DrillWell

Drilling and Well Centre for Improved Recovery

Outline

- Introduction
- Key results
- Drilling&Wells and IOR

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Centre for Research-based Innovation
The Research Council of Norway

DrillWell
DRILLING AND WELL CENTRE FOR IMPROVED RECOVERY

Drilling and Well Centre for Improved Recovery

www.drillwell.no

Vision

❖Unlock petroleum resources through better drilling and well technology

Objective

❖Improve drilling and well technology providing improved safety for people and the environment and value creation through better resource development, improved efficiency in operations and reduced cost

Main targets:

- ❑ Cost reduction
- ❑ Improved recovery
- ❑ Efficient field development

RESEARCH PARTNERS

SINTEF

UiS

NTNU
Innovation and Creativity

IRIS

INDUSTRIAL PARTNERS

Statoil

ConocoPhillips

AkerBP

wintershall
BASF Gruppe

sfi = Senter for forskningsdrevet innovasjon

Forskningsrådet

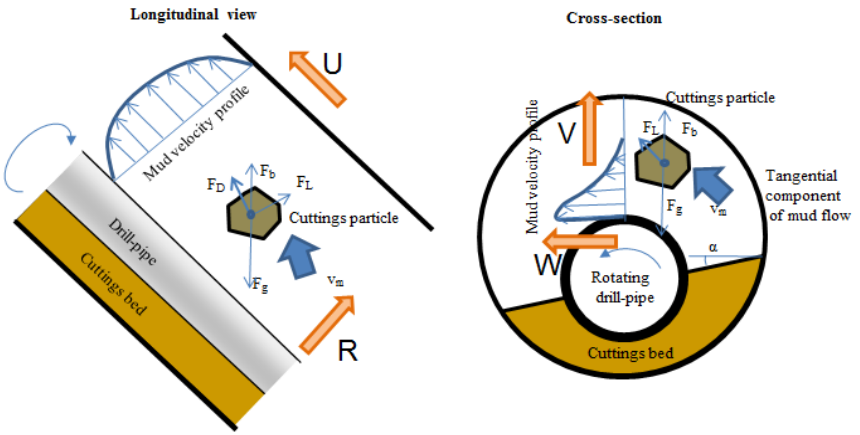
DrillWell R&D targets

- Drilling process optimization
- Well control
- Well integrity
- Permanent plugging and abandonment of wells (P&A)/Slot recovery

Drilling process optimization

Modelling and evaluation of drilling and well processes (transient models)

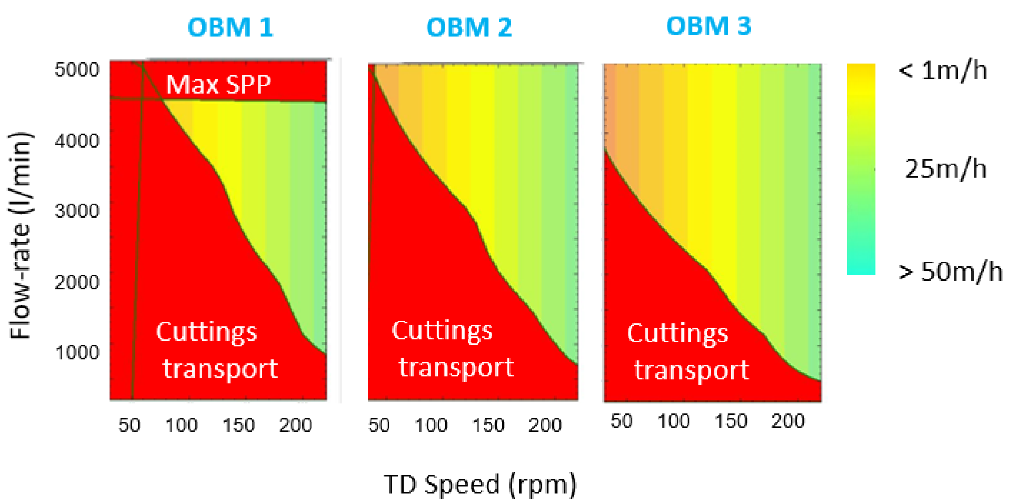
- Cuttings transport
- Well hydraulics
- Drill-string torque and drag forces
- Drill-string vibration
- Risk based optimization of drilling parameters
- Evaluation of field cases



➢Will imply
  - increased drilling speed
  - reduced risk of incidents
  - longer productive well sections

Drilling process optimization
Applications

- Optimize weight on bit and rotational speed (DrillOpPlan)
- Diagnostic of deterioration of drilling conditions (DrillScene*) (improvement)
- Control of drilling machines for safe operations (DrillTronics*) (improvement)
- Improvement of data exchange capabilities between service companies (DDHub)



*: Sekal product

DrillTronics on Songa Enabler

- **Background**
  - DrillTronics is assisting the driller by actively controlling the drilling machines to stay within the drilling margins
  - DrillTronics permanently installed on Statfjord C 2014-17
  - Installation on the semi- submersible drilling rig Songa Enabler for exploration drilling in the Barents Sea 2017
- **Objective**
  - Enable full DrillTronics functionality to work on floating rigs
  - Enable DrillTronics to read and utilize automatic rheology data
  - Install, test & verify on Songa Enabler
- **New models from DrillWell**
  - Transient torque & drag for drill-string elasticity
  - Casing running
  - New hook-load correction for automatic friction test
- **Results**
  - An automated data collection system was successfully used
  - DrillTronics software ensured automated drilling process control
  - The drillers were able to optimize and enhance the safety of the drilling operations
  - Statoil estimated to have saved around NOK 100 million on two wells, using several drilling automation technologies
- **Future**
  - This year DrillTronics on Songa Enabler will be used for more deviated wells

Drilling Data Hub Demonstrations

DEMO 2000 project

➢ **Background**

- Multiple vendors involved in drilling operations; need for interoperability
- Set-up for drilling operations often changes; need for adaptivity

➢ **Objective**

- Demonstrate multi-vendor integration between data providers and data consumers using full version of Drilling Data Hub using OpenLab Drilling

➢ **Why**

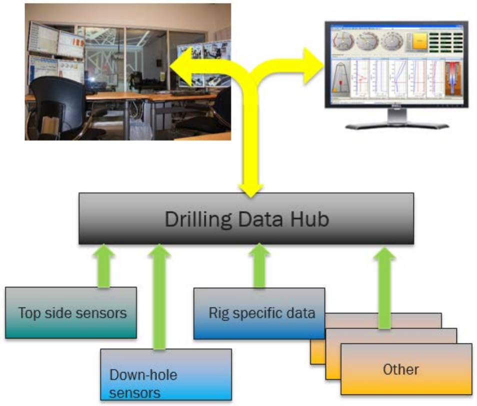
- Need for easy and reliable access to real-time data for processing by more or less complex applications

➢ **What**

- Real-time data acquisition and aggregation based on semantical descriptions

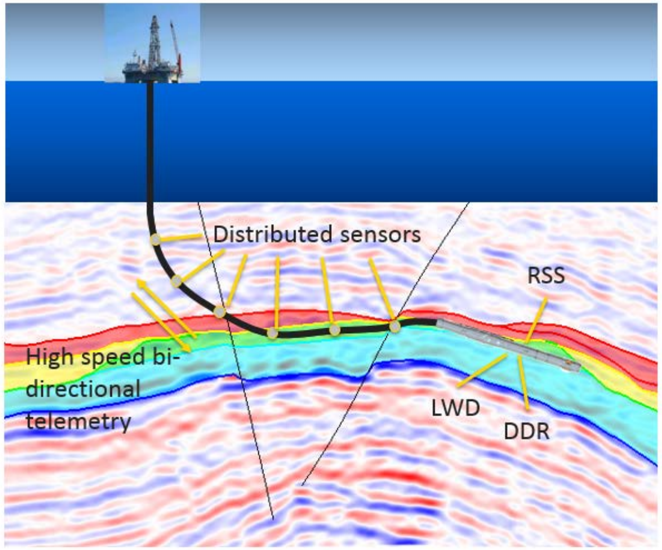
➢ **How**

- Real-time data acquisition and aggregation based on semantical descriptions



Geo-steering for IOR
Petromaks2 project

- **Background**
  - Geo-steering decisions need to balance production potential vs drilling and completion risks
  - Uncertainties should be taken into account in a consistent manner
  - Improvements in downhole logging capabilities (Deep EM, high speed telemetry) and processing capabilities
- **Objective**
  - The primary objective of this project is to develop improved methodology for geo-steering by continuously updating the earth model based on LWD measurements including Deep EM
- **Benefits**
  - Better methodology for using Deep EM with other measurements for geo-steering that treats uncertainty consistently
  - The long-term result will be improved geo-steering in complex fields, which will result in improved oil recovery



Well Integrity and P&A

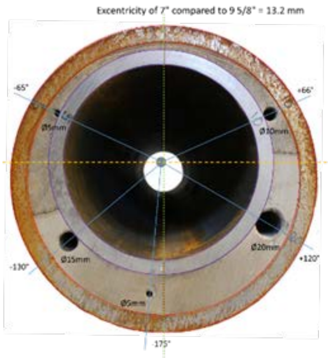
Tubing left in hole experiments

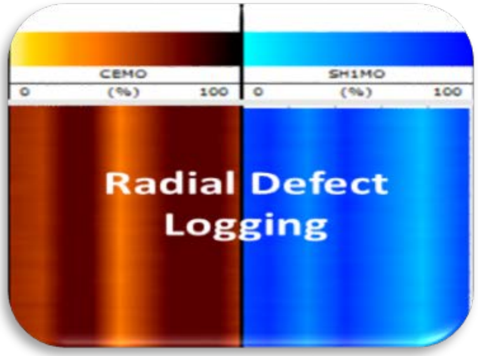
How did we do it?

1. Used two assemblies, one with and one without control lines and cable clamps (inclined to 85°)
2. Used a slow pump rate ≈ 2 bbl/min and s.g. 1.92 cement to displace s.g. 1.20 brine
3. Performed pressure and leakage tests by pumping high pressure water to 110 bar
4. After leakage tests: Assemblies cut through at selected positions to inspect how well the cement had displaced the brine in tubing and annulus

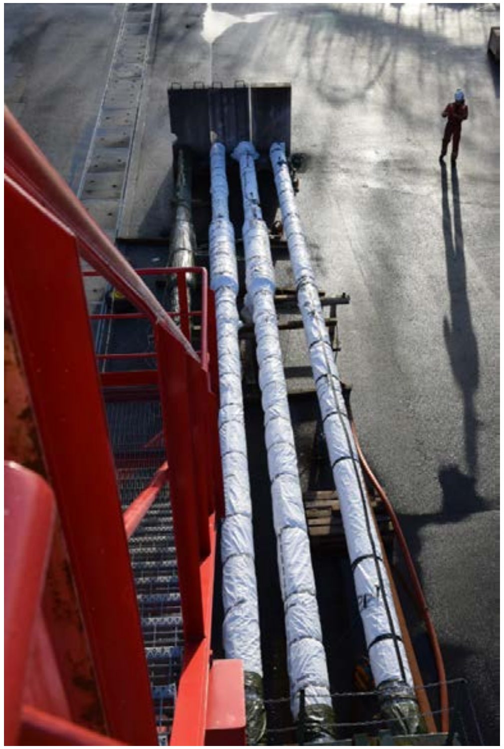
Well barrier evaluation
PILOT logging experiment – Baker Hughes

- Prepared test cells with known channels
- Pilot test with Baker Hughes
- Offer full scale test program





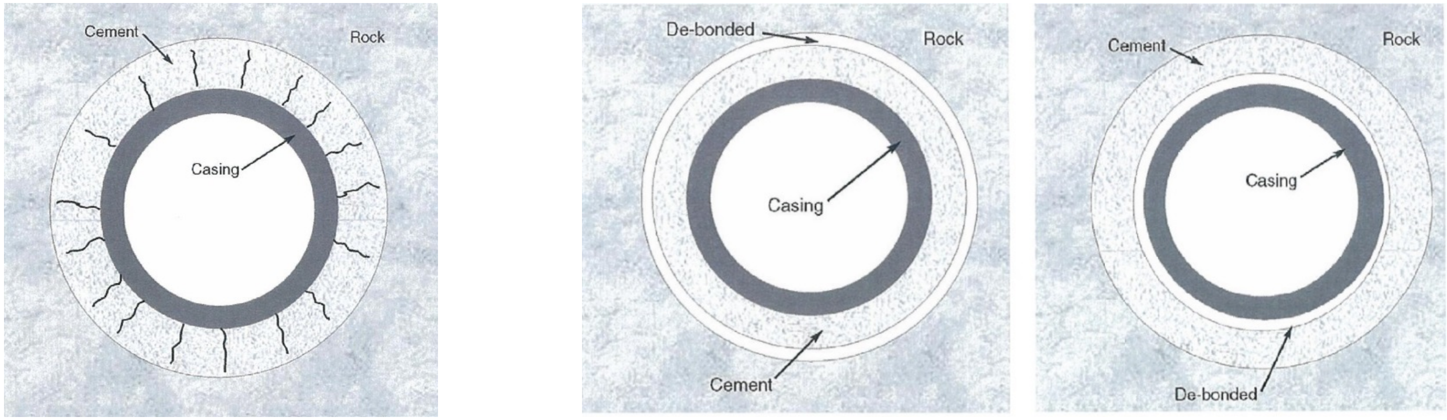
Full-scale cementing experiments



- Cementing experiments investigating effect of inner-string eccentricity and hole enlargement on cement placement
- Four instrumented assemblies, each 24 m long:
  - 7” tubing in 9 5/8” casing
  - 16” casing as washout
- Assemblies filled with viscous spacer that was displaced by cement slurry pumped using the Ullrigg P&A Laboratory batch mixer and Ullrigg mud pump

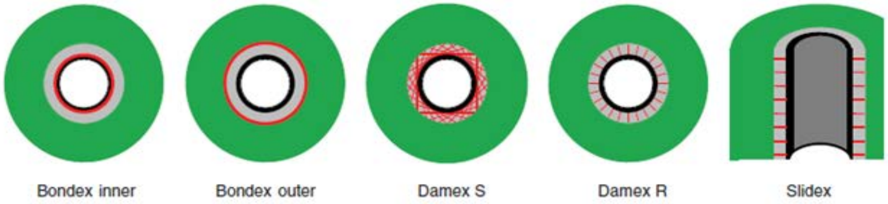
Temperature and pressure cycling of cement sheaths

- Simulations and modeling



Figures from Ravi et al. (2002) SPE-75700

- Radial cracks due to temperature and pressure increase
- Debonding due to temperature and pressure decrease

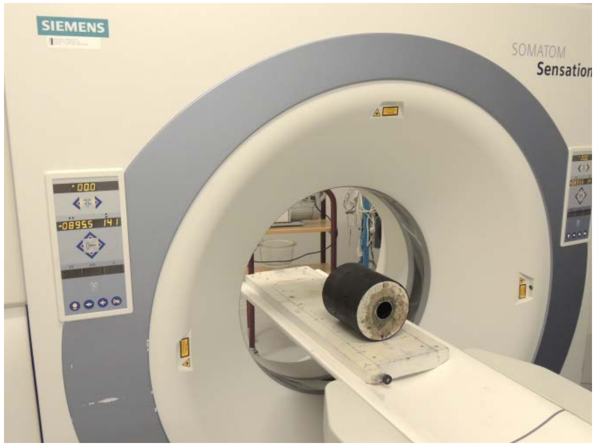


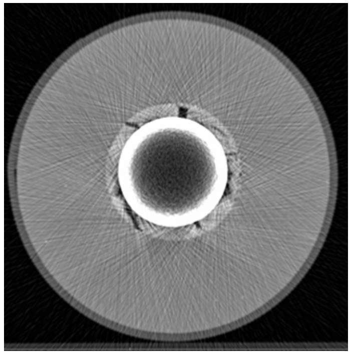
Bois et al. (2011) SPE 124719

Visualization by X-ray Computed Tomography (CT)

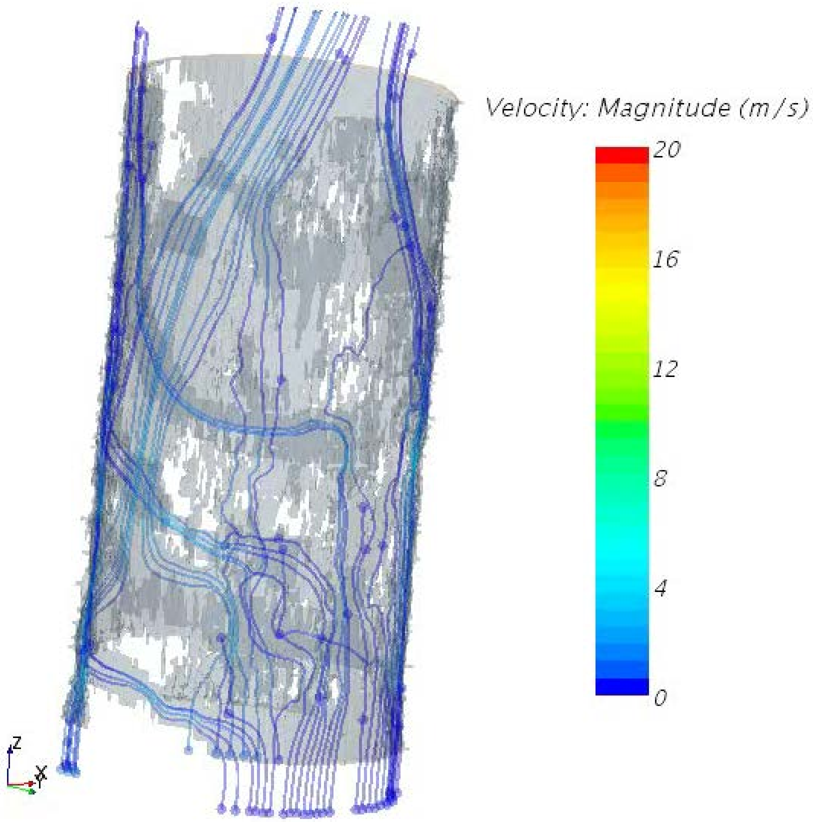
A tomographic method that provides specific information on size and location of potential leak paths

- In-plane resolution ≈ 100-200 µm (w. 140 kV)
- Approximately 200 images per sample

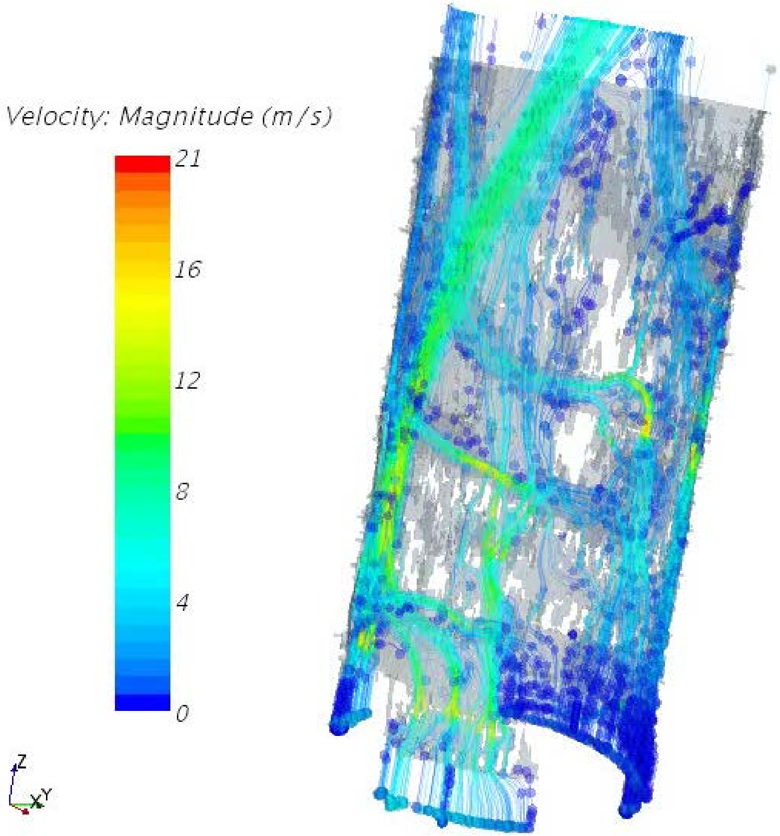




Case - Flow through partial microannulus



20 Pa pressure drop



200 Pa pressure drop

Improved oil recovery

Reduction of well construction & operational cost

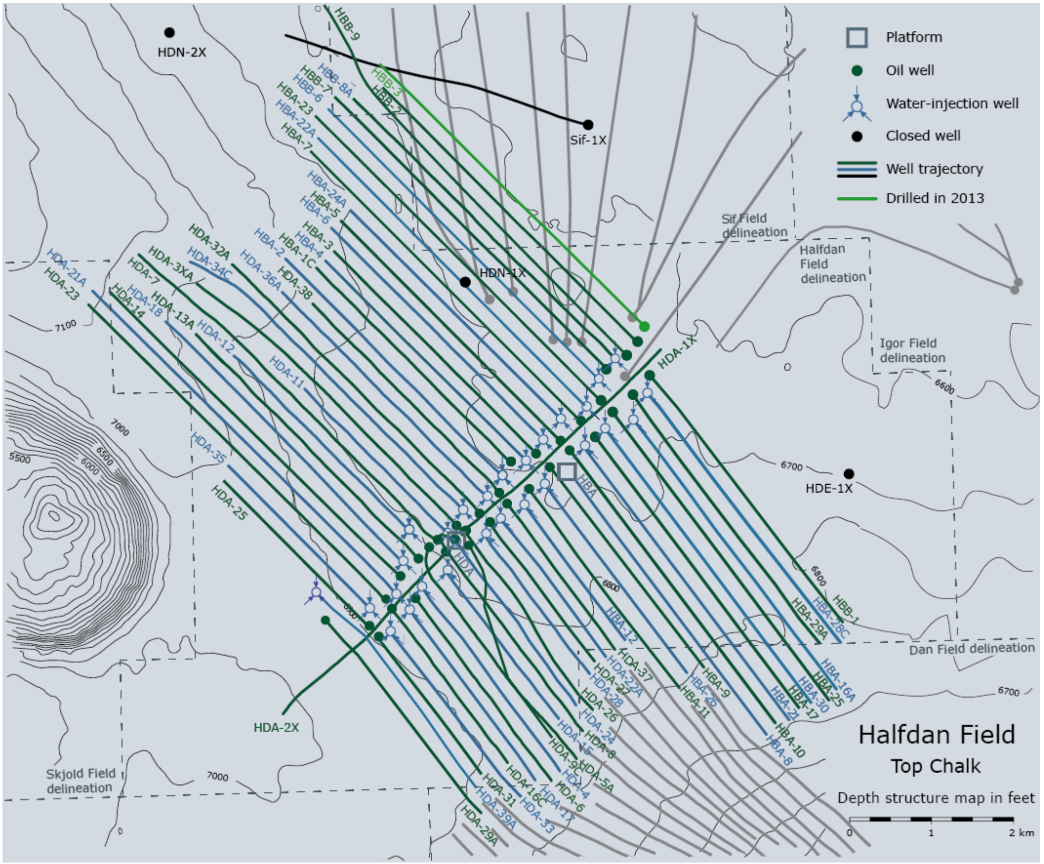
- Less expensive wells will imply reduced field development cost
  - ➢Marginal fields can be developed
- Less expensive well operations will imply reduced field operational cost
  - ➢More oil can be reached through side-tracks
  - ➢Well maintenance will increase well productivity
  - ➢Field life time will be extended

➢Implication: **Increased recovery of oil and gas**

Wells assisting EOR

Cheaper wells may assist EOR

- Small well-to-well distance in multilaterals
- Horizontal injector-producer pairs



Halfdan field, Denmark

Reference: Danish Energy Agency "Oil and Gas Production in Denmark" (2013)

Improved well integrity and P&A

- Improved well integrity will imply increased well lifetime and reduced well maintenance cost
- Reducing cost for slot recovery and P&A will release budgets for well construction

➢ Implication: **Increased recovery of oil and gas**

Conclusion

- Safe and cost efficient well construction contributes to IOR
- Attractive to combine low cost wells with EOR (low well to well distance)

Acknowledgement

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