NEW TECHNOLOGY FOR HANDLING LEGACY WELL INTEGRITY ISSUES

Malin Torsæter
SINTEF Industry, Dpt. Petroleum
6242 wells in Norway

Often hundreds of wells at each field … and they can never be removed!

Figure: ConocoPhillips

Ekofisk field

Figure: npd.no
Engineered structures of steel and cement

Drilling

Cementing

Operational

Plugged

WI issues can be remediated

Re-entry & repair difficult/impossible
State-of-the-art when it comes to handling legacy wells in a CCS context

...is to avoid them...
Candidates: Norwegian full-scale project

• Utsira formation southeast of Sleipner
• Viking Group at Smeaheia
• Heimdal Formation at Heimdal

Favored due to good geological reservoir setting, large available capacity and the scarcity of legacy wells in the area

How can we reach Gt storage volumes while avoiding wells?
Are we OK with not utilizing the best characterized reservoirs?
How can we ensure safety of legacy wells?
Each country has its own specifications of "safe plug lengths" for wells. Where do the different numbers come from?
Not only plug lengths: *materials matter*

CO₂ injection in the period 2009-2013

**Reference**

| 521 m |

Cement from well plug placed 2013, drilled out 2015

| 522 m | 523 m |

Pores  Contamination  Cement

Microscopy study of pipes

- Inside tubing
- Outside tubing
- Inside casing
- Outside casing

Materials: stainless steel (tubing) and steel (casing)

Not only plug lengths: *materials matter*
Operations: *Impact on well integrity*

- **Loads:**
  - Thermal
  - Chemical
  - Mechanical

NCCS: Understanding CCS well conditions

• Unique realistic experiments with high potential

Images recorded in-situ at 280 bars and 80°C

Sample holder

CO₂ injection

0.1mm

10 min

Source: esrf.eu
Work with nature: \textit{shale/salt}

- How can we \textbf{plan} to use formations as barriers?
- How can we \textbf{activate} such barriers?

E. Fjær et al. (2016), How creeping shale may form a sealing barrier around a well, \textit{Am. Rock Mech. Assoc., ARMA 16-482.}
Evaluating wells: *logging and "tophole"

- Physics: material/fluid impact on signals
- Eliminate human log interpretation → machine learning

- **New consortium:** "tophole" (non-invasive) continuous well integrity monitoring
Take home messages

• We should not be happy with avoiding legacy wells, but should learn to deal with them. More research needed:
  • (Locating), evaluating & remediating wells
  • Establishing & forecasting well integrity

• Interesting new technology is on the rise
  • Better understanding of CCS well conditions
  • From engineering materials to formations as barriers
  • Improved barrier verification methods

Thank you for your attention!