UNIVERSITY of HOUSTON

Allied Geophysical Laboratories

Small is beautiful: AGL physical modeling and salt measurements

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Houston
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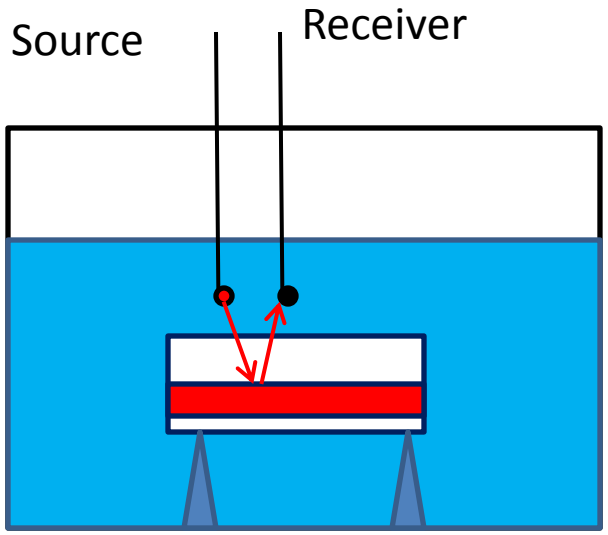
Introduction & motivation

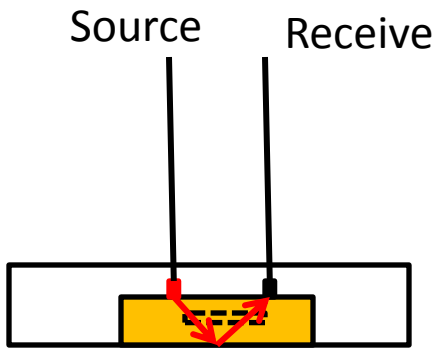
- Why physical modeling?
- AGL physical modeling system
- Scaled models of resource interest
  - laser-etched glass
  - 3D printed materials
  - Inclusions and injection
- Fracture results
- Ultrasonic measurements on salt & sediments

Schematic diagram of ultrasonic system

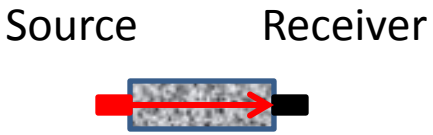
100 kHz to 5 MHz sources and receivers
Use 10,000 factor to compare to seismic:
100 kHz = 10 Hz, 5MHz = 500 Hz



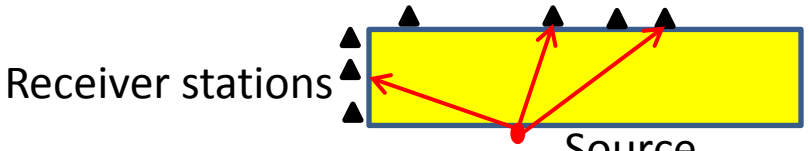
Marine System



Land System



Measurement system

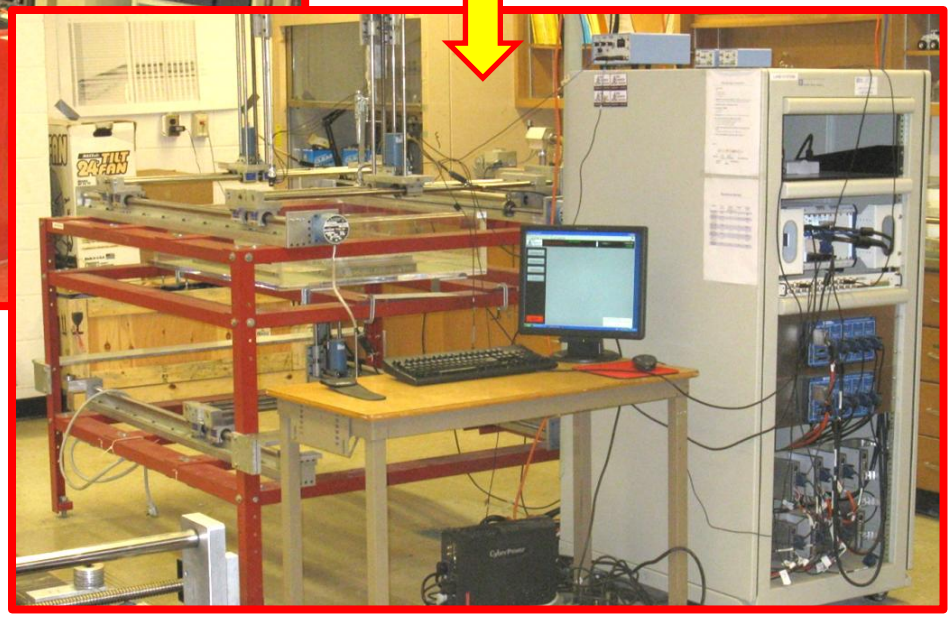


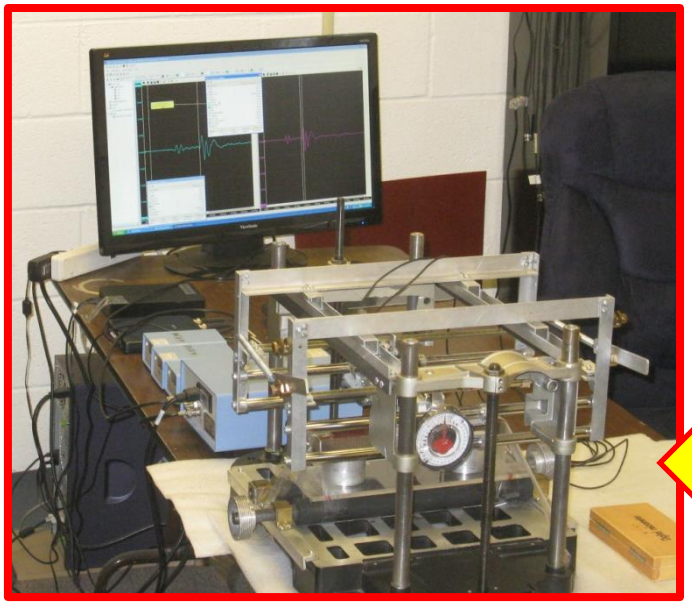
Microseismic experiment

AGL Ultrasonic Research Systems

Marine system

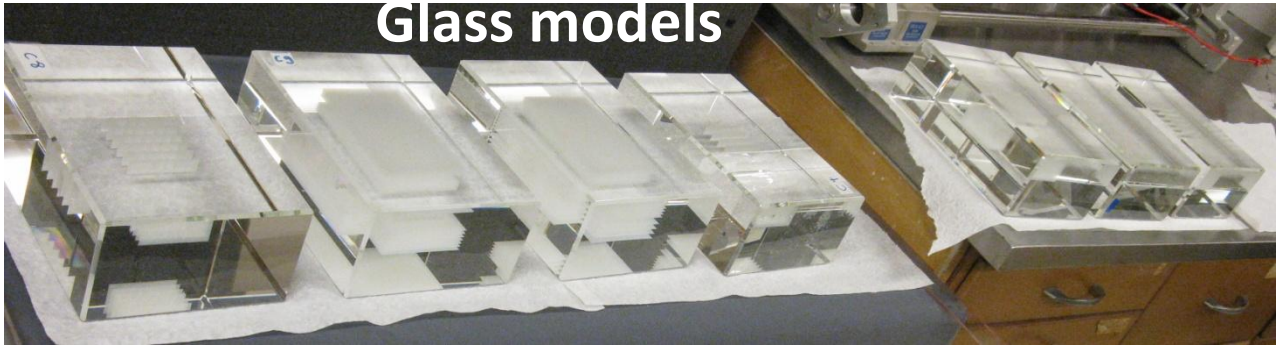
Land System

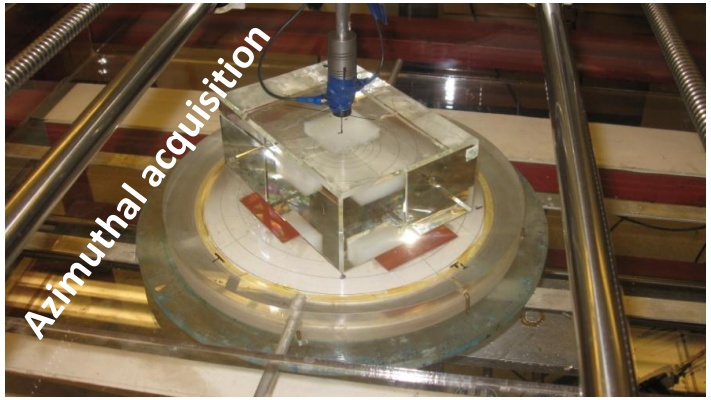


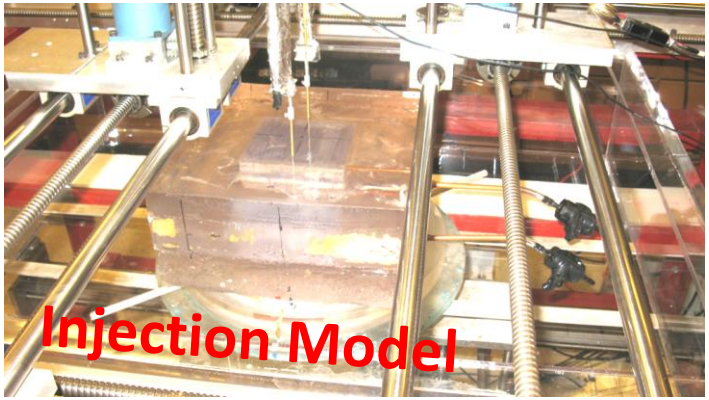


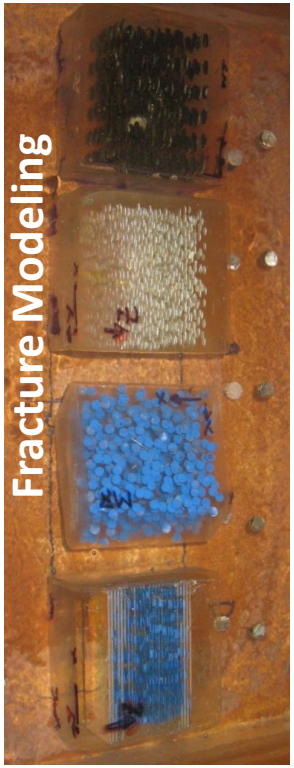
Ultrasonic measurement system

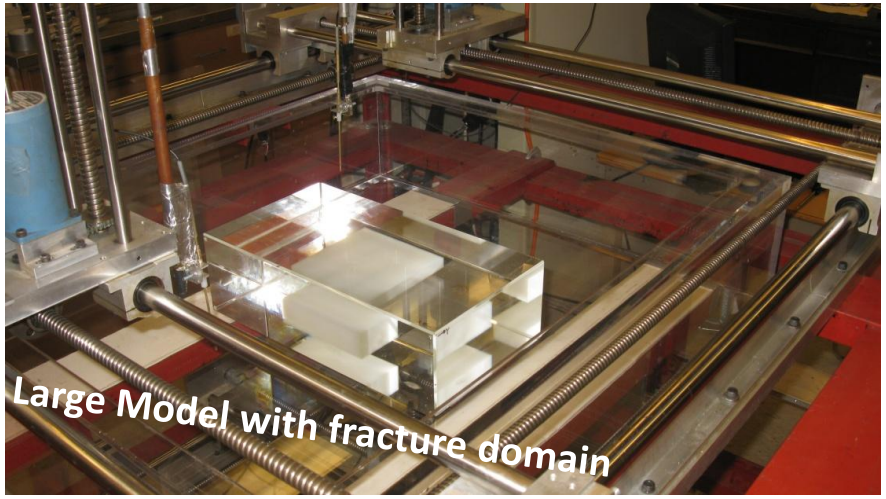
Part of Models





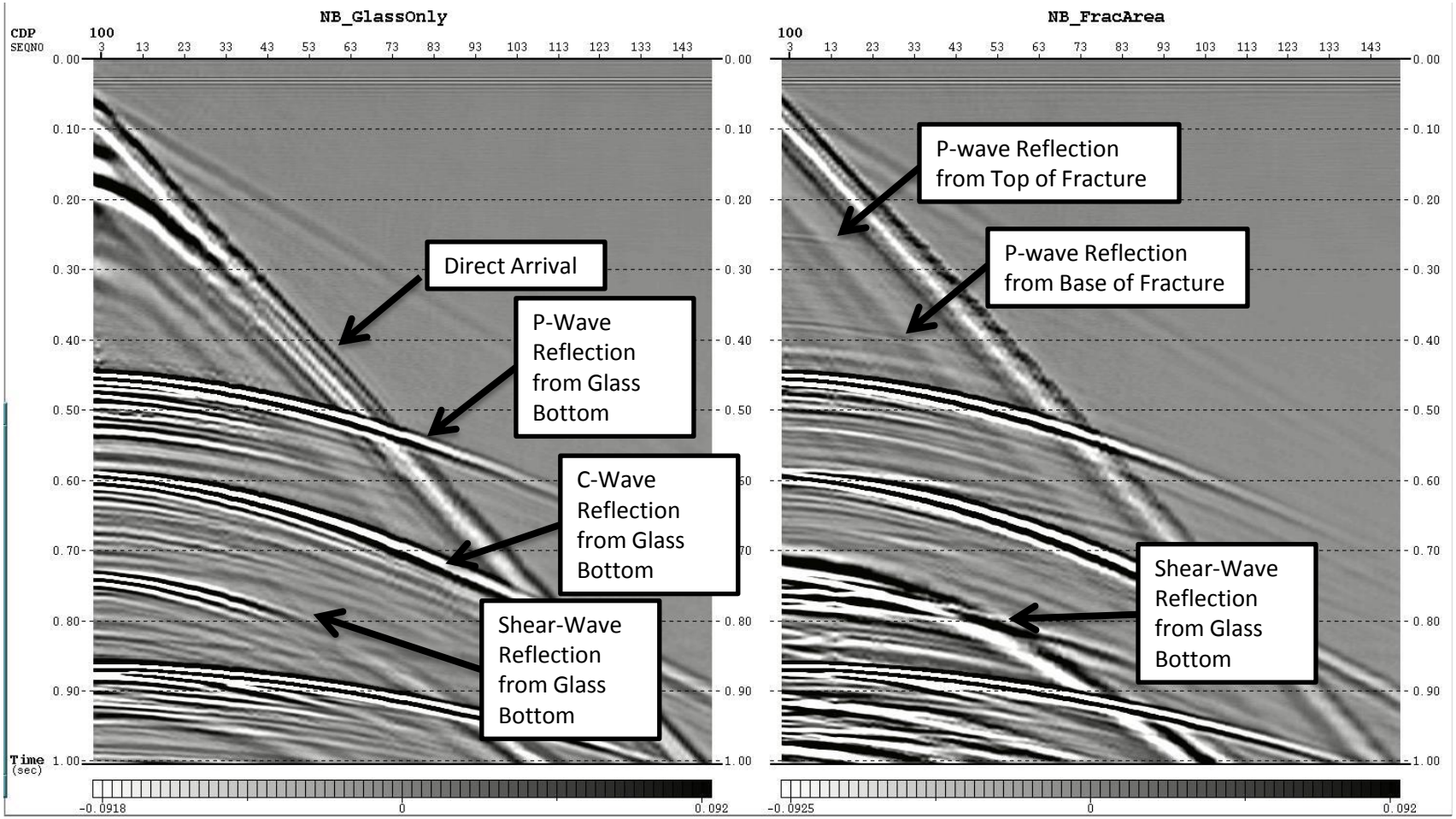






Example of CMP profiles in ultrasonic experiment in laser fractured glass

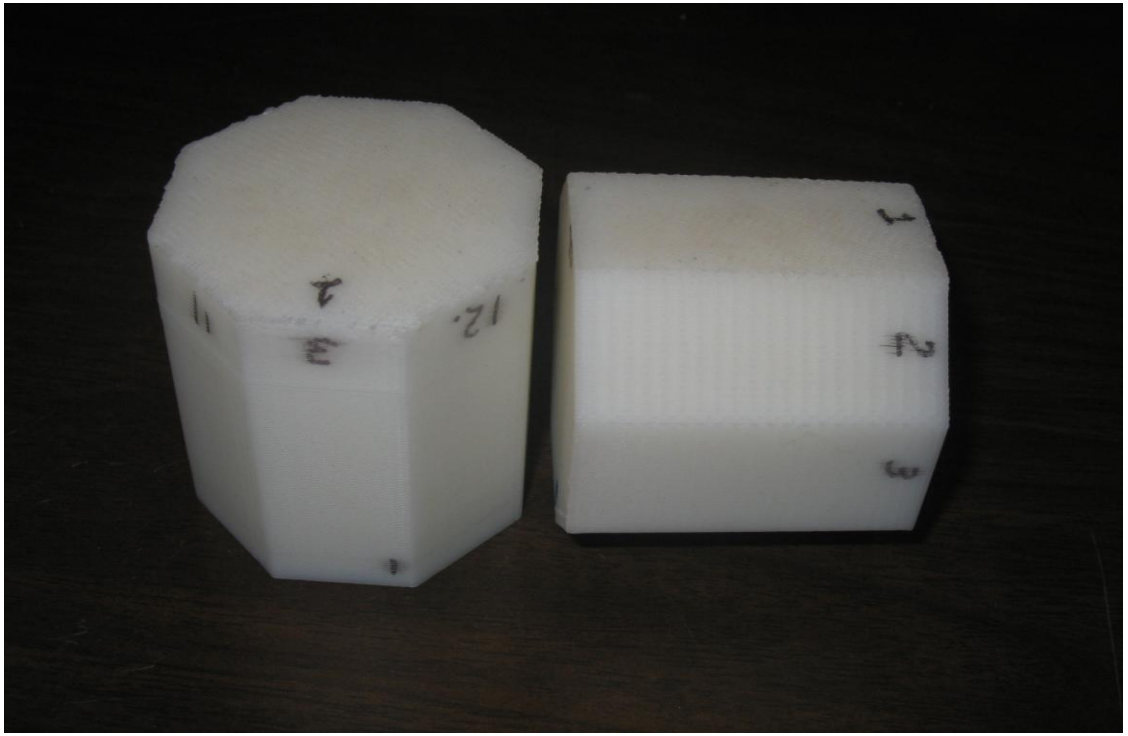
(processed by Bode Omoboya)



OFF Fracture

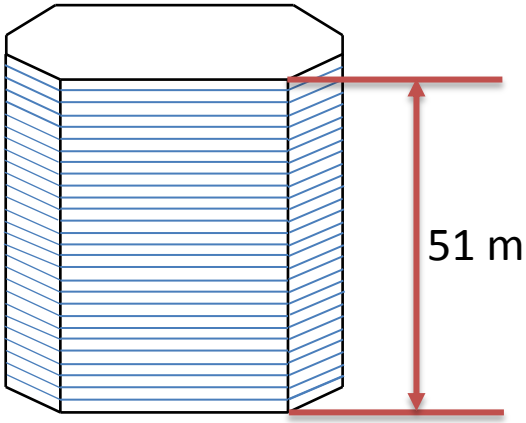
ON Fracture

3D printed models



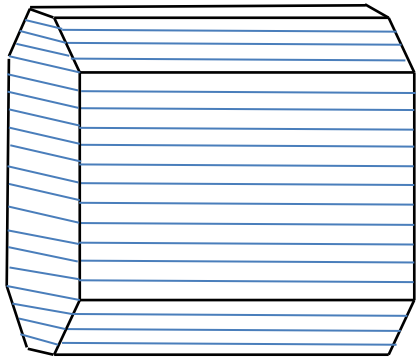
Prism B

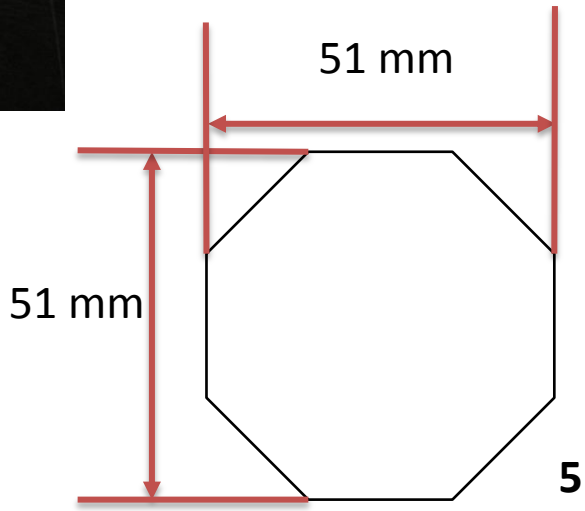
VTI



Prism A

HTI





Hydraulic fracture model with horizontal well

Model PM 4 (real)

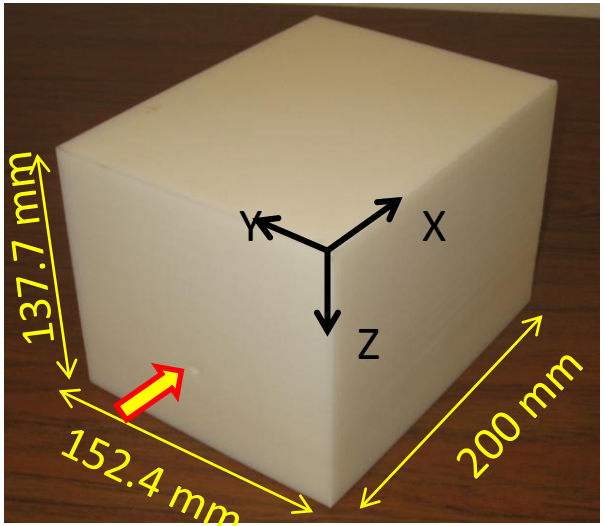
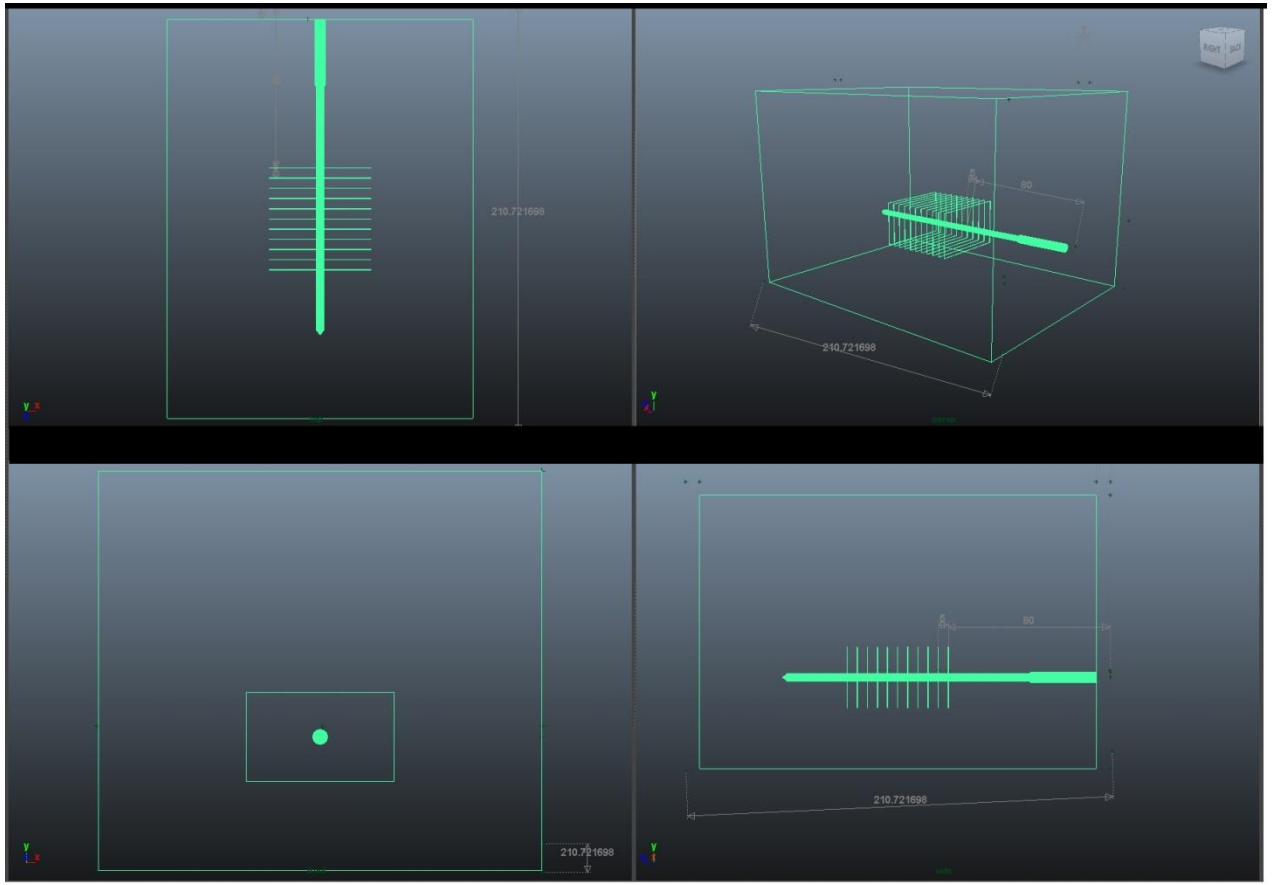
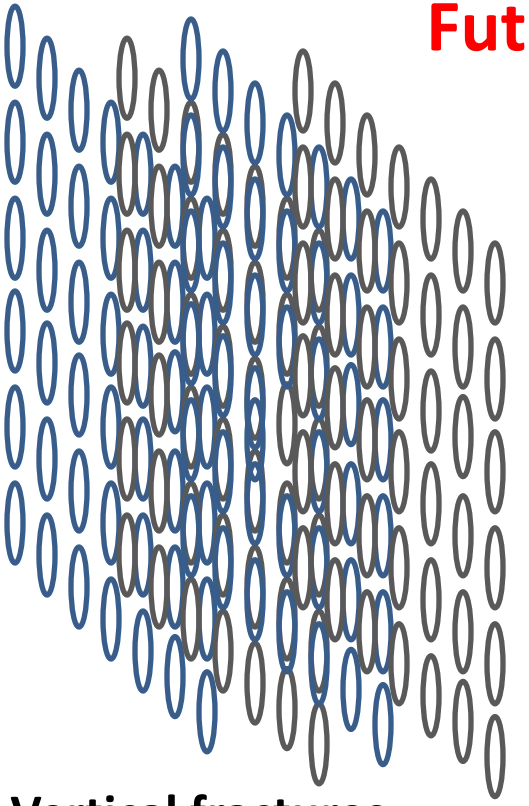


Image patch of fracture in PM 3 (microscope)

Model PM 4 (drawing)

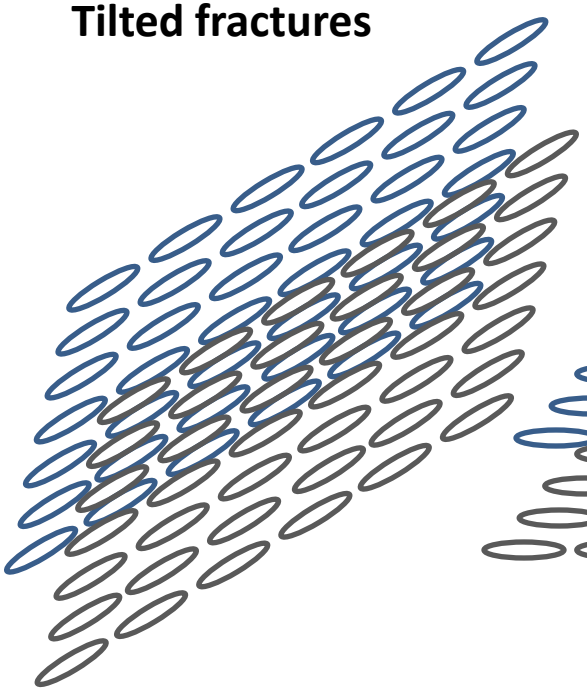


Future of Modeling with 3D printed material

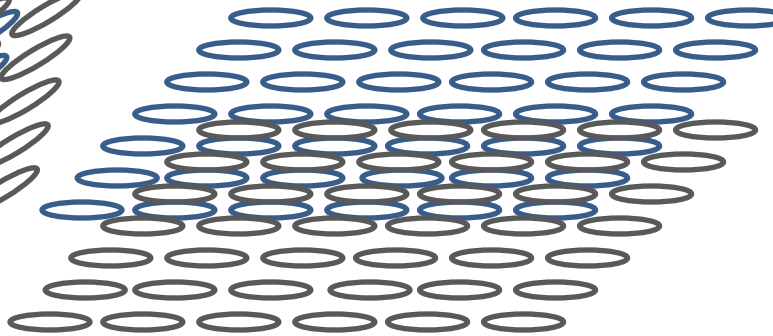


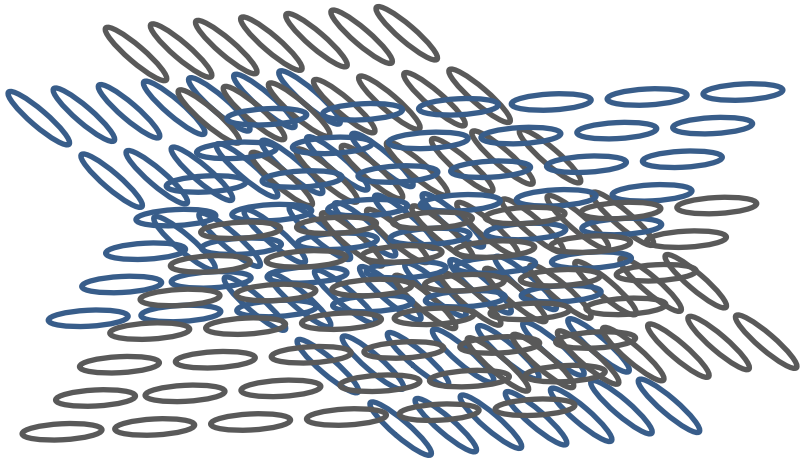
Vertical fractures

Tilted fractures

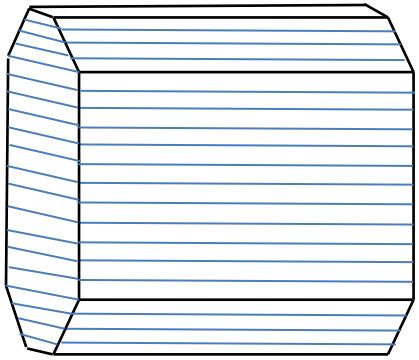


Horizontal fracture



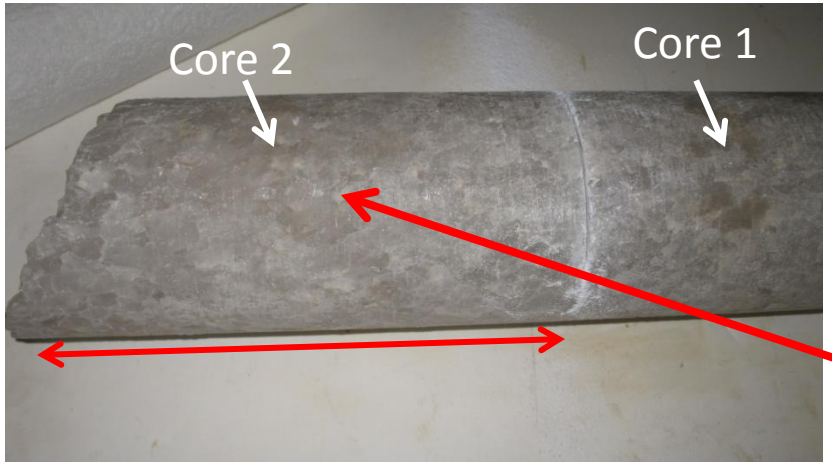


Combination of fracture systems



3D printed Material

Halite Core from a salt dome.



Velocity of Compressional wave (Vp) and Shear wave (Vs) along of axis of Salt core. Density.

Table 1. Results of three tests :
Velocity Vp and Vs, and Vp/Vs ratio

Test N	Vp, Km/s	Vs, km/s	Vp/Vs
1	4.512	2.611	1.728
2	4.532	2.624	1.728
3	4.521	2.609	1.733
Average	4.522	2.615	1.729

Ultrasonic transducers for P- and S-wave
Velocity measurements with central frequency 500 kHz

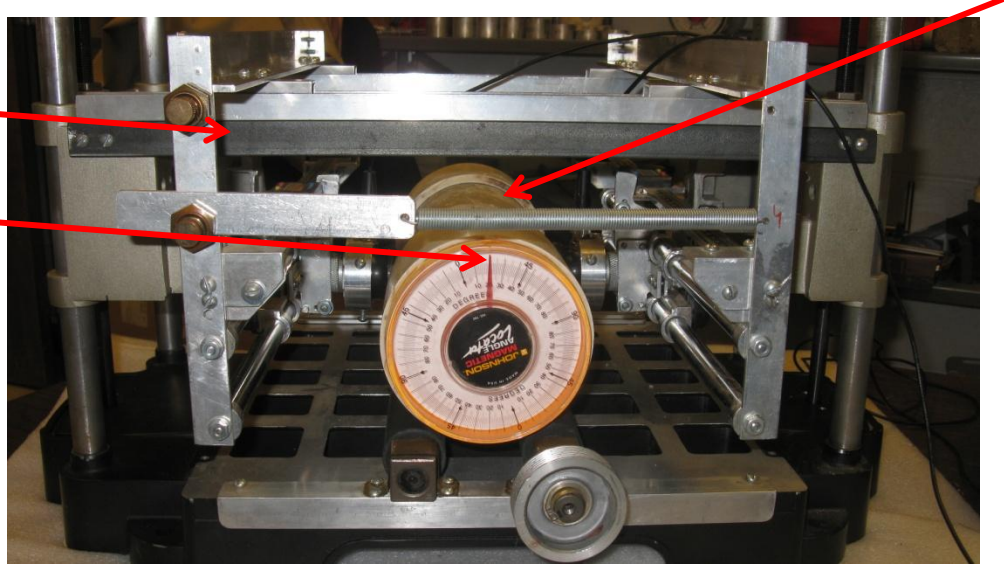
Density:

Core 1 – 2.124 g/ cm^3

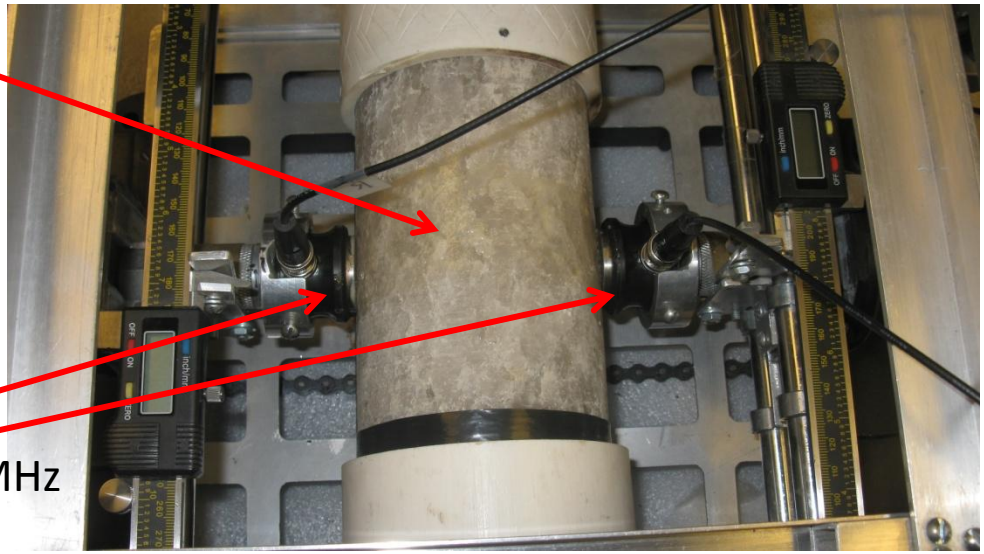
Core 2 – 2.054 g/ cm^3

Ro of salt core – 2.09±0.04 g/ cm^3

Salt core in device for anisotropy measurement.

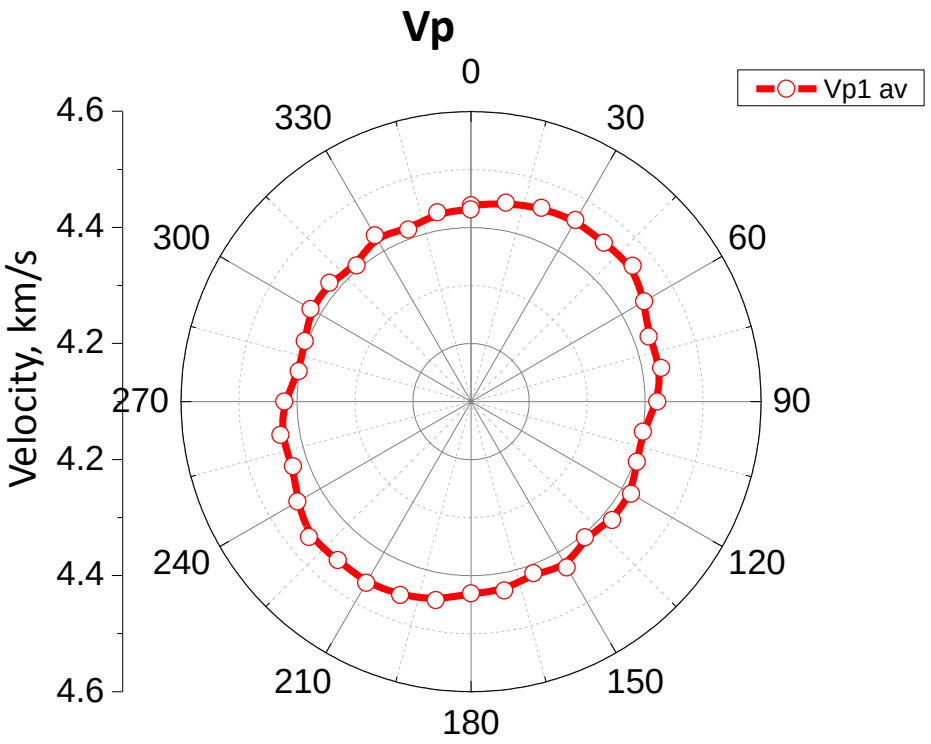


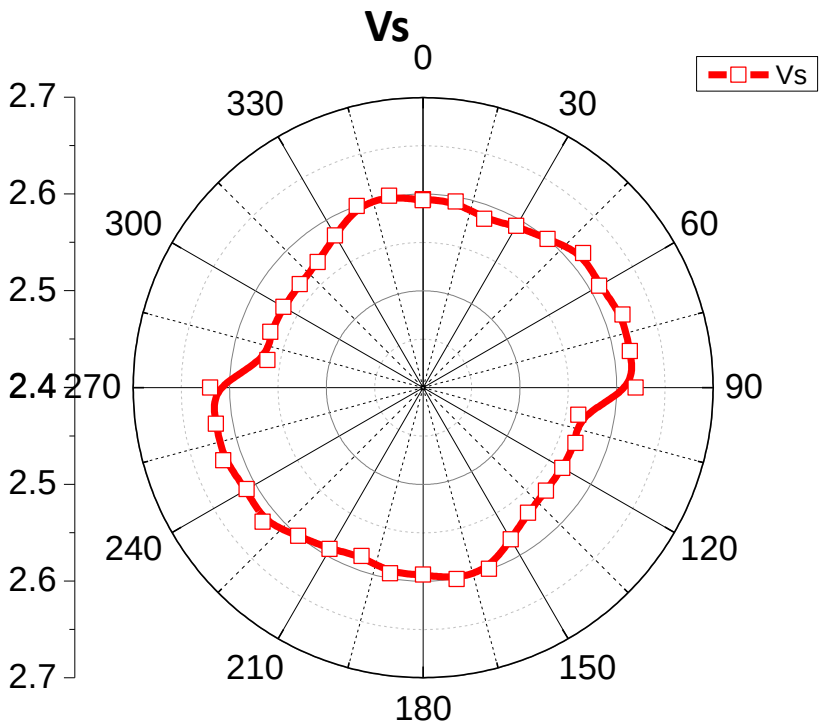
a) Front view

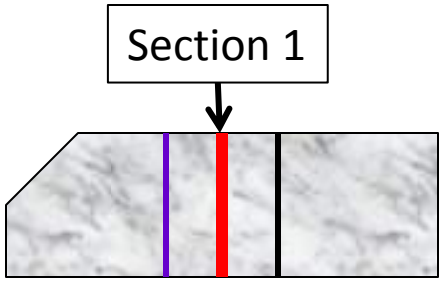


b) Top view

Azimuthal velocity of Compressional (Vp1) and Shear (Vs1) waves for section 1 of salt core-2
Azimuth was taken a confidential.





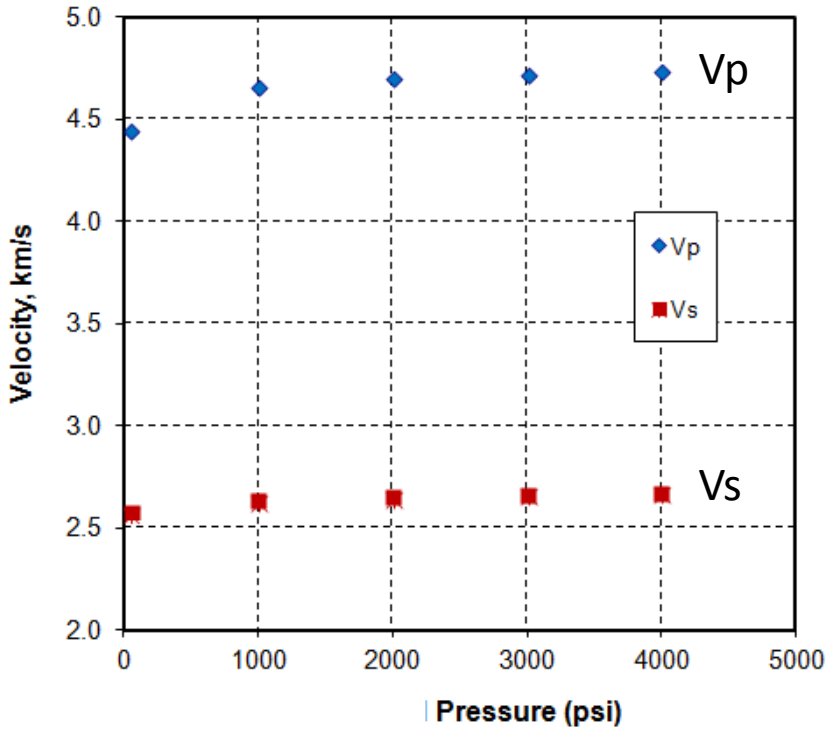


Pressure dependent velocity (Vp and Vs) measurement within sample of core 2

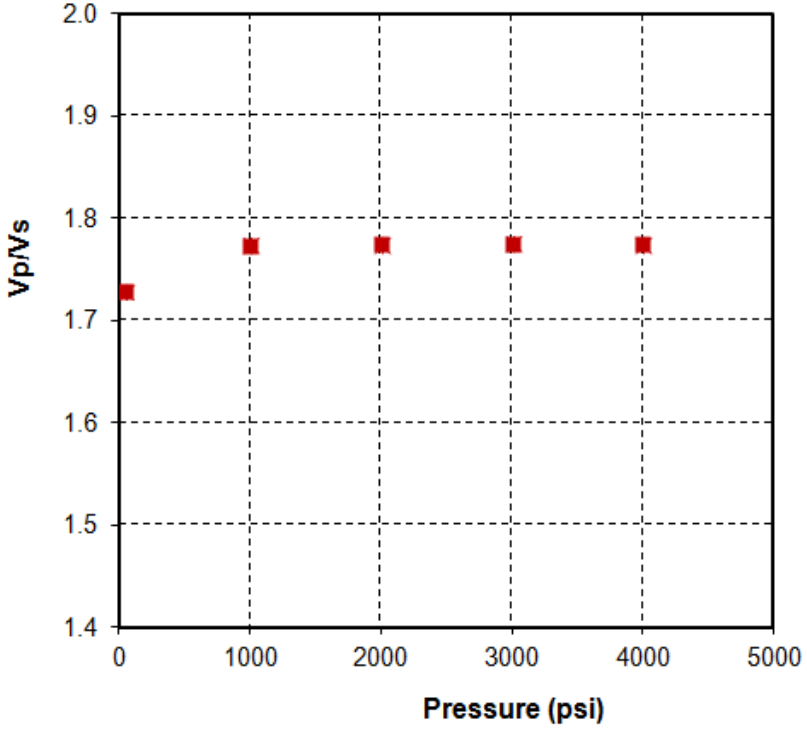
(De-hua-Han Rock Physics Lab, UH, AGL)

Halite cylindrical sample

(D=36.84mm, L=50.36mm)



Vp and Vs of Salt core 2 under Confining pressure



Vp/Vs versus confining pressure

Conclusions:

- AGL physical modeling Laboratory has 3 Ultrasonic research systems: a) Marine, b) Land, c) Ultrasonic measurement system.
- They are used for modeling seismic survey, microseismic monitoring tests, time-lapse seismic, and characterization of rocks and material elastic properties.
- Seismic physical modeling solve the geophysical problems in more economical and fast way.
- Study properties of rocks support in interpreting field data
- 3D printing material gives new opportunity for physical modeling of reservoir or rocks containing tectonic or hydraulic fractures in anisotropic medium.

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Thank you !