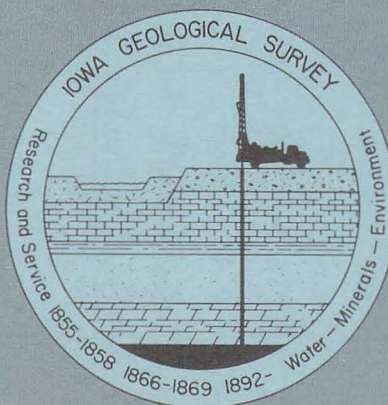


ANNUAL REPORT



of the
STATE GEOLOGIST
to the
GEOLOGICAL BOARD

Volume 49
31 December 1978

STATE OF IOWA
IOWA GEOLOGICAL SURVEY
123 NORTH CAPITOL STREET
IOWA CITY, IOWA 52242
Phone: (319) 338-1173



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a place to grow

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Stanley C. Grant
Director and State Geologist

Orville J. Van Eck
Associate State Geologist

Donald L. Koch
Assistant State Geologist

December 14, 1978

To: Governor Robert D. Ray, Chairman
and Members of the Geological Board

Gentlemen:

Herewith is the Annual 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 1978 to 31 December 1978. The legal responsibilities of the Iowa Geological Survey (IGS) are set forth in the Iowa Code, Chapters 305 and 84.

The Iowa Geological Survey was reorganized internally on 1 July 1978 to provide more efficiency and functional grouping. The new structure is detailed in this report.

Services to and for other state agencies and divisions of government continue to increase. By reassigning of priorities and functions we have been able to support these functions without an increase in permanent personnel.

New programs are presently being undertaken only where contract funding can be provided to us. Persons are hired with Executive Council approval annually for no more than the contract period.

Our evaluation of the cooperative program between IGS and the United States Geological Survey has suggested several modifications which we are implementing. I recommend we continue the program with the new changes for the present.

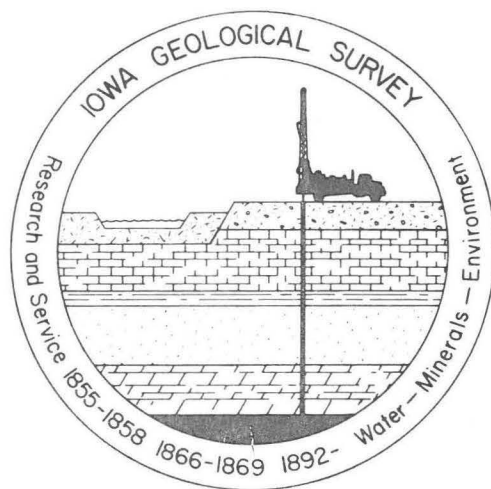
Our new core/sample library, laboratory, and warehouse building is under construction at the Oakdale Campus of the University of Iowa. We hope to occupy it before the end of this fiscal year. We will then vacate the present rented facility and the basement of Calvin Hall.

We hope to schedule a formal dedication of the building next fall and hope the Board members will honor us by participation.

Respectfully submitted,

Stanley C. Grant
Director and State Geologist

ANNUAL REPORT
OF THE
STATE GEOLOGIST
TO THE
GEOLOGICAL BOARD



COMPILED BY
DONALD L. KOCH
ASSISTANT STATE GEOLOGIST

VOLUME 49
31 DECEMBER 1978

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Iowa Geological Survey

ANNUAL REPORT

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FUNCTIONS OF THE GEOLOGICAL SURVEY

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

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 and manipulation of extant data to complex data gathering and interpreting 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 resource agency for a variety of state agencies that exercise regulatory power. The research mandate given the Survey by the legislature separates us from the action agencies in such a way as to permit us to perform an unbiased service for the enforcement and action branches of government such as 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 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 elements of the private sector are shown in figure 1.

IOWA GEOLOGICAL SURVEY

Research Cooperative Programs

U.S. Geological Survey
Groundwater (50/50)
Surface Water (50/50)
National Aeronautics and
Space Administration
U.S. Bureau of Mines
U.S. Geological Survey
Geologic Division
U.S. Department of Agriculture

Consultation, Advisory, and Data- Source Services

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

Participation in Other Agencies

Iowa State Map Advisory Council
Iowa Conservation Education Council
Iowa City Chamber of Commerce
Environmental Concerns Comm.
Department of Environmental Quality
Inter-Agency Resources Council
Department of Soil Conservation
Land Rehabilitation Advisory Board
Watershed Advisory Board
Conservancy District Task Force
U.S. Department of Agriculture
Iowa-Cedar Rivers Basin Coordinating Committee
Energy Policy Council

Fig. 1 Functional Relationships of the Iowa Geological Survey

TABLE OF ORGANIZATION

Figure 2 shows the table of organization for the Geological Survey for this date. Although similar to that presented in the last Annual Report, 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) to develop a management structure that satisfies the requirements of the Iowa Merit Employment Department for supervisory personnel.

The special projects of the former State Water Plan Group have been completed. That group and the former Ground Water Division have been reorganized into the Water Resources Division. Staff assigned to this division have the expertise to continue our role in providing information on water resources availability, and to provide support to the other natural resources agencies, especially when the several elements of the State Water Plan become operative.

The Remote Sensing Laboratory, Data Systems Division, and the Illustrating and Drafting Division have been reorganized as the Technical Services Group. The Mineral Resources Group and Subsurface Studies Division now comprise the Stratigraphy and Economic Geology Division, and the Research Group is now the Geological Studies Division. Administrative Services has been expanded to the Administrative and Support Service Group. These changes permit more efficient utilization of staff within their individual and corporate areas of expertise.

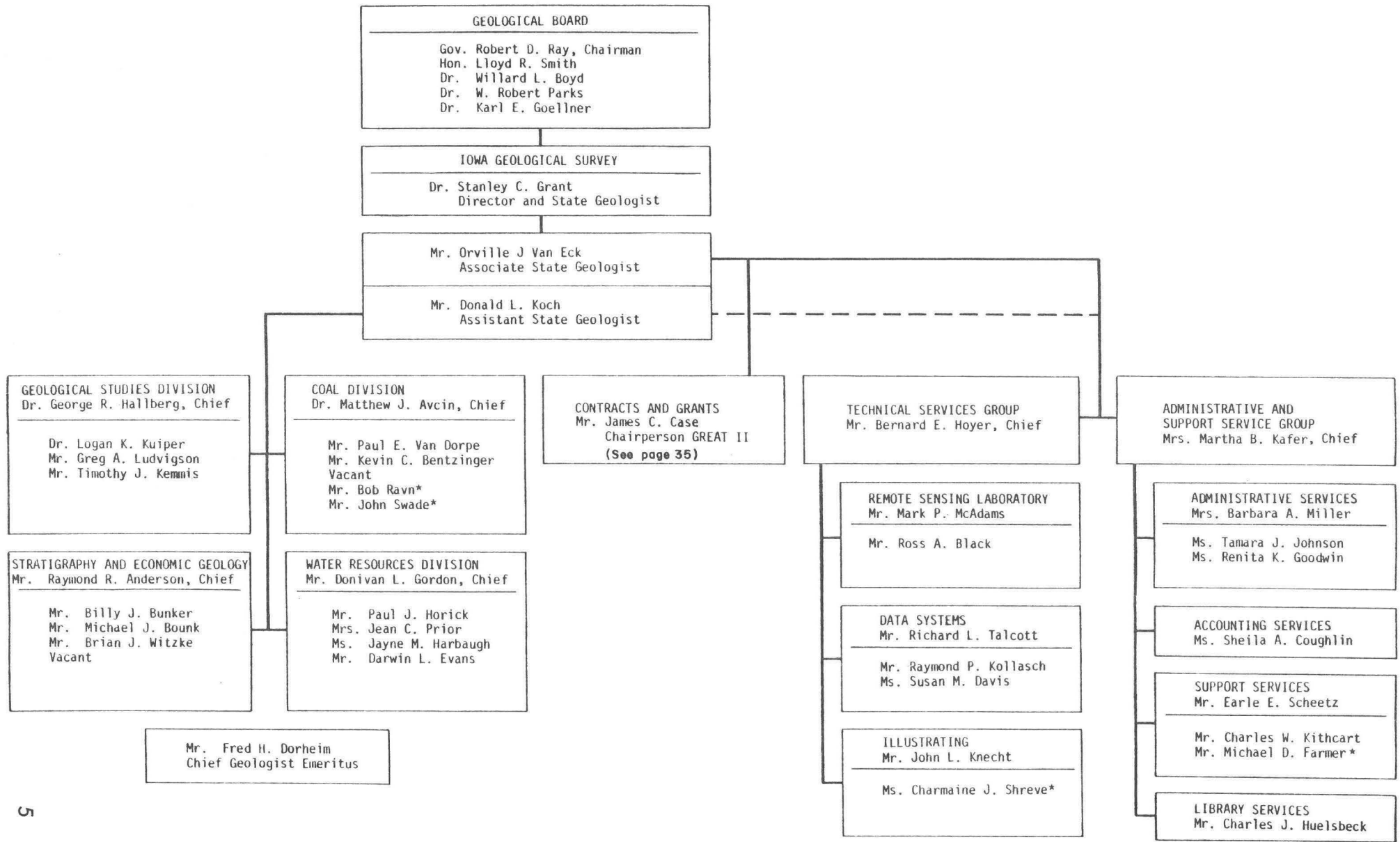


Figure 2. Staff Organization and Responsibility Assignment

*permanent part-time

Personnel Changes

Changes in personnel and staff assignments for the report period are:

Mr. Paul J. Horick -- reassignment to Water Resources Division

Mrs. Jean C. Prior -- reassignment to Water Resources Division

Mr. Greg A. Ludvigson -- reassignment to Geological Studies Division

Mr. Raymond R. Anderson -- promoted to Chief, Stratigraphy and Economic Geology,
November 24, 1978

Mr. Fred H. Dorheim -- retired, November 15, 1978; designated Chief Geologist
Emeritus

Mr. John L. Knecht -- reclassified to Graphic Illustrator

Mr. Brian J. Witzke -- filled vacancy left by resignation of Mr. Jack L. Gilmore

Mr. Ross A. Black -- Geologist, Remote Sensing Laboratory; hired to replace
Mr. Anderson after Division transfer.

Ms. Susan M. Davis -- Computer Programmer - hired upon reallocation of Water
Resources Engineer position

Mrs. Martha B. Kafer -- reclassified to Administrative Officer

Mrs. Barbara A. Miller -- reallocated to Confidential Secretary

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.

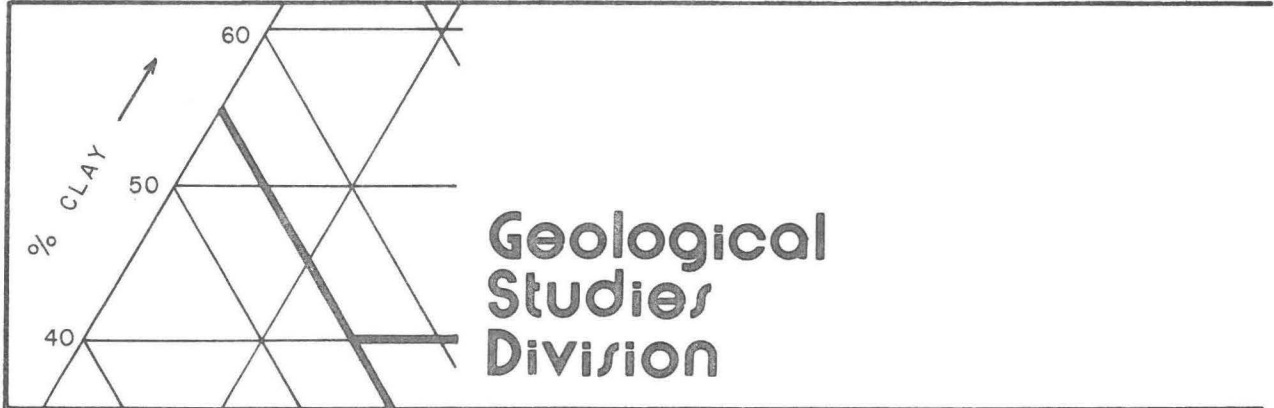
CONSULTATIVE, ADVISORY, AND INFORMATION SERVICES

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 and energy problems, the number of requests has increased substantially. The manner in which the requests are answered is largely predicated by the nature and 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 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 to well drillers, planning agencies, engineers and so forth rapidly with comparatively little demand on staff time and at a nominal cost to the user.

Coincident with the public concern about energy and environmental problems has come 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.



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 may be independent of other Survey divisions or may be performed in support of other division projects. In addition, many of the studies are done in cooperation with other agencies, especially soils-related investigations. Timely dissemination of the results is particularly important. When it is appropriate, papers are published by the Geological Survey. Short notes and papers that are directed to a more limited audience are made available through extrinsic publications.

Dr. George R. Hallberg, Chief

Missouri River Investigations

At the request of the Iowa Attorney General's Office the Survey became involved in federal litigations. In a number of actions, the U.S. Government and the Omaha Indian Tribe as plaintiffs have sued the state of Iowa and various Iowa landowners as defendants for title to approximately 11,000 acres of land adjacent to the Missouri River in Monona County.

The legal issues of riparian land ownership hinge upon the technical issues of how river movements occurred and how this land came into being. With the involvement of the federal government there is no statute of limitations, and most of the events at issue occurred during periods for which there are no longer any eyewitnesses. This necessitated the use of expert testimony, which the Survey successfully provided at a cost of eight man-weeks of preparation and another five man-weeks in residence at the first trial.

The U.S. District Court ruled in favor of the defendants, but this decision was overturned by the U.S. Circuit Court of Appeals. Some work has continued on these cases in preparation for:

1. The state's appeal to the U.S. Supreme Court.
2. The initial hearing of the several remaining suits which are awaiting the Supreme Court decision of the first consolidated cases.

The Geological Studies Division also participated in a technical workshop, sponsored by the Iowa Conservation Commission, on the "Degradation and Aggradation of the Missouri River." Survey personnel chaired working subgroups and aided in compiling a final report, which was published by the Iowa Institute of Hydraulic Research for the Iowa Conservation Commission.

Another new project of the Division is documentation of changes in the channel area of the Missouri River adjacent to Iowa. This project is by the request of, and on contract with, the Iowa Conservation Commission. The purpose of the study is to quantify the changes in the Missouri River during the interim since its natural flow conditions to its present highly controlled regimen. Such quantification will permit evaluation of the resource losses to Iowa in terms of land, wildlife habitat, and other conservation resources.

Pleistocene Stratigraphy, Southwestern Iowa

The Geological Survey is participating in a joint project with the Nebraska Conservation and Survey Division (NCSD) to evaluate the Pleistocene stratigraphy of southwestern Iowa in relation to volcanic ash beds which may be radiometrically dated. Samples from five ash beds have been dated and range in age from 0.6 to 2.2 million years. Such dates will provide a framework for an absolute chronology of these deposits and is a significant aspect of safety analyses for any proposed nuclear power-plant sites in Iowa and adjacent states. This work is supported by the National Science Foundation Grant No. DES 74-23535 to the NCSD.

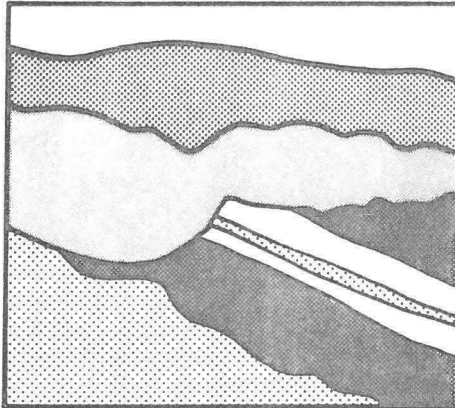
The NCSD is doing the test drilling and NCSD and IGS are jointly evaluating the stratigraphy and conducting laboratory analyses of the materials. Data on engineering and hydrologic properties are also being collected. A total of 13 sites have been test drilled and cored in Iowa with a total footage of approximately 2,190 feet. Data and conclusions from this study will result in modification of the standard stratigraphic nomenclature for North America.

Cooperative Applied Soils Research

During the past several years representatives of the Iowa Soil Survey Program from the U.S. Soil Conservation Service, the State Soil Survey staff of Iowa State University Experiment Station, the Iowa and U.S. Geological Surveys, and members of the Soils Engineering Group at Iowa State University have participated in a cooperative integrated program of research. The Geological Survey is providing geologic data to aid in the initial stages of County Soil Surveys.

In addition, the Division is carrying on the following specific studies as part of this cooperative research effort:

1. Comparison and correlation of particular soil series with large magnitude floods. This analysis has been very successful to date and results in a very useful planning tool. We have worked with several communities and counties relative to floodplain zoning, flood insurance, and flood damage assessment problems.
2. Quantification of soils engineering information. The number of requests received for soils engineering information is increasing. An active program is underway to quantify cohesion, angle of internal friction, bearing capacity, optimum moisture and density, Atterberg limits, shrinkage properties, etc., for soil profiles and their geologically correlative parent materials. Highway engineering properties for 264 soil types are summarized in IGS Technical Information Series No. 7. Also, a research program was completed for the determination of shrink-swell values of montmorillonitic soils. This research was done in cooperation with the National Soil Survey Laboratory. Swelling soils are a serious engineering hazard in Iowa. Each year in the U.S. shrinking or swelling soils cause twice the monetary damage of floods, hurricanes, tornadoes, and earthquakes combined. Hopefully, the quantification of shrink-swell characteristics will alleviate some of these problems in Iowa.
3. Cooperative evaluation of the use of remote sensing in soil surveys.
4. Continuing evaluation of the stratigraphy, mineralogy, hydrology, and geochronology of the unconsolidated materials of the state, including detailed soil-geomorphic studies to model soil-landscape relationships. This year joint detailed studies were conducted in Benton, Buchanan, Cherokee, Des Moines, Henry, Johnson, Linn, Marshall, Muscatine, Story, and Tama Counties.



Stratigraphy & Economic Geology

STRATIGRAPHY AND ECONOMIC GEOLOGY

This division will continue to provide the services and support that previously have been the responsibility of the Subsurface and Mineral Resources Divisions. A large amount of new and significant geologic data has been acquired this year that has been utilized by other division staff and which has had an impact on planning for future projects. We have initiated a study to identify areas of the state that might be suitable for hazardous or toxic waste disposal, and our records on industrial minerals operations in the state have been updated. Knowledge of the stratigraphic sequence of the rocks in Iowa is essential in the search for and the development of the mineral resources of the state. We will begin a compilation of stratigraphic information that previously has been unavailable in a single reference.

Raymond R. Anderson, Chief

Cretaceous Aquifer Study

Support and involvement of nearly all divisions of the Geological Survey will be required during the various phases of this study. However, before the hydrologic parameters of any aquifer can be adequately determined, it is necessary to obtain

specific information on the nature of the host rock. Some of the complexities in the stratigraphy of the Cretaceous rocks of northwest Iowa are described below. It is the task of this division to generate a three-dimensional model from drill hole data to which hydrologic analysis can be applied. For this reason, a review and summary of the present status of the project are presented here.

The Cretaceous aquifer, generally referred to as the Dakota Sandstone, is the principal source of water for domestic use and crop irrigation in the upland areas of northwest Iowa. Although it is known that yields are sufficient to support irrigation in some areas of the region, an intensive research program is essential in order to define the capacity of the aquifer system to support irrigation on both a local and regional basis. Regionally, the volume of water in storage is estimated at between 300 thousand and 7 million acre-feet. The lower value is approximately equivalent to the volume of water presently authorized for irrigation over the entire state, but recharge to the aquifer is estimated at between only 1 thousand and 30 thousand acre-feet per year. Extensive irrigation could result in large-scale mining of water from this aquifer, that is, withdrawals at a rate faster than the aquifer is recharged. Detailed information is needed on the thickness and lateral continuity of the several sandstone units within the Cretaceous sequence, as well as data derived from pumping tests before a reasonable water management program can be established. For these reasons, the Iowa Natural Resources Council (INRC) placed a ban on new irrigation withdrawals from the Cretaceous aquifer, effective 15 June 1977.

A registration program for research wells was authorized by INRC in June, 1977. Under this program, landowners who have made application for the withdrawal of water from the Dakota Sandstone, and for whom a hearing has been held, are eligible to drill a production well and to utilize the water for beneficial use, within the

limitations agreed to by contract. Furthermore, the contract requires that a test hole shall be drilled at the site of the proposed production well to a depth sufficient to penetrate into the rock unit subjacent to the Cretaceous System and that an observation well shall be completed in the same water-producing horizon as the finished production well. Information from pumping tests will be analyzed to obtain quantitative data on the geologic and hydrologic parameters of the Cretaceous aquifer.

Presently, four landowners are participating in the research well program. Pumping tests were conducted on three of these wells this year. One closely controlled pumping test was conducted at each site in order to quantify specific hydrologic parameters for background data prior to extensive withdrawals. In addition, water level measurements were obtained during several other periods of pumping to evaluate any longer term effects on the aquifer. Normal fluctuations in water levels are being monitored by monthly measurements.

The Iowa and U.S. Geological Surveys began a drilling program as part of the Cretaceous aquifer study in July, 1977. As in the above research well program, test holes are drilled through the entire sequence of Cretaceous rocks. Twenty-one test holes have been drilled to date with a total footage of 11,406 feet. Nine of the test holes (5,199 feet of drilling) were drilled this year. Nearly all previously drilled wells in the region, whether for municipal domestic, or irrigation use, penetrate only to the upper or middle portion of the Cretaceous sequence. With complete penetration, we are obtaining valuable data that will aid in defining the physical limits of the aquifer system. Drilling problems do not always permit recovery of drill cuttings from the test holes, but geophysical logs can be used to fill these gaps in the information base.

Core drilling of the older (Paleozoic) rocks subjacent to the Cretaceous beds is necessary at certain selected sites in order to construct a stratigraphic model and to define the degree of hydraulic connection between the two rock systems. Core was recovered from the still deeper crystalline (Precambrian) rocks at two of the drill sites. One of these sites is at the LeMars Community School District's nature education facility at Camp Quest. Separate shallower wells also were completed in the Cretaceous rocks and in the stream valley sand deposits at this site. In addition to the capability for monitoring water level fluctuations in three aquifer systems at a single site, the geologic and hydrologic data add significantly to the educational opportunities available to students and teachers at Camp Quest.

In addition to the research well registration and IGS - USGS drilling project, substantive data is being accumulated from other wells drilled by area contractors. Geophysical logs are obtained from as many of these wells as time and scheduling will permit.

Notwithstanding the impact of irrigation on available water resources, some areas have been burdened with water supply and/or quality problems for many years. Within the limitations of available funding, water samples will be collected for chemical analyses to determine the relationship of water quality to depth and environment of deposition of the host rock.

An interim report on the geohydrology of the Cretaceous rocks of northwest Iowa will be released early in 1979. A subsequent report will include information on the subjacent Paleozoic rock units, particularly with respect to their influence on the hydrology of the Cretaceous deposits.

Well Logging

Drill cuttings from approximately 180 wells were logged for a total footage of about 100,000 feet. Because in most well drilling procedures a sample is collected for each 5-feet of drill penetration, the detailed logging (descriptive and colored graphics) of 100,000 feet of drill samples means a microscopic study of about 20,000 individual samples.

With the continuing load of service work, the number of sample sets and total footage logged has decreased markedly over the last eight years. Currently, samples from about 7,200 wells remain to be studied. Emphasis is being placed on the logging of deep municipal and industrial wells and those wells located within special project areas, such as the coal exploration program and the northwest Iowa Study of the Cretaceous and alluvial aquifers.

Borehole Geophysics

Geophysical logs of boreholes provide a valuable source of information on the geologic and hydrologic parameters of Iowa's aquifers. When arrangements can be made, we are running geophysical logs on wells drilled for municipalities, industry and private institutions, especially on wells that are drilled to the deeper aquifers. Borehole logs obtained include electric (spontaneous potential-resistivity), caliper (hole diameter) temperature, conductivity and natural gamma logs. These records also are extremely valuable to the well owners, particularly when remedial work is necessary.

Sanitary Landfills

The Geological Survey established geologic and hydrologic criteria to be included in the rules that govern sanitary landfill siting, under the jurisdiction of the Solid

Waste Management Division, Department of Environmental Quality. These criteria are designed to protect the water resources of the state. To assist municipal and county governmental agencies in the selection of sites that will best meet the geologic and hydrologic criteria, the Geological Survey has upon request either furnished extant data, made on-site inspections, or conducted earth resistivity surveys on potential landfill sites. All counties in Iowa presently are delivering their wastes to approved landfills. Although Pottawattamie County has no approved site, wastes are being delivered to approved sites outside the county.

High Level Radioactive Wastes (HLW)

The U.S. Energy Research and Development Administration (ERDA), now the U.S. Department of Energy (DOE) has been authorized to develop HLW repositories, and its schedule calls for an operational facility by 1985. The U.S. Nuclear Regulatory Commission (NRC) has the responsibility independently to set criteria and develop regulations for the licensing of an HLW repository. Regional workshops have been held to permit state input into the development of "site suitability criteria" for a waste repository.

As far as we are aware, no specific site has been selected, although a project investigation is under way. Iowa is not a potential candidate for an HLW repository. Present plans call for the development of a repository in salt deposits and/or in a crystalline rock such as granite, or in an argillaceous (clay-shale) rock formation. Minimum depth of storage probably will be about 1,000 feet in a homogenous medium that is several hundred feet thick. With the additional criteria on specifications for appropriate hydrogeologic parameters, no suitable site could be located in Iowa. Iowa would have an interest in, and be affected, relative only to the rail or truck transportation network utilized to transport HLW to a federal repository.

Low Level Radioactive Wastes (LLW) and Other Toxic Wastes

A recent study by the Iowa Department of Environmental Quality shows that nearly 98% of the low level radioactive wastes generated in Iowa are shipped out of state for disposal. If out-of-state facilities refuse to receive Iowa's LLW, one or more approved in-state sites will be required for disposal.

The Department of Environmental Quality has submitted a bill to the legislature that would provide authority to regulate industrial wastes in Iowa. Industrial wastes that are classified as toxic wastes also will require approved disposal sites. This will result in a significant increase in IGS services, working in consultation with DEQ. Activity is already underway relative to the disposal of fly ash and sludge from coal-burning power plants.

With adequate testing and regulatory controls, there are several areas in Iowa that could be considered for disposal of LLW and other toxic wastes. Surficial (trenching) disposal methods could be utilized in areas with thick intervals of low permeability till (unconsolidated glacially-derived sediments), or in areas where low permeability shales comprise the bedrock. Areas with a thick sequence of till above shale might provide optimal sites. We have started to compile data on such areas in the state so that we can respond rapidly to requests for this information.

Plum River Fault Zone

A detailed study of the Plum River Fault Zone was conducted in 1977 as an outgrowth of the Carbonate Hydrology Project and structural mapping for the East-Central Iowa Water Atlas. The fault zone was defined in 1976 (Kolata and Buschback, III. Geol. Survey Circ. 491) as part of a seismic hazard evaluation for a proposed nuclear power generation station near Savanna, Illinois. The 1977 IGS study

demonstrated a western extension of the fault into southern Linn County, Iowa.

Aerial photography was utilized in 1978 to augment further field investigations along the fault zone in an attempt to detail the geometry of the structure, to further resolve the question of when movement occurred along the fault, and to identify other sites where the fault trace might be exposed at the land surface.

Additional areas where the fault trace is exposed occur in Linn, Clinton and Jackson Counties. The central portion of the fault zone consists of a band of broken, shattered rock from 300 to 3,000 feet in width. Highly productive water wells can be realized where the wells are sited within the shattered rock or on the downthrown side of the fault where a greater thickness of the carbonate rock sequence is preserved. In addition, it is possible that deeper drilling along the zone of shattered rock could result in the discovery of metallic mineral deposits such as galena (lead) or sphalerite (zinc).

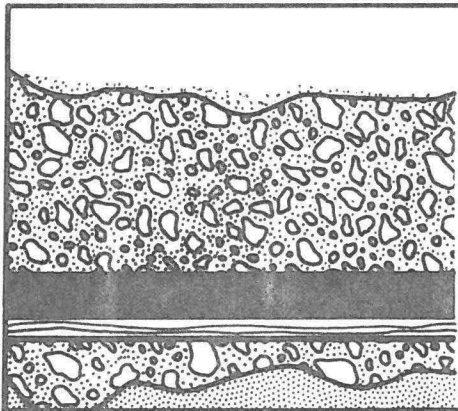
Oil and Gas

As provided in Chapter 84 of the Code of Iowa, the State Geologist is designated as the Administrator of Oil and Gas. In this capacity he is responsible for administering the provisions of Chapter [580] 12 of the Iowa Administrative Code and for reporting to the Iowa Natural Resources Council. Under Chapters 84 and [580] 12 these duties include the issuance of drilling permits for the exploration for or the production of oil and natural gas, including underground gas storage; the maintenance of all administrative, geological and production records; surveillance of associated drilling, compliance with safety regulations, production, and well or facilities abandonment; and evaluating plans for and giving testimony to the Iowa Commerce Commission related to the development and operation of underground gas storage reservoirs.

Eight drilling permits for oil and gas were issued during 1978. All of these were issued to Natural Gas Pipeline Company of America and were issued for the construction of 4 observation wells and 4 injection-withdrawal wells into the Galesville and Mt. Simon storage zones of their Cairo storage reservoir, Louisa County. A permit for an oil exploration test in Linn County is pending.

Drilling statistics accumulated in the administration of Chapter 84 were reported to the American Petroleum Institute. In prior years, quarterly reports were filed with the Iowa Natural Resources Council. However, beginning this year, by agreement with the Council only a single report will be filed. During the past year drilling activity associated with oil and gas has been negligible and quarterly reporting is unwarranted. The quarterly system of reporting will be reinstated as it becomes necessary or advisable.

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 gas storage reservoir. The original acreage under lease for this facility when abandonment began in 1971 was 12,373 acres. Gas Storage Agreements on approximately 10,133 acres on the outer periphery of the field have been dropped through December, 1975. This leaves 2,240 acres remaining under lease. The total gas-in-place as of October 26, 1978 was 2,592,212 Mcf (thousand cubic feet).



Coal Division

COAL DIVISION

The primary objective of the Coal Division is to define Iowa's coal resource base in terms of its quantity, quality, and distribution, with an ultimate goal of assisting in the revitalization of Iowa's coal industry in an environmentally and socially acceptable manner. Exploration drilling costs are held to a minimum by drilling only one hole per township (6-mile centers). The Coal Division has designed its analysis program to extract the maximum amount of information from every potential data source. Currently, the principal effort is directed to stratigraphic, paleontologic and geochemical analyses. These data will permit assignment of relative ages to individual coal beds, construction of a model that will aid in the interpretation of depositional environments, and ultimately provide a predictive tool for coal deposits between control points. With this framework, site-specific exploration and definition of reserves can be accomplished by the coal industry.

Dr. Matthew J. Avcin, Chief

Study Area No. 1

A series of sediments deposited during a single sedimentary cycle in which alternate marine transgressions and regressions occur collectively are termed a cyclothem. These coal-bearing deposits in Iowa are extremely variable in their development. Not all units of a single cyclothem are present from one locality to another, and differences in thicknesses of individual beds often are extreme. Through analysis of spores and pollen (palynology) from cores drilled in Study Area No. 1 (fig.3) we have been able to assign relative ages to the different coal beds and thereby develop a framework for interpretation of the geologic history of the area. Although additional palynological research is ongoing, systematic analysis of spore/pollen content of cores has resulted in the identification of 13 relatively continuous coal beds within Study Area No. 1, in which drilling was completed this year.

The data show that all but one of the thick coals (greater than 3 1/2') reported in this study area are associated with two particular coal seams. These seams occur over parts of several townships, and they contain the major portion of the commercial coal in the area. A summary of exploration drilling for the reporting period follows:

Number of drill holes	17
Total footage drilled	3,509
Number of coal seams	35
Total coal thickness	35' 3"
Coal seams exceeding 14"	11

Including records from several test holes that were drilled last year, 31 descriptive logs that represent 7,900' of drilling were released as open file information. A series of maps and cross-sections that illustrate the elevation, distribution and thickness of the potentially commercial seams are in preparation.

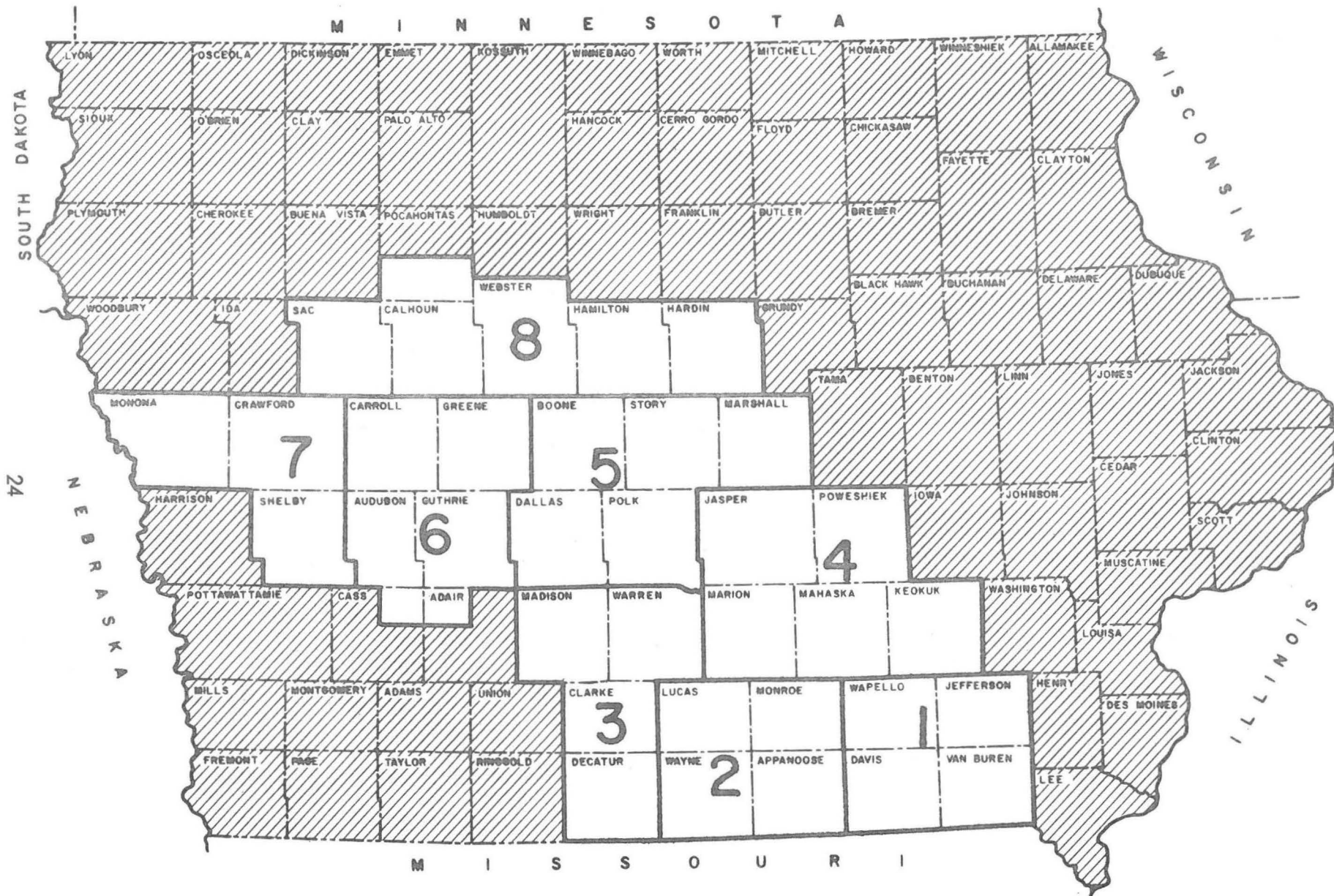


Figure 3. Study Areas for Investigation of Coal Deposits in Iowa

Final reports on Study Area No. 1 will be published next year to make more information available to the public. They will contain interpretive and quantitative data on stratigraphy, paleontology and geochemistry of the coal beds.

Drilling will commence in Study Area No. 2 in 1979. The results of earlier preliminary drilling in Study Areas 2 - 5 suggest that a number of coals higher in the stratigraphic section that are non-commercial in Study Area No. 1 may be commercial elsewhere. Originally, we had intended to increase the spacing between drill holes as the coal exploration program advanced. However, the preliminary drilling in Study Areas 2 - 5 also show that, although our stratigraphic model is adequate to explain the sequence of sediments, coal thickness is controlled by other local factors.

As additional core is recovered, the stratigraphic model for coal deposition will be refined. Much of the research will be accomplished through graduate student theses programs. Two theses have been completed, two are in progress, and one thesis is in the planning stage. In addition, the coal exploration program has received significant support and assistance from staff of the U.S. Geological Survey and the U.S. Bureau of Mines, particularly with respect to geochemistry of the coals. Still more data will derive from exploration companies that test the target areas defined by the Survey's coal program.

Land Subsidence Study, East Des Moines

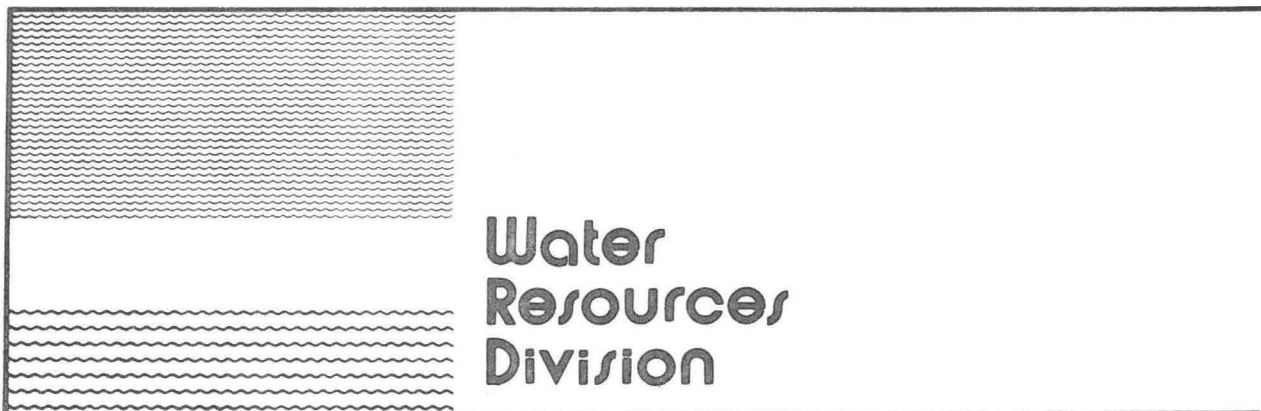
Land subsidence that developed this summer at 1908 Capitol Avenue, Des Moines, exhibited similarities to mine subsidence features both in appearance and mode of development. A review of available mining records indicated that two mines may have extended under the Des Moines property. Based on this information, a grant

was obtained from the Office of Surface Mining to assess the potential danger to the public welfare inherent in the possible undermining of the grain elevators and mill one block east of the original collapse structure.

Six holes were drilled, but no major voids or collapse structures were encountered. However, a detailed examination of the rock cores strongly suggests that mining was at a deeper level beneath the grain elevators than is indicated in the early mining records.

Fractures in the cores show that the rock units have been subjected to vertical stresses, which may ultimately result in further subsidence of the land surface. However, insufficient information was available to assess the potential for damage to surface structures. The Geological Survey initiated a second coring program late in 1978 to obtain additional information.

In conjunction with this study, a list of former mines in metropolitan Des Moines, with an accompanying location map, was prepared for interested parties.



WATER RESOURCES DIVISION

The lead responsibility for water resources service and research functions is assigned to the Water Resources Division. However, today's water resources problems must be addressed through a multidisciplinary approach that requires support and assistance from other divisions of the Geological Survey. The primary goal of the Water Resources Division is to effect public service and research that will promote a better understanding of Iowa's water resources and further enhance the Geological Survey's position as the state's principal advisor and consultant in the area of water resources. This goal can be achieved through the following objectives:

- To collect, catalog, index and archive information on the occurrence, distribution, quality, development and use of water in the state.
- To provide advisory services to the public, private industry, agriculture and the state in relation to the development, use, management, protection and conservation of the state's water resources.
- To research and report findings concerning the occurrence, distribution, quality, development potential and status of the state's water resources.

- To identify and research water problems, as a division or in cooperation with other divisions or agencies, related to the development, use, protection, conservation and management of the state's water resources.
- To provide technical support to the agency, the state, or other state and federal agencies in the areas of data acquisition, research drilling and testing.
- To keep current with developments in research and applied technology in the fields of surface and ground water hydrology and water resources planning and management.

Donivan L. Gordon, Chief

Comprehensive State Water Plan

Division staff concentrated their efforts in the preparation of materials for the "Iowa Water Resources Framework Study Report"; a special film, "Iowa's Precious Water"; the development of a comprehensive report on "Iowa Water Resources Data"; an Iowa Water Resources Data System (IWARDS) demonstration study on "Precipitation Deficiency in Iowa"; completion of the IWARDS Design Document; and completion of the data base management software package for IWARDS. Elements of the IWARDS program will be operational in 1979. The scope of services that will be available through the IWARDS program will benefit all state agencies that are involved with water resources, and aid in the ultimate development and implementation of a State Water Plan. Other aspects of the IWARDS program are presented under the Data Systems Division of the Technical Services Group.

Iowa Water Resources Framework Study Report

Two executive summary reports were prepared for inclusion as chapters in the framework report. These summaries were based on comprehensive task force reports generated by the Geological Survey on "Water Resources Availability" and "Water for Fuels and Energy".

Film, "Iowa's Precious Water"

The Iowa Natural Resources Council contracted with the Iowa State University Film Laboratory for the production of a 28-minute film on Iowa's water resources and associated problems. Geological Survey Water Plan staff assisted in the development of the narrative, the design and preparation of visual aids, the coordination of filming sequences involving survey operations, and technical review of subject matter presented in the film. The premiere showing to the Natural Resources Council and the public was in June. It also was used during the past summer at special hearings, held by the Council in Iowa's six congressional districts, where the principal findings and recommendations of the Water Plan Framework Study were presented to the public.

Iowa Water Resources Data

The third and final report on "Data Base and Needs" was completed and submitted to the Natural Resources Council in August of this year. The three-part report considers water resource planning and management needs, a comprehensive inventory of water data holdings in the state, and a design document for an efficient system for managing and accessing these data -- IWARDS. The latter two sections were completed this year. They comprise major elements of the data task force report, and were published as the final two sections of the IWARDS Data Catalog (the first three sections were published in 1977).

Precipitation Deficiency Study

This is a cooperative project between the State Climatologist, the Iowa Water Resources Data System (IWARDS), and the Water Resources Division of the Geological Survey. The purpose of the study is to quantify the below average precipitation for durations of 3, 6, 12, and 24 months at recurrence intervals of one in 2, 5, 10, and 20 years. Because precipitation deficit has the greatest potential impact during

the summer, the 6-month duration period used is April 1 through September 30. The summer is also divided into two 3-month duration periods: April 1 through June 30 and July 1 through September 30. The base data are derived from monthly precipitation totals for the period 1948 through 1977 for 62 weather stations in Iowa.

The data analysis and work maps have been completed and a final report will be published early in 1979. The report will include isoline maps for the selected duration periods showing the state-wide pattern of average precipitation, and corresponding precipitation deficit maps for the selected recurrence intervals.

Water Availability Requests

The processing of information in response to requests concerning the availability and development of ground water continues to be a major service of the Division. Although the requests declined from the record number received in 1977 as a consequence of the drought cycle, the total for 1978 represents an increase of 25 percent over 1976. Approximately 900 man hours were required to synthesize information and prepare detailed interpretive reports. The requests derived from a wide range of users as follows:

<u>Category</u>	<u>No.</u>
Municipal	82
Industrial	12
Domestic	55
Irrigation	64
Housing Development	25
Rural Water Districts	9
Recreation	15
Livestock Operations	4
Pumping Test Analysis	8
Regional or County	16
Other	31
	<hr/>
	321

Because of the current high per capita use of water and because many shallow domestic and municipal wells locally are subject to stress even during periods of "normal" precipitation and recharge, we anticipate a steady growth in this area of service work. For these reasons a new report format on a county level is under development. Two prototype reports are in preparation -- for Dallas and Jefferson Counties. The format of the reports will be pictorial, and the following information will be provided for subregions within the counties:

1. Estimated depth(s) to potential water-bearing zone(s).
2. Expected quality of water from the various zones.
3. Anticipated sustained withdrawal rates (in gallons per minute).
4. Aquifers utilized by municipalities.
5. Common water quality problems and potability standards.

Additionally, generalized cost information on well construction, and a listing of drilling contractors that service the area will be included. These reports will be open-file reports of about six to eight pages in length. They will be designed for photocopy reproduction which will facilitate periodic updating. This county report format should result in a 50 percent reduction in the need to generate reports for individual requests.

Water Resources Newsletter

The Water Resources and Data Processing divisions of the Geological Survey, and the State Climatologist, are working toward the development of a monthly newsletter. This newsletter will provide water users and managers throughout the state with a monthly accounting of water resources conditions. The newsletter will include monthly rainfall summaries, extended forecasts (30 day), a report on soil moisture conditions and ground water levels, and a summary of streamflow conditions and

reservoir levels. This information never has been issued collectively. The intention is to publish the data while it is current so that it can be used for planning and management purposes, especially by the agricultural sector.

To expedite the process of publication and timely distribution of the newsletter's data, the data processing capabilities of IWARDS will be used. In essence, the newsletter will be machine generated from data input by the various cooperator-contributors -- the Corps of Engineers, U.S. Geological Survey, U.S. Weather Service - State Climatologist, the Iowa State Extension Service, and the Geological Survey.

Silurian-Devonian Aquifer Study

Work has started on a 3-year study of the Silurian-Devonian aquifer. Extant data and field-inventory data will be synthesized and presented in an atlas format similar to publications on the Mississippian and Jordan aquifers. The objectives of this study are (1) to present a detailed picture of the Silurian-Devonian aquifer that shows its distribution and thickness; and (2) define its characteristics as an aquifer, including water level relationships, yield potentials, and water quality data.

Elements of Water Resources Management

Iowa is entering a new era in the management of its water resources, particularly ground water. The growth of our agricultural and industrial economies, plus increasing public demands for goods and services, greater recreational opportunities, and strengthened environmental controls each carry with them new demands for water. Conflicts between users will become more common and the problems of water allocation will become more complex. Just in the past year new regulations

have been promulgated by the Natural Resources Council to quantitatively address certain problems of water allocation and ground water withdrawals. Through these regulations the state now has placed limits on withdrawals from the Jordan and Dakota aquifers, limits on head reduction in the Jordan Aquifer, and limitations on withdrawals from alluvial aquifers that could potentially deplete streamflows during periods of low flow.

Regulation is only one element in the scheme of efficient and wise water resources management. Others that must be considered are water use and consumption (collectively resource depletion) and reserves evaluation (including replenishment). These latter elements have been given high priority within the spectrum of Geological Survey programs.

A large proportion of the ground water which supplies Iowa's farms, industries, homes, and municipalities comes from four extensive aquifer systems - the Dakota, Mississippian, Silurian-Devonian, and Jordan. A comprehensive report on the Mississippian Aquifer was published in 1973 and a similar report for the Jordan was published late this year. Basic field work leading toward this kind of report for the Dakota Aquifer was in its first full year in 1978. Current work on a study of the Silurian-Devonian Aquifer has been noted. These four aquifer studies should provide the ground water use-development-management sectors in the state with a quantitative base for planning, development, allocation, and regulation.



Contracts & Grants

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 (fig. 4). For projects that require additional staff, positions are established only for the duration of the contract or grant. Some 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

Coal Resources

This contract with the U.S. Geological Survey will expedite the completion of field studies related to the Survey's coal exploration program. Descriptions of natural exposures and old strip mines made over several decades are being updated and refined to add to the basic data derived from core drilling.

Aggregate Resources, Southeast Iowa

The Spergen Limestone Formation of southeast Iowa is a source of concrete aggregate for highway construction. However, the rock varies in composition from one area to another, and does not meet specifications for concrete aggregate at all

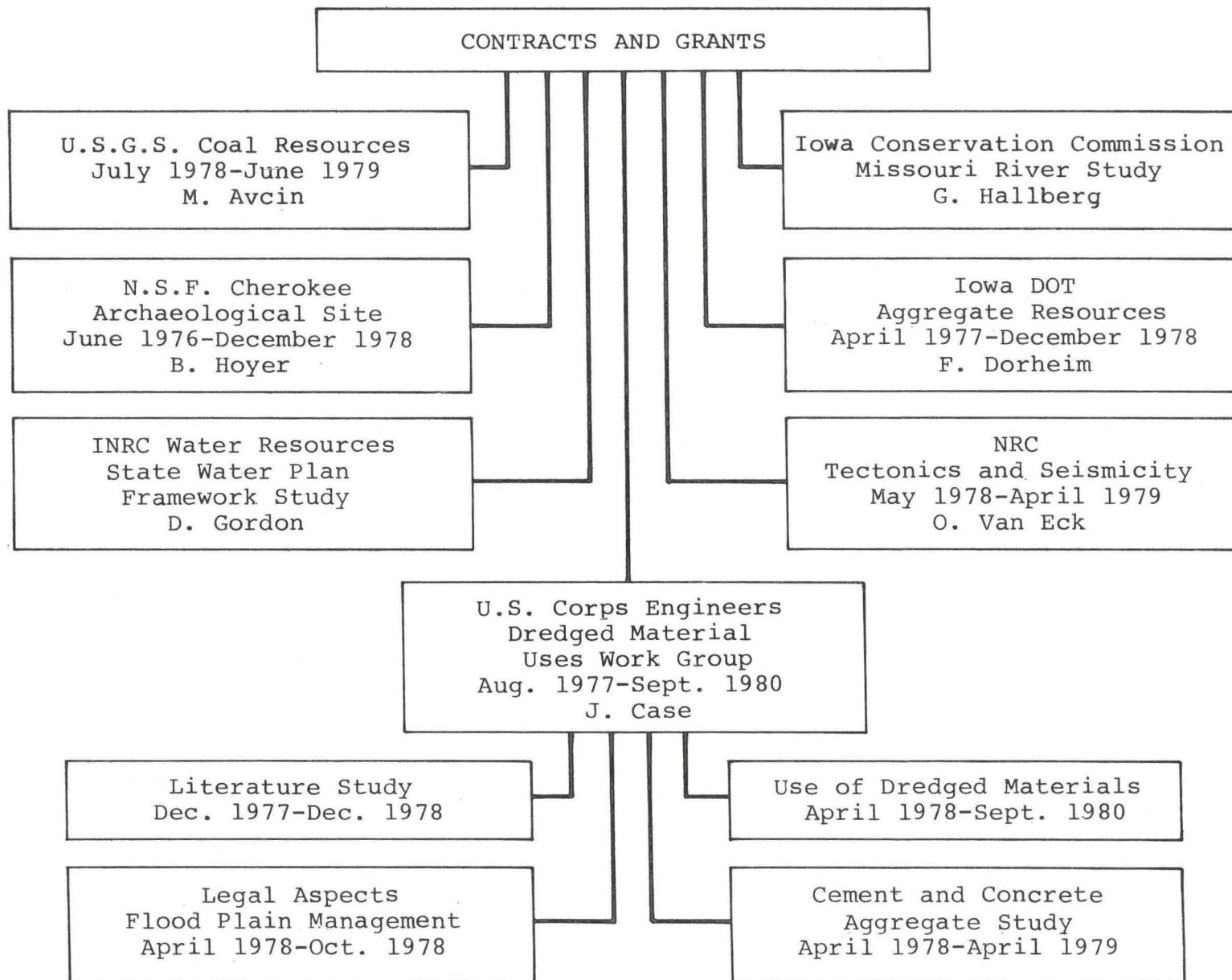


Figure 4.

locations. A contract was arranged with the Iowa Department of Transportation to map the distribution of this formation, to define lithologic changes in both the surface and subsurface sections, and to delineate specific areas where quality stone might be available to replenish the present dwindling reserves.

Cherokee Archaeological Site

A description of this National Science Foundation grant for an ecological and cultural reconstruction study was presented in the 1978 Annual Report. Work for this year consisted of data analysis, construction of maps and profiles, and completion of the final interpretive report. Much of the data from this study is applicable to future ground water investigations, particularly along the Little Sioux Valley and its associated alluvial fans.

Tectonics and Seismicity

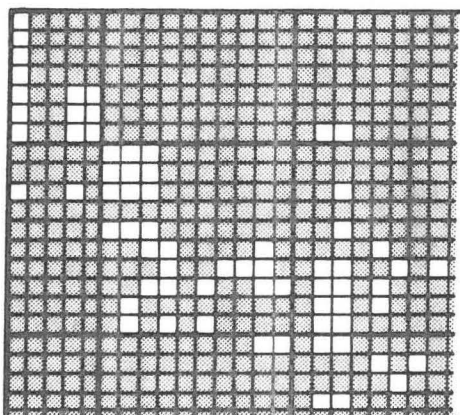
No quantitative information on seismic activity is available for the southwestern Iowa portion of the mid-continent region. A contract was entered into with the Nuclear Regulatory Commission (NRC) to establish a network of seismic stations to obtain background data in advance of any future proposals for siting nuclear power plants in adjacent states. Tentative sites for installing seismic recorder stations have been selected near the towns of Anderson (Fremont County), Prescott (Adams County), Oakland (Pottawattamie County), Magnolia (Harrison County) and Defiance (Shelby County). These sites will be further evaluated prior to final installation in 1979. 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.

GREAT II

In August, 1977 the Survey contracted with the U.S. Corps of Engineers, Rock Island District, to coordinate activities of the Dredged Material Uses Workgroup, Great River Environmental Action Team II (GREAT II). The objectives of this work group are:

- Analyze and describe constituents and properties of dredged material along the segment of the Mississippi River controlled by the Corps of Engineers, Rock Island District.
- Determine productive uses for dredged material.
- Compile a review of legal restrictions on dredged spoil placement.
- Select potential sites for disposal of dredged material.
- Perform a market study of sand and gravel producers and quarry operators in the GREAT II study area.

Mineralogical and size-grade analyses have been performed on sediment samples from all pools within the Rock Island District, and studies are being conducted on the suitability of dredged sand for fine aggregate in mortar, concrete, and asphaltic concrete. Other potential applications for dredged sand include use as levee construction material, road sanding material, fill material, and as a component of sewage sludge compost. All elements of the legal study have been completed, including applicable federal, state, county and city regulations. Selection of acceptable disposal sites is in progress, including analysis of historic disposal sites and sites not in the floodplain. Areas suitable for both permanent containment and temporary stockpiling are being selected. The market study will define the size and types of existing aggregate markets and to what degree the productive use of dredged material will affect the market.



Technical Services Group

TECHNICAL SERVICES GROUP

The Technical Services Group was formed through internal reorganization in July, 1978. The Remote Sensing Laboratory, Data Systems and Illustrating were combined administratively under this group to improve coordination among these three primarily service-oriented operations. Each is responsible for providing services internally to IGS staff, but each also works in close cooperation with other government agencies. Their goal is to provide information in useful formats. All require comparatively large amounts of space for mechanical, electronic, or optical equipment.

As technology develops, the capabilities of the Geological Survey will increase, and the three units of the Technical Services Group will increasingly be utilizing new capabilities in common. The interrelationships between data handling techniques and the programs of the units are apparent. Data Systems is developing increased computer capabilities for analyzing geographically distributed data. At the same time, the Remote Sensing Laboratory is cooperating with NASA and several state agencies to investigate the development of a computer information system

which could utilize satellite data. Both can utilize much of the same processing hardware. Further, both need to produce map products which are useable either as interim or final products. This leads directly to equipment and techniques that can be employed by illustrating. Overall, the Technical Services Group as organized will effect an efficient, well coordinated division to better serve the needs of its component units and the needs of the Geological Survey.

Bernard E. Hoyer, Chief

Remote Sensing Laboratory

General Program

The Remote Sensing Laboratory (RSL) has two primary functions. First, it provides governmental agencies, businesses, and private citizens with information on the location and availability of aerial and satellite imagery of the state (approximately 100 inquiries of this nature were handled by RSL in 1978). Secondly, the RSL provides research, technical and support services to agencies responsible for managing Iowa's natural resources. RSL has investigated and applied new remote sensing techniques to several Iowa resource problems.

High Altitude Aerial Photography

A cooperative effort between the Iowa Department of Soil Conservation, U.S. Soil Conservation Service, U.S. Army Corps of Engineers and the RSL resulted in the acquisition of high altitude aerial photography for about one-half of the state. The entire Des Moines River Basin, the Des Moines Lobe and Louisa, Lee, Henry and Des Moines Counties are covered in this 1:80,000 scale color infrared imagery (fig. 5). The SCS will use the photography for river basin planning, resource and conservation inventories, soils mapping, and land use studies. The Corps of Engineers

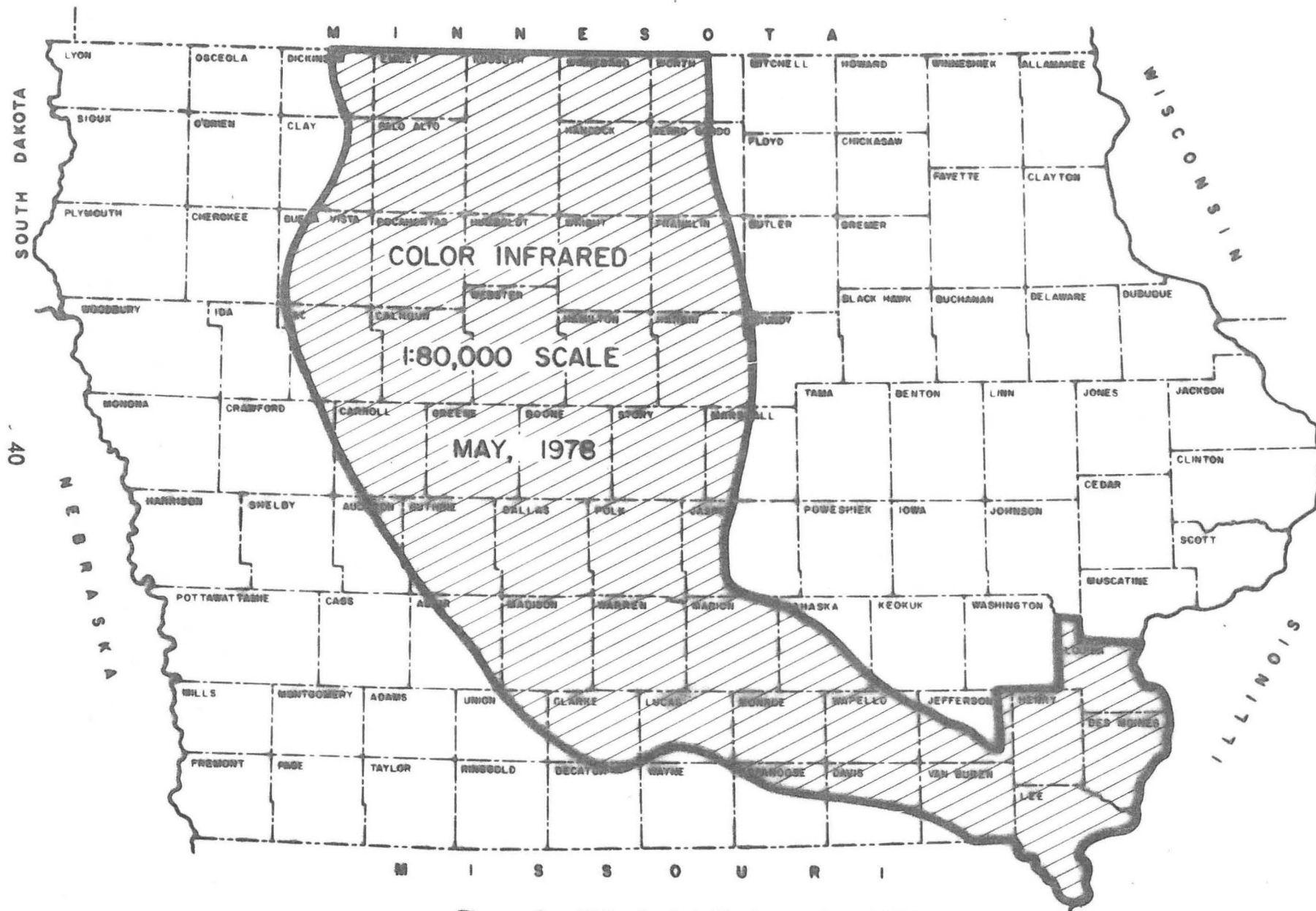


Figure 5. RSL Aerial Photography - 1978

will analyze surface water resources in the Des Moines River Basin. The coverage will provide the Department of Soil Conservation with information on land use and conservation practices. Staff of the Geological Survey are using the imagery to map glacial features on the Des Moines Lobe.

The photography is archived at the RSL and can be viewed by interested parties. Also, the EROS Data Center (Sioux Falls, South Dakota) has duplicated the film and can provide prints and other products.

Landsat Demonstration Project

NASA has instituted a Regional Applications Program that is designed to assist states in applying Landsat satellite data to resource management problems. The Earth Resources Laboratory (ERL) in Slidell, Louisiana is responsible for implementing this program in Iowa. Two members of RSL's staff visited ERL in August to evaluate the program. A Landsat scene of the June 1975 Ames flood was analyzed in order to test the flexibility of the data processing system. The Landsat data was used to classify flooded areas along Squaw Creek and South Skunk River. A data base was used to compare digitized flood boundary maps to the classified Landsat scene. This comparison highlighted the utility of digital data bases and provided information on the accuracy of Landsat land-cover classifications.

Based on the excellent results of this initial contact RSL and ERL implemented a Landsat Demonstration Project for Iowa. RSL drafted a preliminary proposal which was presented to interested state and federal agencies charged with managing Iowa's natural resources. Suggestions from these agencies and from ERL were incorporated and a final proposal was prepared.

The major emphasis of the project will be on the assessment of potential soil erosion hazards in the North Branch Basin in Madison County. The detailed Modern Soil

Survey maps for the basin will be digitized at ERL and entered into a data base. This information will be merged in the data base with Landsat-derived land cover data. This composite data base will then be used to compute potential soil erosion using the Universal Soil Loss Equation. The procedure will illustrate how digital soils data and Landsat data can be used to manage Iowa's soil resources.

Other applications will be tested. Landsat based land cover and digitized soils data will be merged to monitor the conversion of prime agricultural land to non-agricultural uses. The digital data base will be used to extract land use within a proposed interstate highway corridor. In addition, computer classified Landsat data will be used to assess wildlife habitat in central Iowa and to monitor the conversion of forest and pasture land to row cropland during the period 1973 to 1978.

The data analysis will be performed at ERL with assistance from the RSL staff. Present plans call for representatives of cooperating agencies to visit Slidell in January of 1979 to review the results of the project.

Coal Strip Mine Monitoring

In May and August of 1978 the RSL acquired low altitude color infrared photography of all the active coal strip mines in Iowa. This information was used by the Iowa Department of Soil Conservation, Division of Mines and Minerals to monitor mining and reclamation activities. Technical assistance from RSL and financial support from the Office of Surface Mining will allow Mines and Minerals to implement their own aerial monitoring system. All active mines will be flown quarterly during 1979. Photo interpretation will be handled by Mines and Minerals personnel using a newly acquired Richards MIN 3 light table equipped with a stereomicroscope.

Digital Flood Mapping

As reported last year, RSL's flood mapping research has been extended to include the use of computer processed Landsat data. The Earth Resources Laboratory in Slidell assisted RSL in processing a Landsat image of the 1975 Squaw Creek/South Skunk River flood. Digitized, 1:24,000 scale, photo interpreted flood boundaries were compared to flooded areas delineated on the processed Landsat scene. A visual analysis was performed by overlaying the digitized boundaries on the Landsat scene, using a geographically referenced data base. A quantitative analysis, based on a comparison of the number of acres inside the digitized boundary and the number of acres classed as flooded on the Landsat scene, was also performed. The results demonstrated that Landsat data can be used to accurately identify areas of recent flooding.

Wildlife Habitat Assessment

The Conservation Commission has been using maps produced from aerial photography to quantify the area and boundary lengths of various vegetation cover types in wildlife management areas. This data is used to calculate a Diversity Index which is a measure of the suitability of an area for a given species. Until recently the calculations had been performed manually. At the request of the Conservation Commission, a computer program was written to calculate the Diversity Index. The program also outputs suggested changes in areas and lengths which will produce a land cover arrangement that more closely approximates a model wildlife area.

was compiled by the State Water Plan Group (now the Water Resources Division). Data Systems prepared the "IWARDS Design Report". This report provides information on the relationship of IWARDS to the State Water Plan Framework Study. The basic concepts for IWARDS are described, and the scope of systems management services is discussed in relationship to the data processing and data management needs of the natural resource agencies.

Effective coordination with federal-level information handling is accomplished by the designation of IWARDS as a National Water Data Exchange (NAWDEX) Local Assistance Center. The IWARDS manager has participated in training and membership meetings for NAWDEX, a program of the U.S. Geological Survey. Participation in the NAWDEX program serves to avoid duplication of effort by giving IWARDS direct access to NAWDEX data directory files at Reston, Virginia.

Special Projects

Data Systems staff participated in the development of a proposal to the Environmental Protection Agency (EPA) to study the association between certain water quality parameters and the incidence of cancer. Cooperating with the University of Iowa Department of Preventive Medicine, the Geological Survey obtained an administrative award of \$9,990 to accelerate the encoding of water quality data under the auspices of the USGS - IGS cooperative agreement. An expanded role for the Geological Survey is anticipated with a pending proposal to EPA that would provide base data for a large scale analysis of the relationship between water quality and morbidity in Iowa.

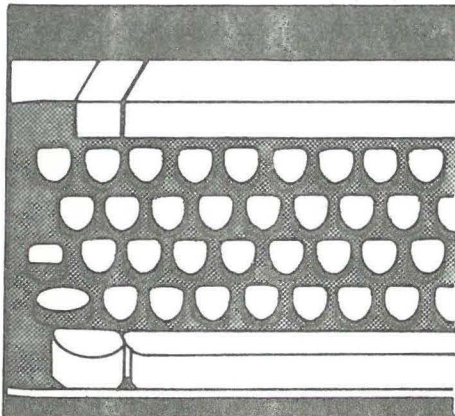
Data Systems staff also assisted in the preparation and analysis of climatological data for the Water Resources Division and the State Climatologist. Graphic displays

will be generated to show the probabilities and magnitudes of precipitation deficiencies throughout Iowa.

Illustrating Division

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. Major illustrative work of the division for the report period has been done for:

- State Water Plan Framework Study, under contract with the Iowa Natural Resources Council
- Geological Survey Newsletter
- Tri-State Geological Field Conference Guidebook
- Jordan Aquifer of Iowa
- Indianola Balloons, Inc.; contract work to produce special maps for the National Hot Air Balloon Championships held annually at Indianola, Iowa.



Administrative & Support Service Group

ADMINISTRATIVE AND SUPPORT SERVICE GROUP

The Administrative and Support Service Group is responsible for all personnel services, elements of budget planning and preparation, and supervision and coordination of administrative functions. Every effort is made to reduce administrative costs wherever possible without a reduction in the quality or scope of services.

Mrs. Martha B. Kafer, Chief

Administrative Services

Secretarial, communications and reception services are provided by Administrative Services. In addition, this division is responsible for mail distribution and publication sales, and maintenance of an adequate map and publication inventory. Significant cost savings were realized this year with the purchase of a copy machine as opposed to leasing, and by acquisition of a bulk mailing permit (non-profit mailing status) and a leased postage meter to ensure precise postage on each item mailed.

Accounting Services

Accounting record keeping, payroll and purchasing services for all programs are provided by Accounting Services. A new cost center code system has been implemented to better record and monitor individual program costs. Detailed quarterly budget reviews are prepared so that Management can evaluate the budget standings.

Support Services

The several responsibilities of Support Services range from the collection of basic data to maintenance of the Geological Survey's vehicle fleet. Personal contacts with drilling contractors, primarily through a regular schedule of visits to collect sets of drill cuttings, and laboratory preparation of the drill cuttings for microscopic study are major responsibilities. Over 500 sets of samples that represent a total footage of over 95,000 feet were collected this year. Although a large backlog of sample sets had accumulated from prior years, over 750 sets (about 182,000' of drilling) were processed this year. We now have 25,410 sets of processed sample sets in our rock library.

Other functions of this division include cataloging and shelving of additions to both the drill cuttings and core library, publications inventory maintenance, and the performance of a variety of support services to nearly all Geological Survey programs.

Library Services

In addition to providing research topics and materials to undergraduate and graduate geology students in the state's universities and colleges, the majority of publications received through the Geological Survey's worldwide publication exchange program are submitted to the library of the University of Iowa Geology

Department. The Survey retains only those periodicals, circulars and other publications that serve its special needs and which are not cataloged by the departmental library.

Prior to this year, the principal work of the Survey's librarian was related to elements of the Task Force reports for the "Iowa Water Resources Framework Study Report" and the IWARDS Data Catalog. This year, Library Services has concentrated on developing and implementing a catalog system for references in the Survey library and for those retained within individual offices. Over 3,000 publications have been cataloged, with about 1,500 remaining to be processed. Additional duties of the librarian include:

- Researching literature for special projects.
- Updating the computerized mailing list.
- Editing the monthly Staff Notes and the annual Newsletter
- Proofreading manuscripts and galley proofs.
- Updating the IWARDS bibliography.

PUBLICATIONS

Publication sales have increased from about \$1,600 in 1968 to nearly \$13,500 in 1978 (fig.6). Orders for A Regional Guide to Iowa Landforms contributed greatly to the nearly \$18,000 record sales in 1977. Several factors account for the overall increase in demand for topographic, geologic and hydrologic information:

1. Availability of the popular 7-1/2 minute topographic map quadrangle (and earlier 15 minute quadrangles) has increased topographical map coverage from about 25% of the state in 1967 to over 70% in 1978. Topographic maps are in various stages of completion over another 25% of the state. These maps are utilized by engineers in planning pipeline routes for hydrocarbon products, distribution lines for rural water systems, and for location of electrical power lines and transportation routes. The maps are relied upon for many other construction projects where information is required for drainage basin studies and zoning of flood plains.
2. An awareness by society in the past decade of the necessity to live in a rational state of balance with nature has resulted in a greater appreciation of our natural surroundings. Fossils and Rocks of Eastern Iowa (1967) and The Minerals of Iowa (1974) were extremely well received by the public. A Regional Guide to Iowa Landforms, the latest publication in our Educational Series, has been praised by the public sector and by elementary science teachers.
3. The format for presentation of water resources information was changed so that the information can be readily understood and used by those with no background in geology or geohydrology. Publication of The Water Story in

Central Iowa in 1965, and Mississippian Aquifer of Iowa in 1973 confirmed the need for less esoteric reports, with supporting illustrations, that can be utilized by engineers, well contractors and private citizens in planning and developing water supplies. Publication of The Jordan Aquifer in Iowa, Water Resources of East-Central Iowa, and Water Resources of South-Central Iowa add significantly to the amount of readily available information on water resources.

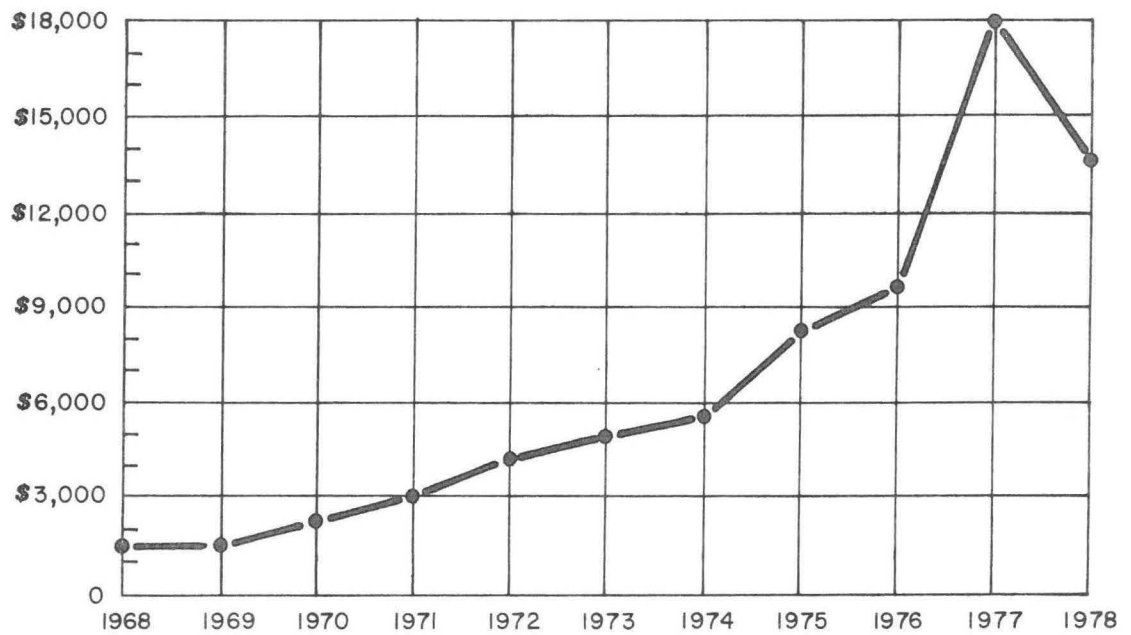


Figure 6. Publications and Map Sales

Geological Survey Publications

1. Anderson, R.R., (editor), 1978, Geology of east-central Iowa: 42nd annual Tri-State Geological Field Conference Guidebook, 221 p.
2. Cagle, J.O., and Heinritz, A.J., 1978, Water resources of south-central Iowa: Water Atlas No. 5, 97 p.
3. Dorheim, Fred H., Gypsum resources of the Ft. Dodge area: Public Information Circular No. 9, limited edition; in press.
4. Hallberg, G.R., (editor), Standard procedures for evaluation of Quaternary materials in Iowa: Technical Information Series No. 8, 109 p.; in press.
5. Horick, P.J., and Steinhilber, W.L., Jordan aquifer of Iowa: Miscellaneous Map Series 6; in press.
6. Huelsbeck, C.J. et. al., 1978, Newsletter: v. 1, no. 3, 28 p.
7. Ludvigson, G.A., and McAdams, M.P., New evidence of Early Ordovician tectonism in the Upper Mississippi Valley: Technical Information Series No. 10; in press.
8. Miller, G.A., Highland, J.D., and Hallberg, G.R., 1978, Highway soil engineering data for major soils of Iowa: Technical Information Series No. 7, 109 p.; in press.
9. Van Eck, O.J., Plugging procedures for domestic wells: Public Information Circular No. 11; in press.
10. Wahl, K.D., Ludvigson, G.A. et. al., 1978, Water resources of east-central Iowa: Water Atlas No. 6, 91 p.

Publications in Preparation

1. Avcin, M.J., and Hatch, J.R., Chemical analyses of selected Iowa coals, including trace element data: Technical Paper No. 5.
2. Bunker, B.J., and Ludvigson, G.A., The Plum River fault zone in east-central Iowa: Report of Investigations No. 12.
3. Bunker, B.J., and Ludvigson, G.A., Status of hydrogeologic studies in north-west Iowa: Technical Information Series No. 11.
4. Dorheim, F.H., Underground mining in Iowa, exclusive of coal: Public Information Circular No. 10.
5. Hoyer, B.E., Development and testing of operational flood mapping techniques: Public Information Circular No. 6.
6. Huelsbeck, C.J. et. al., Iowa Geology, No. 1. This series will replace the Iowa Geological Survey Newsletter.
7. Prior, J.C., et. al., Environmental geology atlas of Linn County: Miscellaneous Map Series No. 7.
8. Ravn, R.L., An introduction to the stratigraphic palynology of the Cherokee Group (Pennsylvanian) coals of Iowa: Technical Paper No. 6.
9. Ravn, R.L., Stratigraphic ranges of miospores in coals of the Des Moines Series of southern Iowa: Technical Paper No. 7.
10. Wahl, K.D., et. al., Alluvial ground-water resources of the Floyd River Basin: Water Supply Bulletin No. 12.
11. Wahl, K.D., and Bunker, B.J., Geohydrology of the Silurian-Devonian carbonate units in the Cedar Rapids area: Water Supply Bulletin No. 13.

Extrinsic Publications

1. Anderson, R.R., 1978, Inventorying migratory geese from aerial photography:
Iowa Acad. Sci. Abs.
2. Anderson, R.R., 1978, Use of aerial photography to evaluate the occurrence of oak wilt in Iowa forests: Iowa Acad. Sci. Abs.
3. Avcin, M.J., and Koch, D.L., Carboniferous stratigraphy of Iowa: in
Ninth International Congress of Carboniferous Stratigraphy and Geology,
USGS Professional Paper; in preparation.
4. Baker, R.G., and Hallberg, G.R., 1978, Pollen analyses of Farmdalian peats in southeastern Iowa: AMQUA abs., 5th biennial meeting, Edmonton, Alberta, p. 184.
5. Geological Highway Map, Northern Plains Map, 1978: Am. Assoc. Pet. Geologists, in preparation.
6. Hallberg, G.R., Wind-aligned drainage in loess in Iowa: Proc. Iowa Acad. Sci.; in press.
7. Hallberg, G.R., 1978, Calibration of COLE-calculated engineering data for montmorillonitic soils: Agronomy Abstracts, Ann. Meetings, Soil Sci. Soc. Am., Chicago, Ill., p. 169.
8. Hallberg, G.R., Home sewage disposal and water resources: in Iowa State Univ. Ext. Ser., Exp. Sta. Special Report; in preparation.
9. Hallberg, G.R., 1978, Problems in water resources related to agriculture, in Proc. 2nd Ann. Midwestern Conf. on Food and Social Policy, Iowa State Univ. Press.; in press.

10. Hallberg, G.R., 1978, Origin of upland sands and gravels and stratified drift in N.E. Iowa: Iowa Acad. Sci. Abs., p. 43.
11. Hallberg, G.R., 1978, Re-evaluation of the time and rock stratigraphy of the type areas of Early Pleistocene Deposits in Iowa and Nebraska; A progress report: Iowa Acad. Sci. Abs., p. 46-47.
12. Hallberg, G.R., 1978, Wind-aligned drainage in west-central Iowa: Iowa Acad. Sci. Abs., p. 42.
13. Hallberg, G.R., and Boellstorff, J.D., 1978, Stratigraphic "confusion" in the region of the type areas of Kansan and Nebraskan deposits: Geol. Soc. Am. Abs., v. 9, no. 5.
14. Hallberg, G.R., and Fenton, T.E., 1978, Comment on Pacific Pleistocene paleoclimatic stratigraphies; a comparative analysis of results, by Mark J. Valencia, Quaternary Research; in press.
15. Hallberg, G.R., Wollenhaupt, N.C., and Miller, G.A., 1978, A century of soil development in spoil derived from loess in Iowa: Soil Sci. Soc. Am. Jour., v. 42, no. 2, p. 339-343.
16. Hoyer, B.E., 1978, Woodfordian and Holocene development of the Little Sioux River: Iowa Acad. Sci. Abs.
17. Hoyer, B.E., and Wollenhaupt, N., 1978, Alluvial Stratigraphy of Crawford Creek: Iowa Acad. Sci. Abs.
18. Kuiper, L.K., Accuracy testing of numerical solutions to the infiltration equation: Water Resources Res.; in press.
19. Kuiper, L.K., Comment on, "A two-dimensional linearized view of one-dimensional unsaturated-saturated flow" by Cushman and Kirkham: Water Resources Res.; in press.

20. Kuiper, L.K., The computational efficiency and Taylor expansion derivation of approximating equations to the groundwater flow equation: Water Resources Res.; in press.
21. Ludvigson, G.A., 1978, Recent investigations in the Upper Mississippi Valley District regarding the origin of the deposits: Iowa Acad. Sci. Abs., p. 49.
22. McAdams, M.P., and Hoyer, B.E., 1978, The application of remote sensing techniques to flood inundation mapping: Iowa Acad. Sci. Abs.
23. Prior, J.C., Present and proposed geological preserves in Iowa; a report to the Iowa State Advisory Board for Preserves, December, 1977, 37 p.