Meetings and Societies

Radiocarbon Dating

The international conference on radiocarbon dating that was held 1–4 Oct. 1956 at Andover, Mass., was an informal, work-session type of conference. It was sponsored by the Robert S. Peabody Foundation for Archaeology and the National Science Foundation, with the assistance of the Socony Mobil Oil Company and the Humble Oil Company. Frederick Johnson was general chairman. There were 53 participants representing archeology, geology, physics, oceanography, geochemistry, soil science, and botany. Fifteen came from six foreign countries. The participants were selected by a steering committee because of their specific interest in the following chosen subjects: methodology; reservoir and mixing problems; regional stratigraphy and chronology in North America; regional stratigraphy and chronology in Europe; chronological problems in the archaeology of Europe; and chronological problems relative to the early stages of culture development in North America. There was a final session, "Major stratigraphic problems," which reviewed, correlated, and coordinated many of the data presented.

Papers were presented by H. deVries, R. Brannon, M. Williams, J. L. Kulp, P. Kruger, E. Ehn, W. Burke, M. Rubin, E. Willis, W. F. Libby, E. Anderson, J. R. Arnold, R. Revelle, H. Suess, H. Craig, W. Broecker, E. Barghoorn, R. Goldthwait, J. A. Elson, J. Thorp, A. C. Blanc, H. L. Movius, F, Brandtner, T. Mathiassen, J. G. D. Clark, A. Krieger, J: C. Kelley, C. Meighan, J. Witthoft, G. Arrhenius, C. Emiliani, and E. McFarlan. The other participants provided discussions of great value.

Following an initial session devoted to recent technical developments in the method, there were discussions of problems of mixing time and of the contemporary assay. Much new work has been done since the 1954 conference, and an entirely new picture is emerging. Measurements of the "age" of surface and deep-ocean water samples and of the Suess effect (the depression of the carbon-14 activity of the biosphere by the burning of fossil fuel) have produced new information on mixing times. Papers presented during two sessions were concerned with experimental and theoretical work.

The results of independent investigations by Arnold, Anderson, Revelle, Suess, and Craig are remarkably consistent. The presentation of these began with the description of a simple model for the mixing process. This divided the exchange reservoir into three parts. Reservoir A contains the atmosphere and land life. Reservoir B is the surface or mixed layer of the ocean, and reservoir C is the deeper ocean. It was concluded that the mixing time from A into B was of the order of 10 years and from B into C perhaps 20 years. It was shown that the "age" of the deep-ocean water could not be due to solution of the bottom sediments. Such ideas were reinforced particularly by a discussion of the Suess effect and of the importance of the consumption of fossil fuel in producing climatic variation. It was pointed out that a fairly rapid mixing time between air and ocean does not exclude a large increase in the carbon dioxide contained in the air, because of the complex equilibria involved. Additional analysis divided the exchange reservoir into five parts. This indicated that the turnover time of the atmosphere into land life is perhaps 20 years, while that for the atmosphere into the mixed layer of the ocean is 7 ± 3 years. This is consistent with Libby's tritium data.

An extensive series of new data on Atlantic Ocean water samples was supplied by Broecker and Kulp. These supersede earlier results and are in general agreement with the earlier work of Rubin, Suess, and Fergusson. These data should permit study of the motion of individual water masses.

In a study of the contemporary assay of wood and shell, Brannon and Williams reported that two trees growing in a swamp environment showed activities differing by several percent from the usual values for 19th century wood. Fortunately, this experience seems to be uncommon, although the Suess effect must, of course, be taken into account in dealing with more modern samples. Suess effects in the neighborhood of 3 percent for the Gulf Coast area were reported. The activity of modern shells shows a considerable variation, depending on the place of origin. Samples obtained in open bay areas, however, show a gratifying consistency. Variations, in some instances large, are found in lagoons and land-locked basins. This effect seems to be related to the "hard-water lake" effect analyzed and published by Deevey and others.

As an example of the importance of the microscopic and chemical study of samples, Barghoorn showed that, among other things, the cellulose fraction of wood may be rather quickly removed while the lignin is retained for longer periods. Unfortunately the lignin fraction is somewhat soluble, and material of similar chemical composition may migrate and be redeposited in another place.

A discussion of several variations in accuracy of carbon-14 dates came to the conclusion that, if 19th-century standards are chosen, the Suess effect probably can be made unimportant. Local variation, especially in shells, can be highly significant. Possible variations in the size of the exchange reservoir under glacial climates are unimportant. The most significant problem is that of biological alteration of materials in the soil. This effect grows more serious with greater age. To produce an error of 50 percent in the age of a 10,000-year-old specimen would require the replacement of more than 25 percent of the carbon atoms. For a 40,000-year-old sample, the figure is only 5 percent, while an error of 5000 years can be produced by about 1 percent of modern materials. Much more must be done on chemical purification of samples.

Sessions devoted to broad problems of regional stratigraphy and chronology produced reviews of great value, aimed particularly at the sequence of events since the last major interglacial period. The data presented brought out the superiority, in many regions, of nonglacial over glacial strata for correlation, although the occurrence of fossil logs in till is of great use in dating till and approximating the rates of advance of glacier margins. The correlation of carbon-14-dated pollen-stratigraphic sequences with glacial sequences within a single region was shown to be feasible.

Review of the accumulated carbon-14 dates in the Great Lakes region, including new dates from Minnesota and from the Lake Agassiz area, showed that knowledge of the classical Wisconsin glaciation and deglaciation is now extensive and fairly consistent throughout a broad belt of country. The region of widespread loess farther west is by no means as well illuminated by carbon-14 dates; not even the widely known Brady soil is adequately dated. The way in which pairs of carbon-14 dates could be

used to approximate rates of soil development was described.

New information, including significant data from ancient soils, has made possible important advances in knowledge of the sequence of glacial drifts in the Rocky Mountains and of the phases of the pluvial lakes Bonneville and Lahontan. Owing to lack of carbon-14-datable material, however, only very late parts of the chronology of these features are known. Knowledge of glacial and permafrost sequences in Alaska is growing rapidly, mainly through studies by the U.S. Geological Survey. Interregional correlations within Alaska are beginning to take form.

In Europe, recent studies in Denmark have established a section, largely pollen-analyzed, extending through most or all of the strata down to the last major interglacial; the section is at least partly controlled by carbon-14 dates. Although far less complete, British data seem to be in general agreement. The British Postglacial sequence is now well established, and it is fairly well controlled by independent carbon-14 dates.

Würm stratigraphic sequences in the Alps, which have long been obscured in part by overlapping and conflicting stratigraphic names, with resulting difficulties in communication, are now beginning to appear as a single unified sequence. The broad outlines of a reasonable correlation with Denmark and with Britain likewise can be discerned. The same is true of the well-documented succession of loess sheets and soil zones in central Europe, the carbon-14 dates on which are in agreement with those of corresponding events elsewhere.

Stratigraphic determinations from subsurface data in western-coastal Italy afford a record of much of the rise of sea level since the last major interglacial age. Segments of the curve of this rise are controlled by carbon-14 dates and by pollen studies in Britain and in Gulf-Coastal United States. In both regions, the evidence favors the concept that sea level has not stood eustatically higher than now at any time since the last glaciation. The conflict of this concept with evidence from other parts of the world is recognized but remains unresolved.

The over-all general similarity of temperature curves for the time since the last major interglacial period, derived from geologic evidence, pollen data, and from sea floor sediments, promises firm intercontinental correlations throughout the Northern Hemisphere. This is consistent with the concept that major climatic events, at least throughout that hemisphere, have been broadly contemporaneous. Furthermore, the similarity of these curves constitutes ground for the belief that a broad temperature history of lands and seas for at least the upper part of the Pleistocene will emerge within the comparatively near future.

Discussions of chronological problems in the archeology of Europe were devoted largely to the presentation of sequences of the several kinds of human occupation and the relationship of these to the geologic sequence. The number of radiocarbon dates for the region is as yet inadequate, and the ages of many crucial points in a number of sequences remain controversial. Discrepancies between archeologic data and the geologic sequence in western France can be interpreted to mean that fluctuations in climate were not closely synchronous with the glacial regimen of central Europe. On the other hand, in central Europe the archeological sequence from Mousterian through Aurignacean, Gravettian, and Magdalenian can be correlated with various soil horizons in the cross section of the loess. In northern Europe, the sequence of Late Palaeolithic hunting cultures commences with the Hamburgian type of culture found at Miendorf and other locations. This dates from the Lower Dryas, between 10,000 and 13,000 B.C. This was succeeded by the Federmesser culture of Alleröd age and the Ahrensburgian, which is not Mesolithic as some would have it. The Lyngby culture of Late Dryas time in some of its expressions is Early Mesolithic in character. The adjustment of peoples to biogeographic changes at the end of Late Glacial times in northern Europe and the British Isles completed this discussion.

Radiocarbon dating has provided a much needed time scale for development of human culture in North America, and this permits tentative correlation of sequences of cultural phenomena across the continent. A crude percussion stone industry may have existed more than 20,000 years ago. Controversial though it may be, there is some evidence of the distribution of a hypothetically very early and crude culture, at least from the Valley of Mexico to caves in Texas and California and on the islands offshore. It is found also on the ancient lake shores of the Great Basin. Usually, the deposits can be identified by associated fauna as middle or late Pleiocene.

A few dates and estimates of the age of the Paleo-Indian suggest that the Folsom material ranges in age from 10,000 to 12,000 years and that the horizon incorporating Clovis fluted projectile points may have existed from 12,000 to 16,000 years ago. The date for the Clovis type of material from the Lewisville, Tex., site "greater than 37,000" years confounds present chronological estimates. By about 10,000 years ago, several other types of stone industries were in existence in the continent. This appears to mark the beginning of a proliferation of stone artifact types giving rise to the many variations which are known to have existed in much later times.

It now appears that human cultures are as old in California as they are in other parts of the New World. What is most astonishing, however, is the conservative nature of the stone industry. There has been relatively little change in basic characteristics for the past 9000 or 10,000 years. Observations on aboriginal life made as late as A.D. 1850 can be projected back for several thousand years into prehistory, and these produce useful inferences concerning the ethnology of very early periods. A crude stone industry, in its early form lacking in well-made projectile points, supported a people who were economically prosperous. Through the ages there were minor changes in the stone industry, largely by the addition of types of stone ornaments and fairly well-made projectile points, but the economics of the civilization remained the same until it was overrun by European culture.

Types of cultures comparable or analogous to the California material, called "Desert cultures," are found in California, Nevada, Utah, Arizona, New Mexico, Texas, and northern Mexico. Almost certainly, they extend into Oregon, Idaho, Wyoming, and Montana. In the Southwest, the Desert cultures appear to be generally later than the Paleo-Indian, but they may have overlapped them in time. These cultures first appeared either in the Altithermal period or toward the close of the preceding Anathermal period. About the beginning of the Christian era, the Desert cultures appear to have been transformed locally into early Southwestern agricultural and ceramic cultures. There is fair agreement between the radiocarbon dates and the geologic-climatic record. However, a few significant inconsistencies require further archeologic investigation and the determination of additional dates.

Archaic occupation of the lower layers of two rock shelters in Missouri and Illinois are clearly related to the Southwestern desert cultures. Furthermore, in Graham Cave in Missouri there is evidence of Paleo-Indian influence. However, the dates for these levels, the oldest being about 8000 years, pose problems in the distribution of the cultures themselves and the animals they used for food.

In the East, archeologic records of early occupation are fragmentary. The types of artifacts from the western slopes of the Appalachians differ from the types found on the eastern side. In addition, a particular type of occupation of the high mountain areas may eventually be identified. There are no dates in the data which are the source of these speculations. However, the material appears to

be later than that of the few Paleo-Indian sites which are known. Slowly a chronology is appearing for the Hopewell and Adena cultures found in Ohio, Kentucky, and much of the Middle West. Presently available carbon-14 dates indicate that the Adena overlaps the Hopewell in time. The problem requires for its solution determination of additional dates on specific sites and more precise archeologic definition of the significance of these sites.

Aside from presentation of new data in a number of specific fields, the conference made possible exchange of ideas between physicists and chemists and scientists representing fields that utilize the results of the method. The joint endeavor impressed upon the participants the character and magnitude of the problems in many lines of research. Its value will be seen in its effect on technical developments and an improved interpretation of results.

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JAMES R. ARNOLD
Princeton University, Princeton, New Jersey
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AAAS Southwestern Division Meeting

A call for papers has been issued for the 1957 meeting of the AAAS Southwestern and Rocky Mountain Division, which is to be held in Tucson, 28 Apr.–2 May. Frank E. E. Germann, who has served so long as executive secretary, has found it necessary to retire from most of the duties of that position. Marlow G. Anderson, president of the division, has agreed to take care of those duties until a secretary is selected at the annual meeting.

The Tucson meeting promises to be outstanding. The Arid Zone Committee is planning a symposium program on the general topic "Climate and man in the Southwest." Anton Berkman has agreed to organize another program to continue the theme introduced at the Las Cruces meetings on "The education of scientists." Albert R. Mead is chairman of the local committee.

Titles and abstracts of papers should be sent to the secretary of the appropriate section no later than *1 Mar.* The secretaries are as follows: Botanical Sciences, Dr. James L. Gardner, P.O. Box 35, State College, N.M.; Physical Sciences, Dr. Edward N. Wise, University of Arizona, Tucson, Ariz.; Social Sciences, Dr. Stanley S. Newman, University of New Mexico, Albuquerque, N.M.; and Zoological Sciences, Mr. Roy E. Gilmore, P.O. Box 832, State College, N.M. The work of the section secretaries will be facilitated if each author indicates the time required for presentation of his paper, and the projection or other equipment needed.

Foreign Membership in Physical Society of Japan

The Physical Society of Japan has recently provided for the establishment of foreign membership. Any physicist abroad can now become a member (annual dues are $4.50) and receive the *Journal of the Physical Society of Japan.* A member may also subscribe to *Progress of Theoretical Physics* at a reduced rate.

Scientific Study of Religion

The Society for the Scientific Study of Religion held its fall meeting at Harvard University on 9 Dec. 1956. Featured on the program was a symposium, "Crime and illness, guilt and sin: contemporary predicaments." Participants were George E. Gardner, director of the Judge Baker Guidance Center; Asher Pacht, director of rehabilitation and training, Massachusetts Department of Correction; Volta Hall, Harvard Medical School; L. Guy Brown, Rhode Island University; and Richard McCann, Andover Newton Theological School.

Social scientists who would like to propose 12-minute reports on empirical research for the spring meeting of the society, which will be held in New York on 13 Apr., should send three copies of an abstract not exceeding 300 words to Werner Wolff, Bard College, Annandale-on-Hudson, N.Y., *before 10 Mar.*

Junior Academies of Science

All persons concerned with Junior Academies of Science are invited to attend the conference to be held on the Navy Pier campus of the University of Illinois, 15–16 Feb., beginning at 9 A.M. This conference is sponsored by the Academy Conference, the American Association for the Advancement of Science, the National Science Foundation, and the Oak Ridge Institute for Nuclear Studies.

Society Elections

■ Mathematical Association of America: pres., G. B. Price, University of Kansas; 1st v. pres., R. V. Churchill, University of Michigan; 2nd v. pres., B. W. Jones, University of Colorado; sec.-treas., H. M. Gehman, University of Buffalo; assoc.-sec., Edith R. Schneckenburger, University of Buffalo.

■ National Association of Biology Teachers: pres., John Breukelman, Kansas State Teachers College, Emporia; past pres., John P. Harrold, Midland Senior High School, Midland, Mich.; pres.-elect, Irene Hollenbeck, Southern Oregon College of Education, Ashland; 1st v. pres., Howard E. Weaver, University of Illinois, Urbana; 2nd v. pres., Frances L. Hall, Columbia University Teachers College, New York; 3rd v. pres. and national membership chairman, Robert Smith, DeKalb High School, DeKalb, Ill.; sec.-treas., Paul V. Webster, Bryan City Schools, Bryan, Ohio.

■ American Society of Parasitologists: pres., Gilbert F. Otto, Abbott Laboratories; pres.-elect, Arthur C. Walton, Knox College; v. pres., Allen McIntosh, U.S. Department of Agriculture; treas., Robert M. Stabler, Colorado College; sec., Paul E. Thompson, laboratory director in parasitology, Research Division, Parke, Davis and Company, Detroit 32, Mich.

■ American Economic Association: pres., Morris A. Copeland, Cornell University; sec.-treas., James Washington Bell, Northwestern University. The vice presidents are Ben W. Lewis and Joseph J. Spengler.

■ Society of Systematic Zoology: pres., Raymond C. Moore, Lawrence, Kan.; pres.-elect, Alfred E. Emerson, Chicago, Ill.; sec., R. E. Blackwelder, Victor, N.Y.

Forthcoming Events

March

7–9. American Orthopsychiatric Assoc., 34th annual, Chicago, Ill. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

7–9. Biometric Soc., Eastern North American Region, Washington, D.C. (A. M. Dutton, Box 287, Sta. 3, Rochester, N.Y.)

7–9. Fundamental Cancer Research, 11th annual symp., Houston, Tex. (L. Dmochowski, M. D. Anderson Hospital, Texas Medical Center, Houston 25.)

7–9. Optical Soc. of America, semiannual, New York, N.Y. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)

10–16. Nuclear Engineering and Science Cong., 2nd, Philadelphia, Pa. (Engineers Joint Council, 29 W. 39 St., New York 18.)

11–15. National Assoc. of Corrosion Engineers, 13th annual, St. Louis, Mo. (R. T. Effinger, Shell Oil Co., Deer Park Refinery, Houston, Tex.)

11–18. Pakistan Assoc. for the Advancement of Science, 9th annual conf., Peshawar, West Pakistan. (B. Ahmad, PAAS, University Institute of Chemistry, The Mall, Lahore, Pakistan.)

12–13. Cellular and Humoral Aspects of the Hypersensitive States, symp., New

York, N.Y. (A. M. Pappenheimer, Jr., Dept. of Microbiology, New York Univ., College of Medicine, 550 First Ave., New York 16.)

13–15. Society of Exploration Geophysicists, 10th annual midwestern, Fort Worth, Tex. (G. A. Grimm, Tide Water Associated Oil Co., Box 2131, Midland, Tex.)

14. Effect of Radiation on Foods, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

15. Fats in Human Nutrition, AMA symp., New Orleans, La. (Council on Foods and Nutrition, American Medical Assoc., 535 North Dearborn, Chicago 10, Ill.)

18–21. Institute of Radio Engineers, natl. convention, New York, N.Y. (B. Warriner, IRE, 1 E. 79 St., New York 21.)

19–21. American Meteorological Soc., 151st national, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

20–22. National Health Forum, Cincinnati, Ohio. (National Health Council, 1790 Broadway, New York 19.)

20–23. National Science Teachers Assoc., annual, Cleveland, Ohio. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

21–23. American Physical Soc., Philadelphia, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27, N.Y.)

21–23. International Assoc. for Dental Research, annual, Atlantic City, N.J. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

21–23. Michigan Acad. of Science, Arts and Letters, annual, Detroit, Mich. (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

22–23. Heart: Law-Medicine Problem, Cleveland, Ohio. (O. Schroeder, Jr., Law-Medicine Center, Western Reserve Univ., Cleveland 6.)

23–28. American Soc. of Tool Engineers, 25th annual, Houston, Tex. (R. Gebers, 10700 Puritan, Detroit 38, Mich.)

24–27. American Assoc. of Dental Schools, annual, Atlantic City, N.J. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25–28. American Acad. of General Practice, 9th annual scientific assembly, St. Louis, Mo. (M. F. Cahal, AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)

25–29. Western Metal Exposition and Congress, 10th, Los Angeles, Calif. (W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.)

26–28. Mechanisms for the Development of Drug Resistance in Microorganisms, Ciba Foundation Symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

26–28. Weather Radar Conf., 6th, sponsored by American Meteorological Soc., Cambridge, Mass. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

27–29. American Power Conf., 19th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Inst. of Technology, 35 W. 33 St., Chicago 16.)

27–29. Effects of Radiation on Materials, colloquium, Baltimore, Md. (Office of Naval Research, Glenn L. Martin Co., Baltimore 3.)

27–29. National Committee on Alcoholism, annual, Chicago, Ill. (Miss E. Jensen, NCA, 2 E. 103 St., New York 29.)

31–9. Pan American Cong. of Social Work, 3rd, San Juan, P.R. (Mrs. M. Velez de Perez, Apartado 3271, San Juan.)

April

1–4. American Assoc. of Petroleum Geologists, 42nd annual, St. Louis, Mo. (R. H. Dott, AAPG, Box 979, Tulsa, Okla.)

1–4. International Anesthesia Research Soc., cong., Phoenix, Ariz. (A. W. Friend, Wade Park Manor. Cleveland 6, Ohio.)

1–4. Society of Economic Paleontologists and Mineralogists, annual, St. Louis, Mo. (S. P. Ellison, Jr., Dept. of Geology, Univ. of Texas, Austin.)

1–5. Assoc. of American Geographers, annual, Cincinnati, Ohio (B. W. Adkinson, Reference Dept., Library of Congress, Washington 25.)

2–3. Future Developments in Food Preservation, symp., Kansas City, Mo. (Food Symposium, Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

4–5. Dietary Fats—Helpful or Harmful, 3rd annual nutrition conf., Detroit, Mich. (A. H. Smith, Wayne State Univ. College of Medicine, Detroit 7.)

5–6. American Mathematical Soc., New York, N.Y. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

(See issue of 18 January for comprehensive list)