GY303 Igneous and Metamorphic Petrology
Aqueous Geochemistry Problem Set

Problem 1. The solubility product of calcium carbonate is 4.5E-9 at 25C. Calculate the following

a) Concentration of Ca^{2+} (Moles/liter) in a H2O fluid that invades fractures in calcite limestone during formation of a skarn.

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b) The solubility of the limestone in (a) would be affected by the presence of $CaCl_2$ in the limestone? Assuming $CaCl_2$ contributes 0.05M solution of Ca^{2+} to the hydrothermal fluid what would the Ca^{2+} concentration contributed by calcite to the solution?

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c) What would the concentration of $[CO_3^{2-}]$ be in the hydrothermal solution?

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Problem 2. For Figure 1 write out a balanced chemical reaction for:

1. The vertical line labeled "D".

2. The reaction Magnetite = Hematite

Note: For reactions that have slopes on Eh-pH diagrams that are not horizontal or vertical you must express the chemical reaction with [H+] and [-e] terms in the reaction.

Problem 3:
a) Balance the below reaction for an acidic aqueous solution:

$Fe^{2+} + UO_2^{2+} = Fe^{3+} + U^{4+}$

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b) Using the Nernst equation calculate the Eh-pH equation needed for plotting the below reaction on an Eh-pH diagram:

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$Pb^{2+} + 2H_2O = PbO_2 + 4H^+ + 2e-$ +1.46v

Problem 4. Register with your USA email address at the web site "materialsproject.org". Then construct an Eh-pH diagram for:

Cr (click on the "Cr" cell in the periodic table, then select "Pourbaix Diagram", then "generate")

Manipulate the Cr concentration to 1E-6 M. Capture the screen image to turn in as a hard copy

Explain why the reaction $Cr = Cr^{2+} + 2e-$ is a horizontal line on the Eh-pH diagram?

Why is the reaction $HCrO_4^- = CrO_4^{2-} + H^+$ a vertical line on the Eh-pH diagram?

Write a balanced chemical reaction for the reaction line that separates the Cr^{2+} and Cr_2O_3(s) fields in the Eh-pH diagram for Cr:

Problem 5. Consider trying to make a battery using a silver (Ag) electrode in a AgCl solution and a tin (Sn) electrode in a $SnCl_2$ solution:

$Ag(s) = Ag^+ + 1e-$ E^0=-0.8

$Sn(s) = Sn^{2+} + 2e-$ E^0=+0.137

If the below reaction represents the battery will it spontaneously produce electricity?

$2Ag(s) + Sn^{2+} = 2Ag^+ + Sn(s)$

Why or why not ? (prove it with electrode potentials)

Explain which of the electrodes would be positive and negative, and why:

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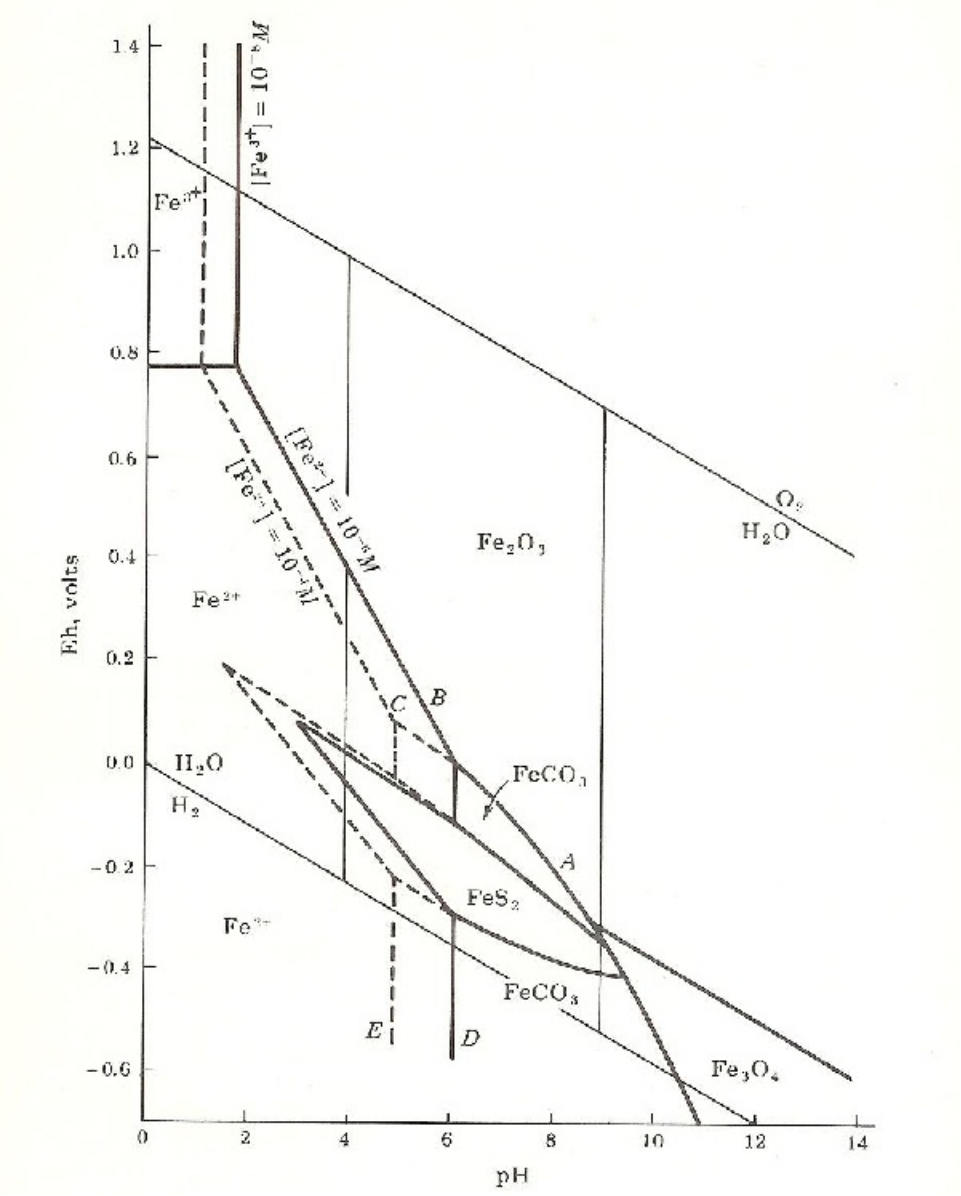

Figure 1: Fe-S-C-O-H Eh-pH system.