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Mobilization of phosphorus, dissolved organic carbon and release of greenhouse gases in an early stage of rewetted fens as a function of the degree of peat decomposition

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Introduction – Natural Fens

~ originally 10 % of NE Germany was covered

„Kidneys of Landscape“ (Succow 2000)

selected peat characteristics (several authors)

- organic matter > 95 % dw
- dry bulk density << 0.1 g/ccm
- Total P content < 0.5 mg/g dry matter
- hydr. conduct. ~2-9 x 10^{-2} cm/sec

Introduction – Drained Fens

- > 95 % of fens of NE Germany are drained

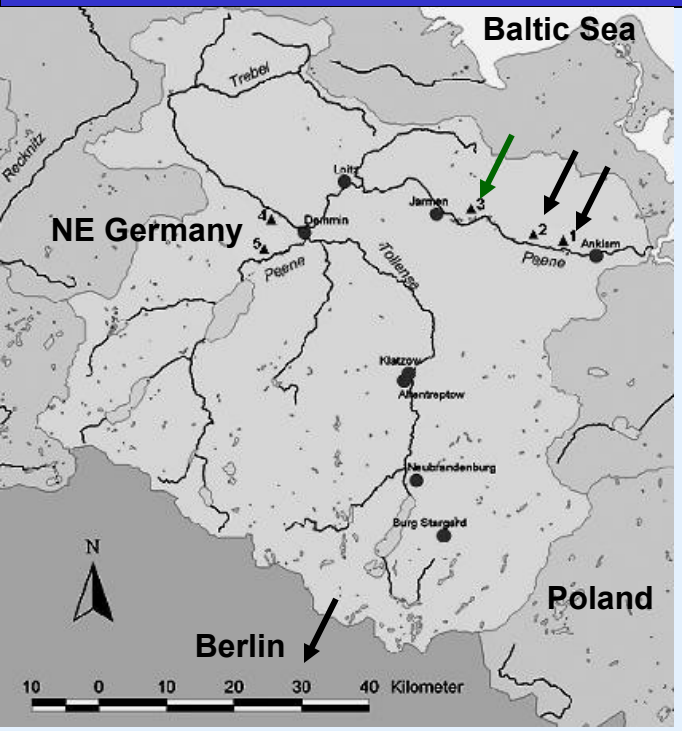
- mainly for agricultural use

- selected peat characteristics of highly decomposed peat layers (several authors)

• organic matter	< 80% dw	(> 95%)
• dry bulk density	> 0.4 g/ccm	(<< 0.1)
• total P content	> 1 mg/g dm	(<0.5)
• hydr. conduct.	>1 x 10^{-4} cm/sec	(~2-9 x 10^{-2})

< loss of matter and water retention

Characterisation of rewetted fens



- Area of investigation: rewetted fens (5000 ha) in the Valley of River Peene, NE Germany (2004)

- shrinkage of peat up to 1m (flooded areas)

- highly decomposed upper peat layers (0-30 cm)

- dissolved substances in porewater of two rewetted fens compared to a natural fen (means; n=24, 0-70 cm):

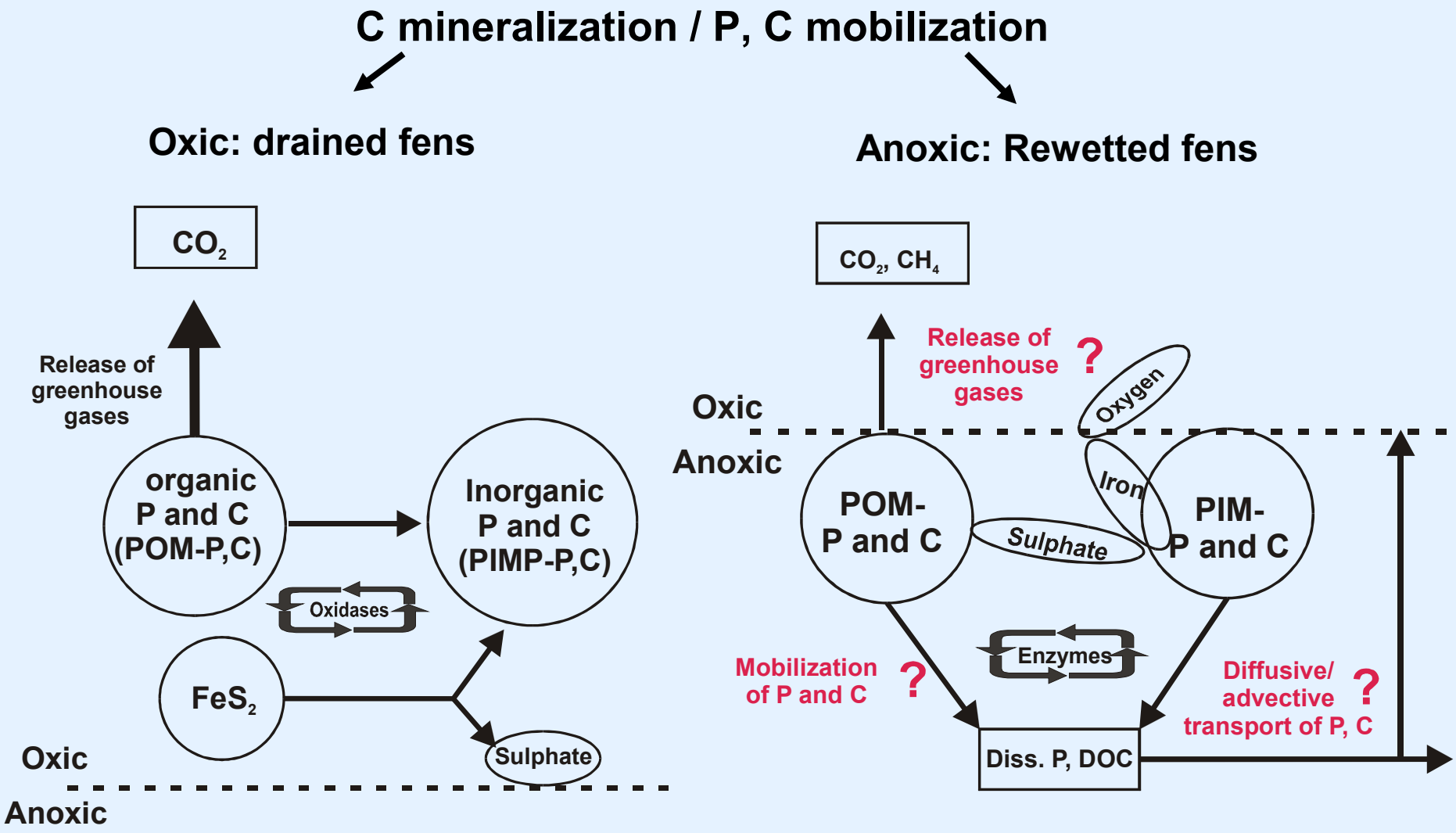
	SRP	DOC	Fe
		[mg/L]	
polder Jargelin (1) (rewetted)	3.9	84	92
polder Menzlin (2) (rewetted)	11.2	89	11
Gützkow (3) (natural)	0.07	16	0.1

Rewetting of fens – a lack of knowledge of matter turnover

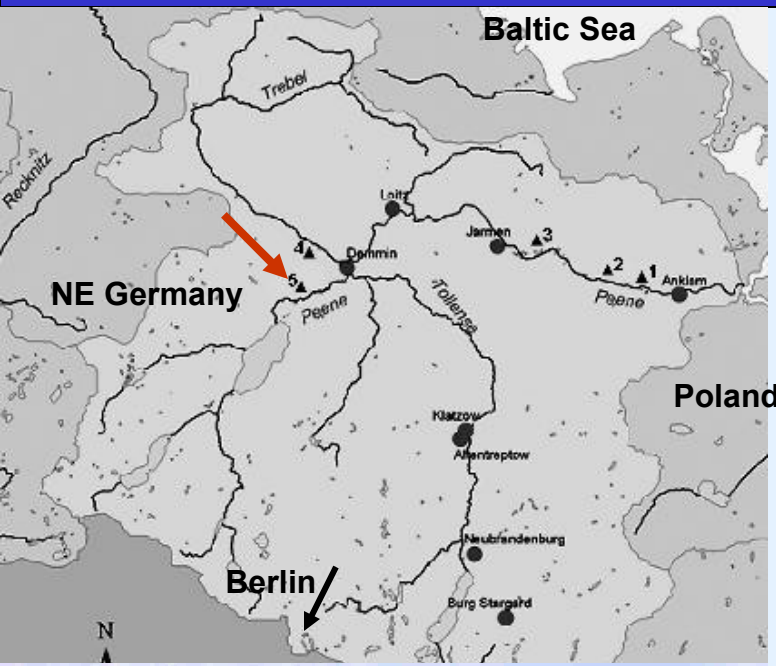
High P and DOC concentrations in rewetted fens could lead to a further or enhanced load of P and C to adjacent surface waters.

What are the reasons for the apparently enhanced P and C mobilization processes in rewetted fens?

Schemes of P and C mobilization - Theory



Study site and peat characterization



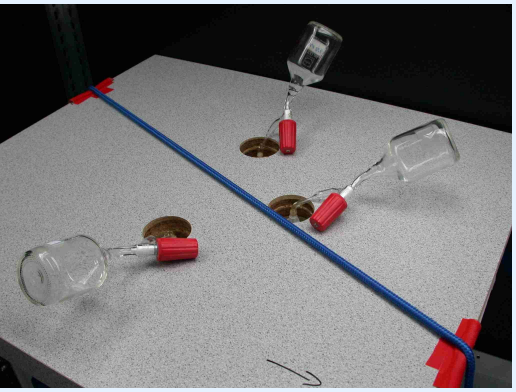
Study site: Polder Zarnekow (rewetted since autumn 2004)

Peat profile:

anoxic mobilizable P, C
(modified Psenner chemical extraction method, Zak et al. in prep.)

		P [µg/g dry matter]	C [µg/g dry matter]
0-10cm	highly degraded	220	25
10-80 cm	moderately degraded	40	25
80-...cm	slightly degraded	10	5

Design of lab experiment



Incubation

- ~ 40 kg peat (9 x 90 L vessels)
- water level: 5 cm, 200 mg/L NaCl
- stagnant cond., shaded, 20°C
- sampling: biweekly, monthly
- 50 weeks

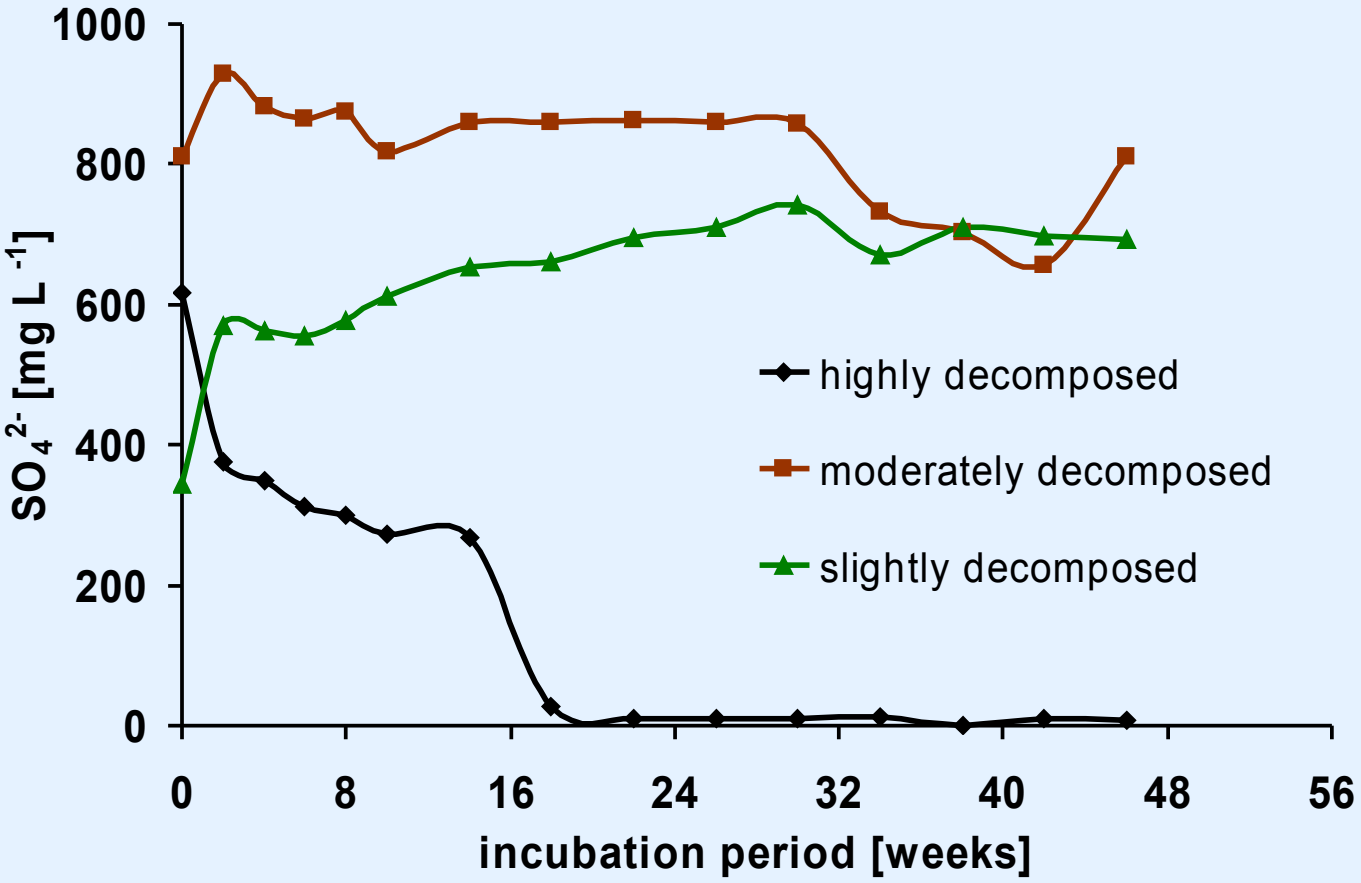
Gas sampling

- chamber method
- evacuated gas bottles
- sampling time: 0 h-0.5 h-1 h
- analysis of CO_2, CH_4 by gas chromatography

Porewater sampling

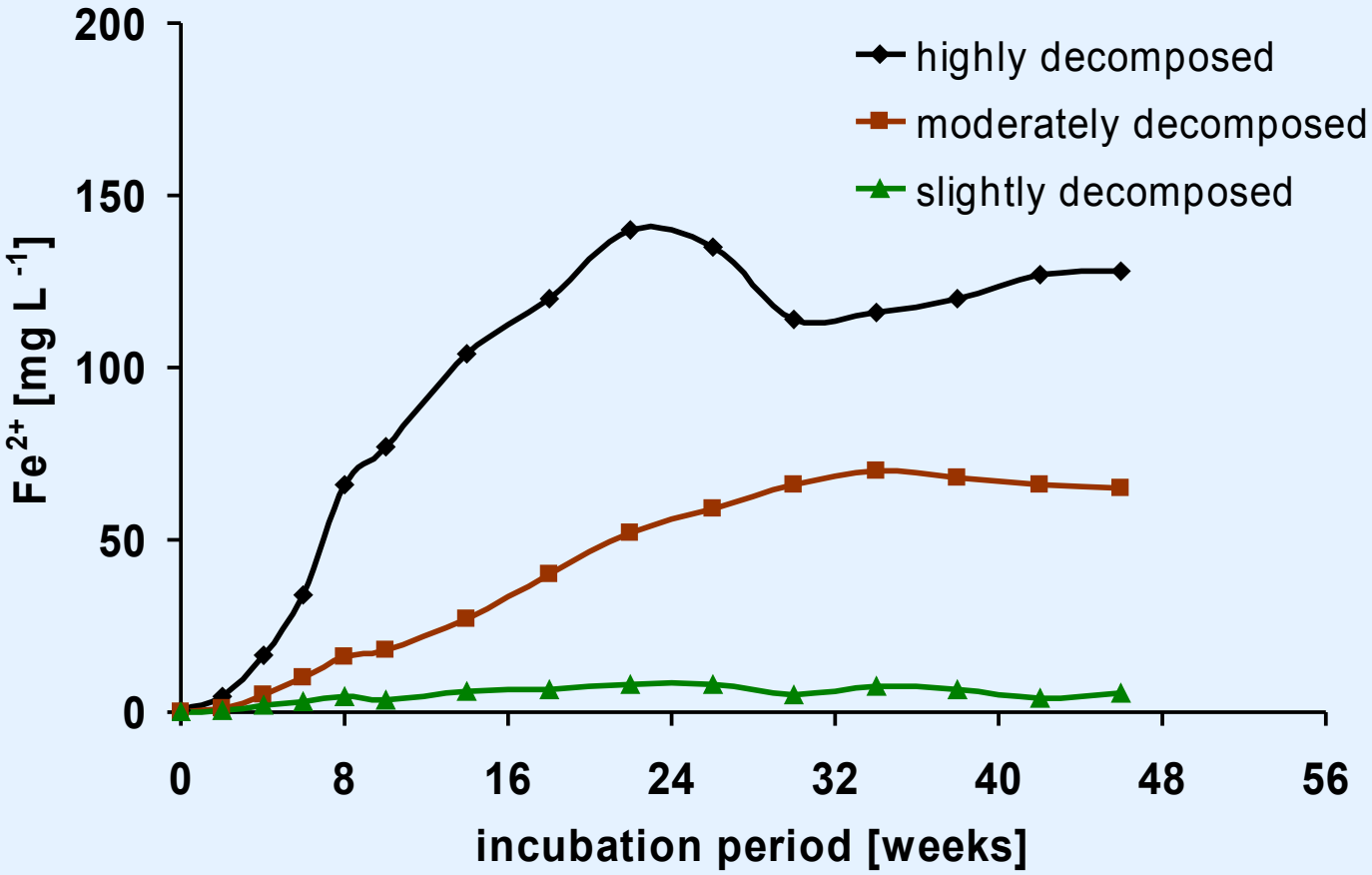
- dialysis sampler method
- rechargeable sampler (0-10 cm)
- analysis of P, DOC, SO_4^{2-}, Fe, and others by standard methods

Results: Sulphate consumption



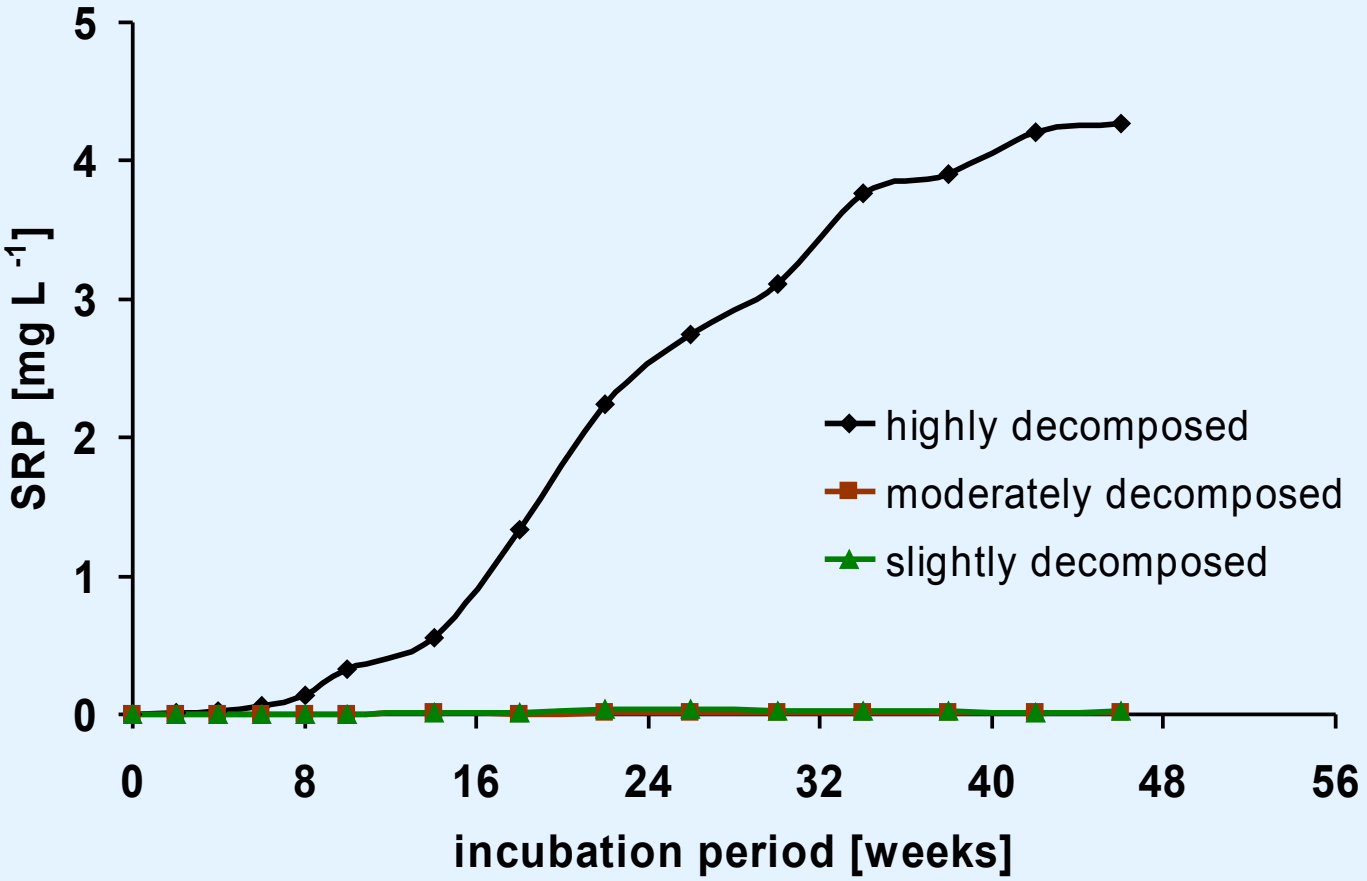
Course of SO_4^{2-} porewater concentrations during incubation (means, n=3)

Results: Fe mobilization



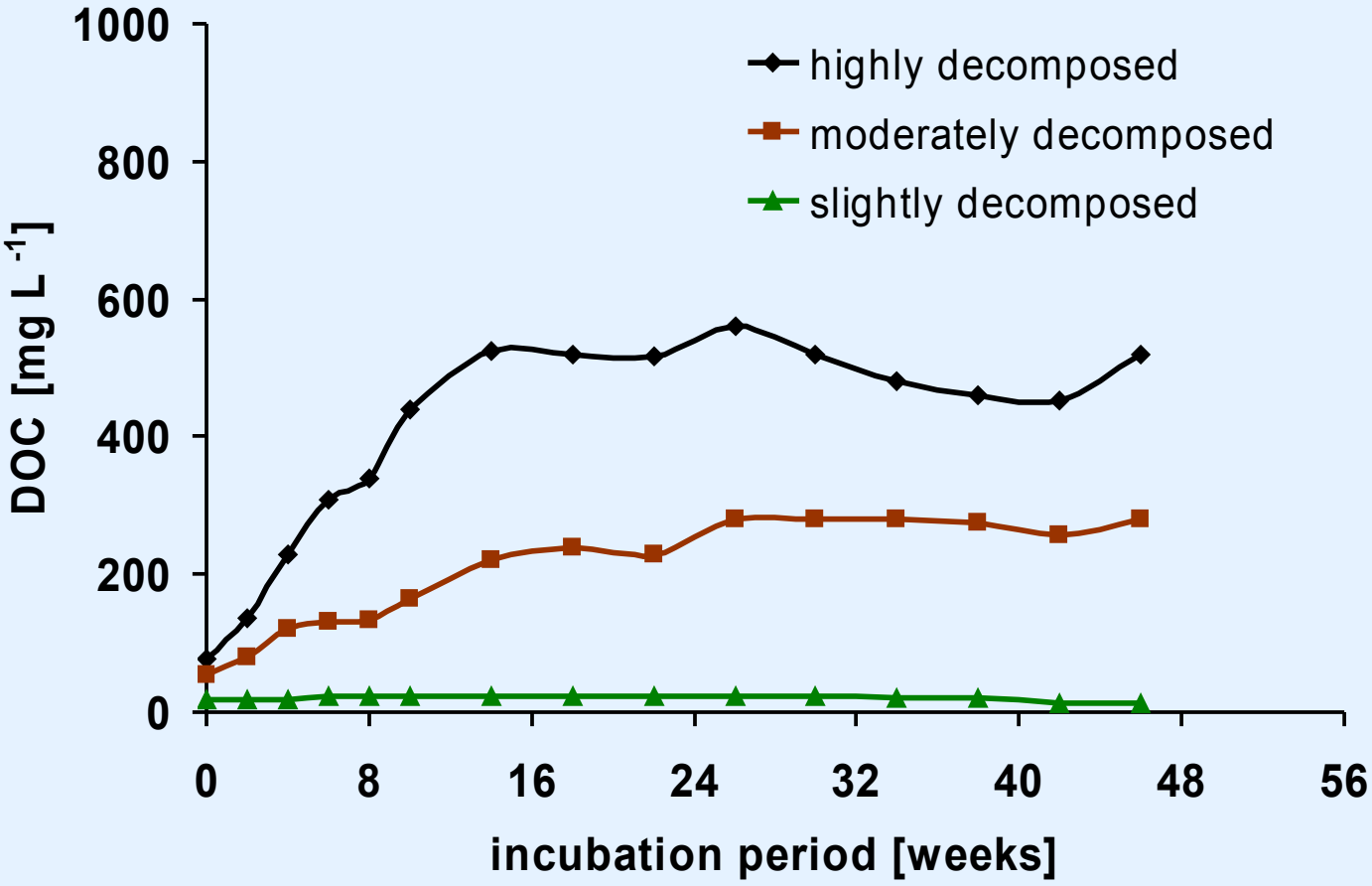
Course of Fe $^{2+}$ porewater concentrations during incubation (means, n=3)

Results: P mobilization



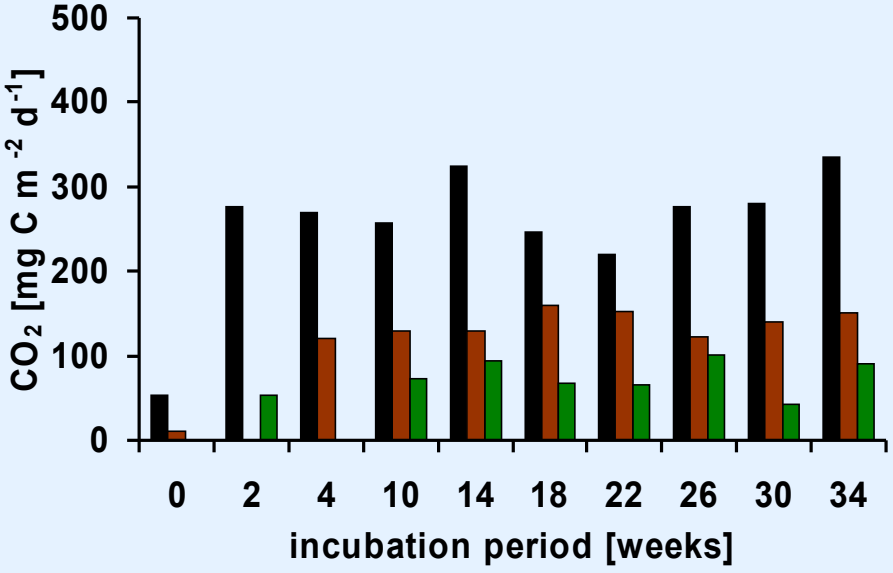
Course of SRP porewater concentrations during incubation (means, n=3)

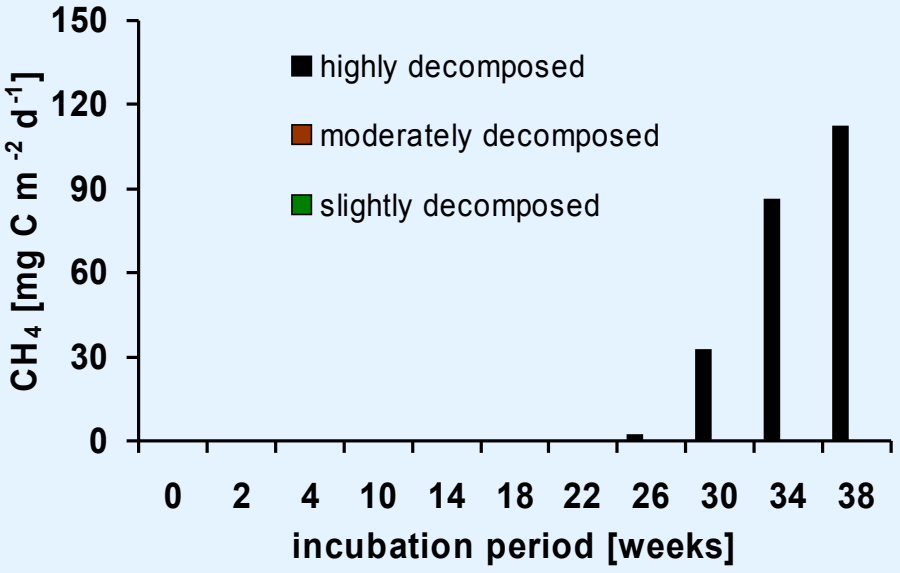
Results: DOC mobilization



Course of DOC porewater concentrations during incubation (means, n=3)

Mobilization of green house gases





Release rates of CO_2 and CH_4 during incubation (means, n=3)

Mobilization of dissolved substances

peat	sulphate [mg/ L d]	iron	phosphorus [µg/ L d]	organic carbon [mg/ L d]
Highly decomposed	-2.4	0.6	12.3	2.3
Moderately decomposed	0.1	0.2	0.04	1
Slightly decomposed	1.7	0.03	0.07	0.003

Summary

1. High sulphate concentrations, more than 500 mg/L, occured in all peat samples regardless on the peat decomposition. But sulphate concentrations were only markedly diminished in highly decomposed peat layer.

3. A distinct P mobilization coupled with a high Fe mobilization occured only in highly decomposed peat.

5. DOC concentrations increased most in highly decomposed peat, somewhat lower in moderately decomposed peat and not at all in slightly decomposed peat.

7. With increasing degree of peat decomposition, the release of carbon dioxide is significantely enhanced. If sulphate concentrations are below 20 mg/L in highly decomposed peat, methane will be released.

Conclusions

1. The typical highly decomposed upper peat layer in rewetted fens is responsible for the accelerated P and C concentrations in porewater of rewetted fens. Thus further investigations on nutrient dynamics in rewetted fens must focus on this „highly reactive“ zone.

2. Reasons for intense mobilization in the highly decomposed peat are:

    1. Enhanced supply of oxidizing substances (sulphate, Fe(III)-hydroxides)
    2. The greater availability of partially decomposed organic matter due to drainage
    3. The distinctly increased pool of redox sensitive or mobilizable P and C

3. These results are important for management of fen rewetting.

Thank you!

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