Energetics and Binding Dynamics of Natural Organic Matter (NOM) with Iron (III) Hydr(Oxides) as Studied by Flow Adsorption Microcalorimetry

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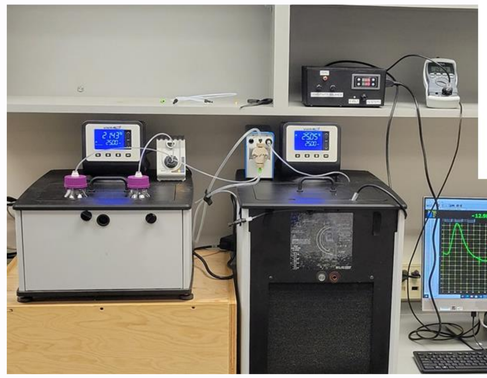
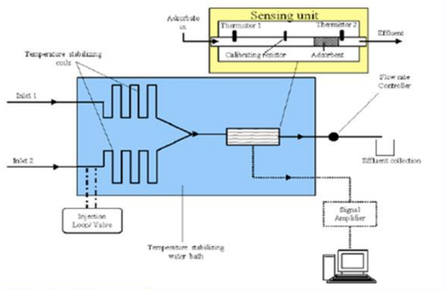
Introduction

- Organic matter (OM):
  - A complex mixture of organic molecules from decaying plant and animal remains
- OM interaction with soil minerals is critical in Earth system processes such as;
  - Global carbon cycle
  - Nutrient cycle,
  - Soil reactivity.

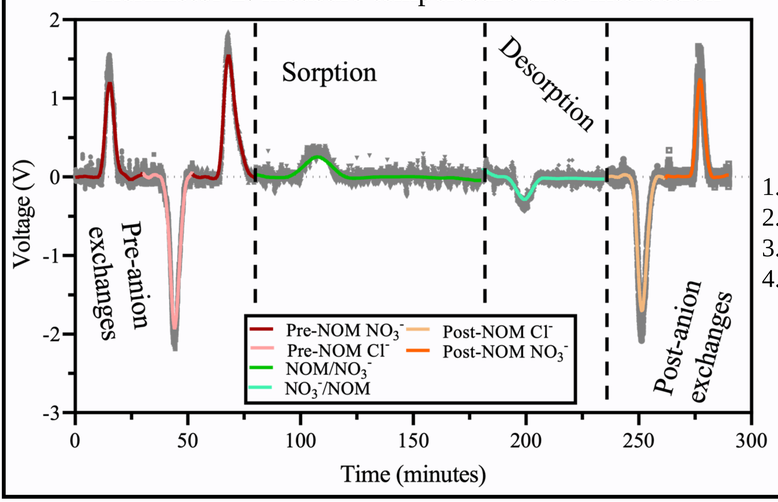
- Knowledge gaps:
  - OM dynamics and energetics of sorption onto mineral surfaces
  - The influence of OM processing on mineral-organics interaction

Methods and Materials



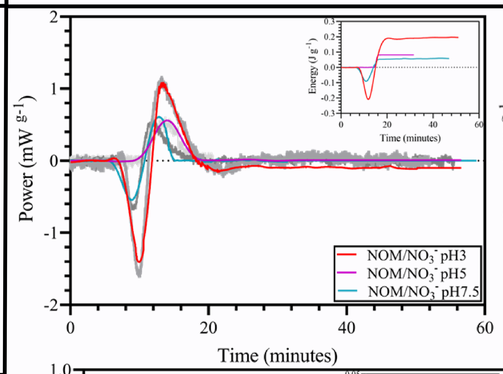


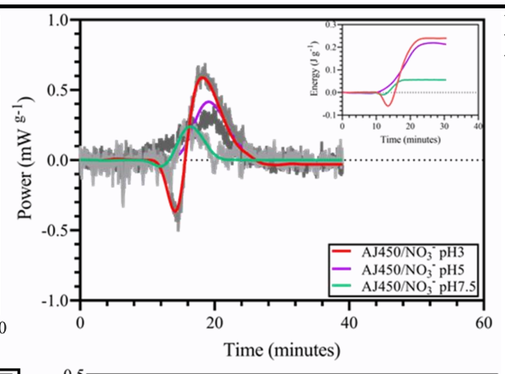
- Flow Adsorption Microcalorimeter (FAMC)
  - Measure energies associated with sorption and desorption of molecules onto surfaces
- Core of FAMC: Sensing unit
  - Thermistor 1: measure temperature of solution before interaction with surface
  - Thermistor 2: measure temperature after interaction

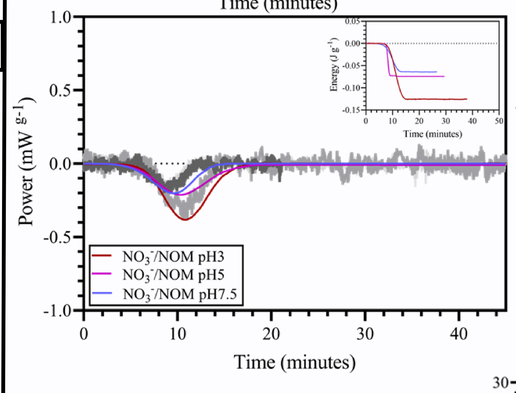


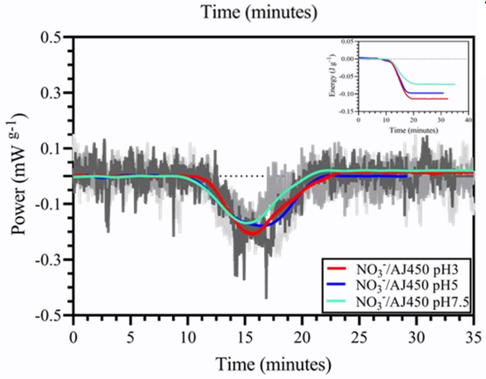
1.Pre-anion exchange
2.Sorption
3.Desorption
4.Post-anion exchange

Results and Discussions



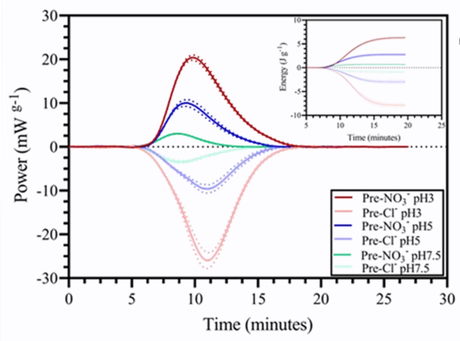


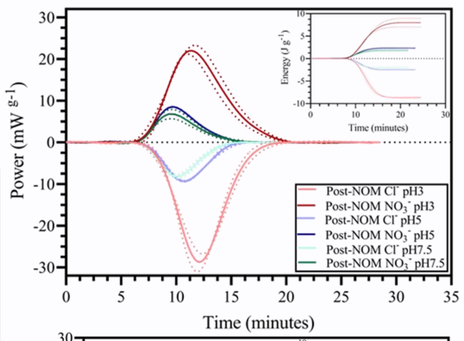


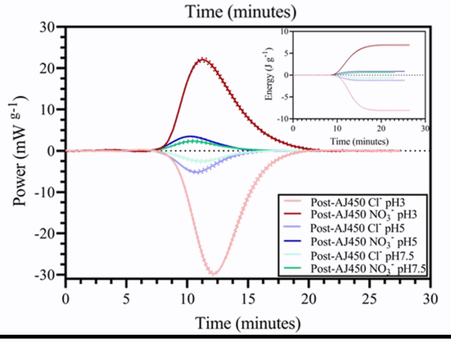


		Microbially-processed (NOM)		Fire-processed (AJ450)	
	pH	Sorption	Desorption	Sorption	Desorption
Rate (min^{-1})					
	3	1.81 ± 0.2	0.93 ± 0.001	0.28 ± 0.001	0.82 ± 0.008
	5	3.88 ± 0.01	1.00 ± 0.009	0.37 ± 0.008	1.16 ± 0.008
	7.5	3.18 ± 0.7	1.60 ± 0.002	0.93 ± 0.1	1.67 ± 0.14
Energy (J g^{-1})					
	3	0.19 ± 0.1	0.13 ± 0.02	0.24 ± 0.2	0.11
	5	0.09 ± 0.02	0.07 ± 0.01	0.22 ± 0.01	0.09
	7.5	0.06 ± 0.1	0.06 ± 0.02	0.06 ± 0.02	0.071
$Q_{ad/des}$ (mg/g)					
	3	61.82	22.25	49.23	35.14
	5	83.14	56.53	58.07	12.62
	7.5	28.32	19.82	49.91	25.83
ΔH ($kJ/g*10^{-3}$)					
	3	3.07	5.84	4.87	3.13
	5	1.08	1.27	3.78	7.13
	7.5	2.12	3.17	1.2	2.71

- Rate:
  - NOM faster than AJ450
  - Desorption is comparable
  - Increase with increasing pH
- Energy:
  - AJ450 more energetic than NOM
  - Desorption is comparable
  - Decrease with increasing pH
- ΔH:
  - Varies with pH
  - Generally higher at pH 3







		Microbially-processed (NOM)		Fire-processed (AJ450)
	pH	Pre	Post	Post
Rate (min^{-1})				
	3	0.82 ± 0.005	0.68 ± 0.009	0.87 ± 0.03
	5	0.86 ± 0.01	0.94 ± 0.004	1.05 ± 0.02
	7.5	1.01 ± 0.005	0.96 ± 0.02	1.02 ± 0.01
Energy (J g^{-1})				
	3	7.80 ± 0.8	8.75 ± 0.15	7.50 ± 0.6
	5	2.90 ± 0.1	2.40 ± 0.1	1.04 ± 0.2
	7.5	0.75 ± 0.05	1.90 ± 0.1	0.65 ± 0.05

- Rate:
  - Slight decrease for NOM and increase for AJ450
  - Increase with decreasing pH
- Energy:
  - Slight increase for both AJ450 and NOM
  - Decrease with increasing pH

Conclusion

- Microbially processed OM is more reactive than the fire processed
- The fire-processed OM is more energetic than the microbially processed.
- Bonding strength varies with pH.

Acknowledgement

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