

1. (20pts) Zinc can precipitate as the mineral hydrozincite which has the formula $Zn_5(CO_3)_2(OH)_6(s)$. Assume that the oceans can be characterized as seawater with the Garrels and Thompson major ion composition at 25 °C, 1 atmosphere and pH 8.1. Given your knowledge of Zn in seawater, demonstrate whether Zn in the model ocean is controlled by precipitation of hydrozincite. Are the results applicable to the "real" ocean? The logK for the formation of hydrozincite is 74 at 25 °C, 1 atmosphere. See the following information to provide supporting documentation for your answer.

Distribution of species in seawater according to model by Garrels and Thompson

I. Major Dissolved Species in Seawater (19‰ chlorinity, 25°C, pH = 8.1)

Metal Ion,	Conc. Total,	Free Ion,	MeSO ₄ (aq),	MeHCO ₃ ,	MeCO ₃ (aq),	
Me	molal	%	%	%	%	
Na(I)	0.48	99	1+	-	-	
K(I)	0.01	99	1	-	-	
Mg(II)	0.054	87	11	1	0.3	
Ca(II)	0.01	91	8	1	0.2	
Ligand,	Conc. Total,	Free Ion,	CaL,	MgL,	NaL,	KL,
L	molal	%	%	%	%	%
SO ₄ ²⁻	0.028	54	3	22	21	0.5
HCO ₃ ⁻	0.0024	69	4	19	8	-
CO ₃ ²⁻	0.00027	9	7	67	17	-
Cl ⁻	0.56	100	-	-	-	-

Note: Equilibrium Formation Constant (given as the logarithm for the formation of complexes and solids from cations and ligands at I=0, 25 °C and one atmosphere). Activity coefficients for singly, doubly and triply charged solution species in seawater are 0.7, 0.3 and 0.1, respectively.

2. (10pts) Please use the above information to calculate the ionic strength of the model seawater.
3. (10pts) Show by calculation that the amount of dissolved bicarbonate in pure water in equilibrium with 390 ppmv carbon dioxide is reduced when also exposed to 1.0 ppmv sulfur dioxide gas (Note: dissociation constants K for CO₂ = 1.42×10^{-8} and SO₂ = 2.04×10^{-2})
4. (15pts) Given Ksp values for several salts at 298K. Calculate the solubility of each in water in grams per 100 milliliters
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|----------------------|----------------------|
| Lead(II) chloride | 1.6×10^{-5} |
| Calcium carbonate | 4.6×10^{-9} |
| Nickel(II) carbonate | 6.6×10^{-9} |
5. (20pts) Write nuclear equations to illustrate the following:
- The alpha decay of Uranium-238
 - The beta decay of Tritium-3
 - The neutron capture of Iodine-127
 - The beta decay of Carbon-14
 - The alpha decay of Radon-222
6. (15pts) Please describe the well-liked methods to determine the Hg species (e.g., Hg⁰, Hg²⁺, MMHg) in seawater.
7. (10pts) Please describe the general methods to determine the nitrate and nitrite in seawater.

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