



Summary

Research collaboration between Dr. Mark P. Barrow (Department of Chemistry) and Environment Canada

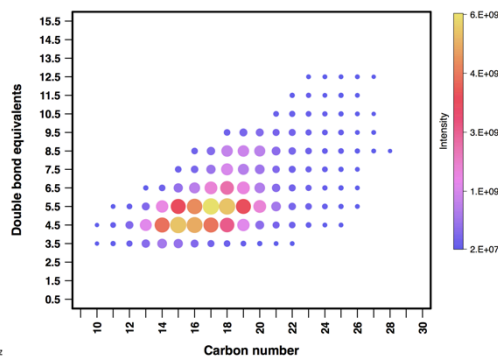
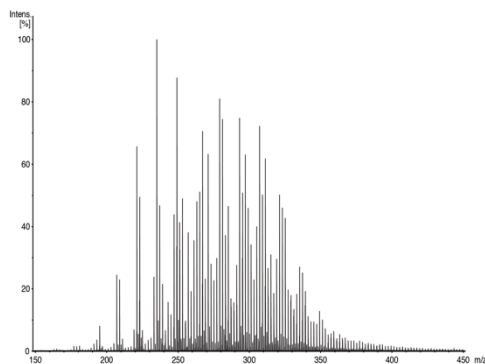
Study of water samples from the Athabasca region of Canada using FTICR mass spectrometry

Water samples each contained thousands of compounds and this “fine print” was determined at the University of Warwick

Potential for delineating origins of organic components within water samples, providing insight into environmental effects

Why is a researcher at the University of Warwick studying water from Canada?

Petroleum is used for a wide range of purposes, including fuels, plastics, waxes, lubricants, pesticides, fertilizers, medicines, synthetic fibres, and more. Worldwide petroleum production has, however, been declining due to decreasing availability. Alternative sources of petroleum are therefore increasingly exploited. One of these alternative sources is the Athabasca oil sands, located in Canada. The oil sands consist of water, sand, clay, and bitumen and an alkaline, hot water extraction process can be used to obtain the bitumen. This process requires approximately three barrels of water to produce one barrel of synthetic oil. Due to concerns about toxicity, there is a zero discharge policy and the water cannot re-enter the environment, instead being stored in large tailings ponds. There is a strong need to characterize the organic components which are present in the oil sands process water (OSPW).



Key facts

- The oil sands cover a region of Alberta approximately the size of the state of Florida (USA)
- The Athabasca oil sands represent 174 billion barrels of bitumen
- Canada has the world's second largest proven oil reserves, second to Saudi Arabia
- Canada is currently the United States' largest oil supplier, providing approximately one million barrels of oil per day
- Approximately two tonnes of oil sands are required to create one barrel of synthetic oil
- Producing one barrel of synthetic oil requires approximately three barrels of water
- There is a "zero discharge" policy, meaning none of the water used is allowed back into the environment and is stored in vast tailings ponds
- 720 billion litres of waste water are currently stored in tailings ponds

At the University of Warwick, there has been investment in state-of-the-art Fourier transform ion cyclotron resonance (FTICR) mass spectrometry. A 12 T Bruker solarix, housed within a purpose-built laboratory, is at the heart of the research. High field FTICR mass spectrometers offer unrivalled resolving power and mass accuracy, making them uniquely suitable for reading the "fine print" of complex mixtures, such as petroleum and environmental samples.

Collaborators at Environment Canada are very interested in studying the effect of the oil sands industry upon the environment. They provided water samples from a range of sites in the natural environment and locations of human activity, such as tailings ponds. The samples were then sent to the University of Warwick, where Dr. Mark Barrow used the FTICR mass spectrometer for the purposes of characterizing the range of samples.

Each mass spectrum resulting from the analyses contained many thousands of peaks, representing organic components that are present in the water samples, where some of these components are naturally occurring. The spectra were interpreted using a variety of data visualization methods and the challenge was to then look for patterns in these profiles. Using principal component analysis, it was possible to demonstrate that the water from natural sources had very different profiles from water associated with the oil sands industry and, furthermore, it was possible to distinguish between OSPW water samples obtained from the sites of different companies.

The preliminary research has demonstrated potential for FTICR mass spectrometry to be used to differentiate possible leakage of tailings ponds from the organic background in the environment.

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Relevant references:

- (1) M. P. Barrow et al., *Anal. Chem.*, **2010**, 82, 3727-3735
 - (2) J. V. Headley et al., *Rapid Commun. Mass Spectrom.*, **2011**, 25, 1899-1909
- Photographs of oil sands industry from David Dodge, Pembina Institute (oilsandswatch.org)