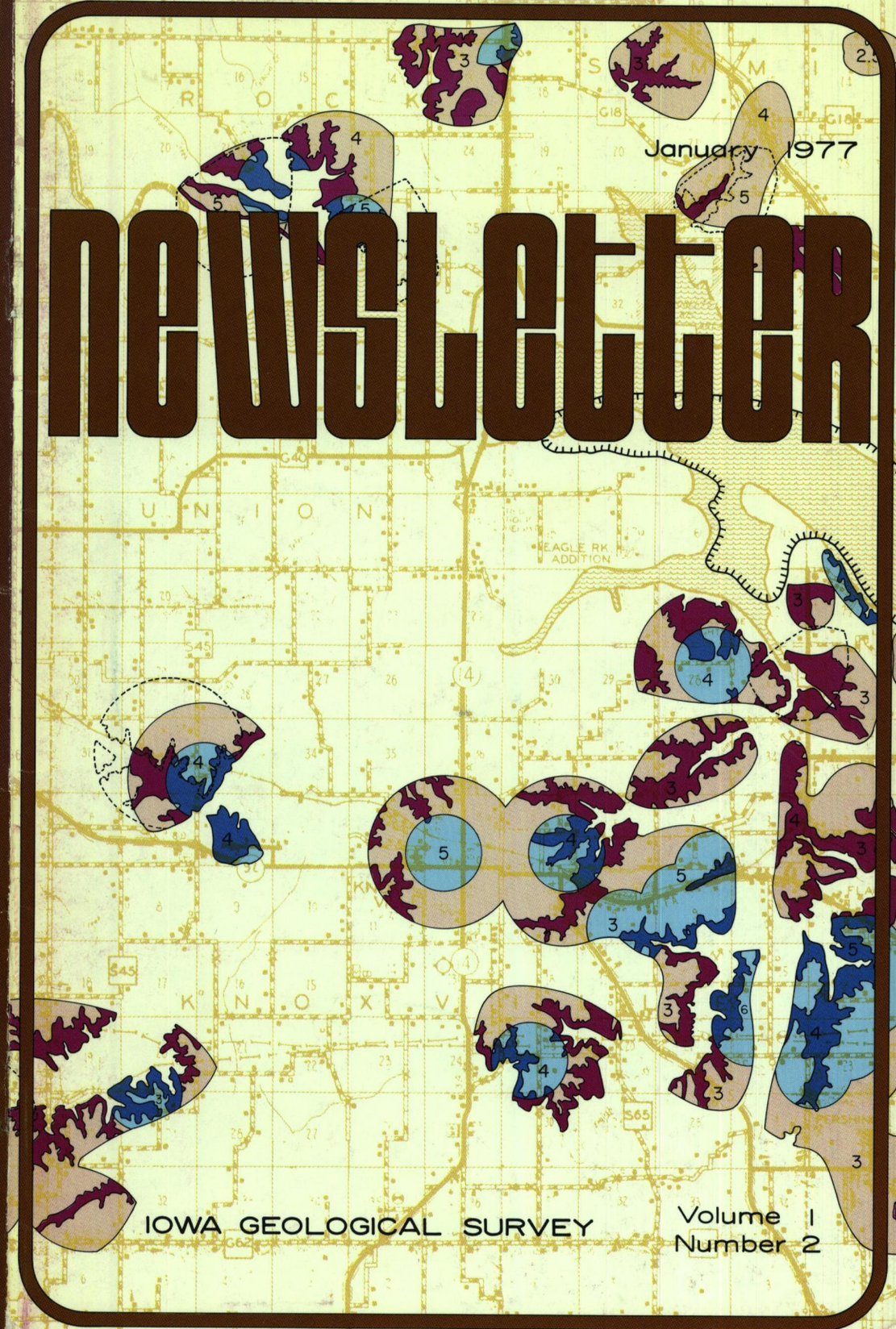
January 1977

newsletter



IOWA GEOLOGICAL SURVEY

Volume 1
Number 2

newsletter

Vol. 1, No. 2 January 1977

IOWA GEOLOGICAL SURVEY

123 North Capitol St.
Iowa City, Iowa 52242

Dr. Stanley C. Grant
Director and State Geologist

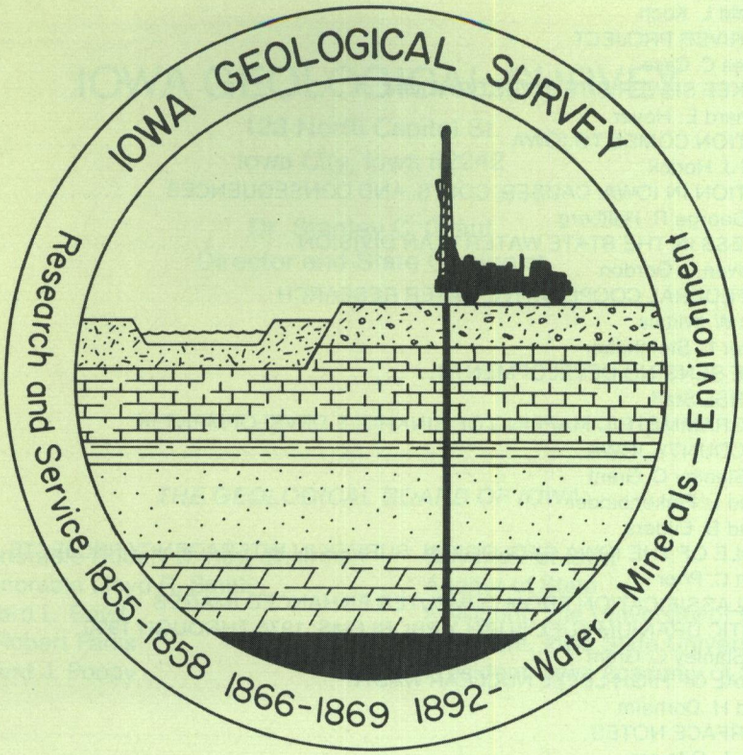
Front Cover: A map of strippable coal reserves for a portion of Marion County. (See article, page 36)

Back Cover: A wood carving by Wilma Gould of "Iowa . . . a place to grow", Iowa's theme and symbol, now hanging in IGS's front office.

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

Cartoons by Jack L. Gilmore

TABLE OF CONTENTS



ON THE OUTCROP WITH THE DIRECTOR

We have been pleased with the reception of the first issue of the *Newsletter*. Three-thousand copies were distributed during the last year, and only a dozen or so remain in permanent file. Most of the distribution came from requests, so we believe that publications such as the *Newsletter* do get looked at and read by many persons. We will continue to publish the *Newsletter* as an informative document prepared for Iowa's citizens who are interested in the physical resources of this state and who are concerned about how the Survey's tax dollars are used.

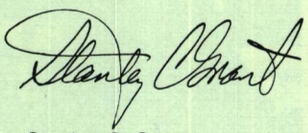
In this issue of the *Newsletter* we want to honor the distinguished members of the Geological Board of Iowa. The Board reviews the work of the Survey each year and approves the annual report as prescribed by law. Recommendations and directions given by the Board become a part of the programs and/or policy of the Survey for the coming year. The Board provides valuable advice, assistance, and direction to the Survey throughout the year.

Also, in this issue, we are presenting short articles on the programs, projects, research, and service carried on by the Survey in our bicentennial year. Service is our principal responsibility. We are tasked by the *Code of Iowa* to investigate all "of the natural resources of the State in all of their economic and scientific aspects." We are also charged to investigate the characters of the various soils and their capacities for agricultural purposes, to investigate the water supply, and investigate "any other scientific and natural history matters that may be of practical importance and interest." Some of these tasks we do in cooperation with other designated agencies.

The Iowa Geological Survey has no regulatory function. We provide technical advice based upon the scientific facts and evidence that we have on record and can determine by research and investigation. We advise state agencies and all branches of government, the colleges and universities, industry, and most of all the people of Iowa. We have joint cooperative programs with several federal agencies, and the State Geologist or members of the Survey staff serve on many state government boards, councils, and commissions. Over 800 direct-contact projects were completed by the Survey staff in fiscal 1976.

The Geological Survey publishes the results of research programs for public use. Books, reports, pamphlets, maps, and data sheets are produced in quantity each year and to the highest of quality standards. The technical level of publications is designed for the most logical users. Elsewhere in this issue you will find a list of new publications of the Survey.

The logo of the Iowa Geological Survey states the basics for our operations and performance: Research and Service in Water-Minerals-Environment.



Stanley C. Grant
Director and State Geologist

GEOLOGICAL BOARD MEETS

The annual meeting of the Geological Board of Iowa was held at the Statehouse in Des Moines September 10, 1976. Discussions of the Survey's accomplishments during 1975-1976 included reviews of the report, *Irrigation in Iowa,* the topographic mapping program, the status of Cold Water Cave, and the progress of the Coal Research Program. All programs and projects of I.G.S. are described in the *Annual Report of the State Geologist,* Vol. 47.

The Board includes as Chairman the Hon. Robert D. Ray, Governor of Iowa; 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. Willard J. Poppy, Professor Emeritus of Physics at the University of Northern Iowa. Serving as Secretary of the meeting was Dr. Stanley C. Grant, Director of the Geological Survey.

The Board in Profile

Governor Ray is a native of Des Moines and saw overseas service with the U.S. Cavalry. As a student at Drake University, he was president of several social, professional, and honorary fraternities and of the student body. In addition to degrees earned at Drake in Business Administration and Law, Governor Ray has honorary degrees from several colleges, including Central, Cornell, Grinnell, Iowa Wesleyan, Luther, the College of Osteopathic Medicine and Surgery, Upper Iowa, and Westmar. From Drake he received the Distinguished Alumnus Award and the Order of the Coif, a legal fraternity honoring those in the top ten percent of a class. As one active in the Iowa Boy Scout recruiting programs, he is an honorary advisor of the National Boy Scout Council. He also has received the National Distinguished Service award from the Future Farmers of America.

Governor Ray has been a leader in protecting natural resources through such environmental clean-up efforts as the "Governor's Spring Environmental Action Week" and reorganizing the various anti-pollution agencies into the single Department of Environmental Quality. He also proposed and implemented the Department of Transportation. He has reformed Iowa's outdated judicial system and has created a new school foundation program that shifts the levy of millions of school dollars from property to more progressive tax sources.

Time magazine in 1974 named Ray one of America's 200 rising young leaders. He chaired the Midwest Governor's Conference in 1972 and the National Conference in 1975-76. He has served as President of the Council of State Governments' Executive Committee and as a member of the Advisory Commission on Intergovernmental Relations. He led a 1972 delegation of 12 governors on a State Department mission to Japan, was chosen as one of six governors to visit the People's Republic of China in 1975, and was one of eight governors to visit the Soviet Union. He has also served on the President's National Reading Council.

At the completion of his current term, Governor Ray will have served as Iowa's chief executive longer than have any of his 32 predecessors. In addition to his many accomplishments cited, he "has stressed problem-solving government . . . promoted agricultural and economic development," begun the revitalization of Iowa's railroads, and initiated energy management and research in the state.

Photo by William Jackson

Geological Board. Left to right: Dr. Parks, Gov. Ray, Dr. Boyd, Dr. Poppy, Mr. Smith

---

The Hon. Lloyd R. Smith has been elected Auditor of State since November 1966. A native of Forest City, Iowa, he holds the A.A. degree from Waldorf College and attended the Chillicothe (Missouri) Business College, Drake University, and Grand View College.

Having served in the U.S. Navy in World War II, Smith is a member of the American Legion and of the National Association of Accountants. He is also a Certified Internal Auditor. Prior to his current office, he served for 16 years in the State Treasurer's office and was Superintendent of the Gas Tax Refund Division and an auditor in the State Auditor's Office for nine years.

Dr. Willard L. Boyd, a native of St. Paul, Minn., became President of the University of Iowa in 1969, the 15th person to hold permanent appointment to that office. He holds bachelor of science in law and bachelor of law degrees from the University of Minnesota and a master of law and doctor of juridical science from the University of Michigan. He holds honorary degrees from the following colleges: Buena Vista, Cornell, Marycrest, and Coe. He also received the Order of the Coif from the University of Minnesota Law School.

From a law instructor in 1954, Dr. Boyd rose to full professor by 1961. He served as Vice-President for Academic Affairs and Dean of the Faculties at Iowa for five years. In 1970-72, he was a delegate to the Hague Special Commission on Succession of the Hague Conference on Private International Law. In 1972 and 1973 he took part in conferences of the Council on Higher Education in American Republics, and from 1972 to 1975 he chaired the Governor's Conference on Iowa in the Year 2000, to which he was reappointed. Also in 1975, he served on the U.S. Senate Commission on Operation of the Senate.

Dr. Boyd is on the American Council on Education Commission on Academic Affairs and the Advisory Committee of the Office for the Advancement of Public Negro Colleges of the National Association of State Universities and Land-Grant Colleges. In September 1976 President Ford appointed Dr. Boyd to the National Council on the Arts. Most of the numerous articles and monographs that he has written deal with international law, decedents' estates, and workman's compensation law.

Dr. W. Robert Parks, a Tennessee native, became the 11th President of Iowa State University in 1965, after serving as Vice-president for Academic Affairs and Dean of Instruction. He holds a B.A. degree from Berea College in Kentucky, an M.A. from the University of Kentucky, and a Ph.D. from the University of Wisconsin, all in political science with minors in economics.

From 1940 to 1948, with the exception of almost three years as an officer in the U.S. Navy, he served in a research and administrative capacity in The Bureau of Agricultural Economics in Washington, D.C. The

author of a basic work on soil conservation, Dr. Parks also contributed to several other books and professional journals in agricultural economics and educational and public policy.

In 1973 he was President of the National Association of State Universities and Land-Grant Colleges and is on the board of directors of Central Life Assurance Company.

Dr. Willard J. Poppy, born in New London, Wisconsin, is Professor Emeritus of Physics at the University of Northern Iowa. He has the bachelor's degree from the University of Wisconsin at Oshkosh and the master's and Ph.D. degrees from the University of Iowa. He taught mathematics at Wisconsin's Oshkosh campus and at Fenn College (now Cleveland State University), where he headed the Physics Department and rose to the rank of Professor. He joined the U.N.I. Physics Department in 1949 and has been a professor of Physics and Astronomy since 1953, having reached emeritus status in 1975. He still teaches an astronomy course at U.N.I.

Dr. Poppy has published eight works in the physical sciences, notably the distinguished textbook, *Exploring the Physical Sciences.* He has held six appointments in the Iowa Academy of Science, to which he was elected President in 1976. He has attained five special awards and recognitions, including the Outstanding Educator of America and Iowa Academy of Science Merit awards. Dr. Poppy holds membership in six professional societies, including Sigma Xi and Kappa Delta Pi.

GEOLOGY AND THE EARTH'S RESOURCES

by Orville J Van Eck

Geology is the study of the earth and the earth is our home. That is a fact and shall remain so until some distant date when man establishes himself on some distant planet. Until such time, man is dependent upon the earth for his total support and sustenance.

The geologist recognizes that such support and sustenance must come from the resources of the earth. If man is to maintain the present level of civilization, or, in some situations, improve the level of civilization, those resources must be managed wisely.

This raises the question: How do we manage wisely when we are not totally sure what we have to manage? The answer is: It can't be done! Geologists are working to provide the answer as to what we have to manage. Geological surveys or their counterparts around the world are attempting to arrive at some reliable estimates of what our total resources are. When those estimates are available, logical management decisions can then be made.

The Iowa Geological Survey has long recognized this fact and as a consequence has set as its goal the following:

> To collect, reposit, interpret, and disseminate earth resources information relevant to the conservation, protection, development, utilization, and management of the geologic and hydrologic resources of the State of Iowa.

Programs are designed to achieve that goal. It is not an ultimate goal in the sense that absolutely all of the resources information will ever be obtained. To achieve that goal would require expenditures of time and money far beyond what could be justified by any means of reasoning. Further, as new technologies develop, the classification of resources broadens and thus puts the ultimate goal further away.

Within the bounds of reasonable economy, the Survey endeavors to design and pursue programs that will bring the state to the goal we have established. With changing socioeconomic conditions the scope of that goal will change, but the intent at all times will be to provide to the decision-makers in the state that information necessary to manage our resources in a wise and conscionable manner.

(Mr. Van Eck is Associate State Geologist)

EXCURSIONS AND MEETINGS

by Donald L. Koch

Earth Resources Data Management Conference

Bernard Hoyer attended a conference on Future Directions for Earth Resources Data Management Systems at Washington University, St. Louis, Missouri in April, 1976. The conference provided a forum for the Center for Development Technology to report the results of NASA sponsored research on the applicability of remote sensing to meet resource data needs in Illinois, Iowa, Minnesota, Missouri, and Wisconsin. Hoyer presented an address on the "Data Needs of Iowa." The presentation reviewed a center report on earth observation systems for N.A.S.A. and showed that the success of remote sensing may be measured by its acceptance into normal data collection procedures by state government. The review concluded that the acquisition of high-altitude, color-infrared imagery, obtained during the springtime, would be the most beneficial remote sensing data for the state of Iowa at the present time.

Our Changing World

Bernard Hoyer participated in a six-week summer archaeological dig at the Cherokee Sewer Site (in Cherokee, Cherokee County) in July and August. A series of buried soil horizons and bone layers (butchered bison bones with artifacts) provide material for documentation of both natural and human events that occurred in this area over the last 10,000 years. Published results of this multi-discipline endeavor will make for fascinating reading. (See article, p. 12)

Huck Finn Returns

From July 12 to 16, James Case participated in the "Great River II" trip under the auspices of the U.S. Army Corps of Engineers to examine dredge sites and potential recreation areas and study the geology of the bluffs of the Mississippi River. (See article, p. 11)

Good Timing

While high temperatures and near drought conditions prevailed, Dr. Stanley Grant, State Geologist, travelled to Denver, Colorado on July 16 to meet with Dick Keefer, Regional Geologist, Central Region, U.S. Geological Survey. Discussion centered on potential cooperative projects with U.S.G.S. to provide geological information in areas with critical unmet needs.

Poor Timing

It was hotter yet in Lawrence, Kansas on July 21 when Orv Van Eck, Don Koch and George Hallberg met with representatives of the Kansas, Minnesota, Missouri, Nebraska, Illinois, and Oklahoma Geological Surveys and the Nuclear Regulatory Commission. The NRC is supporting studies in structural geology and seismicity monitoring in the midcontinent, where most of the current activity in nuclear power plant siting studies is located. (Also see article, p. 27)

A Thick Cover

Jean Prior lectured on landforms of Iowa and presented an overview of the energy situation in Iowa at the Iowa Teachers' Conservation Camp, Iowa Lakes Community College, Emmetsburg, on July 22-23. A field trip on Pleistocene geology in Dickinson County was enjoyed by everyone. The glacial sediments are over 200 feet thick at many upland sites near Emmetsburg. Information on the subjacent bedrock is available only from deep drill holes.

All Roads Lead To Rolla

Topographic maps that you use to study terrain, measure slopes, plan development sites, or to look for the best fishing hole are printed at the U.S.G.S. Topographic Mapping Center, Rolla, Missouri. Ray Anderson and Greg Ludvigson attended a map workshop on July 28-29, and saw the cartographic equipment used in the preparation of modern topographic maps. For areas of Iowa for which 7-1/2' quadrangles presently are unavailable, Ray will arrange to purchase mylar copies of orthophoto quads. IGS will make ozalid prints upon request. (See article, p. 30)

The Missouri River By Way Of Minneapolis

Gary Kress attended the Missouri River Basin Commission Meeting in Minneapolis, Minnesota on August 3-5. MRBC chairman, John Newberger, presented "A Report on Critical Water Issues in the Missouri River Basin". The states are individually and collectively achieving significant input into decisions made at the federal level.

D.C., not A.C.

Suzan Stewart, research librarian, traveled to Washington, D.C., August 10-13 to meet with Iowa Congressional staff and representatives of energy and environmental agencies to inform them of IGS programs and policies, and to provide them with information on Iowa's natural resources.

Land-Use in Iowa

Ray Anderson presented "An Overview of Land-Use in Iowa" to SCATE (Students Concerned About Their Environment) on August 17 at the Springbrook Conservation-Education Center near Guthrie Center. Ray has completed a report on the techniques and procedures used in preparation of the map Land-Use in Iowa, 1976. The report is available as IGS Technical Information Series No. 4. (Also see article, p. 25)

Two In One

Two staff members presented papers at the Sept. 28-Oct. 1 meeting of the American Society of Photogrammetry in Seattle, Washington. Bernard Hoyer presented "Development and Testing of Operational Flood Mapping Techniques", and Pat McAdams presented "Techniques for Estimating Flood-Produced Crop Damage Using Aerial Photography". Both papers are printed in the *Proceedings* volume for that meeting. (See item, p. 20)

Dr. Grant Was On The Outcrop

IGS co-sponsored a field trip with the Geological Society of Iowa in the Ft. Dodge area on September 11. The trip was open to college and university geology and earth science students, professional geologists, and other interested individuals. Gypsum, limestone, coal, clay, and sand and gravel resources of the area were studied. Fred Dorheim, James Case and Dr. Stanley Grant were trip leaders, and approximately 60 persons attended.

Easy Come, Easy Go

Earl "Bud" Scheetz attended technical sessions of the National Water Well Association, September 12-16, at Las Vegas, Nevada. Bud reports that he benefited from the meeting. He was honored as a member of the President's Club for his efforts in securing new members for the organization. (See article, p. 36)

Photo by Dr. Dennis O'Brien

Ft. Dodge Field Trip

Ground Water Quality Symposium

Don Gordon and Logan Kuiper of the Geological Survey attended the third National Ground Water Quality Symposium held September 15-17, 1976 at Las Vegas, Nevada. Topics potentially adaptable to the Iowa situation were Predicting Physical and Chemical Alteration of Land-Treated Wastewater, Land Disposal of Sewage, Controlling Pollution from Sanitary Landfills, Reduction of Nitrate Contamination, Monitoring the Flow of Polluted Ground Water, Artificial Recharge as a Solution to Pollution, Managing the Movement of Contaminants, and Protecting Mines, Wells, and Pits.

D.C. Revisited

Dr. Grant went to Washington, D.C., on September 20 for a meeting of the National Governors' Council on Science and Technology. The NGCST is investigating ways by which it can assist the National Governors' Conference on Energy and the Environment in specific areas of science and technology. Dr. Grant is vice-chairman of the NGCST.

You're Gonna Burn

Matt Avcin and Paul Van Dorpe were in Reston, Virginia September 27-28 for a seminar on coal, hosted by the U.S.G.S. Topics ranged from aspects of coal exploration to present and future, more exotic uses of coal for man's benefit.

Shortcake

Energy and environmental geology are still in the forefront of news. Dr. Grant and Fred Dorheim participated in the Midwest Regional Environmental Education Conference on September 30 at Camp EWALU near Strawberry Point.

Avail Yourself

State Geological Surveys from the Central Region attended a seminar session hosted by the U.S.G.S. Geologic Division October 4-6, for a review of present and planned projects in those states. The meeting was in Vail, Colorado. The geology was great, the aspen were golden, but it was too early for skiing. Nevertheless, Orv Van Eck and George Hallberg volunteered to attend.

Tri-State

The 1976 Annual Tri-State Field Conference of geologists and students of geology was headquartered at Western Illinois University, Macomb, October 8-10. Participants studied Mississippian, Pennsylvanian and Pleistocene stratigraphy and collected geodes. Although this important conference usually is supported by a strong I.G.S. contingent, only Matt Avcin and Mike Bounk attended.

Mapping Symposium

Ray Anderson and Pat McAdams attended the William T. Pecora Symposium on Mapping held at the EROS Data Center, Sioux Falls, S.D., October 25-27. The meeting provided the IGSRSL staff with information on present application of Landsat (satellite) imagery and future Landsat systems.

10-4 Good Buddy

Jean Prior was the leader of a landforms field trip for the West Lakes Division, Association of American Geographers, which met at the University of Northern Iowa, October 28-29. Landforms were examined in parts of Blackhawk, Buchanan and Delaware Counties. Citizens Band Radio was used for communication between vehicles on this dominantly "arm chair" tour. Jean's handle? Top Priority!

Dredged Materials

Chief Geologist Fred H. Dorheim participated in a meeting of the Dredged Materials Use subcommittee of the Great River Environmental Action Team at La Crosse, Wis., November 4. The chief topics discussed were environmentally acceptable methods of placing and the proper use of dredged materials.

A Mile High

Ray Anderson and Jean Prior were the lucky staff members to attend the November 8-11 Geological Society of America meeting in Denver.

Water, Water Everywhere?

The Sioux City Extension of Iowa State University Agricultural Extension Service sponsored a November 16 meeting on Planning an Irrigation System. Don Koch presented information on water sources. If demands on water for irrigation continue to increase, such a meeting might be appropriate for other sections of the state. (Also see articles, pp. 14, 15)

. . . , Kansas City, Here I Come

Donald Koch participated in a November 17-18 meeting at Kansas City, Missouri, sponsored by the Region VII office of the Environmental Protection Agency and the International City Management Association. Participants explored the need for state ground water quality policies relative to Section 208 of the Federal Water Pollution Control Act.

Geology Doesn't Stop At State Boundaries

Directors and selected staff of the Kansas, Nebraska, and Missouri Geological Surveys met at IGS on December 1-2. The object was an exchange of information on topics of mutual concern, such as long-range planning needs, management programs, geological data needed for nuclear power plant siting studies, and new application of remote sensing data.

(Mr. Koch is Assistant State Geologist.)

GREAT RIVER PROJECT

by James Case

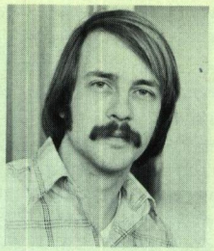


Photo by Jim Case

Mississippi River and River Bank

Two members of the Iowa Geological Survey staff have been involved with the Great River Environmental Action Team (GREAT) for the Mississippi River since mid-1975. The study area is divided into three reaches of the river—from Minneapolis, Minnesota to Guttenberg, Iowa (GREAT I), from Guttenberg to Hannibal, Missouri (GREAT II), and from Hannibal to the confluence of the Ohio River with the Mississippi in southern Illinois (GREAT III). As outlined by the Upper Mississippi River Basin Commission, the basic objective of the study is to develop a river system management plan that will incorporate total resource requirements. The individual sections of the river are each

being studied by eleven work groups that have been assigned a specific environmental issue to explore. Fred Dorheim and I have been involved with the Dredge Materials Use workgroups, and I have also been working with the recreation workgroup.

In the past the usual method of dealing with dredge materials was to dump the dredge slurry either in other portions of the river, thus forming small islands, or on the banks of the river, many times in locations where the material could not be used for anything other than beaches. Some alternative uses suggested by the Dredge Materials Use workgroup include stock piling the sand on land in order to make it available for sanding roads or making concrete, filling in rough sections of land so that it could be developed, or mixing the dredge material with sawdust and sewage sludge to form a compost.

The recreation workgroup is concerned with developing islands, beaches, or parks along portions of the river where public recreation areas are greatly needed. Some of the goals of the recreation workgroup are to define the legal and institutional frameworks in relation to recreation, to inventory existing recreational resources on the river, to determine whether dredged material would add or detract from the recreational value of existing resources, and to estimate recreation demand needs and use.

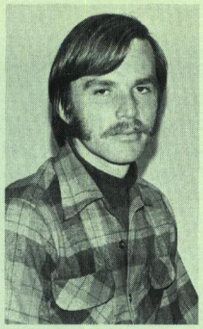
In July 1976 the Great River II team took a barge trip down the Mississippi from Guttenberg to Hannibal, Missouri, with the goal of picking out potential recreation areas and dredge material dump sites near areas in which dredging is planned. Whenever dredging begins on any portion of the river observed on the trip, the Great River teams will be in a position to say how best to use the dredged materials.

The Great River plan encourages public participation. Government and private interests that previously have not been involved with the project are invited to participate in each workgroup effort. It is necessary that work be started now to save the Mississippi River from being permanently damaged by random dredge material disposal, industrial and raw sewage dumping, and misplacement of dams.

(Mr. Case is a Research Geologist in the Economic Geology Division.)

CHEROKEE SEWER SITE INVESTIGATION

by Bernard E. Hoyer



The Iowa Geological Survey received a subcontract from the University of Iowa Department of Anthropology to participate in a $52,000 National Science Foundation research grant entitled "Holocene Ecological and Cultural Reconstruction in Northwest Iowa." The Department of Geology and the State Archaeologist's office at the University of Iowa and the Center for Climatic Research at the University of Wisconsin also are participating in the research. Dr. Richard Shutler, Chairman of the Department of Anthropology, University of Iowa, is the principal investigator. I conducted both the soils and the stratigraphic analyses for the site.

The purpose of the research is the development of an environmental model for northwestern Iowa. How cold was it? How wet? What vegetation grew there? This knowledge may be useful in understanding our present environment and more importantly, in evaluating the probability that present conditions will continue.

Evaluation of past environments is like a giant puzzle—with most of the pieces missing. Thus the remaining pieces assume added importance. Because these pieces are found in a variety of forms, an interdisciplinary research team was assembled. The individual researchers evaluated a wide range of materials that related to the last 10,000 years of Iowa's history. They examined soils, cultural artifacts, vegetable materials such as seeds, pollen, charcoal, and plant remains, bones from animals as large as bison and as small as shrews, and shells from clams and snails. From the piecing together of accumulated information, a general picture of northwestern Iowa's former environment emerges.

Photo by Bernard Hoyer

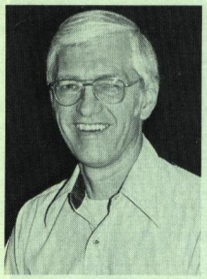
Cherokee Sewer Site Excavation

The research was conducted near the Little Sioux River, south of Cherokee, Iowa, on a small alluvial fan. This site was accidently discovered in 1973 during construction of Cherokee's sewage treatment facilities. A preliminary investigation of the Cherokee Sewer Site was conducted upon discovery and revealed rich recoverable plant, animal, and cultural remains in association with three stratigraphic levels represented by buried soils. This potential for a variety of remains provided the impetus for returning to the area in 1976. The preliminary investigation revealed that the oldest cultural materials were greater than 8,500 years old and the youngest were about 6,300 years old. This period corresponds in time to a widely reported, yet enigmatic, shift to warmer and drier climatic conditions. Details of the preliminary investigation are available in the *Journal of the Iowa Archaeological Society,* 1974, Vol. 21. A more complete assessment, based on this past summer's investigation will be available in 1978.

(Mr. Hoyer is Chief of the Remote Sensing Division.)

IRRIGATION COMES TO IOWA

by Paul J. Horick



Imagine yourself in an Agricultural Engineering classroom and the professor announces a quick quiz, or imagine you are interviewed on the street by the Iowa Poll: How important do you consider irrigation in Iowa?

a) Vital to crop yields
b) Very important
c) Important but not necessary
d) Unnecessary and overreacting
e) None of the above

Regardless of how you answer this question, based on your personal experience or on information picked up via the news media, the interest in irrigation in Iowa has grown rapidly this year, as is evidenced by the large number of requests on the subject being received at the Iowa Geological Survey. I predicted this development several years ago and planned to organize a preliminary investigation, but the activities of the Survey then were concentrated on more pressing environmental concerns—energy resources, coal, disposal of solid wastes, and the remote sensing surveillance programs. Now, the Iowa Geological Survey, in cooperation with the U.S. Geological Survey, is conducting an aquifer test program in the Floyd River valley south of Le Mars as the first step in analyzing water availability in the northwestern Iowa alluvial valleys with an eye to irrigation potential.

Farmland operators in western Iowa and even in parts of eastern Iowa are writing or calling the Survey in steadily increasing numbers with questions on water availability and drilling depths for wells to irrigate their crops. This has resulted in a backlog of information requests to the Survey that probably will continue at least until the public is adequately informed of the situation. Iowa farmers, of course, are astute and successful businessmen. They soon find out the latest technology and initiate the changes needed to update their farm programs. And so, urged on by the recent drought, the irrigation practices of the drier western states have spread into Iowa, beginning in the Missouri River valley and moving eastward into the interior valleys wherever sufficient water could be obtained from shallow wells, gravel pits, and the streams themselves.

At present about 950 irrigation permits are in force in Iowa, with a total annual quantity of 52 billion acre-feet of water authorized for irrigation use (Iowa Natural Resources Council data). However, only about one-half of Iowa's irrigators actually irrigate in any one year. The chief use is irrigation of general farm crops such as corn, soybeans, wheat, alfalfa, and sorghum, and certain specialty crops such as sugar beets and vegetables. Most irrigation is intended to be supplemental, to offset dry periods and prevent crop failure, and to increase yields and improve quality of the specialty crops. Numerous golf courses are also requesting more water to irrigate greens and fairways.

Preliminary information and answers to questions on the need for irrigation in Iowa, the costs and benefits, and related problems of water use and aquifer depletion, potential groundwater contamination, soil erosion, energy demands, and data on federal economic policies versus our state resources, are the subject of a new Iowa Geological Survey Technical Information Report compiled by Dr. George R. Hallberg, with an introductory statement by Donald L. Koch and me on the question of water availability. Cost of this publication is $1.70 postpaid or $1.25 over-the-counter at our Iowa City office. This report, summarized in the following article, will be useful to anyone contemplating an irrigation project in Iowa. The problems and paucity of data are clearly described, as well as the need for additional research. For the Iowa Geological Survey the research, if funded, will take the form of quantitative and qualitative hydrogeologic studies of various aquifers. Other agencies are being encouraged to lead in economic, agronomic, and farm-management research with the Survey as a cooperating participant.

In the meantime, the Iowa Geological Survey Groundwater Division staff struggles to meet the influx of letters and phone calls for irrigation information from down-on-the-farm. We appreciate your inquiries and also your patience while we handle these requests individually.

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

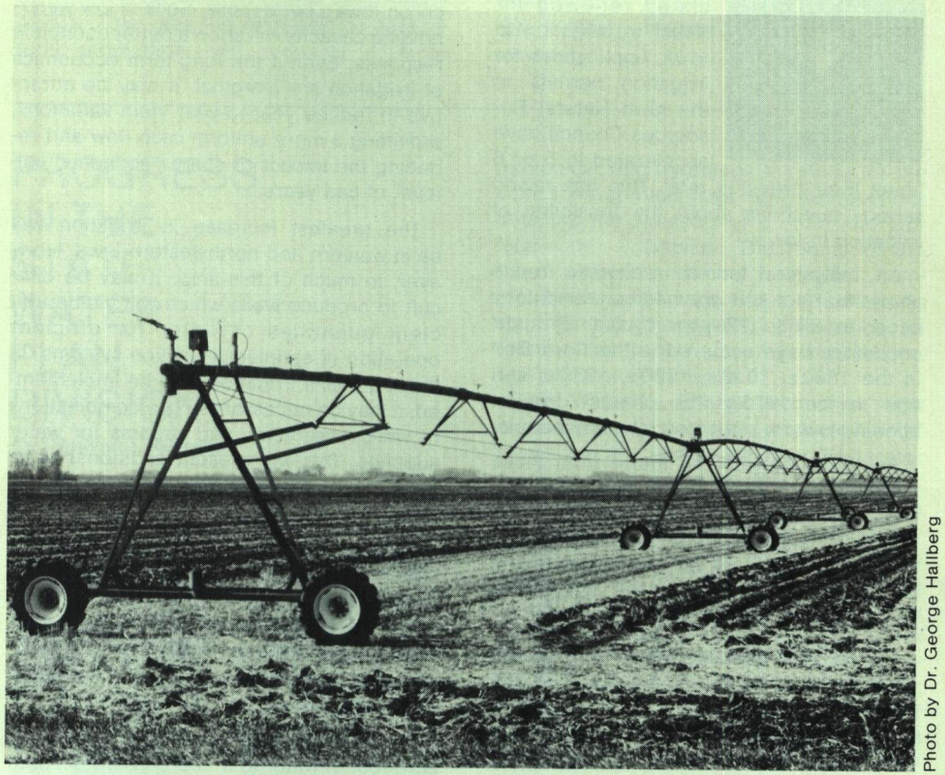


Photo by Dr. George Hallberg

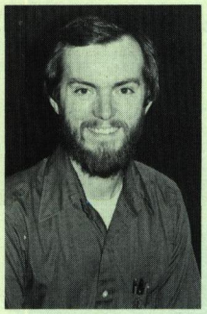
Center-pivot Irrigation System on Missouri River Floodplain

IRRIGATION IN IOWA: CAUSES, COSTS, AND CONSEQUENCES

by Dr. George R. Hallberg

Between 1957 and 1973, the Corn-Belt states were "spoiled" by the consistently high crop yields produced during the unusual consecutive number of climatically favorable years. This consistent high level of production promoted the decline of the U.S. grain reserve and the concurrent use of grain in national foreign trade policy. This in turn created a national agricultural policy promoting a full-production agricultural economy. These policy developments helped to create the present economic pressures which make high production imperative. These effects have also forced

many marginal acres of land into more intensive use for row-crop production. Coincident with these changes, the climatic regime of Iowa and the Corn Belt shifted to the hot, droughty weather of the mid-1970's. These concurrent events have stimulated renewed interest in irrigation in Iowa. Applications for irrigation permits to the Iowa Natural Resources Council have accelerated to 5 or 6 times their previous rate. This has raised serious questions about the feasibility of irrigation in Iowa.



An analysis of long-term climatic trends shows that hot and dry weather conditions occur in 20 to 22 year cycles. Drought conditions have occurred in the Corn Belt in the 1890's, 1910's, 1930's, 1950's, and now in the 1970's. The present drought conditions were predicted by many people.

Extrapolating into the future from these long-term trends, one sees the probability that the remainder of the 1970's will be marked by above-average summer temperatures. The 1980's should see the return of more favorable weather, but with more variability than in the 1960's.

During dry-weather periods like the 1970's, irrigation is attractive. Although irrigation cannot offset the yield reductions caused by excess temperature, it can reduce the year-to-year yield variations from climatic fluctuations.

The cost for a sprinkler irrigation system, based on a 130-acre tract, is in the range of $60 to $80 per irrigated acre per year. This requires an average yearly yield increase of 25 to 35 bushels per acre corn to break even. One study in Nebraska showed additional "extra" costs for seed, fertilizer, etc., to be $25 to $30 per acre. In total this will all require an average annual yield increase of 33 to 40 bushels per acre (for corn at $2.50 to $3.00 per bushel). One six-year study using irrigation in Iowa, on soils of high water-holding capacity showed only an average yearly increase of 23 bushels per acre corn. In one climatically bad year, the study showed a 76 bushels per acre increase over unirrigated corn, but in a climatically good year irrigation increased the yield by only 1 bushel per acre.

Recent county average corn-yield figures for easternmost Nebraska showed only a 30.6 bushels per acre increase. In the long term, considering the mix of favorable and unfavorable climatic conditions, the use of irrigation may be only marginally economical on Iowa's better soils. Soils of low water-holding capacity will show a better economic response. Even if the long-term economics of irrigation are marginal, it may be attractive to reduce year-to-year yield variations, providing a more uniform cash flow and reducing the impact of sharp "economic valleys" of bad years.

The greatest increase in irrigation will be in western and northwestern Iowa. However, in much of this area, it may be difficult to produce wells which will yield sufficient quantities of water for efficient operation of sprinkler irrigation systems. In these areas, if irrigation is to be implemented, it may be necessary to use combinations of wells, reservoirs, and streams for water supplies. This will present additional problems and expense to developing irrigation.

With irrigation there are many problems which may present long-term costs to society and must be carefully evaluated. These problems are principally ground-water depletion and contamination, soil erosion, and energy consumption. The most serious potential problem is depletion of our water resources.

One center-pivot system applying one acre-foot of water to a 160-acre tract (about 133 acres irrigated) will *consume* as much water per year as will a town of 10,000-12,000 people. Obviously, this issue is of serious magnitude, and conflicts in water use will arise. The expansion of irrigation must be carefully managed to avoid serious depletion of water resources.

The problems of ground-water contamination and soil erosion (and non-point source pollution) are primarily problems of good farm and land management. With optimal recommended fertilization and chemical application rates, proper irrigation application rates, and proper land treatment, these potential problems can be minimized.

Depending on the amount of water applied, irrigation may require a 3- to 10-fold increase in the amount of diesel fuel used per acre to produce a crop. In Nebraska irrigation consumes ten times the amount of fuel needed to till, plant, cultivate, and harvest a corn crop.

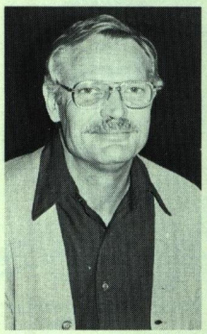
The climate of the 1980's will probably be more favorable than is the mid-1970's, but will likely be more variable than the unusually good weather of the 1960's-early 1970's. This, plus the high cost of agricultural production, will probably promote the expansion of irrigation at a rate higher than in the 1960's, but lower than at present. Irrigation will pose serious problems and questions in the management of Iowa's water resources.

To answer these questions, much research will be needed, especially in the area of ground-water development and depletion and agricultural economics and management.

(Dr. Hallberg is Chief of the Research Division.)

PROGRESS IN THE STATE WATER PLAN DIVISION

by Donivan L. Gordon



Within the past few months, the Water Plan Division staff has completed three background information reports as input to the continuing state water planning process. These reports concerning water resources availability, water for fuel and energy, and a progress statement on data base and needs have been subjected to or are undergoing, final task force review and revision. The reports soon will be forwarded to the Technical Coordinating Committee of the State Water Plan.

The task force report on water resources availability presents, under single cover, a summary of existing information concerning the mode of occurrence, quantity, and quality of Iowa's water resources. The report is developed in three major sections: a general section discussing the physical, geological, and hydrological setting for the state's water resources, and two sections detailing the specifics of ground and surface water availability. The format of the report is pictorial, offering the reader a comprehensive set of maps, tables, and diagrams documenting the spatial distribution of Iowa's water, its quality, movement, amount, and mode of occurrence.

The "Water for Energy Production" task force report begins with an overview of Iowa's fuel and energy situation. Two major water demand areas for fuel and energy, cooling water for electric power generation and water for coal conversion (coal gasification and liquefaction), are discussed, as they have the potential to require large quantities of Iowa's water resources. The section of the report concerning cooling for power generation presents a comprehensive overview of technological alternatives, alternative water demands, and costs. Water demands for coal conversion are presented similarly.

Because approximately 70 percent of the water withdrawn (primarily surface water) in Iowa is used by electrical utilities for cooling, a major section of the "Water for Energy Production" report relates power demands to their water requirements in three different scenarios developed to show the magnitude of future water demands relative to cooling technology applied, and to projections of Iowa's potential power demands. Three power-use projections are developed: "low growth of 4 percent per year, "high growth" of 7 percent per year, and an intermediate growth of 7 percent per year until 1985, with 4 percent per year thereafter. Interestingly, depending upon which scenario is chosen, it appears that Iowa's electrical

energy demands will create companion demands for cooling water equaling twice the amount of current cooling water withdrawals, and ranging upward to possibly five times current withdrawals by the year 2020.

The task force report on data base and needs is a progress report and has been developed in two sections. The first section treats the recognized data needs for future water resources planning and management in Iowa. The second section develops a discussion of the progress that is being made in the development of the Iowa Water Resources Data System (IWARDS). Development of the IWARDS data system was delegated to the Iowa Geological Survey, and the Survey was given authority for its maintenance and management by the Interagency Resources Council.

Presently, the Geological Survey's Data Division is developing the system's database management software package and is working with the other resources agencies in the state toward development of the final design document for the system. The primary goal of IWARDS is to promote and facilitate water resources data exchange and to transfer it within the user community in the state. The "user community" is defined to include all levels of government in Iowa as well as the private and institutional sectors. Several initial elements of the system are nearing completion: an index of agencies involved in water resources management planning, financing, and data collection; a bibliography of water resources publications pertinent to Iowa; and a cross-indexed guide to the *Code of Iowa* and the *Iowa Administrative Code* regulations relative to water resources. The automated portion of IWARDS is targeted for implementation late in 1977 or early in 1978.

In upcoming months, the Water Plan Division will be working closely with the other members of the Technical Coordinating Committee toward the development of the "Water Plan Framework Study" report. This report will mark the culmination of the first phase of comprehensive water planning for Iowa. The study is intended to provide background information and guidelines for water planners and to identify recognizable problem areas (present and future) in order to suggest and evaluate alternative courses of action and remedial solutions, and to identify priorities in water resources planning and management. The framework study report is scheduled to be completed late in 1977 and to be transmitted to the Governor and the General Assembly early in 1978. *(Mr. Gordon is Chief of the State Water Plan Division.)*

STATE—FEDERAL COOPERATIVE WATER RESEARCH

by Sulo W. Wiitala and Walter L. Steinhilber

Sulo W. Wiitala

Walter L. Steinhilber

Under the authority granted in Chapter 305.8, *Code of Iowa,* the Iowa Geological Survey cooperates with the Water Resources Division of the U. S. Geological Survey on a 50/50 cost-sharing water-resources program. The principal objectives of this program are:

(1) appraisal of the occurrence, availability, and quality of the water resources in the state;

(2) surveillance of the water resources to determine changes in discharge, chemical quality, and sediment load of the interior and border streams, and changes in ground-water levels and ground-water quality;

(3) determination of the impact of water development on the total water-resource system.

The cooperative surface-water program began in 1913 when the systematic collection of streamflow records was initiated. This cooperative program was temporarily discontinued during the period 1928-32 but was resumed in October 1932 when the district office of the U. S. Geological Survey was established in Iowa City. Droughts in the mid-30's and mid-50's and outstanding

floods in central Iowa in 1947, on the Missouri in 1952, on the Cedar River in 1961, and on the Mississippi in 1965, gave impetus for the continuation and expansion of the program. Currently the cooperative IGS-USGS program supports approximately one quarter of the 120 streamflow stations in operation. The data collected from this program are published in numerous U.S.G.S. and IGS Water-Supply Bulletins.

Sediment transport in streams has always been of interest in the design and operation of flood-control reservoirs and in the conservation and management of the State's land resources. Beginning in 1943, the Iowa Geological Survey has cooperated with the U. S. Geological Survey in the collection and publication of sediment data for Iowa streams. In this program, daily sediment records have been collected at 23 stations while periodic and miscellaneous sediment data have been obtained at a large number of sites. The data generated by this program are published in U.S.G.S. basic data reports, and a compilation report of all sediment data collected to date will be published soon by the IGS.

The first cooperative ground-water study culminated in 1912, when the monumental treatise "Underground Water-Resources of Iowa" by Norton and others was published jointly by the IGS and USGS. A lengthy period of time elapsed before the present continuous cooperative ground-water program was initiated in the mid-thirties. This program has produced a number of interpretive reports that are published as IGS Water-Supply Bulletins and Water Atlases.

The work of the Water Resources Division, U. S. Geological Survey, in Iowa is carried on by a staff of about 50 engineers, geologists, technicians, and support personnel, headquartered at the district office in Iowa City and at satellite offices in Council Bluffs and Fort Dodge. Occasionally, IGS staff personnel are directly assigned, full or part time, to cooperative projects. Currently, Greg Ludvigson is assigned full-time to a regional appraisal report and, on its completion, will become project chief for another regional investigation. Bill Bunker is assigned to the carbonate research project, in which he has responsibility for all geological data collection and interpretation.

The excellent rapport and working relationships that have been developed and maintained between the State and Federal Geological Surveys fosters a comprehensive approach to the State's water resources problems. The water information generated from the cooperative program should form the basis for sound comprehensive planning and provide the foundation for sound water management.

(Mr. Wiitala is Chief and Mr. Steinhilber is Assistant District Chief of the Iowa District, Water Resources Division of the U.S. Geological Survey.)

REMOTE SENSING DEVELOPMENTS

by the IGSRSL Staff

Map of Land-Use in Iowa, 1976

The staff of the Iowa Geological Survey Remote Sensing Laboratory (IGSRSL) recently completed a land-use map of Iowa based on manual photo interpretation of LANDSAT I images. The map, the first of its kind for Iowa, was prepared at a scale of 1:250,000 and printed at a 1:500,000 scale. It displays nine categories of landuse: urban residential, urban commercial/industrial, urban open, transportation network, extractive land, agricultural land, forest land, water, and reservoir flood pool. Interpretations were verified through the use of Skylab and high-altitude aircraft photography. Information from various maps produced by the U. S. Geological Survey, Iowa Department of Transportation, Federal Aviation Administration, and the Iowa Geological Survey also aided in the production of the map. Preliminary copies of the map were reviewed by each of Iowa's 17 regional planning agencies as well as by the Iowa Conservation Commission and Iowa Office of Planning and Programming. These agencies corrected interpretation or handling errors and insured inclusion of major land-use changes that occurred since LANDSAT imaging of their areas. A total of 6-1/2 man-months was needed to produce the map at a total cost, from image acquisition through printing, of 18¢ per square mile. The map can provide useful information in conjunction with other resource data in defining some management goals or policies.

Copies of the map can be obtained from the Iowa Geological Survey for a cost of $1.50 each. For mail orders add $.40 for folded copies and $1.00 for rolled copies. This covers postage costs for up to 10 maps.

Technical Information Series Number 4, *Land-Use in Iowa: 1976, An Explanation of the Map,* provides detailed information on techniques used in production of the land-use map as well as problems encountered and map limitations.

S.C.A.T.E.

Ray Anderson and Pat McAdams addressed two Project SCATE meetings on the topic "Land-Use Patterns in Iowa." Project SCATE (Students Concerned About Tomorrow's Environment) is an organization composed of high school students and their teachers and is sponsored by the Iowa Department of Public Instruction. The meetings were on August 17 at the Springbrook Conservation Education Center and on September 21 at Camp Wyoming. The talks centered around production of the *Land-Use Map of Iowa: 1976* and the natural and cultural factors that influenced the land-use patterns as mapped.

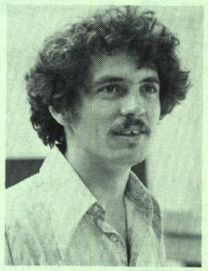
Ray Anderson

Remote Sensing Newsletter

The Iowa Geological Survey Remote Sensing Laboratory periodically publishes a newsletter, including brief descriptions of all Remote Sensing Lab projects as well as upcoming studies, information on new lab equipment and personnel. Copies of this newsletter are available upon request.

IGSRSL Presents Research at Seattle Meeting

Bernard Hoyer and Patrick McAdams of the IGSRSL staff traveled to Seattle during the last week of September to attend the 1976 Fall Convention of the American Congress of Surveying and Mapping/American Society of Photogrammetry. In addition to learning of new developments and research being conducted by other remote sensing organizations, they presented the results of two IGSRSL research projects. Hoyer reported on the development and testing of operational flood mapping techniques and McAdams reported on techniques for estimating flood produced crop damage.



Pat McAdams

A summary of the results of each of these research projects is presented below. The complete papers are published in *Proceedings of the American Society of Photogrammetry, Fall Convention, 1976.*

Flood Mapping Research

The Iowa Geological Survey Remote Sensing Laboratory, in cooperation with the U.S. Geological Survey and the U.S. Army Corps of Engineers, has analyzed multiband imagery from aerial and orbital platforms and has found that the .7 to 1.1 micron band is the most suitable photographic portion of the electromagnetic spectrum for mapping areas of recent flood inundation. It has been shown in Iowa that flood boundaries can be interpreted and mapped by using near-infrared wavelengths in all seasons for a minimum of seven days after flood waters have receded. Color infrared film was determined to be the best available product for operationally mapping flooded areas. This flood mapping technique was tested on a June 1975 flood of Squaw Creek and South Skunk River near Ames, Iowa. The accuracy of the photointerpreted flood boundary was determined by comparing the position of 133 points on the interpreted boundary with the position of a contour line that represented the flood crest elevation at six locations along the flooded zone. Analysis of this comparison indicates that the interpreted flood boundary mapped from post-crest color-infrared photography had a horizontal accuracy of ± 20 feet. It is concluded that color-infrared aerial photography is the most effective method of mapping flood inundation in all rural areas of Iowa.

South Skunk River Flood, 1975

Flood Related Crop Damage Research in Iowa

Flood mapping research conducted by IGSRSL has shown that various remote sensing techniques can be used to determine accurately the aerial extent of flooding. Since determining the number of acres of crop land flooded is a necessary step in estimating flood produced crop damage, it was apparent that these techniques could supply at least part of the information necessary for quantification of crop damage. At the request of the U.S. Army Corps of Engineers, Rock Island District Office, the IGSRSL staff undertook a research project to determine if aerial photography could be manually interpreted to supply the data necessary for estimating crop damage.

The approximate amount of flood-produced crop damage is a function of eight variables:

1. crop types flooded
2. acres of crop land flooded
3. normal expected yield of the flooded crop land
4. acres of crop land flooded but less than 100% destroyed
5. yield of the crop land that was flooded but less than 100% destroyed
6. number of acres replanted
7. crop types replanted
8. yield of the replanted crops.

The results of preliminary research conducted by IGSRSL and the U.S. Army Corps of Engineers indicate that variables 1, 2, 6 and 7 can be determined with greater than 90% accuracy by interpreting time-sequential color-infrared photography. Objective estimates of variable 3 can be made by using remotely sensed data in conjunction with Soil Conservation Service soils and crop yield data. The results suggest that it may be possible to estimate variables 4 and 5 by using aerial photography and to estimate variable 8 by using historical yield data.

PHOTOGRAMMETRIC MAPPING OF SINKHOLE DEVELOPMENT IN FLOYD COUNTY, IOWA

by Dr. Stanley C. Grant
David L. Finkenbinder
David B. Eilders

There are many localities in Iowa where karst topography developed with its characteristic sinkholes, caves, and other expressions of chemical weathering of subsurface limestone formations. In some areas of northeast Iowa, sinkhole development is a problem for road and building construction. Sometimes a sinkhole will open up beneath a building, causing foundation failure or other serious damage to the structure. There are periodic reports of parcels of land that suddenly give way, collapsing into subterranean voids and leaving open pits at the land surface. Old sinkholes become plugged by debris and sediment over the course of months and years and then suddenly open up again, perhaps following a heavy rain. Where sinkholes are prevalent, local residents have tried to plug them with trash, rock, brush, or dirt. Occasionally, and unfortunately, sinks have even been used as sewage drains.

Sinkholes may develop from a combination of natural circumstances. Thin-bedded and creviced limestones with a shallow soil cover, located on uplands which adjoin deeply entrenched stream valleys, and a local water table well below the land surface present favorable conditions for sinkhole development. Adequate annual precipitation also must be available. In addition, sinkhole development may be initiated by gradual slipping of rock blocks down the slopes of steep-sided valleys. For example, slippage of Silurian-age rock on the underlying, groundwater-lubricated Maquoketa Shale may be observed in southern Clayton County. Gradually, sinkholes enlarge, and the potential hazard to people, animals, and structures becomes greater.

Most of the sinkholes in Iowa were formed before the glaciers moved across our landscape. This well-developed karst terrain then was covered by glacial debris, including clay, sand, and rock. Subsequent glacial meltwaters carried some of this sediment into the underlying sinks and caves, filling many of them. In the years of stream erosion since the glaciers melted away, the glacial debris on top of the sinkholes and the material filling the sinks have gradually been removed. This "flushing" is opening many of the old sinkholes and exposing them to new chemical erosion.

In geology, we recognize that changing of the landscape is a slow natural process, often involving thousands or millions of years. Yet, there are continuous changes in the surface of the earth that can be observed and measured in only a few years. The constant erosion and deposition by a river can be observed month by month and year by year. The development of sinkholes in some localities also can be measured in a few years. One such locality is in Sections 4 and 9, T. 96 N., R. 16 W., Floyd County, Iowa. This dramatic topography can be observed along U.S. Highway 218, two miles north of the town of Floyd. In the grassy field to the west of the highway, the pitted terrain resembles a bombardment practice field (Figure 1), as numerous sinkholes give the appearance of bomb craters.

A project was started in 1972 to measure growth and changes in the Floyd area sinkholes by using aerial photography and photogrammetric mapping. Photogrammetric methods have been used for years in engineering projects, but rarely have they been used to measure geologic change. The first air photo series was taken in the fall of 1972, and a second series was obtained in 1974. From the photos, detailed topographic maps were drawn, using a one-foot contour interval (Figure 2). By overlaying the 1972 and the 1974 maps, we found it apparent that significant measurable changes in the sizes of the sinkholes had taken place in only two years. A final series of photos was taken in November 1976, and a section of the field where the most dramatic changes occurred is being mapped again. The study is expected to be completed and ready for publication by the summer of 1977.

Figure 1. Karst terrain north of the town of Floyd, Iowa resembling bomb craters. U.S. Highway 218 at the right

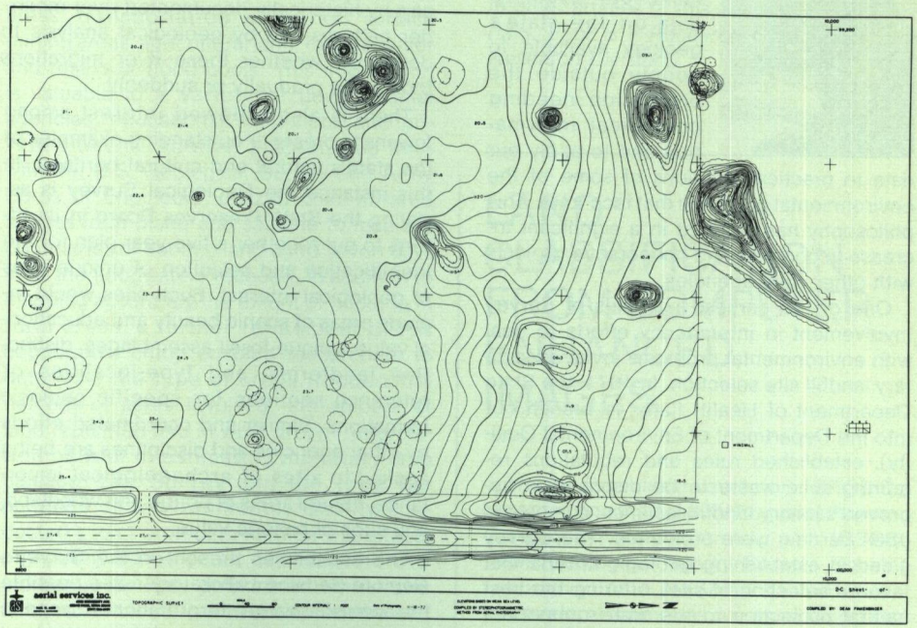


Figure 2. Contour map of a portion of the karst field, 2 miles north of Floyd, Iowa

In this project, we hope to substantiate the usefulness of photogrammetric methods in geologic measurement, not only for sinkholes but for other potential geologic hazards as well.

The aerial photography and photogrammetric mapping was provided by Aerial Services Incorporated of Cedar Falls, Iowa. The mapping was done by Mr. Dean Finkenbinder.

(*Mr. Finkenbinder holds a BA in Geography from the University of Northern Iowa and is employed by Aerial Services Inc.*
Mr. Eilders holds an MA in Earth Science Education from the University of Northern Iowa.)

THE ROLE OF THE IOWA GEOLOGICAL SURVEY IN INTERAGENCY PROJECTS

by Jean C. Prior

A central theme linking the Survey's programs and activities over the past several years has been to make our acquired data on the state's geology available to people outside the profession needing geological information and to apply our data to practical solutions of some of the environmental problems that face Iowa. This philosophy has resulted in a significant increase in contacts and cooperative projects with other state agencies.

One of the earliest examples of Survey involvement in interagency efforts to deal with environmental problems involved sanitary landfill site selection. In 1971, the State Department of Health (later to branch out into the Department of Environmental Quality), established rules and regulations requiring solid waste to be disposed in approved sanitary landfill facilities; dumps and open burning were prohibited. The Survey aided in establishing geologic criteria that favored selection of sites offering the best natural protection to the state's important surface and subsurface water resources. In the years since, the Survey has continued to serve in an advisory role to the Department of Environmental Quality and to many counties and communities, helping to identify and evaluate sites that meet these established criteria in different areas of the state.

Survey information also has served a pivotal role in the courtroom settlement of legal disputes. The State Attorney General's Office, Environmental Protection Division, has sought Survey map records, requested on-site drilling programs and the appearance of expert witnesses in matters where the state's physical features form the basis for decisions relating to land-use and land ownership. Two such cases in recent years have each involved the Missouri River and adjoining lands. In the first, the resolution of a conflict involving taxation of lands to be benefited by soil conservation measures was based in part on Survey information which documented the natural course of a creek across the Missouri River floodplain and was supplemented by a drilling project which determined that sediments in the creek originated from the upland bluffs rather than from the Missouri River. In the second and current case, an eastern Nebraska Indian tribe wants to establish claim to lands on the Iowa side of the Missouri River; resolution here will be determined in part by historically documented river meander patterns and by geological analysis to determine whether these river migrations took place gradually or suddenly.

There is also renewed interest among Iowans to preserve outstanding examples of the state's natural and cultural heritage. In this instance the Geological Survey is assisting the State Preserves Board in its efforts to put together a five-year plan for the identification and selection of unique sites of geological interest. Such sites would include areas of scenic beauty and educational value, unique fossil assemblages, distinctive landforms, and type-localities or reference sections for specific geologic formations. Similar and coordinated efforts by other agencies and disciplines are being applied to sites of archaeological importance, natural areas of prairie and woodland, and sites of historic value.

The capabilities present in the Survey's Remote Sensing Laboratory make possible the acquisition and interpretation of synoptic and time-sequential views of the state's land surface. The practical application of these aerial photographs and orbital satellite images to natural resources and environmental protection has resulted in a great diversity of interagency interest and cooperative projects. Starting in June of 1971, the Survey initiated a remote sensing project designed to study the thermal characteristics of the Mississippi River. This effort was in response to the planned construction of the Quad-Cities Nuclear Power Station and concern for the environmental impact of the plant's heated effluent on the river's aquatic ecosystems. The Iowa Survey, U.S. Geological Survey, Conservation Commission, Hygienic Laboratory, Attorney General's Office, Water Pollution Control Commission, U.S. Army Corps of Engineers, Remote Sensing Institute of Brookings, South Dakota, and Commonwealth Edison of Chicago all participated to acquire background baseline data on the thermal regimen of the river prior to plant operation.

Thus began in Iowa a long series of projects using this unique space-age tool of remote sensing as an impartial observer of the interaction between man and his physical environment. Interpretation of satellite imagery resulted in the publication of a land-use map of Iowa at 1:500,000 scale—a statewide view of the distribution of major urban areas, transportation networks, surface mining areas, agricultural land, forests, water and reservoir flood pools. This information is valuable to a variety of governmental agencies, educational institutions and private citizens. Another project, this time with the U.S. Geological Survey and Army Corps of Engineers, utilized color-infrared images from plane and satellite to map the boundaries of flooded land up to seven days after the floodwaters receded. In addition to mapping accurately the extent of flooding in rural areas, a further refinement of this cooperative study enabled researchers to determine the type of crops flooded, the number of acres involved, the amount of land replanted and in what crops—information helpful in estimating monetary crop damage. The Survey and the Iowa Department of Environmental Quality conducted a joint project to monitor the effects of burning leaves on air quality in the Des Moines area. They determined that smoke plumes from leaf fires could be located and counted and that a qualitative map of smoke concentrations could be produced. Since 1974, the Conservation Commission and U.S. Forest Service have participated in a cooperative program to determine the extent of Oak Wilt damage in Iowa forest lands; results thus far seem to indicate that Oak Wilt is not presently a major problem in the state. In another study, strip-mine sites in southern Iowa were photographed in color-infrared and examined by botanists from Cornell College; interpretation of this imagery permitted measurement of mined land, reclaimed land, the success of revegetation, an analysis of drainage problems, and the assurance that this technique would be useful for long-term monitoring of the effects of strip-mining. In a final example, aerial imagery flown for the U.S. Soil Conservation Service proved very helpful to field crews who were mapping complex soil patterns in an area of intricate meander scars along the Mississippi River in Des Moines County.

Such examples demonstrate the usefulness of remote sensing techniques for mapping and monitoring projects and the continuing growth of interagency and interdisciplinary cooperation. Other examples of the application of Survey staff and information to intragovernmental efforts in the fields of natural resources and environmental protection are described in more detail in other articles of this *Newsletter.*

(Mrs. Prior is a Research Geologist in the Research Division.)

LAND CLASSIFICATION FROM COMPUTER ENHANCED IMAGES

The Jet Propulsion Laboratory, EROS Data center, and the Area XV Regional Planning Commission are cooperating with IGSRSL (Iowa Geological Survey Remote Sensing Laboratory) on a NASA-sponsored project to develop techniques for producing computer enhanced LANDSAT satellite images for obtaining land-use information. Results indicate that computer enhancement may be best accomplished using a linear contrast stretch and that the photographic processing of color negatives derived from computer processing may be a limiting factor to the enhancement process. James Lucas, Principal Investigator on this project, has left IGSRSL and is presently at the EROS Data Center, Applications Assistance Branch.

DOMESTIC URANIUM FUEL SUPPLY PROBLEMS: 1976 THROUGH 1990

by Dr. Stanley C. Grant, State Geologist

During the 7-8 April 1976 meeting of the Midwest Governors' Conference Task Force on Energy, a subcommittee was appointed to investigate uranium supplies available to fuel the proposed expansion of nuclear power plants in the United States. I served on the committee because I had previously been employed as chief geologist for a major uranium company and have many contacts with people in the uranium industry. Dr. Edwin A. Noble, State Geologist, North Dakota Geological Survey, and Dr. Robert J. Robel, Chairman, Governor's Energy Advisory Council for Kansas, also served on the committee.

According to announcements made by the United States Energy Research and Development Administration (ERDA), the Federal Energy Administration (FEA), and the Energy Resources Council (ERC), there are more than sufficient domestic uranium resources to supply existing and planned nuclear reactors until 1990. These optimistic announcements were made publicly while many serious questions remained unanswered. A major problem relates to inadequacies of federal studies in using the word "resources", which, according to ERDA usage includes *reserves* (ore deposits that have been discovered, defined reasonably well as to size, extent, and grade, or blocked out by detailed drilling) and *potential resources* which are *not yet discovered,* or, in a few cases, may have a drill hole or two showing that some ore is present. The "potential resources" estimate is *totally speculative* and in no way represents ore *reserves*.

During the last two years, with more than 50 million feet of exploratory drilling, no new uranium mineral districts have been found. Only two or three new deposits of high-grade uranium ore have been located, and only a few new low-grade deposits of consequence have been discovered. The new sources dominantly are of lower and lower grade, from deeper and deeper deposits, with the additional drawback of posing complex mining and milling problems.

ERDA estimates that our reserves of uranium are 640,000 tons of U_3O_8. An additional 140,000 tons are estimated to be recoverable as a by-product of phosphate and copper mining by the year 2000. These two figures are added by ERDA to the *undiscovered probable potential estimate* of 1,060,000 tons to arrive at a total of 1,840,000 tons of so-called *economically recoverable uranium.* To call this amount a valid resource base for prudent planning of nuclear power plant construction programs for as many as 300 large nuclear plants over their 30-year lifetime suggests a total lack of understanding of the figures and of the facts.

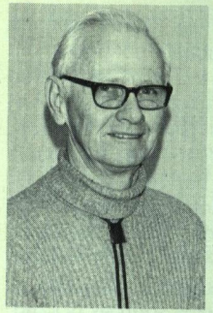
Even with spent-fuel reprocessing, an analysis of the figures shows that we have enough uranium to fuel between 162 and 212 plants of 1,000-megawatt capacity, *not* the 300-plus plants spoken of by ERDA and FEA officials. And the problems only begin here. Along with needed new mines, new large-capacity mills also must be built. Disposal of the waste products from milling will be no small environmental problem. Enrichment of the uranium into nuclear fuel requires that extensive new enrichment facilities must be built. Presently, the existing enrichment facilities are at full operating capacity. There is no assurance that spent-fuel will be reprocessed in the near future. An alternative is to import large amounts of uranium, but that would seriously influence our dollar outflow, and a dependence upon foreign uranium *and* foreign oil certainly puts this nation into a precarious strategic position. A final problem in the nuclear-fuel cycle is the secure and safe disposal of radioactive waste materials.

In short, the nuclear-fuel supply has immense problems that should be solved before too many nuclear power plants are built. We must restrict licensing of new nuclear plants on the basis of known fuel reserves. We must direct greater efforts toward coal mining and coal-fired power plants. And we must fund additional research in solar fuels and exotic fuels.

(Dr. Grant was a geological consultant to the uranium mining industry from 1955 to 1975.) A report on the uranium fuel-supply problem will be presented at the next meeting of the National Governors' Conference.

DISPOSAL OF HIGH-LEVEL NUCLEAR WASTE

by Fred H. Dorheim



The public often has the impression that government and industry approach environmental problems in a careless or haphazard manner. At a conference that I attended on disposal of high-level nuclear waste in May, 1976, I got an entirely different impression. I was impressed by the attention to detail, both in the geologic investigations conducted in the respective areas under consideration and in the design of the potential storage areas. This conference was held at Oakridge, Tennessee, and was sponsored by ERDA (Energy Research and Development Administration) and the Office of Waste Isolation, a department of Union Carbide Corporation, Nuclear Division.

Very briefly, the goal is to have six disposal sites in operation by the year 2000. The specifications are to bury the material in an acceptable host rock, which must be at a depth at least 1000 feet below the surface and at least 2000 feet thick. The first sites being considered are the salt deposits of southeast New Mexico and similar deposits in Michigan. The time schedule is illustrated in the accompanying diagram, Geologic Terminal Storage, General Plan.

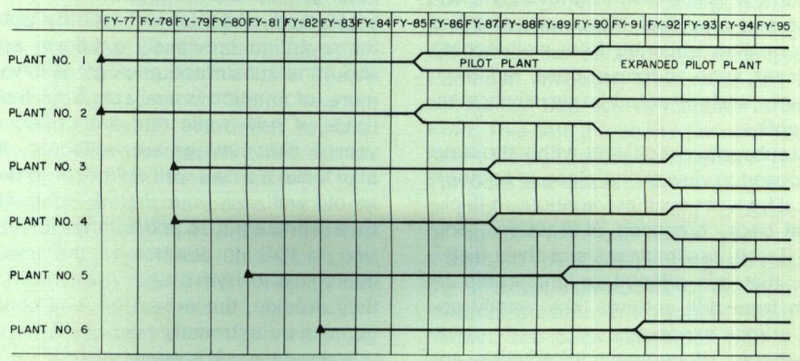
The next two disposal sites to undergo investigation are the salt domes of northeast Texas and northern Louisiana and the Cretaceous shales adjacent to the Williston Basin of North Dakota and Montana. In both of these areas, authorities are avoiding any locality that has an indicated oil potential. Operation of disposal sites at these locations is planned for 1992-1993.

The last two areas designated for investigation are the granites of the Eastern United States, either in New England or the Appalachian Mountains of the Carolinas and Georgia or the granites of the Western United States, specifically in California or the Rocky Mountains. These plans are far from definite at this time but are scheduled for operation in the late 1990's or early 2000's.

I talked with Mr. C. D. Zerby, Director of the Office of Waste Implacement, and with Dr. T. F. Lomenick, Manager of Geology Projects, and they see no possibility that Iowa will be considered for deposit of high-level nuclear waste.

At the time of the meeting, the E.R.D.A. budget for 1976 was approximately $34 million, of which $21 million was earmarked for geology. They were anticipating an increase of $18 million, of which $12 million would be added to the geology budget. Later, as exploration tapers off, design will get a greater portion of the budget.

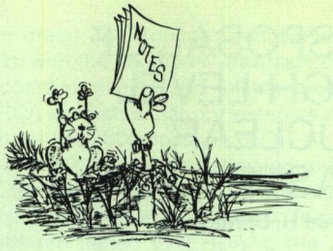
(Mr. Dorheim is Chief Geologist and in charge of the Economic Geology Division.)



Geological Terminal Storage General Plan. (Expanded pilot plant indicates time when area accepts hot waste.)

SUBSURFACE NOTES

by Jack L. Gilmore



The primary function of the Subsurface Division is to obtain and analyze data on the rock units of the state and to make the data available to users through publications and open-file maps and reports. Geologic data normally is obtained from three sources: drill cuttings from wells, geophysical studies, and descriptions of rock exposures.

Most of Iowa's water well contractors provide IGS with 5-foot interval sacks of drill cuttings (soil and rock samples) from wells, along with a descriptive log that includes information on rock types penetrated, length of casing, and production data. The drill cuttings are examined microscopically, and detailed descriptions of the physical characteristics of the rocks are recorded on strip logs. More than 20,000 logs are on file, and they provide the basic data for most geological investigations.

Geophysical data utilized in subsurface studies includes: (1) information derived from measurements taken at or above the land surface, such as magnetic, gravity, seismic and electrical measurements; and (2) information obtained from well-logging equipment, such as temperature, radiation, flow meter, and self potential-resistivity measurements.

Most subsurface rock units within the state are exposed to view at one place or another. Physical features such as variations in thickness of beds, presence of fractures, and faunal (fossil) assemblages and their distribution, that are difficult or impossible to discern from drill cuttings, are readily apparent in rock exposures.

All sources of geologic information are utilized to correlate rock units from one area to another and to construct maps which show their areal extent, thickness, lateral changes in composition, and structural configuration. Within the limitations of available data, these maps can be used to predict subsurface conditions at any given site. Geologic data from IGS files was used to locate sites for underground storage of liquid petroleum gas (LPG) near West Branch and Iowa City, natural gas near Columbus Junction, Keota, Redfield, and Vincent, and to develop a gypsum mine near Mediapolis. Subsurface data also is utilized to prospect for new sources of sand, gravel, and limestone for use in the construction industry.

Knowledge of subsurface geologic conditions is an essential element of any study of the occurrence and quality of ground water. Geologic and hydrologic data are used to define the options available to communities, industry, and private citizens for the development of a dependable water supply. How much water can be obtained? How deep must a well be drilled? What is the quality of the water? These are questions that can be answered with reasonable accuracy from a review of available data.

Geology is a dynamic science. Concepts often are altered or changed as more data becomes available. We have sets of drill cuttings from over 5,000 wells that need to be studied, and each set has the potential for revealing previously unknown aspects about the subsurface geology of Iowa. Still more information is available from the hundreds of new wells that are drilled every year if drill cuttings are collected. If you plan to have a new well drilled, or to deepen an old well, ask your drilling contractor to save representative drill cuttings for submission to IGS. In addition to the important geologic and hydrologic information that they provide, the record on well construction can be extremely helpful if later repair or remedial work is necessary.

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

WATER-WELL DRILLERS SEMINAR

by Orville J Van Eck

January 24 and 25 are the dates for the water-well drillers seminar to be sponsored by the Geological Survey. The seminar, to be held in Iowa City, is the first of what we hope will become a regular event.

There is a long history of cooperation between the water-well drillers and the Survey. In a state where the collecting of samples during the drilling of water wells is not mandatory, the voluntary cooperation of many of the drillers has made invaluable contributions to our knowledge of the subsurface geology of Iowa. In return for the voluntary collection of the drill samples, the Survey provides the sample bags, copies of the well logs that evolve from the study of the samples, well forecasts, and any other information we can provide that will assist the driller.

The program will provide the drillers an opportunity to see how the samples they collect are processed and analyzed, including the use of microscopes for sample study. There will be sessions on the use of topographic maps, pump installation, the use of geophysical logs, and various other topics. It is our belief that through these seminars the exchange of information between drillers and geologists can be greatly increased, and this in turn will benefit the people of Iowa.

(Mr. Van Eck is Associate State Geologist.)

GEOLOGY AND EDUCATION

by Jean C. Prior

Geologists spend a lot of time talking to other geologists and to professional people in the fields of natural resources and environmental protection. However, some of the most rewarding conversations we have are with people who approach the field of geology out of curiosity about their surroundings or out of interest in broadening their own knowledge in order to teach others. When these exchanges take place outdoors, in an area where geological interest is high, the rewards are many.

Such opportunities present themselves several times throughout the course of a year, thanks to outdoor education workshops such as the Iowa Conservation Education Council Fall Workshops, the Iowa Teachers' Summer Conservation Camps, and the Department of Public Instruction regional workshops. These programs often are organized to expose the participants to a variety of learning experiences in the natural environment, such as plant and animal ecology, soil conservation, and geological history. At other times a field workshop may be oriented to a more detailed examination of geology only and will include the study of area landforms, examination of earth materials beneath the surface, and tours of local economic mineral resource operations.

The enthusiasm and interest of these groups in the field is a recurring note of satisfaction to those of us who participate in the programs. To help extend our efforts and increase our contact with people around the state, the Survey is well along on its *Educational Series* of publications. Our *Reports of Investigations, Technical Information Series* and *Water Atlases* are designed to reach specific, usually technically oriented, groups of people. But the introduction of a new publication in our *Educational Series* really puts the peaks on our publication sales chart.

The series began in 1967 with the publication of *The Fossils and Rocks of Eastern Iowa—a half-billion years of Iowa history,* by J. N. Rose. This book, with its distinctive cover background of *Hexagonaria* coral, provides a general summary of geologic and life history for each of the time Systems, Cambrian through Mississippian, represented by bedrock formations in eastern Iowa. This sets the scene for nine separate field trips that can be conducted to examine the rocks and fossils of these various periods of geologic time. Maps and cross-sections of the rock units exposed at each stop are illustrated; the accompanying text describes the geologic significance of the stop, fossil material present, and route-of-travel information. The book concludes with a series of plates which illustrate the various fossil specimens most commonly associated with the different aged rock units. The "Rose

book" recently exhausted its third printing, meaning that over 15,000 copies are now in circulation.

In 1974, Educational Series 2, *The Minerals of Iowa* by Paul J. Horick, was introduced. This handbook, complete with color and black-and-white photographs of mineral specimens, initiates the reader first to the general field of mineralogy—what are they used for, what are they made of, what kinds of physical properties can be used in their identification, and tips on their collection. Minerals found in Iowa's sedimentary rocks are then discussed individually as to their descriptions, locations and uses. Separate chapters are devoted to minerals from stream-gravel deposits, minerals from boulders in glacial deposits, and unusual minerals found in the state. Rockhounds, mineral collectors, lapidarists, students, and teachers find this reference a valuable source of information and a helpful guide to field identification and collection.

Printing of our most recent addition to this publication series was completed last fall. *A Regional Guide to Iowa Landforms*, by Jean C. Prior, demonstrates how Iowa's landscape has been studied through time, from field sketches drawn by the state's earliest naturalists, to photographs taken from space by orbiting astronaut crews. Processes and materials of Iowa landforms are examined next, with attention given to a review of Pleistocene or Ice Age events —what the glaciers did, what they left behind, and what has happened since. A map of the landform regions of Iowa follows and is supported by additional state-wide maps containing information on rivers and lakes, elevations, age of glacial deposits and land-surface relief. Each landform region is then discussed and illustrated, with descriptions of the distinctive characteristics of the terrain, the kinds of materials found beneath the land surface, and some insight into the region's evolutionary history.

These publications can be obtained from the Iowa Geological Survey at minimal cost and thus are available to the maximum number of people. They multiply many times the efforts of our staff to "talk" to those interested in learning more about their surrounding geological environment.

(Mrs. Prior is a Research Geologist in the Research Division.)

THE STATUS OF QUADRANGLE MAPPING IN IOWA

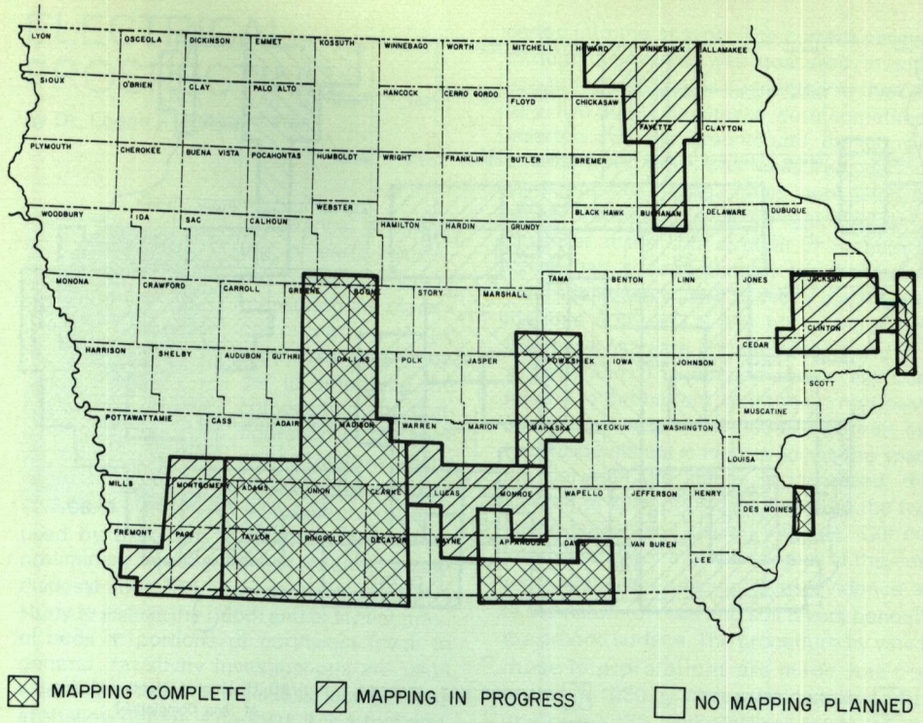
by Raymond R. Anderson

Topographic Maps

Since 1907 the Iowa Geological Survey has participated in a cooperative topographic mapping program with the U.S. Geological Survey's Topographic Branch. The first maps produced were 30 minute (covering a geographical area of 30 minutes of latitude by 30 minutes of longitude—1:125,000 scale) and 15 minute (1:62,500 scale). Although the mapping of the state at these scales was only partially complete, emphasis was later shifted to the production of 7-1/2 minute (1:24,000 scale) quadrangle maps. These full color maps cover an area of about 6 miles east-west by 8 miles north-south and include contour lines which depict the elevation of the land surface (usually at a 10 foot interval), lakes and streams, forested areas, and cultural features, such as towns, roads, and quarries. They are produced on a section —township—range geographic base, which also includes latitude and longitude lines and Universal Transmercator (UTM) tic marks.

The State of Iowa withdrew financial participation from the program for the period from 1931 through 1950 and again from 1972 through 1975. In fiscal year 1976, however, Iowa again reinitiated financial support of the program with an expenditure of $100,000, a sum which is matched by the Federal government and is combined with a significantly larger federal Science Investigation and Research investment to fund the mapping program.

To map the State of Iowa on 7-1/2 minute quadrangle maps will require all or a part of 1083 maps. To date, 629 or 58.1% of the quadrangles have been completed, with the vast majority published since 1965. Of the 454 quadrangles not yet published, work has begun on 310 (68.2%). Map 1 outlines the status of 7-1/2 minute quadrangle mapping in Iowa and Table 1 shows the completion schedule. Mapping on 79 maps (7.1% of Iowa quadrangles) has not yet begun, and 18 additional quadrangles were published only as 15 minute topographic maps. In addition to producing new maps, the USGS updates older, completed topographic maps. At the present time 85 (13.5% of completed quadrangles) are being photo-revised.



Status of Orthophoto Quadrangle Mapping in Iowa

Orthophoto Quads

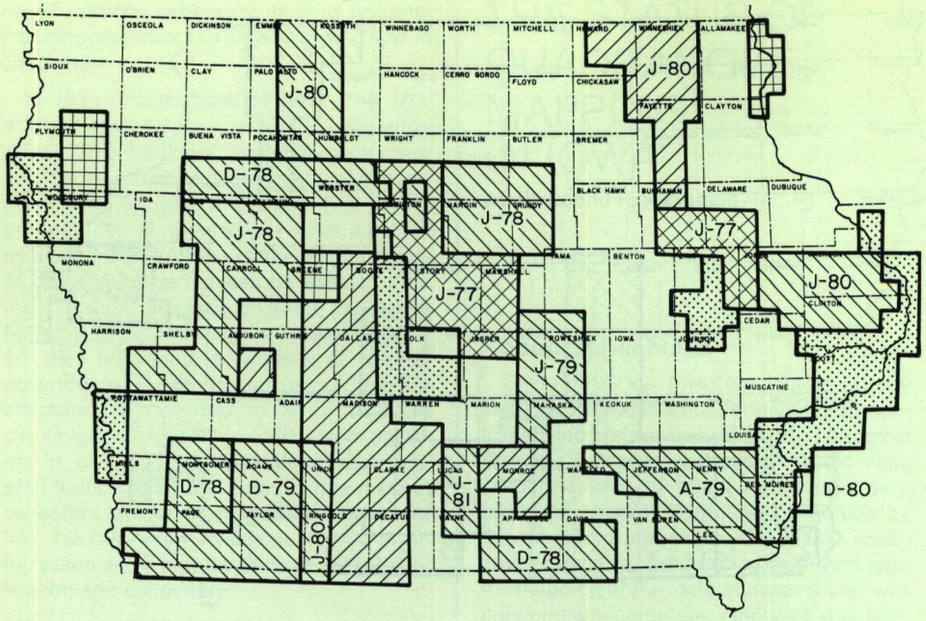
In order to fill the gaps where 7-1/2 minute topographic maps are not to be completed in the near future, the U.S. Geological Survey has initiated production of orthophoto quadrangles. Orthophoto quads are black and white aerial photographs printed at the same 1:24,000 scale as 7-1/2 minute topographic maps. They also cover a 6 by 8 mile area. The present status of orthophoto mapping in Iowa is displayed on Map 2. Orthophoto quads have river and town names printed on them, but no contours or other annotations.

Obtaining the Maps

Completed 7-1/2 minute topographic maps can be obtained from the Iowa Geological Survey for a cost of $1.25 each. About one year prior to map completion, ozalid advance prints become available. These prints are black line ozalid copies and can be obtained from the U.S. Geological Survey in Rolla, Missouri, at a cost of $1.25 each. For information on the availability of these advance prints and complete instructions for obtaining them, contact the Iowa Geological Survey, 123 North Capitol Street, Iowa City, Iowa 52242.

Copies of completed orthophoto quad maps can be obtained for a charge of $1.00 each. The copies are black line ozalids and are produced at the Iowa Geological Survey. At least 24 hours advance notice is required in order to prepare copies of the orthophoto quads. All mail orders must include return postage.

(Mr. Anderson is a remote sensing analyst in the Remote Sensing Laboratory.)



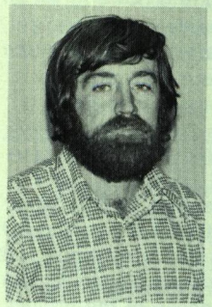
Status of 7-1/2 Minute Quadrangle Mapping in Iowa

Total number of Quads in Iowa	1083
Number of Quad maps completed	629
Number of Maps in progress	283
Completion scheduled for Feb. 1977	16
Completion scheduled for Nov. 1977	33
Completion scheduled for June 1978	114
Completion scheduled for Nov. 1978	161
Completion scheduled for Nov. 1979	8
No mapping begun	104
Available only as 15 minute map	18

Table 1. Schedule for completion of 7-1/2 minute quadrangle maps.

ELECTRICAL PROSPECTING

by Dr. Logan K. Kuiper



Electrical prospecting, or earth resistivity, is the science of measuring the electrical properties of the earth's surface in order to determine the composition and configuration of the rock and soil materials lying beneath the surface. This technique is used by the Iowa Geological Survey for preliminary investigations of potential waste-disposal sites and also has been used in a study to assess the depth and extent of gravel beds in portions of northwest Iowa. In general, resistivity investigations are used where knowledge of the subsurface geology at shallow depths is needed. It is a tool and, if used only by itself, will possibly result in inaccurate interpretations. Earth resistivity is referred to as "electrical drilling" because it is used to attempt the same results as drilling, *i.e.,* to identify accurately the nature and thickness of the subsurface rock and soil layers. It does a great deal less than this, but it can provide useful information and at only a fraction of drilling costs.

One of the early contributors to electrical prospecting was Robert W. Fox, who discovered in 1830 that there are natural electric currents associated with sulfide ore deposits. (Underground in several mines, he succeeded in measuring an electric current flowing between two points on the same vein as well as between two points on different veins.) Fox and other workers eventually determined the relative degree to which various ore materials are able to produce and conduct an electric current. They also measured and attempted to explain the origin of naturally occurring electric currents which come from sources other than ore bodies.

Shortly after 1900 experimentation utilized a man-made current source. This apparatus consisted of a battery with the leads connected by wires to two metal stakes inserted into the ground. The current passing through these wires was measured. In addition to the two stakes connected to the battery, two additional stakes were sometimes inserted into the ground and the current flow between them was measured. Various configurations of the stakes were used by different workers. In 1915 Frank Wenner, a physicist at the U.S. Bureau of Standards, introduced a configuration for the stakes that is still widely used and is in use most of the time at the I.G.S. For his configuration the four stakes are equally spaced and in a straight line. The outside stakes are connected to the battery, and the current passing through a wire connector between the two inside stakes is measured. As the spacing between the stakes is increased, the amount of current passing between the two inside stakes will usually change. Correct interpretation of a graphical plot of the current versus the spacing gives evidence as to the nature of rock and soil layers beneath the ground surface. The procedure by which these interpretations are made was presented in 1930 by Warren Weaver. He properly posed the mathematical nature of the problem and showed how the current must depend upon the results of electrical-potential theory as developed by Laplace, Poisson, and Maxwell several decades earlier.

This mathematical problem, although quite difficult, attracted considerable interest, and several persons solved it in varying degrees in the years after 1930. These early theoreticians showed how the results of the electrical measurements taken at the surface, while changing the spacing of the stakes, must depend upon the thickness and conductivity of the layers of rock and soil beneath the ground surface. They demonstrated how one can correctly infer the thicknesses and conductivities of the subsurface layers from the measured electrical data, as well as the incorrect inferences that can result in some instances. Unfortunately, these mathematical solutions and the insight they provided into the problem came after a host of persons had already developed concepts and methods after many years of empirical observations. Although the mathematical solutions showed clearly that many of these empirical methods were partly or totally in error, the persons who developed them were naturally reluctant to give them up

because they felt the methods were valid. At the center of the confusion was the fact, as the theoreticians had shown, that electrical prospecting had limitations as to its accuracy, and, therefore, the data measured should be interpreted by a person who has a qualitative knowledge of the subsurface geology.

At present, the older empirical methods of interpretation have been largely replaced by mathematical procedures. A procedure called the method of convolution is used at the I.G.S. Although it is computerized and thus requires very little time to use, it allows input from an interpreter who has knowledge of the subsurface. This system, developed by Adel Zoady of the U.S. Geological Survey and modified by I.G.S. staff, is probably the most sophisticated and powerful of all the interpretation methods.

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

COAL EXPLORATION PROGRAM

by Dr. Matthew J. Avcin

Since the last appearance of the *Newsletter,* the coal project staff has continued to accumulate data on coal occurrence and quality in Iowa. The primary source of data has been the drilling phase of the project, which has now completed 50 holes for a total of more than 15,000 feet of drilling and has shown reserves in excess of 700 million tons. Moreover, the core samples recovered by the drilling crew are providing raw material for a number of detailed studies.

Photo by William Jackson

The Geological Board examines a sample of Iowa coal. Left to right: Dr. Avcin, Gov. Robert Ray, Dr. Willard Poppy, Mr. Lloyd Smith, Dr. Willard Boyd, Dr. W. Robert Parks

Several researchers are presently studying the spores and pollen extracted from the coals in various cores. Preliminary results indicate that eventually it will be possible to identify and correlate most of the coals in Iowa. Similarly, preliminary results of study on a single coal indicate that it will be possible to characterize the evolution of the coal swamps through time.

A second research effort is directed toward understanding the occurrence of microscopic fossils in the rock units between the coals. Current results indicate these studies will assist in working out the geologic history of the coal basin in Iowa, particularly where data derived from the coals themselves is insufficient to solve the problem.

The quality of Iowa's coal is the main emphasis of a cooperative study among the U.S. Geological Survey, the U.S. Bureau of Mines, and the Iowa Geological Survey. During its initial phase the study concentrated on obtaining a general data base on Iowa coal. Preliminary results indicate that most Iowa coal is high-volatile C bituminous and high sulfur (greater than 3 per cent), although some of the samples indicate higher quality and lower sulfur. Presently, the sampling for this project is concentrating on potentially economic coals. The early successes of the detailed studies and continuing work on the larger scale properties of the core indicate that through time we will continuously refine our understanding of the coal-bearing rocks of Iowa. As usual, success begets success, and a number of researchers are looking into the possibility of using the I.G.S. cores in their research.

On the more personal side, Mr. Ora Robinson resigned from the I.G.S. to follow his father into railroading. Although Ora will be difficult to replace, his successor, Mr. Kevin C. Bentzinger, Randy's brother, brings a great deal to the job, both physically and mentally. He is big, personable and a graduate of an automotive repair and maintenance school. Both Randy and Kevin moved with their family and now reside in Keosauqua, Iowa.

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

IGS BRIEFS

Major Speeches by the Director:

During 1976, Dr. Stanley C. Grant, Iowa Geological Survey Director, addressed six groups on topics of major significance, beginning with "Energy Alternatives for Hospitals" to the Iowa Hospital Association in Des Moines on March 3. Also in March, he addressed the Penrose Conference at Waterwood, Texas, on "The Role of the Geologist in Society." Later in the month, he spoke on "Iowa Today and Tomorrow" to the Conservation Education Workshop at the University of Northern Iowa.

At the Iowa Academy of Science seminar on employment, held at Dubuque in April, Dr. Grant spoke on the subject of "Employment Requirements for Geology," and in May he addressed the quarterly meeting of the Upper Mississippi River Basin Commission on "The Mississippi, Iowa, and the Future." In June he spoke on "Iowa Coal and the Energy Dilemma" to the Alumni Day audience at Cornell College, Mt. Vernon, Iowa, where he was an undergraduate student.

Hallberg Chairman Geology Section:

Dr. George R. Hallberg was elected Chairman of the Geology Section of the Iowa Academy of Science for 1976-1977. He is also organizing a special interdisciplinary symposium on Iowa coal to be sponsored by the Academy at the annual meeting to be held at Drake University April 21-23. Dr. Hallberg became Chief of the Research Division of the Geological Survey in January 1976.

Promotions:

Billy Joe Bunker, Subsurface Division, to Geologist II, in September 1976; Susan K. Sappington, Administrative Services, from Clerk-Typist I to III, in January 1976; Mrs. Rose Schafer (formerly Shindelar) from Clerk-Typist III to Accounting Clerk II in March 1976 and from Ms. to Mrs. in May 1976.

Scheetz Awarded Honor:

Earl Edward Scheetz, Chief of Technical Support for the Survey, was honored with membership in the National Water Well Association's President's Club at the NWWA convention in Las Vegas, Nevada, September 12-13. To be appointed to the President's Club, a NWWA member must recruit at least four new members in his first year and two new members each succeeding year that he is in the NWWA.

Scheetz joined the Iowa Geological Survey in 1963. According to one of his associates, "Bud", as he is familiarly known, is "a favorite member of the Survey staff" because of "his congenial personality and perennial good humor." A native of Oxford, Iowa, Scheetz married Kathryn Agnes Winter in 1942, and they have 3 sons, 2 daughters, and 6 grandchildren.

Jordan Aquifer Atlas Nearing Completion:

According to Paul J. Horick, principal author, the Jordan aquifer study is on schedule and should be completed by year's end. This long awaited report will describe the geology, hydrology, and water quality of one of the state's major groundwater sources. The three-sheet atlas will make extensive use of illustrations, charts, and graphs to indicate the regional setting of the aquifer and its stratigraphic and hydraulic relations with overlying and underlying beds, its hydrologic properties, including the pressure-indicating surface and the yearly withdrawal rate, and the expected mineral quality of the water, the significance of the dissolved constituents, and water-treatment methods. Water plant operators, engineering consultants, water well drillers, and water-plan regulators should find the atlas particularly valuable.

Sium at Princeton Water Program:

Ogbazghi Sium, Hydraulics Engineer for the State Water Plan at the Geological Survey, attended a program, "Advanced Groundwater Hydrology and Management" conducted at Princeton University from August 30 to September 3, 1976. The program was under the direction of professor Jacob Bear of Technion, Haifa, Israel, with the assistance of Dr. George F. Pinder of Princeton. Bear emphasized the regional approach to the behavior, quality, and quantity of aquifers. Water levels and quality in space and time were explored, with the solution to the space-time problem involving formulating mathematical models, defining coefficients and boundary conditions, and performing calculations. Although the quantity of surface water is small compared to that of groundwater, it is ironic that surface water is well-managed by such regional groups as the Mississippi River Basin Commission, while there is no comparable attention to groundwater. Sium observed that the program gave him "an excellent understanding of the mechanism of ground-water movement and the management problems associated with pumping or recharging from an aquifer and its simulation by mathematical models."

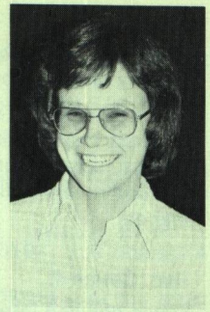
Coal Reserves Studied:

Through the facilities of the Iowa Geological Survey, strippable coal reserves in Appanoose, Jasper, Jefferson, Polk, Van Buren, Warren and Wayne Counties, Iowa were studied in 1975-76 by Dr. Paul L. Garvin, Prof. of Geology at Cornell College, Mt. Vernon, Iowa. The study, funded by the U.S. Bureau of Mines, was coordinated by Orville J Van Eck, Associate State Geologist. A report was issued by the Survey in September, 1976.

The study is a follow-up to a five-county project conducted for the Survey in 1975 by Dr. Garvin under Bureau of Mines funding. The two projects are due for publication in 1977. (The front cover illustrates a portion of strippable coal reserves study.)

RECENT PUBLICATIONS

Compiled by
Suzan M. Stewart



Landuse, Landforms, and Irrigation are Highlights of New IGS Publications

During the past few years, the Iowa Geological Survey has published increasing numbers of maps, data cumulations and technical reports. During 1976, a new list and index of IGS publications became available, and a new series of technical information reports was begun. Other important IGS contributions to the literature of Iowa geology include:

Bedrock and Subsurface Geology

Cagle, Joseph W., 1973, Bedrock topography of south-central Iowa: U.S. Geol. Survey Misc. Geol. Inv. Map I-763. 1 map, scale 1:125,000.

Hansen, R.E., 1972, Bedrock topography of east-central Iowa: U.S. Geol. Survey Misc. Geol. Inv. Map I-717. 2 maps, scale 1:125,000.

Hansen, R.E., 1973, Bedrock topography of southeast Iowa: U.S. Geol. Survey Misc. Geol. Inv. Map I-808. 2 maps, scale 1:125,000.

Hansen, R.E., 1975, Bedrock topography of northeast Iowa: U.S. Geol. Survey Misc. Geol. Inv. Map I-933. 2 maps, scale 1:125,000.

This group of maps, prepared in cooperation with IGS, is part of a continuing series to provide state-wide information on the topography of the bedrock surface. Information is valuable to interpretation and understanding of groundwater resources, rock and mineral resources, geologic history, and environmental problems.

Gockel, D.J. 1976, Summary of ADP drill-hole information. Part I: northeast Iowa: Iowa Geol. Survey Tech. Info. Series 2. In preparation.

Summary of geologic information compiled by automatic data processing and derived from wells in 25 counties of northeast Iowa. Data includes location, elevation, total depth, bedrock top, and bottom rock unit penetrated by the well.

Geophysics

Gilmore, J.L., 1976, Gravity survey of the Randalia magnetic anomaly in Fayette County, Iowa: Iowa Geol. Survey Report of Investigations 11.

Kuiper, L.K., 1976, A thermal model for the surface temperature of materials on the earth's surface: Iowa Geol. Survey Tech. Info. Series 1.

Index

List and index of publications of the Iowa Geological Survey, 1976.

Landuse

Anderson, R.R., McAdams, M.P., and Hoyer, B.E., 1976, Land-use in Iowa: 1976: Iowa Geol. Survey Misc. Map Series 5. 1 map, scale 1:250,000, $1.50 + 40¢ p/h (folded); $1.50 + $1.00 p/h (rolled).

Colored map displays nine categories of landuse: urban residential, urban commercial/industrial, urban open, transportation network, extractive land, agricultural land, forest land, water and reservoir flood pool. Data was obtained primarily from interpretation of LANDSAT I images.

Anderson, R.R., 1976, Land-use in Iowa, an explanation of the map: Iowa Geol. Survey Tech. Info. Series 4.

Gives detailed information on techniques used in production of the land-use map, as well as problems encountered and map limitations.

Landforms

Hallberg, G.R., and Anderson, R.R., 1975, Relief map of Iowa: Iowa Geol. Survey Map 12, 1 map. 8-1/2 x 11, free. Scale 1:1,000,000, 25¢ + 30¢ p/h, folded; 25¢ + 75¢ p/h, rolled. Scale 1:500,000, 50¢ + 30¢ p/h folded; 50¢ + 75¢ p/h rolled.

This black and white contour-line map enhances the relief and physiographic regions of the state. Constructed from a mosaic of the 1:250,000 scale U.S. Geological Survey topographic maps.

Prior, J.C., 1976, A regional guide to Iowa landforms: Iowa Geol. Survey Educ. Series 3, 72 p. $1.50 + 50¢ p/h.

Well-illustrated, non-technical account of how Iowa's landforms are studied, the glacial events that led to their formation, and each of Iowa's landform regions in terms of its appearance, geologic history and materials of composition.

Hallberg, G.R. and Van Zant, K.L., 1976, A late-glacial pollen sequence from northeast Iowa; Sumner Bog revisited: Iowa Geol. Survey Tech. Info. Series 3. In preparation.

Palynologic stratigraphy and radiocarbon evidence for a reinterpretation of sediments of Sumner Bog in Bremer County, Iowa.

Remote Sensing

Anderson, R.R., Hoyer, B.E., and Taranik, J.V., 1976, Guide to aerial imagery of Iowa: Iowa Geol. Survey Public Info. Circ. 8. Update of 1974 publication.

Hallberg, G.R. and Hoyer, B.E., 1975, contributing authors of chapter 19, "Water Resources Assessment," *in* Manual of Remote Sensing: Falls Church, Va., Amer. Soc. of Photogrammetry.

Synopsis of IGS Remote Sensing Laboratory flood studies utilizing multi-spectral analysis is included in this state-of-the-art review.

Hoyer, B.E., McAdams, M.P. and Hallberg, G.R., 1976, Development and testing of operational flood-mapping techniques: Seattle, Washington, Proc. of the Amer. Soc. of Photogrammetry, Fall Convention, p. 485.

Flood boundaries can be interpreted and mapped using near-infrared wavelengths in all seasons for a minimum of seven days after flood waters have receded. Report summarizes and analyzes various flood-mapping techniques tested at IGS.

McAdams, M.P., 1976, Techniques for estimating flood-produced crop damage using aerial photography: Seattle, Wash., Proc. Amer. Soc. of Photogrammetry, Fall Convention, p. 251.

Many factors used to estimate the amount of flood-produced crop damage such as crop type flooded, acres flooded, acres replanted and crop-type replanted can be determined through the use of aerial photography.

Water Resources

Cagle, J.W. and Heinitz, A.J., 1976, Water resources of south-central Iowa: Iowa Geol. Survey Water Atlas 5. In preparation.

Ludvigson, G.A. and others, 1976, Water resources of east-central Iowa: Iowa Geol. Survey Water Atlas 6. In preparation.

Reports present detailed information on the availability, occurrence, quality and utilization of ground and surface water.

Hallberg, G.R., 1976, Irrigation in Iowa: Iowa Geol. Survey Tech. Info. Series 5. $1.25 + 45¢ p/h.

Increased demand for water-withdrawal permits for irrigation is predicted over the next few years. In response, existing information on crop-yield data, climatic trends, cost information, and potential problems is presented.

Horick, P.J. and Steinhilber, W.L., 1976, Jordan aquifer of Iowa: Iowa Geol. Survey Misc. Map Series 6. In preparation.

Three-sheet atlas presents detailed information on one of Iowa's primary ground-water sources.

Ordering Information

The above materials can be ordered for the listed prices plus postage and handling charges from the Iowa Geological Survey, 123 N. Capitol Street, Iowa City, Iowa 52242. American Society of Photogrammetry documents can be ordered from the American Society of Photogrammetry, Falls Church, Virginia.
(Ms. Stewart is a librarian in the Water Plan Division.)

COST-CODING INITIATED

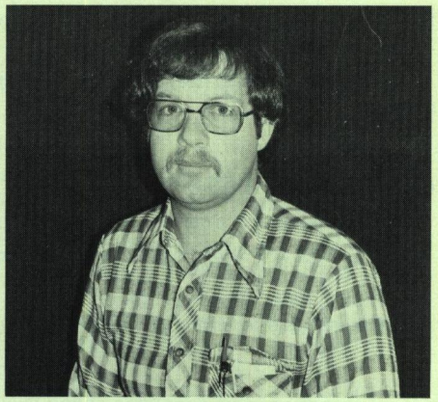
by Wilma V. Gould

In September 1976, the Geological Survey initiated the use of cost-code accounting methods for its eight programs. The purpose of cost-codes is to furnish participating agencies with expenditure information on its various programs. Cost-coding is not new, nor is it utilized by all State agencies, but the State Comptroller is encouraging its implementation. All staff salaries and materials and operating expenses are assigned code numbers representing each program. Printout sheets are sent regularly from the Comptroller showing details of program expenditures. This information will furnish our agency with cumulative and total costs of a program. The formalization of Survey management by objectives and the use of cost-code accounting will be beneficial in monitoring program costs and making prudent fiscal expenditures.
(Ms. Gould is Chief of Administrative Services.)

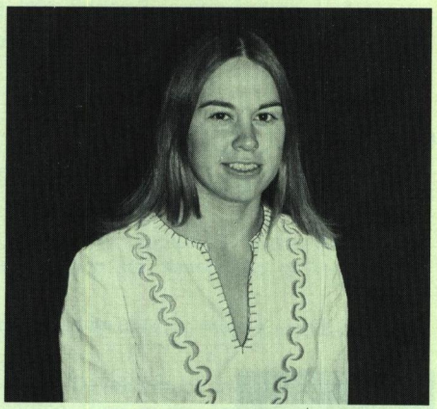
NEW FACES

Kevin C. Bentzinger, a resident of Keosauqua, Iowa, joined the Coal Division as a driller's assistant in June 1976. He is a graduate of the Ryder Technical Institute in Des Moines and is a certified auto and diesel mechanic.

Nyle Wollenhaupt, a native of Bridgewater, Iowa, joined the Research Division of the Iowa Geological Survey in October 1976 as a soils specialist. Wollenhaupt received the B.S. in Agronomy (Soils) and the M.S. in Soil Genesis and Morphology from Iowa State University, Ames, where he was engaged in doctoral studies before joining the Geological Survey. For two years he was Assistant Technical Manager for the Hilton Coliseum at Iowa State University. During his M.S. program he was a teaching assistant and research associate.



Charmaine Shreve, a native of Cedar Falls, Iowa, started in February 1976 with the Survey's Illustrating and Drafting Division. She previously was a graphic designer and illustrator for the Iowa City division of Westinghouse Learning Corporation. She has a B.A. degree in Art from the University of Northern Iowa and a teaching certificate in Art Education as well as graduate credits in graphics from the University of Iowa.



Susan M. Davis, an Iowa City native, joined the Geological Survey in October 1976 as a part-time computer-programming assistant to Raymond P. Kollasch, Chief of the Division of Data Systems. She was with the U.S. Geological Survey Water Resources district office in Iowa City as a hydrologic technician from 1972 to September 1976. She has the B.S. degree in General Science from the University of Iowa.