GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

JUNE 1977

Council Actions: Fall Meeting, November 7 and 9, 1976

The following actions were taken by the GSA Council at its fall meeting in Denver:

1. Adopted the *Annual Report for 1976* as the report of the Council.
2. Approved the 1977 operating budget.
3. Approved certain financial resolutions.
4. Discussed the investment policies and procedures of the Society.
5. Discussed establishing a fund-raising program to be tied to the Society's Centennial in 1988.
6. Selected members for the 1977 committees and members to be Society representatives.
7. Ratified the 1976 Joint Technical Program Committee roster and the membership of the 1977 Committee on Committees.
8. Discussed the appointment of the Science Editor; hired Paul Averitt as Interim Science Editor, effective 1-1-77.
9. Assigned national officers to attend the 1977 Section annual meetings.
10. Advanced 16 Members to Fellowship and ratified the election of 141 candidates to Membership in the Society.
11. Authorized the suspension of membership of those whose dues are in arrears for 13 months; authorization to be in effect until further notice.
12. Devised a mechanism for approving Environmental and Public Policy Committee panel reports which might be ready before the May 1977 Council meeting.
13. Approved the new procedure whereby the Executive Committee would give final approval or disapproval to Penrose Conference proposals on recommendation of the Penrose Conference Committee; approved the arrangement whereby the logistical services for Penrose Conferences would be contracted for with an independent provider, effective 3-1-77; approved two Penrose Conference proposals.
14. Directed that the unrestricted monetary gifts received from Michel T. Halbouty and from Mobil Oil Corp. be added to the funds available for research grants in 1977.
15. Noted the contributions to the GSA research grants program received from oil companies and past research grant recipients.
16. Directed that the Subcommittee on the National Medal of Science be responsible for the selection of a nominee whose name will be submitted to the Texas Instruments Foundation for consideration of that organization's Founders' Prize.
17. Voted to support the *Treatise on Invertebrate Paleontology* for 1977 by a contribution of $20,000.
18. Approved the appointment of an ad hoc committee on the Criteria for GSA Associated Societies.
19. Accepted reports from standing committees, GSA Sections, Divisions, and representatives to non-GSA groups.
20. Approved the award winner from the Hydrogeology Division.
21. Discussed the relationship between GSA's Engineering Geology Division and the Association of Engineering Geologists.

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22. Established a GSA History of Geology Division.

23. Adopted a policy of selling extra copies of *Abstracts with Programs* at Section meetings on consignment.

24. Voted to appropriate $1,000 to each Section to subsidize student attendance on Section meeting field trips.

25. Named representatives to GSA-AEG-ASCE Joint Committee on Engineering Geology and to U.S. National Committee on Tunneling Technology.

26. Adopted a resolution of thanks to outgoing officers, councilors, committee people, and all those responsible for the successful Denver annual meeting.

27. Discussed the items covered during the Section Officers' Meeting in Denver on November 8, 1976.

28. Selected the dates of May 3–4, 1977, for the spring meeting of the Council to be held in Boulder, Colorado.

29. Took other minor actions, records of which are on file at headquarters.

Report of Committee on Publications

To the Council and Membership of The Geological Society of America, Inc.:

Dr. Peter J. Smith of the Open University, England, was chosen as the Society's Science Editor after being interviewed by the Executive Committee in New York and by the Council in Salt Lake City. As a result of discussions with Dr. Smith, the Council approved a new Statement of Publications Policy, which has been published in *GSA News and Information* (April, 1976).

But despite every endeavor by the Society, Dr. Smith's visa had not been granted by the end of the year. Through Congressman Frank Evans, whose intervention on the Society's behalf we greatly appreciate, the papers were treated in the Department of Immigration and marked for expeditious decision.

Through this difficult period, when the Committee was compelled to "tread water," the Chairman kept in touch with the Executive Director and, when needed, with the President. The Committee held its spring meeting at Boulder, March 4–5, 1976. Because many members attended the International Congress in Australia, it was not possible to hold a meeting during the summer, and the Committee met instead during the National Meeting at Denver. We had looked forward to the participation of Dr. Smith as our new Science Editor, but this expectation was disappointed. The Executive Committee had, however, invited Dr. Smith to attend, and he did meet with the Committee, though not in an official capacity. Because the former Chairman was occupied in an attempt to have a decision made regarding Dr. Smith's visa, and because Council had already appointed the Committee for 1977, Leon T. Silver, the new chairman, conducted this meeting.

The Committee discussed or acted on the following:

1. Cost of printing and binding has been considerably reduced and drastic measures have been taken to cut the cost of the Society's publications. Further large economies will be hard to achieve.

2. Dues now almost pay for the publications going to members, but there is no surplus for support of the Membership Department or other activities of the Society.

3. The size of each issue of the *Bulletin* will be increased in order to help reduce the growing backlog of papers, but this action by itself will not solve the problem.

4. Whenever appropriate, publications proposed for the Special Paper series will be handled within the Map and Chart series, with text on microfiche, or be resubmitted for publication in the *Bulletin* or other format.

5. The use of the Microform Publications series is encouraged. Two articles, written by the Chairman, describing available microfiche readers have been published in *GSA News and Information,* (Dec. 1975 and May 1976). The staff was asked to investigate the feasibility of publishing in microfiche some of the papers that would otherwise go into the *Bulletin*.

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6. There is a growing number of papers being submitted by non-American authors requiring extensive rewriting. The Society cannot afford to provide the editorial service needed to make the papers acceptable.

7. Mailing envelopes have been reintroduced reduce the number of damaged copies of the *Bulletin*.

8. The Separates Option has been underpriced, and the Committee recommended reducing the number of separates provided from 36 to 24 per year.

9. Special procedures were approved for the issues of the *Bulletin* dedicated to the scientific results from the international FAMOUS expedition.

10. To avoid increasing the price of the *Bibliography and Index of Geology* in 1977, publication of four annual, cumulative, hard-bound volumes will be discontinued. Two paper-bound volumes of the cumulative index will be issued for volume 41, 1977.

11. Orson L. Anderson was appointed Chairman of a subcommittee to investigate the problems of distributing data bases, especially with regard to copyright.

12. The Society's practice of permitting reviews to remain anonymous has been called in question. The Committee has supported the Editors in continuing the practice.

The Committee expressed profound gratitude to John Frye and his staff, particularly to S. Warren Hobbs, Interim Science Editor, and to Henry Spall, Editor of *Geology*, for continuing our publications program so effectively under these difficult and uncertain conditions. We are deeply indebted to our conferee, George Becraft, and to the U.S.G.S. for permitting Warren Hobbs and Henry Spall to give the Society this invaluable and timely service.

Respectfully submitted,

DONALD McINTYRE, *Chairman*

As well as the Editorial Board of *Geology*, the following have reviewed manuscripts for *Geology* in 1976:

Patrick L. Abbott
Hans D. Ackermann
William Adams
Carol Wagner Allison
Roger N. Anderson
Thomas H. Anderson

Wolfgang H. Berger
Shawn Biehler
David D. Blackwell
Enrico Bonatti
Edwin H. Brown
H. Robert Burger

Lawrence Cathles
Sambhudas Chaudhuri
Clement G. Chase
Philip W. Choquette
Russell E. Clemons
James B. Combs
Lindrith E. Cordell

G. Brent Dalrymple
Stephen E. DeLong
John F. Dewey

David H. Eggler
Donald P. Elston
Robert W. Embley
Paul Enos

Paul J. Fox
Roland B. French
Gerald M. Friedman
Michael D. Fuller

Robert B. Ginsburg
Samuel S. Goldich
Conrad P. Gravenor
Jane Gray
Richard H. Groshong, Jr.

Stephen E. Haggerty
Christopher G. A. Harrison
Robert D. Hatcher, Jr.
Milton T. Heald
Carl E. Hedge
Mason L. Hill
Robert J. Horodyski
Francis M. Hueber
Donald Hunter

W. Porter Irwin

Lois M. Jones

Hiroo Kanamori
William M. Kaula
W.S.F. Kidd
Stephen H. Kirby
Gilbert Klapper

Paul D. Komar
David H. Krinsley
Keith A. Kvenvolden

Edward G. Lidiak
Earl M. P. Lovejoy

William D. MacDonald
Peter Matson
Donald B. McIntyre
Robert E. McLaughlin
Daniel F. Merriam
Arthur A. Meyerhoff
John D. Milliman
John Montagne
James G. Moore
Eldridge M. Moores
Robert A. Morton
M. Paul Mosley
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Dietrich H. Roeder
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Allan R. Sanford
Michael F. Sheridan
Norman H. Sleep
William H. Spence
John Splettstoesser
John H. Stewart
John R. Sturgul
Chandler A. Swanberg
David T. Symons

Michael E. Taylor
Wayne Thatcher
Robert J. Twiss

James B. Urban

James W. Valentine

Stanley H. Ward
E. H. Timothy Whitten
John S. Wickham
Dennis S. Wood
Lauren A. Wright

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Magnetization of sediments and magnetostratigraphy subjects of Penrose Conference, Dec. 12–16

A Geological Society of America Penrose Conference on "Magnetization of Sediments and Magnetostratigraphy" will be held December 12–16, 1977, at Durango, Colorado. The conference is intended to encourage the development and understanding of this topic by providing an opportunity to bring together sedimentologists, sedimentary petrographers, sedimentary geochemists, and stratigraphers with a group of individuals generally classed as geophysicists. These include rock magnetists, paleomagnetists, and solid state physicists.

The interaction of these groups of individuals representing many subdisciplines is certain to increase our understanding of the origin of the magnetization of sediments and should also foster additional applications of this relatively new branch of science to the more classical problems of stratigraphic correlation, sediment diagenesis, and regional and global tectonics.

Fees are expected to be $275–300, including a field excursion to stratigraphic sections in the Colorado Plateau. The deadline for applications is October 15; applications should include (a) name, affiliation, and position; (b) field of interest pertinent to participation in the conference; (c) topics on which the applicant is prepared to present material either as a talk or as part of a discussion group.

Inquiries and applications should be sent to either of the conveners:

Dr. Charles Helsley
Director, Hawaii Institute of Geophysics
University of Hawaii at Manoa
2525 Correa Road
Honolulu, Hawaii 96822

Dr. Ed Larson
Department of Geology
University of Colorado
Boulder, Colorado 80302

National topographic maps available on microfiche

The newest collection of maps on microfiche prepared by the Micrographic Laboratory of the University of Northern Colorado is a complete set of National Topographic Maps for the United States. It includes all contiguous 48 states, Guam, Hawaii, Puerto Rico, and American Samoa; they are collected on some 90 microfiche containing 480 maps. There will be a separate collection of the 183 Alaska topographic maps.

Each map is approximately 22" by 32," though there is a wide variation in size; one of them is 35" x 61." Where possible the series includes the standard 250,000:1 series maps.

Each microfiche title strip contains all of the important information about the map: Series Name–U.S.G.S. National Topographic Maps; States included on the maps–some have only one, others touch several states; Army Map Service identification and file number, unique to each map to facilitate filing; Latitude and Longitude; Map Scale; Date of filming and reduction size; Complete map name; and Date(s) of map survey and publication.

These maps on microfiche have a greater accuracy and wealth of detail than almost any available atlas. Each map is approximately twice the size of a typical atlas page. Maps contain a wide variety of features: contour lines, wooded areas, deserts, dunes, marshes, above-timberline areas, scrub oak and pine, and on a few coastal areas, bathymetric readings. In addition, they include all National Parks and Monuments, National Forests and Wilderness Areas, and many other features. Most of the maps have been revised and updated in the late 1960s or early 1970s.

For more information write to Robert P. Markham, Editor; Micrographic Laboratory; James A Michener Library; University of Northern Colorado; Greeley, Colorado 80639.

Section Officers and Committees please note

Simplified communications system set up for your use

It has been brought to the attention of headquarters that there are many occasions when section officers and section-meeting committee chairmen do not know which unit of headquarters to contact with a question. As a result, it has been requested that a single person be designated as liaison not matter what the question is. To comply with this request, Mrs. Dorothy M. Palmer has agreed to serve in this capacity, therefore all calls should be directed to her. She will not be able to handle all of the problems personally, but she will see to it that the caller is put in contact with the appropriate person. By using this system, for example, if the question involves exhibits, and Fred Handy is out of the office, Dorothy will get you in touch with someone who can cope with the question; if it's a money handling problem, she will put you in contact with the right person in the accounting department.

After the system has operated for a few months, we solicit your comments about how well it is working and how you like it.

Another item of communication: A complete revision of the handbook for section meetings is well along, and section officers will be getting a copy sometime in June. It is hoped that the new handbook will be of assistance for the 1978 meetings. Here again, your comments are solicited as a guide for the next revision of the handbook.

THE IMPACTS AND MANAGEMENT OF OFF-ROAD VEHICLES

A Report of the Committee on Environment and Public Policy

The Geological Society of America, through its Committee on Environment and Public Policy, is playing an increasingly active role in identifying and explaining problems that arise from the impact of civilization on our environment. The solutions to many of these problems require the input of information from Earth science, and, accordingly, the committee has published several Information Papers on topics of immediate environmental interest. A paper on the "Impacts and Management of Off-Road Vehicles" has been prepared, which explains the environmental problem and suggests ways by which a solution can be found, using information from Earth science. The paper is directed particularly to legislators, administrators, and managers at Federal, state, and local levels, but every citizen has an equal responsibility to be informed about the impacts of off-road vehicles. Thus, the paper is being distributed to all GSA members on request as well as to many public officials. Publication and distribution of this paper has been funded by National Science Foundation Grant EAR 75-16285 AO1.

The Geological Society of America
Publication Sales Department
3300 Penrose Place
Boulder, CO 80301

Please send me, free of charge, _____ copies of the "Impact and Management of Off-Road Vehicles"

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BOOK BRIEFS

Interdisciplinary Studies of Peat and Coal Origins

MICROFORM PUBLICATION 7 — Edited by P. H. Given and A. D. Cohen. 1977. 174 pages, 50 figures, 23 tables. On two 24× microfiche. ISBN 0-8137-6007-0. $4.00.

This publication is derived from the symposium, "The Geology, Paleobotany, Geochemistry, and Microbiology of Peats," which was held during the Miami national meeting of the Geological Society of America in 1974, and jointly sponsored by the Coal Geology Division of the Society and the Organic Geochemistry Division of the Geochemical Society. Fourteen papers were presented; five authors elected to make other arrangements for publishing their work, but the abstracts of these five papers are included for completeness. Workers in a variety of fields contributed to the symposium, but it is perhaps fair to say that the central theme is the consideration of peat as the precursor of coal.

Robinson and Melton, Caruccio and Ferm discussed back-barrier coals that formed in saline conditions near a coast behind a beach barrier. Casagrande and Erchull, Reuter and Beck studied the modern Okefenokee Swamp which could be accurately described as a back-barrier peat swamp, inasmuch as it occurs in the lee of a sandy beach barrier. No mature coal laid down in fresh water behind a beach barrier has yet been identified that was already ancient at the time of deposition; even the possibility of this had not been appreciated before the Okefenokee Swamp was studied.

Three studies using different experimental approaches (Ting; Phillips and others; Niklas and Phillips) elucidate the plants that have given rise to peats in past eras. Phillips and others were able to reconstruct, from a study of coal balls, the succession of floras that inhabited a swamp of Carboniferous age. Gleason and his co-workers showed that in three climatically and vegetationally distinct areas a broad similarity occurs in the succession of plant types represented in profiles of modern sediments.

Casagrande and Erchull concluded from their study of Okefenokee peats that there is little need to postulate epigenetic acquisition of trace elements to account for the distributions found in coals. They did not find correlations between trace element distributions and the succession of the plant communities that gave rise to the peats. On the other hand, Cameron and Wright did find evidence that the nature of the plant cover indeed determines distributions of some elements. These authors studied raised bogs formed in glacial kettles that are now populated mainly by mosses rather than vascular plants. Therefore, one may suspect that the character of the biota can, in other environments, determine the relative amounts of the minor and trace elements, including micronutrients, that accumulate in a peat swamp.

Calder and Kearsley noted that although peats may be strictly autochthonous as judged by the recognizable plant tissues in them, chemically they may be partly allochthonous. These authors demonstrated that a Florida salt marsh receives dissolved organic matter from landward areas. They and Reuter and Beck showed that leaching of organic matter from marshes and swamps also occurs. Sassen demonstrated that the distributions of fatty acids in mangrove peats and in the organisms that gave rise to them are distinctively different. This difference may to some extent represent an allochthonous contribution to the peats, but it is due mostly to differential consumption of some fatty acid structures by microorganisms, and may also be due partly to contributions from cellular substances of the microflora itself.

The microbiology of peats may well be the most neglected area of peat studies. It is therefore gratifying that four papers in this symposium bear, in one way or another, on this topic. Fell's study was performed as a contribution to the ecology of the bays and estuaries bordering the Florida Everglades and concerns the fungal and meiofaunal attack on mangrove leaves that were washed into bodies of water by tidal action.

The study of marsh gases by Swain and others provides indirect evidence of the activity of certain taxa of microorganisms in peats. Exarchos and Given showed by experiments with pure polymers that the potentiality for rapid microbial destruction of the polymers of plant cell walls does exist in peats; the authors speculate as to why this potentiality is not fully realized.

Botryococcus braunii (green alga), or a closely related species, is the principal precursor of the Scottish algal coal known as torbanite and of the Australian coorongite. It is also the principal contributor to the coal maceral known as alginite. The observations of Niklas and Phillips to some extent document the way in which this organism makes its contribution to organic sediments.

CONTENTS: Preface. Petrography and Paleobotany of a Petrified Paleocene Peat and Its Bearing on the Coalification of Lignite, Abstract only (by Francis T. C. Ting). The Beckley Seam—An Example of a Back-Barrier Coal in Southern West Virginia, Abstract only (by M. J. Robinson and R. A. Melton). Paleoenvironment Reconstructions—An Aid in Predicting Acid Mine Drainage Problems (by F. T. Caruccio and J. C. Ferm). Paleobotany of Permineralized Peat (Coal Balls) from the Herrin (No. 6) Coal Member of the Illinois Basin (by T. L. Phillips, A. B. Kunz, and D. J. Mickish). Some Peat Bogs in Washington County, Maine: Their Formation and Trace-Element Con-

tent (by C. C. Cameron and N. A. Wright). Organic Geochemistry of Okefenokee Peats: Metal Constituents (by D. J. Casagrande and L. D. Erchull). Characteristics and Peat Stratigraphy of Tree Islands in Certain Wetland Environments (by P. J. Gleason, R. H. Hofstetter, A. D. Cohen, and P. A. Stone). Morphological and Microchemical Correlations of Living and Fossil *Botryococcus*, Abstract only (by K. J. Niklas and T. L. Phillips). Early Diagenesis of Fatty Acids in Mangrove Peats, St. Croix, U.S. Virgin Islands (by R. Sassen [Note: Correct author's name to *Roger* on microfiche card 2, page 109]). Microbial Activities in the Decay of *Rhizophora mangle* Leaves, Abstract only (by J. W. Fell). Cell Wall Polymers of Higher Plants in Peat Formation: The Role of Microorganisms (by C. Exarchos and P. H. Given). Environmental Aspects of Marsh Gases (by F. M. Swain, B. D. Johnson, and J. J. Pittman). Geochemical Effects of Organic-Rich Swamp Effluents from the Okefenokee Swamp-Marsh Complex of Southern Georgia, Abstract only (by J. H. Reuter and K. C. Beck). Particle Size Distribution and ^{13}C Content of Dissolved Organic Matter in a Salt Marsh (by J. A. Calder and F. Kearsley).

June BULLETIN briefs

Brief summaries of articles in the June 1977 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.*

• 70601—Geology and structural evolution of Old Dad Mountain, Mojave Desert, California.

George C. Dunne, Department of Geosciences, California State University, Northridge, California 91324. (12 p., 5 figs., 1 tbl.)

Rock units representative of most pre-Cenozoic formations in the southern Cordilleran geosyncline, as well as major structures developed during multiple periods of Mesozoic and Neogene deformation, are exposed at Old Dad Mountain, Mojave Desert, California. Precambrian metamorphic basement is overlain by upper Precambrian through Permian miogeosynclinal strata; intruding and (or) resting upon these strata are predominantly igneous rocks, which are interpreted as parts of the eastern margin of a Mesozoic Andean-type volcanic-plutonic arc.

Structures formed during three phases of deformation of probable Mesozoic age are exposed at Old Dad Mountain. An important unconformity gives evidence of Late Triassic and (or) Early Jurassic unrest, and a thrust fault of this age may underlie Old Dad Mountain. A younger northwest-trending shear zone appears to have accommodated a significant component of left slip during Mesozoic time; it may be an analog of longitudinal faults within and behind modern volcanic-plutonic arcs. Remnants of the Playground thrust plate that moved eastward or southeastward at least 2.5 km during late(?) Mesozoic time overlie this shear zone.

Superimposed on these older features are steeply dipping faults, gentle folds, and landslide masses related to movements on the Old Dad normal fault, a Basin and Range fault of Neogene age.

Recognition of early Mesozoic and probable late Mesozoic structures of compressional origin at Old Dad Mountain lends support to the hypothesis that the eastern Mojave Desert is the site of widespread overlap of early Mesozoic and late Mesozoic orogenic belts.

• 70602—Agulhas Plateau off southern Africa: A geophysical study.

Douglas M. Barrett, Bernard Price Institute of Geophysical Research, University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg 2001, South Africa. (15 p., 13 figs.)

Refraction data from the Agulhas Basin, south of southern Africa, show a crustal structure compatible with deep-water marine stations. Moho is about 10 km deep, and the crust is believed to be of oceanic origin. On the Agulhas Plateau, a basement layer having a seismic velocity of 4.84 km/s overlies the main crustal layer that has a velocity of 6.72 km/s. This structure is not continental but resembles that of certain volcanic features in the Indian and Pacific Oceans, such as the Chagos-Laccadive and Hawaiian Ridges. The Agulhas Plateau is interpreted to be of oceanic origin. The plateau can be divided into two physiographic provinces. The southern province is characterized by a smooth basement overlain by relatively undisturbed sediment 0.5 to 1.0 km thick. In the northern province, the basement topography is rough. The origin of the relief is not clear, but several possible models are suggested. The influence of bottom currents is marked in this region, and the sediments are more disturbed. Large magnetic anomalies are found over the plateau, many of which are generated by basement topography. Remanent reversal stripes cannot be identified with certainty. Magnetic models that incorporate the basement relief suggest that the basement material is basalt. The magnetic results support the refraction interpretation of a volcanic constitution. The Agulhas Plateau was apparently formed during or after the separation of the Falkland Plateau from southern Africa.

• 70603—Caledonian plate tectonics and the place of the English Lake District.

Frank Moseley, Department of Geological Sciences, University of Birmingham, B15 2TT England. (5 p., 2 figs.)

Since Wilson's (1966) suggestion of a proto-Atlantic ocean, there have been many attempts to explain the relationships between ancient America and Europe and the Ordovician closure of the ocean which separated the two continents. Most of the interpretations (Dewey; Fitton and Hughes;

Church and Gayer) have placed the greater part of Scotland in "America," with the Southern Uplands as a relic of the now extinct ocean (Iapetus, as some prefer). England and Wales have been regarded as the northern limit of "Europe," with the Lake District and much of Wales as part of a complex volcanic arc, with compositional range from tholeiitic in the north to alkalic in the south. Subsequent geophysical investigations then gave a strong indication that the Southern Uplands were, after all, composed of continental crust (Powell), and this led to a revised interpretation in which Scotland's Midland Valley was regarded as the oceanic remnant, with the Highland Border and Girvan ophiolites dipping north and south beneath the opposing continents (Gunn, Jeans). Paleontological studies, however, had already indicated that Girvan (and therefore the Midland Valley) belonged to ancient America; this was reiterated (Williams), and by mid-1975, the chances of a proto-Atlantic relic were becoming slim. In the LISPB experiment (1975–1976), the Moho was determined to be at a depth of between 30 and 40 km for the length of Britain, and this appeared to have finally resolves many of the arguments. Continental crust must now be the acceptable conclusion, and exotic ideas of any remaining fraction of the old ocean have to be abandoned.

It therefore seems likely that after initial closure of the proto-Atlantic during the upper Ordovician, with gentle encroachment of the two continents, there was subsequently latest Silurian to Early Devonian continental collision with much crustal shortening, which can be seen in the sedimentary cover as intense folds and cleavage. The junction between ancient America and Europe is here taken to be along the Solway trough, but it is suggested that the ophiolites of Girvan and the Highland Borders are possibly related to earlier episodes of back-arc spreading, and subsequently were caught up in fault wedges during renewed movements. Geochemical evidence now suggests that it is unlikely that the Lake District and Wales represent an island-arc environment but were part of the continental margin on the northern flank of ancient "Europe."

• 70604—Ancient borderland terranes of the North American Cordillera: Correlation and microplate tectonics.

Michael Churkin, Jr., G. Donald Eberlein, U.S. Geological Survey, Menlo Park, California 94025. (18 p., 6 figs.)

Enigmatic Paleozoic and Precambrian sequences rich in volcanic and plutonic rocks form discrete terranes along the outer border of the North American Cordillera. These borderland terranes occur in California in the northern Sierra Nevada and Klamath Mountains, in central Oregon and eastern Oregon–westernmost Idaho, in Washington in the Northern Cascade Mountains and San Juan Islands, in British Columbia in Vancouver Island, and in Alaska in the Alexander Archipelago. The difficulty in relating the geology of the borderland terranes to that of the North American continent, the recognition of ophiolites and suture zones separating the terranes from the continent, and the Asiatic affinity of certain of the borderland faunas indicate that the terranes are allochthonous relative to the North American continent. Furthermore, major differences in stratigraphy, magmatic activity, tectonic activity, metamorphism, and particularly the ages and types of basement between the terranes—when considered together with discordant paleomagnetic data—suggest that at least six lithospheric plates are represented.

The terranes in the Klamath Mountains have an Ordovician ultramafic rock (ophiolite) basement. The Oregon terranes have ultramafic complexes (ophiolites) in close association with volcanic rocks (volcanic arcs) that form the basement. In the Northern Cascade Mountains and San Juan Islands, the terranes have, respectively, Precambrian and Ordovician crystalline metaplutonic (magmatic arc) basement. The terrane in the southern part of the Alexander Archipelago has a Precambrian crystalline metavolcanic-metasedimentary (remnant arc) basement, but an Ordovician basaltic-andesitic basement (initial deposits of an upward-shoaling island arc) appears farther north. Transcurrent faults segment and truncate parts of the Cordillera, but since the borderlands are in themselves composed of several plates, models of a single allochthonous plate are difficult to apply. More likely, during Precambrian and Paleozoic time, multiple microcontinental plates and volcanic arcs moved outboard and inboard (away from and toward North America) to accommodate a succession of marginal ocean basins opening and closing behind migrating arcs. This was followed in Mesozoic and Cenozoic time by large-scale northwestward drift.

• 70605—Origin of basalt microlapilli in lower Miocene pelagic sediment, northeastern Pacific Ocean.

T. L. Vallier, U.S. Geological Survey, Menlo Park, California 94025; Dennis Bohrer, Deep Sea Drilling Project, Scripps Institution of Oceanography, La Jolla, California 92037; Grover Moreland, Smithsonian Institution, Washington, D.C. 20560; Edwin H. McKee, U.S. Geological Survey, Menlo Park, California 94025. (10 p., 16 figs., 3 tbls.)

Basalt microlapilli consisting of glassy particles and rock fragments were recovered in lower Miocene pelagic sediment from Deep Sea Drilling Project site 32 in the northeastern Pacific Ocean. Major-element chemistry indicates that the parent tholeiitic magma was high in iron and titanium, similar to many of the abyssal basalts from the eastern Pacific Ocean, and the relatively high K_2O content suggests additional fractionation before eruption. The microlapilli most likely were erupted subaerially from an island volcano, although a shallow submarine source cannot be discounted. If wind were the only method of dispersal, then the volcano was probably within 100 km of site 32. If surface or density currents played a role in transport, however, the volcano may have been at a greater distance.

• 70606—Bathymetry and shallow structure of the Pliny and Strabo Trenches, south of the Hellenic Arc.

Derk Jongsma, Bureau of Mineral Resources, Geology and Geophysics, P.O. Box 378, Canberra City, A.C.T., 2601 Australia. (9 p., 5 figs.)

The Hellenic Arc is bounded on its southern side by several deeps, which are considered to be the result of subduction of the African plate below the Aegean plate. The topography of these deeps is more complicated than that

observed over the trenches of the western Pacific. Bathymetric and continuous seismic profiling studies show that there are two trenches, the Pliny and Strabo Trenches. The Pliny Trench is the deeper and more dominant bathymetric feature, and its morphology and structure are similar to those observed in most other trenches in the world. The Strabo Trench is little more than a cleft in the sea floor. Normal faulting, indicating tension, has affected the sediments seaward of these trenches. The floor of the Pliny Trench has been downfaulted in several places. Below the inner wall of both trenches, the sediments appear to be disturbed, since few continuous and coherent reflectors occur in the seismic profiles. Fault-plane solutions support the conclusion that this disturbance is a result of thrusting taking place below the inner wall of the Pliny Trench south of Crete and below the inner wall of the Strabo Trench south of Karpathos. Quaternary turbidite sediments encountered in the Hellenic Trench are also present in the Pliny Trench, but a large part of the trench floor and the underlying sediments are disturbed. Disturbance of the underlying sediments is thought to be a result of subduction occurring at a faster rate than sedimentation.

• 70607—The Frasnian-Famennian (Late Devonian) boundary within the Foreknobs Formation, Maryland and West Virginia.

George R. McGhee, Jr., Department of Geological Sciences, University of Rochester, Rochester, New York 14627. (3 p., 3 figs.)

The approximate position of the Frasnian-Famennian (Late Devonian) boundary is determined within the Foreknobs Formation along the Allegheny Front in Maryland and West Virginia by utilizing the time ranges of the articlate brachiopods *Athryis angelica* Hall, *Cyrtospirifer sulcifer* (Hall), and members of the Atrypidae.

• 70608—Penecontemporaneous folds in cross-bedding: Inversion of facing criteria and mimicry of tectonic folds.

Hugh E. Hendry, Mel R. Stauffer, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0. Canada. (4 p., 6 figs.)

Deformation of cross-bedding by downcurrent drag at or near the time of deposition of sediment can result in structures that resemble cross-bedding in the overturned limb of a tectonic fold. Penecontemporaneous deformation of individual cross-beds into recumbent folds also produces structures that may be easily mistaken for early phases of tectonic deformation in complexly folded terranes.

• 70609—Geochemistry and origin of phosphorite deposits from off Peru and Chile.

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Holocene phosphorite nodules sampled from the sea floor off the coasts of Peru and Chile have been investigated in order to characterize the deposits geochemically and to evaluate their mode of formation. Bulk chemical and mineralogical compositions of the phosphorite nodules reflect varying degrees of dilution of the phosphatic material, fluorapatite, by other authigenic minerals and various allogenic components. Examination with the scanning electron microscope of freshly fractured surfaces of nodules and small pellets separated from associated diatomaceous ooze suggests that the apatite formed authigenically as a direct chemical precipitate rather than by replacement. Surfaces of siliceous biogenic materials as well as some inorganic phases appear to be favored sites for apatite nucleation.

The proposed model of phosphorite formation involves inorganic precipitation of apatite within pore waters of anoxic sediments and subsequent concentration of the apatite by physical processes. Oxidation of organic materials (mainly diatoms) during SO^{2-}_4 reduction is the main source of dissolved phosphate. Apatite precipitation is favored within the sediments by the high phosphate concentration in the interstitial waters, by the availability of suitable nucleation sites, and by diagenetic reactions that remove interfering Mg^{2+} ions from the pore solutions. Concentration of apatite into indurated phosphate nodules is brought about by winnowing and reworking processes, possibly in response to a change in the sedimentary environment caused by eustatic sea-level fluctuations or tectonism.

• 70610—Basal-till fabrics of modern alpine glaciers.

Hugh H. Mills, Department of Geological Sciences, University of Washington, Seattle, Washington 98195 (present address: Department of Chemistry and Geology, Clemson University, Clemson, South Carolina 29631). (5 p., 4 figs., 3 tbls.)

Basal-till fabrics from three alpine glaciers ranging in length from 2.5 to 8.5 km were analyzed. Fabric patterns are similar to those reported from basal tills of lowland glaciers; a single mode parallel to iceflow direction and a preference for upglacier dips. Eigenvalue analysis, however, showed that the preferred planes of the *a* axes are weaker than those reported from one Pleistocene ice sheet. Two methods of analysis indicated that there is little relation between clast orientation and clast size or shape.

• 70611—Transport phases of transition metals in the Amazon and Yukon Rivers.

Ronald J. Gibbs, College of Marine Studies, University of Delaware, Lewes, Delaware 19958. (15 p., 15 figs., 8 tbls.)

Samples representing yearly averages of material transported by the Amazon and Yukon Rivers were analyzed to separate the transition metals (Cr, Mn, Fe, Co, Ni, and Cu) into the following transport phases: (1) crystalline particles, (2) metal hydroxide coatings, (3) solid organic material, (4) sorbed material, and (5) those in solution. The major transport phases are crystalline particles and metal hydroxide coatings, which, combined, carry 65% to 92% of the transition metals transported. Solid organic material, the next most important phase, transports between 5% and 19% of the total transported. Material carried in solution transports 0.6% to 17% of the total trans-

ported. Sorbed transition metals account for between 0.02% and 8% of the total transported. Metal hydroxide coatings represent the major transporting mechanism potentially available to organisms, since, for the Amazon and Yukon Rivers, respectively, 87% and 78% of the Fe, 69% and 73% of the Mn, and 71% and 69% of the Ni are transported in this form.

Comparing the concentrations of transition metals carried to the oceans with the concentrations on the continents, a high Cu ratio (5 to 7) indicates continental depletion or river output enrichment; a moderate ratio (1.1 to 1.7) for Ni, Co, and Cr indicates intermediate depletion or enrichment, and a near-unity ratio for Fe and Mn indicates little depletion or enrichment. The sediments transport >97% of the total mass of transition metals to the world's oceans.

• 70612—Upper Paleozoic section in eastern Plumas and Sierra Counties, northern Sierra Nevada, California.

Cordell Durrell, Jad d'Allura, Geology Department, University of California, Davis, California 95616. (9 p., 2 figs.)

The weakly metamorphosed volcaniclastic rocks of eastern Plumas and Sierra Counties, California, considered to be Jura-Trias by H. W. Turner, are almost entirely Paleozoic, ranging in age from Silurian-Devonian to middle Permian; they are correlative with the Paleozoic rocks of the Taylorsville area, as revised by McMath. The succession of formations from the base upward consists of the Shoo Fly Formation, not described in detail; the Sierra Buttes Formation, mostly quartz keratophyre; the Elwell Formation, characterized by radiolarian chert; the Taylor Formation, composed of andesite; the Peale Formation, a heterogeneous mixture of keratophyre, limestone, chert, and other rocks; the Goodhue Formation, composed of andesite, basalt, and olivine basalt; the Reeve Formation, predominantly of keratophyre; and a residue of contact-metamorphosed calcareous rocks that may be the Mesozoic Milton Formation of Turner.

Exceptions to the dominant volcaniclastic nature of this 10,900-m- (29,000-ft) thick section are a lava flow in the Elwell Formation, a thin section of massive lavas in the Taylor Formation, and minor amounts of pillow lava in the Taylor, Peale, and Goodhue Formations.

No major discontinuity has been recognized other than that between the Shoo Fly and Sierra Buttes Formations, but possible depositional gaps may occur at the base and top of the Peale Formation.

These units appear to be a partial section across an upper Paleozoic island arc that consisted of overlapping volcanoes or sheets of volcaniclastic rock, all deposited in a deep marine environment.

• 70613—Effect of slope on the threshold of motion and its application to orientation of wind ripples.

Alan D. Howard, Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia 22903. (4 p., 3 figs.)

On sloping sand surfaces, the downwind perpendicular to ripple crests is not, as commonly believed, an unbiased indicator of current direction, for the ripple-forming creep load is deflected downgradient as a function of the surface gradient, the orientation of the surface relative to the wind, and the friction angle of the sand. The force required to initiate motion on sloping surfaces is likewise dependent upon these parameters. The mean direction of sand movement is also deflected downgradient from the applied fluid force, but by a lesser amount than the ripples.

• 70614—Sediment transport and deposition at river mouths: A synthesis.

L. D. Wright, Coastal Studies Unit, Department of Geography, The University of Sydney, Sydney, N.S.W., Australia 2006 (12 p., 8 figs., 2 tbls.)

River-mouth process studies and comparisons of river-mouth forms from contrasting environments suggest that sediment dispersal and accumulation patterns are governed by three basic effluent forces and by tide- or wave-induced processes. Neglecting modifications by tides or waves, effluent behavior and consequent depositional patterns depend on the relative dominance of (1) outflow inertia, (2) turbulent bed friction seaward of the mouth, and (3) outflow buoyancy. Inertia-dominated effluents are characterized by fully turbulent jet diffusion, exhibit low lateral spreading angles and progressive lateral and longitudinal deceleration, and produce narrow river-mouth bars. Under most natural circumstances, inertial effects are equaled or exceeded by either turbulent bed friction or effluent buoyancy.

Shallow depths immediately basinward of a river mouth enhance the effects of bed friction, causing more rapid deceleration and lateral expansion. Triangular "middle-ground" bars and frequent channel bifurcation result. Low tidal ranges, fine-grained sediment loads, and deep outlets favor strong density stratification within the lower reaches of the channels. Under such circumstances, effluents are dominated by the effects of buoyancy for at least part of the year. Buoyant effluents produce narrow distributary mouth bars, elongate distributaries with parallel banks, and few bifurcations.

In macrotidal environments where tidal currents are stronger than river flow, bidirectional currents redistribute river sediments, producing sand-filled, funnel-shaped distributaries and causing linear tidal ridges to replace the distributary mouth bar. Powerful waves promote rapid effluent diffusion and decleration and produce constricted or deflected river mouths.

• 70615—Foraminifera and Rb-Sr glauconite ages of a Paleocene Beaufort Formation outcrop in North Carolina.

W. Burleigh Harris, Department of Earth Sciences, University of North Carolina at Wilmington, Wilmington, North Carolina 28401; Gerald R. Baum, Department of Geology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27514. (4 p., 3 figs., 1 tbl.)

A 3.3-m section of the Paleocene Beaufort Formation, which crops out along Mosley Creek at the Lenoir-Craven county line, North Carolina, consists of alternating, unconsolidated, sandy, foraminiferal-glauconitic sediments and thinner, slightly glauconitic, foraminiferal biomicrosparites. A single Beaufort Formation sample collected from unconsolidated sediments about 1.5 m below the Paleocene-Eocene boundary was analyzed for foraminifera and radiometrically dated by glauconites.

The occurrence of *Globorotalia aequa* Cushman and Renz, *G. pseudomenardii* Bolli, *G. pseudobulloides* (Plummer), and *Globigerina triloculinoides* Plummer indicates that the sample is Thanetian in age and is part of the P4 planktonic foraminiferal zone. The zone, identified by

the occurrence of *Globorotalia pseudomenardii*, has a suggested absolute age range of 56 to 58 m.y.

Three hand-picked, mammillated to lobate, glauconite concentrations were separated from the same sample and analyzed for Rb, Sr, and Sr-isotopic composition. Model ages of 64.5, 55.7, and 57.8 m.y. ($\lambda Rb^{87} = 1.39 \times 10^{-11}$ yr^{-1}) using an initial Sr^{87}/Sr^{86} ratio of 0.7078 were determined. Although the older age (64.5) is anomalous, the average model age of 56.8 m.y. for the two younger determinations is in excellent agreement with recent time-scale estimates for the late Paleocene. The results suggest that hand-picked glauconites with a well-documented diagenetic history can yield Rb-Sr radiometric ages accurate to within 1% to 2%.

• 70616—Development of a layered crenulation cleavage in mica schists of the Kanmantoo Group near Macclesfield, South Australia.

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Kanmantoo Group metasedimentary rocks are folded by a large, dextral, second-generation fold near Macclesfield, South Australia. In the hinge regions of this fold, pelitic schists are crenulated, which gives rise to a variably developed, layered, axial-plane crenulation cleavage. The layered cleavage is produced by different microstructural, mineralogical, and chemical changes on alternate limbs of asymmetric crenulations. The long limbs (mica or M domains) become enriched in muscovite at the expense of biotite, quartz, and feldspar with a consequent large increase of Al_2O_3 and a smaller increase in K_2O at the expense of SiO_2, MgO, and FeO + Fe_2O_3. The compositional changes in the short limbs (quartz-feldspar or QF domains) are somewhat complementary, but comparison with uncrenulated rock within 20 mm of these crenulations shows that the layering development involves a bulk chemical change, primarily a depletion in MgO and FeO + Fe_2O_3. All mineral grains are finer and less equidimensional in M domains and coarser and more equidimensional in QF domains than in the equivalent uncrenulated rock. In addition, very little evidence of intracrystalline deformation, recovery, or partial recrystallization was found in a wide range of variably intensely crenulated rocks.

The crenulation cleavage probably developed by a combination of (1) rotation of existing grains accompanied by modification of their shape and size by diffusive processes, (2) migration of material, on the scale of grains and domains, controlled by the deformation path and microstructural anisotropies, and (3) nucleation and growth of grains with an orientation and shape compatible with the strain history in their vicinity during nucleation and growth. It is shown that a pressure solution mechanism driven solely by differences in stress magnitude will not explain the range of microstructural and mineralogical changes. More important controls on diffusive mass transfer are likely to be available from the chemical reactions, strain history, volume changes, and microstructural anisotropies.

• 70617—A kinematic model of preferred orientation. *David G. Willis, Geophysics Department, Stanford University, Stanford, California 94305.* (12 p., 10 figs.)

Kinematic models of mineral grain behavior during deformation have been provided by G. B. Jeffery's study of rigid ellipsoids in a viscous fluid and A. March's analysis of deformable rods and plates. In this paper, a more general kinematic model is presented which is applicable to arbitrarily shaped grains.

The simple premise of a constant linear relationship between the angular velocity of a mineral grain and the macroscopic strain rate of its surrounding material leads to the linear model. A further premise involving certain kinematic properties of the volume of deforming material displaced by an embedded mineral grain leads to a special form of the linear model called the displacement model; this model provides specific equations describing the motion of an individual mineral grain of arbitrary shape.

The displacement model coincides with Jeffery's and March's models in the special cases of ellipsoids and of ideally slender needles or ideally thin plates, respectively. In addition, the displacement model is in good agreement with experimental measurements of the motions of rigid bodies of various shapes suspended in a slowly flowing viscous fluid.

Using the displacement model for a particular class of grain shapes, it is possible to compute the preferred orientation diagrams resulting from an arbitrarily given strain history. Several sequences of such diagrams are presented showing the development of preferred orientation for different shapes and strains. These diagrams have the property that they depend not only upon the grain shape, but also upon the strain history. This is in contrast to March's solutions, which depend solely upon the finite strain ellipsoid and are otherwise independent of the strain history.

The specific properties of the preferred orientations produced by the displacement model can be tested against observations of naturally occurring mineral orientations. In order to be significant, however, such observations will require simultaneous measurements of both grain shapes and grain orientations, a task which has apparently been attempted only by W. A. Duffield. His results are reviewed and are shown to be in agreement with the displacement model in the area studied.

• 70618dr—Hydrogeology of the South Fork of Long Island, New York: Discussion and reply. (2 p.)

Discussion: *M. P. Anderson, Department of Geology and Geophysics, University of Wisconsin—Madison, Madison, Wisconsin 53706; C. Alan Berkebile, Geology Department, Southampton College of Long Island University, Southampton, New York 11968.*

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