

# Source and formation of soil humic colloids and their functional groups responsible for metal binding

NICOLE DiDONATO<sup>1</sup>, HONGMEI CHEN<sup>1</sup>,  
DEREK WAGGONER<sup>1</sup>, SATISH MYNENI<sup>2</sup> AND  
PATRICK HATCHER<sup>1\*</sup>

<sup>1</sup>Department of Chemistry and Biochemistry, Old Dominion University, Norfolk VA (\* correspondence: phatcher@odu.edu)

<sup>2</sup>Department of Geosciences, Princeton University, Princeton, NJ

Fourier transform ion cyclotron resonance mass spectrometry (FTICR-MS) supported by X-ray absorption spectroscopy and nuclear magnetic resonance spectroscopy reveals (Figure 1) that humic acids in soil systems are formed from abiotic hydroxyl radical transformation of lignin and are composed of three predominant molecular structural entities: lignin-like, condensed aromatic, and carboxyl-containing aliphatic molecules (CCAM). Extracts of lignin reacted with hydroxyl radical via Fenton-type chemistry show the formation of both CCAM as well as condensed black-carbon (BC)-like molecules. The relative abundance of these molecular types in humic acids, which form colloids in soils, correlates well with the extent of humification. Kendrick mass defect analysis shows the prevalence of carboxylic acid and hydroxyl functional groups. We propose that the carboxyl/hydroxyl functionality is responsible for the high affinity of humic colloids for metals in soils. In fact the metals, especially Fe and Mn, are closely associated with the radical-forming processes that convert lignin to CCAM and BC-like molecules.

**Figure 1:** Van Krevelen diagram for humic colloids from Catlin, OH. CHO only compounds are identified from unique molecular formulae determined from FTICR-MS.

