

What Controls the Composition of Seawater?

Assignment:

Write a concise analysis of "What controls the concentration of Cl⁻ and Mg²⁺ in seawater?". Compare their global geochemical cycles and then speculate on the relative responses to a sudden decrease in hydrothermal activity.

Maximum length - 3 pages - typed double spaced. Your work should be thoughtful and well written (both grammatically and scientifically)

Include a summary of the origin of the composition of river water (Garrels and Mackenzie, 1967), what composition results when river water is evaporated (Garrels and Mackenzie, 1967), what are the pros and cons of the reverse weathering hypothesis (Lecture Notes) and the mass balance (or kinetic) approach (Broecker; McDuff and Morel; Lecture Notes; Problem Set).

Group Study:

1. All students read all three papers and lecture notes before Thursday (October 18).
2. On the first day (Thursday) there will be 4 groups of students. Each group will focus on one paper with its associated study questions. On Monday the groups will be mixed and students will explain the papers to each other.
3. Each group make their own list of questions as well as those given below. Murray and Van Mooy will be roving question answerers.
4. After class, prepare an answer to the Group Study Synthesis Question given above. This is due Wednesday October 24 by the end of the day.

Reading:

1. R.M. Garrels and F.T. Mackenzie (1967) Origin of the chemical composition of some springs and lakes. In: (Stumm, W., ed) Equilibrium Concepts in Natural Waters. Wiley, p.222

Study Questions:

1A: Weathering:

1. What are the typical concentrations of ions in ephemeral and perennial springs in the Sierra Nevada? How do these compare with global average river water. (Table I)
2. What is the origin of the composition of ephemeral springs. (Table II)
3. What is the origin of the composition in perennial springs and how does it differ from the ephemeral springs. (Table II. Figure 2).
4. Present a general summary of the solution compositions that result from weathering of granitic rock (p. 231, Figure 3)

1B: Evaporation:

5. What are possible precipitates that might form during evaporation of river water (Table VII)
6. How do the ion activity products of these minerals change during evaporation (Table VII, Fig 4)
7. Does evaporation of river water make seawater? (p. 240-241)

Reading:

2. Broecker (1971) A kinetic model for the chemical composition of sea water. Quaternary Science, 2, 188-207.

Questions:

1. What factors control the difference between surface composition and the deep sea?
2. What controls the concentration of Cl and SO₄?
3. What controls the concentrations of Na, K, Mg and Ca?
4. What controls the concentrations of Si, P and C?
5. What controls the P_{CO₂}, pH and P_{O₂}?

Reading:

3. McDuff R.E. and F.M.M. Morel (1980) The geochemical control of seawater (Sillen revisited). Environmental Science and Technology. 14, 1182-1186.

Questions:

1. What are the most important ocean sources and sinks for each of the major elements?
2. Is the concentration of Cl⁻ at steady state in the ocean? What does steady state mean?
3. What role do ridge crest processes play in the controls of seawater composition?
4. How do ridge crest process change the categories as originally proposed by Broecker.
4. What controls the concentrations of Ca-HCO₃⁻ and atmospheric CO₂?