GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

JUNE 1978

Report of Committee on Publications

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

The Committee on Publications held two assembled meetings during 1977 at GSA headquarters in Boulder. The first was on February 18 and the second on October 24. However, there was continuous contact throughout the year, particularly between the Committee Chairman and the Executive Director.

The February meeting was concerned with the full range of publication problems. The backlog of unpublished *Bulletin* manuscripts had continued to increase, publication costs also continued to increase, and it was apparent that plans must be made to remedy the situation in the short term and also provide for a long-term solution.

For the short term, it was recommended that future papers should not exceed 40, rather than 50, manuscript pages. Notice was given to authors of the two-year-plus delay in publication time, and an opportunity was offered to withdraw submitted manuscripts. Associate Editors and reviewers were encouraged to recommend justifiable cuts in length of text. And, if the budget permitted, the size of the *Bulletin* would be increased temporarily.

For some years, the Committee on Publications and the Society have recognized an impending crisis in the costs of publication. It apparently has arrived. Our Society is more vigorous and scientifically productive than ever before. This is clearly indicated by the steady growth of membership and of papers presented at national meetings. (Both have approximately doubled in the last 10 years!) At the same time, the costs per unit of publication have climbed about as fast. The Society cannot absorb the compound impact on its current publications budget. A wholly new approach for providing adequate but not exorbitant formats is indicated for the publications of the Society.

The President and Executive Director presented to the Committee an innovative concept—new to the geological sciences, but based on experimentation that has been carried on in other scientific societies. In essence, the scheme provides for a two-part *Bulletin*. Part I would consist of approximately two-page summaries, edited and printed in the same format as the present *Bulletin*. Part II would carry the full text on 24X microfiche, author-prepared camera-ready copy, not text-edited at headquarters, and the present arbitrary length limits would be eliminated. Parts I and II would have separate subscription prices so that either could be purchased separately. The new system is to go into effect with the January 1979 number of the *Bulletin*.

The advantages of the new system, when fully implemented, are that approximately twice the volume of literature can be handled at less cost than the present length *Bulletin*, and the delay or lag time between acceptance and publication can be reduced to less than one half of the average 2½ years that will prevail for 1978. The first year for the new system, 1979, will be a year of transition with all the problems that term implies. Because of the unpublished backlog of accepted papers, during 1979, Part I will require as many pages each month (160) as the present format and will be a mix of summaries for the microfiche Part II and conventional full papers. Part II will probably consist of only 2 or 3 cards (98 frames or pages each), as authors become accustomed to the new system. By 1980, it is anticipated that Part I will drop to 64 pages (from the 160-page forecast for 1979), and Part II may increase to 4 or 5 fiche (or in the range of 400 to 500 pages) per month.

(continued on p. 346)

Annual Report for 1977 The Geological Society of America

APPLICANT AND EMPLOYER FORMS ARE BACK-TO-BACK ON THE FOLLOWING PAGES

GSA Employment Service operates throughout the year

GSA maintains a computer file, updated continuously throughout the year, of persons seeking jobs. The information contained on this file includes the applicants' areas of interest, years of experience, and educational background. An interested employer with an opening submits the job requirements and receives a computer printout of all applicants whose qualifications match those requirements. It is then up to the employer to contact applicants in whom he or she is interested.

In the past, most employers who have used the GSA Employment Service have been interested in applicants with M.S. or Ph.D. degrees. Recently a few employers have indicated they have positions requiring B.A. or B.S. degrees, especially if the degree holder has work experience.

The minimum fee for employers requesting computer printouts is $40 for two specialty listings; $10 for each additional specialty listing.

Applicant registration is $15 per year and includes participation in the Annual Meeting Interview Service. Apply soon so your name can be included on printouts to employers who use the year-round service as well as to employers who will interview in Toronto.

Join us in Toronto for the Annual Meeting Employment Interview Service

Each fall, GSA holds an Employment Interview Service during its annual meeting. Recruiters rent interview booth space for a nominal charge, and staff is available to help schedule interviews. In some cases, employers contact applicants whom they wish to interview during the meeting. It is also possible for applicants to schedule interviews during the meeting. Additional information may be obtained by writing for

Applicant Information

Jill Couchman
Membership Department
Geological Society of America
3300 Penrose Place
Boulder, CO 80301
(303) 447-2020

Employer Information

Charlene Bicknell
Membership Department
Geological Society of America
3300 Penrose Place
Boulder, CO 80301
(303) 447-2020

NOTE TO APPLICANTS: The deadline for application acceptance is September 15, 1978. Any application postmarked after that date will be accepted and put on file but will not appear on the computer printout that is sent to employers prior to the annual meeting.

(continued from p. 345)

This system was approved by the Council in May 1977, and since then it has been in the process of development by the headquarters staff.

The second major problem for the Committee was the employment of a permanent person as Science Editor. From November 1975 through December 1976, Warren Hobbs served as Interim Science Editor, and Paul Averitt served in the same capacity starting in January 1977. Henry Spall, even after his move to Reston, Virginia, continued to serve as Editor of *Geology*. At the fall meeting of the Council in Salt Lake City, 1975, the position was offered to Dr. Peter J. Smith of the Open University, England, and Dr. Smith accepted, subject to procurement of an immigration visa. Unfortunately, unexpected delays persisted so that by the fall Council meeting of 1976, a time limit for negotiation was established. At the May 1977 Council meeting, the Publications Committee was instructed to assume the responsibility of a search and screening committee for a new permanent science editor. Applications were solicited by multiple announcements in *GSA News & Information* and in *Geotimes*. More than 40 applications, many from highly qualified geologists, were received.

The Committee met at headquarters on October 24 for the purpose of screening the applicant list and preparing a recommendation to the Executive Committee. This was done, and the Executive Committee met in December for interviews with recommended candidates. As a result of this procedure, Vernon E. Swanson was employed as Science Editor on February 1, 1978.

The Committee wishes to add its thanks to Warren Hobbs, Paul Averitt, and Henry Spall for their excellent editorial services for the Society.

Respectfully submitted,

LEON T. SILVER
Chairman

Annual Report for 1977
The Geological Society of America

Letter of appreciation from AGI Minority Participation Committee

Director, Geological Society of America
3300 Penrose Place
Boulder, Colorado 80301

Dear GSA Members:

As a member of the American Geological Institute's Minority Scholarship Advisory Committee, I would like to take this opportunity to thank you for the generosity shown in your recent funding to cover the scholarship program for the 1978-79 academic year. Your involvement, and that of other industrial organigations, professional societies and individuals, will ensure that some minority students will be able to successfully continue their studies and not abandon them due to lack of money.

I want to assure you that these monies will be used wisely to encourage qualified science-oriented minority students to help achieve their academic goals and eventually enter into the geoscience profession. Each member of the Advisory Committee has personally been involved in the various financial programs that are associated with minority students in the academic world. Each Committee member has the knowledge required to accomplish the goals of the AGI minority program. The input of the minority students into the geosciences is still relatively new, but we are beginning to see a large output of qualified students entering professional careers who have accomplished this with the help given by groups such as yours.

Again, my personal thanks and that of the Advisory Committee. We have made some progress in defining the success of some of our scholars. This information has previously been passed to you. I feel sure that each of us is pleased to have had a part in their success story.

Earl H. Bescher, Jr.
Chairman, AGI Minority
Participation Committee

Landsat/Appalachians data sought

As part of the NSF project, entitled "Application of Plate Tectonics to the Location of New Mineral Targets in the Appalachians," a collection is being established and a list compiled of the available/published Landsat geologic interpretations of the Appalachian orogen. Of special interest are the lineament/fracture maps (at all scales) and the analyses of the interpreted data in relation to stress fields and metallogeny. Copies of reports, maps, and other information should be sent to: Dr. George A. Rabchevsky, The American University, Beeghly Building, Washington, D.C. 20016.

Necrology

Notice has been received of the following deaths: Judson L. Anderson, Doylestown, Pennsylvania; Ian Campbell, San Francisco, California; Richard P. Keizer, Austin, Texas; Edward Sampson, Princeton, New Jersey; Edmund M. Spieker, Columbus, Ohio.

? *Common questions on the new* ? GSA *Bulletin, Part II* — Microfiche

"O.K., but can we get paper copies?"

"What if I need a hard copy?"

Paper copies of any article on the *Bulletin Part II* microfiche (beginning January 1979) will be easily available from two sources:

1. University Microfilms, Inc., will supply within 2 weeks one article or as many as ordered. Approximate cost will be $4.00 per article to cover printing, handling, and postage.
2. The microfiche reader/printers, available in most major libraries, make copies instantly, one page or as many as desired.

Duties change for two on Headquarters staff

On June 1, 1978, Marianne L. Faber became Assistant to the Science Editor for GSA, replacing Irene T. Woodall. Marianne Faber, in addition to her new responsibilities, will retain her duties as assistant to the *Geology* editor, and Irene Woodall will assume the approximately one-half-time newly designated position of Abstracts Coordinator.

Marianne, whose voice on the telephone is very familiar to authors and reviewers of manuscripts submitted to *Geology*, has been with the Society for four years. Irene, who has had contact with many GSA members and with most authors of all types of reports prepared for GSA publication during recent years, has been with the Society for eight years. Irene will now be working only half-time, but her valued advice will continue to be available to GSA's Publication Department.

Palynology Association to hold meeting on "Future Challenges"

The 12th Annual Meeting of American Association of Stratigraphic Palynology will be held October 31–November 3, 1979, in Dallas, Texas. The theme of the meeting is "Future Challenges and Innovations," with a symposium entitled "Kerogen Analysis—Visual and Geochemical Relationships." A field trip to the Dinosaur Valley State Park, Glen Rose, Texas, will be conducted November 3.

NEWS FOR POSTER SESSION APPLICANTS

Please note: The available display area for Poster Session Exhibitors during the "Toronto '78" Annual Meeting will be **4' x 6'** instead of the normal 4' x 8'.

How to search GeoRef on-line

• WHAT YOU WILL NEED FIRST

A terminal with an acoustic coupler (for attaching a telephone). You can buy a reliable terminal new for about $2,000, or lease it for less than $100 a month (including maintenance).

ORBIT User Manual ($15, from System Development Corp. Search Service, 2500 Colorado Avenue, Santa Monica, CA 90406). SDC maintains the GeoRef Data Base (and more than thirty other data bases) on its computer, using a program called ORBIT. The ORBIT User Manual includes the procedure for dialing the computer and instructions and examples for each of the search commands.

ORBIT User Manual for GeoRef ($5, from SDC Search Service) describes the on-line GeoRef File.

GeoRef Thesaurus and Guide to Indexing ($35, paper; $20, microfiche, from GeoRef, American Geological Institute, 5205 Leesburg Pike, Falls Church, VA 22041). Provides a cross-referenced list of all the index terms used by GeoRef and includes usage notes.

• ADDITIONAL HELPFUL NEWS:

SDC Microform Index Listing for GeoRef ($25, from SDC Search Service) gives an alphabetical listing of all index terms in GeoRef and the frequency of their occurrence in the file.

Serials in GeoRef ($5) and **KWOC Index to Serials in GeoRef** ($10), both on microfiche (from GeoRef, American Geological Institute).

If you don't have a terminal or don't want to do the on-line searching yourself, you can have a GeoRef editor at the American Geological Institute make the search. Cost: $75 per search, plus 15¢ per reference supplied. For information on a custom search, write to Dr. G. N. Rassam, Chief Editor, GeoRef, American Geological Institute, 5205 Leesburg Pike, Falls Church, VA 22041, or telephone (703) 379-2480.

• BEFORE YOU BEGIN:

Phone the SDC Search Service (800) 421-7229 to request a User ID number for searching on-line.

Plan your search from the GeoRef Thesaurus, select the index terms that best apply to your topic or area of interest. Review the search procedures described in the ORBIT manuals.

• TO MAKE THE SEARCH:

Dial the computer through the nearest communications network (Tymeshare or Telenet) number. For many cities this is a local call. If not, you must pay the long distance charge to reach the nearest node of the network.

Request your references, by typing your selected index terms on the terminal keyboard. The terminal will respond with the number of references found. You can have a sample printed on the terminal. If not satisfied you can alter your search strategy and try again.

For a large number of references—more than 20 or 25—you may find it more economical to request them to be printed off-line and airmailed to you, rather than have them printed at the terminal.

• IF YOU NEED HELP:

For information on terminals, Tymeshare and Telenet, startup procedures, ORBIT commands, search logic, and specific data bases, phone the SDC Search Service Action Desk Monday through Friday, 8 a.m. until 5 p.m. (Pacific Time). (800) 421-7229, or write.

For details on how to search for specific topics in GeoRef, when an in-depth knowledge of GeoRef indexing practice is needed, write or phone Dr. G. N. Rassam, Chief Editor, American Geological Institute.

Opportunities abroad for teachers

Opportunities to attend a summer seminar or to teach abroad will be available under the Fulbright-Hays Act for the 1979–80 school year.

Elementary and secondary teachers, college instructors, and assistant professors are eligible to participate in the teacher exchange program. Basic requirements are: U.S. citizenship, a bachelor's degree, three years of teaching experience for one-year positions and two years of experience for seminars. As most of the positions are on an interchange basis, applicants must be employed currently. Seminars for current teachers of art, the classics, German, and world, Asian, or Middle Eastern history and area studies will be held in 1979. A seminar will be held also for social studies supervisors, curriculum directors, teacher educators, and school administrators responsible for curriculum development.

Application should be made before November 1, 1978. A brochure and application form can be obtained in September by writing to

Teacher Exchange Section
Division of International Education
U.S. Office of Education
Washington, D.C. 20202

Fulbright-Hays awards in geology

Among approximately 500 Fulbright-Hays awards available in about 100 countries for 1979–80, several have been programmed in geology.

Australia: rock blasting design; postdoctoral fellowship in experimental petrology; *Ivory Coast* (French required); *Norway:* petroleum geophysics; rock studies; *Pakistan:* general geology or soil mechanics; *U.S.S.R.:* geophysical prospecting.

Those desiring a copy of the 1979–80 announcement of Fulbright-Hays award opportunities for university teaching and advanced research abroad should send name, address, highest degree, specialization and country interest to the Council for International Exchange of Scholars, Eleven Dupont Circle, Washington, D.C. 20036. Applications are due for Africa, Asia, and Europe by July 1, 1978.

CIES will also assist in the administration of about 500 awards in 1979–80 for Fulbright scholars visiting the U.S. for lecturing and research. In many cases host institutions are expected to assist the scholar with full or partial maintenance; inquiries are welcome. A directory of scholars currently in the U.S. is available on request.

gsa publications

Late Quaternary Geology of the Lower Granite Reservoir Area, Lower Snake River, Washington

MC-18 — By Hallett H. Hammett. 1977. One sheet, in color, 37½″ × 25″. Scale: 1:25,000. Mapped to 1,200-foot contour. Folded, $6.75; rolled, $7.75.

The map, multi-colored, represents the geology of the Lower Snake River valley from the Idaho border northwestward some 50 km to the Lower Granite Dam, Washington. The valley was mapped to about the 1,200-foot level, which represents a valley width of approximately 1 to 2 km. Formations and deposits comprise pre-Pleistocene basalt and granodiorite, and Pleistocene and Holocene gravel and alluvium. Scale is 0.6 km per inch.

Geologic Map of Papoose Flat Pluton, Inyo Mountains, California

MC-20 — By Gerhard Oertel, C. A. Nelson, J. M. Christie, and A. G. Sylvester, 1977. In 3 sheets; geologic, in color, 28½″ × 18½″. Scale, 1:32,000; geologic cross sections, b&w, 19¾″ × 18½″; palinspastic geologic, b&w, 20¾″ × 18½″. Folded, $5.00; rolled, $6.00.

The map comprises three separate sheets: (1) geologic map, in color, (2) palinspastic geologic map, and (3) fence diagram of cross sections. The area is situated 40 km west of the north end of Death Valley, east-central California (lat 37°), and occupies about 240 km². Scale is 0.8 km per inch, on a topographic base.

The Papoose Flat pluton (Cretaceous) consists of coarse-grained, porphyritic quartz monzonite which is strongly foliated in its border zone; the pluton is surrounded by sedimentary and metamorphic rocks of Precambrian and Cambrian ages. Among other structural features recorded are dikes of various types, and mineralized joints. The palinspastic geologic map includes six fabric diagrams showing strong preferred orientation of quartz grains in each of six border-zone specimens.

The Papoose Flat pluton is described in detail in a paper to be published in the August 1978 issue of the *Bulletin*.

Bathymetry of the Norwegian-Greenland and Western Barents Seas

MC-21 — Compiled by R. K. Perry, H. S. Fleming, N.Z. Cherkis, R. H. Feden, and J. V. Massingill for the U.S. Naval Research Laboratory. 1977. One sheet, in color, 42″ × 57″. Scale: 1:2,333,230 at latitude 71°N. Ship tracks are shown on the reverse side for obverse viewing. References. Folded, $7.25; rolled, $8.75.

The map encompasses the oceanic region extending some 2,600 km from the Orkney Islands in the south to the northern shores of Greenland and Spitsbergen. The scale is 1:2,333,230 (at lat 71°N); the bathymetric contour interval is 100 and 200 m, with depths shown in tints ranging from dark blue to pale green. The map sheet measures about 1.1 by 1.5 m.

The location of ship traverses from which soundings were obtained and locations of earthquake epicenters are shown on the reverse side of the sheet for obverse viewing. Two small outline maps show physiographic provinces and aeromagnetic profiles, the latter obtained during 1972, 1973, and 1974 by the Naval Research Laboratory.

Sixteen principal sources of the bathymetric data are given. In addition, a bibliography lists 177 references to literature on the region.

This map was compiled and published originally by the U.S. Naval Research Laboratory in 1977, in a very limited edition.

Geologic Maps of Part of the Spanish Peaks Dike System, South-Central Colorado

MC-22 — By Richard P. Smith. 1978. One sheet, b&w, 23″ × 26″. Scale about 1:3,017, or 1.75 in. per mile. Contour interval 200 ft. Accompanied by 2-page explanatory text. Folded, $4.50; rolled, $5.50.

This detailed map of the interesting radial dike swarm southeast of the Spanish Peaks suggests that the dikes emanated sequentially from two buried intrusive centers interpreted as apophyses of the exposed West Spanish Peak stock. Structural and compositional relations at many points of dike intersections show the sequence of dike intrusion to be as follows: (1) intrusion of a single small lamprophyre dike from the buried center northeast of the stock; (2) intrusion of many nonlamprophyre dikes from the buried intrusive center east of the stock; and (3) intrusion of both lamprophyre and nonlamprophyre dikes from the first buried center northeast of the stock. Absolute ages of the radial dikes and of the buried intrusive centers range from about 20 to about 27 m.y.

June BULLETIN briefs

Brief summaries of articles in the June 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.*

• 80601—Precambrian basement at Molodezhnaya Station, East Antarctica.

Edward S. Grew, Department of Earth and Planetary Sciences, University of California, Los Angeles, Los Angeles, California 90024. (13 p. 9 figs., 7 tbls.)

The Precambrian basement exposed around Molodezhnaya Station (lat 67°40'S, long 45°50'E) in western Enderby Land, Antarctica, consists largely of well-layered, in part migmatitic, gneisses and of plutonic gneisses. The most abundant rock types in the well-layered gneisses are pyroxene gneiss, hornblende gneiss, garnet-biotite gneiss, garnet-pyroxene gneiss, and quartzofeldspathic gneiss. The plutonic gneisses crop out in three bodies, each of a different rock type: charnockitic, granodioritic, and enderbitic. Field relations show that the charnockitic gneiss locally cuts the compositional layering in the well-layered gneisses and that it was emplaced prior to granulite-facies metamorphism and folding.

Total-rock Rb-Sr ages calculated on seven samples of quartzofeldspathic gneiss range from 460 ± 250 to 2,120 ± 155 m.y. (assumed initial Sr^{87}/Sr^{86} ratio of 0.715). Eight samples of charnockitic gneiss give an isochron age of 987 ± 60 m.y. and an initial ratio of 0.7109 ± 0.0015. Seven samples of granite give an isochron age of 512 ± 155 m.y. U-Th-Pb data on monazite, sphene, and allanite from pegmatites indicate an age of crystallization of 500 to 550 m.y. for the pegmatites. Rb-Sr ages of 460 and 465 m.y. were obtained on biotites from gneiss.

The geochronologic data are consistent with the following sequence of events: (1) Formation of the well-layered gneisses, possibly 2,000 m.y. ago. (2) Plutonism, granulite-facies metamorphism, and folding, 1,000 m.y. ago. (3) Dikes of granite and pegmatite, amphibolite-facies metamorphism, and faulting, 500 to 550 m.y. ago. (4) Secondary mineralization, possibly 400 to 500 m.y. ago.

The event 1,000 m.y. ago appears to have been important in this part of Antarctica, and some Antarctic charnockites may have been emplaced at that time.

• 80602—Kink bands in the Somport slates, west-central Pyrenees, France and Spain.

Earl R. Verbeek, U.S. Geological Survey, Federal Center, Denver, Colorado 80225. (11 p., 19 figs.)

The dominant fabric element of the Somport slates of the west-central Pyrenees is a pervasive slaty cleavage of moderate to steep northward dip, attributed to the main phase of Alpine deformation. The slates are locally kinked to lesser dips around subhorizontal, east-trending kink-fold axes. The morphology and angular relationships of the kink bands attest to an origin by the rotation mechanism, in which cleavage segments of invariant length are externally rotated between the kink-band boundaries.

Pervasive slip on the slaty cleavage surfaces predated formation of the kink bands; this slip ended as kinking destroyed the planarity of the cleavage sheet. Additional strain was accommodated by progressive rotation of cleavage segments to lesser dips within kink bands, and by the continued production of new kinks. Later strain increments led to minor rotation of the long cleavage segments between adjacent kink bands (previously a part of the unkinked domain), resulting in interkink dilation of the cleavage laminae and precipitation of calcite in the voids so formed. The formation of microscopic calcite-filled tension cracks spanned the entire deformation.

Kinking by the rotation mechanism implies a volume expansion, for the kinked laminae in ideal rotation kinks dilate upon folding. Evidence for such dilation is common in the Somport slates and is normally taken as an indication of deformation at very shallow crustal levels. Bulk strain effects of this late deformation may be summarized as a vertical contraction, a horizontal, north-south expansion, and an overall dilation of the rock mass in which the kinks formed. It is suggested that these structures developed in response to postorogenic uplift and erosional disection of the Pyrenees, for only then would confining pressures have decreased sufficiently to permit a net dilation during kinking.

• 80603—Late Pleistocene pyroclastic deposits of Soufrière Volcano, St. Vincent, West Indies.

Keith Rowley, Seismic Research Unit, University of the West Indies, St. Augustine, Trinidad, West Indies. (11 p., 10 figs.)

Soufrière is a stratovolcano just higher than 1,000 m which dominates the northern part of the island of St. Vincent in the Lesser Antilles. A succession of pyroclastic fall deposits produced by this volcano covers about 55% of the island. Maximum thicknesses away from the crater area range from 50 m in the northeastern area of the island to 2 m in the Kingstown area at the southern tip. These deposits, believed to be of late Pleistocene age, were produced during a unique phase of extremely violent activity which may not have lasted for more than a few hundred years; during this time, the volcano was in nearly constant activity. The eruptions took place from an open summit crater similar to the present one, which may have been periodically blocked by lava domes during short quiescent spells. The deposits were produced by plinian, vulcanian, and strombolian type eruptions, some of which may have been directed blasts.

The composition of the pyroclastic falls is distinctly more mafic than that of the average Soufrière lava from previous eruptions. Chemical variation in vertical sections

shows that tephre with the highest silica content is ejected at the start of an eruption, usually as pumice, and is followed by more mafic material. High-level fractionation of basaltic magma under the volcano is inferred from this pattern of behavior.

• 80604—Asymmetric sea-floor spreading and a nontransform axis offset: The East Pacific Rise 20°S survey area.

David K. Rea, Department of Atmospheric and Oceanic Science, The University of Michigan, Ann Arbor, Michigan 48109. (9 p., 6 figs., 3 tbls.)

Data obtained from the East Pacific Rise near 20°S provide an opportunity to make a detailed study of an asymmetrically spreading rise crest. During the past 2.4 m.y., crustal accretion has occurred here at 70 mm/yr on the west flank and 92 mm/yr to the east. Ocean-floor depths are also asymmetrically situated across the rise axis with the east flank being 100 to 150 m deeper than the west. These two asymmetries can best be explained by presuming the existence of a heat source located below the west flank of the rise. The axial ridge of the East Pacific Rise is offset 15 km right laterally across a region near 20.7°S that is a 30- to 40-km wide zone of shearing and not a well-defined transform fault. This offset appears to be the result of a small, discrete jump of the spreading center that occurred about 2 m.y. ago. Because of the nontransform nature of the small axis offset, the orientation of its trace recorded by ocean-floor bathymetry and magnetics is not determined by the relative motion of the Nazca and Pacific plates but by the relative motion between each individual plate and the location of the small axial offset. The trace of the small offset at 20.7°S and of apparently similar features occurring near 49°N and 26°N on the Mid-Atlantic Ridge form broad V's about the spreading axis. The trends of the arms of the V's may record absolute motion of individual plates as they move away from the locus of the small, nontransform, axial offsets.

• 80605—Structural petrology of the Olympus ultramafic complex in the Troodos ophiolite, Cyprus.

Richard P. George, Jr., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025 (present address, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024). (21 p., 10 figs.)

The Olympus ultramafic complex is one of three ultramafic complexes that crop out at the lowermost stratigraphic levels of the Troodos ophiolite, Cyprus. The Olympus ultramafic complex comprises two types of ultramafic and related rocks: (1) harzburgite tectonite, a residuum of partial fusion, and (2) cumulus chromitite, dunite, wehrlite, pyroxenite, and gabbro, the products of fractional crystallization and magmatic sedimentation of basaltic magma. The harzburgite tectonite is the basement or "country rock" intruded by the magma from which the cumulates crystallized. Pyrometamorphic textures in the harzburgite (magmatic pyroxenes in metamorphic peridotite) near its contact with the cumulates perhaps record "contact metamorphism" of the harzburgite by the magma.

The stratigraphically lowest cumulates were penetratively deformed (and hence are termed "ultramafic metacumulates") during the same event that produced the dominant pyroxene foliation (S_1) in the underlying harzburgite, whereas the stratigraphically highest cumulates were not penetratively deformed. The structural transition between metacumulates and cumulates is gradual and occurs in olivine cumulates that contain intercumulus clinopyroxene (clinopyroxene-bearing dunites and wehrlites).

Two mechanism can explain the structural transition from metacumulates to cumulates: (1) Deformation of the harzburgite basement occurred during accumulation of the cumulates (syntectonic magmatic sedimentation); the lowermost (oldest) cumulates consequently deformed more than the uppermost (youngest) cumulates. (2) The uppermost cumulates, perhaps rich in intercumulus liquid (now crudely represented by postcumulus clinopyroxene and plagioclase) at the time of the deformation, may have accommodated the strain by grain boundary sliding ("crystal-mush flow") and consequently left little evidence of solid-state, penetrative deformation.

If syntectonic and posttectonic magmatic sedimentation, crystal-mush flow, partial fusion of metamorphic peridotite, and multiple intrusion of magma act simultaneously during the formation of ophiolites, then the resulting field relations, structures, textures, and fabrics will be exceedingly complex, particularly if subsequent transport and emplacement impose strong metamorphic and tectonic overprints. One should expect that differences in the relative chronology and intensity of the processes of the formation of ophiolites make every ophiolite unique.

• 80606—Multiple intrusion and hydrothermal activity, eastern Breckenridge mining district, Summit County, Colorado.

Douglas E. Pride, Department of Geology and Mineralogy, Ohio State University, Columbus, Ohio 43210; Charles S. Robinson, Mineral Systems, Inc., 622 Gardenia Court, Golden, Colorado 80401. (9 p., 8 figs., 2 tbls.)

The Breckenridge mining district is located in Summit County, Colorado, about 95 km west-southwest of Denver, Colorado. Mapping in the eastern end of the district has identified bodies of intrusive rhyodacite porphyry, intrusive breccia, and blow-out breccia in the vicinity of the old Wirepatch mine, an area mapped previously as exclusively quartz monzonite porphyry. The distribution of rock types, alteration patterns, and chronology of emplacement indicate that this portion of the district is part of an intrusive complex that vented periodically in middle Tertiary time.

Propylitic alteration of rocks occurs near the margins of the area, and in the vicinity and to the east of the exposed intrusive rocks, the rocks have been affected by phyllic alteration. Seventy-four composite rock-chip samples were analyzed for lead, zinc, copper, and molybdenum. Eleven of the samples were analyzed also for gold. The amount of lead, zinc, and copper in the sam-

ples appears to be directly related to the degree of hydrothermal alteration of the rocks. Analyses of monzonite and quartz monzonite porphyry yield enrichment factors of 8.9 (lead), 4.3 (zinc), and 6.1 (copper) within the phyllic zone.

Comparison of trace-metal distribution versus intrusive rock types indicates that the metals were added to the host rocks during or shortly following emplacement of the intrusions. Lead, zinc, and copper average 1,143, 1,191, and 259 ppm within samples of rhyodacite porphyry; 2,440, 365, and 278 ppm in samples of intrusive breccia; and 530, 978, and 381 ppm in samples of blow-out breccia. The highest mean molybdenum values are from the blow-out breccia (9.5 ppm), and the two samples bearing significant gold (0.46 and 0.47 ppm) came from the rhyodacite porphyry and the intrusive breccia.

The presence of the intrusive rocks coupled with the pervasive hydrothermal alteration and the high trace-metal concentrations suggest that the area encompassing the Wirepatch mine may contain near-surface sulfide and precious metal deposits in addition to those already exploited. The possible existence at depth of additional intrusions suggests further that the area may contain porphyry-type molybdenum mineralization.

• 80607—Precambrian rhyolites and granites in south-central Wisconsin: Field relations and geochemistry.

Eugene I. Smith, Division of Science, University of Wisconsin–Parkside, Kenosha, Wisconsin 53141. (16 p., 11 figs., 8 tbls.)

Isolates exposures (inliers) of Precambrian rhyolites and and granites (1,765 m.y. old) crop out in the Fox River valley and in the Baraboo area of south-central Wisconsin. The geochemical characterization of rock units, in addition to field and petrographic studies, was used to unravel the complex geology of two of these inliers, the Marquette and Marcellon rhyolites, and to determine in a preliminary fashion the geology of the Precambrian igneous terrain between exposures, which is covered by a section of Paleozoic sedimentary rocks and Pleistocene glacial deposits of varying thickness.

The rhyolite at Marquette consists of a series of ash-flow tuffs, interbedded with mud-flow breccia, which are broadly folded into a series of normal and overturned asymmetric folds. The rhyolite is cut by a 100-m-thick andesite dike that intruded along a northeast-trending normal fault. The top of the exposed section is a porphyritic rhyolite containing quartz, alkali feldspar, and plagioclase phenocrysts. This unit is underlain by ash-flow tuffs ranging from porphyritic quartz, plagioclase, alkali feldspar rhyolite to rhyolite with only plagioclase phenocrysts. Plagioclase units are phenocryst poor and have Rb/Sr ratios greater than 1; the three mineral units are phenocryst rich and have Rb/Sr ratios less than 1.

The rhyolite at Marcellon consists of four ash-flow tuffs folded into a northeast-trending asymmetric antiform. Lithologically, the Marcellon units are spherulitic, flow-banded, brecciated, and massive. Mineralogically, they vary from porphyritic quartz, plagioclase, alkali feldspar rhyolite to plagioclase-bearing rhyolite. Geochemical correlation was used to relate units from one part of the inlier to the other and thus establish the existence of the antiform. This exposure is cut by andesite and basalt dikes.

• 80608—Systematic valley asymmetry in the central California Coast Ranges.

John C. Dohrenwend, Department of Geology, Williams College, Williamstown, Massachusetts 01267. (10 p., 7 figs., 5 tbls.)

Asymmetry of east-west–trending valleys is a prominent landscape feature in the Salinas Valley and Gabilan Mesa of the central California Coast Ranges. North-facing side slopes in these valleys are significantly steeper, less dissected and more heavily vegetated than south-facing side slopes. This systematic asymmetry persists throughout terrains of widely varying lithology, structural style, and tectonic history, and it is most strongly developed in areas that are underlain by horizontal to very gently dipping semiconsolidated sedimentary rocks. Asymmetric distribution of fill terraces and beheaded streams and close correlation between valley side-slope angle and valley gradient demonstrate that preferential lateral stream erosion has played a domint role in the development of this valley asymmetry. For most of the valleys studied, this preferential lateral erosion is not related to tectonic movement; it is caused mainly by the asymmetric operation of slope-wasting processes arising from microclimatic differences on opposing valley side slopes.

• 80609—Separation of Morocco and eastern North America: A Triassic-Liassic stratigraphic record.

Warren Manspeizer, John H. Puffer, Geology Department, Newark College of Arts & Sciences, Rutgers University, Newark, New Jersey 07102; Harold L. Cousminer, American Museum of Natural History, New York, New York 10024. (20 p., 8 figs., 6 tbls.)

New primary data from northwest Africa show that the lower Mesozoic rocks of Morocco rest with profound unconformity on Hercynian metamorphic and/or Autunian sedimentary rocks and occur in three distinct, partially synchronous volcanis-sedimentologic provinces: the Oran Meseta, the High Atlas, and the Moroccan Meseta. The Oran Meseta of northwestern Morocco contains a Middle to Late Triassic andesite and carbonate-evaporite facies related genetically to the Tethys basin. The High Atlas province of southwestern Morocco consists of Late Triassic to Early Jurassic red beds and evaporites interbedded with tholeiite lavas. These tholeiites are underlain by the *Minutosaccus-Patinasporites* Concurrent Range Zone of middle Carnian age and yield an average isotopic age of about 196 m.y. They are time- and rock-stratigraphic correlatives of the First and Second Watchung–York Haven suite and the Quarryville basalts of Pennsylvania and New Jersey. The Moroccan Meseta of western and central Morocco consists of Lower Jurassic (Liassic) evaporites intercalated with low-alkali quartz tholeiites, yielding an isotopic mean age of 186

± 8 m.y. This tholeiite is a rock- and time-stratigraphic correlative of the Rossville basalt of Pennsylvania. The tectonic model best explaining the chemical and stratigraphic distribution of lower Mesozoic rock now on the margins of the North Atlantic includes the following sequence: (1) Permian to Late Triassic uplift and crustal thinning along the axis of the future Atlantic Ocean; (2) Middle to Late Triassic strike-slip faulting and andesitic volcanism along east-trending fracture zones, followed by a westward advance of the Tethys Sea across northern Morocco; (3) Late Triassic rifting along the axis of the proto–Atlantic Ocean and shearing along east-west fracture zones, which had the combined effect of decoupling segments of the African and North American plates and providing a pathway for the marine transgression of the Tethys Sea across north Morocco and south along the axis of rifting; and (4) Late Triassic to Early Jurassic crustal extension and extrusion of olivine and quartz tholeiites, followed by extrusion of subalkalic quartz tholeiites and collapse of the continental margins with the concomitant deposition of marine carbonates.

• 80610—Cenozoic stratigraphy and geologic history of southwestern Arizona.

L. D. Eberly, T. B. Stanley, Jr., Exxon Company, USA, P.O. Box 1600, Midland, Texas 79702, (present address, Stanley: 222 Galbraith Ave., Kerrville, Texas 78028). (20 p., 12 figs., 1 tbls.)

Recently obtained seismic data and the results of stratigraphic drilling in southwestern Arizona indicate that several alluvium-covered valleys in this area are underlain by more than 3,000 m of Cenozoic deposits. These deposits, with the exception of the marine late Miocene clastic wedge of the Yuma basin and the Pliocene Bouse Formation of the lower Colorado River valley, are the result of continental sedimentation. For the most part, these continental rocks consist of locally derived clastic sediments and lesser amounts of interbedded volcanic rocks and, in some valleys, thick bodies of evaporites. On the basis of their position in the stratigraphic sequence in relation to regional or semiregional unconformities, the Cenozoic sequence of southwestern Arizona was subdivided into an older Unit I and a younger Unit II. The boundary between these two units is a widespread unconformity surface resulting from an important period of subsidence, block-faulting, and erosion that began in late Miocene time (13 to 12 m.y. ago). The two Cenozoic units have been dated and correlated on the basis of radiometric age determination of the interbedded extrusive volcanic rocks, on lithologic character, and with the help of seismic interpretation.

• 80611—Genesis of the Skagit Gneiss migmatites, Washington, and the distinction between possible mechanisms of migmatization.

Bruce W. D. Yardley, Department of Geological Sciences, University of Washington, Seattle, Washington 98195, (present address: School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, Great Britain). (11 p., 6 figs., 2 tbls.)

Some possible chemical and morphological criteria to distinguish different migmatization mechanisms are considered and examples of the different processes discussed. Leucosomes formed by anatexis are likely to contain K-feldspar and should have a more sodic plagioclase than the restite rocks. Metamorphic segregation can cause a slight fractionation of albite into the leucosome only. Anatectic leucosomes might form irregular bodies or might agmatize the restite; close-spaced planar veins are improbable. Leucosome veins formed by hydrothermal processes are likely to be coarse grained or pegmatitic, whereas water-rich anatectic melts may freeze readily to aplites.

The criteria developed are applied to the Skagit Gneiss migmatites, and although the temperature of metamorphism was high (<700 °C), an anatectic model is rejected, as in earlier studies. Much of the migmatization that accompanied regional deformation and metamorphism was due to metamorphic segregation. Many other leucosomes are believed to be related to an extensive suite of plagioclase pegmatite dikes, probably of hydrothermal origin, that were emplaced at a late stage. These dikes are of uniform composition (plagioclase ≅ An_{20}), irrespective of the host rock, and the plagioclases of some feldspathized schists tend toward this composition.

Recent fluid-inclusion studies have shown that high-grade rocks have a mixed CO_2-H_2O fluid. Therefore, partial melting is unlikely to begin until temperatures well in excess of the water-saturated granite solidus are reached. Melts so formed might readily coalesce and migrate out of the source rock without producing an extensive migmatite zone. Many migmatite terranes may have formed by predominantly hydrothermal processes, notably metamorphic segregation, and it is possible that this might represent a particular type of tectonic environment.

• 80612—Valley anticlines of the Needles District, Canyonlands National Park, Utah.

Donald Brandreth Potter, Jr., George E. McGill, Department of Geology and Geography, University of Massachusetts, Amherst, Massachusetts 01003. (9 p., 6 figs.)

Valley anticlines to two types exist in the Needles District of Canyonlands National Park: (1) large, upright anticlines following major drainages, and (2) small, generally asymmetrical anticlines confined to rocks along the floors of smaller tributary valleys. The first type includes the Meander anticline along the Colorado River and anticlines following four deep tributary valleys east of the river. The Meander anticline is about 35 km long and follows the sinuosities of the Colorado River. The tributary anticlines also follow valley sinuosities. Severity of folding decreases upward from the valley floors, but arching is still evident at the level of canyon rims, as much as 600 m above the valley floors. These large valley anticlines appear to be due to upward flow of evaporites of the Paradox Member of the Hermosa Formation (Pennsylvanian). The differential stress driving this flow is a result of the unloading generated by canyon erosion.

Much smaller anticlines occur in the Salt Creek, Butler Wash, and Chesler Canyon drainages 4 to 17 km east of

the Meander anticline. These small anticlines are confined to 25 m of thin-bedded rocks straddling the base of the Cutler Formation (Permian) and have been found only where these thin-bedded rocks occur on valley floors. Most have straight limbs and sharp hinges, and all appear to die out downward and laterally so that the rocks of the valley walls and rocks at depth beneath the valley floors are unfolded. The folded rocks show no evidence of plastic behavior of any kind. Although some of the folding could be due purely to elastic rebound following valley erosion, fold amplitudes are best explained by excess horizontal compressive stress.

A close correspondence between structure and landforms generally is interpreted as being due to structural control of landform development through differential erosion. In contrast, fluvial valleys predate folding and have determined the locations and mechanics of formation of anticlines in the Needles District and in a few other localities in the world.

July BULLETIN briefs

Brief summaries of articles in the July 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.*

• 80701—A biogenic-chemical stratified lake model for the origin of oil shale of the Green River Formation: An alternative to the playa-lake model.

George A. Desborough, U.S. Geological Survey, Denver, Colorado 80225. (11 p., 9 figs., 1 tbl.)

A model is proposed which involves biogenic Mg enrichment, a stratified lake environment, and authigenic growth of minerals that led to the development of oil shale in the lacustrine Green River Formation. The chemistry and mineralogy of Ca-Mg-Fe carbonates and other minerals in oil shale are consistent with an authigenic origin. The higher content of magnesium with respect to calcium in kerogen-rich rocks is probably due to the preferential concentration of magnesium with respect to calcium by blue-green algae whose remains released these cations after accumulation on the lake bottom. These elements were available for incorporation in Ca-Mg-Fe carbonates which crystallized in lake-bottom muds, while degradation of admixed algal material led to the development of kerogen. In modern lacustrine environments, primary and secondary Ca-Mg-Fe carbonate development and stability in terms of geologic time are consistent with authigenic development of the Ca-Mg-Fe carbonates present in Green River Formation oil shale. Iron is a significant component of these rhombohedral carbonate assemblages in oil shale, and thus it limits interpretations of origin of oil shale in the context of $CaCO_3$-$MgCO_3$ equilibria.

The variable composition and variety of Ca-Mg-Fe carbonates in oil shale also prohibits interpretations in terms of $CaCO_3$-$MgCO_3$ equilibrium diagrams. Similarly, inferences regarding the chemical composition and structure of these carbonates lead to misinterpretations due either to the lack of adequate chemical data or to misunderstanding of crystallographic parameters.

Greater amounts of mineral matter in time-stratigraphic intervals in the depositional center of the Piceance Creek basin, compared to the basin margins, suggest strongly that authigenic mineral development is more important than detrital accumulation of minerals in the richer oil-shale sequences.

Systematic consideration of all of the arguments developed to promote the playa-lake model to explain the chemical, mineralogical, and geologic aspects of Green River Formation oil shale leads to the conclusion that the biogenic-chemical model proposed here is more appropriate than a strictly chemical model, because the playa-lake model so far does not consider the influence of any biogenic factors.

• 80702—Serpentinite textures in Anglesey, North Wales, United Kingdom.

Alex J. Maltman, Department of Geology, University of Wales, Aberystwyth, Wales, United Kingdom. (9 p., 5 figs.)

Serpentinites of the late Precambrian "Monian" rocks in Anglesey bear petrographic textures which can be arranged in an evolutionary series, the stages of which may correspond to regional events.

The "mesh" texture (lizardite), produced prior to deformation by alteration of a parental peridotite, was modified during the regional D_1 flexural-slip movements to a "ribbon" texture, also lizardite. The ensuing formation of "bladed mat" texture (antigorite) may have resulted from the inhomogeneous response of the serpentinites to the regional greenschist facies metamorphism. "Disturbed" varieties of all of the foregoing textures are probably the result of the regional D_2 movements.

• 80703—Structure and tectonic history of the eastern Panama Basin.

Peter Lonsdale, University of California, San Diego, Marine Physical Laboratory of the Scripps Institution of Oceanography, La Jolla, California 92093; Kim D. Klitgord, U.S. Geological Survey, Woods Hole, Massachusetts 02543. (19 p., 11 figs.)

New marine geophysical data allow the preparation of revised bathymetric and magnetic anomaly charts of the Panama Basin and demonstrate that the eastern part of the basin, between the fracture zone at long 83°W and the Colombian continental margin, was formed by highly asymmetric sea-floor spreading along the boundary of the Nazca and Cocos plates 27 to 8 m.y. B.P. Lineated magnetic anomalies recording this history are oriented approximately east-west. The oldest set of north-flank anomalies overlaps in age with those adjacent to the

Grijalva scarp, south of the western Panama Basin, where they are oriented 065°. Younger anomalies (5C to 5) in the eastern basin are approximately parallel to anomalies of this age identified on the Carnegie platform and the flanks of the Costa Rica rift. The eastern basin now contains a pattern of fossil spreading centers (including the Malpelo rift) and transform faults (including the Yaquina graben) that were abandoned 8 m.y. B.P. by a shift in plate boundaries that transferred a large section of the Cocos plate to the Nazca plate. Cessation of Nazca-Cocos spreading east of long 83°W was heralded by a 3-m.y. deceleration of spreading on the eastern segments, which created rough topography and axial rift valleys typical of slow-spreading ridges. Westward jumping of the Nazca-Cocos-Caribbean triple junction rejuvenated the northern segment of the fracture zone at long 83°W, causing uplift of the adjacent Coiba Ridge. Recently, active transform faulting has jumped farther west, from the foot of the Coiba Ridge to the Panama fracture zone.

Apart from changes in plate boundaries, the main event in the tectonic evolution of the region was initiation about 22 to 20 m.y. B.P. of the hot spot that created the Malpelo, Cocos, and Carnegie Ridges. Precursors of effusive ridge-building volcanism included major fracturing of the oceanic crust to the north of the present Malpelo Ridge. Both processes hamper identification of magnetic anomalies in the vicinity of the ridges. Our interpretation of the tectonic history is also incomplete in the easternmost parts of the basin, where data are insufficient; this impairs our interpretation of the adjacent continental geology in terms of changing interaction between oceanic and continental plates. The geologic history of the Isthmus of Panama is compatible with our application of the plate-tectonic model.

• 80704—Tertiary volcanism and caldera development near Durango City, Sierra Madre Occidental, Mexico.

Eric R. Swanson, Richard P. Keizer, Department of Geological Sciences, The University of Texas at Austin, Texas 78712 (present address, Swanson: Geology Department, Wayne State University, Detroit, Michigan 48202); James I. Lyons, Bear Creek Mining Company, Tucson, Arizona 85702; S. E. Clabaugh, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas 78712. (13 p., 7 figs., 1 tbl.)

Near Durango City, older andesites are overlain by approximately 800 m of rhyolitic volcanic rock, mostly ash-flow tuff of Oligocene age. The rhyolite is unconformably overlain by a few tens of meters of late Miocene basalt in the highlands west of Durango City and by Quaternary basalt and gravel in the Guadiana Valley.

By 32 m.y. ago, voluminous rhyolitic ash-flow tuff was being emplaced over a rugged topography developed on the older andesites. Shortly thereafter, sources in the Durango City area became active and produced two major ash-flow sheets. These ash-flow sheets, together with caldera-fill material, constitute the Carpintero Group. Subsidence in their source areas initiated development of the Chupaderos caldera complex. Most ash-flow sheets overlying the Carpintero Group originated from distant sources, but later eruptions from the caldera area produced one major post-Carpintero ash-flow unit with associated collapse of a distinctive inner caldera.

Rhyolitic volcanism ceased in the Durango area by 28 m.y. ago, but continued until 23 m.y. farther west. Chemical analyses of volcanic rocks from a strip mapped in detail across the Sierra Madre Occidental show systematic variations. Silicic volcanic rocks to the east are higher in silicon and potassium and lower in sodium, aluminum, and calcium than rocks to the west. The phenocryst mineralogy of volcanic rocks along the strip reflects these chemical variations.

Mafic rocks of the Durango area were erupted in three distinct episodes. A small amount of subalkaline basalt is interlayered with the Durango volcanic sequence. Later, alkaline lavas of the Metates Formation were erupted during an episode of late Miocene normal faulting. The large basalt field in the Guadiana Valley is interlayered with Quaternary gravel, and the youngest flows are Holocene.

• 80705—In situ structural observations along Transform Fault A in the FAMOUS area, Mid-Atlantic Ridge.

P. Choukroune, Centre Armoricain d'Etude Structurale des Socles, B.P. 25 A, 35031 Rennes-Cedex, France; J. Francheteau, Centre Océanologique de Bretagne, B.P. 337, 29273 Brest-Cedex France; X. Le Pichon, Centre National pour l'Exploitation des Océans, B.P. 107.16, 75783 Paris-Cedex 16, and Centre, Océanologique de Bretagne, B.P. 337, 29273 Brest-Cedex, France. (17 p., 26 figs.)

Two areas of Transform Fault A were explored in situ during the FAMOUS project. Ten dives were conducted with the diving saucer *Cyana* in the median part and five dives with the bathyscaph *Archimede* near the western intersection with the rift valley. The resulting field observations are the first made along an oceanic transform fault with a resolution similar to the one obtained with morphotectonic observations on land. The existence of left-lateral motion predicted by the plate-tectonics model is demonstrated with the help of microtectonic observations on fault scarps. However, the surface expression of the transform fault does not consist of a unique or major fault. Instead, the fault pattern is complex and variable, in the north-south as well as the east-west directions, although the width of the active zone of transform faulting is small (300 to 1,000 m). A comparison of the north-south sections of the transform fault made in the two areas leads to the conclusion that its dynamics have evolved in a complex way through time. The significance of the axial deep and its associated rubble cover is discussed in this context.

• 80706—Hydrology, morphology, and sedimentology of the Guadalupe fluvial-deltaic system.

Robert A. Morton, Bureau of Economic Geology, University of Texas at Austin, Austin, Texas 78712; Alan C. Donaldson, Department of Geology and Geography, West Virginia University, Morgantown, West Virginia 26506. (7 p., 6 figs., 3 tbls.)

Third-dimensional channel characteristics, bed forms,

sediment load, and discharge data are described for two suspended-load streams (Guadalupe and San Antonio Rivers) and a mixed-load stream (Coleto Creek) that together make up the suspended-load fluvial system of the Guadalupe delta of Texas. Discharge of the Guadalupe River is highly variable and increases downstream, but (1) percentage of sand and mean grain size of bed material, (2) channel gradient, (3) valley gradient, (4) channel sinuosity, and (5) channel width/depth ratio all decrease downstream. The most marked decreases in these parameters occur between the alluvial plain and the delta plain.

The relationships between percentage of silt-clay in channel perimeters, width/depth ratios, and sinuosities for these small coastal-plain rivers with single channels support the classification and empirical relationships established by Schumm for modern alluvial channels. One notable exception is that downstream increases in silt and clay from alluvial plains to delta plains do not necessarily yield higher sinuosity channels. The low channel sinuosities and lack of point-bar accretion along lower reaches of many suspended-load alluvial channels and delta distributaries are related to extremely low channel gradients and a natural gradient threshold below which meandering is minimal.

• 80707—Coastal Complex, western Newfoundland: An Early Ordovician oceanic fracture zone.

J. Karson, J. F. Dewey, Department of Geological Sciences, State University of New York at Albany, Albany, New York 12222. (13 p., 7 figs.)

Oceanic crust and mantle adjacent to fracture zone extensions of ridge-ridge transform faults consist of two strips on either side of and parallel with the fracture zone. One strip with a transform-fault deformation history is welded to a younger strip that has not had a transform history. Observations of oceanic fracture zones and theoretical models indicate that both strips have complex petrologic and structural histories and relationships quite different from oceanic crust and mantle generated at ridge segments away from fracture zones. Geologic relationships predicted by our simple models are matched in a remarkably precise way in ophiolite assemblages in western Newfoundland. The Coastal Complex, a hitherto enigmatic, varied, and complex assemblage of sedimentary and ultramafic and mafic igneous rocks is believed to have acquired its complexity during movement through a Late Cambrian ridge-ridge transform domain and past a ridge termination. The Bay of Islands Ophiolite Complex is, in one region, in direct continuity with the Coastal Complex and is believed to have originated on the nontransform side of the ridge termination past which the Coastal Complex was moving. This Late Cambrian–Early Ordovician fracture zone may have nucleated the medial Ordovician obduction site, the younger, higher Bay of Islands Complex riding across the older, lower Coastal Complex side and, locally, carrying with it and preserving strips of the older fracture zone assemblage.

The high frequency of fracture zones along some accreting plate margins in modern oceans suggests the likelihood that ophiolite complexes will contain parts of oceanic crust and mantle preserving a fracture zone history. This likelihood is further enhanced if fracture zones nucleate obduction zones. Many published accounts of ophiolite complexes, particularly in the Alpine system of Europe and the Middle East, include descriptions of petrologic and structural relationships that accord well with relationships observed in the Coastal Complex and also may have been developed in oceanic fracture zones.

• 80708—Tidal circulation patterns in Precambrian, Paleozoic, and Cretaceous epeiric and mioclinal shelf seas.

George deVries Klein, Sedimentology Laboratory, Department of Geology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801; Thomas A. Ryer, U.S. Geological Survey, Mail Stop 972, Box 25046, Denver Federal Center, Denver, Colorado 80225. (9 p., 1 figs., 2 tbls.)

According to some workers, ancient epeiric and mioclinal shelf seas should have lacked normal astronomical tides because of their shallow depths and great size. A variety of sedimentological and paleontological evidence, however, indicates that Precambrian, Cambrian, Ordovician, and Cretaceous strata of western North America, Carboniferous strata of the eastern United States, Precambrian and Cambrian strata of Scotland, and Precambrian and Ordovician strata of South Africa, which were, in part, deposited in such shallow seas, contain extensive tidalites. On Holocene continental shelves, a positive correlation exists between shelf width, tidal range, and tidal current velocity; the widest shelves are characterized by the greatest tidal ranges and the greatest tidal current velocities. This relationship is generally applicable to ancient epeiric and mioclinal shelf seas, and we conclude that ancient shallow seas were, in fact, characterized and dominated by tides and by tidal circulation patterns. Therefore, sedimentological and paleontological evidence of tidal influences should be sought more widely in strata that accumulated in such seas.

• 80709—Late Quaternary tectonic movements of western and central Asia.

Vladimir G. Trifonov, Geological Institute of the Academy of Sciences of the U.S.S.R., Moscow, 109017 U.S.S.R. (14 p., 11 figs.)

Late Pleistocene and Holocene activity on major faults of western and central Asia is inferred from offsets of young topography. Large active strike-slip faults bound the northward-moving Arabian and Indian plates. The Indian plate moves more rapidly with respect to Eurasia than does the Arabian plate, with the highest rate of young lateral motion (1.2 to 1.4 cm/yr) along the Darvaz fault on its northwestern side. Convergence of these plates on the Eurasian plate produces the north-trending compression of the latter. It results in the creation of northwest-trending dextral wrench faults, smaller northeast-trending sinistral faults, east-west–trending thrust faults, and rare north-trending normal and extension faults. The rates of relative motion are slower here than on the borders of the southern plates, being higher to the north of the Indian plate than to the north of the Arabian. Not all relative motion of the southern plates is

accommodated by their boundary deformation and by the compression of the Eurasian plate. This motion and resistance of the Eurasian plate produce squeezing of the rock masses on both sides of the southern plates that results in dextral west-trending wrench faulting on the western side and sinistral on the eastern side of each plate. This pattern can be recognized throughout the Neogene-Quaternary tectonic evolution of the Asian segment of the Alpine–central Asian orogenic belt. This paper is an attempt to correlate synchronous tectonic movements over huge areas of the continent. The author believes it is appropriate to recognize in such correlation mobile and stable zones of different scales. The depth and character of motion in the mobile zones define important features of the structure and evolution of the Earth's crust.

• 80710—Regional geophysical setting of the Rio Grande rift.

Lindrith Cordell, U.S. Geological Survey, Box 25046, Denver Federal Center, Denver, Colorado 80225. (18 p. 15 figs.)

The Rio Grande rift encompasses uplifts of the southern Rocky Mountains and their southern extension as well as axial fault blocks. The rift widens irregularly southward from a narrow horst in Colorado into a broad collapsed vault, characterized by grabens, in southern New Mexico. Whether manifested by horsts or grabens, primarily extensional strain is involved which increases in magnitude southward. Extensional faulting along the rift occurred in Neogene to Quaternary time, but the rift follows an axis of Laramide, Pennsylvanian, and possibly earlier uplifts. Gravity gradients due to the low density of graben fill delineate major faults of the rift system, which show a gridded or en echelon pattern over distances of tens of kilometres. Aeromagnetic data show these faults to be aligned with basement structural grain. Zigzags hundreds of kilometres long in the trend of the rift may also be related to basement grain. Basement trends in the Colorado Plateau to the west seem to differ in direction from those in the High Plains to the east. Seismic data also show that the rift occurs in an area of transition between anomalous crustal and upper-mantle structure typical of the Cordillera and crustal structure typical of the High Plains. Deep seismic data are sparse within the rift, but high heat flow, high elevation, high electrical conductivity, and both residual positive (shallow source) and negative (deep source) gravity anomalies suggest the presence of symmetrical anomalous crustal and upper-mantle structure along the axis of the rift. In the Socorro area, where the rift has been studied intensively, available data indicate relatively low compressional velocity, rapid Holocene uplift, and the presence of magma within the crust. In view of geomorphic evidence for widespread Holocene faulting, the seismicity of the rift is surprisingly low.

• 80711—Interpretation of geophysical data in the northern Gulf of St. Lawrence and its relevance to lower Paleozoic geology.

Richard T. Haworth, Atlantic Geoscience Centre, Geological Survey of Canada, Bedford Institute of

Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia. (20 p., 16 figs., 3 tbls.)

The southern, subsurface boundary of the crustal section typical of the Grenville Orogen can be traced from the St. Lawrence Estuary to western Newfoundland by means of a prominent gravity and magnetic gradient. North of the boundary, the gravity and magnetic data suggest that the upper surface of the Precambrian basement is irregular and is overlain by Paleozoic sedimentary rocks of the St. Lawrence Platform which outcrop in a regular undisturbed pattern on Ile d'Anticosti. The areas known to have a thick Paleozoic section, such as Ile d'Anticosti and offshore from Bay of Islands, Newfoundland, coincide with areas of relatively low gravity. East of Ile d'Anticosti, however, an area with similar low gravity values and bounded by steep magnetic gradients was previously thought to be underlain by a thin Paleozoic section on the basis of seismic refraction data obtained from nearby areas. If the Paleozoic section is indeed thin, the gravity and magnetic anomalies can be explained by the presence of an anorthosite intrusion with a minimum thickness of 4 km within the Precambrian basement. However, a more tenable interpretation, which is consistent with the known sedimentary thicknesses elsewhere in the Gulf and which does not contravene the refraction data, is that the Paleozoic section thickens locally to at least 5 km. This thick section is postulated to occur over a downfaulted portion of a salient on the early Paleozoic margin of North America.

• 80712dr—Hillslope form and climate: Discussion and reply. (4 p.)

Discussion: *D. L. Dunkerley, Department of Geography, Monash University, Clayton, Victoria, Australia 3168.*

Reply: *Terrence J. Toy, Department of Geography, University of Denver, Denver, Colorado 80208.*

• 80713dr—U-Pb zircon dates from the central Appalachian Piedmont: A possible case of inherited radiogenic lead: Discussion and reply. (8 p.)

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

Reply: *Robert E. Zartman, U.S. Geological Survey, Federal Center, Denver, Colorado 80225.*

• 80714dr—Composition and age of Lau Basin and Ridge volcanic rocks: Implications for evolution of an interarc basin and remnant arc: Discussion and reply. (3 p.)

Discussion: *H. R. Katz, Department of Scientific and Industrial Research, New Zealand Geological Survey, P.O. Box 30 368, Lower Hutt, New Zealand.*

Reply: *James B. Gill, Earth Sciences Board, University of California, Santa Cruz, Santa Cruz, California 95064.*

GSA news & information