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