Geophysical Research Abstracts
Vol. 17, EGU2015-2093, 2015
EGU General Assembly 2015

Shale Gas Petrophysical Models: an evaluation of contrasting approaches and assumptions

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Shale gas refers to fine-grained formations, or mudstones, where organic matter has matured sufficiently to produce predominantly gas, but that gas has not migrated any significant distance and hence the source rock is effectively the reservoir. Due to the success of shale gas extraction in the USA, many European countries are assessing their potential resources.

A key uncertainty in evaluating the resource is the estimation of gas in place and most models are based on North American plays. However, it would seem that no single model to date can confidently predict the gas in place for a ‘new’ shale formation. Shale gas is frequently characterized by two distinct gas components: free gas is able to move and occupies the pores, while adsorbed gas is fixed onto organic surfaces and held in place by pressure. There are a number of different published methodologies that attempt to take account for this complicated distribution of gas within the rock ranging from models where the importance of the adsorbed gas is assumed to be negligible to those where all gas is assumed to exist within the organic pores and none within the mineral pore spaces. Models that assume both components are important and occupy adjacent volumes need to consider how to separate out the two to avoid double counting. Due to the heterogeneity of mudstones the most appropriate model may vary downhole as well as across adjacent wells.

In this pilot study we consider the underlying assumptions and categorize models dependent on the deterministic or probabilistic approach used. We use an initial dataset from North America to test and compare a number of different approaches before expanding the analysis to further formations that span a range of geological and petrophysical characteristics. We then review and evaluate the models, identifying key variables and, where possible, determining their importance through sensitivity analysis.

This work aims to establish guidelines for selecting the most appropriate petrophysical model for evaluating the gas in place in a shale gas play, and as such provides a more informed understanding of this petrophysical maze for both specialists and non-specialists.