RPSEA
Research Partnership to Secure Energy for America

New Albany and Marcellus Shale Gas Projects

A review and update

> RPSEA Unconventional Gas Conference 2011

> April 19th, 2011

> Jordan Ciezobka - GTI

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Marcellus Project Scope of Work

Areas of Study

- Geology
- Reservoir Engineering
- Production Simulation

Intended Outcomes

- Designing optimal fracture stimulation schedule
- Developing the geological frame work
- Determining the dominant orientation of open natural fractures
- Estimating the effective stimulated reservoir volume
- Developing guidelines for placement of horizontal wells

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Hydraulic Fracturing Research Objectives in the Marcellus

- Effective SRV from microseismic imaging
- Optimal fracture treatment design
- Optimal well spacing and orientation

Optimal drilling and completion can reduce future in-fill operations

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Completed Field Data Acquisition

- Zero Offset VSP
  - Vertical seismic velocity calibration
- Cement Bond Log
  - Fracture initiation and propagation
- Borehole & Surface microseismic survey
  - Fracture network complexity and geometry, SRV
  - Source mechanism identification
- Between fracs check-shots
  - Horizontal seismic velocity calibration
  - Completed 93 frac stages on Troyer well pad

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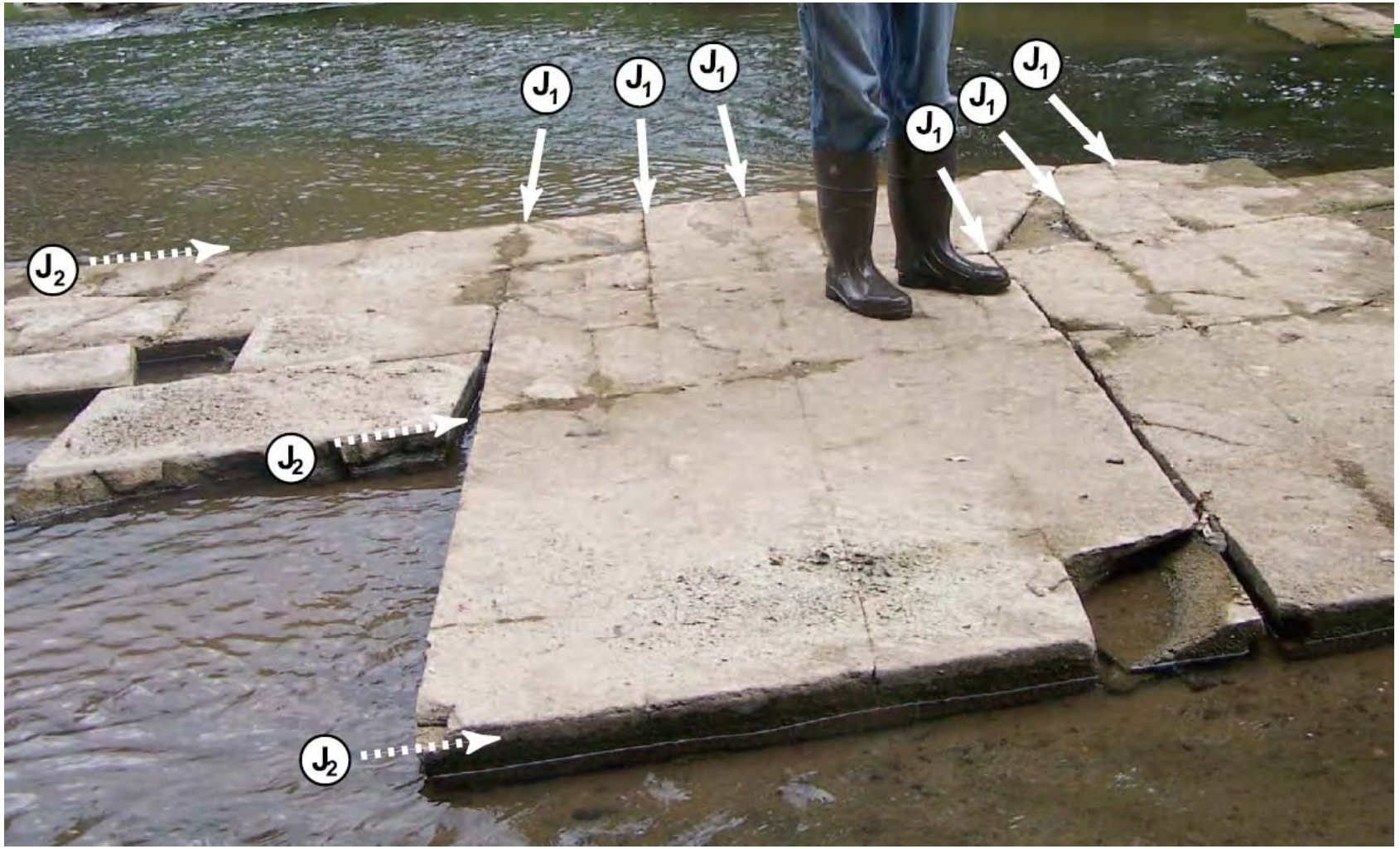
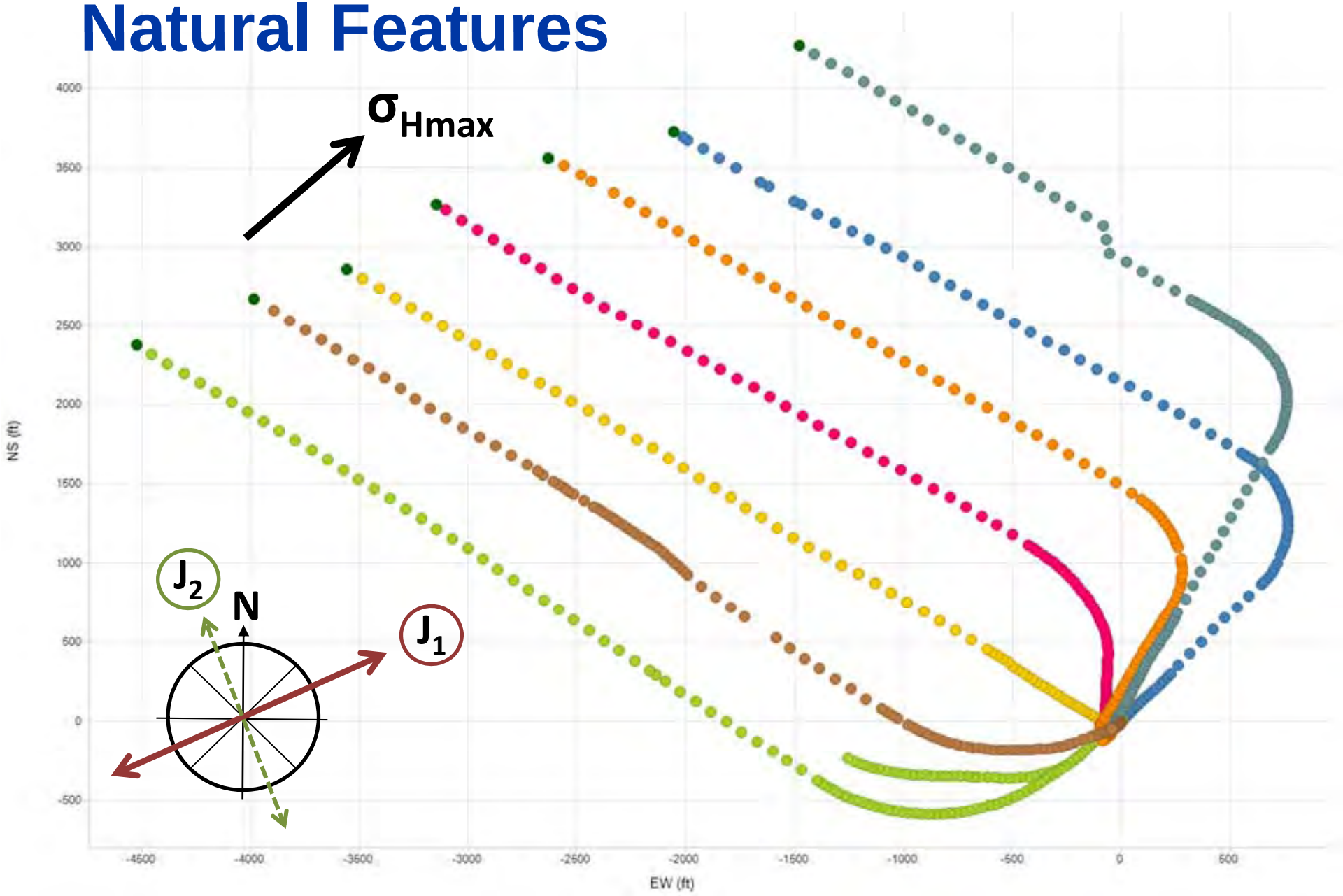
Joint Sets That Enhance Production

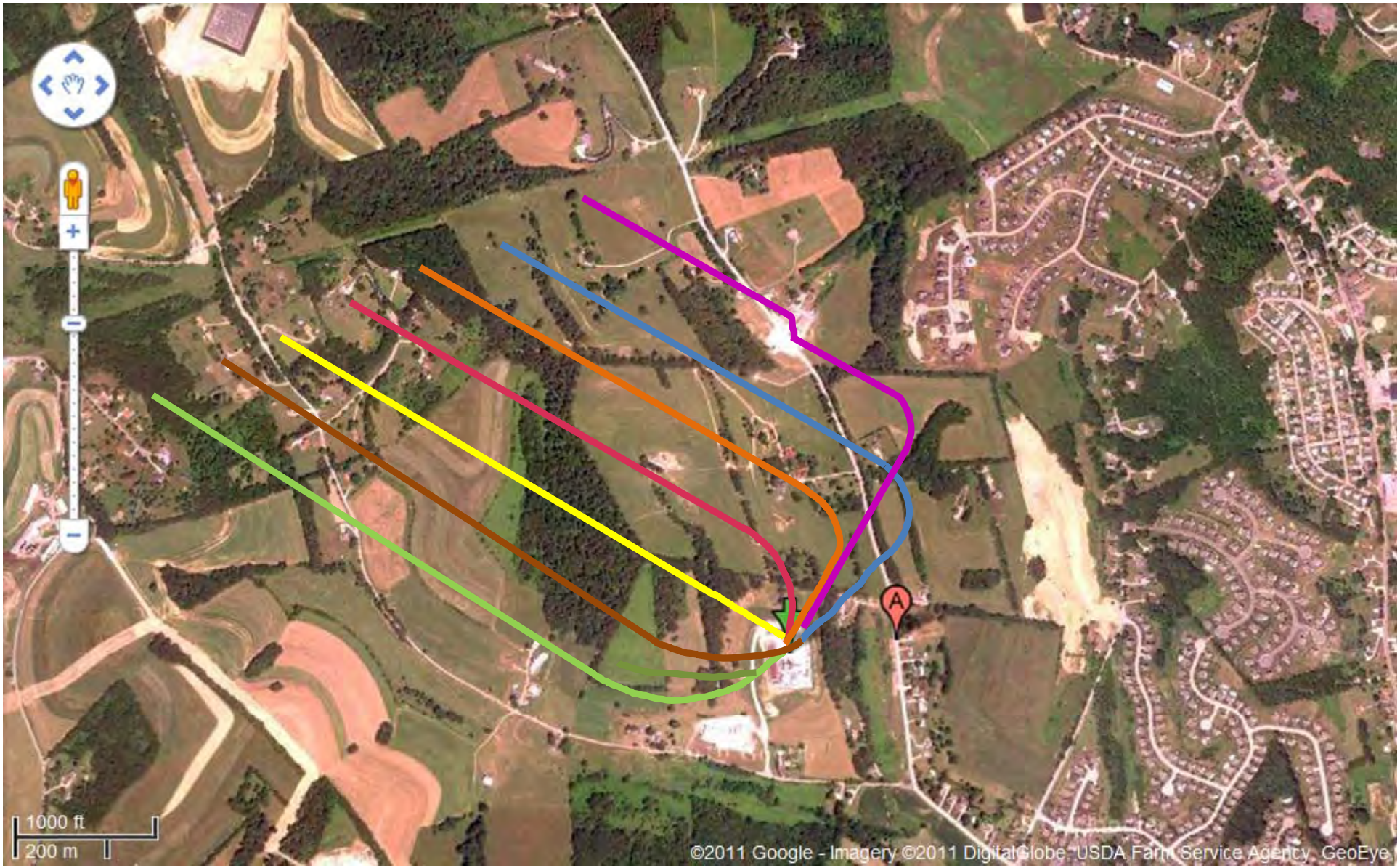


Source: Engelder & Lash: AAPG Bulletin, July 2009

Orientation of Wells Relative to Natural Features



Local Setting



Study Area Formation Properties

- Depth: 6,500’ TVD
- Pore Pressure: 0.65 psi/ft
- Porosity: 7%
- Temperature: 140° F
- Thickness: 80-100 ft

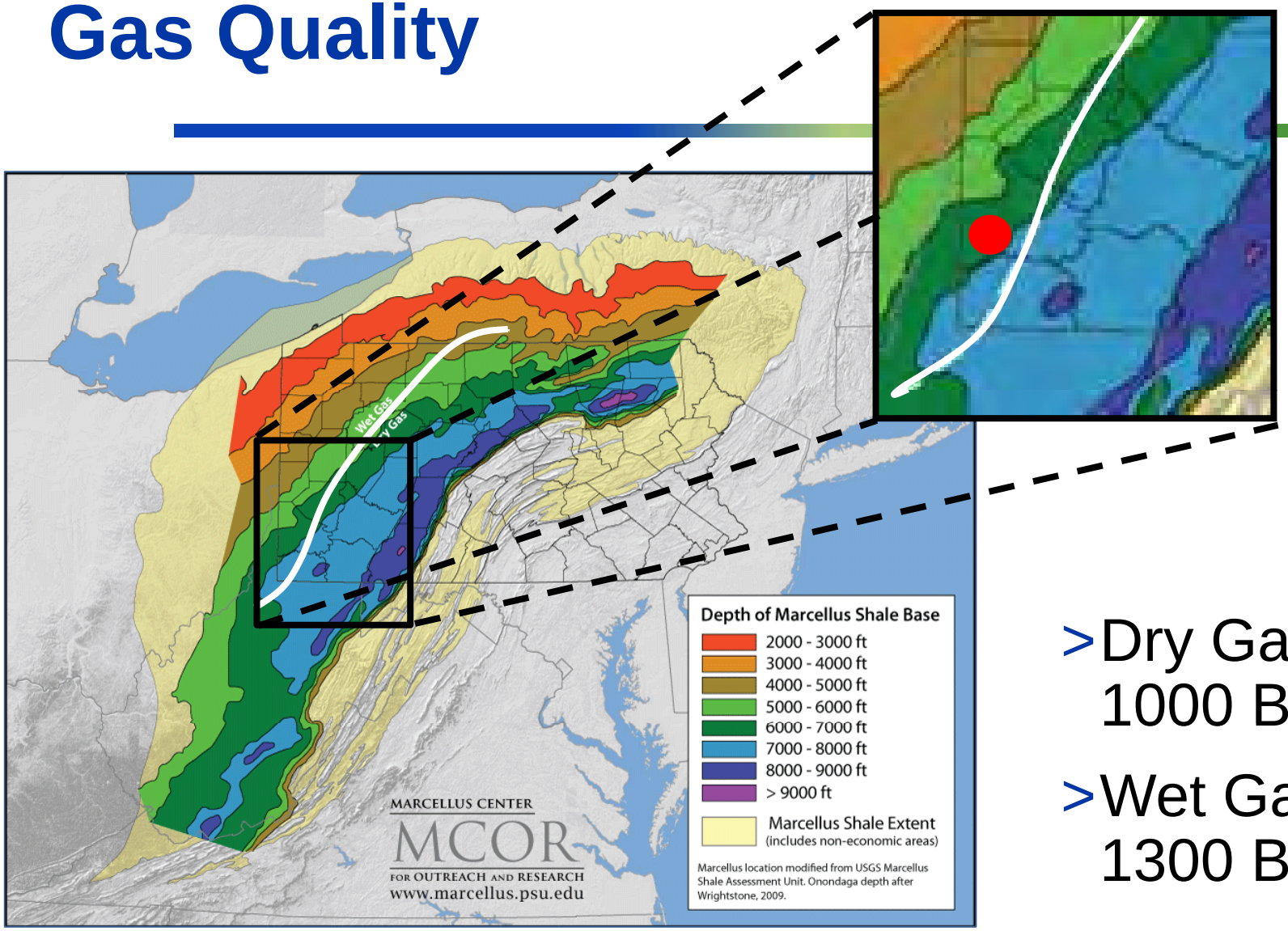
Typical Fracture Treatment

- Number of Frac Stages per Well: 12 - 18
- Spacing: 300-500’
- Rate: 70 - 100 bpm
- Fluid Type: Usually Friction Reduced (FR) Water
- Fluid Volume: 350-500 Mgal/frac
- Proppant Type: 100 Mesh and 30/50 40/70 Sand
- Proppant Volume: 350-500 Mlbs/frac
- Max Proppant Concentration: 2.5 - 4 ppg

Typical Fracturing Fluids

- Slickwater: Mix of Fresh and Produced Waters
  - Friction Reducer
  - Bactericide
  - Scale Inhibitor
  - Iron Control
  - Micro Emulsifier (Load Recovery)

Gas Quality



- Dry Gas – 1000 BTU
- Wet Gas – 1300 BTU

Source: Penn State University

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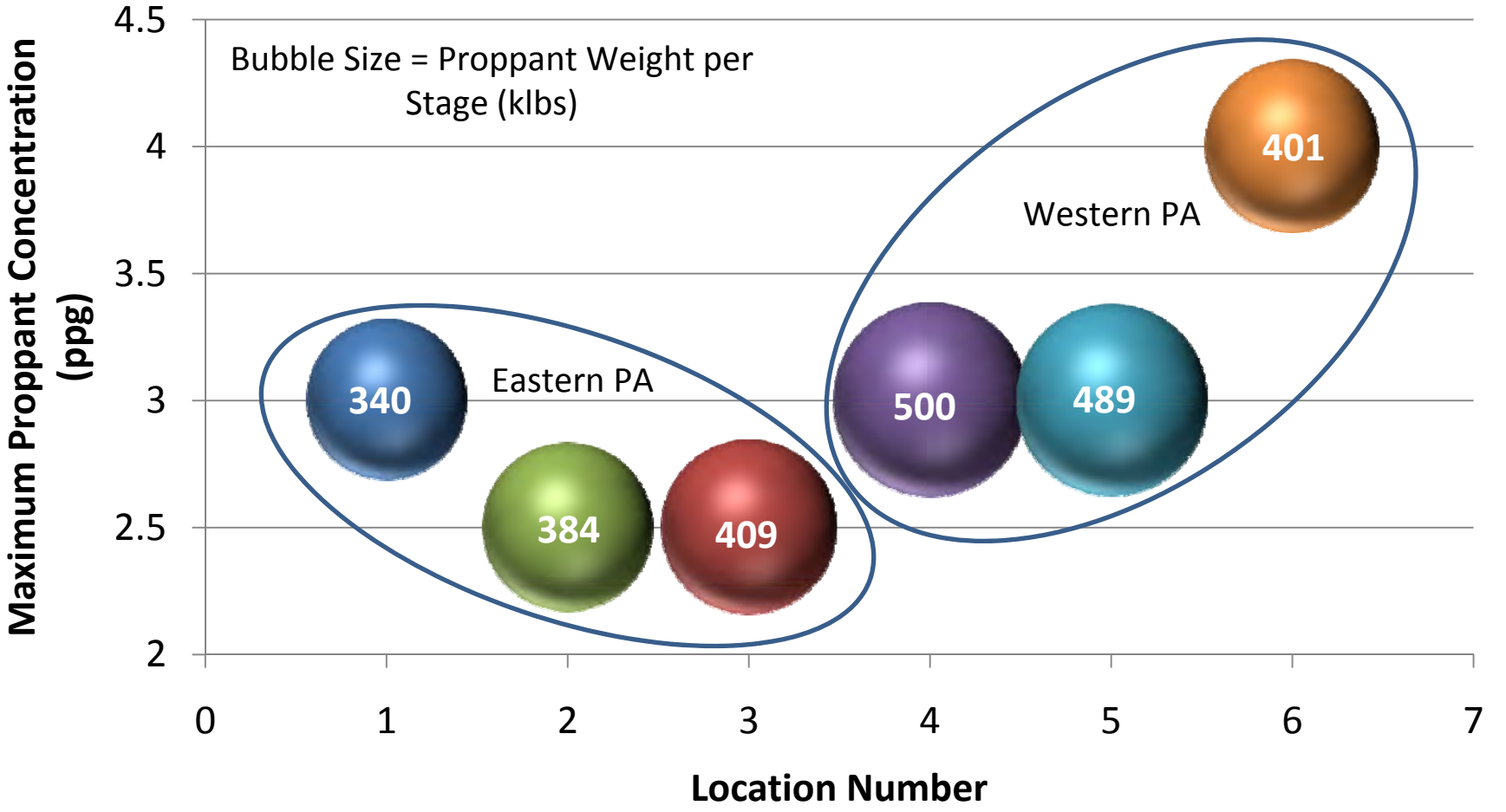
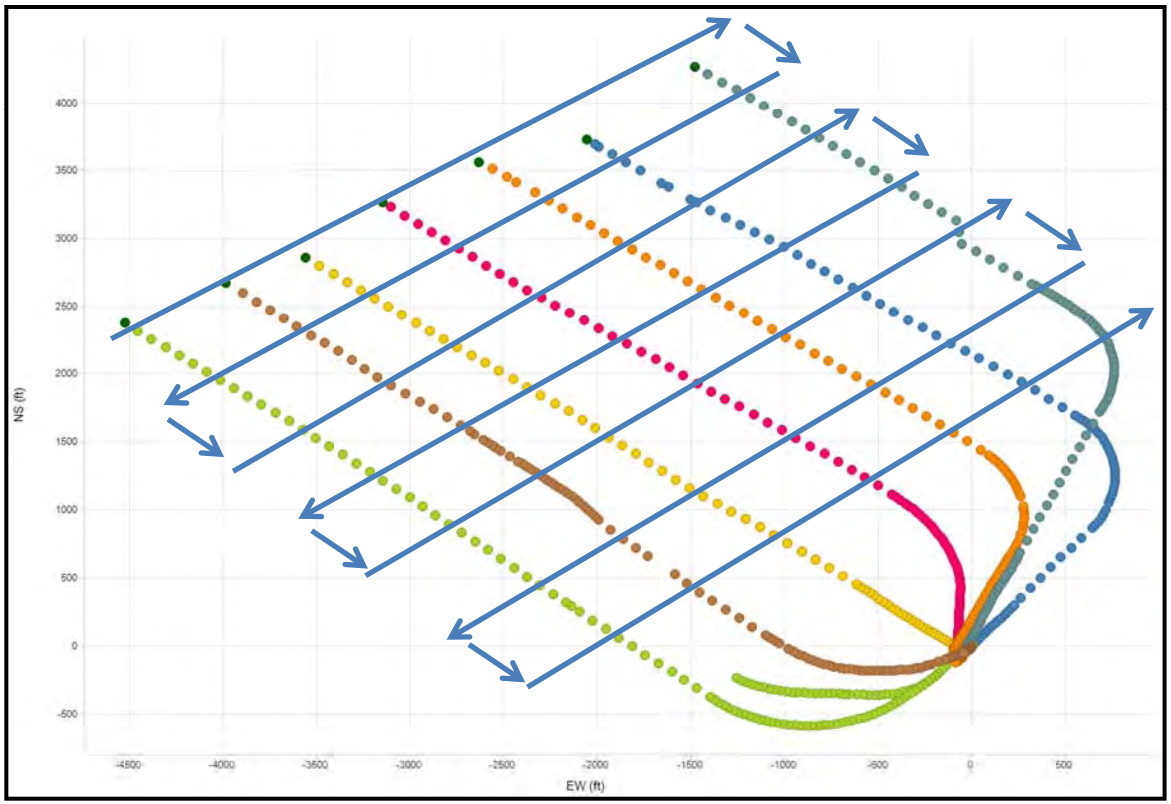
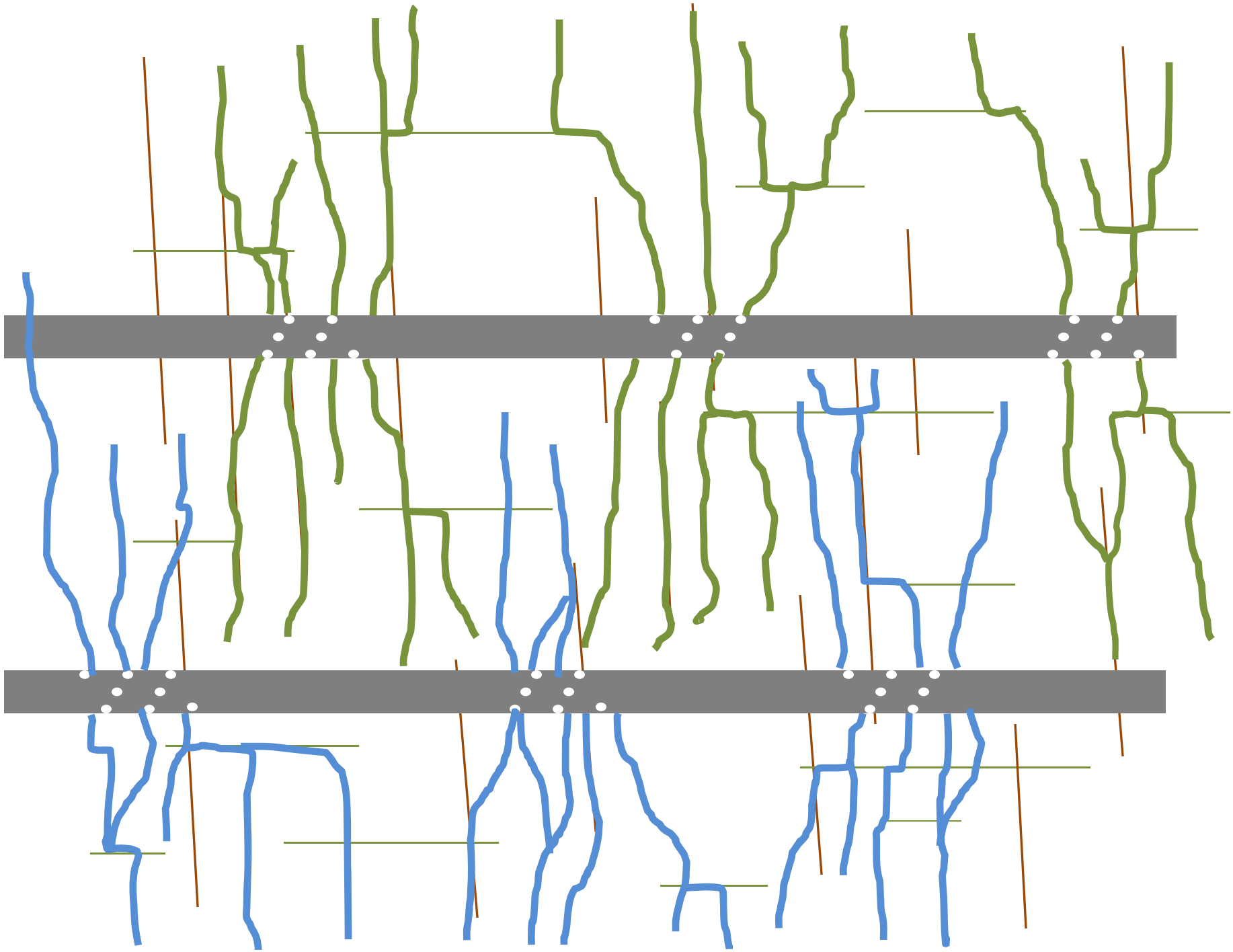
Frac Design Comparison



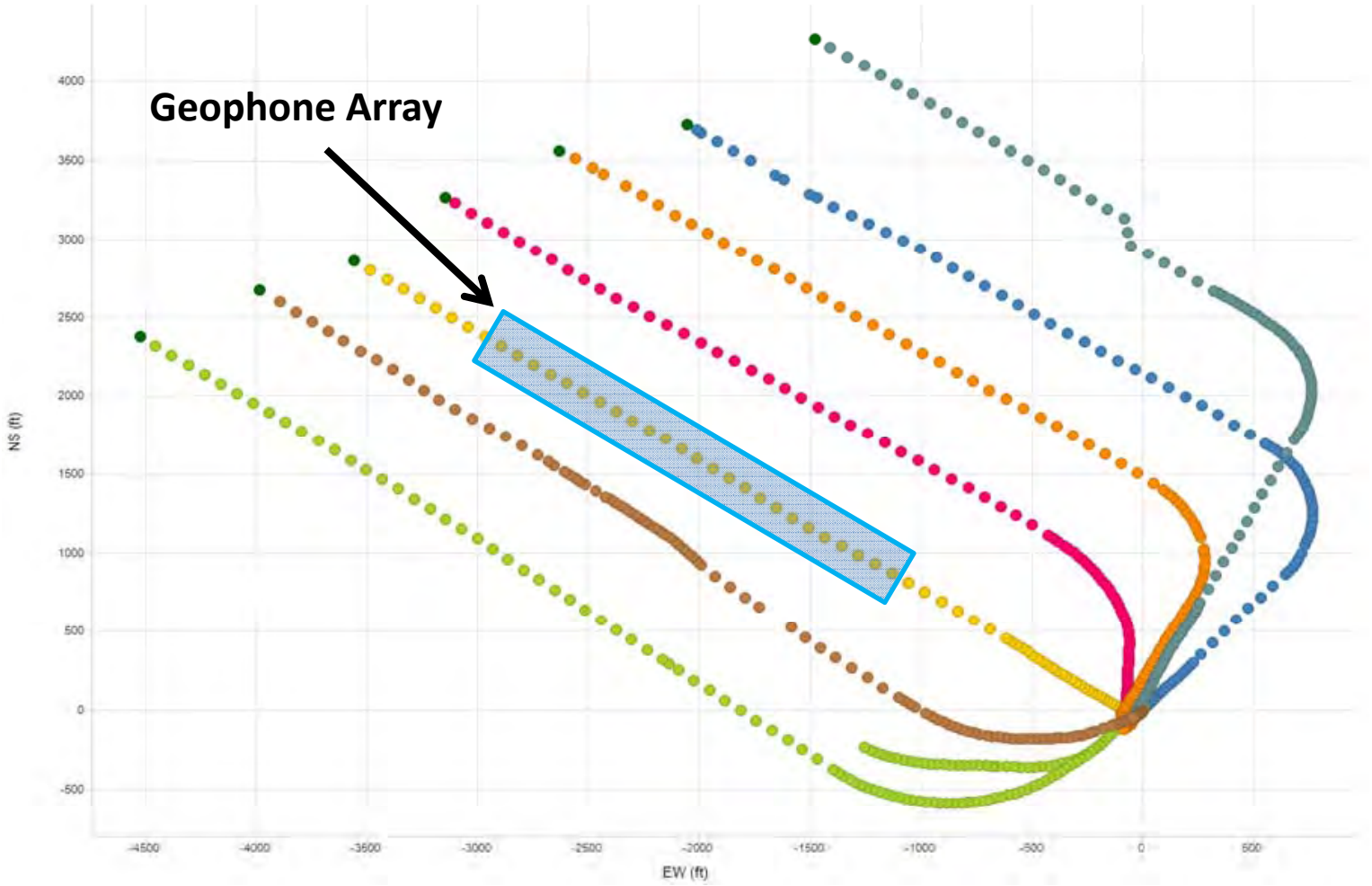
Zipper Frac Sequence

> Troyer well layout with planned fracture zipper sequence to promote complexity.

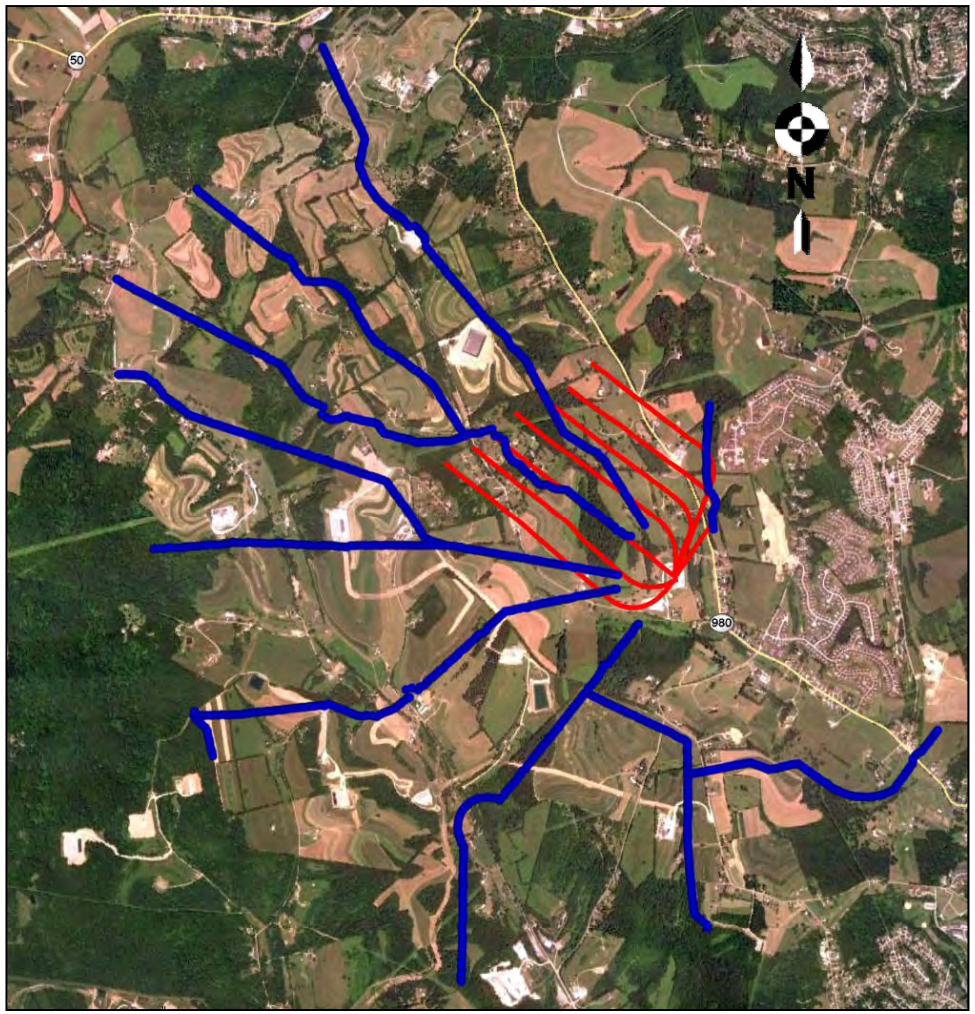




Borehole Microseismic



Surface Microseismic



- 1082 Stations in the array.
- Array consists of 10 arms radiating from the wellhead

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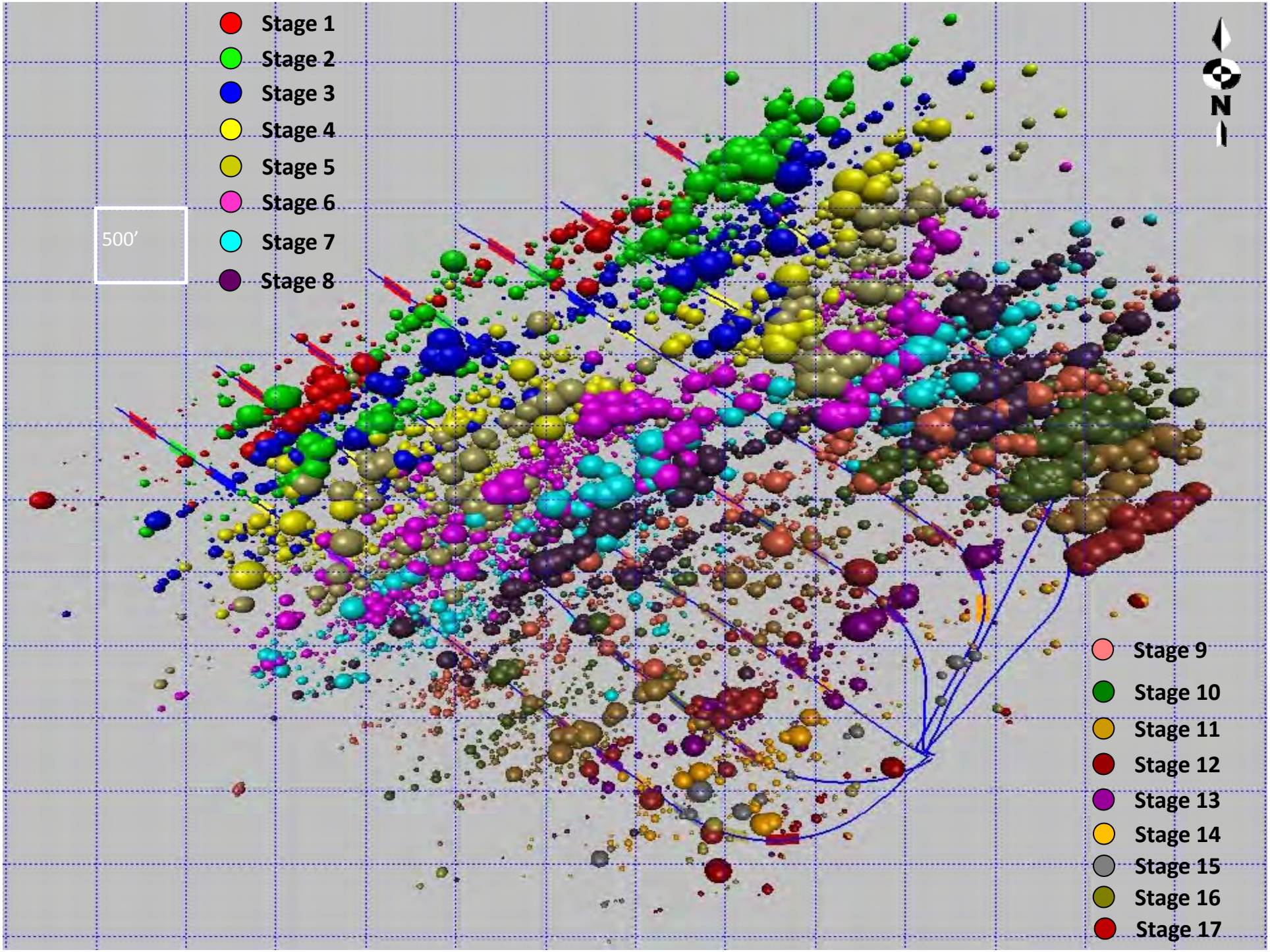
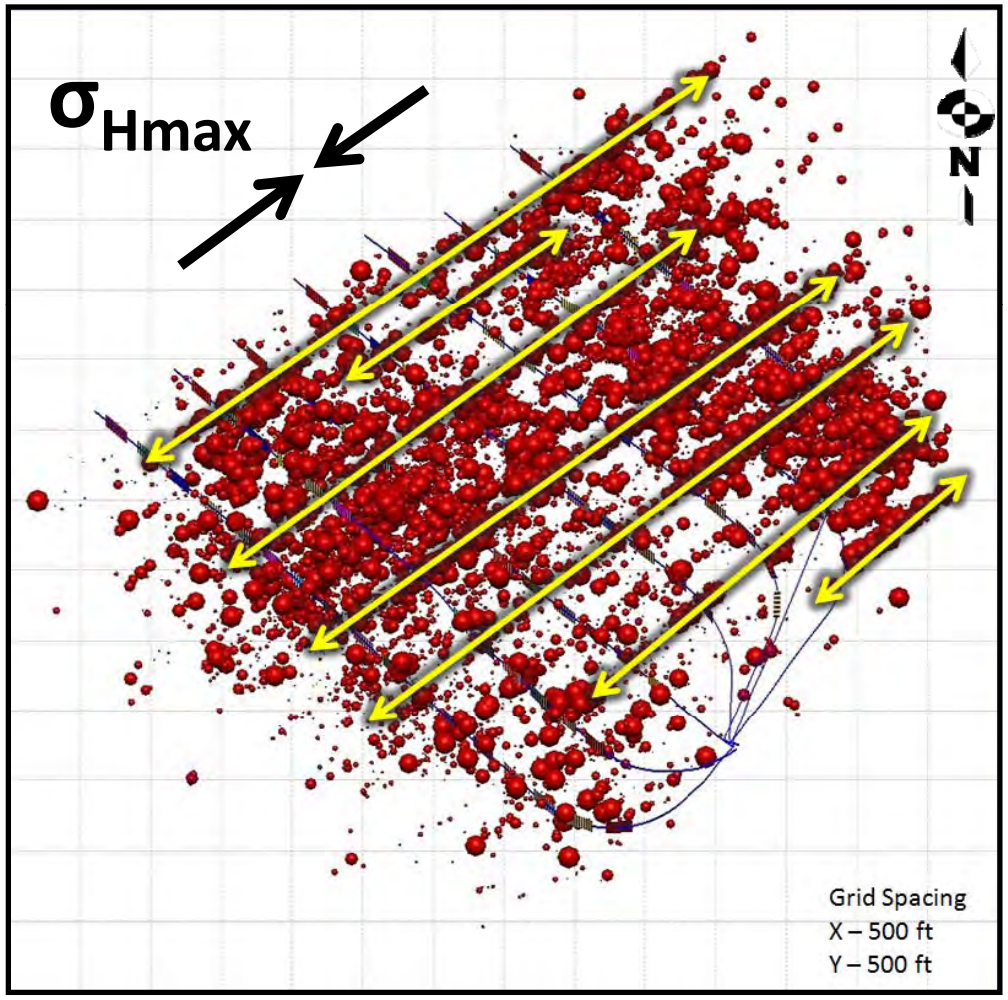

Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Stage 6
Stage 7
Stage 8
500’
N
Stage 9
Stage 10
Stage 11
Stage 12
Stage 13
Stage 14
Stage 15
Stage 16
Stage 17

Estimated Fracture Azimuth



- Frac Events: Bubble Size = Amplitude
- σ_{Hmax} : ~NE-SW

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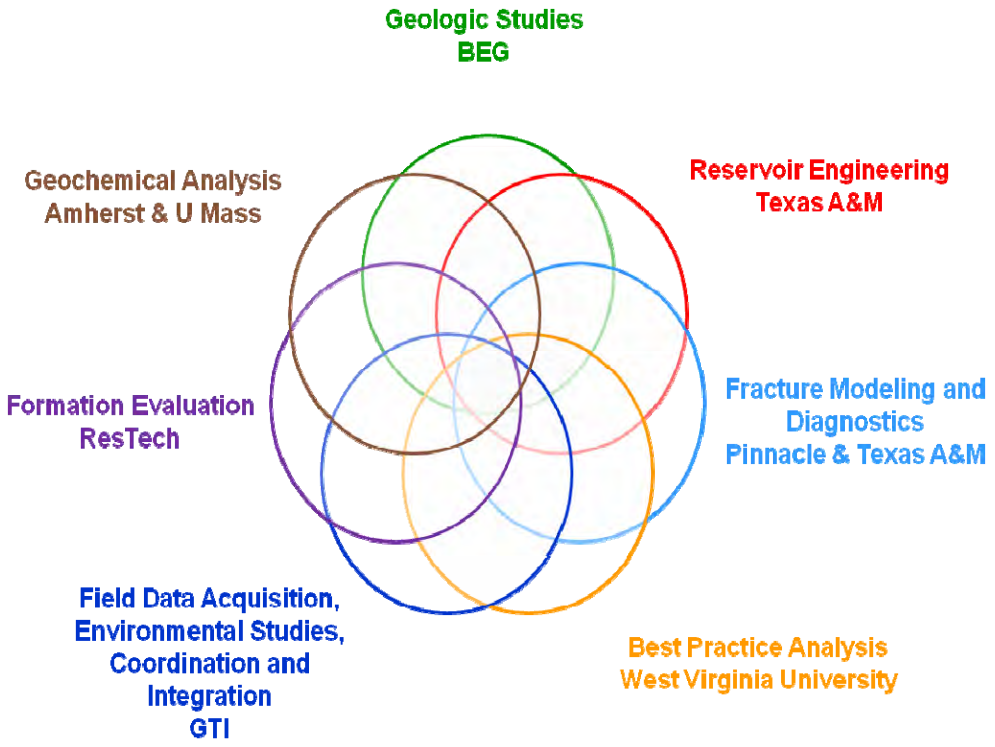
Planned Field Data Acquisition

- Post Frac Production Log
  - Early production contribution from individual frac stages
- 2nd Production Log After 6 Months
  - Late production contribution from individual frac stages
  - Microseismic event frequency/cloud geometry impact on long term production
  - Effect of condensate blockage resulting in permeability reduction

New Albany Shale Project Summary

"Industry cooperative research and development project aimed at the development of techniques and methods for increasing the success ratio and productivity of New Albany shale gas wells to a level where otherwise noncommercial wells may become commercial producers."



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NAS Project Summary of Results

- Top-Down Reservoir Engineering Approach
- Well Optimization Simulator (Excel)
- Adsorbed Gas Density Correction
- Stimulation
- Geochemical Analysis
- Geology
- Fracture Propagation and Interaction

Thank You!