

January 1978

NEWSLETTER

IOWA GEOLOGICAL SURVEY

Volume 1
Number 3

NEWSLETTER

Vol. 1, No. 3

January 1978

IOWA GEOLOGICAL SURVEY

123 North Capitol St.
Iowa City, Iowa 52242

Dr. Stanley C. Grant
Director and State Geologist

THE GEOLOGICAL BOARD OF IOWA

The Honorable Robert D. Ray, Chairman	Governor of Iowa
The Honorable Lloyd R. Smith	Auditor of State
Dr. Williard L. Boyd	President, The University of Iowa
Dr. W. Robert Parks	President, Iowa State University
Dr. Lois H. Tiffany	President, Iowa Academy of Science

Front Cover: Black Hawk Lake, Lake View, and surrounding area, from infrared aerial photos taken by IGS Remote Sensing Lab. (Painting by John Knecht)

Back Cover: Top Photo — Pleasant Hill Outlier southeast of Olin in southern Jones County. The light-colored Middle Devonian rocks in the foreground are faulted against the dark-colored Silurian rocks in the background along the Plum River Fault Zone. See article p. 18 (Photo by Greg Ludvigson)

Bottom Photo — Geese flying over Missouri River, fall 1977. (Photo by IGS Remote Sensing Lab. for Iowa Conservation Commission's Geese Inventory)

Charles J. Huelsbeck Editor
Jean C. Prior Editorial Consultant
John L. Knecht Art Editor, Production Supervisor

Cartoons by Jack L. Gilmore

TABLE OF CONTENTS

	Page
ON THE OUTCROP WITH THE DIRECTOR	2
Dr. Stanley C. Grant	
GEOLOGICAL BOARD MEETS	3
GROUNDWATER RESEARCH—KEYSTONE IN THE BRIDGE TO UNDERSTANDING	
SUBSURFACE GEOLOGY	4
Orville J Van Eck	
OUR RENEWABLE RESOURCE ?	5
Donivan L. Gordon	
GROUNDWATER DIVISION: SERVICE IS OUR BAG	6
Paul J. Horick	
WATER RESOURCES TEST DRILLING PROGRAM: NORTHWEST IOWA	8
Greg Ludvigson and Bill Bunker	
GROUNDWATER	10
Dr. Logan K. Kuiper	
IOWA WATER RESOURCES DATA SYSTEM	11
Richard Talcott	
IOWA WELL DRILLING	12
Earle E. Scheetz	
EXCURSIONS AND MEETINGS IN '77	12
Donald L. Koch	
COAL RESOURCE PROGRAM	16
Dr. Matthew J. Avcin	
OIL & GAS EXPLORATION IN IOWA	18
Jack L. Gilmore	
THE PLUM RIVER FAULT ZONE IN EAST-CENTRAL IOWA: CURRENT STATUS OF	
INVESTIGATIONS	18
Greg Ludvigson and Bill Bunker	
THE MINERAL RESOURCES DIVISION IN 1977	20
Fred H. Dorheim	
ENHANCED COMPUTER CAPABILITIES	21
Sue Davis	
REMOTE SENSING DEVELOPMENTS	22
Bernard E. Hoyer, Raymond R. Anderson, M. Patrick McAdams	
ORTHOPHOTO QUAD LITHOGRAPHS AVAILABLE	23
Raymond R. Anderson	
DREDGED MATERIAL USES WORK GROUP	24
James C. Case	
CAVES IN IOWA	25
Michael J. Bounk	
NEW FACES IN '77	26
RECENT IGS PUBLICATIONS	28
Suzan M. Stewart	

ON THE OUTCROP WITH THE DIRECTOR



This third issue of the *Newsletter* stresses the significance of one of the Iowa Geological Survey's most important responsibilities—water. Though the Geological Survey is not a part of the State of Iowa regulatory system, we are mandated to collect, process, store, interpret, and disseminate information on the water resources of Iowa. We provide information on availability, quantity, quality, depth to supply, geological conditions, and effects of pumping of water. Our services are provided directly to other state agencies and to the people of Iowa. We have cooperative water-related programs with several federal agencies, including the U.S. Army Corps of Engineers, the Bureau of Mines, Department of Agriculture Soil Conservation Service, and the U.S. Geological Survey.

We are now completing our assigned portion of the State of Iowa Water Plan Framework Study, a three-year legislative mandate to provide basic information on all reasonable facets of the water resources of Iowa. The framework study has revealed many holes in our data base and has provided correct questions that must be answered soon. For example, we need comprehensive data on the surface and subsurface water supply in 15 counties of northwestern Iowa. We are now proceeding to get that information. We know that in parts of Iowa, we are using more water faster than it can be recharged, and the water table is getting lower and lower. In other parts of the state, we have a minimal supply of water, and growth of those regions will be limited by water supply shortages—or expensive pipelines will have to be built. We are seriously damaging water quality in parts of

Iowa by severe soil erosion and by concentration of fertilizers, herbicides, and pesticides. In certain areas of Iowa, the influence of karst topography (sinkholes) on water quality also continues to increase. Many rural Iowans are drinking poor quality water already, and the potential remains high for increasing the number of low-quality water sources.

Several agencies have cooperated in formulating the Water Plan Framework Study. We anticipate that the legislature will direct some, or all, of these agencies to develop and manage the Water Plan and Iowa's water resources for the future. The data on water has been and continues to be accumulated by the Geological Survey. Our project teams have developed the Iowa Water Resources Data System (IWARDS), which is now accessible to all state agencies, both for input and retrieval. This is a major milestone in water resources management.

Survey project teams are continually gathering and processing well cuttings, which are provided by well drillers as a service to the state. We prepare the cuttings for microscopic examination, and then logs are constructed. Logged data is entered on the computer system. This activity has increased in magnitude many fold over the past three years because of rapid increases in the number of drilled wells. We are presently more than 3,000 wells behind as a result of these increases and limited staff.

The Survey provides hundreds of water availability forecasts each year for municipalities, industries, and individuals. The demand for this service has risen sharply in recent years. Direct information and in-

terpretation services are provided to the State's regulatory agencies to enable them to make the decisions whether to approve, modify, or disapprove all sorts of applications.

For the future we would hope to see the IWARDS program fully utilized by Iowans and perhaps expanded to include all natural resources data. We see the need for continued detailed study of water supply in some parts of Iowa, a study of drought effects, and models to determine the impact of maximum withdrawals from each of the significant aquifers in Iowa.

Though we have stressed the water resources role in this issue, it is not my intent to downplay our research and service roles in coal, minerals, rock, soils, and surface geology. We also fill an important function in providing information and assistance to earth

science teachers in the state as well as public information services. Our publications list and our sales of published information materials grow each year.

There is a great quantity of geological information yet to be obtained in the state. Oil and gas will probably be produced in modest quantities from Iowa. Large metallic mineral deposits may well be found in Iowa in the next few years. Lead, zinc, iron, and copper have excellent potential. To discover the precise location of these deposits takes very careful work and considerable time, but we are moving forward on all of these avenues. I see a great future for the economy of Iowa based not only on agriculture and industry, but also on coal and minerals extraction. Of course, none of these activities can be performed effectively unless we understand and manage our water resources properly.

Dr. Stanley C. Grant
Director and State Geologist

GEOLOGICAL BOARD MEETS

The Annual Meeting of the Geological Board of Iowa was convened in the offices of Governor Robert D. Ray, Chairman, on Tuesday, December 6, at 11:00 a.m. Dr. Lois Tiffany, new board member, was introduced, as was Mrs. Martha Kafer, new board recorder and the Geological Survey Administrative Assistant.

Status of programs and projects was reviewed, and requests for appropriations and capital askings were discussed. State service activities of the Survey were emphasized. Specific budget allocations will be made for costs of services to other agencies in the

future. The Board reviewed the *Annual Report* and made recommendations for Survey programs. IGS staff participating were Dr. Stanley C. Grant, Mr. Orville J Van Eck, Mr. Donald L. Koch, and Mrs. Kafer.

The Board includes as Chairman the Honorable Robert D. Ray, Governor of Iowa; Honorable Lloyd R. Smith, State Auditor; Dr. Willard L. Boyd, President of the University of Iowa; Dr. W. Robert Parks, President of Iowa State University, and Dr. Tiffany, President of the Iowa Academy of Science and Professor of Botany, Iowa State University, Ames.

GROUNDWATER RESEARCH—KEYSTONE IN THE BRIDGE TO UNDERSTANDING SUBSURFACE GEOLOGY

By Orville J Van Eck

In the beginning there were no subsurface samples, and they knew not what lay beneath them.



That was the plight of the early Iowa geologists. They could study the surface exposures, make certain extrapolations, and deduce what lay beneath them, but beyond that, there was no basis for judgement. As population centers grew and

the demand for water increased, wells were drilled to utilize groundwater. This provided the geologist with the first real opportunity actually to obtain samples of the subsurface and to test the deductions that had been made on the basis of surface observations.

That was a start, but it was a very humble start. Samples from the drilling were usually collected only sporadically, if at all. Often the geologist was lucky to obtain even a descriptive log of the materials penetrated during drilling. Fortunately for all of the citizens of Iowa, the early geologists of the Survey recognized the importance of groundwater and the control that geology exerts on that water. In 1896, W. H. Norton, a member of what was then identified as the Geological Corps, stated: "So intimately is geology concerned with water and its work that the investigation of the deep waters of the state lies clearly within the field of the State Geological Survey." He went on to state that "Economic geology finds in water the most precious of all mineral re-

sources. For water is as much a mineral as is petroleum, and like petroleum, its distribution beneath the surface depends upon stratigraphy and structure. From other minerals it is separated by its abundance and its relations to life; and these are so essential that it becomes a greater value than all the possible wealth of mines and quarries."

With that dictum it is not surprising that the Iowa Geological Survey continues to rank groundwater research as its top priority program. Along with that, we also have paid heed to Norton's admonition that the distribution of groundwater is dependent upon stratigraphy and structure. In recognition of that importance, the collection, preparation, and study of drilling samples is a vital part of the groundwater research, for without that we would in most areas be as in the beginning—we would not know what lies beneath us.

Starting in about 1930, the Survey began a program directed toward the gathering of drilling samples. The program was strictly on a cooperative basis with the well drillers. The Survey provided the sample bags in which the drill cuttings would be placed. The cost to the driller would be the time and effort to collect the cutting samples at certain intervals and to identify that interval in the bag. In return he would receive a copy of the geologic log that resulted from the microscopic study of the samples.

That cooperative program continues, only at a much expanded pace and, we believe, in a much more efficient manner. Many of the drillers now collect a representative sample for every five feet of material penetrated. As a result, our sample library now contains cuttings from over 24,000 wells across the state. The geologic logs derived from the study of those cuttings form the framework for our understanding of the stratigraphy and structure of the state, and thus increases our knowledge of that most precious of all resources—water.

And so it is not as in the beginning. We do know what lies beneath our feet. Certainly not in the detail we would wish, but with the continued valuable cooperation of the many well drillers in the state, and with the dedication of the staff members responsible for the collection, preparation, and study of those samples, we are constantly refining that detail. With that added detail should come the information that will assist in the management of our water resources in the face of increasing demands.

(Mr. Van Eck is Associate State Geologist.)

OUR RENEWABLE RESOURCE?

By Donivan L. Gordon



In Iowa, water is now used at a rate of 60 to 150 gpcd (gallons per capita per day), varying with the size and economic characteristics of communities. In 1970, the total water withdrawn from surface and ground water sources

was about 2.5 million acre-feet, or about 2 billion gallons per day. By 1975, this amount more than doubled to 5 million acre-feet and is expected to double again by the 1980's. About 75 percent of this demand represents withdrawals from Iowa streams for power plant and other industrial cooling. The remaining 25 percent represents withdrawals that serve municipal, industrial, agricultural, and domestic needs, of which about 80 percent is withdrawn from underground sources.

In the past, Iowans have grown to accept a philosophy of water development based on faith in natural abundance and dependence upon the renewability of the supply. By and large, nature has provided abundantly, except for a few critical episodes of drought such as only recently experienced. However, this particular philosophy has not been totally satisfactory to all benefited water interests in the state, and holding to it has caused some very disconcerting precedents to be set in water resources development. Conflicts among water user groups are becoming much more common as each sector attempts to meet its demands for larger and more reliable water supplies.

For Iowa's early settlers, locating an adequate supply of good quality water was no particular problem. The water in the streams of the state was reasonably pure, as was that of the existing lakes and ponds. Natural springs were relatively abundant, and where these natural resources were not conveniently available, shallow "dug" wells sufficed to provide the necessary water for domestic and livestock purposes. In 1870, some 24 years after Iowa was admitted as the nation's 29th

state, not a single system of community water works was in operation, and the state's vast groundwater resources were virtually untapped.

However, in the ensuing 100 years, Iowans have come a long way in developing their water resources. Before the end of 1880, in order to meet growing community demands for water and better sanitation, sixteen systems of water works were in operation in Iowa. By the end of 1885 the number had increased to forty. In 1890, the *Manual of American Water Works* listed some 85 Iowa communities that were served by water works. The list of communities so served has now grown to exceed 700, not including numerous private and industrial systems.

In a hundred years of water management, and possibly mis-management, Iowans have had a considerable impact on their water resources — more specifically their groundwater resources. Since Iowa became a state, the landscape has been converted from virgin prairie to a highly developed agricultural and urban complex. Wetlands have been drained, and many areas for natural groundwater recharge have been disturbed by the plow and tile drainages, or simply have been paved over. These activities, in association with ever increasing groundwater withdrawals, have contributed to a general decline in groundwater levels across the state during the past century.

To exemplify, in 1897 the city of Clinton drew its water from four deep bedrock wells. When the supplying aquifer was originally tapped, its water pressure head, or level, was some 35 feet above the land surface, causing the wells to flow at the surface. In combination, these four wells delivered about 2½ million gallons of water per day to Clinton's water works. These original wells were still flowing in 1910, but their yield had diminished to only about one million gallons per day. As more wells were developed in the same aquifer, to meet the water demands of competing interests in the area, the original wells ceased to flow as water levels declined.

Currently, many large capacity wells in and around Clinton are drawing water from the same bedrock source. However, they are now pumping water at levels about 200 feet below the land surface. The net water-level decline in the aquifer since 1897 has been about 235 feet, most of which has occurred since 1910.

The situation at Clinton is no anomaly, in

that the literature regarding early water wells in Iowa reports many communities around Iowa being supplied by flowing wells. The records show that each followed a history similar to that of Clinton.

In the *Annual Report* of the Iowa Geological Survey, 1927, the Assistant State Geologist, James H. Lees, devoted considerable attention to the problem of water level declines in Iowa. In his discussion Lees summarized some interesting findings of a 1910 study by W. J. McGee, who was in charge of soil water investigations for the U.S. Bureau of Soils. McGee's work inventoried wells and water levels in all 99 Iowa counties, and he stated: "To one familiar with the state since the settlement of the eastern counties, the records and remarks (of well drillers) jointly indicate a mean lowering of subsoil water level during an average of 50 years that can hardly be put

at less than 20 feet." In discussing the cause as related by McGee, Lees states: "The greatest amount of lowering — amounting to 80 or 90 percent — McGee assigns not so much to consumption of accumulated stocks as to the cutting off of the natural source of supply — the fact that under present conditions, of cultivation, storm waters do not enter the ground, but run off to streams and so are unable to replenish the stores of groundwater."

Pausing a moment to reflect upon our past endeavors to manage and develop the state's groundwater resources and current conditions, it should be obvious that very soon we must consider making several philosophical adjustments relative to water management or face impending groundwater supply problems. In general, Iowa's groundwater supply is abundant. However, declining water levels

in major aquifers in the vicinity of several large pumping centers around the state attest to our ability to withdraw water at rates in excess of natural recharge. And locally more communities each year are being forced to adjust periodically to short term water supply deficiencies. These problems generally deal with stresses related to over-drafting, less productive localized supply sources and seasonally droughty conditions. In this past year thirty-three western and southwestern Iowa communities faced such conditions and were forced to institute various mechanisms to conserve water and augment their existing supplies by hauling water from other sources or withdrawing it from available surface sources.

Under natural conditions groundwater recharge must be considered to be a somewhat random, variable, and generally

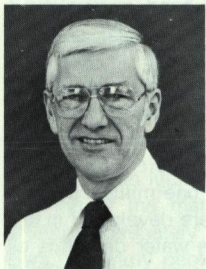
slow process. Although Iowa receives in normal years abundant precipitation, only a relatively small proportion goes into the water cycle as recharge. Each time we pave over an area, drain a wetland, or clear a timbered area, we diminish this capability. On the other hand, each new well that is developed places some new and/or increased demand upon the existing supply.

In Iowa we have reached the point where we can no longer afford to be complacent concerning the use and development of our vital groundwater resources. We must become aware of the fact that, if fully developed, these resources are limited, and we must realize that conservation can, in the future, play a very important part in the wise use of our "renewable" resource.

(Mr. Gordon is Chief of the State Water Plan Group.)

GROUNDWATER DIVISION: SERVICE IS OUR BAG

By Paul J. Horick



Wells drying up? Got a water quality problem? Need advice on drilling depths for a new well? Puzzled and uncertain about what to do? Write or call the Groundwater Division of the Iowa Geological Survey. Service is our bag!

This applies not only to individual landowners and farmers, but also to municipalities, industries, irrigators, recreational facilities, regional planning commissions, rural water districts, well drillers, engineering consultants, and other state and federal agencies with water supply problems. Other typical problems handled by the Survey's groundwater and subsurface experts are pro-

blems of well construction and location, potential interference effects, pumping test interpretation, well development techniques, and water treatment to improve quality.

In the past two years the number of inquiries of this nature to the Iowa Geological Survey has more than doubled, and the Survey staff has been hard pressed to keep up with the demand for information and solu-



tions to problems. Since July 1, 1976 no fewer than 235 cities and towns have been supplied summary groundwater predictions, information on wells, and assistance on water supply problems, while 185 prospective irrigators and 210 individuals with domestic well problems requested help. The Survey answered a total of about 950 groundwater related requests during this period. Although the demand for information was accentuated by the drought beginning with the spring of 1976, a steady increase in water demands, new standards for water quality and water supply facilities, and a growth in rural home dwellings have also contributed to the increase in the number of inquiries. The uptrend in water use is a national phenomenon and is expected to continue in Iowa in response to population growth and as industrial, commercial, and agricultural water needs multiply.

With few exceptions individuals, communities, and industries will benefit by contacting the Survey in advance of well construction or when rehabilitating existing wells. So, before you put in that foundation for your new rural home, even before you buy the acreage with the lovely view, it may save you some trouble to call or write the Survey about groundwater conditions in your area. Chances are we can give you a reasonable review of the aquifer possibilities. If definite answers are not in order, we can at least provide a general summary or discuss the alternatives

based on the data in our files and the expertise of our staff.

Groundwater geologists are not satisfied only with direct service work, however. Research studies are an integral part of our overall service to the public. We need time to collect basic data, synthesize it, and publish the results of our findings on the various underground aquifers. This is highly important because groundwater is the source of supply to about 70 percent of all Iowans and a major source for industrial processing and cooling. Thus we need to study the availability and quality of the water in our aquifers, their recharge and discharge, the direction and rate of movement of the water, artesian pressures, and the flow of water in response to pumping wells. We are undertaking detailed aquifer studies and regional water resources studies in cooperation with the U.S. Geological Survey and test drilling with our drilling rig in support of these projects.

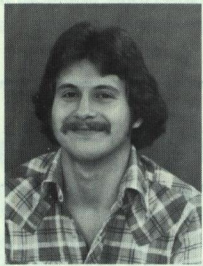
Some of the cooperative groundwater studies soon to be published or begun this year are:

- 1) The Jordan Aquifer of Iowa
- 2) Water Resources of East-Central Iowa
- 3) Water Resources of Northwestern Iowa
- 4) Water Resources of Northeastern Iowa
- 5) A Statewide Hydrologic Model.

(Mr. Horick is Chief of the Groundwater Division.)

WATER RESOURCES TEST DRILLING PROGRAM: NORTHWEST IOWA

By Greg Ludvigson and Bill Bunker



Greg Ludvigson



Bill Bunker

The drought conditions of recent years in northwest Iowa have heavily impacted local crop farmers and spurred an intense and often emotional debate over the advisability of sprinkler irrigation development. Continuous yields sufficient to maintain a center-pivot sprinkler system (approximately 1000 gpm) are known to be available from some alluvial and glacio-fluvial sands and gravels in the area. These deposits, however, are limited in areal extent, and for most potential irrigators, the Dakota Sandstone of Cretaceous age is the only economically available alternative. The hydrogeology of this aquifer, actually a vertical sequence of several sandstones which may or may not be hydraulically connected, is very poorly understood.

Faced with the nearly impossible task of determining who can and cannot obtain irrigation withdrawals from the Dakota Sandstone without adversely affecting neighboring water users or the aquifer itself, the Iowa Natural Resources Council last summer placed a three-year moratorium on new irrigation permits for Dakota wells.

Since that time, the Iowa Geological Survey and the U.S. Geological Survey have been involved in a cooperative test drilling program to construct a stratigraphic model of the Cretaceous rocks of northwestern Iowa. This constitutes the first phase of a regional water resources investigation. Our knowledge of the three-dimensional configuration of sandstones in the subsurface is of critical importance in this study, as no valid hydrologic research can be conducted without an understanding of the geometry and limits of the reservoir in which the water is contained.

Before drilling began, we decided that preliminary mapping of the Cretaceous rocks would be of great value in choosing the best test-drilling sites. To shorten the time needed for this assessment, a computer plotting program designed by Sue Davis was used. (see article on p. 21) The resulting maps have enabled us to: (1) choose drilling sites which afford penetration of the greatest possible thickness of the Cretaceous System, and (2) develop a geologic model which we have been able to test systematically. Each test hole drilled has partially penetrated the sub-Cretaceous rocks, providing data which is needed to refine our present understanding of the pre-Cretaceous topography and the influence it exerted on the earliest Cretaceous deposition in the project area.

From July 1 to October 14, 1977, when this report was written, the Survey drilling crew had drilled six test holes ranging in depth from 292 to 664 feet. During the last month of this period, the first test core hole was drilled near Oak Grove State Park northwest of

Hawarden in Sioux County. This core hole, finished in Precambrian biotite granite at 664 feet, is the deepest test hole yet drilled by the IGS Failing 1250 rotary rig.

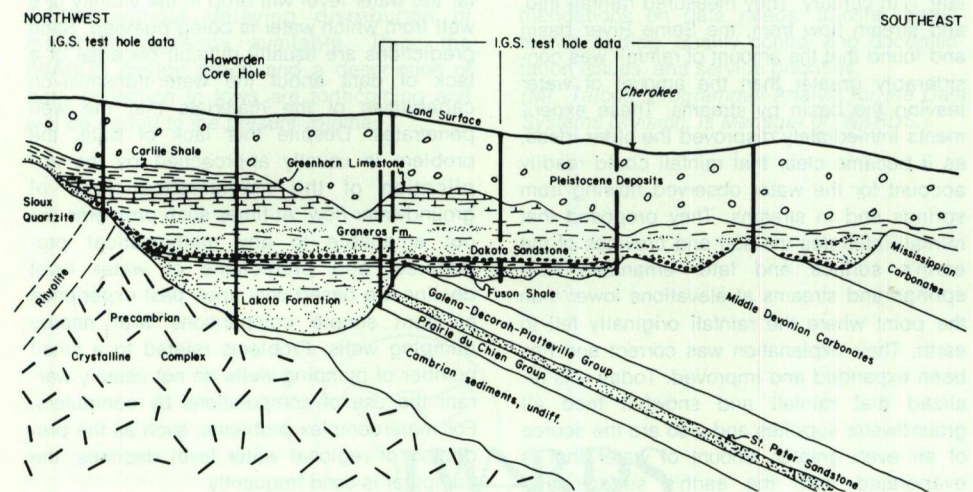
The model presently being tested for basal Cretaceous sandstone sedimentation involves fluvial deposition on a pre-Cretaceous erosion surface controlled by Paleozoic strata dipping from 30 to 60 ft./mile to the southeast. This erosion surface appears to be integrated into a trellis drainage system, with streams draining to the southwest along valleys parallel to the strike of the Paleozoic rocks. This inferred drainage direction is consistent with paleocurrent data reported from Dakota Sandstone outcrops in western Iowa, eastern Nebraska, and central Kansas.

In the past, sandstones penetrated in wells in northwest Iowa have generally been correlated as the Dakota Sandstone; however, it is apparent that there exists a multiple stacking of sandstone units. Within the pre-Cretaceous valley systems there appear to be two major sandstone units, the lowermost of which we are informally calling the *Lakota Sandstone*, which becomes increasingly argillaceous upward and grades into approximately 20 feet of red mottled gray shale that we are tentatively calling the *Fuson Shale*. The overlying Dakota Sandstone is gravelly at

the base and generally cleaner than is the Lakota. The Dakota also appears to be more widespread, probably because of successive burial of the irregular pre-Cretaceous surface. The accompanying generalized illustration depicts the stratigraphic relations between the Cretaceous deposits with the underlying Precambrian and Paleozoic rocks of northwestern Iowa.

In addition to our own test holes, we have actively participated with commercial well drillers and private citizens to obtain subsurface information. We have logged 13 private and municipal wells with the same borehole geophysical logging unit that we are using for our own test holes. We feel that these logs will provide the necessary elements to correlate from test hole to test hole and possibly define some of the hydrologic characteristics of the basal Cretaceous sandstones. Controlled pump testing from Cretaceous sandstone wells should begin in the next few months; however, testing and proving the geometry of the physical system will remain the most important task for the immediate future.

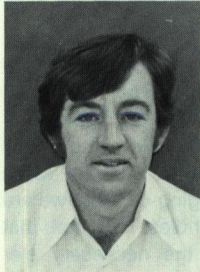
(Mr. Ludvigson is a Research Geologist in the Groundwater Division; Mr. Bunker is a Research Geologist in the Subsurface Division.)



Generalized northwest-southeast cross-section through the northwest Iowa Project Area.

GROUNDWATER

By Dr. Logan K. Kuiper



Groundwater is present in the soil and rock materials beneath the surface of the earth. It is the water that flows from springs, seeps into ravines and streams, and is withdrawn from wells. Despite its great importance to man, its origin was not understood correctly until the latter part of the 17th century. Before this time it was thought that the amount of rainfall received on an area was too small to account for the quantities of water observed in streams and springs. It was believed that this water probably came in some way from the interior of the earth or from the oceans. Various mechanisms were proposed to explain how the water rose through the land areas and flowed out into springs and streams. Kepler (1602-1680) taught that the earth was similar to a large animal, that sea water was digested, and that fresh water from springs was the end product of the earth's metabolism. The situation was first correctly understood by two French scientists, Perrault and Mariotte, in the late 17th century. They measured rainfall into, and stream flow from, the Seine River basin and found that the amount of rainfall was considerably greater than the amount of water leaving the basin by streams. These experiments immediately disproved the older ideas, as it became clear that rainfall could readily account for the water observed flowing from springs and in streams. They proposed that rainfall infiltrates the soil and crevices of the earth's surface and later emanates from springs and streams at elevations lower than the point where the rainfall originally fell to earth. Their explanation was correct and has been expanded and improved. Today it is realized that rainfall and snowfall feed all groundwater supplies and also are the source of an even greater amount of water that is evaporated from the earth's surface and transpired by plants.

The path that water takes after infiltrating

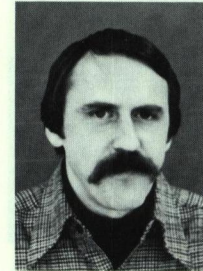
the soil and before discharging again into streams, springs, and wells can be quite complex. Not uncommonly it will migrate to great depths in the rock strata before it rises under pressure to the point of discharge at the land surface. The path can be hundreds of miles in length and the time needed can be as great as millions of years. The situation is somewhat analogous to pouring water into a garden hose filled with sand. No matter what the orientation of the hose and how many loops it has, water will eventually flow from the other end provided that it is at a lower elevation. Most underground materials allow the transmission of water through pores and crevices, although some materials, such as limestone, can have fairly large cracks and channels which readily allow the passage of water. Most water, however, seeps through underground materials much as water would seep through a porous material such as plaster, wood or even concrete. As water moves through underground materials, it obeys certain mathematical laws first discovered by Darcy (1803-1858). These laws permit the application of mathematics to groundwater flow. Today the study of groundwater flow is usually a mathematical problem which can be of such complexity that calculations need to be done by computer.

Groundwater flow problems investigated by the Iowa Geological Survey are of many types, but frequently they deal with predictions about the effects produced by the pumping of wells. A common problem is to determine how far the water level will drop in the vicinity of a well from which water is being pumped. Such predictions are usually difficult because of a lack of data about the water-transmission capabilities of the materials that the well penetrates. Despite this lack of data, the problem is usually approached by the application of the mathematical laws of groundwater flow. At times such problems are not amenable to any mathematical procedures, and predictions of water level decline are based only upon past experience or from simple comparisons with nearby pumping wells. Problems related to a small number of pumping wells do not usually warrant the use of computations by computers. For more complex problems, such as the prediction of regional water level declines, the computer is used frequently.

(Dr. Kuiper is a Geologist in the Research Division.)

THE IOWA WATER RESOURCES DATA SYSTEM

By Richard Talcott



The staff and participants of IWARDS might well adopt the motto, "Be prepared!" as we move towards operational status in four categories of data-management services for the natural resources agencies.

We are striving to be prepared for data requests and data base management assistance.

A significant occasion for IWARDS has been the distribution of the *Data Catalog*, a compendium of background information developed by the Water Plan Group at IGS to support data needs of the Water Plan Framework Study. It contains a directory of water-related agencies in Iowa, an index to Iowa Water laws and regulations, and a computer-based bibliography of documents relevant to water planning, management, and development in Iowa. Because of its loose-leaf construction, additional sections can be added without delaying distribution of materials currently available. Thus, the IWARDS design report and a description of data collection in Iowa are forthcoming and will be added to the present volume.

At present the IWARDS "system management" staff (R. Peter Kollasch and I) are on schedule with the work program in software development and service activity, respectively. Pete has developed the core components of the software package and has undertaken limited data processing demonstration runs with the system. I am reviewing drafts of the IWARDS design report with the Advisory Committee and other staff of participating agencies, am developing priorities for services to agencies, and am working on position statements to aid the Advisory Committee in their policy and procedure decisions. Our participation with the National Water Data Exchange was enhanced by attendance at a NAWDEX Training Center in December.

Demonstration of IWARDS capabilities was scheduled for late 1977 and early 1978, with full operational status by June 1978. At this time IWARDS services will include:

1. Installation and support on the state computer of the IWARDS Data Base Management System.
2. Compilation and maintenance of directories, indexes and a bibliography to provide a "data clearinghouse".
3. Systems analysis services, and
4. Research in data management and data analysis techniques.

The IWARDS goal, to improve the accessibility of water-related data among state agencies and others, is pursued by an inter-agency organizational scheme. The IWARDS Advisory Committee represents participating agencies and makes decisions and recommendations on data needs, transfer agreements, coding, quality control and documentation issues, and service priorities.

(Mr. Talcott, Programmer-Analyst for the Data Systems Division, is Manager of IWARDS.)



IOWA WELL DRILLING

By Earle E. Scheetz



Since 1963 I have been with the Iowa Geological Survey, beginning as a geological technician whose job was to travel the state and enlist the cooperation of Iowa well drillers. This association has resulted in a significant

increase in information provided by the drillers. We gather their samples of drill cuttings and bring them to the Survey for further study. I now visit approximately 240 well drillers in Iowa and neighboring states.

Over the years, I have traveled about 750,000 miles to get data helpful to the Survey. These drillers voluntarily save samples for us and, in return, we furnish them with the results of our geologic analysis for their records and their customers. We provide log books and sample bags to them as well as any information that might help as they drill through Iowa's rock layers. To date, we have 24,618 sets of well samples. The well samples have been processed at our warehouse by a geological aide who prepares them for geologists to examine and log at our main office.

The past few years have been unusual: the drought promoted increased well-drilling, and suburban development also has been an important influence. Wells are being drilled deeper than in the past, resulting in more samples and thus requiring more time in the field distributing sample bags and log books.

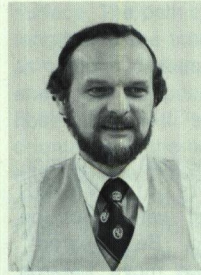
At this time, we have, from about 2,600 wells, samples that haven't been processed for geological study because of lack of time and personnel. In spite of this, our aim is continually to improve service to the drillers and the citizens of the state.

In Iowa we have some of the most professionally-skilled well drillers in the United States, many who are recognized nationally. We are proud to be associated with them.

(Mr. Scheetz is Chief of the Technical Support Division. He is a lifetime member of the Iowa Well Drillers' Association and the National Water Well Association.)

EXCURSIONS AND MEETINGS IN '77

By Donald L. Koch



A Winter Haven

Dr. Stanley Grant attended a meeting of the National Governors' Council on Science and Technology held in New Orleans January 10-11. Dr. Grant was elected vice-chairman for 1977.

Thar She Blows

Bernie Hoyer, Remote Sensing Chief, met with representatives of the Federal Highway Administration on January 10-12 to discuss a program for identifying sites of highway bursts — before they happen. Remote sensing techniques might provide a tool for identifying potential burst sites. Remedial work could be done in advance and result in reduced highway maintenance costs.

Black Gold

IGS staff interested in the Quaternary (Pleistocene and Recent sediments) of Iowa participated in a seminar on January 14 to review the status of projects on soils investigations. New data on engineering properties of soils is an important product of current research.



Driller's Seminar, January 1977: Koch demonstrating petrographic microscope. (Photo by Jim Case)

Play It Again, Sam

Administrative Assistant Wilma Gould submitted her resignation on January 17. Although her new employer is Iowa Electric Light & Power Company at Cedar Rapids, she still retains a tie to the past. Her new (old) boss is former State Geologist Dr. Samuel Tuthill, who now is Vice-President, Energy Resources and Utilization, Iowa Electric Light & Power.

Well, It's a Deep Subject

The IGS-sponsored Water-Well Drillers Seminar of January 24-25 was a great success. The program was rigged to show the drillers what we do with the drill samples that they voluntarily provide us. Everyone agreed that the exchange of information between drillers and geologists is mutually beneficial and, in turn, benefits the people of Iowa.

Over The Lips . . .

Not a bad way to start the month. Orv Van Eck attended a Nuclear Regulatory Commission meeting at the Busch Memorial Center in St. Louis, February 1-2. The topic was seismic studies in the mid-continent region, where most of the current nuclear power plant siting studies are underway.

What's Shallow?

Darwin Evans attended the February 21-23 Shallow Well Drillers' Clinic in Lincoln, Nebraska. One of the shallow IGS-USGS test holes that Darwin drilled in northwest Iowa was 663 feet deep.

Remote Sensor

Bernie Hoyer attended the spring meeting of the American Society of Photogrammetry in Washington, February 27-March 4. He went at the request of the Governor's staff to monitor the national impact of several land-use projects.

. . . , Kansas City, Here I Come

It was an Environmental Protection Agency-sponsored meeting to discuss Public Law 94-469, Toxic Substance Control Act, that brought Fred Dorheim to this fair city on March 9.

Alice In Adventureland

Several IGS staff attended the March 9-10 Annual Convention, Iowa Water Well Association, at Adventureland near Des Moines. Bud Scheetz thought it was an exceptionally profitable experience.

A Mile High

Logan Kuiper attended a ground water modeling workshop in Denver March 23-25.

Listen To It Grow

Pat McAdams and Ray Anderson traveled to Tullahoma, Tennessee for the Sixth Annual Remote Sensing of Earth Resources Conference, March 29-31. The conference placed a strong emphasis on agriculture and included presentations on monitoring of Iowa Corn with LANDSAT and airborne thermography for use in crop irrigation scheduling and monitoring.

We Know The Answer, Teacher

Fred Dorheim and Jean Prior conducted a regional field workshop for geology and geography teachers sponsored by the Department of Public Instruction. Topography, geology, and mineral resources were examined in the Lake Rathbun-Ottumwa-Oskaloosa area during this April 15-16 meeting.

Hot Stuff

April 18-19 saw Orv Van Eck in Knoxville, Tennessee for a conference on National Uranium Resources Evaluation (NURE).

They Went That-a-way

The troops headed for the April 22-23 meeting of the Iowa Academy of Science at Drake University. George Hallberg chaired a special session on Iowa coal as well as the regular Geology sectional meeting.

He's A Card

Ray Anderson presented a Poster session on the production of the Land-Use Map of Iowa at the April 26 International Symposium on Remote Sensing of the Environment at Ann Arbor, Mich.

We Stayed Home

Wally Dressel, the new Liaison Officer for the U.S. Bureau of Mines, visited IGS on April 27 to introduce himself and to review programs of the USBM. And Dr. Robert Corkery, Geological Survey of New South Wales, stopped at IGS on his tour of the U.S. to study deep well waste disposal methods.

The National Scene

Dr. Stanley Grant went to Atlanta, Georgia for the May 19th meeting of the National Governors' Council on Science and Technology. Metrication was a special topic for discussion.

Ole Salty

Orv Van Eck substituted for Dr. Grant at the June 6-9 meeting of the Association of American State Geologists in Delaware. Surf fishing is still fun.

Thirsty Crops

IGS-USGS have started a drilling program in northwest Iowa to evaluate water availability from alluvial deposits and from the Dakota Sandstone. Staff involved met with area drillers in LeMars on June 22 to discuss a program for research wells, paid for by interested landowners, to obtain additional information on water resources of the region.

Drought Continues

Don Koch attended a public hearing held by U.S. Senator Dick Clark in Central City on July 7. The lack of groundwater recharge has resulted in dangerously low water levels in wells in many small communities.

Boston Tea Party

Lucky Bud Scheetz! He attended the September 12-15 meeting of the National Water Well Association in Boston. Bud was given special recognition as a member of the Presidents' Club for his efforts in recruiting new members.

Jazz Quartet

A Nuclear Regulatory Commission-sponsored workshop for state review of site-suitability criteria for high-level radioactive waste repositories was held in New Orleans on September 26-28. Don Koch, State Representatives Mary O'Halloran and Andrew Varley, and Senator Warren Curtis participated.

Pleistocene Confab.

On October 4 and 5 George Hallberg participated in a meeting for Midwestern Geological Survey personnel to discuss the latest findings of investigations into the stratigraphy of early and middle Pleistocene deposits in Nebraska, Iowa, Illinois, and adjacent areas.

Recharged

Paul Horick and Don Koch traveled to Little Rock, Arkansas for the October 5-7 Midwest Ground-Water Conference. It rained.

Tri-State

The 1977 Annual Tri-State Field Conference for geologists and students of geology was headquartered at the University of Wisconsin, Milwaukee, October 8-9. Participants studied Ordovician, Silurian, and Pleistocene units. Jack Gilmore, Ray Anderson, Billy Bunker, and Mike Bounk attended.

No Rest . . .

Friends and former students attended a recognition dinner for Bill Furnish, University of Iowa Geology Department. Although he has retired, he already is active as a Governor's appointee to the State Advisory Board for Preserves.

Where is the Boundary?

IGS co-sponsored a field trip with the Geological Society of Iowa in southeast Iowa on October 29. Facies of the Spergen formation was the topic of discussion. Bonnie Milne, U.I. Geology Department, is studying the formation as a Master's thesis to define areas where the stone is acceptable for road construction.

G.S.A.

Dr. Grant, Jean Prior, and Greg Ludvigson attended the November 7-9 meeting of the Geological Society of America in Seattle, Washington.

Water, Water

On November 8 George Hallberg was part of a panel to discuss "Agriculture and Diminishing Water Resources" at the 2nd Annual Midwestern Conference on Food and Social Policy, in Sioux City.

Bones, Bones, Bones . . .

Bernie Hoyer presented the results of his studies on the several soil horizons at the Cherokee, Iowa Archaeological Site during the November 17 Plains Conference in Lincoln, Nebraska. Three major cultural and soil horizons have been dated at 8,400, 7,200, and 6,350 years. The interdisciplinary studies at this site have provided substantive information on climatic changes in the midwest over the last several thousand years.

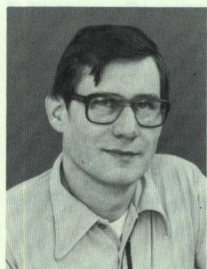
Will Not Compute

Dick Talcott attended the December 13-16 Training Seminar on the National Water Data Exchange (NAWDEX) held at the U.S. Geological Survey's National Center, Reston, Virginia. IGS serves as a NAWDEX Local Assistance Center providing data-search and referral assistance.

(Mr. Koch is Assistant State Geologist.)

COAL RESOURCE PROGRAM

By Dr. Matthew J. Avcin



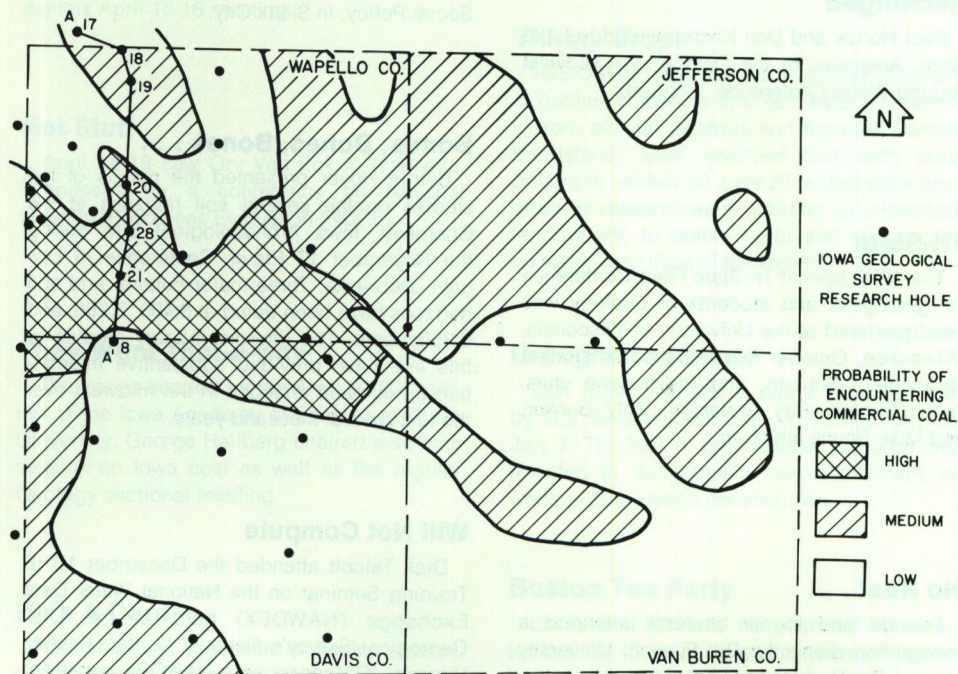
A continuing commitment to the coal research projects introduced in the January 1977 NEWSLETTER has begun to yield results. It has become apparent that study of the microfossils preserved in rock units between

the coals will yield a method of approximate correlations of rock sequences which do not contain readily identifiable coals. More importantly the fossil studies are generating a more nearly complete understanding of the development of these rock sequences.

The palynology, or spore-pollen studies, are progressing even more rapidly than are the other studies, in spite of a number of false starts and some ambiguous results. Approximately 175 species of spores and pollen have been identified from Iowa coal samples, and the staff is assessing the relative utility of each. Particular attention is being given to the easily recognizable and short-ranging forms, such as the two examples illustrated. Presently, it is possible to assign any coal sample to its approximate position within the coal-bearing sequence. Continuing research is being directed at refining our ability to identify coal samples.

Practical application of the data generated by the several research efforts has permitted the staff to produce a preliminary economic potential map of study area I. Similarly, the staff has developed a working model for the deposition of the coal-bearing sequence. In summary, the coal resource program has achieved its immediate objectives, but its ultimate goals will require a good deal of time and hard work.

(Dr. Avcin is Chief of the Coal Division.)



Economic Potential of Study Area I (Preliminary).

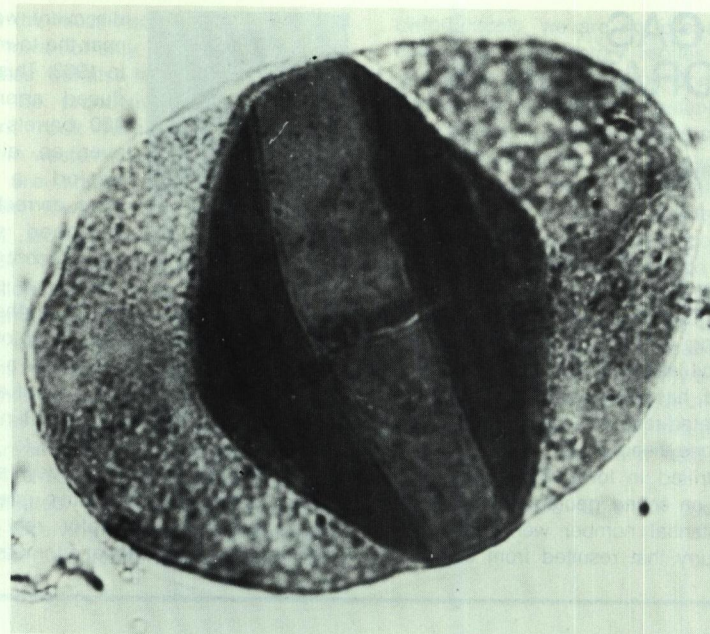


Figure 1. *Florinites cf. diversiformis* Kosanke 1950, 850x, is a fossil pollen grain produced by an early gymnosperm, a group of plants which include the modern pines.

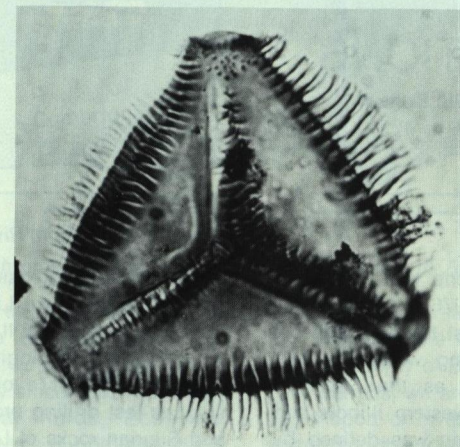
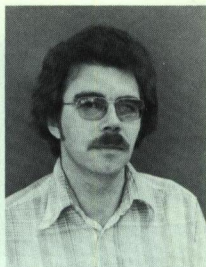


Figure 2. *Renschospora triangularis* Kosanke 1950, 850x, is a fossil spore of unknown affinities. Both examples were extracted from coal samples collected in south-central Iowa and have been enlarged approximately 850 times actual size. (photos by Robert L. Ravn)

OIL & GAS EXPLORATION IN IOWA

By Jack L. Gilmore



discovery well drilled near the town of Keota in 1963. This well produced approximately 400 barrels of crude over an eight-month period, a quantity more correctly termed a "good showing." More recent tests have

similarly produced poor results and only serve further to substantiate the nonproductive nature of the state. Poor results have perpetuated a generally negative attitude upon the part of exploration companies regarding further drilling in Iowa. Large operators are reluctant to invest the substantial amounts of money needed to isolate potentially productive areas, while small operators generally rely on pure speculation in their wildcat attempts.

Historically Iowa has been recognized as an area having a relatively low potential for commercial oil and gas production. Consequently, little has been done in terms of petroleum-related research or exploration. Approximately one hundred oil and gas tests have been drilled in Iowa. Few were prospects based on sound geological investigation. A substantial number were part of a short-lived flurry that resulted from our only

Perhaps the most disconcerting aspect of all is that Iowa not only lies adjacent to producing states, but also has similar rock strata known to be productive in those states. Equivalent rock formations that yield petroleum in western Illinois and northeastern Missouri are known to be present in southeastern Iowa. Similarly, northwestern Missouri, northeastern Kansas, and southeastern Nebraska produce from rock strata analogous to those encountered in southwestern Iowa. It would seem unlikely, then, that Iowa is devoid of petroleum accumulations having commercial value.

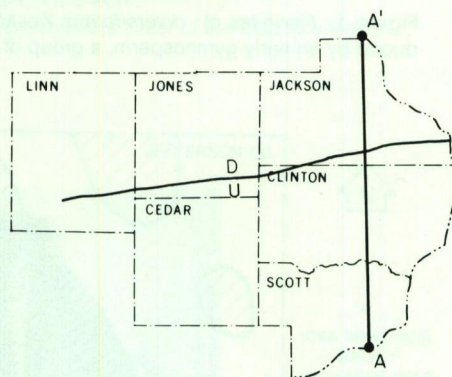
Recent inflation in crude oil prices is having an effect in the petroleum exploration industry. Areas previously considered as marginal in terms of reservoir potential are being re-evaluated. Consequently, we at the Survey are receiving an increasing number of requests for petroleum-related information.

Unfortunately, we are not prepared to make completely satisfactory replies to these requests. In my opinion the primary obstacle confronting exploration companies interested in searching for oil in Iowa is a lack of adequate stratigraphic and structural data and the amount of research and mapping which must be done in order to isolate areas where exploration should be concentrated. Furthermore, I believe this to be precisely the kind of information which should be available from the state. By encouraging exploration through research and publications designed specifically for that purpose, we not only gain a better understanding of our oil potential but also realize benefits through additional knowledge of our water and mineral resources.

(Mr. Gilmore is Chief of the Subsurface Division).

THE PLUM RIVER FAULT ZONE IN EAST-CENTRAL IOWA: CURRENT STATUS OF INVESTIGATIONS

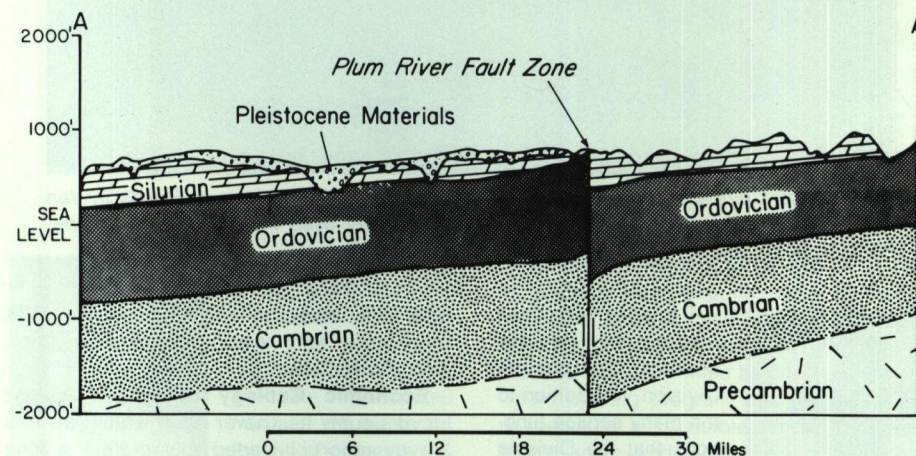
By Greg Ludvigson and Bill Bunker



Location of the Plum River Fault Zone in Iowa.

The potential extension of the fault zone as far west as southern Linn County, Iowa, was first recognized by Bill Bunker in 1975, while he was field geologist for the Carbonate Hydrology Project (a joint IGS-USGS water resources test drilling program in the Devonian and Silurian rocks of Linn County). The zone has major hydrologic significance, as it has placed several aquifers and confining beds in juxtaposition. Several stratigraphic anomalies are associated with the fault zone, suggesting that it was active during Middle Devonian sedimentation and that most of the stratigraphic throw is no later than Pennsylvanian in age (280,000,000-395,000,000 years ago).

The Plum River fault zone was named by Kolata and Buschbach (1976, Ill. Geol. Surv. Circ. 491) for an east-west trending zone of closely-spaced faults along what had previously been recognized as the Savanna-Sabula anticline in northwestern Illinois and east-central Iowa. The zone was defined by detailed geologic studies as part of a seismic hazard evaluation for a potential nuclear-electric generating station at Savanna, Illinois. The studies in Illinois indicated that faulting has displaced equivalent strata from 150 to 400 feet, and was active in pre-Illinoian, post-Silurian time (200,000-395,000,000 years ago).



Generalized north-south cross-section through the Plum River Fault Zone in east-central Iowa.

Where well exposed, the fault zone can be seen to consist of a complex of variably granulated carbonates, which appear to have been locally altered by silica-enriched metal-bearing hydrothermal fluids. Economic mineralization (Upper Mississippi Valley type) at depth along the zone is a distinct possibility.

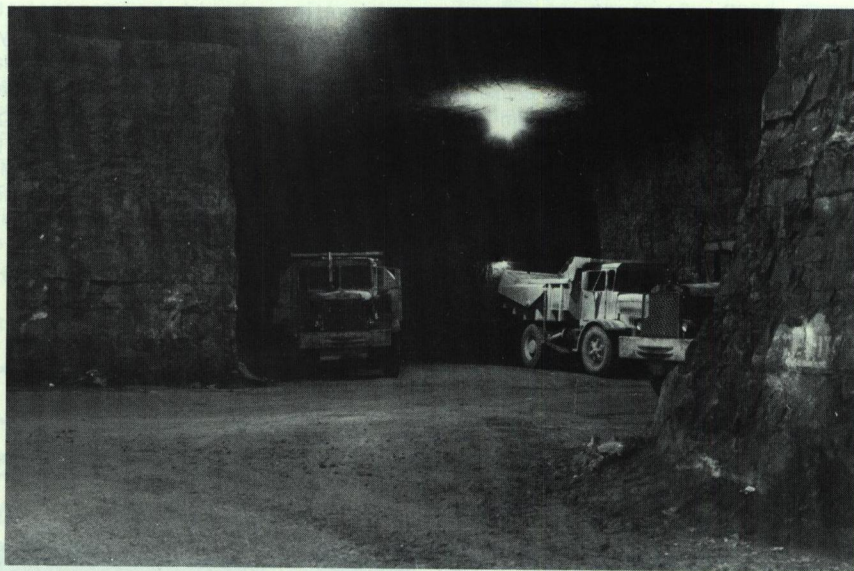
Low altitude color infrared imagery of the fault trace in Iowa was contracted by the Iowa Geological Survey Remote Sensing Laboratory in the spring of 1977 and will serve as a base for future investigations, as topographic map coverage is poor. A joint paper

on the Plum River fault zone was presented by Bill Bunker at the April 1977 meeting of the Iowa Academy of Science in Des Moines. As time permits, we are preparing the text for an IGS Report of Investigations delineating and describing this feature. Looking farther ahead, we are planning on guiding a field trip to examine the fault zone when the Iowa Geological Survey sponsors the fall 1978 Tri-State Field Conference.

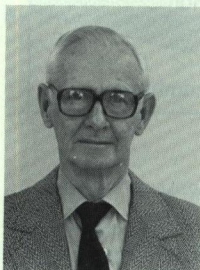
(Mr. Ludvigson is a Research Geologist in the Groundwater Division and Mr. Bunker is a Research Geologist in the Subsurface Division.)

THE MINERAL RESOURCES DIVISION IN 1977

By Fred H. Dorheim



Douds Stone Company Mine, located about a mile east of the town of Douds in Van Buren County, showing the room and pillar arrangement used in underground mining. (Photo by Jim Case)



The year has been interesting for the Mineral Resources Division. In addition to the many service functions that the Division provides, we have been involved in several planned projects.

Fort Dodge Gypsum:

This is a project where, using well logs and earth resistivity, we are attempting to determine the volume of gypsum resources remaining in the Fort Dodge area. This is being done for the municipal zoning board in an effort to prevent the city from growing out over the remaining deposits of gypsum.

Underground Mines: Jim Case and I visited all of the underground mines (exclusive of coal), obtained the histories of the mines, and took pictures. The field work was interesting

and will result in an educational series publication with emphasis on economics. Goal: Early 1978.

Economic Geology of Floyd County:

Floyd County has never been written up in a Survey report. I started this project a long time ago, but landfill work interrupted the research. This report will emphasize economic geology, water resources, and stratigraphy. Goal: Late 1978.

N.W. Iowa Irrigation:

The Mineral Resources Division has been involved in this project running earth resistivity stations between the holes being drilled for the irrigation study. Mike Fox and Bob Lancaster spent part of the summer in N.W. Iowa doing the ER.

Salsbury Project: This project falls in the area of service, and we are involved more than we normally would be because it is the first major study on a toxic-waste disposal site. Out of this study regulations will be formulated to be used in the permitting of

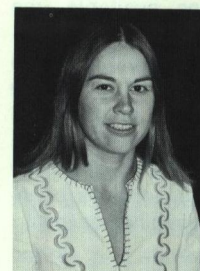
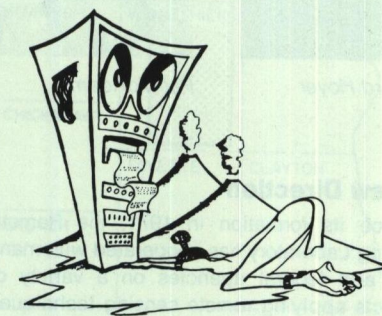
other toxic waste sites. In this study arsenical waste is the major chemical to be disposed. The site is designed to dispose of a slurry type waste in excavated trenches in the Juniper Hill Shale. Working along with the Survey are Department of Environmental Quality staff, consultants for D.E.Q., and consultants for Salsbury Laboratories. Extensive drilling has been done. Permeabilities, both with water and with the waste material, have been run, and studies on the ion exchange

capability of the shale are being run. The trenches will be designed with two low permeability liners with a leachate collecting system under each liner. An elaborate monitoring system also is planned with corrective procedures outlined, should monitoring show any leachate passing the collection systems. Mathematically no leachate should escape the system in hundreds of years.

(Mr. Dorheim is Chief Geologist & Chief of the Mineral Resources Division.)

ENHANCED COMPUTER CAPABILITIES

By Sue Davis



A new geologic printout which eliminates the supplementary "decoding" keys of the past is available. It includes much of the same information presented in the former printout, and, in addition, the thickness and

elevation of the top of each geologic unit is computed. Whereas the former printout required deciphering of the IGS codes for such information as the geologic unit and lithology, the new printout eliminates the codes and "spells out" the information. These printouts are often used by mineral exploration companies, petroleum geologists, and well drillers, as well as by geologists at the Iowa Geological Survey and elsewhere, for use in their research.

In addition, we now can produce computerized plots of geologic and hydrologic

data. Their primary purpose will be to serve as a preliminary step in preparing isopach and other contour maps. A map symbol is centered at the point location of the data, and the data value is printed beside the symbol.

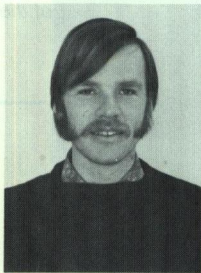
The plotting program was designed to be as versatile as possible. The area of coverage, scale, and projection of the map may be selected to correspond with any selected base map. Optional features include county borders, state borders, latitude and longitude lines or tic marks, a title, and a bar scale in miles or kilometers. Any type of coded data may be plotted.

The computer plots save many tedious hours and therefore costly time spent retrieving the desired data from the files and hand plotting the data at the correct locations. A recent example of the use of the plotting program involved plotting the thickness of unconsolidated materials in northeast Iowa to delineate areas of shallow bedrock.

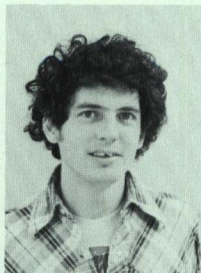
(Ms. Davis is a Geologic Technician in the Data Systems Division.)

REMOTE SENSING DEVELOPMENTS

By Bernard E. Hoyer, Raymond R. Anderson, and M. Patrick McAdams



Bernard Hoyer



Pat McAdams

A New Direction

Since its formation in 1971, the Remote Sensing Laboratory has cooperated with many state and federal agencies on a variety of projects applying remote sensing techniques to specific agency needs. In these projects, the Laboratory has emphasized the use of manually interpreted aerial photography or Landsat photographic products. These can be acquired at low cost, interpreted using existing equipment, and tailored to fit a specific data collection problem. These photographic remote sensing techniques are, and will remain, useful tools for data collection.

In the past, the Laboratory has not vigorously investigated the applications of digitally processed Landsat imagery to resource management problems in Iowa. Our experience has been restricted to cooperative research with the EROS Data Center, Sioux Falls, South Dakota and the Jet Propulsion Laboratory, Pasadena, California. This limited involvement was not, however, without justification. Because of the low resolution capability of the present Landsat satellite imagery and high hardware and operating costs, the general use of digitally processed Landsat imagery in Iowa was not considered to be cost effective.

However, recent software developments now make it possible to process digital Landsat data rapidly, using relatively inex-

pensive hardware configurations based on mini computers. NASA has instituted a "technology transfer" program designed specifically to assist states with incorporating this new technology into their data acquisition systems. The Earth Resources Laboratory (ERL), Slidell, Louisiana, is responsible for the technology transfer program in the Iowa region.

As part of this program, ERL will, upon request, consult with the State of Iowa on the hardware configurations suitable for digital analysis. Also, they will supply software packages for image processing and analysis, for integrating digitally processed satellite data into a natural resource data system, and for the storage, retrieval, and analysis of this integrated resources data base.

In addition to these advances in ground-based technology, the Landsat satellite system will change significantly in the 1980's. Landsat D, scheduled for launch in 1981, will have greatly increased resolution while maintaining the best features of the present Landsat satellites: repetitive, multiband, digital, synoptic coverage.

Looking to the future, the availability of high resolution digital data and rapid, inexpensive, digital analysis systems will greatly increase the effectiveness of Landsat as a natural resources data collection tool in Iowa. To insure that Iowa will be prepared to utilize this data source when it becomes available, the Remote Sensing Laboratory is planning a demonstration project to be carried out with ERL. The objective of this project is to familiarize state personnel with the hardware necessary for digital analysis and the software packages available through the technology transfer program. Interested agencies or individuals are invited to inquire and comment.

Oak Wilt Survey Complete

The cooperative study of the incidence of oak wilt (*Ceratocystis fagacearum*) in selected Iowa forests has been completed. The study was conducted by the Iowa Conservation Commission and the Remote Sensing Laboratory with assistance from the U.S. Forest Service and the Amana Society, and involved development of techniques for identifying diseased trees from color, aerial photography. The forests studied were Amana

(1975), Yellow River State Forest (1975), Stephens State Forest (1976) and Shimek State Forest (1977). Results indicate that oak wilt is not presently a major problem in Iowa, affecting an average of only one of every three-hundred oak trees. Present plans call for a follow-up study of the forests in five years in order to re-evaluate the occurrence of the disease and monitor its spread.

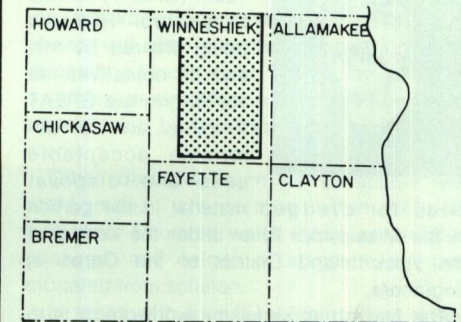
Geologic Hazards and Construction Project Planning

The integration of remotely sensed data and other pertinent information sources into the early stages of large-scale construction project planning can help to reduce delays caused by after-the-fact recognition of environmental hazards. For example, a pipeline company recently proposed the construction of a crude oil pipeline through northeastern Iowa. Much of the proposed pipeline route was in areas of shallow bedrock, with many sinkholes and caves. Recognizing the high potential for pollution of groundwater if a break developed in the line, the IGS and USGS jointly conducted a survey of this hazard. Geologic maps, depth to bedrock data, and Soil Surveys were analyzed to locate those areas prone to sinkhole development. Aerial photography from the 1940's, 1950's, and 1960's was interpreted to map the location of sinkholes and to document the growth of existing sinkholes and the appearance of new sinkholes through time. Conventional 35 mm slides were obtained from a light aircraft to document further the locations of sinkholes. Based on the analysis of these various data sources, the proposed route was abandoned, and another more geologically acceptable route was proposed.

Most of the data utilized in this analysis already existed and could have been integrated into the early planning stages, avoiding the delays created by the proposal of an unacceptable route. We urge that organizations planning similar large-scale construction projects consult with IGS in the early stages of planning. This would help to reduce or avoid potential environmental problems and delays. (Mr. Hoyer is Chief, and Messrs. Anderson and McAdams are Geologists in the Remote Sensing Division.)

ORTHOPHOTO QUAD LITHOGRAPHS AVAILABLE

By Raymond Anderson



Lithographed Orthophoto Quads



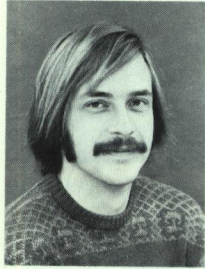
The first lithographed orthophoto quadrangle maps have recently arrived at the Survey. The nine quadrangles, each covering the same 7½ minute area and at the same 1:24,000 scale as the standard topographic maps, are now

for sale here for \$1.25 each plus postage. The quads are all located in the vicinity of Decorah, in Winneshiek County (see map). In all, 10% of Iowa's 252 orthophoto quads will be printed, as were the initial nine, on the same paper stock as used for the topographic maps. The unpublished quads are available as ozalid copies for \$1.00 each. For further information contact me at the Iowa Geological Survey.

(Mr. Anderson is a Geologist in the Remote Sensing Division.)

DREDGED MATERIAL USES WORK GROUP

By James C. Case



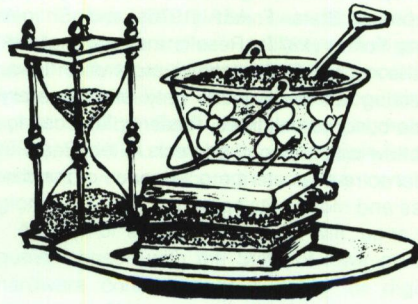
The work group of the Great River Environmental Action Team (GREAT) for the Mississippi River is being chaired by me, and its objectives, as set forth in the GREAT II plan, are to determine acceptable uses and disposal

sites for dredged material in the portion of the Mississippi River under the control of the Rock Island District of the Corps of Engineers.

The first objective of the work group is to analyze and describe constituents and properties of dredged material. We are now in the process of collecting and analyzing sediment samples from disposal sites in the GREAT II reach of the River from Guttenberg, Iowa to Hannibal, Missouri. We are running sieve analyses and studying the mineralogy of critical size fractions for each sediment sample taken. The dredged material is generally a medium-grained sand with variations from a fine sand to a fine gravel.

The second objective of the work group is to determine productive uses for the dredged material. After determining the properties of the material, we will test it for suitability as the fines fraction in concrete and asphaltic concrete. It may be necessary to develop a new concrete mix to come up with a marketable product. It may also be possible to use the material for sanding roads in winter.

The next objective is to conduct a legal study of federal, state, and county statutes that may relate to the disposal of dredged material on private, city, county, or state land. The study will cover the statutes of the states of Iowa, Illinois, Missouri, Wisconsin, and Minnesota. The report will consider permitting



procedures, a study of county and municipal zoning and land use laws, and problems that may arise if the Corps sells the dredged material.

Another objective of the work group is to determine needs for the material. This is where a lot of field work is needed. We expect to contact all private individuals and municipal, county, state, and federal offices that may potentially have a need or know of needs for the dredged material, as well as to get estimates as to how much material is needed, where it is needed, and when it could be used.

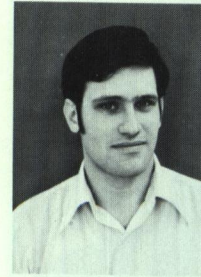
The final objective will be to select potential disposal sites for the dredged material. Many of these will be determined by the need for the material, keeping in mind the restrictions imposed by the dredging process. From a specific dredging location, the dredged material can be hydraulically pumped about a mile up river or down river and about 2,500 feet inland. We will tend to concentrate on areas where there have been chronic dredging problems. We are trying to solicit responses from all sectors, so if any of you know of possible disposal sites or have any ideas concerning productive uses, please let us know.

The GREAT team is composed of 13 work groups that cover nearly all aspects of the Mississippi River. If any of you wish to know more about the work groups and wish to participate, please write me at the Iowa Geological Survey and you will be supplied with all the necessary information. In fact, a Public Participation and Information work group has been formed, and all the members are from the general public. We want your ideas.

(Mr. Case is Chairman of the Dredged Material Uses Work Group.)

CAVES IN IOWA

By Michael J. Bounk



Several hundred caves are known to exist in Iowa. These range in length from fifteen feet to several miles, the majority being under 100 feet. Most are developed in the carbonate rocks of Ordovician to Devonian age in the

northeast and east-central part of the state. Their occurrences depend upon the presence of strata favorable for cave or karst formation and a relatively thin cover of overlying glacial drift.

Although some of the caves along the Niagaran Escarpment in northeast Iowa were formed by the sliding of huge blocks of Silurian Dolomite over the underlying shales of the Maquoketa formation (such as with Bixby Ice Cave in Bixby State Park in Clayton County), most were formed by the solution of carbonate rocks by groundwater below the water table under what are known as phreatic conditions.

Rain picks up carbon dioxide from the atmosphere, forming a weak solution of carbonic acid. When this water reaches carbonate strata, it flows into and through the rock, following any available openings. Because of the relative lack of intergranular porosity in many carbonate rocks, fractures often constitute a major part of the groundwater channelways.

As the water moves through the carbonate strata, it slowly dissolves the rock adjacent to the channelways. This enlarges the openings, allowing a greater volume of water movement and thus a greater rate of solution. As this process continues, the larger openings will pirate water from the smaller, thus enlarging them even more rapidly. The result of this process is a relatively small number of solutional tubes, as compared to the original number of openings, which can vary in diameter from a few inches to several feet. Because these were completely filled with water, moving in response to hydrostatic pressure during formation, they often are characterized by an elliptical shape.

Later, when the ground water level in an area is lowered, these caves will be drained.

However, frequently they will continue to carry ground water as a stream flowing on the floor of the old phreatic tube. These streams will often enlarge the passage under these vadose conditions by downcutting and solution. This has occurred in Cold Water Cave, in Winnebago County, where parts of the main passage have developed a keyhole shape, with the stream flowing in a trench below the original phreatic tube.

Solution may also occur when water flows down joint walls above the water table. Such solution can form a vertical shaft, which when it intersects a cave passage, is known as a dome.

Other modifications of the cave passage may occur when sections of the roof fall, forming breakdown, or cave breccia. The cave stream will often alter the passage further by depositing sand, gravel, silt, or clay, as would a surface stream. Many caves have been completely filled by breakdown and stream sediments.

Other deposits, such as stalactites and stalagmites, are formed when calcium carbonate-saturated water enters an air-filled passage, and calcite or aragonite are precipitated from solution.

In areas with a relatively thin cover of soil and drift directly overlying cavernous carbonate rock, such as in parts of northeast Iowa, a "karst" topography is developed characterized by abundant sinkholes, sinking streams, springs and occasional open caves. Often, sinkholes will be so abundant as to make otherwise good quality land unsuitable for crops.

In many instances, people have attempted to fill sinkholes either with rock and dirt or by using them as refuse disposal sites. Such dumping is unwise for two reasons: (1) unless properly closed, a sinkhole is likely to reopen, and (2) because sinkholes are routes of water travel into the groundwater system, anything dumped into them could result in groundwater contamination.

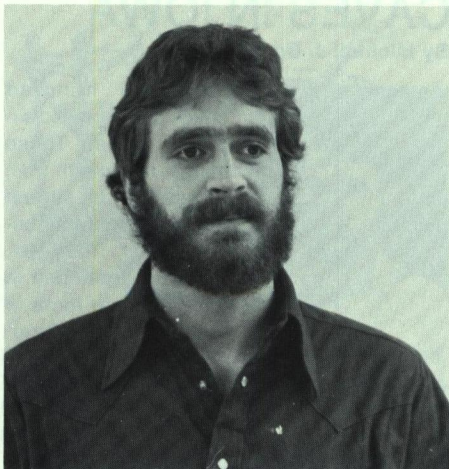
Karst topography also constitutes potential hazards for construction projects. Special engineering design should be included in construction plans where karst conditions exist.

(Mr. Bounk is a Geologist in the Subsurface Division.)



NEW FACES IN '77

KENNETH R. COOK, an Iowa City native, joined the Great River II Team in September as a part-time field assistant to obtain and analyze dredged materials, map potential disposal sites, and determine needs and uses of dredged materials. He attended Washburn University in Topeka, Kansas and in August 1977 received his B.S. degree in Geology from the University of Iowa, where he is a part-time graduate student.



JAYNE HARBAUGH of Iowa City became a full-time member of the Water Plan Group in May after serving part-time for a year. She attended Briar Cliff College in Sioux City and has B.S. and M.A. degrees in Physical Geography from the University of Iowa, where she taught several courses in Geography and environmental impact issues. She has completed most of her requirements for an M.S. degree in Water Resources Engineering and a Ph.D. in Geography. Since completing work with Suzan Stewart on the *Iowa Water Resources Bibliography*, Jayne has been compiling a study report on Iowa water resources data collection programs.



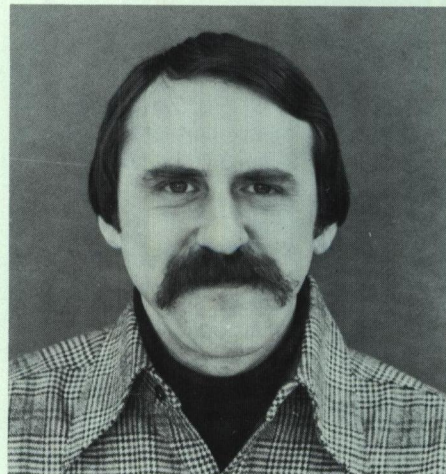
TAMMY JOHNSON, from Mt. Pleasant, Iowa joined the Survey in August, with previous experience as Sales Secretary for Mitchell Engineering, Receptionist and Personnel Clerk for Metro-Mail Advertising of Mt. Pleasant, Iowa and Secretary to the Manager of Aetna Life and Casualty of Davenport. She is a graduate of the Sawyer Business College, Davenport.



MARTHA KAFER of Iowa City began her duties as Administrative Assistant in April after five years as Assistant Executive Director at Oaknoll Retirement Residence, Iowa City. She has an A.A. degree in Liberal Arts from Kirkwood Community College and holds an Iowa Nursing Home Administrator's License. She and her husband Kieth are the parents of five children.



BARBARA MILLER, a Secretary I, came to the Survey in March, with previous experience as Secretary to the Chairman of the Board of Columbus Mills, Columbus Georgia, Service Representative for Pacific Telephone, and as accountant for the Department of Transportation of California, her home state. For three years she attended the University of Maryland branch in Stuttgart, Germany, where her husband, Don, now a Captain and Assistant Professor of Military Science at the University of Iowa, served in the U.S. Army. Barbara and Don have two children. In November she was appointed office manager of the Survey.



RICHARD TALCOTT, a native of Des Moines, joined the Data Systems Division in May as Programmer-Analyst and is Manager of the Iowa Water Resources Data System. Previously he was Research Coordinator at the Institute of Urban and Regional Research at the University of Iowa, where he received his Master's degree in Urban and Regional Planning in 1974 and where he completed the course work for a Ph.D. His academic experience in the design and development of geographic information systems for statewide planning should enhance his work with IWARDS.

RECENT IGS PUBLICATIONS

Compiled by Suzan Stewart



Cagle, J.W., and Heinitz, A.J., 1977, *Water resources of south-central Iowa*: Iowa Geological Survey, Water Atlas 5. In preparation.

Wahl, K.D., Ludvigson, G.A., Ryan, G.L., and Steinkampf, W.C., 1977, *Water resources of east-central Iowa*: Iowa Geological Survey, Water Atlas 6, 90 p. In preparation.

These reports present detailed information on the availability, quality, and utilization of ground and surface water.

Hallberg, G.R., 1977, The use of COLE values for soil engineering evaluation: *Soil Science Society of America Journal*, vol. 41, no. 4, p. 775-777.

An evaluation of the use of the coefficient of linear extensibility (COLE) as a method of quantifying shrink-swell properties of soils and their geologically correlative parent materials.

Hansen, R.E., and Steinhilber, W.L., 1977, *Geohydrology of Muscatine Island, Muscatine County, Iowa*: Iowa Geological Survey, Water-supply Bulletin No. 11, 60 p. \$1.00 plus 50¢ p/h.

Harbaugh, J., Huelsbeck, C., and Stewart S., 1977, *IWARDS data catalog*: Iowa Geological Survey, Iowa Water Resources Data System, volume 1. Not available from IGS: May be consulted at public libraries, college libraries, and county offices of the Cooperative Extension Service.

Reference source on water resources, which includes a comprehensive bibliography of publications on Iowa's water resources, an index of Iowa water laws and rules, and a directory of state and federal agencies with water resources responsibilities.

Schuetz, J.R., and Matthes, W.J., 1977, *Fluvial sediment data for Iowa*: Suspended-sediment concentrations, loads, and sizes; bed material sizes, and reservoir siltation: Iowa Geological Survey, Technical Information Series, No. 6, 410 p. \$3.25 plus \$1.00 p/h.

A compilation of published information on sediment carried in Iowa water bodies.

Stewart, S.M., and Stanek, E.J., 1977, *Impact of restricting beverage container use in Iowa*: Iowa Geological Survey, 40 p. Reports the impacts that a mandatory deposit on beverage containers would have on Iowa's economy and environment.

Maps

U.S. Geological Survey, 1976, *Aeromagnetic map of Iowa*: U.S. Geological Survey, Geophysical Investigations Map GP-910. \$1.25 plus 30¢ p/h.

Zietz, I., Gilbert, F.P., and Kirby, J.R., 1976, *Aeromagnetic map of Iowa: Color-coded intensities*: U.S. Geological Survey, Geophysical Investigations Map, GP-911. \$1.50 plus 30¢ p/h. A compilation of regional aeromagnetic data, available in color-coded and black and white forms.

New 7½ minute topographic quadrangle maps of Iowa:

Anamosa	Elma	Manchester	Ryan
Anamosa NE	Hopkinton W.	Masonville	Springville
Cheney	Independence	New Hampton	Troy Mills
Coggon	Ionia	Prairieburg	Aaker
Earlville	Jerico	Quasqueton	Winthrop

Available from IGS for \$1.25 each plus 75¢ p/h for from 1 to 10 maps, and 25¢ p/h for additional groups of 5 maps.

Availability: All the listed publications, except the *IWARDS catalog*, are available for the listed prices from Iowa Geological Survey, 123 North Capitol Street, Iowa City, IA 52242

(Ms. Stewart is Information Specialist for the Survey.)

