DHI enhancement as key-enabler to portfolio rejuvenation – part I

Examples from the Southern Permian Basin

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NAM

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Rotliegend play

<table>
<thead>
<tr>
<th>Impedance</th>
<th>Porosity</th>
</tr>
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<tbody>
<tr>
<td>6000</td>
<td>0.3</td>
</tr>
<tr>
<td>12000</td>
<td>0</td>
</tr>
</tbody>
</table>

Tertiary
Cretaceous
Jurassic
Permian salt
Trias
Permian

Zechstein = seal
Upper Rotliegend = reservoir
Lower Rotliegend = reservoir
Carboniferous
Triassic
Area of interest: Creaming Curve - Rotliegend reservoir

Ultimate recovery and scope for recovery

Number of exploration wells

Improved portfolio understanding
DHI support
Business as usual

3D seismic
2D only?

State of the art seismic

2005

Number of exploration wells

0 50 100
We have drilled the highs!....and successfully so
Fault Seal evidence

Sealing fault required
Seismic DHI:
Seismic expression of gas bearing reservoir

- Impedance Porosity: 0.3 0
- Zechstein = seal
- Upper Rotliegend = reservoir
- Lower Rotliegend = reservoir
- Carboniferous
- Triassic
- Permian
- Shale
- Porosity
- B_RO: reservoir 300m thick
- T_RO, T_ROCLA: gas
- B_RO: brine
- Seismic DHI: Seismic expression of gas bearing reservoir
Seismic DHI:
Seismic expression of gas bearing reservoir
Visualising a subtle DHI

- DHI very subtle (brightening, subtle flat spot)
- AVO also subtle
- overburden complex

+ rock properties consistent
+ reservoir present and limited thickness variation only
+ DHI horizon consistent
The conventional DHI: Structurally conformable amplitudes?

Deep/Low amplitude

T_ROCLA amplitude

T_ROCLA depth

shallow/High amplitude
The conventional DHI: Structurally conformable amplitudes?

Deep/ Low amplitude

T_ROCLA amplitude

shallow/ High amplitude

T_ROCLA depth
From wedge model to **Common Top Depth stack**

**Wedge model**
- top reservoir depth

**CTD stack**
- top reservoir depth

Slot trace according to top reservoir depth for a fault block

*stack*
Deeper GWC than expected from dip closure: CTD stack quantifies faults seal

Modelled seismic response of GWC

CTD stack (actual seismic response)

Rotliegend reservoir

GWC

gas

brine

discovery

field

Faults seal provides additional 53 m HC column
Every fault block a lead?
DHI evaluation: vintage data

existing wells (blind test)

- CTD stacks vintage seismic
  - correct (GWC within +/-30m)
  - inconclusive
  - incorrect

prospects

- very likely brine
- picked GWC likely
- inconclusive
- picked GWC very likely
Long cable seismic data delivers improved imaging

vintage data

long cable data

+ fault resolution
+ reservoir character
+ structure
....improved CTD stacks

Vintage data

Long cable data

Known GWC

T_RO
towards becoming a CTD stack interpretation expert

4 = dry
5 = inconclusive
towards becoming a CTD stack interpretation expert

4 = dry
5 = inconclusive
....towards becoming a CTD stack interpretation expert

4 = dry
5 = inconclusive
....the high confidence case

4 = dry
5 = inconclusive
....the high confidence residual gas case

1 = dry
2 = possible gas
3 = low confidence gas
4 = dry
5 = inconclusive
....the multiple choice case

4 = dry
5 = inconclusive
Conclusion

• Discoveries in SPB hint at significant HC volumes relying on fault seal

• State of the art seismic, improved imaging and underlying velocity model lead to
  • improved fault & reservoir definition
  • upgrade of the CTD stack quality
  • ....but multiples are a strong challenge
  • ....residual gas may lead to false DHI

• Integration is key: CTD stacks often enable visualisation of DHIs in SPB but no silver bullet.....

....... part 2