

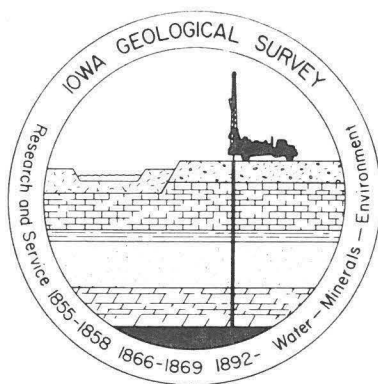
ANNUAL REPORT



OF THE STATE GEOLOGIST TO THE GOVERNOR

Volume 52
1982

ANNUAL REPORT
OF THE
STATE GEOLOGIST
TO THE
GOVERNOR



compiled by
ORVILLE J VAN ECK
ASSOCIATE STATE GEOLOGIST

VOLUME 52

1982

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State of Iowa

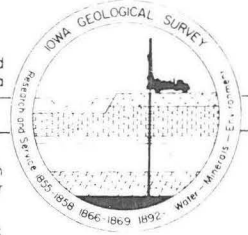
Iowa Geological Survey

123 North Capitol Street • Iowa City, Iowa 52242 • (319) 338-1173

Terry E. Branstad
Governor of Iowa

Donald L. Koch
State Geologist and Director

Orville J. Van Eck
Associate State Geologist



February 28, 1983

Governor Terry E. Branstad
State Capitol Building
Des Moines, Iowa 50319

Dear Governor Branstad:

Herewith is the Report of the State Geologist in accordance with the requirements of the Code of Iowa, Section 305.7 and Section 17.4. It describes the activities and accomplishments of the Iowa Geological Survey for the period of 1 January 1982 to 31 December 1982. The legal responsibilities of the Survey are set forth in the Iowa Code, Chapters 305 and 84.

Projects within each Division continue to become more varied and complex, and staff capabilities continue to increase. Investigations related to the quantity and quality of Iowa's water resources highlight our activities for the year. Nevertheless, basic research still is a key element that has been given considerable attention. All of these efforts are designed to serve the needs of the State and its citizens.

Services provided to regulatory agencies remain a high priority, especially those services that deal with aquifer evaluation and water quality degradation problems. In addition to State funds, Federal contract funds have supported major projects. Staff for the latter are hired with Executive Council approval for no longer than the contract period.

As directed by the 69th General Assembly, the Survey prepared a plan for a comprehensive water resources information system. I am confident that this plan will effect a strong system to enhance management of Iowa's water resources.

Respectfully submitted,

A handwritten signature in cursive script that reads 'Donald L. Koch'. The signature is written in dark ink and is positioned above the typed name and title.

Donald L. Koch
State Geologist and Director

IOWA GEOLOGICAL SURVEY

ANNUAL REPORT

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FUNCTIONS OF THE GEOLOGICAL SURVEY

The fundamental function of the Geological Survey is to collect, interpret and report information on basic geologic features and products of the State, including surface and groundwater. As the principal repository for basic geologic and water data, the Survey makes every effort to secure all such data, and in turn, to make that data meaningful and available to individual citizens and to all agricultural, industrial, and governmental organizations.

In addition to the basic data program, the Survey conducts various research programs aimed at furthering the geologic and hydrologic knowledge of the State. The programs range from re-evaluation of extant data to complex data gathering surveys. To implement research in hydrology and to expedite topographic mapping in the State, the Survey uses the authority granted in Chapter 305.8, Code of Iowa, to cooperate with the Water Resources Division and the National Mapping Division of the U.S. Geological Survey in cost-sharing programs. The knowledge gained through research will lead not only to better management and protection of our known resources, but to discovery and utilization of new resources as well.

The basic method of information dissemination is in the formal reports published by the Survey. In the absence of a report on a particular area, and

where a detailed report is necessary for a specific purpose, unpublished special reports are provided. To further the value of the reports, the Survey acts in a consultative capacity to those who seek assistance. Except where the State can expect to acquire important information, consultations with private consulting firms are not performed, but our data bank and files are available for their use.

In its role as a consultant, the Survey has the responsibility of providing information about naturally occurring resources. In this context the Survey assumes a strong responsibility in advising local and regional planners as to the effects various land uses will have upon the environment under the existing geologic and hydrologic conditions of a given area.

The Survey is a resource agency for a variety of state agencies that exercise regulatory power. The research and problem-solving mandate given the Survey by the legislature separates us from the regulatory agencies so as to permit an unbiased service to the enforcement and regulatory branches of government such as the Attorney General, the Department of Agriculture, the Iowa Natural Resources Council, Iowa Conservation Commission, Iowa Department of Health, Iowa Department of Environmental Quality, Mines and Minerals Division of the Department of Soil Conservation, and the Iowa Department of Transportation, as well as to county and municipal governmental units.

Many aspects of environmental preservation require a detailed, sophisticated knowledge of the nature of earth materials and the nature and behavior of water in a region. Our staff has the highly specialized training and experience in Iowa geology to fulfill these needs at minimal cost to the State.

The functional relationships of the Geological Survey to federal, state, and local governmental agencies, and to the private sector are shown in Figure 1.

IOWA GEOLOGICAL SURVEY

Consultation, Advisory, and Data-
Source Services

Research Cooperative Programs

U.S. Geological Survey
Groundwater (50/50 matching)
Surface Water (50/50 matching)
U.S. Bureau of Mines
U.S. Geological Survey
Geologic Division
National Mapping Division
U.S. Department of Agriculture
U.S. Environmental Protection Agency

Iowa Citizens
Iowa Department of Revenue
Iowa Water Well Drillers
Local and Regional Planning Commissions
Iowa Counties and Municipalities
Iowa Commerce Commission
Iowa Development Commission
Office for Planning and Programming
Iowa State Department of Health
Department of Environmental Quality
University Hygienic Laboratory
Iowa Department of Justice
Iowa Natural Resources Council
Iowa Department of Soil Conservation
Iowa Agricultural Experiment Station
State Archaeologist
Iowa Department of Agriculture
Iowa Department of Transportation
Iowa Preserves Board
Iowa Conservation Commission
The University of Iowa
University of Northern Iowa
Iowa Department of Public Instruction
U.S. Department of Public Instruction
U.S. Department of Agriculture SCS
Private Industry
Engineering Consultants

Participation in Other Agencies

Iowa State Map Advisory Council
Iowa Conservation Education Council
Department of Environmental Quality
Inter-Agency Resources Council
Department of Soil Conservation
Land Rehabilitation Advisory Board
Watershed Advisory Board
Conservancy District Task Board
U.S. Department of Agriculture
Conservancy District Coordinating
Committee
Energy Policy Council
Iowa Coal Utilization Advisory
Committee
Legislative Environmental Advisory
Group

Figure 1. Functional Relationships of the Iowa Geological Survey

TABLE OF ORGANIZATION

The table of organization of the Geological Survey is depicted in Figure 2.

The current table of organization is a result of the need to:

1. maintain an organizational framework that permits ready adaptation to changes in agency programs,
2. retain sufficient flexibility with staff assignments such that appropriate personnel can readily respond to routine and emergency information requests from other agencies, and
3. develop a management structure that satisfies the requirements of the Iowa Merit Employment Department for supervisory personnel.

The level of attainment achieved by any viable organization is limited only by the caliber of its employees. The Geological Survey is fortunate to have enlisted the services of talented, enthusiastic employees in every sector of its operation. Their efforts maintain the esteem of the agency.

IGS ORGANIZATIONAL STRUCTURE

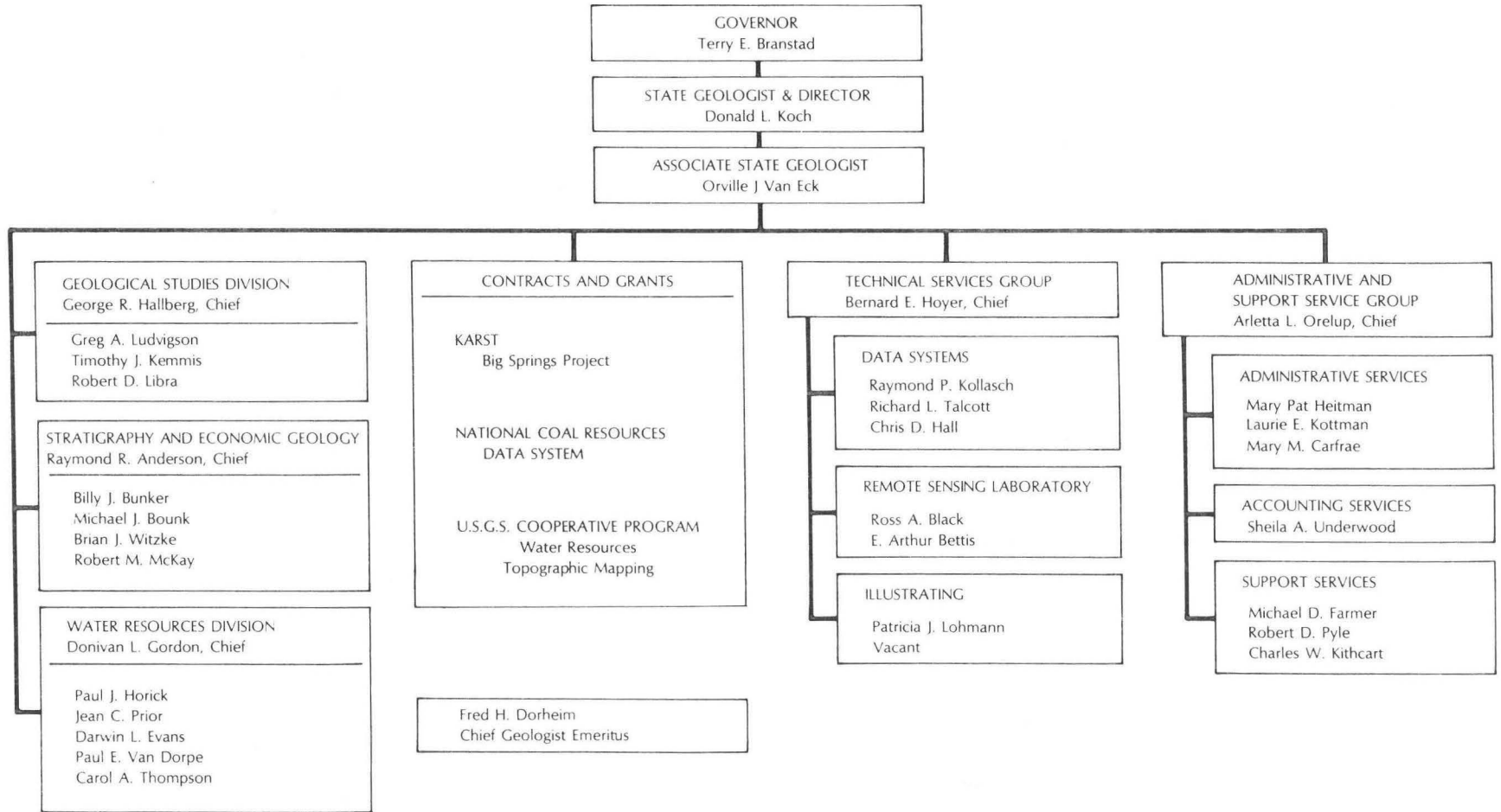


Figure 2. Staff Organization and Responsibility Assignment.

IGS-USGS COOPERATIVE RESEARCH

The Geological Survey uses the authority granted in Section 305.8, Code of Iowa, to cooperate with federal agencies in cost-sharing programs for geologic and hydrologic research in Iowa.

During the current reporting period, the Survey continued a 50/50 cost-sharing cooperative program with the Water Resources Division of the U.S. Geological Survey. The objectives of the program are threefold:

- to collect, analyze, and publish information on the occurrence and quality of groundwater resources--the scope of research may range from the study of a single aquifer system of limited areal extent to analysis of a multiple system of aquifers on a state-wide basis;
- to maintain surveillance of the groundwater resources through a network of observation wells so that water-level and chemical quality changes can be monitored;
- to maintain a system for collection and compilation of basic records of daily stage and flow rate of streams and the concentration and total load of sediments carried by streams.

During 1982, the IGS fully supported 27 and partially supported 11 streamflow data collection stations. IGS also supported five sediment data-collection stations. A tabulation of these stations is presented in Table 1 and the locations are shown in Figure 3. These stations are part of a streamflow and sedimentation data-collection network of 132 stations.

In addition to the use by the IGS of the data provided by these stations, a number of state, federal, and local agencies utilize the data in various ways. Among those agencies that regularly rely upon the data in making regulatory and construction design decisions are the Iowa Natural Resources

Council, the Iowa Department of Environmental Quality, the Iowa Department of Transportation, the Iowa Conservation Commission, the U.S. Soil Conservation Service, and County and City Engineers.

As greater demands continue to be made on our water resources, the need increases for objective and impartial investigations. The data acquired through this cooperative research program forms the foundation for good water-management policies and comprehensive planning. Projects under this program are closely monitored to ensure that the State's needs are addressed. Discussion of specific cooperative projects are included in the reports of the various IGS Divisions that follow.

TABLE 1.

USGS/IGS COOPERATIVE STREAMFLOW DATA COLLECTION PROGRAM, 1982

Stations Fully Supported by IGS

Station

Big Cedar Creek at Varina
 Cedar Creek at Oakland Mills
 Des Moines River at Saylorville
 East Branch Iowa River at Klemme
 East Fork Hardin Creek at Churdan
 East Fork 102 River at Bedford
 Iowa River at Rowan
 Little Sioux River at Correctionville
 Maquoketa River at Maquoketa
 Middle Raccoon River at Panora
 North Fork Maquoketa River at Fulton
 North Raccoon River at Sac City
 North Skunk River at Sigourney
 Ocheyedan River at Spencer
 Platte River at Diagonal
 Shell Rock River at Shell Rock
 Skunk River at Augusta
 South Skunk River at Ames
 Tarkio River at Stanton
 Turkey River at Garber
 Turkey River at Spillville
 Wapsipinicon River at DeWitt
 Wapsipinicon River at Elma
 Wapsipinicon River at Independence
 Weldon River at Leon
 West Nishnabotna River at Hancock
 Winnebago River at Mason City

Stations Partially Supported by IGS:

Station

Cedar River at Charles City
 Blackhawk Creek at Hudson
 Des Moines River at Des Moines
 Little Sioux River at Turin
 Soldier River at Pisgah
 Boyer River at Logan
 East Nishnabotna River at Red Oak
 Mississippi River at Clinton
 Raccoon River at Van Meter
 Iowa River at Marshalltown
 Cedar River at Cedar Rapids

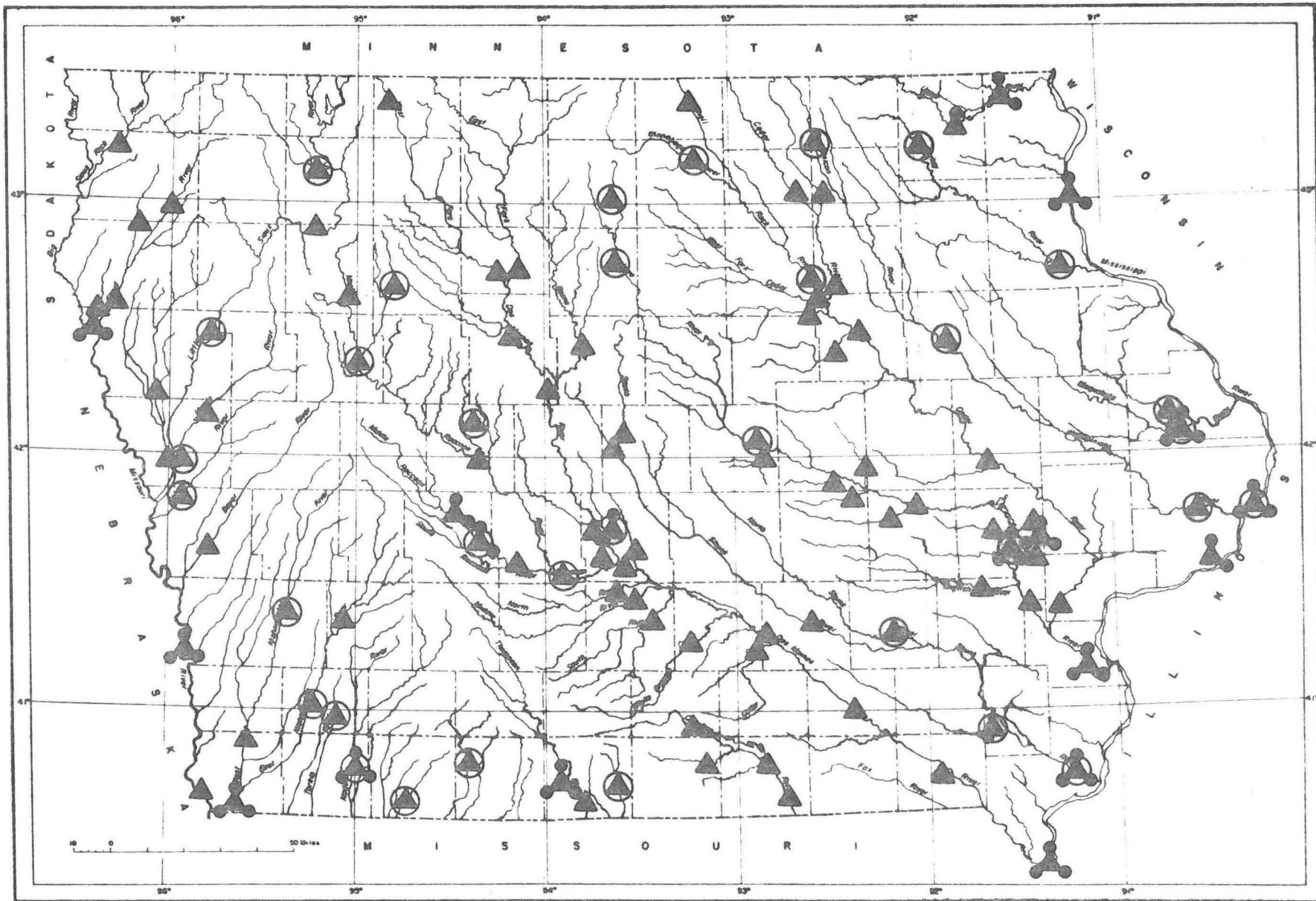
USGS/IGS SEDIMENT DATA COLLECTION PROGRAM

Stations Fully Supported by IGS:

Station

Des Moines River at Saylorville
 Iowa River at Iowa City
 Ralston Creek at Iowa City
 Skunk River at Augusta
 Nodaway River at Clarinda

Active streamflow and water quality stations in Iowa—1982-83 FY



- ▲ Streamflow station
- Water quality station
 - chemical
 - sediment
- Station support by IGS

Figure 3. Index map showing location of streamflow and sedimentation data-collection stations supported by IGS.

CONSULTATIVE, ADVISORY, AND INFORMATION SERVICES

The Survey yearly responds to hundreds of requests for geologic and hydrologic information from various state and federal agencies, consulting engineers, well drillers, industries, and citizens. These services frequently require interpretation of data and quite often on-site investigations in various parts of the State. With continued public concern over environmental, energy, and water resources problems, the number of requests has increased substantially. The manner in which the requests are answered is largely predicated by the nature and the scope of the request.

For those requests that are general in nature, one of the publications of the Survey often will fulfill the needs. For those of a more specific or localized nature, a special letter report is prepared. These reports are generally interpretive.

In contrast to the requests for interpretive reports, we also are called upon to supply much basic data. Recognizing this need some time ago, we have worked to develop an automated geologic and hydrologic data bank. These efforts have progressed to the point where we now can provide such data rapidly with comparatively little demand on staff time and at a nominal cost to the user.

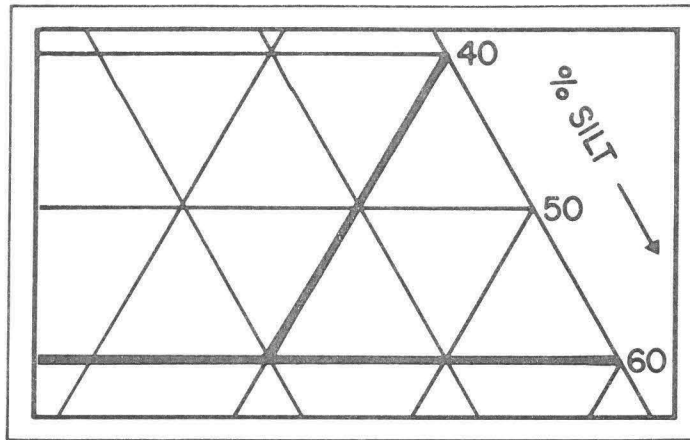
The public interest in, and concern about energy, environmental, and water resource problems have resulted in a greater demand for public addresses by staff members. These have ranged from short presentations to various service groups, to seminars devoted to specific subjects. The results have been gratifying in that there seems to have developed among the general public an entirely new appreciation of our earth resources, and the recognition of the need to protect and conserve them.

LEGISLATIVE WATER INFORMATION SYSTEM PLAN DIRECTIVE

Section 60 of House File 2463 instructed the State Geologist to prepare a plan for the development of a comprehensive state water-data system to monitor the State's water resources on a continuous basis and provide data to the Department of Water, Air, and Waste Management to enable that agency to assess the needs of Iowa's water users and develop a general plan for water allocation. The State Geologist was also instructed to present the plan to the General Assembly by 15 January 1983.

During the last six months of calendar year 1982, coordinating with the State Geologist, the Directors and Staff of other state and federal agencies, and the Legislative Water Study Committee, the Water Resources and Data Processing divisions of IGS have cooperated in preparing a comprehensive Iowa Water Data System Plan. The key elements of the plan are:

- The development of an interagency data system management structure;
- A strategy for the cooperative review of existing state and federal programs which collect and report water resources data;
- Recommendations for new data collection programs where critical data voids exist in the present data base;
- A strategy to enhance the efficient transfer, use, and application of water data in Iowa based on interagency cooperation and communication; and
- Data communications, retrieval system, and data storage improvements to enable IGS to handle the increased data processing workload.



Geological Studies Division

The primary task of the Geological Studies Division is to conduct and coordinate applied studies that are fundamental to the understanding of Iowa's physical resources. Such studies are nearly always multi-disciplinary and are generally performed in cooperation with other IGS divisions and often involve the expertise of other agencies. Timely dissemination of the results is particularly important. When appropriate, papers are published by IGS. Short notes and papers of a more specialized, technical nature are made available through extrinsic publications.

George R. Hallberg, Chief

HYDROGEOLOGIC STUDIES

During the last interim, the major accomplishments of the Geologic Studies Division have been in the area of hydrogeologic research and service programs. Reports were prepared on several major projects, which were completed in 1981. The report on the Floyd River alluvial aquifer study was published

as IGS Water Supply Bulletin No. 12. The final report on the Dakota aquifer study in northwest Iowa was completed and is scheduled for publication. Review of water-quality monitoring data from the LaBounty arsenic waste disposal site at Charles City continues.

New major projects which are continuing include the study of groundwater quality problems in the karst areas of northeast Iowa, and groundwater availability investigations in west-central Iowa.

Groundwater Quality in the Karst Regions of Northeast Iowa

One of the major new hydrogeologic projects continuing this year is the evaluation of groundwater quality in the karst areas, formed in the important Silurian and Devonian aquifers of northeast Iowa. These aquifers are formed of limestone, or carbonate rocks, and are major sources of public and private well or groundwater supplies through-out eastern Iowa.

In humid environments such as Iowa, these carbonate rocks are subject to chemical solution by infiltrating soil and groundwater. As the water dissolves away the rock, fractures, joints, and other openings are enlarged. Over time the result is that groundwater moves through a series of interconnected openings ranging from microscopic fractures to large caves and caverns. The flow of water in these larger openings is like flow through a pipe, in contrast to the slower, intergranular flow through a sandstone. This is one of the problems in carbonate aquifers; the pipe-like flow through the system does not provide the natural filtering that occurs with intergranular groundwater flow. Another consequence of the solution of the carbonate rocks is the development of unique land-surface features, collectively referred to as karst topography. One of the more conspicuous and important features is the sinkhole. Sinkholes form as a consequence of the rock solution and collapse. At

the surface, sinkholes appear as conical depressions which widen upward. As depressions, the sinkholes collect surface drainage, and sometimes intercept and "swallow" streams. This is one of the major problems with the karst regions. The sinkholes provide a direct conduit for surfacewater to run directly into the underground cavities in the limestone, and join the groundwater system. These surfacewaters, and the contaminants they may carry, can reach the groundwater in a wholly unfiltered and undiluted state. As a consequence, carbonate aquifers are highly susceptible to contamination by surface runoff from agricultural or industrial land, effluent from septic tanks, drainage tiles, and other forms of waste disposal. Sinkholes also provide a common and convenient, though dangerous place to dispose of solid waste materials. Observations in Iowa have shown local occurrences where everything from old chemical containers, old car bodies, creamery wastes, to dead animals have been dumped into sinkholes. Out-of-sight is not necessarily out-of-mind in these instances, because this dumping has often seriously contaminated local water supplies.

Because of these problems, water quality in this area has been of concern for some time. In recent years, attention has been drawn to the hazards of the karst area because of proposed pipeline routes through the karst regions. In 1976, IGS began an evaluation of water quality in these karst areas, but the study had to be discontinued because the required funds for the project were not appropriated, and staffing and funds at that time could not accommodate the continuation of the project.

During the past two years the Iowa Geological Survey, in large part through a contract with the Iowa Department of Environmental Quality, has undertaken such a study. This project at times involved nearly the entire staff at IGS, and a number of graduate students who were employed through the

contract. The first phase of this project was completed during 1982 (Hallberg and Hoyer, 1982; in IGS publications list).

The first phase of this project was a regional assessment of the karst regions. In this phase of the study, the actual sinkholes, the depth to bedrock, and soil conditions which effect the karst areas were mapped in detail for 22 counties in northeast Iowa (about 13,400 square miles). Such a detailed evaluation was necessary before the groundwater-quality data could be understood, and before any assessment of remedial measures can be considered. The findings of the study are summarized below.

Pertinent geologic, hydrologic and water-quality data were compiled and analyzed, including over 14,000 water analysis records provided by the University Hygienic Laboratory (UHL). The distribution of over 12,700 sinkholes was mapped. "Soil materials" cover the bedrock to depths varying from 0 to 500 feet, but the sinkholes are only found in certain areas where the "soil-materials" are less than 30 feet thick. There are three main areas of sinkhole concentrations: one in the area of exposure of the Galena aquifer, in southwestern Allamakee County, and adjacent areas; and two areas in the Silurian-Devonian aquifer, in southern Clayton County and adjacent areas, and adjacent to the Cedar River, mainly in Floyd and Mitchell Counties.

Results of the geological studies were used to subdivide the area into three geologic regions: Karst--areas with significant concentrations of sinkholes; Shallow Bedrock--areas with less than 50 feet of "soil" covering the bedrock, but with few sinkholes; and Deep Bedrock--areas with more than 50 feet of "soil" covering the bedrock.

Groundwater in the Karst and Shallow Bedrock areas exhibits significantly higher concentrations of nitrate than in the Deep Bedrock areas, particularly to depths of 150 feet. The greatest differences occur in the 50-99 foot depth

range, where the median nitrate concentration in the Karst regions (34 mg/l) is 1.8 times greater than in the Shallow Bedrock regions (19 mg/l) and nearly 6 times greater than in the Deep Bedrock regions (6 mg/l). Below 100 feet the Karst and Shallow Bedrock areas show similar levels of nitrate. This is attributed to the direct inflow of nitrate in surfacewaters into sinkholes in Karst regions, combined with significant diffuse recharge of nitrate to the aquifer in both the Karst and Shallow Bedrock regions. For perspective, the median nitrate values from all areas are below the 45 mg/l drinking-water standard. For the study area, 18% of all samples exceed 45 mg/l. Within the different geologic settings, 25% of analyses from the Karst areas, 19% in the Shallow Bedrock, and 15% in the Deep Bedrock areas exceeded 45 mg/l. Much of the excessive nitrate contamination is localized to individual wells, but nitrate levels are clearly elevated regionally as well.

The source of the nitrates is clearly man's activity; natural background levels of nitrate are generally less than detectable. Little data is available regarding other widely used chemicals. The fate of these chemicals in the groundwater system is unclear, as are the possible health effects.

The physical setting in both the Karst and Shallow-Bedrock regions present potential hazards for groundwater contamination. Any management strategies developed for protection of these water resources must consider both of these settings, which in total constitute about 53% of the 22 county area or, 6,800 square miles of land overlying important bedrock aquifers.

The relationship between the sinkholes and the groundwater flow system in the carbonate aquifers suggests that the bulk of these surface contaminants in the Karst regions should be contained within the shallow portion of the flow system. This may, in part, explain why significant nitrate contamination is confined to relatively shallow depths (less than 150 feet). However, because

of the lack of detailed data about the aquifers, an alternative which must be considered is that the deeper portions of the aquifer show less contamination because there has not been enough time for the nitrates to diffuse this deep.

Further research is needed on the nature of bacterial contamination of groundwater in the Karst areas. Analysis of bacterial data indicates that bacterial contamination of rural water supplies requires attention. Thirty-five percent of all analyses from UHL for the study area do not meet health standards. This contamination appears to be primarily related to problems in individual rural domestic water systems, but in Karst regions may be increased by the influx of surfacewaters.

The magnitude of chemical and bacterial contamination of an individual well is also related to problems of poor well construction, maintenance and/or well placement. Contamination of a well from surface sources may also introduce contaminants into the aquifer.

Shallow wells, less than 50 feet deep, statistically show high nitrate values regardless of their geologic setting. Shallow wells throughout Iowa, regardless of the aquifer involved, are susceptible to contamination by nitrates, and indeed are exhibiting significantly high levels of nitrate contamination.

Groundwater in the Karst areas is readily susceptible to contamination from hazardous substances which locally may be discharged at the surface. On the regional level, nitrates, bacteria and pesticides are the three general contaminants of concern for public health. Both point and non-point sources can be identified. Land use patterns and other studies suggest that non-point sources, primarily infiltration, tile drainage, and water and sediment runoff from agricultural lands are the most significant. Point sources, however, should be eliminated where possible. There are existing rules and regulations

to control these point sources, but many of these rules are difficult or impossible to enforce. Non-point source problems are particularly difficult to resolve, and given the complex interaction of climate and farming practices some delivery of these contaminants into the groundwater in the Karst areas is unavoidable. Possible control measures or best management practices (BMP's) must take into account these complex variables, as well as the needs of particular farm operations, and the nature and extent of existing tile drainage.

Before any effective management scheme can be developed, further research must address the details of the delivery and fate of these contaminants in the groundwater system, locally and regionally. Also, there is a pressing need for a water-quality monitoring network to provide a base of information on Iowa's water resources. This should include improvements in present water-quality data collection schemes.

The development of a management plan and BMP's to protect groundwater quality in these carbonate aquifers will require the integrated cooperation of many agencies and people. Implementation of any effective measures will require an effective program of public education.

Karst Regions Study, Phase II: Big Spring Basin Study

The second phase of the karst groundwater quality study continued throughout 1982 and involves the very detailed analysis of a small karst basin in northern Clayton County. The study involves the cooperation of over 100 private landowners in the area, and the monitoring of Big Spring at the Iowa Conservation Commission fish hatchery near Elkader. This phase of work is jointly funded by IGS, the Iowa Department of Environmental Quality (through grants from the U.S. Environmental Protection Agency), and the U.S.D.A., Soil Conservation Service. The Iowa Conservation Commission and University Hygienic Laboratory are also cooperating in the study.

The study is assessing land-use practices in relation to groundwater quality and will develop a computer model to quantitatively evaluate what types of land treatment and management may help to reduce groundwater contamination in these areas.

The study has shown that since 1967 nitrate concentrations in groundwater have increased by 2.5 to 3 times. Also, commonly used pesticides, such as atrazine, have been found to be more persistent and pervasive in the groundwater-drinking water than had ever been previously assumed.

The study will be continued through 1983 with joint funding from IGS, the USDA-Soil Conservation Service, and direct funding from the U.S. Environmental Protection Agency.

Karst Regions Study, Phase III: Floyd-Mitchell County Study

A third phase of the study has just begun with funding from the U.S. Environmental Protection Agency. This study will investigate, in detail, the groundwater quality of the Karst (Devonian aquifer) areas in Floyd and Mitchell Counties. These areas are uniquely different than the Clayton County study area, and require investigation of their own. This phase of the project will continue through 1983.

West-Central Iowa Project

West-central Iowa is the current project area for IGS's regional test-drilling and water resources evaluation programs. In part, the project entails the extension of what was learned in the Dakota aquifer project in adjacent northwest Iowa. The west-central Iowa region, however, represents the portion of the state where IGS has the least extant subsurface or well information. This project will continue into 1983.

During 1982, 148 test holes were drilled with a total of about 11,750 feet drilled, and 175 feet cored. Forty of the test holes were completed as observation wells. All the wells have been geophysically logged. Water-quality analyses have been completed on about 25 wells. Synthesis of the data collected will be ongoing during the winter months when field work is not possible.

OTHER GEOLOGIC STUDIES

Lead-Zinc Studies

Since 1974 the Geologic Studies Division has had an ongoing project to compile information and field analyses of lead-zinc deposits in northeast Iowa, which has been conducted on a part-time basis. These studies were culminated with a presentation at an International Conference on Mississippi Valley-Type Lead Zinc Deposits in Rolla, Missouri of a new theory of the origin of these lead-zinc ores, and a new model for exploration for these minerals. The paper will be published in the proceedings of the conference. The favorable response to the paper has resulted in some renewed interest in minerals exploration in northeast Iowa by industry exploration-geologists.

Cooperative Applied Soils Research

Staff of the Geological Studies Division direct, coordinate and/or participate in ongoing cooperative research programs with staff of the Iowa Cooperative Soil Survey (USDA-Soil Conservation Service and Iowa State University Experiment Station and Extension Service), and the Geotechnical Research Group, Department of Civil Engineering, Iowa State University. These research programs are designed to:

1. Establish a modern detailed understanding of the stratigraphic and geologic relationships of surficial materials in Iowa.

2. Apply these relationships, through the use of 3-dimensional soil-landscape models to assist and improve soil survey operations.
3. Quantitatively evaluate engineering properties and problems associated with survey mapping units or geologic units, as appropriate.

As an ongoing part of the cooperative applied soils research, the Survey provides geologic data and topographic maps to aid in the initial stages of county soil surveys. Division staff participate in field reviews to assess mapping problems. Work also continues on the comparison and correlation of particular soil series with large magnitude floods, the cooperative evaluation of remote sensing applications to soil surveys, and an engineering-geologic evaluation of the Des Moines Lobe area in north-central Iowa.

IGS staff also served, with other state and federal officials, on a Task Force to define the future needs of the Iowa Cooperative Soil Survey. George Hallberg, Division Chief, participated with the U.S. Department of Agriculture's Director For Natural Resource Assessment, in a special symposium about soil classification at the national meeting of the Agronomy Society of America.

AIDEX Investigation

Geological Studies Division staff also conducted a preliminary field investigation of the abandoned AIDEX pesticide plant near Council Bluffs. Because of the serious potential for groundwater contamination, IGS installed a series of eight shallow observation wells around the periphery of the site. Water and soil samples were collected and as of this writing are being analyzed by the University Hygienic Laboratory.

CONSULTATIVE INVESTIGATIONS

As a necessary service, IGS has always performed investigations of critical problems for Iowa's regulatory agencies. For investigations that require excessive amounts of time, travel, or other costs, the agencies may share the cost burden, but for the majority of these investigations IGS absorbs the cost.

These are necessary investigations which generally cannot be foreseen, and always upset the scheduling of other planned projects. Thus, flexibility must be built into IGS longer term projects.

Examples of these projects during the past year include:

1. Investigation of several hazardous or toxic waste sites for IDEQ and U.S.E.P.A. involving such things as pesticide dumps. These have involved investigative field work, review of investigations by various consultants, correspondence, and testimony at formal proceedings.
2. Investigation of several hazardous petroleum product leaks and spills for IDEQ and the Fire Marshall's offices.
3. The continuing review of the LaBounty arsenic disposal site.
4. Design and analysis of pump tests for INRC well-permit hearings.
5. Providing information or testimony for various hearings regarding water permits for INRC.
6. Consultation on natural land boundary disputes for the Iowa Conservation Commission and/or the Attorney-General's office.
7. Continuing consultation on Indian land cases along the Missouri River.

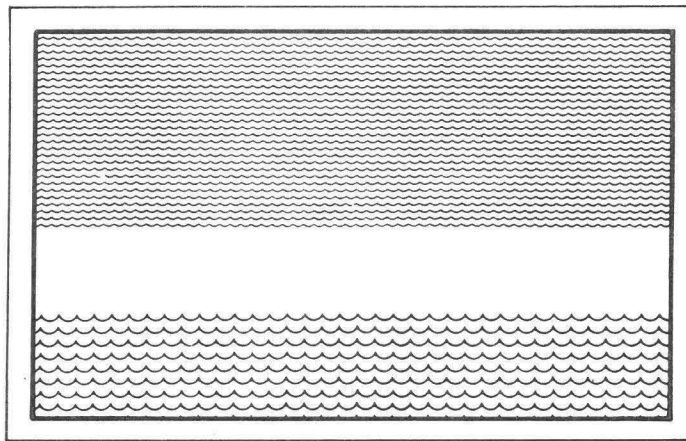
Other types of consultative services are an important function of the Geological Studies Division staff, though these other services are individually

less time consuming than the major items outlined above. These other services include:

1. Review of landfill and other waste disposal site plans.
2. Review of new rules and regulations by Iowa and U.S. regulatory agencies.
3. Providing information on engineering-geologic conditions and potential problems (see discussion below).
4. Providing information on general soils-geologic drainage characteristics, suitability for sewage disposal, and possible economic value of soils in project areas for various state, local, and federal agencies (such as the ICC, INRC, U.S. Army Corps of Engineers, U.S. Department of Agriculture, various Iowa municipalities, regional planning agencies, and, where appropriate, private individuals).

Item 3 above is an area where Geological Studies Division staff have noted a large increase in requests for information. Of particular note is the expansion of requests for information concerning possible foundation conditions and/or problems for new commercial/industrial construction. The requests have come from the interested commercial/industrial firms themselves, or engineering-consulting or architectural firms which represent the firms, and various state or local government agencies involved with commercial development, including the Iowa Development Commission. As IGS' expertise in this area has become better known, the number of requests has risen.

These various major consultative investigations have taken about five-person-months of time for the Geological Studies Division staff during the last interim. Several of these individual cases are pending further study or litigation which also will require IGS input.



Water Resources Division

The Water Resources Division's responsibilities include public service, consulting, planning, research, administration of the Survey's research drilling program, and assistance to the Director in administering Chapter 84 of the Code (the Oil, Gas, and Metallic Minerals Law). The principal goal of the division is to provide information which will enable the state, its people, and industry to develop the state's water resources in a prudent and orderly manner that will not jeopardize the quantity and quality of water available to future generations.

The programs and activities of the division are designed for the attainment of this goal. And, consistent with this, the division's principal work elements are:

- The acquisition, evaluation, and interpretation of data concerning the occurrence, quality, development, and use of water in Iowa.
- The preparation of detailed water-resources reports to aid developers, managers, and planners.
- Providing technical advice to water regulating agencies, planners, water developers, and the general public.

- Providing planning assistance to the state and its agencies with respect to programs which monitor water quantity and quality.
- Operating programs designed to collect and interpret basic data on groundwater occurrence, quality, and development potential.
- Monitoring a program of in-service training to assist staff in keeping abreast of technological developments in the fields of applied hydrology and water resources planning and management.

Donivan L. Gordon, Chief

Water Resources Services

Well Forecasts and Advice on Well Problems

During calendar 1982 division staff responded to over 350 individual requests for advice on the development of new wells or procedures to be followed in correcting specific well problems.

A typical well forecast is a letter report, for a specific development site, that provides information on the thickness and sequence of geologic formations to be encountered, which formations will provide water, the anticipated rate of yield, and the anticipated quality of water. Depending on the nature of the request, detail and precision required, our individual report may take from four to over eight hours to prepare. During 1982, approximately 20 percent of the division's staff time was spent in this activity. The specific types of responses are broken into categories in the following table and are compared to the same categories for calendar 1981.

<u>Category</u>	<u>1981</u>	<u>1982</u>
Municipal	96	93
Industrial/Commercial	53	52
Domestic	56	117
Irrigation	16	12
Housing Developments	15	9
Rural Water Systems	2	8
Recreation	14	16

<u>Category</u>	<u>1981</u>	<u>1982</u>
Livestock Operations	9	4
Regional or County	32	20
Pumping Test Analysis	26	11
Other	<u>23</u>	<u>42</u>
TOTAL	342	384

Pumping Tests and Field Investigations

In most years there are instances when the Geological Survey is called upon to evaluate the impact of new water developments upon existing ones or to assist in determining the capability of groundwater to meet the demand of specific developers. These kinds of requests usually require specific field investigations and quite often that well-pumping tests be conducted.

Although during calendar 1982 only two such field investigations were conducted, both were extensive. In both cases the work was requested by the Natural Resources Council.

Early in the year several days were spent assisting Iowa Beef Processors, Inc. (IBP), their well contractor, and the Iowa Natural Resources Council in evaluating the potential of groundwater sources to provide water for a proposed pork-processing plant near Stanwood, Iowa. The investigation included the analysis of pumping information from a Silurian test well developed by Iowa Beef and its impact on the city of Stanwood's wells in the same aquifer. This alternative was abandoned because of lower than required yield and a potentially severe impact on the city's wells. A second alternative, the Jordan aquifer, was ruled out because of inferior quality water. The company eventually settled on a plan to take water from shallow wells adjacent to the Wapsipinicon River near Olin. Extensive pumping tests were conducted in association with this plan, particularly to determine well-pumping impact on river

flow and upon existing wells. IBP was issued a permit to withdraw approximately 2.1 million gallons of water per day by INRC based on favorable test results.

In November of this year, INRC requested IGS to coordinate a pumping test to determine the impact of an irrigation project proposed by Agri-Equities near the city of Redfield. The irrigation test well was completed in the same local aquifer that supplies the towns of Redfield and Dexter. A four-day pumping test indicated negligible interference with the wells in the two cities' well fields. Permitting for the irrigation project is pending.

In its advisory role to other state agencies, special studies are often necessary to obtain and evaluate hydrogeological data related to actual or potential conflicts in water use and problems of water-quality degradation. Division staff cooperated in the following investigations during 1982:

Iowa Natural Resources Council

1. Drawdown impact of irrigation wells on domestic wells; Carroll County--contested case.
2. Water-quality impact on private water supply by proposed quarry; Madison County.
3. Water-quality impact on municipal water supply by proposed gravel pit; Dallas County.
4. Drawdown impact of rural housing development on private water supply; near Iowa City.
5. Water-quality impact on private wells by operating quarry; Black Hawk County.

Department of Environmental Quality

1. ReInjection of formation water produced with storage of natural gas--underground gas storage; Louisa County.
2. Groundwater quality in vicinity of Black Hawk County Landfill.

3. Potential impact of landfilled power-plant particulate wastes; Muscatine County.
4. Fuel oil leaking to groundwater table at pipeline tank farm; Coralville, Johnson County.
5. Buried gasoline tank leaking to groundwater system; Riverside, Washington County.
6. Chemical degradation of groundwater in private wells; Hospers, Sioux County.
7. Plans for offsite groundwater monitoring for pesticides associated with abandoned Aidex Chemical plant site; Mills County.

Assistance to Small Coal Mine Operators

In 1981 the division had primary responsibility for the Survey's Small Operator's Assistance Program (SOAP) funded by the U.S. Office of Surface Mining (OSM). Because of the past affiliation, requests are still being received by the division for information and technical assistance. These requests would normally be referred to the Survey's STRECOG division; however, because of the Water Resources Division's familiarity with the available data and operator's needs, it is more efficient for the Water Resources Division to process these kinds of requests. During 1982, 42 written responses were forwarded to coal-mine operators on coal occurrence, quality, mine, and geologic information.

Research Drilling

During 1982 the research drilling crew completed 133 test holes for the West-Central Iowa hydrologic study project. Forty of these tests were completed as observation wells to monitor water quality and water-level fluctuations. The total drilling footage in 1982 was 11,741 feet with 2,992 feet of casing installed.

Research Projects

Although a key agency/division goal is to assist Iowa's industries, businesses, communities, and citizens develop the necessary water to meet their needs, there is also an agency awareness that the State's groundwater resources have a finite limit. And, as new pressures have begun to mount between competing water users in some areas of the State, more effort must now be committed to the budgeting aspects of groundwater. Principally, how much water is available, what rates of withdrawal can be sustained, with what impact, and in terms of use--how much is currently used and what additional water use can reasonably be authorized? Because the answers to these questions are so vital to the future of the State they are receiving the highest priority in the agency's/division's research and data collection activities.

During the current fiscal year the Silurian-Devonian aquifer study will be completed. This study along with the studies of the Jordan, Mississippian and Dakota aquifers will essentially complete the regional study of Iowa's most important rock aquifer systems, and open the way to investigating the State's equally important alluvial systems.

The division is currently involved in four principal areas of research:

- the characteristics of municipal water supply systems,
- county water availability,
- the groundwater potential of alluvial aquifer systems, and
- a regional inventory of water resources in northeast Iowa.

Municipal Water Supply Inventory

In July 1981, a program was initiated by the division to comprehensively inventory data on the water supplies of the State's incorporated communities. The primary purpose of the project was to expand the agency's knowledge of

community water developments so that the Survey's consulting and advice to the communities could be more effective and efficient.

The data which is being inventoried is in manual files maintained by the six regional DEQ offices.

The primary data that is being compiled relates to the location and construction of wells, the geologic source of the water, rates of pumping and water use, and water quality. These data are being cross-indexed with existing IGS data for completeness. The objective of the program is to develop a computer data file on municipal wells, which after initial inventory, will be updated annually and maintained as a current data file.

To date, the inventory has been completed for DEQ Region VI and for 10 of 15 counties in Region I. In these regions 224 community supply systems have been inventoried--about a third of the incorporated communities in Iowa. Two hundred eight of these rely on groundwater which is drawn from 511 operating wells. Prior to the inventory, IGS had data for only 260 of these wells--only about 50 percent.

The inventory program is scheduled for completion in fiscal 1983-84.

County Groundwater Availability

Related to the agency's objective of keeping Iowans informed concerning their alternatives for water supply, a program began in 1979 to produce groundwater-availability reports for each of the State's 99 counties. Nineteen of these reports have been published to date, and an additional four have been completed and are in the final stages of publication. Each report contains the following information:

1. General geologic setting
2. Approximate depth(s) to potential water-bearing zone(s)

3. Expected quality of water from the various zones
4. Anticipated sustainable withdrawal rates (in gallons per minute)
5. Index of typical wells
6. Common water quality problems and drinking water standards
7. Index of available topographic maps
8. Agencies that may be contacted for assistance
9. List of drilling contractors that service the county.

Alluvial Aquifers Project

Work was initiated in fiscal 1981-82 to evaluate the hydrogeology of the state's major alluvial aquifer systems. Though many of Iowa's major municipalities, rural water distribution systems, and irrigators draw water from these systems, little is known of their true potential or limitations beyond points of water withdrawal. In many regions of the state the water from alluvial sources represents the only viable alternative for large quantities of good quality water. And, as competition for this water increases, it becomes imperative to inventory the potential and capability of these sources and assess the hydraulic implications relative to stream-flow diminution.

The completed program will consist of systematic evaluations of alluvial aquifer systems associated with Iowa's major interior streams. The priority for which systems are studied first is based on existing development activity. The pilot study effort during 1982 investigated the upper reach of the Des Moines River (above the Saylorville Reservoir).

This first year of activity has been designed to develop seismic techniques which will provide rapid, accurate, and cost-effective methods for defining the presence and extent of alluvial groundwater systems. The time-honored method for locating and mapping alluvial aquifers requires test

drilling which is expensive and time consumptive. The current project is evaluating seismic refraction methods to profile alluvial systems to determine boundaries, thickness of materials, and types of materials. From the results of the pilot work, we are quite confident that these objectives can be satisfied fairly rapidly and at comparatively low field costs, and also that the seismic data will provide good information on primary targets for future water developments or for more detailed testing. The detail provided by the seismic surveys will reduce to a minimum the actual drilling required for verification and determination of hydrologic potential.

During the summer of 1982, 40 traverses were completed across the floodplain of the Des Moines River between the Saylorville Reservoir and Emmetsburg. The seismic data gained has been processed, and a series of geologic cross-sections prepared. The data and interpretations are in accord with the limited geologic data available.

Additional field data is being collected presently to improve on basic field techniques, to improve field efficiency, and to cut field-operating costs.

Water Resources of Northeast Iowa

A project has been initiated to develop a regional water atlas for eleven counties in northeast Iowa. The counties that are included are: Howard, Wineshiek, Allamakee, Chickasaw, Fayette, Clayton, Bremer, Black Hawk, Buchanan, Delaware, and Dubuque. This particular atlas will be the seventh in the Survey's Water Atlas Series. The projected completion date of the project is during fiscal 1985-86.

The reports in the Water Atlas Series are designed to summarize the hydrology and use of water in particular regions of the State and to give

planners and water developers a more precise understanding of the water development potential of the region. As the reports include considerable geologic detail, they are also quite useful in defining the environmental sensitivities of regions as they may relate to the siting of landfills and disposal facilities.

Oil, Gas, and Metallic Minerals

As provided in Chapter 84 of the Code of Iowa, the State Geologist is designated as the Administrator of Oil, Gas, and Metallic Minerals, and he is responsible for administering the provisions of Chapter (580) 12 of the Iowa Administrative Code. His duties include the issuance of drilling permits for oil/gas exploration or production, including underground gas storage; the maintenance of all administrative, geological, and production records; and surveillance of associated well or facilities abandonment. In 1981, Code Chapter 84 was amended to bring the exploration for and production of metallic minerals under essentially the same controls imposed on oil and gas exploration and production.

Nine drilling permits for oil and gas were issued during 1982. Two were issued to Gulf Energy Corporation for drilling in Fremont County. Five were issued to Upland Leasing Limited for drilling in Crawford County. Two permits were issued to Natural Gas Pipeline Company of America to establish return water-injection wells at their underground gas storage facilities in Louisa County. To date, of the seven oil and gas tests, no indication of conditions favorable to gas or petroleum production has been reported.

The Geological Survey continues to serve as consultant to the Iowa Commerce Commission in the review of procedures being followed by Northern Natural Gas Company in the abandonment of the Vincent (Webster County) gas storage

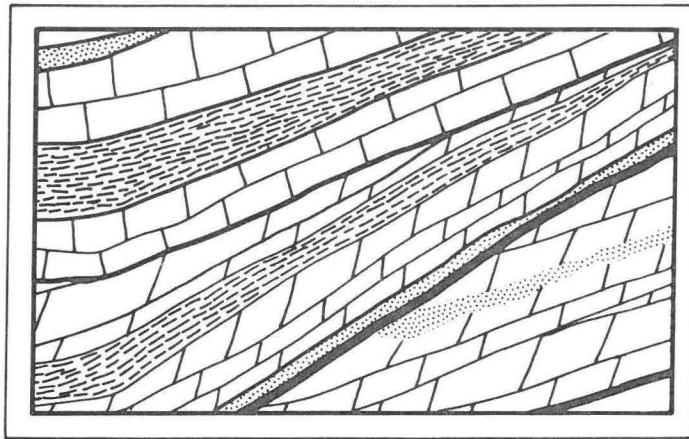
reservoir. The original acreage under lease for this facility when abandonment began in 1971 was 12,373 acres. Gas Storage Agreements on approximately 10,133 acres on the outer periphery of the field have been dropped through December 1975 leaving 2,240 acres still under lease. The total gas-in-place as of November 9, 1982 was 2,404,917 Mcf (thousand cubic feet)--no change in 1982.

Training Sessions Attended by Division Staff

"Groundwater Management Quantity and Quality," Iowa State University, Ames, Iowa.

"Second National Symposium on Aquifer Restoration and Groundwater Monitoring," National Water Well Association, Columbus, Ohio.

"27th Annual Mid-West Groundwater Conference," Iowa City, Iowa (IGS 1982 Sponsor).



Stratigraphy and Economic Geology

The Stratigraphy and Economic Geology (STRECOG) Division staff investigate earth materials that range in age from more than one billion years to sediments deposited in modern stream valleys. The topics reviewed below illustrate the diversity of applied research projects to which staff members lend their individual or collective expertise. Some of the projects are short-term studies. Others are of longer duration or are ongoing. All of them result in increased knowledge of Iowa's physical and historical geology, and thereby improve our capability to assist in the development and management of the State's natural resources.

Raymond R. Anderson, Chief

ECONOMIC GEOLOGY

One of the major goals of STRECOG is to identify and inventory the economic mineral resources of Iowa. To that end the division has conducted various studies during 1982. The studies listed below are in various stages of

completion, but projections are that study reports will be completed in early 1983.

High Calcium Limestone Resources in Iowa

This report will identify and describe the high calcium limestone resources of the State, and will include chemical analyses, along with structure and isopach maps of the various high calcium units. This information will be of special value to producers seeking to develop new resource areas.

Mineral Producers in Iowa

A listing of all mineral producers in the State is being prepared. The listing will be organized by county, giving the name, address and telephone number of each mineral producer and the mineral commodity produced. Also included will be a brief history of the mineral industry in Iowa.

Hydrocarbon Potential in Iowa

Although the history of petroleum production has been very brief, with a total production record of some 410 barrels from a well near Keota, Washington County, numerous petroleum exploration groups continue to express interest in Iowa. A report is in preparation that will discuss the hydrocarbon potential in the State. Included will be a discussion of hydrocarbon traps, source rocks and some rock analyses, along with structure and isopach maps. This report, which will be completed in 1983 will be a tremendous help in answering the almost daily questions about the hydrocarbon potential in Iowa.

STRATIGRAPHIC AND STRUCTURAL STUDIES

COSUNA Project

A major continent-wide stratigraphic correlation project coordinated by the Geological Society of America, with additional support from the American

Association of Petroleum Geologists, USGS, the Geological Survey of Canada, and various state and provincial geological surveys, is near completion. Termed COSUNA (Correlation of Stratigraphic Units in North America), this project will make available detailed stratigraphic information from all areas of North America. The Iowa portion of the COSUNA project was prepared by STRECOG and provides information on the stratigraphic sequence at nine general geographic regions across the State. The regional correlation chart will be published in 1983, and detailed data sheets on individual rock units will be available as computer print-outs from the Geological Society of America. The COSUNA project represents the first attempt to integrate stratigraphic information for the entire geologic column across Iowa.

The Plum River Fault Zone and the Structural and Stratigraphic Framework of Eastern Iowa

This paper summarizes and, in part, refines mid- to late-Paleozoic stratigraphic terminology. Isopach maps, structural maps, and stratigraphic cross-sections have all been combined to develop the structural framework of eastern Iowa. One of the principal structural features of this study is the recognition of the East-Central Iowa Basin, a mid-Paleozoic basin. The Plum River Fault Zone is an integral part of this basinal feature, and movements along the fault record both its development and destruction.

Big Spring Study

STRECOG has participated in several aspects of the karst hydrology study at Big Spring in Clayton County, Iowa, discussed elsewhere in this report. Staff assisted in field mapping and preparation of the final geologic map for the area, and also participated in an enmass well-measuring and sample-collection run. Staff also organized and conducted two dye traces in the study area and measured fracture trends at eight outcrop and study sites.

Forest City Basin Mapping Program

STRECOG, working with geologists at the state geological surveys of Nebraska, Kansas, and Missouri, produced and published four maps of the Forest City Basin in 1982. They include Bouguer gravity anomaly, magnetics, configuration of the Precambrian surface, and lineaments in the study area. Also prepared, but not yet published, is a structure contour map on the base of the Hertha Formation in the area. The Forest City Basin is a major geologic structural feature of the Central United States and includes southwest Iowa.

Decade of North American Geology

In 1979, the Geological Society of America (GSA) designated the 1980s as the Decade of North American Geology. The primary purpose during this decade is to promote a comprehensive synthesis of the geology of the North American continent. This project includes plans for 27 volumes of regional or topical geological synthesis. Workshops have been held for each volume and responsibilities delegated for individual chapters per volume. The Iowa Geological Survey has been asked to serve as chapter organizer for the Forest City Basin area, which will be part of the volume entitled *Sedimentary Cover--North American Craton: U.S.* Publication of this volume is scheduled for early 1985. Participation by the Iowa Geological Survey will allow the integration of much new information that the IGS has been developing over the past few years. Work on this chapter will also allow the synthesis of geological studies from surrounding states and offer the Iowa Survey a framework from which we can work for a better understanding of water resources, oil and gas exploration, and mineral investigations. STRECOG will also participate in the preparation of the volume on the Precambrian of the upper midcontinent. The extent of our participation is not yet known.

Precambrian Stratigraphic Study

Research on the Precambrian of Iowa progressed intermittently in 1982. While much of the work consisted of organization of existing materials, some progress was made in the study of petrology of Precambrian rocks, refinement of existing gravity and magnetic maps of the State, and geophysical modelling of the Midcontinent Geophysical Anomaly, the Spencer Anomaly, and the Archean/Proterozoic boundary in northwest Iowa.

One of the principal products of the organization of existing materials is a list of wells that penetrate to the Precambrian in Iowa. The list identifies 152 wells and will be combined with a map locating the wells.

Refinement of existing gravity and magnetic maps includes the inclusion of new gravity data into the computer gravity-data file as well as the production of detailed gravity maps for the area of the Northern Boundary Fault Zone and the Stratford Anomaly. Existing, detailed aeromagnetic maps in the southwest and northwest quadrants of the State were combined and recontoured using a uniform datum. This is part of a plan to recontour and combine all existing aeromagnetic surveys and produce a series of maps based on the 1:250,000 NK map series. All gravity and magnetic maps produced are on open file at IGS.

Preliminary modeling of the Midcontinent Geophysical Anomaly was completed in 1982. A series of 19 profiles were modeled using gravity and magnetics and a number of maps were produced.

Cambrian Stratigraphic Study

This study will result in a detailed refinement of the Cambrian stratigraphy of the State. Both lithologic and paleontologic methods are being used to determine environments of deposition and to establish accurate stratigraphic correlation. Lithofacies and isopach maps are being prepared.

Ordovician Stratigraphic Study

A revised Middle and Upper Ordovician stratigraphy for eastern Iowa was written for the Plum River Fault Zone report, and part of the stratigraphic terminology originally developed at the Illinois Geological Survey has been utilized. This report forms the preliminary basis for a forthcoming STRECOG synthesis of Ordovician stratigraphy across the entire State. Logging of cored Ordovician intervals in Iowa is proceeding, and stratigraphic cross-sections, available on file at IGS, have been constructed. Biostratigraphic studies, based primarily on conodont collections recovered from cores in western Iowa and adjacent parts of Nebraska, are progressing and will afford a basis for correlating Ordovician strata across the State. Various Ordovician outcrops in eastern Iowa were visited during the year, measurements, samples, and fossil collections were made. Cooperative studies with the USGS have also identified potential oil source rocks in Ordovician strata of Iowa including organic-rich shale intervals in the St. Peter Sandstone, Glenwood Shale, Guttenberg Limestone, and lower Maquoketa Formation.

Some progress was made on the associated study of the Decorah-Platteville Stratigraphic interval. This progress was primarily limited to the study of 156 feet of core.

Silurian Stratigraphic Study

The Silurian stratigraphic sequence in eastern Iowa is described and discussed in some detail in the Plum River Fault Zone report. Definitions of the Hopkinton and Gower Formations have been standardized, and a new formation, the Scotch Grove, is now recognized. Long-term misuse and miscorrelation of the Edgewood and Kankakee Formations has necessitated abandonment of these terms in Iowa. Studies of a Silurian limestone facies in northern Fayette

County are progressing. A summary of Iowa Silurian stratigraphy will be prepared during the next fiscal year.

Devonian Stratigraphic Study

A report on the Devonian stratigraphy of east-central Iowa is included in the Plum River Fault Zone paper, and several modifications in stratigraphic nomenclature are proposed. Field studies of the Devonian sequence in northeast Iowa this year have clarified some long-standing correlation problems. Stratigraphic descriptions of the Devonian sequence in several cored intervals from southeast Iowa became available this year (Open File Rept. 82-2). In addition, a thesis (S. Pearson, 1982, Univ. of Iowa) on barite mineralization in Devonian rocks of northeast Iowa was prepared with support of STRECOG. Subsurface Devonian studies in Iowa are being synthesized, and an east-west stratigraphic cross-section of the Iowa Devonian sequence has been prepared. Completed and ongoing Iowa Devonian biostratigraphic studies by STRECOG personnel and faculty and students at the University of Iowa are providing a basis for state-wide correlation (Open File Repts. in press). A new understanding of Iowa Devonian stratigraphy, particularly in the western part of the State, is emerging and will necessitate a major revision of Middle and Upper Devonian stratigraphic nomenclature. STRECOG is actively working on a synthesis of Iowa Devonian stratigraphy, which should be prepared by 1985. Devonian oil source rocks in southeast Iowa have recently been evaluated in cooperation with USGS.

Pennsylvanian Stratigraphic Study

A complete core of the Pennsylvanian sequence near Logan, Harrison County, was drilled as part of the West-Central Iowa Water Resources project, and a preliminary core description is available on file at IGS. Pennsylvanian

quarry sections in western Iowa were sampled by STRECOG personnel as part of a cooperative Pennsylvanian stratigraphic study with the Department of Geology, University of Iowa. As part of a cooperative study with USGS, Pennsylvanian oil source rocks in Iowa are currently being evaluated. A summary of the Pennsylvanian stratigraphy of east-central Iowa was prepared for the Plum River Fault Zone report. A major report on the Lower and Middle Pennsylvanian stratigraphy of eastern and south-central Iowa is currently in review, and represents the culmination of stratigraphic studies undertaken by the now-defunct Coal Division. Additional Pennsylvanian stratigraphic/biostratigraphic studies utilizing IGS core material are presented in recent theses by J. Gregory and J. Swade (formerly of IGS). R. Ravn (formerly of IGS) has completed a major monograph on spore taxonomy and biostratigraphy from the Lower and Middle Pennsylvanian of Iowa, and will be published by IGS early in 1983. This monograph provides a detailed basis for correlating coal-bearing strata in Iowa, and will be an invaluable aid for future evaluation of Iowa's coal resources. Finally, a review of the stratigraphy and nomenclature of the Cherokee Group is in review and publication by IGS in 1983 is planned.

Cretaceous Stratigraphic Study

Further studies of the Cretaceous stratigraphy of western Iowa were undertaken during this year, and provide a basis for evaluating the physical container of the Dakota aquifer. A summary of the Cretaceous stratigraphy and paleogeography of Iowa and adjacent areas was prepared, and publication early in 1983 is planned. This report synthesizes Cretaceous stratigraphic data from the Dakota aquifer and West-Central Iowa water resources projects, as well as additional information provided through cooperative studies with the Minnesota, South Dakota, and Nebraska Geological Surveys. Ongoing palynostratigraphic studies of the Iowa Cretaceous sequence (primarily R. Ravn)

utilizing IGS materials provides information critical to Cretaceous correlations. A refined Cretaceous bedrock geology map of western Iowa was also prepared this year (on file at IGS). Field studies during 1982 of the lower Dakota Formation in west-central Iowa, the primary container of the Dakota aquifer, culminated in a summary of Cretaceous stratigraphy in western Iowa. The Dakota Formation is now divided into two members of widespread hydrogeologic significance. The first dinosaur bone fragment identified from Iowa was discovered in the lower Dakota Formation of Guthrie County by STRECOG in 1982. A short report on the occurrence of dinosaurs in Iowa is in preparation.

STRECOG SUPERVISED CONTRACTS

Southwest Iowa Seismicity Study

This five year NRC-sponsored study to evaluate the potential for future seismicity in the area of the Nemaha Uplift and its intersection with the Central North American Rift System.

A summary report was prepared in 1982 as a cooperative effort by all states participating in the regional study (i.e., Iowa, Kansas, Nebraska, Oklahoma). As a part of this combined summary report, nine maps were prepared, eight with STRECOG assistance. These include shaded relief, earthquake epicenter, bedrock geology, structure on the base of the Kansas City Group, Precambrian configuration, Bouguer gravity anomaly, aeromagnetic, and Precambrian rock-type maps.

MILS (Mineral Industry Location System)

The one year U.S. Bureau of Mines funded MILS contract ended in 1982. MILS is the location subsystem of the Bureau's Minerals Availability System and provides a computerized data base which presents all available information out of every active, inactive, and abandoned mineral production facility and

primary facility in Iowa. In all, 96 of Iowa's 99 counties were completed; there was not sufficient time to include underground coal mines in Marion and Appanoose Counties or lead mines in Dubuque County. A total of 4,868 locations were entered into the system. The IGS retained xerox copies of the coding sheets and maps with locations cross-referenced to the coding sheets.

NCRDS (National Coal Resources Data System)

The NCRDS is a USGS sponsored program to compile and transmit data for coal resources calculation, geology, and mining information. During 1982, data input for four counties (Van Buren, Jefferson, Davis, and Wapello) was completed. Computer print-out was checked, 50% of previous submittals were proofed, and stratigraphic information input. The program will continue in 1983 but will no longer be associated with STRECOG.

GEOLOGIC LOGGING AND OUTCROP STUDIES

Logging

The microscopic study and description (logging) of cutting samples collected during the drilling of wells is one of the main sources of geologic information. During 1982 the following logging was completed.

A. Cursory Logging

Samples representing 1,000 feet of drilling from three wells were logged in this manner to verify stratigraphic horizons penetrated during the drilling. These were samples brought in by drillers seeking this information because it is vital in making decisions as to where to set well casing, whether to drill deeper, etc.

B. Detailed Logging

During 1982 detailed logging of samples representing 55,012 feet of drilling (samples collected at five-foot intervals) from 248 wells was completed. The information gained from these studies, along with all other information about the particular well, is recorded on what is called a strip log and entered into our files.

C. Core Logging

Cores are solid cylinders of rock recovered by special drilling procedures. During 1982, 7,003 feet of core from 18 wells were logged.

D. Sections Measured

As used here, section refers to an exposure of rock. During 1982, over 11,000 feet of rock at 30 exposures were described in detail. Such work is an integral part of the various stratigraphic studies described here.

Despite the progress in logging, a tremendous backlog of samples remain to be logged. During the last four year period alone we have received samples representing over 290,000 feet of drilling. A vast amount of information remains to be gathered from those unstudied samples.

INFORMATION REQUESTS, VISITING GEOLOGISTS AND SERVICE WORK

Information Requests

The division responded to approximately 530 requests for information during 1982. Most of those requests were answered immediately by telephone; while others were handled by call-backs or written replies.

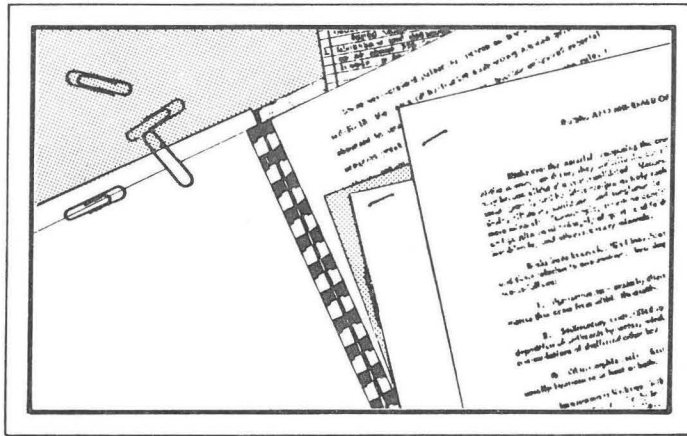
Visiting Geologists

Approximately 50 geologists and other geoprofessionals visited STRECOG in 1982. These were predominantly from the petroleum industry, with others from the base metal industry, limestone production industry, and federal government (especially USGS). Visits by these professionals ranged from a few hours to 1 week, with much interest expressed in STRECOG work and open-file maps, strip log data, cuttings, and cores.

Service Work

At the request of the Iowa DEQ, STRECOG prepared written reviews of seven landfills in 1982. One, the Muscatine Power and Water Coal Combustion Residue Site, entered litigation and staff was required to testify at a hearing.

STRECOG staff spent a total of nine man days monitoring the plugging of two oil tests in Fremont County, and monitoring drilling, collecting samples and interpreting geophysical logs at four petroleum test-well sites in Crawford County during the reporting period.



Contracts and Grants

The Geological Survey has participated in or has been the principal investigator for several contract and grant projects with other state and federal agencies. For projects that require additional staff, positions are established only for the duration of the contract or grant. In no instance is a contract entered into unless it is considered that the product will provide information that is of special benefit to Iowa. Most of these projects are discussed in other parts of this report. A general summary of the projects is presented below.

Orville J Van Eck, Associate State Geologist

Tectonics and Seismicity

In May, 1979, the IGS entered into a contract with the U.S. Nuclear Regulatory Commission (Contract No. NRC-04-78-228) for what was planned to be a five-year study of the tectonics and seismicity of southwestern Iowa. The contract was terminated on July 31, 1982 "for the convenience of the government" on the basis that sufficient information had been obtained and

interpreted by IGS to answer the questions that might arise relative to the siting and construction of nuclear facilities.

During the period of the contract, the IGS installed and operated a five-station microearthquake monitoring network in southwestern Iowa. Numerous very low magnitude events were recorded, as well as several larger earthquakes that occurred in Kansas and Nebraska.

In addition to the operation of the earthquake monitoring network, the IGS conducted extensive gravity and seismic surveys in southwestern Iowa. By combining the newly obtained information with available drill hole data and surface-mapping information, we have a much better understanding of the tectonics of the area.

Annual reports were submitted to the Nuclear Regulatory Commission and were published by that agency. A final report has been submitted and published.

The information gained from the work performed will be useful not only for the siting and design of nuclear facilities, but also for the design of any large structures that may be affected by earth movement. In addition, it has aroused considerable interest among those interested in petroleum exploration in Iowa.

Mineral Industry Location System

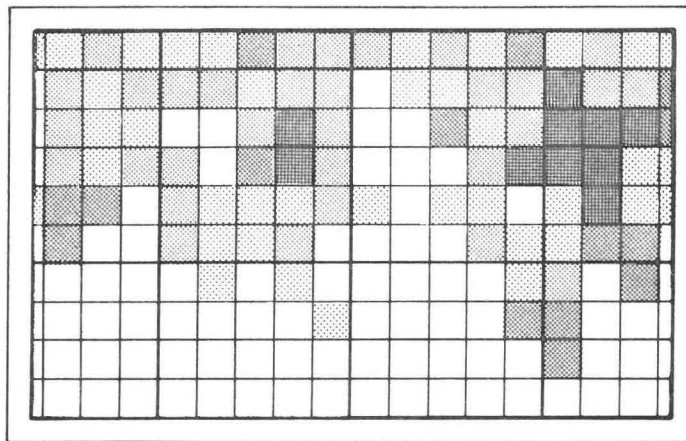
In November 1981, IGS entered into a contract with the U.S. Bureau of Mines to develop the Mineral Industry Location System (MILS). The purpose of the system is to provide a computerized listing of all past and presently operating mineral extraction sites, and primary manufacturers in Iowa. The project was completed in November 1982.

National Coal Resources Data System

This project operates under an Agreement of Understanding with the Geologic Division of the U.S. Geological Survey. The purpose is to check extant coal resources and geologic data and to encode additional information on coal in Iowa for eventual inclusion in a national coal resources data base.

Big Springs

As a continuation of the study of the karst area in northeast Iowa, a detailed study of the Big Springs groundwater basin in Clayton County was begun. The study, jointly funded by the U.S. Department of Agriculture Soil Conservation Service and the Iowa Department of Environmental Quality, is designed to define the pattern of groundwater movement through a complex system of openings in the bedrock and to determine the fate of pesticides and other contaminants that enter the groundwater-flow system.



Technical Services Group

Three diverse yet integrated programs (Data Processing, Graphic Arts, and Remote Sensing) form the Technical Services Division. Each serves other Survey divisions and outside parties as well as conducting projects within their own areas.

Bernard E. Hoyer, Chief

DATA PROCESSING

Our Data Processing program has had an exceptionally busy year--with activities ranging from preparation of a comprehensive water data system plan to installing graphics software, aiding construction of the Big Spring Data Base, and outlining additional software for "on-line" data files of well and water-quality information.

Data System Planning

A legislative initiative on reorganization of resource agencies, House File 2463, section 60, declared:

"By January 15, 1983, the State Geologist shall prepare and submit to the General Assembly a plan for a comprehensive water information system to be managed by the Iowa Geological Survey for monitoring on a continuous basis the quantity and quality of the water resource in this state."

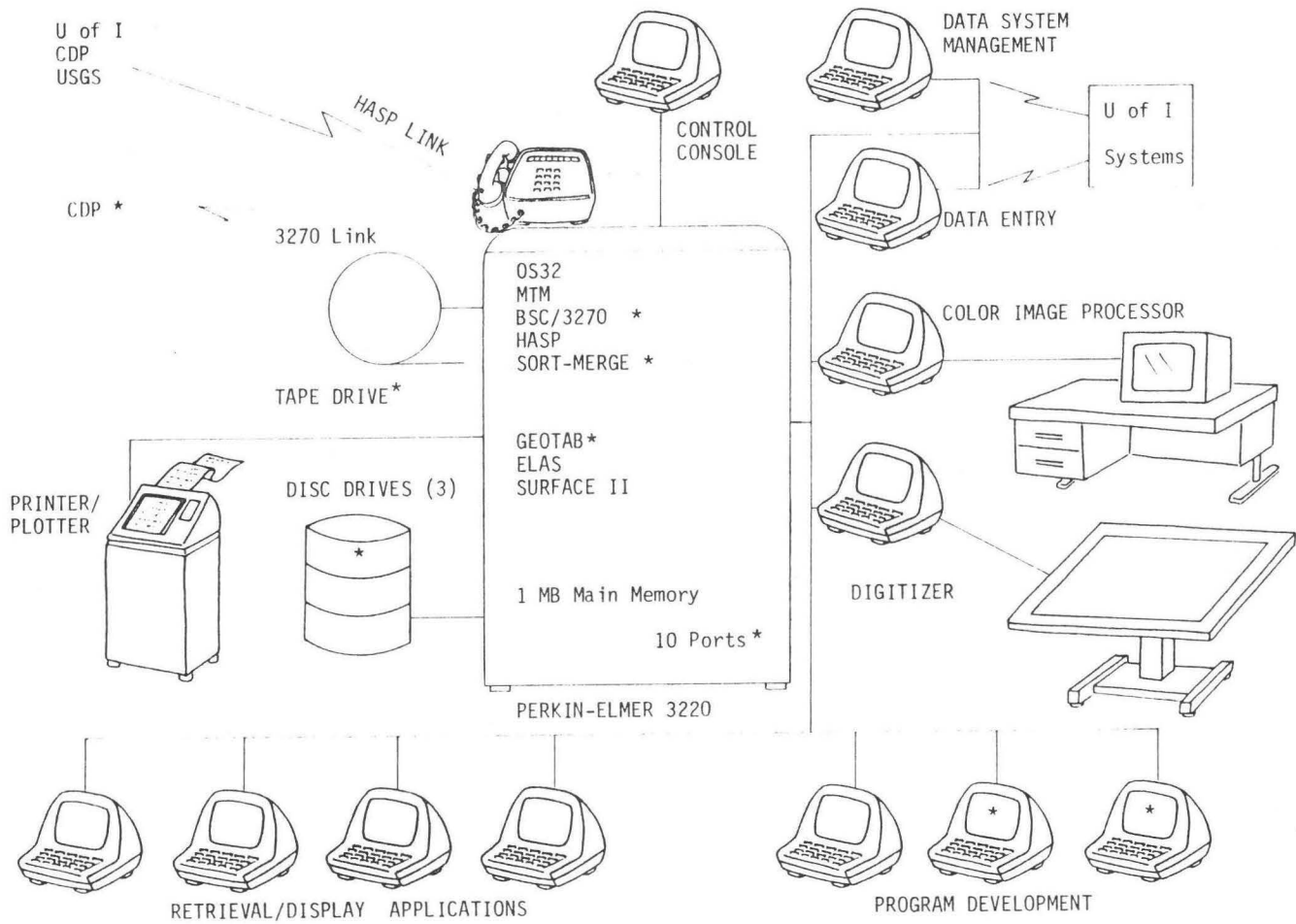
Section 16 of the bill charges the Department of Water, Air, and Waste Management with developing state water allocation plans using data provided by the Iowa Geological Survey and implies which types of data should be included in the system:

". . . the Department with the duty and authority to assess the needs of all water users at five-year intervals for the twenty years beginning January 1, 1983, and ending December 31, 2003, utilizing a data base developed and managed by the Iowa Geological Survey, and prepare a general plan for water allocation in the state considering the types of water resources available in this state designed to meet the specific needs of the water users."

Relying on previous experience from the State Water Plan activities of the 1970's, our IWARDS activities and our own more recent computer experience with data bases, data analysis, graphics, and various retrieval systems, a draft plan was produced for presentation to the legislature in 1983. Parts of this are discussed elsewhere in this report, but a few comments on the data processing system are in order. Development of such a system must occur within the framework of our past experience and existing computer hardware, software, and communications systems. Accordingly, the planning document details needed upgrades in IGS data processing. The accompanying Figure 4 illustrates present and planned equipment at IGS. Significant improvements will include installation of a communications link compatible with those of other state agencies; increased on-line (disc) and peripheral (tape) memory capacity; and additional work stations for new water data system staff.

On-Line Resource Information

Currently geologic information from about 12,000 wells in Iowa is retrievable from "instant access" computer information. An outline to increase



* Denotes Future Development

Present and Future Data Processing Equipment

Figure 4.

this "on-line" computer capability has been produced. These programs, called GEOTAB, will include on-line access to water-quality information and well information. These three capabilities will considerably increase the ability to retrieve, compare, and evaluate information to meet our needs. Further, it will be used to preprocess subfiles for application programs. This program package is a significant link in our overall water data system responsibilities.

IWARDS (Iowa Water Resources Data System)

The IWARDS program is intended to improve access to water-related data for Iowa's agencies, researchers and others. It has continued to provide retrieval and statistical analysis services. A new retrieval from WATSTORE (Water Storage and Retrieval System, U.S. Geological Survey) has netted 10,930 water quality records for the IGS file. A private well water quality file containing over 8000 entries has been edited and reformatted. It contains data from the northeast quadrant of Iowa, including bacterial counts, iron, and nitrates.

Digitizing

As a result of our past year's experience in digitizing soil survey maps of Clayton County, modifications to our digitizing programs are currently under way to make the process easier and the editing and file structures more flexible. Increased needs for this capability make this a very high priority activity as this year ends.

Surface II

A graphics mapping and analysis software package was purchased from the Kansas Geological Survey. Adaptation of this extensive assemblage of computer

programs is partially complete, but the capabilities it has are all available to us. Contour mapping, block model drawing, and trend analysis are three of the capabilities we expect to use most extensively for both geologic and hydrologic analysis. Our adaptation will continue, as our programmers attempt to make this complex package of programs more readily usable by staff geologists and hydrogeologists.

Graphic Arts

The Graphic Arts section at IGS prepares the art materials used in publications, presentations, and displays, as well as designing IGS publications. In recent years, additional professional staff and new projects and responsibilities have added to the Survey's graphic arts needs--resulting in a second graphic artist. A state hiring freeze, combined with the resignation of an artist in September, currently finds some of our needs being unmet as the year ends. Regardless, achievements during the past year have been substantial as new Survey programs have been implemented and other programs continued. Lists of publications found elsewhere in this report have all been processed through our graphic arts program.

Iowa Geology, an annual publication of the Survey, has undergone substantial evolutionary changes since it began, but these became most noticeable in the 1982 edition (Number 7). Numerous content and design changes have occurred which bear mention. Newsletter items about Survey activities have been reduced and articles about geological resources issues and what we know about them have become more prominent. These changes, combined with format improvements to reduce clutter were made to produce a more readable and informative magazine.

The Survey unveiled a booth at the Iowa State Fair for the first time during this past year. Booth design and construction were accomplished under the leadership and talents of our own graphic arts personnel. Content was determined by our geologists and display construction and implementation was accomplished with Support Services staff. The exhibit concerned Iowa's land, water and mineral resources. It included panels about groundwater regions, groundwater storage and movement, groundwater protection, protecting water wells, and uses of Iowa mineral resources. Iowa's landscape was shown from aerial photographs and topographic maps. Further, a three-dimensional scale model of the strata beneath Iowa's soil was built for display and a large, "museum" specimen of the State rock, a geode, was featured. Our geological staff manned the booth throughout the Fair while handing out brochures specially prepared for Fair guests. All staff members reported numerous discussions with Iowa citizens regarding resource issues that concerned them--oil exploration, well problems, irrigation, protecting water supplies, etc.

Remote Sensing

Landsat Processing

Guthrie County was chosen as a test area to evaluate the potential for Landsat data to be used as a base to evaluate wildlife habitat and change across the entire State of Iowa. Processed data from two years was presented to Iowa Conservation Commission staff where final considerations are being made as to extending such processing for all 99 counties. This project would involve processing a minimum of 30 Landsat scenes.

Thematic Mapper Processing

Landsat imagery has a resolution of 80 meters but a new experimental satellite system, the Thematic Mapper (TM) has 30 meter resolution. This

difference is marked as it decreases the spot size from about 1.1 acre to .2 acre. Simulated TM data flown over Lake MacBride and Solon in Johnson County by NASA has been processed and reveals great potential. While its resolution is less than that of high altitude photography, its appearance is quite similar and its computer compatibility makes it especially attractive as a source of resource information. Further testing will continue in the following year with the simulated data as well as actual TM data currently on order.

Big Springs Groundwater Quality Study

A major research study on groundwater quality in northeast Iowa has included much staff time. This research is designed to evaluate possible best management practices to protect threatened groundwater sources in northeast Iowa. Remote Sensing staff collected much of the ground information, produced land-use maps from photographic sources and Landsat as well as produced the Survey's first natural resource, computerized geographic data base. This was the first time we used the geographic-data base capabilities which have been developing as a major analysis tool on research projects. A 100 square mile basin near Elkader was selected to continue analysis about 1) the extent and nature of groundwater degradation in a karst area, 2) how the interactions between the land surface and the subsurface work, and 3) what the effects might be of various farm management practices on the groundwater system.

The computer data base part of this research took enormous amounts of time, as first-time ventures such as digitizing the soil survey for the region were attempted. At years end, the data base was complete and included files of soils information, land cover and farm management information, geologic information and water-quality information. Estimates of soil erosion, surface water runoff and infiltration to streams, sinkholes and the soils in the

region were assessed using standard and modified techniques to assist evaluation of present water quality measured in the area and to model the affects of altered farming and control practices.

An evaluation of the computer-based geographic data base processes is in order. First, original construction is time-consuming and laborious. Soil data was entered, processed, and edited at a rate of about one square mile per six worker hours over the project, but was reduced to about one square mile per four worker hours (50 polygons/hour) at the end as our technique improved. This means that geographic data bases will require large expenditures for data entry before they can be widely used. Second, software system development must continue into the next year and some hardware improvement likewise is necessary to enhance their use. As a result of this experience, software packages, especially our digitizer software, are being modified to enhance data entry. Third, such data bases are powerful and effective. The overlaying of information visually is a powerful method for us to relate to the information. We see relationships quickly, and rapidly develop hypotheses. Further, the computational power of the computer can be used to extract information and make repetitive or complicated computations which would not be attempted by hand. Further, variables can be quickly changed and computed which allow for more modelling to be attempted. Fourth, our resource managers have a long way to go in learning how to utilize the power which these systems possess. Researchers were frequently slowed by their limits in manipulating the systems. These four conclusions will probably persist for a long time into the future, but it may be expressed with confidence that the problems will be reduced and the utility enhanced with further personal and agency experience.

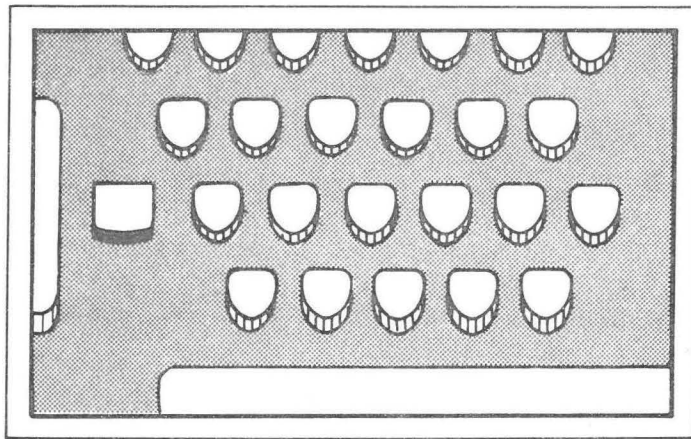
This research, both on the physical groundwater system, and the use of geographic data base using ELAS software will continue as we seek more

complete conclusions about groundwater degradation, best management practices, and the use of geographic data bases.

Landscape Modelling

Investigations of the alluvial stratigraphy in small western Iowa valleys was continued during 1982. Work centered around collection and submission of radiocarbon samples for dating alluviation episodes. A detailed investigation of a reach of Middle Silver Creek near Treynor in eastern Pottawattamie County was undertaken in cooperation with the Agronomy Department of Iowa State University. This was the first detailed work in a large valley in southwest Iowa. Several DeForest Formation members were recognized, mapped, and dated.

An investigation of the alluvial stratigraphy of northeast Iowa began as part of the geologic investigations in the Big Spring area, Clayton County. This phase of the work involved reconnaissance of Roberts Creek basin and portions of Turkey River Basin in Fayette and Clayton Counties.



Administrative and Support Service Group

Administrative and Support Service has the responsibility for all personnel functions, budget planning and preparation, the Oakdale facility support services, and the coordination and supervision of Administrative functions.

The coordination and cooperation with the Merit department and Comptroller's Office regarding personnel and budgeting is handled by the Administrative Officer.

Calendar year 1982 has proven to be one of few personnel changes for IGS. New employees are: Gale Ressmeyer, Geological Technician--Karst; Robert Libra, Geologist 3, Geological Studies; Koby Kielhorn, Driller's Helper; Robert Pyle, Geological Technician, Oakdale Support Services; and, in the front office, Mary Pat Heitman, Exempt Secretary 2; and Mary Carfrae, Receptionist. At the present time we have one vacancy for Graphic Artist, which cannot be filled due to the State hiring freeze.

Three contracts have been completed and the contract employees have left IGS to either further their education or take jobs in other organizations.

Arletta L. Orelup, Chief

ADMINISTRATIVE SERVICES

Administrative Services is charged with the responsibility for all clerical functions in the ongoing routines of mail, telephone communication, word processing of correspondence and manuscripts, and the sale of publications and maps to the general public.

This division also handles the revision of the publications list, bulk mailings, inventories of maps, publications, and office supplies, along with providing assistance in other administrative areas as needed.

Accounting

The Accounting Technician handles all payroll, invoicing, purchasing, and financial records for IGS. The financial reports and accounting for Federal Grants and Contracts, along with monthly and quarterly financial reports for management, are handled by this department. The Accounting Technician is responsible for an annual equipment inventory, plus maintaining inventory records.

Support Services

The activities of the Support Services Staff are many and varied. Foremost is maintaining and providing access to a wide variety of samples, including drill cuttings and rock cores from all areas of the State. The functions of cataloging and preparation of newly received samples, and continuing efforts to inventory past acquisitions are never ending. Continued personal contact with well drillers and other personnel in the water-well industry of the State is a very important function of Support Services.

Support Services is also responsible for storage and care of all types of publications, maps, and field equipment, along with maintenance of the IGS vehicles.

This year has seen many improvements in both functional methods and physical changes in the Oakdale Support Services area.

MAPS AND PUBLICATIONS

Topographic Maps

The Iowa topographic map quadrangles are produced under a cooperative agreement between the IGS and the U.S. Geological Survey Mid-Continent Mapping Center, Rolla, Missouri. These maps are used for planning highways, dams, airports, pipelines, transmission lines, industrial plants, and construction projects. Also, these maps are an important part of hydrologic research and mineral exploration.

The long sought goal of 100 percent topographic map coverage of the State of Iowa by the 7 1/2 minute quadrangle format (7 1/2 minutes of latitude by 7 1/2 minutes of longitude--approximately 55 square miles at this latitude) is nearing reality. The status of the 7 1/2 minute quadrangle mapping of Iowa as of December, 1982 is as follows:

<u>Number of 7 1/2 Minute Quadrangles</u>	<u>% of State Coverage</u>	<u>Availability</u>
995	92.9	Printed; available at IGS
72	6.7	Preliminary copies only, available from USGS, Rolla, MO
<u>16</u>	<u>0.4</u>	Mapping in progress
TOTAL 1,083	100.0	

Although complete State coverage by the 7 1/2 minute quadrangle series is at last nearing reality, it does not signal the end of topographic mapping in the State. There is a continuing need to revise published maps to keep pace with the changes in cultural features, such as roads, urban expansion, and other works of man. Priorities for map revision are based largely on the rate of change in cultural features. The cost of revision is borne entirely by the federal government. It is planned that the IGS will enter into a cooperative mapping program with the National Mapping Division of the U.S. Geological Survey to begin a new series of maps. Each of the maps of the new series will cover one degree of longitude x 30 minutes of latitude. At this latitude, each map will include an area of about 1,850 square miles. The map scale will be at 1:100,000 (one inch on map equals nearly 1.5 miles on the ground), with a vertical contour interval of 20 meters. The purpose for cooperating in this series of maps is to speed the eventual production of individual county topographic maps at the same scale. The eventual product will be an extremely useful tool for most planners and state agencies, plus be a very popular map for the various county residents, as has been proven in those states which have the county topographic maps. It is the opinion of the IGS that cooperating in the one degree x 30 minute quadrangle series will be a rapid and cost-efficient means of reaching the county topographic map goal.

Publications

Educational publications on such topics as fossils, minerals, and landforms are extremely popular with Iowa's citizens. Most of our technical reports, such as water resources publications, are designed so that they can be readily utilized by consulting firms, contractors, and private citizens. More esoteric reports are written for a scientific audience with specialized

areas of interest. Administrative Services is in the process of updating and re-typing the publications list which will be of considerable assistance to the general public.

The following listings show reports published by the Iowa Geological Survey, reports which are in preparation, and papers that were either published in other journals or presented at professional meetings.

Geological Survey Publications

- Bunker, B. J., Ludvigson, G. A., and Witzke, B. J., in review, The Plum River Fault Zone and the structural and stratigraphic framework of eastern Iowa: Tech. Info. Ser., ~100 p.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1982, Bouguer gravity anomaly map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska: Forest City Basin Map Ser.
- _____, 1982, Magnetic map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska: Forest City Basin Map Ser.
- _____, 1982, Precambrian configuration map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska: Forest City Basin Map Ser.
- Hallberg, G. R., and Hoyer, B. E., 1982, Sinkholes, hydrogeology and groundwater quality in northeast Iowa: Contract Rept. 6-31-82, 120 p.
- Horick, P. J., in preparation, the Silurian-Devonian aquifer of Iowa: Misc. Map Ser.
- Iowa, Kansas, Nebraska, and Oklahoma Geological Surveys, 1982, Earthquake epicenter and seismic station location map of the Nemaha Uplift region: Plate 2, Open File Map.
- _____, 1982, Geologic bedrock map of the Nemaha Uplift region: Plate 4, Open File Map.
- _____, 1982, Structural contour map, base of Kansas City Group or older Pennsylvanian rock units of the Nemaha Uplift region: Plate 5, Open File Map.
- _____, 1982, Precambrian configuration map of the Nemaha Uplift region: Plate 6, Open File Map.
- _____, 1982, Bouguer gravity anomaly map of the Nemaha Uplift region: Plate 7, Open File Map.

- _____, 1982, Aeromagnetic map of the Nemaha Uplift region: Plate 8, Open File Map.
- _____, 1982, Precambrian rock type map of the Nemaha Uplift region: Plate 9, Open File Map.
- Klug, C. R., 1982, The subsurface Devonian lithostratigraphy of southeastern Iowa: Open File Rept. 82-1, 33 p.
- Klug, C. R., 1982, Devonian stratigraphy and conodont lithostratigraphy from portions of two cores in central Iowa: Open File Rept., 82-2, 53 p.
- McCauley, J. R., 1982, Lineament map of the Forest City Basin and adjacent regions of Iowa, Nebraska, Kansas, and Missouri: Forest City Basin Map Ser., Open File Rept.
- Munter, J. A., Ludvigson, G. A., and Bunker, B. J., in press, Hydrogeology and stratigraphy of the Dakota Formation in northwest Iowa: Water Supply Bull., 42 p.
- Prior, J. C., 1982, Groundwater resources of Warren County: Open File Rept. 82-91.
- Thompson, C. A., 1982, Groundwater resources of Boone County: Open File Rept. 82-8.
- Thompson, C. A., 1982, Groundwater resources of Story County: Open File Rept. 82-85.
- Thompson, C. A., 1982, Groundwater resources of Polk County: Open File Rept. 82-77.
- Wahl, K. D., Meyer, M. J., and Karsten, R. A., 1982, Hydrology of the surficial aquifer in the Floyd River Basin, Iowa: Water Supply Bull., No. 2, 53 p.

Extrinsic Papers

- Anderson, R. R., 1982, Results of geological and geophysical studies in southwest Iowa, *in* Regional Tectonics and Seismicity of Southwestern Iowa: Final Report, August 1981-July 1982, Nuclear Regulatory Commission.
- Anderson, R. R., and Black, R. A., 1982, Geologic interpretations from geophysical models of the Midcontinent Geophysical Anomaly in southwest Iowa, *in* Regional Tectonics and Seismicity of Southwestern Iowa: NUREG/CR-2548, Nuclear Regulatory Commission, pp. 27-42.
- Anderson, R. R., and Black, R. A., 1982, Geophysical interpretation of the geology of the central segment of the Midcontinent Geophysical Anomaly: (abs.) in EOS, Vol. 63, No. 33, p. 615.

- Bettis, E. A., III, 1982, Geochronology of Late Wisconsinan and Holocene alluvium in the Missouri drainage of Western Iowa (USA): A case for episodic erosion and sedimentation: Eleventh International Congress on Sedimentology, McMaster University, Hamilton, Ontario, Canada.
- Bettis, E. A., III, and Thompson, D. M., 1982, Interrelations of cultural and fluvial deposits in northeast Iowa: Guidebook, Spring Meeting, Association of Iowa Archaeologists, Vermillion, South Dakota, 165 p.
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- Hallberg, G. R., 1982, Analysis of regional water quality in a karst aquifer: contamination--management problems: *in* Proc. Conf. State Sanitary Engineers, p. 10-12.
- Hallberg, G. R., 1982, Soil Taxonomy as a taxonomic system: from the outside looking in: Agronomy Abstracts, Soil Science Society of America, Anaheim, California, p. 231.
- Heckel, P. H., and Witzke, B. J., 1982, Paleoclimatic reconstruction of Devonian stratigraphy and sedimentation: Canada Soc. Petrol. Geol., Sedimentology Div., Calgary, p. 4-5.
- Kemmis, T. J., 1982, Differing sedimentation along the Algona Moraine and its significance to understanding the behavior of the Des Moines Lobe of the Late Wisconsinan Laurentide ice sheet: International Association of Sedimentologists, Eleventh International Congress on Sedimentology, Hamilton, Ontario, Abstracts of Papers, p. 78.
- Kemmis, T. J., 1982, Glacial depositional landforms: a need for a new classification: International Association of Sedimentologists, Eleventh International Congress on Sedimentology, Hamilton, Ontario, Abstracts of Papers, p. 22.
- Ludvigson, G. A., Bunker, B. J., Witzke, B. J., and Garvin, P. L., 1982, A new genetic model for the emplacement of zinc-lead ores in the Upper Mississippi Valley, USA: International Conference on Mississippi Valley Type Lead-Zinc Deposits, University of Missouri-Rolla, Part 1, Abstracts and Program, p. 37.

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- Ravn, R. L., and Whitley, D. L., 1982, Palynology of Upper Dakota Formation lignites from northwestern Iowa and northeastern Nebraska: (abs.), American Association of Stratigraphic Palynologists, 14th Annual Meeting, p. 39.
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- Witzke, B. J., Ludvigson, G. A., Ravn, R. L., and Poppe, J. R., in review, Cretaceous paleogeography along the eastern margin of the western interior seaway, Iowa, southern Minnesota, eastern Nebraska, and South Dakota: Mesozoic Paleogeography of the West-Central United States, SEPM Rocky Mountain Section, ~50 p.