The Lower-Middle Devonian of Mackenzie River Corridor: sequence-stratigraphic updates from core studies

P. Kabanov, Geological Survey of Canada (Calgary),
Pavel.Kabanov@nrcan-rncan.gc.ca

Introduction

The Lower and Middle Devonian of the central and northern parts of the Mackenzie River Corridor contains one giant conventional oil play (Norman Wells) and numerous oil and gas shows in breccias, dolostones and limestones. In this succession, the Muskwa-Canol Member hosts the region's major Paleozoic prospect for shale gas. The package also contains significant shale-gas prospects in the Bluefish and Headless shales (Hannigan et al., 2009). Long-standing uncertainties in formation relationships and sequence boundaries urge improvements in regional sequence-stratigraphic framework as a critical step towards more successful exploration for both conventional and non-conventional hydrocarbon resources. One key step is the revisiting of wells with representative core coverage such as Kugaluk N-02 of Inuvik Area (Fig. 1).

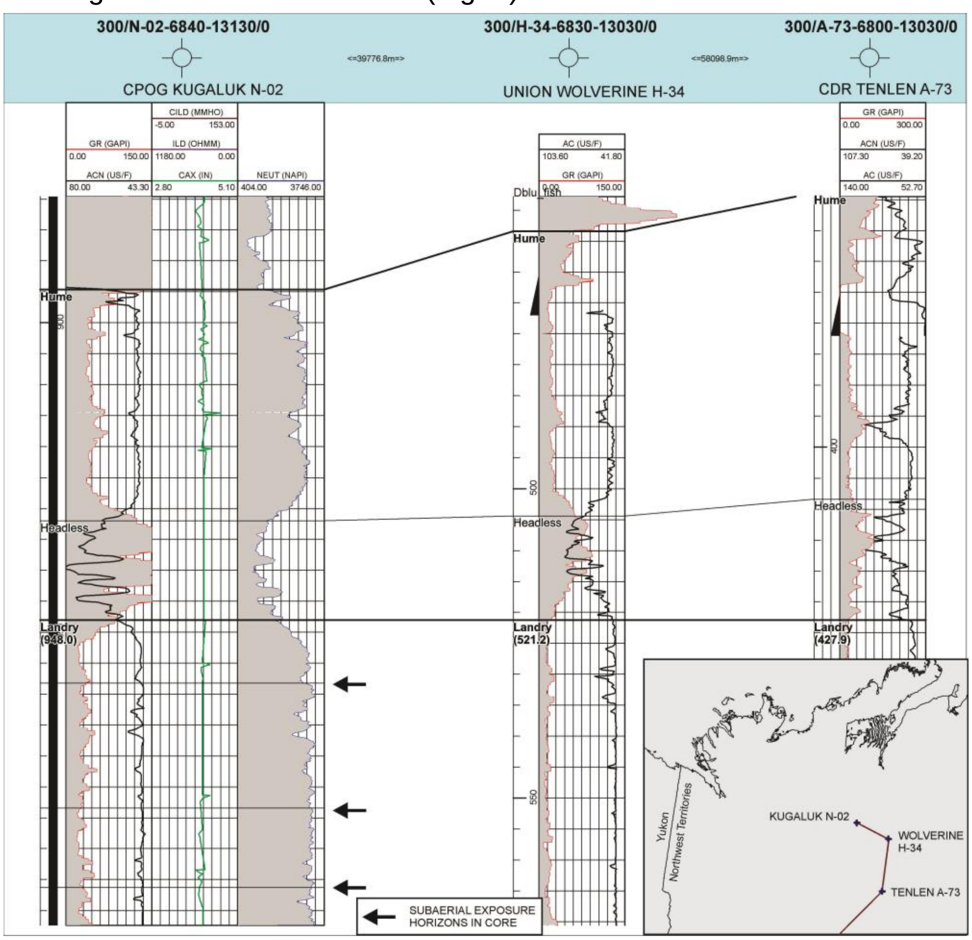

Figure 1: Upper Landry - Hume interval in Kugaluk N-02 well with complete core coverage and its correlation with two other wells; note three upper subaerial disconformities in Landry Formation.

Methods and materials

The core studied to date (over 600 m in total) comes from the Kugaluk N-02, Maida Ck F-57, Norman Wells P32X, Devo Ck P45, and Imperial Bear Island R34X wells, all drilled in the 1960s to 1990s. This core is housed at the NEB Core and Sample Repository at the Geological Survey of Canada in Calgary. The sub-mm scale structures (Figs. 2 & 3) were more adequately revealed by grinding slabbed core surfaces with 35 µm silicon carbide powder (grit 400) and subsequent etching by 10% HCl for 1-2 seconds. A range of methods (Rock-Eval, oxygen isotopes, thin sections, and ESEM-WDS observations) are being applied to obtain a more comprehensive understanding of the facies patterns, sequence surfaces and packages.

Results

Examination of continuous core from Kugaluk N-02 (Fig. 1; northern Anderson Plain) and representative cores from Norman Wells area provide new insight into facies patterns and boundaries of the Landry, Hume, Bluefish, Hare Indian, Ramparts, and Canol formations. Numerous previously unknown subaerial disconformities bounding meter-scale peritidal cycles are discovered within the Landry; whereas, the Landry/Headless, Headless/Hume, and Hume/Canol boundaries appear to be conformable. The Landry succession is a cyclic repetition of shallow-subtidal limestones, thick tidal-flat laminites, and non-marine, supposedly palustrine, micritic limestones. The Landry Fm. (948-1164 m MD) contains 35 simple and composite subaerial disconformities. The most developed vadose alteration profiles extend to depths of 3-4 meters below the disconformity surfaces. Amplitudes of sea-level fluctuations should have exceeded 10 m as indicated by the characteristics of the peritidal cycles within the Landry. This spectacular cyclic pattern does not yield distinctive highly-serrated log signatures, but the caliper seems to show sensitivity to karst breccias (Fig. 1). The Hume Formation. at Kugaluk N-02 represents a lower-ramp argillaceous and apparently conformable limestone succession that grades down into the deeper water calcareous shales of the Headless Member. (tempestites, *Zoophycos* and *Chondrites* traces). In the Norman Wells area, the abrupt top of the Ramparts limestone is a “drowning disconformity” with no evidence for shoaling or subaerial exposure (Fig. 3C; Norman Wells P32X). In the Imperial Bear Island R34X, the 54 m long core penetrating the Carcajou Member of the upper Hare Indian Formation and the basal Ramparts Formation, records the presence of a conformable succession with very gradual upward trend of shallowing and cleaning (argillaceous to non-argillaceous limestones). Data presented here concur to the model of the Ramparts/Kee Scarp carbonate platform evolution and its stratigraphic relationship to the Canol black shale published by Muir et al. (1984). Certain modifications to the interpretation of the regional sequence stratigraphic framework will likely result from the acquisition of new data.

Acknowledgements

This work is part of the Mackenzie Delta and Corridor project (EGM-003, GEM Program). I am grateful to Robert B. MacNaughton for promoting this study and Barry C. Richards for reviewing this paper.

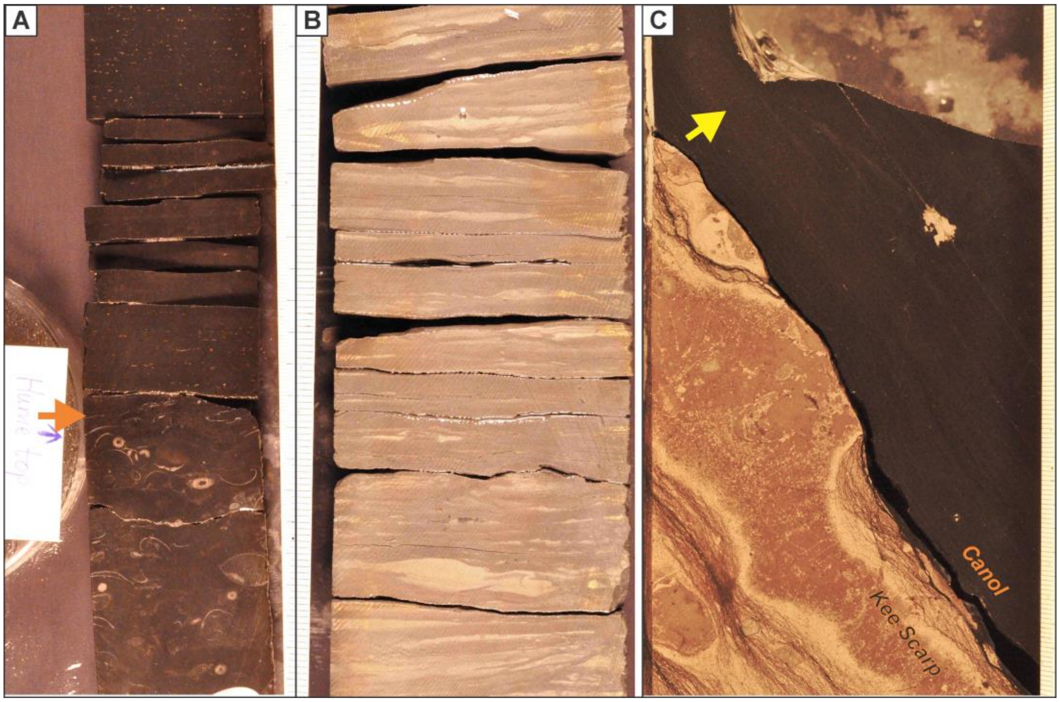

Figure 2: Shale units and their contacts with limestones: (A) Apparently conformable contact of Hume limestone and Canol/Bluefish black shale in Kugaluk N-02 (contact arrowed); (B) laminated calcareous shale of Headless Member (distal tempestite) deposited in lower ramp setting; (C) Ramparts (Kee Scarp) - Canol contact in Norman Wells P32X directional well; yellow arrow shows stratigraphic up.

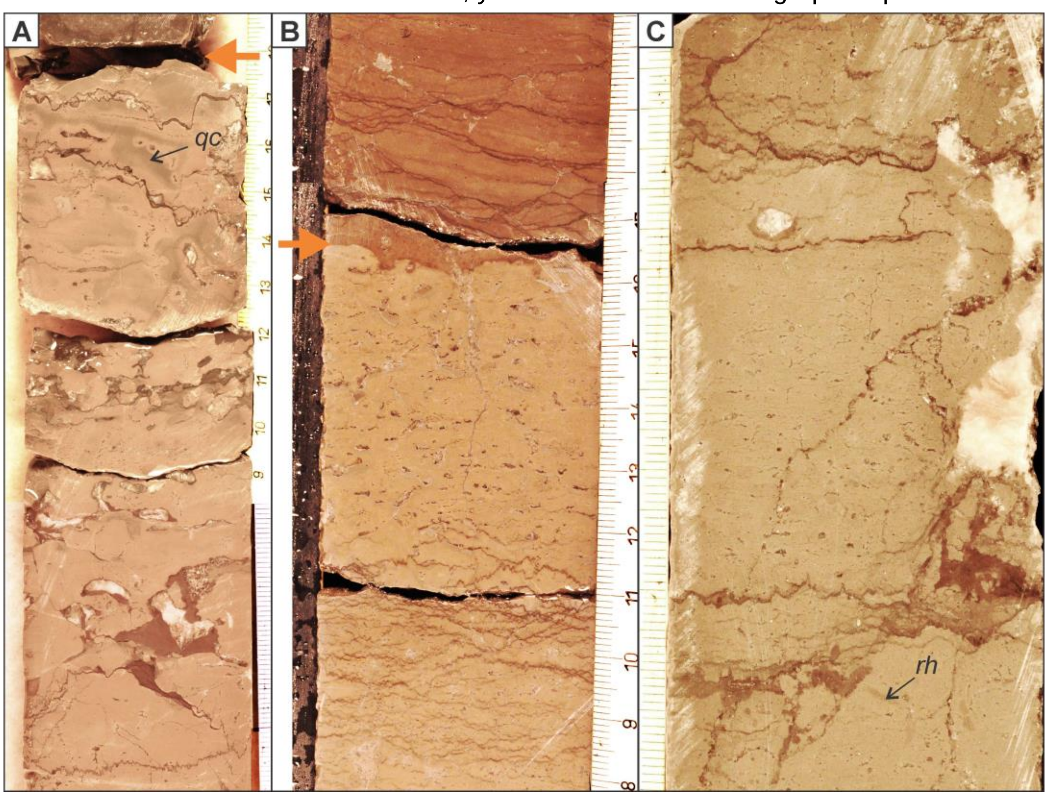

Figure 3: Disconformities (A, B; arrowed) and palustrine limestone (C) in Landry Limestone of Kaugaluk N-02: (A) Stylolitized karst breccia with extensive quasicoatings (qc) and geopetal shale in caverns, some core in top is missing, 978.3 m MD; (B) An erosional surface over a finely karstified calcimudstone (vugs may have developed upon primary fenestrae), 1062.5 m MD; (C) A microbrecciated non-marine calcimudstone with rounded glaebules, chambers, and probably rootlet penetrations (rh), 1058.0 m MD. The ruler is in centimeters and millimeters.

References

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