GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

OCTOBER 1976

GSA Announces Medal and Award Winners for 1976

The 1976 medalists and award winners announced by the Council at its May 1976 meeting are as follows:

Penrose Medal — Preston E. Cloud, Department of Geological Sciences, University of California, Santa Barbara, California 93106.

Day Medal — Hans Ramberg, Division of Mineralogy and Petrology, Institute of Geology, University of Uppsala, Box 555, S-751 22 Uppsalà 1, Sweden.

Honorary Fellows — William Compston, Institute of Advanced Studies, Research School of Earth Sciences, The Australian National University, P.O. Box 4, Canberra 2600, Australia, and Teiichi Kobayashi, M.J.A., Geological Institute, University of Tokyo, Tokyo, Japan.

Kirk Bryan Award — Geoffrey Stewart Boulton, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ England, for his paper, *Processes and Patterns of Glacial Erosion*, 5th Geomorphology Symposium Proceedings, Binghamton, New York.

Meinzer Award — Shlomo P. Newman, University of Arizona, Tucson, Arizona 85721, and Paul A. Witherspoon, University of California, Berkeley, California 94720, for their 1972 paper, *Field determination of the hydraulic properties of leaky multiple aquifer systems*: Water Resources Research, v. 8, no. 5, p. 1284–1298.

Burwell Award — David J. Varnes, U.S. Geological Survey, Box 25046, Mail Stop 903, Federal Center, Denver, Colorado 80225, for his paper, *The Logic of Geological Maps, with Reference to Their Interpretation and Use for Engineering Purposes*, U.S. Geol. Survey Prof. Paper 837, 1974.

National Medal of Science — The Council named Frank Press as the Society's nominee for the National Medal of Science.

R. Drozda Becomes GSA's New Controller August 1

Starting on August 1, 1976, the position of Controller was filled by Richard F. Drozda, who comes to us with a wealth of experience. He is a CPA and spent eleven years with Peat, Marwick, Mitchell & Co., headquartered in Lincoln, Nebraska. Subsequently, he was controller for hospitals in Lincoln and Omaha, Nebraska, before moving to Boulder as controller for Boulder Community Hospital.

AIP Offers GSA Members Courtesy Subscriptions

We have received at headquarters the following information and generous offer from the American Institute of Physics:

It is the policy of the Institute to offer reduced-rate subscriptions for its own journals to members of affiliated societies. This offer is limited to one subscription per person to each journal. Following is a list of Institute-owned journals showing the member rates which are available to members of your Society, and the nonmember rates, for 1977:

	Member Rate	Nonmember Rate
Journal of Applied Physics	$ 23.00	$105.00
Applied Physics Letters	13.00	55.00
The Journal of Chemical Physics	42.00	195.00
Journal of Mathematical Physics	18.00	95.00
The Physics of Fluids	18.00	95.00
Physics Today	10.00	24.00
The Review of Scientific Instruments	15.00	50.00
Current Physics Index	30.00	95.00
Journal of Physical and Chemical Reference Data	25.00	90.00

If any GSA member wishes to take advantage of this offer, he should send his subscription orders, with remittances, directly to the American Institute of Physics, 335 East 45 Street, New York, N. Y. 10017, and include a statement indicating that he is a member of GSA, an affiliated society.

GSA Council actions taken at Spring Meeting 1976

The following actions were taken by the GSA Council at its meeting in Boulder, May 4-5, 1976:

1. Adopted a 1977 dues structure with various publications options.
2. Discussed the break-even operating budget for 1977.
3. Discussed the 1977 GeoRef budget.
4. Approved the Denver annual meeting budget, including the supporting registration fees, as presented.
5. Discussed the tax status of annual meeting exhibit income.
6. Re-established the policy that reimbursement for those required to attend committee and Council meetings be set at travel by economy fare and actual economy subsistence.
7. Selected a firm of certified public accountants to be presented by ballot to the membership in November for election to perform an audit of the financial records of the Society for the year ending 12-31-76.
8. Approved certain financial resolutions.
9. Discussed the investment policies and procedures of the Society.
10. Discussed the possibility of establishing a new endowment growth committee.
11. Selected a slate of nominees for officers and councilors for 1977 to appear on the ballot for the 1976 corporate meeting.
12. Selected Penrose and Day medalists; elected two Honorary Fellows; approved the award winners from the two Divisions; and selected a nominee for the 1976 National Medal of Science.
13. Voted to update the Society's bylaws concerning the annual audit and annual dues.
14. Discussed the appointment of the Science Editor.
15. Voted to accept the invitation from Cincinnati, Ohio, to hold the Society's 1981 annual meeting in that city.
16. Gave preliminary approval to the establishment of a GSA Division on the History of Geology.
17. Approved the recommendations of the Publications Committee to (a) reduce the number of separates to which a member shall be entitled under Option C from 36 to 24, effective 1-1-77; (b) waive the $20 abstract fee for abstracts accepted for the annual meeting from Student Associates when they are the sole authors of the abstracts, effective 1-1-77; and (c) explore with the Associated Societies the possibility of publishing a single series of memorials serving all societies involved.
18. Increased nonmember subscription rates to *Geology, Bulletin,* and *Abstracts with Programs* to accommodate the inflation factor, effective 1-1-77.
19. Approved 111 research grants totaling $70,931 for 1976; voted to budget $75,000 for research grants for 1977 if budgetarily feasible; named the recipient of the second Stearns Fellowship.
20. Advanced 29 Members to Fellowship; ratified the election of 223 candidates to Membership; discussed new Member and Student Associate promotion; discussed Fellowship/Membership opinion poll results; moved that the Membership Committee be increased from four members to five, that it be composed at all times of at least one representative from industry, one from government, and one from academia, and that it meet once a year to conduct its business; discussed dues exemption requirements; and discussed the rejection of Fellowship applications.
21. Approved three Penrose Conferences; discussed the 1975 conference deficit of $3,800; discussed the Lucian B. Platt conference; determined that the recommended number of conferences that headquarters is able to handle during a 12-month period be no more than six, and under no circumstances be more than eight.
22. Voted to continue the solicitation of voluntary contributions to the minority fund on the annual dues statements.
23. Voted to merge the Nominations Committee and the Committee on Committees; the Budget Committee and the Executive Committee by adding the Budget Committee chairman to the Executive Committee.
24. Effective 1-1-77, rescinded the $20 fee charged to all professional authors for abstracts submitted for Section annual meetings and substituted permission for the Sections to raise a sum of money equivalent to $20 per professional abstract by any means they choose. Such monies are to be remitted to national to help defray the cost of processing and publishing the *Abstracts with Programs* for the Section annual meetings.
25. Effective 1-1-77, the $1 fee per professional registrant at Section annual meetings payable to national by the Sections was rescinded; all past debit balances owed by the Sections to national as of 12-31-75 were forgiven.
26. Set the minimum registration fee for Section annual meetings at $10 and the maximum at $30.
27. Voted to permit the Sections to incorporate as separate organizations if they wish.
28. Voted a resolution of thanks to W. Kenneth Hamblin for his eight years' service as Rocky Mountain Section Secretary.
29. Accepted reports from Sections, Divisions, and representatives to non-GSA groups.
30. Selected the dates of November 7 and 9, 1976, for the fall Council Meetings in Denver, Colorado; set the date and time of the corporate meeting as November 9, 1976, from 8 to 9 a.m., in Denver.
31. Designated three proxy holders and tellers of election for the corporate meeting in November.
32. Declined with regret NAGT's request that GSA consider the possibility of handling its business services.
33. Passed a resolution recommending that member societies be involved in the subject selection and planning of any future scientific conferences initiated by AGI and held with governmental personnel.
34. Took other minor actions, records of which are on file at headquarters.

Membership

The following 355 persons transferred from Student Associates to Members during the period from September 1, 1975, through March 31, 1976.

Mark A. Adams
Pamela A. Aey
Syed T. Ahmedali
Mehdi Alavi
John B. Allcock
Brian L. Allen
Ali Al-Temeemi
Michael L. Ammerman
Michael A. Andersen
Norman N. Anderson
Jose Oswaldo Araujo Filho
Robert M. Armstrong

Clyde D. Baker
John P. Barkas
N. Jay Bassin
Ken C. Baum, Jr.
Joy J. Bell
Thomas Crawford Bell
Charles F. Berkstresser, Jr.
C. Richard Berquist, Jr.
Salman Bloch
Kip K. Boden
David S. Bolin
Nancy J. Bolling
Rena Mae Bonem
Gerald W. Book
Patricia J. Bouwman
Paul R. Boyer
John B. Brady
Duane D. Braun
Joseph A. Briskey, Jr.
William T. Brown, Jr.
Paul M. Buehrle
Peter Burtchell
R. Morgan Button

Michael E. Campana
James A. Cappa
Mario J. Carnevale
Thomas E. Carroll
Carmen Fernandez Castain
Travis J. Cato, Jr.
Raymond J. Cheeseman
John A. Cherry
Christopher H. Cherrywell
Odin D. Christensen
Tony F. Clark
C. Michael Clayton
Gaylord Cleveland
Rex D. Cole
Susan G. Cole
Benjamin I. Collins
Rodney A. Combellick
William S. Condit
Clay M. Conway
Philip L. Cook, Jr.
Michael R. Cooper
Andrew B. Core
Theodore F. Cota
Robert L. Countryman
Paul W. Cousins
Anita L. Crews
Jerry D. Cripe
Timothy A. Cross

Abdallah E. Dabbagh
Dorinda G. Dallmeyer
Jad Alan D'Allura
Bruno D'Argenio
Gregory L. Daugherty
R. Laurence Davis
Damon P. Day
John E. Decker
Kelly Dempster
William L. Desormier
William J. Deutsch
Henry J. B. Dick
Paul E. Diehl
John T. Dillon
Allan F. Divis
George H. Dixon
J. Robert Dixon
John T. Doherty
John Dombrowski
Mary M. Donato
Julie M. Donnelly
Philip A. Doyle
James L. Drinkwater
Jeffrey M. Dunleavy
Lee C. Dutcher
Thaddeus S. Dyman

Jan Earle
David E. Eby
James R. Eby
James M. Edwards
Manouchehr Eframian
Frank R. Ettensohn

Michael J. Fiannaca
Michael T. Field
William J. Fincham
Robert A. Fink
Robert L. Fitez
Robert S. Fleming, Jr.
Robert J. Floran
Michael G. Foley
Charles Thomas Foster, Jr.
John C. Fountain
Lindsay A. Fowler, III
Don E. French
Edward D. Frey
David R. Fuller
Kenneth J. Fulton

Richard P. George, Jr.
Gregory S. Gohn
Arthur G. Goldstein
Wayne R. Goodman
Jimmy Goolsby
George M. Graham
Stephan A. Graham
John H. Gray
Aida R. Green
Gerlad R. Grocock
Jeffrey J. Gryta
Robert V. Guzowski

Andrew Hajash, Jr.
William G. Hakes
Charlene R. Hall
Kenneth E. Hall
Stephen Austin Hall
Louis W. Hamm, III
James T. Hanley
Russell S. Harmon
Clare O. Harrison
Gary C. Harrison
M. Eugene Hartley, III
Keith W. Hartman
Constance S. Harvey
Afifa Afifi Hassan
David Alan Hastings
Craig B. Hatfield
William D. Hausel
Gordon Haxel
Robert E. Hay
Kenneth P. Henderson
Gary G. Hendrix
Christopher D. Henry
Mary M. Hertling
Carolyn E. Hill
Carole M. Hinkley
John L. Hinton
Arthur B. Hobbs
David R. Hoffman
Carleen D. Holloway
John C. Hough
James C. Huntington
Brent E. Huntsman
Richard W. Hurst

Dana J. Isherwood

Jacqueline T. Jansky
David N. Jenkins
Dusik Johng
Michael L. Johnson
Nancy L. Joseph

David M. Kaplan
Thomas C. Kartrude
Robert B. Kasper
Suzanne Mahlburg Kay
C. Ernest Kemp
Dennis R. Kerr
Russell B. King
Robert M. Kirkham
Steven W. Koehler
Edward J. Koszalka
Neil P. Kran
Chris M. Kravits
Ralph L. Kugler

Martin B. Lagoe
Richard W. Lahann
David W. Lappi
Stephen B. Larkin
David R. Larson
P. James LeAnderson
Stephen P. Leatherman
Van L. Leighton
Eddie Leivas
Stephen W. Lenhart
O. H. Leonardos, Jr.
Jacques Letendre
Wesley Lilley
Douglas D. Lindsey
Gene R. Litke
John Littlejohn
Darrell P. Locker
Lynn Lodge
Clarence S. Long, Jr.
David A. Lopez
Daryl V. Lovvik
James R. Lucas
Frank R. Luther
Tracy J. Lyman

Copeland MacClintock
Michael N. Machette
Thomas C. MacKinnon
Neil J. Maloney
Gerald K. Manzer, Jr.
Susan J. Mara
Donald L. Marcus
Hampik S. Maroukian
Allen F. Mattis
J. Rolfe Maxon
Stephen McCourt
G. Wayne McCrary
Thomas R. McGetchin
John B. McKeon
John D. McMillen, Jr.
Rebecca W. Metz
Jeffrey K. Miller
Mark A. Miller
Merrell A. Miller
William C. Miller, III
Hugh H. Mills
Steve Minkin
George S. Mochizuki, Jr.
William R. Moehl
Clifford Montagne
David W. Moore
Samuel L. Moore
William A. Moore
Alan J. Morris
Andrew J. Murphy
Daniel J. Murphy
Robert G. Myers

Michael T. Naney
Larry R. Nelson
Lee C. Nesbit
William Nesse
Alan W. Niedoroda
Richard Nishimori
Edmund Nosow

William L. Osburn
Sandra J. Owen

Guy V. Padgett
Harry McDougal Parker
William R. Parrott
Thomas L. Patton
Paul Herman Pause
David M. Petefish
Christopher S. Peters
Thomas John Peters
Robert G. Piepul
Denise D. Pieratti
Stephen E. Pierce
Richard C. Pohle
David H. Polanshek
Dennis W. Powers
Gary L. Prost
Wayne H. Purdin
Elizabeth Curtis Purviance

James S. Rankin
Robert Raymond, Jr.
Jeffry B. Reardon
Scott C. Reeve
John E. Repetski
Richard J. Reynolds
Richard L. Reynolds
Robert F. Reynolds
Douglas W. Rhett
James M. Rhett
Larie K. Richardson
Byron L. Ristvet
James H. Robertson
Edwin S. Robinson
John W. Robinson
Leon M. Roe, II
David K. Rogers
Robert W. Root, Jr.
Arthur K. Rosenboom
Peter L. Russell
Patrick J. C. Ryall
Thomas A. Ryer

Jason B. Saleeby
Peter K. Scheffler
Albert R. Schenker, Jr.
Eugene K. Schmidt
Robert R. Schneider
David H. Scofield
Lance E. Senter
David L. Shearer
Theodore D. Sheldon
Joseph J. Shepherd
Gregory D. Sherman
Steven B. Shirey
Ralph R. Shroba
Gerald S. Sikora
Lyle R. Silka
Eric J. Simison
Edwin Craig Simmons
Susan A. Siwek
John D. Stanesco
Richard G. Stanley
Sandra A. Stansbury
Ronald W. Stanton
William R. Stanton
Joel M. Stratman
Neil M. Sullivan
Neil Suneson
Jeffrey S. Swartz

Patrick A. Tainter
Ronald J. Tanenbaum
Woodrow Thompson
Edward C. Thornton
Robert M. Thorson
G. Sidney Thurmer
John C. Tinsley, III
Claudio C. Toledo
Linda J. Tollefson
Patrick M. Tolson
Margaret A. Townsend
Gilbert L. Treadwell
Jerome A. Treiman
Daniel R. Tucker
Frank S. Turek
Bruce W. Turner
James A. Turner

Gerald K. Van Kooten
Robert A. Vargo
Thomas I. Vehrs

Jerome P. Walker
Jon Joseph Walker
Kenneth R. Walker
James C. Walters
Thomas I. Watkins
C. Michael Wear
Charles E. Wells, Jr.
Craig E. Wells
Ray E. Wells
Dennis G. Welsch
Karen Wenrich-Verbeek
Robert D. Whitman
Sandra E. Whitney
David R. Wilburn
Sydney L. Willard
Frederic H. Wilson
Geoffrey E. Wilson
Jeffrey L. Wilson
Joseph R. Wilson
William M. Wilson
Robert D. Winn, Jr.
Robert P. Wintsch
John P. Witner
Robert M. Wittrock
John H. Woffinden, Jr.
James W. Wright
Wayne A. Wright
John M. Wunder

Robert E. Zilinski, Jr.
William D. Zogg

Report of Committee on Publications

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

GSA's publications once appeared to be supported by investment income so generous that many of us believed we were immune from rising costs. When this illusion was shattered in the fall of 1974, the Society responded with emergency action that kept us realistic as we made decisions in 1975. Whereas members formerly received publications whose cost was subsidized to an extent that few were aware, we must now not only expect to pay for what we get, but, as a Society, we should support publication of those books and papers that may not have wide appeal although recognized as valuable contributions to our science.

Economies, even drastic economies, have been effected wherever possible, and we are all indebted to John Frye and his staff for the ingenuity and assiduous efforts that brought our publications business under fiscal control in the face of inflation at a rate higher than that of the general cost of living. In what might have been a disaster, the Committee on Publications has seen a challenge and an opportunity to be innovative and to do a better job. The most evident change was the introduction of dues options, notably the option for a member to receive separates in place of the complete *Bulletin*. A report on the separates option appeared in the "GSA News & Information" section of *Geology*, June 1976. The number of copies printed and selling prices for Memoirs and Special Papers are now based on expected sales. Unless total cost is borne by the author, fold-outs, requiring expensive hand-work, are no longer included in the *Bulletin*. A new Map and Chart Series provides a flexible means of publishing large sheets that were formerly folded and included in other series.

On recommendation of the Committee on Publications, Council adopted the principle that marketability of books should be an important factor in deciding the format appropriate for publication. The committee is enthusiastic about using the new Microform Publication Series for those scientifically significant contributions whose predicted sales do not justify publication in our other series. Three publications were included in the Microform Publication Series in 1975, and sufficient standing orders have been received to ensure success. Manuscripts accepted for the Microform Publication Series are peer reviewed and meet the same scientific standards as our other publications. Cost is kept down by requiring authors to follow directions for copy editing and to submit camera-ready copy.

The committee believes that microform publication will increase in importance as printing costs continue to soar. Its many advantages are recognized by librarians and by societies such as the American Institute of Physics and the American Geophysical Union. Microfiche can be mailed first-class in a regular envelope, cost of reprinting is small, expensive warehouse charges are eliminated, and photographic enlargements can be made directly from the microfiche. We urge all members to become familiar with this new tool. A review and evaluation of microfiche readers was published in "GSA News & Information," November 1975. A bibliography and address list was published in May 1976.

Bennie W. Troxel resigned as science editor effective October 1, 1975. The Committee on Publications has offered advice to the Executive Committee and the Council, who will select and appoint his successor. The committee's chairman has participated in interviews conducted by the Executive Committee and the Council. In considering the science editor's duties, the Council approved a new statement of publication policy, which was printed in "GSA News & Information," April 1976.

Spring Meeting

The spring meeting, held at the California Institute of Technology, March 27-28, 1975,

1. Discussed reduction of inventory of books more than five years old.
2. Discussed formula for determining selling prices of books.
3. Discussed ways of reducing expected deficit in 1975.
4. Discussed operation of GeoRef in 1975 and the proposed GeoRef budget for 1976.
5. Discussed possible proposal to National Science Foundation for support of a project on dissemination of bibliographical information.
6. Agreed that scientific content of microform publications should be reviewed to ensure that it

is of the same high standard that we expect in the *Bulletin,* Special Papers, and Memoirs.

7. Instructed Donald McIntyre and Fred Honkala to investigate costs and models of available desk-top and portable microfiche readers and to report back.

8. Agreed that GSA must temper acceptance of book manuscripts by evaluation of number of copies likely to be sold. Council instructed the Committee on Publications to bring back a proposal for introducing the factor of marketability into the selection of future publications.

9. Recommended that a publication contribution of $20 be assessed on abstracts submitted for the national and section meetings. Accepted by Council.

10. Recommended that options A through E be offered to the membership in 1976. In accepting the recommendation, Council added supplemental options F and G.

11. Recommended that, starting in 1976, the nonmember subscription price of *Geology* be raised from $9 to $15 a year, and that there be an additional charge to foreign subscribers. In accepting the recommendation, Council increased the $15 charge to $18.

12. Resolved that GSA express deep gratitude to Henry Spall for his success in getting *Geology* to where it is now. Council unanimously adopted the resolution.

Fall Meeting

The fall meeting, held in Boulder, September 11–12, 1975,

1. Concluded that if we cannot make more money by raising dues and book prices, we must cut costs by still further reducing staff.

2. Agreed to transmit to Council Leon T. Silver's amended proposal for introducing the factor of marketability into the selection of future publications. Council accepted the proposal as a working document for the staff.

3. Received with thanks W. H. Freeman's statement on a publishing policy for GSA. Agreed to make this statement part of the committee's report. Council approved a statement of publication policy (see "GSA News & Information," April 1976).

4. Appointed Daniel F. Merriam chairman of a Subcommittee on Long-Range Planning.

5. Discussed changes in production that will reduce editorial overhead.

6. Decided not to recommend starting a quarterly journal of special papers at this time.

7. Discussed proposal to publish a microfiche version of the *Bulletin.*

8. Decided not to recommend increasing page charges or changing the present policy regarding offprints.

9. Approved the editor's recommendation to publish two or three collections of reprints from the *Bulletin* and *Geology*. Instructed the science editor and the Executive Director to proceed with this proposal on a trial basis in the Microform Publication Series.

10. After discussion, referred suggestions regarding dissemination of information to the Subcommittee on Long-Range Planning.

11. Heard a report by Fred Honkala on GeoRef and the *Bibliography and Index of Geology*. Expressed appreciation to John Mulvihill, Ed Kain, Steve Hoskin, and Lee Swift for the job they had done in putting the bibliography on a sound basis.

12. Received a report from Donald McIntyre on microfiche readers (see "GSA News & Information," November 1975, April 1976).

13. Discussed the economics of the $20 publications charge for abstracts. Noted that the Society does not make money from this charge, but that *Abstracts with Programs* is subsidized with more than $6,000. Recommended that the $20 charge be retained. Council accepted the recommendation but rescinded the charge for abstracts authored by Student Associates accepted for sectional annual meetings.

14. Discussed and approved the printing and binding budget for 1976. Supported the Executive Director in making the necessary adjustments to obtain a balanced budget.

15. Recommended that the three-color Bicentennial theme for the 1976 *Abstracts with Programs* be confined to the annual meeting *Abstracts with Programs*. Approved by Council.

16. Recommended that an additional five percent discount be given on publication orders accompanied by cash payments. Approved by Council.

17. Approved expansion of the first three issues of the 1976 *Bulletin* to 160 pages, in order to avoid a backlog of manuscripts.

18. Recommended that Bennie Troxel be commended for his service to GSA and, particularly, for his imaginative leadership of our publications program at a time when financial stress required major changes.

Respectfully submitted,

DONALD McINTYRE, *Chairman*

COMPLETED PUBLICATIONS IN 1975

The following publications, totaling 17,200 pages, were issued by the Society during 1975:

Periodicals

Abstracts with Programs for the national meeting in Salt Lake City and *Abstracts with Programs* for meetings of the Northeastern, South-Central, Cordilleran, Southeastern, Rocky Mountain, and North-Central Sections of the Society; 12 issues of the *Bibliography and Index of Geology*, Volume 39, and the cumulative *Bibliography and Index of Geology*, Volume 38; 12 issues of the monthly *Bulletin*; 12 issues of *Geology* with "GSA News & Information" sections.

Series

Maps and Charts series from MC-8 through MC-11; *Memorials, Volume IV* (1972) and *Memorials* preprints listed in the May and December issues of "GSA News & Information"; 4 Memoirs; 3 Microform Publications (MP-1 through MP-3); 13 Special Papers; *Treatise on Invertebrate Paleontology, Part W.*

Reprints

Reprints for the year included the *Bibliography and Index of Geology*, vol. 39, no. 2; *Bulletin*, vol. 85, no. 7; *Bulletin* articles: Burchfiel (vol. 85, no. 7) and Matthews (vol. 85, no. 9); text for *Map of Surface Sediment Facies of the Florida-Bahamas Plateau*, and MC-6, *Age of the Ocean Basins*, Part 2; *Memoir 132*, edited by R. Shagam (Hess volume); Figures 3 and 4 (foldouts) for *Memoir 107; Rock Color Chart; Treatise on Invertebrate Paleontology, Part D.*

Miscellaneous

Other publications in 1975 were the *Annual Report for 1974* printed in the May, June, July, August, and September issues of "GSA News & Information" sections in *Geology*; Newsletters—*The Engineering Geologist* and *The Hydrogeologist,* newsletters of the Quaternary Geology and Geomorphology Division and the Coal Geology Division printed in the March, May, and October "GSA News & Information" sections of *Geology*; *AESE Blueline* (Association of Earth Science Editors newsletter); Reprint of *Stratigraphic Nomenclature in Reports of the U.S. Geological Survey;* Reprint of *Serial Publications Commonly Cited in Technical Biographies of the U.S. Geological Survey; Yearbook for 1975.*

Necrology

Notice has been received of the following deaths: Ansel M. Gooding, Richmond, Indiana; Marjorie Hooker, Silver Spring, Maryland; Gerald E. Knowles, Djakarta, Indonesia; Clarence S. Ross, Bethesda, Maryland; Richard Foster Flint, New Haven, Connecticut; Benjamin Franklin Howell, State College, Pennsylvania; James C. Taylor, Menlo Park, California; and Allen C. Tester, Sedona, Arizona.

YOU ARE INVITED TO ATTEND THE AGU 1976 FALL ANNUAL MEETING

December 6-10, San Francisco, California

SPECIAL SESSIONS

Union

- Applications of Microprocessors to Geophysical Needs
- Geophysical Predictions
- Geophysics and Public Policy (This session is exempt from the one-paper-per-first-author rule.)

Geodesy

- The Palmdale Bulge
- Geos 3

Geomagnetism and Paleomagnetism

- Origin of Thermal Remanent Magnetization
- Long-Wavelength Magnetic Anomalies

Hydrology

- Symposium on Water Quality Impacts of Energy Development
- Symposium on Use of Aquifer Systems for Cyclic Storage of Water
- Symposium on Soil Water Parameters in the Unsaturated Zone

Oceanography

- General Ocean Numerical Models
- The Norpax Program
- Southern Ocean Dynamics
- Sediment Transport
- Paleoclimatic Indicators
- Results from Deep-Sea Drilling
- Reactions at the Sea Floor
- Estuarine and Coastal Marine Chemistry
- General Papers in Physical Oceanography
- General Papers in Geological Oceanography
- General Papers in Chemical Oceanography

Seismology

- Recent Earthquakes: Guatemala and Hawaii

Solar-Planetary Relationships—Cosmic Rays

- Symposium on the Scientific Results of the Joint German-American Helios Missions (cosponsored by SS)

Tectonophysics

- The February 4, 1976, Guatemala Earthquake (cosponsored by S)

Volcanology, Geochemistry, and Petrology

- Genesis of Andesitic Magma
- Low-Grade Metamorphism of Basaltic Rocks
- Petrology and Tectonic Settings of Ophiolites
- Alpine-Type Peridotites: Their Significance and Metamorphism
- The Search for and Evaluation of Magma Bodies

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 of the Southern Rocky Mountains

MEMOIR 144 — Edited by Bruce F. Curtis. 1975. xiii + 280 p., 123 figures, 8 tables, $25.00.

The papers in this volume were derived from a symposium, organized by Ogden Tweto, for the 1973 Rocky Mountain Section meetings of the Geological Society of America. Some of the information is new since the papers were presented. Basic to much of the history traced are the numerous absolute age determinations presented.

The Southern Rocky Mountains rise abruptly above the Great Plains along a front that extends northward from north-central New Mexico through Colorado and into southeastern Wyoming. On the west, the mountains border the Colorado Plateau. Sedimentary and structural basins complementary to the mountain ranges are mainly in the Plains and Plateau provinces.

Laramide (Late Cretaceous–Early Tertiary) Orogeny in the Southern Rocky Mountains (Ogden Tweto). At the onset of Laramide orogeny most of the buried mountain ranges were re-elevated, and adjoining Laramide basins, in part inherited from late Paleozoic basins, began to subside. Uplift and erosion were rapid. By 66 to 65 m.y. B.P., and before the close of Cretaceous time, 3,000 m of sedimentary rock had been eroded from at least parts of the ranges. Uplift of mountain units continued through Paleocene and into Eocene time, as indicated by nearly continuous Upper Cretaceous to Eocene sedimentary sequences in bordering basins. Laramide events gave way to quiescent conditions by late Eocene time; a widespread erosion surface of subdued relief developed.

Laramide volcanism and intrusion were confined largely to a broad northeast-trending belt that cuts diagonally across major tectonic units. The Colorado mineral belt constitutes an inner zone of this igneous belt. Intrusion of granodioritic porphyries began at about the same time as volcanism but continued longer, at least through Paleocene time. The igneous belt has no evident Laramide structural control.

Geomorphic and Tectonic Implications of the Post-Laramide, Late Eocene Erosion Surface in the Southern Rocky Mountains (Rudy C. Epis and Charles E. Chapin). A late Eocene erosion surface of low relief, which extended throughout south-central Colorado, provides a regional structural datum. The surface truncated deformed middle Eocene and older rocks and deeply beveled crystalline Precambrian rocks. Correlation of surface deposits indicates that it was uplifted 1,500 to 3,000 m and disrupted by block faulting of basin-and-range style in Miocene and later time.

Middle Tertiary Volcanic Field in the Southern Rocky Mountains (Thomas A. Steven). Igneous activity began in latest Eocene time (about 40 m.y.) and persisted into early Miocene time (25 to 20 m.y.). The volcanic field consisted of a southern segment covering all of south-central Colorado and adjacent New Mexico and a northern segment extending into the mountain areas of north-central Colorado. The two segments were linked along the trend of the Colorado mineral belt. Most of the volcanic field consisted of volcanic rock of intermediate composition derived from scattered volcanoes.

Large near-surface batholiths were emplaced beneath the San Juan Mountains and beneath the region that extends northeastward along the trend of the Colorado mineral belt as far as the Rocky Mountain front. The batholith in central Colorado probably consists of plutons of both Laramide (70 to 55 m.y.) and middle Tertiary (40 to 25 m.y.) ages.

Controls of Sedimentation and Provenance of Sediments in the Oligocene of the Central Rocky Mountains (John Clark). Oligocene rocks on the eastern side of the central Rocky Mountains extend from central Colorado to Saskatchewan; they record renewal of sedimentation following an erosional interval and generally have not been disturbed from their original attitude. Heavy mineral suites from the early Oligocene beds indicate derivation from local sedimentary rocks, from volcanic sources, and from the Black Hills, the Laramie Range, the Front Range, and perhaps other mountain uplifts. Late Oligocene strata in channels were derived from similar sources, whereas finer sediments of this age are mostly of pyroclastic origin.

Late Cenozoic Basaltic Volcanism and Development of the Rio Grande Depression in the Southern Rocky Mountains (Peter W. Lipman and Harald W. Mehnert). Initiation of basaltic volcanism coincided approximately with the beginning of extensional block faulting that resulted in development of the Rio Grande depression. Along the west margin of the San Luis Valley, basalt flows as old as 26 m.y. rest unconformably on middle Tertiary andesitic and related rocks (35 to 27 m.y. old), and similar basalt 20 to 0.24 m.y. old interfingers with and overlies volcaniclastic alluvial fan deposits (equivalent to Santa Fe Group).

Late Cenozoic Basic Volcanism in Northwestern Colorado and Its Implications Concerning Tectonism and the Origin of the Colorado River System (Edwin E. Larson, Minoru Ozima, and William C. Bradley). Upper Cenozoic terrestrial sedimentary and basic volcanic rocks are common in the Basalt region. Group 1 rocks attain a thickness of 210 m and range in age from 24 to 20 m.y. (early Miocene); they consist primarily of alkali-olivine basalt and basalt flows interlayered with sandstone. Group 2 rocks, 14 to 9 m.y. old (late Miocene and perhaps early Pliocene), attain a maximum thickness of 180 m and are composed largely of basalt, basaltic andesite, and fine-grained sedimentary rocks. Toward the end stages of the accumulation of group 2 rocks, about 10 m.y. ago, the region was subjected to major tectonism; the initiation of the Colorado River system apparently occurred at that time. By about 8 m.y. B.P. (late Miocene or early Pliocene), the Roaring Fork River had downcut 600 m and had formed a broad flood plain, upon which thin alkali-olivine basalt flows (group 3 rocks) were erupted. Sporadic volcanism since 1.5 m.y. B.P. has accounted for small cinder cones and flows of alkalic basalt (group 4 rocks).

Late Cenozoic Sedimentation and Deformation in Northern Colorado and Adjoining Areas (Glen A. Izett). Late Cenozoic deformation includes folding, uplift, and normal faulting. Faults with late Cenozoic movements are localized along zones of Laramide faulting. The deformed Miocene formations, which formerly were much more extensive, are mainly nonorogenic eolian and fluvial siltstone and sandstone as much as 900 m thick; some sedimentary rocks are interlayered with, or intruded by, basalts that are remnants of a much more extensive volcanic field than is preserved today.

Neogene Tectonism in South-Central Colorado (Richard B. Taylor). Miocene-Pliocene block faulting disrupted an earlier landscape and formed the major modern mountains and basins. The San Luis Valley and upper Arkansas Valley are en echelon segments of the Rio Grande trough. Clastic and volcanic trough fill may be 10,000 m thick near Alamosa and 1,500 m thick near Salida, and adjoining mountains stand as much as 1,500 m above the valley floors. Valley fill in the Wet Mountain Valley graben is as much as 1,500 m thick. The crest of the Wet Mountains was uplifted about 400 m above the valley to the west of the mountains and nearly 1,200 m above the high plains which lie to the east. To the north, Neogene faulting elevated the Rampart Range, dropped the Fourmile Creek graben nearly 400 m, formed fault-bounded basins at the southern margin of South Park, and segmented volcanic deposits in paleovalleys.

Cenozoic Surfaces and Deposits in the Southern Rocky Mountains (Glenn R. Scott). In early Oligocene time, broad shallow channels were cut, and these were partly filled with alluvial deposits. Faulting in early Miocene through Pliocene time displaced mountain versus valley blocks as much as 12,000 m vertically. The late Eocene surface was fragmented, the mountains were deeply eroded, and adjacent grabens were filled. Uplift accelerated in late Pliocene time. Quaternary surfaces are narrow and confined to valleys, and are not more than 140 m above streams.

Late Cretaceous and Cenozoic History of Laramie Basin Region, Southeast Wyoming (D. L. Blackstone, Jr.). Earliest deformation is recorded by conglomerate of late Campanian–earliest Maestrichtian age. Early Paleocene deformation defined the northern Front Range, Medicine Bow Mountains, and the Sierra Madre–Park Range. By early Wasatch time major northwest-trending structural features were outlined. During middle Eocene time, sediments were deposited in the Shirley basin area. A mature landscape was produced in late Eocene time, and northeast-trending structural features developed. During Oligocene time, volcanic debris intertongued with local conglomerate across the northern Laramie Mountains and central Medicine Bow Mountains; Miocene rocks occur in the Saratoga Valley, Hanna basin, and near Cheyenne. Volcanic activity near Specimen Mountain, Colorado, in late Oligocene time (28 m.y.) may have continued into Pliocene(?) time. Post-Miocene normal faulting and folding were active.

Studies in New England Geology

MEMOIR 146 — Edited by Paul C. Lyons and Arthur H. Brownlow. 1976. xvi + 374 p., 119 figures (including 3 black and white foldouts), 48 tables, subject and author indexes, $29.75.

This volume was written to honor C. Wroe Wolfe on his retirement from Boston University in 1974. The volume is divided into two sections: (1) Geology of Eastern Massachusetts and (2) Geology of Northern New England.

Geology of the Boston Basin (Marland P. Billings). The Boston basin is one of several late Paleozoic nonmarine sedimentary basins that developed in eastern New England subsequent to the Acadian revolution. The principal map units—except for the Blue Hills and Nahant—are the Precambrian basement, the Mattapan and Lynn Volcanic Complexes (Mississippian?), and the Boston Bay Group (Pennsylvanian?). The Boston Bay Group consists of the Cambridge Argillite and the Roxbury Conglomerate.

Based mainly on recent tunnel work, the new observations and interpretations are as follows: (1) The maximum thickness of the Boston Bay Group is 5,700 m. (2) The Boston Bay Group thins to the south. (3) The Roxbury Conglomerate, with a maximum thickness of 1,310 m, is a southerly facies of the lower part of the Cambridge Argillite. (4) The Cambridge Argillite reaches a maximum thickness of 5,700 m in the northern part of the basin. (5) The sedimentary rocks were derived from a highland to the south. Important new results that bear on structure are that the Northern border fault, where exposed in a tunnel, dips 55°N; the Charles River syncline plunges 19° in a direction N84°E; and many minor folds and faults complicate the structure.

The volcanic complex of the Blue Hills was erupted onto flat-lying Cambrian sedimentary rocks. The Quincy Granite and Blue Hill Granite Porphyry were injected into the horizontal Cambrian strata and volcanic complex. After a period of uplift and erosion, the Pennsylvanian strata of the Norfolk basin were deposited. All the rocks were then folded into a syncline, the vertical north limb of which is now the Blue Hills. The Blue Hills were then thrust northward over the Boston basin.

Petrography and Geochemistry of the Nashoba Formation, East-Central Massachusetts (Adel Abu-moustafa and James W. Skehan, S.J.). The Nashoba Formation of this report lies east of the Merrimack synclinorium. A 3,740-m-thick section of the formation was exposed in the Wachusett-Marlborough Tunnel. The authors divide this eugeosynclinal formation into 30 members, composed of distinctive sequences of seven lithologic types. The formation is underlain by and grades into the Marlboro Formation and is overlain unconformably by unnamed formations U-1 through U-15. In contrast to the Marlboro Formation, the Nashoba Formation is alumina-rich and has marble and calc-silicate beds. Otherwise, the two formations are similar. The environmental setting is inferred to have been a relatively shallow marine basin that received deeply weathered soils, unaltered volcanogenic sediments, and some volcanic rocks. Mineral assemblages indicate metamorphism corresponding to the sillimanite-almandineorthoclase subfacies of the almandine-amphibolite facies; mineral associations indicate recrystallization at 625° to 650°C at 6 kb.

Petrology, Chemistry, and Age of the Rattlesnake Pluton and Implications for Other Alkalic Granite Plutons of Southern New England (Paul C. Lyons and Harold W. Krueger). The Rattlesnake pluton of Sharon, Massachusetts, is composed principally of coarse biotite granite and fine riebeckite granite. Feldspar phenocrysts of the granite porphyry are chemically related to feldspar of the associated coarse biotite granite; however, the groundmass feldspar is more sodic. In contrast to the fine riebeckite granite, the quartz veins and pegmatite have higher concentrations of Na, Li, Fe, and F. Most granite bodies of the Rattlesnake pluton crystallized at temperatures between 660° and 800°C and at water-vapor pressures probably close to 1,000 kg/cm^2. Two stages of magma upwelling associated with blister collapse and cauldron subsidence are hypothesized.

K-Ar dating indicates a Middle Devonian age (about 370 m.y. B.P.). This date is lower than radiometric dates for the Cape Ann and Quincy Granites, which fall around 400 to 450 m.y. B.P., suggesting two or more periods of alkalic magma intrusion in eastern Massachusetts.

Ayer Crystalline Complex at Ayer, Harvard, and Clinton, Massachusetts (Richard Z. Gore). The Ayer Granodiorite here is divided into two units. The younger unit, the Clinton facies, is composed of foliated porphyritic quartz monzonite. The older unit, the Devens–Long Pond facies, primarily contains feldspathic gneiss which ranges in composition from quartz monzonite to quartz diorite. It is proposed that the Ayer Granodiorite be renamed the Ayer Crystalline Complex.

The age of the Clinton facies is uncertain but is probably Devonian. The heterogeneous nature of the Devens–Long Pond facies suggests derivation from a volcanic-sedimentary sequence, probably of Ordovician age or older. The relationship of the Clinton facies to the Devens–Long Pond facies is uncertain. The preintrusive or synintrusive deformation of the Devens–Long Pond facies and the foliation of the Clinton facies and Chelmsford granite suggest that the Acadian orogeny was characterized by two distinct pulses in this region.

Stratigraphy and Petrography of the Volcanic Flows of the Blue Hills Area, Massachusetts (Uldis Kaktins). The volcanic rocks have been divided informally into six units on the basis of textural and compositional features and stratigraphic position. The Great Dome Trail flow is the oldest, followed by the Wampatuck Hill flow, Chickatawbut Road flow, and the pyritic volcanic rocks. The stratigraphic positions of the Pine Hill and Hemenway Hill units are still uncertain.

Glass shards, eutaxitic structure, fractured crystals, and vertical zonal features indicate an ash-flow origin, as do lack of gradational bedding and the presence of axiolitic structures and pumice. All the rocks are low-Ca rhyolite and have some characteristics of peralkaline rhyolite.

Fossil Plants of Pennsylvanian Age from Northwestern Narragansett Basin (John Oleksyshyn). Fossil plants collected from the lower beds of the Rhode Island Formation in Plainville, Massachusetts, consist of two species of lycopods, ten species of sphenopsids, three species of ferns, twelve species of gymnosperms, and one type of rootlike structure, probably arthrophyte. Two species of gymnosperms, *Palmatopteris narragansettensis* and *Palmatopteris plainvillensis*, are considered new. Known stratigraphic occurrences suggest that the Plainville assemblage is Early Alleghenyan (corresponding to Westphalian C). The upper beds of the Rhode Island Formation and the Dighton and Purgatory conglomerates are probably Late Alleghenyan (corresponding to Westphalian D).

Early Pennsylvanian Age of the Norfolk Basin, Southeastern Massachusetts, Based on Plant Megafossils (Paul C. Lyons, Bruce Tiffney, and Barry Cameron). Plant megafossils from the Pondville Conglomerate suggest a late Pottsvillian age, presumably equivalent to the late Westphalian B of Maritime Canada and Europe. *Neuropteris obliqua, Neuropteris* cf. *scheuchzeri, Cordaites principalis, Calamites cisti, Cordaicarpus* cf. *cordai,* a ?*Samaropsis* species, a ?decorticated *Sigillaria*, and a probable *Lonchopteris* species have now been identified.

Chronology and Styles of Multiple Deformation, Plutonism, and Polymetamorphism in the Merrimack Synclinorium of Western Maine (Robert H. Moench and Robert E. Zartman). The area lies on the transition zone between the sillimanite portion of the Merrimack synclinorium in New Hampshire and the greenschist-facies portion in central Maine. An early deformation and metamorphism (M-1) produced northeast-trending tight folds, longitudinal premetamorphic faults of large displacement, and slaty cleavage. These features were produced throughout the ancestral geosyncline and characterize the structure of the greenschist terrane. Southwestward across the transition zone, they are increasingly blurred by younger superposed structural and metamorphic features. The late deformation (M-2 and M-3) produced schistosity derived from slip cleavage, small recumbent folds, large flexural folds, domes of varied shapes and trends, and conspicuous northwest-trending flexural cross folds. Many structural features are directly magma-generated. Granite and aplite have yielded a Rb-Sr date of 379 ± 6 m.y., which dates the youngest intrusive rocks of the New Hampshire Plutonic Series in the report area, M-3 metamorphism, and the late deformations that accompanied M-3.

The Mooselookmeguntic pluton and the larger Sebago pluton farther south may be subhorizontal sheets only a few kilometres thick that were emplaced at depths of 11 to 15 km. Numerous plutons now exposed northeast of the transition zone are cupolas and possibly isolated bodies that rose above the sheets.

Prehnite-Pumpellyite Facies Metamorphism in Central Aroostook County, Maine (Dorothy A. Richter and David C. Roy). The distribution of metamorphic mineral assemblages, in lower Paleozoic eugeosynclinal sedimentary and volcanic rocks, permit the mapping of three zones corresponding to increasing grade within the prehnite-pumpellyite facies. Metamorphism increases in grade from northwest to southeast. All of the metamorphic assemblages seem to fit Seki's intermediate-pressure type of metamorphism. Most evidence suggests metamorphism during the Acadian orogeny.

Stratigraphic Relationships on the Southeast Limb of the Merrimack Synclinorium in Central and West-Central Maine (Kost A. Pankiwskyj, Allan Ludman, John R. Griffin, and W.B.N. Berry). A complex lithofacies pattern is revealed in Silurian and Silurian or Devonian eugeosynclinal metasedimentary rocks. Stratigraphic units are traced from the highly metamorphosed terrane of western Maine into the slightly recrystallized rocks of the central Maine slate belt interpretations come from 25 new graptolite localities. Four new formation names and one revised designation are given. The lithofacies relationships indicate filling of a sedimentary trough from both western (metamorphic, plutonic, and volcanic) and eastern (dominantly volcanic) sources from at least late Llandoverian through early Ludlovian time. From post–early Ludlovian through Early Devonian(?) time, thick sequences of metasandstone and flyschlike materials blanketed the synclinorium and much of New England. The total section, dominated by metagraywacke and metashale, is more than 6 km thick.

Structural Evolution of the White Mountain Magma Series (Carleton A. Chapman). The series (Jurassic to Cretaceous in age) originated from discrete magma chambers, probably formed within the upper mantle. When the ascending chambers reached the upper part of the crust, the granitic cap was fully developed and the underlying melt had become syenitic.

A new theory of the mechanism of ring dike formation, involving cone fracturing followed by stoping and subsidence, is explained. A model of a floored chamber with coexisting syenitic and granitic melts explains why the subsiding block stops, why mafic ring dikes are rare, why granite is found more commonly in stocks and syenite more commonly in ring dikes, why quartz syenite cuts granitic rock, why rhyolite appears at the surface before quartz syenite forms in associated ring dikes, and why rhyolite dominates the associated volcanic rocks.

Gravity Models and Mode of Emplacement of the New Hampshire Plutonic Series (Dennis L. Nielson, Russell G. Clark, John B. Lyons, Evan J. Englund, and David J. Borns). A gravity network of 700 stations in central and southern New Hampshire, and mapped intrusive contacts and rock density determinations, were used to deduce structural relations. The intrusive bodies occur principally as subhorizontal sheets no thicker than 2.5 km.

Forcible injection of the earliest members of the series, the Bethlehem Gneiss and Kinsman Quartz Monzonite, occurred during nappe development. Next, biotite quartz monzonite and Spaulding Quartz Diorite were forcibly emplaced during predominantly horizontal compression. Emplacement of the posttectonic Concord Granite may have involved forcible injection, cauldron stoping, and possible displacement of roof zones. The authors suggest that the rheidity and the foliation of the metasediments dictated the formation of thin plutonic sheets at the level of the infrastructure and that thick stocks or batholiths were emplaced in the brittle superstructure.

Nickeliferous Pyrrhotite Deposits, Knox County, Southeastern Maine (George D. Rainville and Won C. Park). Nickeliferous ores (pyrrhotite, pentlandite, and chalcopyrite) in the Harriman peridotite and Warren gabbrodiorite occur as lenticular bodies in the Ordovician Penobscot Formation. The ore bodies were emplaced in Late Ordovician time. The Harriman body is a feldspathic lherzolite peridotite with limited serpentinization in the central zone; sulfides occur interstitially or, less commonly, as thin massive layers. The Warren body is composed predominantly of andesine-labradorite; sulfides occur interstitially, as irregular disseminations, and in massive segregation bodies. An orthomagmatic origin is supported by the high combined concentrations of nickel, cobalt, and copper in pyrrhotite (approximately 0.7 wt percent) and more than 2 wt percent cobalt plus copper in all varieties of pentlandite.

These deposits differ significantly in their mineralogic composition from other nickel deposits.

October BULLETIN briefs

Brief summaries of articles in the October 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.*

☐ 61001—Structural elements and deformational history of rocks in eastern Massachusetts. *Arthur E. Nelson, U.S. Geological Survey, National Center 926, Reston, Virginia 22092.* (7 p., 5 figs., 1 tbl.)

Late Precambrian stratified rocks of the Boston platform were intruded by late Precambrian granitic magma. Later they were regionally metamorphosed, folded, mylonitized, and faulted during the Acadian orogeny or an earlier event. Still later, rocks of the Boston basin were folded and faulted during the Acadian orogeny or an earlier event. Still later, rocks of the Boston basin were folded and faulted during the Alleghenian disturbance. Rocks along an extensive fracture system were deformed intermittently by faulting from possibly middle Devonian to Permian time.

The platform rocks were deformed during three periods of deformation. The first period began early in the regional metamorphic event when folds and metamorphic schistosity (S_1) formed in response to ductile deformation. Possibly some cataclastic foliation (S_X) formed during this period. The second period of deformation began near the end of regional metamorphism. First, minor folds developed; later, regional north- to northeast-trending folds formed. The schistosity (S_1) was folded, a slip cleavage (S_2) developed, and cataclastic foliation (S_X) associated with deep-seated faulting also formed in the rocks during the second period. The third period began near the end of Paleozoic time, when rocks of the Boston basin were folded and faulted. A cleavage (S_3) formed in some rocks during this time.

The Bloody Bluff is the principal fault in a complex zone that strikes northeast across a large part of eastern Massachusetts. This zone has an irregular but prominent belt of cataclastic rock associated with it. Regional relations and aeromagnetic data suggest that the Bloody Bluff fault may be part of a fracture system that trends across the Gulf of Maine into Canada.

☐ 61002—Composition and age of Lau Basin and Ridge volcanic rocks: Implications for evolution of an interarc basin and remnant arc. *James B. Gill, Earth Sciences Board and Center for South Pacific Studies, University of California, Santa Cruz, California 95064, and Research School of Earth Sciences, Australian National University, Canberra, ACT, Australia.* (12 p., 6 figs., 5 tbls.).

The Tonga-Kermadec Ridge, Lau Basin, and Lau-Colville Ridge are, respectively, a frontal arc, interarc basin, and remnant arc at the Australian-Pacific plate boundary. Basement rocks of the Lau-Colville Ridge (Lau Volcanics) are 9- to 6-m.y.-old basaltic andesites to dacites with 55 to 66 percent SiO_2, K_{60} = 1.0 to 1.5 percent, little Fe enrichment, Sr^{87}/Sr^{86} = 0.7030 to 0.7034, and enrichment in light rare-earth elements. Westward increases in K, Rb, Th, and U suggest that subducted lithosphere was underthrust from the east. Variations in rock composition are consistent qualitatively with derivataion from basalt by low-pressure crystal-liquid fractionation involving removal of phenocryst phases: plagioclase + clinopyroxene + orthopyroxene + magnetite. Volcaniclastic turbidites of the same age and derived from western sources are found in Tonga. These andesitic volcanogenic rocks are overlain on both ridges by Pliocene limestones, which are capped on the Lau-Colville Ridge by 3.9- to 3.5-m.y.-old olivine + hypersthene normative tholeiites (Korombasanga Volcanics) having minor 56 to 60 percent SiO_2 andesitic differentiates. Lau Basin basalts are transitional between ocean-floor and island-arc tholeiites, sharing with the latter their higher Rb, Ba, light rare-earth element, and Sr^{87} contents and lower Ti, Zr, and Hf contents. These data support Karig's idea that the Lau and Tonga Ridges represent a once-united island arc now dismembered by rifting, which has formed the intervening Lau Basin. This rifting began about 5 m.y. B.P. The change in volcanism on the Lau-Colville Ridge reflects its removal from a subduction site.

☐ 61003c—Elemental accumulation rates in the Bauer Deep: A correction. *Frederick L. Sayles, Department of Chemistry, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543; T.-L. Ku, Department of Geological Sciences, University of Southern California, Los Angeles, California 90007; Paul C. Bowker, Department of Chemistry, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543.* (1 p.).

☐ 61004—Caldera-collapse breccias in the western San Juan Mountains, Colorado. *Peter W. Lipman, U.S. Geological Survey, Hawaii Volcano Observatory, Hawaii National Park, Hawaii 96718.* (14 p., 12 figs., 1 tbl.)

In four large Oligocene calderas in the western San Juan Mountains—Lake City, Silverton, San Juan, and Uncompahgre—spectacular breccias are intermixed with thick intracaldera ash-flow tuffs that accumulated during caldera collapse. These breccias are divided into two intergradational types: (1) mesobreccia in which numerous small clasts are visible within single outcrops and (2) megabreccia in which many clasts are so large that the fragmental nature of the deposit is obscure in many individual outcrops.

In general, mesobreccia occurs as thin tabular deposits locally interlayered with upper parts of the intracaldera ash-flow accumulations; it is readily interpretable as resulting from small- to medium-sized rock falls and rock slides from the caldera walls. In contrast, megabreccia is dominant in the lower part of the caldera-filling sequence and contains only minor intermixed ash-flow material. Megabreccia is difficult to distinguish from pre-collapse caldera floor in places, but local lenses of welded tuff near the deepest stratigraphic levels exposed within the calderas indicate that these rocks are mostly megabreccia that resulted from major slumping and caving of caldera walls during the initial stages of caldera collapse. An especially large megabreccia unit within the San Juan and Uncompahgre calderas is here named the Picayune Megabreccia Member of the Sapinero Mesa Tuff.

Megabreccias similar to those in the western San Juan calderas occur in other eroded collapse structures in the western United States, and the presence of such deposits may be useful guides to the roots of caldera structures in deeply eroded, highly altered, or structurally complex volcanic terranes.

☐ 61005—Significance of conjugate folds and crenulations in the central Sierra Nevada, California. *Othmar T. Tobisch, U.S. Geological Survey and University of California, Earth Science Board, Applied Science Building, Santa Cruz, California 95064; Richard S. Fiske, U.S. Geological Survey, National Center, Reston, Virginia 22092.* (10 p., 13 figs.)

Conjugate folds and crenulations occur in various parts of the central Sierra Nevada. Analysis of individual conjugate folds shows that the principal directions of compression associated with these structures were reasonably constant over a large area during the conjugate folding. Analysis of the modal axial plane distribution of the accompanying crenulations and small folds produces comparable results, suggesting that the direction of maximum compression may be reliably determined from modal data. Both methods of analysis indicate that the axial planes of small folds and crenulations associated with the conjugate set have formed at a moderate angle (generally 40° to 60°) to P_{max}.

In morphology, the crenulations vary from isolated kinks to a crenulation cleavage. Locally this cleavage develops into a differentiated crenulation cleavage and in some outcrops takes on many of the characteristics of a penetrative slaty cleavage. These structures have formed at approximately 40° to 60° to P_{max}. It is proposed that slaty cleavage can develop in two dynamic frameworks: (1) where slaty cleavage forms at 90° to P_{max}, and (2) where cleavage forms at 40° to 60° to P_{max}.

Analysis of the direction of maximum compression shows that during the conjugate folding, P_{max} was oriented approximately parallel to the structural grain of the Sierra Nevada. This implies a shift in P_{max} of nearly 90° between development of the principal slaty cleavage and conjugate structures. Similar shifts in P_{max} between development of slaty cleavage and conjugate folding are observed in other mountain belts. We propose a model that explains this shift in P_{max} by suggesting that the formation of slaty cleavage and subsequent crenulations represents structures formed at different stages of development within a continuous process. This process involves compression normal to the mountain belt (formation of slaty cleavage), and as normal compression ceases, "elastic recovery" becomes active, inducing shortening parallel to the belt (formation of conjugate crenulations). The model implies negligible time lapse between formation of slaty cleavage and subsequent crenulations.

☐ 61006—Magnetic anomalies over the western margin of the New England foldbelt, northeast New South Wales. *W.R.H. Ramsey, John M. Stanley, Departments of Geology and Geophysics, University of New England, Armidale, New South Wales 2351 Australia.* (8 p., 5 figs., 2 tbls.)

Two large linear magnetic anomalies bound a north-northwest-trending belt of folded middle to upper Paleozoic shelf and terrestrial sedimentary rocks on the western margin of the New England foldbelt. The Peel anomaly has an ultramafic source that lies along the Peel thrust fault, a structure separating shelf sedimentary rocks from Paleozoic cherts, argillites, and metabasites. The Mooki anomaly occurs along the boundary of the shelf and terrestrial sediments where these strata are thrust against flat-lying Permian strata. The source of the Mooki anomaly is intermediate and mafic igneous rocks of uncertain age, which have been intruded along a complex thrust system. These findings have been briefly discussed in relation to broadly similar geololgy and large positive linear magnetic anomalies in California and New Zealand.

☐ 61007—Hercynian orogeny in the Montagne Noire (France): Application of Rb^{87}-Sr^{87} systematics. *J. Hamet, Laboratoire de Géochimie et Cosmochimie, Institut de Physique du Globe, Université de Paris VI, 4 Place Jussieu, 75230 Paris, France; C. J. Allègre, Départment des Sciences de la Terre, Université de Paris VII, 4 Place Jussieu, 75203 Paris, France.* (14 p., 16 figs., 8 tbls.)

The Rb^{87}-Sr^{87} whole-rock isochrons of Hercynian granites in the Montagne Noire (southern Massif Central, France) show that two different episodes of granitization occurred during Hercynian time: early alkalic granites were emplaced 340 to 330 m.y. ago, and calc-alkalic granites were emplaced 290 to 280 m.y. ago. The Hercynian orogeny may have occurred between 340 and 270 m.y. ago in this area. Tectonic phases are apparently confined to the beginning of the orogenesis and are short compared to the total lapse of time of the orogeny.

The Sr^{87}/Sr^{86} initial ratios of the granites and of surrounding crustal rocks allow us to put some limitations on the relative amounts of mantle-derived material in each granitic type. The early granites represent remobilized continental crust, whereas in the later ones the mantle contribution increases with time. The mantle-derived material is presumed to be a highly differentiated product, probably of a dioritic composition.

Rb and Sr concentrations are used as tracers to test models of granite genesis, equilibrium partial melting, and (or) fractional crystallization. The mineral isochrons reveal that no important thermal event occurred after the Hercynian episode. The youngest rehomogenization is dated at 280 to 290 m.y. ago. A temperature-time curve summarizes the Hercynian orogeny and represents an attempt to connect the tectonic phases with periods of granitization and metamorphism.

☐ 61008—Lower Ordovician (Gasconadian) Great Meadows Formation in eastern New York. *Donald W. Fisher, Geological Survey, New York State Museum and Science Service, Albany, New York 12234; S. J. Mazzullo, Faculty of Earth Science, University of Texas of the Permian Basin, Odessa, Texas 79762.* (6 p., 8 figs.)

Bedrock mapping and stratigraphic studies by Fisher and sedimentological studies by Mazzullo have resulted in a clearer understanding of the stratigraphy and facies relationships of the Lower Ordovician Great Meadows Formation in New York (largely equivalent to the Cutting Formation in Vermont). In Washington and Warren Counties, New York, the tripartite Great Meadows consists of (1) basal cross-stratified and laminated dolomitic quartzofeldspathic siltstone; (2) middle calcitic dolostone, locally cherty; and (3) upper fine-grained limestone. Some stratigraphic nomenclatural problems are resolved, and two new names are introduced: Winchell Creek for the basal arenites and Fort Edward for the middle dolostone. The existing name, Smith Basin, is retained for the upper member. Probable disconformities occur at the base and summit of the Great Meadows. The inferred environments of the Great Meadows Formation are intermittently near-normal to hypersaline low-energy tidal flats and shallow subtidal facies.

☐ 61009—Barndoor diabase intrusions, north-central Connecticut. *Richard L. Kroll, Department of Earth and Planetary Environments, Kean College of New Jersey, Union, New Jersey 07083.* (6 p., 9 figs., 3 tbls.)

The Barndoor diabase in north-central Connecticut cuts the New Haven Arkose, the oldest formation in the Newark Group of Triassic age in Connecticut. The intrustions are dikes in part and slightly transgressive sills in part. The rocks are typical diabases, with unusual features such as pigeonite with semispherical fractures and pale-green pyroxene. The most calcic augite occurs in interior parts, requiring crystallization in source chambers followed by intrusion of a crystal-bearing magma. Five feeder conduits from two source chambers are proposed. Extensive differentiation occurred in source chambers, and minor differentiation occurred during emplacement and cooling. Plagioclase composition ranges from An_{70} to An_{34} and augite from $Wo_{47}En_{43}Fs_{10}$ to $Wo_{35}En_{40}Fs_{25}$. Chill-zone rocks are chemically similar to Talcott Basalt, which is the lowest of three basalt flows in the Newark Group in Connecticut, and indicate contemporaneity of intrusive and extrusive events.

☐ 61010—Dacites of Bunsen Peak, the Birch Hills, and the Washakie Needles, northwestern Wyoming, and their relationship to the Absaroka volcanic field, Wyoming and Montana. *L. L. Love, A. M. Kudo, D. W. Love, Department of Geology, University of New Mexico, Albuquerque, New Mexico 87131.* (8 p., 12 figs., 2 tbls.)

Three porphyritic dacite plugs from the western Absaroka volcanic belt in northwestern Wyoming have been studied, and their petrography, chemistry, and ages are treated in terms of the regional igneous geology of the Absaroka volcanic field.

The dacite from the northernmost plug studied, Bunsen Peak, is 47.6 ± 1.9 m.y. old, as dated by the fission-track method on apatite; the Birch Hills dacite is 40.5 ± 2.6 m.y. old, as dated by the fission-track method on apatite; and the dacite from the southernmost plug, Washakie Needles, is 38.8 ± 1.6 m.y. old, as dated by the fission-track method on sphene. It appears from the dates available that the oldest igneous activity in the Absaroka volcanic field occurred at the northwestern end about 53.5 m.y. ago. The activity migrated to the southeast, ending about 38.8 m.y. ago at the Washakie Needles.

The Absaroka volcanic field has been subdivided into two belts. The western belt is composed of normal calc-alkalic igneous rocks, and the eastern belt is composed of potassium-rich rocks. When the available analyses of the province are treated in terms of the system quartz-plagioclase-orthoclase, it becomes apparent that the rocks of the two belts lie on two distinct differentiation trends. The trend for rocks of the western belt is best explained by fractional crystallization of plagioclase from an intermediate magma. The trend for rocks of the eastern belt is best explained by crystallization of both plagioclase and potassium feldspars. The mafic members of the eastern belt rocks are similar to shoshonitic rocks.

☐ 61011—Lineament, linear, lineation: Some proposed new standards for old terms. *D. W. O'Leary, J. D. Friedman, H. A. Pohn, U.S. Geological Survey, Federal Center, Denver Colorado 80225.* (7 p., 2 tbls.)

The words "lineament," "linear," and "lineation" have become increasingly popular since the advent of spacecraft and high-altitude aircraft images. With the increased usage has come a concomitant relaxation in the definitions of these terms, until the literature now is overwhelmed with conflicting and equivocal meanings. The need for clarification of these terms is clear. We propose a return to more fundamental conceptual definitions, based on original usage. We define the word "lineament" in an essentially geomorphological sense, on the basis of the usage introduced by Hobbs: A lineament is a mappable, simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs distinctly from the patterns of adjacent features and presumably reflects a subsurface phenomenon. The word "linear" is restricted to its original adjectival sense to avoid the increasingly popular but grammatically and conceptually incorrect nominative use. The word "lineation" is restored to its fundamental petrographic meaning: lineation is the one-dimensional structural alignment of internal components of a rock, is imposed by external agents, and cannot be depicted as an individual feature on a map. In addition, we suggest usages of "line" and "alignment" to refer to nongeologic features and (or) questionable features that do not fit proposed criteria and where definitional restrictions or implications may be a problem.

☐ 61012—Gravity tectonic removal of cover of Blue Ridge anticlinorium to form Valley and Ridge province. *John M. Dennison, Geology Department, University of North Carolina, Chapel Hill, North Carolina 27514.* (7 p., 2 figs.)

Chiefly on the basis of comparative amounts of foreshortening of the Valley and Ridge and Blue Ridge provinces, it is proposed that the eastern Valley and Ridge strata are the remnants of the former cover of the Blue Ridge anticlinorium. This cover slumped to the northwest (by gravity tectonic denudation) as the western Piedmont-eastern Blue Ridge was tilted gently to the northwest during the Alleghany orogeny, probably during the Permian Period. In a later phase of the Alleghany deformation, the Blue Ridge anticlinorium formed, and throughout much of its length it was thrust over the Valley and Ridge province as a result of continued pressure from the southeast. Arguments are presented that the anticlinorium configuration of the Blue Ridge area did not develop until after deposition of the Paleozoic strata in the Appalachian basin.

☐ 61013—Trace-element variations at Summer Coon volcano, San Juan Mountains, Colorado, and the origin of continental-interior andesite. *Robert A. Zielinski, Peter W. Lipman, U.S. Geological Survey, Federal Center, Denver, Colorado 80225.* (9 p., 7 figs., 4 tbls.)

The Oligocene Summer Coon center, an eroded continental-interior volcano of the eastern San Juan Mountains, Colorado, was the source of magmas ranging in composition from basaltic andesite to rhyolite. Previous Pb and Sr isotope studies indicate derivation of the magmas from an isotopically homogeneous source. This study presents new data for rare-earth elements (REE), U, Th, Ba, Sr, Rb, and Ni from 10 samples of the Summer Coon sequence. Alkali elements are high in all rocks; as SiO_2 increases, Ba increases from 900 to 2,000 ppm, Rb increases from 35 to 90 ppm, Sr decreases from 900 to 350 ppm, K/Rb decreases slightly, Ba/Sr increases, U increases from 0.5 to 2.5 ppm, and Th increases from 2 to 7 ppm. Chondrite-normalized REE patterns are strongly fractionated in comparison with oceanic-arc andesite-dacite sequences. La is 80 to 120 times chondritic abundance, but Yb and Lu are less than 10 times chondritic abundance. Small negative Eu anomalies characterize the rhyolites. Nickel in the andesites is 40 to 70 ppm.

The origin of the andesite is interpreted in terms of nonmodal partial melting of a trace-element–enriched garnet-bearing source, possibly subducted crust that has converted to eclogite. Rhyodacite and rhyolite are interpreted as low-pressure crystal-fractionation products of silicic andesite, in which crystallizing phases are hornblende rich in REE and plagioclase.

☐ 61014—Plate tectonics and structural evolution of the Zagros geosyncline, southwestern Iran. *Mansour S. Kashfi, Ultramar Iran Oil Company, P.O. Box 14-1899, Tehran, Iran.* (5 p., 3 figs., 1 tbl.)

The Zagros geosyncline has been a geologic unit extending from the Turkish frontier, north of Mosul, to the entrance of the Persian Gulf at least since the beginning of Paleozoic time. The Zagros Mountains can be interpreted as being the final product of a geosynclinal cycle. In contrast, the evidence for a plate tectonic history in this region is too fragmentary to be meaningful at this time.

☐ 61015—Regional variation of $^{87}Sr/^{86}Sr$ ratios and mineral compositions of sediment from the Ross Sea, Antartica. *Nelson R. Shaffer, Gunter Faure, Department of Geology and Mineralogy; and Institute of Polar Studies, the Ohio State University, Columbus, Ohio 43210. (Present address, Shaffer; Indiana Geological Survey, Bloomington, Indiana 47401.)* (10 p., 4 figs., 2 tbls.)

The $^{87}Sr/^{86}Sr$ ratios and concentrations of rubidium and strontium of <100 mesh noncarbonate fractions of sediment taken from the tops of piston cores vary systematically throughout the Ross Sea. The respective ranges of variation are: $^{87}Sr/^{86}Sr$: 0.710 to 0.726; Sr = 91 to 238 ppm, Rb = 56 to 158 ppm. These data are interpreted in terms of two-component mixing of weathering products of old sialic rocks (high $^{87}Sr/^{86}Sr$ ratio, low Sr concentration) and of young volcanic rock of basaltic composition (low $^{87}Sr/^{86}Sr$ ratio, high Sr concentration). The relevant mixing equation was derived from the data by fitting a straight line to data points in coordinates of $^{87}Sr/^{86}Sr$ and 1/Sr. The strontium concentrations of the two components were calculated from the mixing equation for assumed values of the $^{87}Sr/^{86}Sr$ ratios. For the basaltic component ($^{87}Sr/^{86}Sr = 0.704 \pm 0.001$): Sr = 567 ± 143 ppm, for the sialic component ($^{87}Sr/^{86}Sr = 0.729 \pm 0.001$): Sr = 82 ± 3 ppm. The sialic component consists primarily of clay minerals, but the basaltic component is represented by less-weathered detrital particles. The concentration of volcanic detritus ranges from nearly zero just north of the Ross Ice Shelf to values in excess of 30 percent in the vicinity of Ross Island and off the coast of northern Victoria Land. Quartz and feldspar correlate positively and are both concentrated in sediment collected along the edge of the continental shelf and along the coast of Victoria Land. Illite and kaolinite/chlorite are most abundant in the immediate vicinity of the Ross Ice Shelf. The mineral compositions of the sediment may have been modified by strong bottom currents which apparently limit contemporary deposition of sediment to sheltered depressions. A plot of rubidium versus strontium concentrations of the noncarbonate sediment shows a wide range of scatter along the Rb-axis which is attributed to uptake of rubidium from sea water but may also indicate inhomogeneity of the rubidium concentrations of the sialic component. The $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$ ratios are positively correlated, but this relationship is the result of mixing and does not reflect the age of the provenance nor the time of deposition of the sediment.

☐ 61016—Granitic association of northeastern Sudan. *C. R. Neary, Department of Earth Sciences, University of Leeds, Leeds LS2 9JT, England (present address; Institute of Geological Sciences, Geological Museum, Exhibition Road, London SW7 5DB, England); I. G. Gass, Department of Earth Sciences, The Open University, Milton Keynes MK7 6AA, England; B. J. Cavanaugh, Geochronology Laboratories, Department of Earth Sciences, The University of Leeds, Leeds LS2 9JT, England.* (12 p., 3 figs., 5 tbls.)

Granitic rocks of magmatic origin form about 60 percent of the crystalline basement in the northeastern Sudan. Although divisible on field evidence into older (batholithic) and younger granites and overlying, horizontally disposed rhylotic volcanic rocks, most units have an isotopic age of 700 m.y.; quantitatively minor instrusive masses have ages of 500 and 100 m.y. Field, geochemical, and, to a lesser extent, petrographic and mineralogic evidence indicates that the Eocambrian granitic rocks represent the cratonization of an island arc. The distribution of ultramafic (ophiolite) masses in northeastern Africa and western Arabia suggests that several arc systems have been swept together. Paleomagnetic parameters that preclude extensive horizontal movement and closely spaced arc systems, like those of the present-day southwestern Pacific, are envisaged. The later minor magmatic activity was within-plate; a hot-spot origin is thus postulated.

☐ 61017—Fluids in the evolution of granitic magmas: Consequences of finite CO_2 solubility. *John R. Holloway, Division of Geochemistry, Department of Chemistry, Arizona State University, Tempe, Arizona 85281.* (6 p., 9 figs.)

The small but finite solubility of CO_2 in granitic magmas under crustal conditions, together with the common occurrence of CO_2 in likely magma source materials, suggests that granitic magmas will often be accompanied by a CO_2-H_2O fluid phase during their ascent in the crust.

Polybaric and isobaric calculations have been made for model systems with varying total volatile content, initial CO_2/H_2O ratios, crystallization rates, and closed-system or open-system conditions. The calculations demonstrate that

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the presence of CO_2 in an evolving magma system can result in greatly differing values of H_2O activity (and hence H_2O content, phase equilibria, and physical properties of the magma). Specifically, if the mass ratio CO_2/H_2O is greater than or approximately equal to 0.4 and the initial mass ratio of total volatiles to silicate magma is greater than or approximately equal to 0.05, then, if little or no loss of the fluid phase occurs during magma evolution, the activity of H_2O will remain nearly constant. This is in strong contrast to all other possible cases in which the activity of H_2O increases rapidly with decreasing pressure and (or) anhydrous phase crystallization, invariably reaching a value of unity.

It is also demonstrated that if CO_2 is present in a fluid phase in the magma source region, then there will be a fluid present throughout the evolutionary history of the magma. The presence of fluid bubbles in the magma should considerably alter many properties of the magma system such as heat transfer, mass transfer, and viscosity.

☐ 61018dr—Age, origin, regional relations, and nomenclature of the Glenarm Series, central Appalachian Piedmont: A reinterpretation: Discussion and reply.

Discussion: *Victor M. Seiders, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.*

Reply: *Michael W. Higgins, U.S. Geological Survey, National Center, 928, Reston, Virginia 22092.*

☐ 61019dr—Pliocene climatic and glacial history of Antarctica as revealed by Southeast Indian Ocean deep-sea cores: Discussion and reply.

Discussion: *Fred M. Weaver, Menno G. Dinkelman, Antarctic Marine Geology Research Facility, Department of Geology, Florida State University, Tallahassee, Florida 32306.*

Reply: *Stanley V. Margolis, Department of Oceanography and Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96822; Richard G. Blank, Department of Oceanography, University of Washington, Seattle, Washington 98195.*

☐ 61020dr—Preferred position model and subsurface symmetry of valleys: Discussion and reply.

Discussion: *G. H. Dury, Department of Geology and Geophysics, University of Wisconsin-Madison, Madison, Wisconsin 53706.*

Reply: *R. C. Palmquist, Department of Earth Science, Iowa State University, Ames, Iowa 50010.*

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