

The background of the slide is a photograph of several offshore oil rigs in the ocean. The rigs are silhouetted against a blue sky with some clouds. The water in the foreground is dark blue with some whitecaps. The overall color scheme is monochromatic, using various shades of blue.

Application of continuous multi-axes sensor data for navigation

Ross Lowdon, Junichi Sugiura, Adam Bowler ISCWSA # 37 Paris 2013

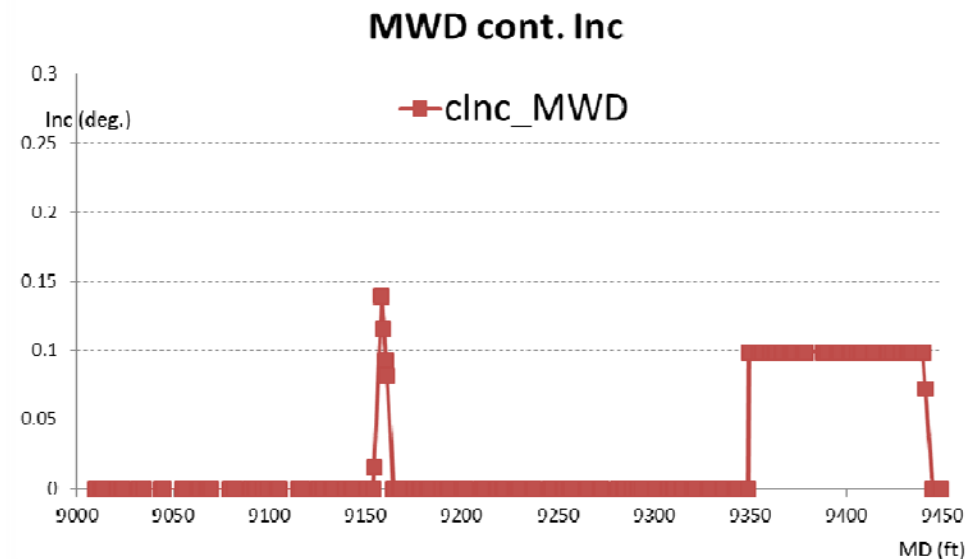
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Agenda

- Defining the continuous surveying issue
- Taking continuous 6 axis surveys
- Field test results
- Further work

Defining the continuous surveying issue

- Low inclination instability
 - Single axis measurement
 - Axial accel cannot measure accurate inclination
 - Swamped by Gravity field
 - Tends to “jump” inclinations

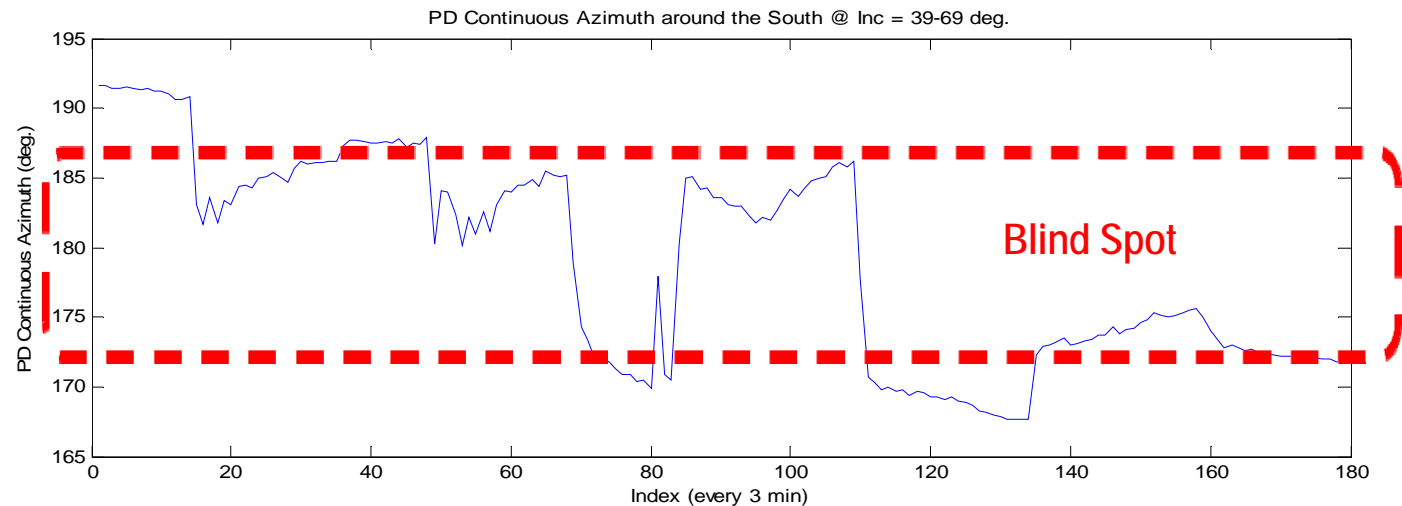


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Defining the continuous surveying issue

- North South Azimuth instability
 - Single axis measurement
 - Axial Mag cannot accurately measure Mag North
 - Swamped by Earth field
 - Tends to “jump” Azimuths

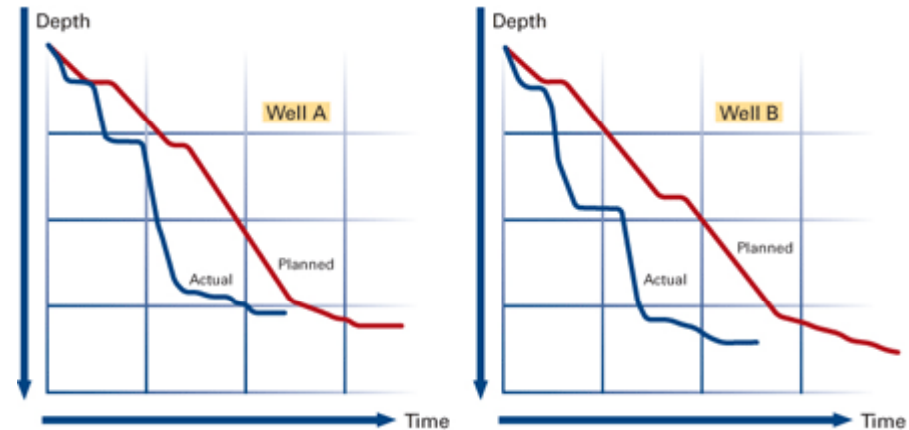


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Impact of single axis sensitivity

- Additional static surveys required
 - Rig time
 - Wellbore stability
 - Directional control
 - Well construction costs



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Continuous 6 Axis surveys – How?

- PowerDrive RSS

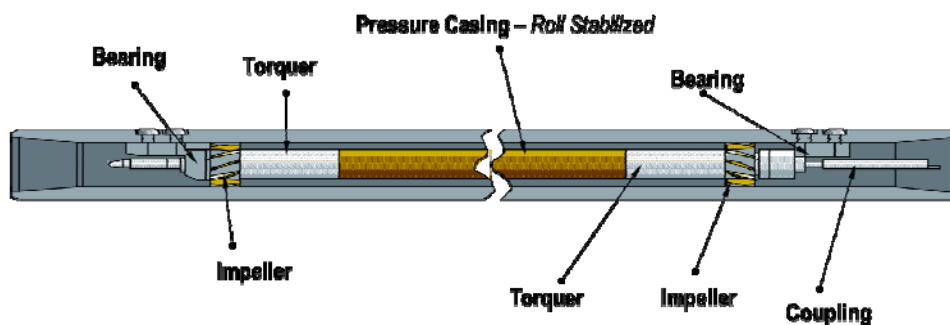
- Non/Controlled Rotating D&I
- Magnetically Clean RSS
- Standard and tweaked Equations

$$Azimuth_{all} = \arctan \left(\frac{(G_x B_y - G_y B_x) \cdot \sqrt{G_x^2 + G_y^2 + G_z^2}}{B_z (G_x^2 + G_y^2) - G_z (G_x B_x - G_y B_y)} \right)$$

$$SignAzi = \text{sign}(G_x B_y - G_y B_x)$$

$$Dip = \arcsin \left(\frac{G_x B_x + G_y B_y + G_z B_z}{G_{tot} B_{tot}} \right)$$

$$AngleX = \arctan2((G_x B_y - G_y B_x), (G_x B_x + G_y B_y))$$

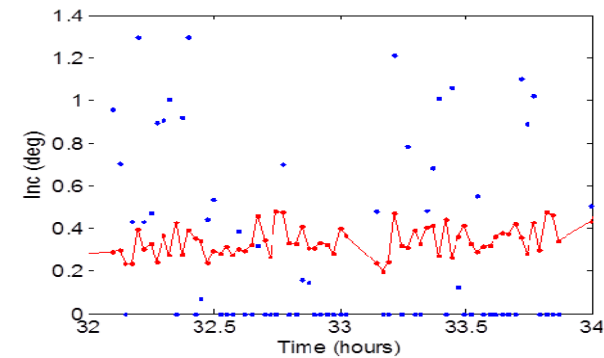


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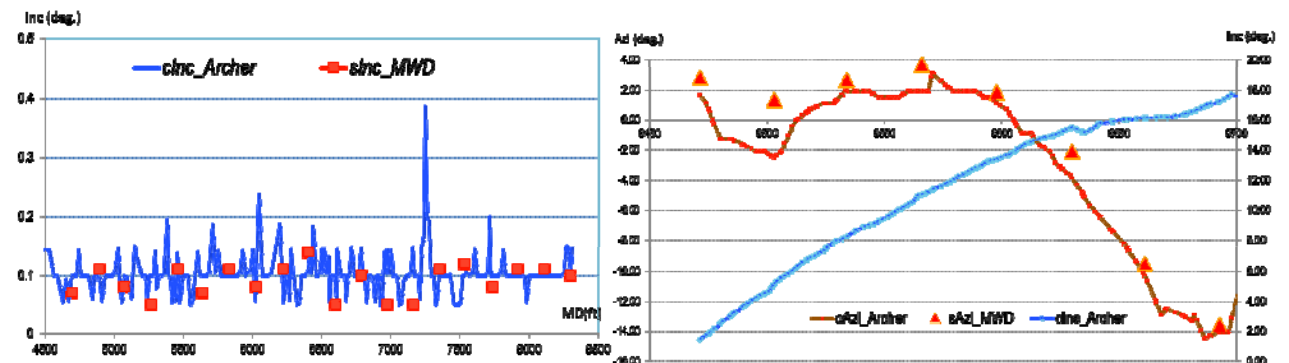
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Field Test Results – Low Inclination

- Improved Inclination definition



- Accuracy?

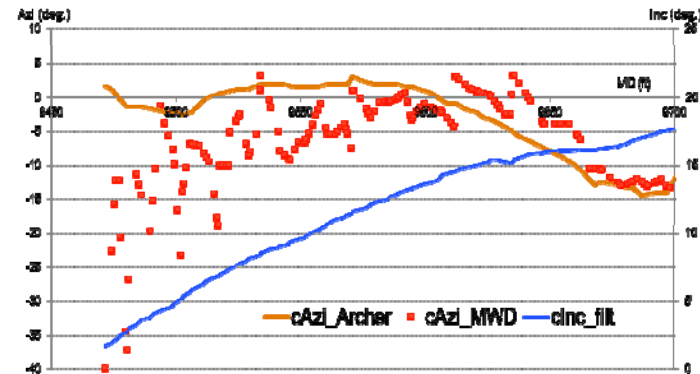


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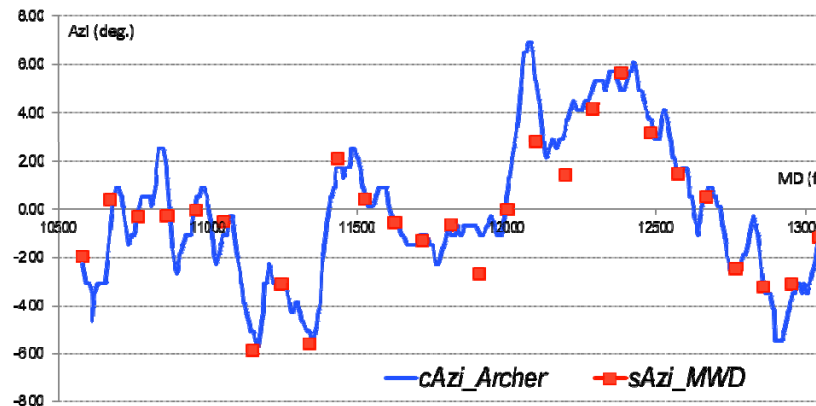
Field Test Results –Azi North/South

- Improved azimuth definition



- Accuracy?

- Modelling required
- MWD reference
- No MSA reduction



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Going Forward

- Further FT required
 - More MWD comparisons
 - Independent Gyro confirmation
 - Azimuth offset to be solved
 - Ensure compliance with MWD std error model
- Develop this for MWD surveys?

Some Questions

- How would you like the D&I values validated?
- Uses for continuous 6 axis surveys
 - Vertical kick off?
 - DD control N/S
 - ???