For Peat's Sake:
A Case for Matrix Specific Methods for Peat Characterization

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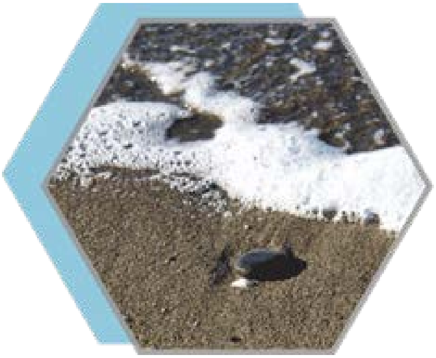

RPIC 2015
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Outline

- What is Peat
- Why Peat Analysis Maters
- Current Peat Methodologies
- New Research
- Suggested Changes
- Reasons Changes Needed
- Conclusion

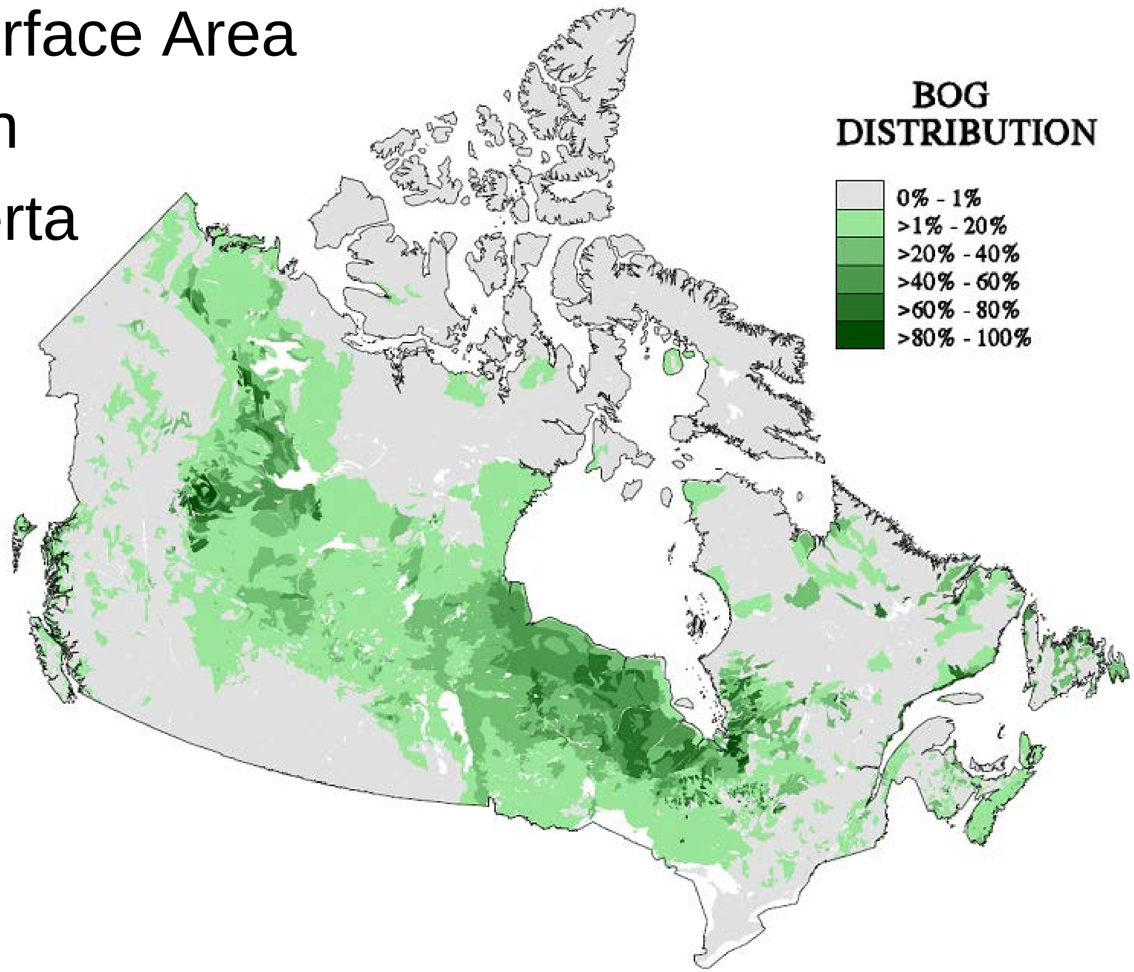
What is Peat?

- Known as Mires, Moors, Muskeg, Wetlands
- Vegetation invading standing water
- Common component is moss
- Peat linked to hydrocarbon rich areas

- Very high capacity to absorb moisture.
- Typical moisture contents between 60-95%

Peat Bog in Canada

- 35% of World's Peatlands in Canada
- 11% of Canada's Surface Area
- Peat Concentrated in
  NE BC and Alberta



Past Work on Muskeg

- CARO
- ALS
- Dr. D. George Dixon, Waterloo University
- SynergyAspen

Past Work on Muskeg

CARO

Abstract for the 2014 SABCS Conference, Sept 2014

- Site Specific Investigation for Salt Contaminated Site in Northeast BC
- Recent investigations have found that lab analyses of salt and hydrocarbon concentrations in peat soils can vary considerably according to the field collection and lab analysis methods used.
- It is understood that lab analyses of muskeg-like soil data can be adjusted using the above techniques on a site-specific basis.
- While this study is site-specific, the results may provide generic insight into the best field and lab methods to obtain meaningful data for investigation and remediation of contaminated oil and gas sites in soils typical of NE BC.

Presenters: Mallory Jackson, M.Sc., P.Ag., Navus Environmental, Inc., Lauren Rae, M.Sc. Navus Environmental Inc, Joseph Harrer, M.S., P.Geo., P.Geol. Navus Environmental, Inc., Steve Graham, P.Geo., P.Geol., P.Eng., AP, PhD, S Graham Engineering and Geology Inc.

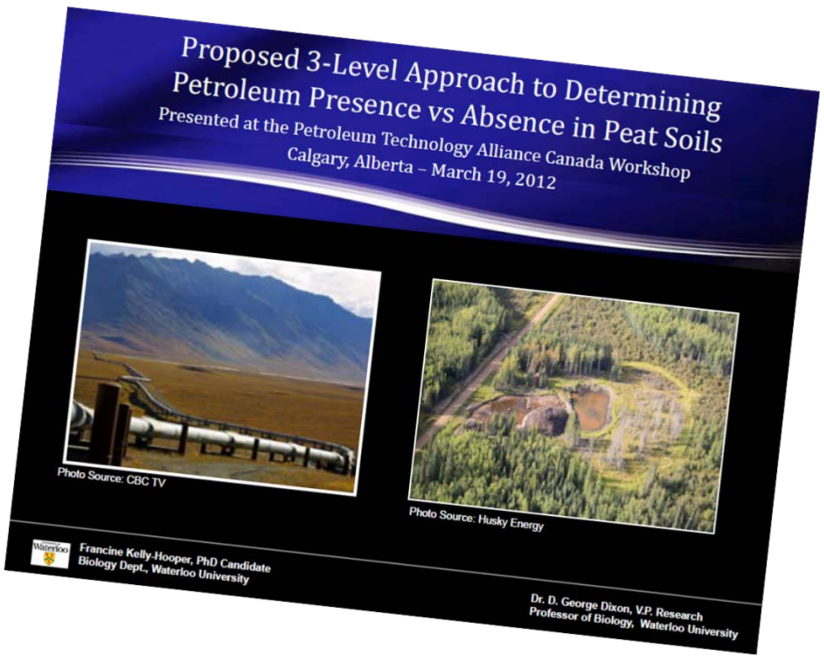
ALS

Challenges with the Analysis of Peat Soils for Sodium and Chloride for BC CSR Applications

Mark Hugdahl,
Technical Director, ALS Environmental (Canada)

Past Work on Muskeg

Dr. D. George Dixon, Waterloo University



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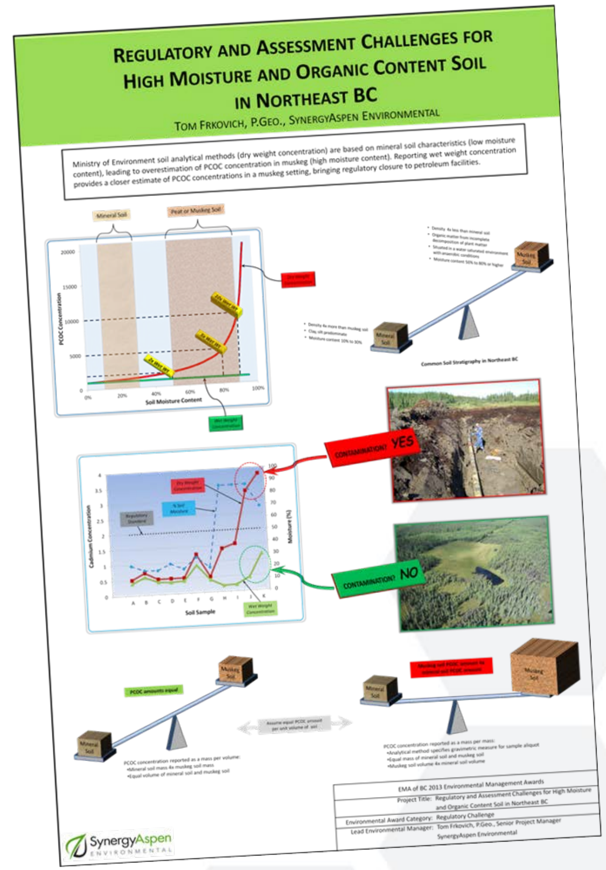


Problem Formulation

- Problem definition:
  - BC MoE analytical methodology for salinity parameters not designed for high moisture content soil such as peat
  - Results in:
    - over estimation of salinity concentrations in peat environment, resulting in inaccurate estimation of extent of contamination and unnecessary remediation of muskeg

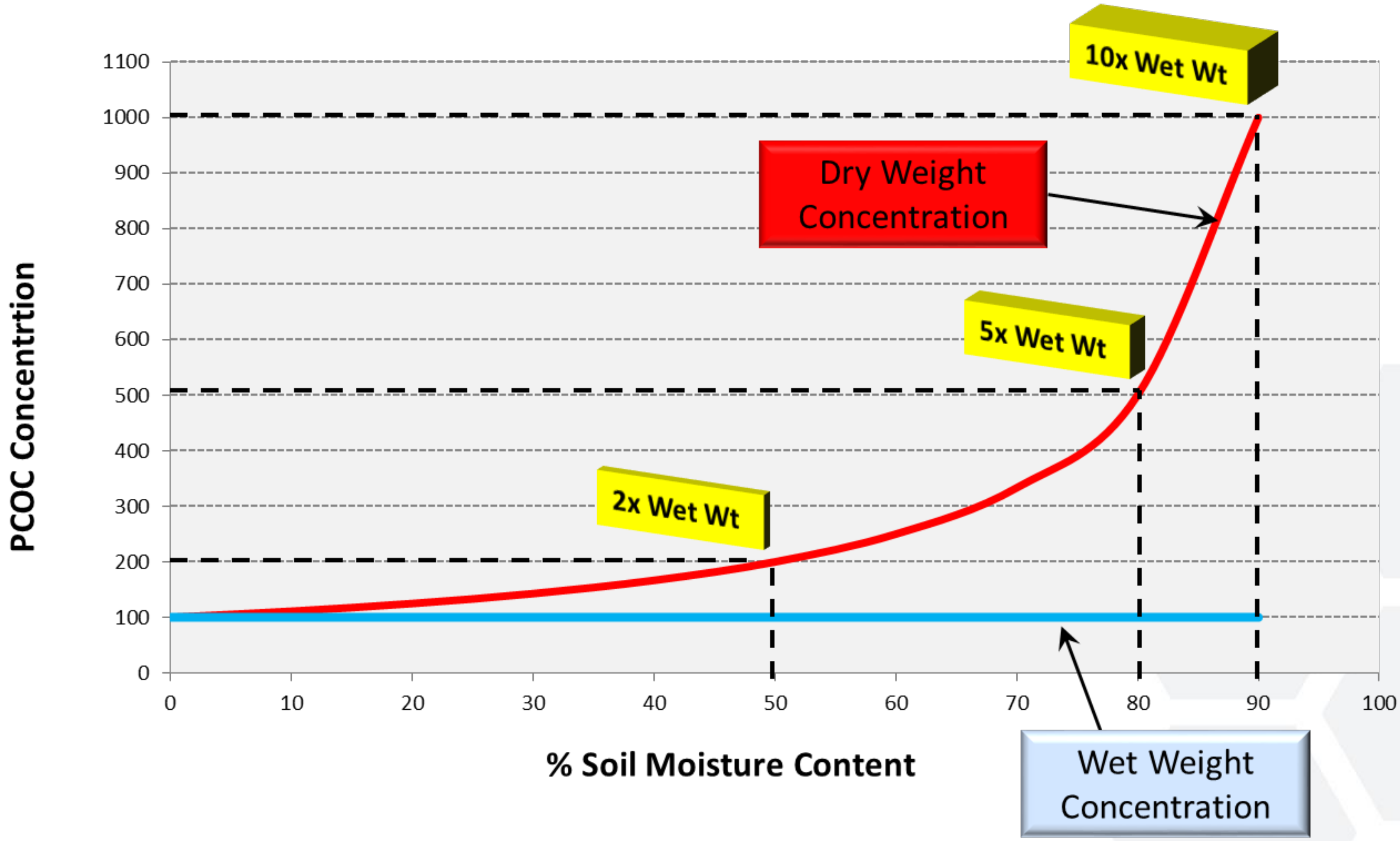
Regulatory Environment

- Oil and gas sites in NEBC undergo environmental site assessments for closure for property
- Successful site closure at oil and gas sites are represented by a Certificate of Restoration (CoR)
  - Administered by the Oil and Gas Commission (OGC)
- OGC acknowledges the tendency of overestimation of analyte concentrations in high moisture soil such as muskeg
- The analyte overestimate rationale has been presented as part of a multiple lines of evidence approach to support successful site closure applications (CoRs) for well sites.

Problem Formulation & Accepted Understanding

- Providing a comparison of dry weight concentration with wet weight concentration for high moisture soil demonstrates the overestimation of analyte concentrations.
- Overestimation can be up to 20x

New Research Findings



Reasons Changes Needed

- Findings So Far Show Using Methods Established For Soil or Water Do Not Accurately Quantify Contaminants in Peat Matrix
- Peat is not soil >50% moisture
  - Soil regulations typically baselined to dry weight basis, hence moisture correction affects results often >100%
- Peat is not water but can often be >80% moisture content
  - Water analysis is typically looking at total concentration, digestion to bring into solution
- New methodologies for tissue analysis – peat more like tissue i.e. vegetation, plants, animals, etc…

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Saturated Paste Analytical Method

- The approved BC MoE saturated paste method includes the following general steps:

1. Dry the “as received” sample
2. Chemist hydrates sample to reach saturation to make the saturated paste
3. Extraction of liquid
4. Analysis of liquid to obtain a mg/L concentration
5. Convert mg/L to mg/kg using the % saturation

Contaminant Calculation

M1 – Dry Soil Weight
(BC MOE method)

$$C_{salM1} = \frac{\text{mass of salt (mg)}}{\text{dry weight of muskeg (kg)}}$$

** Dry sample first, saturate soil, analyze extracted water*

M2 – Lab H20 Wet Weight

$$C_{salM2} = \frac{\text{mass of salt (mg)}}{\text{total volume of water (L) to achieve saturation)}}$$

**mg/L value obtained in M1 method*

M3 – Wet Soil Weight

$$C_{salM3} = \frac{\text{mass of salt (mg)}}{\text{total muskeg sample weight (kg) (sample water + muskeg)}}$$

** Complete sat paste on sample as received and not bring it to saturation first*

Advantages of M3:
- Recognizes muskeg as a two media structure
- Removes potential bias in denominator compared to both M1 and M2

New Research Hypothesis

Primary Focus

- ***M3 – Wet Soil Weight*** representing the water content of sample as received condition and not lab modified
  - Strive for sample concentrations to be actual “spiked” concentrations

Secondary Considerations

1. Confirm dry weight results reported bias high concentrations.
2. Understanding variability between approaches.
3. Trying to understand moisture, saturation and concentration effects

Experiment Setup

- 2 labs independently created controlled samples with
  - –Known moisture content and salinity concentrations
  - –Produced water and muskeg samples from oil and gas site in NE BC
- Samples generated per lab and analyzed using the three presented methods M1, M2 and M3

Table 1: Proposed Sample Matrix for Salinity Analysis

Concentration (mg/L)	Moisture Content			
	60%	70%	80%	90%
C1 – Produced Water	Sample 1: M1: M2: M3:	Sample 5: M1: M2: M3:	Sample 9: M1: M2: M3:	Sample 13: M1: M2: M3:
C2 – 5x dilution of C1	Sample 2 M1: M2: M3:	Sample 6: M1: M2: M3:	Sample 10: M1: M2: M3:	Sample 14: M1: M2: M3:
C3 – 10x dilution of C1	Sample 3 M1: M2: M3:	Sample 7: M1: M2: M3:	Sample 11: M1: M2: M3:	Sample 15: M1: M2: M3:
C4 –25x dilution of C1	Sample 4 M1: M2: M3:	Sample 8: M1: M2: M3:	Sample 12: M1: M2: M3:	Sample 16: M1: M2: M3:

Preliminary Results

1. Alternate methodology to be evaluated for determining sample saturation

M2 – Lab $H_2$0 Wet Weight

$$C_{salM2} = \frac{\text{mass of salt (mg)}}{\text{total volume of water (L) to achieve saturation)}}$$

**Sample dried, then brought to saturation, extracted and analyzed mg/L value obtained per M1 method*

M2B – Lab $H_2$0 Wet Weight

$$C_{salM2} = \frac{\text{mass of salt (mg)}}{\text{total volume of water (L) to achieve saturation)}}$$

- Moisture content determined on sample
- Volume of water added for saturation
- Combined total volume used as denominator

- Modified M2B method, would eliminate laboratory need for drying the muskeg soil, thereby saving efficiency and energy and potential reducing analytical cost

Preliminary Results

2. 100% recovery of salinity virtually impossible in muskeg

- Would need to take sample to ash to completely dry it – nature of peat
- Based on this characteristic of muskeg, it contributes to the bias high when using Method M1
- Further supports observation #1 to using a modified approach for %saturation in muskeg, which would eliminate the drying process in the methodology.

Preliminary Results

3. Methodology Variability

- Assumptions not same for all laboratories or all analysts = not apples to apples.
- Small variations in high moisture samples (peat) have significant impacts.
- Clear, specific methodology needed for high organic samples i.e. If TOC and/or moisture >50% then a modified salinity method used and/or organic matter measurement by combustion.
- At what point is peat not a soil?

Suggested Changes

- Organizations& Industry Groups To Continue Study
- Education Institution(s) Support Further Peat Specific Research
  - Contaminated Site Research
  - Northern Universities Opportunities
- Regulators To Acknowledge Uniqueness of Peat Sites & Develop:
  - Targeted Approach
  - Peat Matrix Specific Standards and/or Analytical Methodologies
  - Peat Risk Assessment Framework

Conclusions

- Peat: it's not soil and not water but a combination of both – Why not analyze it as such?
- Updated analytical methodology could significantly save $$$ being spent unnecessarily in remediation
  - Cost Savings Already being achieved with M2 methodology being used in multiple lines of evidence.
  - Preliminary results suggest a modified saturated paste method for muskeg, eliminating laboratory need for drying the muskeg soil, thereby saving efficiency and energy and potential reducing analytical cost
- Need to evaluate analytical methodology for muskeg before creating standards for the media
- More Data = Better Understanding of Issues
  - Successful Projects & Engaged Stakeholders
  - Environmental Leadership & Stewardship

Questions?

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