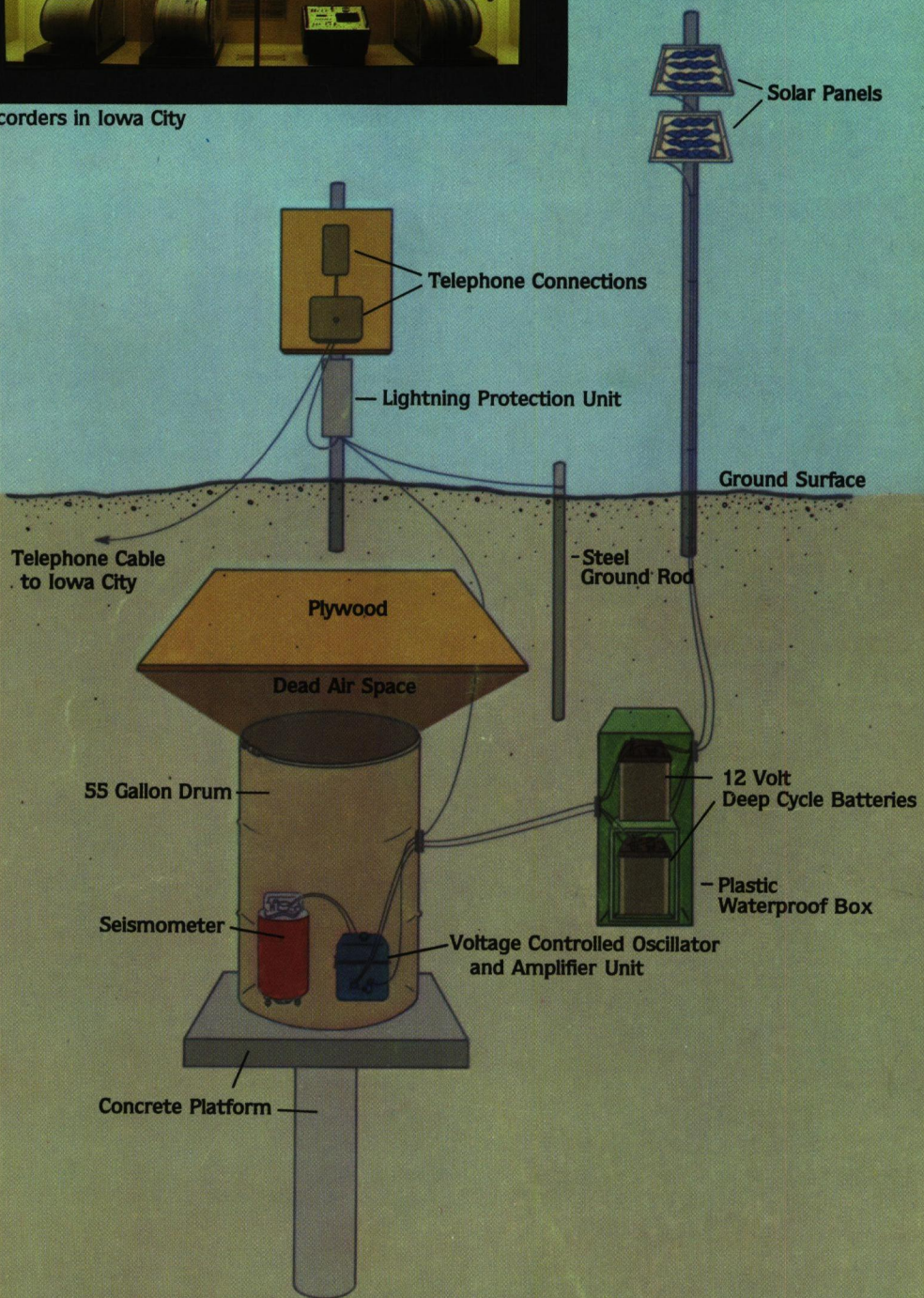
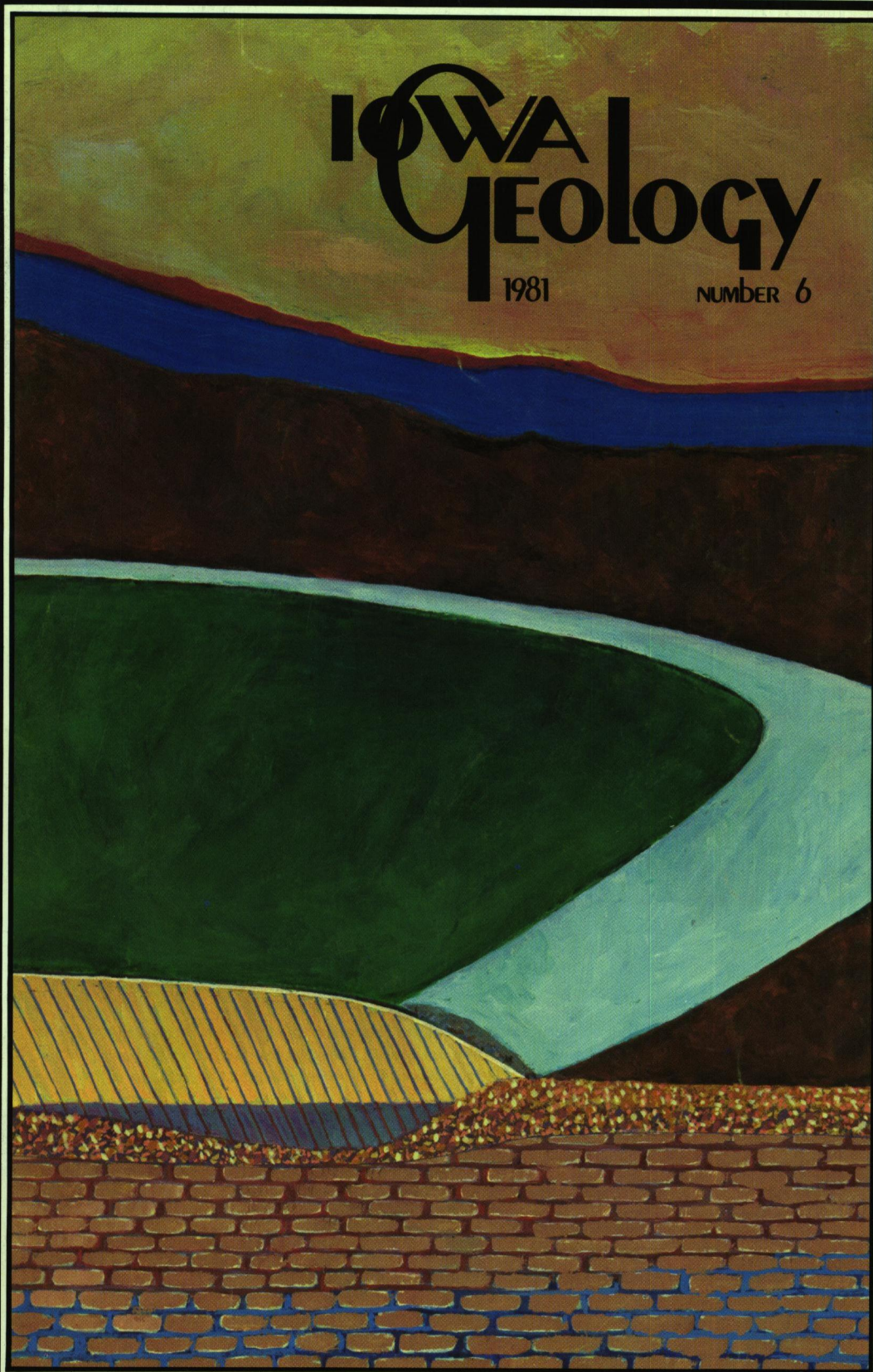


Recorders in Iowa City



IOWA GEOLOGY

1981 NUMBER 6



IOWA GEOLOGY

1981 NUMBER 6

IOWA GEOLOGICAL SURVEY

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

Donald L. Koch
Director and State Geologist

Front Cover: Conceptual illustration of LaBounty Waste-Disposal Site. Painting by John Knecht.

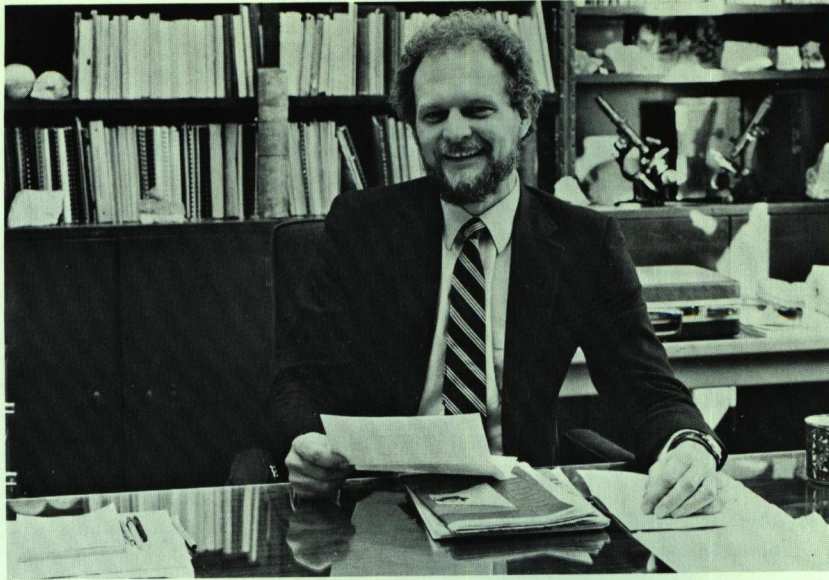
Back Cover: Diagram of the micro-seismic stations installed in southwest Iowa. Earthquake signals are sent to IGS in Iowa City where they are stored on a recorder such as illustrated in the photo. These recorders are located in a display case so that visitors may observe them in operation. Illustration by Patricia Lohmann.

Bernard Hoyer Editor
John Knecht Art Editor
Patricia Lohmann Graphic Artist

Editor's note: *Iowa Geology* is produced by the entire IGS staff. I would like to acknowledge the staff's contributions and express my appreciation for their cooperation.

TABLE OF CONTENTS

FROM THE DIRECTOR'S DESK	2
Donald Koch	
STATE GEOLOGIST GRANT RESIGNS . . . KOCH APPOINTED	4
CHRONOLOGY OF STATE GEOLOGISTS	4
A HAZARDOUS-WASTE LANDFILL IN CHARLES CITY, IOWA	5
James Munter	
HAZARDOUS-WASTE DISPOSAL STUDY	8
Raymond Anderson	
COAL PROGRAM	9
HISTORIC CHANGES ALONG THE MISSOURI RIVER	10
George Hallberg	
BY THE WAY, YOU'LL NEED WATER	13
Donivan Gordon	
THE DAKOTA AQUIFER STUDY AND THE DEVELOPMENT OF WATER ALLOCATION POLICIES IN NORTHWEST IOWA	16
James Munter, George Hallberg, James Wiegand and Michael Smith	
WATER QUALITY DATA	17
DREDGED-MATERIAL USES WORK GROUP	18
James Case	
NATIONAL WATER-USE DATA SYSTEM	19
SURVEY STAFF LEAD GEOLOGICAL FIELD CONFERENCES	20
MONITORING IOWA EARTHQUAKES	22
Orville Van Eck	
TOPOGRAPHIC MAP SERIES NEARS COMPLETION	24
RATHBUN EROSION STUDY	25
Ross Black	
NEW STAFF IN '80	26
COMPLETE PHOTO COVERAGE OF IOWA	28
IGS REPORTS AND PUBLICATIONS IN '80	28



FROM THE DIRECTOR'S DESK

What is a Geological Survey? Why is it needed? How is it organized? What work is to be done? When will the Survey be completed? These questions are asked frequently by people who know little about how or why information on the geology and water resources of their state is important to their well being.

The articles that follow in this issue of "Iowa Geology" comprise a unified theme in response to these questions. The articles

provide a better understanding of how municipalities, industry, other governmental units and the private sector are served by the Iowa Geological Survey, and show why the "survey" is not yet completed. But first, a brief historical note will set the stage for the questions of "What," "Why" and "How."

By the middle of the 19th century it became apparent that the future potential for Iowa's growth and prosperity lay in its natural resources. But what constituted those resources, particularly in the less settled portions of the state? What was the nature of the soils, and what other natural resources were available to aid in the state's economic development?

Like its counterpart in many states, the Geological Survey underwent a series of legislative starts and stops in its early years. In January, 1855, the Legislature passed an "Act to provide for a Geological Survey of the State." The work was to be conducted by the State Geologist and his assistants within two years, but an extension was granted so that a more complete report could be presented to the Governor and to the General Assembly. The results of field investigations conducted during 1855, 1856 and 1857 were printed in a

two-part volume in 1858. Information on the geology of the eastern part of the state was presented in Part I, and fossils characteristic of the rock formations were described in Part II.

Although this first "survey" was a great accomplishment, much work remained to be done. Indeed, the General Assembly that ordered the survey expected that the work would be continued until the whole state had been carefully examined and reported upon. However, no further appropriation was made until reorganization of the "survey" was ordered in April, 1866. That "survey" concentrated on the western part of the state, and on the mineral and other material resources of the whole state. Work on this "survey" terminated in 1869, and two volumes were published to summarize the results.

The first two "surveys" were largely reconnaissance in nature. Field work was accomplished during late spring, summer and early fall, and reports were written during the winter. The State Geologist and a staff of only four or five people comprised the "surveys." Only two or three of the staff were full-time employees—the others were part-time workers or "volunteer assistants." These pioneer investigators established a framework of geologic knowledge about the state. Later workers would build upon this framework.

By 1892 legislators were convinced that more detailed information should be made available on the natural resources and natural history of the state. The value of such information was recognized from the results of the first two reconnaissance "surveys." This time, instead of an "Act to provide for a Geological Survey of the State," a continuing state agency, the Iowa Geological Survey, was established. This Survey would be under the direction of a Geological Board, consisting of the governor, the auditor of state, and the presidents of the State University of Iowa, Iowa Agricultural College, (now Iowa State University), and the Iowa Academy of Science.

Since 1892, the mandate to the State Geologist, as Director of the Survey has been "to make a complete survey of the natural resources of the state in all their economic and scientific aspects . . . including their richness in mineral contents and their fossils; to investigate the different ores, coals, clays, building stones, peats, mineral oils, natural gases, mineral and artesian waters . . . with particular regard to the value thereof for commercial purposes and their accessibility."

Information derived from wells and mineral exploration tests provides invaluable data, unavailable to early geologists, on the state's water resources and geologic materials. The long-term systematic collection of this and other data continues to be of immeasurable value to the state. Refinements in data collection and interpretation have evolved with improved technology, and these refinements permit improved capabilities in problem-solving and service functions of the Survey.

I have briefly discussed the "What," "Why" and "How" of the Iowa Geological Survey. The articles that follow provide definitive answers through examples of applied geologic and hydrologic investigations. "When" will the survey be completed? A statement by the State Geologist in the Annual Report for 1892 is still applicable—"The work of the Survey is now fairly begun."

Donald L. Koch
State Geologist and Director

Note: The Geological Board was dissolved effective December 31, 1980 as part of Senate File 205 which provided for reorganization of the Iowa Department of Environmental Quality and the Iowa Geological Survey. The State Geologist now is appointed directly by the Governor.

State Geologist Grant Resigns...Koch Appointed

Dr. Stanley C. Grant resigned as State Geologist and Director of the Iowa Geological Survey in April, 1980 to become Vice-President of Operations for Bishop Oil and Refining Company in Elizabeth, Colorado. During his five years at IGS, he strongly supported the improvement of geologic research facilities and was responsible for construction of the IGS research and sample storage center at Oakdale. He also promoted the development of IGS computer processing capabilities in order to make our geologic data more accessible and to produce land cover data from the Landsat satellite system. His staff especially remembers his sincere interest in promoting their professional recognition and growth. Statewide, he was recognized for his support of education at all levels and his active participation in the Iowa Academy of Science. While here, he served

as the Governor's Science Advisor and also chaired the Interagency Resources Council. His involvement with Iowa science continues, as he will be President of the Iowa Academy beginning in April, 1981.

Donald L. Koch was appointed State Geologist and Director of IGS in July, 1980. Don, a native of Manchester, Iowa received his B.S. and M.S. degrees in geology from the University of Iowa. He has been with IGS since 1959 and previously has held the positions of Chief of Subsurface Studies and Assistant State Geologist. He has a broad knowledge of Iowa geology as well as experience in applying it to Iowa problems. Paleozoic stratigraphy and paleontology as well as ground water are his special areas of interest and he is professionally recognized in these fields.

Chronology of State Geologists

The Geological Survey of Iowa

James Hall	State Geologist	1855-1859
------------	-----------------	-----------

State Geological Survey

Charles A. White, M.D.	State Geologist	1866-1869
------------------------	-----------------	-----------

Iowa Geological Survey

Samuel Calvin	State Geologist & Director	1892-1904
Frank A. Wilder	State Geologist & Director	1904-1906
Samuel Calvin	State Geologist & Director	1906-1911
George F. Kay	State Geologist & Director	1911-1934
Arthur C. Trowbridge	State Geologist & Director	1934-1947
H. Garland Hershey	State Geologist & Director	1947-1969
Samuel J. Tuthill	State Geologist & Director	1969-1975
Stanley C. Grant	State Geologist & Director	1975-1980
Donald L. Koch	State Geologist & Director	1980-

A HAZARDOUS-WASTE LANDFILL IN CHARLES CITY, IOWA

By James Munter



The disposal of hazardous wastes has become an item of national attention in recent years. The LaBounty site in Charles City, a hazardous-waste disposal site used from 1953 to 1977, has received some of this attention, and rightfully so. The site is located on the floodplain of the Cedar River. Ground water at the site contains high concentrations of arsenic and twenty-four of the United States Environmental Protection Agency's (EPA) 129 "priority pollutants". Contaminated ground water is known to be seeping into the Cedar River only 100 yards from the waste. A compound found in the waste, orthonitroaniline (ONA), is not known to be a human health hazard, but has been detected in low concentrations from wells near the Cedar River in Waterloo, Iowa, 65 river miles downstream. A discussion of the site, including the historical development and the results of ground-water studies conducted at the site, is appropriate in view of the current public concerns over hazardous waste.

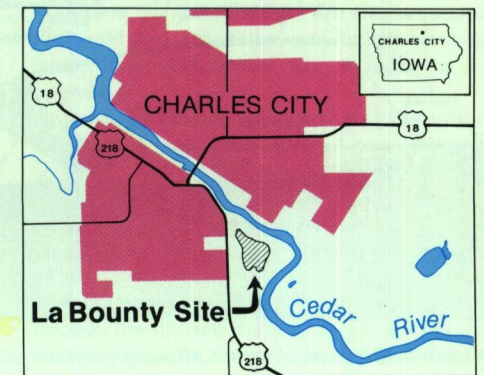
In 1953, Salsbury Laboratories of Charles City, Iowa, requested permission from the Iowa State Department of Health (ISDH) to use property owned by Duane LaBounty as a disposal site for wastes generated by the production of agricultural chemicals. The Iowa Geological Survey (IGS) was informed of their intention, and consultation between the Iowa and United States Geological Surveys resulted in a recommendation that should the site be used, Salsbury Labs should install monitoring wells around the site and regularly monitor the quality of the ground water.

Four observation wells were installed in the Cedar River alluvial aquifer at the site in 1953. Analyses of the chemical quality of the ground water were subsequently submitted to both ISDH and IGS. After its establishment in 1972,

the Iowa Department of Environmental Quality (IDEQ) assumed regulatory responsibility of the site. Since 1979, however, an administrative order established the U.S. Environmental Protection Agency (EPA) as the lead regulatory authority over the site.

Arsenic was first detected in Salsbury Labs monitoring wells in the early 1960's, and concern increased as contamination levels rose throughout the 1960's and early 1970's. A period of intensive monitoring and study began in 1975 with the drilling of three wells at the site by IGS under a contract with IDEQ.

In 1977, upon the discovery of ONA in the water supply of Waterloo, legal, engineering and scientific activity intensified. As the LaBounty site was considered the only possible source of ONA, and because some thought it an imminent health hazard to many Iowans, IDEQ issued an executive order requiring removal of the waste from the present site and subsequent disposal in an approved hazardous-waste site. Such a site, however, did not exist in 1977, and does not exist in Iowa today. Because of the extremely high cost of this alternative, the potential for creating two serious environmental problems rather than one, and the lack of clear evidence of an imminent health danger to anyone, Salsbury Labs has not complied with the executive order. But neither have they been inactive. They have been cooperative with IDEQ, EPA, and IGS in collecting extensive data at the site. At least 51 holes have been drilled in a 50-acre area around the site since 1975. The latest and most comprehensive investigation was funded by Salsbury Labs. Additionally, they have performed extensive remedial measures at the site.



Location of LaBounty waste-disposal site.

The analysis of the technical data from the site has been a cooperative process involving the University Hygienic Laboratory, EPA, IDEQ and several consulting firms employed by Salsbury Labs, EPA and IDEQ. As a result we believe the geology, ground-water flow system and the present contamination pattern is reasonably well known. This information was presented in a 1980 IGS report to IDEQ entitled *Evaluation of the Extent of Hazardous Waste Contamination in the Charles City Area*. This report utilized much of the data collected by all parties involved and relies heavily on the comprehensive monitoring system Salsbury's consultant installed under EPA supervision in 1979.

Waste at the LaBounty site was placed in a gravel pit on the south side of Charles City. Sand and gravel deposits surround the fill material and overlie the Cedar Valley Limestone, which occurs at depths ranging from 0 to 41 feet below the site. This limestone, the primary concern of IGS research, is a major source of drinking water in northeast Iowa because of its broad extent, shallow depth, excellent water-yielding properties, and high quality of water. Ground water in the Cedar Valley aquifer near Charles City originates from rainfall in the upland areas and flows through the aquifer to discharge to local streams and rivers. This flow system can be observed on a local scale at the LaBounty site, where the water table in the floodplain sand and gravel slopes toward the river, parallel to the direction of ground-water flow.

The ground-water contamination pattern emanating from the disposal site generally follows the paths of ground-water flow (Fig. 1). The most highly contaminated water is immediately east of the fill at the base of the sand and gravel deposits. Here, arsenic concentrations exceed 400 milligrams per liter (mg/l), and numerous organic chemicals are present in high concentrations. The EPA primary drinking water standard for arsenic is 0.05 mg/l. No standards have been set for the bulk of the organic chemicals.

Severe ground-water contamination, however, is limited to an area only several acres in size, and does not extend to great depths. Shallow wells in the Cedar Valley Limestone have significantly reduced contamination levels when compared to sand and gravel wells at the same locations. A 335-foot deep Cedar Valley aquifer well only 400 feet southeast of the fill is not contaminated. Ground water in the shallow limestone is not highly contaminated at the site because the regional ground-water flow system in the Cedar Valley aquifer discharges to the Cedar River, and the upward flow tends to flush contaminants out. The contamination that is present in the rock wells is likely a result of short-term fluctuations in the direction of ground-water flow that are caused by heavy rains and high stages of the Cedar River. All available evidence indicates that no regional contamination of the Cedar Valley aquifer has occurred.

Because of dilution, water in the sand and gravel near the river is less contaminated than

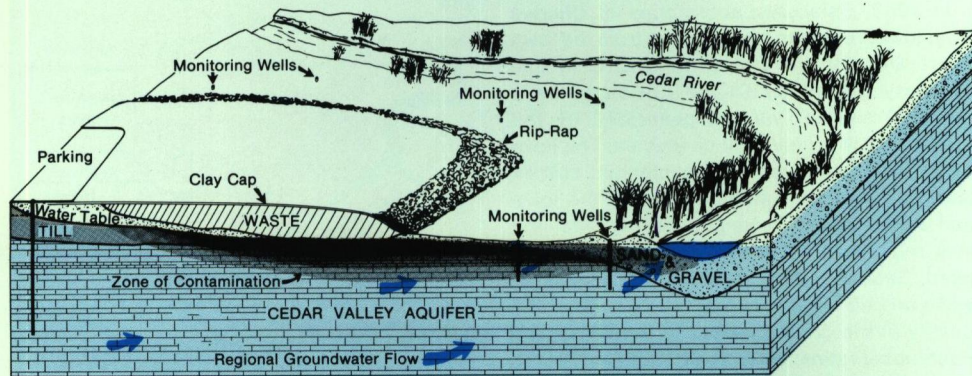
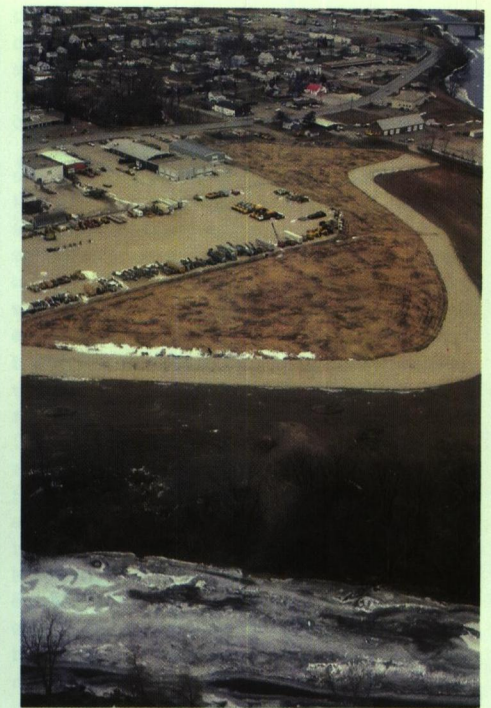


Figure 1. Cross-section of LaBounty disposal site revealing the location of the waste in relation to geologic units, monitoring wells, engineering improvements, the ground-water flow pattern and the zone of contamination.



LaBounty disposal site, December, 1976. Photo by Raymond Anderson.



LaBounty disposal site, January, 1981, after remedial measures were completed. Photo by Bernard Hoyer.

water in the sand and gravel near the waste. Upward flow from the Cedar Valley aquifer, downward flow from infiltrating rainfall on the floodplain, and intermittent flood waters from the Cedar River all combine to reduce contamination levels. Wells up-gradient of the waste show arsenic concentrations well below the EPA drinking water standard. Samples collected from the river immediately adjacent to the site are generally below EPA standards, although samples with higher concentrations have been recorded. While the river's water may not be severely degraded, EPA studies show that the river's biota has been affected locally.

The detection of ONA in shallow wells in Waterloo is a result of the locations of the wells and the physical properties of ONA. The wells containing ONA were located in sands and gravels adjacent to the river. ONA is readily soluble, highly mobile, very stable, and easily detected at very low concentrations in natural waters. The compound is not known to be hazardous to human health. All available evidence indicates that ONA entered the

Cedar River at the LaBounty site, travelled downstream to Waterloo, and was drawn into shallow wells near the river by pumping of the wells. This process reduced the concentration of ONA by a factor of one million. No other contaminants from the LaBounty site were found in measurable concentrations at Waterloo. Monitoring of wells along the Cedar River between Charles City and Waterloo has shown that trace quantities of ONA are also present in Plainfield and Janesville, and similar mechanisms of contamination are thought to be operating.

Remedial actions were taken at the site in the summer and fall of 1980. A two-foot-thick clay cap was placed over the fill material, a storm sewer through the site was rerouted and surface drainage was diverted from the site. The soil placed on the clay cover will be seeded in the spring, 1981. These actions were taken to reduce movement of water through the fill, and thereby obtain a reduction in the volume of contaminants yielded by the site. Riprap was placed around the toe of the site to protect it from possible Cedar River

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

Some uncertainty lingers concerning the ultimate effectiveness of the clay cap. The fact that some of the waste is below the water table means that some level of contamination is likely to continue. However, the general consensus of all parties concerned is that the clay cap will result in significant declines in contamination levels in the shallow ground water and in the Cedar River by substantially reducing the vertical seepage through the waste.

Monitoring the upward flow of ground water from the Cedar Valley aquifer to the river must continue, however, because this upward flow is the primary means of protecting the aquifer from contamination. Further development of water supplies from the aquifer should be evaluated on a case-by-case basis to assure maintenance of the upward ground-water flow.

One of the major impediments to establishing the most cost-effective management strategy for the LaBounty site is that an acceptable level of contamination has never been defined. One obvious goal would be to return to an uncontaminated condition on the LaBounty site. Unfortunately, this is not possible, even with complete removal of the waste and surrounding soil. Regulatory agencies have been understandably reluctant to establish contamination levels pertinent to the LaBounty site below which no significant adverse impact will occur. Without these standards, however, the success or failure of engineering remedies at the site is difficult to establish. It is encouraging that many of those involved with the site think that the remedial measures now in place will be of significant value in reducing contamination levels in both ground water and surface water. Continued monitoring will be necessary to establish the effectiveness of the clay cap and to guide further management actions.

HAZARDOUS WASTE DISPOSAL STUDY

By Raymond Anderson



The problem of hazardous waste disposal in Iowa has generated much public interest in recent years. Studies presently underway by the Iowa Department of Environmental Quality (DEQ) and the U.S. Environmental Protection Agency will identify and locate the types of

hazardous wastes that are generated in the state. These wastes can generally be grouped into seven categories: flammable, explosive, corrosive, pathological, toxic, reactive, and others including radioactive. A study released in 1977 by the Northern Iowa Area Community College estimated that 632,000 tons of hazardous wastes are generated every year in Iowa. Of these wastes, 65% are stored at company-owned sites, 14% recycled, 11% shipped out of state, 9% "disposed of" in municipal sewers, and 1% placed in landfills.

To prevent the degradation of Iowa's physical environments, especially the important surface- and ground-water resources, hazardous wastes must be handled and stored with a great deal of care. High-temperature incineration is the best disposal method for many of these wastes, but because of the high costs, most hazardous waste must be buried. Unfortunately, out of sight is not out of mind; buried wastes have the potential to migrate into the state's important aquifers.

A large percentage of Iowa-produced hazardous wastes can probably be stabilized and safely repositied in already permitted landfills with a minimum of engineering modification. Repositing of the more hazardous wastes, however, cannot be safely accomplished without careful consideration of geologic and hydrogeologic factors. It is this problem of identifying the safest available geologic repositories for these materials that led the Iowa Geological Survey to initiate a waste disposal study. The goals of the study are two-fold; first to develop a set of geologic criteria sufficient to identify units capable of isolating the waste from water resources, and second to delineate those regions of the state

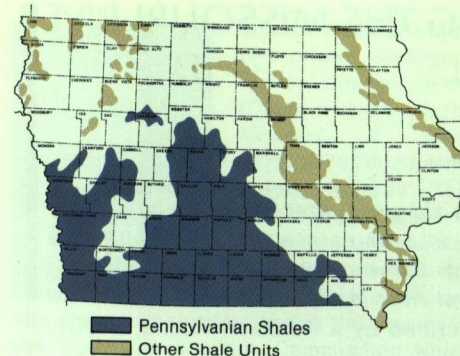


Figure 1. Location of bedrock units under consideration as possible repositories for hazardous waste.

underlain by geologic units which fit these criteria.

Two materials which are presently being considered as repositories of hazardous wastes in Iowa are shale and glacial till. Both of these materials exhibit very low hydraulic conductivity, meaning that water moves extremely slowly through them. Both are composed of clay minerals which can incorporate many constituents found in hazardous wastes within their own molecular structure. To be satisfactory, however, both must be thick enough to impede waste movement, yet shallow enough in depth to provide access from the land surface.

About 40% of Iowa is underlain by shale. Of the four major shale units (Fig. 1), the Pennsylvanian shales appear most favorable for waste disposal site development because they are not directly associated with important, regional bedrock aquifers. Glacial till covers about 85% of Iowa. It is very thick in west-central Iowa but also quite thick over much of western and southern Iowa. The most favorable locations would be where till occurs directly above the shale. Based on hydrogeologic considerations including the association of till and shale and the absence of aquifers, southern Iowa appears to be the most favorable general area for locating a suitable site.

Hazardous waste disposal is probably a necessary evil in Iowa's future. Our study will only identify criteria for siting and general areas which meet the criteria. The actual sites will be permitted by DEQ and the public after rules are established, and after detailed hydrogeologic studies prove that safe, favorable conditions exist at the site. Only through

such detailed, site-specific studies can the risks of hazardous waste disposal be minimized.

COAL PROGRAMS

Although we no longer have an active coal research program, IGS involvement in matters related to coal development, mine reclamation and environmental protection have continued. In addition to participation in the Land Rehabilitation Advisory Board for the Iowa Department of Soil Conservation (DSC) and the Rural Abandoned Mine Program (RAMP) for the U.S. Soil Conservation Service, two new programs are active at IGS which are supplementary to these existing programs.

The Abandoned Mine Lands Inventory (AMLI) is being conducted under a cooperative agreement with the Office of Surface Mining Reclamation and Enforcement (OSM). This inventory is intended to identify areas where hazardous conditions exist from past coal-mining activities. AMLI will produce the primary information to be used by OSM and Iowa in determining priority areas for reclaiming abandoned coal-mined lands.

The Small Operators Assistance Program (SOAP) is being conducted by IGS under contract with DSC. The program provides assistance to small coal-mining companies. IGS will design monitoring programs to protect surface and ground-water resources around permitted mine sites. Funds for SOAP as well as AMLI and RAMP, are all derived from fees collected on coal production both nationally and within our own state.



Abandoned coal mine in Davis County. Photo from Abandoned Mine Lands Inventory.

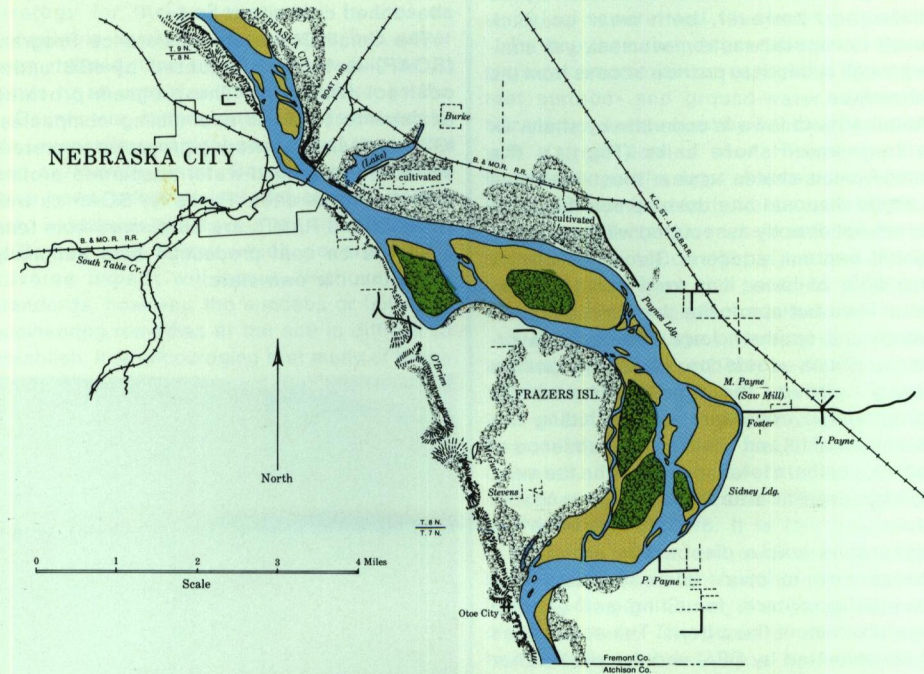
HISTORIC CHANGES ALONG THE MISSOURI RIVER

By George Hallberg

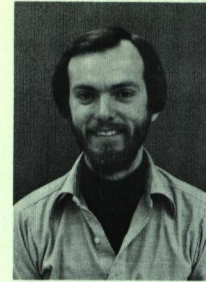
"There is only one river that goes traveling sidewise, that interferes in politics, that rearranges geography and dabbles in real estate; a river that plays hide-and-seek with you today, and tomorrow follows you around like a pet dog with a dynamite cracker tied to its tail. That river is the Missouri." From "The Missouri, Its Habits and Eccentricities Described by a Personal Friend," 1907, American Magazine, George Fitch.

The quote above provides an interesting commentary on the Missouri River at the turn of the century and provides a marked contrast to the Missouri River adjacent to Iowa today. At the time it was written, the Missouri was a broad multi-channeled stream with islands,

sandbars and sloughs throughout its active channel area. Now the river is tightly controlled within a single, narrow, smooth, man-made channel which flows through a series of gentle bends and is contained within well-stabilized banks.



Portion of Map Sheet 21, Missouri River Commission, 1890, showing the location of water, sand bars and islands.



A recent publication of the Iowa Geological Survey, *Changes in the Channel Area of the Missouri in Iowa, 1879-1976*, documents these changes. This project is an example of the technical expertise that IGS provides for other state agencies.

The project was undertaken at the request of the Iowa Conservation Commission which partially funded the research. Stabilization and flood control of the Missouri River have provided benefits, particularly the establishment of thousands of acres of land for agriculture and development on the alluvial plain. However, with alteration of any natural system there are costs as well as benefits. The navigable waterway has been developed at the sacrifice of the river's natural riparian right-of-way. The broad natural channel area of the Missouri River provided some of the most

continuous and diverse habitat for fish and wildlife and other recreational uses in the Midwest. The development of the present design channel significantly reduced the natural fish and wildlife habitat as well as the recreational potential of this area. Significant tracts of state-controlled conservation lands were also lost in the process. These losses of natural areas are reflected in the losses of land and water areas since artificial control of the river was begun. The purpose of the IGS study was to quantitatively document the magnitude of these losses.

Using maps, aerial photographs, and hydrologic data, the natural and man-made changes in the channel of the Missouri River were evaluated for the years 1879, 1890, 1923, 1947, and 1976. For quantitative comparison and documentation, the river mileage, sinuosity and channel area, as well as the water, island, and bar area within the channel were measured.

Natural changes in the river system were evaluated for the 1879-1923 time period.



Interpretation of a 1980 aerial photograph. Comparison with the 1890 map demonstrates the loss of water area, sand bars and islands.

During this interval the channel along Iowa decreased in length by about 14 miles (7%) which is a significant change. However, a natural balance also occurred, because the channel area increased by about 5200 acres (7%). This is in marked contrast to the artificial changes which occurred later.

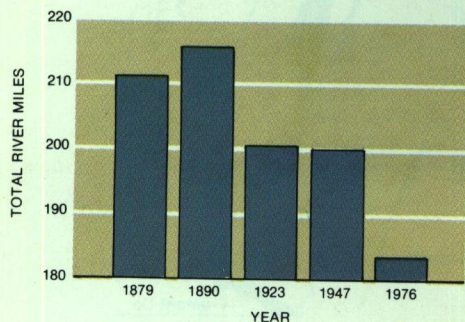
The man-induced channel changes of the Missouri River were equally as dramatic as the natural changes, but a balance was not maintained. The Missouri was altered, by Congressional mandate, in two stages; first by construction of the 6-foot navigation channel, and later by realignment and construction of the present 9-foot design channel. Between 1923 and 1976 the river was shortened about 18 miles (9%) in Iowa. However, no increase in surface area resulted. Instead, the channel area decreased by about 62,000 acres (80%). That's about 96 square miles of lost channel area. All areas of surface water (channel and backwater areas), islands and river bars, all offering special habitats, were all radically reduced. The surface area of water in the channel was reduced by about 30,000 acres. This is equal to the water-surface area, at normal pool elevations, of the Coralville, Saylorville, Red Rock, and Rathbun Reservoirs

combined! Bars and islands have been essentially eliminated, a loss of over 31,000 acres since 1923.

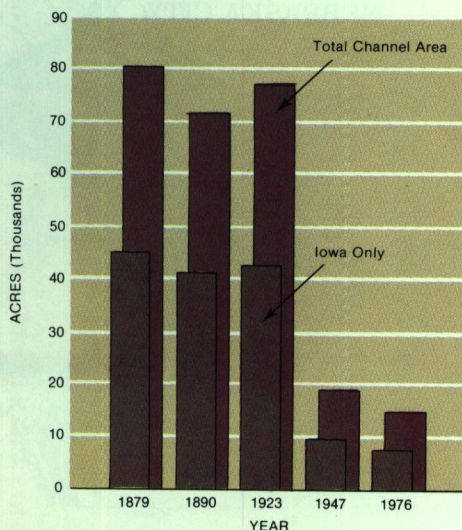
All of these changes often are attributed to the construction of the present design channel. However, as shown by the 1947 data, if the first design channel had been allowed to stabilize, this would have accounted for 95% of the losses in channel area and 99% of the loss of water area.

These areal losses are sizeable—but even these are minimal figures. There are other changes which took place in response to the stabilization and control of the river which cannot readily be quantified over time. These include such things as accelerated clearing of timber, draining of wetlands, and encroachment of developments or agriculture on the remaining natural areas. Also, the remaining water area is a swift and turbid stream which has radically altered the fish population of the river.

It is hoped that documentation of the actual magnitude of these losses will provide a perspective for evaluating future projects and developments. It is also hoped that these figures will aid in the mitigation of these losses to the state of Iowa.



Changes in Missouri River mileage, 1879-1976.



Changes in Missouri River channel area, 1879-1976.

BY THE WAY, YOU'LL NEED WATER By Donovan Gordon



"I've found the property we've been looking for. There's fifteen wooded acres and it's just 20 minutes from town. It's on a good, all-weather road, the taxes will be reasonable, and it's in our price range. You'll love it!"

With little more consideration, Jane and

Tom buy the property and embark upon their experiment with rural living. In the weeks that follow they check building regulations, obtain the necessary permits, choose their contractor and finally, consider their need for water.

In the past several years IGS staff have communicated with too many people who have based their choice of a building site on location and aesthetics. Too many times we have spoken to disillusioned, disappointed homeowners who have been forced to realize that a supply of water cannot be taken for granted. For many of us, our only experience with water supply is a leaking faucet and the water bill. Unlike the rural resident, we have not experienced the frustration of a well going dry, a pump failing or not having enough water when the whole family is in for the holiday. Nor have we dealt with water staining our fixtures and our clothes in the wash, or just plain smelling or tasting bad. And what about fire protection? We do have a tendency to take water for granted. Each year as more lowans move to the country, some are certain to face these and other problems. Worse yet, others will find no reliable or affordable water supply at all. For some of these problems there are remedies, although possibly costly, but for many there are none. Therefore, it is important to investigate water-supply potential before making any decision leading to the purchase of land.

How much water do I need? Generally, it takes 50-60 gallons daily for each family member to satisfy all needs. To meet this need, wells generally must produce sustained yields of 3-5 gallons per minute, and the water system should generally be able to produce 5-7 gallons per minute to meet additional appliance needs. For homes without fire protection, the water system should produce a sustained yield of 500 gallons per hour. Livestock need water

too. Cows and horses need 10-30 gallons a day extra. Discuss your needs with the plumber who installs your water system.

Where do you get help? Obviously, if you need plumbing advice or a well driller you can refer to the yellow pages. But where do you go if you want advice on water-supply alternatives, the quality of water, and how deep your well will have to be. Where do you go to have your water tested?

For many years IGS has been providing advice to the cities, towns, industries, and citizens of Iowa concerning the location and development of ground water. This service is provided free to anyone making a request and is tailored to answer questions concerning:

- The available alternatives for water at a specific site.
- The quality of water available from ground-water sources.
- The geologic horizons from which water is available.
- The anticipated yield for various horizons.
- The kinds and thicknesses of geologic formations that will be penetrated in drilling a well.
- Recommendations on the location of a well or measures to be taken during construction to protect the quality of the supply and serviceability of the well.

Responses to requests are based on the evaluation of hydrogeologic information in the vicinity of the proposed well. IGS currently has over 25,000 individual records on wells in Iowa. The information is more complete in eastern Iowa, where more wells have been drilled, but is helpful throughout the state.

For the individual developing a private water supply, the most common constraint, other than cost, is probably water quality. In many areas of Iowa this goes pretty much hand-in-hand with the quantity of water available.

The shaded area in Figure 1 shows areas in the state where the upper-most rock formations will provide reasonably good quality water, that is water with less than 1000 milligrams per liter of total dissolved solids. Generally, these rock formations can be expected to yield adequate water for most domestic purposes on a sustained basis. There may be local exceptions, as in the fourteen counties of the "karst region" of

northeast Iowa. This area is typified by near-surface limestone formations, thin soil cover, sink holes, and a high degree of communication between surface drainage and ground water. Because of these conditions, numerous wells in the uppermost limestone formations of the area are reported to have excessive nitrate and/or unsafe coliform bacteria concentrations. Many wells in the region have been drilled to deeper rock formations to tap a safe water supply.

Water from rock aquifers in the unshaded area of Figure 1 is usually of poor to unacceptable quality and commonly objectionable for most uses. To develop supplies of acceptable quality, residents in this area generally rely on water from shallow wells completed in glacial sediments—thin strata of sand and gravel buried beneath the soil. Although many such wells are good producers, the majority are not. They are particularly sensitive to seasonal variations in rainfall and during extended dry periods may “go dry.” Wells of this type typically yield less than 3 gpm. In these parts of the state, more reliable water supplies frequently can be obtained from deposits of sand and gravel along the stream valleys.

Drilling a well and selecting a pump to produce one’s own water supply can present a significant investment. Moreover, a poorly

constructed well can affect your family’s health. Therefore, the following considerations are suggested:

- A handshake is not enough! Be sure you are dealing with a reputable well contractor. Get cost estimates from several. Develop a written agreement concerning when the work is to be done, what materials will be used, how the well will be constructed, and what results you can expect in terms of the quantity and quality of the supply.
- Agree on the price of the well and pump before the work is started. Be sure your well is properly located and constructed. Most counties have published rules or guidelines relative to the location of wells. These include minimum distances from livestock operations, sanitary systems, etc. They can be obtained from a county health officer or sanitarian. Locate the well so that it will not receive surface drainage and be susceptible to flooding.
- Make sure that any nearby, abandoned wells are properly plugged (filled). Abandoned wells can be avenues for surface pollutants to contaminate your water supply.
- Avoid well or frost pits unless they are designed to keep out vermin, insects, and

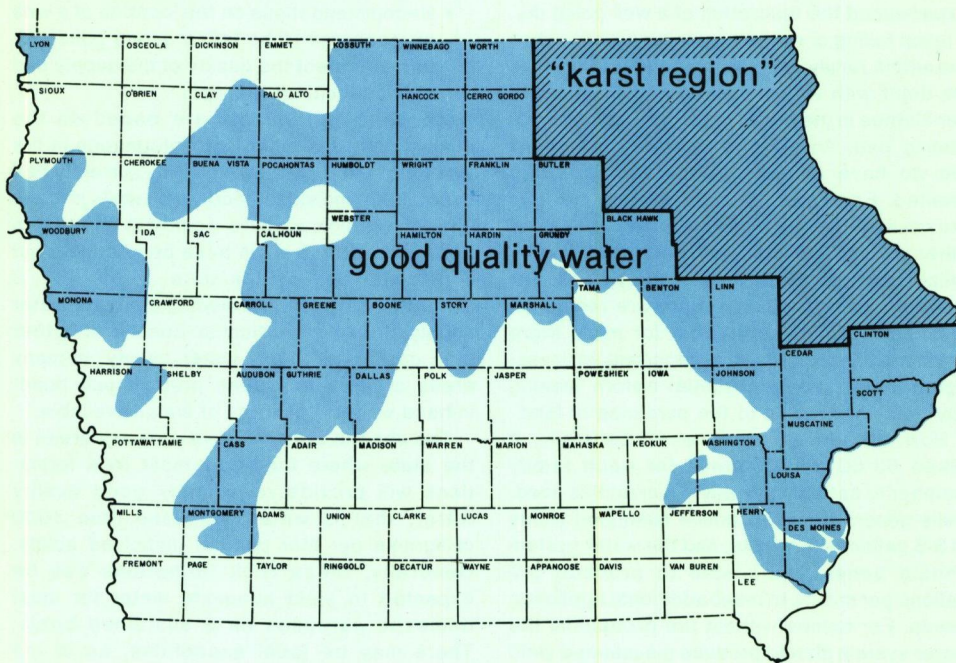


Figure 1. Regions where uppermost bedrock unit will provide good quality water.

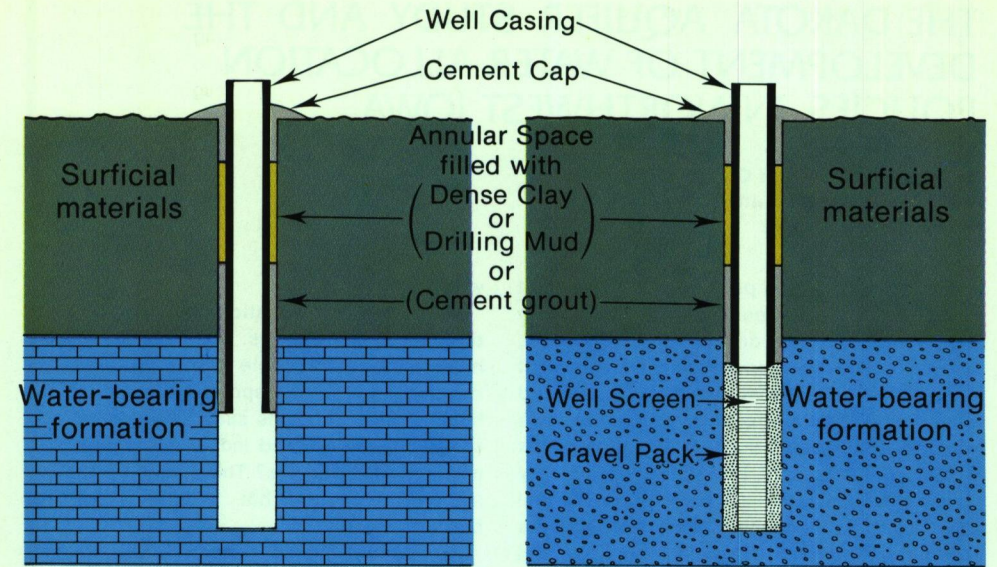


Figure 2. Bedrock well.

Figure 3. Sand and gravel well.

other pests, and they are constructed so that surface water cannot enter the well. Pitless wells are recommended.

- Make sure that your well is tightly cased so no surface water or percolating ground water can enter. Joints between casing sections should be water-tight. The area between the casing and well bore, the annular space, should be filled with material that prohibits water percolation. In bedrock wells, the casing should be grouted into solid rock at the top of the producing formation (Fig. 2). Wells finished in sand and gravel formations should have grouted annular spaces in the interval above the screen and above the producing horizon (Fig. 3).
- If not completed by driving a “sandpoint”, sand and gravel wells require screening. Where the water-bearing formation contains fine sand, the space around the screen should be packed with “pea gravel”. The pack will prohibit the fine sand from eventually clogging the well or damaging the well pump.
- A cement cap which acts to seal out surface contaminants should be placed around the top 5 feet of the well.
- When the well is completed, the well and distribution system should be thoroughly chlorinated to disinfect them and to preclude the possibility of iron-bacteria

contamination.

- After the chlorine has been eliminated from the well, water system samples should be drawn for quality testing. As a precaution, water should be sampled and tested periodically throughout the life of the well.
- Private water supplies may be tested at the University Hygienic Laboratory, located both at the University of Iowa, Oakdale Campus and the Wallace Office Building, Capitol Complex, Des Moines. Tests for the more common quality problems seen in private supplies—coliform bacteria, nitrate, iron, iron-bacteria and hardness—may cost between \$3 and \$11 depending on the tests requested.
- Keep good records on your well. You should know: how it was constructed; where casing was positioned in the well; its total depth; the type of pump in it and how it was set; the original water level, water yield, and results of water-quality tests. This information could prove invaluable when well maintenance work is required.

In this short article it has not been the intention to discuss everything that should be known in developing a private water supply. It is hoped, however, that the information presented will lead to a better understanding of points to be considered before buying that “place in the country.”

THE DAKOTA AQUIFER STUDY AND THE DEVELOPMENT OF WATER ALLOCATION POLICIES IN NORTHWEST IOWA

By James Munter and George Hallberg (IGS)
with James Wiegand and
Michael Smith (INRC)

Federal agricultural policies in the early and mid 1970's placed great pressures on Iowa to increase its grain production. Simultaneously, and independent of market demands, a drought occurred in the Midwest that severely reduced crop yields. The response in northwest Iowa was a dramatic surge of interest in irrigation as a possible means of protecting against dry years. The Iowa Natural Resources Council (INRC) was flooded with hundreds of requests for irrigation permits. Normally, only a handful of irrigation requests from northwest Iowa are received per year. The staff could not evaluate and handle all these applications.

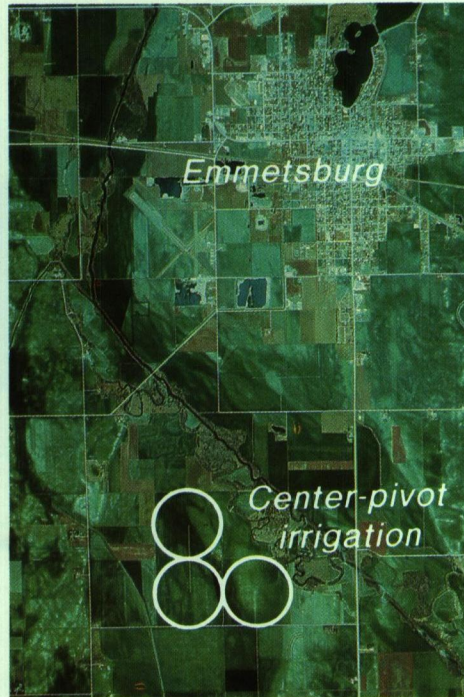
The seriousness of the situation is perhaps best understood in the context of how much water irrigation can consume. A center-pivot sprinkler irrigation system operating on a 160 acre (1/4 section) tract, pumping for one day, may pump as much ground water as a town of 15,000 people! Of course, an irrigation system does not operate continuously throughout the year. But the normal permitted withdrawals for irrigation still equal, on a yearly basis, the amount of water used by a town of 1,200 people. It has been estimated that a small town only consumes about 10-20% of its water. The remainder is returned to streams as treated water to be re-used. However, an irrigation system consumes nearly 100% of the water it withdraws. Consequently the water consumption of 160 acres of corn may equal the consumption of a town with 10,000 people for a year. Multiply this amount by hundreds of requests for irrigation, and the potential for undesirable impacts becomes apparent.

These factors put great pressures on INRC to formulate a new policy for allocating water for irrigation from the Dakota aquifer, the major source of water in northwest Iowa. Unfortunately, at this time the Iowa Geological Survey (IGS) could provide INRC only limited information concerning the distribution and water-yielding capacity of this aquifer, as well as the potential for serious and permanent aquifer damage that could result from excessive water

withdrawals.

Ultimately the question that must be addressed by the state is: Does northwest Iowa have enough available water to allow the development of widespread irrigation in the face of other demands such as domestic use, stock production, and industrial supply, both now and in the future? The simple fact in the mid 1970's was that nobody knew the answer.

As a result of this uncertainty two concurrent actions were taken. To handle the immediate situation, INRC instituted a temporary ban, the "Dakota Rule," effective June 24, 1977. This administrative rule prohibited new withdrawals of water from the Dakota aquifer in excess of



Center-pivot irrigation south of Emmetsburg.
IGS aerial photography.

200 gallons per minute for either irrigation or industrial use. Its purpose was to allow time for the collection of data and interpretation of the characteristics of the Dakota aquifer. To answer the technical questions, the Iowa Geological Survey, with the cooperation of the U.S. Geological Survey, embarked on a four-year aquifer study which is currently nearing completion. Subsequent to these studies, a more permanent set of rules could be established by INRC to comply with the most "beneficial use" concept stipulated in the Iowa Code.

The study of the Dakota aquifer was concentrated in a 16-county area in northwest Iowa—the area of principal occurrence of the aquifer. Preliminary results, first outlined in the last issue of *Iowa Geology* (1980), have been refined and are currently being finalized for publication. The study revealed, among other things, that water production from large parts of the aquifer comes from irregularly shaped bodies of sandstone, which were deposited by ancient rivers during the Cretaceous geologic time period about 100 million years ago. These types of deposits are highly variable and yields from wells are likely to vary significantly over short distances in much of the study area. Some parts of the study area, however, are underlain by thick deposits of nearly uniform sandstone. These deposits yield large quantities of water, and short-term monitoring of water levels have shown no evidence of long-term water-level declines. Thus, it appears that additional allocations of water for many uses are possible.

The IGS research provided the basic information from which a new policy on Dakota water withdrawal permits could be made. On January 1, 1981, three and one-half years after

the start of the "Dakota Rule," the rule expired. Throughout the latter half of 1980, INRC used results of the IGS research to formulate a new set of rules for permitting water use in northwest Iowa.

The current Dakota allocation policy, as recommended by the INRC staff, contains two key elements to protect the aquifer. First, applicants must "prove up" their applications by collecting and submitting specific information on their proposed wells and those of neighboring wells, and they must provide access in their Dakota wells for periodic water-level measurements. Second, through its new rules, INRC notifies all applicants that their investments, based on a permit to use the Dakota aquifer, entails risk because the permit may be modified or cancelled if serious water-level declines should occur. The two components outlined above provide a sensible policy under which additional water may be allocated because the aquifer's integrity would not be in immediate danger. However, the policy also recognizes the need for monitoring the effects of water withdrawals in the future, and the possible modification of the policy if it is shown that more specific allocation criteria are needed. The data collected both from permitted Dakota wells and from further IGS research, will be the basis of any further revisions in the water allocation policy of the Dakota aquifer.

The Dakota aquifer is a complex natural resource, and we have acquired much information about it in recent years. Appropriate management policies based primarily on our knowledge of the aquifer and supported by continuing monitoring efforts can ensure a viable resource for present and future generations.

WATER QUALITY DATA

Computer based studies of Iowa's water quality are now possible thanks to a long history of cooperation among several agencies. For over 35 years the University Hygienic Laboratory has routinely supplied the Iowa Geological Survey with water-quality analysis reports. Since the early 1960's, IGS has cooperated with the U.S. Geological Survey to computerize these reports. Currently there are over 8000 analysis reports on file, and about two-thirds of these are from public drinking water supplies.

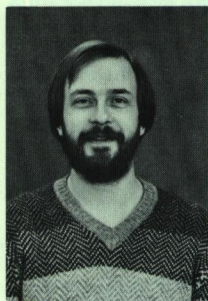
IGS is currently under subcontract with the

University of Iowa, Department of Preventive Medicine and Environmental Health to provide a complete water-quality data file for the study of cancer incidence rates and water quality. IGS has retrieved and supplemented all available public supply water-quality data, added location codes and reformatted the data to make it easily accessible for analysis and graphic display.

The opportunity to use Iowa water-quality data in medical research is one long-awaited dividend of natural resources data gathering at IGS.

DREDGED-MATERIAL USES WORK GROUP

By James Case



The Great River Environmental Action Team (GREAT II), an inter-agency (state and federal) and interstate organization, was developed in 1976 to generate a river-system management plan for a portion of the Upper Mississippi River. GREAT was founded because of concern by environmentalists and conservationists that the river system was being degraded in order to maintain commercial navigation capabilities which require channel-maintenance dredging and disposal activities by the Corps of Engineers.

The Dredged-Material Uses Work Group, chaired by IGS, was one of 12 functional work groups which comprised GREAT. The premise upon which the group operated was that environmental degradation from dredging could be minimized by finding alternate dredge-disposal sites and by turning "waste" into productive, useful material. Alternate sites had to be found, and uses, as well as demand, had to be determined. Then, dredged material could be placed in areas which would cause less harm, and where much, if not all of it, could be put to beneficial use.

Before this could be accomplished, the material to be dredged had to be described and analyzed. Study results found that on the average, dredged material was fairly uniform and could be classified as a poorly graded sand composed mainly of quartz and igneous-metamorphic rock fragments. After being dredged, the sand also was shown to be free from organic impurities.



Dredge operating on the Mississippi River. Photo courtesy of Corps of Engineers.

Determining productive uses for the material was the next step. The Civil Engineering Department of Iowa State University completed a study entitled "Waste Dredged Material for Construction" by Pyung-Hi Chung under the direction of Dr. Dah Yin Lee (ISU) and the Iowa Geological Survey. The results showed that dredged material should be considered a satisfactory fine-aggregate source rather than a waste product. Other uses for the sand that were identified by the work group included beach construction, land fill, road sanding, and levee construction and repair.

Based upon the results of the productive-use study, a potential-market demand study was completed in 1980. Responses were received from numerous cities, counties, states, sand and gravel producers, and levee and drainage districts. The study showed that if dredged material could be made available, all of it could be utilized. In fact, the Corps estimated that in the study area, 14,660,000 cubic yards of material might be dredged over the next fifty years, whereas the potential-market study showed a demand for 22,500,000 cubic yards of material over the same period. Levee districts alone have indicated that they will take all the material they can get. Some potential users expressed a willingness to travel up to 15 miles to pick up the sand if it could be placed in an accessible location.

Further, new disposal sites had to be found. Each site had to be evaluated as to potential environmental problems, relationship to expected dredging locations, and proximity and availability to potential users. Sites were selected from photos and visited on the ground by inspection teams. Finally, sites were evaluated for the ecological habitats which they represented.

The problem that faced both the work group

and GREAT was the final decision as to where dredged material should go, a problem compounded by the fact that the site selection process often developed into a classic case of economics versus the environment. Other problems had to be dealt with as well. The value of sand, costs of dredging and disposal, demand for the material, and the value of certain habitat types, all change through time.

To handle all these problems, a process which stressed flexibility was developed. Initially a plan was established to reflect today's conditions. Primary disposal sites were chosen for each potential dredging area. These were selected by a committee which weighed the economic and environmental considerations of each site to the rest of the river system. Alternate sites also were chosen by the group in order to cover anticipated changes in conditions for each area. Using this method, a balance was struck among the interests for material uses, environmental protection, and the realities of dredging locations and costs. This procedure will continue to be used in evaluating sites. In addition, an on-site inspection team (OSIT) will evaluate annually all potential disposal sites.

The flexible approach to site selection works. Last summer there was to be a dredging occurrence in pool 18 north of Burlington. Both the historic and primary disposal sites were in Illinois, where there was marginal demand for the material. Through the OSIT process, and based upon new information, a disposal site that showed potential for being a good recreation area was selected in Iowa. The cost of disposal was not significantly greater than the historic site; the environmental impacts were not severe, and the development of the site could eventually bring more recreation dollars into the area. Through the procedure developed by GREAT, nearly all the recorded demand for dredged material will be met in the future, and new demands also can be satisfied.

In summary, GREAT was a unique process in that many state, federal, local, and private entities participated and were permitted an equal voice as to how the Upper Mississippi River should be managed. The final products and accomplishments reflect years of study, debate, and compromise. The most important result is the continuation of the study, debate and compromise through the flexible OSIT process.

NWUDS National Water-Use Data System

In many regions of the country, water is used more rapidly than it can be replenished by nature. Regional aquifer systems are being depleted at alarming rates. Along some streams, flows are being diminished by withdrawals and water diversions. Some of these symptoms have appeared locally in Iowa and possibly will become more intense as the need for water increases.

Water use has never been adequately documented in the United States. Growing national concern over the depletion of water supplies, water quality degradation, and increasing demand has led to the development of a federal program to determine where, in what volumes, and for what purposes water is being used. The United States Geological Survey was given responsibility for this program and support funds were appropriated by Congress in 1980.

To achieve its goal of accurately defining water use, the USGS has planned and is developing a National Water-Use Data System (NWUDS). The primary objective of the program is to provide data which can be used for water-budget analysis. States are being urged to cooperate and are being offered financial and technical assistance to develop in-state water-data programs. In return, the states are expected to contribute data to NWUDS on an annual basis.

Because of the critical importance of water-use data in the management of water, the Iowa Geological Survey has been cooperating with other agencies in the development of a state program. This program is designed to meet Iowa's needs and to be compatible with the NWUDS. To date, planning indicates that the state system can be implemented within the framework of existing programs, equipment and personnel. Only minor revisions are needed to be compatible with NWUDS, and to standardize agency data and effect efficient data transfer. The system is scheduled for implementation in 1981 under the direction of IGS.

SURVEY STAFF LEAD GEOLOGICAL FIELD



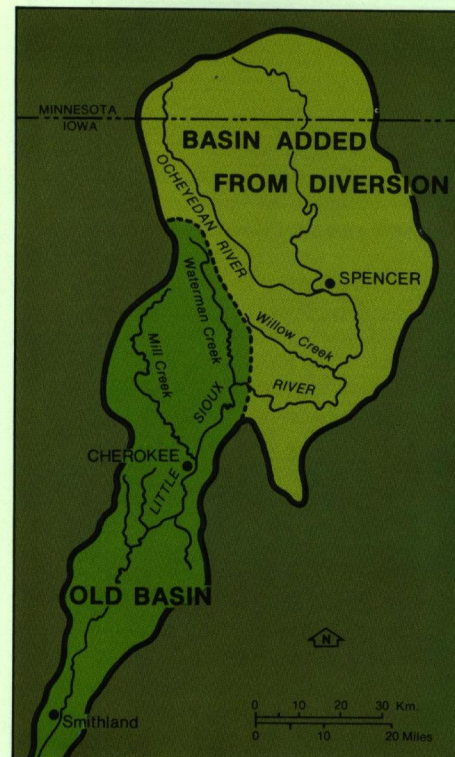
Terrace remnants high above the Little Sioux River. Photo by Bernard Hoyer.

On May 30, 31, and June 1, 1980, the Iowa Geological Survey and the Department of Agronomy, Iowa State University, jointly sponsored the 27th field conference of the Midwest Friends of the Pleistocene. The trip was led by George Hallberg (IGS), and his co-leaders were Timothy Kemmis (IGS), and Thomas Fenton and Gerald Miller (ISU). The "Friends" are an informal group who gather annually to study and discuss glacial deposits and soils. About 180 scientists gathered in Burlington to view deposits with classical significance to Pleistocene studies. Most were from the Midwest, but they came from Bulgaria, Costa Rica, Canada, England and New Zealand too. Deposits at Yarmouth, in southeast Iowa, were interpreted around 1900 to represent a long, warm climatic period. The name Yarmouth was applied to this period of geologic time throughout North America. Scientific methods and concepts have changed dramatically since the turn of the century. Recent work by the IGS and ISU research team on the same deposits reveals that these materials represent a particular form of glacial deposits and represent a cold environment rather than a warm environment. Scientists working on these problems thus convened to discuss the radical



Core of Little Sioux alluvium ready for study. Photo by Bernard Hoyer.

CONFERENCES



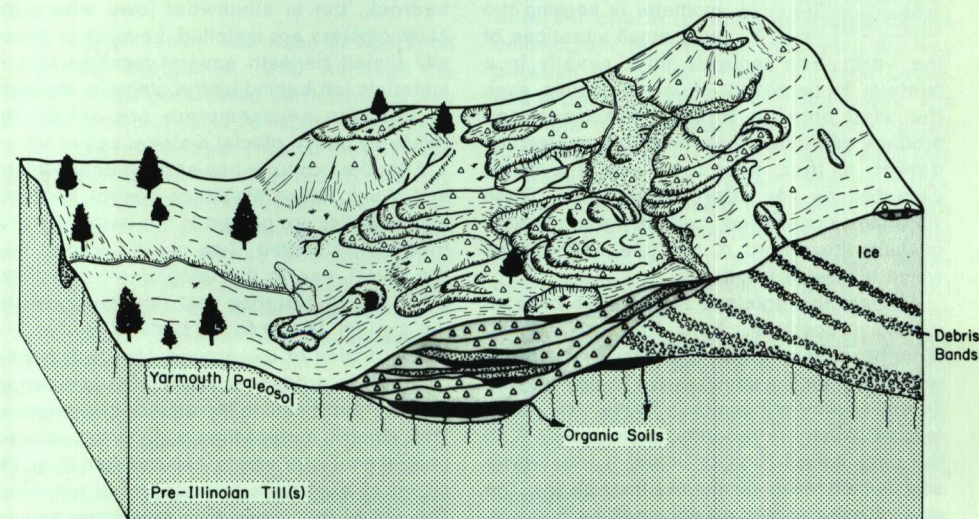
Drainage basin of Little Sioux River both before and after drainage diversion.



Hallberg discussing soils at stop on "Friends" trip. Photo by Bernard Hoyer.

interpretive changes and to evaluate the evidence for themselves. Many did not appreciate learning that their concepts were wrong, but most were convinced.

On September 20-21, 1980 a Geological Society of Iowa field trip was led by Bernard Hoyer (IGS). About 80 people travelled along the Little Sioux River valley from Smithland to Cherokee and later, on to Spencer. The group observed evidence indicating how the valley developed in the last 20,000 years. Glaciers permanently diverted drainage from the Mississippi River into the Missouri about 14,000 years ago. The unique beauty of the valley resulted from this event. Evidence for earlier glacial activity was also highlighted for the group.



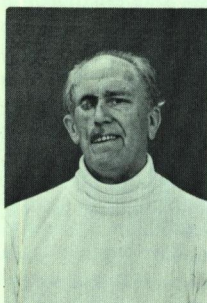
Block diagram of Pleistocene deposits near Yarmouth.

MONITORING IOWA EARTHQUAKES

By Orville Van Eck



Figure 1. Location of seismic stations in Iowa.



Out in an open field, distant from the road and buildings, is a small fenced enclosure with two poles, one for a telephone junction box and the other for two solar panels. Underground, in a barrel, a detector called a seismometer is sensing the very small vibrations of the earth. The isolated site, usually in a pasture, is purposely chosen because even the wind blowing through the trees can produce vibrations that the seismometer can detect. In fact, your footsteps are being detected as you approach the site. Such vibrations, considered "cultural noise," tend to confuse the record of the true earthquakes which are being monitored.

Through the gracious cooperation of landowners in southwest Iowa, five such installations have been made (Fig. 1). The system, referred to as a seismic array, is designed to detect micro-earthquakes. These are earthquakes which are recorded as less than 3 on the open-ended Richter Scale, a logarithmic scale which ranks earthquake magnitudes. The rank of one denotes a very small earthquake, and about nine is the highest so far assigned to

an actual earthquake. Every increase of one magnitude represents a tenfold amplification of the ground motion. The U.S. Nuclear Regulatory Commission is sponsoring the state geological surveys in Iowa, Kansas, Nebraska, and Oklahoma to establish arrays so they can evaluate the potential for major earthquakes to affect nuclear power plants in the region. Contract number NRC-04-78-228 supports the effort in Iowa. The sites of the five seismometer stations were chosen to monitor an ancient continental rift zone that extends from the Lake Superior region to Kansas. The rift zone has played a major role in the development of earth structures during geologic time and is suspected to be a factor in the small earthquakes that are detected in the Midwest. Results also help us to learn more about the deeper earth structures present in the region.

The seismic array consists of a combination of both simple and sophisticated equipment. The installation of the seismometer and accessory equipment is relatively simple. A pit about 5 feet deep is dug and a concrete pad about 6 inches thick is poured in the bottom. Then a 55-gallon barrel with the bottom cut out is pressed into the fresh concrete.

Ideally, the seismometer would be placed on bedrock, but in southwest Iowa where the seismometers are installed, bedrock is generally buried beneath several hundred feet of materials left behind by the glaciers. Because of this, the seismometers are set on the relatively dense glacial material called till.

After the concrete has set, the seismometer and a unit called a voltage-control oscillator and amplifier are placed in the barrel which is then tightly sealed. Two cables extend from the barrel, one to the telephone hookup, the other to the batteries that provide power for the system. (Refer to the back cover.)

Any motion of the ground causes the seismometer to produce a small electrical current that is proportional to the amount of movement. That electric current then goes to the voltage-control oscillator where it is changed to an FM signal of a specific frequency and amplified. The signal then goes to a telephone line for transmission to Iowa City. The signals from all

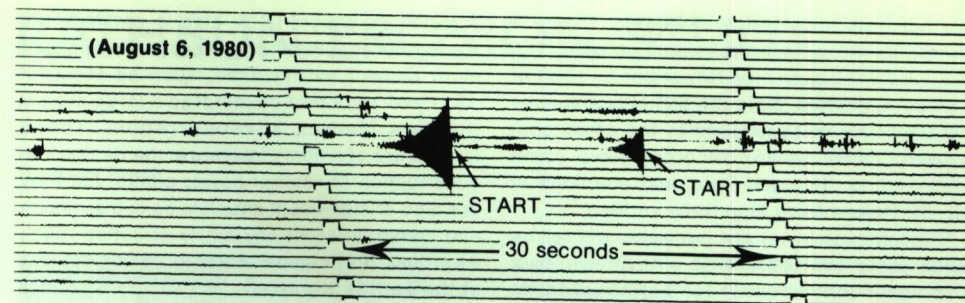


Figure 2. Seismogram of two, high-frequency, shallow micro-earthquakes originating less than 2.5 miles from station near Carbon. Seismogram reads from right to left.

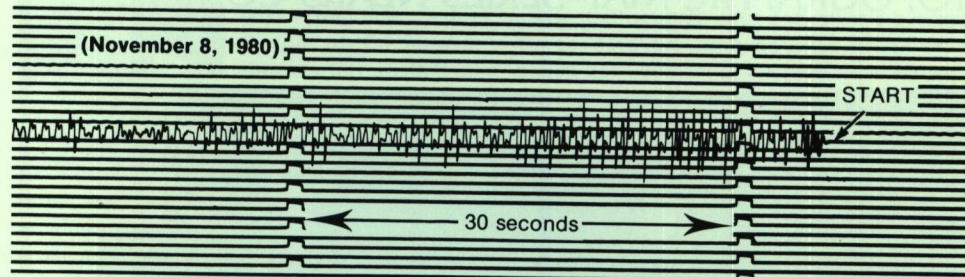


Figure 3. Seismogram of earthquake centered near Eureka, California, recorded near Elk Horn.

five stations come into the IGS offices in Iowa City on a single telephone circuit. There devices called discriminators are able to sort out the particular frequency from a given installation and route that signal to a recorder. The five recorders operate 24 hours a day, 7 days a week, so recording charts are changed daily.

The seismic array has been in operation since early September, 1980. Although the Midwest is not considered earthquake prone, we have recorded about 70 micro-earthquakes which originated in Iowa. Thus far they all have been too small to be detected across the entire array. If we could detect the event at two or more stations, we would be able to state with a rather high degree of accuracy just where the "quake" occurred. At this time we can only estimate the distance of the event from the detecting station. We do know that the magnitudes are very small and that the quakes occur at a shallow depth beneath the surface of the earth.

Micro-earthquakes produce a distinctive signature on the recording chart, called a seismogram. Figure 2 reveals the signature recorded from two events detected at the station located about one mile south of Carbon

in Adams County. The "Christmas Tree" shapes are typical for these small earthquake events. Precise time recording is important in the analysis of seismograms. Various types of seismic waves generated by an earthquake travel at different speeds, produce different movements at the detector and thus, produce different characteristic signatures on the seismogram. By precisely measuring the time between the arrival of different type waves, and knowing the velocity of those waves, it is possible to determine the distance to the earthquake. Note in Figure 2 that on each line, or trace, there are regularly spaced marks. These marks represent one minute intervals and they are 120 millimeters (about 4.7 inches) apart on the original records. These marks permit measuring time with a precision of 0.1 seconds. Each hour there is an hour mark. All time is kept on Universal Coordinated Time basis and coordinated with the National Bureau of Standards so that all records over the entire world are on the same time, regardless of time zones, and so that all records may be studied together for earthquake evaluation.

Although the system is designed to detect micro-earthquakes, we regularly record major

earthquakes from around the world. Figure 3 illustrates the seismogram which recorded the magnitude 7.0 quake on November 8, 1980 at Eureka, California. Note the signal is distinctly different than that produced by the small local quakes. Other quakes recorded have come from Algeria, Italy and Peru, and eruptions of Mt. St. Helens have also been verified.

The information we are gathering will tell us much about the subsurface structure in Iowa and about the potential for earthquakes. In

addition we expect to be able to estimate the amount of shaking that will result from larger, more distinct earthquakes, such as those of 1811 and 1812 that devastated a large area in the New Madrid, Missouri region. These factors are of primary interest in the design and construction of nuclear power plants, but they are also of significant importance in the design and construction of any major structure, such as a dam, that can be affected by the shaking of the earth.

TOPOGRAPHIC MAP SERIES NEARS COMPLETION



- Maps completed since 1970
- Maps completed prior to 1970
- Maps available in preliminary form
- No 7 1/2 minute maps available (15 minute maps available)

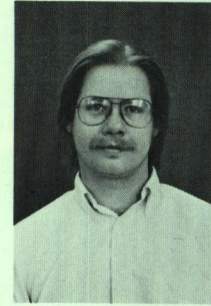
Status of 1:24,000 scale, topographic mapping, January, 1981.

The 7 1/2 minute quadrangle (1:24,000 scale) topographic mapping program in Iowa is speeding towards completion at an unprecedented pace. In 1970 after the mapping program was 25 years old, only 250 maps were completed. In the past 10 years, more than twice that number were completed. Presently 862 of the total 1,083 maps are printed and

available for sale at \$1.25 each. Another 157 maps are complete and are available in preliminary form, but are awaiting final printing. Thus, mapping is complete for 94% of the state. The remaining 64 maps either have been authorized or begun and will be available by 1983.

RATHBUN EROSION STUDY

By Ross Black



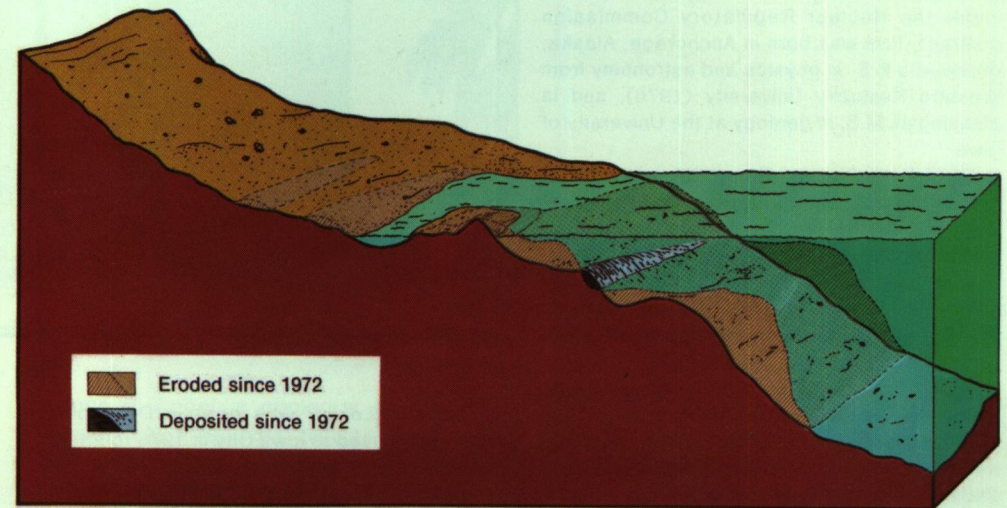
During 1980, the Iowa Geological Survey Remote Sensing Laboratory undertook a cooperative project with the U.S. Army Corps of Engineers, Kansas City District at Rathbun Lake in south-central Iowa. The project was designed to document locations, rates, and geological controls on shoreline erosion around the lake, and to predict future erosion rates and locations.

In the nine years since the filling of the reservoir to multi-purpose level, many of the man-made improvements built in public-use areas have been damaged or destroyed by the constant backcutting of the shoreline by wave attack. This backcutting has produced some of the high bluffs and the boulder-strewn beaches

on the north side of the lake. Under the current multi-purpose reservoir management plan, backcutting may continue for some time.

A series of shoreline positions were mapped from aerial photographs, detailed topographic maps, bathymetric data and ground surveys. These data provided detailed histories of beach development at six public-use areas. It was found that the shoreline had receded as much as 60-80 feet per year in many places, and that the severity of damage to improvements was controlled by surficial geologic materials and by the original topography of the sites. Improvements built on well-drained Late-Sangamon paleosols, near the shoulder of the original slope, were the most severely damaged.

This information is now being utilized in the redesign of damaged improvements and in the planning of future erosion-protection measures.



Block diagram representing an eroding Rathbun Lake shoreline.

NEW STAFF IN '80

Beverly J. Bakker, a native of Denver, Colorado joined the Survey in September, 1980 as the receptionist. Beverly attended Rockmont College in Denver and was employed by the World Savings and Loan Association before moving to Iowa. She plans to complete her education at Colorado State University and get a BFA in Art.

Calvin L. Cumerlato received a general science degree at the University of Iowa (1979) and is currently a M.S. candidate at the University of Iowa in geology. A native of Chicago, Illinois, Cal is a geological technician at IGS conducting the gravity analysis under the NRC contract in southwest Iowa.

Thomas H. Faller joined IGS as a research geologist to conduct the seismic monitoring under the Nuclear Regulatory Commission contract. Tom was born in Anchorage, Alaska, received a B.S. in physics and astronomy from Western Kentucky University (1976), and is pursuing an M.S. in geology at the University of Iowa.

Chris D. Hall joined the staff on November 3rd as a programmer analyst in the Technical Services Division. Chris comes to us from Administrative Data Processing at the University of Iowa and previously programmed at Mercy Hospital in Dubuque. He received his B.A. degree in math and physics from Luther College at Decorah in 1977.

Laurie E. Kottman, born in Oskaloosa, Iowa, joined the Survey as a secretary in July, 1980 after graduating first in her class from the Kirkwood Community College secretarial program. Laurie attended the University of Iowa from 1977-1979 as a Psychology major. She is also a certified nurse's aide, and worked at Beverly Manor Convalescent Home for a year.

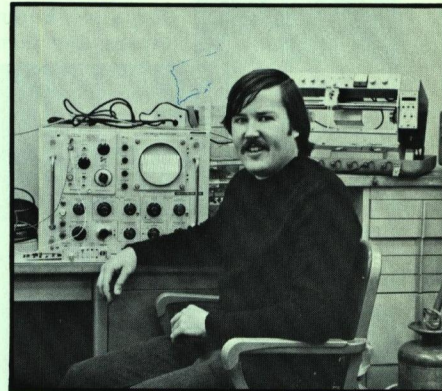
Susan J. Lenker was born in Davenport, Iowa. She moved to Iowa City in 1975 to attend the University of Iowa, and in 1978 she received a Bachelor's degree in geology. Sue worked for the U.S. Geological Survey, Surface Water Division from 1978 until 1980 when she joined the IGS staff as a research geologist for the Abandoned Mine Lands Inventory.

John D. Logel, a geologist at IGS was formerly a hydrologic technician with the U.S. Geological Survey from 1978-1980. John is conducting the reflection and refraction seismic research under the NRC contract. A native of Muscatine, John received an M.S. degree in geology from the University of Iowa (1979) where he is now seeking an M.S. degree.

Marsha J. Miller hails from Deerwood, Minnesota. She received a Bachelor's degree in geology from the University of Minnesota at Duluth. Prior to coming to the IGS as a research geologist assigned to the Abandoned Mine Lands Inventory, Marsha was a geologist for the Minnesota Department of Natural Resources in Hibbing.



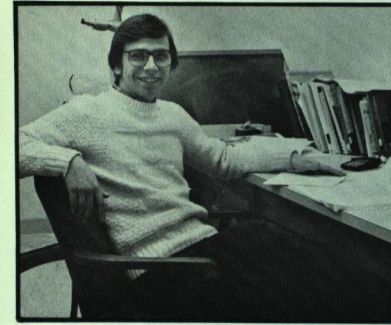
Susan Lenker



Thomas Faller



Marsha Miller



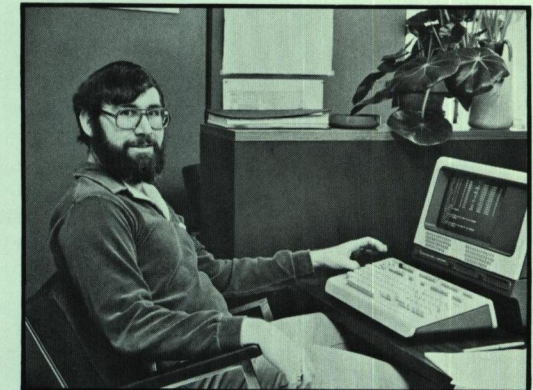
John Logel



Beverly Bakker



Laurie Kottman



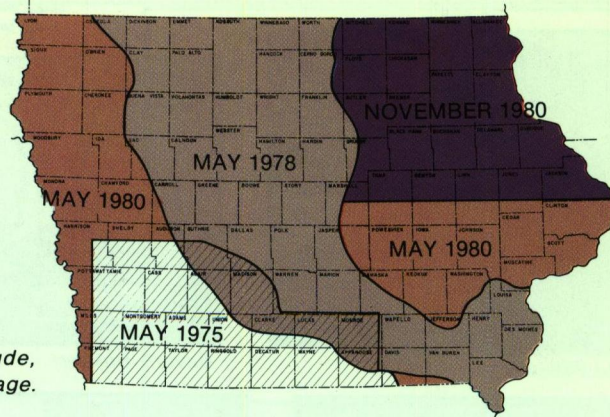
Chris Hall



Calvin Cumerlato

Staff photos by Patricia Lohmann.

COMPLETE PHOTO COVERAGE OF IOWA



Date and location of high-altitude, color-infrared photographic coverage.

High-altitude, color-infrared photographic coverage of Iowa was completed in 1980. Northwest and east-central Iowa were photographed in May; the northeast was imaged during November. This completed the 1:80,000 scale coverage of the state on a one-time basis. A legislative appropriation combined

with a cooperative agreement with the U.S. Soil Conservation Service (SCS) allowed this long-term goal of the Remote Sensing Laboratories to be completed. The photos can be viewed in Des Moines at the SCS office and the Iowa Department of Soil Conservation, as well as in Iowa City at IGS.

IGS REPORTS AND PUBLICATIONS IN '80

- Anderson, R. R., 1980, Locations of Sites for Hazardous Waste Repositories in Iowa. Phase 1: Geological Reconnaissance Mapping Progress Report 1. Open File Report, 18 p., FREE plus \$.20 postage.
 - Black, Ross, A., 1980, Evaluation of Shoreline Erosion at Rathbun Lake, A report to the U.S. Army Corps of Engineers, Iowa Geological Survey, 37 p., Limited Edition.
 - Hallberg, G. R., 1980, Pleistocene Stratigraphy in East-Central Iowa, Technical Information Series 10, 168 p., \$3.50 plus \$1.18 postage.
 - Hallberg, G. R., 1980, Illinoian and Pre-Illinoian Stratigraphy of Southeast Iowa and Adjacent Illinois, Technical Information Series 11, 207 p., \$3.75 plus \$1.56 postage.
 - Hallberg, G. R., Fenton, T. E., Kemmis, T. J., and Miller, G. A., 1980, Yarmouth Revisited, 27th field conference of Midwest Friends of the Pleistocene, Iowa Geological Survey Guidebook, 130 p., Limited Edition.
 - Ludvigson, G. A., and McAdams, M. P., 1980, New Evidence of Early Ordovician Tectonism in the Upper Mississippi Valley 1980, Technical Information Series 9, 29 p. \$1 plus .35 postage.
 - Munter, J. A., 1980, Evaluation of the Extent of Hazardous Waste Contamination in the Charles City Area. Iowa Geological Survey Contract Report, 74 p., Limited Edition.
 - Witink, P. M., and Whelan, G., 1980, Distributed Parameter Watershed Sedimentation Model, Guidebook, 10 p., FREE plus \$.20 postage.
- Ground Water Resources Reports are now available for the following counties for \$.50 plus \$.50 postage:
- Appanoose, Dallas, Davis, Des Moines, Henry, Jefferson, Keokuk, Louisa, Lucas, Mahaska, Marion, Monroe, Van Buren, Wapello, and Washington.

IGS ORGANIZATIONAL STRUCTURE

