PART B. SUBSURFACE GEOLOGY

In addition to looking at the flow of groundwater, it is important to have a mental understanding of what the distribution of subsurface geologic units may be like. Different geological units will allow different amounts of water to flow through them depending on their hydraulic conductivity (Table 12.1). Understanding the relationships among subsurface geologic units is very important in developing an understanding of how groundwater moves in complex subsurface environments. Although there is much difference in the geology of subsurface units in different geological settings, the example below illustrates how sedimentary units might be related in many parts of the northern United States where glaciation has modified or formed the regolith.

When geologists begin to investigate the subsurface geology of an area, they often are limited to data gathered from existing wells. These data are in the form of well logs, which are a driller's or a geologist's written records of the different types of rock materials encountered as a well was drilled. By using logs from one well, a graph can be drawn that shows units encountered, as is illustrated in Figure 12.4. The depths at which different geologic units are encountered are shown. Depths below ground surface often are converted to elevations, so multiple wells can easily be plotted and compared. The transition from one geologic unit to another is called a contact.

Data from multiple wells can be connected (correlated) to form a geologic cross section. A cross section illustrates the subsurface relationships among different geologic units.

Where data are available from multiple wells, lines linking the geology in one well with the geology in another well can be sketched between the wells. Although there are no data between wells to suggest at what depth a particular geological unit may be encountered, it is reasonable to sketch a straight line where units can reasonably be connected (wells are vertical lines in Figure 12.5). If a unit is encountered in one well, but not in the next, the section must be drawn to indicate that it has not been encountered in the latter well. This is illustrated in Figure 12.5. Note that the sand unit at 760 ft was only found in one well on the right. Either it was not deposited elsewhere, or it has been eroded.

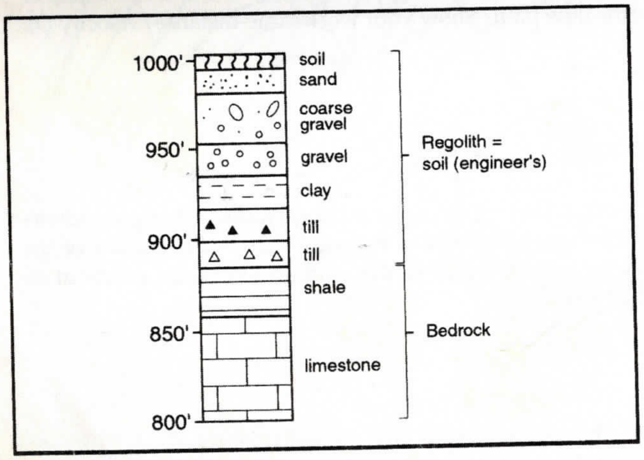

FIGURE 12.4 Typical log from a well, showing geologic materials and contacts.

QUESTIONS 12, PART B

Your assignment is to interpret the well logs in Table 12.2, draw a topographic map, draw a geologic map, draw cross sections that illustrate the subsurface geology, and answer related questions about how water may move in the subsurface. The distribution of wells is shown on the map in Figure 12.6.

1. List the five different types of sediment or rock found in the wells (see Table 12.2).

2. Which sediment has the highest hydraulic conductivity? Which two have the lowest? (See Table 12.1 for hints.)

3. In Table 12.2, complete the data for *Depth* (to the bottom of each unit) and *Elevation* (height above sea level for the bottom of each unit) for wells 4–8. Wells 1–3 are completed in the table as guides.

4. On Figure 12.6, put the land elevation beside each well. Draw topographic contours showing the configuration of the land surface. Use a contour interval of 20 feet for your *topographic map*. The 260-foot contour is given on the map.

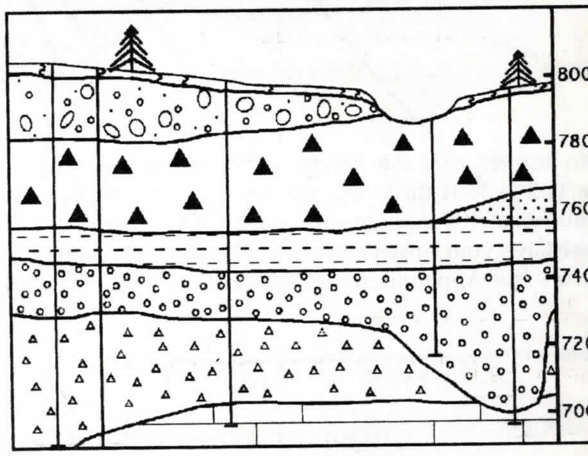

FIGURE 12.5 Geologic cross section, showing the correlation (connection) of geologic units in the subsurface between wells.

TABLE 12.2 Darcyville Well Logs. All measurements are in feet. Material is the type of geologic deposits (sediments). Thickness records how many feet of a particular unit were encountered when the well was drilled. Depth is how far down it is from the surface to the bottom contact of the specific type of geologic deposit. *Elevation is the height above sea level for the bottom of the geologic deposit.* Data for wells 1, 2 and 3 are filled in. Till is a poorly sorted silt and clay-rich sediment deposited by a glacier.

Well 1; Darcyville (land elev. 265)

Material	Thickness	Depth	Elevation
coarse gravel	40	40	225
till	45	85	180
clay	10	95	170

Well 2; Darcyville (land elev. 275)

Material	Thickness	Depth	Elevation
till	15	15	260
coarse gravel	25	40	235
till	15	55	220
fine sand	10	65	210
till	30	95	180
clay	25	120	155

Well 3; Darcyville (land elev. 290)

Material	Thickness	Depth	Elevation
till	60	60	230
fine sand	25	85	205
till	25	110	180
clay	25	135	155

Well 4; Darcyville (land elev. 305)

Material	Thickness	Depth	Elevation
coarse gravel	45		
till	20		
fine sand	45		
till	15		
clay	10		

Well 5; Darcyville (land elev. 310)

Material	Thickness	Depth	Elevation
coarse gravel	15		
till	40		
medium sand	40		
till	35		
clay	10		

Well 6; Darcyville (land elev. 290)

Material	Thickness	Depth	Elevation
till	70		
fine sand	15		
till	25		
clay	4		

Well 7; Darcyville (land elev. 265)

Material	Thickness	Depth	Elevation
coarse gravel	15		
till	35		
fine sand	10		
till	25		
clay	15		

Well 8; Darcyville (land elev. 255)

Material	Thickness	Depth	Elevation
coarse gravel	40		
till	35		
clay	10		

5. On Figure 12.6, beside each well, place the name of the material that is found at the land surface. These materials are those found in the top unit for each well.

6. Make a *geologic map* of the area in Figure 12.6 by interpreting the distribution of sediment (material) types and grouping any areas with similar materials. Do this by drawing a line to show the approximate contact between any two different materials at the surface. Without knowing the exact location of contacts, there will be more than one way to show the extent of materials. Your geologic map provides the distribution of sediments at the surface in this map area.

7. Draw two *geologic cross sections* (x to x′, and y to y′, for the map on Figure 12.6). The first cross section is through wells 1, 2, 3, and 4 (x–x′). The second cross section is through wells 5, 6, 7, and 8 (y–y′). Construct the cross sections on Figure 12.7 following the instructions below.

a. Draw the *profile* of the land surface; the profile for y–y′ is given as an example. On the upper diagram in Figure 12.7 at the locations of the wells on the lower axis, draw a light line vertically above each well to the top of

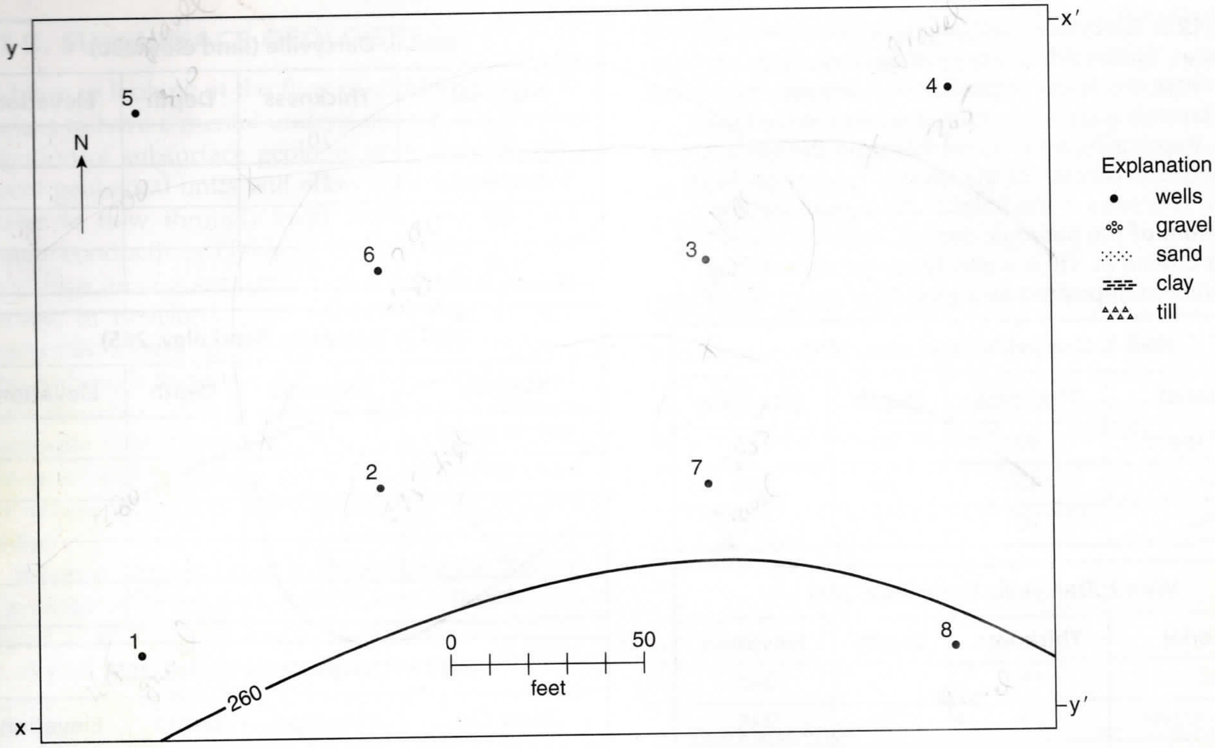

FIGURE 12.6 Map showing well locations near Darcyville, for completion of topographic and geologic maps. The 260-foot contour line is given.

the diagram (the line for well 1 is given). Mark the land elevation at the top of each well on this line with a short bar and label the elevation. Obtain the land elevation value for each well from Table 12.2.

Note: Optional: You could check agreement between your profile and a profile made from the topographic map constructed in Question 4, but this is optional. The points on profile y–y′ between wells were obtained from the contour map.

b. Add the stratigraphy for each well (wells 2–4 and 5–8). Starting from the topographic profile, place a tick mark on the vertical line for each well corresponding to the elevations where the geologic units change (i.e., the contacts of the units). The contacts for well 1 are entered on Figure 12.7.

c. Label each layer of each well as done for well 1.

d. Now complete the *geologic cross sections*. Look at the labeled geologic units in each well. Draw lines between wells to connect the same contacts separating geologic units. Not all units can be connected because some units may not occur in adjacent wells. Such units must "pinch out" before reaching an adjacent well when you construct your cross section.

8. Where is the best location to drill a water well for a house (domestic use well)? Briefly explain your choice based on the cross sections and geologic map that you constructed.

9. Assuming that all wells obtain water from every sand or gravel unit they intersect, which wells have the greatest potential for pollution from a nearby spill of toxic liquids? Explain your choices on the basis of the geology in your cross sections (Figure 12.7).

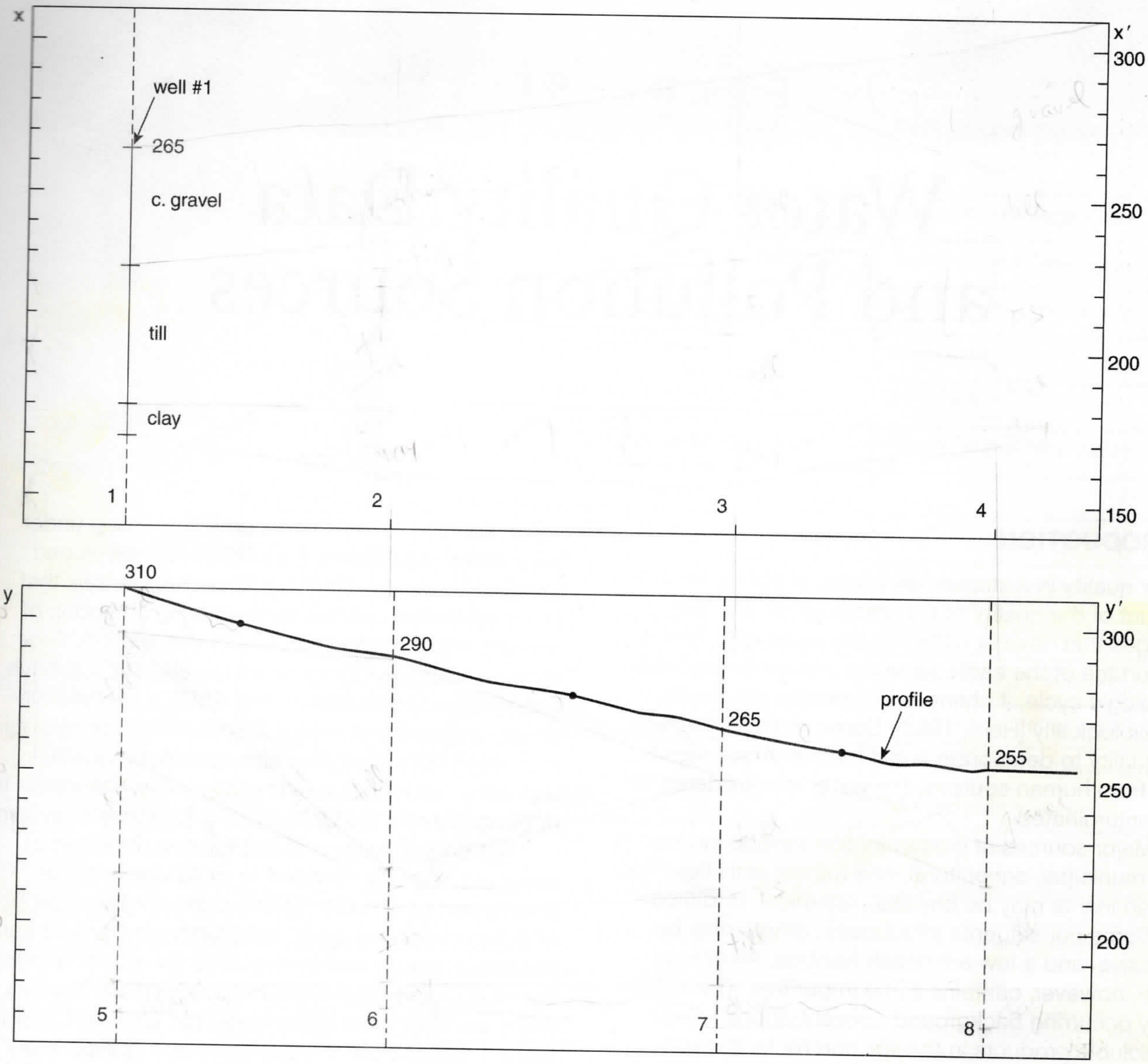

FIGURE 12.7 Geologic profiles and cross sections of the subsurface near Darcyville (x–x′ and y–y′). See Figure 12.6 for location. Interpretation based on wells 1–8; elevation of land surface given in feet.

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