Wednesday, April 20, 2011

Petroleum Club • 800 Bell (downtown)
Social 11:15 AM, Luncheon 11:30 AM

Cost: $30 pre-registered members; $35 for non-members & walk-ups; Emeritus/Life/Honorary: $15; Students: FREE

To guarantee a seat, you must pre-register on the HGS website (www.hgs.org) and pre-pay with a credit card.
Pre-registration without payment will not be accepted.
You may still walk up and pay at the door, if extra seats are available.

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2010-11 AAPG Distinguished Lecture

A Paradigm Shift in Understanding Fracture Origin and Fracture Influence on Deep Carbonate Reservoir Performance: A Study of Onshore Permo-Triassic Deep Reservoirs in Saudi Arabia

Characterizing fractures and their geomechanical impact on reservoir performance is the ultimate objective of fracture and in-situ stress characterization. This presentation provides evidence contrary to the common perception of the major role played by fractures in the production performance of deep carbonate reservoirs. It is based on a recent study by Saudi Aramco in Saudi Arabia.

Reservoir performance is mainly controlled by the matrix porosity and permeability that were preserved by early hydrocarbon placement.

The highly variable performance of the Permo–Triassic reservoirs in onshore giant fields in Saudi Arabia has been attributed to the presence of natural fractures. Similar preproduction pressure profiles and hydrocarbons in the different reservoir units have been attributed to vertical communication through large faults. To validate these assumptions, we studied the static and dynamic data from the reservoirs. We identified two distinctive fracture domains based on fracture orientation and density. Fracture evolution is mainly controlled by extensional and consequent compressional plate tectonics instead of local structures. In-situ stresses in the study area are dominated by Zagros Plate tectonics and affect fracture aperture differently in the two fracture domains. The impact of fractures on reservoir performance is mostly subtle because of the nature and distribution of the fractures. Fracture-enhanced productivity occurs locally in some of the producing wells and results from high-density fracture clusters (including mesoscopic faults) with channel-type apertures. Reservoir performance is mainly controlled by the matrix porosity and permeability that were preserved by early hydrocarbon placement.

The following findings challenge the common views on the influence of fractures in the reservoir performance: 1) individual fractures are dominantly tensile and small (mesoscopic and microscopic); 2) individual faults are small and not readily resolvable at seismic scale; 3) the depth and carbonate nature of the reservoir make the fractures highly susceptible to fast-healing unless preserved within the hydrocarbon column; 4) initial vertical pressure gradient changes with production indicate a lack of present-day communication across the anhydrite sealing layers between the different reservoir units; 5) horizontal well direction does not generally have an impact on productivity; and 6) sustained and heavy losses of circulation are rarely encountered in the reservoir wells. ■

Biographical Sketch

Mohammed S. Ameen received his Ph.D. and Diploma in Structural Geology and Geomechanics from Imperial College, London in 1988 and has had 25 years of academic and industrial experience. He has published 26 articles on fractures and folds, edited three special publications for the Geological Society (London), and has patented a new method for the characterization of microfractured reservoirs.

In his early research, Ameen conducted the classic work on the fractures and folds across the Taurus-Zagros Range, Iraq, covering 30 major fold traps. The work has been published in the *AAPG Bulletin*, the *Geological Magazine*, *The Journal of Petroleum Geology*, and the *Proceedings of the Conference on Fractured and Jointed Rock Masses*, USA, 3-5 June 1992. Subsequently he worked on geotechnical, environmental and hydrocarbon-related projects in Europe and the Middle East, including fracture and geomechanical

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characterization for nuclear waste repositories and strategic gas storage in depleted reservoirs.

Dr. Ameen joined the Reservoir Characterization Department at Saudi Aramco in 1998 as the in-house fracture and geomechanics specialist dealing with development issues. Since 2004, he has been leading the Structural Geology and Rock Mechanics Group in Saudi Aramco. In his 13-year career with Aramco he has researched and dealt with exploration and development applications of fractures and geomechanical characterization in the vastly diverse reservoirs and environments across Saudi Arabia. His recent publication on the deep Khuff carbonate gas reservoir (*AAPG Bulletin*, January 2010) set a paradigm shift in understanding fractures and their impact on carbonate reservoir performance. Ameen is an active member of the AAPG, Society of Petroleum Engineers, European Association of Geoscientists and Engineers, and the Geological Society (London).