

WHAT ARE NON-DESTRUCTIVE ORE CHARACTERIZATION TECHNOLOGIES & WHY ARE THEY IMPORTANT?

- Tools that assess ore quality (e.g., bitumen content and mineral makeup) without destroying the sample, enabling faster, cheaper and more sustainable analyses.
- Fast, on-site scanners offer non-destructive analysis of oil sands cores and ores, replacing lab methods with much faster data turnaround on bitumen, fines, and clay— essential for improving mine planning and process optimization in oil sands operations.



WHAT ARE THE ADVANTAGES OF NON-DESTRUCTIVE ORE CHARACTERIZATION ANALYSIS?

- **Improves efficiency and safety** in oil sands core analysis workflow by providing an sustainable alternative to lab methods.
- **Delivers fast and near real-time data** on key properties like bitumen content, fines, and clay activity, enabling faster decision-making.
- **Supports automation and data-driven operations**, aligning with industry trends toward smarter mining and digital data practices.

COMMON TECHNOLOGIES

- **Imaging & Optical:** Captures visual and structural information using light and X-rays.
 - Examples: Hyperspectral imaging (HSI), computed tomography (CT), high resolution imaging
- **Spectroscopic:** Analyzes how samples interact with light or X-rays across different wavelengths.
 - Examples: Infrared (FTIR, NIR, Mid-IR), Raman Spectroscopy, X-ray fluorescence
- **Nuclear & Magnetic:** Probes sample properties using nuclear scintillation and magnetic fields.
 - Examples: Magnetic resonance, gamma ray logging

HOW TO STAY CONNECTED & INFORMED

- To learn more about the evaluation of non-destructive ore characterization technologies, or to explore related projects, resources, and technical insights, visit the [Centre for Energy and Environmental Sustainability website](#) or contact us at CEES@nait.ca.

REFERENCES & ACKNOWLEDGEMENT

- Greiner, L. (2023, August). Comparing characterization techniques. CIM Magazine, 18(5), 36-37.
- We gratefully acknowledge the contributions and funding from the **Institute of Oil Sands Innovation (IOSI)**, whose expertise and collaboration were instrumental in the development of the research presented in this technical sheet.

TECHNOLOGIES

- CEES, with support from the Institute of Oil Sands Innovation (IOSI), evaluated multiple core scanning technologies. The following is the summary of our findings.

Technique	Bitumen Content Determination	Fines Determination	Clay Activity (MBI) Determination	Application
HSI with Infrared Spectroscopy	★ ★ ★ ★ ☆ (dry cores only)	★ ★ ★ ☆ ☆	★ ★ ★ ☆ ☆	<ul style="list-style-type: none"> • Sensitive to surface water & roughness • Best for dry, flat slabbed cores. • Requires a robust machine learning model.
X-ray Fluorescence (XRF)	Not applicable	★ ★ ☆ ☆ ☆ (deposit specific)	★ ★ ☆ ☆ ☆ (deposit specific)	<ul style="list-style-type: none"> • Elemental correlation to fines & clays are highly deposit specific. • Useful as a complementary technique.
HSI + XRF	★ ★ ★ ★ ★ (dry cores only)	★ ★ ★ ★ ☆	★ ★ ★ ★ ☆	<ul style="list-style-type: none"> • Combination of HSI & elemental analysis improves overall effectiveness.
Laser Induced Breakdown Spectroscopy	★ ★ ★ ☆ ☆	★ ★ ☆ ☆ ☆ (deposit specific)	★ ★ ☆ ☆ ☆ (deposit specific)	<ul style="list-style-type: none"> • Broad elemental coverage, including lighter elements such as H, C. • Useful as a complementary technique.
Gamma Spectroscopy	Not tested	Not tested	★ ★ ★ ☆ ☆ (deposit specific)	<ul style="list-style-type: none"> • Measures radioactive elements (Th, U) that occur naturally in clays, but concentrations are low. • Effectiveness is heavily influenced by deposit.
LiDAR Fluorescence	★ ★ ★ ☆ ☆	Not tested	Not tested	<ul style="list-style-type: none"> • Detects the fluorescence emitted by bitumen with an excitation laser. • May be affected by bitumen fractions (asphaltenes/maltenes) and ageing.
Micro CT (Micro-Computed Tomography)	Not tested	★ ★ ☆ ☆ ☆	Not tested	<ul style="list-style-type: none"> • Useful for microstructure and fabric analysis but not for core scanning. • High resolution micro-CT requires long data acquisition and processing time.
Low field ¹ H NMR	★ ★ ★ ★ ★ (for synthetic cores)	Not tested	Not tested	<ul style="list-style-type: none"> • Requires no core slabbing. • Very effective for bitumen and water measurement in synthetic cores. • Further research and validation needed for real heterogenous cores.