# Continuous 6-Axis Drilling Mode Surveys Case Studies

Industry Steering Committee on
Wellbore Survey Accuracy
Wellbore Positioning Technical Section

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Calgary, Canada



ISCWSA

# Speaker Bio

Mahmoud ElGizawy

- E.H. Wellbore Positioning Manager, Schlumberger k+m
- PhD & MSc in Geomatics Engineering, U.of Calgary
- 20 years in positioning and navigation (15 years in wellbore positioning)
- Based in Abu Dhabi, UAE

# Agenda

- Motivation
- MWD Evolution
- Drilling Mode Surveys
- Case Studies
- Summary

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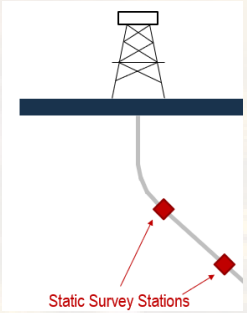
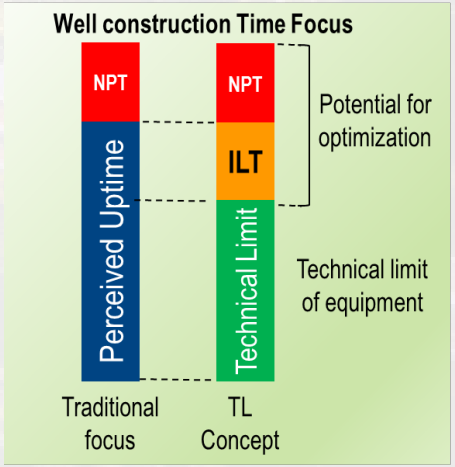
# Motivation

Wellbore Trajectory at stationary surveys every 100 ft (30m)




ILT - Rig time

NPT - Reduce differential stuck risk and Lost in Hole BHA



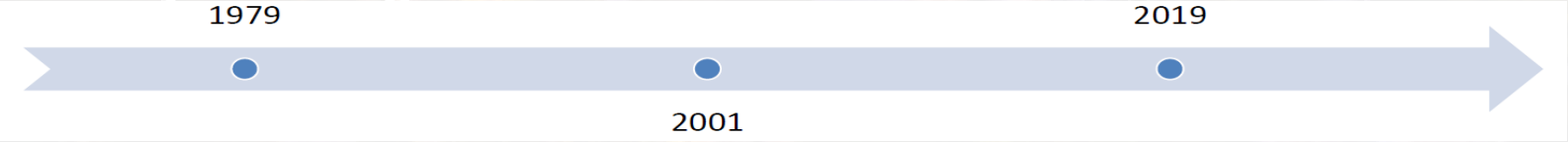

*Bond and Scott, 1998

| Traditional MWD survey action | Time |
|---|---|
| Working the drill string | 2-4 mins |
| Pulling off bottom | 1 min |
| Cycling the pumps | 2 mins |
| Waiting on MWD to take a survey | 2 mins |
| Waiting on telemetry | 2-4 mins |

# Measurement While Drilling Evolution

- MWD Measurement
- 6 axis (3 accelerometers and 3 magnetometers)
- Robust reliable and auditable
- Survey taken when stationary
- Time penalty

- Continuous 6-axis surveying
- Definitive survey taken while drilling
- No “survey time”
- Reduced pump cycles
- Improved directional control




Continuous single-axis surveying

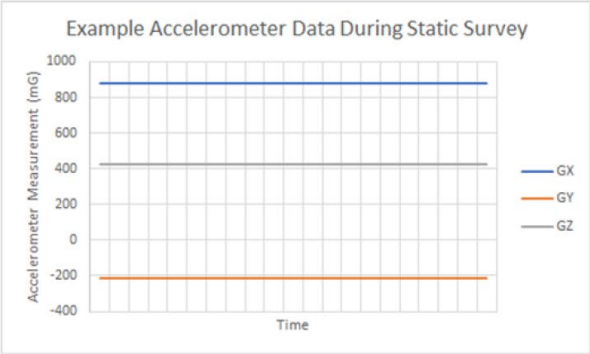
Improved trajectory control

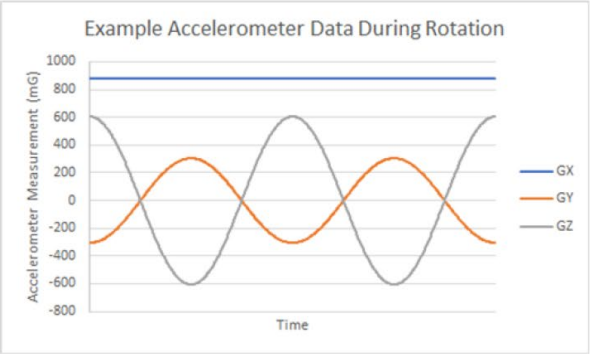
Not definitive without static surveys

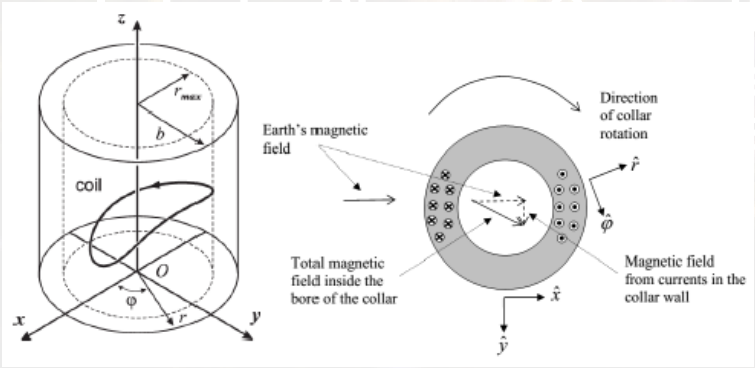
# Continuous 6-Axis Surveys - DMS

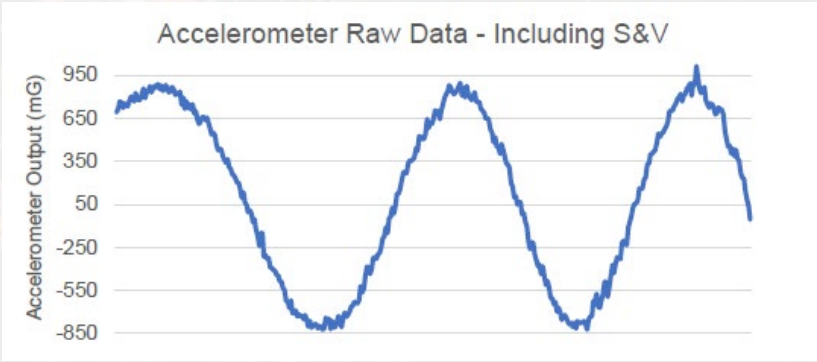
## Challenges

- Phase compensation
- Shock and vibration
- Eddy Currents



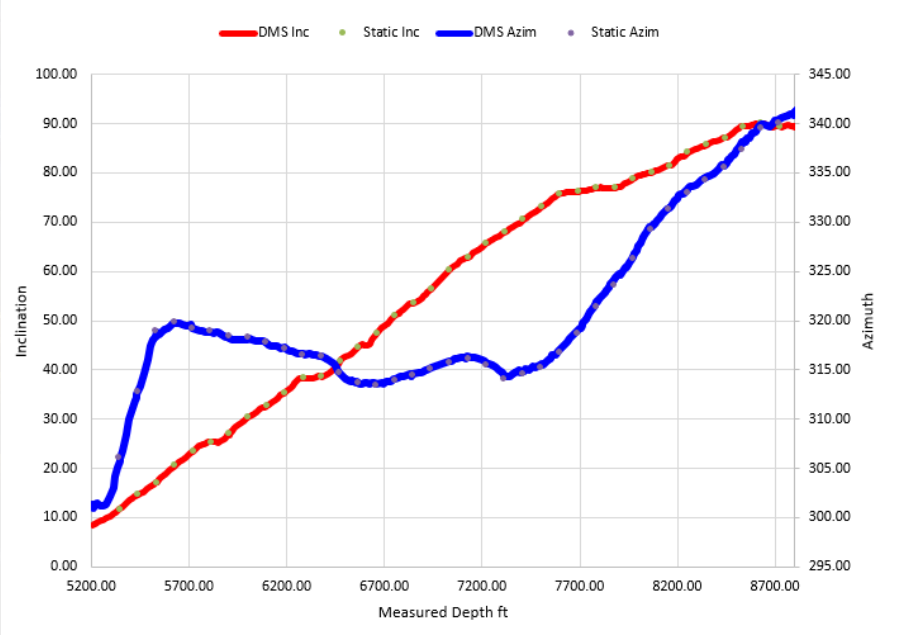



# Case 1

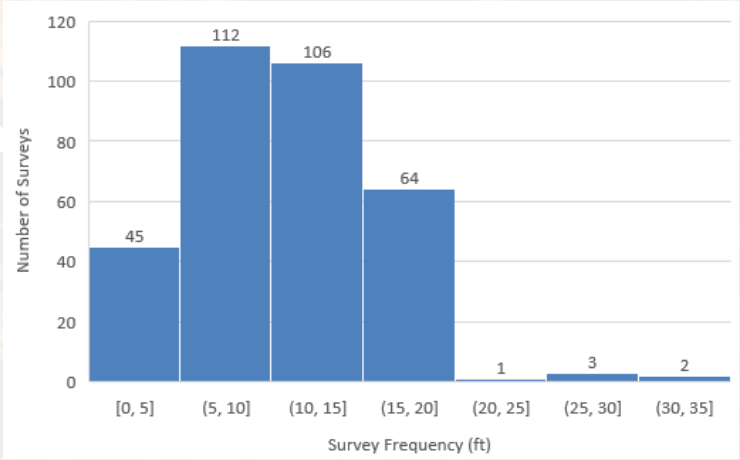
MD 3656 ft




38 Stationary surveys

335 DMS

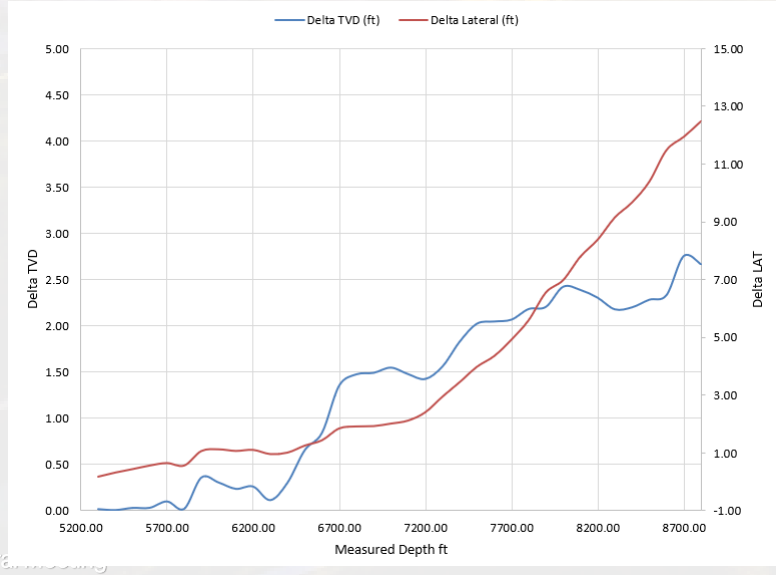
Over 3 hours of rig time savings

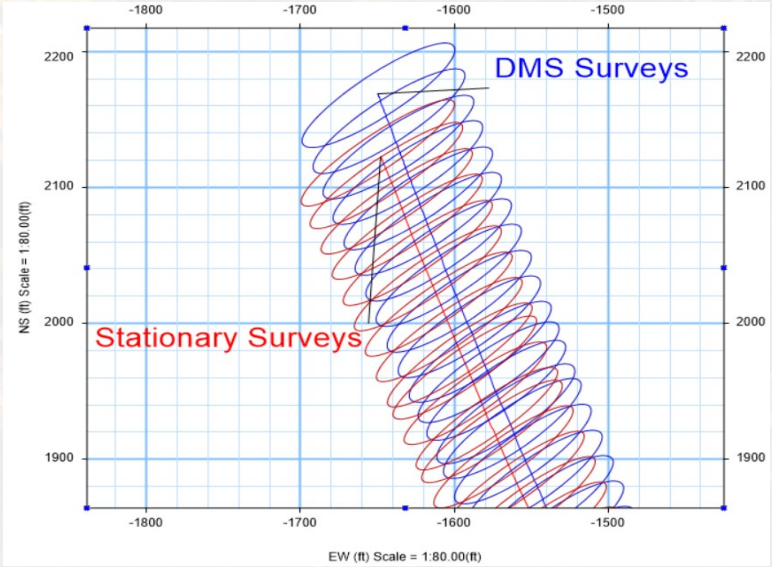


# Case 1 cont.

TVD difference is 2.67 ft

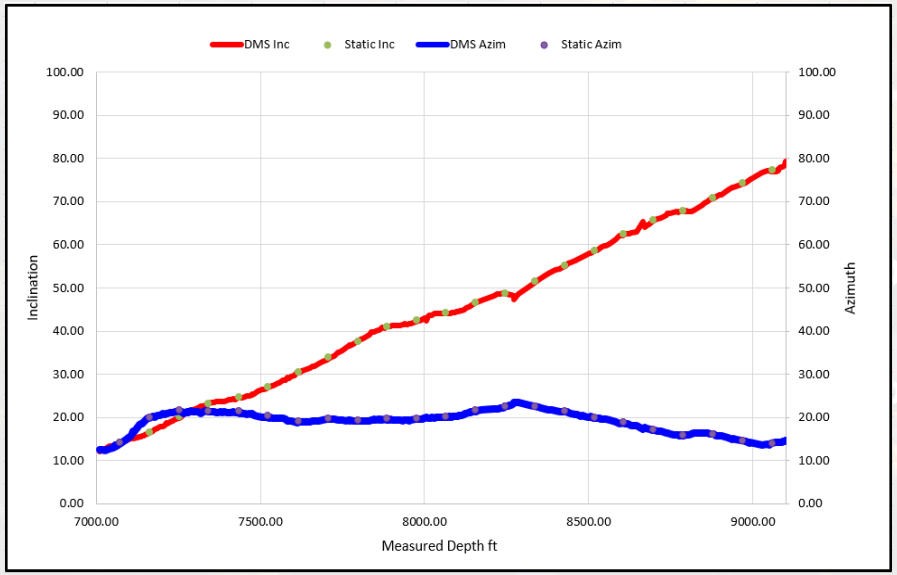
Difference in lateral displacement is 12.49 ft



# Case 2

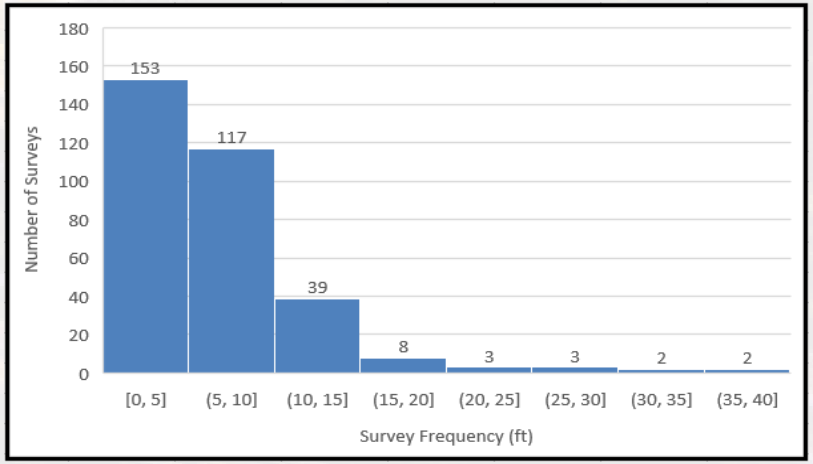
MD 2141 ft




24 Stationary surveys

328 DMS

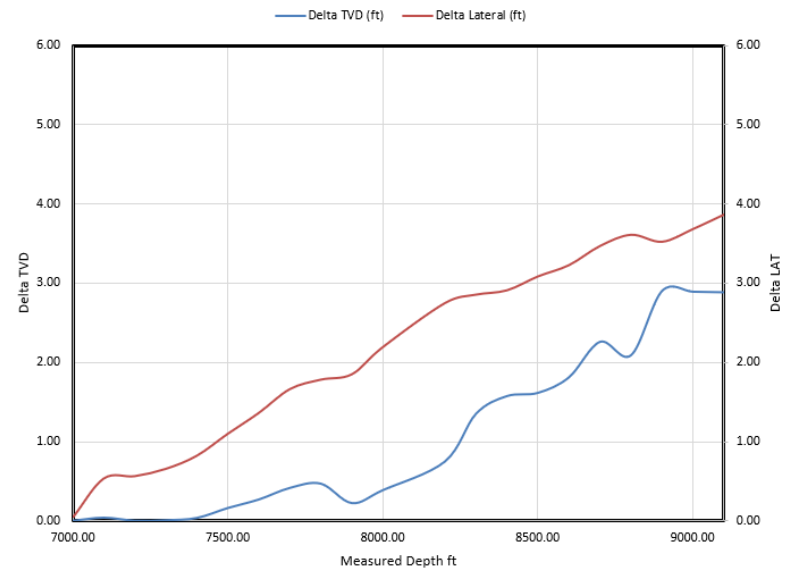
2 hours of rig time savings

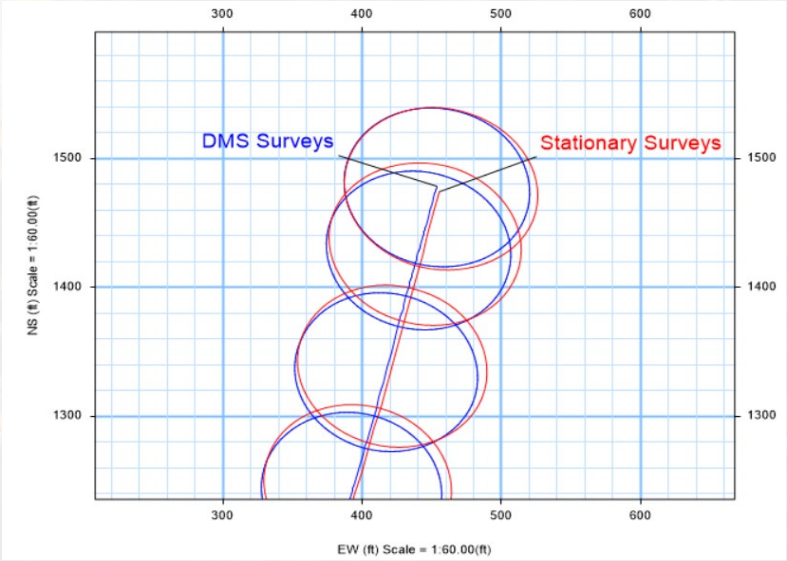


# Case 2 cont.

TVD difference is 2.89 ft

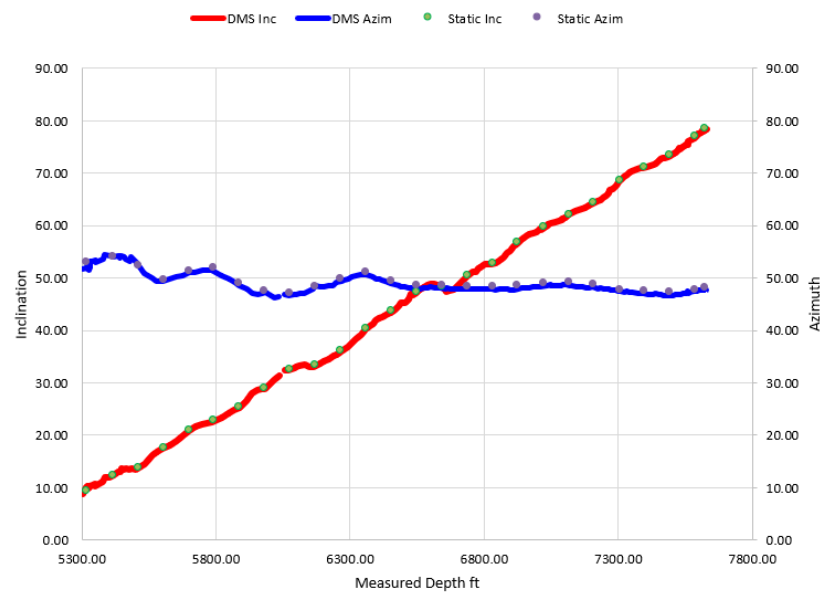
Difference in lateral displacement is 3.87 ft



# Case 3

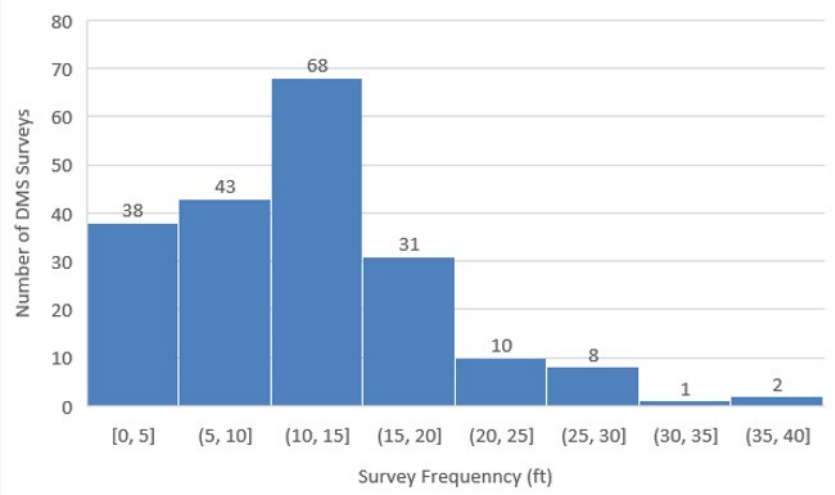
MD 2328 ft




26 Stationary surveys

201 DMS

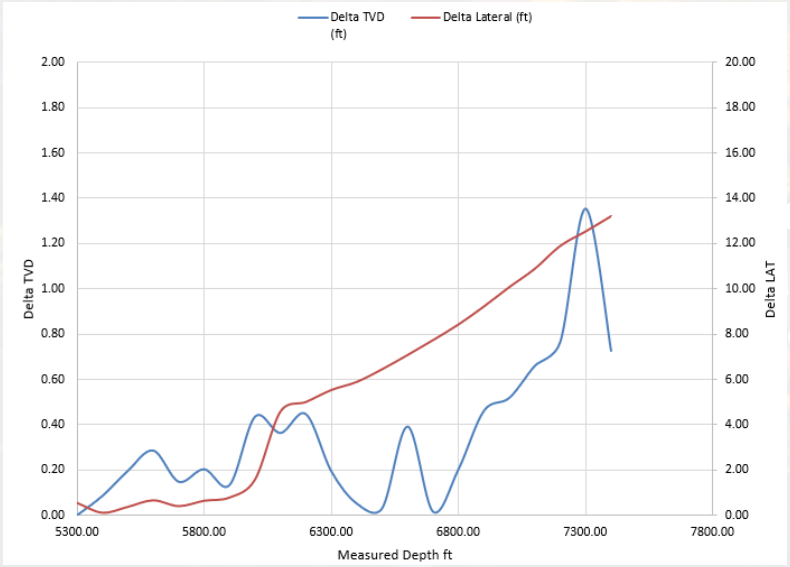
2 hours of rig time savings

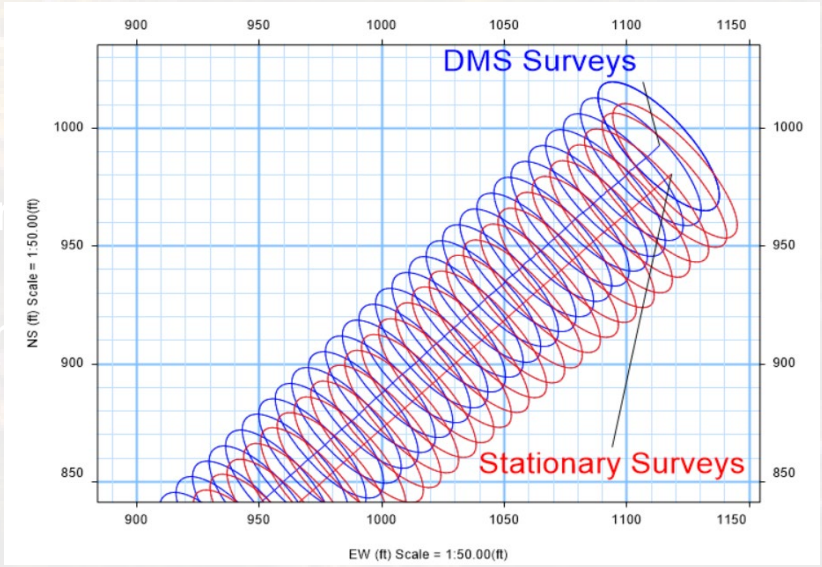


# Case 3 cont.

TVD difference is 0.73 ft

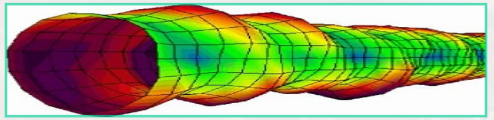
Difference in lateral displacement is 13.18 ft



# Summary

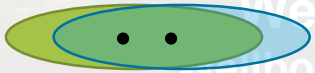
DMS are taken while drilling, drill pipe moving/rotation



DMS are definitive surveys with MWD-STD accuracy and better

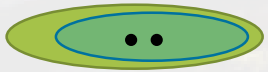
More frequent surveys better define the wellbore trajectory





Full EOU enclosure with MWD-STD error model

$ ILT - Rig Time Savings



DMS surveys are anticipated to have tighter EOU with ISCWSA rev5 for sections with high DLS

$ NPT - Minimize differential stuck risk and reduce LIH/ST cost

# Thank You

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Q&A
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