NFES

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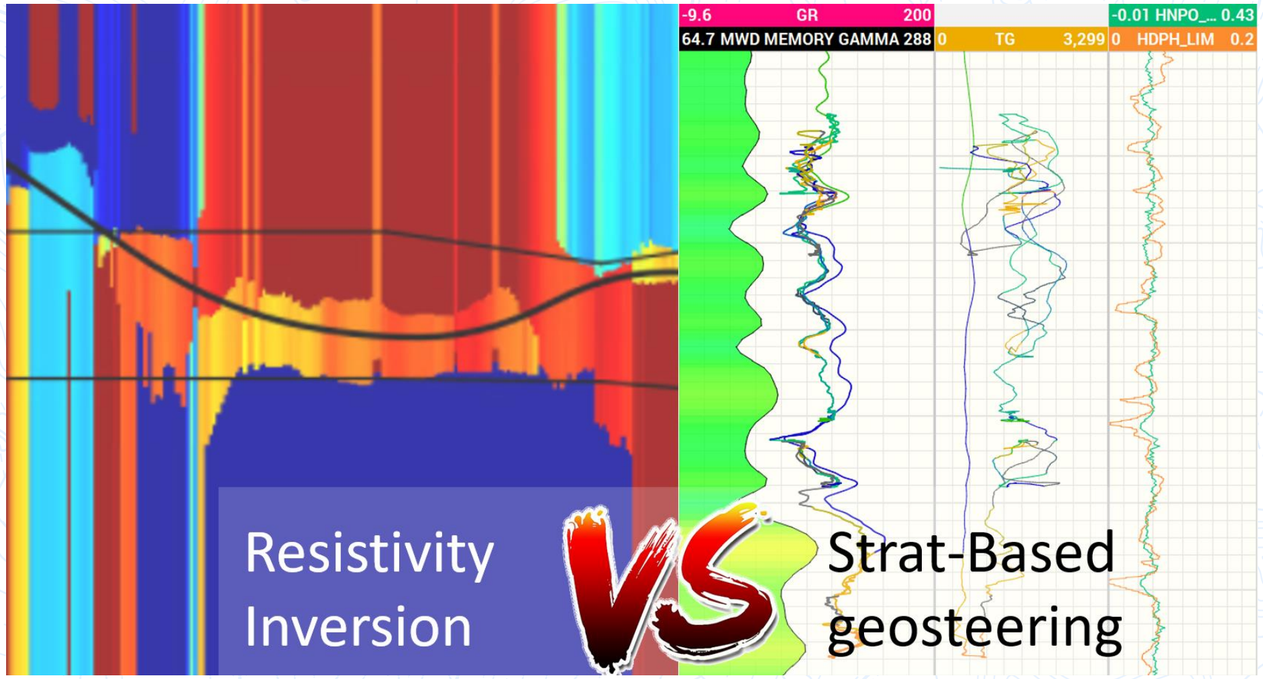
Geosteering in Conventional Reservoirs: what can we learn from US unconventional experience?

Igor Kuvaev
CTO ROGII



ROGII Overview

Customized software solutions for Upstream Oil & Gas

Team

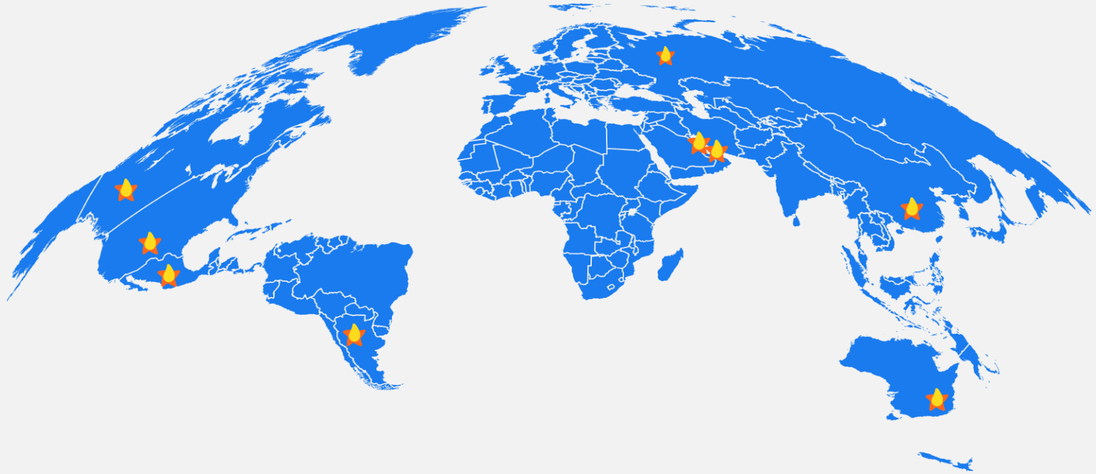
Over 100 geoscientists, mathematicians, in-house software engineers

Clients

- **300+** clients in over 10 countries: Oil & Gas, Service Companies
- **3000 +** multi disciplinary users (geology, drilling, completions, data analytics)
- Conventional/Unconventional projects

Company

- Founded in 2013
- Innovative spirit, unique know how, bulletproof stability
- Core belief that data should be integrated



United States | Canada | Argentina | Australia | China | Mexico | Qatar | UAE

StarSteer | StarLite | Solo RTM | Solo DTM | StarFrac

Clients at a glance

bp | Apache | REPSOL | noble energy | OXY | ConocoPhillips | TOTAL

CONCHO | XTO ENERGY | DIAMONDBACK Energy | Chevron | devon | Canadian Natural | Ovintiv

Difficulties of Conventional vs. Unconventional Geosteering

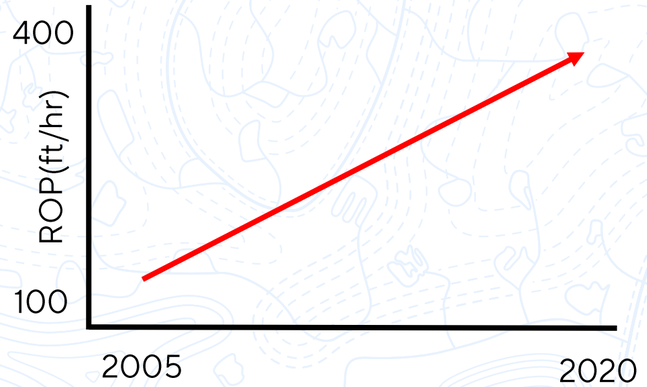
Conventional

- Laterally discontinuous reservoirs, channels, lenses
- "Complex Channel Sands"

Lower Frasier River, BC, Canada – possible analogue for McMurray Fm.

Unconventional

- "Drill cheaper and faster!"
  - Bare bone downhole tools
  - Ever increasing ROP
  - Spotty/dirty data
- Real-time well adjustments made in seconds to minutes
- Downhole data measures directly adjacent bedrock



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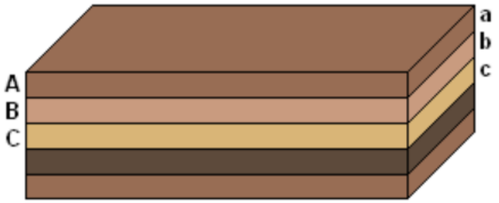
Brief History of Unconventional North America Wells



- 2005 to 2010 – Development of Barnette and Marcellus
  - 45 days per well, full suite of tools (triple combo)
  - Data analyzed in general geoscience solution, Excel, sometimes even paper print outs
- 2010s – Full scale development of Bakken, Eagle Ford, Permian and more …
  - "We need you to drill these wells faster with less downhole tools!"
  - Operators forced to increase ROI – reduce drilling days and slim down MWD tools
  - New reservoir complexities:
    - Changing facies, discontinuous reservoirs, debris flows, highly faulted/structured
- New drilling evolution required new methods to process and analyze data more effectively

Lower Eagle Ford Outcrop

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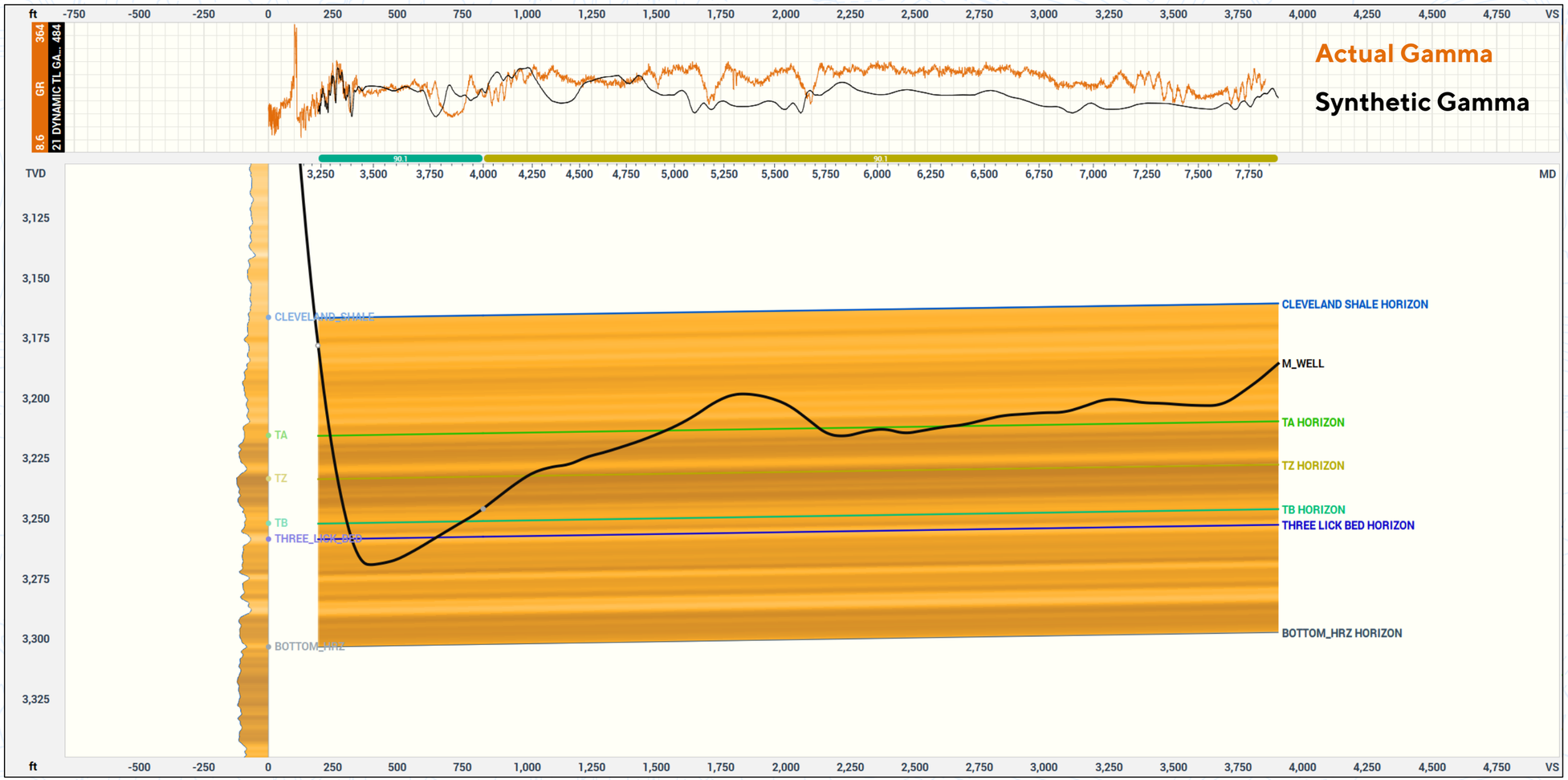
Early Geosteering Approach: Model-Based

- Method: Compare synthetic log to actual measured data, adjust bed model to fit
- Assumes continuous formation with typewell log signature
- Synthetic log based on low resolution typelog



Marcellus Formation

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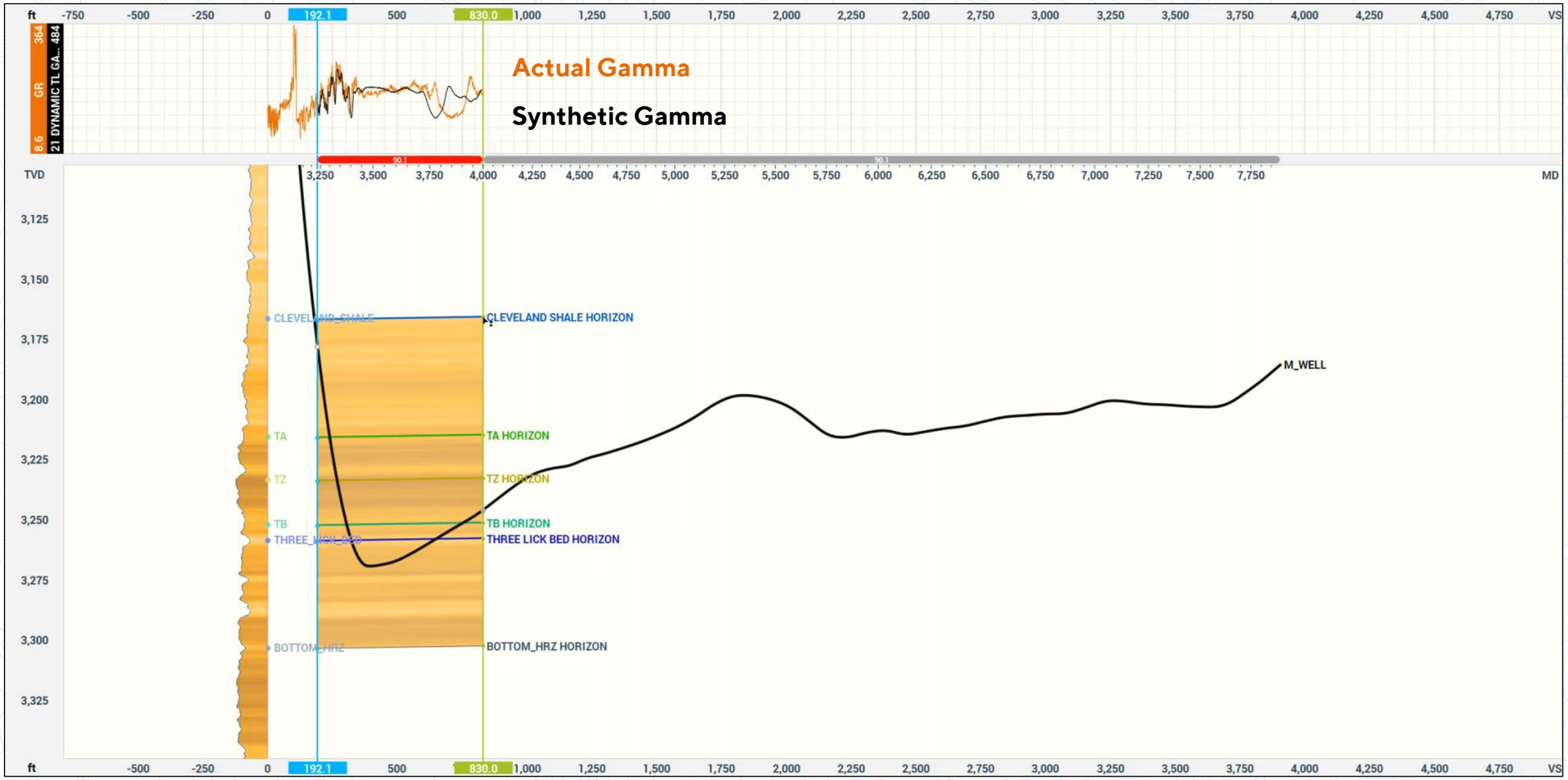
Early Geosteering Approach: Model-Based

- Difficult to determine highest confidence bed model interpretation
- Notice low resolution Synthetic Gamma



Marcellus Formation

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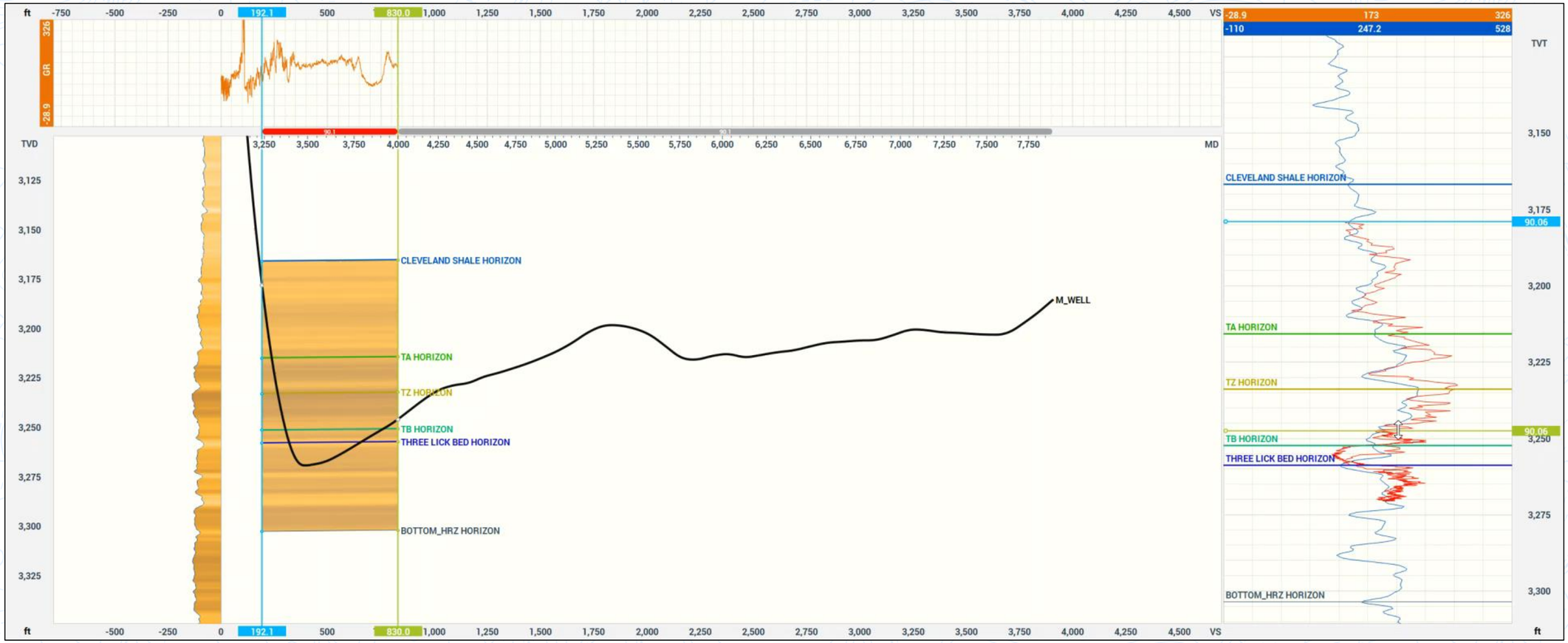
Modern Geosteering Approach: Stratigraphy-Based

- Method: Compare acquired data directly back to typelog in True Vertical Thickness (TVT) scale
- Possible to identify lateral reservoir changes (“steering on itself”)
- Higher confidence interpreted bed models due to high resolution correlation



Marcellus Formation

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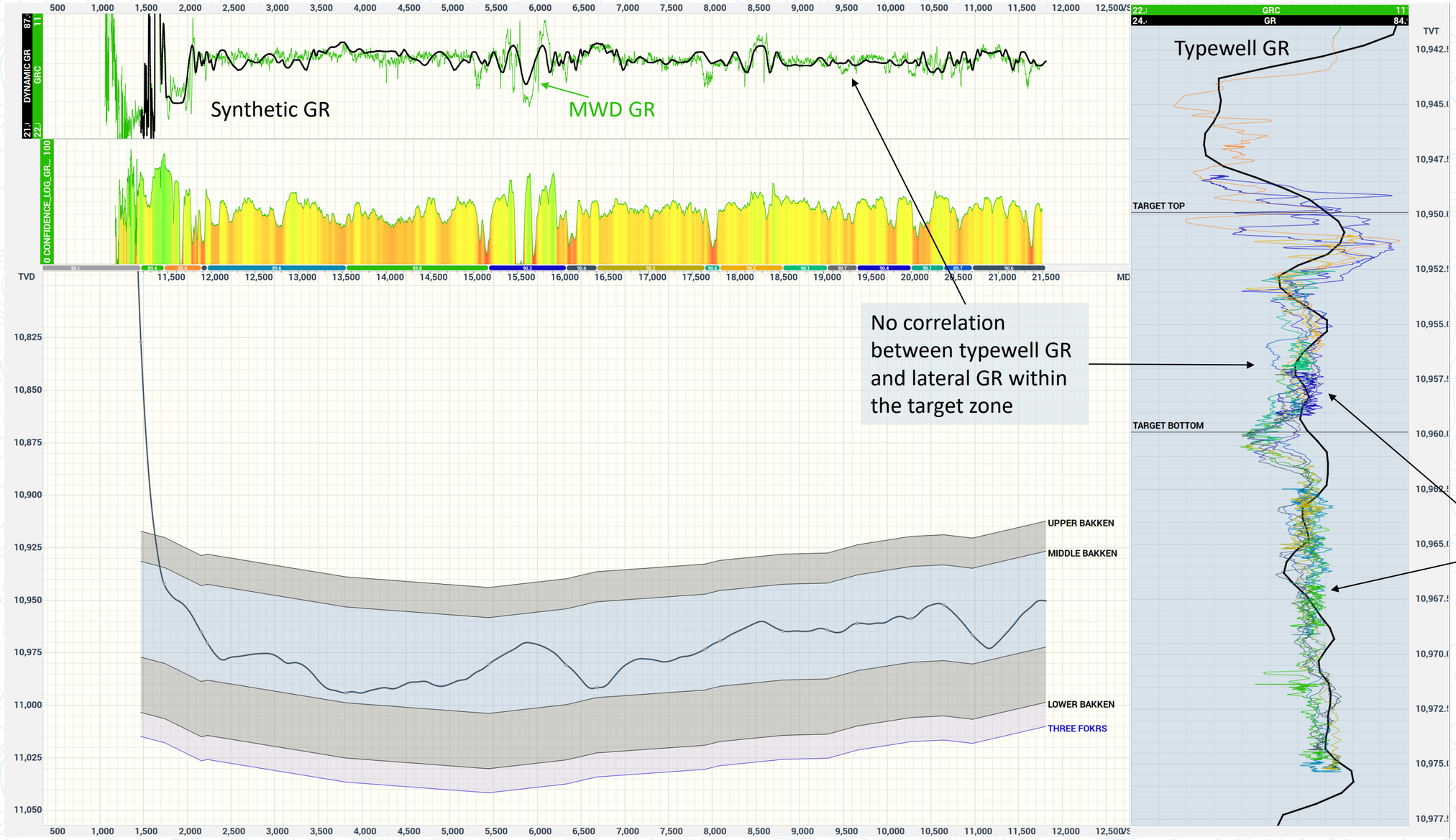
Modern Geosteering Approach: Stratigraphy-Based



Strat-based approach

Strat-based geosteering: The lateral GR data can be verticalized and correlated on itself

Bakken

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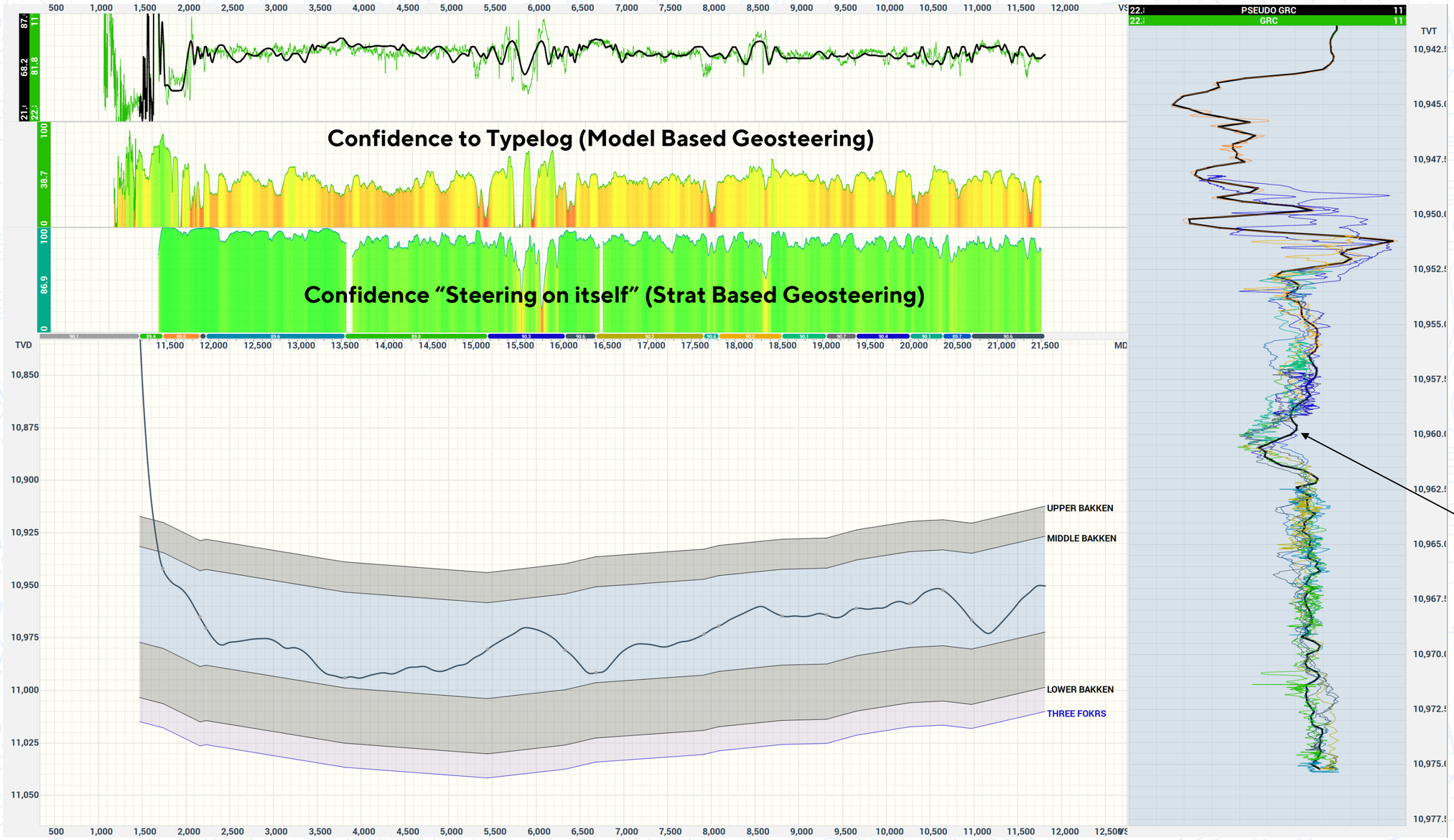
Modern Geosteering Approach: Stratigraphy-Based



Pseudo-typewell can be created from verticalized lateral GR data

Bakken

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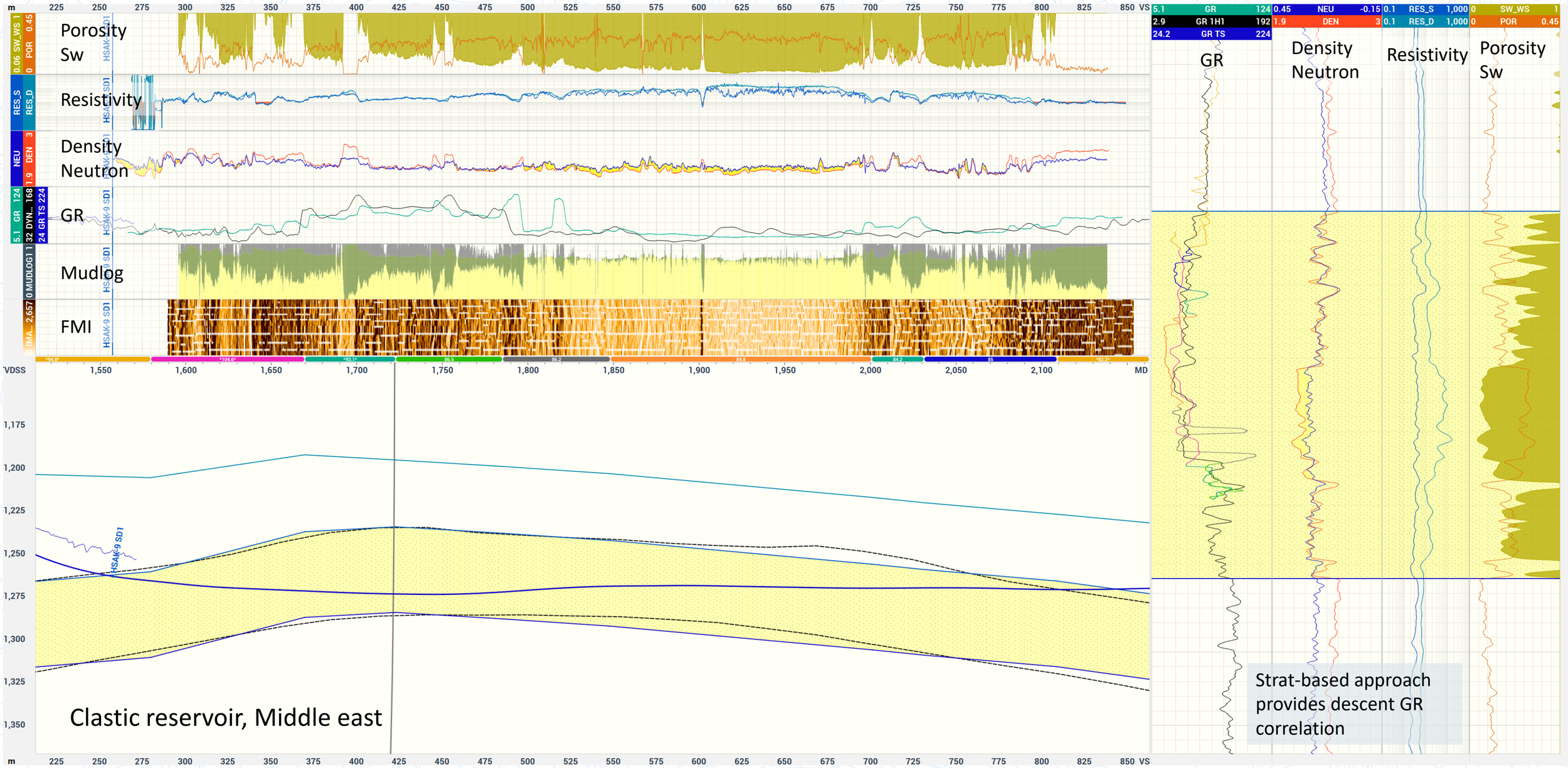
Geosteering in data-rich environment



Conventional geosteering challenge

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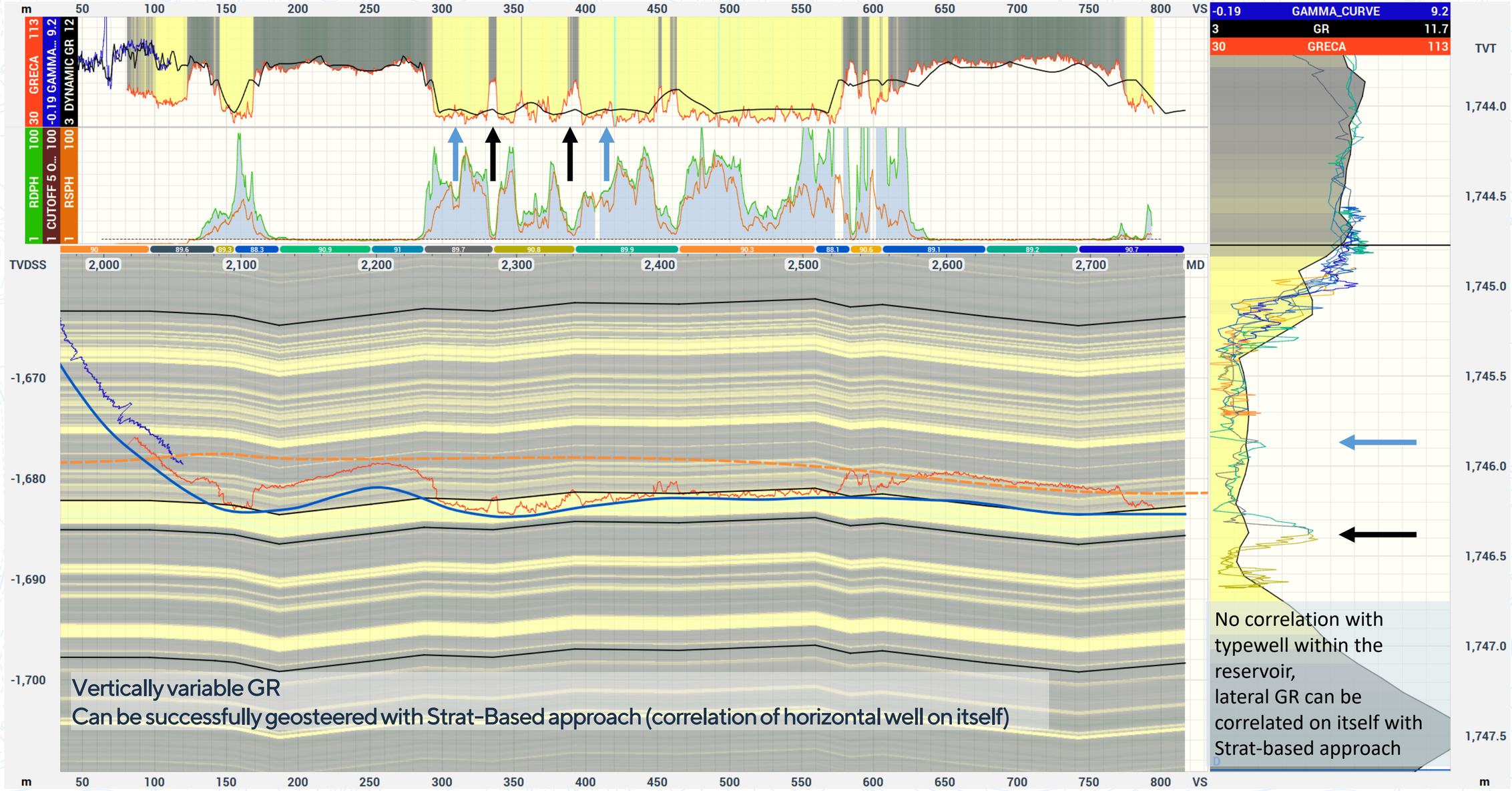
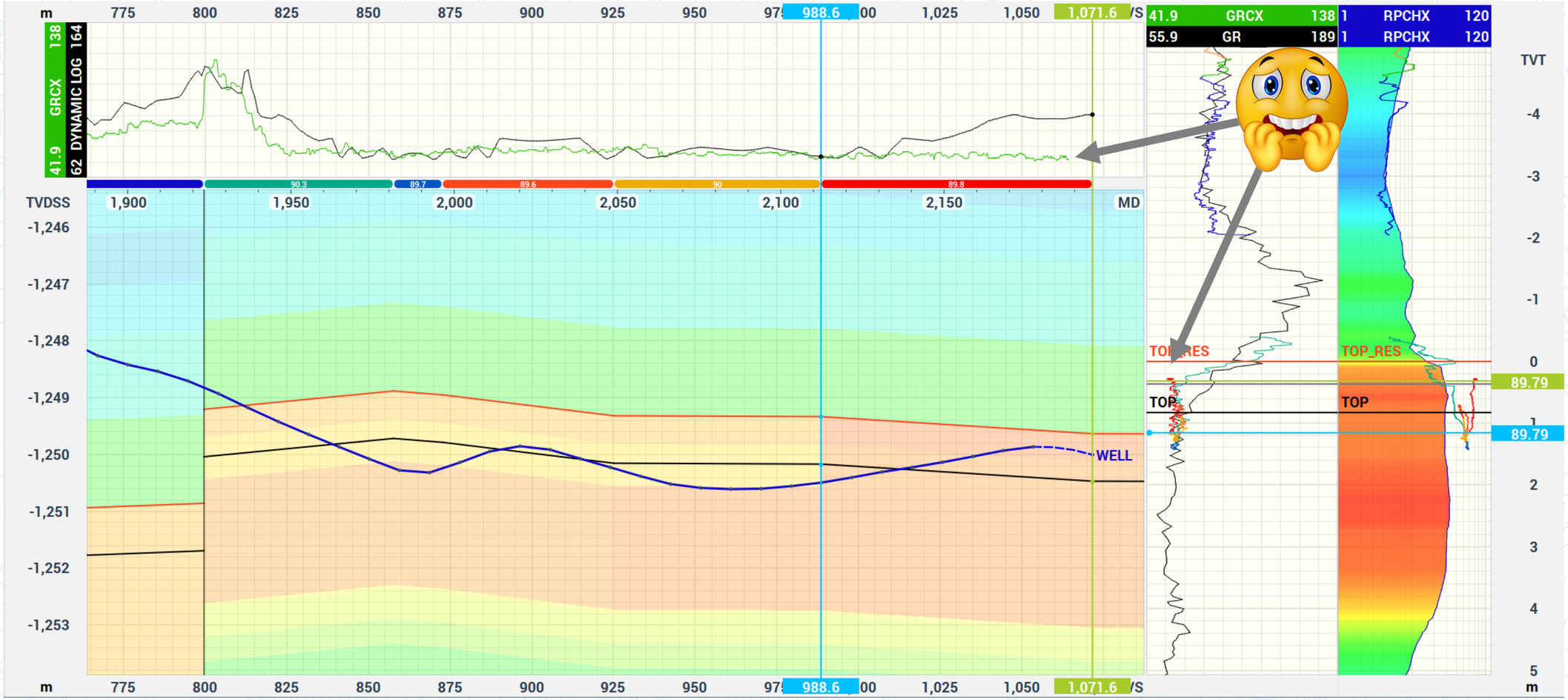


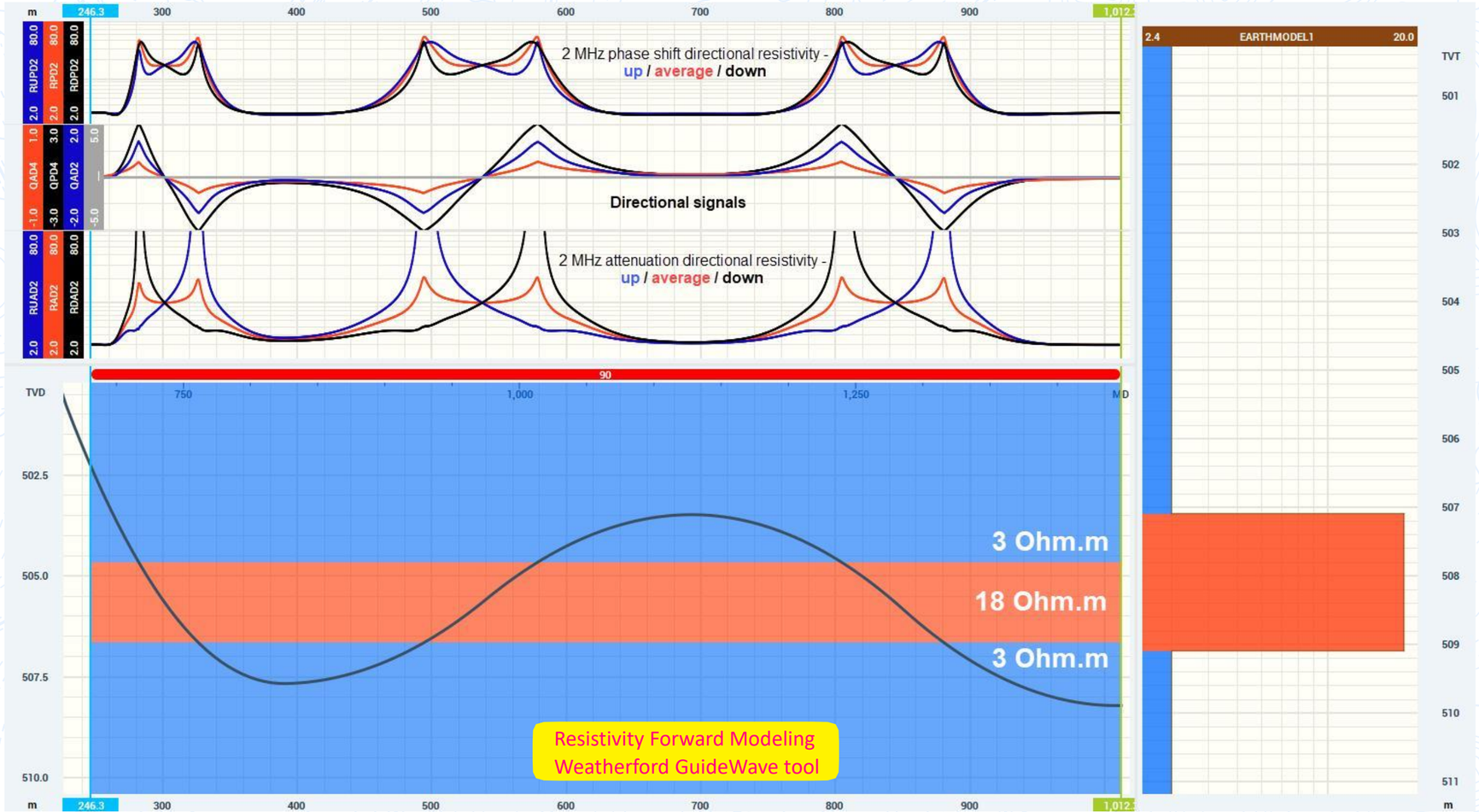
Conventional geosteering challenge



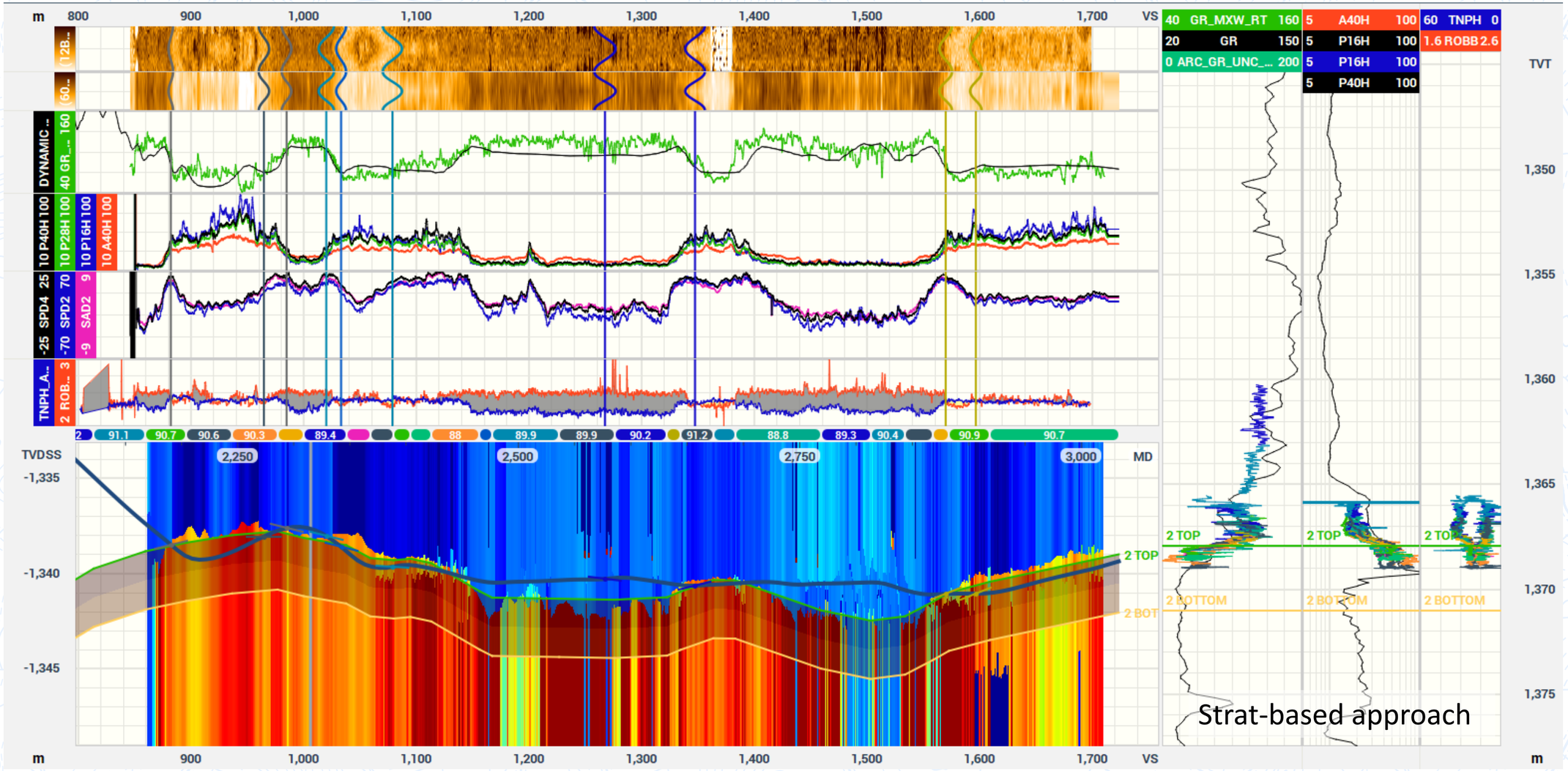
Poor GR correlation, propagation resistivity is needed

Resistivity Data – Why?

- Not enough GR contrast in target
  - Conventional
  - Heavy oil
  - Carbonates
- Ability to calculate distance to boundary
- Resistivity interpretation technique is different from GR



Multilayer Stochastic Inversion in StarSteer



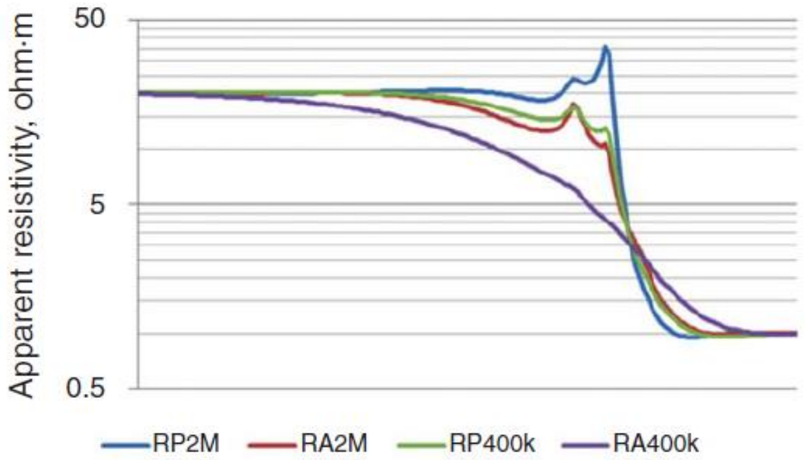
11:00 Session 17A – Geosteering

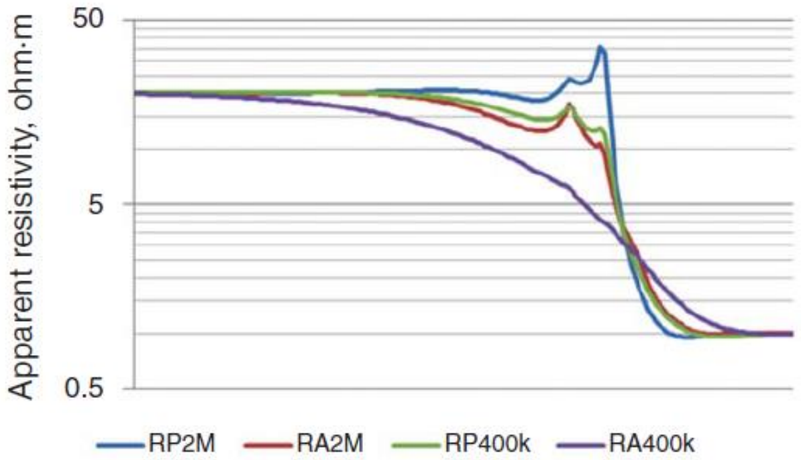
11:05 SPWLA-2021-0103 VENDOR-NEUTRAL STOCHASTIC INVERSION OF LWD DEEP AZIMUTHAL RESISTIVITY DATA AS A STEP TOWARD EFFICIENCY STANDARDIZATION OF GEOSTEERING SERVICES

Mikhail Sviridov, Anton Mosin, Sergey Lebedev, ROGII Inc. and Ron Thompson, Beach Energy Limited

Schlumberger Peiscope HD tool (azimuthal resistivity), clastic reservoir, Australia

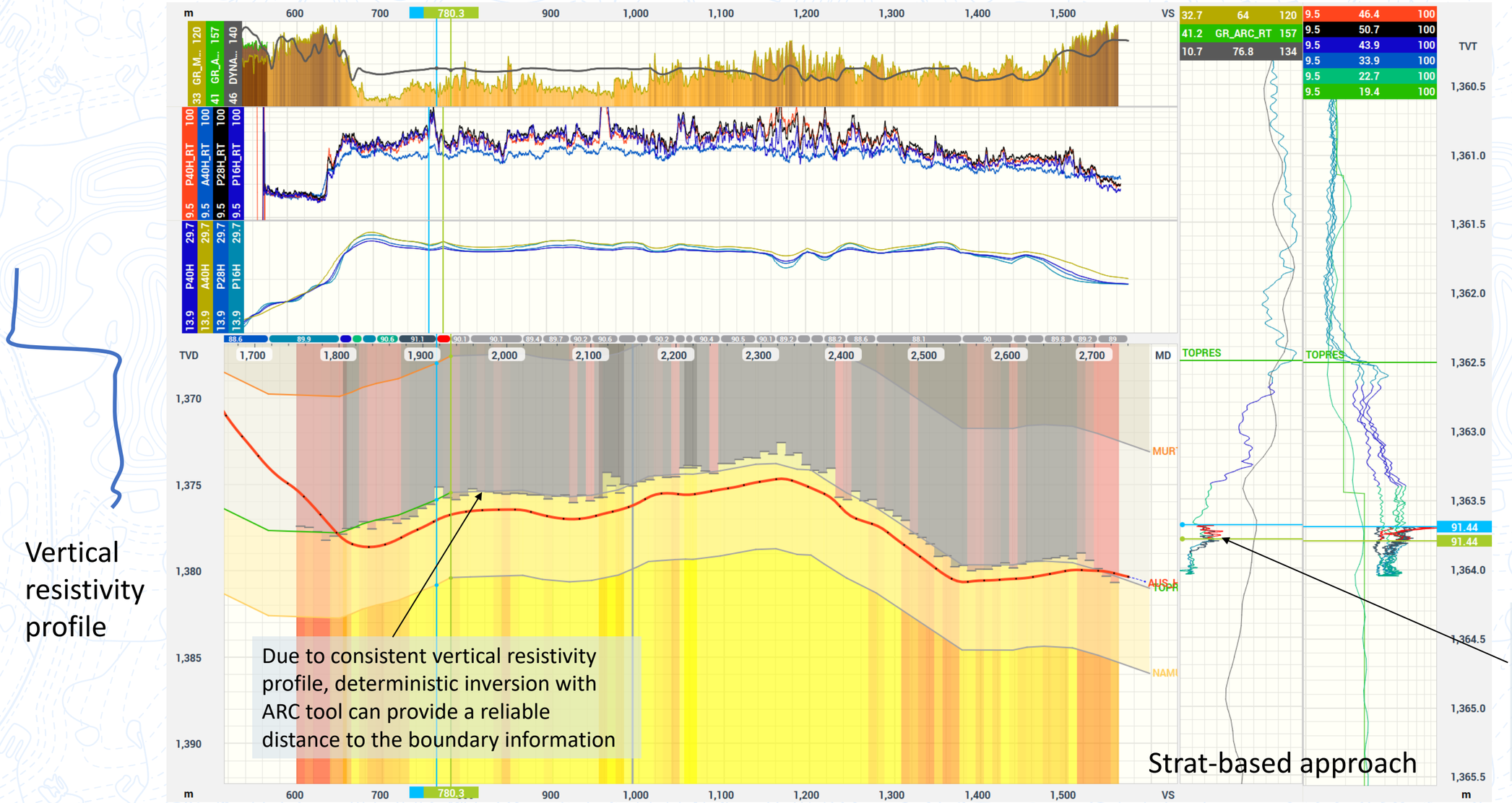
2 types of tools: propagation and azimuthal





- Most tools are propagation resistivity (omnidirectional)
- Additional geological constraints are needed for inversion

2 Layer deterministic inversion



Vertical resistivity profile

Due to consistent vertical resistivity profile, deterministic inversion with ARC tool can provide a reliable distance to the boundary information

Strat-based approach

The lateral GR data can be verticalized and correlated on itself
No correlation with typewell GR

Schlumberger ARC tool (propagation resistivity), clastic reservoir, Australia

2-layer deterministic inversion

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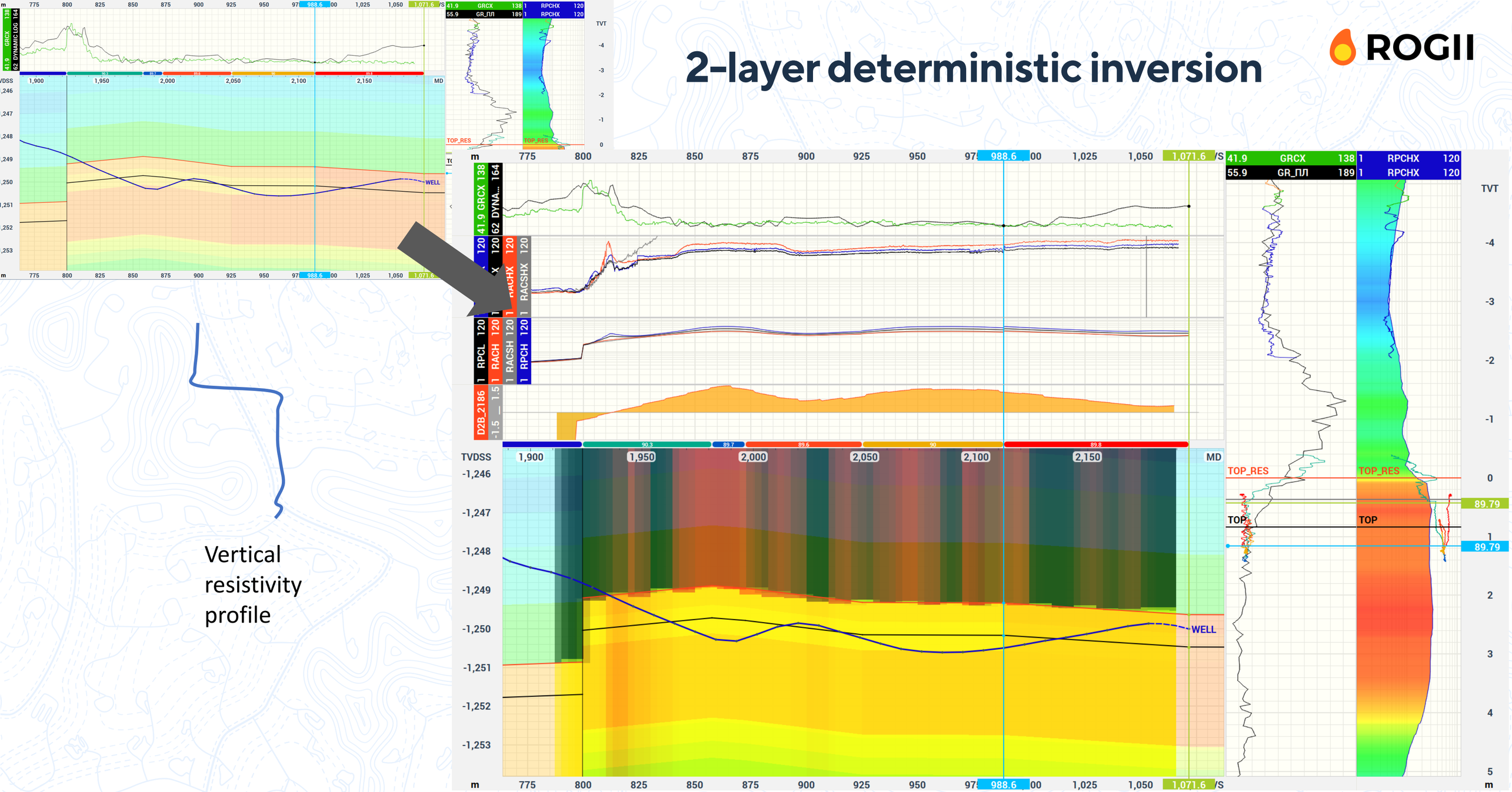
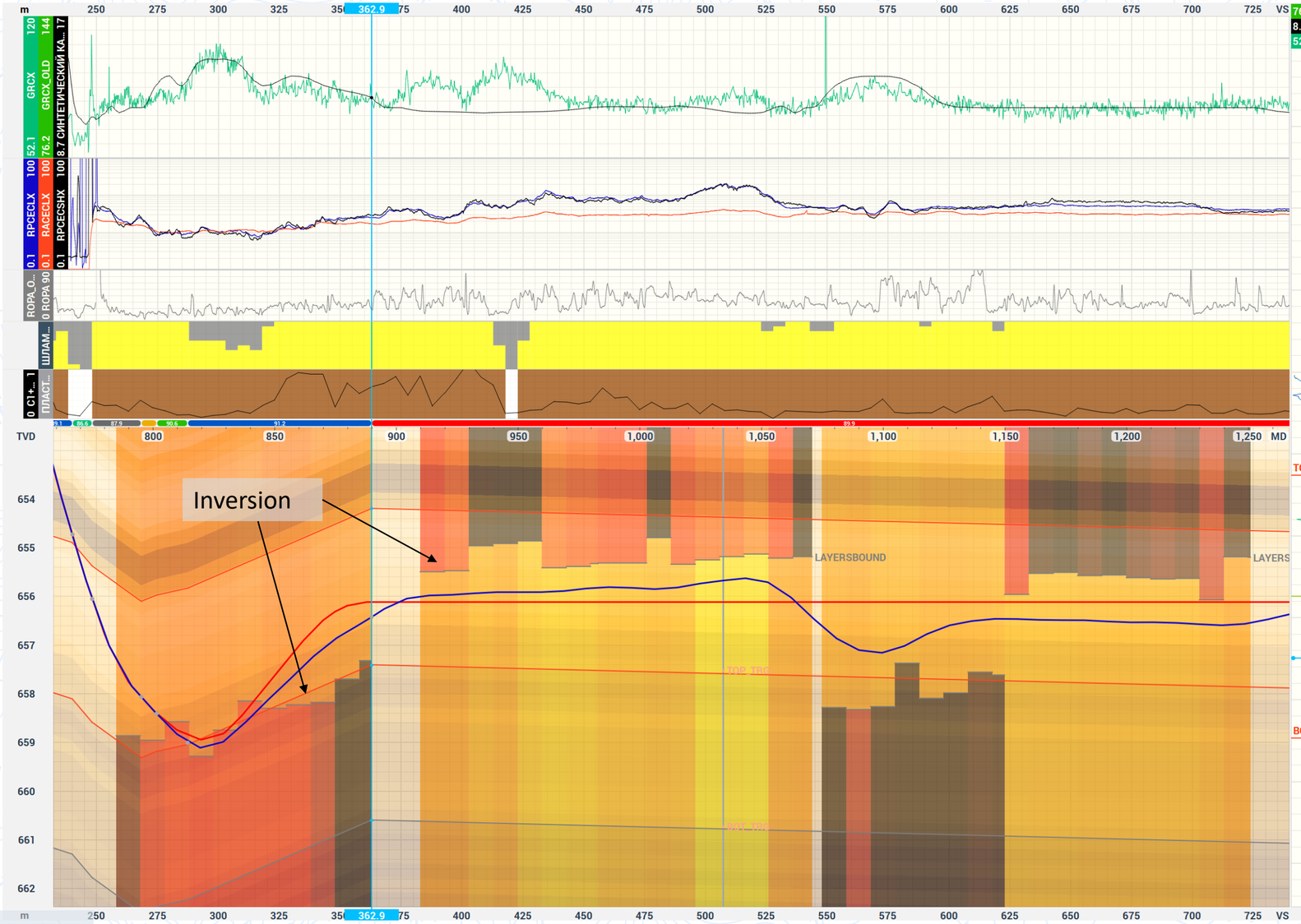


Vertical resistivity profile

Distance to the boundary, propagation resistivity tool (MPR from BakerHughes)

2-layer deterministic inversion

Vertical resistivity profile

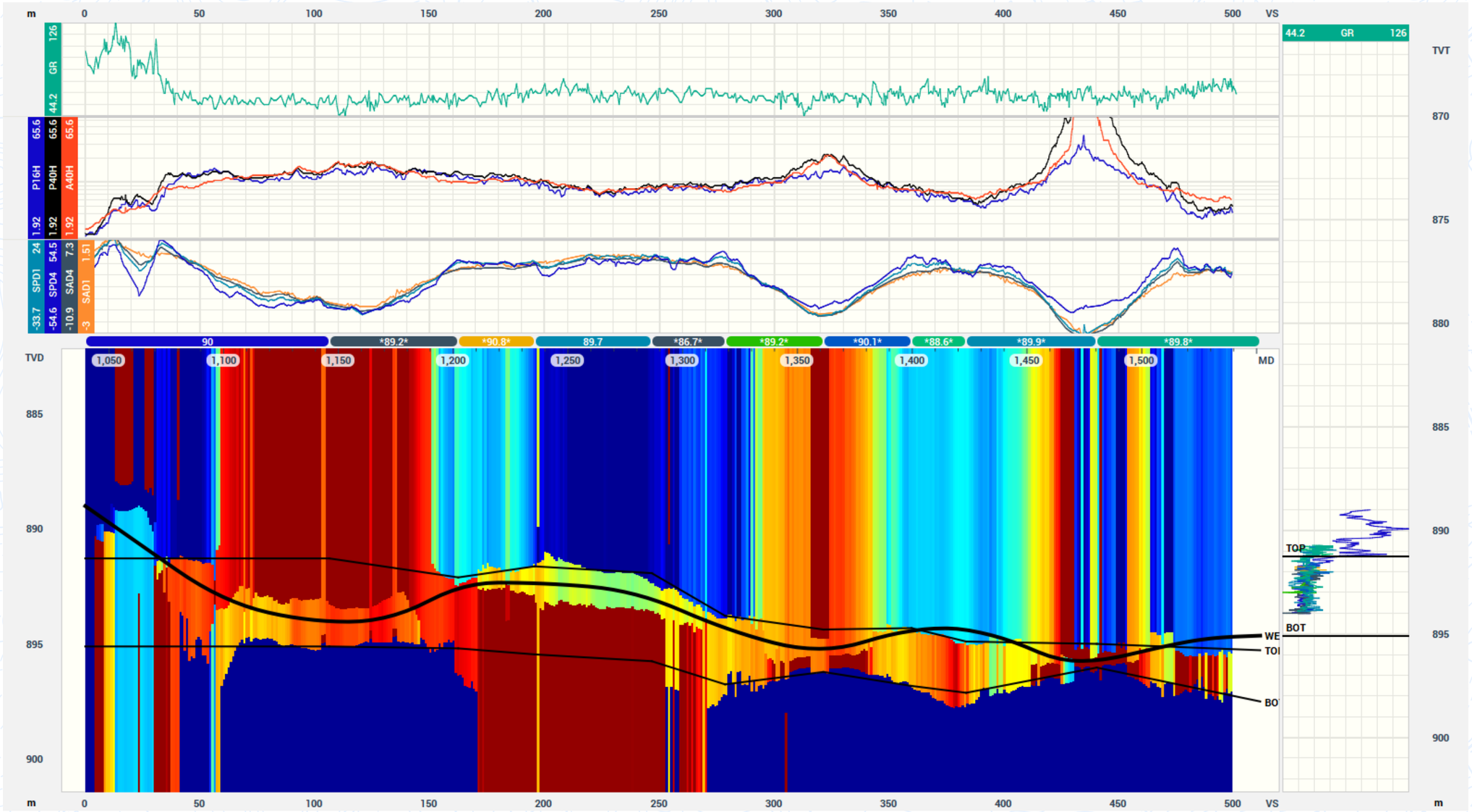


Strat-based approach

Deterministic inversion is constrained by geosteering model obtained from Strat-based geosteering

Distance to the boundary, propagation resistivity tool (WPR from APS)

Multilayer Stochastic Inversion in StarSteer



Schlumberger Peiscope tool (azimuthal resistivity), clastic laterally discontinuous reservoir

Thank you!

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