Abstract 20
1 - Petroleum Systems of Unconventional Resources
Special Keynote Talk

EVOLUTIONARY UNDERSTANDING OF SHALE RESOURCE SYSTEMS

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Shale resource systems evolved exponentially over the last 30 years. Their recognition now as prodigious resource systems has been a long, slow process. Beginning with the Mitchell Energy C. W. Slay well drilled in the Fort Worth Basin, Texas in 1981, shale development potential has evolved to resources likely of several thousand Tcf-equivalency on a worldwide basis. The Newark East Field of the Barnett Shale is now the largest gas field in the United States, having been the 87th largest in 2005. It has now produced over 8 Tcf of gas. Interestingly the far more recent development of the Haynesville Shale in the East Texas North Louisiana (ETNL) Salt Basin has surpassed the Barnett Shale in daily gas production.

Interestingly, this process has often been a “relearning” process that would have been aided by a better understanding of coals and their petrography. For example, gas storage in shales is aided by development of organic porosity, i.e., porosity in nanopores due to organic matter decomposition. The earliest difficulty in understanding the Barnett Shale was where the gas was stored. It was thought that open fractures must be present and after years of searching, basically none have been found. There are healed fractures that play a role in creation of a dendritic fracture network, but their storage capacity is nil. Work by Reed and Loucks (2007) using argon ion milling and SEM identified Barnett Shale nanopores that are the primary gas storage mechanism in the Barnett Shale. What is interesting from this work is that it is still not recognized per se for the role this storage mechanism plays relative to diffusion and uplift.

Certainly understanding thermal maturity has been a key in identifying the best producing areas for gas. Thresholds for gas production, however, are lower than often reported in the literature as good shale gas wells occur above about 1.0% Ro although gas certainly becomes much drier above 1.4% Ro. However, in addition, there is a limit to gas preservation in shale reservoirs. Gas contents decrease above about 2.5% Ro possibly reaching 50% or more loss at 3.5% Ro. Wells drilled in very mature areas of the Fayetteville, Marcellus, and Posidonia shales have proven to be non-productive. Thus, an understanding of gas preservation and reservoir alteration at high maturity remain poorly understood by industry and scientists alike.

Ethane carbon isotopic rollover (Ferworn 2008) has been shown to provide an indication of the best producing areas for shale gas, yet there are a few highly productive areas where such rollover does not occur, e.g., the Haynesville Shale in the southern ETNL Salt Basin. Ethane carbon isotopic rollover is not explicable by thermogenesis alone as the isotopic signatures do not match. The fact that at least some systems do not show such rollover indicates that there is a potential relationship to inorganic geochemistry that is necessary to invoke.

Shale oil resource systems are a new challenge. While oil has been produced from open fractures in shales for over 100 years, producing oil from tight, low porosity shales or juxtaposed lithofacies is a new challenge. Utilization of our knowledge of generation, oil cracking, and adsorption are important factors in such systems, but have not yet been fully integrated into evaluation of these systems.

Organic geochemistry stands alone as a science; yet unconventional shale resource systems show that a more complete integration and expansion of our knowledge with other geosciences disciplines is essential to more fully understand these systems.