GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

APRIL 1976

Policy approved at Salt Lake City annual meeting

Council approves GSA publication policy

The primary mission of the Geological Society of America is communication, principally through its publication program. Such communication takes a number of forms.

First, the Society's publication program has the objective of encouraging, publishing, and disseminating a high level of scholarly research in the geological sciences. The *Bulletin* of the Society is the principal journal for scholarly contributions. Its continuing improvement of quality and effectiveness is a prime responsibility of the science editor. The science editor is likewise expected to maintain comparable levels of scholarship and competence in the Memoirs, Special Papers, Map and Chart Series, and other scientific publications of the Society.

A second area of communication in which the Society has a concern and involvement is that of information dissemination and retrieval. The contribution of GSA in this area has been through publication of the *Bibliography and Index of Geology* and sponsorship of AGI's GeoRef program. The Committee on Publications over the years has developed plans for inexpensive, fast systems of geological information storage, retrieval, and dissemination that are suited to the individual scientist's interest. Implementation of such plans at a favorable time will allow the Society to discharge its responsibilities in an ever more important area of scientific data communication.

In a third area, the Society has attempted to broaden its communication base through publication of *Geology*. This publication serves an important communication function through presentation therein of short reports on recent work and as a forum for scientific discussion. It further serves as a vehicle for distribution of "GSA News & Information," which includes briefs of articles to be printed in forthcoming issues of the *Bulletin*. The compilation and editing of "GSA News & Information" is the responsibility of the executive director. *Geology* is a new publication, and its format is not fixed; therefore, within the limitations of the budget, it offers an opportunity for innovation. Such innovation may extend to reviews, "state of the art" essays, and discussions of the geologic scientific base related to societal problems.

This leads to the fourth area, which deals with careful, objective evaluation and discussion of issues that affect Earth science. GSA took a step in this direction when it formed its Committee on Environment and Public Policy, but does not, as yet, provide a forum in its publications for statement and commentary in this area. It is appropriate that such comment be published by GSA with the following conditions:

a. Publication policy is the responsibility of the Council through its Publications Committee; editorial policy is the responsibility of the science editor. The science editor may collect, or even produce, commentary; he must, however, make it clear that he is not speaking for the Society.
b. The contribution of the Society should be to dig out and present scientific facts; however, the Society should not take an editorial stance nor distribute its publications in a manner that might jeopardize its 501(c)(3) tax-exemption status.

Subject to budget limitations, *Geology* appears to the Council to be the appropriate medium for publication of such commentary.

The current publications of the Society named above are designed for peer consumption. While it would be inappropriate at this time to develop new publication ventures because of lack of available financial and manpower resources, the possibility of future development of a publication which provides an educational service for nonspecialists and for the community at large should not be ignored by the Society.

Council actions: Fall 1975 meeting

The following actions were taken by the GSA Council at its fall meeting, 1975, in Salt Lake City:

1. Adopted as the report of the Council the *Annual Report for 1974* that was submitted to the annual corporate meeting as required by the bylaws.

2. Discussed the break-even operating budget for 1976.

3. Approved certain financial resolutions.

4. Voted to admit the Cushman Foundation as an Associated Society of GSA.

5. Discussed the second annual meeting of the GSA Executive Committee and the presidents of the associated societies for January 1976 in Boulder, Colorado.

6. Accepted the resignation of Bennie W. Troxel as science editor; discussed the appointment of his replacement; invited a candidate to appear before the Council in Salt Lake City.

7. Authorized an on-site inspection of Cincinnati and New Orleans as possible national meeting sites; declined the Kansas City invitation for the present.

8. Voted to share the financial responsibilities of the 1978 Toronto Annual Meeting on a fifty-fifty basis with the Geological Association of Canada.

9. Ratified the 1976 Committee on Committees roster.

10. Voted to include in the Society's bylaws a section on contracts.

11. Discussed the objections raised by some members concerning the $20 publication charge.

12. Rescinded the $20 publication charge for abstracts authored by Student Associates accepted for section annual meetings, effective 7-1-76.

13. Assigned national officers to attend the 1976 section annual meetings.

14. Moved to invite one officer from each section to attend the Council meetings as an observer.

15. Set the minimum registration fee for section annual meetings at $7.50 and the maximum at $20.

16. Ratified the North-Central Section bylaw changes concerning the 89th meridian, the annual business meeting, and quorums for meetings.

17. Ratified the Rocky Mountain Section bylaw amendment concerning election of officers.

18. Accepted reports from GSA sections, divisions, and representatives to non-GSA groups.

19. Developed a publication policy statement for the Society.

20. Approved the recommendations of the Publications Committee to (a) confine the use of a three-color bicentennial theme to the cover of the annual meeting volume of the 1976 *Abstracts with Programs;* (b) allow an additional five percent discount on publication orders when accompanied by cash payment; (c) accept the committee's marketability proposal as a working document for the staff.

21. Approved a policy permitting fold-outs, maps, and special printing in the *Bulletin* provided the total cost for such is borne by the author.

22. Instructed the staff to look into the matter of damaged *Bulletin* issues and recommend a solution.

23. Advanced 29 Members to Fellowship and ratified the election of 275 candidates to Membership in the Society.

24. Authorized the Membership Committee to poll the membership concerning the two classes of Society membership by way of a questionnaire in "GSA News & Information."

25. Voted membership suspensions because of nonpayment of dues.

26. Approved five Penrose Conferences for 1976 (making a total of nine); voted that beginning in 1977, the Penrose Conferences be limited to six a year, none to fall within six weeks prior to the annual meeting; instructed the executive director to determine the number of Penrose Conferences that headquarters is able to handle during a 12-month period and report to the Council in May 1976.

27. Discussed the investment policies and procedures of the Society.

28. Appointed an Ad Hoc Committee on the Structuring of the Society.

29. Selected members for the 1976 committees and members to be Society representatives.

30. Directed that the unrestricted money gift from the Mobil Oil Corporation be added to the funds available for research grants in 1976.

31. Noted the contributions to the GSA research grants program received from oil companies and past research grant recipients.

32. Voted to allow the $10/day subsistence rule to expire at the close of the May 1976 Council meeting.

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Annual Report for 1975 The Geological Society of America

Penrose Conference on Thermal Evolution of Sedimentary Basins set for November 11-15, 1976, at Aspen, Colorado

A GSA Penrose Conference on "Thermal Evolution of Sedimentary Basins" will be held November 11-15, 1976, at the Pomegranate Inn, Aspen, Colorado.

The thermal evolution of sediments has an effect on almost every measurable rock property because of its influence on the diagenesis of both organic and inorganic parts of a rock. Quantitative interpretations of temperature history require that the major controls of temperature be identified, accurately interpreted from the rock record, and related mathematically.

Basic mass and energy transport equations will be used as an introduction and guide to discussions concerning the importance and time dependence of the geological and geophysical constants and boundary conditions required to model the temperature history of sediments. Moreover, as the tests of such models must ultimately come from direct measurements of sediment properties, techniques for relating certain properties to temperature history will also be discussed.

Topics to be considered include basic transport equations, thermal properties of sediments, heat flow —continental and oceanic, depositional history as a constraint on thermal models, fluid flow, and low-temperature paleothermometry.

Attendance will be limited to approximately 70 people. A registration fee of $265 will cover all conference costs, food and lodging, and transportation from Denver to Aspen and return.

Those interested in attending are invited to contact the conveners, Glenn R. Buckley, Exxon Production Research Company, P.O. Box 2189, Houston, Texas 77001, or John Sclater, Department of Earth and Planetary Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

Mineralogical Society offers short course November 5-7

The Mineralogical Society of America is sponsoring a short course, *Mineralogy and Petrology of Rock-Forming Oxide Minerals*, to be held at the Green Conference Center, Colorado School of Mines, Golden, Colorado, November 5-7, 1976, immediately preceding the annual meeting of the Geological Society of America. The short course lecturers are Ahmed El-Goresy (Max Planck Institut fur Kernphysik), S. E. Haggerty (University of Massachusetts), D. H. Lindsley (SUNY, Stony Brook), and D. Rumble (Geophysical Laboratory). Topics to be discussed include crystal chemistry, structure, and magnetic properties; phase equilibria; igneous, metamorphic, lunar, and meteoritic petrology; as well as alteration parageneses. Prospective registrants should contact Douglas Rumble, Geophysical Laboratory, 2801 Upton Street, N.W., Washington, D.C. 20008.

Council actions (continued)

33. Voted to support the *Treatise on Invertebrate Paleontology* for 1976 by a contribution of $20,000.

34. Directed that the funds for the minority scholarships collected by GSA through the dues statements be transferred to the AGI Scholarship Fund at the end of 1975.

35. Discussed the possibility of the Society establishing a Gifts & Bequests Fund.

36. Discussed the reduction in GSA staff.

37. Directed that a private, internal telephone system to be owned by the Society be installed at headquarters as an economy measure.

38. Named Charles L. Drake as GSA's representative on the AGI Governing Board for the term 1976-1977.

39. Noted that the AEG joined the ASCE/GSA Committee on Engineering Geology and named two representatives.

40. Named representatives to the U.S. National Committee on Geology and to the U.S. National Committee on Geochemistry.

41. Noted the termination of the Particle Size Distribution Committee.

42. Noted the "Code for Geological Field Work" issued by the Geologists' Association of London.

43. Discussed the "Annual Survey of Geosciences" as proposed by Charles H. Behre, Jr.

44. Discussed the items covered during the section officers' meeting and the associate editors' meeting in Salt Lake City on October 20, 1975.

45. Voted resolutions of thanks to the Salt Lake City Local Committee and to the retiring officers, councilors, and committee chairmen.

46. Selected the dates of May 4-5, 1976, for the spring meeting of the Council to be held in Boulder, Colorado.

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

Annual Report for 1975 The Geological Society of America

Associated societies name officers for 1976

Geochemical Society

President, *Karl K. Turekian,* Geology Department, Box 2161, Yale University, New Haven, Connecticut 06520. Vice-President, *Edwin Roedder,* U.S. Geological Survey, National Center, M.S. 959, Reston, Virginia 22092. Secretary, *Ernest E. Angino,* Department of Geology, University of Kansas, Lawrence, Kansas 66045. Treasurer, *George R. Helz,* Department of Chemistry, University of Maryland, College Park, Maryland 20742. Past-President, *George W. Wetherill,* Carnegie Institute of Washington, Department of Terrestrial Magnetism, 5241 Broad Branch Road, N.W., Washington, D.C. 20015.

Geoscience Information Society

President, *Vivian S. Hall,* Geology Librarian, University of Kentucky, 100 Bowman Hall, Lexington, Kentucky 40506. Vice-President and President-Elect, *John Mulvihill,* 9516 Rockport Road, Vienna, Virginia 22180. Secretary, *Mary Scott,* Geology Department, Leonard Hall, University of North Dakota, Grand Forks, North Dakota 58202. Treasurer, *Katherine Keener* (Code 25111), Navy Environmental Support Office, Naval Const. Battalion Center, Port Hueneme, California 93043. Past-President, *Jack L. Morrison,* U.S. Geological Survey, Department of the Interior, P.O. Box 7944, Metairie, Louisiana 70071.

Mineralogical Society of America

President, *E-an Zen,* U.S. Geological Survey, National Center, M.S. 959, Reston, Virginia 22092. Vice-President, *F. Donald Bloss,* Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. Secretary, *Larry W. Finger,* Geophysical Laboratory, 2801 Upton Street, N.W., Washington, D.C. 20008 (through July 1, 1976: Department of Earth and Space Sciences, State University of New York, Stony Brook, New York 11794). Treasurer, *George W. Fisher,* Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, Maryland 21218. Past-President, *Arnulf Muan,* 243 Deike Building, Pennsylvania State University, University Park, Pennsylvania 16802.

National Association of Geology Teachers

President, *Edward C. Stoever, Jr.,* School of Geology and Geophysics, University of Oklahoma, Norman, Oklahoma 73069. Vice-President, *Robert L. Heller,* 515 Administration Building, University of Minnesota, Duluth, Minnesota 55812. Secretary-Treasurer, *Edgar J. McCullough, Jr.,* Department of Geosciences, University of Arizona, Tucson, Arizona 85721. Past-President, *Robert E. Boyer,* Department of Geological Sciences, University of Texas, Austin, Texas 78712.

Paleontological Society

President, *Ellis L. Yochelson,* U.S. Geological Survey, National Museum of Natural History, Washington, D.C. 20560. President-Elect, *David M. Raup,* Department of Geology and Geography, University of Rochester, River Campus Station, Rochester, New York 14627. Secretary, *Warren O. Addicott,* U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. Treasurer, *John A. Fagerstrom,* Department of Geology, University of Nebraska, Lincoln, Nebraska 68508. Past-President, *William A. Oliver,* U.S. Geological Survey, National Museum of Natural History, Washington, D.C. 20560.

Society of Economic Geologists

President, *H. D. Bruce Wilson,* Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba R3T 0B8. Vice-President, *Walter S. White,* U.S. Geological Survey, National Center, M.S. 954, Reston, Virginia 22092. Secretary, *Arnold L. Brokaw,* 185 Estes Street, Lakewood, Colorado 80226. Treasurer, *Robert M. Grogan,* Energy & Materials Department, Dupont Company, Wilmington, Delaware 19898. Past-President, *Paul K. Sims,* 1315 Overhill Road, Golden, Colorado 80401.

Society of Vertebrate Paleontology

President, *Malcolm C. McKenna,* American Museum of Natural History, 79th & Central Park West, New York, New York 10024. Vice-President, *William D. Turnbill,* Field Museum of Natural History, Roosevelt Road & Lake Shore Drive, Chicago, Illinois 60605. Secretary-Treasurer, *Ernest L. Lundelius, Jr.,* Texas Memorial Museum, Route 4, Box 189, Austin, Texas 78757. Past-President, *Wann Langston, Jr.,* Texas Memorial Museum, Route 4, Box 189, Austin, Texas 78757.

Cushman Foundation

President, *Emile A. Pessagno, Jr.,* Geosciences Division, University of Texas, Box 688, Richardson, Texas 75080. Vice-President, *Don L. Eicher,* Department of Geological Sciences, University of Colorado, Boulder, Colorado 80302. Secretary-Treasurer, *Frederick J. Collier,* Cushman Foundation, E-501 U.S. National Museum, Washington, D.C. 20560.

GSA committees and representatives

PLEASE NOTE: Names of committee chairmen are printed in italics. The president shall be an ex officio member of all committees of the Council. He may designate a member from the Council to represent him.

Executive Committee

Robert E. Folinsbee, Charles L. Drake, August Goldstein, Jr., Julian R. Goldsmith.

Committee on the Budget

Leon T. Silver (1974-1976), William R. Muehlberger (1975-1977), Howard R. Gould (1976-1978). Ex officio: August Goldstein, Jr., Treasurer (voting); William B. Heroy, Jr., Chairman, Committee on Investments (non-voting); Donald B. McIntyre, Chairman, Committee on Publications (non-voting).

Committee on Committees

Albert W. Bally, Mary R. Dawson, Robert P. Sharp, Samuel J. Tuthill.

Committee on Environment & Public Policy

John H. Moss (1975-1977), Helen L. Cannon (1974-1976), George B. Maxey (1974-1976), John D. Moody (1974-1976), Peter H. Given (1975-1977), Howard R. Waldron (1975-1977), M. Genevieve Atwood (1976-1978), Donald D. Runnells (1976-1978), Nathaniel Rutter (1976-1978). Conferee: Harold E. Malde.

GSA-Treatise Advisory Committee

J. Tom Dutro, Jr. (1975-1978), Norman J. Silberling (1975-1976), John C. Frye (continuing).

Headquarters Advisory Committee

Douglas R. Callier (1973-1976), Harry C. Kent (1974-1977), William C. Bradley (1975-1977).

Committee on Honors and Awards

Digby J. McLaren, W. G. Ernst, Bruce R. Doe, Gerald J. Wasserberg, William H. Smith, Frank W. Wilson, Don J. Easterbrook.

Subcommittee on the Penrose Medal Award

Digby J. McLaren (1976), J. Robert Dodd (1974-1976), Ronald L. Shreve (1974-1976), Richard R. Doell (1975-1977), Stanley R. Hart (1975-1977), Henry W. Menard, Jr. (1975-1977), Richard L. Armstrong (1976-1978).

Subcommittee on Arthur L. Day Medal Award

W. G. Ernst (1976), G. Ross Heath (1974-1976), James R. Heirtzler (1975-1977), Peter Robinson (1976-1978), Robert E. Zartman (1976-1978).

Subcommittee on Honorary Fellows

Bruce R. Doe (1974-1976), John Rodgers (1975-1977), Guillermo P. Salas (1975-1977), Curt Teichert (1976-1978).

Subcommittee on National Medal of Science

Gerald J. Wasserberg (1974-1976), Kenneth O. Emery (1975-1977).

Coal Geology Division Panel on Gilbert H. Cady Award

William H. Smith (1975-1977), Edward C. Dapples (1975-1977), James M. Schopf (1974-1976), Arthur D. Cohen (Division Chairman, 1976), M. E. Hopkins (Division Vice-Chairman, 1976).

Engineering Geology Division Panel on E. B. Burwell, Jr., Award

Frank W. Wilson (1975-1977), James W. Skehan, S.J. (1974-1976), James H. Williams (1974-1976), Murray R. McComas (1975-1977), Lloyd B. Underwood (1976-1978), Bernard W. Pipkin (1976-1978).

Quaternary Geology & Geomorphology Division Panel on Kirk Bryan Award

(Term of office to begin immediately following the annual business meeting at which election is announced and to run for two years.)

Don J. Easterbrook (Division Secretary), W. Hilton Johnson (1974-1976), Kenneth L. Pierce (1974-1976), John W. Hawley (1974-1976), Peter W. Birkeland (1975-1977), Ernest H. Muller (1975-1977), Stephen C. Porter (1975-1977).

Committee on Investments

William B. Heroy, Jr. (1974-1976), Robert L. Fuchs (1975-1977), Michel T. Halbouty (1975-1977), Peter T. Flawn (1976-1978).

Ex officio: August Goldstein, Jr., Treasurer (voting), Leon T. Silver, Chairman, Committee on the Budget (non-voting). Conferees: James Boyd (non-voting), Robert E. King (non-voting).

Committee on Membership

Theresa F. Schwarzer (1974-1976), William C. Kelly (1974-1976), E. Julius Dasch, Jr. (1975-1977), Diana Chapman Kamilli (1975-1977).

Committee on Nominations

Brian J. Skinner, Fred A. Donath, John C. Harms, F. Michael Wahl, A. Lincoln Washburn.

Committee on Penrose Conferences

Zell E. Peterman (1974-1976), C. A. Burk (1974-1976), Raymond A. Price (1975-1977), Robert E. Riecker (1975-1977).

Committee on Publications

Donald B. McIntyre (1974-1976), David B. MacKenzie (1974-1976), Orson L. Anderson (1975-1977), Leon T. Silver (1975-1977), William W. Hutchison (1976-1978), Frank E. Kottlowski (1976-1978).

Conferees: John C. Frye, Executive Director; Josephine K. Fogelberg, Production Manager; Fred S. Honkala, Executive Director, AGI; John C. Mulvihill, Manager, GeoRef Project; George E. Becraft; William H. Freeman; Daniel F. Merriam (through May 1976).

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GSA committees and representatives (cont'd)

Ad Hoc Committee to Study the Microform Publication Problem
Daniel F. Merriam.

Committee on Research Grants
Anthony J. Naldrett (1974-1976), Burrell C. Burchfiel (1975-1977), Steven M. Stanley (1976-1978).

Conferees: William E. Benson, George deVries Klein, Gregory A. Davis.

Ad Hoc Committee on Minority Group Members in the Earth Sciences
Louis C. Pakiser, Jr., Clyde Wahrhaftig, Randolph W. Bromery, William D. Romey, Samuel Smith.

Ad Hoc Committee on Long-Range Planning of Annual Meeting Programs—No. 2
John C. Reed, Jr., Charles L. Drake, Richard H. Jahns, Reuben J. Ross, Jr.

Ad Hoc Headquarters Advisory Art Committee
Edwin B. Eckel, R. Dana Russell, John C. Frye.

Ad Hoc Subcommittee on Structuring of the Council
Sheldon Judson.

GSA representatives to American Association for the Advancement of Science (AAAS)
Murray Felsher (1976-1978): Section E—Geology and Geography. Leo A. Heindl (1976-1978): Section W—Atmospheric & Hydrospheric Sciences.

GSA representatives to American Commission on Stratigraphic Nomenclature (ACSN)
(Term of office to begin at the end of the GSA national meeting.)

G. Brent Dalrymple (1973-1976), Jack E. Harrison (1974-1977), William W. Hay (1975-1978), Malcolm P. Weiss (1976-1979).

GSA representatives to GSA-AEG-ASCE Joint Committee on Engineering Geology (American Society of Civil Engineers)
Paul L. Hilpman (July 1, 1973—June 30, 1976), Harry F. Ferguson (July 1, 1975—June 30, 1978).

GSA representative to U.S. National Committee on Geochemistry
Rosemary J. Vidale (July 1, 1975—June 30, 1979).

GSA representative to U.S. National Committee on Geology
Clarence R. Allen (July 1, 1975—June 30, 1979).

GSA representative to U.S. National Committee on Rock Mechanics (USNCORM)
Bruce R. Clark (September 1973 through 1976 USNCORM Symposium).

GSA representative to U.S. National Committee on Tunneling Technology
Arthur B. Cleaves (July 1, 1974—June 30, 1977).

GSA representatives to GSA-SSSA Inter-Disciplinary Committee (Soil Science Society of America
Leon R. Follmer, John W. Hawley, Robert V. Ruhe, Peter W. Birkeland.

GSA advisors to Treatise on Invertebrate Paleontology
A. Lee McAlester (January 1973—December 1976), John C. Frye (September 1974—December 1978).

GSA member of the AGI Governing Board
Charles L. Drake (November 1975—November 1977).

GSA representative to the AAPG Ad Hoc Committee on Revision of the Stratigraphic Correlation Charts for North America
Mitchell W. Reynolds.

GSA representative to Earthquake Engineering Research Institute
Richard J. Jahns

GSA representative to Assembly of Mathematical & Physical Sciences (NRC)
John C. Frye (effective May 1, 1975).

GSA representative to the Advisory U.S. National Committee for the International Hydrological Program
Stanley N. Davis, David Stephenson (alternate).

ASSOCIATE EDITORS AND AUTHORS PLEASE NOTE:

In order to expedite your communications with Interim Science Editor S. Warren Hobbs and other GSA staff editors regarding your manuscripts or articles in press, direct dialing to the Publications Department at headquarters has been made available. Simply dial **(303) 447-8850**.

All other general calls to headquarters may be made to the old number. Dial (303) 447-2020 for:

Executive Director John C. Frye
Publication Sales
Membership Secretary
Customer Services
Business Office

BOOK BRIEFS

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

Cenozoic stratigraphy of the Transverse Ranges and adjacent areas, southern California

SPECIAL PAPER 162 — by Michael O. Woodburne. 1975. x + 92 p., 13 figures (black and white foldouts in pocket), 1 table, $11.00

Part I relates the largely Neogene nonmarine strata of the Transverse Ranges and adjacent areas of southern California to the tectonic history of the region, with emphasis on constraints for late Cenozoic offset on various branches of the San Andreas fault system; Part I utilizes the basic chronologic and stratigraphic data summarized in Part II. The discussion begins in the northwest, 75 to 100 km north-northwest of Los Angeles, with terranes cut by the San Gabriel fault, and progresses southeastward to the San Andreas fault between Tejon Pass and Cajon Valley, the Punchbowl-Nadeau fault in the same area, the north and south branches of the San Andreas fault in the Mill Creek area, and finally to the San Andreas in the vicinity of the Orocopia and Chocolate Mountains, near the Salton Sea.

During much of Neogene time, and especially during Hemphillian time (from about 5 to 10 m.y. B.P.), nonmarine deposits of the Transverse Ranges accumulated in basins that appear to have been within less than 30 km of their present positions. Although many of these basins are now truncated by various branches of the San Andreas fault system, it appears that none of these faults underwent large-scale right-lateral slip since Hemphillian time. Therefore, there has been considerable depositional continuity between basins associated with the Transverse Ranges. Data on the magnitude of pre-Hemphillian slip are more ambiguous and, in some cases, directly conflicting.

Part II considers several Tertiary rock units in districts that are located with reference to several branches of the San Andreas fault system; from this, the sedimentary record of one district can be compared to that of another in order to evaluate, for example, the possibility of their former alignment or the alignment of a given basin with a particular source area. Although the basic data are not new in many cases, Part II gives an updated arrangement of many of those data. Information is given on the local geologic history of each district, the shape and extent of its depositional basin, the paleoslope that prevailed during deposition, the kinds and distribution of clastic components, the timing of episodes of sedimentation, and the duration of hiatuses in the record; radiometrically determined ages are included.

Relief on elements of the Transverse Ranges probably was not as rugged in the past as it is now. Locally elevated source areas shed sedimentary debris into generally east-to-west depositional systems. The westerly tectonic and depositional setting of the Transverse Ranges was pervasive in scale and typical of the Tertiary Period. An important reversal in the westerly direction of the regional paleoslope occurred in about Pleistocene time when the San Gabriel and San Bernardino Mountains were uplifted.

Gravity field of the northwest Pacific Ocean basin and its margin: Aleutian island arc–trench system

MAP & CHART 10 — compiled by Anthony B. Watts. 1975. One chart, 58" x 34", in color, with summary statement. Rolled in sturdy mailing tube: $6.00. Folded in 9" x 12" envelope: $5.00

A compilation of at least 22,600 surface-ship and pendulum sea gravity measurements have been combined with land measurements from the Aleutian island arc. The map, which averages about 65 km to the inch, is contoured at 25-mgal intervals, and gravity anomaly values have been annotated at maxima and minima points between contours. The most prominent features are a narrow belt of large-amplitude positive anomalies (maximum of +242 mgal) over the northwest part of the Aleutian island arc and a narrow belt of large-amplitude negative anomalies (minimum of −219 mgal) over the central part of the Aleutian Trench. The positive anomalies extend over the sea areas between the islands; the maximum of the positive anomalies is closely associated with the location of historically active volcanoes between the Rat Islands and the Islands of Four Mountains in the central part of the Aleutian island arc. Free-air anomalies are generally zero over the Aleutian Basin landward of the central part of the Aleutian island arc and generally positive (as much as +50 mgal) seaward of the Aleutian Trench. The text discusses the significance of the anomalies.

Pennsylvanian conodont biostratigraphy and paleoecology of northwestern Illinois

MICROFORM PUBLICATION 3 — by Glen K. Merrill. 1975. Two standard 98-frame fiche for use on 24x readers and four 3x5 cards of direct prints of photographs of fossils. $6.00.

Pennsylvanian rocks form the bedrock surface beneath approximately 75 percent of Illinois. The study area (about 7,000 km^2) lies generally northwest of the Illinois River and northeast of the LaMoine River; it includes Rock Island, Mercer, and Warren Counties plus the entire stratigraphic column in Knox, Peoria, Fulton, and Schuyler Counties. The study area excludes Henry, Bureau, Stark, and LaSalle Counties. The work is both a geographic and stratigraphic extension of the study by G. K. Merrill and C. W. King, published in 1971.

The stratigraphic column for this region has become more or less a standard for the entire Illinois basin and, in some respects, for the Pennsylvanian system of North America as a whole. Moreover, the area was of major importance in the development of the Weller-Wanless model of Pennsylvanian cyclic sedimentation and the resulting concept of cyclothems.

The overwhelmingly dominant influence upon all the Pennsylvanian environments in this part of Illinois was the presence of one or more delta systems. Sedimentation and subsidence plus compaction were the major determinators of the distribution of

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land and shallow sea, although the greater part of the stratigraphic column can be regarded as subaerial deltaic in origin. Purely marine environments nevertheless span a wide range of conditions, and the conodont biofacies sharply differentiate and reflect this diversity.

The oldest marine unit is late Atokan in age and the youngest is early Missourian; the remainder are Desmoinesian in age. The studied marine units, all of which yield conodonts, in descending order are the Cramer (Trivoli in literature), Exline, Lonsdale, "Sparland," Pokeberry, "Sheffield," Brereton, St. David, Hanover, Oak Grove, Seahorne, "Seville," and Seville members; the aggregate thickness is approximately 200 m. More than 300 samples yielded in excess of 160,000 conodont specimens, which can be grouped into not fewer than 78 kinds that are considered species in disjunct element taxonomy. At least 10 multielement genera and 40 multielement species are represented. Six new species are described: *Diplognathodus illinoisensis, Neognathodus metanodosus, N. polynodosus, N. oligonodosus, N. anodosus,* and *Gondolella pulchra.*

Neognathodus is the most useful conodont genus for biostratigraphic control in these rocks. Four zones and subzones are based on species of this genus and it has permitted relatively precise interregional correlations. Secondary zonations can be based on other genera that supplement the *Neognathodus* zonations and assist in identifying units. In decreasing importance these are *Gondolella,* the *Idiognathodus-Streptognathodus* plexus, and *Diplognathodus.*

Ecologic controls on conodont distribution are believed to have been salinity, energy relative to wave base, pH, and possibly biologic antagonism.

Magnetic and gravity anomalies in the Great Valley and western Sierra Nevada metamorphic belt, California

SPECIAL PAPER 168 – by John W. Cady. 1975. vii + 56 p., 12 figures (including foldout map in pocket), 1 table, $9.00

Sixty-seven aeromagnetic flight lines, totaling about 4,500 km, were flown in 1969 to tie together existing aeromagnetic maps of the Great Valley, California, and western Sierra Nevada foothills. These data are combined here in a new composite aeromagnetic map (20 km to the inch) of most of the Great Valley and adjoining areas, between latitudes 35° N and 41° N. The paper describes the geometry and probable rock types reflected by the magnetic and gravity highs, which are typically 1,000 gammas and 50 mgal, respectively; current speculation about the origin of the Great Valley is evaluated.

The Great Valley is the site of a sedimentary basin 700 km long, 100 km wide, and 6 km or more deep, which contains relatively undeformed Upper Jurassic through Holocene sedimentary rocks.

Correlation between the gravity and magnetic anomalies suggests that dense, magnetic rock is the source of the anomalies. A nearly continuous magnetic high and weak gravity highs occur where serpentinite is exposed along the Coast Range thrust fault. Magnetic highs, without associated gravity highs, occur where serpentinite crops out in the western Sierra Nevada metamorphic belt. Major magnetic highs with strong associated gravity highs are caused by gabbro at three places in the western Sierra Nevada; two of these are probably part of ophiolite complexes.

Gravity, magnetic, and drill-hole data were used to construct a map of basement rock types. Gabbro and similar mafic rocks are abundant beneath crests of the Great Valley anomalies. Ultramafic rocks are very rare in drill holes that reach basement. A major break in the anomaly patterns suggests a possible east-trending fault in the basement rocks near Fresno.

A two-dimensional crustal model across central California was derived from seismic refraction data and gravity and magnetic modeling. Magnetic rock extends to within 2.5 km of the surface just east of the center of the Great Valley and dips steeply to the west beneath the western side of the valley. If gabbro is the source of the anomalies, sialic crust must be virtually nonexistent beneath the Great Valley. Analogy with the ophiolite complexes of the Sierra Nevada foothills suggests that the source of the Great Valley anomalies is a tectonically emplaced fragment of oceanic crust.

In Late Jurassic time, an eastward-dipping subduction zone in the western Sierra Nevada foothills became detached and stepped westward to the present position of the Coast Range thrust fault, leaving behind a fragment of oceanic crust. The author proposes that this fragment, covered by Tithonian (Upper Jurassic) and younger strata, causes the Great Valley magnetic and gravity anomalies.

INQUA announces travel support program

The U.S. National Committee of the International Union for Quaternary Research (INQUA) is seeking funding for a travel support program to ensure that the United States will be represented by an adequate number of qualified scientists at the X International Congress of INQUA, to meet in Birmingham, England, August 16-24, 1977. Funds for this purpose, now being solicited from a number of government agencies and private institutions, will be coordinated by the U.S. National Committee for INQUA. Applications from younger scientists are encouraged.

Applicants for travel grant support should request application forms from W. L. Petrie, USNC/INQUA, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Four completed application forms, together with four copies of the abstract of the paper submitted to INQUA, must be received by the Academy Office no later than December 1, 1976. Grant awards may be made as late as August 1, 1977, depending on funds received. If possible, some advance indication of tentative selections will be communicated by April 1, 1977.

April BULLETIN briefs

Brief summaries of articles in the April 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.*

☐ 60401—Late Cenozoic volcaniclastic deposits, Andean foredeep, Colombia. *Franklyn B. Van Houten, Department of Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey 08540.* (15 p., 12 figs., 3 tbls.)

Volcaniclastic deposits preserved in the upper Magdalena Valley, Colombia, were derived from stratovolcanoes on Cordillera Central during and after the late Cenozoic Andean orogeny. Andesitic lava clasts and suites of mineral grains, commonly mixed with plutonic and metamorphic rock fragments, predominate in proximal debris flows and in torrential channel lenses; reworked dacitic pyroclastic material is more common in distal debris flows, sheeted overbank sands, and flood-plain muds.

Earliest Colombian volcanism is recorded by montmorillonite in the mid-Cenozoic La Cira Formation (1,000 m). During early phases of Andean orogeny in middle and late Miocene time, abundant volcanic clasts and volcanic mineral grains accumulated in coarse channel and flood-plain sediments of the Honda Group (3,000 m). The overlying conglomeratic Neiva Formation (200 m) records renewed uplift and a fresh supply of lava. In latest Miocene time (8 to 9 m.y. ago), the climax of explosive activity swamped the Andean foredeep with debris of the Gigante Formation (750 m).

About 7 to 5 m.y. ago, the final Andean orogenic phase deformed both Cordillera Central and its foredeep. Subsequent excavation of the uplifted eastern lowland was interrupted at least ten times by local incursions of volcanic detritus 10 to 75 m thick. These deposits include polymictic debris flows and torrential sediments that filled valleys and formed large fans, as well as reworked pumiceous debris that spread widely across the Magdalena lowland. Older deposits are preserved in high-level mesas, valley terraces, and deeply dissected fans; younger deposits form low, relatively undissected fans and inner terraces along major streams.

☐ 60402—Early Tertiary sedimentation in the western Uinta Basin, Utah. *Robert T. Ryder and Thomas D. Fouch, Shell Oil Company, Western Division Exploration, P.O. Box 831, Houston, Texas 77001 (present address: U.S. Geological Survey, Branch of Oil and Gas Resources, Denver Federal Center, Denver, Colorado 80225); and James H. Elison, 3132 18th Street, Suite 6, Bakersfield, California 93301.* (17 p., 16 figs.)

During latest Cretaceous through middle Eocene time, over 3,000 m of siliciclastic and carbonate sediment accumulated in the Lake Uinta depocenter in northeastern Utah. Stratigraphic analysis of this extensive lacustrine system indicates three major facies: open lacustrine, marginal lacustrine, and alluvial.

The open-lacustrine facies consists primarily of mud-supported carbonate and claystone units with minor amounts of sandstone and siltstone deposited away from terrigenous clastic influxes either near the center of the lake or in nearshore settings. Kerogen and other organic compounds produce shades of gray and brown. Many of these rocks contain abundant fossils (mollusks and ostracodes) and scattered desiccation features.

The marginal-lacustrine facies is composed of gray-green calcareous claystone, channel-form sandstone, and grain- to mud-supported carbonate units. The dominant depositional environments are interpreted to be lake-margin carbonate flat, deltaic, and interdeltaic. Lake-margin carbonate-flat deposits consist of carbonate beds as thick as 30 m which grade lakeward from an ostracode and oolite grain-supported texture to a mixed mud- and grain-supported texture. Deltaic deposits consist of channel-form sandstone units as thick as 15 m which cut adjacent thin beds of sandstone, siltstone, and gray-green claystone. Ostracode- and oolite-bearing grainstone beds of lake-margin carbonate-flat origin are commonly interbedded with the deltaic rocks. Interdeltaic rocks contain more carbonate beds of lake-margin carbonate-flat origin and far fewer sandstone units.

The alluvial facies, representing alluvial-fan, lower deltaic-plain, and high mud-flat environments, occupied the most proximal setting within the depositional system. The alluvial-fan environment is characterized by thick conglomerate beds with crude horizontal stratification. The lower deltaic-plain environment is typified by 15- to 30-m-thick channel-form sandstone units and associated thin-bedded sandstone, siltstone, and red, mud-cracked claystone. Red claystone, minor isolated channel-form sandstone, and thin fossiliferous gray-green claystone units characterize the high mud-flat environment.

During most of early Tertiary time, the Lake Uinta system exhibited a northeast-trending core of open-lacustrine facies surrounded by successive halos of marginal-lacustrine and alluvial facies. The width of the open-lacustrine core fluctuated with climatic and tectonic conditions prevailing at the time. Southerly derived feldspathic sands dominated the sediments supplied to the south flank of the basin; quartzose sand contributed to the north flank and originated from rocks exposed in the Sevier orogenic belt to the west and the Uinta uplift to the north. The north flank of the basin had a steeper depositional slope than the south flank.

☐ 60403—Chlorite and mica as indicators of depositional environment and provenance. *Richard S. Liebling and Horst S. Scherp, Department of Geology and Geography, Hunter College, 695 Park Avenue, New York, New York 10021.* (2 p., 1 fig.)

The nature and distribution of clay minerals in three distinct penecontemporaneous facies of Upper Devonian alluvial-plain sedimentary deposits have yielded information on contrasting drainage conditions and the petrology of the source rocks. Slip-off slope deposits characteristically have (1) chlorite of relatively high magnesium content and (2) a low proportion of chlorite to mica. In contrast, the chlorite in oxbow-lake and overbank flood-plain deposits is more abundant and is of an iron-rich variety. The source rocks appear to have consisted predominantly of pelitic schist of the greenschist facies.

☐ 60404—Nubrigyn algal reefs (Devonian), eastern Australia: Allochthonous blocks and megabreccias. *P. J. Conaghan, School of Earth Sciences, Macquarie University, North Ryde, New South Wales, 2113, Australia; E. W. Mountjoy, Department of Geological Sciences, McGill University, Montreal, Quebec H3C 3G1, Canada; D. R. Edgecombe and J. A. Talent, School of Earth Sciences, Macquarie University, North Ryde, New South Wales, 2113, Australia; and D. E. Owen, Department of Geology, Bowling Green State University, Bowling Green, Ohio 43403.* (16 p., 14 figs., 2 tbls.)

The widely known Lower Devonian "algal reef" limestones of the Nubrigyn Formation, New South Wales, are enormous allochthonous blocks contained within a 400-m interval of interbedded mudstones, allodapic carbonates, and megabreccias that form part of a 5,000-m succession of Lower Devonian volcanics and flysch. Previous workers have interpreted these massive limestone bodies to be algal bioherms that developed in sublittoral to littoral environments around volcanic pedestals on a "Nubrigyn shelf." The allochthonous nature of the limestone bodies is clearly indicated by (1) occurrence of a wide range of clast sizes, as much as 1 km across; (2) presence of a wide range of clast types and sizes in close juxtaposition; (3) discordance between stratigraphic facing of the large limestone bodies and stratification in surrounding beds; (4) lack of distinctive and regular facies changes within the limestone bodies; (5) abrupt and random truncation of internal fabrics at block margins; (6) lack of an autochthonous volcanic foundation for the "reefs"; and (7) anomalous lithofacies association of the massive bodies of shoal-water limestone with enclosing flysch.

The limestones initially formed in a shoal-water carbonate complex to the west upon a geologically persistent volcanic archipelago, the Molong Arch, where source rocks for the Nubrigyn megaclasts and megabreccias crop out. The Nubrigyn megaclasts were transported eastward as debris flows into the adjacent and relatively deep water Hill End Trough. Megaclasts isolated within hemipelagic mudstones and flysch were presumably transported by sliding or rolling. The loci of accumulation of the debris flows and exotic blocks occupy a meridional basin-margin position between the Molong Arch to the west and the predominantly turbidite-filled Hill End Trough to the east.

Other debris-flow megabreccias occur in the Paleozoic rocks of the Tasman mobile belt of eastern Australia.

☐ 60405—Origin of regional geomagnetic variations recorded by Wisconsinan and Holocene sediments from Lake Michigan, U.S.A., and Lake Windermere, England. *Kenneth M. Creer, University of Edinburgh, Department of Geophysics, Edinburgh EH9 2HX, Scotland; and David L. Gross and Jerry A. Lineback, Illinois State Geological Survey, Urbana, Illinois 61801.* (10 p., 12 figs., 4 tbls.)

The declination of the Earth's paleogeomagnetic field, determined from sediments in Lake Michigan deposited during the past 11,500 C^{14} yr, exhibits fluctuations east and west of the mean declination with a period of about 2,090 C^{14} yr. Inclination and intensity measurements do not exhibit similar fluctuations. Each extreme in declination occurs in the same stratigraphic position in cores from different parts of the lake. The variations in declination in Lake Michigan are similar to those found in sediments from Lake Windermere, England, deposited during the same time span, but the period of the Windermere cycles is 2,800 C^{14} yr. Plots of the paleogeomagnetic poles for inclination-declination pairs representing each east or west extreme for the two lakes are quite different, indicating that the geomagnetic effects were not a result of shifts of the main dipole field.

In a model of the standing nondipole field, the foci, represented by radial dipoles located one-fourth of the Earth's radius from the geocenter, are each allowed to oscillate with a characteristic period. This model gives a satisfactory explanation of the principal features exhibited by the declination and inclination records at the two lakes.

☐ 60406—A physical model for the rate of deposition of fine-grained sediments in the deep sea. *I. N. McCave and Stephen A. Swift, School of Oceanography, Oregon State University, Corvallis, Oregon 97331 (permanent address, McCave: School of Environmental Sciences, University of East Anglia, Norwich NOR 88C, England).* (6 p., 3 figs., 4 tbls.)

A model for the net entrapment of fine suspended sediment in the viscous sublayer of a turbulent boundary layer yields an expression of the same form as one derived previously on an empirical basis. The expression is modified by a factor that takes into account the reduction in rate of deposition caused by occasional erosion, bottom roughness, and organic resuspension. A curve for the variation in critical deposition shear stress with particle settling velocity uses the assumption that the critical deposition stress is equal to the critical erosion stress for fine noncohesive material. Application of the model to postglacial deposition rates using modern concentration data gives reasonable agreement and suggests values of the factor little less than unity. The model involves assumption of a constant near-

bed suspended sediment concentration. An alternative case of decrease in concentration with distance along the flow path shows that the grain-size modes in the deposited sediment resemble the pattern of size modes found north of the Carnegie Ridge in the Panama Basin.

☐ 60407—Episodic Aleutian Ridge igneous activity: Implications of Miocene and younger submarine volcanism west of Buldir Island. *David W. Scholl, Michael S. Marlow, Norman S. MacLeod, and Edwin C. Buffington, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.* (8 p., 2 figs., 2 tbls.)

Extrusive rocks of Miocene and younger age have been dredged from the submerged insular slopes of the arcuate, 2,220-km-long Aleutian Ridge. Hornblende dacite porphyry recovered at station 70-B29 (lat 52.6°N, long 174.8°E; depth, 700 m) was extruded less than 610,000 yr ago. The dacite crops out approximately 80 km west of the westernmost volcanic edifice of the Aleutian volcanic chain. The submerged dacite extends the westward limit of this chain of eruptive centers, which are the product of a distinct phase of late Cenozoic (chiefly early Pliocene to present) volcanism. This part of the ridge is not associated with a north-dipping Benioff zone, a fact that may imply that arc-type calc-alkalic magma can be emplaced along sectors of the ridge either obliquely underthrust by the Pacific plate or in strike-slip contact with it (western 800 km).

Vesicular augite andesite at the western end of the Aleutian Ridge is greater than 8.8 m.y. old. It was probably extruded in middle Miocene time as a distinct phase of calc-alkalic plutonism and subaerial volcanism that affected the ridge's eastern or Aleutian Island sector. The age of this andesite and our interpretation of the magmatic history of the nearby Komandorsky Islands imply that this episode of volcanism extended along the full length of the ridge and may have been the last major pulse of igneous activity to do so. The middle Miocene ridge, unlike the present one, was presumably everywhere underthrust by Pacific plate lithosphere.

The Pliocene and Pleistocene episode of Aleutian activity is coeval with volcanism that affected much of the North Pacific perimeter. A similarly widespread pulse of igneous activity and tectonism in middle Miocene time is suggested by other dated rocks and regional geologic mapping. Determination of the timing of major pulses of North Pacific activity bears on the important question of episodic magma generation during what is presumed to be continuous plate subduction.

☐ 60408—Petrofabric stress analysis of the Dry Creek Ridge anticline, Montana. *H. Robert Burger and Marion N. Hamill, Department of Geology, Smith College, Northampton, Massachusetts 01060.* (12 p., 14 figs.)

Macrofracture analysis and dynamic analysis of calcite twin lamellae and quartz deformation lamellae detail the stress history during evolution of the Dry Creek Ridge anticline—a multilayered, multilithologic fold near Livingston, Montana. This study analyzes data from sandstone and limestone units in the Jurassic Rierdon, Swift, and Morrison Formations and in the Cretaceous Kootenai Formation. During the early stages of folding, σ_1 was parallel to layering and was oriented normal to the anticlinal axis. A fracture system, F_1, formed in all layers in response to this stress state. A neutral surface developed as folding proceeded. The location of this surface approximates the Kootenai-Morrison contact. In the lower portion of the anticline, σ_1 remained parallel to bedding. In the upper portion, σ_1 became reoriented normal to bedding. At this time (or later during fold growth), the lower units deforming in the compressional domain of a single mechanical plate subdivided into two separate plates. During this stage of deformation, the upper portion of the fold (Morrison and Kootenai Formations) did not change behavior. The stress history of this anticline agrees in general with published theoretical models and explains the superposition of several fracture sets at one position in a fold.

☐ 60409—Cryptoexplosive structure near Wetumpka, Alabama. *Thornton L. Neathery, Geological Survey of Alabama, University, Alabama 35486; Robert D. Bentley, Central Washington State College, Ellensburg, Washington 98926; and Gregory C. Lines, U.S. Geological Survey, Cheyenne, Wyoming 82001.* (7 p., 6 figs.)

A cryptoexplosive structure that probably resulted from a meteorite impact is located near Wetumpka, Alabama (lat 32°31′42″N; long 86°14′12″W), along the boundary between the Gulf Coastal Plain and the Piedmont physiographic provinces. Its main features are (1) an approximately concentric structural system about 6.5 km in diameter, its rim formed by metamorphic rocks and surrounded by Cretaceous sedimentary rocks; (2) an arcuate ridge of schist extending two-thirds of the way around the structure, which stands 60 to 150 m above the adjacent Piedmont peneplain; (3) the chaotic orientation of Cretaceous and metamorphic units in the center of the structure, perhaps corresponding to the central rebound area; (4) concentric marginal faults with an estimated displacement of 240 to 300 m; and (5) shock effects in feldspar and quartz crystals in rock units that form the rim.

A shallow marine setting may best explain the shape and distribution of rocks. Nowhere else along the 1,600 km of Coastal Plain-Piedmont boundary is there any faulting of the magnitude described in this report. The age of the Wetumpka cryptoexplosive structure is post-Mooreville (Late Cretaceous) and pre-terrace (Pleistocene?). The name "Wetumpka Astrobleme" is proposed for this structure.

☐ 60410—Block Island, Rhode Island: Evidence of fluctuation of the late Pleistocene ice margin. *Les Sirkin, Department of Earth Sciences, Adelphi University, Garden City, Long Island, New York 11530.* (7 p., 10 figs.)

Superimposed drift sheets on Block Island provide evidence of two advances of the late Pleistocene glacial margin. The lower Montauk Drift crops out as two till units separated by a deformed stratified unit or till over outwash. This complex unit was probably deposited by a glacial lobe that moved across the Narragansett Bay region. The upper New Shoreham Drift forms the morainal topography of the island and was probably derived from a glacial lobe that crossed the Connecticut region.

The stratigraphy indicates that an oscillating early Wisconsinan ice sheet deposited the Montauk Drift and subsequently receded from its terminal position. Laminated silt, sand, and clay (varves?) were deposited in a proglacial lake, and irregularly stratified silt was deposited as alluvium adjacent to the end moraine. With the advance of the late Wisconsinan glacier, the New Shoreham Drift was deposited. This ice overrode and deformed existing drift and created a drumlin field and prominent morainal topography.

☐ 60411—Franciscan blueschist-facies metaconglomerate, Diablo Range, California. *Jeremy B. Platt, J. G. Liou, and Ben M. Page, Department of Geology, Stanford University, Stanford, California 94305 (present address, Platt: Electric Power Research Institute, 3412 Hillview Avenue, P.O. Box 10412, Palo Alto, California 94303).* (11 p., 4 figs., 3 tbls.)

Certain Franciscan conglomerate units are shown to be metaconglomerate and to exhibit selective blueschist-facies metamorphism of various constituents. Petrographic and x-ray studies were made on pebbles and matrix of 18 Franciscan conglomerate units forming blocks in mélanges and lenses in stratiform bodies of graywacke in the vicinities of Mount Hamilton and Pacheco Pass. The conglomerate ranges from little-deformed varieties (textural grade 1) to tectonite with pronounced secondary planar structures (textural grade 2). Significant minerals in conglomerate of textural grade 1 are quartz + albite ± lawsonite ± minor glaucophane ± $CaCO_3$, and those of textural grade 2 are lawsonite + glaucophane + quartz ± jadeitic pyroxene ± albite ± aragonite. Thus the most intense metamorphism is empirically associated with internal deformation; however, the converse is not invariably true.

Lawsonite in granitic clasts favors feldspar, but its abundance varies within single clasts, from clast to clast, and between adjacent conglomerate units; it commonly forms crystallographically oriented prisms in albite and is locally concentrated near the margins of albite crystals. Glaucophane, which is scarce in conglomerate of textural grade 1, is locally concentrated as rinds in some clasts of fine-grained basalt, or it forms rare fibrous prisms in granitic clasts. In rocks of textural grade 2, it commonly forms beards on green amphibole in the matrix and in granitic clasts and completely replaces some mafic clasts. Jadeitic pyroxene replaces albite in conglomerate of textural grade 2 and is concentrated in the outer parts of certain clasts. Carbonate, commonly aragonite, shows crosscutting relations with lawsonite, glaucophane, or jadeitic pyroxene. Both lawsonite and glaucophane probably formed earlier than jadeitic pyroxene.

Albite is apparently the only feldspar in the metaconglomerate units. Granitic clasts are enriched in sodium relative to average granite of similar silica content.

The mineral assemblages of the metaconglomerate are consistent with those reported from nearby metagraywacke units. Petrographic features indicate postdepositional blueschist facies metamorphism of the conglomerate units and demonstrate the presence of a fluid phase during metamorphism.

☐ 60412—Andean Cenozoic volcanism: Magma genesis in the light of strontium isotopic composition and trace-element geochemistry. *David E. James, Carnegie Institution of Washington, Department of Terrestrial Magnetism, Washington, D.C. 20015; Christopher Brooks, Université de Montréal, Department of Geology, Montreal, Quebec, Canada; and Arturo Cuyubamba, McGill University, Department of Geological Sciences, Montreal, Quebec, Canada.* (9 p., 9 figs., 2 tbls.)

The upper Cenozoic andesitic-dacitic volcanic rocks of southern Peru may be divided geographically and geochemically into the *Arequipa volcanics* and the *Barroso volcanics.* Although these rocks exhibit strong chemical affinities with calc-alkalic rocks of the island arcs, their Sr^{87}/Sr^{86} ratios are significantly higher.

Comparison of trace-element and Sr-isotope data of the volcanic products with that of Precambrian sialic rocks indicates that the anomalously high Sr^{87}/Sr^{86} is not due to upper crustal contamination, nor is a lower crustal origin likely on the basis of geophysical arguments. We explain the observed variation of Sr^{87}/Sr^{86} by means of a modified continental volcanic-arc subduction model in which the overlying continental plate (200 to 300 km thick) abuts the downgoing oceanic plate to form a lithosphere-lithosphere subduction boundary to depths in excess of those at which magma is generated. By this model, andesitic magma either is generated by subduction-zone melting of the ancient lithosphere of the South American plate or is derived from the downgoing oceanic plate but then is isotopically re-equilibrated with the overlying continental lithosphere. Thus, the Arequipa and Barroso volcanics are the products of magmas derived from, or isotopically equilibrated with, different parts of the thick lithosphere of the South American plate. Different Rb/Sr ratios frozen into different parts of the continental lithosphere during the course of its formation are the cause of both the anomalously high Sr^{87}/Sr^{86} ratios and the regional variations observed.

☐ 60413—Northern margin of the Limpopo mobile belt, southern Africa. *M. P. Coward, P. R. James, and L. Wright, Department of Earth Sciences, University of Leeds, Leeds LS2 9JT, United Kingdom (present address, James: Department of Geology, University of Adelaide, Adelaide, South Australia 5001).* (11 p., 12 figs.)

The Limpopo mobile belt is a zone of complexly deformed Archean gneiss units and rocks of high metamorphic grade. The Limpopo belt separates Archean greenstone belts and gneiss units of lower metamorphic grade in the Rhodesian craton to the north from similar lower grade rocks in the Kaapvaal craton to the south. At the northern edge of the Limpopo belt (that is, the southern edge of the Rhodesian craton), volcanic and sedimentary rocks of the greenstone belts, dated at 2,600 m.y. B.P., were deposited on gneissic basement, dated at 3,500 m.y. B.P. The greenstone belts were intensely deformed (F_1) into recumbent folds and thrust slices before being intruded by large diapiric masses of granite.

The subsequent deformation (F_2 and F_3) can be considered in terms of intracratonic block tectonics. During the main phase of deformation, the deformation can be considered as having been produced by the Rhodesian block moving to the southwest, parallel to (not across) the trend of the Limpopo belt. This movement produced horizontal shortening across the cleavage, normal to the Limpopo trend, by about 50 percent in southwest Rhodesia and northeast Botswana; in southeast Rhodesia, however, the result was northeast-trending zones of heterogeneous simple shear with nearly horizontal sinistral movement parallel to the Limpopo trend.

During a later (F_4) phase, the deformation involved moving the Messina block west against the Rhodesian block, nearly parallel to the Limpopo trend. In southern Rhodesia, the junction between these two blocks is a zone of gently dipping mylonite, but in Botswana the junction is a steep shear zone. From the intensity of deformation, more than 40 km of displacement during this phase have been estimated.

☐ 60414—Geology and geochemistry of the alkali basalt-andesite association of Grenada, Lesser Antilles island arc. *Richard J. Arculus, Department of Geological Sciences, University of Durham, Durham, England (present address: Department of Geology, Rice University, Houston, Texas 77001).* (13 p., 9 figs., 8 tbls.)

Basanitoids and alkalic basalts that are strongly undersaturated in silica occur on the island of Grenada in the Lesser Antilles. Several volcanic centers have erupted basic lava of these compositions together with subalkalic basalt, andesite, and dacite from Miocene to Holocene time. The volcanic rocks overlie a folded volcanic-sedimentary formation of Eocene to Miocene age. Tuff rings and maars of explosive origin are present. Andesite and dacite are less significant volumetrically on Grenada in comparison with other islands in the Lesser Antilles.

The variable trace-element geochemistry of the basanitoids and alkalic basalts is related, on the basis of rare-earth-element data, to a model of variable degrees of partial melting of an upper-mantle garnet peridotite source. It is suggested that fractional crystallization of olivine, clinopyroxene, and spinel, observed as the phenocryst assemblage in the basanitoids and alkalic basalts, takes place at high temperatures; at lower temperatures, these phenocrysts are joined by amphibole and plagioclase. A trend toward increased silica saturation is the result of this fractional crystallization process. The presence of alkalic lava rocks together with variable trace-element abundances and Sr isotope ratios are unusual features of the volcanicity.

☐ 60415—Distribution, composition, and transport of suspended particulate matter in the vicinity of Willapa submarine canyon, Washington. *Edward T. Baker, Department of Oceanography, University of Washington, Seattle, Washington 98195.* (8 p., 7 figs., 2 tbls.)

The distribution and composition of suspended particulate matter in the waters over Willapa submarine canyon and the adjacent continental slope off the coast of Washington describe an apparently continuous bottom nepheloid layer ranging in thickness from 160 to 530 m and composed of particles supplied primarily by the nearby Columbia River. Near-bottom particulate concentrations, estimated by continuous vertical profiles of light-scattering intensity, systematically decrease from the continental shelf to the base of the slope. Within this trend, concentrations in Willapa Canyon are greater by a factor of as much as 3 than concentrations present at comparable locations on the adjacent open-slope areas.

Mineralogical analysis of the suspended sediment within the bottom nepheloid layer suggests that the increased concentrations found within Willapa Canyon result from a preferential accumulation of Columbia River-derived particles. Montmorillonite/chlorite ratios >1 characterize the Columbia River suspended load. Chemical homogeneity of the suspended particulates from the Columbia River to the base of the slope is indicated by the nearly constant ratios of the major-element oxides to Al_2O_3.

The excess density provided by the intense nepheloid layer found in Willapa Canyon may be influential in generating a net downcanyon component of bottom flow such as observed in other submarine canyons. Predicted rates of net basinward transport of the bottom nepheloid layer sediments range from 2.8 cm sec^{-1} at 635 m to 1.5 cm sec^{-1} at 1,500 m, values that are in good agreement with long-term current measurements in other canyons.

☐ 60416—Possible eucaryotic algae (Bangiophycidae) among early Proterozoic microfossils. *Helen Tappan, Department of Geology, University of California, Los Angeles, Los Angeles, California 90024.* (7 p., 1 fig.)

Recent data concerning extant planktonic red algae, chrysophytes, and haptophytes suggest possible reallocation of certain previously described middle and late Precambrian microfossils to one or more of these eucaryotic groups. Both binary fission and budding reproductive methods characterize *Huroniospora* of the Gunflint Iron Formation and *Palaeocryptidium* of the Bohemian Proterozoic. Their reproduction, morphology, habitat, and wide geographic distribution, as well as phylogenetic interpretations, suggest possible assignment of the Precambrian fossils to the unicellular red algal Order Porphyridiales (Subclass Bangiophycidae) rather than to the procaryotic blue-green algae or to the terrestrial fungi. Living *Porphyridium* may show peripheral multiple budding, with the resultant small cells held in the mucilaginous sheath that surrounds the parent cell, suggesting a similar relationship of *Eosphaera tyleri* Barghoorn and the Type 4 organism of Hofmann and Jackson. *Eucapsis*? from the Paradise Creek Formation also might be referable to the Rhodophyta or Chromophyta rather than to the blue-green algae.

Reassignment of the Gunflint taxa to the red algal Subclass Bangiophycidae would make this the earliest fossil record of this group; preservation of these unicellular organisms is due to the exceptional nature of the enclosing chert. The suggested reassignment also would date the evolution of the eucaryotic cell and of vegetative mitotic cell division by binary fission and budding by at least 1.9 $\times 10^9$ yr B.P., about the time hypothesized for final transition from an anoxic to an oxygenic atmosphere. Genetic recombination resulting from sexual reproduction first appeared in red or green algae at some time within the succeeding 1 b.y.

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