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Dynamic and Static Rock Mechanical Properties of Heavy Oil Sandstones

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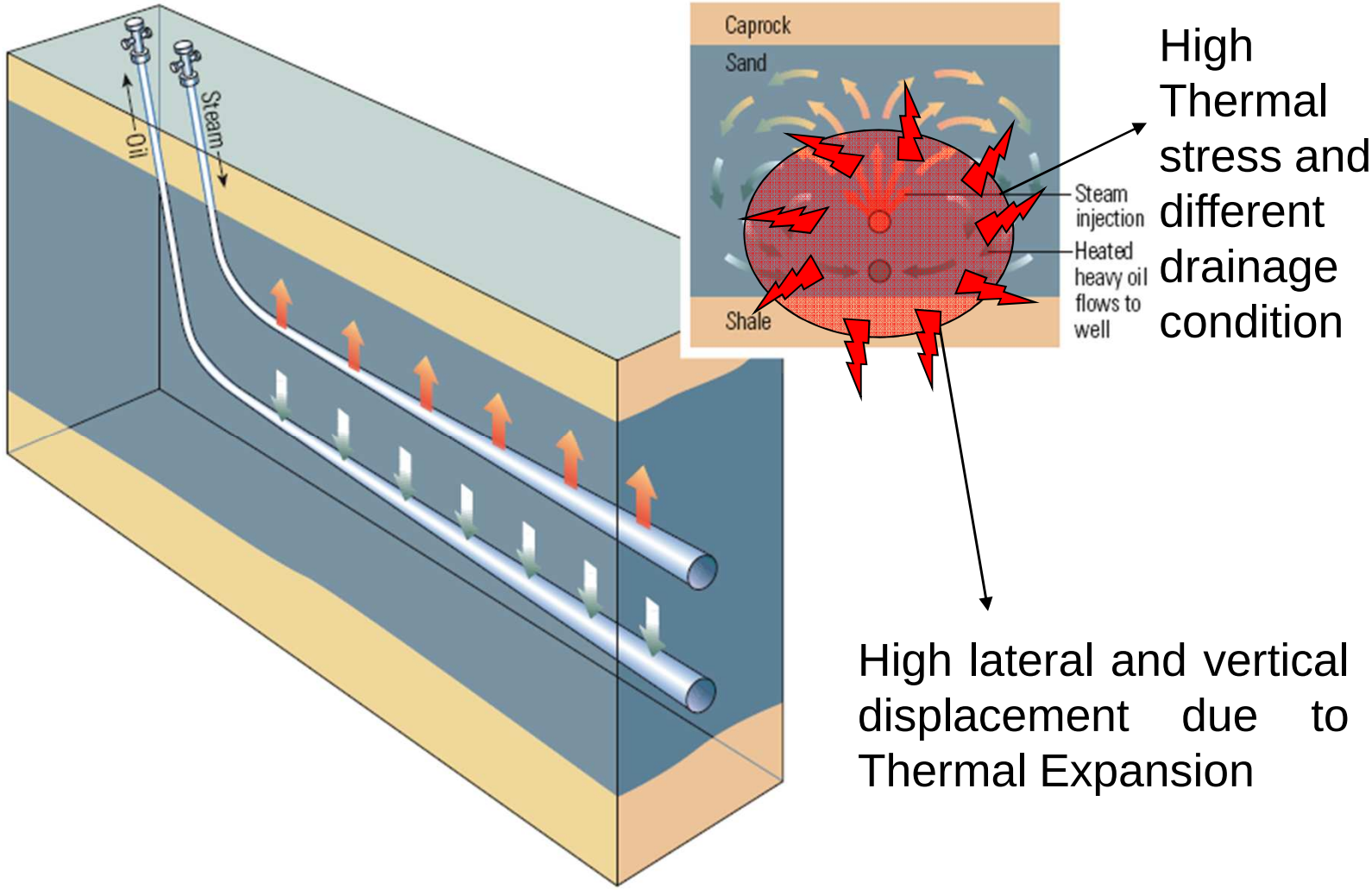
Goals of Investigation

- This study investigates the effects of geomechanics on SAGD operations in the Orinoco Oil Belt in order to obtain a better perspective of the process

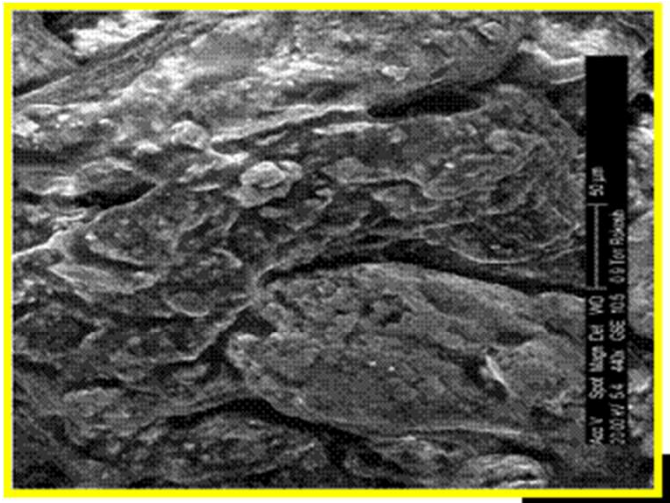
- Identify the effect of high viscosity/temperature in the rock characterization.

Introduction

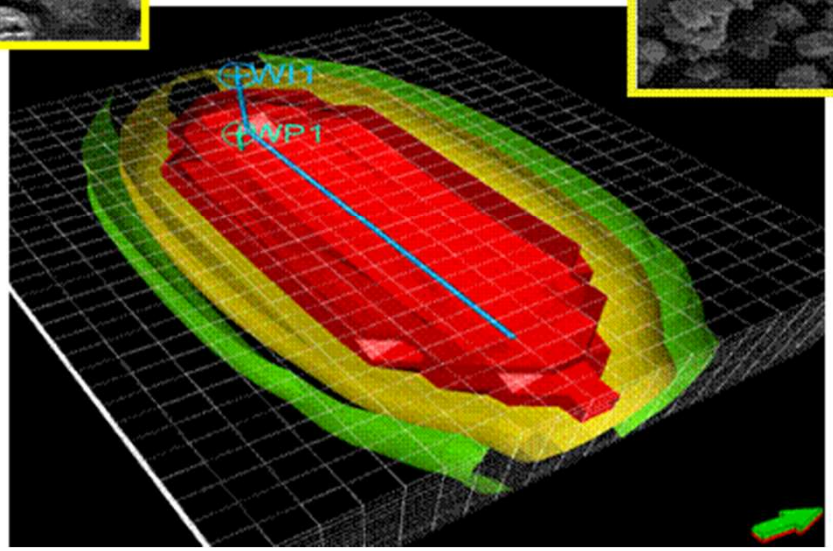
Steam Assisted Gravity Drainage (SAGD)

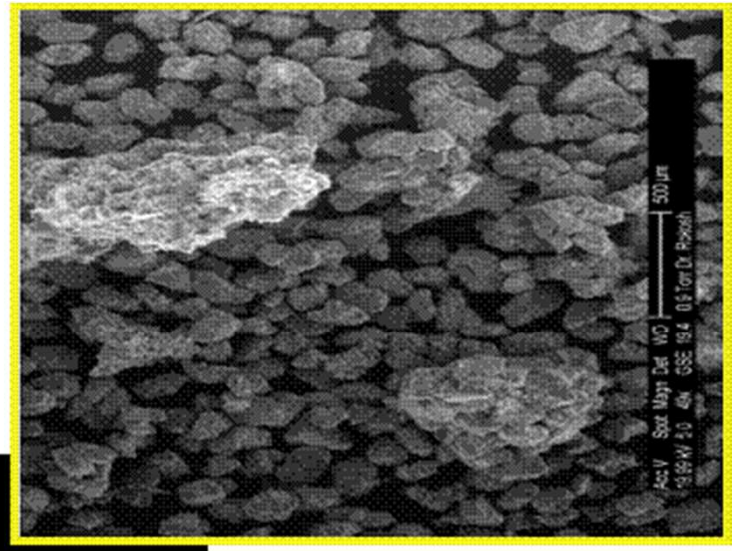


Introduction



Outside the steam chamber





Schimmitt D 2005

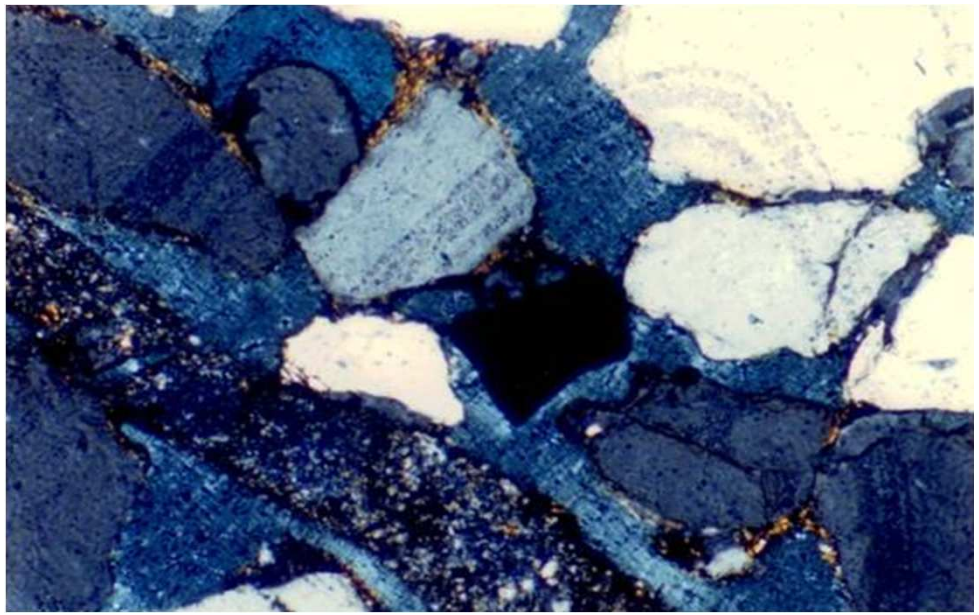
Inside the steam chamber

Laboratory Characterization

Mineral Percentage

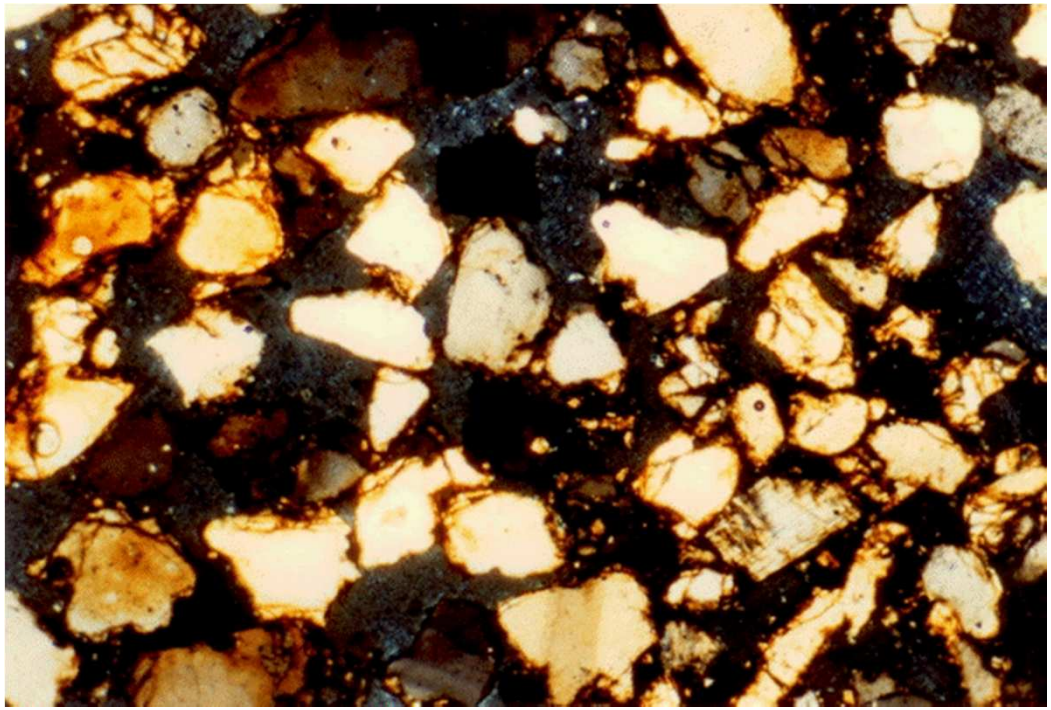
Mineral	Percentage
Quartz	95 %Course-23% %Medium-46% %Fine-26%
kaolinite	2.0
Albite	1.0
Muscovite	<1
siderite	<1

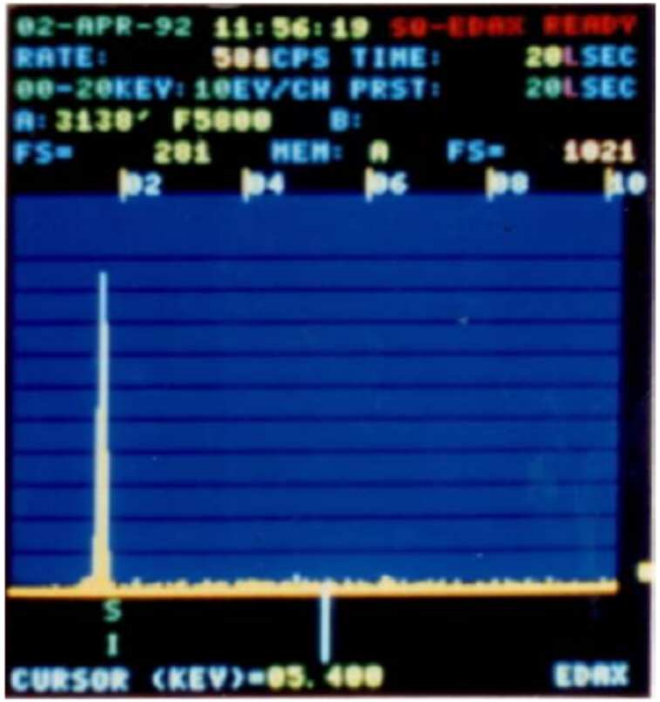
Sandtone - Microstructure



Poly-crystalline quartz with fine grains materials loose from the fine matrix. Poly-crystalline quartz present to be over-grows.

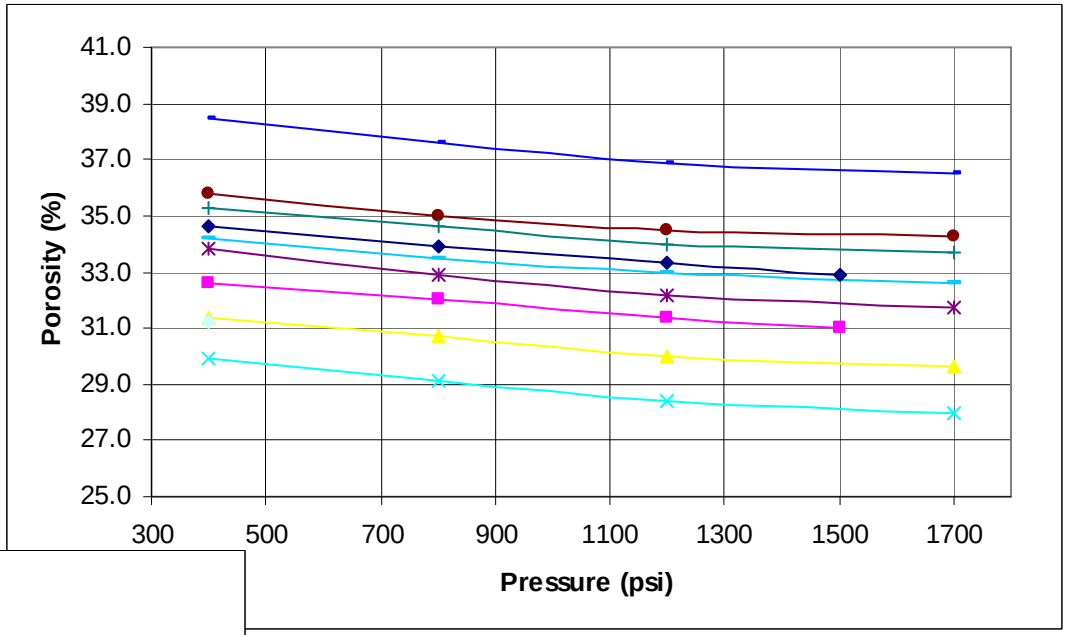
Thin Section

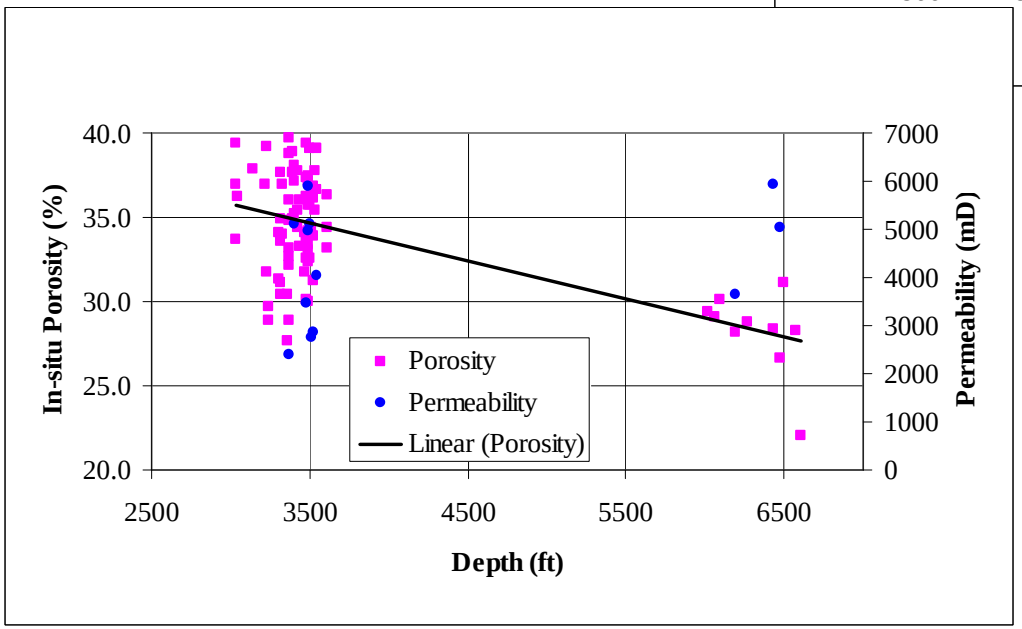




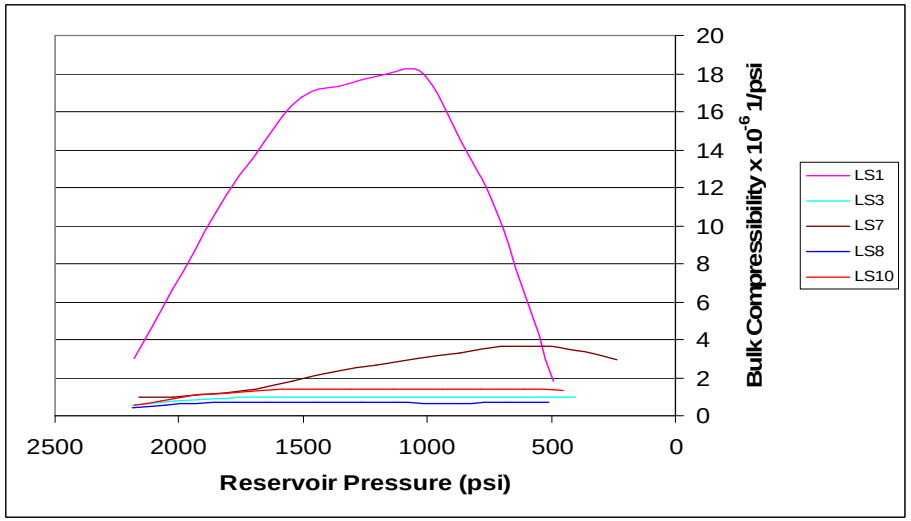
Sands of poor packing, Very loose and Primary poral space well developed. Low content of clay minerals. No expansible clay minerals was detected

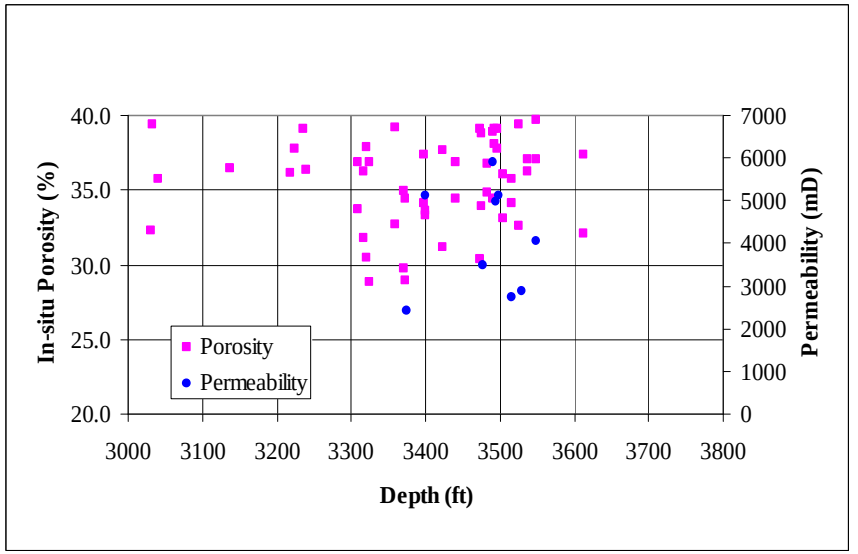
Porosity-Permeability Analysis

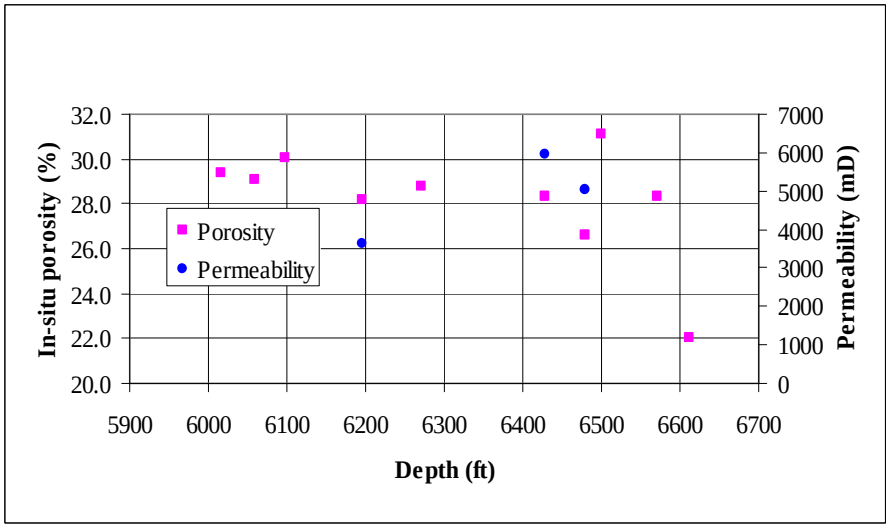




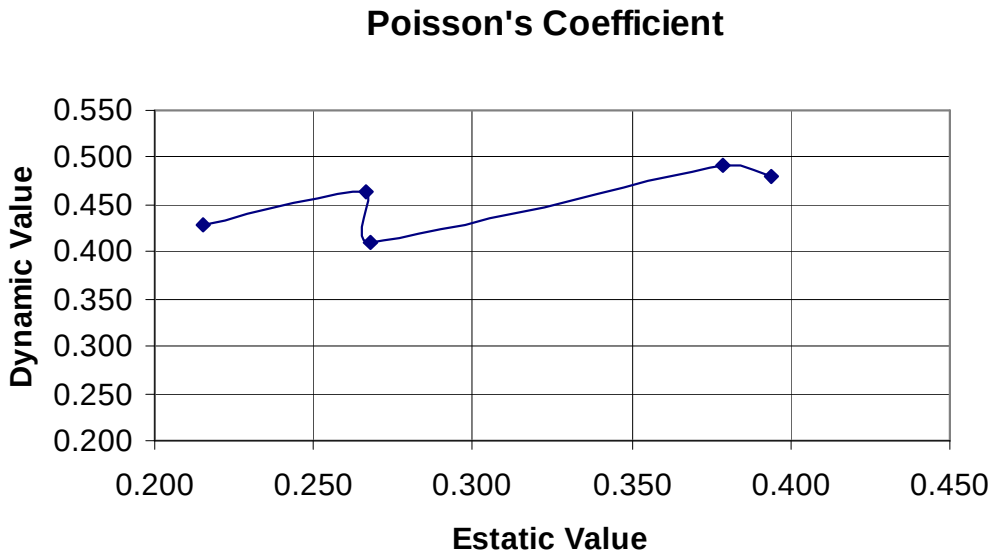
Bulk Compressibility – Porosity - Permeability Analysis

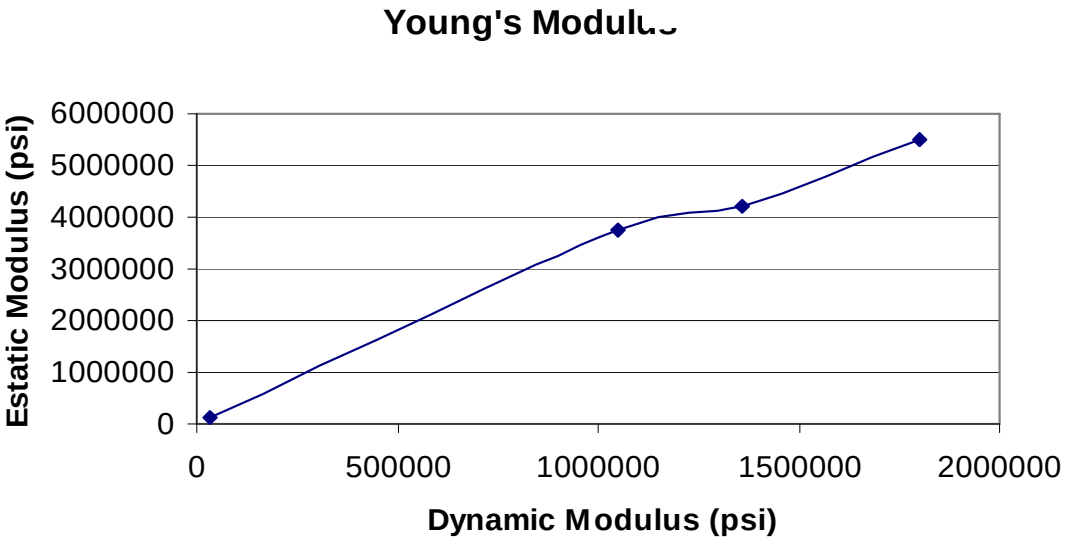




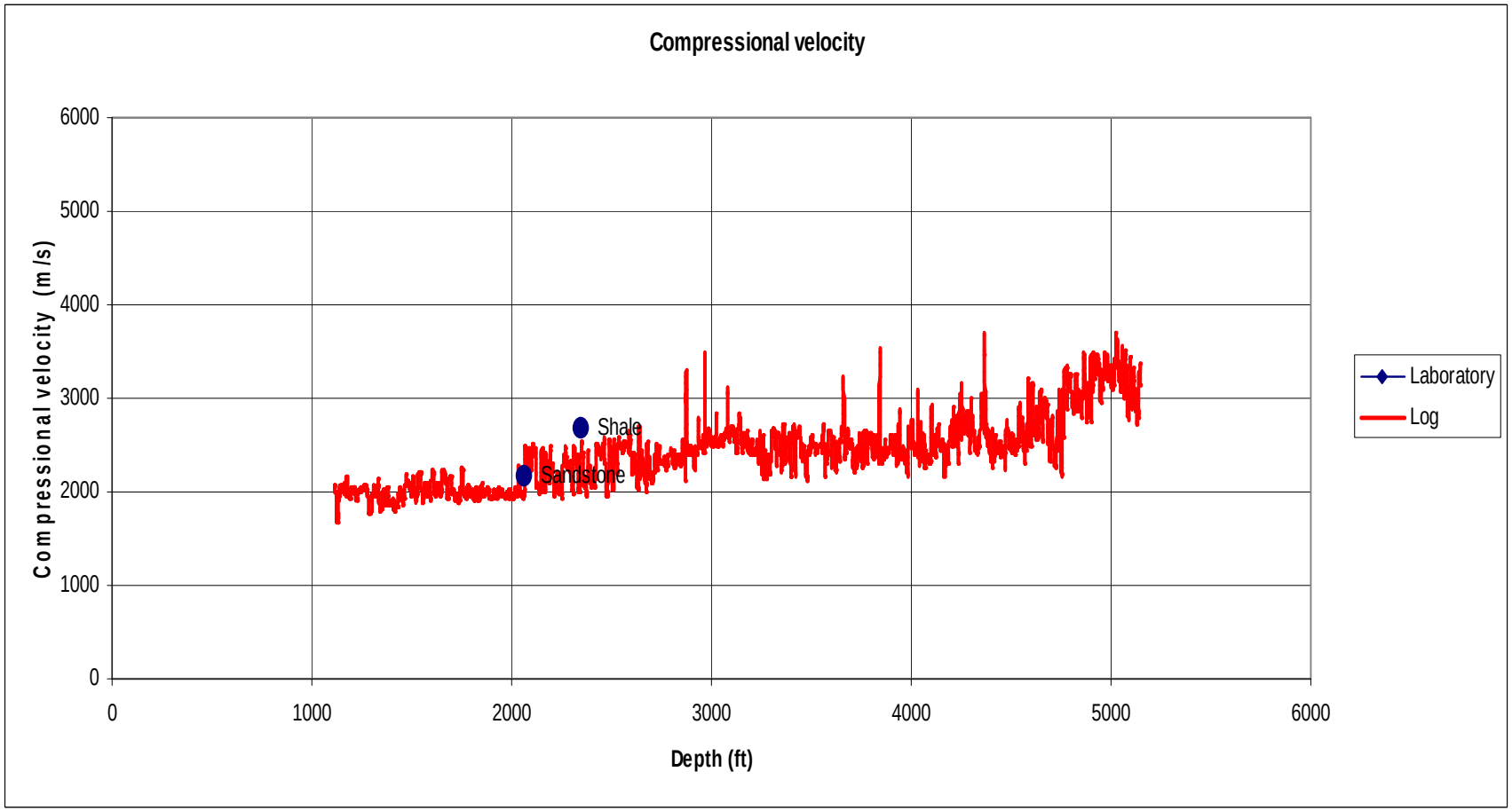


Triaxial Test Campaign

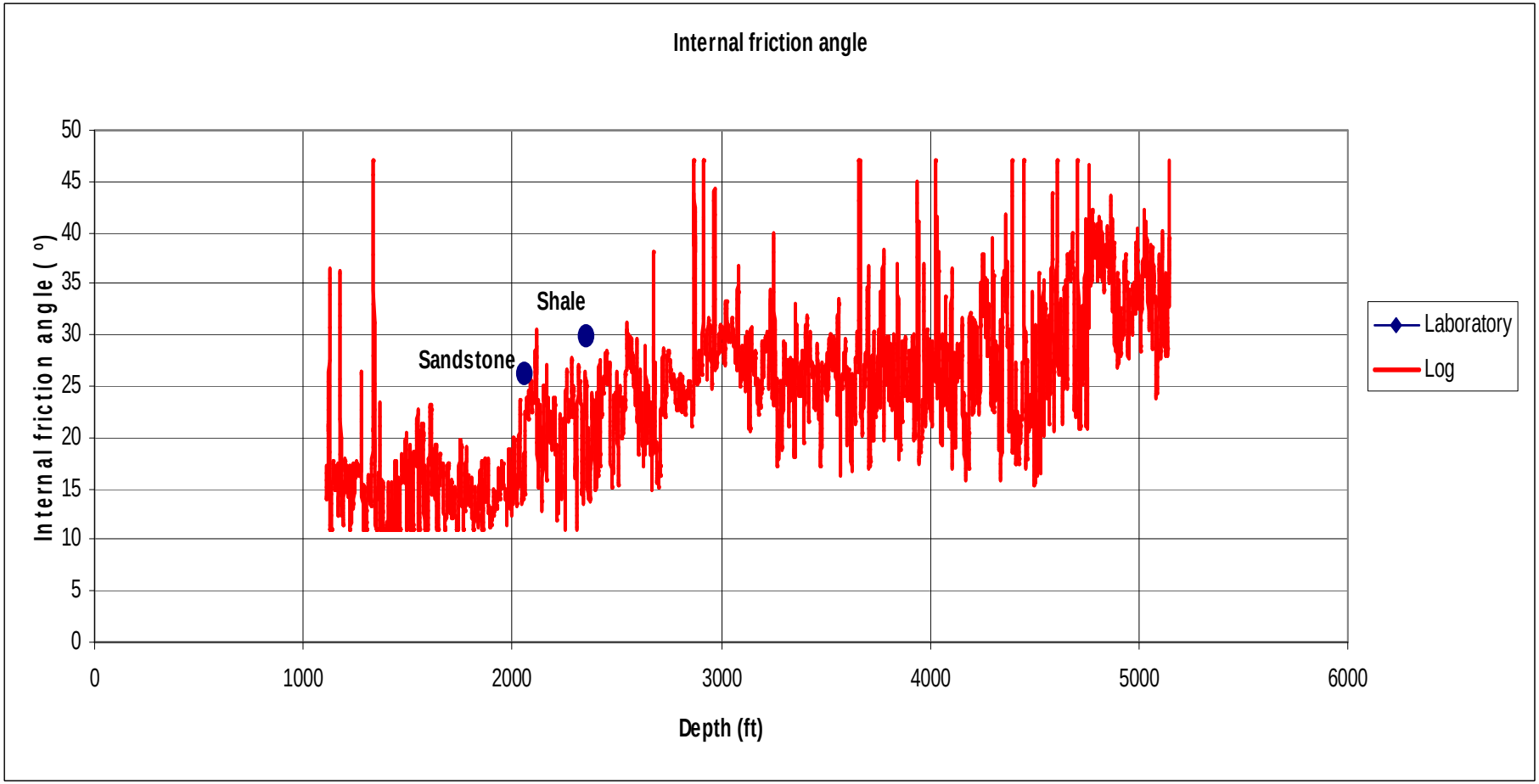




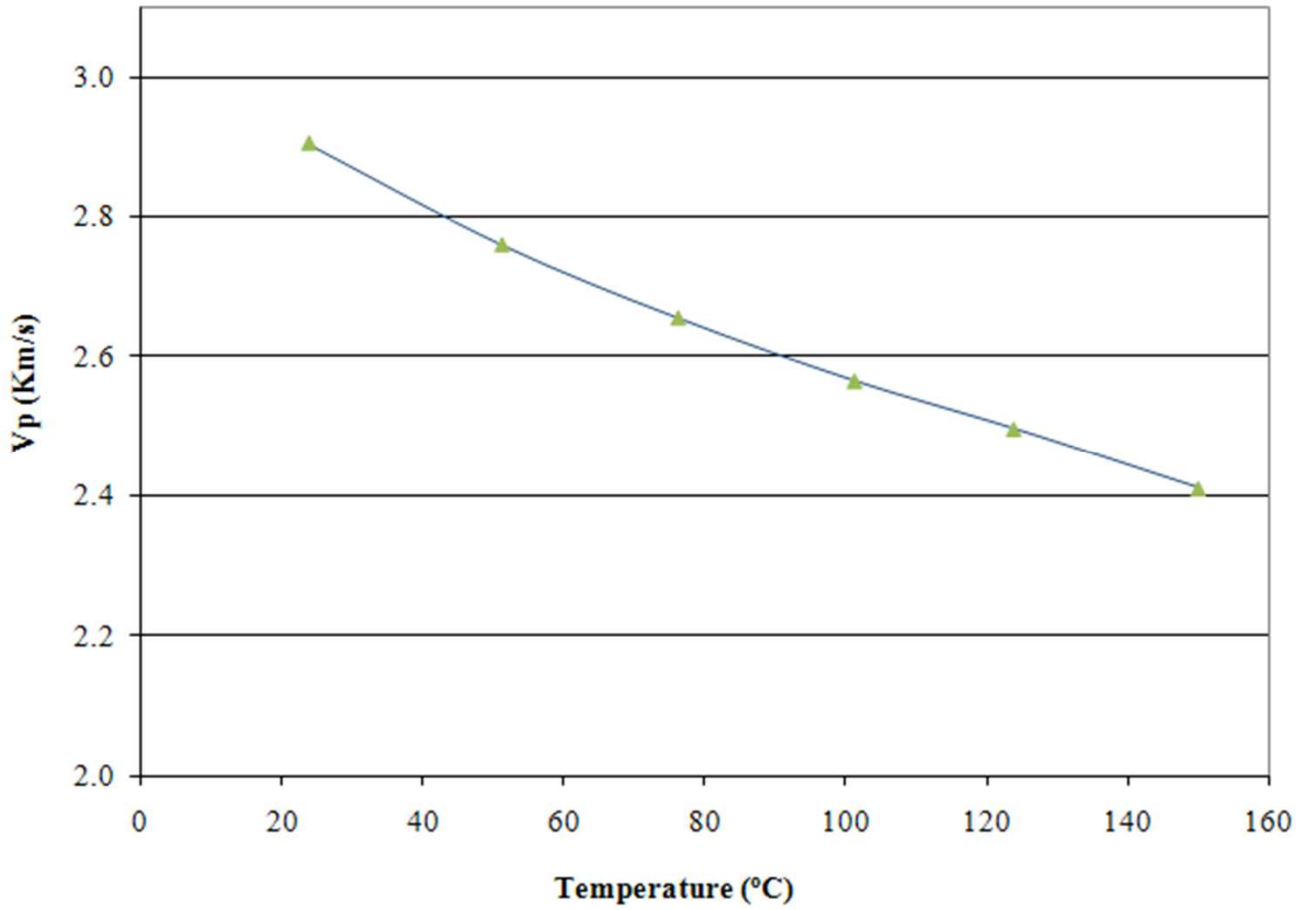
Compressional Velocity Analysis – Field vs Lab.



Internal Frictional Analysis – Lab vs Field



Ultrasonic Triaxial Test – Temperature Effect in velocity



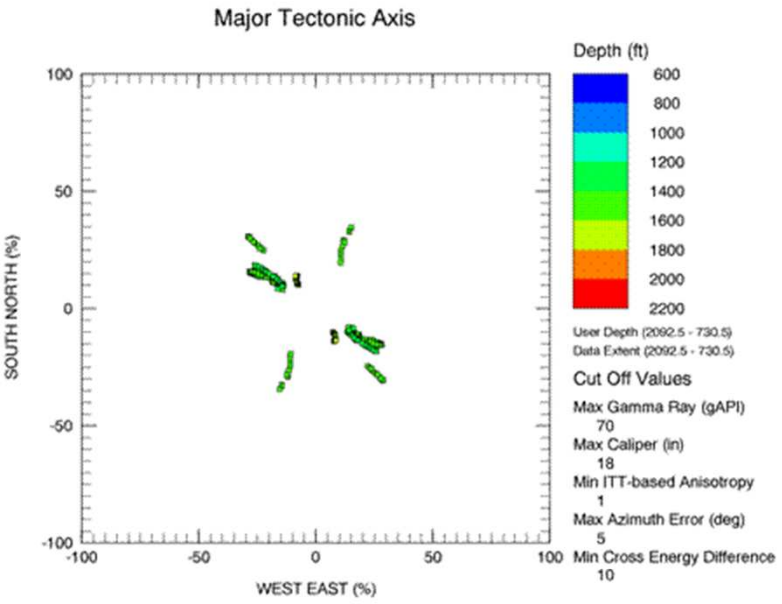
Immersion Test

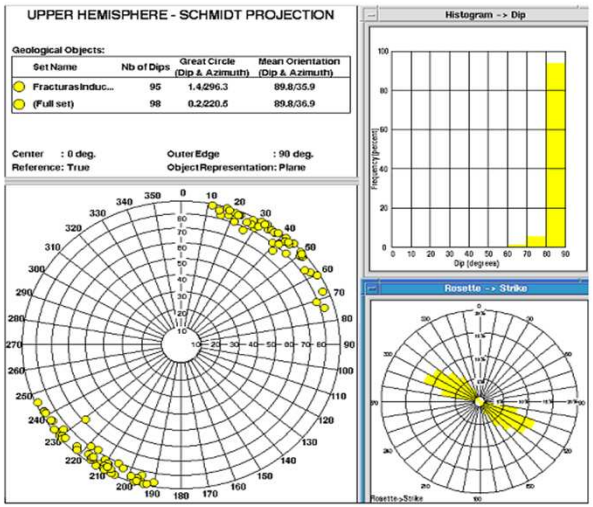
Before

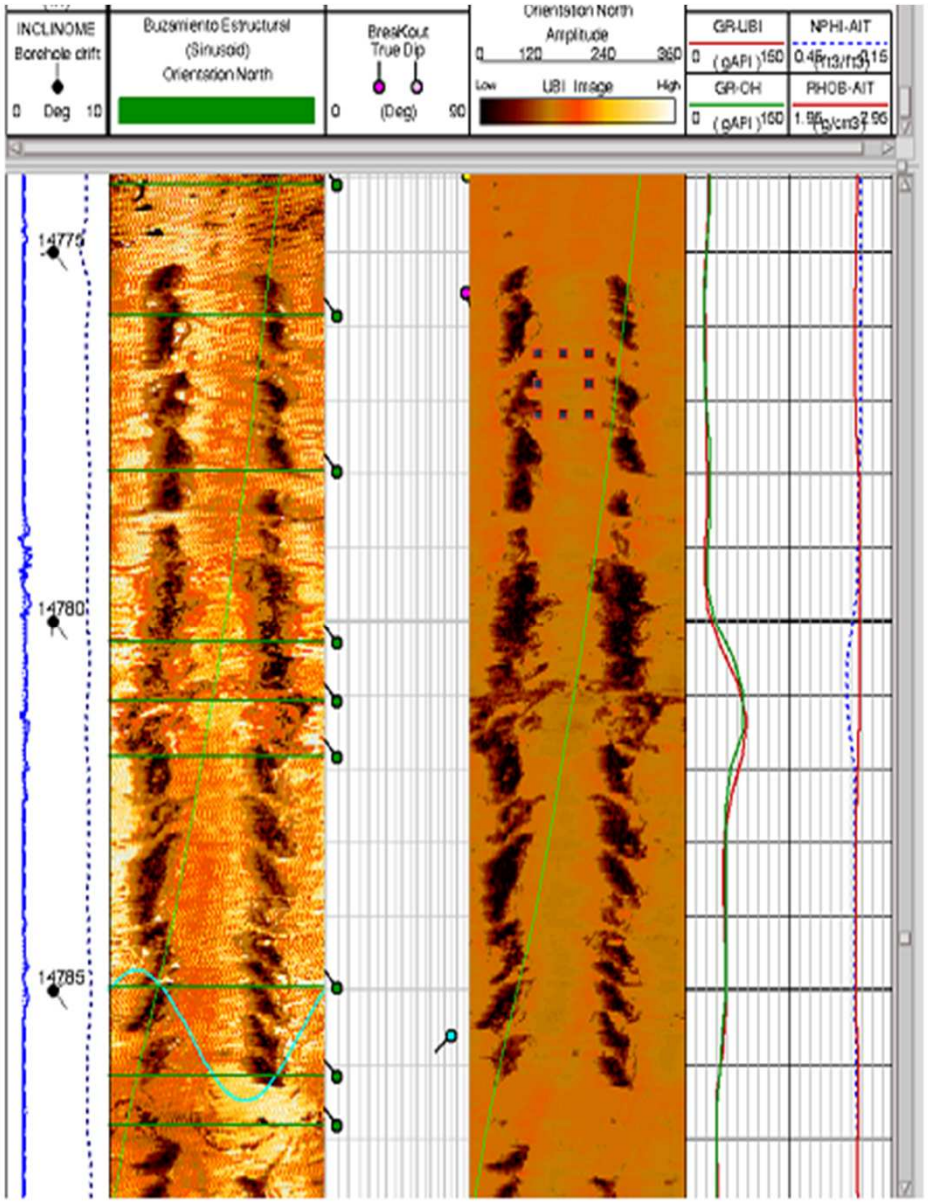
After 72 hours

Acoustic Log/Image - Stress Direction

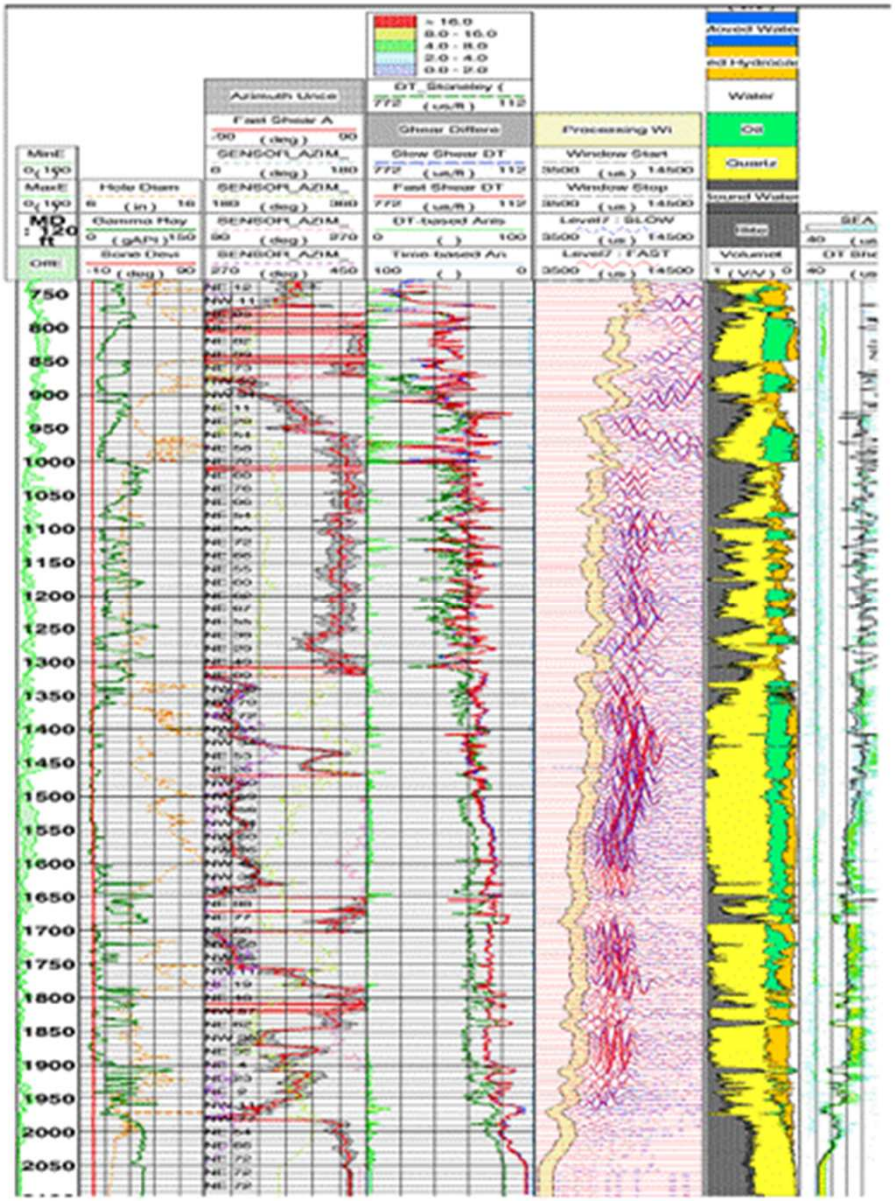
From Acoustic tool







Acoustic Log - Anisotropy



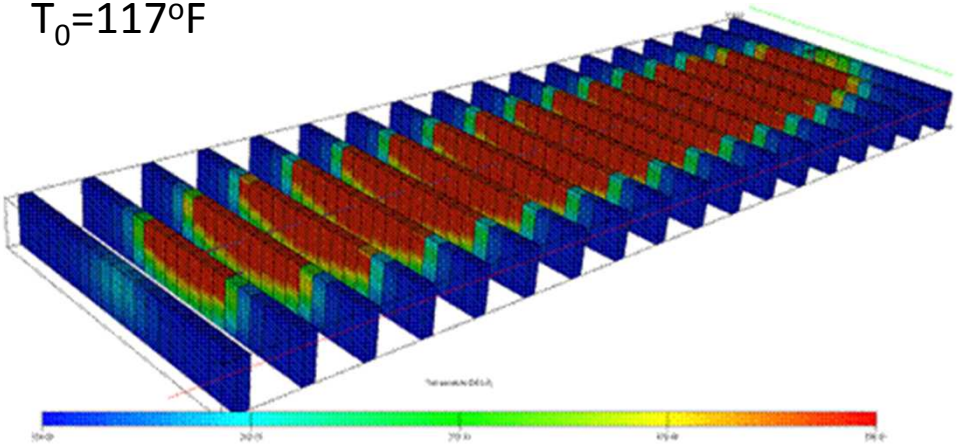
Anisotropy in shales - around 9%

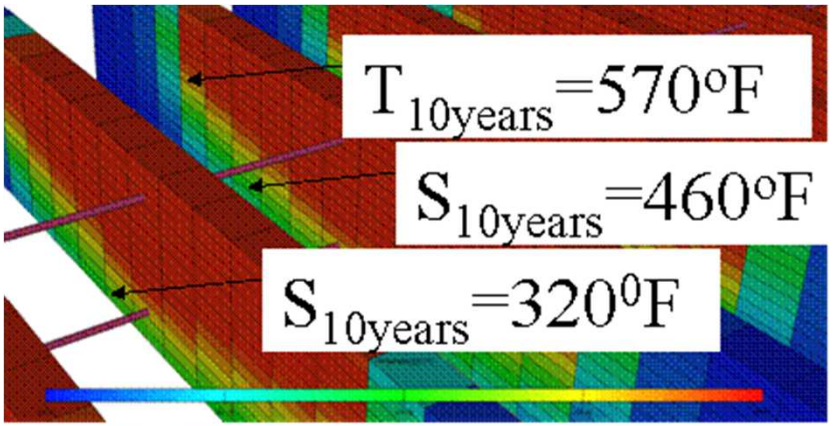
In Sandstones - less than 0.5%

Coupled Fluid-Thermal-Geomechanics Simulation

Temperature

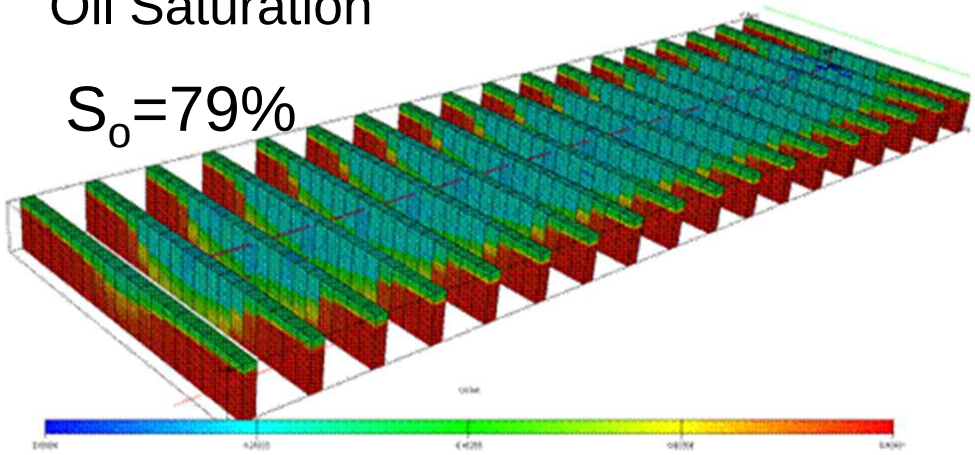
T_0=117°F

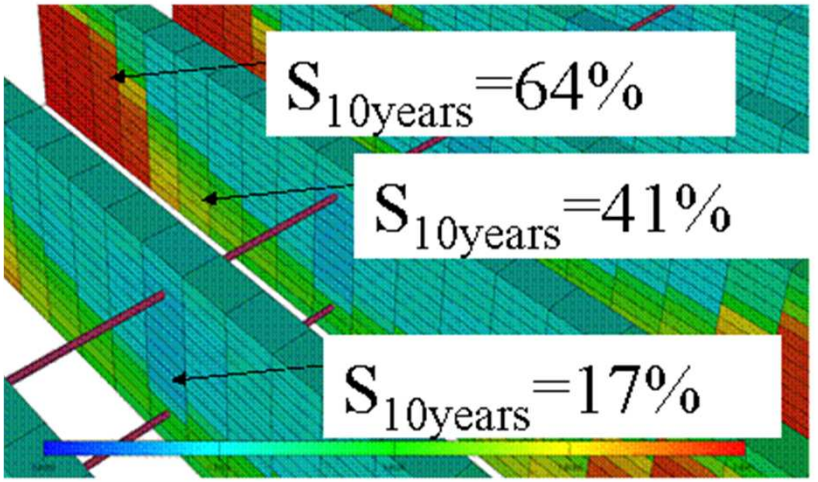




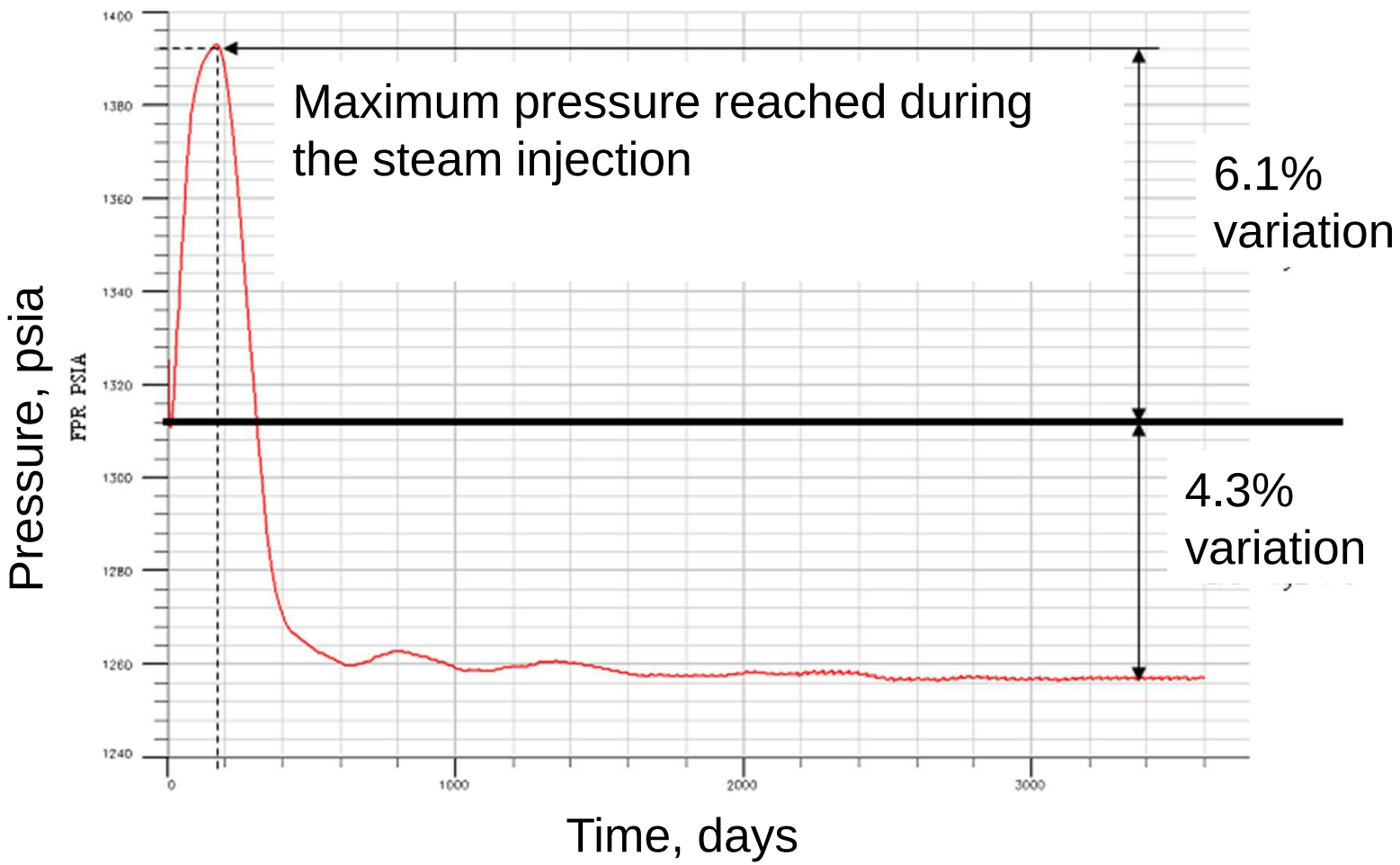
Oil Saturation

S_o=79%

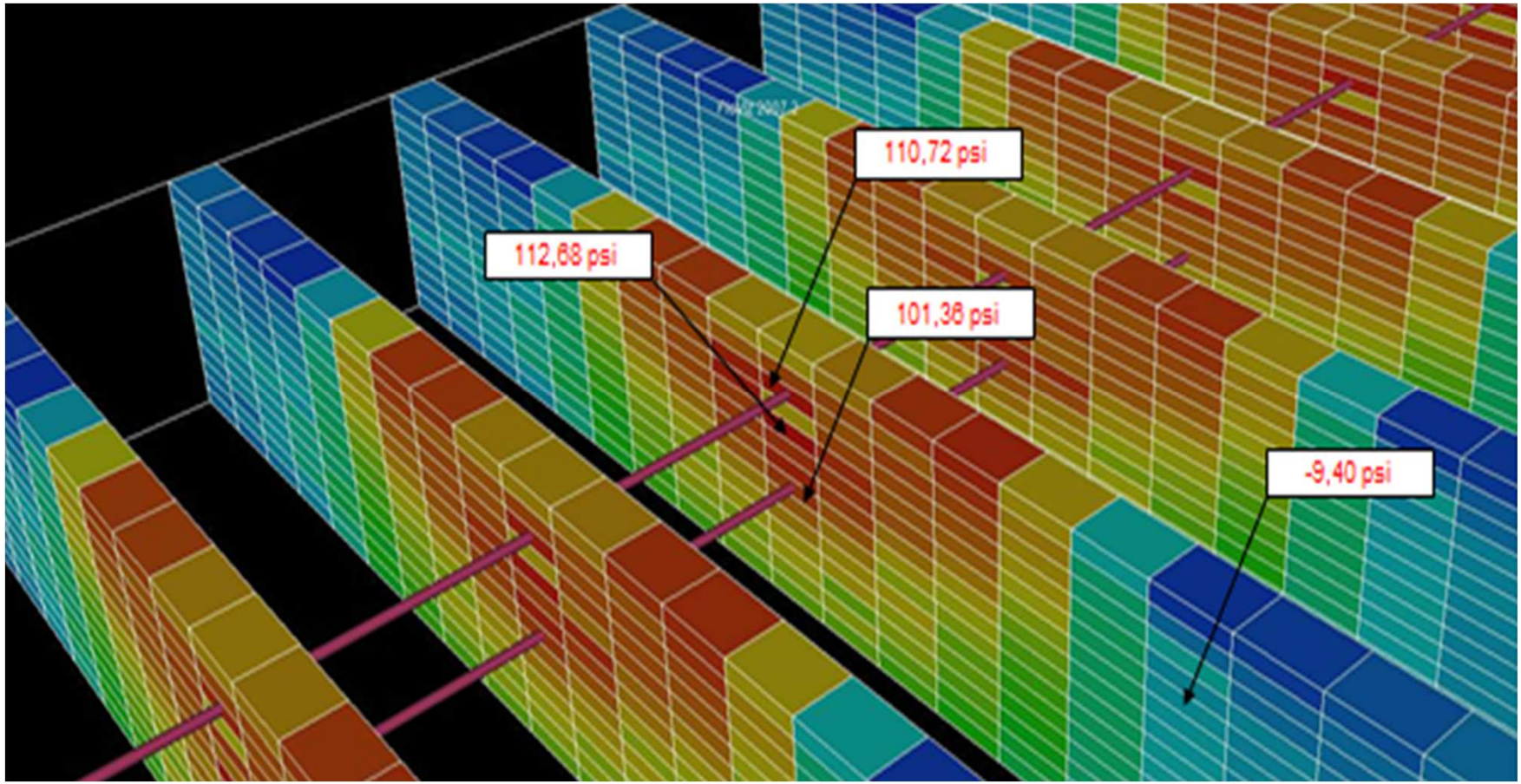




Variation of Pressure



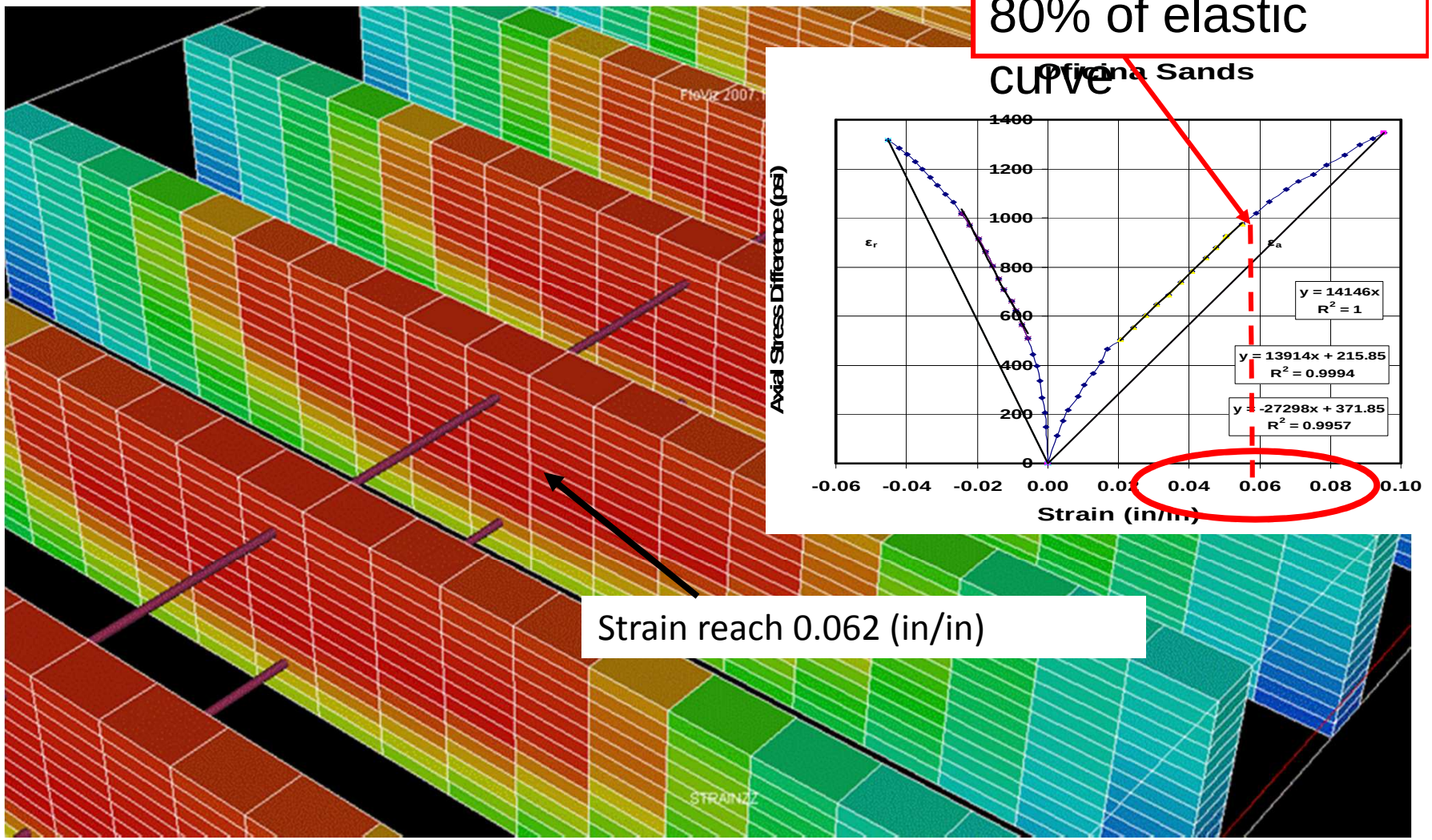
Reservoir Simulation- Pressure Distribution



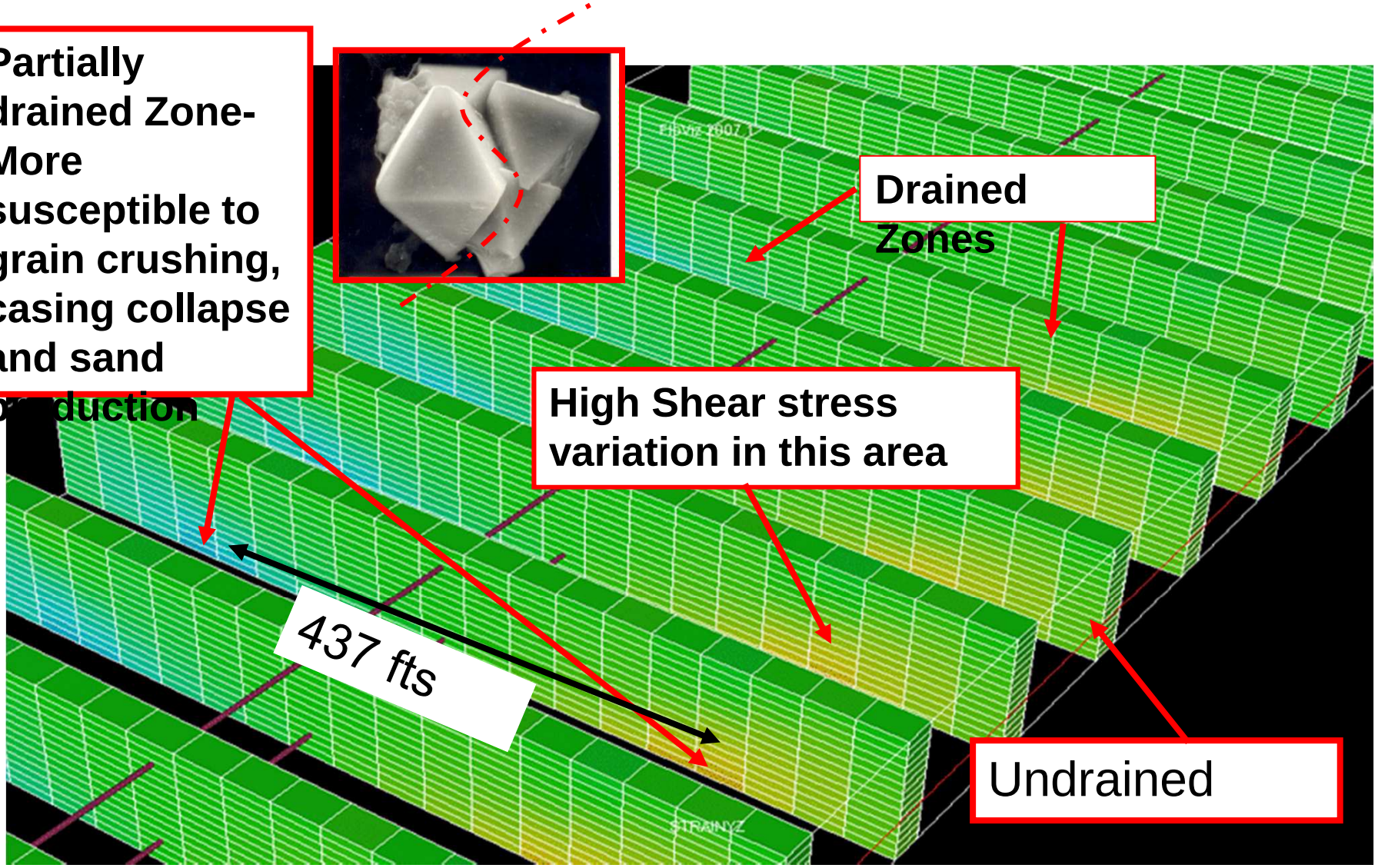
Vertical Strain

450 tons/day

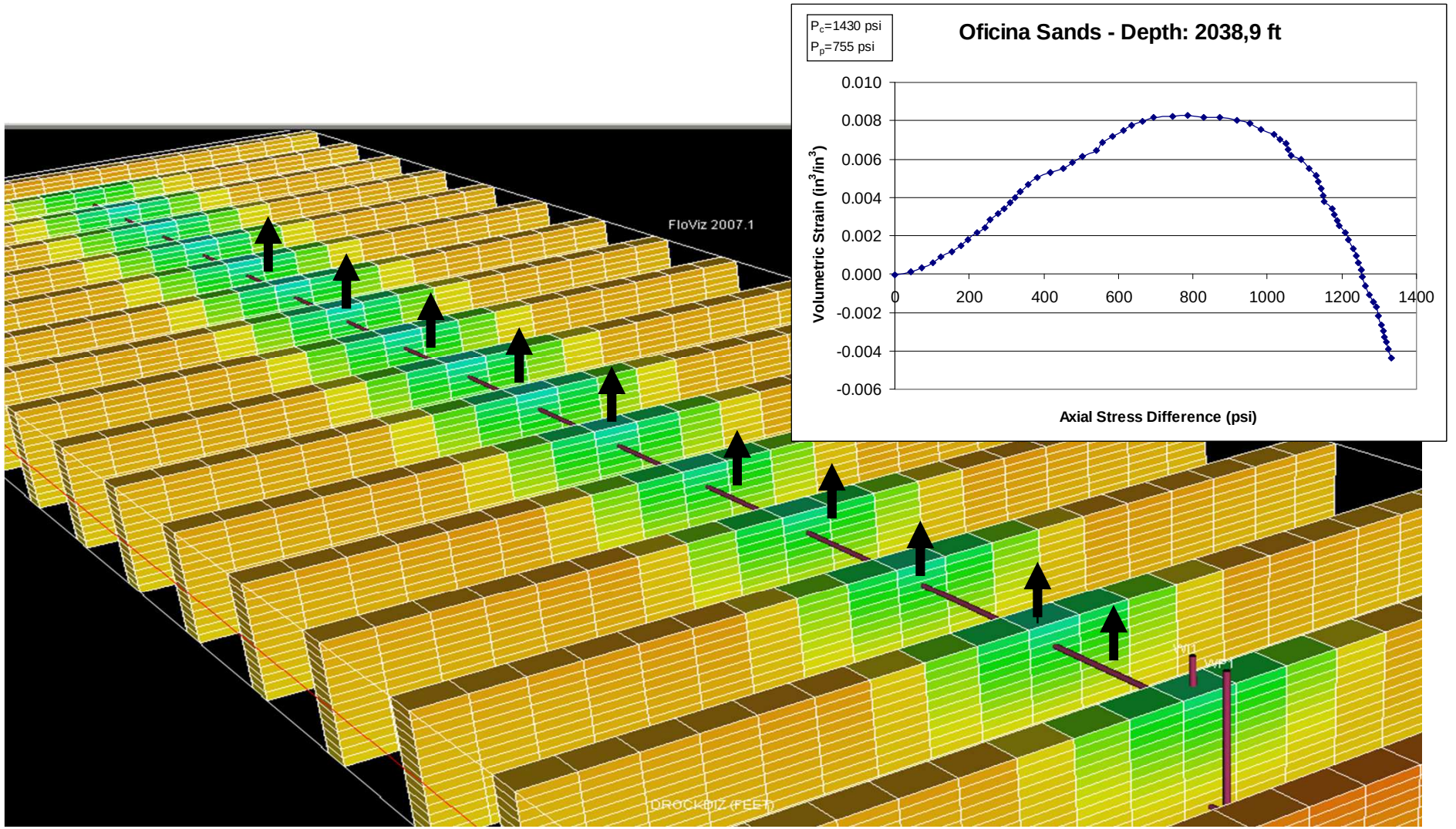
Core test evaluation
+ reach more than 80% of elastic curve



Shear Strain

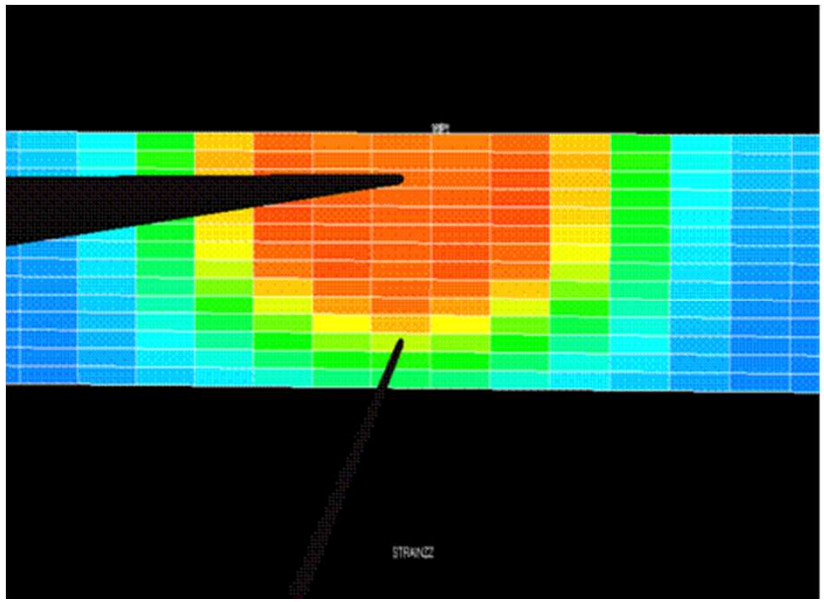


Dilation

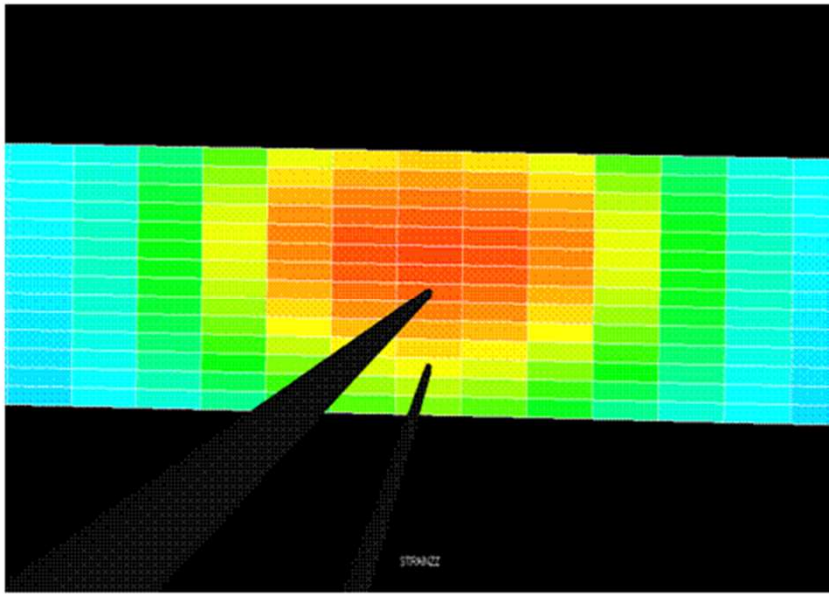

FloViz 2007.1
Oficina Sands - Depth: 2038,9 ft
P_c=1430 psi
P_p=755 psi
Volumetric Strain (in^3/in^3)
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
0
200
400
600
800
1000
1200
1400
Axial Stress Difference (psi)

Temperature Distribution

60 ft



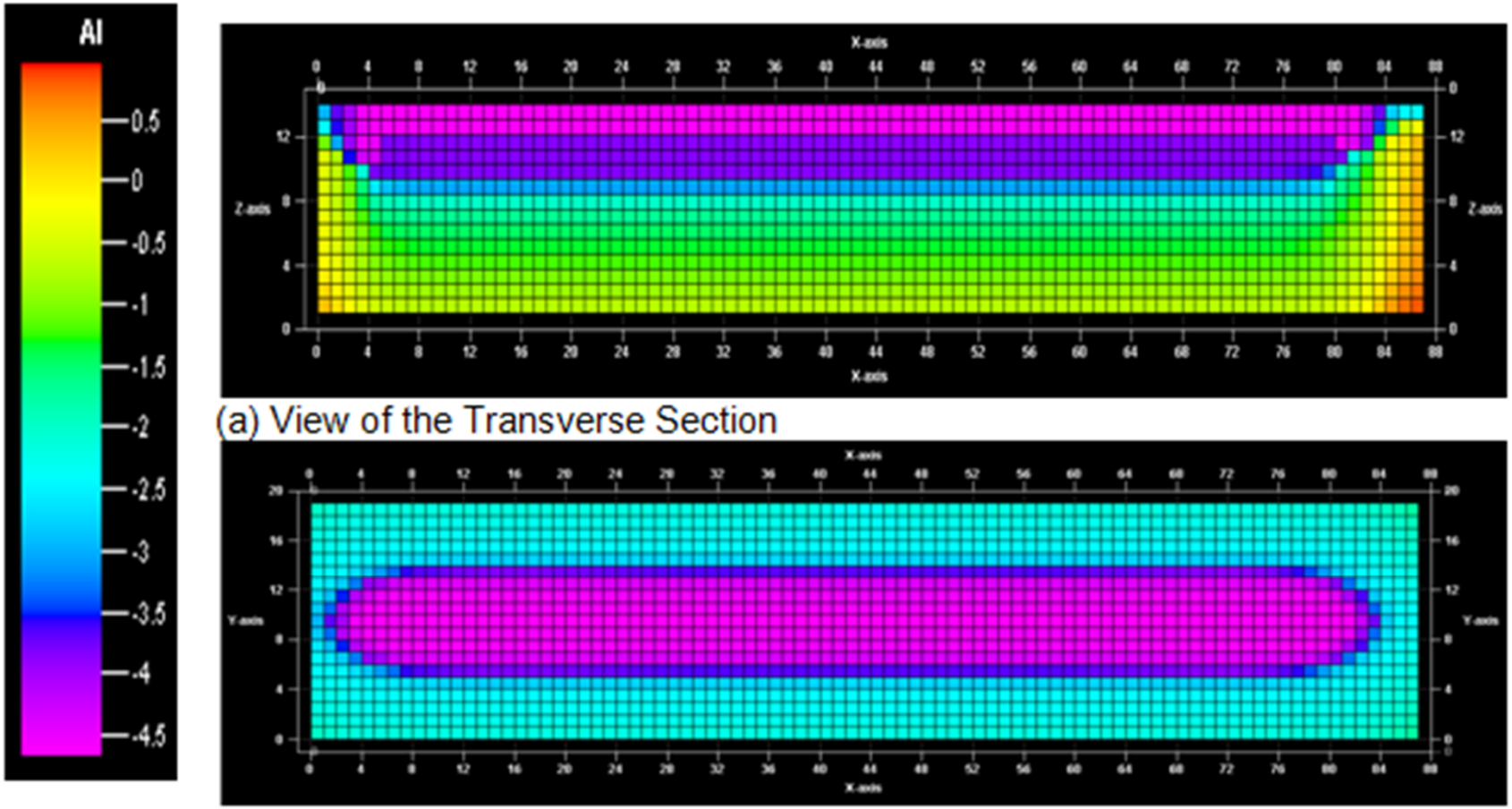
15 ft



2. Injector Well - Strain Analysis – 0.062 in/in - 450 tons/day

- 0.093 in/in- 650 tons/day

Acoustic Impedance contrast inside the steam chamber



(a) View of the Transverse Section

(b) View of Top of Reservoir

Conclusions

- The information generated in this study demonstrates the effects of the geomechanics on SAGD operations for the Orinoco Oil Belt reservoirs, and the optimal configuration to apply this technology, obtaining a more realistic and representative results about the SAGD potential for the Orinoco Oil Belt reservoirs.

- The geomechanics play a very important hole for operators to optimize SAGD:
  - Design wells - well's orientation and spacing
  - Select the optimum injection pressure