

SPE Aberdeen **Simplified** **Series 2014**

Demystifying Petroleum Engineering

Sponsored by Shell UK Limited



Ross Lowdon

June 4th 2014



SPE Aberdeen Simplified

Series 2014

Demystifying Petroleum Engineering



Society of Petroleum Engineers
Aberdeen Section
www.spe-uk.org

Kindly Sponsored by
Shell UK Limited



Ross Lowdon

June 4th 2014

Agenda

- Defining a survey
- History of Wellbore surveying
- Why do surveys matter?
- Survey errors
- Future of surveying

What is a Survey?

MEASUREMENTS OFF

- **SURFACE LOCATION**
start point
- **DEPTH**
measured from a datum
- **INCLINATION**
from vertical
- **AZIMUTH**
aligned to a North ref

Existing well
Currently drilling
Surface well
location
Wellbore
trajectories

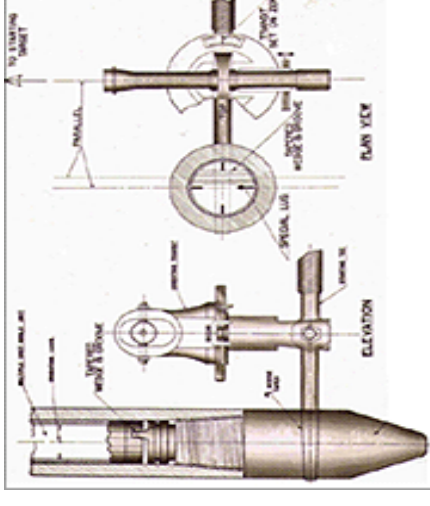
History of Wellbore surveying

- Texas 1890's
- Next door “stealing oil”
- “Prove it”
- Jam Jar acid level



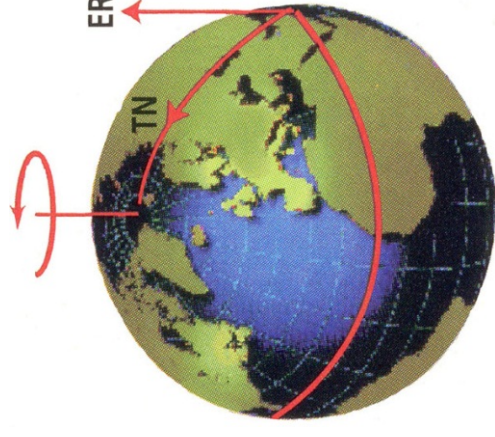
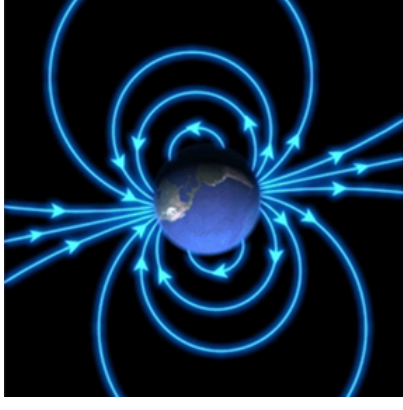
History of Wellbore surveying

- 1930 Photo Magnetic single shot
- 1930 Photo Gyroscopic survey
- 1980 Measurement While Drilling
- 1999 Gyro While Drilling



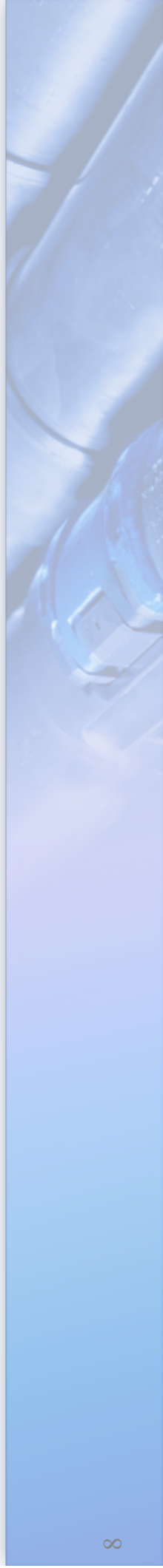
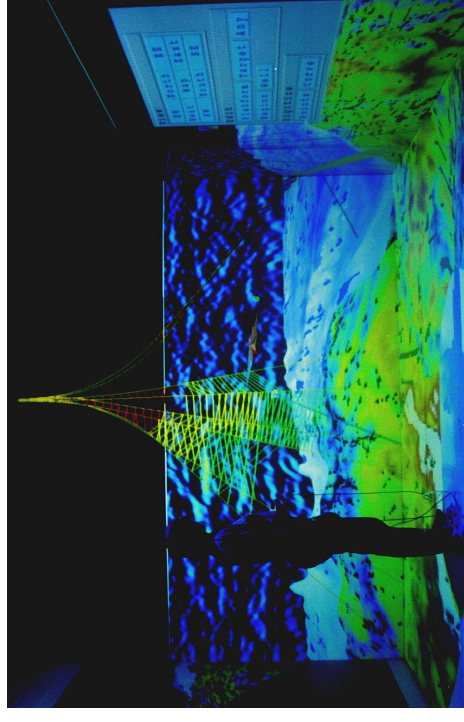
Survey Technologies

- **Magnetic**
 - Robust and RT 5 second surveys
 - Poor reference
 - Affected by offset casing
- **Gyroscopic**
 - Excellent Reference
 - Sensitive RT 2-7mins
 - Not affected by offset casing



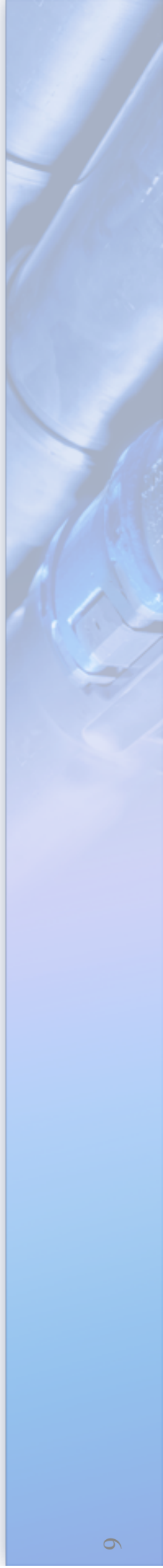
Why Does a Wellbore Survey Matter

- Avoiding wells collisions
- Avoiding well control issues
- Relief wells
- Ensure you hit the your targets
- LWD to reservoir model tie in
- Reserves estimates
- Legal requirements



The Value of Good Surveying Practice

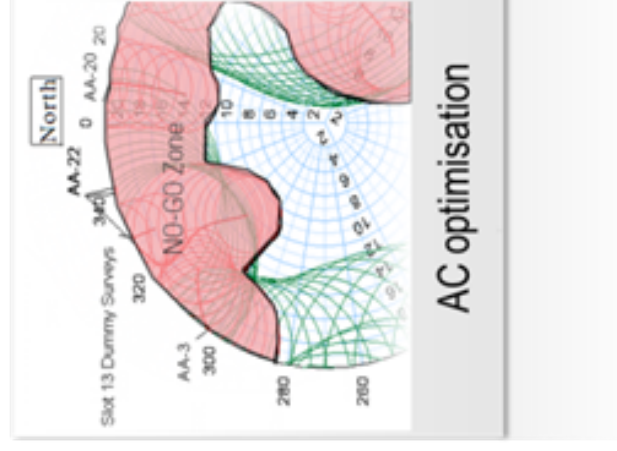
Shorter gyro run	\$15K
Saved casing survey	\$125K
Production 'shut in'	\$700K
Target sidetrack	\$2-3M
Dry well	\$25M
Major collision blowout	\$\$\$\$??



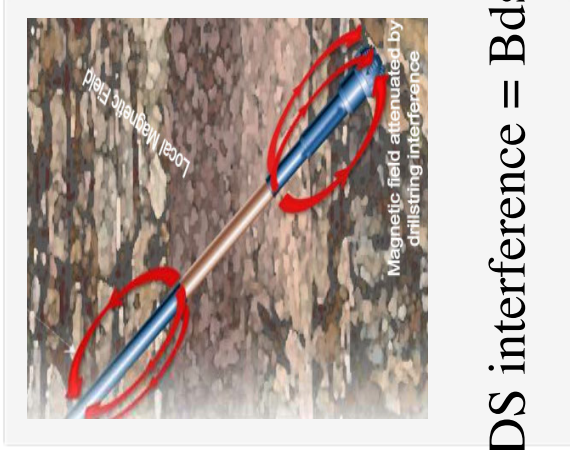
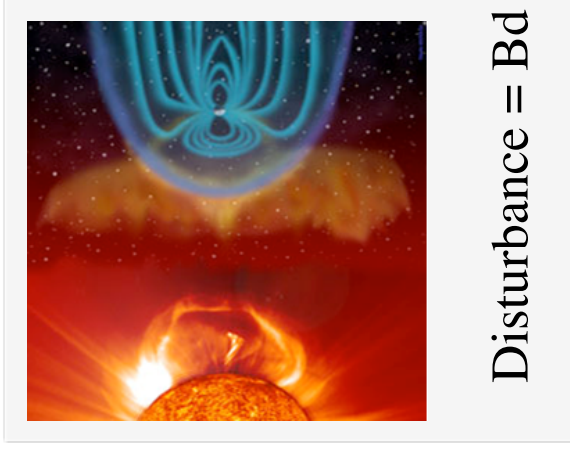
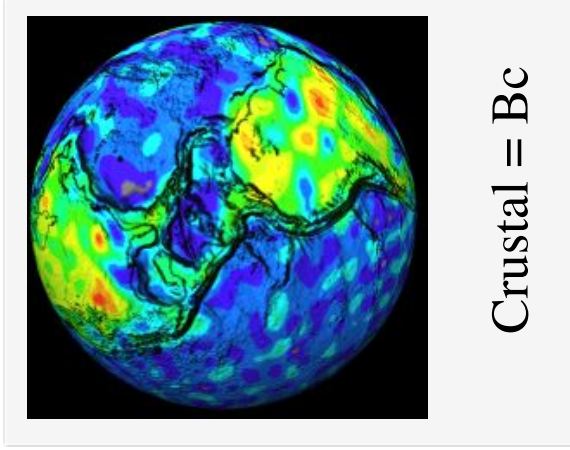
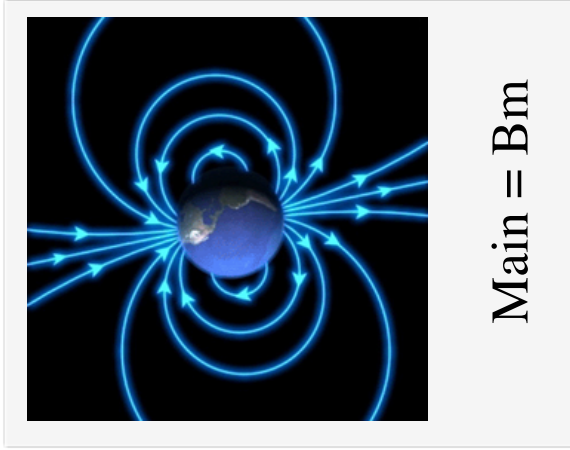
Avoiding other Wells

- Well avoidance
 - Complex and contradictory data
 - Managing the survey data
 - Poor data quality/missing data

- Survey Management
 - Ensuring data accuracy
 - Ensuring reserves estimates
 - Ensuring HSE



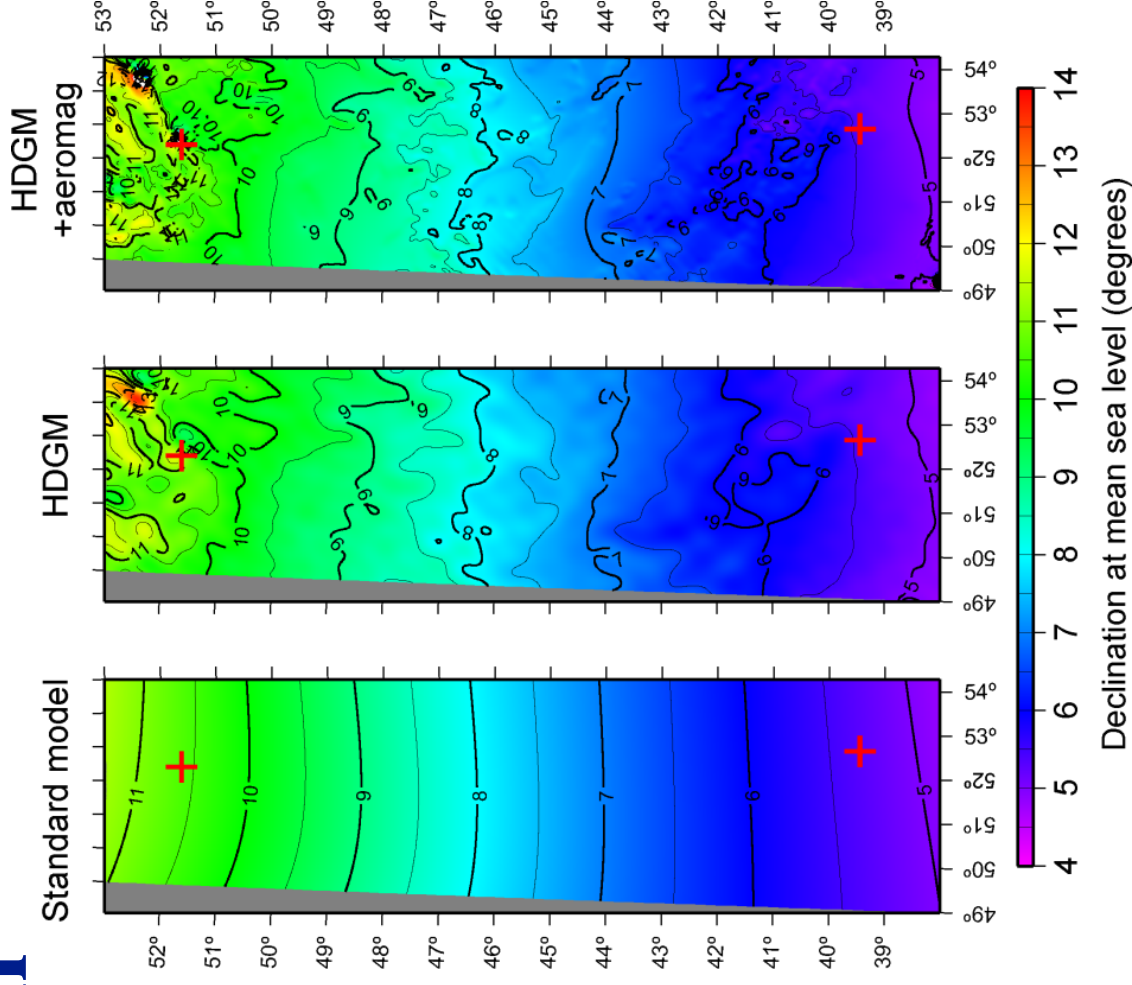
Lateral MWD Survey Errors



$$\text{Total Magnetic Field} = B_m + B_c + B_d \pm B_{ds}$$

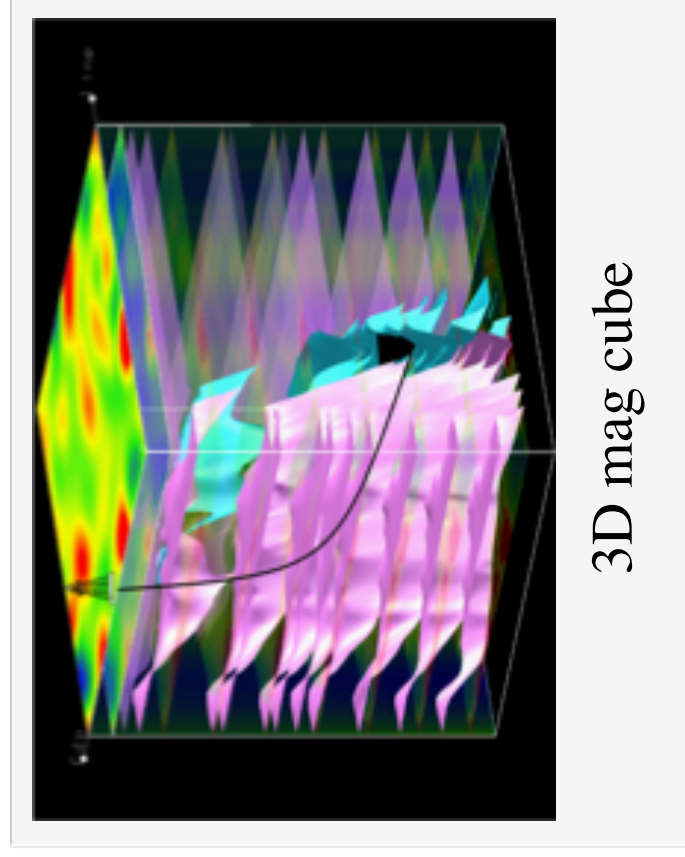
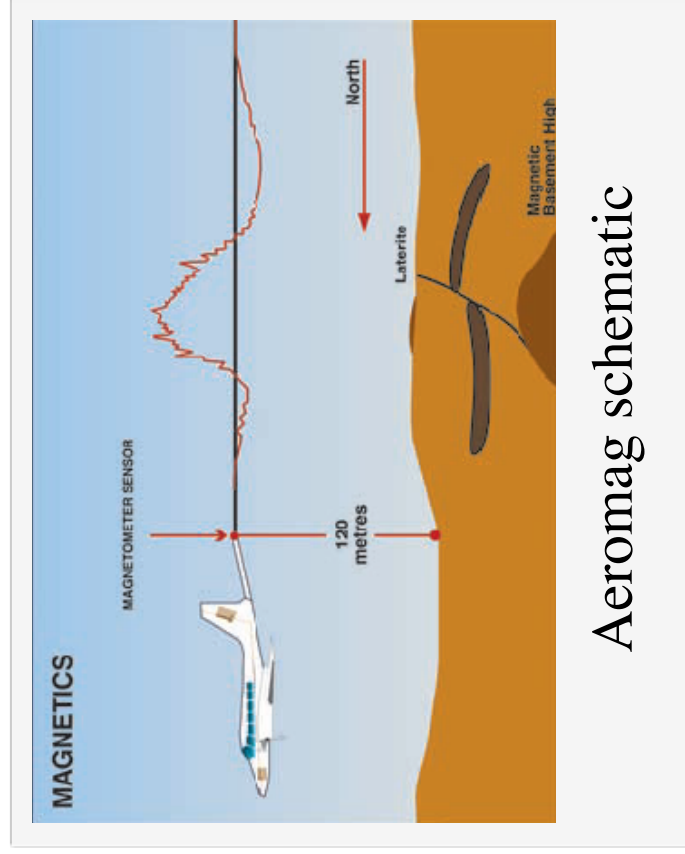
Improving Definition

- BGM 54 degree
- HDGM 720 degree
- MagVar 5,400 degree

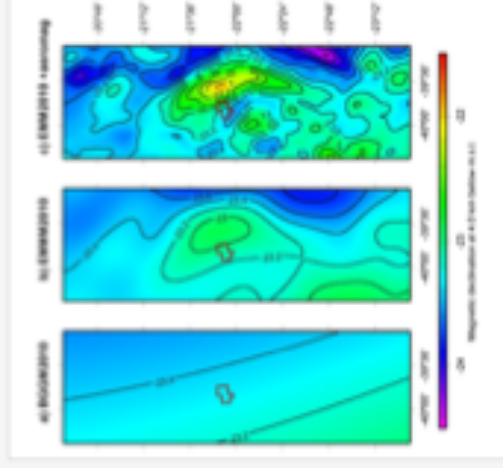


Capturing the Crustal Field

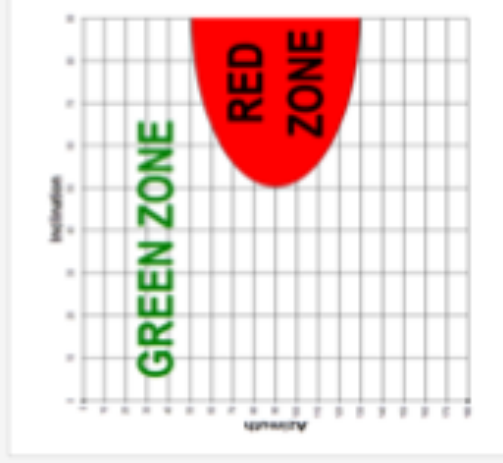
Aeromag or Marine



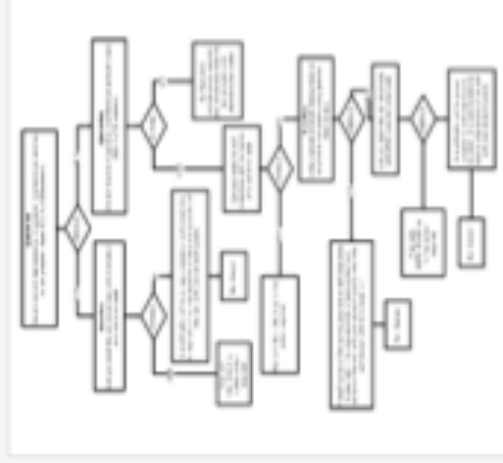
Optimising Lateral Survey Accuracy



Local magnetic map



Multi-station correction

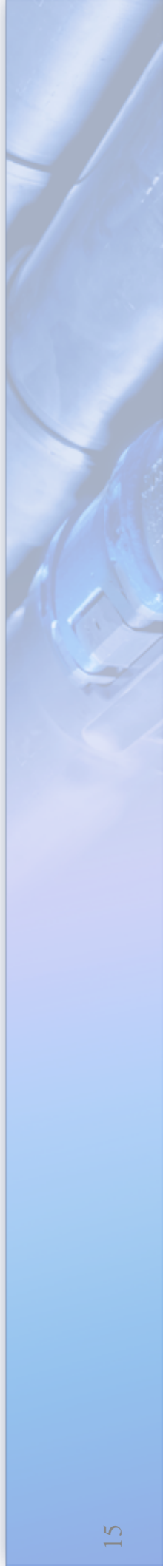


Advanced survey QC

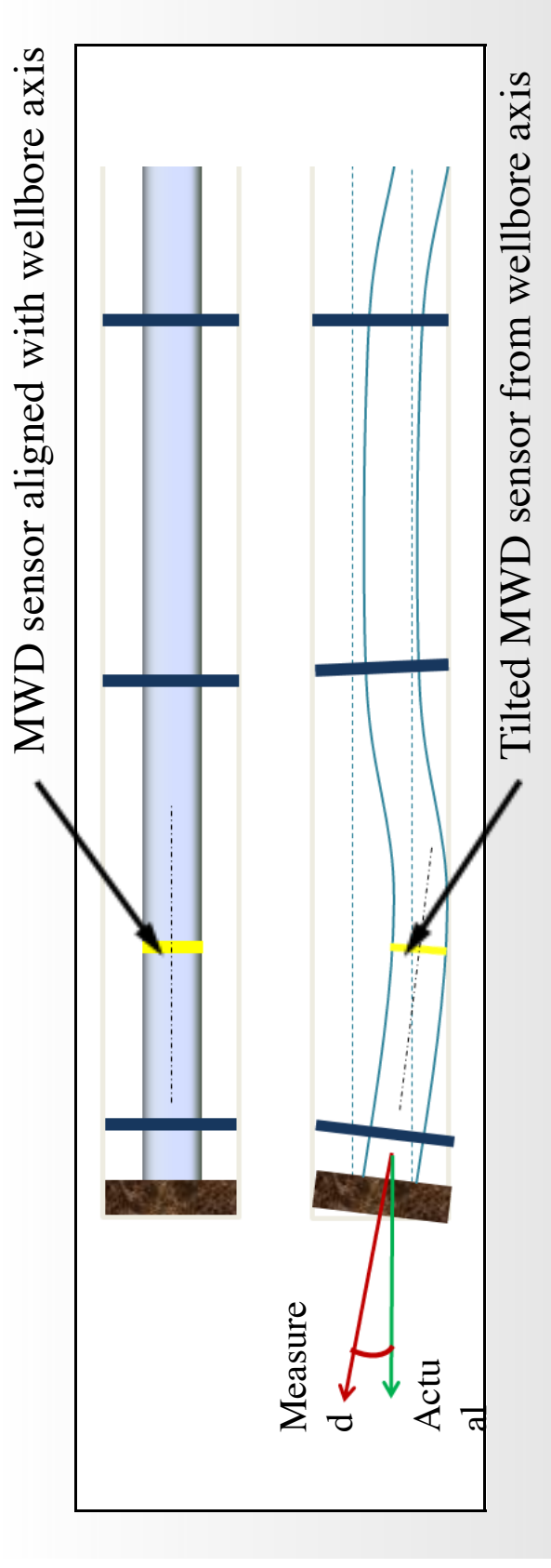
IFR = 65% Lateral EOU reduction

TVD Survey Errors

- BHA misalignment
- Mechanical and temperature pipe stretch
- Survey frequency
- Measurement error



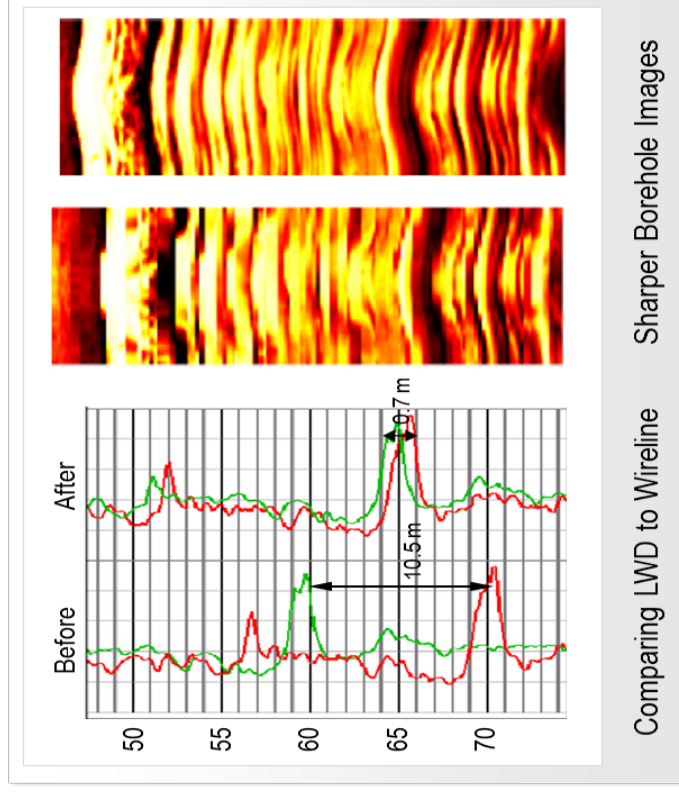
BHA Mis-alignment



- What effect does it have?
 - $<0.1^\circ$ to 1.0° in inclination
 - 0 ft to 100+ ft of TVD
 - Stabilizer wear?

Mechanical and Temperature Stretch

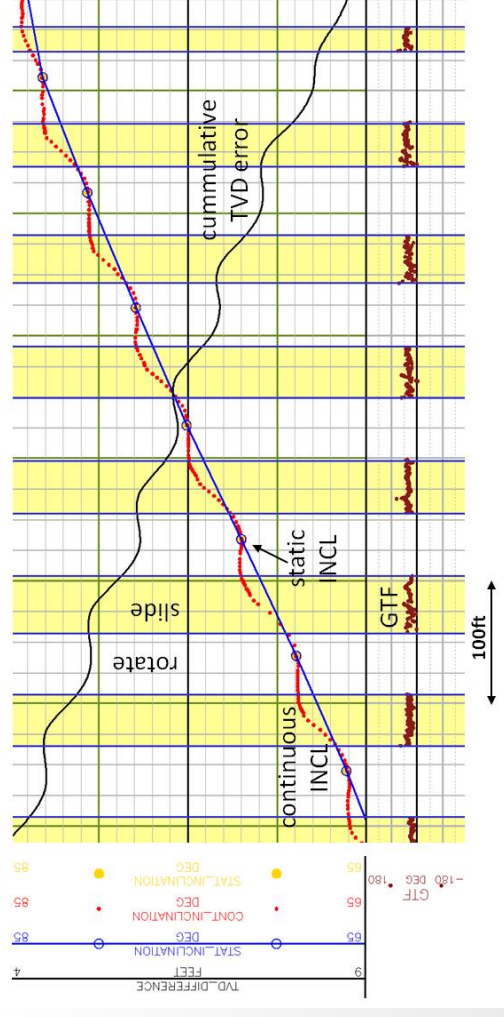
- Steel expands with temperature and stress
- Pipe stretch
 - Vertical—TVD error
 - Horizontal—MD error
 - 1.3 m/1,000 m/100 degC—thermal
 - Mechanical 1 m/1,000 m—force
- Can be corrected



Survey Frequency

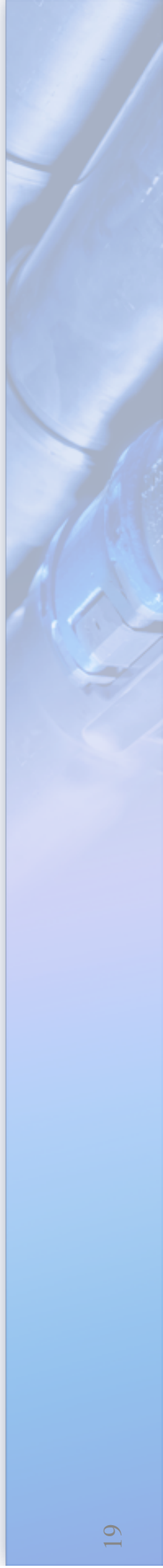
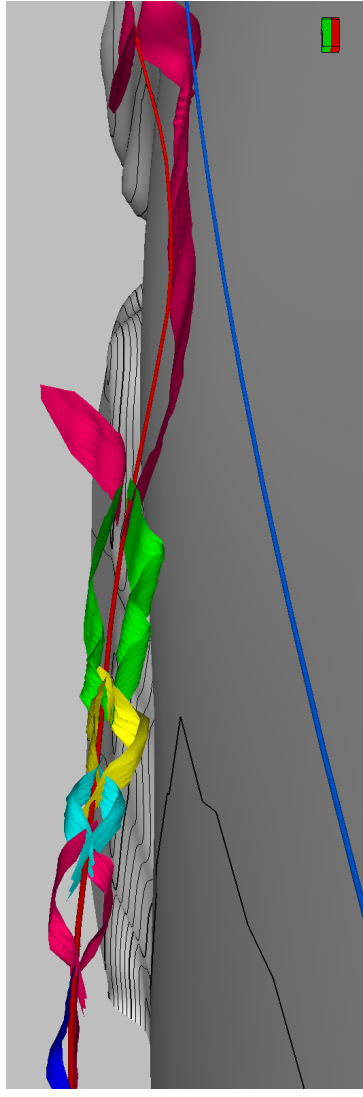
What is happening between 90 ft surveys?

- Well placement issues
 - Reservoir modeling
 - Geo-steering
 - Log interpretation
- Well engineering issues
 - Running casing
 - Completion flow modeling
 - ESP flow modeling



Sensor Errors

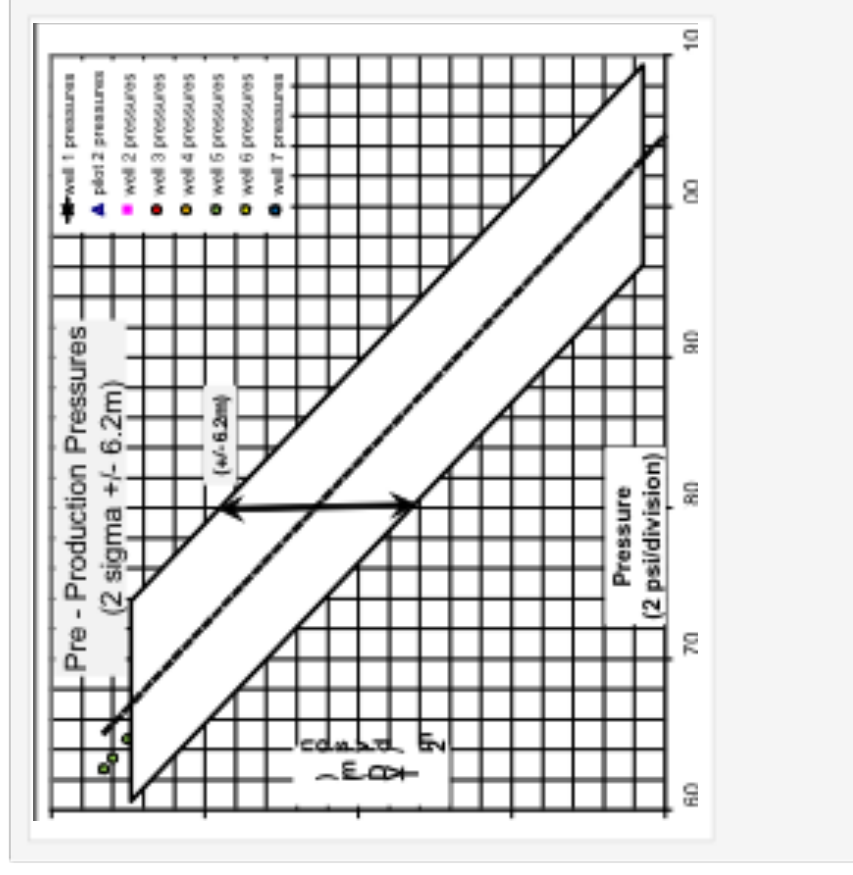
- Inclination measurements $\pm 0.1^\circ$
 - Industry standard
 - Gyro tools same specification
 - Calibrated
 - Capable of higher accuracy



TVD Optimisation—is the Accuracy Real?

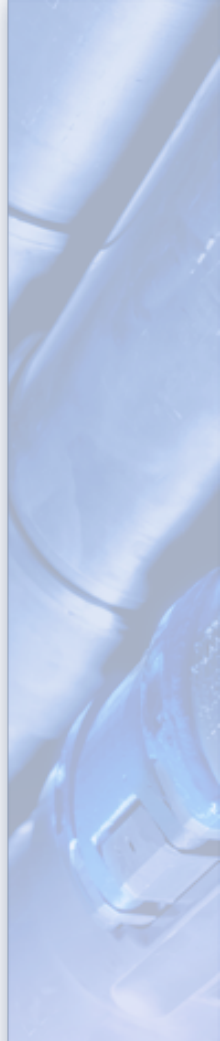
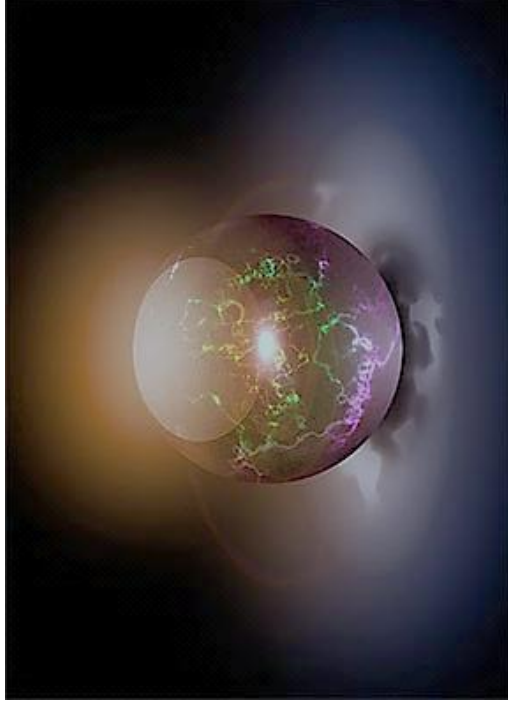
Case Study

- Use RSS + MWD D&I
- EMS used to confirm MWD
- LWD proved TVD
- Captured stabilizer wear
- Saved appraisal well
- 12 m TVD error at 12,5 km

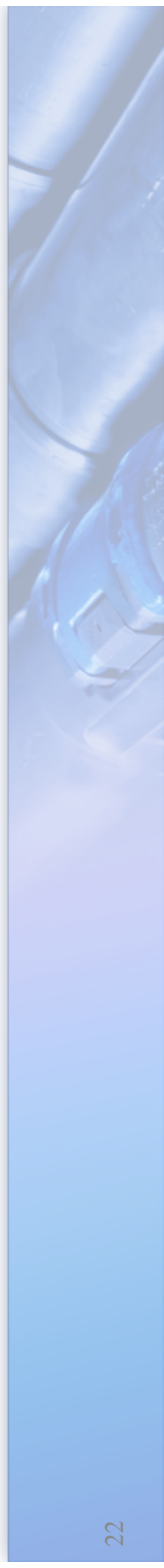


Future of Surveying

- Combined magnetic and gyro tools
- Real time inertial surveying
- Hole curvature measurements
- Autonomous drilling machines



Questions?





NEXT SIMPLIFIED SERIES

SPE Simplified Series
Sponsored by Shell UK Limited



PRESENTATION

- Simplified Series is held every first **Wednesday** of each calendar Month
- Next Venue – **Wednesday** July 2, 2014
- Station Hotel Aberdeen (The Ballroom)
- Russel Morrice North Sea Drilling Engineering Manager BP
- Drilling Engineering Simplified

SPE Aberdeen Simplified Series 2014

Demystifying Petroleum Engineering



Introduction to Drilling Engineering

Presented by:
Russell Morrice

North Sea Drilling Engineering Manager, BP



Wednesday 2nd July 2014 | 6:30–8:30pm
Station Hotel Aberdeen | AB11 6GN
Free Venue & Refreshments

Book Online from June 18th at: www.spe-uk.org/aberdeen/

Russell started as a mechanical technician offshore with BP in the North Sea in 1990 and spent 9 years in the area working on onshore and offshore shut down projects. In 1999 Russell decided in a change of career direction and transferred into the world of drilling engineering. From then Russell has progressed through all the drilling roles - Well Site Leader, Operations Drilling Engineer, Senior Drilling Engineer, Team Leader, and on to his current role as Drilling Engineering and Well Decommissioning Manager for BPs North Sea business unit.

Russell will present an introduction to drilling engineering. He will start with a brief run through of the history of drilling around the world and BPs involvement. Following this Russell will explain the complex and multi-disciplinary design, planning and execution phases of drilling a well. After the presentation there will be time for a Q&A and networking session.

Organised by **SPE Aberdeen Young Professionals**

Contact us: george.grangeon@reefsubsea.com
or ross.taylor@maerskcoil.com
or adam.miszewski@uk.bp.com

SPE Simplified Series
Sponsored by **Shell UK Limited**

