Making Movies of Oil Generation

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Scanning Electron Microscopy (SEM) of organic-rich shales is a powerful tool for understanding the distribution of organic matter, mineral content, porosity and permeability. Focused Ion Beam Scanning Electron Microscopy (FIB-SEM) makes possible digitized 3-d shale reconstructions in which thin layers can be sequentially stripped away or added on a computer-rendered 3-d image. These types of “movies” show the interconnections of pore networks. These important methodologies are routinely utilized to better understand unconventional oil and gas plays.

Here we report another breakthrough methodology, namely making movies of oil generation, through the use of an Environmental Scanning Electron Microscope (ESEM) with a heating stage. By heating a thermally immature, organic-rich shale while continuously recording the image beneath an ESEM, we were able to make a movie showing the oil generation process. The heating program used was the same as that used by Rock-Eval pyrolysis and water vapor was pumped into the chamber to enhance the image making the pyrolysis in effect a hydrous pyrolysis.

The movie can be found at:
http://www.youtube.com/watch?v=lISNwF5tMXM

From this movie, it is possible to actually visualize many of the processes that occur during oil generation. These include the creation of porosity and permeability by the conversion of solid kerogen to liquid and gas and the subsequent migration of those hydrocarbons. In the case of this experiment, migration is into the vacuum. In nature, migration is either within or out of the tight shale. Furthermore, pressure associated with kerogen and oil to gas cracking can be observed in the movie by the creation of fractures parallel to bedding. At high maturities, as the amount of oil and gas being generated decreases, the fracture can be seen to begin to close. Fracturing parallel to bedding, as seen in the film, would result in horizontal migration within the carrier bed.

The making of ESEM movies of oil and gas generation from organic-rich shales will lead to a better understanding of the process in both conventional and unconventional plays.