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# Sedimentological, ichnological, and geochemical characterization of the Horn River Group, British Columbia, Canada

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## Summary

The Middle and Upper Devonian Horn River Group is a major shale gas resource in northeastern British Columbia that has seen substantial development over the last decade. We are conducting a detailed sedimentological and stratigraphic analysis of these shales in order to understand the fundamental architecture of the reservoir and to characterize the depositional setting, in particular redox conditions. Black shales, including the Horn River shales, have historically been interpreted as deposited in deep anoxic settings, but such interpretation has recently been called into question for some Mesozoic and Paleozoic formations.

The Horn River Group consist of three formations: Evie, Otter Park, and Muskwa, which are relatively carbonate-rich, clay-rich and silica-rich, respectively. In this study two main lithofacies associations were identified, based on physical sedimentary structures, bioturbation intensity (BI), and geochemical analysis from four cored wells. One association is characterized by dark massive mudstones with significant pyrite, rare current generated structures (e.g., starved ripples), biogenic silica and scarce bioturbation (BI 0-1), and is interpreted to represent anoxic deep water (ADW) conditions. A second association is characterized by light to dark color mudstones with event beds, and well persevered primary sedimentary structures including horizontal parallel to wavy laminations, possible hummocky cross stratification, double mud drapes, and tidal rhythmites. Overall BI varies from 3-6. This association is interpreted to represent a relatively oxygenated shallow water (OSW) depositional setting.

The Evie and Muskwa Formations mainly represent ADW while the Otter Park represents OSW. The Evie and Muskwa members have significantly higher total organic carbon values (average of 3.8 and 3.3 wt.%, respectively) compared to the Otter Park member (2.2 wt.%). The results of this study indicate that the Horn River Group displays noticeable variations in lithology, sedimentary structures, the presence of event beds, and TOC content that are related to water depth, oxygenation and proximity to the basin margin, consistent with patterns of trace metals that reflect redox conditions. Mapping the extent of each lithofacies association within the basin will provide insight into reservoir quality in Horn River gas fields, and will lead to the construction of a sequence stratigraphic framework for these units within the basin.