GSA news & information

VOLUME 1, NUMBER 4 APRIL 1979

# Report of the President

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

Peter T. Flawn

During 1978, the Society, through the efforts of the Executive Director, Dr. John C. Frye, and the Controller, Richard F. Drozda, and under the eagle eye of Treasurer William B. Heroy, continued to review and improve its internal fiscal control system. This system is now producing timely information for management decision. The year 1978 concluded with a modest budget surplus to contribute to rebuilding of the reserve fund.

The big events in 1978 revolved around the publications department and the initiation of planning for our 1988 Centennial year. In publications, the new Science Editor, Vernon E. Swanson, came aboard early in the year and was immediately faced with problems of transition to the new *Bulletin* format. The publications department made a great effort in 1978, and I believe that the Society's principal business—scientific communication—is in good hands and proceeding in the right direction.

If the Society mobilizes its membership and its resources, the 1988 Centennial will be a great event for the science as well as for the Society. What is contemplated is no less than a North American Geological Decade culminating in a 1988 Centennial celebration. A planning committee under the chairmanship of Past President Richard H. Jahns set the course in its report to the Council in Toronto. The membership will be informed through *GSA News & Information* as to the progress of planning and action. It is important that all members of the Society become involved in one phase or another of the several efforts that will mark the decade as a very special time for geology.

For me personally, 1978 was a year to return to geology after many years in administration. As President of the Geological Society of America, I had an opportunity to renew old friendships and make new ones. The lively, healthy, and sometimes prickly, debates about directions and policies that went on during the year convince me that communications between membership and Council, between sections and Council, between divisions and Council, and between associated societies and Council have never been better.

I appreciate very much the opportunity to have served.

Respectfully submitted,

Peter T. Flawn.

PETER T. FLAWN, President 1978

# Annual Report for 1978
# The Geological Society of America

# Report of the Executive Director

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

The year 1978 in many respects was a continuation of operational policies and programs of the two preceding years. It was during 1978, however, that all of the work was done in preparation for the new two-part *Bulletin*, for the development of a new and flexible dues and member publication-purchase system, and the development of *GSA News & Information* as a member publication separate from *Geology*. Thus, although 1978 was a year of stability, it was also the year of readiness for major change.

The total membership stayed slightly above 12,000 for the fifth year, but the number of Members slightly increased, and the number of Student Associates slightly decreased. At year's end, an analysis of the age distribution of the membership was run, and it appears that the membership is younger than had been thought. The largest 5-year group was 31–35 years, with 16% of Members and Fellows; 54.4% of Members and Fellows were 45 years or younger; of the Student Associates, 82% were 30 years or younger. The dues notice for 1979 went out during 1978, and it carried a questionnaire concerning type of employment. Returns by year's end indicated that about 32% of employed members were in academic work, and about 32% in one of the several phases of industry or commerce. About 27% of the employed membership were employed by government agencies.

The system of five options, which had been in effect for several years, continued in 1978 for member publication purchase of the Society's periodicals and membership directory. The response from the membership to the five options in 1978 was at about the same level as in previous years. The new system for 1979, however, which provides complete flexibility for each member to purchase just those items wanted, was put into effect and mailed to the membership in mid-September. By year's end, 75% had been returned to headquarters. Of these, 36.5% ordered *Bulletin, Part I*; 9.7% ordered *Bulletin, Part II*, on microfiche; and 17.8% ordered either 10 or 20 separates from *Part I*. *Geology* was ordered by 58% of the membership and the annual meeting book of *Abstracts with Programs* by 56.5%. The *Membership Directory/Yearbook* was ordered by 18.5% of the membership. *GSA News & Information* now goes as a separate publication to all members in good standing.

The headquarters staff by the last quarter of 1978 was 23% below its maximum size reached during the first quarter of 1975. Vernon E. Swanson assumed the position of Science Editor on February 1, 1978, and has (among other things) been busily involved with conversion to the new two-part *Bulletin*.

The October Annual Meeting in Toronto was a joint meeting of GAC-MAC-GSA and associated societies. With a total registration of 4,826, it was second in size only to the 1976 meeting in Denver; and it exceeded all previous meetings in number of papers presented. There were 26 well-attended field trips in association with the annual meeting.

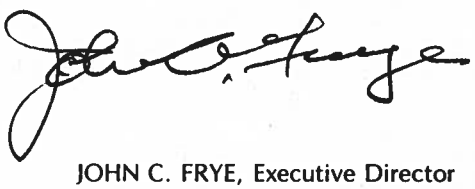
The Employment Service continues to be well utilized and well regarded by employers and applicants. At the Toronto meeting, 68 employers conducted 865 interviews in the booths provided. An additional 31 employers used the service by printouts of applicants, posting notices of job openings, and use of the message center. A new feature this year was a special briefing session on employment trends by representatives of industry, government, and education.

All six of the GSA sections conducted successful annual meetings during the year, and nine topical Penrose Conferences were held.

There were 265 applicants for research grants during 1978, and of these, 125 were funded. A total of $80,000 was awarded, of which 78% came from endowment income and 22% from industry contributions, and contributions from the membership and former recipients. The Harold T. Stearns Fund produced a $600 special award, and during the year the principal of the Stearns Fund was increased by $10,000 by an additional contribution.

Although at the time of this writing the books have not yet been closed for the year 1978, it appears that the total Society's operations for the year finished in the black—that is, income from investments (not including capital gain or loss), from dues, from publication sales, and from meetings slightly exceeded total expenditures. The Irving Trust Company of New York continues to be custodian for the Society's securities, and advice is furnished to the Investments Committee by the Irving Trust Company and by Reich and Tang, Inc., also of New York. The final turnover of the *Bibliography and Index of Geology* to AGI was not completed by year's end because of delays in publication of monthly numbers, and therefore, the final settlement of the transfer will not be accomplished until several months into 1979.

Respectfully submitted,



JOHN C. FRYE, Executive Director

# Annual Report for 1978
# The Geological Society of America

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Howard Wilshire
Edward L. Winterer
Irving J. Witkind
Joseph Wooden
Herbert E. Wright
Thomas L. Wright
Robert E. Zartman

## PUBLICATIONS COMPLETED IN 1978

The following publications, totaling 14,832 pages, were issued by the Society in 1978:

PERIODICALS. *Abstracts with Programs* for meetings of the Northeastern, South-Central, Cordilleran, Southeastern, North-Central, and Rocky Mountain Sections and for the joint annual meeting with the Geological Association of Canada and the Mineralogical Association in Toronto, Canada; 9 issues of the *Bibliography and Index of Geology*, volume 42, and the cumulative volume 40 (1977); 12 issues of the monthly *Bulletin*, volume 89; 12 issues of *Geology* with "GSA News & Information" sections, volume 7.

SERIES. 10 in the Maps and Charts series: MC-19, (MC-20, 1977), MC-21, MC-22, MC-23, MC-24, MC-25, MC-26, MC-27, MC-28A, MC-28B; Memorials preprints and Volume VIII; 2 Memoirs, 151 and 152; Engineering Geology Case Histories #11; Special Paper 179. *Treatise of Invertebrate Paleontology*, Part T with fascicle (References and Index).

REPRINTS. *Treatise of Invertebrate Paleontology*, Parts C, G, L, and S.

MISCELLANEOUS. Other publications in 1978 were the *Annual Report for 1977* printed in the March, May, June, and September issues of "GSA News & Information" sections of *Geology*; Mini-Catalogs for Spring and Fall; Newsletters: *2-The Archaeological Geology Division, 2-The Coal Geologist, 2-The Engineering Geologist, 2-History of Geology Division, The Hydrogeologist*, and *The Quaternary Geologist and Geomorphologist*; Report of the Committee on Geology and Public Policy, "Floods and People"; *Membership Directory/Yearbook* for 1978.

# Annual Report for 1978
# The Geological Society of America

# GSA UPDATE

## Articles in *Bulletin, Part II,* April 1979

Articles in *Bulletin, Part II* are listed below. (Summaries only of these articles are in *Bulletin, Part I.*) Articles in *Part II* are not on the separates subscription.

Paper copies of *Part II* in its entirety are available at cost ($6/month) as a special service to those users (members and nonmember subscribers) who request them. Any such order should be addressed to the Publication Sales Department and be accompanied by advance payment, and no discount can be offered for multiple orders or orders for a sequence of months.

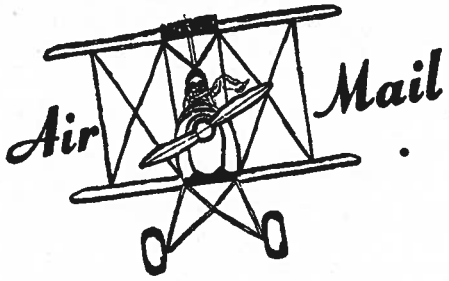
1. Origin and emplacement of the Academy Pluton, Fresno County, California, by Seymour Mack, Jason B. Saleeby, and John E. Ferrell. Doc. no. M90401 (On microfiche: 62 p., 13 figs., 10 tables.)
2. Geology and structure of the central Ruby Range, Madison County, Montana, by John M. Garihan. Doc. no. M90402 (On microfiche: 94 p., 17 figs., 2 tables.)

### Rock Mechanics Symposium

The 20th U.S. Symposium on Rock Mechanics will be held at the University of Texas in Austin, June 3–6, 1979. The intent of the meeting is to present the results of current research in a broad range of rock mechanics applications, including rock measurements (lab, field, remote sensing), fracture mechanics, tunneling, underground openings for storage, stability of surface excavations, and mining of coal and oil shale.

## *NOTE:*

All members living outside North America will probably receive *Abstracts with Programs* after the annual meeting unless they write to GSA headquarters and ask to have it sent




GSA News & Information

Vol. 1, no. 4 April 1979

GSA NEWS & INFORMATION (ISSN 0164-5854) is the monthly newsletter of The Geological Society of America, Inc., 3300 Penrose Place, Boulder, Colorado 80301. Second-class postage rates paid at Boulder, Colorado, and at additional mailing office.

Prepared from contributions from the staff and membership by John C. Frye, Executive Director; Jo Fogelberg, Publications Manager; and June Thomas, Judy Hall, and Renée Gitchell, Production Assistants.

## In April *Geology* (separates not available)

1. Mesozoic forearc basin in central Oregon, by William R. Dickinson
2. Bismarck Sea: Evolution of a back-arc basin, by Brian Taylor
3. Paleomagnetism and tectonic significance of the Goble Volcanic Series, southwestern Washington, by Myrl E. Beck, Jr., and Cynthia D. Burr
4. The Carolina slate belt—Evidence of a continental rift zone, by Leland Timothy Long
5. Variation in strain and strain rate during underthrusting of trench deposits, by J. Casey Moore
6. Elisée Reclus—Neglected geologic pioneer and first(?) continental drift advocate, by James O. Berkland
7. The effect of low-temperature alteration of basalt on the oceanic budget of potassium, by Salman Bloch and James L. Bischoff
8. Compositional evolution of intrusive rocks in the eastern Greater Antilles island arc, by Stephen E. Kesler and John F. Sutter
9. Sedimentary facies and gravity anomaly across master faults of the Rio Grande rift in New Mexico, by Lindrith Cordell
10. A geophysical investigation concerning the continuation of the Clarendon-Linden fault across Lake Ontario, by D. R. Hutchinson, P. W. Pomeroy, R. J. Wold, and H. C. Halls
11. Comparison of Miocene provincial foraminiferal stages to coccolith zones in the California Continental Borderland, by James K. Crouch and David Bukry
12. Endolith microborings and their preservation in Holocene-Pleistocene (Bahama-Florida) ooids, by P. M. Harris, R. B. Halley, and K. J. Lukas
13. Differences in incongruent weathering of plagioclase and microcline—Cation leaching versus precipitates, by Roy A. Nixon

### Memorial preprints ready for free distribution

The following memorial preprints are now available for distribution, free of charge, by writing to GSA, 3300 Penrose Place, Boulder, Colorado 80301.

| | |
|---|---|
| Aaro Emil Aho | by W. H. Mathews |
| George Brown Barbour | by Hugh S. Barbour |
| Alfred Hannam Bell | by George V. Cohee |
| Lorin Delbert Clark | by Paul C. Bateman |
| Lincoln Dryden | by W. C. Krumbein |
| John Robert Hayes | by L. W. LeRoy |
| Verner Everett Jones | by Walton Sumner |
| John Lawrence Lester | by Garth W. Caylor |
| George Burke Maxey | by Davis A. Stephenson |
| Josie Winifred McGlamery | by Charles W. Copeland |
| Malcolm Christie Oakes | by Robert H. Dott |
| Nicolas Oulianoff | by Stephen Ayrton |
| Alonzo Wallace Quinn | by Marland P. Billings |
| Edgar P. Rothrock | by David P. Rothrock |
| Raymond Eugene Whitla | by W. Harold Stuart |

# Are we traitors to our own cause?

Concerns are repeatedly expressed over the decline in field training in the undergraduate curriculum. Substantial agreement exists that minimal field training is essential. Remedies for the existing problems that result in decline in field work are insufficient to reverse trends unless professional geologists support—even demand—minimal undergraduate field experience. Pressure on academic institutions to support the increasingly costly but unique feature of undergraduate geological education is needed now; the field orientation is in great danger of early elimination.

## Introduction

Abstracts that should be of fundamental concern to all geological scientists, and not just to geological educators, appeared in the Program of the 1978 Joint Annual Meeting of Professional Geological Societies held in Toronto in October. A systematic erosion of the field requirement for the undergraduate degree is occurring. Were the titles of these abstracts to be viewed dispassionately by a non-geologist, they could well suggest that we professionals are seeking excuses to discard, or at least to subordinate, the main artery of undergraduate excellence at a time when enrollments in the undergraduate major are as high as at any time in history.

The profession must be made aware of setbacks to field programs, heightened by shifts in professional and educational interests, and social circumstances that increase the difficulties of accomplishing the field aspects of the educational mission. Bureaucratic requirements designed to "protect us from ourselves," financial constraints, and colleagues more interested in their own advancement than in the well-being of undergraduates also contribute heavily to the decline in field emphasis. Such constraints to field programs, however, are not new. They are only exaggerated by the pressures of numbers, and by the quickened competition for increasingly scarce resources. There is a need for articulate support from all levels of the geological community if field programs are to survive.

## Field Role: Present Viewpoints and Threats to the Geology Major

Undergraduate curricular patterns for baccalaureate degrees in the geological sciences have been discussed almost continuously since World War I, when universal accessibility to college education became the goal in the United States. To expect agreement on content for the best background for the future geologist would be unrealistic and, in my view, undesirable. Agreement, however, does seem to emerge on the following essentials: (1) fundamental foundations in mathematics, chemistry, and physics, at least to the level permitting enrollment in upperclass courses in these fields as specializations are narrowed for graduate study, and (2) systematic introduction to field practice in some concentrated pattern, usually by a summer field course. Other specific subject content desirable in geological sciences has not been given overwhelming endorsement in past surveys, although consensus among practicing professionals would probably suggest at least introduction to mineralogy, petrology (including use of the petrographic microscope), structure, stratigraphy, paleontology, and geophysics as basic in an undergraduate curriculum.

Hendrix and Suttner (1978) report regarding field courses that all respondents to a survey of 95 institutions agree that a field course is "a unique learning experience. . . . [and] is considered essential," but half of those schools do not require a field course for the baccalaureate degree "presumably because of its high cost . . . to students." Is this a concession to student pressure? Or is it a reflection of the human trait to find excuses to avoid that which is becoming increasingly more time consuming in a program in which less and less interest is taken in the individual student as a result of the policies of universities and colleges?

Dorr (1978), in a depressing statement, points up some ten or more deterrents to a successful and continuing summer field program at least through permanent summer field station facilities. Reading his list of concerns would impel most educational administrators to cancel the budgets forthwith! The abstract, I infer, is designed to alert us all to the very real possibility that the main artery of the undergraduate geology major is in danger of being severed.

Having spent nearly 50 years in two institutions, where a (summer) field course is required for the baccalaureate degree in geology, and having served as official major academic advisor to several thousand undergraduate geology students, I know that it is the field program that attracts the student to geology in the first place. The field program is also the part of the degree requirement that is the overriding motivation for the student to "endure" the vigorous requirements in mathematics, chemistry, and physics against which so many students rebel, especially since students seldom experience early the need for these basic disciplines. Carefully planned field experience early in the curriculum assists in understanding the role of these basic disciplines (Sylvester,

1977). Regrettably, few schools have the climatic luxury that permits year-around field work, a condition almost essential for freshman and sophomore field courses, and meaningful frequent field experiences. Even schools in favored locales seldom take full advantage of it.

The threats to field programs are further expounded by Laudon (1978) in a paper entitled "Risk Management Problems of Geology Field Camps," and by Hileman and Cygan's (1978) paper, "Field Work Opportunities are Limited in the Petroleum Industry." These titles, examined apart from their actual contents, suggest that the field requirements for undergraduates are traditional, rather than essential. But a careful reading clearly supports the fundamental necessity of having field experience as the basis for undergraduate and often graduate specialization.

Finally, as almost a capstone of what this writer sees as an unintentional, but nevertheless critical, "attack" on the field orientation so fundamental to the curriculum, is the suggestion of Podolsky (1978) that the baccalaureate degree in geology should be discontinued. His contention is based primarily on the fact that the degree does not guarantee entrance into the profession. The role of the baccalaureate degree in colleges and most universities in the United States has not been primarily professional at least since World War II. The degree promises to be even less professional as the interest in environmental geology accelerates. Many departments of geological science have joined this currently favored educational bandwagon. The resulting increased enrollments make unprecedented demands upon department facilities, often by poorly prepared though usually highly dedicated students. Pressure inescapably reduces standards of expectancy, often with concomitant reduction of resources heretofore allocated to the costly fundamentals of the geology major. Are these developments sufficient to question the validity of the baccalaureate in geology? The writer does not believe so.

One other threat is nowhere articulated in the series of papers cited. To what extent do the patterns that exacerbate the problems of field work reflect the announced policies of institutions of higher learning—both collegiate and university—that industrial and professional education best prospers in the strongest climate possible of research and teaching? The latter usually means at the undergraduate level that fewer and fewer resources are allocated to the great undeveloped student mass in favor of the highly selected graduate minority. Though the trend seems permanent, should we as geological professionals in academe acknowledge that we propose to reduce our dedication to the agreed undergraduate essential primarily for this reason? Are we not in fact merely seeking scapegoats in the form of administrative bureaucracy, financial limitations, or environmental and social hazards, to justify our neglect?

## Conclusion

The pressures that lead to extinction of an ideal are often last known to those who should be first aware. Too much is at stake to allow demise of an essential ingredient which so vitally affects our professional future and that of our successors. I like to think that, recognizing the hazards, geologists will demand of educators continued dedication to the field base, and will not knowingly be traitors to the heritage and goals of geological science. Pressure on the Alma Mater is needed now if field programs are to continue to receive adequate financial support in this crisis time of scarce dollars.

## References Cited


Dorr, John A., Jr., 1978, Some current and future problems in the operation of a permanent geology summer field station: Geological Society of America Abstracts with Programs, v. 10, p. 391.

Hendrix, Thomas E., and Suttner, Lee J., 1978, An assessment of field courses in geology: Journal of Geological Education, v. 26, p. 160–164; and Geological Society of America Abstracts with Programs, v. 10, p. 419.

Hileman, Mary E., and Cygan, Norbert E., 1978, Field work opportunities are limited in the petroleum industry: Geological Society of America Abstracts with Programs, v. 10, p. 421.

Laudon, Thomas S., 1978, Risk management problems of geology field camps: Geological Society of America Abstracts with Programs, v. 10, p. 441.

Podolsky, Terrence, 1978, The discontinuance of the bachelor level degree in geology: Geological Society of America Abstracts with Programs, v. 10, p. 473.

Sylvester, Arthur G., 1977, U. C. Santa Barbara's "why?" course in field geology: Journal of Geological Education, v. 25, p. 54–57.


## Acknowledgments


Preliminary review by Robert M. Norris and Arthur G. Sylvester, University of California, Santa Barbara, is appreciated. Official appraisers were John E. Allen, Portland State University, Thomas E. Hendrix, Grand Valley State Colleges, and Richard L. Threet, San Diego State University. Their assistance is acknowledged.



**Robert W. Webb**
Department of Geological Sciences
University of California
Santa Barbara, California 93106

## COMMITTEE ON COMMITTEES SEEKS NOMINATIONS

The Committee on Committees requests help from all members. As is customary, an entirely new committee has been appointed by Vice-President Laurence L. Sloss. Its sole purpose is to look for talent to serve GSA as members of our committees and as our representatives to other organizations.

The Committee on Committees will do its work late in August and will present at least two nominations for each open position to the Council at its November meeting in San Diego. During that meeting, individual councilors may or may not add other names to the lists for consideration. The entire Council will then select appointees for all positions, thus completing the process of bringing new blood into Society affairs.

The Committee on Committees for 1979 is made up of the following people: *Robert E. Boyer* (chairman), *W. G. Ernst, Bruce B. Hanshaw, Frederick T. Mackenzie, and Hugh R. Wynne-Edwards.*

This group is broadly based, both geographically and in disciplines, but its members cannot possibly know all the GSA members who are potential candidates for serving the Society. You can help them immensely by volunteering yourself or by suggesting names of others who you think should be considered for any of the openings.

Mere listing of names for these positions will be helpful to the committee, *but you can be far more helpful,* and will ensure more thorough consideration of your candidates, *if you will attach a note explaining the special qualifications of your candidates* for particular jobs. Please be sure that your candidates are Members or Fellows of the Society.

If you can think of a better or more democratic process for providing governance of the Society, please let us know. If you think the present system is at least adequate, do your part by suggesting candidates!

Listed below are all GSA committees and organizations to which GSA has representatives or designees. Appointments to fill vacancies will be made by the Council at its fall meeting. (Duties of the committee members are described in the manual *Council Rules, Policies, and Procedures.*)

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PLEASE RETURN THIS FORM TO HEADQUARTERS BY AUGUST 1, 1979

| **GSA Committees for 1980** | **Members suggested to serve on committees** |
|---|---|
| Day Medal | |
| Geology & Public Policy | |
| Headquarters Advisory | |
| Honorary Fellows | |
| Investments | |
| Membership | |
| National Medal of Science | |
| Nominations | |
| Penrose Conferences | |
| Penrose Medal | |
| Publications | |
| Research Grants | |

| **GSA Representatives or Designees for 1980** | **Members suggested to serve as GSA Representatives or Designees** |
|---|---|
| ACSN | |
| GSA-AEG-ASCE Joint Comm. on Engineering Geology | |
| U.S. Natl. Comm. on Rock Mechanics | |
| U.S. Natl. Comm. on Tunneling Technology | |

**Remarks:** _____

**Signature (optional)** _____

# FIRST ANNOUNCEMENT ANNUAL MEETING

**SAN DIEGO**, often billed as America's finest city, will host the annual meeting of the Geological Society of America during November 5 to 8, 1979. San Diego is one of the fastest growing cities in the United States and contains a wide diversity of recreational activities along with excellent climate and great scenery. San Diego is truly a vacationer's paradise.

Highlights of the meeting will include recognition of the U.S. Geological Survey Centennial, and will focus as well on the international geological communities of Canada, the United States, Mexico, and Central America.

Headquarters for the annual meeting will be the Convention Center at the Town and Country Hotel located in San Diego's Hotel Circle. Seven associated societies will hold concurrent annual meetings with GSA: Cushman Foundation, Geochemical Society, Geoscience Information Society, Mineralogical Society of America, National Association of Geology Teachers, Paleontological Society, and Society of Economic Geologists.

Serving as general chairman for the 1979 meeting is **Richard L. Threet**, San Diego '79, Department of Geological Sciences, San Diego State University, San Diego, CA 92182. Telephone: (714) 286-5586.

San Diego's location allows for the planning of a wide variety of field trips. These will include ground and air trips of local and regional scope, as well as opportunities to visit regions in Mexico. Climatic conditions during early November are usually mild, with some morning fog and generally sunny days with little chance of rain.

Social events will include the welcoming party in the large foyer of the Town and Country Hotel Convention Center on Sunday, November 4; the annual GSA Banquet on Tuesday, November 6; and a special GSA private party at Sea World on Wednesday evening, November 7. This party will include a Polynesian luau dinner, admission to all scientific educational exhibits, rides on the Sea World Sky Tower and Skyride gondolas, and all five aquatic shows (climaxing with famous Shamu, the killer whale, and a special GSA fireworks display).

**REGISTRATION.** Take advantage of preregistration rates, which will be lower than on-site registration rates. Registration fees and forms will be included in the second announcement and will appear in the August issue of *GSA News & Information*. **MEETING AND FIELD TRIP PREREGISTRATIONS MUST BE RECEIVED BY GSA HEADQUARTERS NO LATER THAN SEPTEMBER 14, 1979.**

**HOUSING.** Room rates will start at approximately $26 for singles and $31 for doubles. Please use the official housing form which will appear in the August issue of *GSA News & Information*.

**TECHNICAL PROGRAM.** The technical sessions will consist of symposia and volunteered papers, and these will be presented orally or as poster sessions. Up to nine concurrent sessions will be held at the Town and Country Convention Center. Numerous other hotels and motels are located within short walking distance. Chairman for the technical program is **Richard W. Berry**, Department of Geological Sciences, San Diego State University, San Diego, CA 92182. Telephone: (714) 286-5586.

Speakers in the regular technical sessions will be alloted a total of 15 minutes and will be expected to leave time for questions and discussion at the end of their presentation. Projection facilities will consist of a single 35-mm projector in each room; dual projectors will not be available. Each poster session participant will be provided with one 4′ x 8′ tackboard for display, but no projection equipment, electrical outlets, or tables will be available.

Abstracts for the technical sessions (oral presentations and poster sessions) should be submitted on an abstract form available from the GSA Abstracts Coordinator (Boulder). **The abstract form will be used as camera-ready copy for publication in** *Abstracts with Programs*, and a $15 fee will be charged to the senior author if retyping is necessary. There will be no opportunity for authors to review or revise the retyped abstract. Please note that, excluding symposia, no author may appear on more than two abstracts (senior or junior author) and may present only one abstract. Deadline for receipt of abstracts for technical and poster sessions at GSA headquarters is **June 15, 1979.** Mail abstracts to **Abstracts Coordinator**, Geological Society of America, 3300 Penrose Place, Boulder, CO 80301.

**SYMPOSIA: Titles, Sponsors, Organizers.** Twenty symposia will convene during the three and one-half day meeting. The additional symposia will convene on Sunday or Thursday afternoon. Any communications concerning symposia abstracts and participation or requests for symposia information should be addressed to specific symposium organizers.

1. *Earthquake Hazards and Prediction:* Geophysics Division, GSA; James N. Brune and Kerry E. Sieh
2. *Depositional Processes in Continental Margin Basins:* Michael E. Field and Donn S. Gorsline
3. *Cenozoic Correlations of North America–The Neogene:* Warren O. Addicott, Lloyd Burckle, and John M. Armentrout
4. *Mesozoic and Cenozoic Microplate Tectonics of the Pacific Continental Margins:* John Hillhouse and David Jones
5. *The Nature and Origin of Granitic Magmas:* Bruce Chappell
6. *Miocene Paleoceanography:* CENOP; James P. Kennett and Samuel M. Savin
7. *The Evaluation of North American Coal Resources:* Coal Geology Division, GSA; Jack A. Simon and Paul A. Bailly
8. *Collection Development in Geoscience Libraries:* Geoscience Information Society; Rosalind Walcott
9. *Human Origins:* Paleontological Society; Leo F. Laporte
10. *Properties of Silicate Liquids:* Mineralogical Society of America; Bjørn Mysen
11. *Oxygen and Carbon Isotopes in Foraminifera:* Cushman Foundation; Wolfgang H. Berger and Allan W. H. Bé
12. *Geodynamics: Subduction of Oceanic Plates–Magma and Minerals:* R. Gordon Gastil and Richard P. Phillips
13. *Project CLIMAP: Progress in Understanding Quaternary Climatic Change:* W. F. Ruddiman and W. L. Prell
14. *Recent Advancements in Analytic Methods Applicable to Archaeological Geology:* Archaeological Geology Division, GSA; William R. Farrand
15. *Perspectives on Government and Science: Occasioned by the Centennial of the U.S. Geological Survey:* M. Gordon Wolman
16. *Water Quality Management:* Hydrogeology Division, GSA; John F. Mann, Jr., and Darwin Knochenmus
17. *Hydrothermal Alteration of the Oceanic Crust (or Deeper?):* Geochemical Society; Debra S. Stakes and Michael J. Mottl
18. *The Environmental Constraints and Impacts Related to the Extraction of Uranium Resources:* GSA Committee on Geology and Public Policy; Dawn S. Kaback and Donald D. Runnells
19. *G. K. Gilbert Symposium: Geology in America–Growth of a Scientific Community:* History of Geology Division, GSA; C. C. Albritton, C. M. Nelson, C. J. Schneer, E. L. Yochelson
20. *A Century of Research on Metallic Mineral Deposits:* Society of Economic Geologists; Eugene M. Shoemaker
21. *Geochemical Exploration for Uranium:* Association of Exploration Geochemists, U.S. Department of Energy; Robert H. Carpenter
22. *Academic Training for Engineering Geologists:* Engineering Geology Division, GSA–Association of Engineering Geologists–National Association of Geology Teachers; Richard H. Jahns, James V. O'Connor, and Martin L. Stout

**FIELD TRIPS.** For further information concerning field trips, contact **Patrick L. Abbott**, Department of Geological Sciences, San Diego State University, San Diego, CA 92182. Telephone: (714) 286-5586. It should be noted that the present schedule is subject to change.

# NOVEMBER 5-8, 1979 SAN DIEGO, CALIFORNIA

**Premeeting**

**1. Quaternary Terraces and Crustal Deformation in Coastal Southern California:** J. Philip Kern, San Diego State University, and Ken Lajoie, U.S. Geological Survey, Menlo Park

**2. Geology of Santa Cruz Island:** David G. Howell, Jack G. Vedder, and Hugh McLean, U.S. Geological Survey, Menlo Park

**3. Roundtrip Flight to Colorado Plateau:** John S. Shelton, Consultant John Crowell, University of California, Santa Barbara, and Gregory A. Davis, University of Southern California

**4. Geomorphology of the Salton Basin:** Robert Norris and Edward Keller, University of California, Santa Barbara, and George Meyer, College of the Desert

**5. Pegmatites, San Diego County:** Richard H. Jahns, Stanford University

**6. Geology of Death Valley:** Bennie Troxel, University of California, Davis, and Lauren Wright, Pennsylvania State University

**7. Geology and Geothermics of the Salton Trough:** Wilfred A. Elders, University of California, Riverside, and Ing. Armando de la Pena, CFE

**8. Some Prehistoric Earthquakes on the San Andreas Fault, Los Angeles Area:** Kerry Sieh, California Institute of Technology

**9. Evaporites and Related Minerals in the Death Valley and Mojave Desert Region:** G. I. Smith, U.S. Geological Survey, Menlo Park

**10. Geology of Vizcaino Peninsula and Cedros Island, Baja California Sur:** R. Gordon Gastil, San Diego State University, Claude Rangin, University of Paris, and Frank Kilmer, Humboldt State University

**11. SCUBA, Southern California Borderland:** Robert Dill, West Indies Laboratories

**12. Geology of Baja California, La Paz to San Diego:** John A. Minch, Saddleback College

**13. Geology of Northern Baja California:** Richard P. Phillips, University of San Diego

**14. Water Management Practices in Coastal Southern California:** Darwin Knochenmus and William Hardt, U.S. Geological Survey, Laguna Niguel, and John Mann, Jr., Consultant

**15. Geology and Coal Deposits of the Black Mesa Region, Arizona:** S. A. Friedman, Oklahoma Geological Survey, and Wesley Pierce, Arizona Bureau of Geology and Mineral Technology

**16. Regional Low-Angle Fault Terrane of Miocene Age, Southeastern California and Western Arizona:** Gregory Davis, J. L. Anderson, and Eric Frost, University of Southern California

**During Meeting**

**17. Geology of San Diego Metropolitan Area (Mini-Trips):** San Diego State University Staff

**Postmeeting**

**18. Eocene Depositional Systems in San Diego:** Martin Link, Los Angeles Harbor College, Gary Peterson, San Diego State University, and John Warme, Rice University

**19. Geologic Hazards in San Diego:** William J. Elliott, Consultant

**20. Pegmatites, San Diego County:** Richard H. Jahns, Stanford University

**21. Peninsular Ranges Batholith, San Diego County and Northern Baja California:** Victoria Todd, U.S. Geological Survey, San Diego, Michael Walawender, San Diego State University, and Leon Silver, California Institute of Technology

**22. San Andreas Fault, Salton Trough:** John C. Crowell and Arthur G. Sylvester, University of California, Santa Barbara

**23. Miocene Lithofacies and Depositional Environments, Coastal Southern and Baja California and Coronado Islands:** Charles J. Stuart, University of Texas, El Paso

**24. Point Sal Ophiolite:** Clifford Hopson, University of California, Santa Barbara

**25. Geology of Baja California, Air-Ground Trip:** R. Gordon Gastil, San Diego State University, and Francisco Suarez, CICES de Ensenada

**26. Geology of Northern Baja California:** Richard P. Phillips, University of San Diego

**27. Geology of Northern Sonora:** Tom Anderson, University of Pittsburgh, Jaime Roldan, Instituto de Geologia, UNAM, and Jesus Najera-Garza and Guillermo A. Salas, Universidad de Sonora

**GUEST ACTIVITIES.** A wide variety of programs offer personalized tours of San Diego, including the elegant La Jolla residential areas, and Point Loma with its historic lighthouse and breathtaking views of San Diego Bay and the Pacific Ocean. One tour will end at the beautiful and unique Hotel del Coronado, with lunch amid luxurious surroundings; another tour will feature historic Old Town, with a Mexican lunch and serenading mariachis. More authentic Mexican emphasis is offered in an international shopping trip to the markets of Tijuana, with lunch at one of Tijuana's fine restaurants.

November usually has ideal weather to enjoy outdoor activity, with full-day and half-day tours to San Diego Wild Animal Park, 50 km north of San Diego, for a safari through Africa and Asia. Other open-air events are two-hour and one-hour narrated cruises on spectacular San Diego Bay.

Informal tours are recommended to Balboa Park and Zoo, Reuben Fleet Space Theater and Planetarium, Museum of Natural History, Museum of Man, and Art Museum.

**GROUP ACTIVITIES.** In order to assign rooms for the meetings, breakfasts, luncheons, dinners, and cocktail parties, space assignment questionnaires will be sent to those who used space at the Toronto '78 Meeting. Those who do not receive a form and wish to reserve space should write to the **Annual Meeting Secretary,** Geological Society of America, 3300 Penrose Place, Boulder, CO 80301. Deadline for reserving space is **June 1, 1979.** No official space assignments will be made after that date.

**SPECIAL ACTIVITIES.** The Committee on Minorities in the Geosciences will sponsor a one-day program on career opportunities in the geosciences for secondary-school teachers, career counselors, and minority students from the San Diego area at the annual meeting in November. The program will consist of informal discussion groups led mainly by minority geoscientists rather than the formal sessions of previous years.

**SCIENCE THEATER.** The Science Theater will provide registrants with an opportunity to view, during technical session hours, an absorbing program of geologically oriented films. In charge is **John S. Shelton,** P.O. Box 48, La Jolla, CA 92038.

**EXHIBITS.** Exhibit space will be available in the Convention Center of the Town and Country Hotel. Companies, organizations, and universities interested in exhibiting should write or call **Fred Handy,** Annual Meeting Manager, Geological Society of America, 3300 Penrose Place, Boulder, CO 80301. Telephone: (303) 447-2020.

**EMPLOYMENT INTERVIEWS.** The Geological Society of America holds an employment interview service during its annual meeting each fall. Interview booths are provided for employers to conduct interviews at the meeting. Staff is available to help with the scheduling of the interviews. Application forms will appear in the July issue of *GSA News & Information.* For further information about this service, please contact **Charlene Bicknell,** Geological Society of America, 3300 Penrose Place, Boulder, CO 80301. Telephone: (303) 447-2020.

**SECOND ANNOUNCEMENT.** Additional information about the 1979 Annual Meeting will appear in the August issue of *GSA News & Information.* In addition to preregistration forms, this second announcement will contain forms for making reservations for housing, field trips, society functions, and guest activities. **If you anticipate that your address will change due to summer fieldwork or for other reasons, you can be assured timely receipt of your copy of the second announcement by sending your temporary address change to the Annual Meeting Secretary, Geological Society of America, 3300 Penrose Place, Boulder CO 80301.** Additional copies of the announcement may be obtained by writing to the above address.

# Five Penrose Conferences for 1979 invite your participation

The Penrose Conferences, sponsored by the Geological Society of America, provide the opportunity for exchange of current information and exciting ideas pertaining to the science of geology and related fields. They are intended to stimulate and enhance individual and collaborative research and to accelerate the advance of the science by the interactions and development of new ideas.

It is essential that the conferences be informal. Groups should be small enough that personal discussion among all participants is encouraged, and large enough to provide diversity and depth. As an empirical rule, the maximum number for success is about 70. Normally, the minimum number required to convene a conference is 50.

Anyone interested in attending a specific conference is encouraged to contact the conveners of that conference. Conveners initially invite a few key speakers necessary to the organization and success of the conference. Aside from these invitations issued in the early planning stages of a conference, the conveners utilize indications of interest from those actively working in the field to complete the list of conference participants. Participation is not restricted to members of the Geological Society of America. GSA members, however, will receive preference when there is a choice between equally qualified persons. The final decision on participation will be made by the conveners, whose decision shall not be subject to appeal. Acceptances for participation are not transferable.

Anyone interested in convening a Penrose Conference may submit a proposal; but at least one of the conveners must be a member of the Geological Society of America.

Proposals are now being accepted for 1980 Penrose Conferences and are reviewed, as received, by the Penrose Conference Committee. In acceptance of a proposal, the Penrose Conference Committee may offer advice, which in some cases may be a condition of acceptance. The committee chairman will address an advisory letter to the conveners calling attention to any matters that seem likely to pose a problem that must be resolved if the conference is to be successful. Proposals are then recommended for approval or rejection by the Society's Executive Committee which reserves full authority for the final approval.

Requests for information about Penrose Conferences in general should be sent to Penrose Conference Coordinator, The Geological Society of America, 3300 Penrose Place, Boulder, CO 80301.

Proposals for Penrose Conferences should be sent to the Executive Director at the above address.

## CALENDAR OF PENROSE CONFERENCES FOR 1979

**June 24–29, 1979,** ***Granite II: Granitic Rocks and Batholiths***

Fairmont Hot Springs
Gregson, Montana

Deadline for application:
April 1, 1979

Conveners:
Charles Vitaliano
Dept. of Geology
Indiana University
Bloomington, IN 47401

Lee Suttner
Dept. of Geology
Indiana University
Bloomington, IN 47401

Donald Hyndman
Dept. of Geology
Univ. of Montana
Missoula, MT 59801

**August 19–24, 1979,** ***Komatiites***

Empire Hotel
Quebec, Ontario, Canada

Deadline for application:
May 15, 1979

Conveners:
Nicholas T. Arndt
Dept. of Geological Sciences
University of Saskatchewan
Saskatoon, SK S7N OWO

Christopher Brooks
Department of Geologie
University of Montreal
Montreal, PQ H3C 3J7

**September 9–15, 1979,** ***Antler Orogeny***

Holiday Inn
Elko, Nevada

Deadline for application:
June 1, 1979

Conveners:
Tor Nilsen
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

John H. Stewart
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

**October 7–12, 1979,** ***Mesozoic and Cenozoic Microplate Tectonics of Western North America***

Islander Lopez, Lopez Island
Fisherman's Bay, Washington

Deadline for application:
July 1, 1979

Conveners:
Myrl E. Beck, Jr.
Dept. of Geology
Western Washington State Univ.
Bellingham, WA 98225

Allan V. Cox
Dept. of Geophysics
Stanford Univ.
Stanford, CA 94305

David L. Jones
P & S Branch, MS 15
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

**November 9–13, 1979,** ***Role of Pore Pressure on Deformation in Geologic Processes***

Town & Country Hotel
San Diego, California

Deadline for application:
July 1, 1979

Conveners:
T. N. Narasimhan
Earth Sci. Div.
Lawrence Berkeley Labs
Berkeley, CA 94720

W. N. Houston
Dept. Civil Eng., Univ. of Calif.
434 Davis Hall
Berkeley, CA 94720

Amos M. Nur
Dept. of Geophysics
Stanford University
Stanford, CA 94305

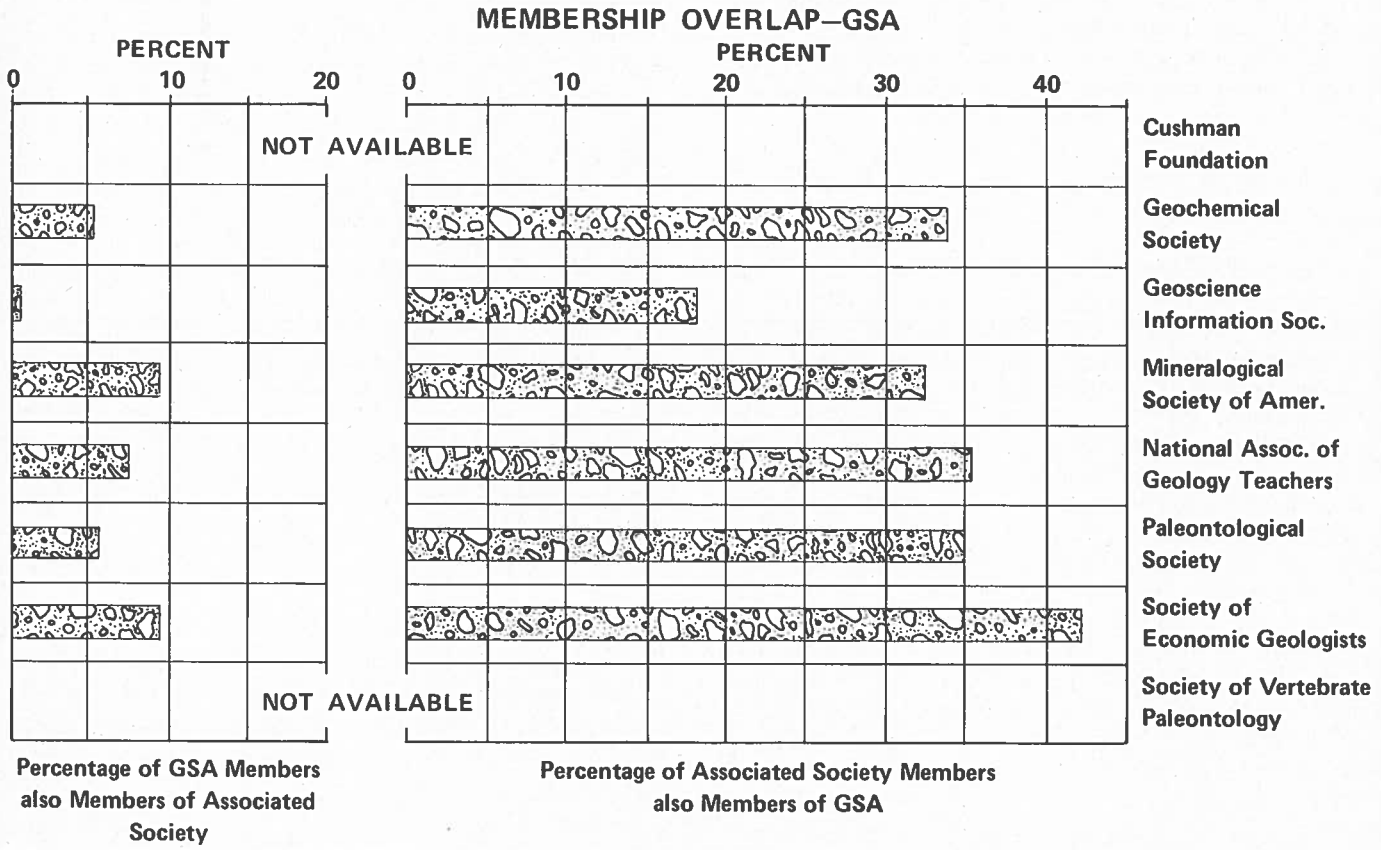
# GSA's Associated Societies

There are eight fully independent Earth Science societies that, by mutual agreement, are classed as associated societies with the Geological Society of America. Most of these societies hold their annual meeting at the same time and place as GSA, and their technical programs are merged in the overall program of a joint annual meeting. Each of the eight is a specialized society either by subject matter or by professional activity. This aspect places them in contrast to GSA, which by its constitution and traditions is dedicated to the advancement of all aspects of the geological sciences. Through the years, the association has been beneficial and profitable both for the specialized independent societies and for GSA. It has enriched the joint annual meeting by the many specialized sessions and symposia sponsored by them, and it has made available to their members a broadly diversified program for those with a range of interests within the geological sciences. Planning for the scientific program has been done on a joint basis by way of the Joint Technical Program Committee, and the chore work of arranging for facilities, food service, projection equipment, and the myriad of other details, are taken care of by GSA's Meetings Department and the local committee.

In order to explore possible ways to improve the operations of the JTPC and the annual meeting program, the GSA Council set up a special committee, consisting of the two past and two upcoming chairmen of the JTPC, under the chairmanship of William R. Dickinson of Stanford University, to examine the procedures and make recommendations for improvements. As necessary background for this committee, the GSA Meetings Department has manually compared the membership lists of six of the eight associated societies against the GSA membership list to determine the extent of membership overlap. The results of these six counts are shown on the accompanying charts. The area of membership overlap among the several associated societies is not known.

Although the 1978 meeting in Toronto—because it was joint with two Canadian societies—was not typical of GSA annual meetings, it is the most recent one for which we have numbers on society memberships. Of the students and professionals registering for the meeting, 33% indicated no society affiliation, 42% of total registrants indicated GSA membership, and 28% indicated membership in one of the GSA associated societies. However, of the associated society members, 60% were also members of GSA and are included with both percentages. GAC-MAC members accounted for 24% of total registrants, with 23% of these also members of GSA and therefore included with both percentages. For the one-third of total registrants who did not indicate a society affiliation, we do not know how many indeed do not belong to any of the listed societies and how many simply failed to check their affiliation.

The societies associated with GSA are Cushman Foundation, Geochemical Society, Geoscience Information Society, Mineralogical Society of America, National Association of Geology Teachers, Paleontological Society, Society of Economic Geologists, and Society of Vertebrate Paleontology.



# GSA PUBLICATIONS

## Cenozoic Tectonics and Regional Geophysics of the Western Cordillera

MEMOIR 152 — Edited by R. B. Smith and G. P. Eaton. 1978. viii + 388 pages, 146 figures, 9 tables, 8 plates (8 b&w maps) folded in slipcase. ISBN: 0-8137-1152-5. ..... $55

A comprehensive summary of on-going geological and geophysical research in the Western Cordillera is provided by the editors of this recently published volume. The volume comprises 16 individual papers, the substance of which was presented at the 1975 annual meeting of the Geological Society in Salt Lake City.

Under the umbrella title of the volume, most papers discuss the Basin and Range province, but others discuss the Pacific Coast Ranges and the continental margin to the west, and the Colorado Plateau province to the east. Most of the discussion deals with the area north of latitude 37°N, the boundary between Utah and Arizona. Major emphasis is placed on Cenozoic activity and structural features.

Regional maps, published for the first time, show age distribution of igneous rocks; regional faults; fault-plane solutions; seismicity; $P_n$-velocities; heat-flow, gravity, and magnetic data; and crustal structure of the Great Basin and high volcanic plateaus to the northwest, the Snake River Plain, the Pacific Coast Ranges, and the continental margin off the western United States. The individual papers, maps, and related tabular data are useful and valuable additions to knowledge of this large, highly complex region.

The volume should also contribute to a better understanding of mineral resource occurrences in the region, and thus aid in planning mineral exploration programs.

CONTENTS: Preface. Basin-range structure in western North America: A review: J. H. Stewart. Mesozoic-Cenozoic Cordilleran Plate tectonics: P. J. Coney. Regional gravity and tectonic patterns: Their relation to late Cenozoic epeirogeny and lateral spreading in the western Cordillera: G. P. Eaton, R. R. Wahl, H. J. Prostka, D. R. Mabey, and M. D. Kleinkopf. Regional magnetic patterns in part of the Cordillera in the Western United States: D. R. Mabey, I. Zietz, G. P. Eaton, and M. D. Kleinkopf. Fault-plane solutions of the Western United States: A compilation: R. B. Smith and A. G. Lindh. Seismicity, crustal structure, and intraplate tectonics of the interior of the western Cordillera: R. B. Smith. Seismic evidence for the structure and Cenozoic tectonics of the Pacific Coast States: D. P. Hill. Heat flow and energy loss in the Western United States: D. D. Blackwell. Models of an extending lithosphere and heat flow in the Basin and Range province: A. H. Lachenbruch and J. H. Sass. Geophysical studies and tectonic development of the continental margin off the Western United States, lat 34° to 48°N: E. A. Silver. Generalized maps showing distribution, lithology, and age of Cenozoic igneous rocks in the Western United States: J. H. Stewart and J. E. Carlson. Cenozoic igneous history of the U.S. Cordillera from lat 42° to 49°N: R. L. Armstrong. Late Cenozoic volcanic and tectonic evolution of the Great Basin and Columbia intermontane regions: R. L. Christiansen and E. H. McKee. Origin of the northern Basin and Range province: Implications from the geology of its eastern boundary: M. G. Best and W. K. Hamblin. Bright Angel and Mesa Butte fault systems of northern Arizona: E. M. Shoemaker, R. L. Squires, and M. J. Abrams. Some quantitative aspects of orogenic volcanism in the Oregon Cascades: C. M. White and A. R. McBirney.

TREATISE ON INVERTEBRATE PALEONTOLOGY, PART T, ECHINODERMATA 2 (CRINOIDEA). Edited by Raymond C. Moore and Curt Teichert. 1978. xxxviii + 1,027 pages, 619 figures, 7 tables (in 3 volumes). ISBN: 0-8137-3201-X. ..... $55

The three volumes contain comprehensive, authoritative, and up-to-date descriptions and illustrations of morphological features accompanied by an extensive glossary of terms, with chapters on recent crinoids, ontogeny, ecology, paleoecology, and the crinoid stereom. Taxonomic sections show classification and diagnosis of units (over 1,000 genera listed) down to generic and subgeneric levels.

Volume 1: xxxviii + 402 pages, 218 figures, 5 tables. Covers the morphology, classification, and distribution of the class Crinoidea. A fascicle of the references and index to Volumes 1–3 is included with Volume 1 purchased separately. ..... $27

Volume 2: pages T403–T812, figures 219–548, 2 tables. Covers the systematics of Paleozoic crinoids including the subclasses Echmatocrinea, Camerata, Inadunata, and Flexibilia. A fascicle of the references and index to Volumes 1–3 is included with Volume 2 purchased separately. ..... $26

Volume 3: pages T813–T1,027, figures 549–619. Covers the systematics of post-Paleozoic crinoids including the subclass Articulata; references; index. Volume 3 purchased separately. ..... $13

*NOTE:* **PART T** is offered as a set of three volumes for $55 and each volume is offered separately: Volume 1, $27; Volume 2, $26; Volume 3, $13.

**Books may be purchased through the Publication Sales Department, Geological Society of America, 3300 Penrose Place, Boulder, CO 80301. Please follow "GSA Member Discount and Purchase Procedures" printed on the back of the membership card.**

# APRIL BULLETIN SEPARATES

## Summaries

*At the request of members, the Summaries section may be ordered as one separate by those who have purchased the separates option. To order, write "April Summaries" on coupon.*

• S90401—Origin and emplacement of the Academy Pluton, Fresno County, California: Summary.

*Seymour Mack, Geology Department, California State University, Fresno, California 93740; Jason B. Saleeby, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125; John E. Ferrell, Geology Department, California State University, Fresno, California 93740.*

• S90402—Geology and structure of the central Ruby Range, Madison County, Montana: Summary.

*John M. Garihan, Department of Geosciences, Indiana University Northwest, Gary, Indiana 46408.*

• S90403—Structural interpretation of the southern part of the northern Coast Ranges and Sacramento Valley, California: Map Summary.

*John Suppe, Department of Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey 08540.*

## *Bulletin* Briefs

*Titles and abstracts of conventional articles in the April 1979 GSA* Bulletin, Part I *are provided on the following pages to aid members who have purchased the separates option to select* Bulletin, Part I *separates of their choice.* *See instructions for ordering on page 63.*

• 90404—Tectonic rotations of the Santa Monica Mountains region, western Transverse Ranges, California, suggested by paleomagnetic vectors.

*Marc J. Kamerling, Bruce P. Luyendyk, Department of Geological Sciences, University of California, Santa Barbara, California 93106.* (7 p., 6 figs., 3 tbls.)

The paleomagnetism of middle to late middle Miocene volcanic rocks from regions of the western Transverse Ranges suggests that large amounts of subsequent clockwise tectonic rotation has occurred. We studied rocks from five sites in the western Santa Monica Mountains, Conejo Hills, and Anacapa Island. East declinations of from 64° to 81° were found, compared to expected Miocene declinations of 0°, and inclinations were too shallow by up to 21° for the present latitude. Preliminary data from Santa Cruz and San Miguel Islands suggest similar but larger rotations. Stratigraphically higher units show the least amount of rotation, which may indicate that about 60° of rotation occurred primarily during middle and late Miocene time. North-pointing directions can be restored by rotating the northern Channel Islands and Santa Monica Mountains counterclockwise about a pivot near the eastern end of the range. This restoration also changes paleocurrent directions in Eocene and Oligocene rocks from north to west, which is consistent with data from surrounding regions. Shallow remanent inclinations suggest northward movement of this block of ~10° since early Miocene time.

• 90405—Neogene tectonic evolution of the California Continental Borderland and western Transverse Ranges.

*James K. Crouch, Scripps Institution of Oceanography, La Jolla, California 92093.* (8 p., 2 figs.)

Geologic, geophysical, and paleomagnetic data suggest that major lithologic belts which now make up the outer California Continental Borderland and western Transverse Ranges were disrupted from their original geographic and tectonic setting off northern Baja California. Disruption began in the early Miocene and is closely linked to a change in relative plate motions from subduction to right-lateral strike-slip (transform) motion along the southern California–Baja California continental margin.

A model is proposed which restores these lithologic belts to their original tectonic setting within an earlier arc-trench system. The model is based on the following assumptions: (1) major lithologic belts in southern California, northwestern Baja California, and the California Continental Borderland are equivalent in age, lithology, and structure to the Franciscan and Great Valley lithologic belt of northern and central California; (2) the Franciscan and Great Valley belts and their southern equivalents, respectively, represent the subduction complex and forearc basin deposits of a Late Jurassic to mid-Cenozoic arc-trench system; (3) the borderland off southern California contains paired Franciscan and Great Valley belts that are repeated in map view, and the western Transverse Ranges are made up largely of Great Valley or forearc basin deposits which have undergone large-scale clockwise rotation. The model is supported by areal distributions of lithofacies, paleocurrent trends, structural trends, and paleomagnetic data from Miocene volcanic rocks. If valid, the model proposed here will require major reconsiderations of earlier lithologic correlations and Paleogene and Neogene paleogeographic and paleotectonic models of southern California and the offshore borderlands.

• 90406—Chemical variation within the Coast Plutonic Complex of British Columbia between lat 53° and 55°N.

*T. E. Smith, Chris Riddle, T. A. Jackson, Department of Geology, University of Windsor, Windsor, Ontario, N9B 3P4 Canada (present addresses: Riddle: Division of Mines, Ministry of Natural Resources, 77 Grenville St., Toronto, Ontario, Canada; Jackson: Department of Geology, University of the West Indies, Mona, Kingston, Jamaica, West Indies).* (11 p., 5 figs., 6 tbls.)

Approximately 130 samples of plutonic rocks were collected from two sections across the Coast Plutonic Complex of British Columbia, between lat 53° and 55°N. Major-element oxide ($SiO_2$, $TiO_2$, $Al_2O_3$, $\Sigma Fe_2O_3$, MgO, CaO, $Na_2O$, $K_2O$, $P_2O_5$) and trace-element (Cr, Mn, Ni, Cu, Zn, Rb, Sr, Y, Zr, Ba) contents of the samples were determined by X-ray fluorescence spectroscopy.

Chemical and mineralogical variation within the plutons of the complex suggest that they may have formed by differentiation of magmas comprising a mixture of crystals and liquid. The data also suggest that these magmas formed from a source material of tonalitic or quartz dioritic bulk composition, probably the Central Gneiss Complex, by equilibrium fusion.

Statistical analysis of the raw chemical data reveals systematic increases in $K_2O$, Rb, and Ba contents and decreases in CaO, $Na_2O$, Mn, and Sr contents from west to east across the complex. The patterns of variation are not identical in the northern and southern sections, and analysis of the variance between the two populations confirms that chemical differences exist between them. Statistical analysis of the data normalized to 60% $SiO_2$ shows that there are systematic decreases in MgO and $Na_2O$ and an increase in $P_2O_5$ contents from west to east across the pluton.

Differences in chemical composition and in the patterns of spatial chemical variation between the northern and southern sections across the complex and between raw and normalized data are interpreted as resulting largely from differential uplift and erosion of the plutons. Variations in composition of the source material and/or in the physical conditions of fusion are also significant.

• 90407—Metal accumulation rates in the central equatorial Pacific during Cenozoic time.

*Margaret Leinen, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881; Debra Stakes, School of Oceanography, Oregon State University, Corvallis, Oregon 97331.* (19 p., 16 figs., 4 tbls.)

Accumulation rates of Mg, Al, Si, Mn, Fe, Ni, Cu, Zn, opal, and calcium carbonate have been calculated from their concentrations in samples from equatorial Deep Sea Drilling Project sites. Maps of element accumulation rates and of *Q*-mode factors derived from raw data indicate that the flux of trace metals to equatorial Pacific sediments has varied markedly through time and space in response to changes in the relative and absolute influence of several depositional influences: biogenic, detrital, authigenic, and hydrothermal sedimentation. Biologically derived material dominates the sediment of the equatorial Pacific. The distributions of Cu and Zn are most influenced by surface-water biological activity, but Ni, Al, Fe, and Mn are also incorporated into biological material. All of these elements have equatorial accumulation maxima similar to those of opal and calcium carbonate at times during the past 50 m.y. Detritus distributed by trade winds and equatorial surface circulation contributes Al, nonbiogenic Si, Fe, and Mg to the region. Detrital sediment is most important in areas with a small supply of biogenic debris and low bulk-accumulation rates. Al accumulation generally increases toward the north and east, indicating its continental source and distribution by the northeast trade winds. Maxima in biological productivity during middle Eocene and latest Miocene to early Pliocene time and concomitant well-developed surface circulation contributed toward temporal maxima in the accumulation rates of Cu, Zn, Ni, and Al in sediments of those ages. Authigenic material is also important only where bulk-sediment accumulation rates are low. Ni, Cu, Zn, and sometimes Mn are associated with this sediment. Fe is almost entirely of hydrothermal origin. Mn is primarily hydrothermal, but some is probably scavenged from sea water by amorphous iron hydroxide flocs along with other elements concentrated in hydrothermal sediments, Ni, Cu, and Zn. During the past 50 m.y. all of these elements accumulated over the East Pacific Rise at rates nearly an order of magnitude higher than those at non–rise-crest sites. In addition, factor analysis indicates that some of this material is carried substantial distances to the west of the rise crest. Accumulation rates of Fe in basal metalliferous sediments indicate that the hydrothermal activity that supplied amorphous Fe oxides to the East Pacific Rise areas was most intense during middle Eocene and late Miocene to early Pliocene time.

• 90408—Origin and provenance of some exotic blocks in lower Mesozoic red-bed basin deposits, southern Arizona.

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In southern Arizona, a profound change in tectonic regime from quiescence to major instability took place near the beginning of Mesozoic time. One manifestation of this instability was the free gliding of large blocks of Paleozoic sedimentary rocks into fault troughs containing volcanic material and continental sediments. In the northwestern Canelo Hills, a succession of exotic blocks composed of Permian sedimentary rocks is intercalated with the Canelo Hills Volcanics of Triassic(?)-Jurassic age. The blocks are as large as 400 m thick and 2 km in strike length. Bedding faults, slickensides, and open-space breccias formed near the base of each Permian block during epidermal gliding,

whereas the underlying sediments of the Canelo Hills Volcanics deformed by penecontemporaneous flow.

Slickenside and fold-axis orientations place northeast-southwest constraints on the direction of block emplacements. The *sense* of movement is interpreted to have been northeast to southwest because paleocurrent directions for red beds within the Canelo Hills Volcanics are dominantly southwest and the stratigraphy of the glide blocks is most similar to Permian rocks to the northeast. Palinspastic reconstruction of the blocks to a provenance northeast of the Canelo Hills fits present models of distribution of Permian formations in southern Arizona. Slide block emplacement was synchronous with Triassic(?)-Jurassic vertical movements along northwest-striking fault zones in southern Arizona. One of these fault zones, the Sawmill Canyon, marks the approximate northeast boundary of the Canelo Hills and in early Mesozoic time furnished a scarp from which the slide blocks were derived.

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• 90409—Quantitative morphology of landforms in carbonate rock basins in the Appalachian Highlands.

*Elizabeth L. White, Department of Civil Engineering and Institute for Research and Land and Water Resources, The Pennsylvania State University, University Park, Pennsylvania 16802; William B. White, Materials Research Laboratory and Department of Geosciences, Pennsylvania State University, University Park, Pennsylvania 16802.* (12 p., 12 figs., 6 tbls.)

Karst topography occurs in the Appalachian Highlands where carbonate rocks are exposed. The principal landforms are sinking streams, dolines, and caves. Landform measures were devised for the drainage features and for dolines and applied to 62 small basins between Pennsylvania and Alabama. Conventional measures included a relief factor, drainage factors, and size and shape factors. Karst measures included carbonate rock fractions, measures of doline development, and measures of internal drainage. Factor analysis showed that the 15 measures contained only five independent variables. Various stream length measures are related to the basin area in much the same way as streams in noncarbonate basins showing the fluviokarst character of the Appalachian basins. Sinking stream length, SINKL, relates to the area of the sinking stream catchment, AB, by $SINKL = 2.29\ AB^{0.85}$. Doline karst was measured by either the area of internal drainage into dolines, AD, or by the number of dolines, N, per unit area of carbonate rock. These measures are related by $AD = 0.0136\ N^{1.17}$. The frequency of occurrence of dolines falls off exponentially with depth independent of rock type or structural setting. Comparison of several measures of karst in relation to rock type shows smallest and fewest dolines in the Ordovician dolomites and an intermediate size and number in the Ordovician limestones. The largest and most numerous dolines occur in the flat-lying Mississippian limestones of the Appalachian Plateau. This result may be an expression of the more sluggish solution kinetics of dolomite compared to calcite.

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• 90410—"Eyed folds" in Precambrian marbles from southeastern Rajasthan, India.

*Dhruba Mukhopadhyay, Subhashish Sengupta, Department of Geology, Presidency College, Calcutta 700 073, India.* (8 p., 12 figs., 1 tbl.)

"Eyed folds"—acute domes and basins having elliptical cross sections and subparallel hinge lines at the two ends of the ellipses—on major and minor scales are common in the Precambrian marbles in part of southeastern Rajasthan, India. Closely associated with these structures are tight to isoclinal folds with rectilinear axes that are subparallel to the hinge lines of the "eyes." These structures belong to the first phase of deformation. A later cleavage cuts across them, and minor second-generation folds occur on the limbs of the earlier structures. Where the "eyed" structures are bent by later folds, a boomerang-shaped pattern results. The axes of the earlier and later folds are everywhere mutually parallel to subparallel, but their attitudes vary from one part of the area to another. It is suggested that the "eyes" and "boomerangs" of this area were not formed by the superposition of later shear folds on earlier folds having rectilinear axes, but, rather, the "eyed folds" were formed by strong flattening during later deformation of earlier folds having original plunge culminations and depressions. Buckling accompanying this later compression was responsible for the formation of the boomerangs. The strong compressive strain rotated all the linear elements toward the X-axis of the strain ellipsoid, and this explains the parallelism of the early and the late linear directions.

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• 90411—Distributional model for marine isopod crustaceans and its bearing on early Paleozoic paleozoogeography and continental drift.

*Michael E. Taylor, Richard M. Forester, U.S. Geological Survey, Denver Federal Center, Denver, Colorado 80225.* (9 p., 5 figs., 1 tbl.)

Multivariate analysis of Holocene marine isopod faunas from the Arctic, Antarctic, northwestern Atlantic, southeastern Pacific, and northwestern Pacific regions confirms that on a global scale, generic-level faunal resemblance is highest between cold-water biofacies regardless of water depth or latitude. In general, warm-water biofacies are most similar to each other and least similar to cold-water biofacies. These faunal trends are apparently related to the division of the present world oceans into two general thermal realms: the psychrosphere, consisting of cold high-latitude shallow waters and deep waters at all latitudes; and the thermosphere, consisting of mainly lower latitude warm waters and temperature-variable waters above the permanent thermocline. Analogous trends in faunal resemblance and distributional characteristics have been documented for some Late Cambrian trilobite faunas, and they probably also existed during other parts of the Cambrian and during at least some parts of the Ordovician. This suggests that a two-layered thermally stratified ocean may have existed during some parts of the early Paleozoic.

Regional trends in taxonomic resemblance during present thermal stratification of the world oceans suggest by analogy that early Paleozoic paleozoogeographic data are inconclusive for reconstruction of Paleozoic predrift continental positions. Concomitantly, taxonomic resemblance between early Paleozoic vagile benthic faunas cannot be used with complete fidelity to critically "test" continental reconstructions that have been based primarily on geological or geophysical evidence.

• 90412—Morphology and distribution of residual limestone hills (mogotes) in the karst of northern Puerto Rico: Discussion and reply. (3 p.)

Discussion: *Roy Charles McDonald, School of Geography, University of Oxford, Oxford, OX1 3TB, England.*
Reply: *Michael J. Day, Department of Geography, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.*



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