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GEOLOGIC HAZARDS DATA

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Regina A. Brown

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PREFACE

Presentations given at the seventeenth annual meeting of the Geoscience Information Society, October 17-20, 1982, in New Orleans are contained within these Proceedings. The Society's symposium had as its theme "Geologic Hazards Data." Other technical programs were a Contributed Papers Session and a Poster Session. Papers included in this publication are given in the order of presentation.

The symposium theme was chosen for its timeliness and for the apparent lack of publicity regarding information sources. Most geologic hazards exist as a potential, rather than an actual, continuous threat. Data that have been collected are often the result of studies conducted by academia; Federal, state or local agencies; corporations, etc. Those in the geoscience field, as well as those in non-geological professions, need to be made aware of the existence of such data.

Regina A. Brown
Program Chair, 1982

PART I

SYMPOSIUM: GEOLOGIC HAZARDS DATA

GEOLOGIC HAZARDS DATA: SOURCES, USES, AND ABUSES

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Abstract: Geologic hazards data have many sources, are presented in several forms, and serve different purposes. They are gathered, interpreted, and re-presented by and for not only geologists but also economists, psychologists, social scientists, and government officials. And the data are used by these groups for such disparate purposes as to support cost-benefit analyses of options for reducing damages from various geologic hazards, to study of behavioral response to disasters, including the onset of psychological disorder, and to draft public policy in response to threats of natural disasters.

This diversity of sources and uses of geologic hazards data enriches our understanding of the full range of impacts resulting from geologic hazards; ironically, however, this same diversity also hinders this very understanding when geologic hazards are used for purposes for which they are not properly suited.

The challenge for those providing, and those using, geoscience information then is fairly simple to express. Recognizing the potential for misusing hazards data, we must take extra care to match the sources we give with the purposes for which the data are being requested. Meeting this challenge will be difficult but as an overview of the relationship among the sources, uses, and abuses of geologic hazards data indicates, it is not hopeless.

Geologic Hazards Data

Geologists generally view the Earth differently than do most others. They study the Earth's history, physical and chemical makeup, and behavior, including such processes as mountain building and land erosion. They look at it from afar using Earth-orbiting satellites and scrutinize its most minute details with electron microscopes. Some geologists mechanically squeeze slabs of rocks to learn more about the behavior of the Earth's crust under the forces of great earthquakes. Others map the land surface and the relations among the various geologic formations to deduce the Earth's past. Geologists then can use such insights and lessons of the past to look into the future and determine how the Earth's natural forces will continue to shape our planet and our lives.

Through geologists' observations, mapping, and probing, we now know that the Earth's landforms, both the spectacular and the unimpressive, are caused by natural processes--processes that dominated the planet's past and will likely control its future. Some natural processes, such as volcanic eruptions, earthquakes, flooding, and subsidence, however, are hazardous; and each year considerable time, talent, and money are spent to devise and apply ways of reducing the damage they cause.

Many famous centers of culture and commerce and far more numerous uncelebrated towns and villages have suffered loss from sudden unanticipated natural catastrophes. For example, in 1531, Lisbon, Portugal, lost 30,000 people during an earthquake; in 1970, 20,000 residents in Peru's Yungay Valley were buried by a rapidly moving landslide. And, in one of the most famous natural catastrophes, the entire town of Pompeii, then a flourishing Greco-Roman city, was buried by the ashfall from the A.D. 79 eruption of Mount Vesuvius.

Despite our increasing knowledge about these natural events-- why they happen, where they are likely to happen, and how we may better cope with them--the damage they cause has been increasing nationally and globally. Perhaps this mounting toll of damage is due to larger populations and greater accumulation of goods and wealth. Or maybe it is because many of the more hazardous areas happen to be lands promising greatest wealth and growth. It also could be that some of the ways we use our resources and technology to cope with natural hazards and risk are instead causing greater damage.

The data on average annual loss from geologic hazards in the United States are fairly poor. Because no single institution has the task of accounting for all the various types of costs and payoffs--the extensive exchange of insurance payments, personal and business losses deducted from income and corporate taxes, unreported damages, public funds used to recover from damaging geologic hazards, and all the other ways money and other resources are involved in a disaster--the various cost estimates are not in complete agreement and likely contain gaps in some places and overlaps in others. The following though are some estimates of both the average annual loss and the potential for sudden loss as a result of earthquakes, floods, ground failures, and volcanic eruptions:

Hazard	Annual loss (in billion dollars)	Sudden loss potential (in billion dollars)
Earthquakes--ground shaking, surface faulting earthquake-induced ground failures, tsunamis.	0.6	50
Floods--flash floods, riverine floods, tidal floods.	3	5
Ground failures--landslides, expansive soils, subsidence.	4	6
Volcanic eruptions--tephra, lateral blasts, pyroclastic flows, mud flows, lava flows.	--	3

The upward trend in both the annual loss and the amount of people and property at risk from geologic and hydrologic hazards helped stimulate renewed interest by legislators, town managers, and emergency response officials in issues about natural hazard management. In 1978, Executive Order 11988 was issued to bolster the Federal Government's management of flood plains. And, of course, the National Flood Insurance Program is another expression of the Nation's response to an increasing loss. Other Federal actions include the

Earthquake Hazards Reduction Act of 1977, the Disaster Relief Act of 1974, and the establishment of a new agency, the Federal Emergency Management Agency (FEMA), which is to be the Federal focus for a wide range of emergency management activities. Recently States have taken similar steps. California has an active Seismic Safety Commission; FEMA and California support an innovative project to assist and urge several Southern California counties to prepare for an earthquake of major proportions--this project the Southern California Preparedness Project (SCEPP) may be a model for a Northern California equivalent; and several States have undertaken significant vulnerability assessment projects. The National Governor's Association, IBM, Atlantic Richfield Company, and other businesses and associations have sought, both individually and as consortiums, to better assess and respond to their risk of loss from geologic hazards.

A variety of actions for reducing loss and potential loss are available to these groups and individuals. Among these actions are:

- Avoidance--Avoid the hazard by selecting other appropriate areas in which to live and build where the probability of occurrence of the hazard is lowest.
- Land-use zoning--Reduce losses to certain types of structures susceptible to a particular hazard either by reducing their density or by prohibiting them within parts of the area characterized by a relatively high severity or probability of occurrence of the hazard.
- Engineering design--Allow all types of structures within a potentially hazardous area, but require site-specific engineering design and construction to increase the capability of the site or the structure to withstand the hazard.

o Distribution of losses--Use insurance and other financial methods to distribute the potential losses in a potentially hazardous area.

All of those categories of loss mitigation require the kind of basic data kept by the more than 100 data bases operated by the Federal agencies alone. Both avoidance and land-use zoning measures require such basic geologic hazards data as fault maps, epicenter maps, and flood records so that we can tell on even a simple level of understanding which areas are to be most likely affected by the various geologic hazards. And, by refining these maps, there is the possibility that they could be used for instance to help set acturial rates for insurance. For example, simple flood inundation maps can be adjusted to show the expected frequency of flood heights thereby allowing the type of site-by-site discrimination needed for insurance purposes. Early national seismicity maps became part of the Uniform Building Code which recommended building standards to code setting and enforcing agencies; now probabilistic ground shaking maps hold promise of similarly influencing and improving model building codes. Many of the most promising hazard mitigation measures would be impossible to properly implement without the kind of earth-science data that fill our files, libraries, and computers.

However, as our governmental representatives began to take a deeper look at how they could help reduce our vulnerability to geologic hazards, it became clearer that some of the prime methods for reducing loss conflict, or appear to conflict, with other socially desirable goals, such as economic development and maintaining the stability of existing neighborhoods, social support systems, and political alliances. Maps of active faults and epicenters cannot fully answer critical public policy questions. Further, emergency preparedness planning, design of public education programs, and selecting optimum land-use patterns commonly require multidisciplinary data and information. For example, in order to write a guide and handbook for home, family, and community preparedness called "How to Survive an Earthquake," the authors had to compile and comprehend not only data on the physical processes--shaking duration and magnitude for example--but also how they have affected various types of structures as well as the psychological response of children, elderly, handicapped, and others to the particular stresses caused by earthquakes. As another example, civil authorities are responsible not just for a single type of geologic hazard but have to make certain that their plans for one geologic hazard do not conflict with those of another hazard. This is quite evident for Los Angles or San Francisco--earthquake data has to be considered with landslide data, liquefaction data, and flood data; not to mention other considerations--transportation needs and non-geologic hazards. There is no single source to go for such a variety of geologic hazards data. To complicate the process of using geologic hazards data for such purposes, this multidisciplinary group--city planners, emergency services officers, economists, and politicians--has difficulty understanding geologic information and concepts, much less raw data.

These problems--a narrow data base and inability to adequately interpret geologic data and information--are well recognized but not yet sufficiently resolved. As a result, decisionmakers can be placed in the position of trying to make wise decisions with little data, or data they do not understand; or they defer decisions. And when they are forced to use whatever data are on hand, the data are sometimes not used properly.

I think many of you can recall the past winter's heavy rainfall and devastating landslides that occurred throughout much of coastal central California. Several lives were lost in the hills near Santa Cruz, California;

Route 1, from the Golden Gate bridge to Marin County was closed for several days; and many communities spent days restoring roads and removing the rubble that use to be shelter for hundreds of people. A few years ago the U.S. Geological Survey and the Housing and Urban Development Department funded a project in the San Francisco Bay Region. One product of the project was a series of landslide susceptibility maps that covered most of the area devastated by the winter's landslides. Why weren't these maps used by town officials, and others, to prepare for these landslides; we all knew that eventually they would occur? This summer I discovered that some of the officials thought that they had used these maps. One town official claimed that he was familiar with the maps and said the landslides did not happen where the maps said they would happen. He, and probably other officials, overlooked one very important aspect of the data that was summarized on the maps. The report and maps pertained only to deep seated landslides, essentially failures of the bedrock. The landslides that occurred were shallow soil-slips and debris or mud slides. So where the officials thought the data could apply to landslides in general, it actually applied only to a particular type of landslide. One could argue that this type of misuse could be easily avoided with appropriate caveats printed in the map legend. Perhaps, but experience with such consumer labelling suggests that labels alone are not enough and a more aggressive consumer education program is needed.

But there are other ways that geologic hazards data are misused--I'll give just three categories. One type is the misuse of statistical data and probability statements, which are fundamental to risk analyses. I think the understanding of flood risks is still hampered by a general confusion of the 50- or 100-year floodplain; to some it means that 50 or 100 years would pass between equivalent events. And, I do not think restating the risk as a 1 in 100 chance per year has had the desired result as it now perceived as a probability next to zero. Seismic risk data faces a similar but probably worse problem. Second, a lot of geologic hazards data are essentially static descriptions of a dynamic event. And, this leads to another type of abuse--failure to update applications of geologic data or to plan around the likely changes to the static data. For example, seismicity, fault location, and earthquake intensity maps have changed and will continue to be updated as research progresses. However, because land-use patterns cannot be expected to change with each piece of new data and it is politically difficult to build in considerations of unknown, future changes in the data, I am not sanguine that all of this type of misuse can be eradicated. In some instances though this type of misuse can be avoided. Emergency preparedness plans as well as insurance rates and engineering designs, for example, can be changed to keep pace with new data and information.

The third category is what I might call the "I'm on the left side of the line, therefore I am safe syndrome." It arises from one of my more challenging and frustrating problems--how to represent the type, distribution, or likelihood of a geologic hazard on a map. Red, yellow, and green are used to depict the relative risk for a hazard; or hatched lines and colors show the distribution of different types of hazards; or, reduced to the simplest level, a black line separates safe territory from unsafe territory. Whatever scheme is used, inevitably someone assumes that by moving to the left of a line security and peace of mind will follow. I believe that such strict interpretation overly flatters the accuracy of our data. As you know, geologist have adhered to the uniformity principle for years and base their expectations of future events on the geologic or hydrologic record. For example, the 100-year flood standard adopted by the National Flood Insurance Program as a minimum level of safety is used widely by communities to design flood works and map areas for restrictive land usage. Some communities have found this standard too low for their particular situation and are enforcing higher standards. The point is that there is a dangerous tendency to take the lines drawn on a flood map as inviolable when they are, of course, lines reflective of a statistically validated tendency. Similarly, at Mount St. Helens there was a signigicant, fortunately not universal, perception that areas outside the Red and Blue Zones, areas restricted to the public, simply could not and would not suffer damage from the anticipated volcanic eruption. Because of such strict interpretations of hazard maps and the difficulty of convincing people of the need to build in a margin of error, the latest volcanic hazard map for Long Valley-Mono Craters, California, purposefully avoided detailing areas likely to be affected by the separate volcanic hazards and instead mapped a broad zone that integrated all the hazards.

All of my examples of data misuse illustrate well documented behavioral traits which would serve us all well to keep in mind as we provide data and information to our clients. People have errant perceptions of natural hazards, conduct abbreviated information searches, and have limited abilities to process the information they do collect. Hasten to understand that all decisionmakers are hampered by these tendencies and is it unlikely that we will soon change. The solution then may be to improve our abilities as information providers.

Fortunately, not all data are misused, or ignored, by our new clientele. Social scientists and public administrators have researched the transfer of technical information to public authorities to try to find out what works and why. One school of thought is that the information must be brokered or chaperoned. The USGS conducted a series of urban area studies to test and document the application of earth sciences to land resource and planning issues. The San Francisco study was the largest and most successful. It produced over 150 maps and reports as well as about six interpretive reports. Over the years, some of the data has become incorporated in the general plans of some cities and counties. Under California law, all counties and most cities are required to prepare a general plan, and one of the mandated elements is on seismic safety. Although the value of these plans has not been tested by an actual earthquake, they seem to be technically sound. The success of the San Francisco Project, and it's failure--such as the landslide susceptibility maps I talked about earlier--attest to the importance of information brokers, for where the project worked well it was due to many hours of testimony and assistance by the geologic researchers.

Such time-consuming and costly partnerships cannot be repeated on a wide scale. Further, it is foolish to blame public administrators, economists, urban planners, and other professionals for a lack of geologic training and it is naive to suggest they begin enrolling in geology courses. Yet, it is equally clear that the present cadre of data sources, which have served geologists and allied professionals so well, are not designed to fulfill the special needs of today's hazard managers.

New sources of geologic hazards and data information are being established. Sources such as:

1. The Natural Hazards Research and Applications Information Center at the University of Colorado in Boulder. The center is a national clearinghouse of research information dealing with the economic

loss, human suffering, and social disruption caused by natural disasters. The center is particularly adept at strengthening communication between researchers and the individuals, organizations, and agencies concerned with public action relating to natural hazards.

2. The Resource Referral Service of the Academy for State and Local Government, an umbrella organization for the several associations for State and local governments, focuses on information dissemination and researching inquiries. The Service specializes in researching questions on disaster recovery and mitigation and brokering the needs of State and local officials to research organizations.

3. The Disaster Research Center at Ohio State University. Although primarily a research center, it has amassed a good collection of information on many topics in the fields of natural and technological disaster.

These data centers have the flexibility and multidisciplinary orientation to ensure a good match between the user and sources of geologic hazards data. By nurturing such flexibility and broad orientation, I believe many members of the Geoscience Information Society can be equally skilled at matching users and sources of geologic data.

The following parable illustrates the problems and the second one suggests my solution:

> Once upon a time there was a rajah who called to a certain man and said: "Gather together in one place all the men who were born blind . . . and show them an elephant."

"Very good, sire," said the man, and did as he was told and said to them, "O blind, such as this is an elephant"--and to one man he presented the head of the elephant, to another its ears, to another a tusk, to another the trunk, the foot, back, tail, and tuft of the tail, saying to each one that that was the elephant . . . .

Thereupon, brethren, that rajah went up to the blind men and said to each: "Tell me, what sort of thing is an elephant?" Thereupon, those who had been presented with the head answered, "Sire, an elephant is like a pot." And those who had observed an ear only replied, "An elephant is like a winnowing basket." Those who had been presented with a tusk said it was a plowshare. Those who knew only the back, a mortar; the tail, a pestle; the tuft of the tail, just a broom.

Then they began to quarrel, shouting, "Yes, it is!" "An elephant is not that!" and so on, till they came to fisticuffs over the matter. Then, brethren, that rajah reflected deeply upon the scene.

Udana, IV, 6

And . . . When Yen Ho was about to take up his duties as tutor to the heir of Ling, Duke of Wei, he sent to Ch'u Po Yu for advice. "I have to deal," he said, "with a man of depraved and murderous disposition . . . How is one to deal with a man of this sort?" "I am glad," said Ch'u Po Yu, "that you asked this question . . . . The first thing you must do is not to improve him, but to improve yourself."

Taoist Story, quoted by Arthur Waley in Three Ways of Thought in Ancient China.

DATABASES THAT SUPPORT INVESTIGATIONS OF GEOLOGICAL HAZARDS

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Abstract: As a national repository for many kinds of geophysical data, including databases that are useful in investigating geological hazards, NGDC provides access to a myriad of information. Data, which are available at cost of servicing, encompass the subjects of earthquake seismology, tsunamis, volcanology, geological hazards (marine and land), glaciology, and hazards to communications and navigation. In addition, standard geophysical investigations--such as seismic reflection, gravity, magnetics and topography--often provide clues to the source mechanism for many destructive phenomena.

Services offered for these data range from simple duplication to sophisticated retrievals using customer-defined criteria. Specialized data products, such as hazards maps or other geophysical plots, can be customized to meet the unique needs of the data user. Typical customers include industry, academia, governmental organizations, and the general public.

Introduction

The Environmental Data and Information Service (EDIS), a part of the National Oceanic and Atmospheric Administration, has been given the task of collecting, managing, and disseminating a great mass of information produced by the scientific observation of the physical environment. Environmental data provide a view of the physical earth as it was -- a history of certain aspects of the earth, sea, sun, and atmosphere as they were at a given place and time.

To manage these data, specifically those relating to risks associated with geological hazards, national and international data repositories have been established. This paper summarizes many of the geophysical databases that are routinely accessed by public, government, and academic users, and made available through the National Geophysical Data Center (NGDC) -- one of EDIS's four data data management centers.

Earthquake Seismology

NGDC is the focal point for disseminating historical earthquake data and information to both technical and general users. Information on recently occurring earthquakes, however, is initially disseminated by the U.S. Geological Survey's (USGS) National Earthquake Information Center in Golden, Colorado. This recent information is then released to NGDC for further processing and dissemination. From these data, NGDC prepares seismic histories of local and regional areas; answers public inquiries on all aspects of historical earthquakes; publishes historical compilations and annual earthquake summaries (jointly with USGS); and makes available seismograms, strong-motion earthquake records, computer listing of earthquake locations, and other data in many formats.

Seismogram Data. Standard seimsograms (records that document ground motions) are routinely received by NGDC from 115 stations of the Worldwide Network of standard seismographs, 25 stations in the Canadian Network, 17 stations in the People's Republic of China Network, and miscellaneous other stations. For international earthquake events of magnitude 7.5 or more, several dozen stations send NGDC their seismograms through an international data exchange agreement. There are approximately 5 million seismograms on file at NGDC.

The Worldwide Network of Seismogram Stations (WWNSS) send their data first to the U.S. Geological Survey (USGS) where the records are examined to see that standards are being maintained. These data are then sent to NGDC where they are combined with data received directly from other networks and are filmed using special high resolution cameras. These data are available to the public on 35-mm microfilm, 70-mm file chips, microfiche, and paper copy. Several million copies of seismograms are distributed annually. Digital records from about 20 stations are available on magnetic tape since March 1977. There is also an historical seismogram film file. This file contains several hundred thousand historical seismograms from 1903 to 1962 for selected significant earthquakes.

Strong-Motion Data. These records are generated when an event, usually an earthquake, causes an acceleration greater than 0.01 g (1/100 of the acceleration of gravity), that is, when the event occurs near one of the recording instruments. These conditions are met only a few times a year. Generally, each of these events generates 1/2 dozen or so records. Our file contains the most significant strong-motion records from the United States and other areas of the world for the period from 1933 to 1981. In addition to the digitized data, which is available on magnetic tape, records also are available in microfilm, microfiche, and paper. The file contains 347 events and approximately 500 stations.

Stations participating in the USGS network forward their records to the USGS Seismic Engineering Branch in Menlo Park, California. The significant records are digitized by the USGS, then forwarded to NGDC, where they are standardized.

Earthquake Data File. This file contains locations of more than 350,000 worldwide earthquakes and other recorded earth disturbances. In addition to the USGS, more than 20 worldwide sources have provided data. The parameters that may be specified in obtaining data from this file include: geographic coordinates, date and time of occurrence, Modified Mercalli intensity, depth, and magnitude range. In addition to computer listings, computer-drawn maps and cathode-ray tube (CRT) plots are available.

When an earthquake event occurs, reports are compiled from seismogram records. The USGS receives these telegraphic reports from stations throughout the world. The USGS Earthquake Center in Golden, Colorado then uses these data to derive global earthquake parameters. When the results of a month's efforts are completed, NGDC is notified. NGDC then taps into the USGS's computer system and extracts the event records, provides quality control, and enters the data into the Earthquake Data File.

Significant Earthquake Data File. This Significant Earthquake Data File contains records of 2500 worldwide earthquakes reported in 114 written sources covering the time span from 2000 BC to 1979 AD and meeting at least one of the following criteria: Damage of one million or more in 1979 dollars, ten deaths, magnitude 7.5 or greater or where the magnitude is unknown, intensity of X or greater. The date and time of occurrence, latitude, longitude, depth, magnitude, number of casualties, damage, references, and political geography are given for each earthquake. These data are available as a wall map entitled Significant Earthquake Map, and as a publication entitled Catalog of Significant Earthquakes. In September, a new publication became available: New Catalog of Strong Earthquakes in the USSR from Ancient Times through 1977. This is the first major translation from the Russian of this type of report to be distributed by NOAA.

Earthquake Effect Data File. The earthquake effect file consists of 115,000 earthquake intensity observations for the U.S. since the beginning of the century, gleaned from canvasses, newspapers clippings, the Reid Catalog (contained on 5 reels of microfilm and available from NGDC). Each record in the file contains date and time of occurrence, location of the earthquake, geographic coordinates of the event, two-digit state code and coordinates of the observing sites, and the observed intensity at each site. A search can be performed for any geographic area in the U.S. for any specified time period, and for any intensity level. Computer plots on mylar film and also cathode-ray tube plots are available.

When an earthquake occurs in the U.S., questionnaires are sent to postmasters in communities surrounding the earthquake. These questionnaires are filled out and returned to the USGS in Golden, CO where they are analyzed, and intensities are assigned to each community. These data are published in an annual report entitled U.S. Earthquakes. After publication, the data are entered into the NGDC digital file entitled the Earthquake Effect File. The questionnaires are also forwarded to NGDC where they are placed on microfilm and archived.

Tsunami Data

The great waves that follow some strong earthquakes and can surge as high as 30 meters above normal sea level have been erroneously called "tidal waves". They have nothing to do with the tides, thus the more common scientific term "tsunami" from the Japanese, or seismic sea wave, have become popular.

Nearly 3000 tide gage records dating back to 1850 from U.S. and foreign tide stations in the Pacific are available on microfiche. The Coast and Geodetic Survey/National Ocean Survey, a part of the National Oceanic and Atmospheric Administration, has loaned these records to NGDC for filming and distribution. Each tide station has supplied records that contain a 5-day span of wave data encompassing the tsunami event with adequate gage quiet time. The number of stations available for a given event range from 1 to 50. We have a limited number of records from foreign countries. Our file also includes 520 paper copies of tsunamigrams. A data base entitled the Pacific Tsunami Historic File (PTHF) is being prepared. A tsunami data report and a matching earthquake data report can be generated from this data base. We have the capability of searching the PTHF data base for tsunamis that have occurred in a given region during a given period of time.

Future plans include the production of a wall-sized multi-color map showing tsunami source locations. Other parameters that may be included are: earthquake magnitude, tsunami magnitude or intensity, frequency of occurrences and travel time lines. This map will be accompanied by tabular data for pre-20th century events.

Another project is the production of tsunami travel time maps using detailed bathymetric data for a few key locations. For example, residents of Hilo, Hawaii who might be in the path of a tsunami generated in the Aleutian Islands could be warned of the predicted arrival time of the great wave, based on the time travel map. NGDC is preparing a listing of tsunami events in the Mediterranean, Atlantic, and Indian Oceans to supplement the work being completed by Dr. Doak Cox. We presently have data on 325 events dating to the second millenium B.C.

NGDC has a collection of about 30 million bathymetric observations of the U.S. coastal areas, collected since 1930 by the U.S. Coast and Geodetic Survey and its successor, National Ocean Survey, NOAA. These data are on magnetic tape and also can be formatted to provide plots, even-spaced grids, or profiles on paper.

Volcanology

Volcanoes have been known to destroy entire civilizations; consequently, they rank very high on a list of serious geological hazards. Data associated with volcanoes come in many forms -- from maps that depict "Volcanoes of the World", to photographs (over 250 available from NGDC), to computer files. Computerized files, too, are available in a number of differing formats -- containing such data as: (1) compilation of all volcanic events during the last 12,000 years (created by the Smithsonian Institution), (2) geothermal data,

(3) aeromagnetic data before and after the eruption of Mt. St. Helens, and (4) geochemistry of volcanic rocks.

Glaciology, Snow And Ice

Glaciological data, such as information on snow cover, sea (and Great Lakes) ice, avalanches, and ice cores, are often very useful to those evaluating risks associated with perhaps the most hazardous geological mineral -- ice. Operated under the auspices of the National Geophysical Data Center is the World Data Center - A (WDC-A) for Glaciology (Snow and Ice). Available through this WDC-A are numerous data reports, photographs, and digital inventory and data files, for world-wide events.

Offshore Drilling Hazards

To alleviate risks associated with hazards to offshore oil and gas exploration, the former Conservation Division of the U.S. Geological Survey (now a new agency of the Interior Department, the Minerals Management Service-MMS) historically supported investigations that identify regions of structural instability on the continental shelves. These studies, which utilize geophysical data such as faults and slope instabilities, have been associated primarily with Lease Sale areas. NGDC manages and disseminates for MMS the data from Lease Sales hazards surveys for Alaska, Pacific, Atlantic, and Gulf Coast offshore areas. The data consist of seismic sections, maps, and reports available in the usual formats.

Hazards to Navigation

To mitigate hazards to marine navigation, the National Ocean Survey (NOS) has engaged in extensive surveying of U.S. coastal waters. Few ships sail without an extensive file of coastal maps, however, a large computerized file of dangers to navigation is available -- identifying channels, shoals, banks, reefs, rocks, pilings, wrecks, oil platforms, etc. These data are available on magnetic tapes or as computer plots.

Natural Hazards Photograph File

This file consists of nearly 2000 photographs depicting earthquake, tsunami, and volcanic eruption damage and effects. The file is global in coverage, includes 93 earthquake and/or tsunami events, and spans more than 150 years. Photographs, slides, and negatives are available for the cost of reproduction and processing of the order. NGDC can fill requests for specific types of damage or damage occurring in specific locations from its photograph file. An earthquake damage slide set including outstanding photographs of earthquake damage is available.

Conclusion

Servicing the needs of the scientific community (i.e., government, academia, and industry) and the general public for data and information on geological hazards (or any other environmental parameters) is the responsibility of the National Geophysical Data Center. Data are obtainable at the cost of services, and are available in forms suited to customer's special needs. Services range from simple duplication of data to customized products such as hazards maps or other geophysical plots.

THE NATIONAL EARTHQUAKE INFORMATION SERVICE

Waverly J. Person

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Abstract: The National Earthquake Information Service (NEIS) has two basic responsibilities: publication of earthquake data and operation of the Earthquake Early Alerting Service (EEAS). The primary responsibility of the NEIS is to publish the Preliminary Determination of Epicenters (PDE), the Monthly Listings, and the Earthquake Data Report (EDR). For these publications, seismic data are processed to obtain earthquake location and intensity of shaking. In this role, the NEIS is the foremost collector of earthquake data from around the world, including data from the People's Republic of China and the USSR.

Another equally important responsibility of the NEIS is the operation of the Earthquake Early Alerting Service (EEAS), a service that is manned 24 hours a day. This service requires the NEIS to determine the location and magnitude of significant earthquakes in the United States and around the world as rapidly and accurately as possible and to communicate this information to interested persons or groups. The information is given to federal and state government agencies who are responsible for emergency responses, to government public information channels, to the national and international news media, to scientific groups including groups planning aftershock studies, and to private citizens who request information. In the case of a damaging earthquake in a foreign country, the information is passed to the staffs of the American embassies and consulates in the affected countries and to the United Nations Relief Organizations (UNDRO).

(Paper not available for publication.)

FLOOD INFORMATION FROM THE

U.S. GEOLOGICAL SURVEY

Marshall E. Jennings

U.S. Geological Survey
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Abstract: Flooding, a geologic hazard that ranks first in causing loss of life, is a natural characteristic of rivers. Because about 6 percent of the conterminous land area of the United States (along about 3 million miles of streams) is prone to flooding, flood hazards are significant. However, flood hazards can be alleviated by intelligent planning using adequate flood information. The U.S. Geological Survey is an active provider of flood information in the form of flood-hazard maps, reports documenting floods, reports describing techniques for flood-estimation, computer-based files of flood data, and by flood-frequency analyses.

Flood Hazards

Floods rank second among geologic hazards (behind expansive soils) in causing damage but first in causing loss of life (ten times as many deaths annually as second-place earthquakes) (Robinson, 1978). In terms of dollars alone, the average annual flood loss in the United States (1981 dollars) has increased from less than $100,000 at the beginning of the century to more than $4 billion in 1981. By the year 2000, potential annual flood loss is expected to be greater than $4 billion on the average (U.S. Water Resources Council, 1977).

Flooding--a natural characteristic of rivers--is simply defined as any abnormally high streamflow that overtops the natural or artificial banks of a stream. Flooding may be due to dam breaks (an unnatural event) perhaps associated with intense rainfall and natural flooding; flash floods (local floods of great volume but short duration); riverine floods (caused by precipitation or snowmelt over large areas); or tidal floods (caused by high tides, waves or storm surge). An excellent brief description of the kinds of floods and their impact is given by Edelen, (Hays, 1981).

Because about 6 percent of the conterminous land area of the United States (along about 3 million miles of streams) is prone to flooding, flood hazards are significant. The U.S. Water Resources Council in 1977 states that 20,800 communities--6100 with populations greater than 2500--have flood problems. It is clear also that man's use of flood-prone areas is increasing. Thus, increasing costs associated with losses and flood protection are explainable. Given this situation, the key action according to U.S. 89th Congress, HD 465, 1966, in effective reduction of losses from floods, involves intelligent planning for and regulation of the use of land exposed to flood hazards. Intelligent planning requires adequate information about floods.

This paper briefly discusses several programs of the U.S. Geological Survey that aid in the planning process to reduce flood hazards.

Flood Hazard Maps

Since 1969, the Geological Survey has identified flood-prone areas throughout the Nation on more than 13,000 topographic maps. The usual flood-hazard maps of this kind delineate the approximate areas inundated during the hypothetical 100-year (1% chance of being exceeded each year) flood. The flood-prone areas on these maps are identified by past flood records and statistical estimates of the 100-year flood depths, rather than by detailed hydraulic field surveys.

More complete analyses and maps have been prepared as a result of flood insurance needs. These studies, arising out of the Federal Flood

Insurance Act of 1956 (PL 1016) with reports available from the Federal Insurance Administration, show areas inundated by hypothetical 100- and 500- year floods and show water-surface profiles of the 10-, 50-, 100- and 500- year floods. Also shown are depth of flooding at specific places. These studies are frequently supported by detailed hydraulic calculations. Flood insurance studies in more than 6,000 of the 20,800 communities subject to flooding have been completed by various agencies and consulting groups.

Flood hazard maps are available without charge from the Geological Survey, Water Resources Division (WRD) field offices. A WRD Information Guide (USGS, 1982) gives a listing of addresses, telephone numbers, and office hours for WRD offices.

Documentation of Floods

Several types and series of U.S. Geological Survey book reports and atlases constitute special flood studies made by the U.S. Geological Survey. Such studies include all kinds of flooding occurrences. Table 1 is a summary of flood reports including Water Supply Papers, Circulars, and Hydrologic Atlases listed by year of the flood. These reports present a documentation of the particular flood and in some cases a compilation of historical data. Through 1979, approximately 150 reports were available.

A joint effort by the U.S. Geological Survey and National Weather Service, has produced a continuing series of Geological Survey Professional Papers documenting floods. Table 2 is a list of these reports.

Since 1951, more than 200 Hydrologic Investigation Atlases describing and documenting flood events have been prepared. For example, HA-656, (Massey and others, 1982), documents the flood of May 24-25, 1982, in the Austin, Texas metropolitan area. This flash flood resulted in the loss of thirteen lives and caused 100 others to be injured. Monetary losses exceeded $35 million.

Flood Estimation

The U.S. Geological Survey has published numerous reports describing statewide or regional methods, based on statistical techniques or mathematical models, for estimating flood magnitudes and associated frequency characteristics. Flood magnitude-frequency estimates are used for many engineering design and planning purposes.

Table 3 is a list of reports describing flood-depth frequency estimation methods, by State. Tables 4 and 5 are flood-peak discharge estimation methods for rural and urban settings, respectively. Noteworthy within table 5 is a report by Sauer and others, (1981) that describes a nationwide study of flood magnitude and frequency in urban areas. This report provides methods of estimating urban flood discharges for ungaged sites for flood recurrence intervals up to 500 years. This significant flood estimation study utilized a data base of 269 gaged basins in 56 cities and 31 states.

Flood Peak Data File

For more than a decade the U.S. Geological Survey has compiled and maintained a computer file of flood information for annual and more recently, partial duration (floods above a base value) events at both active and discontinued gaging stations. As of September 1982, this file contained about 1/2 million flood peaks at more than 20,000 locations with an average length of record of about 22 years. The file also contains more than 3,000 historical accounts. Each flood peak is qualified by code for effects such as regulation, backwater, dam break, and others.

Updated Flood-Frequency Information

Beginning in 1976, the U.S. Geological Survey has made available to the public, current flood-frequency curves at more than 9,000 sites on streams and rivers in all 50 states. These analyses are made via computer using the U.S. Water Resources Council guidelines as detailed in Bulletin 17B, (Water Resources Council, 1981). For example, in a given year, the Jackson, Mississippi Water Resources Division office answers about 100 requests for flood-frequency curves from engineers or planners. The requests come from both public and private agencies for purposes ranging from highway or pipe-line crossings to flood-plain management planning.

References

Edelen, G. W., Jr., Ferguson, G. E., and Langbein, W. B., 1979, Flood studies led to national flood insurance: Civil Engineering, February, p. 89-94.

Hays, W. W., and others, 1981, Facing geologic and hydrologic hazards, earth science considerations, Geol. Survey Prof. Paper 1240-B, p. B39-B53.

Massey, B. C., Reeves, W. E., and Lear. W. A., 1982, Flood of May 24-25, 1981, in the Austin, Texas metropolitan area, U.S. Geol. Survey Hydrol. Inves. Atlas 656, 2 sheets.

Robinson, G. D., and Spieker, Andrew M., 1978, Nature to be commanded: U.S. Geological Survey Professional Paper 950, 96 p.

Sauer, V. B., Thomas, W. O., Jr., Stricker, V. A., and Wilson, K. V., 1982, Flood characteristics of urban watersheds in the U.S. - Techniques for estimating magnitude and frequency of urban floods, U.S. Geol. Water Supply 2207, 83 p., in press.

U.S. Geological Survey, 1982, Water Resources Division Information Guide, February, 15 p.

U.S. Water Resources Council, 1977, Estimated flood damages--Nationwide analysis report: Appendix B, Flooding Technical Committee, U.S. Government Printing Office, 27 p.

U.S. Water Resources Council, 1981, Guidelines for determining flood flow frequency, Bull. 17B of the Hydrology Committee, 27 p. + 14 app.

TABLE 1

FLOOD SUMMARIES

U.S. GEOLOGICAL SURVEY WATER SUPPLY PAPERS, HYDROLOGIC ATLASES,

CIRCULARS, AND PROFESSIONAL PAPERS

1902-1979

Year of Flood	Annual Flood Summary	
1902		Passaic, New Jersey, WSP 88
1903	WSP 96	Passaic, New Jersey, WSP 92
1904	WSP 147	
1905	WSP 162	
1913		Ohio Valley, WSP 334
1916		Southern California, WSP 426
1921		Arkansas River, WSP 487; Central Texas, WSP 488
1922		Colorado, WSP 520-G
1923		Wyoming, WSP 520-G
1927		New England, WSP 636-C
1931	WSP 847	
1934	WSP 771	California, WSP 796-C
1935		New York, WSP 773-E; Kansas-Nebraska, WSP 796-B; Texas, WSP 796-G; and Ohio, WSP 869
1936		New England Rivers, WSP 798; Hudson River to Susquehanna River, WSP 799; Potomac River and Upper Ohio River, WSP 800; Texas, WSP 816

See footnotes at end of table

TABLE 1--Flood Summaries--Continued

Year of Flood	Annual Flood Summary	
1937		Ohio and Mississippi Rivers, Jan.-Feb., WSP 838; New Mexico, WSP 842; Northern California, WSP 843
1938		Connecticut, WSP 836-A; Northeastern States, WSP 867; Utah 18501938, WSP 994; Southern California, WSP 844; Texas, WSP 914; North Atlantic States, WSP 966
1939		Colorado River below Boulder Dam, WSP 967-A; Kentucky, WSP 967-B; Maine, WSP 967-C; Texas, WSP 914
1940		Texas, WSP 1046; S. E. States, WSP 1066
1942		Pennsylvania, WSP 1134-B
1943		West Virginia, WSP 1134-B
1946		San Antonio, Texas, C. 32
1947		North Atlantic States, WSP 966; Oregon, WSP 968-A; Washington, WSP 968-B
1948		Colorado, WSP 997; Colorado River, Washington, WSP 1080
1949		New England, C. 155
1950	WSP 1137-I	Missouri, WSP 1137-A; Red River, WSP 1137-B; Hawaii, WSP 1137-C; Nebraska, WSP 1137-D; Oregon, WSP 1137-E; California WSP 1137-F; Minnesota, WSP 1137-G; Nevada, WSP 1137-H; and Wichita Falls, C. 99
1951	WSP 1227-D	Kansas-Missouri, WSP 1139; Alabama, WSP 1227-A; Oklahoma-Texas, WSP 1227-B; New York, WSP 1227-C
1952	WSP 1260-F	Texas, WSP 1260-A; Missouri River Basin, WSP 1260-B; Upper Mississippi River, and Red River WSP 1260-C; California, WSP 1260-D; Utah-Nevada, WSP 1260-E
1953	WSP 1320-E	Iowa, WSP 1320-A; Montana, WSP 1320-B; Louisiana, WSP 1320-C; Oregon-California, WSP 1320-D

See footnotes at end of table

TABLE 1--Flood Summaries--Continued

Year of Flood	Annual Flood Summary	
1954	WSP 1370-C	Iowa, WSP 1370-A; Illinois-Indiana, WSP 1370-B
1955	WSP 1455-B	New England to North Carolina, WSP 1420; Colorado-New Mexico, WSP 1455-A; Northeastern States, C. 377; Far Western States C. 380
1956	WSP 1530	Far Western States Part I, WSP 1650-A and Far Western States Part II, WSP 1650-B
1957	WSP 1652-C	Kentucky, WSP 1652-A; Texas, WSP 1652-B; and Indiana, C. 407
1958	WSP 1660-B	Louisiana WSP 1660-A
1959	WSP 1750-B	Ohio River, WSP 1750-A; Ohio River, C. 418; Indiana, C. 440
1960	WSP 1790-B	Nebraska, WSP 1790-A; Puerto Rico, C. 451
1961	WSP 1810	Southeastern States, C. 452; Mississippi, C. 465; Skagit River Washington, WSP 1527
1962	WSP 1820	Idaho-Nevada, C. 467; Tampa Bay, Florida, HA-66
1963	WSP 1830-B	California-Nevada, WSP 1830-A
1964	WSP 1840-C	Ohio River, WSP 1840-A; Montana, WSP 1840-B; Far Western States, WSP 1866-A; WSP 1866-B
1965	WSP 1850-E	Upper Mississippi River, WSP 1850-A; Colorado, WSP 1850-B; Arizona-New Mexico, WSP 1850-C; Colorado-New Mexico, WSP 1850-D
1966	WSP 1870-D	Utah, WSP 1870-A; Texas, WSP 1870-B; California, WSP 1870-C
1967	WSP 1880-C	Alaska, WSP 1880-A; Texas, WSP 1880-B
1968	WSP 1970-B	Arkansas, WSP 1970-A

See footnotes at end of table

TABLE 1--Flood Summaries--Continued

Year of Flood	Annual Flood Summary	
1969	WSP 2030	Mississippi-Alabama, HA-395 to HA-408; Virginia HA-409 to HA-412
1972		Virginia, WSP 547 and C. 667; South Dakota, PP-877; and PP-924
1973		Mississippi River, PP-937; Southeastern States, PP-998
1974		Nevada, PP-930
1976		Maine, PP-1087; Idaho, WSP 565; Colorado, WSP 1115
1977		Appalachian Flood, PP-1098, HA 588; Kansas City, Missouri, PP-1169; Kelly Barnes Dam, HA 613
1978		Montana-Wyoming, PP-1244; Central Texas (in press)
1979		Mississippi-Alabama (in press); Alabama-Florida 1979, HA 621 to HA 641; Jackson, Mississippi, HA 655

C. - Circular
HA - Hydrologic Investigations Atlas
PP - Professional Paper
WSP - Water Supply Paper

TABLE 2

JOINT USGS-NOAA FLOOD REPORTS

Professional Paper (PP) Series

Date of Flood	Authors	Title	Prof. Paper Number	Year Published
June 9-10, 1972	*Schwarz, F.K. *Hughes, L. A. *Hansen E. M. Petersen, H. S. Kelley, D. B	The Black Hill-Rapid City Flood of June 9-10, 1972: A Description of the Storm and Flood. (see also HA-511)	PP-877	1975
June-July, 1972	Bailey, J. F. Patterson, J. L. *Paulhus, J. L. H.	Hurricane Agness Rainfall and Floods, June-July, 1972	PP-924	1975
Spring, 1973	*Chin, E. H. Skelton, J. Guy, H. P.	The 1973 Mississippi River Basin Flood: Compilation and Analysis of Meteorologic, Streamflow, and Sediment Data.	PP-937	1975
March-April, 1973	Edelen, G. W. *Miller, J. F.	Floods of March-April 1973 in Southeastern United States	PP-998	1976
Feb. 2, 1976	R. A. Morrill *E. H. Chin *W. S. Richardson	Maine Coastal Storm and Flood of February 2, 1976	PP-1087	Aug. 1979
April 4-7, 1977	G. S. Runner *E. H. Chin	Flood of April 1977 in the Appalachian Region of Kentucky, Tennessee, Virginia and West Virginia (see also HA-588)	PP-1098	April
July 31, - Aug. 1, 1976	J. F. McCain *L. R. Hoxit *R. A. Maddox *C. F. Chappell *F. Caracena R. R. Schroba P. W. Schmidt E. J. Crosby W. R. Hansen **J. M Soule	Storm and Flood of July 31-August 1, 1976 in the Big Thompson River and Cache La Poudre River Basins, Larimer and Weld Counties, Colorado	PP-1115	Nov. 1979

*National Weather Service, NOAA
**Colorado Geological Survey

TABLE 2--Professional Paper Series--Continued

Date of Flood	Author	Title	Prof. Paper Number	Year Published
July 19-20, 1977	*L. R. Hoxit S. A. Brua *R. A. Maddox *C. F. Chappell	Johnstown-Western Pennsylvania Storm and Floods of July 19-20, 1977	PP-1211	In press
Sept. 12-13, 1977	L. D. Hauth W. J. Carswell *E. H. Chin	Floods in Greater Kansas City,--Missouri and Kansas, Sept. 12-13, 1977	PP-1169	Aug. 1981
May 19-20, 1978	C. Parrett D. D. Carlson G.S. Craig, Jr. *E. H. Chin	Floods in Powder River and Bighorn River Basins, Montana and Wyoming, May 19-20, 1978	PP-1244	In press
Aug. 3-6, 1978		Floods in Central Texas, Aug. 1978		
April 13-22, 1979		Flood of April 1979 Mississippi and Alabama		
Feb. 13-22, 1980	*E. H. Chin B. N. Aldridge	Floods of Feb. 1980 in California and Arizona		

* National Weather Service, NOAA

TABLE 3

FLOOD-DEPTH FREQUENCY REPORTS
(For Estimating Flood Peak Depths)

Alabama:

Hains, C. F., 1976, Regional flood depth-frequency relationships for Alabama: U.S. Geological Survey Open-File Report 76-528.

Arkansas:

Hines, M. S., 1977, Graphs for determining the approximate elevation of the 50-year flood in Arkansas: Arkansas Geological Commission, Water Resources Summary No. 12.

__________, 1978, Graphs for determining the approximate evaluation of the 100-year flood in Arkansas: Arkansas Geological Commission, Water Resources Summary No. 13.

Colorado:

McCain, J. R., and Jarrett, R. D., 1976, Manual for estimating flood characteristics of natural-flow streams in Colorado: Colorado Water Conservation Board, Technical Manual No. 1.

Georgia:

Price, M., 1977, Techniques for estimating flood-depth frequency relations in natural streams in Georgia: U.S. Geological Survey Water-Resources Investigations 77-90 (PB-275 381/AS).

Illinois:

Prugh, B. J., 1976, Depth and frequency of floods in Illinois: State of Illinois Department of Transportation, Division of Water Resources.

Louisiana:

Lowe, A. S., 1980, Flood depth-frequency relations for Louisiana: Louisiana Department of Transportation and Development, Office of Public Works, Water Resources Technical Report No. 23.

Maryland:

Herb, W. J., 1978, Exceedance probability-depth relationships of floods for Maryland streams west of Chesapeake Bay: U. S. Geological Survey Open-File Report 78-171.

TABLE 3--Flood Depth Frequency Reports--Continued

New Jersey:

Velnick, A. J., and Laskowski, S. L., 1979, Technique for estimating depth of 100-year floods in New Jersey: U.S. Geological Survey Open-File Report 79-419.

New York:

Archer, R. J., 1978, Discharge, gage-height, and elevation of 100-year floods in the Hudson River basin, New York: U.S. Geological Survey Open-File Report 78-332.

North Carolina:

Coble, R. W., 1979, A technique for estimating heights reached by the 100-year flood on unregulated non-tidal streams in North Carolina: U.S. Geological Survey Water-Resources Investigations 79-69 (PB-301 372).

Eddin, H. A., and Jackson, N. M., Jr., 1980, A technique for estimating flood heights on small streams in the city of Charlotte and Mecklenburg County, North Carolina: U.S. Geological Survey Water-Resources Investigations 80-106.

Oklahoma:

Thomas, W. O., Jr., 1976, Techniques for estimating flood depths for Oklahoma streams: U.S. Geological Survey Water-Resources Investigations 2-76 (PB-253 310/AS).

Tennessee:

Gamble, C. R., and Lewis, J. G., 1977, Technique for estimating depth of 100-year floods in Tennessee: U.S. Geological Survey Open-File Report 77-668.

Virginia:

Miller, E. M., 1977, Equation for estimating regional flood depth-frequency relation for Virginia: U.S. Geological Survey open-file report.

TABLE 4
LIST OF REPORTS FOR ESTIMATING
RURAL (FLOOD PEAK) DISCHARGES

Alabama:

Hains, C. F., 1973, Floods in Alabama--Magnitude and frequency based on data through September 30, 1971: U.S. Geological Survey open-file report.

Olin, D. A., and Bingham, R. H., 1977, Flood frequency of small streams in Alabama: Alabama Highway Department HPR Report No. 83, Research Project 930-087.

Alaska:

Lamke, R. D., 1978, Flood characteristics of Alaskan streams: U.S. Geological Survey Water-Resources Investigations 78-129.

Arizona:

Roeske, R. H., 1978, Methods for estimating the magnitude and frequency of floods in Arizona: U.S. Geological Survey Open-File Report 78-711.

Arkansas:

Patterson, J. L., 1971, Floods in Arkansas, magnitude and frequency characteristics through 1968: Arkansas Geological Commission, Water Resources Summary No. 11.

California:

Waananen, A. O., and Crippen, J. R., 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations 77-21 (PB-272 510/AS).

Colorado:

Hedman, E. R., Moore, D. O., and Livingston, R. K., 1972, Selected streamflow characteristics as related to channel geometry of perennial streams in Colorado: U.S. Geological Survey open-file report.

Livingston, R. K., 1980, Rainfall-runoff modeling and preliminary regional flood characteristics of small rural watersheds in the Arkansas River Basin in Colordao: U.S. Geological Survey Water-Resources Investigations 80-112 (NTIS).

McCain, J. R., and Jarrett, R. D., 1976, Manual for estimating flood characteristics of natural-flow streams in Colorado: Colorado Water Conservation Board, Technical Manual No.1.

TABLE 4--List of Reports--Continued

Connecticut:

Weiss, L. A., 1975, Flood flow formula for urbanized and non-urbanized areas of Connecticut: Watershed Management Symposium of ASCE Irrigation and Drainage Division, p. 658-675, August 11-13, 1975.

Delware:

Simmons, R. H., and Carpenter, D. H., 1978, Technique for estimating the magnitude and frequency of floods in Delaware: U.S. Geological Survey Water-Resources Investigations Open-File Report 78-93.

Florida:

Seijo, M. A., Giovannelli, R. F., and Turner, J. F., Jr., 1979, Regional flood-frequency relations for west-central Florida: U.S. Geological Survey Open-File Report 79-1293.

Georgia:

Price, M., 1978, Floods in Georgia, magnitude and frequency: U.S. Geological Survey Water-Resources Investigations 78-137 (PB-80 146 244).

Hawaii:

Nakahara, R. H., 1980, An analysis of the magnitude and frequency of floods in Oahu, Hawaii: U.S. Geological Survey Water-Resources Investigations 80-45 (PB-81 109 902).

Idaho:

Harenberg, W. A., 1980, Using channel geometry to estimate flood flows at ungaged sites in Idaho: U.S. Geological Survey Water-Resources Investigations 80-32 (PB-81 153 736).

Kjelstrom, L. C., and Moffatt, R. L., 1981, Method of estimating flood-frequency parameters for streams in Idaho: U.S. Geological Survey Open-File Report 81-909.

Thomas, C. A., Harenburg, W. A., and Anderson, J. M., 1973, Magnitude and frequency of floods in small drainage basins in Idaho: U.S. Geologial Survey Water-Resources Investigations 7-73 (PB-222 409).

TABLE 4--List of Reports--Continued

Illinois:

Allen, H. E., Jr., and Bejcek, R. M., 1979, Effects of urbanization of the magnitude and frequency of floods in northeastern Illinois: U.S. Geological Survey Water-Resources Investigations 79-36 (PB-299 065/AS).

Curtis, G. W., 1977, Technique for estimating magnitude and frequency of floods in Illinois: U.S. Geological Survey Water-Resources Investigations 77-117 (PB-277 255/AS).

Indiana:

Davis, L. G., 1974, Floods in Indiana: Technical manual for estimating their magnitude and frequency: U.S. Geological Survey Circular 710.

Gold, R. L., 1980, Flood magnitude and frequency of streams in Indiana - Preliminary estimating equations: U.S. Geological Survey Open-File Report 80-759.

Iowa:

Lara, O., 1973, Floods in Iowa: Techniques manual for estimating their magnitude and frequency: State of Iowa Natural Resources Council Bulletin no. 11.

Kansas:

Jordan, P. R., and Irza, T. J., 1975, Magnitude and frequency of floods in Kansas, unregulated streams: Kansas Water Resources Board Technical Report no. 11.

Hedman, E. R., Kastner, W. M., and Hejl, H. R., 1974, Selected streamflow characteristics as related to active-channel geometry of streams in Kansas: Kansas Water Resources Board Technical Report no. 10.

Kentucky:

Hannum, C. H., 1976, Technique for estimating magnitude and frequency of floods in Kentucky: U.S. Geological Survey Water-Resources Investigations 76-62 (PB-263 762/AS).

TABLE 4--List of Reports--Continued

Louisiana:

Lowe, A. S. 1979, Magnitude and frequency of floods for small watersheds in Louisiana: Louisiana Department of Transportation and Development, Office of Highways, Research Study No. 65-2H.

Neely, B. L., Jr., 1976, Floods in Louisiana, magnitude and frequency, 3d Edition 1976: Louisiana Department of Highways.

Maine:

Morrill, R. A., 1975, A technique for estimating the magnitude and frequency of floods in Maine: U.S. Geological Survey open-file report.

Maryland:

Carpenter, D. H., 1980, Technique for estimating magnitude and frequency of floods in Maryland: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-1016.

Massachusetts:

Wandle, S. W., 1981, Estimating peak discharges of small rural streams in Massachusetts: U.S. Geological Survey Open-File Report 80-676.

Michigan:

Bent, P. C., 1970, A proposed streamflow data program for Michigan: U. S. Geological Survey open-file report.

Minnesota:

Guetzkow, L. C., 1977, Techniques for estimating magnitude and frequency of flood in Minnesota: U.S. Geological Survey Water-Resources Investigations 77-31 (PB-272 509/AS).

Mississippi:

Colson, B. E., and Hudson, J. W., 1976, Flood frequency of Mississippi streams: Mississippi State Highway Department.

Missouri:

Hauth, L. D., 1974, A technique for estimating the magnitude and frequency of Missouri floods: U.S. Geological Survey open-file report.

Spencer, D. W., and Alexander, T. W., 1978, Technique for estimating the magnitude and frequency of floods in St. Louis County, Missouri: U.S. Geological Survey Water-Resources Investigations 78-139 (PB-298 245/AS).

TABLE 4--List of Reports--Continued

Montana:

Parrett, C. and Omang, R. J., 1981, Revised techniques for estimating magnitude and frequency of floods in Montana: U.S. Geological Survey Open-File Report 81-917.

Nebraska:

Beckman, E. W., 1976, Magnitude and frequency of floods in Nebraska: U.S. Geological Survey Water-Resources Investigations 76-109 (PB-260 842/AS).

Nevada:

Moore, D. O., 1974, Estimating flood discharges in Nevada using channel-geometry measurements: Nevada State Highway Department Hydrologic Report no. 1.

__________, 1976, Estimating peak discharges from small drainages in Nevada according to basin areas within elevation zones: Nevada State Highway Department Hydrologic Report no. 3.

New Hampshire:

LeBlanc, D. R., 1978, Progress report on hydrologic investigations of small drainage areas in New Hampshire--Preliminary relations for estimating peak discharges on rural, unregulated streams: U.S. Geological Survey Water-Resources Investigations 78-47 (PB-284 127/AS).

New Jersey:

Stankowski, S. J., 1974, Magnitude and frequency of floods in New Jersey with effects of urbanization: New Jersey Department of Environmental Protection Special Report 38.

New Mexico:

Scott, A. G., 1971, Preliminary flood-frequency relations and summary of maximum discharges in New Mexico--A progress report: U.S. Geological Survey open-file report.

Scott, A. G., and Kunkler, J. L., 1976, Flood discharges of streams in New Mexico as related to channel geometry: U.S. Geological Survey open-file report.

Thomas, R. P., and Gold, R., 1982, Technique for estimating flood discharges for New Mexico Streams: U.S. Geological Survey Water-Resources Investigations 82-24.

TABLE 4--List of Reports--Continued

New York:

Zembruzuski, T. J., and Dunn, B., 1979, Techniques for estimating magnitude and frequency of floods on rural unregulated streams in New York, excluding Long Island: U.S. Geological Survey Water-Resources Investigations 79-83 (PB-80 201 148).

North Carolina:

Jackson, N. M., Jr., 1976, Magnitude and frequency of floods in North Carolina: U.S. Geological Survey Water-Resources Investigations 76-17 (PB-254 411/AS).

North Dakota:

Crosby, O. A., 1975, Magnitude and frequency of floods in small drainage basins in North Dakota: U.S. Geological Survey Water-Resources Investigations 19-75 (PB-248 480/AS).

Ohio:

Webber, E. E., and Bartlett, W. P., Jr., 1977, Floods in Ohio magnitude and frequency: State of Ohio, Department of Natural Resources, Division of Water, Bulletin 45.

Oklahoma:

Thomas, W. O., Jr., 1977, Techniques of estimating flood discharges for Oklahoma streams: U.S. Geological Survey Water-Resources Investigations 77-54 (PB-273 402/AS).

Orgeon:

Harris, D. D., Hubbard, L. L., and Hubbard, L. E., 1979, Magnitude and frequency of floods in western Oregon: U.S. Geological Survey Open-File Report 79-553.

Laenen, Antonius, 1980, Storm runoff as related to urbanization in the Portland, Oregon-Vancouver, Washington, area: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-689.

Pennsylvania:

Flippo, H. N., Jr., 1977, Floods in Pennsylvania: A manual for estimation of their magnitude and frequency: Pennsylvania Department of Environmental Resources Bulletin no. 13.

TABLE 4--List of Reports--Continued

Puerto Rico:

Lopez, M. A., Colon-Dieppa, E., and Cobb, E. D., 1978, Floods in Puerto Rico: magnitude and frequency: U.S. Geological Survey Water-Resources Investigations 78-141 (PB-300 855/AS).

Rhode Island:

Johnson, C. G., and Laraway, G. A., 1976, Flood magnitude and frequency of small Rhode Island streams--Preliminary estimating relations: U.S. Geological Survey open-file report.

South Carolina:

Whetstone, B. H., 1982, Floods in South Carolina--Techniques for estimating magnitude and frequency of floods with compilation of flood data: U.S. Geological Survey Water-Resources Investigations 82-1.

South Dakota:

Becker, L. D., 1974, A method for estimating the magnitude and frequency of floods in South Dakota: U.S. Geological Survey Water-Resources Investigations 35-74 (PB-239 831/AS).

_________, 1980, Techniques for estimating flood peaks volumes, and hydrographs on small streams in South Dakota: U.S. Geological Survey Water-Resources Investigations 80-80 (PB-81 136 145).

Tennessee:

Randolph, W. J., and Gamble, C. R., 1976, A technique for estimating magnitude and frequency of floods in Tennessee: Tennessee Department of Transportation.

Texas:

Dempster, G. R., Jr., 1974, Effects of urbanization on floods in the Dallas, Texas metropolitan area: U.S. Geological Survey Water-Resources Investigations 60-73 (PB-230 188/AS).

Liscum, F., and Massey, B. C., 1980, Technique for estimating the magnitude and frequency of floods in the Houston, Texas metropolitan area: U.S. Geological Survey Water-Resources Investigations 80-17 (ADA-089 495).

Schroeder, E. E., and Massey, B. C., 1977, Techniques for estimating the magnitude and frequency of floods in Texas: U.S. Geological Survey Water-Resources Investigations Open-File Report 77-110.

TABLE 4--List of Reports--Continued

Utah:

Butler, E., and Cruff, R. W., 1971, Floods of Utah, magnitude and frequency characteristics through 1969: U.S. Geological Survey open-file report.

Vermont:

Johnson, C. G., and Tasker, G. D., 1974, Flood magnitude and frequency of Vermont streams: U.S. Geological Survey Open-File Report 74-130.

Virginia:

Miller, E. M., 1978, Technique for estimating the magnitude and frequency of floods in Virginia: U.S. Geological Survey Water-Resources Investigations Open-File Report 78-5.

Washington:

Cummans, J. E., Collins, M. R., and Nassar, E. G., 1974, Magnitude and frequency of floods in Washington: U.S. Geological Survey Open-File Report 74-336.

West Virginia:

Runner, G. S., 1980, Technique for estimating magnitude and frequency of floods in West Virginia: U.S. Geological Survey Open-File Report 80-1218.

Wisconsin:

Conger, D. H., 1980, Techniques for estimating magnitude and frequency of floods for Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-1214.

Wyoming:

Lowham, H. W., 1976, Techniques for estimating flow characteristics of Wyoming streams: U.S. Geological Survey Water-Resources Investigations 76-112 (PB-264 224/AS).

TABLE 5

URBAN FLOOD-FREQUENCY REPORTS

(For Estimating Urban Flood Peak Discharge)

Alabama:

Knight, A. L., 1976, Urbanization and flooding in Shades Creek basin, Jefferson County, Alabama: U.S. Geological Survey Water-Resources Investigations 76-37.

Olin, D. A., and Bingham, R. H., 1982, Synthesized flood frequency of urban streams in Alabama: U.S. Geological Survey Water-Resources Investigations 82-683.

California:

Waananen, A. O., and Crippen, J. R., 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations 77-21 (PB-272 510/AS).

Connecticut:

Weiss, L. A., 1975, Flood flow formula for urbanized and non-urbanized areas of Connecticut: Watershed Management Symposium of ASCE Irrigation and Drainage Division, p. 658-675, August 11-13, 1975.

Georgia:

Golden, H. G., 1977, Preliminary flood-frequency relations for urban streams metropolitan Atlanta, Georgia: U.S. Geological Survey Water-Resources Investigations 77-57 (PB-272 504/AS).

Illinois:

Allen, H. E., Jr., and Bejcek, R. M., 1979, Effects of urbanization on the magnitude and frequency of floods in northeastern Illinois: U.S. Geological Survey Water-Resources Investigations 79-36 (PB-299 065/AS).

Iowa:

Lara, O. G., 1978, Effects of urban development on the flood-flow characteristics of Walnut Creek basin, Des Moines metropolitan area, Iowa: U.S. Geological Survey Water-Resources Investigations 78-11 (PB-284 093/AS).

TABLE 5--Urban Flood-Frequency Reports--Continued

Kansas:

Peek, C. O., and Jordan, P. R., 1978, Determination of peak discharge from rainfall relations for urbanization basins, Wichita, Kansas: U.S. Geological Survey Open-File Report 78-974.

Missouri:

Gann, E. E., 1971, Generalized flood-frequency estimates for urban areas in Missouri: U.S. Geological Survey open-file report.

Spencer, D. W., and Alexander, T. W., 1978, Technique for estimating the magnitude and frequency of floods in St. Louis County, Missouri: U.S. Geological Survey Water-Resources Investigations 78-139 (PB-298 245/AS).

New Jersey:

Stankowski, S. J., 1974, Magnitude and frequency of floods in New Jersey with effects of urbanization: New Jersey Department of Environmental Protection Special Report 38.

North Carolina:

Putnam, A. L., 1972, Effect of urban development on floods in the Piedmont province of North Carolina: U.S. Geological Survey open-file report.

Martens, L. A., 1968, Flood inundation and effects of urbanization in metropolin Charlotte, North Carolina: U.S. Geological Survey Water-Supply Paper 1591-C.

Oklahoma:

Sauer, V. B., 1974, An approach to estimating flood frequency for urban areas in Oklahoma: U.S. Geological Survey Water-Resources Investigations 23-74 (PB-235 307/AS).

Thomas, W. O., Jr., and Corley, R. K., 1977, Techniques for estimating flood discharges for Oklahoma streams: U.S. Geological Survey Water-Resources Investigations 77-54 (PB-273 402/AS).

Oregon:

Laenen, Antonius, 1980, Storm runoff as related to urbanization in the Portland, Oregon-Vancouver, Washington, area: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-689.

TABLE 5--Urban Flood-Frequency Reports--Continued

Tennessee:

Boning, C. W., 1977, Preliminary evaluation of flood-frequency relations in the urban areas of Memphis, Tennessee: U.S. Geological Survey Water-Resources Investigations 77-132 (PB-280 310/AS).

Wibben, H. C., 1976, Effects of urbanization on flood characteristics in Nashville-Davidson County, Tennessee: U.S. Geological Survey Water-Resources Investigations 76-121 (PB-266 654/AS).

Texas:

Dempster, G. R., Jr., 1974, Effects of urbanization on floods in the Dallas, Texas, metropolitan area: U.S. Geological Survey Water-Resources Investigations 60-73 (PB-230 188/AS).

Johnson, S. L., and Sayer, D. M., 1973, Effects of urbanization on floods in the Houston, Texas, metropolitan area: U.S. Geological Survey Water-Resources Investigations 3-73 (PB-220 751).

Liscum, F., and Massey, B. C., 1980, Technique for estimating the magnitude and frequency of floods in the Houston, Texas, metropolitan area: U.S. Geological Survey Water-Resources Investigations 80-17 (ADA-089 495).

Virginia:

Anderson, D. G. 1970, Effects of urban development on floods in Northern Virginia: U.S. Geological Survey Water-Supply Paper 2001-C.

Regional Report:

Sauer, V. B., Thomas, W. O., Jr., Stricker, V. A., and Wilson, K. V., 1982, Flood characteristics of urban watersheds in the United States--Techniques for estimating magnitude and frequency of urban floods: U.S. Geological Survey Water-Supply Paper 2207 (in press).

SOURCES OF INFORMATION ON HAZARDOUS WASTES

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Abstract: The hazardous waste problem is described and the various kinds of wastes characterized. Both nuclear and non-nuclear wastes, their quantities, characteristics, and modes of disposal are presented. Sources of information and their availability are discussed including kinds of information, bibliographies, source books, and on-line data bases.

Introduction

The high level of interest and attention directed at the disposal and destruction of hazardous materials by the public, industry, and government requires that those of us who are information providers maintain an awareness of the sources of information on this subject. As a preface to discussing information sources, I would like to provide some background on hazardous wastes and some of the problems we, as a nation, face in disposing of them.

All human activity generates wastes which must be treated or disposed of in ways which protect the biosphere from contamination if the health and safety of mankind are not to be threatened. In the past, disposal techniques which have aroused public discussion and attention have been focused on containment (landfills) and destruction. The earth receives most of the world's waste burden, and fortunately the vast majority of it is solid and non-hazardous. Household and non-hazardous commercial refuse can be disposed of safely in sanitary landfills without threat to life or the environment.

Quantities. The highly industrialized countries, such as the United States, Japan, Germany, France, and the United Kingdom produce the greatest quantities of hazardous wastes. In the U.S. there are about 300,000 industrial operations that generate hazardous materials. The U.S. Environmental Protection Agency (EPA) estimates that 33 to 44 million tons of hazardous wastes are generated annually. That is about 300 to 400 pounds per person. The European nations produce about 28 million tons. By the year 2000, the generation of this non-nuclear waste is expected to double (Pizzuto et al 1981).

For nuclear waste the numbers are also impressive. In the U.S. there are about 9,000 tons of spent fuel assemblies from commercial nuclear reactors alone, stored in cooling tanks at the reactor sites, which would occupy about 117,000 cubic feet of space - equivalent of one football field over two feet deep, and by the year 2000 it is estimated that there will be 950,000 cubic feet (Answers ... 1981). There are 10 million cubic feet of defense high-level waste stored in tanks at federal sites in Barnwell, SC, Idaho Falls, ID, and the Hanford Reservation in Washington (Gillis 1982). High level waste is a particular problem because it is highly radioactive having some radionuclides which require thousands of years to decay. The U.S. Department of Energy has responsibility for the management of high level wastes.

Whether we like it or not, the generation of hazardous wastes is a permanent part of our world. The public is aware that the mismanagement of these substances is potentially harmful to health. Love Canal, an abandoned chemical waste dump near Niagara Falls, NY, attests to the serious danger created by the disposal of hazardous waste in which ground water is polluted. Some substances have been shown to increase birth-defect rates while others possess carcinogenic tendencies (Pizzuto et al 1981). There is no question that the world's hazardous waste problem is formidable and expected to increase substantially by the end of the century.

Non-Nuclear Wastes. The non-nuclear wastes are produced by a variety of industries such as asbestos, chemicals, glass, metals, leathers, oils and solvents, paint and varnish, petroleum, plastics, rubbers, soaps and detergents, textiles, mining, agriculture and defense. With such diverse origins, a way had to be devised to characterize which products of the manufacturing process were hazardous. The EPA considers a waste to be hazardous if it possesses any one of the following (1) ignitability, (2) corrosiveness, (3) reactivity, or (4) toxicity. There are approximately 400 chemicals and 85 process wastes listed as hazardous.

Historically our approach to management of these wastes has been responsive to environmental legislation. Early regulations were media specific, such as the Clean Air and Clean Water Acts, so the approach had an end-of-pipe perspective. Recent legislation, the Resource Conservation and Recovery Act of 1976 (RCRA), and the Comprehensive Environmental Response Compensation and Liability Act (Superfund) provide a basis for a more systematic approach. In the "systems" context interaction between and among industrial processes and total life-cycle costs are considered in the evaluation and selection of waste treatment options. Thus developing chemical process technologies are being pursued to minimize or eliminate hazardous and toxic materials. Figure 1 depicts these technology development activities. Selection of the best option depends upon knowledge of the waste sources, the volume and character of the waste being generated, technical feasibility of the proposed options, cost and liability: the components of the total system evaluation. The options include waste reduction; separation/concentration; material substitution; energy/material recovery; treatment, (e.g. incineration), and secure ultimate disposal. The new technologies offer opportunities to industry to

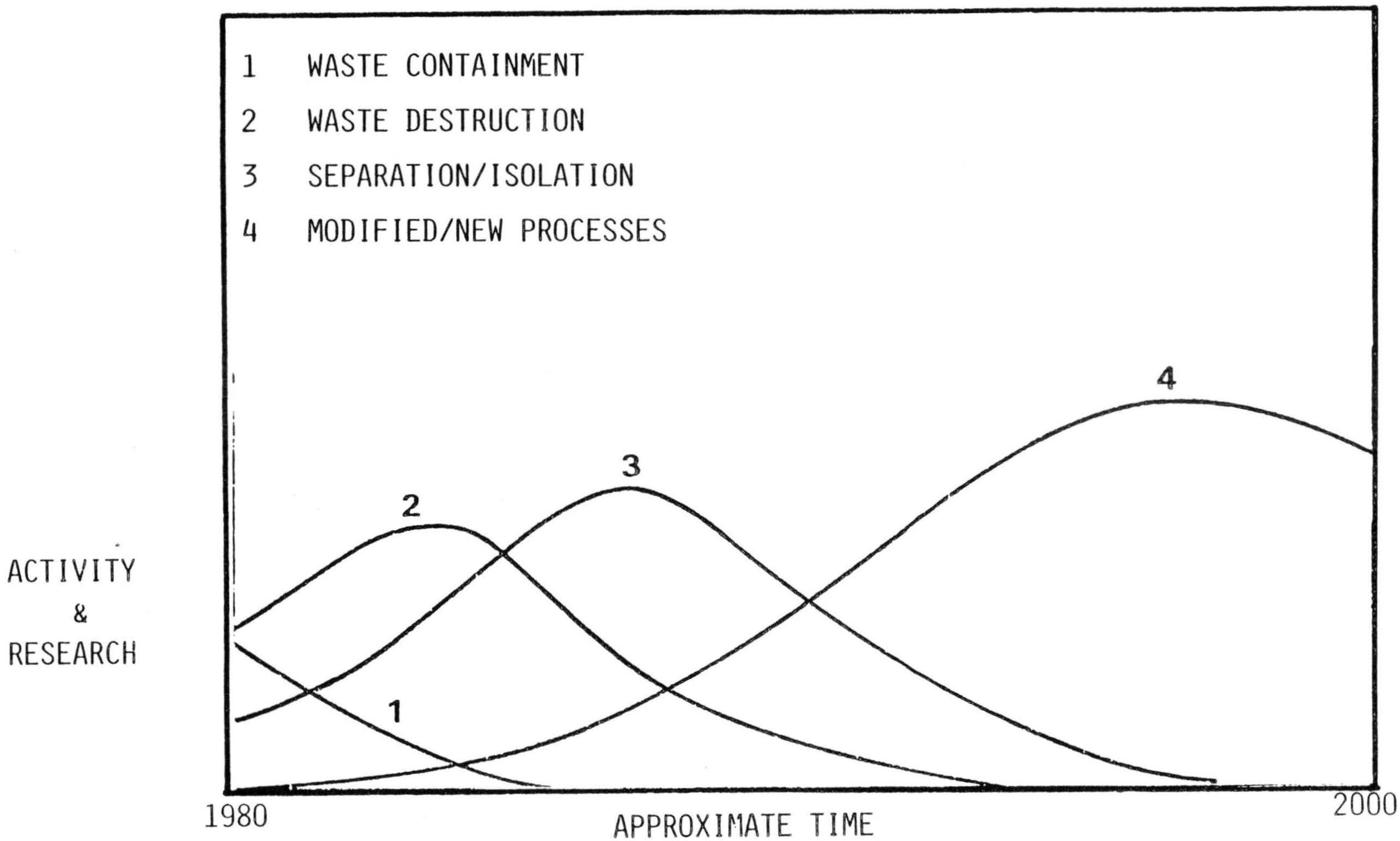

Figure 1. Technology Development Activity Sequence

turn waste into resources, and to counter the past practices of shallow land burial and its related problems of contamination and need for remedial actions. There also is a partial solution to the staggering rate of increase of waste volumes and the need for new containment sites. Future trends, then, are away from landfilling toward the use of higher technology processes.

Information Sources on Non-Nuclear Wastes

The immensity of the waste problem and the concern of the public and the scientific community demand that reliable information must be made readily available. This job falls to the libraries and information centers of universities, industry and government.

Role of the Environmental Protection Agency (EPA). Information sources on non-nuclear wastes in the federal government are primarily the domain of the EPA for the generation of regulations and technical reports, and the National Technical Information Service (NTIS) for their distribution.

Hazardous waste regulation is done through the Resource Conservation and Recovery Act (RCRA) of 1976. In this Act, EPA defines hazardous wastes and lists many chemical substances which meet the definition of toxicity, reactivity, ignitability, and corrosivity. As mentioned earlier, in addition to regulating the handling and disposal of wastes, RCRA encourages resource recovery and reuse.

EPA has two major Environmental Research Centers each having four laboratories: Cincinnati, OH, and Research Triangle Park, NC. Each center is engaged in some aspect of pollution control technology development. At Cincinnati, the Center for Environmental Research Information (CERI) is the focal point for the exchange of technical information within government and with the public:

> "The objective of CERI is to develop and disseminate communication tools which successfully reach key audiences. Seminars, workshops, newsletters, manuals, handbooks, capsule and summary reports, brochures, and project records are the principal means of bridging the gap between research and implementation. Research progress and results produced in these forms are supplied to environmental decision makers, the technical applications community, environmental regulars and planners, and to the interested public" (Andrew W. Breidenbach ... 1980).

CERI is responsible for the publication and distribution of the reports of EPA's Office of Research and Development (ORD). The technical information staff supports ORD with a comprehensive program. The Center publishes a newsletter, Technology Transfer, which announces new publications, current seminars, and other CERI activities.

EPA also maintains regional libraries in the major cities of Boston, New York, Philadelphia, Atlanta, Chicago, Dallas, Kansas City, Denver, San Francisco, and Seattle. In addition, there are libraries at EPA research centers in Wenatchee, WA, Corvallis, OR, Las Vegas, NV, Ada, OK, Ann Arbor, MI, Duluth, MN, Cincinnati, OH, Research Triangle Park, NC, Gulf Breeze, FL, Athens, GA, Annapolis, MD, Narragansett, RI, and at its headquarters in Washington, DC (Guide to ... 1980). These libraries are open to the public; the collections are generally technical in nature and oriented toward research. The Guide to EPA Libraries describes each library, its collection and research focus, and provides addresses and telephone numbers.

EPA's Library Systems Branch produces a quarterly abstract bulletin, EPA Publications Bibliography, covering reports generated by EPA (EPA Publications ... 1982). The Bibliography and the documents cited are available from NTIS. The keyword index includes "Hazardous Materials", where one can identify reports published on this topic.

The Role of the Disaster Research Center (DRC). The DRC was established in 1963 at The Ohio State University for the purpose of studying group and organizational preparation for and recovery from community emergencies, including natural and technological disasters. Current research is concerned with behavioral responses to severe chemical hazards and the problems of mass evacuation and sheltering of people. Ongoing research on acute chemical disasters is one of the largest efforts ever undertaken by DRC. In these studies 18 cities are being monitored in connection with their chemical disaster planning; over 20 site studies have been made of actual acute hazardous chemical incidents.

The Center's library contains a comprehensive collection of books, periodicals, and reports, on socio-behavioral aspects of disasters. It is open to scholars and public and private agencies involved in emergency planning. The Center publishes a newsletter, Unscheduled Events, which is issued irregularly (Quarantelli n.d.).

DRC has disseminated information by means of lectures, papers, seminars, conferences, articles, monographs, and its own publication series (DRC Publications ... 1981).

Other Information Sources on Non-Nuclear Wastes. In the published literature there are many good sources of information on non-nuclear hazardous materials. A sample of these is given below:

- Hazardous Waste News, a weekly newsletter published by Business Publishers, Inc., 951 Pershing Dr., Silver Spring, MD 20910.
- Environmental Information Sources Handbook, G.R. Wolff, Editor, NY, Simon & Schuster, 1974.
- Hazardous Waste Sites in the U.S., L. Cranberg and A.A. Moghissi, Editors, NY, Pergamon, 1981, 175 pp.
- Hazardous Waste Regulations: An Interpretive Guide, A. Mallow, NY, Van Nostrand-Reinhold, 1981, 640 pp.
- Hazardous Materials Handbook, J. Meidl, NY, MacMillan, 1972, Fire Science Series.
- Hazardous Materials Waste Disposal, Vol 1: 1964-1976, and Vol. II: 1977 - June 1979. (A Bibliography with Abstracts), D.M. Cavagnaro, Springfield, VA, NTIS, 1979.
- "The Secure Landfill Disposal of Hazardous Wastes", J.F. McGahan, Toxic Hazardous Waste Disposal, 1978, Vol. 2, 67-88.

There has been inadequate information on the size, scope, and nature of the non-nuclear hazardous waste problem - the management system has been deficient; identification of wastes, poor; and the assignment of responsibility of generators, transporters, and owners and operators of storage and disposal facilities, unclear. There has been no notification system for emergencies, and little incentive to solve these problems (Peirce 1981).

The waste management challenge therefore includes a) reduce waste generation, b) introduce more adequate management practices, c) decrease costs of waste handling, d) find environmentally and politically acceptable sites, e) upgrade public confidence, and f) deal with regulations.

Nuclear Wastes

Nuclear wastes are categorized according to their origin, level of radioactivity, and potential hazard:

- High level wastes are the by-products of nuclear reactions in the fuel of commercial and defense reactors. Their radioactivity is predominantly characterized in high energy radiation and rapid decay; they pose significant and long-term hazards.
- Transuranic wastes are those which result from reprocessing spent fuel. They consist of elements heavier than uranium, including man-made, long-lived radioactive elements. Their radioactivity is characterized by medium energy radiation and slow decay. They also pose significant and long-term hazards.
- Low-level wastes are produced by many commercial, medical, and industrial nuclear facilities and include laboratory clothing and equipment, waste paper, filters, rags and biological materials. They consist of small amounts of radioactive materials in large volume which do not require extensive shielding. These wastes pose low potential hazard and can be disposed of by shallow land burial in controlled locations.
- Tailings are by-products of uranium mining and milling and consist of large volumes of rock and soil that contain residual natural radioactivity.

Nuclear Waste Disposal. The first storage tanks for high-level wastes were constructed at the Hanford Reservation in Washington in the mid-1940s. These were the wastes from the production of the Nagasaki bomb. In the 1950s commercial nuclear power production began, and it became clear that a permanent solution for the waste problem would have to be found.

In 1957 the National Academy of Sciences - National Research Council recommended to the Atomic Energy Commission that salt deposits be studied for isolating this waste. The proposal initiated the concept of geologic disposal as the best strategy for isolating high-level nuclear waste (Gillis 1982).

In 1970, the AEC announced its intention to build a pilot repository in salt at Lyons, Kansas, based upon several years of successful experiments. However, Kansas State officials objected when it was discovered that water might enter the site from old oil and gas exploration holes. In 1972, AEC dropped Project Salt Vault and moved to an interim plan for dealing with spent fuel - a Retrievable Surface Storage Facility - for storing assemblies for as long as 100 years until a permanent solution could be developed. By this time, however, the environmental movement was in full swing and government plans were again interrupted. By 1975, EPA had been organized and the National Environmental Policy Act (NEPA) had been passed, along with other legislation.

By 1974, the Energy Research and Development Administration (ERDA) had replaced the AEC and in that year ERDA proposed a Waste Isolation Pilot Plant (WIPP) in salt to be located near Carlsbad, NM, for storage of military waste.

The current National Waste Terminal Storage Program (NWTS) was established in 1976 by ERDA and plans to undertake field work were announced to the States. The response was generally negative with several states adopting measures to restrict or prohibit the siting of a repository within their borders.

Today the U.S. Department of Energy (DOE) has responsibility for the management of high-level nuclear wastes. There are three programs which make up the NWTS program with the mission of selecting suitable sites for deep geologic repositories. Figure 2 depicts the regions under consideration for the isolation of these wastes.

- The Office of Nuclear Waste Isolation (ONWI) which is investigating bedded and domed salt in Utah, Texas, Mississippi, and Louisiana.
- The Basalt Waste Isolation Project (BWIP) is conducting investigations of the basalt underlying the Hanford Reservation in Washington, and
- The Nevada Nuclear Waste Storage Investigations (NNWSI) is evaluating the tuff at that site for a potential repository site.

Sites for the disposal of low-level wastes are located at Barnwell, SC; Richland, WA; and Beatty, NV. Policy governing low-level wastes is contained in the Low-Level Radioactive Waste Policy Act of December 22, 1980, (PL 96-573; 94 STAT. 3347). Under this law, states are primarily responsible for the regulation of waste disposal.

Information Activities. A very important part of the NWTS program is the public information program in which interactions with state and local

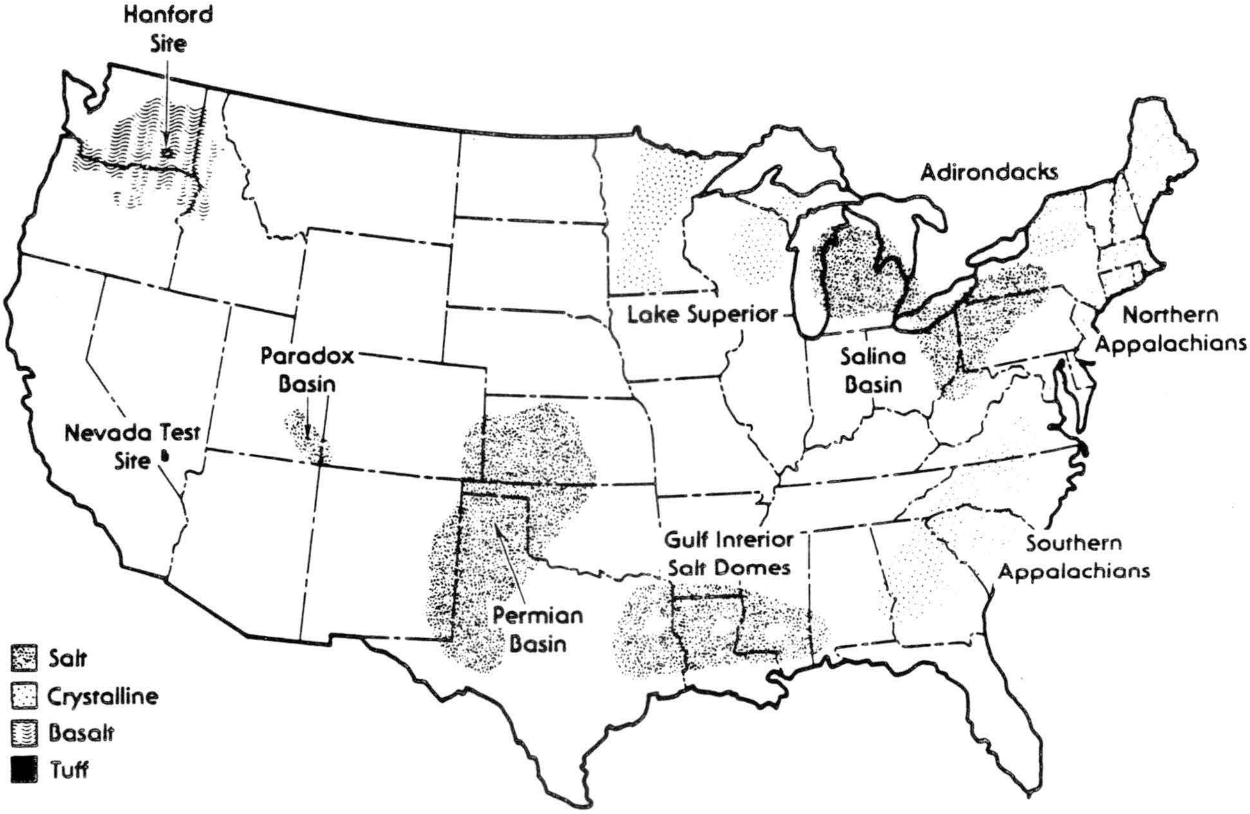

Figure 2. Regions and Areas Studied or Now Being Considered for Terminal Storage of High-Level Nuclear Waste

officials and the public are emphasized. The activities which constitute this part of the program include:

- Written communications in the form of brochures, pamphlets, information sheets, books, articles, press releases, and technical reports.
- Visual communications such as exhibits which travel to technical and non-technical conferences, library and educational meetings, and science museums.
- Audiovisuals such as films and slide presentations which are used for many kinds of meetings and audiences.

- Speakers bureau which supplies experts on the scientific aspects to give talks and other presentations.
- Public meetings and hearings which function as a forum for meeting with the officials and citizens of affected communities.
- Libraries which include reports produced by the program and other relevant documents on waste management.

Sources of Information on Nuclear Wastes

The extensive research on nuclear waste and the development of technologies related to its safe isolation have produced a large body of scientific literature in this area dating back to the 1940s. The National Technical Information Service, the Defense Technical Information Center, DOE's Technical Information Center, and the nation's libraries are the repositories for this information.

Fortunately today we have computerized indexes which provide access to the published literature. Extensive efforts toward organizing and computerizing the reports and technical publications have been invested by the U.S. Department of Energy and its predecessors. For example, Nuclear Science Abstracts began publication in 1948. It is now part of the DOE data bases called RECON, maintained by the Technical Information Center at Oak Ridge, TN (How to Find ... 1981). These data bases and their coverage include:

- Energy Data Base, June 1976 to present.
- Nuclear Science Abstracts, 1968 to June 1976.
- Energy Research in Progress, 1976 to present.

Commercial vendors of computerized literature searches also have extensive data bases. RECON is available to the public through this channel.

The major providers of this service are Lockheed with its DIALOG system and System Development Corporation's ORBIT. Some of the data bases they provide which cover information on nuclear waste are the following:

- NTIS - The index includes reports of more than 200 federal agencies - 1964 to present.
- Energyline - 1971 to present.
- Chemical Abstracts - 1967 to present.
- Compendex (On-line Engineering Information) - 1970 to present.

The U.S. DOE as the major funder of research and development in the nuclear waste isolation technologies has many contractors producing reports, books, and articles which find their way into the data bases listed above, the NTIS for distribution, and the DOE network of libraries and reading rooms. These facilities which are open to the public are located in Boston, New York, Philadelphia, Washington, DC, Atlanta, Chicago, Kansas City, Dallas, Denver, Seattle, San Francisco.

Similarly, the U.S. Nuclear Regulatory Commission (NRC) is a major funder of research in this area and makes its reports available through NTIS and NRC reading rooms.

At Battelle, as part of the National Waste Terminal Storage Program, we have established a library of reports and documents on waste management for use by our staff and the public. In addition, we disseminate both technical and non-technical publications and films for use by the public. Our library provides reference service and responds to requests for information from the public. Our report collection is indexed by computer for quick access, and we can provide microfiche copies to requesters. A bibliography of our holdings is available. Requests should be addressed to:

Library
Battelle Project Management Division
505 King Avenue
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REFERENCES CITED

Andrew W. Breidenbach Enironmental Research Center, 1980, Cincinnati, Ohio, U.S. EPA, p.24.

Answers to Your Questions About High-Level Nuclear Waste Isolation, 1981, Washington, D.C., U.S. Department of Energy, p. 6.

DRC Publications List, 1981, Columbus Ohio, Disaster Research Center, 14 pp.

EPA Publications Bibliography, Quarterly Abstract Bulletin, 1982, Washington, DC, U.S. EPA, (Available from NTIS, U.S. Department of Commerce, Springfield, VA 22161).

Gillis, D., 1982, Managing Nuclear Waste; The Underground Perspective: Underground Space, V. 6, No. 4-5, p. 206-210.

Guide to EPA Libraries, 1980, Washington, DC, U.S. EPA, 28 pp.

How to Find Information on Nuclear Waste Isolation, 1981, Columbus, Ohio, Office of Nuclear Waste Isolation, 2 pp.

Peirce, J.J., and Wesilind, P.A., 1981, Hazardous Waste Management, Ann Arbor, MI, Ann Arbor Science Publications, Inc., p. 12.

Pizzuto, J.S., and Townley, C.W., 1981, The Land and Hazardous Waste Management: Journal of Soil and Water Conservation, V. 36, No. 2, p. 79-81.

Quarantelli, E.L., and Wilson, E.A., n.d., History and Current Activities of the Disaster Research Center, Columbus, Ohio, Disaster Research Center, Miscellaneous Report No. 26, 9 pp.

PART II

CONTRIBUTED PAPERS

GEOLOGIC AND OTHER HAZARDS IN THE GEOREF SYSTEM 1982

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Abstract: In May of 1982, the GeoRef bibliographic information system contained 735,204 references to the world geoscience literature covering the years 1961-1982 approximately. Of that total, 6,858 documents have been indexed with the term "geologic hazards", and 6,359 with "slope stability". Statistical data are presented on research on hazards in English, French, Russian, German, and Spanish, as well as on hazards in different continents. Overall, it is shown that there is a major increase in hazard literature in the seventies relative to the sixties, both relative to all geologic literature and absolutely. Recent developments in the GeoRef database are also described.

Introduction

Just as man poses hazards to the ecology in which he lives, so does the environment pose natural hazards to mankind that could lead to damage or loss of life and equipment.

Geologic hazards have been defined as the highest levels of natural phenomena (geological, oceanographic and meteorological) in a given area at a given time. Examples include hurricanes, tsunamis, ice, faults, landslides, erosion, and deposition as well as any sediment of low bearing capacity. This paper examines the coverage of geoscience literature dealing with geologic hazards in the GeoRef Information System in terms of time changes and language, and trends in this coverage are discerned.

Hazards

That life on this Earth can be a hazardous enterprise is a truism which is by and large ignored between disasters. The evidence of this willful shortsightedness is abundant in history: earthquakes keep leveling the area of El Asnam in Algeria, and people keep coming back to build houses there.

The government promises a rebuilt El Asnam with "earthquake-resistant foundations... using the latest technology...", thus contributing to the myth of man's perpetual domination of nature.

The inhabitants of the slopes of Mount Etna seem to be fascinated by the certainty of violent destruction, as were the people who ignored the warnings about Mt. Saint Helens.

The Earth moves and its surface adjusts itself to a plethora of internal forces and external influences. It has been doing that, judging by the geologic record, for most of its history: there exists evidence of Precambrian volcanism, Tertiary earthquakes, and Mesozoic subsidence.

More recently, Man has added his influence to these forces affecting the surface of the Earth, and so we have man-induced earthquakes (reservoirs), land subsidence (due to withdrawal of oil, gas, and water), landslides (of mine tailings), floods (due to tampering with natural channels), and coastal destruction (by building jetties and altering the coastline).

As population increases there is a growing demand for land, pushing more and more hazardous areas into service as sites for human occupation, thereby increasing the potential risk for a given population. (It is estimated that there is a need for over 200,000 new housing units in the San Francisco Bay area from 1980-1985 alone.)

In the past few decades, geoscience education moved from the "classical" phase of teaching about the constituents of the Earth in a descriptive manner, to the current phase of emphasizing process and effect, and with the concomittant increase in awareness of the ultimate futility of a purely engineering approach to natural disasters, the study of geologic hazards increased as part of geotechnical and geophysical curricula. This trend must be encouraged and developed in the direction of multi-disciplinary programs involving geology, engineering, sociology, political science, military science, meteorology, and psychology. (The military aspects of hazards were recognized during the Vietnam War, when several reports appeared about Defense Department programs in weather modification and man-induced landslides to close the passage of mountain passes. The strategic implications can also be seen when you consider the reported attempts of the Soviets to divert rivers from the Arctic Ocean, and the possible consequences of the "greenhouse effect" of burning fossil fuels on the shorelines of the industrial nations.)

Already the cost of geologic hazards is estimated to be $8 billion in material damage per year in the U.S. alone. And given the fact that prediction is difficult if not impossible within a reasonable time framework, and that the status of national or local preparedness in the form of emergency procedures and evacuation plans is awfully inadequate (The Natural Hazards Observer, 1982, quotes a letter from a county planning commission director in Maryland as writing "Please remove us from your mailing list. I'm not interested in disasters."), it becomes vitally important that such education efforts are coupled with serious attempts at infusing legislation with an awareness of the dimensions of the risk involved and the need for long-range planning.

Such attempts are fortunately being made, and many are spear-headed by geologists. An excellent example is the group of geologists concerned about the erosion of the American seashore.

Information on geologic hazards

Like other geologic phenomena, geologic hazards are not easily classifiable as they are not only closely interrelated but reflect complex dynamic processes. But to classify is to understand, and the classification given in the tables here is just simply a breakdown of easily-identifiable phenomena; it is not complete or exhaustive.

The study of these phenomena is rather young. It grows from the twin tendencies of the increasing complexity of modern life which entails more and more disturbance of the natural order of things and resultant interface or confrontation with natural phenomena on the one hand, and the increasing awareness of the essential dependency of man on nature despite all the technological advances made. It is also a reflection of the growing acceptance of the holistic approach to natural order (or disorder) especially appropriate in geoscience and evidenced in such a dramatic fashion by the spread of the idea of plate tectonics, sometimes called global (i.e. holistic) tectonics.

Information sources: The Natural Hazards Observer, which is the major U.S. newsletter on the subject, lists organizations ranging from the Academy for Contemporary Problems to Insurance Information Institute. (The insurance people refer to most geologic hazards as "Acts of God", thus both admitting ignorance and avoiding risk.)

Fourteen database sources are listed including GeoRef, AGRICOLA, NOAA, Earthquake Engineering Research Center, and the Federal Emergency Management Agency.

Hazards in GeoRef: A problem that one faces in discussing information about geologic hazards is that of terminology. In fact, there is hardly agreement on what to call the thing itself; i.e., whether it is "geologic" or "natural". Strictly speaking, it seems to this author there should be a hierarchy of phenomena with "geologic" or "geological" hazards being a subset of "natural" hazards, and with such phenomena as "mudslides" and "rockslides" being subsets of a more general slope-stability hazard. Furthermore, a distinction can be made between "natural" and "man-induced" phenomena (for example, see Legget, Sept. 1981, Rassam, Nov. 1981, Peck, Sept. 1982).

Being a young phase of science, geotechnical analysis of natural hazards has not yet spouted a major terminology. In fact, most of the terminology is old (except for such terms as active faults and capable faults with newly restricted definitions) and belongs to the "classical" phase of the evolution of geologic science.

More specifically, the hazards themselves are well-defined: a volcanic eruption follows a course and has effects that are clearly distinct from, say, a sinkhole collapse. On the other hand, what is included in one class of hazards is still subject to controversy. Zaruba and Mencl (1982) consider, for example, avalanches as a restricted term for mass movements of snow and thus not belonging to the general set of slope movements.

Such nomenclatural distinctions are naturally important when attempting a discussion of the literature coverage of a subject such as geologic hazards.

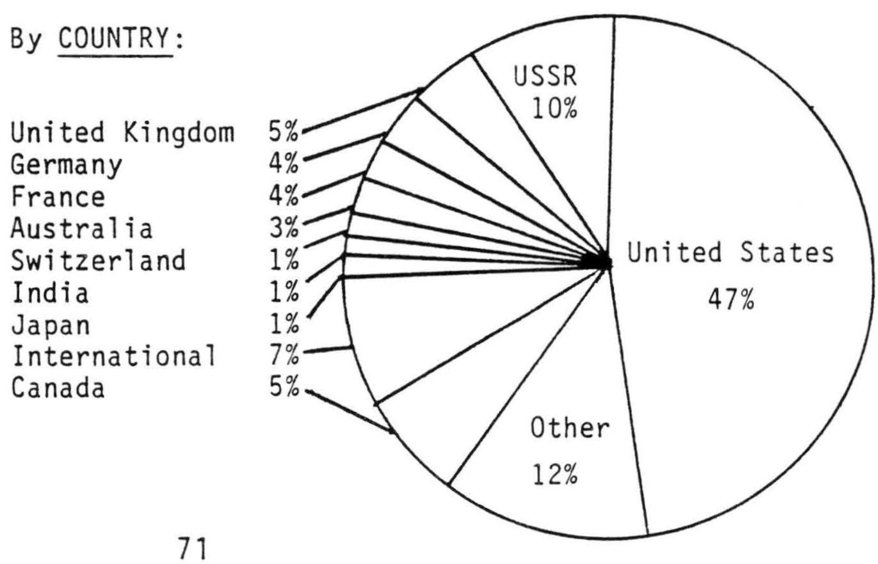
In the present study on GeoRef's coverage, it must be remembered that while the specific terms such as hurricanes and earthquakes pose no possibility of misconstruance, a general (and subjective) term such as "geologic hazards" is dependent on the judgment of the individual database indexer and may therefore be not always added when it should have been.

A search was conducted online on the GeoRef database of the American Geological Institute. GeoRef presently contains more than 750,000 references in all the geosciences. At the time of the search, GeoRef contained citations of articles published between 1961 and 1982. Its language and country breakdown can be seen in the figures below.

By LANGUAGE:

English. . . .	68%
Russian. . . .	10%
French	7%
German	4%
Spanish. . . .	2%
Japanese . . .	1%
Italian. . . .	1%
Other.	7%
	100%

By COUNTRY:



Hazards in time: An examination of Table 1 indicates an absolute and relative increase in the study of hazards in the past 20 years. This is especially true of earthquakes, landslides and floods.

It is difficult if not fruitless to attach too much significance to changes in the number of citations of individual phenomena over a given range of years, but the obvious relative stress on a phenomenon like earthquakes in relation to the others indicates the economic and sociologic importance attached to the study of forces that may be destructive of life and property.

Hazards in place: The figures in Table 2 indicate the importance given to studies of geologic hazards in various parts of the world. The breakdown of the table is by region studied and not necessarily where the funding or initiative originated. These are the same essentially for a country like the USSR but very different for a region like Africa where most of the studies are made by outsiders.

While it is not surprising that the U.S. leads in number of studies overall as well as in percentage relative to the total number of geologic studies in the past twenty years, it is clear that published geologic hazards studies in the Soviet Union have been scanty even given the fact that GeoRef does not contain a comprehensive view of the Soviet literature.

Whether this is due to lack of interest in the subject by Soviet geologists, or an awareness of the political sensitivity of the subject hence a desire to minimize published results, or still some other reason or combination of reasons is hard to say.

The distribution by language in Table 3 confirms the trends in Table 2 in showing the dominance of English as a medium of communication in the field of geologic hazards.

Table 1. Geologic hazards, 1961-1982

	1961-64 (total= 35,010)	1965-69 (total= 160,650)	1970-74 (total= 225,883)	1975-79 (total= 233,539)	1980-82 (total= 78,650)
geologic hazards	8	116(0.07%)	1209(0.5%)	3340(1.4%)	1919(2.5%)
avalanches	5	54	4	223	95
catastrophes	0	0	131	53	28
earthquakes (eng.)	174	704	1095	2669	1257
explosions	31	98	101	918	210
faults (eng.)	5	41	1174	695	309
floods	14	60	322	969	433
land subsidence	22	114	484	681	186
landslides	106	556	465	1436	474
slope stability	16	284	1012	2272	768
mudflows	10	65	1257	156	80
rockbursts	8	33	124	90	34
storms	41	426	34	534	301
tsunamis	37	168	942	186	77
hurricanes	19	75	283	92	55
volcanism	1	4	64	149	154
	310 (0.9%)	2,730 (1.7%)	7,990 (3.5%)	12,842 (5.5%)	6,431 (8.1%)

Table 2. Geologic hazards in various regions

	Europe (78,549)	Africa (18,568)	S. Am. (12,312)	Asia (33,010)	U.S. (118,440)	Mexico (5,769)	Canada (28,134)	USSR (69,136)	Aus. (12,242)
geologic hazards	590 (0.8%)	49 (0.3%)	108 (0.9%)	395 (1.2%)	3174 (2.7%)	38 (0.6%)	194 (0.7%)	201 (0.3%)	39 (0.3%)
avalanches	50	0	12	20	143	1	38	65	0
catastrophes	9	0	7	8	32	2	1	3	0
earthquakes (eng.)	249	32	121	557	1581	46	65	188	17
explosions	176	35	14	99	550	4	60	175	19
faults (eng.)	103	18	20	91	700	8	27	33	23
floods	167	32	25	103	1013	4	45	67	36
land subsidence	236	7	10	360	507	14	25	38	24
landslides	642	25	65	373	954	4	167	134	42
slope stability	787	48	76	32	1058	19	293	167	84
mudflows	52	12	14	12	111	0	14	70	2
rockbursts	42	12	0	21	10	0	4	18	1
storms	68	48	6	96	41	2	66	28	13
tsunamis	12	0	13	0	98	3	10	35	1
hurricanes	2	1	0	0	177	0	1	3	0
volcanism	21	1	4	20	182	5	2	3	1
	2,876 (3.6%)	281 (1.5%)	437 (3.5%)	1,962 (5.9%)	8,725 (7.3%)	130 (2.2%)	912 (3.2%)	1,178 (1.6%)	280 (2.3%)

Table 3. Geologic hazards and language

	Russian (total=79,479)	German (total=28,197)	French (total=38,757)	English (total=450,000)
geologic hazards	188(0.2%)	114(0.4%)	149(0.4%)	5781(1.3%)
avalanches	65	12	19	345
catastrophes	2	3	4	82
earthquakes (eng.)	296	19	29	4542
explosions	193	26	54	1965
faults (eng.)	18	11	25	1272
floods	64	17	62	1740
land subsidence	34	89	35	1137
landslides	110	115	124	2344
slope stability	179	128	152	3499
mudflows	68	8	18	268
rockbursts	18	14	3	107
storms	36	16	14	1765
tsunamis	72	5	3	379
hurricanes	3	1	2	230
volcanism	1	0	9	299
	1,254 (1.8%)	519 (1.8%)	628 (1.6%)	18,886 (4.1%)

Detailed examination of the figures however indicates that certain hazards are more "popular" than others in certain languages and regions.

While volcanism or hurricanes are barely studied as a hazard outside the English-language block, there is an emphasis on slope stability aspect in all parts of the world.

Mine rockbursts are studied more, relatively speaking, in Germany and the USSR than in the United States.

The figures can be examined in detail for many reasons but general conclusions can be drawn to indicate emphasis of research and outlays of funds in major industrial countries and to suggest that the awareness of hazard issues is becoming more and more acute with time, at least in the U.S.

The literature is scattered in journals dealing with environmental geology, engineering geology, politics: there is no important journal dealing with geologic hazards and much as I hate to do so, I for one see the need for a journal covering the various aspects of this phenomenon.

Conclusions

The analysis of published information on geologic hazards indicates increased awareness of the problems and more participation of geoscientists all over the world in the study of the phenomena involved.

References

Legget, Robert F., 1981, The hazard of 'hazard', Geotimes, vol. 26, no. 9, p. 21.

Natural Hazards Observer, 1982, No comment, vol. VI, no. 4, p. 14.

Peck, Dallas L., 1982, the USGS geologic hazards program, Natural Hazards Observer, vol. VII, no. 1, p. 1.

Rassam, G. N., 1981, Thinking of hazards, Geotimes, vol. 26, no. 11, p. 10.

Zaruba, Q. and Mencl, V., 1982, Landslides and their control, second edition, Academia, Prague, 324 p.

COMPUTER STORAGE OF PALEONTOLOGIC DATA

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Abstract: The Deep Sea Drilling Project has now recovered ocean cores from 595 sites in all the major ocean basins. A considerable amount of data concerning the stratigraphy of those cores has now been collected. In order to make these data more easily usable, we have created a computer storage system which permits an investigator to find the occurrence of any fossil, its preservation and abundance in addition to other pertinent data. The system permits manipulation of data so that, among other things, specialized range charts can be prepared incorporating user named species for particular sites.

Currently the system contains over 10,000 species representing 27 fossil groups found at 394 sites.

INTRODUCTION

The Deep Sea Drilling Project (DSDP) has now recovered ocean sediment and hard rock cores from 581 sites. Approximately 70,000 samples concerning the stratigraphy of these cores have been collected. In order to make these data more usable, we have attempted to create a meaningful and versatile paleontologic data base. The data base includes all macro- and micro fossils described in the Deep Sea Drilling Tertiary and Quaternary material.

The reasons for creating a paleontologic data base were three-fold:

1. Make the vast amount of DSDP data readily available to the scientific community.
2. Allow paleontologic data to be stratigraphically comparable and compatible with other DSDP files.
3. Allow computer manipulation of data in order to create range charts, maps, and other compilations.

THE DATA BASE

Background

The data base includes mega- and microfossils from both the plant and animal kingdoms (Fig. 1). We have also included trace fossils such as burrows and fecal pellets. The importance of all these fossils to the paleontologist is the fact that they occupy distinct periods in geologic time and therefore provide information about the age of the sediment as well as the environment in which it was deposited.

Data Source

In trying to create the data base we had to decide what would be the most appropriate source for our information. Although shipboard data is available immediately after a two month cruise is completed, it is not really refined. Only stratigraphically important species are included and because of time constraints only a relatively few samples are described. In fact, the shipboard paleontologic data does not reflect the complete final paleontologic picture that appears in the Initial Report series. The data from the DSDP Initial Reports represents fossil information which has been thoroughly studied. The final result is a reasonably complete study of a particular fossil group. Also, shore based paleontologists who prepare reports on fossil groups not described in the shipboard data will have their fossil descriptions included.

Method of Coding

After having decided on the fossils we would include, the next step was to determine how we could handle the data so that errors would be kept to a minimum and the data could be most easily accessed.

There is a definite problem involved in attempting to use fossil names as they appear in a chart or text. The spelling of a fossil name often varies: either as a result of investigative or editorial error; the names can be extraordinarily long thereby creating unnecessarily long computer records; and the length of fossil names vary so that using the names as they appear would preclude the use of a fixed field format. A code was devised that still related to the original fossil name, so a quick glance at the code would provide the user with some basic information.

Anatomy of The Code

An example of a typical code such as FGLOD0070 (Globigerinoids bolli) will be discussed here. The first letter is the fossil group designator. This informs the user to which major fossil group the species belongs. For example, F (Foraminifer), N (Nannofossil), R (Radiolaria), etc. Letters 2-5 represent the first four letters of the genus. In cases where different genera in the same fossil group begin with the same letters (i.e. Globotruncana and Globigerinoids in the planktonic foraminifers), the first three letters plus an arbitrary fourth letter is used. The four numbers represent the alphabetic position (if possible) of the species in the genus. The Q after a species name encompasses situations of questionable fossil identification.

The dictionary (Fig. 2) consists of the fossil name and its corresponding code name. It was originally started with a basic list gleaned from a selected number of the Initial Reports. This list was supplemented as new species were encountered. In using the dictionary and the code system we can be assured that a fossil name will be spelled in a consistent manner and should a mispelling be found, the correction need only be performed once. The dictionary is used by the coder to translate the fossil name to code and by the computer to translate the code name back to its original form.

Data Entry

The paleo data is encoded by student scanners. One of the following two methods is employed:

1. The data is hand encoded on to standard encoding sheets and then keypunched; or
2. The data is entered on-line through a remote terminal which allows a single page of memory to be transmitted to disk file at one time. This is certainly a more efficient method of entry, but at present we have limited access to the type of terminal which permits this kind of data entry.

Content and Construction of The File

There are two types of records comprising the raw data. The first (lead) record contains the standard Deep Sea Drilling label and bibliographic information. The second record repeats the label, which is then followed by up to four codes per card. The second card is repeated as necessary to complete the sample description.

Description of Card 1 (Figures 3 a and b)

Columns 1-19. This comprises the standard DSDP label. This label appears in the same format on all our data, thereby making cross-referencing of files possible.

Columns 20-21. Card sequence number.

Columns 23-52. Investigator(s) name. This feature permits a data user to identify the original describer of the fossil data.

Columns 53-57. Publication data of the Initial Report. This sets the data in a time frame so that a user is aware of the state of the art at the time the sample was studied. This is important in helping to clarify the original describer's definition of the species. In the case of newly described species, priority of publication determines the true fossil name should two paleontologists describe the same species using different names.

Columns 59-60. Volume number. Occasionally the data described from a particular leg is not published in the volume associated with that leg. The volume is included so that the source material may be referred to if necessary.

Column 62. Group identifier. A single letter that identifies 1 of the 26 possible fossil groups. Only one fossil group per sample is described in a single card set.

Column 63. Fossil abundance. This can be defined relatively (dominant, abundant, common, etc.) or as a numerical percentage. There is no consistency among investigators.

Columns 65-66. Chemical preservation. This refers to overgrowth and solution and is almost always used in reference to calcareous nannofossils. This data is not often provided.

Column 67. Mechanical preservation. This is a relative feature and is usually described as good (G), poor (P), and moderate (M). Unfortunately, group abundance and preservation is not always provided. Samples missing this information are not as useful as those which include it.

Columns 69-75. Age of sediment. Numerical code identifying the age of the sediment. Age codes are consistent in all DSDP data. The age is described at the epoch level where available.

Columns 76-79. Page number. This is the page number from which the information was coded. This, taken with the volume number provides a quick, accurate inventory method to ascertain whether or not a specific data set had been coded.

Description of Card 2 and all subsequent cards for the same sample

Columns 23-36, 37-50, 51-64, and 65-78. Fossil code name, individual abundance and preservation. The system allows for four fossils per card.

RESULTS

To date, 44 legs of paleontologic data from 392 sites have been processed, edited, and are now available. This represents all the pre-international phase of DSDP. We are now proceeding with Legs 54-66 in order to complete all the available data for the Pacific. This represents an integral unit for which we have already received requests.

Since we have started distributing the paleo data, we have provided various investigators with:

a. range charts which duplicate chart or transformed text data (Fig. 4);

b. created charts showing only species queried by the investigator;

c. combined selected paleontologic data with other information such as carbonate percentages or absolute depth of a sample;

d. performed searches for a particular species occurrence qualifying information for age, preservation of sample, abundance, etc.

The dictionary now contains over 10,000 elements. The data included approximately 34,000 sample descriptions. The data and the dictionary are both available from DSDP on magnetic tape. The dictionary is also available on microfiche.

FOSSIL GROUPS INCLUDED
IN THE DSDP DATA BASE

Algae	G
Ammonites	W
Aptychi	A
Archaeomonads	J
Benthic Foraminifers	B
Bryozoans	Z
Calcispheres	K
Calpionellids	L
Coproliths	U
Crinoid	E
Diatom	D
Dinoflagellates	C
Ebridians	Q
Fish Debris (including teeth, bones, etc.)	Y
Mics. Fossils	I
Molluscs	M
Nannofossils	N
Ostracodes	O
Phytolitharia	X
Planktonic Foraminifers	F
Pollen & Spores	P
Pteropod	H
Radiolaria	R
Rhynchollites	V
Silicoflagellates	S
Trace Fossils	T

GLOBOROTALIA TRUNCATULINOIDES TRUNCATULINOIDES	-FGLOA0550
GLOBOROTALIA TRUNCOROTALOIDES TOPILENSIS	-FGLOA0552
GLOBOROTALIA TUMIDA (Q)	-FGLOA0553
GLOBOROTALIA TUMIDA	-FGLOA0554
GLOBOROTALIA TUMIDA SUBSP.	-FGLOA0555
GLOBOROTALIA TUMIDA FLEXUOSA	-FGLOA0556
GLOBOROTALIA TUMIDA LATA	-FGLOA0558
GLOBOROTALIA TUMIDA PLESIOTUMIDA	-FGLOA0560
GLOBOROTALIA TUMIDA PLESIOTUMIDA (Q)	-FGLOA0561
GLOBOROTALIA TUMIDA TUMIDA	-FGLOA0562
GLOBOROTALIA TUMIDA TUMIDA (Q)	-FGLOA0563
GLOBOROTALIA UNCINATA	-FGLOA0564
GLOBOROTALIA UNGULATA	-FGLOA0566
GLOBOROTALIA UNGULATA (Q)	-FGLOA0567
GLOBOROTALIA VARIANTA	-FGLOA0568
GLOBOROTALIA VENTRIOSA	-FGLOA0569
GLOBOROTALIA VELASCOENSIS	-FGLOA0570
GLOBOROTALIA VELASCOENSIS (Q)	-FGLOA0571
GLOBOROTALIA WARTSTEINENSIS	-FGLOA0572
GLOBOROTALIA VENEZUELANA	-FGLOA0573
GLOBOROTALIA WHITEI	-FGLOA0574
GLOBOROTALIA WILCOXENSIS	-FGLOA0576
GLOBOROTALIA WILSONI	-FGLOA0578
GLOBOROTALIA ZEALANDICA (Q)	-FGLOA0579
GLOBOROTALIA ZEALANDICA	-FGLOA0580
GLOBOROTALIA ZEALANDICA GROUP	-FGLOA0581
GLOBOROTALIA ZEALANDICA INCOGNITA	-FGLOA0582
GLOBANOMALINA CHAPMANI	-FGLOB0010
GLOBANOMALINA LACCADIVENSIS	-FGLOB0020
GLOBANOMALINA MICRA	-FGLOB0030
GLOBANOMALINA MICRA (Q)	-FGLOB0031
GLOBANOMALINA PRAEPUMILIO	-FGLOB0040
GLOBANOMALINA PSEUDOMENARDII	-FGLOB0050
GLOBANOMALINA PSEUDOSCITULA	-FGLOB0060
GLOBANOMALINA PUSILLA LAEVIGATA	-FGLOB0070
GLOBANOMALINA PUSILLA PUSILLA	-FGLOB0080
GLOBANOMALINA WILCOXENSIS	-FGLOB0090
GLOBANOMALINA WILCOXENSIS (Q)	-FGLOB0100
GLOBOCONUSA CONUSA	-FGLOC0010
GLOBOCONUSA DAUBJERGENSIS	-FGLOC0020
GLOBOCONUSA EUGUBINA	-FGLOC0030
GLOBOCONUSA PSEUDOBULLOIDES	-FGLOC0040
GLOBIGERINOIDES ADRIATICUS	-FGLOD0010
GLOBIGERINOIDES ADRIATICUS (Q)	-FGLOD0012
GLOBIGERINOIDES AGUASAYENSIS	-FGLOD0020
GLOBIGERINOIDES ALTIAPERTURUS	-FGLOD0030
GLOBIGERINOIDES ALTIAPERTURUS (Q)	-FGLOD0031
GLOBIGERINOIDES AMPLUS	-FGLOD0040
GLOBIGERINOIDES APERTASUTURALIS	-FGLOD0050
GLOBIGERINOIDES BISPHERICUS	-FGLOD0060

Col. #	# Cols.	Field Title	Example	Possible Entries	Comment
1-2	2	Leg	32	Any 1 or 2 digit number	Always numerical, right justified
3-5	3	Site	303	Any 1, 2, or 3 digit number	ditto
6	1	Hole	A, B, etc.	Any letter	Always alphabetic
7-9	3	Core #	85	Any 1, 2, or 3 digit number	Always numerical, right justified
10-11	2	Section	1, 2, etc.	0, 1, 2, 3, 4, 5, 6, CC, CB	Numerical or alphabetic, right justified
12-15	4	Interval (Top)	103.5	Any number 2-4 digits (0.0-999.9)	Decimal point implied between columns 14 and 15
16-19	4	Interval (Bottom)	104.5	ditto	ditto
20-21	2	Card #	1	1-99	Numerical, right justified
22	1	Space			
23-52	29	Authors' last name and initials	Martini, E. J.		Alphabetic, left justified
53-57	5	Publication date	12/76		Right justified
58	1	Space			
59-60	2	Volume number	32	Any 1 or 2 digit number	Right justified
61	1	Space			
62	1	Group identifier	N	Any letter	Always alphabetic

63	1	Fossil abundance	A	D, A, C, R, P	Always alphabetic
64	1	Space			
65	1	Overgrowth	1	0, 1, 2, 3	Represents amount of crystal overgrowth
66	1	Solution	1	1, 2, 3, 4	Amount of dissolution
67	1	Mechanical preservation	G	G, M, P	Mechanical abrasion
68	1	Space			
69-75	7	Age	1033330	Any 7 digit number between 0000000-7000000	Code number identifying geologic age. These numbers are consistent in all DSDP data
76-79	4	Page number	839	Any number from 1-4 digits	Right justified. Used to quickly identify data source

Card 2 and all subsequent cards as needed.

1-22		Standard label as outlined on Card 1			
23-36 37-50 51-64 65-78	14	Fossil name	FORBU0010 C/G or NFASC0010 80/-1	Five letters followed by 4 numbers. This is a code name for each fossil in the DSDP volumes. The first letter defines the fossil group, the next four letters define the genus and the 4 numbers represent the species. The abundance can be a letter (D, A, C, R, P) or a numerical percentage. The preservation can be a letter (G, M, P) or a number (-1, -2, -3, 0, 1, 2, 3)	Dividing slashes are placed in Column 34, 48, 62, and 76. The abundance and preservation are right justified on either side of the slash.

LEG 32

AUTHOR: VINCENT, E.
REFERENCE: VOLUME 32, PAGE: 773

BUG GROUP: PLANKTONIC FORAMS

305

Core	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4	4	4	5	5	5	5	5	5	6	6	6	6	6	6	
Section	2	3	3	4	5	6	CC	1	2	3	CC	1	2	3	1	2	3	CC	1	2	3	4	5	CC	1	2	3	4	5	5	
Depth	2.51	3.41	4.15	5.09	6.31	6.21	5.10	6.51	10.76	12.37	12.60	18.09	15.65	21.36	27.87	29.36	30.74	31.06	36.76	38.24	39.74	41.24	42.74	43.10	46.30	47.84	49.38	50.86	51.31	52.11	
Age	MGUAT		PGUAT		PGUAT		MGUAT		PGUAT		MQUAT	NEOG		NECG		NEOG		NECG		NECG		MIC		MIO		PIC		LMIO		MMIC	
FCATAC030-																			R					R						C	CATAPSYDRAX DISSIMILIS
FGLOA0105-																C		C	R	C		P									GLOBOROTALIA CONOIDEA S. L.
FGLOA0118-				F	F	C	R	R	F	R	R	R				P	C		R												GLOBOROTALIA CRASSAFORMIS
FGLOA0222-	R	R	R	P																											GLOBOROTALIA HIRSUTA
FGLOA0246-	A	A	A	C	A	A	A	A	A	A	C	C	C	C	C																GLOBOROTALIA INFLATA
FGLOA0268-																			R				R	R							GLOBOROTALIA LIMBATA
FGLOA0272-																					P										GLOBOROTALIA MARGARITAE
FGLOA0298-		C	R	C		R	R		R	R	R												R	P							GLOBOROTALIA MENARDII
FGLOA0310-																									R	P					GLOBOROTALIA MEROTUMIDA
FGLOA0386-																					P							R			GLOBOROTALIA PERIPHERORONDA
FGLOA0404-																								R							GLOBOROTALIA PLESIOTUMIDA
FGLOA0454-												R	R	R	R				C												GLOBOROTALIA PUNCTICULATA
FGLOA0486-	R	F	F	P		P					P	P	F		P				P												GLOBOROTALIA SCITULA
FGLOA0506-																P		F													GLOBOROTALIA SPHERICOMIOZEA
FGLOA0526-						P			F																						GLOBOROTALIA TOSAENSIS
FGLOA0544-	P	F	R	R	R	P	R	F	F	P	P																				GLOBOROTALIA TRUNCATULINOIDES
FGLOA0554-	P			F		R	R		F	R	P	R	R	F	R		C	R	P	P	R										GLOBOROTALIA TUMIDA
FGLOC0090-			F								P	R					R														GLOBIGERINOIDES CONGLOBATUS

NATIONAL WATER WELL ASSOCIATION'S GROUND WATER LIBRARY IS NOW AS CLOSE AS YOUR TELEPHONE

Jay H. Lehr, Ph.D.

Valerie J. Orr

National Water Well Association
500 West Wilson Bridge Road, Worthington, Ohio 43085

Abstract: The National Water Well Association's Research Institute, Education Foundation and Publishing Company have long been considered information central for the world's community of hydrogeologists. Under contract to the U.S. Environmental Protection Agency's National Center for Ground Water Research, NWWA's Library has been transformed into a sophisticated, computerized data base which to date includes 18,000 literary citations indexed in 22 fields of information including Accession Number, Indexer's initials, Date Entered Into Data Base, Author, Title, Source, International Standard Serial Number, International Standard Book Number, Publisher, Non-US Geographic Area, State Abbreviation, County Name, Aquifer Region, Publication Date, Call Number, Language, Holding Library, Contents Notes, Chemical Constituents, Descriptors, Biological Factors, Author Affiliation.

The Thesaurus of key words contains 700 terms developed by a panel of hydrogeologists. Biological and chemical terms are searched freely.

The NWWA Library is now stored on Battelle Memorial Institute's Columbus Laboratory computers where the library search program "Basis" was developed.

Research groups, libraries, universities, private consultants and industrial firms can become regular users of the Library for a one time fee of $100 which includes the assignment of an access code, a user manual and personnel training. User fees for connect time are billed bi-monthly. A competent searcher can complete a search for under $20. Full detailed printouts describing desired literature is printed off line and sent via mail to reduce main computer connect time and costs.

The NWWA Library and Research Staff indexes over 100 periodicals on a regular basis and is continuously expanding its already mammoth collection with esoteric state and international publications.

The National Water Well Association is a Ground Water Research Institute, Education Foundation, and Publishing Company with a staff of 55. NWWA is the center of competence for the Ground Water Industry and is a combined professional society for hydrogeologists and trade association for water well drillers.

The National Water Well Association Library was initially conceived to support NWWA's Research Facility, but it has rapidly evolved into a public library of ground water information.

In 1979, the National Water Well Association received a three year grant from the U.S. Environmental Protection Agency to establish a National Ground Water Library and Information Center which would be accessible to scientists, government agencies, industry, and the public.

In 1981, the National Ground Water Information Center, operated by NWWA became an official part of the National Center for Ground Water Research. The National Center for Ground Water Research is a consortium of Oklahoma, Oklahoma State and Rice Universities which is overseen by the U.S. EPA's ground water research laboratory at Ada, Oklahoma.

With the assistance of dozens of members of the scientific community, the National Water Well Association has successfully established the world's largest catalogued and retrievable collection of ground water literature.

The collection contains approximately 10,000 volumes which are currently being converted from an in-house system of cataloguing to the Library of Congress Classification System using OCLC. The collection contains state publications, technical reports, government documents, maps, reference books, and other ground water quality related literature. In addition, the center maintains over 120 periodical subscriptions.

In January 1982, we made available to the public, our computerized retrieval system that searches our extensive bibliographic data base of references in the areas of hydrogeology and water well technology.

In order to describe the world's ground water literature, we have developed a thesaurus of nearly 700 hydrogeologic terms. Three years of effort with the assistance of some of the nation's leading hydrogeologists have gone into developing the thesaurus.

The National Ground Water Information Center (NGWIC) under contract with Battelle Columbus Laboratories is using BASIS, the most sophisticated computer software available. Basis software permits the user to: perform proximity searching; search on numeric ranges; scan the records for terms; use prefix, suffix and infix searching; use the full compliment of Boolean logic; and save search requests.

Currently there are 18,000 records in the data base which are indexed by 22 possible fields of information. The fields that a record may contain are:

Accession Number

Indexer's Initials

Date Entered into Data Base

Author

Title

Source

International Standard Series Number (ISSN)

International Standard Book Number (ISBN)

Publisher

Non-U.S. Geographical Area

State Abbreviation

County Name

Aquifer region

Publication Date

Call Number

Language

Holding Library

Contents Notes

Chemical Constituents

Biological Factors

Author's Affiliate Organization

More than 700 Key Hydrogeological Terms

Most of these fields are self explanatory but some are rather unique. It is possible to limit searching to foreign countries, particular states, counties or even specific aquifer regions.

When searching using descriptors, they must appear exactly as they do in the thesaurus. Chemicals and biological factors, on the other hand, may be searched freely. They appear in the references exactly as they do in the literature. As a result of this freedom it is suggested that variations in formula, name and spelling be taken into consideration (For example: H_2S, HYDROGEN SULFIDE and HYDROGEN SULPHIDE all appear in the chemical field).

Some of the most commonly used commands in searching are FIND, DISPLAY, and PRINT, but you may SCAN fields, LOOK for terms or BROWSE the thesaurus on-line. Once you have created a document set you may choose to display a full or partial record, or to save on-line computer time you may have the citations printed off-line on a high speed printer and mailed to you from Battelle. An example of a record appears below.

ACCESSION NUMBER	811000276
DATE ENTERED INTO DATA BASE	810716
AUTHOR	PETTYJOHN W A;DUNLAP W J;COSBY R; KEELEY J W
TITLE	SAMPLING GROUND WATER FOR ORGANIC CONTAMINANTS
SOURCE	GROUND WATER;V19 N2;P180-189
INT'L. STANDARD SERIAL NUMBER	0017-467X
STATE ABBREVIATION	KY;CA;NY
PUBLICATION DATE	MA-1981
LANGUAGE	ENGLISH
HOLDING LIBRARY	NWWA
CONTENTS NOTES	TABLES;FIGURES;REFERENCES
CHEMICAL CONSTITUENTS	ALDICARB;TRICHLOROETHYLENE;DBCP
DESCRIPTORS	POLLUTION;SAMPLING;MONITORING WELLS;EQUIPMENT
AFFILIATE ORGANIZATION	OK STATE UNIV;ROBERT S. KERR ENVIRONMENTAL RESEARCH LABORATORY

The data base contains references to journal articles, technical reports, proceedings of symposia from all over the world, state publications, international reports and current ground water research. We have also indexed all ground water related abstracts in Selected Water Resources Abstracts.

Our entire technical staff indexes over 100 periodicals on a regular basis while outside indexers from various parts of the world index somewhat esoteric materials not readily accessible to us. The data base is updated every two weeks adding approximately 500-1,000 records per update. It is our ultimate goal to include in the data base references to every article written about ground water since the beginning of time.

The data base is accessible from any where in the world using a computer terminal with a modem and standard telephone lines. You may dial the data base direct or use TYMNET.

The data base has already proven to be of great interest to government agencies, industry, consultants and those in the academic community concerned with ground water quality and development.

Research groups, libraries, universities, private consultants and individual firms may subscribe to the data base for a one-time $100 fee. For this fee, the user receives a personal user name and passsword and a complete user's manual. After the initial fee, subscribers are only billed for computer time and off-line prints at rates of $75.00 per hour and $1.50 per 500 lines respectively.

Scientists throughout the country are rapidly learning that the NGWIC Data Base is among the most proficient systems available for literature research. It is clearly in a class by itself in the field of ground water science.

COASTAL INFORMATION SYSTEMS

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Abstract: While developing a coastal classification system, a research team at the University of Virginia discovered that about 90% of published information dealt with only 5-10% of the world's coasts, and that only a very small fraction of that data was known beyond the confines of the original research team. As a result, we developed the Coastal Environmental Reference Service (CERS), a computer-based information system designed to catalog data about coastal research programs. Three modes are available: geophysical research programs, modelling programs, and an analog, or data transfer, capability. CERS delivers details of research programs and the means to access data collections.

Extending the scope of our program, we have now developed the Coastal Erosion Information System (CEIS). CEIS contains primary-source, shoreline rate of change data and calculated statistics for the United States, including the Great Lakes, Delaware and Chesapeake Bays, Alaska, and Hawaii. Currently catalogued on a 3-minute grid, the nested design permits updating to grids as fine as 1 m, as appropriate data become available. The system is being expanded to include land use, storm, and risk evaluation information.

(Paper not available for publication.)

AUTOMATED MAP INDEXING

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Abstract: To facilitate the creation and distribution of its Geologic Map Indexes, the U.S. Geological Survey embarked on a project to utilize automation and computer technology. One of the goals was to establish a data base from which information could be extracted to compose the indexes. An automated system was designed and installed. The system consists of skilled people, dedicated hardware, special software, communications to a general-purpose computer, documentation, and, of course, the data. This system, the Geoindex, now generates the Geologic Map Indexes of the U.S. Geological Survey.

Introduction

In the 1940's, Leona Boardman began a compilation of State indexes to geologic mapping which were published by the U.S. Geological Survey (USGS). From the 1960's to the present, these State indexes have been continued by Willard L. McIntosh and Margaret Eister of the USGS. The original indexes were base maps having colored and numbered outlines showing the areas for which published geologic maps were available. A similarly numbered list of bibliographic references ranged down the side of the map.

Until 1969, the geologic index maps showed all geologic map coverage, but by then, the coverage had increased so much that a legible index map was virtually impossible to produce. Since then, if a map is to be included on the index map, it must be equal or superior in quality and comprehensiveness to the latest State geologic map.

Coverage has continued to increase, and computer-assisted techniques have been adopted to facilitate the publication process.

The System

This computer-assisted system, the Geoindex, includes both a data base and a data-base-management system. Its purpose is to create an index of geologic maps as efficiently as possible.

The information shown on a geologic map index consists of the identifiable area covered by a published geologic map and a bibliographic reference that further defines the map. The two types of data in the computerized index are map outlines and bibliographic text. All data are checked for accuracy and completeness before data entry begins.

Text Data

The bibliographic references constitute the text, or, in computer-database terminology, the attribute data. Table 1 lists the data items and their descriptions.

Table 1

Computer name tag	Description of data item or attribute
id	identifying number for bibliographic reference
state	name of State
author	author or authors of geologic map
year	year of publication of geologic map
title	title of geologic map
county	county or region covered by geologic map
publish	publisher of map
series	title of publication series
emphasi	type of geology emphasized on map--surficial, economic, stratigraphic, oil, gas, coal, metal, etc.

area	area covered by map
aunit	dimension for area, generally square kilometers
nlat	extreme north latitude of map boundary
slat	extreme south latitude of map boundary
wlong	extreme west lontitude of map boundary
elong	extreme east longitude of map boundary
clat	latitude of center point of map
clong	longitude of center point of map
omaps	other maps not included as outlines, i.e., title
avail	depositories where maps are available
base	base for geologic map--USGS topographic, DMA-TC topographic, photomosaic, shaded relief, etc.
geology	only geologic maps are now included in the indexes
plate	plate, or map, or sheet identification
idstate	FIPS numeric State code
scale	scale of geologic map - 1:24,000, 1:250,000, etc.
idsub	secondary identification number for geologic map
ibound	identification number of map outline; this ties together text and graphic, (x,y) coordinate files
ispan	secondary number of boundary outline; further ties text to graphic file
othermap -	phrase used in bibliography

The bibliographic data are recorded by key entry on word-processor computer terminals in an offline mode. The data are transmitted to a mainframe general purpose computer and are stored for subsequent processing in two very different forms. First, the software creates a special version of the file and transmits it back to the word processor, where it is printed in its bibliographic form as camera-ready copy (Figure 1). The original text file, still stored on the general-purpose computer, will be combined with the map data file.

Map Data

The map data are converted to computer files by manually tracing the outlines on a dedicated digitizing system. This digitizing system is configured as follows: backlighted digitizer (drafting table), vector plotter, minicomputer with two tape drives and two disk units, card reader, card punch, and a raster plotter.

For each geologic map that appears on the index, the computerized map data contain an identifying code for the map, the Federal Information Processing Standards (FIPS) code for the State, the number of points in the outline, and the string of Cartesian coordinates that delineates the map outline. Cartesian coordinates (x,y) are transformed into latitude and longitude by software that uses the necessary input variables of map projection, scale, and control points with common geographic and Cartesian coordinates. This file of latitude and longitude coordinates is saved and constitutes a second map data-file.

The map data in Cartesian coordinates are written on magnetic tape and are sent to the general-purpose computer. The software stores the original file, reformats a copy of the data, and then creates plot files on magnetic tape. A matrix plotter reads the tape with the plot files and creates the index maps. To provide good legibility, the area covered by each geologic map is shaded in a different pattern. These map plots are camera-ready copy for photographic reproduction (Figure 2).

1. Swadley, W.C., 1972, Geologic map of parts of the Lawrenceburg, Aurora, and Hooven quadrangles, Boone County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-989. 1:24,000.

2. Gibbons, A.B., 1972, Geologic map of parts of the Burlington and Addyston quadrangles, Boone County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1025. 1:24,000.

3. Luft, S.J., 1971, Geologic map of part of the Covington quadrangle, northern Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-955. 1:24,000.

4. Gibbons, A.B., 1973, Geologic map of parts of Newport and Withamsville quadrangles, Campbell and Kenton Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1072. 1:24,000.

5. Swadley, W.C., 1971, Geologic map of part of the Rising Sun quadrangle, Boone County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-929. 1:24,000.

6. Swadley, W.C., 1969, Geologic map of the Union quadrangle, Boone County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-779. 1:24,000.

7. Luft, S.J., 1969, Geologic map of the Independence quadrangle, Kenton and Boone Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-785. 1:24,000.

8. Gibbons, A.B., 1971, Geologic map of the Alexandria quadrangle, Campbell and Kenton Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-926. 1:24,000.

9. Gibbons, A.B., Kohut, J.J., and Weiss, M.P., 1975, Geologic map of the New Richmond quadrangle, Kentucky-Ohio: U.S. Geol. Survey Geol. Quad. Map GQ-1228. 1:24,000.

10. Kohut, J.J., Weiss, M.P., and Luft, S.J., 1973, Geologic map of the Laurel quadrangle, Ohio-Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1075. 1:24,000.

11. Swadley, W.C., 1969, Geologic map of parts of the Patriot and Florence quadrangles, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-846. 1:24,000.

12. Swadley, W.C., 1969, Geologic map of the Verona quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-819. 1:24,000.

13. Luft, S.J., 1973, Geologic map of the Walton quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1080. 1:24,000.

14. Luft, S.J., 1970, Geologic map of the De Mossville quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-862. 1:24,000.

15. Luft, S.J., 1972, Geologic map of the Butler quadrangle, Pendleton and Campbell Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-982. 1:24,000.

16. Luft, S.J., Osborne, R.H., and Weiss, M.P., 1973, Geologic map of the Moscow quadrangle, Ohio-Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1069. 1:24,000.

17. Osborne, R.H., Weiss, M.P., and Outerbridge, W.F., 1973, Geologic map of the Felicity quadrangle, Ohio-Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1063. 1:24,000.

18. Outerbridge, W.F., Weiss, M.P., and Osborne, R.H., 1973, Geologic map of the Higginsport quadrangle, Ohio-Kentucky, and part of the Russellville quadrangle, Mason County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1065. 1:24,000.

19. Palmquist, W.N., Jr., and Hall, F.R., 1960, Geologic map of Boone, Campbell, Grant, Kenton, and Pendleton Counties, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA-15. Map 1, 1:125,000.

20. Hall, F.R., and Palmquist, W.N., Jr., 1960, Geologic map of Carroll, Gallatin, Henry, Owen, and Trimble Counties, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA-23. Map 1, 1:125,000.

21. Swadley, W.C., 1976, Geologic map of part of the Carrollton quadrangle, Carroll and Trimble Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1281. 1:24,000.

22. Swadley, W.C., 1973, Geologic map of parts of the Vevay South and Vevay North quadrangles, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1123. 1:24,000.

23. Swadley, W.C., 1973, Geologic map of the Sanders quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-1095. 1:24,000.

Figure 1. Part of a sheet of bibliographic references taken from the published Kentucky index map. (U.S. Geological Survey, 1978).

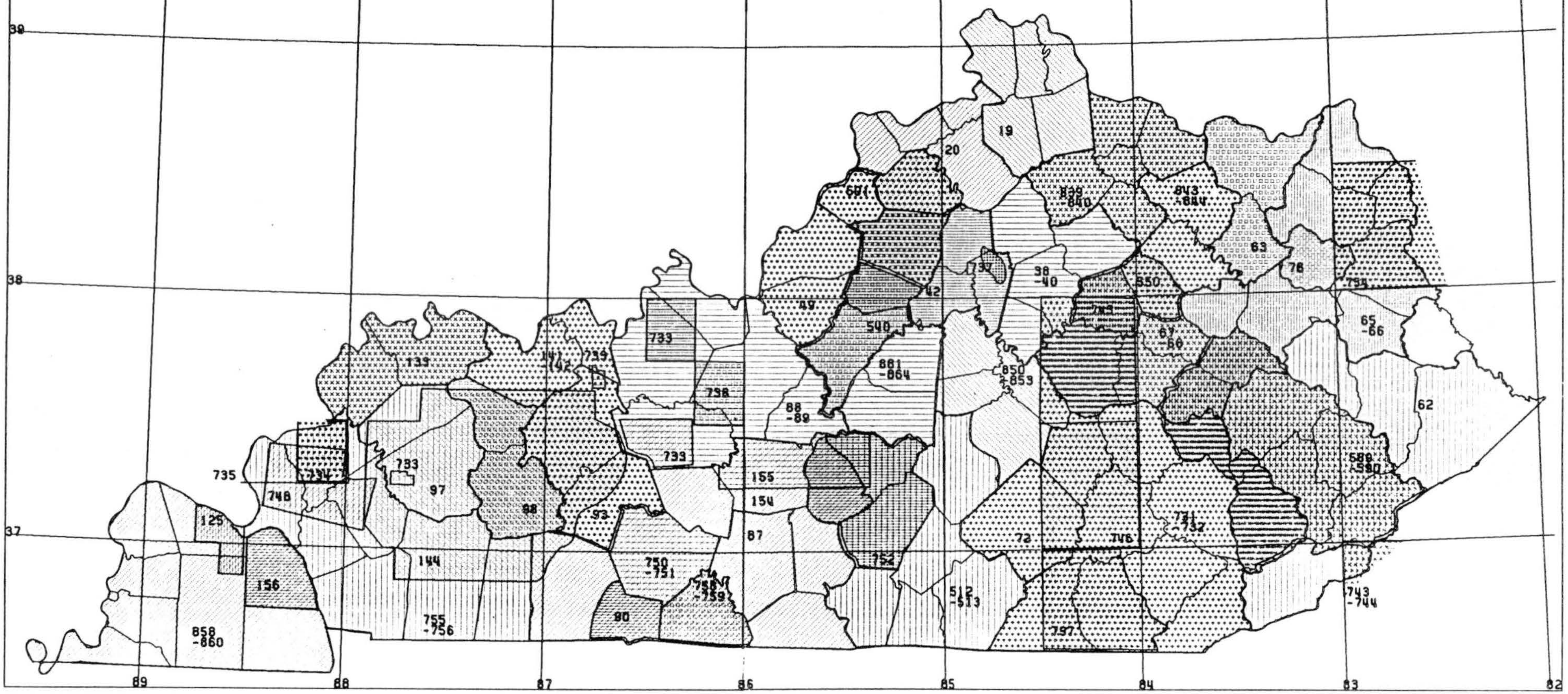

Figure 2. Sheet from the published Kentucky index, showing geologic maps whose scales range from smaller than 1:63,360 through and including 1:250,000.

Geologic Map Index

One of the more noticeable results of computer automation is the new format for a printed index. The old index was one large State map averaging 30 x 45 inches. Now, each published index is a streamlined 18 x 11 inches, easily folded to fit most file cabinets. When opened, each index is large enough to provide good legibility for both maps and bibliographic references.

One geologic map index still covers one State except for small Northeastern States, where one geologic map index can cover two or three States.

Most of the geologic map indexes contain three map plots grouped according to the scale of the published geologic map. One map plot shows maps published at scales of 1:24,000 and larger. Another plot shows maps at scales smaller than 1:24,000, through and including 1:63,360. The third map plot contains maps at scales smaller than 1:63,360, through and including 1:250,000. Some States having a great many mineral occurrences require two map plots for each scale range. The number printed on each map outline corresponds to its identically numbered bibliographic reference.

The most attractive result of computer automation, as far as the public is concerned, is that now the USGS distributes the geologic map indexes without cost.

Storage and Retrieval System

The original bibliographic and map files stored on the general-purpose computer provide the data for the interactive storage and retrieval system. This system is The Geologic Retrieval and Synopsis Program (GRASP) (Bowen and Botbol, 1975) written and developed within the USGS. GRASP creates a relational data file for storage and retrieval, so the Geoindex contains a relational data base with inverted fields. GRASP accesses all data items listed in Table 1 in any desired combination, using the Boolean operators "and," "or," and "not." Specific data can be selected, listed, and plotted to make a personalized index. For example, an index could be created for all the mapping done by one or more geologists. Information from several States can be combined for regional studies.

Status of the System

The development and implementation of the automated system was completed during the latter part of 1979. Figure 3 shows the status at that time, and Figure 4 shows the status as of October 1, 1982. "Geoindex," (Fulton and Johnson, 1982) USGS Professional Paper 1172 contains a comprehensive description of the entire system.

References

Bowen, R.W., and Botbol, J.M., 1975, The Geologic Retrieval and Synopsis Program (GRASP): U.S. Geological Survey Professional Paper 966, 87 p.

Fulton, P.A., and Johnson, H., 1982, Geoindex: U.S. Geological Survey Professional Paper 1172, 298 p.

McIntosh, W. L., and Eister, M.F., 1978, Geologic map index of Kentucky: Reston, Va., U.S. Geological Survey, [19] p.

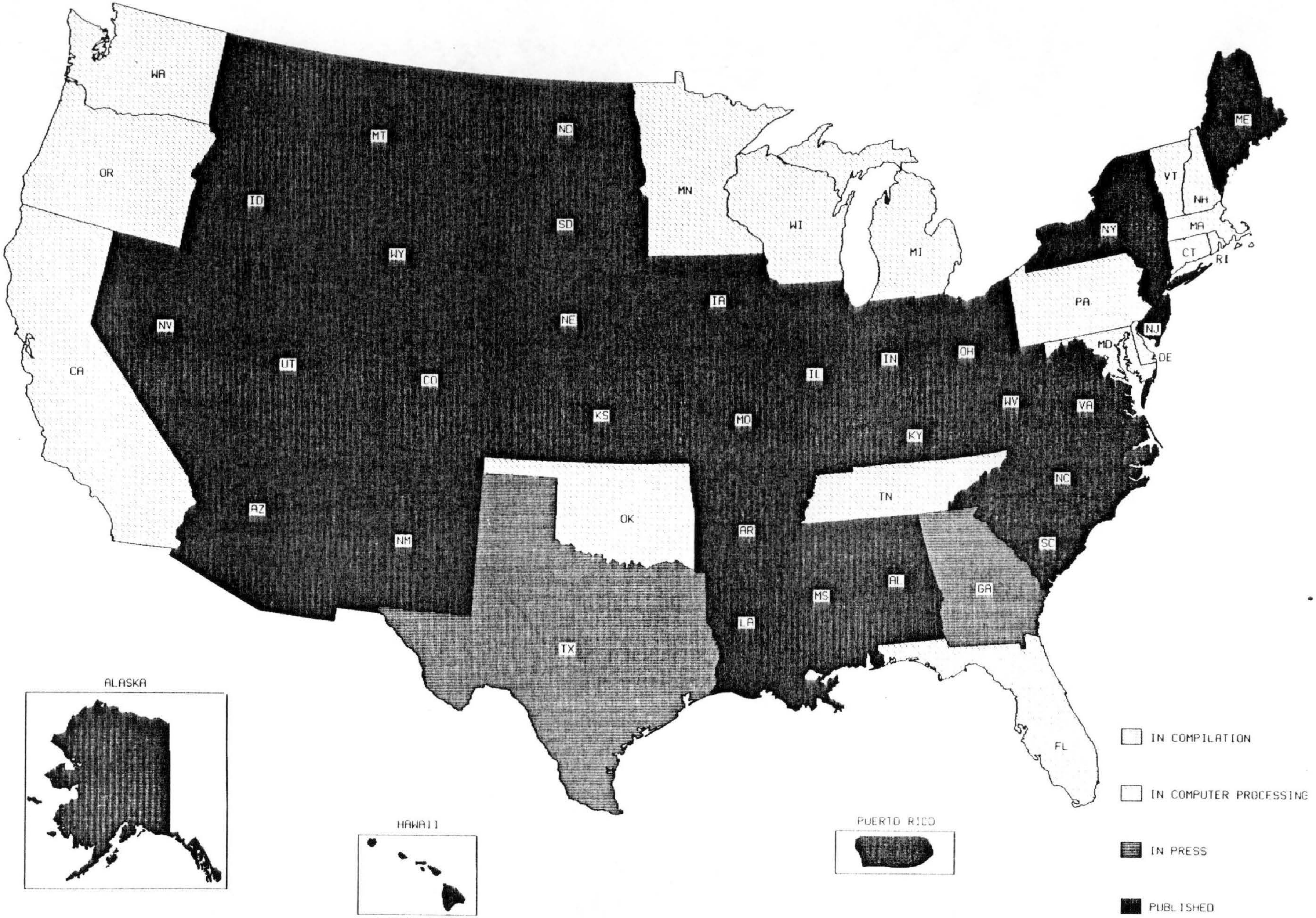

Figure 3. Status map for the Geoindex October 1, 1979.

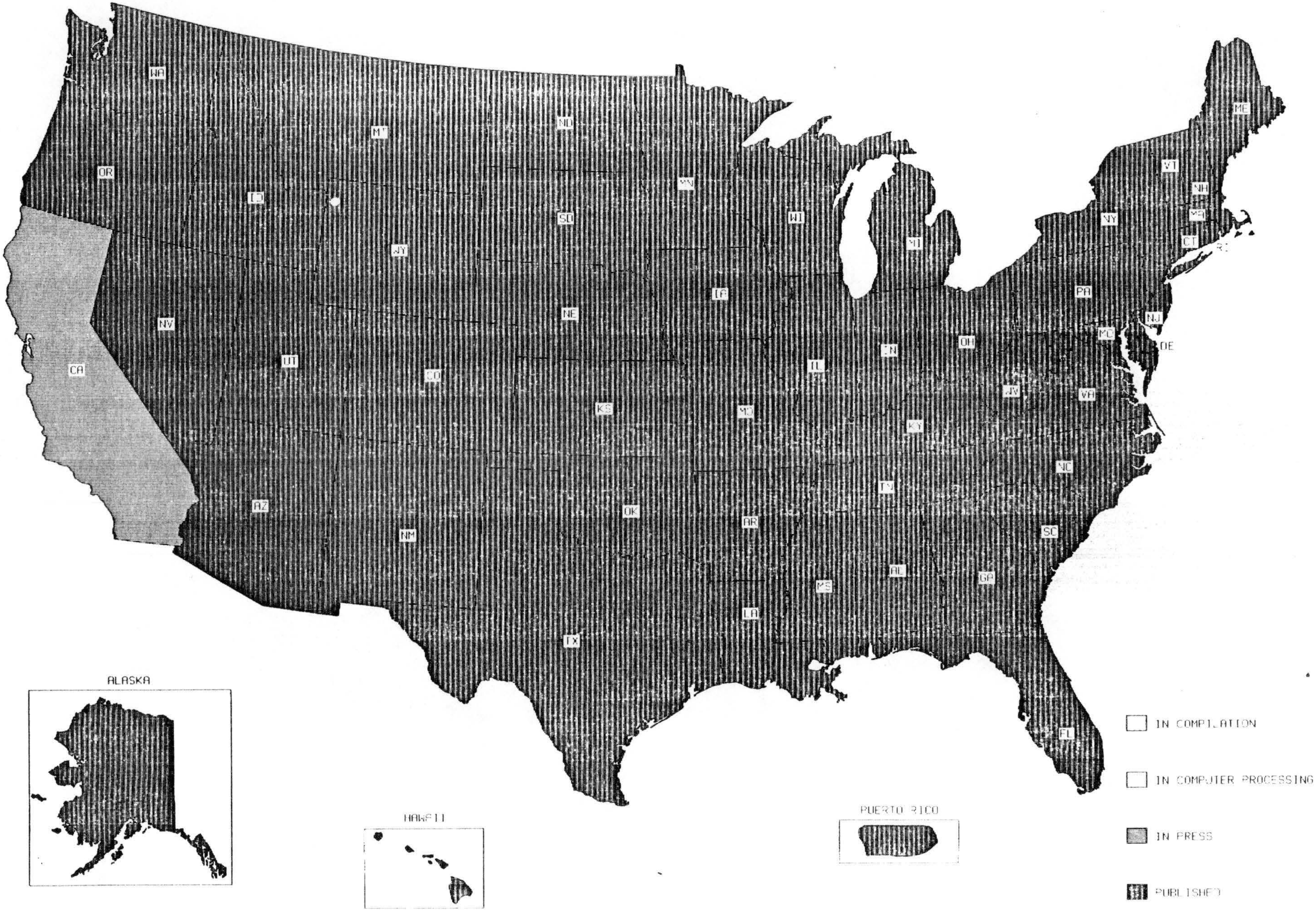

Figure 4. Status map for the Geoindex October 1, 1982.

A COMPUTER APPROACH TO ORGANIZATION OF A MEDIUM-SIZED MAP COLLECTION IN AN ACADEMIC LIBRARY

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Abstract: In July 1979, a batch computer system was designed to identify and locate holdings in a USGS depository map collection. Major requirements were: production of a finding list which can be updated at regular intervals by staff with limited knowledge of maps; adaptability to different types of maps; ease of use by patrons and by staff; access by geographic area with secondary access by subject; and an inexpensive method.

The MARK IV program runs on an IBM 3031 computer, but can run on any medium to large scale IBM system. A six character numerical record is assigned to each entry which stores 150 characters of information in six fixed fields. The first three fields are geographical areas followed by location, date of holdings, and subject fields. The geographical fields accomodate continents, oceans, countries of the world, and extraterrestrial maps as major divisions. Minor divisions include continent, state, planet, and ocean names. A third field describes the area of the minor division. At present, the formatted holdings list records 24,000 maps occupying 3.6 million characters of storage space.

Background Information

The map finding list to be described was developed in-house utilizing the University Computer Center equipment and expertise. A number of map automation projects are described or proposed in the literature of the sixties and early seventies. These include the Army Map Service Library (Murphy 1970), the San Juan Island Project (Thomas 1963), the University of California at Los Angeles (Hagen 1966), the McMaster University Map Library (Donkin et al 1967; Ready 1967). The above systems used keypunch cards of 80-90 columns, and much of the information was coded to reflect typical card catalog information. The Map Library at Illinois State University at Normal used three keypunch cards allowing 220 columns per map (Easton 1967). Computer produced card catalogs are reported for Simon Fraser University (Phillips et al 1969; McDonald 1973) and Laval University (Phillips 1973). Arizona State University produced a catalog using a KWOC index approach (Al-Hazzam 1973). All of the above projects used either the Library of Congress G classification for maps or other geographic codes. The Bancroft Library at the University of California, Berkeley, provides up-to-date lists of topographic maps using IBM card files (Hoehn et al 1971). Later in the seventies, with the availability of MARC map records, individual as well as library networks began converting to automated catalogs.

A cataloged collection of maps was not one of the options available to identify and provide access to the Wright State University map collection. The major requirements of the methodology to be utilized to provide bibliographic control of the USGS depository map collection are to include:

Production of a finding list which can be updated at regular intervals by staff with limited knowledge of maps.

Adaptability to different types of maps.

Ease of use by patrons and by staff.

Low cost.

It was decided that access by geographic area with secondary access by subject would best meet these requirements. A 1953 survey by an SLA Geography and Map

Division Committee indicated that "74% of the requests were by area, 24% by subject, and a few scattered ones were by title, publisher, and date." (Gerlach 1961:250). In addition to area and subject, the other essential information listed includes series/location number and date. Area, subject, and date are the elements which satisfied the reference queries of our patrons. Scale has been identified as an element of higher priority than date for answering patron's requests (Christy 1973:30). The only patron requests by scale in our experience have been for topographic maps.

More sophisticated systems using coordinates (van de Waal 1974), or centroids (Stallings 1966), or designed to produce a database (Lea et al 1978) have been described in the literature.

History of Wright State University

Wright State University began in 1964 as the Dayton Campus of Ohio State and Miami Universities and became an independent state university in 1967. Today there are more than 80 undergraduate programs, 27 programs leading to a master's degree, and programs of study for the M.D., Psy D., and biomedical Ph.D. degrees.

The University Library built in the Fall of 1973 was designed to house a collection of 400,000 bound volumes and now contains more than 362,000 bound volumes, 138,742 United States and Ohio documents, 45,000 pieces of nonprint media, 565,306 microforms, 24,000 maps, and 3,570 current periodical subscriptions.

The initial map collection was limited to topographic maps of Ohio, arranged alphabetically by quadrangle name, and a small collection of world maps, United States maps, and road maps, most of which were filed in the pamphlet collection.

Since its inception, the University has had active geography and geology departments. In March of 1974, a reference librarian who had graduated from the geology program was hired and she began the task of organizing and identifying the items in the small map collection. Working with the faculty of these departments, she began to acquire additional maps to support the programs.

In 1976 the University Library became a depository for USGS maps and shipments began to arrive in June 1977. The total number of maps added to the collection in fiscal year 1976/77 was 416; of these, 338 maps were the June 1977 depository shipment. By comparison, 2,587 and 5,365 maps arrived in the next two fiscal years. A handwritten 3 X 5 card file arranged by area and listing date and map series was maintained. This card file became the input for the computer produced holdings list.

In July of 1978, the University Archives and Special Collections started a project which resulted in a computer printout of holdings of Local Government Records for an eleven county area. Arrangement was geographical by county, city or township, subarranged by office of origin. This printout and the categories of information maintained on cards for the map file were analyzed, similarities noted, and planning for a computer printout of map holdings was initiated.

The ideas for the computer map file, as well as the structure of the file, are the work of Dorothy Carr, former reference librarian (1974-1980). The programming was provided by Kent Meyer, Director, Computer Services, Wright State University.

Computer Map File

In July 1979, a batch computer system was designed to identify and locate holdings in the map collection. Access is by geographic area with secondary access by subject. Three of six fields are allotted for geographic areas: a Major Division, a Minor Division, and a Quadrangle or Area Designation.

Major and Minor Divisions. The Major Divisions are Continents, Extra-Terrestrial Bodies, Oceans, World, and Country Names. The Minor Divisions for the above categories are:

Continents	Extra-Terrestrial	Oceans	Countries
Africa	Universe	Antarctic	States
Asia	Callisto	Actic	Provinces
Europe	Europa	Atlantic	
North America	Ganymede	Indian	
South America	Io	Pacific	
	Mars		
	Mercury		
	Moon		

This geographic breakdown has some features in common with a catalog card filing arrangement described for a geology map collection (Tanaglia 1977:18).

Quadrangle/Area Designation. The Quadrangle/Area Designation can include the broad categories of continent map, planet map, ocean map, world, country map, state map, East, North, South, West, as well as named quadrangles or areas such as regions, counties, cities.

Areas that are not quadrangle names have parenthetical qualifiers identifying them as area, city, county, district, national park, region, river basin, volcanic center, vicinity. See Appendix I for examples in the Sample Printout.

Series/Location. This field indicates to the user the location of the desired map. The 7.5 ORTHO, 7.5 TOPO, 1 X 2 degree series, TOPO, and TUBE maps are filed in twenty-two 5-unit map case files. Arrangement in the map cases is alphabetical by quadrangle name. Recently the designation ORTHO has been changed to ORTHOM and ORTHOQ to specify orthophotomap and orthophotoquad.

Maps which have a scale of 7.5 X 15 minutes, 15 minutes, 30 minutes, or 1 X 2 degrees, but are not physically located with these series, have scale indicated in parentheses following the quadrangle name. See examples in Appendix I.

Maps which arrive folded in envelopes are filed in seven 4-drawer filing cabinets by series symbol and number. The A, GM, GP, GQ, HA, HYDRO UNIT, I, L, MF, OC, and OM series from the U.S. Geological Survey are housed in these file cabinets. Arrangement is alphabetical by series and numerical by series number. Similar organization of geological maps has been described (Lukens 1970:51-2). A collection of miscellaneous maps are filed in a separate ENV (envelope) series by accession number.

Other locations identified in the printout include the separate Federal documents collection (FED DOC), the Ohio documents collection (OHIO DOC), and the FOLIO set. The Federal documents and Ohio documents are arranged in these collections by Superintendent of Documents and Ohio document number. The FOLIO sets are located on atlas stands adjacent to the map cases.

Arrangement alphabetically by quadrangle/area, alphanumerically by series, and alphanumerically by document number is working well for patrons and staff. Other methods of arranging maps described in the literature include provenance, function, subject, or format (Ehrenberg 1973), and numeric arrangements (Berthelson 1964; Johnson 1977; Davis et al 1978; Ansari 1980; Roney et al 1981).

Edition. The Edition field lists the dates of the map . Adequate space has been allowed to indicate original date and any modification. Included are the terms reprint, revised, field checked, phototorev(ised), photoins(pected), and verified. The abbreviation N.D. is used to indicate no date listed. Faculty in the Geography and Geology departments indicate that information other than the latest date is essential. See examples in Appendix I.

Subject. The subject field utilizes the terminology taken directly from the map to indicate the subject or subjects of the map. Single subjects have been listed as nouns. A selection of the wide variety of subjects in the sample printout (AppendixI) include: political boundaries, geography, vegetation, geology, topography, age of the ocean basins, tectonics, magnetism and bathymetry, landforms, seismology, subsea mineral resources, ecoregions, population change, city ratings, oil and gas data, pleistocene lakes, aeromagnetism, hydrologic investigation, mineral industries, glacial geology, shallow bedrock, soil survey, stratigraphy, water resources, streets, land use, roads.

Also included in the subject field following the subject of the map is the document number by which Ohio and federal documents are shelved. Maps from the Ohio Department of Natural Resources include the following agency publications: the Geological Survey Bulletin (ONR 84.3:), General Soil Maps of the Division of Lands and Soils (ONR 132.8/2:), Publications of the Division of Wildlife (ONR 246.17:) and Ground-water Resources of named County by the Division of Water (ONR 242.8:). Federal document maps include Soil Survey Reports of the Soil Conservation Service (A57.38:) and CIA maps and atlases (PrEx 3.10/4:). Recently selected series from the Bureau of Land Management (I53.11:) and the Federal Highway Administration (TD2.37:) will be added as maps are received.

Map File Program

The MARK IV program runs on an IBM 3031 computer, but can run on any medium to large scale IBM system. MARK IV is a proprietary licensed program available from Informatics, Inc. Print is limited to uppercase letters. The IBM 3031 computer with attached processor (AP), located in the University Computer Center, has 8 million characters main memory and 4.1 billion characters disk storage. The 3031 system uses the Multiple Virtual System (MVS) control program, although the MARK IV will run under other control programs.

A six character numerical record is assigned to each entry which stores 150 characters of information in six fixed fields described above. Records are stored on magnetic tape. File location and size are listed below:

LIB-MAP Fields

FIELD NAME	FIELD LOCATION	FIELD LENGTH	COLUMN HEADING
Delete	1	1	
Rec-No.	2	6	Rec. No.
Country	8	15	Major Division
State	23	15	Minor Division
Quad	38	30	Quadrangle/Area Designation
Series	68	10	Series/Location
Holding	78	33	Edition
Subject	111	30	Subject
Last	150	1	

Date Input. Data input is batch keypunch utilizing a six character record number assigned in numerical sequence. Data is entered on two coding sheets: the A record (Illustration 1) lists the record number and the major division, minor division, and quadrangle/area designation; the B records lists the record number plus the last three fields, series/location, edition, and subject. A third coding sheet, the C record, is used to delete errors from the file.

Cost of Data Output. The map file program is designed to produce a formatted holdings list at minimal cost. It is printed on an IBM 3203 printer using standard green bar computer paper. The printer, which operates at 1,200 lines per minute can produce up to five copies per run. Current figures for the holdings list are $1.00/1,000 entries or approximately $24.00 for the present file size. The program is capable of producing updates to the file. The update lists all new or changed holdings and invalid transactions and is carefully proofread prior to merging the information with the formatted holdings list. File update costs are $7.00 plus $1.00/1,000 transactions.

When the file size approaches 50,000 entries, it will be necessary to change from printed paper output to COM fiche. In addition to COM fiche, printed output will be maintained for Ohio and surrounding states. Present cost figures are $2.00 per fiche which accomodate 207 pages of print.

Advantages

The computerized map file described has now been operating more than three years. The 3 X 5 card file which had the same hierarchical structure predated the computer file by two years. The system provides access to the map collection the same way that patrons request information, by geography with secondary access by subject. Since the formatted holdings list uses natural language, instead of codes, it is easy to use and to understand. This is especially important for libraries with staff that have no training in cartography. A brief list of the order of geographic categories in the map file, correlated with the various location designations, is attached to the inside cover of the computer printout. This aids the patron in use of the printout and most patrons are able to locate their maps with very little assistance.

The file provides access to maps that are physically located in collections other than the map files. Prior to the computer printout, maps that were a part of the federal and Ohio documents collections, were frequently underused, since holdings in these collections are arranged by document classification numbers and access was through separate indexes.

The map files are easy to update and the updates and formatted holdings list are inexpensive to produce. The information stored in machine readable format is capable of incorporation into an online circulation system, when such a system is available to the University Library.

Program Availability

The Director of Computer Services, Wright State Univeristy will share this program for the map file with libraries that have access to MARK IV at reproduction costs.

Illustration 1

WSU LIBRARY MAP HOLDINGS

	Record No	Country (Major Division)	State (Minor Division)	Quadrangle Name (Etc.)	
1	2 3 4 5 6 7	8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67	68 69 70 71 72 73 74 75 76 77 78 79 80
A					

WSU LIBRARY MAP HOLDINGS

	Record No.	Series/ Location	Date of Holding	Subject
1	2 3 4 5 6 7	8 9 10 11 12 13 14 15 16 17	18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
B				

Appendix I

QUADRANGLE/AREA DESIGNATION	SERIES/ LOCATION	EDITION	SUBJECT
CONTINENTS EUROPE			
CONTINENT MAP	ENV 66	1969	POLITICAL BOUNDARIES-NATL.GEOG
EAST	FED DOC	N.D.	POWER FACIL./PREX3.10/4:EA7E
NORTH	ENV 318	1958	GEOGRAPHY AND TOPOGRAPHY
SOUTH	ENV 76	1968	VEGETATION
SOUTHEAST	ENV 314	1958	GEOGRAPHY
WEST	ENV 322	1956	GEOGRAPHY
EXTRA-TERR. MARS			
PLANET MAP	I-1083	1978	GEOLOGY
	I-940	1975 REPRINTED 1977	SHADED RELIEF
AEOLIS NORTHWEST	I-1213	1979	CONTROLLED PHOTOMOSAIC
AMENTHES	I-1024	1977	TOPOGRAPHY
CANBERRA (REGION)	I-1060	1977	MOSAIC(VIKING 2LANDING SITE)
CAPRI (REGION)	I-1046	1977	TOPOGRAPHY (VIK.CILAND.SITE)
TITHONIUM CHASMA (REGION)	I-1294	1980	TOPO ORTHOPHOTO MOSAIC
YORKTOWN	I-1059	1977	MOSAIC (VIKING 1 LANDING SITE)
OCEANS ATLANTIC			
OCEAN MAP	ENV 180	1974	AGE OF THE OCEAN BASINS
	ENV 181	1974	MAGNETIC LINEATIONS OF OCEANS
	TUBE	N.D.	BATHYMETRIC STUDIES
DE SOTO CANYON	I-475	1966	LAND AND SUBMARINE TOPOGRAPHY
GREAT BAHAMA BANK	I-475	1966	LAND AND SUBMARINE TOPOGRAPHY
GREATER ANTILLES (REGION)	I-732	1972	TECTONICS
MID-ATLANTIC CONTINENTAL SHELF	OC-79	1978	GEOLOGY-COST NO.B-2 WELL
SOUTH ATLANTIC CONTINENT.SHELF	OC-90	1979	GEOLOGY-COST NO.GE1 WELL
UNITED STATES MID-EAST COAST	I-536	1968	MAGNETISM AND BATHYMETRY
WORLD WORLD			
WORLD	ENV 313	1968	LANDFORMS
	ENV 65	1970	POLITICAL BOUNDARIES-NATL.GEOG
	ENV 9	1974	SEISMOLOGY
	I-632	1970	SUBSEA MINERAL RESOURCES
UNITED STATES COUNTRY MAP			
COUNTRY MAP	ENV 139	1976	ECOREGIONS
	ENV 74	N.D.	POPULATION CHANGE 1960-70 CTY
	ENV 77	N.D.	CITY RATINGS
	MF-916	1975 REPRINT 1979	YOUNG FAULTS
EAST	ENV 235	1965 REVISED 1966	USAF OPERATION NAVIGAT. CHART
GREAT BASIN (REGION)	I-416	1964	PLEISTOCENE LAKES
NORTHEASTERN CONTINENTAL SHELF	I-861	1974	PRE-PLEIST.GENERAL GEOLOGY

QUADRANGLE/AREA DESIGNATION	SERIES/ LOCATION	EDITION	SUBJECT
37TH PARALLEL	GP-597	1967	AEROMAGNETIC,GRAVITY PROFILES
	I-448	1965	GEOLOGIC AND CRUSTAL CROSS SEC
OHIO			
STATE MAP	GP-445	1964	AEROMAGNETISM
	HA-341	1969	HYDROLOGIC INVESTIGATION
	OHIO DOC	1928	MINERAL INDUSTRIES ONR84.3:33
	TUBE	1971	SHADED RELIEF
	TUBE	1971	GEOGRAPHY-COUNTY BOUNDARIES
STATE MAP-NORTHEAST	OHIO DOC	1979	GLACIAL GEOLOGY ONR84.9:6
STATE MAP-NORTHWEST	OHIO DOC	1973	SHALLOW BEDROCK ONR84.10:38
APPALACHIAN BASIN (REGION)	I-917E	1978	OIL AND GAS DATA
	OC-80	1977	STRATIGRAPHY-RADIOACTIVE ZONES
BELMONT (COAL FIELD)	OHIO DOC	1978	COAL RESOURCES ONR84.19:106
CANTON	1X2 DEGREE	1955 FIELD CHECKED 1957	TOPOGRAPHY
CANTON (CITY)	HA-50	1962	HYDROLOGIC INVESTIGATION
CANTON EAST	7.5 TOPO	1967 PHOTOREV 1978	
	7.5 TOPO	1958	
CANTON WEST	7.5 TOPO	1967 PHOTOREV 1978	
CELINA	15 TOPO	1914 REPRINT 1942	
CHAMPAIGN (COUNTY)	OHIO DOC	1979	WATER RES.ONR242.8:C449/979
CINCINNATI	1X2 DEGREE	1953 REVISED 1974	TOPOGRAPHY
CINCINNATI (AND VICINITY)	OHIO DOC	1916	PHYSIOGRAPHY ONR 84.3:14
	OHIO DOC	1916	TOPOGRAPHY ONR 84.3:19
CINCINNATI (1X2 DEGREE)	ENV 188	1972	GEOLOGY
CLEVELAND (CITY) AND VICINITY	ENV 85	1967	STREETS
CLEVELAND (1X2 DEGREE)	L-72	1972	LAND USE
COLUMBUS (30 MIN QUAD)	FOLIO 197	1915	GEOLOGY
COLUMBUS GROVE	7.5 TOPO	1960	
COLUMBUS-DAYTON (AREA)	GP-491	1965	AEROMAGNETISM
DAYTON NORTH	7.5 TOPO	1965	
DAYTON SOUTH	7.5 TOPO	1965	
DAYTON-COLUMBUS (AREA)	GP-491	1965	AEROMAGNETISM
FAIRBORN	ENV 86	N.D.	STREETS
FINDLAY (CITY) AND VICINTY	GP-500	1965	AEROMAGNETISM
GREENE (COUNTY)	ENV 90	1978	ROADS WITH TWP BOUNDARIES
GREENE (COUNTY)BEAVERCREEK TWP	ENV 171	1965	ROADS-COUNTY ENGRS OFFICE
LUCAS (COUNTY)	FED DOC	1980	SOIL SURVEY A57.38.L96/2
MONTGOMERY (COUNTY)	ENV 102	1976	IMPORTANT FARMLANDS
	ENV 403	1976 AND 1978	AV. DAILY TRAFFIC VOLUMES
ROSS (COUNTY)	ENV 114	1979	IMPORTANT FARMLANDS
WITHAMSVILLE	GQ-1072	1973	GEOLOGY
TENNESSEE			
STATE MAP	ENV 111	1970	AAPG GEOL. HIGHWAY SERIES
	ENV 147	1913	MINERAL RES,SOIL,AGRICULTURE
	HYDRO UNIT	1974	HYDROLOGY
MOUNT LE CONTE	7.5 ORTH	1976	
	7.5 TOPO	1964	
NEW MIDDLETON	GM-318 NE	1976	GEOLOGY AND MINERAL RESOURCES
OAK RIDGE NATIONAL LAB (AREA)	GP-308	1962	AERORADIOACTIVITY

References

Al-Hazzam, Elizabeth, 1973, Arizona State University, Hayden Library: KWOC index to the map collection: Western Association of Map Libraries Information Bulletin, v.5, no.1, pp. 26-37.

Ansari, Mary B., 1980, A simple numeric filing system for 7.5- and 15- minute topographic maps, the McLane System: Western Association of Map Libraries Information Bulletin, v.12, no.1, pp. 4-8.

Berthelson, John F., 1964, A map classification system for transportation studies: SLA Geography and Map Division Bulletin, no.57, pp. 6-9.

Christy, Barbara, 1973, Map classification, basic considerations and a comparison of systems: Western Association of Map Libraries Information Bulletin, v.4, no.2, pp. 29-42.

Davis, John S., and Haymes, Mary F., 1978, The organization of a geophysical data collection: Special Libraries, v.69, no.5/6, pp. 215-219.

Donkin, Kate, and Goodchild, Michael, 1967, A computerized approach to increased map library utility: The Canadian Cartographer, v.4, no.1, pp. 39-45.

Easton, William W., 1967, Automating the Illinois State University map library: SLA Geography and Map Division Bulletin, no.67, pp. 3-9.

Ehrenberg, Ralph E., 1973, Non-geographic methods of map arrangement and classification: Drexel Library Quarterly, v.9, no.4, pp. 49-60.

Gerlach, Arch C., 1961, Geography and map cataloging and classification in libraries: Special Libraries, v.52, no.5/6, pp.248-251.

Hagen, C.B., 1966, An information retrieval system for maps: UNESCO Bulletin for Libraries, v.20, no.1, pp. 30-35.

Hoehn, Phil, and Silberstein, Steve, 1971, Computerized control file for topographic quadrangles developed for the Bancroft Library: SLA Geography and Map Division Bulletin, no.86, pp. 24, 56.

Johnson, Sheila Grant, 1977, Geographic arrangement of topographic maps: Special Libraries, v.68, no.3, pp. 115-118.

Lea, Graham, Shearer, James, and Paterson, Donald, 1978, Computerized indexing of the Institute of Geological Sciences geological map collection: SLA Geography and Map Division Bulletin, no.112, pp. 27-46.

Lukens, Beatrice, 1970, Arrangement and organization of geologic maps in the library: SLA Geography and Map Division Bulletin, no.81, pp. 51-53.

Macdonald, Ronald G., 1973, Simon Fraser University map library: Western Association of Map Libraries Information Bulletin, v.4, no.31, pp. 25-26.

Murphy, Mary, 1970, Map collection prepares to automate: Special Libraries, v.61, no.4, pp. 180-189.

Phillips, Brian, and Rogers, Gary, 1969, Simon Fraser University computer produced map catalogue: Journal of Library Automation, v.2, no.3, pp. 105-115.

Phillips, B.F., 1973, The computer-produced map catalog: some considerations and a look at operating systems: Drexel Library Quarterly, v.9, no.4, pp. 71-78.

Ready, William B., 1967, This works for us: Special Libraries, v.58, no.5, p. 365.

Roney, John I., and Ogilvie, Bruce C., 1981, Increasing the availability of national mapping products: Western Association of Map Libraries Information Bulletin, v.12, no.2, pp. 133-140.

Stallings, David L., 1966, A look at automated cartographic retrieval: SLA Geography and Map Division Bulletin, no.64, pp. 5-11.

Tanaglia, Barbara Ragnar, 1977, Catalog card filing arrangement for a geology map collection: SLA Geography and Map Division Bulletin, no.110, pp. 17-22.

Thomas, Kenneth A., 1963, The San Juan Island Project: cataloging maps by mechanized techniques: SLA Geography and Map Division Bulletin, no.54, pp. 8-12.

van de Waal, Hans, 1974, The application of geographical coordinates for the retrieval of maps in a computerized map-catalogue: International Yearbook of Cartography, v.14, pp. 166-173.

RATE OF GROWTH OF THE LITERATURE OF CHEMICAL GEOLOGY, 1946-1980, AND A PEEP INTO THE FUTURE

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Abstract: The literature of chemical geology, as measured by the abstracts printed in Sec. 53 of Chemical Abstracts, showed a remarkably constant rate of growth during the title period of 35 years. From 1946 to 1980, the number of abstracts per year increased from 1,150 to 11,135, a rate equivalent to doubling every nine years. There has been a noticeable decrease in the rate of growth during the past three years, and some observers expect this trend to continue. However, comparison of the number of published papers vs. population per country shows that some heavily populated areas of the world now contribute relatively few papers, and that therefore a potential exists for high rates of growth of the literature.

Introduction

In a recent study of the literature of chemistry, Baker (1981) concluded that for the first time "the growth of newly published chemical and chemical engineering literature has been slowing somewhat in recent years." It seemed to me to be of interest to look at the literature of geology to determine whether a similar trend was discernible in that field, but it soon became apparent that the problem of definition of the field to be covered (geology, geophysics, mining), as reported in the two complete abstract journals, Bulletin Signaletique, and Referativnyi Zhurnal, made the task so difficult that it was decided to limit the study to the field of chemical geology, as measured by the number of papers abstracted in Section 53 of Chemical Abstracts, Mineralogical and Geological Chemistry, with which I am most familiar, having served as section editor since 1941.

Rate of Growth of Chemical Geology

The number of articles abstracted in Section 53, Mineralogical and Geological Chemistry, of Chemical Abstracts is given for each year 1946-1981 in Table 1. As will be noted, the numbers fluctuate considerably, yet show an overall steady increase. The data of Table 1 have been plotted as average number per year over 5-year periods in Fig. 1, which serves to smooth out small fluctuations. The over-all increase corresponds roughly to doubling the number of abstracts every nine years.

What fields are covered? The data of Table 1 include nearly complete coverage of Mineralogy, Economic Geology, Petrology (igneous, metamorphic, and sedimentary), Geochemistry, Age as Determined by Isotopic Measurements, and Meteorite and Planet Chemistry, Chemistry of the Atmosphere, and Chemistry of Hot Springs, plus the Mineralogy of Soils. Not included are Paleontology, Stratigraphy, Structure, Engineering Geology, Tectonics, Petrography, Magnetism, Glaciology, and Water Supply.

It is evident that there are many abstracts that might be assigned to Sec. 53 that are actually placed in other sections, such as Sec. 20, Soils; Sec. 68, Equilibria, and Sec. 75, Crystal Structure. Nor has policy on these assignments been consistent, in part because the number of sections has increased over the years - 31 in 1946, 48 in 1959, 73 in 1962, 80 at present, in part because of policy decisions. For example, in 1981 it was decided that abstracts of papers on natural resources of coal, gas, and oil would be transferred from Sec. 53 to Sec. 51, Fossil Fuels, Derivatives, and Related Products. Thus, the numbers in Table 1 do not necessarily form a consistent set, but the deviations are probably small. Chemical Abstracts attempts to cross-refer abstracts as appropriate. If all the cross-references given had been added to the number of abstracts listed in Table 1,

Table 1

Number of abstracts per year by five-year periods in Sec. 53, Chemical Abstracts

Year	No. of Abstracts	Year	No. of Abstracts
1946	815	1964	6,297
1947	922	1965	5,816
1948	1,337	1966	5,633
1949	1,240	1967	6,164
1950	1,451	1968	5,986
1951	1,351	1969	6,919
1952	1,293	1970	9,040
1953	1,466	1971	9,193
1954	1,830	1972	8,674
1955	1,998	1973	9,135
1956	2,065	1974	8,826
1957	2,908	1975	8,632
1958	3,069	1976	10,470
1959	3,622	1977	9,156
1960	3,764	1978	12,642
1961	4,806	1979	11,297
1962	4,509	1980	12,112
1963	5,256	1981	9,990

The number of abstracts does not include abstracts of books, nor does it include abstracts of papers that are in related fields that were published in other sections of Chemical Abstracts. Inclusion of these abstracts would probably raise the figures in Table 1 by 5-12%.

those numbers would have been increased by 5-12%.

If one compares the numbers in Table 1 with those for all of chemistry, the figure for 1980 corresponds to about 2.5% of all the Chemical Abstracts, about 33% of those published in Referativnyi Zhurnal, Geologiya, and about 20% of the combined abstracts of Referativnyi Zhurnal, Geologiya and Geofizika.

A Peep into the Future

It will be noted that the figures in Table 1 show a maximum for 1978, with a decrease of 20% from 1978 to 1981. Decreases have been noted in previous years (13 in Table 1) but none was as large. Baker (1981) noted that the number of papers abstracted by Chemical Abstracts grew at an average annual rate of 8.2% in 1951-1960, 8.4% in 1961-1970, 6.9% in 1971-1975 and 4.6% in 1976-1980. Baker states, "The deceleration in growth of the chemical literature over the past five years makes it difficult to predict growth patterns even for the next five years. A single extrapolation of the growth curve would indicate a continued heeling over, with annual growth gradually slowing."

At first look, one would be inclined to believe that this conclusion would also apply to Chemical Geology and perhaps to all of Geology. But one should consider another factor, namely a possible change in the rate of publication in some parts of the world. I have gathered in Table 2 data on the number of papers in Chemical Abstracts Sec. 53, 1981, by countries with estimates of the total population for each country. It is seen that whereas the index of papers per million population in all of Europe is within an order of magnitude, there are many countries in Asia, Africa, and South America that have very low indexes.

Average Number of Abstracts per Year per 5-year Period

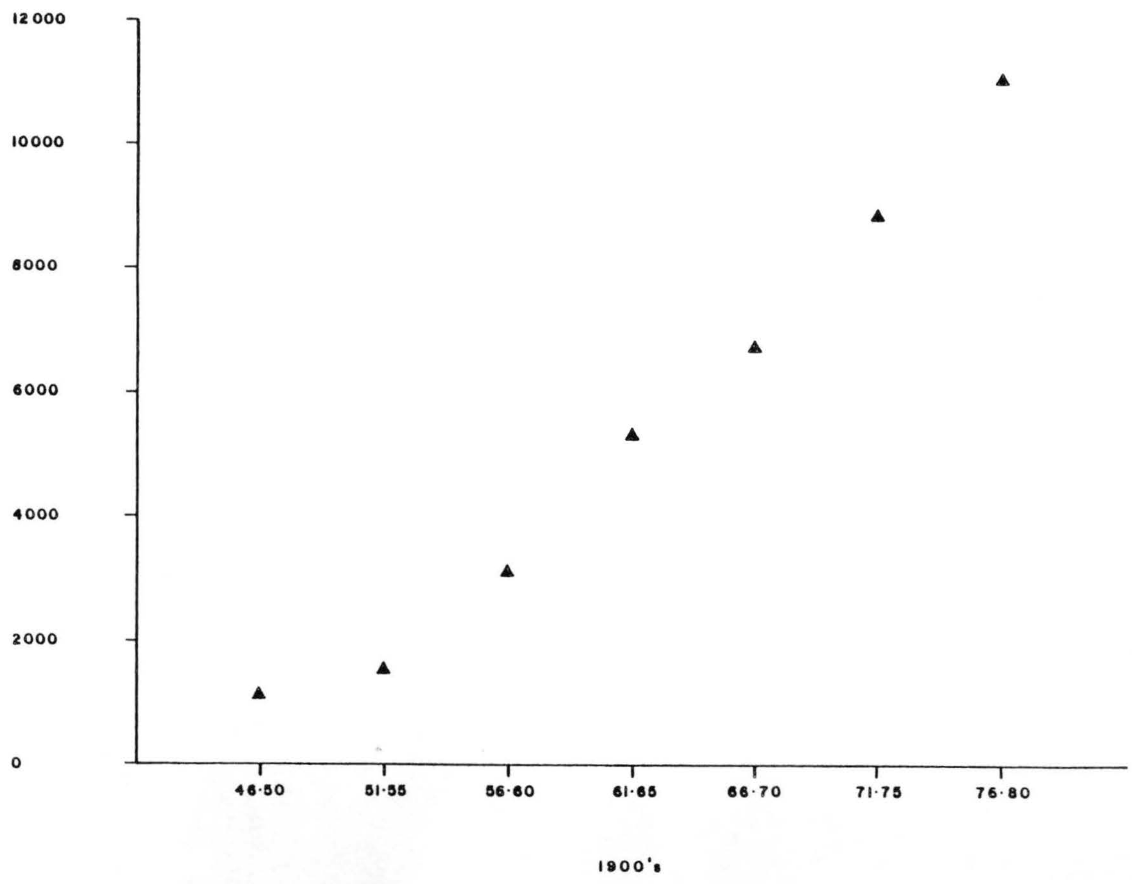

Table 2

Index of Rate of Publication per Million of Population

A. Estimates of population, millions, mid-1980, from Information Please Almanac, 1981

B. No. of papers in Sec. 53, Chemical Abstracts, 1981

B/A = papers per million population

	A	B	B/A		A	B	B/A
Argentina	27	17	0.64	Japan	116.9	418	3.57
Australia	14.6	262	17.4	Korea(N+S)	56.1	41	0.73
Austria	7.5	48	6.4	Mexico	71.9	16	0.22
Belgium	9.9	50	5.1	Morocco	20.0	8	0.40
Bolivia	5.6	1	0.18	Netherlands	14.1	49	3.48
Brazil	122	58	0.48	New Zealand	3.2	42	13.1
Bulgaria	9	61	6.78	Nigeria	77.1	11	0.14
Canada	23.85	391	16.4	Norway	4.1	39	9.51
Chile	11.2	4	0.36	Pakistan	82.4	11	0.13
China	957	136	0.14	Philippines	49.2	5	0.10
Colombia	27.6	3	0.11	Poland	35.5	105	2.96
Czechoslovakia	15.4	185	12.2	Portugal	9.9	11	1.11
Denmark	5.1	41	8.0	Romania	22.3	36	1.61
Egypt	42	20	0.48	Saudi Arabia	8.0	20	2.50
Finland	4.8	28	5.83	S. Africa	23.5	60	2.55
France	53.7	407	7.58	Spain	37.6	84	2.23
Germany(W+E)	78.1	429	5.49	Sweden	8.3	53	6.39
Greece	9.5	38	4.00	Switzerland	6.3	93	14.8
Hungary	10.7	28	2.62	Turkey	45.4	17	0.37
India	663.6	245	0.37	USSR	265.8	3215	12.1
Indonesia	151.9	5	0.033	U.K.	55.8	406	7.28
Iran	38	3	0.079	U.S.A.	222.6	2391	10.8
Iraq	13.2	7	0.53	Venezuela	13.9	4	0.29
Ireland	3.4	10	2.94	Vietnam	57.3	1	0.02
Israel	3.9	31	7.95	Yugoslavia	22.3	73	3.27
Italy	57.1	155	2.71	Zaire	28.8	3	0.10

In Table 3 are given calculations of the number of papers that would have been published in 1981 by the world and by the two countries that have the greatest populations, China and India, if they had achieved the rate of publication (A) of the USA + USSR, (B) Europe excluding USSR. Neither assumption is likely to be fulfilled for years to come. Nevertheless, the rate of publication in China has increased noticeably during the past few years and I think that it is likely that the overall decrease of the past few years will be reversed to a position of slow growth in the future.

Table 3

Calculated Number of Abstracts in Sec. 53, assuming:

A. If the world had been publishing at the rate of U.S.A. + U.S.S.R. (ratio 11.48):

B. If the world had been publishing at the rate of Europe excluding U.S.S.R. (ratio 5.06):

1981 publication would have been:

	A Calcd.	B Calcd.	1981 Actual
World	48,890	21,550	9,970
China	10,980	4,840	140
India	7,620	3,360	245

References

Baker, D. B., 1981, Recent trends in chemical literature growth: Chem. and Eng. News, v. 59, p. 29-34.

PREPARATION OF A STATE BIBLIOGRAPHY OF GEOLOGY

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Abstract: The *Bibliography of Ohio Geology, 1755-1974* is a compilation of several previous bibliographies plus added references. The index is completely revised. The references were gathered from the U.S. Geological Survey's bibliographies of North American geology and from inspection of current books and periodicals for references to Ohio. The compilation was done from index cards. To prepare a bibliography that will serve a useful purpose, it is necessary to have access to a large geology library, knowledge of the geology of the region covered, and much patience, zeal, and time.

The first bibliography of Ohio geology published by the Ohio Geological Survey was *Bulletin* 6 by Alice Greenwood Derby and Mary Wilson Prosser (issued in 1906). In 1952 the great need for an up-to-date bibliography was met by *Bulletin* 52, *A Bibliography of Ohio Geology, 1819-1950*, by Dorothy Watkins. Most of the references from that bulletin are incorporated into the latest bibliography and the methods used by Watkins were, with some variations, the methods described in this paper. Subsequent bibliographies, which covered restricted periods of time are: *Information Circular* 32 for the years 1951-1960, published in 1963; *Information Circular* 36 for the years 1961-1965, published in 1969; and *Information Circular* 37 for the years 1966-1970, published in 1972.

After the publication of *Information Circular* 37, a need was seen for a compilation of bibliographies into one volume. It was necessary to consult four separate books to find all the references to any particular subject. In 1973 I started to work on a bibliography which would bring together in one volume all the references to Ohio geology, from the earliest through 1974 and to index them all on a standard system. This paper will describe the preparation of that volume, Ohio Geological Survey Information Circular no. 48, Bibliography of Ohio Geology, 1755-1974, by Pauline Smyth (published in 1979).

During all this time I kept a card file of Ohio references whenever I noticed anything which would apply to Ohio. I checked all the exchange publications which came to the Ohio Geological Survey from other geological surveys and scientific societies. Periodically I searched the geology library at The Ohio State University for new articles which might mention Ohio. Many articles about a broad area were not indexed under Ohio but contained significant parts about the geology of the state. I looked for Paleozoic paleontology and stratigraphy articles and checked them for references to Ohio specimens or localities. If I found Ohio references I made a card with the bibliographic reference to that article.

The Bibliography of North American Geology, published by the U.S. Geological Survey, was the principal source of references, but there are many articles which apply to Ohio which are not indexed under Ohio in this bibliography. Furthermore, the latest Bibliography of North American Geology available in 1973 was for the year 1970.

Unfortunately there is a gap of several years between the time that a bibliography covers and the date when the bibliography is published. The bibliography cannot be completed until the end of the last year that the bibliography covers. This takes some time, especially if the compiler has other duties, as I did. After the bibliography and index are completed, there are many delays in publication, if it is a government publication. Other publications may get priority for the time of the editor, the typist and the printer and also the budget. Derby's bibliography published late in 1906 contained references to articles published early in that same year. The bibliographies which I prepared had time lags of three years for Information Circular 32, four years for Information Circular 36, two years for Information Circular 37, and five years for Information Circular 48.

The work was all done on 3x5 cards. I went through Bulletin and Information Circulars 32, 36 and 37 and typed each reference on a 3x5 card. If the article had more than one author, a separate card was made for each additional author, with a reference to the principal author. These cards were kept together at this stage. Cards were made for all new articles and publications.

FIGURE 1

BLICKLE, ARTHUR H. See also Hoskins, J.H., 1940.

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HOSKINS, JOHN H.

1940. (and Blickle, Arthur H.) Concretionary Callixylon from the Ohio Devonian black shale: Am. Mid. Nat., v. 23, no. 2, p. 472-481, 11 figs.

The indexing was done on the back of the principal author card. I took the cards to the libraries where the geologic publications were deposited and found the article listed on each card. First I checked the author, title, volume number, pages and illustrations to be sure the card was typed correctly. Then I turned the card over and listed on the back all the topics which should be indexed for that article. I tried to do this under the principal and subordinate headings which would be used in the index of the bibliography. (See figure 2.)

FIGURE 2

HOSKINS, J.H., 1940

Adams County
  Paleobotany
Paleobotany
  Ohio shale
  Callixylon

Most of the publications were available at the geology library and the main library at The Ohio State University. I also searched in the library of the State of Ohio and the Ohio Historical Society library. Theses were also included in the bibliography and it was necessary to visit a number of college libraries to seek these out and to index them. I visited a number of Ohio universities which grant advanced degrees in geology and also the University of Michigan, where there are a number of Ohio geology theses. I also found there periodicals on the Great Lakes I had not found in Ohio.

The basic areal unit used in indexing is the county and the bibliography has a map showing Ohio counties, for the convenience of the user. Stratigraphic divisions are subheadings under the main headings of the geologic ages. Columbus limestone is a subheading under Devonian. A generalized stratigraphic column is included to aid the user in finding stratigraphic units.

The philosophy of the indexing was to try to imagine where a user would start looking if he wanted the information in the article. It is not enough to have the subjects indexed in an orderly manner. They must also be indexed in a way in which the user will be most likely to find them. A general geologic bibliography such as this will be used not only by professional geologists but also by students and the general public.

After the indexing on the cards was completed, the typing began. The cards were arranged alphabetically by author and the second cards were placed alphabetically with reference back to the principal author card. The bibliographic part of the book was typed from the cards.

The cards were arranged in order to type the index. All the second and third author cards were put aside because the indexes were in the back of the principal author cards. All the cards beginning with A were put together and alphabetized. As the index was typed from the cards, the topic which was typed was checked on the card and that card was placed according to the next topic in alphabetical order.

The typing continued and the cards were reshuffled until all the index subjects were checked off through the letter Z. During the time of the typing of the bibliography and index, a number of new articles were found which should have been included. These were inserted in the proper place.

Editing and printing followed. This took many months, so that by the time the Bibliography of Ohio Geology, 1755-1974 was published, there were many new articles which needed to be cited. These will be included in the next bibliography of Ohio geology.

We are fortunate in Ohio to have an excellent geology library at The Ohio State University. It is a depository for the U.S. Geological Survey publications and maps and also for all the state survey geologic publications. It also has complete files of the Journal of Paleontology, Geological Society of America publications, U.S. Bureau of Mines publications and so on. Furthermore, it is a pleasant place to work.

I found it convenient to have a general knowledge of the geology and the geography of Ohio in order to recognize places and formations and to index them accordingly.

The main prerequisite to preparing a large bibliography is the desire to do it. The work is fascinating and the satisfaction continues when the bibliographer thinks that in years to come, people will be able to locate information they need by using the index. They will be going back in a reverse direction from that the bibliographer took and will find some bit of information which would be useless hidden in an unopened book on the shelf.

REFERENCES

Derby, Alice Greenwood and Prosser, Mary Wilson, 1906, A bibliography of Ohio geology: Ohio Geological Survey Bulletin 6, 332p.

Smyth, Pauline, 1963, Bibliography of Ohio geology, 1951-1060: Ohio Geological Survey Information Circular 32, 63 p., 1 map.

______________, 1969, Bibliography of Ohio geology, 1961-1965: Ohio Geological Survey Information Circular 36, 46 p., 1 fig.

______________, 1972, Bibliography of Ohio geology, 1966-1970: Ohio Geological Survey Information Circular 37, 52 p., 1 map.

______________, 1979, Bibliography of Ohio geology, 1755-1974: Ohio Geological Survey Information Circular 48, 249 p., 3 figs.

Watkins, Dorothy G., 1953, Bibliography of Ohio geology, 1819-1950: Ohio Geological Survey Bulletin 52, 103 p., 1 map.

GEOLOGIC MAPS IN BOOKS AND SERIALS:

A HIDDEN PRESERVATION PROBLEM

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Abstract: Preservation of printed materials is a major problem in libraries today. The poor quality paper produced during the 19th and 20th centuries is deteriorating rapidly, aggravated in many libraries by poor climatic control and heavy use by patrons. This problem is of particular concern in the earth sciences where the old literature continues to be used longer than in most sciences. It is an especially difficult problem to solve because of the frequent inclusion of fold-outs, maps and color maps which are difficult to accommodate on traditional microform. The results of a Columbia University Geology Library preservation survey are presented, documenting the prevalence of special preservation problems in the geological literature and the importance of making careful preservation decisions.

The data that I will present today is from a three-part preservation study undertaken in the Geology library at Columbia University. The data is evidence that maps in geological materials are a widespread preservation problem for geology libraries that necessitates examination of and experimentation with alternative means of preservation. The costs will be high and it is important to establish the prevalence of the problem of maps in geology books so that we will receive the time and money needed to look into this problem. The study also examined other preservation problems in the context of the Columbia Geology collection that I believe may be common to all geology libraries. Work is already underway at Columbia to examine and cost out alternative solutions to the problem of maps in geology books, which I will present in greater detail at a later time.

Before I discuss the data that has been collected, I would like to explain why this project was done and describe the type of collection it was based on so that you will have a framework on which to compare your collections.

In 1947 the Geology Library at Columbia occupied a large reading room and two floors of stacks. In 1949, the geophysicist Maurice Ewing, frustrated by the lack of space, took the offer of the Thomas Lamont estate in Palisades, New York to build a geophysics department. The facility became known as the Lamont Doherty Geological Observatory and established a satellite library in 1954.

This past summer, the last Columbia-based geology faculty member retired, leaving the teaching classrooms, labs, and library the last remnants of the Geology Department on campus. It is expected that within the decade the campus geology library research collection will be moved up to Lamont to be housed in new facilities with the Lamont library.

In the fall of 1981, a year-long moratorium on binding was lifted and my library assistant started digging into the Geology binding backlog. A number of things became apparent. There seemed to be a tremendously large backlog of binding and it appeared that a substantial amount of it was too brittle for binding. It was also clear that a large proportion of our serials could not be sent to our "economy" binder but had to be sent to a "premium" binder because of the prevalence of "complex binding," i.e., fold-outs and maps needing pockets, both of which required special handling.

The first of these observations was rather alarming. It occurred to us that if the collection was really in as bad condition as we thought, it might not make the trip up to Lamont. The prevalence of maps presented another problem--if it was necessary to use a microform alternative, how would the maps be handled? Would the largely oversize maps be photographed in sections for the user to piece together with possible loss of scale around the abutting edges? Would color maps be microfilmed in black and white? Could we store the maps separately or put titles on new storage media such as videodisks?

We had no idea of the extent of the problem facing us or of the practicality of solutions offered. As a result, we designed a preservation survey.

Just a bit more on the differences between the main campus Geology collection where we did this study and the Lamont Doherty Geoscience collection. The two libraries seem worlds apart. The Geology Library is housed in a classic building on the crowded main campus. We estimate there are 98,000 volumes in traditional hard rock/soft rock geology including stratigraphy, mineralogy, petrology and extensive collections of United States and foreign geologic surveys. There are 1200 active serials, that is "active" in the way any of our erratically published survey publications are active.

The Geoscience Library is housed in the estate home of Thomas Lamont. Although a beautiful home, it is not especially well-suited to being a library with stacks under stove hoods and my office in the pastry closet. We have approximately 20,000 volumes and 550 subscriptions in the "new" geoscience areas: geochemistry, seismology, geophysics, marine geology, and marine biology. We are crowded but busy and looking forward to a new facility.

The preservation study was conducted in the Geology Library primarily on books in our stacks. The area is not air-conditioned and has, at best, poor air circulation. The second shelf from the top, second section from the left of each range of books in the stacks and reading room was examined in phase one of the survey. This was not a random sample but insured that the sample was evenly distributed through all call numbers and yet also grouped the samples in "bibliographic units," i.e., a small range of call numbers for each shelf. We checked the validity of our sample by examining a couple of shelves near the floor to see if nearness to the ceiling or lights changed our results--it did not. The total sample was 3474 items, roughly 3% of the collection.

In phase one of the survey, the relationship between binding status and preservation status was expanded. First the shelf of books was sorted into binding status. There were three types: bound in standard bindings, pambind--a commercial pamphlet cover of fibre-board and tape, and unbound. Then each group was examined for condition. Acceptable--the binding intact. Repair--included here were items that had never been bound, volumes needing rebinding and books having brittle paper, but an unbroken text block which our preservation department feels can be successfully recased. Finally, items beyond repair including loose issues that had become too brittle to bind and brittle volumes with broken sewing or breakage of pages along the sewing.

We found that of the sample 47% was unbound and 10% was in pambinding. We found that 43% of the collection needed to be repaired or bound and another 13% was beyond repair: a staggering 56% of the collection.

We cannot draw the conclusion that this is typical of the state of the library geology collections. It does document the fact that historically the Columbia Geology Library did not keep up with its binding and there are big preservation problems now. However, aside from the binding status information based on Columbia binding practices, the preservation status may be more universally relevant. The bound volumes show signs of deterioration. 19% of the bound volumes need preservation treatment. 2%, which translates into 43 books, were beyond repair. This rate of deterioration occurred despite the fact that these were bound volumes. It makes one realize that standard library binding may not be as permanent as one might assume.

The data suggests that pambinds might hold up better than we thought, 77% being in acceptable condition, 23% in need of repair and less than 1% were beyond repair. One person did suggest that "less important" things were put in pambinds and they generally received less use.

Finally, if we ever needed reinforcement regarding the importance of binding, the high mortality rate, 28% beyond repair, for items that had not been bound, should certainly give it. Under current Columbia preservation guidelines, unbound serials and paperback binding are not acceptable.

Once we had established the importance of the preservation problems in our library, we decided to examine the items in need of preservation more closely. A subset of the phase one survey was examined in detail. It contained 1022 items, approximately 1% of the total collection. Every fourth shelf of the original sample was put on a book truck brought into the reading room. They were again sorted into items needing preservation treatment and those which did not. We also removed items that were exact duplicates--mostly journal issues. The items needing preservation came to 55% of the sample.

We then examined the items, recording whether they were sets or monographs and the level of preservation treatment needed.

11% of the items needing preservation were monographs. The relatively low percentage of monographs to sets was probably the result of the fact that most monographs are received bound. Only 3 of the 67 items in this monograph sample were paperbacks. 81% of the monographs could be rebound, repaired, or recased. These were not examined further as repair of these books would be the easiest, least expensive method of preservation. 19% of the monographs were beyond repair. This group could be subdivided into the 11 books which were text and standard sized and could be replaced by a reprint if available or microform if not. The smaller section, a little over 3% (consisting of 2 books) were what we termed complex--a designation that gets to the heart of the special problems of preserving a geology library collection. Just as an example, one volume contained 2 oversize color maps, 2 oversize black and white maps and numerous fold-outs.

Although in the case of the sampled monographs the complex binding preservation was only 3% of the total, they are a difficult problem to solve, not easily accommodated on traditional microforms. Fortunately, it was a difficult but relatively minor part of our monograph preservation problem.

The remaining part of the preservation subset consisted of 503 items which were parts of 49 sets. The shift from evaluation of one title, one book, to evaluation of sets including many volumes represented a big change in my understanding of the complexity of making preservation decisions. A good example may be seen in the two shelves of Jahrbuch der Koniglich Preussischen Geologischen Landesanstalt which later became the Geologisches Jahrbuch. There are volumes in serviceable library binding, volumes with detached boards and unbound volumes. Some of the volumes can be recased and others are beyond repair as are the loose issues. A quick easy decision might be to at least repair the repairable volumes. But that does not solve the immediate problem with this set--that some of the volumes are already beyond repair. The whole set is not now available for use. I have come to the conclusion that when evaluating a set like this one that includes volumes beyond repair, now is the time to replace the set to minimize long term costs, including some volumes not yet in need of replacement or even repair because of the nature of many preservation treatments--microfilm, videodisk. An additional note: the concept of a set rather than a serial is used since a multi-volume title--an encyclopedia or a multi-part series, for example--would be treated in the same way.

Of the sample of serials, three-quarters of the titles could be bound, repaired or recased. The remaining 12 titles, or 24% of the total, were beyond repair. This group was divided into the 6% or 3 titles that were simple preservation problems and 18% or 9 titles containing the problematic maps and foldouts. This is a greater proportion of the problem titles than we found in monographs where only 3% of the titles ended up in this category. It is also important to see how these decisions on titles relate to the actual body of 503 set items examined. Based on the decisions made on titles, 48% of the pieces can be bound, rebound or recased. 58% of the pieces are part of titles which contain volumes beyond repair, subdivided again into the 4% of those that can be replaced by standard microforms and the rest, 54%, that contain fold-outs and maps and will require special preservation treatment just as they now require special handling for binding.

In summary, although the preservation decision should be made for the title, the effect will be much larger as some volumes not yet in need of preservation will be "preserved." In addition, in geology complex problems created by the prevalence of fold-outs and maps will require not an occasional special solution, but a standard method of treatment.

The third phase of our preservation survey has just begun. We are taking the records that were made for items beyond repair in the first parts of the survey and checking to find what commercial microforms are available and how they handle maps. We have no choice; our problem is large and immediate. Although our problems are extensive today, it is just a matter of time before they become the problems of all geology libraries.

PART III

POSTER SESSION

CATALOG OF GEOLOGICAL PUBLICATIONS PRINTED BEFORE 1850 HELD IN THE LIBRARY OF THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Harriet E. Wallace and Dederick C. Ward

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Abstract: Geological publications were part of the Library of the land-grant Illinois Industrial Institute, predecessor of the University of Illinois at Urbana-Champaign, because geology was considered a science basic to the state's agriculture and mineral industry. Growth of the collection was continuous over the years, and following the establishment of the Geology Library as a separate departmental unit in 1959, special attention was given to the purchase of books important to the history of geology. In 1979, the Geology Library was dedicated to Dr. George W. White in recognition of his efforts toward this goal.

This outstanding collection of early geological and "proto-geological" works is the subject of a catalog currently being compiled by Wallace and Ward. The catalog will include (with some exception) monographs, maps, and serial sets printed before 1850. The date 1850 was chosen arbitrarily to mark the beginning of extensive publishing in geology. All editions and translations of a given title held at Illinois will be included.

Announcement of the catalog coincides with the current wave of popularity of the history of geology. The catalog will be an important aid to scholarship in the field. The literature cited in the catalog will be available to use through the auspices of the University of Illinois Rare Books Room.