San Joaquin Geological Society

Date: **Friday, March 7th, 2014**

Time: **11:30 AM Lunch**
12:00 PM Lecture

Place: **Petroleum Club of Bakersfield**
5060 California Ave., Suite 1200
Bakersfield, CA 93309

PSAAPG Members & Mesozoics
$25 w/ reservation
$30 without reservation

Non PSAAPG Members
$30 w/ reservation

Full-time Students with ID:
Free, Courtesy of Chevron & Occidental

SJGS WEBSITE

http://www.SanJoaquinGeologicalSociety.org/

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By: Wednesday, March 5th, 2013

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Natural Fractures in Shale Hydrocarbon Reservoirs

Dr. Julia Gale, Research Scientist
Bureau of Economic Geology, Jackson School of Geosciences, UT Austin

Using examples from shale reservoirs worldwide, I demonstrate the diversity of shale-hosted fracture systems and present evidence for how and why various fractures systems form. Core and outcrop observations, strength tests on shale and on fractures in core, and geomechanical models allow prediction of fracture patterns and attributes that can be taken into account in well placement and hydraulic fracture treatment design. Both open and sealed fractures can interact with and modify hydraulic fracture size and shape. Open fractures can enhance reservoir permeability but may conduct treatment fluids great distances, in some instances possibly aseismically.

We have addressed the challenge of incomplete sampling of subsurface fractures through comprehensive fracture data collection in cores and image logs and careful selection of outcrops, coupled with an understanding of how fractures and their attributes scale. We also use tested mechanistic models of how fractures grow in tight sandstones and carbonates to interpret fractures in shale. In order to predict fracture patterns and attributes it is helpful to understand their mechanism of formation and timing in the context of the burial and tectonic histories of the basin in which they are forming. A key variable is the depth of burial, and thereby the temperature, pore-fluid pressure and effective stress at the time of fracture development. For the most part the origin of fractures cannot be determined from their orientation or commonly-measured attributes such as width, height and length. The mineral fill in sealed fractures does provide an opportunity, however, and we use fluid-inclusion studies of fracture cements tied to burial history to unravel their origin.

Interaction with hydraulic fracture treatments may serve to increase the effectiveness of the hydraulic fracture network, or could work against it. Factors governing the interaction include natural fracture intensity, orientation with respect to reservoir stress directions, and the strength of the fracture plane relative to intact host rock. We tested the effect of calcite-sealed fractures in Barnett Shale on tensile strength of shale with a bending test. Samples containing natural fractures have half the tensile strength of those without and always break along the natural fracture plane. Yet in other examples the weakness is in the cement itself, partly because of retained fracture porosity.

Natural fractures in shales likely grew by slow, chemically assisted (subcritical) propagation and we use a subcritical propagation criterion to model the growing fractures. The subcritical crack index is a mechanical rock property that controls fracture spacing and an input parameter for the models. We measured the subcritical crack index for several shales. The index is generally high for Barnett Shale, in excess of 100, although it does show variability with facies. By contrast, subcritical indices in the New Albany Shale are much lower, and also show considerable variability. Barnett Shale subcritical indices suggest high clustering whereas New Albany Shale subcritical indices suggest fractures are likely to be more evenly spaced, with spacing related to mechanical layer thickness. We are investigating the variability in subcritical index in shale and how it might tie to other rock properties.

Dr. Julia Gale – Bio

Julia Gale started her career in geology with undergraduate studies at Imperial College, London. She obtained a Ph.D. in Structural Geology from Exeter University, UK in 1987, working on the Archean of southern West Greenland. She taught structural geology and tectonics for 12 years at the University of Derby, UK, having research interests in the Dalradian of NE Scotland and the Mona Complex of Anglesey, NW Wales. Julia moved to the University of Texas at Austin in 1998, where she is a Research Scientist at the Bureau of Economic Geology in the Jackson School of Geosciences. Her research focus is on natural fracture characterization and prediction in shale and carbonate hydrocarbon reservoirs.