

Optimized Well Placement Using Cost Effective Logging While Drilling Real-Time Imaging Technologies in First Unconventional Horizontal Well in the United Arab Emirates: A Case Study*

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Abstract

A horizontal well was drilled in an unconventional source rock for the first time in the UAE, using advanced logging while drilling (LWD) high-resolution microresistivity and near-bit gamma ray imaging sensors. The well plan required locating a ± 3 ft. true vertical thickness (TVT) source rock sublayer within a giant undeveloped unconventional carbonate reservoir in a middle Cretaceous carbonate sequence onshore Abu Dhabi. The absence of offset wells in this field and the associated structural geological uncertainty presented additional challenges in terms of planning and execution. A vertical pilot hole was first drilled to evaluate local geological structure and determine reservoir properties. A well placement methodology and workflow were developed and applied using azimuthal focused resistivity and near-bit azimuthal gamma ray sensors to land and geosteer the well in the targeted thin target layer, while maintaining the planned trajectory with minimum borehole tortuosity using real-time drilling optimization. The well was successfully drilled and the geosteering objectives were achieved with 100% reservoir contact. The high resolution microresistivity images were analyzed to classify image patterns to correlate to reservoir units for further field development and better understanding of reservoir flow units. The laterolog resistivities were also determined to be better suited for inferred R_t and R_{xo} measurements for petrophysical formation evaluation than modeled electromagnetic wave resistivity inverted values. The field development strategy for the horizontal drain in the undeveloped source rock is being reviewed based on these recent data to benchmark and optimize well placement, formation evaluation, and production technologies to evaluate the economic potential of this unconventional reservoir. This paper presents a case study following the

completion of the first unconventional horizontal well in the UAE, describing the integration of fit for purpose geosteering technologies and optimized drilling performance for maximizing reservoir contact and improved reservoir insight. Benchmarking of cost effective well placement and petrophysical data gathering requirements for the future field development program are also discussed in terms of maximizing asset value.



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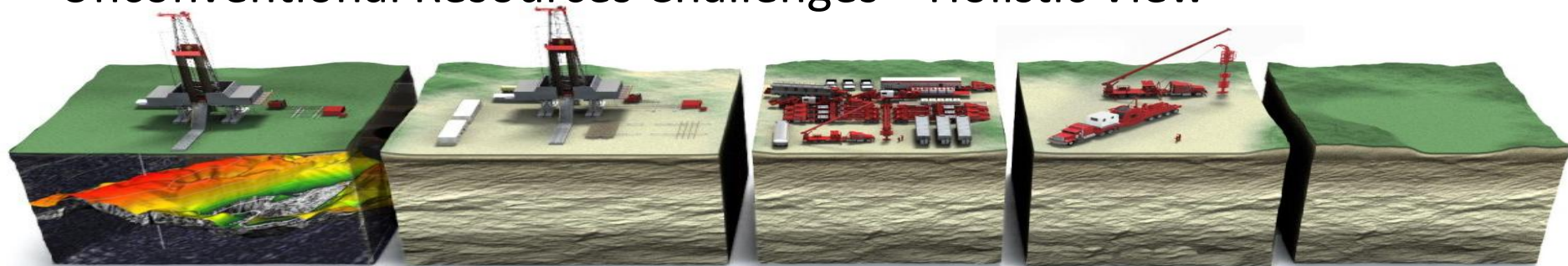
Pierre Van Laer, ADNOC

Ehab Negm, Wael Fares, Emad Diab, and Ahmet Aki, Halliburton



HALLIBURTON

Unconventional Resources Challenges—Holistic View



Exploration

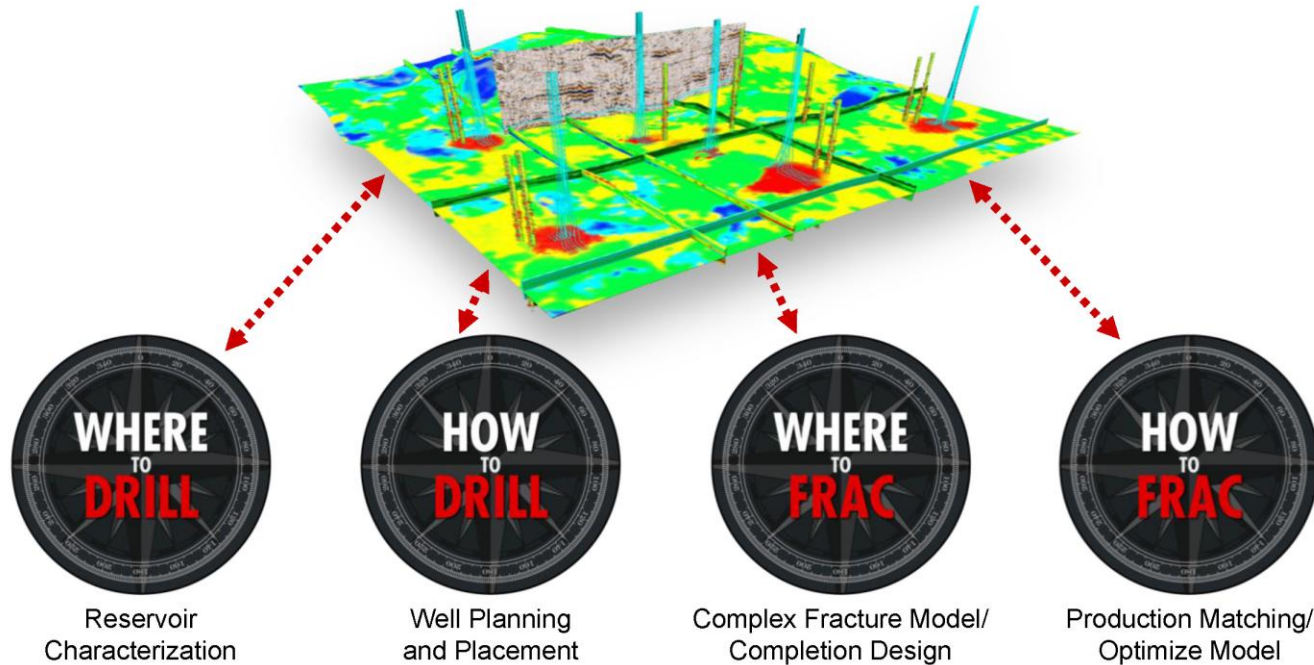
Well Construction

Completions

Production

Sweet Spot	Petrophysics	Well Location	Design	Operation Design
Basin/Play	Geochemistry	Well Placement	Wellhead Equipment	Chemicals
Reserves	Geomechanics	Borehole Stability	Liners	Equipment
Extension	Reservoir	High-Pressure/ High-Temperature	Tubular Design	Post-Job Cleanup
		Mud	Memory Logging Tool (MLT)	Treatment Evaluation
		Infill Drilling		

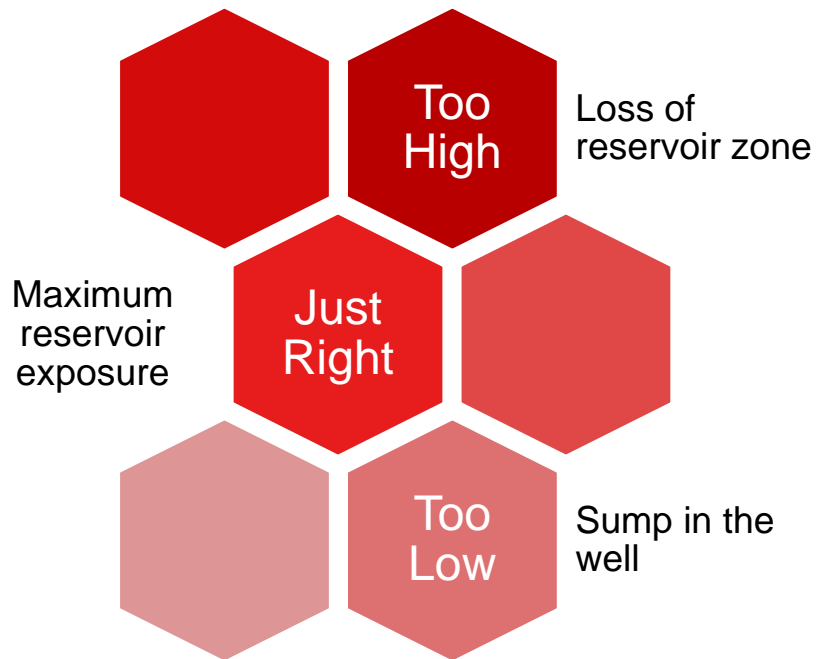
Seismic-to-Stimulation Service



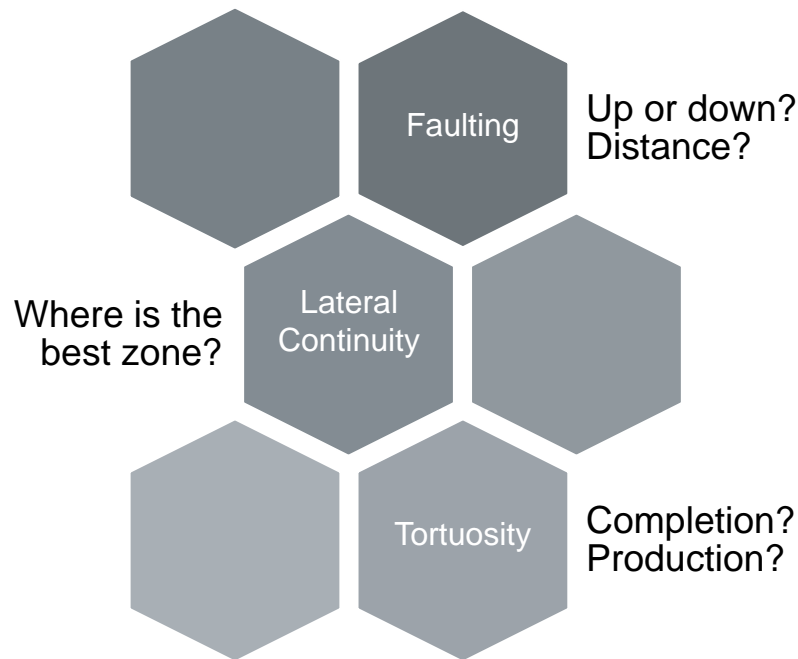
Presenter's notes: For source rock reservoirs, we developed a unique, collaborative approach that enabled us to address the associated challenges. This approach, the CYPHER seismic to stimulation service, was built on reservoir knowledge, helping us determine Where and How to Drill and Where and How to Frac to optimize every stage of a field development.

Geosteering Challenges

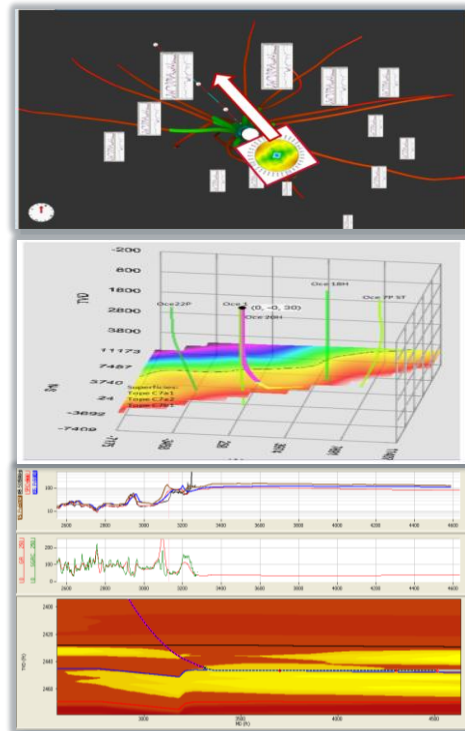
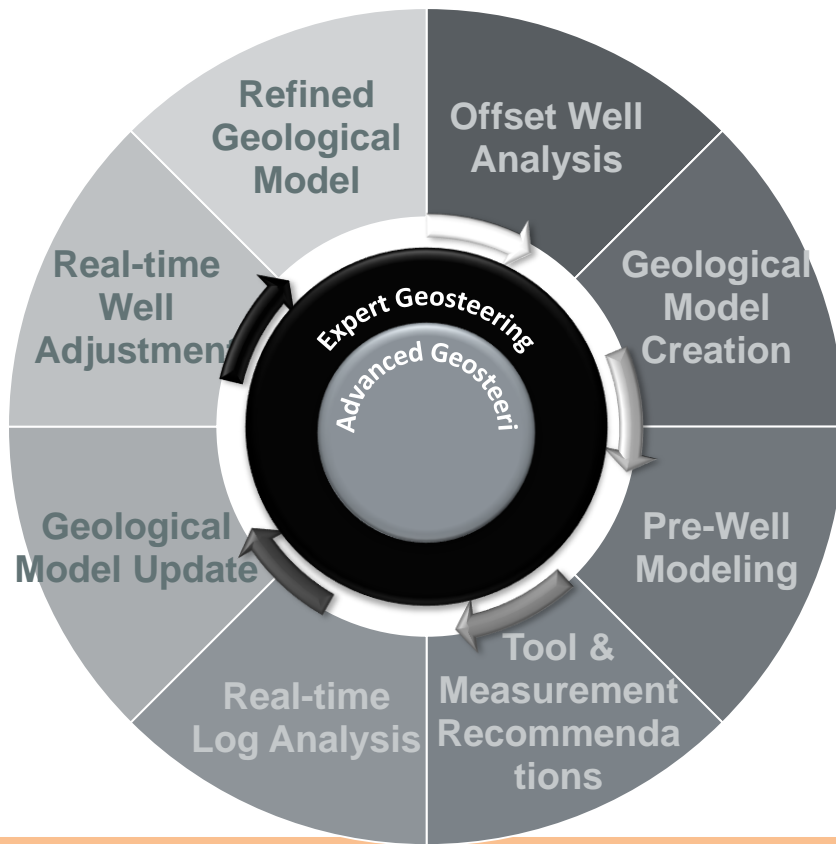
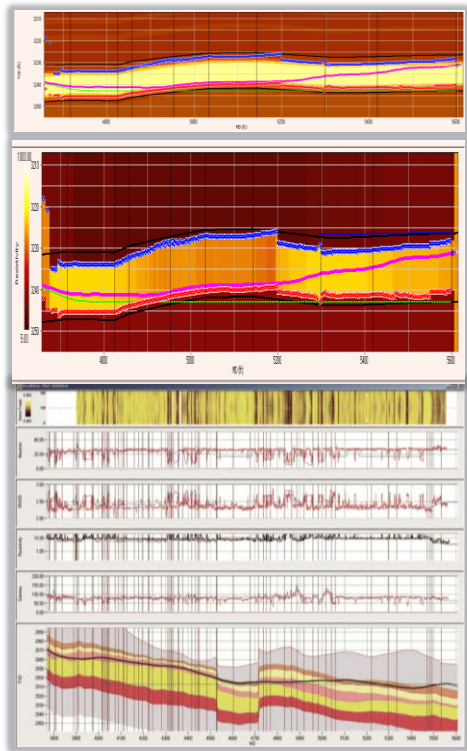
Landing



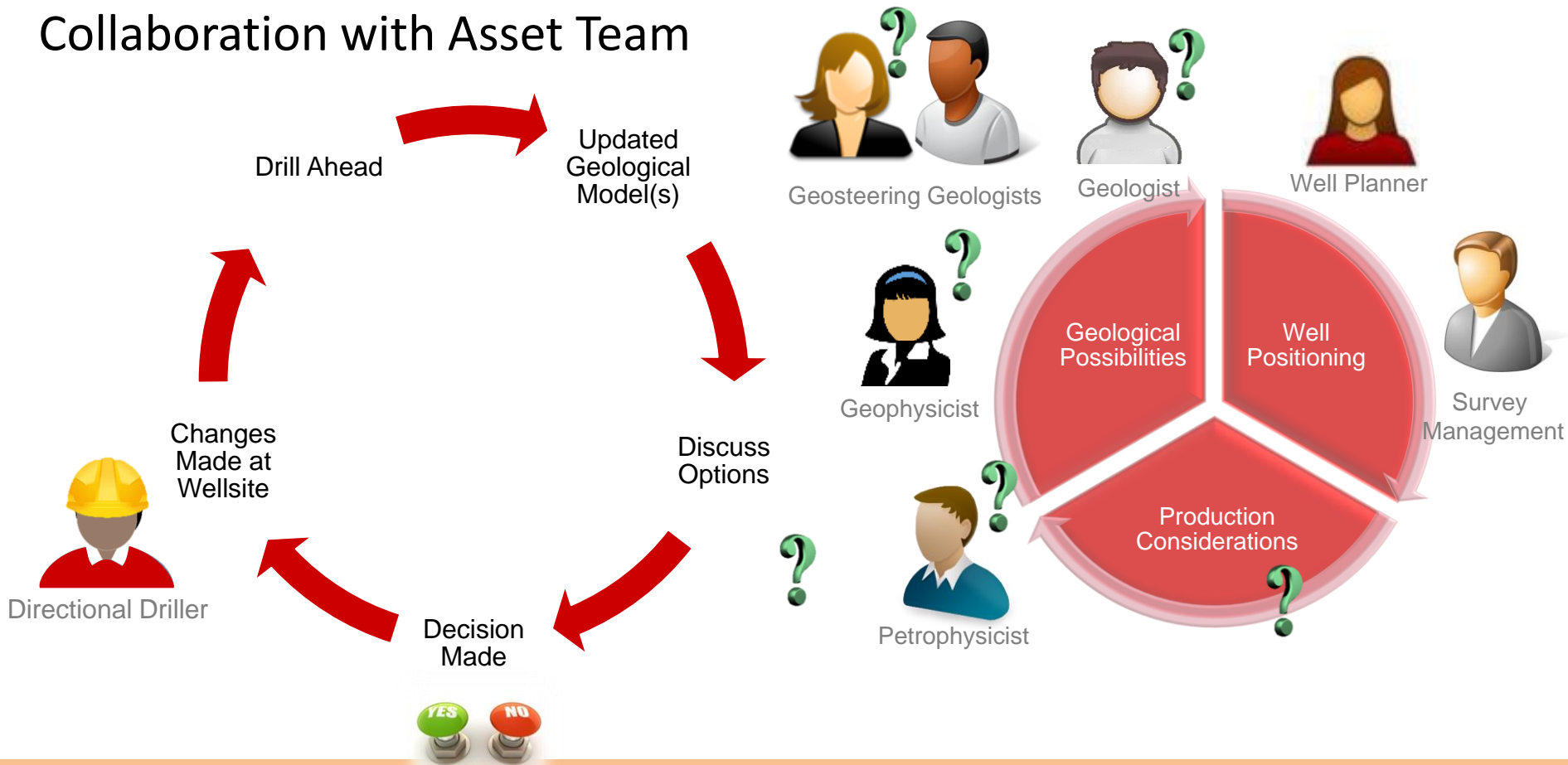
Lateral



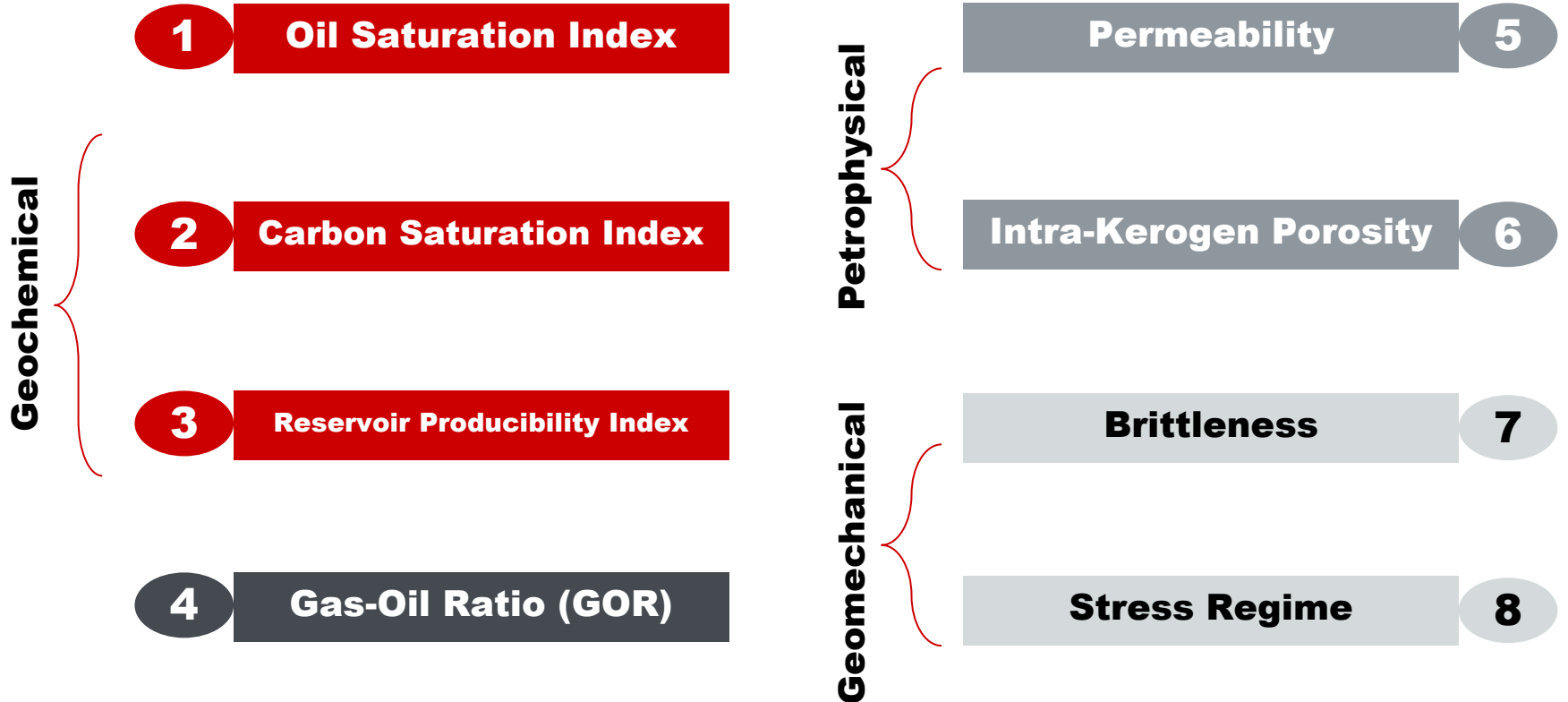
Geosteering Solutions Process



Collaboration with Asset Team



Reservoir Quality Indices

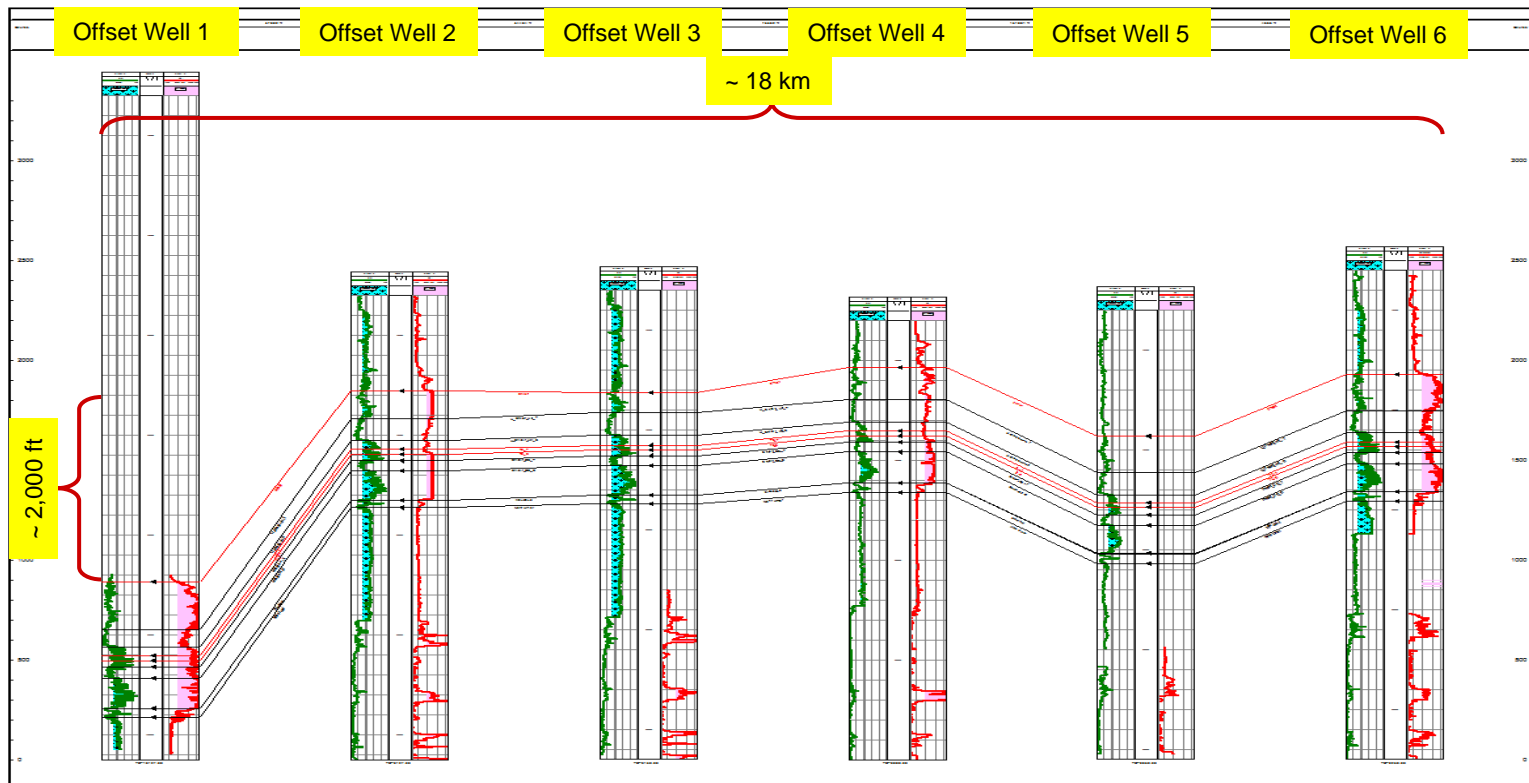


Challenges

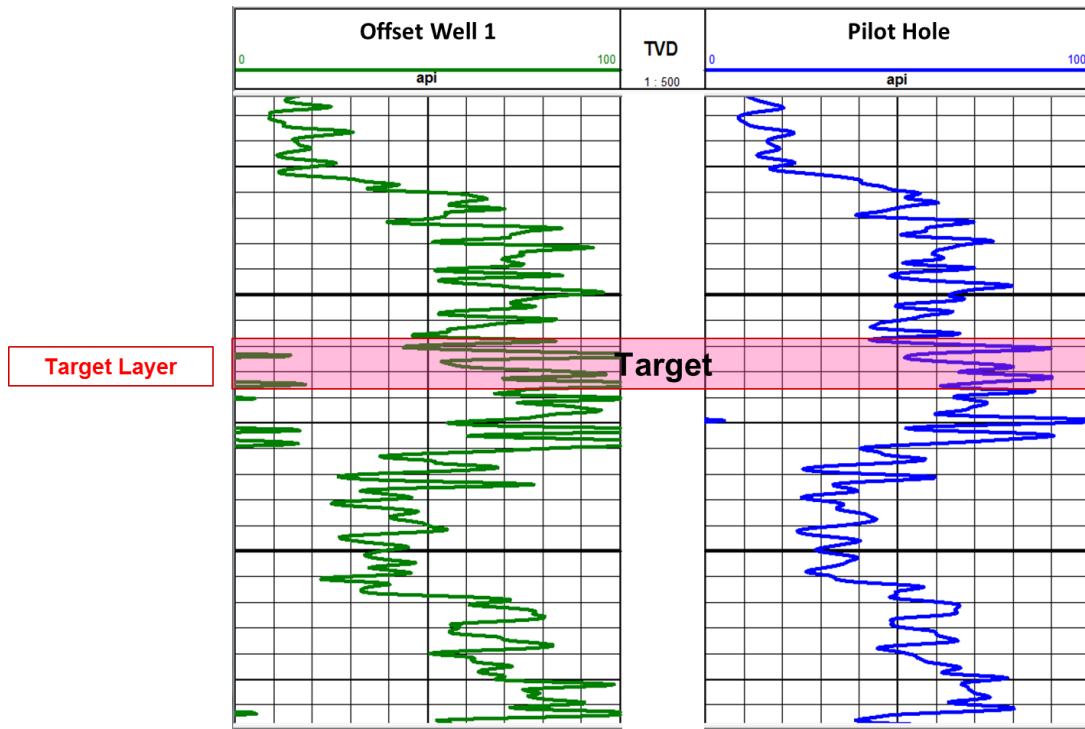
are...

- **Earth model uncertainty (formation dipping, faults, etc.)**
- **Reservoir properties uncertainty**
- **Maximizing reservoir contact within +/- 3 ft true vertical thickness (TVT)**
- **Avoiding water zone**
- **Logging-while-drilling (LWD) tools selection and limitation**
- **Optimizing well plan**

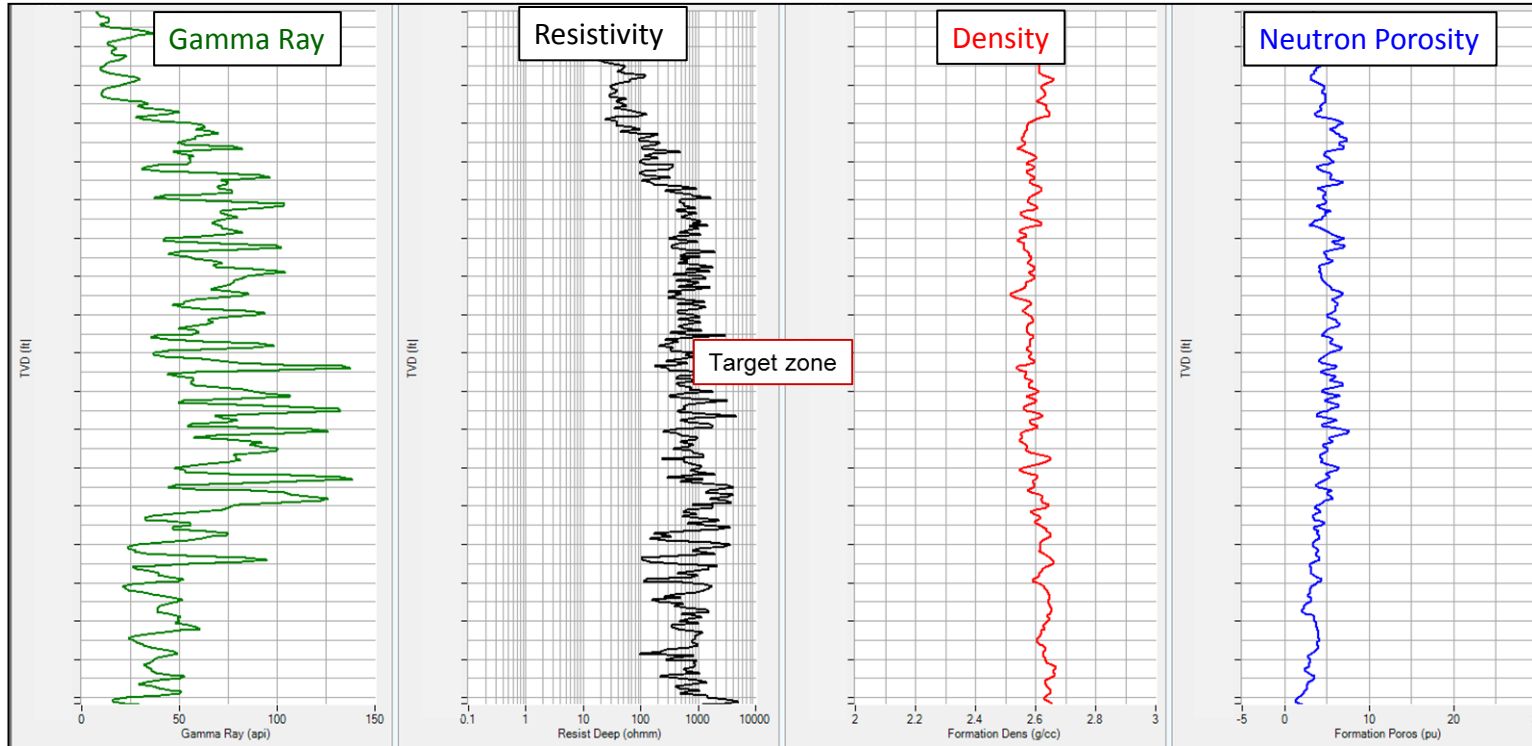
Structure Model



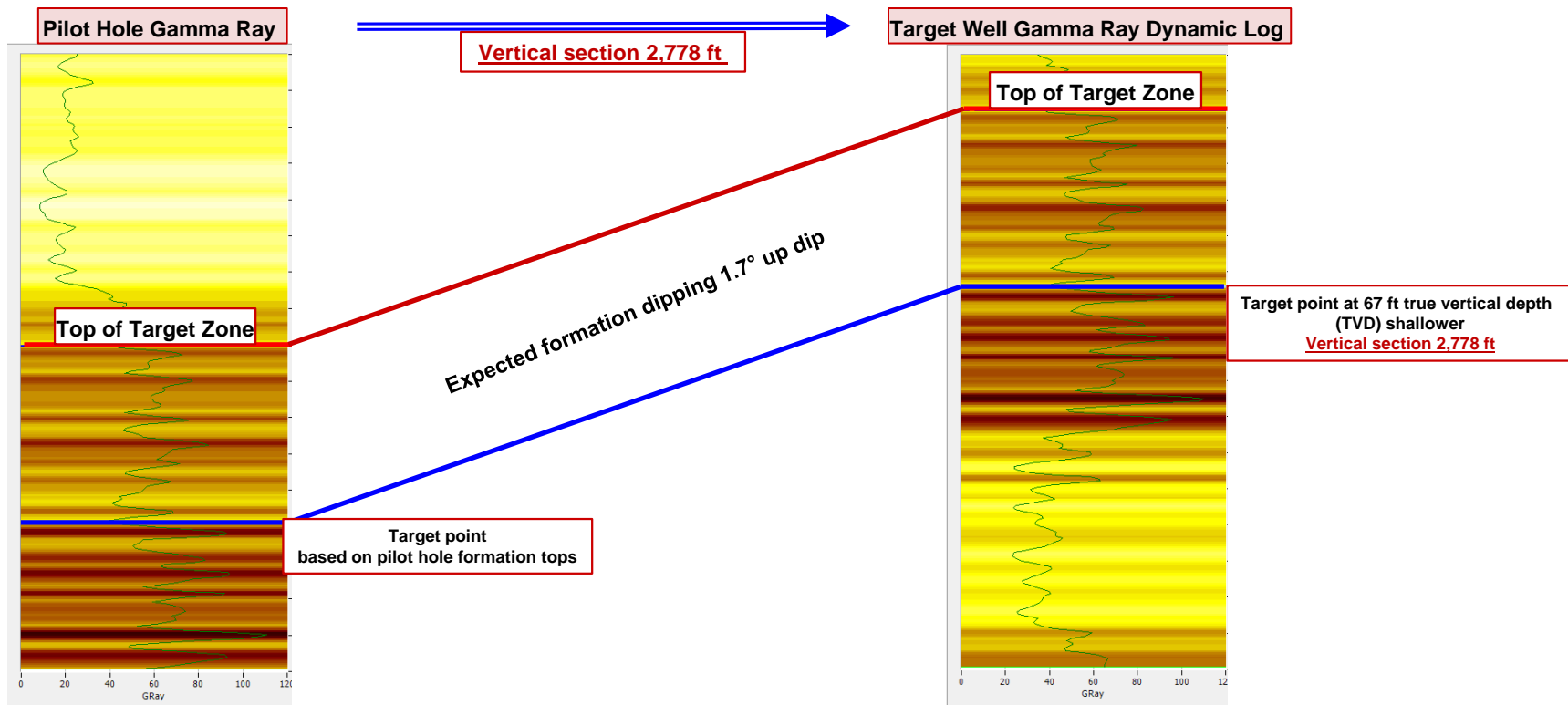
Offset Wells Correlation



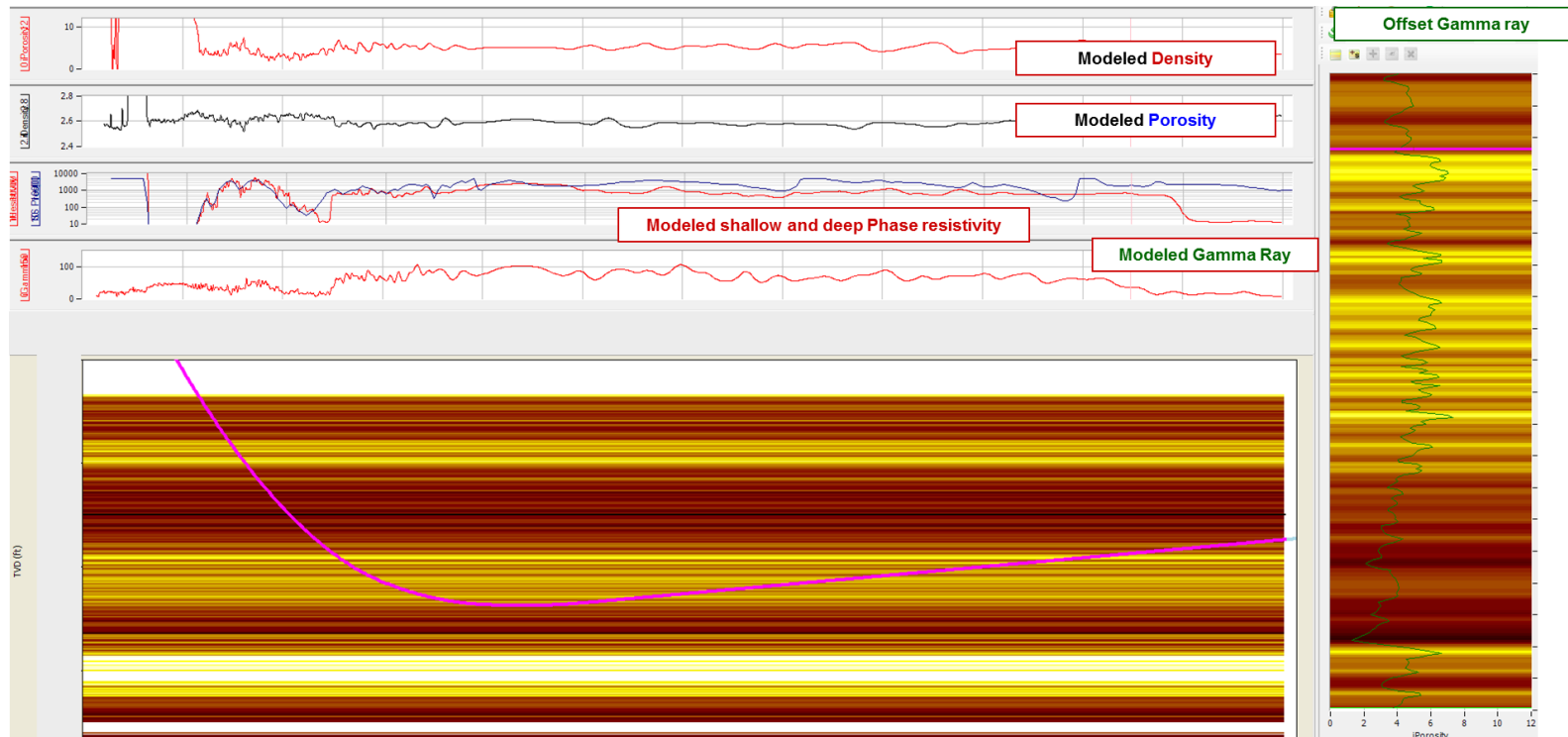
Offset Well 1 Logs



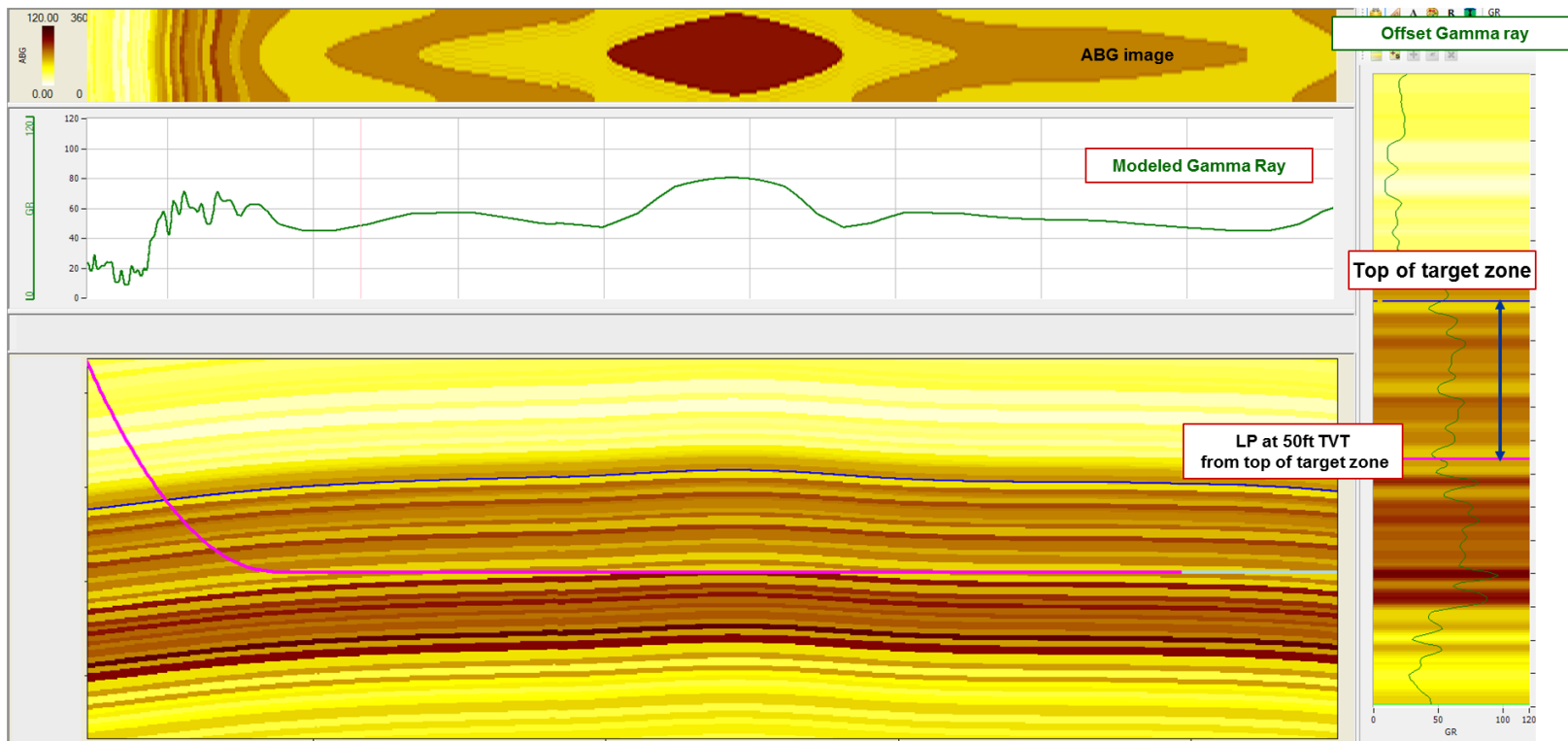
Target Well Prognosis



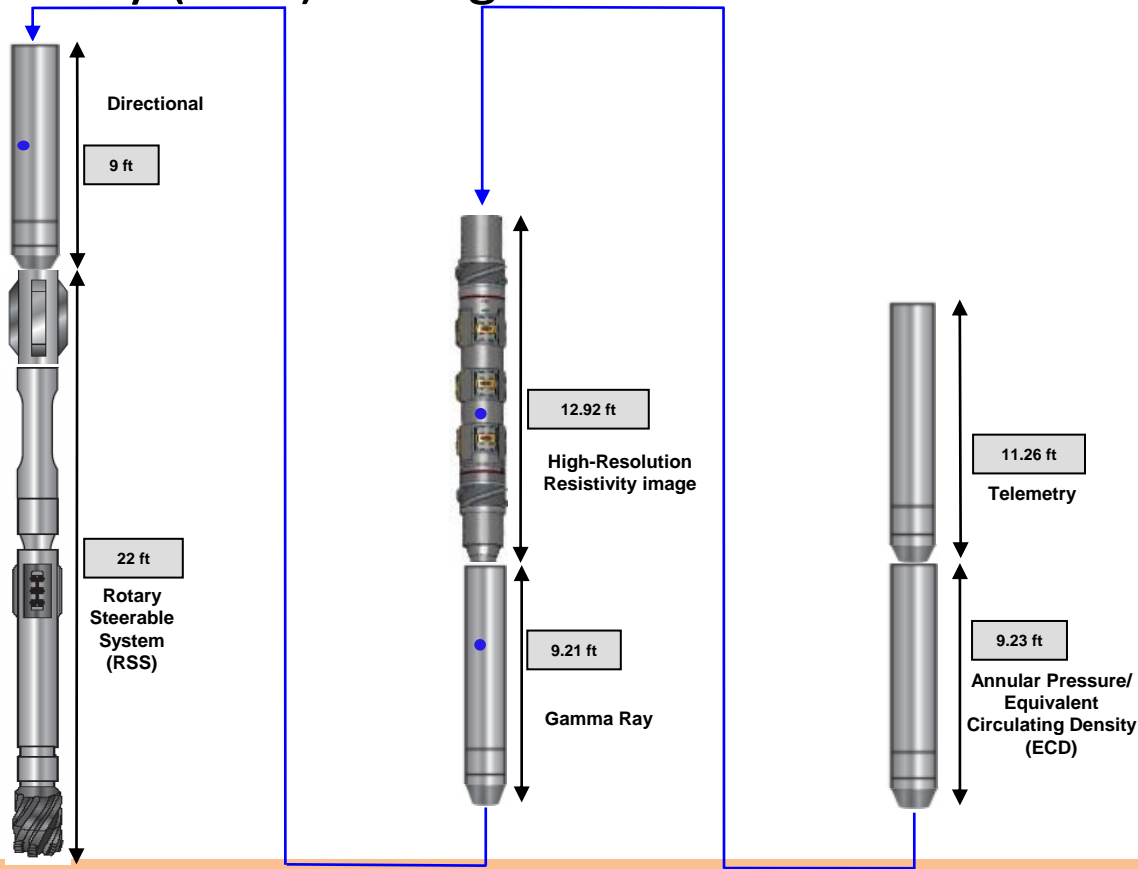
Forward Modeling for Gamma Ray, Resistivity, Density, and Porosity



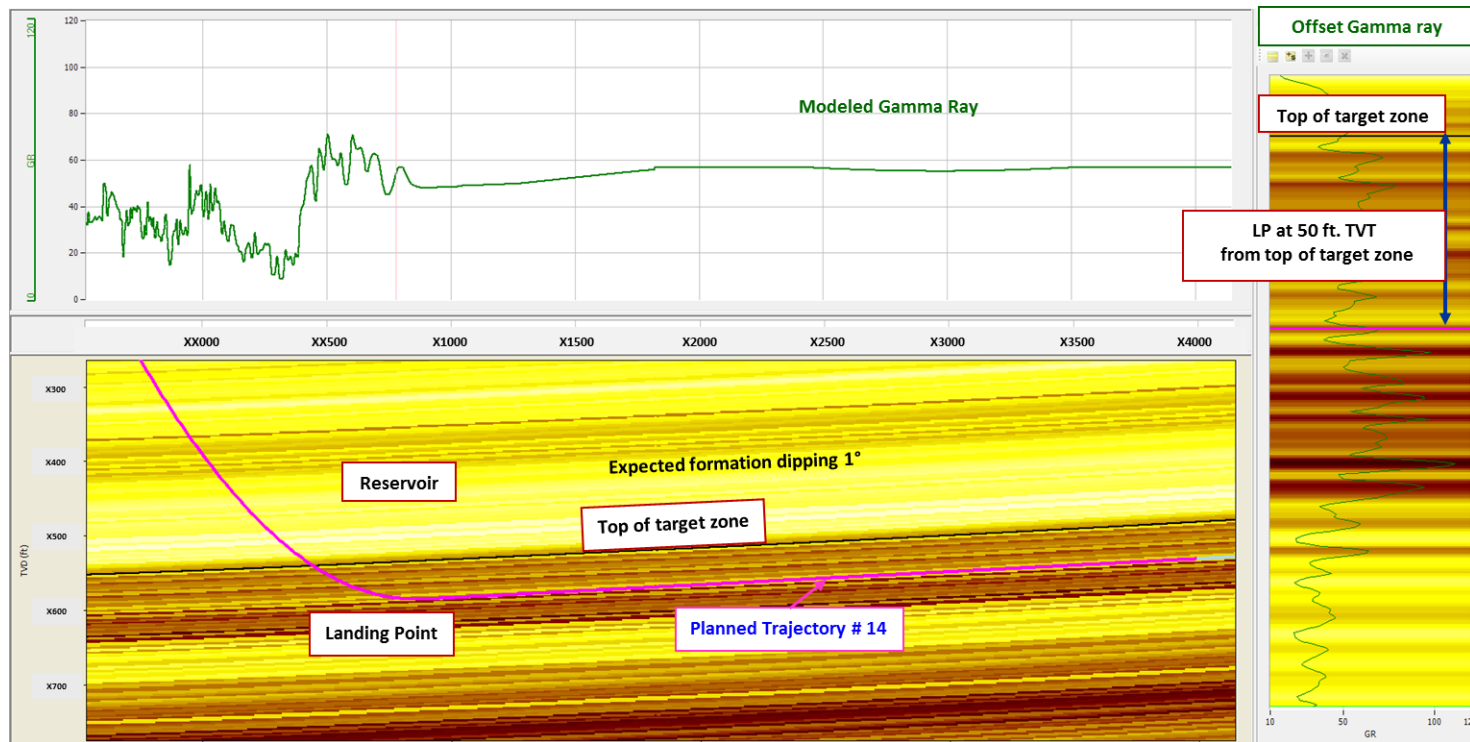
Forward Modeling Cutting-Up and Cutting-Down Scenarios



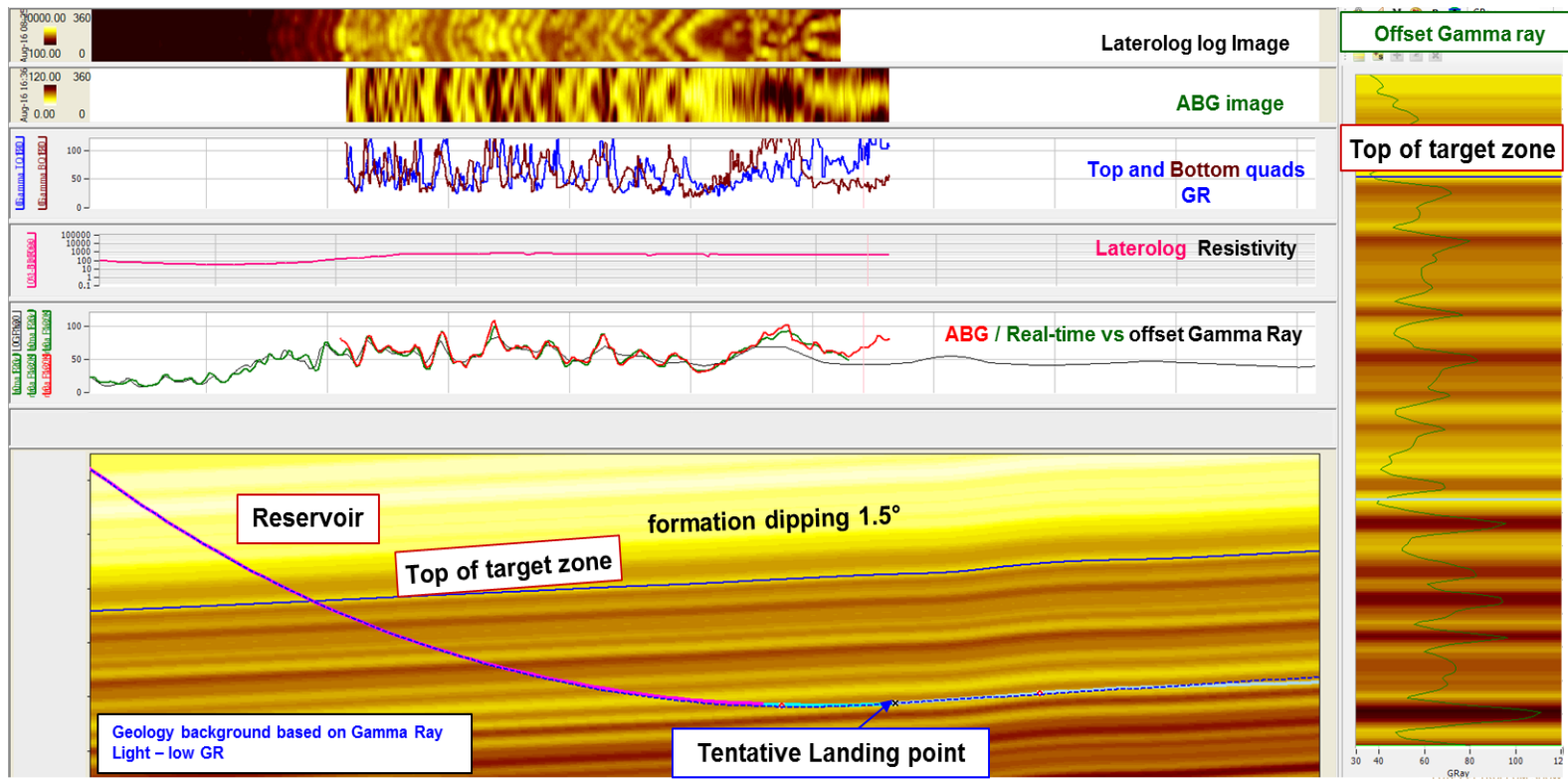
Bottomhole Assembly (BHA) Configuration and Sensor Measure Points



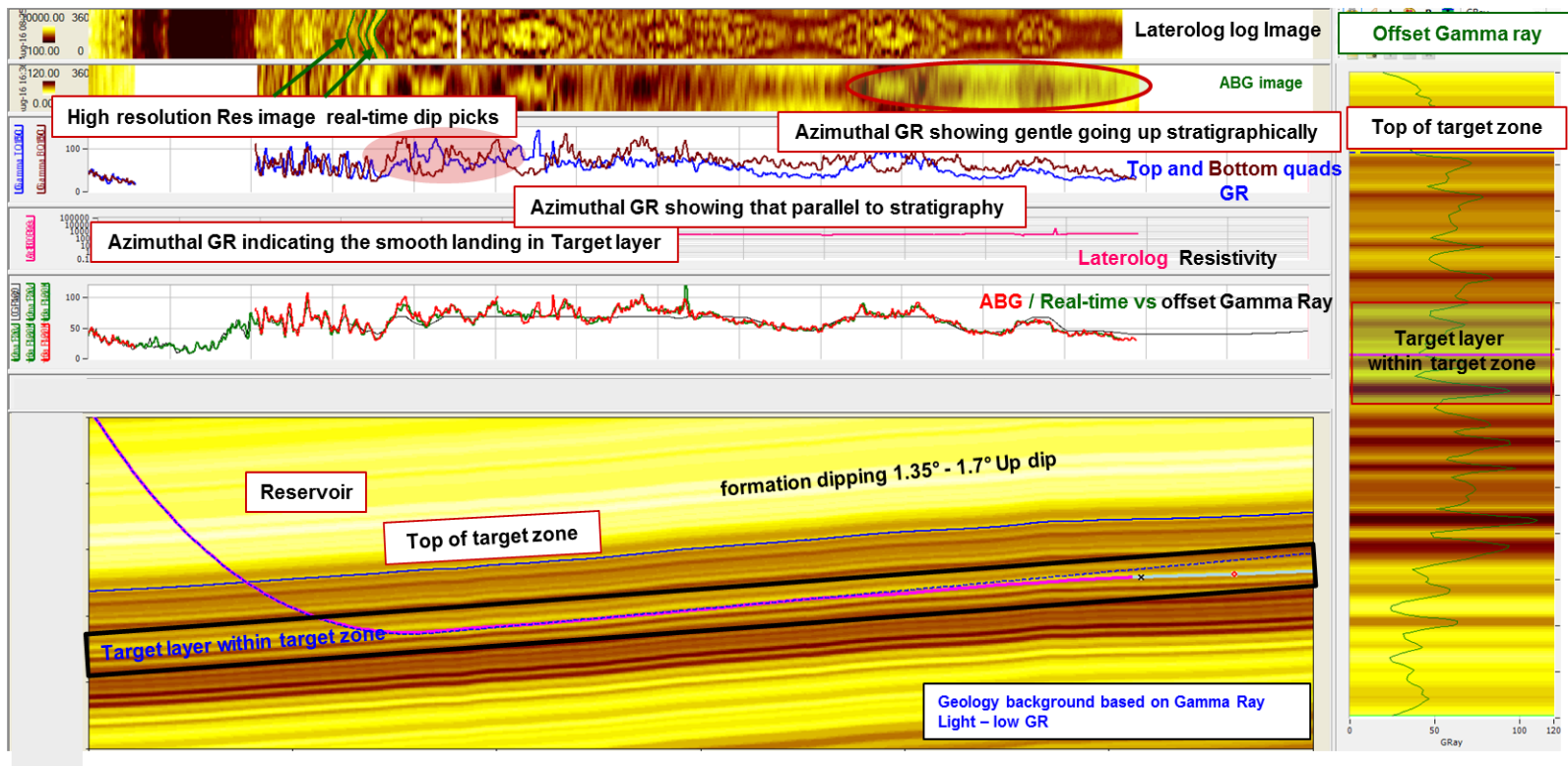
Forward Modeling Using Agreed Well Plan



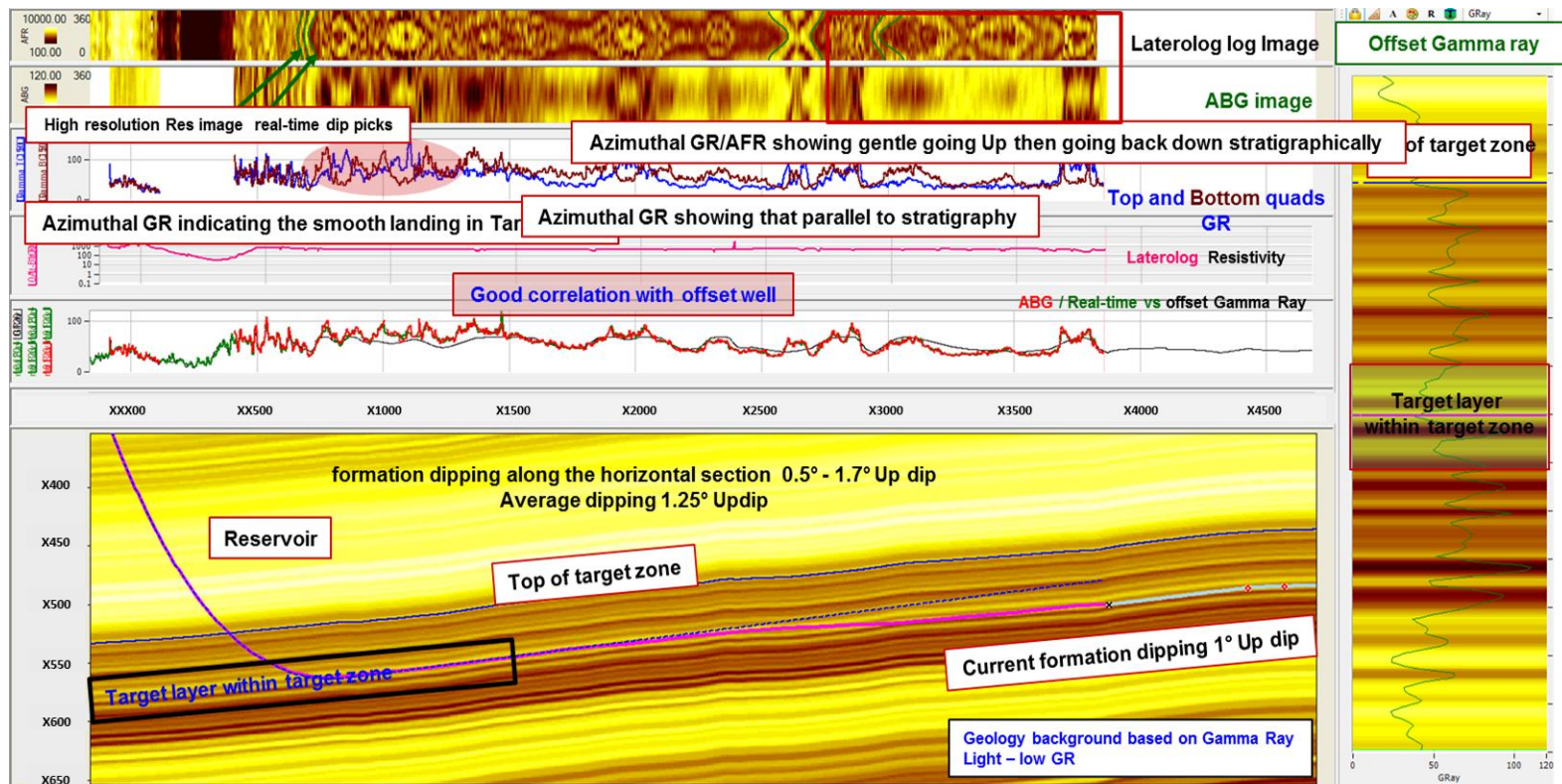
Landing the Well



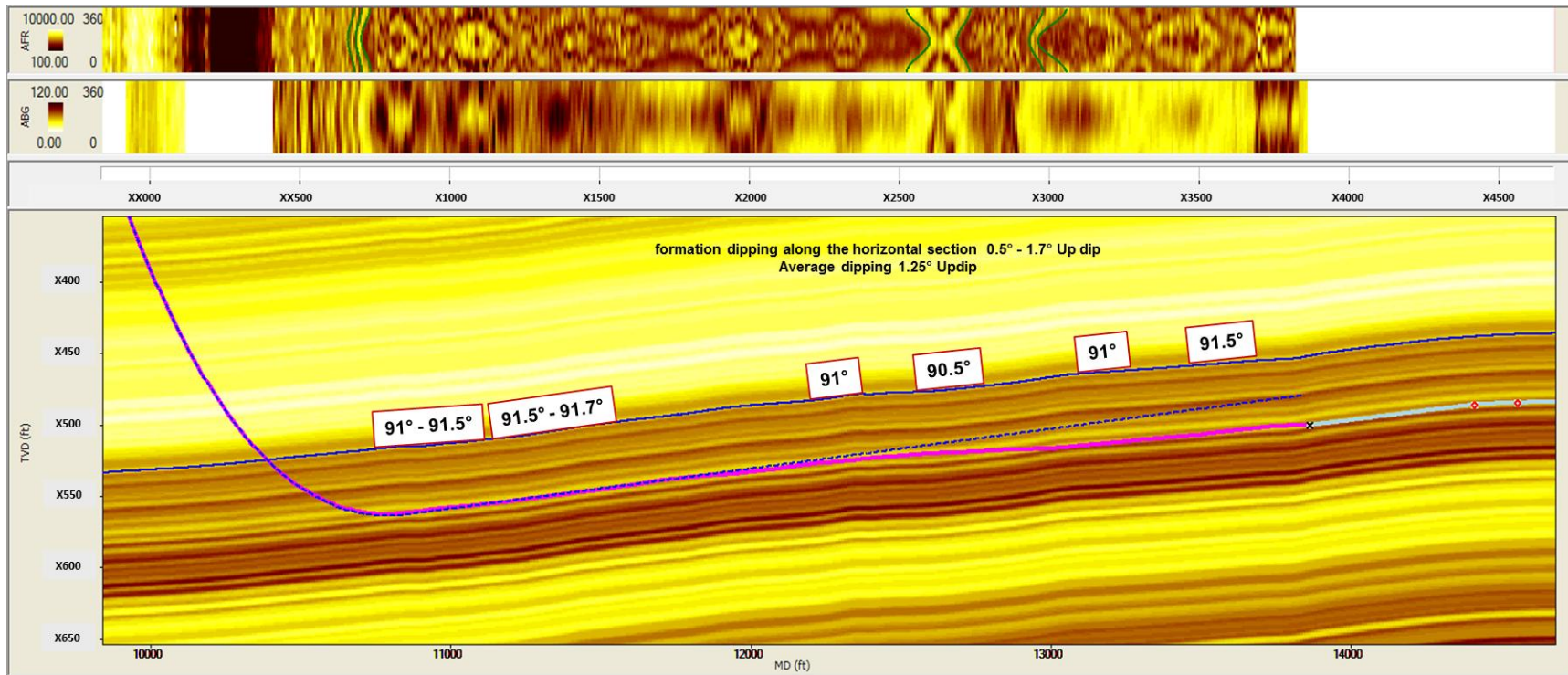
Horizontal Section



Horizontal Section



Geosteering Decisions



Conclusions

Optimized LWD configuration for landing in the lateral section

Precise landing within the reservoir (47 ft TVT from marker)

Maintained stratigraphic wellbore position within +/- 3 ft TVT

Achieved 100% reservoir contact

Lessons learned helped optimize costs



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Acknowledgements / Thank You / Questions

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