Navigating Messy Rock Physics Problems

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Two common tools for modeling physical properties of rocks are *Estimators* and *Bounds*. Estimators predict a particular value of rock property: for example, Archie's Law to predict saturation or porosity, or Gassmann's equations to predict how effective moduli change when the pore fluid changes. In contrast, bounds predict the range of possible rock properties, given the limited information that we typically have in geophysics. Rock microstructure and heterogeneity are critical – determining where the measured value falls within the bounds, and why predictors sometimes fail or mislead us.

In this presentation, I'll show strategies for using bounds to navigate messy rock physics problems. Examples include (1) using bounds to test and sometimes falsifying popular predictors, (2) using bounds to infer microstructure from common measurements, and (3) using bounds, themselves, as predictors, especially in complex materials such as unconventionals. I'll also touch on a less familiar topic: using bounds on the cross-relations between different measurements (elastic modulus, electrical resistivity, dielectric constant, thermal conductivity, etc.) on the same rock. Cross bounds help us to validate our multi-physics measurements and our assumptions used to interpret measurements.