AAPG Annual Meeting
March 10-13, 2002
Houston, Texas

William J. Bosl[1], Amos Nur[2], Jack Dvorkin[3] (1) Lawrence Livermore National Lab, Livermore, CA (2) Stanford University (3) Stanford University, Stanford, CA

Ab Initio Computational Rock Physics

We present a computational methodology to determine the relationships between various rock properties by direct computation from realistic digital representations. The fundamental goal of rock physics is to find precise physical relationships between different rock properties. In particular, relationships between measurable properties, such as wave velocity, and properties of great interest that are not easily measured, such as permeability, are the ‘holy grail’ of rock physics. Our basic assumption is that the pore scale structure (geometry) of the mineral grains, the mineral composition of the grains, and the pore fluid together completely determine physical rock properties.

We compute rock properties from digital rocks using a variety of numerical methods, each appropriate for the property to be computed. In all cases, we attempt to compute rock properties by simulating a laboratory measurement. In principle, as the digital representation of the rock geometry and composition becomes finer, the computed properties become more exact. We currently compute porosity, permeability, electrical conductivity, elastic moduli, and seismic wave velocities from digital rocks. Comparisons between computed rock properties and laboratory measurements for bead packs are presented to demonstrate the usefulness of our approach.

Current research is focused on optimizing computational kernels to allow finer grid resolution to be used in our digital rock models and development of algorithms for rock diagenesis. The latter is particularly important because it will form the foundation of our attempt to find definitive rock physics relationships with rock composition and structure as the only free parameters.