GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

JANUARY 1978

Message from the President

". . . I am convinced that the decision to move to a microfiche Part II for the *BULLETIN* was a good decision . . . to advance the science of geology."

Last year, as Vice-President of GSA, I participated in the long and thorough discussions that preceded the Council decision to adopt a new *Bulletin* format, to become effective January 1, 1979. As a result of the studies, analyses, and recommendations that were presented to the Council, I am convinced that the decision to move to a microfiche Part II for the *Bulletin* was a good decision. At the Seattle meeting, I spent several hours in the "New-Bulletin Format Room" listening to the questions that came to the staff from concerned members. The most common opening question was "Why are we doing this?"

Under its charter, the mission of GSA is to advance the science of geology. Traditionally, the Society carries out its mission primarily by dissemination of scientific information; support of research has been a minor effort of the Society. The Society is engaged in the dissemination of scientific information through its publications, through the annual meeting, through section meetings, and through the Penrose Conferences. I believe it is fair to say that GSA is now the world leader in this effort.

The Council adopted the new *Bulletin* format so that GSA can maintain this leadership position. As of 1977, the Society was faced with a formidable and growing backlog of manuscripts, steadily lengthening delays in publication of papers submitted, and alarming increases in costs. The Council concluded that merely increasing selectivity in paper acceptance would not solve the problem. GSA's publications must cover the ever-broadening field of geological sciences, and they must offer to the membership a fair, reasonable, and timely access to publication for high-quality work. The science of geology is growing, not shrinking; there will be more good papers, not fewer. The demands of our membership for access to a publication vehicle will increase, not decrease. I conclude that without a new direction in publication, the GSA will find itself in a very few years with a diminished capability to carry out its mission to disseminate geological information.

The adoption of the new format—a summary *Bulletin, Part I,* and a *Bulletin, Part II,* on microfiche—will enable the Society to offer increased publication opportunities at decreased costs and with three to four months between acceptance of camera-ready articles and publication. For some years, at least, the members and nonmember subscribers will be relieved of the need to bear the rapid increases in costs of publications. There will be other minor benefits, such as economy of shelf space, ease of use in the field, and with a pocket-reader, increased ease of use while traveling. But the principal benefit is in more pages of high quality, at less cost (and with much more timely publication). Quality control will continue to reside in the peer-review process.

There are some disadvantages in the initial cost and inconvenience of learning to work with the microfiche reader. In my judgment, benefits outweigh costs.

I shall not address the other questions that are relevant to this change in format. They have been addressed in previous communications to the membership and will be addressed at Section meetings this spring. Headquarters will respond to questions as expeditiously as possible. I ask the membership to take the time to inform themselves about the new *Bulletin* and the reasons for the change. I am satisfied that as a result of this decision, GSA will retain its pre-eminence in the field of geological information dissemination.

Peter T. Flawn
President, Geological Society of America

COCORP data on Rio Grande Rift area of New Mexico now available

The second phase of acquisition of deep seismic reflection data in the Rio Grande Rift area of New Mexico in the vicinity of Socorro, New Mexico, has been completed, and the data are available for the cost of reproduction of the displays and magnetic tape reels. This operation, another step in the application of sophisticated continuous seismic reflection techniques of the petroleum industry to the solution of geologic problems in the lower crust and upper mantle of the Earth, was conducted by the Consortium for Continental Reflection Profiling (COCORP) as part of the U.S. Geodynamics Project sponsored by the National Academy of Sciences and funded by the National Science Foundation. The executive committee of the Consortium consists of members from Cornell University, the University of Houston, Princeton University, the University of Wisconsin, and Shell Oil Company. Cornell University has the operational responsibility.

A total of 128 km of lines was run, including an east-west line spanning the rift in the neighborhood of Bernardo, New Mexico. A 48-channel MDS-VIII recording system with data sampling at 8 ms intervals was used. Station intervals were 134 m, with 32 geophones per station arranged in-line with 70% overlap. A variable spatial distribution of the 32 equal-sensitivity geophones was employed. The source array consisted of five vibrators operated in-line and spaced at 27-m intervals, moving through sixteen stages at 8.9-m intervals at each station. The summed output of the sixteen stages comprised a record, and 24-fold stacking resulted. The vibrator pilot signal was 10-32 Hz linear upsweep of 25 s duration, and the recording duration was 50 s. The data acquisition and basic processing were performed by Petty-Ray Geophysical, and their interest and efforts, beyond normal contractual responsibilities, are gratefully acknowledged.

The procedure required and the data available are the following: (1) Indicate in writing which items are desired. Address your letter to Sidney Kaufman, Department of Geological Sciences, Cornell University, Ithaca, New York 14853. Do *not* send payment. (2) In response to your letter, a formal "Authorization for Purchase" will be sent to you. (3) Forward the authorization to the contractor in the manner indicated on the authorization, together with your purchase order.

I. Basic display package of 90 prints for $150, consisting of location maps, a display of 18 correlated records covering Line 1A, a display of the 67 velocity analyses, and the following displays for each of the four lines: (a) CDP stack/filter/AGC (½ scale); (b) CDP stack/decon/filter/AGC (½ scale); (c) residual statics/stack/decon/filter/AGC (full scale); (d) same, ½ scale; and (e) same, rescaled. The full-scale sizes are horizontally, 5 cm = 1 km, and vertically, 4 cm = 1 second of two-way travel time. The rescaled sizes are horizontally, 2.8 cm = 3 km, and vertically, 2.8 cm = 1 second of two-way travel time. The stacked sections are 24-fold.

II. The number of reels of digital tapes available at $35 per reel, including the ½" by 2400' copy reel, is given in the following table:

	Field	Correlated	Stack(1)	Stack(2)
Line 1A	17	7	1	1
Line 2A	9	4	1	1
Line 3	6	2	1	1
Line 4	3	1	1	1

Stack(1) is a true amplitude stack with no AGC or automatic residual statics applied; stack(2) has AGC and automatic residual statics applied. Writing density is 1600 bpi. The format for the field tapes is SEG-B; the other processed tapes are SEG-X with data values in IBM (short) floating point notation.

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

A paper describing the Socorro Area operation and interpretation is in preparation.

S. Kaufman
Cornell University

Rocky Mountain Section announces 1978 slate

The following slate of nominees will be voted on by the voting membership present at the annual business meeting of the Rocky Mountain Section on Saturday, April 29, 1978, at Provo, Utah.

Chairman ..... Robert B. Johnson
Vice-Chairman ..... Tommy B. Thompson

Stanley S. Beus will continue to serve as Secretary and Accounting Officer of the Section.

Morris S. Petersen, *Chairman*
Rocky Mountain Section

Career Planning Program available from WGC

The Women Geoscientists Committee (WGC) of the American Geological Institute (AGI) has prepared a *Career Planning Program* which consists of a thirty-minute color slide show with accompanying script on career opportunities in academic institutions, government, and industry. The presentation includes a summary of AGI-WGC employment statistics, comments and suggestions from women geoscientists, and a view of a variety of career paths. It is directed to upper-level undergraduate and graduate women students primarily. However, the Committee encourages anyone who wants to modify this program for use in high school or community career programs to do so.

Those wishing to borrow the program should contact William H. Matthews III, Director of Education, American Geological Institute, Box 10031, Lamar University Station, Beaumont, Texas 77710.

AGI Advisory Committee reports on minority geoscience scholars

The majority of minority geoscience scholars, who were recipients of American Geological Institute scholarships during academic years 1974–75 and 1975–76 but are not currently supported, are rated by their faculty members and employers as good prospects for future professional success. Of the 42 students we have studied, 30 (71%) are rated as good prospects, 8 (19%) are in doubt, and 4 (10%) are rated poor prospects for success. When asked whether AGI made a good, questionable, or poor investment in awarding the scholarships, faculty members and employers responded with almost the same results: 30 (71%) rated AGI's investment as good, 9 (21%) thought it was questionable, but only 3 (7%) thought it was poor. (Some percentages do not total 100 percent because of rounding errors.)

Twenty-nine (69%) of the students had good-to-excellent academic records, 10 (24%) were satisfactory, and 3 (7%) were well below average.

Hispanic (primarily Mexican-American and Puerto Rican) and American-Indian students were more strongly represented among the scholarship recipients than in the minority fraction of the general population, whereas Black students were relatively underrepresented. Eighteen (43%) of the students were Black 19 (45%) were Hispanic, and 4 (10%) were American Indian; one student (2%) was Oriental. (According to the Bureau of the Census, 11% of all Americans are Black and 5% are Hispanic; fewer than 0.5% are American Indian, and fewer than 1% are Oriental.) Thirty-two (76%) of the students were men and 10 (24%) were women, paralleling the trend for more nonminority women to enter the geoscience professions.

The tendency for relatively more Hispanic and American-Indian than Black students to apply for AGI scholarships reflects, to a degree, the efforts of such organizations as the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) to bring the AGI scholarship program to the attention of Hispanic and American-Indian young people. But we believe that it indicates also that Hispanic young people in particular are moving more rapidly into science than are Black young people. Many Indian tribes and associations are showing increasing concern over developing the talent to evaluate energy and mineral resources on reservation lands. The Association on American Indian Affairs, for example, has started publishing a quarterly bulletin on "Indian Natural Resources." Some colleges and universities in the West are moving toward emphasis on special resource-oriented educational programs for Indian young people.

At the time of AGI support, 29 (69%) of the students were undergraduates, 11 (26%) were M.S. candidates, and 2 (5%) were Ph.D. candidates. These results seem to suggest a departure from the inclination of minority students to regard the B.A. or B.S. degree as their educational goal.

What are the significant results of the AGI scholarship program so far? Of the 42 students included, 22 (52%) were awarded the degree for which they were enrolled and 6 (14%) dropped out. The remaining 14 (33%) are still in school.

Industry has recruited AGI scholars who have received degrees more vigorously than have government agencies or academic institutions. Of the 20 graduates who have left full-time study, more than half (11 or 55%) have gone into industry and 4 (20%) have entered government. One (5%) has become a faculty member at Virginia State College, a predominantly Black school. One Navajo geologist has gone to work for the Navajo Tribe. Two former AGI scholars (10%) have entered fields other than geoscience. One is unemployed, but because of poor health, not because he was unable to find a job.

The minority students supported by AGI scholarships were not concentrated in predominantly minority schools. They studied at schools ranging from predominantly Black or Hispanic colleges in the Southeast and Southwest to the most prestigious universities in the Northeast and on the West Coast. They performed about as well academically as nonminority students, but they were probably more successful in obtaining jobs, especially at the B.S. level. Performance of some minority graduate students did not come up to that of their nonminority colleagues, suggesting that predominantly minority schools need assistance in strengthening their academic programs. The greatest need is better undergraduate preparation in mathematics, chemistry, and physics.

Many faculty members and employers made favorable comments about the students and the AGI program, but some critical comments were made on performance of a few of the students selected. One enthusiastic faculty advisor told us, "AGI's support solidified Don's determination to pursue studies in the Earth sciences. It gave him just that extra bit of confidence he needed. An added benefit was that Don's AGI scholarship served to publicize support and encouragement for minority students to enter the Earth sciences and thus helped our university to attract additional good minority students to the Earth-science program."

L. C. Pakiser
Advisory Committee to the AGI Minority Participation Program

A PERSONAL NEW YEAR'S GREETING
from the
GSA STAFF

The Committee on Environment and Public Policy reports on important goals for new geologists

We have all had the experience of meeting or watching a truly impressive and commanding person. If we think carefully about the characteristics of such a person, we recognize at least the following: he or she is (1) knowledgeable, (2) self-confident, and (3) communicates well. How do most geologists measure up to such a model? Allowing some slight benefit of the doubt, we can answer in the affirmative to the first point; that is, most geologists seem to be knowledgeable in their field. But how many are also self-confident *and* good at oral and written communication?

Now that we have planted the seeds of doubt, let us ask ourselves how many geologists occupy positions of importance and prestige in modern society. The answer is painfully obvious: despite the fact that all of the serious problems involving the environment and natural resources have a strong geologic flavor, remarkably few geologists have assumed positions of leadership in the debates and decisions that swirl about these problems. Why? Maybe we are stupid, or poorly trained in our field, or maybe there is some other flaw in our background.

Possible flaws in the background of geologists are not, in fact, difficult to recognize. As an example, let us try to recall our earliest exposure in college to the science of geology. It is highly probable that one of our instructors began by telling us that geology is an inexact science, not amenable to rigorous analysis, and laden with the burden of "multiple hypotheses." What a wonderful way to begin a career, by learning that we will probably never *really* understand the subject! Perhaps this tells us that a geologist may lack the self-confidence and inner strength that go with knowing that he has total command of his field of endeavor. If this is true, it means that when the time comes for debates and decisions concerning the important problems that confront society, geologists may be excluded because we have been programmed to lack the self-confidence of true leaders.

To stab at another area, how well do we communicate? The answer is clear: most geologists are characterized by a pathetic inability to communicate, either with the lay public or with professionals in other fields. Many of us recognize this weakness, whether or not we admit it to others, and as a consequence, we are psychologically handicapped in our efforts to assume leadership. We are either unable or unwilling to enter into the public or private arena and fight for what we know to be right. The blame for this fundamental flaw in the training of young geologists must rest squarely on the shoulders of those of us who teach at the college level. It is during the academic years that students can be most easily encouraged, or coerced, into learning the basic skills of oral and written communication. It is far more difficult for the young Earth scientist to learn these skills after graduation. We professors of geology must open our eyes and recognize the fact that in today's world it is becoming increasingly more difficult for new graduates to find a quiet niche in which to practice the hobby of geology. Society, with its urgent need for survival, will pass by the geologists or will listen in amused silence to our faltering words. Decisions must and will be made, many involving the science of the Earth, but such decisions will be made by those who communicate well with other leaders in society and with the public.

We must now begin to insist that our new geology graduates be properly trained in the skills of communication. Perhaps this can be accomplished by requiring each geology student to take at least one course in oral communication and one or more courses in writing. Probably an easier route, however, is to demand constant and active oral and written involvement by the students in seminars and research courses. And although it may appear unthinkable, we might even have to omit a course or two in geology in order to give the student time to learn how to speak in public!

Self-confidence and the ability to communicate—these are two key elements that must be inserted into the minds of new graduates in the Earth sciences. We must stop downgrading our importance and begin to recognize our true role in the future of the world. And we must learn how to communicate the importance of this role, and of our science, to others.

Donald D. Runnells
Committee on Environment and Public Policy

Honors and Awards Committee seeks suggestions

The Committee on Honors and Awards needs your help in nominating potential recipients of GSA's highest honors—the Penrose Medal, the Day Medal, and Honorary Fellowship. The criteria for these honors are described in the booklet *Council Rules, Policies, and Procedures,* or you can get a good idea of the kinds of scientists who have been honored in the past by glancing at the lists on pages viii and x of your *1977 Yearbook*.

Suggestions for consideration for 1978 awards must be received by headquarters by February 1, 1978. They will be forwarded to the appropriate subcommittee chairmen.

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

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

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The impact of the geosciences on critical energy resources subject of AAAS Symposium, Feb. 1978

This symposium will focus on the past research achievements of the Earth sciences in developing the nation's energy resources and the future requirements and opportunities to meet our impending energy crisis. Efficient exploration, evaluation, and development of these resources and the effective control of associated environmental factors depend largely on the basic concepts and knowledge developed within the geosciences.

Continued reliance on the scientific and technical background of the Earth sciences will help to assure a reasonable approach to the solution of our future energy problems, and continued vigorous support of the geosciences will be necessary to assure the flow of the needed skilled personnel and fundamental knowledge required to attack these problems.

A broadly based group of nationally recognized speakers will discuss governmental, academic, and research aspects of energy resources, as well as the related environmental issues, with particular discussions of hydrocarbons, coal, geothermal and nuclear energy resources. Past accomplishments, present knowledge, and needed research will be discussed, including the problems associated with achieving these objectives.

This symposium is sponsored by Section E of the American Association for the Advancement of Science; the American Association of Petroleum Geologists; the American Geological Institute; the Geological Society of America; and the Society of Exploration Geophysicists.

The symposium was arranged and will be presided over by Creighton A. Burk, Director, Marine Science Institute, The University of Texas, and Professor of Geological Sciences; and Charles L. Drake, Chairman, Department of Geological Sciences, Dartmouth College, and Past-President, Geological Society of America.

Speakers and topics will be

Harrison H. Schmitt, U.S. Senator, New Mexico; "Federal Objectives and Organizations Relative to the Geosciences."

Peter T. Flawn, President, The University of Texas at San Antonio, and President, Geological Society of America; "Importance of the Universities to the Geosciences and Natural Resources."

John D. Moody, International Energy Consultant, and Past-President of the American Association of Petroleum Geologists; "Hydrocarbon Resources."

Jack A. Simon, Chief, Illinois State Geological Survey; "Coal Resources."

William L. Fisher, Director, Texas Bureau of Economic Geology, and Past Assistant Secretary for Energy and Minerals, Department of the Interior; "Geothermal Resources."

Leon T. Silver, Professor, Geological and Planetary Sciences, California Institute of Technology; "Nuclear Energy Resources."

Priscilla C. Grew, Director, Department of Conservation, State of California; "Environmental Impact of the Geosciences."

New map of geothermal energy resources of the Western United States

A multicolor map showing the geothermal energy resources and related data for the Western United States has been prepared by the National Geophysical and Solar-Terrestrial Data Center (NGSDC) in cooperation with the Energy Research and Development Administration and the U.S. Geological Survey. The area covered extends from slightly east of the Rocky Mountains to the Pacific coast and from Mexico to Canada.

The geothermal areas shown include those that are now producing electrical power from steam-driven turbines, or that are under development or have a known potential for the generation of electricity. Also depicted are areas where hot water presently is being used for nonelectrical purposes (that is, heating of buildings, agriculture, and various manufacturing processes) or where there is a known potential for such use. In addition, the map presents other types of geological and geophysical data that are closely associated with geothermal resources.

The map, which measures approximately 46 by 35 inches, is on the standard Albers Equal Area Projection at a scale of 1:2,500,000. Copies of the map (specify Geothermal Energy Resources Map of the Western United States) are available from our distribution agent: NOAA/National Ocean Survey, Distribution Division, C44, Riverdale, MD 20840. Specify if the map is to be folded or sent in a mailing tube (rolled). The cost is $2.50. Make check or money order payable to "COMMERCE/NOS."

gsa publications

Quaternary Sedimentation in South Florida

MEMOIR 147 — By Paul Enos and Ronald D. Perkins. 1977. x + 198 pages, 14 tables, 130 figures. Soft cover book and 16 folded maps, in color, in slip case. ISBN: 0-8137-1147-9. $34.00

The primary objective of Part I (Holocene Sediment Accumulations of the South Florida Shelf Margin, by Paul Enos) is to examine patterns of Holocene carbonate accumulation in three dimensions. The shelf of the southeastern Florida peninsula between Miami and Dry Tortugas is the only area of the continental United States and one of relatively few areas in the world where shallow-water marine carbonate sediments are actively being deposited on a large scale. The shallow carbonate shelf is 360 km long, 6 to 35 km wide, and generally less than 12 m deep.

Natural subdivisions of the south Florida shelf are the restricted inner shelf (Florida Bay), the slightly restricted inner shelf margin, the outer shelf margin where circulation and turbulence are maximum, and the shallow slope seaward of the shelf break. Substrate is a primary control on the organism habitat communities.

Holocene sediment is thickest in three discontinuous linear accumulations parallel to the shelf break. The most extensive and thickest accumulations (as much as 14 m) are along the outer reefs. Behind the outer reefs, a second belt is formed by sand shoals as much as 40 km long or by discontinuous patch-reef banks. The belt of sediment accumulations on the shallow slope is a seaward-thinning wedge as much as 12 m thick. Sediment accumulation in the inner shelf margin is thickest in patch-reef banks, tidal deltas (as much as 8 m), and broad flat-topped wedges near the Florida Keys (as much as 7 m). The belts of thick sediment vary along depositional strike, parallel to the shelf break, in thickness, width, and continuity.

The Holocene transgressive sedimentary sequence represents an incomplete cycle comparable to the five Pleistocene stratigraphic units of Perkins (Part II).

The study for Part II (Depositional Framework of Pleistocene Rocks in South Florida, by Ronald D. Perkins) was conducted in that portion of south Florida extending from Lake Okeechobee southward through the Florida Keys. Much of this area is underlain by marine sedimentary sequences that are interrupted by freshwater limestones and subaerial exposure surfaces. This wedge of Pleistocene sediment, which is approximately 60 m thick in the lower Florida Keys, pinches out northward against topographically higher Miocene and Pliocene sediments. Detailed stratigraphic analysis, based on 56 measured sections, indicates that these deposits are divisible into five marine units separated by regional discontinuity surfaces. Discontinuity surfaces are commonly found to be intraformational. Each stratigraphic unit was analyzed from the following viewpoints: (1) role of pre-unit topography, (2) isopach patterns, (3) lithofacies patterns, (4) ecologic facies patterns, and (5) interpretation of depositional environments.

Pre-unit paleotopography strongly influenced isopach thicknesses and lithofacies patterns within individual Pleistocene units, although to a lesser degree upward in the section as paleotopography became more subdued.

Considered as a whole, the Pleistocene record of south Florida may be thought of as simple infilling of pre-Pleistocene paleotopography during repeated marine transgressions, modified by subaerial exposure and the production of discontinuity surfaces during low sea-level stands.

January BULLETIN briefs

Brief summaries of articles in the January 1978 Bulletin *are provided on the following pages and 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.*

• 80101—The role of vorticity in developing lineation by wind erosion.

Marion I. Whitney, Central Michigan University, Mount Pleasant, Michigan 48859. (18 p., 9 figs.)

Experiments and field observations indicate that both the gross shaping and the sculpturing of lineation and pit details on wind-eroded surfaces may be accomplished by the impact of particles which have been impelled aerodynamically by interfacial flow or by vorticity. The vorticity operates along lines of positive, negative, and secondary flow over all surfaces of an object.

The axis of vorticity is typically normal to or at some high angle to the surface undergoing erosion. Therefore, it is not the so-called roller vortex type which has been postulated by other investigators, for one typical erosion pattern left abundantly by the vortex configuration is a round pit either helically or radically scored. Often such pits occur in chains along the beds of the lineations. A second type of erosion pattern common in channels is parallel transverse lineation, which this writer has seen in development in snow flutes under influence of normal-axis vortices. Such vortices travel singly along lines of flow, pulling particles centripetally into the vortex configurations. In snow flutes, for example, vortices become visible due to suspended snow, and the secondary flow can be delineated. Where general windflow is essentially unidirectional, the erosional result of such vorticity is the creation of cross-lineated, essentially symmetrical grooves.

• 80102—Diagenesis in first-cycle desert alluvium of Cenozoic age, southwestern United States and northwestern Mexico.

Theodore R. Walker, University of Colorado, Boulder, Colorado 80309; Brian Waugh, University of Hull, Hull HU6 7RX, England; Anthony J. Crone, University of Colorado, Boulder, Colorado 80309 (present address, Crone: Bond Exploration Co., Denver, Colorado 80202). (14 p., 12 figs.)

Petrographic studies of first-cycle desert alluvium of Cenozoic age in the southwestern United States and northwestern Mexico show that the mineralogy, texture, and chemical composition of the deposits have been changed diagenetically. The mineralogy has been changed by addition of mechanically infiltrated clay, partial removal of framework grains of feldspars and ferromagnesian silicates, and precipitation of authigenic potassium feldspar, zeolite, montmorillonite, quartz, hematite, and calcite. The texture has been changed by three processes: (1) infiltration of detrital clay and formation of authigenic montmorillonite, which form interstitial clayey matrix not present in the original sediment, (2) formation of voids where framework grains have been dissolved, and (3) *in situ* formation of silt and other fine-grained sizes. The chemical composition has been changed by infiltration of clay minerals that are richer in aluminum and lower in alkalis and alkaline earths than the original sediment and by removal in ground water of some of the ions released by dissolution and replacement of framework grains. These changes have significantly increased the mineralogical maturity and decreased the textural maturity of the sediments diagenetically.

Four major conclusions are drawn from the studies. (1) Some or all of the diagenetic alterations observed in these deposits probably occurred in many analogous ancient first-cycle alluvial deposits at a comparable time in their history. (2) Prolonged movement of ground water through first-cycle deposits may cause unstable minerals to be removed completely, or nearly so, leaving no direct evidence that they were important original constituents of the deposits. (3) Ancient first-cycle alluvium probably rarely, if ever, has the same mineralogy, texture, or chemical composition that the sediments had when deposited. (4) The present mineralogy, texture, and chemical composition of ancient first-cycle alluvial deposits probably do not accurately reflect lithology and climate in the source area or the nature of depositional currents and other environmental factors in the depositional basin.

• 80103—Little Chief Granite Porphyry: Feldspar crystallization history.

S. Douglas McDowell, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125 (present address: Dept. of Earth Science, University of California, Riverside, California 92521). (17 p., 16 figs., 7 tbls.)

The Little Chief Granite originated as an almost completely liquid magma with a water content of at least 3 wt %. The initial crystallizing phases were oscillatorilly zoned calcic plagioclase (An_{45-65}), magnetite, and rare augite. Upward movement and decrease of load pressure caused resorption of the calcic plagioclase followed by crystallization of intermediate plagioclase (An_{31-44}), hornblende, biotite, magnetite, and ilmenite as the magma stabilized at depth. After less than 5% crystallization, the magma again moved upward to form a laccolithic magma chamber whose roof was near a depth of 4 km. This magma chamber was zoned from a core with bulk compositions near 68 wt % SiO_2 at temperatures near 750 °C outward to margin with bulk compositions near 77 wt % SiO_2 and temperatures near 700 °C, in a load pressure range of 1.2 to 1.7 kb. Crystallization of sanidine, sodic plagioclase (An_{17-23}), hornblende, biotite, magnetite, sphene, and ilmenite occurred from a melt that was water rich but probably not water saturated. In the core of the

magma chamber, sanidine crystallized briefly and was then rimmed by oligoclase, whereas in the outer parts, sanidine and oligoclase continued to coesist.

After the magma was 30% to 50% crystallized, extensive assimilation of dolomitic wall rocks produced a contaminated, diopside-bearing marginal phase of the magma. Sufficient CO_2 vapor was generated that $P_{fluid} > P_{load}$, causing extensive fracturing of the roof rocks, allowing a major dike swarm to be emplaced along the fractures, and initiating ascent of the magma. The over-pressure was recorded throughout the stock by single or paired macro-oscillations on the outer edges of the plagioclase phenocrysts. The magma moved upward and finally stabilized in the presently observed stock, which existed in a load pressure range of 0.3 to 0.9 kb and probably locally vented to the ground surface. During upward movement, sanidine was extensively replaced by sodic oligoclase (An_{10-15}) through a complex mechanism that included metastable patch perthite exsolution. The groundmass feldspar composition varied as a function of depth in the magma chamber and apparently crystallized metastably under subsolidus "pressure quench" conditions at temperatures near 650 °C.

• 80104—Structural distinction between a metasedimentary cover and an underlying basement in the 600-m.y.-old Pan-African domain of northwestern Nigeria, West Africa.

Norman K. Grant, Department of Geology, Miami University, Oxford, Ohio 45056. (9 p., 7 figs., 1 tbl.)

Structural data from an area of gneisses, migmatites, and low-grade metasedimentary rocks in northwestern Nigeria suggest the presence of two contrasting structural styles, one simple and monocyclic and the other complex and polycyclic. The simple structural style is coextensive with one of two distinctive metasedimentary formations, the Birnin Gwari Schist Formation, which is interpreted as a sedimentary cover infolded during the Pan-African event into a basement of complex style consisting of the second metasedimentary formation, the Kushaka Schist Formation, and the gneisses and migmatites. This infolding may have occurred within the limits 730 to 650 m.y. ago, and it was followed by the 550- to 530-m.y.-ago epeirogenic uplift and cooling of the basement assemblage and the later emplacement of the Kusheriki granite 500 ± 4 m.y. ago.

The gneissic and migmatitic basement of the Birnin Gwari Schist Formation includes ~2000-m.y.-old Eburnean rocks, but neither the depositional nor metamorphic ages of the Kushaka Schist Formation are known.

• 80105—Petrologic evolution of the San Juan volcanic field, southwestern Colorado: Pb and Sr isotope evidence.

Peter W. Lipman, Bruce R. Doe, Carl E. Hedge, Thomas A. Steven, U.S. Geological Survey, Hawaiian Volcano Observatory, Hawaii National Park, Hawaii 96718, and Federal Center, Denver, Colorado 80225. (24 p., 12 figs., 6 tbls.)

Two distinct suites of igneous rocks occur within the San Juan volcanic field: an Oligocene suite of predominantly intermediate-composition lavas and breccias, with associated silicic differentiates erupted mainly as ash-flow tuffs, and a Miocene-Pliocene bimodal suite of silicic rhyolites and mafic alkalic lavas.

The Oligocene volcanism, probably related to subduction along the western margin of the American plate, has chemical and isotopic characteristics indicative of complex interactions with Precambrian cratonic lithosphere. It also appears to record the rise, differentiation, and crystallization of a large composite batholith beneath the San Juan field. The earliest intermediate-composition lavas and breccias have major- and minor-element compositional patterns indicative of high-pressure fractionation and are relatively nonradiogenic in both Pb and Sr, suggesting significant interaction with lower crust of the American plate. The more silicic ash-flow tuffs show compositional evidence of low-pressure fractional crystallization and are more radiogenic in Pb and Sr—features thought to indicate significant shallow residency for the magmas and interaction with upper crust. Especially radiogenic Pb-isotope compositions of some of these rocks may reflect interactions between the magmas and convecting meteoric water rich in leached Pb, a process thought to have been even more important in forming associated hydrothermal ore deposits. Ore leads tend to be more radiogenic than associated rock leads.

Many of the Miocene-Pliocene basaltic lavas seem to be mantle-derived lavas, similar to those of oceanic islands, but some anomalous xenocrystic basaltic andesites, containing relatively nonradiogenic lead, may have been slightly contaminated by lower crustal components. Rhyolitic lavas and intrusions of the bimodal suite are also nonradiogenic in Pb and Sr, in comparison with the Oligocene rhyolites, and do not appear to have interacted with Precambrian upper crust, probably because they erupted largely through the subvolcanic batholith. The Miocene-Pliocene rhyolites are best interpreted as partial melts of lower crust, with the thermal energy to initiate magma generation provided by concurrent basaltic volcanism.

• 80106—Subduction of the Kula Ridge at the Aleutian Trench.

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A simple model of the probably topographic and thermal consequences of subducting an oceanic spreading center at an island arc predicts three geologic effects: (1) shoaling and subaerial emergence of the crest of the arc, (2) decrease or cessation of subduction-related magmatism, and (3) regional low-grade thermal metamorphism ($\Delta T \cong$ 100 to 300 °C) of the arc rocks. All three of these phenomena are recorded in the geology of the Aleutian

Islands, and the following sequence of events is indicated: (1) diminution of magmatism on approach of the Kula Ridge in middle Eocene time (≅45 m.y. ago), marked by a conformable transition from volcanic-rich to volcanic-poor early-series rocks; (2) shoaling and emergence of the crest of the Alleutian arc in late Eocene to Oligocene time, marked by a deep- to shallow-marine transition in sedimentation and then an arc-wide unconformity above the early series and its probable "submarine equivalent," the now-dissected Aleutian crestal platform; (3) subduction of the Kula Ridge and greenschist metamorphism of the early-series rocks at about 30 to 35 m.y. ago, inferred from K-Ar ages; (4) subsidence of the arc down the south flank of the Kula Ridge in middle Oligocene to Miocene time, as the Pacific plate was subducted; and (5) abrupt resumption of arc magmatism 15 m.y. ago. This history of events is consistent with the timing of plate motions in the North Pacific and suggests that there has been essentially continuous underthrusting at the Aleutian Trench since at least 45 to 50 m.y. ago, with subduction of 900 to 1,000 km of ocean floor since 30 to 35 m.y. ago.

• 80107—Volcanic rock associations at convergent plate boundaries: Reappraisal of the concept using case histories from Papua New Guinea.

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Three volcanic rock associations—identified by the geographic acronyms TLTF, MRB, and SBS—can be recognized in seven late Cenozoic provinces at convergent plate boundaries in Papua New Guinea. These associations are distinguished on a variation diagram showing the Differentiation Index relative to normative nepheline or to normative quartz plus the silica of normative hypersthene; this diagram serves as the basis for a preferred scheme of volcanic rock nomenclature for arc-trench systems. Rocks of the TLTF group constitute a dominantly alkalic (nepheline-normative) association. In contrast, the MRB and SBS groups do not correspond to any of the associations widely postulated for other circumoceanic regions. Calc-alkalic–type rocks, for example, are found in both associations: in the MRB group, they form compositional continua with shoshonitic rocks; in the SBS group, they form continua with tholeiitic ones. We suggest that circumoceanic rocks should not be classified into these artificial, world-wide, "standard" associations, but on a regional basis. However, the most useful procedure would be to correlate the same ranges of rock compositions and relative abundances of rock types in individual tectonic provinces with specific geodynamic features or source-region compositions. These correlations may lead to the recognition of natural rock associations on a world-wide basis.

• 80108—Structure of the Rio Grande rift in southern New Mexico and West Texas based on gravity interpretation.

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The Rio Grande rift, which is marked by a positive heat-flow anomaly in southern New Mexico, was the subject of a gravity study based on 4,500 stations which cover a strip across New Mexico. The area consists of a series of basins and intervening ranges formed during Miocene time. This basin-and-range structure is strongly reflected in the Bouguer gravity anomalies, which range from −125 mgal over uplifts to −190 mgal over basins. Lineaments in trends of gravity anomalies are oblique to the predominant north-south trend of the rift and suggest that, in detail, the crust broke upon fractures oblique to the large-scale north-south trend. Thicknesses of Cenozoic sediments, determined from gravity measurements, range from 2 to 3 km in basins. The gravity effect of sediments is removed by stripping, and a broad 30-mgal gravity anomaly is located over the rift. Regional and residual Bouguer gravity anomaly maps have been constructed. The source of the 30-mgal gravity high is interpreted to be a shallow slab of basalt or a deep upwarp of the mantle that results in crustal attenuation. The low-velocity zone may project up toward the base of the crust under the Basin and Range province. Experiments and the observed fault pattern suggest an extensional origin for the Rio Grande rift fracture system.

• 80109—Geologic structure and evolution of the Keta basin, Ghana, West Africa.

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The Keta basin, covering approximately 2,200 km², lies along the east coast of Ghana. It is one of the chains of Mesozoic and Tertiary sedimentary basins in the Gulf of Guinea. The basin is filled with 870 m of Paleozoic marine and nonmarine sediments that were deposited in an interior basin that once occupied the present site of the Keta basin. These sediments are unconformably overlain by 3,600 m of Mesozoic-Tertiary deposits. Three major post-Paleozoic depositional cycles are recognized in the basin.

Jurassic dolerites from well samples in the basin are correlative with dolerite exposures in other coastal regions of Ghana and West Africa. Radiometric ages of these dolerites (162 to 192 m.y.) agree with the presumed initial time of separation of Africa and South America.

Bouguer gravity anomalies show that the Keta basin is dominated by two major northeast-trending anomalies,

with an axial high of 36 mgal to the north and a low of −15 mgal to the south, where the sediments are thickest. The prominent northeast-southwest orientation of the basinal structure, faults, and gravity anomalies coincide with the orientation of the Romanche Fracture Zone. The structure exerts considerable influence on sediment accumulation in the basin. Seismic data from the adjacent continental shelf and gravity data from the basin suggest that the Romanche fracture extends into the West African continent as the Fenyi-Yakoe fault. The Keta basin is a graben that is modified by basement faulting.

• 80110—Late Mesozoic and Cenozoic movements of the Italian Peninsula: Further paleomagnetic data from the Umbrian sequence.

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About 210 samples of rocks of late Early Jurassic to early Tertiary age from 37 sites in the Umbrian carbonate sequence in the Northern Apennines were investigated paleomagnetically. Special attention was paid to the Scaglia Formation of Cenomanian to middle Eocene age, and three well-correlated sections were studied in detail. Accurate relative ages were determined from the well-preserved planktonic foraminiferal faunas.

Paleomagnetic directions of Toarcian-Aalenian to late Aptian sites group fairly well, which implies the absence of major rotational and latitudinal movements of the sampling area during that interval. An only minor phase of movement at about Tithonian time resulted in a counterclockwise rotation over approximately 10°. Late Aptian to late Cenomanian directions indicate a southward movement over 10° of latitude; this was followed by a 30° counterclockwise rotation during Turonian, Coniacian, and Santonian time, and in addition, a northward movement over 10° of latitude during Santonian and Campanian time. Maastrichtian to early Eocene data group reasonably well but also deviate from the present local field direction; this indicates a further 25° counterclockwise rotation and an additional northward movement over more that 10° post–early Eocene time.

We suggest that the data presented here from the Northern Apennines are representative for the general pattern of movements of the Italian Peninsula.

These paleomagnetically deduced movements conform during at least late Early Jurassic to early Tertiary time with the movements of the African plate as established from sea-floor spreading and paleomagnetic data. At the same time, however, the paleomagnetic results indicate

that this coupled motion of the Italian Peninsula and the African continent did not persist until the present: a post-early Eocene 25° counterclockwise rotation of the Italian Peninsula must have occurred relative to Africa.

Our data are compared with available paleomagnetic data from the western Mediterranean area. Their relation to the structural evolution of the areas concerned is discussed.

• 80111—Mid-Cretaceous paleoenvironments and biostratigraphy of the Benue Trough, Nigeria.

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The epeiric sea that flooded the Benue Trough attained a maximum depth of about 30 m during late Turonian time. It encroached from the south and shoaled northeastward, with evaporites and carbonates accumulating at the distal end.

• 80112—Tectonic framework of the southwestern Kenai Peninsula, Alaska.

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The southwestern Kenai Peninsula consists of four northeast-trending pre-Tertiary tectonic units, each characterized by a different deformational style and rock assemblage. Well-bedded Upper Triassic and Lower Jurassic volcanogenic strata are laterally adjacent to a discontinuous belt of medium-grade metamorphic rocks. The Seldovia Bay complex, a deformed and locally chaotic subduction complex of probable late Mesozoic age, consisting largely of argillite, chert, graywacke, and greenstone, underlies most of the area to the east of the metamorphic terrane. Farther to the southeast, the Seldovia Bay complex is adjacent to and structurally underlain by late Mesozoic turbidites of the Valdez Group. These units are integral parts of extensive parallel belts, separated by major faults, that extend from the Kodiak Islands through the Kenai Peninsula to the Chugach Mountains.

• 80113dr—Lineament, linear, lineation: Some proposed new standards for old terms: Discussion and reply.

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