Rocky Mountain Section AAPG Meeting
Bakken Play Essentials
September 24, 2005

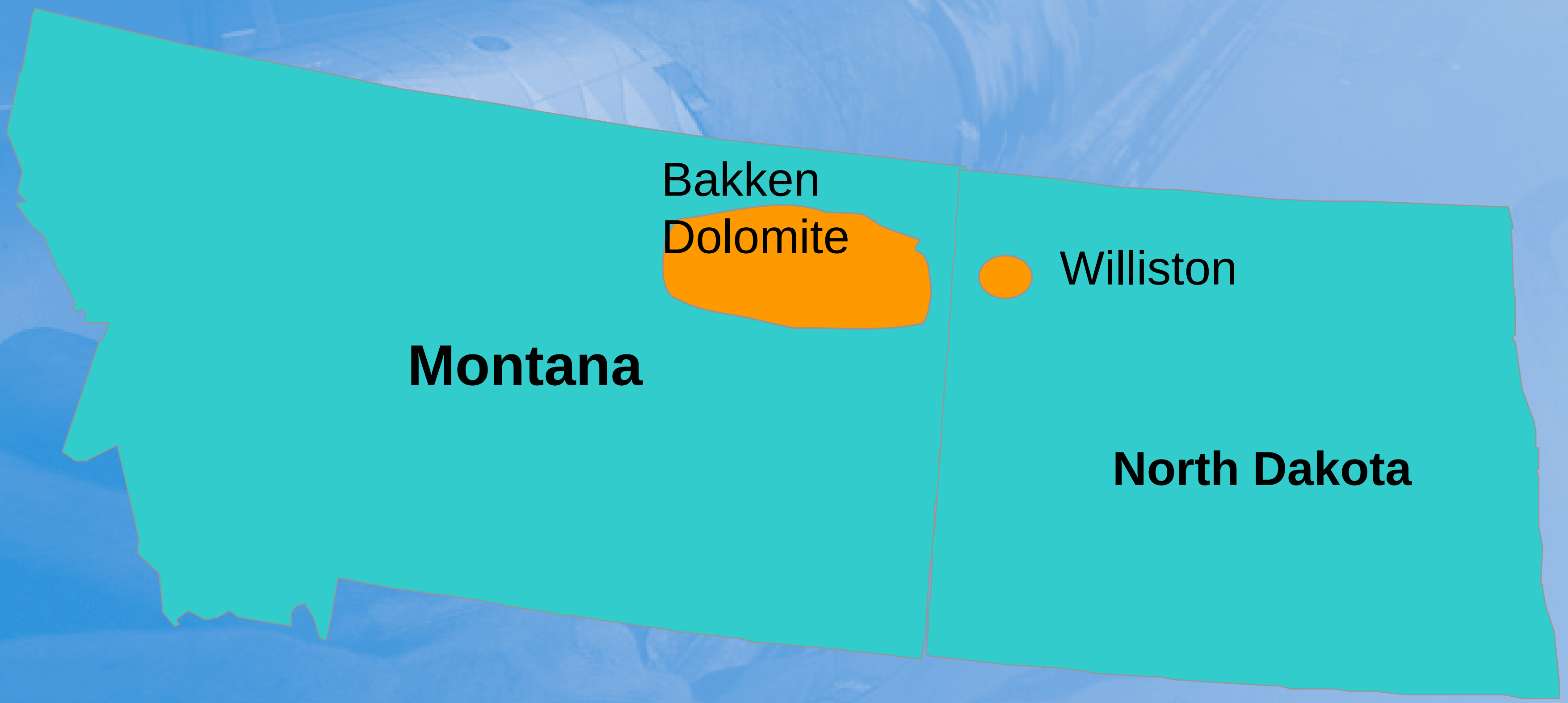
Multilateral Completion and Williston Whipstock Misalignment study

Gary Gill Schlumberger

Ron MacDonald APA

Schlumberger

Bakken Play Eastern Montana Case Example



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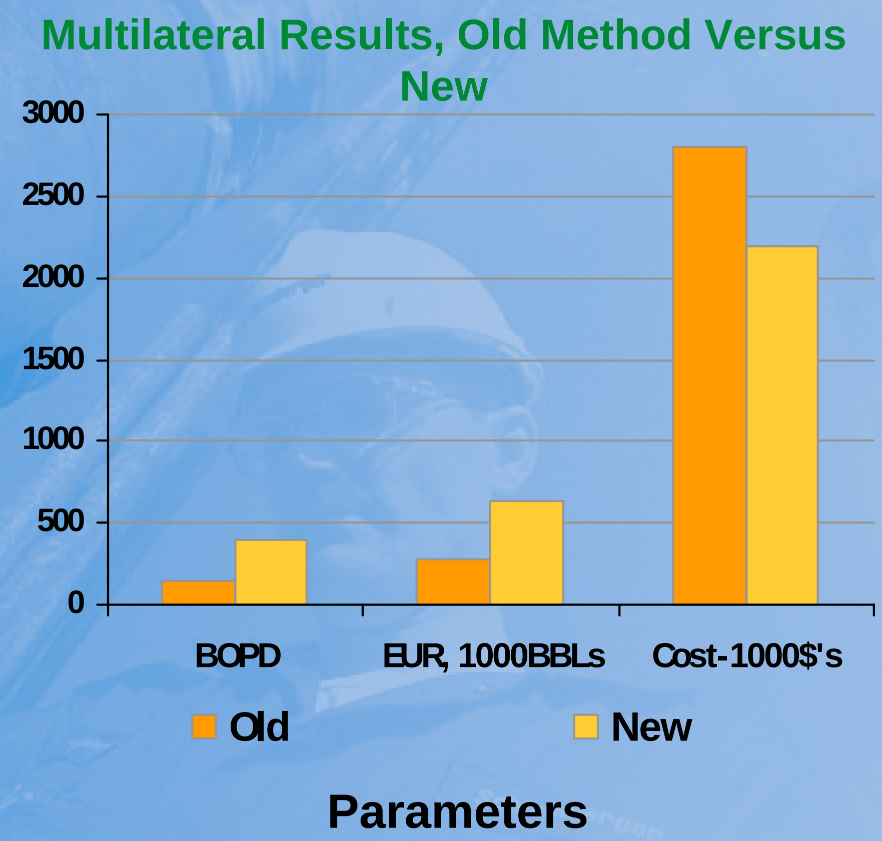
Montana Case Example

- Reservoir description
  - Reservoir pressure: 6,000 psi
  - Matrix permeability: 0.1–0.5 mD
  - Net pay height: 15–20 ft
  - Porosity: 9%
  - Initial water saturation: 70–75%
  - Gravity: 36.0 API
  - Gas/oil ratio: 750 scf/STB
  - Drainage: 320 acres
  - Bottomhole static temperature: 250°F

- The field was a mature one in which the conventional development plan was single lateral or vertical wells.
- The client was looking for an unconventional approach to developing a mature field that could improve economics.
- The new approach was to drill dual 4,000-ft horizontal lateral legs from one main wellbore.

Status Summary of Well/Field

- Operator results and benefits, actual versus historical
  - Production is 390 BOPD versus 150 BOPD, based on a 90-day stabilized rate. Decline is less than 10%, versus 18%.
  - Estimated unrecovered reserves (EUR) are 640,000 bbl versus 280,000 bbl.
  - Actual cost is USD 2.2 million versus USD 2.8 million.
  - Microseismic data show fracture containment and near-heel fracture stimulation.
- As many as six rigs are drilling and installing multilateral systems.

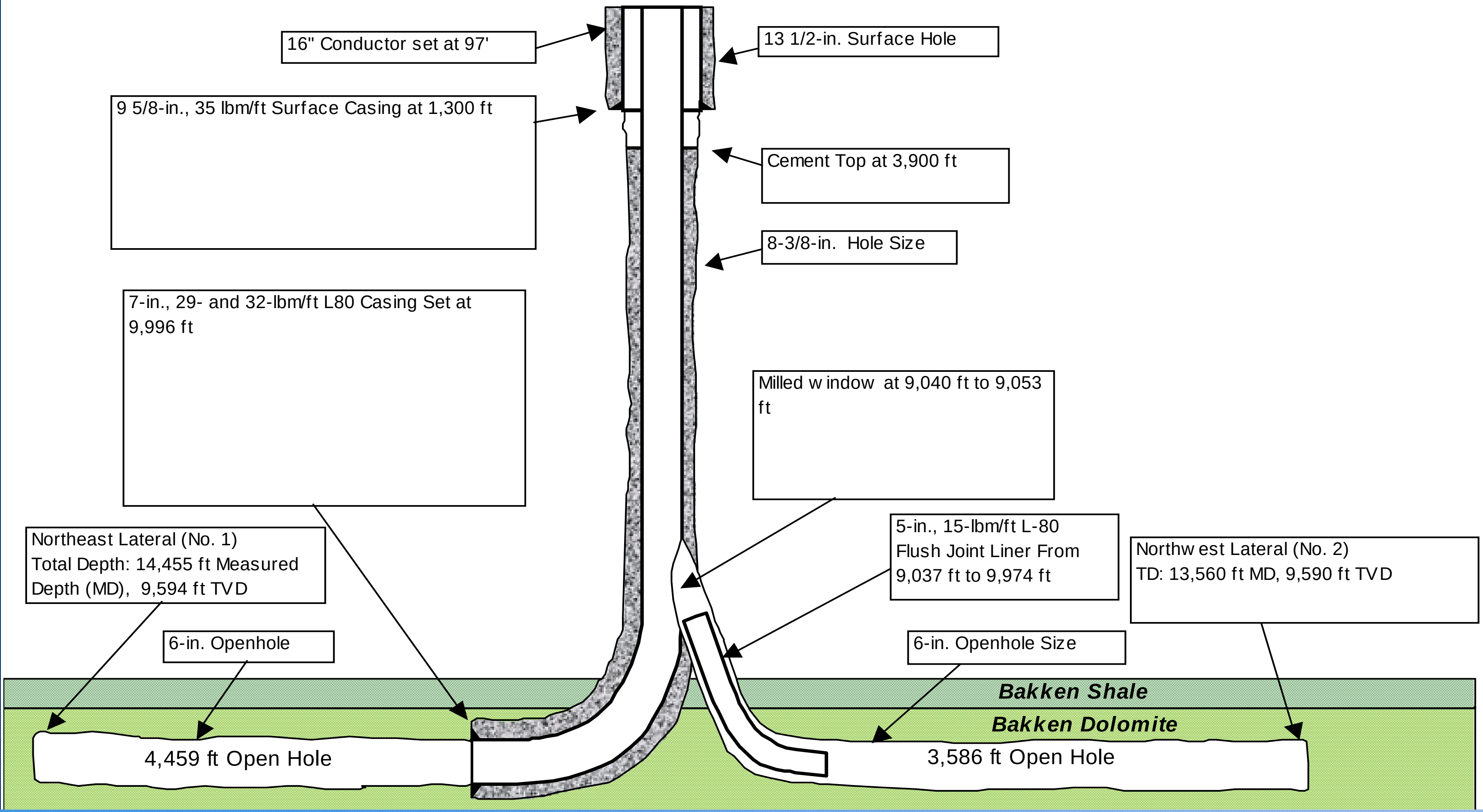


Typical Dual Lateral Bakken Well

Section 18-25N-54E

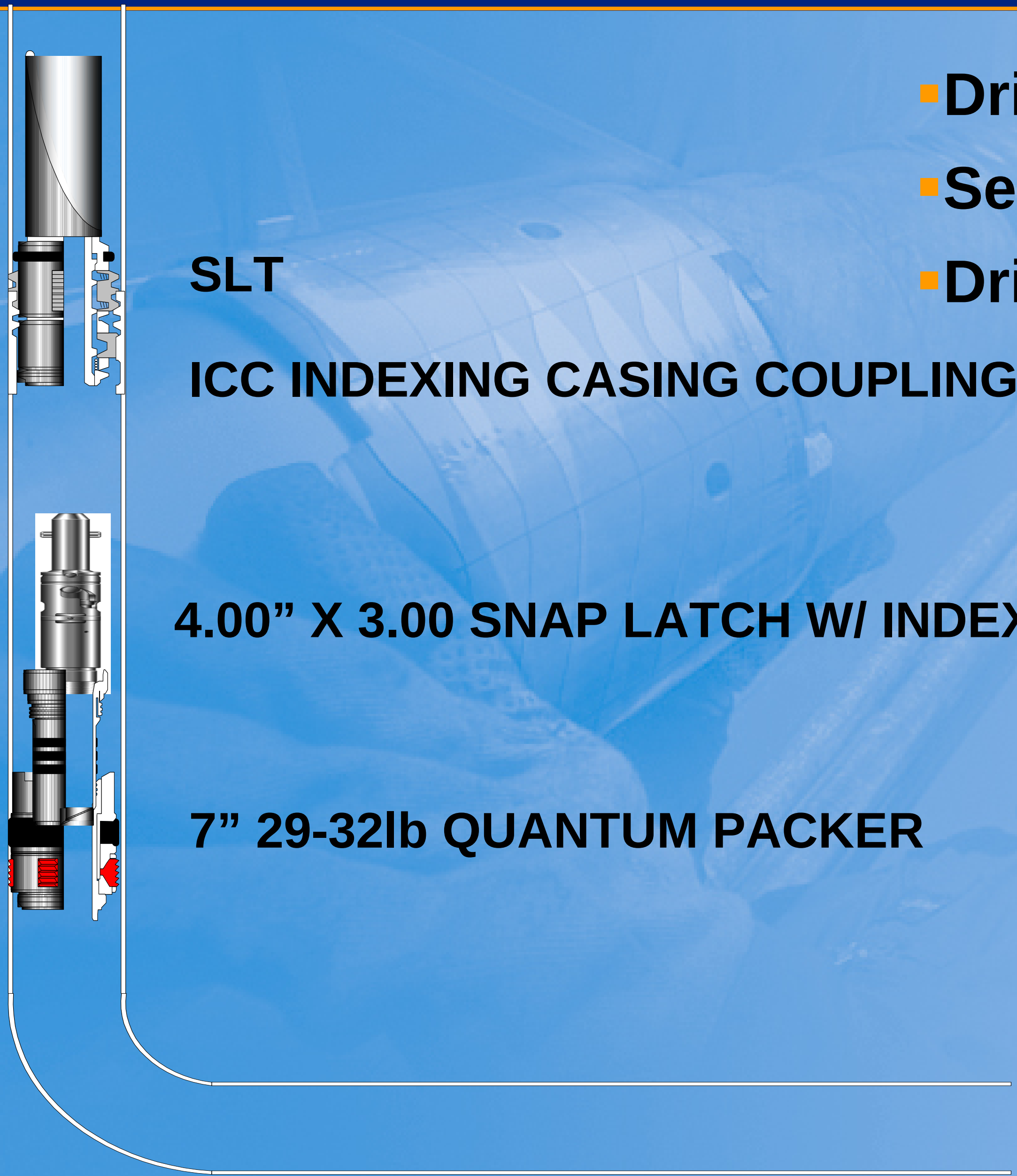
Richland County, MT

Dual Lateral Well Construction Diagram

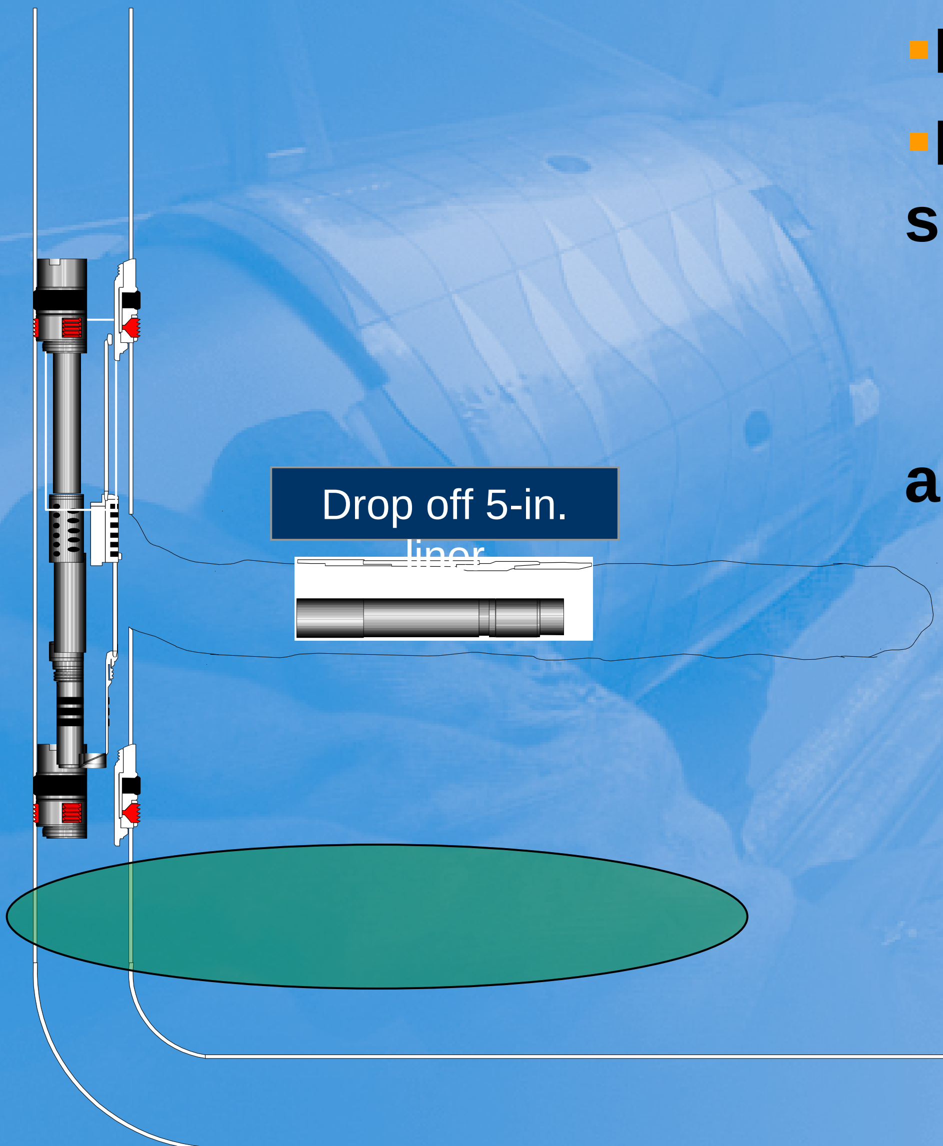


Drill laterals

- Drill lower lateral
- Set Packers and Plug on wir
- Drill upper lateral



Drop Off Liner Assembly

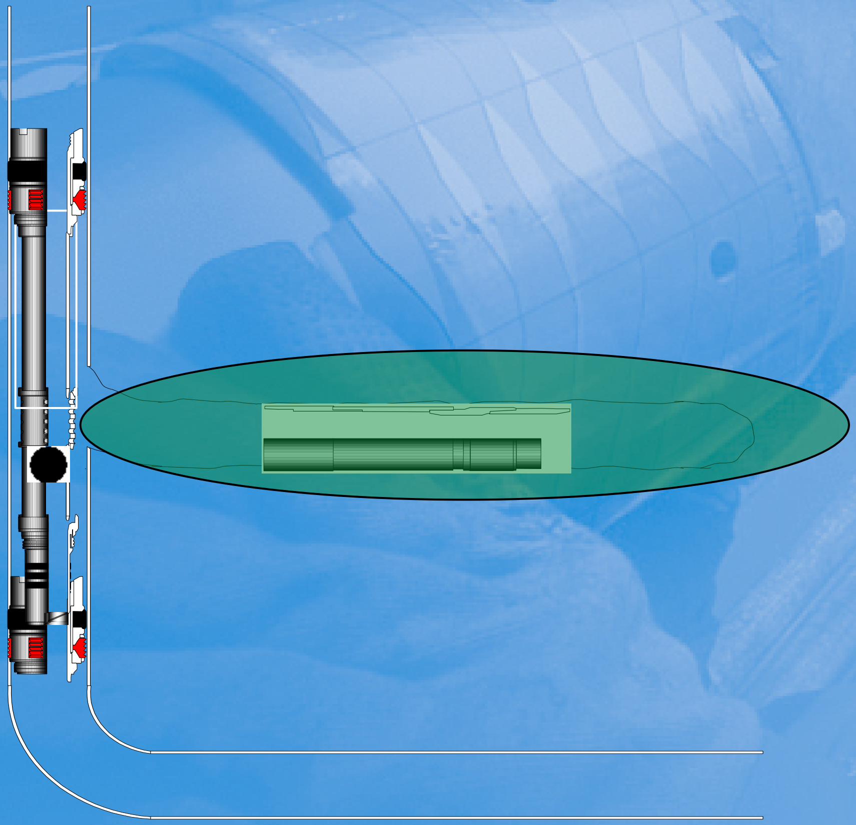


- Run Liner
- Run upper packer and sliding sleeve assembly with hydraulic setting tool, and fracture lower zone

Drop the Ball and Shift the Sleeve

Vision & Goals

Fracture the upper zone



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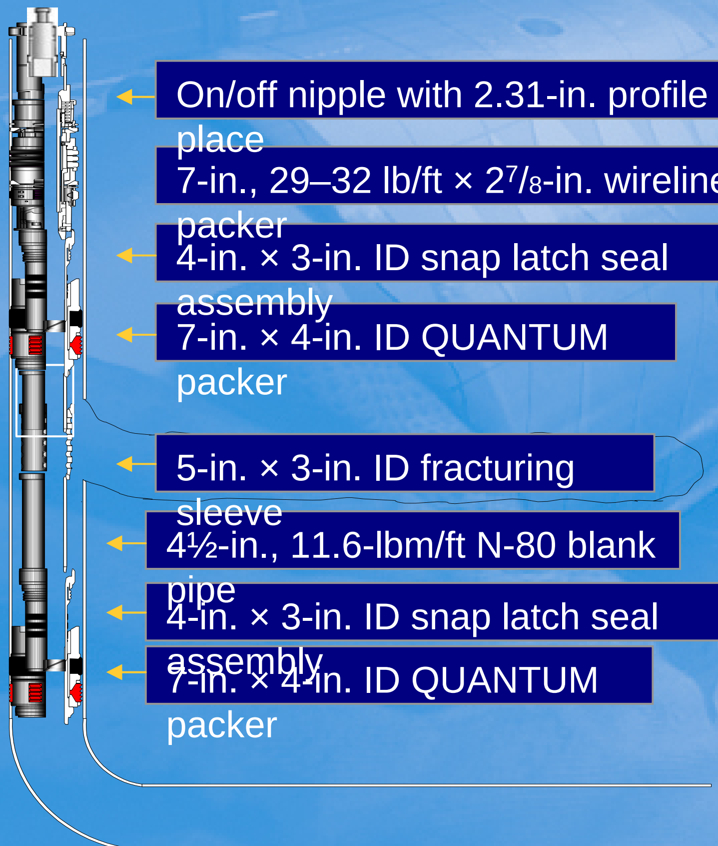
Run Completion Packer On Wireline



Lessons Learned

- 6 hr were saved on each installation by shortening the ICC jetting assembly.
- A two-trip milling operation was considered more time-efficient in the Lodgepole Limestone after experiencing difficulty with a one-trip milling operation attempt.
- The reliability of the whipstock retrieval process was enhanced after the shear force safety release mechanism threshold was increased to 100,000 lbm from 70,000 lbm. This change ensured that the whipstock and CSLT were reliably retrieved in a single trip.

Conclusions

- Teamwork is imperative to successfully plan and reliably install a multilateral well
- A field development plan that includes multilateral well construction can
  – deliver additional reservoir access at incremental cost
  – accelerate recovery
  – be cost-effective in a mature field

Whipstock misalignments

Ron MacDonald of APA Petroleum Engineering Inc.

Gary Gill, Schlumberger

Critical events – 180 degree Whipstock misalignments

- Early 2004, Burlington event
- April 2004, Kerr McGee Corporation
- Questioning Gyro failure
- Discovered two Headington events, Q4 2003
- Problem situation, 4/40 installations, assumed to be Gyro failure (did not make sense)
- Decision to investigate with an independent auditor

Critical events, continued

Kerr McGee second event, during audit

Launched QUEST SQ investigation

Discovered EOG one trip event

Operator B event

Discovered three more for Headington (one trip), Q1 and Q2, 2004

August 2004, Operator C event (one trip)

Eleven misalignment events in Williston Basin (since Nov. 03)

Critical event evaluation

Over 25 exits with Milling Service Company (MSC) “A”, original milling BHA up to Mid 2003 (short Rat Hole), however top 6 to 18 inches of Whipstock was milled off. Concern that a Whipstock would be lost in hole resulted in modifications to BHA. This resulted in other problems.

Burlington : drilled ahead, collided with casing, milled up packer, assumed gyro failure. Had deployed a one trip milling system with MSC”B”.

Critical event evaluation

Vision & Goals

Kerr McGee, deployed MSC “A”’s latest version of BHA to avoid milling top of Whipstock, Drilling BHA surveyed 180 out at bottom of rat hole, back on track in 20 feet or so.

Discovered two more 180 degree exits in 2003 with Headington. One was a Gyro failure, other deemed to be human error by Gyro hand.

Investigation launched.

Kerr McGee second 180 degree event. Cause has not been determined, however mechanical equipment has not been ruled out. Gyro Surveys were good.

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Critical event evaluation

The industry seemed to be assuming that if the drilling BHA could not exit the window once oriented to the window, and had to be rotated 180 degrees to exit the window and get to the bottom of the milled rat hole, the Whipstock had to be set 180 out.

EOG event, utilizing a bottom trip / one trip system MSC “C”. Assumed drill string turned while setting Whipstock

Rumored failure with Operator B

Two more Headington events. One was fixed by reaming the window out, the second by drilling off Whipstock

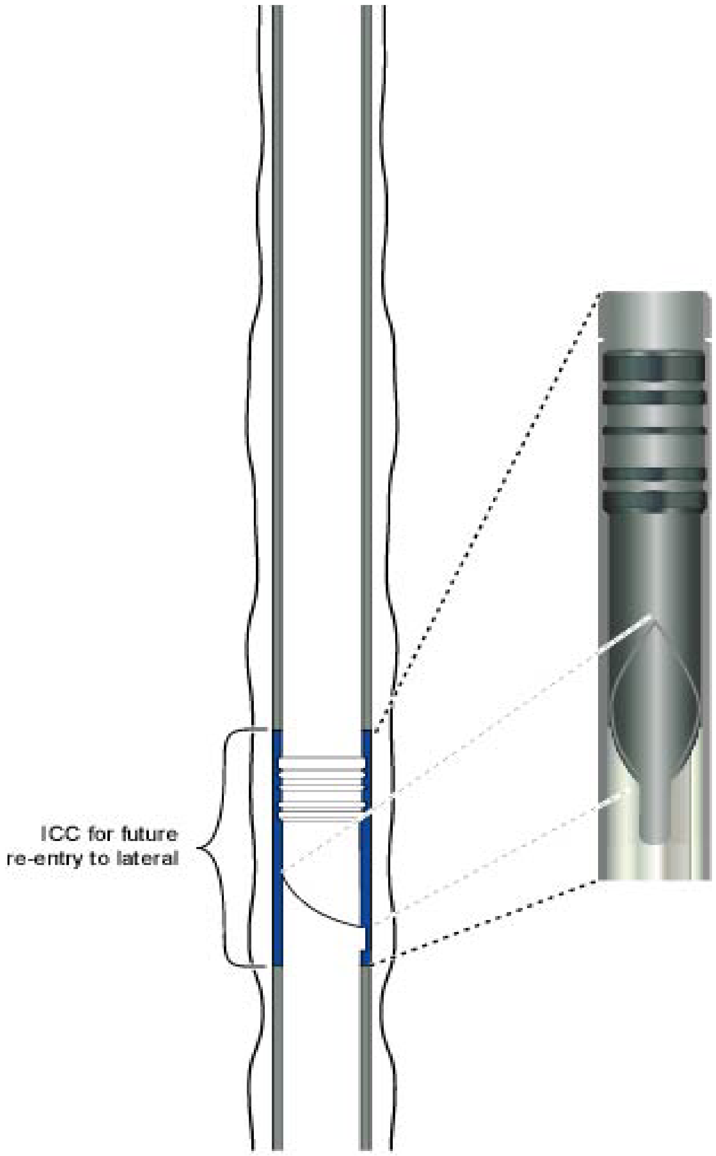
Critical event evaluation

Third Headington event. When Drilling BHA on bottom, the survey read 180 out. Ran hook tool w/ UBHO and surveyed two times that the Whipstock was correctly aligned. Unhooked, ran to bottom, surveyed 180 out.

This was the event that made us look at the window exits and previous job reports.

Running the Indexing Casing Coupling (ICC)

Vision & Goals



Drill the hole section to TD.

Run the appropriate open hole-logging package.

Run coupling in casing string at required depth

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Selective Landing Tool (SLT)

Williston Whipstock Misalignment study

Ron MacDonald of APA Petroleum Engineering Inc. was contracted by Schlumberger to provide an independent evaluation of the Whipstock misalignment problem.

Initial causes of alignment problems where suspected to be procedural, with three service companies involved,Gyro, ML, and Window milling.

Analysis identified multiple possible causes.

Directional Drilling Terms

- Gyroscopic survey (Gyro)
- Azimuth
- High side
- Tool face

Inclination change

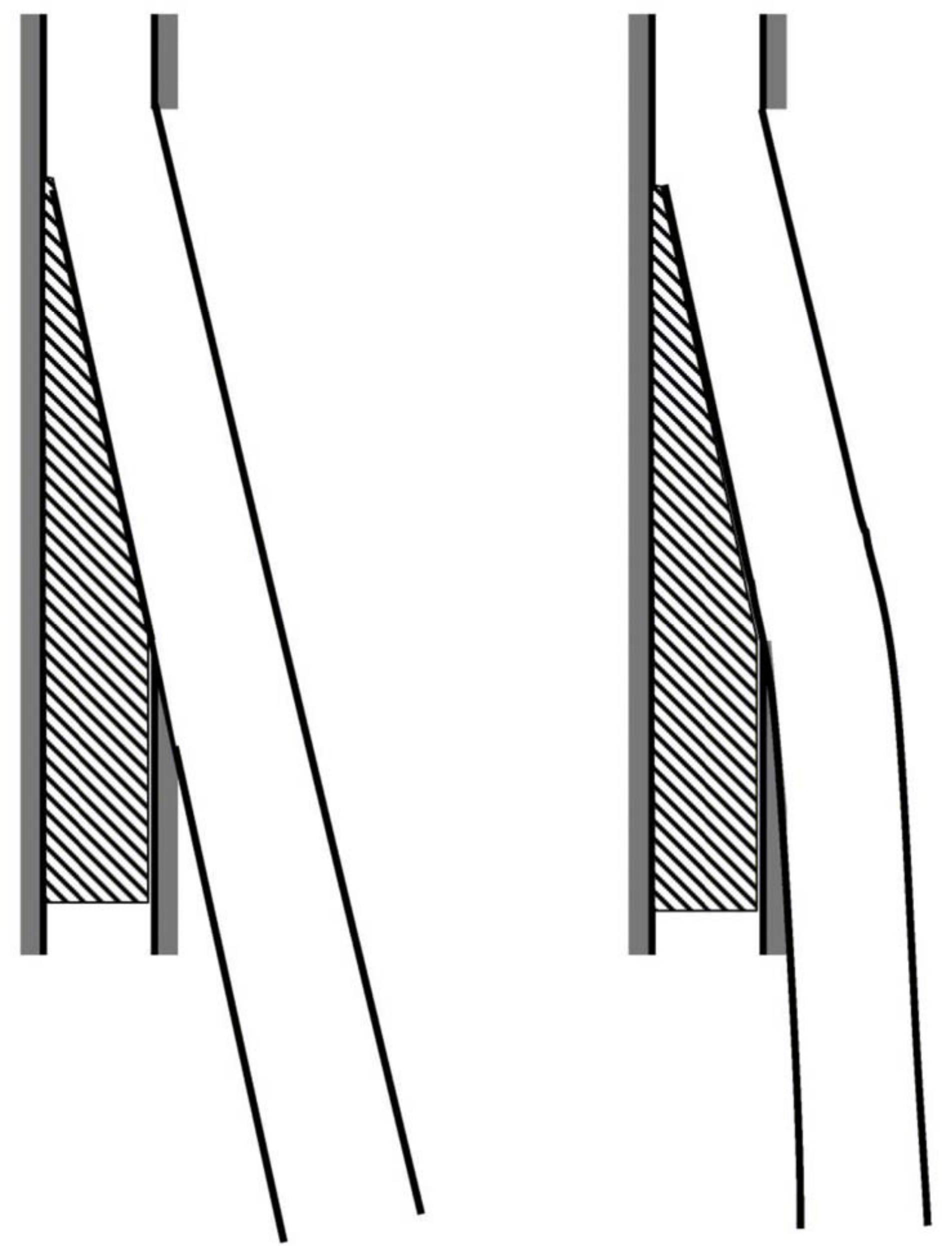

FIGURE 4 Steinbesser 21-23H Window Section View

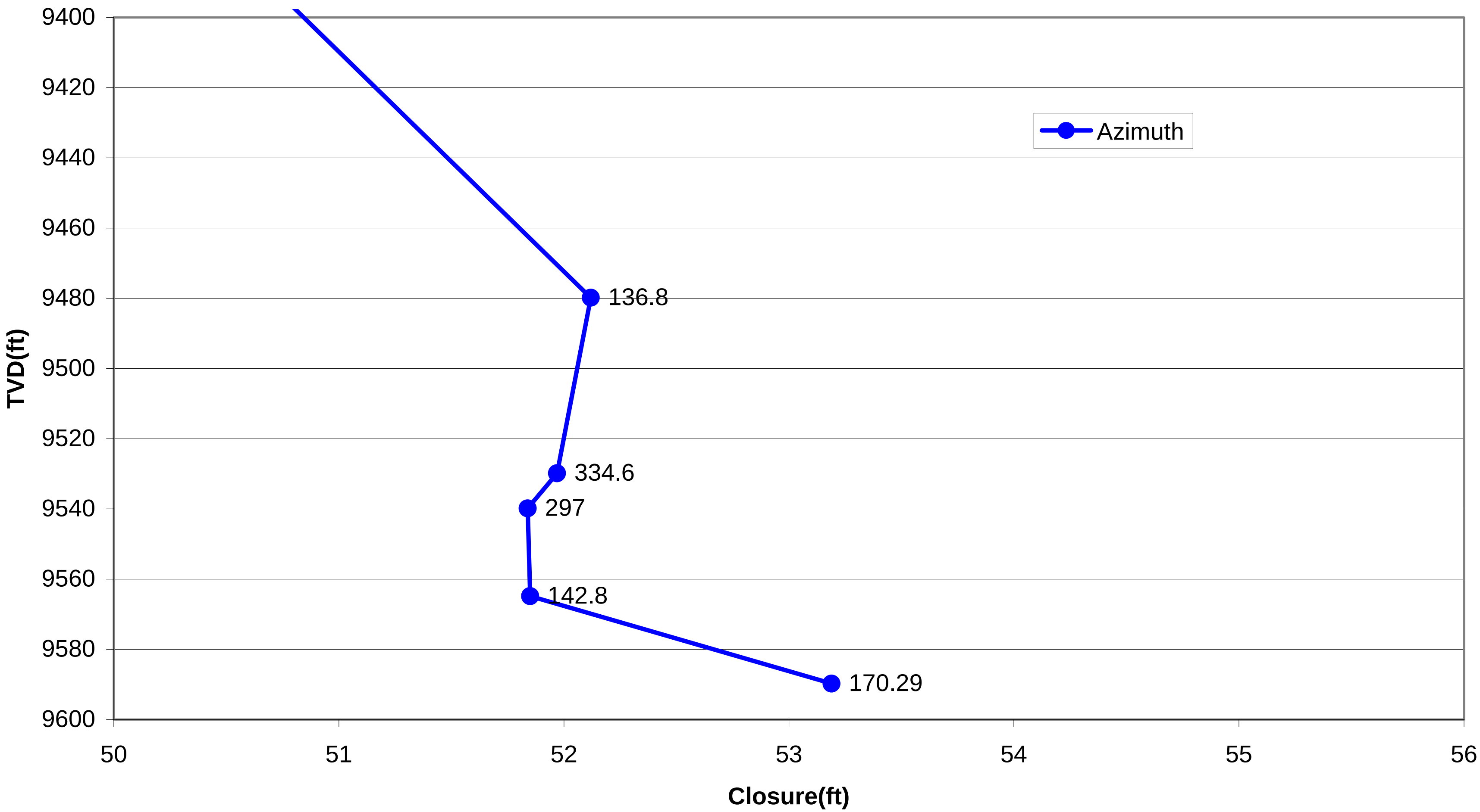

FIGURE 5 Steinbesser 21-23H Window Plan View

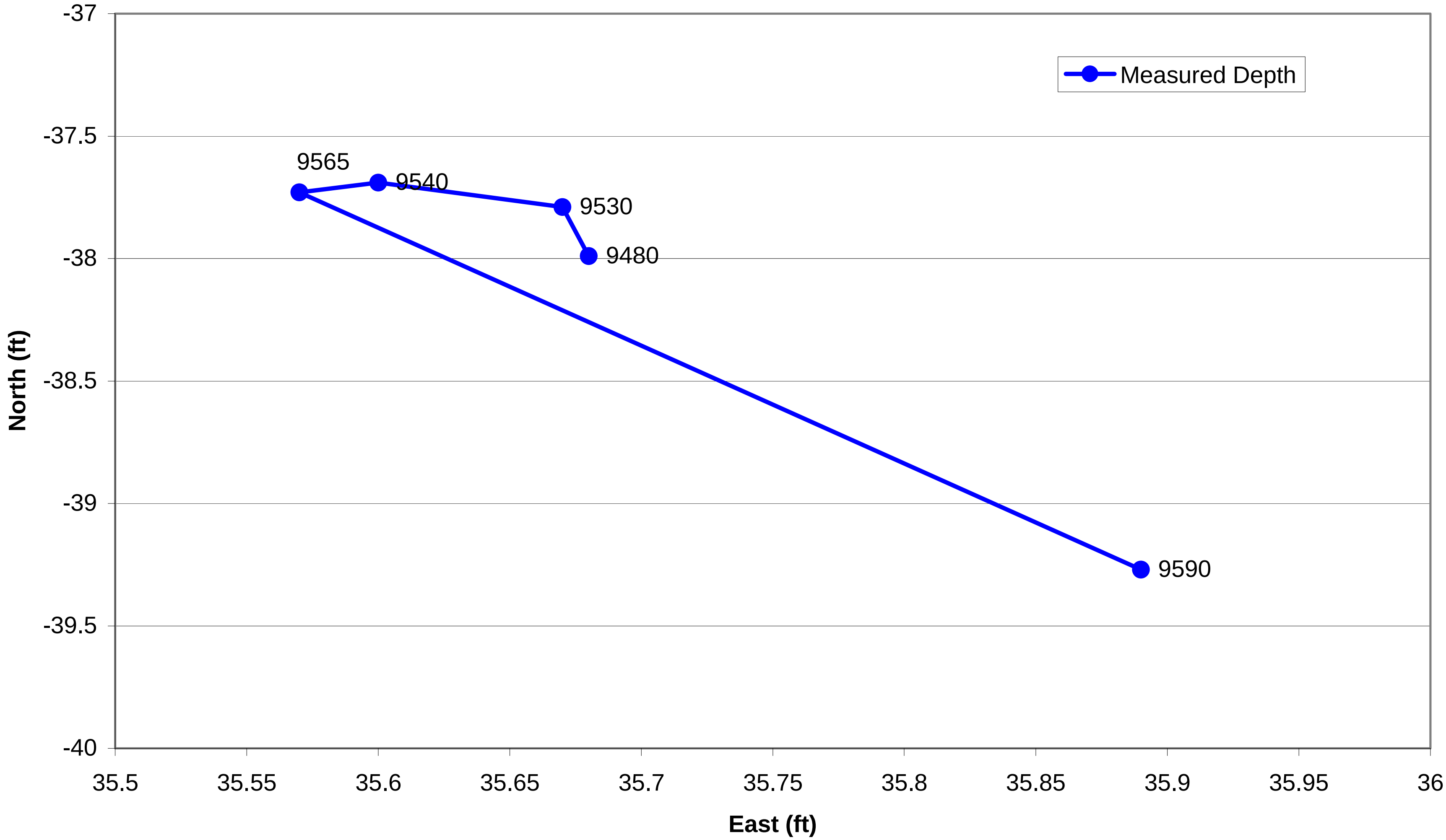

TABLE 1
Misalignment Possibility Comparison

Cause	Possibility
Surface Misalignment	Low
Downhole Misalignment	
- Gyro	Low
- CSLT Landing	Low
- Downhole String Make-up	Low
Milled Window Roll Off	High
Milled Rathole Inclination Change	High
Gyro Survey Error	Low

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CSLT / ICC Debris/Mechanical analysis

- Procedures followed at rig to save rig time contribute to a low risk of mechanical misalignment
- Debris may be present as Jetting tool is run but not used if CSLT lands and sets
- Landing in ICC depth profiles with out shearing indicating pins, mark pipe, Hoist and rotate 90 degrees will absolutely eliminate the possibility of mechanical downhole misalignment.

CONCLUSIONS

Multiple causes for an interpreted 180° Whipstock misalignment exist therefore, a systems approach should be taken to ensure the multiple potential causes for failure are managed.

Other low probability explanations for misalignment including Gyro errors, surface string make-up errors or down hole make up or back off problems. While they have a low probability of happening, their potential is not precluded. Therefore, due diligence is required to manage this risk.

CONCLUSIONS continued

Milling effectiveness has a significant influence on the success of the window and the possible interpretation of a misaligned window. Significant improvement is required to reduce the risk of a loosing window and a well due to milling quality.

The Schlumberger ICC coupling and CSLT orientation system could have a reliability problem related to the existence of debris in the ICC and/or clearances between ICC coupling and CSLT orienting tool. This potential has not been demonstrated to be significant.

CONCLUSIONS continued

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RECOMMENDATIONS

An integrated team approach to delivering a successful window exit should be utilized. Either the operator takes the lead to manage the interfaces or a single service company should take this responsibility.

When the directional BHA is first run in the hole across the Whipstock, the bent assembly should be gyro steered across the Whipstock to interpret its orientation and that of the rat hole below the Whipstock.

RECOMMENDATIONS continued

The Schlumberger ICC and CSLT window system should be examined for tolerances that could result in a premature set and the impact that debris might have on the reliability of a set. The ICC should be jetted in the orientation run.

A second downhole correlation method for the ICC and CSLT should be considered. The use of a radioactive PIP tag and Gamma ray log run with the gyro should be considered.

RECOMMENDATIONS continued

Milling techniques and milling and Whipstock equipment should be evaluated and enhanced to improve exit reliability.