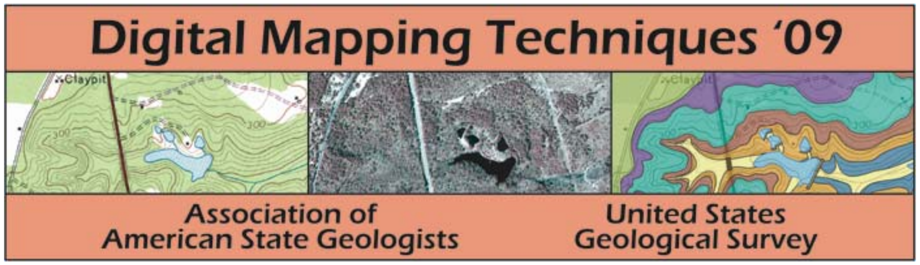

The following was presented at DMT'09 (May 10-13, 2009).

The contents are provisional and will be superseded by a paper in the DMT'09 Proceedings.

See also earlier Proceedings (1997-2008)
http://ngmdb.usgs.gov/info/dmt/

Ohio Underground Mine Map Georeferencing Project

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BACKGROUND

The Ohio Department of Natural Resources, Division of Geological Survey, in association with various state agencies, has been providing the public with information about underground mines for years. Division staff members spatially locate the mines within a GIS to identify their proximities to roads, river systems, and communities. However as of January 2008, over 2,200 mine maps—approximately 45% of the known and available underground mine maps in Ohio—had not been georeferenced and incorporated into the existing database. The project's primary goal was to complete underground mine map coverage in the Ohio underground mine GIS by georeferencing as many of the 2,200 maps as possible (fig. 1).

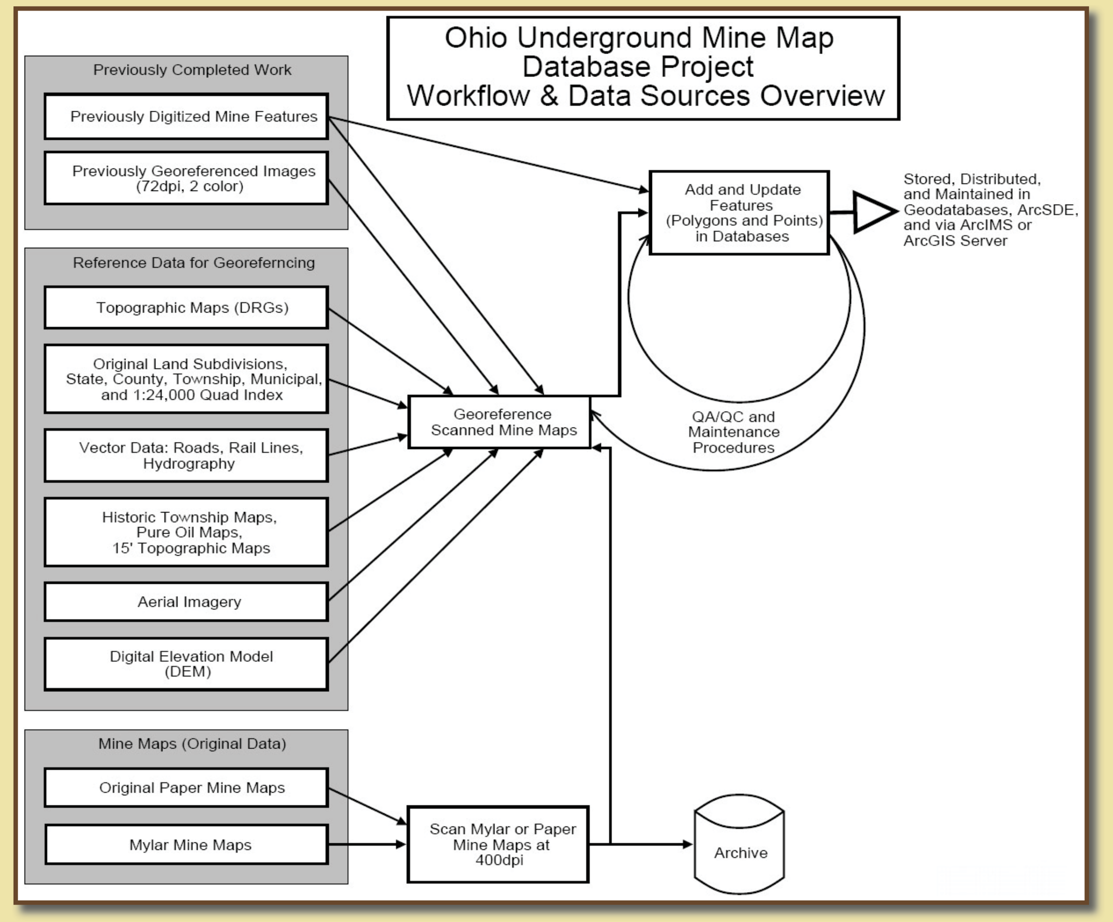

FIGURE 1.—The overall workflow of the project, including major data sources.

The project was funded by the Office of Surface Mining and the Ohio Department of Natural Resources, Division of Geological Survey.

http://www.osmre.gov/ • http://www.ohiodnr.com/geosurvey/

GEOREFERENCING

Common georeferencing practices use a series of control points to orient an image in space and set the proper scale. A manual, scale-based method was preferred in this project because of the scarceness of reliable control points drafted on many of the original mine maps. The age of the mine maps, some of which were created in the mid- to late-nineteenth century, further compounded the issue.

The project team founded its scale-based methodology on assumptions that the maps were surveyed accurately and that their scales were correct. Overall, this proved to be the case. Project staff scaled the image in GIS software using a scale bar (or a feature of known length) and the written scale (e.g., 1 inch equals 100 feet). Next, control points were collected at either end of the scale bar (fig. 2) or feature, and the distance was entered (fig. 6). Then, the image was generally located using one control point, the "Translate" button, and county, township, section, and other available information. Finally, the "Rotate" and "Shift" functions were used with topographic maps and other reference feature layers to adjust the exact location of the image (fig. 3).

As an added benefit, when compared to a polynomial transformation-based method, the map and mine workings exhibit virtually no distortion.

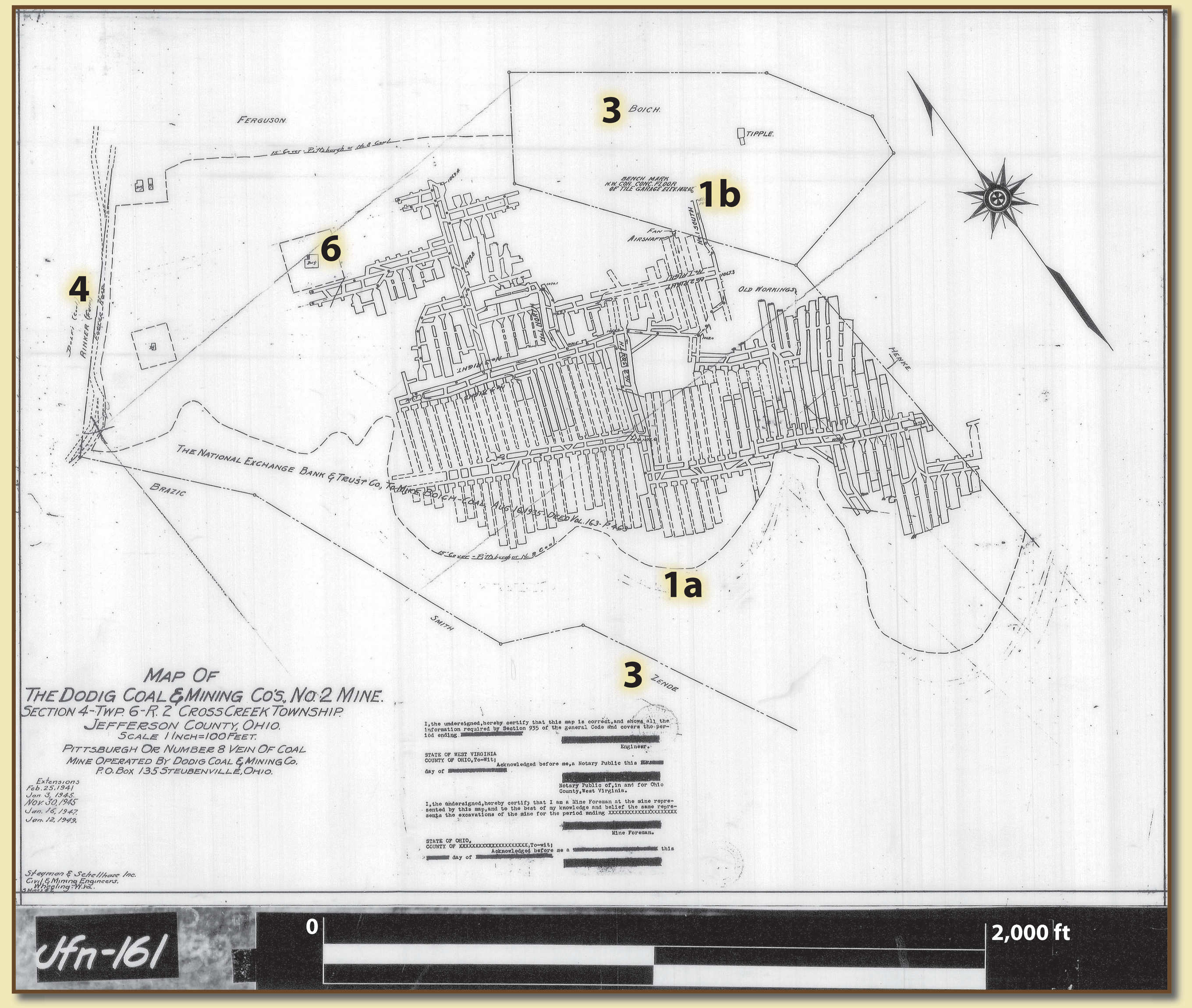

FIGURE 2.—A scanned mylar copy of the Dodig Coal and Mining Company's No. 2 Mine located in Cross Creek Township, Jefferson County, Ohio. The mine was abandoned in January 1949. The coal crop line (**1a**), adit (**1b**), property owners (**3**), road (**4**), and dwelling (**6**) were the features used to georeference the map. Knowing the county, township, sections, and scale (below the map title) are critical when control features are scarce. Maps with scale bars, such as this one, were convenient for the method of georeferencing used in this project. The numbers on this map correspond to the common reference features in Table 1.

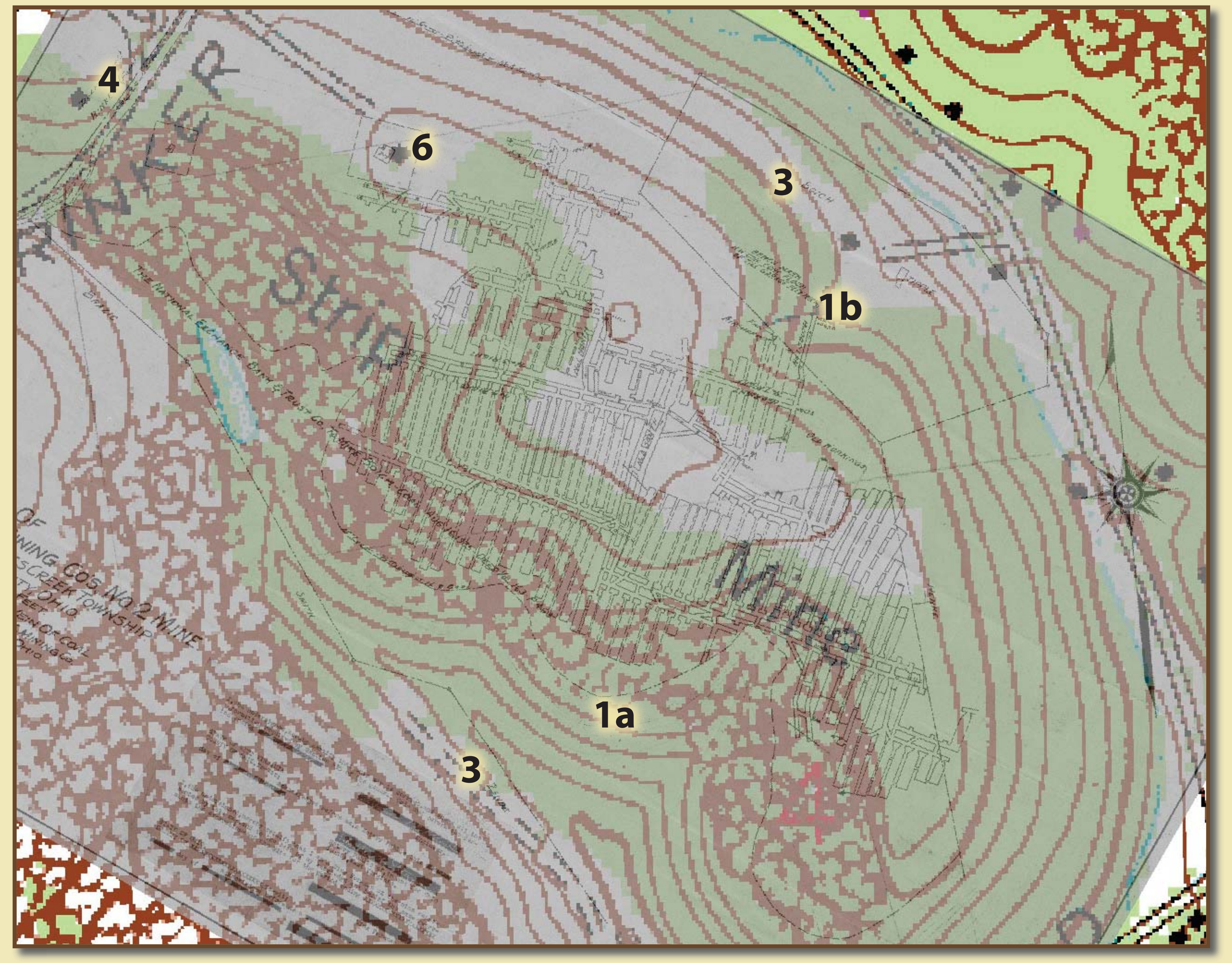

FIGURE 3.—A view of the transparent georeferenced mine map image over digital topographic maps. The topographic maps are used along with other reference feature layers to locate the mine maps. The numbers on this map correspond to the common reference features in Table 1.

TABLE 1.—*Common reference features, in order of importance*

1. Topography (contour lines, spot elevations, etc.)
2. Survey features (original land subdivisions)
3. Property owner information
4. Rail lines and roads
5. Rivers, streams, and bodies of water
6. Structures

TOOLBAR

A toolbar developed by OSU students was critical for the task of georeferencing. The project team later recoded and updated the ArcMap customization (fig. 4) to streamline production and efficiency while promoting quality control and data accuracy. Redesign included:

- Removing seldom-used buttons.
- Adding quality-control tracking (fig. 8).
- Improving ease of adding images to the project.
- Supporting more than one editor.
- Reducing the amount of disk space being used by at least 50%.

Ultimately, the application added the ability to track work items edited by multiple users through various stages of completion across different dates. A tracking database seamlessly stored comments, dates, user IDs, and other data. The database generated reports and statistics for tracking project and user progress.

The toolbar also handled file management aspects of the project, such as moving images and associated files from the originating directory to either of two destination directories (fig. 5). The selected destination was based on whether or not an image could be georeferenced (fig. 7). Other added features yielded convenience, such as a button to toggle the transparency of the georeferenced image and a tool to calculate and display the quadrants and quarter-quadrants of subdivision sections (fig. 9).

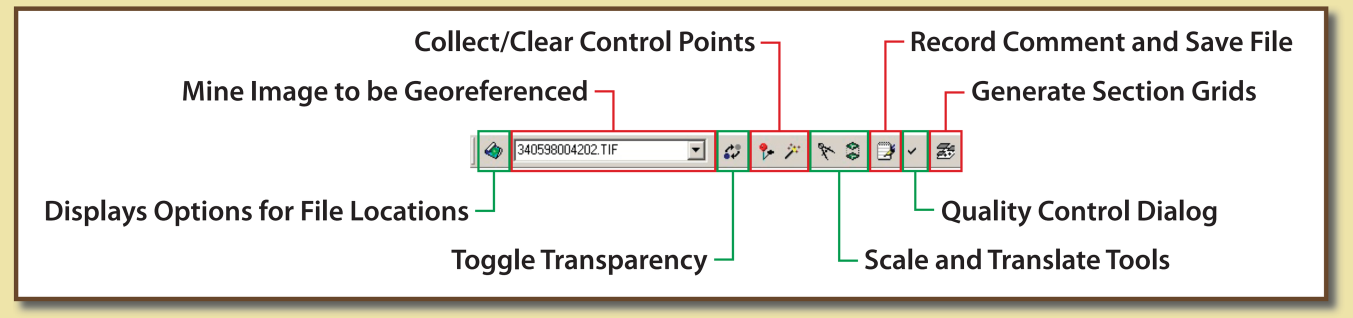

FIGURE 4.—The toolbar used in ArcMap to assist with georeferencing and project tracking.

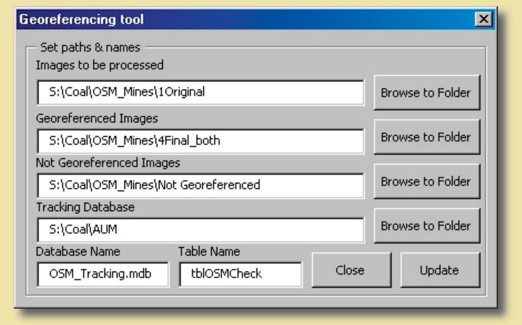

FIGURE 5.—The Settings window, where the names of the directories and database to be used by the tool are set. These settings are stored in the Windows registry.

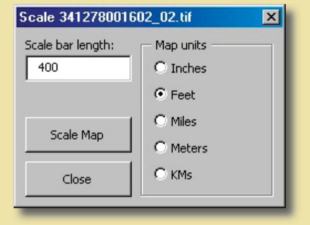

FIGURE 6.—The Scale Image window, where the length and units are set for scaling the image.

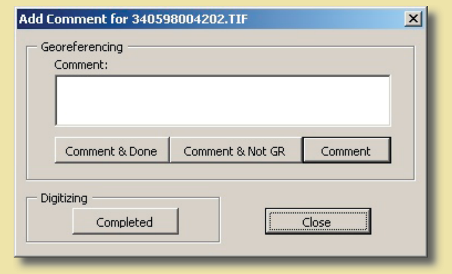

FIGURE 7.—The Comment window allows the user to record comments relevant to the image. Choosing the "Comment & Done" or "Comment & Not GR" buttons will copy the files to the appropriate directory. The "Comment" button only records the comment. This also is where the user marks the map as digitized.

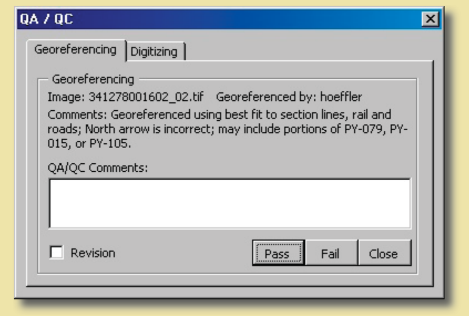

FIGURE 8.—The Quality Control window displays information previously recorded in the tracking database, allows users to record comments and pass or fail previous work, and tracks revisions.

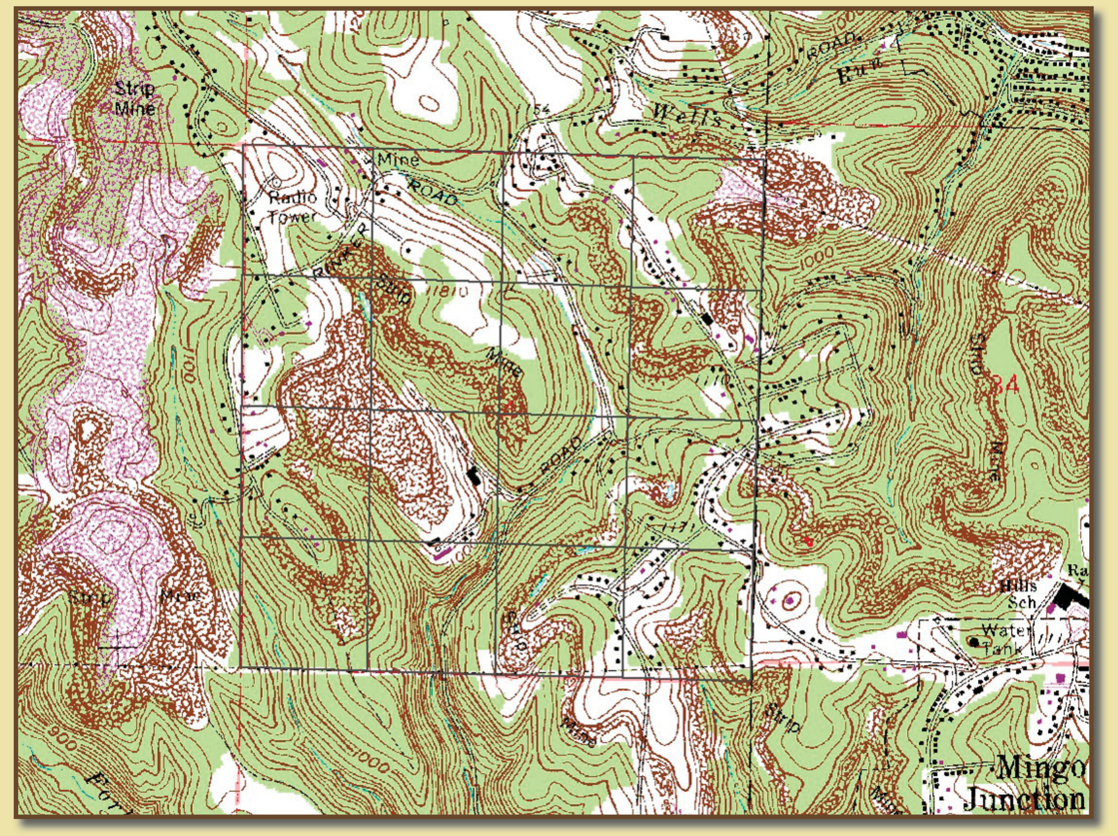

FIGURE 9.—The revised toolbar included a function to calculate and display the quadrants and quarter-quadrants of sections