CEE 680 Spring 2020

Water Chemistry

# Homework #9

Consider a deep lake sediment in equilibrium with $10^{-4}$ atm of oxygen. Like many large lakes, this one has substantial deposits of manganese in its sediments.

1. Write a balanced equation for the oxidation of Mn(+II) to Mn(+III), and then on to Mn(+IV) by oxygen.
2. Determine the stoichiometric requirements of oxygen for the complete conversion of Mn(+II) to Mn(+IV) in mg-oxygen/mg-manganese.
3. Determine the Log K for this reaction.
4. Based on the partial pressure of oxygen, determine pε for this system.
5. Now calculate the the ratios of the various free-Mn species (i.e., $Mn^{+2}$, $Mn^{+3}$, $Mn^{+4}$) in the pore water.
6. Assume the lake contains large deposits of $Mn(OH)_2(s)$ . What will the total concentration of soluble manganese be in the pore water, if all species are in redox equilibrium?

Use the following thermodynamic data. Assume the system is buffered at pH 7.0.

| Equ# | Half Cell Reaction | $\Delta E^o$ (Volts) |
|---|---|---|
| 1 | $O_2(g) + 4H^+ + 4e^- = 2H_2O$ | +1.23 |
| 2 | $Mn^{+3} + e^- = Mn^{+2}$ | +1.51 |
| 3 | $Mn^{+4} + e^- = Mn^{+3}$ | +1.65 |
| 4 | $MnO_4^- + 8H^+ + 5e^- = Mn^{+2} + 4H_2O$ | +1.49 |
| 5 | $Fe^{+3} + e^- = Fe^{+2}$ | +0.77 |

| Equ# | Equilibrium | Log K |
|---|---|---|
| 6 | $Mn^{+2} + H_2O = MnOH^+ + H^+$ | -10.6 |
| 7 | $Mn^{+2} + 3H_2O = Mn(OH)_3^- + 3H^+$ | -35 |
| 8 | $Mn^{+2} + 4H_2O = Mn(OH)_4^{-2} + 4H^+$ | -48.3 |
| 9 | $Mn(OH)_2\,(s) = Mn^{+2} + 2OH^-$ | -12.8 |

*Assigned: 27 Apr 20*
*Due: 4 May 20*