GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

Who's who: Officers and councilors for 1976

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 1976 be listed in the Society's News & Information. The following is our attempt to condense a great deal of information into a few words about each.

PRESIDENT

ROBERT E. FOLINSBEE, b. Edmonton, Alta, Apr. 16, 17; m. 42; c. 4. GEOLOGY. B.Sc, Alberta, 38; M.S, Minnesota, 40, Ph.D. (petrol), 42. Asst. geologist, Geol. Surv. Can, 41-43; asst. prof. GEOL, UNIV. ALBERTA, 46-50, assoc. prof, 50-55, PROF, 55- Pres, 24th Int. Geol. Cong, Montreal, 72. R.C.A.F, 43-45. fel. Geol. Soc. Am; Soc. Econ. Geol; Am. Geochem. Soc; Am. Asn. Petrol. Geol; Royal Soc. Can; Can. Inst. Mining & Metall; Geol. Asn. Can. Petrology; economic and structural geology; field geology; geochemistry. Address: Department of Geology, University of Alberta, Edmonton, Alberta, Canada T6G 2E1. PHONE: (403) 432-4255

VICE-PRESIDENT

CHARLES L. DRAKE, b. Ridgewood, NJ, July 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- Nat. Sci. Found. sr. fel, Cambridge, 65-66; Condon lectr, Univ. Ore, 69; pres, inter-union comt. on geodynamics, Int. Coun. Sci. Unions, 70-; chmn. comt. on geodynamics, Nat. Acad. Sci, 70-; comt. adv. to Envir. Sci. Serv. Admin, 70-, mem. Ocean Affairs Bd. & Geophys. Res. Bd; exec. bd, Law of Sea Inst. U.S.A, 43-46. AAAS; Am. Asn. Petrol. Geol; fel. Geol. Soc. Am; Marine Tech. Soc; Soc. Explor. Geophys; Am. Geophys. Union; Royal Astron. Soc; Seismol. Soc. Am. Marine geology and geophysics; tectonics; structural geology; seismology. Address: Department of Earth Sciences, Dartmouth College, Hanover, NH 03755. PHONE: (603) 646-3338

PAST-PRESIDENT

JULIAN R. GOLDSMITH, b. Chicago, IL, Feb. 26, 18; m. 40; c. 3. GEOLOGY, GEOCHEMISTRY. S.B, Chicago, 40, Ph.D. (geol), 47. Asst. petrol, Chicago, 41-42; res. chemist, Corning Glass Works, 42-46; asst. petrol, UNIV. CHICAGO, 46-47, res. assoc. GEOCHEM, 47-51, asst. prof, 51-55, assoc. prof, 55-58, prof, 58-69, CHARLES E. MERRIAM DISTINGUISHED SERV. PROF, 69-, ASSOC. DEAN PHYS. SCI. DIV, 60-72, chmn. dept. geophys. sci, 63-71, assoc. chmn, 61-62, acting dean phys. sci. div, 62. Co-ed, J. Geol, 57-62; mem. earth sci. panel, Nat. Sci. Found, 58-61, chmn, 60-61, mem. Nat. Sci. Bd, 64-70; consult, Lawrence Radiation Lab, Univ. Calif; U.S. Geol. Surv; consult. ed, Encycl. Britannica; McGraw-Hill Encycl. Sci. & Technol. AAAS; fel. Geol. Soc. Am; Mineral. Soc. Am. (award, 55, v. pres, 68-69, pres, 70-71); Am. Acad. Arts & Sci; Am. Chem. Soc; Am. Crystallog. Asn; Geochem. Soc. (v. pres, 55); Am. Ceramic Soc; Am. Geophys. Union; Mineral Soc. Gt. Brit. & Ireland. Phase equilibria and crystal chemistry of silicates and carbonates. Address: Hinds Laboratory, 5734 South Ellis Avenue, Chicago, IL 60637. PHONE: (312) 753-8155

TREASURER

AUGUST GOLDSTEIN, JR., b. Shreveport, LA, Dec. 3, 20; m. 45; c. 3. GEOLOGY. B.S, La. State, 40, M.S, 42; Colo. Sch. Mines, 46; Ph.D. (geol), Colorado, 48. Geologist, Remvo Superior Vermiculite Co, Colo, 45-46; Winter-Weiss Co, 46-47; asst. geol, Colorado, 47-48; res. geologist, Stanolind Oil & Gas Co, 48-57; chief geologist, Bell Oil & Gas Co, 57-63, mgr. explor, 63-65; GEN. MGR, LUBELL OIL CO, 65- Instr, Denver exten, Univ. Colo, 48. U.S.A.A.F, 42-46, Res, 46-65, Lt. Col. (ret). Fel. Geol. Soc. Am; Soc. Econ. Paleont. & Mineral; Am. Asn. Petrol. Geol. (distinguished serv. award, 71). Sedimentary petrography; petroleum geology. Address: Lubell Oil Company, 1033 Mayo Building, Tulsa, OK 74103. PHONE: (918) 587-0015

COUNCILOR 1974-1976

LEON T. SILVER, b. Monticello, NY, Apr. 9, 25; m. 74; c. 2 (by prev. marriage). PETROLOGY, GEOCHEMISTRY. B.Sc, Colorado, 45; M.S, New Mexico, 48; Ph.D. (petrol, geochem), Calif. Inst. Tech, 55. From jr. geologist to GEOLOGIST, U.S. GEOL. SURV, 47-; PROF. GEOL, CALIF. INST. TECHNOL, 65-, assoc. prof, 62-65, asst. prof, 55-62. Guggenheim fel, 64-65; mem. subcom. geochronology, Int. Union Geol. Sci, 70-; consult, NASA, 71- Excep. Sci. Achievement Medal, NASA, 71. U.S.N, 43-46, Res, 46-59, Lt. (jg). Fel. Geol. Soc. Am; fel. Mineral. Soc. Am; Geochem. Soc; Am. Geophys. Union; Meteoritical Soc. 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:

(continued on p. 26)

Officers and councilors for 1976 (continued from p. 25)

Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125. PHONE: (213) 795-6811

COUNCILOR 1974-1976
MANIK TALWANI, b. India, Aug. 22, 33; m. 58; c. 3. GEOPHYSICS. B.Sc, Delhi, 51, M.Sc, 53; Higgins fel, Columbia, 54-55, Lydig fel, 55-56, univ. fel, 56-57, Ph.D. (geol), 60. MEM. STAFF, LAMONT GEOL. OBSERV, COLUMBIA UNIV, 57-, DIR, 73-, PROF. GEOL, UNIV, 70-. Mem, ocean affairs board, chmn., Ex. comm. Joint Oceanog. Insts. Deep Earth Sampling. Indian Geophys. Union First Krishnan medal, 65. Am. Soc. Explor. Geophys; fel. Am. Geophys. Union (James B. Macelwane award, 67); Seismol. Soc. Am; fel. Geol. Soc. Am; European Asn. Explor. Geophys; fel. Royal Astron. Soc. Marine geophysics; oceanography, geodesy. Address: Lamont-Doherty Geological Observatory, Palisades, NY 10964. PHONE: (914) 359-2900

COUNCILOR 1974-1976
HELEN L. CANNON, b. Wilkinsburg, PA, Apr. 30, 11; m. 35; c. 1. BIOGEOCHEMISTRY. A.B, Cornell Univ, 32; M.S, Univ. Pittsburgh, 34. Northwest. Univ, 32-33; Univ. Okla, 34-35; GEOLOGIST, oil geol, Gulf Oil Co, 35-36; minor metal commodity admin, U.S. GEOL. SURV, 42-46, geochem. prospecting methods, 46-62, GEOCHEM. CENSUS, 62- Chmn. subcomt. geochem. environ. in health & disease, Nat. Res. Coun, 69-73; meritorious award & nominee, Fed. Woman of the Year, Dept. Interior, 70, Distinguished Service Award, 75. Fel. AAAS; Soc. Econ. Geologist; fel. Geol. Soc. Am; Am. Geochem. Soc; Int. Asn. Geochem. & Cosmochem. Botanical methods of prospecting; trace element distribution in soils and plants as related to geology, health and disease. Address: U.S. Geological Survey, Federal Center, Denver, CO 80225. PHONE: (303) 234-4318

COUNCILOR 1974-1976
SHELDON JUDSON, b. Utica, NY, Oct. 18, 18; m. 43; c. 3. GEOLOGY. A.B, Princeton, 40; M.A, Harvard, 46, Ph.D. (geol), 48. Teaching fel. geol, Harvard, 41-42, geomorphol. & geog, 47-48; instr. GEOL, Wisconsin, 48-49, asst. prof, 49-52, assoc. prof, 52-55; PRINCETON, 55-64, KNOX TAYLOR PROF, 64-, CHMN. DEPT. GEOL. & GEOPHYS. SCI, 70- Fund Adv. Ed. fel, 54-55; Guggenheim & Fulbright fels, Italy, 60-61; Guggenheim fel, 66-67. Mem, Viking Fund-Peabody Mus. Exped, France, 48, 50. U.S.N.R, 42-45, Lt. AAAS; fel. Geol. Soc. Am; Assoc. Arctic Inst. N. Am. Glacial geology; geomorphology; geologic antiquity of man. Address: Department of Geological and Geophysical Sciences, Princeton University, Princeton, NJ 08540. PHONE: (609) 452-4100.

COUNCILOR 1975-1977
ALBERT W. BALLY, b. Hague, Holland, Apr. 21, 25; m. 50; c. 3. GEOLOGY. B.S, Fed. Inst. Tech, Zurich; Ph.D, Univ. Zurich, 53; Post-Doc, Columbia Univ, 53-54. Lectr. Columbia Univ; asst. geol. & micropaleont, Fed. Inst. Tech, Zurich, 49-53; Shell Canada, 54-66, chief geol, 62-66; mgr. geol. res, Shell Development Co, 66-68; chief geol, SHELL OIL CO, 68-75, CONSULT. GEOL, 75- Am. Asn. Petrol. Geol; Am. Geophys. Union; Can. Soc. Explor. Geol; Germany Geol. Soc; Switz. Geol. Soc; fel. Geol. Soc. Am. Structural geology, stratigraphy, micropaleontology. Address: Shell Oil Company, P.O. Box 481, Houston, TX 77001. PHONE: (713) 667-5661.

COUNCILOR 1975-1977
JOAN R. CLARK, b. Madison, WI, Jan. 22, 20; wid. CRYSTALLOGRAPHY. B.A, Barnard Col, 45; Ph.D. (crystallog), Hopkins, 58. Jr. scientific aide phys. chem, east. regional res. lab, U.S. Dept. Agr, 43; math. asst, Manhattan proj, Carbide & Carbon Chem. Corp, 45; jr. proj. engr. develop. eng, Brown instruments div, Minneapolis-Honeywell Regulator Corp, 46-49; asst. physics, Inst. for Cancer Res, 49-53; mathematician, U.S. GEOL. SURV, DEPT. INTERIOR, 53-56, physicist crystallog, 56-72, PHYSICAL SCIENTIST, 72- Fulbright res. scholar, Sydney, 62; co-investr. Apollo lunar samples, NASA, 69- AAAS; fel. Geol. Soc. Am; fel. Mineral. Soc. Am; Am. Crystallog. Asn; Am. Phys. Soc; Geochem. Soc; Am. Geophys. Union; Mineral. Asn. Can. X-ray diffraction studies of crystal structures; borates and other inorganics. Address: U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025. PHONE: (415) 323-8111

COUNCILOR 1975-1977
JOHN C. CROWELL, b. State College, PA, May 12, 17; m. 46; c. 1. GEOLOGY. B.S, Texas, 39; M.A, California, Los Angeles, 46, Ph.D. (geol), 47; hon. D.Sc, Louvain, 66. Asst. geologist, Shell Oil Co, Inc, 41-43; instr. GEOL, UNIV. CALIF, Los Angeles, 47-49, asst. prof, 49-54, assoc. prof, 54-60, PROF, 60-67, chmn. dept, 57-60, 63-67; SANTA BARBARA, 67- Guggenheim Found. fel, 53-54; Fulbright res. prof, Austria, 53-54; Nat. Sci. Found. sr. res. fel, Scotland, 60-61. U.S.A.A.F, 42-46, Capt. Fel. Geol. Soc. Am; Am. Asn. Petrol. Geol; Am. Geophys. Union; Soc. Econ. Paleont. & Mineral. Structural and general geology. Address: Department of Geological Sciences, University of California, Santa Barbara, Santa Barbara, CA 93106. PHONE: (805) 961-3224

COUNCILOR 1975-1977
WILLIAM R. MUEHLBERGER, b. N.Y.C, Sept. 26, 23; m. 49; c. 2. GEOLOGY, B.S. & M.S, Calif. Inst. Tech, 49, Ph.D. (geol), 54. Asst. prof. GEOL, UNIV. TEX, AUSTIN, 54-57, assoc. prof, 57-62, PROF, 62-, chmn. dept. geol. sci, 66-70. Geologic field asst, U.S. Geol. Surv, 48-49, geologist, 49, 71-; State Bur. Mines & Mineral Resources, N. Mex, 53-61, dir. crustal studies lab, 61-66; prin. investr, Apollo Field Geol. Invests, Apollo 16 & 17, 71- U.S.M.C, 42-46, 50-52. AAAS; fel. Geol. Soc. Am; Am. Asn. Petrol. Geol; Am. Geophys. Union; Nat. Asn. Geol. Teachers. Structural, areal and lunar geology. Address: Department of Geological Sciences, University of Texas, Austin, TX 78712. PHONE: (512) 397-5810

COUNCILOR 1976-1978
W. G. ERNST, b. St. Louis, MO, Dec. 14, 31; m. 56; c. 4. PETROLOGY, GEOCHEMISTRY. B.A, Carleton

Officers and Councilors for 1976 (continued)

Col, 53; M.S, Univ. Minn, 55; univ. fels, Johns Hopkins Univ, 55-56, 57-58; Nat. Sci. Found. fel, 56-57, Ph.D. (geol), 59. Geologist, petrol. br, U.S. Geol. Surv, 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 Geology & Institute of Geophysics, University of California, Los Angeles, CA 90024. PHONE: (213) 825-8149

COUNCILOR 1976-1978
HOWARD R. GOULD, b. Adrian, WV, Nov. 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, 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) 622-4222, ext. 2796

COUNCILOR 1976-1978
DIGBY J. McLAREN, b. Carrickfergus, North. Ireland, Dec. 11, 19; m. 42; c. 3. GEOLOGY. B.A, Cambridge, 41, M.A, 46, Harkness scholar, 48; Ph.D. (geol), Michigan, 51. Chief paleontologist, GEOL. SURV. CAN, 48, dir, inst. sedimentary & petrol. geol, 48-73, DIRECTOR GENERAL, 73- Brit. Army, 40-46, Capt. Am. Paleont. Soc; fel. Geol. Soc. Am; fel. Brit. Geol. Soc. Devonian paleontology and stratigraphy of western Canada. Address: Director General, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A OE8. PHONE: (613) 994-5817

COUNCILOR 1976-1978
BRIAN J. SKINNER, b. Wallaroo, S. Australia, Dec. 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) 436-1189

The Salt Lake City annual meeting: Thanks to all who made it a success

The 1975 annual meeting of the Society in Salt Lake City, Utah, was acclaimed a success. It also was a large meeting, slightly surpassing in total attendance the 1974 meeting in Miami Beach. Total registration was 3,733, which included 2,379 professional registrants, 271 spouses and guests, and 955 students. The exhibits area was also well populated. Approximately 144 registered exhibit personnel represented 72 exhibitors, and all available booth space was occupied.

The Salt Lake City meeting was the second year for poster sessions. This experimental and different way of presenting a scientific paper was somewhat modified from the first time it was offered at the Miami meeting, and the changes were largely in response to suggestions following the 1974 meeting. Suggestions and comments are solicited for guidance of future planning. Thirty-nine papers were presented at the four half-day poster sessions.

The operation of the employment interview service was the largest ever. Thirty-two interview booths were available for use by the 45 prospective employers and the 258 persons interviewing for prospective positions. Approximately 800 interviews were conducted in the booths provided in the Salt Palace, and, in addition, an unknown number of private interviews were arranged by using the Society's services.

Although it is rumored that some of the post-meeting field trips encountered weather conditions not conducive to good visibility, the weatherman was kinder to the premeeting trip participants. Approximately 580 persons took part in the 13 scheduled field trips before and after the meeting, not counting those who attended the trips for spouses and guests that were held concurrently with the technical sessions.

There were 57 technical sessions, not counting the poster sessions, at which 667 papers were presented. The facilities at the Salt Palace proved highly satisfactory, and the new regulation prohibiting smoking in the meeting rooms has received favorable comment.

As always, the local committee, working long and hard behind the scenes, was a key to the success of the meeting. The Society extends thanks and congratulations for a job well done. In case you have forgotten who did the work, the committee membership was as follows:

M. Dane Picard, General Chairman; *John M. Hummel*, Co-Chairman and Treasurer; *J. Keith Rigby* and *James L. Baer*, Technical Program; *John C. Wilson* and *Beverly Andreason*, Employment Interviews; *Howard R. Ritzma*, Field Trips; *Terence L. Britt*, Information and Student Assistance; *James A. Colburn* and *Janet Benjamins*, Meeting Rooms; *Howard F. Albee*, On-Site Registration; *William Lee Stokes*, Printing; *Robert P. Kunkel*, Science Theater; *Lou Deen Jensen*, Spouses' Program; *A. A. Ekdale*, Technical Services; *James B. Lindsay*, Transportation.

HOBBS NAMED INTERIM SCIENCE EDITOR

S. Warren Hobbs (left) is acting as interim replacement for Bennie Troxel, pending the selection of a new permanent science editor.

GSA's editorial policies will continue under Dr. Hobbs' direction so that delays in the time involved for the reviewing process will be kept to a minimum and so that no unmanageable backlog will occur.

Dr. Hobbs is on part-time loan from the USGS in Denver, where he is a member of the Branch of Central Environmental Geology and is currently involved in geologic mapping in east-central Idaho. He also devotes part of his time to the mineral resource studies as the Geological Survey's commodity geologist for tungsten.

Calendar of Penrose Conferences for 1976

January 4–9
Interpretation of Geochronology in Metamorphic Terranes
UNICOI Station, Helen, Georgia
Convener: *R. David Dallmeyer,* Department of Geology and Mineralogy, Ohio State University, 125 South Oval Drive, Columbus, Ohio 43210.

March 14–19
The Function of the Geologist in Society
Waterwood National, Huntsville, Texas
Conveners: *A. W. Bally,* Shell Oil Company, P.O. Box 481, Houston, Texas 77001; *C. L. Drake,* Department of Geology, Dartmouth College, Hanover, New Hampshire 03755; *S. J. Tuthill,* Special Assistant for Energy Policy, Room 5858, Department of Commerce, Washington D.C. 20230.

April 4–8
Late Orogenic Sedimentation and Related Tectonics in the Cordilleran and Appalachian Orogens*
Banff School of Fine Arts, Banff, Alberta, Canada
Conveners: *G. H. Eisbacher,* Geological Survey of Canada, 100 West Pender Street, Vancouver, British Columbia, Canada; *F. B. Van Houten,* Department of Geology, Princeton University, Princeton, New Jersey 08540.

May 28–June 2
Formation of Cleavage in Rocks, Especially Shale
St. David Inn, St. David, Pennsylvania
Convener: *Lucian B. Platt,* Department of Geology, Bryn Mawr College, Bryn Mawr, Pennsylvania 19010.

* IMPORTANT NOTE: *Because it is impossible to send mail to Canada during the current mail strike, please direct all inquiries or applications for this conference to Dr. Van Houten at Princeton. The deadline for applications has been extended to February 15. Also, we regret that this conference was inadvertently scheduled in conflict with the Cordilleran Section meeting, April 5–7, 1976.*

September 12–18
The Hydrologic Regime of Inland Lakes
Wisconsin (exact site not yet determined)
Conveners: *D. A. Stephenson,* Professor of Geology, University of Wisconsin, 1815 University Avenue, Madison, Wisconsin 53706; *C.L.R. Holt, Jr.,* U.S. Geological Survey, Water Resources Division, 1459 Peachtree Street, Atlanta, Georgia 30309.

September 26–October 1
Evaluation of Fault Activity
Sierra Nevada Inn, Mammoth, California
Conveners: *Duane R. Packer,* Woodward-Clyde Consultants, P.O. Box 24075, Oakland, California 94623; *George E. Brogan,* Woodward Clyde Consultants, P.O. Box 24075, Oakland, California 94623.

November 12–17
Thermal Evolution of Sedimentary Basins
Pomegranate Inn, Aspen, Colorado
Conveners: *Glenn R. Buckley,* EXXON Production Research Co., P.O. Box 2189, Houston, Texas 77001; *John G. Sclater,* Massachusetts Institute of Technology, Department of Earth and Planetary Science, Cambridge, Massachusetts 02139.

November 28–December 3
The Application of Crystal Growth Theory and Experiments to Rock Forming Processes
California (exact site not yet determined)
Convener: *Gary Lofgren,* National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Texas 77058.

December 13–17
Implementation of Geological Information in Land-Use Planning
Texas (exact site not yet determined)
Conveners: *B. W. Troxel,* California Division of Mines and Geology, 1416 9th Street, Room 1341, Sacramento, California 95184; *G. D. Robinson,* U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

January BULLETIN briefs

Brief summaries of articles in the January 1976 GSA Bulletin *are provided on the following pages to aid members who chose the lower dues option to select* Bulletin *separates of their choice. The Document Number of each article is repeated on the coupon and mailing label in this section.*

☐ 60101—Paleotemperature analysis of the marine Pleistocene of Long Island, New York, and Nantucket Island, Massachusetts. *Thomas C. Gustavson, University of Massachusetts, Amherst, Massachusetts 01002 (present address: Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas 78712).* (8 p., 10 figs., 2 tbls.)

Fossil marine faunas from the Pleistocene sediments of eastern Long Island, New York, and Nantucket Island, Massachusetts, previously attributed to the Sangamonian interglacial, appear to transcend the Sangamonian-Wisconsinan boundary.

The Gardiners Clay in its type area on Gardiners Island, New York, is of questionable age and is not correlative with the rhythmically bedded glaciolacustrine Gardiners Clay of Wisconsinan age on Long Island. The Wisconsinan Jacob Sand at its type area (Jacobs Hill, Long Island) is a nonfossiliferous glaciolacustrine or glaciofluvial unit. It is not correlative with the fossiliferous marine Jacob Sand of Gardiners Island. The Jacob Sand and the underlying glaciolacustrine Gardiners Clay are simply fluvial and lacustrine facies of the outwash that developed as part of the depositional system of the Montauk ice sheet.

The Jacob Sand or the Tobaccolot Bay fauna of Gardiners Island contains cold-water marine species extant north of Cape Cod, Massachusetts. This fauna suggests that Long Island waters were once 3° to 7°C colder than at present.

The marine fossil fauna from Bridgehampton, Long Island, contains species extant farther south, suggesting that Long Island waters were previously 2° to 11°C warmer than at present. The sparse fauna of the Gardiners Clay of Gardiners Island prevents its correlation with any of the other fossil-bearing units. The fauna of the lower unit of the Sankaty Beds exposed on Nantucket Island is extant in the Nantucket area, while the fauna of the upper unit is extant in the Gulf of Maine. This suggests that water in the Nantucket area was 2° to 7°C cooler when the upper Sankaty Beds were deposited.

It is thought that the warm-water Bridgehampton fauna is Sangamonian in age and that the marine waters of that time were as much as 6°C warmer than at present. The cold-water faunas from the upper Sankaty Beds and Tobaccolot Bay are Wisconsinan in age and suggest a cooling of approximately 5°C during the last glacial stage.

☐ 60102—Geochronology of the Arabian Shield, western Saudi Arabia: K-Ar results. *Robert J. Fleck, R. G. Coleman, and H. R. Cornwall, U.S. Geological Survey, Menlo Park, California 94025; W. R. Greenwood, D. G. Hadley, and D. L. Schmidt, U.S. Geological Survey, Jeddah, Saudi Arabia; W. C. Prinz, U.S. Geological Survey, Washington, D.C. 20244; J. C. Ratté, U.S. Geological Survey, Denver, Colorado 80225.* (13 p., 15 figs., 4 tbls.)

An orogenic event, correlated with the Pan-African event in eastern Africa, affected the Arabian Peninsula between 510 and 610 m.y. ago and is well recorded geochronologically. The event probably included two thermal pulses or maxima, the first occurring between 560 and 610 m.y. ago and the second between 510 and 540 m.y. ago. The earlier pulse, the more severe one, included the majority of the igneous activity and metamorphism. During the last part of the 510- to 610-m.y. period, left-lateral strike-slip faulting occurred along a set of northwest-trending en echelon fracture zones, whose composite displacement may be as large as 240 km. At least one and probably more orogenic events affected the Arabian Peninsula before the Pan-African event, but only minimum ages can be assigned to these, because thermal effects of the 510- to 610-m.y. event have reset K-Ar ages. Major diorite-granite batholiths, however, formed before 760 m.y. ago.

☐ 60103—Gravity anomalies and granite emplacement in west-central Colorado. *Laurie B. Isaacson, Department of Oceanography, Oregon State University, Corvallis, Oregon 97331; and Scott B. Smithson, Department of Geology, University of Wyoming, Laramie, Wyoming 82071.* (7 p., 5 figs.)

A major negative gravity anomaly with a minimum of -325 mgal and an amplitude of -70 mgal occurs in west-central Colorado between Aspen and Gunnison. The gravity minimum is closely associated spatially with Late Cretaceous to Oligocene granitic rocks and continues along the Colorado mineral belt to the northeast. Gradients indicate that the source of the negative anomaly is in the upper crust, but part of the negative anomaly is attributed to crustal thickening that resulted from isostatic compensation. The most plausible explanation is that most of the negative gravity anomaly is caused by a granite batholith from 8 to 25 km thick and that the numerous granitic stocks in the area are protrusions from this batholith so that the mineral belt occurs along the roof zone of the batholith. Although the stocks appear to be primarily emplaced by stoping, the gravity effect of the stoped material must be at the base of the crust or dispersed, because the gravity effect is minimal. Temperatures may be high enough for the granite to have been formed by partial melting in the lower crust. The postulated batholith forms a major crustal feature that cuts obliquely across many Laramide structural trends.

☐ 60104—Variations in surface roughness within Death Valley, California: Geologic evaluation of 25-cm-wavelength radar images. *Gerald G. Schaber, U.S. Geological Survey, Flagstaff, Arizona 86001; Graydon L. Berlin, Department of Geography, Northern Arizona University, and U.S. Geological Survey, Flagstaff, Arizona 86001; and Walter E. Brown, Jr., Jet Propulsion Laboratory, California Institute of Technololgy, Pasadena, California 91103.* (13 p., 19 figs., 2 tbls.)

Images—processed from 25-cm wavelength, side-looking airborne radar—of the salt flats and gravel fans on the floor of Death Valley, California, show distinctive variations in radar backscatter (that is, variations in image gray tones) that can be correlated with systematic changes in the surface roughness of different geologic units. Well-developed desert pavements on the oldest boulder gravel units of late Pleistocene age are clearly delineated as weak backscatterers on the images. A gradation in the size of gravel constituents near the base of the giant gravel fans is associated with an abrupt change in the backscatter energy. The change takes place at gravel radii between 0.08λ and 0.14λ (2.0 and 3.5 cm). A breakpoint observed in the Rayleigh scattering region of the total radar cross section is virtually independent of the antenna depression angle as long as the resolution area does not lie in the first pulse width of the echo (the 90° depression angle). With the longer wavelength radar systems, antenna depression angles of 45° to 90° appear to be well suited for investigations of surface roughness because of the suppression of radar shadows and the increased radar return from the near range.

☐ 60105—Definitive doline characteristics in the Clarksville quadrangle, Tennessee. *Phillip R. Kemmerly, Department of Geology, Austin Peay State University, Clarksville, Tennessee 37040.* (5 p., 4 figs., 5 tbls.)

Two random samples of dolines in the Clarksville quadrangle, Tennessee (selected on the basis of the presence or absence of natural ponds), were statistically compared on the bases of long-axis orientation, vectorial mean long-axis orientation, agreement with systematic joint sets, and length of doline long axis versus doline mean width.

The two doline samples are not members of the same population of doline long-axis orientations, nor do the two samples have the same preferred long-axis orientations. Both samples have different vector mean long-axis orientations, and the vector mean long axis-orientations of dolines without natural ponds is statistically significant. The polymodal preferred doline long-axis orientations correlate with the three systematic joint sets in the study area, particularly the N20° to 40°E and N10° to 30°W sets.

Both doline samples belong to the same population of length/mean-width ratios and are related allometrically in the form $L = 1.656\ W^{1.024}$.

☐ 60106—Geology and plate tectonics interpretation of the sediments of the Mesozoic radiolarite-ophiolite complex in the Neyriz region, southern Iran. *A. Hallam, Department of Geology and Mineralogy, University of Oxford, Parks Road, Oxford OX1 3PR, England.* (6 p., 3 figs.)

New investigations in the Neyriz region of Iran provide support for the hypothesis that Mesozoic radiolarite and ophiolite have been thrust southwestward as nappe complexes over the autochthonous Cretaceous carbonate platform deposits directly south of the Zagros Crush Zone. A Late Cretaceous wildflysch sequence is excluded from the nappe complex and put in the autochthonous unit. Different types of radiolarite are distinguished, and a variety of limestone olistoliths are recognized within these rocks. The structural and stratigraphic sequence in the Neyriz region closely resembles that of the Oman Mountains. A model is proposed in which a rifted and subsequently aseismic continental margin of Arabia persisted through much of the Mesozoic Era. In Late Cretaceous time, the pattern of plate motion changed, and Arabia was driven toward central Iran, with the consequent progressive destruction of the intervening ocean and emplacement of nappes from the northeast.

☐ 60107—Petrochemical and geochronologic studies of plutonic rocks in the southern Appalachians: II, The Sparta granite complex, Georgia. *Paul D. Fullagar and J. Robert Butler, Department of Geology, University of North Carolina, Chapel Hill, North Carolina 27514.* (4 p., 5 figs.)

Samples from near the center of a granite complex in Hancock County, Georgia, have a Rb-Sr isochron age of 295 ± 2 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.7035 ± 0.0004 ($\lambda\ Rb^{87} = 1.39 \times 10^{-11}\ yr^{-1}$). This low initial ratio makes it highly unlikely that the magma was significantly affected by anatexis or assimilation of sialic crustal material. The age, initial ratio, mineralogy, and texture of these rocks are very similar to other 300-m.y.-old granite masses in the eastern Piedmont of North and South Carolina.

Twenty-one samples from the same granitic complex but with different textures than the above five samples also plot on a series of approximately 300-m.y. isochrons. The initial ratios vary with sample location, but most range from 0.729 to 0.741. Scatter on a $CaO\text{-}K_2O\text{-}Na_2O$ diagram suggests Na and K migration; the values group according to sample location and texture.

The linearity and distribution of data points on isochron diagrams argue against significant contamination of magma with low initial Sr^{87}/Sr^{86} ratios by older country rock. Intrusion of magma with a low initial Sr^{87}/Sr^{86} ratio apparently was accompanied by Na and K migration, Sr-isotopic re-equilibration, and recrystallization of pre-existing granitic rocks. If this model is correct, Rb/Sr ratios suggest that the older rock is at least 530 m.y. old.

☐ 60108—Beach cusps formed by intersecting waves. *Robert A. Dalrymple and Glenn A. Lanan, Department of Civil Engineering, College of Engineering and College of Marine Studies, University of Delaware, Newark, Delaware 19711.* (4 p., 2 figs., 2 tbls.)

From the time when theories were first postulated on beach cusps, intersecting wave trains have been mentioned as one possible mechanism for cusp formation. However, this mechanism has been largely ignored, and no real effort has been made to understand it since Branner's work in 1900. It can be experimentally shown that rip currents, generated by intersecting waves of the same length, can create beach cusps of a known periodicity that depends on the wave length and the angle between the intersecting wave trains.

☐ 60109—Pleistocene glaciation in the southern part of the North Cascade Range, Washington. *Stephen C. Porter, Department of Geological Sciences and Quaternary Research Center, University of Washington, Seattle, Washington 98195.* (15 p., 12 figs., 5 tbls.)

Three major Pleistocene drift sheets preserved along a transect across the southern North Cascade Range are distinguished on the basis of stratigraphic relationships and differences in morphology, weathering characteristics, and soil-profile development. The two youngest drifts have been further subdivided into members representing second-order fluctuations of glacier termini. Deposits of former southeast-flowing valley glaciers in the upper Yakima River drainage basin can be traced across a low divide at Snoqualmie Pass to the west-draining valley of the South Fork of the Snoqualmie River where alpine drift is interstratified with deposits of the Puget Lobe of the Cordilleran Ice Sheet. Preliminary paleomagnetic measurements indicate that the deeply weathered and extensively eroded oldest drift (Thorp) antedates the Brunhes-Matuyama reversal (700,000 yr). Relative-age criteria suggest that the time elapsed between deposition of Thorp drift and the intermediate drift (Kittitas) was substantially longer than that between the intermediate drift and the youngest drift (Lakedale). Soil developed on Kittitas Drift shows pronounced clay enrichment in the B horizon, in marked contrast to the weakly developed post-Lakedale soil, suggesting that the Kittitas ice advances antedate the last interglaciation of the global marine record and therefore are more than 120,000 yr old. On the basis of reconstructed ice gradients, the next-to-youngest member (Domerie) of the Lakedale Drift is believed to correlate broadly with Vashon Drift that was deposited during the last major expansion of the Puget Lobe between 15,000 and 13,500 yr ago. Two more extensive, pre-Domerie advances of Lakedale glaciers (Bullfrog and Ronald) preceded the maximum stand of the Puget Lobe, as indicated by stratigraphic relationships and reconstructed glacier profiles. A late Lakedale readvance led to deposition of the Hyak Member prior to 11,050 yr ago in valley heads draining high-altitude source areas.

☐ 60110—Flume study of knickpoint development in stratified sediment. *W. N. Holland and G. Pickup, Department of Geography, University of Sydney, New South Wales 2006, Australia.* (7 p., 8 figs., 2 tbls.)

In a flume study of knickpoint development in stratified sediment, two thin sand beds were intercalated between beds of cohesive material. The sand beds acted as knickpoint-forming horizons on which stepped knickpoints were developed and maintained as they moved upstream, creating an apparently stable form, consisting of a channel-in-channel system. The system had four basic elements: (1) an aggraded reach upstream of the knickpoint, terminating on the downstream end at a fill-incision transition zone; (2) an oversteepened reach just above the knickpoint face; (3) the knickpoint face; and (4) an incising reach, often covered by moving sediment between successive knickpoints.

Apparently the presence of a knickpoint-forming horizon reduces knickpoint retreat rates, which were much lower in this study than those observed in an experiment with cohesive material but no intercalated sand beds and a similar discharge. Also, the channel-in-channel system that results from stratification is apparently fairly insensitive to the effects of changing discharge.

☐ 60111—Metalliferous deposits from the Apennine ophiolites: Mesozoic equivalents of modern deposits from oceanic spreading centers. *Enrico Bonatti, Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964; Marco Zerbi, Istituto di Petrografia, Università di Parma, Parma, Italy; Robert Kay, Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964; and Harold Rydell, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida 33146.* (12 p., 9 figs., 9 tbls.)

Northern Apennines ophiolite complexes, consisting of peridotite-gabbro-basalt assemblages overlain by chert of Late Jurassic age, are probably fragments of oceanic crust created at a Mesozoic spreading center. Metalliferous sedimentary deposits are found at the base of the chert formation, close to the basalt-chert contact. The main mineral component of these deposits is braunite; the deposits are rich in Mn and contain less than 1 percent Fe; no equivalent Fe-rich sedimentary rocks have been observed. The geochemistry of the minor transition metals, the rare-earth elements, Ba, U, and Th in these deposits, as well as their stratigraphic position, indicate that they are not similar to "hydrogenous" ferromanganese deposits from modern oceans; they instead show affinities to metalliferous deposits of hydrothermal origin associated with modern spreading centers. Fe-Cu-Zn-sulfide deposits are common in basalt of the Apennine ophiolite and are often close to the metalliferous sedimentary rocks. The metalliferous sedimentary rocks and the metal sulfide mineralizations probably originated as a result of the mobilization of metals from basalt during circulation of thermal waters in the basaltic-gabbroic crust close to a Mesozoic spreading center. Upper mantle volatiles may have provided additional metals to the thermal waters. The sulfide deposits formed during the subbottom convective circulation, whereas the manganiferous sediment originated from precipitation of the metals after discharge of the thermal solutions through the sea floor. Extensive metal fractionation may have occurred during the subbottom circulation, especially during deposition of the sulfide phases; the lack of Fe in the metalliferous sedimentary rocks may be due to such fractionation. This model can be applied to associations of sulfide ore and metalliferous sedimentary deposits in other ophiolitic complexes of various ages and to metallogenesis in modern spreading centers.

☐ 60112—Holocene bioherms (algal ridges and bank-barrier reefs) of the eastern Caribbean. *Walter H. Adey and*

Randolph Burke, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560 (present address, Burke: Department of Marine Science, University of South Florida, Tampa, Florida 33620). (15 p., 16 figs.)

Based on aerial and surface reconnaissance of shallow-water reefs and algal ridges throughout the Lesser Antilles and coring of reef-ridge structures on St. Croix, Martinique, Antigua, and Guadeloupe, major emergent and shallow-water Holocene bioherms are characterized by maps and sections.

On St. Croix, an extensive bank-barrier reef about 13 to 18 m thick is developed on the inner part of the carbonate shelf. Stratigraphically, this reef has a lower *Diploria-Montastrea*-rubble-sand (or bank) facies, formed during middle to late Holocene time, overlain by a shallow-water *Acropora palmata* facies, formed during the past 1,000 yr. In exposed areas, at depths of less than 2 m, crustose coralline pavements are presently forming incipient algal ridges on the reef crest. Shoreward of the barrier reef, on pre-existing benches at depths of 3 to 10 m, algal ridges had developed from 5000 to 2000 yr B.P. The developing barrier reef has since blocked wave action from the bench algal ridges, and many are now degenerating.

This same pattern occurs on the windward sides of many Lesser Antillean islands, with the following variations. (1) Where wave energy is generally greater than on St. Croix, an extensive coralline-*Millepore* crust in the form of mounds or spurs, incipient algal ridges, or even well-developed algal ridges cap bank-barrier systems. (2) Where bank barriers have not blocked inshore bench algal ridges (especially on limestone islands), they remain well developed and active. (3) Under some conditions, apparently associated with high energy and turbidity, fleshy algal pavements cap some bank-barrier structures.

In the Lesser Antilles where present shelf or bench depths are less than 10 to 12 m, the uppermost surfaces of Holocene bioherms have had sufficient time to build to maturity and now have reef flats and (or) algal ridges. Where shelf depths are between 10 and 20 m, modern *Acropora palmata* reef or algal ridge systems are forming on late Holocene deeper water bank bioherms. Where shelf depths are greater than 20 to 25 m, sufficient Holocene time has not elapsed to allow the extension of bioherms into shallow water. Shelf-edge reefs, especially without the possibility of a bank base, fall into this latter category and are generally immature and submerged.

□ 60113—Use of K_2O, Rb, Zr, and Y versus SiO_2 in volcanic ash layers of the eastern Mediterranean to trace their source. *Darlene Richardson and Dragoslav Ninkovich, Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964.* (7 p., 7 figs., 1 tbl.)

The two main provinces of Pleistocene tephra eruption in the Mediterranean Sea are the eastern half of the Hellenic arc, represented by calc-alkalic and weakly alkalic material, and the Neapolitan area, represented by high-K_2O material.

Of twenty distinctive ash layers that have been identified in Pleistocene deep-sea cores of the eastern Mediterranean, one is calc-alkalic ash that originated in the Minoan eruption of Santorini at about 3500 yr B.P., and another is trachytic ash that originated in the Citara-Serrara eruption on Ischia Island at about 25,000 yr B.P. Rb, Zr, and Y content has been analyzed in the upper and the lower ash from both the land and deep-sea cores and in three tephra deposits from the east Hellenic volcanoes of Nisyros, Yali, and Kos.

In addition to the K_2O/SiO_2 ratio, values of the trace elements Rb, Zr, and Y versus SiO_2 in the ash layers can be used in correlating the ash layers and in tracing the source of ash. All relative K_2O, Rb, Zr, and Y contents can be used to trace the source of ash to one of the two main provinces of tephra eruption. Zr and Y are most useful for identifying individual volcanoes as sources.

Good agreement of chemical analyses of correlatable samples of the two ash layers from land and deep-sea cores argues against major alteration of the glass shards or a measurable cation exchange between glass shards and sea water on the time scale of 25,000 yr.

□ 60114—Experimental studies in Precambrian paleontology: Structural and chemical changes in blue-green algae during simulated fossilization in synthetic chert. *John H. Oehler, CSIRO, Baas Becking Geobiological Laboratory, Box 378, Canberra City, A.C.T. 2601, Australia.* (13 p., 14 figs., 2 tbls.)

Experimental data concerning the effects of diagenesis and fossilization on soft-bodied microorganisms (particularly algae preserved in siliceous sediments) have been obtained through systematic monitoring of morphological and organic chemical changes in filamentous blue-green algae (*Lyngbya majuscula*, Oscillatoriaceae) during simulated fossilization in synthetic chert. With increasing time and temperature, there were tendencies toward reddening, darkening, and fragmentation of algal filaments, reduction in the size of algal cells and sheaths, destruction of micellar order in sheaths (with consequent loss of birefringent character), coalescence of trichomes, and destruction of intracellular components with preferential preservation of sheaths and cell walls. In addition, some algal filaments were damaged by growth of quartz spherulites, producing artifactual morphologies that appear to have natural counterparts in Precambrian fossiliferous cherts. Original algal hydrocarbons, and particularly normal alkanes, were relatively stable, but several previously absent hydrocarbons were produced through decomposition of other organic compounds. Isoprenoid compounds, chlorins, and probably porphyrins were derived from the degradation of algal chlorophyll. The δC^{13}_{PDB} value of algal carbon was unaffected in most experiments but decreased by $3^0/_{00}$ under extreme time and temperature conditions. Results of this study suggest trends in the morphological degradation of naturally silicifed algae, demonstrate that certain morphologies are artifacts of the silicification process, and suggest possible explanations of observed organic chemical trends in recent and ancient sediments.

□ 60115—Eolian transport textures on the surfaces of sand grains of Early Triassic age. *David H. Krinsley, Department of Earth and Environmental Sciences, Queens College, City University of New York, Flushing New York 11367; Peter F. Friend, Department of Geology, University of Cambridge, Sedgwick Museum, Downing Street, Cambridge CB2 3EQ, England; and Robert Klimentidis, Department of Earth and Environmental Sciences, Queens*

College, City University of New York, Flushing, New York 11367. (3 p., 2 figs.)

The surface textures of quartz sand grains from a Lower Triassic sandstone unit are almost identical to eolian sands from modern hot deserts, suggesting similar environments. This is the earliest example known of eolian surface textures unmodified by diagenesis; it shows how studies of surface textures of pre-Pleistocene sand grains may provide information about their depositional environments and subsequent diagenetic history.

☐ 60116—Palinspastic base map: Central and southern Appalachians. *George W. Pedlow III, Department of Geology, University of South Carolina, Columbia, South Carolina 29208.* (4 p., 1 fig.)

Paleogeographic reconstruction of orogenically deformed sedimentary rocks requires restoration of lithologic data points to predeformation locations. One method available for this purpose is the palinspastic base map, which is a cartographic representation of a "stretched back" orogenic belt. Although many regional sedimentologic studies have been conducted in the Appalachians, very few have included palinspastic restoration. In order to facilitate future paleogeographic reconstruction in the central and southern Appalachians, this paper presents a palinspastic base map covering Paleozoic sedimentary rocks of the region.

☐ 60117—A uniform measure of subaerial erosion. *Nel Caine, Institute of Arctic and Alpine Research and Department of Geography, University of Colorado, Boulder, Colorado 80302.* (4 p., 2 tbls.)

It is suggested that observations of contemporary sediment movement in subaerial situations be estimated by the physical work (in joules) that they represent. This can be conveniently done by estimating the change due to erosion in the potential energy of the landscape. An example from an alpine area in southwestern Colorado is used to illustrate the use of geomorphic work as a measure of erosion and to show how it may be compared to other environmental exchanges of material and energy.

☐ 60118—Boundary between two Precambrian W terranes in Minnesota and its geologic significance. *G. B. Morey, Minnesota Geological Survey, University of Minnesota, St. Paul Minnesota 55108; and P. K. Sims, U.S. Geological Survey, Federal Center, Denver, Colorado 80225.* (12 p., 8 figs.)

Minnesota lies astride two Precambrian W (lower Precambrian) terranes that differ in age, rock assemblages, metamorphic grade, and structural style. In northern Minnesota, greenstone-granite complexes 2,700 to 2,750 m.y. old, which are typical of the majority of the Canadian Shield, are exposed. These rocks trend northeastward, dip steeply, and typically produce narrow curvilinear aeromagnetic and gravity anomalies. In southwestern Minnesota, much older (3,550 m.y.) granulite-facies granitic and mafic gneisses, which are moderately flat-lying and produce relatively broad magnetic and gravity anomalies, are

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exposed through a window in the Phanerozoic cover in the Minnesota River valley. Similar gneiss, some of which has been dated radiometrically, is exposed sporadically in central Minnesota and is considered part of the same terrane as the gneiss in the Minnesota River valley. Judged from the outcrop pattern and available geophysical data, the boundary between the two terranes trends diagonally across central Minnesota, from approximately latitude 45°30′N at the western boundary to the vicinity of Duluth, on Lake Superior.

We postulate that the volcanic and sedimentary rocks in the greenstone terrane accumulated adjacent to the preexisting gneiss terrane, which 2,700 m.y. ago was part of a sialic protocontinent of moderate size. There is no geologic or geochemical evidence that these rocks were deposited on a sialic crust. The tectonic environment that existed 2,700 m.y. ago, when the greenstone-granite complexes were formed, is not known; there is no compelling evidence that they were formed in a plate tectonic regime.

☐ 60119dr—Stratigraphy and palynology of late Quaternary sediments in the Puget Lowland, Washington: Discussion and reply.

Discussion: R. J. Fulton, Geological Survey of Canada, Ottawa, Ontario K1A OE8; J. E. Armstrong, Geological Survey of Canada, Vancouver, British Columbia; and J. G. Fyles, Geological Survey of Canada, Ottawa, Ontario K1A OE8.

Reply: Don J. Easterbrook, Department of Geology, Western Washington State College, Bellingham, Washington 98225. (4 p., 1 fig.)

☐ 60120d—Coulee alignment and the wind in southern Alberta, Canada: Discussion. *Perry H. Rahn, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701.* (1 p.)

☐ 60121dr—Paleosalinities within a Pliocene bay, Kettleman Hills, California: A study of the resolving power of isotopic and faunal techniques: Discussion and reply.

Discussion: Thomas C. Williams, Florida Gas Exploration Company, 1750 Bank of New Orleans Building, New Orleans, Louisiana 70112.

Reply: J. Robert Dodd, Department of Geology, Indiana University, Bloomington, Indiana 47401; and Robert J. Stanton, Jr., Department of Geology, Texas A&M University, College Station, Texas 77843. (3 p.)

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