Cleaning Drilling Fluids for Magnetic Debris and its Consequence for Surveying

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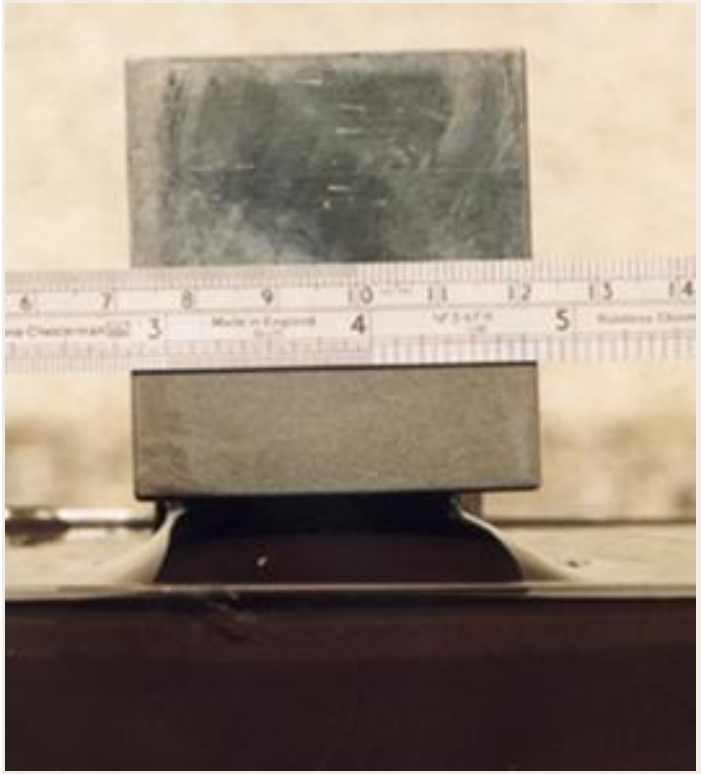
Content

- How to clean drilling fluids for magnetic debris
  - Methods
  - Challenges
- Cleaning results from North Sea fields
- Effect on directional measurements
  - The Ivar Aasen field

Why do we want to remove magnetic material from the drilling fluid?

- Removal of swarf
  - Swarf can agglomerate on downhole tools and BOP
  - Swarf in the flow will create erosion on pumps and tools
- Removal of magnetic fines
  - Improve logging – Better signal to noise ratio
  - Improve directional drilling
  - The magnetic steel fines agglomerate on down-hole tools

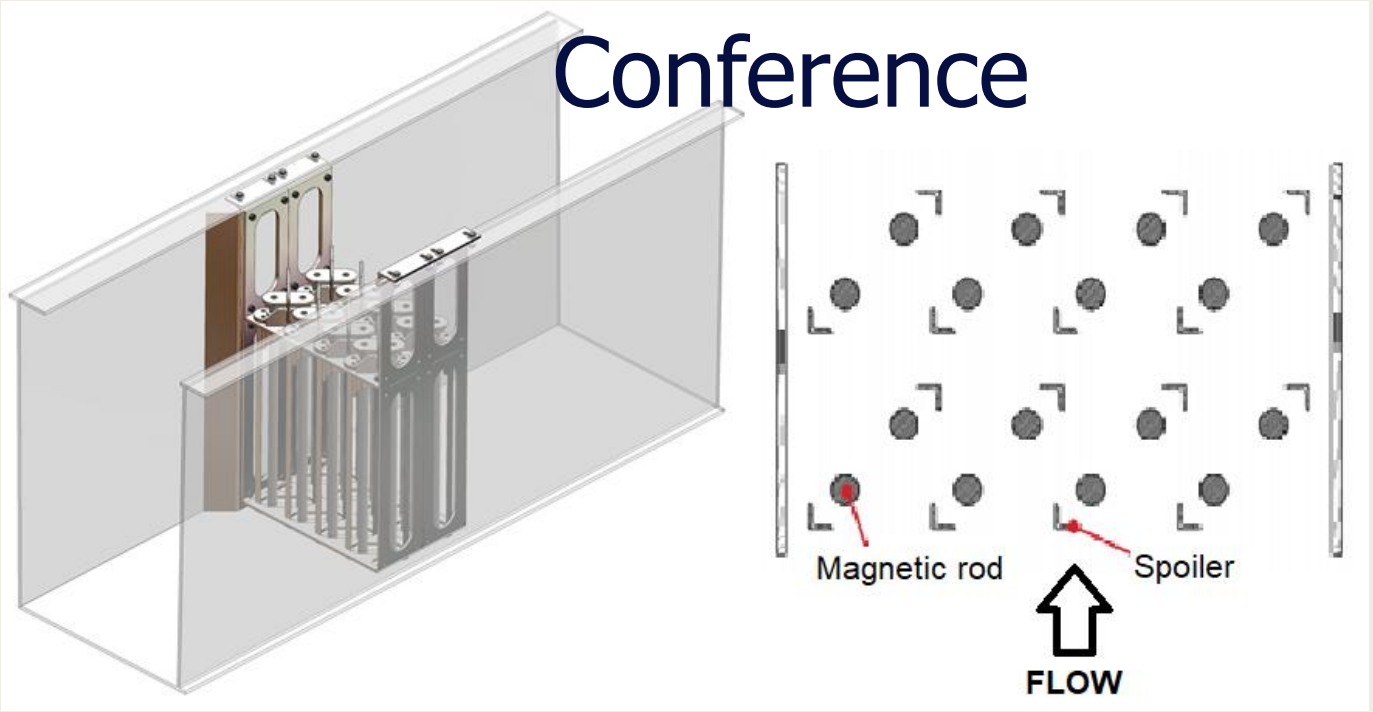
How do we clean the drilling fluid for magnetic contamination?



- Use ditch magnet systems (normally) upstream the shakers
- Traditional ditch magnets are normally capable of extracting only larger particles like swarf
- Magnetic fines are very difficult to remove

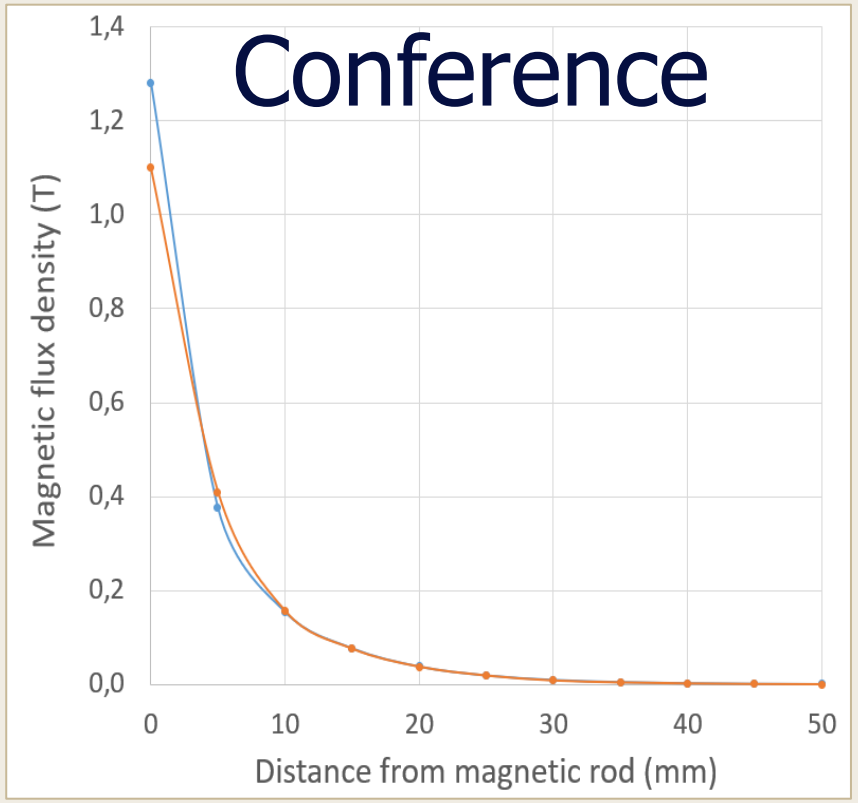
How do we clean the drilling fluid for magnetic contamination?

- To be able to remove smaller particles it is necessary to
  - Modify the flow to reach the very near vicinity of the magnets
  - Use strong magnetic rods
  - Clean the magnets at sufficiently short intervals
  - A good cleaning system is required



How to remove magnetic contamination

- Utilize a special designed ditch magnet system
- Very strong magnets
  - 1.2 T at the magnetic rod surface
  - The field strength decays rapidly with distance
- Strong magnetic field is required
  - "Gel forces" can be larger than the magnetic forces
- Removal of smaller particles requires;
  - Modify flow to reach the near vicinity of the magnets
  - Use very strong magnetic fields
  - Clean the magnets at sufficiently short intervals

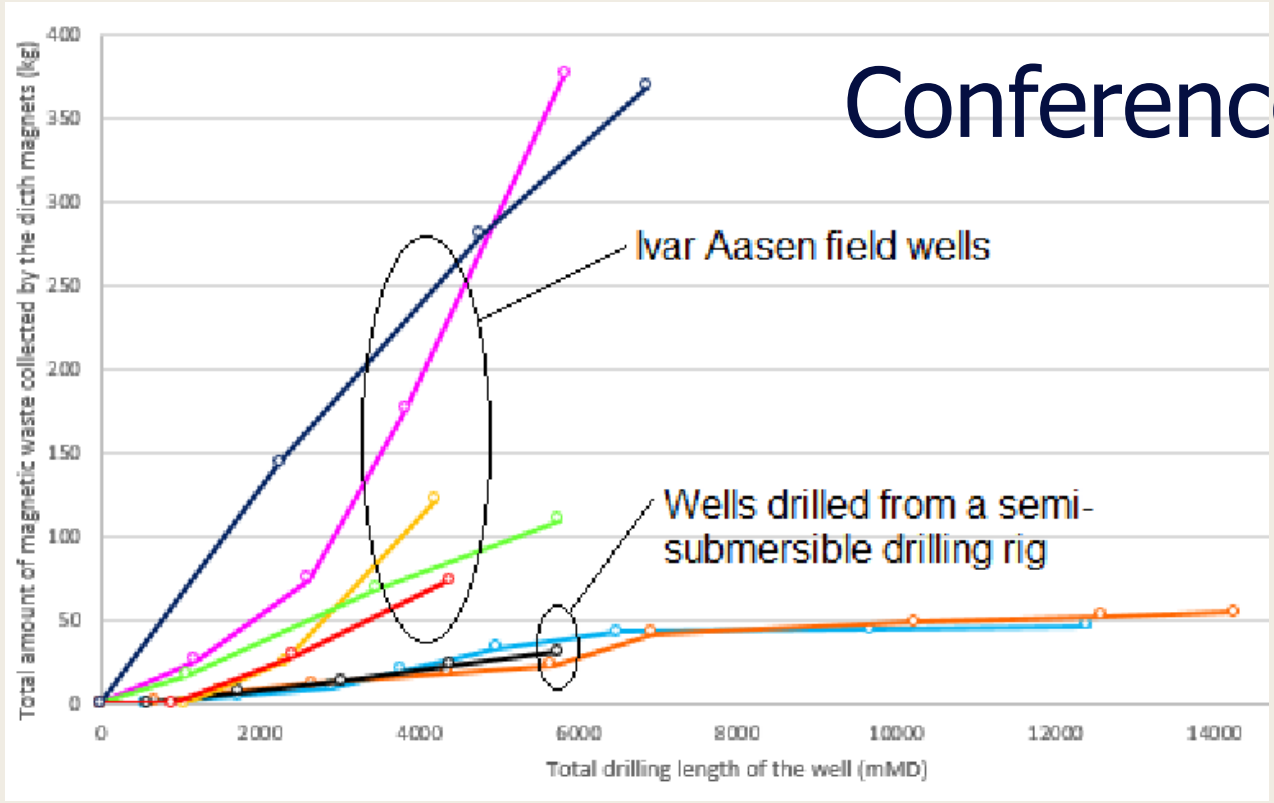


What were the operational results from the Ivar Aasen (SPE-195721-MS)

- Flow field position ditch magnet system
  - Easy to clean with proper cleaning procedures
  - Significantly improved efficiency compared to use of simpler systems
- Logging results at Ivar Aasen field
  - No need to pull out of the well the replace or repair tools
  - Unusual good signal to noise ratio in logging tools

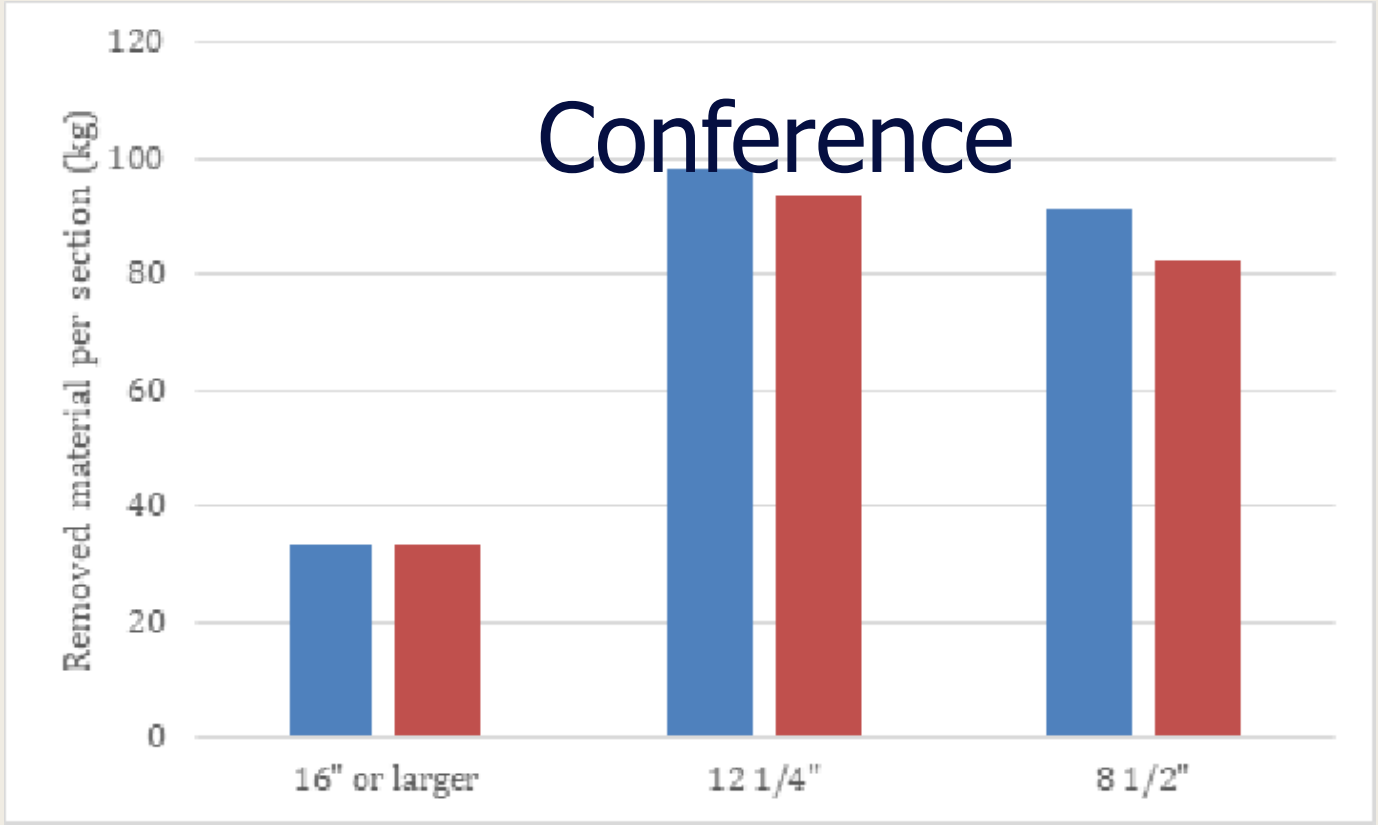
Magnetic fines removal efficiency

- Very high efficiency in removal of magnetic debris



What are the operational results?

- Average removal of magnetic debris per section for the Ivar Aasen field (blue columns) and all wells drilled on Maersk Interceptor (red columns)

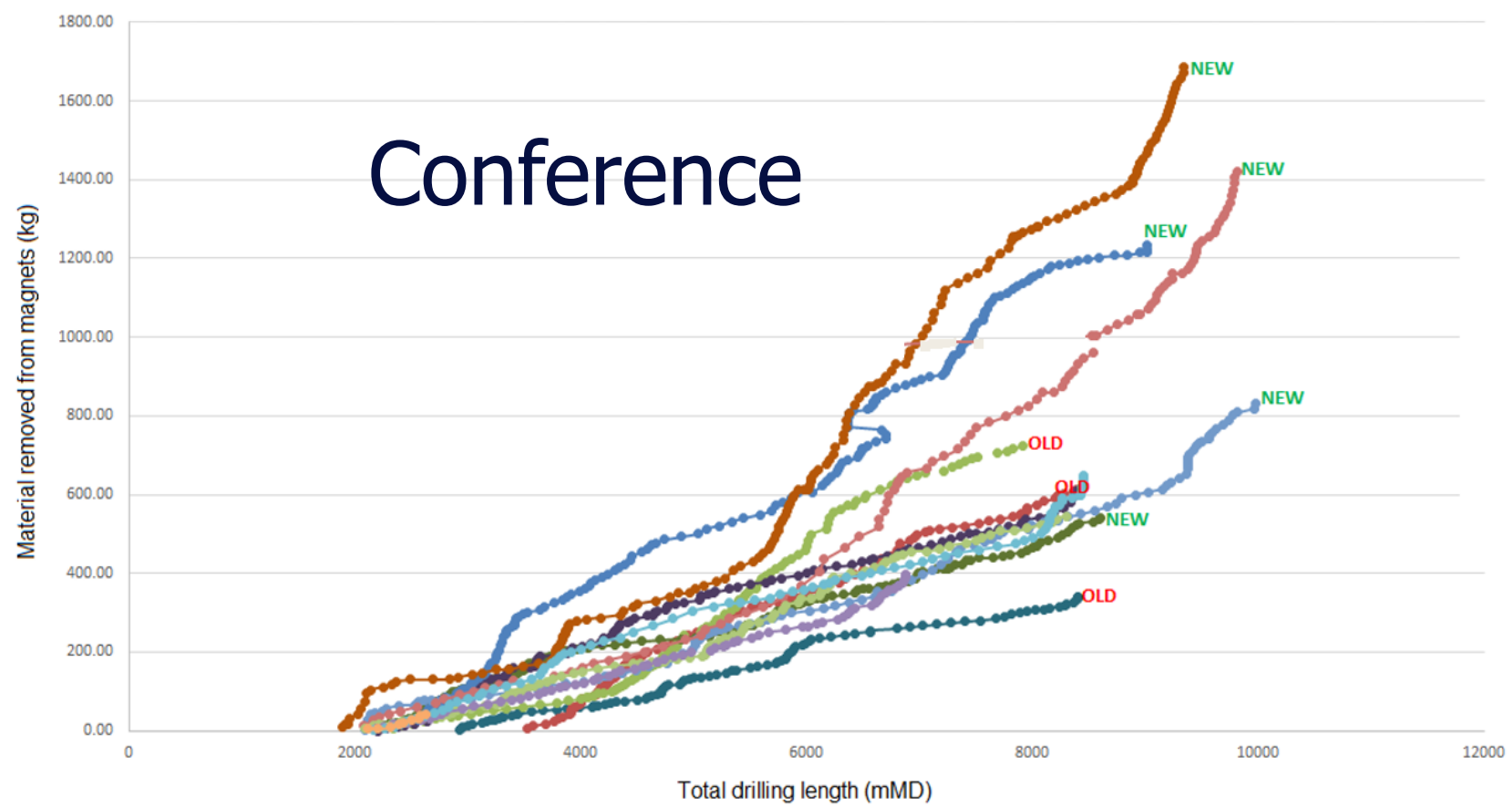


Troll field case (SPE-215604-MS)

- Why was it important to use a very efficient ditch magnet system in this particular well?

- Magnetic Fines hindered proper MWD function in previous well
  - The magnetic clutch in the turbine powered communication module was stuck
  - Magnetic fines together with sticky clays agglomerated on downhole tools hindering the tool function.

Troll field case (SPE-215604)

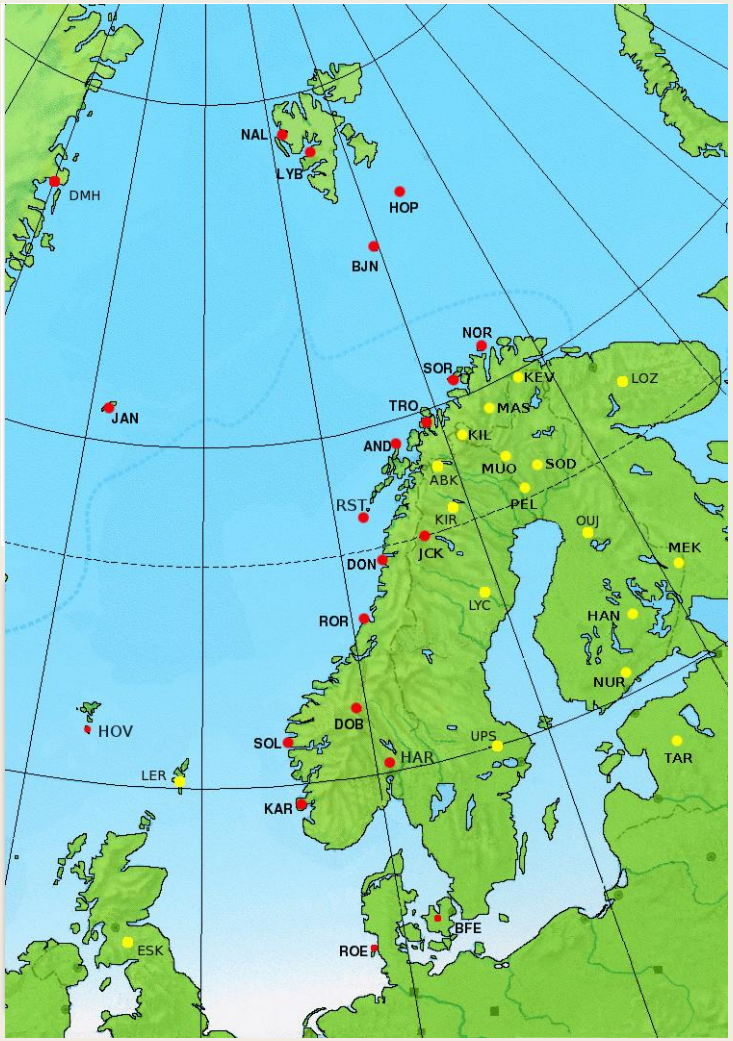


- 6628m drilled in a single bit run
  - Removal of magnetic fines was important
- Operators in the US
  - Removal of large quantities of debris

Directional drilling challenges – error sources

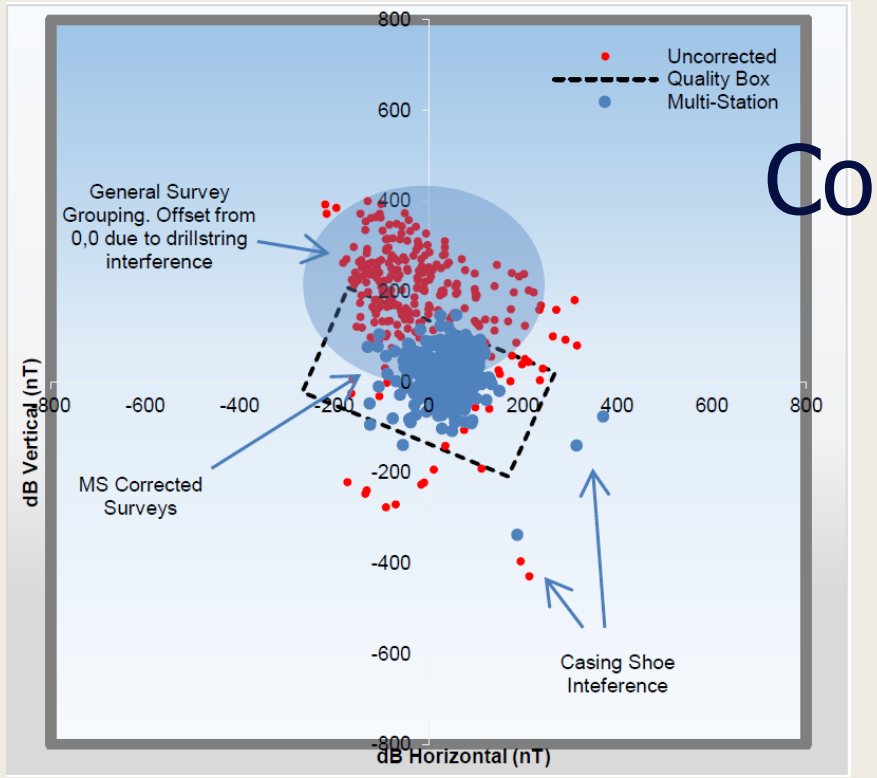
- Surveying in Ivar Aasen, Arctic Challenges
  - Gyro - Reduced Earth Spin Rate increases error
  - MWD - Smaller Horizontal Magnetic Field increases error

- Control Sources of Magnetic Error
  - Declination Errors – IFR2
  - Drill-String Interference – Non-Mag BHA
  - **Contaminated Mud Shielding – proper mud cleaning**

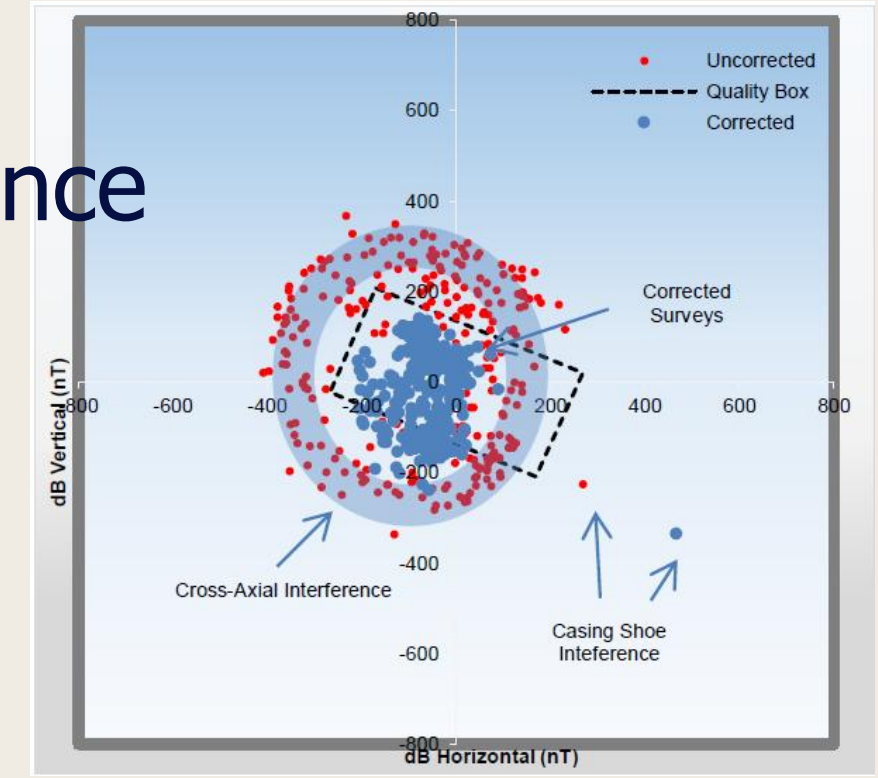


MWD Pump-On response in Arctic Region

- Drill-String Interference



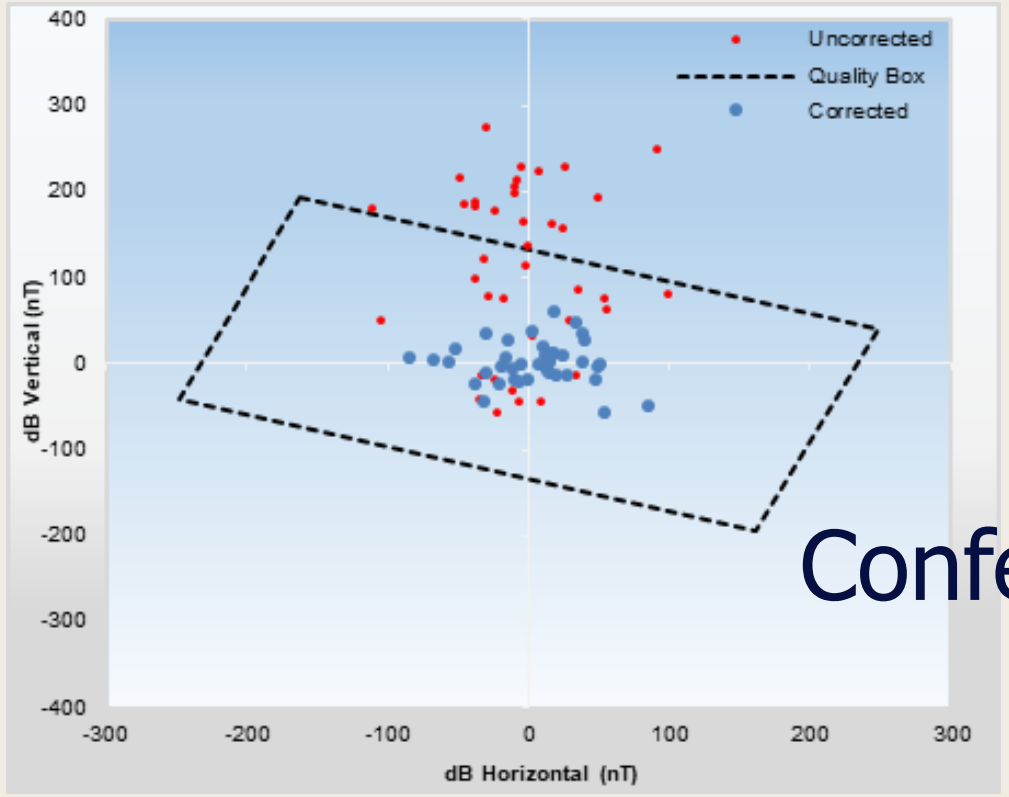
- Cross-Axial Interference

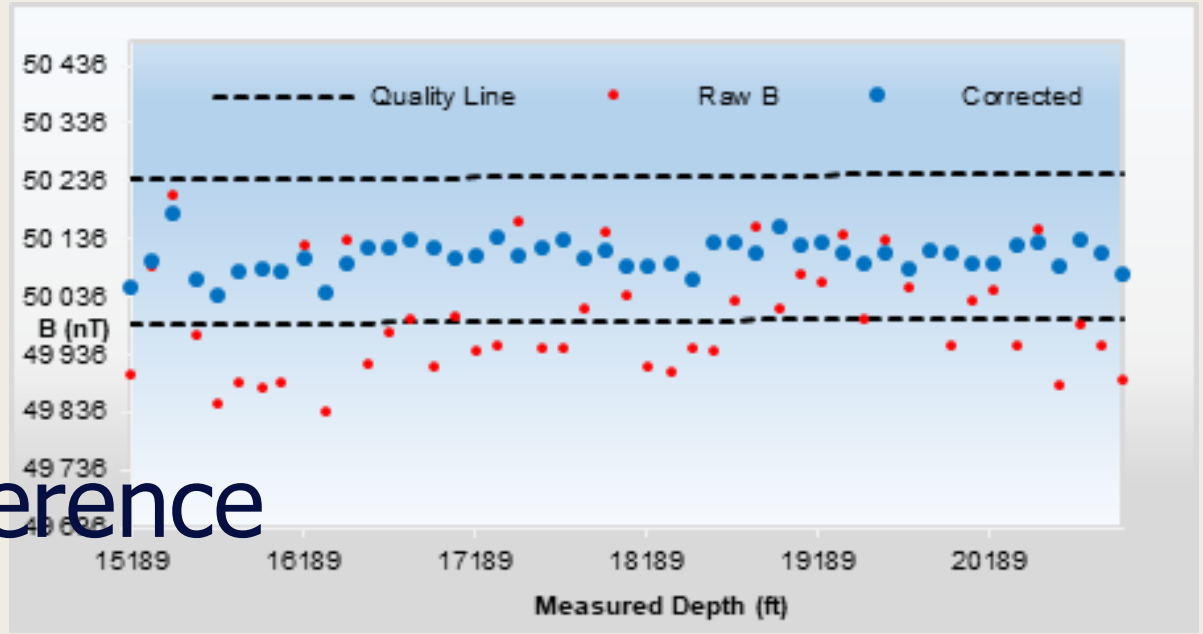


Conference

MWD Pump-ON response in a North Sea well

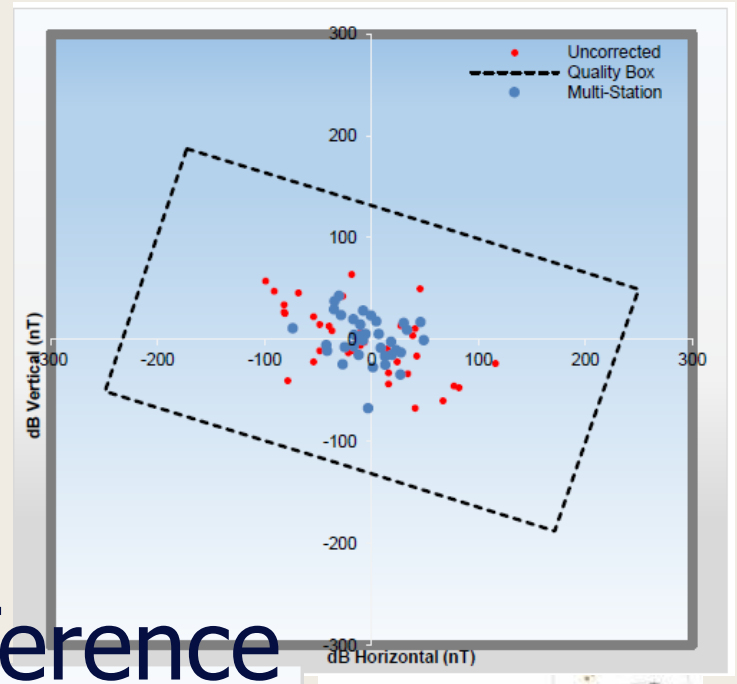
Drill-string and Magnetic-shielding





MWD Pump-On response in Ivar Aasen Field

- Overcome Drilling Challenges
  - IFR2 – reduce declination error
  - BHA Design – non-mag spacing
  - Flow modified ditch magnets – remove magnetic debris from mud
- Clean MWD signature gives confidence in directional drilling control



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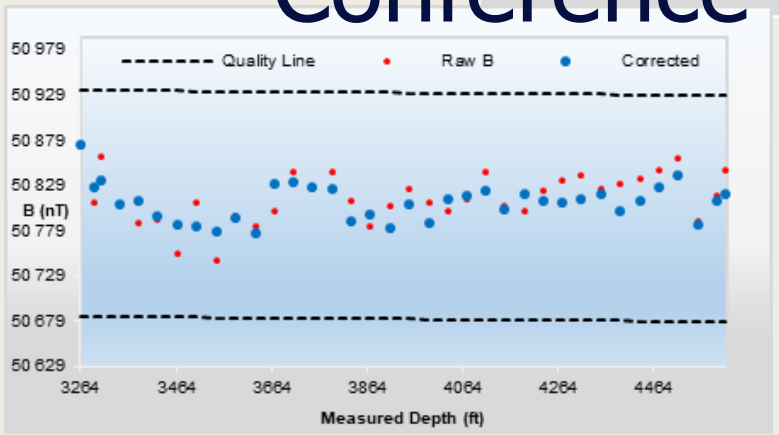

Conclusion

- Flow modified ditch magnets improved magnetic debris removal from drilling fluids 3-7 times
- Directional Drilling Challenges Overcome with confidence in magnetically clean mud on the Ivar Aasen field

More data:

- **https://doi.org/10.1115/1.4049290**
- SPE-195721-MS
- SPE-215604-MS
- This year’s AADE conference on April 15-16

Thank You!