GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

NEWS FROM GSA DIVISIONS

GSA has seven specialty divisions, all of which prepare and publish newsletters paid for from their division dues. Much of the information contained in the newsletters is of interest to division members only, but, with the thought that some of the items are of general interest, here are a few excerpts from several recent issues.

John C. Frye, Executive Director

from the Engineering Geologist

EARTHQUAKE STUDIES AT THE WATERWAYS EXPERIMENT STATION

Research and advisory services for earthquake problems in the Corps of Engineers are largely centered at the U.S. Army Engineer Waterways Experiment Station (WES). WES also provides the Corps with publications, manuals, and training courses. The areas of work include geological and seismological studies, specification of time histories of earthquake shaking, values for recurrence, possible problems of induced seismicity from reservoir loading and fluid injection, effects of earthquake shaking on foundation soils, and the capacity of structures, chiefly major earth dams and concrete dams, to sustain shaking.

WES is contributing to current projects at the Passamaquoddy Tidal Power Project at Eastport, Maine, the Dickey-Lincoln School Dams on the St. John River in Maine, Richard B. Russell Dam on the Savannah River in Georgia-South Carolina, and Warm Springs Dam and Isabella Dam in California. Restudies are under way of the Alben Barkley Dam near Paducah, Kentucky, the Sardis Dam at Sardis, Mississippi, and Ririe Dam near Idaho Falls, Idaho. WES also is handling the geological-seismological studies for the Susitna Project in Alaska which will include two dams, one 700-ft and the other 800-ft high.

from the Geophysics Division

DIVISION SYMPOSIUM HIGHLY SUCCESSFUL

The division sponsored a highly successful symposium at the Seattle meeting, attended by over 1,000 members and participants. The organizers were Gordon P. Eaton, J. G. Souther, and Donald A. Swanson, with the topic "Cenozoic Tectonics and Regional Geophysics of Arc and Back-Arc Environments in the Pacific Northwest."

from the Archaeological Geology Division

CENTER FOR MATERIALS RESEARCH IN ARCHAEOLOGY AND ETHNOLOGY

The Center for Materials Research in Archaeology and Ethnology (CMRAE) is a new center established by nine educational, research, and cultural institutions in the Boston area. Its purpose is to encourage new directions for research in anthropology, archaeology, art history, and related disciplines by providing them with an expanded technical base in the sciences of organic and inorganic materials. Participating institutions are Boston University, Brandeis University, Harvard University, the University of Massachusetts, Massachusetts Institute of Technology, Museum of Fine Arts of Boston, Robert S. Peabody Foundation for Archaeology, Tufts University, and Wellesley College. M.I.T. has agreed to serve as the Center's coordinating institution. Heather Lechtman is Center Director in addition to maintaining her present responsibilities as associate professor of archaeology and ancient technology in the M.I.T. Departments of Humanities and of Materials Sciences and Engineering. Joel Orlen, executive officer in the Office of the Provost at M.I.T. will be executive officer of the Center.

from the History of Geology Division

U.S. NATIONAL COMMITTEE ON THE HISTORY OF GEOLOGY

The United States National Committee on the History of Geology was officially formed in 1974 with Dr. George W. White as President. The Committee is a sub-committee of the U.S. National Committee on Geology, operating under the aegis of the Department of the Interior and the National Academy of Sciences. The Committee includes geolo-

(continued on p. 666)

("History of Geology," *continued from p. 665)*
gists involved in the history of their subject and historians working primarily with Earth sciences.

The organization of the U.S. National Committee has as its purposes the forwarding of historical studies of geology within the United States and the representation of American scholarship on the international scene. We hope to compile and disseminate information on archives, work in progress, courses in the history of geology, and biographical data. The full participation of historians of science in these activities is highly desirable as a counterweight to the enthusiasms and disciplinary orientation of professional geologists. At the same time, we believe that historians will benefit by the corrective of closer acquaintance with scientists and contemporary geology.

Historians and geologists wishing to join the Committee should address Aurèle LaRocque, Chairman, Sub-Committee on Correspondents, briefly indicating their background and current interests. Cecil Schneer serves as Chairman of USHIGEO and Vice-President for North America of INHIGEO.

from the Hydrogeologist

BIRDSALL DISTINGUISHED LECTURER IN HYDROLOGY

The second Birdsall Distinguished Lecturer is Dr. William Back of the U.S. Geological Survey, Reston, Virginia. A firm itinerary for Dr. Back's lectures has not yet been established. However, the schools where he is slated to speak, together with the organizer at each institution, are as follows: University of Alabama (co-sponsor, Alabama Geological Survey; Thomas J. Joiner), University of South Florida (Richard A. Davis, Jr.), University of Illinois (Patrick A. Domenico), University of Missouri (John M. Sharp, Jr.), University of New Hampshire (Francis R. Hall), Texas Tech University (Warren W. Wood), University of Waterloo, Canada (John A. Cherry), and a five-school consortium composed of the University of Massachusetts, Amherst, Holyoke, Smith, and Hempshire (Ward S. Motts).

Dr. Back plans to give between two and four lectures and spend two or three days at each school. His lectures will center on the geochemistry of ground water and will include environmental problems related to the chemistry of ground water in limestone areas with emphasis on Yucatan Peninsula of Mexico, and a seminar to meet with hydrogeology students and others interested in discussing recent developments in the geochemistry of ground water. He also plans to lecture on hydrology and mythology in ancient America.

INTERNATIONAL HYDROLOGIC PROGRAM

David A. Stephenson has been named as the new GSA representative to the U.S. Committee on Scientific Hydrology, which coordinates U.S. activity in the International Hydrologic Program (IHP). He replaces Stanley N. Davis. The new alternate is Paul A. Witherspoon.

The Committee is currently working on program plans and identification of high priority areas for UNESCO funding for the second phase of the IHP. The second phase of the IHP is to emphasize education, especially training programs for developing countries, although the scientific programs are to be maintained also. A meeting of the Intergovernmental Council of IHP is to be held about January 1979 to finalize the plans. Stephenson plans to summarize activities of the U.S. National Committee at the Toronto business meeting.

Nominations Committee seeks suggestions

The Committee on Nominations seeks members' advice in one of the most important contributions that can be made to the health of the Society. Early in 1979, the committee will draw up a list of Members or Fellows whom they consider to be suitable replenishments for the gradually changing group that guides and manages the Society affairs. Their final lists will be presented to the Council in May. In its turn, the Council will decide on a slate of officers to be placed on the ballot for the fall election. Chances are that a single slate will be presented for vote of the membership, although write-in votes are encouraged and are always welcome. The single slate concept, however, is all the more reason why your advice is needed for the Committee on Nominations. Its members cannot possibly know all of the potential leaders of the Society—they need your help. Nominations are to be made for president (usually the incumbent vice-president), vice-president, treasurer, and four councilors.

All suggestions received by February 1, 1979, will receive careful consideration. Write directly to headquarters. Suggestions will be forwarded to the committee.

To ensure thorough consideration by the committee, please back up each suggested nomination with a brief biographical sketch and a summary of his or her chief contributions to geology.

Honors and Awards Committee solicits nominations for recipients

The Committee on Honors and Awards solicits your help in nominating potential recipients of GSA's highest honors—the Penrose Medal, the Day Medal, and Honorary Fellowship. The criteria for these honors are described in the booklet *Council Rules, Policies, and Procedures,* or you can get a good idea of the kinds of scientists who have been honored in the past by glancing at the lists on pages viii and x of your 1978 *Membership Directory*.

The deadline for receipt of nominations has not been established because of the restructuring of the subcommittees. We ask that you please send your documented nominations to headquarters where they will be held until the new deadline has been established. Those nominations arriving before the new deadline will be forwarded to the appropriate subcommittees; those arriving after the deadline will be held for the following year.

To ensure thorough consideration by the particular subcommittee, please back up each suggested nomination with a *brief biographical sketch* and a *summary of his or her chief contributions to geology*. In the case of the Penrose and Day Medals, a *selected bibliography* must accompany the nomination.

Please follow the same procedure for nominating your candidates for the National Medal of Science.

In answer to many inquiries . . .

Preparation of material and submittal of copy for GSA's Map and Chart series

General Instructions

Material intended for publication in the Map and Chart series must undergo the same critical review process as all other GSA publications. Two copies of the map and of any accompanying text should be mailed to the GSA Science Editor as a complete package.

Map Preparation

Maps should be prepared in as near final form as possible, with explanation, index map, and subordinate material in proper position, and with title, scale, and authors shown as anticipated for a final printed product. Maximum dimensions of paper stock are 42 x 58 in. (107 x 147 cm) with the map image no larger than 40 x 56 in. (102 x 142 cm). Note: Only the *form* need be "near final"; the drafting may be preliminary. Two copies of this product, one hand-colored if appropriate, should be submitted for review.

After review and acceptance, a copy of the map will be returned to the author for changes and corrections necessitated by review and for preparation of final copy suitable for reproduction. This work may be done by the author, by the author's institution, or, if desired, the work may be done at the author's expense by our map printer, Williams & Heintz Map Corporation in Washington, D.C. By Council ruling, authors must bear the total cost of art work through color separations. The Society will pay the cost of plates and printing.

At an advanced stage in preparation, a final proof of the map is sent to the author, which, after proofreading, he forwards to GSA. At that time, GSA inserts necessary marginal lines identifying the map as a GSA publication and prepares an envelope for the Map and Chart series.

Text Preparation

A publication in the Map and Chart series may be accompanied by a text. The author may choose one of the following options:

A. As many as 32 printed pages of text may be included in the envelope with the map. (Commonly an expanded explanation of only three or four printed pages is necessary to present details on correlations, contacts, structures, and the color, grain size, bedding, and fossils of mapped rock units.)

B. The text may be published on microfiche from author-prepared, camera-ready copy of 32 to 98 pages and may be included in the envelope with the map.

C. The text may be published simultaneously as a summary article in *Bulletin, Part I* (maximum of 2,000 words).

D. The text may be published simultaneously as a summary article in *Bulletin, Part I*, with the full-length article in *Bulletin, Part II* (should not exceed 98 pages of author-prepared, camera-ready copy).

E. The text may be published simultaneously as a Special Paper or Memoir.

The author must select which of the above options is most appropriate for publication of his material.

If the author chooses options A or B, he should follow the general instructions above.

If the author has a map or maps and a Special Paper or Memoir manuscript accepted under option E, he should follow the instructions for map preparation above and instructions for preparation of book manuscripts that will be provided by GSA.

Simultaneous Publication of Map and *Bulletin* Article

If the author chooses options C or D to accomplish simultaneous publication of a map in the Map and Chart series with the text in the *Bulletin, Part I* or *Part II*, or both, he should follow these procedures:

1. If the author chooses option C, he should (a) submit two copies of a preliminary draft of the map to the Science Editor and (b) two copies of the summary article for publication in *Bulletin, Part I.*
2. If the author chooses option D, he should (a) submit two copies of a preliminary draft of the map and (b) two copies of the summary for *Part I* and two copies of the complete article for *Part II.*
3. After review by GSA, all parts are returned to the author for revision as suggested by reviewers. The author then returns the revised version *or* revised manuscript to the Science Editor for final approval to publish. On notification of acceptance, the author (a) proceeds with the final preparation of the map, (b) retypes the manuscript for the microfiche publication in the *Bulletin, Part II* (format paper and instructions will be provided). If necessary, GSA will arrange for preparation of camera-ready copy with a commercial firm at about $2 per page; this expense must be borne by the author.
4. The author then returns his package for final editing and approval. The edited summary for *Part I* will be mailed to the author for his final approval, and galleys will be mailed to him for proofreading. If the camera-ready copy for duplication on microfiche in *Part II* does not meet GSA standards for publication, the copy will be sent back to the author for correction.
5. The month of simultaneous publication of map and article will be determined when the map has been printed and when the manuscript has been edited to make sure that clear reference is made to the map in the *Bulletin* article and listed in the References Cited section. All pieces will be interrelated by citations to the Map and Chart series number and the *Bulletin* parts.

Symposium on Rock Mechanics reported

The 19th Symposium on Rock Mechanics was held May 1–3, 1978, at Lake Tahoe, Nevada, and was sponsored by the Mackay School of Mines, University of Nevada. Preceding the symposium the U.S. National Committee for Rock Mechanics held its annual meeting.

The symposium was attended by more than 200 mining engineers and geologists concerned with surface and underground excavation, earthquake hazard reduction, and the interpretation and application of hydraulic fracturing. Principal symposium session topics were hydraulic fracturing, probabilistic approaches in rock mechanics, earthquakes and rock mechanics, underground excavation, fracture mechanics, and surface excavation. The recently increased interest in stress measurements using the hydrofracture technique was represented by 11 papers and 2 sessions. Geologists were involved as authors or contributed data to a majority of the 75 papers presented. Perhaps as a result of their involvement, in recent years these meetings have taken on a more applied, field-oriented aspect in contrast to dominantly theoretical or laboratory-based presentations of some earlier symposia. This greater emphasis upon the in situ behavior of natural rock masses has led to a dilemma that was expressed by several speakers; it is increasingly evident that existing rock-mechanics technology is limited by inadequate knowledge of the geologic and hydrologic properties that control rock-mass stability. Although assumptions of rock properties may hasten progress in analytical techniques, solutions so obtained do not appear in nature. However, as S. J. Green said in the opening address, representative in situ properties are difficult to obtain because of poor rock exposures and inhomogeneities in composition, structure, and in situ stresses. Attempts at precision lead to gaps in required results.

The recent report of the U.S. National Committee for Rock Mechanics, "Limitations of rock mechanics in energy-resource recovery and development," determined that the following rock mechanics problems critically limit energy-resource recovery and development: (1) Determination and prediction of porosity, permeability, and fluid flow in situ; (2) Development of better methods to obtain shallow and deep in situ stresses; (3) Mapping of fracture patterns, particularly major fractures and faults at depth; (4) Understanding the relation of laboratory-measured quantities to in situ conditions; (5) Research to provide thermophysical and thermomechanical properties of rock, including fractured rock; (6) Improvement of the understanding of rock-fragmentation processes for increasing the effectiveness of drilling and excavation systems.

The committee assigned greatest research importance to the identification and determination/quantification of significant rock properties, particularly rock-mass discontinuities on the scale of faults, shear zones, and folds.

This year the U.S. National Committee made five Best Paper awards, which were presented by W. R. Judd.

Basic Research: H. R. Pratt, H. S. Swolfs, A. D. Black, W. F. Brace, and J. W. Handin, "Elastic and transport properties of an in situ jointed granite"

Applied Research: D. C. Banks, W. E. Strohm, Jr., R. J. Lutton, and M. De Angulo, "Study of clay shale slopes along the Panama Canal: Engineering analyses of slides and strength properties of clay shale along the Gaillard Cut"

Student (M.S. or below): Gary Couples (Rice and Texas A&M), "Stress and shear fracture (fault) patterns resulting from a suite of complicated boundary conditions with application to the Wind River Mountains"

Student (Ph.D.): A. R. Ingraffea (Univ. of Colorado), "Discrete fracture propagation in rock: Laboratory tests and finite-element analysis"

Student (Ph.D.): P. N. Sundaram (Univ. of California, Berkeley), "Water pressure and resistivity changes during stick-slip and stable sliding in direct shear of rock surfaces"

Fitzhugh T. Lee
GSA Representative,
U.S. National Committee for Rock Mechanics

AAAS to conduct inventory of programs for women and girls

The National Science Foundation has asked the American Association for the Advancement of Science to survey programs in science for women and girls. The results will appear in a publication that describes all efforts made between 1966 and the present to improve the science, mathematics, and engineering education of girls and women in the United States and to increase their participation in science-related careers.

Programs directed at any age level will be eligible for inclusion, as will work conducted by any type of organization or agency. Projects of direct benefit to women and girls and research on the topic will be surveyed.

Persons who know of projects that might be within the scope of this inventory are asked to contact Dr. Michele L. Aldrich, OOS-AAAS, 1776 Massachusetts Avenue N.W., Washington, D.C. 20036 (202) 467-5431.

CORDILLERAN SECTION

WRONG NUMBER!

The correct number for Mary Hill, Program Chairman,

is **415-323-8111, ext. 2953.**

COCORP data on Southwestern Wyoming now available

The data packages for three seismic lines that were run in the Wind River uplift area of Wyoming are now available for the cost of reproduction and shipping. These data were obtained by the Consortium for Continental Reflection Profiling. COCORP applies sophisticated, continuous, seismic-reflection techniques to the solution of geologic problems of the crust and upper mantle of the Earth (see, for example, article by Smithson and others, p. 648 in the November 1978 issue of *Geology*). The operation is part of the U.S. Geodynamics Project sponsored by the National academy of Sciences and funded by the National Science Foundation. The executive committee of the Consortium consists of members from Cornell University, the University of Houston, Princeton University, the University of Texas at Austin, the University of Wisconsin, and Shell Oil Company. Cornell University has the operational responsibility.

Three lines totaling a coverage of 160 km were run. Line 1 was obtained using a 48-channel MDS-8 system with a station spacing of 134 m; lines 1A and 2 were obtained using a 96-channel MDS-10 system with station spacings of 100 m. Data sampling was at 8-ms intervals, and the receiver arrays consisted of 24 geophones per station. The source array consisted of five vibrators operated in-line with move-up arranged so that 16 stages across the station interval were summed to form each record, and arranged so that 24-fold data resulted. The vibrator pilot was an 8- to 32-Hz linear upsweep of 30-s duration, and the recording duration was 50 s.

The procedure to obtain the data, either sections or magnetic tapes, is as follows: (1) Indicate in writing which items are desired. Address your letter to Professor S. Kaufman, Department of Geological Sciences, Cornell University, Ithaca, NY 14853. Do *not* send payment. (2) In response to your letter, a formal "Authorization for Purchase" will be sent to you. (3) Forward the authorization to the contractor in the manner indicated on the authorization, together with your purchase order.

I. Basic display package of 14 prints for $45, consisting of location maps, isovelocity plots for each of the three lines, and CDP stacked prints of each line at each of the following scales: (a) horizontally 5.6 cm = 3 km, and vertically, 5.6 cm = 1 s of two-way traveltime; (b) horizontally 2.8 cm = 3 km, and vertically 2.8 cm = 1 s of two-way traveltime; (c) horizontally 2.5 cm = 1 km, and vertically 2 cm = 1 s of two-way traveltime. The processing sequence has been the following: demultiplex, correlation, sorting, velocity-analysis scans at approximately 1.6-km intervals, constant velocity stacks, NMO correction, mute, automatic residual statics, 24-fold CDP stacking, predictive deconvolution, time-varying filtering, AGC, and datum-plane correction.

II. The number of reels of digital tapes available at $35 per reel, including the ½ in. 2,400 ft copy reel, is given in the following table:

	Field	Correlated	Stack (1)	Stack (2)
Line 1	16	8	1	1
Line 1A	23	10	1	1
Line 2	20	8	1	1

Stack (1) is a true amplitude stack with no automatic residual statics or AGC applied; stack (2) has automatic residual statics and AGC applied. Writing density is 1,600 bpi. The format for the field tapes is SEG-B; the other processed tapes are SEG-X. Data values are in IBM (short) floating point notation.

Cornell University is required to maintain a repository for all aspects of COCORP operations. We therefore request all recipients to furnish us with any nonproprietary results of their use of the data, including write-ups, reports, and reprints of published articles.

Several papers (5) concerned with different aspects of the Wyoming work have been drafted and submitted to several publications. A paper titled "Nature of the Wind River Thrust, Wyoming, from COCORP Deep-Reflection Data and from Gravity Data," by Smithson and others, is in the November 1978 issue of *Geology*, pages 648 to 652.

S. Kaufman
Cornell University

Nominations for Cady Award accepted through January 15, 1979

Nominations for the 1979 Gilbert H. Cady Award, sponsored by the Coal Division of the Geological Society of America, will be accepted through January 15, 1979.

Individuals nominated should have made significant contributions to coal geology defined as "knowledge concerning origin, occurrence, relationships and geologic characteristics of the many varieties of coal and associated rocks including economic implications." The award is intended to honor outstanding contributors to coal geology of North America but is not restricted to North American scientists.

Letters and documents of nomination should be in quintuplicate and consist of professional vita and bibliography of the nominee, together with supporting letters from the sponsor or sponsors. Dossiers and any requests for supplemental information should be addressed to E. C. Dapples, Department of Geological Sciences, Northwestern University, Evanston, Illinois 60201.

To authors writing for *Geology*: New instructions for sizing tables

To simplify typing tables for *Geology* articles, the following instructions have been compiled by GSA staff editors:

1. All tables in any given paper must be reducible at the same percent.

2. If a table contains small subscripts or superscripts or lower-case italics (other than *Note*), the reduction should be 65%.

3. If there are no small letters or numbers (that is, less than 6 points in height—the height of the lower-case Letter Gothic "a" or "z"), the reduction should be 50%.

4. To avoid the 65% reduction, large subscripts and superscripts (that is, normal-sized typewriter numbers) may be used. Roman instead of italics may be used for centered or flush-left divisions of the table body. Allow one line space above and one-half line space below such "internal headings."

5. Italics should be used for genus and species; thus, the 65% reduction is required because IBM does not have a large italics font for the Selectric.

6. The following table gives typing widths in inches, for both reductions:

	Reduction at 50%	Reduction at 65%
For one-third page width (14 picas) type on	4 5/8" width	3 9/16" width
For two-thirds page width (29 picas) type on	9 5/8"	7 3/8"
For full-page width (44 picas) type on	14 5/8"	11 3/16"
For half-page width (21.5 picas) type on	7 1/8"	5 1/2"

Procedures for ordering books and maps

The following procedures are enumerated for your convenience:

1. PAYMENT MUST ACCOMPANY ALL ORDERS that total less than $25.00 and that originate within North America (U.S.A., Canada, Mexico) and possessions of the U.S.A.

2. PAYMENT MUST ACCOMPANY ALL ORDERS that originate from outside North America and possessions of the U.S.A. Orders that originate in Continental Europe must continue to be sent to the Society's exclusive distributor: Office International de Librairie, Avenue Marnix 30, B1050 Brussels.

3. Orders for more than $25.00 that originate in North America and possessions of the U.S.A. will be accepted for 30-day billing. Postage and handling charges will be added to invoices. The Society reserves the right to limit credit to organizations and individuals with established lines of credit.

4. ALL *Fellows, Members,* and *Student Associates* must send their orders to Boulder and must compute and deduct the membership discount. Discounts will not be allowed unless claimed. Member discount is stated on the reverse side of the membership card.

5. All payments must be in US funds (check or draft, money order, UNESCO coupons).

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:

Harold MacColl Bannerman	by W. H. Bradley
Leslie Madison Clark	by E. W. Shaw
Lincoln Dryden	by W. C. Krumbein
Arthur Earl Fath	by Walter Small
Richard Foster Flint	by Stephen C. Porter
Roald Hilding Fryxell	by Friends of Roald Fryxell
Richard Eugene Fuller	by Julian D. Barksdale
Ansel Miller Gooding	by Charles W. Martin, Ronald O. Kapp, and William J. Wayne
Marjorie Hooker	by Anna Jesperson
Benjamin Franklin Howell	by Erling Dorf
Gerald Elgin Knowles	by Mason L. Hill
Phillip H. Kuenen	by Francis Shepard
George Burke Maxey	by Davis A. Stephenson
Frank Albert Morgan	by Mason L. Hill
William Charles Rasmussen	by Henry C. Barksdale
Eugene C. Reed	by V. H. Dreeszen
William Low Russell	by Robert J. Stanton, Jr.
John Roy Sandidge	by Samuel P. Ellison, Jr.
Ned Myron Smith	by M. Wm. Pullen and Ted V. Jennings
Eugene J. Szmuc	by Rodney Feldman
Martin Van Couvering	by Frank B. Conselman
Raymond E. Whitla	by W. Harold Stuart
Eugene J. Wilson	by Robert M. Kleinpell
Monta Eldo Wing	by David M. Delo

PRELIMINARY ANNOUNCEMENT AND CALL FOR PAPERS

ROCKY MOUNTAIN SECTION, GSA, 32nd Annual Meeting Fort Collins, Colorado, May 24–25, 1979

The Department of Earth Resources at Colorado State University in Fort Collins, Colorado, will host the 32nd Annual Meeting of the Rocky Mountain Section of the Geological Society of America on May 24 and 25, 1979.

CALL FOR PAPERS. Papers of general interest to the Western U.S. are solicited. Papers will be allowed 15 minutes for presentation and 5 minutes for discussion.

TECHNICAL SESSIONS will be held on Thursday and Friday, May 24 and 25.

SYMPOSIA: (1) U.S. Geological Survey Centennial (W. R. Hansen). This symposium will review historical, present, and future roles of the U.S. Geological Survey as viewed in its centennial year. (2) Geologic Hazards (John Rold). (3) Fluvial Sediments: Transport and Deposition (S. A. Schumm).

FIELD TRIPS: All field trips are post meeting. (1) Sedimentology and stratigraphy of selected Paleozoic and Mesozoic sequences: Northwest Denver Basin; May 26 and 27, 1979. Field trip leaders: A. Berman, T. Jackson, R. Shepard, and W. Wescott. (2) Glacial and fluvial Quaternary stratigraphy of the St. Vrain drainage basin, east slope Front Range; May 26, 1979. Field trip leaders: R. F. Madole and R. R. Shroba. (3) Structural relations, metamorphic grade and intrusive rocks: Big Thompson Canyon, Poudre Canyon, and Virginia Dale areas; May 26 and 27, 1979. Field trip leader: W. A. Braddock. (4) State Line kimberlites; May 26, 1979. Field trip leaders: M. McCallum and D. Eggler. (5) The Big Thompson flood and the recovery; May 26, 1979. Field trip leaders: D. Doehring and J. Dolson.

ABSTRACTS, which are limited to 250 words, *must* be submitted camera-ready on official abstract forms available from

Tommy B. Thompson
Program Chairman
Department of Earth Resources
Colorado State University
Fort Collins, CO 80523
(303) 491-5430

OR

Abstracts Coordinator
Geological Society of America
3300 Penrose Place
Boulder, CO 80301
(303) 447-2020

ABSTRACTS ARE DUE December 21, 1978. Acceptance or rejection of abstracts will be based on at least one outside review. There will be no opportunity to revise abstracts. The abstracts will be returned to the Program Committee as acceptable, marginal, or unacceptable. Guidelines for review are as follows (in order of importance): (1) If majority of information has been presented at another professional meeting, abstract will be rejected. (2) Abstract should be informative (see Landes, 1966, AAPG Bull., v. 50, p. 1992). (3) Data should be reliable and conclusions should be reasonable. (4) Data should be of interest to members of the Rocky Mountain Section.

The Program Committee will review all abstracts marked "marginal" or "unacceptable" for final decision of acceptablility. Only two abstracts will be accepted from any one author or coauthor.

Send one original and four copies to:

Tommy B. Thompson
Program Chairman
Department of Earth Resources
Colorado State University
Fort Collins, CO 80523
(303) 491-5430

PROJECTION EQUIPMENT. All slides must be 2" x 2" and fit in a standard 35-mm carousel projector. Dual projectors will not be available. Movies are acceptable, but request for projection equipment must be made on the abstract form.

STUDENT AWARDS. Student papers are strongly encouraged, and awards will be made to students presenting the most outstanding papers. Student papers should be clearly indicated as such and should be authored exclusively by students.

DETAILED INFORMATION concerning registration, motel accommodations, and other activities will appear in a later issue of *GSA News and Information* and as a part of the *Abstracts with Programs* for 1979.

CALENDAR OF SECTION MEETINGS FOR 1979

NORTHEASTERN
Hershey Motor Lodge, Hershey, PA
March 1-3, 1979
Abstract Deadline: November 1, 1978

SOUTH-CENTRAL
Folk Center, Mountain View, AR
April 9-10, 1979
Abstract Deadline: November 17, 1978

CORDILLERAN
San Jose State University, San Jose, CA
April 9-11, 1979
Abstract Deadline: November 9, 1978

SOUTHEASTERN
Virginia Polytech. Inst. and State Univ., Blacksburg, VA, April 26-27, 1979
Abstract Deadline: December 7, 1978

NORTH-CENTRAL
Normandy Inn, Duluth, MN
May 10-11, 1979
Abstract Deadline: December 21, 1978

ROCKY MOUNTAIN
Colorado State University, Fort Collins, CO, May 24-25, 1979
Abstract Deadline: December 21, 1978

Antler orogeny, topic of Penrose Conference in September 1979

A Penrose Conference on the "Antler orogeny—Mid-Paleozoic tectonism in western North America," sponsored by the Geological Society of America, will be held in Idaho or Nevada from September 9 to 15, 1979, Conveners of the conference are Tor H. Nilsen and John H. Stewart, U.S. Geological Survey, Menlo Park, California.

First recognized in Nevada about 25 years ago, the Antler orogeny has been the subject of numerous studies by workers in Alaska, western Canada, the western United States, Mexico, and Central America. Sedimentologists, structural geologists, paleontologists, field mappers, stratigraphers, geophysicists, and historical geologists have all examined various aspects of the orogeny. However, the orogeny has not been fully or satisfactorily explained in terms of either modern plate tectonics or more classical geosynclinal theory. Particularly puzzling is the relative synchroneity of the orogeny from Alaska to Central America. In addition, the well-documented eastward-directed overthrusts of siliceous oceanic sedimentary rocks over carbonate shelf rocks in the western United States, amounting to more than 100 km of movement without major igneous activity or thermal events, has not been satisfactorily explained. The conference will bring workers from Alaska, Canada, the western United States, Mexico, and Central America together for a long-needed exchange of ideas and information. Sessions being planned include (1) mid-Paleozoic geology and paleogeography of western North America and Central America before, during, and after the Antler orogeny; (2) structural analyses and studies of the Antler orogenic belt; (3) sedimentology of Antler flysch and related deposits; (4) interpretation of the Antler orogeny in terms of classical geosynclinal theory and plate tectonics; and (5) paleobiogeographic effects of the orogeny.

Four days will be occupied with discussions, and emphasis will be placed on informal communication at meetings of both the entire group and smaller working groups. The type area of the Antler orogeny in Nevada will be examined during a two-day field trip, which will focus on study of overthrust lower Paleozoic oceanic deposits and postorogenic flysch sequences. A one-day field trip will examine Antler flysch in the Sun Valley area (only if the meeting is held in Sun Valley).

The registration fee will be approximately $300 per person, which will include lodging, meals, and field trip. Attendance will be limited to 50 persons. Application deadline is June 1, 1979. If you are interested in attending this conference, please write to the conveners.

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Coal Resources of the Americas: Selected Papers

SPECIAL PAPER 179 — Edited by Frank E. Kottlowski, Aureal T. Cross, and A. A. Meyerhoff. 1978. vi + 90 pages, 67 figures, 48 tables. ISBN: 0-8137-2179-2. $13.00.

This new publication provides an introduction to, a summary of, and an update of information available on coal in Central and South America. It contains many informative maps, stratigraphic sections, structural sections, and tables of analytical data.

Interest in the coal of Central and South America has increased substantially in recent years, and this has led to expanded programs of geologic mapping and exploratory drilling in areas of coal-bearing rock. Much of the new information is not readily available to English-speaking and -reading geologists. To supply this information in compact form, the editors of this newly published volume have assembled 9 papers on coal in 15 countries of Central and South America, prepared by national coal specialists, and a related paper on the utilization of lignite in the United States, prepared by a technical specialist on this subject. The 10 papers were presented originally in Mexico City at the 1968 annual meeting of the Geological Society of America. They were subsequently revised, and those in Spanish and Portuguese translated into English. Most of the countries of Central and South America contain small to modest deposits of coal that range in rank from lignite to anthracite. The largest and best-known deposits are in Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela.

In Brazil and Mexico, much of the coal is flat-lying or gently dipping, and because of this favorable geologic setting, more is known about the coal, mining is facilitated, and the two countries are leaders in coal production. In Brazil, annual production is 5 to 6 million metric tons; in Mexico, it is 4 to 5 million metric tons.

In other countries, except for local deposits of Tertiary lignite, the coal beds are commonly folded, faulted, and locally intruded by igneous rocks associated with the Andean uplift. In these more complex geologic settings, knowledge of the coal deposits is less far advanced, mining is more difficult, and production levels are lower. In Colombia, annual production is about 3 million metric tons; in Chile, 1 to 2 million metric tons; and in Argentina, Peru, and Venezuela, the annual production for each country is less than 1 million metric tons.

This book should be of interest to geologists, mining engineers, and anyone concerned with industrial development in Central and South America.

CONTENTS: Introduction: Frank E. Kottlowski, Aureal T. Cross, A. A. Meyerhoff. Chilean, Argentine, and Bolivian coals: Hector Flores-Williams. Coal resources of the Argentine Republic: Federico A.J. Bergmann. Coal in Brazil: Eurico Rômulo Machado. Coal resources of Peru: C. Richard Petersen. Coal basins of Ecuador: J. E. O'Rourke. Coal deposits in Colombia: Dario Suescún-Gomez. Supplementary bibliography on coal in Colombia: Compilers, E. R. Landis and Paul Averitt. Coal deposits of Latin America: Wilds W. Olive. Coal resources in Central America: Otto H. Bohnenberger and Gabriel Dengo. Main coal regions of Mexico: Jesús Ojeda-Rivera. Utilization of lignite in the United States: T. Reed Scollon and Eugene T. Sheridan.

Laramide folding associated with basement block faulting in the western United States

MEMOIR 151 — Edited by Vincent Matthews III. 1978. vi + 370 pages, 228 figures, 6 tables. ISBN: 0-8137-1151-7. $46.75.

Most of the Laramide structures in the Rocky Mountains and adjoining regions are interpreted as drape (or forced) folds imposed on ductile sedimentary rocks by differential uplift of underlying brittle blocks of the older structural basement. This mechanism and alternatives are presented in 16 individual papers that comprise this newly published volume.

The introductory paper, by D. W. Stearns, is a review of recent and current research on the concept of forced folding. Specific examples of forced folding in Arizona, Utah, Colorado, Wyoming, and South Dakota, are discussed in seven papers: G. H. Davis; R. A. Cook; V. Matthews III and D. F. Work; M. T. Stearns and D. W. Stearns; J. C. Palmquist; J. E. McClurg and V. Matthews III; and A. L. Lisenbee. Experiments in which drape folds have been simulated in the laboratory are reported in two papers: one by G. H. Davis and the other by J. M. Logan, M. Friedman, and M. T. Stearns. New theoretical analyses of the forced fold mechanism are presented in three papers: Z. Reches and A. M. Johnson, G. Couples, and G. Couples and D. W. Stearns. The contrast in kinematics between Paleozoic and Mesozoic strata in forced folds is discussed by D. M. Weinberg. The seismic evidence for forced folds in the subsurface of Wyoming is presented by W. R. Sacrison. And, for a change in point of view, Z. Reches presents evidence that a monocline in the Grand Canyon is in part, at least, a buckle fold rather than a pure drape fold. In the concluding paper, W. R. Dickinson and W. S. Snyder suggest that Laramide-type structures may be produced by an abnormally shallow angular relation between the subducted plate and the overlying plate.

CONTENTS: Preface. Faulting and forced folding in the Rocky Mountains foreland: David W. Stearns. Seismic interpretation of basement block faults and associated deformation: W. R. Sacrison. Some two-dimensional kinematic analyses of the drape-fold concept: David M. Weinberg. Experimental folding of rocks under confining pressure: Part VI. Further studies of faulted drape folds: John M. Logan, M. Friedman, and M. T. Stearns. Laramide folding associated with basement block faulting along the northeastern flank of the Front Range, Colo-

rado: Vincent Matthews III and David F. Work. Laramide structures and basement block faulting: Two examples from the Big Horn Mountains, Wyoming: John C. Palmquist. Geometric analysis of multiple drape folds along the northwest Big Horn Mountains front, Wyoming: Martha Tirey Stearns and David W. Stearns. Origin of Elk Mountain anticline, Wyoming: James E. McClurg and Vincent Matthews III. Laramide structure of the Black Hills uplift, South Dakota–Wyoming–Montana: Alvis L. Lisenbee. A relationship between strike-slip faults and the process of drape folding of layered rocks: Robert A. Cook. Monocline fold pattern of the Colorado Plateau: George H. Davis. Development of monoclines: Part I. Structure of the Palisades Creek branch of the East Kaibab monocline, Grand Canyon, Arizona: Ze'ev Reches. Development of monoclines: Part II. Theoretical analysis of monoclines: Ze'ev Reches and Arvid M. Johnson. Analytical solutions applied to structures of the Rocky Mountains foreland on local and regional scales: Gary Couples and David W. Stearns. Comments on applications of boundary-value analyses of structures of the Rocky Mountains foreland: Gary Couples. Plate tectonics of the Laramide orogeny: William R. Dickinson and Walter S. Snyder. Index.

French-American Mid-Ocean Undersea Study (FAMOUS): Multi-Beam Sonar Study of the Mid-Atlantic Ridge Rift Valley, 36°–37° N.

MC-19 — Compiled by Joseph D. Phillips and Henry S. Flemming. Four black and white maps: I, Transform Fault A, 53½″ × 32″; II, North FAMOUS AB Rift Valley, 36″ × 57″; III, Tranform Fault B, 50″ × 35″; IV, South FAMOUS BC Rift Valley, 39″ × 45″. Scale, 1:36,457. Source and reliability of the data are shown on the back of each map. Accompanied by 24 pages of explanatory text, maps, and figures. Folded: $9.00; rolled: $10.00.

The Mid-Atlantic rift valley and surrounding areas are shown in extraordinary detail on four maps covering the FAMOUS area (French-American Mid-Ocean Undersea Study) south of the Azores Islands Triple Junction between 36° and 37° north latitude. The maps were prepared from data obtained mainly through use of the SONARRAY (sonar array) multi-beam echo-sounding system developed for the U.S. Naval Oceanographic Office. The SONARRAY system permits charting of bathymetric features with relief measured in tens of metres in very deep water over very large areas in a very short time. The data used in preparing these four maps were obtained in three days of ship time.

The new charts show several distinctive topographic features: (1) linear hills of low-relief (≈100-m elevation) form the inner floor of the rift valley; (2) narrow (≈1-km) flat-topped terraces and benches with outward-facing antithetic scarps characterize the median rift walls; (3) quasi-circular (≈ 10-km diameter) nodal basins occur at the intersections of the transform faults with the median rift valley; and (4) narrow (≈ 2-km) trough and ridge lineaments found along the transform rift valley floors probably mark the site of recent horizontal faulting.

These maps are a fundamental part of a series on the scientific results of Project FAMOUS. Other articles in this series appear in the April and May 1977 issues of the *Geological Society of America Bulletin*, v. 88, no. 4 and 5.

November BULLETIN briefs

Brief summaries of articles in the November 1978 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.*

• 81101—A large landslide on Mars.

B. K. Lucchitta, U.S. Geological Survey, Geologic Division, Branch of Astrogeologic Studies, Flagstaff, Arizona 86001. (9 p., 5 figs., 2 tbls.)

A large landslide deposit on the south wall of Gangis Chasma contains at least 100 billion m^3 of material that moved 60 km across the trough floor at a speed of more than 100 km/hr. The deposit consists of slump blocks at the head, hummocky material farther out, and a vast apron of longitudinally ridged material extending to the toe. The landslide deposit resembles many terrestrial ones but is much larger, and differs from most in having longitudinal rather than transverse ridges on its surface. However, some terrestrial landslides also have longitudinal ridges, particularly those in Alaska that traveled long distances over glacial ice and thus were highly efficient. In order to explain this high efficiency, two possible mechanisms of emplacement are singled out. The first involves a sliding motion on a cushion of air; on Mars, this implies a once much denser atmosphere, or the release of a gas, possibly steam. The second mechanism involves a flow motion of debris that is lubricated by some water; on Mars, the water may have come from ice in the source rock. An analysis of the possible causes for the Martian slide shows that the Martian trough walls are highly susceptible to sliding, and that the landslide may have been triggered by a Mars quake.

• 81102—Fault mechanism and recurrence time of major earthquakes in southern Kanto district, Japan, as deduced from coastal terrace data.

Tokihiko Matsuda, Earthquake Research Institute, University of Tokyo, Tokyo, Japan; Yoko Ota, Department of Geography, Yokohama National University, Yokohama, Kanagawa, Japan; Masataka Ando, U.S. Geological Survey, Menlo Park, California 94025 (present address: Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto, Japan); Nobuyuki Yonekura, Department of Geography, University of Tokyo, Tokyo, Japan. (9 p., 12 figs., 1 tbl.)

The southern Kanto region has had two shocks of magnitude 8 or greater during the past 1,000 yr. They were the 1703 and 1923 earthquakes, which occurred along the Sagami trough, a northeastern boundary of the Philippine Sea crustal plate in contact with the Asian plate. Although they occurred in nearly the same region, the 1703 earthquake was significantly different from the 1923 earthquake in the distribution of coastal uplift and tsunami height. The 1703 earthquake deformation is described on the basis of the height of the marine terraces along the coast of the southern Kanto region.

The 1703 earthquake is interpreted, as is the 1923 earthquake, as the result of low-angle right-lateral faulting with a thrust component at the plate boundary. However, the fault surface in 1703 was longer (about 200 km) and was located farther east than that of the 1923 earthquake. On the basis of the pattern of coastal uplift and the trend of the Sagami trough, the fault surface of the 1703 earthquake can be divided into three planes, which involve the eastern part of the source region of the 1923 earthquake to the west (plane A), the Kamogawa submarine cliff in the middle (plane B), and a segment near the source region of the 1953 Boso-Oki earthquake (M = 8.0) to the east (plane C).

The Boso and Miura Peninsulas in the southern Kanto region have been uplifted during at least the last 6,000 yr, and major uplifts have been accompanied by earthquakes like those of 1703 and 1923 many times. The recurrence time of similar uplifts is estimated at 800 to 1,500 yr, on the basis of the numbers of the uplifted Holocene terraces in the Boso Peninsula, the rate of upheaval during the last 6,000 yr, and the present geodetic data. Thus, it is unlikely that major earthquakes such as the 1703 and 1923 earthquakes will occur in the same segments in the near future. The Oiso area, however, which is located west of the western end of the 1703 faulting, seems higher in seismic risk than the other parts of the Sagami trough fault, because the sum of the recent uplift in the 1703 and 1923 earthquakes in that area is significantly less than the average rate of uplift there during the past 6,000 yr.

• 81103—Separation of primary ice-rafted debris from lag deposits, utilizing manganese micronodule accumulation rates in abyssal sediments of the Southern Ocean.

Michael T. Ledbetter, Norman D. Watkins, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881 (Watkins, deceased). (11 p., 10 figs., 3 tbls.)

Changes in the abundance of ice-rafted debris in abyssal sediments of the Southern Ocean have been interpreted as evidence of variations in Antarctic glacial activity. When accompanied by a simultaneous increase in Mn micronodules, however, it is proposed that ice-rafted debris maxima may represent residual lag deposits, created during a period of reduced sedimentation rate caused by selective removal of the finer or lighter fraction by high-velocity bottom currents.

An empirical relationship between ice-rafted debris and Mn micronodules in the southeast Pacific Ocean has been used to suppress the lag component in the total ice-rafted debris signal in order to isolate the ice-rafted debris caused by increased iceberg supply associated with increases in glacial activity in Antarctica.

The spatial distribution of the mean accumulation rate of ice-rafted debris during the past 690,000 yr is complicated by local bottom-scouring activity, which causes erratic latitudinal variations of total ice-rafted debris accumulation rates. When the residual portion of ice-rafted debris is removed, a coherent latitudinal decrease of the mean accumulation rate of debris is revealed. The average northern limit of debris during the past 690,000 yr is not different from present conditions. A sharp maximum in debris accumulation occurs in the vicinity of the present Antarctic convergence, suggesting that the factors governing iceberg supply and melting rate have not changed appreciably during the period involved.

Six periods of increases in Mn micronodule production are defined at intervals of 100,000 to 110,000 ± 20,000 yr. The linear correlation coefficient between ice-rafted debris and Mn micronodules during the past 690,000 yr defines two areas of intense winnowing, separated by the East Pacific Rise. The southernmost zone corresponds to an area independently described as one of high bottom-current activity. Our results indicate that the intensity of bottom-current winnowing on the north flank of the East Pacific Rise may be as great as in the southern zone. This could mean that the Eltanin Fracture Zone serves as a conduit for high-velocity Antarctic Bottom Water flowing onto the northern flank of the East Pacific Rise.

• 81104—Pliocene-Pleistocene emergence of the Moroccan Meseta.

Charles E. Stearns, Department of Geology, Tufts University, Medford, Massachusetts 02155. (15 p., 11 figs.)

The Atlantic coast of Morocco is extensively veneered by littoral marine-eolian calcarenite. Modified littoral dune ridges mark successive strandline positions occupied during progressive emergence since late Miocene time. Principal strandline deposits are mildly transgressive, recording fluctuations in general sea level. Comparisons with Mediterranean chronology set general limits to local rates of emergence. On some transects, rates may have been uniform during the past 3 m.y.—for example, Casablanca, 0.065 m/1,000 yr, and Rabat, 0.053 m/1,000 yr.

Ages of strandlines derived by interpolation, based on the assumptions of uniform rates of emergence and of

uniform heights of sea-level maxima, are in broad and some detailed agreement with ages of O^{18} minima in deep-sea cores. The degree of correspondence encourages confidence in the initial assumptions.

Moghrebian (early Pliocene, 4.2 to ? m.y. ago), Fouaratian (late Pliocene, 2.8 to 2.4 m.y. ago), and Messaoudian (Calabrian, 1.8 to 1.1 m.y. ago) stages were sustained intervals of high sea level. Each was transgressive—that is, each was preceded by one of three Pliocene intervals of low sea level, presumably reflecting expanded continental ice sheets. Disconformities within Fouaratian and Messaoudian stages reflect smaller fluctuations of sea level, with a periodicity of about 0.2 m.y.

Quarry exposures in a small area southwest of Casablanca allow distinction of at least nine transgressive "cycles" during the past 1 m.y. The implied period of fluctuation is about half that during the Fouaratian and Messaoudian stages; amplitudes are presumably greater. Strandlines marking sea-level peaks between the first, Maarifian, and the sixth, Anfatian, are now as low as or lower than during the early part of the Anfatian cycle. They indicate that "interglacial" sea levels fell short of present sea level during a late Matuyama–early Brunhes interval (0.8 to 0.6 m.y. ago). Correlative features will not ordinarily be recognized on coasts with low rates of emergence.

• 81105—Distribution, orientations, and ages of mafic dikes in central New England.

J. Gregory McHone, Department of Geology, University of North Carolina, Chapel Hill, North Carolina 27514. (11 p., 5 figs., 3 tbls.)

Geometric data from more than 1,100 localities and 13 radiometric ages have been compiled and measured for postmetamorphic dikes in eastern New York, Vermont, New Hampshire, western Maine, and southern Quebec. Alkalic lamprophyres (monchiquite and camptonite) in Vermont and Quebec form three westward-trending lobate swarms. The northernmost lobe envelops the Monteregian Hills of Quebec, the central lobe crosses the central Lake Champlain Valley into the eastern Adirondacks, and the southernmost lobe crosses the northern Taconic Mountains into New York. These lobes extend from central New England, where numerous alkalic lamprophyre, spessartite, and diabase dikes were intruded in several episodes and orientations during Mesozoic time.

Most of the monchiquite dikes are found in the Monteregian and Champlain areas, and with associated camptonite dikes intruded west-northwest– to east-trending regional fractures during Early Cretaceous time. Alkalic lamprophyres of this episode can also be found in New Hampshire and Maine. Most diabase dikes are found east of central Vermont, where they intruded northeast-trending fractures during Late Triassic to Early Jurassic time. Many camptonite and some spessartite dikes in eastern New England and the Taconics lobe have northeast trends and may also be of Early Jurassic age.

Extensional stress directions in the New England crust shifted from northwest to north or north-northeast between Early Jurassic and Early Cretaceous time, as inferred from dike trends. The dikes may delineate extensional fracture zones that also controlled the emplacement of Mesozoic plutons in Quebec and New England.

• 81106—Seismic trends and travel-time residuals in eastern North America and their tectonic implications.

Jon B. Fletcher, Lamont-Doherty Geological Observatory, Palisades, New York 10964 and Department of Geological Sciences, Columbia University, New York, New York 10027 (present address: U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025); Marc L. Sbar, Lamont-Doherty Geological Observatory, Palisades, New York 10964 (present address: Department of Geosciences, University of Arizona, Tucson, Arizona 85721); Lynn R. Sykes, Lamont-Doherty Geological Observatory, Palisades, New York 10964 and Department of Geological Sciences, Columbia University, New York, New York 10027. (21 p., 10 figs.)

The crust and upper mantle beneath four major seismic zones—Boston-Ottawa, Charleston-Cumberland, Grand Banks, and New Madrid—are compared with that of surrounding areas by examining differences in travel-time residuals for *P* waves from large nuclear explosions at teleseismic distances, geologic features, particularly the distribution of Mesozoic structures and igneous rocks that postdate the initial opening of the Atlantic Ocean, and other geophysical data. Many, but not all, of the larger historic earthquakes located east of the Rocky Mountains occurred in these zones, which are a few hundred kilometres wide, and do not appear to be related to single through-going faults; hence, their locations may be governed by deep-seated structures. A zone of early *P*-wave arrivals (negative travel-time residuals) is found in northern New York, in Canada along the St. Lawrence Valley from Ottawa to Seven Falls, Quebec, and in central Vermont. The anomaly, which is between -0.6 and -1.5 s for sources to the northwest, indicates that appreciable differences in seismic velocity (and presumably in petrology) extend into at least the uppermost mantle. This difference, which cannot be attributed to reading errors, is found at nine stations and is nearly as large as that between stations in the eastern and western United States. This negative anomaly may be caused by ultramafic rocks in the crust and upper mantle, such as those in the nearby Monteregian Hills, or by velocity inhomogeneities related to an ancient suture zone. Positive travel-time residuals between 0.4 and 1.2 s are associated with stations from central New York to West Virginia and Virginia in the miogeosynclinal Appalachians. These anomalies may be explained at least in part by a greater crustal thickness.

In eastern North America considerable siesmic activity, particularly large earthquakes, appears to occur along the inferred continental extensions of major fracture zones that were active in the early opening of the Atlantic. The Boston-Ottawa seismic zone appears to be nearly spatially coincident with Mesozoic alkalic igneous rocks of the White Mountain Magma Series and the Monteregian Hills. These rocks are similar in age to the New

England (Kelvin) Seamounts, a major transform fault across which magnetic lineations of Mesozoic age in the western Atlantic change strike and appear to be offset. The Boston-Ottawa seismic zone, the Mesozoic igneous rocks, and the seamount chain appear to define a major tectonic zone about 2,000 km long. The trend of this zone fits a small circle (line of constant latitude or transform direction) about the center of rotation for the early (Mesozoic) opening of the North Atlantic. Other major offsets of Mesozoic magnetic anomalies (interpreted as major transform faults active in the early opening of the western Atlantic) occur at the Blake and Newfoundland fracture zones. Two small circles drawn about the same pole of rotation as that used to fit the Boston-Ottawa seismic zone and the New England Seamounts fit (1) the Blake Fracture Zone and Charleston-Cumberland seismic zone; and (2) the Newfoundland Fracture Zone and the epicenter of the large Grand Banks earthquake of 1929. A zone of major seismic activity in southeast Missouri and alkalic intrusive rocks of Cretaceous age are found at the northern end of the Mississippi embayment, which has been sinking since Cretaceous time. Any mechanism for the localization of earthquakes in eastern and central North America must explain the apparent association of offshore fracture zones, seismic activity, and Mesozoic alkalic rocks as well as their fit about a small circle constructed for the early opening of the Atlantic and the lack of a spatial progression in ages of the alkalic rocks.

• 81107—Monzonites of the White-Inyo Range, California, and their relation to the calc-alkalic Sierra Nevada batholith.

Arthur G. Sylvester, Department of Geological Sciences, University of California, Santa Barbara, Santa Barbara, California 93106; Calvin F. Miller, C. A. Nelson, Department of Earth and Space Sciences, University of California, Los Angeles, Los Angeles, California, 90024 (present address, Miller: Department of Geology, Vanderbilt University, Nashville, Tennessee 37235). (11 p., 7 figs., 2 tbls.)

Monzonitic rocks are found in two plutons in the Deep Springs Valley area of the White-Inyo Range, California. These intrusive rocks, among the oldest in the Sierra Nevada region (170 m.y.), are characterized mineralogically by their abundance of potassium feldspar and paucity of quartz, and chemically by exceptionally high concentrations of alkalis (K_2O + Na_2O generally greater than 8% by weight) and strontium (greater than 1,000 ppm) and low silica (generally less than 60%). Both quartz-bearing and feldspathoidal varieties are present.

Modal and chemical data clearly show that these alkalic intrusive rocks are not petrogenetically compatible with the far more abundant quartz-rich, calc-alkalic rocks that characterize the Sierra Nevada batholith. Instead, the monzonitic rocks constitute part of a discrete petro-

genetic unit that is in part contemporaneous but certainly not comagmatic with the Sierra Nevada batholith.

The available data are compatible with an origin for the Inyo monzonites during an early Mesozoic magmatic episode related to an arc-trench–subduction system that tapped an upper-mantle source beneath the western edge of the North American plate.

• 81108—Sedimentology of medial moraines on Berendon Glacier, British Columbia, Canada: Implications for debris transport in a glacierized basin.

N. Eyles, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, England; R. J. Rogerson, Departments of Geography and Geology, Memorial University, St. John's, Newfoundland, Canada A1C 5S7. (6 p., 9 figs.)

The character of sediments from medial moraines on Berendon Glacier, British Columbia, reflects periglacial processes rather than direct glacial erosion and transport. Sediments are passively transported as talus by the glacier, and a distinct sedimentology can be contrasted with lodgment tills. Medial moraine sediment is derived from a number of sources and is transported on the glacier surface and at depth near the glacier bed—there is no evidence of either textural evolution with increasing distances of glacial transport or enhanced scour of the glacier bed in the vicinity of medial moraines.

Particle-size distribution of both medial moraine debris (supraglacial morainic till) and lodgment tills is found to be independent of source rock. A bimodal grain-size distribution widely reported from the analysis of far-traveled Pleistocene tills from the mid-latitudes, reflecting the crushing characteristics of component minerals in the source rock, is not exhibited by tills from Berendon Glacier which have well-defined lithological sources. This reflects the short distance of debris transport by the glacier and is considered to be typical of other temperal valley glaciers.

• 81109dr—Caledonian plate tectonics and the place of the English Lake District: Discussion and reply. (3 p.)

Discussion: *W. S. McKerrow, J. K. Leggett, Department of Geology and Mineralogy, University of Oxford, Parks Road, Oxford, OX1 3PR, England; M. H. Eales, Department of Geology, The University, Glasgow G12 822, Scotland.*

Reply: *Frank Moseley, Department of Geological Sciences, University of Birmingham, P.O. Box 363, Birmingham B15 2TT, England.*

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