Two Penrose Conferences for Fall 1976


A Penrose Conference on “The Application of Crystal Growth Theory and Experiments to Rock Forming Processes,” sponsored by the Geological Society of America, with additional support from the Lunar Science Institute, is scheduled for November 28–December 3, 1976. Convener of the conference is Gary Lofgren, Geology Branch, TN 6, NASA Johnson Space Center, Houston, Texas 77058. The site of the conference has not yet been determined and will be announced at a later date.

This conference will bring together experimentalists and theorists interested in crystal growth in silicate melts with petrologists concerned about the interpretation of dynamic (kinetic) igneous rock-forming processes. The purpose will be to identify dynamic processes in igneous rocks, to apply crystal growth theory to crystallization of natural silicate melts, and to evaluate and propose laboratory crystallization experiments that duplicate natural mineral and rock features. Subjects for discussion will include (1) the properties of silicate melts; (2) nucleation and crystal growth in natural and synthetic silicate melts; (3) crystal-liquid fractionation and partition coefficients in dynamically crystallizing systems; (4) effects of crystal growth conditions on crystal structure, zoning, shape, and composition; and (5) the application of experimental results to understanding rock histories.

Registration fee for the conference is expected to be approximately $250, including room, all meals, and transportation from the airport to the meeting site and return. Attendance will be limited to approximately sixty. Application deadline is September 1, 1976.


A Penrose Conference on “Implementation of Geological Information in Land-Use Planning,” sponsored by the Geological Society of America and the Texas Bureau of Economic Geology, is scheduled for December 13–17, 1976, in Austin, Texas. Conveners of the conference are Bennie W. Troxel, California Division of Mines and Geology; Donald A. Woolfe, Planning Director, San Mateo County, California; and James G. Slosson, Engineering Geology Consultant.

The purposes of the conference are to gather together a group of experts to discuss, in free dialogue, ways and means to present geological information in a palatable form and to ensure its use, where pertinent, in making land-use decisions. Subjects for discussion will include case histories of areas where available geological information has been used in land-use decisions, case histories where it was not used, the problem from the decision-makers’ points of view, and the problem from the points of view of both the users and the data-gatherers.

Planning staffs, zoning officials, those responsible for public safety, legislators, and other key public officials are encouraged to apply and should make up about 60 percent of the group. Geologists included should have generated such information for selected areas; some of these will be selected because they were successful in implementing its use, and others because they were not. The conveners hope to maintain an equitable balance between the varying backgrounds and regional representation needed for a useful conference.

Registration fee for the conference is expected to be approximately $225 to $250, including lodging, meals, and transportation from the airport to the meeting site and return. Attendance will be limited to approximately seventy. Application deadline is October 1. Those interested in attending the conference are urged to write to B. W. Troxel, California Division of Mines, Room 1341, 1416 Ninth Street, Sacramento, California 95814.
Book review

Geological Highway Map of the Southeastern Region

Compiled by Allan P. Bennison. Published by the American Association of Petroleum Geologists, Tulsa, Oklahoma, 1975, $3.00.

This is the ninth map in this popular series, which began in 1966. Prepared with the cooperation of state agencies and the U.S. Geological Survey, these geological highway maps are designed especially for use by laymen. The maps in the series, all of which are multi-colored, are (1) Mid-Continent Region, (2) Southern Rocky Mountain Region, (3) Pacific Southwest Region, (4) Mid-Atlantic Region, (5) Northern Rocky Mountain Region, (6) Pacific Northwest Region, (7) Texas, (8) Alaska-Hawaii, and (9) Southeastern Region. The series will be completed with future publication of (10) Northeastern Region, (11) Great Lakes Region, and (12) Northern Great Plains Region. All are published at a scale of approximately 30 miles to the inch, except for Alaska-Hawaii, which is 50 miles to the inch (Alaska) and 8 miles to the inch (Hawaii). Overall map size is 28 by 36 inches.

The southeastern region comprises Louisiana, Mississippi, Alabama, Georgia, and Florida. The geological highway map, which includes most federal and many state highways, was compiled from the Geological Map of the United States (USGS, 1974), the Tectonic Map of the United States (USGS-AAPG), and from regional and numerous state and local publications.

Nearly every bit of space on both sides of the map sheet is crammed with displays of geologic interest; the scope is broad. One side includes the geologic map and accompanying text (entitled “The Southeast Story—From Rocks to Rockets”), a regional state-by-state correlation chart of stratigraphic units, a surficial map and text describing the Everglades National Park, and a road mileage chart.

The other side of the sheet displays three cross sections (map scale), a tectonic map and a physiographic map (80 miles to the inch), a series of seven small outline maps showing paleogeography from Late Cambrian to Pleistocene time (“Restless Seas of the Southeastern Region”), and two outline maps showing 87 mineral (“gemstone”) locations and 28 fossil locations, which also serve as guides to roadcuts, along with locations of one national park (Everglades), six state parks, seven museums, three caves or caverns, one waterfall, one canyon, two springs, three gas and oil areas, and eight other places of geologic interest. Explanatory notes accompany these displays.

The main text gives a general and rather extended account of the regional geology. Geologic problems are also mentioned or discussed, such as the nature of the buried intersection of the Appalachian and Ouachita systems, the origin of the Florida Straits, origin of salt domes, and plate tectonics. An appropriate discussion of economic mineral deposits of the region is included. There is one glaring slip where “... the buried extensions of the great Appalachian and Ouachita mountain systems trend respectively southeast and southwest . . . .”

The regional physiographic map is reproduced directly from ERTS photographs and, unfortunately, the result is generally unsatisfactory; physiographic features that are labeled on this foggy reproduction appear to have been interpreted largely from the original photographs. Additionally, the explanation with the tectonic map calls for red color in areas of igneous rock, but the red color was omitted; this map also omits reference to the southeasterly extension of the Ouachita Tectonic Belt. The cross sections, which lie where possible along the routes of major highways, would be more convenient were they on the same side of the sheet as the geologic map. A few other drawbacks and minor errors were noted, but these do not detract significantly from the presentation.

This map should become a welcome addition to the series. It can be obtained from AAPG, P.O. Box 979, Tulsa, Oklahoma 74101.

P. T. Moyer
MICROFICHE READERS AVAILABLE

In reply to the many requests for addresses of firms and publications that were received after the publication of "Microfiche readers" in the November 1975 issue of Geology, the following list was compiled by Donald B. McIntyre, author of the article and chairman of GSA’s Committee on Publications.

Selected bibliography on microfiche

Introduction to Micrographics
8728 Colesville Road, Silver Spring, Maryland 20910

A Primer in Micrographics
Photomethods (January 1975)
Adapted from Introduction to Micrographics, National Microfilm Association

How to Select a Microform Reader or Reader Printer

Industry Standard. Microfiche of Documents
National Microfilm Association MS5-1972 $3.75

Industry Standard. Glossary of Micrographics
National Microfilm Association MS-100-1971 $5

Buyer’s Guide to Micrographic Equipment, Products, and Services
National Microfilm Association (1975)

What It Takes to Microfilm
Joan Zaffarano, Managing Editor

Administrative Management (March 1975) 38-55
Published monthly by Geyer-McAllister Publications, 51 Madison Avenue, New York, New York 10010

Trout Ficheing in America
Kenneth Iverson, Bell & Howell Business Equip. Group

Computer Decisions (June 1975) 36-40
Published monthly by Hayden Publishing Company, 850 Third Avenue, New York, New York 10022

Quantor. Facts on Film.
Computer Output Microfilm Industry (May 1974)

Users’ Guide to Microfilm Readers and Reader-Printers
The Office (March 1975) 111-122
Published monthly by Office Publications, Inc., 1200 Summer Street, Stamford, Connecticut 06904

Directory of firms dealing in microfiche equipment

Alan Gordon Enterprises, Inc.
5362 North Cahuenga Blvd.
North Hollywood, Calif. 91601
Agent for Realist and other manufacturers

Bell & Howell
6800 McCormick Road
Chicago, Illinois 60645
and
360 Sierra Madre
Pasadena, Calif. 91109
Readers

Blue-Ray
Essex, Conn. 06426
Diazo and Vesicular copy equipment

Bruning Division
Addressograph-Multigraph
1834 Walden Office Square
Schaumburg, Ill. 60172
Readers from $175 to $2,575. Equipment for making and duplicating silver and diazo fiche

Business Efficiency Aids
8114 North Lawndale Avenue
Skokie, Ill. 60076
Systems for filing fiche

Canon, Micrographics Division
10 Nevada Drive
Lake Success, New York 11040
and

3407 West 6th Street
(Astro Office Products)
Los Angeles, Calif. 90020
Front projection reader.
Vesicular copy equipment

Computer Micrographics
5345 West 102nd Street
Los Angeles, Calif. 90045
Readers. COM service

Creative Micrographics
P.O. Box 96
518 Ryers Avenue
Cheltenham, Penn. 19012
Hand-held Miniview reader

[Continued on following page]
Datagraphix
(Subsidiary of General Dynamics)
P.O. Box 82449
San Diego, Calif. 92138
Readers with range of screen sizes and holders

Data View, Inc.
P.O. Box 537
Menomonee Falls, Wisc. 53051
Modular viewers. Printers. Ultraliche

D. O. Industries
70 Mt. Hope Avenue
Rochester, New York 14620
Hand-held viewers with fine optics

Eastman Kodak
Rochester, New York
Sales & Display Office
10100 Santa Monica
Los Angeles, Calif. 90067
and
Union Bank Square
Orange, Calif. 92668
Desk and library readers. Microfiche cameras and service

GAF Corporation
Micrographics Department
140 West 51st Street
New York, New York 10020
Readers and printers

Metagraphic Systems
1624 Stillwell Avenue
New York, New York 10461
Retrieval systems

Micobra Corporation
176 King Street
Hanover, Mass. 02339
Lap readers. Diazo copy equipment

Micro Design
Div. Bell & Howell
857 West State Street
Hartford, Wisc. 53027
(See also Computer Micrographics)
Briefcase reader. Library readers. Reader/printers

Microfilm Enterprises
12 New Dover Road
E. Brunswick, N. J. 08816
Storage of microfilm

Micro Information Systems
467 Armour Circle NE
Atlanta, Ga. 30324
Reader/printers. Ultraliche

Microseal Corporation
222 West Main Street
Evanston, Ill. 60204
Record systems

Microvision
895 West 16th Street
Newport Beach, Calif. 92660
Pocket reader

Minolta
101 Williams Drive
Ramsey, N. J. 07446
Reader/printer

National Microsales
45 Seymour Street
Stratford, Conn. 06607
A mail-order supplier with good prices on discontinued readers

Northwest Microfilm, Inc.
15 North 8th Street
Minneapolis, Minn. 55403
Desk reader

Orco Microfilming
101 Lacy Avenue
Anaheim, Calif. 92805
Agent for Micobra's lap reader. Microfiche service

Quantor
520 Logue Avenue
Mountain View, Calif. 94043
COM readers

Realist, Inc.
N93 W16288 Megal Drive
Menomonee Falls, Wisc. 53051

Ring King Visible
215 West 2nd Street
Muscatine, Iowa 52761
Microfiche filing systems

Taylor-Merchant Corp.
25 West 45th Street
New York, New York 10036
Pocket and portable readers

Terminal Data Corporation
21221 Oxnard Street
Woodland Hills, Calif. 91364
Camera for microfilming documents

Three M Company
Microfiche Division
Three M Center
St. Paul, Minn. 55101
and
2343 Saybrook Avenue
City of Commerce, Calif. 90040
Readers and reader/printers

Visidyne
19 Third Avenue
Northwest Industrial Park
Burlington, Mass. 01803
Lap reader

Visuflex
1641 West Collins Avenue
Orange, Calif. 92667
Microfiche filing systems

Washington Scientific Industries
Long Lake, Minn. 55356
Portable readers

Wilson Jones Company
2907 Supply Avenue
City of Commerce, Calif. 90040
Microfiche filing systems

Xerox
500 Carson Plaza Drive
Carson, Calif. 90745
Library readers. Printer
Availability of geologic data from deep-sea drilling

Thomas A. Davies,* Lillian F. Musich, Peter B. Woodbury, Barbara Long
Scripps Institution of Oceanography, P.O. Box 1529, La Jolla, California 92037

INTRODUCTION

A primary responsibility of the Deep Sea Drilling Project (DSDP) is to make available to the scientific community the geologic information gathered as a result of deep-sea drilling. The primary means of disseminating such information has been the Initial Reports of the Deep Sea Drilling Project, a series of volumes published by the U.S. Government Printing Office. Some 30 volumes in the series have been published thus far, and at least 13 more are planned or in various stages of preparation. Because of the limitations of space, not all of the detailed observational data can be presented in the Initial Reports, and an increasing number of geologists are becoming aware of the need to have access to this basic data. The purpose of this short article is to describe some of the ways in which DSDP is attempting to meet this need, in the hope that this will stimulate more widespread use of DSDP materials.

As a matter of general policy, all of the observational data gathered aboard the D/V Glomar Challenger are available to interested researchers, subject to the restriction that distribution is limited to members of the appropriate scientific party for a period of 12 months following the completion of the cruise. (There may be a charge for the cost of responding to unusually large or complex requests.) Initially, data are recorded on standard forms, but many data are subsequently processed to a greater or lesser degree by computer and hence are available in various machine-readable forms (Table 1). Maintaining the files of DSDP data, responding to requests for data, and devising methods to increase the availability of data are among the duties of a small group of geologists, computer programmers, and other data processing staff at DSDP, collectively referred to as the Information Handling Group. The long-term goal of this group is to establish a full-scale system for the automated processing, storage, and retrieval of DSDP data. In the interim, a number of more limited projects have been attempted, each designed to aid the prospective user. In the following sections of this article we will describe in general terms the treatment of the data and some of the steps we are taking to assist users. More detailed accounts of the procedures and capabilities of the Information Handling Group are presented in a series of informal memoranda entitled “Data Data,” obtainable by writing to the group at DSDP.

UNDERWAY DATA

While underway between sites, bathymetric, magnetic, and subbottom profiles are recorded on board the Glomar Challenger. Processing of these underway data is handled jointly by DSDP and the Geologic Data Center at Scripps as follows:

1. Navigation. Satellite fixes and course and speed changes are recorded aboard the Glomar Challenger from data given in the Underway Geophysical Log. The data are keypunched onshore, put through a navigation smoothing program, and edited on the basis of reasonable ship and drift velocities; a deck of corrected navigation points is punched out for later merging with the depth and magnetic data.

2. Magnetics. Analog records produced on the Varian magnetometer are digitized in gamma units at 5-min intervals on the Oscar XY digitizer, put through a profile program, and edited by comparison with the original analog records.

3. Depth. The depths scaled from the fathograms are recorded at sea at 5-min intervals. The depths are keypunched onshore and edited in the same fashion as the magnetics.

4. Subbottom profiles. Subbottom profiles are photographed at DSDP. The records are then microfilmed at the Scripps Geological Data Center. Commencing with Leg 22 of DSDP, processed data are summarized in a Preliminary Report and Index of Navigation, Depth, Magnetic, and Subbottom Profiler Data, which contains an explanation of what forms of data are available from whom, an index chart giving the track of the cruise and the boundaries of the depth compilation plots, and track charts annotated with dates and hour ticks. Copies of this preliminary report are distributed by the Scripps Geologic Data Center, DSDP, and the National Geophysical Data Center. Original records, plots, and lists of the processed data are held at DSDP for subsequent publication and for use by prospective investigators. (Requests for copies of this data should be addressed to Barbara Long.)

* Present address: Department of Geology, Middlebury College, Middlebury, Vermont 05753.

TABLE 1. SUMMARY OF AVAILABLE DATA

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Medium</th>
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<tbody>
<tr>
<td>Underway data</td>
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<tr>
<td>Navigation</td>
<td>PCM</td>
</tr>
<tr>
<td>Magnetics</td>
<td>PC</td>
</tr>
<tr>
<td>Depth (PDR)</td>
<td>PC</td>
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<tr>
<td>Seismic profiles</td>
<td>PM</td>
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<tr>
<td>Physical properties and quantitative data</td>
<td></td>
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<tr>
<td>Water content by syringe method</td>
<td>PC</td>
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<tr>
<td>Porosity by syringe method</td>
<td>PC</td>
</tr>
<tr>
<td>Density by syringe method</td>
<td>PC</td>
</tr>
<tr>
<td>Density by GRAPE method</td>
<td>PC</td>
</tr>
<tr>
<td>Porosity by GRAPE method</td>
<td>PC</td>
</tr>
<tr>
<td>Acoustic velocity</td>
<td>PC</td>
</tr>
<tr>
<td>Thermal conductivity*</td>
<td>P</td>
</tr>
<tr>
<td>Natural gamma radiation*</td>
<td>PC</td>
</tr>
<tr>
<td>Carbon-carbonate</td>
<td>PC</td>
</tr>
<tr>
<td>Grain size</td>
<td>PC</td>
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<tr>
<td>X-ray mineralogy</td>
<td>PC</td>
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<tr>
<td>Core subbottom depths</td>
<td>PC</td>
</tr>
<tr>
<td>Lithologic data</td>
<td></td>
</tr>
<tr>
<td>Visual core descriptions†</td>
<td>PC</td>
</tr>
<tr>
<td>Smear slide observations †</td>
<td>PC</td>
</tr>
</tbody>
</table>

Note: P, paper; C, computer-readable media; M, microfilm.

*Data are not available from all cruises.
† Computer-readable records are incomplete; coding is in progress.
PHYSICAL PROPERTIES AND OTHER QUANTITATIVE CORE DATA

Several physical properties of the sediments are recorded on the Glomar Challenger routinely as the cores are brought on board. These measurements include (1) water content, porosity, and bulk density by the syringe method; (2) density and porosity by the GRAPE (Gamma Ray Attenuation Porosity Evaluator) method; (3) acoustic velocities by the Hamilton Frame method; and (4) overall core-section density (by weighing). At the DSDP shore laboratory, sediment samples are analyzed for mineralogical properties by x-ray diffraction.

All of the classes of data mentioned above are routinely converted to computer-readable form and exist either on card or on magnetic tape in simple FORTRAN-or ALGOL-readable formats, the choice of storage medium being determined by the volume of the class of data in question. The density and porosity data from the GRAPE device and the x-ray mineralogy data are the only two properties presently routinely stored on magnetic tape. All of the quantitative data are processed by a series of data reduction programs. These reduce the raw data to the appropriate quantitative units and scan for points that are apparently in error. Both a printed report and a clean card deck or tape are generated for each set of data. After further inspection and correction, a final clean report is prepared. The data reduction programs also convert the standard DSDP labeling notation to a subbottom depth in metres, in order to provide a more readily interpretable location for the sample.

One of the most convenient methods for comparing sets of coordinated data taken on particular core samples is graphical display against a common depth axis. To do this, an extremely flexible graphics package (MUDPAK) has been developed using the standard FORTRAN Calcomp routines. MUDPAK permits precise location of any data curve in a composite plot which may contain several curves derived from separate files. For purposes of publication we have constructed plots containing as many as ten parameters derived from five separate data files in one coordinated plot presentation. The flexible placement of the data curves permits superimposition of like parameters measured by different methods. (Requests for quantitative data should be addressed to Barbara Long.)

LITHOLOGIC DATA

Many scientists with diverse backgrounds have participated in the cruises of the D/V Glomar Challenger. Despite efforts to encourage them to adhere to uniform standards, there is considerable variability in lithologic description and nomenclature. Such nonuniform information seriously hampers any attempt to discover regional patterns and trends and indeed can render such attempts utterly meaningless unless treated with extreme caution.

For this reason we have been concerned with bringing uniformity to the lithologic data gathered by DSDP. For this purpose we have been experimenting with a program that uses the existing body of observational data and, by using computer processing techniques, reclassifies the sediments according to a standard scheme. We use a modification of a classification scheme developed by a working group1 from the JOIDES Advisory Panel on Sedimentary Petrology and Physical Properties (van Andel and others, 1973, unpub. report). The basic visual description prepared by the shipboard geologist is retained, but the smear slide data are processed by the classification program (JOIDESSCREEN) to rename the rock types. This technique operates with reasonable success, giving sensible rock and sediment names and substantially reducing the number of names used. Failures are usually due to incomplete or inadequate data rather than to failure of the classification logic.

Two aspects of our treatment of lithologic data should be emphasized here. First, this work is still largely in the experimental stage. JOIDESSCREEN is far from being a routine "production program." We cannot therefore routinely offer all DSDP lithologic data treated in this way. We are, however, more than willing to work with prospective investigators in attempting to meet their needs. Second, our system is designed to increase the availability and usefulness of the DSDP data. The system is a flexible one, and changes, even to the extent of incorporating an entirely new classification scheme, can be added, subject to the limitations imposed by the original data. We therefore welcome the comments and ideas of our colleagues.

A more comprehensive account of the treatment of lithologic data and a detailed account of the data processing techniques and the algorithm used to implement JOIDESSCREEN are in preparation. In the meantime, general questions can be addressed to Lillian Musich and specific questions about the operation of the program to Peter Woodbury.

AIDS TO RESEARCH

In addition to responding to specific requests for original data, we are developing a number of tools designed to aid researchers in locating materials relevant to their studies. Two of these are described below.

Guide to DSDP Cores. The large volume of core material being accumulated by DSDP and the great amount of information contained in the Initial Reports are such that it has been found advisable to prepare a summary of the core material and available information to guide researchers in locating materials relevant to their studies. Guides covering core material gathered during Phases I and II of DSDP from the Atlantic, Pacific, and Indian Oceans are now available, and work is proceeding on the incorporation of material gathered during Phase III. As a complement to the guide, a computerized search system called GUIDESCREEN has been developed.

Some 30 categories of data have been selected (in consultation with a number of sedimentologists, palaeontologists, and stratigraphers) that give the information most generally useful for the selection of core material. The data have been extracted manually from the published Initial Reports and the guide is considered only a guide to these volumes and to the cores. The appropriate parts of the Initial Reports should be consulted for qualifying statements that could not be

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1 The members of the group were Tj. H. van Andel, E. L. Winterer, and J. Duncan. P. R. Supko also attended group discussions.
Cenozoic History and Paleoceanography of the Central Equatorial Pacific Ocean


This study has three distinct but interrelated objectives: to prepare a geological synthesis of Deep Sea Drilling Project data from the central equatorial Pacific Ocean, to interpret this information in terms of the paleoceanographic history of this region, and to evaluate the usefulness of drill data and develop procedures and strategies for future studies of this kind. The investigation is restricted to the past 50 m.y. B.P.

Most of the stratigraphic and lithologic information used in this study comes from approximately 20 drill sites located between lat 15°N and 15°S and long 150°W and 95°W, largely west of the crest of the East Pacific Rise and Galapagos rift zone; all of the drill sites except one are on the Pacific plate. Drilled during the interval from April 1969 to May 1971, the primary data are contained in the Initial Reports of the Deep Sea Drilling Project.

The principal data used are the biostratigraphy, lithology, carbonate content, bulk density, and porosity of the cores. From these properties, sedimentation rates, carbonate and carbonate-free accumulation rates, and paleo-
The paleoceanographic indicators resulting from the study, in context with data from other regions, yield the following oceanographic history for the past 50 m.y. During the initial phase, prior to 38 m.y. B.P., carbonate supply was low, and dissolution was extensive. This resulted in a narrow carbonate zone and low rates of accumulation. Silica was mobilized to form chert, and erosion became widespread. About 38 m.y. B.P., carbonate input increased abruptly, and solution decreased markedly. As a result, the equatorial carbonate zone widened greatly. Bottom-water characteristics may have changed owing to the first extensive development of sea ice around Antarctica. About 33 m.y. B.P., dissolution rates at depth began to increase again, but this increase was compensated for either by a large increase in the carbonate supply or by a depression of the lysocline. As a result, until about 26 m.y. B.P., a very broad and extensive equatorial carbonate zone with maximal accumulation rates existed. The steepening of the dissolution gradient may be related to a decrease in influx of bottom water resulting from major hydrographic changes around Antarctica. The increase in carbonate supply may have resulted from final closure of the Tethys seaway and the ensuing narrowing and intensification of equatorial upwelling. About 15 m.y. B.P., the rate of carbonate dissolution increased further, and the equatorial carbonate zone became much narrower, and many hiatuses were formed. At this time, the lysocline may have attained its present position, which suggests that the present configuration of sources and mechanisms of intermediate- and deep-water supply to the Pacific was being developed. This probably resulted from the major development of Antarctic glaciation that began during this period and increased the supply of bottom water. Some evidence from the carbonate and carbonate-free accumulation rates also suggests an increase in the fertility of the equatorial region, perhaps resulting from closure of the eastern Pacific Ocean and the formation of the Cromwell Current at this time. About 3 to 4 m.y. B.P., the onset of arctic glaciation marked the beginning of large and rapid changes in depositional conditions that cannot be followed in detail with the Deep Sea Drilling Project data.

Reconnaissance Geology of the State of Baja California


The Mexican state of Baja California, which comprises the northern half of the peninsula of Baja California, extends northward from lat 28°N approximately 550 km to lat 33°N and ranges in width from 200 km to less than 100 km. In the present project, which began in 1963, the mapping is compiled on a three-sheet reconnaissance geologic map, at a scale of 1:250,000 (about 6.5 km to the inch).
May BULLETIN briefs

Brief summaries of articles in the May 1976 GSA Bulletin are provided on the following pages to aid members who chose the lower dues option to select Bulletin separates of their choice. The Document Number of each article is repeated on the coupon and mailing label in this section.

- 60501—Biostratigraphic problems of Morrowan and Derryan (Atokan) strata in the Pennsylvanian System of western United States. D. L. Dunn, Gulf Research and Development Company, H.T.S.C. P.O. Box 36506, Houston, Texas 77036. (5 p., 1 fig.)

Although both foraminiferal and conodont zonations have been proposed for Lower and Middle Pennsylvanian strata, the current state of the art indicates that several proposed Morrowan conodont zones and one important Derryan (?) fusulinid zone (21) and the ranges of several important associated conodonts and fusulinids are in question. The conodont zones in question are the Gnathodus girtyi simplex, the Streptognathodus expansus—S. suberectus, the Idiognathodus hemerus—I. sinuosis, and the Streptognathodus parvus—Adetognathus spathus Zones of Dunn (1970b), and the Idiognathodus sinuosus, I. klapperi, and I. convexus Zones of Lane and Straka (1974). The conodonts whose ranges are in question are Gnathodus girtyi simplex, Rachistognathus muriatus, Declinognathodus noduliferus, Adetognathus spathus, Neognathodus basleri basleri, and Idiognathoides convexus.

Evidence based on conodonts suggests that there is a time overlap between uppermost type Morrowan and lowermost type Derryan strata. Because of this, there is as yet no precise paleontological definition of a single Morrowan-Derryan (or Morrowan-Atokan) boundary.

- 60503—Element partitioning in alkali feldspars from three intrusive bodies of the central Wasatch Range, Utah. R. J. Kuryvial, Exploration and Production Research, Cities Service Oil Company, Tulsa, Oklahoma 74150. (4 p., 4 figs., 1 tbl.)

The partitioning of elements in alkali feldspars from the Clayton Peak, Alta, and Little Cottonwood stocks of the central Wasatch Range, Utah, suggests a common magmatic origin for the three intrusive bodies. With decrease in age of intrusion, the alkali feldspars show a successive depletion of Ca, Sr, and Ba and a decrease of the K/Rb ratio. Alkali feldspar phenocrysts from the Little Cottonwood stock contain higher concentrations of Ca, Sr, and Ba and a higher K/Rb ratio than the groundmass alkali feldspars, indicating an earlier period of crystallization in the melt. The phenocrysts are zones in Ba and have relatively low concentrations in the rims and high concentrations in the centers, suggesting that they crystallized in a melt undergoing progressive depletion of barium.

- 60504—Tectonic fabric and hydrothermal activity of Mid-Atlantic Ridge crest (lat 26°N). Peter A. Rona, Reginald N. Harbison, Bobby G. Bassinger, National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories, 15 Rickenbacker Causeway, Miami, Florida 33149; Robert B. Scott, Department of Geology, Texas A&M University, College Station, Texas 77843; Andrew J. Nalwalk (deceased), Marine Sciences Institute, University of Connecticut, Groton, Connecticut 06340. (Present address Harbison and Bassinger: U.S. Geological Survey, P.O. Box 7944, Matairie, Louisiana 70011.) (14 p., 11 figs., 2 tbls.)

An asymmetric tectonic fabric was delineated by narrow-beam bathymetric profiles in a 180-km² area of the Mid-
Atlantic Ridge crest at lat 26°N. Features of the tectonic fabric are a continuous rift valley offset by small (<10-km) transform faults and minor fracture zones expressed as valleys with intervening ridges that trend normal and oblique to the two sides of the rift valley. The discharge zone of a postulated sub-sea-floor hydrothermal convection system is focused by faults on the southeast wall of the rift valley and driven by intrusive heat sources beneath the rift valley.

The rift valley has a double structure consisting of linear segments (bounded by ridges) and basins at the intersections of the minor fracture zones. The double structure of the rift valley acts like a template that programs the reproduction of the tectonic fabric. The minor fracture zones form an asymmetric V about the rift valley at variance with the symmetric small circles formed by major fracture zones. To reconcile the asymmetry of minor fracture zones with the symmetry of major fracture zones, it is proposed that the minor fracture zones have been preferentially reoriented by an external stress field attributed to interplate and intraplate motions. Major fracture zones remain symmetric under the same stress field owing to differential stability between minor and major structures of oceanic lithosphere.

□ 60505—Aeromagnetic survey of the San Gabriel Anorthosite Complex, San Gabriel Mountains, southern California. David Cummings, Department of Geology, Occidental College, Los Angeles, California 90041; Robert D. Regan, U.S. Geological Survey, National Center, Reston, Virginia 22092. (6 p., 3 figs.)

The Precambrian San Gabriel Anorthosite Complex, San Gabriel Mountains, southern California, is composed of genetically related anorthosite, gabbro, and norite. Aeromagnetic studies and field observations indicate that the gabbro and norite underlie the anorthosite.

Field relations of the three units and textures of primary igneous features indicate that final stages of crystallization occurred, in part, by crystal settling. These observations and a geophysical interpretation of one magnetic anomaly as a feeder dike for the complex suggest that the anorthosite complex may have formed in two stages: (1) intrusion of crystal mush through the feeder dike, possibly by flow differentiation, and (2) final crystallization, after intrusion, by crystal settling. Subsequently, the complex was tectonically raised to its present position.

□ 60506—Circulation in the Gulf of Mexico during the last glacial maximum 18,000 yr ago. Charlotte A. Brunner, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881; Judith F. Cooley, Department of Geological Sciences, Brown University, Providence, Rhode Island 02912. (6 p., 10 figs., 2 tbls.)

Frequency distribution of Holocene planktonic foraminifera was determined for the Gulf of Mexico and the North Atlantic Ocean by counts of 246 trigger core tops. These were compared with planktonic foraminifera that were counted from the 18,000-yr isochron in 12 piston cores from the western Gulf of Mexico. Factor analysis was used to define five groups of faunal frequency data and to predict summer and winter temperatures and salinities. Circulation of near-surface water in the Gulf of Mexico 18,000 yr ago, during the last glacial maximum, was significantly different from that of the present. Surface waters supported a cooler subtropical fauna during the glacial maximum, compared with the warm subtropical fauna of the present. Surface temperature was 1° to 2°C cooler and salinity was 0.4 to 0.5 per mil higher than now. In the present gulf, winter isotherms trend northeastward, and summer surface waters are nearly homogeneous. In the glacial western gulf, isotherms trended northerly during winter and summer. In the present gulf, isohalines parallel the basin edge, and the gradient decreases coastward. In the glacial gulf, although isohalines also followed the basin margin, the gradient increased coastward. These patterns of isotherms and isohalines suggest that an anticlocky current system existed in the western Gulf of Mexico during the last glaciation.

□ 60507—Fission-track ages and uranium concentration in garnets from Rajasthan, India. Nand Lal, K. K. Nagpaul, Department of Physics, Kurukshetra University, Kurukshetra 132119, India; K. K. Sharma, Wadia Institute of Himalayan Geology, Delhi University, Delhi 110007, India. (4 p., 2 figs., 3 tbls.)

Fission-track ages determined from garnets in pegmatite and garnetiferous amphibolite from Bhilwara and Ajmer districts of Rajasthan range from 900 m.y. to 1,370 m.y. They date the time of formation of the pegmatites (about 1,000 m.y. B.P.) and the metamorphism during F1. Fission-track ages determined from garnets in pegmatite and garnetiferous amphibolite from Bhilwara and Ajmer districts of Rajasthan range from 900 m.y. to 1,370 m.y. They date the time of formation of the pegmatites (about 1,000 m.y. B.P.) and the metamorphism during F1 (~1,400 m.y. B.P.) folding in the area. The uranium content of the garnets varies from 1.76 x 10^-4 g/g to 21.4 x 10^-4 g/g.


Segments of the U.S. Atlantic coast differ markedly in shoreline and shelf configuration because of both geologic setting and Quaternary geologic history. Regional trends in shelf structure, sediment sources, and history correlate with regional trends in adjacent shoreline configuration, and the Holocene transgressive history of the shelf has a direct bearing on the evolution of the present coastline.
The shelf sedimentary record, particularly in the mid-Atlantic region, contains substantive evidence that precursors to existing barrier islands were common in Holocene time. Nearshore linear shoals are associated with barrier-island coastlines, and their continuity in position on the shelf, coupled with the presence of an underlying lagoonal substrate, implies persistent retreat of a barrier coastline during sea-level rise. Retreat paths of shoals off large capes and estuaries similarly indicate a consistency in shoreline type and orientation through time.

Collectively, this information strongly suggests that barrier islands of the U.S. Atlantic coast originated far out on the shelf, and it invalidates certain criteria (coastal linearity, lithology of sediments beneath the modern lagoon) formerly cited as evidence for mode of formation.

Understanding how and the process by which barriers evolved relate directly to present and future behavior of barriers. Sediments eroded from the foreshore and shoreline are transported both along the coast and landward, aggrading as nearshore shoals, spits, tidal deltas, dunes, and overwash fans. Barrier islands lengthen both by sand accumulation (spit extension) and by submergence (deepening and headward extension of the lagoon).

Development of barrier islands is influenced by rate of sea-level advance and sediment supply. Once initiated, barrier islands lengthen and retrograde through a combination of processes, including spit elongation, overwash, and flooding of back barrier lagoons.

The ages of the last two glaciations near West Yellowstone, Montana, can be calculated by obsidian hydration techniques that are calibrated by K-Ar dating of obsidian-bearing lava flows. The average age of glacial abrasion of obsidian in the Pinedale terminal moraines is about 30,000 yr, with most age measurements between 20,000 and 35,000 yr. For the Bull Lake moraines, it is about 140,000 yr, with most measurements between 130,000 and 155,000 yr. This age for the Bull Lake moraines is also supported by geologic relations that show that the moraines are older than a rhyolite flow dated by K-Ar as 114,500 ± 7,300 yr old (1).

These obsidian hydration ages of the Pinedale and Bull Lake Glaciations correlate well with the last two cold intervals of the marine record. The age determined for the Bull Lake Glaciation near West Yellowstone antedates the last interglaciation of the marine record, which is commonly correlated with the Sangamon Interglaciation.

Our results suggest correlation of the Pinedale Glaciation near West Yellowstone with much or all of the Wisconsin Glaciation and of the Bull Lake with the late Illinoian. This differs with the commonly accepted correlation of the Pinedale with the late ("classical") Wisconsin and of the Bull Lake with the early Wisconsin. The correlation of Bull Lake with late Illinoian appears equally or more compatible with traditional criteria for correlation, namely comparative soil development and degree of preservation of morainal morphology.

Hanauma Bay on the southeast coast of Oahu is a breached compound explosion crater invaded by the sea. Ten core holes through an active fringing reef within the bay provided 63 samples for which C\textsuperscript{14} dates have been determined. These ages indicate that (1) the reef started growing about 7,000 yr ago; (2) most of its vertical growth was during the interval from 5,800 to 3,500 radiocarbon years ago, when its average upward growth rate was 1 m/300 yr; and (3) during the past 3,000 yr, it advanced seaward at the rate of 1 m/45 yr. The data indicate that Koko Bench at -5 m was formed at least 5,800 radiocarbon years ago when the sea stood from 5 to 9 m below its present level. This result is contrary to a previously suggested date of origin of 4,100 to 4,400 yr ago. During the past 3,500 yr, sea level on the reef has risen to its present position at a decreasing rate, but at an overall rate for the interval of 1 m/2,900 yr. It is unlikely that sea level ever stood appreciably higher than at present during the past 3,500 yr. Volcanic ash at the base of several cores marks the latest eruption of nearby Koko Crater, which the C\textsuperscript{14} dates place at no later than 5,800 and possibly 7,000 or more radiocarbon years ago.

In most cases, the radiocarbon dates follow a sequence that is consistent with stratigraphic position, but age inversions occur that are clearly beyond the statistically defined errors in age. They are probably caused by irregularities in the growth pattern of the reef near channels and large pockets. The profile of ages in this most extensively dated reef indicates that casual and sparse sampling of a reef could lead to dubious results in interpreting reef history and chronology of sea levels.
north and south. To describe the pattern of faults and to interpret the mechanics of deformation of the triangle, a two-dimensional model from theory of plasticity is proposed wherein an analogy is made between the Mojave Desert triangle and L. Prandtl’s compressed cell. To simulate regional stresses, the cell is subjected to north-south compression. The maximum shear-stress trajectories developed in the theoretical model have the same orientation and sense of relative movement as the faults in the Mojave Desert area. The model may be used to predict the orientations and sense of movement along faults that might form in the future.

A detailed mineralogical and chemical investigation has been made of shale cuttings from a well (Case Western Reserve University Gulf Coast 6) in Oligocene-Miocene sediment of the Gulf Coast of the United States. The <0.1-, 0.1- to 0.5-, 0.5- to 2-, 2- to 10-, and >10-μm fractions from the 1,250- to 5,500-m stratigraphic interval were analyzed by x-ray diffraction. Major mineralogical changes with depth take place over the interval 2,000 to 3,700 m, after which no significant changes are detectable. The most abundant mineral, illite/smectite, undergoes a conversion from less than 20 percent to about 80 percent illite layers over this interval, after which the proportion of illite layers remains constant. Over the same interval, calcite decreases from about 20 percent of the rock to almost zero, disappearing from progressively larger size fractions with increasing depth; potassium feldspar (but not albite) decreases to zero; and chlorite appears to be derived from the decomposition of muscovite. The gain in argon with depth. The coarser fraction, from which the 40Ar loss is occurring, concentrates the older 40Ar-rich phases of the rock such as K-feldspar and mica. These results strongly imply that the K2O for the new illite layers of the illite/smectite is derived by chemical decomposition of the K-feldspar and mica. The gain in 40Ar of the finest fraction also just corresponds with depth to the change in mineralogy of the illite/smectite and a large gain of K2O in this fraction from 2 to 5 percent K2O. The 40Ar gain indicates that the mean time of K2O gain, which is the mean time of burial metamorphism, was about 18 m.y. ago.

The whole-rock K-Ar apparent age shows a decrease from about 150 m.y. to 75 m.y. over just the same depth interval (1,850 to 3,700 m) that the illite/smectite mixed-layer clay progressively changes from 20 percent illite layers to 80 percent. This decrease in apparent age of the total shale is due to loss of 40Ar from the rock. The 40Ar loss is not caused by outgassing from increasing temperature, because the finest ( <0.1-μm) fraction, which is nearly pure illite/smectite, actually gains 40Ar with depth. The coupled problems of the tectonic significance and mechanism of development of slaty cleavage and schistosity have been studied in high-temperature and pressure deformation experiments. The primary mechanistic question concerns whether preferred orientation of mica in slates and schists develops by rotation of tabular grains or by mechanisms that require crystallization or recrystallization. Most proposed orienting mechanisms predict the same relationship between principal strain directions and preferred orientation. This frustrates attempts to determine the principal orienting mechanisms.

Simple theoretical models of rotation of passive planar markers and of isolated rigid ellipsoids in a deforming fluid predict similar relationships between the magnitudes of the strain and the preferred orientation. In room-
temperature experiments, these predictions are followed when interactions between adjacent grains are minimal; when interactions are important, the rotation mechanism is less effective.

In high-temperature experiments in which phlogopite is syntectonically crystallized from the constituent oxides or when fluorophlogopite or biotite is syntectonically recrystallized, the preferred orientations match the predictions of the rotation models. This suggests that crystallization or recrystallization aided the rotation process by reducing mutual grain interference. Textural observations of the recrystallized samples support this interpretation.

In all of the deformation experiments, maximum, intermediate, and minimum principal compressive strain directions coincide with maximum, intermediate, and minimum concentrations of poles to mica basal planes, respectively, even for general noncoaxially accumulating strain. These results, coupled with studies of natural slates, suggest that mica preferred orientations may be used to estimate both magnitudes and directions of finite strain.

\[ \text{Sr}^{87}/\text{Sr}^{86} \]

60515—Elemental and isotopic geochemistry of non-hydrated quartz latite glasses from the Eureka Valley Tuff, east-central California. Donald C. Noble, Mackay School of Mines, University of Nevada, Reno, Nevada 89507 (present address, Department of Geology and Geological Engineering, Michigan Technological University, Houghton, Michigan 49931); Marjorie K. Korringa (deceased), Woodward-Lundgren and Associates, 2730 Adeline Street, Oakland, California 94607; S. E. Church, Department of Geological Sciences, University of California, Santa Barbara, California 93106; Harry R. Bowman, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720; Miles L. Silberman, C. E. Heropoulos, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. (9 p., 5 figs., 6 tbls.)

The Eureka Valley Tuff, erupted from the late Miocene Little Walker volcanic center, east-central California, includes two major ash-flow sheets: the more voluminous, widespread, and more silicic Tollhouse Flat Member and the overlying By-Day Member. Nonhydrated quartz latitic glasses from the Tollhouse Flat and By-Day Members have, respectively, 65.5 and 63.3 wt percent SiO₂ and are extremely rich in large-ion lithophile elements. The K₂O contents and K/Rb ratios are 5.3 wt percent and 195 for the Tollhouse Flat glass and 5.5 wt percent and 190 for glasses from the By-Day Member. FeO*/MgO (FeO* = total Fe as FeO) ratios are transitional between values characteristic of basaltic and calc-alkaline suites. Initial ⁸⁷Sr/⁸⁶Sr ratios of 0.7054 to 0.7055 are consistent with the pattern of northward decrease in FeO*/MgO ratios of the Sierra Nevada batholith that have comparable Sr contents and initial Rb/Sr ratios. A large-ion lithophile element-rich glass from the By-Day Member has a Sr content of 3.53 wt percent and a Sr/Sr ratio of 205, and a Rb/Sr ratio of 190, consistent with the By-Day Member. Nonhydrated quartz latitic and Rb/Sr glasses from the By-Day Member have, respectively, 65.5 and 63.3 wt percent SiO₂, 5.3 wt percent K₂O, and 5.5 wt percent total Fe as FeO. FeO*/MgO ratios range from 60 to 100. The By-Day Member is characteristically high in Ba/Sr and K/Sr ratios, and approximately 25 percent of the Sr anomalies are consistent with the By-Day Member. Its rather low Sr/Sr ratio (0.70545) suggests that the magma source is likely in the upper mantle. The Yenqian orogenic belt in southeastern China may belong to the inner belt of the Pacific-type orogeny; it is characterized by polygenic deformation, magmatism, and regional metamorphism. Unlike a classical geosynclinal regime, the magmatic activities in this region were not immediately preceded by a major marine geosynclinal
subsidence. The apparent absence of marine deposits after Triassic time suggests that marine transgression is not a universal result of rapid sea-floor spreading. The extensive development of magmatic belts along the eastern margin of the Asian continent appears to require large-scale consumption of oceanic lithosphere at the edge of the continental plate. The age distribution and structural trend data of the magmatic rocks suggest that the presumed subduction zone may have dipped westward or northward in the western Pacific region during late Mesozoic time.

Strontium isotope and major- and trace-element data from the voluminous middle Miocene tholeiitic basalts of the Columbia River Group differentiate the lavas stratigraphically and reflect the origin of the basalts. The Picture Gorge Basalt has relatively low Sr\(^{87}/Sr^{86}\) ratios (0.7035 to 0.7039) and a major- and trace-element composition consistent with an origin from the upper mantle. The Picture Gorge Basalt is clearly distinguished from the Imnaha basalt in northeast Oregon and from the widespread, mainly younger Yakima Basalt. The Yakima Basalt, including lava flows in the Vantage, Grande Ronde, and Imnaha regions, forms a relatively coherent geochemical group with moderate to high initial Sr\(^{87}/Sr^{86}\) ratios (0.7045 to 0.7080), which increase with decreasing age of the lava and show an inverse relation with Sr abundance. Possible explanations include progressive contamination of parental mantle-derived magmas by crustal material or derivation from an inhomogeneous upper mantle.

It is suggested that the Yakima Basalt formed during a major readjustment episode related to plate motions in an extensional tectonic regime. This caused diapiric upwelling of upper mantle peridotite with formation of great volumes of olivine tholeiite magma, which underwent extensive olivine fractionation. The Columbia Plateau may be a continental analogue of the marginal seas of the western Pacific Ocean.

The Aleutian abyssal plain is a fossil abyssal plain of Paleogene age in the western Gulf of Alaska. The plain is a large, southward-thinning turbidite apron now cut off from sediment sources by the Aleutian Trench. Turbidite sedimentation ceased about 30 m.y. ago, and the apron is now buried under a thick blanket of pelagic deposits. Turbidites of the plain were recovered at site 183 of the Deep Sea Drilling Project on the northern edge of the apron. The heavy-mineral fraction of sand-sized samples is mostly amphibole and epidote with minor pyroxene, garnet, and sphenite. The light-mineral fraction is mostly quartzose debris and feldspars. Subordinate lithic fragments consist of roughly equal amounts of metamorphic, pelitie, sedimentary, and volcanic grains. The sand compositions are arkoses in many sandstone classifications, although if fine silt is included with clay as matrix, the sand deposits are feldspathic or lithofeldspathic graywacke. The sands are apparently first-cycle products of deep dissection into a plutonic terrane, and they contrast sharply with arc-derived volcanic sandstones of similar age common on the adjacent North American continental margin. The turbidite sands are stratigraphically remarkably constant in composition, which indicates derivation from virtually the same terrane through a time span approaching 20 m.y.

Comparison of Aleutian plain data with the compositions of coeval sedimentary rocks from the northeast Pacific margin shows that the Kodiak shelf area includes possible proximal equivalents of the more distal turbidites. Derivation from the volcaniclastic Mesozoic flysch of the Shumagin-Kodiak shelf is unlikely; more probably, the sediments were derived from primary plutonic sources. The turbidites also resemble deposits in the Chugach Mountains and the younger turbidites of the Alaskan abyssal plain and could conceivably have been derived from the coast ranges of southeastern Alaska or western British Columbia. The Aleutian plain sediment most likely was not derived from as far south as the Oregon-Washington continental margin, where coeval sedimentary deposits are dominantly volcaniclastic.

This work lends some support to earlier suggestions that the fan-shaped turbidite body originated on the continental margin in the Gulf of Alaska, and it supports models of little or modest motion of the Pacific plate relative to North America. The mineralogy alone cannot refute more ambitious motion models, but when combined with previously published evidence on size of the plain, sediment thicknesses, and nanofossil species diversity, the data seriously constrain models requiring large-scale northwestward motion of the Pacific plate in post-Eocene time.

The Laramie granite underlies most of the northern half of the Laramie Range and forms a sharply discordant, nearly horizontal contact with older metamorphic rocks west of Boxelder Creek. Seven whole-rock samples of Laramie granite yield a Rb-Sr age of 2,567 ± 25 m.y., with an initial Sr\(^{87}/Sr^{86}\) ratio of 0.7026. The metamorphic rocks consist mainly of gray granite gneiss (2,759 ± 152 m.y. old) and leucogranite (2,776 ± 35 m.y. old), with sillimanite-bearing migmatitic gneiss.
(3,020 ± 221 m.y. old), amphibolite, and ultramafic rocks occurring interlayered with or as pods and stringers in the granite gneiss and leucogranite. The metamorphic rocks form a large fold with a nearly vertical axis. The granite gneiss and leucogranite are inferred to have been intruded magmatically into sillimanite-bearing gneiss, amphibolite, and ultramafic rocks between 2,700 and 2,800 m.y. ago. A low initial Sr$^{87}$/Sr$^{86}$ ratio for the granite gneiss suggests an origin in the lower crust or upper mantle. An unusually high initial Sr$^{87}$/Sr$^{86}$ ratio for the leucogranite suggests derivation largely from an older crustal source with a high Rb/Sr ratio.

□ 60520—Technique for measurement of isotropic magnetic susceptibility of till. M. Stupavsky, C. P. Gravenor, Department of Geology, University of Windsor, Windsor, Ontario N9B 3P4; R. Dumala, Department of Geography, University of Windsor, Windsor, Ontario N9B 3P4. (3 p., 4 tbls.)

Recent studies have shown that the isotropic magnetic susceptibility of till is a diagnostic property that can be used to characterize a till unit. The purpose of this study is to examine the techniques that have been used to measure the specific magnetic susceptibility of till and to recommend standard methods of measurement. Studies of specific magnetic susceptibility on till units from Illinois and Ontario show that the susceptibility of various size ranges of till carries information characteristic of the till and that in order to gain the maximum amount of information on a till, the susceptibility of various size fractions should be measured. It is also recommended that low-field measurements should be made so that measurements obtained in one laboratory can be duplicated in other laboratories.

□ 60521—Permian-Triassic boundary in eastern Nevada and west-central Utah. James W. Collinson, Department of Geology and Mineralogy, Ohio State University, Columbus, Ohio 43210; Christopher G. St. C. Kendall, EXXON Production Research Company, Houston, Texas 77001; Jonathan B. Marcantel, Shell Oil Company, Houston, Texas 77001. (4 p., 3 figs.)

The Permian-Triassic boundary in eastern Nevada and west-central Utah is placed at a disconformity above the Gerster Formation (Wordian) and below the Thaynes Formation (Smithian and Spathian). Evidence of subaerial erosion at the disconformity includes local truncation of Gerster beds by channels filled with chert and quartzite-pebble conglomerate. Westward onlap of Lower Triassic sedimentary deposits, as demonstrated by conodont zones, suggests an east-facing paleoslope over which the Early Triassic sea slowly advanced. The Sonoma orogeny, which coincided with the Late Permian—Early Triassic hiatus, may have been the cause of regional upwarping in eastern Nevada that produced the eastward paleoslope.
Underthrusting and Quaternary faulting in northern Central America. Michael J. Carr, Department of Geology, Rutgers College, New Brunswick, New Jersey 08903. (5 p., 6 figs.)

Earthquakes relocated by joint hypocenter determination define an inclined seismic zone in Guatemala and El Salvador approximately 15 km thick. This zone is segmented by one large change of strike and dip and two smaller changes in dip. The inclined seismic zone marks the upper part of the underthrust slab, and the discontinuities represent breaks segmenting the slab. The breaks occur in areas where they had been predicted on the basis of abrupt discontinuities in the volcanic chain.

Quaternary faulting is dominated by transcurrent fault zones. Left-lateral strike-slip fault zones strike transverse to the arc and coincide with the proposed breaks in the underthrust slab. Right-lateral fault zones strike parallel to the arc and approximately coincide with the volcanic chain. Subsidence of at least 500 m has occurred along the strike of the left-lateral and right-lateral fault zones and created a grid of troughs and depressions. The amount of horizontal movement is about 10 km for the transverse and longitudinal fault zones.

These seismic and geologic data suggest a segmented underthrusting process in northern Central America. The wedge of overriding lithosphere and the underthrust slab have transverse structures in the same areas. The left-lateral motion on N30°E-striking transverse faults can be deduced from the segmentation and an increasing rate of plate convergence to the southeast.