CHARACTERIZATION OF DEVONIAN SHALES WITH X-RAY COMPUTED TOMOGRAPHY

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1 Introduction

The Devonian shales of the eastern United States are considered a major potential source of future natural gas production, containing an estimated 1860 to 2580 trillion standard cubic feet of gas [1,2]. While natural gas has been produced from the shales since the 1820's, only an estimated 2.5 Tscf of gas had been produced through 1980 [3]. One key factor that has hindered more substantial production from the shales is that the tight shale rock has very low matrix permeability, so extensive natural or induced fractures may be required to obtain economic rates of gas production. Another factor is that a substantial quantity of gas may be stored in a fluid state other than as "free" gas in the pore space and may not be so readily identified or produced with conventional methods [4]. Presently, the manner of storage and transport in the shales is not well understood; this has hindered the development of reliable methods for exploration and production in the Devonian shales.

One problem in studying the shales is that conventional core tests on reservoir core samples simply do not work well. Special equipment or procedures are required to determine the permeabilities and porosities as low as those encountered in the shales [5]. However, a more fundamental problem is the very heterogeneous nature of the shales. A core sample may contain extremely low permeability matrix (with permeabilities of micro- or even nanodarcies [5]) but also contain fractures or other features that have permeabilites many orders of magnitudes higher. The presence and orientation of such high permeability features can have profound effects on the permeability that would be observed in a conventional test. Such an "averaged" value may not be very useful in describing reservoir behavior.

In this paper we report the use of X-ray computed tomography (CT) for investigating basic properties of Devonian shales. Unlike conventional experiments, CT imaging provides the means for detecting properties at various locations throughout the core sample. Of particular interest is the utility of the CT scanner for detecting microfractures and for quantitative determination of gas storage. When combined with other petrophysical experiments X-ray CT scanning can provide significant new information concerning the manner in which gas is transported and stored in the shales.