A Petrophysical Model of the Jurassic Abenaki Carbonates at Deep Panuke Gas Field - Offshore Nova Scotia: Integration of Logging-While-Drilling (LWD), Wireline Log, and Core Data

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ABSTRACT

At Deep Panuke, exploration and subsequent delineation wells drilled on a Jurassic carbonate complex have penetrated a major gas pool discovery in the Baccaro Member of the Late Jurassic Abenaki formation. This major reef trend complex extends from Eastern Canada to the Bahamas.

Operational considerations and the geology of the Abenaki, featuring a complex diagenetic porosity history of dolomitization and dissolution, led to the introduction of comprehensive LWD techniques, backed up by wireline, for drilling and evaluating these exploration and delineation wells offshore Nova Scotia. Furthermore, the dolomitized/leached carbonate rock fabric motivated the application of a dual porosity, complex lithology model built on sonic, density, photoelectric, neutron, resistivity, borehole image logs and standard and special core data.

To maximize model robustness, limitations of and measurement environment differences among LWD, wireline, and core data are reconciled as much as possible in the data acquisition program and model design. The model employs the response difference of sonic and nuclear porosity logs to vug dissolution pores in rock that otherwise exhibits an intergranular / intercrystalline pore fabric response. The resulting dual porosities set up a variable “m” (cementation exponent) relationship to describe water saturation on the resistivity. Gas effects on nuclear porosity logs identify gas-bearing intervals. Sequence stratigraphy and petrophysical core data provides control on model lithology and porosity end points. Production test data ultimately provides control on fluid and permeable zone identification.

Across seven wells, the Abenaki gas pool reservoir rock exhibits complex dolomite and limestone lithology where rock pore fabric and corresponding petrophysical properties are dominated by a heterogenous spatial distribution of diagenetic and dissolution porosity features. Porosities range from 3 - 40+ % with permeabilities of one millidarcy to several darcies, and net gas pay intervals ranging from 30 to 100 metres.