Investigating Dissolved Organic Matter Decomposition in Northern Peatlands Using Complementary Analytical Techniques

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Introduction

The chemical transformations that govern storage, degradation, and loss of organic matter in northern peatlands are poorly characterized, despite the significance of those peat deposits as pivotal reservoirs in the global carbon cycle. One of the most challenging problems concerns the character of dissolved organic matter (DOM) in peat porewaters, particularly higher-molecular weight compounds that may function either as non-reactive sinks or reactive intermediates for organic byproducts of microbial decay.

Experimental

We determined the composition and reactivity of DOM from representative bog and fen sites in the Glacial Lake Agassiz Peatlands (GLAP) in northern Minnesota, USA by use of four complementary techniques: electrospray ionization 9.4 T Fourier transform ion cyclotron resonance mass spectrometry, proton nuclear magnetic resonance spectroscopy (^{1}H NMR), specific UV absorbance (SUVA), and excitation–emission matrix (EEM) fluorescence spectroscopy.

Results and Discussion

We observed that the vast majority (>80%) of molecular formulas that appear in the surface bog DOM are also present at 2.9 m depth, indicating that much of DOM in the bog is resistant to microbial degradation. In contrast to bog samples, a considerable number of new compounds with low O/C and high H/C elemental ratios were observed in the 3 m fen horizon relative to surface samples (Figure 1). These results indicate a more pronounced difference in the composition of surface and deep DOM in the fen. Aromatic and carbohydrate components represented up to 70% of deep bog DOM but comprised a much smaller proportion of deep fen DOM based on ^{1}H NMR, which was dominated by functionalized and non-functionalized aliphatics.

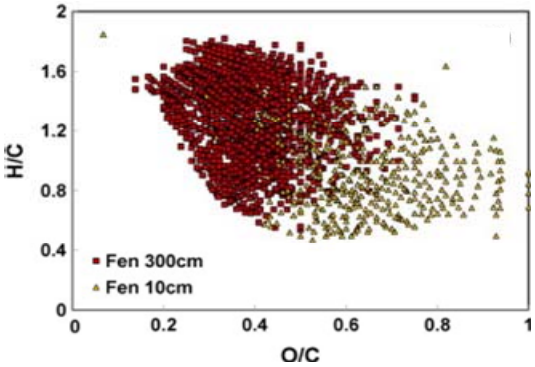

Figure 1. van Krevelen diagram of formulas unique to Fen 10 and 300 cm horizons.

Conclusions

The observed differences between bog and fen DOM, attributed to either variations in source vegetation or environmental factors that render DOM more reactive in fen sites or less reactive in bog sites, have important implications for the response of peatlands to climate change, because climatic change leading to moister conditions may enhance the abundance of sedge-dominated fens and increase the pool of more labile soil carbon.

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References

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