



**Changes in the binding form of copper and zinc  
in sewage field soil by addition of biochar after  
eight years of field exposure**

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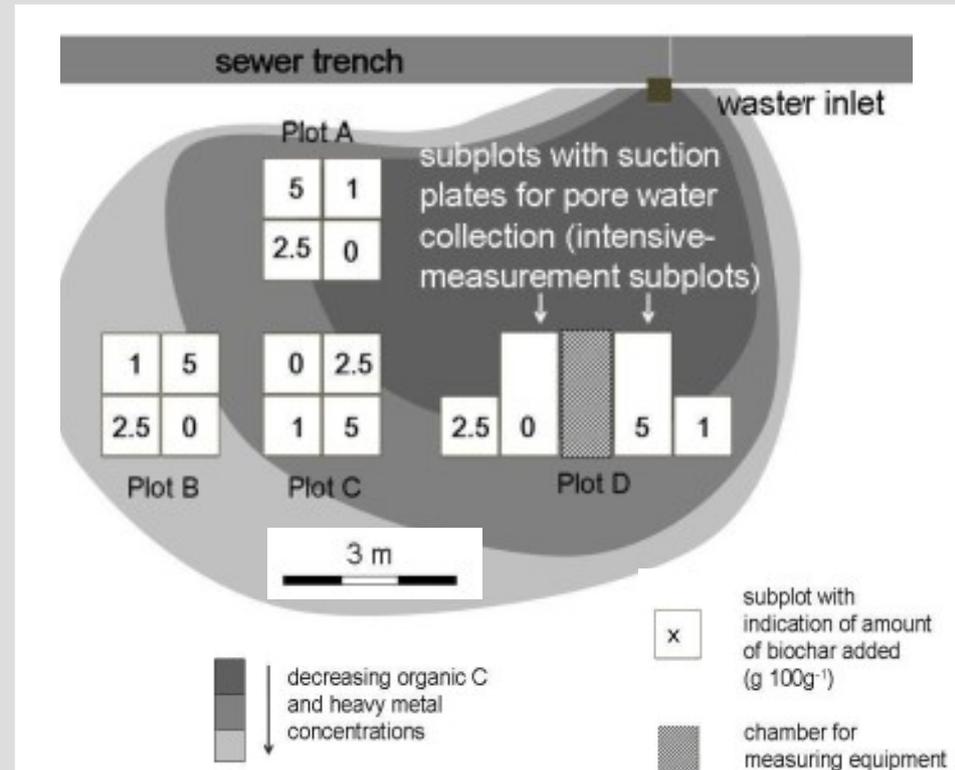
# Background & Hypothesis

In previous field studies we analyzed the short-term effects of biochar (BC) on heavy metal mobility on former sewage fields

Schweiker et al. (2014), Wagner & Kaupenjohann (2015)

Now we are interested in aging of heavy metal binding form under field conditions.

We hypothesise that BC causes shifts from weaker to stronger heavy metal binding forms.



# Materials and Methods

## Soil

from sewage field with 0% and 5% biochar addition taken 2011, 2013 and 2019

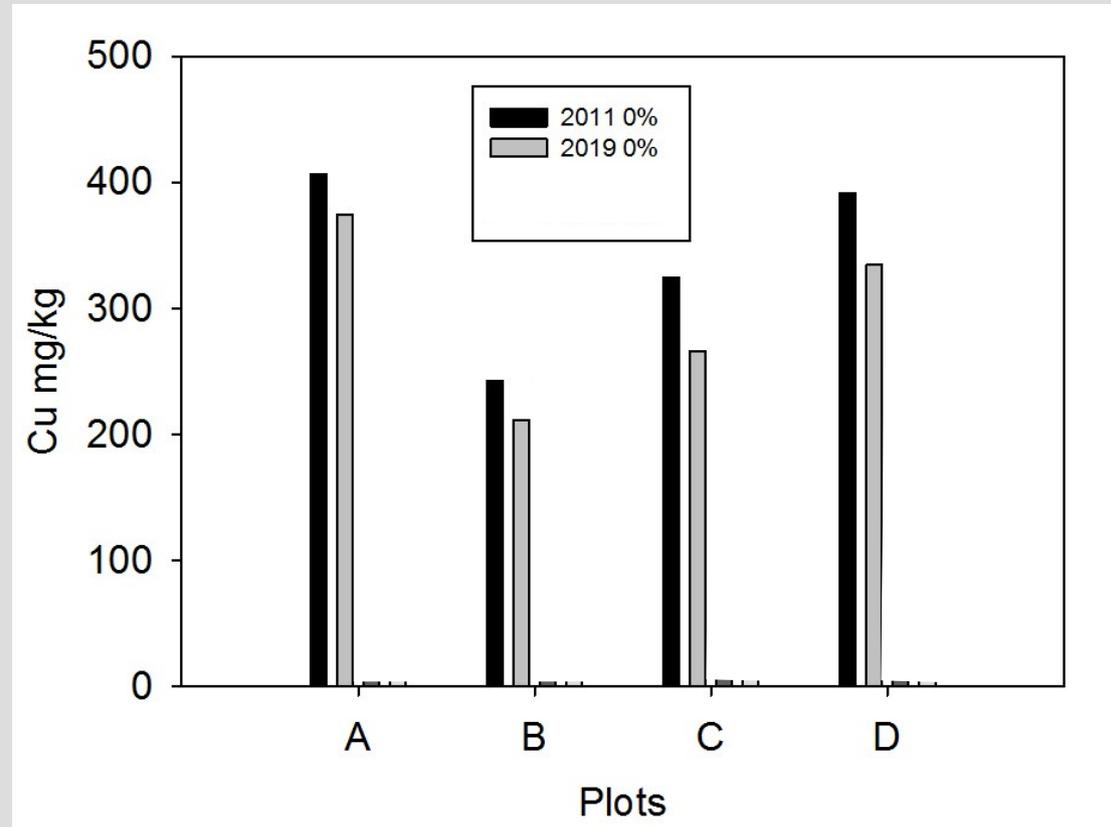
Sequential extraction procedure (Zeien and Brümmer, 1989) slightly changed

I	in water-soluble and exchangeable form
II	in easily available and mobilizable form
III	bound to Mn oxides
IV	bound to organic matter
V	bound to amorphous iron oxides
VI	bound to crystalline iron oxides
VII	<b>bound in residual forms (calculated from total content determined separately by digestion with aqua regia minus metal in other fractions)</b>

# Soil total Cu concentrations

significantly  
decreased from  
2011 to 2019  
without BC  
addition

(mean 13% = 44mg/kg)



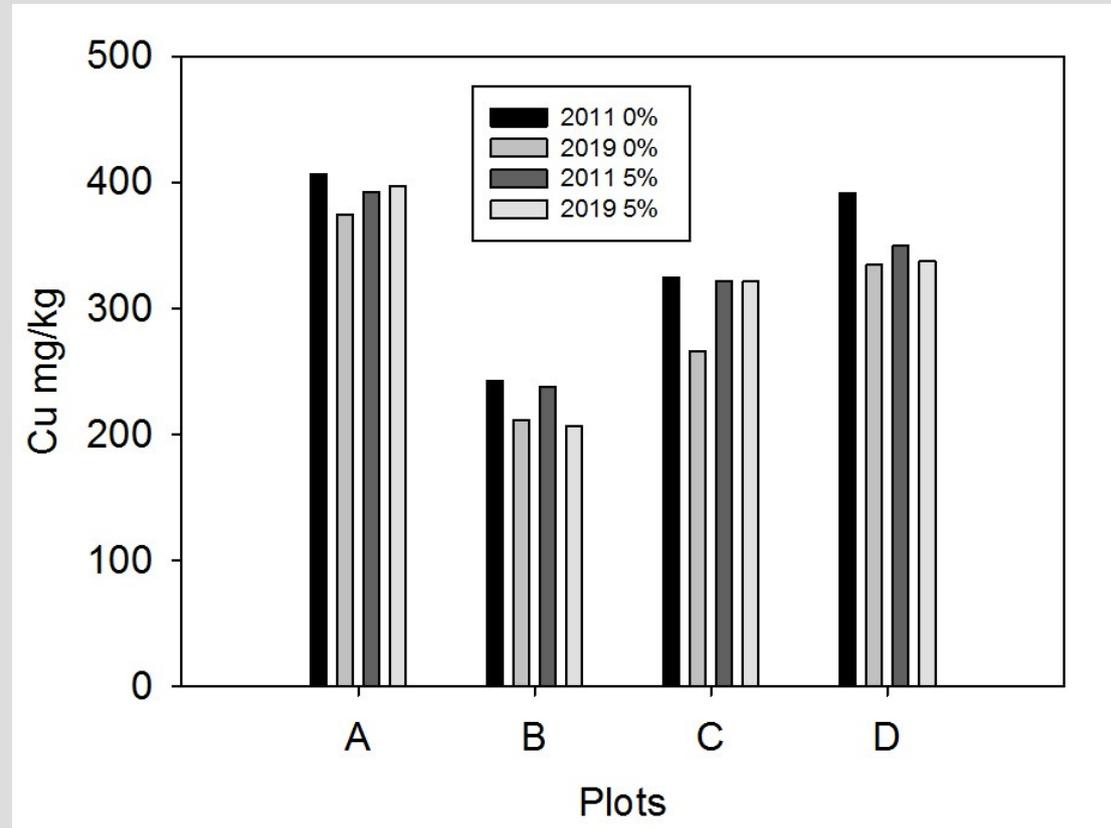
# Soil total Cu concentrations

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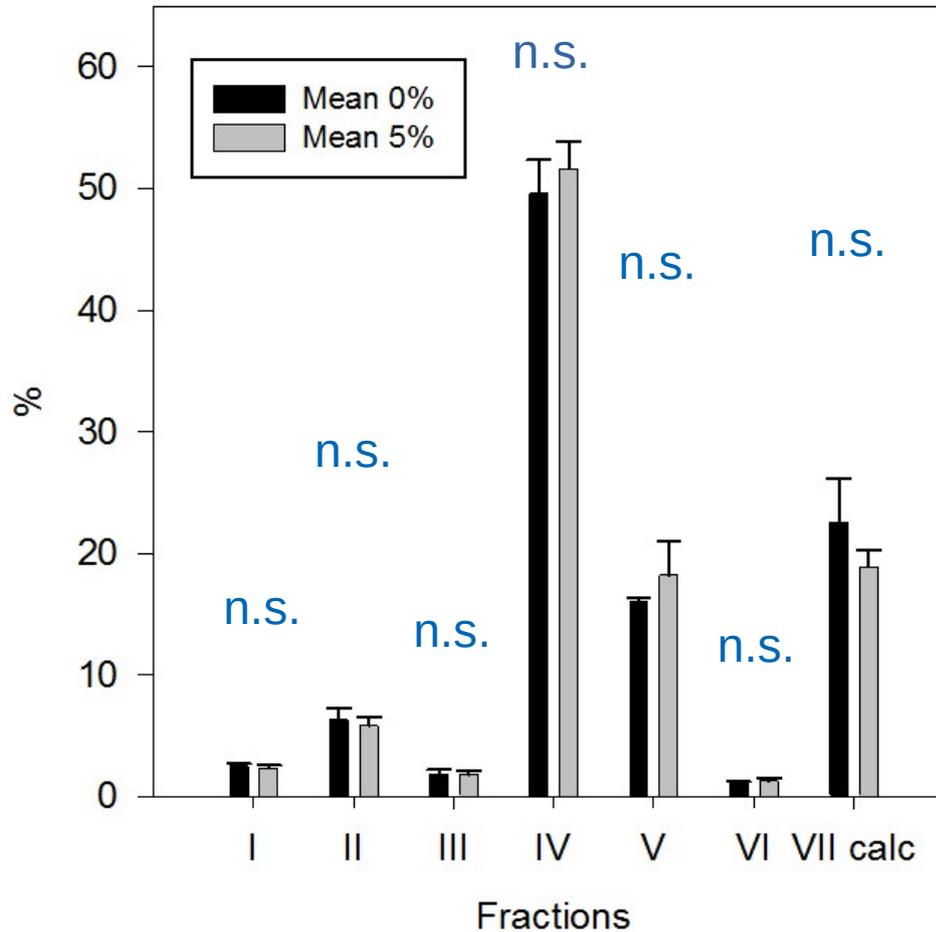
but not with BC -

**Why?**



10 % tolerance in measurement accuracy,... anything else?

# Soil Cu 2011

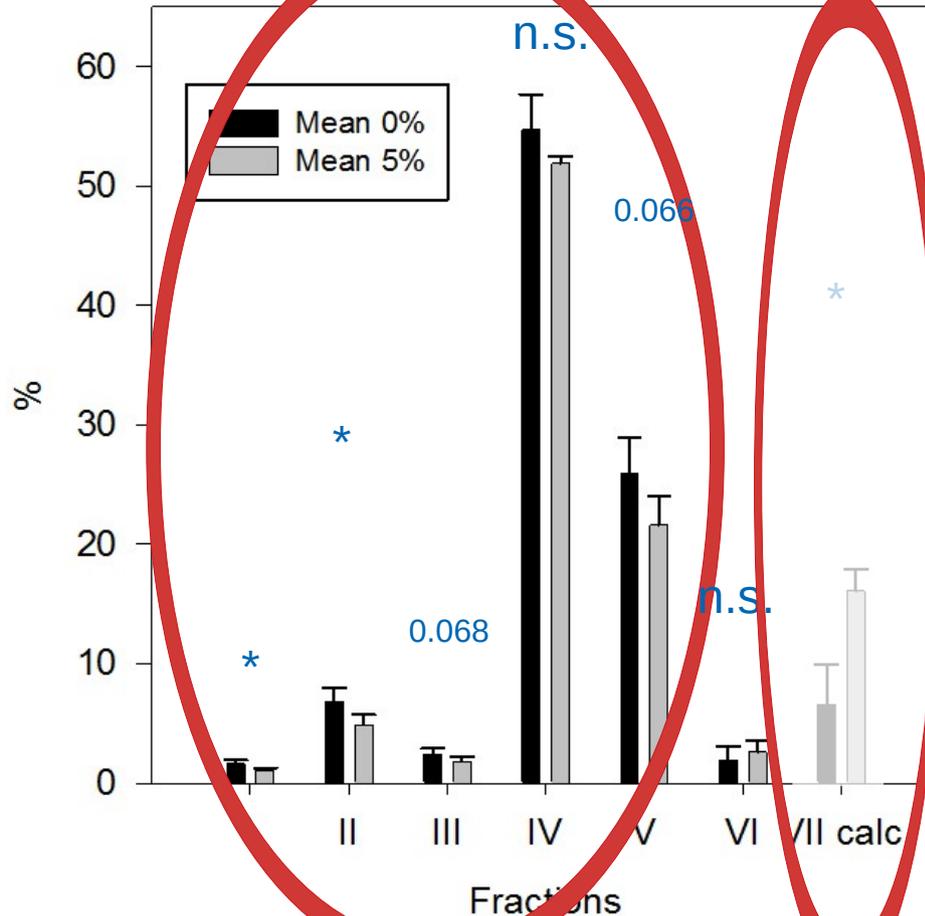


Means and standard deviation

T-test

# Soil Cu 2019

With BC:  
Only small  
changes in Cu  
binding form

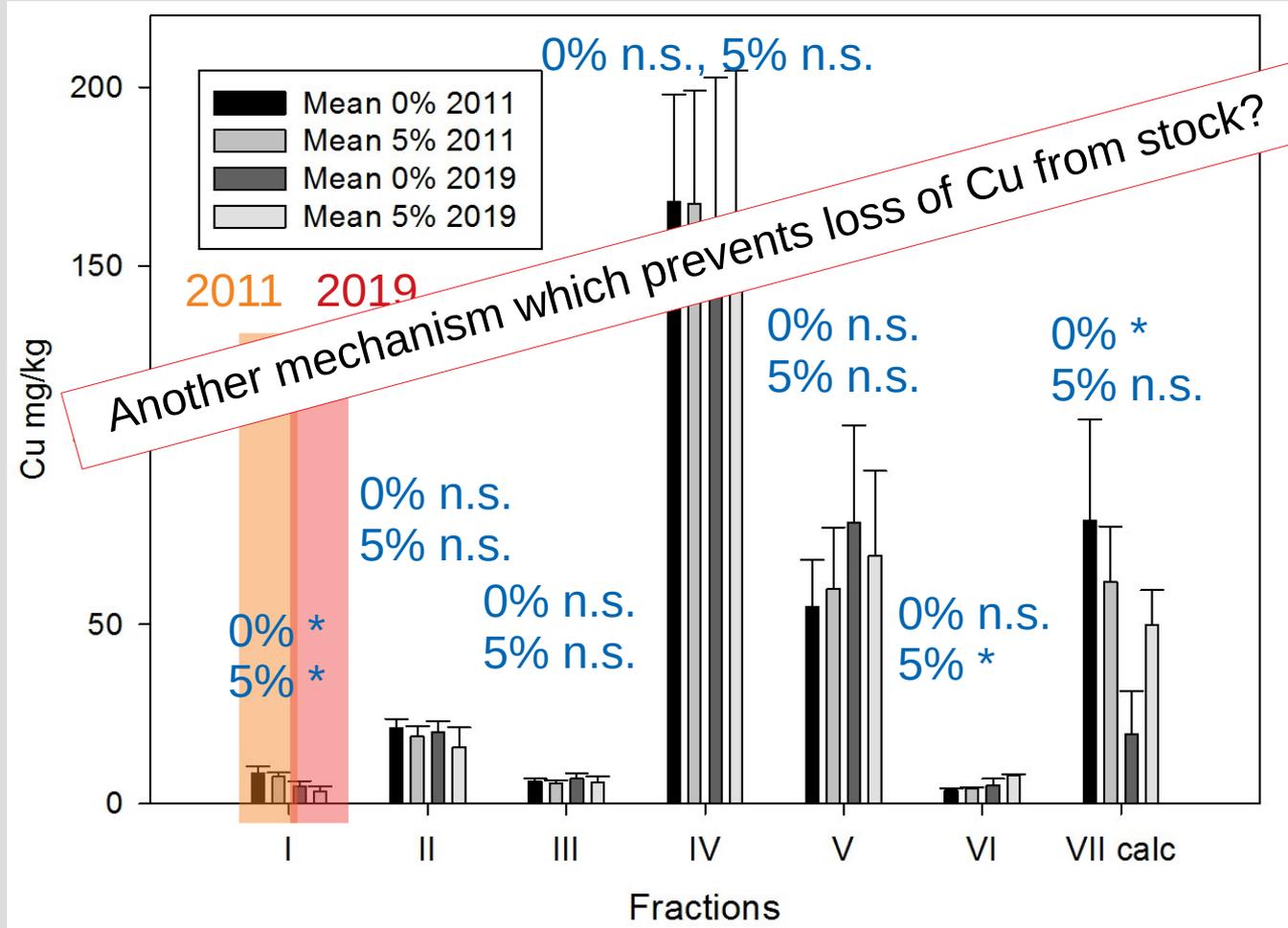


higher Cu content  
in residual fraction with  
BC-  
due to lower total Cu  
concentrations in 0%

Means and standard  
deviation

T-test

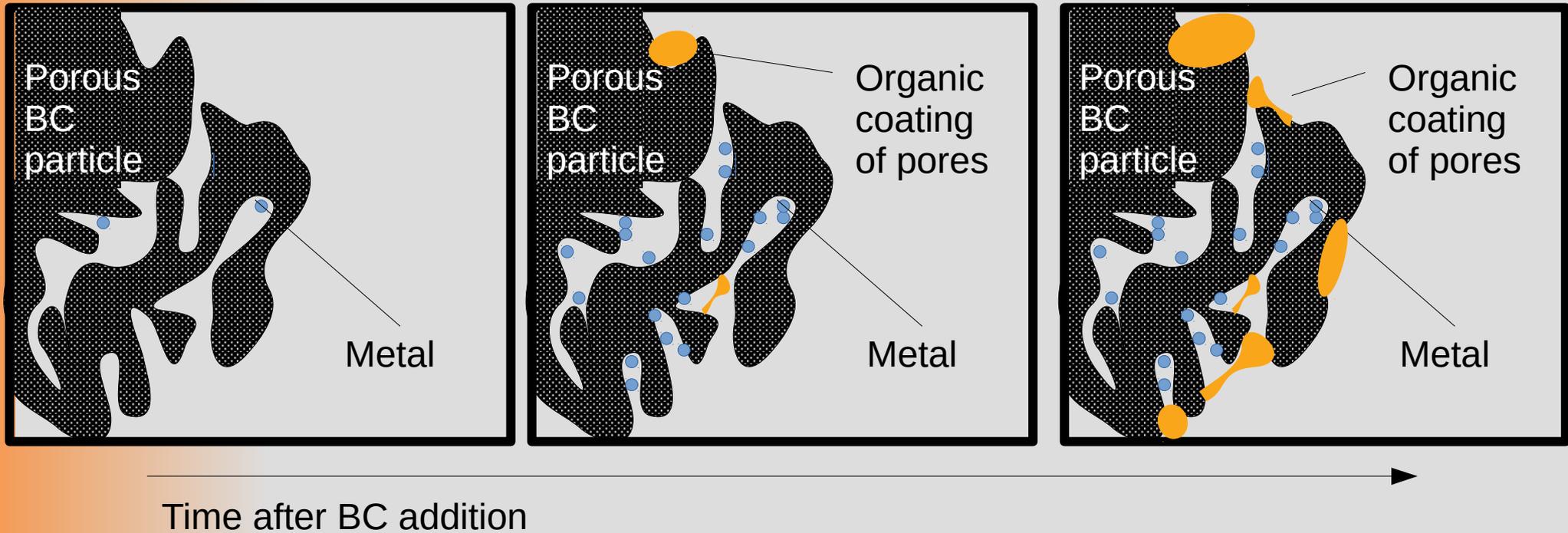
# Soil Cu in mg/kg 2011 vs 2019



Means and standard deviation

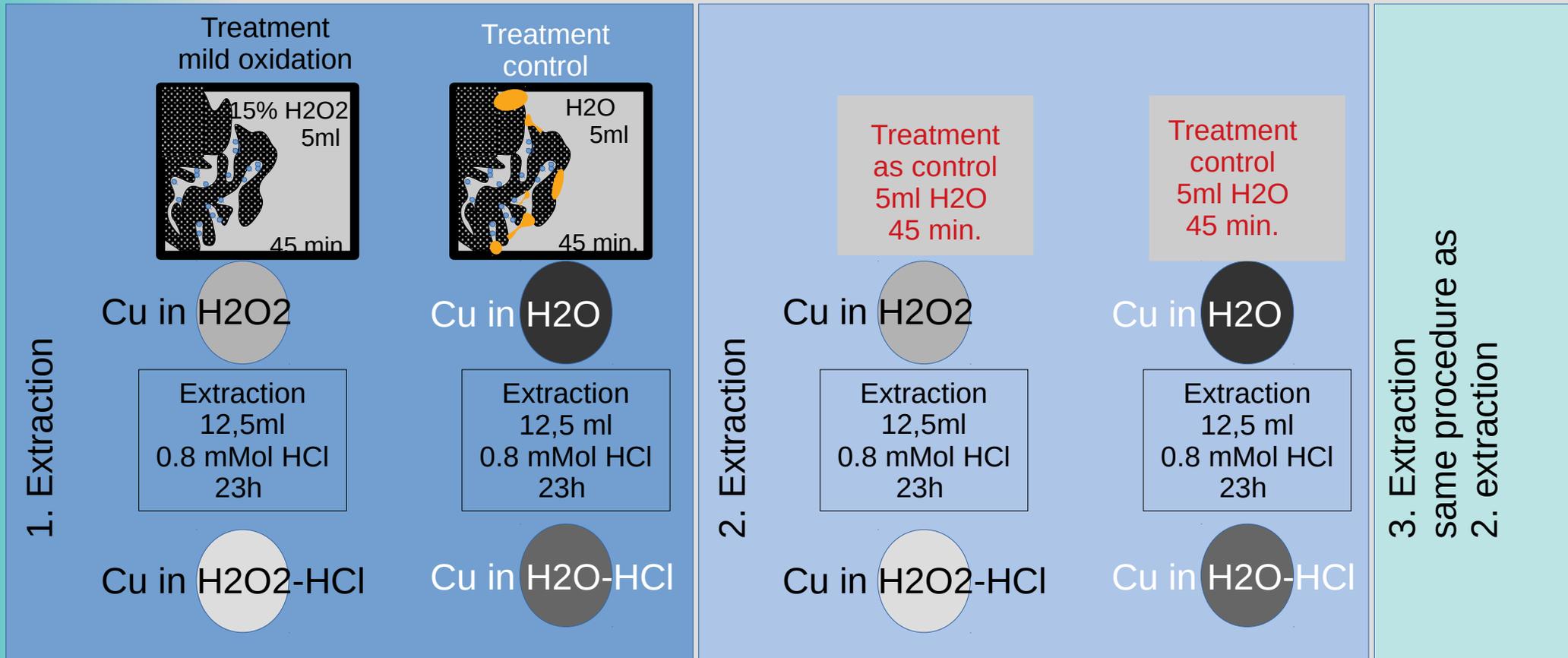
Paired t-test

# Another idea how biochar might prevent loss of Cu?

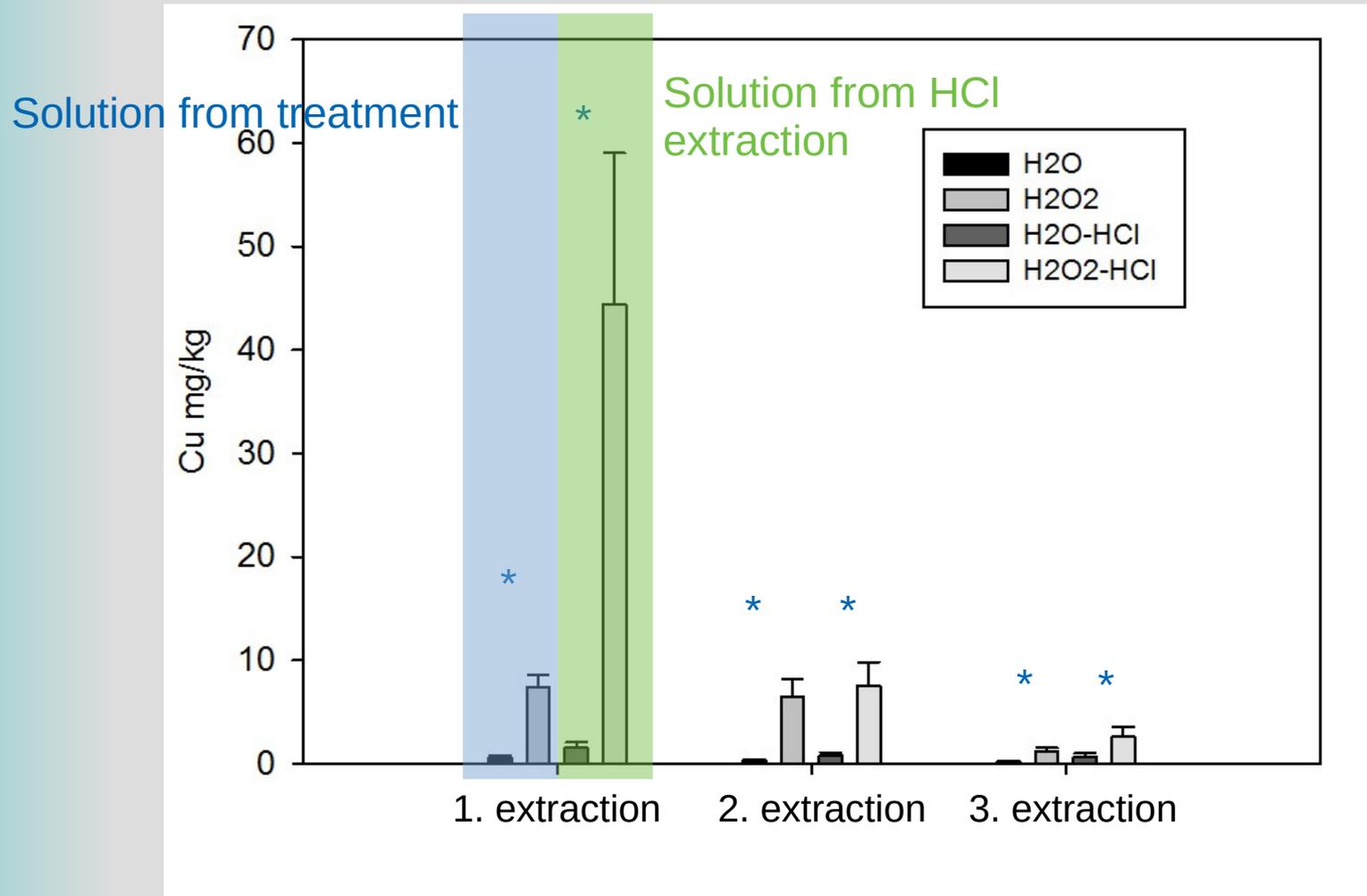


# Successive extraction of aged BC

0.5 g **Biochar particles** (>1mm) picked from sewage field with 5% biochar addition after 8 years of field exposure



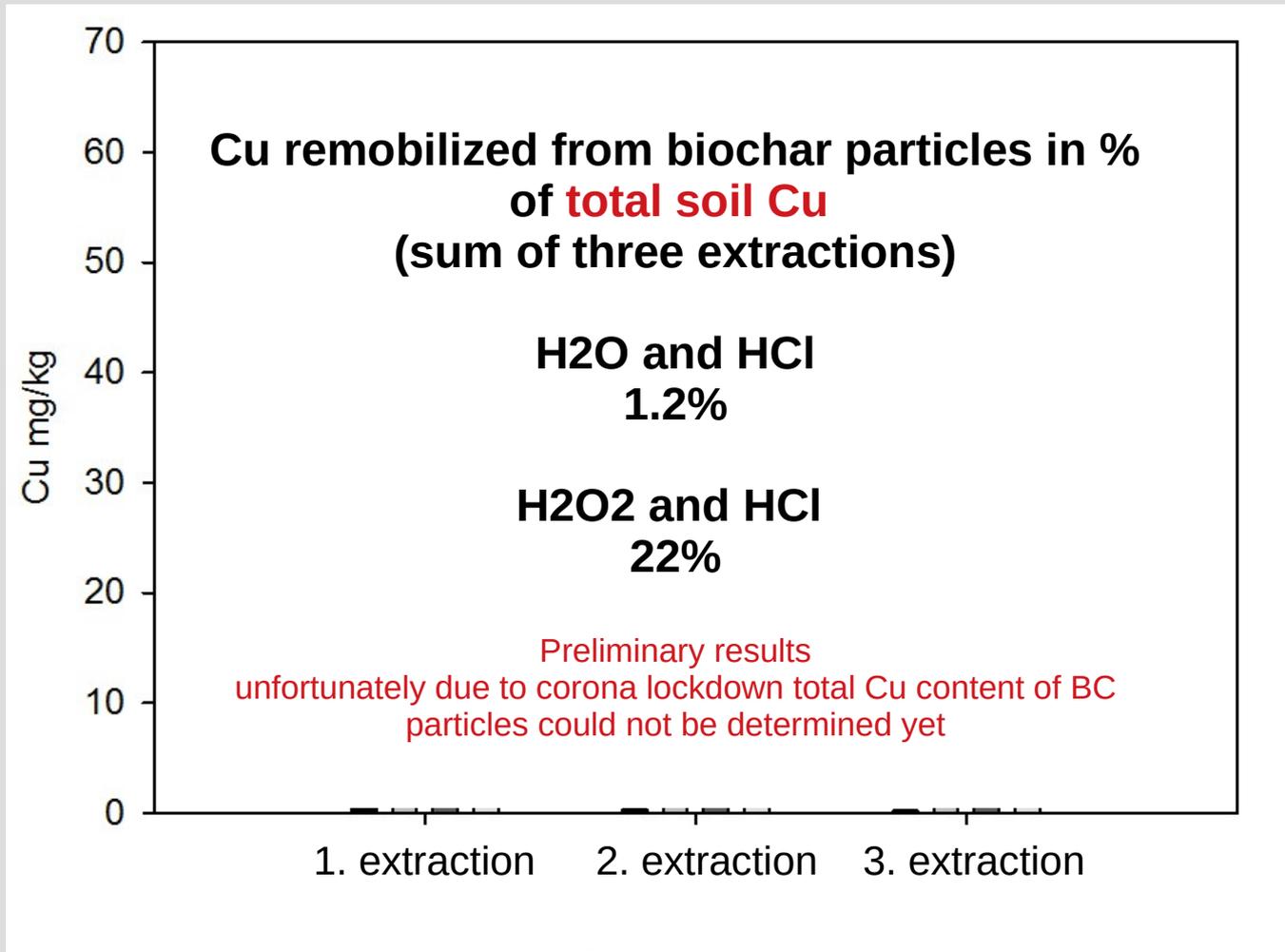
# Cu in biochar particles 2019



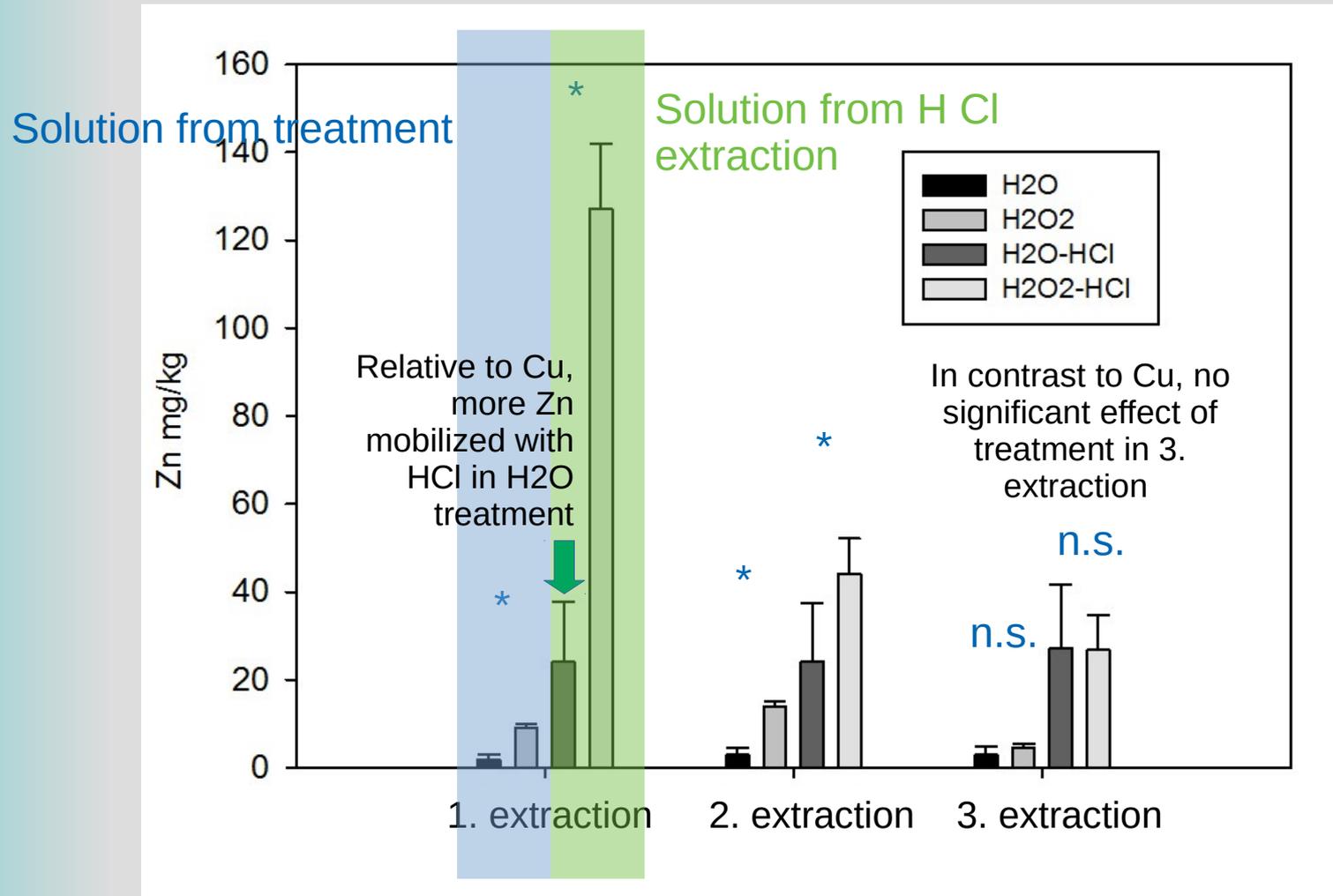
Means and standard deviation

T-test

# Cu in biochar particles 2019



# Zn in biochar particles 2019



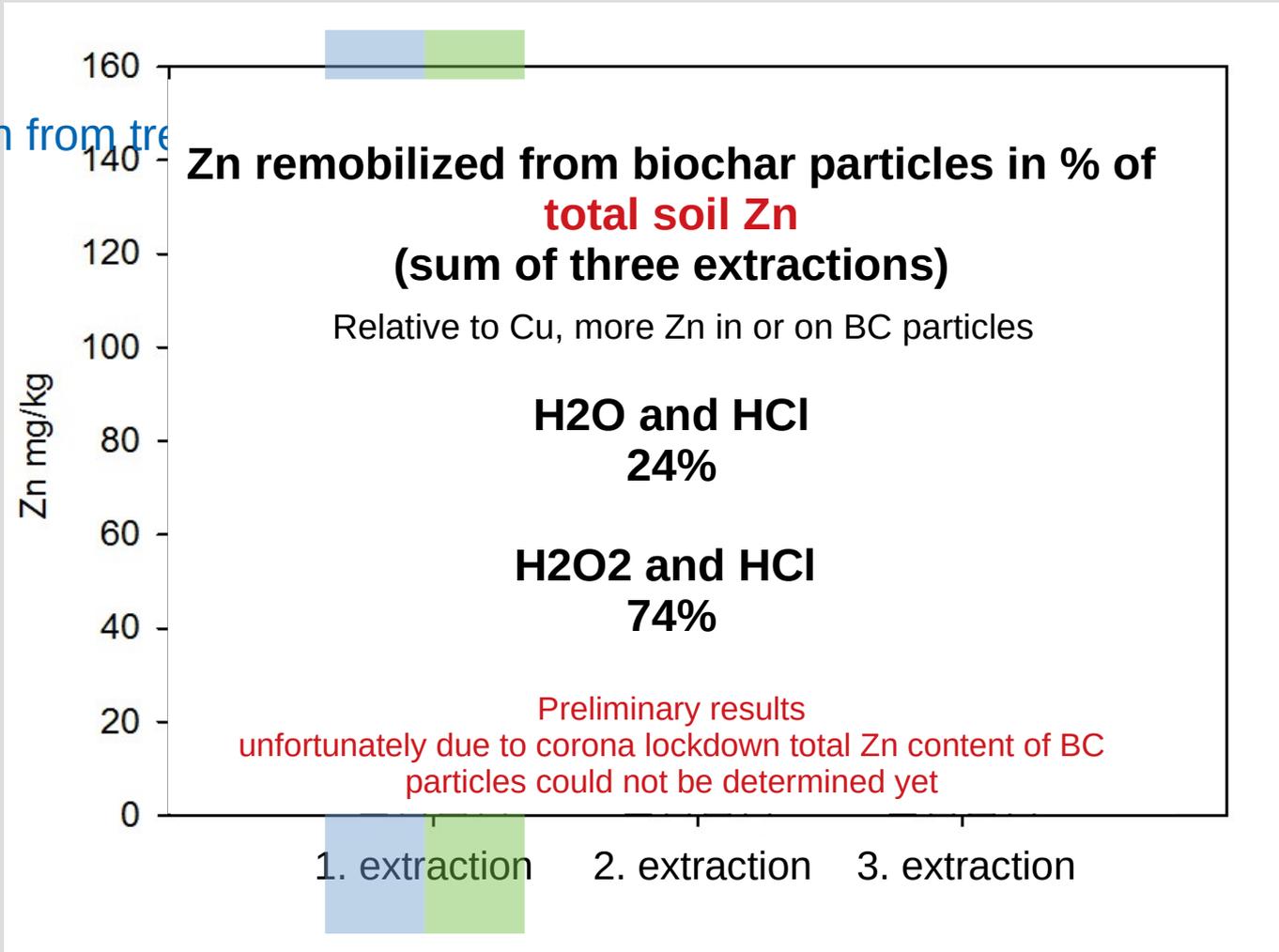
Zn is found **inside and on the surface of BC particles** which dissolves successively with each extraction step

Means and standard deviation

T-test

# Zn in biochar particles 2019

Solution from tree



Means and standard deviation

T-test

# Summary and Conclusions

- (1) BC reduces loss of Cu from stock
- (2) This is not seen in an increase of Cu in stronger binding forms according to Zeien and Brümmer
- (3) We assume that Cu und Zn diffuse in pores of BC and are fixed and trapped inside

Thank you!