

Lower Paleozoic Petroleum Systems in the Canadian Arctic

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Six geological episodes control the hydrocarbon potential of the lower Paleozoic. 1) deposition of Cambrian to Ordovician shelf carbonates and evaporites; 2) step-back of the shelf margin and deposition of widespread Silurian shale; 3) north-south folding of the Early Devonian Boothia Uplift; 4) progradation of the Mid to Late Devonian clastic wedge in front of the advancing Ellesmerian orogenic belt; 5) folding and thrusting of the Late Devonian-Early Carboniferous Ellesmerian Orogeny; 6) rifting and deposition of the Carboniferous to Cretaceous Sverdrup Basin.

Thick potential source intervals occur in Silurian shales. The total organic carbon content can be >2% over 300 m, with intervals of >4 % TOC common. Rock-Eval pyrolysis indicates oil-prone, Type II kerogen.

Maximum burial (and maximum hydrocarbon generation) in most areas occurred during the advance of the Devonian clastic wedge. The thermal maturity of specific horizons is complicated, with high maturity in the west, central, and northeast parts of the islands, but decreasing thermal maturity towards the southern edge of the Sverdrup Basin (i.e., northward).

Maximum burial occurred before the folding and faulting in the Late Devonian. Hydrocarbon migration appears to have occurred before trap development over much of the Arctic. Also, the old age of hydrocarbon generation means that most hydrocarbons have likely been lost due to leakage or degradation. Only evaporites will form an effective seal over this length of time.

Two hydrocarbon plays are envisaged. The first occurs on eastern Bathurst Island. In this area, the Eleanor River Formation was folded into N-S trending folds during the Early Devonian Boothia Uplift. The Eleanor River Formation is overlain by thick evaporites of the Bay Fiord Formation. If porosity occurs within the Eleanor River Fm., then hydrocarbons generated during Late Devonian burial of Silurian shales on western Bathurst Island could have migrated into these pre-existing folds and have been preserved by the salt seal.

The second play occurs on the Sabine Peninsula on northeastern Melville Island, Cameron Island, and an unknown distance below the Sverdrup Basin to the north. The Devonian clastic wedge was thin in this area and the Silurian shale retained a low thermal maturity with most of its hydrocarbon-generating potential intact. Burial by sediments of the Sverdrup Basin may have been sufficient to drive Silurian strata back into the oil or gas window. This second hydrocarbon charge could be held in traps within the lower Paleozoic succession or in upper Paleozoic and Mesozoic traps.