Sedimentology and Stratigraphy (GEOL 334)
HOMEWORK 2. Acid Rain and Related Topics

Due Date: Thursday April 18, 2019

In the early part of this course we have discussed some basic concepts in aqueous geochemistry, including reactions that dissolve calcium carbonate ($CaCO_3$), and produce bicarbonate ions (HCO_3^-) and H^+. This assignment is intended to help you further explore the interface between geochemistry, sedimentary petrology, climate, environmental science, and environmental policy. It will also help to improve your skills in web research, map reading, and interpretation of online data.

Instructions:

Follow the link to EPA Acid Rain Page under Related Links at the course homepage. Read the information here, and explore others too if you want. Follow the top link on the left to: What Is Acid Rain? Go to the bottom of this page and link to National Atmospheric Deposition Program (NADP). (**Note:** the link to NADP at EPA is currently broken: use the ***working link*** at the course web page).

At the top of the NADP web page, select the third blue tab from the left labeled "Maps and Data". Follow the link on the left to Annual Maps. At that page beneath "Available Maps", link to "NTN maps" (animated maps are optional), and follow the link to Annual Gradient Maps near the top. Explore the maps (pdf are easiest). These maps show the U.S. distribution of pH and concentrations of different oxides and cations relevant to acid rain and its products, for the years 1985 to 2017, and how conditions have changed over time. "Deposition" refers to accumulation by rain, fog and snow.

Answer the following questions:

(please type your answers, and include your name and the Homework # at the top of the page)

1. View maps for Lab pH and Lab H^+ (especially earlier years) to see the distribution of acid rain in the U.S. What part of the country has the biggest acid rain problem? Why is it located there?

2. **(a)** Look at the maps of Lab pH. Overall did the **pH** increase or decrease from 1994 to 2017? Does this reveal a change to *more acid* or *less acid* rain?

   (b) What has been the main control on the change in pH over time? *Hint:* read "Acid Rain Program" at the Acid Rain home page, *please think about* the information provided here.

3. Now look at maps for SO_4. How has the concentration of the sulfate ion changed through time (increase or decrease)? Do you think this change is related to changes in pH? Why or why not?

4. **(a)** What is the main factor that controls the concentration of Ca^{2+} in the U.S.? *Hint:* look at the geologic map of the U.S. at the course web page (posted next to the link to EPA Acid Rain).

   (b) How does the presence of limestone in a lake or watershed help to moderate (buffer) pH?

   For b, please include the relevant chemical reactions that we discussed in class.

5. For any given year (see for example 2006), what is the geographical distribution of the highest chloride (Cl) ion concentrations (mg/L)? Why are the high values located where they are?

6. Go to the PRISM Climate Data page for precipitation at http://www.prism.oregonstate.edu. This is an excellent source of climate data. Link to **Comparisons**, and then **Anomalies**.

   (a) In March, 2015, where were the two highest ***positive*** precipitation anomalies in the U.S.?

   (**b**) In March, 2016, what two states had the most severe ***negative*** precipitation anomalies in the U.S.?

   (c) Select annual comparisons and look at precipitation in California for the years 2010 and 2013. Which of these two years had the ***positive anomaly***, and which year had the ***negative anomaly***?