5. Contouring By Hand

Print

This page will walk you through a methodical approach to rendering contour lines from an array of spot elevations (Rabenhorst and McDermott, 1989). To get the most from this demonstration, I suggest that you print the illustration in the attached image file. Find a pencil (preferably one with an eraser!) and straightedge, and duplicate the steps illustrated below. A "Try This!" activity will follow this step-by-step introduction, providing you a chance to go solo.

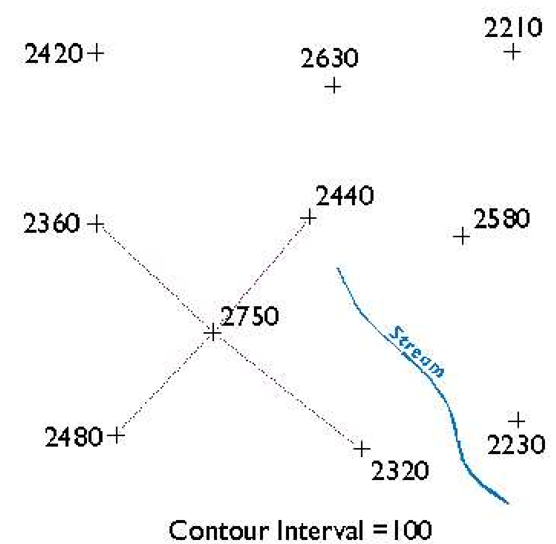

Figure 7.6.1 Beginning a triangulated irregular network.

Starting at the highest elevation, draw straight lines to the nearest neighboring spot elevations. Once you have connected to all of the points that neighbor the highest point, begin again at the second highest elevation. (You will have to make some subjective decisions as to which points are "neighbors" and which are not.) Taking care not to draw triangles across the stream, continue until the surface is completely triangulated.

The Nature of Geographic Information

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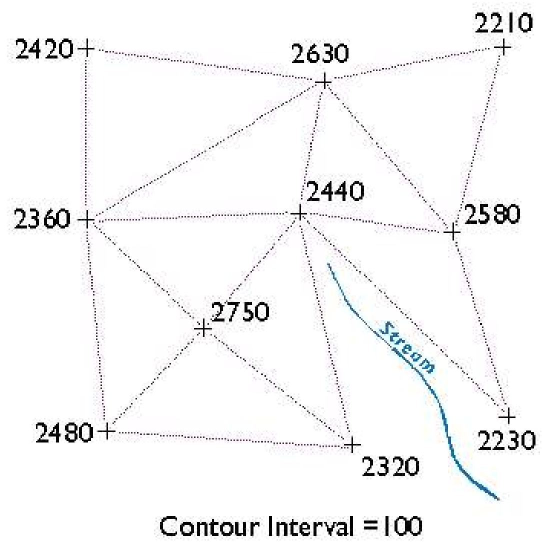

Figure 7.6.2 Complete TIN. Note that the triangle sides must not cross hydrologic features (i.e., the stream) on a terrain surface.

The result is a **triangulated irregular network (TIN)**. A TIN is a vector representation of a continuous surface that consists entirely of triangular facets. The vertices of the triangles are spot elevations that may have been measured in the field by leveling, or in a photogrammetrist's workshop with a stereoplotter, or by other means. (Spot elevations produced photogrammetrically are called **mass points**.) A useful characteristic of TINs is that each triangular facet has a single slope degree and direction. With a little imagination and practice, you can visualize the underlying surface from the TIN even without drawing contours.

Wonder why I suggest that you not let triangle sides that make up the TIN cross the stream? Well, if you did, the stream would appear to run along the side of a hill, instead of down a valley as it should. In practice, spot elevations would always be measured at several points along the stream, and along ridges as well. Photogrammetrists refer to spot elevations collected along linear features as **breaklines** (Maune, 2007). I omitted breaklines from this example just to make a point.

You may notice that there is more than one correct way to draw the TIN. As you will see, deciding which spot elevations are "near neighbors" and which are not is subjective in some cases. Related to this element of subjectivity is the fact that the fidelity of a contour map depends in large part on the distribution of spot elevations on which it is based. In general, the density of spot elevations should be greater where terrain elevations vary greatly, and sparser where the terrain varies subtly. Similarly, the smaller the contour interval you intend to use, the more spot elevations you need.

(There are algorithms for triangulating irregular arrays that produce unique solutions. One approach is called **Delaunay Triangulation** which, in one of its constrained forms, is useful for representing terrain surfaces. The distinguishing geometric characteristic of a Delaunay triangulation is that a circle surrounding each triangle side does not contain any other vertex.)

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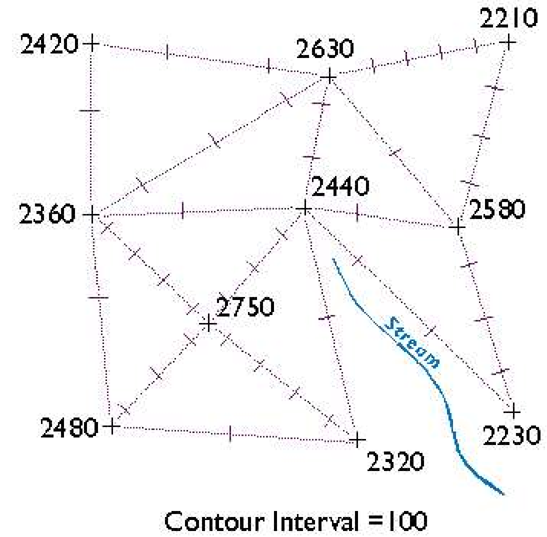


Figure 7.6.3 Tick marks drawn where elevation contours cross the edges of each TIN facet.

Now draw ticks to mark the points at which elevation contours intersect each triangle side. For instance, see the triangle side that connects the spot elevations 2360 and 2480 in the lower left corner of Figure 7.6.3, above? One tick mark is drawn on the triangle where a contour representing elevation 2400 intersects. Now find the two spot elevations, 2480 and 2750, in the same lower left corner. Note that three tick marks are placed where contours representing elevations 2500, 2600, and 2700 intersect.

This step should remind you of the equal interval classification scheme you read about in Chapter 3. The right choice of contour interval depends on the goal of the mapping project. In general, contour intervals increase in proportion to the variability of the terrain surface. It should be noted that the assumption that elevations increase or decrease at a constant rate is not always correct, of course. We will consider that issue in more detail later.

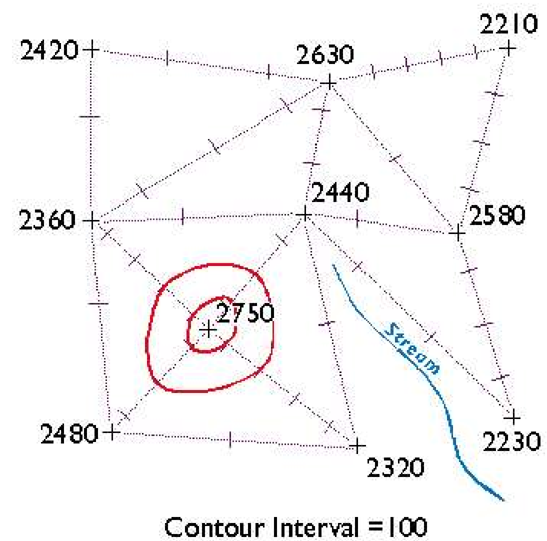


Figure 7.6.4 Threading elevation contours through a TIN.

Finally, draw your contour lines. Working downslope from the highest elevation, thread contours through ticks of equal value. Move to the next highest elevation when the surface seems ambiguous.

Keep in mind the following characteristics of contour lines (Rabenhorst and McDermott, 1989):

- Contours should **always point upstream** in valleys
- Contours should **always point downridge** along ridges
- Adjacent contours should **always be sequential or equivalent**
- Contours should **never split into two**
- Contours should **never cross or loop**
- Contours should **never spiral**
- Contours should **never stop in the middle of a map**

How does your finished map compare with the one I drew below?

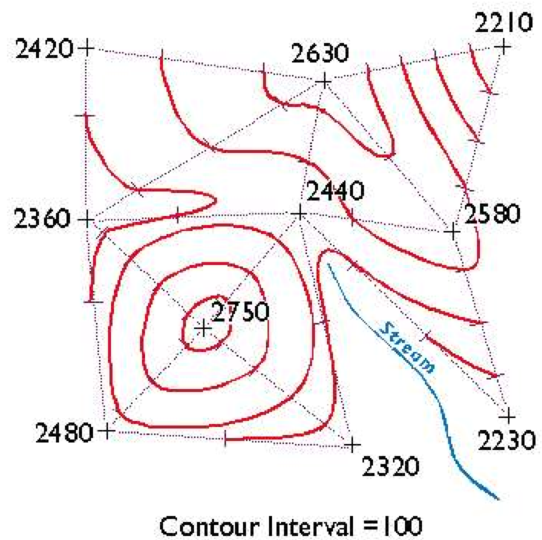


Figure 7.6.5 Finished map.

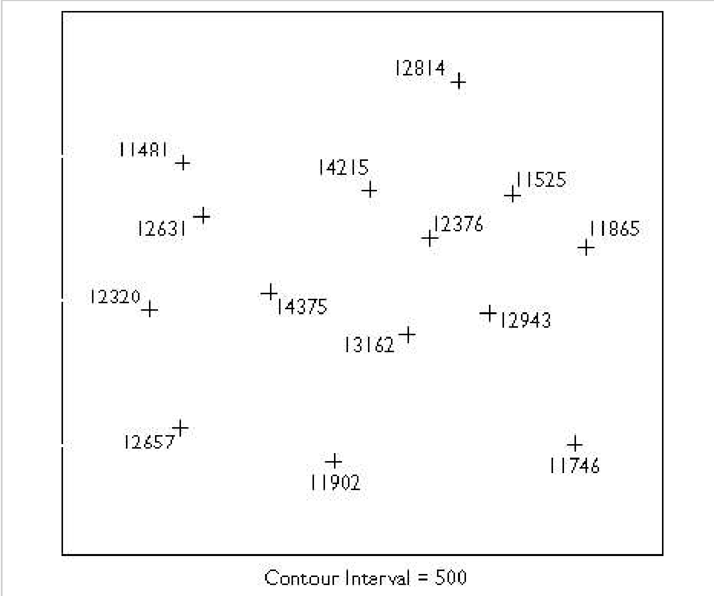
Try This!

Now try your hand at contouring on your own. The purpose of this practice activity is to give you more experience in contouring terrain surfaces.

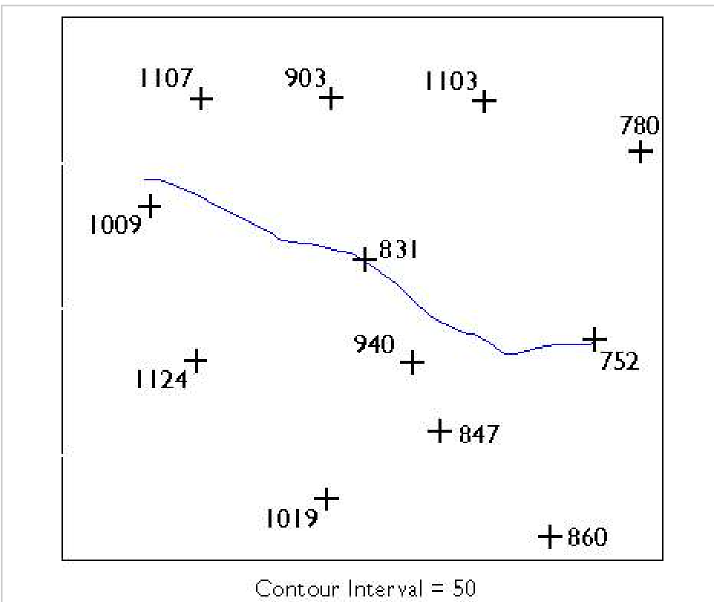
1. First, view an image of an irregular array of 16 spot elevations.
2. Print the image.
3. Use the procedure outlined in this chapter to draw contour lines that represent the terrain surface that the spot elevations were sampled from. You may find this to be a moderately challenging task that takes about a half hour to do well. TIP: label the tick marks to make it easier to connect them.
4. When finished, compare your result to an existing map.

Here are a couple of somewhat simpler problems and solutions in case you need a little more practice.

Practice Problem #1



[Practice Problem #1 Solution](#)



[Practice Problem #2 Solution](#)

Kevin Sabo (personal communication, Winter 2002) remarked that "If you were unfortunate enough to be hand-contouring data in the 1960's and 70's, you may at least have had the aid of a Gerber Variable Scale. After hand contouring in Chapter 7, I sure wished I had my Gerber!"

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