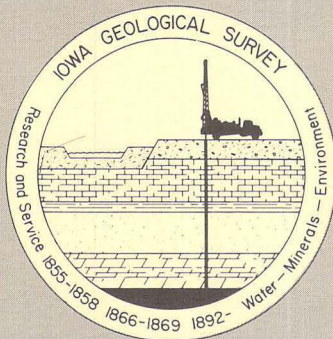


ANNUAL REPORT



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

Volume 54
1984

State of Iowa

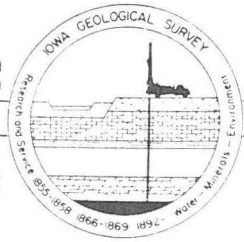
Iowa Geological Survey

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

Terry E. Branstad
Governor of Iowa

Donald L. Koch
State Geologist and Director

Orville J. Van Eck
Associate State Geologist



May 10, 1985

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

Dear Governor Branstad:

In accordance with the Code of Iowa, Section 305.7 and Section 17.4, I hereby transmit to you the *Annual Report of the State Geologist to the Governor*. It describes accomplishments and activities of the Iowa Geological Survey for the period January 1, 1984 to December 31, 1984. The legal responsibilities of the Survey are set forth in the Code of Iowa, Chapters 305 and 84. I believe an examination of this report will demonstrate that the Survey is providing information and services valuable to the proper protection, management, and development of our state's natural resources, as well as striving to improve the necessary information base to meet anticipated needs in the years ahead.

Respectfully submitted,

A handwritten signature in cursive script that reads "Donald L. Koch".

Donald L. Koch
Director and State Geologist

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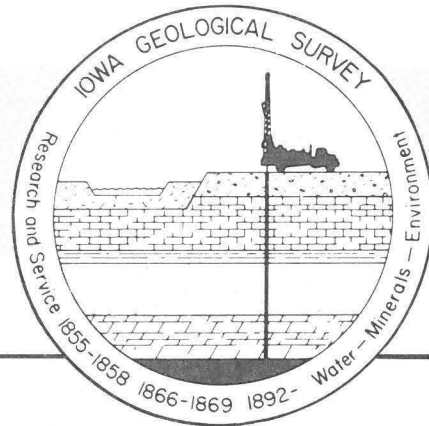
IOWA GEOLOGICAL SURVEY
123 North Capitol Street
Iowa City, Iowa 52242

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Highlights and Summary



The Iowa Geological Survey (IGS) was permanently established as a state public service and research agency in 1892 "...to make a complete survey of the natural resources of the state in all their economic and scientific aspects...." Two earlier reconnaissance surveys of Iowa geology had been commissioned from 1855 to 1859 and again from 1866 to 1869. Today, as then, IGS has the responsibility to collect, manage, interpret, and report geologic and hydrologic data that are relevant to Iowa's resource development and protection. In addition, IGS administers the exploration rules for oil, gas and metallic minerals in conjunction with the Iowa Department of Soil Conservation. An underlying assumption governing all IGS activities is that natural resource development, management, and protection must be based on both reliable, unbiased data and interpretations. The Survey makes every effort to secure and maintain basic resource data to meet immediate and anticipated needs and to develop the analytical capabilities and staff to address the resource questions. To meet these objectives, IGS conducts its own data collection/analysis programs and participates in a variety of cooperative efforts. Our highest priority is given to providing information relating to water supply, environmental concerns, or economic development. Our professional staff provided assistance to about 1500 individuals, corporations, or agencies during the past year, published 11 Survey publications and open-file reports, as well as 15 other professional articles.

We believe our agency has the capability for providing timely assistance in resource matters and that our capabilities have continued to expand. Our data base grows daily; we've significantly improved our data management systems this past year, as well as our analytical tools; and we have successfully maintained our staff in spite of difficult, uncertain state revenues.

Three areas of activity deserve special mention: groundwater contamination research, potential oil development, and improved data management.

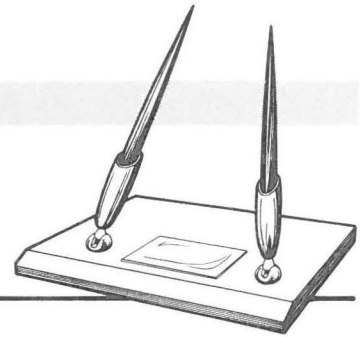
Studies conducted by IGS researchers over the past several years in cooperation with various state and federal programs have concluded that contamination of groundwater is widespread in Iowa, especially in unprotected, carbonate bedrock aquifers and in alluvial aquifers. Much of this contamination has been caused by non-point, agricultural chemical losses from the land. Increased nitrogen fertilization has resulted in concentrations of nitrate in groundwater that commonly exceed accepted health standards; increased pesticide applications on corn and soybeans have led to the detection of persistent concentrations (exceeding one part-per-billion) of widely used herbicides in our groundwater. Identification of problems is the first step in protecting our water resources. The next steps involve making plans and taking appropriate actions to safely manage the resource, to protect it, and if possible, to alleviate the contamination. In response to these findings, many Iowa agencies, including IGS, have been discussing these issues and have

developed plans which could help reduce this contamination problem in the future. Plans call for continued groundwater monitoring, evaluation of alternative agricultural chemical-management techniques, and the integration of this information into existing education and natural resource programs.

Interest in the deep-lying Midcontinent Gravity Anomaly as a region for oil and gas exploration is growing. A minimum of three million acres in Iowa appears to be under lease, and an estimated one-thousand miles of geophysical seismic data has been obtained as of 1984. Our staff has handled over 300 requests for information on the subject, including contacts from 57 oil, service, or consulting companies. Much of this interest is the direct result of IGS research activities which yielded a new interpretive geologic "model" of the area. This model was widely reported both at professional meetings and in professional publications. Such activities publicized our interpretation and helped to spur interest in the region among oil exploration groups. To serve the increasing needs of these groups, all previous oil and gas tests were re-searched and compiled into a new computerized record in order to improve its timely update and availability.

Data management is not an outwardly apparent activity, but improvements in its application allow the service and research activities of IGS to progress more smoothly. Our library of rock cuttings and cores was completely inventoried and reorganized to make more efficient use of space and to make the samples more readily available for examination. Facilities for sample study also have been improved, and make the research rock repository more useful to IGS professionals as well as visiting geologists. Furthermore our on-line, computerized geological information retrieval system, GEO, has been improved to handle water quality and well construction records in addition to the original geological data. Currently, the system contains about 11,200 sites with geologic records. Of these sites, about 3300 include water quality information and 5300 contain well construction information. Additionally, new software application packages have been written or adopted to improve the research utility of selected information from GEO.

Administration



DIRECTOR AND STATE GEOLOGIST

The Director and State Geologist is appointed by the Governor of the State of Iowa. It is the State Geologist's responsibility to plan and manage Iowa Geological Survey programs and staff so that the agency's service and research objectives, as well as administrative responsibilities pertaining to the Oil, Gas and Metallic Minerals law, may be met. The State Geologist represents IGS on various boards and committees, and frequently represents the State at public meetings pertaining to natural resource issues.

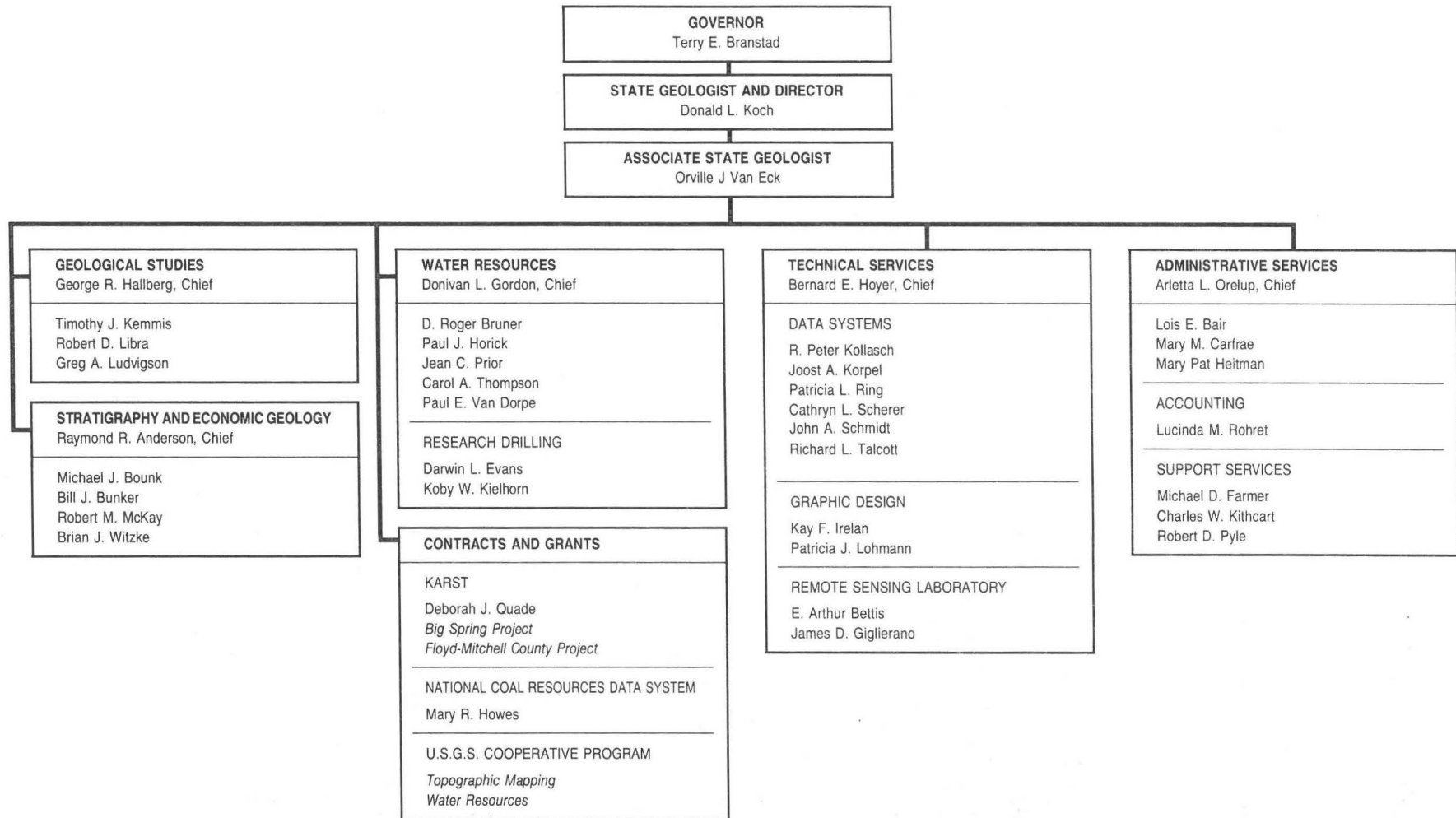
The Iowa Geological Survey operated in fiscal year 1983-84 on a State appropriated budget of \$1,523,030. State revenue shortages required reversions to the State Treasury of 2.8 percent of this amount. An additional \$134,447 was made available through outside contracts and grants and \$19,000 through map and publication receipts.

The agency has five operational divisions: Geologic Studies, Stratigraphy and Economic Geology, Water Resources, Technical Services, and Administrative and Support Services. The organization currently has 39.5 full-time equivalent staff members including 21 geologists and geohydrologists. A table of organization listing current personnel is included on the following page.

RETIREMENT

Orville J Van Eck, the Associate State Geologist since 1975, retired in November, 1984. Mr. Van Eck began his career at IGS in 1953, after completing an MS degree in geology from the University of Michigan. Orv, like all IGS geologists, conducted research and responded to requests for information on a wide range of topics. His research on aggregate materials in southwest Iowa, conducted during the 1950's, remains the standard geologic work in this area. Orv's special areas of interest were coal, groundwater, and geophysics. As an administrator, he had primary responsibilities for budgeting, coordinating programs with the U.S. Geological Survey, and administration of all contracts and grants. His friendship, practical knowledge, common-sense wisdom and steadying influence will be missed. Orv and his wife, Pat, have maintained residence in Iowa City.

IGS ORGANIZATIONAL STRUCTURE



Geological Studies



HYDROGEOLOGIC STUDIES

Agricultural Chemicals and Groundwater Quality

IGS studies of the contamination of groundwater by agricultural chemicals have continued in cooperation with various state and federal agencies. The studies continue to focus on the Big Spring basin in Clayton County, and on Floyd and Mitchell counties. Studies completed in 1984 corroborate previous results and continue to provide information necessary to begin an assessment of the effect of agricultural practices on groundwater quality. These data indicate that contamination of groundwater in susceptible aquifers (notably the regional carbonate aquifers and alluvial aquifers) is widespread and is caused by non-point source, agricultural chemical use.

Increased and excessive nitrogen fertilization and poor nitrogen-management have resulted in nitrate concentrations in groundwater which are above accepted health standards. In 1984 over 40 public water supplies exceeded the health standard for nitrates. These studies in northeastern Iowa have shown that in a wet year, an equivalent of over 50 percent of the fertilizer-nitrogen applied may be lost to water supplies; even in a normal year, more than 30 percent may be lost. These data clearly show that the losses are an economic as well as an environmental concern.

Increased pesticide usage on corn and soybeans has also led to the contamination of groundwater by pesticides. Many of the most-commonly used herbicides have been detected in groundwater in Iowa; some now occur throughout the year. These pesticides generally appear in very low concentrations (0.1 -1.0 part-per-billion) but locally have exceeded 20 parts-per-billion. The concentrations of some of these herbicides are the highest reported from anywhere in the United States. The long-term health effects from such chemicals in drinking water are unknown. These studies have been partially supported by the U.S. Environmental Protection Agency during the past year; analytical costs have been partially supported by the Iowa Department of Water, Air, and Waste Management (DWAWM) and the University of Iowa Hygienic Laboratory.

Ad-Hoc Karst Committee

To begin to deal with the problems of agricultural chemicals appearing in

drinking water, particularly groundwater, IGS staff helped coordinate the meetings of the Ad-Hoc Karst Committee. This interagency committee includes representatives from: (1) all the Iowa natural resource agencies; (2) Iowa State University -- Cooperative Extension Service, Agronomy Dept. and Experiment Station; (3) University of Iowa -- Hygienic Laboratory and Institute of Agricultural Medicine; (4) private citizens from the Northeast Iowa Conservancy District and various county soil conservation districts; (5) the Iowa Fertilizer and Ag-Chemical Dealers Association; and (6) Federal agencies - the U.S.D.A. - Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the U.S. Environmental Protection Agency. This group has accomplished three primary tasks this past year: (1) identified the problems associated with karst areas; (2) reviewed agency policies and responsibilities pertinent to resolution of groundwater quality problems in northeastern Iowa; and (3) developed possible solutions including a comprehensive, interdisciplinary research -demonstration project designed to develop economically efficient agricultural-management practices that would reduce chemical losses into water supplies. Agronomic research being conducted at Iowa State University and hydrogeologic research conducted by IGS indicate that ag-chemical losses can be reduced, resulting in a more efficient agriculture, possible economic gains for farmers, and water-quality improvement. Alternative management practices, however, are yet to be proven and demonstrated. It is hoped that the proposed Big Spring Basin Demonstration Project which the Ad-Hoc Karst Committee has outlined can be one vehicle for demonstrating effective environmental protection. Currently, funds are being sought to support the project.

West-Central Iowa Project

Field work for the IGS - U.S. Geological Survey cooperative regional test-drilling and water-resources evaluation program in west-central Iowa was completed. In part, this program was an extension of the Dakota aquifer project which was completed previously in adjacent northwest Iowa. Before this project was initiated, however, west-central Iowa was the portion of the state where IGS had the least extant subsurface information. During the data collection for this project, 241 test holes totalling 298,555 feet were drilled, 94 of which were developed as observation wells. In addition, 120 water samples were collected for chemical analysis so that the quality of waters from aquifers in the region could be characterized. Since the completion of field work, data synthesis has proceeded. Map and report preparation is underway.

OTHER GEOLOGIC STUDIES

Sand and Gravel Resource Study

Geological Studies staff have been conducting research on the nature and distribution of sand and gravel deposits which occur in terraces along the Iowa and Des Moines river valleys in north-central Iowa. The geologic model being developed will allow extrapolation throughout the valley. Although the

study is still in its preliminary stages, the data already have proved useful for an assessment of the alluvial aquifer of the Des Moines River, an appraisal of local sand and gravel resources, and an assessment of a toxic and hazardous-waste site involving litigation.

Lead-Zinc Studies

Since 1974, the Geological Studies Division has had an ongoing project to compile field and laboratory analyses of lead-zinc deposits in northeast Iowa. Several recent publications have focused attention on the Plum River Fault Zone in eastern Iowa as a potential frontier exploration area for new lead-zinc deposits. Systematic field collecting from special areas of interest was continued in 1984, and laboratory analyses will be performed on these samples to evaluate potential for economic mineralization. This work has precipitated some renewed interest in Iowa from various mining companies which have visited IGS this past year.

Cooperative Applied Soils Research

Staff of the Geological Studies Division direct, coordinate, and/or participate in ongoing cooperative research programs 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 three-dimensional soil-landscape models, to assist and improve soil-survey operations.
3. Quantitatively evaluate engineering properties and problems associated with survey mapping units or geologic units, as appropriate.

As an ongoing part of the cooperative applied soils research, IGS 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. IGS serves as an ex officio advisor to the Cooperative Soil Survey Planning group.

CONSULTATIVE INVESTIGATIONS

As a necessary service, IGS has always performed investigations of critical problems for Iowa's regulatory agencies. For individual investigations that require excessive amounts of time, travel, or other costs, the

agencies may share the cost burden, but for the majority of these investigations IGS absorbs the cost. These are necessary investigations which generally cannot be foreseen, and always interrupt the scheduling of other planned projects. Thus, flexibility must be built into IGS's longer-term projects. These investigations are categorized below.

Toxic and Hazardous-Waste Sites

Staff have provided general information to DWAWM and U.S. EPA on numerous sites involved with the Resource Conservation and Recovery Act and Superfund programs. Site reviews generally include evaluating the general hydrogeologic setting, identifying and detailing the nature of groundwater supplies used in the area, and evaluating monitoring plans.

The staff have also provided more detailed investigations of 15 sites for DWAWM and county or local health departments and fire marshals, including pesticide dumps and spills, hazardous-waste disposal, and petroleum leaks and spills. These projects have involved investigative field work, directing field investigations by other agency personnel, review of consultants' reports, and testimony at formal proceedings.

In this general area, the review of progress and data from the LaBounty arsenic disposal site and the Aidex pesticide dump are continuing affairs.

Other Waste-Disposal Sites

Geological Studies staff also provide a review of plans for all newly proposed, or expansions of existing landfills. In addition, because of the collapse of a newly constructed sewage-disposal system, IGS has been asked to review all waste-disposal operations in northeastern Iowa.

Other Water and Land Issues

Staff routinely provided review and information on a number of other issues, including:

1. Design and analysis of pumping tests for DWAWM well-permit hearings.
2. Information or testimony for various hearings regarding water permits obtained from DWAWM.
3. Consultation on natural land-boundary disputes for the Iowa Conservation Commission and/or the Attorney General's office.
4. Continuing consultation on Indian land cases along the Missouri River.
5. Review and testimony regarding the ETSI water-allocation litigation.
6. Review of new rules and regulations proposed by Iowa and federal regulatory agencies.

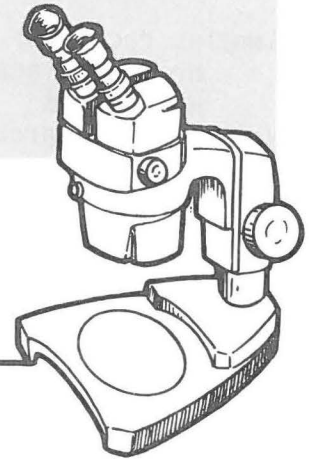
Site-Development Potential

Requests for information regarding site-development potential is an area that has increased markedly over the past two years. As the cost of development increases, it has become more common to seek preliminary information on alternative sites before expensive on-site investigations are undertaken. Of particular note are a number of requests (primarily from eastern Iowa and the Des Moines area) for information concerning engineering-geologic conditions for foundations and/or potential problems for new commercial/industrial construction. The requests have come directly from the interested commercial/industrial firms, from engineering-consulting firms or architectural firms which represent clients, and from various state and local government agencies involved with commercial development, including the Iowa Development Commission. As IGS expertise in this area has become better known, the number of requests has risen.

Parallel to these inquiries have been information requests regarding general soil-geologic and drainage conditions, the suitability for sewage disposal, water and utility lines, and possible economic value of soils in various development areas. These requests have come from various state, local, and federal agencies, several Iowa municipalities, regional planning agencies, and private firms and individuals.



Stratigraphy and Economic Geology



BASIC GEOLOGIC DATA ACQUISITION AND STUDY

Basic rock data in Iowa is developed from the systematic collection and study of rock chips collected from drilling water wells (well cuttings), continuous cores of rock obtained from IGS research programs or industry, and exposures of rock developed artificially in quarries, along road cuts, or naturally along streams and rivers. By far the largest amount of data comes from well cuttings. These samples are saved and donated by private well drillers active in Iowa. Actual exposures of rock and continuous rock cores provide more detailed information. The following table provides a summary of research activity during 1984.

IGS Rock Samples received, processed, and studied in 1984

	<u>Number of wells or sites</u>	<u>Total Feet</u>
Samples received:		
Well cuttings	325	72,105
Rock cores	12	3,500
Well cuttings processed	239	152,187
Samples studied:		
Well cuttings	85	33,000
Rock cores		
Detailed logs	25	2,500
Reconnaissance logs	17	2,600
Outcrops studied:		
Detailed measurements	58	2,700
Reconnaissance measurements	77	2,500

The well cuttings, rock cores, and outcrops studied during 1984 add to the information previously compiled. Following are actual counts and estimates of the total rock data available at IGS at the end of 1984.

Total IGS Rock Samples received, processed, and studied through 1984

	<u>Number of wells or sites</u>	<u>Total Feet</u>
Samples received:		
Well cuttings	28,061	7,500,000
Rock cores	804	92,400*
Well cuttings processed	27,441	7,250,000
Samples studied:		
Well cuttings	20,416	6,500,000
Rock cores		
Detailed logs	100	10,000
Reconnaissance logs	250	30,000
Outcrops studied:		
Detailed measurements	2,000	60,000
Reconnaissance measurements	2,000	60,000

*Most cores are not complete from top to bottom. The number represents the feet of core collected from the 804 holes. The core was recovered from holes which represent about 354,700 feet of section.

The backlog of unstudied wells, however, continues to grow. Following is a tabulation of unstudied well data.

IGS Unstudied Wells (Rock Cuttings)

	<u>Number of Wells</u>	<u>Approx. Footages</u>
Bedrock wells:		
Iowa wells	4,244	450,000
Out-of-state wells	20	20,000
Wells not reaching bedrock:		
Iowa wells	2,113	220,000
Out-of-state wells	<u>26</u>	<u>20,000</u>
TOTAL	6,403	710,000

Additionally, about 52,400 feet of core has been collected which is currently unstudied. The study of rock cores is very time consuming, but rich in information. Normally, cores are studied only in direct response to particular problems. Their availability is invaluable, however, because even if they are not fully studied immediately, they may provide the most important information available for researching future problems.

RESEARCH PROJECTS

Iowa Stratigraphic Study

The Stratigraphic Study is a comprehensive reevaluation of the entire rock sequence in Iowa. It includes a restudy of each geologic system and constitutes the major research effort of the division.

To conduct this study, previous data is being merged with new data collected in the field. This data is often analyzed in ways which were not available previously. Rock walls in quarries and along road cuts and streams are being carefully described and sampled. Rock characteristics are also being combined with microscopic examination, especially petrographic and micro-paleontological analyses, in order to recorrelate them and aggregate them into more meaningful units. Geophysical logs and geochemical data which were not available earlier are also being used in this restudy of Iowa's rock sequence.

This work has already produced tangible results. The reevaluation has enabled staff to help develop interest in oil exploration and to understand water quality and quantity issues in north-central and east-central Iowa, especially in Floyd, Mitchell, Linn, Jones, and Jackson counties. More tangible benefits are expected as the study progresses and as the future brings additional questions which must be addressed. Reports on each geologic system will be prepared before the centennial of the Iowa Geological Survey in 1992.

Biostratigraphic and Micro-paleontologic Studies

In 1984, the Stratigraphic and Economic Geology Division (STRECOG) greatly increased its capabilities to utilize micro-paleontology in stratigraphic studies. The IGS laboratory facilities at Oakdale were improved and made more functional. Of greater importance, several staff members increased their proficiency at preparing and/or identifying microscopic paleontologic specimens.

Microscopic fossils have great utilization for correlation of rock strata from one part of Iowa to another. The use of established world biostratigraphic zones is of particular value here in Iowa for defining the geologic history of the state within the context of the North American continent. The ability to correlate rock units from one area to another in Iowa is particularly important to IGS hydrologists who are redefining regional aquifer systems and areas of groundwater pollution. During 1984 approximately 80 samples were run, primarily in the Floyd and Mitchell counties area, as part of an aquifer study in the local karst terrain. Preliminary indications show a relationship between lithic types and the contained microfossils. Such study has helped to define the multiple aquifer systems present within the Devonian System in northern Iowa and will help to define other relationships previously not understood in Iowa.

Plum River Fault Zone

The Plum River Fault Zone research was completed and a draft report was prepared for publication in early 1985. It includes stratigraphic descriptions of Ordovician, Silurian, Devonian, and Pennsylvanian rock units in eastern Iowa. New stratigraphic subdivisions in the Silurian are proposed. The structural history of eastern Iowa and the geological development of the fault zone are described. The fault zone has importance in water resources and may have economic significance as well.

Midcontinent Strategic and Critical Minerals Program

In 1984 STRECOG completed its first of perhaps a five-year, multistate evaluation of the known and potential strategic and critical minerals in the north-central U.S. The study area is delineated by latitudes 36° to 44° N and longitudes 88° to 100° W. The program is funded partially by the U.S. Geological Survey. The non-fuel mineral resources to be assessed in this study are dominantly base metals. The USGS arranged to reimburse STRECOG for the production of a series of Iowa maps and cross-sections that will be integrated into regional maps. Following is a list of maps produced in 1984.

1. Stratigraphic Control Wells and Data
2. Precambrian Geology and Structure on the Precambrian Surface
3. Cross-Sections Along Even-Numbered Lines of Latitude and Longitude (4)
4. Review of USGS Map of Mineral Districts (surface mineral occurrences)
5. Isopach/Lithofacies of Sauk Sequence
6. Subsurface Mineral Occurrences

Precambrian Dating

The Kansas Center for Research provided nearly \$5000 to the IGS to re-occupy the IGS D-21 Camp Quest hole and obtain an additional 250 feet of Precambrian core. The core was obtained to provide material for a radiometric date. This would allow these western Iowa deposits to be compared with Precambrian deposits elsewhere in the Midwest. Earlier dates from this area have proved problematical.

Source Rocks for Oil and Gas

STRECOG has been working with the USGS Oil and Gas Division in Denver on potential source rocks in Iowa. Many rock units in Iowa have been analyzed; some have contained as much as 41 percent organic carbon. The Glenwood shale of Ordovician age was positively identified as the source rock for the 410 barrels of oil produced near Keota (Washington County) in 1963.

SERVICE

Oil and Gas Exploration in Iowa

In 1984 STRECOG responded to about 300 requests for information on oil and gas exploration in Iowa. These requests included technical information to petroleum exploration and service companies, general information to Iowa residents, and interviews with the media. During the year, STRECOG was contacted by seven major oil companies, 23 independent oil companies, and 27 consultants and service companies. Geologists from nine companies visited our offices for information and to examine samples in our rock library.

Six oil tests were drilled in 1984, one each by Teague Operating Company and Milo Ditterline in Montgomery County, and four by Diversified Resources Inc. in Mills County. An estimated 1000 miles of deep seismic profiles were produced in Iowa in 1984 by Texaco, Western Geophysical, Geosource Inc., and Richardson Seismic Services and other unidentified companies. We estimate that about three-million acres of Iowa land were leased by oil leasing companies along the trend of the Midcontinent Geophysical Anomaly.

Other Information Requests

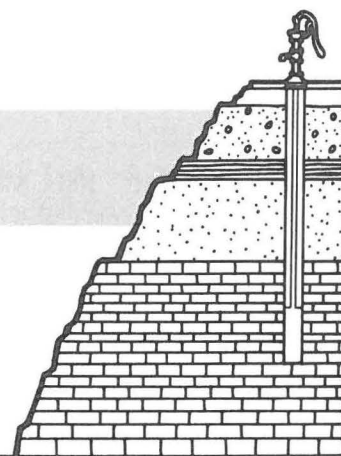
Many other information requests were answered by STRECOG in 1984. The most common (excluding oil and gas subjects) concerned topographic maps (interpretations, benchmarks, latitude and longitude), rock identifications, mineral resources information (gypsum, limestone, sand and gravel, silica sand, clays, etc.), and field trip information. STRECOG staff responded to over 200 such information requests in 1984.

State Map Advisory Council

The Iowa State Map Advisory Council was reborn in 1984. The membership of the council includes 10 representatives from state and county government and private industry. The Division Chief was elected chairman for 1984-85. Meetings were held in August and October, 1984.



Water Resources



SERVICE ACTIVITIES

Well Forecasts and Advice on Well Problems

During 1984, Division staff responded to over 500 individual requests for advice on the development of new wells or procedures to be followed in correcting specific well problems.

A typical well forecast is a letter report that provides site-specific information on the thickness and sequence of geologic formations to be encountered during drilling, formations that will provide water, the anticipated rates of yield, and the expected quality of water. Depending on the detail and precision required by the request, an individual report may take from four to over eight hours to prepare. During 1984, approximately 20 percent of the Division's staff time was spent in this type activity. Information requests are arranged by categories in the following table and are compared with similar data for 1982 and 1983.

<u>Category</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
State/Federal Agencies	0	37	46
Municipal	93	118	142
Commercial/Industrial	52	76	71
Domestic	117	151	137
Irrigation	12	6	11
Housing Developments	9	7	8
Rural Water Systems	8	1	0
Recreation	16	4	3
Livestock Operations	4	12	4
Regional or County	20	14	14
Pumping Tests	11	0	3
Other	42	56	69
TOTALS	384	482	508

Consulting and Field Investigations

Each year WRD staff are called upon to provide information and participate in a variety of non-routine office and field investigations. These requests come from individuals, commerce and industry, city and county government, and state and federal agencies. Many require coordination with other state and federal agencies or with other operating divisions of IGS.

During calendar 1984, division staff responded to over 150 of these types of requests. Only six required investigative work in the field. The following list provides a sampling of problems IGS addressed and the source of the particular requests:

- Organic chemicals in private wells, Hospers; DWAWM.
- Toxic materials discharge to groundwater, U.S. Nameplate, Mt. Vernon; local interests.
- Excessive nitrate in municipal well, Manchester; City and DWAWM.
- Potential groundwater contamination by electro-plating wastes, Helgeson Landfill, Lake Mills; DWAWM.
- Excessive radionuclides in mobile-home park well, Iowa City; DWAWM.
- Impact of reinjected process water from underground gas-storage facility, Columbus City; DWAWM and Region VII EPA.
- Ammonia nitrogen in public water supply, Malcom; DWAWM.
- Diminished capacity in several industrial wells, Cedar Rapids; Cargill Inc.
- Site hydrologic evaluation of acid mine-drainage problem, abandoned coal mine, Mahaska County; Department of Soil Conservation.
- Evaluation of potential water-impoundment site, Sac County; Iowa Conservation Commission.
- Landslide problem (mine subsidence/hydrology) evaluation along Northwestern R.R., Marion County; Department of Soil Conservation.
- Definition of groundwater supply problem areas within the Iowa-Cedar River Conservancy District, for the Conservancy District Action Plan; Department of Soil Conservation.
- Evaluation of a local aquifer with respect to potential well interference problems between several municipal wells and an irrigation well, Dallas County; cities of Dexter, Redfield, Stuart, Agri Industries and DWAWM.

Assistance to the Division of Mines and Minerals (DSC) and Coal Mine Operators

During 1984, 53 written responses and numerous telephone responses were made to coal miners, state and federal mine regulators, and private parties regarding information and technical assistance on coal occurrence and quality, underground-mine maps and mine-subsidence problems.

Staff reviewed and updated the Iowa section of the Keystone Coal Industry Manual. In addition, they also co-authored technical papers dealing with the revision of Pennsylvanian stratigraphy in Iowa and with the potential for land subsidence resulting from past underground mining at What Cheer, Iowa.

Division staff continued to provide assistance to the Department of Soil Conservation, Division of Mines and Minerals in the technical review of operators' mine plans and subsidence-control plans. Such plans are required for new coal mine operations before approval and permitting. The Division also coordinates and supervises the program for reevaluation of the Iowa Abandoned Mine Lands Inventory. The work is being accomplished under contract with the Office of Surface Mining and the Department of Soil Conservation. An element of the program is the restoration of historic mine maps. This work is funded by OSM, administered by the Department of Soil Conservation and coordinated by division staff. The map restoration is being done by the Iowa Historical Society.

RESEARCH ACTIVITIES

Although a key agency/division goal is to assist Iowa's industries, businesses, communities, and citizens in the development of water supplies to meet their needs, there is also an agency awareness that the state's groundwater resources have a finite limit. In this regard, Division research objectives have been adjusted to consider the budgeting aspects of groundwater planning and management. Fundamentally, how much water is available; what rates of pumping can be sustained; in terms of water-use, how much is used, where, and for what purposes; and how much additional use can safely be authorized. Relative to state water-allocation priority planning, these information elements are receiving high agency priority in research and data collection activities.

During calendar 1984, the Silurian-Devonian aquifer study was completed and published. This study, along with prior studies of the Jordan, Mississippian, and Dakota aquifers, essentially completes the study of Iowa's most important regional aquifer systems, and opens the way to accelerating investigations of the water resources of southwest Iowa and the state's alluvial groundwater systems.

Municipal Water-Supply Inventory

In July, 1981, a program was initiated by the Division to comprehensively inventory data on the water supplies of the state's incorporated communities. The primary purpose of the project is to expand the agency's knowledge of community water developments and to allow IGS to be more effective and efficient in providing services to Iowa communities. The data being inventoried resides in files maintained by the six regional offices of the Department of Water, Air and Waste Management (DWAAM).

The data being compiled includes the location and design of wells, the geologic source of water, rates of pumping, water use, and water quality. These data are merged with existing IGS data to generate a more comprehensive information base. The objective of the program is to develop and maintain a computer file for municipal wells which can be used to assist communities with problems related to water-supply management and development.

To date, all DWAAM regions except Region IV have been inventoried. In these regions, 743 community-supply systems have been researched representing approximately 92 percent of the incorporated communities in Iowa. Six hundred

and ninety-seven of these communities rely on groundwater which is drawn from 1775 operating wells. Prior to the inventory, IGS had data on only 665 of these wells, or about 57 percent of them.

County Groundwater Availability

Related to the agency's objective of keeping Iowans informed on their alternatives for water supply, a program began in 1979 to produce groundwater-availability reports for each of the state's 99 counties. Twenty-three of these reports have been published to date, and three others are being prepared for publication. Each report contains the following information:

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

Alluvial Aquifers Project

Work was initiated in fiscal 1981-82 to evaluate the hydrogeology of the state's major alluvial aquifer systems. Though many of Iowa's major municipalities, rural water distribution systems, and irrigators draw water from these hydrogeologic systems, little is known of either their true potential or their limitations beyond local points of water withdrawal. In many regions of the state, water from alluvial sources represents the only viable alternative for large quantities of good-quality water. As competition for this water increases, it becomes imperative to inventory the potential capability of these sources and to assess the hydraulic implications relative to stream-flow depletion. The completed program will consist of systematic evaluations of alluvial aquifer systems associated with Iowa's major interior streams. Existing development activity established the priority for studying the river systems. The pilot study, the upper reach of the Des Moines River (above the Saylorville Reservoir), was completed late in 1984 and published as Open File Report 84-5.

During the summer of 1984, field investigations on the Ocheyedan, Little Sioux, and Upper Raccoon alluvial systems were essentially completed. The seismic and other data obtained has been processed, and a series of geologic cross-sections have been prepared.

Observation wells will be emplaced along these rivers during the spring of 1985. The wells will be used to monitor groundwater quality, to define aquifer hydraulic parameters, to monitor pumping effects on river stage, and to observe seasonal changes in water levels. Water-quality work has expanded because of monies made available to the Division through a grant from Region

VII EPA. Under the terms of this grant, the Division will be investigating the occurrence of pesticides, nitrate, and coliform bacteria in the aquifers during the next year.

Water Resources of Northeast Iowa

A regional water atlas covering eleven northeastern Iowa counties is in preparation. This project, initiated during 1982, includes the following counties: Howard, Winneshiek, Allamakee, Chickasaw, Fayette, Clayton, Bremer, Black Hawk, Buchanan, Delaware, and Dubuque. The atlas will be the seventh in the Survey's Water Atlas Series and is scheduled for publication in 1986.

Evaluation of Data Needs for the State Water Resources Information System

As mandated in Section 60 of House File 2463, the State Geologist was directed to prepare a plan for a State Water Resources Information System, and to implement and maintain the associated data system. The plan was presented to the General Assembly during January 1983, and it was accepted. Funds to begin implementing the plan were appropriated by the 1983 Legislature.

As proposed by IGS, these funds were earmarked for improvements in IGS data processing capabilities, for data system implementation, and for expansion of the Division's technical support capabilities in the areas of water budgeting and computer modelling.

During the past year, the Division provided one staff hydrologist to assist DWAWM in accessing and interpreting IGS computer-file hydrologic data for the State Water Allocation Plan. This also involved coordinating with IGS data processing staff.

After determining the information system needs for groundwater modelling capabilities, a general purpose, three-dimensional flow model developed for the U.S. Geological Survey was selected and purchased. The model has been installed on the IGS computer and has been enhanced by merging it with an existing graphics software package. This improvement enables the generation of graphic displays of the model's numerical results.

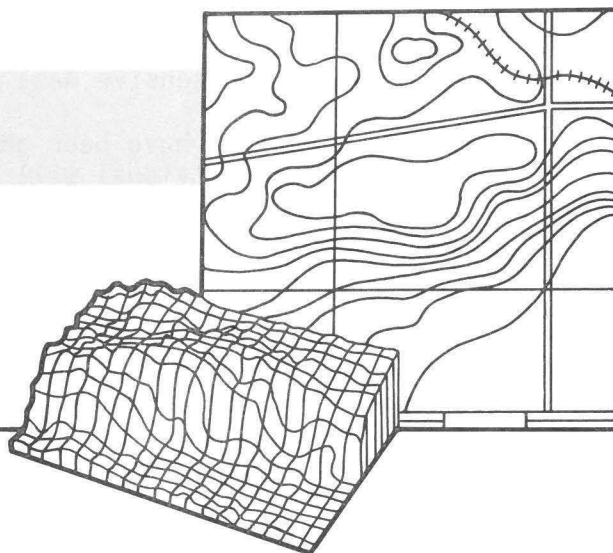
OIL, GAS, AND METALLIC MINERALS

As provided in Chapter 84 of the Code of Iowa, the State Geologist is designated as the Administrator of Oil, Gas, and Metallic Minerals, and is responsible for administering the provisions of Chapter (780) 29 of the Iowa Administrative Code. His duties include the issuance of drilling permits for oil/gas exploration or production, including underground gas storage; the maintenance of all administrative, geological, and production records; and surveillance of associated well or facilities abandonment.

Six drilling permits for oil and gas exploration were issued during 1984. They were issued to Diversified Resources Ltd. (4), Denver, CO; Teague Operating Co. (1), Mabank, TX; and Milo Ditterline (1), Brownfield, IL. Four of these tests were drilled in Mills County and two in Montgomery County. All were plugged and abandoned with no report of oil or gas potential.

The Iowa Geological Survey continues to serve as consultant to the Iowa Commerce Commission by reviewing procedures of the Northern Natural Gas Company concerning the abandonment of the Vincent (Webster County) gas-storage reservoir. The acreage under lease for this facility when abandonment began in 1971 was 12,373 acres. Gas storage agreements on approximately 10,113 acres along the outer periphery of the field have been dropped.

Technical Services



DATA PROCESSING

Data processing has become an increasingly important tool for IGS geologists and hydrologists as they respond to routine service and information requests as well as perform their more detailed assignments.

Emphasis has been placed on making extant computer data available in convenient formats for our technical staff. Programming manpower has improved the usage of geological, water quality, and well-construction data developed through the IGS-USGS cooperative data-coding projects. This includes improvements in GEO, our basic data retrieval master program, as well as special applications programs for research topics such as groundwater allocation planning and groundwater contamination of karst regions. Emphasis has also been placed on modification of software developed elsewhere so that our staff has it available in convenient, easily usable forms.

Data processing priorities may shift somewhat in the near future. Internally IGS needs to integrate data processing directly into the basic data acquisition and management programs, such as the study of water-well samples and records. Data processing should not require additional steps to the process of recording well locations, geologic formations, and water quality, but should be integrated into data handling so that redundancy and mistakes are avoided. Emphasis will be placed on data entry and data management as part of an agency-wide review of our basic information programs. Currently, out of 20,416 studied wells, 11,124 or 54 percent are in the computer, and represent a total of 3,381,686 feet of rock section. GEO also has access to 9,228 water-quality records from 3,376 wells, and site-inventory data on 5,313 of these wells. This is an impressive data set available for retrieval under GEO, however, core data is not available to GEO; outcrop data is not available to GEO; unstudied well sites are not available; and even routine water-quality sampling from recent groundwater research is not conveniently available to our staff. This situation requires improvement.

Improvements in the GEO Data Retrieval System and Related Analytical Programs

The GEO on-line data retrieval system has been improved by the inclusion of records on well construction, aquifers utilized, and pumping tests from 5,313 wells in Iowa. Most of the sites in this Groundwater Site Inventory

file complement sites in the Geologic and/or Water Quality files. Thus, GEO has become a more comprehensive data base to consult for information on hydro-geologic problems.

Other new features have been added to GEO. The system will now search the geologic file by individual well number. A 'radius search' also has been installed. The user can specify a town name and a given radius and then receive all data contained in the specified file from within the circular area specified. By entering the names of two towns or two geographic point locations, the user can retrieve data from within a rectangular corridor. This feature was introduced to aid those doing traverses for cross-sectional diagrams using a program named XSECT.

Considerable effort also has been spent to develop capabilities for producing contour maps or geologic data displays. The contour-mapping algorithm adapted for use at IGS is the SURFACE II mapping package, a software package developed by the Kansas Geological Survey. This computer program provides a new tool for use in geological studies at IGS and greatly expands our graphics capabilities. CONTOUR is a program which controls SURFACE II and makes it easier to use. In keeping with the trend established by previous graphics programs at IGS, CONTOUR uses stratigraphic records selected from GEO and produces contour maps and three-dimensional 'net' diagrams. The program is menu-driven and allows the geologist to select the stratigraphic interval, contour interval, area, and map size. Location maps and various other plotting options are also provided. The maps produced by CONTOUR may be displayed and modified at a terminal or routed to the Versatec or Hewlett-Packard plotting devices. The modular design of CONTOUR allows for programming of additional features as needs arise.

XSECT is the program used to draw stratigraphic cross-sections and has been in use for two years. This program was enhanced with options which allow the cross-section to be displayed on graphics terminals and to be modified as desired before paper copies are produced.

Oil and Gas Well Files

Public inquiries regarding oil and gas test wells in Iowa are now being handled with up-to-date, automated listings and location maps. This service is available since the adoption of an interactive data-entry routine and use of a modified version of the GEO system which retrieves only oil and gas well records. Additional data are entered immediately upon being received. All public records are automatically available in the generated report.

COMPREHENSIVE WATER RESOURCES INFORMATION SYSTEM

The Iowa Comprehensive Water Resources Information System, described in a report to the Iowa General Assembly in January, 1983, is the context within which IGS Data Systems staff cooperate with members of other agencies on data issues of mutual interest. The principle of direct interagency cooperation at the technical staff level has been established through a number of projects involving IGS and other natural resource agencies. For example, IGS programmers have worked with the University Hygienic Laboratory staff on a design for electronic water-quality data transfer procedures which could replace the cur-

rent practice of mailing analysis reports. Public water-supply records compiled by the IGS Water Resources Division from the DWAWM regional office files have been converted to computer-readable form for five of the six DWAWM regions. Arrangements are pending with DWAWM to share the task of maintaining up-to-date public supply records on the data base system in Des Moines.

The project receiving major attention this past year was related to generating aquifer, streamflow, rainfall, and other hydrologic data supporting the State Water Allocation Study. About 100 graphs and 20 data sets were assembled and prepared cooperatively by IGS data-processing staff and Water Resources Division staff for this study directed by the Department of Water, Air, and Waste Management. This effort required many special programming adjustments to meet DWAWM's requests and to facilitate the linkage of several different computer programs together. These efforts will pay major dividends in the near future as linkages between capabilities are established.

The "Technical Coordinating Committee Report on Short-and Long-term Needs" was completed in 1984 and was based on meetings with the Technical Coordinating Committee of the Comprehensive Water Resources Information System and on internal discussions. Data availability needed for an accurate assessment of water-resources reserves remains an issue among Iowa's natural resource agencies. Short-term solutions to data needs as presented in this report are as follows:

- A. Interagency cooperative maintenance of a more extensive, up-to-date, and easily accessible Municipal Supply Inventory data-base.
- B. Equipment and computer-memory expansion for graphics processing and for storing water resources information.
- C. A computer terminal for the State Climatologist's Office to allow more timely access to current weather data by other agencies in Iowa.
- D. A seminar on computer resources available through IGS, Comptroller's Data Processing, and the state universities with emphasis on data management and transfer, and on graphics and analytical techniques.
- E. Systematic evaluation of water resources data presently available on computer.
- F. Data communications linkage between IGS and the U.S. Geological Survey office at Iowa City.

Long-term needs addressed in the report included:

- A. Entry and electronic transfer of water-quality analysis reports by the University Hygienic Laboratory.
- B. Closer cooperation among state agencies collecting, managing, and sharing water resources data.
- C. Study of data users' needs relative to existing data collection networks.
- D. Augmentation of data-entry and data-quality control programs at IGS.
- E. Development of user-friendly, on-line and batch data analysis and display routines by IGS. These routines should be tailored for geographic applications, e.g., sub-basin studies of water use and availability.

REMOTE SENSING LABORATORY

Landsat Thematic-Mapper Scene Evaluations

Two Landsat Thematic-Mapper digital scenes were acquired this year covering areas in northeast and east-central Iowa. The Thematic Mapper is a new satellite imaging sensor which has improved spatial resolution (30 meters) and spectral resolution (seven bands -- three visible, three near-infrared, and one thermal infrared). Evaluation, both visual and by computer, was conducted to determine the usefulness and information content of these images.

Visual inspection was done on the Survey's Comtal color-image analysis system. Several combinations of bands were used, and they proved to be exceptionally graphic. Boundaries between landuse categories such as fields, forests and urban areas were sharp and distinct. Strip-cropping practices in northeast Iowa were easily identified. Residential streets, small parks and large buildings were recognized on an image of Iowa City. Meander scars were visible along the Iowa River, and strip-mining operations were observed around Oskaloosa. Water-temperature differences were seen clearly in Coralville Reservoir and Lake Macbride using the thermal bands.

The computer evaluation involved use of a maximum-likelihood classification program which categorized landuse patterns near Oskaloosa. The program recognized seventy distinct classes which were grouped into major categories: water, trees, pasture, urban, plowed and unplowed fields. Agricultural areas could be grouped into classes in which class boundaries corresponded to field boundaries. Thus, homogenous classes represented farm management units. In addition, slight variations in similar classes were thought to reflect small differences in surface conditions. For example, variations within plowed fields and between different plowed fields showed that two variables, moisture content and time since plowing, were being measured. Within unplowed fields, at least three subgroups were observed which probably represent differences between unharvested corn, soybeans, and crop residue. It is expected that further investigations could lead to the identification of the amount of crop residues left on fields. In summary, Thematic-Mapper data represents a significant improvement over the older Landsat data in the ability to detect different vegetation and underlying soil properties or conditions within Iowa's agricultural landscape.

Geophysical Data Base

To facilitate the study of hydrocarbon potential associated with the Mid-continent Geophysical Anomaly, a geophysical data base is currently being prepared. Information in this data base will improve attempts to model the deep Precambrian basement structure and to correlate geophysical anomalies with known geologic features. Data sets will include gravity, aeromagnetism, Precambrian rock type and elevations, and possibly Paleozoic surfaces for the entire state. Data sets will be registered and gridded to facilitate modelling and correlations.

During the past year, new software was acquired for registering and gridding data. The software is part of ELAS and was created by NASA's Earth Resources Laboratory. ELAS was originally developed for manipulating Landsat

imagery, and many of its image-processing functions can be applied to other data sets as well. Once all the data is registered and gridded, it will be analyzed on the Survey's Comtal color-image processing system. Several data sets can be displayed together and may enable correlation of unknown with known features and allow interpretative maps to be generated and stored. Automated geophysical modelling analysis can then be run on the gridded data sets. Thus far, the gridding software has been tested with data from a digitized Precambrian surface map, and gridding of the gravity data has commenced. Data on aeromagnetism and Paleozoic surfaces will be added soon.

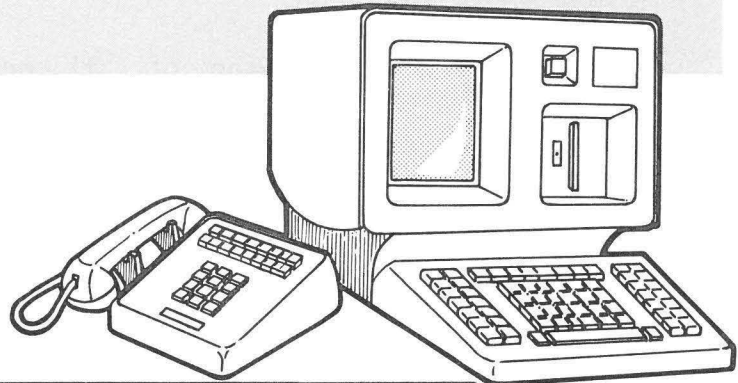
Landform Development and Chronology

Field work and a final report were completed on an investigation of Late Wisconsinan and Holocene alluvium in Roberts Creek valley and the Turkey River valley in Clayton County, Iowa. This project was supported in part by a survey and planning grant-in-aid from the Iowa State Historical Department, Division of Historic Preservation. The investigation focused on documenting the distribution and lithology of the valley alluvium, as well as extensive radiocarbon dating of the deposits. The alluvial-fill sequence in Roberts Creek spans the last 20,000 years and is quite similar in lithology and age to the sequence found in southwestern Wisconsin as reported by Knox and his co-workers.

Work was begun on a contract with the U.S. Army Corps of Engineers, Rock Island District to investigate the Late Wisconsinan and Holocene geology and geomorphology of the Saylorville Reservoir area in central Iowa. Goals of the project are: (1) to identify, map and date the terrace sequence found in the central Des Moines River valley; (2) to investigate the relationships between alluvial deposits in tributary valleys with those in the main valley; and (3) to document the relationship between the valley-margin slopes and the valley floor. This information will be used to help evaluate and manage the cultural resources in the reservoir area as the Corps prepares to raise the conservation-pool elevation.



Administrative Services



COMPARABLE WORTH

An evaluation of all state job classifications was completed in 1984. The study was designed to evaluate "comparable worth." In general, it concluded that clerical and secretarial positions were undervalued relative to technical and scientific/engineering positions. Upgraded positions are expected to receive salary increases in 1985, but the fate of downgraded positions is unclear. IGS objected strongly to results of the study which recommended downgrading most of our geological, computer, and graphic positions. Our objections were based on our agency's need to recruit and maintain professional staff.

STAFF CHANGES

Employees who joined IGS during 1984 are: Lois Bair, Secretary II; Cindy Rohret, Accounting Technician II; Joost Korpel and Cathy Scherer, Computer Programmers; and Jim Giglierano, Geologist III in Remote Sensing. In addition, Deb Quade is now full time as a Geological Technician on the Karst Contract. For the 1984 summer-exempt period, the Survey had seven full-time and two part-time students employed. Six of these full-time positions were paid with federal dollars. During the year, a number of emergency employees were hired temporarily with federal contract funds.

The position of Receptionist was reallocated to a Clerk-Typist III, and one Computer Programmer position was reallocated to Programmer/Analyst under the Trainee/Journeyman concept.

ACCOUNTING

New accounting procedures were implemented which will provide more detailed and up-to-date financial reports, and make information on both state-appropriated funds and federal-contract monies more readily available. Purchasing assistance has been broadened to give added support to all staff members.

OAKDALE RESEARCH AND WAREHOUSE FACILITY IMPROVEMENTS

The reboxing and shelving of all core samples in the Oakdale Rock Library was completed by the Oakdale staff in 1984. Cuttings from approximately 28,000 wells, and core from 800 holes are now readily accessible for study by IGS personnel or visiting geologists.

The conodont and pollen labs at Oakdale were redesigned in 1984, with the aid of the University of Iowa Environmental Health and Safety Office. An exhaust hood, shelving, and a safety shower and eye bath were installed in the lab to increase its safety and efficiency.

The Oakdale darkroom was converted to a data-storage and examination area containing well-sample files, geophysical logs, mine maps and files, along with other miscellaneous items.

PUBLICATIONS

The Iowa Geological Survey has a large number of publications available for the general public, schools, libraries, state and federal agencies, and professional consulting firms. Both technical and nontechnical reports are a result of our research activities, and all are designed to make resource information available to a variety of users. During the year, the Survey sold more than \$19,000 worth of maps and publications. Of this total, approximately \$15,000 were from map sales and \$4,000 were from IGS publication sales.

Iowa Geological Survey Publications, 1984

Hallberg, G.R., Libra, R.D., Ressimyer, G.G., Bettis, E.A. III, and Hoyer, B.E., 1984, Temporal changes in nitrates in groundwater in northeast Iowa: Iowa Geological Survey, Open File Report 84-1, 11 p.

Hallberg, G.R., Libra R.D., Bettis, E.A. III, and Hoyer, B.E., 1984, Hydrogeologic and water-quality investigations in the Big Spring basin, Clayton County, Iowa; 1983 water-year: Iowa Geological Survey, Open File Report 84-4, 231 p.

Hatch, J.R., Avcin, M.J., and Van Dorpe, P.E., 1984, Element geochemistry of Cherokee Group coals (Middle Pennsylvanian) from south-central and southeastern Iowa: Iowa Geological Survey, Technical Paper No. 5, 108 p.

Horick, P.J., 1984, Silurian-Devonian aquifer of Iowa: Iowa Geological Survey, Miscellaneous Map Series No. 10, 4 sheets.

Libra, R.D., Hallberg, G.R., Ressimyer, G.G., and Hoyer, B.H., 1984, Groundwater quality and hydrogeology of Devonian-carbonate aquifers in Floyd and Mitchell Counties, Iowa: Iowa Geological Survey, Open File Report 84-2, Part I, p. 1-106.

- Prior, J.C., (ed.), 1984, *Iowa Geology*: Iowa Geological Survey, No. 9, 28 p.
- Ravn, R. L., Swade, J.W., Howes, M.R., Gregory J.L., Anderson, R.R., and Van Dorpe, P.E., 1984, Stratigraphy of the Cherokee Group and revision of Pennsylvanian stratigraphic nomenclature in Iowa: Iowa Geological Survey, Technical Information Series No. 12, 76 p.
- Thompson, C.A., 1984, Hydrogeology and water quality of the upper Des Moines River alluvial aquifer: Iowa Geological Survey, Open File Report 84-5, 170 p.
- Van Eck, O.J., (ed.), 1984, *Annual report of the State Geologist to the Governor*, 1983, v. 53, 77 p.
- Van Dorpe, P.E., Howes, M.R., Miller, M.J., and Lenker, S.J., 1984, Underground mines and related subsidence potential What Cheer, Iowa: Iowa Geological Survey, Open File Report 84-3, 62 p.
- Witinok, P.M., 1984, Potential water-supply impoundment sites in southwest Iowa: Iowa Geological Survey, Water-Supply Bulletin No. 14, 214 p.
- Witzke, B.J., (ed.), Geology of the University of Iowa campus area, Iowa City: Iowa Geological Survey, Guidebook No. 7, 76 p.
- Witzke, B.J. and Bunker, B.J., 1984, Devonian stratigraphy of north-central Iowa: Iowa Geological Survey, Open File Report 84-2, Part II, p. 107-149.

Other Publications Authored by Iowa Geological Survey Staff

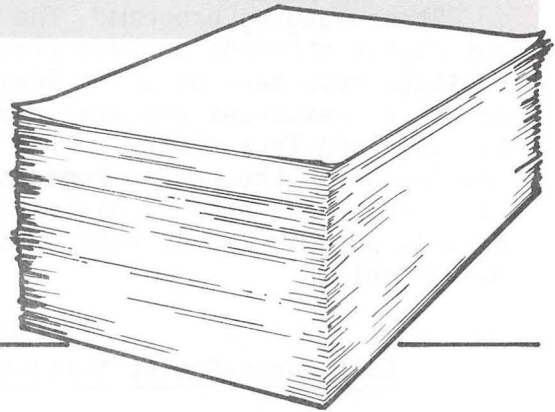
- Anderson, R.R., 1984, The Precambrian history of Iowa: Program abstracts 96th Session Iowa Academy Science, Iowa geology symposium, Abstract A.
- Bettis III, E. A., Koster, R.A., Hoyer, B.E., and Kaap, J.D., 1984, Groundwater quality in northeast Iowa field tour: Iowa chapter Soil Conservation Society of America meeting, Groundwater quality in northeast Iowa, Decorah, Iowa, October, 1984, 9 p.
- Bettis III, E. A. and Benn, D.W., 1984, An archeological and geomorphological survey in the central Des Moines River valley, Iowa: Plains Anthropologist, v. 29, no. 105, p. 211-227.
- Bouck, M.J. and Bettis III, E.A., 1984, Karst development in northeastern Iowa: Proceedings Iowa Academy Science, v. 91, no. 1, p. 12-15.
- Bunker, B.J. and Anderson, W.I., 1984, Devonian of Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract E.
- Bunker, B.J. and Hallberg, G.R., (eds.), Underburden-overburden: an examination of Paleozoic and Quaternary strata at the Conklin Quarry near Iowa City: Geological Society Iowa, Guidebook 41, 81 p.

- Bunker, B.J. and Klapper, G., 1984, Conodont zones and correlation of the Cedar Valley-State Quarry interval of eastern Iowa, *in* Geological Society of Iowa, Guidebook 41, 81 p.
- Canfield, H.E., Hallberg, G.R., and Kemmis, T.J., 1984, A unique exposure of Quaternary deposits in Johnson County, Iowa: Proceedings Iowa Academy Science, v. 91, no. 3, p. 98-111.
- Glenister, B.G. and Witzke, B.J., 1984, The Mississippian system in Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract F.
- Hallberg, G.R., 1984, Delivery of agricultural chemicals to groundwater in carbonate aquifers: Abstracts from Iowa chapter Soil Conservation Society of America symposium, Groundwater quality in northeast Iowa, Decorah, Iowa, October, 1984.
- Hallberg, G.R., 1984, The Quaternary system in Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract J.
- Hallberg, G.R., 1984, The U.S. system of soil taxonomy: from the outside looking in, *in* Soil taxonomy -- achievements and challenges, Soil Science Society America, Special Publication 14, p. 45-60.
- Hallberg, G.R., Bettis III, E. A., and Prior, J.C., 1984, Geologic overview of the Paleozoic Plateau region of northeastern Iowa: Proceedings Iowa Academy Science, v. 91, no. 1, p. 3-11.
- Hallberg, G.R., Kemmis, T.J., Wollenhaupt, N.C., Esling, S.P., Bettis III, E. A., and Bicki, T.J., 1984, The overburden: Quaternary stratigraphy of the Conklin Quarry, *in* Geological Society Iowa, Guidebook 41, 81 p.
- Hallberg, G.R., Prior, J.C., Bettis III, E.A., and Lutenegger, A.J. 1984, Quaternary geology of the Loess Hills region: Program abstracts 96th session Iowa Academy Science, Loess Hills symposium, Abstract A.
- Hoyer, B.E., 1984, Carbonate aquifers and the water quality problems in northeast Iowa: Abstracts from Iowa chapter Soil Conservation Society of America symposium, Groundwater quality in northeast Iowa, Decorah, Iowa, October, 1984.
- Kemmis, T.J. and Hallberg, G.R., 1984, Discussion: Lithofacies types and vertical profile models; an alternative approach to the description and environmental interpretation of glacial diamict and diamictite sequences: *Sedimentology*, v. 31, p. 886-890.
- Ludvigson, G.A., 1984, The Cretaceous system in Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract I.
- Lutenegger, A.J., Kemmis, T.J., and Hallberg, G.R., 1983, Origin and properties of glacial till and diamictons, *in* Special Publication on Geological Environment and Soil Properties: American Society Civil Engineers, Geotechnical Engineering Division, p. 310-331.

- McKay, R.M., 1984, The Cambrian system in Iowa: Program abstract 96th session Iowa Academy Science, Iowa geology symposium, Abstract B.
- Prior, Jean C., 1984, Water in motion: *Iowa Falls Times Citizen*, August 2, 1984.
- Prior, Jean C., Anderson, Duane C., and Roosa, Dean M., 1984, Nomination of the Mines of Spain, Dubuque County, Iowa as a National Natural Landmark, Report to the National Park Service: Iowa Preserves Board, 27 p.
- Prior, Jean C. and Bettis III, E. Arthur, 1984, Motor Mill geological reconnaissance summary report: Clayton County Conservation Board, 18 p.
- Prior, J.C., Hallberg, G.R., and Bettis III, E.A., 1984, Loess Hills geology: *Iowa Conservationist*, v. 43, no. 4, p. 3-5.
- Quade, D.E., Kemmis, T.J., and Bettis III, E.A., 1984, Late Wisconsinan valley train terraces in north-central Iowa, AMQUA Abstracts, p. 106.
- Roosa, Dean M., Esling, Steven P., Bettis III, E. Arthur, and Prior, Jean C., 1984, Natural history of the Lake Calvin basin of southeast Iowa: Iowa Natural History Association, Field Trip Guidebook, no. 2, 25 p.
- Thompson, D.M., Bettis III, E. A., and Benn, D.W., 1984, Archaeology of the Loess Hills: *Iowa Conservationist*, v. 43, no. 4, p. 6-9.
- Van Dorpe, P.E. and Howes, M.R., 1984, Iowa, *in* 1984 Keystone Coal Industry Manual: McGraw-Hill Mining Publications, New York, p. 525-528.
- Witzke, B.J., 1984, The Ordovician system in Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract C.
- Witzke, B.J., 1984, The Silurian System in Iowa: Program abstracts 96th session Iowa Academy Science, Iowa geology symposium, Abstract D.
- Witzke, B.J., 1984, Pennsylvanian strata at Conklin Quarry, *in* Geological Society Iowa, Guidebook, . 41, p. 21-23.
- Witzke, B.J., 1984, The Genesis Flood: the biblical record and its scientific implications, *in* Weinberg, S., (ed.), Reviews of thirty-one creationist books: National Center for Science Education, Inc., Syosset, NY, p. 60-62.
- Witzke, B.J. and Bunker, B.J., 1984, The underburden: the Devonian stratigraphic sequence at Conklin Quarry, *in* Bunker, B.J. and Hallberg, G.R., (eds.), Underburden-overburden: an examination of Paleozoic and Quaternary strata at the Conklin Quarry near Iowa City: Geological Society Iowa, Guidebook 41, p. 2-10.



Contracts and Grants



U. S. GEOLOGICAL SURVEY COOPERATIVE PROGRAMS

Topographic Mapping

The 1:24,000 scale, 7.5 minute topographic mapping program neared completion in 1984. Currently, 1071 maps are printed. A total of 1083 maps cover Iowa. The remaining 12 maps are available in preliminary form and will be printed by 1986.

The cooperative program has shifted production to a new series of 1:100,000 scale county topographic maps. Sixteen county maps were authorized with the initial \$78,000 state contribution for the state fiscal year 1983-84, and a second \$78,000 appropriation authorized an additional twenty-two counties for FY 1984-85. As of the end of 1984, no county maps have been received under the agreements.

Progress was also made on another 1:100,000 scale metric topographic map series, based on 30 minutes of latitude and 60 minutes (one degree) of longitude. During 1984, the Indianola map joined the four maps printed earlier: Harlan, Leon, Centerville, and Oskaloosa. Thus, five of the forty maps necessary to cover the State of Iowa in this series are printed and available.

Water Resources

During the past year, IGS has continued a cooperative program with the Iowa District Office, Water Resources Division, U.S. Geological Survey. The program is intended to collect, analyze, maintain, and publish data and information pertinent to understanding and managing Iowa's water resources. IGS contributed \$169,700 and services worth \$149,400 to the program during 1984 which was matched evenly by federal funds. An additional \$35,400 was included in the cooperative agreement which enabled other Iowa agencies to participate in stream-gaging and sediment-data collection programs which were critical to their individual needs.

Results of most data collection programs are maintained on computer files and published annually. Water Resources Data, Iowa Water Year 1984 contains the data collected from the stream-gaging program, the groundwater monitoring project, and the sediment data-collection project. The results of other

research will be published at the conclusion of the projects. These reports are published either by the U.S. Geological Survey or IGS.

Stream-gaging program: The U.S. Geological Survey maintained 116 continuous-gaging stations on Iowa rivers, 125 crest-stage stations on Iowa rivers, and stage recorders on seven Iowa lakes. These records are vital to assessing our water resources and are especially useful and basic to any engineering studies along Iowa rivers. The U.S. Army Corps of Engineers is the largest contributor to the gaging program which is also supported by various cities, industries, and other organizations. State money is channelled through IGS for this purpose and is used to support 30 gaging sites as listed in the following table.

Continuous-Gaging Stations Cooperatively Supported: IGS-USGS

Stream	Station Number	Location
Big Cedar Creek	05412870	Varina, Pocahontas Co.
Cedar Creek	05473400	Oakland, Mills Co.
East. Br. Iowa River	05449000	Klemme, Hancock Co.
East Fk. Hardin Creek	05483000	Churdan, Greene Co.
Iowa River	05449500	Rowan, Wright Co.
Little Sioux River	06606600	Correctionville, Woodbury Co.
Maquoketa River	05418500	Maquoketa, Jackson Co.
Middle Raccoon River	05483600	Panora, Guthrie Co.
Nodaway River	06817000	Clarinda, Page Co.
North Fk. Maquoketa River	05418450	Fulton, Jackson Co.
North Raccoon River	05482300	Sac City, Sac Co.
North Skunk River	05472500	Sigourney, Keokuk Co.
Ocheyedan River	06605000	Spencer, Clay Co.
Platte River	06818750	Diagonal, Ringgold Co.
Shell Rock River	05462000	Shell Rock, Butler Co.
Skunk River	05474000	Augusta, Des Moines Co.
South Skunk River	05470000	Ames, Story Co.
Tarkio River	06811840	Stanton, Montgomery Co.
Turkey River	05412500	Garber, Clayton Co.
Turkey River	05412500	Spillville, Winneshiek Co.
Wapsipinicon River	05411600	Elma, Howard Co.
Wapsipinicon River	05421000	Independence, Buchanan Co.
Weldon River	06898400	Leon, Decatur Co.
West Nishnabotna River	06807410	Hancock, Pottawattamie Co.
Winnebago River	05459500	Mason City, Cerro Gordo Co.

Continuous-Gaging Stations Cooperatively Supported: IGS-USGS-Corps of Engineers

Stream	Station Number	Location
Boyer River	06609500	Logan, Harrison Co.
East Nishnabotna River	06809500	Red Oak, Montgomery Co.
Floyd River	06600500	James, Plymouth Co.
Little Sioux River	06607500	Turin, Monona Co.
Soldier River	06608500	Pisgah, Harrison Co.

Sediment station program: Fourteen locations on Iowa streams were monitored periodically for sediment load carried by the stream. The stations that IGS cooperatively supports are indicated in the table below.

Sediment Stations Cooperatively Supported: IGS-USGS

Stream	Station Number	Location
Iowa River	05454500	Iowa City, Johnson Co.
Nodaway River	06817000	Clarinda, Page Co.
Ralston Creek	05455000	Iowa City, Johnson Co.
Skunk River	05574000	Augusta, Des Moines Co.

Groundwater monitoring: Approximately 200 groundwater-quality monitoring sites are sampled each year from this program. Sites are selected from different aquifers throughout the state, and plans call for repeated water-quality sampling every five or six years.

Iowa River Aquifer: The alluvial aquifer between Coralville Reservoir and Belle Plaine is being monitored to evaluate water quality and resource availability. During 1984, sites were selected, 128 wells installed, and preliminary water-quality analysis begun.

West-Central Iowa Water Supply: The evaluation of water availability from and water quality of alluvial systems in west-central Iowa was completed in 1984. The publication of results is expected during 1985.

Bedrock Maps: This project was nearly completed during 1984. The mapping of the topography of the bedrock surface is a very important factor in evaluating groundwater-resources potential and environmental problems. Four published maps, covering the northwest quadrant of Iowa, are expected in the near future and will complete this series.

National Coal Resources Data System

The National Coal Resources Data System (NCRDS) is a cooperative program funded by the U. S. Geological Survey. The purpose of the program is to compile data for evaluation of coal resources and reserves in Iowa and to transmit this data so it can be added to a national coal resource data base maintained by the U.S.G.S.

The portion of Iowa which is underlain by potential coal-bearing strata was divided into areas at the beginning of the project. Data collection was completed for Area II during the 1983-1984 fiscal year. Area II includes Monroe, Marion, Jasper, Mahaska, Lucas, Wayne, Clarke, Decatur, and Poweshiek counties. Location maps have been prepared for all data points in Area II. These maps show the extent of mineable coal, by each coal seam, and include outcrop/subcrop information, overburden thickness, and the location and extent of previously mined coals.

During the last half of 1984, similar data compilation began for Area III, a block of eight counties in central Iowa.