

12 April, 2011

RDRG 2011 - Houston, Texas

Reservoir Deformation Research Group Meeting

Houston, Texas

April 12, 2011 • 7:00 – 10:00 PM

Meeting theme:

Fracs, Facts and Fabrications - a stimulating conversation about Unconventional Resources and the role of Structural Geology

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Theme overview

There is still considerable uncertainty, and a distinct lack of public domain material, with respect to characterizing the roles and relative importance of natural and induced fractures in enhancing the flow rate and ultimate recoveries in very low permeability matrix rocks, both for gas- and liquidbearing petroleum systems. Hopefully (!) these presentations and the discussion thereof will help clarify which data we need to collect & how we can begin to effectively model the impacts of faults, natural fractures, stress and strain and the interaction with induced fractures to optimize well & completion planning and reservoir performance in these very low matrix permeability systems.

The presentations will be informal and a max. of 15 minutes duration with 5 minutes for questions, followed by a longer open discussion session at the end of the evening.

Agenda

- 7:00-7:45 pm
 - Beer and social
- 7:45-8:00 pm
 - **Introduction and other RDRG/AAPG Business**
Tim Buddin & Peter Hennings
 - 2011 Chair Tim Buddin (Noble Energy) opened the meeting, along with vice chairman Alan Morris (Southwest Research Institute) and more than 65 attendees. Nominations for vice chair in 2011 were taken, and with one nomination from the current vice chair and no further nominations from the floor, David Wolf (Shell) was unanimously elected. Peter Hennings (Conoco Phillips and AAPG research committee liaison) then raised the issue of forming a

professional association/formal community for Structural Geologists and there was some support from the floor for this idea, to be followed up with Peter post-meeting. Bob Krantz also noted that there was momentum gaining for a Hedberg on 3D Geologic interpretation. There was also a brief discussion on the ongoing remit of RDRG beyond beer, technical conversation on topical themes and fringe discussions of AAPG business related to structural geology, though there seemed to be perceived value for continuing with the current remit, however loosely defined. In terms of the technical agenda (laid out above) there was much discussion around appropriate modeling of the multi-physics problem that is stimulation of fractured lowpermeability source rocks/shales. Peter Hennings garnered much muttering support for the assertion that the pragmatic, but largely engineering-based solution to the problem that decomposes stimulation geometry to 2D 'bi-wing' models is inappropriate when we see complex geometry from microseismic and our understanding of the geometry of the natural fracture network pre-stimulation. Moving towards a more robust geomechanical and geometric solution including distinguishing between the pressure front vs. the fluid penetration/propping front was agreed to be a key, and as yet undescribed (at least in the public domain) modelling exercise to move to a more robust description of timedependent stimulation and flow-back/production.

- 8:00-8:15 pm
 - **Fundamental Framework for Frac-ing into Formation Fractures**
Peter Hennings & Seth Buseti (ConocoPhillips)
- 8:15-8:35 pm
 - **Degradation & Stimulation for Unconventionals**
Steve Laubach (BEG)
 - Described the importance of looking at a paragenetic/diagenetic sequence in terms of discriminating which parts of a given fracture network will be susceptible to reactivation and be able to flow effectively. He showed many compelling examples of cement bridges in what would otherwise be characterized as open fractures and catalogued predictable examples of reservoir performance associated with cemented vs. open fracture systems.
- 8:35-8:55 pm
 - **The microseismic story**
Sherilyn Williams-Stroud (Microseismic Inc.)
 - Described some robust integration of microseismic event analysis with sound geologic models of the fault/fracture networks that had been stimulated. Moment-tensors clearly validated the failure mode

as shear and related to reactivation of an existing fault. There was some discussion as to our ability to see the connected fracture network with microseismic if the failure mode of at least some of the network/hydro-fracs was tensile, as is assumed to be the case in many stress-tensor scenarios in the subsurface.

- 8:55-9:15 pm
 - **Fracture plumbing system of an 1800 ft thick gas-shale package: Borehole-to-field-scale test of seismo-tectonic reservoir monitoring**
Al Lacazette (EQT Production)
 - Showed an extremely interesting approach, whose physics were not described in detail due to their proprietary nature and pending patents, that used surface arrays and tomographic imaging coupled with sound subsurface constraints from wells/outcrop, to DIRECTLY image flow paths in the subsurface. Despite multiple attempts, little detail on the tomographic approach/resolution was forthcoming for obvious reasons (mentioned above), but this technique clearly had the potential to be a breakthrough and move us beyond the 'cloud of dots' of standard microseismic approaches.
- 9:15-9:30 pm
 - **Combined FE-DE Geomechanical Modeling for natural fracture prediction**
Dean Thornton, (Rockfield Software Ltd.)
 - Described their ELFEN Finite/Discrete Element modeling toolkit and approach that is evolving rapidly to be able to provide evolutionary 3D geomechanical models of stimulated matrix/fracture networks with leading edge constitutive models (deformation modes) and the ability to model the propagation of apertures beyond the existing static natural fracture network during stimulation and then look at pressure and fluid-flow within that network. The models presented for stimulation impacts under varied differential stress were simple and elegant and how this approach evolves to a full 4D modeling approach will be exciting to see. A question from the floor asked whether we were constrained by the questions we were asking or our ability to model... and on that insightful note we degenerated to beer and offline discussions.
- 9:30-10:00 pm
 - Open discussion