

Well Logs

You will work on this assignment individually. Each person must complete his or her own drawings and answers to the questions.

Introduction

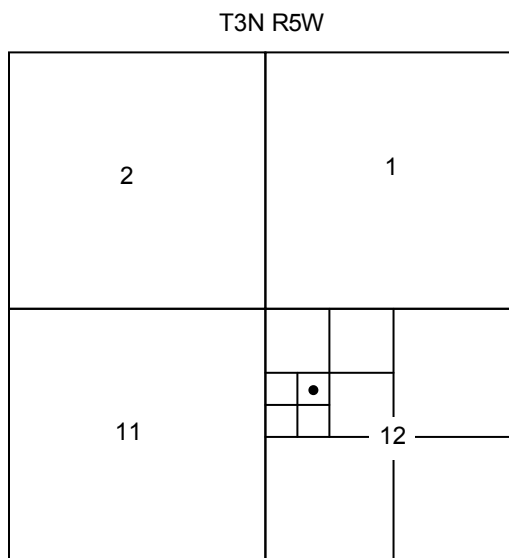
In this lab, you will examine four well logs, correlate major unit boundaries, and construct three figures: a cross-section diagram, a structure map, and an isopach map.

You also will examine another well electric log and associated drilling chips/cuttings, construct a drill cuttings log, and correlate the electric log with the cuttings log.

Skills

The skills you will apply in this lab include:

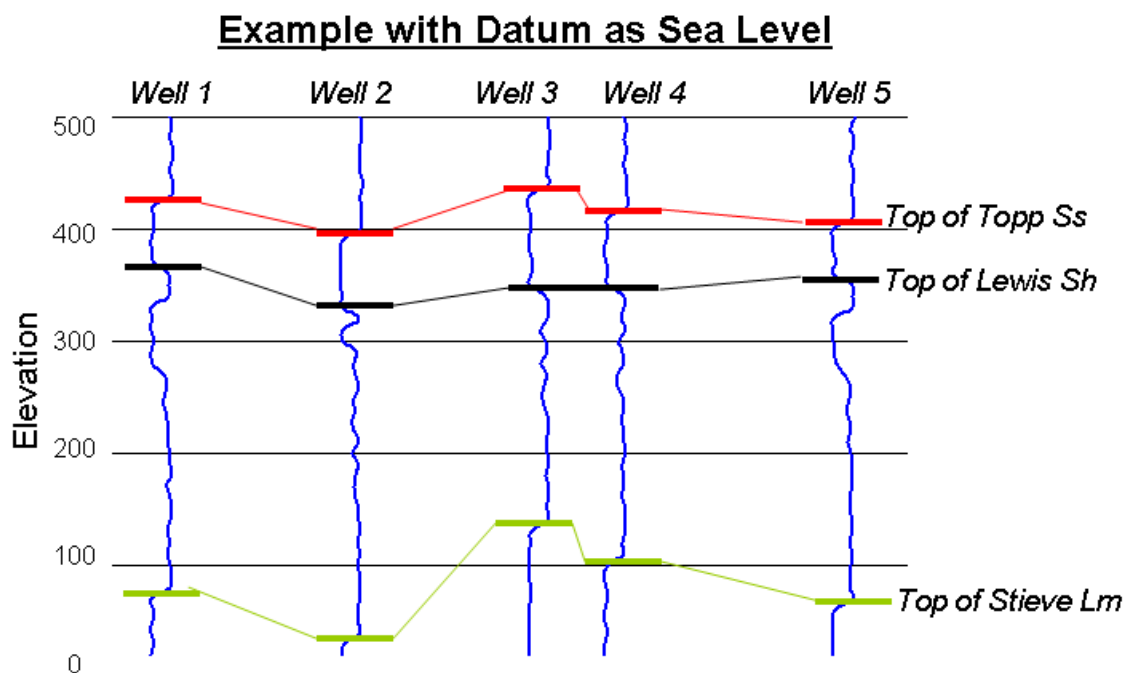
- (a) **Locating wells** using the *Public Land Survey System information from well log heading information*. The well logs you will be given use the PLSS to locate each well. This system uses “township-range” indicators, “quartering” designations, and finally distances from the finest quarter boundaries (in this lab, we are going to ignore the distances and assume the wells are located in the center of the finest quarter). An example location definition is: NE SW NW 12 T3N R5W. You say the location from left to right: “north-east quarter of the south-west quarter of the north-west quarter of section 12, township 3 north – range 5 west,” but you locate on a map by going from right-to-left (find section 12, go to the north-west quarter, then go to the south-west quarter of that quarter, then go to the north-east quarter of that quarter). The following shows the location of our example:



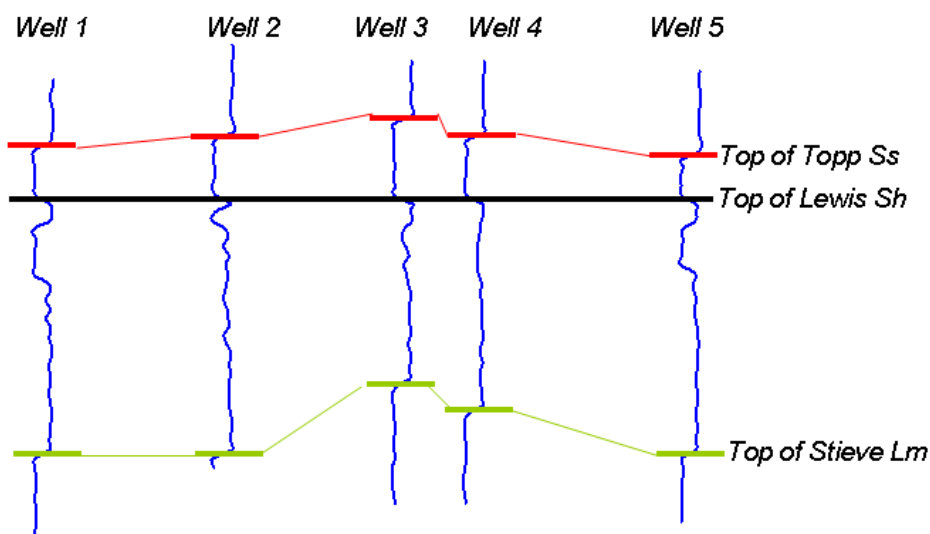
- (b) **Making picks** from *electric logs*. Picks are the analyst's (geologist's) determination (pick) of the depths where significant geologic changes occur (typically formation tops/bottoms). Picks are based on interpretation of the various log information. See below for a simplified summary of formation type based on electric log information. Sometime picks are easy to make when the well log displays rapid and distinct changes, but picks can be speculative when limited information, conflicting indicators, and/or non-distinctive changes occur.

Spontaneous Potential	Resistivity	Simple Interpretation
High	Low	Shale
Medium	Medium	Shaly Sand
Low	High	Sandstone with oil
High	Very High	Limestone
Very High	High	Sandstone with Fresh Water
Low	Medium to Low	Sandstone with Salt Water

- (c) **Correlating** picks amongst various well logs, choosing a **datum**, and constructing a **cross-section diagram**. A cross-section diagram is a vertical section through the subsurface, along a roughly straight line of data – commonly with the perspective of looking northward perpendicular to the line. It is constructed by first determining the well line/order and spacing the well locations along the cross-section based on distances from each well. The next step is to choose a datum – a defined indicator that is assumed to be horizontal. Often that datum is sea-level, but any formation top/bottom can be used depending on the purpose of the cross-section. The final step is to plot the picks of each well on the cross-section (according to the datum) and connecting the picks that represent the same geologic change (this is the correlation part). Often, dotted lines are used to indicate correlations that are suspect and/or assumed. Here are two examples of datum choices:



Example with Datum as Top of Lewis Sh



- (d) **Constructing maps based on well locations and picks.** Structure and isopach maps are essentially just contour maps of information. Structure maps show the contours of the elevation of a particular formation boundary (top or bottom). An isopach map is a contour map of a thickness of a desired type of information (a formation thickness, the thickness of certain types of material, etc.). As with cross-sections, dashed lines are used to indicate contour lines that are minimally supported by the data and/or assumed.
- (e) **Create a drill-cuttings log.** A drill-cuttings log (sometimes called a “mud log”) is a descriptive record of the characteristics of the drill-cuttings returned to the surface when drilling a well. The description is recorded for the current depth of the drilling – even though there is a lag in time for the cuttings to reach the surface. In addition to a cuttings description, the drill-rate (i.e., feet drilled per minute) can/should be recorded as different rock types will drill at different “speeds” – another indicator of formation changes.

Activity #1 – Correlation

1. You have been given copies of a portion of four actual Illinois oil-well logs. Line up the logs from Northwest to Southeast, left to right. Use locations from the headings. Note the geologic interpretations provided on logs for Wells #4 and #5. Pick the base of the persistent limestone (Bottom of Glen Dean Limestone) on each log, then align the logs with this boundary as datum (i.e., arrange the logs so the datum is a single horizontal line across all logs). Tape the logs together to construct your cross-section. Pick the following additional boundaries and connect them across all logs (note: the connections will likely not be horizontal):
 - a. Top of Tar Springs Sandstone
 - b. Top & Bottom of Golconda Limestone
 - c. Top & Bottom of Barlow Limestone
 - d. Top & Bottom of Cypress Sandstone “doublet”

Activity #2 – Mapping

1. You have been given copies of a two additional actual Illinois oil-well logs. Fill out the following table to get the elevation of the base of the Glen Dean Limestone and the thickness of the “pay zone” (i.e., the thickness of the Glen Dean Limestone).
2. Plot the location of all six wells on graph paper. Use locations from the headings. Using the calculated values in the table, construct a structure map using the base of the Glen Dean Limestone. Don’t forget a legend, north arrow, and scale.
3. On a second sheet of graph paper, again plot the location of all six wells. Using the calculated values in the table, construct an isopach map of the “pay zone”. Don’t forget a legend, north arrow, and scale.

Well #	Well Datum (Kelly Bushing, KB) [ft amsl]	Depth to Base of Glen Dean Ls [ft]	Elevation of Base of Glen Dean Ls [ft amsl]	Thickness of Pay Zone [ft]
1-A				
4				
5				
6				
25				
36				

ft amsl = feet above mean sea level

4. Using your constructed maps and cross-section, speculate as to why there is no oil in this “pay zone”. Note that the overlying shale should act as a barrier to petroleum migration.

Activity #3 – Mud Logging

1. Set out for you in the lab is a series of boxes with drilling chips from 1850 feet to 2275 feet depth for Well Post No. 1. You have also been given the well electric log acquired for the same interval.
2. Create a “Mud Log” (drill-cuttings log) based on your observations of the drilling chips. Use the form provided.
3. Compare your Mud Log to the electric log provided. Assuming the electric log elevations/depths are correct, about how far off, in feet, is your Mud Log?