded fracture strength of mechanically weaker shallow sediments gas escaped to surface in vicinity of rig.
Geological Setting

Shallow Gas (SG) = gas in unconsolidated, Miocene-Pleistocene sands
Geological Setting

- Amplitude anomalies
- Mid-Miocene Unconformity
- Top Chalk
- Salt domes

~1 km
~10 km
Shallow gas: stratigraphy

**SG depthrange:** 400-800 m

<table>
<thead>
<tr>
<th>Cenozoic</th>
<th>Holocene</th>
<th>Pleistocene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6Ma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neogene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleogene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesoozoic</td>
<td>Cretaceous</td>
<td></td>
</tr>
<tr>
<td>Jurassic</td>
<td>Late Early</td>
<td></td>
</tr>
<tr>
<td>Triassic</td>
<td>Late Early</td>
<td></td>
</tr>
<tr>
<td>Permian</td>
<td>Late Early</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Late Early</td>
<td></td>
</tr>
<tr>
<td>Devonian</td>
<td>Late Middle</td>
<td></td>
</tr>
<tr>
<td>Silurian</td>
<td>Late Early</td>
<td></td>
</tr>
<tr>
<td>Ordovician</td>
<td>Late Middle</td>
<td></td>
</tr>
</tbody>
</table>
Shallow Gas Pays Off!
Shallow Gas: Production

• Presence shallow gas known since 70’s

• Early water breakthrough & sand production expected → development considered not feasible

• Technical breakthrough (e.g. sand control in horizontal wells)

• Currently 4 successfully producing fields:
  - A12-FA (2007)
  - F02a-B-Pliocene (2009)
  - B13-FA (2011)
  - A18-FA (2018)

- Despite low pressure, expected RF: 50-70%, today >10 bcm gas produced
Shallow Gas: new play with upside

1. New technology proven successful for SG developments

2. New 3D seismic points to more opportunities

3. First pass portfolio characterization using pseudo-quantitative approach based on seismic attributes.
Seismic Characterisation Shallow Gas

SG portfolio

- *Bright Spots* identified (RMS ampl. scanning)
- 150 leads

*Bright Spot* ranking

- Geometrical Characterisation
- Seismic Characterisation

Highest ranking *Bright Spots*:

- 3D reservoir model
- Volumes
Each SG lead characterized pseudo-quantitatively using *radarplot*
**Amplitudes conform Structure**

*Figure 4* A) Amplitude extraction plotted on the top reservoir map (TWT) of a four-way dip closure bright spot (area 5 km²). B) Amplitude extraction plotted on the top reservoir map (TWT) of a faulted dip closure bright spot (area 40 km²). The white stippled line indicates the brightest part of the anomaly that is conforming to structure.
Seismic Characterisation - Amplitude

Gassmann fluid substitution approximately valid (despite unconsolidated sediments)
Seismic Characterisation - Amplitude

Amplitudes bright for all gas saturations > 2%
Seismic Characterisation – AVO

AVO class 3 (or2) (Vs logs lacking)

Feng & Bancroft, 2006

Sg=70%

Sand reservoir

GR

Offset (angle)

Amplitude

Class 1

Class 2

Class 4

Class 3
Seismic Characterisation Shallow Gas
Flat Spots

- Flat Spot visible
- No flat Spot visible

Producing field

- Top Sand
- No flat Spot visible
Seismic Characterisation - *Flat Spot*

Visibility of flat spot dependent on:

- Dip of reflectors
- Reservoir thickness
- Column height

Flat spot indicates reservoir thickness & HC column, not saturation
Seismic Characterisation - Velocity Pull Down

- Pull-down indicates (total) HC column
- Absence pull-down indicates very low saturation

Seismic data courtesy Spectrum
Seismic Characterisation Shallow Gas
Seismic Characterisation - *Attenuation*

- Absence attenuation indicates very low saturation
Seismic Characterisation - Gas Chimney

- Gas chimney indicator for gas
• Bright spots indicative for Shallow gas.

• Since 1965 no significant SG drilling incidents in NL.

• 4 producing fields.

• > 100 leads in portfolio.

• Pseudo-quantitative seismic characterization useful for first order ranking.

• Ultimate derisking requires the bit?
Acknowledgements

- Petrogas (E. Campbell, K. Borowski)
- Spectrum, seismic data courtesy
- TNO
- EBN Exploration team

See also:
Prospectivity analysis of shallow gas in the Netherlands
M. van den Boogaard and G. Hoetz
First Break volume 36, Dec 2018
(P47-54, Regional Focus The Netherlands)