New Data and Techniques for Evaluating Subsidence from Abandoned Underground Mines in Ohio

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NEW DATA SETS

Since the early 2000s, new digital datasets have become available for mapping abandoned underground mines. These GIS datasets include the abandoned underground mine map images; the new 1:24,000-scale bedrock geology, bedrock topography, and structure contour GIS datasets; point data from the National Coal Resources Data System (Carlton, 2001) and elevation and thickness point data captured from detailed georeferenced mine maps; datasets on roof rock conditions and areas the pillars have been sliced or removed from the detailed mine maps; and high-resolution digital orthophotos and LiDAR data created for the State of Ohio. Each of these GIS datasets can be used to investigate mine subsidence claims and predict the potentially occurrence of mine subsidence.

Starting in early 2000s, the U.S. Department of Interior, Office of Surface Mines and the Ohio Mine Subsidence Insurance Fund board funded the scanning and georeferencing of the abandoned underground mine maps. Over 5,000 abandoned underground mine maps have been scanned at 72 dpi, 150 dpi, and 400 dpi. The 72 dpi images have been georefenced (fig. 12A) and the 400 dpi images (fig. 12B) are currently undergoing georeferencing. The detailed mine maps allow for determining the accurate locations of the mines. The mine map images also provide detailed information on the occurrence of the room-and-pillar configuration, which can be used to aid in mine subsidence insurance investigations.

During the 1990s, the Survey embarked on a long-term project to remap the bedrock geology of the state of Ohio. The primary GIS datasets include the 1:24,000-scale bedrock geology (fig. 13A), the bedrock topography (fig. 13B), and the bedrock structure contours (fig. 13C). The mapping project was completed in 1997, the maps were converted to GIS datasets by 2003 (McDonald and others, 2003) and released to the public in 2006. These GIS datasets are useful for identifying particular coal beds and for calculating the unconsolidated drift thickness within alluvial valleys and glaciated portions of the state.

In 2006 and 2007, the State of Ohio collected high-resolution, digital orthophoto imagery (1-foot resolution), and LiDAR for the entire state. A historical mine subsidence site (Nowell, 1970) is used to show how the high-resolution imagery and the LiDAR data can be used to identify pit subsidence features (Figs. 14A–14D).

The georeferenced mine maps have additional information that can be captured within the GIS. Elevations and thickness points are being captured from the mine maps (fig. 15). Roof rock and mined-out features are currently being captured from the georeferenced abandoned underground mine maps. In figure 16A, the mine map indicates a "Fault." A fault or "horsebacks" indicate a fluvial sandstone channel that cut down through the overlying roof rock and into the coal bed. The edges of the sandstone fluvial channels are areas of weakness within the mine and are potential areas whereby a collapse can occur. Other typical features captured in the GIS include "Horseback" and "Bad Roof" (fig. 16B).

The last dataset used in this study includes publicly available mine subsidence events information from the U.S. Department of Interior, Office of Surface Mines (fig. 17).

FIGURE 12A.—Low-resolution mine map image (72 dpi) of the Puritan Coal Mine (GY-006), abandoned in 1921.

FIGURE 12B.—High-resolution mine map image (400 dpi). Note that the 400 dpi scan is far more readable than the 72 dpi images in figure 12A.

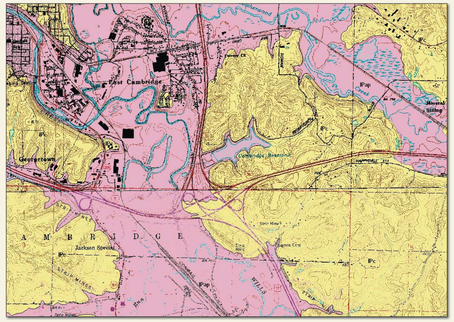

FIGURE 13A.—A portion of the 1:24,000-scale bedrock geology map in the Cambridge, Ohio area.

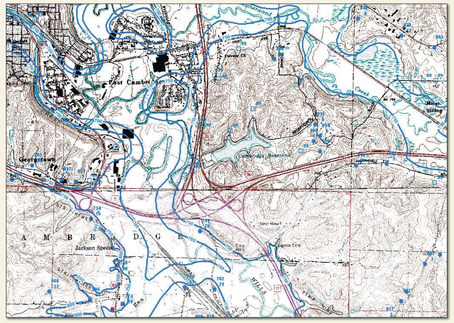

FIGURE 13B.—A portion of the 1:24,000-scale bedrock topography map in the Cambridge, Ohio area.

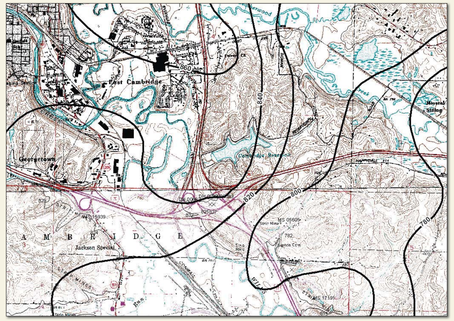

FIGURE 13C.—A portion of the bedrock structure contour map of the Upper Freeport coal bed in the Cambridge, Ohio area.

FIGURE 14A.—Location of historic mine subsidence features south of Byesville, Ohio (Nowell, 1970).

FIGURE 14B.—Zoomed-in view of the mine subsidence features south of Byesville, Ohio.

FIGURE 14C.—Hillshade overlay of the gridded LiDAR dataset. Some of the pit subsidence features can be easily identified, especially if the pit subsidence feature has a vertical resolution of greater than the LiDAR accuracy.

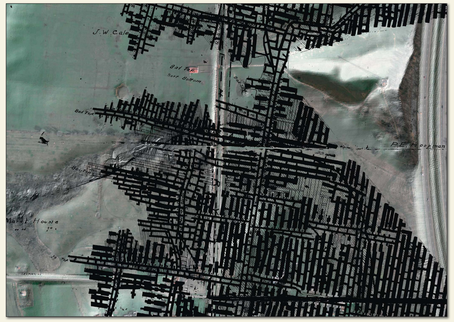

FIGURE 14D.—Overlay of the detailed abandoned mine map. Some of the pit subsidence features lie outside of the mapped mine workings, possibly indicating that the detailed mine map does not completely show the full extent of the mine workings.

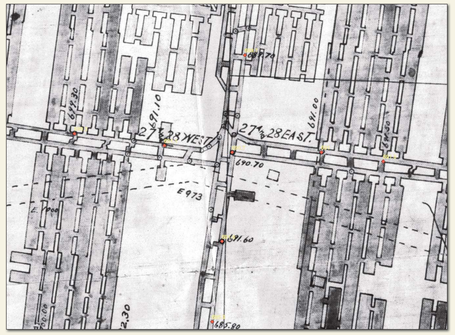

FIGURE 15.—Example elevation data points digitized from an abandoned underground mine map.

◀ FIGURE 16A.—Roof rock features that have been captured from an abandoned underground mine map. In this figure, the mine map indicates a "Fault." A fault or "horsebacks" indicate a fluvial sandstone channel that cut down through the overlying roof rock and into the coal bed. The edges of the sandstone fluvial channels are areas of weakness within the mine and are potential areas whereby a collapse can occur.

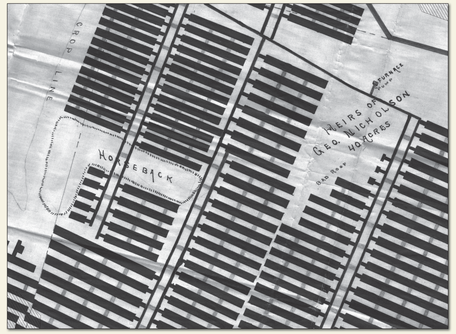

FIGURE 16B.—Roof rock features labeled "Horseback" and "Bad roof." Again, these are areas of weakness whereby a collapse can occur.

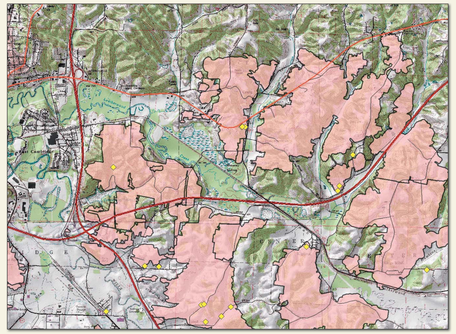

FIGURE 17.—Example map showing the mapped subsidence events and the abandoned underground mines near the I-70/I-77 interchange near Cambridge, Ohio.