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## High GR readings (hot-shale and hot-mud) in McMurray Formation - characterization and origin

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### Summary

This study focuses on the origin and characterization of high gamma ray (GR) readings in the McMurray Formation. A number of “hot”, variably thick intervals occur in numerous wells between Township 81, Range 9 West of 4 and Township 76, Range 7 West of 4. The most detailed investigation is done on an interval from 1AA 09-02-081-09W4.

A number of methods including thin section petrography, Energy Dispersive Spectroscopy (EDS), microprobe of K-feldspar, XRD, XRF and spectral gamma using scintillometer were used to investigate the interval of interest in core samples. The interval is comprised of bitumen saturated cross bedded sands (high energy deposit) and light-colored intensely bioturbated (bioturbation index 5-6) mudstone (low energy deposits). Thin section petrography shows the predominance of quartz and presence of potassium feldspar, mica, a minor amount of scattered zircon grains and traces of uranium rich monazite. Uranium recorded by Energy Dispersive Spectroscopy (EDS) is likely sourced by uranium rich monazites. Small amount of kaolinite detection in XRD analyses may indirectly suggest the presence of K-feldspar and microprobe results point to their plutonic origin. In contrast, embayments in numerous quartz grains suggest possible volcanic origin. Scintillometer and XRF results do not show increased uranium (U), thorium (Th) and potassium (K) spikes. However, XRF analyses reveal higher concentration of zirconium (more than 5 times). Zirconium spikes are consistent with results from other wells in the region. None of the commonly employed equations for calculating total gamma ray from U, Th, K were able to reconstruct the open hole logging gamma ray curve through the study interval.

In summary, contradicting results suggest: i) the complex provenance that in addition to the well documented Canadian Shield, Appalachian, and Grenville sources may involve airborne transported volcanic ash (poorly preserved) and perhaps local kimberlite sources. Recent literature provides analogues and a strong foundation for novel proposed mechanisms; and ii) source of total natural radioactivity is inconclusive and requires further research.

Radiometric dating of observed zircons may help shed light on the age and sources of these heavy minerals. Investigation of observed relationship between intense bioturbation and natural radioactivity is a matter of ongoing research.

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