



## Advanced characterisation of organic matter in oil sands and tailings sands used for land reclamation by Fourier transform-ion cyclotron resonance-mass spectrometry (FT-ICR-MS)

M. Noah, A. Vieth-Hillebrand, and H. Wilkes

Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Telegrafenberg, Potsdam, 14473, Germany  
(noah@gfz-potsdam.de)

The Athabasca region of northern Alberta, Canada, is home to deposits of oil sands containing vast amounts ( $\sim 173$  billion barrels) of heavily biodegraded petroleum. Oil sands are recovered by surface mining or by in situ steam injection. The extraction of bitumen from oil sands by caustic hot water processing results in large volumes of fluid tailings, which are stored in on-site settling basins. There the tailings undergo a compaction and dewatering process, producing a slowly densifying suspension. The released water is recycled for extraction. The fine tailings will be reclaimed as either dry or wet landscapes. [1] To produce 1 barrel of crude oil, 2 tons of oil sand and 2 – 3 tons of water (including recycled water) are required. [2]

Open pit mining and the extraction of the bitumen from the oil sands create large and intense disturbances of different landscapes. The area currently disturbed by mining operations covers about 530 km<sup>2</sup> and the area of tailing ponds surpasses 130 km<sup>2</sup>. An issue of increasing importance is the land remediation and reclamation of oil sand areas in Canada and the reconstruction of these disturbed landscapes back to working ecosystems similar to those existing prior to mining operations. An important issue in this context is the identification of oil sand-derived organic compounds in the tailings, their environmental behaviour and the resulting chances and limitations with respect to land reclamation. Furthermore the biodegradation processes that occur in the tailings and that could lead to a decrease in hazardous organic compounds are important challenges, which need to be investigated.

This presentation will give a detailed overview of our compositional and quantitative characterisation of the organic matter in oil sand, unprocessed and processed mature fine tailings samples as well as in tailings sands used as part of land reclamation. The analytical characterisation is based on the extraction of the soluble organic matter, its subsequent separation into asphaltenes, aliphatic hydrocarbons, aromatic hydrocarbons, neutral nitrogen, sulphur, oxygen (NSO) compounds and carboxylic acids. The asphaltene fractions are analysed using pyrolysis-GC, all other fractions are analysed by GC-MS. Additionally Fourier transform-ion cyclotron resonance-mass spectrometry (FT-ICR-MS) is used to study the chemical composition of the samples on the molecular level using different ionisation methods.

### References

- [1] Leung, S.S.-C., MacKinnon, M.D., and Smith, R.E.H., Aquatic reclamation in the Athabasca, Canada, oil sands: Naphthenate and salt effects on phytoplankton communities. *Environmental Toxicology and Chemistry*, 2001. 20(7): p. 1532-1543.
- [2] Kelly, E.N., et al., Oil sands development contributes polycyclic aromatic compounds to the Athabasca River and its tributaries. *Proceedings of the National Academy of Sciences*, 2009. 106(52): p. 22346-22351.