SUMMARY REPORT
OF THE BEDROCK GEOLOGIC MAP OF
THE COLWELL 7.5' QUADRANGLE, CHICKASAW, FLOYD, HOWARD, AND MITCHELL COUNTIES, IOWA

Iowa Geological Survey
Open File Map OFM-17-3
June 2017

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

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

Iowa Geological Survey, Robert D. Libra, State Geologist

Supported in part by the U.S. Geological Survey
Cooperative Agreement Number G16AC00193
National Cooperative Geologic Mapping Program (STATEMAP)
Completed under contract with the Iowa Department of Natural Resources

INTRODUCTION

The Colwell 7.5’ Quadrangle is located on the border area of Floyd, Mitchell, Howard and Chickasaw counties in north-central Iowa. It covers an area from 43° 7’ 30” to 43° 15’ N latitude and 92° 37’ 30” to 92° 30’ W longitude. The bedrock geologic map of the Colwell 7.5’ Quadrangle was completed as part of the Iowa Geological Survey’s (IGS) ongoing participation in the National Cooperative Geologic Mapping Program (STATEMAP) in north-central Iowa, and was supported in part by the U.S. Geological Survey (USGS; grant number G16AC00193) and under contract with the Iowa Department of Natural Resources (IDNR).

The land surface of the Colwell 7.5’ Quadrangle is almost completely covered by Quaternary sediments. In terms of landforms, this quadrangle lies in the Iowan Surface landform region where the land surface has been modified by various episodes of erosion before and during the Wisconsin-age glacial events (Prior, 1991). Due to extensive glacial and erosional activities, the landscape of this area is characterized by relatively low topographic relief, slightly inclined to gently rolling with long slopes, and open horizons. This landform region also features common fieldstones of glacial origin known as glacial erratics (Fig. 1). Two major rivers of north-central Iowa, the Wapsipinicon River in the eastern part and the Little Cedar River in southwest corner of the quadrangle, run through the mapping area.

Fig. 1: Typical landscape and glacial erratics on the land surface in the mapping area.

The Quaternary sediments in the mapping area consist of loamy soils developed in loess, glacial till, and colluvium of variable thickness, and alluvial clay, silt, sand, and gravel. Thickness of the Quaternary deposits is commonly more than 18 m (60 ft) in most of the mapping area except the far east portion of the quadrangle, and it reaches a maximum thickness more than 90 m (295 ft) in a bedrock valley located in the western part of the quadrangle. For the detailed Quaternary stratigraphy and distribution, see the surficial geologic map of this quadrangle (Kerr et al., 2017).

The bedrock surface of the Colwell 7.5' Quadrangle is comprised of Devonian strata which mainly consist of carbonates with minor shale and other lithologies. These Devonian carbonates form the important upper bedrock aquifer in the mapping area (Libra et al., 1984, 1994), and this aquifer becomes vulnerable when not covered by thick surficial materials. These carbonate rocks, especially those of relatively pure limestones, are also easily karstified (Fig. 2; Moore, 1995). Historic flooding in 2008 caused serious damages to north-central Iowa and created significant interest from local government and conservation groups. This led to the formation of several watershed protection and management coalitions and initiatives in north-central Iowa. Key societal concerns that can be addressed with geologic mapping projects in this area include watershed management, water quality and quantity issues, flood management, and aggregate production and resource protection. Thus, as part of the geologic mapping program in north-central Iowa, producing a bedrock geologic map for Floyd County was strongly recommended by the Iowa State Mapping Advisory Committee (SMAC), and approved by the National Cooperative Geologic Mapping Program (STATEMAP). The bedrock geology of the Colwell 7.5' Quadrangle is mapped as part of the second phase towards the completion of the bedrock geologic map of Floyd County.

Fig. 2: A developing sinkhole found in the mapping area. The lower-right picture shows the central hole of the structure.

The previous bedrock geologic map of north-central Iowa was completed by Witzke and others in 2001. Since then, new geologic data from this area have been accumulated and become available for more detailed geologic mapping. To better understand the geology of this area, the new bedrock geologic map presented herein subdivides the widespread Devonian Cedar Valley Group and Wapsipinicon Group into their distinct formations, which were undifferentiated on both of the bedrock geologic map of north-central Iowa (1:250,000; Witzke et al., 2001) and the bedrock geologic map of Iowa (1:500,000; Witzke et al., 2010).

GEOLOGIC SETTING AND RESEARCH HISTORY

As described above, the bedrock surface of the Colwell 7.5' Quadrangle is occupied by Devonian deposits. Paleogeographically, the mapping area is within the northern portion of the Devonian Iowa Basin, a region with thickened carbonates, shale, and minor other lithologies deposited from the Eifelian through part of the Famennian age (Witzke et al., 1988; Witzke and Bunker, 2006; Day, 2006; Day et al., 2008). Lower Devonian strata have not been recognized in this part of the basin.

The Devonian Iowa Basin was the site of shallow marine to supratidal deposition during the Devonian. Sedimentation kept pace with subsidence, and did not develop as a bathymetric basin (Witzke et al., 1988). Many stratigraphic units in the Devonian Iowa Basin are fossiliferous. Based on the lithology and fossils, a stratigraphic sequence consisting of a series of formations was established in the northern part of the Iowa Basin, and it has been recognized that these deposits were controlled by seven corresponding major 3rd order relative sea level fluctuations which have been labeled as the Iowa Devonian transgressive-regressive (T-R) cycles (Witzke et al., 1988; Day et al., 2013a). Represented by typical sediments, several type sections of the Devonian stratigraphic sequence are located in north-central Iowa surrounding the mapping area. Five formations of the Devonian sequence have been recognized in this bedrock geologic map, representing the deposition of the Eifelian through early Frasnian in the Devonian Iowa Basin.

Due to the special depositional environments, complex sedimentary lithology, and many richly fossiliferous units, the geology, paleoenvironments, paleontology and stratigraphy of the Devonian Iowa Basin have been intensively studied. Early studies include the publications of Belanski (1927 and 1928) and Koch (1970). Recent studies of the Devonian Iowa Basin are represented by Witzke and Bunker (1984), Anderson (1984), Bunker and others (1986), Witzke and others (1988), Bunker (1995), Anderson and Bunker (1998), Groves and others (2008), McKay and Liu (2012), and Day and others (2006, 2008, 2013). Geologic mapping projects at 1:24,000 scale in north-central Iowa have been undertaken by the IGS since 2009. In addition to 7.5' quadrangle maps, 1:100,000 scale bedrock geologic maps have been recently completed for Bremer County (McKay et al., 2010), Worth County (Liu et al., 2012), Black Hawk County (Rowden et al., 2013), Cerro Gordo County (Liu et al., 2015), and Mitchell County (Clark et al., 2016) in the Devonian Iowa Basin. The bedrock geologic map of north-central Iowa (1:250,000) and the bedrock geologic map of Iowa (1:500,000) were completed by Witzke and others in 2001 and 2010, separately. Results from these geologic studies and bedrock geologic mapping projects provide significant regional geologic information and new data for the compilation of the present bedrock geologic map.

METHODS

The bedrock geologic mapping process includes data collection, subsurface geologic data analysis, descriptive logging when drilling materials are available, geologic field investigation and test drilling when needed, bedrock topographic map construction, and geologic map compilation.

All available sources of geologic information from the region were utilized in the production of this map, including subsurface geologic information, U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil survey data, aerial photography, satellite imagery, and LiDAR. Since the bedrock surface in the mapping area is almost completely buried by Quaternary sediments, subsurface bedrock information was mainly derived from the analysis of water well data which are stored in the IGS GeoSam database. Where available, engineering borings from public utilities, the Iowa Department of Transportation (IDOT), and monitoring well records of the U.S. Geological Survey (USGS) and IGS were also used. Information from the county assessors helped to determine some of the well locations.

During the compilation of this bedrock geologic map, a total of 87 private and public wells located in the mapping area were studied, including six newly holes drilled especially for this mapping project. Among these wells, 49 have descriptive striplogs with cutting samples which are reposited at the IGS Oakdale Rock Library, and 26 of which were newly logged for this bedrock geologic mapping task. The rest of these wells usually have driller's logs containing basic geologic and locational information. These striplogs and most driller's logs provide important subsurface geologic information including bedrock depth, lithology, thickness, and distribution of mapping units. The locations of data points in the IGS GeoSam database were checked for accuracy and updated where needed. The topography of the buried bedrock surface has been updated based on all available well penetrations. The previous bedrock topographic map (50' contour interval) was reconstructed with a 25' contour interval (Fig. 3). This formed an essential basis for the development and compilation of the new bedrock geologic map.

No natural bedrock exposure was found within this quadrangle except two rock quarries, the Cecelia Quarry in the northeast and the Deerfield Quarry in the east-central portion of the quadrangle (Fig. 4). Geology and stratigraphy of these two quarries were previously studied by IGS and IDOT, and they provided direct local geological information including some distinguishing features of involved strata. The brecciated texture in Coralville Formation (Fig. 5) and cherty nodules in the Little Cedar Formation (Fig. 6) have been recognized from the Deerfield Quarry. Shallow bedrock information from the digital soil surveys in Floyd County (Voy, 1995), Mitchell County (Voy and Highland, 1975), Howard County (Buckner and Highland, 1974) and Chickasaw County (Wilson 1996) was consulted. Bedrock information from the surrounding area, including bedrock outcrops, rock quarries, and subsurface geologic information from wells, was also studied and utilized for this mapping project.

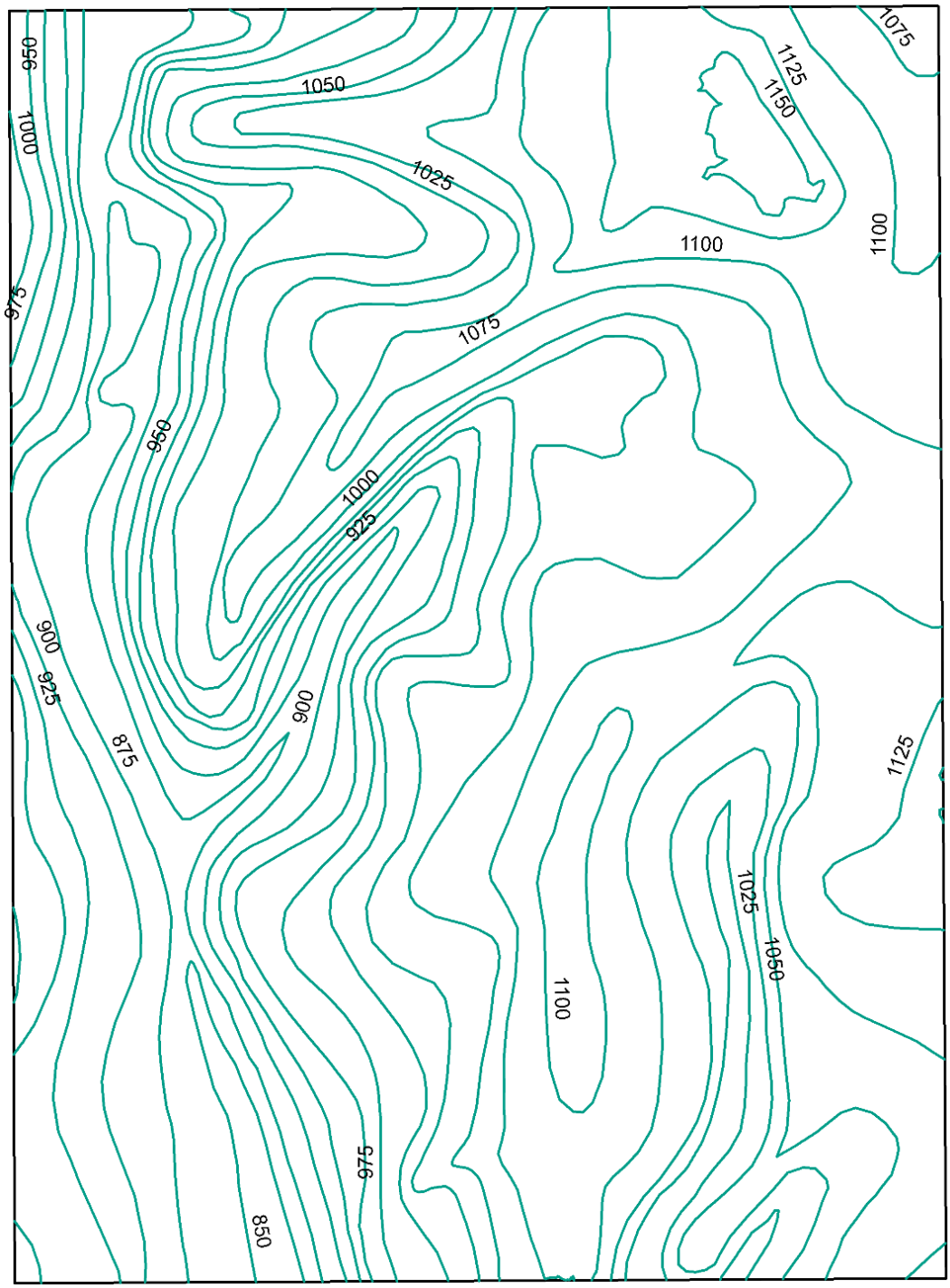

Fig. 3: The bedrock topographic map of the Colwell 7.5’ Quadrangle with a 25’ contour interval.

Fig. 4: Northern wall of the Deerfield Quarry which is partially located in the map area.

Fig. 5: Brecciated texture in the Coralville Fm.

Fig. 6: Cherty nodules in the Little Cedar Fm.

ArcGIS 10.3 software and on-screen digitizing techniques developed during previous STATEMAP projects has been used for this mapping project. The newly compiled bedrock geologic map is stored and available as a shapefile in the NRGIS library of the Iowa Department of Natural Resources (IDNR), and as a PDF file on the IGS Publications website http://www.iowageologicalsurvey.org.

BEDROCK STRATIGRAPHY AND MAPPING UNITS

The strata occurring on the bedrock surface of the Colwell 7.5' Quadrangle are of Devonian age. Stratigraphic units mapped on the new bedrock geologic map are outlined on the map Legend and the Stratigraphic Column. The boundaries separating the various bedrock mapping units were selected to reflect 1) prominent lithologic changes, 2) fossils when available, and 3) major regional unconformities and/or disconformities. The bedrock stratigraphic nomenclature and correlation of the Devonian for this map follow the stratigraphic framework proposed by Witzke and others (1988). The thickness of each map unit was derived from well penetrations within the map area. However, variations in thickness occur for each unit across the map area.

Five bedrock units of the Devonian, in descending order, the Lithograph City, Coralville, Little Cedar, Pinicon Ridge and Spillville formations comprise the bedrock surface of the map area. The general lithologic features and thickness of each bedrock mapping unit are described as follows:

Paleozoic

Devonian System

Dlgc - Limestone, Dolomite, and Shale (Lithograph City Formation) Middle to Upper Devonian. This map unit mostly occurs on the bedrock surface in the northeast part of the quadrangle. The reginal thickness of this unit is around 21 to 30 m (70-100 ft), but it is usually less than 6m (20 ft) in the mapping area due to erosion. This unit consists of limestone, dolomitic limestone, dolomite, and minor shale. It is usually characterized by interbeds of laminated lithographic and sub-lithographic limestone and dolomitic limestone, in part argillaceous. "Birdseye" structures, vugs and calcite vug-fills are common. Some intervals are fossiliferous and stromatoporoid-rich.

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. This map unit occurs at the bedrock surface of east part and southwest corner of this quadrangle. The thickness of this map unit varies between 12 and 21 m (40-70 ft) in the mapping area. It consists of limestone, dolomitic limestone, and dolomite, in part laminated, argillaceous, or shaly. Brachiopods, echinoderm debris and corals usually occur in the limestone facies.

Dlc - Dolomite, Limestone, and Shale (Little Cedar Formation) Middle Devonian. This formation dominates the bedrock surface of the west part except the deep bedrock valley of the quadrangle. The thickness of this formation ranges from 24 to 30 m (80-100 ft) in the mapping area. This unit is dominated by slightly argillaceous to argillaceous dolomite and dolomitic limestone, usually vuggy and partially cherty. A shaly layer about 3 to 6 m (10-20 ft) thick commonly occurs in the upper part of the formation. This formation is commonly fossiliferous, and brachiopods are especially abundant in the lower portion.

Dpr - Dolomite and Dolomitic Limestone (Pinicon Ridge Formation) Middle Devonian. This map unit occurs on the bedrock surface along the deep bedrock valley in west part of the quadrangle. This formation consists of dolomite and dolomitic limestone with varying textures (shaly, laminated, brecciated, sandy, and/or cherty). The thickness of this unit usually ranges from 6 to 14 m (20-45 ft). Compared to other Devonian strata in the mapping area, this formation is usually unfossiliferous.

Dsp - Dolomite (Spillville Formation) Middle Devonian. This map unit only occurs at the bedrock surface within the deep bedrock valley in west part of the quadrangle. This unit is dominated by medium to thick bedded dolomite with scattered to abundant fossil molds, with a maximum thickness of approximately 21 m (70 ft) in the mapping area. Its basal part, where present, is variably sandy, shaly, and/or conglomeratic with reworked Ordovician cherty clasts.

HIGHLIGHTS OF THIS MAPPING PROJECT

- **The bedrock occurrence**

The Colwell 7.5' Quadrangle is characterized by relatively thick Quaternary deposits, and no natural bedrock exposure was found in the map area except two rock quarries. Subsurface geologic information was mainly derived from well data analysis, which indicates that the bedrock surface of the quadranle is dominated by Coralville and Little Cedar formations of the Devonian. These well data also indicate that a shaley layer with a general thickness of 10-25', the Chickasaw Shale Member of Witzke et al. (1988), almost constantly occurs in the upper portion of the Little Cedar Formation in the mapping area.

- **The new bedrock topographic map**

As mentioned above and illustrated in Fig. 3, the bedrock topographic map of this quadrangle was based on multiple geologic sources, and completed with a 25' contour interval. The new bedrock topographic map provides the basis for accurate compilation of the bedrock geologic map herein.

- **The bedrock valley**

Based on the subsurface geologic data, a deep bedrock valley occurs in the western part of the mapping area, and a north-south valley runs through the quadrangle. The oldest strata on the bedrock surface of this quadrangle, the Pinicon Ridge and Spillville formations of the Devonian, occur only within the ancient valley.

ACKNOWLEDGMENTS

We thank Bruening Rock Products Inc., Croell Co. and L. R. Falk Construction Co. for allowing us to work in their quarries in and around the mapping area. Special thanks to Shirley Kohliska, Dorothy & Dana Martin, Joe Meirick, and Gerald Reiss for allowing and/or helping us to access bedrock outcrops in their properties. Zachary Demanett of the Iowa Geological Survey (IGS) and University of Iowa (UI) students Samantha Moser, Ryan McKeon, and Gia DeBartolo prepared well cutting samples for stratigraphic logging. New subsurface geologic data was generated by Tanner Hartsock and Diar Ibrahim, UI Department of Earth and Environmental Sciences students, by producing descriptive logs of water well drilling samples. Thanks also to Rick Langel (IGS) for managing the Iowa geologic sampling database (GeoSam). Adriana Schnoebelen of the Iowa Department of Transportation (IDOT) provided important geologic information for some quarries in the mapping area. Jed Day of Illinois State University, Bill Bunker, Brian Witzke, Robert McKay, and Ray Anderson of the Iowa Department of Natural Resources (IDNR) provided valuable discussions regarding the geology of north-central Iowa. Bedrock topography is updated from Ray Anderson's (IDNR) previous work. Casey Kohrt and Chris Kahle of IDNR and Andrew Roers of IIHR Hydroscience & Engineering provided GIS technical help. Administrative support was provided by Megan Delaney, Rosemary Tiwari, Teresa Gaffey, Angi Roemerman, and Carmen Langel.

REFERENCES

Anderson, W.I. (ed.), 1984: General Geology of north-central Iowa. Guidebook for the 48th Annual Tri-State Geol. Field Conf., 150 p.

Anderson, R.R., and Bunker, B.J., (eds.), 1998: Fossil shells, glacial swells, piggy smells, and drainage wells: the geology of the Mason City, Iowa, area. Geol. Soc. of Iowa Guidebook No. 65, 71 p.

Belanski, C.H., 1927: The Shellrock Stage of the Devonian. American Midland Naturalist, v. 10, p. 316-370.

Belanski, C.H., 1928: The Shellrock Stage of the Devonian; Description of some typical fossils of the Shellrock Stage. American Midland Naturalist, v. 11, p. 165-212.

Buckner, R.L., and Highland, J.D., 1974: Soil Survey of Howard County, Iowa. U.S. Dept. of Agriculture, Soil Conservation Service, 149 p. with 70 map sheets.

Bunker, B.J., Witzke, B.J., and Day, J.E., 1986: Upper Cedar Valley Stratigraphy, North-Central Iowa, Lithograph City Formation. Geol. Soc. of Iowa Guidebook No. 44, 41 p.

Bunker, B.J., (ed.), 1995: Geology and hydrogeology of Floyd-Mitchell counties, north-central Iowa. Geol. Soc. of Iowa Guidebook No. 62, 169 p.

Clark, R., Liu, H., Kerr, P., Tassier-Surine, S., Rowden, R., and Streeter, M., 2016: Bedrock geologic Map of Mitchell County, Iowa. Iowa Geological Survey Open File Map OFM-16-1.

Day, J., 2006: Overview of the Middle-Upper Devonian sea level history of the Wapsipinicon and Cedar Valley Groups, with discussion of new conodont data from the subsurface Cedar Valley Group of southeastern Iowa. *in* Day, J., Luczaj, J., and Anderson, R., (eds.), New Perspectives and Advances in the Understanding of Lower and Middle Paleozoic Epeiric Carbonate Depositional Systems of the Iowa and Illinois Basins. Iowa Geological Survey Guidebook Series No. 25, p. 3-21.

Day, J., Witzke B., and Bunker, B.J., 2008: Overview of Middle and Upper Devonian Cedar Valley Group and Lime Creek Formation carbonate platform facies, faunas, and event stratigraphy of northern Iowa. *in* Groves, J.R., Walters, J.C., and Day, J., (eds.), Carbonate platform facies and faunas of the Middle and Upper Devonian Cedar Valley Group and Lime Creek Formation, northern Iowa. Iowa Geological Survey Guidebook No. 28, p. 15-39.

Day, J., Witzke B., and Lundy, S., 2013: Aspects of the Paleozoic history of epeiric seas of the Iowa basin. Iowa Geological and Water Survey Guidebook No. 29, 118 p.

Groves, J.R., Walters, J.C., and Day, J., (eds.), 2008: Carbonate platform facies and faunas of the Middle and Upper Devonian Cedar Valley Group and Lime Creek Formation, northern Iowa. Iowa Geological Survey Guidebook No. 28, 96 p.

Kerr, P., Tassier-Surine, S., Liu, H., and Clark, R., 2017: Surficial geologic map of the Colwell 7.5' Quadrangle, Floyd, Mitchell, Howard and Chickasaw counties, Iowa. Iowa Geological Survey Open File Map OFM-17-4.

Koch, D.L., 1970: Stratigraphy of the Upper Devonian Shell Rock Formation of north-central Iowa. Iowa Geological Survey Report of Investigations 10, 123 p.

Libra, R.D., Hallberg, G.R., Ressmeyer, G.G., and Hoyer, B.E., 1984: Groundwater quality and hydrogeology of Devonian-Carbonate aquifers in Floyd and Mitchell counties, Iowa. Iowa Geological Survey Open File Report 84-2, p. 1-106.

Libra, R.D., Quade, D.J., Hallberg, G.R., and Littke, J.P., 1994: Groundwater quality, hydrogeology, and agricultural drainage wells, Floyd and Mitchell counties, Iowa. Iowa Geological Survey Technical Information Series 29, 64 p.

Liu, H., McKay, R., Rowden, R., Quade, D., Tassier-Surine, S., and Giglierano, J., 2012: Bedrock Geology of Worth County, Iowa. Iowa Geological and Water Survey Open File Map OFM-12-1.

Liu, H., Clark, R., Fields, C., McKay, R., Rowden, R., Tassier-Surine, S., Kerr, P., and Streeter, M., 2015: Bedrock Geology of Cerro Gordo County, Iowa. Iowa Geological Survey Open File Map OFM-15-1.

McKay, R.M., Liu, H., and Giglierano, J.D., 2010: Bedrock Geology of Bremer County, Iowa. Iowa Geological and Water Survey Open File Map OFM-10-10.

McKay, R.M. & Liu, H., 2012: Cedar Valley Group: the Lithograph City – Shellrock Formation contact at Mason City, Iowa. Geol. Soc. of Iowa Guidebook No. 90, 12 p.

Moore, F., 1995: Floyd County groundwater protection project and sinkhole cleanout. *in* Bunker, B.J., (ed.), Geology and hydrogeology of Floyd-Mitchell counties, north-central Iowa. Geol. Soc. of Iowa Guidebook No. 62, p. 75.

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

Rowden, R., McKay, R., Liu, H., Quade, D., Tassier-Surine, S., and Giglierano, J., 2012: Bedrock Geology of Black Hawk County, Iowa. Iowa Geological and Water Survey Open File Map OFM-13-3.

Voy, K.D., 1995: Soil Survey of Floyd County, Iowa. U.S. Dept. of Agriculture, Soil Conservation Service, 260 p. with 63 map sheets.

Voy, K.D., and Highland, J.D., 1975: Soil Survey of Mitchell County, Iowa. U.S. Dept. of Agriculture, Soil Conservation Service, 125 p. with 70 map sheets.

Wilson, J.H., 1996: Soil Survey of Chickasaw County, Iowa. U.S. Dept. of Agriculture, Soil Conservation Service, 182 p. with 74 map sheets.

Witzke, B.J., and Bunker, B.J., 1984: Devonian stratigraphy of north-central Iowa. Iowa Geological Survey Open File Report 84-2, p. 107-149.

Witzke, B.J., Bunker, B.J., and Rogers, F.S., 1988: Eifelian through lower Frasnian stratigraphy and deposition in the Iowa area, central midcontinent, U.S.A. in McMillan, N.J., Embry, A.F, and Glass, D.J. (eds.): Devonian of the World. Canadian Soc. of Petroleum Geologists, Memoir 14, vol. I, p. 221-250.

Witzke, B.J., Anderson, R.R., Bunker, B.J., Ludvigson, G.A., and Greeney, S., 2001: Digital geologic map of Iowa, Phase 3: North-Central Iowa (1:250,000). Iowa Geological Survey Open File Map OFM-01-3.

Witzke, B.J. and Bunker, B.J., 2006: Middle shelf facies of the Cedar Valley Group (Devonian) and their stratigraphic relationships in eastern Iowa. *in* Day, J. E., Luczaj, J., and Anderson, R., (eds.), New Perspectives and Advances in the Understanding of Lower and Middle Paleozoic Epeiric Carbonate Depositional Systems of the Iowa and Illinois Basins. Iowa Geological Survey Guidebook Series No. 25, p. 23-46.

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.