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Soil-water partitioning and kinetics of PFAS in aquifers to be remediated using pump—and-treat technology

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Infiltration and spread of PFAS in groundwater

- Per and polyfluoralkyl substances-PFAS
 - Highly persistent
 - Highly mobile in the environment
- Infiltration into groundwater from contaminated areas
- Can lead to contamination
 - Drinking water
 - Surface waters
 - Agricultural crops





Hovgården waste management facility

- Multiple possible sources of PFAS contamination
- Concentrations of Σ_{32} PFAS of >5000 ng/L detected in groundwater
- Contaminant transport in aquifer along a fault line
- Containment of contamination at the site by combining a pre-existing barrier with a pump and treat system







The LIFE SOURCE project (LIFE20 ENV/ES/000880) has received funding from the LIFE Programme of the European Union

LIFE SOuRCE project - Demonstration at PFAS contaminated sites







43rd International Symposium on Halogenated Persistent Organic Pollutants (POPs)



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LIFE SOuRCE project – Surface active foam fractionation (SAFF)









LIFE SOuRCE

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LIFE SOuRCE project – Electrochemical oxidation (EO)







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LIFE SOuRCE project – Anion exchange chromatography









LIFE SOuRCE project – *Phytoremediation* (*PHYTO*)







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LIFE SOuRCE project – *Incineration (INCIN)*





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Aim of this study

Determination of solid liquid partitioning coefficient (K_d) of PFAS to predict the mobility of PFAS and asses the removal of PFAS using pump and treat







- Sonic drilling with collections of drill cores
- Installation of groundwater wells for sampling









- Two aquifer samples and one fill sample
- Comparison with samples from the Spanish LIFE SOuRCE site













- Field K_d
 - C_{gw} = Field K_d [L/kg]

Field sampling, analyze PFAS concentration of soil and groundwater in the saturated zone

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- Field K_d
 - $C_{\rm s}/C_{\rm qw}$ = Field $K_{\rm d}$ [L/kg]
- Desorption experiment to determine $K_{d, \text{ desorption}}$ and kinetics
 - $C_s/C_{leachate} = K_d [L/kg]$



Analyze concentration of solution at 4 time points





- Field K_d
 - C_{gw} = Field K_d [L/kg]
- Desorption experiment to determine K_{d, desorption} and kinetics
 - $C_s/C_{leachate} = K_d [L/kg]$
- Adsorption experiment to determine K_{d, adsorption} and kinetics
 - $C_s/C_{leachate} = K_d [L/kg]$



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Analyze concentration of solution at 4 time points Analyze concentration of solution at 4 time points











Results

0,9 **FTSAs Adsorption** 0,8 (b,0 (b)0,7 (b)0,6 𝒴 𝔅 0,5 **PFCAs Adsorption PFSAs Adsorption** PFCAs Field K_d 0,4 PFSAs Field K_d 0,3 Ι 0,2 **PFSAs Desorption** 0,1 0 2 5 8 6 7 9 0 1 3 4 Perfluorated carbon chain length

 K_d method comparability







 $K_{d, PFOS}$ Sample comparison



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 Relatively high K_d of top fill could make it act as a PFAS pool









- Relatively high *K_d* of top fill could make it act as a pool of PFAS
- Rapid desorption rate of PFAS in top fill allows for mobilization of parts of the PFAS pool during precipitation events









- Relatively high *K_d* of top fill could make it act as a pool of PFAS
- Rapid desorption rate of PFAS in top fill allows for mobilization of parts of the PFAS pool during precipitation events
- Low K_d of aquifer material allows for PFAS transport throughout the aquifer







Take home message

- Field K_d values corresponds to small scale batch tests
- PFAS desorption is a rapid process
- Possible correlation between PFAS K_d and oxalate extractable compounds Al, Fe and Si
 - Larger sample sets needs to be studied
- Top soils can act as a pool from which PFAS can be mobilized into groundwater where it can spread throughout the aquifer







Moving forward

- Study larger sample sets in order to find correlations between *K_d* and soil chemistry
- Refine methodology to be able to more accurately determine low K_d values





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Thank you for your attention!













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