页岩油藏压窜模拟及压裂裂缝设计
Frac Hit Modelling & Fracture Treatment Design

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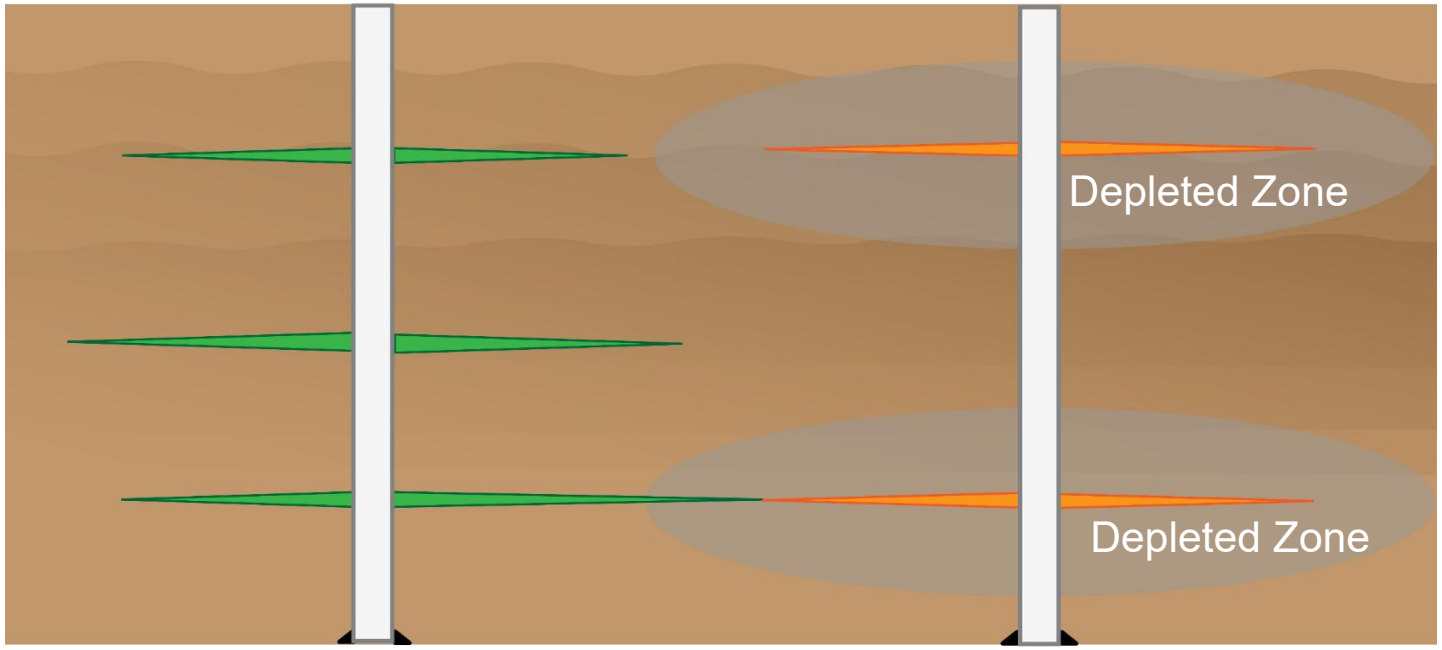
September 19th, 2023

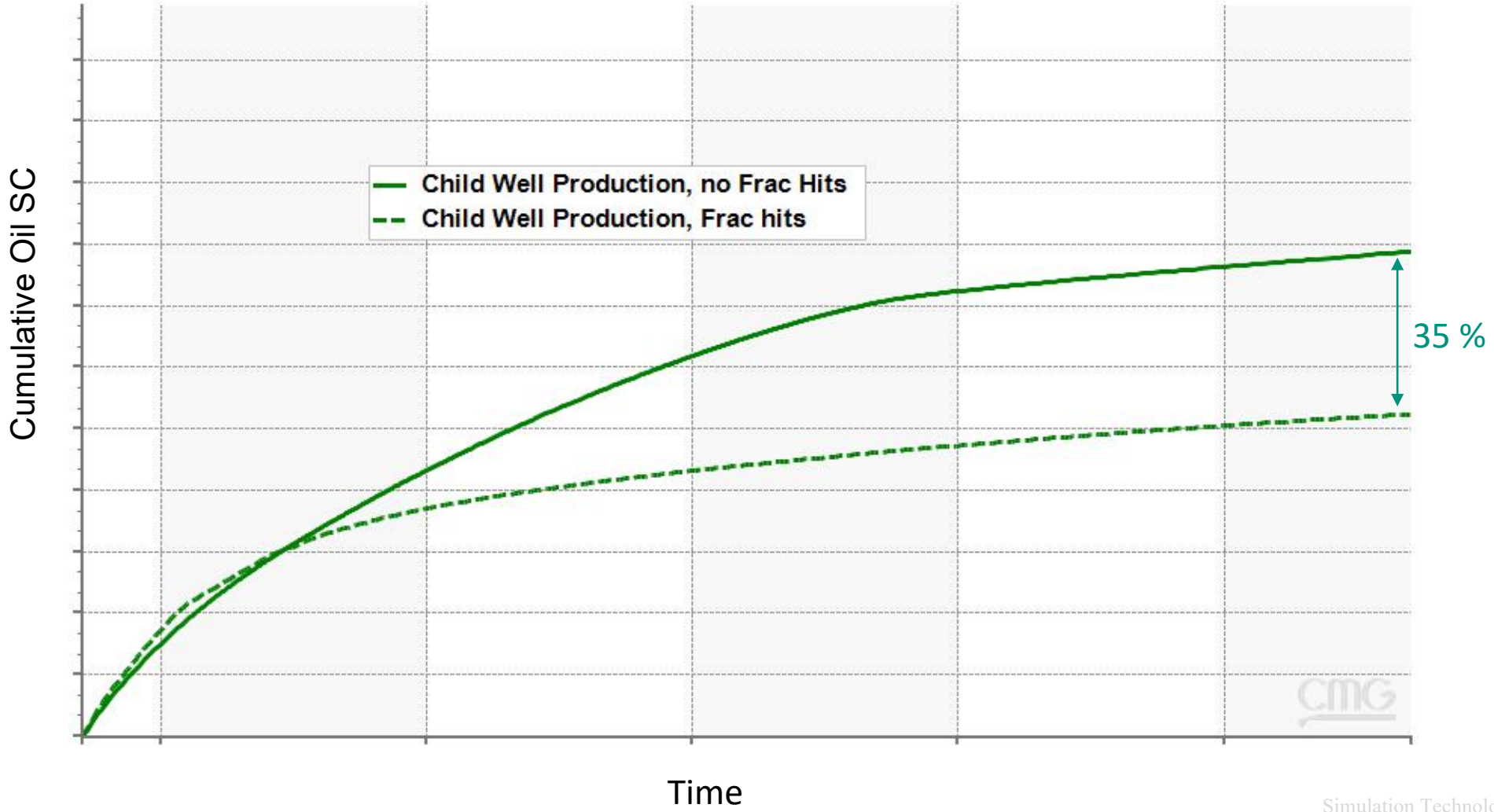
CMG

What is a Fracture Hit?

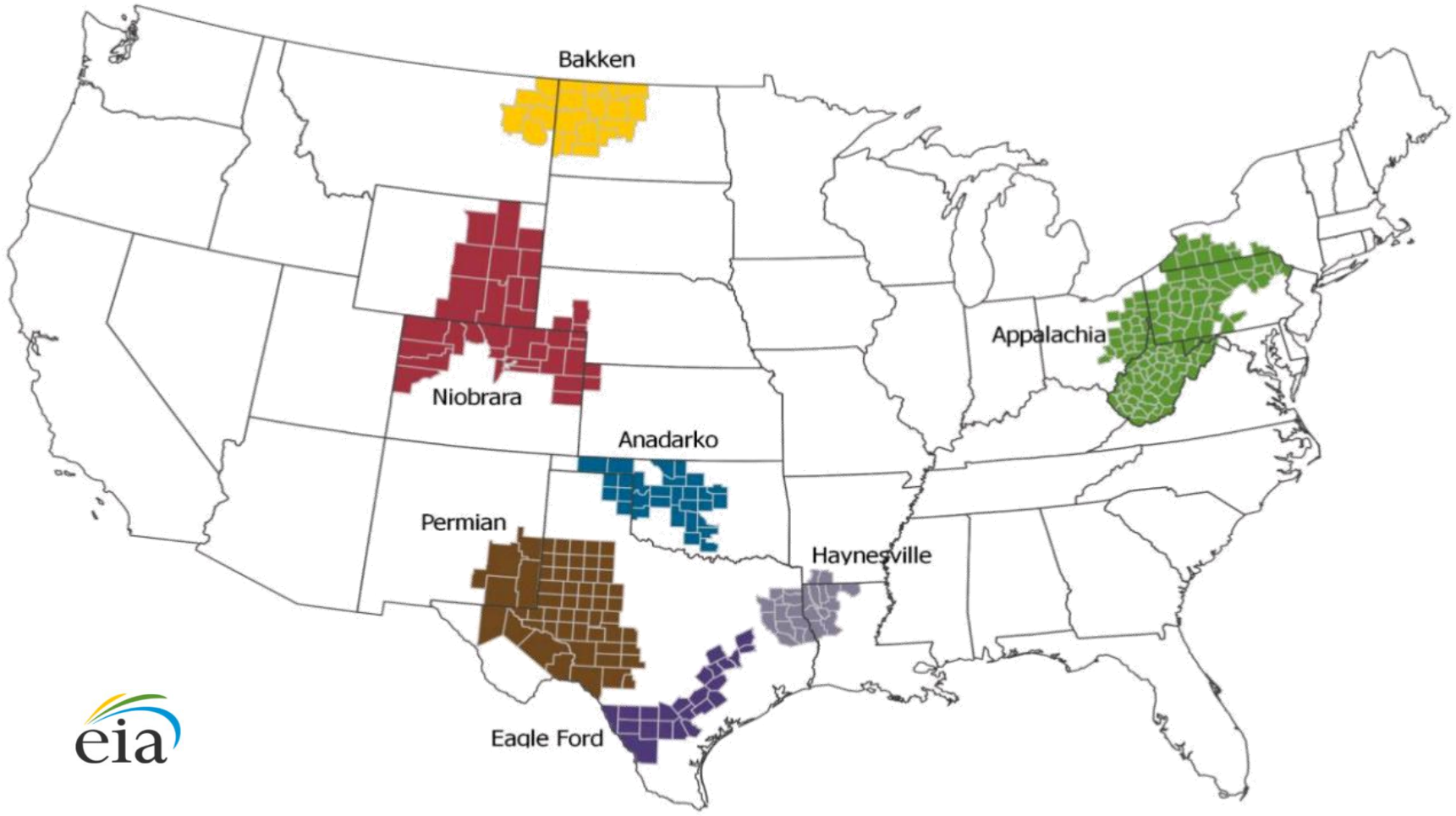
- Fracture hits are defined as hydraulic fractures generated by a child well (new well) that grow towards and interact with a parent well (existing well).



Impact on Production-Child Well

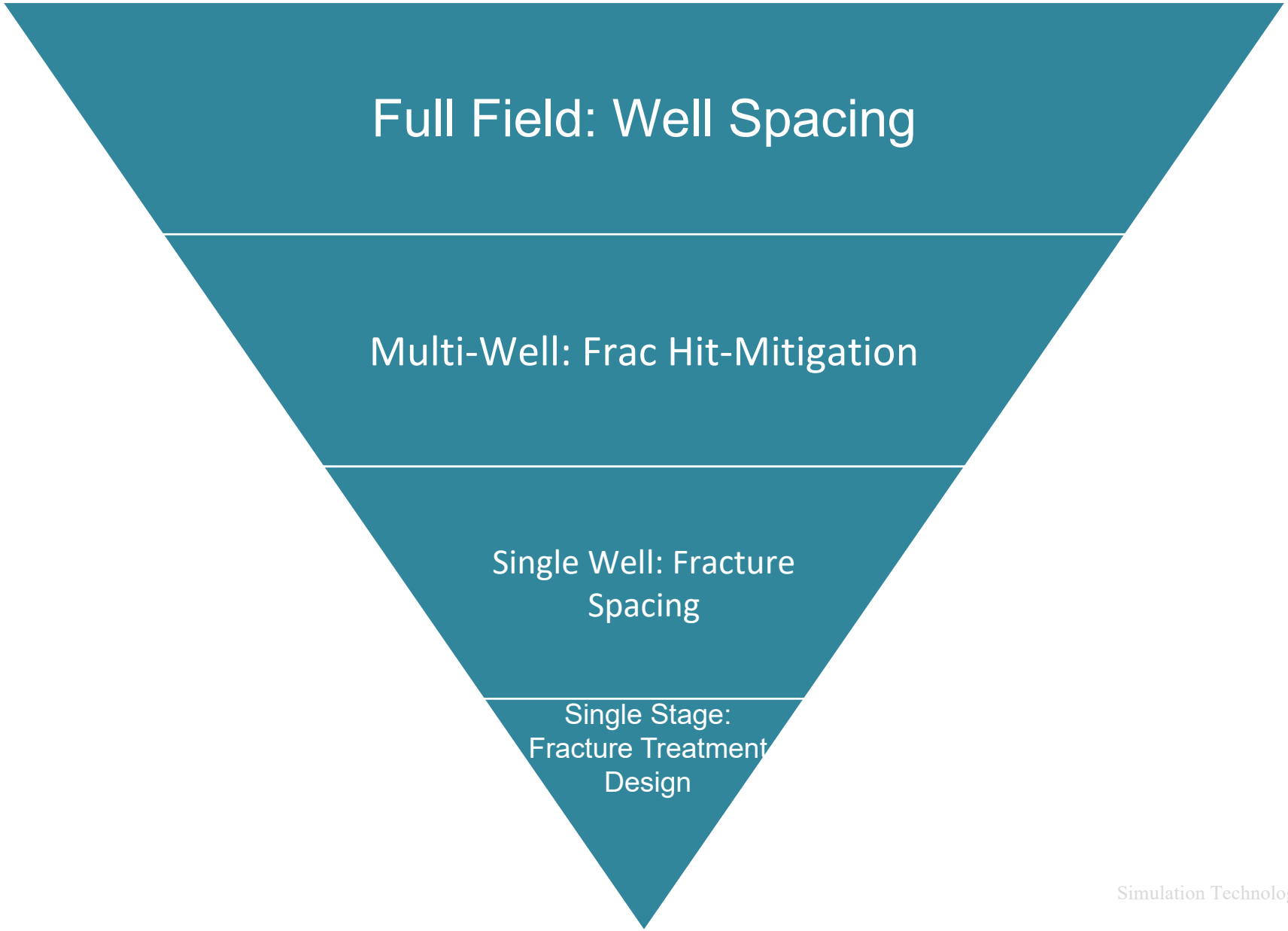


Tight Oil and Gas Formations Across the US



Source: U.S. Energy Information Administration

Levels of Frac-hit and Unconventional Modelling



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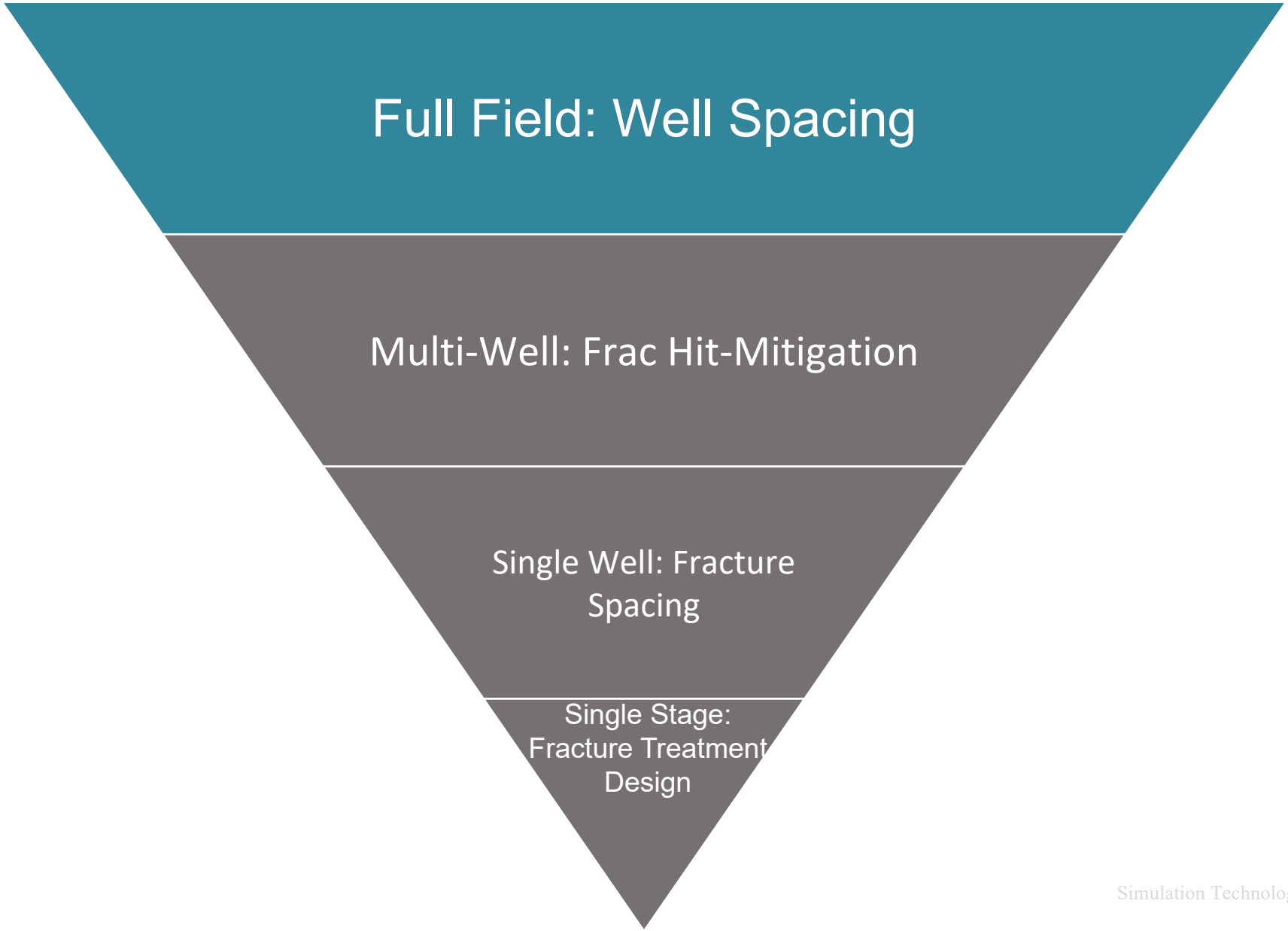


Full Field Study: Well Spacing Optimization

Why Implement?

Appropriate placement of infill wells in unconventional resources is essential for large-scale development of these assets

Why Simulate?

Investigate scenarios at a multi-pad field scale level

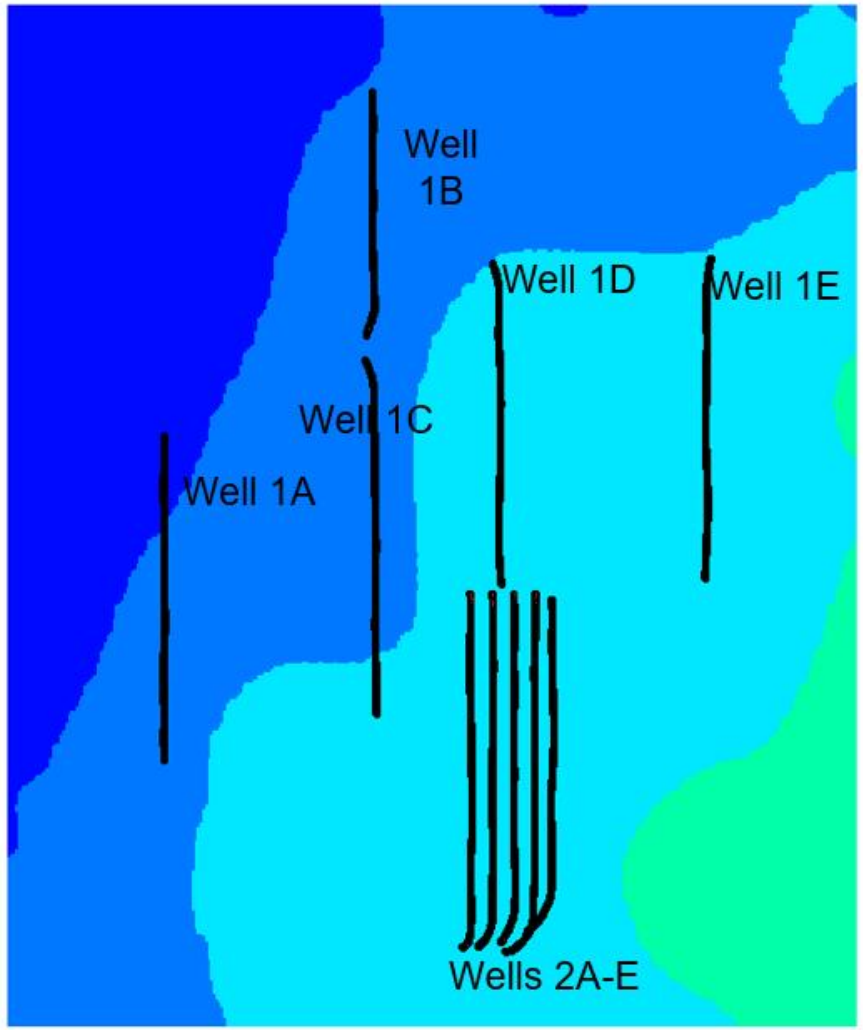
Results

Realize a significant improvement in **Net Present Value (NPV)** over the base case development scenario

Source: CMG Case Study: A Multi-Well History Match and Optimization: A Bakken Case Study

Full Field Study: Well Spacing Optimization

- Bakken and Three Forks Formation
- History Match
  - 10 wells
  - Undersaturated Black Oil
- In-fill well optimization
  - Well spacing



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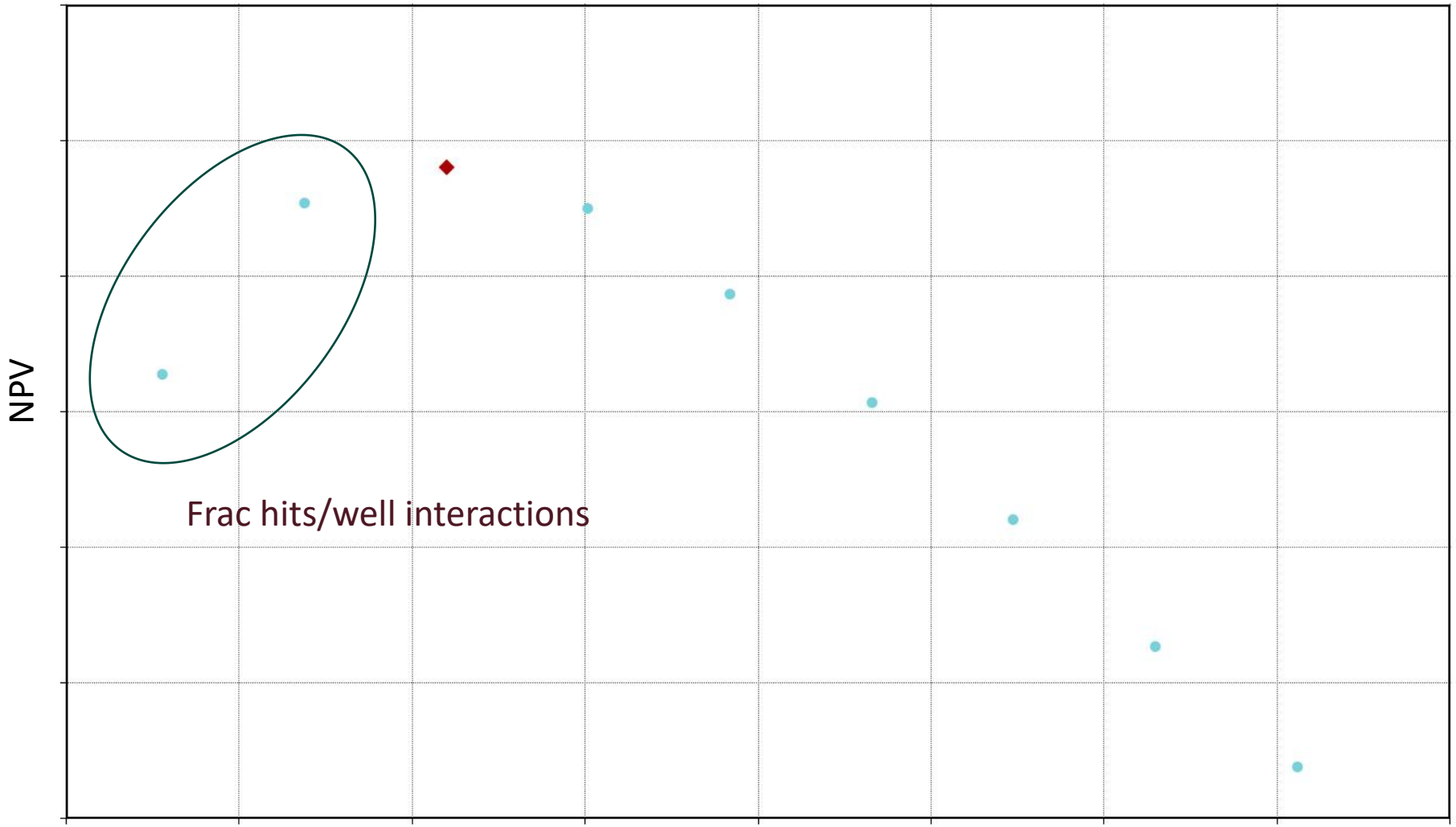
Full Field Study: Well Spacing Optimization



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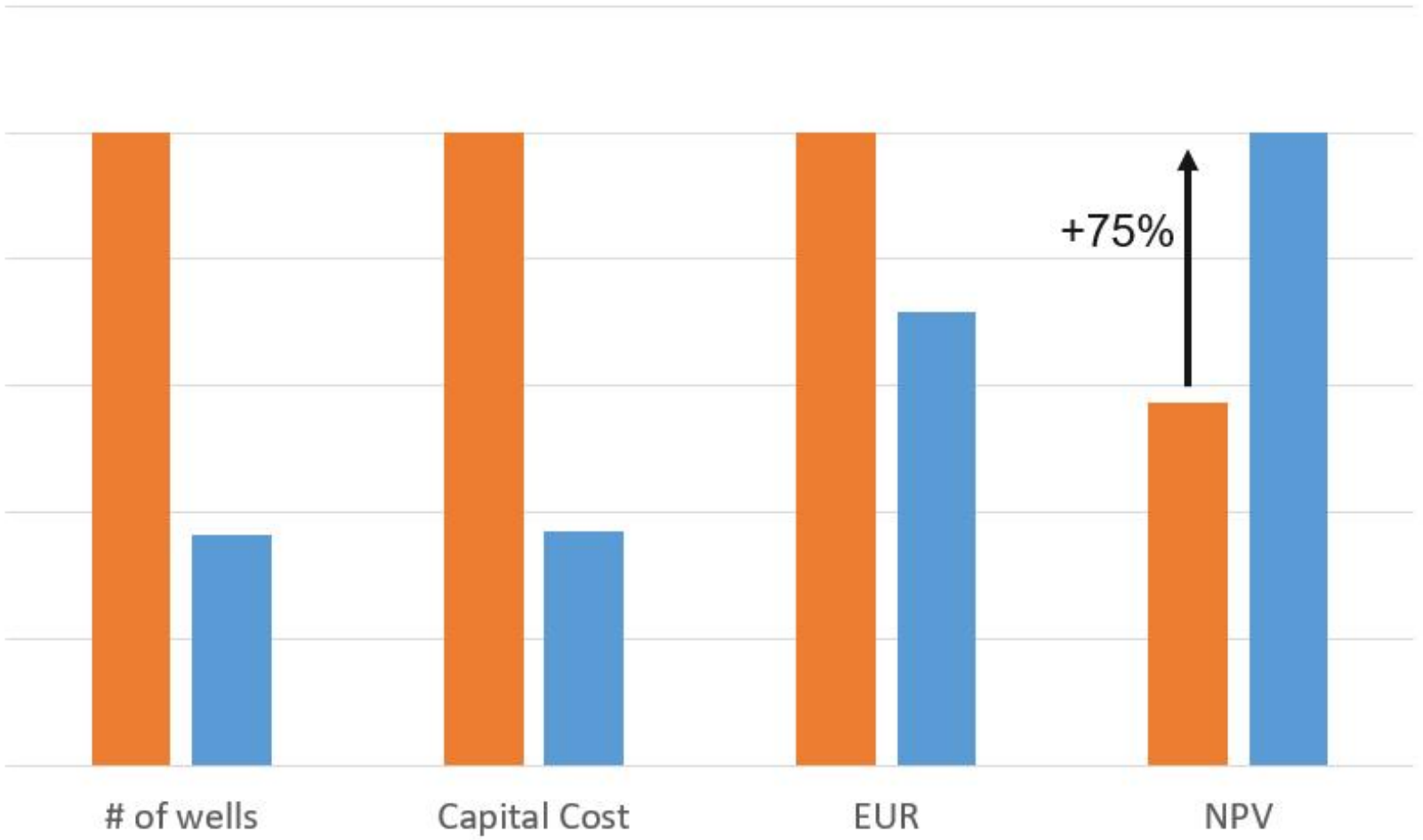

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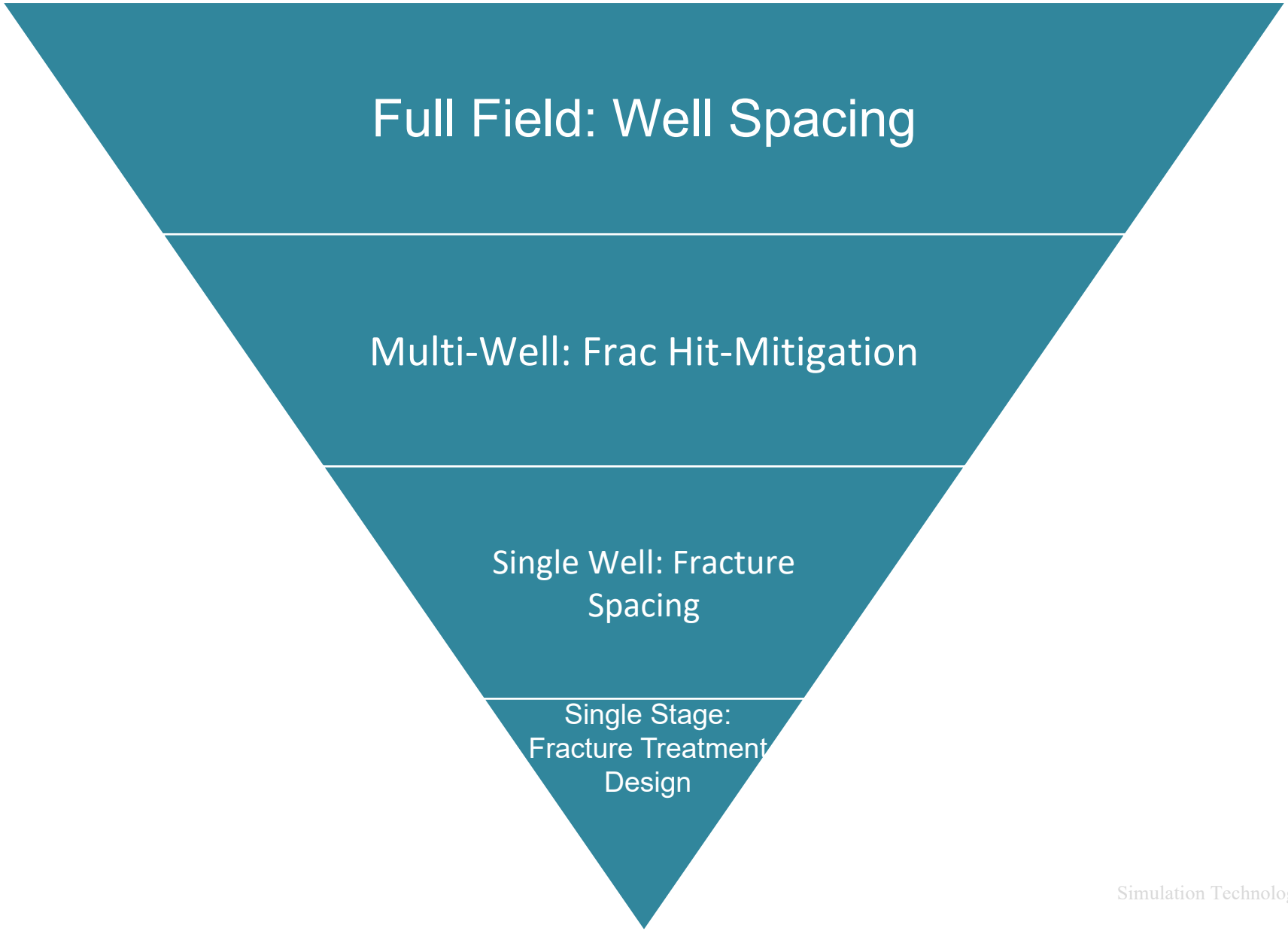

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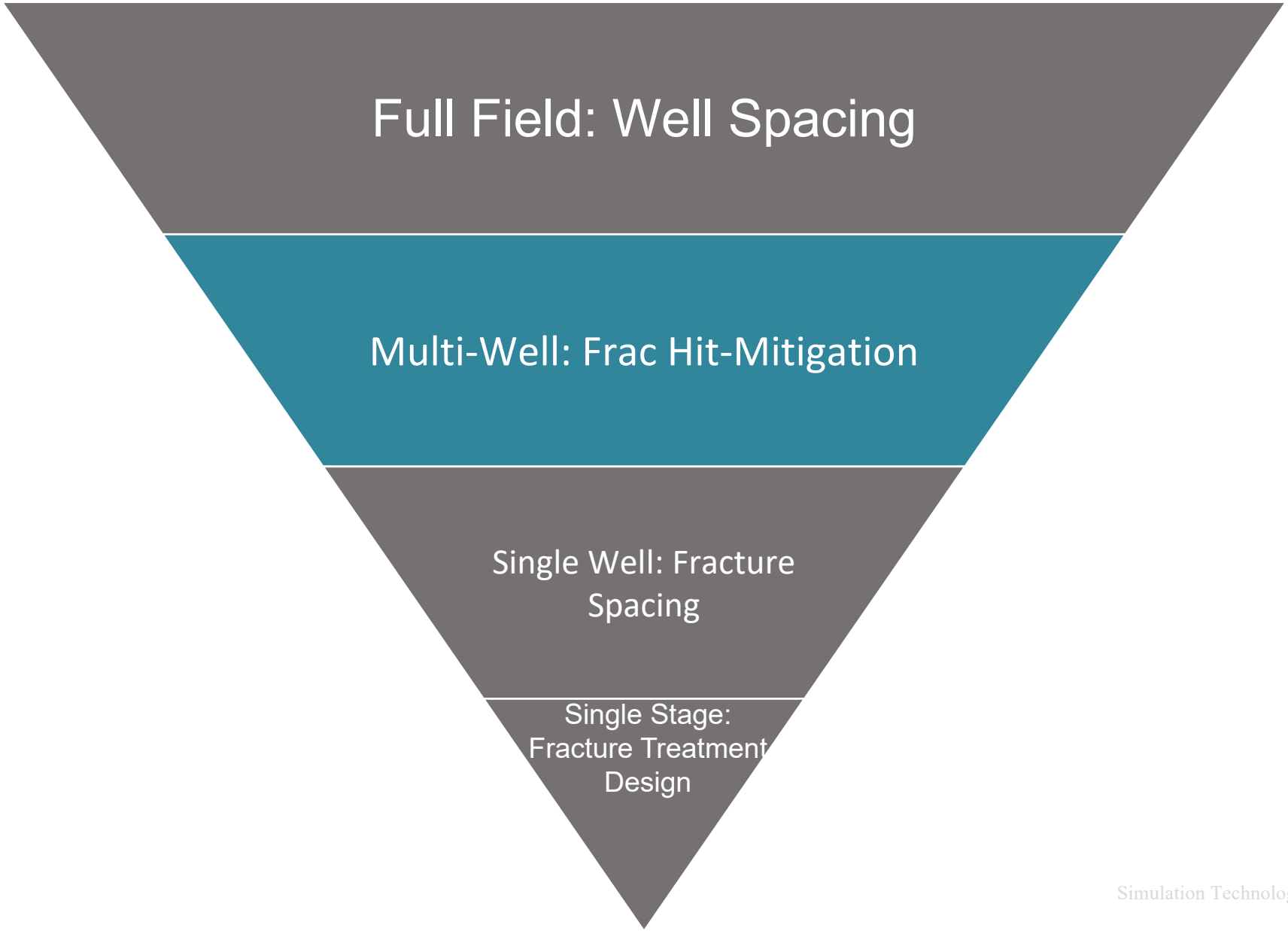
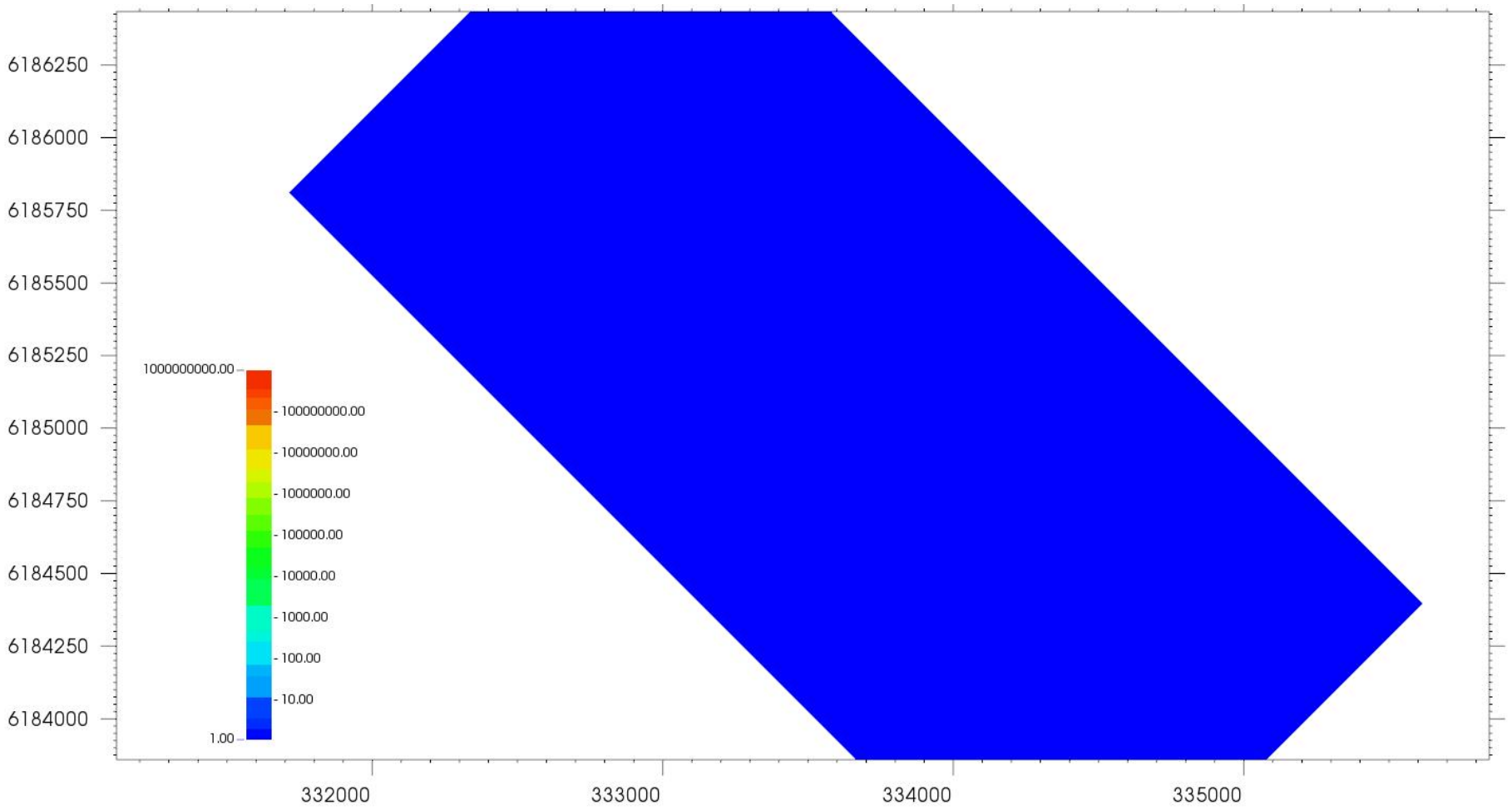


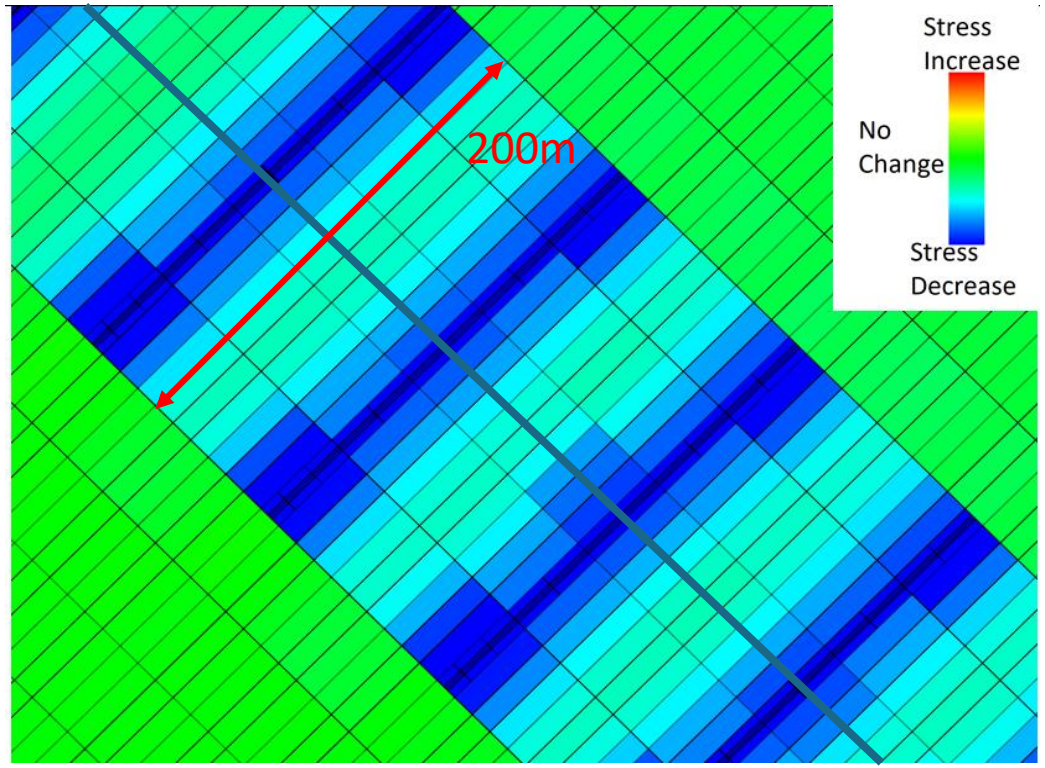
Fracture Hit Mitigation: Fracture Creation Modelling



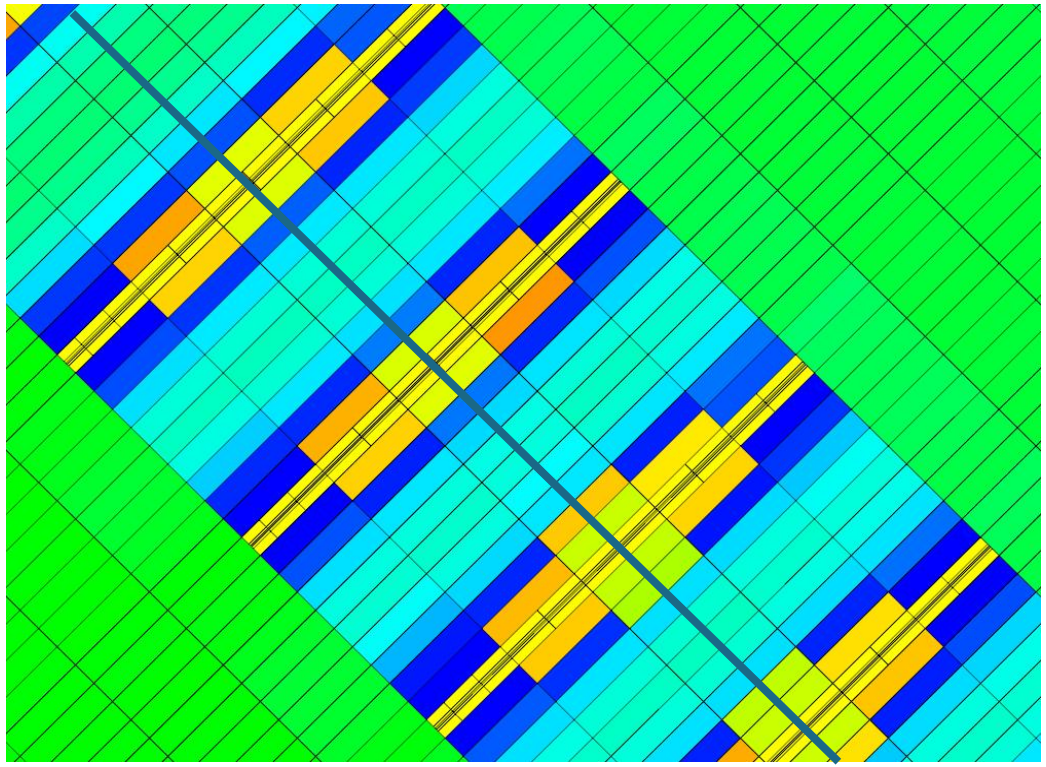
Source: SPE 199969

Fracture Hit Mitigation: Parent-well Pre-loading

Stress Sink at Start of Pre-loading



Stress Barrier After Pre-loading



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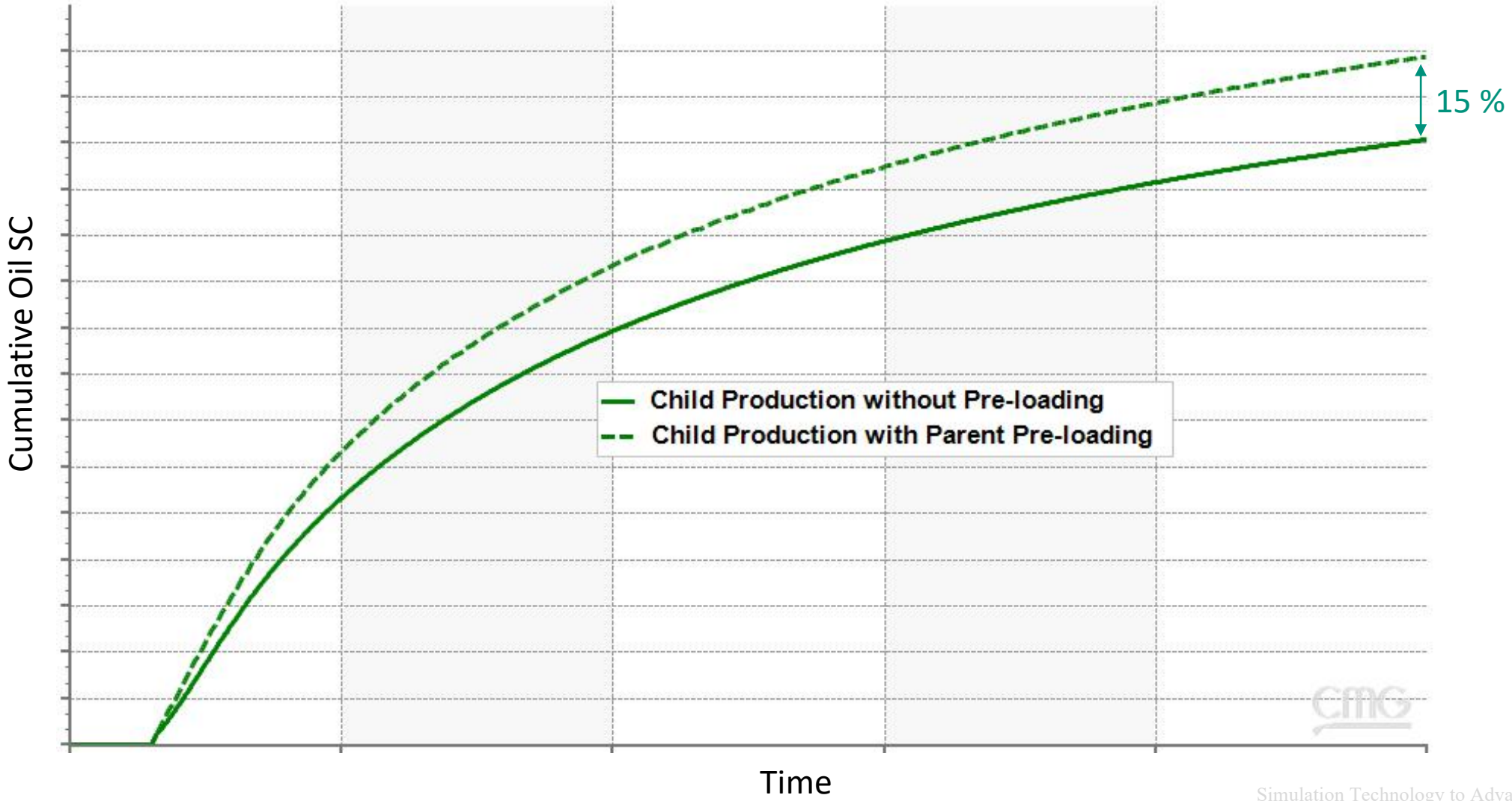
Frac Hit Mitigation: Parent well Pre-loading



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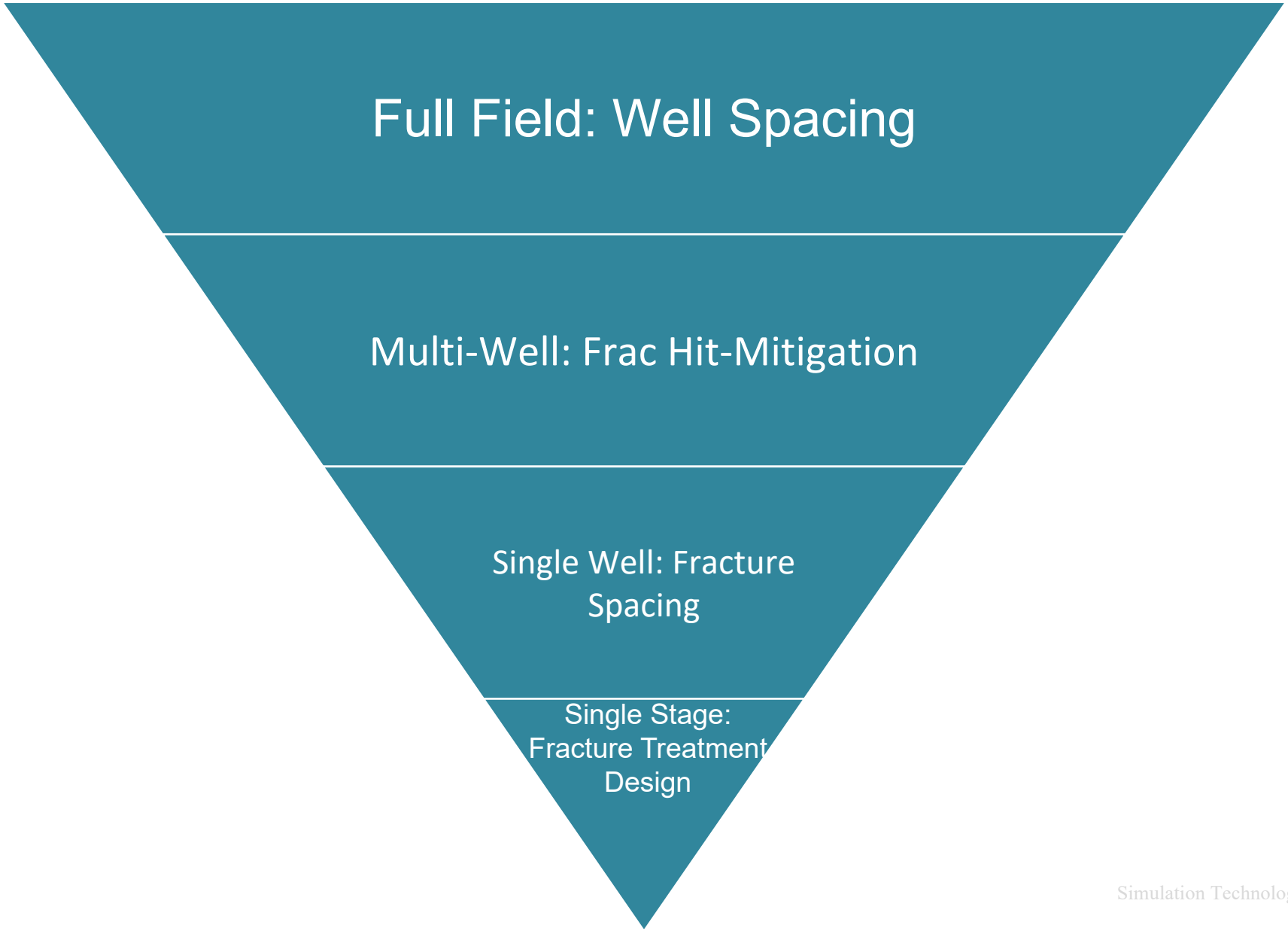

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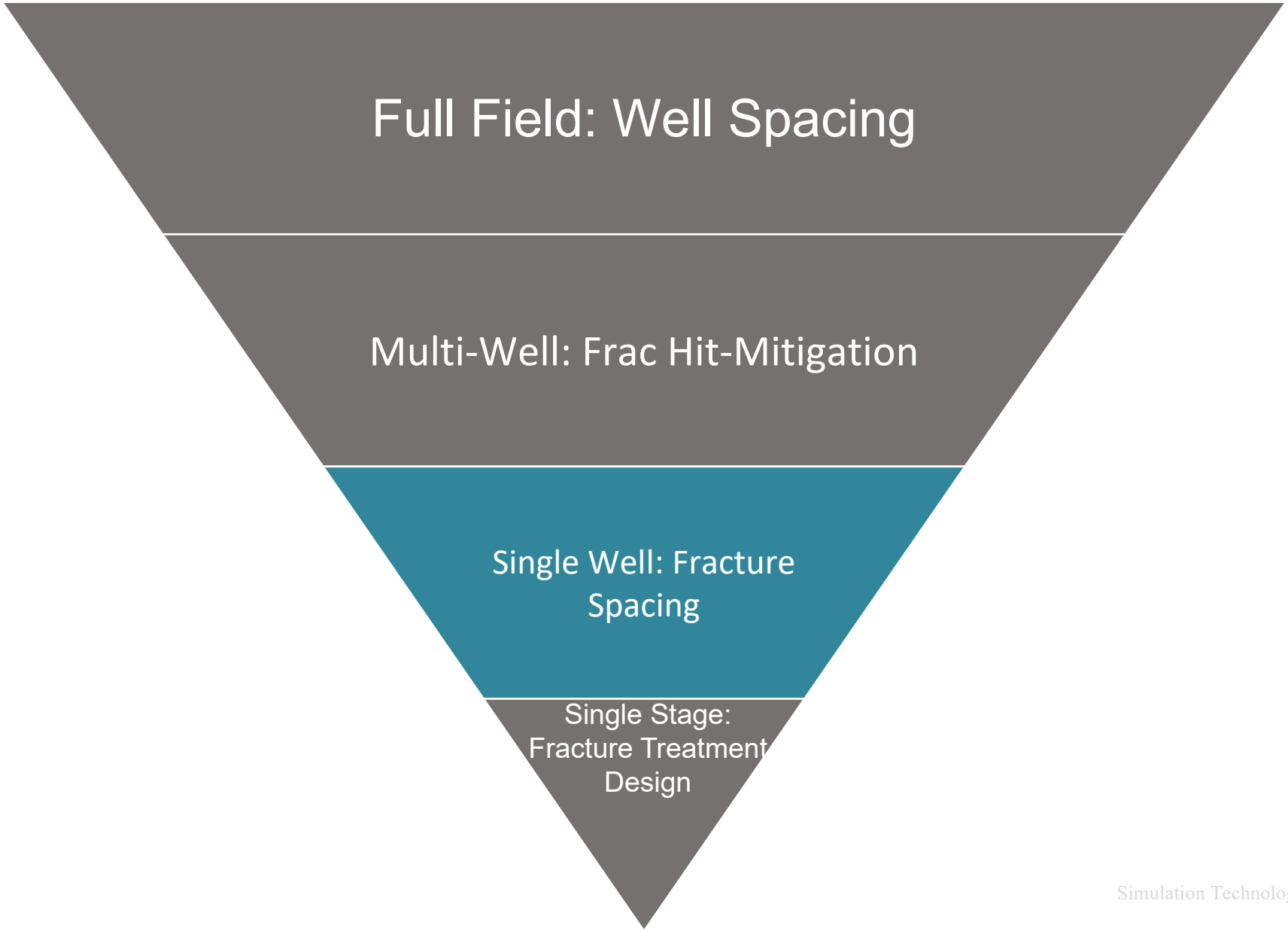
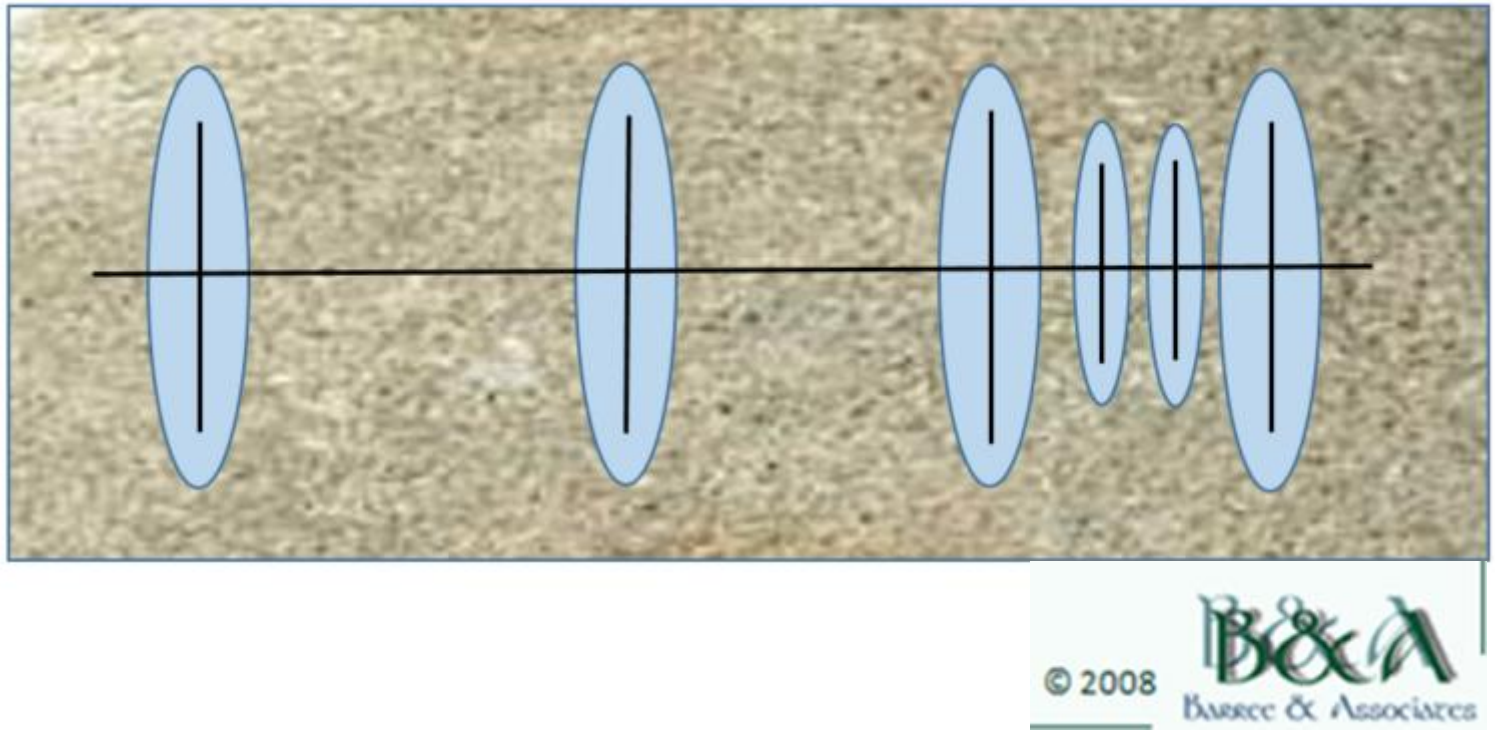


Stress Shadowing and Fracture Spacing

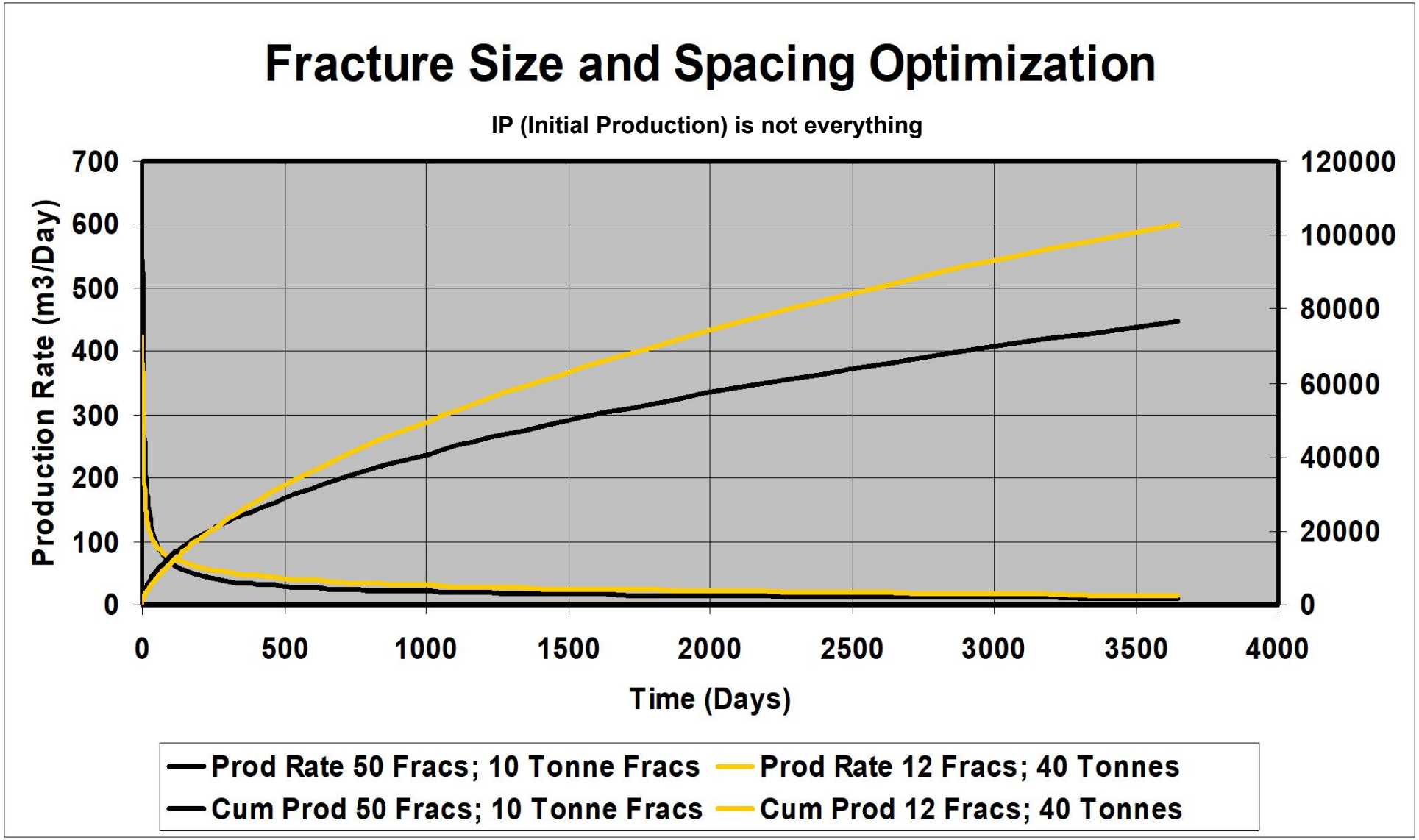
Stress Shadowing Is Real

- Between fractures within same stage;
- Between stages: Previous stage impacts subsequent stages;
- Tighter spacing, stronger stress shadowing;



Source: Barree and Associates

Fracture Size and Spacing Optimization



Source: CMG Training Material: Introduction to Fracture Treatment Design Skills

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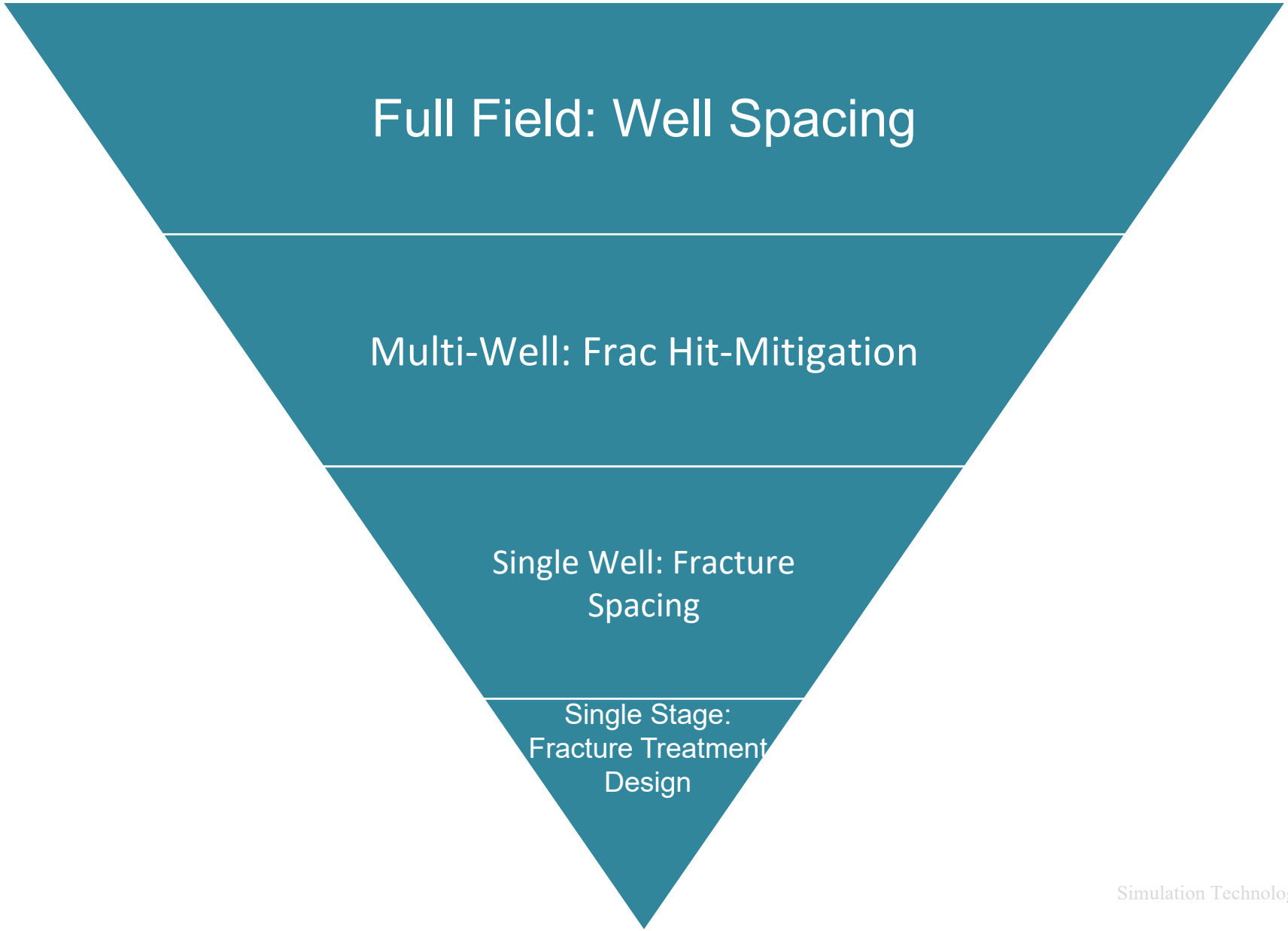

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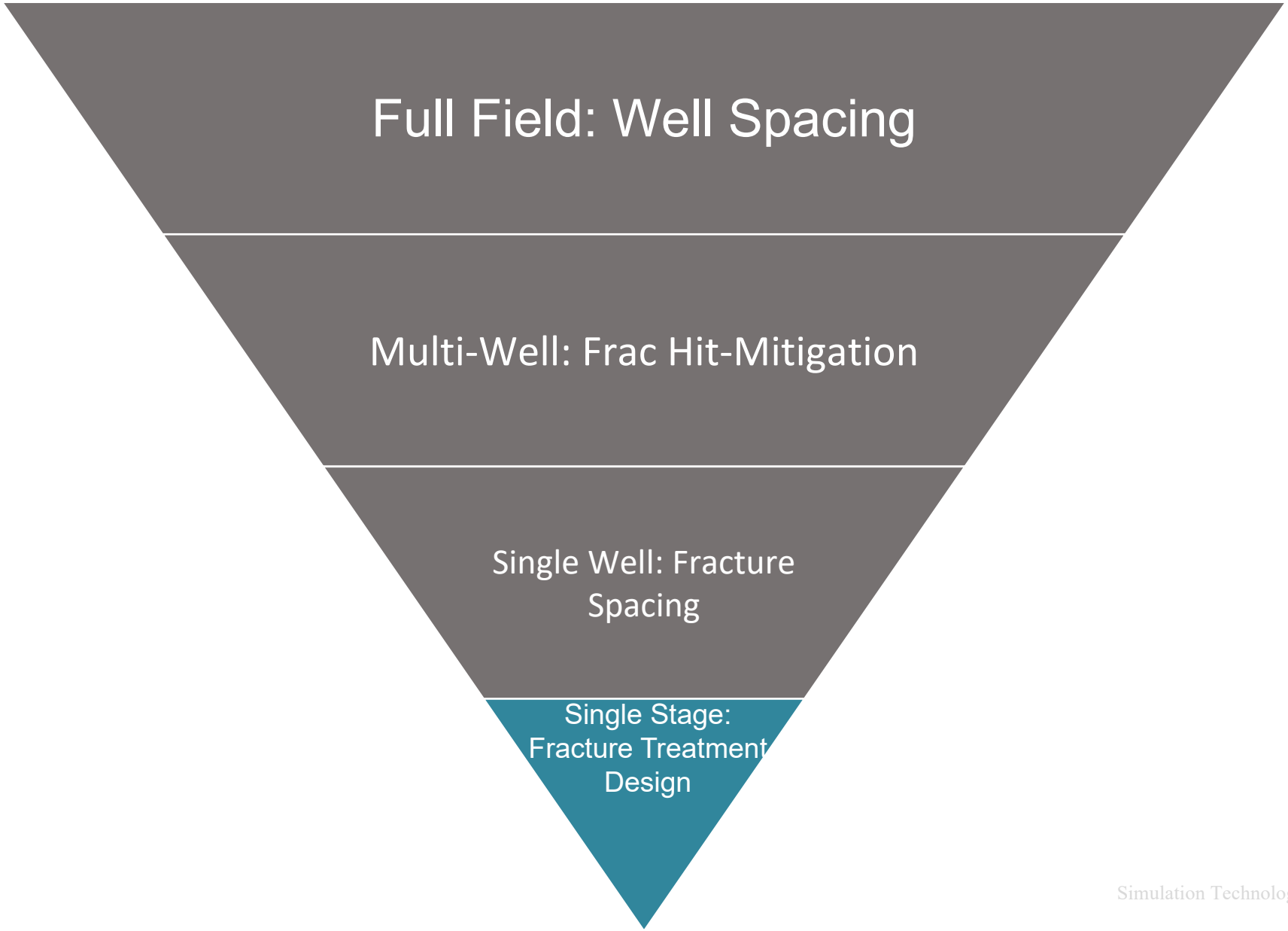
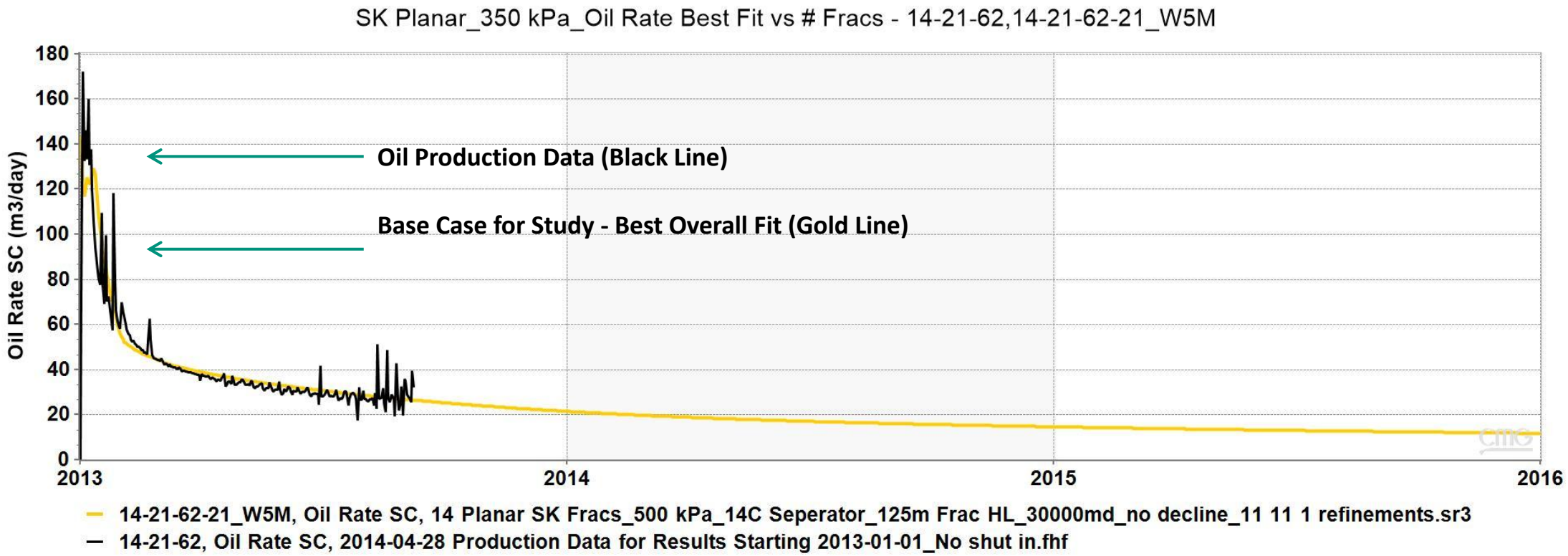


Fracture Treatment Design: History Match



- Stages designed with 3 to 4 clusters per stage and 14 total stages
- History Match with 14 Planar Fractures (1 effective fracture per stage)

Source: CMG Training Material: Introduction to Fracture Treatment Design Skills

Fracture Treatment Design: Limited Entry

Improve Cluster Efficiency

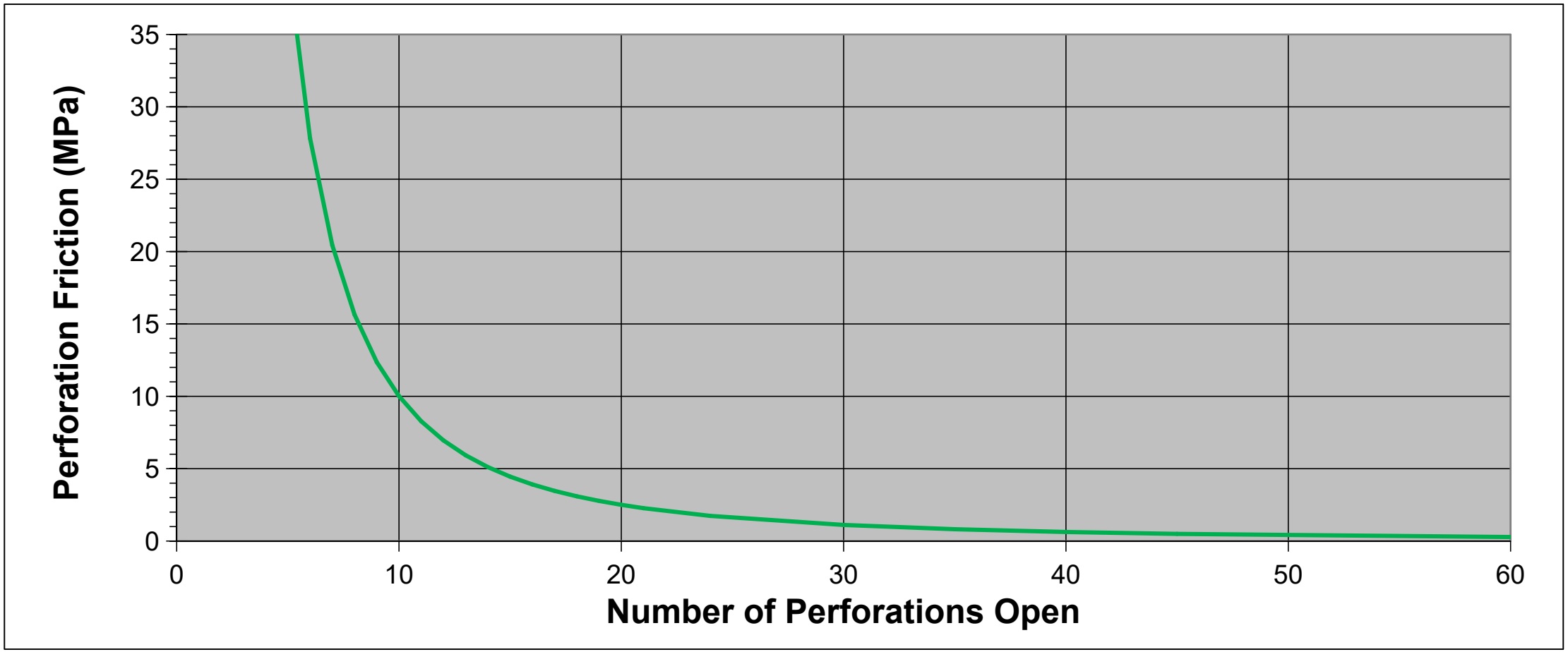
- By creating high pressure drop (7-10 MPa) across perforations.
- To encourage even distribution of frac fluid to all perfs/clusters.

Limitations

- Perf friction is in addition to fluid pipe friction,
- Once proppant starts eroding perfs, slurry distribution through perfs can change greatly.
- Key factors include perforation diameter, perforation coefficient of discharge, number of perforations, perforation erosion, injection rate, and formation pressure behind the perforations.

Source: CMG Training Material: Introduction to Fracture Treatment Design Skills

Fracture Treatment Design: Limited Entry

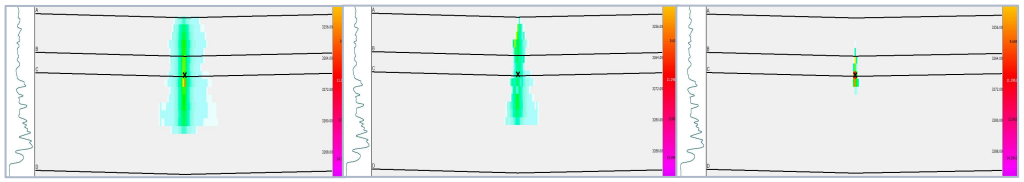


Source: CMG Training Material: Introduction to Fracture Treatment Design Skills

Fracture Treatment Design: Cluster Spacing Sensitivity

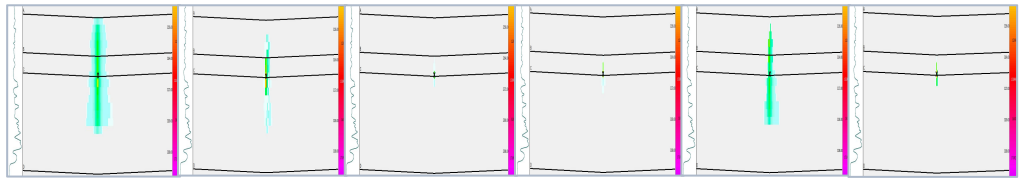
GOHFER

3 Clusters x 15m/cluster



Heel Toe

6 Clusters x 15m/cluster



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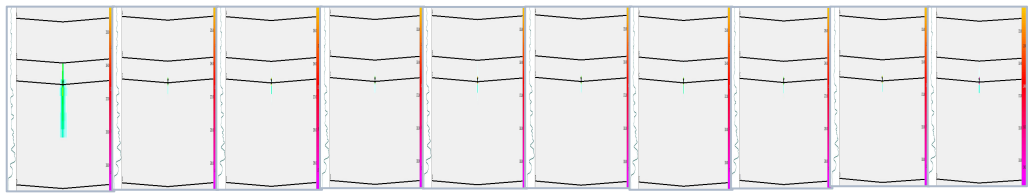
10 Clusters x 12m/cluster



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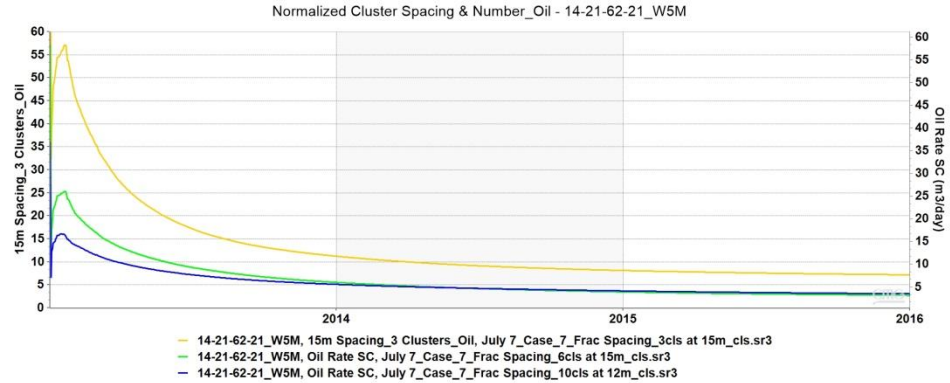

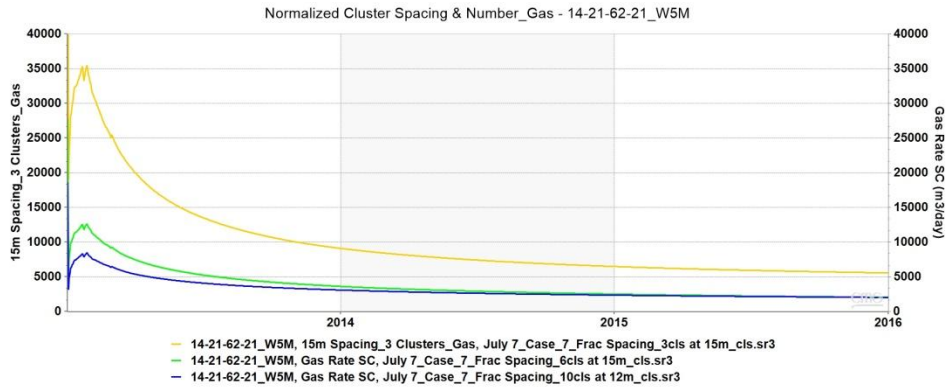

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Conclusions

- Hydraulic fractures and unconventional assets can be effectively modelled using CMG
- Optimizing hydraulically fracture wells can be done at the field scale all the way down to the perforation scale
- Drilling wells too close together will result frac-hits and loss of production
- Pre-loading the parent wells can help protect against frac hits
- Frac spacing too close together will result in high IP but low EUR
- Proper fracture treatment design can help improve cluster efficiency