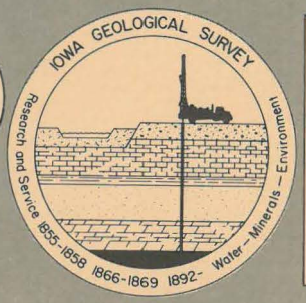
ANNUAL REPORTS



OF THE **STATE GEOLOGIST** TO THE **GOVERNOR**

Volume 51
1980 and 1981

STATE OF IOWA
IOWA GEOLOGICAL SURVEY
123 NORTH CAPITOL STREET
IOWA CITY, IOWA 52242
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Robert D. Ray
Governor of Iowa

Donald L. Koch
Director and State Geologist

Orville J Van Eck
Associate State Geologist

March 24, 1982

Governor Robert D. Ray
State Capitol Building
Des Moines, IA 50319

Dear Governor Ray:

Herewith is the Report of the State Geologist in accordance with the requirements of the Code of Iowa, Section 305.7 and Section 17.4. It describes the activities and accomplishments of the Iowa Geological Survey for the period of 1 January 1980 to 31 December 1981. The legal responsibilities of the Iowa Geological Survey (IGS) are set forth in the Iowa Code, Chapters 305 and 84.

For the Survey, the end of 1981 marks 90 years of continuous service and applied research. Throughout, I believe that the major natural resource issues of the times have been addressed, while building a stronger foundation for ensuing research.

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.

With cooperation and assistance from the Merit Employment Department we were successful in upgrading our Geologist Series positions. This will improve our ability to retain and recruit qualified staff to serve the State and its citizens.

Respectively submitted,

Donald L. Koch

Donald L. Koch
State Geologist and Director

DLK/lek

Enclosure

MEMORIAM

SUSAN J. LENKER

1957-1981

The Geological Survey suffered its first in-service fatality with the death of Susan Lenker on November 19, 1981 in a two-vehicle accident near Elkader, Clayton County. Ms. Lenker was a geologist engaged in obtaining data for a hydrologic study of Big Springs in Clayton County.

Ms. Lenker graduated from the University of Iowa in December 1978 with a Bachelor of Science in Geology. She was employed by the U.S. Geological Survey from April 1978 until October 1980 at which time she began working for IGS.

ANNUAL REPORT

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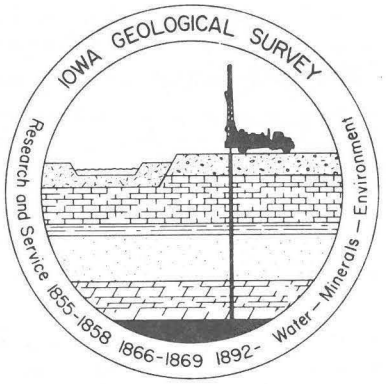

compiled by

ORVILLE J VAN ECK

ASSOCIATE STATE GEOLOGIST

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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 ground water. 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 Topographic 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 resources 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 in such a way as to permit us to perform an unbiased service for the enforcement and regulatory branches of government such as the Attorney General, the Department of Agriculture, the Iowa Natural Resources Council, Iowa Conservation Commission, Iowa Department of Health, Iowa Department of Environmental Quality, Mines and Minerals Division of the Department of Soil Conservation, and the Iowa Department of Transportation as well as 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 have 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	Iowa Citizens	Iowa State Map Advisory Council
Ground water (50/50 matching)	Iowa Department of Revenue	Iowa Conservation Education Council
Surface Water (50/50 matching)	Iowa Water Well Drillers	Department of Environmental Quality
U.S. Bureau of Mines	Local and Regional Planning Commissions	Inter-Agency Resources Council
U.S. Geological Survey	Iowa Counties and Municipalities	Department of Soil Conservation
Geologic Division	Iowa Commerce Commission	Land Rehabilitation Advisory Board
Topographic Division	Iowa Development Commission	Watershed Advisory Board
U.S. Department of Agriculture	Office for Planning and Programming	Conservancy District Task Board
	Iowa State Department of Health	U.S. Department of Agriculture
	Department of Environmental Quality	Conservancy District Coordinating Committee
	University Hygienic Laboratory	Energy Policy Council
	Iowa Department of Justice	Iowa Coal Utilization Advisory Committee
	Iowa Natural Resources Council	Legislative Environmental Advisory Group
	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	

Figure 1. Functional Relationships of the Iowa Geological Survey

TABLE OF ORGANIZATION

Figure 2 shows the current table of organization of the Geological Survey which reflects significant changes that occurred during the years 1980 and 1981. The 68th General Assembly passed legislation that abolished the Geological Board, effective December 31, 1980. Dr. Stanley Grant resigned as State Geologist in April, 1980; and Mr. Donald L. Koch, Assistant State Geologist, was appointed State Geologist in June, 1980. The 68th General Assembly declined to continue funding for the Coal Research Program of the Geological Survey, which resulted in abolishing the Coal Division at the close of the 1980 fiscal year.

The Governor's Economy Committee recommended two organizational revisions within the Geological Survey, 1) abolish the positions of the Associate and the Assistant State Geologist, and 2) merge the Coal Division with the Stratigraphy and Economic Geology Division. The denial of funding for the Coal Research Program effectively accomplished recommendation 2. With the appointment of Mr. Koch to State Geologist and the resultant vacancy in the position of Assistant State Geologist, a compromise was reached to satisfy the first recommendation whereby that vacant position was reallocated downward to a Geologist II position. That position was then assigned to the Water Resources Division. With those actions, the recommendations of the Governor's Economy Committee were satisfied.

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 operations. Their efforts maintain the esteem of the agency.

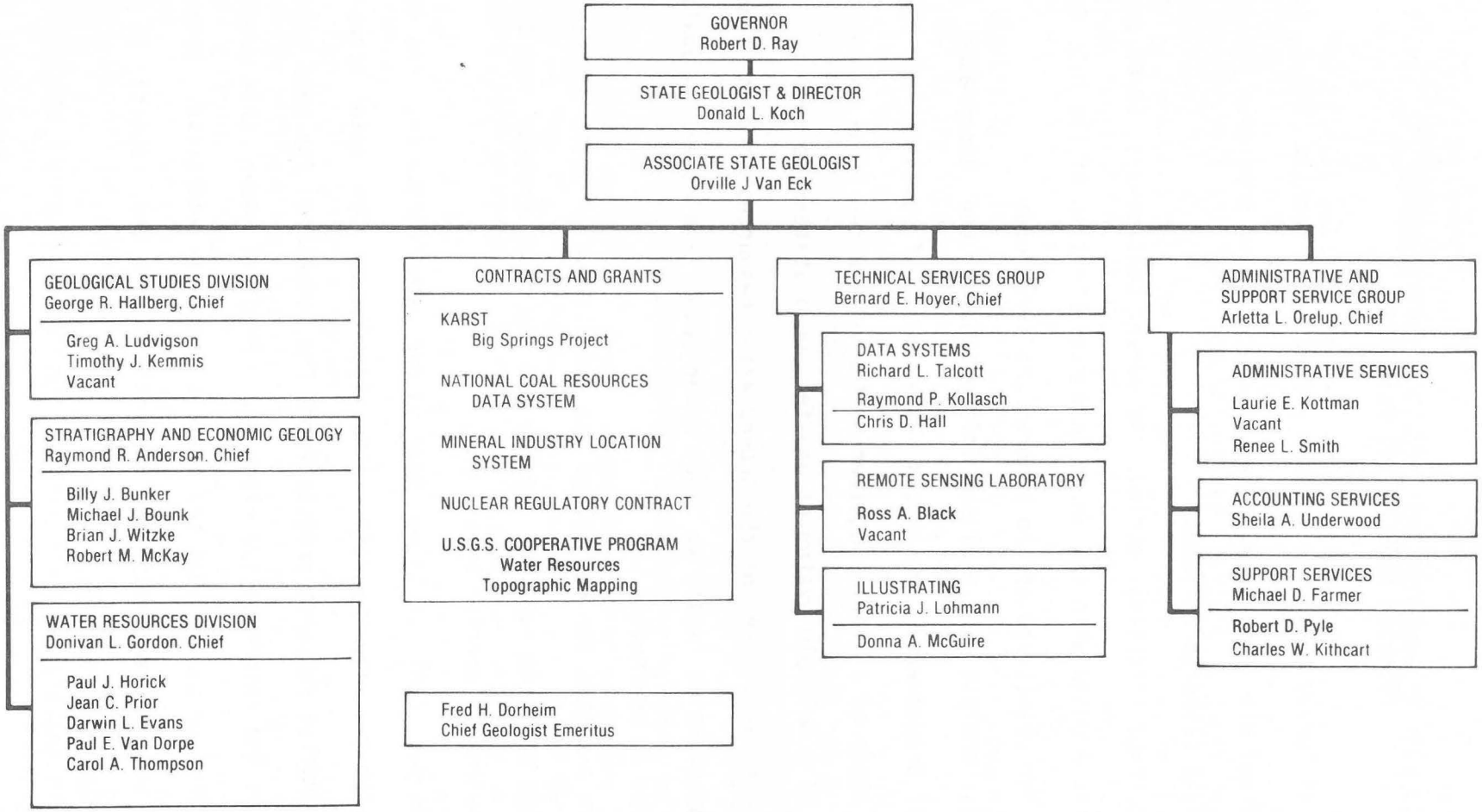


Figure 2. Staff Organization and Responsibility Assignment

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 ground-water 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 ground-water resources through a network of observation wells so that water-level and chemical quality changes can be monitored;

--to maintain a system for collection and compilation of basic records of daily stage and flow rate of streams and the concentration and total load of sediments carried by streams.

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

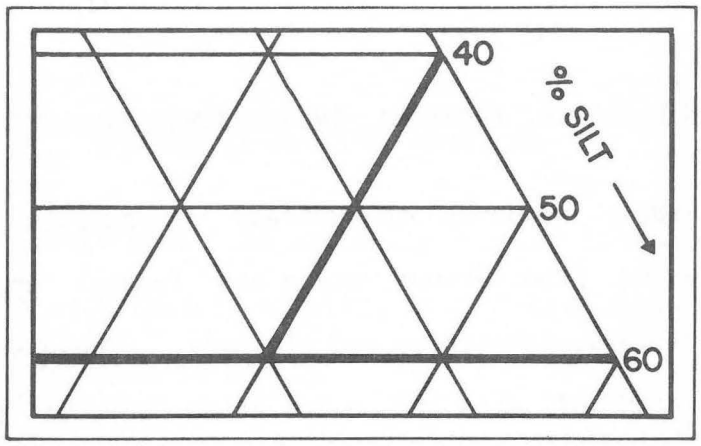
CONSULTATIVE, ADVISORY, AND INFORMATION SERVICES

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

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

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

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



Geological Studies Division

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

George 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. Several major projects were completed, including the study of hydrogeology of the Dakota aquifer in northwest Iowa, the study of the Floyd River alluvial aquifer in northwest Iowa, and a review of the hydrogeologic framework of the LaBounty arsenic waste disposal site at Charles City in northeast Iowa. All of these research programs involve the inputs from all other IGS divisions.

New major projects which were initiated include a study of ground-water quality problems in northeast Iowa, and ground-water resources investigations of west-central Iowa.

Dakota Aquifer Study

Cooperatively with the U.S. Geological Survey (USGS), IGS completed the regional study of the Dakota aquifer in the 16 northwestern counties of Iowa. Analysis of outcrops and over 30,000 feet of research drilling by IGS resulted in the first detailed knowledge of the nature of the important Dakota aquifer in this region.

Results of the research show that the Dakota aquifer can be divided into two units: an upper unit of variable lithology, commonly 100 to 150 feet in thickness which produces only limited yields of water to wells in the region. The lower unit is dominated by sandstone, and in the western and north-central parts of the study area may reach 200 to 300 feet in thickness. The safe, productive capacity of the aquifer is related to the thickness of this lower unit of the Dakota.

In most of northwest Iowa, the Dakota aquifer is buried by 200 to 400 feet of fine-textured glacial deposits, which act as confining beds because of their low hydraulic conductivity. Recharge to the aquifer occurs by downward percolation through these confining beds and also by lateral inflow from Minnesota. Natural discharge occurs to the lower reaches of most of the major rivers in the area, by downward ground-water flow into several underlying Paleozoic aquifers, and to South Dakota beneath a 30-mile segment of the Big Sioux River. Regional water-level data suggest that the aquifer is not heavily stressed at the present time. Several local areas appear to have experienced long-term water-level declines, but the extent, magnitude, and

cause of these declines are not well known. Controlled pumping-test data were obtained through the IGS-INRC research well contract program cooperatively with private landowners. These data were very important and were used to estimate the water transmitting capabilities of the aquifer, and to construct a map that can be used to facilitate the estimation of potential yields from the aquifer and the long-term changes in water levels caused by pumping. The construction of the map was complicated by the fact that the transmissivity data appear to be substantially influenced by the distance separating the production and observation wells at each site. These findings are important considerations for analysis of future permitted wells.

During completion of the study, IGS staff worked with the INRC staff to devise new, realistic allocation policies for the Dakota aquifer. The research on the Dakota shows that there are extensive areas where large water withdrawals, such as those for irrigation, can be sustained, but the research also indicates other broad areas where such withdrawals would not be possible, or would only be possible with large drawdown and depletion of available water. Thus, the current Dakota allocation policy, as recommended by the INRC staff, contains two key elements to protect the aquifer. First, applicants for withdrawal permits must "prove up" their applications by collecting and submitting specific information on their proposed wells and those of neighboring wells, and they also must provide access in their Dakota wells for periodic water-level measurements. Second, through its new rules, INRC notifies all applicants that their investments, based on a permit to use the Dakota aquifer, entails risk because the permit may be modified or cancelled if serious water-level declines should occur. The two components outlined above provide a sensible policy under which additional water may be allocated

because the aquifer's integrity would not be in immediate danger. However, the policy also recognizes the need for monitoring the effects of water withdrawals in the future, and the possible modification of the policy if it is shown that more specific allocation criteria are needed. The data collected both from permitted Dakota wells and from further IGS research, will be the basis of any further revisions in the water allocation policy for the Dakota aquifer.

The completion report on the Dakota project is undergoing final editing and illustrating and will soon be ready for publication.

Floyd River Alluvial Aquifer System

As part of the total research program on water resources in northwest Iowa (i.e. -Dakota aquifer project), the aquifer formed by the alluvial deposits in the Floyd River Valley was also studied. The alluvial aquifers form the second major source of ground water in the region. The Floyd River basin was chosen for study because it is typical of the surficial aquifers in northwest Iowa. It is expected that the analysis will be applicable to the other major streams in the region. Data collection included test drilling, water-level measurements, and chemical analyses of surface and ground water. The alluvial aquifer ranges from 10 to 40 feet in thickness and averages about 20 feet thick. An aquifer test conducted in the alluvial aquifer where it is about 25 feet thick and is confined by an overlying low-permeability bed indicated an average hydraulic conductivity of 383 feet per day and a storage coefficient of 0.0001. The well was pumped at 650 gallons per minute for 43 hours. An observation well about 70 feet from the pumping well had a maximum drawdown of about 10 feet.

The results indicate that there are areas in the alluvial aquifers where significant withdrawals of ground-water can be obtained. The completion report for this project is currently being laid out for publication.

LaBounty Waste Disposal Site

Geological Studies Division personnel, in part via a contract with the Iowa Department of Environmental Quality (IDEQ), conducted a summary study of the hydrogeology of the LaBounty hazardous-waste landfill in Charles City. The study provided the first comprehensive synthesis of the various technical data and individual reports of investigations prepared by the University Hygienic Laboratory, Environmental Protection Agency (EPA), IDEQ and several consulting firms employed by Salsbury Labs, EPA and IDEQ. This information was presented in a 1980 IGS report to IDEQ entitled *Evaluation of the Extent of Hazardous Waste Contamination in the Charles City Area*. This report utilized much of the data collected by all parties involved and relies heavily on the comprehensive monitoring system Salsbury's consultant installed under EPA supervision in 1979.

The findings of this study were also reviewed in the 1981 edition of Iowa Geology. Only a brief synopsis will be reported below. The LaBounty site has been of great concern because of the concentration of hazardous waste emplaced at the disposal site, including an estimated 6 million pounds of arsenic. Also, ground water at the site contains high concentrations of arsenic and twenty-four of the United States Environmental Protection Agency's (EPA) 129 "priority pollutants." Contaminated ground water is known to be seeping into the Cedar River only 100 yards from the waste. A compound found in the waste, orthonitroaniline (ONA), is not known to be a human health hazard, but has

been detected in low concentrations from wells near the Cedar River in Waterloo, Iowa, 65 river miles downstream.

Waste at the LaBounty site was placed in a gravel pit on the south side of Charles City. Sand and gravel deposits surround the fill material and overlie the Cedar Valley Limestone, which occurs at depths ranging from 0 to 41 feet below the site. This limestone, the primary concern of IGS research, is a major source of drinking water in northeast Iowa because of its broad extent, shallow depth, excellent water-yielding properties, and high quality of water.

The ground-water contamination pattern emanating from the disposal site generally follows the paths of ground-water flow. The most highly contaminated water is immediately east of the fill at the base of the sand and gravel deposits. Here, arsenic concentrations exceed 400 milligrams per liter (mg/l), and numerous organic chemicals are present in high concentrations. The EPA primary drinking water standard for arsenic is 0.05 mg/l. No standards have been set for the bulk of the organic chemicals that also are present.

Severe ground-water contamination, however, is limited to an area only several acres in size, and does not extend to great depths. Shallow wells in the Cedar Valley Limestone have significantly reduced contamination levels when compared to sand and gravel wells at the same locations. A 335-foot deep Cedar Valley aquifer well only 400 feet southeast of the fill is not contaminated. Ground water in the shallow limestone is not highly contaminated at the site because the regional ground-water flow system in the Cedar Valley aquifer discharges to the Cedar River, and the upward flow tends to flush contaminants out. The contamination that is present in the rock wells is likely

a result of short-term fluctuations in the direction of ground-water flow that are caused by heavy rains and high stages of the Cedar River. All available evidence indicates that no regional contamination of the Cedar Valley aquifer has occurred.

The detection of ONA in shallow wells in Waterloo and other areas is a result of the locations of the wells and the physical properties of ONA. The wells containing ONA were located in sands and gravels adjacent to the river. ONA is readily soluble, highly mobile, very stable, and easily detected at very low concentrations in natural waters. All available evidence indicates that ONA entered the Cedar River at the LaBounty site, travelled downstream to Waterloo, and was drawn into shallow wells near the river by pumping of the wells. This process reduced the concentration of ONA by a factor of one million. No other contaminants from the LaBounty site were found in measurable concentrations at Waterloo.

Remedial actions were taken at the site in the summer and fall of 1980. A two-foot thick clay cap was placed over the fill material, a storm sewer through the site was rerouted and surface drainage was diverted from the site. These actions were taken to reduce movement of water through the fill, which, it is expected, will result in a reduction in the volume of contaminants yielded by the site.

Considerable time will be required to observe the changes expected to result from these engineering solutions. The ground water only moves about two feet per day, so the observation wells are not likely to show any significant changes for many months.

Some uncertainty lingers concerning the ultimate effectiveness of the clay cap. The fact that some of the waste is below the water table means that

some level of contamination is likely to continue. However, the general consensus of all parties concerned is that the clay cap will result in some decline in contamination levels in the shallow ground water and in the Cedar River by substantially reducing the vertical seepage through the waste.

Monitoring the upward flow of ground water from the Cedar Valley aquifer to the river must continue, however, because this upward flow is the primary means of protecting the aquifer from contamination. Further development of water supplies from the aquifer must be evaluated on a case-by-case basis to assure that new wells would not reverse the upward ground-water flow.

One of the major impediments to establishing the most cost-effective management strategy for the LaBounty site is that an acceptable level of contamination has never been defined. One obvious goal would be to return to an uncontaminated condition on the LaBounty site. Unfortunately, this is not possible, even with complete removal of the waste and surrounding soil.

The study also made other technical recommendations for monitoring or for refining our understanding of the hydrogeologic system. Continued monitoring will be necessary to establish the effectiveness of the clay cap and to guide further management actions.

Ground-Water Quality in the Karst Regions of Northeast Iowa

One of the major, new hydrogeologic projects begun this interim is the evaluation of ground-water quality in the karst areas, formed in the important Silurian and Devonian aquifers of northeast Iowa. These aquifers are formed of limestone, or carbonate rocks, and are major sources of public and private well-or ground-water supplies throughout eastern Iowa.

In humid environments such as Iowa, these carbonate rocks are subject to chemical solution by infiltrating soil and ground water. As the water

dissolves away the rock, fractures, joints, and other openings are enlarged. Over time the result is that ground water moves through a series of interconnected openings ranging from microscopic fractues to large caves and caverns. The flow of water in these larger openings is like flow through a pipe in contrast to the slower, intergranular flow through a sandstone. This is one of the problems in carbonate aquifers; because the pipe-like flow through the system does not provide the natural filtering that occurs with intergranular ground-water flow. Another consequence of the solution of the carbonate rocks is the development of unique land-surface features, collectively referred to as karst topography. One of the more conspicuous and important features is the sinkhole. Sinkholes form as a consequence of the rock solution and collapse. At the surface, sinkholes appear as conical depressions which widen upward. As depressions, the sinkholes collect surface drainage, and sometimes intercept and "swallow" streams. This is one of the major problems with the karst regions. The sinkholes provide a direct conduit for surface water to run directly into the underground cavities in the limestone, and join the ground-water system. These surface waters, and the contaminants they may carry, can reach the ground water in a wholly unfiltered and undiluted state. As a consequence, carbonate aquifers are highly susceptible to contamination by surface runoff from agricultural or industrial land, effluent from septic tanks, drainage tiles, and other forms of waste disposal. Sinkholes also provide a common and convenient, though dangerous place to dispose of solid waste materials. Observations in Iowa have shown local occurrences which served as convenient dump sites. Out-of-site is not necessarily out-of mind in these instances, because this dumping has often seriously contaminated local water supplies.

Because of these problems, water-quality in this area has been of concern for some time. Recently attention has been drawn to the hazards of the karst area because of proposed pipeline routes through the karst regions. In 1976 IGS began an evaluation of water-quality in these karst areas but the study was discontinued because of the lack of funds.

During 1981, the Iowa Geological Survey, in large part through a contract with the Iowa Department of Environmental Quality, has undertaken such a study. This project involved nearly the entire staff at IGS and a number of graduate students, who were employed through the contract. This work is currently in progress, and has expanded into a second phase (for 1982), which is jointly funded, and/or supported by IGS, IDEQ, the USDA Soil Conservation Service (SCS), and the Iowa Conservation Commission (ICC).

The first phase of the study, currently being completed, involves a regional assessment of the karst regions. In this phase of the study of the karst areas, the actual sinkholes, the depth to bedrock, and soil conditions which affect the karst areas have been mapped in detail. This detailed delineation of the karst regions is necessary for the evaluation of the groundwater quality data.

All available water-quality data for the region is being evaluated, including over 6,000 nitrate analyses and over 8,000 bacterial analyses performed by the University Hygienic Laboratory. The final data analysis and the final report on this phase of the project are currently in preparation. One major conclusion may already be noted: there are significant levels of nitrate contamination in wells less than 150 feet deep in the karst areas. The study has also shown that very shallow wells (less than 50 feet deep)

throughout Iowa, are showing high levels of nitrate contamination, regardless of the geologic setting of the wells.

The second phase of the study, which will be conducted during 1982, involves the very detailed analysis of a small karst basin in northern Clayton County. The study involves the cooperation of over 100 private landowners in the area, and the monitoring of Big Spring at the ICC fish hatchery near Elkader. The study will assess land-use practices in relation to water quality to address what types of land-management may help to reduce groundwater contamination in these areas.

West-Central Iowa Project

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

During the 1981 initial field season, over 5,000 feet of test-drilling was completed, in 24 test-holes. Seventeen of these test wells were established as monitoring wells for analysis of the piezometric surface or water levels in the aquifers, and for water quality analyses. This project will continue into 1984.

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.

Several publications have been completed under these cooperative programs. Geotechnical research on loess materials which cover about 38 percent of Iowa is reviewed in an open-file report, (this report was also included in the report of the U.S. working group to the International Quaternary Association Loess Commission). Two other projects related to soils investigations were completed. These include a detailed analysis of Pleistocene stratigraphy in east-central Iowa and a study of shrink-swell problems of Iowa soils.

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.

CONSULTATIVE INVESTIGATIONS

As a fundamental 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 impinge upon the scheduling of other planned projects. Thus, flexibility must be built into longer term projects of IGS.

Examples of these projects during the past interim include:

1. The review and investigation of the LaBounty arsenic disposal site, already outlined.
2. Design and analysis of pump tests for INRC well-permit hearings in sensitive areas of west-central Iowa.
3. Investigation of several hazardous petroleum product leaks and spills in eastern Iowa for IDEQ and the Fire Marshall's offices.
4. Consultation on natural land boundary disputes for ICC and/or the Attorney-General's office.
5. Testimony at various hearings regarding water permits for INRC.
6. Investigation of several hazardous or toxic waste sites in western Iowa for IDEQ and USEPA involving such things as pesticide dumps, paint manufacturing residue disposal sites, and disposal of animal processing wastes. These have involved investigative field work, review of investigations by various consultants, correspondence, and testimony at formal proceedings.

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

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:

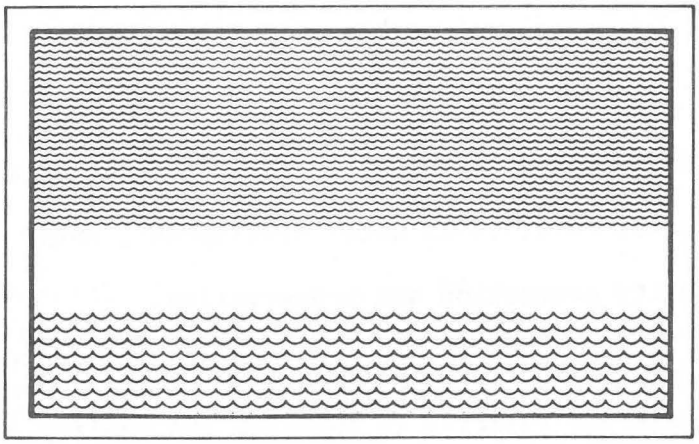
1. Review of landfill and other waste-disposal site plans.
2. Review and comment on new rules and regulations by Iowa and U.S. regulatory agencies.
3. Providing information on engineering-geologic conditions and potential problems (see discussion below).
4. Providing information on general soils-geologic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

Item 3 above is an area where Geological Studies Division staff have noted a large increase in requests for information. Of particular note is the increase in the number of requests for information concerning foundation conditions and/or possible problems for new commercial/industrial firms themselves, or engineering-consulting firms or architectural firms which represent the firms, and various state or local government agencies involved

with commercial development. As IGS' expertise in this area has become better known, the number of requests has risen.

Dam Inspection Program

Division staff have continued to assist (with the STRECOG Division staff) the Iowa Natural Resources Council and the Rock Island District, U.S. Army Corps of Engineers in making dam inspections. These inspections were funded under the Federal Dam Safety Act (PL 920367). All dams scheduled for inclusion under this Act in Iowa have been inspected.



Water Resources Division

The Water Resources Division is structured to provide technical information and consulting advice to the state and people of Iowa in relation to the development, use, conservation and protection of the state's ground water resources. Through its day-to-day operations and its research projects, the division's primary goal is to enhance the state's information base concerning the distribution, quantity and quality of the resource, and to evaluate ways of incorporating the information into the decision-making process.

During the reporting period, several objectives were outlined to assist in achieving our primary goal in addition to maintaining the agency's desired services posture. They are as follows:

1. To acquire, catalog, index and store information on the occurrence, distribution, quality, development and use of water in the state.
2. To prepare research reports on the location, availability, and quality of the state's ground water resources.
3. To provide technical information and advice to water developers in Iowa.

4. To provide technical information and advice to state/federal regulatory agencies relative to water development, water conservation, and water quality protection and preservation.
5. To assist other agencies in developing programs to monitor groundwater conditions relative to quantity and quality.
6. To provide technical assistance to the agency and other agencies relative to research drilling and testing.
7. To keep current with developments in research and applicable technology in the fields of hydrology and water resources planning and management.
8. To develop research and data collection programs/projects that are consistent with and responsive to state water management needs.

Donivan L. Gordon, Chief

WATER RESOURCES SERVICES

Well Forecasts and Service Requests

For the period 1980-1981, about 19% of the division staff's time was required in compiling detailed reports concerning the development of groundwater resources and related well problems. This marks the first decline in this work area for several years (down from about 25% staff hours in 1979). During 1980 and 1981 the total number of requests dropped by about 35% in both years as compared with 1979. The major areas of decline were in the municipal, domestic and housing development categories. Requests relative to industrial-commercial developments increased by about 30% each year. The following compilation identifies the number of requests for assistance processed during the reporting period by several development categories.

Category	1980 No.	1981 No.
Municipal	88	96
Industrial-Commercial	54	53
Domestic	63	56
Irrigation	18	16
Housing Developments	5	15
Rural Water Systems	2	2
Recreation	15	14
Livestock Operations	3	9
Regional or County	31	32
Pumping Test Analyses	26	26
Other	34	23
TOTAL	339	342

Pumping Tests and Field Investigations

As the competition for ground water intensifies so also do concerns over the stability of supplies and the potential for interference between wells in more heavily developed areas. At present the best available tool for assessing aquifer yield potentials, and the impact of withdrawals, is the controlled pumping test. During the 1980-1981 period in excess of 800 staff hours were devoted to this activity. The following partial list is typical of the testing and analyses performed:

Requested By	Developer	Use	Reason
INRC	S-5 Farms	Irrigation	Interfrence
Urbana	Urbana	Municipal	Well Performance

INRC	Louis Rich Foods	Industrial	Interference
INRC-COE	COE/Coralville Reservoir	Recreation	Well Performance/ Interference
INRC	Clover Leaf Village	Housing	Interference
INRC	River Products	Quarry Dewatering	Interference
Mt. Auburn	Mt. Auburn	Municipal	Well Performance
Worthington	Worthington	Municipal	Well Performance
INRC	Collins	Irrigation	Interference
New Vienna	New Vienna	Municipal	Well Performance
INRC	IBP (Stanwood)	Industrial	Well Performance/ Interference
Clarksville	Clarksville	Municipal	Well Performance
INRC	Land-O-Lakes (Mason City)	Industrial	Interference

Because of the Geological Survey's advisory role to other state agencies, field studies often are necessary to obtain and evaluate hydrogeological data related to actual or potential conflicts in water use and problems of water quality degradation. Similar studies occasionally are conducted for local governmental units. Division staff cooperated in the following investigations during 1980 and 1981 for the agencies listed:

Iowa Natural Resources Council

1. Drawdown impact on private wells caused by quarry dewatering near Keota.
2. Potential drawdown impact of industrial wells near Stanwood.
3. Interference between private well and commercial housing development near Iowa City.

4. Drawdown impact on private wells caused by quarry dewatering near Iowa City.
5. Drawdown impact of commercial wells and city wells in Waterloo.
6. Potential drawdown impact of proposed wells at Clear Lake on city wells at Mason City.
7. Interference effect on private well by operating gravel pit, Buena Vista County.
8. Potential drawdown impact of proposed industrial wells near Low Moor.

Department of Environmental Quality

1. Assessment of ground-water conditions and recommended monitoring for abandoned agricultural chemical plant/site, Mills County.
2. Ground-water contamination potential related to animal waste disposal problem, Floyd County.
3. Assessment of ground-water conditions and recommended monitoring for industrial metal plating operation, Clinton County.
4. Clean up recommendations and monitoring requirements, fuel oil spill, Muscatine.
5. Recommendations, sewage sludge disposal on irrigated land along Cedar River near Cedar Falls.
6. Nitrate in city wells, Jamesville.
7. Nitrate in public water supply, Malcom.
8. Nitrate in wells, Homestead/Middle Amana.
9. Ammonia in water supply, Malcom.
10. Oil residue in commercial wells, Ft. Dodge, flow through waste discharge system.

11. Sulfate concentration in raw water for industrial application, Stanwood.
12. Feasibility of land application of alcohol plant wastes, Pottawattamie County.

Department of Soil Conservation

1. Disposal of coal washing waste in abandoned underground mine.
2. Disposal of coal washing waste water in open pit mine.
3. Use of coal washing waste as surface material -- farm operations.

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 ground-water resources have a finite limit. And, as new pressures have begun to mount between competing water users in some areas of the state, more effort must now be committed to the budgeting aspects of ground water. Principally, how much water is available, what rates of withdrawal can be sustained, with what impact, and in terms of use -- how much is currently used and what additional water use can reasonably be authorized? Because the answers to these questions are so vital to the future of the state they are receiving the highest priority in the agency's/division's research and data collection activities.

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

Alluvial Aquifer Studies

Work was initiated in the 1980-1981 period to evaluate the hydrogeology of the state's major alluvial aquifer systems. Though many of Iowa's major municipalities, rural water distribution systems, and irrigators draw water from these systems little is known of their true potential or limitations, beyond points of water withdrawal. In many regions of the state the water from alluvial sources represents the only viable alternative for large quantities of good quality water. And, as competition for this water increases, it becomes imperative to inventory the potential and capability of these sources and assess the hydraulic implications relative to stream-flow diminution.

The program that will be followed calls for the systematic evaluation of the alluvial systems associated with Iowa's major interior streams, the Des Moines, Skunk, Iowa-Cedar, etc. Our priority in terms of which systems will be studied first has been based on current development activity. The pilot effort in the project will be looking at the upper reach of the Des Moines River, above the Saylorville Reservoir.

The fundamental objective of the program is to define the areal limits of the alluvial systems, their thickness, and their hydrology in terms of yield potential and water quality. For most of these systems, little data exists other than at centers of development. Therefore, in a preliminary phase, available IGS data will be correlated with information from DOT bridge sounding work and data that has been compiled for floodplain sand and gravel operations. During the upcoming field season, gaps in these records will be enhanced with data from field seismic surveys.

In a later project phase, test wells will be established to monitor water-level and water-quality conditions. As opportunities arise in the private sector, controlled pumping tests will be conducted to determine aquifer hydraulic parameters, and if possible, streamflow impacts.

As designed, the evaluation of each river/alluvial system is scheduled for approximately 2 years of study.

Hydrologic Data - Municipal Water Supply Systems

The Geological Survey is frequently called upon for advice concerning municipal water supply problems. To work effectively in this area many kinds of information are needed. Because of problems in this area, most attributable to poor data, a program was initiated in 1980 to systematically develop a comprehensive computer data file on municipal water supply systems.

The information to be incorporated into the system includes the location and number of wells, their design and pumping capability, plus data on the geologic source of water, water quality, and quantities of water used. This information will, in the future, be merged with an extant municipal water quality data file. Both bodies of information are intended to be maintained on a current basis, updated annually, once the file system is completed.

The incentive for this data file is to allow the Geological Survey to be more thorough and efficient in its service to communities, to evaluate changing conditions with respect to community water quality, and to enable more precise evaluation of the pattern and quantity of ground water being used. Three years have been projected for the establishment of this system.

County Ground-Water Availability Reports

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

1. General geologic setting
2. Approximate depth(s) to potential water-bearing zone(s)
3. Expected quality of water from the various zones
4. Anticipated sustainable withdrawal rates (in gallons per minute)
5. Index of typical wells
6. Common water quality problems and drinking water standards
7. Index of available topographic maps
8. Agencies that may be contacted for assistance
9. List of drilling contractors that service the county

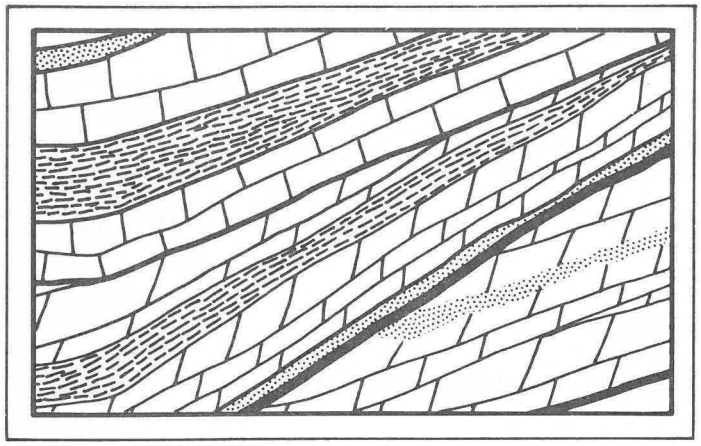
OIL AND GAS

As provided in Chapter 84 of the Code of Iowa, the State Geologist is designated as the Administrator of of Oil and Gas, and he is responsible for administering the provisions of Chapter (580) 12 of the Iowa Administrative Code. His duties include the issuance of drilling permits for oil/gas exploration or production, including underground gas storage; the maintenance of all administrative, geological and production records; and surveillance of associated well or facilities abandonment.

Ten drilling permits for oil and gas were issued during the 1980-1981 period. All were issued to Minnesota Gas Company for exploratory test drilling in Winnebago County. The testing related to the evaluation of geologic structure and reservoir characteristics of a potential underground gas storage structure extending in subsurface from southern Minnesota into Iowa.

The Geological Survey continues to serve as consultant to the Iowa Commerce Commission in the review of procedures being followed by Northern Natural Gas Company in the abandonment of the Vincent (Webster County) gas storage reservoir. The original acreage under lease for this facility when abandonment began in 1971 was 12,373 acres. Gas Storage Agreements on approximately 10,133 acres on the outer periphery of the field have been dropped through December 1981, leaving 2,240 acres under lease. The total gas-in-place as of December 26, 1981 was 2,404,909 Mcf (thousand cubic feet).

The 1981 session of the General Assembly passed legislation that amended Code Chapter 84 to bring the exploration for and production of metallic minerals under essentially the same controls imposed on oil and gas exploration and production. It was considered important that this be done to insure that wells drilled for metallic minerals be properly constructed or plugged to prevent ground water waste and pollution. Rules applicable to Chapter 84 have been revised to reflect the changes within the Chapter.



Stratigraphy and Economic Geology

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

Raymond R. Anderson, Chief

Stratigraphic and Structural Studies

Stratigraphic Study

One of the major long-term divisional projects is a comprehensive review of the entire stratigrahic section in Iowa. In 1980, progress was made on

several major stratigraphic packages, Precambrian, Cambrian, Silurian and Cretaceous. Much of this progress was made as parts of other projects.

Cretaceous Aquifer Study

Geologic mapping and stratigraphic studies have been a critical part of the Cretaceous Aquifer study in northwest Iowa. Analysis of the Cretaceous stratigraphy of northwest Iowa was based on both surface exposures and subsurface well sections. These stratigraphic studies were essential to defining the geometry of the Cretaceous Aquifer. Stratigraphic, petrologic, and paleontologic studies on the Iowa Cretaceous sequence were undertaken by the Division, and the preliminary results of these studies have been published by the Iowa Geological Survey (IGS) as an Open-File Report.

A follow-up study has begun in west-central Iowa where Cretaceous rocks in an eight county area will be examined. This study will end in 1984 at which time the Cretaceous section of the Stratigraphic Study will be completed.

Pennsylvanian Studies

With the pending completion of the study of the stratigraphy of the Lower and Middle Pennsylvanian sequence of southern Iowa, an important step has been taken toward completion of the Pennsylvanian section of the stratigraphic study. Compilaton of information for the complex Upper Pennsylvanian has not yet begun and completion of this segment is not planned for several years.

Carbonate Hydrology Study

In 1981 the writing of the report on the U.S. Geological Survey (USGS)/IGS Carbonate Hydrology Study was completed. The study examined the occurrence, availability, quality and flow regime of ground water in the

glaciated-carbonate terrain in parts of Linn, Johnson, Iowa and Benton Counties. The report is now in USGS review, but should be published in 1982. Much of the information gained from this study will be utilized in the study of Devonian Stratigraphy in Iowa.

Silurian Study

Work continued on the Silurian Stratigraphy study in 1981. Only a small exposure area in Fayette County remains to be examined. All other mapping, field work, paleontology and interpretations have been completed. The final report should be completed in 1982.

Cambrian Study

All field work, core studies, and most well-cuttings examinations have been completed in the study of Cambrian strata in Iowa. Key fossils have been collected and sent to experts for identification. Mapping and interpretations should be completed in 1982 with the publishing of a final report, now scheduled for 1983.

Precambrian Study

The geophysical study and modeling of the Midcontinent Geophysical Anomaly and its associated, clastic-filled basins was very nearly completed in 1981. Most Precambrian well data have been compiled and will be organized into a report in 1982. Completion of the state-wide study is scheduled for 1983 or 1984.

Karst Studies

As a part of our continuing karst research program, STRECOG, in 1980, studied the factors influencing the development of karst and caves in the

Silurian strata of Iowa. This research led to the presentation of a paper on this topic to the National Speleological Society in Minneapolis.

In the summer of 1981, STRECOG assisted with the execution of a contract between IGS and the Iowa Department of Environmental Quality (DEQ) to provide an overview of the development of karst (sinkholes) in northeast Iowa and its effect on water quality in the region. STRECOG provided stratigraphic information and assisted in geologic mapping and dye tracing in the study area.

In a follow-up one year contract with the DEQ and the U.S. Soil Conservation Service, the IGS was asked to examine the effects of karst on the groundwater quality of a small ground-water basin which provides water to Big Spring in Clayton County. The final report for this project will be completed in 1982.

Hazardous Waste Disposal

With the realization that Iowa would soon be facing a hazardous waste disposal problem, STRECOG completed a study of potential Iowa geological repositories for hazardous wastes, exclusive of spent reactor fuel. Five geological units were studied in rocks of Pleistocene, Cretaceous, Pennsylvanian, Devonian and Ordovician age. The final report "Location of Sites for Hazardous Waste Repositories in Iowa; Phase 1: Geological Reconnaissance Mapping" is on open file at the IGS.

Structural Development of the Forest City Basin

The study of the structural development of the Forest City Basin continued in 1981. A total of 17 maps developed from this study were published in 1981, seven in the 1981 Nuclear Regulatory Commission progress report

ten in a Cretaceous guidebook, and one, a map of the structure of the Precambrian surface, became an open file map at the IGS.

Plum River Fault Zone Study

All field work and research have been completed on the study of the Plum River Fault Zone of eastern Iowa. STRECOG has been assisting in the study. Writing of the final report is nearly completed.

Correlation of Stratigraphic Units in North America (COSUNA)

The division participation in the COSUNA program began in 1980 and continued in 1981. The project is sponsored by the American Association of Petroleum Geologists and the U.S. Geological Survey and is an effort to correlate and define all stratigraphic units in North America. In 1981 work began on the computer coding of stratigraphic informatin for Iowa's six representative sections. STRECOG participation in COSUNA is scheduled to end in 1982.

Well Logging

One of STRECOG's most important tasks is the production of strip logs. These logs represent information gained from studying rock cuttings collected by well drillers from all areas of the state in the course of their drilling activities. The strip logs form the background of our geologic data base in Iowa. In 1980 over 79 wells were studied all or in part totaling over 29,560 feet. This included a detailed study of 38 wells (total 20,470 feet), and the picking of stratigraphic contracts or tops on an additional 41 wells (9,100 feet). In addition to this work, an estimated 2,000 feet of core was logged by STRECOG geologists. In 1981, STRECOG logged samples from 65 wells for a

total footage of over 26,000 feet. These were primarily deep wells, wells from the west-central Iowa study area, wells from the Big Spring Study area, and wells studied in response to public or in-house requests. In addition to cuttings logged, over 1600 feet of core was studied and logged.

In addition to the above summarized activities, the division participated in a number of contract projects which are briefly outlined below.

National Coal Resources Data System (NCRDS)

The USGS contracted with IGS to provide information on Iowa coal resources and geology. Most of this work was completed over a two year period by the now defunct Coal Division. Work on the contract was finished early in 1980 with submittal of the final logs of IGS coal test cores.

After a year of non-activity in the program, STRECOG renewed a working arrangement with the NCRDS of the USGS. This project is a ten-month agreement for checking extant data and coding additional information on coal in Iowa for eventual inclusion in a national computer data base.

Abandoned Mine Lands Inventory (AMLI)

In the fall of 1980, STRECOG began work on the AMLI, a program sponsored and funded by the U.S. Department of Interior Office of Surface Mining. The contract work included the identification, field inspection, and reclamation recommendations for all surface areas disturbed by coal mining prior to 1977. The contract was for a one year program, with work in 1980 being primarily limited to file and literature searching and preliminary mapping. Most field work began in the spring of 1981. A total of over 14,000 acres of land was field examined, with 181 sites described, and recommendations made for future

reclamation estimated to cost $47 million. A final report on the project was prepared and is on open file at the IGS.

MAGSAT

STRECOG provided only minimal input into the National Atmospheric and Space Administration sponsored contract to study data obtained from the MAGSAT satellite. STRECOG involvement in the study in 1982 will be more extensive.

Mineral Industry Location System (MILS)

A new contract for Iowa participation in U.S. Bureau of Mines' MILS program was initiated by STRECOG in 1981. The study will result in a computer data base including all past and presently operating mineral extraction sites and primary manufacturers in Iowa.

ECONOMIC GEOLOGY

Coal Studies

With the closing out of the Coal Division in June 1980, some work remained to finalize the efforts of that division. Since that time, three papers based on data gained from the activities of the coal program are nearly ready for publication. They are:

1) "Formational Subdivision of the Cherokee Group,"
2) a follow-up to the pollen stratigraphy report published earlier, and
3) an elemental analysis of Iowa Coals.

In addition, a bibliography of Pennsylvanian Geology and coal was prepared and is now on open file.

Coal Core Logs

In 1981, STRECOG completed logging the last of Coal Division related cores. A total of 84 cores were obtained as a part of the coal stratigraphy research program, nine cores were drilled for subsidence investigation, and eight additional cores, drilled by the Office of Surface Mining, were obtained and logged. All logs are now on open file.

Mine Subsidence Response

STRECOG, representing the IGS, has agreed to act as the state contact for handling reports of mine subsidence in Iowa. STRECOG investigates areas of reported mine subsidence and report the findings to the Office of Surface Mining which has the responsibility for initiating any remedial action. In 1981, STRECOG responded to five such subsidence reports.

Industry Coal Data Available

In an attempt to clear out the Confidential Files in STRECOG, all companies with confidential materials reposited at the IGS were contacted. They were given copies of a new IGS confidentiality policy and asked for permission to release materials at the IGS. Most companies agreed to allow immediate open filing of their materials. Consequently, a variety of new information, well samples, logs, and reports primarily dealing with coal exploration, is now available to the public.

Interest in Iowa Uranium

In 1981, a minerals exploration company touched off an active response by attempting to purchase mineral rights for uranium exploration in northwest Iowa. After a telephone conversation with the company's chief of exploration,

STRECOG prepared a report on Iowa's uranium potential. Although the geologic conditions are suitable for one of the most valuable type of deposits, there is no indication that any uranium is actually present. Test drilling across the border in South Dakota by another uranium exploration company apparently found no traces of the mineral.

High Calcium Limestone Data Compiled

STRECOG has compiled all existing data on high calcium limestone resources in Iowa. The compilation, in tabular form, is organized by county and includes the names and locations of all mines and quarries from which limestone have been analyzed. Also included on these tables are percent $CaCO_3$ for the unit sampled, unit thickness, and stratigraphic name. This information is available on open file, and will be expanded and published in 1982.

Mineral Producers List Upgraded

The list of mineral producers in Iowa was updated in 1981. The list, compiled from the U.S Bureau of Mines data, was first made available through the IGS in 1978. It is presently available on open file, but will be expanded and published in 1982.

AAPG Presentation

In June, 1980, STRECOG presented a poster display at the annual meeting in Denver of the American Association of Petroleum Gelogy entitled "Assessment of Potential for Fluid Hydrocarbons in Iowa." This presentation allowed STRECOG geologists to present a substantial portion of our recent data and interpretations concerning oil in Iowa. This presentation heightened industry

interest in Iowa's petroleum potential and was, in part, responsible for the present interest in Iowa petroleum.

Gypsum Resources, Fort Dodge Area

STRECOG completed an Open-File Report entitled "Gypsum Resources, Fort Dodge Area." The principal goal of the study was the areal delineation of the gypsum and some estimates of thickness. Data utilized in compilation of the report included water well files, confidential company files, and interpretation of earth resistivity measurements which were obtained as a part of the study.

SERVICE PROJECTS

Dam Inspections

STRECOG has assisted the Iowa Natural Resources Council in the National Program of Inspection of Non-Federal Dams since 1978. The division inspected nine dams in 1980 and three in 1981, and provided a written report to the INRC on each site. These reports included descriptions of the geologic setting of each dam site, delineation of potential geologic problems which should have been addresed in designing the structure and observations. Our reports were incorporated in individual INRC reports on each impoundment.

Freeway 520

In response to a request from the Iowa Department of Transportation, STRECOG prepared a report, now on open file, delineating the extent of gypsum resources, area of land disturbed by previous gypsum mining and areas of potential subsidence due to coal extraction in the Fort Dodge area. The report included a map of these areas as well as descriptions of potential problems

and estimates of the amount of potentially mineable gypsum that would be made unobtainable by each of the four proposed freeway routes.

Polk County Greenbelt Study

At the request of the U.S. Army Corps of Engineers (Rock Island District), STRECOG produced a report evaluating the sand and gravel potential of the Des Moines River floodplain south of the Saylorvile Dam and north of Interstate 80 in Polk County. The Corps was attempting to create a greenbelt along the river and wanted to know if sufficient sand and gravel resources existed beyond the greenbelt to replace those operations nearer the river which the Corps desired to shut down. Examination of topographic and soils maps and well data was supplemented by photointerpretation of medium altitude color infrared aerial photography to produce a map of potential sand and gravel deposits in the area.

Geology of Buchanan County

At the request of the Iowa Northland Regional Council of Governments, STRECOG compiled a report on the geology, mineral resources and geologic hazards of Buchanan County. This 24 page report will be incorporated into a larger volume on planning in Buchanan County, but is also availale at the IGS on open file.

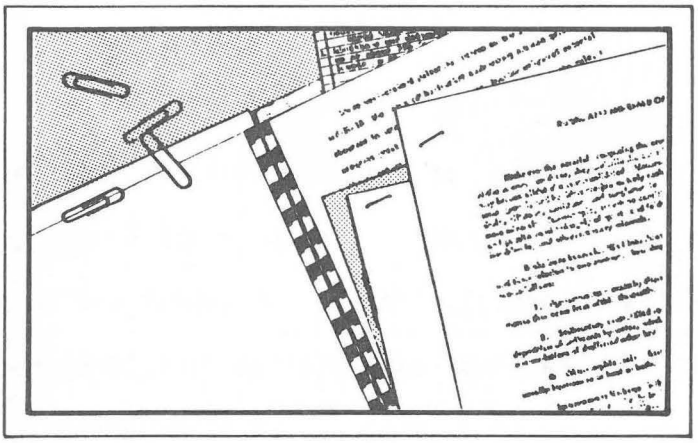
State Capitol Examined

Responding to a request by the Director of the General Services Administration and consulting architects, STRECOG completed a study of the various stone types used in the construction of the Iowa State Capitol Building in Des Moines, their histories, mineralogies and their present state of preservation.

Laboratory analysis of the fresh and deteriorated stones enabled us to determine the cause of the stone's deterioration. The 22 page report is on open file at the IGS.

Information Requests

STRECOG responded to an estimated 180 information requests in 1980 and another 220 in 1981 on almost all aspects of geology. These requests included letter, telephone and personal visits.



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 were mentioned earlier in this report. A general summary of the other projects is presented below.

Orville J Van Eck, Associate State Geologist

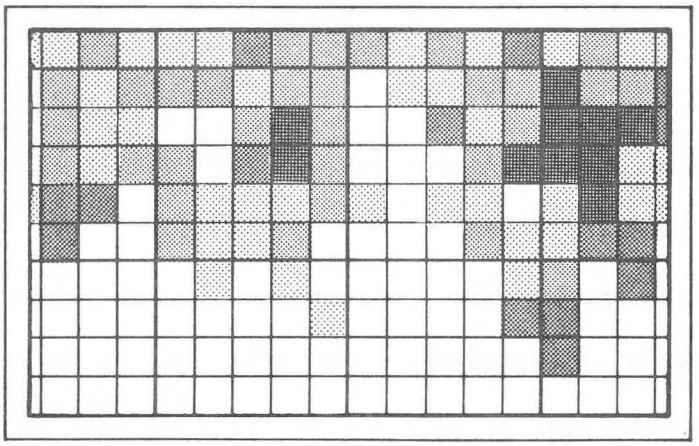
Tectonics and Seismicity

No quantitative information on seismic activity is available for the southwestern Iowa portion of the mid-continent region. Through a contract with the Nuclear Regulatory Commission (NRC), a network of seismic stations was established to obtain background data in advance of any future proposals

for siting nuclear power plants at locations near southwestern Iowa. Equipment was installed at stations near Carbon (Adams County), Elkhorn (Shelby County), Pisgah (Harrison County), Treynor (Pottawattamie County), and Riverton (Fremont County). Data from each station is telemetered to a receiving center at our Iowa City office. The equipment is designed to detect microearthquakes (less than 3.0 on the Richter scale) which generally are not felt by humans. Other work under this contract has included the construction of maps that show structural features, thickness of glacial sediments, bedrock topography, and known and inferred composition of the deep crystalline rocks. During the field seasons of 1980 and 1981, extensive seismic exploration and gravity studies were conducted to help in understanding the tectonics of southwest Iowa. The acquired information will be important not only in the design of nuclear reactors, but also any large structure that must consider possible earthquake movement, such as large dams and high-rise buildings.

Small Operators Assistance Program (SOAP)

This program is funded by the U.S. Office of Surface Mining (OSM) and administered in Iowa by the Department of Soil Conservation. The program is designed to assist operators of small coal mines, (those that plan to produce 100,000 tons or less of coal annually) in the preparaton of the mine operational and reclamation plans that are required for issuance of a mining permit. IGS was certified by OSM as a qualified laboratory to prepare the hydrologic impact statement that must accompany each permit application. During 1981, the first year of operation under SOAP in Iowa, three companies took advantage of the assistance provided by the program. IGS assessed the geology and hydrology of seven separate sites, and prepared the required report of the expected hydrologic impact of surface mining for each site.



Technical Services Group

The Technical Services Group provides for coordination among three areas: data processing, graphic arts and remote sensing. Each is primarily science oriented and serve other divisions of the Survey as well as providing services and coordination with other state agencies.

The addition of a mini-computer system has greatly affected operations at IGS. The system was purchased to implement digital processing of Landsat imagery, but is also functioning to handle all our geologic processing needs and much of our responsibilities with IWARDS as well.

The system increases our capabilities by an order of magnitude, but has also been a stimulus to increase computer usage, develop applications software and direct research into new areas which previously were unavailable to us.

Getting the system running, developing user procedures and maintaining the system for both the Landsat processing and other computer applications has been a difficult and time consuming task involving both data processing and remote sensing personnel. However, there is little doubt that it has been

very valuable to increasing our agencies ability to analyze problems and produce useful resource information.

Our graphic arts program has continued to provide our staff with quality assistance in preparing information. One only has to look at *Iowa Geology*, attend an oral presentation, or read any of the long list of publicatons produced by our staff to assess the output of our graphic arts program.

Bernard E. Hoyer, Chief

REMOTE SENSING LABORATORY

Laboratory Functions

The Remote Sensing Laboratory (RSL) has two primary functions. First, it assists governmental agencies, business and private citizens to locate, acquire, interpret and utilize aerial and satellite imagery of the state. Secondly, the RSL provides research, and technical support services to agencies responsible for managing Iowa's natural resources.

During 1980 and 1981 the RSL assisted the Iowa Department of Soil Conservation (DSC), the Conservation Commission (ICC), the U.S. Soil Conservation Service (SCS) and the U.S. Army Corps of Engineers and other agencies in applying remote sensing techniques to resource management problems.

Priority Projects

The years 1980 and 1981 saw the completion of four major RSL projects. The dominant activity was the procurement and installation of a mini-computer based digital image processing system. The system also hosts on-line geologic processing, plotting and general scientific computation. High-altitude, color-infrared (CIR) photography of western and northestern Iowa was acquired

in 1980. This provides the RSL with complete photographic coverage of the state. Under a cooperative agreement with the U.S. Army Corps of Engineers (USACE), RSL staff documented shoreline erosion problems at Lake Rathbun Reservoir. RSL also conducted an analyses of midcontinent magnetic data acquired by NASA's MAGSAT satellite.

Digital Image Processing

RSL now has a fully operational Landsat satellite image processing system. The major components of the system include a minicomputer, color display device, printer/potter, digitizing tablet and graphic terminal, and standard terminals. A National Aeronautics and Space Administration (NASA) package of image processing programs known as ELAS is used for the analysis of the satellite data. The system has a number of features which will enhance the Survey's resource anslysis capabilities.

The ELAS package contains programs which provide the user with an interactive environment for the display and analysis of digital Landsat images. Using simple commands, the operator can select a portion of an image which can then be displayed in black and white or color on the color display device. The user can also display portions of several images simultaneously, or display several different segments of the same image. These and other display functions form the basis of the interactive capabilities. These functions are very important because they allow the operator to review the results of the image analysis routines.

A major function of ELAS is to convert an unprocessed satellite image into usable output products such as land cover maps or computer files of land cover. Classification (converting an image to land cover information) is

simply the assignment of each image element to a statistically unique land cover category such as corn, forest, etc. The classified image can then be converted to a map product using programs which remove the geometric distortions present in all Landsat images. At least four ELAS programs are needed to classify an image and produce a geometrically corrected land cover map. The analysis of the 10,000 square miles of one image requries about 24 hours of computer time.

A land cover map by itself can be a valuable aid to resource managers. However, the most powerful management tool available in ELAS is the ability to merge land cover information with ancillary resource information such as soils, soil conservation practices, topography and others. The digitizing tablet and graphics terminal can be used to convert existing maps to a digital format which is compatible with the land cover information produced by ELAS. The different data sets can be overlaid in the computer forming a geographic data base. The data base can then be analyzed to provide information for resources management decisions.

The application of satellite imagery and data bases to the management of Iowa's natural resources is still in the early stages of development. It will take considerable time to implement systems capable of providing the resource agencies of Iowa with rapid access to the information needed to make rational management decisions. We at the Survey feel that our present capabilities are an important step in that direction.

High Altitude Photography

In May of 1975, RSL and the U.S. Soil Conservation Services (SCS) acquired 11,600 square miles of 1:80,000 scale photography in S.W. Iowa. This

flight began a five year program to acquire high-altitude CIR coverage of the entire state. Cooperators included RSL, SCS, USACE, and Iowa Department of Soil Conservation (DSC). In April of 1978, 18,600 square miles were flown, 15,500 square miles in May of 1980, and 12,736 square miles in November of 1980. The original photography and a complete set of duplicates are archived at RSL. The EROS Data Center also holds a complete set of duplicates. The photography has been used extensively by the SCS, DSC, USACE and RSL for land use analysis, soils mapping, geologic mapping, including karst areas, and educational purposes. Numerous private companies and individuals have used the photography for powerline routing, sand and gravel exploration and various site selection processes. The photography will provide an historical record of Iowa's resources in the period 1975 to 1980.

MAGSAT

The MAGSAT satellite, launched by the National Atmospheric and Space Administration (NASA) on October 30, 1979, had on board two magnetometers, a cesium vapor scalar instrument and a three-component fluxgate instrument. The three-component instrument gathered data for seven and one-half months, whereas the scaler instrument did not provide consistently interpretable data.

This study was an attempt to utilize the MAGSAT magnetic data to:

1) Develop and implement a computer processing sequence to extract Magsat anomalies due to magnetic sources in the earth's crust beneath the Midcontinent of the U.S.

2) Compare the processed MAGSAT magnetic anomalies with regional gravity, seismic, geologic and geochronologic data over the Midcontinent region.

3) Interpret the results in a regional geologic framework.

Data between 77 degrees to 108 degrees west longitude and 22 to 53 degrees north latitude were subjected to several processing steps. All vector magnitude and individual component data were processed to remove spurious data and striping effects. The processing was conducted on RSL's mini computer system.

Four major anomalous features were observed on the final processed vector magnitude map. A bullseye magnetic high over Kentucky, a low over the Mississippi Embayment, a low over the Dakotas, and an arcuate high stretching from the Texas panhandle to southern Wisconsin, were brought out by the processing. This work has greatly assisted IGS's geologists in interpreting the early geologic history of Iowa and neighboring midcontinent areas.

The satellite magnetic data were provided by the MAGSAT project group at NASA's Goddard Space Flight Center. Financial support for various aspects of this research has been provided by NASA contract NAS5-26425.

Lake Rathbun Erosion

In the years since the impoundment of the Chariton River and the creation in the late 1970 of Rathbun Lake, severe erosion problems have developed along the shoreline in several areas. The areas exhibiting the most severe problems include some of the shoreline developed as public use areas by the U.S. Army Corps of Engineers (USACE), Kansas City District. The study conducted by RSL dealt with several aspects of the shoreline problem. The results were used for planning continued improvements and relocation of existing improvements in and around the USACE public use area. Specific topics addressed in the study included:

1) Locations of specific problem areas;
2) Rates of erosion for each area;

3) Geologic and hydrologic controls on location and rates of erosion;
4) Probable future rates of erosion;
5) Probable stabilized bank geometry of "ultimate erosion line."

The Iowa Geological Survey (IGS), under funding from USACE, coordinated data acquisition, performed field investigations, and made all geological interpretations.

DATA PROCESSING

General

The acquisition in July, 1980 of a complete computer system with color image processing and display equipment, marks a watershed in the development of up-to-date research support by data processing staff at the Survey. After four years of planning, preparation and partial acquisition, the minimum configuration of hardware is in place and has been operating quite well. A number of application areas that have benefited by having this equipment are described below.

Geologic Data On-Line

A program was developed in the past year that enables geologists to retrieve and review geologic data records on video terminals located at their work stations. The data are retrievable by several selection criteria and may be printed if desired.

Graphic System

Capable of encoding point data in 1979, the graphics software now operates on lines and areas with several labeling options. Plotting on our standard Iowa base map is now performed on the in-house system. Because of the

expense and set-up time involved when plotting was performed off-site, a substantial increase in productivity has been realized.

Remote Job Entry

The Perkin-Elmer now provides service as a remote batch workstation giving access by phone lines to Comptroller's Data Procesing, WEEG Computer Center (University of Iowa), and the U.S. Geological Survey at Reston, VA. Plans are underway to increase the volume of activity on this workstation by implementing water use data processing, initiating retrievals directly from the U.S. Environmental Protection Agency's STORET data base, and by submitting edit and update records to the USGS WATSTORE system.

Iowa Water Resources Data System (IWARDS)

IWARDS has endured as a concept of service in the area of water resources-related data. An effort has been made to capitalize on common resources in the provision of IWARDS Services, as a means of avoiding duplication -- especially in the areas of equipment and software. In the period covered by this report, several hundred inquiries on water-related data have been handled. Two special projects have been underway that are handled by the IWARDS Manager and temporary staff. They are described next.

Water Quality and Cancer

During FY 80 and FY 81 two positions (computer programmer and data entry operator) were supported by the U.S. Environmental Protection Agency funds under a subcontract with the University of Iowa Department of Preventive Medicine, chaired by Dr. Peter Isacson.

The product of this subcontract is a locally-maintained computer file containing 8069 drinking water quality analyses obtained from the University Hygienic Laboratory. In addition to its application in Dr. Isacson's research, this data set has been utilized in studies undertaken at the University of Northern Iowa, by the Department of Environmental Engineering and Geography at the University of Iowa, by the University Hygienic Laboratory, by the Iowa Department of Environmental Quality, the U.S. Environmental Protection Agency at Kansas City, by IGS staff and others. The subcontract was discontinued after January, 1982 owing to funding cuts by EPA.

Water Use Data System

A design, data dictionary, data gathering scheme and plan for data management have been accomplished in the development of a state system for compiling and reporting water-use data. The program was initiated by the Iowa City District Office of U.S. Geological Survey, and data gathering and definition plans were developed under contract by the Iowa Natural Resources Council. The IGS role in the system would be to coordinate the project and manage and transfer data using facilities established for the Iowa Water Resources Data System (IWARDS). Continuation of the IGS role would require a replacement for staffing funds now coming from the USGS that are slated for curtailment in October, 1982.

To date, a pilot data set has been collected and reformatted for transfer by INRC to IGS, where it will be aggregated to geographic reporting units and entered into the National Water Use Data System at Reston, VA.

Activity in the current year includes investigation of estimating and verification techniques as an adjunct to a census approach to data collection;

and additional coordination with the University Hygienic Laboratory to assure collection of water samples for quality analysis from entities reporting use levels.

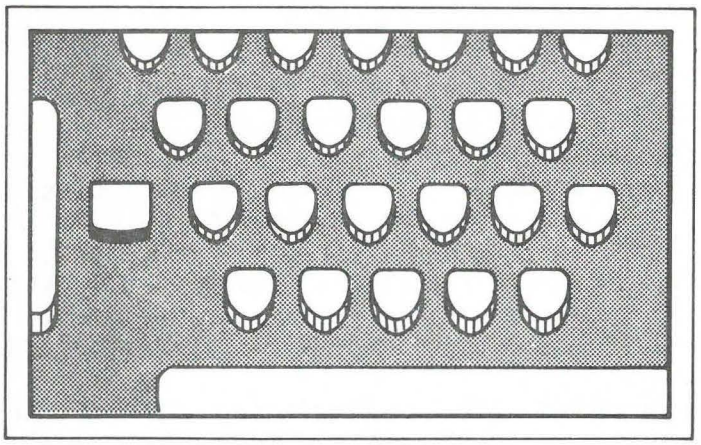
Outlook

The acquisition of new equipment and developments associated with several special projects have greatly enhanced the technical resources at IGS. This has not occurred without a need for certain adjustments. As an example, workloads and job descriptions have necessarily changed as software becomes operational rather than under development. For example, we expect the following developments in the coming years.

1) Municipal Water Supply Inventory file
2) On-line water quality file
3) Extended graphic capabilities, including contour mapping
4) A shared-access data base for use among water-data providers such as U.S. Corps of Engineers, USGS, other state agencies and IGS.

GRAPHIC ARTS

Quality graphic art is a fundamental, inseparable part of producing much of the resource information that is generated and distributed by the Geological Survey. The ability to communicate effectively is enhanced dramatically by the use of attractive, clear illustrative materials, whether the illustrations are to be used in publications, for displays, or for slide presentations. Staff of the Illustrating Division are responsible for conceptual design and layout work as a service to all divisions of the Geological Survey. The publications listed in this report contain examples of the quality work completed during 1980 and 1981.



Administrative and Support Service Group

Administrative and Support Service has the responsibility for all personnel functions, portions of budget planning, and preparation, support services at the Oakdale facility, along with coordination and supervision of Administrative duties. Personnel functions involving hiring, promotions, job reclassification, keeping current on Merit rules and regulations along with keeping IGS employees informed on new policies and procedures are managed by the Administrative Officer.

A major accomplishment by the Administrative Offices was the revision of the Geologist Series which was approved late December, 1981. This followed several months of close cooperation with the Department of Transportation (the only other State agency to employ the geologist series), and the Merit Employment Department. Included in the revision were changes in pay grades and job specifications. In general, required experience was increased for all levels except the Geologist 1, which is considered a trainee position. The revision takes the following form:

Former Class & Pay Grade		Present Class and Pay Grade	
Geologist 1	23	Geologist 1	25
Geologist 2	28	Geologist 2	28
Geologist 3	31	Geologist 3	31
		Geologist 4	34

These changes involved all 23 (including six employed under contract) geologist positions with IGS, either with salary increases and/or reclassification.

It is expected these revisions will enable IGS to be more competitive with private industry and other governmental geological surveys in recruiting and maintaining our work force. The Geologist 1 and Geologist 2 entry/journey level concept provides the option to upgrade a Geologist 1 after satisfactory completion of 12 months of "trainee" level experience to a Geologist 2 without reallocation and/or waiting for a "2" opening. This will aid in retaining highly qualified persons in our system.

The following employees are new to IGS since our 1979 Annual Report:

New members of the office staff are: Laurie Kottman, Secretary 1 as of July 1, 1980; and Renee Smith, Receptionist, August 10, 1981.

New people in Technical Services are Chris Hall, Programmer/Analyst, hired November 3, 1980 and Donna McGuire, Graphic Artist, hired Janauary 4, 1982.

As of October 9, 1981, Carol Thompson has been our Geologist 3 in the Water Resource Division.

On August 14, 1981, Arletta Orelup transferred from Job Service to IGS as the new Administrative Officer II.

The following persons are working at IGS under various contracts. John Logel (Geologist 1), hired November 12, 1980 and Cal Cumerlato (Geological

Technician) hired November 21, 1980, are part-time employees working under the Nuclear Regulatory Commission Contract.

Art Bettis, Geologist 1, hired January 11, 1982 with Steve Esling, and Curt Klug, Geological Technicians hired November 9, 1981 are working on the Big Springs-Karst Studies.

Marsha Miller, Geologist 1, hired October 24, 1980, is working under the Mineral Industry Location System Contract with the U.S. Bureau of Mines, along with David Heer, Geologist 1, hired March 20, 1981.

Arletta L. Orelup, Chief

ADMINISTRATIVE SERVICES

Administrative Services is responsible for all clerical functions involved in the daily processing of letters, manuscripts, charts, and telephone communications for all IGS employees; along with the sale of maps and publications to the general public. This division also handles incoming mail, bulk mailings, maintenance of maps, publication and office supply inventories. IGS has added a word processing system to aid in handling our many typing duties, i.e., manuscripts, reports and publications.

ACCOUNTING

All payroll, invoicing, purchasing and financial records for all IGS divisions are handled by the Accounting Technician. The accounting and the financial reports for our Federal Contracts are handled by this department. Monthly and quarterly financial reports are prepared to assist management in keeping abreast of expenditures and budget evaluations.

SUPPORT SERVICES

The activities of the Support Services Staff are many and varied. Foremost is maintaining and providing access to a wide variety of samples, including drill cuttings from approximately 26,500 wells and approximately 100,000 feet of rock core. The functions of cataloging and preparation of newly received samples and continuing efforts to inventory past acquisitions are never ending. The personal contact with well drillers and other personnel in the water well industry of the State to maintain the voluntary cooperative program of saving drilling samples is a very important function of Support Services. The Support Services Staff is also responsible for storage and care of publications, original manuscripts and field notes, care of a variety of field equipment and maintenance of IGS vehicles.

The constant improving, updating and further development of our Oakale laboratory-warehouse facility makes it possible to provide a greater range of field and office assistance for a large number of projects for IGS.

MAPS AND PUBLICATIONS

Topographic Maps

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

The long-sought goal of 100% topographic map coverage of the State of Iowa by the 7 1/2 minute quadrangle format is nearly a reality. The status of topographic mapping of Iowa as of December, 1981 is:

Number of 7 1/2 Minute Quadrangles	% of State Coverage	Availability
953	88.0	Printed; avaiable at IGS
88	8.1	Preliminary copies only, available from USGS, Rolla, MO
44	3.9	Mapping in progress
TOTAL 1083	100.0	

Publications

Education publications on such topics as fossils, minerals, and landforms are extremely popular with Iowa's citizens. As an example, over 5,000 copies of A Regional Guide to Iowa Landforms have been purchased since December, 1976. Most of our technical reports, such as water resources publications, are designed so that they can be readily utilized by consulting firms, contractors and private citizens. More esoteric reports are written for a scientific audience with specialized areas of interest.

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.

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SALES

The combined sales for maps and publications totaled $15,569 for 1980 and $19,351 for 1981. Topographic maps are sold at the price set by the U.S. Geological Survey (currently $2 per the 7 1/2 and 15 minute quadrangles). The selling price for IGS publication is based principally upon the printing costs, and the majority of publications are priced under $3.