AGING EFFECTS ON BIOCHAR-Cd RETENTION

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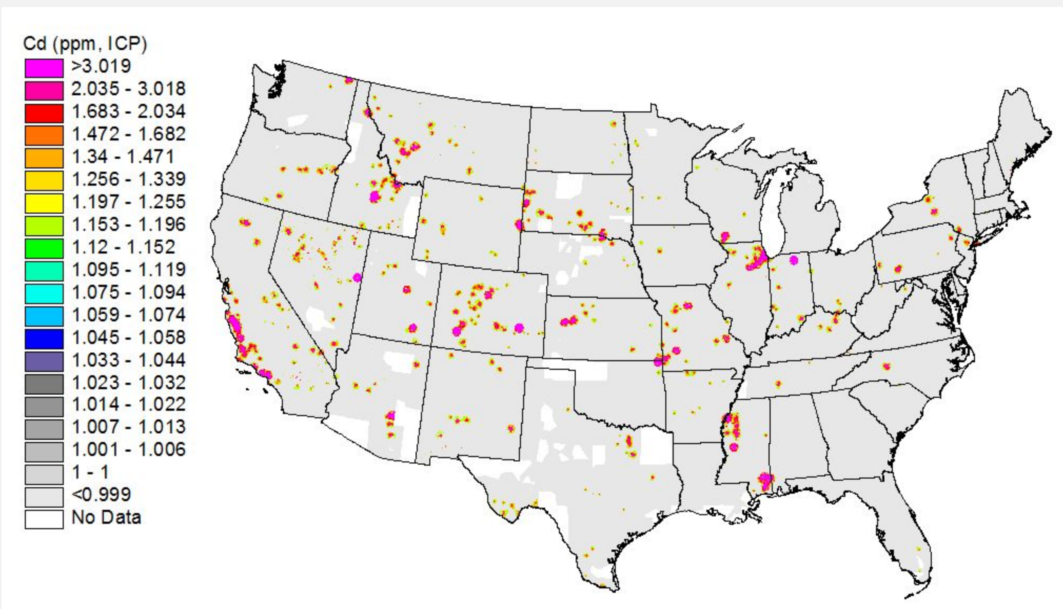
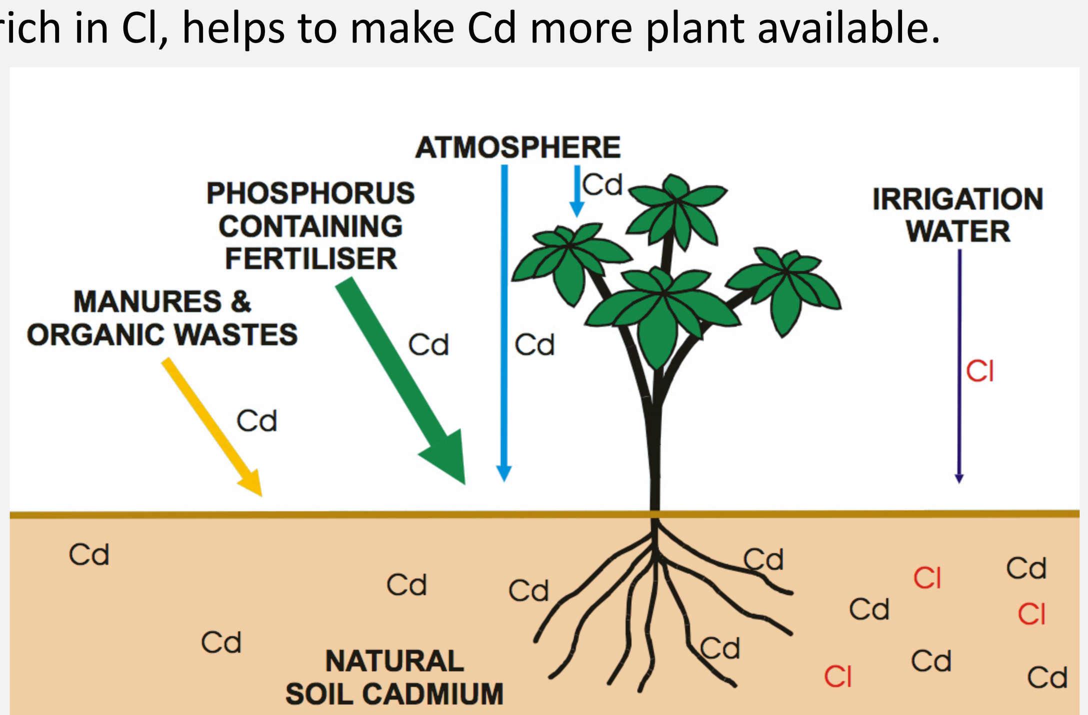
INTRODUCTION

Cadmium-soil contamination In USA



Source: Ernst (2012).

- Cadmium is a non-essential **heavy metal** and **persists** in the environment. It **accumulates** in the food chain (half-life in human kidney: 10-30 years) and is **toxic** for organisms at very low concentrations. Non-smoking humans are exposed mainly by ingestion of **contaminated food**.
- **Sources of Cd**: Geogenic, manure, phosphorous fertilizers and atmospheric deposition. Irrigation with recycled water, usually rich in Cl, helps to make Cd more plant available.



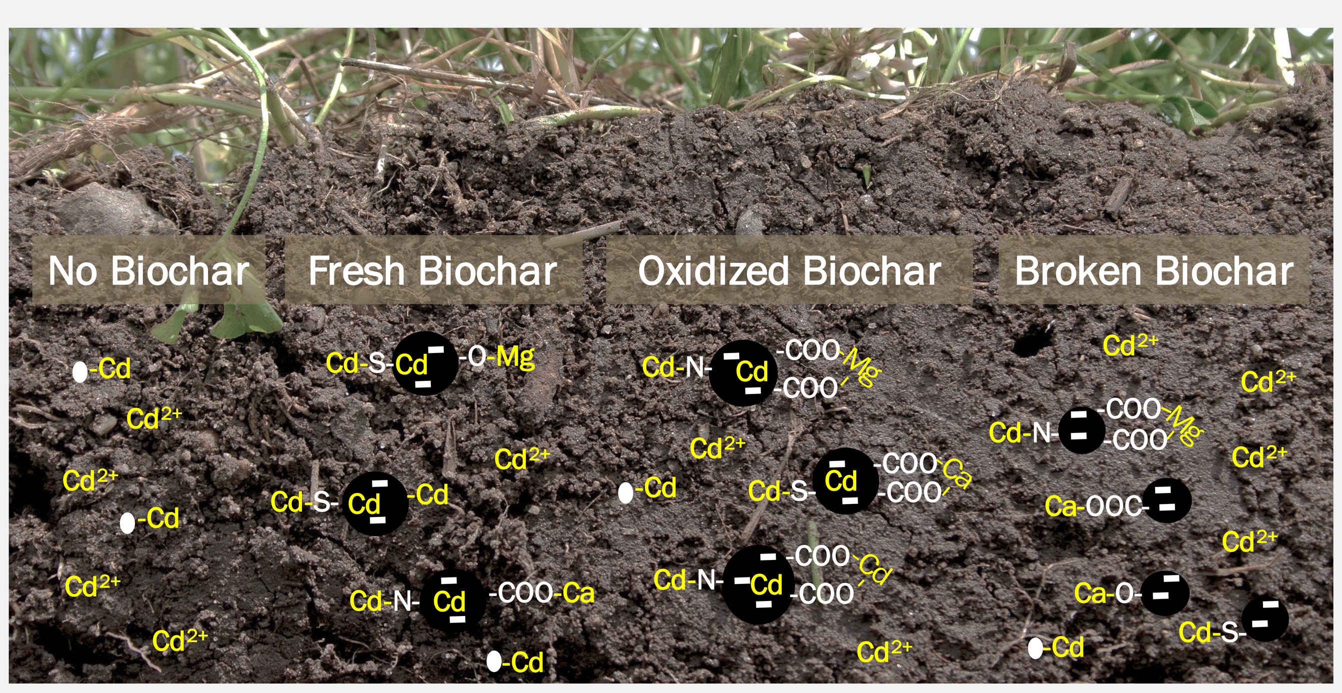
Source: ACMS (2003).

OBJECTIVE

To explain and quantify differences in Cd retention between fresh and oxidized biochars (charcoal produced via pyrolyzed organic matter).

HYPOTHESIS

Though biochar can be effective for Cd retention, biochar **weathering will cause mixed effects depending on their degree of aromaticity.**



METHODS

Experimental Matrix:

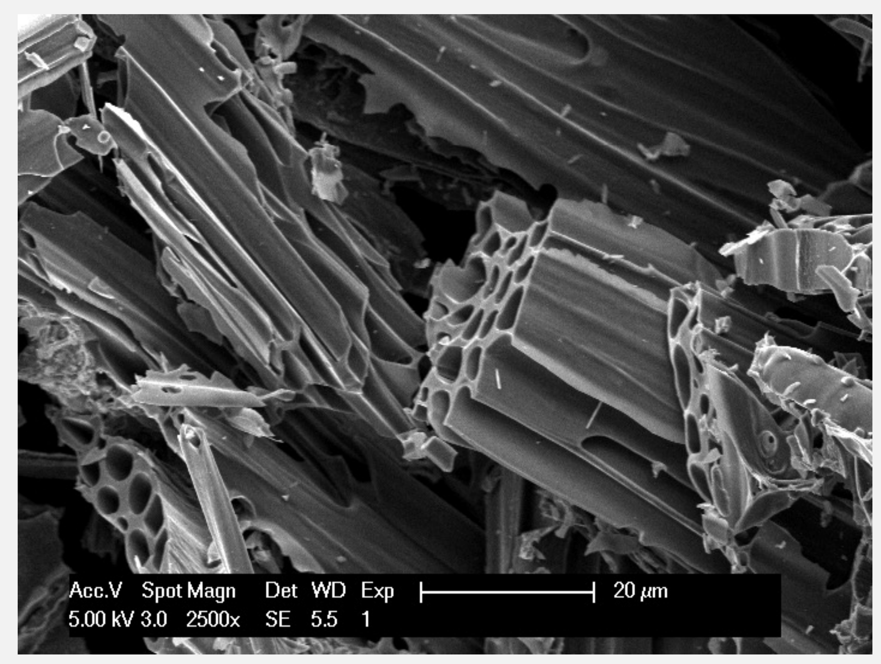
#	Sample ID	Pyrolysis	Temp. (ºC)	Feedstock	Post treatment
1	CP1 raw	Slow	600	Coconut shell	No
2	CP2 raw	Slow	650	Softwood	No
3	CP1*	Slow	600	Coconut shell	Yes***
4	CP2**	Slow	650	Softwood	Yes***
5	CP3*	Slow	600	Coconut shell	Yes***
6	CP8*	Slow	600	Coconut shell	Yes***
7	CP10*	Slow	600	Coconut shell	Yes***
8	ASB	Fast	500	Almond Shell	No
9	WSB	Fast	500	Walnut shell	No
10	P2	Gasification	900	Walnut shell	No
11	SWB	Gasification	800	Mix Softwoods	Yes: inoculation

*Based on CP1 raw. ** Based on CP2 raw. ***Proprietary information at present.

Biochar characterization:

Properties measured
pH & EC
WHC & CEC
Moisture, Volatile & Ash%
DOC & Dissolved N
Total C, N, S*, H%
Total elements - ICPMS
FTIR & SEM-EDS
Alkalinity
Particle size distribution
BET Surface Area (N_2)*

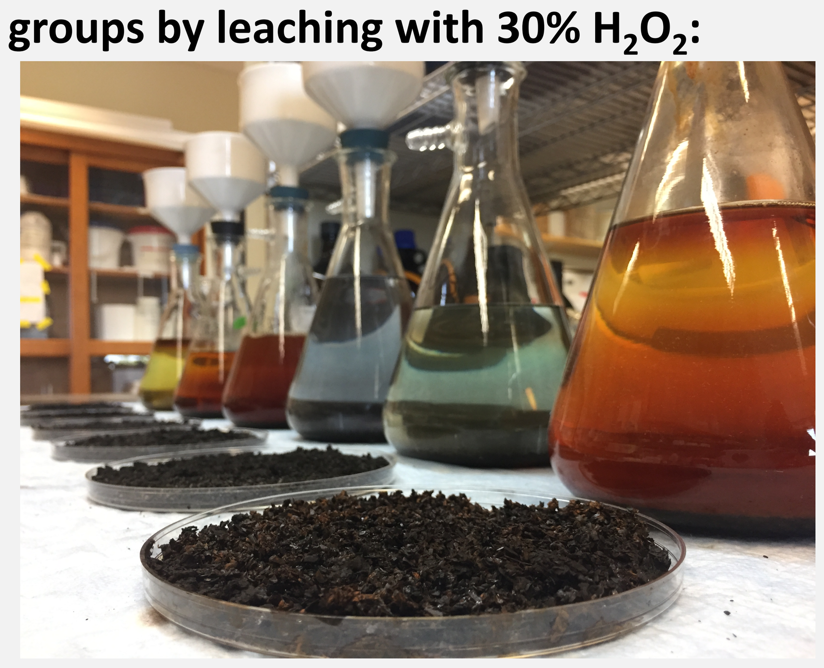
*Pending



Sorption & desorption isotherms at pH 7:

- Solid-liquid ratio: 1:25
- Solution: NP H_2O + 5 mmol L^{-1} NaCl
- React 24h (8 rpm at 25ºC).

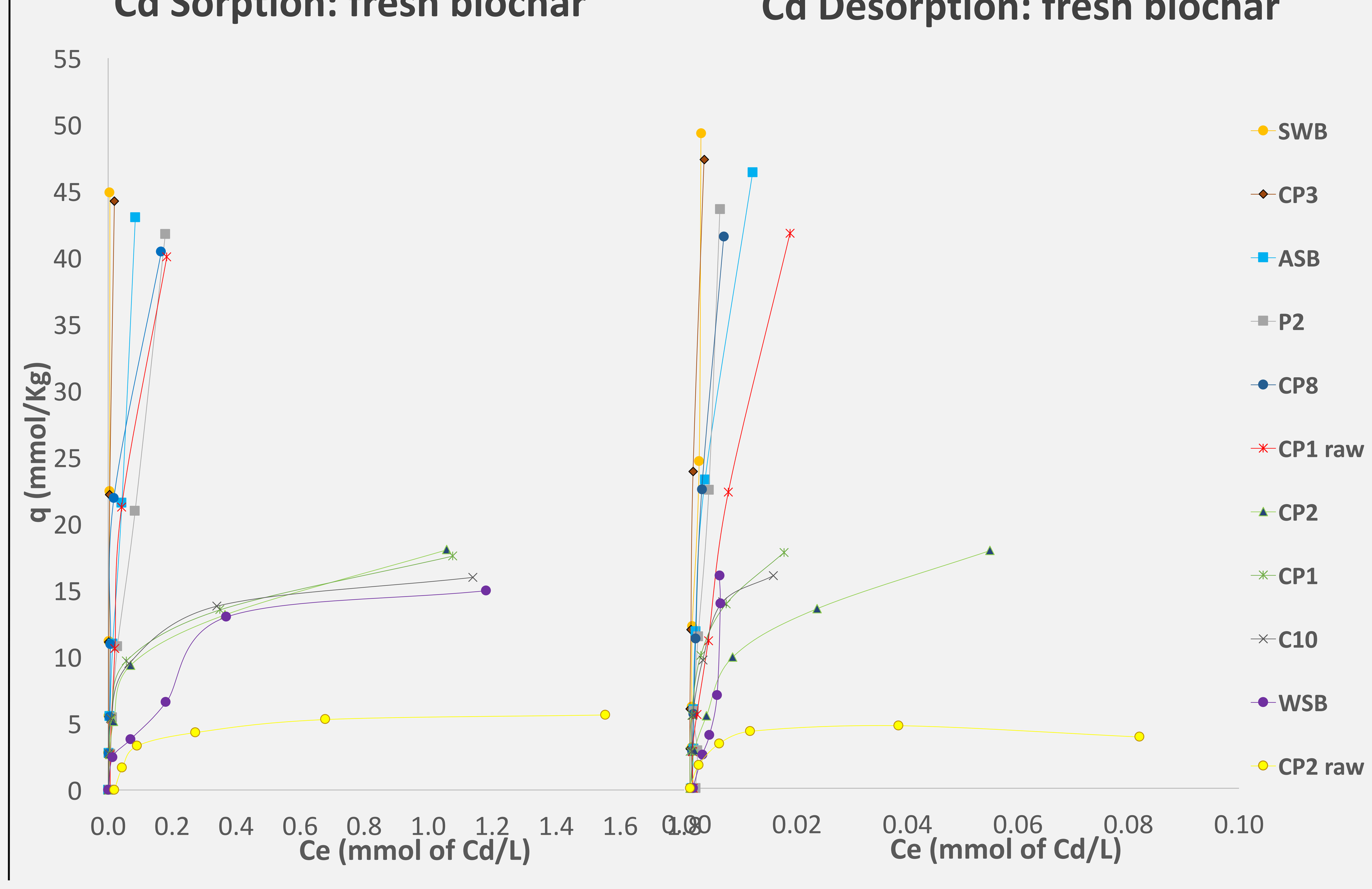
Aging: Increasing oxygenated functional groups by leaching with 30% H_2O_2:



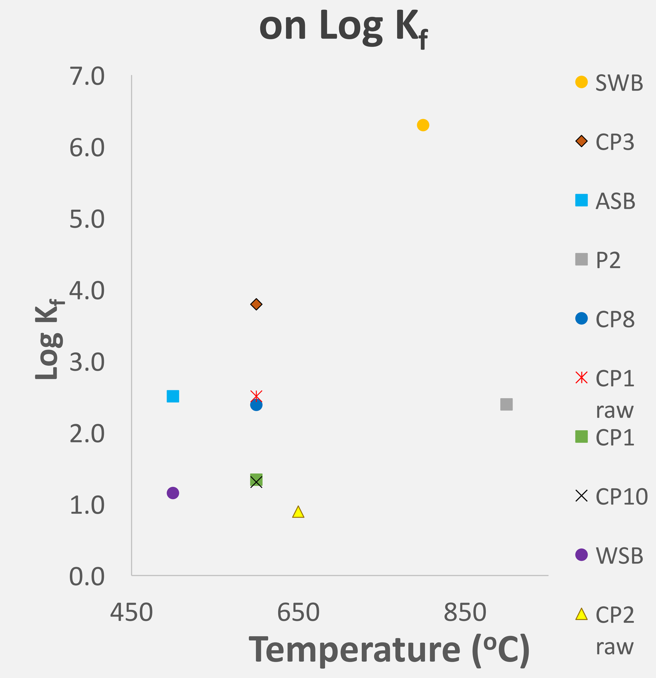
- Shake 2h (120rpm) + 16h reaction time.
- Samples filtrated, and washed with DI H_2O.
- Biochars air-dried for 72h.

RESULTS

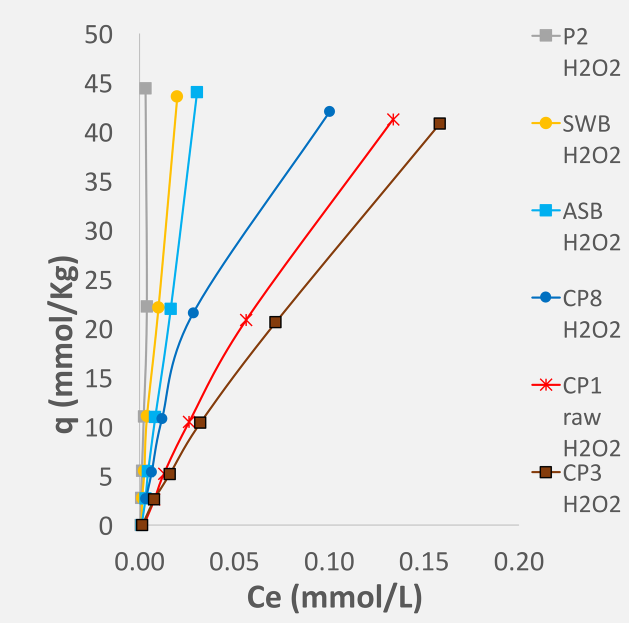
Cd Sorption: fresh biochar **Cd Desorption: fresh biochar**



Impact of pyrolysis temperature on Log K_f

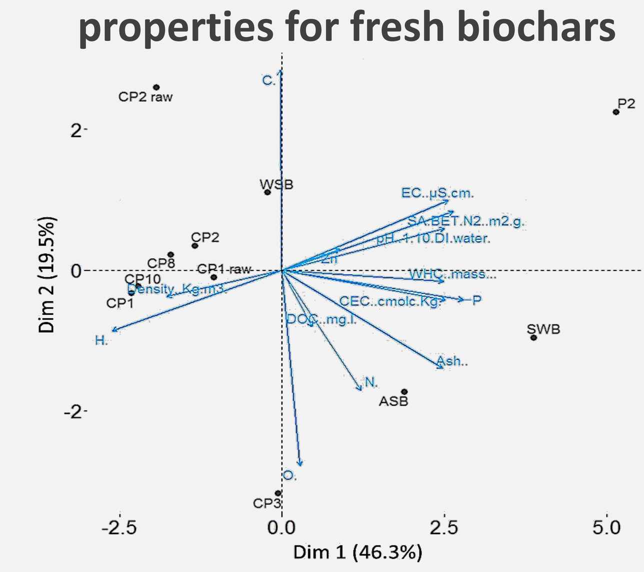


Cd Sorption to oxidized biochars

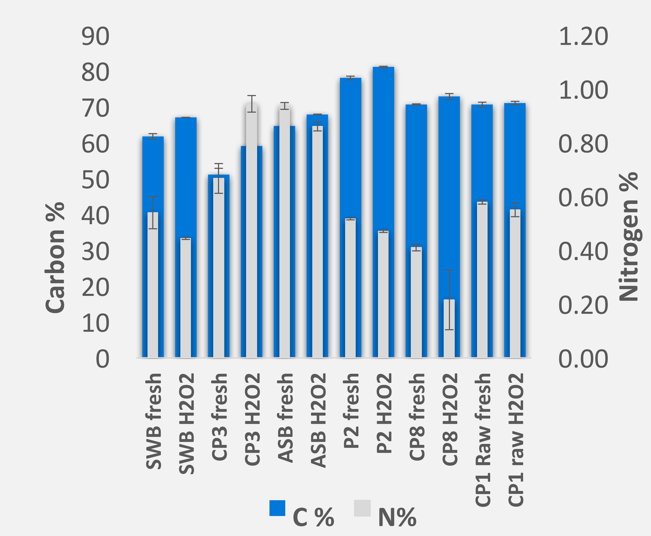


Freundlich Model	Fresh		Oxidized		Δ log K_f
Sample	log K_f	R^2	log K_f	R^2	(%)
SWB	6.29	0.967	3.74	0.949	- 41
CP3	3.79	0.842	2.22	0.988	- 41
ASB	2.50	0.991	3.42	0.995	+ 37
P2	2.39	0.955	5.69	0.934	+ 138
CP8	2.38	0.896	2.55	0.976	+ 7
CP1 raw	2.50	0.860	2.45	0.994	-2

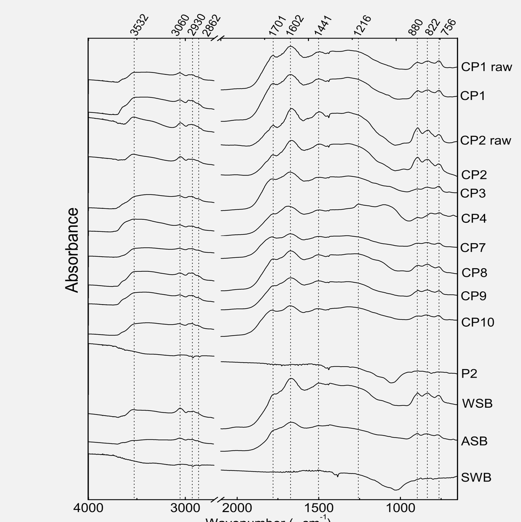
Correlations between the properties for fresh biochars



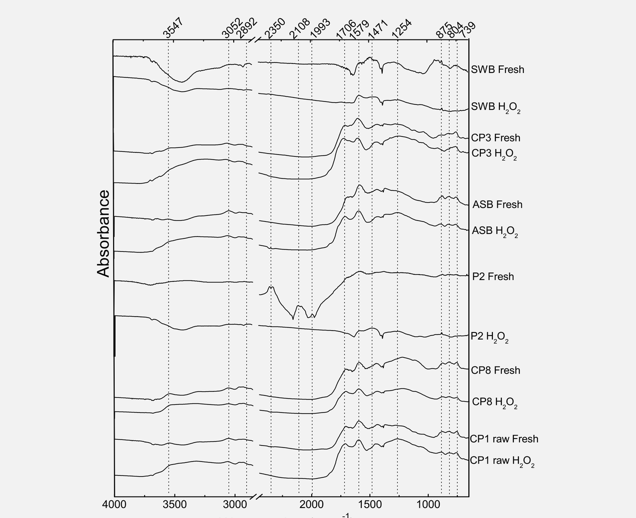
C and N % for fresh & oxidized biochars



DRIFTS: fresh biochars



DRIFTS: fresh & oxidized biochars



SUMMARY

- No trend between pyrolysis temperature and Cd retention
- Cd retention does not correlate with a single property and is likely driven by a set of properties, such as: aromaticity, surface functional groups, ash content, CEC, surface area and alkalinity
- Biochar oxidation only increased Cd retention in highly aromatic chars

NEXT STEPS

- Complete characterization to compare fresh and aged biochar
- Complete 1 yr incubations & evaluate additional aging effects
- Analyze competition between Cd and essential elements

REFERENCES

Ernst, WG 2012. Overview of naturally occurring Earth materials and human health concerns. *J of Asian Earth Sci*, *59*, 108-126

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