

## Overcoming GWD Inclination Limits

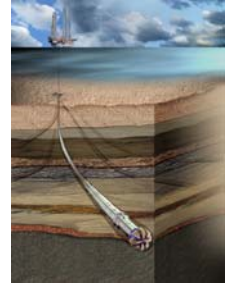
Steve Mullin, Gyrodata Inc.  
SPE WPTS, Florence Italy  
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## Gyro While Drilling (GWD)

- North Seeking gyro sensors located in the BHA
- Utilizes mud pulse or E.M. telemetry to transmit survey information to surface
- Primarily run to replace wireline gyro orientation and steering services
- Originally limited to about 20° inc.



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## Why GWD ? In the Past

- Replaces wireline conveyed orientation and steering
- Used in areas of magnetic interference
- Offers significant rig time savings and increased safety by removing wireline from the drilling operation



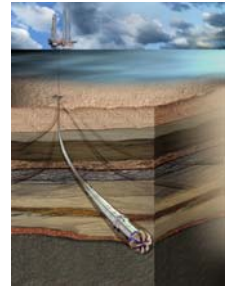
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## Client Driven Development

- Continued calls for GWD capable of working at higher inclinations
- More robust system
- Increased system accuracy
- A survey system that improves the reliability of error models and would detect gross errors in real-time



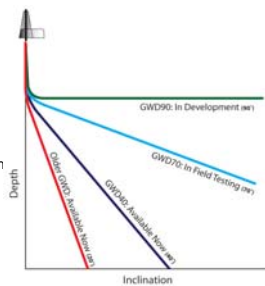
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## Advantages

- High inclination re-entry and sidetracks and new wells
- Improved reliability of error models
- Real-time gross error detection
- In Hole Referencing of magnetic sensors, overcoming need for magnetic field monitoring and referencing
- Multi-shot survey on trip out at section TD
- Combination of gyro and magnetic surveys provide overall accuracy improvement



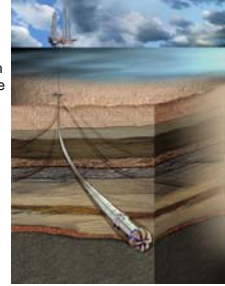
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## Why a GWD Inclination Limit

- Increasing inclination moves the sensitive gyro axis away from horizontal component of Earth rate
- Gravity sensitive error terms effect on azimuth measurement becomes more significant over 20°



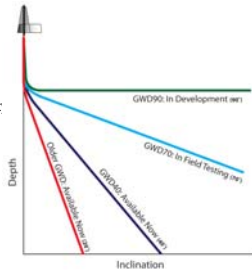
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## GWD40™

- Capable of surveying to 40° inc. by implementing the CAP system firmware
- CAP (Continuous Adaptive Processing) Kalman filter like processing, continuously monitors and corrects for any change in gravit sensitive errors while drilling
- New drilling shock isolation package
- Tool can be switched into multishot mode at section TD
- Data processing enhancements reduce pumps-off surveying time
- Gross error detection in conjunction with MWD magnetic sensors



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## Multishot on TOOH

- Through new communication link tool can be switched to multishot mode at section TD
- High accuracy survey qualifies both MWD and GWD while drilling surveys
- Data improved by MSC (multi-station correction) calculations
- Additional service per run with no increased rig time used may result in elimination of some additional gyro runs



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## GWD70™

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## New Gyro Sensors

- First gyro developed and optimized specifically for oilfield applications
- Larger mass and higher run speed resulting in increased sensitivity
- Improved signal to noise ratio
- Better bias stability
- Increased shock tolerance
- Higher temperature rating
- Complete control of system design, manufacture, calibration, deployment and operation



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## Conclusion

- The inclination limit of GWD is now increased to 70° and all attitude GWD is within sight
- Combination of gyro and magnetic sensors, surveying in real-time while drilling, will enhance the accuracy and reliability of wellbore positioning



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# Thank You

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