

# Introduction

The Hudson Bay and Foxe Basins Project is in its third year. It is part of the Geological Survey of Canada Geo-mapping for Energy and Minerals (GEM) program, whose energy side aims to study the hydrocarbon potential of these Phanerozoic sedimentary basins. In Manitoba, the Hudson Bay Basin is represented by the Paleozoic carbonate succession of the Hudson Bay Lowland (HBL) in the northeastern corner of the province (Figure 1). Project activities this year included core logging and collecting samples for various laboratory analyses, including biostratigraphy and organic geochemistry.

# Core logging

This summer the Manitoba Geological Survey (MGS) completed the examination of all the available exploration cores from the HBL. Previously logged cores were re-examined for the presence of thin oil shale intervals, and sampled for geochemical and biostratigraphical analysis. High resolution photographs of all the cores were taken to create a photographic log.

Preliminary results from the core logging indicate a complex stratigraphy. Stratigraphic correlations are challenging primarily due to the long distances between cores, as well as complex relationships, including facies changes and pinch out of formations. It is also challenging to correlate modern core descriptions with older outcrop descriptions. Biostratigraphy is used to help decipher some stratigraphic issues.

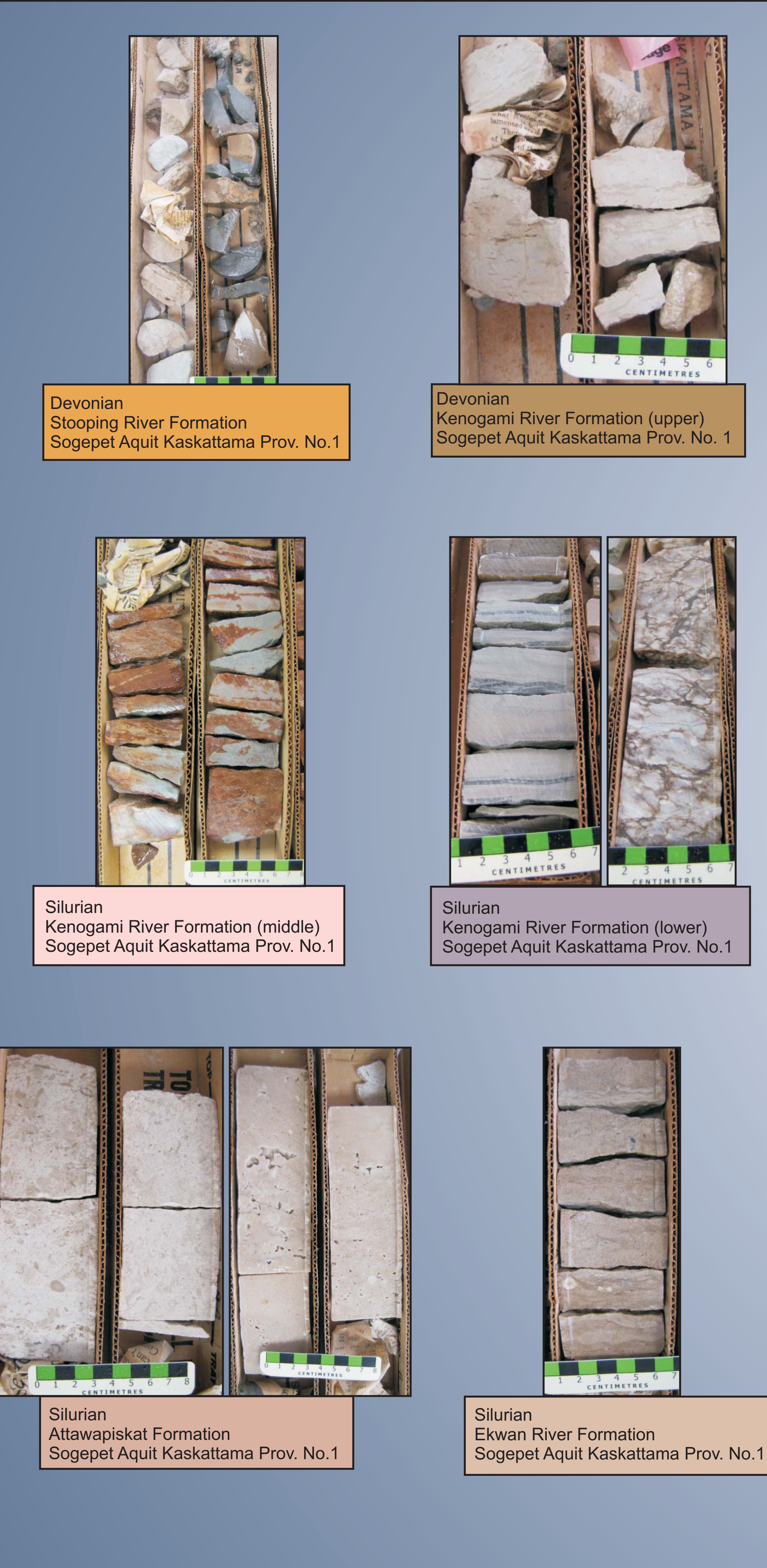
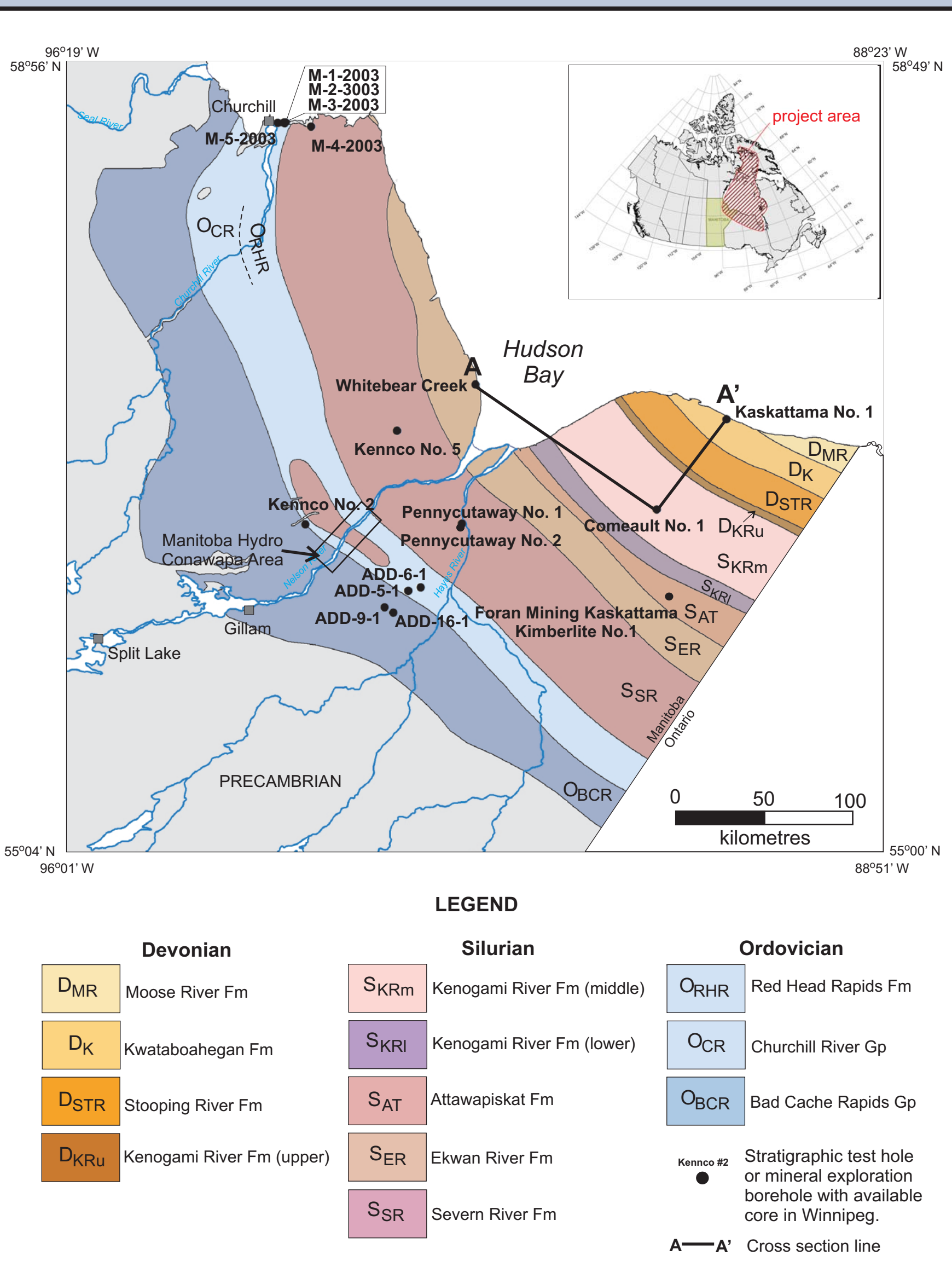
Of significance, is the discovery of potential oil shale intervals in the Ordovician Red Head Rapids Formation (Figure 2) and the Silurian Severn River and Attawapiskat formations in core. Hydrothermal dolomites have been identified in the core M-4-2003 (Figure 3; Lavoie et al. 2011) near Churchill, Manitoba, with another potential occurrence in the Silurian section of the Comeault No. 1 core.

# Stratigraphy & Structure

Attempting to develop a solid stratigraphic framework for the entire Hudson Bay Basin is a challenge, particularly considering this frontier basin covers 600 000 km<sup>2</sup>. As part of this GEM project team, the MGS is focusing on the stratigraphy of the HBL region in Manitoba. The development of Manitoba's HBL stratigraphic column have been by correlating lithostratigraphy, chemostratigraphy and biostratigraphy information from various sources, spanning decades of work, and logging of available core by the authors (Nicolas and Lavoie, 2010; Nicolas, 2011). Figure 4 shows the current stratigraphic column used in the Manitoba HBL.

Figure 5 shows stratigraphic cross-section AA' through the three onshore oil wells in Manitoba and displays the variability in thickness of the formations over a distance of 200 km.

The Ordovician formations as a whole show little variability in thickness towards the basin's centre. In comparison, the Silurian formations, particularly the Severn River Formation, show tremendous thickening in the same direction. This is indicative of increased sediment productivity in the Silurian compared to the Ordovician, which translates to an increase in sediment load and downwarp of the basin during this time. This is evident in the structural cross-section (Figure 6) through the same oil wells that show a pronounced northeastern dip towards the centre of the basin. These conditions are favourable for the basin to have undergone enough burial and heating for source rocks to pass through the oil window.



# Hudson Bay Lowland Paleozoic Stratigraphy

Period	Series	System/ stage	Hudson Bay Lowland northeastern Manitoba	
DEVONIAN	Lower	Eifelian	Couvinian	Moose River Formation
		Emsian	Dalejan Zlichovian	Kwatabohegan Formation
		Siegenian	Pragian	Stoooping River Formation
	Gedinnian	Lochkovian		
	SILURIAN	Lower	Pridolian	Kenogami River Formation
Ludlovian				middle
				lower
Upper		Wenlockian	Attawapiskat Formation	
			Ekwon River Formation	
	Llandoveryian	Severn River Formation		
ORDOVICIAN	Upper	Gamachian	Red Head Rapids Formation	
		Richmondian	Churchill River Group	Chasm Creek Formation
		Maysvillian		Caution Creek Formation
	Carabodocian	Edenian	Bad Cache Rapids Group	Surprise Creek Formation
				Portage Chute Formation
			Member 2	
			Member 1	
PRECAMBRIAN				

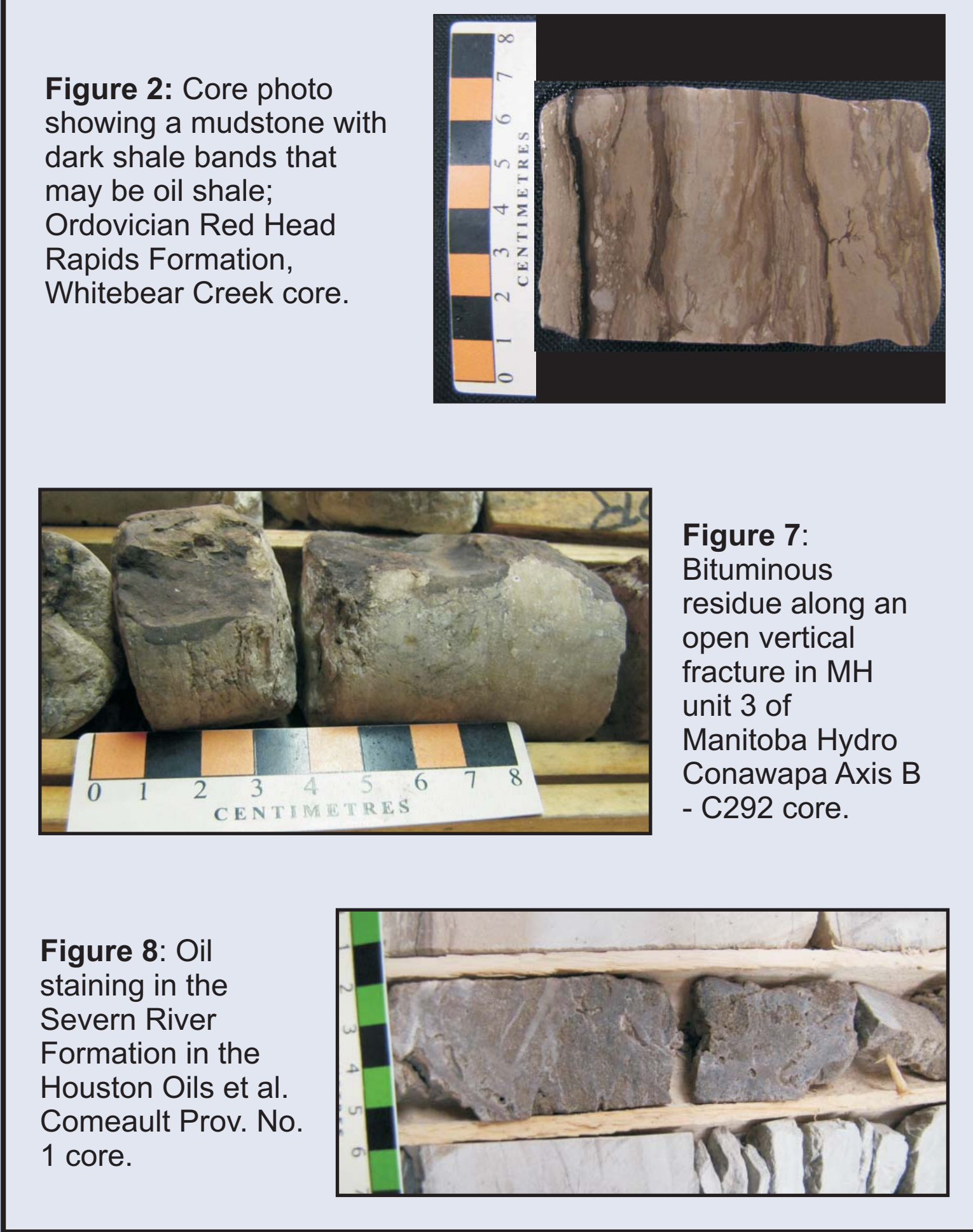
Figure 4: Stratigraphy of the Hudson Bay Lowlands, with correlations to the Manitoba Hydro units; Ordovician System/Stages from Zhang and Barnes (2007) and Silurian System/Stages from Norris (1993); photographs from most of the formations are shown.



# Hydrocarbon systems evidence

Evidence for a hydrocarbon system, such as bituminous residues and oil staining were found. In some cores, bituminous residues are present along open fractures, as shown in Figure 7. Oil staining in the Comeault No. 1 core was also found, and is shown in Figure 8. These bituminous residues and oil staining indicate that a hydrocarbon system was active at a poorly constrained stage of basin evolution; however, whether hydrocarbons were locally produced or have undergone long-range migration from the centre of the basin is uncertain. Bituminous residues were identified in most of the cores examined, and samples of the Conawapa cores, Comeault and Whitebear cores have been sent for Rock Eval™ analysis.

Identification of mature source rocks is key to a having a hydrocarbon system, and have been identified in other parts of the basin. Figure 2 shows a potential oil shale in the Red Head Rapids Formation in the Whitebear Creek core. Samples of the oil shale intervals were sent for Rock Eval™ analysis for confirmation; results are pending.



# Economic considerations

A good comprehension of the stratigraphy of the HBL and how it correlates and changes across the basin is critical in understanding the geological evolution and, in turn, the economic potential of the Hudson Bay Basin. New biostratigraphic data are being acquired and will help resolve stratigraphic correlations, whereas organic geochemistry will help characterize potential hydrocarbon source rocks.

A modern synthesis and solid understanding of the architecture and nature of potential hydrocarbon systems of the Hudson Bay and Foxe basins aims to promote hydrocarbon exploration in this region. Manitoba's primary advantage is that it manages the only deepwater port in northern waters at Churchill. Exploration activities resulting in hydrocarbon production, development and related infrastructure would therefore provide a source for significant economic growth and stimulus in northern Manitoba.

# Acknowledgments

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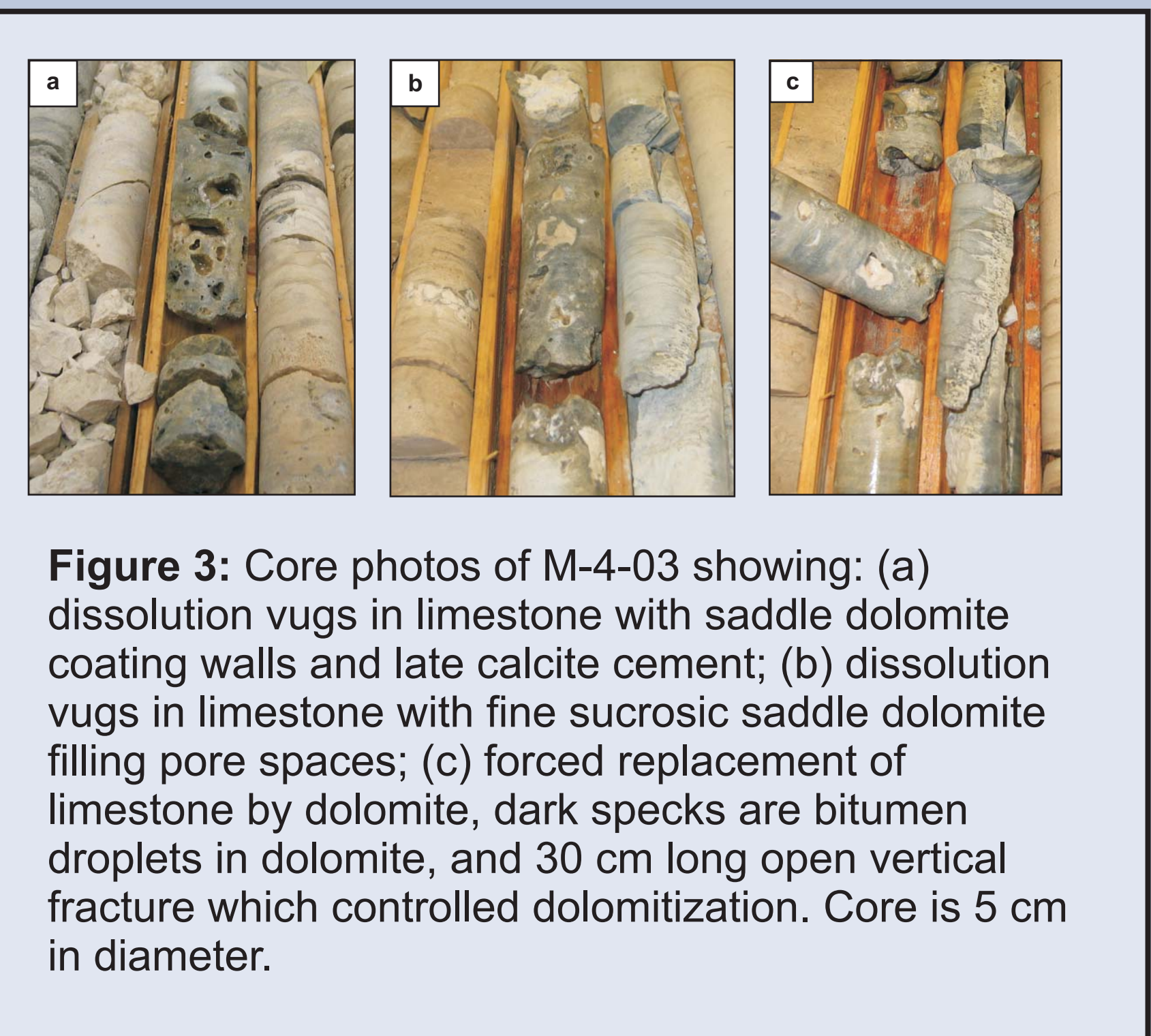


Figure 1: Hudson Bay Lowlands in northeastern Manitoba, showing the location of the cores available; inset is the project area for the GEM Hudson Bay and Foxe Basins Project.

