SHAWNEE NATIONAL FOREST SUBSIDENCE STUDY[1]

Uldis Jansons and Diann D. Gese[2]

Abstract: The U.S. Bureau of Mines initiated a mine subsidence study in the Shawnee National Forest in southern Illinois in 1990. Abandoned mine lands may constitute a hazard and the U.S. Forest Service did not have sufficient records of the abandoned tripoli mines to ensure public safety. Identifying areas of potential subsidence is vital for land-use planning, land acquisition, and ensuring the public's safety. During the Bureau's study, approximately 200 inactive tripoli mine and prospect sites were located and 120 of these underground mines and subsidence holes were mapped. Some immediate results from the Bureau's study follow: (1) Undermined land was withdrawn from the timber base, (2) a road-closure point was moved and a land acquisition was reconsidered because in both instances the land was undermined, (3) an all-terrain-vehicle road site was relocated, and (4) an access road was closed because it was undermined and caved to within 4.5 m of the surface. Because mapping underground mines in active collapse is hazardous and because many mines were inaccessible, the use of reconnaissance geophysical methods is being considered to outline areas of potential surface collapse. Geophysicists are currently attempting to determine possible geophysical methods to identify undermined areas and areas of potential collapse.

Additional Key Words: tripoli, subsidence, Shawnee, Illinois.

Introduction

In 1990, the Intermountain Field Operations Center of the U.S. Bureau of Mines initiated a mineral appraisal of the Shawnee National Forest in southernmost Illinois (fig. 1), as requested by the U.S. Forest Service. Early in this study, the Forest Service decided that a mine subsidence study of the Jonesboro district should be given the highest priority and requested the Bureau to determine the location and extent of the undermined areas. This district has been mined extensively for tripoli, and many of the inactive underground mines are caving, in some cases leading to surface collapse.

The Jonesboro district is in the southwest part of the Shawnee National Forest in Union and Alexander Counties. Tripoli has been mined here since the early 1900's, and much of the area is honeycombed with shallow, inactive mines. Tripoli is composed of microcrystalline quartz crystals or silica. It is fine grained (particle sizes usually range from 1 to 10 m), soft, porous, and friable. The tripoli deposits in the Jonesboro district occur as flat-lying beds, mostly in the Devonian Clear Creek Chert Formation (fig. 2). This formation consists of interbedded chert, limestone, and dolomite. Deposits are discontinuous and there is no specific stratigraphic horizon within the Clear Creek Formation in which the tripoli deposits occur. These deposits appear to be confined to areas where silica has been introduced and the carbonates leached. (Berg and Masters 1993.)

Historically, tripoli deposits were interpreted to be a weathering product of chert and limestone. Berg and Masters (1993) indicate that the introduction of hydrothermal silica to this sequence of sedimentary rocks was accompanied by leaching of all carbonates forming a sequence ranging from hard chert to friable

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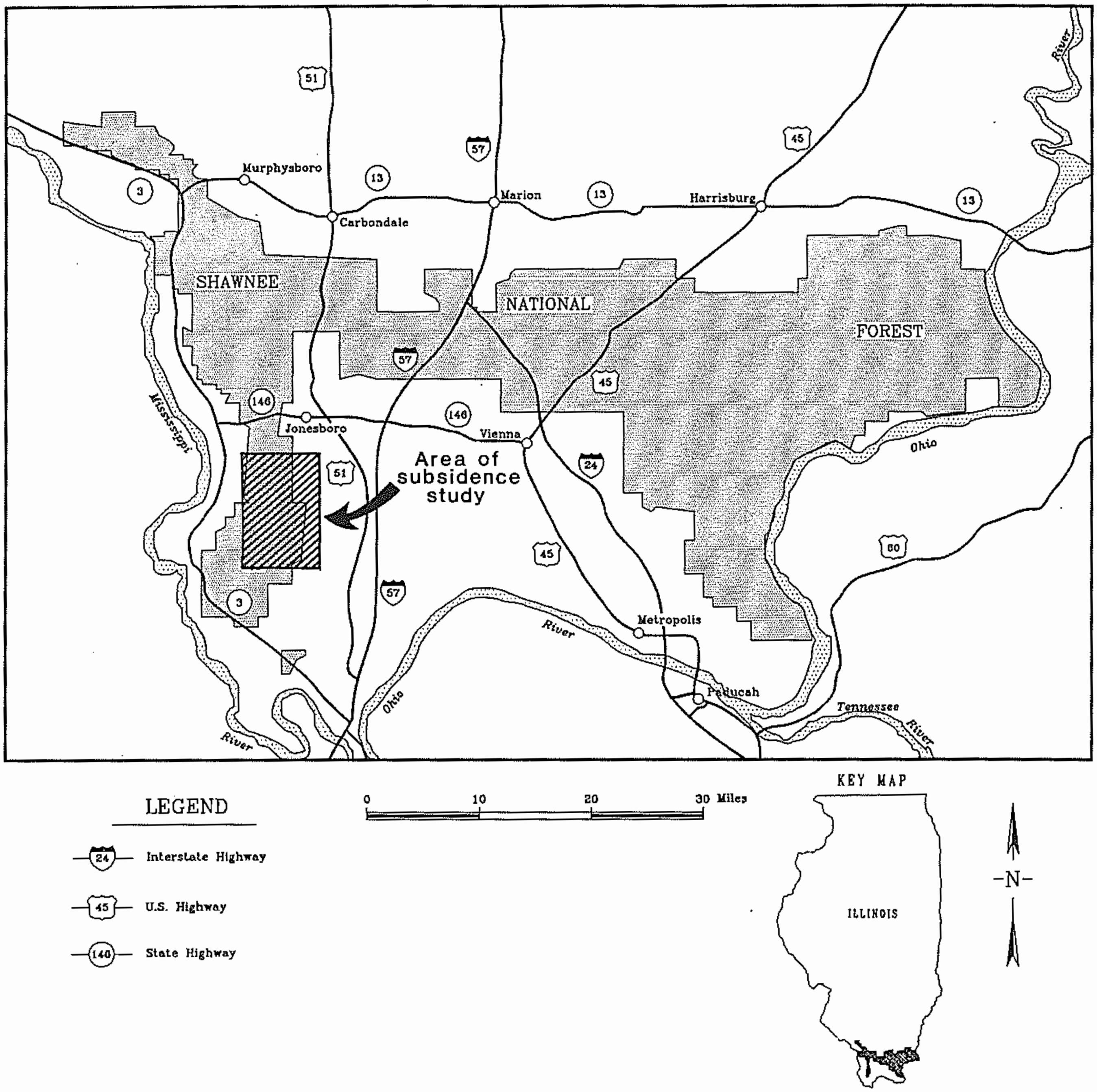

Figure 1. Index map of the Shawnee National Forest, IL.

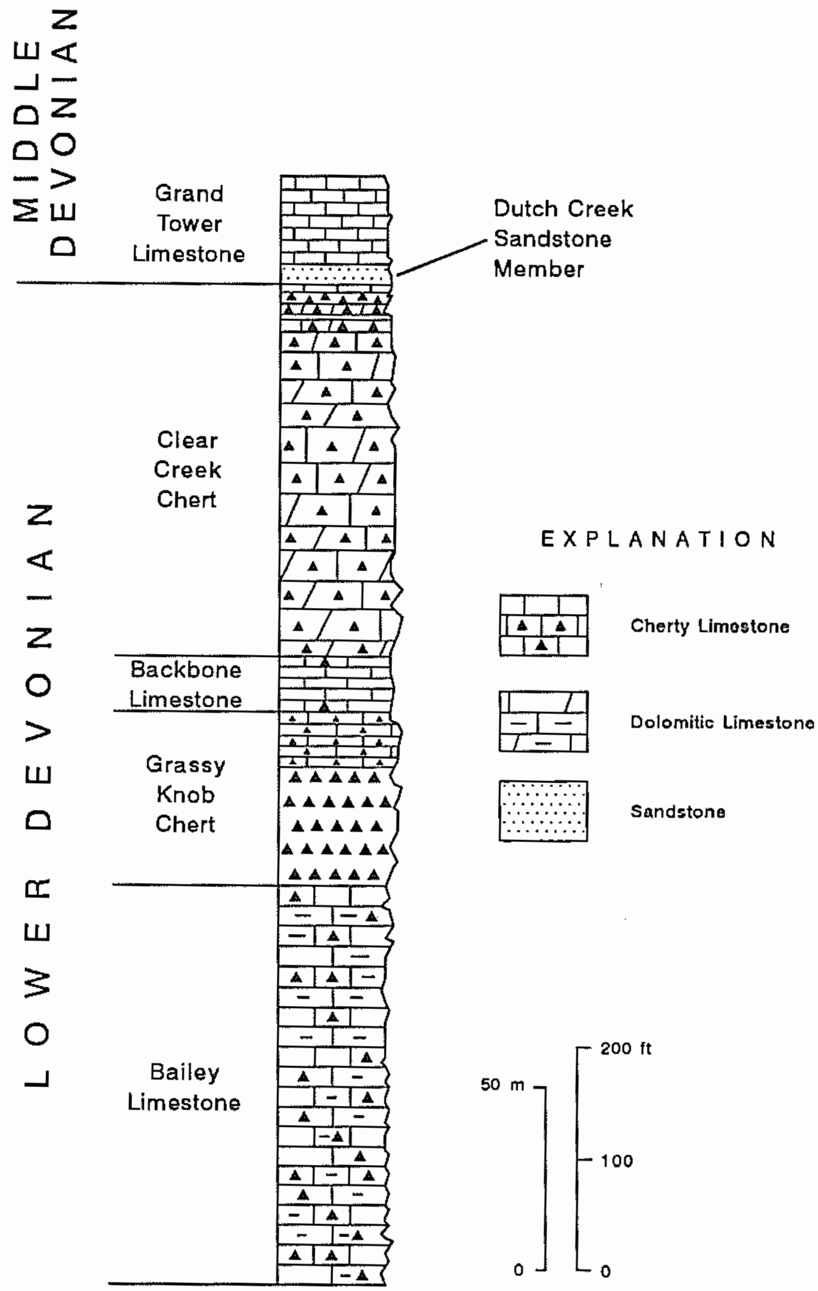

Figure 2. Generalized stratigraphic section for part of the Devonian in southwestern Illinois (Berg and Masters, 1993).

microcrystalline silica with thin clay beds. The nature and origin of the tripoli deposits is discussed in detail by Berg and Masters (1993).

Pulverized tripoli is used primarily as functional fillers and extenders in paint, plastic, and rubber and as mild abrasives. Southwest Illinois has been and continues to be a major domestic source of tripoli (U.S. Bureau of Mines).

This report is based on field work carried out by Brian J. Hannigan, Steven E. Tuftin, and Mark L. Chatman.

Subsidence Problem

The abandoned shallow tripoli mines are caving, resulting in surface collapse of land to which the Forest Service holds the surface rights. In April 1986, about 60 m (200 ft) of a major Forest road was down-dropped 15 m (50 ft) in one catastrophic event. Numerous mines in other areas also had collapsed, resulting in deep, steep-walled holes and sheer highwalls which were unfenced and unposted. The number of additional potential collapse sites was not known. Surface subsidence could result in damage to personal property, personal injury, or loss of life.

The Forest Service was aware that it had a subsidence problem in the Jonesboro district. However, it did not have sufficient records or information concerning the number and location of old mine workings to ensure public safety or manage land use adequately in this area. It had no way of determining the number of abandoned mines, how extensive the undermined areas are, or which undermined areas were the most likely to subside.

At the early tripoli operations, many companies and individuals did not make mine maps because the shallow deposits were prospected by driving exploratory adits into steep slopes on the sides of flat-topped ridges; if a tripoli deposit of desired quality was found, the operations were expanded into a room-and-pillar underground mining system. Haulage ways were typically 4.5 to 6 m (15 to 20 ft) high and 6 m (20 ft) wide (Berg and Masters, 1993). The locations and configurations of the mine workings were, for the most part, unknown, few mine maps were available, and the mining records are vague or incomplete.

This was the situation in 1990, when the Bureau was requested to supply the Forest Service with subsidence data to enable it to make informed land-use and land-acquisition decisions. In addition to timber use, this area also has a high recreation use (hunters, hikers, all-terrain-vehicle users, etc.). Abandoned mines tend to attract the curious.

Methods Used

To begin the inventory of the tripoli workings, the Bureau identified probable sites of past mining activity by reviewing published literature, examining aerial photographs, interviewing Forest Service and mining company employees, carrying out an aerial reconnaissance, and conducting surface traverses. Because virtually all the mined material was hauled away to a mill, there is little or no dump material outside any of these workings. The extent of underground workings was determined by inspection on a "one mine at a time" basis. Underground workings were mapped using the tape and Brunton compass method and electronic distance meters (fig. 3). Only those workings where the Forest Service holds the surface rights were mapped. A total of 50 field days involving two to three people was required to carry out this project.

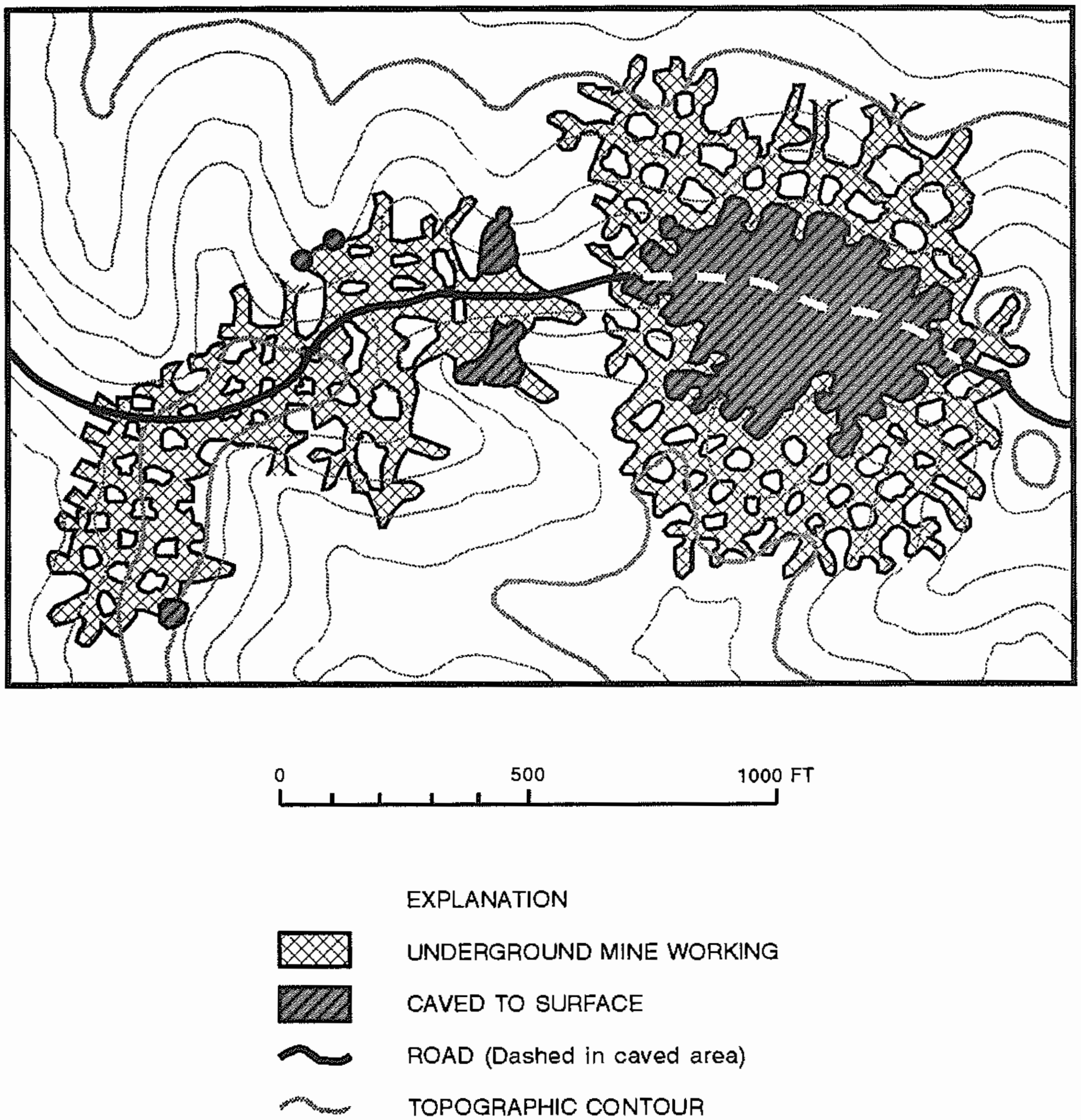

Figure 3. Map of abandoned tripoli mines showing surface collapse, Shawnee National Forest, IL.

Study Results

Starting in the fall of 1990 and continuing through the spring of 1991, all potential mines sites were field-checked. About 200 inactive mines and prospects were identified and located on land of interest to the Forest Service (fig. 4). Approximately 120 underground mines and subsidence holes were mapped (over 30.5 km [19 miles] of workings)(fig. 3). The use of electronic distance meters expedited the work and allowed measurements to be taken without compromising personnel safety. Potentially hazardous conditions, such as winzes and areas with active roof fall, were identified and avoided; a premium was placed on personal safety. The mine maps were digitized using ARC/INFO geographic information system (GIS) software, plotted, and released to the Forest Service. For planning and presentation purposes, the mine configurations were superimposed on an enlarged topographic base (fig. 3). This presentation method is ideal for land-use planning purposes. Use of the GIS system enables the user to present the information at any scale and make revisions quickly and easily.

The Forest Service's immediate benefits from the Bureau's study were that: (1) previously unknown subsidence holes were identified, posted, and fenced, (2) undermined land was withdrawn from the timber base for future timber sales, (3) the use of an undermined service road was stopped, (4) the site of a proposed all-terrain-vehicle trail was relocated, (5) gates were erected at mine entrances to prevent ATV entry and to avoid disturbing bat populations, and (6) a land acquisition was reconsidered.

The Forest Service initiated a subsidence-remediation project which included fencing and posting of areas of immediate danger to the public. The Forest Service is also using the mine maps as a base for a 5-yr study to monitor additional subsidence. Data from this study are also available for future land-use decisions. To date, the Forest Service does not plan to fill any of the collapse holes because of the expense involved and because such action would disturb threatened and endangered populations of the Indiana bat, which inhabit some of the caves associated with these openings.

Future Studies

Because mapping abandoned mines in active collapse is hazardous, and many mines in the Jonesboro district are inaccessible due to caving, flooding, and bad air, the use of reconnaissance geophysical methods is being considered to outline general areas of potential collapse. The Intermountain Field Operations Center is currently working with various U.S. Bureau of Mines Research Centers to determine possible geophysical methods to identify undermined areas and/or to assist in determining which undermined areas are more likely to collapse.

Two aspects of a proposed geophysical investigation are to: (1) determine a workable, cheap reconnaissance technique for outlining the general area of shallow underground workings that could lead to surface collapse and (2) where shallow workings are known, determine if surface subsidence is imminent, which would be important in areas accessible to the public.

Geophysical systems that are being considered include seismic, electrical resistivity, electromagnetic, ground penetrating radar, and gravity surveys. Seismic surveys have been used by the Bureau to detect, locate, and characterize a subsiding mine. Ground penetrating radar may work for outlining shallow openings (less than 30 m [100 ft]) in areas of no or very thin overburden. Gravity surveys may be used to detail gravity lows in areas of possible workings. Field methods would be tried to determine if they can detect underground openings and, if so, can they be adapted to airborne reconnaissance methods.

Testing for the immanency of surface subsidence would make use of a Bureau sponsored and tested seismic system (Munson, 1992). This system detected and measured characteristic seismic signals prior to surface collapse in tests conducted at both a hard-rock and a coal mine. Such seismic monitoring can accurately

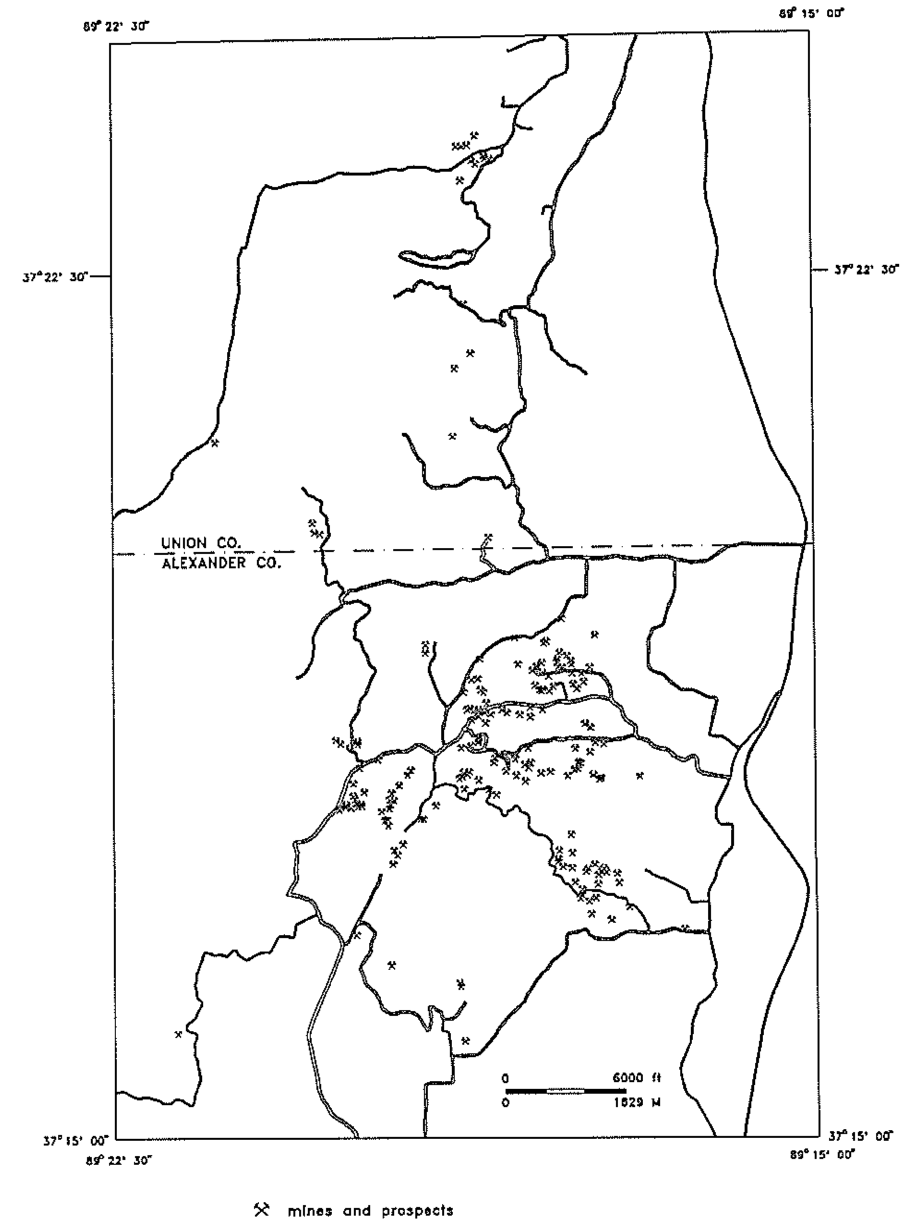

Figure 4. Area of subsidence study showing abandoned mine sites, Shawnee National Forest, IL.

locate the site and define the stage of subsidence and its areal extent. This system may be applicable in identifying areas of potential collapse in the Shawnee National Forest, which would allow the Forest Service to withdraw these areas from public access. An added feature of this system is that detection equipment can be placed to encircle areas of possible undermined areas, detect seismic activity, and prioritize areas for more focused work.

Conclusions

A subsidence study of the Jonesboro district was carried out by the Bureau in order to provide a Federal land management agency with detailed information regarding the locations and extent of the undermined areas. This information is enabling the Forest Service to ensure public safety and manage the resources in this area much more easily, efficiently, and accurately. Geophysical tests could lead to the development of quick and relatively safe methods to evaluate other undermined areas and determine if they are susceptible to surface subsidence. These areas could then be blocked off from public access.

Literature Cited

Berg, R. B. and J. M. Masters, 1993. Geology of microcrystalline silica (tripoli) deposits, southernmost Illinois. Illinois State Geological Survey (in press).

Munson, R. D., 1992. Abandoned mined lands program TN#9. Technology News No. 404, U.S. Bureau of Mines.

U.S. Bureau of Mines, various years. Mineral industry of Illinois. In Minerals Yearbook.