GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

MAY 1976

Two Penrose Conferences for Fall 1976

The Application of Crystal Growth Theory and Experiments to Rock Forming Processes, November 28–December 3, 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.

Implementation of Geological Information in Land-Use Planning, December 13–17, 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
National Microfilm Association (1973) $1 26 p.
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
National Microfilm Association (1974) $2 19 p.

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. Ultrafiche

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. Ultrafiche

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. 06497
A mail-order supplier with good prices on discontinued readers

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

Orco Microfilming
1010 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
and
20 Oakmont Court
San Rafael, Calif. 94901
Vantage readers with same-way scan

Ring King Visibles
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.

TABLE 1. SUMMARY OF AVAILABLE DATA

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

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.

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.

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 grain size (sand-silt-clay) and carbon-carbonate content, and the laboratory at the University of California, Riverside, has in the past examined sediment samples for mineral content 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.

Gross lithologic features of the DSDP cores are described from visual observation. Lithologic names are assigned after microscopic examination of smear slides. The visual core descriptions have been encoded using a simple data grammar and a minimum of editing. The resulting computer-readable files can be processed to generate an index of terms or searched for specific key words. The smear slide data are available for further processing as component-abundance couplets. Our processed smear slide file can also be used to generate a selective or exhaustive index by component. We are 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 group[1] 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 GUIDESEARCH has been developed.

Some 30 categories of data have been selected (in consultation with a number of sedimentologists, paleontologists, and stratigraphers) that give the information most generally useful for the selection of core material. The data have been extracted manually from the published volumes of the *Initial Reports* and should be 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

[1]The members of the group were Tj. H. van Andel, E. L. Winterer, and J. Duncan. P. R. Supko also attended group discussions.

included in the compressed format of the guide. Since samples used to determine different parameters are taken at different levels within a core, these parameters are not directly correlatable. The guide, however, does provide a general tabular summary of what may be found within each core.

At the present time copies of the guide may be obtained by writing to DSDP. It is hoped that in the near future copies will also be obtainable through the National Technical Information Service.

GUIDESEARCH is a data retrieval program designed to search the Master Guide File (MGF) and extract core records that fit a user-defined set of conditions. Thus, it is possible for the researcher to request a list of those cores that are, for example, Miocene in age, have a carbonate content less than 25 percent, and contain 25 percent or more montmorillonite. There is no practical limit to how many parameters may be specified in the request. We welcome requests for searches of the MGF. Search requests may be submitted as narrative descriptions of your search conditions or the type of geological environment you wish to define. These requests will be translated into GUIDESEARCH retrieval statements and submitted for processing. Requests for lists of cores meeting specific criteria, which can be answered using the GUIDESEARCH routine, should be addressed to Lillian Musich. Users who wish to exercise more direct control over their requests may wish to submit them directly as GUIDESEARCH statements. A complete document describing the syntax used with GUIDESEARCH is available by writing to Peter Woodbury.

Sample Request Information. Subsequent to the preparation of an initial shipboard description of the core material, samples of cores gathered by DSDP are made available to qualified investigators wishing to conduct their own detailed studies. (Availability of samples is governed by a Sample Distribution Policy approved by the National Science Foundation [August 1972]. Researchers intending to request samples should write to the Curator, DSDP, for further information.) In response to a growing need for information pertaining to a "subsequent sample request," DSDP has devised a system whereby necessary information can be quickly and efficiently retrieved. The data base is built from the sample request and bibliography files of the West Coast Repository and is initially used in the preparation of a computer-generated listing made available to investigators by the repository, entitled *A Guide to Publications and Subsequent Investigations of DSDP Materials.* It is updated every six months. Along with the data base is a program package (SAMSTAT) designed to rearrange the data base and perform simple calculations in order to provide basic management data relevant to monitoring subsequent research work and assisting in future planning for DSDP and related activities. Typical output is in the form of classified lists and matrix charts showing investigations currently in progress; the output is classified by type of investigation, types of institution with which investigators are associated, locations of investigators, and so forth.

CONCLUDING REMARKS

We would like to reiterate that DSDP represents not only a collection of core material but also an invaluable collection of marine geologic data that is available for the use of researchers throughout the world. We have described some of the ways in which we are trying to increase the accessibility and usefulness of these data.

This article has been written in response to numerous verbal requests from our colleagues concerning the availability of DSDP data. We hope we have answered their questions and perhaps have stimulated others to make use of this valuable resource.

The work described here represents a major part of an overall information handling scheme for DSDP. We appreciate the advice and guidance of the JOIDES Advisory Panel on Information Handling. The Deep Sea Drilling Project is supported by the National Science Foundation under contract NSF-C-482 with the University of California.

BOOK BRIEFS

This feature is included occasionally in the News & Information section to keep members informed of recent books published by the Society.

Cenozoic History and Paleoceanography of the Central Equatorial Pacific Ocean

MEMOIR 143 — by Tjeerd H. van Andel, G. Ross Heath, T. C. Moore, Jr. 1975. x + 134 p., 68 figures, 7 tables, $16.50.

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 paleobathymetric histories of the drill sites were derived. Additional supporting data from a set of sea-floor surface cores that penetrated pre-Quaternary deposits have been used for study of the temporal history of the dissolution of calcium carbonate.

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 calcite compensation depth shoaled. As a result, 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 western 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

MEMOIR 140 — by R. Gordon Gastil, Richard P. Phillips, and Edwin C. Allison. 1975. xii + 170 p., 66 figures, 14 tables, 6 plates (including a three-sheet folded map in color), $25.00—hardbound, $21.00—softbound.

The Mexican state of Baja California, which comprises the northern half of the peninsula of Baja California, extends northwestward 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).

The prebatholithic terrane of Baja California is represented by a western belt of rocks like those of the Franciscan assemblage, a belt of Mesozoic volcanic-volcaniclastic rocks, a belt of Mesozoic(?) slate and metasandstone, and, along the Gulf of California, Paleozoic rocks of various types. The volcanic-volcaniclastic rocks are, in part, contemporaneous with emplacement of batholiths.

Mesozoic regional metamorphism and the emplacement of batholithic rocks can be described in terms of four metamorphic rock associations: (1) essentially unmetamorphosed rocks, (2) slate and phyllitic rocks, (3) schist and amphibolite, and (4) rocks in which premetamorphic fabric has been entirely destroyed. Most of the plutons are found in schist and amphibolite; these exposures include tonalite (73 percent), granodiorite (23 percent), and gabbro (2 percent). Gabbro is common in the western half of the batholithic belt. No systematic increase in $(K_2O+Na_2O)/SiO_2$ is recognized across the peninsula.

The postbatholithic interval began about 90 m.y. ago. The erosion of the western portion of the metamorphic-plutonic terrane was accomplished within the first 20 m.y.; basement rock underlying the gulf area cooled somewhat later. Upper Cretaceous deposits were derived from the erosion of the western part of the peninsula. In contrast, the Paleocene-Eocene deposits included detritus derived from areas now within the Gulf of California depression and from areas farther east.

Although volcanism occurred locally during early Cenozoic time, widespread calc-alkalic volcanism and downfaulting of the gulf area began during late Oligocene time; the northern part of the gulf was flooded about 9 m.y. ago. About 6 to 8 m.y. ago, the gulf area was subjected to folding, uplift, and erosion that removed the early Cenozoic volcanic rocks from wide areas. During this interval, the peninsula also was uplifted and stripped of much of its Cenozoic cover. Alkalic basalt and basaltic andesite then poured across the dissected Pliocene-Pleistocene surface.

Remnants of erosional surfaces and coastal configurations were produced during Late Cretaceous and early Cenozoic time. These features were disrupted by volcanism and faulting in Miocene and later time, uplifted in the Pliocene Epoch, and deeply dissected by subsequent erosion.

Structurally, Baja California is divided into the stable western and central peninsula (Peninsular Ranges), the unstable continental borderland to the west, and the gulf depression to the east, which is a portion of the Basin and Range province. The borderland has been structurally distinct since at least Late Cretaceous time. The gulf depression has undergone about 50 percent dilation since the Oligocene Epoch, and extensional deformation is probably continuing.

A regional gravity survey of the state of Baja California shows the peninsula to be generally in isostatic balance. The Bouguer anomaly map reveals a gravity high that extends down the west coast from the Agua Blanca fault to at least lat 28°N.

Three distinct mineral provinces are the volcanic copper-iron province, which corresponds to the Mesozoic volcanic-volcaniclastic belt; the schist-gold province, which corresponds to the Mesozoic(?) slate and metasandstone belt; and the Cenozoic hydrothermal province of the gulf area where both base and precious metals are probably being deposited at the present time.

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 humerus—I. sinuosis,* and the *Streptognathodus parvus—Adetognathus spathus* Zones of Dunn (1970b), and the *Idiognathodus sinuosis, I. klapperi,* and *I. convexus* Zones of Lane and Straka (1974). The conodonts whose ranges are in question are *Gnathodus girtyi simplex, Rhachistognathus muricatus, Declinognathodus noduliferus, Adetognathus spathus, Neognathodus basleri bassleri,* 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.

☐ 60502—Crystallization history of lunar picritic basalt sample 12002: Phase-equilibria and cooling-rate studies. *D. Walker, R. J. Kirkpatrick, J. Longhi, J. F. Hays, Hoffman Laboratory, Harvard University, Cambridge, Massachusetts 02138.* (11 p., 12 figs., 2 tbls.)

Experimental crystallization of a lunar picrite composition (sample 12002) at controlled linear cooling rates produces systematic changes in the temperature at which crystalline phases appear, in the texture, and in crystal morphology as a function of cooling rate. Phases crystallize in the order olivine, chromium spinel, pyroxene, plagioclase, and ilmenite during equilibrium crystallization, but ilmenite and plagioclase reverse their order of appearance and silica crystallizes in the groundmass during controlled cooling experiments. The partition of iron and magnesium between olivine and liquid (K_D = 0.33) is independent of cooling rate (0.5°to 2000°C/hr), temperature (1325° to 600°C), and pressure (0 to 12 kb). Comparison of the olivine nucleation densities in the lunar sample and in the experiments indicates that the sample began cooling at about 1°C/hr. Pyroxene size, chemistry, and growth instability spacings ("swallowtails"), as well as groundmass coarseness, all suggest that the cooling rate subsequently decreased by as much as a factor of 10 or more. The porphyritic texture of this sample, then, is produced at a *decreasing,* rather than a discontinuously increasing, cooling rate.

☐ 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 northeasterly, 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 anticyclonic 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 F_1 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 F_1 ($\sim$1,400 m.y. B.P.) folding in the area. The uranium content of the garnets varies from 1.76×10^{-8} g/g to 21.4×10^{-8} g/g.

☐ 60508—Post-Pleistocene history of the United States inner continental shelf: Significance to origin of barrier islands. *Michael E. Field, David B. Duane, Geology Branch, U.S. Army Coastal Engineering Research Center, Kingman Building, Ft. Belvoir, Virginia 22060. (Present address, Field: Pacific-Arctic Branch of Marine Geology, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. Duane: Grants Management Program, National Sea Grant Program, NOAA, 3300 Whitehaven Street N.W., Washington, D.C. 20235.)* (12 p., 10 figs.)

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 shoreface 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.

☐ 60509—Obsidian hydration dating and correlation of Bull Lake and Pinedale Glaciations near West Yellowstone, Montana. *Kenneth L. Pierce, John D. Obradovich, Irving Friedman, U.S. Geological Survey, Denver, Colorado 80225.* (8 p., 5 figs.)

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 (1σ).

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.

☐ 60510—Radiocarbon profile of Hanauma Reef, Oahu, Hawaii, *W. H. Easton, Department of Geological Sciences, University of Southern California, Los Angeles, California 90007; E. A. Olson, Department of Earth Sciences, Whitworth College, Spokane, Washington 99251.* (9 p., 4 figs., 2 tbls.)

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^{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^{11} 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.

☐ 60511—Theory of plasticity applied to faulting, Mojave Desert, southern California. *David Cummings, Department of Geology, Occidental College, Los Angeles, California 90041.* (5 p., 3 figs.)

The Mojave Desert region, a triangle-shaped area in southern California, is bounded on the northwest by the left-slip Garlock fault and on the southwest by the right-slip San Andreas fault. Within the triangle partly defined by these two faults, right-slip northwest-trending and left-slip northeast-trending faults occur. The structural geology and fault pattern within the triangle are uniform and internally consistent and are markedly different from the structural geology and fault pattern of the areas to the 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.

□ 60512—Mechanism of burial metamorphism of argillaceous sediment: 1. Mineralogical and chemical evidence. *John Hower, Department of Earth Sciences, Case Western Reserve University, Cleveland, Ohio 44106; Eric V. Eslinger, Department of Geology, West Georgia College, Carrollton, Georgia 30117; Mark E. Hower, Department of Mathematics, Middlebury College, Middlebury, Vermont 05753; Edward A. Perry, Department of Geology, University of Massachusetts, Amherst, Massachusetts 01002.* (13 p., 12 figs., 9 tbls.)

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 mineralogic 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 increase in amount. Variations in the bulk chemical composition of the shale with depth show only minor changes, except for a marked decrease in CaO concomitant with the decrease in calcite. By contrast, the <0.1-μm fraction (virtually pure illite/smectite) shows a large increase in K_2O and Al_2O_3 and a decrease in SiO_2. The atomic proportions closely approximate the reaction smectite + Al^{+3} + K^+ = illite + Si^{+4}. The potassium and aluminum appear to be derived from the decomposition of potassium feldspar (and mica?), and the excess silicon probably forms quartz. We interpret all the major mineralogical and chemical changes as the response of the shale to burial metamorphism and conclude that the shale acted as a closed system for all components except H_2O, CaO, Na_2O, and CO_2. Compositional changes in the shale as a function of metamorphic grade closely parallel compositional changes in shale as a function of geologic age.

□ 60513—Mechanism of burial metamorphism of argillaceous sediment: 2. Radiogenic argon evidence. *James L. Aronson, John Hower, Department of Earth Sciences, Case Western Reserve University, Cleveland, Ohio 44106.* (7 p., 5 figs., 2 tbls.)

Variations in the $^{40*}Ar$ of the whole rock and the <0.1-μm fraction were used to monitor the involvement of K_2O in the inferred burial metamorphic reactions of argillaceous sediment from Texas Gulf Coast well CWRU (Case Western Reserve University) 6. These data strongly support the occurrence of the reactions involving the illite/smectite mixed-layer clay inferred from depth-dependent mineralogical and chemical changes reported in a companion paper by Hower and others (this issue). The ^{40}Ar released from all samples was generally greater than 40 percent radiogenic ($^{40*}Ar$), allowing precise measurement of differences of $^{40*}Ar$ with depth.

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 $^{40*}Ar$ from the rock. The $^{40*}Ar$ loss is not caused by outgassing from increasing temperature, because the finest (<0.1-μm) fraction, which is nearly pure illite/smectite, actually gains $^{40*}Ar$ with depth. The coarser fraction, from which the $^{40*}Ar$ loss is occurring, concentrates the older $^{40*}Ar$-rich phases of the rock such as K-feldspar and mica. These results strongly imply that the K_2O for the new illite layers of the illite/smectite is derived by chemical decomposition of the K-feldspar and mica. The gain in $^{40*}Ar$ of the finest fraction also just corresponds with depth to the change in mineralogy of the illite/smectite and a large gain of K_2O in this fraction from 2 to 5 percent K_2O. The $^{40*}Ar$ gain indicates that the mean time of K_2O gain, which is the mean time of burial metamorphism, was about 18 m.y. ago.

□ 60514—Experiments on the origin of slaty cleavage and schistosity. *Terry E. Tullis, Department of Geological Sciences, Brown University, Providence, Rhode Island 02912.* (9 p., 8 figs.)

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.

☐ 60515—Elemental and isotopic geochemistry of nonhydrated 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 SiO_2 and are extremely rich in large-ion lithophile elements. The K_2O 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-alkalic suites. Initial $^{87}Sr/^{86}Sr$ ratios of 0.7054 to 0.7055 are consistent with the pattern of northwestward decrease in $^{87}Sr/^{86}Sr$ observed for Mesozoic plutonic and Cenozoic volcanic rocks in the western Great Basin and Sierra Nevada provinces. The glasses are higher in Rb than are Mesozoic granitic rocks of the Sierra Nevada batholith that have comparable Sr contents and initial $^{87}Sr/^{86}Sr$ ratios. Pb isotopic compositions fall at the upper end of arrays found for upper Cenozoic calc-alkalic rocks from the Cascade Mountains and nearly on trends found for rocks of the Sierra Nevada batholith. The moderately high FeO*/MgO ratios, very low Co, Cr, and Ni contents, high Ba/Sr and K/Sr ratios, and approximately 25 percent negative Eu anomalies demonstrate that the glasses are the products of appreciable crystal fractionation. This in turn strongly suggests that the Eureka Valley Tuff was derived from a hypersthene-normative or only slightly quartz-normative parent magma. A model is outlined in which a potassic mafic parent magma was produced by a moderate degree of partial melting of diapirically upwelling, undepleted ultramafic mantle material followed by zone refining of upwelling mantle and other material within the asthenosphere and lithosphere. Extensive fractional crystallization and crystal separation subsequently enriched the melt further in large-ion lithophile elements. The evidence for appreciable plagioclase separation demonstrates that much fractionation took place well within the Earth's crust. The Tollhouse Flat and By-Day Members were erupted from discrete—although closely related—bodies of magma. Lower water and halogen contents of the By-Day magma may have prevented the intratelluric crystallization of biotite and thereby allowed the magmatic liquid to become richer in K and Rb than that of the more highly fractionated Tollhouse Flat Member.

☐ 60516—Rb-Sr ages of granitic rocks in southeastern China and their tectonic significance. *Bor-Ming Jahn, TN7/Geochemistry Branch, National Aeronautics and Space Administration Johnson Space Center, Houston, Texas 77058; P. Y. Chen, Department of Geology, National Taiwan University, Taipei, Taiwan; T. P. Yen, Geological Survey of Taiwan, Taichung, Taiwan.* (14 p., 7 figs., 2 tbls.)

Rb-Sr age data and initial Sr^{87}/Sr^{86} ratios (I values) are reported for the Mesozoic granitic batholiths along the coast of southeastern China. Two major thermal episodes are recognized: 90 to 120 m.y. B.P., derived from the mineral isochrons, and 165 ± 13 (2σ) m.y. B.P., derived from a whole-rock isochron. These episodes appear to be correlative with periods of rapid spreading of the Mesozoic Pacific Ocean floor and embrace two orogenic phases of the Yenshan orogeny.

The I values of granitic gneisses (0.7060 to 0.7159) vary systematically with the Rb/Sr ratios of their whole-rock samples. The high I value (0.7112) of a pegmatite dike cutting a granitic gneiss in Chinmen suggests that the pegmatite is derived from remelting of upper crustal rocks. The narrow range of I values for more mafic intrusive bodies in Matsu (0.7065 to 0.70695) suggests that they are genetically related and are probably derived from an upper mantle source and have some crustal contamination. An unmetamorphosed granitic sample from Changlo has a mineral isochron age of about 120 m.y., which is interpreted as the time of intrusion. Its rather low I value (0.70546) suggests that the magma source is likely in the upper mantle.

The Yenshan orogenic belt in southeastern China may belong to the inner belt of the Pacific-type orogeny; it is characterized by polycyclic 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 northwestward in the western Pacific region during late Mesozoic time.

□ 60517—Geochemistry and origin of basalt of the Columbia River Group, Oregon and Washington. *Ian McDougall, U.S. Geological Survey, Menlo Park, California 94025 (present address, Research School of Earth Sciences, Australian National University, Canberra, A.C.T. Australia 2600).* (16 p. 9 figs. 7 tbls.)

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.

□ 60518—Turbidites of the Aleutian abyssal plain: Mineralogy, provenance, and constraints for Cenozoic motion of the Pacific plate. *Richard J. Stewart, Department of Geological Sciences, University of Washington, Seattle, Washington 98195.* (16 p., 14 figs., 3 tbls.)

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 sphene. The light-mineral fraction is mostly quartzose debris and feldspars. Subordinate lithic fragments consist of roughly equal amounts of metamorphic, plutonic, 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 nannofossil species diversity, the data seriously constrain models requiring large-scale northwestward motion of the Pacific plate in post-Eocene time.

□ 60519—Precambrian geochronology and geology of the Boxelder Canyon area, northern Laramie Range, Wyoming. *Ronald C. Johnson, F. Allan Hills, Department of Geological Sciences, State University of New York at Buffalo, Buffalo, New York 14226. (Present address: Johnson, U.S. Geological Survey, Branch of Chemical Resources, Denver, Colorado 80225; Hills, U.S. Geological Survey, Branch of Uranium and Thorium Resources, Denver, Colorado 80225.)* (9 p., 9 figs., 1 tbl.)

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.

PLEASE NOTE: Only those GSA members who have paid for 1976 dues options B or C are entitled to Bulletin separates. Those who chose options A, D, or E, or those who have not yet selected and paid for their 1976 options, are not entitled to Bulletin separates.

Indicate documents desired by checking appropriate boxes; insert coupon in envelope and mail to GSA. You may choose as many articles per month as you wish, but no more than the number specified for the option you selected (24 or 36) per year.

If you desire multiple copies, note on the coupon the number of copies you want. *Only original coupons and labels with proper membership numbers will be honored.* Inquiries should be mailed to the Publication Sales Department.

From
Publication Sales Department
The Geological Society of America, Inc.
3300 Penrose Place
Boulder, Colorado 80301

TO:

MAY

☐ 60501	☐ 60513
☐ 60502	☐ 60514
☐ 60503	☐ 60515
☐ 60504	☐ 60516
☐ 60505	☐ 60517
☐ 60506	☐ 60518
☐ 60507	☐ 60519
☐ 60508	☐ 60520
☐ 60509	☐ 60521
☐ 60510	☐ 60522
☐ 60511	☐ 60523dr
☐ 60512	

☐ ____________

☐ ____________

☐ ____________

(from other issues)

☐ May *Bulletin* @ $6 each

☐ 60522—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.

☐ 60523dr—Carboniferous subduction complex in the Harz Mountains, Germany: Discussion and reply.

Discussion: *W. Krebs, H. Wachendorf, Institut für Geologie und Paläontologie der Technischen Universität, Pockelsstrasse 4, 33 Braunschweig, Federal Republic of Germany.*

Reply: *Timothy A. Anderson, Bundesanstalt für Geowissenschaften und Rohstoffe, Stille Weg 2, 3 Hannover 51, Federal Republic of Germany.*

GSA news & information