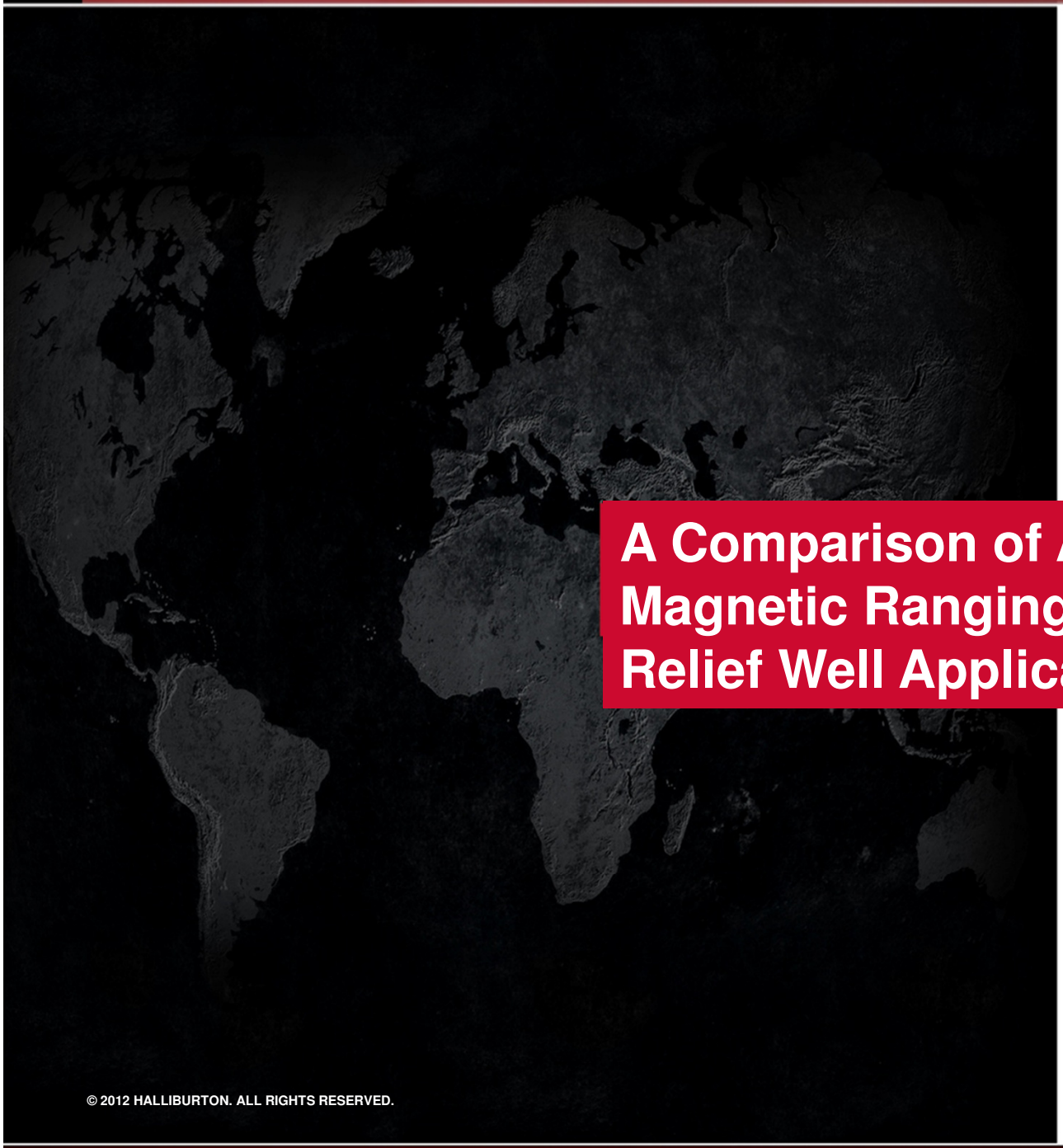


A Comparison of Active and Passive Magnetic Ranging Techniques in a Relief Well Application

Clinton Moss
Halliburton – Sperry Drilling

SPE Wellbore Positioning Technical Section Meeting #36

Oct 11th, 2012

A Comparison of Active and Passive Ranging

1. **Problem Well History**
2. A Review of Passive Ranging Attempts
3. A Review of Active Ranging Results
4. Lessons Learned/Summary
5. Going Forward – A More Robust Approach

Martinez del Tineo #14 (MdT-14) - History

- MdT-14 was drilled in 1975, abandoned in 1978 and observed to be out of control in 2006.
- A crater 300 feet wide formed around the wellhead.
- The well produced water at high volume. CO2 from the well endangered crew and killed livestock in the area.
- After an unsuccessful surface intervention attempt in 2007, a relief well was planned.

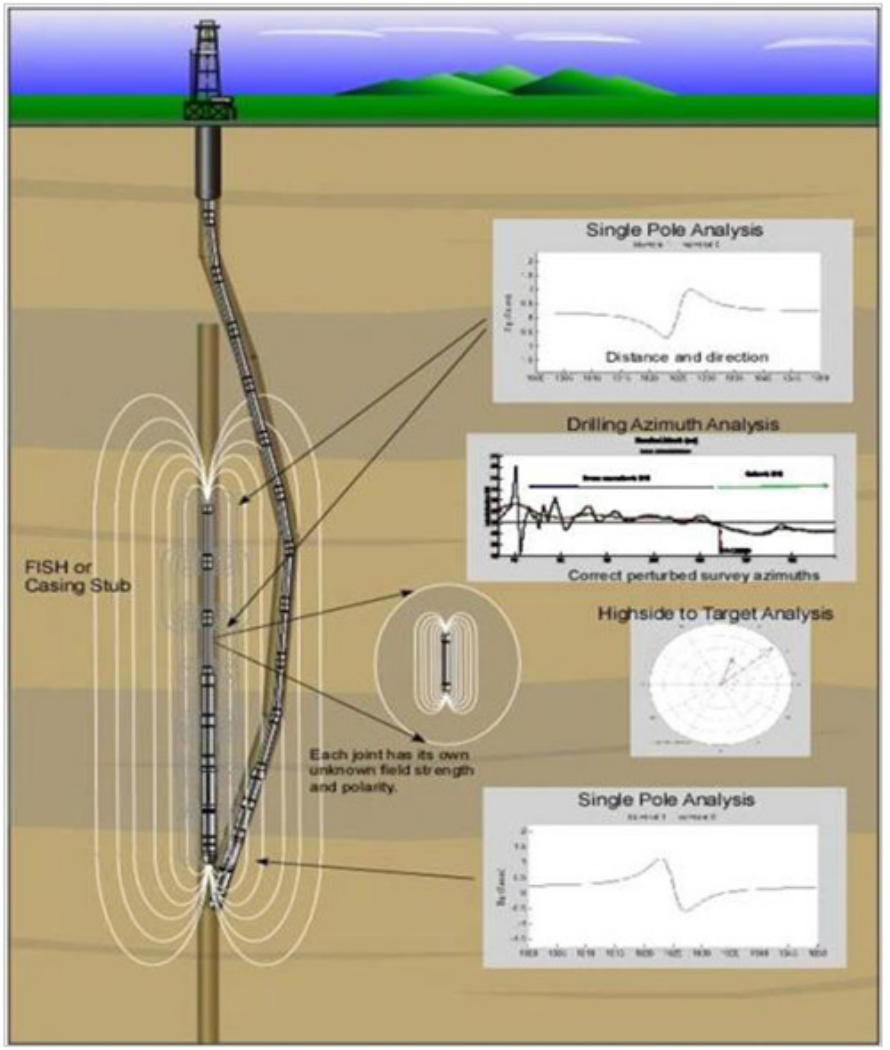
MdT-14 Site Assessment

A Comparison of Active and Passive Ranging

1. Problem Well History
2. **A Review of Passive Ranging Attempts**
3. A Review of Active Ranging Results
4. Lessons Learned/Summary
5. Going Forward – A More Robust Approach

Passive Ranging Attempt – Overview of the Technique

- PMR is the analysis of distance and direction to a static magnetic field signal source (passive magnetic). This is the magnetic field from a metal pipe in a target well.
- Passive Magnetic ranging is achieved by analyzing three component MWD gravity and magnetic data over a range of measured depths to estimate the location and orientation of the target relative to the drilling well



Passive Ranging Attempts – Overview of Operations

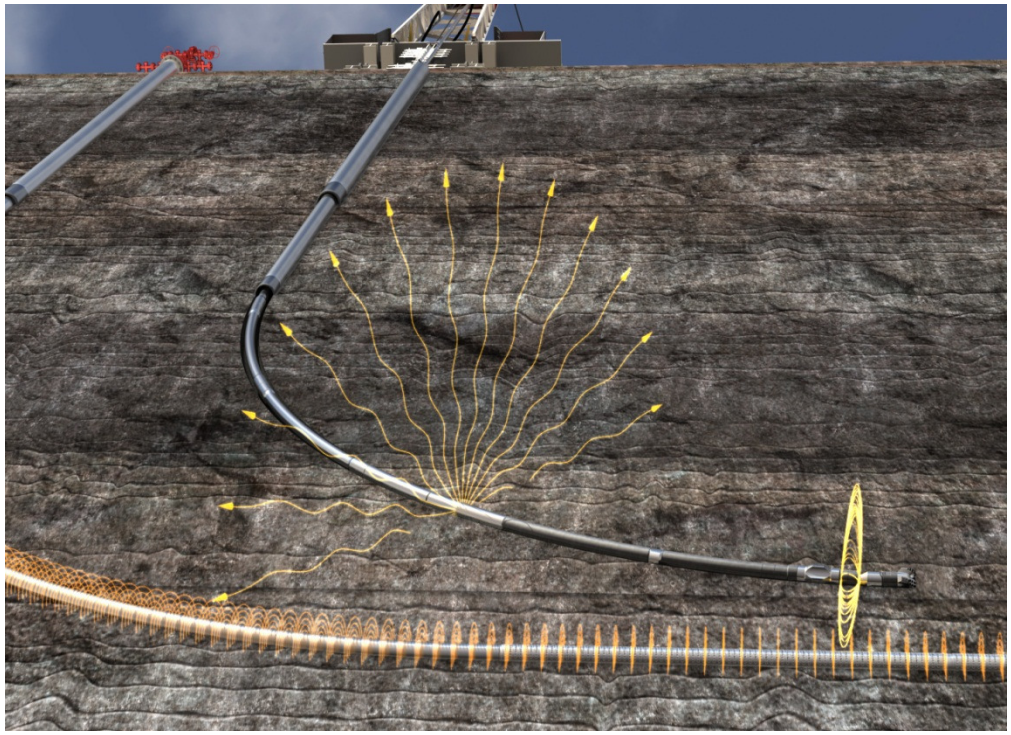
- The first relief well, N300, was spudded in December 2008.
- N300 was directionally drilled towards the MdT-14 (the “target well”) and employed passive magnetic ranging analysis from MWD data.
- Numerous Passive ranging reports were provided to YPF indicating the target well was identified and contacted.
- After 7 months on location and 11 Sidetracks, relief well operations were suspended. MdT-14 continued to produce water and C02. No hydraulic communciation could be established with the target.
- From the YPF operations summary, the passive ranging service providers attributed the failure to intersect on “severe corrosion of the target casing”.

A Comparison of Active and Passive Ranging

1. Problem Well History
2. A Review of Passive Ranging Attempts
3. **A Review of Active Ranging Results**
4. Lessons Learned/Summary
5. Going Forward – A More Robust Approach

Active Ranging Results– Overview of the Technique

- Active ranging technology is comprised of two main components, current injection and a downhole sensor.
- When current is injected into the formation nearby a target well casing, a short circuit is created and current flows along the casing. This current produces a magnetic field which is detected by the downhole sensor in the drilling well.



- The magnetic field is analyzed, and a distance and direction to the target is calculated.

Active Ranging Results– Overview of Operations

- The second relief well was spudded in May 2012 on a new drilling location south east of the crater.
- The first active ranging run was performed for anti-collision purposes, no target signal was expected or observed.
- After a drilling interval, the second active ranging run was performed. **The target well was identified.**
- The target well was identified with active ranging with a separation between the two wells of **more than 45m.**

Active Ranging Results– Overview of Operations

- The target well was intersected on the first attempt without the need for any sidetracks. **Full hydraulic communication was established.**

- On July 6th 2012, the target well was dynamically killed two weeks ahead of schedule.

A Comparison of Active and Passive Ranging

1. Problem Well History
2. A Review of Passive Ranging Attempts
3. A Review of Active Ranging Results
4. **Lessons Learned/Summary**
5. Going Forward – A More Robust Approach

Lessons Learned – How close were the first relief well sidetracks to the target?

- Active Ranging measurements, an accurate relief well survey, and a predicted/successful intersection allowed the target well position to be established with great accuracy.

- The target well position was within a few meters of the original survey supplied to all directional drilling and magnetic ranging service providers.

- A proximity scan of the 11 sidetracks on the first relief well attempt against the actual position of the target well reveal that the first relief well sidetracks were **never closer than 30 meters from target well.**

Summary of Observations

- It is unlikely that low target signal on the first attempt was caused by corrosion.
- Active ranging would likely have identified the target well at or near the sidetrack #1 kick off point.
- The limited range of passive techniques in general greatly complicates the process of locating and intersecting a target well
- The surveying process and sidetracks associated with passive methods can amount to a dramatic increase in project time and cost.

A Comparison of Active and Passive Ranging

1. Problem Well History
2. A Review of Passive Ranging Attempts
3. A Review of Active Ranging Results
4. Lessons Learned/Summary
5. **Going Forward – A More Robust Approach**

Going Forward – A More Robust Approach
A Combination of Ranging Techniques

- Passive ranging is technically useable, but has poor performance in most circumstances.
- The limitations of passive ranging and reliance upon it as a primary detection method invite cost increase and operational failure.
- A more robust and systematic approach uses active ranging which can be complimented with passive ranging (in the limited number of circumstances where it is appropriate)
  - Example: To extend the drilling interval between active ranging runs.

Conclusion

- Success in a relief well ranging operation is not defined as identifying or tracking a well, but instead by the ability to intersect and establish hydraulic communication with the target.

Conclusion

Conclusion

Conclusion

Conclusion

For additional information, please contact Clinton Moss, Global Product Champion for Magnetic Ranging Services, Halliburton - Sperry Drilling.

clinton.moss@halliburton.com

Cell 780-231-8736