GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

FEBRUARY 1978

The Seattle Annual Meeting third largest ever Thanks to all who helped

The Annual Meeting in November in Seattle was in all regards a success. It was the third largest annual meeting in the history of the Society, being exceeded in size by the Washington, D.C., meeting in 1971 and by the 5,351 attendance at Denver last year.

Total registration at Seattle was 3,956, which included 2,802 professional registrants, 793 students, 281 guests, and 80 one-day registrants. More than half of the professionals (1,478) and guests (186) had preregistered, as had 323 of the students. The large number of preregistrations contributed to the speed of the on-site registration procedure.

The 1977 Annual Meeting was a 3-day affair, following the 4-day meeting in Denver in 1976. We are in a period of varying lengths for annual meetings—the Toronto meeting in 1978 will go to 4 days, and the San Diego meeting in 1979 will last 3½ days.

From a total of 971 abstracts submitted, 718 papers were presented. These were grouped into 31 regular sessions and 19 half-day symposium sessions at which 200 papers were presented. Also, there were 138 poster presentations in five half-day sessions. Two special symposia were held on Sunday preceding the meeting, one on Geochemical Cycles and one on Geology of Uranium Deposits. On Monday evening there were two open forum sessions, one on Geochemistry and Public Policy, and one on Geologic Constraints on Nuclear Policy.

In association with the meeting were 13 field trips, conducted by 28 leaders. The trips were attended by 490 participants.

For the first time the Association of Engineering Geologists held its annual meeting in the same city and immediately preceding the annual meeting of GSA and Associated Societies. The arrangement not only made possible some economies for individuals attending both meetings but also provided an opportunity for "cross-attendance" on field trips.

The employment interview service was a busy operation with the largest number of employers (115) yet involved in the program. Of these, 53 employers conducted 751 interviews in the spaces provided; 5 posted job descriptions and used the message center; 31 posted job notices and interviewed outside the employment service area; and 26 employers received printouts but did not interview in Seattle. Before the meeting there was a total of 465 applicants on the file; 184 preregistered applicants attended the meeting, and 60 applicants registered at the meeting.

The exhibit hall is always a major attraction at the annual meeting, and Seattle was no exception with one of our larger exhibits. There was a total of 98 booth spaces occupied by 22 educational exhibits and 49 technical exhibits. The membership booth was visited by more than 200 people seeking information about the Society.

A special feature of the Seattle meeting was the "New *Bulletin*" demonstration room. It had been announced 6 months before that the format of the GSA *Bulletin* would change on January 1, 1979. After that date it would consist of two part: Part I, with the same appearance as the present *Bulletin*, to contain summaries, and Part II published on microfiche to contain the full-length articles. In order to furnish information about preparation, general format, type of fiche, and available readers and reader-printers, the room was staffed by members of the Publications Department all 3 days of the meeting. Nearly 600 individuals visited the room during the meeting, and many who came as skeptics went away with a much better understanding of the new system.

The local committee, as is always the case, had been working behind the scenes for months to assure the success of the meeting. The Society and all who attended owe them thanks and congratulations. In case you have forgotten who did the work, the committee membership was as follows: *Norman R. Anderson*, Technical Services; *Gayle Babcock*, Guest Program; *R. Scott Babcock*, Technical Program; *Edwin H. Brown*, Field Trips; *Robert A. Christman*, Science Theater; *Don J. Easterbrook*, General Chairman; *Ross C. Ellis*, Field Trips; *Larry G. Hanson*, Student Assistance; *A. Dan Horn*, Transportation and Publicity; *Kurt L. Othberg*, Co-Chairman/Treasurer, Publicity; *L. Don Ringe*, Meeting Space Assignments; *John Whetten*, Technical Program; and *Patty Combs*, Administrative Assistant, Department of Geology, Western Washington University.

Who's who of GSA: Officers and councilors for 1978

The direction and destiny of the Geological Society of America are in the hands of the officers and councilors that you, the membership, elect each year. All too often only a few of these individuals are known to any one member. For that reason it has been suggested that a few basic facts about each of them serving during 1978 be listed in the Society's *News and Information.* The following is our attempt to condense a great deal of information about each into a few words.

PRESIDENT

PETER T. FLAWN, b. Miami, FL, 2-17-26; m. 46; c. 2. GEOLOGY. B.A, Oberlin Col., 47; M.S, Yale, 48; Ph.D. (geol), 51. Jr. geologist, USGS, 48-49; res. scientist & geologist, bur. econ. geol., Univ. Texas, Austin, 49-60, dir. bur. & prof. geol., 60-70, dir. div. natural resources & environment, 70-72, V. Pres. acad. affairs, 70-72, prof. geol. sciences & prof. public affairs, 70-, Exec. V. Pres., 72-73; President, Univ. Texas, San Antonio, 73-77. USAAF, 44-45. Fel. GSA, AAPG, Am. Inst. Mining, Metall. & Petrol. Eng., Natl. Acad. of Eng.; Mem. Assn. of Am. State Geologists, Assn. of Professional Geological Scientists, Soc. Econ. Geologists, Sociedad Geologica Mexicana. Economic and environmental geology; geology of Texas and Mexico. Address: Department of Geological Sciences, University of Texas, Austin, Texas 78712. Phone: (512) 471-4962.

VICE-PRESIDENT

LEON T. SILVER, b. Monticello, NY, 4-9-25; m. 47; c. 2; m. 74. PETROLOGY, GEOCHEMISTRY. B.Sc, Univ. Colo, 45; M.S, N. Mex. Univ, 48; Ph.D. (petrol, geochem), Calif. Inst. Technol, 55. Jr. geologist, 47-65, geologist, USGS, 65-76; PROF. GEOL. CALIF. INST. TECHNOL, 65-. Asst. prof. to assoc. prof. geol, Calif. Inst. Technol, 55-65. Guggenheim fel, 64-65. Mem. subcomm. geochronology, Int. Union Geol. Sci, 70-; consultant, NASA, 71-. Mem. Natl. Res. Counc. Board on Mineral and Energy Resources, 1975-. Exceptional Sci. Achievement Medal, NASA, 71. Mem, Natl. Acad. Sci; fel, GSA, Mineral Soc. Am, Geochem. Soc., Am. Geophys. Union. Igneous and metamorphic petrology; geochemistry of uranium, thorium, and lead; geochronology; regional geology of southwestern United States; tectonic history of North America; mineralogy and petrology of meteorites and lunar materials. Address: Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125. Phone: (213) 795-6811 Ext. 2101.

PAST-PRESIDENT

CHARLES L. DRAKE, b. Ridgewood, NJ, 7-13-24; m. 50; c. 3. GEOPHYSICS. B.S.E, Princeton, 48; Ph.D. (geol), Columbia Univ, 58. Lectr. Geol, Columbia Univ, 53-55, instr, 58-59, asst. prof, 59-62, assoc. prof, 62-67, acting asst. dir, Lamont Geol. Observ, 63-65; prof. & chmn. dept, 67-69; PROF, DARTMOUTH COL, 69-, CHMN, 77-. Natl. Sci. Found. sr. fel, Cambridge, 65-66; Condon lectr, Univ. Ore, 69; pres, inter-union comm. on geodynamics, Int. Coun. Sci. Unions, 70-75, past-pres, 75-; chmn. comt. on geodynamics, Natl. Acad. Sci, 70-; mem. Geophys. Res. Bd; mem. U.S. Natl. Comm. on Geol, 77-. U.S.A. 43-46. Fel. AAAS, Am. Assn. Petrol. Geol; fel. Geol. Soc. Am, Marine Tech. Soc, Soc. Explor. Geophys, Am. Geophys. Union, Royal Astron. Soc, Seismol. Soc. Am; Hon. Fel. Geol. Soc. France. Marine geology and geophysics; tectonics; structural geology; seismology. Address: Department of Earth Sciences, Dartmouth College, Hanover, NH 03755. Phone: (603) 646-3338.

TREASURER

WILLIAM B. HEROY, JR., b. Washington, D.C, 8-13-15; m. 37; c. 4. GEOLOGY, GEOPHYSICS. A.B, Dartmouth Col, 37; Ph.D. (geol), Princeton, 41; adv. mgt. prog, Harvard, 61. Asst. geol, Princeton, 39-41; asst. geologist field party, Tex. Co, 41-42, geologist, 42-45; Geotech. Corp, 45-46; supvr, 46-50, v. pres. & dir, 50-59; exec v. pres, 59-61, pres, 61-65, exec v. pres, Teledyne Inc, 65-68, pres, Geotech. Div, 65-67, group mgr, 67-68, asst. to pres, Teledyne Inc. 68-70; v. pres.-treas, 70-76, PROF. GEOL. SCI, SOUTH. METHODIST UNIV, 70-. Fel. GSA; Soc. Explor. Geophys; Seismol. Soc. Am; Am Asn. Petrol. Geol; Am. Geophys. Union. Geology of the Shell Canyon area; economic geological petroleum; geophysical prospecting; surface and structural geology; stratigraphy, sedimentation and seismology. Address: 111 Heroy Building, Southern Methodist University, Dallas, TX 75275. Phone: (214) 692-2425.

COUNCILOR 1976-1978

W. G. ERNST, b. St. Louis, MO, 12-14-31; m. 56; c. 4. PETROLOGY, GEOCHEMISTRY. B.A, Carleton Col, 53; M.S, Univ. Minn, 55; univ. fels, Johns Hopkins Univ. 55-56, 57-58; Natl. Sci. Found. fel, 56-57, Ph.D. (geol), 59. Geologist, petrol. br, U.S. Geol. Survey, 55-56; fel geophys. lab, Johns Hopkins Univ, 58-60; asst. prof. GEOL & GEOPHYS, UNIV. CALIF, LOS ANGELES, 60-64, assoc. prof, 64-68, PROF, 68-AAAS; fel. Mineral. Soc. Am. (award, 69); Mineral. Soc. Gt. Brit. & Ireland; Am. Geophys. Union; fel. Geol. Soc. Am; Nat. Acad. Sci. Geochemistry; igneous and metamorphic petrology; application of theoretical and experimental phase equilibria to geologic problems; plate tectonics. Address: Department of Earth & Space Sciences, University of California, Los Angeles, CA 90024. Phone. (213) 825-8149.

COUNCILOR 1976-1978

HOWARD R. GOULD, b. Adrian, WV, 11-10-21; m. 48; c. 2. GEOLOGY. B.A, Minnesota, 43; California, 46-47; Ph.D. (geol), Southern California, 53. Training assoc, div. war res, California, 43-45, assoc. marine geologist, 46; asst. geol, Scripps Inst, California, 46-47, geologist, U.S. Geol. Surv, D.C, 47-54; asst. prof. oceanog, Washington (Seattle), 53-56; sr. geologist,

Peter T. Flawn

Leon T. Silver

William B. Heroy, Jr.

geol. res. sect, Humble Oil & Ref. Co, 56-63, staff geologist, 63-64, chief, 64; mgr. stratig. & struct. geol. div, EXXON PROD. RES. CO, 64-66, mgr. stratig. geol. div, 66-67, RES. SCIENTIST, 67- Spec. consult, U.S. Navy. Civilian with Off. Sci. Res. & Develop, 44. AAAS; fel. Geol. Soc. Am; Soc. Econ. Paleont. & Mineral; Am. Asn. Petrol. Geol; Am. Geophys. Union. Sedimentation, especially in marine and lake environments; general geology of the sea floor; petroleum geology. Address: EXXON Production Research Company, P.O. Box 2189, Houston, TX 77001. Phone: (713) 965-4796

COUNCILOR 1976-1978

DIGBY J. McLAREN, b. Carrickfergus, North Ireland, 12-11-19; m. 42; c. 3. GEOLOGY. B.A, Cambridge, 41, M.A, 46, Harkness scholar, 48; Ph.D. (geol), Michigan, 51. GEOL. SURV. CAN, 48-, chief paleontologist, 60-67, dir, inst. sedimentary & petrol. geol, 67-73, DIRECTOR GENERAL, 73-. Brit. Army, 40-46, Capt. Am. Paleont. Soc; fel. Geol. Soc. Am; fel. Geol. Soc. of London; fel. Royal Soc. of Canada. Devonian paleontology and stratigraphy of western Canada. Address: Director General, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8. Phone: (613) 994-5817

COUNCILOR 1976-1978

BRIAN J. SKINNER, b. Wallaroo, South Australia, 12-15-28; nat; m. 54; c. 3. GEOLOGY, GEOCHEMISTRY. B.Sc, Adelaide, 50; A.M, Harvard, 52, Ph.D, 55. Lectr. crystallog, Adelaide, 55-58; res. geologist, U.S. Geol. Surv, 58-62, chief, br. exp. geochem. & mineral, 62-66; PROF. GEOL, YALE, 66-, chmn. dept. geol. & geophys, 67-73; EUGENE HIGGINS PROF, 73- Mineral. Soc. Am; Geochem. Soc; Mineral. Soc. Can; Mineral. Soc. London; Am. Geophys. Union; Soc. Econ. Geol; fel. Geol. Soc. Am. Geochemistry of ore deposits. Address: Department of Geology & Geophysics, Yale University, New Haven, CT 06520. Phone: (203) 436-1073

COUNCILOR 1977-1979

PAUL A. BAILLY, b. Paris, France, 12-3-26; m. 58; c. 2. GEOLOGY. M.S, Univ. Nancy, France, 48; Graduate Studies, Internatl. Inst. Education Fellowship, Yale, 48-49; Ph.D. (geol), Stanford Univ, 51; Am. Mgmt. Assoc, Mgmt. Seminars, 62-65. Field geol. instr, Stanford Univ, 50-51; Second Lieut. French Paratroops, 51-52; Field geol. (Morocco), Kennecott Copper Corp, 52; Bear Creek Mining Co, 53-67; Field geol (US), 53-56, Explor. dist. mgr, 57-60, Pres, 60-67; PRESIDENT, OCCIDENTAL MINERALS CORP. 68-. Author of numerous articles on geology, exploration, mine development, and public land laws. Mem, SEG, GSA, AIME, Canadian Inst. Mining & Metallurgy; Mem. Editorial Board of Economic Geology, 65-68. Mem. Advisory Comm. Program for Engineering Development, School Mineral Engineering, Univ. Minnesota, 69-72. Mem. Panel ad hoc Comm. Materials Policy, NMAB, NRC, 72. Mem. Comrate, Comm. Mineral Resources & Environment, Div. Earth Sci, NAS, 72-75. Chmn. Comrate's Task Force Minerals Policy, 73-74. Mem. Advisory Board of Office of Earth Sci, NRC, 77-80. Address: Occidental Minerals Corp., Irongate Building 4, 777 South Wadsworth Blvd., Lakewood, CO 80226. Phone: (303) 988-2200

COUNCILOR 1977-1979

RANDOLPH W. BROMERY, b. Cumberland, MD, 1-18-26; m. 47; c. 5. GEOLOGY, GEOPHYSICS. B.S, Howard Univ, 56; M.S, Amer. Univ, 62; Ph.D, Johns Hopkins Univ, 68. Explor. Geophys, USGS, 48-67; Geophys. Consult, U.S. Dept. State, 67-68; Assoc. Prof. Geophys, Univ. Massachusetts, 67-69; Prof. Geophys, Chmn. Dept. Geol. & Geog, Univ. Massachusetts, 69-70 Vice-Chancellor, 70-72; Chancellor, Univ. Massachusetts, Amherst, 72-77; EXEC. VICE PRESIDENT, UNIV. MASSACHUSETTS, 77-. Commendation, Rep. Liberia Geol. Survey, 66; Cum Laude, Howard Univ; Hon. Doc. Educ. degree, Western New England College, 72; Hon. Doc. Sci. degree, Frostburg State College, 72; Hon. Doc. Laws degree, Univ. of Hokkaido, Japan, 76. Mem. NAS Spec. Pres. Adv. Panel Minority Part. Sci; Mem. Natl. Comm. Mineral Res. & Envir, NAS, 72; Chmn. Adv. Comm. Sec. Interior, Washington, D.C; Mem. Comm. on Human Resources, NAS; Mem. Sea Grant Review Comm, U.S. Dept. Commerce; Incorporator, Woods Hole Oceanographic Institute. Address: Office of the Chancellor, Whitmore Administration Building, University of Massachusetts, Amherst, MA 01002. Phone: (413) 545-2211

COUNCILOR 1977-1979

DON U. DEERE, b. Corning, IA, 3-17-22; m. 44, c. 2, ENGINEERING GEOLOGY. B.S, Iowa State, 43; M.S, Colorado, 49; Ph.D, Illinois, 55. Asst. prof. Univ. Puerto Rico, 46-48, assoc. prof. & head CE Dept, 49-51. Assoc. prof, Univ. Illinois, 55-58, prof, 59-72, vis. prof, Univ. FL, 74-75. CONSULTANT, 72-. Mem. Tau Beta Pi; Phi Kappa Phi; ASCE; AIME; Am. Soc. Testing & Mtl; Int. Soc. Rock Mech; AGU; AAAS; GSA; Assn. Engr. Geol; AIPG; Geol. Soc. London; NAE; NAS. Served on Rock Mechanics Comm. of NAS; Board of Dir. Int. Soc. of Rock Mech; Chmn Comm. Rock Mech. of ASTM; Chmn. Comm. Tunnel. Geol. of Engr. Geol. Div, GSA; NAS Comm. Rapid Excavation, Rock Mech; Comm. of Soil Mech. & Found, ASCE; Chmn. Comm. Stand. of Lab. & Field Tests, Int. Soc. of Rock Mech; Chmn. Subcomm. Nomenclature & Classif. Rock for ASTM; Comm. Underground Works of US for Large Dams; Chmn. US Natl. Comm. Tunneling Tech, NAS/NAE; Councilor, GSA Engr. Geol. Div, 64-65. Address: 6834 S.W. 35th Way, Gainesville, FL 32601. Phone: (904) 378-3061

COUNCILOR 1977-1979

M. GORDON WOLMAN, b. Baltimore, MD, 8-16-24; m. 51; c. 4. GEOLOGY. B.A, Johns Hopkins Univ, 49; M.A, 51, Ph.D. (geol) 53, Harvard. GEOLOGIST, USGS, 51-; PROF. GEOG. & CHMN. DEPT. GEOG. & ENVIRON. ENG, JOHNS HOPKINS UNIV, 58-. USNR, 43-46. Fel GSA, AGU, Assn. Am. Geog. (award, 72). River morphology; water resources. Address: Department of Geography & Environmental Engineering, Johns Hopkins University, Baltimore, MD 21218. Phone: (301) 338-7090

COUNCILOR 1978-1980

WILLIAM C. BRADLEY, b. Madison, WI, 2-22-25; m. 58; c.3. GEOLOGY. B.S, Univ. Wisconsin, 50; M.S, Stanford, 53, Ph.D. (geol) 56. Instr. to assoc. prof, 55-68, chmn dept, 68-72, PROF. GEOL, UNIV. COLORADO, BOULDER, 68-. Res. scientist, Univ. Texas, 65-66. AAAS, GSA. Geomorphology. Address: Department of Geological Sciences, University of Colorado, Boulder, CO 80309. Phone: (303) 492-6188.

COUNCILOR 1978-1980

WILLIAM R. DICKINSON, b. Nashville, TN, 10-26-31; m. 53, 70; c. 2. GEOLOGY. B.S, 52, M.S, 56, Ph.D. (geol), 58, Stanford. Asst. prof. to assoc. prof, 58-68, PROF. GEOL, STANFORD UNIV., 68-. Guggenheim fel, 65. AAAS, GSA, Soc. Econ. Paleontologists & Mineralogists, Am. Geophys. Union, Natl. Assn. Geol. Teachers. Petrology, structural geology, sedimentology, plate tectonics. Address: Department of Geology, Stanford University, Stanford, CA 94305. Phone: (415) 497-2537

COUNCILOR 1978-1980

ROBERT N. GINSBURG, b. Wichita Falls, TX, 4-26-25; m. 56. SEDIMENTOLOGY. A.B, Univ. Illinois, 48; M.A, Univ. Chicago, 50, Ph.D. (geol), 53. Asst. marine geol, Marine Lab, Univ. Miami, 50-54. Res. geologist, Shell Develop. Co., 54-60, res. assoc. geol, 60-65; prof. geol & oceanog, Johns Hopkins Univ., 65-70; PROF. SEDIMENTOL, COMP. SEDIMENTOL. LAB, UNIV. MIAMI, 70-. Fel, GSA, Soc. Econ. Paleont. & Mineral., Am. Assn. Petrol. Geol. Recent sediments, coral reefs, ancient and modern algal structures, carbonate geochemistry, marine geology. Address: University of Miami, Fisher Island Station, Miami Beach, FL 33139. Phone: (305) 672-1840

COUNCILOR 1978-1980

JAMES B. THOMPSON, Jr., b. Calais, ME, 11-20-21; m. 57. PETROLOGY, GEOCHEMISTRY. A.B, Dartmouth Col, 42; Ph.D, Mass. Inst. Technol, 50. Instr. geol, Dartmouth Col, 42; asst, Mass Inst. Technol, 46-47, instr, 47-49; instr. petrol, 49-50, asst. prof. petrog, 50-55, assoc. prof. mineral, 55-60, PROF. MINERAL, HARVARD UNIV, 60-. Ford Found. fel, 52-53; Guggenheim fel, 63. A. L. Day Medal, GSA, 64. Natl. Acad. Sci, AAAS. Fel. GSA, Mineral. Soc. Am, Am. Acad. Arts & Sci. Metamorphic petrology, geology of New England. Address: Department of Geological Sciences, Harvard University, Cambridge, MA 02138. Phone: (617) 495-2083

Geologists—Speak to your Neighbor

A major concern of the GSA Committee on Environment and Public Policy has been to find ways of getting sound geologic information into the hands of public decision makers in a way that will insure its sensible use. This is very difficult because the tax code under which GSA is incorporated does not permit lobbying. Even if lobbying were permitted, the membership of the Society may be too diverse to achieve strong internal agreement. However, publication of data on specific geologic problems or hazards by the Committee on Environment and Public Policy has been quite worthwhile. So, also, has been the personal contact of the leaders of our science (many of whom are GSA members) with lawmakers and key people in the bureaucratic maze. But the task of placing geologic data before the public cannot really be done until every geologist is willing to discuss geology with his or her neighbors and describe how their lives and their future are influenced by geologic processes and by the limited mineral and water resources of this of this planet.

For instance, how many of our neighbors even realize that geologic processes are touching and influencing the life of every person on Earth at all times? Do they know that the Earth is not static, but that geologic processes continually alter the interior and the exterior of the Earth? Are they aware that world society could not function without minerals—minerals that must be searched for and found by geologists? Most do not. Most simply accept the fact that water comes from a tap, and electricity flows when the switch is flipped. If our neighbors knew the urgency of the need to use geologic information in making public policy, they would demand its use.

Perhaps most geologists are aware that a world population that doubles every forty years or so is seriously depleting the Earth's mineral resources. They probably realize the added demand created by the rising expectations of each succeeding generation, including those of the Third World, which now demand a place in the sun. Most geologists know that a balancing act of excruciating delicacy is required in the use of the mineral and water resources of the Earth if catastrophic disaster is to be avoided.

Yet geologists have had little influence on public policy and decisions. In the United States, few geologists serve on the staffs of state and national lawmakers, who are making decisions every day that desperately need to be influenced by geologic data. But the voice of the geologist, armed with convincing data, is not heard.

It is a paradox that the group of scientists which collectively know the most about the mineral and water resources of the Earth, and who have the highest regard for the total environmental balance of the world, have no effective voice in public policy.

Actually, geologists are often viewed as persons of little credibility; as impractical dreamers to whom the responsibility of influencing public decisions cannot be entrusted. *This must change, and geologist as individuals must bear the responsibility.* I repeat, we must tell our neighbors what we know. No matter what our particular specialty, we must talk about it. The paleontologist can show his neighbors his collection of fossils. Don't laugh, the neighbors will be interested. They will be fascinated by the story of Earth's changing life forms. Who knows, the paleontologist's good neighbor may invite him to speak to a service club or some other civic group about geology. The geomorphologist can easily interest his neighbor in what is happening in a local ditch, creek, or even a driveway. The neighbor will learn of geologic processes, and how they affect the world about him. The petroleum geologist can reveal the romance of seeing the unseen, of gathering data, and of the thrill of discovery of a substance marvelously useful to mankind. The hydrologist will find that his neighbor is thirsting to learn about water in the Earth. When he learns the truth he may contact his congressman and request that hydrologic data be used. The point is, no matter how esoteric the specialty, there is a story to be told about the dynamics of geologic processes and about the limits of the resources of the world. *Every geologist should assume some responsibility for the telling.*

If we speak of what we know at every opportunity, a ripple effect will take place, and eventually our goal will be reached—lawmakers will demand that geologic information be studied before public decisions are made.

To make it happen, we must overcome our ingrained hesitancy to talk about geology to nongeologists. Perhaps we have believed too strongly that ours is an inexact science. Yet it is far more exact than behavioral sciences, which are currently in vogue and influencing public policy. Perhaps our tradition of multiple working hypotheses has made us hold our tongues. We seem to shrink from discussing geology with engineers, economists, lawyers, and others, even when the data suggest firm conclusions. We must change. The time has come when all geologists must speak. We must speak of what we know from wherever we are to whomever is there. Geologists can provide a vital influence on public policy. But it cannot be done in silence.

Again I say, "Speak to your neighbor." Tell him the geology that you know, and how important it is that those who make public policy do so from a firm base of geologic information. To do less is to invite disaster.

Robey H. Clark
GSA Committee on Environment and Public Policy

February BULLETIN briefs

Brief summaries of articles in the February 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.*

- 80201—The Colorado Lineament: A middle Precambrian wrench fault system.

Lawrence A. Warner, Department of Geological Sciences, University of Colorado, Boulder, Colorado 80309. (11 p., 5 figs.)

The "Colorado Lineament" is the name herein assigned to a northeast-trending belt of Precambrian faults that traverses the Rocky Mountains of Colorado and the Colorado Plateau and is followed along much of its trend by the Colorado River. It has been established that northeast faults in the Colorado Mineral Belt have a Precambrian ancestry; other faults in the system have been identified in north-central Colorado. Similar faults in the Grand Canyon region have been traced across the Colorado Plateau into Utah, defining an extension of the zone in Colorado. The entire belt constitutes a fault lineament more than 1,100 km long and 160 km wide.

The northern margin of the belt is the Mullen Creek–Nash Fork shear zone, which traverses southeastern Wyoming, separating an ancient basement terrain (≥2,400 m.y. old) in central Wyoming from younger rocks (≤1,750 m.y. old) in Colorado. Gravity and aeromagnetic data, together with radiometric ages obtained for deep-well samples, suggest an extension of this boundary beneath the high plains and into the northern midcontinent region.

The pattern that emerges resembles a fault system of the San Andreas type. Although the record is fragmentary, the sum of the evidence suggests that the system formed adjacent to the southeastern margin of the ancestral North American continent in connection with Penokean orogeny 2000 to 1700 m.y. B.P. It appears to represent a Precambrian counterpart of Phanerozoic wrench fault systems that have formed commonly along continental plate margins during episodes of mountain building.

- 80202—Emplacement of the Ronda peridotite, Sierra Bermeja, Spain.

Margaret Thompson Lundeen, Department of Geological Sciences, Harvard University, Cambridge, Massachusetts 02138 (present address: Department of Geology, Wellesley College, Wellesley, Massachusetts 02181). (9 p., 6 figs., 2 tbls.)

Metasedimentary rocks of the Blanca unit, previously reported as roof pendants overlying the Ronda peridotite (Betic Cordilleras, southwest Spain), have been reinterpreted on the basis of field evidence to overlie this ultramafic body.

Textural analysis of Blanca rocks reveals that they have experienced first mechanical degradation and later static metamorphism. Blastomylonites several hundred metres below the base of the peridotite show fluxion banding overprinted by the metamorphic assemblage crd + bio + sil + ksp + pla + qtz. In the intervening layer, the mylonitic texture has been totally annealed to form a medium-grained, nonfoliated gneiss of the same mineralogy (hornfels of some authors). Lithic fragments in the gneiss show mineralogical and textural similarities with underlying blastomylonites and are interpreted as resistant blocks in a subsequently metamorphosed tectonic breccia or mélange.

The structural position of the peridotite together with the mylonitic history of the Blanca rocks is most satisfactorily explained by the tectonic emplacement of the peridotite over the Blanca unit along a major thrust fault. The distribution of cordierite-bearing gneiss in a layer directly beneath the ultramafic sheet suggests that the peridotite was sufficiently hot to cause metamorphism at a temperature between 700 and 800 °C in an aureole at its base. To account for pressures of about 3.5 kb indicated by the cordierite assemblages, the metamorphic complex that overlies the peridotite (Casares unit) is interpreted as cover riding passively on the ultramafic sheet during thrusting.

The interpretation of Ronda peridotite as part of a thrust sheet suggests that it has participated in Alpine nappe tectonics in the Betic Cordilleras. The magnitude and direction of apparent tectonic displacement are similar to those of nappes in the western end of this foldbelt.

- 80203—Tectonic cycles and sedimentary sequences in the Brazilian intracratonic basins.

Paulo Cesar Soares, Paulo Milton Barbosa Landim, Departamento de Geociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil; Vicente Jose Fulfaro, Instituto de Geociências, Universidade de São Paulo, Brazil. (11 p., 9 figs.)

The geometry and petrology of sedimentary rocks preserved in the three intracratonic basins of the Brazilian craton (Paraná, Parnaiba, and Amazon) indicate the history and character of vertical movements of the cratonic area. Cyclic successions of erosional and depositional events are synchronous on the Brazilian craton and are correlated with cratons of other continents. The principal evolutionary stages of the Brazilian craton are interpreted as tectonic-sedimentary cycles, each represented by a stratigraphic record identified as a *sequence,* and each distinguished by its own special characteristics.

Cambrian-Ordovician sedimentary rocks, representing deposition in paraplatform basins during a transitional stage at the close of the Brazilian orogenic cycle, are assigned to the Alpha sequence. The Beta (Ordovician and

Silurian), Gamma (Devonian–early Carboniferous), and Delta (late Carboniferous–Late Permian sequences) and the Delta-A subsequence (Middle Triassic–Jurassic), corresponding to geotectonic cycles of the cratonic stabilization stage, indicate accumulation in large subsiding basins. The succession of facies in each of these sequences documents cyclical changes in the ratio of sediment supply to subsidence. Marine transgression and basin subsidence increased progressively through the Devonian phase of the Gamma sequence and declined thereafter, in a pattern similar to that of the North American craton and the Russian platform. The frequency of stratigraphic discordances in the three lower sequences suggests a higher degree of cratonic upwarping, progressively diminishing to a stage of maximum stabilization during Delta-A deposition, perhaps related to conditions immediately prior to rupture of the Gondwana plate.

Breakup of the Gondwana plate, accompanied by volcanism and remobilization of cratonic areas, initiated the reactivation stage during which two geotectonic cycles are recognized. The first, represented by the Epsilon sequence (Cretaceous), began with local subsidence in isolated basins, followed by widespread continental sedimentation under platform conditions. The second reactivation cycle was responsible for accumulation of the Zeta sequence (Cenozoic), which was characterized by thin residual deposits on an extensive Tertiary peneplain and by accumulations in Quaternary basins, the latter of minor importance except where adjacent to the uplifted eastern continental margin.

• 80204—Re-evaluation of some geophysical observations in the Caroline Basins.

Jacqueline Mammerickx, Scripps Institution of Oceanography, University of California, La Jolla, California 92093. (5 p., 5 figs.)

Well-identified magnetic anomalies in the Caroline Basins define a sequence 28 to 38 m.y. old; reflection profiles show fracture-zone offsets on the Eauripik Rise, and narrow, broad topographic ridges help identify two abandoned spreading centers and several fossil trenches. A combination of these geophysical parameters supports an interpretation of the evolution of the region in two phases.

Two phases of sea-floor spreading are recognized in the East and West Caroline Basins. The West Caroline and Kiilsgaard troughs represent two disjointed segments of an extinct spreading center abandoned at 28 and 31 m.y. B.P., respectively. The spreading center then jumped into the Eauripik position and was active for the next 5 m.y.

• 80205—Diagenesis and distribution of late Cenozoic volcanic sediment in the southern Bering Sea.

James R. Hein, David W. Scholl, Pacific-Arctic Branch of Marine Geology, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. (14 p., 6 figs., 4 tbls.)

Late Cenozoic ash deposits cored in Deep Sea Drilling Project Leg 19 in the far northwest Pacific and in the Bering Sea have altered to bentonite beds. Some bentonite layers were subsequently replaced by carbonate beds. A significant part of the Neogene volcanic history of land areas adjacent to the far north Pacific is represented by these diagenetic deposits. Bentonite beds are composed of authigenic smectite and minor amounts of clinoptilolite. Authigenic smectite has fewer illite layers than detrital smectite.

Opal-A and opal-CT, abundant in Bering Sea sediment, are not found in ash or bentonite layers. The percentage of smectite in the total clay-mineral assemblage of ash beds is greater than that for adjacent terrigenous sediment, but the total amount of clay minerals in ash sequences is less than in surrounding deposits. Morphology of the 17-A peak of smectite found in ash may represent newly formed, poorly crystalline smectite. Smectite becomes better crystallized as bentonite layers form. The percentage of smectite of the total clay-mineral assemblage in bentonite beds is greater than that in surrounding sediment, and, in contrast to ash beds, the total amount of clay minerals (mostly smectite) in bentonite layers is greater than in adjacent terrigenous sediment. Apparently, silica is not mobilized when volcanic ash layers transform to bentonite beds.

Saponite-nontronite varieties of smectite and high Fe/Al and Ti/Al ratios distinguish bentonite beds derived from basaltic parent material from those beds formed from more silicic volcanic ash. These silicic ash beds produce bentonite composed mostly of montmorillonite. The basal sediment section at site 192 is rich with bentonite beds. Smectite in the upper part of this section (Eocene) was formed by low-temperature diagenesis of volcanic debris of intermediate or more silicic composition derived from arc or Pacific volcanoes. In contrast, smectite from the lowest 10 to 20 m of the sedimentary section (Cretaceous) is formed from either low-temperature or hydrothermal alteration of the underlying basaltic basement and associated pyroclastic debris. This near-basement smectite contains Mg and K acquired from sea water and Si, Al, Fe, Ti, and Mn released from the volcanic material.

• 80206—Minerals in bottom sediments of the South China Sea.

Pei-Yuan Chen, Department of Geology, National Taiwan University, Taipei, Taiwan, Republic of China (present address: Indiana Geological Survey, Bloomington, Indiana 47401). (12 p., 10 figs., 1 tbl.)

The clay fraction separated from bottom sediments of the South China Sea consists of illite, chlorite, kaolinite, smectite, and mixed-layer clay minerals. The relative abundance of these clay components varies in different regions and also with depth below the bottom. Six different clay-mineral provinces can be recognized. Illite and chlorite derived from the Asiatic continent are predominant on the continental shelf beyond the China coast, but they diminish southward to the Sunda shelf. Fe-rich smectite and subordinate kaolinite, derived mainly from the igneous material of the tropical archipelagoes, are the principal minerals in the equatorial region. They prevail on the Sunda shelf and in the Gulf of Thailand (Gulf of

Siam) but not in the deltaic area beyond the mouth of the Mekong River. Here, the archipelagic smectite-kaolinite suite is overlapped by a continental illite-rich suite discharged by the Mekong River. High-smectite clays also form a halo surrounding the Philippine volcanic arc. The clay-mineral assemblage in the central China Basin is transitional, but it is more akin to the northern (continental) suite than to the southern (archipelagic) suite, on the basis of its clay-mineral composition. Therefore, it is clear that provenance controls the pattern of clay-mineral distribution in the South China Sea.

• 80207—Jackstraw-textured talc-olivine rocks, Preston Peak area, Klamath Mountains, California.

Arthur W. Snoke, Department of Geology, University of South Carolina, Columbia, South Carolina 29208; Lewis C. Calk, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. (8 p., 5 figs., 3 tbls.)

An unusual ultramafic rock characterized by elongate olivine crystals forms several small masses in alpine-type, tectonitic peridotite of the Preston Peak ophiolite, Klamath Mountains, California. The largest mass of this distinctive ultramafic rock, which has been mapped in detail, has contacts with the surrounding peridotite tectonite that vary from indistinct to sharp. In several areas, the country-rock tectonitic peridotite is impregnated by a network of talc-olivine veins locally containing elongate olivine crystals. Within the mass, the elongate olivine crystals, many of them pseudomorphosed by serpentine, are typically arranged in a crisscrossed pattern (jackstraw texture), but radial and parallel patterns also occur. The olivine crystals are bladelike but lack the skelatal or dendritic textures characteristic of elongate igneous olivines. Microprobe analyses of the olivine blades indicate that they are magnesium-rich ($Fo_{89.4}$) and unzoned. The coexisting mineral assemblage includes talc, tremolite, magnesite, chlorite, and pentlandite, minerals that are not compatible with a magmatic origin. Furthermore, at several localities within the mass, relict structures and minerals of the peridotite tectonite are preserved in the jackstraw-textured rocks, indicating a replacement origin. Major- and minor-element chemical data support a replacement origin, in that the jackstraw-textured talc-olivine rocks are similar in chemical composition to the surrounding tectonitic peridotite of the ophiolite. The most obvious difference is that the jackstraw-textured rocks contain more sulfur. Experimental data on the coexisting mineral assemblages indicate a low-temperature (500 to 600 °C) origin, and field relations suggest the importance of a volatile-rich phase.

• 80208—Age and origin of the major syenite centers in the Gardar province of south Greenland: Rb-Sr studies.

Alan B. Blaxland, Otto van Breemen, Isotope Geology Division, Scottish Universities Research and Reactor Centre, East Kilbride, Glasgow G75 OQU, Scotland; C. Henry Emeleus, Department of Geological Sciences, University of Durham, South Road, Durham DH1 3LE, England; James G. Anderson, Department of Geology and Mineralogy, University of Aberdeen, Aberdeen AB9 1AS, Scotland (present address, Blaxland: Institut für Mineralogie, Universität Munster, Gievenbecker Weg 61, D-44 Münster, West Germany). (14 p., 11 figs., 2 tbls.)

Rb-Sr whole-rock isochron data for nine intrusive centers (including the major oversaturated and undersaturated syenite bodies) in the Precambrian Gardar alkalic igneous province of south Greenland complete a systematic isotopic study of the major complexes of the region (15 distinct igneous centers). The new data show that magmatic activity occurred throughout the region over a period in excess of 150 m.y. and that there is a clear distinction between two major magmatic events—an early Gardar (~1,300 m.y. old) event and a more widespread late Gardar (~1,160 m.y. old) event, which also involved extensive east-northeast–trending dike emplacement. Two relatively small intrusions in the western part of the province have middle Garder (~1,250 m.y. old) ages. There does not appear to be any relationship between emplacement age and geographic location, mode of emplacement, or the recognized petrologic division into saturated or undersaturated types; indeed, some adjacent complexes with strikingly similar petrologic characteristics have originated during different events, and, conversely, adjacent complexes with very different compositions are chronologically indistinguishable with present techniques.

Initial $^{87}Sr/^{86}Sr$ ratios for the Gardar rocks are broadly divisible into three groups. Low (0.702 to 0.704) ratios are characteristic of most of the intrusions in the province, including most of the syenites (both undersaturated and oversaturated) and gabbros—which indicate a primitive (mantle) origin for the parental Gardar magmas. Intermediate ratios (0.704 to 0.707) are observed in fewer centers, particularly in the Nunarssuit complex (gabbro, oversaturated syenites, and granites). For these centers, the possibility of closed-system enrichment in ^{87}Sr (by decay of ^{87}Rb during a complex molten history extending throughout 150 m.y. of Gardar time) is rejected as unlikely, as is a direct origin by partial melting of older crust; field, chemical, and isotopic evidence presented here strongly support a bulk-assimilation hypothesis. Only two complexes have high (>0.707) ratios; both show evidence of introduction of radiogenic ^{87}Sr into their magmas at a late stage of development through *selective* leaching of radiogenic ^{87}Sr from older crust, and both of these complexes are associated with mineralization.

• 80209—Anorthosite-mangerite relations on Baker Mountain, New York.

Karl E. Seifert, Department of Earth Sciences, Iowa State University, Ames, Iowa 50011. (6 p., 3 figs., 3 tbls.)

Outcrop scale mapping indicates that the contact zone between Marcy anorthosite and Tupper-Saranac mangerite on Baker Mountain in northeastern New York consists of mangerite dikes cutting both anorthosite and a granofelsic jotunite. All three units are intruded by younger granitic dikes that have produced contact aureoles in the anorthosite, and all of these rocks were metamorphosed and deformed during the Grenville orogeny. Postorogenic mafic dikes cut all other rocks on Baker Mountain.

Patches of exceptionally calcic plagioclase reach a composition of An_{80} in the Marcy anorthosite.

Rare-earth element analysis reveals that both anorthosite and mangerite have positive europium anomalies, whereas the jotunite and a skarn inclusion have no europium anomalies. Both mangerite and jotunite have high total rare-earth abundances compared to anorthosite.

• 80210—Cenozoic volcanic geology and probable age of inception of basin-range faulting in the southeasternmost Chocolate Mountains, California.

Bruce M. Crowe, Geosciences Group Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545. (14 p., 9 figs., 2 tbls.)

A complex sequence of Oligocene-age volcanic and volcaniclastic rocks form a major volcanic center in the Picacho area of the southeasternmost Chocolate Mountains, Imperial County, California. Basal-volcanic rocks consist of lava flows and flow breccia of trachybasalt, pyroxene rhyodacite, and pyroxene dacite (32 m.y. old). These volcanic rocks locally overlie fanglomerate and rest unconformably on pre-Cenozoic basement rocks. They are intruded and overlain by rhyodacitic to rhyolitic plug domes, lava flows, volcaniclastic deposits, and locally thick unwelded and welded rhyolite ignimbrite. South and southeast of a prominent arcuate fault zone in the central part of the area, the rhyolite ignimbrite (26 m.y. old) forms a major ash-flow sheet. In the southwestern part of the Picacho area the rhyolite ignimbrite interfingers with and is overlain by dacite flows and laharic breccia derived from a probable cone complex, the deeply eroded center of which is marked by a dacite plug that forms the southern half of Picacho Peak. The rhyolite ignimbrite and the dacite of Picacho Peak are overlapped by lava flows and breccia of pyroxene andesite (25 m.y. old) that locally rest on pre-Cenozoic basement rocks. The rhyolite ignimbrite has a minimum volume of 40 km^3 and is not associated with a collapse cauldron or major subsidence features.

The volcanic rocks of the Picacho area form a slightly bimodal volcanic suite consisting chiefly of silicic volcanic rocks with subordinate andesite. The lavas have an alkali-lime index of 61, show no iron enrichment, and define a slightly potassic volcanic suite. Late Miocene augite-olivine basalt contains normative hypersthene but is most similar in major-element abundances to transitional alkali-olivine basalt of the Basin and Range province.

• 80211—Late Cenozoic subduction and continental margin truncation along the northern Middle America Trench

D. E. Karig, R. K. Cardwell, G. F. Moore, Department of Geological Sciences, Cornell University, Ithaca, New York 14853; D. G. Moore, Naval Undersea Center, San Diego, California 92132 (present address, D. G. Moore: DSDP, A-031, Scripps Institution of Oceanography, La Jolla, California 92093). (12 p., 9 figs.)

The narrow inner trench slope and the truncated igneous and metamorphic terrane along the west coast of Mexico between Cabo Corrientes and the Gulf of Tehuantepec indicate that part of the continental margin has in some way been removed during the process of subduction. However, a detailed marine geophysical survey of the inner trench slope near Acapulco indicates that this removal is not occurring now. South-southwest–trending magnetic anomalies produced by the Xolapa metamorphic complex extend seaward only 20 to 30 km. Oceanic magnetic anomalies that trend N50°W extend as much as 30 km landward of the trench. The boundary between these two magnetic patterns lies landward of the trench-slope break and beneath the upper-slope sediment pile. The nonmagnetic material forming the acoustic basement trenchward of the metamorphic rocks is interpreted to consist of late Miocene to Holocene deformed trench-floor turbidites. Deformation associated with subduction has reversed the gradients of several submarine canyons and tilted the seaward edge of the upper-slope sediment pile away from the trench. The morphology and structure of the inner trench slope is typical of accreting trench-arc systems, although the morphotectonic units in this system are smaller than usual.

Accretion since late Miocene time is suggested by the age of dredged slope sediments and by analysis of offshore magnetic anomalies, which indicate a change from right-lateral oblique to perpendicular subduction at that time. Removal of the continental margin probably occurred intermittently between Late Cretaceous and late Miocene time. Possible mechanisms include subduction of continental crust (tectonic erosion), left-lateral translation associated with the Caribbean–North American plate boundary, and right-lateral translation associated with oblique subduction between the Farallon or Cocos plates and the North American plate. Geological data favor right-lateral offset and suggest that some of the missing margin may be the slivers of subduction complex found along the west coast of Baja California and possibly even farther north.

• 80212—Relict oysters on the United States Atlantic continental shelf: A reconsideration of their usefulness in understanding late Quaternary sea-level history.

Ian G. Macintyre, Department of Paleobiology, Smithsonian Institution, Washington, D.C. 20560; Orrin H. Pilkey, Department of Geology and Marine Laboratory, Duke University, Durham, North Carolina 27706; Robert Stuckenrath, Radiation Biology Laboratory, Smithsonian Institution, Washington, D.C. 20560. (6 p., 3 figs., 1 tbl.)

Relict oyster shells are thought to be unreliable references for reconstructing sea-level history owing to interrelationships between their age and present depth of occurrence off North Carolina. Radiocarbon dates were obtained from 44 relict oyster shells of *Crassostrea virginica* (Gmelin) collected within a relatively narrow area of the continental shelf from north of Cape Hatteras to Cape Fear (less than 40,000 km^2) in depths to 60 m. Data indicate significant postdepositional and landward transport of these shells, calling into question some previous interpretations of sea-level history that were based partly on the dating of relict oyster shells and other unreliable relict shoreline deposits.

- 80213—New K-Ar dates and the late Pliocene to Holocene geomorphic history of the central Rio Grande region, New Mexico.

G. O. Bachman, H. H. Mehnert, U.S. Geological Survey, Federal Center, Denver, Colorado 80225. (10 p., 4 figs., 1 tbl.)

The aerial distribution, dissection, and stratigraphic relations of Pliocene and younger mafic volcanic flows indicate that the Rio Grande in central New Mexico became a throughflowing drainage system during late Pliocene time (between about 3.0 and 4.5 m.y. ago). K-Ar dates indicate that the course of the Rio Grande was established more than 4.0 m.y. ago in central New Mexico and about 3.0+ m.y. ago in north-central New Mexico. The Ortiz geomorphic surface was probably graded to the ancestral Rio Grande about 3 m.y. ago and is considerably older than the Llano de Albuquerque surface. The central Rio Grande region has been warped and faulted since late Pliocene time. A complex fault block in the southeastern part of the Albuquerque-Belen Basin includes volcanic rocks more than 20 m.y. old that originated from southwestern New Mexico before rifting of the Rio Grande depression.

- 80214—Deformation phases and the tectonic history of the eastern Alps.

M. J. Bickle, C. J. Hawkesworth, Department of Geology and Mineralogy, University of Oxford, Parks Road, Oxford OX1 3PR Great Britain (present address, Bickle and Hawkesworth: Department of Earth Sciences, The University, Leeds LS2 9JT Great Britain). (14 p., 13 figs., 2 tbls.)

The Tauern window exposes a section through some of the major Alpine thrust sheets. Deformation phases both within and around the southern and eastern margins of the Tauern window are shown to correlate. Different pre-Alpine structural and thermal histories are recognized in the metamorphic rocks of the Pennine basement and the allochthonous Altkristallin sheet. Overthrusting took place during two main phases of deformation, and most of the associated strain was taken up by a mélange of largely Mesozoic metasedimentary and metavolcanic rocks (the Peripheral Schieferhülle and the Unterostalpin). The consistent orientations of the pre-Alpine structures within the Altkristallin sheet and the consistent displacement directions derived from the Alpine fold orientations in the underlying units (implying overthrusting toward the northeast), suggest that the Altkristallin was emplaced as a coherent unit with little internal deformation.

- 80215—Load structures at the sediment-saprolite boundary, Fall Line, Maryland.

Juergen Reinhardt, U.S. Geological Survey, Reston, Virginia 22092; Emery T. Cleaves, Maryland Geological Survey, Baltimore, Maryland 21218. (7 p., 10 figs.)

The field relationship of Lower Cretaceous sedimentary

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rocks to saprolite along the Fall Line provides new information about sedimentation and saprolite burial in Howard County, Maryland. The response that the saprolite, which was formed from a felsic gneiss, has made to the overlying sediment suggests that (1) the crystalline rock had weathered to saprolite before sediment emplacement, (2) the sediment was deposited by a highly erosive agent, (3) the saprolite was water saturated and deformed plastically during sedimentation, and (4) later reorientation of the sediment-saprolite deformation structures took place, probably during sediment compaction.

Sedimentary petrology, sediment-saprolite contacts, and reverse density and injection structures along the sediment-saprolite boundary seem to rule out a Quaternary periglacial origin (congeliturbations) or any other origin involving saprolitization later than sedimentation. The field relationships and sedimentological analysis indicate synsedimentary deformation of the saprolite during Early Cretaceous time.

- 80216—The composition of basal ice from a glacier sliding over limestones.

B. Hallet, Department of Applied Earth Sciences, Stanford University, Stanford, California 94305; R. Lorrain, R. Souchez, Laboratoire de Géomorphologie, Faculté des Sciences, Université Libre de Bruxelles, B-1050 Bruxelles. (7 p., 4 figs., 1 tbl.)

Samples of ice from the Tsanfleuron Glacier (Switzerland) were analyzed for Ca, Mg, Na, and K by atomic absorption. The basal ice is distinctly richer in Ca and Mg but slightly poorer in Na and K than the overlying glacier ice. The relative enrichment of Ca and Mg in basal ice appears to result from the limited incorporation of solutes as the ice forms by refreezing of pressure meltwaters that have flowed in intimate contact with the carbonate bedrock underlying the glacier. Because the bulk of the solutes are selectively rejected by the growing ice, they tend to accumulate in freezing subglacial waters until they eventually precipitate in areas where basal freezing is localized. This subglacial precipitation of $CaCO_3$ results in thin superficial coatings of calcite that are abundant and particularly well developed in small concavities of the bedrock surfaces recently exposed by the retreat of the Tsanfleuron Glacier. Calculated minimum solute concentrations required to maintain such $CaCO_3$ precipitation used in conjunction with an experimentally determined effective distribution coefficient, which characterizes the solute partitioning during the growth, can yield estimates of the Ca content of the regelation ice. The close agreement obtained between predicted and measured Ca contents in basal ice strongly supports the hypothesis that ice layers at the base of the Tsanfleuron Glacier are formed, at least in part, by regelation and that the calcite deposits result from the selective solute rejection that accompanies basal ice growth.

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