MAY-JUNE 1969

GEOTIMES

NEWS OF THE EARTH SCIENCES

YOU'VE JUST UNEARTHED CHARRED WOOD.

WITHIN WEEKS WE CAN TELL YOU ITS AGE.

Our radiocarbon laboratory and counting facilities can give you the fastest service available anywhere. A complete age determination report on your charred wood sample will be in your hands within weeks.

And the stress is on accuracy. Not only do we routinely date samples of your charred wood using C^{14} age determination methods, but our C^{12}/C^{13} analysis, also done routinely, can compensate for natural isotopic fractionation, one of the key factors affecting the accuracy of the date. The prices of our radiocarbon dating service are based on the number of samples we date for you during any given 12 month period. The prices range from $160 for a single sample to $120 per sample for 50 or more samples. For C^{14} plus C^{12}/C^{13} analysis, the charge is $185. Again, less for multiple analyses.

For complete details on the fastest, most accurate age determination service available anywhere, call or write ISOTOPES, 50 Van Buren Avenue, Westwood, New Jersey 07675. (201) 664-7070.

ISOTOPES

A TELEDYNE COMPANY

managing editor
WENDELL COCHRAN

production editor
LYNNE STOTT

advertising
GERRY JAMES

circulation
BEVERLEE BLACK

editorial board
C. HARRY BURGESS
PETER T. FLAWN
VINCENT McKELVEY

publisher
LINN HOOVER

Address: Send all mail, including ad copy, to 2201 M St. NW, Washington, D. C., 20037.

Telephone: (202) 296-7950

Advertising sales: Fairfax Associates. **New York**—C. R. Tunison, Box 448, Lenox Hill Station, New York, 10021. (212) RH 4-8107. **Chicago**—Robert Dunn, 2 North Riverside Plaza, Chicago, 60606. (312) 372-6266. **Los Angeles**—Richard Hatfield, 2322 West Third St., Los Angeles, 90057. (213) 385-3991. **Birmingham**—Fred Smith, Box 20060, Birmingham, Ala., 35216. (205) 822-3804.

Closing dates: Space for display ads must be reserved a month before the date of issue; for example, the deadline for the July issue is June 1. Classified ads will be accepted till the 15th of the month before date of issue.

Editorial matter: News items and articles on a contributing basis are welcome. However, following standard practice, we cannot return an unsolicited manuscript unless it is accompanied by a stamped envelope.

Geotimes is published monthly except June and August by the American Geological Institute, 2201 M St. NW, Washington, D. C., 20037. Type set by Artisan Type Inc., 613 Massachusetts Ave. NW, Washington, D. C. Printing by Kaufmann Printing Inc., 806 Rhode Island Ave. NE, Washington, D. C. Second-class postage paid Washington, D. C.

TO CHANGE YOUR ADDRESS

Attach mailing label (or your old address) here and print your new address below and mail to Geotimes. Give a month's notice.

Name .....

Street .....

City ..... **State** ..... **Zip** .....

Geotimes, 2201 M St. NW, Washington, D. C., 20037

May-June 1969

v. 14 n. 5

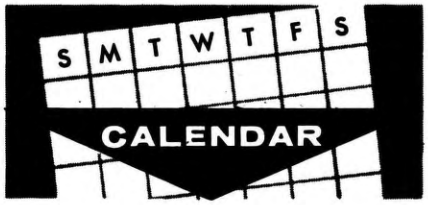
news of the earth sciences

GEOTIMES

PUBLISHED BY THE AMERICAN GEOLOGICAL INSTITUTE

on the cover: Powell's Colorado

These entrenched meanders of the Colorado River are in southern Utah and are shown from an altitude of about 3,000 ft. The meanders were probably formed on the surface of a gently sloping flood plain about the time the entire Colorado Plateau began to rise more than a million years ago. The mode of development was first understood by Powell: the river cut downward because the land was lifted under it. As Chas. B. Hunt puts it, the analogy is of a block of wood raised into a chain saw. (USGS photo)



May 19-21 Intl symposium on determination of **stresses in rock masses,** Lisbon. Intl Society of Rock Mechanics. (Secretariado do ISDSRM, Laboratorio Nacional de Engenharia Civil, Avenida do Brasil, Lisboa 5, Portugal)

May 24-25 **Michigan Basin** Geological Society, field trip to Sudbury, Ont.: effects of Precambrian basement on Michigan Basin. (R. Thomas Segall, Department of Natural Resources, Geological Survey Division, Lansing, Mich., 48926)

May 25-28 Society of Professional **Well Log** Analysts, ann. mtg & logging symposium, Houston. (C. R. Glanville, SPWLA, 13507 Tosca, Houston, Tex., 77024)

May 26/June 6 Seminar on **chromatographic analysis,** University of Newcastle, New South Wales. (A. S. Ritchie, Dept. of Geology, University of Newcastle, NSW, Australia

June 1/July 31 Summer course for **hydrology teachers,** Moscow, by Unesco & USSR Natl Committee for IHD. (International Summer Course for Hydrology Teachers, Geographic Faculty, Moscow State University, Lenin Hills, Moscow B-234, USSR)

June 5-7 Ann. mtg, Geological Assn of **Canada** & Mineralogical Assn of Canada; Montreal. **Symposiums on alkaline intrusions & flysch sedimentation.** (Guy Perrault, Dept. of Geological Engineering, Ecole Polytechnique, 2500 Ave. Marie-Guyard, Montreal 26)

June 9-14 **X-ray spectrometry** clinic, State University of New York, Albany. (Henry Chessin, Department of Physics, State University of New York, 1400 Washington Ave., Albany, N.Y., 12203)

June 16-19 11th Symposium on **Rock Mechanics,** by Intersociety Committee on Rock Mechanics & University of California; Berkeley. Abstracts deadline, Jan. 15. (Rock Mechanics Symposium Committee, University of California, 328 Hearst Mining Bldg., Berkeley, Calif., 94720)

June 16-18 Status of the art: **computers** in each sciences. Intl symposium by Kansas Geological Survey and Intl Assn. for Mathematical Geology; Lawrence, Kan. (D. F. Merriam, Kansas Geological Survey, University of Kansas, Lawrence, 66044)

June 16-20 American **Water Resources** Assn. research conference on ground-water systems analysis. (General Secretary, AWRA, Box 434, Urbana, Ill., 61801)

June 17-20 American **Astronautical Soc.** & Operations Research Soc. of America joint natl mtg: challenges of the '70s in space & the public domain, Denver. (G. W. Morgenthaler, Martin Marietta Corp., Box 179, Denver, 80201)

June 18-21 Ann. mtg, Western Society of **Malacologists,** Asilomar State Park, Pacific Grove, Calif. (Mrs Paul O. Hughes, 12871 Foster Rd., Los Alamitos, Calif., 90720)

June 22-30 **Earthquake displacement fields** & rotation of Earth, a Nato Advanced Study Institute. Deadline for applications for financial aid: April 30. (A. E. Beck, Department of Geophysics, University of Western Ontario, London, Ont.)

June 23-25 American **Water Resources** Assn. symposium, Water Balance in North America, Banff, Alberta. (A. H. Laycock, Dept. of Geography, University of Alberta, Edmonton, Alberta)

June 23-27 Short course on engineering problems of **Appalachian shales,** West Virginia University. (R. K. Seals, Dept. of Civil Engineering, West Virginia University, Morgantown, 26506)

June 24-26 Conference on trace substances in **environmental health,** Columbia, Mo. (D. D. Hemphill, 1-43 Agriculture Bldg., University of Missouri, Columbia, Mo., 65201)

June 29/July 2 American Assn. of **Petroleum Geologists** & Institute of Petroleum, joint mtg, Brighton, England. (AAPG headquarters, Box 979, Tulsa, Okla., 74101)

June 30/July 2 Rudolfs Research Conference, Rutgers University: **organic compounds** in aquatic environments. (Roger Locandro, Office of Resident Instruction, College of Agriculture & Environmental Sciences, Rutgers University, New Brunswick, N. J., 08903)

July 7-11 Ann. congress, **Geological Society of South Africa,** Pretoria. Theme: South Africa's contribution to International Upper Mantle Project. (L. E. Kent, Geological Survey, Private Bag 112, Pretoria, South Africa)

July 8-12 **Layered igneous intrusions,** symposium in Pretoria, plus field trips to Bushveld Complex & maybe to Great Dyke of Rhodesia. (D. J. Visser, Dept. of Geology, University of Pretoria, Pretoria, South Africa)

July 13-25 Intl Seminar for **Hydrology Professors,** Urbana, Ill. (V. T. Chow, Dept. of Civil Engineering, University of Illinois, Urbana, 61801)

July 31/Aug. 2 AIME **Intermountain** Section, ann. minerals conference, Vail, Colo. (H. B. Ham, Intermountain Section AIME, Box 713, Leadville, Colo., 80461)

Aug. 7-27 Intl Union of **Crystallography,** 8th gen. assembly & congress, U.S.A. Aug. 7-12, mtg on crystallography of biologically important substances, Buffalo, N. Y. Aug. 14-21, sessions at Stony Brook, N. Y. Aug. 23-27, sessions at Stony Brook & Brookhaven, Long Island. Aug. 25-27, visits to Washington, D. C. (Intl Congress of Crystallography, Congress Office, State University of New York, Stony Brook, 11790)

Aug. 11-15 **Guyana** Geological Conference, Georgetown, Guyana. (Geological Survey Department, Box 789, Georgetown, Guyana)

Aug. 19-22 Workshop on **snow & ice hydrology,** Colorado State University, Ft Collins. (R. E. Dils, Associate Dean, College of Forestry & Natural Resources, Colorado State University, Ft Collins, 80521)

Aug. 23/Sept. 4 Colloquium on **geochronology of Phanerozoic orogenic belts,** Switzerland. Aug. 23-28, field trip in central Alps. Aug. 29-31, mtg in Zürich; Sept. 1-3, in Bern. Sept. 4, **Commission on Geochronology** mtg in Bern; topic, Tertiary-Mesozoic & Mesozoic-Paleozoic boundaries. (E. Jäger, Mineralogisch-Petrographisches Institut der Universität Bern, Sahlstrasse 6, 3000 Bern, Switzerland)

Aug. 26-29 Intl symposium on **geodesy & geology of mines,** & geometry of ore deposits, Prague. (F. Kyntera, Institute of Mineral Research, Modranska 23, Prague, Czechoslovakia)

Aug. 29/Sept. 3 Colloquium on **geochronology** of Phanerozoic orogenic belts, field trip to Central Alps. (E. Jager, Universitat Bern, Mineralogical Institute, Sahlistrasse 6, Ch-3000 Bern, Switzerland)

Aug. 30/Sept. 5 Intl Congress of the Intl Union for **Quaternary** Research, Paris. (Henri Elhai, 8th Congress of Inqua, 191 rue St Jacques, Paris 5°, France)

Sept. 1-5 **Offshore exploration** conference, Rio de Janeiro. (Box 20810, Long Beach, Calif., 90820)

Sept. 1-12 General Assembly, **IUGG's Assn of Seismology** & Physics of Earth's Interior and Assn of Geomagnetism & Aeronomy, Madrid. (Comite Local Organizador, Asamblea General Cientifica IASPEI/IAGA, Consejo Superior de Investigaciones Cientificas, Serrano 117, Madrid (6), Espana.

Sept. 3-10 Centennial celebration of **Hungarian Geological Institute,** Budapest. Sept. 3-8, colloquium on Mediterranean **Jurassic** stratigraphy. Sept. 4-8, conference on **bauxite** geology. Sept. 6-8, colloquium on **Eocene** stratigraphy. (Hungarian Geological Institute, Nepstadion ut 14, Budapest, XIV)

Sept. 4-6 **Intermountain Assn.** of Geologists, ann. field trip, Uinta Mountains, Utah. (C. L. Dahl, I.A.G., Box 11334, Salt Lake City, 84111)

Sept. 4-6 **Rocky Mt** Assn of Geologists, field trip & symposium: petroleum potential of Raton Basin, Colo. & N. M. (J. E. Lawton, International Nuclear Corp., 308 Lincoln Tower Bldg., Denver, 80203)

Sept. 5-7 North American **Paleontological** Convention, & field trips, Chicago. (Ranier Zangerl, Field Museum of Natural History, Roosevelt Rd & Lake Shore Drive, Chicago, Ill., 60605)

Sept. 5-10 Intl **Clay Conference,** Tokyo. (Organizing Committee, c/o Geological & Mineralogical Institute, Faculty of Science, Tokyo University of Education, 3-chome, Otsuka, Bunkyo-ku, Tokyo, Japan)

Sept. 7-13 **Volcanoes & Their Roots,** symposium by Intl Assn. of Volcanology & Chemistry of Earth's Interior, at Oxford University; field trips before & after. (J. D. Bell, Dept. of Geology & Mineralogy, Parks Rd, Oxford, England)

Sept. 8-10 Conference on **pyroxenes & amphiboles,** Virginia Polytechnic Institute. Abstracts deadline, June 1. (F. D. Bloss, Dept. of Geological Sciences, Virginia Polytechnic Institute, Blacksburg, Va., 24061)

Sept. 9-12 **German Mineralogical** Soc. assembly on metamorphism of rocks, in Bern. (E. Niggli, Mineralogisch-petrographisches Institut, Sahlstrasse 6, CH-3012, Bern, Switzerland)

Sept. 11-13 Soc. **Economic Geologists,** field conf., Wyoming uranium deposits, Casper, Wyo. (R. A. Laurence, Box 1549, Knoxville, Tenn., 37901)

Sept. 14-18 Soc. **Exploration Geophysicists,** ann. intl mtg, Calgary, Alberta. (Howard Breck, Box 1067, Tulsa, Okla., 74101)

Sept. 17-19 Intl **computer applications** symposium, by Soc. Mining Engineers, Salt Lake City. (Alfred Weiss, 1356 Kennecott Bldg., Salt Lake City, 84111)

Sept. 17-22 Intl symposium on **land subsidence,** Tokyo. Abstracts deadline Feb. 10. (A. I. Johnson, Water Resources Div., U. S. Geological Survey, Federal Center, Denver, 80225)

Sept. 24-26 Systematics Assn. symposium on **data processing** in biology & geology (source-data automation, computer-data systems for research, data banking, communication), Cambridge University. (J. L. Cutbill, Dept. of Geology, Downing Street, Cambridge, England)

Sept. 28/Oct. 1 Soc. **Petroleum Engineers,** fall mtg, Dallas. (SPE, 345 E 47th St., New York, N. Y., 10017)

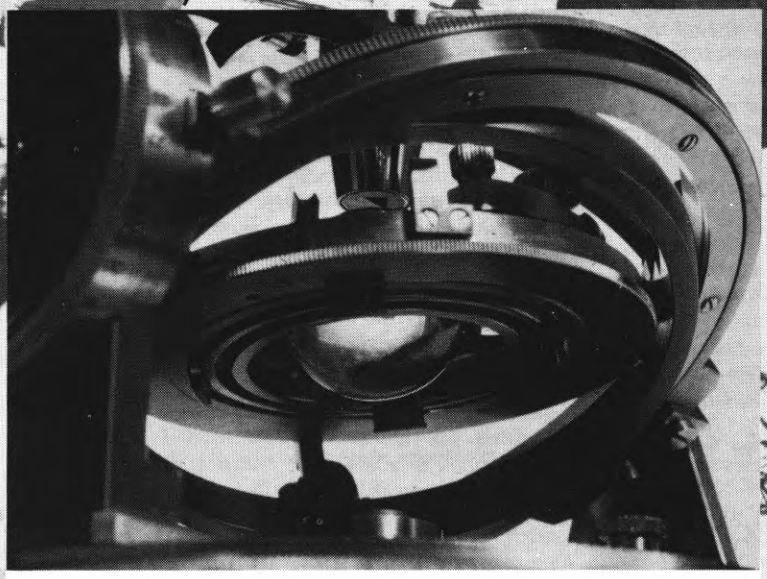
Sept. 30/Oct. 5 Intl **Man and Water** exhibition, Le Bourget Airport, Paris. (L'Homme et l'Eau, 8 Rue de la Michodiere, Paris 2e)

Oct. 1-3 **Mid-Continent** Section of AAPG, regional mtg, Amarillo, Tex. (Lloyd Pippin, Box 2473, Amarillo, Tex.)

Oct. 1-5 American Soc. for **Information Sci-**

Olivine Gabbro

Leitz polarizing microscopes help you dig out its secrets with astonishing precision. (As well as the secrets of other minerals, plastics, textiles and chemicals.)



DIALUX-POL... our most advanced universal polarizing research microscope. A choice of more than 100 optional, interchangeable components permits almost infinitely varied combinations for precision measurement, examination and photomicrography. Many exclusive optional features.

ORTHOLUX-POL... widest-range universal research microscope for all types of polarizing microscopy, plus incident phase contrast and interference.

LABOLUX-POL... laboratory and research polarizing microscope with built-in transmitted light and provisions for work in incident light (ore microscopy).

SM POL... student polarizing or chemical microscope for general applications in transmitted polarized light.

ARISTOPHOT Photographic Unit... adapts Leitz polarizing microscopes for photomicrography, macrophotography and low-power surveys with incident or transmitted light. Mirror reflex system for 3¼ x 4¼ (9 x 12 cm), 4 x 5 or Polaroid*; also adapts to Leica® 35mm.

Leitz ORTHOMAT Microscope Camera... attachable to any microscope, this unique, automatic 35mm camera calculates exposure, trips the shutter and advances the film.

Write for catalogs on any one of these advanced Leitz polarizing microscopes and accessories.

Leitz®

E. Leitz, Inc., 468 Park Avenue South, New York, N.Y. 10016

*TRADEMARK OF POLAROID CORPORATION.

68668

ence, ann. mtg, San Francisco. (C. P. Bourne, Programming Services Inc., 999 Commercial St., Palo Alto, Calif., 94303)

Oct. 6-8 **Seismological Society** of America, Eastern Section mtg, Blacksburg, Va. (G. A. Bollinger, Dept. of Geological Sciences, Virginia Tech, Blacksburg, Va., 24061)

Oct. 10-11 **Atlantic Coastal Plain** Geological Assn., ann. field trip: Miocene & Pleistocene of James-York peninsula & S bank of James River. (G. H. Johnson, Dept. of Geology, College of William & Mary, Williamsburg, Va., 23185)

Oct. 10-11 **AIPG,** ann. mtg, St Louis. (A. F. Brunton, American Institute of Professional Geologists, Box 836, Golden, Colo., 80402)

Oct. 14-16 Intl symposium on **remote sensing** of environment, University of Michigan, Ann Arbor. (Extension Service, Conference Dept., University of Michigan, Box 618, Ann Arbor, 48104)

Oct. 19-22 **Clay Minerals Society,** ann. mtg, field trip; Ft Worth. Titles deadline (W. F. Bradley, Dept. of Chemical Engineering, University of Texas, Austin, 78712), July 31. (E. C. Jonas, Dept. of Geology, University of Texas, Austin, 78712)

Oct. 19-22 **Economic geology of eastern Montana** & adjacent area, a symposium by Billings Geological Soc. Papers invited. (Fred McCotter, Billings Geological Soc., Box 844, Billings, Mont., 59103)

Oct. 20-22 Ann. mtg, American Assn. of **Stratigraphic Palynologists,** Penn State. (Alfred Traverse, Department of Geology & Geophysics, Pennsylvania State University, University Park, Pa., 16802)

Oct. 20-23 Progress into the Sea, a symposium on **Sealab III** &c. (Marine Technology Society, 1030 15th St. NW, Washington, D. C., 20005)

Oct. 21-25 Assn. of **Engineering Geologists,** ann. mtg, San Francisco. (Peter Vardy, 3777 Cass Way, Palo Alto, Calif., 94306)

Oct. 22-25 N.M. Geological Society field trip, **Juarez, Casas Grandes/Chihuahua,** Mexico. (Bill King, Drawer 3AB, N.M. State University, Las Cruces, 88001)

Oct. 27-31 Conf. **American Water Resources,** San Antonio, Tex. (W. B. Davis, Engineering Div., Texas A & M University, College Station, 77843)

Oct. 29/Nov. 1 **Gulf Coast Assn.** of Geological Societies & Gulf Coast Section of Soc. **Economic Paleontologists & Mineralogists,** ann. mtg, Miami Beach. (R. O. Vernon, State Geologist, Florida Board of Conservation, Tallahassee, Fla.)

Nov. 6-8 **West Texas** Geological Society field trip to Guadalupe, Hueco & Franklin Mts. (J. F. Sides, Superior Oil Co., Box 1900, Midland, Tex., 79701)

Nov. 10-12 **Geological Soc.** America & associated societies, ann. mtg, Atlantic City. (GSA headquarters, Box 1719, Boulder, Colo., 80302)

Nov. 10-12 Society **Econ. Geologists,** informal mtg, Atlantic City, N.J. (R. A. Laurence, Box 1549, Knoxville, Tenn., 37901)

Nov. 10-12 **American Petroleum Institute,** ann. mtg, Houston. (API, 1271 6th Ave., New York, N.Y.)

Nov. 10-15 Intl congress & exhibition on **marine technology,** Munich. (Kallman Associates, 30 Journal Square, Jersey City, N.J., 07306)

Nov. 12-14 Royal Society discussion of petrology of igneous & metamorphic **rocks from deep-ocean floor,** London. (D. H. Matthews, Lamont-Doherty Geological Observatory, Palisades, N.Y., 10964)

Nov. 18/Dec. 2 Intl **conference on tin** (Nov. 18-22) & field trips (Nov. 25/Dec. 2), Bangkok. (W. Fox, Secretary, Intl Tin Council, Haymarket House, 28 Haymarket, London SW 1)

Dec. 1-5 Intl **Offshore Exploration** Conf., Monaco. (OECON, Box 88, Palos Verdes Estates, Calif., 90274)

Dec. 5-6 **Alabama** Geological Soc. field trip, Appalachian structural front in Alabama. (W. G. Hooks, Geol. Dept., Univ. of Alabama, Tuscaloosa, Ala.)

Dec. 15-18 Fall mtg, **American Geophysical Union,** San Francisco. (AGU, 2100 Pennsylvania Ave. NW, Washington, D. C., 20037)

Dec. 26-31 American Assn. for Advancement of Science, ann. mtg, Boston. (**AAAS,** 1515 Massachusetts Ave. NW, Washington, D. C., 20005)

1970

March 19-20 AAPG **Pacific Section** mtg, Newport Beach, Calif. (AAPG Headquarters, Box 979, Tulsa, Okla., 74101)

March 26-28 **Cordilleran** Section, Geological Soc. America, California State College, Hayward. (J. C. Cummins, Dept. of Earth Sciences, California State College, Hayward, 94542)

April 2-4 **South-Central** Section, Geological Soc. America, Texas A&M University. (M. C. Schroeder, Texas A&M University, College Station, Tex., 77843)

April 16-18 Intl **Geochemical Exploration,** Symposium, Toronto; by Canadian Institute of Mining & Metallurgy, Soc. Econ. Geologists. Abstracts deadline: Jan. 1, 1970. (R. W. Boyle, Geological Survey of Canada, 601 Booth St., Ottawa, Ont.)

April 20-23 Ann. mtg, **American Geophysical Union,** Washington, D. C. (AGU, 2100 Pennsylvania Ave. NW, Washington, D. C., 20037)

April 23-24 **Highway Geology** Symposium & field trip, Kansas University, Lawrence. (Highway Geology Symposium, University Extension Bldg., Lawrence, Kan., 66044)

May 8-10 Institute on **Lake Superior** Geology, Port Arthur, Ont. Field trip May 10. (J. L. Talbot, Dept. of Geology, Lake Head University, Port Arthur, Ont.)

June 22-24 American Assn. **Petroleum Geologists/Soc. Economic Paleontologists & Mineralogists,** ann. mtg, Calgary, Alberta. (AAPG headquarters, Box 979, Tulsa, Okla., 74101)

June 29/July 2 Ann. congress, **Geological Society of South Africa,** Cape Town. (E. S. Simpson, Dept. of Geology, University of Cape Town, Rondebosch, C. P., South Africa)

July 3-25 **Gondwana System** symposium, Cape Town & Johannesburg, by Intl Union of Geological Sciences. (W. T. de Kock, Council for Scientific & Industrial Research, Box 395, Pretoria, Republic of South Africa)

July 26-31 American **Water Resources** Assn. ann. symposium on hydrobiology, Miami Beach, Fla. (James C. Warman, Director, Water Resources Center, Auburn, Ala.)

Aug. Ann. mtg Geological Assn. of **Canada** & Mineralogical Assn. of Canada, Winnipeg. Symposium on geology of Manitoba. (Dr A. Turek, Manitoba Mines Branch, Winnipeg, Man.)

Aug. 24/Sept. 6 Intl Mineralogical Assn. & Intl Assn. on the Genesis of **Ore Deposits,** mtg. Aug. 28-29 in Tokyo & Aug. 31/Sept. 2 in Kyoto. Field trips Aug. 24-27 & Sept. 3-6. (Dr I. Sunagawa, Geological Survey of Japan, 8 Kawada-cho, Shinjuku-ku, Tokyo 162)

Sept. 21-26 Intl Society for **Rock Mechanics,** 2d congress, Beograd, Yugoslavia. (Sekretarijat II kongresa Medunarodnog drustva za mehaniku stena, Institut za vodopirvredu Jaroslav Cerni, Bulevar vojvode Misica 43, Beograd, Yugoslavia)

Oct. 4-9 American Soc. for **Information Science,** ann. mtg, Philadelphia. (K. H. Zabriskie Jr, Biosciences Information Services of Biological Abstracts, 2100 Arch St., Philadelphia)

Oct. 16-17 American Institute **Professional Geologists,** ann. mtg, Oklahoma City. (A. F. Brunton, AIPG, Box 836, Golden, Colo., 80402)

Oct. 22-24 Assn. of **Engineering Geologists,** ann. mtg, Washington, D. C. (E. T. Cleaves, Maryland Geological Survey, Latrobe Hall, Johns Hopkins University, Baltimore, 21218)

Oct. 26-30 American **Water Resources** conference, Las Vegas, Nev. (W. S. Butcher, Acting Director, Center for Water Resources Research, University of Nevada, Reno)

Nov. 8-12 Soc. **Exploration Geophysicists,** ann. intl mtg, New Orleans. (Howard Breck, Box 1067, Tulsa, Okla., 74101)

Nov. 11-13 **Geological Soc.** America, ann. mtg, Milwaukee. (GSA headquarters, Box 1719, Boulder, Colo., 80302)

Nov. 16-18 American **Petroleum Institute,** ann. mtg, New York. (API, 1271 6th Ave., New York, N.Y.)

Dec. 4-5 **Alabama** Geological Soc. field trip, Piedmont of Alabama. (Robert Bentley, Anniston, Ala.)

1971

March 29/April 1 American Assn. **Petroleum Geologists** and Soc. of **Economic Paleontologists & Mineralogists** ann. mtg, Houston. (AAPG headquarters, Box 979, Tulsa, 74101)

April Symposium on **Precambrian granites** and **gneisses** in southern Africa, University College of Rhodesia, Salisbury. (C. A. Gibson, Box 8427, Causeway, Salisbury, Rhodesia)

April 13-16 Natl mtg, **American Geophysical Union,** Washington, D. C. (AGU, 2100 Pennsylvania Ave. NW, Washington, D. C., 20037)

June Ann. mtg Geological Assn. of **Canada** & Mineralogical Assn. of Canada, Sudbury; symposium on Sudbury geology. (D. H. Williamson, Laurentian University, Sudbury, Ont.)

July Intl symposium on **gold mineralization** in space & time. (D. A. Pretorius, Economic Geological Research Unit, University of the Witwatersrand, Milner Park, Johannesburg, South Africa)

Aug. 23-26 Intl Conference on **Permian & Triassic,** Calgary, Alberta. (Alan McGugan, Dept. of Geology, University of Calgary, Calgary 44, Alberta)

Aug. Intl conference on **palynology,** Novosibirsk, USSR. (M. I. Neustadt, Institute of Geography, Academy of Sciences of the USSR, Staromonetny per-29, Moscow B-17, USSR)

Aug. Intl Assn. of **Sedimentologists,** 8th intl congress. (German Muller, Laboratorium fur Sedimentforschung, University, Heidelberg, Germany)

Nov. 3-5 **Geological Soc. America, ann. mtg,** Washington, D. C. (GSA headquarters, Box 1719, Boulder, Colo., 80302)

offshore oil drilling

As one of your few nonspecialist readers, I need an expert's advice about future offshore oil drilling in California. Will any of your readers answer these questions?

- Should not these areas be preserved for needed use in the future? Is the need for oil this great now?
- Are our present geological knowledge and our present techniques advanced enough to insure that the catastrophe at Santa Barbara will not occur again and again—even with tighter regulations?
- I believe that testimony should come from oil geologists in the field—not Wyoming representatives or spokesmen from the huge oil lobby.

Lois B. Wood
Santa Cruz County Parks & Recreation Commissioner
Watsonville, Calif.

fossil arthropods

I am now preparing a bibliography titled *Bibliography of fossil arthropods.* It will list only publications and magazine articles dealing with fossil arthropods that are still available when this bibliography is printed. Since there is such a large number of organizations that carry such information, I would appreciate the help of earth scientists in alerting me to organizations that have such information. Please specify the exact address of the organization. All information will be of great help to me.

David F. Dickeson
613 South Federal Highway
Lake Worth, Fla., 33460

deep sea drilling

We find that 2 errors crept into the article on the Deep Sea Drilling Project in the February issue of *Geotimes.* Since the interest in our future plans is high, we request this correction: 'Leg 6 traverses a northern route from Hawaii to Guam, and Leg 7 traverses a southern route from Guam to Hawaii, not the reverse.'

Elizabeth Lee Gealy
T. A. Davies
Deep Sea Drilling Project

lost verse

Can anyone help me find a poem? I read it years ago and can't recall the middle of it. However, I have this much:

The geologist

Down the hill he slowly travels
Nature's secrets he unravels . . .
. . . . . .
I've never done such a good job before
On my map is every structure,
every batholith and rupture.
But I wonder where in hell they'll find the ore.

Ronald A. Labreque
Cheyenne, Wyo.

gravity increase

In the February issue you report some work I did on the South Pole gravity base station. The point of my original article was that the gravity is increasing at the South Pole station. I suggested horizontal motion across a gravity gradient and a decrease in elevation as possible causes. Since that time further work by C. R. Bentley has substantiated the gravity increase but shown that the horizontal movement is not a possible explanation and that sinking is the likely cause for all the changes. This work was reported in 1968 in *Transactions of AGU.*

John C. Behrendt
APO New York

oil & gas futures

Thank you very much for publishing Krinitzsky and Rader's article 'Problems in Geological Employment' in the February *Geotimes.*

The part on petroleum geology certainly confirms my impressions after several years with a major oil company. There's no doubt about it: petroleum geology in the U. S. *is* a 'static or contracting field'. Now, this isn't due to malice, ill-will, or widespread incompetence on the part of oil-company management. Rather, it is the inevitable result of a gradual evolution in the U. S. oil and gas industry over the years.

Part of the problem is the fact that oil and gas is now a relatively slow-growing 'mature' industry in this country, and opportunities therein are naturally slow in coming. Petroleum's share of the energy market (its main market) leveled off at about 75 per cent more than 10 years ago. Interfuel competition will probably keep this share about the same for the foreseeable future. So, demand for petroleum products will pretty much grow along with the population, like demand for steel, automobiles, and foodstuffs. As a result, the oil industry as a whole just doesn't (and can't) offer the great career opportunities it did in its earlier, fast-growing years.

Moreover, the geological end of the U. S. petroleum industry won't even grow slowly, but will continue to decline over the next 20-30 years. This is unavoidable, because the status of domestically produced petroleum as a raw material for the industry is very shaky and is progressively deteriorating. For most of the past 100 years domestically produced petroleum was the cheapest and most dependable source of raw material for hydrocarbon fuels, lubricants, chemicals, etc; it itself had displaced whale oil, shale oil, and coal (remember coal oil?). But this no longer holds true.

During the past century of intensive exploration for and exploitation of domestic resources, the U. S. oil and gas producing industry has gradually evolved into a typical mature, high-cost, indigenous mineral operation. It is now under continual pressure from cheaper imported supplies and alternate mineral sources. Sooner or later, probably within the next 20 years, it will be overcome by these pressures. It will be destroyed by either: removal or partial dismantlement of the present import-quota system and flooding of the domestic market with cheap foreign crude oil, or gradual replacement of 'conventional' oil and gas by synthetic hydrocarbons, which are steadily getting cheaper to make (in case cheap foreign crude is still largely kept out by import quotas).

Petroleum product consumption will probably continue to grow slowly along with the population. But the need to employ large numbers of geologists in the U. S. to look for conventional hydrocarbon raw materials for those products will have vanished; and so will petroleum geology as a career in this country.

Major oil-company managements are aware of this. It undoubtedly underlies much of their recent diversification into synthetic hydrocarbons, other mineral fuels, metallic and nonmetallic minerals, and even nongeological areas such as forest products. They're obviously preparing for the demise of domestic conventional petroleum production. This is only sensible long-range planning.

This long-term outlook also influences the companies' attitudes toward geologists, with the employe reactions found by Krinitzsky and Rader. Most oil-company geologists are well treated as far as wages and fringe benefits are concerned. But, as the survey shows, most feel shorted on psychological wages — challenge, participation, satisfaction with their jobs, etc. The major companies are obviously not devoting much time to personnel development and motivation of geologists.

The aspect of the companies' policies which I object to, however, is their continuing efforts to recruit

young geologists into what the companies know damn well is a declining field. They do this mainly because the young fellows can be hired at somewhat lower salaries and appreciably lower benefit costs (e.g. group-insurance plans) than older men.

name withheld

consultants

I am one of the 'consultant-independent' group, and as such, I am quite familiar with the findings, as are most of my friends. We continue to be amazed and dumbfounded that industry — supposedly constantly in search of money-making ideas — is overlooking this vast pool of talent.

I don't know of anything that pays off as much as a newly found oil or gas pool, and with old, experienced and proven oil finders, where can industry look for lesser risks?

We've got the prospects: there's no shortage of them. We haven't the money to lease and drill, and unless we can follow through to the casing point, we just don't care about exposing our secrets — and getting nothing for them. We'll just live it out this way. But if industry wants to benefit, if they want to help themselves, and don't mind helping us, we can help make money — to establish new products, new materials, new sales, and the most efficient and economical method of this operation is for them to make direct connections with the proven oil-finding geologists.

Eliminate the middlemen; let the geologist contract for all third-party services, just as he is now being contracted as a third-party service.

Joseph D. Watzlavik
Bellaire, Tex.

geosynclinal couple

The geological literature is studded with descriptions of what Auboin has called the geosynclinal couple. In a typical representation the couple is made up of a miogeosyncline and a eugeosyncline; the two are held together by a central geanticline in which ophiolites are commonly present. Ophiolites or related volcanics are also commonly present in the eugeosyncline. Sometimes, as in the Hellenides, the members of the couple are approximately equisubsident, but in most cases the eugeosyncline is hypersubsident, in distinct contrast to the only moderately subsident miogeosyncline.

If I am not mistaken most eugeosynclines are intensely deformed and contain monotonous lithofacies whose lack of key beds defeats the elucidation of detailed structure. Under these conditions I tend to question the great thickness figures which are often submitted for the eugeosynclines. The risk of having overlooked repetitions of beds is great. Also, confusion may arise in the minds of some authors because they correlate the deep-water paleoenvironment of dark shales, cherts and turbidites with hypersubsidence. On the whole I suggest that eugeosynclines need not be as hypersubsident as commonly supposed.

On the other hand not all miogeosynclines need to be only moderate in their subsidence. We have only to look at the largely carbonate sediments that accumulated on the Great Basin Province platform during the Paleozoic prior to Basin & Range deformation. There we see 'miogeosynclinal' thicknesses of the order of 20,000 ft; some believe 30,000 ft. There seems little reason to assign thickness figures of a greater order to the neighboring 'eugeosyncline' in the Great Basin Province. I suggest that the platform and deep-water deposits of the Great Basin Province were laid down in the envelope of a simple prism. My model contains a couple, but this is a lithofacies couple (platform-deep water) not a differential-subsidence couple. My model also contains a link of ophiolites or volcanics; but this central link is no more than another lithofacies, not a tectonic intervention of geanticlinal type.

I do not insist that my simple prism is the required reconstruction for all cases where geosynclinal couples have been represented. I suggest only that the standard 'mio-', 'eu-' tectonic interpretations be applied with caution at the very least.

Maurice Kamen-Kaye
Cambridge, Mass.

California State

The Department of Earth & Physical Science at California State College, Hayward, offers a new degree program in earth science. It is a rigorous major designed for people with a wide range of objectives in geology and related sciences. We are not a teacher's college and do not offer a degree in earth-science teaching as stated on page 3 of the new *Directory of geoscience departments*. We do train teachers along with our other students who go on to graduate school or find employment in industry, but would-be teachers form only a minor percentage of our students. We plan to have a separate Earth Science Department this coming academic year and hope to have a field station soon thereafter.

Leigh W. Mintz
California State College
Hayward

ENTER YOUR PHOTOS

Send copies of your best photos to the American Geological Institute's photo contest. Winners will be printed in Geotimes. See the November issue, page 18, for details. Or write to the Institute at 2201 M St. NW, Washington, D.C., 20037.

Why a Powell centennial?

On May 24, 1869, John Wesley Powell and 9 companions set out from Green River, Wyo., in 4 small boats to explore the canyons of the Green and Colorado rivers. After 98 days, 6 of the original party reached the mouth of the Virgin River just beyond the Grand Canyon. This trip, which historian W. H. Goetzmann has called the climactic event of late 19th century exploration, traversed the largest unknown region of continental United States. In a year when we expect Americans to land on the Moon, is this event of more than nostalgic interest?

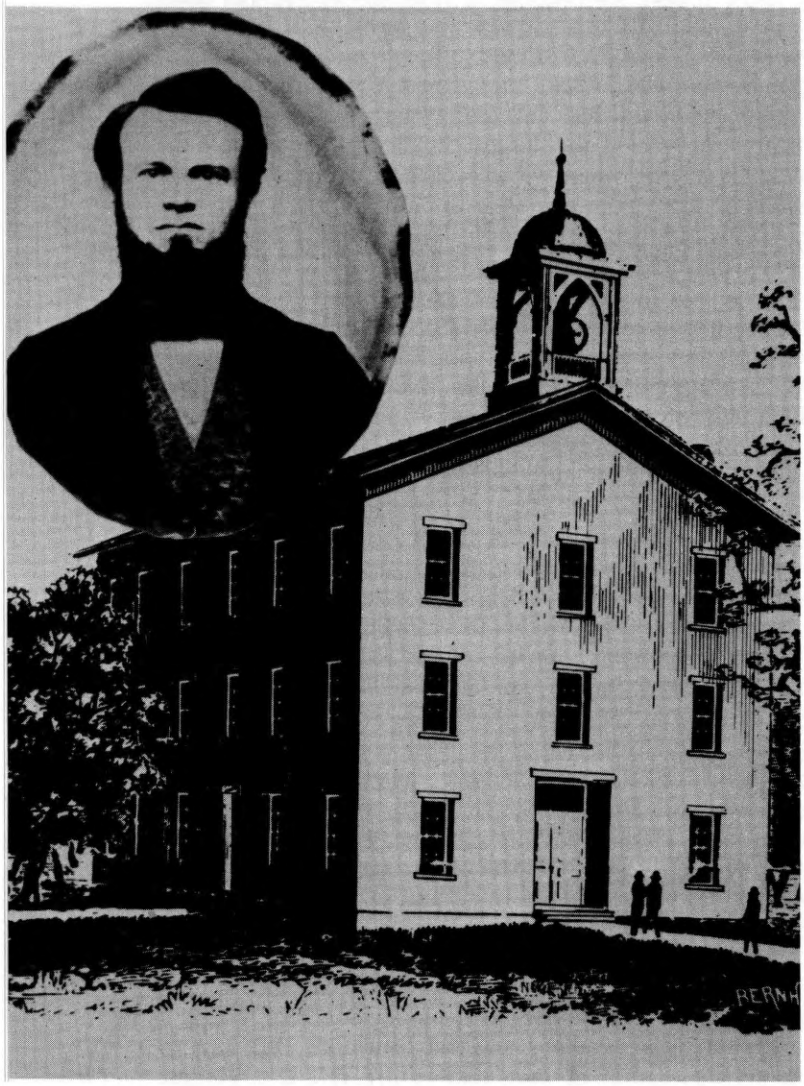
Powell, of course, was more than an explorer. The river trip was made, not just to find a path through the unknown, but to study the geology and geography of the canyon lands. From his observations then and in later years, he developed important new concepts on drainage and erosion that formed the basis of the 'new geology', now called geomorphology. Still, geomorphology is a comparatively esoteric science, and one might expect that only historians of science would take appropriate notice of Powell's contributions. But John Wesley Powell was also more than a scientist; his genius for organization and leadership has left its imprint on several scientific agencies and societies. When conflicts of interest began to develop among the Western surveys in the 1870s and Congress called on the National Academy of Sciences for advice, it was Powell's plan that was recommended and that led to the establishment of the United States Geological Survey in 1879. It was Powell's interest in ethnology and his personal initiative that led to the establishment of the Bureau of American Ethnology in the Smithsonian Institution in that same year. For 13 years, from 1881 to 1894, he did double duty as director of both agencies. While making substantial contributions to the science of ethnology, then in what he would have called a 'nascent' state, he transformed the Geological Survey from a small mining bureau for the Western territories into a truly national survey. The period of his directorship was one of rapid development of geology in the United States, and the Geological Survey played no small part in this development.

Powell, like any scientist, collected and organized observations and sought the meaning behind them, but he was firm in his belief that the highest purpose of science was to further the progress of the human race. His knowledge of the Western lands and their development, coupled with a sympathetic interest in the Indians and the Mormons, led him to an understanding of the interaction of man and nature in the arid part of the United States and to the formulation of principles for the wise settlement and use of this region. He fought for these principles over a period of many years, and though in his own time they were not accepted, ultimately they led to the establishment of the Bureau of Reclamation. Today, they form an integral part of any scientific program for the wise use of the world's natural resources.

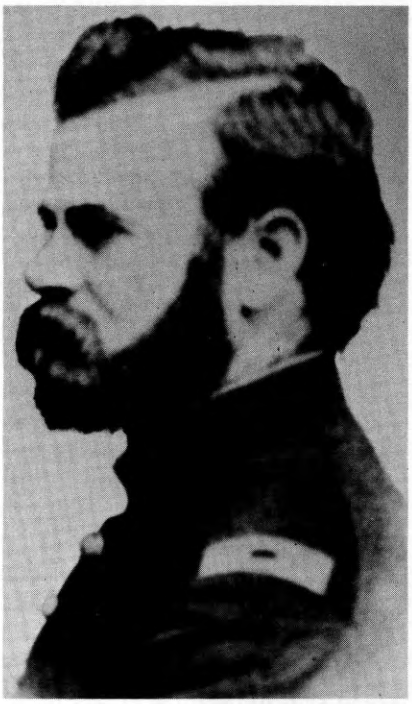
For all these accomplishments, Powell is honored. But in marking any centennial observance, whether it be Powell's exploration of the Colorado or the completion of the transcontinental railroad, both to be celebrated this year, we are not just commemorating the past. In this rapidly changing world with its new and challenging problems, our predecessors of only a century ago seem a bit archaic. However, unless we understand how the world has changed and the forces that have brought about the change, we cannot hope to guide these forces or control them so as to make our world more representative of our true ideals and aspirations. John Wesley Powell understood this. In an era that subscribed to social evolution by the law of the jungle and laissez-faire, he was one of the few who believed in evolution by endeavor and who fought for intelligent and scientific planning for the development of society. He believed that progress comes by increasing coöperation among men, and he dreamed of developing a science that would provide the knowledge whereby men could live together in peace and mutual coöperation. It is to rekindle this spirit that this year is designated the John Wesley Powell Centennial Year.

W. T. Pecora
Director, U. S. Geological Survey

John Wesley Powell his life & times



Mary C. Rabbitt
U. S. Geological Survey
Washington, D. C.



Powell's career as a teacher included work here. (Photo by Illinois Wesleyan University, Bloomington, Ill.) The inset shows him as teacher and principal in the fall of 1859 at Hennepin, Ill.; this photo, by E. O. Beaman, is one of the earliest known photos of Powell. Above is one of the few known photos of Powell in his Civil War uniform. (Portraits from the William Culp Darrah Collection, Gettysburg, Pa.)

On July 1, 1869, Andy Hall wrote to his brother to explain his whereabouts: he was exploring the Colorado with Maj. John Wesley Powell. 'I suppose you never herd off him and he is a Bully fellow you bett,' he said. Major Powell was certainly not well known at the time, although he would soon become a national figure and remain in the spotlight for the next 30 years. He was destined to influence the development of two sciences, to provide leadership and direction for the development of government policy in science and the conservation and management of natural resources—and to be forgotten, only to be rediscovered many years later at another critical period in man's struggle with his environment.

John Wesley Powell was born March 24, 1834, at Mount Morris, N. Y., the son of Joseph Powell, an itinerant preacher in the Methodist Church, and his wife, Mary. The Powells had emigrated from England in 1830 to spread the doctrine of Methodism to the American frontier. Powell's formal schooling was suspended temporarily when he was 12. After one of the family's many moves —this one from Ohio to Wisconsin— Joseph Powell devoted himself to the ministry, while his son managed the farm. After 4 years of farming, young Powell left home in search of further education and for several years studied and taught school to earn money for his tuition. During this period he became an enthusiastic student of botany and zoology and had a large herbarium, a collection of shells, and a cabinet of reptiles that he had collected in the Mid-West. Finally, in 1858, he settled down to teach at Hennepin, Ill.

In the spring of 1861, after the outbreak of the Civil War, President Lincoln called for volunteers, and Powell immediately enlisted as a private in the 20th Illinois. A month later he was commissioned a second lieutenant, and when he left the service in January 1865 he was a major and brevet lieutenant colonel. Meantime he had become a military engineer, and despite the loss of his right forearm, amputated after the Battle of Shiloh in April 1862, he served with distinction at Vicksburg, Meridian, Chattanooga, Atlanta, and Nashville where he was Chief of Artillery of the Department of the Tennessee. He was married in November 1861 after persuading General Grant to give him a few days leave for the purpose. His bride accompanied him back to camp by way of a honeymoon and remained with him throughout the war.

After his discharge from the Army he became professor of geology at Illinois Wesleyan University for $1,000 a year. He had become greatly interested in geology and had been studying it during the war. At Wesleyan he devoted his attention to developing methods of instruction. It

was his theory that the study of science should include more than the study of textbooks: Students should become familiar with nature's phenomena and derive principles from observed facts; the teacher should serve as guide. Thus he spent much time organizing the museum and laboratories and taking his students on field trips, and in the spring of 1867 he organized an expedition to the Colorado mountains.

To finance the expedition, he secured an endowment from the Illinois Legislature for the Museum of the State Natural History Society and was elected its curator. Next he proposed an expedition to Colorado to add to the Museum collections, and the trustees allocated $500 to the project. Then, with rations obtained from the Army, passes from the railroads, equipment borrowed from the Smithsonian Institution, some funds from other institutions that were promised duplicate specimens, and his own salary, he equipped an expedition of 12 persons that spent the summer of 1867 in the Colorado mountains. The next year, a still larger group accompanied him. From these trips came his determination to explore the canyons of the Colorado.

The expedition of 1869 catapulted John Wesley Powell from relative obscurity to the position of national hero. His war record, coupled with the hardships of the expedition, the tragic loss of 3 men who were killed by Indians, and public fascination with the exploration of the West, combined to make him a romantic figure. It also matured him as a scientist. The trip had been hurried, the results less than he had hoped for, so he quickly decided on a second expedition.

The second expedition was better planned and executed. It also had Federal endorsement by Congressional appropriation beginning in 1870. The river was retraversed in 1871 and 1872, and a topographic survey, based on triangulation from a measured base line, was begun. Year by year this survey continued, gradually extending over the Plateau Province.

Powell was deeply engaged in both geology and ethnology. He made friends easily with the Indians, learned their language, observed their ways of life, and listened to their mythology. In 1873, he was appointed a temporary commissioner by the Indian Bureau and took advantage of the opportunity to visit many of the tribes in Utah, Nevada, and southern Idaho.

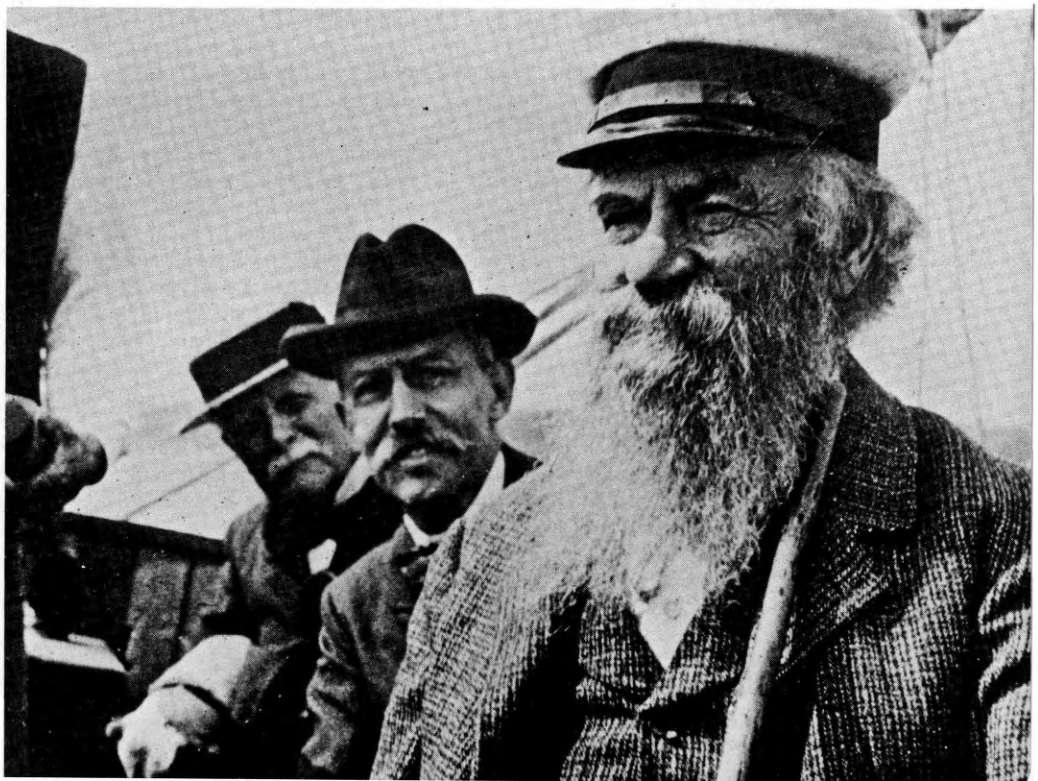
The report on the exploration of the Colorado River was completed in 1874 and published in 1875. Here for the first time several important principles were clearly stated. Valleys were classified in relation to the stratigraphy and structural geology, and the terms 'antecedent,' 'consequent,' and 'superimposed' were proposed and defined. Powell's classic description of an antecedent stream is that of the Green River, cutting through the Uinta Mountains 'like a saw revolving on a fixed pivot as the log through which it cuts is moved along.' The concept of the base level of erosion was also proposed.

In 1873, there were 4 surveys operating in the western territories (6 if the Coast Survey and the Land Office Survey are counted). Rivalry among the surveys, and especially the rivalry between civilian scientists and Army engineers, led to a Congressional investigation in 1874. Powell was not one of the chief participants, though he clearly espoused the civilian cause, but in his testimony he was more concerned with the efficiency of the mapping. He stressed the need for a general survey and pointed out that much of the West was arid and there was need to determine the areas that could be redeemed by irrigation. In the aftermath of the investigation, the Powell Survey was transferred from the Smithsonian Institution to the Department of the Interior and received a larger appropriation. G. K. Gilbert and Capt. Clarence Dutton were added to the staff to continue and extend the geological investigations that Powell had begun.

As he continued to work in the West, Powell became convinced that the land system was completely unsuited to the region and when the change of administration in March 1877 brought reform-minded Carl Schurz into the Department of the Interior, he began work in earnest on his *Report on the lands of the arid region of the United States.* The manuscript was delivered to the Commissioner of the General Land Office on April 1, 1878, and reached Congress two days later with a strong endorsement from the Secretary. Included in the report were plans and drafts of proposed bills to provide for changes in the land system that would make it better suited for the arid lands. Congress authorized printing the report but did nothing about the controversial legislation.

The question of consolidating the Western surveys was again a live one in the spring of 1878, for the depression after the panic of 1873 showed no evidence of ameliorating, and economy was the Congressional watchword. The National Academy of Sciences recommended that there be only 2 surveys, one for topography, called the Coast & Geodetic Survey transferred to Interior and renamed the Coast & Interior Survey, and the other for geology—a new bureau to be called the U.S. Geological Survey. The contract system of land-parceling surveys was to be abolished. The recommendations strongly resembled the major's views, and he played an active role in lobbying for legislative enactment of the Academy program.

A mutilated bill was finally adopted on March 3, 1879. Reform of the land laws was to be studied by a commission, the Coast & Geodetic Survey remained as it was, but the Hayden, Powell, and Wheeler Surveys were



Powell on a boat off Maine; the men behind him are Arthur Keith and John D. McChesney of the U.S. Geological Survey. (USGS photo)

abolished and the U.S. Geological Survey established. The leading candidates for directorship of the new bureau were F. V. Hayden, whose survey had been longest in the field, and Clarence King, whose Fortieth Parallel Survey had long since completed its field work. Powell actively supported the candidacy of King and he was named director by President Hayes.

Powell was appointed to the Commission to Codify the Land Laws. The commission, although admitting the validity of Powell's arguments about the unsuitability of the land laws to the arid region, was unwilling to set aside the existing system; thus the Commission's report was a compromise. Congress accepted the report, authorized its printing, and then ignored it. It was not ready to reform the public land system.

With the completion of the work of the Commission, Powell was not at a loss for occupation. He was active in the Cosmos Club, which he had helped found, in the Anthropological Society, of which he was the first president, the Philosophical Society of Washington and the American Association for the Advancement of Science. And in the Sundry Civil Bill that provided for the Geological Survey there was an item of $20,000 for completion of the ethnological reports of the Powell Survey under the auspices of the Smithsonian Institution. Congress may not have intended to establish a new bureau, but the result was the Bureau of Ethnology, and Powell became its director. He chose to concentrate research on the classification of American Indian tribes, and as this was a matter of practical concern in the establishment of reservations as well as of scientific interest, the Bureau was enabled to continue.

In March 1881, Clarence King resigned and Powell became the second director of the Geological Survey. He retained the directorship of the Bureau of Ethnology and combined the administration of the two bureaus. The problem of the Survey's field of operations, which had plagued King, was quickly solved by obtaining authorization 'to continue preparation of a geologic map of the United States', thus making it necessary to work in states other than the public-lands states. This clause was also taken as authorization for establishment of a topographic corps, for Powell had long asserted that a geologic map must be based on a topographic map. Other activities were added or expanded — paleontology, chemistry and physics, a library, a thesaurus, a bibliography. Survey appropriations increased steadily and by 1885 were nearly a half million dollars a year.

The rapid growth of Federal science in the 1870s and '80s prompted a Congressional investigation in 1884, ostensibly to secure efficiency and economy but also to examine the more fundamental question of the role of science in the Federal government. The National Academy of Sciences argued that management of scientific bureaus required unusual talents and proposed a 'Department of Science'. Powell was called before the committee several times. He too subscribed to the principle of a unified administration for science, but personally preferred that it all be placed under the Smithsonian.

After the change of administration in March 1885, the investigation took on a different tone. Professor Alexander Agassiz of Harvard attacked the centralization of science in Washington as disastrous and suggested that the government should limit itself to work that was not within the province or capacity of individuals or non-governmental institutions. Powell took sharp issue with that view. The government, he said, should not undertake research in fields where private enterprise could be relied on to do good and exhaustive work, but the government should promote the welfare of the people by providing for investigations in fields most vitally affecting the great industries. Agassiz feared that government science would overwhelm private science. Not so, said Powell; government research tended to stimulate and guide private research. When research is properly organized, he said, 'every man's work is an aid to every other man's.'

In the end the Committee recommended only minor changes. No Department of Science was established, but the necessity of having scientists administer the scientific bureaus was recognized. Perhaps most important, science was accepted as an essential part of the Federal government.

In 1888, Powell helped establish 2 societies for the advancement of science. In January the National Geographic Society was founded, and Powell was the speaker at the first regular meeting. He was president of the American Association for the Advancement of Science that year, and one of the 37 members who sponsored the American Geological Society. He was elected one of the 3 councilors-at-large when the Society (soon to change its name to Geological Society of America) was formally organized in December.

The year 1888 also gave Powell an opportunity he had long awaited. A series of drought years had made irrigation a subject of immediate and vital concern. Congress asked the Survey to determine which lands were irrigable and to locate sites for reservoirs and canals. Powell had a program ready — first a topographic survey, then a hydrographic survey and an engineering survey. The entire plan he thought could be accomplished in 6 or 7 years. But as soon as it was realized that inauguration of the irrigation survey had in effect closed the public domain, there was an immediate outcry. A quick answer was wanted, not the slow careful survey that Powell had undertaken. In the spring of 1890, the appropriation was cut drastically, and Powell's hope that science could provide for orderly settlement of the West was again thwarted.

Two years later Survey appropriations were cut again and, more serious than the cut, salaries and programs were specified. Powell was no longer in charge. He was not well, and as soon as his successor was ready he resigned. After a third operation on the stump of his arm, which provided a long-sought relief from pain, he devoted himself to writing and to the Bureau of Ethnology. For many years he had been working on a survey of knowledge from savagery to the age of enlightenment. He firmly believed that in science was the great promise for the future, and hoped to develop a new science of man that would lead to mutual understanding and peace among all men.

He died Sept. 23, 1902, at Haven, Me. Before he died, the Newlands Act established the Reclamation Service, not all that he had fought for but still a beginning. Five years later the Reclamation Service became an independent agency, the Bureau of Reclamation. Two of Major Powell's proteges, W J McGee and F. H. Newell, were major contributors to the conservation programs that began under Theodore Roosevelt. His chosen successor in the Geological Survey, C. D. Walcott, led the Survey to a still greater role in natural-resource investigations and became himself one of the great leaders in the development of Federal science.

After a time the major and his ideas were forgotten. Then in 1930, Walter Prescott Webb in his book *The Great Plains* pointed out the significant part Powell had played in bringing about reforms in the Federal government's land policies. More than 20 years went by and then W. C. Darrah, Wallace Stegner, Bernard DeVoto, and A. H. Dupree began calling attention to the role Powell had played in Western exploration, in conservation, and in the development of Federal science.

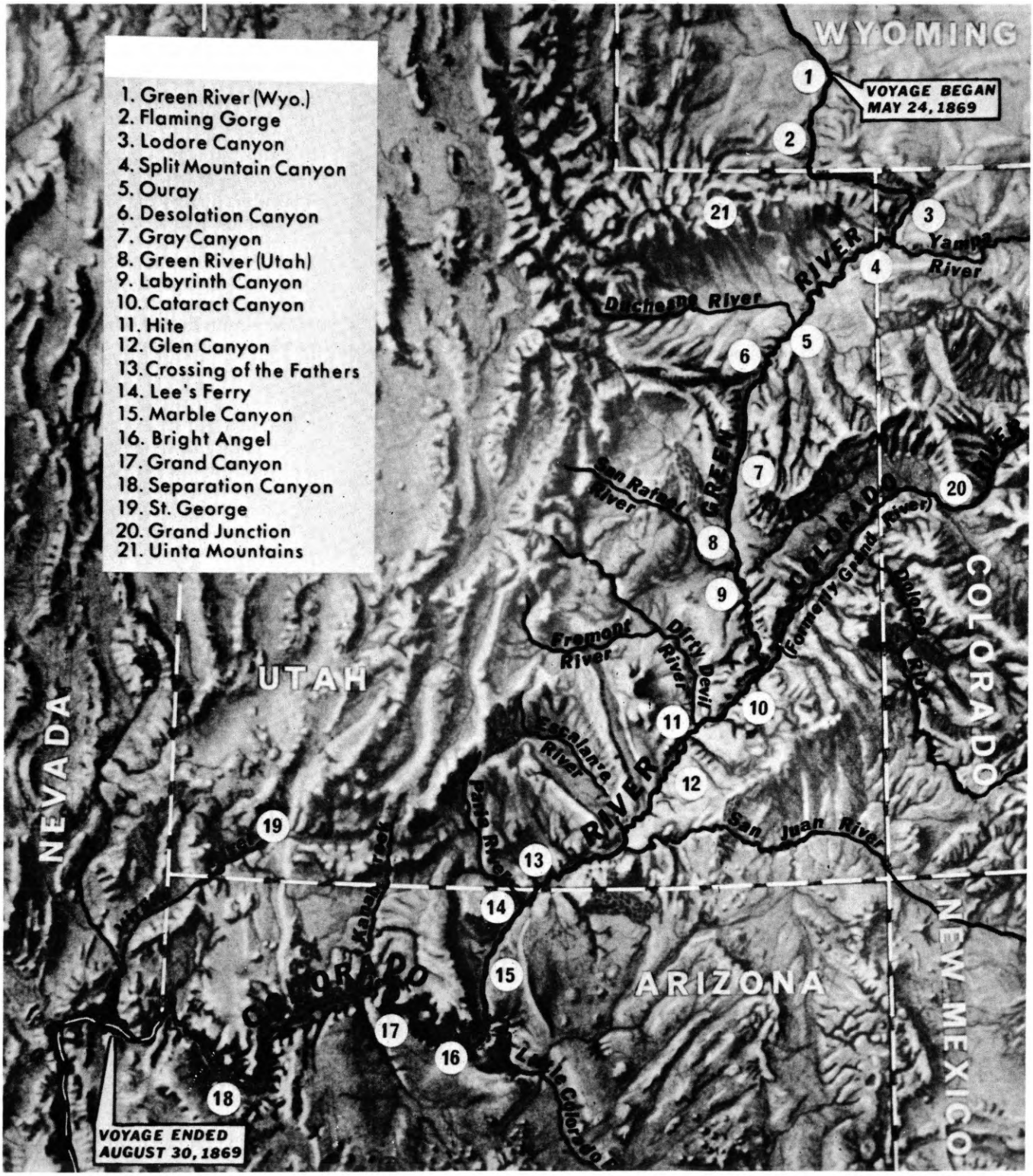
Bernard DeVoto perhaps explained it best when he wrote: 'He was a great man and a prophet. Long ago he accomplished great things and now we are beginning to understand him.'

John Wesley Powell

his Western explorations

William C. Darrah
Gettysburg College

THE NAME JOHN WESLEY POWELL is linked historically with the Colorado River. He conceived, organized and in 1869 executed the exploration of the can-



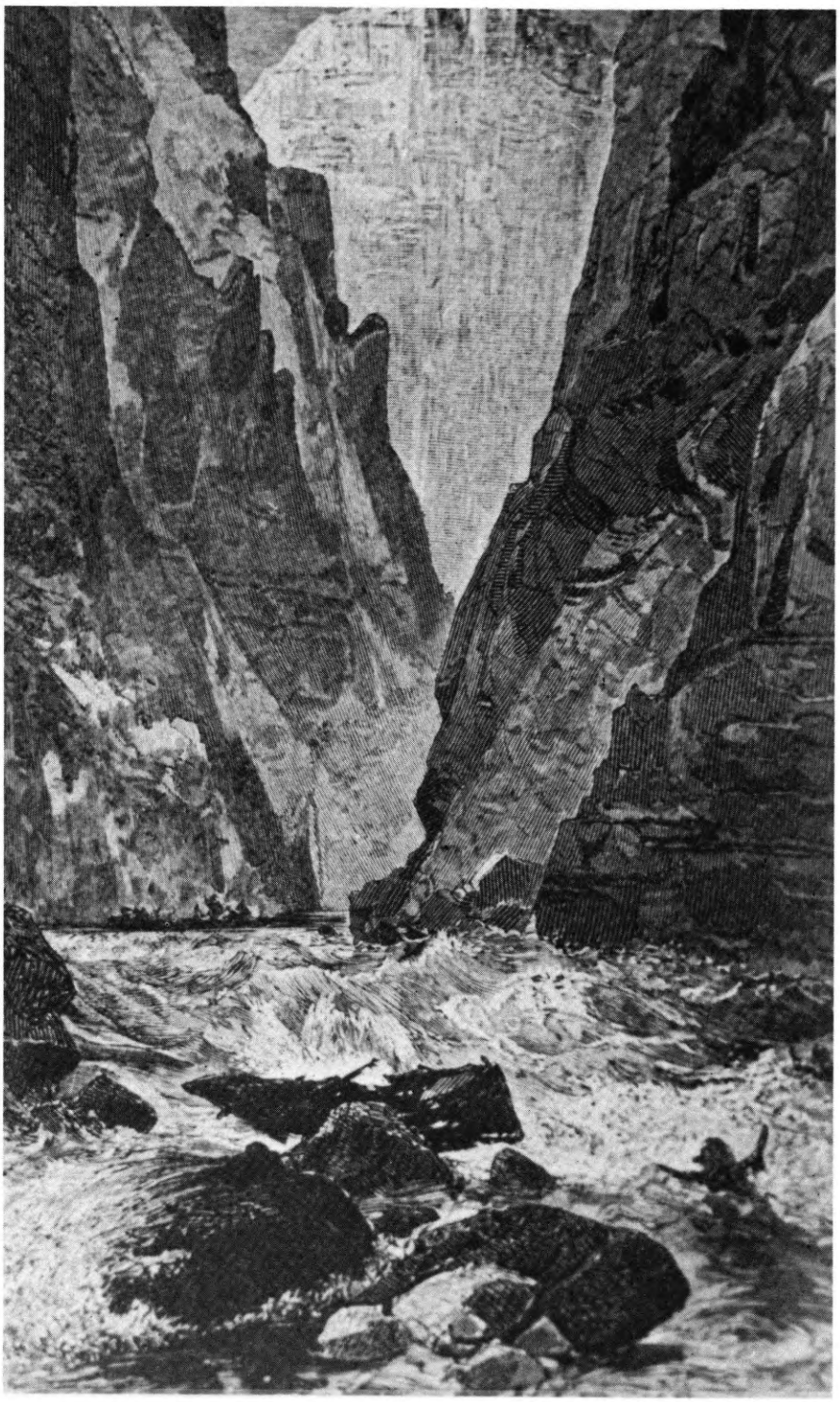
U.S. Department of the Interior/Geological Survey

yons of the Colorado, the last unexplored region in the United States. This fact is doubly significant because it marked the turning point in Powell's career and set in motion a broad movement of government involvement in science with implications not yet fully appreciated.

In 1869, Major Powell was 35 years old, of medium height, slight build and with his right arm amputated as the result of a wound suffered at the Battle of Shiloh. He was professor of geology and natural history at Illinois State Normal University, although he never completed study for a college degree. Before the war he taught in public schools and became principal of the schools of Hennepin, Ill. Nothing in his early career warranted calling him a geologist, scientist or administrator of promise or capacity.

In 1867 Powell solicited modest sums of money to lead students and amateurs to the park country of Colorado to study geology and collect specimens for the Illinois State Natural History Society and his college. A party of 20 traveled by wagon train from Council Bluffs to Middle Park and remained 2 months in the field. During the course of the work, Powell determined to descend the Colorado River and search for as much information about the region as possible.

Disaster Falls. A line drawing from 'Canyons of the Colorado' (1895).



The next summer Powell returned to Colorado with his 'Rocky Mountain Exploring Expedition' comprising students and amateurs and augmented in the field by several guides, among them Jack Sumner, Billy Hawkins and Oramel Howland. When the party disbanded in September, Powell remained in the field, moving his winter camp to the headwaters of the Colorado River to explore the White and Grand rivers. Satisfied that the river could be run by sturdy boats, Powell arranged in March for construction of 4 boats in Chicago and then proceeded to Washington to seek Federal support for his venture. The only support he received was authorization to draw Army rations and the loan of a few scientific instruments from the Smithsonian Institution. Again Powell was forced to solicit money from colleges and friends, to obtain free railroad passes for men and supplies, and to make up the remaining cost himself.

On May 24, 1869, Major Powell and 9 companions, including Sumner, the Howland brothers and Hawkins, pushed their boats into Green River at Green River Station, Wyo., with provisions deemed sufficient for 10 months, although only a 5-month trip had been planned. Harrowing experiences, mishaps and loss of food, almost at the outset, warned the crew that it would be a dangerous expedition. Scientific work included determinations of latitude, longitude and altitude made at intervals, and sampling rock formations. The spectacular scenic features were named as we know them today, fossils were collected, and a general concept of the canyon country was developed.

Dwindling food supply with short rations forced the party to hurry the schedule. In the Grand Canyon, with barely 5 days' rations remaining, anxiety mounted. Three men refused to go farther. The food, guns and ammunition were divided and, at the point known as Separation Rapids, they took to the plateau, only to be slain by Indians.

However, Major Powell had calculated correctly, and two days later, on Aug. 30, the party arrived at the Rio Virgin where a small group of Mormons were fishing. Instantly Powell was a national hero. Newspapers throughout the country carried stories of the exploration and its leader. The

scientific results were modest, but Powell's brief report published early in 1870 (W. A. Bell, *New Tracks in North America*) indicates how clearly he recognized the interrelations of water, erosion, uplift and vegetation.

In 1871-1872, a second exploration of the Colorado River was undertaken, this time under the jurisdiction of the Department of the Interior and but one of 4 government topographic and geologic surveys in the public domain. Powell's survey was charged with the responsibility of mapping a narrow strip of land, 15 miles wide, on each side of the river. The task was completed as far as Kanab Wash, where the river survey was discontinued. Several photographers accompanied Powell's parties on this exploration. Of these, John K. Hillers is especially important for his work is among the finest produced, not only for its artistic merit but also as a historical record of the Indians of the region.

Powell left a large measure of the leadership of the survey to his brother-in-law, A. H. Thompson, chief topographer, in order to devote his time to observing Indian bands and studying the regional geology. Slowly he was formulating a concept of land, water, people and social institutions, their interaction and equilibrium. Inasmuch as the lands in question were public domain, the role of the Federal government was paramount.

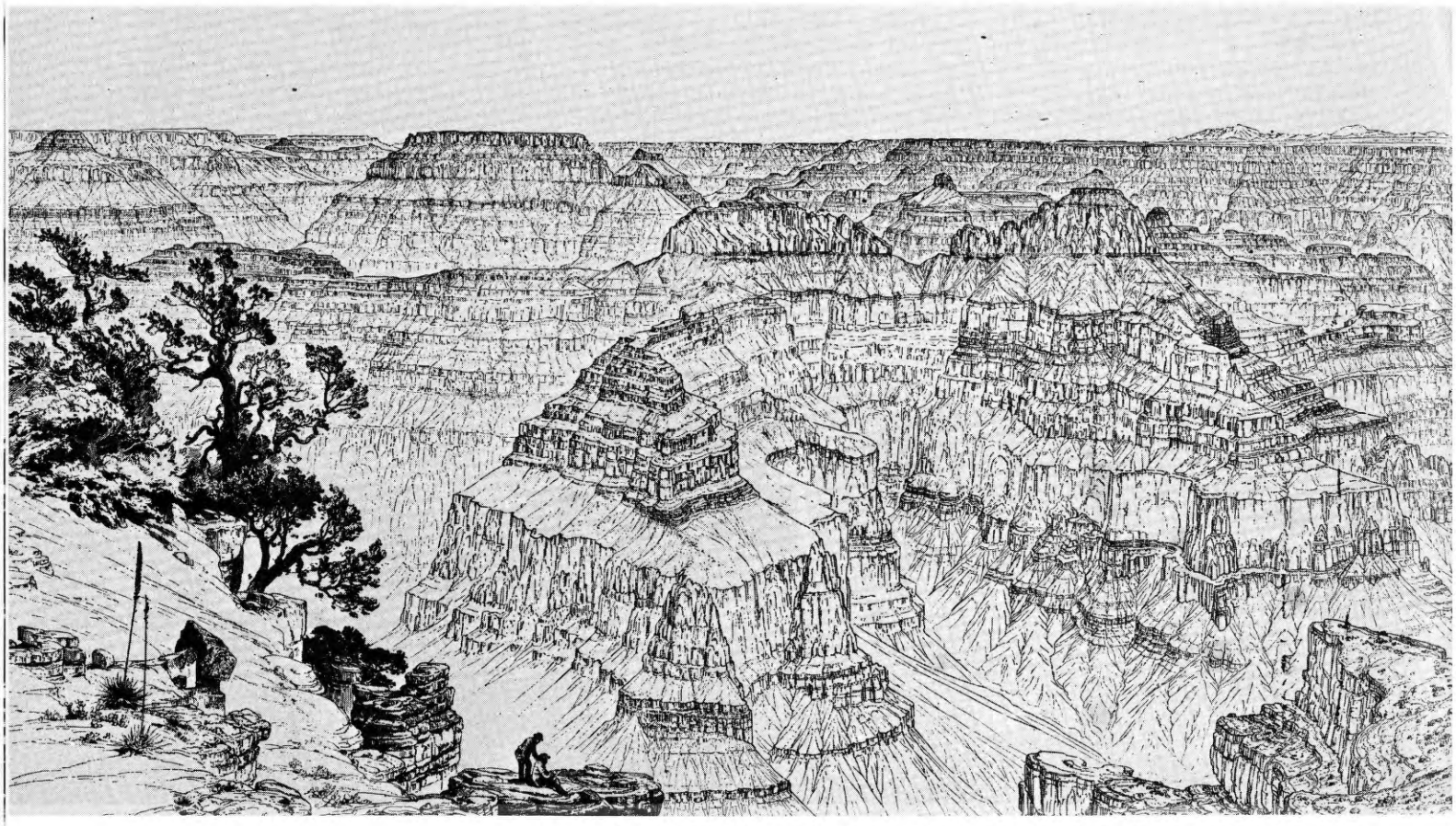
From 1872 to 1877, the Powell Survey continued topographic mapping and geologic investigations. G. K. Gilbert and Clarence Dutton joined the staff and found in association with Powell close camaraderie and a rich source of ideas. Throughout their professional careers, these two brilliant geologists acknowledged the inspiration derived from their chief.

Powell prepared monographs on the *Geology of the Uinta Mountains* (1876), *Introduction to the study of Indian language* (1877) and, most important of all his works, *Report on the lands of the arid region* (1878). The plains had led to the mountains, the mountains to the region he named 'the Great Basin'; the region to 'environment' — the land, the water, the vegetation, the native people.

Aside from a few excursions in later years, Powell's field explorations were done. In less than a decade, this self-taught geologist, anthropologist and sociologist had grasped the basic facts upon which could be constructed a unified concept of the total environment, the ecosystem, but the term is of mid-20th century invention. During that decade, 1867-1877, chance, coincidence and insight led Powell into a vast region where geologic processes were laid bare, unobscured by vegetation or by human occupancy. Almost intuitively he sensed even more than Lyell, Hall or Rogers the dynamics of change. Thus Powell had unwittingly prepared himself in a unique way and with a unique experience to exploit the opportunities that later opened to him as director of the U. S. Geological Survey.

Whatever his accomplishments, Powell's philosophy of his work and public service is simple indeed: intelligent use of scientific knowledge to achieve a harmonious balance of the human environment.

Powell's second expedition, at Green River Station, Wyo. From left: Beaman, Hattan, C. Powell, Jones, Hillers, J. W. Powell, Dellenbaugh, Thompson, Steward, Bishop, Richardson. (National Archives)



Powell's antecedent Colorado River in Grand Canyon, as seen from Point Sublime, looking east. The sketch is by W. H. Holmes, whose artistic ability for drawing landscapes realistically and showing their geology accurately was appreciated and encouraged by Powell, who provided opportunity for Holmes to use his great talent. Now with photography, few geologists attempt such sketches, yet the sketching, even though not to the quality of Holmes, forces thoughtful observation.

John Wesley Powell
his influence on geology

Chas. B. Hunt

Johns Hopkins University

JOHN WESLEY POWELL'S influence on geologic thought extends to the present day, partly as a result of observations he made while studying the Colorado River and concepts he developed based on those observations, and partly as a result of his leadership, first of one of the exploratory surveys (Geographical & Geological Survey of the Rocky Mountains) and later of the U. S. Geological Survey during its critical, formative stages. Not only was he first to chart the canyons and rapids of the Green and Colorado rivers from Wyoming to the foot of the Grand Canyon, but he also was first to attempt to explain how such canyons form. He recognized and was first to stress that study of these rivers, or of any other, involves the mutual relationships of structural geology, landforms, and erosion processes.

The morphologic relationships between streams and folds as Powell observed them (1875) are shown in the accompanying sketches. He noted that valleys formed by streams are modified by the amount of dip of the formation, by their resistance to erosion, and by diversions such as those caused by lava flows. Powell also contributed (1876) a similar morphologic classification of mountain forms and their relation to geologic structure, and later (1896) broadened this classification to include many kinds of landforms — plains, plateaus, lakes, marshes, as well as mountains.

Of much greater influence on geologic thought, however, is Powell's analysis of the dynamic relationship between rivers and the structural features they cross. A drainage might be older than one fold that is crossed and younger than another. We still debate the age relationships of the Colorado River to the folds it crosses. In considering this problem Powell distinguishes three age relationships:

In one kind of drainage, which he named *consequent*, the stream course is directly inherited from a bedrock surface formed by folding, tilting, or other Earth movement that is more rapid than the downcutting by the river. The axis of a newly formed syncline contains a consequent stream course; the axis of a newly formed anticline becomes a drainage divide with consequent drainage off the flanks.

However, most of the Colorado River drainage is not consequent, and Powell distinguished two kinds of nonconsequent valleys. One kind, which he called *antecedent*, persists on a land surface where folds or other displacements develop after a stream course has been established. Here the folds or other displacements are produced so slowly that the drainage lines are not diverted, and the streams cut vertically downward as the folds are raised across the stream course. The analogy is that of pushing a block of wood into a chain saw.

A second kind of nonconsequent drainage he called *superimposed*. This involves burial of an old structure by younger sediments unconformable on it. Consequent drainage that develops on the younger sediments cuts vertically into the buried structures as they are exhumed and becomes incised into them.

Powell concluded that the canyon of the Green River across the Uinta Mountains and the canyons of the Colorado River across the Colorado Plateau, including Grand Canyon, were due to antecedence. He was vague about the ages of the rivers, but about the Uinta uplift he wrote (in 1876) that '. . . the Uinta upheaval began at the close of Mesozoic time, and has continued intermittently near to the present . . .' But his interpretation of antecedence requires an ancient (too ancient) drainage system, and later workers, especially Davis, correctly pointed out that many of the drainage anomalies on the Colorado Plateau are better explained by superposition than by antecedence. So it became fashionable to dismiss Powell's hypothesis.

Now it appears that Powell was as right (and as wrong) as his later critics. The course of the Green River across the Uinta Mountains was established after the Miocene-Pliocene Brown Park Formation was deposited, which is much too late for the canyon to be due *solely* to antecedence. But the canyon through the mountains cannot be due *solely* to superposition either. The altitude of the canyon rim is about the same as the altitude of the terminal moraines where the headwaters of the Green River discharge into the Wyoming Basin from the Wind River Mountains. This basin is only 5 to 10 per cent of the Colorado River drainage basin, and there is not enough Pliocene and Quaternary sediment in the delta of the Colorado River to restore its surface (together with the rest of the drainage basin) to the height that would be necessary for the Green River to be superimposed across the Uinta Mountains! Part of the topographic relief there must be due to Pliocene or Quaternary deformation, or both, and part of the canyon deepening must be due to antecedence, as Powell indicated.

Powell explicitly stated that folds develop slowly over long periods of time, the rate averaging little or no faster than downcutting by the streams. Geologists profess not to be catastrophists, yet geological literature is replete with 'great upheavals', technically called orogenies. At heart, geologists still seem to be revolutionaries, but at least one group — the Daughters of the Laramide Revolution — need to be reminded that the amounts of Earth movement in the Colorado River basin seem to have been roughly proportional to the times that were involved and, considering the basin as a whole, so has the rate of erosion. The known geologic history raises grave doubts whether, during the Cenozoic, there has been any period of time as long as the Quaternary (about 2 million years) without major Earth movements somewhere in the river basin.

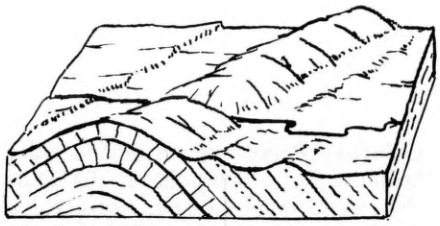
The concept of superposition requires that the uplifts crossed by the Colorado River and its tributaries be ancient (too ancient). Some of the structural barriers are old; others are demonstrably young. Neither the hypothesis of superposition nor the hypothesis of antecedence is adequate alone to explain most of the drainage anomalies. Both processes are needed, a concept of duality I have previously referred to (in 1956) as *anteposition*. By this interpretation the river course across a particular structural barrier may have been established by superposition, and then because of continued later uplift at the barrier, the canyon across it continued to be deepened by the process called antecedence.

One result of Powell's morphologic nomenclature of valleys was a rash of other descriptive terms. Besides learning about consequent streams, student geomorphologists have had to remember definitions of subsequent, obsequent, resequent, and insequent streams — or flunk the course. But it would be unfair to blame Powell.

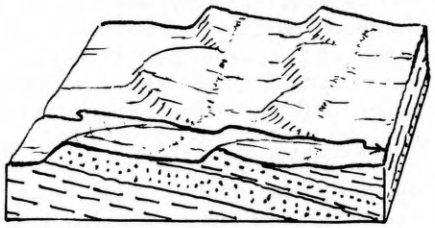
Rates of erosion and the capacity of streams to transport sediment, Powell observed, were dependent on the amount and velocity of the moving water. The amount depends on rainfall and catchment area; the velocity depends on the declivity. The greater the declivity, the greater the velocity and turbulence and the greater the transporting capacity of a stream. Steep headwaters move coarse debris; the flatter and more sluggish lower stretches move muds. Powell thus provided an explanation for the concavity of stream profiles.

Powell also gave us the concept of base level. He wrote (in 1875) that 'We may consider the level of the sea to be a grand base level, below which the dry lands cannot be eroded; but we may also have, for local and temporary purposes, other base levels of erosion, which are the levels of the

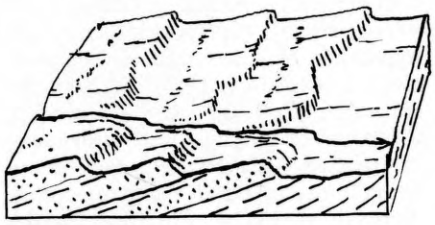
transverse valleys



diaclinal valley

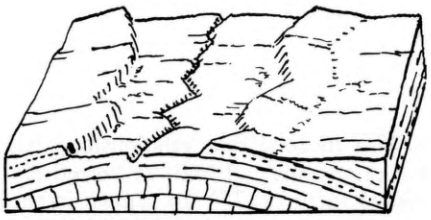


cataclinal valley

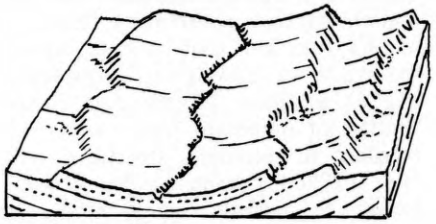


anaclinal valley

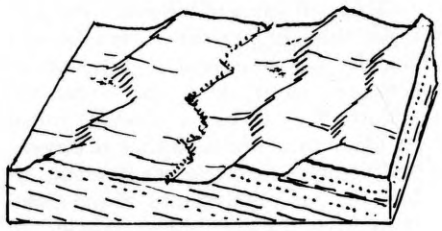
longitudinal valleys



anticlinal valley



synclinal valley



monoclinal valley

On the basis of morphologic relationships of streams to great folds, Powell distinguished two principal orders of valleys, each with three variants. His first order, transverse valleys, have directions at right angles to the strike of the structures. One variety of these, diaclinal valleys, passes through folds. The second variety, cataclinal valleys, flows down the dip. The third variety, anaclinal valleys, flows against the dip. By these definitions a diaclinal valley has two parts, one cataclinal and the other anaclinal.

His second order, longitudinal valleys, have directions parallel to the strike of the structures. The first variety of these, anticlinal valleys, follows anticlinal axes. The second variety, synclinal valleys, follows synclinal axes. The third variety, monoclinal valleys, is along the flanks of folds and is parallel to the strike of the formations.

principal streams. . . . Where . . . a stream crosses a series of rocks in its course, some of which are hard, and others soft, the harder rocks form a series of temporary dams, above which the corrosion of the channel through the softer beds is checked, and thus we may have a series of base levels of erosion, below which the rocks . . ., though exceedingly friable, cannot be degraded.'

Powell's analysis of structure, process, and base level undoubtedly was a major inspiration to his colleague G. K. Gilbert, who carried the analysis still farther. In a very real sense we are indebted to Powell for the concepts growing out of Gilbert's classic studies of erosion processes and structures in the Henry Mountains, Lake Bonneville, and the Sierra Nevada.

Powell's Colorado River studies led to other important geological concepts, for example, about igneous intrusions. On his trip down the river, he climbed the canyon walls near the Henry Mountains and there he saw the colorful Jurassic sandstones rising onto the flanks of those mountains. Gravels of porphyry in the canyons showed him that the mountains had igneous cores.

This observation that there must be a close relationship between the igneous activity and the dip of the formations came at a time when there still was controversy about 'craters of elevation'. So he arranged for Gilbert to examine the Henry Mountains, and Gilbert's report—a contribution of the Powell Survey—did indeed demonstrate that igneous intrusions deform the country rocks into which they are intruded. Today this is accepted as elementary, but not so at that time; more than one critic exclaimed that Gilbert's evidence needed confirmation.

Another contribution of Powell has come to us through his encouragement of geological art work of the kind created by W. H. Holmes (at the head of this article)—the artist-geologist-archeologist. Today, most of us approach an outcrop or a scenic view with a camera, and the photographic record clearly has its place in geology. But for close geologic observation try drawing the scene, too, and see how much more one learns by looking at it closely enough to draw it!

By comparison with other rivers, Powell's Colorado is trivial. Its flow is only 5 to 10 per cent as great as the flow of other major rivers in the United States; a dozen very much shorter and less widely known ones on the Atlantic seaboard have more water. But the Colorado River crosses the arid lands that need its water, and to this problem Powell also gave attention. His report on the arid lands and how they should be administered started national and local controversies about land use and conservation in that region. The controversies have not ended. Will the Grand Canyon be dammed?

As director of the U. S. Geological Survey, Powell was instrumental in guiding the Survey to become the world's finest geological organization, a government agency that has been able to maintain its scientific integrity despite political pressures. In a very real sense, therefore, Powell continues to influence geologic thought, not only in this country, but in the world.

References

G. K. Gilbert, 1877, Geology of the Henry Mountains: U.S. Geographical & Geological Survey of the Rocky Mountain Region, Washington, 160 p.

Chas. B. Hunt, 1956, Cenozoic geology of the Colorado Plateau: U.S. Geological Survey, Professional Paper 279, 99 p.

J. W. Powell, 1875, Exploration of the Colorado River of the West, 1869-72, Washington, 291 p.

_____, 1876, Report on the geology of the eastern portion of the Uinta Mountains, Washington, 218 p.

_____, 1896, The physiography of the United States, American Book Co., p. 33-64.

John Wesley Powell

the monuments

Ellis L. Yochelson

U. S. Geological Survey
Washington, D. C.

WHEN JOHN WESLEY POWELL traveled down the Colorado, other organized expeditions were being vigorously conducted by Ferdinand V. Hayden, Clarence King, and Lieut. George M. Wheeler. Most geologists have heard of Powell, but few have heard of the other men. To the general public, they are unknown figures. One reason may be that the West lacks historical signs, plaques, markers, or monuments that mark the routes they took and where major discoveries were made. Efforts to find historical markers of the geological and geographical results of Wheeler's and King's surveys have been fruitless; only one sign and an obscure monument record the work of Hayden.

In contrast, Powell's boat route has been partly marked and thus brought to the attention of the public, as on a granite monument at Green River, Wyo.

MARKING THE SPOT FROM WHICH
MAJOR WESLEY POWELL
AND PARTY
DEPARTED MAY 24, 1869,
TO MAKE THE FIRST EXPLORATION
GREEN AND COLORADO RIVERS,
ARRIVING MOUTH OF
GRAND CANYON, AUG. 29, 1869.

PLAQUE PLACED
BY THE HISTORICAL LANDMARK
COMMISSION OF WYOMING
1949

This plaque is in Island Park on the bank of the Green River. However, it is a few hundred yards south of the point where Powell probably first launched his boats, just below the Union Pacific railroad bridge.

In the 1940s the Utah Department of Highways erected a sign at the bridge that crosses the Colorado River at Moab. Highway construction and other considerations, such as the fact that Powell had not been closer than 65 miles from this spot on his boat ride, resulted in its being moved to Green River, Utah. This wooden sign in a limestone frame is now at a point where U. S. 50 crosses the Green River.

MAJOR POWELL,
COLORADO RIVER EXPLORER
THE FIRST ORGANIZED ATTEMPT TO CONQUER THE SWIRLING RAPIDS AND PRECIPITOUS WALLED CANYONS OF THE GREEN AND COLORADO RIVERS WAS MADE BY MAJOR JOHN WESLEY POWELL, CIVIL WAR HERO AND EXPLORER. WARNED BY INDIANS AND MOUNTAINEERS THAT THEY WOULD NEVER RETURN ALIVE, POWELL AND NINE COMPANIONS STARTED FROM GREEN RIVER STATION, WYOMING TERRITORY ON MAY 24, 1869 WITH FOUR BOATS, INSTRUMENTS FOR MAKING SCIENTIFIC OBSERVATIONS, AND PROVISIONS TO LAST 10 MONTHS. FOR 97 DAYS POWELL AND HIS MEN BATTLED THE ELEMENTS, ENDURING TREMENDOUS DEPRIVATIONS AND HARDSHIPS.
ONE MAN (FRANK GOODMAN) LEFT THE COMPANY EARLY IN THE JOURNEY, AND THREE OTHERS—(WILLIAM DUNN, O. G. AND SENECA HOWLAND) LATER KILLED BY SHIVWITS INDIANS—DESERTED NEAR GRAND CANYON, ARIZONA.
ON AUGUST 29, 1869 THE SIX REMAINING MEN (J. W. POWELL, W. H. POWELL, W. R. HAWKINS, A. HALL, J. C. SUMNER, AND G. Y. BRADLEY) ARRIVED AT THE JUNCTION OF THE RIO VIRGIN IN SOUTHERN NEVADA, HAVING NAVIGATED AND CHARTED OVER 900 MILES OF THE RIVER.
IN MAY 1871, 2 YEARS AFTER HIS FIRST RIVER VOYAGE, J. W. POWELL AGAIN LED AN EXPLORING PARTY OF 11 MEN IN 3 BOATS DOWN THE GREEN AND COLORADO RIVERS. WELL INTO 1873 MEMBERS OF POWELL'S PARTY CONTINUED EXTENSIVE AND SIGNIFICANT EXPLORATION AND SURVEYS OF THE REGION BORDERING THE RIVERS TRAVERSED. THE POWELL SURVEYS ARE SOME OF THE MOST SIGNIFICANT EXPLORATIONS ACHIEVED ANYWHERE IN THE WORLD.

On the Colorado itself, at the east side of Separation Canyon (at mile 239.6, below Lee's Ferry), a small obscure tablet was placed as a reaction to the monument downriver at Grand Canyon National Park.

IN MEMORY OF
SENECA HOWLAND
O. G. HOWLAND
WM. H. DUNN
WHO LEFT THE FIRST POWELL PARTY
AT THIS POINT AUG. 28, 1869
AND WERE KILLED BY INDIANS
ON THE SHIVWITS PLATEAU
ERECTED BY
COLORADO RIVER CLUB
1934

In 1939, this plaque was replaced by another, and concerned parties moved it up the canyon wall as the Lake Mead reservoir filled behind Hoover (formerly Boulder) Dam.

HERE ON AUGUST 28
1869
SENECA HOWLAND, O. G. HOWLAND
AND
WILLIAM H. DUNN
SEPARATED FROM THE ORIGINAL
POWELL PARTY, CLIMBED TO
THE NORTH RIM AND WERE
KILLED BY THE INDIANS.
FOR FURTHER AUTHENTIC
INFORMATION SEE "COLORADO RIVER
CONTROVERSIES" OBTAINABLE FROM
UNIVERSITY LIBRARIES.
THIS CENOTAPH WAS PLACED AND
DEDICATED IN 1939 BY LATER
COLORADO RIVER VOYAGERS

Markers now being constructed are also worth noting. In the Carl V. Hayden Visitor Center at Glen Canyon Dam, the Bureau of Reclamation will install a plaque:

MAJOR JOHN WESLEY POWELL,1834-1902
EXPLORER OF THE COLORADO RIVER
1869 AND 1871-72
ON AUGUST 3, 1869,
POWELL WROTE IN HIS JOURNAL,
". . . WE HAVE A CURIOUS ENSEMBLE
OF WONDERFUL FEATURES—
CARVED WALLS, ROYAL ARCHES,
GLENS, ALCOVE GULCHES, MOUNDS
AND MONUMENTS. WE DECIDED
TO CALL IT GLEN CANYON."

Finally, a substantial monument to Powell and his men—authorized by Act of Congress—was built on the South Rim of Grand Canyon National Park at Powell Point. It is built of Permian Kaibab Limestone with a large bronze plate on its south face. Legend has it that the broad flat monument was built in the shape of an Aztec sacrificial altar. This seems most unlikely, as no friend of the founder of the Bureau of Ethnology would have located the Aztecs in the Grand Canyon, yet that is exactly what the pyramidal steps and block construction looks like. The monument—dedicated May 20, 1918—has a medallion of Powell between two lists of names.

1869
JOHN C. SUMNER
WALTER H. POWELL
G. Y. BRADLEY
WILLIAM R. HAWKINS
ANDREW HALL

1872
A. H. THOMPSON
F. S. DELLENBAUGH
JOHN K. HILLERS
STEPHEN V. JONES
W. CLEMENT POWELL
ANDREW J. HATTAN

ERECTED BY THE CONGRESS OF THE UNITED STATES TO MAJOR JOHN WESLEY POWELL FIRST EXPLORER OF THE GRAND CANYON WHO DESCENDED THE RIVER WITH HIS PARTY IN ROW BOATS TRAVERSING THE GORGE BENEATH THE POINT AUGUST 17, 1869, AND AGAIN SEPTEMBER 1, 1872.

The reason for omitting the names of the three members of the 1869 expedition would make interesting reading. F. S. Dellenbaugh may have been the force behind erecting the monument and writing the inscription. However, it no longer matters who completed the river voyages. In August 1969, two bronze plaques will be installed on a large limestone boulder to record the Powell centennial and the golden anniversary of the park without any reference to names.

There is at least one other marker to the work of the Powell Survey. At Kanab Camp, Kane County, Utah, the Daughters of Utah Pioneers erected a sign:

FROM 1870 TO 1876 MAJOR WESLEY POWELL AND ASSISTANT ALMON H. THOMPSON, OF THE U.S. COLORADO RIVER EXPLORATIONS, ESTABLISHED HEADQUARTERS AT KANAB. ON THIS SPOT THEY ERECTED A STONE FOUNDATION AND RAISED A TENT WHICH HOUSED A TELESCOPE, BY WHICH MEANS THE MERIDIAN WAS ESTABLISHED. DURING THE WINTER OF 1872 AND 1873 THE FIRST MAP OF GRAND CANYON WAS MADE AND MAJOR POWELL GAVE THE CANYON ITS NAME. FREDERICK S. DELLANBOUGH WROTE THE NAME ON THE FIRST MAP. THE MEN OF KANAB HELPED IN THE WORK AND WERE FAITHFUL, AGREEABLE AND COMPETENT.

One unofficial source suggests that Dellenbaugh was again the moving force behind erection of the sign and got his name misspelled for all his efforts.

Nothing marks the headquarters used by Wheeler, Powell, or King when they led their territorial surveys; a plaque at Hayden's headquarters in Washington, D. C., was destroyed when the building was remodeled.

The Powell Memorial Museum at Illinois Wesleyan University, where Powell taught, bears a plaque to the major. Signs on the Vicksburg and Shiloh battlefields record positions and activities of the Powell battery of the 2d Illinois. Curiously enough, the Order of Redman of America built a grotto to Powell at his boyhood home of Jackson, Ohio, with each state that contained a lodge at the time contributing a large native stone. It is a geologic monument if one stretches a point; a marker to Powell is conspicuous among the plaques for the individual stones.

Powell was honored by an obscure railroad siding in Arizona, but it has since been abandoned. Powell County, Montana, is reported to have been named for him. Powell, Wyo., was probably also named for him, but, again, I have no proof. Powell National Forest was established in 1908 in southwestern Utah but in 1945 it was incorporated into Dixie National Forest and the name disappeared.

Town names are of dubious merit, but prominent geographical features are fine monuments to explorers, even if they do not bear historical signs giving derivation of the name. Powell never worked in California but there is a Mt Powell in King's Canyon National Park. Mt Powell (13,137 ft) in Duchesne and Summit counties, Utah, in the Uinta Mountains, is a far more imposing landmark. Colorado has honored Powell with Powell Peak in Larimer and Grand counties as well as Mt Powell in Eagle and Summit counties. A few minor streams and lakes bear his name. Powell never visited Alaska but that state has 2 Powell Peaks; the smaller, east of Sitka, is named for him.

Arizona also has place names honoring the leaders of the Territorial surveys, and Grand Canyon National Park is the first place to look. Powell Plateau is prominent on the north side of the river as an outlier of the Kaibab Plateau (at least one map gives this incorrectly as Powell's Plateau). Powell Lake should be noted as a barely moist slough in Mojave County. Many people will argue that this is the name of the reservoir behind Glen Canyon Dam on the Colorado, but experts know that it is designated as Lake Powell, or unofficially, Powell's Puddle.

John Wesley Powell died Sept. 23, 1902, at Haven, Me. As befitted a soldier, he was buried at Arlington National Cemetery. In May 1909, W. H. Holmes of the Hayden Survey, Bureau of Ethnology and U. S. National Museum; H. C. Rizer, Chief Clerk of the U. S. Geological Survey, and C. D. Walcott, Secretary of the Smithsonian and former director of the Geological Survey, distributed a circular letter: 'The Sixtieth Congress appropriated Five Thousand Dollars for the erection of a suitable memorial to Major J. W. Powell, to be placed on the brink of the Grand Canyon of the Colorado. . . . At the earnest solicitation of numerous old-time associates of Major Powell, we have consented to initiate a movement among his friends for the erection of an appropriate monument over his grave at Arlington National Cemetery, which remains as yet unmarked. . . .'

Powell's colleagues rallied for one final gesture and on June 30, 1911, C. D. Walcott wrote to President Taft for permission to erect the monument at Arlington. He added, 'If ever a man deserved to have such a recognition, he certainly did. He was my chief for twelve years as Director of the Geological Survey and I learned to appreciate and admire his unusual character and qualities.'

A huge rough-hewn granite monolith on the site is the support for a medallion of the major, which seems to be a better likeness than the one used on the Grand Canyon National Park monument.

1834 1902
JOHN WESLEY
POWELL
SOLDIER
EXPLORER SCIENTIST
EMMA DEAN POWELL
1835 1924

The reverse of the monument gives the major's Civil War record.

We geologists have nothing to be particularly proud of in honoring the men who helped build our science a century ago. The few monuments which do exist were erected mainly by interested historical groups, not by geologists. Of course the next mail will undoubtedly direct my attention to a 40-ft-tall flashing neon sign erected by local geologists in, perhaps, downtown Denver as a testimonial to all four explorers! However, even if the number of historical signs is double that listed here, chary praise is being given to the Western surveys.

If geologists want to bring their science to public attention, more historical markers are one way to accomplish it. Markers to local geology are erected from time to time. Why not give some thought to local history monuments?

Sir Archibald Geikie

letters from American geologists

Gordon Y. Craig
University of Edinburgh

Mary C. Rabbitt
U. S. Geological Survey

SIR ARCHIBALD GEIKIE, who became the first director of the Geological Survey in Scotland in 1867 and director general of the Geological Survey of Great Britain in 1882, was also the first professor of geology in the University of Edinburgh, being appointed to the Regius Chair of Geology in 1871. Through his official duties and his broad interests in the science, Sir Archibald had a wide acquaintance among geologists all over the world, and many of them wrote to him seeking his advice or commenting on current developments. Most of this correspondence was left to the University of Edinburgh but only recently has it been examined. Colin Graham, one of the senior students, discovered several letters from Clarence Dutton describing in exciting fashion the exploration of part of the Grand Canyon and the Plateau country and also commenting on the problems and early growth of the U. S. Geological Survey.

Further examination by us has revealed letters from at least 30 widely known American geologists of the late 19th century, a treasure trove for the historically minded.

One of Dutton's most interesting letters, written in 1883, told of the controversy then current over '"Pre-Cambrian" (?) rocks'. During the two years preceding, fossiliferous Upper Cambrian beds had been found overlying an immense series of unmetamorphosed beds with a high degree of unconformity in two places—on the south side of Lake Superior and in the Grand Canyon. R. D. Irving and T. C. Chamberlin had suggested that the underlying beds in the Lake Superior region correlated with Logan's Huronian rocks, but, said Dutton, this 'calls out Selwyn and the Canadian geologists who maintain the much older age of the Huronian.' The discovery in the Grand Canyon region Dutton thought still more remarkable. Several years before, G. K. Gilbert, basing his inference on the discovery of a single fossil, had assigned the lower part of the conformable series to the Cambrian. If Gilbert were right, then an apparently conformable series of beds was Carboniferous above and Cambrian below without any Silurian or Devonian, and the very fresh-looking rocks below the unconformity were pre-Cambrian without any known equivalent in that part of the country. This, said Dutton 'was a little too much so Powell and myself dissented from Gilbert.' But Gilbert was right. Young Mr Walcott had gone into the Canyon along a new trail and found an abundant fauna 'most decisively and unquestionably Cambrian' for 500 ft above the unconformity. After two months' search he found only a single *Stromatopora* in the beds below. Dutton commented that 'I cannot imagine how Gilbert could have had the courage to adopt such a preposterous conclusion, and yet be right about it after all.'

James D. Dana was another who wondered about some of Gilbert's conclusions. Much of his correspondence with Geikie was on the Taconic question, but in 1880 he wrote that the Henry Mountains report contained 'an account of queer facts—which . . . I confess I accept only with questionings.'

Gilbert was another of Geikie's correspondents. In 1887 he sent him a paper for publication in England. 'In common with a number of American geologists,' he confessed, 'I have held aloof from the International Geological Congress, believing that it was attempting to regulate that which should not be regulated by legislation. I had thought very little was likely to be accomplished by it, but I am now convinced that unless the conservatives make themselves heard geology may be saddled with a tyranny of authoritative classification that will seriously hamper its development.'

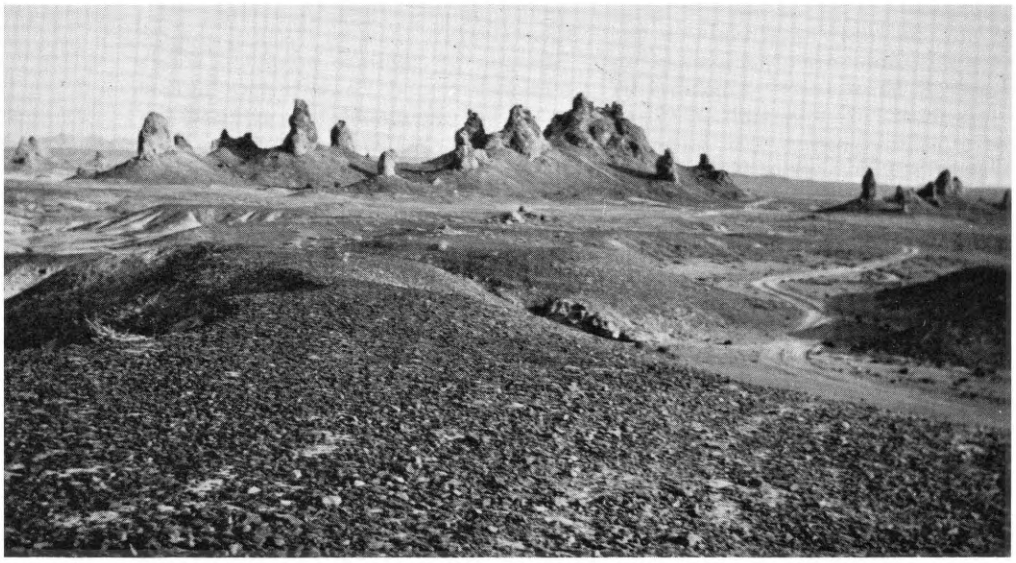
There are very human touches in some of the letters. N. S. Shaler apologized for not sending reprints—'My wife has a "scunner" against unbound things which has been communicated to me.' J. S. Newberry postponed his trip to England—the Public Printer told him that if he would wait long enough to read galleys he could have his memoir on Triassic fishes in print in 10 days! J. P. Lesley confessed that he had begun to find science rather drab—'like the artemisia plant on the alkaline steppes of Montana' — and preferred to read Sir Walter Scott and G. P. R. James.

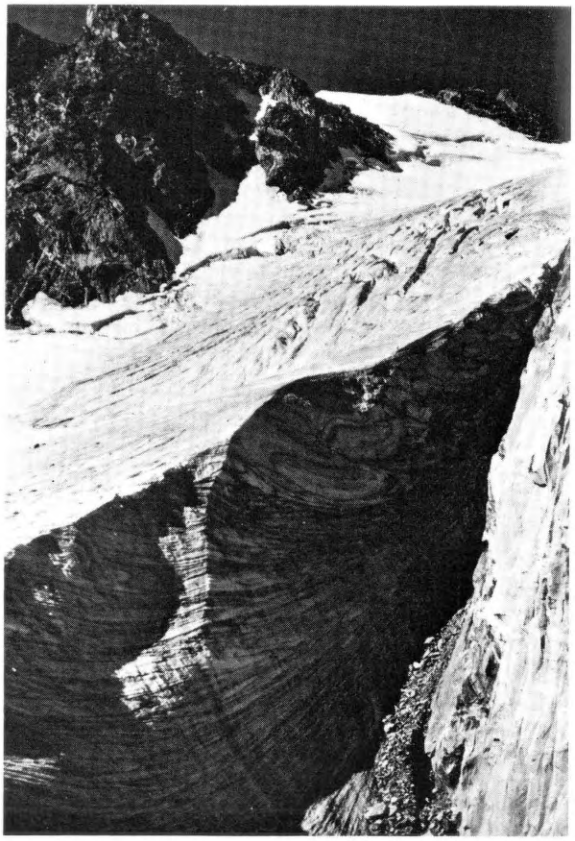
Several letters provide new insight on the early days of the U. S. Geological Survey. There are 50 letters from F. V. Hayden over a 20-year period from 1874—when the question of civilian vs military control of the Western surveys was the subject of Congressional investigation — until shortly before his death. Hayden was bitterly disappointed by the nomination of Clarence King as the first director of the Survey. He had written some months before to Geikie that King was his only serious competitor for the job but in fact thought that the President had already promised the position to *him*. Dutton wrote in detail about King's disillusionment and his wish to resign in the summer of 1880. However, King feared that President Hayes would appoint Hayden and so waited for President Garfield to be inaugurated so there would be no question that his successor would be Powell. It has been assumed that the secret was kept so Hayden would not find out and prevent Powell's appointment — Mrs Henry Adams so wrote to her father in March 1881. But Hayden knew all about it—in the summer of 1880 he predicted King's resignation and Powell's appointment and said he could not serve under Powell (of course he later changed his mind on that).

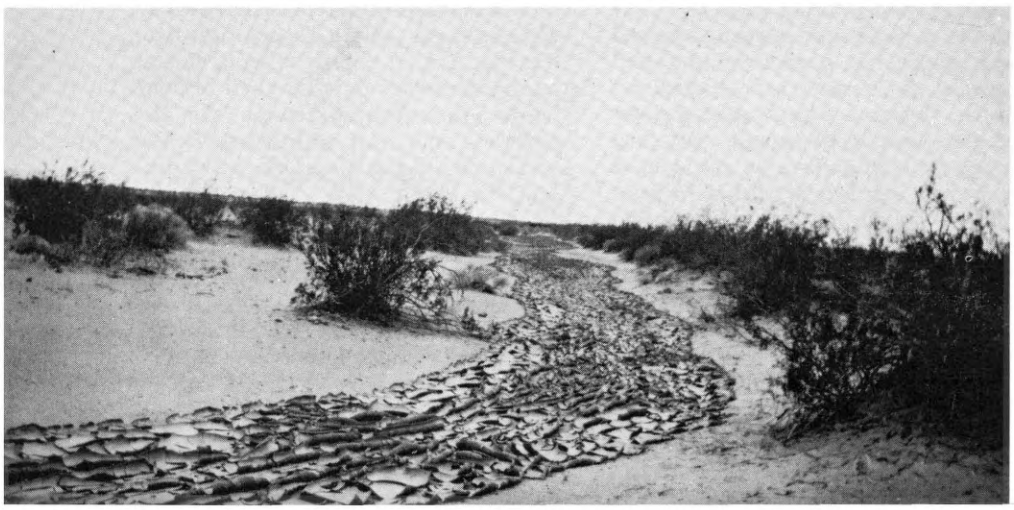
Only a few years later, Dutton took a rather pessimistic view of the future of the Survey. During the Allison Commission hearings in 1885, he told Geikie that 'Our Survey is now at its zenith and I prophesy its decline. The "organization" is rapidly "perfecting" i. e. more clerks, more rules, more red tape, less freedom of movement, less discretion on the part of the geologists and less out turn of scientific products. This is inevitable. It is the law of nature and can no more be stopped than the growth and decadence of the human body.'

One of the most interesting aspects of the letters has been the sense of timelessness they convey. Though they were writing nearly a century ago, these American geologists seem almost our contemporaries as they tell of their hopes and fears and recount their discoveries and their enthusiasms. We and some other geologists hope to present the letters as a small volume in 1971 as part of the centenary celebrations of the Department of Geology in the University of Edinburgh. Meantime, on the occasion of the centennial of the first trip down the Grand Canyon, it seems appropriate to draw attention to this part of the Geikie collection.

◄ First place in the American Geological Institute's photo contest (geomorphology-glaciology): Apron and wave ogives of the Vaughan Lewis Icefall, Juneau Ice Field, Alaska. (Photo by P. Jay Fleisher, State University College, Oneonta, N.Y.) At center, tufa pinnacles and desert pavement at the south end of Searles Lake, Mojave Desert; at lower left, a mudflow at the margin of Bristol Dry Lake, Amboy, Calif. (Photos by Richard Stone, University of Southern California) ▼ A feeder cirque of Dinwoody Glacier in the Wind River Range, Wyoming, showing thrusting and folding of dirt bands. (Photo by Robert Michael, University of Wyoming)







NEW SEISMIC INSTRUMENT

*CUT YOUR FIELD TIME AND COST WITH DMI'S ALL-NEW MODEL 117C**

- **FULLY PORTABLE, WITH SELF-CONTAINED RECHARGEABLE BATTERIES**
- **EXPANDED RANGES — 0 TO 999 MS AND 0 TO 99.9 MS, SELECTABLE**
- **SELF-ILLUMINATED, DIRECT READING DECIMAL TIME DISPLAY**
- **DUAL GEOPHONE INPUTS, WITH SIGNAL POLARITY SELECTOR**
- **NOISE LIMIT CONTROL**
- **ALL SOLID STATE — NO MOVING PARTS**

*SOILTEST Catalog No. R117C

The new Model 117C Seismic Timer is the most advanced portable seismic instrument yet developed. It brings you the money-saving benefits of ten years design evolution and field experience.

Geologists and engineers using shallow seismic investigations on highway, foundation, pipeline, mining, tunneling, excavation, compaction and other work, will quickly appreciate the 117C's time-saving convenience and accuracy. Its carefully shielded electronics and brightly-lighted time display — with no wear-susceptible or dirt-sensitive moving parts — provide field reliability for profitable site investigation. Its internal power source is rechargeable with the external charger supplied, or from car or truck battery, and you get a month's normal field use from one charge.

Write for specifications and application information.

DynaMetric, Inc.

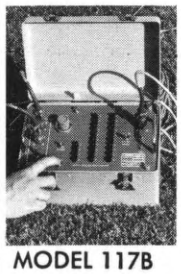
330 W. HOLLY ST. PASADENA, CALIF. 91103 PHONE 449-4300 · 684-1630 CABLE: DMI PASADENA, CALIF.

AVAILABLE THROUGH

SOILTEST®

SOILTEST, INC.
2205 LEE STREET
EVANSTON, ILLINOIS
60202
TEL. 312 869-5500

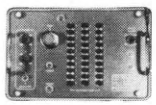
OTHER INSTRUMENTS FROM DMI



MODEL 117B
Standard, dual-range, dual-geophone, seismic timer, 0-399 MS.

R221A RADIO LINK
Eliminates need for hammer cable, permits fuse-fired explosives.

MODEL 217B
MICRO SEISMIC TIMER



For investigation of rock, concrete and similar materials

late late news

May 11 Walter J. Hickel, Secretary of the Interior, said today that the Nixon administration will 'take a hard look at oil depletion and the whole problem of oil-import programs and the oil industry.' He added that 'the new approach to the oil-depletion allowance has some merit.' Congress seems sure to reduce the present 27 1/2 per cent allowance--perhaps by limiting it to operations in the U. S.--if only because representatives generally believe the public regards it as a tax loophole.

May 11 Lee A. DuBridge, science adviser to President Richard M. Nixon, has assembled a special panel to make recommendations on the future of the Union Oil lease off Santa Barbara. Among the 11 members: John Calhoun Jr (chairman) of Texas A&M, Lloyd S. Cluff of Woodward-Clyde & Associates, Hamilton M. Johnson of Tulane, Gordon J. F. MacDonald of the University of California (Santa Barbara), Henry W. Menard of Scripps, and Carl H. Savit of Western Geophysical Co.

May 9 In Washington, the U. S. National Committee on Geology met and heard William Thurston, secretary, report that Unesco had accepted its nominees to the International Geological Correlation Program. (The program will be held Sept. 9-11 in Budapest.) The U. S. representatives: Hollis Hedberg of Princeton University; George Cohee of the U. S. Geological Survey; John Rodgers of Yale University; Daniel Merriam of Kansas University; Paul C. Bateman and Vincent McKelvey of the USGS.

May 8 'It is man's way of using the Earth that is resulting in greater problems' in geologic hazards, Montis R. Klepper, associate chief geologist of the U. S. Geological Survey, said today before the Special Studies Subcommittee of the House of Representatives. The hearing concerned Federal involvement in housing construction in earthquake and landslide areas. Representatives of the Federal Housing Administration and the Veterans Administration also were called because they lend money and insure homeowners' loans. Committee interest centered on housing developments in the San Francisco Bay Area and in Los Angeles County where landslides and settlement have damaged and destroyed houses.

May 7 The House of Representatives' Subcommittee on Mines & Mining heard testimony today from George Fumich, director of the Office of Coal Research (who said synthetic oil, made from coal, costs $2.50 to $3 a barrel) and Hollis M. Dole, Assistant Secretary for Mineral Resources ('there is a great need for R&D in minerals'). The subcommittee chairman, Ed Edmondson (D, Okla.), said 'we are at a standstill with mineral research and it distresses me.' John Saylor (R, Pa.) said 'we will be a nation of have-nots without research' and John Wold (R, Wyo.) said the Office of Coal Research is 'one of the few government research programs that have almost universal approval.'

May 2 The Governor's Conference on Environmental Geology, held in Denver, drew 283 registrants from as far away as Guam and included ecologists and lawyers. Many were geologists; nearly half were planners or engineers. Edwin B. Eckel, editor for the Geological Society of America, reports that 'this was not a group of geologists and hydrologists extolling their virtues to one another. Instead, the beginnings of real mutual understanding between earth scientists and potential users of their knowledge were achieved.' The conference, sponsored by Gov. John A. Love, was arranged by local sections of the Association of Engineering Geologists and the American Institute of Professional Geologists.

NEWS NOTES

Sigsbee Knolls

Laboratory tests of oil-and-gas-bearing cores taken last year during Leg I of the Deep Sea Drilling Project have shown almost conclusively that the Sigsbee Knolls are salt domes.

The tests showed that the oil is relatively young, that the rock is mainly calcite and sulfur, and that the rock contains an accumulation of palynomorphs of Jurassic age. These characteristics are found in salt domes on or near shore in the Gulf of Mexico, and lend support to the belief that the Sigsbee Knolls are sea-floor mounds produced over upward-thrusting salt formations.

The Sigsbee Knolls were discovered in 1954 by Maurice Ewing of Lamont-Doherty Geological Observatory. He predicted that the knolls were salt domes and urged drilling into them.

California board

A recently enacted law has increased membership in the California Mining & Geological Board from 5 to 7 members. Gov. Ronald Reagan appointed Clarence R. Allan of California Institute of Technology, and Karl V. Steinbrugge, head of the earthquake department of the Pacific Fire Rating Bureau, to fill the new positions.

Iceland Ridge

In an article that appeared in the Jan. 15 issue of the *Journal of geophysical research*, Columbia University scientists say that the Mid-Atlantic Ridge can be traced to the southern edge of Iceland and northward from the island. The relationship of the Ridge to Iceland has been uncertain. Because Iceland is the largest land area straddling the Ridge, it is the best location for making direct studies with land-based instruments.

earthquake prediction

Scientists have developed a technique for forecasting the severity of possible future earthquakes, by using a computer to chart strain patterns along earthquake faults.

Applying the technique to a part of the San Andreas Fault, the scientists found that according to the computer calculations, the magnitude 6.3 earthquake at Santa Barbara in 1925 and the magnitude 7.7 temblor in Kern County in 1952 have reduced the amount of strain stored in the rock along the fault in the vicinity of Ft Tejon in the Tehachapi Mountains. This could mean that there is less likelihood than anticipated of a great earthquake occurring in southern California in the next few years.

California landslides

The U. S. Geological Survey has warned that although the destruction from floods and mudflows subsides when heavy rains cease, the danger from landslides will persist well into the summer in hilly and mountainous areas of California. Survey scientists said that near record-breaking rains this spring have created one of the greatest potentials for landsliding in the history of the state.

granitic rocks

Granitic-type rocks have been discovered on the floor of the Caribbean Sea by Columbia University scientists and students. The discovery was made on an expedition of Duke University's research vessel *Eastward* by students led by Bruce C. Heezen of the Lamont-Doherty Geological Observatory of Columbia University.

The granite material was dredged

from the eastern flank of the Aves Ridge, a north-south submarine feature that extends from Venezuela to the Virgin Islands. The discovery may have wide geological implications because, up to now, geologists generally believed that light granitic, or acid igneous rocks, are confined to the continents and that the crust of the Earth beneath the sea is composed of heavier, dark-colored basaltic rocks.

engineers

The National Academy of Engineering elected 44 new members from the United States. Among them are these engineers who have contributed to the earth sciences:

Robert F. Bauer, Global Marine Inc., Los Angeles; John A. Blume, Blume & Associate Engineers, San Francisco; Harold W. Fisher, Standard Oil Co. of New Jersey, New York; John S. Foster Jr, Department of Defense, Washington, D.C.; Robert C. Gunness, Standard Oil Co. of Indiana; J. Donovan Jacobs, Jacobs Associates, San Francisco; Robert I. Jaffee, Battelle Memorial Institute, Columbus, Ohio; Harvey F. Ludwig, Engineering-Science Inc., Arcadia, Calif.; Plato Malozemoff, Newmont Mining Corp., New York; Murrough P. O'Brien, consultant, Berkeley, Calif.; Frank E. Richart Jr of University of Michigan, Ann Arbor; Monroe E. Spaght, Shell Oil Co., New York; John E. Swearingen Jr, Standard Oil Co. of Indiana, Chicago; Edward Wenk Jr, National Council on Marine Resources & Development, Washington, D.C.

metallurgy conference

The 1969 Gordon Research Conference in physical metallurgy will be held July 7-11 at Providence Heights College, Issaquah, Wash.

Discussion topics include hot creep of olivine, mechanisms of creep in rocks, steady-state flow in NaCl & $CaCO_3$, and flow of glaciers.

Information on attendance is available from Alexander Cruickshank, Director, Gordon Research Conferences, University of Rhode Island, Kingston, R.I., 02881.

Government

U. S. coal

The U. S. Geological Survey estimates that U. S. coal resources remaining in the ground total 3,210 billion tons, about half of which is believed to be recoverable. The United States has about one-fifth of the total estimated world coal reserves.

About 50 per cent of the U. S. coal resources are known from detailed geologic mapping and studies by the Survey and various state agencies. The remaining resources are inferred to be present in unmapped areas and in deeper parts of larger coal basins.

Of known resources: 44.5 per cent is bituminous coal; 26.5 per cent, subbituminous; 27.5 per cent, lignite; 1.5 per cent anthracite.

seabed survey

The Coast & Geodetic Survey is making the first detailed large-scale survey ever made of the seabed off the Atlantic Coast between Hatteras and Cape Fear, N.C.

Part of the 5,000-square-mile survey was done this spring; the work will be continued from August to October. The survey data will be used for a new bathymetric map of the continental shelf from Wilmington to Hatteras that will be published in the next 2 years. The survey is part of a long-range program, begun in 1967, to map the entire Atlantic Coast continental shelf.

oil-shale retorting

The U. S. Bureau of Mines reports that retorting a mixture of oil-shale pieces produced by underground fracturing of shale with nuclear explosives is feasible.

This finding is encouraging to those who hope that deep nuclear explosions will become a means of extracting oil economically from thick shale. H. C.

Carpenter, chemist for the Bureau, said oil yields as high as 80 per cent were achieved in an above-ground simulated retort.

In the societies

Geológica Mexicana

The Sociedad Geológica Mexicana lists these officers for 1969-70:

President, Diego Cordoba M., Chairman of the Geological Institute; vice-president, Eduardo J. Guzman, head of exploration technology of the Mexican Petroleum Institute; secretary, Jorge Garcia Calderon, research geologist of the Geological Institute; treasurer, Rodolfo del Arenal, research geologist, the Geophysical Institute; editor, Luis R. Segura, biologist, the Geological Institute; past-president, Jesus Ruiz Elizondo.

AAPG officers

The American Association of Petroleum Geologists has elected these new officers for 1969-70: president, Kenneth H. Crandall, retired, formerly director of Standard Oil of California; vice-president, Willis G. Meyer, consultant, Dallas; secretary-treasurer (incumbent), James M. Forgotson Jr, Petroleum Information Inc., Denver; editor of the *AAPG bulletin* (incumbent), John D. Haun, Barlow & Haun Inc., Denver; past president, Frank B. Conselman, consultant, Abilene, Tex.

•

The AAPG has appointed these officers of its Professional Division: President, George R. Gibson, consultant, Midland, Tex.; vice-president, John T. Rouse, Mobil Oil Corp., Houston; secretary-treasurer, Ted L. Bear, Bear & Kistler, Los Angeles. The Professional Division of AAPG consists of petroleum geologists who have been certified by a 5-man board appointed by the division president.

Fine Particle Society

The Fine Particle Society has been formed to serve scientists and engineers who share a common interest in the physical and chemical properties of particulate matter. A newsletter will be published, and plans are underway to provide an interdisciplinary abstract service or a listing of papers, books, and reports dealing with the science and technology of fine particles. Preliminary arrangements have also been made to give Society members a discount on pertinent journal

IF YOU'VE GOT THE PROBLEM, WE'VE GOT THE TIME!

Time on our Control Data 6600 Computer System in a custom configuration . . . delivers more work per dollar spent! Work space is available in our computer building in Midland . . . terminals provide easy access over ordinary telephone lines from your location, anywhere! Supporting equipment includes the highly accurate Gerber 2032 plotter, Texas Instruments TIOPS system, and Electrotech section camera.

Public and proprietary files are available . . . you can process them along with your confidential information with complete security! And, you don't need sophisticated programming knowledge. Software and related services are on call . . . exclusive ICCC talent specializes in scientific computer applications and systems design.

SERVICES INCLUDE . . .

Data Encoding and Reduction
Well Data Systems
Information Storage and Retrieval
Trend Surface and Residual Analyses
Management Information Systems
Decision Strategy

Computer Management
Regional and Detailed Geology
Reservoir Modeling and Simulation
Petrophysical Analyses
Reservoir Engineering
Hydrodynamics

Geologic Modeling
Circuit Board Graphics
Digital Seismic Processing
High-Resolution Plotting
Three-Dimensional Plotting
Computer Time Rental

To put ICCC's advanced computers and exclusive talent to work for you . . . call or write Thomas A. Raymond, VP-Marketing

INFORMATION AND COMPUTING CENTERS CORPORATION

HOME OFFICE
Expressway Tower
Dallas, Texas 75206
214 369-8374

ISIS DIVISION
777 S. Central Expressway
Richardson, Texas 75080
214 231-4896

PICC DIVISION
Building of the Southwest
Midland, Texas 79701
915 MU 3-4861

subscriptions.

Applications for charter memberships are invited. For information, write to S. Gebura, Secretary, Fine Particle Society, Box 671, Wharton, N. J., 07885.

geophysicists

Candidates for office in 1969-70 in the Society for Exploration Geophysicists: for president, Milton B. Dobrin, Pasadena, Calif., and Craig Ferris, Tulsa; first vice-president, Sydney Kaufman, Houston, and E. John Northwood, San Francisco; vice-president, Ralph C. Holmer, Salt Lake City, and J. Richard Hunt, Houston; secretary-treasurer, O. H. Armstrong, Denver, and H. F. Patterson, Ft Worth; editor, Pierre L. Goupillaud, Ponca City, Okla., and Franklyn K. Levin, Houston.

Balloting will be by mail and winners will be announced Aug. 1.

Far Western

New officers of the Far Western Section of the National Association of Geology Teachers:

President, Jon Cummings of California State College at Hayward; vice-president, Scott Creely of San Jose State College; secretary-treasurer, John Martin of San Jose City College.

Aid and grants

Sigma Xi

The Society of Sigma Xi recently made these research awards to earth scientists:

Han-Ling Ong of the Institut Teknologi Bandung, Indonesia, migration of copper in tropical soils over known base-metal vein deposits; George L. Meyer of the University of California at Santa Barbara, Franciscan and associated rocks of south-central Santa Barbara County, Calif.

graduate fellowships

The National Science Foundation has awarded 1,929 graduate fellowships in the sciences, mathematics, and engineering for 1969-70. 633 awards were made in the physical sciences, including 63 in the earth sciences.

44 per cent of the fellowships awarded are for 2 years. Continuation for the second year depends on academic progress of the Fellow and the availability of appropriated funds.

Graduate fellowships provide basic stipends of $2,400 for the first-year level of study, $2,600 for the intermediate level, and $2,800 for the last year. They include allowances for dependents and for limited travel. In lieu of tuition and fees, U. S. institutions receive a standard $2,500 cost-of-education allowance for each fellow.

The Foundation expects to reopen the fellowship program for 1970-71 in October. Application forms will be available when the program is announced.

postdoctoral awards

The National Science Foundation has awarded 130 postdoctoral fellowships in the sciences, including 4 in earth science. Each award carries an annual stipend of $6,500, an allowance for dependents, and an allowance to help defray travel costs to the fellowship institution.

graduate traineeship

The National Science Foundation has awarded $28.7 million in support of graduate traineeships. The grants will enable 216 institutions in the United States to appoint 5,238 students for full-time graduate study, beginning in the fall of 1969 and 852 graduate teaching assistants for full-time study this summer. The awards provide for stipends for students and reimbursement to the institutions for tuition and fees or cost-of-education allowance.

The traineeship program covers all fields in the natural and social sciences, and includes interdisciplinary fields such as oceanography, geochemistry, and meteorology. Grants last year in this program totaled $31 million.

Pan Am fellowship

The State Geological Survey at the University of Kansas awarded the Pan American Petroleum Foundation postdoctoral fellowship for 1969-70 to John D. Holroyd-Doveton of Addiscombe, Surrey, England. The award was created at the University a year ago for the purpose of studying application of computer techniques and solutions to geological problems.

pollution study

The Western Oil & Gas Association, a trade group representing the oil industry in western United States, made an unrestricted $150,000 grant to the University of California for a year-long study of the effect of oil pollution on ocean plants and animals in the Santa Barbara Channel. Bernard C. Abbott, chairman of the Department of Biological Sciences, is in charge of the research. Ronald Kolpak of the geology department is in charge of the geological and oceanographic aspects of the study.

From departments

University of Rochester

David M. Raup has been named chairman of the Department of Geological Sciences at the University of Rochester. He succeeds Robert G. Sutton, who is returning to full-time teaching and research.

Polar Studies Institute

The Institute of Polar Studies at Ohio State University has expanded its facilities and staff.

Garry D. McKenzie, a glacial geologist, became assistant to the director in November. New members of the research staff are Terence J. Hughes, a metallurgist-glaciologist, and James R. Rastorfer, a botanist. Two new postdoctoral fellows with the Institute are Jean-Roland Klay, a glacial geologist, and Steven B. Young, a botanist.

Cornell

The Department of Geological Sciences at Cornell added 2 new staff members this spring. Bill Bonnichsen, formerly a research associate with the Minnesota Geological Survey, teaches courses in petrology and petrography. V. Mencl of the Technical University, Brno, Czechoslovakia, is a visiting professor.

marine science

The Marine Science Consortium of Pennsylvania Colleges & Universities will offer a series of courses this summer at the Delaware Bay Marine Science Center in Lewes. There will be 4 3-week sessions and courses will be primarily for undergraduates.

The consortium was established last winter, comprising these schools: Bloomsburg State, Community College of Philadelphia, Edinboro State, Indiana University of Pennsylvania, Kutztown State, Millersville State, Shippensburg State, Slippery Rock State, West Chester State.

Ben L. Oostdam of Millersville State is president of the consortium and director of the Delaware Bay Center. The Center is a former Coast Guard Station and includes living facilities for 35 persons, wet and dry labs, workshops, classrooms, and a library. Field experience at sea will be an integral part of all courses.

short courses

The University of Michigan will offer these short courses this summer in Ann Arbor:

Fundamentals of infrared technology, June 2-6; advanced infrared technology, June 9-13; infrared radiometry—instrument calibrations & precision measurements, June 16-20; underground storage of natural gas, June 16-27; fundamentals of remote sensing, July 14-25; principles of imaging radars, July 21/Aug. 1.

For application and information about individual courses write to Engineering Summer Conferences, Chrysler Center, University of Michigan, Ann Arbor, Michigan, 48105.

Virginia Polytechnic

The Department of Geological Sciences at Virginia Polytechnic Institute now offers the geophysics degree at the BS, MS, and PhD levels.

The department is moving into a new building that will house several research programs in geophysics, including terrestrial heat flow, seismicity of the central Appalachian region, earthquake focal mechanisms, earth tides, and ultrasonic model seismology.

About people

ALLEN F. AGNEW, director of the Water Resources Research Center at Indiana University, to director of the State of Washington Water Research Council . . . J. R. BEERBOWER of McMaster University, to chairman, Department of Geology, State University of New York at Binghamton . . .

ALAN H. COOGAN of the geology department at Kent (Ohio) State University to be assistant dean, Graduate School & Research at Kent State . . . J. C. DAVIS of the Kansas Geological Survey, visiting professor of geology this spring at Wichita State University . . . On leave: GEORGE DEVRIES KLEIN of the University of Pennsylvania to be visiting fellow of Wolfson College, Oxford University, during the fall and winter quarters, and in spring of 1970 to be visiting associate professor of geology at the University of California, Berkeley.

HOLLIS M. DOLE, state geologist for Oregon, now assistant secretary for mineral resources in the Department of the Interior; his deputy is GENE P. MORRELL, geologist from Ardmore, Okla. . . . To FREDERICK C. FUGLISTER of Woods Hole Oceanographic Institution: the Alexander Agassiz Medal of the National Academy of Sciences for his 'stimulating and successful observations of the Gulf Stream and its vortices' . . . WILLIAM W. KEPHART,

from Texaco Inc., New Orleans, to the research department of Brockway Glass Co. Inc., Brockway, Pa. . . .

On sabbatical: ALAN MCGUGAN of the geology department, University of Calgary; to visit Europe, Australia, New Zealand, and Japan . . . Retiring: PAUL H. PRICE, state geologist and director of the West Virginia Geological & Economic Survey, after 35 years of service.

WILLIAM ROMEY of the University of Syracuse to be director of AGI's Earth Science Curriculum Project when JOSEPH WEITZ returns to teaching in the fall . . . To ROBERT V. RUHE of the agronomy department at Iowa State University: the 1968 award for the most outstanding book published by the Iowa State University Press and written by an Iowa author; the book is *Quaternary landscapes in Iowa* . . . DONALD D. RUNNELLS from the geology department, University of California, Santa Barbara, to the Department of Geological Sciences, University of Colorado . . . NICHOLAS SHORT, now at Goddard Space Flight Center, NASA, will be professor of geology at Kent (Ohio) State University . . . H. W. STRALEY III, from Geotek, Atlanta, to the geoscience faculty, Morehead (Ky.) State University . . . To F. G. WALTON SMITH, director of the Institute of Marine Sciences, University of Miami, the 1969 Gold Medal Award & citation of the Florida Academy of Sciences . . .

LAWRENCE A. WALTERS, from the U. S. Bureau of Mines in Denver, to Northlode Exploration Ltd in Beverly Hills, Calif.

MOVING?

Please send us your addresses—both old and new—at least a month in advance. You'll save time and trouble, and it'll help us get Geotimes to you.

Geotimes
circulation dept.
2201 M St. NW
Washington, D.C.
20037

Alaska earthquake

The Great Alaska Earthquake of 1964 by Panel on Hydrology, Committee on the Alaska Earthquake, publication 1603, National Academy of Sciences (1968). 441 p. $19.75

Earthquakes being 'not welcome' the customary reviewer's 'welcome' to the appearance of this volume on the hydrology of the Alaska earthquake of March 1964 seems inappropriate. Yet this, the first of an 8-volume series covering geology, seismology and geodesy, hydrology, biology, oceanography, and coastal engineering, engineering, human ecology, and a volume of summary and recommendations is indeed a report to be welcomed, not for the event it records, but for the evidence it provides that now and again we are capable of making a true learning experience from an otherwise devastating human experience. The comprehensive observations in these volumes hold lessons not only for the scientific profession but for John Q. Public, homeowner, builder, planner, and politician.

Catastrophist and gradualist among the earth scientists will each find something to their liking in this volume on hydrology. The simple facts about the earthquake, its magnitude and effects are in themselves extraordinary—8.5 on the Richter scale (8.9—the greatest known), duration 3 to 4 minutes, damage zone 50,000 square miles, shock experienced over 500,000 square miles, maximum uplift on land 38 ft, area of crustal deformation 100,000 square miles. A graceful sentence in the introduction by Konrad Krauskopf, chairman of the Alaska Earthquake Committee, sets the stage, 'Seismic surface waves, with periods of many seconds, gently displaced the ground surface of most of the North American continent by as much as 2 inches.' Ground-water levels from South Africa to Australia throughout the world responded to the seismic waves, while locally stream flow, lake levels, sediment ejections, debris slides and avalanches, and glacier budgets were affected by the earthquake. The earthquake, however, did not directly accelerate the motion of glaciers as postulated in one hypothesis nor did the Earth movements significantly af-

fect ice-dammed lakes or the loci of snow avalanches. Hugh rock avalanches and landslides were triggered by the earthquake and many moved out over glacier surfaces where in a few instances the cover of debris will have a pronounced effect on the mass budget of the glacier over a period of years. (Almost a billion cubic feet from Shattered Peak covered the ablation zone of Sherman Glacier.)

In addition to the factual reports I was particularly struck by two general features of this report. First, while it is indeed packed with fascinating observations, measurements and photographs, these observations are related throughout not only to previous experience in Alaska but to the empirical and theoretical framework of knowledge bearing on each topic. The sections on well-level fluctuations contain a theoretical treatment of the response of well-aquifer systems to seismic waves; field observations of waves in lakes are tied to principles of seismic seiches, avalanche movement to the fascinating hypothesis of air-cushioned sliding, and the glaciological effects of debris cover to processes controlling the mass budget and to principles of glacier flow. Eyewitness accounts, bare facts, mere facts, and superb photographs not only present a vivid picture, but together with relevant theory permit a better evaluation of the causes and mechanics of the phenomena observed and of the place of this major event in the context of continuing processes in the area. Thus the earthquake triggered many snow avalanches not in new locations, but along paths whose loci would have required many years of observations to discern separately. Similarly, landslides were shown to be related to structure, thickness of surficial mantle and other parameters, and ground fracturing to sedimentary materials and water conditions. Many features produced by the earthquake were found to have historic counterparts throughout the landscape.

A second striking quality which this study reveals comprises two parts; one, the alacrity with which observers took to the field, and two, the comprehensiveness of this subsequent report and the others which it presages. The Panel on Hydrology responsible for this volume points to the need for the establishment of an adequately financed emergency-alert organization including a current roster of earth scientists available for call to provide rapid planned observation of rare natural events. Rueful notes in the text allude to the fact that funds for follow-up studies began to dry up a few short years after this event. In addition the report notes that in some instances, such as river-channel studies, pre-earthquake baseline observations were lacking with which to compare post-quake conditions. This documentation, however, not only provides insight into the behavior of natural processes but a basis for the development of such practical tools as hazard-zoning maps, building standards, and warning procedures.

Careful systematic scientifically documented post-mortems have not characterized our approach to 'catastrophic' natural events, whether these be floods in Maryland, droughts in New York City, oil slicks in California, or tornadoes in Oklahoma. Of course there are exceptions such as Lawson on the 1906 San Francisco earthquake, or the report on the Hebgen Dam quake. But these simply test the rule. With the emergence of the possibility of continuous observation by high-altitude sensors, the development of new sensors for aerial use, high-speed transport to disaster scenes, helicopters as reconnaissance vehicles, and new base observational programs, the opportunity is at hand to organize a truly systematic program of observation and reporting of natural phenomena, rare events as well as human behavior associated with these phenomena. The Committee on the Alaska Earthquake, those who organized it, and those participating are to be congratulated for providing a model. Is there a way of assuring that such models will not have recurrence intervals of 100 years comparable to the events they chonicle? The daily papers suggest that lightning not only strikes twice in the same place, but strikes somewhere almost every day. Small beginnings have been made in flood studies and in the Smithsonian's program for the reporting of unusual events. More and better documentation is needed. In addition, geophysical facts must be translated into terms appropriate for public decisions in land-use planning.

M. Gordon Wolman
Johns Hopkins University
Baltimore

layered igneous rocks

Layered igneous rocks by L. R. Wager & G. M. Brown. W. H. Freeman (1967). 588 p. $26

This is a book that most petrologists will covet until they can raise the money to purchase it or persuade someone to send it to them as a birthday or Christmas present. The book is lavishly illustrated with line drawings, photographs, maps and charts that fold out, and even has 3 colored plates. For many years, a review of

WE'RE A DOWN-TO-EARTH COMPANY

We've been on good terms with Mother Earth for more than 70 years now. As a result, we know something about her. Such familiarization enables us to deal expertly with any mining, drilling or tunneling task. Our experienced personnel are exceptionally well qualified to handle core drilling, rotary drilling, shaft sinking and tunnel driving. We also specialize in soil sampling, exploration in depth, quarrying and grouting.

We leave no stone unturned to satisfy our customers' needs. Consult Boyles Bros. on your next drilling, mining, tunneling or related project. Boyles Bros. Drilling Company, 1624 Pioneer Road, Salt Lake City, Utah 84104.

No job too tough for the experienced men from Boyles.

Boyles Bros. DRILLING COMPANY

District Offices:

P.O. Box 9578
Phoenix, Arizona 85020

15865 West 5th Ave.
Golden, Colorado 80401

P.O. Box 946
Sparks, Nevada 89431

P.O. Box 4307
Spokane, Washington 99202
Alaska contact Spokane office

P.O. Box 818
Norman, Oklahoma 73069

P.O. Box 831
Auburn, California 95603

P.O. Box 7495
Louisville, Kentucky 40207

Casilla 28-D
Santiago, Chile S.A.

Reforma 403–1106
Mexico City 5-D.F.

Boyles Bros., Diamantina
Casilla 5166
Lima, Peru S.A.

the Skaergaard intrusion has been an essential part of any petrology course, but it has become increasingly difficult to keep track of the successive studies completed on the extraordinary sequence of rocks brought back from Greenland by Professors Wager and Deer, and their followers of later expeditions. The difficulty is now eased, because nearly half this book is concerned with the Skaergaard intrusion. The data and ideas presented in the original 1939 Memoir are here revised, with the late Professor Wager being chiefly responsible for most of this section, although Professor Brown's contributions are substantial. It is sad that Wager did not live to see his life's work represented by this fine volume, but his friends, colleagues, and former students will be pleased that this volume will perpetuate his work.

Because it has been investigated in such detail, the Skaergaard intrusion provides a basis for comparison with all other layered intrusions derived from gabbroic magma. About one quarter of the volume is devoted to detailed descriptions of 3 other important layered intrusions: the small Rhum intrusion, and the large Stillwater and Bushveld intrusions. Except for the Rhum intrusion, which was studied in detail by Professor Brown, these accounts are essentially reviews and syntheses of the published work of various petrologists, written for the most part by Brown, although both authors had experience with the intrusions. Everett D. Jackson has emphasized that many of the similarities in texture, rock type, and stratigraphy among layered intrusions in general, and between the Stillwater and Bushveld intrusions in particular, are obscured by differences in terminology used by the various authors who have described them. Therefore, it is especially useful to have these intrusions described, compared and contrasted by two pioneers who have long emphasized the significance of layering in igneous rocks.

The remaining quarter of the book describes other types of basic layered intrusions, layering in granites and syenites, and differentiated sills, and there is also an additional list of layered or fractionated intrusions from 29 locations throughout the world, each with a brief description and appropriate literature citations. Thus, the volume does provide a comprehensive account of layered igneous rocks.

The book is destined to become a classic; indeed, one might almost consider it as a classic from its day of publication, because it deals with a topic — layered-intrusion petrology and the influence of gravity settling on petrogenesis — that dominated igneous petrology for 20 to 30 years, but which now tends to be overshadowed by other topics and approaches to the problems of petrogenesis. This book concerns the processes of crystallization of basic magma, whereas most research efforts today concern the origin of basic magma, the conditions of formation of the magma from crystalline mantle, and the relationships of the various types of basic magma that are now recognized. I have been telling students in class for some years that we cannot cope with igneous petrology unless we know something about the upper mantle. According to the index, 'Mantle, partial fusion of' is discussed only on pages 508 and 541 of the text, and these discussions extend only for a sentence or two; in this respect, the book is classical. This does not imply that it is any less valuable as a contribution to petrology, because processes of crystallization and differentiation operate once we have our basic magma. We cannot cope with igneous petrology unless we understand these processes, as well as those occurring in the upper mantle, and the confidence of most petrologists that these processes are reasonably well understood is due, in large part, to the detailed study of layered intrusions described in this volume. I shall use and enjoy this book for many years to come, and so will students in my petrology classes.

Peter J. Wyllie
University of Chicago

marine geology

An introduction to marine geology by M. J. Keen. Pergamon (1968). 218 p. $7

Professor Keen has produced in his *Introduction to marine geology* a volume that will be welcomed by instructors and students alike. He has taken the extensive mass of marine geological material that exists and boiled it down, condensing and compressing it until only the most fundamental information remains; this is done in less than 200 pages. It was certainly no small or easy task and required not only a precise and intimate knowledge of the subject but thorough and meticulous care to review and condense material from the 342 cited references included.

He covers the material in chapters on geophysical exploration, topography, sediments, movement of the sea floor, rocks of the basins, structure of the basin, and polar wandering and continental drift.

The text is extremely well written

and appropriately complemented with graphics and tables. Dr Keen takes particular pains to refer the reader to authoritative material for additional details and information on the subject under discussion. The book is, I believe, intended as a text and seems best suited for college-level instruction. Chemical elements (ions) are mentioned in many places; it would be well if the reader had an elementary knowledge of that subject. The book will probably appeal to the exceptional high-school science student and might be used in a scholarly science class if marine geology is a subject of specific coverage for several weeks. However, the teacher should take a college-level course in marine geology before attempting to use this book as a text unless he has had time to become acquainted with the substance of the many references. The two appendixes can prove invaluable for the beginner; the author has wisely assembled the definitions of select technical terms in the appendixes where these are readily available for referral.

For an initial yet complete exposure to marine geology, this book is excellent; it is a solid and concise treatment that provides ready access to a wealth of supplemental details through the bibliography. Above all, the text maintains scientific integrity in its presentation; the reader therefore is required to learn the jargon in order to understand the material. Too often introductory books on science water down the unique terminology of the specialty, so that the volume reads like material from a Sunday-supplement magazine or *Reader's digest*. Professor Keen has presented marine geology in scientific terms and, though an introduction, he rightly expects the interested reader to grasp, assimilate, and use proper geological terms.

Harold W. Dubach
Naval Oceanographic Office
Washington, D. C.

current ripples

Current ripples, their relation to patterns of water and sediment motion by John R. L. Allen. North-Holland Publishing Co. (1968). 433 p. $30

Although several of the 19th century giants of American geology contributed to the body of knowledge on sediment transport (for example, Grove Karl Gilbert's classic study of transport by streams), most U. S. sedimentologic work before about 1950 concentrated on composition and textural studies. I suspect that the recent return to an investigation of processes and structures has been in great part the result of the contacts after World War II with German and Dutch scientists. Although initially not represented in the international game except by Bagnold, the rising generation of British geologists has now moved strongly into the play. John Allen's new monograph on current ripples is the first major product of this 'new wave'.

In essence, the book is a review of the very effective experimental work that has been carried out in the past few years at the Sedimentologic Research Laboratory at the University of Reading under the general direction of Percy Allen.

John Allen opens his discussion with a brief review of fluid mechanics, discusses problems of the classification of bed forms, and successfully places this on a quantitative basis. Although his descriptive scheme is perhaps an overkill of the problem, he has met his objective of providing a universal description of the various forms and associations. His approach made me so enthusiastic that I began mapping ripple forms in a Baja California tidal lagoon using his dimensional terms. I predict that others will be similarly inspired.

In the closing pages of chapter 3, Allen spends several pages on the question of preservation of bed-form-generated structures. I felt that this belabored a relatively straightforward

subject for the sake of quantitative development. If the book has a fault, it lies in the direction of overexplanation. Conversely, this can also be a virtue in that the reader is left with few doubts about the method of approach to conclusions of major interest.

The rest of this section of the book is a fine summary of associations and environments of the various defined ripple forms. I was particularly gratified to see an abundance of illustrations, both photographs and diagrams, that clearly document the terms defined and discussed. As a result, field workers will have little trouble applying the descriptive terminology.

Perhaps of greatest interest to stratigraphers and sedimentary petrologists are the chapters on crossbedding formation (chapter 5) and the discussions of the limiting conditions and ultimate associations of surface forms and resulting crossbedding (chapter 6). These parts are complex reading but are worth the effort because the argument is in effect for a rationalization of thinking on the mechanisms of the preservation of this distinctive form of lamination and a good mathematical analysis of the governing factors and end members. I am bound to comment that a certain economy of style might have been more effective in the earlier parts of these chapters. The later parts move much more strongly and complex associations are handled well. Most chapters are provided with summaries that highlight the author's main points.

The largest part of the text is devoted to comparisons of the theoretical and experimental patterns of fluid flow associated with a selection of basic-bed forms. These are well done and also clearly and concisely describe the methods used to obtain the experimental data. There are again abundant illustrations and diagrams to document the discussion. Several fine summaries of supporting topics are included of which the brief review of model theory is a good example (chapter 9). A good reference list has been carefully woven into the narrative.

In the closing chapters Allen considers the behavior of grain movement and settling in the lee of ripple forms and also develops settling behavior in general. One strength of this book is that it provides a focus for a broad spectrum of field studies. It is apparent at every step where the critical information is needed and notes the parameters to be most critically examined. I expect the book to be a primary citation in a host of papers over the next decade. It is the type example of the combination of theory and experiment to provide design information for field study. Certainly the work being done on contemporary shallow marine sediments and sedimentary processes at my institution will be greatly assisted by this publication.

Although the text will be of primary interest to civil engineers and sedimentologists, I strongly recommend it to all students of the rock record. The price will probably prohibit its use as a graduate text, but it should become part of the library of all those investigating the dynamics of sediment transport and deposition. It is well indexed and includes a detailed table of contents. Citations are reduced to journal, volume and page, with titles omitted, unfortunately, although the topics of the references are easily inferred from the text at the point of citation. Typographical errors are minor. The work is definitely a major contribution of which the author can be justly proud.

Donn S. Gorsline
University of Southern California
Los Angeles

new books

regional geology

Albuquerque: its mountains, valley, water, and volcanoes by Vincent C. Kelley. New Mexico Bureau of Mines (1969). 101 p. $1. Scenic Trips to the Geologic Past no. 9.

Arctic and Alpine research, a quarterly journal of the Institute of Arctic & Alpine Research, University of Colorado, Boulder, 80302. $12 a year. V. 1, n. 1, has 78 pages and includes papers on patterned ground, moraine chronology and shoreline relations.

Atlas of the Great Barrier Reef by W. G. H. Maxwell. American Elsevier (1969). 258 p. $32.50. Evolution in terms of geology, bathymetry, hydrology and biology.

A geologic cross-section of Delaware showing stratigraphic correlations, aquifer distribution, and geologic setting within the Atlantic coastal plain—continental shelf geosyncline by John C. Kraft & Marilyn D. Maisano. University of Delaware, Water Resources Center, Newark, 19711. Free.

The geology of some ore deposits in southern Africa, edited by S. H. Haughton. Geological Society of South Africa (1964), Box 1071, Johannesburg, South Africa. V. I, 625 p.; v. 2, 739 p.; and many separately bound plates with each volume. Price, $43, including postage for the 2 volumes — not sold separately.

Ground-water resources in Cleveland and Oklahoma counties by P. R. Wood & L. C. Burton. Circular 71, Oklahoma Geological Survey (1968). 75 p., plus 1 map (scale: 1 inch = 3 miles) & 1 chart. $3.75, paper. From: Oklahoma Geologi-

cal Survey, University of Oklahoma, 830 South Oval, Room 163, Norman, 73069.

New York State Geological Association: *Guidebook to field excursions at the 40th annual meeting.* (1968). Available from P. C. Hewitt, Department of Geology, State University College, Brockport, N.Y., 14420. 253 p. Softbound, $6. The New York City area.

Proceedings of the 19th annual Highway Geology Symposium edited by Robert B. Erwin. West Virginia Geological Survey (1968). 119 p. $2.50. The 1969 meeting.

Quaternary landscapes in Iowa by Robert V. Ruhe. Iowa State University Press (1969). 255 p. $8.50

general

Annual progress report of the Smithsonian Institution's Center for Short-lived Phenomena (1969) by Robert Citron. 60 Garden St., Cambridge, Mass., 02138. Free (limited supply).

The course of evolution by J. Marvin Weller. McGraw-Hill Book Co (1969). 696 p. $15.50. 14 chapters.
Written by a paleontologist. Contents include plants; noncoelomate, lophophorate animals; schizocoelate animals; enterocoelate invertebrates; vertebrates; problematic fossils, evolution in perspective, human evolution and the future.

Direct current geoelectric sounding by P. K. Bhattacharya & H. P. Patra. American Elsevier (1969). 135 p. $10.75. Principles and interpretation.

Dusters and gushers edited by James D. Hilborn. Pitt Publishing Co. Ltd., Toronto (1968). 278 p. $11.95. The Canadian oil & gas industry, in some 25 chapters by various experts. Among them: 'Some colorful personalities in the industry.'

Fossil vertebrates by Margaret C. Thomas (1968). Paper, 72 p. Wholesale quantities available from the author at 519 Harbor Drive, Venice, Fla., 33595. Single copies $2 from Smithsonian Institution museum bookshop, Washington, D. C., 20560. Beach and bank collecting for amateurs.

International geochemical exploration symposium edited by Frank C. Canney, Harold Bloom & John A. Hansuld. V. 64, n. 1, of the *Quarterly of the Colorado School of Mines* (January 1969). 520 p. Paper, $10. Proceedings of the symposium held April 17-20, 1968, in Golden and described by Dr Hansuld in the April 1969 issue of *Geotimes*. More than 25 provocative papers by geochemists from throughout the world.

Invention of the meteorological instruments by W. E. Knowles Middleton. Johns Hopkins (1969). 362 p. $12

Junior college teachers of science, engineering, and technology, 1967: experience and employment characteristics. National Science Foundation publication 69-3.

(1969). 89 p. $1 from Government Printing Office.

National Advisory Committee on Research in the Geological Sciences, *18th annual report,* 1967-68. Geological Survey of Canada, paper 68-73. (1969). 99 p. $1.50

The physical sciences by E. J. Cable & others, Prentice-Hall (1969). 577 p. $9.95. The 5th edition of this college text, in which 'The sections on chemistry, meteorology, and geology have been largely rewritten.'

Scientific writing for graduate students edited by F. Peter Woodward. Rockefeller University Press (1968). 190 p. $5.75. A manual on the teaching of scientific writing, prepared for the Council of Biology Editors by its Committee on Graduate Training in Scientific Writing.

Seismic activity during the 1968 test pumping at the Rocky Mountain Arsenal disposal well by D. B. Hoover & J. A. Dietrich. U. S. Geological Survey (1969). Circular 613. 35 p. Free.

Weather and health by Helmut E. Landsberg. Anchor (1969). 148 p. Paper, $1.25. An introduction to biometeorology by the president of the American Geophysical Union.

rocks & minerals

Coal and coal-bearing strata edited by D. G. Murchison & T. S. Westoll. American Elsevier (1969). 418 p. $28.50. Coal in relation to the sediments with which it is associated, and the fauna and flora of those sediments.

Fourth *forum on geology of industrial minerals* edited by L. F. Brown Jr. Texas Bureau of Economic Geology (1969). 175 p. Paper, $2. The 1968 forum, on geology of chemical raw materials, and depositional models in economic stratigraphy.

Handbook of world salt resources by Stanley J. Lefond. Plenum Press (1969). 384 p. $25. Location and production of mines throughout the world, country by country.

Rock and mineral analysis by John A. Maxwell. John Wiley (1968). V. 27 in a series of monographs on analytical chemistry and its application. 584 p. $24.50. Developments in methods and techniques of rock and mineral analysis since the early 1950s. Emphasis on silicates and carbonates.

The practical study of crystals, minerals, and rocks by K. G. Cox, N. B. Price & B. Harte. McGraw-Hill (1967). 233 p. $4.63

Royal Ontario Museum, Gallery of Mineralogy: *A general guide and a guide to the teaching section* by R. I. Gait (1969). 34 p. each. $1.25 Canadian per set, from Sales Desk, Royal Ontario Museum, 100 Queen's Park, Toronto 5, Ont., Canada.

CLASSIFIED ADVERTISING

Ads (or cancellations) for the July-August issue must reach the Geotimes office by June 15.

There are no issues in June or August.

Cost per line	1x	3x	6x	10x
Positions wanted	$0.60	$0.50	$0.45	$0.40
Vacancies	2.25	2.00	1.80	1.70
Services & supplies	2.75	2.60	2.50	2.40
Consultants	2.75	2.60	2.50	2.40

Minimum charge $2 **Box numbers $2 extra**

Please do not pay in advance; all classified advertisers will be billed. State whether you want a box number.

To answer an ad that has a box number, use this address:

Box . . . .
Geotimes, 2201 M St. NW, Washington, D. C., 20037.

All mail to box numbers is forwarded the same day it arrives in the Geotimes office.

Vacancies

Invertebrate paleontologist. Expanding university department, in Rocky Mountain region, needs assistant professor for undergraduate and graduate paleontology, field methods, and introductory geology. PhD and research plan required. State availability date. Box 358, Geotimes.

Meteorologist/geologist or **meteorologist/geographer.** One full-time position as associate professor or professor, starting September 1969 or January 1970. PhD desired and teaching experience required. Salary competitive. Teach meteorology courses, meteorology part of introductory earth/space science course and, if desired, an elective in geography or geology. Current staff of 6 geologists and 11 geographers. Several undergraduate degree programs plus MEd in earth sciences. Twelve-hour teaching load. Summer teaching at extra salary. New, well-equipped building. Dr Michael C. Schneider, Acting Head, Geography and Earth Sciences Department, Edinboro State College, Edinboro, Pa., 16412. Phone: 814-732-3301, ext. 308. (397)

Photogeologist or **geophysicist** with remote-sensing experience for full-time work or possibly on a consulting basis with a new growing company in the Rocky Mountain area. All replies confidential. Forward résumé to box 398, Geotimes.

Teaching position. Teach in beautiful Florida at the nation's finest jr college. Required: MS in geology with course work and/or experience in meteorology or oceanography. Box 409, Geotimes. (409)

Experienced mining **exploration geophysicists** wanted by large mining company. One position requires Canadian Shield experience for foreign assignment. Other positions are for continental U. S. Must be willing to travel; salary open. Box 416, Geotimes. [416]

Electronics technicians, preferably with experience in geophysics, must be willing to travel, mainly western U. S. Salary open. Box 417, Geotimes. [417]

The Geology Department, University of New Brunswick, Fredericton, N.B., Canada, invites applications for the following positions, effective either July 1, 1969, or September 1, 1969.

Geophysicist, preferably with experience in some type of mineral exploration.

Petrologists or **mineralogists,** to participate in an expanding program.

Laboratory instructors, to supervise laboratory instruction in elementary geology, or mineralogy and petrology. BSc minimum.

Chemical analyst, to supervise, organize and initiate techniques in laboratory for rock analysis. Atomic-absorption experience helpful.

In addition, the following one-year appointments will be made to replace staff on leave of absence.

Mineralogist, to provide instruction in two undergraduate courses.

General geologist, to teach an introductory course.

Apply to: Chairman, Department of Geology,

The University of New Brunswick, Fredericton, New Brunswick, Canada. (422)

Teaching position: Assistant professor, PhD or MSc, with training in computer applications, to teach **introductory geology** and **computer application in geology** plus applied research in computer applications; salary based on qualifications and experience. Send résumé to William S. Shaw, Head, Dept. of Geology, St. Francis Xavier University, Antigonish, Nova Scotia. (423)

Teaching position: September 1969. PhD or PhD candidate to teach **physical/historical geology** in eastern liberal-arts college now attempting to establish education/earth science/liberal arts geology programs. Ability to establish undergraduate mineralogy, igneous and metamorphic petrology, optical crystallography courses desired. Excellent facilities for teaching and research. Salary and rank commensurate with training and experience. Send complete résumé and three references to:

Dr Walter J. Spink, Chairman
Department of Earth Sciences
Rider College
Lawrenceville Road
Trenton, New Jersey, 08602 (424)

PhD petrologist (igneous and metamorphic) to teach basic earth science, physical geology, and petrology courses. Growing department with three geologists at present. State supported liberal-arts college on far northwest side of Chicago. Offer B.A. and M.A. in earth science teaching. Send résumé to Dr Albert W. Forslev, Professor of Earth Science, Northeastern Illinois State College, Chicago, Illinois, 60625. (425)

State University College, Geneseo, N.Y., 14454, Department of Earth Science invites applications for positions at ranks and salaries (competitive with AAUP 'A' scale) commensurate with experience. Personal interview necessary.

Geochemist. To teach introductory earth science courses and advanced courses in theoretical geochemistry (e.g. environmental geochemistry, cosmochemistry, phase equilibria; **not** igneous petrology). New building has full geochemical facilities. PhD or nearly completed degree required.

Specialist in earth science teaching. To teach introductory earth-science courses and advanced courses in field of geologic specialization and to supervise student teachers. Teaching experience in secondary-school earth science and advanced degree (PhD preferred) in earth science (**not** science education) are required. (426)

Economic geologist. The State Geological Survey of Kansas has a permanent staff position open for an economic geologist. Candidate should be statistical and computer oriented as well as having strong fundamental economic training or experience. Some teaching may be possible. Qualifications: PhD and some publication. Candidate should be able to deal with industry and public officials. Salary depends upon training and experience. Position available July 1, 1969. Send résumé to R. G. Hardy, Chief, Mineral Resources Section, State Geological Survey of Kansas, The University of Kansas, Lawrence, Kansas, 66044. (427)

PhD (or near completion) **for fall** 1969 to teach mineralogy, optical mineralogy, petrology, mineral deposits and physical science at Western State College, Gunnison, Colorado. Send complete credentials to Dr T. Prather, Department of Geology, Western State College, Gunnison, Colorado, 81230. (428)

Positions wanted

Micropaleontologist (ecology/stratigraphy), German, 31, married. MS 1966, PhD 1967, major U.S. universities. Experience: Recent, Tertiary, Cretaceous foraminifera; computer analysis; electron microscopy; teaching; publications. Fluent English, German, French. Presently employed in research position, desires teaching and research position in U.S. or Canadian university. Available for fall 1969. Box 2859, Geotimes.

Petrologist-geochemist, experienced in studies of Southeastern Piedmont igneous and metamorphic rocks, wants teaching-research position in or close to western portion of Southern Appalachians, beginning Sept. '69. Box 2866, Geotimes.

Geologist-petrologist-petrographer, PhD spring 1969, 29, family. Seeks teaching and research position in growing geology department. MS environment or sed. deposition. PhD ign. petrology. Field experience in High Sierra, Mexican desert, Columbian rainforest. Currently Field Support Manager for Atlantic-Pacific Interoceanic Canal Studies. Fluent German, functional Spanish. Avail. June-July 1969. Résumé on request. Box 1151, Howard AFB, Canal Zone.

Geologist, 48, BS, CPG, widely diversified 17-year background in the Four Corners and West Texas. Explorationist, prospect evaluator and production specialist. Will relocate. Box 2881, Geotimes.

Micropaleontologist/paleoecologist, BS, MS, PhD (1969), 32, married. Specialization in foraminifera with emphasis on planktonics. 9.5 years experience of which 4 years spent in exploration research in Middle East with major oil company. Research on Gulf Coast and NE continental shelf of U. S. with statistical methods and computer applications. Currently postdoctoral investigator. Desires to return to work in research or production division of an oil company or to teach in an institution with research opportunities, either domestic or foreign. Vitae on request. Available July 1969. Box 2897, Geotimes.

Geophysicist, 37, family. BS, MS in geology. 8 years seismic interpretation and digital processing experience, including computer programming. 3 years teaching. Seeks Rocky Mtn location, industry or teaching. Box 2907, Geotimes.

Geologist-teacher, 49, family, M.A. and all of PhD requirements except seemingly endless dissertation, ten years in exploration geology on several continents and eight years college teaching including undergraduate geology, astronomy, conservation, and physical science, desires to escape from suburban East to Pacific Northwest or Rocky Mountain region; small department or liberal-arts college preferred with opportunity for research but with major emphasis on effective teaching. Résumé on request; available September 1969. Box 2923, Geotimes.

Geologist, PhD, age 39, desires temporary position for summer of 1969. Currently teaching in a university. Box 2929, Geotimes.

Geologist, 25, MS, married—one child. References. Publications. 2 years petroleum geologist. 1 year teaching. Experience in mineral analysis. Ardent desire to teach. Can organize research. Seeks position in active dept of 4 year college. Will consider work in large university if concurrent work toward PhD permitted. Box 2932, Geotimes.

Geology major in sophomore year at Toledo University seeks summer employment in either laborer or assistant capacity. Box 2939, Geotimes.

Geological engineer, MSE, 31, married. Interest in subsurface and surface hydrology, applied geophysics, environmental surveys. Experience in research management/coordination, field operations, interpretation and reporting of data. Familiar with Plowshare events, meteorology, subsurface and atmospheric tracers. Can carry out detailed office/laboratory operations, scheduling, budgeting, supervision, and field work. Have performed regional gravity surveys and geologic mapping. Publications. Extremely interested in concurrent pursuit of graduate courses. Résumé. Box 2943, Geotimes.

Paleoecologist, MS, 29, experience in establishing an applied research program in contemporary ecology and paleoecology. Experience also in theoretical and experimental limestone petrology. Desires research basic or applied in industry, government, or university. Salary open. Résumé upon request. Box 2948, Geotimes.

Marine geologist/oceanographer seeks position in teaching, industry, or consulting. Expects PhD in 1969, upon completion of thesis concerning sedimentary processes on the continental shelf. Background includes instruction in geophysics, engineering geology, mineralogy, and geomorphology as well as marine science. Qualified diver. Age 26, married. Résumé on request. Box 2951, Geotimes.

Geologist-physicist, PhD, desires teaching-research position. Research in sedimentology, radiation damage, extraterrestrial geology. Publications. Editor of new journal. Can teach most courses of geological curriculum. Box 2952, Geotimes.

Oceanographic group, PhDs expected from major department by Sept. 1969; cumulative experiences in sedimentology, sedimentary geochemistry, descriptive physical, chemical, and biological oceanography, clay mineralogy, Pleistocene and coastal geology, geopolitics, broad spectrum of research, publications, extensive shipboard, submersibles, and scuba experience, seeking academic positions individually or as group. Instant marine program —just add sea water. Box 2953, Geotimes.

Geochemist-petrologist, 44, new PhD geology, desires teaching/research position in academic surroundings. Teaching experience includes freshman chemistry, qualitative analysis, economic geology, structural geology and general introductory geology. BS in chemical engineering and MS in metallurgy help in application of chemical techniques to problems of rock alteration, carbonate weathering or theoretical geochemical sampling. Available June or Sept. 1969. Box 2956, Geotimes.

Geologist-geochemist, 37, family, PhD. Interests include metallic ore deposits and geochemical prospecting. Four years experience in field operations, in set-up and operation of geochemical laboratory, and in interpretation of results. Desires teaching position or position with small company actively engaged in minerals exploration in western U.S. Box 2958, Geotimes.

Petrologist-geochemist, PhD, over 10 years of broad research and administrative experience including phase-equilibrium studies, crystal chemical research, mineralogy and economic geology. International reputation, publications, patents, honors. Desires responsible academic or industrial position. Box 2960, Geotimes.

Geophysicist/ground water—35, married, PhD expected before June 1969. Five years experience in gravity and the application of the geophysical methods for ground-water prospecting. Extensive experience in the application of computer techniques in the solution of geological and geophysical problems. Two years teaching experience. Desires teaching-research position with a university. Will consider a challenging position with a research firm or industry. Available after June 1969. A. W. Ibrahim, Geology Department, Michigan State University, East Lansing, Michigan, 48823.

Palynologist-geologist. 15 years research and applied stratigraphic, ecologic use in exploration. Paleozoic, Mesozoic, Cenozoic, and Recent. Will consider teaching. Box 2962, Geotimes.

Research geophysicist, 39, formal education in mathematics and potential theory. Degree in earth sciences. Familiar with ocean acoustics and theory of vibration. Original contributions to the theory of wave propagation and information theory. Publications and patents. Experiments in propagation of sound. Four major languages. Available Sept. 1969. Canada acceptable. Box 2964, Geotimes.

Geophysicist, Indian, 33, MSc, Math. Polyglot, outstanding academic career. 4 yrs experience in gravity and magnetics followed by 8 yrs experience in seismic fieldwork and interpretation of data as party chief. Immigrating shortly, desires suitable position immediately. Box 2966, Geotimes.

Summer teaching, Canada, U. S., PhD. Taught 20 years, most undergraduate geology. Box 2969, Geotimes.

Geologist-biostratigrapher, PhD, seeks permanent teaching position; broad background in earth-science teaching; also micropaleo, paleoecology, sediments, geophysical interpretation. Available Sept. 1969. Résumé on request. Box 2970, Geotimes.

Geological engineer, BS, 24, family, petroleum geology, geophysics, and geological engineering experience. Desires to relocate in western U.S.; preferably in Pacific northwest with a firm performing site investigation and hydrology projects. Box 2973, Geotimes.

Exploration geologist, MS plus additional hours, single, 15 years petroleum geology in South America, Caribbean and Southeast Asia. All aspects of petroleum geology, basin evaluation; also many assignments in minerals. Managerial responsibility. Publications. Available for overseas location or based in U.S. Box 2974, Geotimes.

Geologist from India, 26, married, PhD, experience in igneous petrology and economic geology of nonmetallic deposits for 5 years. Publications. Seeks employment in a university or commercial organization. Résumé on request. Willing to work anywhere outside India, preferably U.S.A. or Canada. Box 2975, Geotimes.

Geologist-petrologist, 27, Swiss, bachelor. MSc, University of Lausanne 1968. Good geological background. Surface mapping in the Alps, gravel research. Fluent French and English, knowledge of German. Seeks position abroad as exploration or mining geologist. Box 2976, Geotimes.

Teaching position, 28, family, M.A.T. in geology; doctorate in science education, spring 1969; graduate degrees from major Mid-Western university; 5 years teaching at high school and university levels. Desires position teaching undergraduate geology. Résumé and recommendations on request. Box 2977, Geotimes.

14C & 3H PhD **physicist,** 31, German, head of a C-14 lab. 700 samples/yr and 3H lab. 6 years experience in development of low-level equipments, familiar with management, administration and programming, in application of C-14 dating in geology, hydrology, archeology. Publications. Seeks academic or industrial position. Box 2978, Geotimes.

Geophysicist/physicist, MSc, 26, seeks employment in exploration program or research position with teaching. 2 years teaching experience, 2 years exploration experience, 3 years of lab assistance. Box 2979, Geotimes.

Geologist, 25, BS earth science, M.A.T. geology, married, no family. Desires college or industry position, domestic or foreign. Will consider temporary position because of desire to start PhD in 1970. Strong background in paleontology and geomorphology. 2 years of diversified geology teaching in an eastern college; field experience. Résumé on request. Box 2980, Geotimes.

Explorationist, 32, Peruvian, married, 2 children, BS and MS from Louisiana State University. Broad geological background, part-time field assistant at Louisiana Geological Survey, 6 years field experience in Amazon jungle and Peruvian coast, 2 years subsurface in N.W. Peru, all with major oil company. Seeks challenging position in U.S. or overseas. Roberto A. Leigh, Prolongacion Arenales 338, San Isidro, Lima, Peru.

Economic geologist, 31, MS, Missouri, 1962; PhD, Heidelberg, 1968, married. 4 years teaching in introductory geol., econ. geol. and ore microscopy; two years exploration in B.C. and Yukon. Broad acquaintance with major N. American and W. European ore deposits. Publications in major journals. Strong and wide knowledge in basic earth science, carbonate sedimentology, diagenesis and geochemistry. Fluent in English and German (some French). Presently research fellow in Germany. Desires teaching or research position in N. America. Will also consider industry; interested in stratiform ore deposits. Résumé upon request. Available immediately. Box 2981, Geotimes.

Geologist with a desire to return to the profession. MS from New York University, 1940. Experience in petroleum geology and seismic interpretation with experience in petrography. Interested in a permanent position in applied geological or research activity. Box 2982, Geotimes.

Geological oceanographer, 26, nearing completion of PhD work, desires a teaching and/or research position with an aggressive organization. Extensive work in sedimentology, marine geophysics, sediment-current interrelationships, and coastal engineering. Some teaching experience. Résumé on request. Box 2983, Geotimes.

Geophysicist/hydrologist, 41, PhD geophysics, MS ground-water hydrology. 5 years experience seismology, 5 years hydrology and geophysical prospecting, 2 years borehole geophysics. Publications. Desires teaching or industrial work. Box 2984, Geotimes.

Geologist/petrologist, PhD, Heidelberg 1969, German, 28, married, no children. German, Russian, English knowledge. Seeks position. Broad background in economic geology, mineralogy-petrography, stratigraphy, paleontology, geomorphology. Research in igneous and metamorphic petrology. Experience in hydrogeology and geol. mapping. Available Jan. 1970. Box 2985, Geotimes.

Micropaleontologist / biostratigrapher, (Mrs), PhD Heidelberg 1969, German, 28, married, no children. German, French, English knowledge. Seeks position. Broad background in paleontology and stratigraphy. Research in Eoc./Oligocene of the Rhinegraben (Foraminifera, Ostrac.) Experience in geol. mapping. Available Jan. 1970. Box 2986, Geotimes.

Petrologist/teacher, PhD, 38, family, publications, current research. Fifteen years exploration geology-mining and petroleum; 5 years college and university teaching including physical and historical geology, mineralogy, crystallography, optical mineralogy, petrol-

ogy, petrography and field methods. Desires to relocate. Available September 1969. Box 2987, Geotimes.

Geological/civil engineer. Officer in Corps of Engineers desires position in consulting firm or teaching position in photo interpretation-engineering geology. BS civil engineering, MS engineering geology, PhD candidate geological engineering. Five years teaching, research and practical experience in photo interpretation, highway geology, soil mechanics. Married, family, age 28. Available December 1969. Résumé upon request. Box 2988, Geotimes.

Paleontologist, 8 years teaching experience in paleontology, stratigraphy, biostratigraphy and introductory geology; publications in sedimentary models, Paleozoic reefs, stratigraphy and taxonomy, also desires to teach introductory physical and biological sciences within philosophical and historical framework. PhD, September 1969. Box 2989, Geotimes.

Teacher/mineralogist/crystallographer seeks opportunity to bridge generation gap with the thrust of a scintillating personality, the fold of his embracing knowledge and cause a metamorphism in your sedimentary department with the heat and pressure of his teaching. Standard academic detritus on request. Box 2990, Geotimes.

Geological engineer, BS, 32, single. Desires employment in Australia. Interest in hard-rock and soft-rock geology, exploration civil engineering, mapping and photography, geophysics, geochemistry, lab work and research. Experience with civil engineering and petroleum engineering companies in research, lab, and field work. Experience as a geologist. Presently teaching. Associate member of AEG. Résumé on request. Box 2991, Geotimes.

Ground-water geologist, M.A., 29, married. 2 years ground-water experience in Panama (continuation of AID-sponsored development program). Prefers ground-water position with state or federal agency (western U.S.), or junior college teaching position; background sedimentology and economic geology; 2 years teaching assistant at Mid-Western university. Available July 1969. Request résumé (airmail): John C. Miller, Apartado Postal 9672, Panama 4, Panama.

Hydrologist/programmer, 27, married. MS hydrology, BS geology, 2½ years graduate research experience in hydrology, thesis published. Presently employed by major utility company on West Coast; responsibilities include runoff forecasting, reservoir and hydroplant regulation, computer programming. C. F. Armstrong, 620 Nevada St., Sausalito, Calif., 94965.

Ambitious geologist, 29, MS plus 5 years industrial and teaching experience in sedimentary geology, publications, seeks responsible, challenging, and varied work. Box 2992, Geotimes.

Geological technician. B.A. and 1 yr of graduate work in geology, plus laboratory and teaching experience in geology. Desires a position as geological technician or instructor in a university geology department with option to continue graduate work toward MS or PhD on a part-time basis. Résumé on request. Box 2993, Geotimes.

Geologist, MS, 17 years in the practical application and 6 years teaching of geology. Desires position teaching or applying stratigraphy, structure, and geologic history—surface and/or subsurface—to oil or nonmetallic minerals. Box 2994, Geotimes.

Geologist, family 26, M.A. in geology. 2 years experience in exploration geophysics with major oil company. Seeks position in geology involving some field work. Particularly interested in geomorphology and hydrology. Résumé upon request. Box 2995, Geotimes.

Hydrologist, ground- and surface-water. 17 years experience in western U.S., Mediterranean and South Asia. Desires position in western U.S,, but will accept challenging work anywhere in the U.S. Will be available in June or thereafter. Box 2996, Geotimes.

Geophysicist, 35, PhD expected July 1969, teaching experience. Desires a teaching position; physical and structural geology, intermediate and advanced level geophysics and ground water. Research interests include exploration geophysics, emphasis gravity. Available August 1969. Box 2997, Geotimes.

Marine sedimentology-geochemistry, MS August '69. Am a free-lance photographer with own equipment; have scuba training; have taught instructor-level first aid; rescue-trained; some electronic trouble-shooting experience. Prefer a position requiring much shipboard duty and maximum utilization of my skills. Will relocate practically anywhere. Richard Fuhrman, 91 College Ave., Troy, N.Y., 12180. Phone: (518) 273-9374.

Geologist, 29, B.A. June 1969, with background in electrical engineering and mathematics. Desires position (governmental or private) with active organization involved in geophysics, mineralogy or structural geology; prefer Rocky Mountains, southwest or northwest location. Résumé on request. Box 2998, Geotimes.

Geophysicist/petroleum engineer, BS (Geo.), MS (Geop.), PhD (Pet. Eng.). Specialized in well logging, both in research and operations, domestic and foreign. Some publications and a few patents pending. Presently employed, interested in responsible post in U.S.A. or abroad. Box 2999, Geotimes.

Manager/hydrogeologist, 39, near PhD, no family, desires **foreign** position, preferably Latin America. Fluent Spanish. Former U.N. geologist/geophysicist; 5 years water resources development, well design, aquifer testing, regional surveys; 5 years mineral exploration; 4 years systems analysis, ops research-mgmt experience (5 years overseas). Have passport. Available immediately. Publications. Résumé. Box 3002, Geotimes.

Consultants

J. Sheridan Wright, hydrologist. Ground-water control—mines, tunnels, shafts, underground installation. Cryogenics and chemical injection systems designed, formulated and applied. Call HA 1-3570, Area 816, or write P. O. Box 1029, Mission, Kansas, 66222.

Services & supplies

Fossils for study, research, display. Bulk microfossils, laboratory specimens. Geological Enterprises. Box 996, Ardmore, Oklahoma.

Inorganic Analytical Capabilities Available

- X-ray Fluorescence
- Atomic Absorption
- Wet Chemical

Corporate Development Dept.
Ottawa Silica Company
Box 577
Ottawa, Illinois, 61350

Diamond powders & pastes. Tight budgets? Save with DuPont explosion diamond. Price list, Sinkankas Diamond Products, P.O. Box 9103, San Diego, Calif., 92109.

Library, Gulf Coast micropaleontology & petroleum geology. List of titles on request; many out of print. 1000 Lund St., Austin, Texas, 78704.

Petrographic suites, rocks, and minerals for earth science and geology courses. Catalog sent on request. Mackinaw Geological Supply, Box 375, Ishpeming, Michigan, 49849.

For sale: **geological library,** strong in stratigraphy and micropaleontology. Includes memoirs, monographs, professional papers, reprints; many scarce and out-of-print publications. Preference to univ. libraries or those interested in purchasing entire lot. Requests for specific publications treated on basis of earliest postmark. Send inquiries to John R. Fleming, 844 Garfield Ave., South Pasadena, Calif., 91030.

Magnetic mineral separators, small hand-operated. Write K. R. Jewett, 7458 Kilgarry Ave., Pico Rivera, Calif., 90660.

Mineral locations books, North America. List (send stamp). Camping. Guiding. Outstanding rock shop. **Quarryside,** Rt 3 Weirs-G, Laconia, N.H., 03246.

Does anyone have any new ideas on the possibilities of **prediction of gravity** in unsurveyed areas through geological interpretations and/or geophysical correlations? If so, please contact:

Dr William Van Royen, Director
Division of Environmental Sciences
U.S. Army Research Office — Durham
Box CM, Duke Station
Durham, North Carolina, 27706

Grand Canyon stratigraphic rock set, 3x4 hand specimens, stratigraphic chart, $10 plus postage. Fossils included at additional cost. Write for estimate: Sigma Gamma Epsilon, Box 7723, NAU, Flagstaff, Arizona, 86001.

Geotimes advertisers

the geologic column

by Robert L. Bates

Nowadays about half one's time seems to be spent in reading Xerox copies of someone else's correspondence, especially if one is on an executive committee and must therefore be kept informed on matters at all levels. The other day, in plugging through a long letter from one compere to another, I was brought to sudden attention by this clause, which led off a paragraph: 'Since you are a natural gas producer . . .' Gad, I thought, the man must have a frightful case of flatulence; I'll bet his rumblings abdominal are simply phenomenal. Would Tums help? In context, however, the expression turned out to mean 'a producer of natural gas.'

There's nothing wrong with producer; there's nothing wrong with gas producer. But when you put an unattached adjective in front, you don't know what it applies to. Hyphenating the natural to the gas clears things up instantly. It doesn't help to say, 'Well, you figured it out from the context, didn't you?' Writing is supposed to aid the reader, not trip him up. Every time he has to stop, even momentarily, and fumble around for the meaning, he's been had. Especially if he's got a lot of reading to do, and who doesn't?

An 'explosive company representative'—what's he, a short-tempered insurance salesman? And here's a state survey that has just issued a 'crude oil inventory' —presumably a crude inventory of oil. A 'fraudulent sales law' is apparently a deceitful law that deals with retailing; a 'moving van fire' is a truck that affects your emotions as it burns up. And so it goes. The annoying thing about such expressions is that all it takes to give them instant sense, aiding the reader instead of faking him out, is a lousy little hyphen: fraudulent-sales law, moving-van fire. If the writer isn't too fast and sloppy, he can even turn the expression around into good English, as in 'inventory of crude oil.' But this is probably asking too much.

For a while, my colleagues on the weekly *AGI Report* referred to the 'Peaceful Uses of the Sea-Bed Committee.' It is a pleasure to note that, presumably to avoid implying that the sea-bed committee had any peaceful uses, the name now appears, understandably, as the 'Committee on Peaceful Uses of the Seabed.' Plain English always makes sense.

A group of our students recently ran a spring field trip, which they advertised to other students as being 'for outdoor lovers.' In warm weather there are outdoor lovers in every corner of the campus; who needs a field trip? What they really meant, it is to be hoped anyhow, was 'for lovers of the outdoors.'

Not that there's much likelihood of improvement. What can you expect when 190 million Americans say *home* when they mean *house, disinterested* when they mean *uninterested, hopefully* for *it is hoped,* and *verbally* for *orally*?

products & services

Sepor Laboratory Supply manufacturers morphological **crystal models** for use as teaching aids. The hardwood models are supplied in 30-, 60-, or 120-model sets that include a variety of forms. Details, specifications, prices and arrangements for obtaining samples are available from Sepor, Box 1366, Torrance, Calif., 90505.

More than 1,200 labeled compounds and primary radioisotopes are described in *Radiochemical catalog 69/70.* For copies, write to Amersham/Searle Corp., 2000 Nuclear Drive, Des Plaines, Ill., 60018.

Hand-sluice is a small, light, portable sluice box designed for recovering gold. The sluice box weighs 1 lb and is made of fiberglass. The manufacturer says the sluice boxes can be used by the family outdoorsman or professional prospector. For more information, write to Gold-Sport, Box 696-F3, Hawthorne, Calif. 90250.

Buehler Ltd has 2 new models of the compact AB **Pneumet Press.** Both allow economical mounting of samples used in metallurgy, ceramography and petrography. One model produces 1-inch molds, the other 1¼-inch molds. Both models have interchangeable screw-base molds. The presses can be used to mount samples with either thermosetting or thermoplastic materials. Other features include center ejection, 'in position' loading of sample and molding materials, rapid mold closure and a thermostatically controlled heater. More information about either press is available from Buehler Ltd, 2120 Greenwood St., Evanston, Ill., 60204.

The **Pulverit 1** is a new laboratory jaw crusher, for batch or continuous precrushing of hard materials, in feeding sizes of up to 2½ inches at rates up to 260 lb an hour. The jaw-gap width of the unit can be adjusted to produce fines of from $\frac{1}{16}$ to $\frac{7}{16}$ inch for processing minerals, shale and well cuttings for analysis of petroleum samples. Pulverit 1 has a removable fixed crushing jaw and a movable jaw. Jaws are available in hardened tool steel, Cr-Ni alloy steel, or tungsten carbide. 10 gap widths can be selected, and gap adjustments can be made while the machine is running. Pulverit 1 is a product of Geoscience Instruments Corp., 435 East Third St., Mt Vernon, N.Y., 10553.

Braincon Corp. has introduced a high-reliability timing system for oceanographic and other battery-operated applications. The **interval timer** uses special magnetic counting circuits for frequency division and storage developed by General Time Corp. The timer can be set to count up to 1,000 hours with an accuracy of $\pm$ 0.02 per cent under all stated environments, including 9 to 15 volts power-supply variations, over a $-6°C$ to $30°C$ temperature range. More information is available from Braincon Corp., Marion, Mass., 02738.

Penrose Research Conference

To be held on Monterey Peninsula, California 15-19 December 1969

A Penrose Research Conference on "The Meaning of the New Global Tectonics for Magmatism, Sedimentation, and Metamorphism in Orogenic Belts" will be convened by William R. Dickinson, Professor of Geology, Stanford University at Asilomar Conference Grounds in Pacific Grove on the Monterey Peninsula, 15-19 December 1969. Attendance will be limited to approximately 72 conferees selected by invitation of the convener. Proceedings of the conference will not be published, and acceptance of an invitation to attend (see below for procedure) implies agreement that the ideas and data presented at the conference will not be in the public domain until individually published elsewhere. A participation fee of $125 will cover triple occupancy accommodations, all meals from Monday evening through Saturday noon, and two afternoon field trips on Wednesday and Friday. Morning and evening sessions will be arranged to emphasize the opportunity for discussion.

The occasion for the conference is the recent development, by Wilson, Vine, Morgan, Sykes, LePichon and numerous others, of a comprehensive theory for global tectonics that embodies a movement plan for large, semi-rigid plates made of crust and upper mantle combined. This theory of a mobile and segmented lithosphere incorporates earlier ideas of continental drift, ocean-floor spreading, and the deep structure of island arcs. The purpose of the conference is to review concepts of the major geologic processes in orogenic belts from the viewpoint of the theory. The review may serve to improve the concepts, or test aspects of the theory, or both. In the framework of the new global tectonic theory, orogenic belts must be viewed as the elongate regions where crust-mantle plates, moving intact toward one another, impinge to crumple on their edges and to slide over and under one another.

To sharpen discussion, the conference will focus attention on three aspects of the geologic history of orogenic belts: (a) The genesis of the magmas erupted as andesitic and related rocks in volcanic arcs and the magmas intruded as granitic and related rocks in orogenic batholiths; (b) The origins of the tectonic basins of mobile belts and of the graywackes and related rocks deposited in them; (c) The timing and causes of rock deformation and regional metamorphism in orogenic belts. In specifying these central themes, the convener hopes to guide participant's thoughts into common channels without discouraging the presentation of fresh insights or newly perceived relations.

A thorough appraisal of orogenic geology requires a wide span of special knowledge brought to common terms. Those encouraged to consider attendance include both senior and junior scientists, including graduate students, with understanding of appropriate geophysical evidence for the geometry of rock masses and the distribution of heat flow in orogenic belts, of the elemental and isotopic geochemistry of orogenic rocks, of the inferred P-T conditions of magmatism and metamorphism, of the geometry and timing of tectonic movements, of the field relations of batholiths and metamorphic belts, and of the provenance and sedimentation of arkoses and graywackes.

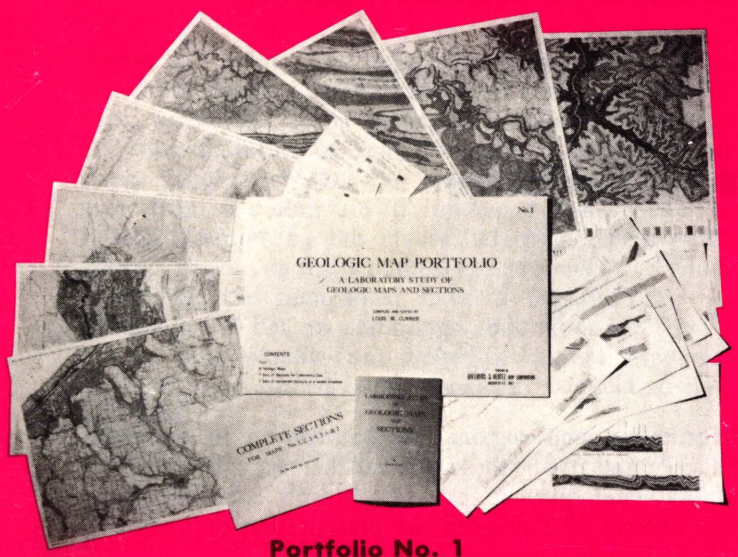
Those who wish to be considered for invitation to attend should write directly to William R. Dickinson, Geology Department, Stanford University, Stanford, California 94305 no later than August 15, 1969. The communication should include: (a) name, position, and affiliation; (b) field(s) of special knowledge and interest pertinent to participation in the conference; (c) topic(s) on which the correspondent is prepared to make a talk and/or to join in extended discussion; (d) (optional) list of other individuals whom the correspondent would like to find in attendance if he is invited; (e) minimum financial support necessary if attendance is contingent upon it. Limited funds will be available if necessary to help defray the expenses of a few key participants and the travel expenses of graduate students, who will not be asked to pay the conference fee.

Invitations will be extended no later than September 1, 1969.

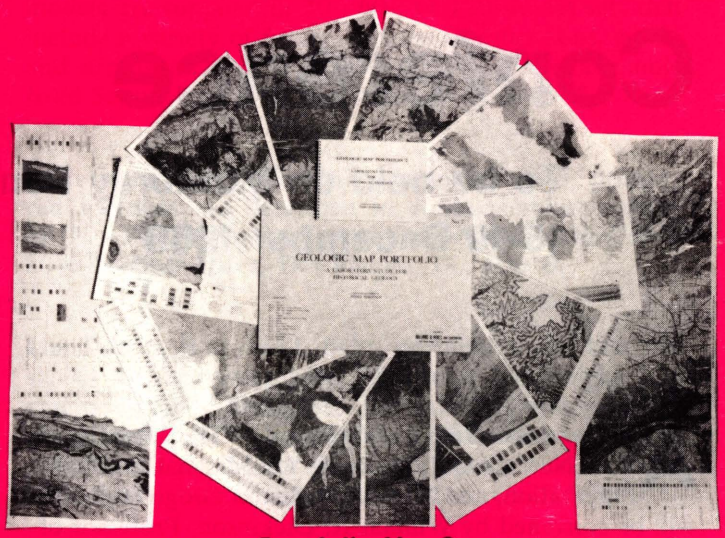
THE GEOLOGICAL SOCIETY OF AMERICA

P.O. BOX 1719, BOULDER, COLO. 80302, U.S.A.

THE DYNAMIC DUO



Portfolio No. 1
PHYSICAL GEOLOGY



Portfolio No. 2
HISTORICAL GEOLOGY

These laboratory studies compliment each other and constitute a tremendous value!

- **Full color maps, texts and exercises**
- **A price every student can afford**
- **Discounts apply to gross order of both portfolios**
- **Order now for the fall term — immediate delivery**

PRICE LIST

No. of Copies	Cost per Copy	No. of Copies	Cost per Copy
1-5	$5.00	31-50	$4.00
6-10	4.75	51-75	3.50
11-20	4.50	76-100	3.25
21-30	4.25	over 100	3.00

WILLIAMS & HEINTZ MAP CORPORATION
8119 Central Avenue • Washington, D.C., 20027