Sorption of 17-α-ethynyl estradiol on iron minerals of hydromorphic soils

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Introduction

Endocrine disrupting compounds (EDCs) interfere with hormone system and may cause adverse health effects in an intact organism. Steroid estrogens, for instance 17-α-ethynyl estradiol (EE2), are identified as one of the most important endocrine disruptors.

Iron Fe(III) oxide-hydroxides (mainly goethite) are considered as adsorbents in water-soil systems, due to their relatively large specific surface area. In this research, sorption of 17-α-ethynyl estradiol on soils formed on the same parent material with different composition of clay minerals and iron oxides in aqueous solutions was investigated.

Materials and methods

Our samples were collected from the soil of a periodically water covered wetland in the Danube-Tisza Interfluve, central Hungary. We used pure goethite standard as a control.

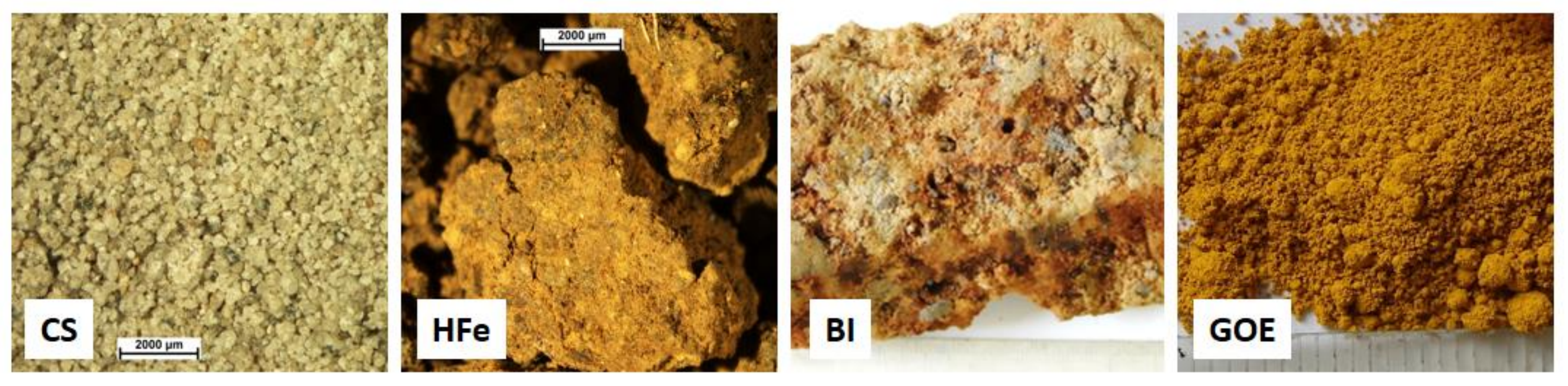


Figure 1. Adsorbents

CS - parent material, sedimentary coarse quartzose calcareous sand of Pleistocene age, absence of hydromorphy, consisting mainly of quartz and calcite

HFe - hyperferritic horizon of a Gleysol, containing XRD-detectable amounts of goethite and smectite

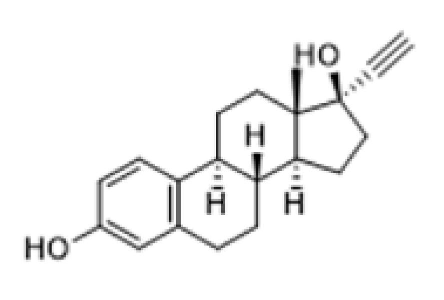
BI - porous, hardened, carbonate-rich iron accumulation, 'bog iron'

GOE - goethite standard: Aldrich Chemistry Goethite (30-63% Fe)

Table 1. Adsorbents properties

	TOC %	$CaCO_3$ %	Clay %	Silt%	Sand %
CS	0,23	11,41	24,12	16,63	59,25
HFe	2,10	7,18	52,86	41,36	5,78
BI	1,22	40,99	52,23	41,09	6,68
GOE	0,00	0,00	100,00	0,00	0,00

Adsorbate: 17-α-ethynyl estradiol (Sigma Aldrich, ≥98%)



17-α-ethynyl estradiol

EE2 was determined by high-performance liquid chromatography (HPLC) with a fluorescence detector. The size fractions were 250 µm. The Freundlich isotherms and the Langmuir isotherms were used to characterize adsorption.

$$q_e = k_F * c_e$$

$$\frac{c_e}{q_e} = \frac{1}{k_{L*}Q} + \frac{c_e}{Q}$$

q_e – the solid-phase concentration (µg/g),

k_F – Freundlich adsorption coefficient ((mg/g)/(mg/l)$^{1/n}$)

c_e - the equilibrium solution phase concentration (µg/l)

Q - the maximum adsorption capacity (mg/g)

k_L - the Langmuir fitting parameter (l/mg)

p – the dimensionless number related to surface heterogeneity

Results

- Samples adsorbed EE2 at different extent
- The values of Freundlich adsorption coefficient (k_F) and adsorption capacity (Q) show variety

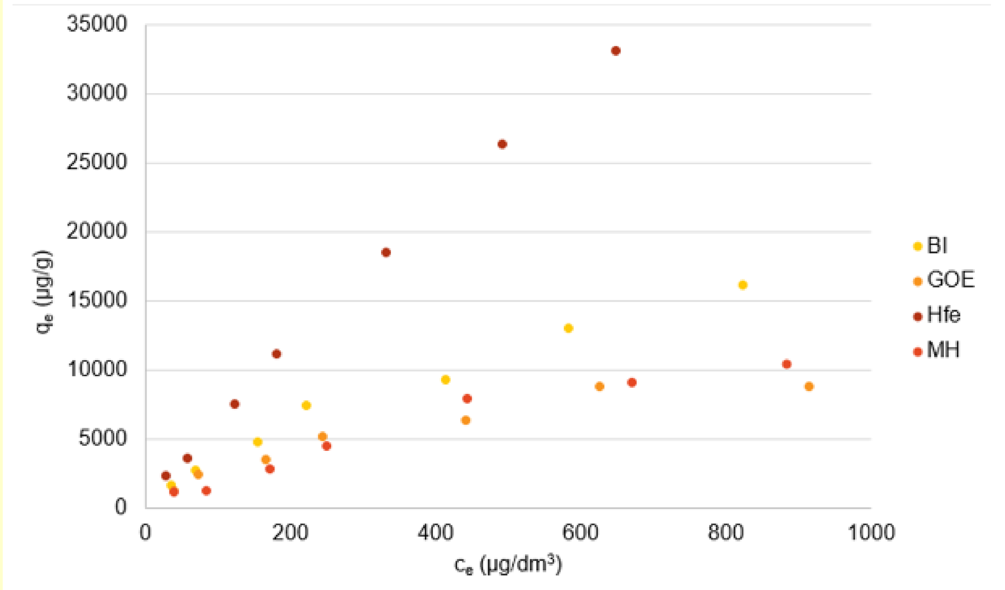


Figure 2. Sorption isotherms for 17-α-ethynyl estradiol on soil samples

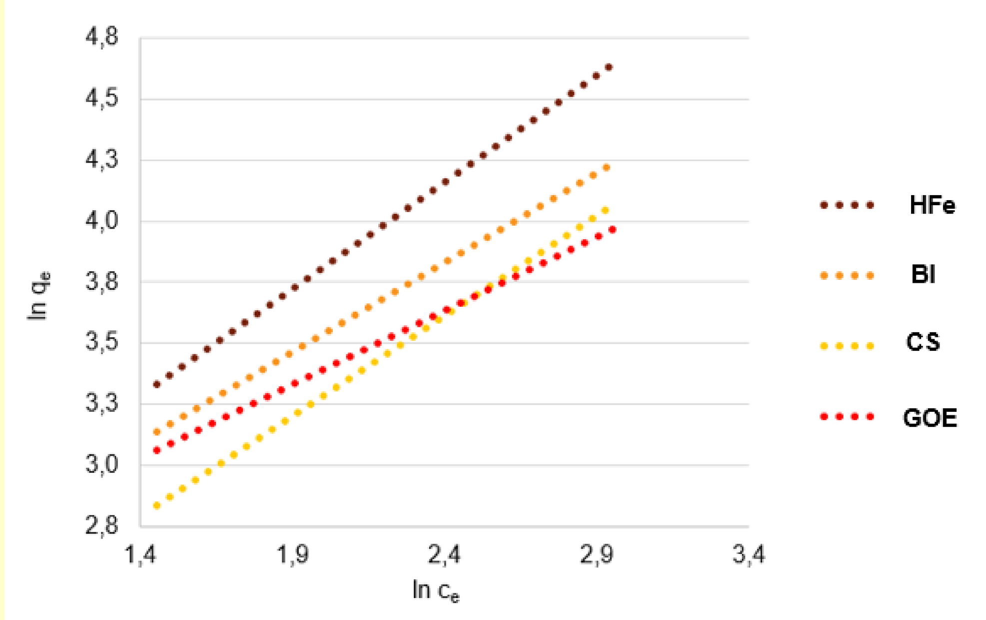


Figure 3. The linearized forms of Freundlich isotherms

Table 2. Freundlich and Langmuir fitting parameters for adsorption of EE2

Langmuir model			Freundlich model	
	Q (mg/g)	k_L (l/µg)	k_F ((mg/g)/(mg/l)$^{1/n}$)	p
HFe	111	0,0006	116	0,87
BI	33	0,0012	118	0,73
CS	25	0,0008	44	0,82
GOE	11	0,0031	153	0,60

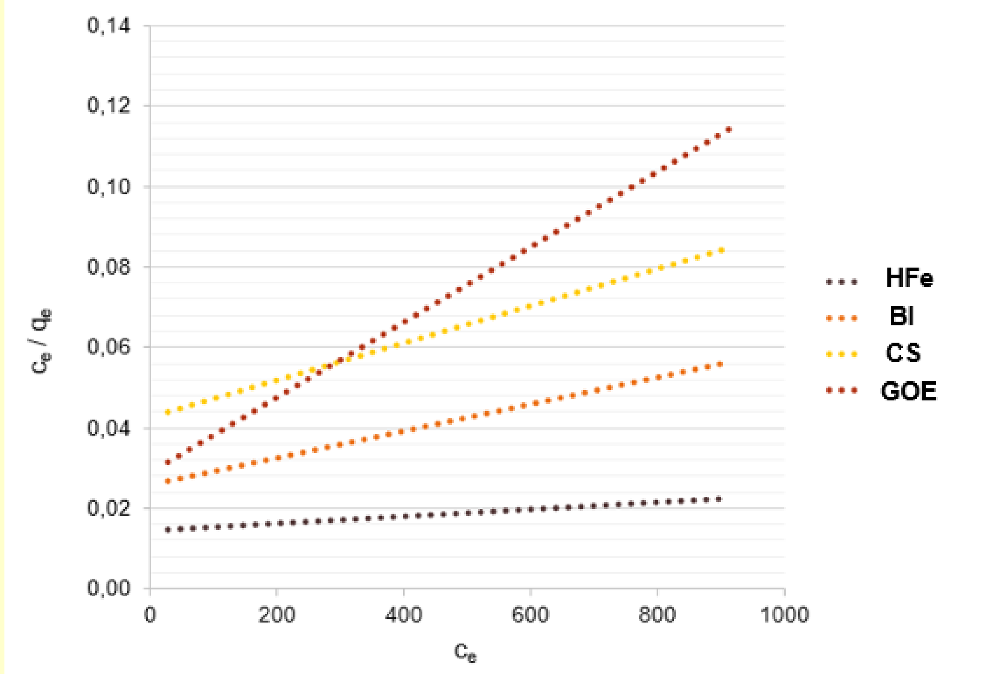


Figure 4. The linearized forms of Langmuir isotherms

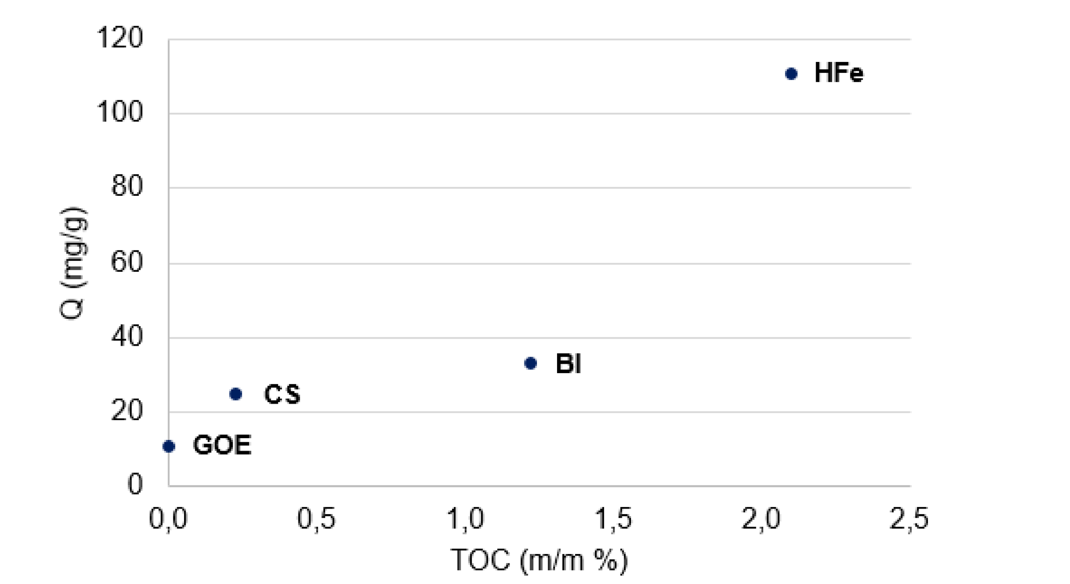


Figure 5. Adsorption capacity of the samples depending on their organic content

- To reveal the effect of soil properties on the adsorption of EE2 , soil parameters were investigated
- The organic content of the adsorbents significantly modify the adsorption capacity (Q) of the samples

Conclusions

- **The adsorption of EE2 is primarily determined by the organic content**
- **The role of goethite is less significant**

The research was carried out with the support of NVKP (16-1- 2016-0003)