Zechstein drilling

WINZ approach & experiences
Introduction

- PPFG model uncertainty & offset well analysis

- Seismic mapping of potential floaters
  - Trajectory optimisation – floater avoidance

- Generic well design & drilling strategy
  - Casing/liner design
  - Drilling fluid strategy

- Drilling experiences / challenges / concerns
PPFG model uncertainty & offset analysis

- Modelled fracture gradient in upper Zechstein is lower than indicated by offset data (FIT/LOT data)

- Formation pressure plot does not illustrate formation pressure of potential floaters
  - Annotate plot with relevant offset data points
  - Annotate plot with average Zechstein floater kicks (industry experience – 17.5 ppg brine kicks / 15.4 ppg gas kicks)

ZECHSTEIN FLOATERS

- Upward movement of halite leads to the uplift of (permeable) dolomite.
- Uplift leads to breakup into “rafts” completely encased in halite.
- Once encased these dolomite rafts cannot de-water giving rise to overpressure.
- The expected pressure of rafts cannot be modelled.
- Offset data: No inflows in the listed offsets but one on Wingate A6

<table>
<thead>
<tr>
<th>mMD</th>
<th>mTVD</th>
<th>mTDSS</th>
<th>MW (ppg)</th>
<th>SP (psi)</th>
<th>EMW (ppg)</th>
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</thead>
<tbody>
<tr>
<td>3557</td>
<td>3248.3</td>
<td>3380.8</td>
<td>13.7</td>
<td>1950</td>
<td>17.0</td>
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Mapping in seismic

- 3D seismic evaluation
  - Seismic resolution ~30-50m
  - Lateral uncertainty

- Define “avoidance windows/targets” as input for well placement / trajectory optimisation
  - Aim for >200m clearance
Zechstein floater mapping & well placement
Generic well design & drilling strategy

- 9 5/8" Production casing in top Zechstein salts to ensure sufficient shoe strength

- Drill Zechstein sequence separately or in combination with Silverpit sequence
  - Section/sequence lengths
  - MW / ECD vs PPFG

- 7 5/8in MUST liner to case off Zechstein
  - Mobile/squeezing salts
  - Non-uniform loading in washed out areas
Drilling fluid strategy for Zechstein

- 13.5 – 14.5ppg salt saturated WBM for most applications
  - Tolerance to formation brine influx / fluid exchange
  - Preference for NaCl/KCl type salt saturated WBM for corrosion management

- Pilot testing with salt saturated WBM
  - Confirm ability to use ‘active’ mud system to successfully weigh up from planned drilling weight to kill weight
  - Confirm ability to build and pre-shear fresh mud on the rig with use of shearing system in pit
Experiences / challenges / concerns

- Monitoring type of salts present and effect on drilling fluid
Experiences / challenges / concerns

- Brine / gas kicks
  - Controlled successfully with MW increase
  - potential for losses in basal carbonates
  - Planned shoe depth achievable?

- (Dynamic) Losses & flowback in basal carbonate sequence
  - Establish/confirm flowback scenario
  - Gain rate trends
  - Any associated hydrocarbons?

- Investigate options for use of rotating control device / MPD control unit
Questions?