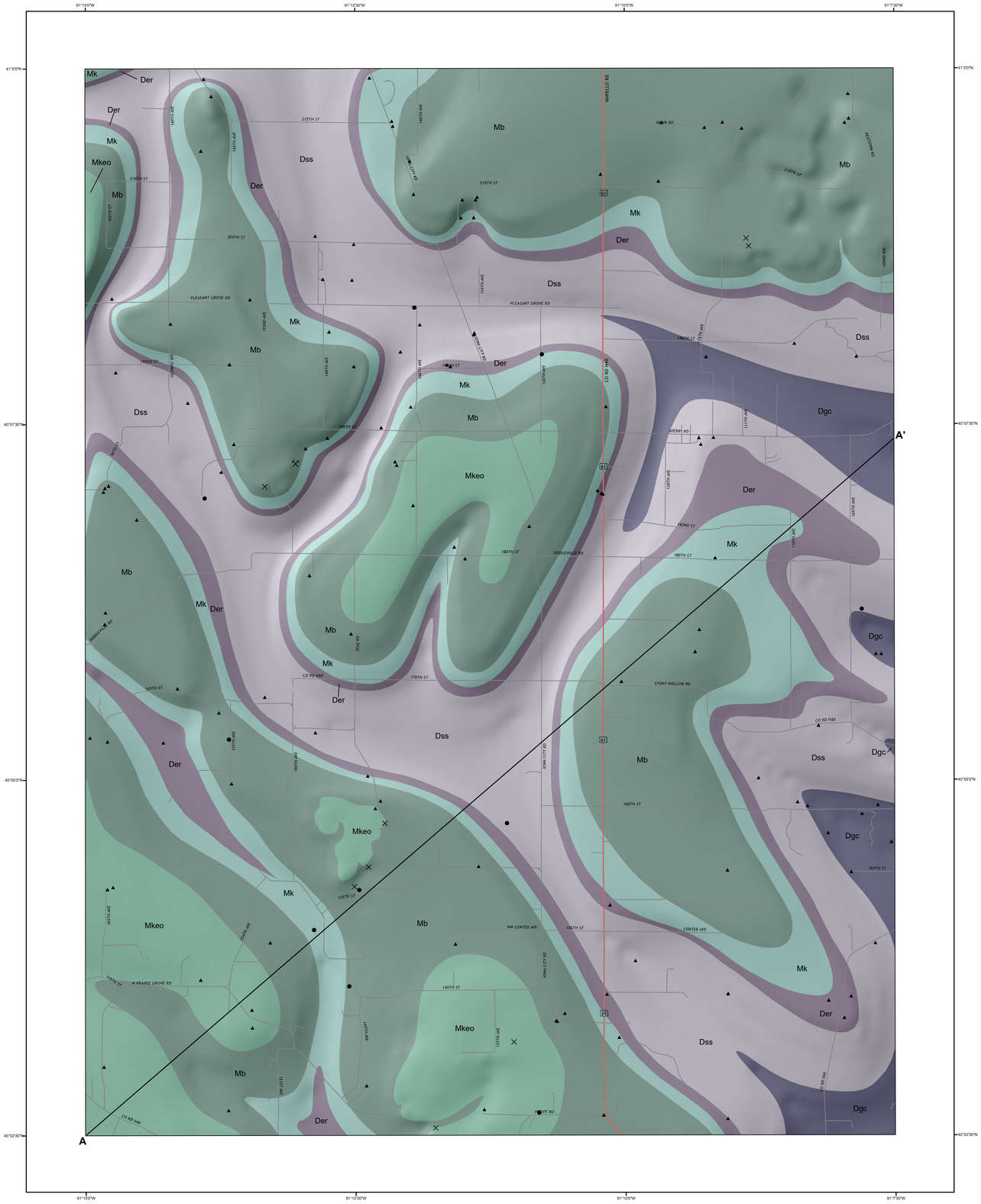
BEDROCK GEOLOGIC MAP OF THE SPERRY (IOWA) 7.5' QUADRANGLE



LEGEND

CENOZOIC

QUATERNARY SYSTEM

Qu – Undifferentiated Unconsolidated Sediments - Consists of loamy soils developed in loess, glacial till, and colluvium of variable thickness, and alluvial clay, silt, sand, and gravel. The total thickness of the Quaternary deposits generally ranges between 5 and 20 m (16 – 66 ft), but can be as much as 110 m (360 ft) thick in the south eastern part of the mapping area. This unit is shown only on the cross-section, not on the map.

PALEOZOIC

CARBONIFEROUS SYSTEM

MISSISSIPPIAN SUBSYSTEM

Mkeo – Limestone, Dolomite, Chert, and Shale (Keokuk Formation) Upper Osagean. The Keokuk Formation can be up to 23 m (75 ft) in thickness in the mapping area. This unit is dominated by tan to gray interbedded skeletal limestones displaying packstone/grain-stone fabrics. Nodular to bedded chert, in part fossiliferous, is common in the lower half of the sequence. Dolomitic, variably argillaceous, and thin shales also occur throughout the unit. The unit displays multiple hardground surfaces and bone beds with scattered to abundant fish debris, the most prominent of these serves as a marker bed at the base of the formation (sometimes referred to as the Burlington-Keokuk or B-K bone bed). Brachiopods, crinoids, bryozoans, solitary corals, and fish bones and teeth occur throughout this unit as both abraded debris and partly articulated specimens. Molds of sponge spicules are noted in the dolomite facies. Traces of glauconite and minor geodes are also found in this formation. A handful of outcrops were found along small tributaries of Flint Creek in the south-central portion of the mapping area.

Mb – Limestone, Dolomite, and Chert (Burlington Formation) Lower Osagean. The Burlington Formation typically ranges between 12 to 18 m (40 – 60 ft) in thickness, reaching a maximum thickness of 26 m (85 ft) in the southwestern corner of the mapping area. This unit is subdivided into three members (in ascending order: the Dolbee Creek, Haight Creek, and Cedar Fork), characterized by distinct lithologic groupings. The Dolbee Creek Member is dominated by white to tan skeletal limestone displaying packstone/grainstone fabrics and nodular to bedded chert. The Haight Creek Member is characterized by dolomite with an intermittent unit of skeletal limestone (sometimes referred to as the "middle grainstone") and thick beds of chert. A glauconite-rich zone marks the lower contact between the Dolbee Creek and can be used as a regional marker bed. Fossil molds are also present in the dolomite facies. The Cedar Fork Member is a pure white crinoidal packstone limestone unit which is usually differentiated from the packstones of the overlying Keokuk Formation by its white appearance. Occasional fish debris and glauconite are also observed in this member. Only a few outcrops of the Burlington Formation were found within the mapping area, along Big Hollow Creek, Yellow Spring Creek, and an unnamed tributary of Flint Creek.

Mk – Dolomite, Limestone, and Siltstone (Kinderhookian formations) Lower Mississippian. The Kinderhookian sequence ranges in thickness from 6 to 11 m (20 – 36 ft) in the mapping area. This unit comprises three formations (in ascending order: the McCraney, Prospect Hill, and Wassonville), characterized by distinct lithologic groupings. These formations are separated by minor unconformities noted by the occasional thinning or absence of one or more units observed within the mapping area. The McCraney Formation is composed of alternating beds of sparsely fossiliferous, sub-lithographic limestone and dark brown, unfossiliferous dolomite, generating a unique "zebra striped" appearance in outcrop. A basal oolite is locally present. The Prospect Hill Formation is a light to medium gray, dolomitic siltstone that grades to shale in some locations. This unit is often laminated with vertical and horizontal burrow fabrics and faint cross stratified bedforms. Fossils are rare to absent, although fossil molds are locally abundant. The Wassonville Formation, now including the former Starr's Cave Formation as the basal member, consists of massive dolomite that is variably cherty grading into dolomitic limestone lower in the section. The basal Starr's Cave Member is a fossiliferous limestone with packstone/grainstone fabrics and is commonly oolitic. Crinoids (partly articulated) are the dominant fossil type of the Starr's Cave Member. A diverse assemblage of brachiopods are present with lesser amounts of blastoids, starfish, corals, bryozoans, and trilobites reported. Outcrops of the Kinderhookian were not observed within the mapping area.

DEVONIAN SYSTEM

Der – Siltstone and Shale (English River Formation) Upper Devonian, lower to upper Famennian. The English River Formation is up to 7 m (23 ft) thick within the mapping area. This unit is dominated by gray to olive green siltstone with apparent bioturbated fabrics. Bivalves and brachiopods are common, especially in the upper beds, with scattered to abundant fossil molds as well. Outcrops of the English River Formation were not observed within the mapping area.

Dss – Shale (Saverton Shale Formation) Upper Devonian, lower to upper Famennian. The Saverton Shale Formation can be up to 46 m (150 ft) thick within the mapping area. This unit is dominated by green-gray shale, commonly burrowed with sparse to absent macro-fossils. Outcrops of the Saverton Shale Formation were not observed within the mapping area.

Dgc – Shale (Grassy Creek Formation) Upper Devonian, lower to upper Famennian. The Grassy Creek Formation can be up to 52 m (170 ft) thick within the mapping area. This unit is dominated by organic-rich brown shale with minor green-gray shale in the upper part of the unit. Differentiation between the Grassy Creek and overlying Saverton Shale was primarily based on color and relative abundance of spore scarps identified in well cuttings. Outcrops of the Grassy Creek Formation were not observed within the mapping area.

OTHER FEATURES

- **New drill holes for this map project**
- **Bedrock outcrops**
- **IGS GEOSAM data points** – records available at www.iowageologicalsurvey.org
- **Quarries**
- **Roads**
- w7036 **Wells used for geologic cross-section**
- **Bedrock Hillshade-** shades of gray show the bedrock surface as it would be illuminated by an artificial light source from the NW direction

STRATIGRAPHIC COLUMN

System[1]	Subsystem[1]	Series[1]	Stage[2]	Lithostratigraphic Unit	Map Symbol	Lithology	Thickness (in feet)
Carboniferous	Mississippian	Middle	Osagean	Keokuk Fm.	Mkeo		30-75
		Lower		Burlington Fm.	Mb		40-60
				Kinderhookian	Mk		20-35
Devonian		Upper	Famennian	English River Fm.	Der		<25
				Saverton Shale Fm.	Dss		>150
				Grassy Creek	Dgc		>170

[1]Global stratigraphic units
[2]Regional stratigraphic units

Lithologies

- Dolomite
- Dolomitic shale
- Fossiliferous Packstone
- Limestone
- Lithographic Limestone
- Sandstone
- Sandy Limestone
- Shale
- Siltstone

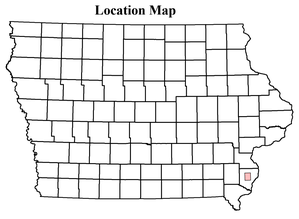
Symbols

- Geodes
- Chert
- Oolitic
- Argillaceous zone
- Breccia
- Unconformity

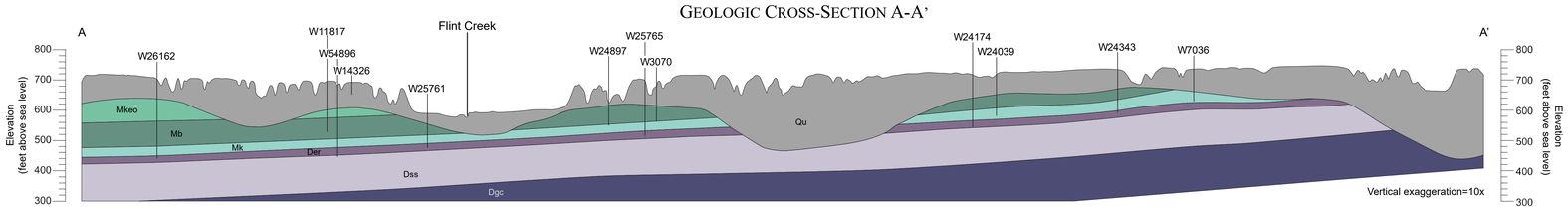
Adjacent 7.5' Quadrangles

MORNING SUN, IOWA	MEDIAPOLIS, IOWA	OAKVILLE, IOWA
PLEASANT GROVE, IOWA	SPERRY, IOWA	KINGSTON, IOWA-ILL.
DANVILLE, IOWA	WEST BURLINGTON, IOWA	BURLINGTON, IOWA-ILL.

Location Map



GEOLOGIC CROSS-SECTION A-A'



BEDROCK GEOLOGIC MAP OF THE SPERRY 7.5' QUADRANGLE, DES MOINES COUNTY, IOWA

IOWA GEOLOGICAL SURVEY
OPEN FILE MAP OFM-18-3
JUNE 2018

Ryan Clark, Huaibao Liu, Stephanie Tassier-Surine, and Phil Kerr

Iowa Geological Survey, IIHR-Hydroscience & Engineering, University of Iowa, Iowa City, Iowa

Iowa Geological Survey, Keith Schilling, Associate State Geologist

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INTRODUCTION TO THE BEDROCK GEOLOGY OF THE SPERRY 7.5' QUADRANGLE, DES MOINES COUNTY, IOWA

The West Burlington Quadrangle lies within the Southern Iowa Drift Plain landform region (Prior, 1991). The map area is dominated by loess mantled till plains in the uplands, and fine to coarse grained alluvial deposits within Flint Creek and its tributaries. This area hosts glacial deposits of both Illinoian (130,000 to 190,000 years before present) and Pre-Illinoian age (ranging from 0.5 to 2.6 million years ago).

The thickness of Quaternary materials overlying the bedrock surface varies widely across the quadrangle ranging from 5 to 20 m (16 – 66 ft), reaching a maximum thickness of 125 m (410 ft) in the extreme northeastern part of the mapping area. Shallow bedrock information from the soil survey of Des Moines County (Brown, 1983) was used for identifying potential bedrock outcrop locations during field mapping activities. Bedrock outcrops were found mostly along tributaries of Flint Creek in the northern part of the mapping area and along tributary creeks of the Skunk River in the southern part. Outcrops exposed are comprised of Keokuk, Burlington, and Kinderhookian formation rocks with Devonian English River Formation exposed only at Starr's Cave State Preserve in the northeastern corner of the mapping area. There are no operational quarries within the quadrangle. Subsurface information was mostly derived from the analysis of water well cutting samples reposited at the Iowa Geological Survey (IGS). Lithologic and stratigraphic information from these samples are stored in the online GeoSam database of the IGS. Geologic information from eight outcrops and more than 200 private and public wells within the West Burlington Quadrangle and the surrounding area were used for bedrock geologic mapping purposes.

The Mississippian System (now Subsystem) was historically proposed for the succession of strata exposed in the Mississippi River Valley between Burlington, Iowa and southern Illinois. Therefore, the bedrock exposures in southeastern Iowa take on a special significance as they comprise part of the historic "body stratotype" on which the concept of the Mississippian System was defined and based (Witzke et al., 2002). The Mississippian had been primarily a North American chronostratigraphic label roughly synonymous with the Lower Carboniferous of the Old World. After approval by the Subcommission on Carboniferous Stratigraphy in 1999 and ratification by the International Union of Geological Sciences and the International Commission on Stratigraphy in 2000, the Carboniferous System was officially subdivided into lower and upper subsystems, the Mississippian and Pennsylvanian, respectively. As such, the Mississippian now has meaning and application as a major subdivision of geologic time not only in North America, but as a globally defined subsystem. The bedrock strata seen in the West Burlington Quadrangle and surrounding area provide a significant historic reference for the Mississippian as a whole.

The conundrum that is the Mississippian in Iowa has been the subject of curiosity for many previous workers. Owen (1852) and Hall (1857) were the first to recognize that the abundant bedrock exposures in southeastern Iowa likely correlated with those observed farther down the Mississippi River Valley. Decades later, Van Tuyl (1923) took on the ambitious task of correlating all of the Mississippian units across Iowa. Many of their lithologic interpretations were valuable; however, the correlations were, and continue to be, subject to revision as later workers attempted to piece the Mississippian into the global stratigraphic framework. Harris and Parker (1964) provided inspirational insights into the structural context of southeastern Iowa by identifying a series of northwest-southeast trending anticlines that were later found to be superimposed on the larger northeast-southwest trending structural feature known as the Mississippi Arch (Witzke et al., 1990). Many questions remain regarding the stratigraphic correlations within the Mississippian such as whether the "St. Louis" Formation in Iowa truly belongs in the St. Louis Formation or should some of the upper members be reassigned to the Ste. Genevieve Formation; whether the Prospect Hill Formation is an offshoot of the Hannibal Formation of Missouri and Illinois; and whether the McCraney Formation is correlative to the McCraney in Illinois or if it should become a new stratigraphic interval (as proposed by Witzke et al., 2002). In an effort to address the question regarding the "St. Louis" Formation, detrital zircon analyses from sandstone samples collected near the mapping area were processed with the help of Emily Finzel (Assistant Professor of Geology at the University of Iowa (UI)). The geochronologic data provided by the detrital zircon analyses were not able to differentiate the sandstone units within the "St. Louis" Formation, however, further study of the geochemistry and lithology of these sandstones may provide the evidence needed to identify whether these units belong in the St. Louis proper or in the Ste. Genevieve. Clarifying the issue regarding the Prospect Hill and McCraney formations is being done with the help of Brad Cramer (Assistant Professor of Geology at the UI), Brittany Stoflus (UI undergraduate student), and Jannes "Jed" Day (Professor of Geology at Illinois State University). Samples collected from within the mapping area as well as at other locations in southeastern Iowa, eastern Illinois, and northeastern Missouri for conodonts and carbon isotopes have provided valuable bio- and chemostratigraphic information. Preliminary results suggest that the Prospect Hill and McCraney formations in Iowa may correlate with the Hannibal Formation. Further study will commence with additional sampling of surface exposures as well as core samples. Rectifying the questions posed by Witzke et al., 2002, may now become attainable.

Although the Mississippian bedrock in southeastern Iowa is no longer a widely used aquifer due to low yields and locally poor water quality, many of the bedrock units are highly desirable sources of aggregate, thus necessitating the continued effort to gain a better understanding of the local and regional stratigraphic characteristics and relationships of the Mississippian Subsystem in southeastern Iowa. The mapping area consists of bedrock of the Mississippian Subsystem from late Kinderhookian to early Chesterian (about 355 – 330 million years ago) and Devonian strata of Famennian age (about 370 – 360 million years ago) (Ogg et al., 2008). Famennian strata are represented by brown, organic rich shales of the Grassy Creek Formation followed by gray-green silty shales of the Saverton Shale Formation and capped by the English River Formation siltstone. The thick shale packages represent major transgressive-regressive cycles of deposition in a stratified seaway (Witzke, 1987). Kinderhookian strata represent a sequence of interbedded carbonates and siltstones that unconformably underlie the Burlington Formation (early Osagean) within the mapping area. The Burlington, Keokuk, and Warsaw formations (collectively the Augusta Group of Witzke et al., 2010) represent a relatively conformable package of marine rocks deposited during the Osagean transgressive-regressive (T-R) cycle. Interpreted as part of the central middle shelf of the Osagean sea that transgressed toward the northwest and the Transcontinental Arch, the Burlington Formation rocks were deposited across a vast subtidal epicontinental shelf that stretched from Illinois and Iowa into central Kansas and Oklahoma (Lane, 1978; Witzke et al., 1990). The Keokuk and Warsaw formations represent the regressive phase of the Osagean T-R cycle punctuated by a stark unconformity below the overlying Pella and "St. Louis" formations, regionally displaying up to 40 m (130 ft) of erosional relief (Witzke et al., 2002). For a more detailed description of the lithologic units and further discussion of mapping methodologies, please refer to the accompanying Summary Report

References:

Brown, M.D., 1983: Soil Survey of Des Moines County, Iowa. U.S. Department of Agriculture, Soil Conservation Service, 199 p., 66 map sheets.

Hall, J., 1857: Observations upon the Carboniferous limestones of the Mississippi Valley. American Journal of Science, v. 23, p. 187-203.

Harris Jr., S.E. and Parker, M.C., 1964: Stratigraphy of the Osage Series in Southeastern Iowa, Iowa Geological Survey Report of Investigation No. 1, 52 p., 17 figs, 7 plates.

Lane, H.R., 1978: The Burlington Shelf (Mississippian, north-central United States). Geologica et Palaeontologica v. 12, p. 165-176.

Ogg, J.G., Ogg, G., and Gradstein, F.M., 2008: The Concise Geologic Time Scale, Cambridge University Press, 177 p.

Owen, D.D., 1852: Report of a Geological Survey of Wisconsin, Iowa, and Minnesota; and incidentally of a portion of Nebraska territory. Lippincott, Gambo and Co., 638 p.

Prior, J.C., 1991: Landforms of Iowa. Univ. of Iowa Press, Iowa City, 154 p.

Van Tuyl, F.M., 1923: The stratigraphy of the Mississippian formations of Iowa. Iowa Geological Survey, Annual Report, v. 30, p. 33-359.

Witzke, B.J., 1987: Models for circulation patterns in epicontinental seas applied to Paleozoic facies of North American craton. Paleoceanography, v. 2, p. 229-248.

Witzke, B.J., McKay, R.M., Bunker, B.J., and Woodson, F.J., 1990: Stratigraphy and Paleoenvironments of Mississippian Strata in Keokuk and Washington Counties, Southeast Iowa. Iowa Geological Survey Guidebook No. 10, 105 p.

Witzke, B.J., Bunker, B.J., Anderson, R.R., Artz, J.A., and Tassier-Surine, S.A., 2002: Pleistocene, Mississippian, & Devonian Stratigraphy of the Burlington, Iowa, Area. Iowa Geological Survey Guidebook No. 23, 137 p.

Witzke, B.J., Anderson, R.R., and Pope, J.P., 2010: Bedrock Geologic Map of Iowa, 1:500,000. Iowa Geological and Water Survey Open File Map OFM-10-1

Base map from USGS Sperry 7.5' Digital Raster Graphic (IGS GIS file IA_Sperry_USGS_topo.tif) which was scanned and modified from the Sperry 7.5' Topographic Quadrangle map, published by The US Geological Survey in 2015
Land elevation contours (10' interval). Bedrock topography raster created internally for this map project.

Iowa Geological Survey digital cartographic file Sperry_BedrockGeology.mxd, version 6/30/18 (ArcGIS 10.5)
Map projection and coordinate system based on Universal Transverse Mercator (UTM) Zone 15N, datum NAD83.

The map and cross-section are based on interpretations of the best available information at the time of mapping. Map interpretations are not a substitute for detailed site specific studies.

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