Application of continuous multi-axes sensor data for navigation

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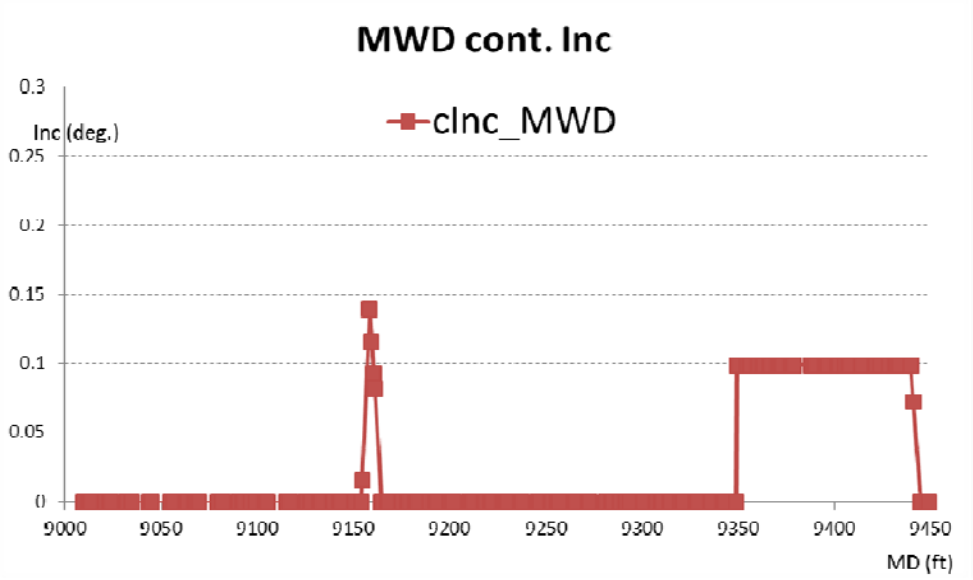
Agenda

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

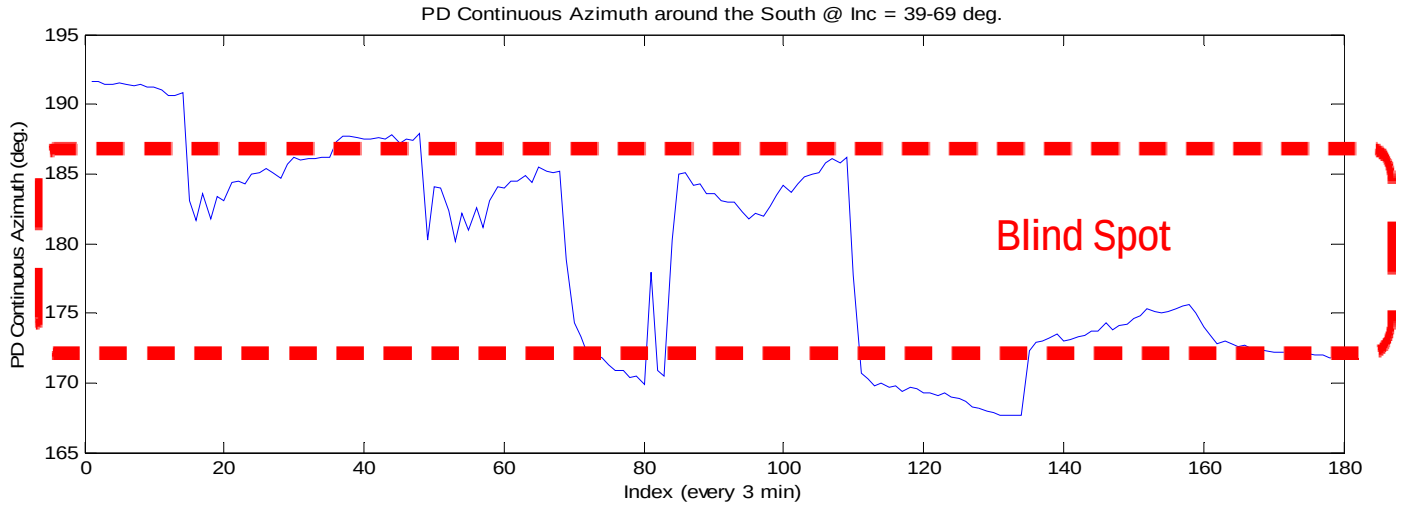
Defining the continuous surveying issue

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



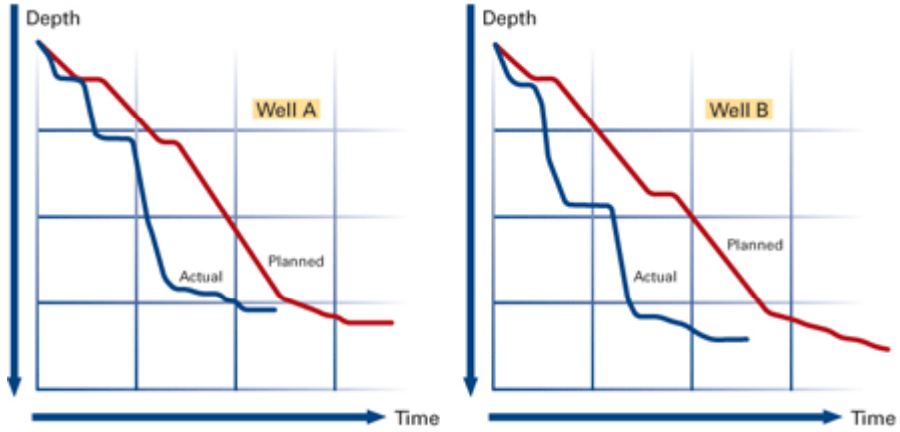
Defining the continuous surveying issue

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



Impact of single axis sensitivity

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



Continuous 6 Axis surveys – How?

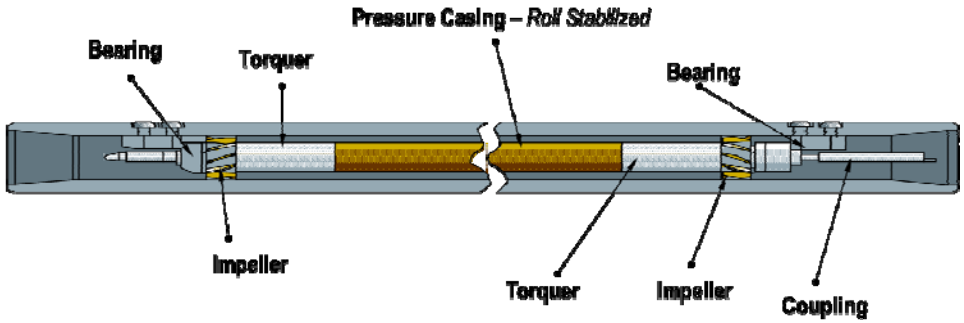
- PowerDrive RSS
  - Non/Controlled Rotating D&I
  - Magnetically Clean RSS
  - Standard and tweaked Equations

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

$$SignAzi = sign(G_x B_y - G_y B_x)$$

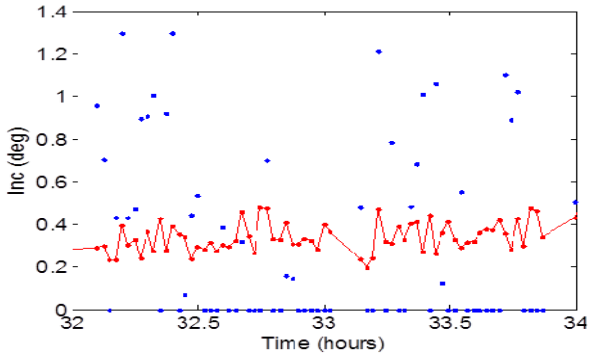
$$Dip = \arcsin\left(\frac{G_x B_x + G_y B_y + G_z B_z}{G_{tot} B_{tot}}\right)$$

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

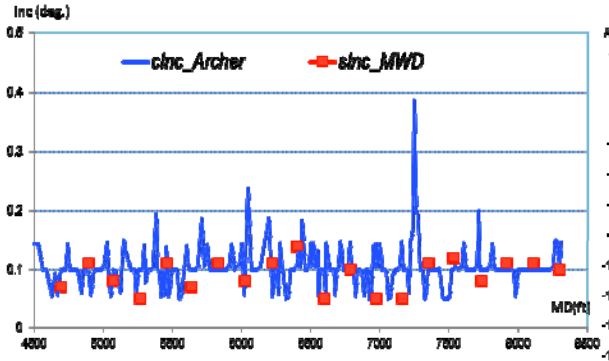


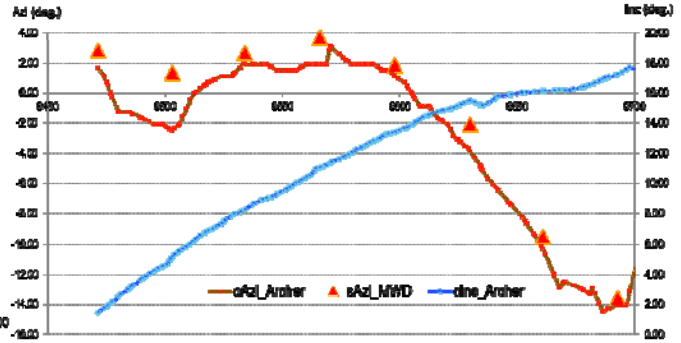
Field Test Results – Low Inclination

- Improved Inclination definition



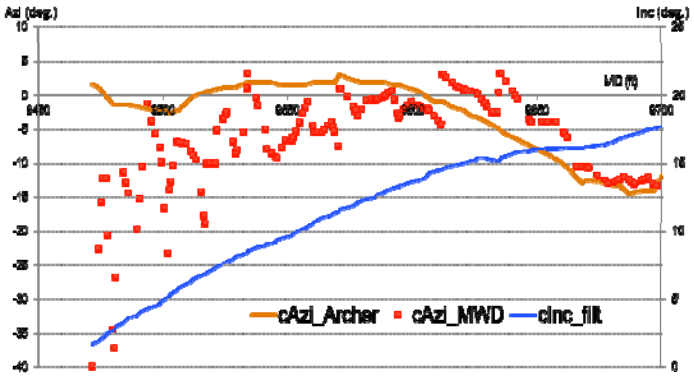
- Accuracy?



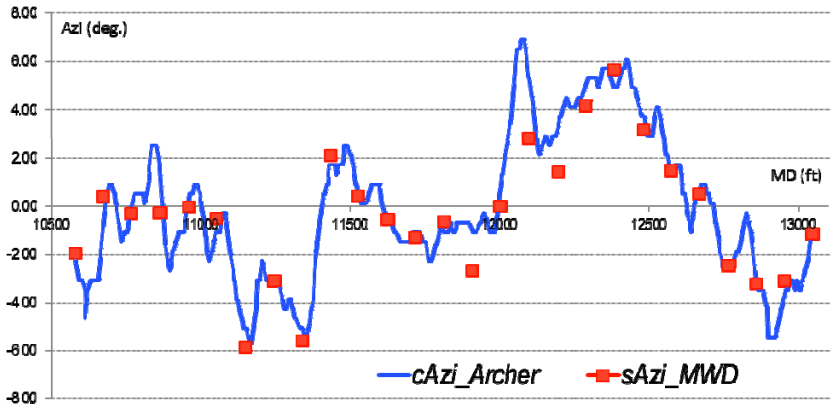


Field Test Results –Azi North/South

- Improved azimuth definition



- Accuracy?
  - Modelling required
  - MWD reference
  - No MSA reduction



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
  - ???