

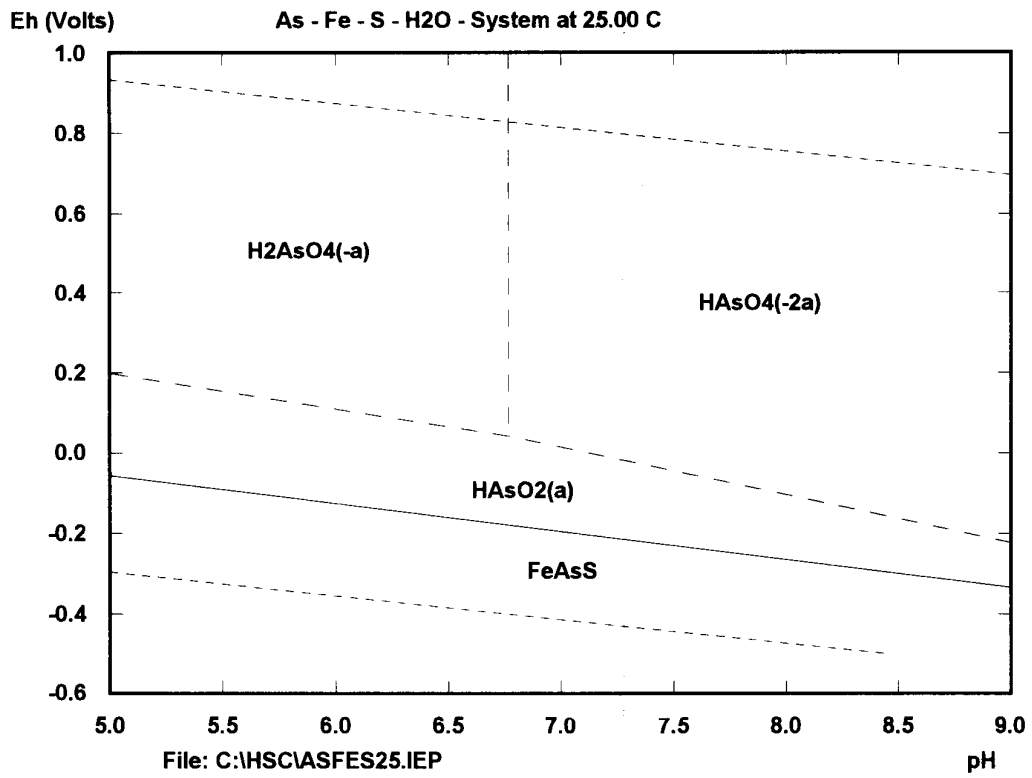
## Geology 431 Exam 2 Fall 2000

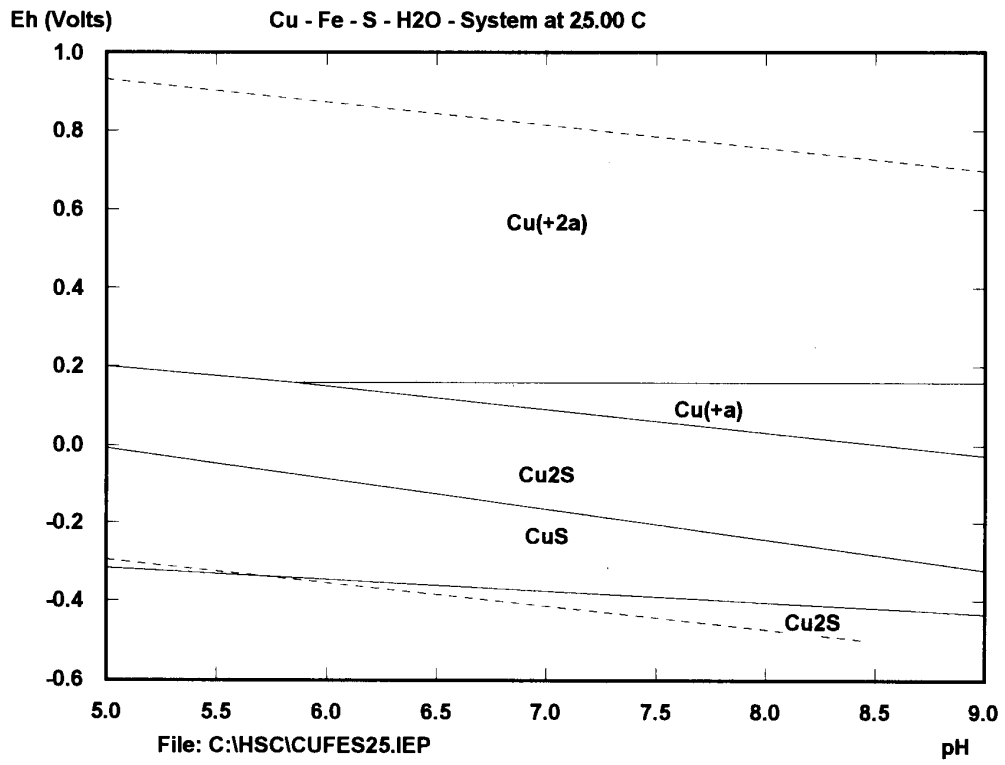
1. (25 pts) In a stream in St. Kevin's gulch, Colorado, a researcher pumped in acid and/or base at an upstream site and measured the pH downstream. The sediments of the stream are highly enriched in metals and arsenic. In the first experiment she varied the pH from a high of 7.0 to a low of 5.5. In the second experiment she varied the pH from 7.0 to 4.0. She also took water samples to measure the dissolved metal concentration, specifically As, Cu and Zn. What would the relationship between these elements and pH look like? (Draw appropriate diagrams) Why would it look like that? What evidence did you use to come up with your answer? And, very important, what major assumptions did you make to come up with this answer? (Be specific)

In another experiment in the same stream she varied the pH from 7.0 to 9.0. What would she expect to see in that experiment? (same qualifications as above about evidence, etc.).

2. (25 pts) The pH-Eh diagrams below were produced for the concentrations of important components found in the deep sediments of Milltown Reservoir. The program I used to make these diagrams does not do sub/superscripts. So,  $\text{H}_2\text{AsO}_4(-a)$  is really  $\text{H}_2\text{AsO}_4^-$ . Where the "a" in the "()" after the species shows it is aqueous and the "-" shows it is negatively charged. The "(a)" is a neutral aqueous species and "(-2a)" is a negate two charged species. The other species (without "()") are solid phases.

On each diagram draw and label the position of Milltown deep sediment in Eh-pH space based on all knowledge you have about the site. Explain how you picked those values. Now considering this information and what you know about the hydrology of the system, what would you expect the conditions to be just beneath the sediment in the alluvial aquifer that underlies Milltown sediment? What would be the forms of copper and arsenic in that aquifer? Now, suppose that one of the remedies to clean up Milltown Reservoir is to remove the sediment overlying the aquifer. What would be the fate of the phases you just described in the aquifer under the new conditions with the contaminated sediment removed? Draw a line that would follow the change to the new conditions. Be specific and complete and make sure to back up your ideas with references to papers we have read, etc. and provide any important reactions, figures, etc. that you need to support your ideas.





3. (25 pts) About 2 years ago a large tailings dam impounding tailings from a Zn mine in SW Spain failed. The flood of tailings spread over the floodplain of the Rio Guadimar where up to a meter of fine-grained, pyrite rich (up to several percent) tailings were deposited. The tailings contained high concentrations of Zn, As, Cu, Pb, and of course Fe. The Spanish Government moved quickly and removed the bulk of the tailings within a few months of the spill (several million cubic meters worth). SW Spain has a fairly arid climate with strong rains certain times of the year and then very hot and dry summers. If the tailings had not been removed, what would likely be the fate of the metals in the tailings over time? What would have been the dangers to the Rio Guadimar? Describe what you think would have happened in detail, giving any important equations, etc. needed to justify your answer and citing any appropriate references to support your ideas.

4. (25 pts) You are giving the task to decide if the sediments and water in a particular river are dangerous to aquatic life. The following data were made available to you:

Sediment Data:

Element	Concentration (ppm)
As	100
Cd	5
Cu	550
Pb	300
Zn	750

Water Data:

Element	Concentration (mg/l)
As	0.062
Cd	0.006
Cu	0.035
Pb	0.025
Zn	0.150
Hardness	100

What do you think? Make sure to completely explain your answer and back it up with details.

