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Improving the Legibility of Base Maps for Geologic Mapping at the Missouri Division of Geology and Land Survey

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SUMMARY

Legibility of base maps for compilation and publication of geologic maps is a significant concern at the Missouri Division of Geology and Land Survey. Standard USGS Digital Raster Graphics have been used and their appearance can be improved by increasing the resampling ratio and dots per inch (dpi) when exporting the map from ArcMap. Scanning the paper topographic maps ourselves at 400 dpi and georeferencing them also creates an improved product. A third option under consideration is procuring a custom set of digital scans at 1200 dpi from the USGS. This paper will compare these options and discuss limitations imposed by the plotters available to us. Figure 1 demonstrates the improvement in base map quality by comparing the output from the selected method with that of previous years.

REVIEWING THE OPTIONS

For the past twelve years, geologists at the Missouri Division of Geology and Land Survey have been using standard USGS digital raster graphics (DRGs) as base maps for geologic mapping projects. The geologic maps are currently produced using ArcGIS ArcMap, and the DRG's are used as a semi-transparent overlay. A HP 1055 plotter is currently used to plot the maps for publication. Printing hard copies of the map layout using a DRG as the base map often produces an unsatisfactory product. Topographic contour lines appear fuzzy and some lettering is illegible. Increasing the resampling ratio when printing helps improve the map's legibility, but the product still needs improvement. The maps are improved by printing at a resampling ratio of 1:2 (compared to 1:3, the default value), but the maps cannot be printed with a resampling ratio of 1:1 because the plotter memory is exceeded.

The Missouri Division of Geology and Land Survey is currently considering two options. One option is to purchase digital scans of the mylar map separates from the USGS. These scans are produced at 1200 dpi, and from approximately three to five

digital scans per map would be required. Another option is to scan the paper topographic maps ourselves using our HP Designjet 4500 Scanner.

A third option is to replicate the USGS topographic map with hypsography, roads, and public land survey system data sets. This option is not currently being considered because the job of labeling the base map is so time-consuming.

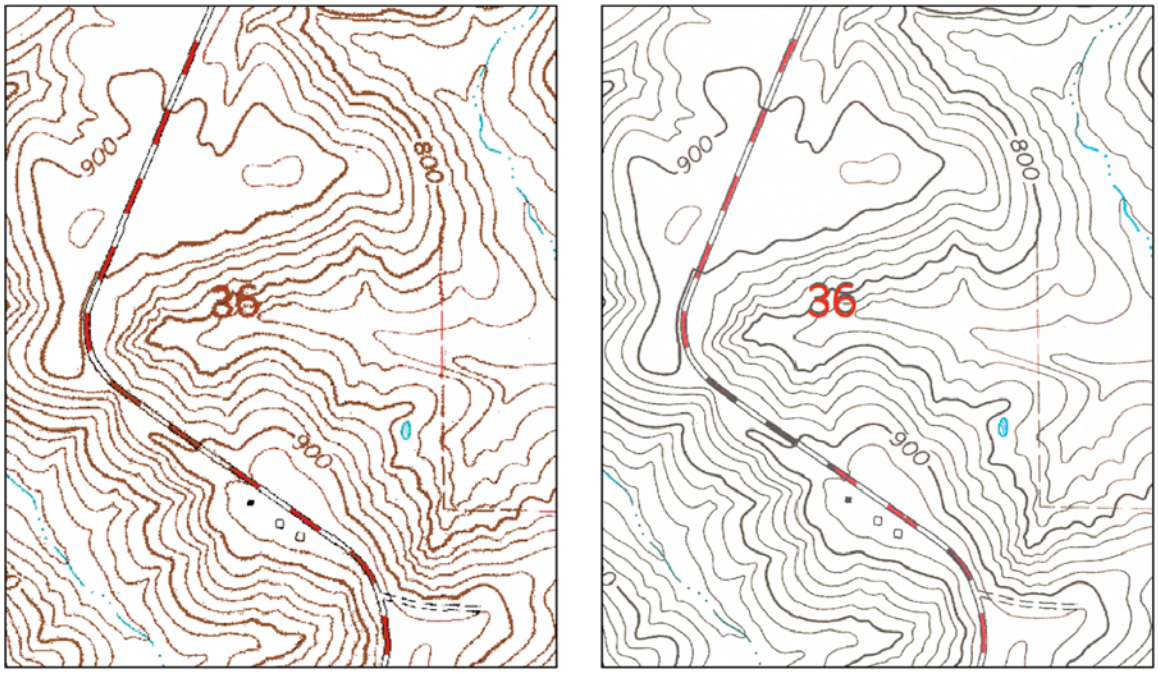

Figure 1. Base maps have been improved in two ways. The appearance has been muted by showing contour lines and text in dark gray. This allows the geology to be more prominently displayed. In addition, the DGLS has begun using DRGs that are produced in-house at higher resolution than the standard USGS DRGs. In this example, a paper topographic map was scanned at 400 dots per inch. The higher resolution base maps will improve the legibility of the final product and improve its appearance, particularly when users zoom in on the digital image. A – USGS digital raster graphic plotted at 1:10,000 scale; the resolution of most USGS DRGs is 250 dots per inch. B – Digital raster graphic created at DGLS and plotted at 1:10,000 scale; the DGLS scans paper topographic maps at a resolution of 400 dpi.

Producing our own images

To produce the scanned images ourselves, the HP Designjet 4500 Scanner was used to scan paper USGS topographic maps at 400 dpi to produce a TIF image file. The file was then opened in Adobe Photoshop software and converted to an indexed color image. The resulting TIF image file is then georeferenced in ArcMap.

In the past, the hard copy plots that are sent to the USGS, as part of the fulfillment of the STATEMAP contract, were printed directly from ArcMap. However, for customers, the geologic maps are plotted on demand from the PDF files exported from ArcMap. A decision was made to put an emphasis on making certain that the plots provided to the public will be of a high quality. Fortunately, it was discovered that the plots from PDF files are equal in quality, or superior to the plots directly from ArcMap.

For the plots directly from ArcMap, the output image quality (resample ratio) varied. In general, the plots with a resample ratio of I:3 were somewhat fuzzy, and contour lines appear discontinuous. Plots with a resample ratio of 1:1 could not be completed by the plotter. The best quality that could be achieved was with the resample ratio of 1:2.

For the plots from PDFs, the "Export Map" function was used to make the PDF, and the Resolution in dots per inch (dpi) and Output Image Quality (Resample Ratio) were varied. Other settings that were not varied are:

- Destination Colorspace: RGB
- Compress Vector Graphics
- Image Compression: Deflate
- Picture Symbol: Rasterize layers with bitmap markers/fills
- Embed all document fonts

The files were opened and plotted from Adobe Reader. As might be expected, images with a resolution of 600 dpi and resample ratio of 1:2 look very similar to images with a resolution of 300 dpi and resample ratio of 1:1. The optimum settings were to export the map with a resolution of 400dpi and a resample ratio of 1:1. Higher resolutions did not improve the appearance of the PDF plot since the topographic map was scanned at 400dpi, and the large files created at higher resolutions open and refresh slowly, and did not print successfully.

USGS Digital Scans

The USGS Mapping Center in Rolla, Missouri, supplied us with samples of digital scans of map separates. These were copies of products that had been ordered by other customers and had been scanned at 1200 dpi. Attempts to plot the maps from ArcMap indicated that, again, the optimum resample ratio was 1:2. At a resample ratio of 1:3, the contour lines appear discontinuous and at 1:1, the plotter memory was exceeded.

A test geologic map was made by placing digital scans of three of the separates from the Nokesville, VA Quadrangle into an existing map layout. This map was exported from ArcMap to a PDF with a resample ratio of 1:1 and resolution of 400 dpi. The resulting plot was very legible. The lines are crisp and continuous, and the PDF file is smaller than the PDF file that was created when the geologic map was exported with the DGLS version of the topo map at the same resolution and resample ratio.

A Better Plotter

To determine the effect that a plotter with more memory would have on our product, we were permitted to use the Missouri Department of Natural Resources, Water Resources Center plotter, which is a HP Designjet 5500. The plots were printed faster, and large PDF files that could not be printed on the 1055 could be printed. However, the legibility of the base map was not significantly improved beyond that of the plots of the PDF files that were exported with a resample ratio of 1:1, a resolution of 400dpi and plotted on the 1055. Changing the image used for the base map made a much more significant difference.

RESOURCES

ArcGIS, GIS and Mapping Software, ESRI
http://www.esri.com/software/arcgis/index.html

HP Designjet 5500 Printer
http://h10010.www1.hp.com/wwpc/us/en/sm/WF06a/18972-18972-3328061-12600-3328080-82218.html

HP Designjet 4500 Scanner
http://h10010.www1.hp.com/wwpc/pscmisc/vac/us/product_pdfs/1143093.pdf

HP Designjet 1055 Printer
http://h41186.www4.hp.com/country/us/en/support/1055CM.html?pageseq=793510