

ANNUAL REPORT



OF THE STATE GEOLOGIST TO THE GOVERNOR

Volume 53
1983

State of Iowa

Iowa Geological Survey

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

Terry E. Branstad
Governor of Iowa



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February 29, 1984

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 1 January 1983 to 31 December 1983. 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. This system is being implemented, and I am confident that it will enhance management of Iowa's water resources.

Respectfully submitted,

Donald L. Koch

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State Geologist and Director

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compiled by
ORVILLE J VAN ECK
ASSOCIATE STATE GEOLOGIST

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IOWA GEOLOGICAL SURVEY

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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, Iowa Conservation Commission, Iowa Department of Health, Iowa Department of Water, Air and Waste Management, 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

Research Cooperative Programs	Consultation, Advisory, and Data-Source Services	Participation in Other Agencies
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 Water, Air and Waste Management University Hygienic Laboratory Iowa Department of Justice 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	Iowa State Map Advisory Council Iowa Conservation Education Council Department of Water, Air and Waste Management Inter-Agency Resources Council Department of Soil Conservation Land Rehabilitation Advisory Board Watershed Advisory Board Conservancy District Task Force 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

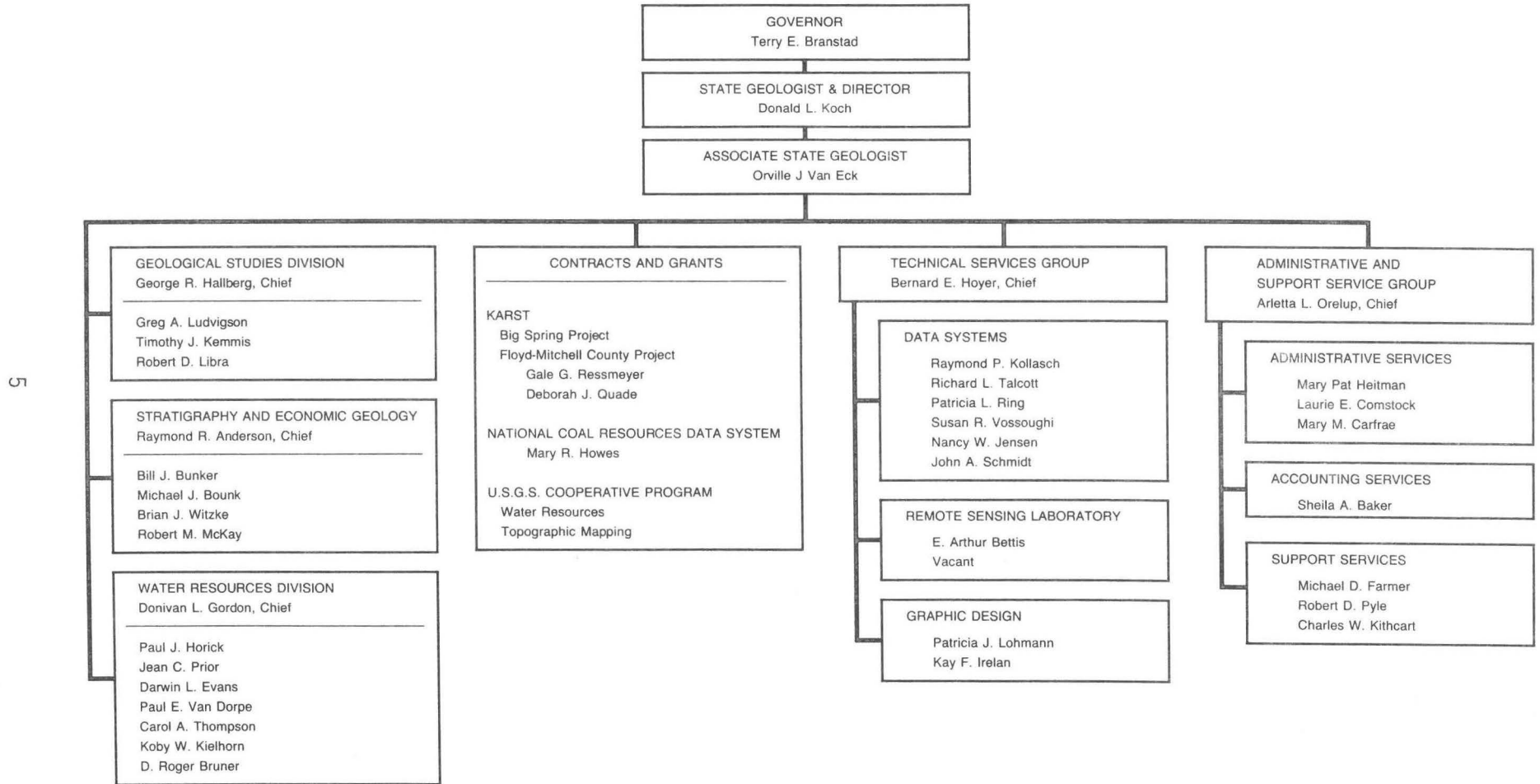


Figure 2. Staff Organization and Responsibility Assignment.

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 storage and flow rate of streams and the concentration and total load of sediments carried by streams.

During 1983, the IGS fully supported 25 and partially supported five streamflow data collection stations. IGS also supported four sediment data-collection stations. A tabulation of these stations is presented in Table 1 and the locations are shown in Figure 3 and 4. These stations are part of a stream-flow 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 Department of Water, Air and Waste Management, the Iowa Department of Transportation, the Iowa Conservation Commission, the U.S. Soil Conservation Service, and County and City Engineers.

TABLE 1.

USGS/IGS COOPERATIVE STREAMFLOW DATA COLLECTION PROGRAM, 1983

Stations Fully Supported by IGS

Station

Big Cedar Creek at Varina
 Cedar Creek at Oakland Mills
 East Branch Iowa River at Klemme
 East Fork Hardin Creek at Churdan
 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 Elma
 Wapsipinicon River at Independence
 Weldon River at Leon
 West Nishnabotna River at Hancock
 Winnebago River at Mason City
 Nodaway River at Clarinda

Stations Partially Supported by IGS:

Station

Little Sioux River at Turin
 Soldier River at Pisgah
 Boyer River at Logan
 East Nishnabotna River at Red Oak
 Raccoon River at Van Meter

USGS/IGS SEDIMENT DATA
 COLLECTION PROGRAM

Stations Fully Supported by IGS:

Station

Iowa River at Iowa City
 Ralston Creek at Iowa City
 Skunk River at Augusta
 Nodaway River at Clarinda

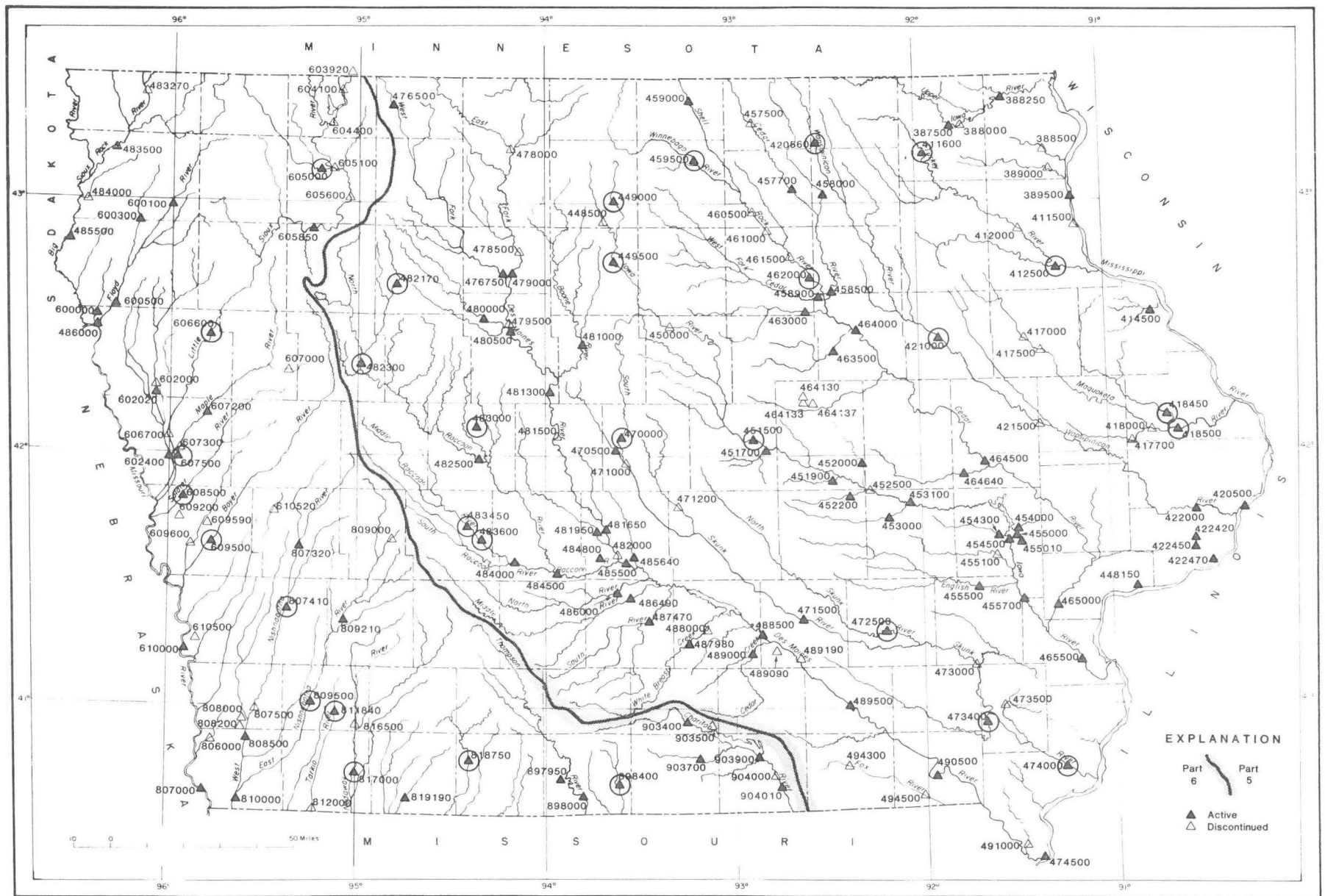


Figure 3. Location of continuous-record gaging stations in Iowa.

○ Station supported by IGS

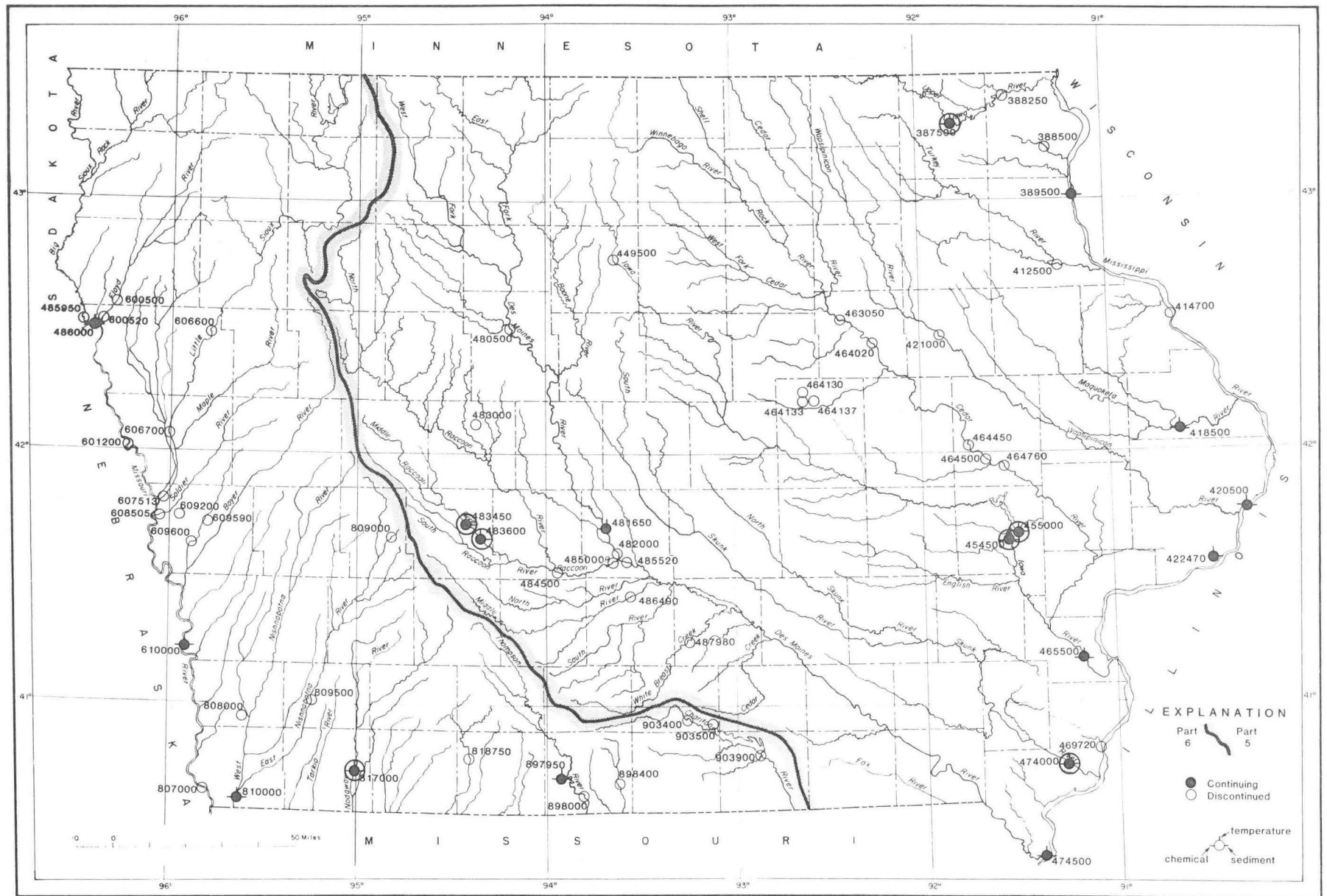


Figure 4. Location of water-quality stations in Iowa.

○ Station supported by IGS

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.

The following is a brief summary of the groundwater-related projects of the cooperative program for 1983.

I. Groundwater Stations

a. Observation-Well Network.

The purpose of this project is to maintain a network of wells to monitor the changes in groundwater levels in the various aquifers in the state. At the present time, the network includes 92 observation wells (municipal, industrial, and domestic) plus 30 project wells. Project wells are those drilled under the IGS-USGS Cooperative Program. Plans are under way to expand the network geographically and the aquifers being monitored.

b. Bedrock-Topography Mapping

This project is aimed at completing the mapping of the configuration of the bedrock surface. Knowledge of that configuration is especially important to our understanding of groundwater resources, but is also important in such matters as waste disposal and construction. During 1983 the central Iowa portion was completed and is now in the review process.

c. Data Coding/Entry

Under this project, hydrologic and geologic data are coded and entered into a computerized system to facilitate recall of data. These data are an important part of the Comprehensive Water Information System being developed by IGS.

II. Water Use

A vital element of water management is the knowledge of the amount of water being used. This project attempts to better determine water usage within Iowa. A report is now ready for publication, although it is recognized that because of lack of accurate and comprehensive data, the report cannot adequately evaluate water use in the State. To reach the desired level of accuracy, a number of changes in the water-use reporting requirements must be emplaced.

III. West-Central Iowa

This project entails the drilling of test holes to determine the geologic and hydrologic parameters in eight counties in west-central Iowa. The project, a three-year drilling effort that was completed in August, 1983, greatly expanded the knowledge of the important Cretaceous (Dakota Sandstone) aquifer plus the unconsolidated local aquifers. A report of the results of the project is being prepared.

IV. Northeast Iowa

This project will result in another in the Water Atlas Series that is a comprehensive evaluation of the water resources of an area. The report is complete and is now being prepared for publication.

V. Groundwater Quality Network

The cooperative program maintains a network of 130 wells to monitor water quality in the various aquifers of the State. The network not only portrays the present water quality, but by comparison with past records, makes possible the detection of water-quality changes.

A more detailed discussion of some of these cooperative projects is included in the following reports of the IGS divisions.

CONSULTATIVE, ADVISORY, AND INFORMATION SERVICES

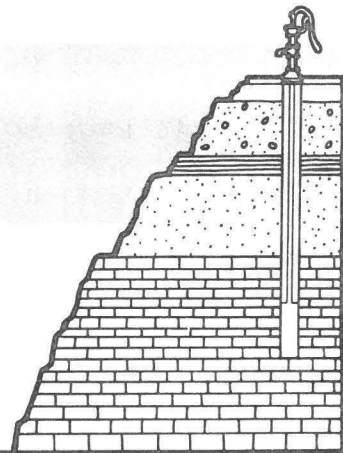
The Survey yearly responds to hundreds of requests for geologic and hydrologic information from various state and federal agencies, consulting engineers, well drillers, industries, and citizens. These services frequently require interpretation of data and quite often on-site investigations in various 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 will often 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.

Water Resources Division



Public Service, water-resources research, and state water-resources planning and assistance were the top priorities of the Water Resources Division during the 1983 reporting period. The division also provided technical assistance to several State agencies, departments, and public entities with respect to environmentally-related problems, water-resource development, and water-quality and quantity concerns.

Nineteen eighty-three was a year of renewed interest in Iowa's oil and gas production potential. This interest has yet to translate into much in the way of exploration drilling, but 1984 holds considerable promise based on requests for drilling-permit applications processed in 1983. The Division coordinates these activities for the State Geologist--the Administrator of Oil, Gas, and Metallic Minerals (Code Chapter 84).

During the past year, the Division's research-drilling staff has functioned to support a wide variety of state/federal, interagency, and division research and investigative projects.

The Division's goal of public service and assistance in the areas of groundwater development, management, and protection remain constant. To attain that goal we consider it important to provide the public with as much in-

formation concerning their water resources as possible. This is accomplished through the following division activities:

--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.

--Maintaining 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 year 1983, division staff responded to over 450 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 during drilling, 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, an in-

dividual report may take from four to over eight hours to prepare. During 1983, approximately 20 percent of the Division's staff time was spent in this type activity. The specific types of responses are broken into categories in the following table and compared to the same categories for calendar 1981 and 1982.

<u>Category</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
State/Federal Agencies	0	0	37
Municipal	96	93	118
Industrial/Commercial	53	52	76
Domestic	56	117	151
Irrigation	16	12	6
Housing Developments	15	9	7
Rural Water Systems	2	8	1
Recreation	14	16	4
Livestock Operations	9	4	12
Regional or County	32	20	14
Pumping Tests	26	11	0
Other	<u>23</u>	<u>42</u>	<u>56</u>
TOTALS	342	384	482

Consulting and Field Investigations

In most years, there are instances where IGS is called upon to evaluate specific or potential problems which require field or non-routine office investigations. These special-type projects derive from a variety of sources; individuals, commerce and industry, city and county governments, or State and Federal agencies. Many require coordination with other State and Federal agencies or between divisions of the IGS.

During calendar year 1983, Water Resources Division staff responded to

over 150 of these kinds of requests. Only one required investigative work in the field. The following list exemplifies the variety of problems addressed in this category:

1. Taste and odor problems in water from city well--City of Worthington
2. High selenium concentration in private well in vicinity of Black Hawk County Landfill.
3. Potential impact of proposed limestone quarry on domestic water wells --Buchanan County.
4. Elevated nitrate concentrations in private and commercial wells--City of Muscatine.
5. Potential impact of proposed gravel pit on local water wells--Emmet County.
6. Land subsidence related to abandoned coal mines--City of Des Moines.
7. Elevated nitrate concentration in city well and possible relation to bulk fertilizer plant--Guthrie Center.
8. Natural gas venting from a private water well and system--Cass County.
9. Radium problems in city wells--West Bend.
10. Impact of quarry drainage on local water supply--Black Hawk County.
11. Potential impact of injection of process water at an underground natural gas storage facility--Louisa County.
12. Installation of water-quality monitoring wells at abandoned AIDEX pesticides plant--Mills County.
13. Alternatives for contaminated water supply, Amana Refrigeration--Iowa County.
14. Review and evaluation of technical reports on Missouri Basin water diversion for the Missouri River Basin Coordinator and The Office of the Attorney General.

Research Drilling

During 1983, the research drilling crew completed eighty-one test holes for the IGS/US Geological Survey cooperative hydrology study project in west-central Iowa. Thirty-five of these were completed as observation wells to

monitor water levels and water quality. On this project, the total footage drilled was 9,564 feet, and 1983 marks the end of drilling for the project.

The drilling crew also completed three Dakota observation wells as prescribed by the 1983 Legislature; one 640-foot well in Osceola County, and two at 93 and 94 feet in Kossuth County.

Forty-three test holes were drilled for the upper Des Moines River alluvial aquifer project. Twenty-six of these were completed as observation wells. The total drilling footage on this project was 1,946 feet and 963 feet of casing were used in completing the 26 observation wells.

Assistance to Coal Mine Operators

During 1983, twenty-six written responses and numerous telephone responses were made to coal miners, State and Federal government agencies, and private individuals regarding information and technical assistance on coal occurrence and quality, underground mine maps, and coal and mineral forecasts.

Staff reviewed and updated the Iowa section of the Keystone Coal Industry Manual. Staff also co-authored a technical paper dealing with the trace-element geochemistry of Iowa's coals.

Division staff continues to provide technical assistance to the Department of Soil Conservation--Division of Mines and Minerals with respect to the technical review of mine plans and subsidence control plans. Such plans are required of coal-mine operators as a requisite for mining approval and permitting.

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 re-

sources 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 management. Principally, how much water is available, what rates of withdrawal can be sustained, with what impact, and in terms of use--how much water is currently used and what additional water usage can 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 calendar year 1983, the Silurian-Devonian aquifer study was completed and is being readied for publication. This study, along with prior studies of the Jordan, Mississippian, and Dakota aquifers, essentially completes the study of Iowa's most important regional rock aquifer systems, and opens the way to accelerating investigations of the State's important alluvial aquifer systems.

The Division is currently involved in five principal areas of research:

- An inventory of municipal water-supply systems,
- county water-availability studies,
- the groundwater potential of alluvial aquifer systems,
- a regional inventory of water resources in northeast Iowa, and
- an evaluation of critical water-data needs consistent with the development and implementation of the State Water Resources Information System.

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 is to expand the agency's knowledge of community water developments so that the Survey's service to communities can be more effective and efficient. The data which is being inventoried is in files

maintained by the six regional offices of the Department of Water, Air and Waste Management (DWAAM).

The 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 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 DWAAM Regions I, II, V, and VI. In these regions, 507 community-supply systems have been inventoried--somewhat over two-thirds of the incorporated communities in Iowa. Four hundred and eighty-four of these rely on groundwater which is drawn from 1121 operating wells. Prior to the inventory, IGS had data for only 535 of these wells--about 48 percent of them.

Because of a requirement for this data for state water-planning purposes, DWAAM has asked that the program be accelerated. Accordingly, the inventory has been scheduled for completion by June of 1984. This will include encoding the data by IGS for computer processing by DWAAM. This phase of the program is underway at the moment.

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. Twenty-one of these reports have been published to date, and two others 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 in the county
6. Common water-quality problems and drinking-water standards
7. Index of available topographic maps
8. Agencies that may be contacted for assistance on water-supply questions
9. List of drilling contractors that service the respective counties

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 to 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).

One objective of the field work associated with the study has been the development of 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 alluvi-

al aquifers requires test drilling which is expensive and time consuming. Current indications are that seismic refraction data will provide good information on primary targets for future water developments or for more detailed assessment through limited test drilling. Also, that the detail provided by the seismic surveys will reduce to a minimum the actual drilling required for verification and determination of hydrologic potential. Additional economies were realized in the seismic part of the program by using a mechanical seismic energy source designed and built by the Division. Formerly, blasting reagents were used for this purpose. The mechanical energy source cut costs by approximately seventy-five percent compared with the former method.

During the summer of 1983, the field investigation of the Ocheyedan River alluvial system was initiated. The seismic and other data obtained has been processed, and a series of geologic cross sections are in preparation.

Along the reach of the upper Des Moines river alluvial system, twenty-five observation wells were emplaced. These wells will be used to monitor fluctuations in water quality, to define aquifer hydraulic parameters, to monitor pumping effects on river stage, and to observe seasonal changes in water levels. Water-quality work on the upper reach of the Des Moines System has been allowed to expand because of monies made available to the Division through a grant from Region VII EPA. Under the terms of this grant, the Division will be investigating nitrate and coliform bacteria conditions in the aquifer over the next year. In addition, we will be looking for the presence of agricultural pesticides in our observation wells during the fall of 1983, and the spring of 1984.

Water Resources of Northeast Iowa

A project initiated during 1982 to develop a regional water atlas for eleven counties in northeast Iowa is continuing. The counties that are in-

cluded are: Howard, Winneshiek, Allamakee, Chickasaw, Fayette, Clayton, Bremer, Black Hawk, Buchanan, Delaware, and Dubuque. The atlas published for the study will be the seventh in the Survey's Water Atlas Series. The projected completion date of the study is during fiscal 1985-1986.

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 also are quite useful in defining the environmental sensitivities of regions as they may relate to the siting of landfills and other kinds of land-management considerations.

Evaluation of Data Needs for the State Water Resources Information System

As mandated in Section 60 of House File 2463, the State Geologist was instructed to prepare a plan for a State Water Resources Information System, and to implement and maintain the data system. The plan was presented to the General Assembly during January 1983, and accepted. Certain funds for implementing the plan were appropriated as IGS budget line items by the 1983 Legislature.

The funds appropriated, as outlined in the IGS budget, were earmarked for making improvements in IGS data processing capabilities related to data system implementation, and to expand the Water Resources Division's capabilities in the area of technical support to the information system--primarily considerations in water budgeting and computer modelling.

The basis for the latter activities is first determining how much data is available and applicable to make quantitative assessments or satisfy the input requirements of predictive models. Work in this area was initiated during 1983 and will continue into 1984. At this level of assessment our objectives

are:

- to define all existing sources of quantitative data,
- to aggregate this information into a single data base,
- to define deficiencies and make recommendations to obviate them
- to develop summary statistics on the status of water resources in terms of water quantity and quality, and
- to develop methods to present this information to end users--planners, developers, and the principal regulators.

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 (780) 29 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.

Only one drilling permit for oil and gas exploration was issued during 1983. It was issued to Upland Leasing Limited of Storm Lake, Iowa. Drilling under this permit was accomplished in Crawford County. To date, there have been no indications of conditions favoring completion of the test well for the production of oil or gas.

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. From De-

cember 1975 through the present, the acreage which has remained under lease has been constant--2,240 acres. The total gas-in-place in the reservoir as of November 26, 1983 was 2,404,917 Mcf (thousand cubic feet)--no change from 1982 through 1983.

TRAINING SESSIONS ATTENDED BY DIVISION STAFF

"28th Annual Mid-West Groundwater Conference," Champaign, IL

"1983 Annual Meeting Iowa Water Well Association," Des Moines, IA

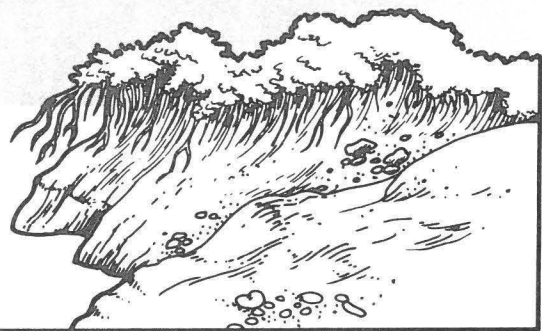
"Missouri School of Mines--Subsidence Engineering Short Course,"
Pittsburgh, PA

"Short Course on Geophysical Logging," Kansas Geological Survey,
presented in Iowa City, IA

"Meetings of the Geological Society of America--North-Central Section,"
Madison, WS

"Leadership Effectiveness," presented by the Iowa Management Training
System, Des Moines, IA

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, 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 1982. The report on the Dakota aquifer study was published as IGS Water Supply Bulletin No. 13. Review of water-quality monitoring data from the La-Bounty arsenic waste-disposal site at Charles City continues.

Major projects which are continuing include the study of groundwater

quality problems in the Silurian-Devonian and Ordovician Carbonate aquifers of northeast Iowa, and groundwater-availability investigations in west-central Iowa.

Groundwater Quality in the Carbonate Aquifer Regions of Northeast Iowa

One of the major hydrogeologic projects during 1983 was the evaluation of groundwater quality in the karst areas, formed in the important Silurian-Devonian aquifer and Ordovician-Galena aquifer of northeast Iowa. These aquifers are formed of limestone, or carbonate rocks, and are major sources of public and private wells or groundwater supplies throughout eastern Iowa. These projects have involved nearly the entire staff at IGS and a number of graduate students, who were employed through contracts. The first phase of this project, a regional assessment, was completed during 1982 (Hallberg and Hoyer, 1982: in IGS publications list) and the first year's results of the Big Spring project were compiled in 1983 (Hallberg, et al., 1983). These projects are continuing.

These studies, particularly the detailed Big Spring Basin study, and the Floyd-Mitchell County study, have provided one of the first comprehensive investigations of the relations between agricultural chemical-use and groundwater quality in the corn-belt. These studies clearly suggest that the increase in nitrate levels noted in groundwater are directly related to the dramatic increases in the use of chemical-nitrogen fertilizers since the 1950's. The used pesticides are leaching into shallow groundwater supplies over extensive areas of Iowa. Although the concentrations found are generally quite low, these findings are distressing because the long-term health impacts of such chemicals in drinking water is not well known. The focus of the studies is on the mechanisms of how these chemicals are delivered into the groundwater system. These technical issues must be understood before plans to les-

sen these problems (such as best farm-management practices) can be designed. A variety of state and federal agencies are reviewing and participating in these studies because the results have broad implications. This consortium of agencies has begun meetings to discuss potential programs needed to address and resolve these issues, hopefully, before they become more serious. The study results are outlined below.

Karst-Carbonate Aquifer Study, Phase I: Regional Study

The first phase of this project was a regional assessment of the karst-carbonate aquifer regions. In this phase of the study, the geologic conditions and groundwater-quality data were reviewed in detail for 22 counties in northeast Iowa (about 13,4000 square miles). 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). For perspective, the median nitrate values from all areas are below the 45 mg/l drinking water standard.

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 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.

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.

Karst-Carbonate Aquifer Study, Phase II: Big Spring Basin Study

The Big Spring study is the second phase of an assessment of groundwater quality in the karst-carbonate aquifers of NE Iowa. The project has been jointly funded and conducted by the Iowa Geological Survey (IGS), the Iowa Department of Water, Air and Waste Management (DWAWM), the U.S.D.A.-Soil Conservation Service (SCS), the U.S. Environmental Protection Agency (EPA), with assistance from the Iowa Conservation Commission (ICC), University Hygienic Laboratory (UHL), and U.S. Geological Survey. Staff from other institutions have participated in a consultative role, including personnel from Iowa State University, the Cooperative Extension Service, the U.S.D.S.-Agricultural Stabilization and Conservation Service, and the Iowa Department of Soil Conservation. The study has also involved 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. 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 assumed previously.

Results of monitoring groundwater in this study confirm many conclusions of the first phase of this study, which assessed regional water-quality problems in these karst-carbonate aquifers. During an original basin-wide water-sampling inventory, the median nitrate concentrations from the Galena aquifer was 35 mg/l, with individual analyses as high as 280 mg/l. However, where the Galena aquifer is protected from significant surficial infiltration or sinkhole "run-in" by a cover of Maquoketa shale, nitrates are not detected (<5 mg/l) in the groundwater. For the 1982 water year, the mean nitrate concentration in groundwater discharging at Big Spring was 40 mg/l, approaching the U.S.E.P.A. drinking water standard for nitrate (45 mg/l). This is in marked contrast to water-quality analyses from Big Spring from 1951 and 1968 which had a mean nitrate concentration of 13 mg/l. Comparison of these values suggests a 230% increase in nitrate concentrations in groundwater since the late 1960's. During this period, corn acreage increased about 40% and the application rates are "additive," the total fertilizer-N applied in the basin increased by about 250% during this same period. Other potential sources of increased nitrate were negligible by comparison. The primary reason for increased nitrate concentrations in the Galena aquifer clearly seems to be the dramatic increase in nitrogen fertilization.

The total discharge of nitrogen (as nitrate-N) from the Big Spring basin for the 1982 water-year was 905 tons; 527 tons in groundwater and 378 tons in streamflow. This amounts to 27 lbs-N/acre for the entire basin or, 47 lbs-

N/acre for the row-crop area of the basin. As a matter of perspective, the total N lost from the basin was equivalent to 33% of the total fertilizer-N applied in 1982. This is not to imply that all the N lost was 1982-applied N. Monitoring of the Turkey River indicates that such substantial N-losses occur regionally, and constitute an economic as well as an environmental loss. The N-losses were even higher in the 1983 water-year in spite of the PIK program which reduced application (these results are being analyzed at the current time).

Pesticides, particularly the corn herbicide atrazine, have been found routinely in the groundwater, in the Big Spring Basin, persisting even through the winter months of 1982-83. The maximum concentrations of various pesticides that have been detected in groundwater are (in mg/l--parts per billion): atrazine, 5.1; Lasso, 0.63; Bladex, 1.2; Dual, 0.62; and 0.11 Dyfonate. Also, up to 9.2 mg/l atrazine and 3.6 mg/l of the banned insecticide dieldrin have been found attached to particulate matter (sediment) in the groundwater. Miscellaneous samples from small groundwater springs have even higher concentrations (atrazine, 10.0 mg/l; Lasso, 6.0 mg/l). In general however, the concentrations routinely found in this region are very low (0.1-1.0 mg/l), well below toxic levels and estimated-safe-average-daily-intake levels. However, there are many uncertainties about the potential health effects of such chemicals in drinking water. Bacterial contamination of the aquifer was also found particularly in association with peak runoff periods. Turbidity and associated problems, such as sediment, soil-attached pesticides (especially dieldrin), and other organics, are also related to peak runoff. Persistent bacteria problems are not necessarily related to the karst-groundwater system, but may be associated with faulty domestic water systems. Cisterns, in particular, were found to be a common source of bacterial contamination in rural

drinking water supplies.

Groundwater discharge was separated into two principle components: 1) a "base-flow" or "infiltration" component; and 2) a "peak conduit flow" or "run-in" component, related to surfacewater run-in to sinkholes. The "infiltration" component delivers to groundwater: 1) the highest concentrations and largest mass (over 90%) of nitrate (and other soluble nutrients); 2) the largest mass (over 80%) of soluble pesticides, but in very low concentrations; and 3) generally little sediment, turbidity, organic, or bacteria problems. The "run-in" component delivers to groundwater: 1) peak pesticide loadings, with concentrations 10 to 100 times greater than the "infiltration" component; 2) peak turbidity and sediment problems; 3) peak bacteria problems; and 4) generally lower concentrations of nitrates, compared to the "infiltration" component. The respective contributions of these components must be considered in any planning of control measures or management practices.

The recognition that infiltration is the primary mechanism for the delivery of ag-chemicals into groundwater has broad implications, because this is the recharge mechanism common to all aquifers.

Health problems related to bacteria and viruses are widely known, and their potential existence in karst aquifers has been a concern of health officials for many years. The health effects of elevated levels of nitrate and persistent low levels of pesticides are not well known, and represent important subjects for further research.

Quantitative and qualitative evaluation of land-treatment changes are being conducted. Soils information (soil types, slopes, etc.), current landuse, geologic, and hydrologic data were all merged in a computer data base. Using this data base, computer models were used to provide quantitative estimates of soil erosion and surface runoff under various land-treatment practices.

Common soil conservation measures and other land-management practices which effect groundwater quality in karst regions were evaluated, based on the quantitative modelling and the qualitative assessment of various practices. Agricultural-management practices which could improve groundwater quality are those which will reduce leaching losses of nitrate (e.g., through better N-management, reduced rates of application, and/or reduced acreages), reduce leaching losses of pesticides (e.g., through integrated pest control, use of less soluble products, and/or reduced acreages), and reduce pesticide and sediment delivery to sinkholes (e.g., through conservation measures, especially crop rotations or strip cropping).

Although some aspects of waste disposal and management can be regulated, the larger concerns with agricultural chemicals must be addressed primarily through public education and further research. People living in karst areas should be made aware of the condition of their groundwater resource, and alerted to potential health hazards. Information on domestic water treatment and alternative groundwater sources should be developed. Further, a program to promote research and implementation of appropriate land-management practices should be undertaken.

Karst-Carbonate Aquifer Study Program, Phase III: Floyd-Mitchell County

This third phase of the study began in November 1982 with funding from the U.S. Environmental Protection Agency. This study has been investigating, 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, but are providing further corroboration of the findings of the other studies. Analysis is continuing at the present time. However, a few conclusions may be outlined.

The Floyd-Mitchell County area is more intensively farmed for corn and

soybeans than the Clayton County region. Thus, it is more typical of large portions of Iowa. In general, higher concentrations, and more types of pesticides are being found in the groundwater in the Floyd-Mitchell County area. Locally, the maximum concentrations measured in groundwater are (in ug/l-parts per billion): Lasso, 16.6; Sencor, 4.35; Bladex, 0.48; atrazine, 1.6; and Dual, 0.11. In particular, the Floyd-Mitchell County study results emphasize the importance of infiltration in the delivery of chemicals from the land surface into the groundwater system.

West-Central Iowa Project

Field work for the IGS's regional test drilling and water resources evaluation program in west-central Iowa was completed in August 1983. In part, this program was an extension of the Dakota aquifer project which was previously completed in adjacent northwest Iowa. Before this project was initiated, however, west-central Iowa was that portion of the state where IGS had the least-extant subsurface information. During the data collection for this project, 241 test holes totalling 298,555 feet were drilled, 94 of which were developed as observation wells. In addition, 120 water samples were collected for chemical analysis, in order to characterize the quality of waters from aquifers in the region.

Since the completion of field work, data synthesis has proceeded on a full-time basis. Initial interpretive products will be two maps, one depicting the buried bedrock surface in west-central Iowa, and another showing the distribution and thickness of the Dakota aquifer in west-central Iowa. The bedrock topography map is tentatively scheduled to be published in October 1984 as a Open File Report, and later as a Miscellaneous Geologic Investigation Map by the U.S.G.S., the collaborator with IGS on the west-central project. All data collected during the project will be compiled and published

as an Open File Report in October, 1984. A final report with interpretations of regional groundwater will be published as a U.S.G.S. Water Resources Investigations Series in 1985.

OTHER GEOLOGIC STUDIES

Lead-Zinc Studies

Since 1974, the Geological Studies Division has had an ongoing project to compile field and laboratory analyses of lead-zinc deposits in northeast Iowa, which has been conducted on a part-time basis. Preliminary results from these studies, including a new theory of origin and exploration model for the lead-zinc ores, were presented at an International Conference on Mississippi Valley-Type lead-zinc deposits in Rolla, Missouri, and formally published in the Conference Proceedings in 1983. Several recent publications have focused attention on the Plum River Fault Zone in eastern Iowa as a potential frontier exploration area for new lead-zinc deposits. Systematic field collecting from special areas of interest was initiated in 1983, and laboratory analyses will be performed on these samples to evaluate potential for economic mineralization.

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 Agronomy Society of America.

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's longer term projects.

Examples of these projects during the past year include:

- 1) Investigation of several hazardous or toxic waste sites for DWAWM and U.S.E.P.A. involving such things as pesticides 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 DWAWM and the Fire Marshall's offices.
- 3) The continuing review of the LaBounty arsenic disposal site.
- 4) Design and analysis of pump tests for DWAWM well-permit hearings.
- 5) Providing information or testimony for various hearings regarding water permits for DWAWM.
- 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.
- 8) Review and testimony regarding the ETSI water allocation litigation.

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 those major items outlined above. These other services include:

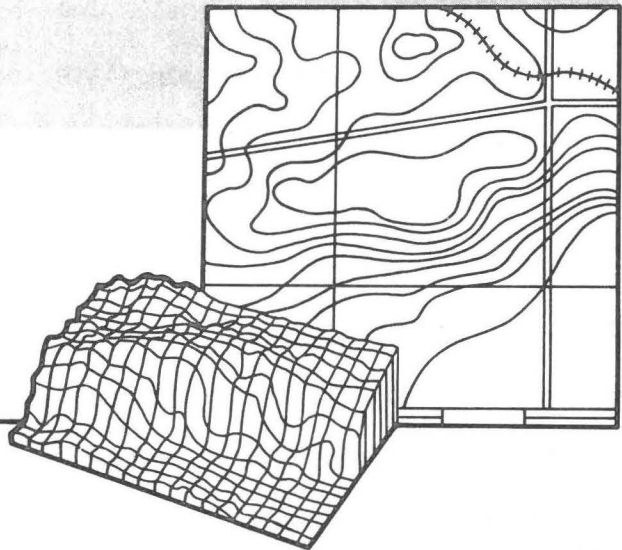
- 1) Review of landfill and other waste-disposal site plans.
- 2) Review of new rules and regulations by Iowa and U.S. regulatory agencies.
- 3) Providing information on engineering-geologic conditions and potential problems (see discussion below).
- 4) Providing information on general soils-geologic drainage characteristics, suitable 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.

Items 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 firms or architectural firms which represent the firms, and various state and 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 take about five-person-months of time for the Geological Studies Division staff. Several of these individual cases are pending further study or litigation which also will require IGS input.

Technical Services Division



The computer processing, graphic arts, and remote sensing programs are all grouped within the Technical Services Division. Each serves other portions of the Survey and outside parties, as well as conducting projects within their own areas. Emphasis over the past year has been placed on interagency water-data system planning, and activities related to completing the first year of analysis relating land management and water quality in the Big Spring study area.

Bernard E. Hoyer, Chief

DATA PROCESSING

The data-processing staff provides data entry, management, analysis, and display services for research within and outside the Iowa Geological Survey. Significant projects during this past year have included:

1. A bolstered water-data system project with additional staff and upgraded communications facilities;
2. Substantial revision of graphics data-handling routines;

3. Extension and refinement of the online system that searches for and displays geologic records;
4. A program that plots geologic cross sections using records retrieved by the online system;
5. A number of data entry, digitizing, programming, and data-processing services connected with projects at IGS and elsewhere.

Water-Data System Project

House file 2463 instructed the State Geologist to prepare and submit a plan for a "Comprehensive Water Resources Information System," by January 15, 1983. The resulting "Comprehensive State Water Resources Information System Design Report," was adopted by the Water Resources Joint Legislative Committee. Subsequently, budget requests for first-year development were approved. A hydrologist, two programmers, and a data entry operator were hired during this past year. IGS has ordered equipment to establish a teleprocessing link with the Comptroller's Data Processing (CDP) facilities in Des Moines.

In accordance with the data-system plan, two committees were formed. The Advisory Committee is composed of the directors of natural resource and CDP agencies and representatives from the Governor's office and the legislature. The Technical Coordinating Committee (TCC) includes data-processing specialists and researchers directly involved in the processing and exchange of water-resources data. The TCC makes recommendations to the Advisory Committee, and implements directives of the Advisory Committee. The initial task of the TCC is to report to the Advisory Committee on short- and long-term needs for information-system capabilities. This year special emphasis was placed upon the immediate need for adequate information to assess resource availability and demand for water.

Equipment acquisition for the current fiscal year includes items to enable two-way interactive communications between IGS and CDP: software, a

phone line, communications equipment and terminals are being installed at IGS to allow utilization of CDP resources. Additional equipment is being installed so that other agencies can dial in to the IGS computer system and make use of its capabilities.

Integrated Database Management System (IDMS) is a proprietary software package supported at Comptroller's Data Processing in Des Moines. IGS data-processing staff are assessing its applicability to water-resources data management. We expect this system may be effective in the management of data files that are used cooperatively among the state agencies.

Staff members of the Department of Water, Air and Waste Management (DWAWM) and IGS data-processing staff are cooperating at this time on compilation of data that might be jointly maintained using IDMS. The data are being obtained from a number of sources, including files maintained by DWAWM in administering the Safe Drinking Water Act; from the U.S. Geological Survey's WATSTORE system; and from the inspection reports filed by DWAWM regional offices. The file will be accessible by regional offices as well as by IGS and the DWAWM central office. It will contain current information about plant facilities, treatment types, storage, pumpage, well construction, and pumping tests. Later, water-quality reports and geologic data may become a part of this file. It has several uses and applications. First, it is a source of records on municipal water sources and rates of withdrawal that can be reviewed by water-resources planners when estimating Iowa's water usage. Second, IGS Water Resources Division staff will use the file when troubleshooting well problems and when making water forecasts. The file will help bring IGS data to DWAWM regional offices. And third, the data will be more accessible for many other legitimate research or informational purposes, such as for epidemiological studies. In addition to basic data-handling activities, Data

Processing staff are working closely with IGS Water Resources Division staff in the area of groundwater availability. A data inventory is currently being conducted and it is anticipated that a file containing aquifer characteristics and related graphics data processing software will emerge as a result of this effort.

Digitizing and Plotting Software

A new program for computer-based digitizing has been written. In the extensive digitizing done for the Big Spring study, several drawbacks to the previous software were noted. The best features of the original version were retained and new features were added to create a comprehensive digitizing environment. As before, the user has extensive power to copy and append data files and convert them to different coordinate systems and display them. New features permit the user to edit and delete data elements, attempt to insure that maps are properly initialized before digitizing, and make it easier to recover from erroneous initialization. A control file is used to preserve the digitizing environment from one session to the next, and a menu-type selection feature makes it less intimidating to a user. Limited experience with the new program has shown it to be much easier to use than the older version.

Development has begun on a new plotting program for producing computer-generated maps. It is envisioned that the program will use an overlay approach, where a library of prepared "overlays" is available and the user may compose a map by combining existing overlays such as state and county borders, rivers, highways, etc., with specially-digitized data or data selected from the GEO retrieval system. Some of the overlays are already being developed.

Online Resource-Data Retrieval System

GEO is a computer program developed two years ago at IGS that displays or

prints selected geologic records. In the past year it was substantially re-done to enable handling of water-quality records, as well. There are currently around 11,000 water-quality records in GEO. During the upcoming year, GEO will again be modified to handle groundwater-site records that are being prepared in conjunction with the Municipal Supply Inventory project of the Water Resources Division. Other refinements include new selection criteria, such as by town name, or "W number" (IGS sample identification number), or along a corridor, improvements in the format of displayed water-quality data, and initiation of a data-entry project to bring the water-quality and site records up-to-date.

Cross-Section Program

This computer program stands out because it establishes a completely new tool for use in geologic studies at IGS. Using stratigraphic records selected in GEO, one may enter the cross-section program and have an annotated cross-section diagram produced on the plotter with a map of the site locations (see accompanying figure). The base map is automatically drawn at the largest scale that will fit on an 8 1/2 x 11" sheet. The scale of the cross-section diagram may be specified, but if it is not, it is scaled to a 9 x 10 inch area. A title block is produced and axes are labelled. Lithologies of the stratigraphic units are represented by about 15 graphic patterns conventionally used in geologic displays. The sea-level datum, land-surface datum, and unit contacts are linked by lines drawn between the depicted sites. System, series, group, formation, and member labels are provided, as are labels identifying the location and sample identification number.

Miscellaneous Data-Processing Projects

In the area of digitizing and data entry, the most substantial single

project has been the digitizing of the State's township corners. This township file will be useful as a locational reference in map overlays and it will be used by a program for converting between latitude-longitude and Land Office Coordinates. Earlier in the year, a pilot road-digitizing project was performed, to estimate the cost, time requirements, and accuracy of a state-wide road-network file, based on the Iowa Department of Transportation county road map series. A variety of digitizing, locating, and data entry services were performed in connection with the Big Spring study, soils studies, IGS mailing label lists, equipment inventory, etc. Other responsibilities shouldered by our staff have included the compilation of data-file documentation for the karst area study and the water-quality file; regular transfer of data files among the U.S. Geological Survey, the Department of Water, Air and Waste Management, and the University Hygienic Laboratory; retrieval of data files, e.g., the U.S.G.S. Groundwater Site Inventory, for use in compiling the Municipal Supply Inventory in cooperation with the IGS Water Resources Division and DWAWM; and by no means the least of these chores, the maintenance of files and reference manuals for the many computer systems and files that are used at IGS.

Data-processing staff are frequently asked to write small, special purpose programs in connection with particular applications. Those listed below represent the types and variety of such requests:

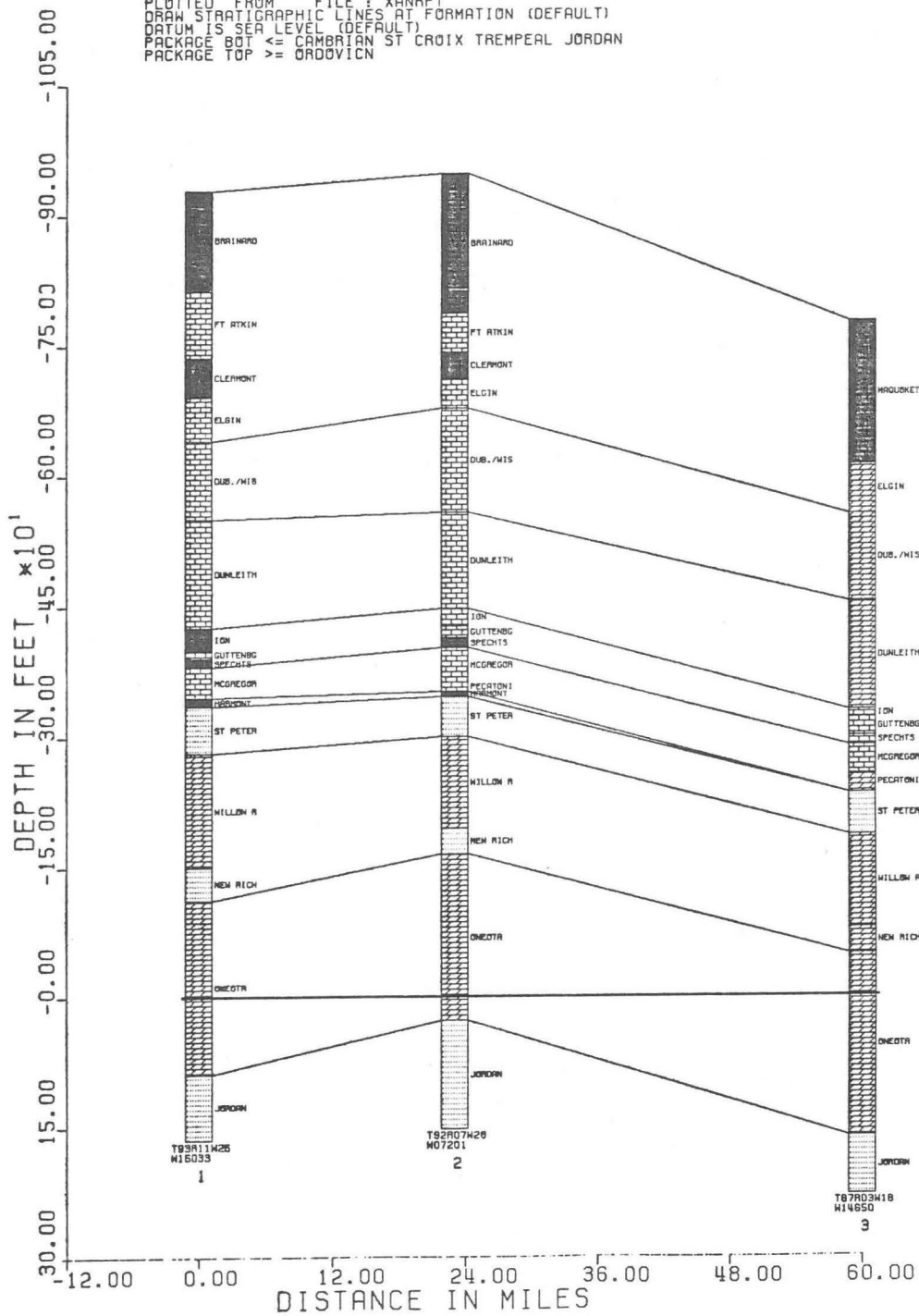
EDDIG is a program to combine and edit digitized data elements. It is used to assemble many files into a set of base maps for plotting or screen display.

PLANIM measures the perimeter and/or calculates the area of a polygonal map area.

SIZDIST produces a plot of relative soil particle-size distribution

A.

PLOTTED FROM FILE : XANAPT
 DRAW STRATIGRAPHIC LINES AT FORMATION (DEFAULT)
 DATUM IS SEA LEVEL (DEFAULT)
 PACKAGE BOT <= CAMBRIAN ST CROIX TREMPEAL JORDAN
 PACKAGE TOP >= ORDOVICIAN



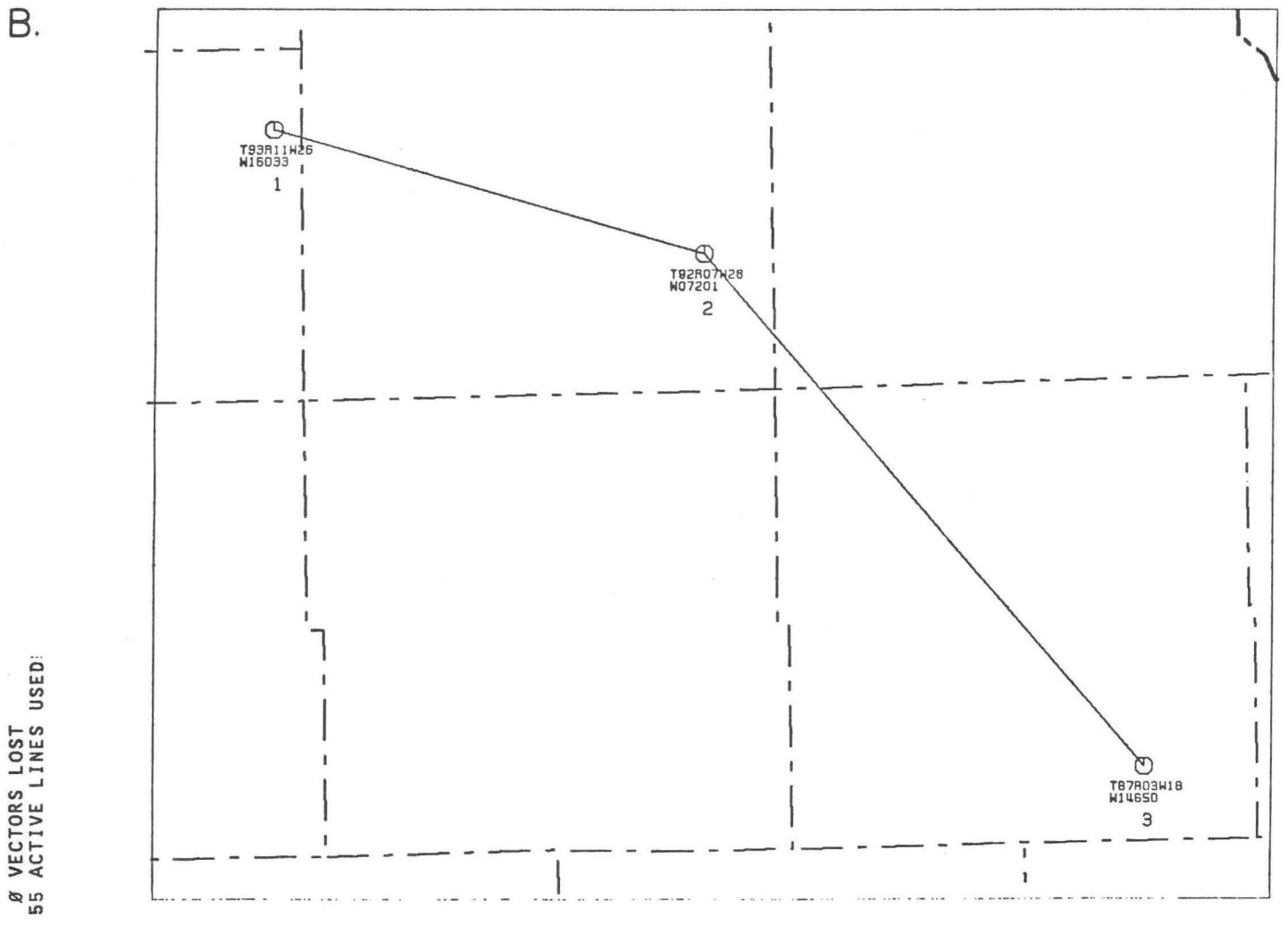


FIGURE 5. Computer-generated stratigraphic cross section (A) and map (B) trend of the cross section.

against depth of the sample. It is being used in the study and classification of soils.

BSPLIT generates a color graph on the Comtal image monitor that shows changes in water quality over a specified time period. Several selected parameters may be shown on the graph at one time, and the quality of the graphic display makes it suitable for photographing and making color slides.

As the equipment and software resources at IGS have mushroomed, so has the amount of training and system management overhead. We are pleased that the operation of our system has been accommodated as shared additional responsibilities by all our staff. There were no major equipment or software failures this past year, and the system has been available for use at all times, except when receiving factory preventive maintenance.

GRAPHIC DESIGN

Since August 1983, we have again had our Graphic Design program back to full strength with two artists. After a year at one-half strength, IGS is again enjoying full graphic support. This has allowed us to begin art work on some major projects, such as the North-Central Water Atlas, as well as meet more pressing and incidental staff needs.

REMOTE SENSING

Thematic Mapper

The Thematic Mapper is an experimental imaging system on the Landsat 4 satellite. It has different spectral characteristics than the earlier Multi-spectral Scanner System (MSS) and much higher ground resolution. The system has failed, but while it was functioning, several images over Iowa were obtained. We have obtained one image over north-central Iowa (September 3,

1982) and conducted some preliminary assessment of its quality and utility.

The differences are striking; the utility potential much greater. Field boundaries appear sharp; roads are straight; urban landuses are much more easily differentiated; small patches of forest are readily apparent. Many limitations of the earlier MSS system were related to resolution. Most landuse assessment could be done using the improved resolution of the Thematic Mapper.

Unfortunately, the greatly-improved potentials of such a system are not widely known and are not likely to be known. A second Thematic Mapper is to be launched in March 1984, but funding to investigate its use is low. Further, political and economic factors have made future United States involvement in continued space ventures unlikely. This is unfortunate because the widespread optimism which preceded use of the earlier MSS system could probably be met with the newer Thematic Mapper system.

Basic Seismic Reflection Processing

Software was developed to conduct basic processing of seismic-reflection data on our Perkin-Elmer computer using data in various formats. The package will reformat data, display field records or processed data, perform velocity analysis, filter, stack, and perform deconvolution. It is expected that such basic processing will complement the refraction processing currently being conducted on a microcomputer system for the alluvial aquifer study in northwest Iowa.

Big Spring Study

The first evaluation of land-management modelling with erosion and groundwater quality has been completed. Perhaps the most significant finding is that under current management, a considerable percentage of nitrogen applied to row crops is being lost to the groundwater in areas where the aquifer

is not naturally protected. Results have been published, and considerable interest has been generated among agricultural interests in the conclusions. Significantly, the results have generated discussions on the land-management practices which impact our water resources, and serious attempts are being made to develop information and programs which can lessen the adverse effects on these resources.

As a part of this continuing research, black and white aerial photos from 1970 were interpreted to give us a better historical record of land management, and 35 mm photography from 1983 was acquired to establish a record of current management, especially the effects of the Payment in Kind (PIK) program, which so strongly affected agriculture in 1983 and will have a major impact on it again in 1984.

Landscape Modelling

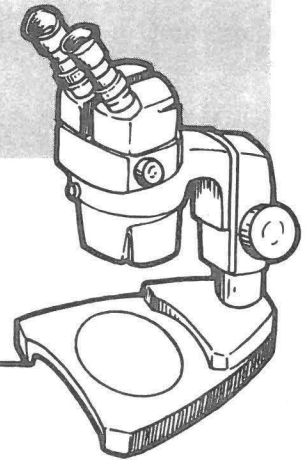
Investigations of late Quaternary deposits in northeast Iowa continued as a part of understanding the karst environment in Northeast Iowa. Emphasis has been placed on dating alluvium in Robert's Creek and the Turkey River. Also, drilling transects in the uplands have been conducted to relate to the alluvium and to understand the infiltration characteristics in the Big Spring area.

Michael's Creek

An alluvial fan was investigated for the DOT as part of the mitigation process of archaeological sites caused by construction of the Great River Road in Louisa County. Located where Michael's Creek empties onto the Mississippi River alluvium, the deposits were found to be young, probably less than 3000 years old. Deposits in such positions were previously believed to be considerably older, and therefore, could have contained much older archaeological

materials. However, local meandering in the Mississippi River and, perhaps, a very incomplete understanding of our Iowa landforms, account for the differences and underscore the need for on-site investigations.

Stratigraphy and Economic Geology



The Stratigraphy and Economic Geology (STRECOG) Division staff investigate earth materials that range 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 an 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

STRATIGRAPHIC AND STRUCTURAL STUDIES

I. Progress on the Iowa Stratigraphic Review (Strat. Study) in 1983

The STRECOG review of the rock stratigraphy of Iowa, the "Strat Study" has not progressed as quickly as anticipated. In 1983, the project fell victim to a number of higher-priority projects, and yet, sub-

stantial progress was realized.

A. *Precambrian Study*

The study of the Precambrian geological history of Iowa is progressing well. Much of the work on the Early Proterozoic history has been completed with interpretations presented for peer review at 1983 meetings of the North Central and National Geological Society of America. These interpretations include a sequence of glacial and related sediments deposited about 2300 MA (million years ago), rifting and ocean development about 1900 MA, continental collision and suturing about 1850 MA, emplacement of intrusive and extrusive rocks between about 1810 and 1760 MA, and finally another episode of rifting with emplacement of Raraboo Interval quartzarenites about 1750 MA, metamorphosed by a plate collision about 1630 MA.

Initial work on the Upper Proterozoic began in 1983. One of the most difficult problems with interpreting rocks of this age in Iowa is understanding the thick Keweenawan sedimentary sequence. Last year we began the process of examining the petrography and clay mineralogy of the clastic rocks of the Keweenawan--Cambrian Mt. Simon transition interval. Samples are derived from cuttings recovered from a few deep wells in Iowa.

Work on the Early Proterozoic will continue, with emphasis shifting to the Middle and Upper Proterozoic early in 1984 and then the Archean history of Iowa by the summer of 1984. Work should be completed by the end of that year.

B. *Cambrian Study*

The stratigraphy, paleontology, sedimentology, and petrology

of Cambrian strata in the Dallas County area is 25 percent written. Over 500 feet of additional Cambrian core from northwest, north-central, and central Iowa has been slabbed and prepared for further description and synthesis into Cambrian core data file. The final report on the Cambrian of Iowa will be completed sometime in 1984.

C. *Ordovician and Silurian Study*

Studies of the Ordovician and Silurian Systems in Iowa have progressed considerably during 1983. Continuing studies of the Middle and Upper Ordovician sequence in the Iowa subsurface and outcrop belt have resulted in a series of stratigraphic cross-sections and lithofacies/isopach, and isolith maps presently on open file at IGS. These include maps of Glenwood-Starved Rock, Decorah, Dunleith, Wise Lake, Dubuque, and Maquoketa relationships in the Iowa subsurface. Silurian studies have neared completion, and field work in 1983 focused on completing studies on the Waucoma Limestone of northeast Iowa. The final report on the Silurian stratigraphy of Iowa will be prepared for publication in 1984. Much of the work on the Ordovician stratigraphy will also be completed in 1984, with publication anticipated in early 1985.

D. *Devonian Study*

A summary describing the Middle Devonian stratigraphic relationships in east-central Iowa is included in the Plum River Fault Zone report. Stratigraphic relationships of these Middle Devonian rocks are becoming increasingly well understood with recognition of a new Devonian framework for northern Iowa. The sub-Devonian unconformity is extremely important in interpreting these relationships, in particular, the existence of a buried Silurian escarpment

across northern Iowa, where isolated Middle Devonian rocks have been identified. These important stratigraphic relationships may potentially define a unique hydrologic system in north-central Iowa, a possibility currently under investigation in the Floyd-Mitchell Karst Study. (See Geological Studies Division, this report).

Upper Devonian stratigraphic problems are still unresolved, however, work is progressing. Several theses projects at the State Universities are expected to provide information that will lead to a better understanding of this particular stratigraphic section.

E. *Mississippian Study*

Formal study of Mississippian stratigraphy in Iowa has not yet been initiated. STRECOG personnel, however, have been assisting in the supervision of a number of student theses on Mississippian rocks in Iowa by University of Iowa students. Formal work on this system may begin in 1984.

F. *Pennsylvanian System*

A large stride towards completion of our Pennsylvanian study was taken late in 1983 with the completion of a manuscript on the "Stratigraphic subdivision of the Cherokee Group and proposed revision of Pennsylvanian stratigraphic nomenclature in Iowa." This manuscript is one of four papers on Pennsylvanian rocks in Iowa being prepared for publication in early 1984. The others include "Palynostratigraphy of the Lower and Middle Pennsylvanian coals of Iowa," "Conodont distribution, paleoecology, and preliminary biostratigraphy of the Upper Cherokee and Marmaton Groups (Upper Desmoinesian, Middle Pennsylvanian) in south central Iowa," and "Ele-

ment geochemistry of the Cherokee Group coals (Middle Pennsylvanian) from south central and southeastern Iowa."

STRECOG has also assisted in the supervision of several thesis projects on Pennsylvanian rocks of Iowa. Work on the Pennsylvanian of Iowa will continue in 1984.

G. *Cretaceous Study*

Cretaceous stratigraphic studies have advanced considerably, especially with publication of the Cretaceous paleogeography paper cited later. Study of Cretaceous outliers and paleontology in north-central Iowa continues. Preparation of a final report summarizing the Cretaceous stratigraphy of Iowa will begin in 1984. Additional information on the Cretaceous stratigraphy within the Manson Anomaly would be critical to this synthesis, although additional core drilling would be necessary.

H. *Jurassic Study*

Work on the Jurassic of Iowa has not yet been started. Initial investigations may begin late in 1984.

II. STRECOG Publications in Progress

A. *High Calcium Limestone Resources of Iowa*

The work of compiling chemical analyses and core and outcrop stratigraphic information is now being shifted to the IGS computer system. An interactive computer program is being designed which will integrate existing stratigraphic data files with chemical analyses of carbonate rocks.

B. *Element Geochemistry of Cherokee Group Coals (Middle Pennsylvanian) from South-Central and Southeastern Iowa*

C. *Palynostratigraphy of the Lower and Middle Pennsylvanian Coals of Iowa*

This report will be an extremely valuable research tool and should encourage additional research on the Pennsylvanian section of Iowa.

- D. *Stratigraphic Subdivision of the Cherokee Group and Proposed Revision of Pennsylvanian Stratigraphic nomenclature in Iowa*
- E. *Conodont Distribution, Paleoecology, and Preliminary Biostratigraphy of the Upper Cherokee and Marmaton Group (Upper Desmoinesian, Middle Pennsylvanian) From Two Cores in South-Central Iowa*

This report will provide marine biostratigraphic control which will complement the terrestrial biostratigraphic control provided by the Palynostratigraphy report cited as C above.

- F. *Lower and Middle Paleozoic Source Rocks in Iowa, and the Occurrence of Oil in Southeast Iowa*

This is an investigation of petroleum source rocks in Iowa, their stratigraphic position, and geographic extent. The occurrence of oil at Keota (Washington County) will be evaluated in terms of stratigraphic and structural controls. A final report will be prepared in 1984.

- G. *Hydrocarbon Potential in Iowa*

This report will discuss the oil potential of the state, traps, source rocks, and include structure contour and isopach maps as well as source-rock analyses.

- H. *Precambrian Wells of Iowa*

This will provide a list of wells drilled to the Precambrian of Iowa.

- I. *Hydrology of Carbonate Aquifers in Southwestern Linn County, Iowa, and Vicinity*

This report defines and describes the occurrence of groundwater, its availability, quality, and flow-regime in a glaciated carbonate terrane in east-central Iowa.

J. *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.

K. *Decade of North American Geology (DNAG)*

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 syntheses. The Iowa Geological Survey was invited to serve as chapter organizer for the central midcontinent region, which will be part of the volume entitled *Sedimentary Cover--North American Craton: U.S.* During the spring of 1983, a manuscript was prepared, including 12 maps and 3 cross sections. The manuscript is now under extensive review, both by our own outside reviewers and IGS personnel, and by the volume editors and their selected reviewers.

L. *Deposition and Stratigraphy of the Upper Maquoketa Sequence (Upper Ordovician) in Iowa*

This report will primarily deal with the Brainard and Neda Members of the Maquoketa Shale.

M. *Devonian Stratigraphy of North-Central Iowa*

This report is being prepared to provide a geologic framework for the north-central Iowa Karst study which is being conducted by the Geological Studies Division.

N. *Ordovician Conodont Biostratigraphy in Iowa*

This study was undertaken to establish a biostratigraphic framework for completion of the Ordovician phase of the Strat. Study. This study will be organized during 1984.

O. *Ordovician Camerate Crinoids of Iowa*

P. *The Washington County Quartzite, A Probable "Baraboo Interval" (Proterozoic) Quartzite in Southeast Iowa*

Q. *Oil and Gas Wells in Iowa*

The list of oil and gas wells is being revised, updated, and entered into the IGS computer.

R. *Guidebook, A Walking Field Trip to the Geology of Iowa City*

STRECOG is presently in the process of preparing a guidebook for a walking field trip to observe the geology in the area of the University of Iowa campus.

S. *Undermining in the What Cheer Area*

A paper describing undermining at What Cheer has been 90% complete for some time. The Department of Soil Conservation (DSC) has expressed an interest in funding the publication of this report.

T. *Undermining in Ottumwa, Oscaloosa, and Centerville/Mystic*

The DSC has also expressed an interest in IGS production of reports on undermining in the Ottumwa, Oscaloosa, and Centerville/Mystic areas.

III. Miscellaneous Projects

A. *Oil and Gas Exploration in Iowa*

Interest in oil and gas exploration in Iowa this past year has been rapidly increasing, although only one new test well (Crawford County) has been drilled. Increased activity and development in

west-central Illinois has sparked interest by several independent operators in southeastern Iowa's potential. Research activities by STRECOG personnel have indicated two potential reservoir horizons, the uppermost of which is the target horizon (Hoing Sandstone) of west-central Illinois. An understanding of the pre-Devonian unconformity and the regional overstep of this surface by the on-lapping Wapsipinicon and Cedar Valley Formations, combined with source rock bounding these units above (Upper Devonian black shales) and below (Elgin organic brown shales and carbonates), provides for potential stratigraphic traps across the region. Structural trends (NW-SE oriented) have cross-folded these stratigraphic traps, adding to the increased likelihood of at least small traps of oil in southeastern Iowa. The lower potential horizon is exhibited in the Keota Dome (Washington County) area where the stratigraphic-structural entrapment occurs along the northern pinchout edge of the Starved Rock Sandstone. Geochemical studies, by USGS personnel in Denver, have shown that brown shales contained within the Glenwood Shale immediately underlying the Starved Rock is the source for the oil present at Keota. Brown shales in the Glenwood Shale are noted occurring in southeastern Iowa, and appear closely related to the distribution of the Starved Rock sands. Organic brown shales are also found occurring in the overlying Decorah Formation, and asphaltic residues are noted in void fills in the Wise Lake Member of the Galena Group.

The other area of potential exploration interest is located in central and western Iowa, and involves the Midcontinent Geophysical Anomaly (MGA), which stretches across Iowa from the southwest to

the north-central part of the state. Source rocks along the extent of the MGA have been noted occurring in the Upper Peninsula of Michigan and in a core hole along the central axis of the MGA in south-central Minnesota. Current exploration activity in southwestern and central Iowa included leasing of large acreages across the central area of the MGA, and the acquisition of over 300 miles of vibro-seis seismic data by two companies in the summer of 1983. Both companies have verbally agreed to provide IGS with the seismic data (and probably interpretations) at a later date, and have indicated intentions to drill test wells in 1984. A third company has also expressed a strong interest in exploring for the Precambrian resource, and we are optimistic that several deep Precambrian test wells will be drilled in 1984, including one or more to depths in excess of 5300 feet, the present deepest well in Iowa.

B. *IGS Core Inventory*

Inventory of the 100,000 or so feet of core that is repositied at the Oakdale Facility has begun. Reboxing and sorting of core material is approximately 95% complete. Cross checking of records to core in hand is approximately 30 to 50% complete. Inventory listing and organizing will be computerized in 1984. An inventory of the geologic intervals represented in the cores is progressing. The overall inventory then will allow a cross-checking system by name, county, legal location, and geologic (stratigraphic) intervals represented. The system will then be incorporated into the present geologic data base.

C. *Karst Research*

Research is continuing on the Fayette County Karst; the de-

velopment of the Big Spring conduit system; the hydrology, geology, and development of Cold Water Cave; and structural controls and developmental history of the Silurian karst of east-central Iowa.

IV. STRECOG Cooperative Research Projects

A. *IGS Intradivisional Cooperative Work*

Close cooperation with other IGS divisions involved a variety of topics of mutual concern. Stratigraphic input to personnel of the Water Resources Division occurred on a regular basis. Cooperation with IGS computer programmers concerning computer-generated stratigraphic cross sections is providing exciting opportunities for rapidly identifying stratigraphic problems and relationships. Division staff has been involved on a regular basis with the karst geohydrology project, providing stratigraphic information and reports of use in the project synthesis. In addition, editorial review of in-house manuscripts were undertaken on an irregular basis.

B. *Cooperative Work With Other States*

1. Forest City Basin maps

The Forest City Basin is a large structural basin that underlies southwestern Iowa, southeastern Nebraska, western Missouri, and eastern Kansas. A series of six maps of that basin, produced late in 1982 and early in 1983, were published in 1983. The series, produced in cooperation with the Geological Surveys of the named states, included maps of magnetic anomalies, gravity anomalies, Precambrian structure, structure on the base of the Kansas City Group, lineaments, deep wells, oil and gas fields, and mineral resources of the Forest City Basin

and adjacent areas. Additional maps will probably be produced in 1984.

2. Decade of North American Geology (DNAG)

Participation of the Iowa Geological Survey in DNAG has allowed for interaction with a variety of the state geological surveys, U.S. Geological Survey, and private individuals to gather together the data needed to compile a synthesis of the geological history of the central midcontinent region. Staff of the Kansas Geological Survey were included in the overall synthesis, which permitted a short meeting here of respective staffs to discuss and, in part, resolve some mutual problems in regional stratigraphic relationships. This meeting should allow for other longer-term studies of mutual concern regarding geologic, hydrologic, and economic interest. For more information on DNAG, see a discussion of the study in the section on STRECOG publications in this report.

3. Radiogenic Age Dating of Precambrian Rocks

STRECOG staff has been working with the University of Kansas to attempt to obtain U/Pb age dates of Precambrian rocks in Iowa. None of the three samples tested in 1983 (Manson Gneiss, Manson Granite, or Spencer Granite) yielded sufficient volumes of zircons to obtain a date, but the Spencer Granite shows promise, and more samples will be tested in 1984.

The IGS and University of Kansas also reached agreement on a cooperative project to reoccupy the IGS Camp Ovest test hole (Le Mars, Plymouth County) and obtain an additional 100 feet of Camp Ovest Gneiss. Initial dating of this unit yielded an age

of 2065 million years, an anomalous date for the midcontinent, which raised many questions of its origin. The core will be obtained early in 1984.

C. *Cooperative Work With Federal Agencies*

1. Trace Elements Paper

STRECOG helped to coordinate production of a paper on Trace Elements in Iowa coal. The paper will be published early in 1984.

2. Oil Genesis and Source Rock-Study

Cooperative work with the USGS is underway in an effort to define the petroleum source rocks in Iowa. This timely study will provide critical information of interest for petroleum exploration in the state. During 1983, Ordovician source rocks were defined and analyzed, and compared with known liquid petroleum samples from Iowa and adjacent areas of the Midcontinent. The stratigraphic and structural context of oil occurrences in the Keota Dome area (Washington County, Iowa) are currently being investigated. A joint paper will be prepared in 1984 summarizing the results of this study.

V. Information Requests

A. *Approximately 650 information requests were answered in 1983.*

1. Fifty-nine oil and gas information requests
2. Fifty-two mineral-resources information requests
3. Approximately 60 requests for information from well drillers
4. Thirty-eight identifications of rocks, minerals, or fossils brought into our office by citizens

5. The remaining requests included well forecasts, bedrock-geology predictions, depth to bedrock, latitude and longitude identifications, bench-mark information, and topographic map questions.

B. *Miscellaneous Projects in Response to Requests*

1. Karst at the Columbus City Limestone Mine

Late in 1983 STRECOG became involved in an investigation of extensive Pennsylvanian karst fills within the mine. These fills include rock which is not useable and, in addition, present safety problems during mining activity. Work on this project is being done by request of the management of the River Products Company, Iowa City.

VI. Well Cuttings Studied, Core Logged, and Outcrops Measured

A. *Well Cuttings*

1. Total cuttings studied--29,594 ft. (172 wells)
 - a. West Central Study wells--10,140 ft. (97 wells)
 - b. Des Moines River Aquifer Study wells--3,610 ft. (30 wells)
 - c. Private wells--4,779 ft. (18 wells)
 - d. Deep city wells--6,435 ft. (4 wells)
 - e. Shallow city wells--430 ft. (1 well)
 - f. Stratigraphic study--4,200 ft. (22 wells)
 - g. Cuttings studied in last 5 years

1983--29,594 ft. (172 wells)
1982--55,012 ft. (248 wells)*
1981--26,000 ft. (65 wells)
1980--20,470 ft. (38 wells)**
1979--35,000 ft. (60 wells)

*included work by part-time logger

**tops picked for 41 additional wells (9100 ft.)

2. Total cuttings received--56,463 ft. (309 wells)

- a. IGS wells--12,009 ft. (126 wells)
- b. Municipal and private wells--44,454 ft. (193 wells)
- c. Cuttings received in last 5 years
 - 1983--56,463 ft.
 - 1982--51,900 ft.
 - 1981--71,769 ft.
 - 1980--99,866 ft.
 - 1979--66,875 ft.

3. Wells yet to be studied (estimated) for last 5 years

- 1983--1,712,000 ft. (8560 wells)
- 1982--1,682,000 ft. (8410 wells)
- 1981--1,685,000 ft. (8426 wells)
- 1980--1,639,400 ft. (8200 wells)
- 1979--1,560,000 ft. (7800 wells)

4. Remarks

Because of the demands placed on the time of STRECOG personnel in 1983, the total footage of cuttings studied was somewhat less than anticipated.

B. *Core Logging*

- 1. Total Core Studied--1000 ft. (parts of 6 cores)
- 2. Core studied in last 5 years
 - 1983--1000 ft. (6 cores)
 - 1982--7803 ft. (18 cores)
 - 1981--1600 ft.
 - 1980--2000 ft.
 - 1979--4000 ft.

- 3. Core yet unstudied--83,600 ft. of an estimated total 100,000 ft.

4. Remarks

Core logging in 1983 was reduced by a number of higher priority projects.

C. *Outcrop Studies*

- 1. Outcrops studied in detail and drafted--812 ft. (23 sections)
 - a. Paleozoic sections from NE and NC Iowa

2. Outcrops with cursory descriptions--1000 ft. (25 sections)

D. *Thin Sections Produced for Studies*

1. By STRECOG personnel--30 sections

2. By graduate students:

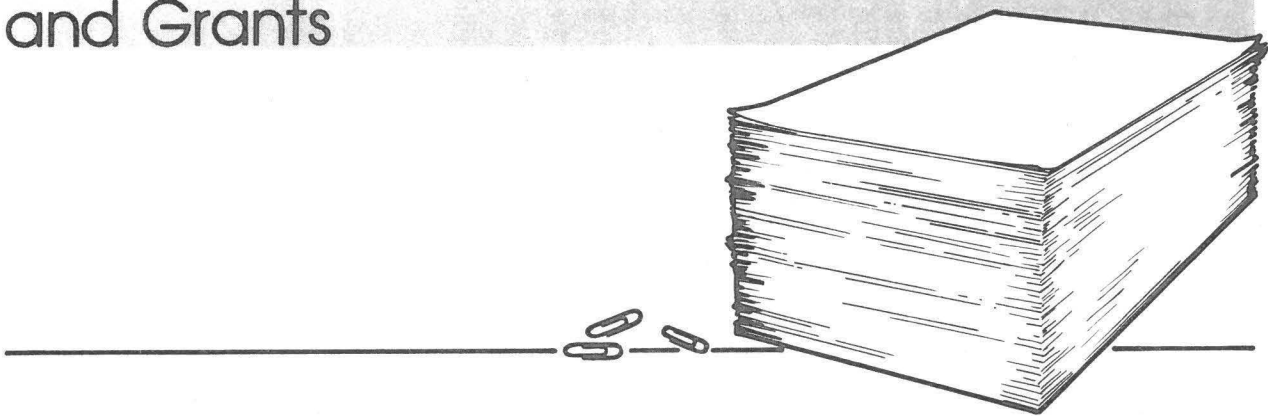
a. Matlock cores--256 sections

VII. STRECOG Supervision of Geology Studies in Iowa

A. *Cooperative Education--Geology Interns*

This new program provides academic credit to senior undergraduate geology students with high grade points for conducting a geologic research project. STRECOG has been supervising the first two students to participate in this program.

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

National Coal Resources Data System

The National Coal Resources Data System (NCRDS) is a program funded by the U.S. Geological Survey. Its purpose is to compile, format, and transmit coal data to NCRDS. The data will be used to evaluate coal resources in Iowa and will be added to a nation-wide coal-resources data base.

The portion of Iowa which is underlain by potentially coal-bearing strata was divided into five groups of counties. Area I, which was completed in the 1982-1983 fiscal year, includes Wapello, Jefferson, Davis, Van Buren, Appa-

noose, Keokuk, Washington, Lee, Henry, Scott, and Muscatine counties. Compilation of geologic data, including water-well logs, and mine and outcrop data was completed for these areas. Coal-mine locations and mined-out areas were determined where possible for all counties. All information was plotted on 7.5 minute topographic quadrangle maps and outcrop lines and overburden thickness contours added. Outlines of areas of mined-out coal were plotted where such information was available; otherwise locations were plotted as accurately as information permitted.

A total of 80 point-location maps and 106 outcrop/mine maps were prepared and submitted to NCRDS. In addition, all previously submitted data was proof-read and returned to NCRDS for corrections in the computer files.

Activities for the coming year include compilation of geologic and mine data for Area II which includes Monroe, Marion, Jasper, Mahaska, Lucas, Wayne, Clarke, Decatur, and Poweshiek counties. Point-location maps and mine/outcrop maps will be prepared as for Area I. Data for counties to the west and northwest will be compiled in subsequent years.

Alluvial Aquifer Study

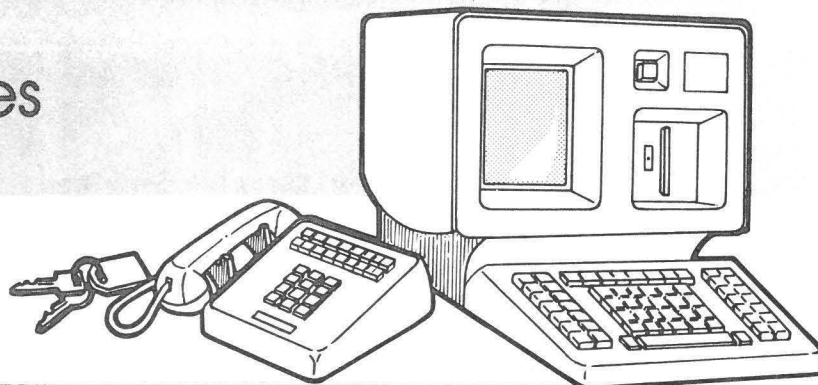
During the summer of 1982 IGS began a study to determine the geologic and hydrologic parameters of the alluvial aquifers of northwestern Iowa. Those aquifers are a major source of groundwater, but because they are generally relatively shallow they are subject to contamination. To assess the nature and extent of alluvial aquifer contamination, IGS sought and received funding from the U.S. Environmental Protection Agency (EPA) to support water-quality analyses. The EPA funding will permit us to examine not only the extent of nitrate contamination, which has been recognized as a problem in some areas, but also to investigate possible pesticide contamination. For a more complete discussion of this project see the Water Resources Division section of this

report.

Big Spring Basin Study

A detailed discussion of this study is included in the report of the Geological Studies Division. Funding for the study came from the Iowa Department of Water, Air and Waste Management and the U.S. Department of Agriculture Soil Conservation Service. The study was unique in that it permitted the quantifying of the relationships of land-management practices and the amount of agricultural chemicals reaching the groundwater system within the study area.

Administrative and Support Services Group



A wide variety of assistance to all divisions of the Survey is provided by the Administrative and Support Services Group. The areas of support include personnel functions, all phases of budgeting, purchasing, clerical assistance, and services from the Oakdale facilities.

Coordination with the Merit Employment Department involving IGS personnel is handled by the Administrative Officer, as well as coordination and cooperation with our Budget Analyst on matters of budgeting and expenditures.

During calendar year 1983, approximately 60% of all IGS employees participated in the State's Comparable Worth Study. The results of this study are to be published in February or March of 1984.

Personnel for the Survey grew from 35.5 FTEs to 39.5 FTEs on July 1, 1983. New positions for a Hydrogeologist 2, two Computer Programmers, and a Data Entry Operator 2 were approved through legislation.

For two of the positions, Sue Vossoughi and Pat Ring were moved to IGS State-appropriated funds. The second computer-programming position was filled by Nancy Jensen, and D. Roger Bruner was hired to fill the Geologist position.

Other new faces for 1983 are John Schmidt, Computer Programmer, and Kay

Irelan, Graphic Artist, filling vacant positions.

Arletta L. Orelup, Chief

Administrative Services

The Administrative Services staff has the responsibility of providing clerical support for all members of the Survey. This support covers a large number of duties including correspondence, telephone communications, daily mail handling as well as bulk mailings of publications, sale of publications and maps to the general public, the continuous processing of reports and manuscripts for publications, and the task of keeping office supplies on hand as needed.

Accounting

The past year has been one of many changes for the Iowa Geological Survey's Accounting section. On July 1, 1983, the State of Iowa, after many months of planning, implemented a new state-wide accounting system, based on generally accepted accounting principles. After the initial confusion settled, the new forms adapted, and the many changes incorporated into the Survey's financial operation, we realized that we now have capabilities for doing much more with our accounting system than we were able in the past. We are now looking forward to the acquisition of a computer terminal early in 1984 to put us directly "on line" to the Comptroller's Office in Des Moines. It is hoped that with this terminal we will have better access to our financial records in a shorter space of time.

Support Services

The Oakdale facility took on a new look during 1983 with the construction

of new shelving along with the repackaging and reshelving of drill cuttings and core samples held in the sample library. The shelving improvements will continue during 1984, providing increased shelving, better accessibility, and inventory controls.

Support Services also maintains contact with and collects soil samples from state well drillers.

Storage and care of publications, maps, and field equipment, along with vehicle maintenance, is handled by Oakdale personnel.

MAPS AND PUBLICATIONS

Topographic Maps

The Iowa topographic map quadrangles are produced under a cooperative agreement between 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, 1983 is as follows:

<u>Number of 7 1/2 Minute Quadrangles</u>	<u>% of State Coverage</u>	<u>Availability</u>
1,019	94.1	Printed
49	4.5	Preliminary copies
15	1.4	Mapping in progress
TOTAL <u>1,083</u>	<u>100.0</u>	

Although complete State coverage by the 7 1/2 minute quadrangle series is at least 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. IGS has entered 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 complete county. 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 map product will be an extremely useful tool for most planners, state and county agencies. It is also expected to be a very popular map for the various county residents, as has been proven in those states which have the county topographic maps.

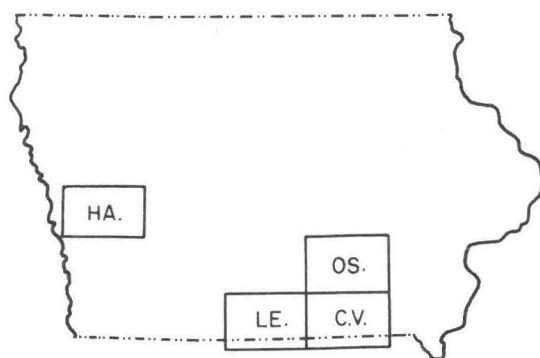
Maps of the following counties are now in preparation:

Woodbury	Bremer
Linn	Crawford
Black Hawk	Johnson
Webster	Pottawattamie
Wayne	Dubuque
Winneshiek	Story
Shelby	Allamakee
Iowa	Clayton

It is expected that maps of at least ten of the above-listed counties will be completed by June 30, 1984.

The U.S. Geological Survey Mid-Continent Mapping Center has completed a series of four maps in their new 1:100,000 scale, 30 x 60 minute metric topographic mapping program. Completed maps (and their abbreviations for the index map below and publication dates) are Harlan (HA, 1980), Leon (LE, 1981),

Centerville (CV, 1981), and Oskaloosa (OA, 1982), and display most of the same features as other U.S.G.S. topographic maps, but are contoured at a 20-meter interval. These maps are available only in a folded form (about the same size as a highway map) from the Iowa Geological Survey for \$3.50 each. No additional maps in this series are planned with the Iowa Geological Survey.



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. Although these publications are prepared in terms that are readily understood, they are as scientifically accurate as available data permit. Most 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. Not included in the

list is *Iowa Geology*, which is a compilation of articles of current popular geological interest, published annually by IGS. The publication has received an excellent response from both the public and geological communities. Copies are free upon request.

Geological Survey Publications

- Anderson, R. R., 1983a, Recent research on the Precambrian Geology of Iowa (abs.). Iowa Academy of Science proceedings, v. 90, No. 1, abs. 106.
- Anderson, R. R., 1983b, In search of Iowa oil, in *Iowa Geology*, No. 8, p. 10-11.
- Anderson, R. R., and Black, R. A., 1983, Early Proterozoic development of the southern Archean boundary of the Superior Province in the Lake Superior region (abs.). Abs. with Prog., 96th Ann. Meeting, Geol. Soc. of Am., Indianapolis, IN, v. 15, No. 6, p. 515.
- Anderson, R. R., and Ludvigson, G. A., 1983, A new Proterozoic quartzite--the Washington County Quartzite, SE Iowa (abs.). Abs. with Prog., 17th Session, North-Central G.S.A., Madison, WI, p. 209.
- Bouck, M. J., 1983a, Some factors influencing phreatic cave development in the Silurian strata of Iowa. Proc., Iowa Acad. Sci., v. 90, p. 19-25.
- Bouck, M. J., 1983b, Karstification on the Silurian Escarpment in Fayette County, northwestern Iowa. Guidebook 40, Geol. Soc. of Iowa, Fall Field Trip, 26 p.
- Bouck, M. J., 1983c, The status of research at Cold Water Cave (abs.). Iowa Acad. Sci., Proceedings, v. 90, No. 1, Abs. 104.
- Bouck, M. J., 1983d, Preliminary model of the Big Spring conduit system of Clayton County, Iowa (abs.). Iowa Acad. of Sci. Pro., v. 90, No. 1, abs. 108.
- Bouck, M. J., and Bettis, E. A., 1983, Karst development in northeast Iowa. Presented at symposium on the Driftless Area, 95th Session, Iowa Acad. of Sci., Luther College, Decorah, IA.
- Bunker, B. J., Klapper, G., and Witzke, B. J., 1983, New stratigraphic interpretations of the Middle Devonian rocks of Winneshiek and Fayette Counties, northeast Iowa. Guidebook 39, Geol. Soc. of Iowa, Spring Field Trip, 38 p.
- 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: Iowa Geol. Surv., Tech. Info. Ser., .100 p.

- Bunker, B. J., Witzke, B. J., and Ludvigson, G. A., 1983, Phanerozoic tectonism in the central midcontinent: historical aspects of spatially discordant structural patterns (abs.). Abs. with Prog., 96th Ann. Meeting, Geol. Soc. of Am., Indianapolis, IN, v. 15, No. 6, p. 536.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Bouguer gravity anomaly map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series, 1:500,000 scale.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Magnetic map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series 1:500,000 scale.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Precambrian configuration map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series: 1:500,000 scale.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Structure contour map on the base of the Kansas City Group (Pennsylvanian) of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series, 1:500,000 scale.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Deep well and oil-gas field location map of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series, 1:500,000 scale.
- Burchett, R. R., Wilson, F. W., Anderson, R. R., and Satterfield, I. R., 1983, Mineral resources of the Forest City Basin and adjacent regions of Iowa, Kansas, Missouri, and Nebraska. Iowa Geol. Surv., Forest City Basin Map Series, 1:500,000 scale.
- Glenister, B. F., and Witzke, B. J., 1983, Interpreting Earth history, Chapter 5 in Wilson, D., and Dolphin, W., (ed.), Did the Devil Make Darwin do it? Modern perspectives on the creation-evolution controversy. Iowa State Univ. Press, Ames, IA, p. 55-84.
- Hallberg, G. R., Hoyer, B. E., Libra, R. D., Bettis, E. A., III, Ressmeyer, G. G., 1983, Additional regional groundwater quality data from the karst-carbonate aquifers of northeast Iowa: Iowa Geol. Surv., Open-file Rept., 83-1, 16 p.
- Hallberg, G. R., Hoyer, B. E., Bettis, E. A., and Libra, R. D., 1983, Hydrogeology, water quality, and land management in the Big Spring basin, Clayton County, Iowa: Iowa Geol. Surv., Open-file Rept. 83-3, 191 p.
- Ludvigson, G. A., Bunker, B. J., and Witzke, B. J., 1983, Burial diagenetic origin for upper Mississippi Valley zinc-lead ores: a hypothesis. Abs. with Prog., Geol. Soc. Am., v. 15, No. 4, p. 219.

- McKay, R. M., 1983, Lithic equivalents of the Eau Claire Formation in central Iowa (abs.). Abs. with Prog., North-Central GSA, p. 31.
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- Witzke, B. J., 1983a, Fossils; evidence of ancient life in Iowa. *In* Iowa Geology, No. 8, p. 4-9.
- Witzke, B. J., 1983b, Ordovician Galena Group in Iowa subsurface, *in* Delgado, D. J., (ed.), Ordovician Galena Group of the Upper Mississippi Valley--Deposition, Diagenesis, and Paleoecology. Guidebook, 13th Ann. Field Conf., Soc. Econ. Paleon. and Mineral., Great Lakes Sect., Sept. 30-Oct. 2, p. D1-D26.
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- Witzke, B. J., and Heathcote, R. C., 1983, The distribution, composition, and deposition of the Upper Ordovician Neda Member in Iowa (abs.). Abs. with Prog., Geol. Soc. of Am., v. 15, No. 4, p. 222.
- Witzke, B. J., Ludvigson, G. A., Poppe, J. R., and Ravn, R. L., 1983, Cretaceous paleogeography along the eastern margin of the Western Interior Seaway, Iowa, southern Minnesota, and eastern Nebraska and South Dakota, *In* Reynolds, M. W, and Dolly, E. D., (ed.), Mesozoic Paleogeography of the West-Central United States. Rocky Mountain Paleogeography Symposium 2, Soc. Econ. Paleon. and Mineral., Rocky Mtn. Sec. Denver, CO, p. 225-252.

Extrinsic Publications

- Bunker, B. J., Witzke, B. J., and Ludvigson, G. A., 1983, Phanerozoic tectonism in the central midcontinent, U.S.A.: historical aspects of spatially discordant structural patterns: Geol. Soc. of Am., Abs. with Prog., v. 15, No. 6, p. 536.
- Hallberg, G. R., 1983, Problems in the interpretation of Pre-Wisconsinan paleosols: Geol. Soc. Am., Abs. with Prog., v. 15, No. 4, p. 212.
- Hallberg, George R., Bettis, E. Arthur, and Prior, Jean C., 1983, Northeast Iowa's paleozoic plateau: *Iowa Conservationist*, April-May, 1983, p. 3-6.
- Hallberg, George R., Bettis, E. Arthur III, and Prior, Jean C., 1983, Geologic overview of the paleozoic plateau region of northeast Iowa: Iowa Academy of Science Proceedings (in press).

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- Hallberg, G. R., Hoyer, B. E., Bettis, E. A., III, and Libra, R. D., 1983, Nitrates, pesticides, and water quality in a karst groundwater basin in Iowa: *Agron Abs.*, Am. Soc. Agron.--Soil Sci. Soc. Am. meetings, p. 33.
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- Hallberg, G. R., and Johnson, D. L., 1983, Geomorphic principles and soil geomorphology: *Agron. Abs.*, Am. Soc. Agron.--Soil Sci. Am. meetings, p. 188.
- Krothe, N. C., and Libra, R. D., 1983, Sulfur isotopes and hydrochemical variations in spring waters of southern Indiana, U.S.A. *in* W. Back and P. E. LaMoreaux (Guest-Editors), V.T. Stringfield Symposium--Processes in Karst Hydrology. *J. Hydrol.*, 61:267-283.
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- Ludvigson, G. A., Bunker, B. J., Witzke, B. J., and Garvin, P. L., 1983b, A burial diagenetic model for the emplacement of zinc-lead sulfide ores in the Upper Mississippi Valley, U.S.A.: *in* Proceedings Vol., Int. Conf. on Mississippi Valley Type Lead-Zinc Deposits, Kisvarsanyi, G., Grant, S. K., Pratt, W. P., and Koenig, J. W., eds., Univ. of Mo.-Rolla, p. 497-515.
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- Roosa, Dean M., Prior, Jean C., Smith, Daryl D., Knutson, Roger M., Henning, Dale, and Bettis, E. Arthur, 1983, Natural History of the Upper Iowa Valley between Decorah and New Albin: Iowa Natural History Association Field Trip Guidebook #1, 16 p.