

# Phytoremediation of groundwater contaminated with halogenated volatile organic compounds

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## INTRODUCTION

Halogenated volatile organic compounds (VOCs) are in the first row of contaminants where lack of economic remediation technologies combines with high abundance of contaminated sites. About one third of all contaminated sites in Austria are expected to contain halogenated VOCs as the primary contaminant. Sites where halogenated VOCs are expected are former laundries and grease removal plants. Currently the standard methods for remediation of halogenated VOCs are pump & treat for groundwater or soil gas extraction for the vadose zone, which can become very expensive due to long running times. Thus, alternative possibilities for in situ remediation technologies like phyto-remediation are explored. Phytoremediation might be a cheap method for treatment of smaller sites at the edge of villages (like many grease removal plants) where open areas for planting of trees are provided, but that are too small for expensive remediation methods like pump and treat.

## RESULTS

- A toxicity test showed no significant influence of 16.8 mg/L trichloroethene on *Populus nigra* L. cv. Max 5
- Pot experiment simulating a soil / ground water system



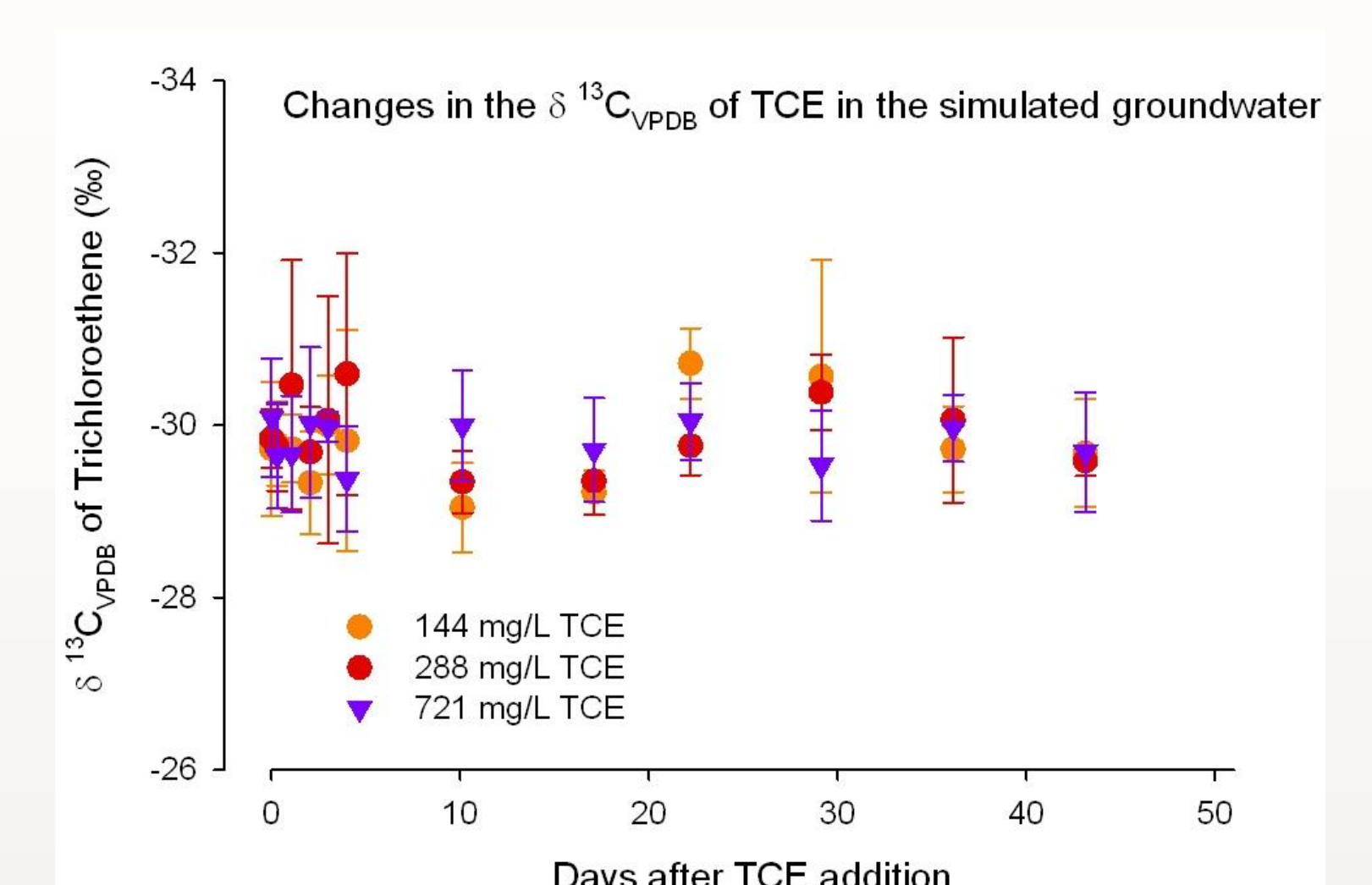
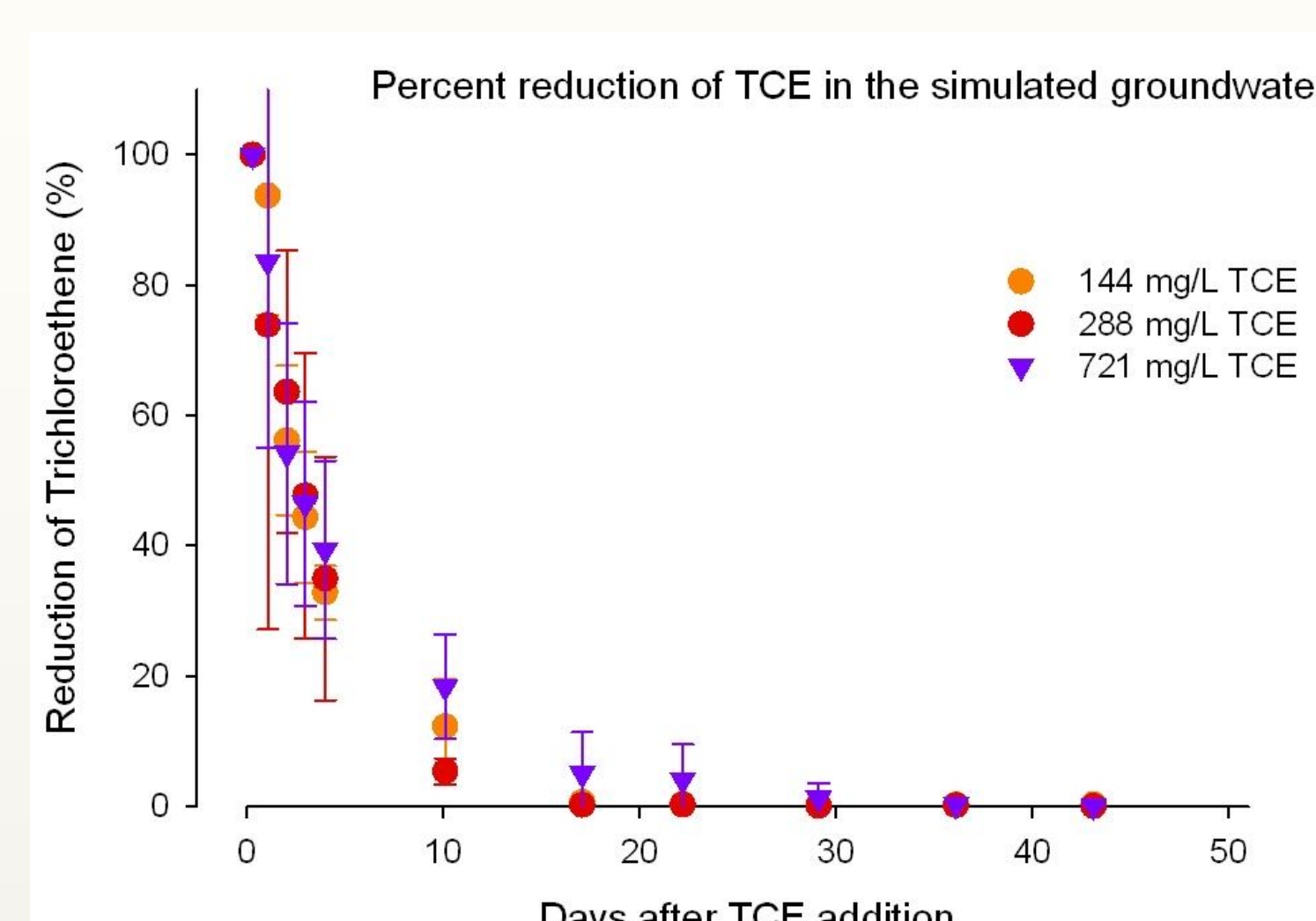
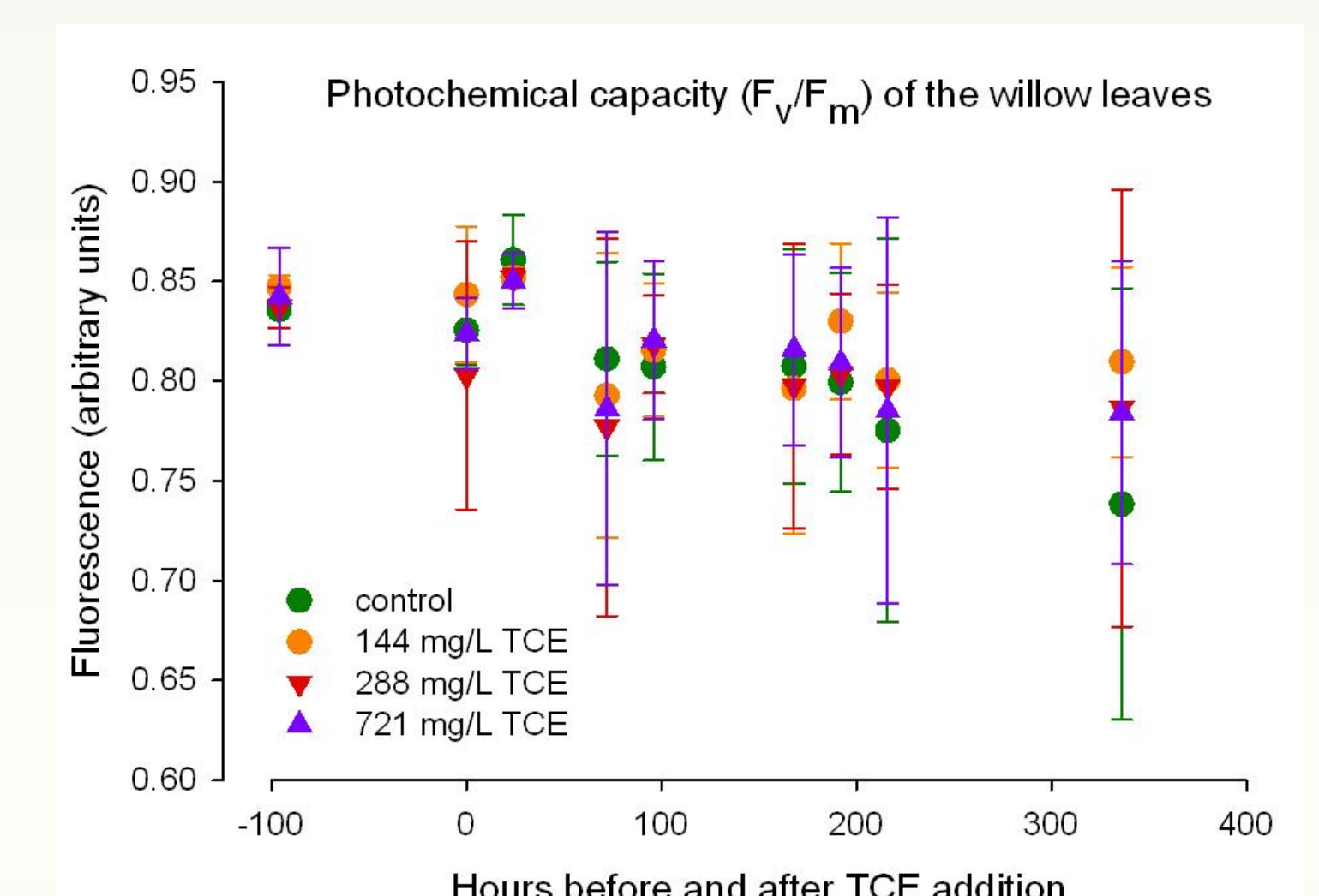
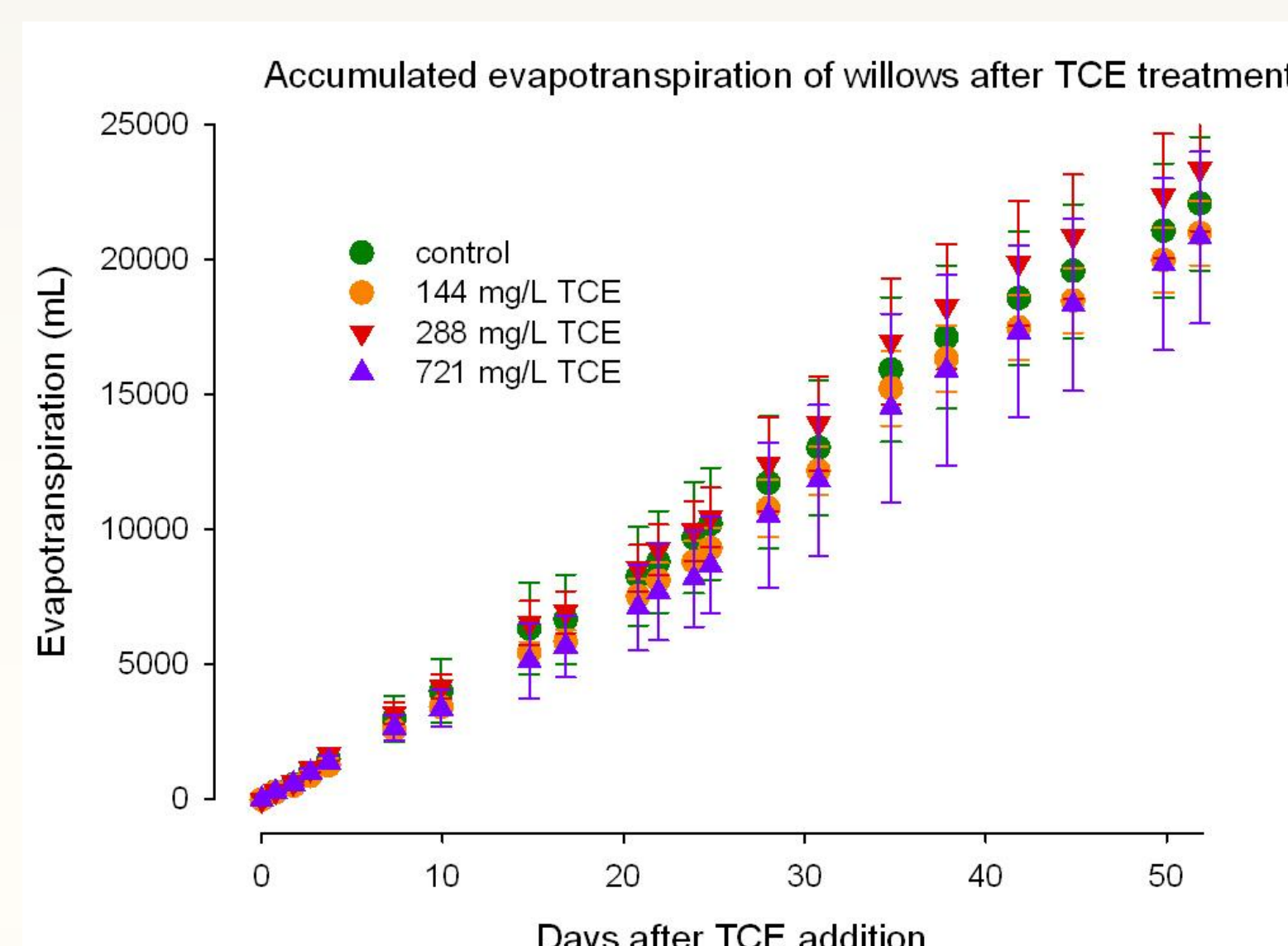
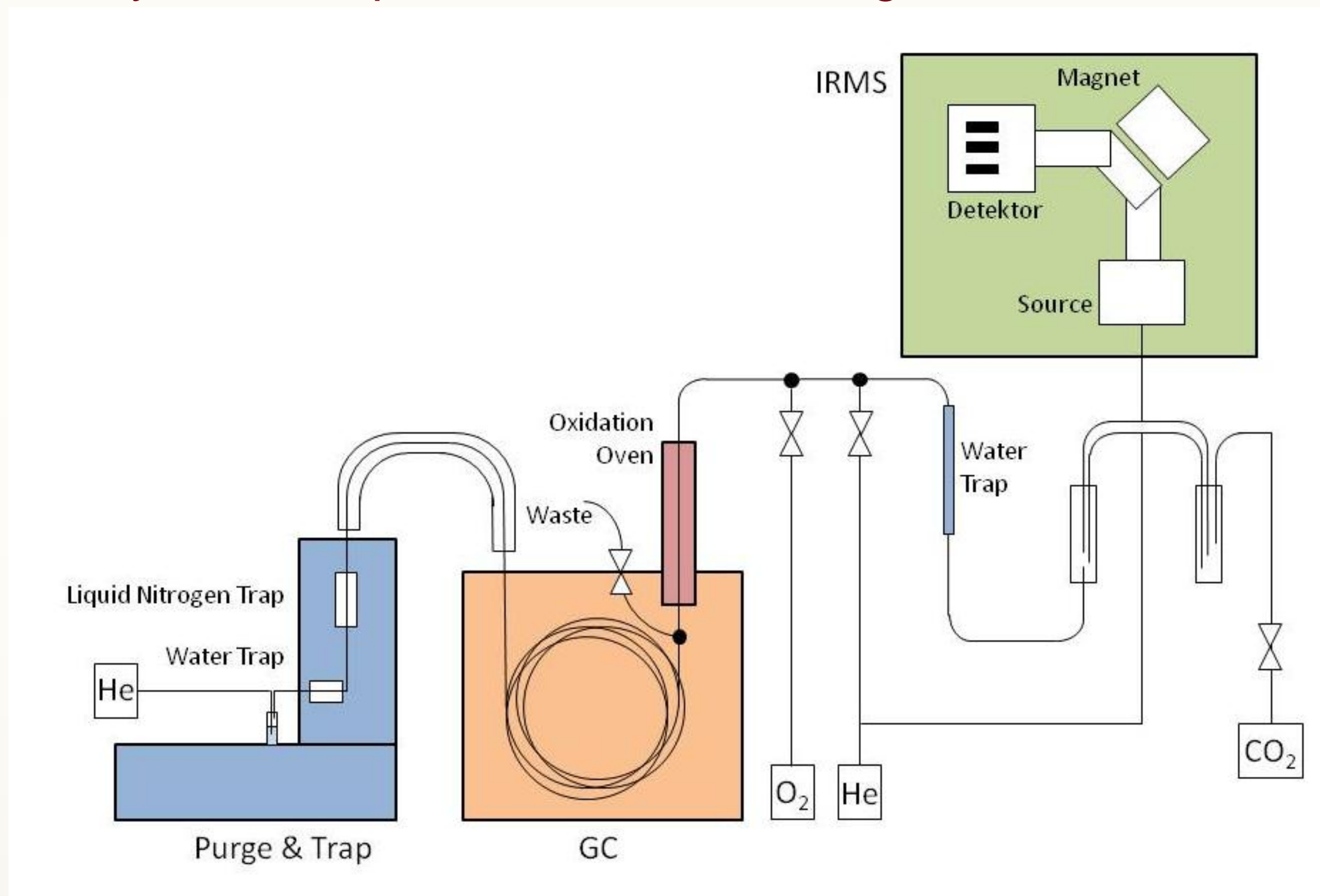
Trichloroethene (TCE) treatment:

- 0 mg/L TCE (control)
- 144 mg/L TCE
- 288 mg/L TCE
- 721 mg/L TCE

Monitoring:

- Evapotranspiration
- Photochemical activity
- Concentration and  $\delta^{13}\text{C}$  of TCE in the ground water

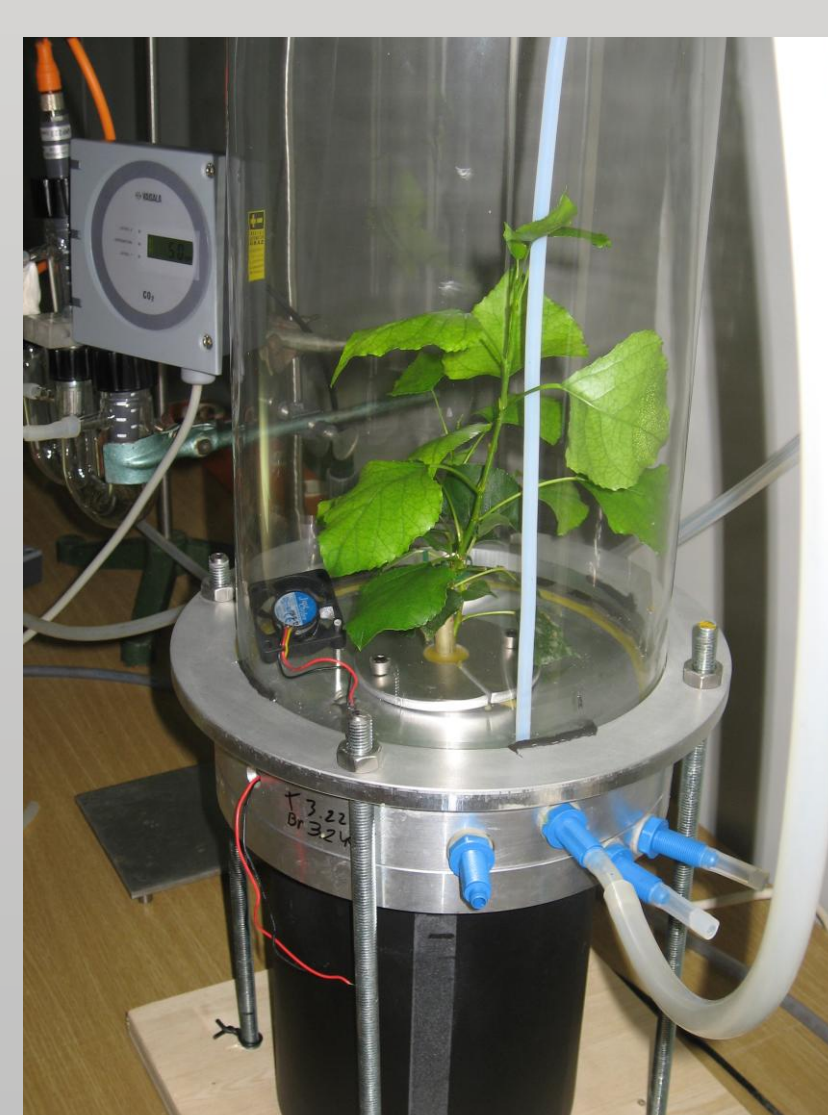
## Analytical set up to measure $^{13}\text{C}$ halogenated VOCs



## EXPERIMENTAL DESIGN & METHODS

The focus of our work is to contribute to open research questions concerning phytoremediation of halogenated VOCs. Compound specific stable isotopic methods are used to gain insight into the behaviour of halogenated VOCs in plants and to contribute to its profound application as a monitoring tool in the field. The following work was conducted or has been started:

- Toxicity testing of poplar trees (*Populus*)
- Pot experiment simulating a soil / ground water system
- Closed hydroponic microcosm experiment



Closed hydroponic microcosm experiment – TCE balance calculation (water, plant, air)

## CONCLUSION

- Trichloroethene (TCE) concentrations of up to about 500 mg/L neither showed a reduction of the transpiration and the photochemical capacity (measured by dark adapted chlorophyll fluorescence) nor visible toxic effects on poplar and willow plants.
- The TCE concentrations decreased by about two third in a groundwater simulating pot experiment after 4 days and reached a value below 10 % of its starting concentration after 10 days.
- The  $\delta^{13}\text{C}$  of the TCE did not change significantly within 50 days.
- To conclude, active biological processes (e.g. microbial degradation) unlikely played a major role in the removal of TCE in our experimental set up lasting for 50 days. Volatilization and passive uptake by plants via the transpiration flow likely were the driving force for TCE reduction in our pot experiment.

## OUTLOOK

- $\delta^{13}\text{C}$  of TCE and metabolites in plants - development of methods for plant extraction
- $^{13}\text{C}$  TCE analysis in air - selection of absorber material and development of the sampling and measurement procedure
- TCE balance calculation (water, plant, air) in a closed hydroponic microcosm experiment