

Georeferenced Map Images

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As earth scientists, we are used to communicating our ideas and concepts through maps. Indeed, many of us spend much time every day preparing such maps. You certainly don't need a computer to make a map, but computers, the Internet, and GIS systems enable extensive flexibility and sophistication in the map making practice.

Workflows for assembling maps and spatially-related data, from the Internet and other sources, using a layer-based computer mapping environment such as GeoGraphix Discovery or SMT Kingdom, are presented below.

In the August 2009 *SIPES Quarterly*, I described how to access wellfile information on the Internet for my Yegua prospect in Hardin County, Texas. The same wellfiles also contain location plats with lease and unit boundaries that I would like to overlay on my geological maps. Furthermore, an aerial photo will also be overlain to portray certain cultural issues associated with this prospect.

These tasks are easily accomplished in typical computer mapping packages. Steps include (1) capturing the map or plat as a tif or jpg formatted image; (2) georeferencing the image; and (3) importing the georeferenced image into the mapping software. These three steps are detailed below:

Step 1: Capture the map/plat as a tif or jpg formatted image

If you have SnagIt or another screen capture program installed on your computer, you can take a snapshot of the image displayed on your monitor, crop it as needed, and save it as a tif or jpg. If you do not have a screen capture program, you can use the tools provided by Microsoft. In Windows XP, it can be done as follows:

- a) Make the window containing the map image your active window
- b) Press the Alt and PrtScn keys to copy that window onto the "clipboard"
- c) Paste the image in Microsoft Paint (Windows' standard image editor)
- d) Crop the image as desired
- e) Save the image in either tif or jpg format

Screen capture programs are simpler and more efficient for this purpose than the tools in Windows XP. Furthermore, screen capture programs typically offer image editing, format conversion, automatic cataloging/saving, and other features that are not available from Microsoft.

In my Yegua prospect example, a screen shot of the surveyor's plat from the Gemini well permit, found online in the Texas Wellfile Image Database, has been cropped and saved to files "Gemini_plat.tif." Surveyor's plats of three nearby Blackstone Minerals well locations have also been captured and saved as tif images. For culture, a screen shot of an aerial photo taken from Google Maps has been cropped and saved to file "Aerial_photo.tif"

Step 2: Georeference the image

Georeferencing establishes the location of the image in terms of the map projection and coordinate system by assigning geographic coordinates and scale factors to the image. These coordinates and scale factors are commonly saved in a "world file." A world file is a 6-line ASCII file that shares the same base file name as the image file and ends with the extension tfw (in the case of a tif image) or jgw (in the case of a jpg image). The world file must also reside in the same folder as the companion image file. The world file contains:

Line 1: scaling factor, x-dimension, in map units per pixel

Line 2: 0 (rotation)

Line 3: 0 (rotation)

Line 4: scaling factor, y-dimension (negative value because pixel rows increase in opposite of northing)

Line 5: easting (x-coordinate) of upper left pixel of image

Line 6: northing (y-coordinate) of upper left pixel of image

The world file can be created and edited in Notepad. World file data can be entered in any columns; blank spaces on each line are disregarded.

How is the scale factor calculated? In the example, Gemini_plat.tif has file dimensions of 1050 (x-dimension) by 1420 (y-dimension) pixels. The image x-dimension of the image spans 5,400 feet. The software map projection is in SPCS feet. Therefore, the x-dimension scale factor is:

$$5,400 \text{ feet} / 1050 \text{ pixels} = 5.14 \text{ feet/pixel}$$

Similarly, the y-dimension scale factor is -5.14 (remember that this is a negative value because it is measured from the upper left of the image). I have estimated the easting and northing of the upper left pixel of the Gemini_plat.tif image by comparing it to my basemap. With this information, I can use Notepad to create the companion world file, Gemini_plat.tfw (**Figure 1**).

In practice, several iterations through Step 3 may be necessary to refine these factors to a sufficient level of accuracy. Image rotation can also be cumbersome. Some mapping packages cannot perform rotation, so a tool such as

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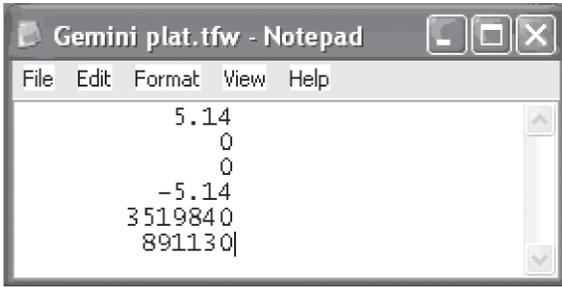


Figure 1. The "world file" assigns coordinates and scale factors to an image.

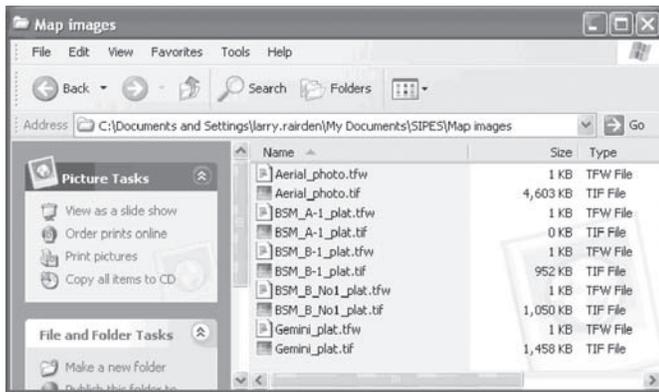


Figure 2. Tif images and companion world files must reside in the same folder.

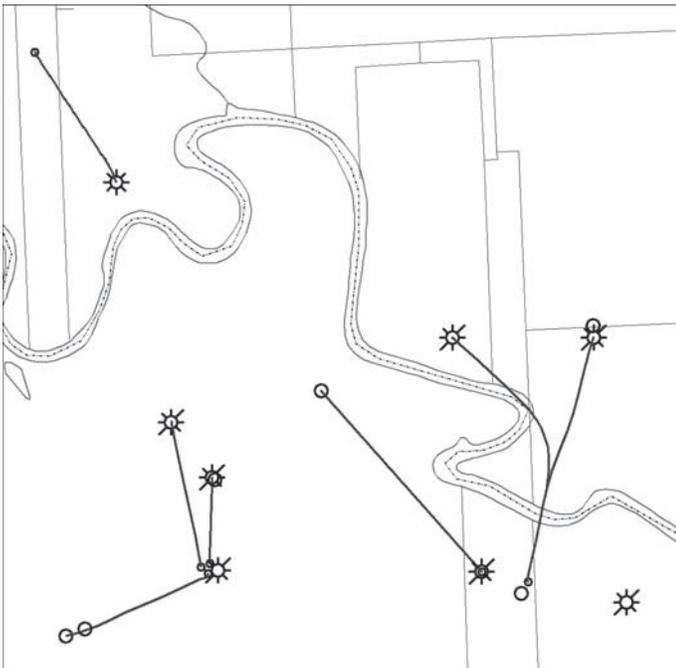


Figure 3. Base map of Hardin County, Texas prospect area.

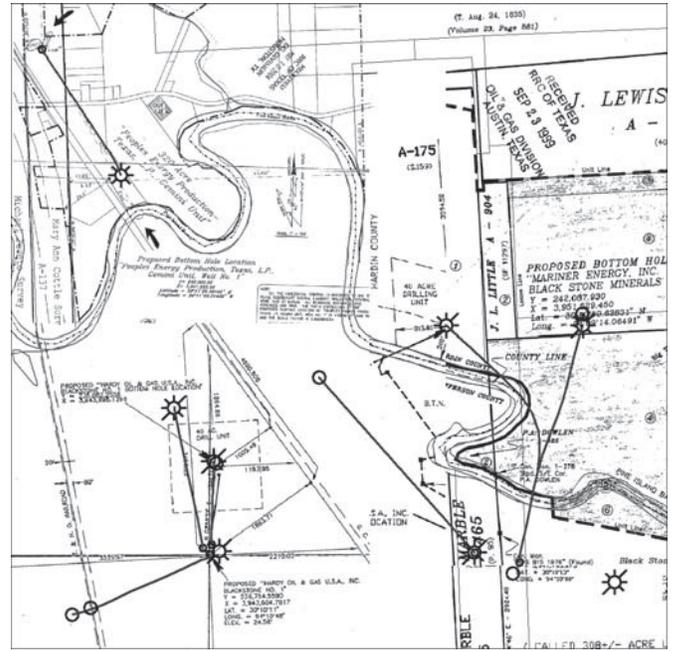


Figure 4. Mosaic of georeferenced well plats overlain on base map.

Picasa (free photo-editor from Google) or PaperPort may be brought into the workflow just to handle image rotation.

Repeating the above procedure, I have created world files for the Blackstone Minerals well plats and for the aerial photo. My collection of images and world files is shown in Figure 2.

Step 3: Importing the georeferenced image into the mapping software

GeoAtlas, the mapping module of GeoGraphix Discovery, provides my mapping environment. This should be similar for other mapping systems.

I already have separate GeoAtlas map layers containing wells (with directional wellbores), survey boundaries, rivers and streams, depth contours, fault polygons, and prospective reservoir areas. A basemap is shown in Figure 3.

Each georeferenced image can be imported to an individual layer with a few mouse clicks. The resulting well plats layers can now be incorporated into my maps. Mosaic overlay of these plats on my basemap shows drilling units, production units, survey measurement, and other useful information (Figure 4).

If the world files have been prepared correctly, the surveyor's x and y coordinates on the map layers should match the map projection x and y. In this case, it can be seen that not only do the surveyor's proposed location annotations align with the wells posted on the basemap,

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