S1: M. Sc. Water Science	**Environmental Microbiology**	**14.10.2015**
Name:	**Signature:**	
Matriculation No.:	**Participation No.: 1, 2 or 3** (circle appropriate)	
Prof. Meckenstock / Prof. Siebers	*PKZ: 1722 / 40105 / 40191*	

Part A: Prof. Meckenstock

1. a) Imagine an aquifer which is contaminated with 1 mM toluene. The groundwater has a background concentration of 0.5 mM. Show with a chemical equation if the amount of sulfate is enough to oxidize the toluene. (*10 points*)

b) In your study you find that acetate is accumulating in the aquifer. Can it be that anaerobic acetate oxidation with sulfate is not thermodynamically feasible? Show a thermodynamic calculation under standard conditions. (See table next page)

(*5 points*)

Tafel 9.7. Bildungsenthalpien biologisch relevanter Stoffe ΔG_{of} (kJ/mol)

H_2	0	H^+ (1 M)	0
H^+ (pH=7)	-39.9		
H_2O	-237.2	O_2	0
CO	-137.2	CO_2	-394.4
HCO_3^-	-586.9	CH_4	-50.8
Formiat$^-$	-351.0	Acetat$^-$	-369.4
Glucose	-917.2	Lactat$^-$	-517.8
Pyruvat$^-$	-474.6	Butyrat$^-$	-352.6
Succinat^{2-}	-619.2	Ethanol	-181.8
N_2	0	NH_4^+	-79.4
NO	+86.6	NO_2^-	-37.2
NO_3^-	-111.3	N_2O	+104.2
S^o (rhombisch)	0	HS^-	+12.5
H_2S	-33.6	S^{2-}	+85.8
$(H_2S + HS^-)/2$	-10.5	SO_3^{2-}	-486.6
HSO_3^-	-527.8	SO_4^{2-}	-744.6
$S_2O_3^{2-}$	-513.4	$S_3O_6^{2-}$	-1022.2
$S_4O_6^{2-}$	-958.1		
Fe^{2+}	-78.8	Fe^{3+}	-4.6
FeS_2	-150.8		
Mn^{2+}	-227.9	Mn^{3+}	-82.1
MnO_4^{2-}	-506.6	MnO_2	-456.7

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2) Is the classical redox sequence model for hydrocarbon contaminated aquifers still valid? Discuss your statement. (*10 points*)

3) How would you assess the biodegradation of PCE in a contaminated aquifer? (*10 points*)

4) Imagine a pollutant which can only be degraded with molecular oxygen and which is buried in 1 m depth of the saturated sandy sediment of a lake. A consultant proposes to leave the situation untouched because oxygen will diffuse into the sediment and the pollutant will be degraded. Do you agree? (*10 points*)

5) In a hydrocarbon-contaminated aquifer, you detect benzoic acid, and benzyl-succinic acid. What does tell you about biodegradation? (*5 points*)