

Iowa Geology 1992

Centennial Edition
1892-1992

Iowa Department of Natural Resources
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Donald L. Koch
State Geologist and Bureau Chief

Cover:

This 1905 Geological Map of Iowa was a remarkably detailed presentation of the state's geology as it was known at that time.

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Printed on Recycled Paper

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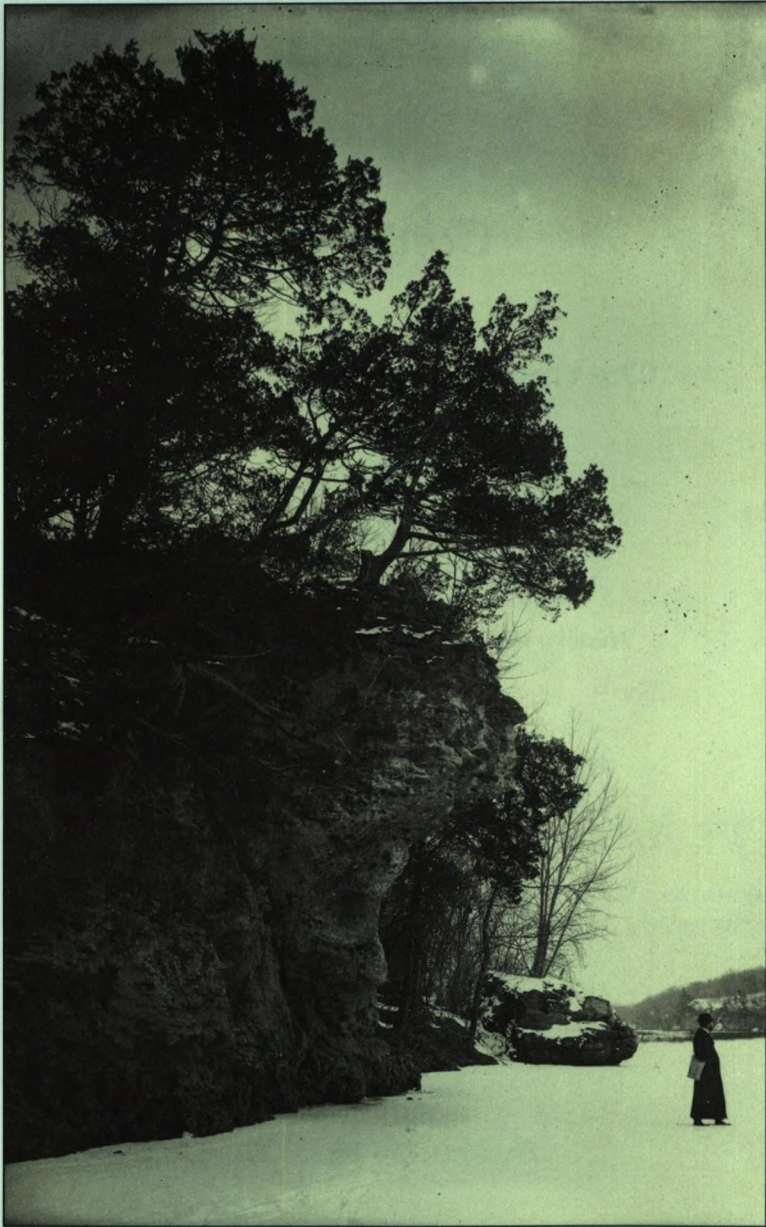
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Calvin Collection, University of Iowa

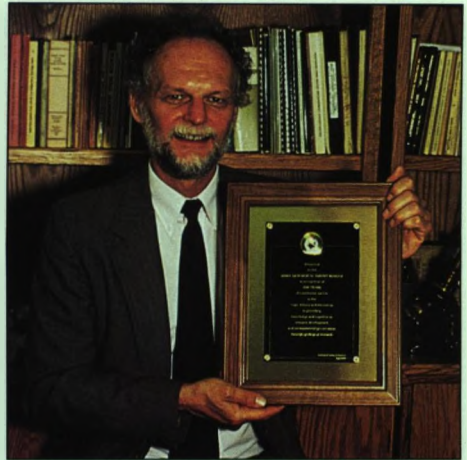
A turn-of-the-century geologist scans the valley of the frozen Cedar River, framed by cliffs of Silurian dolomite. This area is now part of Palisades-Kepler State Park in Linn County.

The Geological Survey in Iowa

100 Years of Research and Service

Iowa's geologic past has left a legacy of fossils, minerals, layers of rock, glacial deposits, river valleys, and groundwater. The exploration, settlement, economic development, and environmental issues of this state are literally rooted in these geologic features and materials. The year 1992 marks one-hundred years of continuous state support of a Geological Survey in Iowa. This milestone provides an opportunity to emphasize the importance of geological knowledge in the functioning of our society.

This centennial issue of Iowa Geology examines the historic impact of this state's geology on its people. It looks at the foundations of our present relationship with the earth we live on. It looks at some of the people who led the way to our present understanding of Iowa's geology. It demonstrates



Donald L. Koch, State Geologist and Chief of the Geological Survey Bureau since 1980, holds a centennial commemorative plaque presented by the Geological Society of America.

the long-term, continuing need to locate resources, cope with problems, and plan for the future in accordance with the geologic conditions and processes that Iowa's land and water present to its inhabitants. The Department of Natural Resources' Geological Survey Bureau has a special role in linking science and public policy, in disseminating to a wide audience what geologists know about the state's vital and delicately balanced environmental relationships, and through basic research to continue building a trustworthy base of geological information for application to Iowa's future.

History of Geological Investigations

The search for mineral wealth in the Upper Mississippi Valley first brought Iowa to geological notice and resulted in one of the country's most remarkable volumes of geological reconnaissance, David Dale Owen's "Report of a Geological Survey of Wisconsin, Iowa, and Minnesota" in 1852. This effort was followed by two short-term, but important forerunners of the present Survey that were directed by James Hall of New York and Charles A. White, M.D. Their reconnaissance work, published in 1858 and 1870,

contained the state's first regional correlations of rock strata here with those in the eastern United States and Europe. These early volumes established a preliminary framework for the more comprehensive geological studies which were to follow.

Beginning in 1892, when the present Geological Survey was established, Samuel Calvin and his colleagues began to examine Iowa's geology county by county. Their readable accounts reflect the prevailing broad approach to natural science, as they are

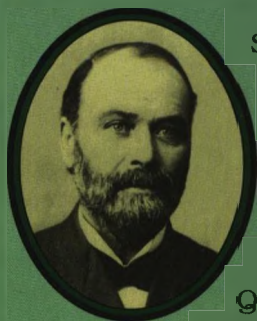


Calvin Collection. University of Iowa

Samuel Calvin, State Geologist from 1892-1904 and 1906-1911, examines a large glacial boulder in Buchanan County.

SAMUEL CALVIN, PIONEERING GEOLOGIST

Brian J. Witzke



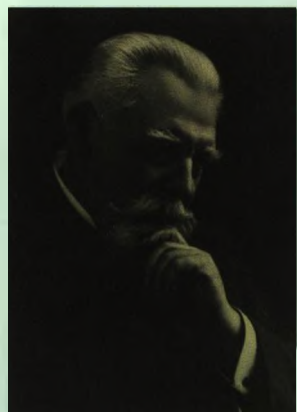
Samuel Calvin's legacy of accomplishments has influenced generations of Iowa geologists. Even today, he is regarded as Iowa's premier geologist among the many scientists to have worked in our fine state. Born in Scotland in 1840, Calvin's family moved to eastern Iowa in 1854. His talents in science, teaching, and administration led him to service as a school teacher in Quasqueton, an instructor of mathematics at Lenox College in Hopkinton, a school principal in Dubuque, and Delaware County Superintendent. He also enlisted as a volunteer in an Iowa regiment during the Civil War.

Calvin was appointed State Geologist for the fledgling Iowa Geological Survey in 1892. It was under his able leadership that the newly commissioned Survey undertook detailed county-by-county studies of the bedrock and surficial geology and evaluated their water and mineral resources. These reports remain an indispensable source of geologic information to this day. Calvin was also an active field geologist whose astute powers of geologic observation were widely respected. He personally wrote 12 of the Survey's detailed county reports, as well as dozens of other articles on natural resources, bedrock stratigraphy, paleontology, and Pleistocene geology.

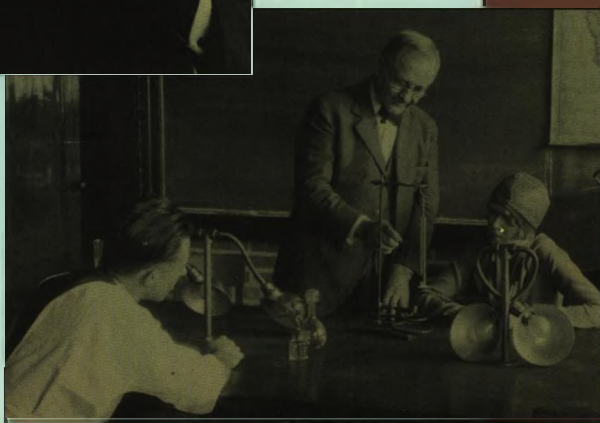
His depth of scientific knowledge made him eminently qualified to be Chairman of Natural History at the University of Iowa, a position he assumed in 1874. This department subsequently expanded into the departments of Geology, Botany, and Zoology under his guidance. Calvin also served as editor of the *American Geologist*, president of the Geological Society of America and the Iowa Academy of Science, and served on federal panels related to fuels and conservation of natural resources.

Calvin was recognized by the Iowa Academy of Science (1911) for having given shape, proportion, and character to the work of the Geological Survey and for having effectively combined its scientific and economic aspects. His colleagues found in his example of service to the state, to education, and to science "the purest inspiration for future effort and devotion."

supplemented with information on prairie and forest flora, meteorological records, and archaeological remains. Calvin, Thomas Macbride, and Bohumil Shimek, three of Iowa's most influential and inspiring scientists, were equally at home in several fields of natural history. The tradition of service and science which they established remains an important theme of the Survey's present and future operations.



Thomas Macbride, who mapped the glacial geology of 17 counties, also served as President of the Univ. of Iowa from 1914-1916.



photos from Special Collections, University of Iowa Library

Bohumil Shimek, known for his work on Iowa's loess deposits, works with plant ecology students (ca. 1925).

THE LEGACY OF THOMAS MACBRIDE AND BOHUMIL SHIMEK

E. Arthur Bettis III
Debby Z. Baker

Interdisciplinary studies are an integral part of our approach to earth science study. Collaborative work among scientists with diverse interests and training often leads to new perspectives on old issues and innovative solutions to problems. For example, Iowa's effort to reduce the impact of non-point source groundwater contamination is exemplary of the interdisciplinary approach, with specialties ranging from agronomy to sociology contributing to the identification of key issues and solution of problems.

Modern interdisciplinary natural science studies in Iowa have their roots in the late 1800's and early 1900's. Especially important is the legacy of Thomas Macbride and his student Bohumil Shimek, two prominent members of the University of Iowa faculty and special assistants of the Iowa Geologi-

cal Survey. The two were widely recognized for their contributions to botany and geology, contributions resulting from an ability to incorporate knowledge from diverse fields in the interpretation of the landscape. Macbride mapped glacial geology in north-central Iowa, and published articles on plant geography, paleobotany, and fungi. Shimek exhibited a similar breadth, mapping two counties in the loess hills of western Iowa, elucidating the origin of loess (by recognizing the habitat of its fossil snails), and publishing classic works on loess, glacial deposits and molluscs, Iowa's plant geography, and the antiquity of humans in the upper midwest.

Natural scientists in Iowa took note of the great loss in natural areas that occurred late in the 19th century, and in 1901 a group was organized to establish state parks and protect forest songbirds and wildflowers. This was the Iowa Park and Forestry Organization, the precursor of today's DNR, and Thomas Macbride was the organization's first president.

Shimek and Macbride believed that education, whether formal instruction in classrooms, sitting in the back of buckboards discussing landscapes

and specimens with students on field trips, or addressing citizen groups in small communities, could solve most of society's problems. An informed populace was the purpose of science, and as teachers Macbride and Shimek were unsurpassed. This drive to educate reached fruition in 1909 when, through the efforts of Calvin, Macbride, Shimek, and others, Lakeside Laboratory was established on the shore of Iowa's deepest lake amid the prairies, marshes, and potholes of Dickinson County -- a place where natural history could be studied, touched, smelled, and experienced as a multidisciplinary entity.

Macbride and Shimek provided us with a record of Iowa's native landscape and a vision of the conservation ethic necessary to preserve what little remains of that native condition. They left a body of knowledge upon which generations will continue to build. Their spirit of wonder and respect for the landscape, and their casting aside of disciplinary boundaries in nature's study are the foundation upon which our understanding of Iowa's natural history stands.



Illustration from 1897 Sears Roebuck Catalogue

Iowa has long been recognized as one of the important areas in the world for the study and interpretation of glacial deposits. As F.A. Wilder, G.F. Kay, and A.C. Trowbridge followed Calvin as

State Geologist, they continued to emphasize examination of the state's glacial record. Questions related to glacial drifts, gravels, buried soils, peats, and loess deposits were inseparable from

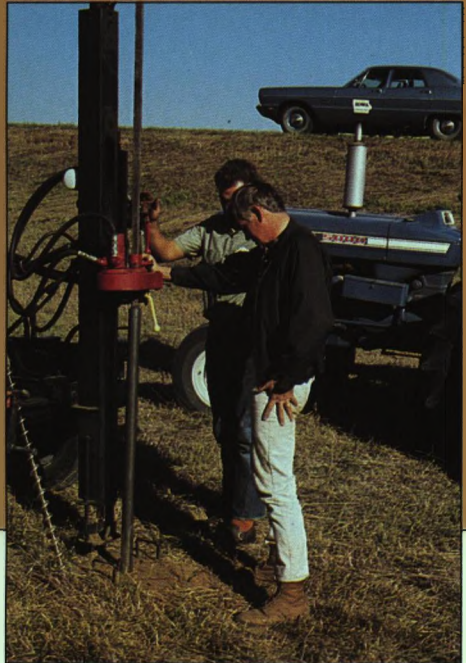
UNDERSTANDING THE SOIL WE LIVE ON **Timothy J. Kemmis**

There is a remarkable variety of surficial earth materials ("soils") in Iowa. For over 100 years, Survey geologists working to understand the distribution and characteristics of these materials have also made significant scientific contributions.

Materials accumulated during glacial activity comprise much of the state's surficial deposits. C.A. White (1860's) recognized ridges that were significant to later regional mapping of continental glacial deposits; W.J. McGee (1880's) recognized that the "Ice Age" was really composed of several ice ages separated by mild periods when soils formed; and Calvin, Shimek, Bain, Udden, and Norton helped to establish the classic sequence of glacial and interglacial stages recognized worldwide. After Shimek established the wind-blown origin of loess, predictable variations in its properties could be applied to erosion potential, slope stability, and rates of groundwater infiltration.

Studying buried soils in southern Iowa, Kay demonstrated that they were products of weathering rather than deposition. In the 1960's Ruhe's identification of erosion surfaces provided a means for understanding how subsurface conditions can change with landscape position. Continuing scientific contributions of Survey geolo-

Samuel J. Tuthill, State Geologist 1969-1975, drills into surficial deposits in Fremont County.



James C. Davis

economic geology in Iowa -- and today are inseparable from environmental assessments. The adaptability of Iowa's terrain and soils to agriculture, and the importance of agriculture to Iowa's

economy and as a factor in today's environmental issues warrant a strong and continuing commitment to research of Iowa's Quaternary-glacial deposits.

gists include improved understanding of Iowa's oldest glacial deposits, of the alluvial sequence in river valleys, and of Des Moines Lobe glacial advances.

As we enter the 21st century, intensive land use, especially by agricultural production and urban expansion, make it imperative that land-use decisions be based on understanding Iowa's surficial deposits. Our need is for detailed county maps that portray not only the type, sequence, and properties of these surficial deposits, but their suitability and vulnerability for various uses. Our challenge is to have the foresight to fund such mapping.



George F. Kay, State Geologist 1911-1934, ponders his plight after a June 1924 windstorm during field work in Lucas County.



photos from Calvin Collection, University of Iowa

Arthur C. Trowbridge, State Geologist 1934-1947, took these 1912 geology students to a Johnson County quarry to study Devonian limestones.

"Continuing to refine our understanding of the sequence of different geologic deposits and the three-dimensional picture of their arrangement below the Earth's surface is an enduring priority of Geological Surveys. Future improvements in our predictive capabilities in Iowa depend on this progress."

Greg A.
Ludvigson
(1992)

IOWA'S BEDROCK GEOLOGIC MAPS

Brian J. Witzke




A bedrock geologic map portrays the geographic distribution of various rock units present at the bedrock surface. It shows what kind of rocks, grouped according to their geologic age and stratigraphic position, would be encountered if all overlying "soil" materials were removed. This distribution of rock units results from the interplay between the three-dimensional structure of tilted and domed rock layers and the configuration of the eroded surface which cuts across them. The earliest geologic maps were prepared from visual reconnaissance of bedrock exposures. Information about areas where the bedrock is buried has become possible as water wells are drilled across the state, and the accuracy of our geologic maps has shown progressive improvement.

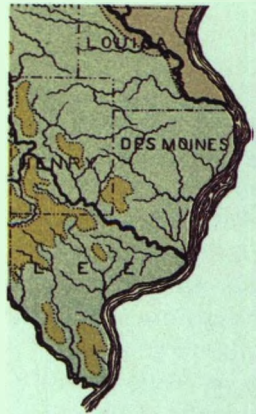
Regional and statewide geologic maps were produced by Owen (1844, 1852), Hall (1858), White (1870), Calvin (1893, 1894, 1897, 1898, 1900, 1904, 1905, 1907), Kay (1912, 1914, 1922), Trowbridge (1937), and Hershey (1969). County geologic maps were also printed in the Survey's *Annual Report* series between 1895 and 1941. Although the 1969 map is the most current, new revisions are ready to publish.

Production of a 1990's bedrock geologic map will be facilitated by recent improvements in bedrock topographic mapping, geologic structure maps, locations of bedrock exposures, resolution of bedrock units, completion of 7.5' topographic maps, and a computer-based geographic information system. A revised bedrock geologic map of Iowa will be an invaluable tool for natural resources planning, industrial minerals assessment, groundwater systems evaluation, and environmental protection.

Bedrock Geology of Southeast Iowa

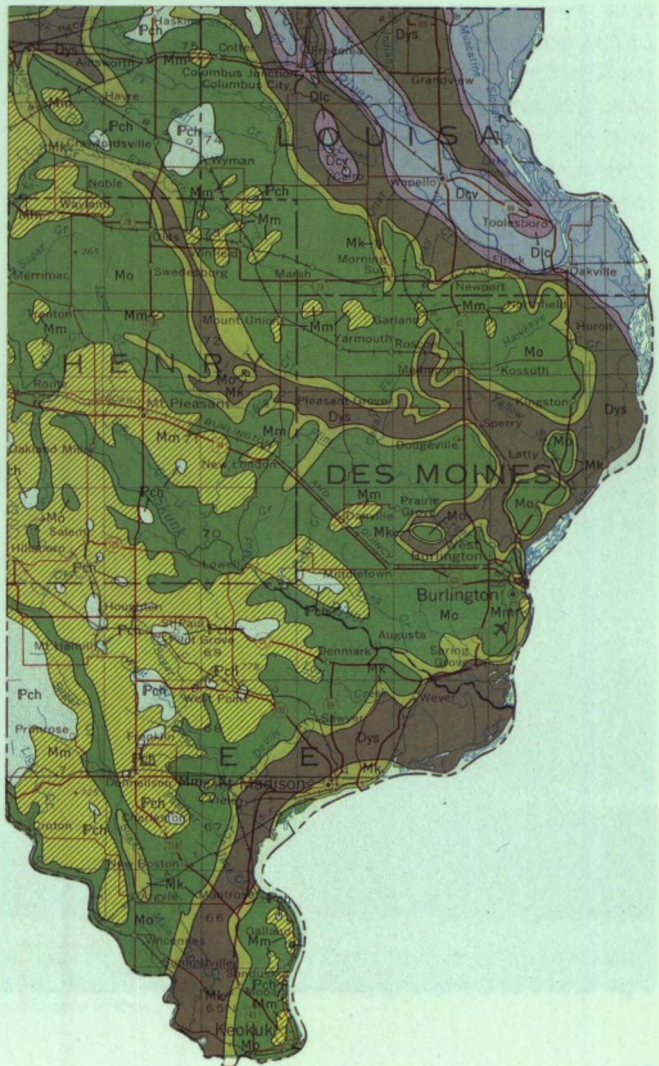
1892 Map

-  Upper Carboniferous
-  Lower Carboniferous
-  Devonian



Current Map

-  Pennsylvanian
-  Cherokee Group
-  Meramec Series
-  Mississippian
-  Osage Series
-  Kinderhook Series
-  Yellow Spring Group
-  Devonian
-  Lime Creek Formation
-  Cedar Valley Group



Economic Mineral Resources

The variety and extent of the state's mineral resources became better known as the counties were systematically investigated and a basic framework of glacial and bedrock deposits was developed. Over the years an interesting combination of mineral products has been mined and quarried in Iowa, based on studies done by the Geological Survey. The work of extracting and processing these natural resources has provided generations of Iowans with raw materials for building and construction, agricultural needs, and

valuable export commodities. The state's supplies of industrial minerals are in need of further assessment, particularly in areas where urban expansion limits extraction of these materials. Also, there is more to learn about Iowa's potential for commercial oil and gas production, especially from deeply buried deposits where few wells have penetrated. The increasing demand for mineral resources information will require a more detailed level of geologic mapping than now exists.



Calvin Collection. University of Iowa

Kilns, sheds, and neat stacks of finished clay products are shown at the Iowa Pipe and Tile Company plant in Des Moines about 1896.

MINERAL PRODUCTION IN IOWA

Robert M. McKay

Lead and Zinc: Indians and French voyageurs were probably the first to extract the heavy, metallic-gray lead ores in the Dubuque area along the Upper Mississippi River valley some-time prior to 1650. They began a lengthy period of mining lead and zinc ores that peaked between 1830 and 1860. The last of the Dubuque area mines closed in 1910.

Iron: Iron ore from the Waukon area in Allamakee County is the only other metallic mineral ever commercially mined in Iowa. The Iron Hill deposit was explored in the 1870's and was first mined in 1899. Operations were suspended in 1901 until the Missouri Iron Company of St. Louis acquired the deposit in 1906, and an ore beneficiation plant was built which sporadically produced and shipped ore concentrate until 1918.

Clay: In 1900 there were 381 clay-products companies operating in 89 counties. Clay was mined from shale bedrock, river alluvium, and glacial drift and turned into drain and sewer tile as well as several grades of brick. By 1920 Iowa was the

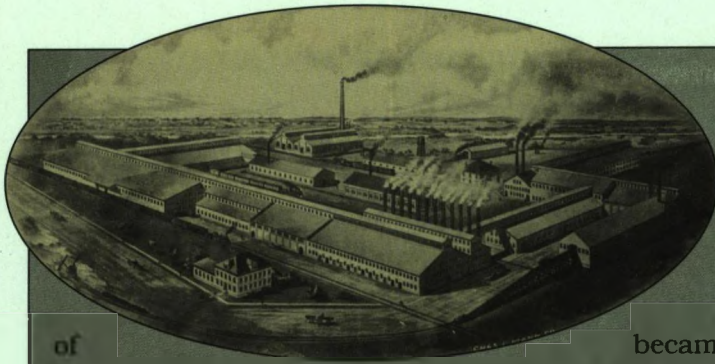
leading producer of drain tile. By 1938, however, the number of active firms had dwindled to 12 plants in 8 counties. Today, only 3 firms in Dallas and Woodbury counties produce clay products, primarily facing brick.

Cement: Simple cements were produced by burning limestone or dolomite in kilns fired by wood, coal, or oil. Many small 19th-century towns had kilns that produced lime for mortar used by local builders. Engineers, architects, and builders preferred lime burned from Silurian-age dolomites in Cedar and Jackson counties. This lime was desirable because of the hardness and durability of its mortar and its slow setting time, giving masons and plasterers longer to work. The dominance of these cements was preempted by the rapid acceptance of a new cementing product -- Portland cement.

Portland cement: The ability



Made in Iowa



The Northwestern States Portland Cement Co. in Mason City is shown in this turn-of-the-century illustration.

of Portland cement to harden under water and its finished strength make it a superior cementing product. By 1928, Iowa was in the midst of an extensive road building program, which involved constructing cement culverts and bridges as well as paving miles of roads. Industry output peaked in 1973 and remained brisk through 1979. Today four plants operate in Cerro Gordo, Polk, and Scott counties accounting for about 37% of the total value of mineral production in Iowa.

Stone: Many of Iowa's 19th-century bridges and buildings were built of limestone in towns along major rivers, where rock exposures were common. The growth of railroads, the need for improved highways, and the increased use of ag-lime required sources of crushed stone. Prominent production districts included Cedar, Jones, Des Moines, Marshall, Lee, Madison, Jackson, and Scott counties. By 1982 the value of crushed stone surpassed cement and

became the leading mineral commodity, accounting for 41% of the state's total mineral value. By 1990 there were 460 registered quarry sites in Iowa.

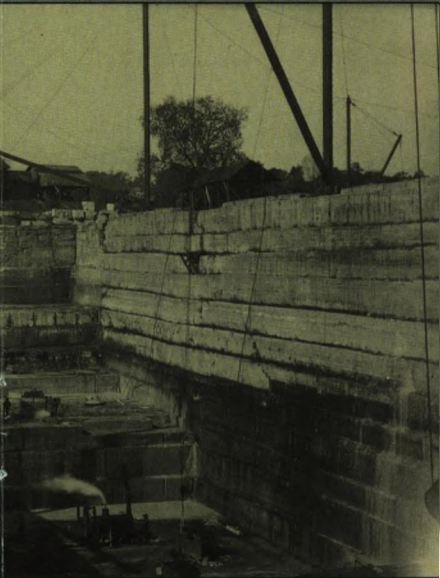
Gypsum: Gypsum, one of the softest minerals known, was discovered in Iowa in the 1850's near Fort Dodge and quarried as building stone. It is best known today as the principal ingredient in the manufacture of wallboard or sheet-rock. Ground gypsum is also a component of Portland cement and is used as a soil conditioner. Current production



is from four surface mines in Webster County and two underground mines in Des Moines and Marion counties.

Sand and Gravel: Sand and gravel constitute an important resource used in every Iowa county for maintenance of the gravel road system as well as for aggregate to be mixed into concrete. Most large dredge and dragline operations are located along Iowa's major stream valleys where these deposits were originally sorted and concentrated by stream flow.

The Bealer Quarries in Cedar County were famous for their mechanization and output of stone for bridge abutments and piers (ca. 1900).



Calvin Collection, University of Iowa

UNDERGROUND STORAGE OF GAS

Donald L. Koch

Liquefied Petroleum Gas (LPG), is a compressed by-product of petroleum distillation. While Iowa is not a producer of petroleum or natural gas, it does store large volumes of liquefied butane, propane, and ethane in excavated "caverns" deep beneath the land surface. LPG products arrive in Iowa via pipeline from Wyoming, Utah, and Canada and are injected into these underground facilities, which provide safety, economy, and operating flexibility.

The storage caverns were excavated from shale or shaly limestone into rooms about 20 ft wide and 20 ft high with 45 ft-wide pillars left for support. Two LPG storage caverns are located in southeast Johnson County at depths of 490 ft and 770 ft. They both began operation in the 1960's. In Polk County, three storage caverns were excavated at depths of 375 ft, 595 ft, and 1,410 ft beneath a single tract of land at the southeast edge of Des Moines. These became operational between 1967 and 1970.

IOWA COAL: FUEL FOR A NEW STATE'S GROWTH

Mary R. Howes



The main street of Buxton, a thriving community in 1915, is lined with homes of coal miners, including many African-American families.

Iowa's coal resources played an important role in the state's social and economic history. The westward expansion of railroads made it easier for people to move into Iowa and have access to supplies. Steam locomotives required large amounts of coal, and the mining industry grew along with the rail network.

Small quantities of coal were first mined in the 1840's near Fort Des Moines to fuel the post's blacksmith forge and from shallow seams along the lower Des Moines River to power coal-fired steamboats. In 1854 the Rock Island Railroad reached the Mississippi River, and by 1860, 500 miles of track existed in Iowa. By 1876

PONY MINES

Ponies and small mules were used to pull carts

loaded with coal through the low-roofed mines. Iowa's last pony mine, in Appanoose County, was closed in 1971.



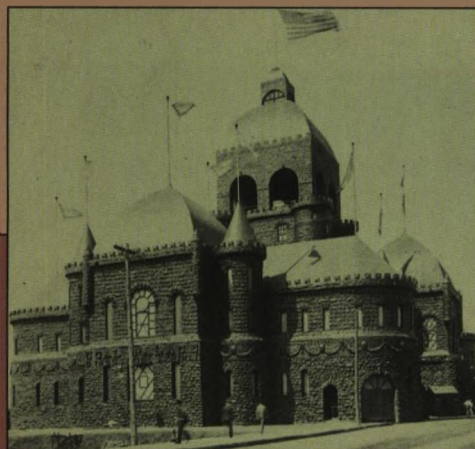
the North Western Railroad reached Council Bluffs, and Iowa was the leading coal producer west of the Mississippi and fifth in the U.S. By 1914 the state's rail network included 9,216 miles of track, and by 1918 annual coal production in Iowa peaked at 9.3 million tons. Production declined thereafter and the industry shifted from underground to surface mining operations.

Many of the larger companies constructed camps to house miners and their families. A few of these camps, such as Hiteman in Monroe County and Beacon in Mahaska County, have persisted as small communities, but most left little evidence of their existence. Buxton was

one of the best known of these, and included among its population African-Americans recruited from the South in 1873. It was a thriving community with schools, stores, a YMCA, a municipal band, and a baseball team. Children went on to become doctors, lawyers, and teachers. Eventually, the coal was mined out, and in 1927 the last of the mines closed with many residents resettling in Des Moines where their descendants live today.

OTTUMWA COAL PALACE

Erected in 1890 with the backing of local businessmen and 12 coal-producing counties, this impressive structure resembled a medieval fortress, featuring a 200-foot tower with a dance floor near the top. The building was veneered with coal and was brightly decorated inside with sheaves of wheat, oats, sorghum, and corn. It boasted a 30-foot waterfall, a solarium of tropical plants, and a 6,000-seat auditorium where concerts, plays, and operas were performed. It also enclosed a functioning reconstruction of an underground coal mine.



photos and lithograph from State Historical Society of Iowa

GROUND COLLAPSE OVER ABANDONED MINES

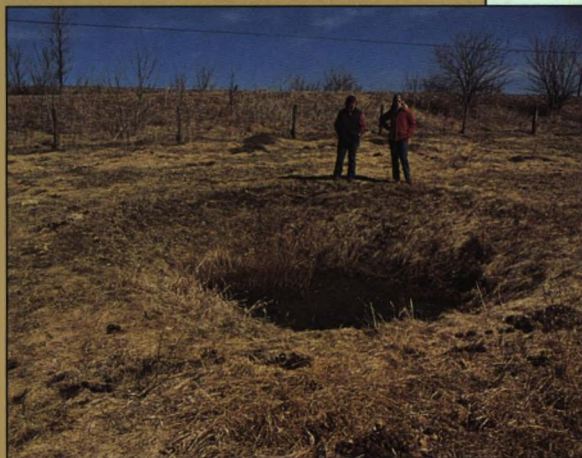
Paul E. VanDorpe

Underground coal mines can cause collapse of the land surface, resulting in problems that range from annoying nuisances to serious, costly hazards. These problems in any area depend on various geologic and past mining conditions.

Since 1840, coal mining in Iowa has left approximately 6,000 mines underlying 80,000 acres, 3,800 of which are urban. Most areas with histories of

underground mining have experienced some collapse (subsidence) problems. Well documented cases in the Des Moines area resulted in damage to structures and utilities, and periodic problems are likely to continue. In the What Cheer area (Keokuk County), subsidence craters have damaged roads, yards, pastures, row crops, and utilities. Geologic and mining conditions differ in the Centerville area (Appanoose County) and few subsidence incidents are known, though the potential for them exists. In Oskaloosa (Makaska County) the extent of mining is not well documented. Some minor property damage may be attributable to this cause. Subsidence in rural areas affects pasture and row crops, and reduces the land area available for agriculture.

This environmental legacy from our historic use of a geologic resource will be with us for decades to come. We need to be more aware of the problem, document subsidence events when they occur, take remedial action where possible, and utilize available information in land-use planning.



Marsha Miller

This Keokuk County crater resulted from ground collapse into an abandoned coal mine.

OIL EXPLORATION IN IOWA

Raymond R. Anderson

As early as 1901 Calvin cautioned those who were "... ready to stake their own fortune and that of their nearest friends on the belief that oil and gas are everywhere underneath the surface." Efforts to coax oil from the ground in Iowa have included exploding nitroglycerine to induce oil flow, salting with crank case oil to induce investors, using radar salvaged from a WWII bomber, and visions of a psychic from Massachusetts.

Of the 123 known exploration wells in Iowa, three have yielded oil, all in Washington County. Others have yielded encouraging signs and valuable information. The state's first show of oil was from a well in Fremont County

in 1925. The deepest oil test yet drilled was to 17,851 feet in Carroll County in 1987, and while no petroleum was found, thick black shales suggest past formation and migration of potentially large volumes of oil.

The best prospects for oil in Iowa are in: 1) southeast Iowa where local structures may have preserved small quantities of oil that migrated from the Illinois Basin in southern Illinois; 2) southwest Iowa, which includes the northern limits of the Forest City Basin (centered in northwestern Missouri); and 3) the deep flanks of the Midcontinent Rift, a 100-mile wide belt from the central Minnesota border to the southwest corner of Iowa.

Iowa's first oil production (370 barrels) was from Washington County in 1963. Don Koch (right), now State Geologist, was on site for the Geological Survey.



Young's Studio, Iowa City

PEAT PRODUCTION AND PROTECTION IN IOWA

Carol A. Thompson



Peat deposits do occur in Iowa, though most people tend to associate them with Ireland or the more northern states and Canada. A site in Linn County was producing peat as early as 1866. The story of peat in Iowa, however, was foretold in an 1899 geological report on Worth County which noted, "Although of value as a fertilizer and in some localities used for fuel, the peat bogs ... are generally regarded as impediments to agricultural purposes and much is being done to eliminate them."

In the early 1900's, coal miners' strikes in the East and advances in mechanical harvesting methods renewed interest in peat as a fuel. The industry was short-lived however, as Iowa's peat has a high ash content and low combustible carbon and thus does not make a high-Btu fuel.

No further mention was made of peat in state mineral reports until 1934-39 when one producer was listed, Colby Pioneer of Hanlontown in Worth County. Established in 1929, this business remains in operation today. A fascinating history written by founder John W. Colby describes some early uses for their peat, including packing around "ice-less ice cream shippers" and refrigerated lockers, as well as for shredded chick litter. He describes securing an Irishman experienced in cutting peat on the bogs of Kilarney, to supervise harvesting. In the 1930's and '40's, blocks of peat were still being cut by hand and transported by mules. It was shipped by rail to many other parts of the country, including California. During World War II when help was scarce, a bus load of 36 German prisoners from a camp in Algona arrived each day to help harvest the peat crop. Colby described them as good workers who enjoyed being out on "the moor," and he had many letters after they returned home, thanking him for his courtesy.

By the late 1940's to early '50's, the focus of Iowa's peat industry shifted to horticultural uses. The state presently produces about 15,000 tons of peat annually, a minor amount compared to Michigan, which produces over 300,000 tons, a third of the nation's total.

Because many peat deposits occurred in shallow basins on prime agricultural land, most have been drained. A recent search of county soil maps and high-altitude air photos revealed that all peat deposits listed by Survey geologist S.W. Beyer in 1908, representing over 15,000 acres, have been drained and are under agricultural production. Only those in public marshes or those less suitable for farming remain today.

In recent years, emphasis has shifted from utilization of peat to its conservation, with more attention being given to the state's smaller deposits. Many of these sites, called fens, occur on hillslopes and are associated with springs or seeps. Drainage is impractical because of the continual flow of groundwater supplying the fens. Often only one or two acres in extent, these unusual hydrologic sites harbor many rare plants, and recognition of their biological value and the need for their preservation is growing.



(Left) Hand-cut peat blocks are trucked from a field during the 1930 harvest.

(Above) Experimental vacuum equipment for picking up and loading peat is tested in 1959.

Photos courtesy of Colby Pioneer Peat Co.



Groundwater Studies

Groundwater investigations in Iowa intensified as the post-World War II economic expansion included industry as well as agriculture, and more precise information on water resources was required. In 1947, H. Garland Hershey succeeded Trowbridge as State Geologist, and cooperative programs with the state's water-well

contractors and the U.S. Geological Survey were emphasized. This was also the watershed year in which the Director of the Geological Survey and the Chairman of the University of Iowa Geology Department became two separate positions.

An emerging set of resource, environmental, and energy issues

WATER-WELL INQUIRIES

Paul J. Horick



The Geological Survey maintains a long-standing commitment to record keeping and well-sample curation. The benefits of this activity are especially pronounced in the area of "forecasting" the availability of Iowa's groundwater resources. Also, well samples can yield valuable information benefits later, when viewed in light of new ideas and techniques. Thousands of well samples have been logged, and our knowledge of the hydrogeology of the state has made great strides. From about 1940 to 1975, the Survey shared offices with the U.S. Geological Survey personnel who also contributed much to our understanding of aquifer characteristics and groundwater flow, and many suggestive reports were published.

Today, Survey geologists handle hundreds of requests per year from engineering consultants, well contractors, municipalities, industries, landowners, farmers, real-estate developers, recreational interests, and state and federal agencies on all aspects of well production and groundwater problems. We anticipate these requests will continue for at least the next two decades. Our geologists continue will require further education as we meet these needs and assist efforts to protect Iowa's groundwater quality.

Illustration from 1897 Sears Roebuck Catalogue

faced Iowa in the early 1970's. Samuel J. Tuthill, who in 1969 followed Hershey as State Geologist, applied the Survey's traditional research and service functions to these contemporary problems and altered the direction of the Survey along a course of diversified public service and interagency cooperation that



State Historical Society of Iowa

WELL SAMPLES

Donivan L. Gordon

The last horse-powered drilling rig known to operate in Iowa was photographed at Fraser (Boone County) in 1955.

Much credit for our understanding of the subsurface geology and water-bearing condition of Iowa's bedrock formations must go to the state's water-well drillers and contractors. Much of the information used by Survey geologists over the last several decades came from an ambitious sample-gathering program. The Survey furnishes well contractors with cloth bags for drill cuttings and driller's notebooks for recording facts about drilling procedures, well casing, water levels, and pumping tests. In return, drillers record data on each well drilled and collect samples from each five-foot interval penetrated. Through the years, this valuable data base on subsurface geology has grown to over 32,000 sets of samples, augmented by samples recovered from oil exploration tests and other drilling projects. Survey geologists then examine the samples microscopically and prepare graphic logs of each well. Information is also entered in an electronic data base from which records can be extracted and forwarded to clients.

Drillers and geologists have benefited immensely from this program. The state is better able to define its subsurface geologic and groundwater conditions, and well contractors have helpful information with which to predict their success in providing water supplies for their customers.

continues today.

The application of computer technology bloomed during the 1980's and '90's and had an enormous impact on data management, improving our geologic and hydrologic assessments and services. During this period, Stanley C. Grant (1975-1980) and Donald L. Koch (1980-present) were appointed State Geologist. Two other important events were the reorganization of state government in 1986, which placed the Survey into a new Department of Natural Resources, and passage of the 1987 Groundwater Protection Act.

(Below) Field notes of soil and water conditions on the farm are typed by a County Extension agent using his 1920's version of today's lap-top computer.

WATER QUALITY AND AGRICULTURE

George R. Hallberg

As we enter the second century of the Geological Survey in Iowa, the impact of agriculture on groundwater has become a prominent issue -- one of many symptoms of the vast changes in our society over the past 100 years. Since 1950, agriculture has changed dramatically. In this transformation from rotation to fertilization and from hoes to herbicides, the productivity of the American farmer became legend, but with unforeseen consequences as well.



State Historical Society of Iowa

Beginning in the mid-1970's, it became clear that cultivating more land and applying more nutrients and pesticides was also taking a toll on Iowa's waters. Nitrate concentrations had increased regionally in shallow groundwater, and some pesticides and herbicides were detected in shallow groundwater and surface waters. Iowa's early lead to define this emerging problem gathered national attention, as other states were facing similar concerns.

Just as important as Iowa's leadership in defining these problems has been Iowa's leadership in resolving them. Many agencies and institutions came together to form the Iowa Consortium for Agriculture and Water Quality. Working at first with farm families, management practices were developed that would reduce the loss of nutrients and chemicals from crop production. The lessons learned were applied through statewide programs, and in the process, improved management and efficiency also improved our profitability and our environmental performance.

As a measure of success, we know that between 1985 and 1991 these programs helped Iowa farmers reduce nitrogen application rates on corn by about 15%,



reducing statewide nitrogen loading by over 1 billion pounds. These improvements saved Iowa farmers over \$200 million. The special monitoring programs and demonstration projects that produced these results cost a total of \$10 to \$12 million over this time -- a nearly 20-fold return to Iowa's economy.

As impressive as these accomplishments are, there is still a long way to go. The dilemma of dealing with agricultural impacts on water quality is their "nonpoint source" nature -- they are diffuse, widespread, and difficult to see. It took nearly two decades to see the impacts; they grew gradually and will only dissipate gradually. It will take time and diligence to monitor and measure the extent of our water-quality improvements. In the Geological Survey's second century, we must work together with agronomists, agricultural engineers, and biologists on such complex problems. There are few easy problems left, and fewer easy answers.

Images, Maps, and Computer Applications

Abundant data about Iowa's land surface and the condition of its underlying glacial, bedrock, and water resources is stored in images and coded computer files. The newest computer tool to link and display various sets of data, and compare one type of information with another, is the geographic information system. Computers also enable us to track sets of samples from well drillers, contour the elevation or thickness of different geologic deposits, plot locations of abandoned mines, model the behavior of groundwater as wells are pumped, analyze trends in groundwater quality from chemical data, and assemble the publication you are reading.

FROM REMOTE SENSING TO GIS **Bernard E. Hoyer**

In the early 1970's, environmental issues and imaging technologies were evolving concurrently. Conflicts involving Iowa's land, air, and water were on the public's agenda, and new tools to evaluate these issues began to be accessible and affordable. The Geological Survey initiated a new venture -- remote sensing -- the acquisition of information using recording devices not in direct contact with the objects under study.

This technology utilizes properties of the electromagnetic spectrum (heat and light are common examples) to image and evaluate the landscape for specific purposes. Examples of investigations which the Geological Survey conducted in cooperation with other government agencies included: evalu-

ating thermal discharges to the Mississippi River, mapping the inundation of crops by flood waters, inventorying diseased trees, inventorying land use, monitoring strip mines and reclamation, and estimating soil erosion. Images were obtained from both low and high-altitude aircraft as well as from orbiting satellites, depending upon the situation under study.

Several common themes emerged from these studies. Remote sensing imagery was generally best used in conjunction with other mapped data. Digital imagery was most effectively analyzed in computers, not as "photographic" images of the data. Imagery was best analyzed when merged with other geographically referenced resource data in the computer, and often the other

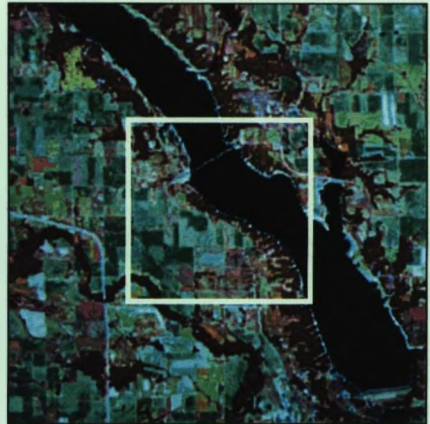
The ability to view the same area through time and from different altitudes enhances our ability to evaluate changing patterns in land use. This sequence shows the course of the Des Moines River through northwest Polk County prior to and after construction of Saylorville Reservoir.



1950 Black and white aerial photograph from about 10,000 feet



1978 Color-infrared photograph from 40,000 feet



1990 Color-infrared satellite image from 438 miles

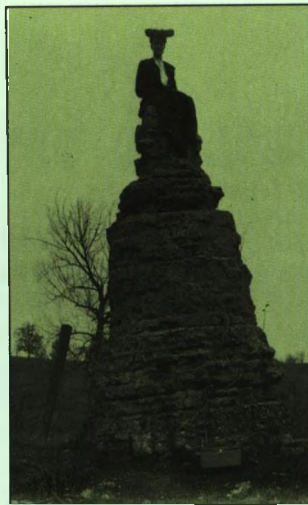
resource data was more useful to solving problems than the imagery itself. Thus, as early as 1973, our staff determined that a library of geographically referenced, digital, natural resource data would be a powerful tool for use in examining and evaluating Iowa's natural resources.

With the continued evolution of environmental issues, the tremendous development of computer hardware and software, and the 1986 coalescing of agencies into the Iowa Department of Natural Resources, that library is now being built as our Natural Resources Geographic Information System. The adaptation of this technology will assist us in meeting our future natural resource information needs with greater speed, accuracy, and insight.

The Next 100 Years

This colorful and historical look at the roots of today's Survey also frames a view of our future. The inventory, development, and conservation of our state's geological resources are vital elements of Iowa's economic stability and future growth. Geological resources are limited and are not uniformly distributed in either quantity or quality. There is increasing competition for their use. Some geologic settings are vulnerable to contamination. Iowa needs a qualified source of reliable information on soil, rock, mineral, and water resources. The Geological Survey's historic emphasis on both science and service must continue. We must respond to the state's changing economic and environmental needs with new theories and technologies, needed areas of expertise, and a willingness to accept new responsibilities applied with the traditional integrity, quality, and esprit de corps. A strong program of meeting scientific challenges while producing practical results recognizes, in Calvin's words, that "The pure science of today becomes the basis of the applied science of tomorrow." Coupled with the effective communication of our research to the public, the Geological Survey should continue its contributions to Iowa for the next 100 years.

Narrative by Jean C. Prior



Continuing field studies are essential to building a trustworthy base of geological information. (A pinnacle of Galena dolomite is visited in 1905 near Rockdale in Dubuque County.)



Iowans depend on groundwater supplies for a variety of uses. (Hotel Colfax was a popular health resort built in 1884 around the presumed therapeutic effects of mineral water from Jasper County wells.)



There is a continuing need to locate adequate sources of groundwater in Iowa. (An unexpected gush of water, known as "Jumbo," flowed out-of-control for months during well drilling in Belle Plaine, Iowa County in 1886.)



Jumbo and crinoid photos:
Calvin Collection, University of Iowa

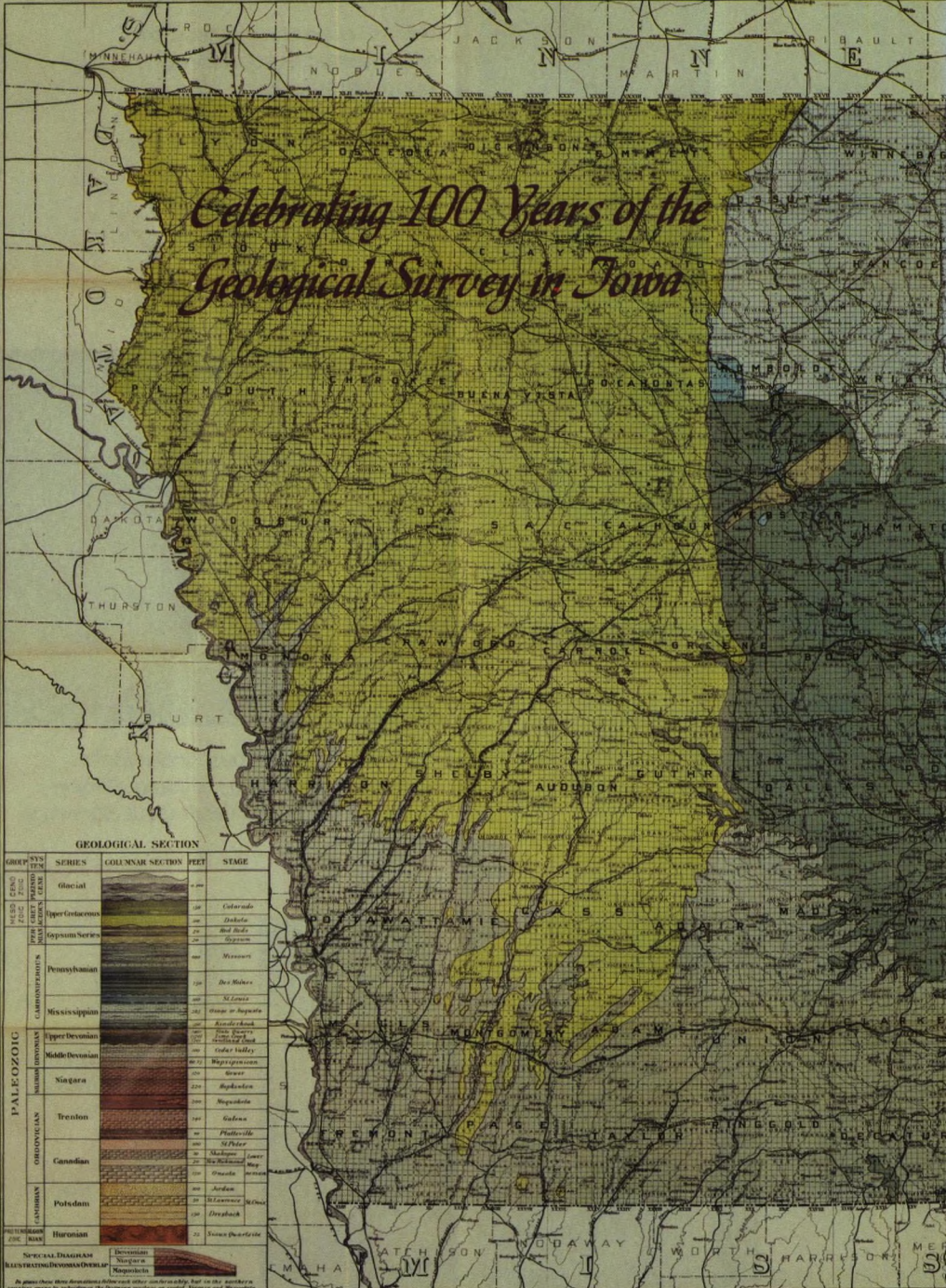
Other photos: State Historical Society of Iowa

A bouquet of "sea lilies" (crinoids) concludes this edition of Iowa Geology commemorating the Geological Survey's centennial.



Public awareness of geologic events should be encouraged. (In 1929, Daughters of the American Revolution dedicated a monument to the Estherville Meteorite which fell in Emmet County in 1879.)

Celebrating 100 Years of the Geological Survey in Iowa



GEOLOGICAL SECTION

GROUP	SYS	SERIES	COLUMNAR SECTION	FEET	STAGE	
PALEOZOIC	CARBONIFEROUS	Glacial		100		
		Upper Carbonaceous		100	Carbonate	
		Tappan Series	Red beds		75	Dakota
			Green		25	Green
		PENNSYLVANIAN	Waverly		100	Waverly
			Des Moines		100	Des Moines
			St. Louis		100	St. Louis
		MISSISSIPPIAN	Orange or Argenta		250	Orange or Argenta
			Keokuk		100	Keokuk
		UPPER DEVONIAN	Lower		100	Lower
Upper			100	Upper		
MIDDLE DEVONIAN	Order Valley		200	Order Valley		
	Wagon Wheel		100	Wagon Wheel		
SINAIAN	Shinarump		200	Shinarump		
	Shinarump		200	Shinarump		
TRENTON	Shinarump		100	Shinarump		
	Galena		100	Galena		
CANADIAN	Protector		100	Protector		
	St. Peter		100	St. Peter		
PRE-CAMBRIAN	Lower		100	Lower		
	Upper		100	Upper		
POCASSON	Jordan		100	Jordan		
	Lawrence		100	Lawrence		
Huronian	Dwight		100	Dwight		
	Yonca		100	Yonca		

SPECIAL DIAGRAM
REPRESENTING DEVONIAN OVERLAP

As given these three divisions show each other's underlap, but in the northern portion, where the Devonian overlaps on both Niagara and Huronian.