Book Reviews

Presumptions About Geologic Time

Lord Kelvin and the Age of the Earth. JOE D. BURCHFIELD. Science History Publications, New York, 1975. xii, 260 pp. $15.

In the second half of the 19th century, the theory of evolution by natural selection was widely acknowledged as the epitome of the intellectual adventure that had begun 300 years before. But for many scientists it was thermodynamics that was, in Duhem's words, the paradigm of the exact sciences. While Charles Darwin was writing the *Origin of Species*, William Thomson, Lord Kelvin, was establishing the first and second laws as the foundation on which to rest a science of thermodynamics. Kelvin, who early interested himself in matters geological, saw a profound discrepancy between the second law of thermodynamics with its implications of a universe inexorably running down and the dominant geological orthodoxy of uniformitarianism. Charles Lyell's *Principles of Geology* had explained the configuration of the earth's crust as due to the operation of present causes, seemingly insignificant but operating over times multiplied sufficiently to account for the vastest effects. With his 18th-century predecessor James Hutton, who had found "no vestige of a beginning" and could envision "no prospect of an end," Lyell and his followers made virtually limitless "drafts upon the bank of time." Charles Darwin had seized upon this concept of the action of infinitesimal causes operating over indefinitely long times to account for the variation and proliferation of species. Lyell's was a steady-state earth, essentially unhistorical. This conception led him to withhold for many years support of his friend Darwin's evolutionary theory, but both were prodigal in their calls for time "inconceivably vast" for the geologic record.

When Kelvin applied the energy laws to the sun, the constancy of solar radiation over any considerable period of time was manifestly impossible. In addition, all calculations of the thermal budget of the earth's crust pointed to a hotter past and a rapidly approaching fall of temperature of catastrophic portions. The apparent steady state of the geological record was in direct contradiction to the laws of physics in their purest form.

Joe D. Burchfield, a historian of science who began his career as a student of physics, has traced in full detail the conflict that arose between the geologists and biologists on the one hand and the physicists on the other. It is a record not without its ironies. Maxwell's first principle of physical science—the independence of experience from time or place—was the resort of the geologists, while the physicists insisted upon the directionality of the history of the earth. The discovery of radioactivity and the invalidation of the second law when Pierre Curie put radium salts in a vacuum bottle reversed the situation. Now the physicists became geological uniformitarians with boundless expanses of available time, while the geologists clung to their arithmetic calculations designed originally to meet Kelvin's restrictions.

It was a conflict that engaged the major figures of 19th-century science and that reached to the roots of the scientific outlook. Burchfield's book is a thorough, point-by-point analysis of the shifting opinions, positions, and results of the many participants in the conflict. At the end, it was the American geologist Clarence King who placed the closest curbs on time and the greatest trust in the second law. As an analysis of British Victorian science—the few Americans involved were probably more Victorian than their British colleagues—this book reveals all the defects of institutionalized and professional science. The laws of thermodynamics were elevated into articles of faith. Reason and observation were subordinated to obsequious conformism. The success of whole generations of prominent geologists in obtaining, by a variety of methods, values for the duration of geologic time that were in close agreement with each other and with the constraints of Kelvin is testimony to the sterility of their thought. How pallid they seem beside Lyell, who proposed what was essentially a perpetual motion mechanism to meet the difficulties, or Darwin, or Kelvin himself with his total self-confidence! But there were heroes also—John Perry, who did not hesitate to subject Kelvin's assumptions to critical analysis, and T. C. Chamberlin of Chicago, who asserted the supremacy of the observed geologic record to any pyramid of deductions however powerful the mathematical apparatus brought to bear.

It was a classic encounter between tiger and whale. For the construction of a philosophy of science (as distinct from a philosophy of physics), this interaction of historical and analytic sciences in which each took the other's role is a major challenge. As intellectual and social history Burchfield's book is a challenge of another order. It is not a comfortable book for those of us who cherish illusions of the infallibility of science. It is in fact a profoundly disturbing one. For a generation that has learned to question the assumption of the moral superiority of the scientist, this record of half a century of hubris is heavy indeed. Those who are ignorant of history are condemned to relive it. If Burchfield's book can contribute to relieving us of this burden, it will have amply justified its publication.

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Tercentenary

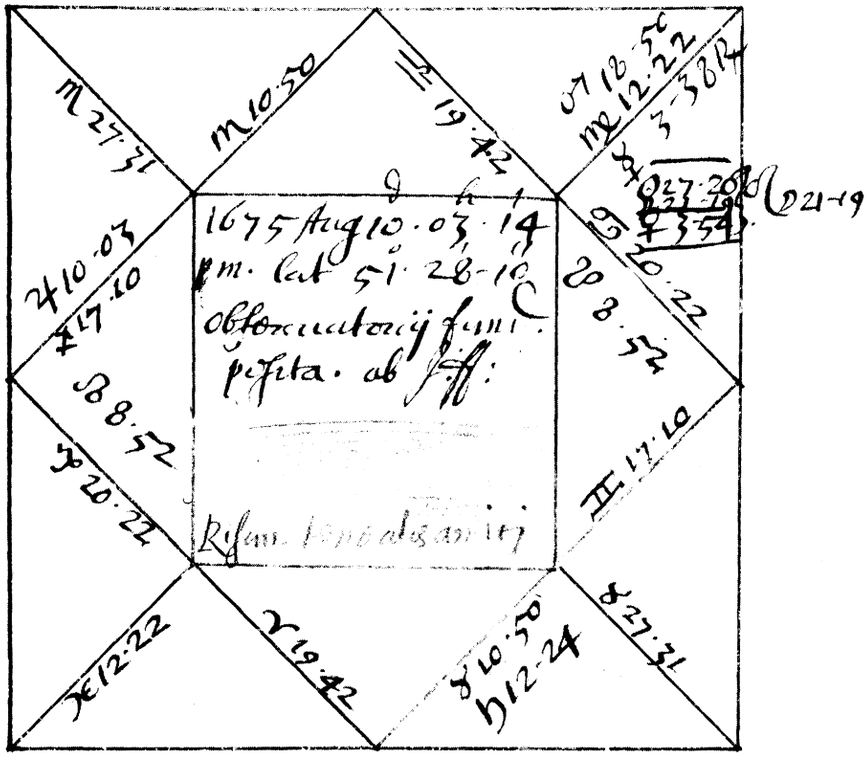
Greenwich Observatory. Three volumes, boxed. Vol. 1, Origins and Early History (1675–1835). ERIC G. FORBES. xvi, 204 pp. + plates. Vol. 2, Recent History (1836–1975). A. J. MEADOWS. xii, 136 pp. + plates. Vol. 3, The Buildings and Instruments. DEREK HOWSE. xx, 178 pp. + plates. Taylor and Francis, London, 1975 (U.S. distributor, Scribner, New York). $60.

Francis Place and the Early History of the Greenwich Observatory. DEREK HOWSE. Science History Publications, New York, 1975. 64 pp., illus. $12.95.

300 Years of Greenwich. *Nature*, Vol. 255, No. 5510 (19 June 1975), pp. 581–606. *Nature*, 711 National Press Building, Washington, D.C. The issue, $1.25.

Royal Greenwich Observatory. An Historical Review Issued on the Occasion of Its Tercentenary. WILLIAM HUNTER MCCREA. Her Majesty's Stationery Office, London, 1975 (U.S. distributor, Pendragon House, Palo Alto, Calif.). viii, 80 pp. + plates. Paper, $5.

The Royal Observatory at Greenwich, established by King Charles II in 1675, claims distinction as Britain's oldest scientific institution. Unlike the Paris Observatory, founded in 1667 for general astronomical researches, the Royal Observatory was chartered with a specific Baconian purpose: to perfect the art of navigation through the determination of



"Horoscope of the Royal Observatory, cast by John Flamsteed, first Astronomer Royal, for the moment of 'birth'—the time the foundation stone was laid by Flamsteed himself—1675 August 10^{d} 03^{h} 14^{m} p.m. He added: *Risum teneatis amici–(May this keep you laughing, my friends).*" [Reproduced in *Francis Place and the Early History of the Greenwich Observatory* from RGO MSS 18/2^{r}]

the position of the stars and the motions of the moon and the planets. The steadfastness of purpose of the astronomers royal and the repetition of observations with ever more precise instruments combined to ensure Greenwich's commanding place in the realm of positional astronomy, and its selection as the prime meridian from which longitude and time are measured.

The 300th anniversary of the founding of the Royal Observatory has been widely celebrated this year. Foremost among the commemorative publications is *Greenwich Observatory*, a handsome, generously illustrated three-volume boxed set. Volume 1, "Origins and Early History (1675–1835)," was written by Eric Forbes, a renowned scholar who has worked closely on such subjects as Tobias Mayer's highly successful lunar theory, and with newly discovered Flamsteed papers. Consequently, the book contains a truly amazing amount of detail, much of which is new, concerning the history of observational and computational techniques and personal and institutional maneuverings; an extensive bibliography provides a useful introduction to other relevant literature. The main arguments of this volume will be difficult for readers lacking a familiarity with the history of astronomy and biographies of the principal actors, however. Volume 2, "Recent History (1836–1975)," written by A. J. Meadows, differs from the first in scope, depth, and intended audience. Aimed at the general reader, it proves a highly readable introduction to general scientific, institutional, and personality matters. None of these, however, is pursued at any great length, and several obvious problems are passed over in silence. The focus of this volume is the mid-19th century and the actions and ideas of the idiosyncratic and quotable George Biddell Airy, next to whom his successors appear pale. Margaret Burbidge, the first female director of the Royal Observatory, rates but six lines. The decision to appoint a radio astronomer to the post of astronomer royal, and to split that post from director of the observatory, is mentioned only in passing, whereas each minor appointment of a Cambridge man to a Greenwich post is noted. Volume 3, "The Buildings and Instruments," is an extensive and useful catalog providing descriptions, methods of use, notes, historical summaries, bibliographies of contemporary accounts, and pictures. The wealth of information it contains is but a reflection of its authorship. Derek Howse, head of the astronomy department of the National Maritime Museum, has been largely responsible for the historical astronomical exhibits developed at Greenwich since the removal of the Royal Observatory to Herstmonceux Castle in Sussex in 1958.

In honor of the opening of the Royal Observatory, Greenwich, in September 1676 Sir Jonas Moore commissioned a pictorial portfolio drawn by Robert Thacker and etched by Francis Place. The set of 12 pictures included a map of Greenwich Park, views from the observatory, eastward across the park and west toward London, a plan of the observatory and prospects of its various sides, and detailed views of the instruments. Of the original edition, which must have been small, only one complete set is now known. In honor of the tercentenary Howse has, in *Francis Place and the Early History of the Greenwich Observatory*, republished the original etchings and supplied a lively historical and iconographical commentary.

The 19 June 1975 issue of *Nature* contains seven essays in a section headed "300 years of Greenwich." In their contributions Eric Forbes and A. J. Meadows present succinct summaries of the arguments developed in *Greenwich Observatory*. A. Hunter, the current director, describes the work at Greenwich in the 20th century; and F. Graham Smith, director designate, surveys the next 300 years. Two essays concern English astronomy before and at the time of the establishment of the Royal Observatory, and one relates various Greenwich anecdotes.

The fourth Greenwich tercentenary publication under review, *The Royal Greenwich Observatory*, is simply a historical chronicle of staff, buildings and apparatus, observations and research.

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North American Prehistory

The Archaeology of Missouri. Vol. 1. CARL H. CHAPMAN. Illustrations by Eleanor F. Chapman. University of Missouri Press, Columbia, 1975. xiv, 288 pp. $20. University of Missouri Studies, 62.

In 1934 Carl Chapman was among the founding members of the Missouri Archaeological Society, and since 1946 he has held the directorship of American archeology at the University of Missouri. This study is thus the culmination of a career devoted to research on the topic and to the development of both a vigorous university program and one of the most effective state amateur programs. The utility and importance of the amateur programs are readily seen from the substantial portion of the data reported in the volume that are provided by materials from private collections.

The book covers a time span ranging