


Part 3 - Georeferencing images

In this part, you will register the scanned image file to real-world geographic space.


The last step is to register the image to geographic space. This is necessary because the software doesn't know where to place the image. Using the control points you generated in the previous step, you will "pin down" the map to its correct geographic location, size, and scaling.

1. Add the scanned image of the topographic map sheet
2. Click "Yes" when asked to build pyramid layers
3. The map will NOT appear. This is correct!
4. Click the Imagery tab > [Georeference](#) button
5. Be sure you are zoom to the extent of the control points

The *Fit to Frame* command represents a starting point for the georeferencing process. The goal is not to perfectly match the unregistered image to the coordinates or base data, but to get the image into the ballpark per se.

6. In the Contents panel, click on the scanned image
7. Click on [Fit to Display](#) (); Map should move to region
8. Zoom into corner of map at a scale of [1:1000](#)

When georeferencing images, it is helpful to have a *hardcopy printout* of the map in hand. This will help when fitting the unregistered image to the current display, as well as giving you perspective when trying to evenly distribute the control points around the map.

9. Click on [Add Control Point](#) () tool
10. Using tool, left-click on corner of map
 - a. Actual corner, NOT dashed line
 - b. From point (source)

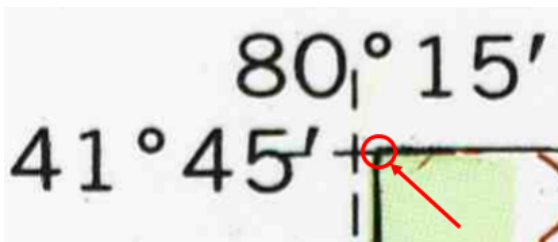
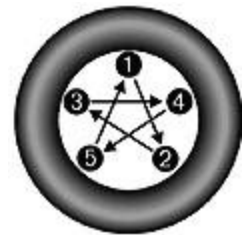


Figure 4: Enter control point at actual map corner, NOT the dashed line.

11. Zoom into corresponding control point (+) at scale of 1:1000

- a. Roll the mouse wheel up/down to zoom in and out
 - b. Press the mouse wheel and drag to move the map
12. Turn on snapping > Edit tab > Snapping > Point snapping
 13. Next, **left-click** on the point to establish the first link
 14. Move to the opposite side of the map and repeat process
 - a. Establish links on the four corners first
 - b. Maintain a consistent scale of 1:1000

While establishing links between the unregistered image and base data, try to use the following pattern. Just like tightening lugnuts on the wheel of a vehicle, establish the first link on one side of the map and then place the next one on the opposite side. Working in a back-and-forth pattern, will help you avoid problems associated with the calculation of RMS errors on-the-fly. For instance, if you establish 3 or 4 links right in a row down the edge of the map, you'll receive a message stating that the control points are not well distributed and the image will appear distorted and thus, difficult to work with.



15. Continue adding control around the margins of the map
16. Finish by adding control in the interior of the map

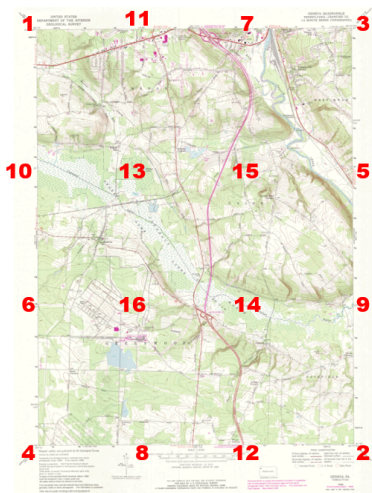




Figure 5: Order for entering control points.

Total RMS error is an indication of the overall accuracy of the transformation, **NOT** an exact measure of accuracy. The goal is to achieve an RMS error of $\frac{1}{2}$ the width of the pixels in the unregistered image. You can determine pixel dimension by accessing the Source tab in the Layer Properties window. If the pixels are 1x1 meter, you would want to strive for an RMS of 0.5. If achieved, it does not mean that every location in the image is accurate to within 0.5 m. It simply means that each pixel was required to only move 0.5 m in any direction based on the distribution of control points. It is entirely possible for extremely inaccurate control points to result in a low total RMS error.

17. Find the floating [Georeferencing popup](#) window
18. Examine the total RMS errors:
 - a. Forward: map units (degrees, in this case)
 - b. Inverse: pixel units
19. Record the Forward RMS error: _____
 - a. Value should be $< \frac{1}{2}$ cell dimension (x or y)

Occasionally, when working with a geographic coordinate system (e.g. NAD27), the total RMS error is expressed using scientific notation. So, an RMS error of 4.63616e-00 is actually 0.0000463616.

20. In the Contents panel, right-click on the image > [Properties](#)
21. Click on Source > Expand [Raster Information](#)
22. Record the cell dimensions: _____

Is the RMS error acceptable?
23. When finished, close the window
24. When finished, zoom out to the entire map
25. Click on the [Control Point Table](#) () button
26. Verify [1st Order Polynomial transformation](#)
27. When finished, close the window
28. On the Georeferencing tab, click on [Save](#) ()
29. Finally, close the Georeferencing tab
30. Find the lat&long coordinates at the bottom
31. Move cursor around and watch them change
32. Save the project file