

Freyer, Carsten (Scientific Drilling)

MAGNETIC RANGING TECHNOLOGY – ENABLES UNIQUE WELL GEOMETRIES AND WELL INTERSECTION APPLICATION

In der Richtungsbohrtechnologie wird bei der Ermittlung des Bohrlochverlaufs der Azimutwert (Kompassgradteilung 0-360°) mit Hilfe von sehr genauen Magnetfeldsensoren ermittelt. Zum Einsatz kommen hier sehr sensible 3-Achsen (x,y,z) Sensoreinheiten, die das natürliche Erdmagnet messen und somit die Richtung des Bohrlochs im azimutaler Ausrichtung bestimmen.

Erdmagnetfeld basierte Azimutmessungen haben den Nachteil, dass diese durch magnetisch leitende Metalle, wie Casing-Rohre und Bohrgestänge einem Messfehler unterliegen. Diese Messfehler können mit speziellen Rechenmethoden kompensiert werden, so dass die Messung mit einer ermittelten Messfehlerabweichung (Ellipse of Uncertainty) weiterverwendet werden kann.

Die Magnetic Ranging Richtungstechnologie macht sich den Nachteil der Messfehlergröße zu nutzen und kann durch weitere Rechenverfahren, die Magnetfeldabweichungen in einen absoluten Abstand und Richtung zur Störgröße, also dem Casing-Rohr oder einem benachbarten Bohrwerkzeugs, bestimmen. Der Bohrlochverlauf kann dann entsprechend angepasst werden und je nach Applikation kann dann entweder weg, parallel oder zur Störgröße hin, gebohrt werden.

Mit Hilfe der Magnetic Ranging Technologie, werden somit Richtungsbohroperationen mach-bar, die für sehr spezielle und komplex Bohroperation zum Einsatz kommen.

In dem Vortrag werden die unterschiedlichen Ranging Methoden, wie das Aktive und Passive Ranging erläutert sowie unterschiedlichen Einsatzgebiete für die Magnetic Ranging Technologie an Hand von Fallbeispielen erklärt.



75. Freiberg Universitäts Forum

Magnetic Ranging Technology enables novel wellbore geometries and applications

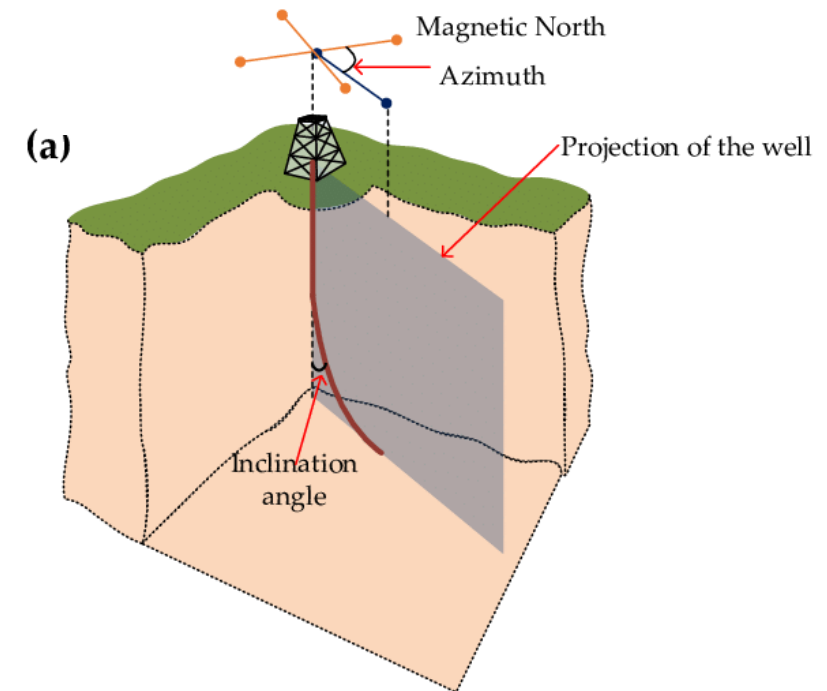
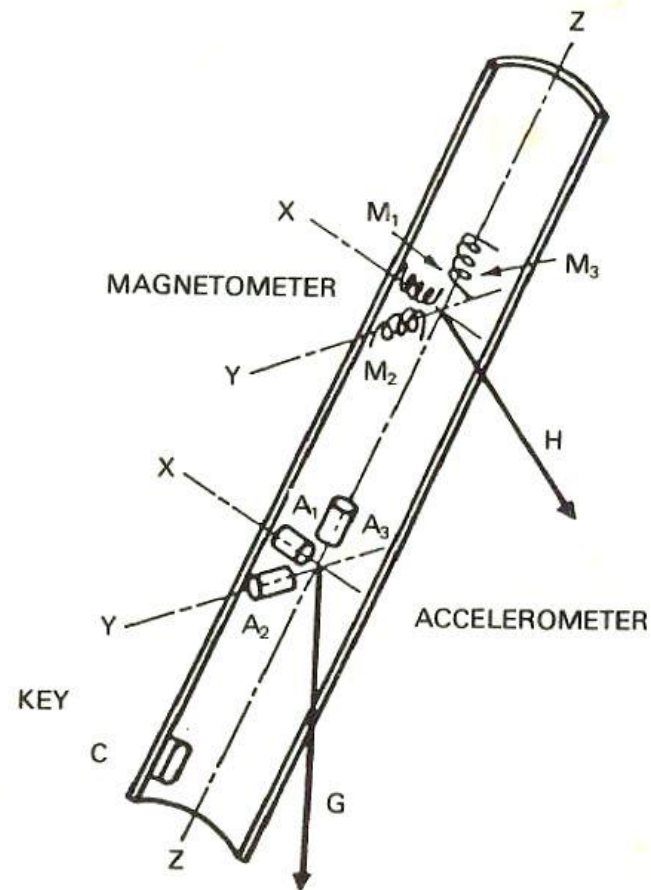
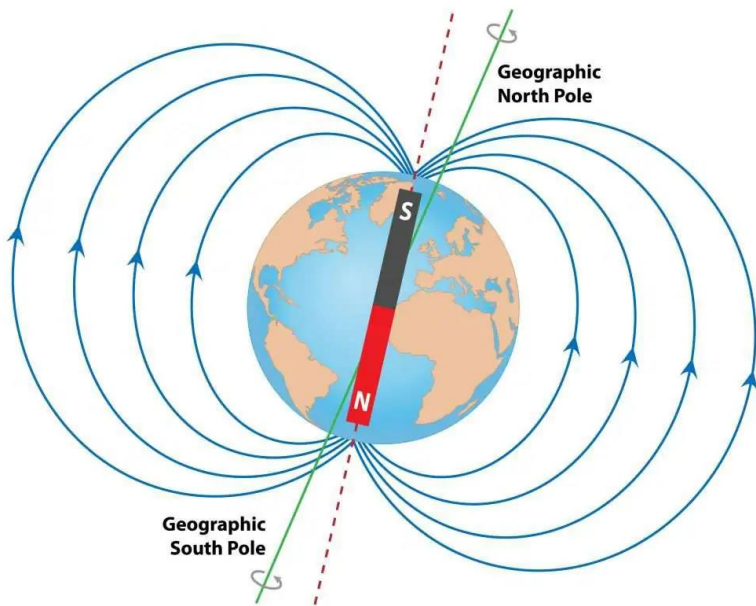
Carsten Freyer

Director Engineering - Scientific Drilling International



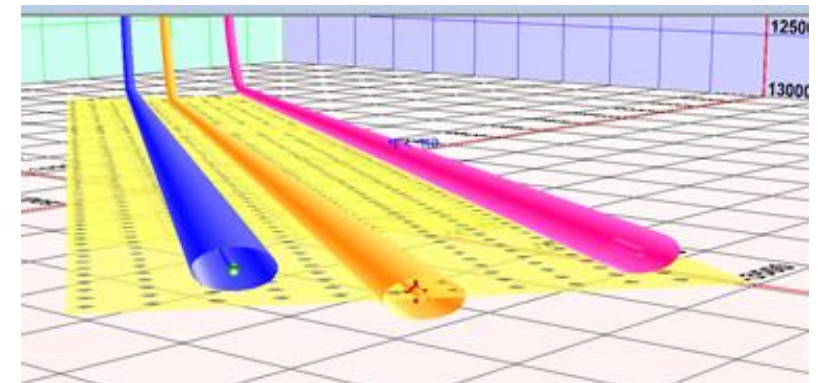
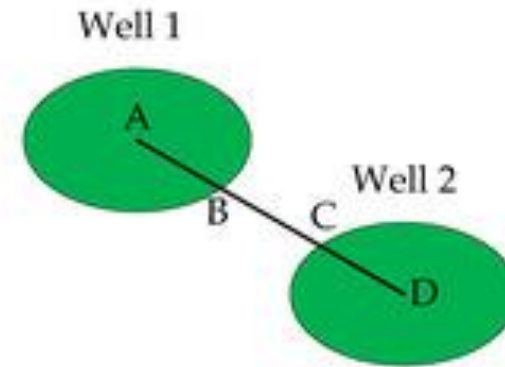
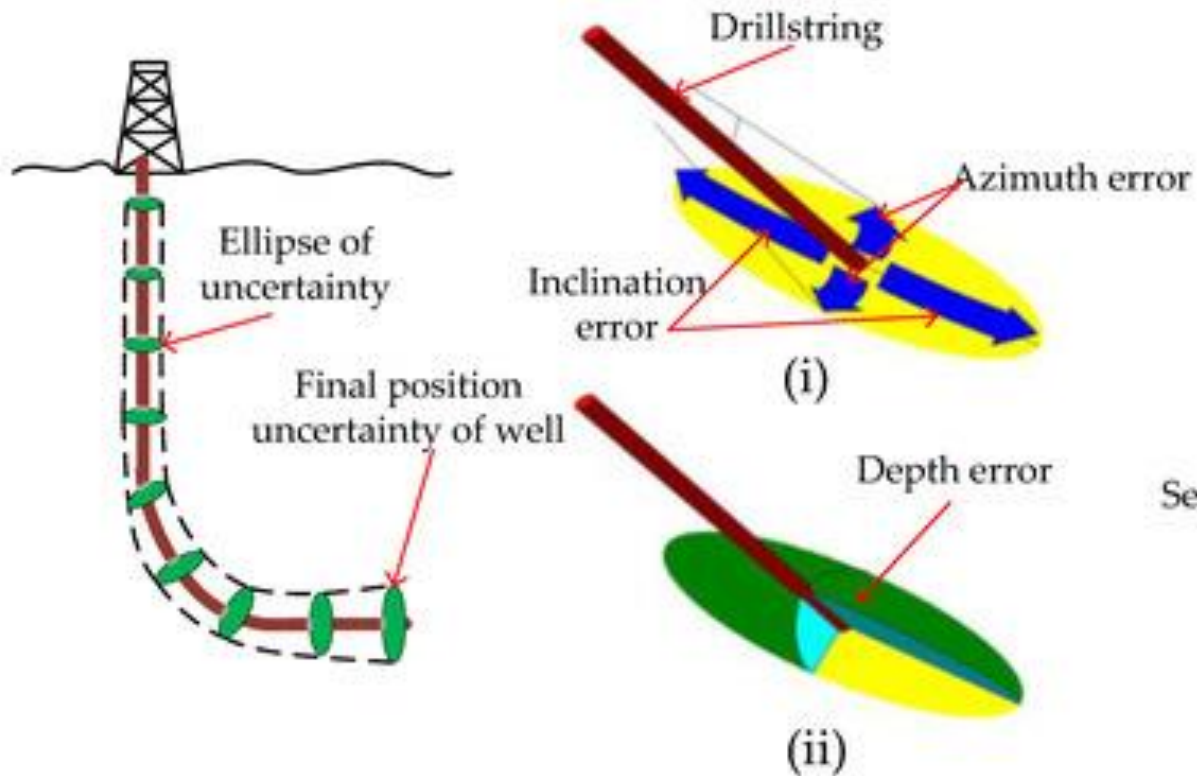
Fundamentals of Wellbore Position Measurement

+ Position measurements based on magnetoresistive directional sensors



Fundamentals of Wellbore Position Measurement

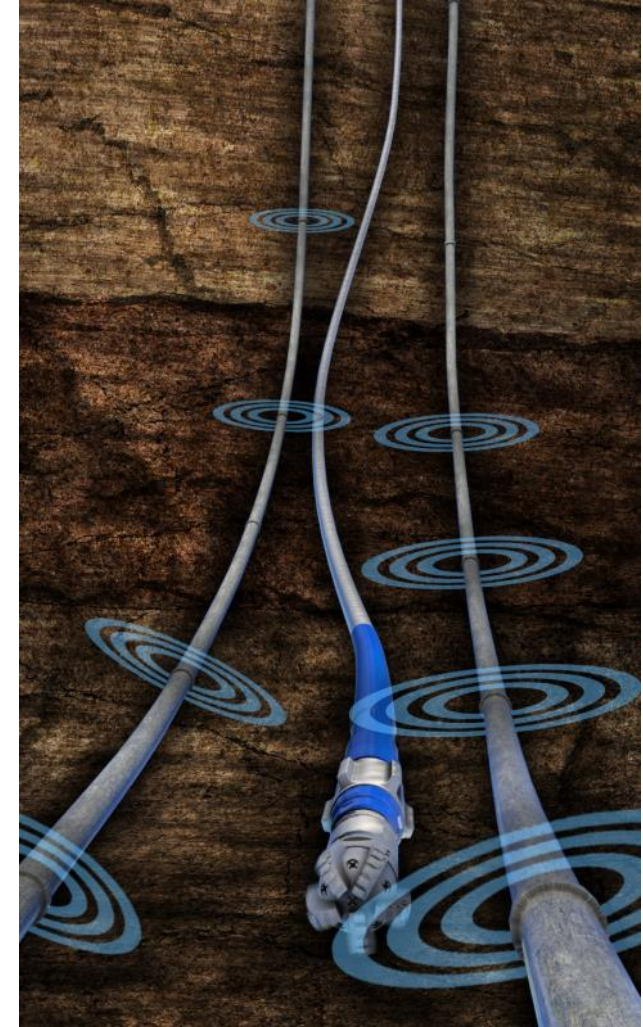
+ Importance to know “Ellipse of Uncertainty” of Wellbore Survey



What is Magnetic Ranging?

What is Magnetic Ranging?

- + Magnetic ranging is a technique used in the oil and gas industry to determine the location and orientation of a wellbore.
- + It involves measuring the magnetic field and using this information to determine the position and orientation of the well casing for an offset wellbore.
- + Magnetic ranging can be used to identify the location and orientation of an offset wellbore casing, which can help to prevent costly drilling mistakes and improve the efficiency of drilling operations.
- + The technology has been used successfully in a wide range of drilling environments, from onshore oil fields to deep water offshore and Geothermal wells

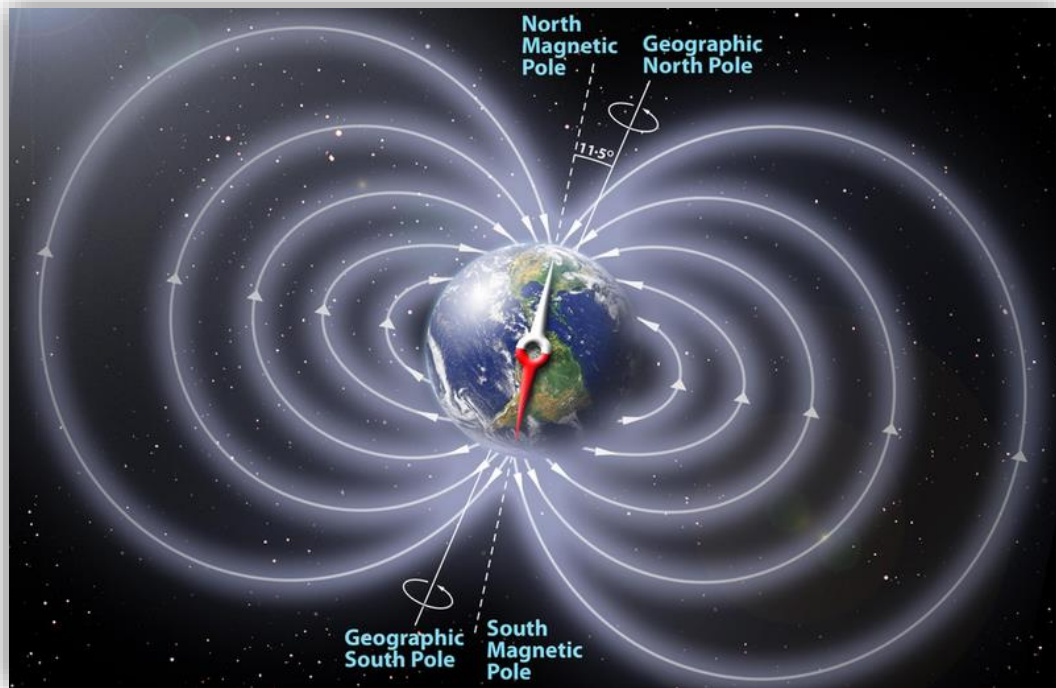


How Does Magnetic Ranging Work?

How Does Magnetic Ranging Work?

Passive Magnetic Ranging

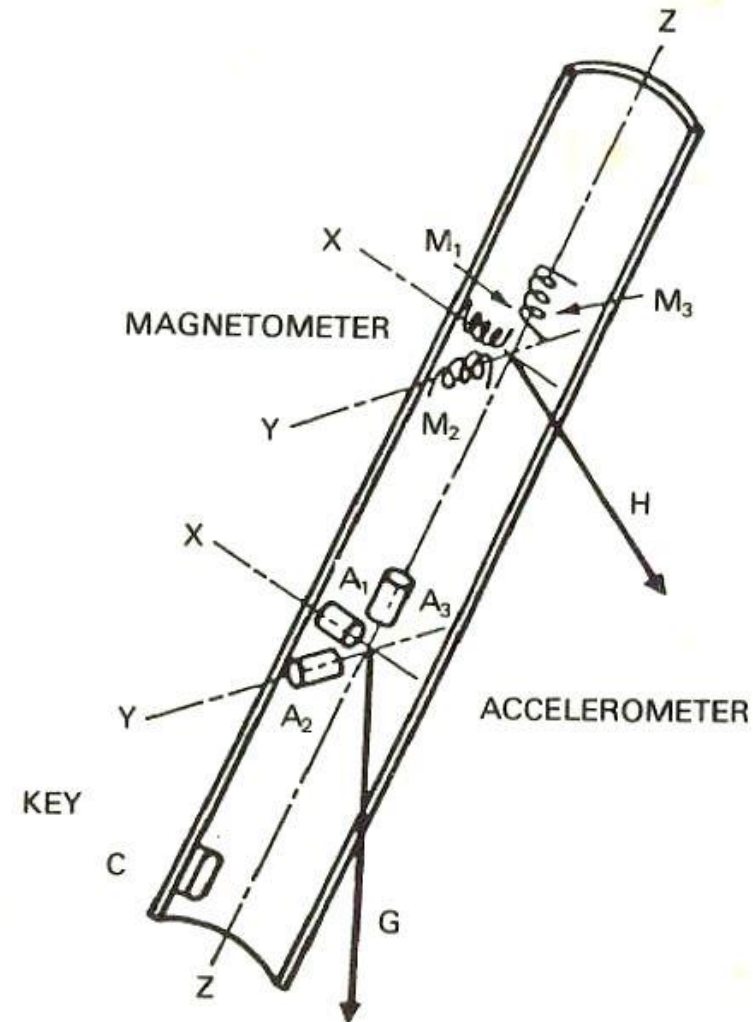
- + Passive magnetic ranging involves detecting the natural magnetic field of the Earth to locate an offset wellbore in the area.



How Does Magnetic Ranging Work?

Passive Magnetic Ranging

- + Magnetic sensors are placed in the drilling Bt to measure the natural magnetic field of the surrounding rock formations. Typically, this is the MWD tool.



How Does Magnetic Ranging Work?

Passive Magnetic Ranging

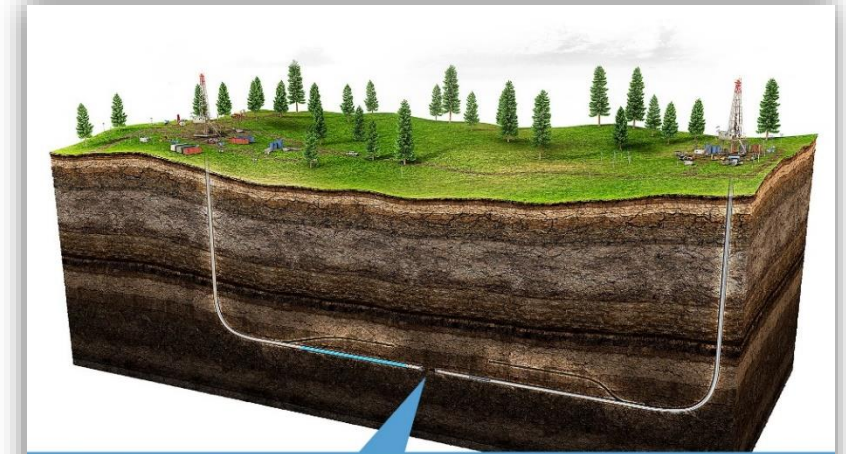
- + Computer algorithms are used to analyze the magnetic field data and identify variations that may indicate the presence of other wellbores
- + The magnetic field data is compared to known data about the magnetic properties of the Earth's magnetic field to estimate the location and orientation of other wellbores.



How Does Magnetic Ranging Work?

Active Magnetic Ranging

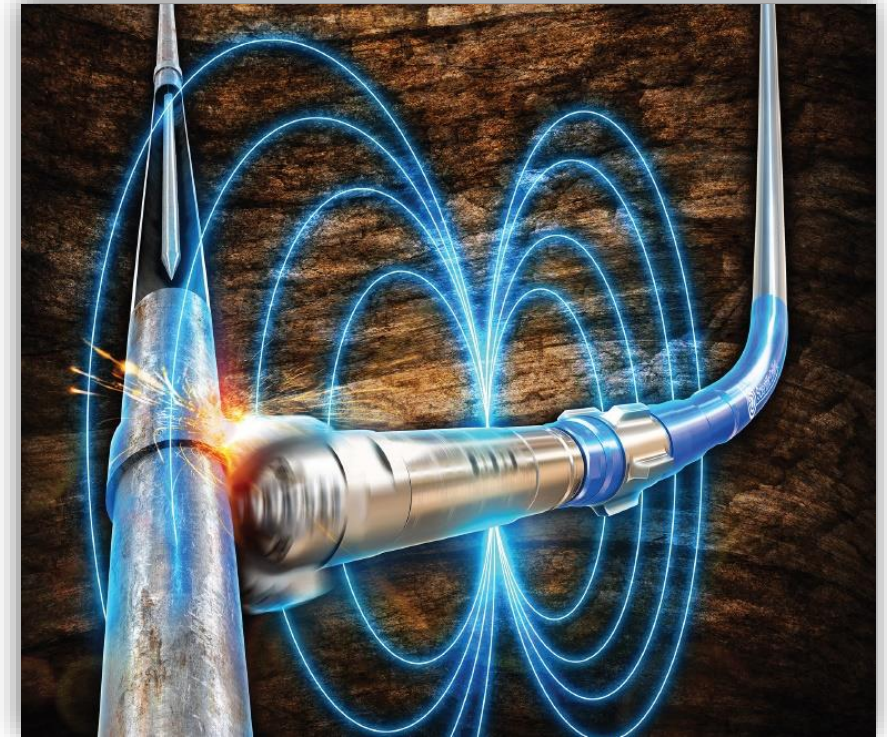
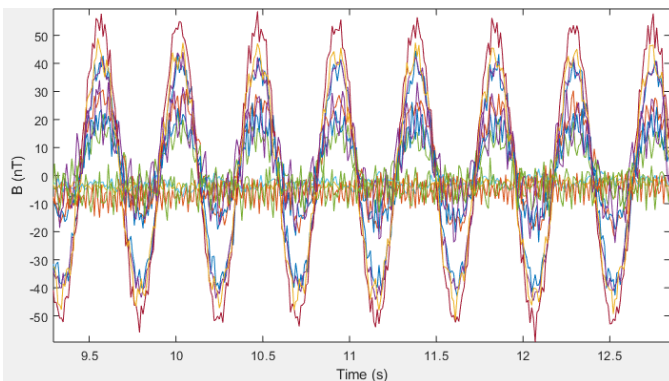
- + Active magnetic ranging is a technique used in drilling and well completion operations to determine the position and orientation of a wellbore
- + It involves generating a magnetic field in one wellbore using a magnetic source and detecting the magnetic field at another wellbore using magnetic sensors.



How Does Magnetic Ranging Work?

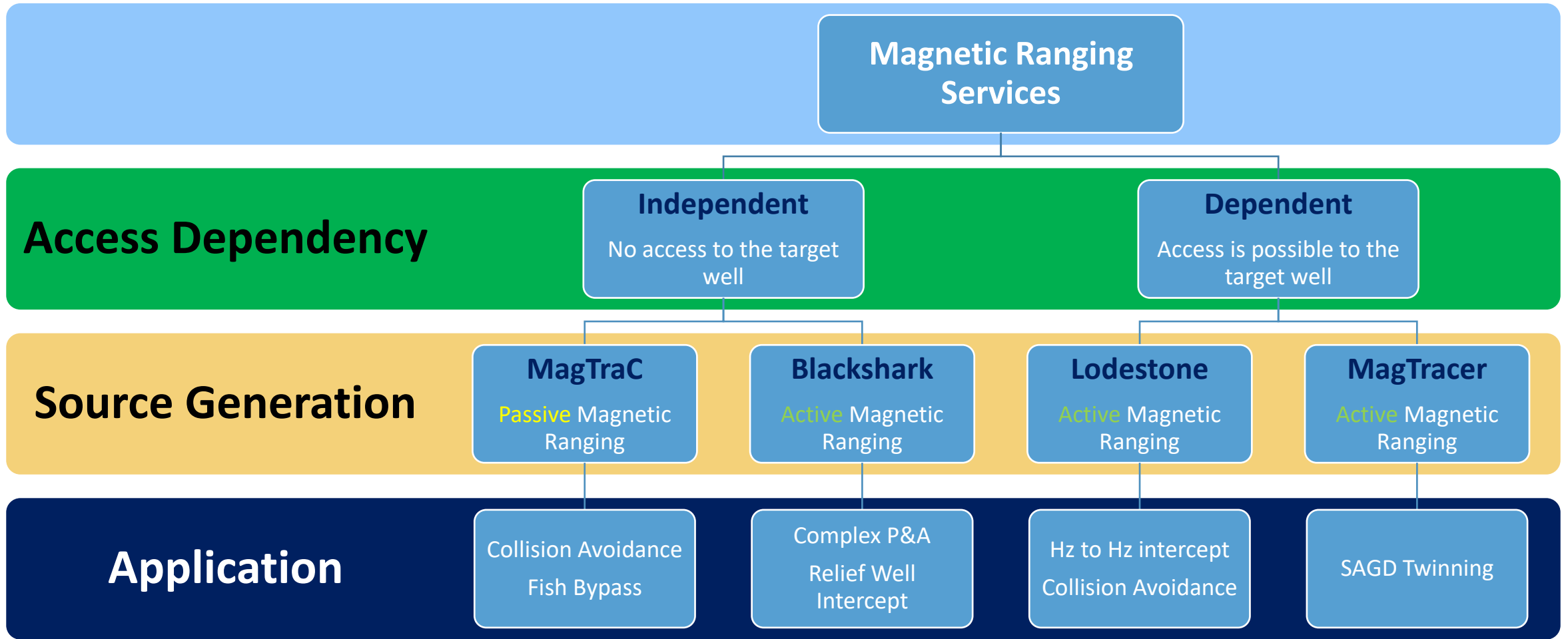
Active Magnetic Ranging

- + By analyzing the variations in the magnetic field, the distance and direction between the two wellbores can be determined.
- + Active magnetic ranging can be used to measure the distance between two wellbores in a multilateral well, determine the orientation of a deviated wellbore, or locate a lost tool or equipment in a wellbore.



Technology Summary

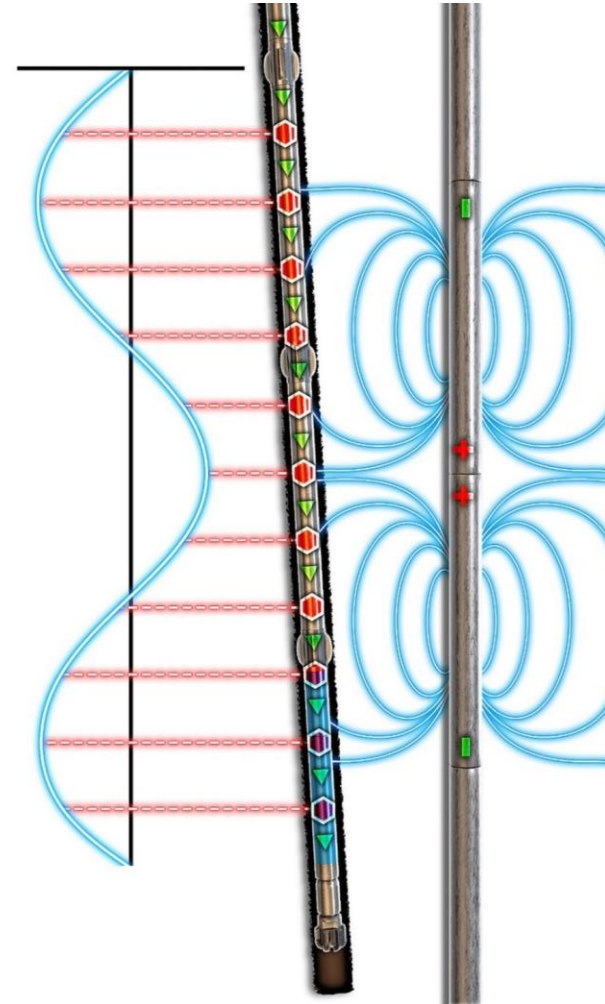
Ranging Definitions



MagTraC Passive Magnetic Ranging

Passive Magnetic Ranging

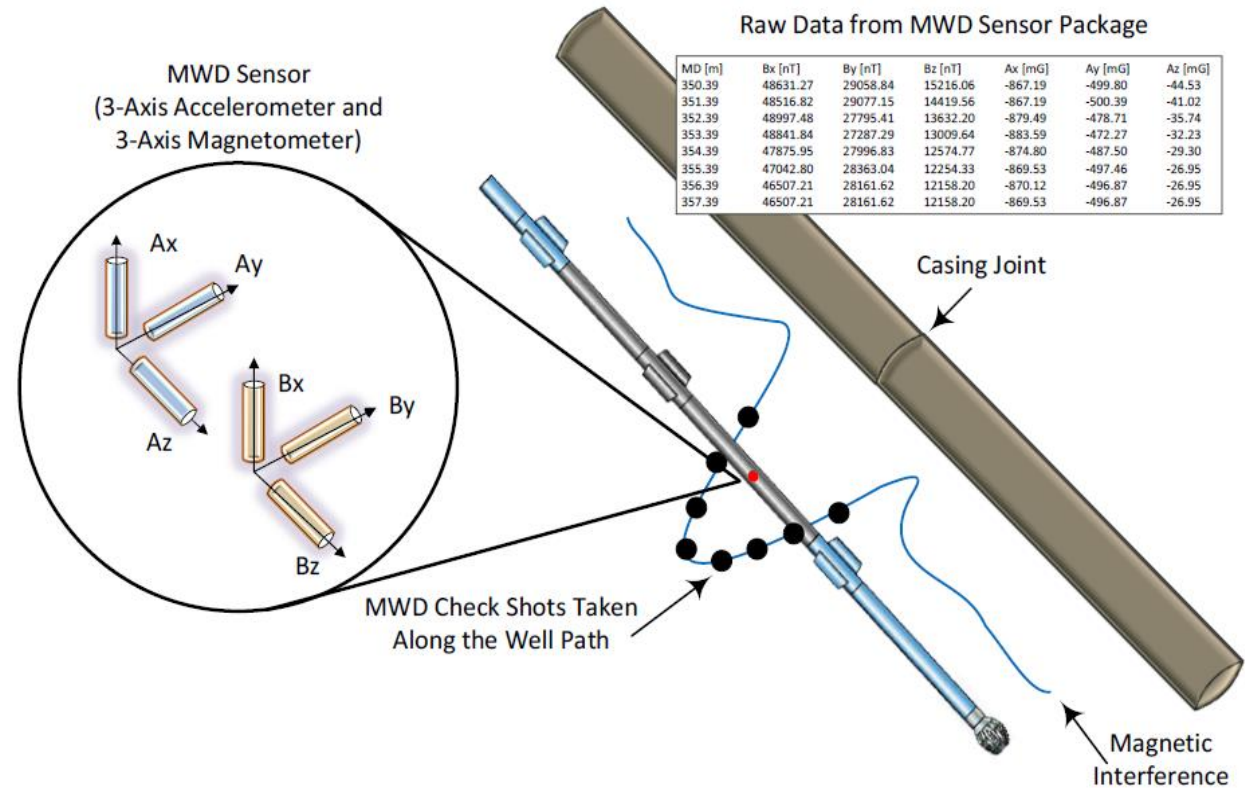
- + MagTraC data is acquired using the Measurement While Drilling (MWD) tool in the drilling Bottom Hole Assembly (BHA).
- + Magnetic poles exist at the casing connections and densely spaced raw MWD surveys are taken across the interfering magnetic pole at each ranging point.



MagTraC Passive Magnetic Ranging

Passive Magnetic Ranging

- + Analysis is performed on the recorded data to generate a model of the magnetic anomaly.
- + The position of the pole is reported as a distance and direction from the MWD sensor to the target well, relative to the surveyed position of the MWD tool.



BlackShark

Active Magnetic Ranging

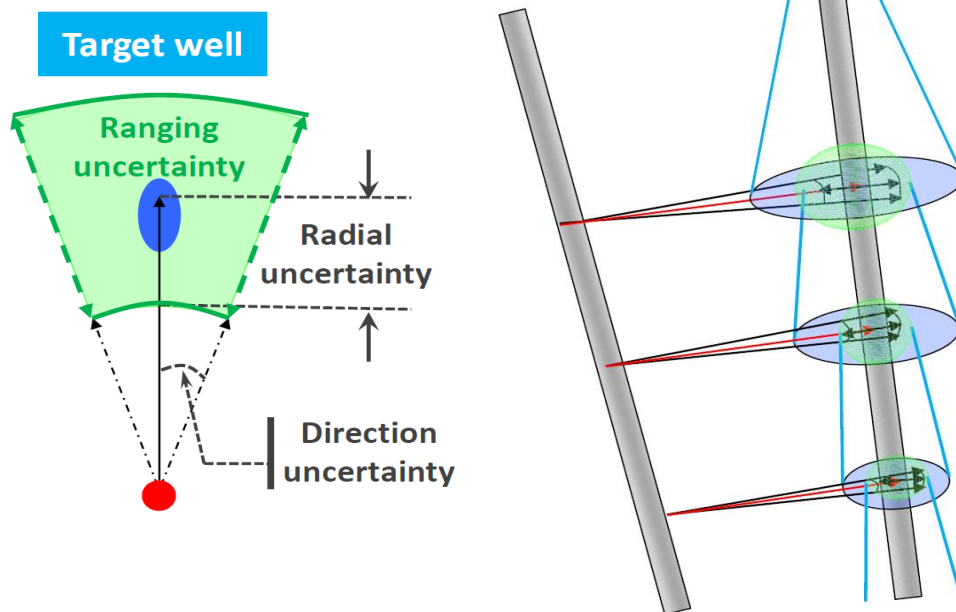
- + Wireline Deployed Sensor
- + Current Injection and Detection in one assembly
- + Does not require any access to the target well.



BlackShark

Active Magnetic Ranging

- + Analysis provides a direction and distance from the intercept wellbore to the target well.
- + Detection range of sensors exceeds 200ft/60m.

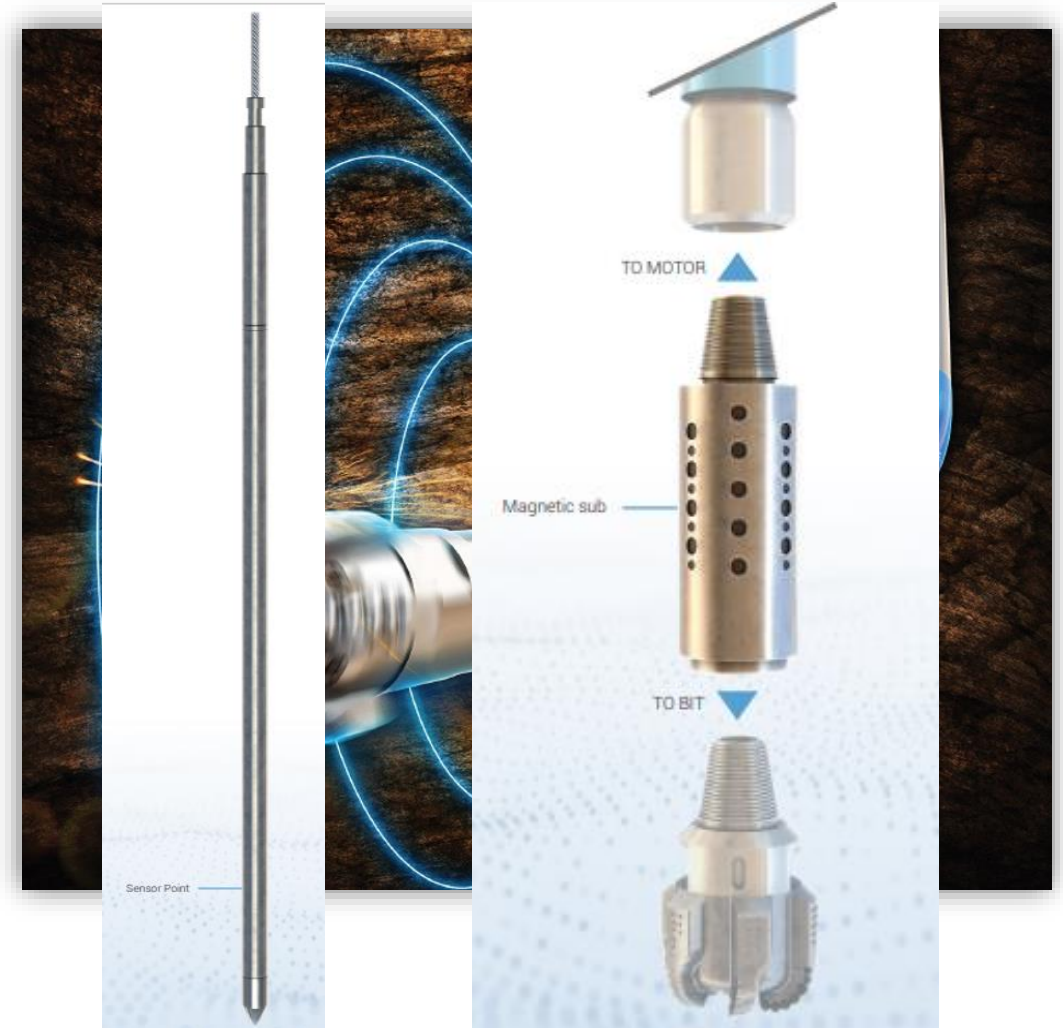


Rugged proven design,
using decades of
industry experience with
relief well interceptions.

Lodestone Active Magnetic Ranging

Active Magnetic Ranging

- + Wireline deployed sensor in target well.
- + Near bit magnet sub spins with bit rotation.
- + Alternating magnetic field is detected by the sensor.
- + Three-dimensional result from the sensor to the bit is obtained in under 1 minute.
- + Superior range (128 meters) to alternative technology.
- + Does require access to the target well to position sensor
- + Ideal for wellbore interceptions including horizontal to vertical and horizontal to horizontal geometry.

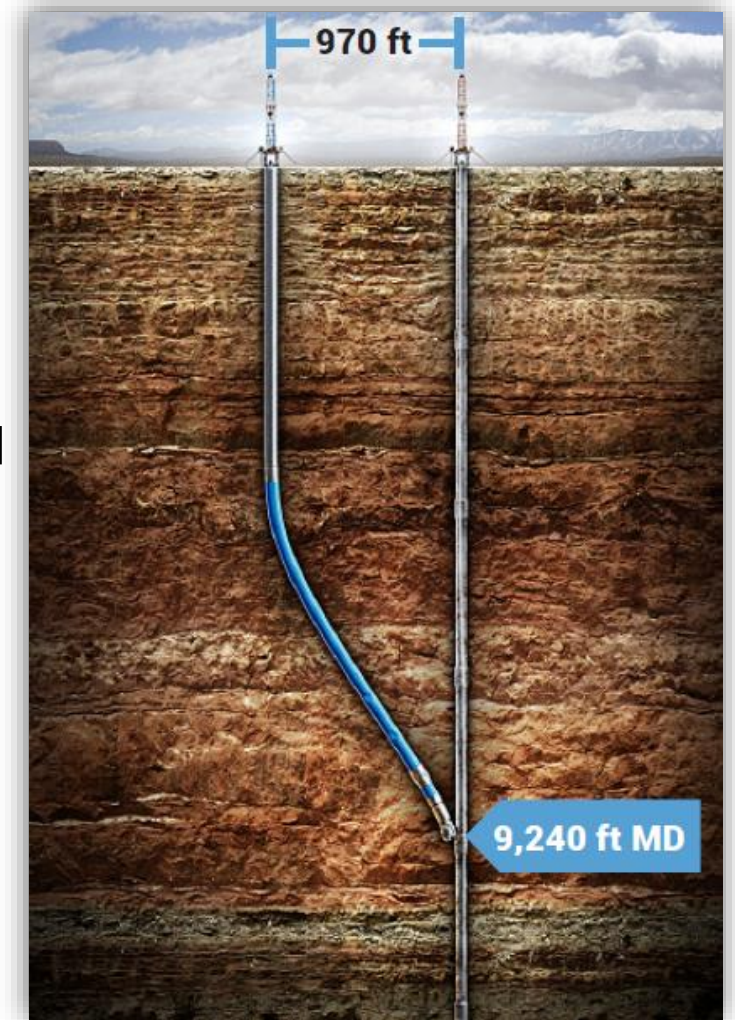


Case Studies

Case Studies

Relief Well from Spud to Intercept in 30 days

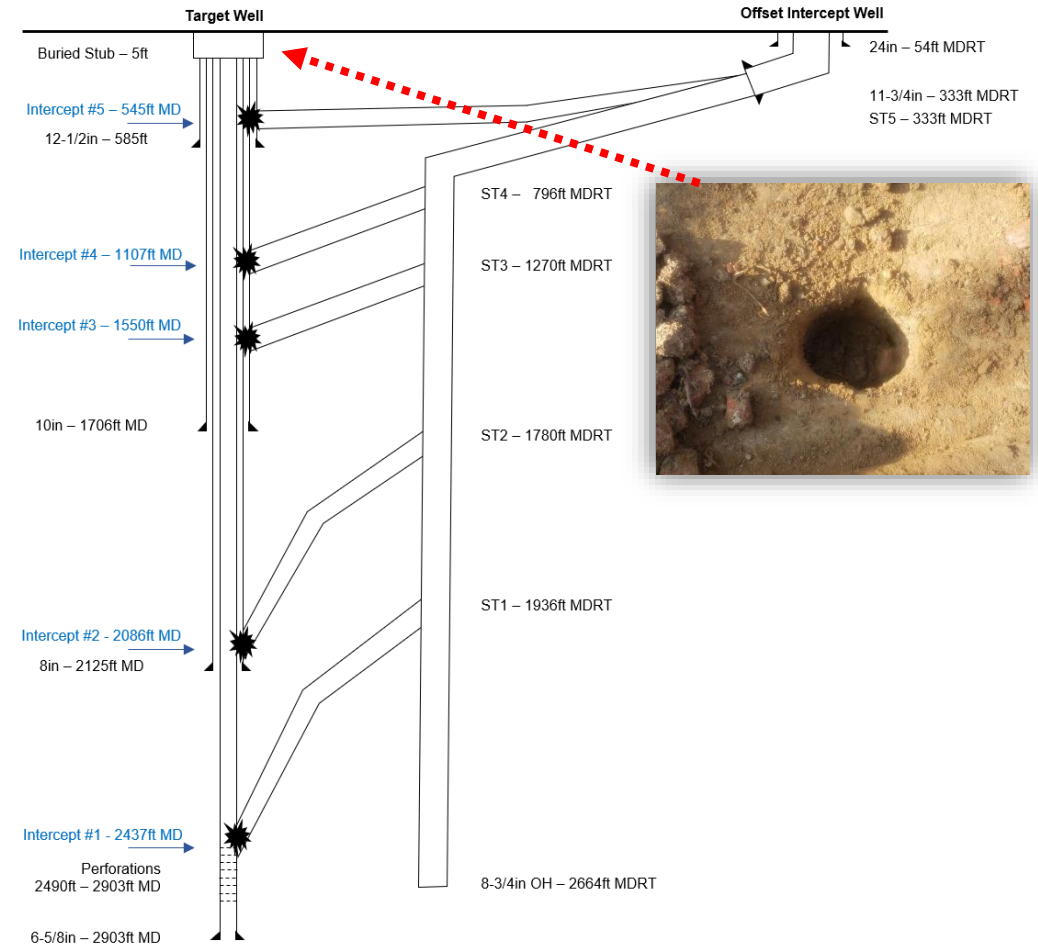
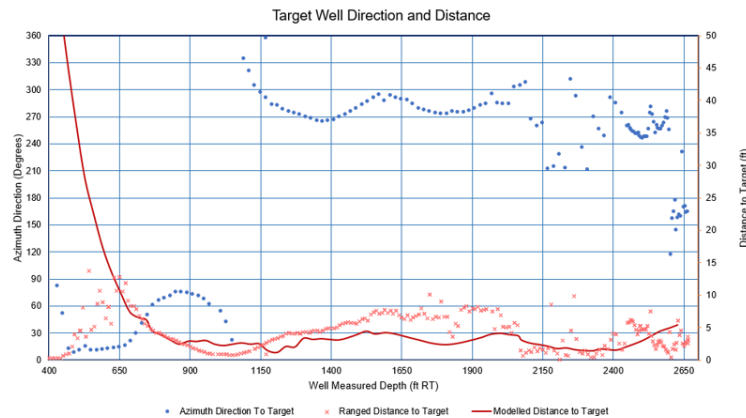
- + Target well was damaged and under pressure.
- + High probability that a blowout could occur to surface.
- + To mitigate this risk, a relief intercept well was drilled from an offset location +/- 970ft away on surface.
- + Target well intercept was at 9240ft MD.
- + BlackShark Active Magnetic Ranging deployed – located, tracked and provided ranging data to precisely align and mill into the target well casing.
- + URSA Advanced solid state gyro technology used to combat magnetic interference from the target well casing.
- + Special environmental safety measures were required due to extreme cold and blizzard conditions.
- + Well pressure was relieved and brought under control.



Case Studies

P&A of Complex Multiple Well Targets

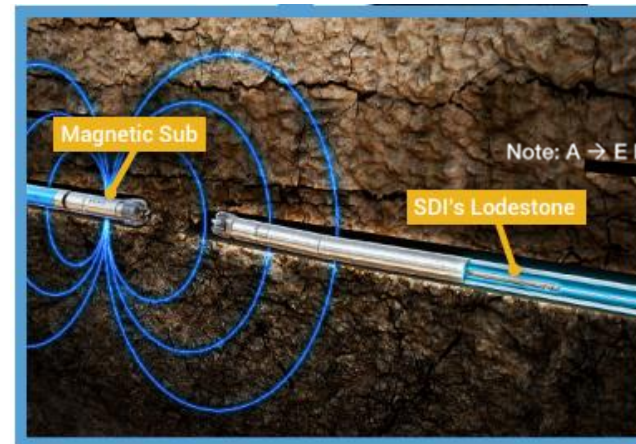
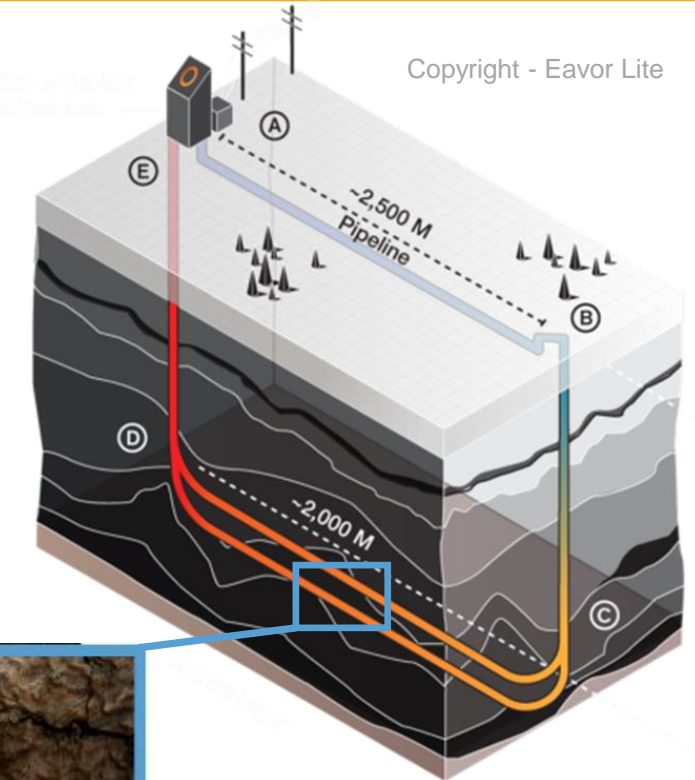
- + No existing wellhead on surface – Well detected by oil seep and magnetic anomaly survey.
- + Drilled in 1909, abandoned 1912.
- + Urban development in direct area of well – restricted rig access.
- + Target well mapped, then successfully intercepted across target zones



Case Studies

Multilateral Geothermal Well Intersection

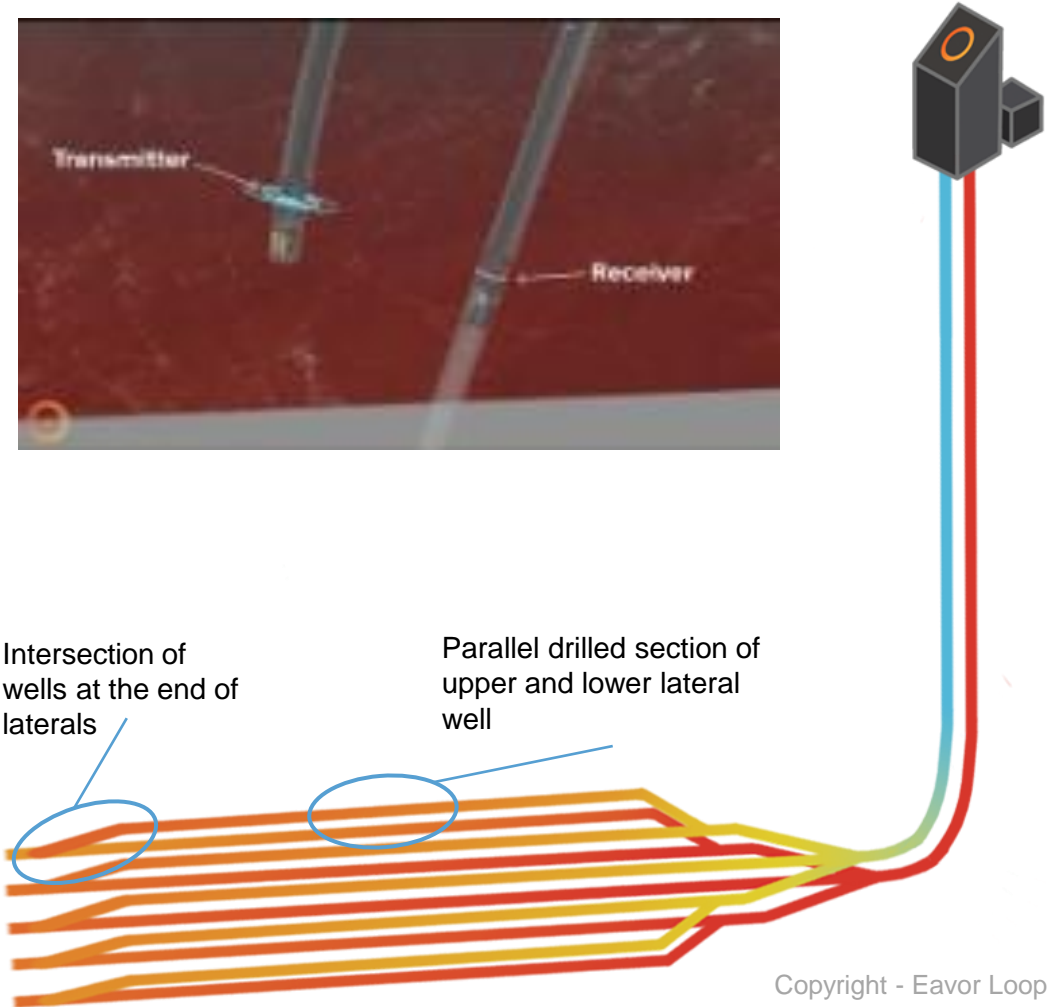
- + Two wells with 2.300m lateral separation and each well with two lateral section drilled and precisely connected at bit face.
- + Total well length 3.440m/well
- + Ranging service based on Lodestone and Ranging Received sonde enables is complex well geometry
- + Successfully demonstrated and delivered Active Ranging based Well Intersection Service for EAVOR's Geothermal Pilot Project in Canada
- + World's first of its kind multi-lateral horizontal drilling intersection



Case Studies

Multilateral Geothermal Well Intersection

- + The Eavor Loop Geothermal Geretsried Project requires the construction of complex multilateral well “downhole heat exchanger”
- + Active Magnetic Ranging Technology as enabling technology for this kind of complex well
- + Simultaneous drilling of two well bores with in precise parallel distance of 50-100m and connection of both wells at the end of the long lateral section





Questions and Discussion

Thank You

[Scientific Drilling's Magnetic Ranging Webinar \(youtube.com\)](https://www.youtube.com/watch?v=...)