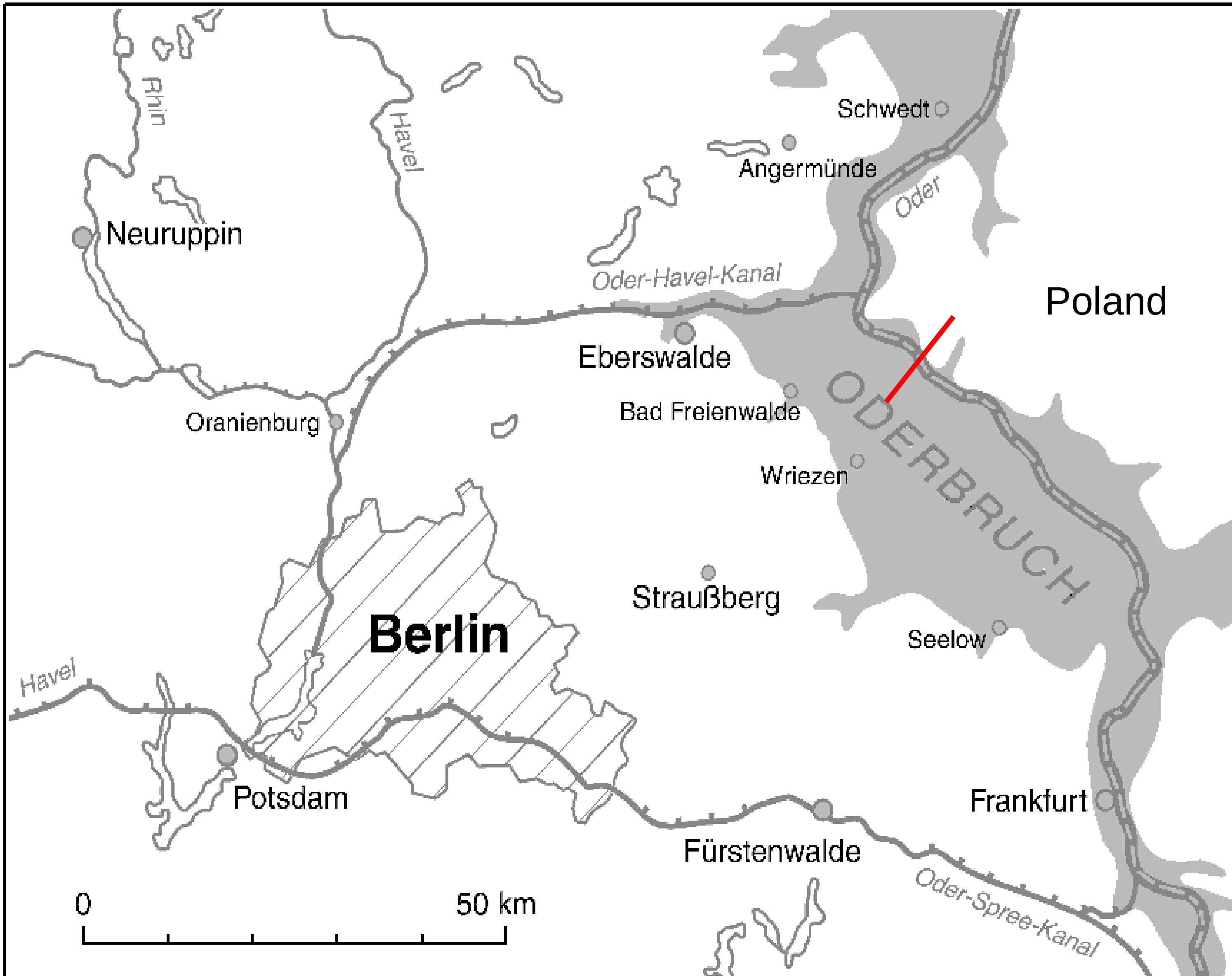
TRACE METAL BEHAVIOUR IN DRAINED FLOODPLAINS

Ch. Merz, A. Winkler, A. Pekdeger und A. Quast

10^{th} International Drainage Workshop of ICID Working Group on Drainage Helsinki, Finland | Tallinn, Estonia

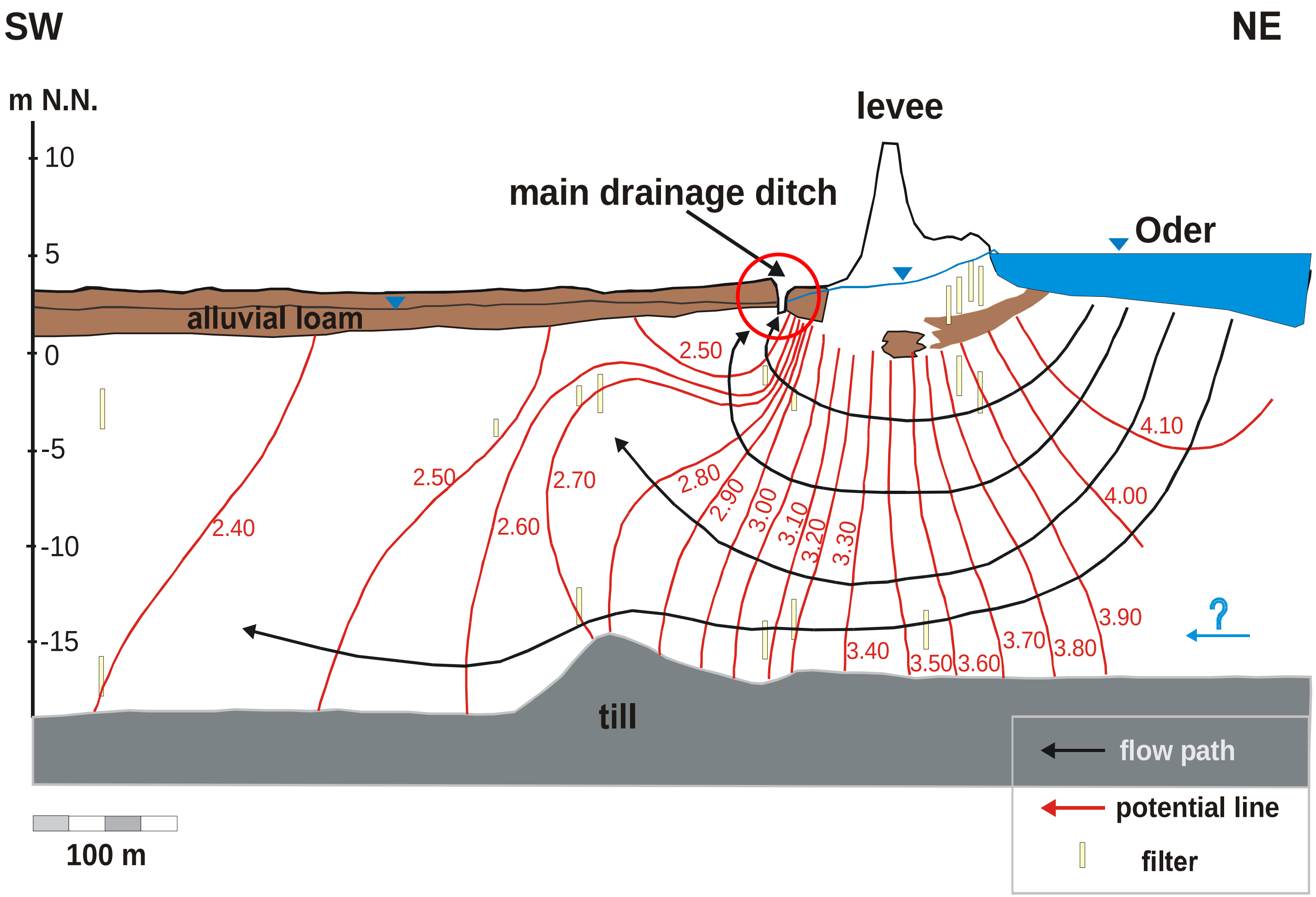
Department of Geochemistry, Hydrogeology, Mineralogy FU-Berlin

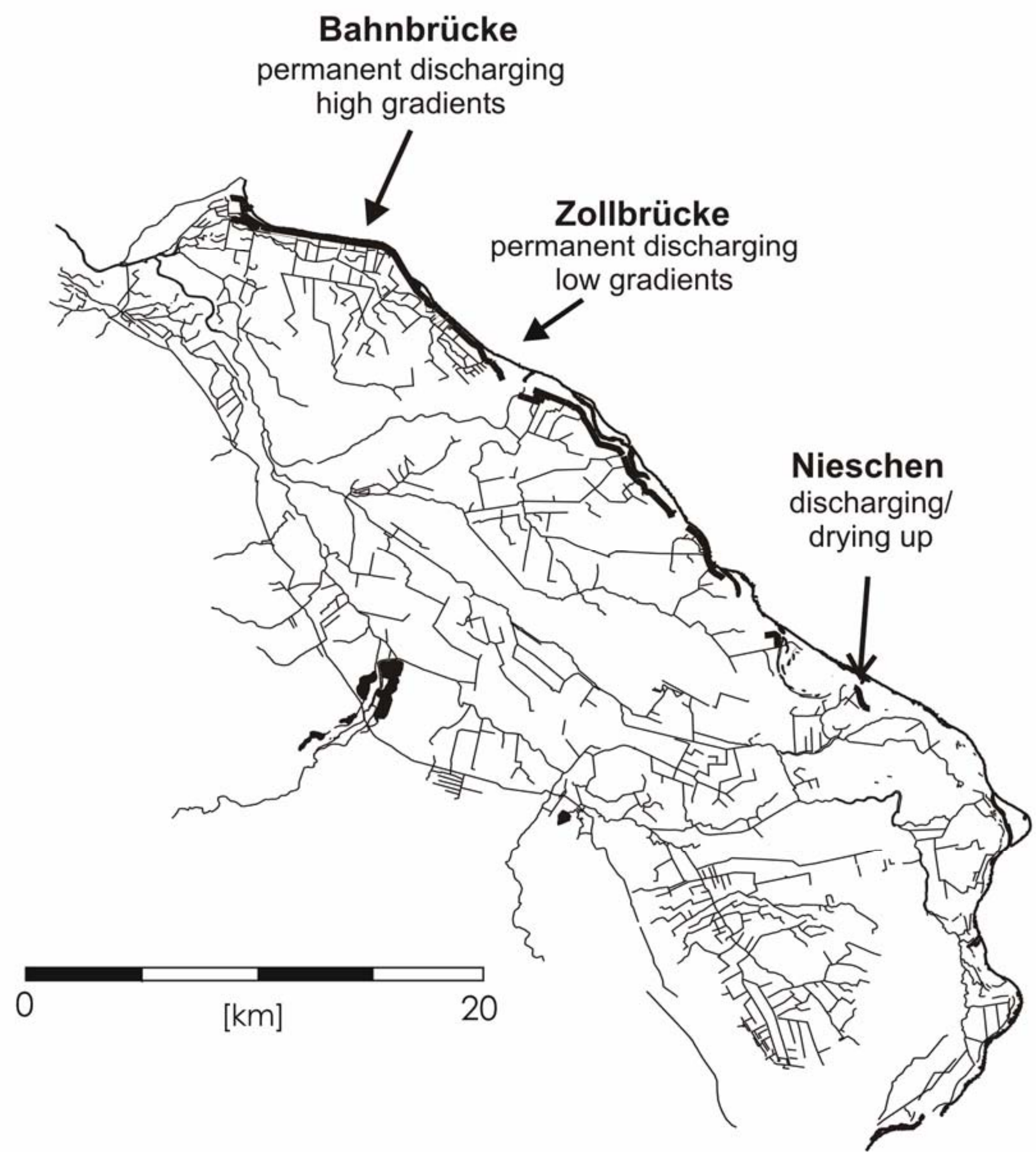
veritas iustitia libertas



Schwedt
Angermünde
Rhin
Havel
Oder
Neuruppin
Oder-Havel-Kanal
Poland
Eberswalde
ODERBRUCH
Bad Freienwalde
Oranienburg
Wriezen
Straußberg
Berlin
Seelow
Havel
Potsdam
Frankfurt
Fürstenwalde
Oder-Spree-Kanal
0
50 km

Hydraulic situation in the Oderbruch polder

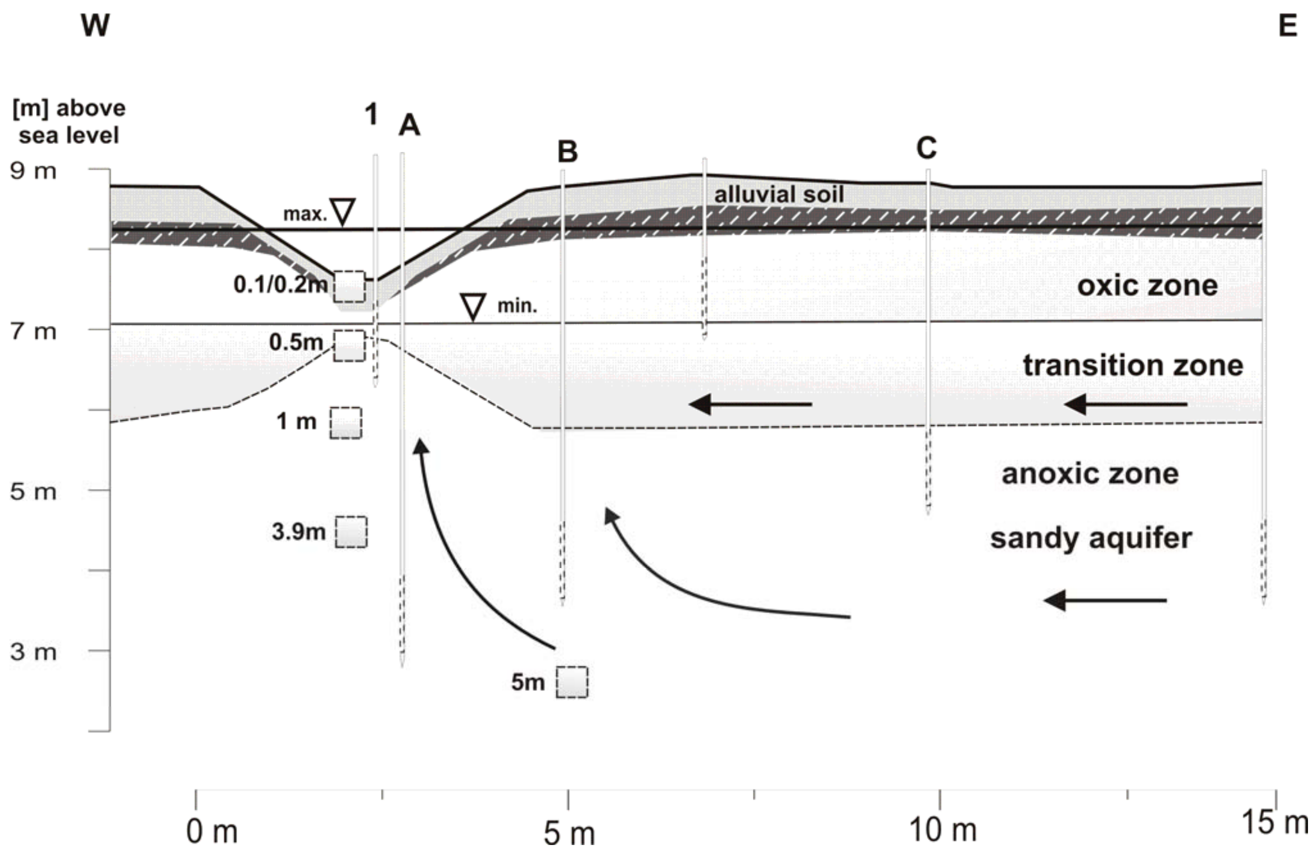



Bahnbrücke
permanent discharging
high gradients
Zollbrücke
permanent discharging
low gradients
Nieschen
discharging/
drying up
0
[km]
20

Objectives

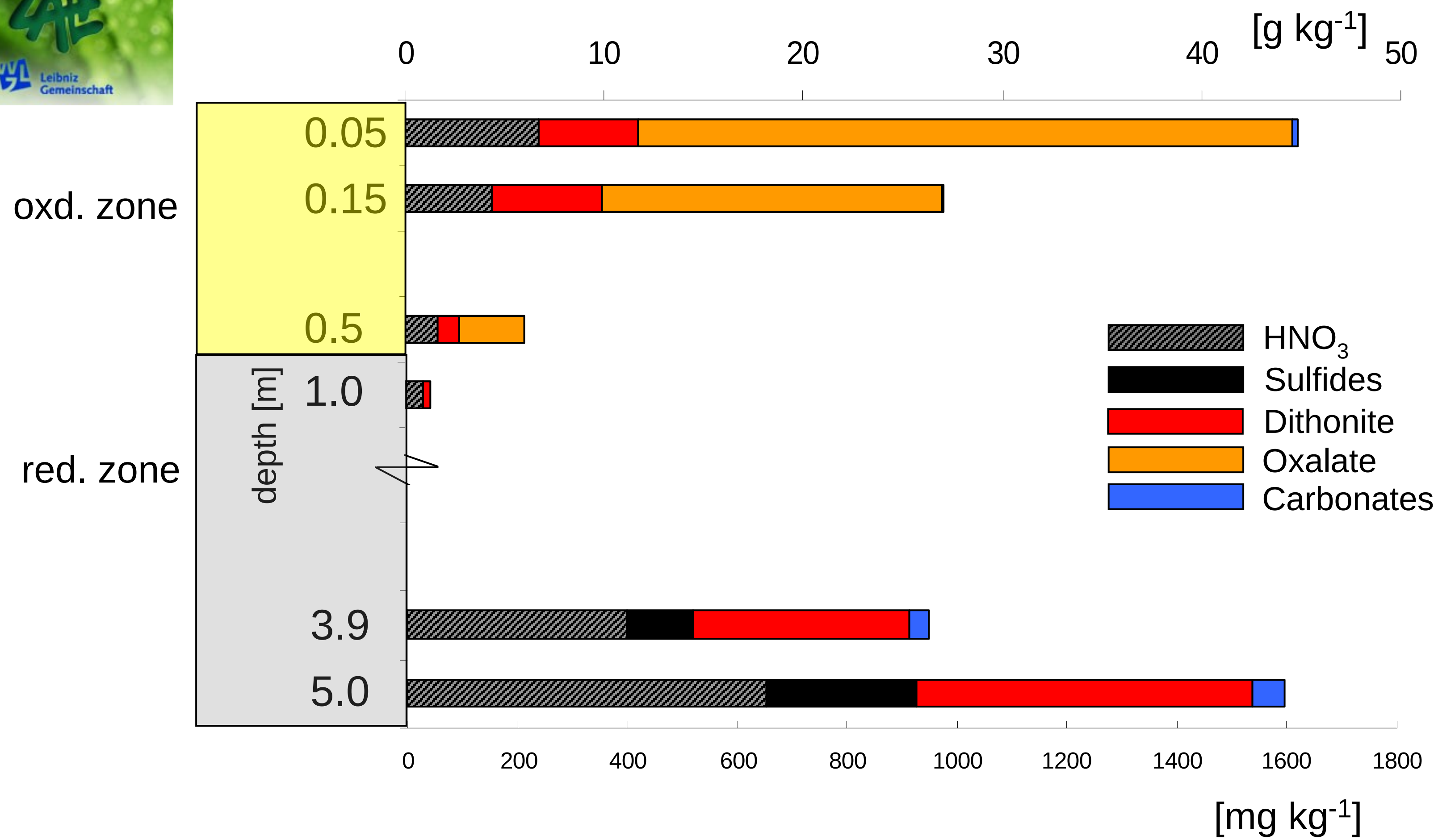
- Characterizing of trace metal migration at the interface between groundwater and the drainage system
- Identification / correlation of specific hydraulic and hydrochemical processes in floodplains
- Balance calculations of mass transport processes for specific channel types
- Implementation of process knowledge in prospective management strategies for minimizing negative impacts on lowland regions

Investigation site Nieschen
(seasonally drying up channel)



extracting agent	extracted phase
NH_4-acetate solution at pH 5	absorbed ions und carbonates
Na-Dithionit ($Na_2S_2O_4$)	Fe- und Mn-oxides + hydroxides
30% H_2O_2 at pH 5	organic matter/sulfides
65% HNO_3 (105 ºC)	total metal (soluble)
additional extraction steps, exclusive performed for iron :	
0.2 M oxalate (without light)	amorphous und low crystalline Fe-hydroxides
9 M HCl	AVS-sulfide
1 M Cr(II)Cl-solution + 15 ml 37% HCl	AVS-sulfide + pyrite

Distribution of Fe-fractions in Nieschen



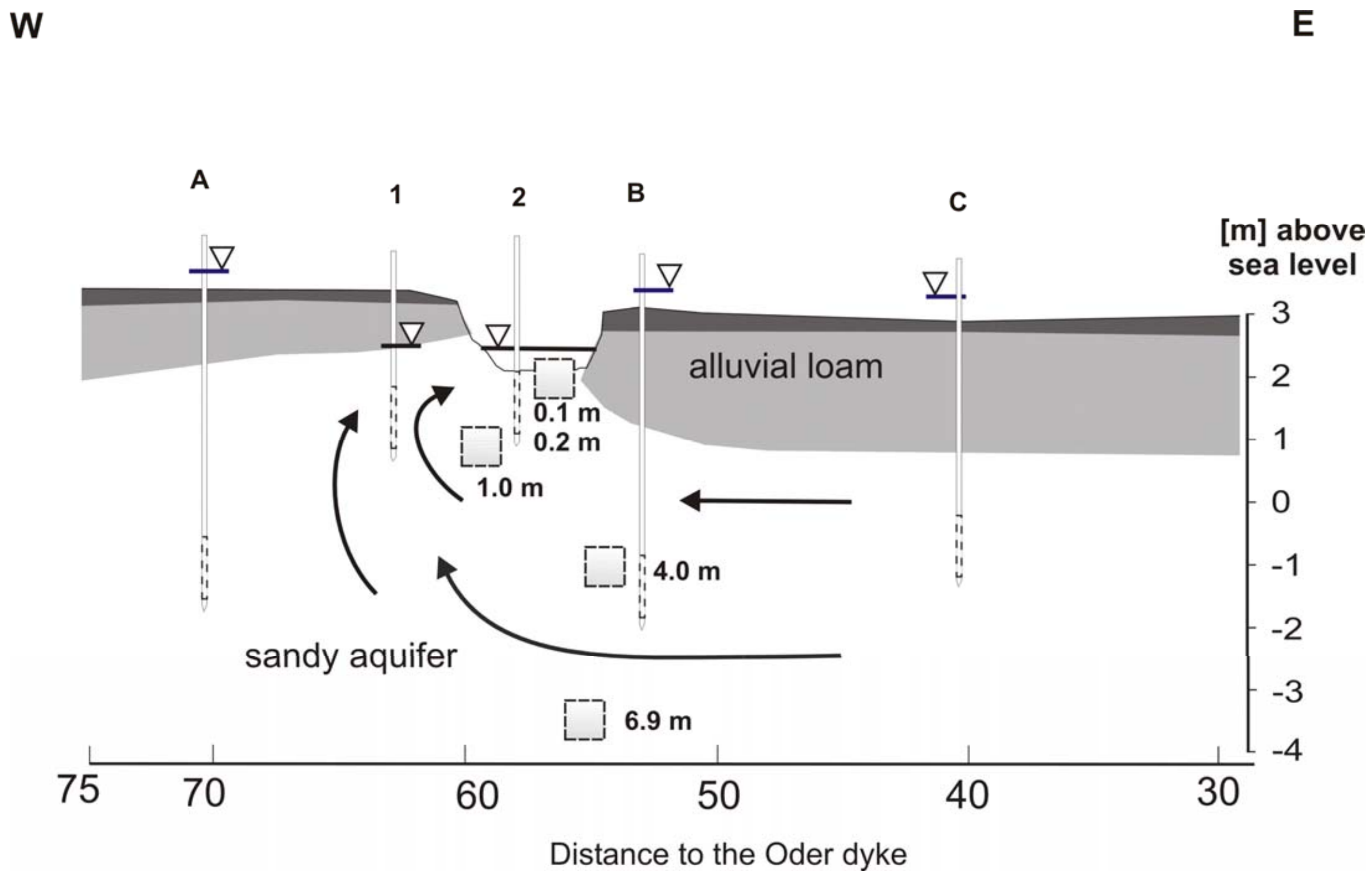
Balance calculations for the „drying up channel type“

Element	concentration in the groundwater [µg l^{-1}]	Accumulation rate [g $(m^2\ a)^{-1}$]	Percentage of maximum accumulation [%]
As	2.2	0.24	56.1
Zn	7.4	0.1	6.5
Cu	2	0.33	81.8
Cd	0.2	0.0027	6.8
Fe	1600	332.2	102.8
Mn	300	4.83	8.0

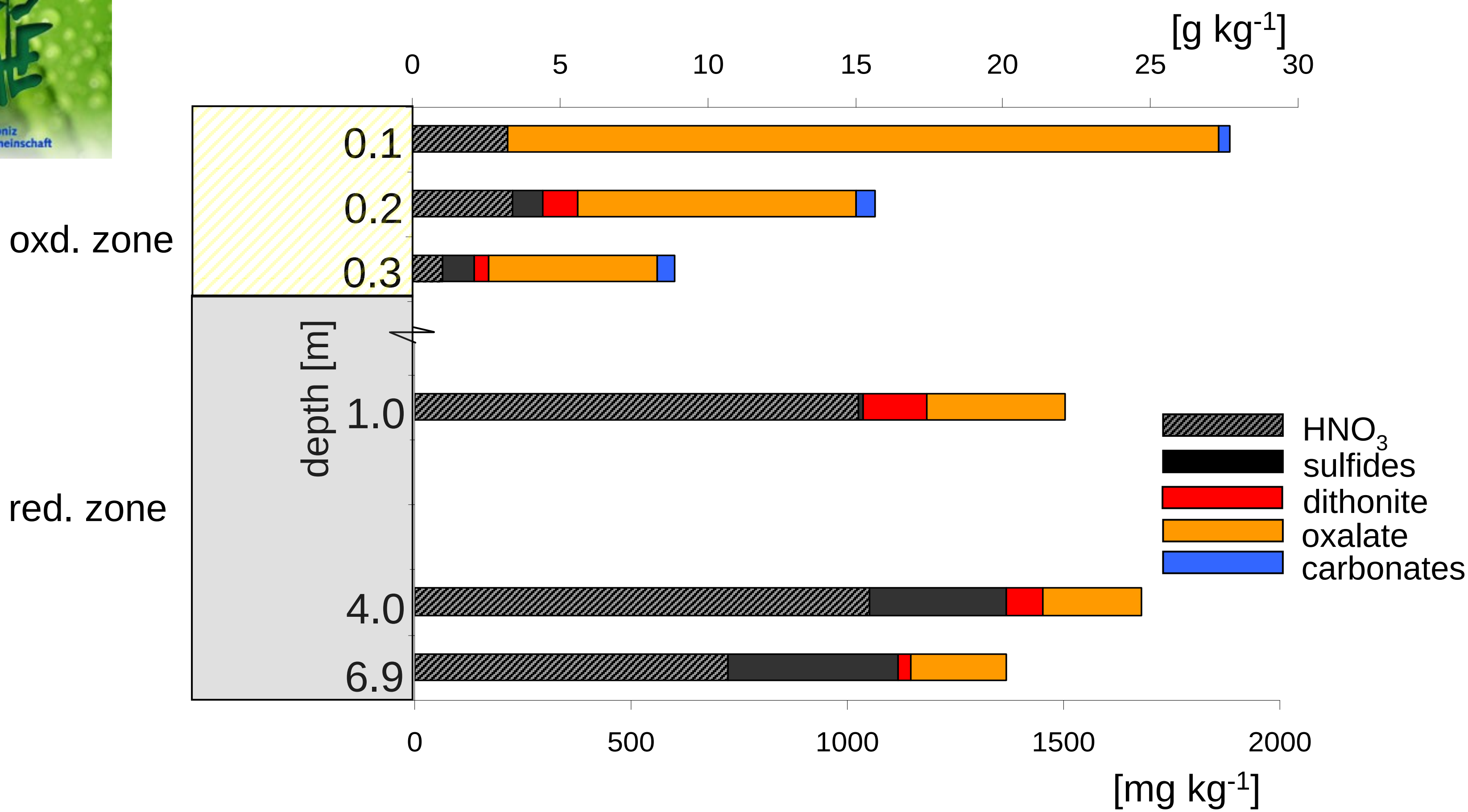
Fe >> Mn > Cu > As > Zn > Cd

Investigation site Zollbrücke

(discharging channel, low gradients)



Distribution of Fe-fractions in Zollbrücke

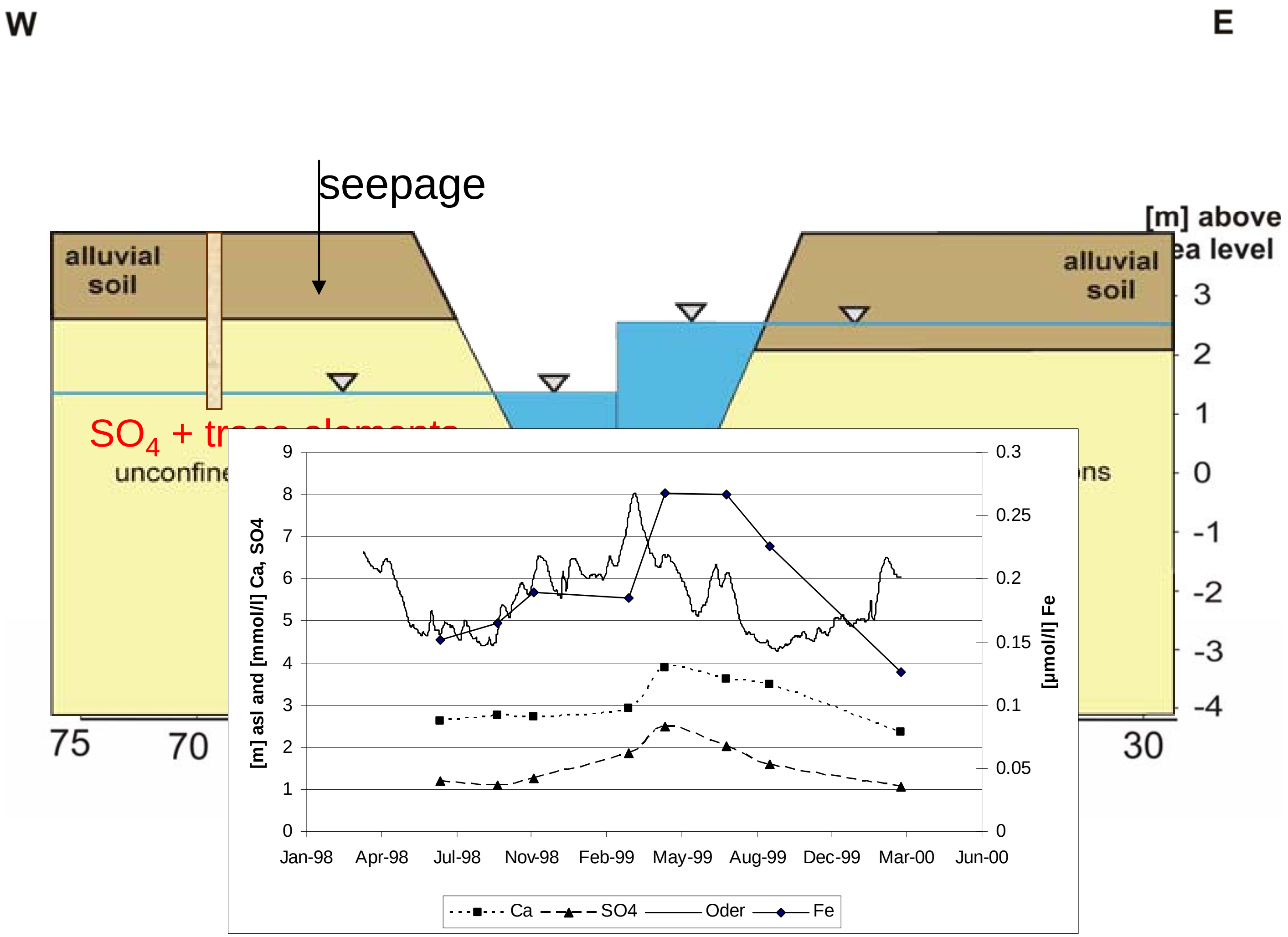


Balance calculations for the „discharging low gardient type“

Element	concentration in the groundwater [µg l^{-1}]	Accumulation rate [g $(m^2\ a)^{-1}$]	Percentage of maximum accumulation [%]
As	5.5	0.1	16.5
Zn	17.8	0.11	5.2
Cu	2	0.02	10.0
Cd	not detectable		
Fe	9500	170.9	15.5
Mn	2700	38.0	12.1

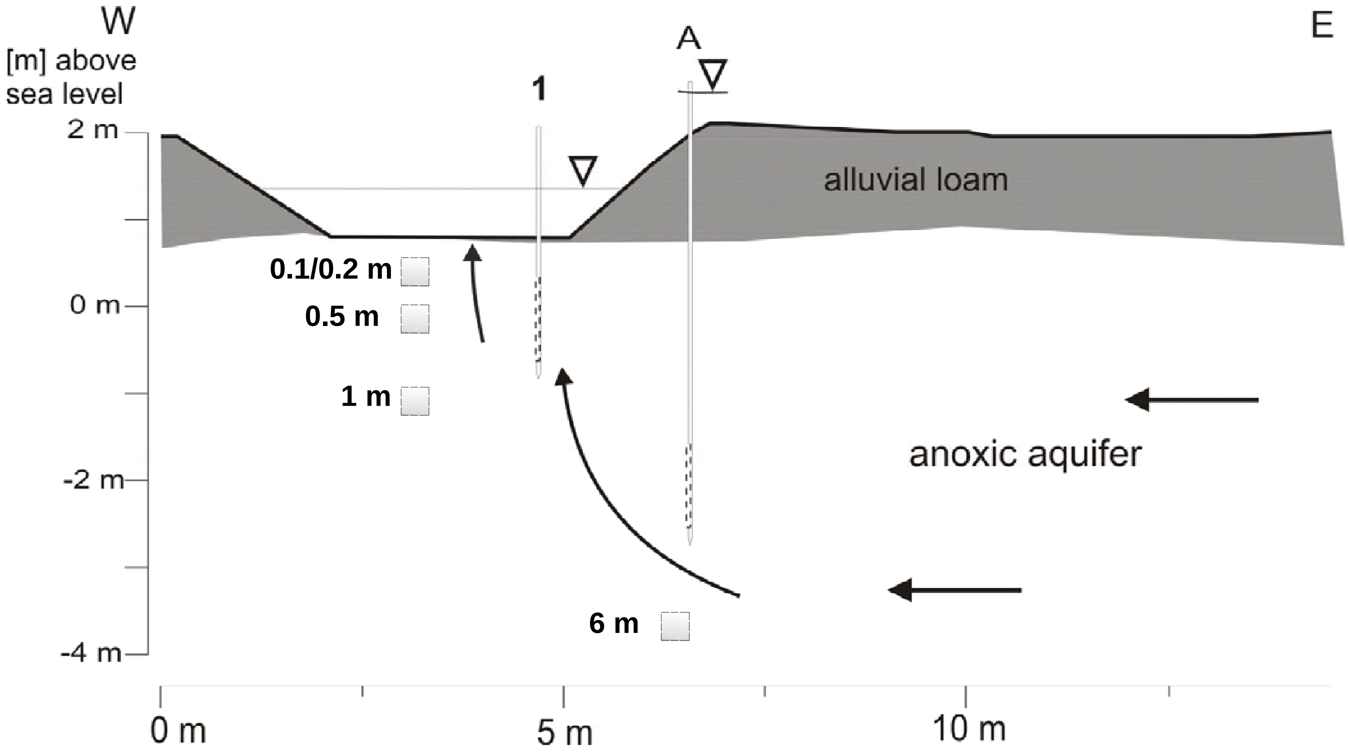
Fe > Mn >> As > Cu > Zn >> Cd

Investigation site Zollbrücke
(discharging channel, low gradients)



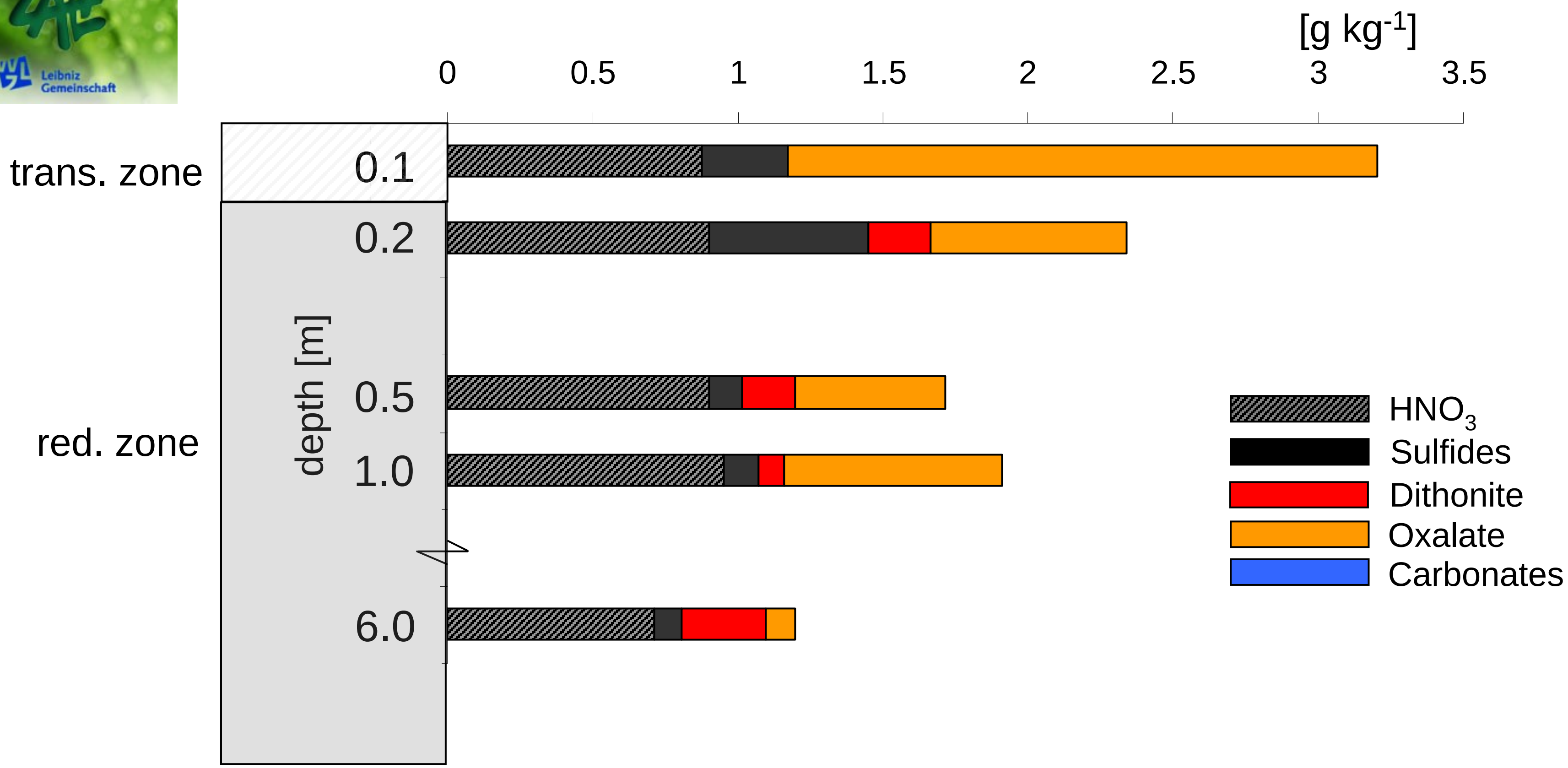
Investigation site Bahnbrücke

(discharging channel, high gradients)



Distribution of Fe-fractions in Bahnbrücke

(discharging channel, high gradients)

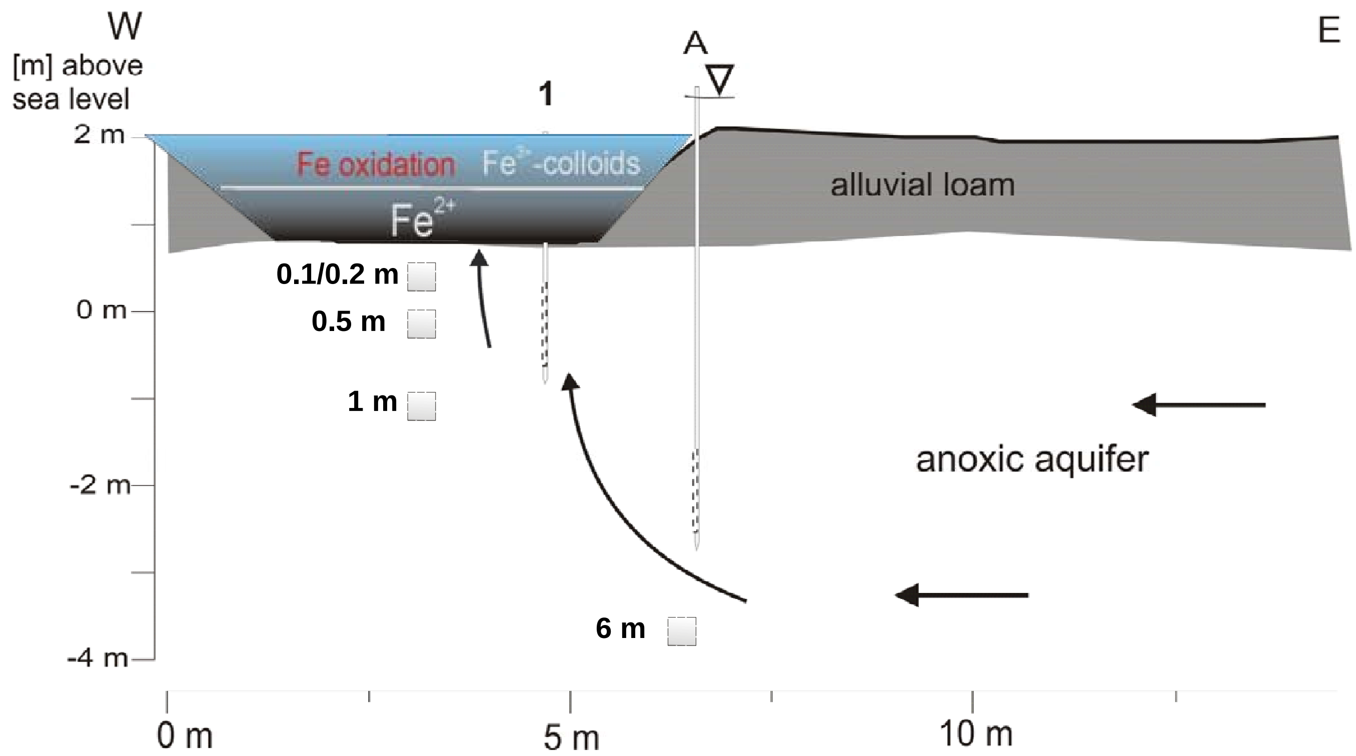


Balance calculations for the „discharging, high gardient type“

Element	concentration in the groundwater [µg l^{-1}]	Accumulation rate [g $(m^2 a)^{-1}$]	Percentage of maximum accumulation [%]
As		not detectable	
Zn		not detectable	
Cu		not detectable	
Cd	not detectable	not detectable	
Fe	1500	18.2	2.2
Mn	3000	4.4	0.3

Investigation site Bahnbrücke

(exfiltrating channel, high gradients)



Conclusions

- The mobility of trace elements at the interface between groundwater and surface water strongly depends on specific hydraulic controlled redox sequences
- Fe, Cu and As accumulate in the oxidized channel sediments as precipitated hydroxides and oxides or by adsorption to Fe/Mn-hydroxide coatings. Carbonate precipitations can increase Mn accumulation.
- Management strategies should preserve geochemical barriers - Chemical gradients should be stabilized to avoid intensive fluctuations of the redox sequence in the sediment profile
- It is important to adjust the oxidation zone deep in the sediment column - additional charge of fresh water into the channels is recommended
- An undisturbed relationship between groundwater and the alluvial loam guarantees an effective sink for trace metals in lowlands