Using salt knowledge to reduce drilling risks

Marinus den Hartogh
February 7th, 2018
Introduction

- Marinus den Hartogh
- 33 years old
- Working at AkzoNobel since 2009
- Started as Geologist, now Technology Manager Brinefields

Message:
- A 3D model of the salt body helps to reduce drilling risks upfront
- To build a 3D model different well data can be combined with Zechstein salt knowledge
- Still operator should be prepared for any potential risk including drilling a stringer
Introduction

- AkzoNobel Specialty Chemical – currently still part of AkzoNobel together with Paints & Coatings
- Revenue: € 4.8 billion
- Employees: 9000
- Sites worldwide: 80+
- 5 Business Units ‡ Industrial Chemicals ‡ Salt
Zechstein drilling experience
Salt mining operations AkzoNobel

AkzoNobel Salt production locations:

- 2 Brinefields Delfzijl
- 1 Brinefield Mariager
- 1 brinefield Hengelo in Triassic salt
- Haaksbergen development
- Before 2003: 2 brinefields Stade
Zechstein drilling experience

- Delfzijl:
  - Heiligerlee: 12 wells
  - Zuidwending: 9 wells \( \downarrow \) **1 kick**
  - Supervision for gas buffer Gasunie Zuidwending: 13 wells
  - Sometimes 'anhydrite floater' without any observable gas pressure

- Mariager:
  - 7 wells

- Hengelo:
  - 1 well in Haaksbergen

- Stade:
  - 10 wells (7 in brinefield Stade, 3 in brinefield Hollenbeck \( \downarrow \) **1 kick**
Zechstein stratigraphy
Zechstein salt - knowledge build-up

- Research bij DEEP Underground Engineering – an engineering firm providing services to the salt industry (2012-2013)
  † Based on results new drillings for gas buffer Zuidwending

- Further study by geologist Roderick van der Kroef – University of Utrecht (2013)
  † Based on data from existing AkzoNobel wells and brine production data
Zechstein salt - background

- Zechstein evaporites formed about 255 Ma BP
- Source: Zechstein sea, Southern Permian Basin
- Evaporation and crystallization analogue to salt production
Zechstein stratigraphy - evaporation

- 50% Evaporation = CaCO₃
- 85% Evaporation = Gypsum
- 90% Evaporation = Halite
- 95% Evaporation = K, Mg salts

Stringer origin

1 km of seawater

17 m of evaporites

Chemistry of Seawater
Zechstein stratigraphy - deposition

- Zechstein deposited in cycles driven by climate and tectonics
- About 6 main cycles, with subcycles.
  † Each cycle has a different seawater chemistry
- Seawater chemistry determines evaporite composition
  † Detailed stratigraphy based on evaporite composition
Zechstein stratigraphy - chemistry

- Within salt rock in a dome: >97% salt, the other 0.5 - 3% non-NaCl ions
- The chemical composition of the non-NaCl ions is determined by the stratigraphy
- This applies both for core-/cutting material and brine composition
- Example: lower Z3 and upper Z3 in one well
Modeling and drilling preparation
Modeling – 3D model

- 3D model made for Zuidwending, next step: Heiligerlee
- Stratigraphic knowledge of Zechstein salt
- Vertical Seismic Profile
  ‡ reflectors indicate differences in seismic wave velocity
- Ground Penetrating Radar
  ‡ reflectors indicate potassium and anhydrite
- Seismic Data
Drilling preparation

- Check on 3D model
- Check on GPR log interpretations from neighboring wells
- In case of strong indications for stringers adapt well trajectory if possible
- **Always be prepared!**
  - in our case well control measures up to 5000 psi at wellhead
**Summary**

- AkzoNobel Salt has drilled >50 wells in different Zechstein salt bodies
- Sometimes (anhydrite) floaters/stringers have been hit, resulting in a kick in two cases
- Stratigraphical knowledge of Zechstein salt bodies in combination with well logging and 3D modeling is helpful to reduce drilling risks upfront
- Still operators should always be well prepared in case of hitting a pressurized stringer
Thank you for your attention

Questions?