

Homework Set #1

1. Measures of Concentration & Charge Balance

In 2008 Northampton MA completed construction of a filtration plant to treat their surface water supplies (see: <http://www.ecs.umass.edu/eve/background/Utilities/DWT/MA/Northampton/>). This facility is located near one of Northampton's two major surface water sources, the Mountain Street Reservoir in Williamsburg. This source is characterized as low-alkalinity and low-hardness, quite typical of most surface waters in New England. On March 19, 1997, a sample of the Mountain Street Reservoir water was collected and submitted for chemical analysis. The results are shown below.

Constituent	Concentration	Units
Turbidity	0.59	NTU
TDS	29	mg/L
Color	10	Color units
Odor	1	TON
pH	6.75	Log units
Total Alkalinity	13	mg-CaCO ₃ /L
Total Hardness	20	mg-CaCO ₃ /L
Calcium	6.7	mg/L
Magnesium	0.89	mg/L
Aluminum	<0.05	mg/L
Potassium	<1	mg/L
Sodium	5.0	mg/L
Iron	<0.05	mg/L
Manganese	0.016	mg/L
Sulfate	5.9	mg/L
Chloride	3.0	mg/L
Silver	<0.005	mg/L
Copper	<0.01	mg/L
Zinc	<0.05	mg/L
TOC ¹	3	mg/L

- a. Estimate the bicarbonate concentration assuming that all of the measured alkalinity is bicarbonate.

¹ Not measured; estimated from historical data

b. Calculate the ionic strength

c. Determine the “analytical” concentration of [H⁺] using the Debye-Huckel equation.

d. Perform a charge balance on this water based on the measured concentrations. Is there apparent excess charge, and if so, why?

e. Calculate the “theoretical” TDS based on the chemical analysis above and compare with the actual measured TDS. Are they different and if so why do you think this is the case?

2. Activity

A series of 10⁻³ F HCl solutions are prepared², each solution containing a different concentration of KCl in the range of 0.01 F to 0.50 F. Plot pH (i.e., -log{H⁺}) vs log I using:

a. Davies Equation;

b. Extended Debye-Huckel Equation.

3. Stable Isotope Ratios

Blasch and Bryson (2007; Groundwater 45:3:294) investigated stable isotopes in groundwaters across central Arizona. Their average isotopic ratio for the four major zones are listed below.

Subbasin	δ²H (‰)	δ¹⁸O (‰)
Little Chino	-70	-9.7
Big Chino	-75	-10.3
Verde Valley North	-84	-11.6
Verde Valley South	-78	-10.6

² F refers to Formality, which is the concentration in moles per liter that would exist if the material added to the solvent did not dissociate or react in any way to change its chemical structure

- a. If the Verde River under base flow conditions is fed only by the Big Chino, Verde Valley North and Verde Valley South aquifers, and the average deltas for the Verde River water are: $\delta^2\text{H} = -81.3$ and $\delta^{18}\text{O} = -11.17$, estimate the percent composition of the Verde River base flow from each of the three aquifers.
- b. Calculate the deltas ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) for water vapor in equilibrium with the Verde River water at 30C.

Assigned: 29 Jan 20

Due: 5 Feb 20