Seismic Reservoir Characterization of the Morrow "A" Sandstone, Postle Field, Texas County, Oklahoma*

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Abstract

Three multicomponent (9-C) seismic surveys were conducted at Postle Field, Oklahoma. Interpretation of the surveys illustrates that the Morrow "A" sandstone can be detected. The sandstone was previously considered acoustically invisible, yet the combination of multicomponent and time-lapse seismic data has enabled us to detect the reservoir, with average thickness of 38 ft (8.5 m) buried beneath a complex overburden at 6,100 ft (1,850m) depth.

Even though the sandstone is thin, it has a greater elastic impedance contrast than acoustic impedance contrast. We have found that shear wave data enables reservoir mapping of at least half the minimum thickness seen on P-wave data. This is because the shear wave reflectivity contrast between the sandstone and adjacent shale is three times that of P-wave, thus enabling higher definition of the thin sandstone reservoir with shear wave data. Dynamic changes introduced by water and carbon dioxide flooding enable further delineation of the sandstones in the shale-dominated interval.

References

Bowen, D.W., and P. Weimer, 2003, Regional sequence stratigraphic setting and reservoir geology of Morrow incised-valley sandstone (Lower Pennsylvanian), eastern Colorado and western Kansas: AAPG Bulletin, v. 87/5, p. 781-815.

Tamimi, N., S. Sherkati, and I.A. Fard, 2009, The Effects of Structural Components on Seismic-Wave Velocity in Incompetent Units, Case Study: Gachsaran Formation (SW Iran): SEG 79th Annual International Meeting Technical Program, Houston, TX, 5 p.

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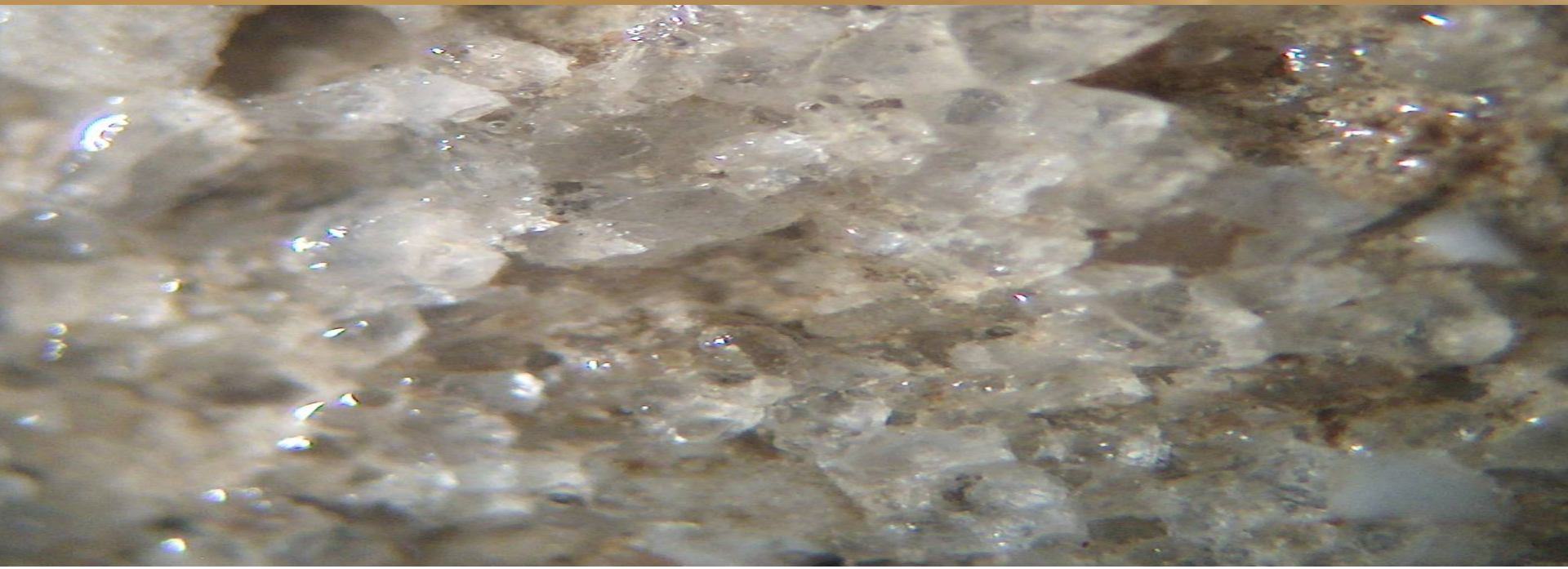
Zerpa, L.E., A.K. Sum, E.D. Sloan, C.A. Koh, 2011, Generation of Best Practices in Flow Assurance Using a Transient Hydrate Kinetics Model: Offshore Technology Conference Proceedings, Houston, Texas, 7 p.

Seismic Reservoir Characterization of the Morrow A Sandstone

Postle Field, Texas County, Oklahoma

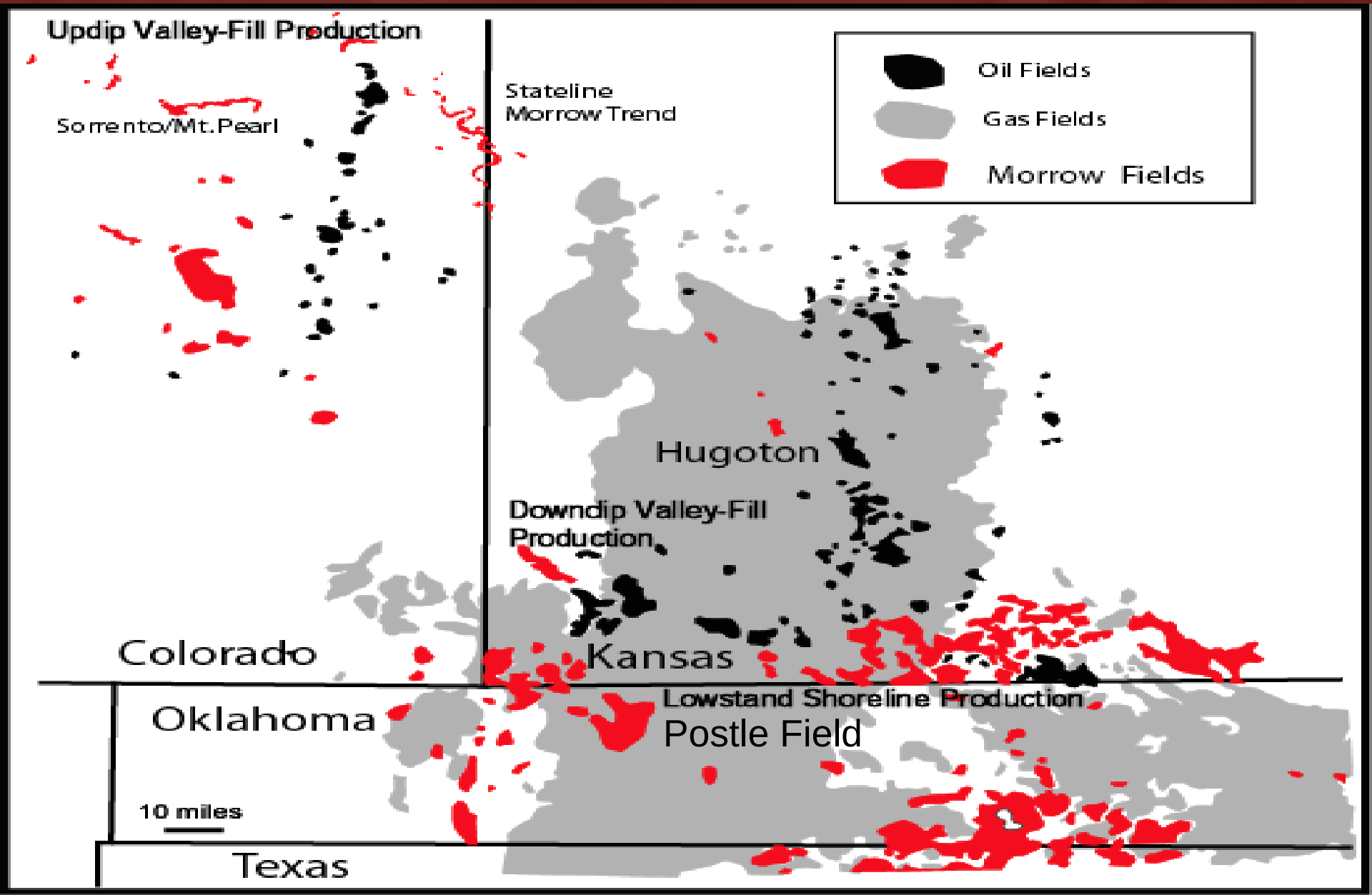


Thomas L. Davis & Robert D. Benson CSM

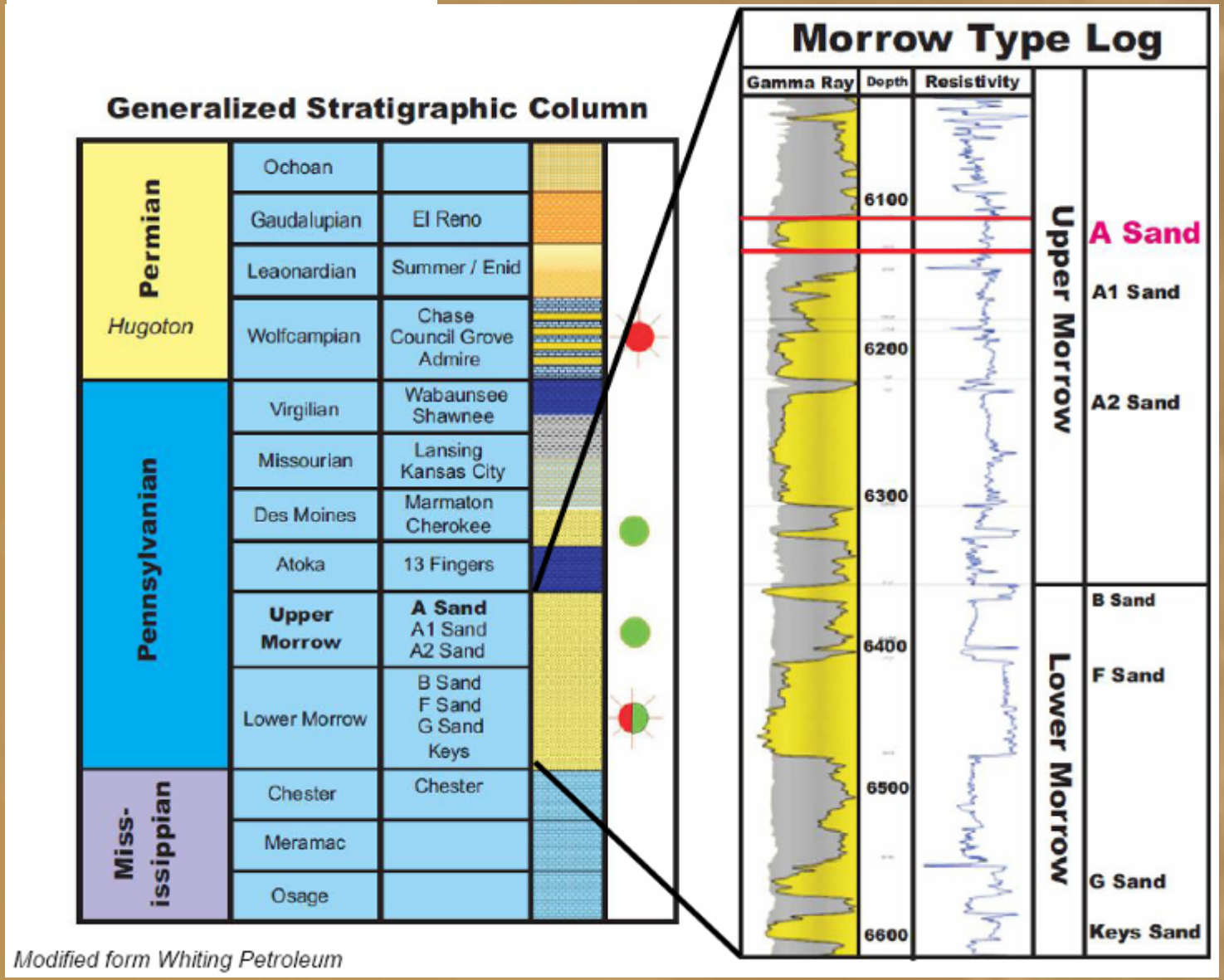
Scott Wehner, Michael D. Raines and Roger Freidline

Whiting Oil and Gas Corp

Location of Postle Field

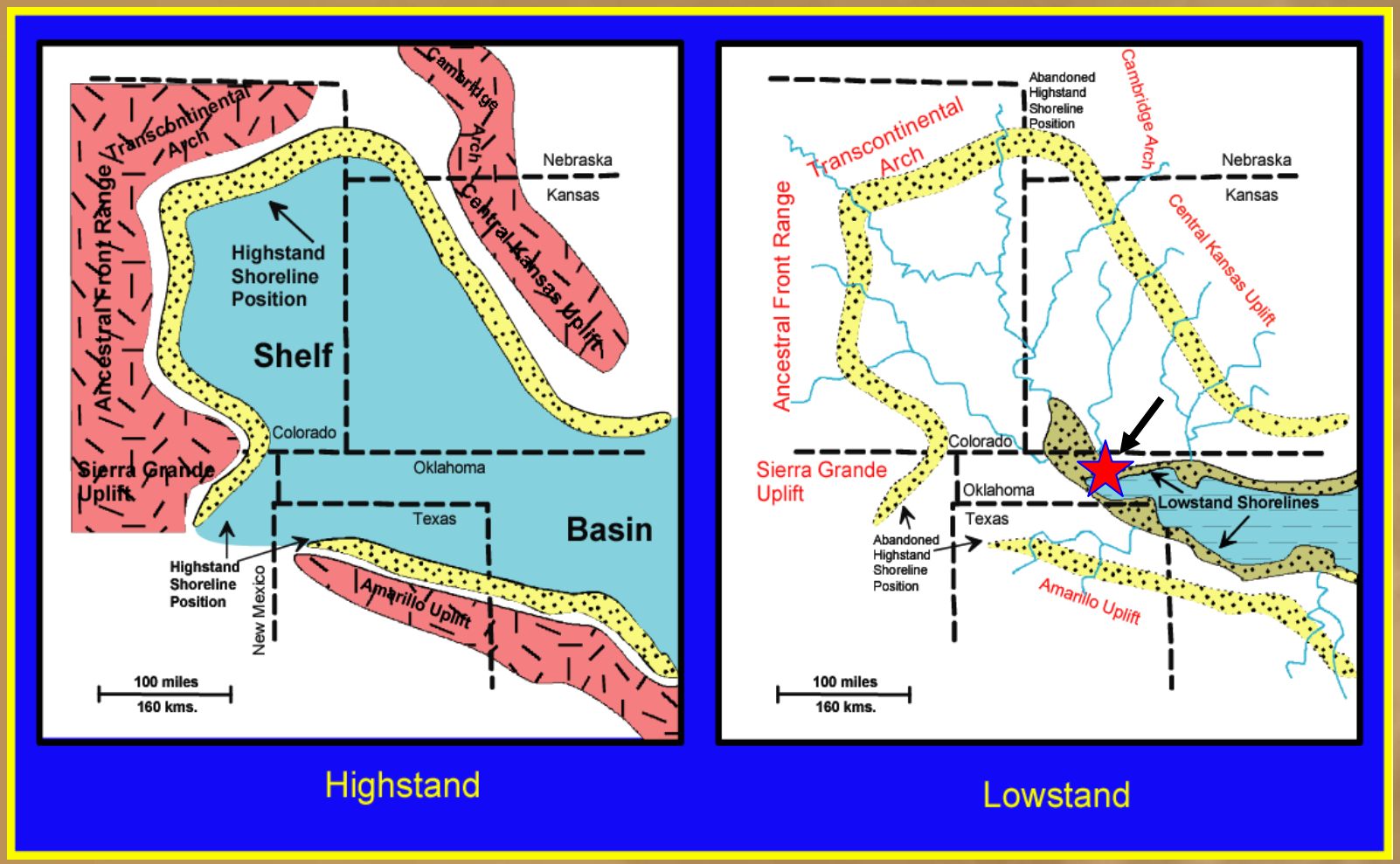


Morrow Stratigraphic Section



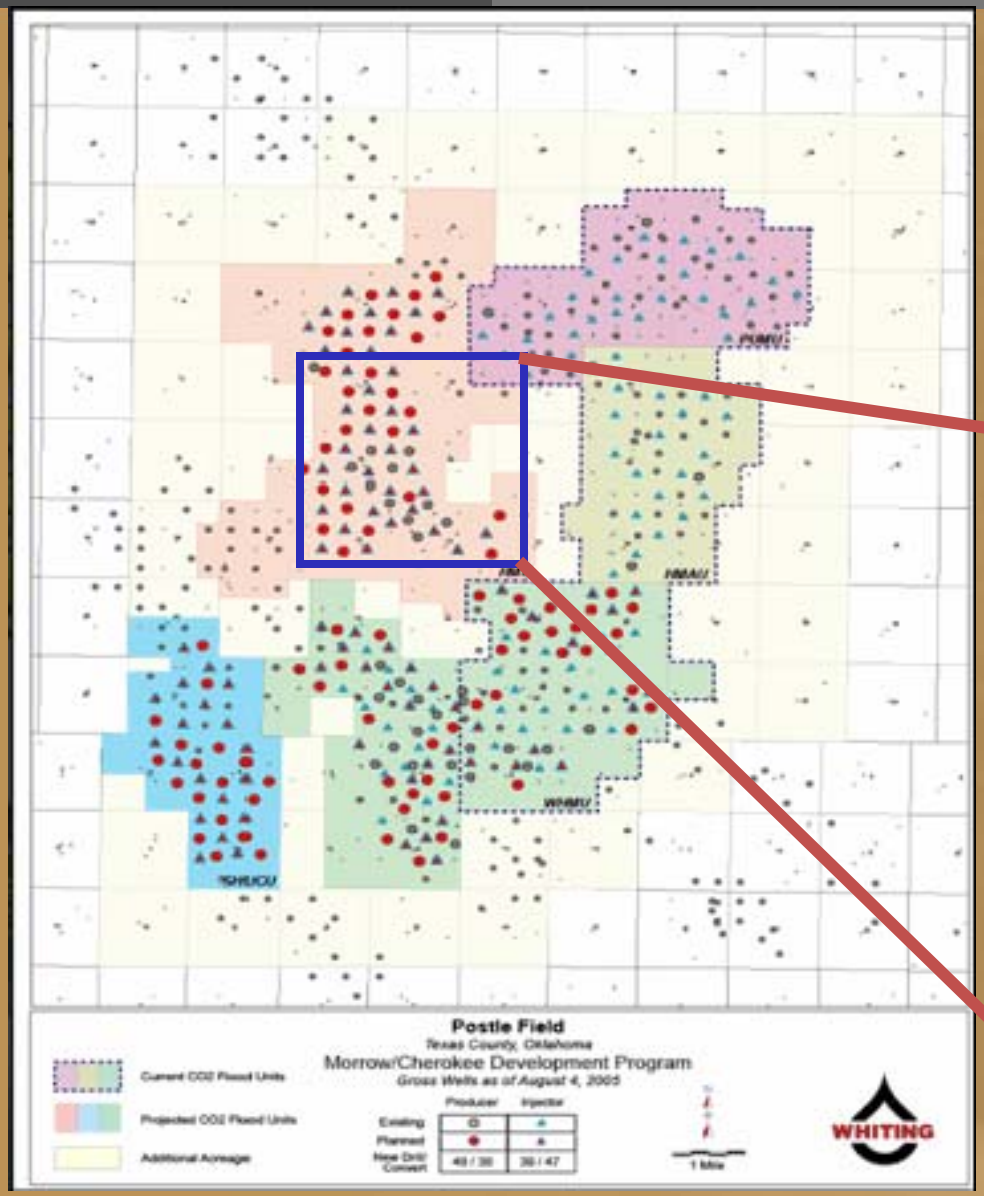
Modified form Whiting Petroleum

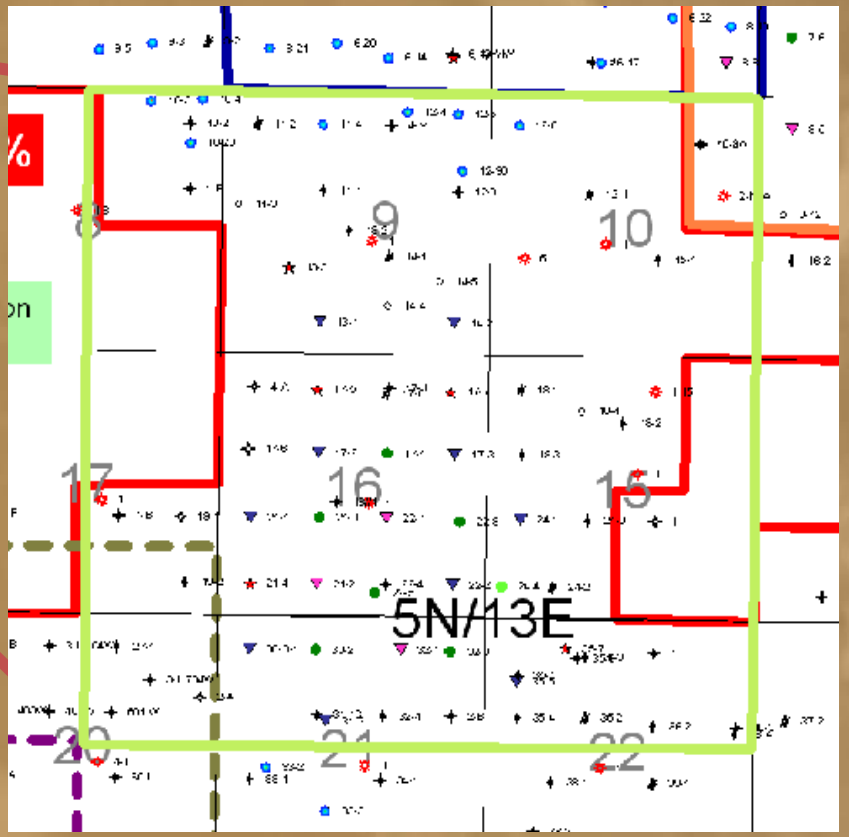
Postle Field – Geologic Setting



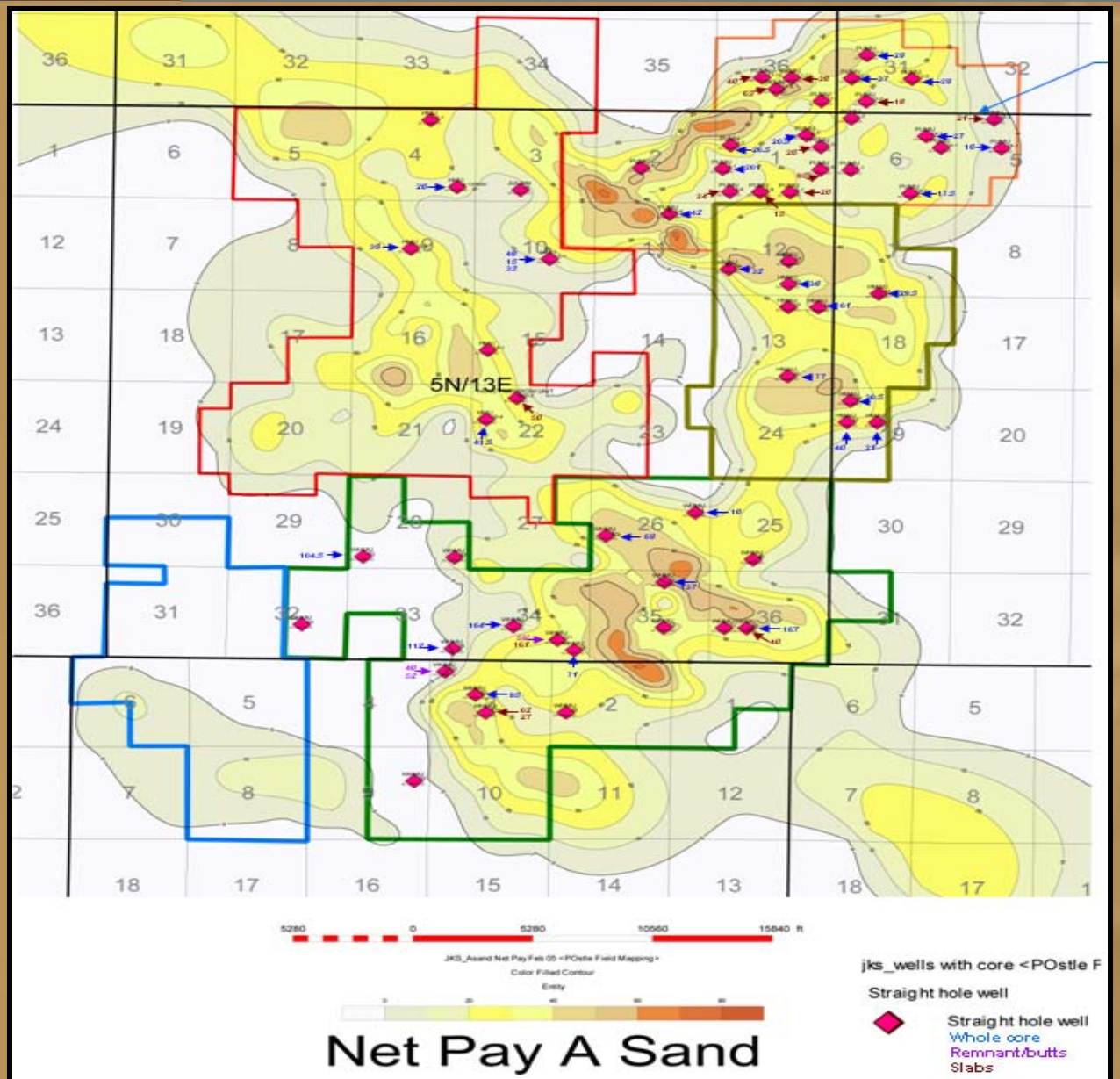
Pennsylvanian Morrow (~217Ma) paleogeography. Modified from Bowen and Weimer (2003).

Study Location in the Hovey Morrow Unit





Net Pay A Sand



Postle Reservoir Parameters

•Depth	6100’
•Producing formation	Upper Morrow sand
•Average Thickness	28’ (10-70)
•Porosity	17% (10-23)
•Permeability	50 mD (20-500)
•Soi	70%
•Reservoir Temp	140 F
•Reservoir pressure Initial	1630 psi
•Reservoir Pressure Current	200 - 2300 - 4500 psi
•Minimum Miscibility Pressure	2100 psi
•Oil Gravity	40 API
•Oil FVF orig	1.28
•Oil FVF current	1.20
•Well spacing	40 Ac (80-Ac 5-spot inj. patterns)
•Area	26000 Ac
•Cumulative Production	120 MMBO (40% OOIP)
•OOIP	~300 MMBO

Motivation

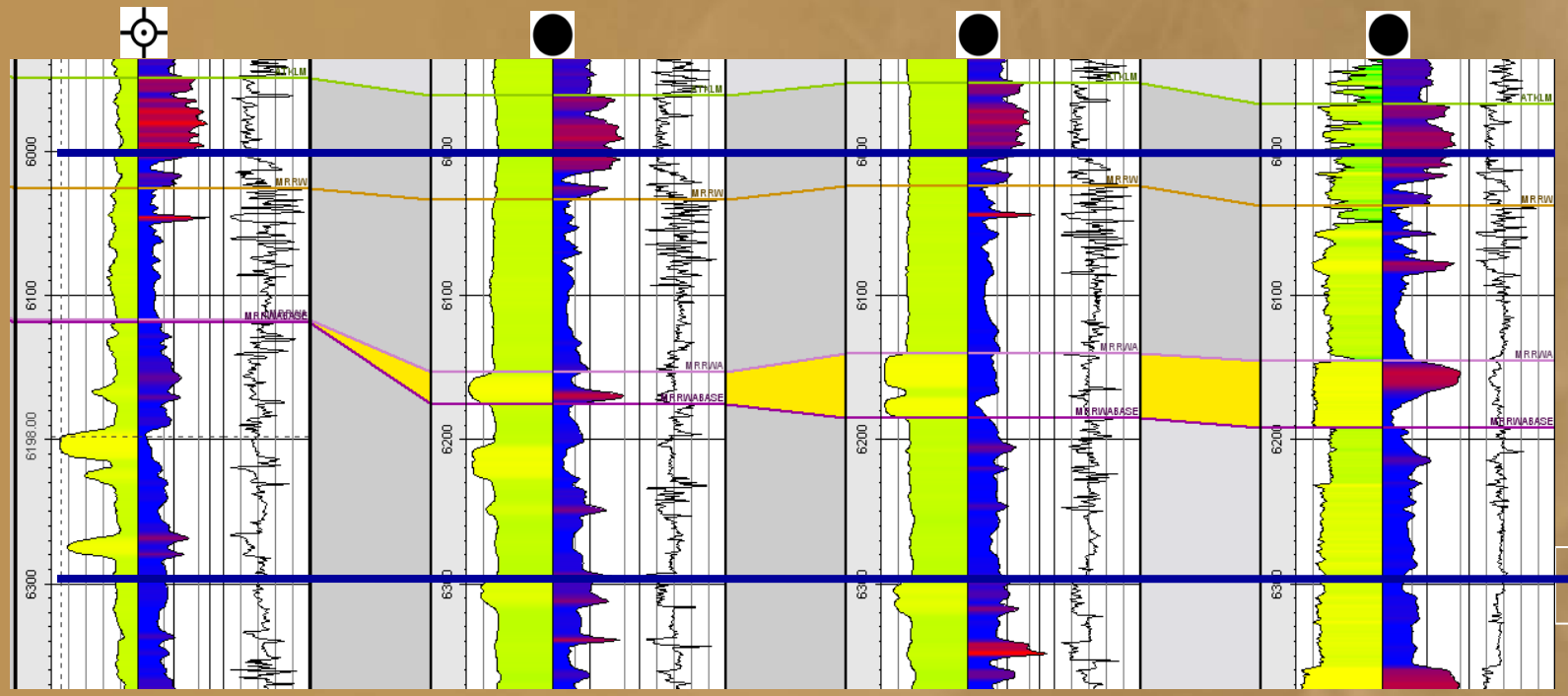
Dry holes drilled

Cross Section

Valley – Fill Sandstones

West

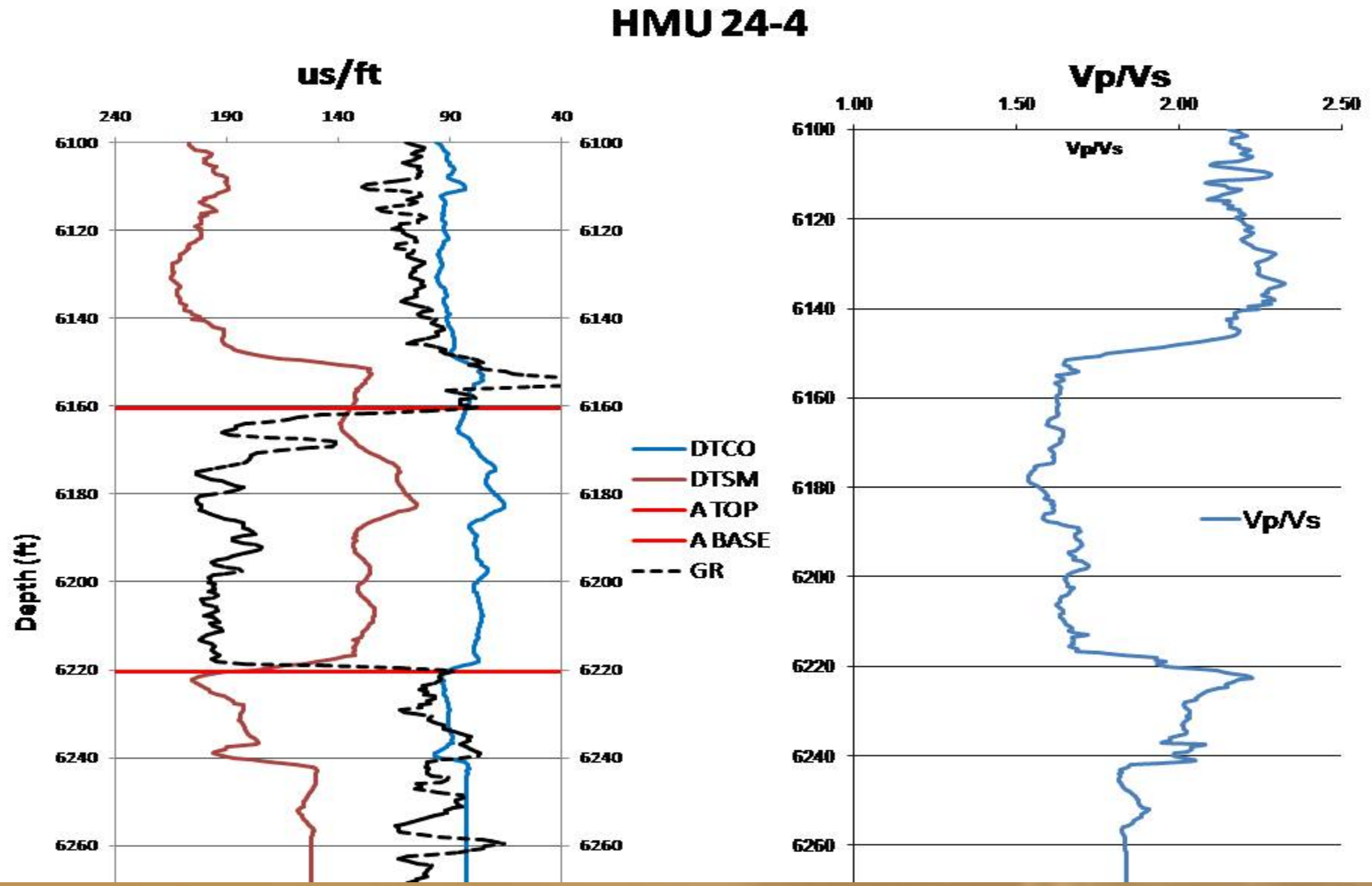
East



The Morrow Sandstone

Binocular Microscope Image

Dipole Sonic Log – Postle Field



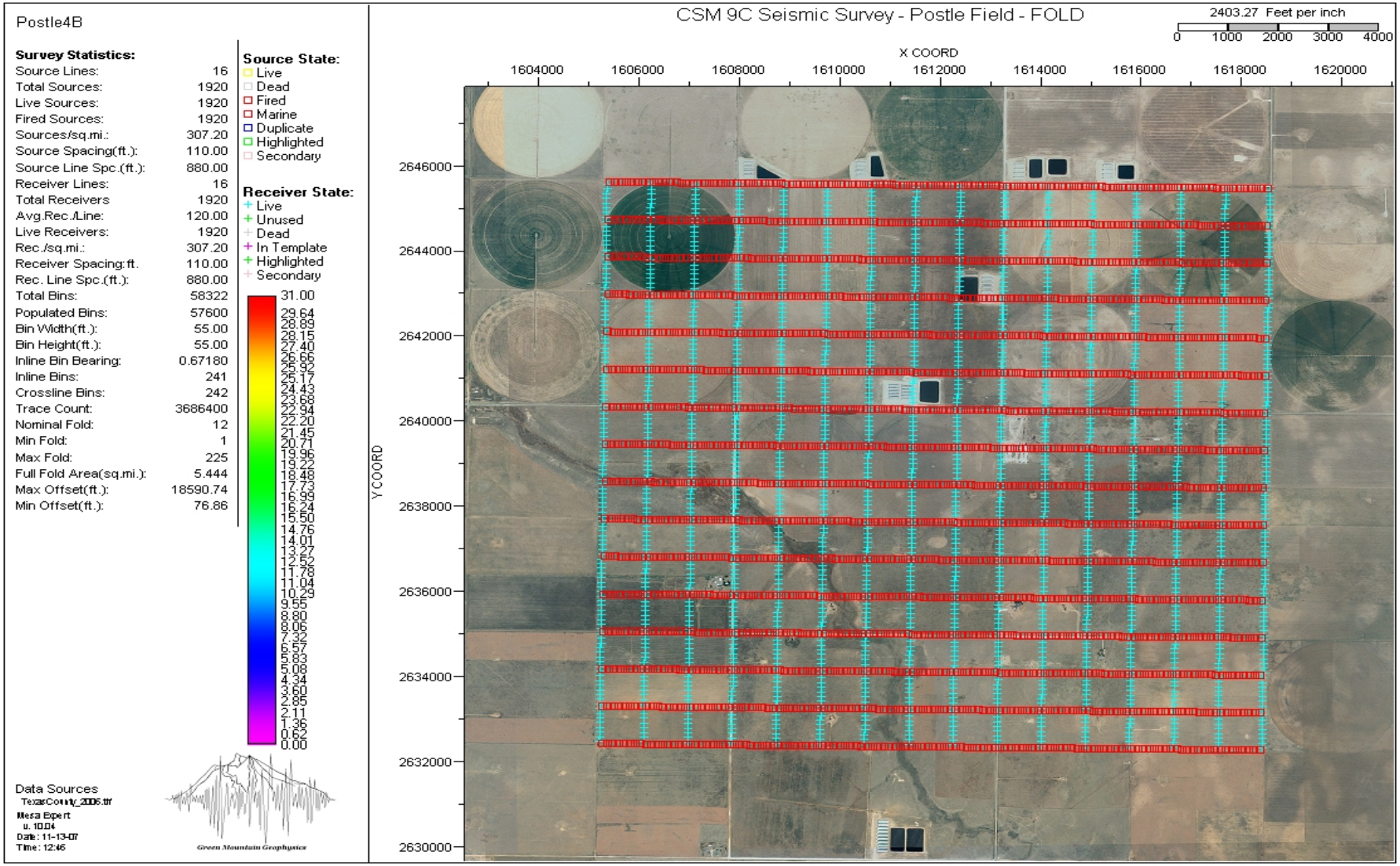
The **Challenge**

Acoustic impedance contrast between Morrow sandstone and shale is small (<10%).

The Morrow A is a thin sandstone reservoir below seismic resolution.

Average ~45 ft.

4-D, 9-C Seismic Survey



Field Survey Layout

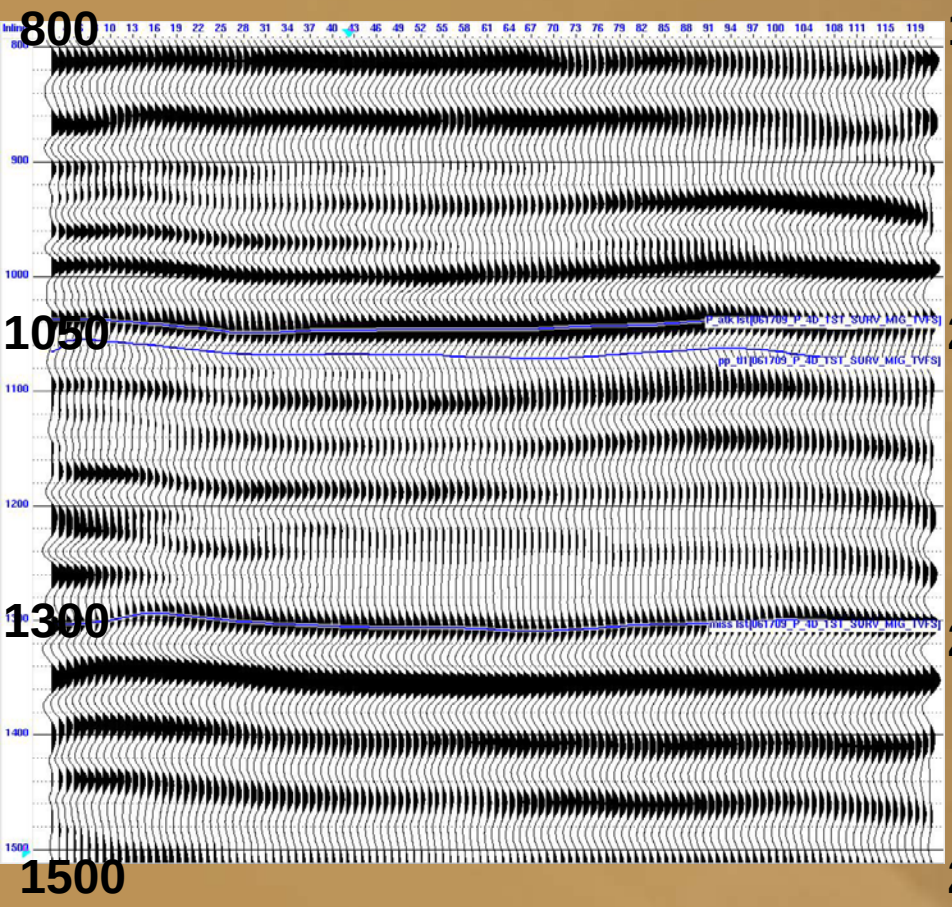
4-D, 9-C Seismic Acquisition Parameters

Type survey	**4-D, 9-C (time-lapse)**
Subsurface bin size	**55 feet X 55 feet**
Number of receiver locations	**1920**
Number of source locations	**1920**
Total number of source points	**5760**
Type receiver spread	**Stationary: 13,200’ X 13,200’**
Instrumentation	**I/O System IV, 2 ms sample rate, 4/5 sec. record length**
Receiver array	**Single 3-C Digital Sensor (VectorSeis)**
Source (P-wave)	**Vertical vibrator: 6-100 hz linear sweep, 8 sec duration, 4 sweeps**
Source (S-wave)	**Horizontal vibrator: 4-60 hz linear sweep, 8 sec duration, 4 sweeps, one source oriented N-S, one source oriented E-W**

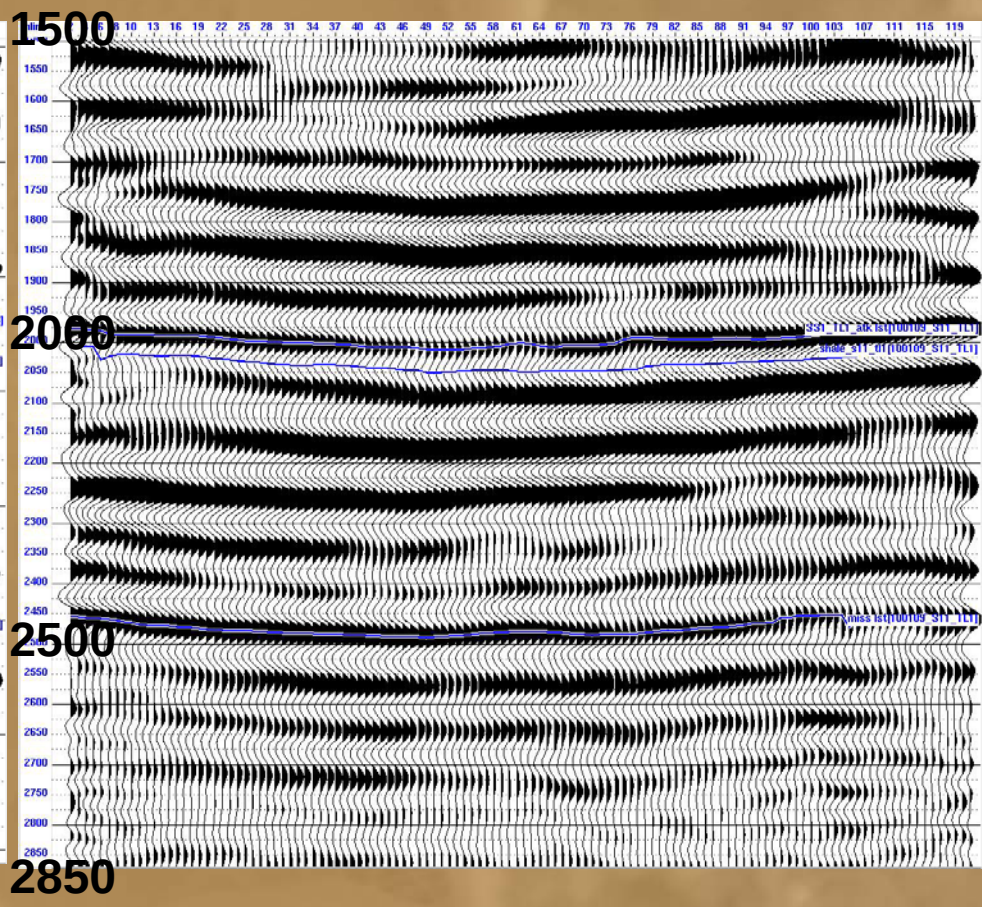
Special Thanks to Paragon

Postle Seismic Survey

P Stack

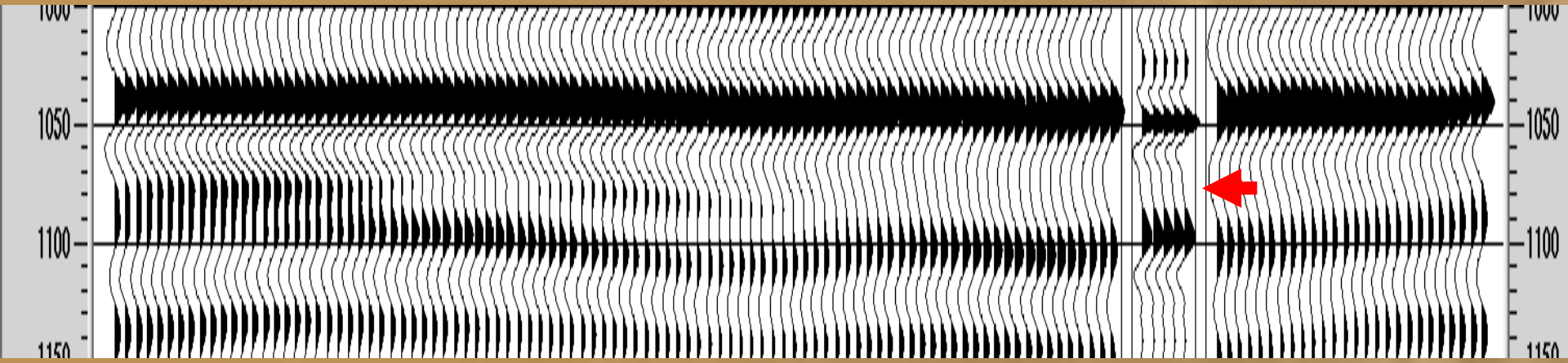


S11 Stack

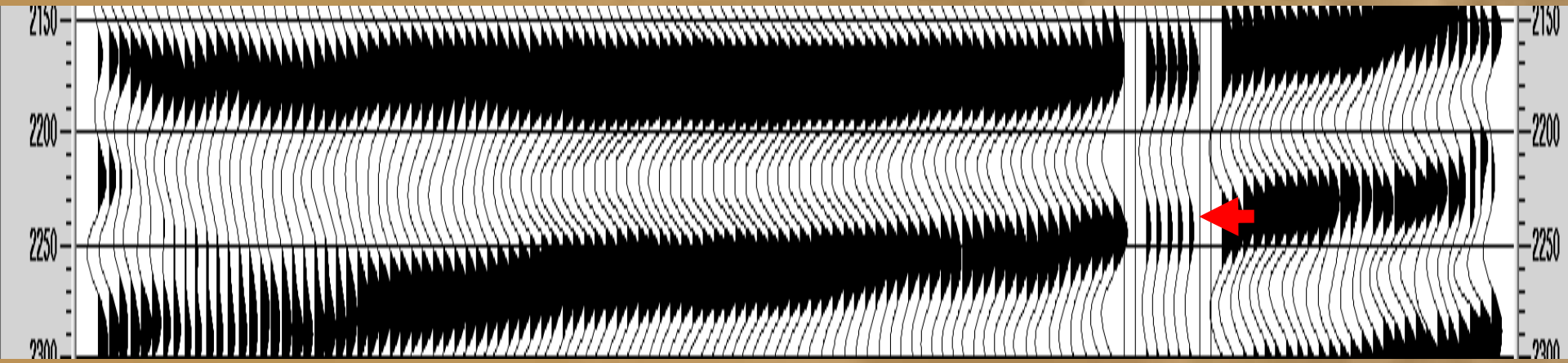


VSP Well Tie

***P-Wave* Corridor STK March 08 in Inline 45**

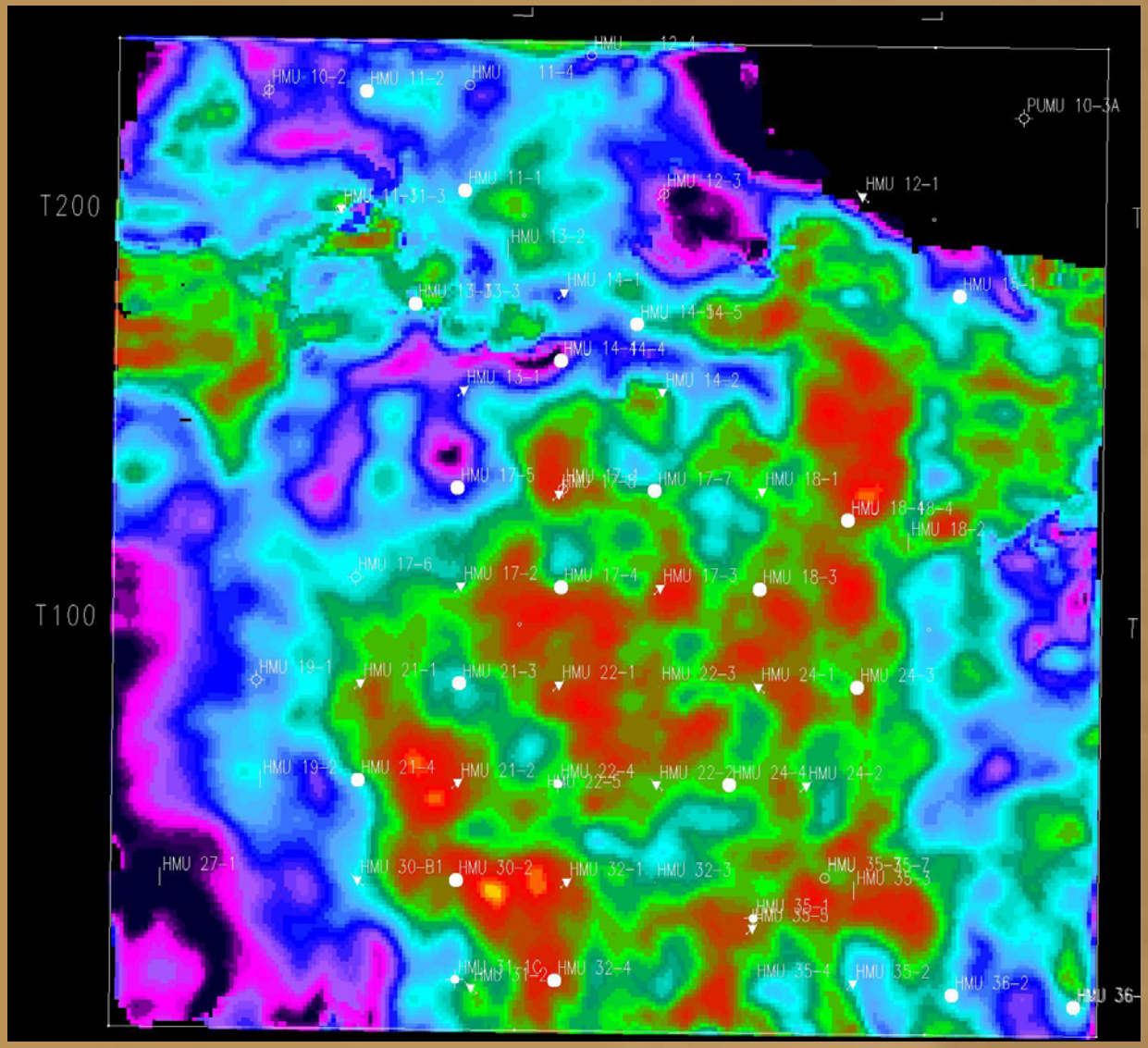


***S-Wave* Corridor STK March 08 in Inline 45**

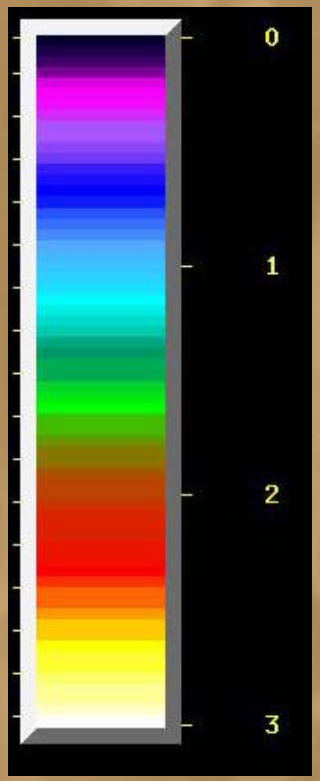


Tamimi 2009

P-Wave Max Peak Amplitude



Pmig4
Band Pass 30,35
Morrow Peak 20 ms Center
Correlation: 0.42

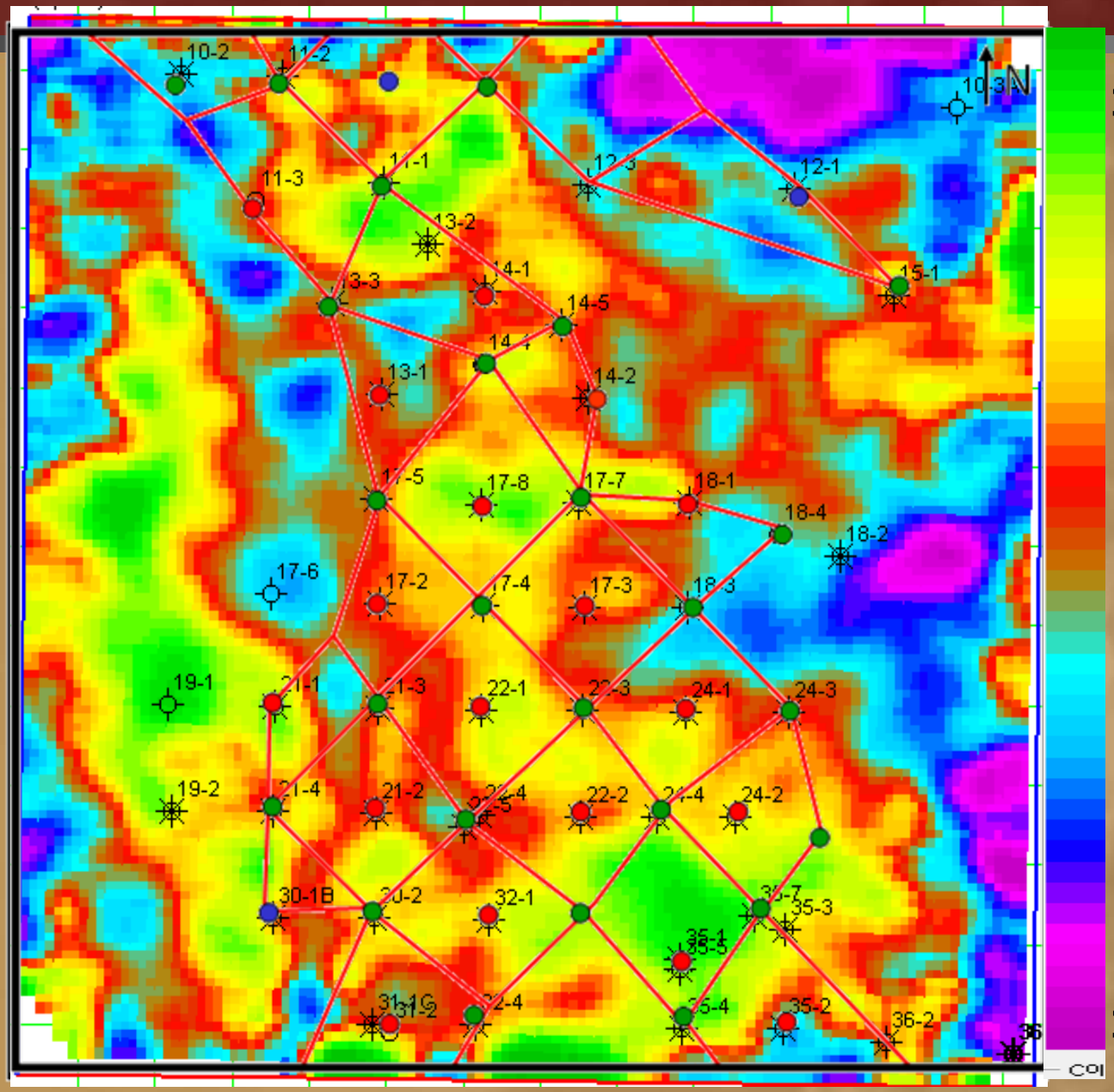


Wyllie, 2008

S -Impedance

Correlation Coeff
.65

- WAG injectors
- water injectors
- producers

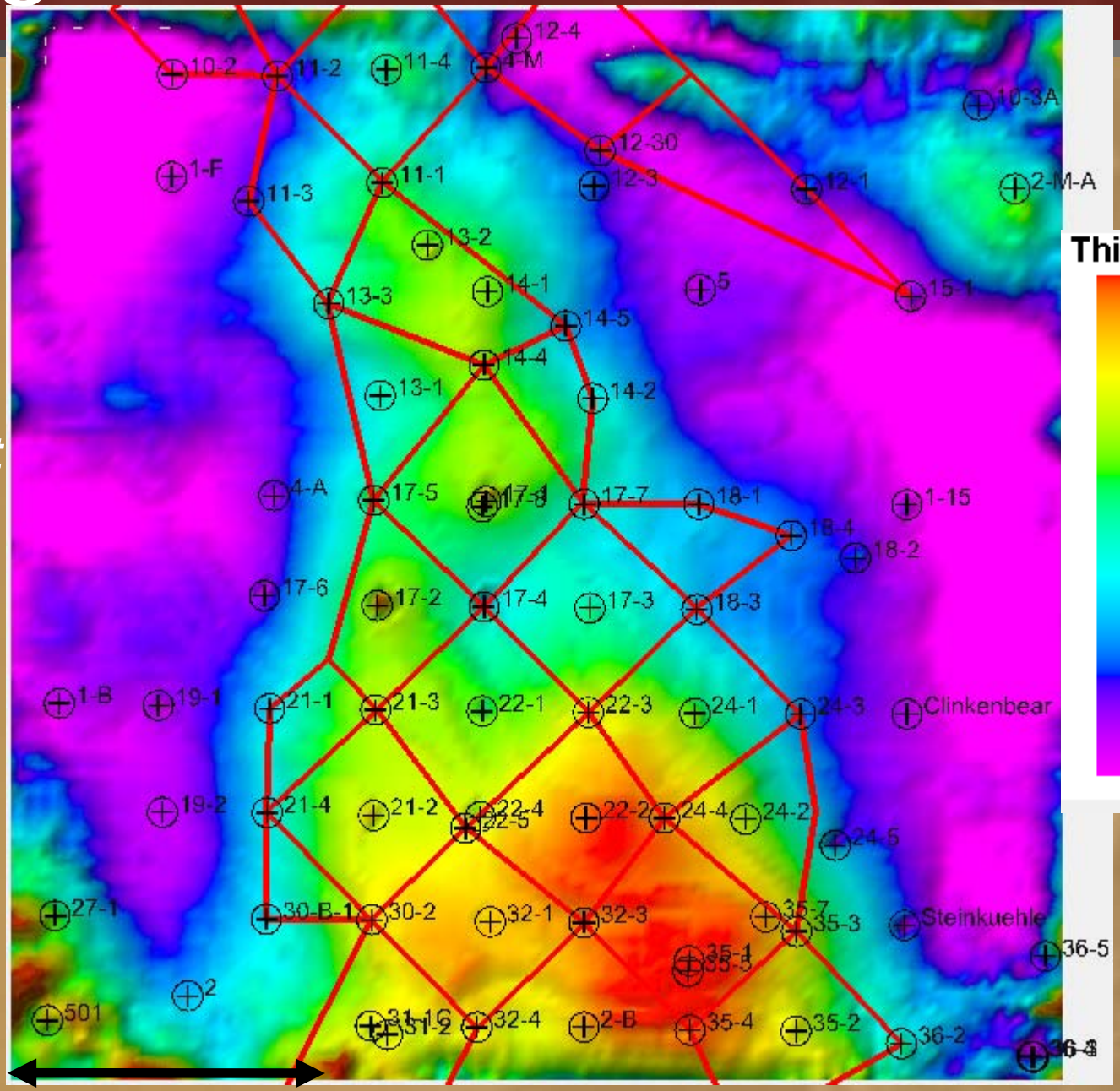


Seismic guided Morrow A Sandstone

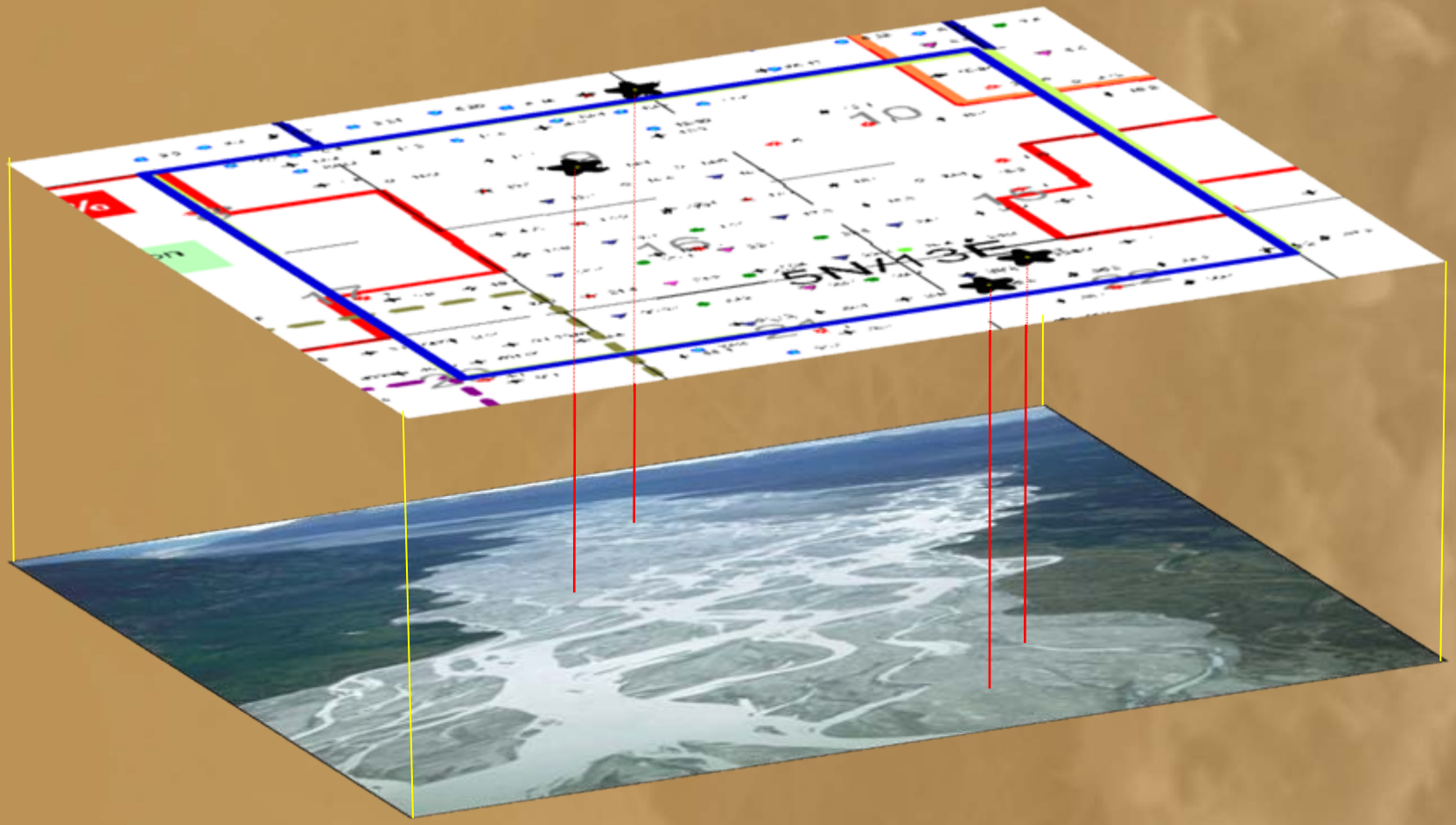
Multicomponent guided Isopach

.73 CC

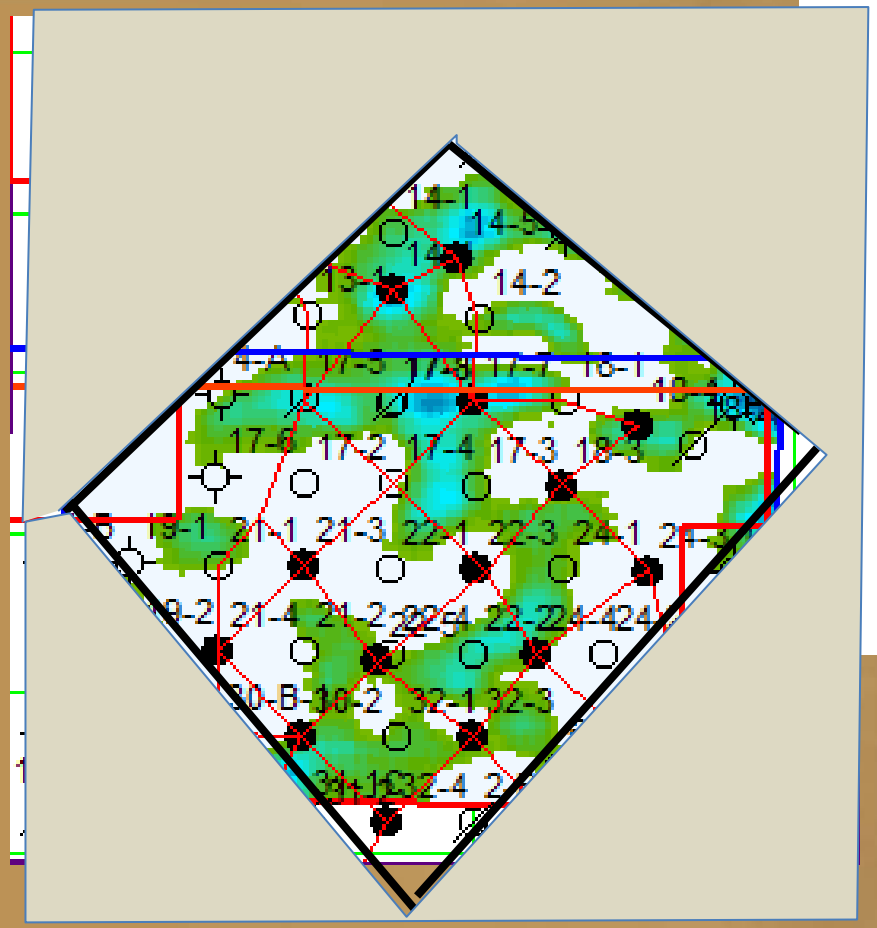
From Pinto 2011



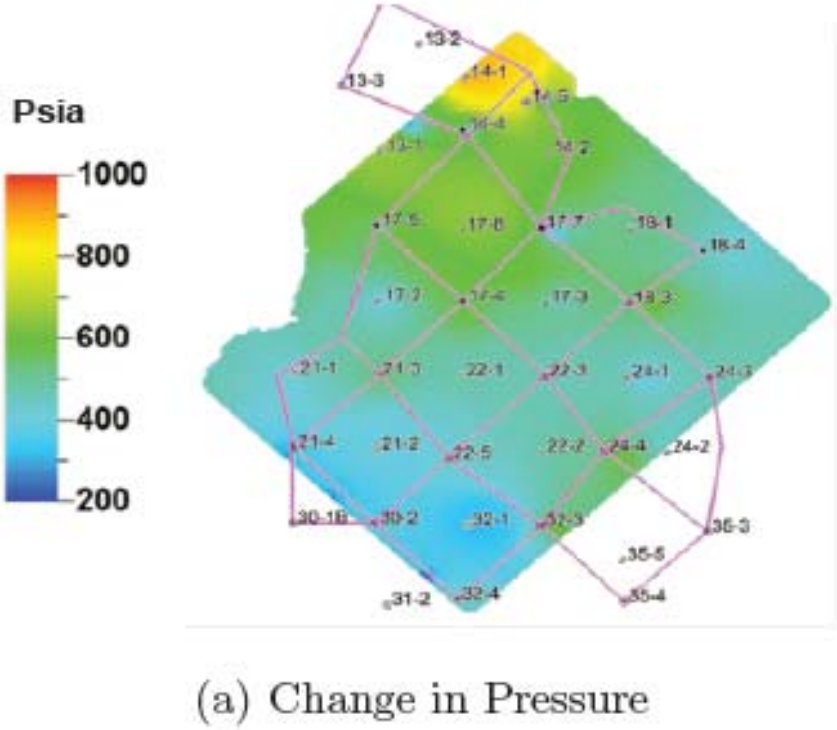
How connected are we?



S11 1ST monitor to baseline



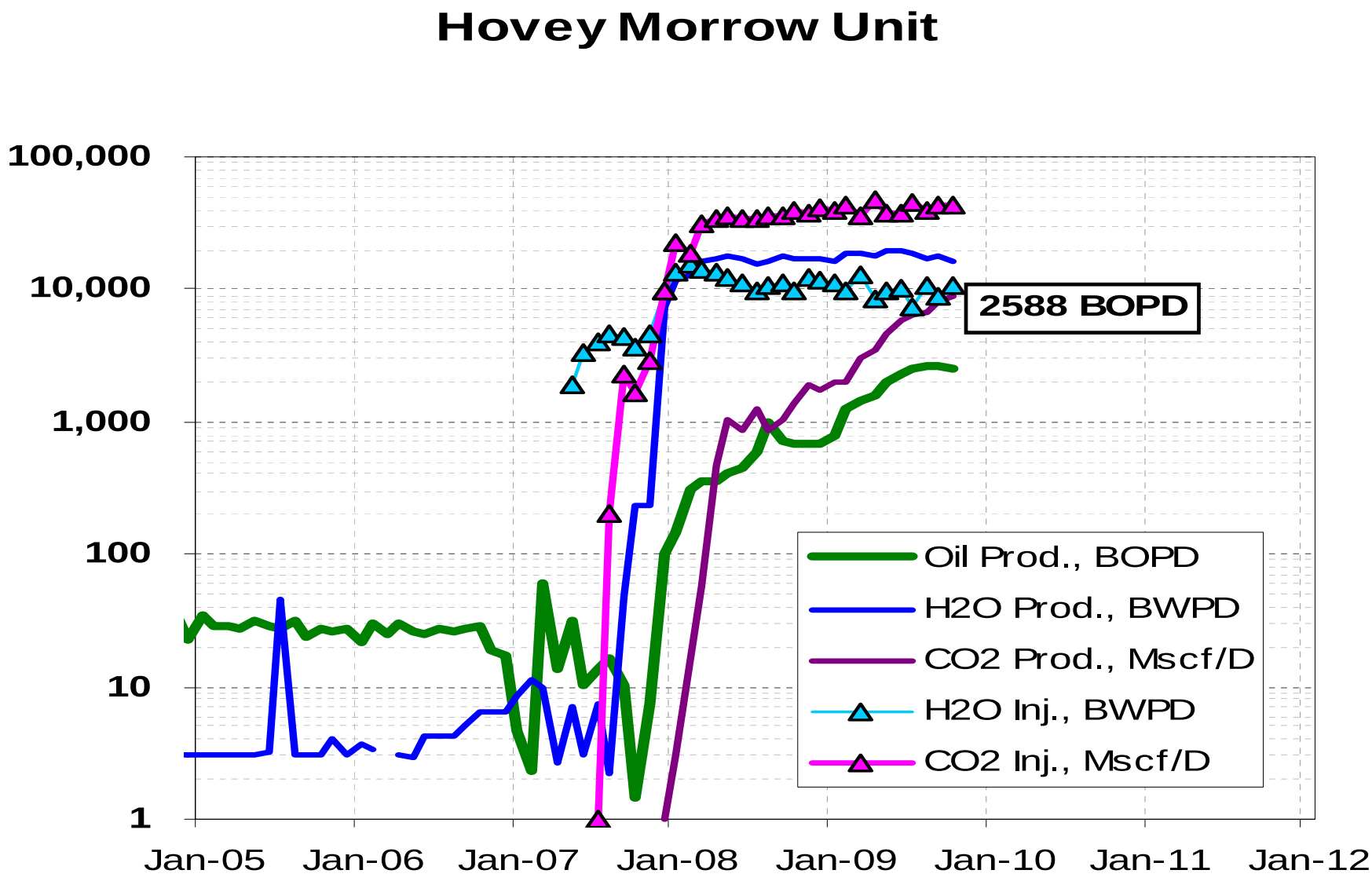
From Zerpa, 2011



(a) Change in Pressure

Increase in pressure → Decrease in S-IMPEDANCE

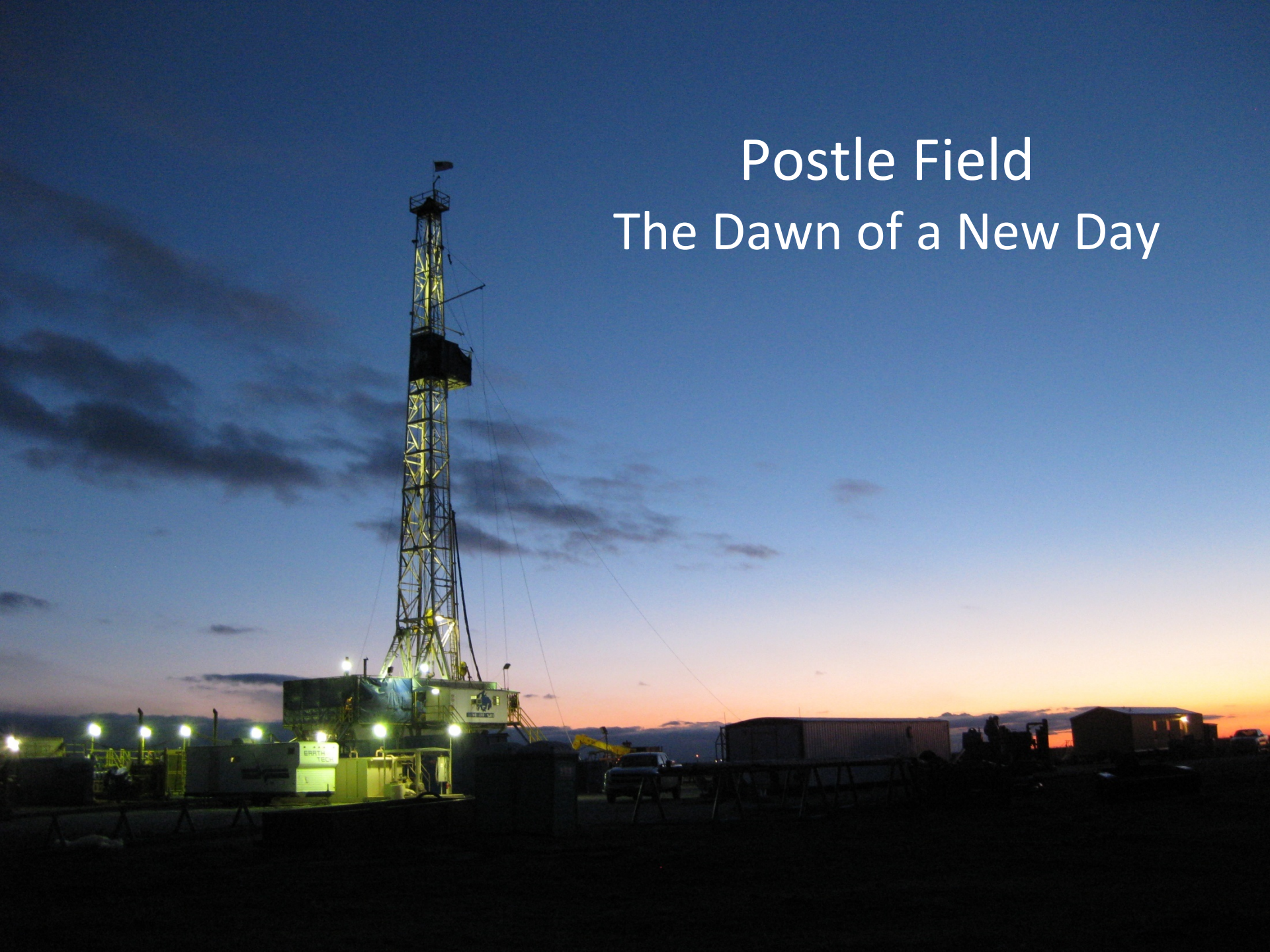
Production History & Field Revitalization



Conclusions

- The Morrow A Sandstone Reservoir is better imaged with shear waves

- Reservoir conformance mapping with shear waves provides the insight to change or adjust the current injection-production pattern to improve CO_2 conformance


Postle Field
The Dawn of a New Day

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