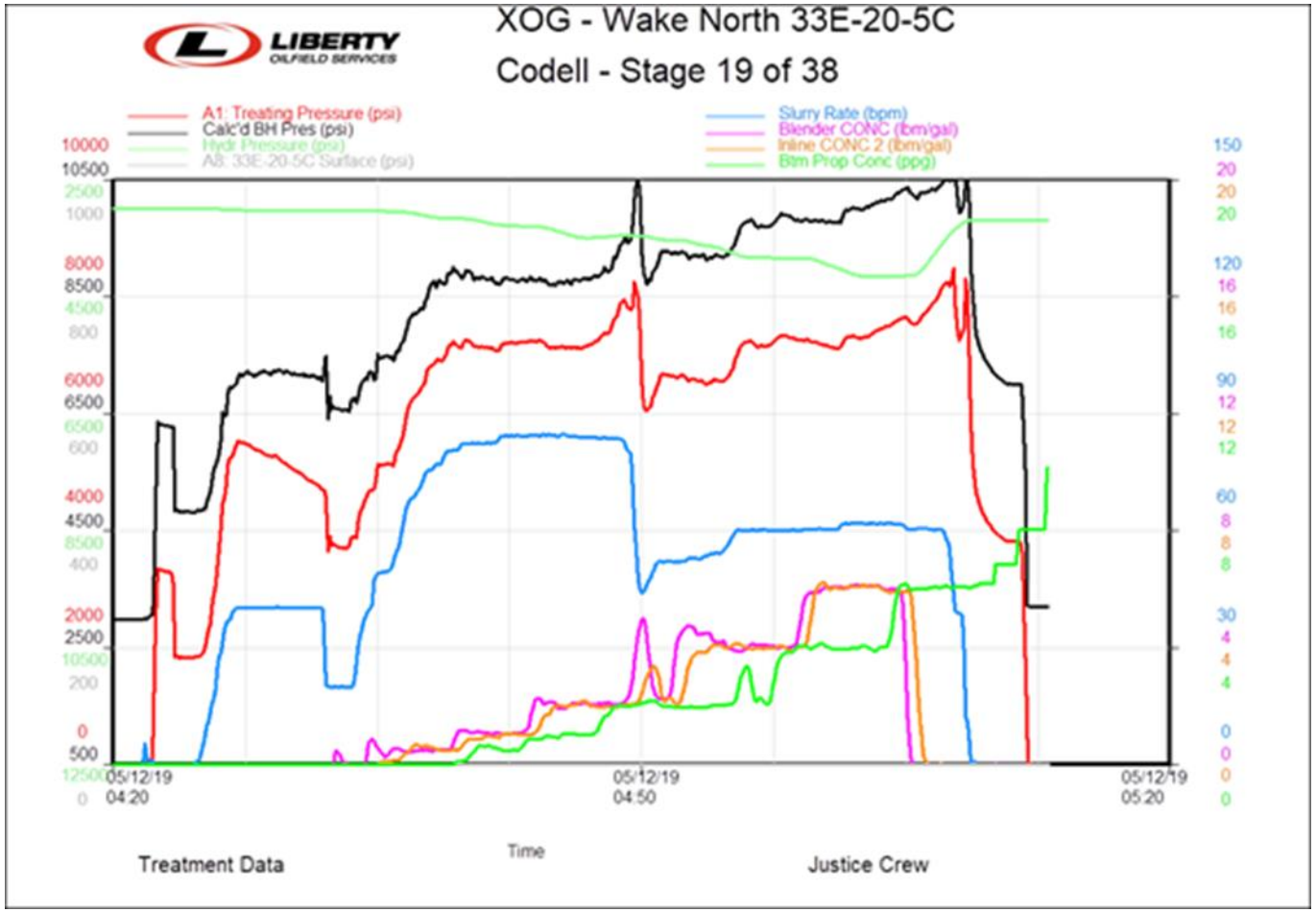
Screen-Out Assessment

Liberty Engineering Solution

Problem Stages

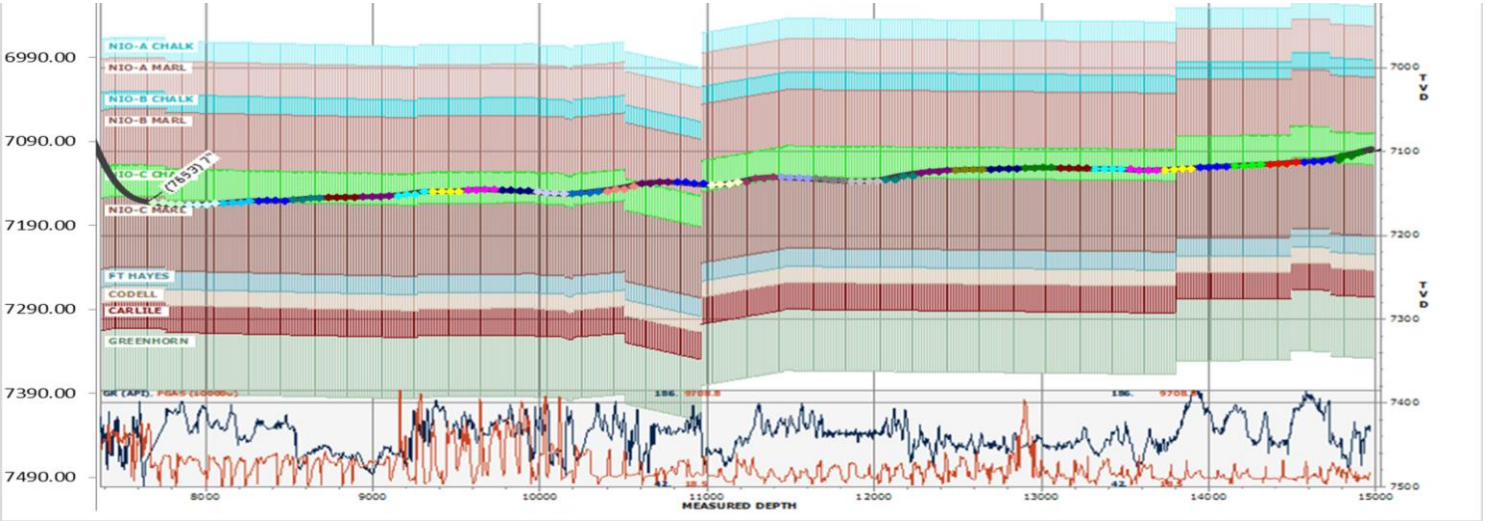
- High near-wellbore (NWB) Pressure
- Screen-outs

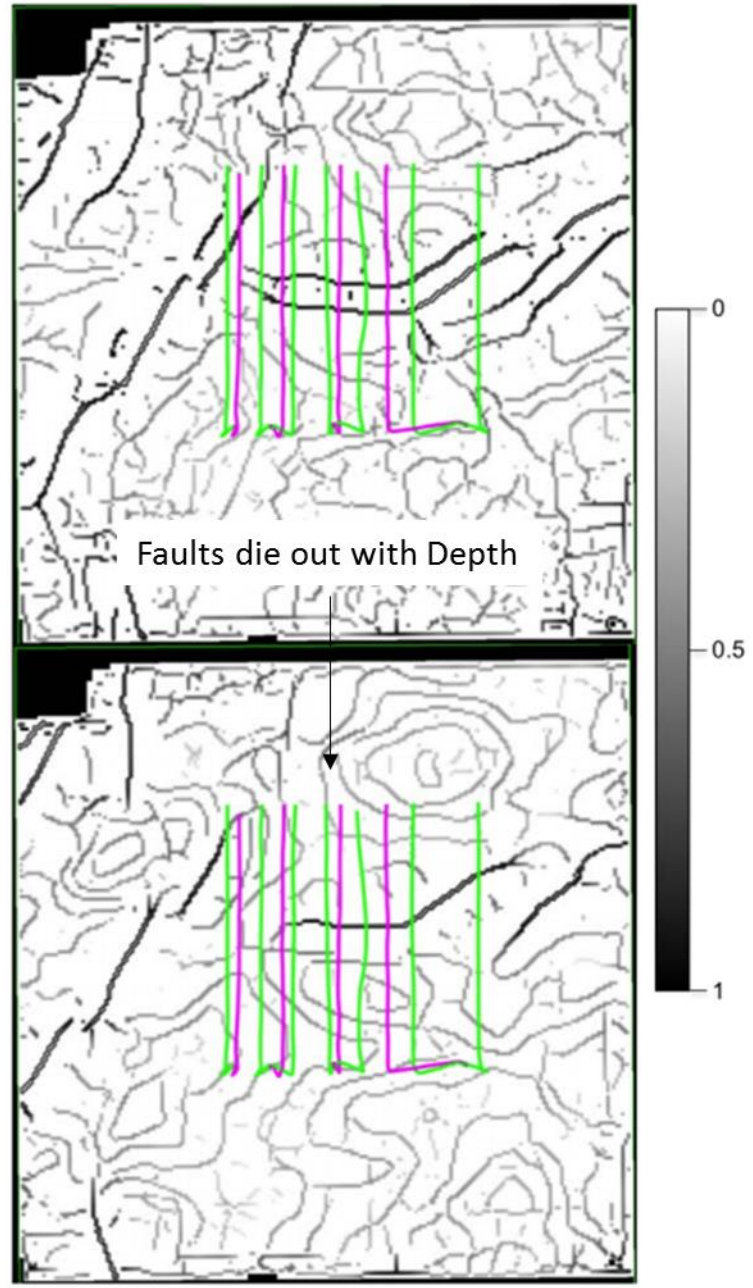
Costs Everyone- $$ and Time



Why Problems Happen?

- Geology-
  - Lithology (marls, bentonites, etc.)
  - Structure (faults, regional stresses, etc.)
- Engineering-
  - Proppant size or amount
  - Fluid type (gel viscosity, acid, etc.)
  - Stress Shadow (previous stage or adjacent zipper well)





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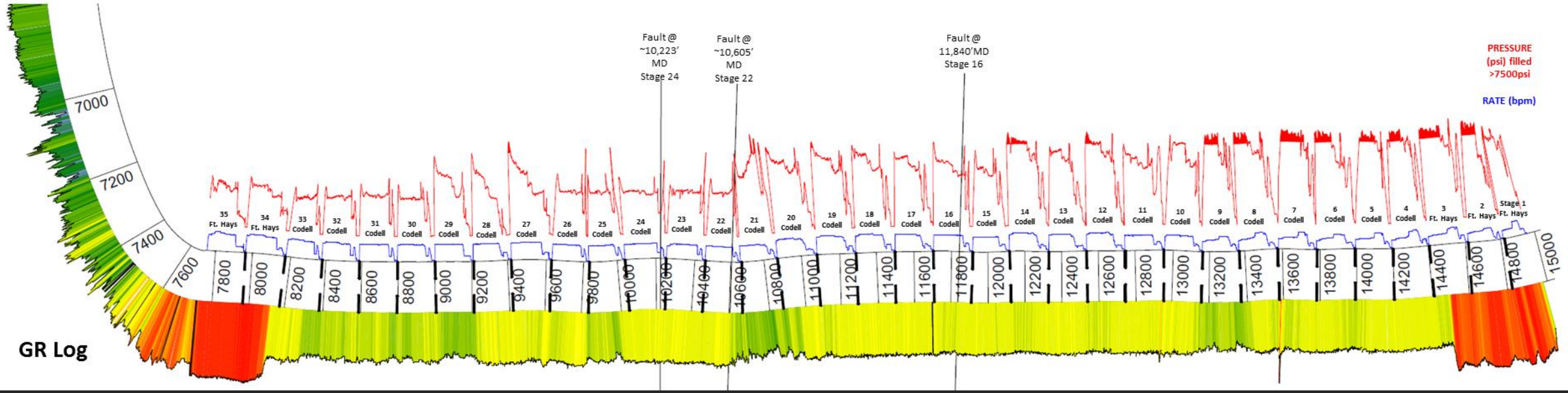
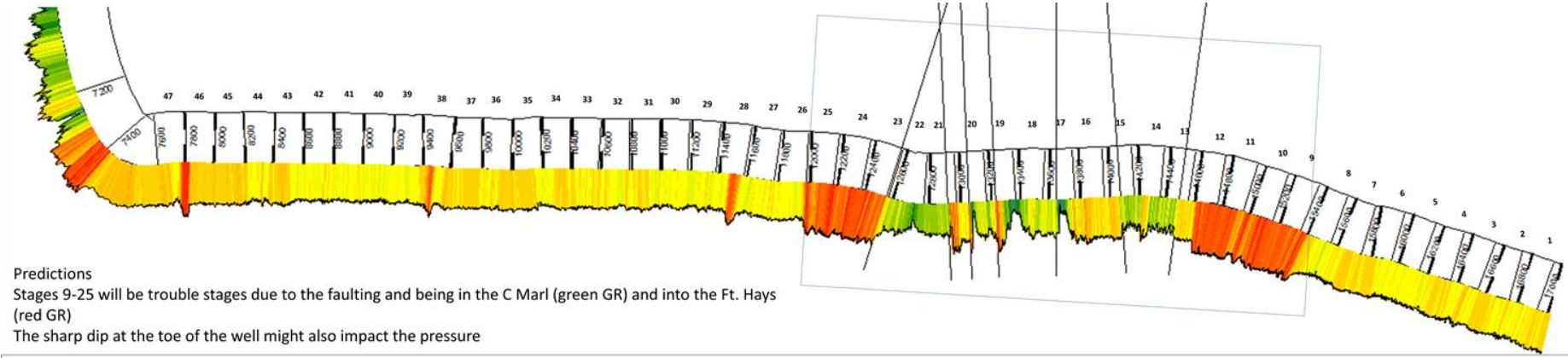
Integrating Geology with Completions

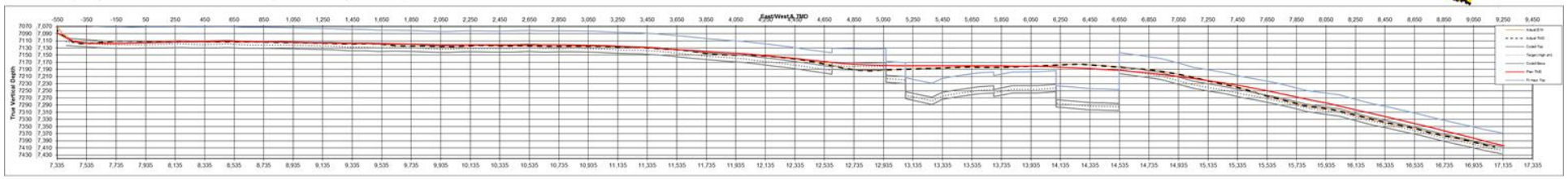
- **Gamma Ray log** (api)- Measurement of the radioactivity of rocks (Uranium, thorium, potassium)
- Used to interpret lithology (Chalks/Clean sands low GR, Marls/Bentonites/clays high GR), recorded in feet during drilling
- **BH Pressure** (psi)- pressure being applied to the formation including net pressure, normalized for friction, recorded in time during completion
- **Rate** (bpm)-downhole rate that fluid is entering the formation, recorded in time during completions
- **Injectivity** (psi/bpm)*100- BH Pressure divided by the downhole rate, to determine fracture efficiency and growth.

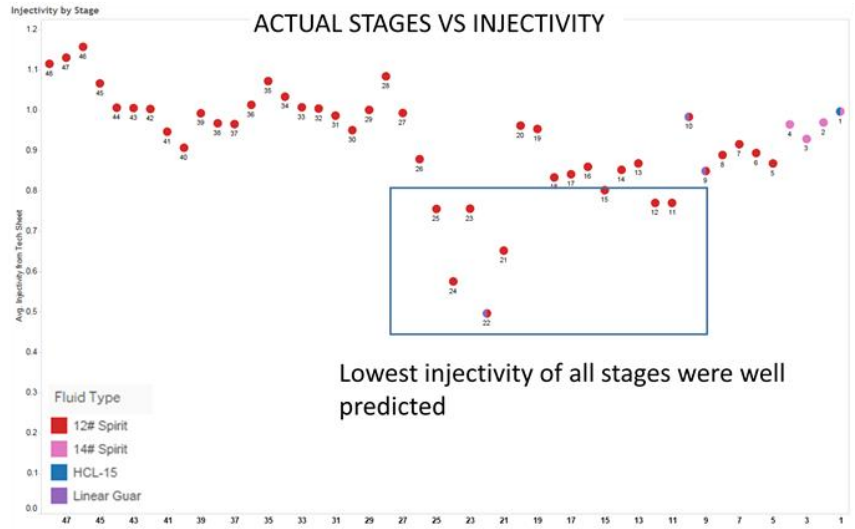


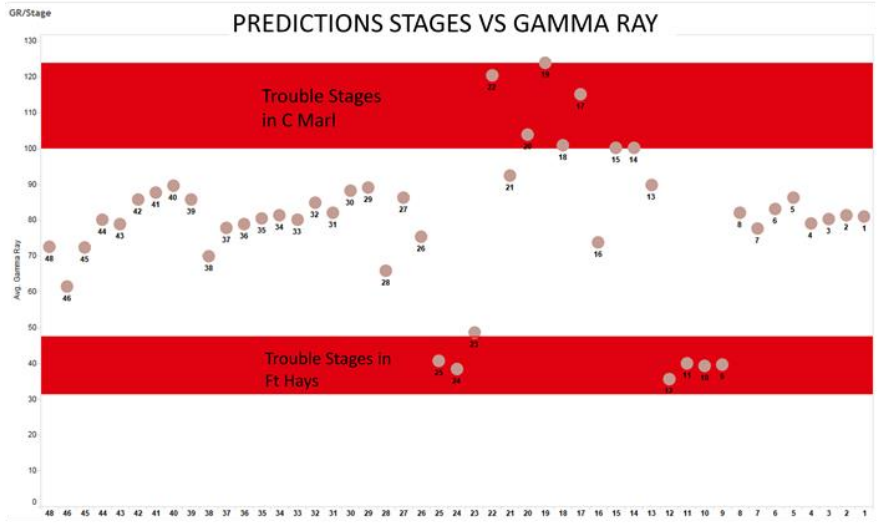
Integrating Geology with Completions



Predictions
Stages 9-25 will be trouble stages due to the faulting and being in the C Marl (green GR) and into the Ft. Hays (red GR)
The sharp dip at the toe of the well might also impact the pressure







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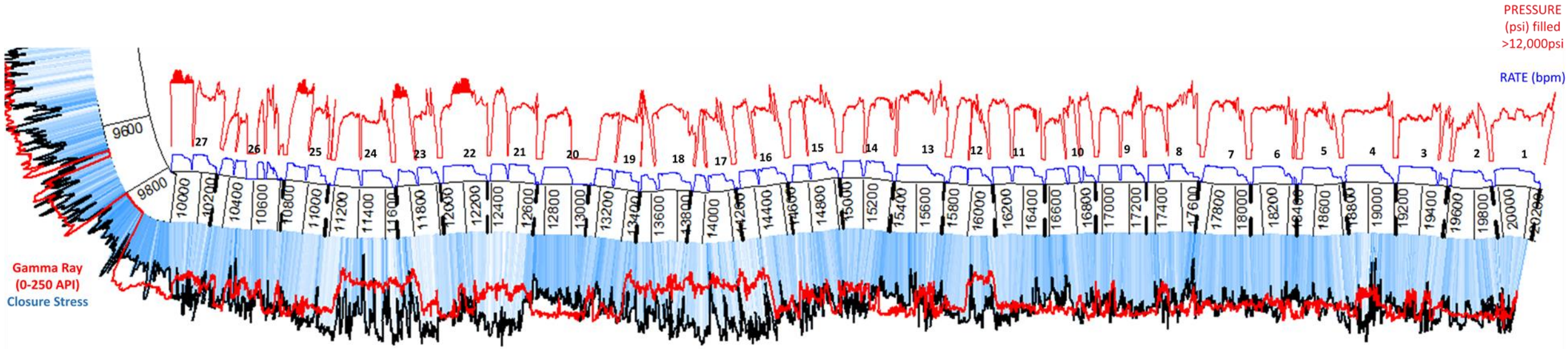
Data Integration – Well Completion Planning

- Mitigate or Prepare for Problem Stages
  - Gamma Ray, Closure Stress, or any other log
  - Completion stage packer/plug depths
- Geometric vs Engineered or a back up plan for tough problematic stages



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