Hydrocarbon Reservoir Evaluation in Triassic-Jurrasic Strata in the Western Sverdrup Basin, Canadian Arctic Islands

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Abstract

The western Sverdrup basin is a petroliferous basin in the Canadian high Arctic, in which 17 oil and gas fields were discovered from 1969 to 1986 (Embry, 2011; Chen et al., 2000). Almost all discovered oil and gas fields of the basin (Fig.1) occur in Triassic-Jurassic strata and are sourced by primarily by oil-prone, bituminous shale of Middle and Late Triassic age (Embry, 2011), and a deeper source rock has been suggested for the gas accumulations found in Drake and Hecla gas fields (Dewing and Obermajer, 2011). The main reservoirs consist primarily of shallow marine sandstones in the Upper Triassic-Lower Jurassic Heiberg Group, Mid-Upper Jurassic Awingak Formation and the sandstones in the Schei Point Group of Mid-Upper Triassic succession, as well as the sandstones of the Bjorne Formation of Lower Triassic succession (Fig.2). In this study, the reservoir characteristics of Triassic-Jurassic sandstones are studied using core measurements (Hu & Dewing, 2010) and through petrophysical analyses of well logs. Cross sections are constructed by a combination of well logs, estimated petrophysical parameters, core analysis and well test results, illustrating the reservoir properties in tested hydrocarbon zones and identified potential intervals. Data analysis suggests that the Triassic-Jurassic strata contain large volumes of sandstone reservoirs that display a variety of porosity and permeability characteristics. This study will provide key petrophysical parameters for further hydrocarbon resources assessment.

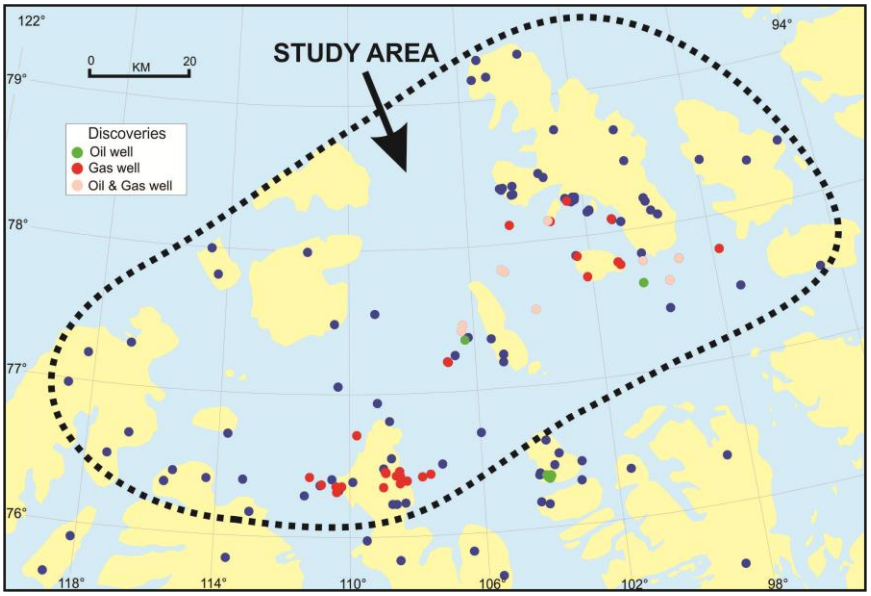

Figure 1: The main prospective areas for hydrocarbon fields in Triassic-Jurassic strata in the western Sverdrup basin

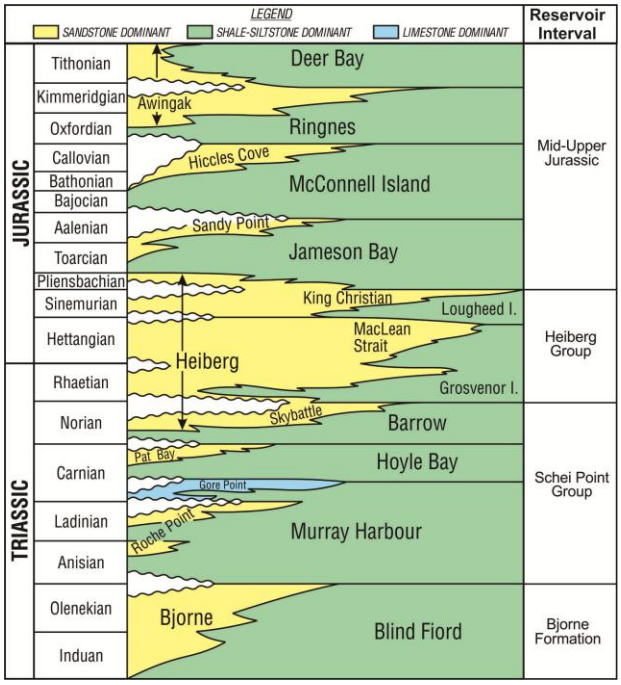

Figure 2: Triassic-Jurassic stratigraphy and reservoir intervals in the western Sverdrup basin, modified from Embry (2011).

Core petrophysical data

In the Triassic-Jurassic succession of the western Sverdrup basin, 3474 core samples (3417 core samples from sandstones; 57 samples from siltstone and conglomerate) were subject to conventional core petrophysical analysis, including porosity, permeability, grain density, residual water and oil saturation. About 72% of the samples are from Heiberg Group. Core porosity and permeability distributions show that most of the reservoirs have porosity values between 10% and 25% with a wide range of permeability values from 0.1 md to 1000 md (Fig.3). Core analysis indicates that, of the four reservoir intervals, sandstones in the Triassic-Jurassic Heiberg Group exhibit highest porosity and permeability. Figure 4 shows the relationship between core porosity and permeability for all samples in the study area.

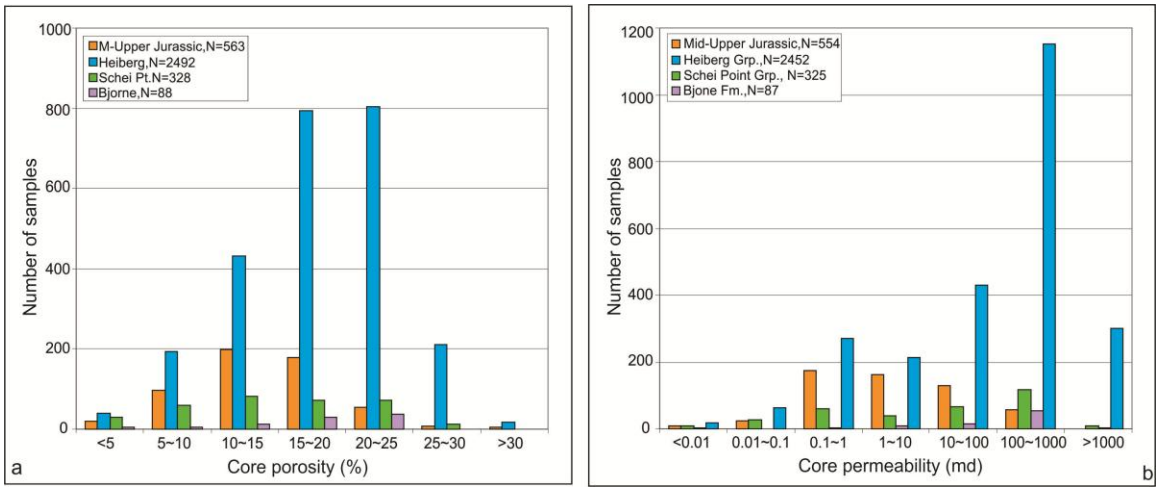

Figure 3: Histogram plots show distributions of core porosity (a) and permeability (b) for all analyses core samples for different reservoir intervals in the western Sverdrup basin.

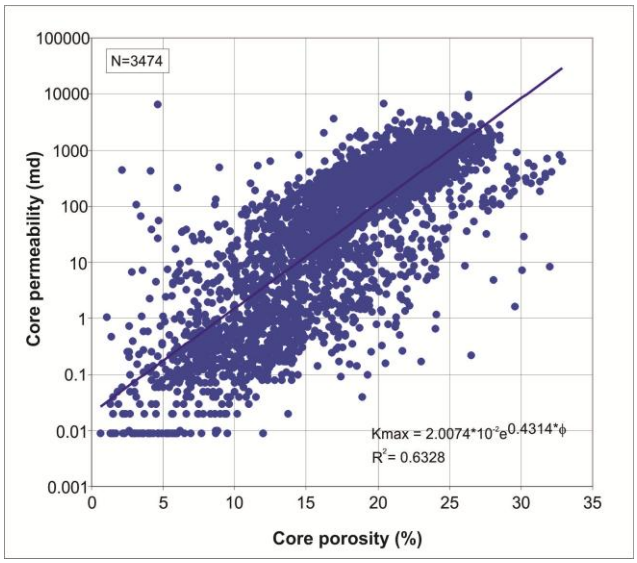

Figure 4: Core permeability versus core porosity for all samples in the western Sverdrup basin.

Reservoir Characterisation

Petrophysical studies include determinations of lithology, porosity, permeability and water saturation for reservoir intervals. Calibrated with core data and test results, the estimated petrophysical properties, such as porosity, permeability and water saturation from logs provide a basis for the inference of potential hydrocarbon pools and the parameters for resource evaluation. Based on select porosity and water saturation cutoff values (ϕ>10% and Sw<55%), possible hydrocarbon reservoirs are identified. The petrophysical evaluation indicates that sandstone reservoirs with fair to good porosity and permeability occur mostly in Mid-Upper Jurassic succession (Fig.5); Heiberg sandstones have the best overall reservoir quality in the study area (Fig.6); fair porosity and relatively lower permeability hydrocarbon zones occur in Schei Point Group (Fig.7) and Bjorne Formation, which are consistent with the core study and well test.

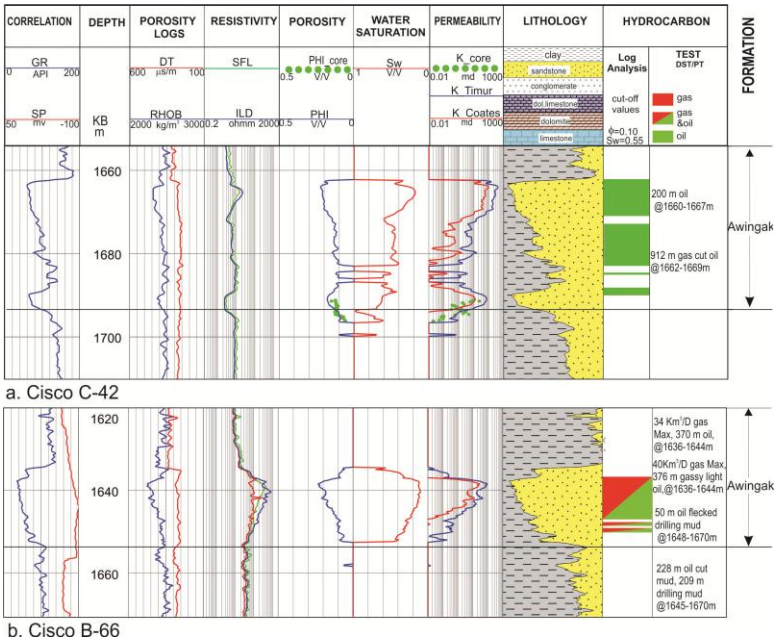

Figure 5: Log analysis result for Awingak Formation of Mid-Upper Jurassic reservoir interval For oil well Cisco C-42 and oil and gas well Cisco B-66 in the western Sverdrup basin.

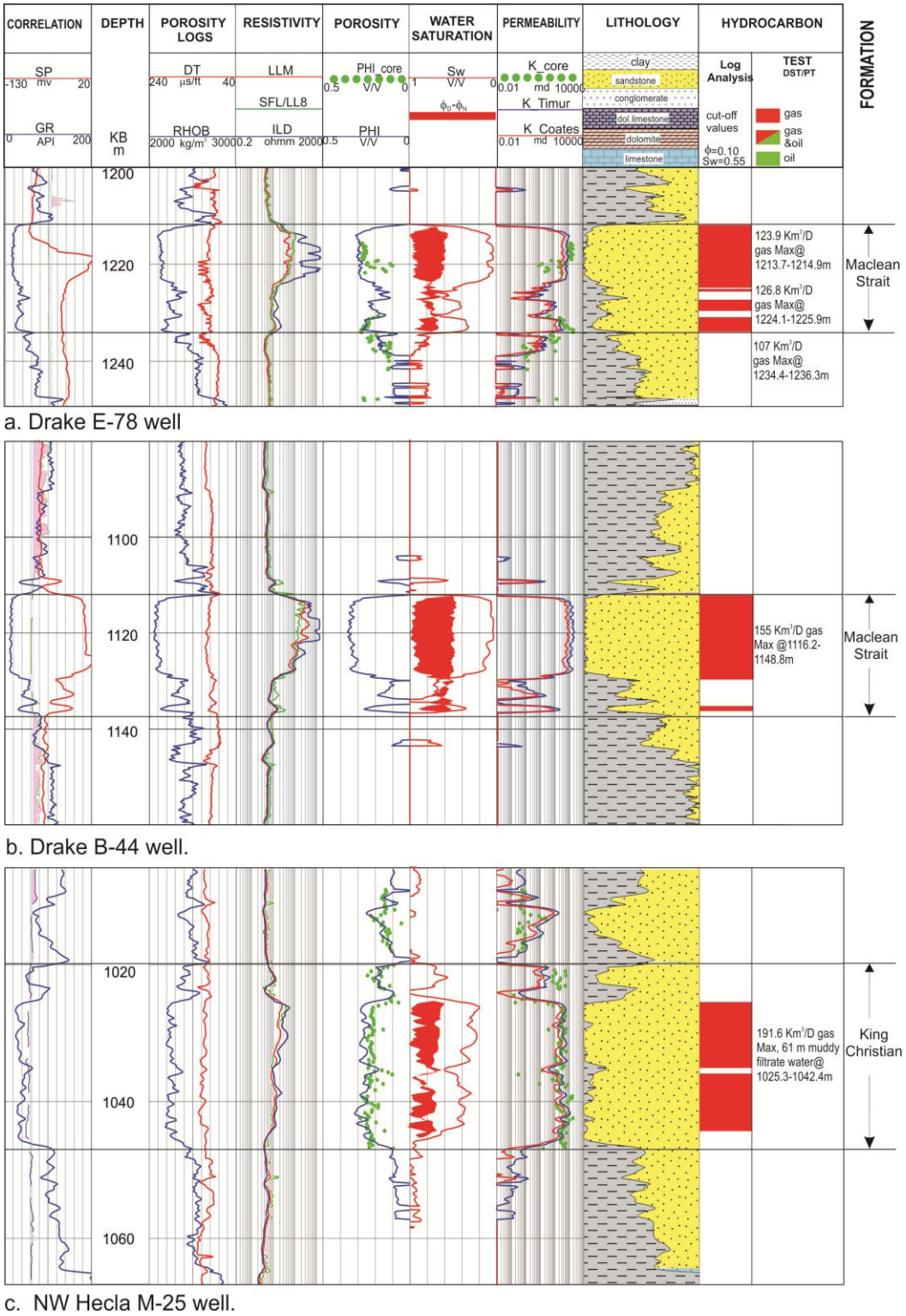

Figure 6: Typical gas zones are identified from log analysis for King Christian Formation of Heiberg Group, exhibiting excellent porosity and permeability, and high hydrocarbon saturation, in the Drake gas field and Hecla gas field of western Sverdrup basin.

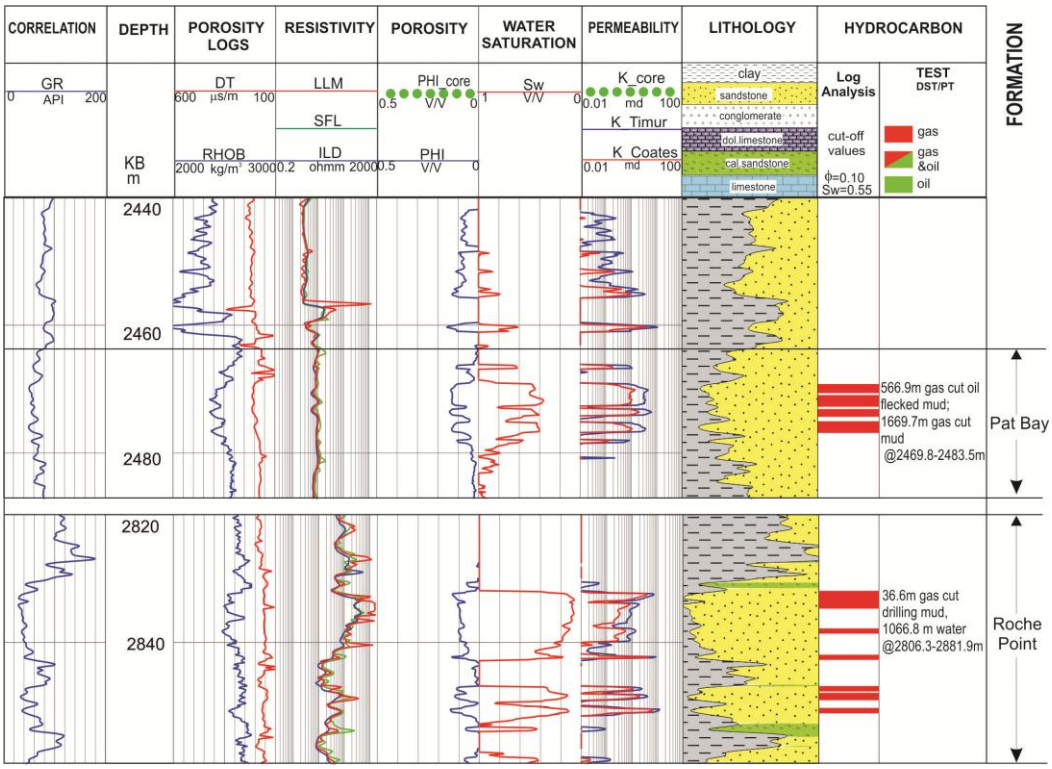

Figure 7: Example to show the petrophysical properties and identified hydrocarbon zones for Pat Bay Formation and Roche Point Formation of Schei Point Group in Roche Point O-43 well of the of western Sverdrup basin.

Acknowledgements

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