GG325 -- GEOCHEMISTRY
Fall 2009 - Midterm Examination Study Guide

This list should help you prepare for the upcoming midterm exam. Please feel free to come by my office (POST 606E) if you have questions about the material.

A. Important points and logistical details

✺ The exam will contain both qualitative/short-answer questions and some quantitative sections.

✺ It should be of similar difficulty to most of the homework; it will cover lectures through Estuaries. Be familiar with material found in your reading, class handouts and in the lecture notes.

✺ In studying the broad range of topics that we have discussed thus far, I suggest that you focus your thoughts into two categories: 1. chemical concepts and 2. their applications to environments within the hydrosphere. Although we also discussed high temperature applications during our thermodynamics intro, I won't be putting this material on the exam.

✺ Try also to be familiar with the mathematical relationships we have used in class (for solving equilibria problems, for relating G, E_H and equilibrium constants, for chemical potential, for non-ideality in various solutions, etc.). They are useful even when a quantitative answer to a question isn't required

✺ Don't memorize class notes and the text – you can use them during the exam. Focus on the concepts. Try to be familiar diagrams in the reading and lectures show, and be able to rationalize observed variations in terms of the chemical and geological concepts that we have discussed this semester. On the exam you may want to draw a diagram to answer a question or explain one I give you.

B. Some specific topics we have covered (in no particular order)

Chemical concepts	**Geological/Hydrological concepts**
Acid-base, pH, the aqueous CO_2 system, alkalinity	Weathering and Soil formation.
Lewis acids and lewis bases; ions, ligands, complexation, and chelation	Elemental Cycles, The hydrologic cycle, Calculations using residence times
Redox in natural systems, poising of E_H, typical half reactions involved in E_H poising, the role of organisms in this, the redox ladder	Physical processes in rivers, lakes and estuaries that affect the geochemistry of their waters and sediments
Aqueous Solubility, dissolution of gasses and solids in H_2O).	Major climate zones of the earth
Periodic properties of element sand their relationship to the electronic structure of atoms and their nuclei (1st ionization potential, electronegativity, size, relationships between an element and its neighbors in the periodic chart). Chemical trends (especially ion type and their aqueous solubility) through the Periodic Chart	Major Chemical characteristics (TDS, pe, pH, common ions) of rain, river, lake and estuarine waters, sources of major chemical constituents in each system, processes involved in their acquisition.
Properties of colloids/charged particles in aqueous environments, exchange of ions/sorption with natural aqueous solutions.	The various role of particles and surface chemical reactions in setting composition within the hydrosphere
Photosynthesis and respiration, the role of nutrients, the Redfield ratio (stoichiometry of processes), aerobic biological processes in rivers, lakes and estuaries)	Heat Balance on the Earth and circulation within various hydrospheric/atmospheric reservoirs
Chemical Thermodynamics (balancing chemical equations, writing equilibrium constant expressions, calculations using thermodynamic relationship between K_{eq}, ΔG, E_H and pe	The rate of breakdown of rocks as a function of mineralogy and texture during weathering

C. An example question and answer from a previous year's exam

Explain how suspended particles can affect the composition of natural waters. Explain how pH and ionic strength of the local environment influence reactions occurring on particle surfaces. Include in your answer *two* processes that occur on particle surfaces that affect the abundance of dissolved ions in solution.

Particles obtain charge primarily by acid-base reactions on their surfaces (see below). Some minerals may also obtain charge by elemental substitution into their structural matrix, requiring additional ions to adhere to the mineral surface to balance the charge.

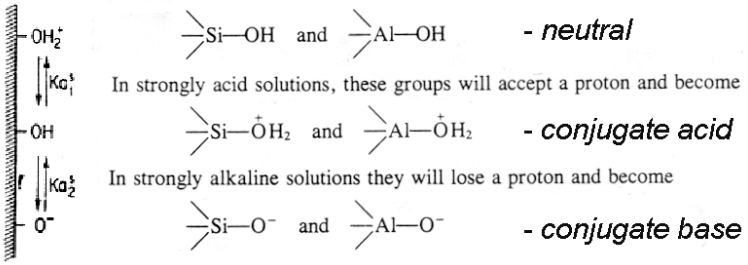
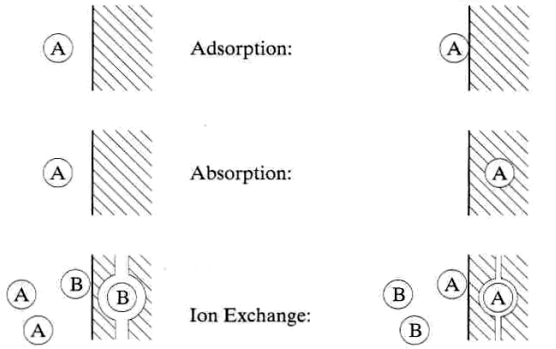


FIGURE 4–25 Processes of adsorption, absorption, and ion exchange.



This charge then causes them to exchange materials with solution by both ion exchange and sorption. Ions and solutes will exchange between suspended particles and the aqueous phase in a natural body of water. When those particle settle out, the composition of the water is also changed.

These processes for obtaining charge and trading solutes with solution are pH sensitive because the particle surfaces and the sorbing species change charge (become protonated or deprotonated) as a function of pH.

Small particles, can be solvated as colloids, such that they act as though they are "dissolved" in solution, even at relatively slow flow rates, and their compositional attributes are in effect part of the solution chemistry. These colloids can be destabilized (particularly by salt addition and water flow changes) and are then flocculated. This effectively removes some "dissolved" constituents from the water and transfers them to the suspended load and/or sediments of that body of water.