

*Iowa Geology*  
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# Iowa Geology 1997

Iowa Department of Natural Resources

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## COVER:

Water circulates through our environment in a process known as the hydrologic cycle. Precipitation from clouds falls to the ground where it may be taken up by plant roots, flow as surface runoff to streams, or slowly percolate deeper into the earth to become groundwater. Water returns as vapor to the atmosphere primarily by evaporation from lakes and streams, and by plant transpiration.

Cover photo by Photographic Services, The University of Iowa



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# GEOLOGY of IOWA

## IOWA'S EARTH HISTORY SHAPED BY ICE, WIND, RIVERS, AND ANCIENT SEAS

JEAN CUTLER PRIOR

Iowa's geologic history lies buried beneath the ground. The deeper, older and least frequently seen portions of this history consist mostly of sedimentary rocks such as sandstone, limestone, dolomite and shale, which are over 3,000 feet thick in places.

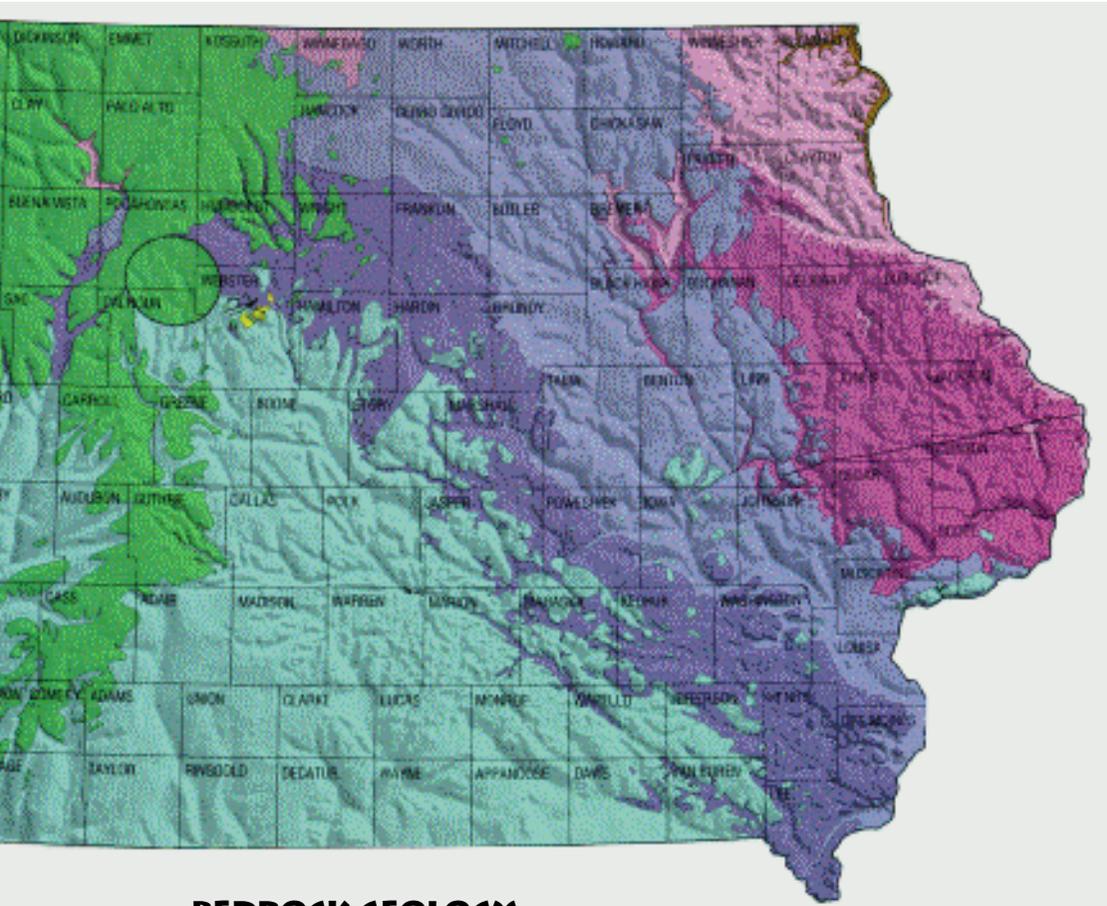
These rocks originated as layers of loose sediment accumulating in shallow seas and along coastal and floodplain environments that occupied Iowa between 74 million years ago (Cretaceous) and 530 million years ago (Cambrian; see map, right). With time, this sediment hardened into rock containing fossil remains of past animal and plant life. Fossil-bearing rocks are found among the abundant outcrops of northeastern Iowa, a topographic region called the Paleozoic Plateau (see map, p. 5). Also, bedrock is occasionally exposed along the state's river valleys, at roadcuts, and in quarries. Elsewhere across the state, the bedrock surface is covered with younger glacial-age materials. As a result, much of our information about Iowa's bedrock

geology comes from rock samples brought up to the land surface during the drilling of wells.

Iowa's bedrock geology map (right) shows rocks from younger periods overlapping older rocks. Most of the rock units are dipping gently to the southwest, and this bedrock structure, coupled with a long history of surface erosion, contributes to the irregular bedrock surface crossing rock units of different ages.

Two small, but noteworthy features interrupt this general bedrock pattern. The first is in the far northwest corner of Iowa, where an ancient ridge of silica-cemented sandstone pokes to the land surface. At 1.6 billion years of age (Precambrian), these scattered outcrops of hard, reddish Sioux Quartzite are the oldest bedrock exposed anywhere in Iowa. Elsewhere beneath the state, the Precambrian rocks are usually igneous and metamorphic types, and they lie deeply buried by the thick sedimentary strata.





## BEDROCK GEOLOGY AND BEDROCK TOPOGRAPHY OF IOWA

GEOLOGIC SYSTEMS  
(MILLION YEARS BEFORE PRESENT)

- |   |                         |   |  |
|---|-------------------------|---|--|
|  | CRETACEOUS (74-102)     |  | ORDOVICIAN (439-505)   |
|  | JURASSIC (160)          |  | CAMBRIAN (505-530)   |
|  | PENNSYLVANIAN (298-320) |  | PRECAMBRIAN (600?-2,910+)  |
|  | MISSISSIPPIAN (325-353) |  | FAULT TRACE  |
|  | DEVONIAN (355-385)      |  | MANSON IMPACT STRUCTURE  |
|  | SILURIAN (415-435)      |   | GAPS IN TIME REPRESENT PERIODS OF EROSION OR LACK OF DEPOSITION. |

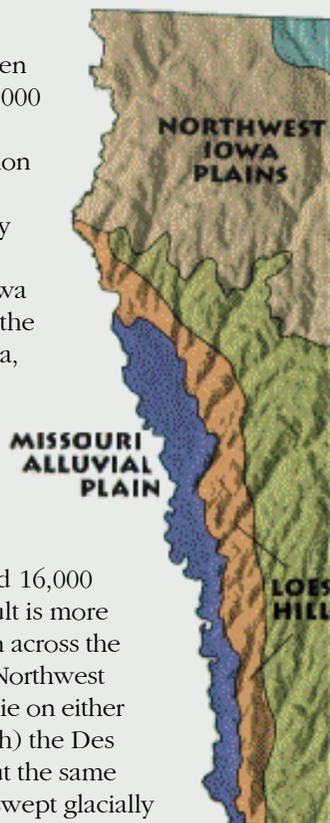
The second irregularity in the bedrock surface is a 23-mile-diameter circular feature known as the Manson Impact Structure, located primarily in Pocahontas and Calhoun counties. Here, a meteor impact 74 million years ago caused massive disruption of the Cretaceous bedrock and older strata beneath, an event so forceful that it brought deeply buried Precambrian granite rebounding to the land surface. The resulting crater and its highly faulted, distorted rocks are covered with over 100 feet of glacial deposits, so are not visible on today's landscape.

The present land surface across Iowa is dominated by loose materials much younger than the bedrock beneath. These materials consist of sediment originating from ice sheets, meltwater streams, and strong winds during a series of glacial events between 2.5 million and 10,000 years ago (Quaternary). This familiar "dirt" consists of pebbly clay, sand, gravel, and abundant silt, which over time have weathered into Iowa's productive loamy soils. These easily eroded "Ice Age" deposits account for the gently rolling appearance of much of the Iowa (and Midwestern) landscape.

Differences observed in the landscapes across Iowa are the result of overlapping glacial advances coupled with the effects of erosion and wind. The last glacier to enter the state formed the Des Moines Lobe region (map, right) between 14,000 and 12,000 years ago. Knobby moraine ridges and numerous wetlands are the direct result of a stagnant, disintegrating ice sheet. The rest of Iowa's land surface is formed of

much older glacial deposits, left between 2.5 million and 500,000 years ago. Across southern Iowa, erosion has carved these deposits into steeply rolling, well-drained terrain (Southern Iowa Drift Plain). Across the northern half of Iowa, however, these same deposits were leveled by intense erosional activity during a peak of glacial cold between 21,000 and 16,000 years ago. The result is more gently rolling terrain across the Iowan Surface and Northwest Iowa Plains, which lie on either side of (and beneath) the Des Moines Lobe. About the same time, strong winds swept glacially ground "rock flour" from river floodplains. This airborne silt was deposited as loess across much of the Iowa landscape, and unusually thick deposits along the Missouri Valley in western Iowa became the steep, picturesque ridges of the Loess Hills.

The flow of rivers is the primary geologic process affecting Iowa's landscape today (note valleys on map, above right). Many valleys, such as the Missouri and Mississippi alluvial plains, are much wider than the rivers within them, which indicates excavation by flood flows during glacial melting. Abundant gravel deposits along the valleys also reflect the power of meltwa-





## LANDFORM REGIONS AND SURFACE TOPOGRAPHY OF IOWA

ter to move coarse material. Even modern floods demonstrate how earth materials are eroded from one portion of a valley, sorted by flowing water, and redeposited downstream. Such episodes of sediment transport by rivers are an on-going part of the geologic evolution of Iowa.

Iowa's earth history continues to be shaped by slow, gradual processes as

well as by brief, intense events. We live on the surface of a deep geologic inheritance, whose materials and processes – past, present, and future – affect the lives of us all. ❖

# THE MIDCONTINENT RIFT

## IOWA'S *Almost* OCEAN . . .

Raymond R. Anderson

One billion years ago, the Earth's crust split across part of the North American continent. This tear or rift, known as the Midcontinent Rift System, extended for 950 miles from what is now Lake Superior to Oklahoma, and was on its way to becoming a full-fledged ocean when the process halted. Rocks deposited during the rift's formation can be seen today surrounding Lake Superior, including basalts along Minnesota's North Shore and sandstones along Wisconsin's Bayfield Peninsula. Across most of Minnesota, Iowa, and part of Kansas, the rift is buried by nearly one-half mile of younger sedimentary rocks. Studies of exposed Lake Superior rocks, combined with gravity, magnetic, and seismic information, have improved our understanding of the Midcontinent Rift, one of the largest and most spectacular geologic features in North America.

Research suggests that stresses, generated by deep heat and pressure differences, pulled at the continent and opened fissures through its crust. Huge volumes of molten rock flowed up to the surface and were deposited in the developing rift valley as dense, dark volcanic rocks, especially basalt and gabbro. As the rift grew and the valley

floor sank, still more volcanic rocks were deposited, ultimately reaching tens of thousands of feet in thickness. When the outpouring of volcanic rock ceased, crustal settling continued, producing a lowland trough into which rivers flowed, and a large lake formed. The lake filled with gravels, sands, and silts, setting the stage for the final dramatic episode in the history of the rift.

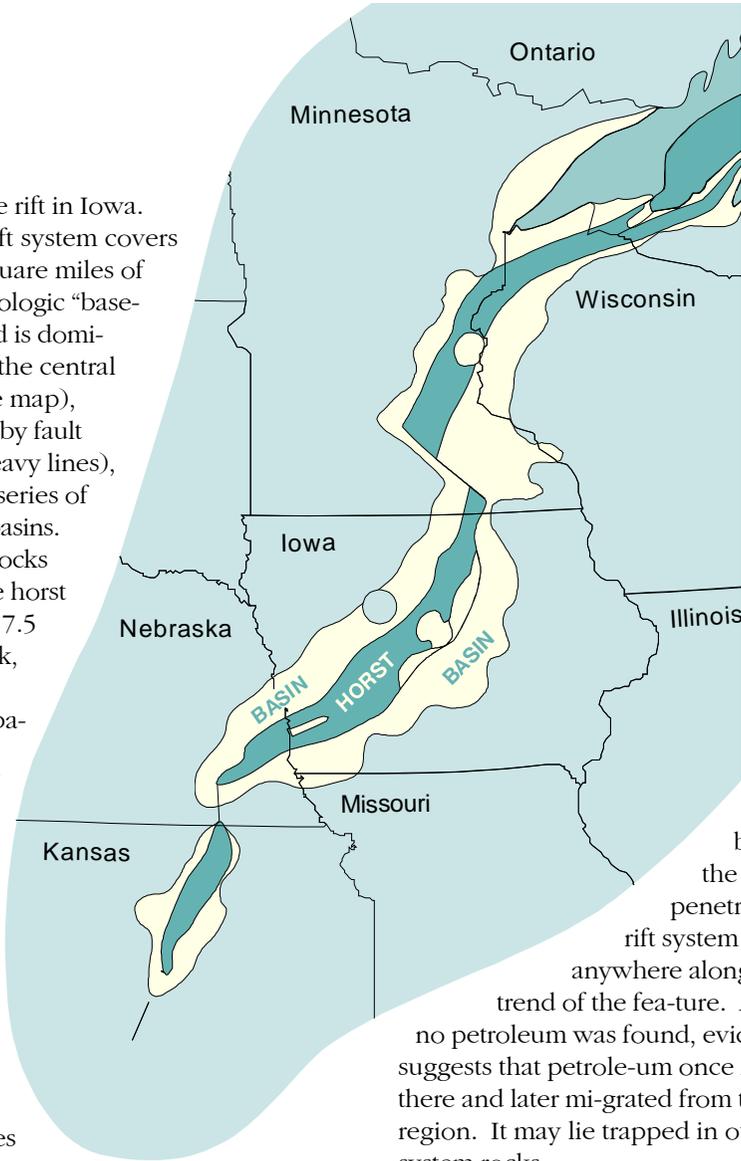
Crustal movement that first pulled the continent apart then reversed and began to push it back together. This compression forced the dense basaltic rocks upward, producing a range of mountains along the axis of the rift. The thick lake deposits were eroded off the steadily uplifting mountain range and were redeposited in a series of deep sedimentary basins along its flanks. In Iowa, the sediments were almost completely removed from the uplifting central block (known as a horst) and the basaltic volcanic rocks were exposed.

Though now deeply buried in Iowa, the dense rocks of the horst and the less-dense sedimentary rocks in the flanking basins produce strongly contrasting gravity signatures. Recent computer modeling of these gravity data, guided by seismic and drill-hole data, has given geologists a better pic-

ture of the rift in Iowa.

The rift system covers 42,000 square miles of Iowa's geologic "base-ment" and is domi-nated by the central horst (see map), bounded by fault zones (heavy lines), and by a series of flanking basins. Volcanic rocks within the horst are up to 7.5 miles thick, while the adjacent ba-sins reach depths of 5.5 to 6.5 miles. These basins contain an astounding 36,000 cubic miles of sedimentary rocks, nearly 3 times all the earth materials above sea level in Iowa!\*

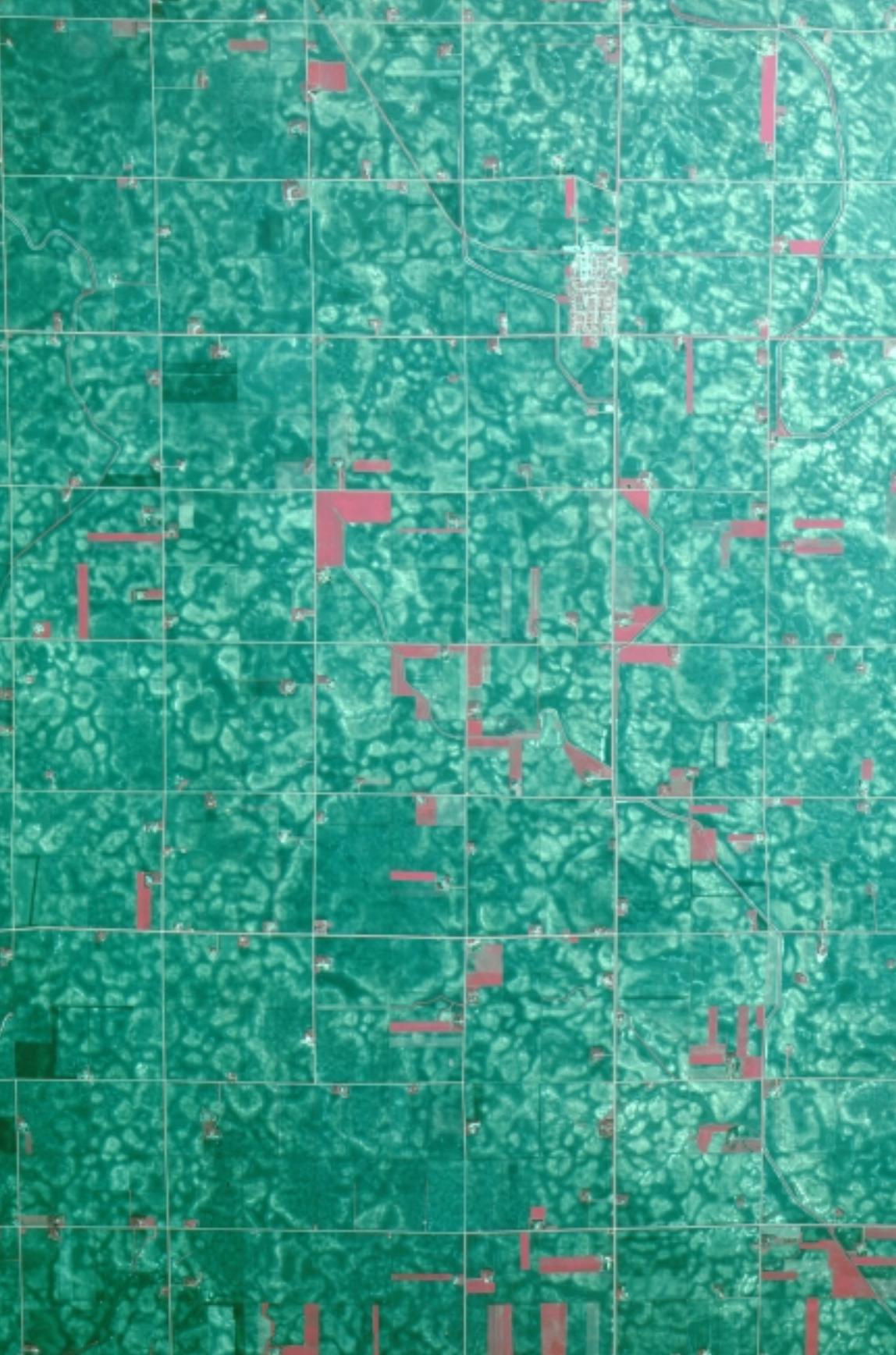
In northern Michigan, oil seeps from the rift's sedimentary rocks, though it has not been found in large enough quantities to be economically attractive. In 1987, Amoco completed drilling of a petroleum test well over 3 miles deep in Carroll County, Iowa. This well penetra-ted over 2.5 miles of the sedimentary rocks in one of the flanking



basins – the deepest penetration of rift system rocks anywhere along the trend of the fea-ture. Although no petrole-um was found, evidence suggests that petrole-um once formed there and later mi-grated from the drilled region. It may lie trapped in other rift system rocks.

Although much is known about the Midcontinent Rift System, many aspects of its history remain to be investigated by future scientists with new data and techniques. ❖

\*Iowa's average elevation is 1200 ft above sea level.



# Linked Depressions on the Des Moines Lobe

E. Arthur Bettis III  
Deborah J. Quade

Iowa's Des Moines Lobe (see map, p. 5) forms the southernmost extent of the Prairie Pothole Region of central North America. Prior to agricultural drainage, this region contained abundant wetlands, many associated with "prairie potholes" or "kettles." Recent geologic studies of the Des Moines Lobe have changed our ideas concerning the origin and hydrology of these wetlands and their relationship to other aspects of the landscape. These new interpretations have valuable application to assessing the potential for contaminants to reach water resources in the region.

Geologists previously thought that Iowa's potholes and kettles formed when chunks of buried glacial ice melted to create isolated, bowl-shaped depressions on the freshly exposed land

surface between 14,000 and 11,500 years ago. These depressions were viewed as being "closed," that is having no drainage outlets. Since then, detailed examination of aerial photographs and subsurface earth materials reveal that many of the Des Moines Lobe's depressions are only partially closed, and they actually join with neighboring depressions to form linked systems.

These are subtle features when looked at on the ground, but when viewed from the air, the linked depression systems stand out as dark web-like patterns (aerial photos left and on p. 10). The links outline the routes of former meltwater channels, and some of these pathways actually connect drainageways that today lie in two separate surface drainage basins. The darker tones of the linked depression systems indicate greater soil moisture and the presence of groundwater near the surface. The contrasting lighter tones are better-drained, slightly higher portions of the land surface.

**Network of linked depressions** (photo left): This high-altitude color-infrared photo shows a dark-toned webbed pattern across Kossuth County near the town of Fenton (upper right) that reveals routes taken by glacial meltwater through a disintegrating ice sheet about 12,000 years ago. These linkages often contain sand and gravel, which can serve as pathways for contaminants to enter groundwater and surface-water resources.

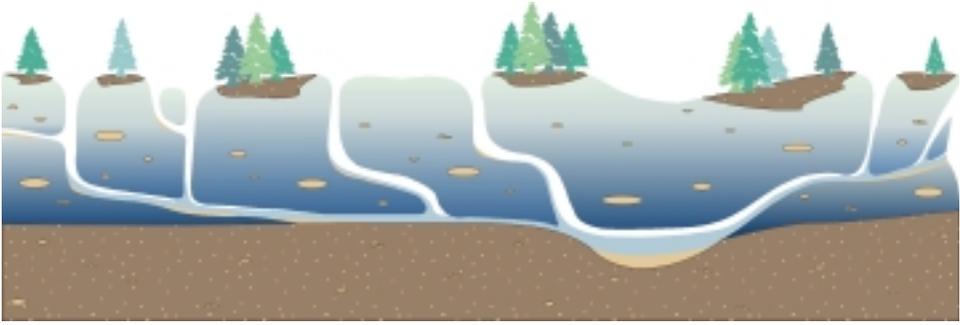
The linked-depressions originated as part of a glacial karst system that developed in a stagnant glacier loaded with sediment (see model, right). As the glacier's surface melts, water enters cracks in the ice and begins to widen and deepen them by melting. These eventually form drainage tunnels within the non-moving glacier that join with other drainageways near the base of the ice. As water flows through the system, sediment within the ice also enters the tunnels. In time, fine-grained silt and clay are flushed from the tunnels, but more coarse sand and gravel settle along their routes. When ice melting is

**Meltwater tunnels in a stagnant glacier** (diagram right): Water drains into cracks in immobile glacial ice laden with soil material and enlarges them into a series of interconnected tunnels. As meltwater moves sediment along these routes, sand and gravel are concentrated. Today these materials link many shallow depressions on the land surface.

**Chain of prairie potholes** (below): This low-altitude photo shows a linked depression system consisting of several shallow basins joined by low saddle-like areas. Darker vegetation and more soil moisture mark the low outlets between the basins. Doolittle Prairie State Preserve, Story County.

Gary Hightshoe, Iowa State University





complete, the former branching passages, with their permeable sand and gravel deposits, are preserved as linked systems set into and interfingering with other surrounding glacial materials.

Two characteristics are essential to development of glacial karst systems in modern glaciers, and so also must have characterized the Des Moines Lobe glacier: 1) the ice sheet must be stagnant – no longer moving, for the system of sinkholes and tunnels to form and remain open; and 2) the surface of the glacier must be covered by enough sediment to prevent the ice from melting too quickly. Such debris can be carried up to the ice surface by compression and shearing within the glacier or carried onto the surface by wind.

An important ramification of the pattern of glaciation of the Des Moines Lobe is the influence of the resulting linked depression system on groundwater movement and vulnerability in the region today. The few field studies that have been undertaken so far suggest the sand and gravel deposits that accumulated in the former tunnels form a connected network that hydrologically

links the semi-closed depressions with existing drainage-ways. This means that rather than the sluggish shallow groundwater system previously envisioned for large parts of the Des Moines Lobe, the linked depressions actually act as an extensive system of “natural drainage tiles” joining poorly drained upland areas with surface waters. This linkage provides a previously unrecognized pathway for dissolved contaminants, such as crop nutrients, to enter the region’s streams, rivers, and lakes. More research is needed to further document the extent of the linked-depression sand and gravels, as well as to determine the direction, speed, and seasonal variability of water flow through these features. This information will aid the development of scientifically sound agricultural management practices designed to protect Iowa’s groundwater and surface-water resources in the future. ❖

# *Iowa Water: A century of Study behind a d*



*“Iowa’s Groundwater Protection Act is one of the most important environmental laws ever passed by a state. . . . Unlike most laws aimed at helping the environment, this one employed more demonstration and education than it did regulation. A major premise within the Act is that most people would do the right thing for the environment if they knew what the right thing was, and could be shown how to do it in an affordable and practical manner. . . . The Act is extraordinarily broad in its coverage. From landfills to sinkholes, farm fields to gas stations, virtually anything that would have an impact on groundwater quality is addressed in the Act. . . . The Groundwater Protection Act stepped up the need for partnerships in Iowa to address not only groundwater, but environmental issues in general.”*

—Larry J. Wilson, Director  
Iowa Department of Natural Resources  
*Iowa Conservationist*, Jan/Feb. 1997



This statement highlights several remarkable aspects of the 1987 Iowa Groundwater Protection Act as we commemorate the tenth anniversary of its passage. The legislation was a response to growing public concern about groundwater quality as manufactured chemicals and wastes were detected in the state’s drinking water supplies. Because water resources were shown to be vulnerable to the effects of human activity at the land’s surface, more attention became focused on the character of Iowa’s intervening earth materials.

Groundwater is stored in layers of soil and rock beneath the land surface. The vulnerability of these aquifers to contamination depends on their depth below the land surface and the porosity of their overlying materials.

For over a century, the Geological Survey Bureau has studied Iowa’s groundwater resources, seeking to continually improve our knowledge of the geological materials affecting them. By the late 1960’s, questions arose about the degradation of these resources, especially the effects of landfills and the increased

## *Decade of Focus*

*“Prudent development, management, and conservation of Iowa’s geological and other natural resources are vital elements to the state’s economic stability and growth.”*

—Donald L. Koch, State Geologist  
*Iowa Geology*, 1986

applications of nutrients, pesticides, and herbicides to the land. In response, efforts were intensified to monitor the quality of water supplies in specific geologic settings and to examine the vulnerability of Iowa’s aquifers statewide. The contribution of Geological Survey Bureau geologists to this activity and to the historic legislation that followed is significant.

A glance through past issues of *Iowa Geology* highlights the role of geology and the Bureau in the evolution of this legislation. Topics included sinkholes and groundwater (1982); contamination of carbonate aquifers, and underground leakage of oil and gasoline (1983); abandoned water wells (1984); alluvial aquifers (1985); agricultural chemicals and groundwater quality (1986); groundwater policy and geology (1987); agricultural drainage wells (1988); water quality in Floyd and Mitchell counties (1989); the statewide sampling of rural water wells (1990); the groundwater vulnerability map of Iowa (1991); and water quality and agriculture (1992). This sampling of articles by our staff highlights the enormous volume of information gathering that was underway prior to and following enactment of the legislation.

Prominent among the authors of these

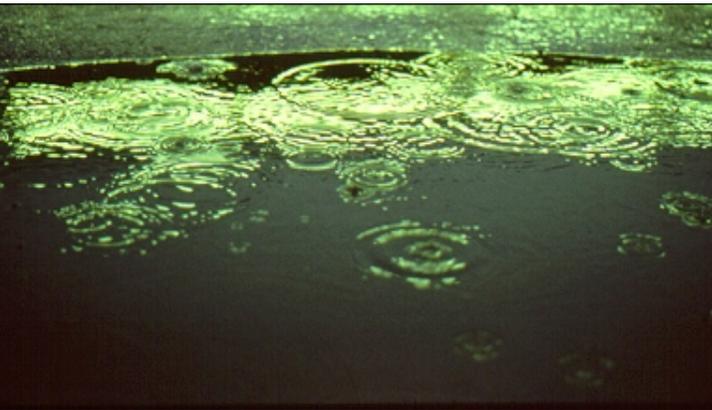
articles are George Hallberg and Bernard Hoyer, who were leaders not only of our Bureau’s work, but were also state and national leaders of groundwater research, public education, and policy development. The Iowa Groundwater Protection Strategy, which was the precursor to the legislation, was authored by Bernard Hoyer. He also has led the State’s use of geographic information system technology (GIS) to combine and map various layers of soil, geologic, and hydrologic information for application to resource management and environmental protection. George Hallberg knit together cooperative and creative partnerships involving government, education, and public interest groups, demonstrating that changes in land management could both improve the environment and profit individual farm families. He incorporated geology into the broader arena of environmental and natural resource issues and gave the Iowa experience a national voice.

Iowa has been a national leader in defining water quality problems, and a leader in resolving them. The tenth anniversary of the Groundwater Protection Act is an opportunity to acknowledge a long and continuing tradition of geological research and interpretation. ♦

# Water forms

*Jean Cutler Prior*

With the puddling of raindrops, water gathers for its innumerable journeys throughout Iowa. As it moves along, water may become part of a kettlehole, a marsh, a farm pond, a river, a flood, an aquifer, a fen, a cave, a spring, or a waterfall. In all of its aspects, water adds fluid beauty to the landscape. Both above and below ground, water is an ever-present geologic force as well as a vital natural resource, and the focus of environmental protection and natural resource issues.



Photographic Services, The University of Iowa

Thousands of years ago, water in its crystalline form of ice carried the raw building materials of much of Iowa's present landscape into the state within the grasp of massive glaciers. In turn, the melting of these glaciers laid the course of most rivers seen on

today's maps of Iowa. Even the state's bedrock foundation, whose picturesque ledges and bluffs outcrop along some of these river valleys, originated as layers of sediment settling out of water on ancient sea floors, along coastlines, and in stream channels millions of years ago.

Iowa's past geological environments supplied the earth materials that contain our present surface and groundwater resources. These materials shape the forms that water takes on the land surface, and they also determine how fast and how far water moves underground and where it can be tapped for wells. They affect groundwater's natural quality, as well as its vulnerability to contamination introduced from the land surface.





*This shallow **marsh**, with its lush aquatic vegetation, lies along the Iowa River floodplain at Otter Creek Marsh State Wildlife Refuge in Tama County. The sluggish backwaters persist in broadly curved lowland sloughs that were scoured by earlier meander channels of the river. They tend to fill slowly with silt and clay, and are periodically disturbed by returning floodwaters.*

Roger A. Hill

Roger A. Hill

*The water in these poorly drained **kettleholes** accumulates from rainfall and snowmelt as well as groundwater seepage. The wetland features are a legacy of melting glacial ice 13,000 to 11,000 years ago. (Below) Freda Haffner Kettlehole State Preserve, Dickinson County. (Right) Bjorkboda Marsh, Hamilton County.*



Dick Baker



Lowell Washburn

*This historic **milldam** was constructed on the Winnebago River at Fertile, in Worth County, to put the river's flow to work. The dam raised the river level so the force of falling water could be used to turn wheels and stones within the mill to grind grain into flour.*

*A berm built across a hillslope captures the runoff from rainfall, storing it for livestock use. **Farm ponds** are particularly abundant in the southern half of Iowa where the rolling topography favors their construction, and the lack of abundant groundwater resources makes these impoundments a valuable water supply. Story County.*



Roger A. Hill



Lynette Seigley

*The consistent flow of groundwater from this column of concrete and steel at Osage Spring Municipal Park (Mitchell County), resembles a **flowing artesian well**. The site has yielded a year-round water supply for wildlife, livestock, and people for at least 100 years. Upwelling of groundwater can occur where a water source, confined under the pressure by overlying impermeable rock, finds a natural opening to the land surface or is tapped by a drilled well. This groundwater source contains noticeable amounts of dissolved iron (note rust-colored buildup on the column) and hydrogen-sulfide gas.*

Greg Ludwigson



Carol Thompson

**Springs** occur where groundwater flows from rock or soil material to the land surface. This spring tumbles from crevice openings in dolomite near the entrance to Spook Cave in Clayton County. In northeastern Iowa, springs often flow near the base of steep-sided valleys, where water moving downward through permeable limestone or dolomite encounters less-permeable shale and moves laterally, finding an opening to the land surface along a valley wall.

Michael Bounk



A **river** is a volume of water flowing along a well-defined channel toward some larger (and lower) body of water. Also, in a river channel the local groundwater table is visible as surface water. Springs and seeps are significant contributors to northeast Iowa rivers. Along the Upper Iowa River in Winneshiek County, bluffs of dolomite overlook the channel and provide scenic views around each bend.

**Caverns** form as groundwater moves through subterranean crevices in limestone over long periods of geologic time. In this scenic chamber, water seeps in along the ceiling and slowly adds more calcium carbonate (lime) to the glistening formations that decorate the cavern walls. Groundwater continues to flow by gravity along the cavern floor and down through other openings in the limestone formation. Cold Water Cave, Winneshiek County.



During low-flow conditions along a river channel, it is possible to see the **sediments carried by water**. These rounded cobbles and boulders are part of the load that is moved during high flood flows along the Skunk River in Story County. Smaller grains of sand, silt and clay can travel farther and gradually settle as the flow volume decreases. The capacity of flowing water to erode and deposit earth materials makes it the most effective geological process shaping the Iowa landscape today.



The **reservoir** of water in Lake Macbride (right) is separated from the Iowa River (left) by a dam near the center of this aerial view. Shown during flood, the muddy Iowa River is moving a greater load of suspended silt and clay compared to the clearer water in Lake Macbride. This reflects the greater land area draining to the Iowa River (its watershed) and the effects of runoff from cultivated land.

Photographic Services, The University of Iowa

A **flood** occurs when a river overflows its banks and spreads out to cover land not normally under water. When these Cedar River floodwaters over Seminole Valley Park in Cedar Rapids recede, cleanup crews will find deposits of sand and silt as well as scoured out areas.



Peter M. Schulmeyer, USGS



Carol Thompson

A **fen** is a spongy mound of peat fed by mineralized groundwater and supporting a unique wetland flora. In Iowa, these “mound springs” are typically found on hillsides. Note the rust color as groundwater flow comes in contact with the air, causing dissolved iron to oxidize. Silver Lake Fen State Preserve, Dickinson County.

A **waterfall** is an abrupt step down along a stream’s channel, usually caused as the water drops vertically over an outcropping ledge of resistant bedrock onto softer, more easily eroded rock. A series of five waterfalls breaks the flow of this Story County brook before it reaches the Skunk River.



Roger A. Hill

# McGregor 's 19<sup>th</sup> Century Refrigerators

Robert M. McKay



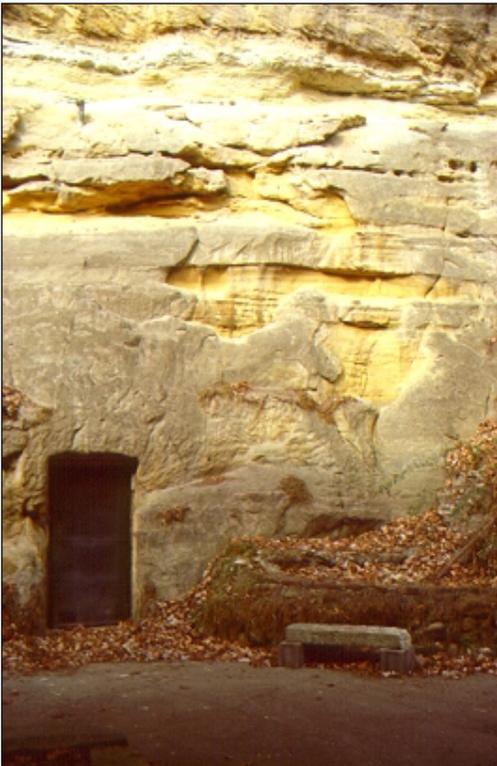
Robert McKay

The McGregor area of Clayton County in northeastern Iowa is known for its rugged bluffs along the scenic Mississippi Valley and its well-preserved 19th century architecture. In the days before refrigeration, the town's early residents made innovative use of the bedrock

geology composing these bluffs.

The 400-foot descent along the main highway into McGregor passes through numerous rock outcroppings of 450 to 550 million-year-old limestones and sandstones (Ordovician and Cambrian) to the town's flat valley floor. Of particular interest to residents during the steamboat era were two prominent sandstone layers that outcropped in the valley, rock units now referred to as the St Peter and Jordan formations. Residents found that the unusually soft, uniform "sand rock" was easily excavated with hand tools, and that "caves" or "cellars" carved into these sandstones provided ideal space and cool temperatures for refrigeration and storage of river ice.

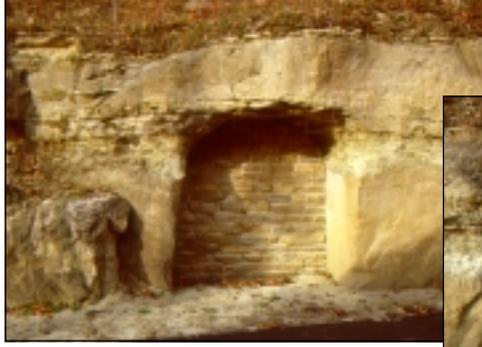
Most of the cellars were carved into the Jordan Sandstone along the northern end of Main Street, where hotels, taverns, and apartment buildings backed into small courtyards framed by the nearly vertical sandstone bluffs. The cellars varied in size and were entered via arched doorways (note photos).



Pat Lohmann



Robert McKay



Pat Lohmann



*These entryways were hewn into bluffs of Jordan Sandstone at McGregor, Iowa, and opened into caves excavated for cold storage. In addition to brewery cellars (photos, upper right), 20 tons of ice were once stored in the cave at left (former site of the popular “Mississippi House” hotel and tavern), and the brick-lined cave at center left functioned as a cistern for water storage.*

Smaller caves, typically associated with taverns and apartments, were about 20 feet deep and housed items ranging from food to ammunition. One building even had two second-story caves (photo, upper left), with one connected to the balcony by a catwalk. Larger, multi-room caverns were excavated for business interests, especially breweries. For example, the once-flourishing J. L. Hagensick Brewery, built in 1845 between McGregor and Marquette, had four cellars cut into the Jordan Sandstone (two shown, upper right) where most of its 10,000 barrels of annual production were cooled and aged.

Two miles south of town, the St. Peter Sandstone was also used for cold storage. The present White Springs Supper Club was once site of the Klein

Brewery, built in 1857. Three arched-ceiling caverns, 30 feet below ground level and each measuring 25 by 60 feet by 7 feet high, held casks of aging lager beer. The casks were slid down a steep stairway into the caverns, then floated in a spring-fed, water-filled trough to their storage locations.

Most of these historic caverns are now inaccessible because of the deteriorating effects of time and weather. As one strolls through McGregor, however, several sandstone entryways remain visible, reminding us of the interesting and historic influence of local geology on the lives of the people who lived there. ❖

# Lacey-Keosauqua State Park

## Iowa's "Big Bend" Country

Robert M. McKay



**T**ravel south along Iowa Hwy. 1 through central Van Buren County and you'll sense a real difference in the landscape as you gradually descend a series of broad terraces into Iowa's "Big Bend" country. Level lowlands spread out ahead, ending against a forested bluff in the far distance. The sweeping bluff outlines a great bend in the Des Moines River and the beginning of Lacey-Keosauqua State Park. The park itself overlooks nearly 2 miles of the unusually large, 13-mile long loop in the Des Moines River, a major diversion from its dominantly southeastern course to the Mississippi River. This "Big Bend" segment of the river is steeped in both geologic and human history, for its past reaches back to the sandy floors of ancient seas and to the splash of pioneer wagons fording the river.

From the historic village of Keosauqua, visitors cross a vintage 1939 steel bridge that leads to the east entrance of the sprawling 1653-acre park. The view upstream is of the park's extensive forest, mantling a steep bluff carved by the river's flow. Beyond this bluff the park extends south, away from the river, and rises into level-topped uplands by way of numerous narrow ridges and steep ravines that drain to the Des Moines River. These dissected woodland habitats along a major river corridor make Lacey-Keosauqua one of Iowa's premiere bird-watching localities (see inset, p. 27).

It's uncertain how long the Des



***Purdum Cemetery overlook*** (above): *The view from this gentle rise is southwesterly, across broad lowlands of the Des Moines River's "Big Bend," and toward Ely's Ford and the wooded bluffs of Lacey-Keosauqua State Park (see map opposite).*

***Topographic map view*** (opposite): *Sharp contrasts in terrain at Lacey-Keosauqua State Park appear on the Keosauqua Quadrangle (U.S. Geological Survey, 1968). The level land inside the river's bend is underlain by sandy river deposits. The outside of the bend is cutting into much older glacial and bedrock deposits, and the result is rougher terrain.*



**Ledges of limestone** (left) still bear the vertical drill holes where splitting wedges and sledge hammers were used by Civilian Conservation Corps (CCC) crews as they hand-quarried blocks for building stone structures within the park.

**A beautiful stone bridge** (right) constructed by the CCC spans Wesley Creek. The light-gray rock was quarried from natural exposures of 325 million-year-old limestone within the park.

Moines River has occupied this valley. The river's first routes probably originated during melting of glaciers that covered southern Iowa over 500,000 years ago. The appearance of the present valley was affected by more recent meltwaters from glaciers in north-central Iowa between 30,000 and 12,000 years ago, with final landscape touch-ups during the past 10,000 years. As today's visitors hike the park's roads and trails, the geologic history is seen in earth materials along the way. The narrow ridge tops along the road and campground are mantled with a thin cap of loess, a yellowish-brown silt deposited by the wind 20,000 to 12,000 years ago. Down-slope from the ridge-tops, the

ravines and small tributaries are carved into the older glacial deposits mentioned earlier, and these are best seen in scattered exposures along gullies and trail-cuts. Stones, referred to as "glacial erratics," are eroded from the glacial deposits, and these cobbles dominate the rocks found in the upper parts of tributary streams. One such boulder-sized erratic in the western part of the park forms a monument dedicated to Major John Fletcher Lacey, honoring his work in conservation earlier this century.

Below the glacial deposits, the sides of the river valley steepen considerably, as they are cut into bedrock which is much more resistant to erosion. Bedrock outcrops are seen along the lower reaches of Wesley, Thatcher, and Ely's creeks as well as along the Des Moines River. The interbedded sandstone, limestone, and dolomite are about 325 million years old (Mississippian age; see bedrock geology map, p. 3).



The bedrock formations seen by most visitors include the Keosauqua Sandstone and the overlying Pella Limestone which form large cutbank outcrops in the area where the main park road crosses the creeks. The Keosauqua Sandstone, referred to as such in 1895 by C.H. Gordon in his report on the geology of Van Buren County, forms the largest outcrops in the park. This tan sandstone, up to twenty-five feet thick, displays well-preserved cross-stratification, a feature that reflects its origin as large ripples on the sandy floor of an ancient shallow sea. Hikers along the main river trail cross this rock formation in several places, and picnickers at Ely's Ford, an historic river-

crossing, can walk along a cool sandstone-lined glen upstream of the footbridge. Canoeists and boaters see the best exposures of Keosauqua Sandstone along the base of the big bend bluff, where the swift current has carved vertical rock walls. A still older brown dolomite, belonging to the St. Louis Formation, also is exposed here but only during low-water stages.

While the Keosauqua Sandstone may be the most obvious rock formation in

***This stone picnic shelter*** (below) overlooking the Des Moines River was built of brown dolomite quarried west of the park.

Park photos by Robert McKay





*Summer Tanager*

## ***Birding at Lacey-Keosauqua by Carol A. Thompson***

In addition to its geology and historical aspects, Lacey-Keosauqua State Park and the surrounding area is noted as one of the premier birding spots in the state. Because of its extensive woodlands, many birds that are rare elsewhere in the state are relatively easy to find here. The park list includes 160 species. Rare nesting birds include Pileated Woodpecker, Acadian Flycatcher, White-eyed Vireo, Northern Parula, Cerulean, Worm-eating, Kentucky, Hooded, and Yellow-throated warblers, Louisiana Waterthrush and Summer Tanager. Henslow's Sparrow, Short-eared owl, Northern Mockingbird, and Northern Harrier can often be seen in the grasslands west of the park. The best birding is often in the area of Ely's Ford, along the trail which parallels the small creek to the west, and in the campground area.

Bird photos by Carol Thompson



*Hooded Warbler*



*Scarlet Tanager*

the park, park-goers will also be drawn to the beautiful historic stone structures originally constructed by Civilian Conservation Corps (CCC) work crews during the Depression Era. Two distinct types of stone were used, the brown dolomite of the St. Louis Formation, taken from quarries west of the park along Chequest Creek, and the younger light-gray limestone of the Pella Formation quarried within the park from ledges exposed along Wesley Creek. The picnic shelters and park residence are built of the brown dolomite, while the bridges, stone lodge and lake bath house are constructed from the lighter-colored gray limestone. This light-gray to white, fine-grained limestone is the product of a clear-water shallow sea, and is well-suited to dimensioning for building stone. The limestone was

extracted from several Keosauqua area quarries during the 1800's and early 1900's. The historic CCC quarry along Wesley Creek within the park, while somewhat overgrown, is still accessible by foot, and while walking along the sun-drenched quarry ledges examining the air-drilled holes, one can easily imagine industrious crews of young men landing their sledges on the splitting pins.

Lacey-Keosauqua State Park is an example of conservation foresight, historic construction projects, and southeast Iowa geologic history. It is a jewel in the state park system and well worth a trip into Iowa's "Big Bend" country. ❖

# *A View of Underground Water*

*Water takes many recognizable forms on the land surface. Its movement, behavior, and uses are fairly familiar. As water seeps below the land surface, however, it becomes a more mysterious subject. Though the ground generally is regarded as being “solid,” underground water pumped by wells flows through the kitchen faucets of over 80 percent of Iowa homes. It is a myth that this water is stored in large underground rivers and lakes.*

*It is the openings within earth materials – their abundance, size and interconnectedness – that determine what happens to water below ground. In sand, gravel or sandstone, spaces between the grains store groundwater. In limestone and dolomite, these openings are actually fractures, from hairline to cavern-size. Groundwater can move freely through all these materials. Clay and shale have the opposite effect. The tiny pores in these tightly packed materials may hold water, but it cannot easily pass through. Water movement underground is further affected by the slope of water-bearing earth materials and whether they are confined by dense overlying materials or are under the influence of a nearby pumping well.*

*To find Iowa’s vital but concealed underground water resources, and safeguard their drinking quality, we need to know how water-bearing materials (called aquifers) are distributed beneath the state – their depth, thickness, extent and the details of their composition as well as the earth materials above and below them. Ongoing research to improve the accuracy of this geologic information will give Iowans the information they need to locate wells and protect water supplies from contamination now and in years to come.*

*Jean Cutler Prior*  
*Editor*



Roger A. Hill