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## The Bedrock Configuration of Iowa

LYLE V. A. SENDLEIN<sup>1</sup>

*Abstract.* A review of bedrock topographic mapping of Iowa indicates that less than half of the state has been mapped. A map compiled primarily from the published literature of the bedrock configuration of Iowa and segments of the adjacent states of Minnesota, Illinois, Missouri and Nebraska suggests that the bedrock valley pattern parallels modern drainage as hypothesized by Kay and Apfel, in 1928. An unpublished map by Hale (1950) captured major valley trends remarkably well for the limited amount of data available. Studies of the bedrock surface by the United States Geological Survey in cooperation with the Iowa Geological Survey and by the Hydrogeology Research Group at Iowa State University are presently being conducted.

The purpose of this paper is threefold: (1) to summarize the literature and knowledge of the bedrock topography of Iowa since 1928, (2) to compile a map from the published literature and (3) to point to future trends in bedrock topography mapping.

### PREVIOUS WORK

Prior to Kay and Apfel's report in 1928, observations of the occurrence of buried valleys had been made by several investigators. Keyes (1918) suggested the occurrence of a buried valley extending from southeastern Iowa beneath the Des Moines River to Des Moines and then northwestward to Woodbury County. Leverett (1895) and Clem (1910) described pre-glacial valleys of the upper Mississippi River. Gordon (1895) delineated a buried valley segment of the Mississippi River valley in southeast Iowa.

#### *Kay's Contribution*

In 1928, Kay and Apfel published the results of their studies of the pre-Illinoian Pleistocene history of Iowa. The amount of subsurface information was quite limited and led Kay and Apfel to say the following:

"The first ice sheet left a mantle of drift which in many places protected the bedrock surface from further erosion and the deposits of succeeding ice sheets still more deeply covered the rocks. Under such conditions, how is it possible to determine the topography and relief of the bedrock surface? Well data must be relied upon largely, and since such data are not available except in comparatively limited number of places, a detailed topographic map of the bedrock surface cannot be made."

With the extremely scattered data Kay and Apfel felt it necessary to publish a map which might only approximate the shape of the bedrock surface (Figure 1). This map represents the first and last bed-

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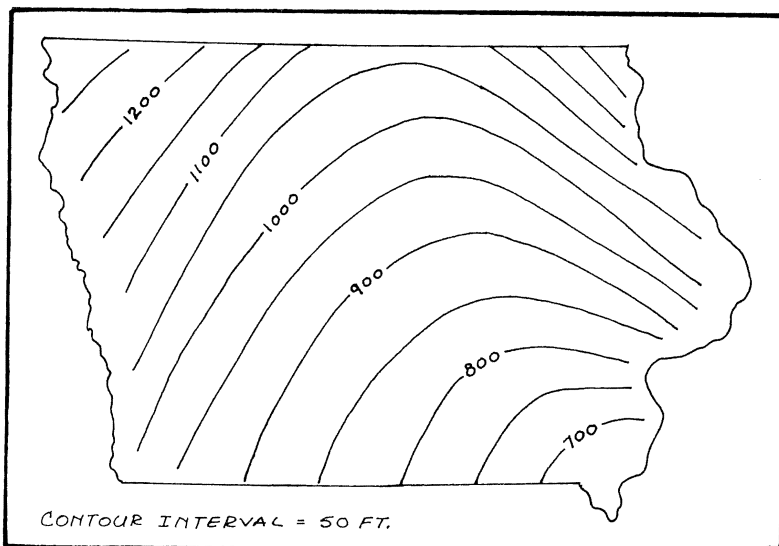


Figure 1. Kay and Apfel's (1928) bedrock configuration map.

rock configuration map of the state of Iowa published by the Iowa Geological Survey (I.G.S.).

Kay and Apfel concluded from their studies that, (1) relief on the bedrock surface did not exceed 300 feet, (2) buried valleys could have steep walls, (3) buried valleys are of limited length and (4) the general pre-glacial drainage of Iowa was much like the present drainage of today.

Between 1928 and 1943, segments of buried valleys were described by various authors in county reports of the geology published in the annual publications of the Iowa Geological Survey and by independent investigators (Wood, 1934; Frye, 1941; MacGraw, 1936) in other publications.

#### *Beveridge's Study*

In 1947, Beveridge studied southeast Iowa and compiled bore hole information which had accumulated in the Iowa Geological Survey files by that time. He presented a map that generally stands unchanged today. Beveridge's map showed two major buried valleys trending northwest-southeast with a large segment of the modern Iowa River presently over this system. Beveridge's study demonstrated that construction of a map from existing well data could produce a reliable contribution.

#### *Horberg's Study*

Horberg and Anderson (1956) published a highly generalized map of the bedrock surface with a contour interval of 250 feet. The map was compiled from information obtained from the various state sur-

veys. The Iowa Geological Survey provided well data and proofed the final map of the bedrock topography of Iowa presented in the paper. Their map is shown in Figure 2 and clearly shows only one major bedrock valley in the state of Iowa.

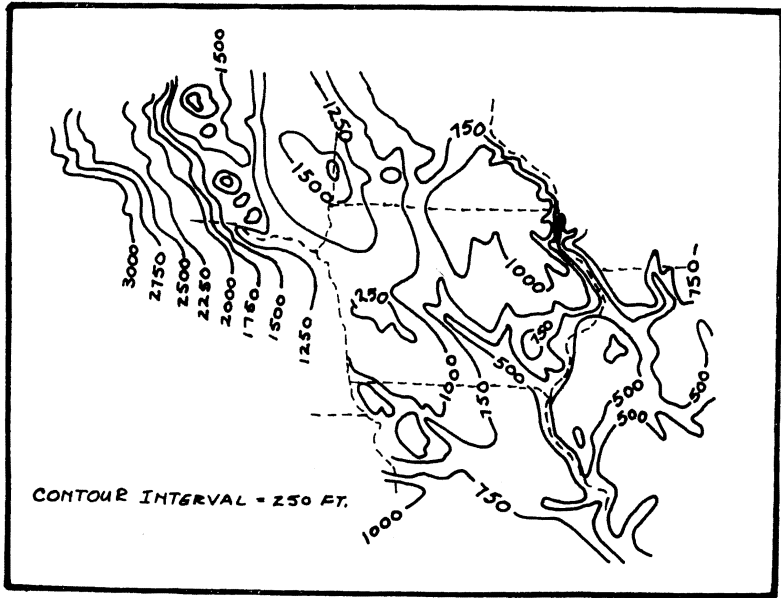


Figure 2. A part of Horberg and Anderson's (1956) bedrock configuration map.

#### *Other Work*

This research on topics selected by students from the two major state universities and particularly from the University of Iowa, cover many counties and generally include a bedrock map of the county. Because of the major differences in the interpretation of the data between the counties these maps could not be included in a single map.

A bedrock map compiled around 1950 by W. Hale of the U. S. Geological Survey has proven to be remarkably accurate considering the limited data available to Hale at the time. The map includes Beveridge's map and therefore shows the two major northwest-southeast valleys, but it also shows a major north-south trending buried valley in western Iowa extending from the southern border of the state in Fremont County to the northern boundary of the state in Emmet County. Other minor tributary streams to the modern Missouri were shown and the upper end of a valley extending from Missouri into Decatur County was shown on the map. This map is on file at the Iowa Geological Survey, Iowa City, Iowa.

#### PRESENT WORK

An active sub-surface investigation program was initiated in 1962

by the United States Geological Groundwater Branch under the direction of Walter Steinhilber. This is a cooperative program with the Iowa Geological Survey and includes several different kinds of studies. Existing well and stream data for a ten-county area in central Iowa was compiled and published as a Water Atlas by Twenter and Coble (1965). Included in this study was a bedrock topographic map and an evaluation of the groundwater potential of the buried valley sand and gravel system. A project of similar nature is being conducted by Coble for an eleven-county area in southeastern Iowa. Robert Hansen of the United States Geological Survey is compiling data for the northeastern part of Iowa. The results of this study will be published as a Water Atlas.

An eleven-county area in south-central Iowa has been extensively drilled under the U.S.G.S.-I.G.S. cooperative program. The first phase of this study was published by Cagle and Steinhilber (1967) as a Water Atlas of Decatur County.

The author has been conducting water resources research projects in central and southwestern Iowa which have included the use of geophysical methods in delineating buried valleys. The areas chosen for study cover approximately 3,500, 350 and 35 squares miles each. These various sized areas were chosen in order that a combined geological and geophysical approach could be tested on groundwater research problems which varied in scope from very local in nature to broad regional studies. In the course of these studies, the bedrock surface of the Nishnabotna River Basin has been mapped by Henkel (1968) and a detailed map of the Ames area has been constructed by Backsen (1963) and Schoell (1967).

#### COMPILATION OF EXISTING DATA

All published bedrock topography maps of Iowa and the surrounding states plus Beveridge's unpublished thesis map were combined in Figure 3.

The map for Minnesota was obtained from a publication by Wright and Ruhe (1965) and is the only bedrock topographic map of Minnesota available. The map of Illinois is from Horberg (1950) and Missouri's map was compiled by Heim and Howe in 1962 and represents the results of an extensive drilling program. The southeastern part of Nebraska was compiled in 1964 by Burchett and Dreszen. No information was available from South Dakota. The data shown in southwestern Iowa is from a report by Hershey et al. (1955) and Cagle and Steinhilber's study of Decatur County. The map of southeastern Iowa is Beveridge's bedrock map and the central Iowa area is from Twenter and Coble's (1965) report.

A simplified view of the map showing drainage lines only is shown in Figure 4. The drainage in South Dakota comes from a map pub-  
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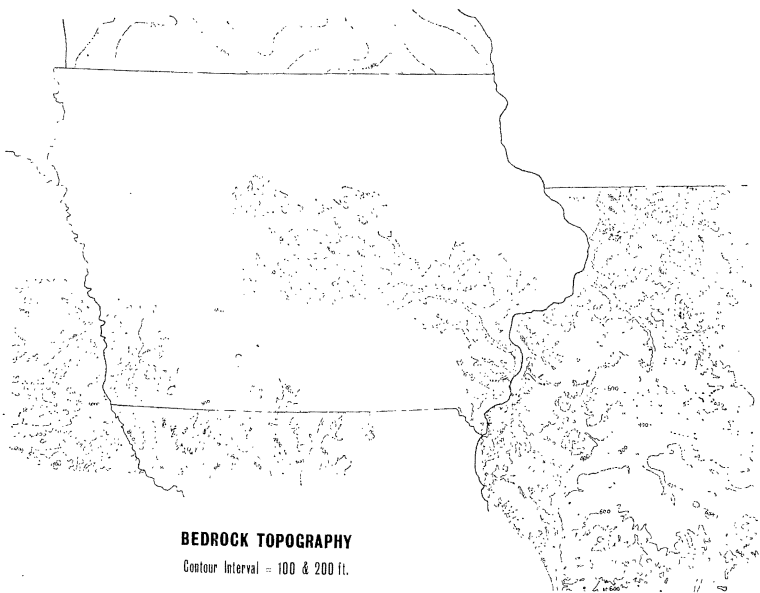


Figure 3. Bedrock configuration map of Iowa and surrounding states compiled from published maps.

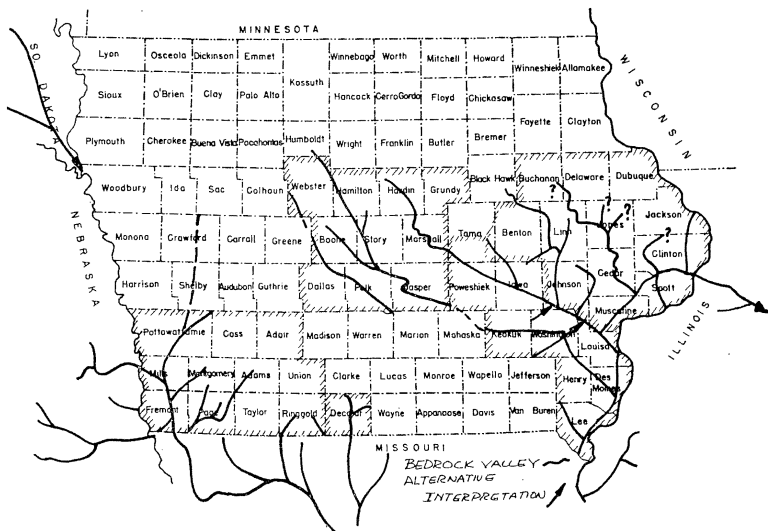


Figure 4. Bedrock valley trends in Iowa and surrounding state compiled from published maps.

lished by Tipton et al. (1965). Recent studies by the South Dakota Geological Survey show that pre-glacial drainage was probably to the northeast. This is substantiated by Walter Steinhilber (personal com-

munication) from an ongoing study of northwestern Iowa well logs. The northeastern portion of Figure 4 comes from a preliminary map constructed by Hansen (personal communication) of the U. S. Geological Survey.

#### SUMMARY

As more detailed information of the bedrock surface is made available, it becomes apparent that the history of the development of this surface is complex. Several periods of bedrock erosion must have occurred. Bedrock valleys of different elevation intersect each other and some tributaries to major valleys occur as hanging valleys. The bedrock topographic map shown in Figure 3 is an improvement over Kay and Apfel's first map; however, it is far from complete.

At the present time there are three groups in Iowa mapping the bedrock surface. They are: (1) the Iowa Geological Survey, (2) the United States Geological Survey Groundwater Branch and (3) The Hydrogeology Research Group at Iowa State University. The U.S.G.S.-I.G.S. method of study consists of compiling existing well data and following with an extensive drilling program; or, compilation of existing well data, field checking and well inventory. The ultimate goal is to evaluate groundwater availability. The I.S.U. Hydrogeology Research Group method consists of compiling existing well data, conducting a well inventory program, geophysical studies, and limited test drilling. The goal of this research effort is to evaluate the geophysical methods as tools in groundwater studies and to investigate the occurrence and movement of groundwater at the basin level.

Kay and Apfel's (1928) conclusions about the bedrock surface were remarkably accurate. The relief on the bedrock surface is approximately 400 feet instead of 300 feet as they postulated, steep walled valleys as they hypothesized have been found, the modern drainage does roughly parallel the bedrock valley system as they stated; however, the buried valleys are of longer length than they speculated.

With this in mind and the additional fact that Beveridge's 1947 map is fairly reliable, it is unfortunate that Hale's map was not published in 1950. Of course, hindsight is always better than foresight, but perhaps a valuable lesson can be learned from this. No matter how limited the data, it should be published in some form so that researchers will have access to it. An incomplete or preliminary map can raise questions and stimulate discussion and perhaps further study.

#### ACKNOWLEDGMENTS

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