Provenance, Distribution and Prospectivity of Potential Shale Gas Units in the Deer Lake and Bay St. George Basins, Western Newfoundland

Unconventional petroleum reserves are increasingly seen as critical components of oil and gas exploration programs around the world. Western Newfoundland has several prospective shale intervals in the Deer Lake and Bay St George Basins that are potential reservoirs of shale gas. There has been little detailed work on these units but they seem to have similarities to producing shale gas resource plays elsewhere such as the Barnett Shale of Texas. Onshore exploration in western Newfoundland may be seen as more attractive if there was a better understanding of the origin, distribution and characteristics of the shale gas units, and parallels could be drawn with successful plays such as the Barnett Shale.

This project will determine the chemical and isotopic composition of the bulk clay fraction and the composition and age of the detrital minerals in the shales in order to determine the source terranes from which they were derived. This will allow us to reconstruct the transport directions of detritus into the Deer Lake and Bay St. George Basins, and predict where the thickest intervals of the shales might now be encountered. The Barnett Shale is divided into "core" (thicker) and "non-core" (thinner) areas, and the core areas have lower production costs. We will also "map" the micron-scale permeability of the shales in thin sections to evaluate in which intervals gas might be most easily removed from along fractures. All of the data sets provided in the study would also be useful for exploration programs of conventional oil plays in that the shales could also represent the source rocks for sandstone reservoirs in these basins.

The focus will be on Carboniferous shales and interbedded clastic rocks from the Deer Lake and Bay St. George Basins. In the Deer Lake Basin, the shales of interest are in (from oldest to youngest) the 45 Brook Formation, Saltwater Cove Formation and the Cape Rouge Formation of the Anguille Group, the Rocky Brook Formation of the Deer Lake Group, and the Howley Formation (Martin, 2009). In the Bay St. George Basin, prospective shales are in (from oldest to youngest) the Snake's Bight Formation of the Anguille Group, the Highlands and Mollichignick Members of the Codroy Group, and associated with unnamed coal measures in the Barachois Group (Hicks, 2009). Samples will be collected from onshore exposures and drill cores from the core storage facility administered by the DNR Energy Branch.

Samples will be treated as follows:

1. Thin section analyses

- Two polished thin sections will be made from each sample including one highlighting typical clay rich material and a second emphasizing more sandy components

- The texture and amounts of visual kerogen of the samples in the thin sections will be described and estimated using an optical microscope

- The micro-permeability of each sample will be determined by mapping the distribution and abundance of pore space in the thin sections using the scanning electron microscope-mineral liberation analyzer (SEM-MLA)

This data (along with TOC below) will be used to evaluate the prospectivity of the intervals for gas plays or as sources for conventional oil plays. Comparisons will be made to similar shale gas units elsewhere (Barnett Shale, Texas; Antrim Shale, Michigan; Utica Shale, Quebec; Muskwa Shale, B.C.; Horton Bluff Shale, Nova Scotia).

2. Bulk silt and clay analyses

- The remaining material will be gently crushed and sieved into a silt and clay fraction (less than 50 microns) and a fine sand fraction (50 to 175 micron fraction), and the proportions of each, and the coarser fraction (>175 micron) will be determined by weight

- An aliquot of the silt and clay fraction from each sample will be analysed for total organic carbon (TOC), major and trace elements, and following column separation in high-purity acids, Sm-Nd isotopes and Pb-isotopes

3. Grain mount analyses

- The fine sand fraction will be subsampled for statistical representativeness using a microriffler, the heavy minerals will be separated using heavy liquids, and the material will be poured into epoxy mounts

- The mineralogy of the mounts will be determined by SEM-MLA, mineral abundances will be tabulated and representative images of each mineral type will be made using backscattered electron detector on the SEM

- The major element compositions of representative grains of feldspars and the heavy minerals present (zircon, monazite, tourmaline, garnet, chromite, apatite, rutile) will be determined by electron microprobe analysis (EPMA)

- Trace element compositions of the same representative grains will be determined by laser ablation inductively coupled mass spectrometry (LA-ICPMS)

- Uranium-(thorium)-lead ages of the zircons and monazites will be determined by LA-ICPMS

- Lead isotopes of the feldspars and tourmalines and Sm-Nd isotopes of the monazites and apatites will be determined by LA-multicollector (MC) -ICPMS

The data from the bulk silt and clay and the grain mounts will be used to evaluate the source terranes from which the shales were derived, by matching the chemical, isotopic

and age of the detritus in the shales to the characteristics of potential basement rocks in the region. With this information, and an understanding of the paleogeography, the direction of transport of detritus into the Deer Lake and Bay St. George Basins will be modeled, and areas of thick accumulations of the shales will be predicted.