IMAGE ENHANCEMENT COOKBOOK

Prepared for Part 3 of the blog series
“Scanning and vectorising old mine drawings”
Published August, 2015

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1 INTRODUCTION

Successfully vectorising a map depends on the quality of the scanned image, and by starting with a clean black-and-white image you’ll create vector data that only needs minimal cleaning up. Starting with an old and discoloured map will simply give you nightmares.

This cookbook provides some ideas for enhancing a scanned map in preparation for vectorising. They are based on GIMP, but you’ll generally find the equivalent options in paint.net and Photoshop.

The enhancements needed to prepare an image for vectorising fall into three different categories:

1. Enhancing the contrast between the linework and the paper
2. Removing polygon fill
3. Correcting uneven paper colour or brightness

Linework drawings generally only need basic contrast enhancement to ensure the linework is black and the paper is white.

For a geological map that has areas of relatively light pattern fill, try the threshold method before you do anything else. If you’re lucky you’ll be able to isolate the polygon boundaries in just a few seconds. If your geological map includes dark fills, start with posterise, select and delete, and then use the threshold method.

If neither method works then you can experiment with some of the others.

Discolouration in the paper or uneven lighting should ideally be corrected before starting any other enhancements. I’ve put it at the end of the document because it’s by far the most complex enhancement to carry out.

The number one rule for tweaking an image is simple: always deal with the biggest problem first, remembering that you may need to combine two or three methods to produce a useable result.
2  ENHANCING CONTRAST

Basic contrast stretch

Applies to colour and greyscale images. A very simple technique, but might not be strong enough to produce pure black lines and pure white paper. If so, try one of the interactive methods.

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Before Image" /></td>
<td><strong>Colors</strong></td>
<td><img src="image2.png" alt="Result Image" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="Before Image" /></td>
<td><strong>Auto</strong></td>
<td><img src="image4.png" alt="Result Image" /></td>
</tr>
<tr>
<td><img src="image5.png" alt="Before Image" /></td>
<td><strong>Stretch Contrast</strong>, or <strong>Colors</strong></td>
<td><img src="image6.png" alt="Result Image" /></td>
</tr>
<tr>
<td><img src="image7.png" alt="Before Image" /></td>
<td><strong>Levels &gt; Auto</strong></td>
<td><img src="image8.png" alt="Result Image" /></td>
</tr>
</tbody>
</table>

Interactive brightness-contrast adjustment

Applies to colour and greyscale images. Provides direct control over image brightness and contrast.

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9.png" alt="Before Image" /></td>
<td><strong>Colors</strong></td>
<td><img src="image10.png" alt="Result Image" /></td>
</tr>
<tr>
<td><img src="image11.png" alt="Before Image" /></td>
<td><strong>Brightness-Contrast</strong></td>
<td><img src="image12.png" alt="Result Image" /></td>
</tr>
<tr>
<td><img src="image13.png" alt="Before Image" /></td>
<td><strong>Use Contrast slider to create black lines and white paper; use Brightness slider to adjust density of lines:</strong></td>
<td><img src="image14.png" alt="Result Image" /></td>
</tr>
</tbody>
</table>

Brightness: 15  
Contrast: 80
Interactive levels adjustment

Applies to colour and greyscale images. Adjust the black, grey, and white-point sliders to enhance contrast.

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Before" /></td>
<td><img src="image2.png" alt="Settings" /></td>
<td><img src="image3.png" alt="Result" /></td>
</tr>
</tbody>
</table>

**Colors | Levels**

Either use eyedroppers to set black/white points, or drag triangular sliders in from edges. Use middle slider to adjust middle (grey) tones:

![Levels](image4.png)

Interactive curves adjustment

Only relevant to colour images with fill. Change the shape of the curve to darken boundaries and lighten fill. You can then extract the boundaries using one of the removing fill techniques.

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Before" /></td>
<td><img src="image6.png" alt="Settings" /></td>
<td><img src="image7.png" alt="Result" /></td>
</tr>
</tbody>
</table>

**Colors | Curves**

Drag left-hand endpoint right to strengthen lines; adjust right-hand side of curve to weaken fill while preserving lines:

![Curves](image8.png)
Convert to black and white (1-bit) palette

*Only applies to previously enhanced images. Use as a final processing step before saving the completed image.*

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>(any black-and-white image)</td>
<td>**Image</td>
<td>Mode</td>
</tr>
</tbody>
</table>

3 REMOVING FILL

Removing fill from a colour image makes it easier to extract the polygon boundaries.

Threshold

*Thresholding is a brute-force method that converts all pixels below the threshold value to black, and all pixels above it to white. Best for greyscale images, but also suits unenhanced colour images (such as geological maps) with good contrast between boundaries and fill.*

*If you’re lucky you might be able to extract black boundaries in one pass using this method, which will obviously save you a ton of time. It’s always worth a shot. Plus, most vectorisers have a built-in threshold tool so you may not need any other software.*

*This method is not good for images with dark fills; use posterise, select and delete or colour decomposition instead.*

<table>
<thead>
<tr>
<th>Before</th>
<th>Settings</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image]</td>
<td>**Colors</td>
<td>Threshold. Use Auto button for preliminary value, then adjust slider to refine:**</td>
</tr>
</tbody>
</table>
Posterise, select and delete

Applies to unenhanced colour images. Posterising reduces the number of colours, which makes polygon fills more consistent and easier to select. It’s pretty much the only way I’ve found to remove dark fills from polygons, short of manually painting them out.

Use this method with care: it only works when there is enough contrast between fills and boundaries. If the colours are too similar you may end up deleting boundaries along with the fills.

<table>
<thead>
<tr>
<th>Step</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original image.</td>
<td><img src="image1" alt="Original image" /></td>
</tr>
<tr>
<td>**1: Colors</td>
<td>Posterize**</td>
</tr>
</tbody>
</table>

Starting with 2 posterize levels, slowly increase the number until you see something that resembles the original map, with a clear distinction between boundaries and fills:
Step | Result
--- | ---
2: Select by Color Tool, or Select | By Color

Click on an unwanted fill colour to select all pixels with that colour (marching ants visible):

![Select by Color Tool](image)

Use the **Threshold** setting in the **Tool Options** to adjust the tolerance of the selection.

3: Press Delete key, or Edit | Cut, or Edit | Clear, or Edit | Fill with...

Replaces dark fill colour with white.

Repeat for other areas of dark fill, and then use **threshold** method to extract black borders.

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**Colour decomposition and enhancement**

*Applies to colour images with dark fills. Breaks a colour image into separate layers that each contain one component of the overall colour. An alternative method for extracting black boundaries. The image should be enhanced to make the boundary lines as dark as possible before using this method.*

*HSV seems to be the best output colour model, but you might consider using another model such as HSL or CMYK, depending on the map contents.*

*You can also use this method to create separate images for different line colours; for example, decomposing to CMYK or RGB may allow you to save roads (drawn in red) to one image and drainage (blue) to another.*
<table>
<thead>
<tr>
<th>Step</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original image, enhanced to emphasise boundaries.</td>
<td><img src="image-url" alt="Enhanced Image" /></td>
</tr>
<tr>
<td>1: **Colors</td>
<td>Components</td>
</tr>
<tr>
<td>Decompose the previously enhanced image:</td>
<td><img src="image-url" alt="Decomposition Process" /></td>
</tr>
<tr>
<td>2: Right-click and delete the <strong>hue</strong> and <strong>saturation</strong> layers in the decomposed image:</td>
<td><img src="image-url" alt="Layers Deletion Process" /></td>
</tr>
</tbody>
</table>
4 CORRECTING UNEVEN PAPER COLOUR OR LIGHTING

Correcting a discoloured map or an unevenly lit photograph is probably the most difficult enhancement you might do. You should approach this problem as if it were a regular digital photograph in need of enhancement, by working on different parts of it at a time.

**Masking** is an effective way to correct part of an image. A mask is like a shield that protects the pixels underneath it; only pixels falling outside the masked area are adjusted whenever a mask is active. A mask can be any shape, allowing you to focus on specific parts of the image, and have varying transparency, allowing you to change the strength of the adjustment from place to place. The easiest way to create a mask is to select the to-be-adjusted pixels directly from the image.

**Masked adjustment**

*The example for this workflow is a wall-mounted map photographed with a smart phone. The vignetting (darkening) near the corners is typical for photos taken with a cheap lens. (Much of the cost of expensive lenses arises from correcting such defects.) The corners of this map are almost as dark as lines elsewhere, and enhancing the contrast simply blackens them as if they were lines:*
Although an image can be enhanced in an infinite number of ways, the following steps outline a workflow for overcoming this problem. Hint: You can view the selection as a mask anytime from Step 6 onwards by selecting **Select | Toggle Quick Mask** from the main menu.

<table>
<thead>
<tr>
<th>Step</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>**1. Layer</td>
<td>Duplicate Layer.** The duplicate of the image layer is temporary and will eventually become the selection.</td>
</tr>
<tr>
<td>**2. Colors</td>
<td>Invert.** The temporary layer must be inverted to produce a selection that cancels out the unevenness. Otherwise it would only make things worse.</td>
</tr>
<tr>
<td>**3. Filters</td>
<td>Blur</td>
</tr>
<tr>
<td>**4. Colors</td>
<td>Desaturate.** A selection and resulting mask is essentially a greyscale image. The temporary layer doesn’t need colour.</td>
</tr>
</tbody>
</table>
5. **Colors | Levels > Auto.** Expand the brightness range of the temporary layer to the full 0-to-255 range.

Note how pixels near the edges of the image are lighter than those in the middle. The lighter the pixels, the stronger the adjustment. Black areas are not adjusted.

6. Switch to **Channels** tab, then Right-click | **Channel to Selection** (any channel). Marching ants visible (or Select | **Toggle Quick Mask**):

7. Switch to **Layers** tab; hide temporary layer and target original. Marching ants visible:

8. **Colors | Levels or Colors | Curves** and adjust image until paper colour is even:
9. Select | None.

With the selection removed, apply normal enhancements and then *threshold* the image to produce the final result.

For comparison, here is the “enhanced” image shown at the beginning of the workflow.

Note the extra details around the edges of the new version that are completely hidden in the original.

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5  **SAVING YOUR WORK**

Keep in mind GIMP’s quirks when it comes to saving your enhanced image. You don’t *save* it, you *export* it (via File | Export As). And, instead of browsing for an image file type, simply append the desired file extension to the filename. Use PNG for a pure black-and-white (1-bit) image. It’s a lossless format that is idea for this kind of data, and produces very small files. Use TIF for greyscale or colour images.

6  **CONCLUSION**

I’ve only very briefly glossed over the countless ways to enhance a map for vectorising, so please feel free to leave a comment if you’d like to know more about any of them, or if you have some ideas of your own.