

**Geology 431**  
**Fall 2000 Final Exam**

All the rules from previous exams apply.

1. (20 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. (15 pts) You are given 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.

3. (15 pts) Elemental mercury was used extensively to concentrate gold during early mining throughout the west. Analyses of soils at abandoned mine sites commonly finds high levels of Hg in waste materials. Elevated sediment–mercury is commonly found in streams flowing away from these sites. Some people argue that we should not be concerned about this contamination because the elemental Hg used at these sites is not very toxic. What do you think? Be detailed and use equations where needed to show expected reactions.

4. (20 pts) A sewage treatment plant in a growing Rocky Mountain city discharges effluent directly into a river. The following data was collected from the plant, the river above and a series of samples extending below the plant:

Sample	Cl (ppm)	Na (ppm)	As (ppb)
Effluent from Plant	400	100	360
River above Plant	12	4	2
Site 1 below plant	332	82	
Site 2 below plant	208	49	
Site 3 below plant	99	26	
Site 4 below plant	39	12	
Site 5 below plant	41	13	
Site 6 below plant	38	12	

What is the concentration of arsenic at each of the stations? Should the regulators be worried about using the water farther downstream from the plant for drinking water, based on arsenic concentration and the present MCL? What if the MCL is changed to the level proposed by EPA? Make sure to be complete, show all your steps with data and/or graphs and justify your answer.

5. (15 pts) The sediment in a stream flowing away from a large Pb mine is elevated in Pb. The owners of the mine claim that the sediment was always elevated due to the natural inputs from the ore body (which has a surface grade of about 1% Pb and an area of approximately 1 square kilometer). At a site several miles downstream from the mine (where the drainage area above is 500 sq km), the sediment concentration is 1000 ppm Pb. The background Pb concentrations in tributaries flowing into the stream average about 50 ppm Pb. Calculate what the original concentration of Pb was at this site before mining? If the site is elevated over what it was before mining, what is the exaggeration? Make sure to show all your steps and justify your approach with references to readings, etc.

6. (15 points) A mining pit lake in Nevada is found to have high concentrations of dissolved arsenic and sulfate and measurable oxygen. One plan to remediate the lake is to add organic material from nearby cattle feed lots (cow poop) or a sewage treatment plant (sewage sludge). What reactions would you expect if these organics were added to the pit lake and what would be the result as far as sulfate and arsenic is concerned? Be complete and specific and back up your answer with diagrams and/or data.