An Integrated Fault Seal Study of the Hebron/Ben Nevis and Terra Nova Oilfields, Offshore Newfoundland

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ABSTRACT

Fluid flow in faulted reservoirs is commonly difficult to predict prior to bringing a field to production. Seismically mapped and sub-seismic faults can act as fluid conduits, baffles and/or barriers on a production and geologic time scale. Risk assessment, economics, field development and exploration strategies require a model capable of explaining and predicting fault-related permeability heterogeneity in the reservoir. Integrated fault seal and fault population analysis can provide such a model.

The Hebron/Ben Nevis and Terra Nova oilfields, in the Jeanne d'Arc Basin, offshore Newfoundland are characterized by the presence of numerous seismically-mapped faults that partially to completely offset the reservoir intervals. Fault seal analysis was performed on selected faults in each field to ascertain the sealing behaviour of key faults and to test the utility of the Shale Gouge Ratio (SGR) method for predicting fault seal in both reservoirs. The structural components of this analysis, including juxtaposition mapping and SGR calculation, were performed using FAPS (Fault Analysis Projection System) software. These data were supplemented by oil-water contact, oil geochemistry, oil PVT, static oil pressure gradient, fault rock property and reservoir geohistory information. Fault population analysis, based on seismically mapped faults and a core-based structural study, was also performed on both fields.

Preliminary results of this study suggest that both fields contain sealing and non-sealing faults. Offset oil-water contacts, across-fault differences in oil composition and disparities in oil pressure gradients between adjacent fault blocks are indicative of the presence of sealing faults. The utility of the SGR method for predicting fault seal is variable, and was found to be particularly poor for faults in the Hebron/Ben Nevis Field. Core from both fields exhibit low densities of micro-faults (<10cm throw) and fractures, with no major fault surfaces cored in either field. Micro-faults sampled from the Terra Nova cores have been shown to reduce fault-orthogonal permeability in sandstones by up to two orders of magnitude.