

Bonding strength of biomolecules on dominant field-soil minerals by pyrolysis-gas chromatography/mass spectrometry

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Soil organic matter (SOM) is crucial to soil fertility and agricultural sustainability in the face of climate change, yet the mechanisms of SOM stabilization are not well understood. Many SOM studies focus on the chemical composition of SOM rather than the strength of bonds between biomolecules and mineral surfaces which may act as a proxy for SOM stability. Pyrolysis-gas chromatography mass spectrometry (Py-GC/MS) produces electron impact (EI) data which can assess bonding strength by characterizing the thermal energy needed to break organo-mineral and/or organo-organo bonds. To test the sorption strength of organo-mineral interactions we interrogated a ubiquitous phyllosilicate (montmorillonite) and Fe-oxide (goethite) which both play important roles in SOM stabilization. Batch sorption isotherm studies were performed using these model soil minerals and one of two common plant-derived biomolecules (tannic acid, lignin) at two field-relevant pH values (4 and 6). Pyrolysis evolved GC/MS gas analyses uncovered the thermal sensitivity of free versus adsorbed compounds and demonstrated that pH affected the quantity of biomolecules adsorbed on mineral surfaces while mineralogy and compound type affected the quantity and strength of biomolecule adsorption. Outcomes of this project will provide modeling parameters, such as the distribution coefficient (Kd) and binding strength, based on the data collected from the macro-scale experiments and measurements taken during this study. Our initial results indicate that Py-GC/MS is a cost-effective technique that can be successfully used to determine organo-mineral bonding strength with the potential to inform controls on organic carbon stabilization in terrestrial ecosystems.

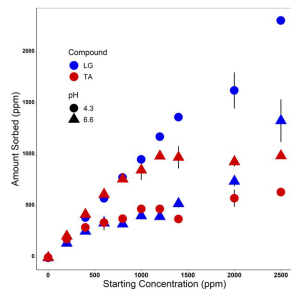


Figure 1: Sorption isotherm showing the quantity of lignin and tannic acid sorbed to montmorillonite at pH 4.3 and 6.6. More lignin is sorbed to montmorillonite at pH 4.3 than at pH 6.6 while the opposite is true for tannic acid.