GSA news & information

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Who's who of GSA: Officers and councilors for 1977

The direction and destiny of the Geological Society of America are in the hands of the officers and councilors that you, the membership, elect each year. All too often only a few of these individuals are known to any one member. For that reason it has been suggested that a few basic facts about each of them serving during 1977 be listed in the Society's News & Information. The following is our attempt to condense a great deal of information into a few words about each.

PRESIDENT

CHARLES L. DRAKE, b. Ridgewood, NJ, July 13, 24; m. 50; c. 3. GEOPHYSICS. B.S.E, Princeton, 48; Ph.D. (geol), Columbia Univ, 58. Lectr. GEOL, Columbia Univ, 53-55, instr, 58-59, asst. prof, 59-62, assoc. prof, 62-67, acting asst. dir, Lamont Geol. Observ, 63-65; prof. & chmn. dept, 67-69; PROF, DARTMOUTH COL, 69- Nat. Sci. Found. sr. fel, Cambridge, 65-66; Condon lectr, Univ. Ore, 69; pres, inter-union comt. on geodynamics, Int. Coun. Sci. Unions, 70-; chmn. comt. on geodynamics, Nat. Acad. Sci, 70-; comt. adv. to Envir. Sci. Serv. Admin, 70-, mem. Ocean Affairs Bd. & Geophys. Res. Bd; exec. bd, Law of Sea Inst. U.S.A, 43-46. AAAS; Am. Asn. Petrol. Geol; fel. Geol. Soc. Am; Marine Tech. Soc; Soc. Explor. Geophys; Am. Geophys. Union; Royal Astron. Soc; Seismol. Soc. Am. Marine geology and geophysics; tectonics; structural geology; seismology. Address: Department of Earth Sciences, Dartmouth College, Hanover, NH 03755. PHONE: (603) 646-3338

VICE-PRESIDENT

PETER T. FLAWN, b. Miami, FL, 2-17-26; m. 46; c. 2. GEOLOGY. AB, Oberlin Col, 47; MS, Yale, 48, Ph.D. (geol), 51. Jr. geologist, USGS, 48-49; res. scientist & geologist, bur. econ. geol, Univ. Texas, Austin, 49-60, dir. bur. & prof. geol, 60-70, V. Pres. acad. affairs, 70-73; Exec. V. Pres, 73, PRESIDENT, UNIV. TEXAS, SAN ANTONIO, 74- USAAF, 44-45. Fel. GSA; AAPG; Am. Inst. Mining, Metall. & Petrol. Eng; Nat'l. Acad. of Eng. Economic and environmental geology; geology of Texas and Mexico. Address: Office of the President, The University of Texas @ San Antonio, San Antonio, TX 78285. Phone: (512) 691-4101

PAST-PRESIDENT

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

TREASURER

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COUNCILOR 1975-1977

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COUNCILOR 1975-1977

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

COUNCILOR 1975-1977

JOHN C. CROWELL, b. State College, PA, May 12, 17; m. 46; c. 1. GEOLOGY. B.S, Texas, 39; M.A, (meteor), California, Los Angeles, 46, Ph.D. (geol), 47; hon. D.Sc, Louvain, 66. Asst. geologist, Shell Oil Co, Inc, 41-43; instr. GEOL, UNIV. CALIF, Los Angeles, 47-49, asst. prof, 49-54, assoc. prof, 54-60, PROF, 60-67, chmn. dept, 57-60, 63-67;

SANTA BARBARA, 67- Guggenheim Found. fel, 53-54; Fulbright res. prof, Austria, 53-54; Nat. Sci. Found. sr. res. fel, Scotland, 60-61. U.S.A.A.F, 42-46, Capt. Fel. Geol. Soc. Am; Am. Asn. Petrol. Geol; Am. Geophys. Union; Soc. Econ. Paleont. & Mineral. General geology, tectonics, ancient glaciations. Address: Department of Geological Sciences, University of California, Santa Barbara, Santa Barbara, CA 93106. Phone: (805) 961-3224.

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

COUNCILOR 1976-1978
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COUNCILOR 1976-1978
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COUNCILOR 1976-1978
DIGBY J. McLAREN, b. Carrickfergus, North Ireland, 12-11-19; m. 42; c. 3. GEOLOGY. B.A, Cambridge, 41, M.A, 46, Harkness scholar, 48; Ph.D. (geol), Michigan, 51. GEOL. SURV. CAN, 48-, chief paleontologist, 60-67, dir. inst. sedimentary & petrol. geol, 67-73, DIRECTOR GENERAL, 73-. Brit. Army, 40-46, Capt. Am. Paleont. Soc; fel. Geol. Soc. Am; fel. Geol. Soc. of London; fel. Royal Soc. of Canada. Devonian paleontology and stratigraphy of western Canada. Address: Director General, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8. Phone: (613) 994-5817

COUNCILOR 1976-1978
BRIAN J. SKINNER, b. Wallaroo, S. Australia, Dec. 15, 28; nat; m. 54; c. 3. GEOLOGY, GEOCHEMISTRY. B.Sc, Adelaide, 50; A.M, Harvard, 52, Ph.D, 55. Lectr. crystallog, Adelaide, 55-58; res. geologist, U.S. Geol. Surv, 58-62, chief, br. exp. geochem. & mineral, 62-66; PROF. GEOL, YALE, 66-, chmn. dept. geol. & geophys, 67-73; EUGENE HIGGINS PROF, 73- Mineral. Soc. Am; Geochem. Soc; Mineral. Soc. Can; Mineral. Soc. London; Am. Geophys. Union; Soc. Econ. Geol; fel. Geol. Soc. Am. Geochemistry of ore deposits. Address: Department of Geology & Geophysics, Yale University, New Haven, CT 06520. Phone: (203) 436-1073

COUNCILOR 1977-1979
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COUNCILOR 1977-1979
RANDOLPH W. BROMERY, b. Cumberland, MD, 1-18-26. GEOLOGY, GEOPHYSICS. B.S, Howard Univ, 56; M.S, Amer. Univ, 62; Ph.D, Johns Hopkins Univ, 68. Explor. Geophy, USGS, 48-67; Geophy. Consult, US Dept. State, 67-68; Assoc. Prof. Geophy, Univ. Massachusetts, 67-69; Prof. Geophy, Chmn. Dept. Geol. & Geog, Univ. Massachusetts, 69-70 Vice-Chancellor, 70-72; CHANCELLOR, UNIV. MASSACHUSETTS, AMHERST, 72- . Commendation, Rep. Liberia Geol. Survey, 66; Cum Laude, Howard Univ; Hon. Doc. Educ. degree, Western New England College, 72; Hon. Doc. Sci. degree, Frostburg State College, 72; Hon. Doc. Laws degree, Univ. of Hokkaido, Japan, 76. Mem. NAS Spec. Pres. Adv. Panel Minority Part. Sci; Mem. Nat'l. Comm. Mineral Res. & Invir, NAS, 72; Chmn. Adv. Comm. Sec. Interior, Washington, DC; Incorporator, Woods Hole Oceanography Institute. Address: Office of the Chancellor, Whitmore Administration Building, University of Massachusetts, Amherst, MA 01002. Phone: (413) 545-2211.

COUNCILOR 1977-1979
DON U. DEERE, b. Corning, IA, 3-17-22; m. c. 2. ENGINEERING GEOLOGY. B.S, Iowa State, 43; M.S, Colorado, 49; Ph.D, Illinois, 55. Asst. prof. Univ. Puerto Rico, 46-48, assoc. prof. & head CE Dept, 49-51. Assoc. prof, Univ. Illinois, 55-58, prof, 59-72, vis. prof, Univ. FL, 74-75. CONSULTANT, 72- . Mem. Tau Beta Pi; Phi Kappa Phi; ASCE; AIME; Am. Soc. Testing & Mtl; Int. Soc. Rock Mech; AGU; AAAS; GSA; Assn. Engr. Geol; AIPG; Geol. Soc. London; NAE; NAS. Served on Rock Mechanics Comm. of NAS; Board of Dir. Int. Soc. of Rock Mech; Chmn. Comm. Rock Mech. of ASTM; Chmn. Comm. Tunnel. Geol. of Engr. Geol. Div, GSA; NAS Comm. Rapid Excavation, Rock Mech; Comm. of Soil Mech. & Found, ASCE; Chmn. Comm. Stand. of Lab. & Field Tests, Int. Soc. of Rock Mech; Chmn. subcomm. Nomenclature & Classif. Rock for ASTM; Comm. Underground Works of US for Large Dams; Chmn. US Nat. Comm. Tunneling Tech, NAS/NAE; Councilor, GSA Engr. Geol. Div, 64-65. Address: 6834 S.W. 35th Way, Gainesville, FL 32601. Phone: (904) 378-3061

COUNCILOR 1977-1979
M. GORDON WOLMAN, b. Baltimore, MD, 8-16-24; m. 51; c. 4. GEOLOGY. B.A, Hopkins, 49; fel. Harvard, 50; M.A, 51; Ph.D. (geol) 53. GEOLOGIST, USGS, 51- ; PROF. GEOG. & CHMN. DEPT. GEOG. & ENVIRON. ENG, JOHNS HOPKINS UNIV, 58- ; USNR, 43-46. GSA; AGU; Asn. Am. Geog. (award, 72). River morphology; water resources. Address: Department of Geography & Environmental Engineering, Johns Hopkins University, Baltimore, MD 21218. Phone: (301) 338-7090

BOOK BRIEFS

This feature is included occasionally in the News & Information section to keep members informed of recent books published by the Society.

Investigations of Late Quaternary Paleoceanography and Paleoclimatology

MEMOIR 145 — Edited by R. M. Cline and J. D. Hays. 1976. x + 464 pages; 245 figures, 66 tables, 26 appendixes on 3 98-frame microfiche for use on 24x readers, $30.00.

The CLIMAP project (Climate/Long Range Investigation Mapping and Predictions), operational since 1971 and funded by the Office of the International Decade of Ocean Exploration, seeks to document global climatic change over the past million years. The purpose of the project is to determine both the underlying factors that induce climatic change and the response of the ocean-atmosphere-ice system that reflects these factors. The program has as its central thrust the monitoring of paleoceanographic changes through the study of a global distribution of deep-sea sediment cores; other studies, in addition, use climatic records obtained above the strandline, such as paleo-sea levels, vegetational patterns, ice sheets, and fluctuations of alpine glaciers.

The volume is divided into two principal parts: Atlantic (10 papers) and Antarctic (7 papers).

New Transfer Function for Estimating Past Sea-Surface Conditions from Sea-Bed Distribution of Planktonic Foraminiferal Assemblages in the North Atlantic (Nilva G. Kipp). The main purpose is to describe a new transfer function that reflects significant improvements in the size and quality of a data base used previously. Maps are presented of the distribution of 29 planktonic foraminiferal species in 191 North Atlantic Ocean core tops. The new transfer function, derived from these core data by factor analysis and regression techniques, relates six assemblages of foraminifera to seasonal temperatures and salinities at the sea surface and at a depth of 100 m for the past 20,000 yr. Paleotemperatures were derived, in this paper as well as in others in this volume, using the technique developed by Imbrie and Kipp for foraminiferal assemblages.

At 18,000 yr B.P. the Artic Polar Front, centered on lat 42°N, marked the fundamental dividing line for all climatic regimens between a northern dynamic zone and a southern area of relative stability.

Glacial North Atlantic 18,000 Years Ago: A CLIMAP Reconstruction (Andrew McIntyre and Nilva G. Kipp with Allen W. H. Bé, Thomas Crowley, Thomas Kellogg, James V. Gardner, Warren Prell, and William F. Ruddiman). Temperature maps of surface water in the North Atlantic for 18,000 yr B.P. have been reconstructed for the four seasons. Temperatures were estimated by transfer-function analysis of foraminiferal assemblages, and geometric patterns of surface waters were derived from water-mass-related assemblages of Coccolithophorida and Foraminifera; 100 cores proved useful.

The greatest temperature differences between today and 18,000 yr B.P. are found in a latitudinal band from 42°N to 60°N, with differences in some areas exceeding 10°C.

Late Quaternary Climatic Changes: Evidence from Deep-Sea Cores of Norwegian and Greenland Seas (Thomas B. Kellogg). The paper has four sections: (1) Surface-sediment distributions of various sedimentary and faunal parameters are presented as a base representing modern nonglacial conditions. (2) Stratigraphic analyses of sedimentary and faunal parameters in six cores are compared with surface-sediment distributions. (3) Time control is established for climatic changes observed in the cores. (4) Observed climatic phenomena are discussed with reference to late Quaternary climatic change in the region surrounding the Norwegian and Greenland Seas.

Temperatures during most of the past 150,000 yr have been much lower than they are now. Only between 127,000 and 110,000 yr B.P. did temperatures approach of surpass present-day temperatures.

Northeast Atlantic Paleoclimatic Changes over the Past 600,000 years (W. F. Ruddiman and A. McIntyre). The authors summarize both new and previously published evidence that delineates the geography, intensity, and periodicity of polar-water movements and relate the oceanic data to continental ice-sheet fluctuations.

In the subpolar Atlantic Ocean during the Quaternary Period, water-mass environments have migrated across more than 20° of latitude, which is equivalent to temperature oscillations of ocean surface of at least 12°C. During peak glaciations, polar water moved south to lat 42°N. Seven complete climatic cycles have occurred in the past 600,000 yr, within which at least 11 separate major southward advances of polar water have occurred.

Quantitative determinations are included that give the absolute input rates of the major sediment fractions.

O^{18} Record of the Atlantic Ocean for the Entire Pleistocene Epoch (Jan van Donk). The first oxygen-isotope record for the entire Pleistocene Epoch is presented. Twenty-one isotopically "interglacial" and an equal number of isotopically determined "glacial" or near-"glacial" stages are recognized in the isotope record of a planktonic foraminiferal species, from a well-dated equatorial Atlantic core representing the past 2.3 m.y. Many of the glacial stages (especially before 1 m.y. B.P.) are less pronounced than the most recent glacial maximum. The observed maximum change in oxygen-isotope values is 1.1 *o/oo*. At least 90 percent of the changes in the isotopic composition are attributable to variation in the isotopic composition of ocean water, which is due to the waxing and waning of large continental glaciers.

Late Quaternary Climatic Record in Western Equatorial

(continued on p. 34)

Book Brief (continued from p. 27)

Atlantic Sediment (Allan W. H. Bé, John E. Damuth, Leroy Lott, and Rosemary Free). The objectives are (1) to determine the temporal successions of planktonic foraminiferal assemblages for the past 80,000 yr and to compare the faunal and sedimentary records, in 10 cores, with the timing of known global climatic changes and (2) to decipher the climatic history of the western equatorial Atlantic by means of quantitative estimates of paleotemperatures.

Despite a twofold increase in cool equatorial species, a tropical climate prevailed in the region throughout the last glaciation. Paleotemperature estimates derived by factor analysis and regression techniques indicate only a small (0.1° to 3.6°C) difference between glacial and postglacial winter temperatures. The coldest sea-surface temperatures occurred at about 73,000 yr B.P.

Late Pleistocene Faunal and Temperature Patterns of the Colombia Basin, Caribbean Sea (Warren L. Prell and James D. Hays). The planktonic foraminifera living within the basin during late Pleistocene time are defined and then mapped in the present-day North Atlantic Ocean to establish their oceanographic associations. The late Pleistocene faunal data are also used to make quantitative estimates of paleotemperature and paleosalinity; 10 out of 100 cores were judged continuous enough for detailed faunal analysis.

The interglacial assemblage has maximum abundances in the equatorial zone. The glacial assemblage occurs today in the distinctive southern Sargasso Sea water of high salinity, low nutrients, and low productivity.

Responses of Sea-Surface Temperature and Circulation to Global Climatic Change During the Past 200,000 Years in the Eastern Equatorial Atlantic Ocean (James V. Gardner and James D. Hays). The prediction of paleotemperatures is refined using multivariate statistical analyses of foraminiferal populations and closely spaced samples. Analyses of 11 deep-sea cores suggest strong variation in the intensity of atmospheric and oceanic circulation in response to the waxing and waning of ice sheets.

Comparisons between Holocene sediments and sediments from an 18,000-yr-B.P. datum in an equatorial core show only small changes (1° to 2°C) for estimated temperatures for February, but changes of 2° to 10°C for temperature estimates for August. By contrast, the zone of upwelling off northwest Africa shows almost a 10°C decrease in temperatures for February 18,000 yr B.P. but only a 1° to 4°C difference in August.

Equatorial Atlantic and Caribbean Foraminiferal Assemblages, Temperatures, and Circulation: Interglacial and Glacial Comparisons (Warren L. Prell, James V. Gardner, Allan W. H. Bé, and James D. Hays). This study integrates the individual geographic areas of the region. Seventy-five core samples are used to represent late Holocene and interglacial conditions, and 47 samples from the 18,000-yr-B.P. level (McIntyre and others, this volume) to represent glacial conditions. The percentage of abundance of species of planktonic foraminifera is the basis for this analysis.

Seasonal temperature contrast (August to February) is three to four times greater in all cores for glacial conditions than for interglacial conditions. The Northern and Southern Hemispheres are generally in phase and more severe winters control the glacial temperature pattern.

Corresponding Patterns of Contemporary Pollen and Vegetation in Central North America (T. Webb III and J. H. McAndrews). Maps are presented that show the distribution of modern pollen based on 606 samples from central North America. Data from 69 sites are presented for the first time.

Trend-surface analysis and principal components analysis summarize the regional trends of each pollen type and illustrate the patterns of covarying pollen types within the data.

Relationship of Radiolarian Assemblages to Sediment Types and Physical Oceanography in the Atlantic and Western Indian Ocean Sectors of the Antarctic Ocean (Jose A. Lozano and James D. Hays). A quantitative approach is taken by estimating temperatures using the techniques developed by Imbrie and Kipp for foraminiferal assemblages and first used for Radiolaria by Sachs.

The relative abundance of 18 selected taxonomic groups of Radiolaria were determined for 145 core-top samples. A factor analysis of 72 samples, considered to represent nonreworked recent sediments, resolved Antarctic, subantarctic, and subtropical assemblages. Estimated surface-water temperatures range from near 20°C in the northern parts of the area to 0°C at the location of the southernmost cores. Variations in the calcite compensation depth (CCD) for locations north of the Antarctic Polar Front depend mainly on varying dissolution.

Reconstruction of the Atlantic and Western Indian Ocean Sectors of the 18,000 B.P. Antarctic Ocean (James D. Hays, Jose A. Lozano, Nicholas Shackleton, and Grace Irving). Using relative abundance changes of the radiolarian *Cycladophora davisiana,* the study establishes a high-resolution biostratigraphy for the Antarctic and subantarctic ocean covering the past 150,000 yr. Through the use of paleoecological equations developed by Lozano and Hays (this volume), the authors also estimate paleotemperatures for the Antarctic Ocean at 18,000 yr B.P.

The Antarctic Polar Front 18,000 yr ago, based on 34 core-top samples, was displaced north of its present position by as much as 7° of latitude. The subtropical convergence was little changed from its present position; consequently, the width of subantarctic waters was reduced. Estimates of sedimentation rates indicate that summer ice cover extended nearly to lat 55°S 18,000 yr ago, whereas today it melts back to the Antarctic continent.

Late Quaternary Sediment of the Panama Basin: Sedimentation Rates, Periodicities, and Controls of Carbonate and Opal Accumulation (Nicklas G. Pisias). Assuming a constant rate of quartz accumulation, the authors estimated the age of samples from a core and constructed a curve for sedimentation-rate versus time. The model sedimentation rates, when combined with data on mineralogic composition, allow the determination of accumulation rates for $CaCO_3$, opaline SiO_2, and remaining "detritus."

Spectral analysis determination of the accumulation rate of $CaCO_3$ in the core and of the oxygen-isotope record of another core indicates a 23,000-yr periodicity. Spectral analysis of the opal accumulation rate suggests a 100,000-yr periodicity. Both of these periodicities are close to those found in fluctuations in the Earth's orbital parameters.

Late Quaternary Accumulation Rates of Opal, Quartz, Organic Carbon, and Calcium Carbonate in the Cascadia Basin Area, Northeast Pacific (G. Ross Heath, Ted C. Moore, Jr., and J. Paul Dauphin). The authors reconstruct in detail the sedimentation history of the area for the past 35,000 yr. Accumulation rates of terrigenous (quartz, organic carbon) and biogenic (calcium carbonate, opaline silica) components of two cores are highly correlated with total-sediment accumulation rate and each other throughout late Pleistocene and Holocene time. In contrast, the correlations of the biogenic and terrigenous rates in a core on the east flank of Gorda Ridge are much lower. Several major episodes of climatic change are evident.

The increased resolution of late Quaternary oceanographic changes, which is theoretically possible in rapidly deposited hemipelagic sediments, appears to be readily degraded by turbidite deposition, even where classic course-grained turbidites are absent. Cores from hemipelagic areas free of sediments carried in autosuspension are most likely to preserve detailed climatic and oceanographic records of late Quaternary time.

Glacial Advance in the Gulf of Alaska Area Implied by Ice-Rafted Material (Roland von Huene, Jim Crouch, and Edwin Larson). An abundance curve for ice-rafted detritus based on data from cores from five sites depicts the main continental glacial events, on which curves of a series of shorter events are superimposed. The curves suggest cycles of glacial advance lasting 12,000 to 15,000 yr. Under certain conditions, a rapidly deposited deep-sea marine section, which characteristically has temporal continuity, can record variations in the intensity of alpine glaciation. The correspondence is remarkable between the curves developed here and curves of Pleistocene ocean water and ice temperatures, glacial advances, and lake levels.

Modern Pacific Coccolith Assemblages: Derivation and Application to Late Pleistocene Paleotemperature Analysis (Kurt R. Geitzenauer, Michael B. Roche, and Andrew McIntyre). Factor analyses of relative abundance counts of coccoliths from selected Pacific Ocean core tops yield six assemblages that coincide with the following surface water masses and regions: (1) the Kuroshiro system and Pacific Equatorial Water Mass; (2) the southern and northern central Pacific regions (both occupied by two assemblages); (3) the Western South Pacific Central Water Mass; and (4) the Subarctic Pacific and Intermediate Water Masses.

Transfer functions relating the assemblages to sea-surface temperatures were applied to coccolith populations that existed over the past 200,000 yr and that were taken from two cores in the western equatorial Pacific and one from the eastern Pacific.

The data support the theory that sea-surface temperature over the past 200,000 yr has not globally varied sinusoidally but has been subject to complex regional dynamics.

Oxygen-Isotope and Paleomagnetic Stratigraphy of Pacific Core V28-239 Late Pliocene to Latest Pleistocene (N. J. Shackleton and N. D. Opdyke). Core V28-239 from the western equatorial Pacific (Solomon Rise), and representing about 2.1 m.y., has been analyzed at 5-cm intervals (one sample every 5,000 yr). Glacial stage 22, above the Jaramillo magnetic event, may represent the first major Northern Hemisphere continental glaciation of middle Pleistocene character. Prior to this, higher frequency glacial events extend to near the level of the Olduvai magnetic event. Glacial events of less regular frequency extend to the bottom of the core. Fluctuations in carbonate dissolution intensity occur throughout the core with a similar frequency to the oxygen-isotope fluctuations.

January BULLETIN briefs

Brief summaries of articles in the January 1977 GSA Bulletin *are provided on the following pages to aid members who chose the lower dues option to select* Bulletin *separates of their choice. The document number of each article is repeated on the coupon and mailing label in this section.*

☐ 70101—Extension of the geomagnetic polarity time scale to 6.5 m.y.: K-Ar dating, geological and paleomagnetic study of a 3,500-m lava succession in western Iceland. *Ian McDougall, Research School of Earth Sciences, Australian National University, Canberra, A.C.T., 2600; Kristjan Saemundsson, Haukur Johannesson, National Energy Authority, Reykjavik, Iceland; Norman D. Watkins, Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island, 02881; Leo Kristjansson, Science Institute, University of Iceland, Reykjavik, Iceland.* (*15 p., 6 figs., 1 tbl.*)

More than 400 successive lavas in Borgarfjördur, western Iceland, have been subjected to paleomagnetic and K-Ar age analysis. Volcanism in the region was virtually continuous between about 7.0 and 2 m.y. ago, during which time more than 3,500 m of volcanics and interbedded sediments accumulated. Regression analysis of the K-Ar age and aggregate thickness data demonstrates that the rate of growth of the lava pile was remarkably uniform at 730 m/m.y. throughout the whole period. The magnetostratigraphic and K-Ar data indicate a nearly complete record of the geomagnetic polarity history and extend the polarity time scale based upon data from subaerial volcanic rocks to about 6.5 m.y. ago. The boundaries of polarity epoch 5 are shown to be 5.34 and 5.83 m.y. Epoch 6 lies between about 6.54 and 5.83 m.y. ago, during which time three normal polarity events are recognized. The ages determined for the polarity-interval boundaries in this study confirm recent estimates derived from analyses of marine magnetic anomalies using sea-floor–spreading assumptions.

The results show that it is possible to obtain reliable K-Ar ages on lavas that have undergone zeolite facies metamorphism at temperatures up to about 150°C by careful selection of samples that are well crystallized and have their original high-temperature mineralogy preserved.

A revised estimate of 5.2 ± 0.1 m.y. is proposed for the age of the Miocene-Pliocene boundary.

☐ 70102—Hillslope form and climate. *Terrence J. Toy, Department of Geography, University of Denver, Denver, Colorado 80208.* (*7 p., 4 figs., 6 tbls.*)

The relationship between climate and hillslope form was investigated at 29 sites along two traverses: one from Berea, Kentucky, to Pioche, Nevada; the other from Glendive, Montana, to Ruidoso, New Mexico. A rigorous site-selection procedure was used to minimize the importance of nonclimatic factors and to ensure the inclusion of hillslopes in a variety of climatic regions.

Five hillslope variables were selected for comparison with nine climate variables. Each hillslope and climate variable has a theoretical or conceptual basis for use in this study.

The results support the hypothesis that hillslopes reflect regional climatic variations. Fifty-nine percent of the variation in the rate of curvature of the convex segment was explained by the climate variables. Forty-three percent of the variation in the slope of the straight segment was accounted for on the basis of climate. Thirty-seven percent of the variation in the slope of a regression line fitted through the entire profile was explained by variations in climate. Twenty-six percent of the variation in the slope-length ratio was explained by the climate variables.

It was concluded that hillslopes in arid areas tend to be shorter, steeper, and have smaller radii of curvature of the convex segment than those in humid areas. Examination of the residuals from regression suggests that the site-selection procedure was successful in minimizing the geologic influence on hillslope form while in no way ignoring its importance. The statistical significance of the relationships indicates that there exists a state of quasi-equilibrium on the hillslopes. Lastly, evidence is provided for the existence of quantifiable relationships between geomorphological processes and hillslope forms. While this has been frequently asserted and is the basis of climatic geomorphology, it has rarely been tested.

☐ 70103—Strain in metamorphosed volcaniclastic rocks and its bearing on the evolution of orogenic belts. *Othmar T. Tobisch, Earth Science Board, Applied Science Building, University of California, Santa Cruz, California 95064; Richard S. Fiske, U.S. Geological Survey, National Center, Reston, Virginia 22092 (present address, Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560); Steven Sacks, Dennis Taniguchi, Earth Science Board, Applied Science Building, University of California, Santa Cruz, California 95064 (present address, Sacks, 125 South Swall Drive, Beverly Hills, California 90211; Taniguchi, 5984 Monterey Avenue, Richmond, California 94805).* (18 p., 19 figs., 2 tbls.)

Orogenic belts commonly contain thick deposits of volcaniclastic and associated rock types that bear abundant strain markers. Detailed mapping of a deformed assemblage of volcaniclastic rocks in a well-exposed part of the Ritter Range (central Sierra Nevada, California) has yielded five types of strain markers: lithic lapilli, accretionary lapilli, tuff-breccia fragments, reduction spots, and "ash-flow ellipsoids." The axial ratio and angle between the long axis of the markers to a reference line were measured in a large number of specimens, and the strain was determined using the shape factor grid method and data on initial fabrics.

Strain in these rocks is markedly heterogeneous over short distances owing mostly to the heterogeneous nature of the stratigraphic section. The mean strain ellipsoid ($X > Y > Z$) for the area has the following values: a 62 percent increase in X, a 15 percent increase in Y, and a decrease of 46 percent in Z (shortening normal to the slaty cleavage). The mean strain magnitude (ε_S) for the area is $\varepsilon_S = 0.77$, considerably below that of the mean slate ($\varepsilon_S = 1.44$); the symmetry of the deformation is principally one of flattening, however, and has a Lode's value ($\nu = 0.40$) close to that of the mean slate ($\nu = 0.43$).

Results indicate that thick stratigraphic sections can be profoundly affected by internal strain: for the volcanogenic assemblage in the Ritter Range, calculations made show that tectonic deformation has thinned the part of the pendant studied by more than 50 percent, from a thickness of 9.0 to 4.3 km. It appears likely that significant portions of the central Sierra Nevada country rock may have undergone comparable thinning of section.

A plot of mean strain ellipsoids from a number of orogenic belts ranging in age from Archean to Mesozoic defines two mean deformation paths, one clearly a flattening deformation in which extensions of the X and Y axes of the main strain ellipsoids have a ratio of $(\% X/\% Y) \approx 4$, while the other path lies close to a plane strain ($Y \approx 1$). The elongate shape characteristic of most orogenic belts is probably the most important factor controlling the extension ratios of thick stratigraphic sections during deformation, and hence their mean deformation paths. The fact that mean strain ellipsoids from orogenic belts spanning a considerable period of geologic time (2.5 b.y.) show closely comparable symmetries, suggests that present-day deformation is likely to provide realistic models for interpreting paleostrain found in ancient orogenic belts.

☐ 70104—Subsidence of the Sverdrup Basin, Canadian Arctic Islands. *J. F. Sweeney, Earth Physics Branch, Department of Energy, Mines and Resources, Ottawa, Canada K1A 0E4.* (8 p., 8 figs., 1 tbl.)

Sverdrup Basin subsidence is separated into three phases: late Paleozoic (330 to 225 m.y. B.P.), early Mesozoic (225 to 124 m.y. B.P.), and late Mesozoic (124 to 74 m.y. B.P.). Each phase begins with high subsidence rates that decrease exponentially with time. During periods of rapid basin subsidence, regions adjacent to the basin perimeter experience mild uplift that migrates inward toward the basin center over a 10- to 30-m.y. period. Most of the observed basin subsidence (at least 70 percent) probably results from lithospheric response to loading of an initial depression. For the late Paleozoic and most of the early Mesozoic phases, observed subsidence and peripheral uplift relations, together with the pattern of exponential decay constants determined from subsidence curves, are consistent with the loading response of a lithosphere modeled as a viscoelastic beam. Late Mesozoic subsidence, because of thermal and structural events within the basin, presents no clear picture of lithospheric loading response. Late Paleozoic subsidence may have been initiated by thermal contraction of the lithosphere, whereas early Mesozoic subsidence probably resulted from downdropping of a graben block beneath the basin and late Mesozoic subsidence from downdropping centered along an axis collinear with the north-trending Boothia Arch exposed to the south of Sverdrup Basin. Pronounced increases in subsidence rates, mafic intrusions, and cessation of north-derived sediment in Sverdrup Basin at the beginning of Mesozoic time suggest that the opening of the Amerasian Basin of the Arctic Ocean by rifting and sea-floor spreading may have begun in Early Triassic time.

☐ 70105—Mississippian pyroclastic flow and ash-fall deposits in the deep-marine Ouachita flysch basin, Oklahoma and Arkansas. *Alan R. Niem, Department of Geology, Oregon State University, Corvallis, Oregon 97331.* (13 p., 16 figs.)

Two pumiceous vitric-crystal tuffs, the Hatton Tuff Lentil and Beavers Bend tuff, occur in the deep-marine Mississippian Stanley Group. These widespread rhyodacitic tuffs range in thickness from 7 to 40 m and are separated by tens of metres of nontuffaceous quartzose and feldspathic turbidite sandstone and shale. The tuffs consist of varying proportions of ash-sized embayed quartz crystals, plagioclase crystals (oligoclase to andesine), relict shards, volcanic dust, and altered flattened pumice fragments.

Each pyroclastic unit consists of two or more tuff lithologies, including a thick lower unstratified pumiceous vitric-crystal tuff with a density-graded crystal-rich base overlain by thin-bedded pumiceous tuff and an upper massive fine-grained siliceous vitric tuff.

These tuffs were probably formed by highly explosive eruptions of vesiculating acidic magma from a vent or fissure that produced incandescent avalanches of pyroclastic debris and accompanying ash clouds. The hot turbulent suspensions were rapidly quenched by sea water to form steam-inflated density slurries that flowed into the Ouachita basin. Pyroclastic flows created thick, density-graded, pumiceous vitric-crystal tuff. Numerous smaller density slurries following the main flow in rapid succession deposited the overlying bedded pumiceous tuff. Toward the end of each volcanic eruption, continuous settling of fine ash formed thick, fine-grained upper vitric tuff.

Isopach maps of tuff thicknesses, an isopleth map of pumice sizes, logarithmic plots of crystal size versus distance, paleocurrent indicators, and Late Mississippian paleogeography suggest a southern volcanic source that may have been part of a magmatic arc formed at a continental margin during plate convergence between the North American plate and a southern continental(?) plate.

☐ 70106—Trends in trans-North Atlantic commonality among Phanerozoic invertebrates, and plate tectonic events. *W. C. Fallaw, Department of Geology, Furman University, Greenville, South Carolina 29613.* (5 p., 2 figs, 1 tbl.)

Invertebrate commonality trends at the generic level between landmasses on the eastern and western sides of the present North Atlantic, as computed from data in the *Treatise on Invertebrate Paleontology,* have an intriguing relationship with plate tectonic events. Commonality peaks in early Paleozoic time coincided roughly with Taconic and Caledonian orogenic events. Following an Early and Middle Devonian decrease, an increase in commonality through the late Paleozoic apparently reflects plate tectonic processes associated with the Acadian, Alleghenian, and Hercynian orogenies. Commonality highs can be attributed to proximity of land masses, building of island arcs, and transfer of crustal blocks during continental convergence and divergence. The commonality data support the hypothesis of a proto-Atlantic Ocean during early Paleozoic time.

An all-time commonality high was reached in Triassic time, associated with Pangean continental assembly, and commonality has decreased since then, reflecting continental fragmentation and divergence.

☐ 70107—East-west patterns of Cenozoic igneous rocks, aeromagnetic anomalies, and mineral deposits, Nevada and Utah. *John H. Stewart, William J. Moore, U.S. Geological Survey, Menlo Park, California 94025; Isidore Zietz, U.S. Geological Survey, Reston, Virginia 22092.* (11 p., 6 figs.)

In Nevada and western Utah, Cenozoic igneous rocks within several age increments crop out in arcuate, generally east-trending belts, each successively younger to the south. Broad aeromagnetic highs with superimposed short-wavelength anomalies are associated with some of these outcrop belts. Mineral deposits are aligned along the belts in easternmost Nevada and western Utah. The east-west patterns are the result of a southward-migrating front of igneous activity that, in Nevada and Utah, started about 43 to 34 m.y. ago near lat 40°N and ended about 17 to 6 m.y. ago near lat 37°N. During any one time interval, igneous activity was concentrated near the leading edge of the east-trending front. The volcanic front may be related to igneous activity localized along a southward-propagating transverse break or structural warp in a subducting plate.

☐ 70108—Nucleation and growth of plagioclase, Makaopuhi and Alae lava lakes, Kilauea Volcano, Hawaii. *R. James Kirkpatrick, Department of Geological Sciences, Harvard University, Cambridge, Massachusetts 02138 (present address, Deep Sea Drilling Project, A-031, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093.* (7 p., 5 figs., 4 tbls.)

The Hawaiian lava lakes offer an unparalleled opportunity to study the processes that occur during the crystallization of basaltic magma. This paper presents estimates of the rates of nucleation and growth of plagioclase in the Kilauea lava lakes, Makaopuhi and Alae, and a discussion of the processes that control the nucleation and growth. The observed growth rates perpendicular to (010) vary from 1.7 to 11.0×10^{-10} cm sec^{-1}. The nucleation rates vary from 6.8×10^{-3} to 2.0 cm^{-3} sec^{-1}. In general the rates increase with increasing crystallization at any point, decrease with increasing distance from the surface, and are higher in the shallower lake, Alae. For the most part, nucleation appears to occur heterogeneously on previously existing crystals. The growth appears to be controlled by the interface attachment kinetics and not by diffusion in the melt. The observed results are in qualitative agreement with theoretical predictions.

☐ 70109—Multivariate empirical test of the Leopold and Miller stream order—hydraulic geometry hypothesis. *Theodore K. Miller, School of Public and Environmental Affairs, Indiana University, Bloomington, Indiana 47401; Lawrence J. Onesti, Department of Geography, Indiana University, Bloomington, Indiana 47401.* (4 p., 1 fig., 3 tbls.)

The relationship between stream order and hydraulic geometry was tested using multivariate discriminant analysis. Data on the hydraulic geometry variables were collected for 103 streams of order 3 through 6 in the Pecatonica River drainage network in southwestern Wisconsin. The results indicate that the relationship is not as strong as suggested by L. R. Leopold and J. P. Miller. Channel width, depth, and gradient appear to account for the existing strength, whereas velocity and roughness make only a negligible contribution.

☐ 70110—Distribution, correlation, and radiocarbon dating of late Holocene tephra. Mono and Inyo craters eruptions, eastern California. *Spencer H. Wood, Division of Geological Planetary Sciences. California Institute of Technology, Pasadena, California 91109 (present address, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025).* (7 p., 5 figs., 2 tbls.)

Two pumiceous tephra layers, widespread in meadow topsoils of the southern Sierra Nevada, are correlated on the basis of radiocarbon dates and trace-element analyses with two eruptive centers at the northern and southern ends of the Mono Craters—Inyo craters volcanic chain in eastern California. Pumice and obsidian that were erupted in the northern part of the chain are uniform in trace-element content, whereas those erupted from the southern part are nonuniform and distinctly different, particularly in Sr content. Similar differences are recognized in the two most recent and widespread tephra layers originating from these sites. These tephra layers are the deposits of the most recent explosive eruptions of magma from the Mono Craters and the Inyo craters.

☐ 70111—Isotopic studies on a Precambrian geochronologic boundary, Sierra Madre Mountains, Wyoming. *Allan F. Divis, Geology Department, Colorado School of Mines, Golden, Colorado 80401.* (5 p., 6 figs., 1 tbl.)

Geochronologic evidence indicates that a profound discontinuity separating two discrete Precambrian provinces parallels the Wyoming-Colorado border. This east-trending boundary transects the Sierra Madre Range in southern Wyoming adjacent to a fault-bounded sequence of folded middle Precambrian sedimentary rocks.

Precambrian rocks of the Sierra Madre Mountains reveal a series of igneous and sedimentary events that occurred near the probable edge of the Archean continental nucleus between 2,600 and 1,600 m.y. B.P. North of the boundary, Archean quartz-biotite gneiss, probably 2,800 to 2,900 m.y. old, grades eastward into a northwest-trending antiform of microcline augen gneiss and granite. The Rb-Sr isochron of the granite gneiss complex yields an age of 2,560 m.y. and an initial Sr^{87}/Sr^{86} intercept of 0.7000. Geochemical evidence suggests that the quartz-biotite gneiss may have evolved from a supracrustal dacitic protolith formed by anatexis of a basaltic amphibolite.

Calc-alkalic volcanic flows, tuffs, and volcanogenic sediments and a 4-km-thick sequence of conglomerate, quartzite, and limestone were deposited on the gneiss basement after 2,560 m.y. B.P. A period of igneous activity and tectonism between 1,650 and 1,900 m.y. B.P. resulted in the metamorphism and folding of the sediments into an east-trending anticlinorium of isoclinal folds.

The Sierra Madre south of this metasedimentary structure consists principally of a composite batholith of plutons ranging from gabbro to granite. The Encampment River Granodiorite, the oldest intrusion, is a gneissic unit that was probably derived by partial melting and remobilization of the polycyclic quartz-biotite gneiss, as suggested by isotopic and rare-earth-element data. This thermal reactivation occurred between 1,900 and 2,000 m.y. B.P. The majority of the batholith is made up of a distinctive red granite that yields an isochron age of 1,680 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.7024. A white quartz monzonite discordantly intrudes the granite and hornblende gneiss country rock. Isochron ages and initial Sr^{87}/Sr^{86} intercepts of the monzonite and gneiss are 1,680 m.y. and 0.7020 for the quartz monzonite and 1,880 m.y. and 0.7015 for the country rock. At least three distinct generations of mafic dikes are present in the Sierra Madre; field relations with dated units indicate ages of ∿2,700 m.y., 1,800 to 2,650 m.y., and ∿1,680 m.y.

☐ 70112—Timing of spreading in the South Atlantic: Information from Brazilian alkalic rocks. *Norman Herz, Department of Geology, University of Georgia, Athens, Georgia 30602.* (12 p., 4 figs., 6 tbls.)

Information about the onset of spreading in the South Atlantic and the rate of motion of the South American plate can be developed using Brazilian alkalic and basaltic rocks and the stratigraphy of the coastal basins. The first basalts are 147 m.y. old and herald the start of general domal uplifts. With continued uplift, fracturing parallel to the coast led to diabase dike filling and the Jacupiranga and Anitapolis nodes of alkalic activity, 122 to 138 m.y. ago. This may be the time the first triple junctions developed in the area: two arms of each became sites of plate movement and outline the present coast; the third arm failed and was the locus of basaltic or alkalic activity. Normal faulting and deposition of typical rift-filling sediments occurred at this time.

After a Barremian hiatus, both alkalic and basaltic activity was renewed about 110 m.y. ago. The first marine sediments and thick evaporite sequences were laid down, so plate accretion must have begun. The Minas Gerais–Goiás belt of alkalic rocks was emplaced in a restricted zone within a foldbelt formed during the Precambrian Brazilian cycle in a phase lasting from 91 m.y. until about 65 m.y. ago. A hot-spot–South America relative motion approximately 1.4 ± 0.5 cm/yr in a northwest-southeast direction is suggested for this time.

The littoral belt of alkalic rocks developed from Sao Sebastião to Cabo Frio starting about 82 m.y. ago and lasting until about 59 m.y. ago. This was about the same time as a northerly shift in the pole describing Africa–South America motion and accompanied an increase in the half-spreading rate to about 2.0 cm/yr. The South America–hot-spot relative motion for the past 59 m.y. is inferred from the track of seamounts leading to Trindade Island. If it is the same hot spot or a similar one to that which was on the coast, then the rate has been about 2.3 cm/yr.

☐ 70113—Quaternary glaciation and volcanism, Metolius River area, Oregon. *William E. Scott, Department of Geological Sciences, University of Washington, Seattle, Washington 98195 (present address, U.S. Geological Survey, Federal Center, Denver, Colorado 80225).* (12 p., 12 figs., 4 tbls.)

Evidence of three major Quaternary glaciations is recognized in the Metolius River area on the east flank of the High Cascades. The latest glaciation (Cabot Creek glaciation) is multiple, with evidence of a late readvance (Canyon Creek advance) well displayed in cirques. Post-Altithermal glacial activity is restricted to a twofold late Neoglacial advance on Mount Jefferson and Three-Fingered Jack. Stone-weathering characteristics and soil development are used to differentiate and correlate the drifts throughout the area. The degree of soil development on the drifts suggests that there was a longer period of time between the oldest and intermediate glaciations than between the intermediate and youngest glaciations.

Volcanic activity may have been restricted to times of little ice cover, since no evidence of intraglacial volcanism was observed. Tephra and lava flows were erupted during two Pleistocene interglaciations and during Holocene time at scattered locations. The High Cascade platform and probably the stratovolcanoes were largely constructed prior to the earliest recognized glaciation (Abbott Butte glaciation).

Information on extent of ice cover during the Cabot Creek glaciation and the Neoglacial advance is sufficiently detailed to reconstruct past glacier margins and estimate former equilibrium-line altitudes (ELA). An accumulation-area ratio of 0.6 ± 0.1 was employed to calculate past ELAs. During the Cabot Creek glaciation, ELAs ranged from about 950 m lower than present at the maximum to 700 to 750 m lower than present for the Canyon Creek advance. Neoglacial ELAs on Mount Jefferson glaciers were lower than present by 200 to 250 m. ELA gradients across the Western Cascades during the Cabot Creek glaciation averaged about 5 m/km, increased to 14 m/km across the High Cascades, and were greater than 38 m/km farther east. This reflects a pattern of precipitation similar to that of the present.

☐ 70114—U-Pb zircon dates from the central Appalachian Piedmont: A possible case of inherited radiogenic lead. *Michael W. Higgins, U.S. Geological Survey, Reston, Virginia 22092; Akhaury K. Sinha, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24016; Robert E. Zartman, U.S. Geological Survey, Denver, Colorado 80225; William S. Kirk, U.S. Geological Survey, Reston, Virginia 22092.* (8 p., 3 figs., 1 tbl.)

Zircon dates from metavolcanic and metaplutonic rocks of the central Appalachian Piedmont in Maryland and

Virginia are important for interpreting the age of the Glenarm Series. Compilation and evaluation of available data from this area suggest that Piedmont zircons may have inherited a component of older radiogenic lead in seed crystals, which were derived from the Precambrian basement complex. The zircons were also affected by lead and uranium loss during subsequent Paleozoic metamorphism recorded in the Piedmont terrain and (or) recent dilation of the rock at surface conditions. Thus, the apparent dates might not represent precise rock ages, but may still give valuable information about the evolution and history of the rocks.

☐ 70115—Was development of brackish oceans a factor in Permian extinctions? *Calvin H. Stevens, Department of Geology, San Jose State University, San Jose, California 95192.* (6 p., 2 figs., 1 tbl.)

Extinction of major components of marine communities during Permian time was the most devastating event in the history of life. The pattern of extinction suggests that, among other possibilities, salinity changes in the oceans could have been a primary contributing factor. New data on Permian halite deposits show that the volume is far greater than previously suspected, amounting to at least 10 percent of the volume of salt presently in solution in the oceans. This amount is well over one-half the volume that, if removed from modern oceans, would produce brackish conditions resulting in mass extinctions in modern marine communities. Inasmuch as there may be considerably more Permian halite than has yet been discovered or dated as Permian, and as vast amounts of halite may have been lost from Permian deposits through solution in the past 225 m.y., it is considered probable that development of brackish oceans was an important factor in Permian extinctions.

☐ 70116—Late Pleistocene environment of the central Delmarva Peninsula, Delaware-Maryland. *Leslie A. Sirkin, Department of Earth Sciences, Adelphi University, Garden City, New York 11530; Charles S. Denny, Meyer Rubin, U.S. Geological Survey, Reston, Virginia 22092.* (4 p., 3 figs.)

The Parsonsburg Sand, which is part fluviatile and part eolian, mantles terraces and uplands in the central Delmarva Peninsula. Its organic horizons are fresh-water peats, which range in age from about 30,000 to 13,000 yr. Pollen assemblages in the sediments suggest colder and perhaps drier conditions than at present.

☐ 70117—Pleistocene stratigraphy of the western equatorial Pacific. *Mark J. Valencia, Department of Oceanography, University of Hawaii, Honolulu, Hawaii 96822 (present address, Old Port Road, Kennebunk, Maine 04043).* (8 p., 5 figs., 4 tbls.)

Paleomagnetic and C^{14} age-supported correlations of fluctuations in the frequency of the *Globorotalia cultrata* complex and other faunal and lithologic parameters in seven carbonate cores establish a paleoclimatic stratigraphy for the past 700 × 10^3 yr in the western equatorial Pacific. Oscillations in the faunal and lithologic parameters are interpreted as being due primarily to variations in surface-water productivity, which are in turn linked to waxing and waning of equatorial upwelling intensity. Apparent in the western equatorial Pacific stratigraphy are eight to nine upwelling-intensity cycles in the Brunhes normal polarity epoch.

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☐ 70118—Geologic setting of some destructive earthquakes in Central America. *Michael J. Carr, Department of Geology, Rutgers College, New Brunswick, New Jersey 08903; Richard E. Stoiber, Department of Earth Sciences, Dartmouth College, Hanover, New Hampshire 03755.* (6 p., 5 figs.)

Most destructive earthquakes in Central America are either shallow earthquakes of moderate size ($4 \leqslant M \leqslant 7$) that occur in the volcanic belt or large shallow earthquakes ($M > 7$) that occur along the inclined seismic zone. Each of these classes of earthquakes, as well as the locations where population centers have developed, appears to be spatially controlled or influenced by Quaternary structures. This study examines the relationships between destructive earthquakes and Quaternary tectonics and uses this information to develop qualitative estimates of seismic hazard.

Quaternary structures in the volcanic belt of Central America are linked to the zone of plate convergence by transverse breaks that segment the overriding slab and the underthrust slab. The surface expressions of these breaks are transverse structural depressions. Longitudinal structural depressions coincide with lines of active volcanos.

Moderate-size shallow earthquakes in the volcanic belt occur within the grid of transverse and longitudinal structural depressions. Many of these shallow earthquakes occur near the lines of active volcanos or are associated with volcanic eruptions. The grid of structural depressions that localizes these earthquakes provides a topographically favorable urban site. Many cities have therefore been built in especially hazardous areas.

Large shallow earthquakes that occur in the inclined seismic zone can be divided into two types: major earthquakes that have relatively small focal areas and short recurrence times and which cluster around transverse breaks in the arc, and great earthquakes that have large focal areas, cause great damage, are infrequent, rupture one or more segments of the arc, and have focal areas that end at transverse breaks. Most great Central American earthquakes occurred in two brief space-time progressions. During 1847–1851 great earthquakes ruptured the El Salvador, eastern Nicaragua, and two Costa Rican segments of the arc. During 1898–1902, the western Nicaragua segment, the three Guatemalan segments, and a segment in southeast Mexico were ruptured. The most probable areas for the next great earthquake are the El Salvador and central Costa Rica segments of the arc.

☐ 70119dr—Large-scale recumbent folding in the valley and ridge province of Alabama: Discussion and reply.

Discussion: *Dietrich Roeder, Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37916.*

Reply: *Charles E. Shaw, Geological Consultant, 2405 Briar Ridge, Houston, Texas 77057.*

☐ 70120dr—Paleotemperature analysis of the marine Pleistocene of Long Island, New York, and Nantucket Island, Massachusetts: Discussion and reply.

Discussion: *Horace R. Blank, Department of Geology, Texas A&M University, College Station, Texas 77843.*

Reply: *Thomas C. Gustavson, Bureau of Economic Geology, University of Texas at Austin, Austin, Texas 78712.*

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