**Tuesday, November 21, 2017**

Southwestern Energy Conference Center, 10000 Energy Drive, Spring, TX 77389
Social 11:15 a.m., Luncheon 11:30 a.m.

**Cost: $35 Preregistered members; $40 non-members/walk-ups**

**To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.**
**Pre-registration without payment will not be accepted.**
**Walk-ups may pay at the door if extra seats are available.**

*If you are an Active or Associate Member who is unemployed and would like to attend this meeting, please call the HGS office for a discounted registration cost. We are also seeking members to volunteer at the registration desk for this and other events.*

# Impact of Clay Content on Elastic Anisotropy and Stresses in the Permian Basin Mud Rock Systems

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The relationship between the horizontal elastic modulus, $E_h$, and the vertical elastic modulus, $E_v$, is a function of clay content in unconventional resource plays in the Permian Basin. Increases in clay content in the Permian Basin mud rock systems are associated with increases in elastic anisotropy, $E_h/E_v$. When elastic anisotropy is high, over ~1.5, calculated stresses increase and affect the results and interpretation of 1D geomechanical models, wellbore stability models, and hydraulic fracture models. To assess the significance of the impact of clay content and elastic anisotropy on the stress calculation, we analyzed data from 60 pairs of vertical and horizontal one-inch diameter core plugs (120 plugs total) taken from three wells in the Permian Basin.

Whole 4-inch diameter cores were collected from four different formations with lithotypes that included calcareous siltstones, carbonate debris flows, siliceous siltstone, calcareous mudstones, siliceous mudstones, and organic rich mudstones. Each sample was analyzed for clay content and mineralogy using FTIR and XRF techniques. Static and dynamic elastic properties, Poisson's ratio, and uniaxial compressive strength were measured in confined compressive tests. Static elastic anisotropy was calculated at discrete locations over a range of depths and lithotypes. Bivariate regressions between each vertical and horizontal static Young's modulus and a commonly available wireline log were used as a method to upscale static elastic properties from the triaxial core plug measurements to log scale. The upscaled $E_h$ and $E_v$ data were used as input to the vertical transverse isotropic, VTI, stress model and compared to the poroelastic plane-strain model. The results showed an increase in stress in the VTI model compared to the plane-strain model up to 2,500 psi when elastic anisotropy is high. When anisotropy is low, the models converge on similar stress magnitudes, as expected. The changes in stress increase have a significant impact on 1D geomechanical models, bi-wing hydraulic fracture models, and wellbore stability models. Anisotropy increases proportionally with an increase in clay content the preliminary results indicate that a clay content of 4-5% can be enough to effect stress magnitudes. Higher calculated stresses can present commercial challenges impact on well design, well spacing, SRV estimation. All factors that can significantly change the bottom line. ■

## Biographical Sketch

**James Kessler** is a senior geologist currently working as a geomechanics specialist in the Subsurface Technologies group at Occidental Petroleum. His work is focused primarily on the characterization of mechanical stratigraphy through the upscaling of elastic rock properties and rock strength from core to reservoir scale and the characterization of stress in the subsurface. James applies his work to solving wellbore stability problems and enhancing the quality of rock property and stress inputs to hydraulic fracture models. James has over 15 years of experience as a geologist in a variety of research, consulting and petroleum industry roles focused on structural geology, hydrogeology, and geomechanics. He has been at Oxy for for the past four years.