UNIVERSITY of HOUSTON

ALLIED GEOPHYSICAL LABORATORIES

Student Name: Suresh Dande

Degree and Year: Ph.D. Geophysics (4th Year)

Research Interests: 3D-printed rock models, fluid viscosity effect, Proppant, Rock Physics, Python, Microseismic

e-mail: sdande85@gmail.com

Abstract

In a hydraulically fractured reservoir, estimating propped reservoir volume is key to predict production. In this study, we use various samples, including **3D-printed models** with air-filled plus sand and ceramic proppant-filled fractures, as well as **Eagle Ford Shale** samples with artificially created fractures with air and sand-proppant. From the 3D-printed model in uniaxial compression experiments, we found that V_s is decreased by 10% for the sand-proppant model, and the Young's modulus of sand-propped models are lower than the air-filled or unpropped models, suggesting that propped models may be more compliant. Normal compliance calculated from the static data confirms that propped models are more compliant. We extend this experiment with Eagle Ford Shale samples, we find that **S-wave velocity increased by 10-14%** in **propped rock** in all directions (0^0, 45^0, 90^0 to the bedding) while no significant change in P-wave velocity. The increase in shear velocity could be attributed to the addition of faster material(sand) to the saw cuts. In another study, the effects of pore fluid and rock structure on the seismic velocity, V_p/V_s ratio and anisotropy of **3-D printed rock models** are studied in the laboratory. We performed fluid substitution experiments on the rock models using **water, engine oil, crude oil and glycerol**. We printed two models: a solid model (6% porosity, 4% anisotropic) and a fractured model (24% porosity, 26% anisotropic) with penny-shaped horizontal inclusions. When the dry solid model was saturated with the above fluids, compressional velocity increased by 11-17%. For the inclusion model, compressional velocity is increased by 19-56%, and the shear velocity decreased by 4-13% in all directions. We observed maximum variations across the inclusions. The P-wave anisotropy was reduced significantly (to about 1% for both solid and inclusion model) making both models more isotropic when saturated with glycerol. We observed very high V_p/V_s ratio for inclusion model suggesting the effect of anisotropy and fluid saturation. We observed variations in shear wave anisotropic parameter gamma indicating the effect of fluid viscosity on shear wave moduli.

Fig: 3D-printed model with proppant

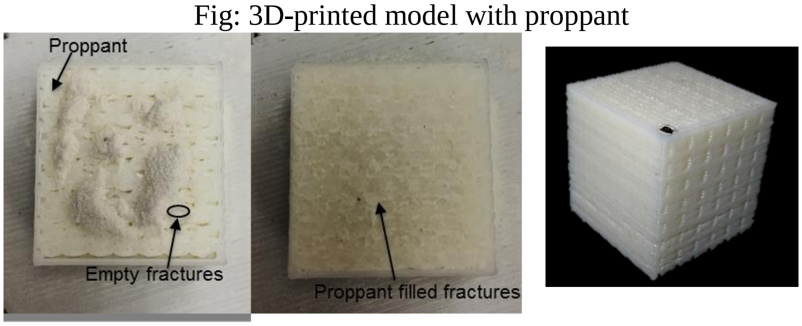
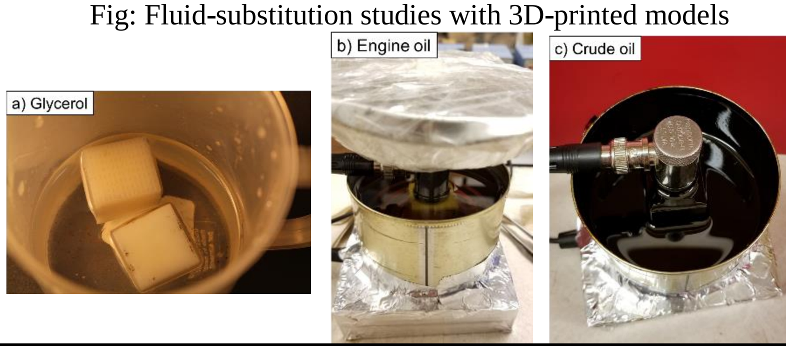


Fig: Fluid-substitution studies with 3D-printed models



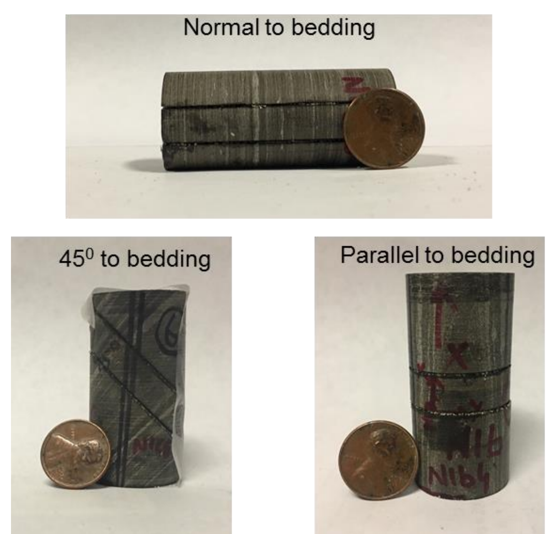


Fig: Eagle Ford outcrop shale with proppant