The following was presented at DMT’11 (May 22-25, 2011).

The contents are provisional and will be superseded by a paper in the DMT’11 Proceedings.

See also earlier Proceedings (1997-2010) http://ngmdb.usgs.gov/info/dmt/
**INTRODUCTION**

Underground mining for coal in Ohio first occurred in 1889 (Crowell, 1995). The majority of underground mining takes place in coal and clay mining areas of eastern and southern Ohio (Fig. 1). Older coal mines have been abandoned underground within Ohio, such as coal gypses, limestone, shales, and over-pow. Studies have estimated that over 8,900 mines have been operated in Ohio over the last 200 years (Byers, 1998). With an average of 2,000 to 3,000 mines occurring every 50 years, there is an increasing probability that mines will collapse and subside as they age and deteriorate as abandonment occurs across the Ohio landscape.

While subsidence in Ohio has been problematic, it has been recognized for the last 60 years. In 1917, a mine shaft collapse happened at a place in Youngstown, Ohio. A car located in the garage fell 110 feet down a 130-foot shaft. Since that location, the ODNR Division of Geological Survey has been mapping detailed mapping of locations of abandoned underground mines (Byers, 1998; Fisher and Higgins, 2011). Other prominent incidents have occurred in Ohio, such as the collapse of International 77 near Cambridge (Crowell, 1995), and the recent subsidence beneath a house in Sugartown. The costs associated with remediation of abandoned mines are high. The repair of the collapse of International 77 near Cambridge cost approximately $2.2 million to repair the highway between the collapse and subsidence (Crowell, 1995). As of 2008, the Ohio Department of Transportation had spent approximately $60 million to repair highway damage caused by underground mining collapse (ODOT, 2008). In 2008, the ODNR Division of Mineral Resources Management invested more than $1.5 million to complete 32 projects related to abandoned-underground mines (Gordon, 2009). In abandoned-underground mines age and deteriorate, remediation costs are expected to increase.

**MAPPING CONVENTIONS**

One method being investigated to detect unmapped, abandoned surface mines and abandoned-underground mines is Light Detection and Ranging (LiDAR). Airborne LiDAR, also known as laser surveying, uses a laser to measure the precise distance between the aircraft and the ground surface. The distance—which is measured pointing downward in the aircraft—is timed, and the time that the laser light pulse travels through the ground surface and the aircraft altitude is measured. Using differential kinematic GPS and inertial navigation systems (INS), the location and elevation of the ground surface is computed for the thousands of laser pulses that are fired every second (Harding, 2000). The large number of data points generated using the LiDAR technique produces a high-resolution model of the surface topography.

The State of Ohio has a program to provide high-resolution digital imagery and LiDAR datasets for state government entities and the general public. The images, known as the Ohio Statewide Imagery Program (OSIP), images the state with high-resolution imagery in 2004 and 2005. The color imagery was generated using the LiDAR technique producing a high-resolution model of the surface topography.

**REFERENCES**


Harding, D.J., 2000, Principles of airborne laser altimeter terrain mapping: James McDonald (jim.mcdonald@dnr.state.oh.us) • Ohio Department of Natural Resources, Division of Geological Survey • 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693

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