8th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2010"

P-415

Advances in Rock Physics: Imaging and Computation at the Pore Scale

Tapan Mukerji*, *Stanford Center for Reservoir Forecasting, Stanford University*

Summary

Rock physics, and geosciences in general, has undergone a massive shift from descriptions of rocks and earth systems to include also process modeling, simulation, and process visualization. This keynote will focus on examples of advances in imaging and computation in rocks at the pore and grain scale. Pore scale microstructure provides the underpinning of geological processes specially those involving fluid flow and transport in the earth's crust. Pore microstructure also impacts the geophysical response of the rocks, through their elastic and electrical properties.

A key challenge in computational property estimation of rocks is the need to image the actual structure and topology of the pore space at different scales. The computational challenge is then to use the imaged complex microstructure to compute various properties, and simulate processes.

The talk will show how a confluence of modern imaging technologies from biology, geochemistry, and material science, when applied to rock physics has started to yield massive micro- and nano-structural data about the pore geometry. This in turn has lead to the need of massive computing to keep up with the data fluxes. Examples of different imaging techniques include confocal scanning laser microscopy (CSLM), scanning acoustic microscopy (SAM), micro- and nano-CT scans, acoustic force microscopy (AFM) and focused ion beam imaging (FIB). Some of these have been described in Vanorio et al., 2008; Dvorkin et al., 2009; and Ahmadov et al., 2009. Advances in computing have lead to algorithms that can handle the complex pore geometry without oversimplification (Keehm et al., 2001). Figure 1 shows an example of 3-D microstructure of macerals imaged using confocal scanning laser microscope obtained at different laser wavelengths. The application of imaging and analysis techniques promises to lead to new methods to infer rock properties and provide critical inputs for computational modeling.

Acknowledgements

We acknowledge the sponsors of the Stanford Center for Reservoir Forecasting (SCRF) and the Stanford Rock Physics project (SRB). We also would like to thank Amos Nur and Ingrain Inc. for their inputs.

References

Ahmadov, R., Vanorio, T., and Mavko, G., 2009, Confocal laser scanning and atomic-force microscopy in estimation of elastic properties of the organic-rich Bazhenov Formation, The Leading Edge, **28**, 18-23

Dvorkin, J. et al., 2009, From micro to reservoir scale: Permeability from digital experiments, The leading Edge, **28**, 1446-1453.

Keehm, Y., Mukerji, T., and Nur, A., 2001, Computational rock physics at the pore scale: transport properties and diagenesis in realistic pore geometries, The Leading Edge, **20**, 180-183.

Vanorio, T., Mukerji, T., and Mavko, G., 2008, Emerging methodologies to characterize the rock physics properties of organic-rich shales, The Leading Edge, 27, 780-787.

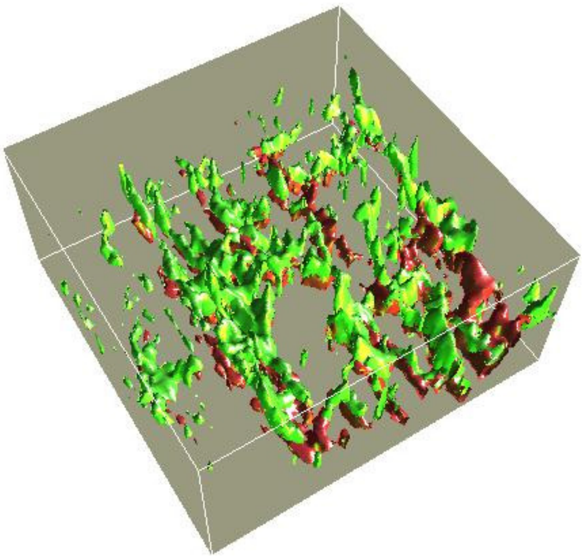

Figure 1: Elongated regions of green and red fluorescence obtained from 3-D CSLM data from Monterey shale sample. Stack size is 636 x 636 x 55 μm The fluorescence indicates microgeometry of liptinite macerals. (Vanorio et al., 2008)