

Unique Geochemical Methods for Regional On-shore Petroleum Exploration in the Mackenzie Delta, Northwest Territories, Canada

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A regional geochemical orientation survey was conducted over the Tuk Tertiary oil field, Tuk Cretaceous gas field and the Mayogiak Devonian oil field located in the Mackenzie Delta of the Northwest Territories, Canada. The orientation survey was performed to determine which, if any, of four analytical methods tested on lake sediments and soil cores would provide the most coherent surface expression of the oil & gas fields in a regional survey. Effective geochemical methods could then be used to focus more cost-prohibitive seismic surveys and drilling over on-shore parts of the Mackenzie Delta.

Lake sediment and soil core samples were collected at 1 km intervals on 2-km spaced lines over an approximate area of 150 square kilometers. The samples were analyzed for C1-C6 alkane hydrocarbons using headspace, acid and pulverization extraction methods, and for aromatic hydrocarbons by fluorescence analysis. Anomaly thresholds for the hydrocarbon data were selected from probability plots and the variables were plotted as proportional symbols on a topographic background.

The headspace, acid-extraction, pulverization and fluorescence analysis of soil cores revealed hydrocarbon anomalies over and adjacent to the oil and gas fields. More specifically, the C2+ alkane concentrations, wet gas ratios (C3/C1) and 3-ring aromatics are anomalous over and near the Tuk oil & gas fields. Thermogenic (C2+) headspace hydrocarbons are also anomalous in lake sediments over the Tuk and Mayogiak fields, but the methane is erratic probably because of its biogenic origin.

The main conclusion from the geochemical orientation study over the Tuk and Mayogiak fields is that hydrocarbon analysis of 2-meter deep soil cores provides statistically significant thermogenic hydrocarbon anomalies over oil and gas fields, even at 1 km sample intervals. Thermogenic headspace hydrocarbons are also anomalous in lake sediments over the fields. Regional surveys in the Mackenzie Delta should therefore involve the collection of 2-meter deep soil cores and/or lake sediments at approximately 1 km sample intervals. The samples should be analyzed for headspace C1-C6 alkanes and solvent-extractable aromatics (fluorescence method) to search for oil & gas reservoirs because these methods are less expensive than the acid and pulverization extraction techniques. The hydrocarbon data should be evaluated in probability plots to establish thresholds between anomalous and background populations.