Strata, structure and selected petrophysical and source rock properties for the Winterhouse Formation, Port au Port Peninsula, Newfoundland and Labrador

Proponents: Joe MacQuaker and Elliott Burden

(a) Joe MacQuaker - formerly Department of Earth Sciences, Memorial University (since 2012, Exxon-Mobil, Houston TX)

(b) Elliott Burden Department of Earth Sciences, Memorial University

Outline: In western Newfoundland, fine-grained, organic carbon-rich sediments (black shales) are emerging as exploration targets for hydrocarbon source rocks and unconventional shale gas plays. In spite of their similar visual appearance, recent research reveals that there are subtle differences manifested by strata exhibiting systematic differences in grain size; containing widely varying proportions of particles delivered to the basin and produced within the basin - i.e. different varieties of organic matter types (Type I, II and III kerogen); strata organized into a variety of graded beds with different laminae styles; and different pre-compaction cements (variously composed of pyrite, carbonates, silica and clay minerals). This results in these rocks being classifiable into very different lithofacies types and exhibiting highly variable source rock / shale gas reservoir qualities. In the context of these units being potential source rocks, these lithofacies differences may show successive strata, even within the same shale succession, exhibiting highly variable source properties and, where beds are being considered as potential shale gas reservoirs, rocks may have different susceptibilities to fracturing and adsorbed gas capacity. All of this affects exploration and production strategies.

In western Newfoundland most of the unconventional petroleum exploration activity has been directed towards the organically enriched Cow Head Group (Green Point Formation) mudstones. There are, however, other potential source intervals in the region and including the Winterhouse Formation, the lateral equivalent of the prolific Utica Formation in Quebec and in the Central Appalachian Basin (USA).

The aim of this proposal is to determine a detailed lithofacies variability in the Winterhouse Formation, to compare this variability with that in the Utica Formation in Quebec and elsewhere (e.g. Central Appalachian Basin), and provide an opinion on the suitability of the Winterhouse Formation as a source rock / shale gas reservoir rock / shale oil resource.

Currently, because these rocks are assumed to be largely homogenous, the strategies for determining the source potential of a particular unit is mainly treated as a “geochemistry problem”, with the differences in lithofacies not being considered a significant factor for understanding the controls on source rock quality. Similarly differences in lithofacies are not considered to particularly influence shale gas reservoir attributes. Geological processes however, play a profound role controlling: (a) the volume of hydrocarbons generated; (b) the composition of the hydrocarbons generated, (c) primary migration pathways, (d) how the rock will behave if it is going to be fractured and (e) distribution of porosity. As we now know that these attributes cannot be considered to be “constants”, thus it is extremely important that we have a better understanding of both the lithofacies and organic matter variability in these units to predict the distribution of potential source rock characteristics and shale gas sweet spots.

Knowledge of the spatial and temporal distributions of these attributes can be gained from detailed lithofacies analyses utilising microscopic methods (optical, spectroscopic and electron optical analyses of thin sections prepared from these materials), combined with geochemical analyses of black shales. Using a combination of these techniques to obtain these data is very important, because it is necessary to have both microtextural and compositional information available to determine lithofacies and organic matter variability. Once these attributes are known then facies models in source rocks / shale gas / shale oil systems can be produced and the spatial and temporal distributions of likely source intervals / sweet spots identified. Such information is a vital component of assessing the petroleum systems in western Newfoundland

To this end we propose to identify the lithofacies of the Winterhouse Formation, measure petrophysical and geochemical variability, and compare this with the lithofacies and geochemical variability in the Utica Formation in both Quebec and in the Central Appalachian Basins. The work will characterise bedding thicknesses, examine porosity and permeability, explore the origin of the constituent components and the location of the silica, carbonate and organic matter (specifically whether these mineral and organic components are in the detrital fraction as granular materials, produced by primary production in the basin, or generally dispersed throughout as cements and lower quality source rock).