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CHARACTERIZATION OF KARST TERRAIN AND REGIONAL TECTONICS USING REMOTELY SENSED DATA IN JO DAVIESS COUNTY, ILLINOIS

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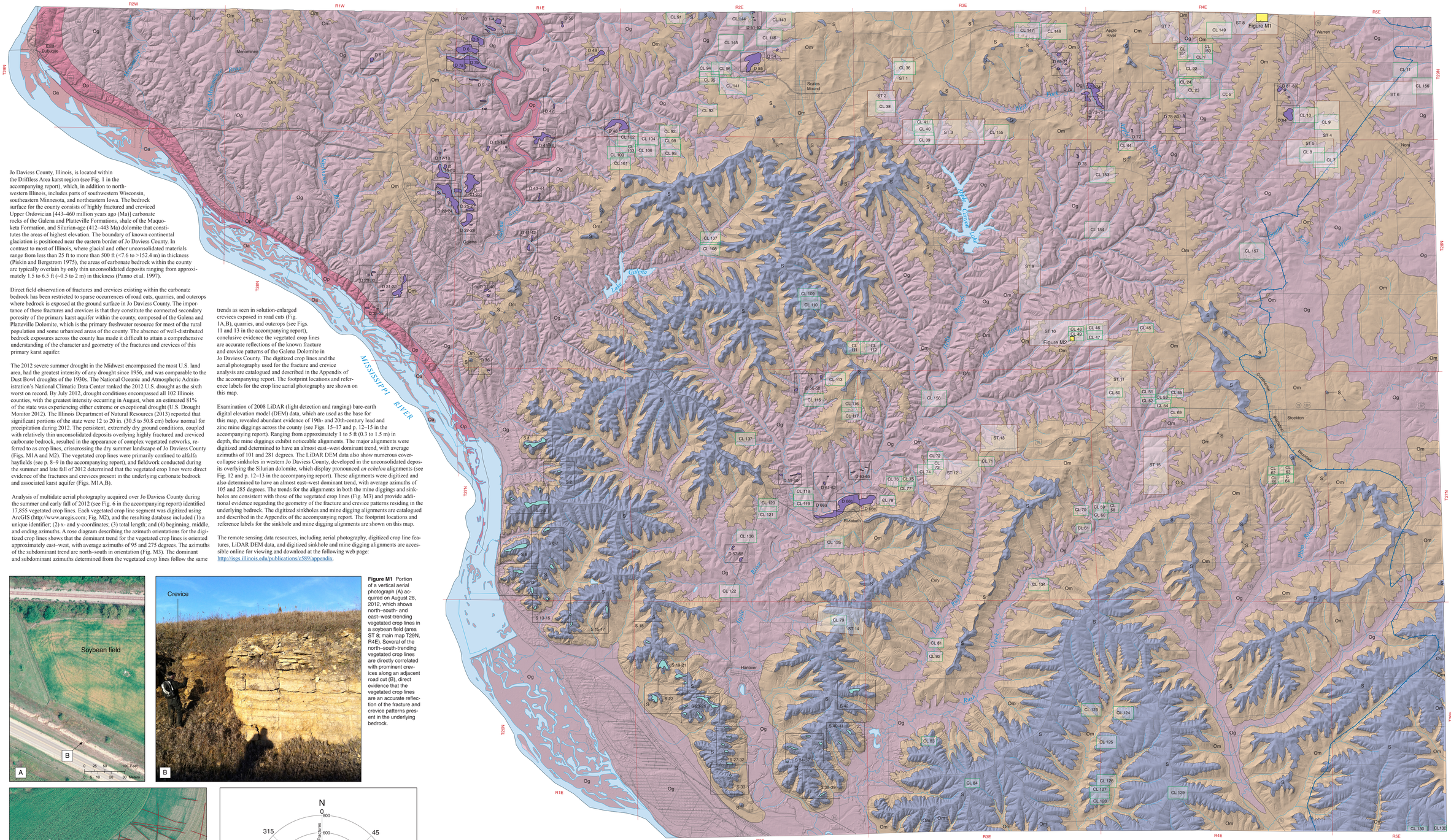
Circular 589, Map 1



Jo Daviess County, Illinois, is located within the Driftless Area karst region (see Fig. 1 in the accompanying report), which, in addition to northwestern Illinois, includes parts of southwestern Wisconsin, southeastern Minnesota, and northeastern Iowa. The bedrock surface for the county consists of highly fractured and creviced Upper Ordovician [443–460 million years ago (Ma)] carbonate rocks of the Galena and Platteville Formations, shale of the Maquoketa Formation, and Silurian-age (412–443 Ma) dolomite that constitutes the areas of highest elevation. The boundary of known continental glaciation is positioned near the eastern border of Jo Daviess County. In contrast to most of Illinois, where glacial and other unconsolidated materials range from less than 25 ft to more than 500 ft (<7.6 to >152.4 m) in thickness (Piskin and Bergstrom 1975), the areas of carbonate bedrock within the county are typically overlain by only thin unconsolidated deposits ranging from approximately 1.5 to 6.5 ft (~0.5 to 2 m) in thickness (Panno et al. 1997).

Direct field observation of fractures and crevices existing within the carbonate bedrock has been restricted to sparse occurrences of road cuts, quarries, and outcrops where bedrock is exposed at the ground surface in Jo Daviess County. The importance of these fractures and crevices is that they constitute the connected secondary porosity of the primary karst aquifer within the county, composed of the Galena and Platteville Dolomite, which is the primary freshwater resource for most of the rural population and some urbanized areas of the county. The absence of well-distributed bedrock exposures across the county has made it difficult to attain a comprehensive understanding of the character and geometry of the fractures and crevices of this primary karst aquifer.

The 2012 severe summer drought in the Midwest encompassed the most U.S. land area, had the greatest intensity of any drought since 1956, and was comparable to the Dust Bowl droughts of the 1930s. The National Oceanic and Atmospheric Administration's National Climatic Data Center ranked the 2012 U.S. drought as the sixth worst on record. By July 2012, drought conditions encompassed all 102 Illinois counties, with the greatest intensity occurring in August, when an estimated 81% of the state was experiencing either extreme or exceptional drought (U.S. Drought Monitor 2012). The Illinois Department of Natural Resources (2013) reported that significant portions of the state were 12 to 20 in. (30.5 to 50.8 cm) below normal for precipitation during 2012. The persistent, extremely dry ground conditions, coupled with relatively thin unconsolidated deposits overlying highly fractured and creviced carbonate bedrock, resulted in the appearance of complex vegetated networks, referred to as crop lines, crisscrossing the dry summer landscape of Jo Daviess County (Figs. M1A and M2). The vegetated crop lines were primarily confined to alfalfa hayfields (see p. 8–9 in the accompanying report), and fieldwork conducted during the summer and late fall of 2012 determined that the vegetated crop lines were direct evidence of the fractures and crevices present in the underlying carbonate bedrock and associated karst aquifer (Figs. M1A,B).

Analysis of multidate aerial photography acquired over Jo Daviess County during the summer and early fall of 2012 (see Fig. 6 in the accompanying report) identified 17,855 vegetated crop lines. Each vegetated crop line segment was digitized using ArcGIS (http://www.arcgis.com; Fig. M2), and the resulting database included (1) a unique identifier; (2) x- and y-coordinates; (3) total length; and (4) beginning, middle, and ending azimuths. A rose diagram describing the azimuth orientations for the digitized crop lines shows that the dominant trend for the vegetated crop lines is oriented approximately east–west, with average azimuths of 95 and 275 degrees. The azimuths of the subdominant trend are north–south in orientation (Fig. M3). The dominant and subdominant azimuths determined from the vegetated crop lines follow the same trends as seen in solution-enlarged crevices exposed in road cuts (Fig. 1A,B), quarries, and outcrops (see Figs. 11 and 13 in the accompanying report), conclusive evidence the vegetated crop lines are accurate reflections of the known fracture and crevice patterns of the Galena Dolomite in Jo Daviess County. The digitized crop lines and the aerial photography used for the fracture and crevice analysis are catalogued and described in the Appendix of the accompanying report. The footprint locations and reference labels for the crop line aerial photography are shown on this map.

Examination of 2008 LiDAR (light detection and ranging) bare-earth digital elevation model (DEM) data, which are used as the base for this map, revealed abundant evidence of 19th- and 20th-century lead and zinc mine diggings across the county (see Figs. 15–17 and p. 12–15 in the accompanying report). Ranging from approximately 1 to 5 ft (0.3 to 1.5 m) in depth, the mine diggings exhibit noticeable alignments. The major alignments were digitized and determined to have an almost east–west dominant trend, with average azimuths of 101 and 281 degrees. The LiDAR DEM data also show numerous cover-collapse sinkholes in western Jo Daviess County, developed in the unconsolidated deposits overlying the Silurian dolomite, which display pronounced *en echelon* alignments (see Fig. 12 and p. 12–13 in the accompanying report). These alignments were digitized and also determined to have an almost east–west dominant trend, with average azimuths of 105 and 285 degrees. The trends for the alignments in both the mine diggings and sinkholes are consistent with those of the vegetated crop lines (Fig. M3) and provide additional evidence regarding the geometry of the fracture and crevice patterns residing in the underlying bedrock. The digitized sinkholes and mine digging alignments are catalogued and described in the Appendix of the accompanying report. The footprint locations and reference labels for the sinkhole and mine digging alignments are shown on this map.

The remote sensing data resources, including aerial photography, digitized crop line features, LiDAR DEM data, and digitized sinkhole and mine digging alignments are accessible online for viewing and download at the following web page: http://isgs.illinois.edu/publications/c589/appendix.

Figure M1 Portion of a vertical aerial photograph (A) acquired on August 28, 2012, which shows north–south- and east–west-trending vegetated crop lines in a soybean field (area ST 8; main map T29N, R4E). Several of the north–south-trending vegetated crop lines are directly correlated with prominent crevices along an adjacent road cut (B), direct evidence that the vegetated crop lines are an accurate reflection of the fracture and crevice patterns present in the underlying bedrock.

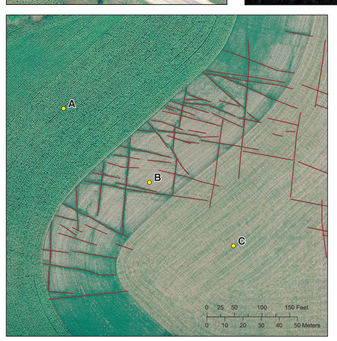


Figure M2 Portion of a vertical aerial photograph acquired on August 28, 2012, showing a mature-stage cornfield (A), drought-affected alfalfa field (B), and recently harvested alfalfa field (C) (areas ST 10 and CL 49; T28N, R3E; also see the Appendix in the accompanying report). The red lines show digitized crop lines based on direct interpretation of the aerial photograph. A total of 128 georeferenced aerial photographs distributed across Jo Daviess County (see map) yielded 17,855 digitized crop lines, which were determined to be direct evidence of buried fractures and crevices developed in the underlying carbonate bedrock.

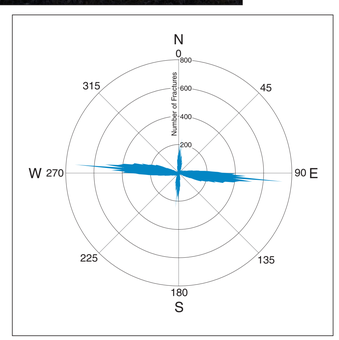


Figure M3 Rose diagram summarizing the azimuth orientations for 17,855 digitized crop lines interpreted from georeferenced aerial photography, acquired during the summer and early fall of 2012. The strongly dominant trend is oriented east–west, with average azimuths of 95 and 275 degrees, respectively. The azimuths of the subdominant trend are north–south in orientation. See the accompanying report for further discussion.

References

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ST 15 — August 2012 crop line aerial photographs
CL 36 — September 2012 crop line aerial photographs
D 5 — Areas of mine digging alignments
S 2 — Areas of sinkhole alignments
Continental glaciation boundary (Willman and Frye 1970)

Bedrock Geology

- S — Silurian System
- Om — Maquoketa Shale Group
- Og — Galena Group
- Op — Platteville Group
- Oa — Ancell Group

Road Classification

- U.S. Highway
- State Route

SCALE 1:62,500
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 KILOMETERS

ADJACENT COUNTIES
1 Stephenson
2 Carroll

APPROXIMATE MEAN DECLINATION, 2015
1½° EAST OF TRUE NORTH
MAGNETIC NORTH

Bedrock geology from Kolata, D.R., 2005, Bedrock geology of Illinois: Illinois State Geological Survey, Illinois Map 14, 1:500,000.

2008 LiDAR data for Jo Daviess County, Illinois, made available through the Illinois Department of Transportation and the Illinois Height Modernization Program (http://isgs.illinois.edu/nsdihome/webdocs/ilhmp/). Universal Transverse Mercator, zone 15. North American Datum of 1983 (NSRS2007), North American Vertical Datum of 1988. Vector base data from 2013 TIGER/Line Shapefiles provided by the United States Census Bureau.

Cartography and graphics by Jane E. Johnshoy Domier, Donald E. Luman, and Jennifer E. Carrell, Illinois State Geological Survey.

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