

Origin and Significance of Surface Hydrocarbon Seeps on Melville Island, Canadian Arctic Archipelago for Sverdrup Basin Petroleum Systems

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The Sverdrup Basin is a large basin in the Canadian Arctic Archipelago where a number of petroleum fields were discovered between 1965 and 1985. These were mostly in the Melville to Ellef Ringnes islands area in Upper Triassic to Lower Jurassic reservoirs although minor shows occur throughout the Mesozoic. It is generally accepted that Middle Triassic Schei Point shales are the source of most of these hydrocarbons. Recently, the Geological Survey of Canada has begun to reassess the hydrocarbon potential of the Sverdrup Basin using a combination of new fieldwork and laboratory analyses including organic geochemistry to characterize oils and potential source rocks.

The Lower Triassic Bjorne Fm tar sands found in the Marie Bay area of north west Melville Island occur over a 70 by 20 km area. While suspected to be sourced from the Schei Point Group, no definitive data has been published to support this. Other lesser known seeps have also been reported on Melville Island including in the Lower Cretaceous Isachsen Fm at Cape Grassy to the north of the Bjorne Fm occurrences, and another over a hundred kilometres further east at the south end of the Sabine Peninsula within the Upper Carboniferous Canyon Fiord Fm. In July 2009, all these bitumen deposits were sampled for organic geochemical analyses.

Although the Bjorne Fm bitumen samples were all severely biodegraded, they could be confidently correlated to Schei Point extracts and most Sverdrup Basin oils based on distributions of more resistant biomarkers. The Cretaceous hosted sample could similarly be correlated to a Triassic source. Regional maturity maps for the Schei Point Group suggest there must have been long distant migration for these hydrocarbons.

The Carboniferous seep hydrocarbons are also biodegraded but clearly have a different source from the other seep samples. Biomarker characteristics suggest a Paleozoic carbonate source rock. Comparison with source rock extracts suggest that the very organic-rich Upper Ordovician to Upper Silurian Cape Phillips Fm is the most likely candidate. This unit has also been suggested as a source for the Bent Horn light oils found in Middle Devonian carbonates on Cameron Island. The presence of Cape Phillips sourced hydrocarbons on Melville Island has major implications for finding petroleum in pre-Mesozoic Franklinian Basin strata, that were mostly overlooked in the previous exploration cycle.