



# GSA news & information

VOLUME 2, NUMBER 12

G.S.A. ARCHIVES

DECEMBER 1980

## GSA Research Grants awarded to 192 applicants

The Committee on Research Grants met at headquarters in Boulder, Colorado, on April 21 and 22, 1980. The meeting was overshadowed by the death of its new member, Robert K. Fahnestock, as a result of a light plane accident the day before the meeting. The committee reviewed 402 applications and recommended 192 of them to the Council for financial support. Eighty-three grants were awarded to M.S. student applicants and 109 to students working toward Ph.D. degrees. The total amount awarded was \$81,000, with grants ranging from \$100 to \$1,000 each. Funds provided by the Society were augmented by donations from industry, former grant recipients, and GSA members, in addition to the interest from the Harold T. Stearns Fund.

### Robert K. Fahnestock Award established

The committee recommended to the Council that a Robert K. Fahnestock Award be designated from existing funds and granted annually to the applicant of the most outstanding proposal in the field of geomorphology. At its May meeting, the Council established the award in memory of this distinguished scientist. The awardee chosen this year is James A. Pizzuto, University of Minnesota doctoral candidate, for his project titled, "The effects of sediment load and channel sediment type on the cross-sectional shape of straight rivers."

### Harold T. Stearns Fellowship Award

This year three recipients were chosen for the 1980 Harold T. Stearns Fellowship Award for research on one or more aspects of the geology of the Pacific Islands and of the circum-Pacific region. They are:

*David L. Kimbrough, University of California, Santa Barbara:* Structure, petrology and geochronology of Baja California ophiolitic terranes, Vizcaino Peninsula and Cedros Island.

*Kristian E. Meisling, California Institute of Technology, Pasadena:* Neotectonics of the north frontal fault system of the San Bernardino Mountains, southern California.

*Richard G. Stanley, University of California, Santa Cruz:* Oligocene and early Miocene sedimentation and tectonics in the Santa Cruz Mountains, central California.

Mr. Kristian Meisling subsequently returned his award funds because he received duplicate funding from other sources.

### Donations received from Marathon and Mobil

Contributions of \$2,000 each were received from Marathon Oil Company and Mobil Oil Corporation in support of the research grants program. Nine promising young earth scientists were chosen as recipients of these funds, as follows:

*Karen Kluger Cohen, University of Pittsburgh:* Tectonic development of the Gulf of Mexico, Caribbean Sea, and adjacent middle American landmasses: Paleomagnetism of Permian through Cretaceous units from northwest Sonora, Mexico, and correlative units in western Nevada as a test for sinistral displacement along the proposed Sonora-Mojave megashear.

*Marcus W. Johnson, Indiana University, Bloomington:* Stable isotopic analysis of skeletal remains and lithologic samples of Niobrara Formation (Upper Cretaceous) in U.S. Western Interior Basin.

*Carol G. Lepzelter, University of Illinois, Urbana:* Use of brachiopods as a reference standard for isotopic data in interpretation of origin and diagenesis of constituents of ancient limestones.

*Douglas M. Parker, University of South Florida, St. Petersburg:* A comparison of deep coral reef foraminiferal assemblages in the Gulf of Mexico.

*Deborah L. Patterson, University of California, Santa Barbara:* The physical, magnetic, and biostratigraphy of the Valle Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

*Imants J. Reks, Virginia Polytechnic Institute:* Curvature in marginal foreland fold and thrust belts: Analysis of central and southern junction zone, Appalachian orogen.

*Richard J. Robinson, Kansas State University, Manhattan:* Strontium isotopic composition of formation waters from lenticular Pennsylvanian Morrowan sandstone reservoirs in Kansas.

*Robert B. P. Stevens, Boston College, Newton, Massachusetts:* An investigation of the effects of wave-

*(continued next page)*

RESEARCH GRANTS, continued

induced cyclic loads on pore pressures and sand liquefaction within a beach face environment.

*Patricia A. Whalen-Helwig, University of Texas, Dallas:* Lower Jurassic radiolarian biostratigraphy of the Kunga Formation, Queen Charlotte Islands, British Columbia, and of the Hurwal Formation, Northern Willowa Mountains, Oregon.

**Outstanding Mention**

The committee has singled out eighteen young scientists and their proposals for special mention in the belief that they should be brought to the attention of the Council and to the membership of the Society. They are:

*Lung Sang Chan, University of California, Berkeley:* Tectonic evolution and neotectonics of China.

*Karen Kluger Cohen, University of Pittsburgh, Pennsylvania:* Tectonic development of the Gulf of Mexico, Caribbean Sea, and adjacent middle American landmasses: Paleomagnetism of Permian through Cretaceous units from northwest Sonora, Mexico, and correlative units in western Nevada as a test for sinistral displacement along the proposed Sonora-Mojave megashear.

*Cynthia Ann Evans, Scripps Institution of Oceanography, La Jolla:* Petrology and geochemistry of chromite deposits in ophiolites.

*John Joseph Flynn, Columbia University, New York:* Correlation of fossiliferous, middle to late Eocene strata from Wyoming, California, and Texas.

*Christopher J. Hale, University of Toronto, Canada:* Paleomagnetic investigation of some Archean rocks.

*Robert Hershler, Johns Hopkins University, Baltimore, Maryland:* The late Quaternary history of the hydroblid snails of Cuatro Cienegas, Mexico.

*Marie D. Jackson, Johns Hopkins University, Baltimore, Maryland:* Deformation styles in dikes from low temperature and pressure geologic terrains.

*John W. King, University of Minnesota, Minneapolis:* An examination of the relationship between secular variation of the Earth's magnetic field and its relationship to climatic change: three-time series from western New York and Pennsylvania.

*Linda A. Kovach, Johns Hopkins University, Baltimore, Maryland:* Dynamics of magma ascent through the Sierra Nevada.

*Frederick W. Kunzinger, Old Dominion University, Norfolk, Virginia:* Slack-water deposits: Their origin, description, and use in long-range flood frequency analyses.

*Judy A. Massare, Johns Hopkins University, Baltimore, Maryland:* The ecology and evolution of marine reptiles of the Mesozoic.

*Charles Merguerian, Columbia University and Lamont-Doherty, New York:* Tectonic significance of Paleozoic basement terranes in the west-central Sierra Nevada, California.

*James E. Pizzuto, University of Minnesota, Minneapolis:* The effects of sediment load and channel sediment type on the cross-sectional shape of straight rivers.

*Luis A. Sanchez-Barreda, University of Texas, Austin:* Tectonic history of the Isthmus of Tehuantepec, in Southeastern Mexico.

*Diane R. Smith, Rice University, Houston, Texas:* Petrology and geochemistry of Mount St. Helens volcano, Washington.

*Kim S. Stemen, Ohio State University, Columbus, Ohio:* Late glacial history of the San Poil Lobe of the Cordilleran Ice Sheet in northeastern Washington.

*Robert B. P. Stevens, Boston College, Newton, Massachusetts:* An investigation of the effects of wave-induced cyclic loads on pore pressures and sand liquefaction within a beach face environment.

*David B. Weishamp, University of Pennsylvania, Philadelphia:* The evolution of jaw mechanics of ornithopod dinosaurs (Reptilia: Ornithischia) and its bearing on plant-herbivore interaction.

The distribution of supported projects among generalized fields is shown in Table I.

TABLE I

	Requested	Funded
1. Paleontology . . . . .	32	15
2. Sedimentology & Stratigraphy . . . . .	104	31
3. Structure & Tectonics . . . . .	77	48
4. Igneous & Metamorphic Petrology . . . . .	93	53
5. Economic Geology . . . . .	35	14
6. Quaternary Geology . . . . .	33	20
7. Geophysics . . . . .	13	8
8. Other . . . . .	15	3

The committee again is concerned that the value of the average grant has decreased significantly from that of the past several years. This decrease is due both to inflation and to the larger number of proposals funded this year. Data pertaining to the rapid dollar value of the average grant are listed in Table II. This year the standard required for funding did not change compared to those of previous years, but the number of deserving applications was far higher.

(continued next page)

**Applications for 1981 Grants**

Application forms and detailed instructions for 1981 grants will be sent, upon request, by the Executive Director, Geological Society of America, P.O. Box 9140, Boulder, Colorado 80301. **PLEASE WRITE FOR 1981 FORMS. Applications must be postmarked by FEBRUARY 15, 1981.**

TABLE II

	1960	1965	1970	1975	1978	1979	1980
Applicants	40	86	256	320	263	254	402
No. Supported	13	53	128	95	124	154	192
% Supported	32%	62%	50%	30%	47%	60%	48%
Total Requested	\$17,709	116,036	302,606	296,382	264,589	255,771	420,247
Total Granted	\$10,763	37,200	76,846	62,430	85,000	84,868	81,000
Average Grant	\$ 827	702	600	657	686	551	422
% of Funding	61%	32%	25%	21%	30%	30%	19%

The Committee believes the GSA research grant program represents one of the most effective scientific funding mechanisms in the country, yielding an enormous return for the relatively small amount of money expended. *If the*

*impact of the program is not to decline further with inflation, the level of funding must increase.* This year the committee could easily have awarded to worthy projects at least \$20,000 more than was available.

### Recording for the Blind wants you to talk in their library

It is a living library of spoken words. A library of roughly 50,000 textbooks on tape, available free of charge to blind students. Eligible students also include the visually impaired, the learning disabled, and the physically handicapped who cannot handle printed material.

These students continually require new texts. To fill this need, volunteer readers make tapes in 29 recording studios across the country.

They need readers with technical or professional backgrounds in mathematics, physics, economics, engineering, and sciences. If you wish to volunteer, contact Recording for the Blind, 215 East 58th St., New York, NY 10022.

### Research proposals solicited

The United States Geological Survey requests proposals for research contracts under the continuing Earthquake Hazards Reduction Program.

The goals of the program are (a) to delineate and evaluate hazards associated with earthquakes and to predict earthquake effects, and (b) to develop the capability to predict the time, place, and magnitude of earthquakes.

Program objectives for each goal and the tasks required to achieve each objective are described in Proposal Information Package No. RFP-922W.

Written inquiries concerning this program and requests for Proposal Information Package No. RFP-922W should be addressed to:

Contracting Officer  
U.S. Geological Survey, Mail Stop 85  
345 Middlefield Road  
Menlo Park, CA 94025

Due date for receipt of proposals is February 13, 1981. It is anticipated that funding of selected programs will start on or after October 1, 1981.

### The Gladys W. Cole Memorial Research Award

It is a great pleasure to announce the establishment of a new research award by GSA. W. Storrs Cole has generously established a fund for support of the Gladys W. Cole Memorial Research award. It is hoped that the first grant will be awarded early in 1982. Information regarding application forms and deadline date will be published later.

Similar to the Harold T. Stearns Research Grant, it is a special award, distinct from the Penrose Research Grants, and administered in accordance with the guidelines specified by the donor as given below:

1. An award for investigation of the geomorphology of semi-arid and arid terrains in the United States and Mexico to be given each year to a GSA Fellow between 35 and 60 years of age who published one or more significant papers on geomorphology.
2. The Committee on Research Grants, with the advice of the Quaternary Geology and Geomorphology Division, will be charged with selecting the recipient of this award. However, they do not need to follow the recommendation of the Division if it is contrary to their own.
3. Only the interest of the fund may be used.
4. In any year in which a grant is not made, the interest must be used to increase the principal until this principal is increased to fifty thousand (\$50,000) dollars.
5. After the principal of this fund reaches \$50,000, the interest must be assigned each year in one of the following ways: (a) Investigation of semi-arid and arid geomorphology as specified in one and two above. (b) Assistance to either the *Journal of Paleontology* or the *Journal of Foraminiferal Research* in the publication of micropaleontological manuscripts on Foraminifera only. (c) To increase the principal of this fund if options (a) and (b) are not available in any one year.

## UPDATE

### Articles in *Bulletin*, Part II, December 1980

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 separate subscription.

Paper copies of Part II in its entirety are available at cost (\$10/month) as a special service to those users (members and nonmember subscribers) who request them. Any such order should be addressed to the Publications 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. Geology and petrology of the Nordeste volcanic complex, São Miguel, Azores, by Louis A. Fernandez, Doc. no. M01201. (On microfiche: 101 p., 17 figs., 10 tables)
2. Stratigraphic evidence for crustal thickness changes on the southern Tethyan margin during the Alpine cycle, by Bruno D'Argenio and Walter Alvarez, Doc. no. M01202. (On microfiche: 30 p., 2 figs., 13 tables)

### International Fellowship available through AAUW Educational Foundation

The American Association of University Women Educational Foundation awards International Fellowships for advanced study and training to women of outstanding ability who are citizens of countries other than the U.S. and who may be expected to give effective leadership upon return to their home countries.

There are no restrictions as to the age of the applicant or the field of study.

Approximately fifty International Fellowships are awarded yearly for one year's graduate study or advanced research at an approved institution in the United States.

Women who are members in their own countries of national associations/federations affiliated with the International Federation of University Women are eligible for the six AAUW-IFUW awards which are made for advanced research in any country other than the Fellow's own. The period of award is one academic year, beginning in September—not renewable.

Qualifications: (1) Academic degree equivalent to the bachelor's degree from a U.S. university at the time of application. (2) A plan of study or research that will advance the applicant's professional competence. (3) Intention of applicant to return home to pursue her professional career. Preference will be given to applicants who have specific positions to return to in their own countries. (4) Intention of applicant to devote full time to her graduate work during the Fellowship year. (5) Satisfactory English proficiency is required for study in the United States. Unless the applicant's native language is English or she is presently enrolled in a university in the United States, she must submit an up-to-date score on one of the following tests of English: Test of English as a Foreign Language (TOEFL); University of Michigan

### In December *Geology*

1. Sedimentary masses and concepts about tectonic processes at underthrust ocean margins, by D. W. Scholl, R. von Huene, T. L. Vallier, D. G. Howell
2. Hydrothermal quartz vug from the Mid-Atlantic Ridge, by P. A. Rona, K. Boström, S. Epstein
3. Paleomagnetism of intrusive rocks in the Coast Range of Oregon: Microplate rotations in middle Tertiary time, by M. E. Beck, Jr., P. W. Plumley
4. Relationship between biological extinctions and geomagnetic reversals, by R. E. Plotnick
5. Planktonic foraminiferal diversity in the interglacial and glacial North Atlantic: A test of diversity gradients as a paleoceanographic technique, by W. L. Balsam, K. W. Flessa, N. G. Kipp, L. G. DuBois
6. Stumps transported and deposited upright by Mount St. Helens mud flows, by W. J. Fritz
7. Ortigalita Peak gabbro, Franciscan complex: U-Pb dates of intrusion and high-pressure-low-temperature metamorphism, by J. M. Mattinson, L. M. Echeverria
8. Pre-Cenozoic normal faulting in the Osgood Mountains, Humboldt County, Nevada, by B. R. Berger, B. E. Taylor
9. Structural uses of tangent diagrams, by C. A. Bengtson

Examination for Proficiency in English; or American Language Institute, Georgetown University (ALIGU).

Financial Provisions: To assist qualified women in attaining their educational and professional goals, AAUW provides stipends to help cover cost of living according to the applicant's needs and place of study. Amounts of stipends usually range from \$2500 to \$7000. No travel costs or stipends for dependents will be paid by AAUW. Awards do not include funds for research equipment, research assistants, and similar costs, nor are funds available for subsidizing publication costs, travel expenses for professional meetings, or for other special projects. AAUW does not award grants-in-aid or travel grants.

Women of other countries now residing in the U.S. may obtain an application by writing to: Educational Foundation Programs Office, AAUW, 2401 Virginia Ave., NW, Washington, DC 20037. Women not residing in the U.S. may obtain an application from the Cultural Affairs Officer at the American Embassy in most countries, from the association of university women in her country, or by requesting an application from the above address. Applications must be requested in writing.

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Prepared from contributions from the staff and membership by John C. Frye, Executive Director; James R. Clark, Publications Manager; and June Thomas, Judy Hall, and Ann Fogel, Production Assistants.

## REPORT---

### 21st U.S. Symposium on Rock Mechanics

The 21st Symposium on Rock Mechanics was held May 28-30, 1980, at Rolla, Missouri, and was sponsored by the University of Missouri-Rolla with cooperation from the U.S. National Committee for Rock Mechanics. The National Committee held its annual business meeting before the symposium.

The symposium was attended by more than 175 engineers and geologists who heard papers that dealt with radioactive waste disposal, longwall coal mining and subsidence, ground support and strata control, rock fracture, temperature effects, laboratory testing, seismicity and acoustic emission, and mathematical modeling. Out of 90 papers listed for presentation, 26 had foreign authors, somewhat more than in past symposia. Energy issues were paramount with a majority of reports dealing with underground coal mining and radioactive waste disposal. If research and knowledge were correctly represented by the presentations and the ensuing discussion, it would appear our science is poorly prepared to deal with the long-term changes in deep rock masses brought about by heating and deformation. While groundwater migration in rock masses is a foremost concern to radioactive waste disposal, it cannot be adequately described until the long-term behavior of transport properties (rock matrix and fracture systems) of the host rock medium is known.

The 22nd Symposium will be held at the Massachusetts Institute of Technology from June 29 to July 2, 1981. Those wishing to present papers should submit abstracts by December 1, 1980, to Lea A. Johnson, Director, Conference and Seminar Office, Room 9-335, Center for Advanced Study, Massachusetts Institute of Technology, Cambridge, MA 02139; telephone (617) 253-7411.

As has been customary, the U.S. National Committee for Rock Mechanics (USNC/RM) held its annual meeting immediately before the symposium on May 27. The main effort of the committee this year has been the completion of "Rock Mechanics Research Requirements for Resource Recovery, Construction and Earthquake-Hazard Reduction," a report to the National Science Foundation, Department of Energy, and Geological Survey resulting from a study conducted by the Panel on Rock Mechanics Research Requirements. The comprehensive study was directed by a steering group composed of Howard J. Pincus, Study Director, John W. Handin, and William R. Judd, cochairmen. A second draft of the report has been completed, and the final report is expected to be printed early in 1981.

The Executive Secretary, R. L. Bangert, announced results of the election of officers and members as follows:

Kate H. Hadley, Chairman Elect from July 1, 1980, to June 30, 1981.

John D. Bredehoeft, member from Government for three-year term starting July 1, 1980.

Bruce R. Clark, member from Industry for three-year term starting July 1, 1980.

## CENTENNIAL NEWS

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### THE D-NAG FUND

The Geological Society of America Foundation is now a reality. The Foundation will have as one of its special funds a Fund for the Decade of North American Geology. Contributions to the Foundation that are designated "D-NAG Fund" will be used to support the many activities specifically planned for this Centennial decade and will also provide the donor with valuable tax benefits. The most exciting of the projects currently under way is the 27-volume series on the geology of North America and surrounding oceanic regions. Together with various topical maps of the entire continent at a scale of 1:5,000,000, these publications will provide the first comprehensive synthesis ever attempted of an entire crustal plate. Part of the D-NAG Fund will support publication costs for this project so that its products will be available at reasonable prices to students as well as professionals. The purpose of this synthesis of knowledge about the North American Plate and adjacent areas is to stimulate, in the creative minds of as large a segment of the geological community as possible, ideas about new approaches to the search for economic resources important to our future and about new relationships that will contribute to our understanding of the geological evolution of North America.

"... something more might be comprehended from the whole, and from every part, than I can possibly foresee..."  
from Joseph Lister's proposal of a geological map to the Royal Society of London, 1683.

### Thanks to volunteers

The GSA Council wants to inform the membership that they greatly appreciate the expression of interest in committee work of the Society by the many members who volunteered during the past year. These were all considered by the Committee on Committees; however, there are only a few slots to fill each year and therefore only a small fraction of those volunteering have been given committee assignments. Please keep volunteering as this is a prime source of names for the Committee on Committees and the Council.

Don C. Banks relinquished his duties as Chairman, USNC/RM, to N.G.W. Cook, who stated he looked forward to working with the committee in the coming year. He particularly would like to see more of the body of accumulated world-wide rock mechanics experience used in the practice of rock mechanics in the United States.



## CORDILLERAN SECTION, GSA, March 25-27, 1981

### International Meeting

In March 1981, The Cordilleran Section will hold its first meeting in Mexico. It will take place at the Casa de la Cultura, Hermosillo, Sonora. It will be co-sponsored by the Departamento de Geología, Universidad de Sonora and by the Instituto de Geología, Universidad Nacional Autónoma de México, in Hermosillo, Sonora.

#### REGISTRATION

Registration will be by preregistration as well as at the welcoming party at the Casa de la Cultura, Tuesday evening, March 24, from 1930 to 2300 hours and during the meeting. Preregistration costs are \$25 for professionals, \$10 for GSA student associates, and \$15 for other students. To qualify for the GSA Student Associate preregistration rate, you must show both your 1981 GSA Membership Card and your student ID when picking up your preregistration packet. On-site registration is \$35 for professionals and \$15 for all students.

All are urged to take advantage of the lower preregistration rates. Preregister before March 6, 1981 (or February 22, if field trips are included).

Two free drink tickets for the Tuesday night welcoming party will be provided to all preregistrants.

Refunds on cancelled preregistrations and luncheons will be made only until March 10, 1981, less a \$5 processing fee. Refunds will be made for field trip fees only until March 10, unless the trip is cancelled. After March 20, 1981, no refunds of any type will be made, except for cancelled trips.

#### WELCOMING PARTY

On Tuesday evening, March 24, a no-host cocktail party will be held at the Casa de la Cultura from 1930 to 2300 hours. All preregistrants will receive two free drink tickets for this party.

#### QUESTIONS OR PROBLEMS

If you have questions or problems, contact Jaime Roldan, Local Co-Chairman, Apdo. Postal 1039, Hermosillo, Sonora, Mexico; telephone (621) 3-17-20 and 3-17-53 (new phone numbers as of October 30, 1980).

#### SYMPOSIA (organizers in parentheses)

1. *Geology of the Mar de Cortez, Mexico* (P. Lonsdale).
2. *Porphyry copper-molybdenum deposits of northern Sonora* (J. Guilbert, J. Islas).
3. *Geochemical prospecting in the southern Basin and Range Province* (J. L. Lee-Moreno, R. Farias).
4. *Precambrian of western North America* (L. Silver, T. Anderson, M. A. Gonzalez).
5. *Hydrology of Arizona and Sonora* (S. Davis and J. Najera).
6. *Tectonics of the southern Cordillera* (P. Coney, M. F. Campa).
7. *Geology and mineral resources of the Sierra Madre Occidental* (K. F. Clark, P. Damon).
8. *Neogene paleoclimate and paleoecology and early man in American Southwest and Northern Mexico* (J. P. Bradbury).

9. *Upper Precambrian and Paleozoic rocks in northwest Mexico in relation to Cordilleran geosyncline in western United States* (J. H. Stewart, J. F. Longoria).

#### GENERAL TRAVEL INFORMATION

Hermosillo can be reached from the United States by plane from Tucson (departure time: 5:15 p.m.) or by Greyhound bus (to Nogales) and train (from Nogales to Hermosillo; departure time from Nogales: 10:15 a.m.). Charter flights might be organized from some airports (Phoenix and Tucson) to Hermosillo and back. If interested, please inquire as soon as possible with Viajes Pitic, Apdo. Postal 929, Hermosillo; tel. (621) 4-36-72.

#### PROJECTION EQUIPMENT

Carousel projection equipment will be provided for standard 2" x 2" (35 mm) slides only; no dual projectors will be employed. Please plan talks accordingly. If possible, bring your own loaded carousel tray.

#### GSA ANNUAL LUNCHEON

GSA Cordilleran Section business luncheon will be held at the Casa de la Cultura. The lunch will be served Thursday, March 26, at 1215 hours, for a price of \$10 per person.

**SPECIAL NOTE:** The Arizona Geological Society will sponsor a special symposium, "Relations of Tectonics to Ore Deposits in Southern Cordillera," at the University of Arizona in Tucson on March 19-20, 1981, with field trips on March 17-18 and 21-22. Those interested may obtain further information by writing to

Tectonics and Ore Deposits Symposium  
Director of Conferences, University of Arizona  
Babcock Building 1201,  
1717 E. Speedway Blvd.  
Tucson, AZ 85721

#### FIELD TRIPS

(Note: All field trip registrants **MUST ALSO** preregister for the meeting.)

Field trip registration is on a first-come, first-served basis. If a trip is oversubscribed, the full registration fee will be refunded to late registrants. Field trip preregistration **MUST BE RECEIVED IN HERMOSILLO BY FEBRUARY 22, 1981**, accompanied by payment in full. Trips may be cancelled owing to a low number of registrants or for reasons beyond our control; full refunds will be made under such circumstances. No other trip refunds will be made unless the request is received before March 10. The trips will start from Hotel Valle Grande, Boulevard Kino & R. Corral (see map), Hermosillo, unless otherwise indicated. In some cases, camping may be available to lower the cost of trip. Contact the field trip leader(s) directly.

#### Premeeting

1. *Geochemistry and ecology of salt pans at Guerrero Negro, Baja California.* (March 22-24). Leaders: W. T. Holser, B. Javor, C. Pierre. Largest salt pan operation in the world; previously one of the very few sabkha evaporites depositing halite and polyhalite as well as gypsum; one of the few sites where halophile algae and related ecology have been studied in detail. Includes lodging, meals, guidebook,

## PREREGISTRATION DEADLINE March 6, 1981

and transportation (chartered flight and vans). Leave March 22, 0800 hours and return March 24, 1300 hours. Limit 25. US \$375.

2. **Geology of coastal Sonora between Puerto Lobos and Bahia Kino (March 22-24).** Leaders: R. G. Gastil, L. Ortlieb. Unmetamorphosed, fossiliferous carbonate-quartzite strata of late Jurassic age; weakly metamorphosed carbonate-chert-volcanic rock sequences of Mesozoic and uncertain age intruded by Late Cretaceous plutons and Laramide age dikes; terrigenous and volcanic strata of 9 to 22 million years, tilted and in some places folded. Middle(?) Pleistocene and Sangamonian marine deposits and wave-cut terraces. Includes meals, transportation (vans), and guidebook. Two nights will be spent camping outdoors in the field; please bring sleeping bag. Leave March 22, 0700 hours, and return March 24, 1700 hours. Limit 20. US \$95.

3. **Sedimentology and paleoecology of the Puerto Peñasco coast, northwestern Sonora (March 21-23).** Leaders: K. Flessa, J. Schreiber. Tidal flats of Cholla Bay, Pleistocene marine deposits and aeolianites, coastal geomorphology and sedimentology of the Estero Marua, east of Puerto Peñasco. Includes lodging, meals, guidebook, and transportation (vans). Leave March 21, 1300 hours, from University of Arizona, Geology Building, Tucson, Ariz., and return to Tucson March 23, 1900 hours, with possibility of trip termination in Hermosillo. Limit 32. US \$150.

4. **Regional geology of northwestern Sonora (March 22-24).** Leaders: J. F. Longoria, M. A. Gonzalez. Lithostratigraphy of Precambrian, Paleozoic, and Mesozoic terrain in the Pitiquito-La Primavera quadrangle; structural and tectonic models; attempt of correlation between this region and similar terrains from western U.S. Includes lodging, meals, guidebook, and transportation (vans). Walking and climbing expected. Leave March 22, 0700 hours, and return March 24, 1900 hours. Limit 15. US \$165.

5. **Tectonic relations between regional thrust faulting (Cordilleran orogeny) and the Rincon Mountains gneiss-cored dome (March 21-23).** Leaders: H. Drewes, C. H. Thorman. Late Cretaceous-Paleocene thrust faulting and mid-Tertiary gravity faulting, in relation with the early and late stages of dome development; Precambrian to Tertiary sedimentary and volcanic rocks; tectonic and fabric features in the metamorphosed core of the dome. Includes lodging (March 21, 22, and 23), meals, guidebook, and transportation (vans). Check-in March 21, 1800 hours, at Howard Johnson's Hotel, Tucson, Ariz., and end (same place) March 23, 2100 hours. Arrangement to go to Hermosillo on March 24 will be provided. Limit 40. US \$250.

6. **Oposura massive sulfide, near Moctezuma, Sonora (March 24).** Leaders: C. Marrs, D. Gomez. The Oposura volcanogenic massive sulfide deposit and environment of stratabound-stratiform sphalerite-galena with minor manganese in felsic tuffs and shallow water limestones, with rhyolite below and dacite above. Includes lunch, guidebook, and transportation (vans). Leave March 24, 0600 hours, and return 2000 hours. Limit 40. US \$40.

7. **Opedepe molybdenum-copper porphyry deposit (March 24).** Leaders: F. Leon, J. Guilbert. The Opedepe, or Creston deposit, a molybdenum-copper porphyry type, 70 km NE of Hermosillo; quartz-moly stockwork in altered

and silicified roof pendant, prebatholithic rocks, hypogene molybdenite with irregular zones of supergene enriched copper. Includes lunch, guidebook, and transportation (vans). Leave March 24, 0630 hours, and return 2000 hours. Limit 40. US \$40.

### Postmeeting

8. **Hydrogeology of the Costa de Hermosillo region (March 28).** Leaders: J. Najera, G. Celaya, J. L. Jardines. Visit to the agricultural fields and to the pumping and observation wells in the region west of Hermosillo; detection and controls of saline intrusion in the aquifer. Includes box lunch, guidebook, and transportation (bus). Leave March 28, 0800 hours, and return 1800. Limit 20. US \$30.

9. **Neotectonics and Plio-Quaternary volcanism of the area of Santa Rosalia, Baja California (March 28-30).** Leaders: B. Colletta, A. Demant, L. Ortlieb. Pliocene sedimentary stratigraphy of Santa Rosalia Basin; Early, Middle, and Late Quaternary interglacial marine terraces; Pliocene and Quaternary volcanics of the Tres Virgenes volcano and La Reforma caldera; post-Miocene fracturing and vertical deformation in relation to the Gulf of California tectonics. Includes lodging, meals, guidebook, and transportation (chartered flight and vans). Leave March 28, 0800 hours, and return March 30, 1800 hours. Limit 25. US \$275.

10. **Metamorphic core complexes in northern Sonora and southern Arizona (March 28-30).** Leaders: G. Davis, T. Anderson. We will examine tectonics and decollement zones which have been fashioned from Precambrian basement rocks, Paleozoic sedimentary rocks, Jurassic meta-volcanic rocks, and Laramide batholiths in Sierra Mazatan and Sierra Magdalena (Sonora) and in the Coyote Rincon and Santa Catalina Mountains (Arizona). Includes meals, lodging, guidebook, and transportation (bus). Leave (from Hermosillo) March 28, 0800 hours, and end at Tucson, March 30, 1700 hours. Arrangement to return to Hermosillo will be made. Limit 40. US \$225.

11. **Geology and mineral deposits of southern Sonora and the sonoran Sierra Madre Occidental (March 28-30).** Leaders: K. Clark, P. Damon, J. Islas. Laramide batholithic intrusions, Cenozoic volcanic stratigraphy, and ore deposits of the western margin of the Sierra Madre Occidental and adjacent Basin and Range province; also included will be Mesozoic and Paleozoic stratigraphy and Ordovician baryte deposition. Includes meals, lodging (1 night), guidebook, and transportation (vans). One of the two nights will be spent camping outdoors; please bring sleeping bag and warm jacket. Leave March 28, 0800 hours, and return March 30, 1500 hours. Limit 24. US \$150.

12. **Mesozoic through early Tertiary sedimentational and tectonic patterns of northeast Sonora and southeast Arizona (March 28-30).** Leaders: S. Keith, W. L. Bilodeau, J. F. Longoria. Representative Mesozoic through early Tertiary rocks will be examined in their classic type localities on both sides of the border; numerous complex and controversial Laramide structures that deform these rocks will be viewed. Includes lodging, meals, guidebook, and

(continued)



BEFORE MAILING THIS FORM, PLEASE COPY THE REVERSE SIDE. IT CONTAINS IMPORTANT INFORMATION.

### PREREGISTRATION FORM

77th Annual Meeting, Cordilleran Section, Geological Society of America  
March 25-27, 1981, Hermosillo, Sonora, Mexico

Name (last, first, initial) \_\_\_\_\_

Registered as  PROFESSIONAL  GSA STUDENT ASSOCIATE  OTHER STUDENT

If accompanied by spouse or guest, list name for badge \_\_\_\_\_

Address (street) \_\_\_\_\_

City, State, Zip \_\_\_\_\_

Phone (business) ( ) \_\_\_\_\_ (home) ( ) \_\_\_\_\_

Affiliation (abbreviate for badge) \_\_\_\_\_

GSA Member: Yes  No

Speaker: Yes  No

#### REGISTRATION FEES

Preregistration (before March 6) . . . . .	\$ 25.00	\$ _____
Registration (after March 6—on site) . . . . .	\$ 35.00	\$ _____
GSA Student Associates (before March 6) . . . . .	\$ 10.00	\$ _____
GSA Student Associates (after March 6—on site) . . . . .	\$ 15.00	\$ _____
Other Students with I.D. (before or after March 6) . . . . .	\$ 15.00	\$ _____
GSA Cordilleran Section Business Luncheon, March 26 . . . . .	\$ 10.00	\$ _____

#### FIELD TRIPS

##### Premeeting

1. Geochemistry and ecology of salt pans at Guerrero Negro, Baja California (March 22-24) . . . . .	\$375.00	\$ _____
2. Geology of coastal Sonora between Puerto Lobos-Bahia Kino (March 22-24) . . . . .	\$ 95.00	\$ _____
3. Sedimentology and paleoecology of the Puerto Peñasco coast, NW Sonora (March 22-24) . . . . .	\$150.00	\$ _____
4. Regional geology of NW Sonora (March 22-24) . . . . .	\$165.00	\$ _____
5. Regional thrust faulting and the Rincon Mountains gneiss-cored dome (March 21-23) . . . . .	\$250.00	\$ _____
6. Oposura massive sulfide, near Moctezuma, Sonora (March 24) . . . . .	\$ 40.00	\$ _____
7. Opedepe molybdenum-copper porphyry deposit (March 24) . . . . .	\$ 40.00	\$ _____

##### Postmeeting

8. Hydrogeology of the Costa de Hermosillo region (March 28) . . . . .	\$ 30.00	\$ _____
9. Neotectonics and Plio-Quaternary volcanism of Santa Rosalia, Baja California (March 28-30) . . . . .	\$275.00	\$ _____
10. Metamorphic core complexes in N Sonora and S Arizona (March 28-30) . . . . .	\$225.00	\$ _____
11. Mineral deposits of S Sonora and the sonoran Sierra Madre Occidental (March 28-30) . . . . .	\$150.00	\$ _____
12. Mesozoic-early Tertiary sedimentational and tectonic patterns of NE Sonora- SE Arizona (March 28) . . . . .	\$150.00	\$ _____

**TOTAL** \$ \_\_\_\_\_

Make all checks payable to Cordilleran Section GSA and Mail **BEFORE** March 6, 1981, with this preregistration form to:

Martha A. Gamper  
Apdo. Postal 1182  
Hermosillo, Sonora, Mexico

If field trip registration is included, registration fee must be received **BEFORE FEBRUARY 22, 1981**. Refunds on cancelled preregistration will be made until March 10, 1981, less a \$5.00 processing fee. No refunds will be made after March 20, except for cancelled field trips.





# SOUTHEASTERN SECTION, GSA, March 18-20, 1981

## PREREGISTRATION FORM

**Southeastern Section of the Geological Society of America  
30th Annual Meeting, March 18-20, 1981  
Hattiesburg, Mississippi**

(for office use only)

ck/m.o.n. \_\_\_\_\_ \$ \_\_\_\_\_

Personal check                      other check

Issued by \_\_\_\_\_

Name: (last, first, middle) \_\_\_\_\_

Registered as                      Professional     Student     Spouse/Guest

Spouse/Guest name for badge \_\_\_\_\_

Affiliation: (Abbreviate for badge) \_\_\_\_\_

Professional Address: \_\_\_\_\_

City, State, Zip \_\_\_\_\_

Phone: Business \_\_\_\_\_                      Home \_\_\_\_\_

GSA Member: yes \_\_\_ no \_\_\_                      Speaker: yes \_\_\_ no \_\_\_

GSA Student Associate: yes \_\_\_ no \_\_\_

Enclosed is a check or money order (U.S. funds only) payable to USM-SEGSA in the amount of \$ \_\_\_\_\_ for:

Preregistration (before March 2) per person . . . . .	\$ 25.00	\$ _____
Registration (after March 2) per person . . . . .	30.00	\$ _____
Student preregistration* (before March 2) per person . . . . .	12.50	\$ _____
Student registration* (after March 2) per person . . . . .	15.00	\$ _____
Guest/Spouse preregistration per person . . . . .	13.50	\$ _____
Guest/Spouse registration per person . . . . .	16.00	\$ _____
GSA banquet, USM Commons, March 19, per person . . . . .	12.50	\$ _____
Golden Nugget Golf Tournament, March 18, per person . . . . .	7.50	\$ _____
5-Kilometre Run, March 19, per person . . . . .	3.00	\$ _____

\*Valid ID will be required at on-site registration.

### ALL FIELD TRIP REGISTRANTS MUST ALSO PREREGISTER FOR THE GENERAL MEETING

<b>Field trip 1</b> , Neogene Geology of Southeastern Mississippi and Southwestern Alabama (premeeting), per person . . . . .	100.00	\$ _____
<b>Field trip 2</b> , Teaching Hardrock and Softrock Geology in the Gulf Coastal Plain (during meeting), check one: Th <input type="checkbox"/> , Fri. <input type="checkbox"/> , either <input type="checkbox"/> , per person . . . . .	30.00	\$ _____
<b>Field trip 3</b> , Detailed Mid-Tertiary Stratigraphy along the Chickasawhay River, East-Central Mississippi (postmeeting) per person . . . . .	60.00	\$ _____
<b>Field trip 4</b> , General Overview of the Economic Geology and Stratigraphy of Central and East-Central Mississippi (postmeeting), per person . . . . .	60.00	\$ _____
<b>Field trip 5</b> , Miocene(?) Geology of the Hattiesburg District (postmeeting), per person . . . . .	50.00	\$ _____

### MAIL FOR DELIVERY BY MONDAY, MARCH 2, 1981, TO

**Tony Stuart, Department of Conferences & Workshops  
Southern Station Box 5136, University of Southern Mississippi  
Hattiesburg, MS 39402**

To register more than one person, please duplicate or request additional forms.

The Southeastern Section of the Geological Society of America will hold its 30th Annual Meeting at the University of Southern Mississippi campus in Hattiesburg, Mississippi, March 18, 19, and 20, 1981. The meeting is hosted by the Department of Geology and the Department of Conferences and Workshops of the University of Southern Mississippi. Geologists from a number of other organizations in Alabama, Louisiana, and Mississippi will be conducting symposia, special sessions, and field trips.

### REGISTRATION

Registration is required for all those attending the meetings, field trips, exhibits, and spouses' programs. Registration will be held in R. C. Cook University Union Lobby on March 18 from 1700 to 2130 hours and during the meeting.

Preregistration forms must be received by March 2, 1981.

Refunds on cancelled preregistrations will be made in full until March 2, 1981. After that date, no refunds will be made except if a field trip is cancelled.

### WELCOMING PARTY

A welcoming party for all those attending the meeting will be held from 1930 to 2200 hours on Wednesday, March 18, at Cash McCools, a large lounge off-campus and adjacent to most of the motels on Highway U.S. 49 North.

### SYMPOSIA

- (1) *Geology of the Talladega Slate Belt*; James F. Tull and Denny N. Bearce.
- (2) *Salt Dome Structure and Genesis*; Joseph D. Martinez.
- (3) *Coastal Plain Mollusks*; Patricia H. Kelley and Ernest E. Russell.

### SPECIAL SESSIONS

- (1) *Appalachian Structure and Geology beneath the Coastal Plain Overlap*. Oscar L. Paulson, Jr.

# PREREGISTRATION DEADLINE March 2, 1981

- (2) *Neogene Geology of the Northeastern Gulf Region.* Wayne C. Isphording.
- (3) *Marine Geology and Geophysics of the Gulf, Caribbean, and Atlantic Offshore.* Fred A. Bowles and Randall S. Jacobson.

### SPOUSES' PROGRAM

The program for spouses and guests on Thursday, March 19, will provide a luncheon/fashion show at the Serendipity Cafe. A tour of historical Hattiesburg will follow. On Friday afternoon, March 20, a tour of the University of Southern Mississippi campus and exhibit area will be conducted. For those staying on in Hattiesburg for the weekend, the Festival String Quartet from the New Orleans Symphony will be on campus. Details for the above will be provided at registration.

### HOUSING

Motels are centered around the R. C. Cook University Union (convention headquarters) where all sessions and symposia will be held. Housing forms should be mailed to

**William A. Bufkin, Director**  
**USM Conferences & Workshops**  
**Southern Station Box 5136**  
**Hattiesburg, MS 39402**  
**(601) 266-4265**

Motel	Rates plus 5% tax	
	Single	Double
<b>Carriage Inn</b> (1 mi. south of campus) 914 Broadway Dr.	\$22.50	\$32.00
<b>Hampton House</b> (6 blocks SW of campus) US 98 (Hardy St.)	\$25.00	\$33.00
<b>Holiday Inn North</b> (1 mi. north of campus) US 49 North	\$29.40	\$38.85
<b>Knights Inn</b> (1 mi. north of campus) 3113 Hwy. US 49 North	\$18.90	\$24.15
<b>La Grace Motor Inn</b> (1 mi. north of campus) US 49 North (1 bed) (2 beds)	\$19.00	\$22.00 \$25.00
<b>Peddlers Inn</b> (1 mi. south of campus) 900 Broadway Dr.	\$22.05	\$29.40
<b>Ramada Inn</b> (1 mi. north of campus) US 49 North	\$26.00	\$33.40
<b>Southernaire</b> (1 block south of campus) US 49 North	\$19.00	\$25.00

### AIR TRANSPORTATION INFORMATION

The Pine Belt Regional Airport, which serves the Laurel-Hattiesburg area, is located 12 miles north of the campus on I-59. Republic Airlines has connecting flights from Atlanta and Memphis. Limousine service, as well as rental cars,

are available from the airport. For additional information contact

**Daniel A. Sundeen**  
**Department of Geology**  
**Southern Station Box 8196**  
**Hattiesburg, MS 39402**  
**(601) 266-7195**

### HOUSING FORM

**Southeastern Section, Geological Society of America**  
**March 18-20, 1981**

**Headquarters: R. C. Cook University Union, Hattiesburg, Mississippi**

**Applications for housing must be received by March 2, 1981.** The confirmation will be mailed from the hotel to the name and address listed below.

Please reserve \_\_\_\_\_ room(s) for \_\_\_\_\_ persons \_\_\_\_\_ beds

**List names of all occupants.**

**Bracket names of people sharing the same accommodations.**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

#### Indicate 1st and 2nd choice motel

- Carriage Inn   
  Hampton House   
  Holiday Inn North   
  Knights Inn  
 La Grace Motor Inn   
  Peddlers Inn   
  Ramada Inn   
  Southernaire

Reservations will be held until 1800 hours local time. To hold reservations beyond 1800 hours, please indicate that the room is to be held on a guaranteed basis for late arrival.

\_\_\_\_\_ 1800 hours  
 \_\_\_\_\_ Guaranteed (Enclose credit card number & type or check for first night's lodging)

Will arrive on \_\_\_\_\_  
day                      date                      time

Will depart on \_\_\_\_\_  
day                      date                      time

#### CONFIRM TO:

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

#### WHEN THIS APPLICATION IS COMPLETED PLEASE MAIL TO

**William A. Bufkin, Director, USM Conferences & Workshops**  
**Southern Station Box 5136, Hattiesburg, MS 39402**

## SOUTHEASTERN SECTION, GSA

### GOLF TOURNAMENT

To accommodate the geo-golfers in the area, the Golden Nugget Golf Tournament will be scheduled for Wednesday, March 18. Trophies will be awarded for best individual and foursome scores. Final details on the rules for the tournament will be based on the number of registrants. Details will be given on the day of the tournament. (March 18—tee-off time 1200 hours at the USM 18-hole golf course). **Limit: 48; Fee: \$7.50.**

### 5-KM RUN

To keep joggers and runners in shape, a 5-kilometre campus run will be sponsored by the University Department of Intramural Sports. Runners will gather on the east side of the R. C. Cook University Union at 1500 hours on Thursday, March 19. No limit on number of participants. **Fee: \$3.00.**

### GUIDEBOOKS

All field trip road logs and text will be published as a single volume by the Southern Geological Society. One copy of this volume will be provided to participants of each field trip. Additional copies will be on sale during the meeting. After the meeting, the guidebooks will be available from the Southern Geological Society, Southern Station Box 5044, Hattiesburg, MS 39402.

**FIELD TRIPS—** Field trip registrants **MUST ALSO** preregister for the meeting. Field trip registration is on a first-come, first-served basis. If a trip is over-subscribed, the full registration fee will be refunded to late registrants. **Field trip preregistration must be received by March 2, 1981, accompanied by payment in full.** Trips may be cancelled owing to low numbers of registrants or for other reasons beyond our control. Full refunds will be made under such circumstances. No other trip refunds will be made after March 2, 1981.

### Premeeting

1. **Neogene Geology of Southeastern Mississippi and Southwestern Alabama** (March 18—leave 0800 hours from Mobile; March 18—return 1800 hours to University of Southern Mississippi, R. C. Cook University Union. Departure site and transportation options provided upon receipt of registration). Leaders: R. L. Bowen, W. Isphording, and E. Otvos.

The field trip will provide the opportunity to examine the exposed Miocene(?)–Holocene of the northeastern Gulf, the type "Citronelle," and the study of the "Citronelle" problem. Examples of problematic upland depressions, Quaternary deposition and tectonics, and hurricane-induced coastal alterations will be visited and discussed. **Limit: 35; Cost: \$100.**

### During Meeting

2. **Teaching Hardrock and Softrock Geology in the Gulf Coastal Plain** (March 19 and 20—leave 0730 hours from R. C. Cook University Union; March 19 and 20—return 1330 hours). Leaders: L. Jones and D. Sundeen.

The excursion visits both a constructed and a natural geologic setting suited for instructional purposes. The University

Natural Science Park features outcropped blocks of rock which are representative of common types found in the crust. They display many of the structural-textural features seen in the field. The natural setting features a canyon incised into a hill by a tributary stream to the Pearl River. Various sediments and structures are exposed in cross-section and most of the depositional patterns associated with alluvial processes are displayed. **Limit: 15; Cost: \$30.**

### Postmeeting

3. **Detailed Mid-Tertiary Stratigraphy along the Chickasawhay River, East-Central Mississippi** (March 21—leave 0700 hours from R. C. Cook University Union; March 21—return 1700 hours). Leaders: D. Dockery and J. May.

The field trip will visit some of the classic Tertiary outcrops of Wayne, Clarke, and Lauderdale Counties in eastern Mississippi. In this region, the Tertiary marine sequences of southern Alabama intertongue with the fluvial-deltaic sequences of the Mississippi Embayment. Stops will include both deltaic and fossiliferous marine units of Eocene and Oligocene age. The depositional environments of these

units will be discussed in the context of the regional depositional systems.

**Limit: 40; Cost: \$60.**

4. **General Overview of the Economic Geology and Stratigraphy of Central and East-Central Mississippi** (March 21—leave 0630 hours from R. C. Cooke University Union; March 21—return 1900 hours). Leaders: F. Pescatore and M. Meylan.

Oil and natural gas, lime rock and lignite are found in subsurface and surface sedimentary rocks of Jurassic, Cretaceous, and Tertiary age in east-central and central Mississippi. The field trip will visit a deep Smackover test well in the Piney Woods Field in Simpson County, quarries in which fossiliferous and glauconitic Oligocene limestone are being mined for agricultural lime, and outcrops of Wilcox lignite beds in Newton and Lauderdale Counties and adjacent Alabama.

**Limit: 40; Cost: \$60.**

5. **Miocene(?) Geology of the Hattiesburg District** (March 21—leave 0700 hours from R. C. Cook University Union; March 21—return 1700 hours). Leader: R. Bowen.

The field trip will visit selected outcrops that demonstrate interesting and controversial relations between the Catahoula, Hattiesburg, and "Citronelle" formations. Suggestions for resolving the perplexing nature of their contacts and problems of their ages will be discussed. Locations in the Hattiesburg area where gravel and clay are being exploited will also be visited. **Limit: 40; Cost: \$50.**

# DECEMBER 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 "December Summaries" on coupon.*

• S01201—Geology and petrology of the Nordeste volcanic complex, São Miguel, Azores: Summary.

Louis A. Fernandez, Department of Earth Sciences, University of New Orleans, New Orleans, Louisiana 70122. (6 p., 4 figs.)

## Bulletin Briefs

*Titles and abstracts of conventional articles in the December 1980 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 195.*

• 01202—Stratigraphic evidence for crustal thickness changes on the southern Tethyan margin during the Alpine cycle.

Bruno D'Argenio, Istituto di Geologia e Geofisica dell'Università, Largo San Marcellino 10, Naples, Italy; Walter Alvarez, Department of Geology and Geophysics, University of California, Berkeley, California 94720. (9 p., 7 figs., 1 tbl.)

Passive continental margins must be viewed as tectonically alive; they undergo thinning, subsidence, and possibly extension, and their form influences and is influenced by the pattern of the overlying sedimentary cover. Mesozoic and lower Tertiary carbonates deposited on the South Tethyan continental margin during opening of the central Atlantic and Tethys Oceans carry a useful record of subsidence. Since a very large area subsided for more than 150 m.y. with apparently no tectonic activity other than normal faulting, the subsidence was probably an isostatic response to crustal thinning. Isostatic considerations, using reasonable densities, indicate that crustal thickness  $t'_c$  at a particular time is given by

$$t'_c = t_c - 4.6t'_w - 1.8t'_s,$$

where  $t_c$  is the original crustal thickness, and  $t'_w$  and  $t'_s$  are the water depth and sedimentary thickness, respectively. Calculations based on Apennine stratigraphic sequences indicate thinning of the Italian continental crust by approximately 40% beneath pelagic basins and 20% beneath carbonate platforms.

We suggest that this thinning may have been due to extension of the crust resulting from a mechanism, proposed by Bott in 1971, which indicates that unbalanced lateral forces should be present at the contact between crusts of different thickness, even when they are in isostatic equilibrium. Extension and thinning of the South Tethyan margin affected a belt several hundred kilometres wide; we suggest that this was due to the effect of the Triassic intracontinental rifting that preceded Jurassic oceanic rifting. During the earlier, intracontinental rifting, numerous basins of Newark type were formed, and the associated crustal discontinuities would have provided a number of loci where Bott's lateral flow mechanism could have acted.

The Apennine crust is now of at least normal thickness, indicating that it has been rethickened; this probably

occurred during Tertiary collisional orogeny, as was suggested for the Eastern Alps by Helwig in 1976. An important aspect of Helwig's rethickening model is that it removes the need for subduction of large volumes of buoyant continental crust during collisional orogeny.

• 01203—The Great Lakes tectonic zone—A major crustal structure in central North America.

P. K. Sims, U.S. Geological Survey, Denver, Colorado 80225; K. D. Card, Geological Survey of Canada, Ottawa K1A 0E4, Canada; G. B. Morey, Minnesota Geological Survey, St. Paul, Minnesota 55108; Z. E. Peterman, U.S. Geological Survey, Denver, Colorado 80225. (9 p., 4 figs.)

The Great Lakes tectonic zone is a major Precambrian crustal feature more than 1,200 km long extending eastward from Minnesota into Ontario, Canada. It is a zone of distinctive tectonism, affecting both Archean and early Proterozoic rocks, along the northern margin of the early Proterozoic Penokean fold belt adjacent to the Archean Superior province. The zone coincides with the boundary between two Archean crustal segments recognized in the region: a greenstone-granite terrane (~2,700 m.y. old) to the north (Superior province) and an older (in part 3,500 m.y. old) gneiss terrane to the south. Tectonism along the zone began in the late Archean, during the joining together of the two terranes into a single continental mass, and culminated in the early Proterozoic, when steep or northward-facing overturned folds were formed in the supracrustal rocks, and intense cataclasis and a penetrative cleavage developed in subjacent basement rocks of the greenstone-granite terrane. The Proterozoic deformation took place under low to intermediate pressures.

Movement occurred along the Great Lakes tectonic zone through much of the Precambrian time recorded in the region. In the early Proterozoic, crustal foundering, which was parallel to the zone and was diachronous, initiated the structural basins in which the early Proterozoic sequences of the Lake Superior and Lake Huron regions were deposited. Later, during the Penokean orogeny (~1,850 to 1,900 m.y. ago), compression deformed the sequences in both regions. Still later, intermittent (~1,850 to 1,100 m.y. ago) crustal extension provided sites for emplacement of abundant mafic igneous rocks. There is no definite evidence that any of the extensional events progressed to the stage of develop-

ment of oceanic crust; probably the zone has been wholly intracratonal since its inception in late Archean time.

During the Phanerozoic, minor differential movements occurred locally in the Great Lakes tectonic zone, as recorded by the thinning of Cretaceous strata and their subsequent tilting and by historic earthquakes in Minnesota.

- 
- 01204—Late Precambrian evolution of Afro-Arabian crust from ocean arc to craton.

*A.E.J. Engel, T. H. Dixon, R. J. Stern, Geological Research Division, Scripps Institution of Oceanography, La Jolla, California 92093 (present address: Dixon, Jet Propulsion Laboratory 183-701, 4800 Oak Grove Dr., Pasadena, California 91603; present address: Stern, Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Rd., N.W., Washington, D.C. 20015. (8 p., 5 figs., 3 tbls.)*

Large parts of northeast Africa and Saudi Arabia consist of a telescoped, Proterozoic island-arc ocean-basin complex less than 1 b.y. old. In the central Eastern Desert of Egypt, the oldest units in the complex are a mafic and ultramafic sequence representing an oceanic substrate. Concentrations of elements in constituent rocks least altered by metamorphism, including Cr, Ni, Ti, and REE in the ultramafic rocks and pillow basalts, are essentially those found in similar rocks of contemporary oceanic crust.

Thick sequences of calc-alkaline volcanic rocks and related volcanogenic metasediments, including wackes, breccias, and banded iron formations, overlie the oceanic substrate. The andesitic volcanic rocks are similar to those in modern circum-Pacific island arcs, although amounts of Cr and Ni tend to be higher. Rare cobble beds in the metasediments in the Eastern Desert of Egypt contain granitic and quartzitic clasts derived from old Proterozoic and Archean forelands, presumably those exposed west of the Nile River. Stratiform ultramafic sills as much as 1 km thick, as well as thinner gabbroic sheets are intruded as magmas within the metasediments. The composition of the ultramafic sills approximates that of basaltic komatiites.

In eastern Egypt, granitic plutons, ranging from syntectonic quartz diorites to a post-tectonic flood of LIL-enriched granite emplaced 550 to 570 m.y. B.P. partly engulf and surround much of the ocean-arc complex. Age studies suggest that the Egyptian segment of the ocean-arc complex could have evolved, been telescoped, and intruded by progressively more voluminous and fractionated granitic rocks between about 550 and 850 m.y. B.P. In southwest Saudi Arabia, limited radiometric data obtained by the U.S. Geological Survey suggest that these processes may have begun slightly earlier.

Both the volcanic rocks within the complex and the granitic rocks intrusive into it have low initial ratios of  $Sr^{87}/Sr^{86}$  ( $<0.704$ ), suggestive of a mantle origin. There is no evidence of older sialic roots beneath the complex.

- 
- 01205—Permian-Carboniferous glaciation in the Arabian Peninsula.

*H. A. McClure, Arabian American Oil Company, Dhahran, Saudi Arabia. (6 p., 3 figs.)*

Sedimentary, palynologic, and stratigraphic analyses indicate

that late Paleozoic glaciation probably occurred in the southern part of the Arabian Peninsula. Till and glacial boulder deposits appear to have been reworked and re-deposited in a fluvial and nearshore environment near the southern edge of the Arabian paleo-Tethys Sea. Spore and pollen analyses and stratigraphic relationships indicate a Permian-Carboniferous age for the beds containing the glacial evidence. Gondwanaland connections between southeast Arabia and the Indian plate possibly existed.

- 
- 01206—Valders-Two Creeks, Wisconsin, revisited: The Valders Till is most likely post-Twocreekan.

*Robert F. Black, Department of Geology and Geophysics, University of Connecticut, Storrs, Connecticut 06268. (11 p., 6 figs.)*

The well-documented and dated post-Twocreekan drift (classical Valders Till) of the Green Bay-Fox River-Lake Winnebago lowland is traced to an interlobate junction with the Lake Michigan Lobe that overrode the Valders type locality. Additional support for the post-Twocreekan age of the surface drift between Valders and Two Creeks comes in part from geomorphic evidence of drainage from Later Lake Oshkosh into Glacial Lake Shoto between Manitowoc and Two Rivers.

The key new data and reinterpretations include: (1) a radiocarbon-dated site demonstrating that the surface till of the Green Bay Lobe there is post-Twocreekan, (2) the correlation of that site to the Brillon esker only 500 m northeast and at the same elevation, (3) the correlation of the stratigraphy and morphologic forms of those two localities to an interlobate moraine, (4) the recognition of the interlobate character of the moraine by the amount and structure of lacustrine and fluvial sediments to the crest of that moraine which required ice on both sides simultaneously, (5) the relationships of the drainage of post-Twocreekan Later Lake Oshkosh to Twocreekan wood and to the upper level of Glacial Lake Shoto, (6) the equivalent level of post-Twocreekan Glacial Lake Shoto to the (I believe) erroneously interpreted pre-Twocreekan Glenwood Stage of Glacial Lake Chicago, and (7) other details of the stratigraphy and morphology of the drift that support the thesis outlined above.

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- 01207—Wind-driven sand in Coachella Valley, California: Further data.

*Robert P. Sharp, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125. (7 p., 8 figs., 2 tbls.)*

The last 5 yr (1964–1969) of a 16-yr field experiment involving unidirectional wind-blown rock and mineral debris focused on study of ground-based objects. A large increase in wind-blown material crossing the plot resulted from accelerated fluvial flooding of the upwind alluvial source area starting in 1964. The plot itself was destroyed by such flooding in early 1969.

Maximum cutting of 2.8 cm in 15 yr on a vertical lucite rod occurred on its oblique upwind sides, at 10 to 15 cm above ground. Cutting rate in the last 3 yr was 15 times greater than in the preceding 12 yr, coincident with the

increased flux of wind-borne material. A 30-cm gypsum-cement cube showed an 11-fold increase of cutting rate during the last 4 yr (3.6 cm/yr compared to 0.34 cm/yr). Total cutting on the front face was 18 times greater than on the two side faces combined, an average cutting ratio of 36/1. Common red bricks recorded an average front-to-side-face cutting ratio of 20/1, and a front-to-top ratio of 45/1. Cutting of 1 to 2 mm occurred on hard crystalline rock within 15 yr, much of it in the last 5 yr.

Changes in orientation and position of gypsum-cement cubes and common bricks were produced by basal ground scour, tilting, rotation, creep, and tumbling. Newly placed hydrocal cubes developed upwind tilts as much as 17° in as little as 69 days (d), owing to basal scour. A slow upwind creep of 2 to 3 cm accompanied scour and tilt. A 90° rotation around a near-vertical axis of a brick demonstrated the importance of lever-arm length offered to the wind. Movements of many centimetres and complete reversals, bottom for top, were caused by tumbling. Separation of the base of cubes from the ground by tilting or by perching on residual pebbles, owing to scour or overturn, usually produced an instability favorable to movement.

• 01208—Furrowed mud waves on the western Bermuda Rise.

R. E. Embley, *National Ocean Survey, NOAA, Rockville, Maryland 20852*, P. J. Hoose, *Lamont-Doherty Geological Observatory, Palisades, New York 10964*, P. Lonsdale, *University of California, San Diego, Marine Physical Laboratory of Scripps Institution of Oceanography, La Jolla, California 92093*, L. Mayer, *University of California, San Diego, Marine Physical Laboratory of the Scripps Institution of Oceanography, La Jolla, California 92093*, B. E. Tucholke, *Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543* (present address: Mayer, *Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881*.) Note: Authors listed alphabetically. (10 p., 11 figs.)

A deep-tow sonar and photographic survey of 75 km<sup>2</sup> of the western Bermuda Rise, supported by limited coring and bottom-current measurements, mapped several types of bed forms molded by a northeasterly Antarctic Bottom Water current. Large-scale mud waves as much as 30 m high and 4 to 6 km apart are oriented 30° to the left of the mean current, and preferential deposition on their northwest faces has caused slow migration in that direction. Most of these faces have been dissected by straight parallel troughs or large furrows, as much as 50 m wide and 10 m deep, which form strips of roughened sea floor with anomalously high acoustic bottom loss. The "smooth" sea bed on the opposite faces of the mud waves is lineated by lower amplitude, closely spaced "small furrows." The distribution of these inter-

mediate-scale, furrow bed forms may correlate with variations in sediment erodibility or in current strength over the surface of the large-scale mud waves. Some recent current ripples, tool marks, and current-smoothed sea bed indicate continued local current activity. However, the site is exposed to variable and generally weak bottom currents, which now may only maintain furrows that formed under a different flow regime.

• 01209—Submarine topography and shallow structure of the Madagascar Ridge, western Indian Ocean.

Jean Goslin, Jacques Segoufin, Roland Schlich, *Institut de Physique du Globe, Laboratoire de Géophysique Marine, 4, Avenue de Neptune, 94100 Saint Maur des Fossés, France*; Robert L. Fisher, *Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093*. (13 p., 7 figs., 1 tbl.)

Bathymetric, seismic-reflection, seismic-refraction, and magnetic-anomaly data suggest that the Madagascar Ridge consists of two different domains. North of 31°S, both the sea floor and the basement topography appear to be locally and regionally complex. Small sediment-filled pockets are present between numerous basaltic basement highs. Large-scale normal faulting shapes the western flank; on the east, the Late Cretaceous fracture zones of the Madagascar Basin penetrate deeply into the ridge. South of 32°S, an extensive area of thick undeformed sediments is found over the central part of the ridge. Two prominent seismic horizons—the upper one being attributed to an unconformity between lower Eocene–upper Oligocene and lower Miocene sediments—can be mapped throughout this area. The steep western slope reflects the Mozambique Basin fracture-zone trends. Both the topography and sediment cover at the southeastern limit are closely related to the north-south-trending fracture zones of the Southwest Indian Ridge. The character of magnetic anomalies is in accord with this regional subdivision. An east-west-trending rise situated near 32°S and marked by the 4,000-m isobath marks the former boundary of two spreading systems that are related to the Central Indian Ridge and the Southwest Indian Ridge. The shallow structural data and our interpretation of those data favor an oceanic nature for the entire Madagascar Ridge.

• 01210—Tectonic origin for Sudbury, Ontario, shatter cones: Discussion and reply. (3 p.)

Discussion: Edward F. Pattison, *Exploration Department, Inco Metals Company, Copper cliff, Ontario POM INO, Canada*.

Reply: Michael E. Fleet, *Department of Geology, University of Western Ontario London, Ontario N6A 5B7, Canada*.

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