

Thermodynamics and Isotopes in Geology, Problem 4

Solubility of Halite.

Let's use thermodynamics to calculate how much halite (NaCl) can be dissolved in water at 25°C and 1 bar pressure. Let's try to get our final answer in weight (mass) percent NaCl.

Step 1:

In the space below, write a balanced reaction that shows the dissolution of halite (at 25°C, 1 bar):

Step 2:

$$\Delta G \text{ NaCl}_{(s)} = -384.138 \text{ KJ/mol}$$

$$\Delta G \text{ Na}^+_{(aq)} = -261.905 \text{ KJ/mol}$$

$$\Delta G \text{ Cl}^-_{(aq)} = -131.228 \text{ KJ/mol}$$

Using the Gibbs Free Energies listed above, calculate the ΔG_{rxn} . Express your final answer in J/mole.

Step 3:

Calculate the $\log K_{\text{eq}}$ for your reaction using the equation discussed in class.

Express your answer first with a value for K (i.e. $K = 10^x$), and then finally as a whole number.

Step 4:

Write an expression for the K_{eq} using activities of products and reactants.

Step 5:

Using K_{eq} from Step 3, and what you know about the a_{NaCl} in pure halite, calculate the $a_{Na^+ (aq)}$ and $a_{Cl^- (aq)}$ dissolved in liquid water:

*remember: 1) there's an equal number of Na^+ and Cl^- atoms;
2) for ideal solutes, activity is the same as molality.*

Step 6:

If the mass of 1 mole of Na is 22.98977 grams and the mass of 1 mole of Cl is 35.4527 grams, how many grams of Na and Cl can be dissolved in 1 kilogram of pure water?

grams Na _____

grams Cl _____

Total grams NaCl _____

After dissolution, what is the new mass of the halite-saturated brine?
(mass of 1 kilogram liquid water plus mass of dissolved halite)

Calculate the weight percent of halite dissolved in liquid water?

The weight percent NaCl in ocean water is about 3.5%. Are the oceans saturated with halite? _____

The experimentally determined halite solubility at 25°C, 1 bar is 26.242 weight %.

Is your determination in good agreement? _____