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The Hydraulic Fracturing Test Site—Midland Basin, West Texas - A Resource Recovery Field Research Experiment in the Wolfcamp Formation

Kent F. Perry, Director E&P Research

Gas Technology Institute

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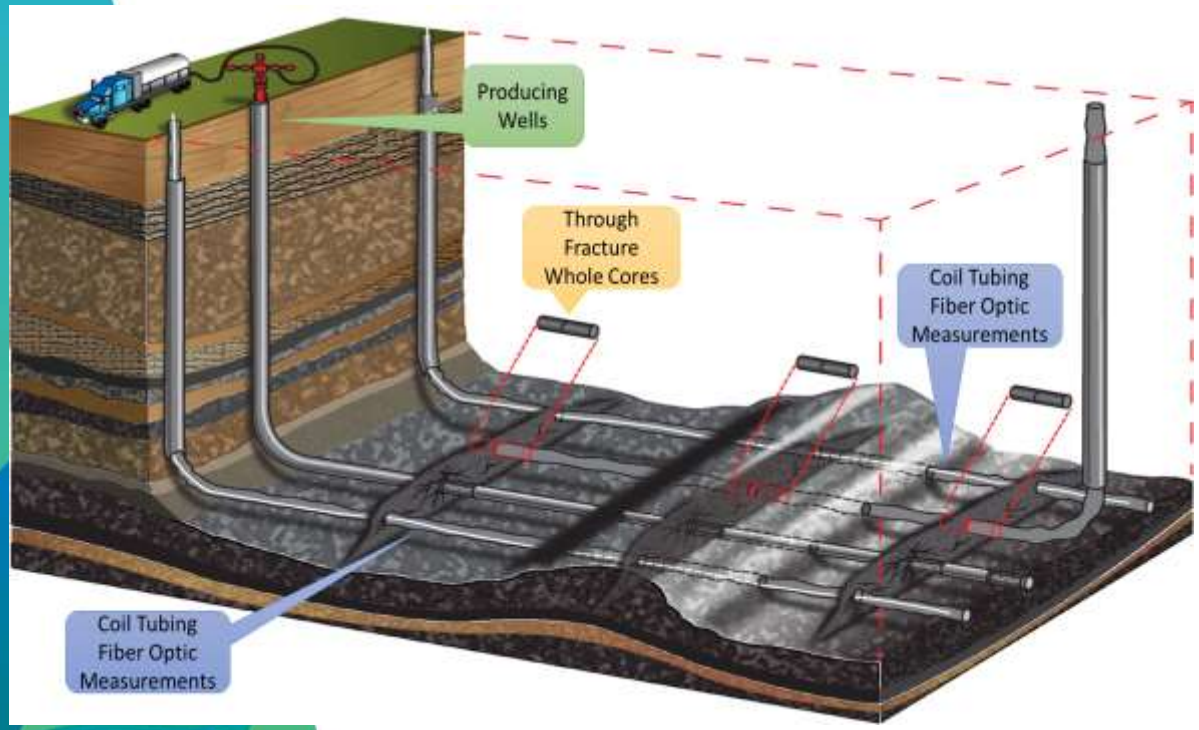
Hydraulic Fracturing Test Site #1(HFTS) - Project Overview

Ground Truth: Through-Fracture Cores



- Field-based hydraulic fracturing research program in west Texas, Permian Basin
- Public-private partnership with NETL and multiple industry partners providing financial support
- $25+ million of new hydraulic fracturing research “piggy backing” on 11 new horizontal wells over 400 fracture treatments, over $100 million in background data
- Advanced diagnostics including coring through hydraulically fractured reservoir, multi horizon pressure monitoring, proppant quantification, etc.
- Potential to reduce the number of wells required to develop west Texas resources by thousands

HFTS Team – Successful Public-Private Partnership

Site Host

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

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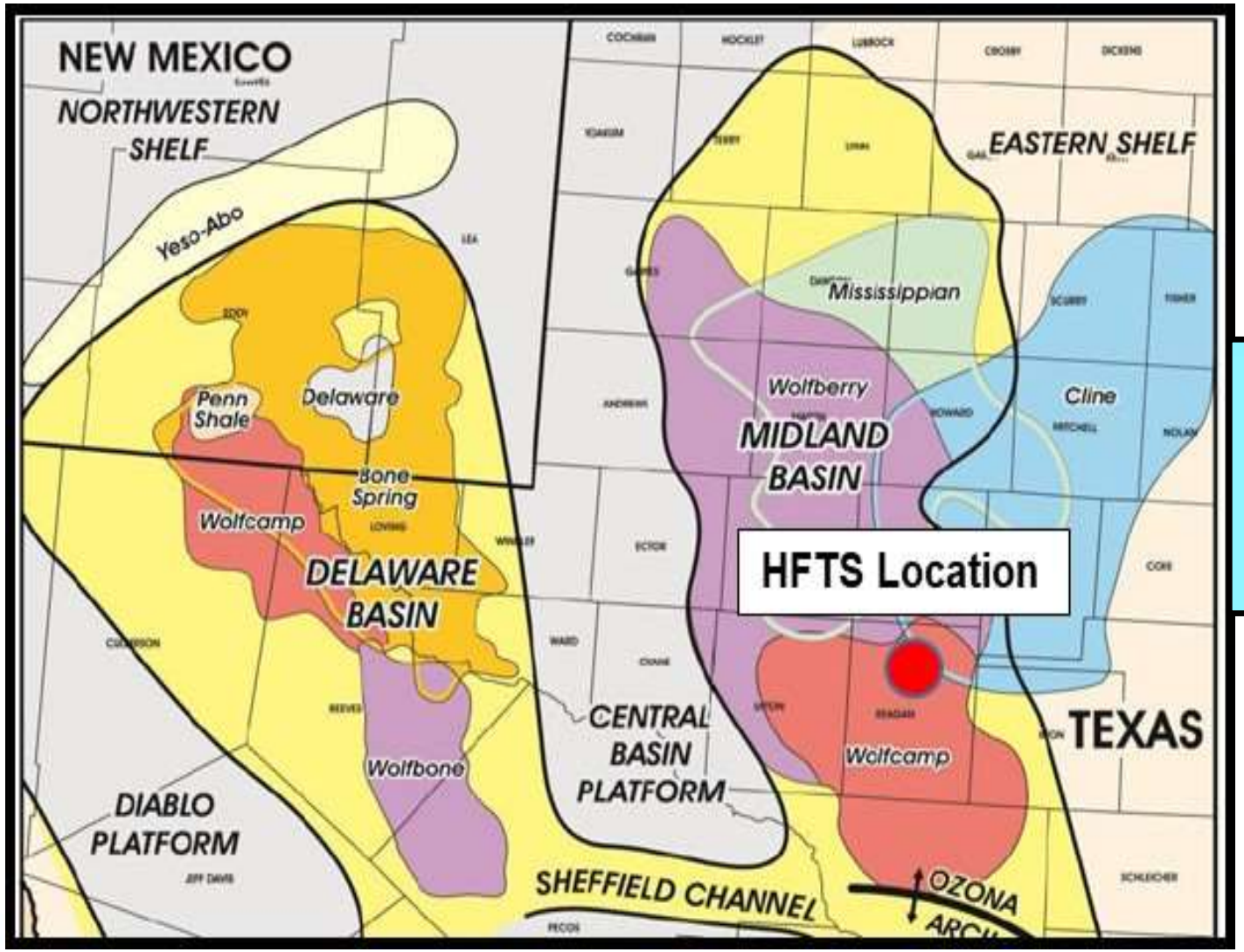
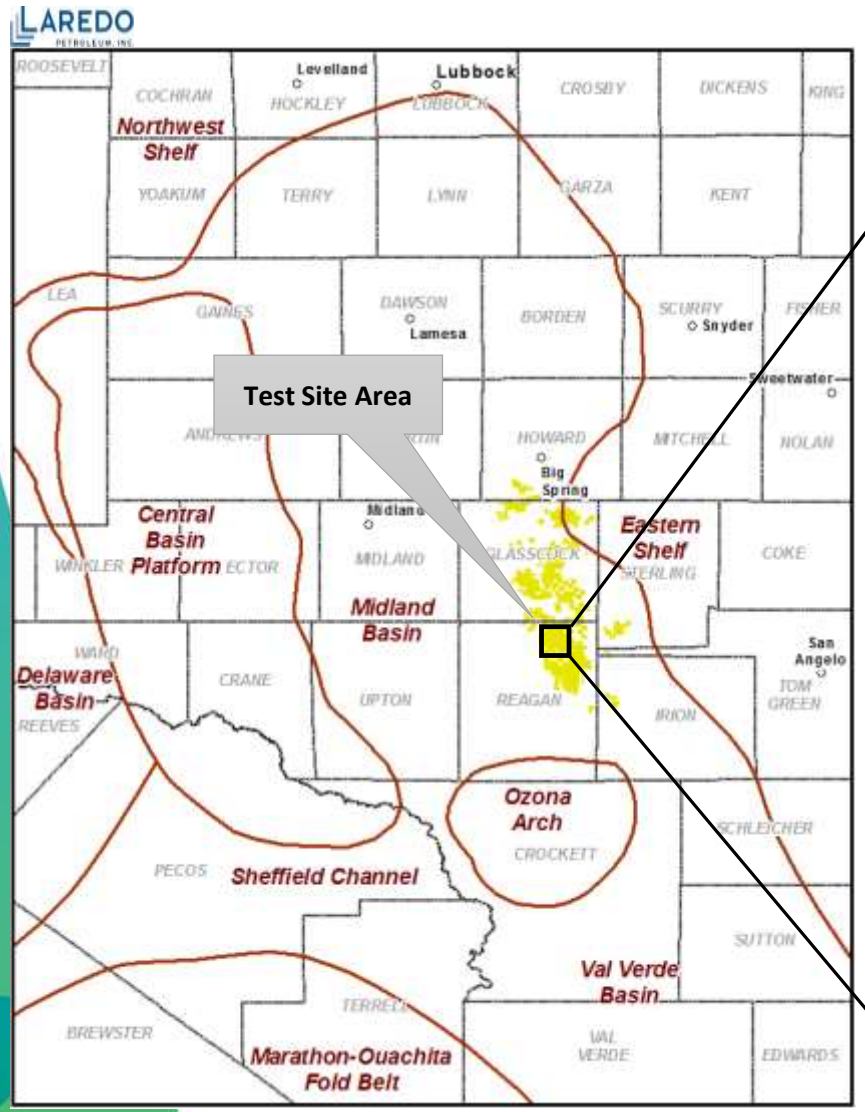
Core Lab

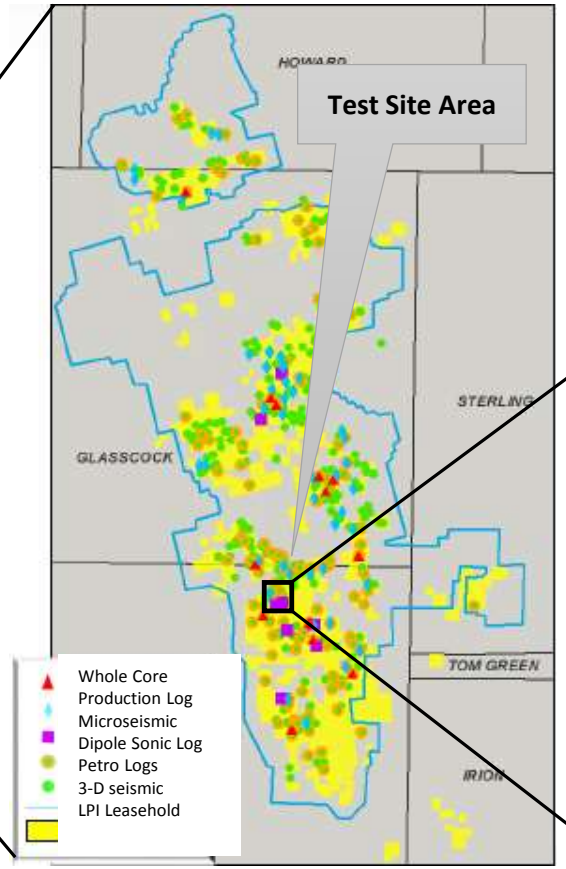
TOTAL

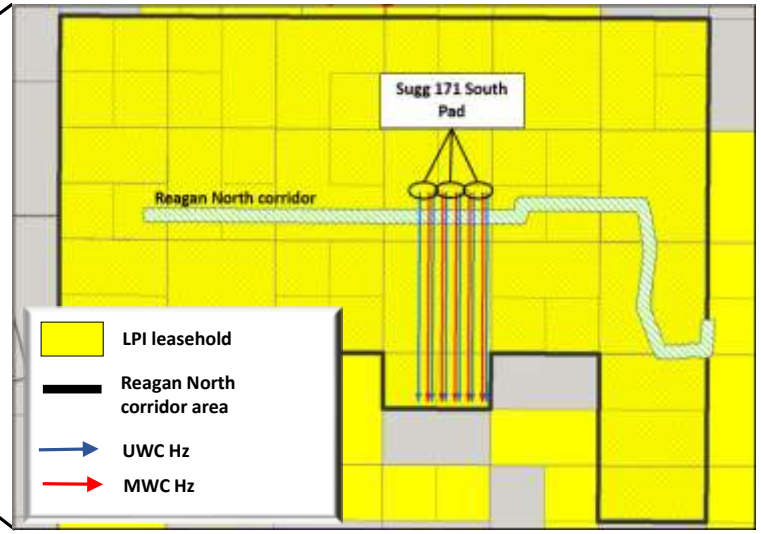
HFTS Experiment Location – West Texas Permian Basin



Test Site Location – Midland Basin



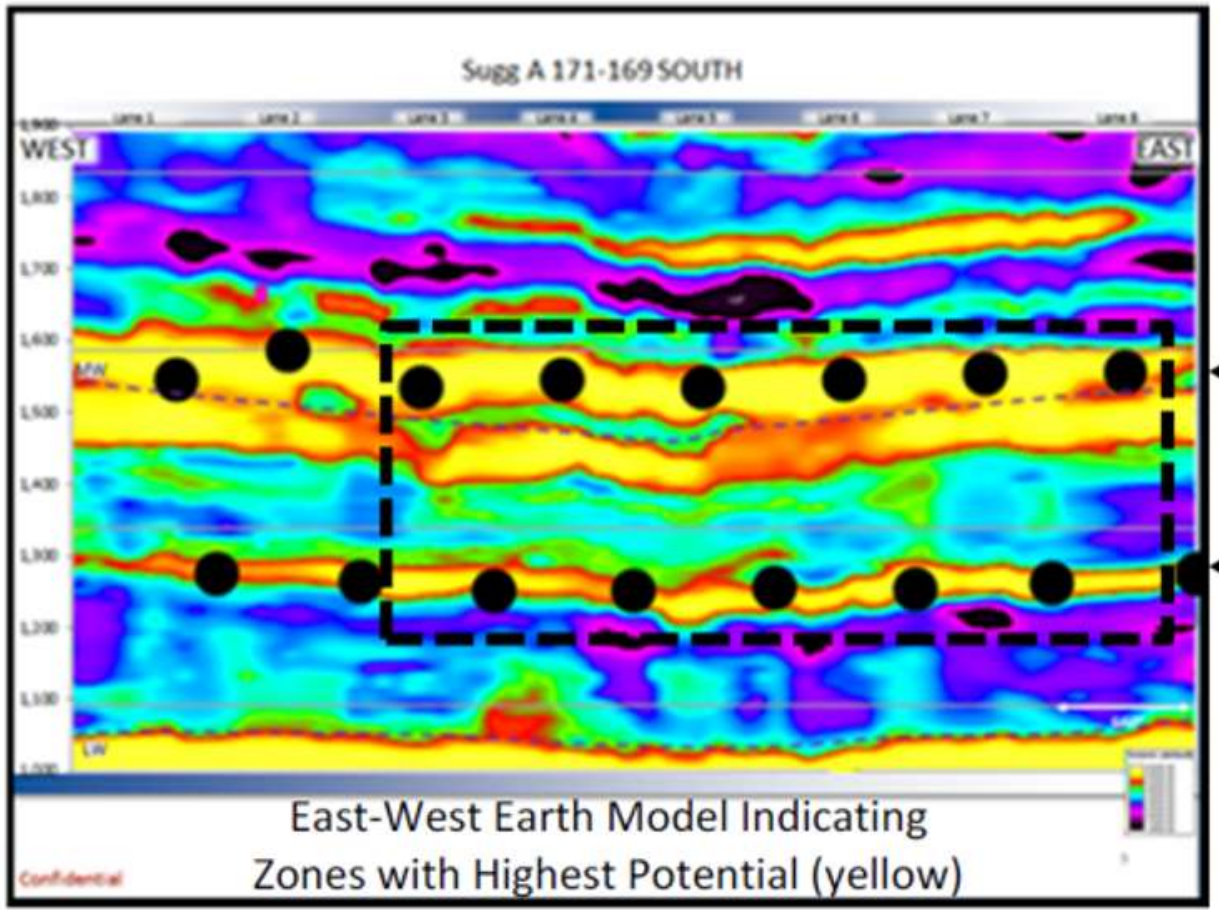




Study Area

Midland Basin
Reagan County
Hydraulic Fracturing Test Site

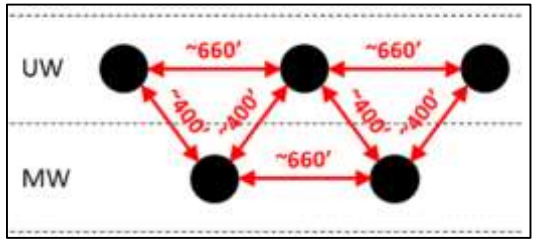
Eleven Test Wells in Cross Section – Wolfcamp Formation



Targeted Zones

← Upper Wolfcamp

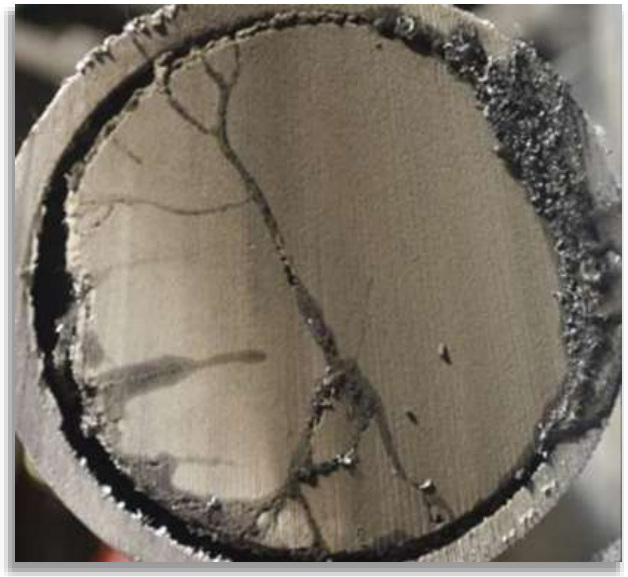
← Middle Wolfcamp

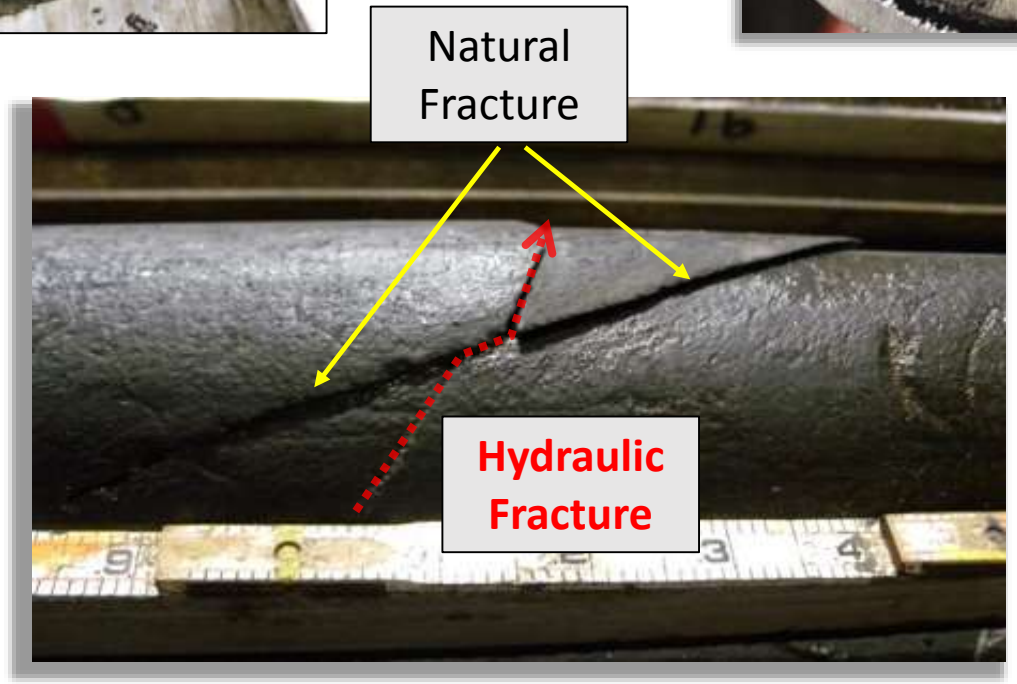


HFTS1 – Midland Key Learnings to Date

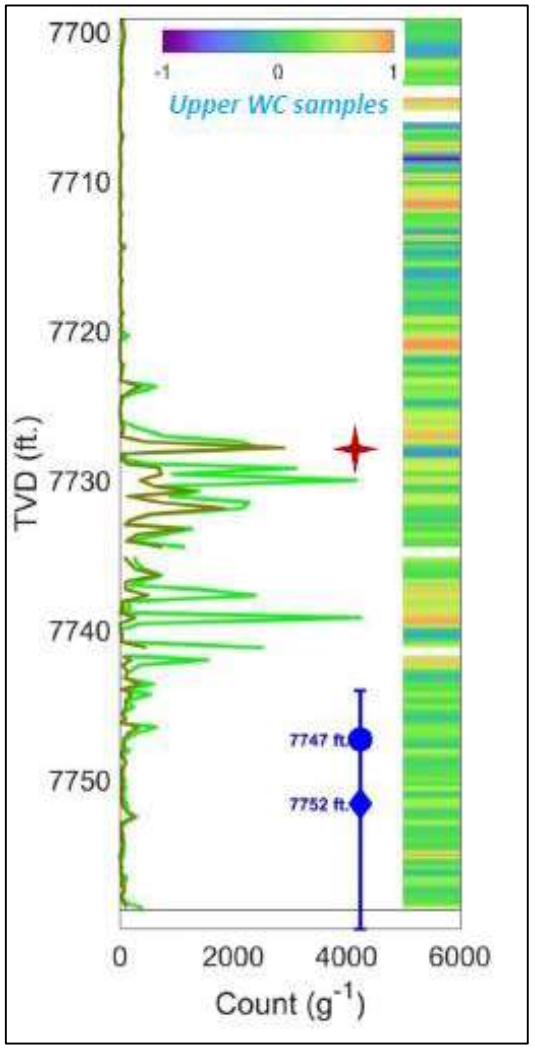
1. Created hydraulic fractures are very complex.
2. Variable rate fracturing provides a significant (30%) uplift to production.
3. Vertical proppant distribution is measured to be 5% of the dispersion indicated by microseismic measurements.
4. The upper and lower Wolfcamp formation vary considerably; the upper with five times the created and natural fractures.
5. Far field created fractures are multiple in number.
6. Water and air impact from an 11 well Permian basin pad was minimal.
7. Well-to-well communication at 660 ft. spacing. Proper well spacing still being investigated.

Through Fracture Core Description



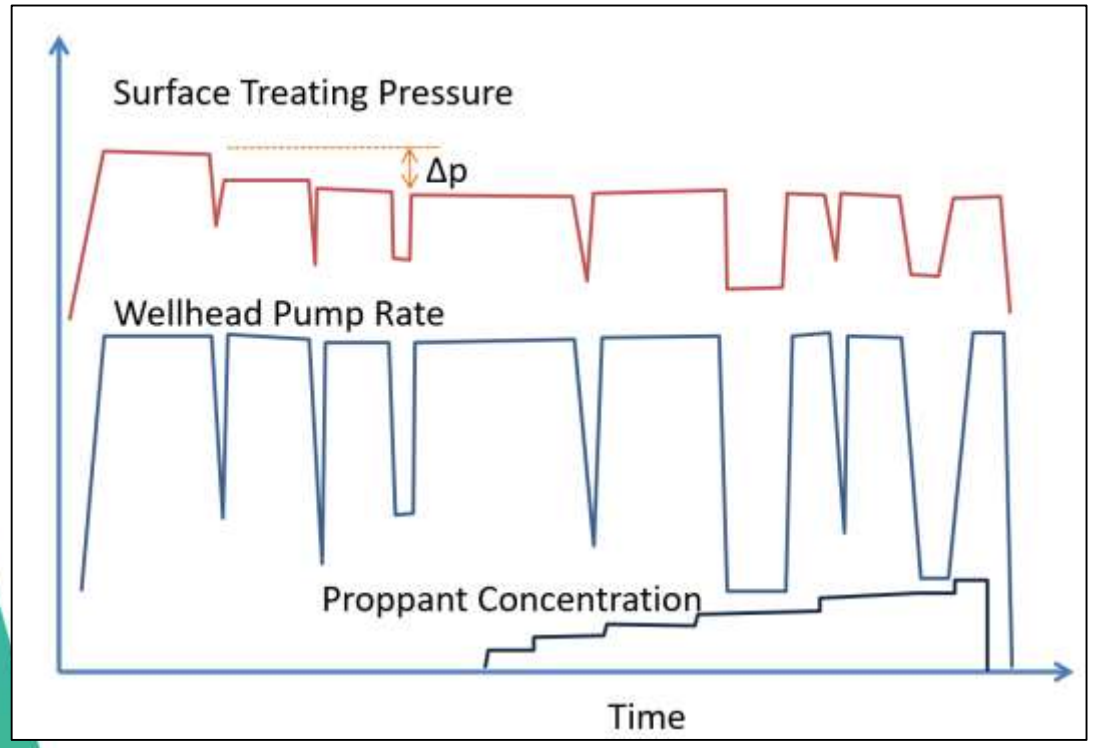


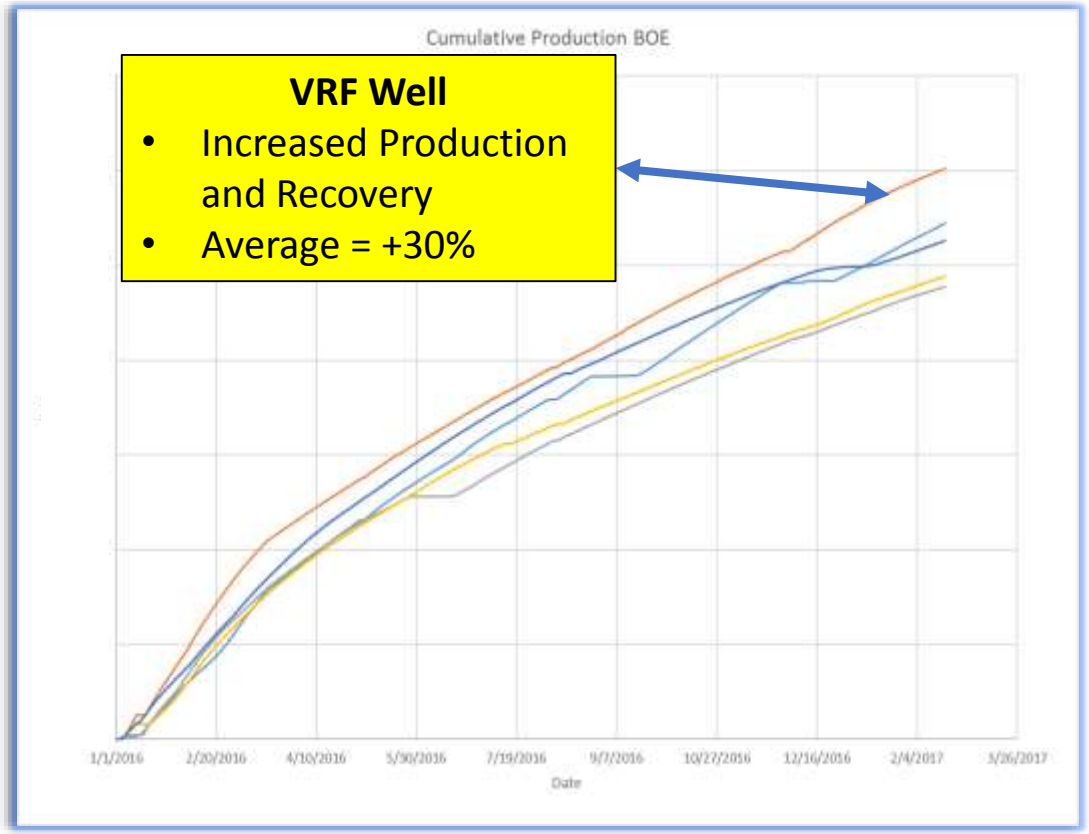
Subsurface Proppant Distribution



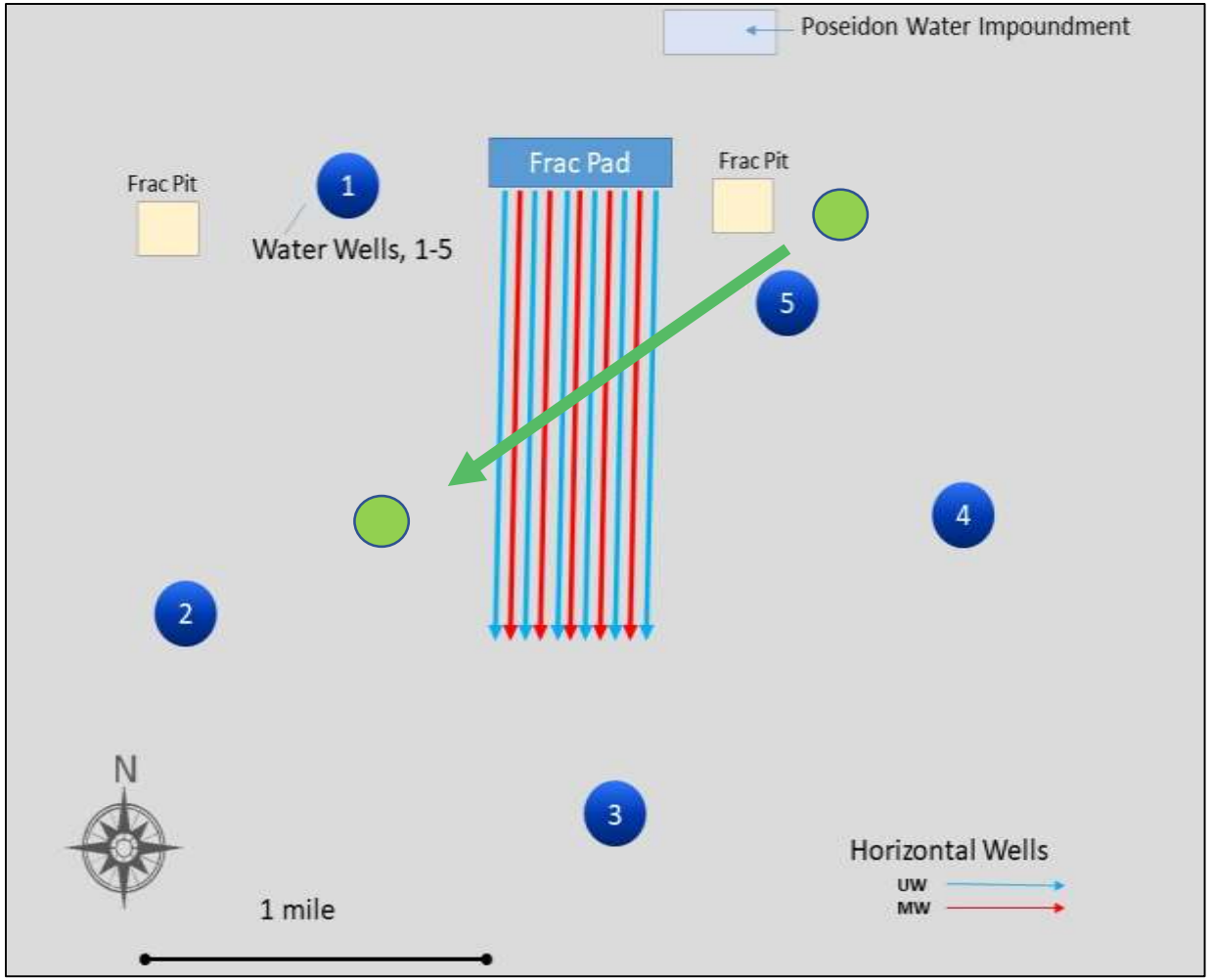
Proppant height of only 30’ in Upper Wolfcamp - 5% of Microseismic height

Variable Rate Fracturing





HFTS Environmental – Air and Water



Water Well

Air Sampling Station

Air Quality

- Elevated levels of BTEX measured during flowback period.

Water Quality

- No evidence of produced water or hydrocarbon migration into aquifer.
- Drawdown of water for hydraulic fracturing had temporary impact on groundwater salinity.

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Jordan Ciezobka
R&D Manager
847-768-0924
jordan.ciezobka@gastechnology.org

Kent Perry
Director, E&P Research
847-768-0832
kent.perry@gastechnology.org

Sarah Eisenlord
R&D Manager
847-768-0927
sarah.eisenlord@gastechnology.org

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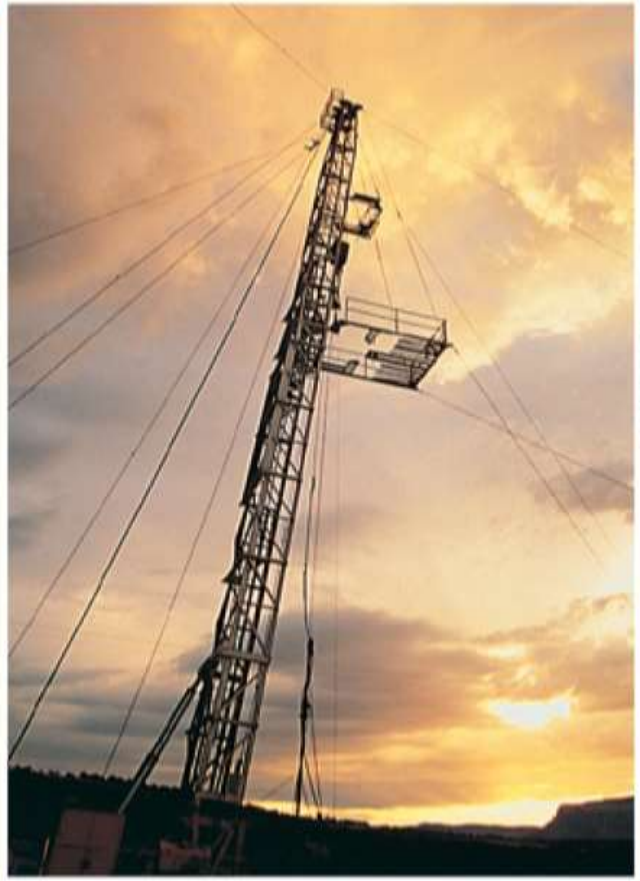

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