Homework 7: Texas Aquifer Piper Diagram
GEOS 4430 - Fall 2011

Due: Dec. 6th

We have studied chemical classification diagrams for groundwater in class. In this homework you'll use plotting software to generate one such diagram, a Piper diagram, for common water types in Texas major aquifers.

1 Problems

I. Review the Texas Major Aquifer Map, which represents the major zones of groundwater extraction across the state. These aquifers are delimited by their hydrostratigraphy.

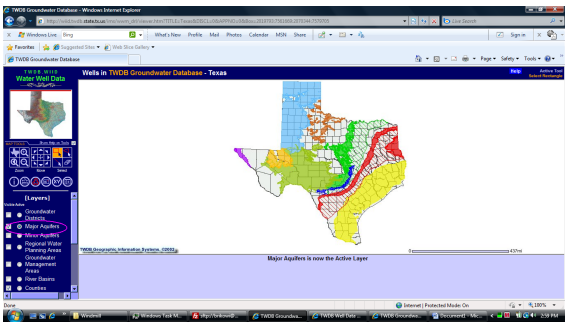
   A. the Ogallala Aquifer is composed of latest Tertiary and Quaternary sediments shed from the Rocky Mountains. The Edwards (and Trinity) Aquifers are composed of limestone. What would you expect the major differences to be between these two aquifers in terms of hydraulic conductivity, its heterogeneity and anisotropy.

II. Obtain at least one water analysis from each of 5 major aquifers. Be sure to get a range of values in TDS or Electrical Conductivity (i.e. some wells located in an aquifer area may be much deeper)

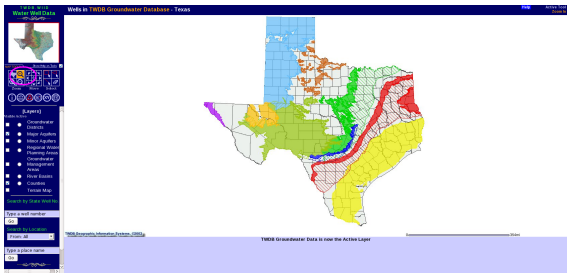
   A. Either

      1. Use TWDB ArcGIS interface (sometimes fails with Firefox; if so, try Internet Explorer ☹, `enable popups for ''*.tx.state.us''`) to select wells in each aquifer

         a. make "Major Aquifers" layer visible, i.e. in left frame `select square checkbox` adjacent to "Major Aquifers" (Fig. 1(a))



(a) Display aquifers



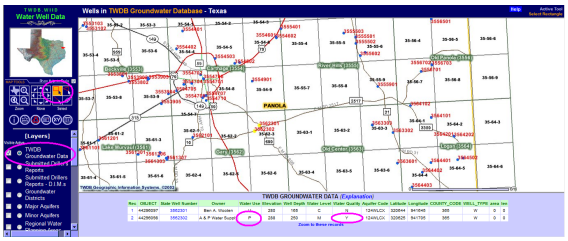
(b) Zoom to aquifer

Figure 1: Displaying and zooming in to major aquifers, TWDB groundwater database

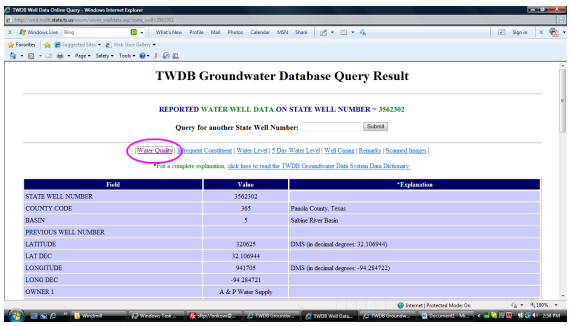
         b. zoom in to your favorite county (drag a box in the area of interest, Fig. 1(b))

c. zoom in until you see wells (blue dots with 6-7 digit ID's in red (Fig. 2(a))

d. `select a likely well` using the selection tools (near top right of left-hand frame), or `type the well number` in the "Search by State Well No." box at the bottom of the left-hand frame. The best wells for recent data are city-owned, i.e. at intersections of major highways.



(a) Zoom to wells



(b) Well description

Figure 2: Displaying and selecting desired wells, TWDB groundwater database

e. a "TWDB GROUNDWATER DATA" entry will appear at the bottom of the map frame (Fig. 2(a)). Make sure there's a "Y" in the "Water Quality Data" column, and the best wells will be **P**ublic Water Supply ("P" in "Water Use" column)

f. `select desired State Well Number` in bottom frame, a new window opens with a general well description (Fig. 2(b))

g. `select ''Water Quality'' link` and a new "Groundwater Database Query Result, Reported Water Quality" window will appear (Fig. 3)

Groundwater Database Query Result

REPORTED WATER QUALITY DATA ON STATE WELL NUMBER = 3554704

Query for another State Well Number: Submit

| Water Quality | Infrequent Constituent | Water Level | 5 Day Water Level | Well Casing | Remarks | Scanned Images |

Click here to read the TWDB GroundWater Data System Data Dictionary for explanation.

No.	STATE WELL NUMBER	MONTH	DAY	YEAR	SAMPLE NUMBER	SAMPLE TIME	TEMPERATURE CELSIUS	TOP OF SAMPLED INTERVAL	BOTTOM OF SAMPLED INTERVAL	SAMPLED INTERVAL AQUIFER CODE	COLLECTION REMARKS	RELIABILITY REMARK	COLLECTING AGENCY	LAB CODE	BALANCED / UNBALANCED	SILICA MG/L	CALCIUM MG/L	MAGNESIUM MG/L	SODIUM MG/L	POTASSIUM MG/L	STRONTIUM MG/L	CARBONATE MG/L	B
1	3554704	5	20	1951	1							99	08	04	B		8	2.2	101.2			6	
2	3554704	7	20	1951	1							99	08	04	B		11.9	2.1	85.3			2.4	
3	3554704	10	6	1951	1							99	02	01	B	23	19	5	83			0	
4	3554704	3	19	1954	1							99	02	01	B	31	8	5	90			0	
5	3554704	5	13	1986	1		21					03	01	01	B	26	8	2	85	1		0	
6	3554704	4	24	2002	1	0910	21					10	01	23	B	29.4	8	1.97	81.8	1.18	0.39	0	
7	3554704	4	19	2006	1	1215	22					10	01	24	B	24.2	9.9	2.1	75.4	1.3	0.42	0	

Figure 3: Well water quality report, TWDB groundwater database. Use most recent or apparently highest quality analysis.

h. scroll across to find the cations and anions needed for plotting on the Piper diagram

2. **Or** Download full water analysis database from the Texas Water Development Board, import into Excel, select appropriate records (rows) from all five of the major aquifers

III. Use the free USGS software GW Chart to plot the samples on a Piper diagram

A. install the executable and start it

B. select the `Piper Diagram` mode from "Chart Type" (Fig. 4)

C. the data entry screen for Piper Diagrams opens. At the bottom enter the `Number of data points`, and select `concentrations(mg/l` (Fig. 5)

D. enter the elements from the TWDB database for your well. Use EC for TDS.

E. select the `Plot` tab to see your plot

F. label each point with its aquifer name. You can set the symbol type and labels by selecting the `Format Chart` icon in the lower left of the Plot tab window (name is set on the legend tab)

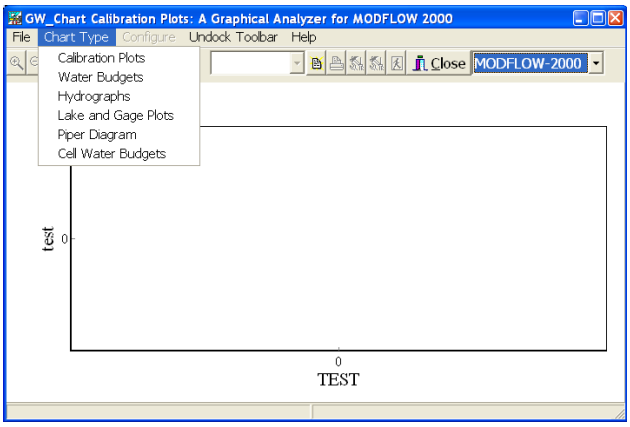


Figure 4: GW_Chart opening screen

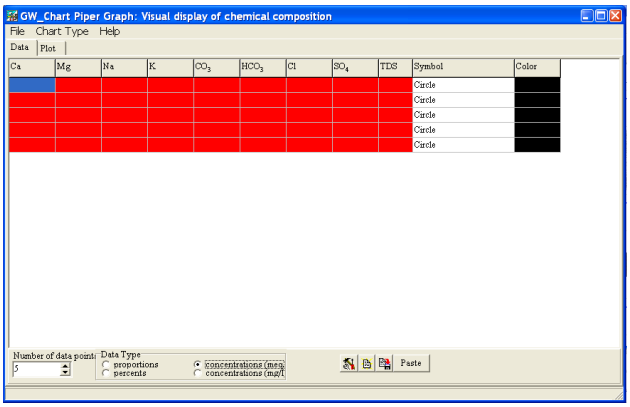


Figure 5: GW_Chart openingPiper data entry screen

⇒ Print your point-labeled Piper Diagram and turn it in

⇒ Explain your diagram. Why do you see the pattern exhibited by your Piper diagram? E.g. are the cations and anions for the Gulf Coast Aquifer what you'd expect for a near-seawater aquifer? How about for the extremely rapidly-recharged Edwards-BFZ (Balcones Fault Zone)? See USGS Florida example for ideas.