

of polymers are described very well. Those of us who employ plastic track detectors in a variety of pure and applied fields of physics research should benefit from the discussions in the third chapter, especially from those relating to the oxygen effect and its consequences for the damage sustained by polymeric track detectors in various environments. Clearly, knowledge of the long-term persistence of free radicals following irradiation is crucial to an understanding of track formation phenomena.

There are many other subtle points that should be valuable in chemical physics and surface physics. Under radiation, polymer cross-linking is greatly enhanced over degradation in amorphous polymers, in contrast to the ratio of these competing processes in crystalline polymers. Cross-linking is also the dominant mechanism at increased temperatures.

Radiation protection of polymers is described in an entirely pragmatic fashion. The numerous ambiguities of the response of polymers to radiation are explored in the sixth chapter, where it is noted that irradiation in hard vacua and over a wide range of temperatures can produce quite different effects on the structural properties of different polymers—some improve, while others deteriorate completely. This chapter should emphasize to all readers that there is a very rich field for scientific investigation remaining in polymer-radiation effects under variable environments. The survey of potential applications in the seventh and last chapter contains much useful information on the radiation environments that are encountered by space probes, although many of the prohibitions against the use of polymers in nuclear power reactors are surely gratuitous. The design of various types of test facilities presented in the second chapter, together with appropriate cautionary remarks with regard to consideration of temperature influences when attempting to study radiation effects (and on the methods for and requirements on dosimetric procedures) should be most valuable in the design of engineering tests.

In all of the chapters cited, the qualitative description of the problems is extraordinarily useful (even though the quantitative descriptions are incomplete and are necessarily qualified), and the book will have some value to all scientists who plan to employ polymers in radiation fields. About one third of the very numerous references have been previously published only in Russian, and their results have been inaccessible to those who do not read Russian.

Unfortunately, most physicists will be turned off by Chapter 1, which purports to explain the basic physics of the

interactions of various radiations with matter. While most of the equations presented are the familiar ones we use to describe energy-loss processes by neutral and charged particles, the author does not seem to understand their meaning. Thus one finds on page 38 the statement: "... at a γ -quantum energy of 10 keV ... in thiokol, the Compton electrons are absent altogether" (sic). This extravagant assertion simply means that, at 10 keV, the Compton cross-section does not exceed 10^{-3} of the photoelectric cross section in thiokol. No distinction between "negligible" and "absent" is made. It seemed possible at first that the errors might have originated in the execrable translation. However, it eventually became clear that some of them must probably be attributed to the author. In Figure 5, the "paths" (ranges) of protons in carbon dioxide and water are shown as decreasing with increasing proton energy. American physicists who have been disturbed by their apparent failure to communicate basic physical concepts to students in related technological fields should be reassured to learn that Russian teachers of physics have done no better. Makhlis's first chapter is a very poor introduction to a rather good book.

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Growth Rhythms and the History of the Earth's Rotation

G. D. Rosenberg, S. K. Runcorn, eds.
559 pp. Wiley, New York, 1975. \$57.00

The Rotation of the Earth: A Geophysical Discussion

W. H. Munk, G. J. F. MacDonald
323 pp. Cambridge U. P., New York, 1960.
(reprinted 1975). \$19.95

The first listed of these books constitutes the proceedings of a symposium held in January, 1974; the second is a reprinting—without change in substance—of an already classic treatise.

The symposium "Growth Rhythms and the History of the Earth's Rotation" brought together 23 biological scientists and 15 physical scientists at Newcastle-upon-Tyne. Their contributions have resulted in a volume almost equally divided in number of pages between 17 primarily biological papers and 12 that are primarily physical. I find the biological part of the book more of interest, as a representative report of research on growth patterns in tidal-zone organisms.

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Most of the biology papers deal with shellfish and corals and hence pertain only to the Phanerozoic—the last 6×10^8 years. Contributions by William B. N. Berry and Richard M. Barker, George R. Clark, John W. Evans, Clarence A. Hall, Jr and others contain a wealth of fascinating detail. Generally, they emphasize that many factors other than tides—age of the organism, water depth, and so forth—influence the patterns of skeletal growth. It does seem fairly well established, however, that the tidal deceleration of Earth's rotation must have had an appreciably slower rate during much of the Phanerozoic than at present.

Only two papers treat stromatolites, the alternating bands of algae and sediments that are the main hope of measuring days per month in Precambrian times (more than 600 million years ago). Roland A. Mohr obtains a figure of 25.6 ± 1.2 days per month 2×10^9 years ago, which would imply lunar origin not long before then; he presents data only in the form of histograms of band counts. J. F. Truswell and K. A. Eriksson present a more detailed discussion of 2.25-billion-year-old stromatolites in South Africa; cautiously, they do not reach any such numerical conclusion.

Unfortunately, the time of year and location of the symposium were totally effective in discouraging attendance by university and government physical scientists from outside Europe. The resulting physical-science papers thus give a quite uneven coverage of the subject, with a couple barely this side of the lunatic fringe. By far the most important work, a report by Paul M. Muller and F. Richard Stephenson, explores the acceleration of Earth's rotation and the Moon's orbit based on medieval and ancient observations. The authors have succeeded in tidying up this subject considerably; their most significant advance consists in the realization that the unambiguity of a total solar eclipse to even the simplest observer, together with the narrowness of the path of totality compared to the path of partiality, gives the total eclipse such overwhelming weight that all other data are best thrown out. As a main result, they obtain a rate fairly close to that from modern observations and constant throughout historical time, as is geophysically reasonable.

The high price and uneven quality of the volume make it suitable only for library reference by researchers. For those seriously interested in the ancient-eclipse analyses and their geophysical implications, P. M. Muller's dissertation, with some significant improvements over the paper, is obtainable from the author so long as the supply lasts.

The Rotation of the Earth, by Walter H. Munk and Gordon J. F. MacDonald, remains the most comprehensive and insightful discussion of the subject. In particular, the formulation of solutions to

Joseph Liouville's generalization of the Euler equations in Chapter 6 represents the happiest extant treatment of an often confusing problem. Also good is the exposition of the Love number representation of Earth deformation. Their treatments of anelasticity in the solid Earth and the orbital effects of tidal friction prove less satisfying.

The book has been out of print for some years. It is a pity that this new issue has only a few minor corrections. A new edition would have served better, since there have been significant advances in the last 16 years. Some of these advances confirm in detail the work of Munk and MacDonald, as in atmospheric effects on rotation and tidal-phase lag of the oceans; however, in other areas, such as the wandering of the poles, Chandler-wobble excitation and biological indicators of past rotation—the subject of the Newcastle volume—there have taken place considerable revisions in ideas and techniques. The book even sounds oddly archaic in regard to yielding in the solid Earth, now that plate tectonics and its implications of mantle flow are well established. Nonetheless, I expect to be using the text in graduate courses for some years to come.

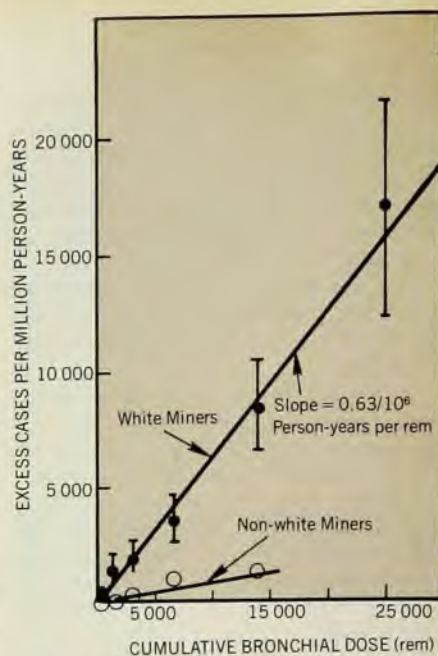
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Radioactive Contamination

V. Brodine
190 pp. Harcourt Brace Jovanovich, New York, 1975. \$4.95

Virginia Brodine, a consulting editor for "Environment" magazine, has written a readable introduction to the issues involved in the use of nuclear energy. The book is the third in the Environmental Issues Series, sponsored by the Scientists' Institute for Public Information and edited by Barry Commoner. *Air Pollution*, one of the other two books in the series, is also by Brodine.

The author takes the point of view of the environmentalist. However, she treats controversial issues such as the determination of the biological effects of chronic low-level radiation exposure accurately and fairly, recognizing the different opinions involved. A strong point of the book is its portrayal of the role of the professional scientist in the public arena. In particular, Brodine gives an extensive discussion of how decisions regarding the peaceful uses of nuclear energy and radioisotopes have been made; she criticizes the US Atomic Energy Commission for its past activities in this area. Mention is made, for example, of the landmark case, *Scientists' Institute for Public Information vs. the Atomic*



Risk of lung cancer for US uranium miners, 1951–1971. Dose–response data appear in *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, a committee report to the National Academy of Sciences.

Energy Commission (1973), in which the court ruled in favor of SIPI and required the AEC to prepare an environmental impact statement for the entire breeder-reactor program.

Radioactive Contamination begins with some case histories of nuclear accidents. Brodine relates how the AEC's Project Chariot—excavation of a harbor on the northwest coast of Alaska by nuclear explosives—was abandoned after pressure from concerned scientists and citizens. Then the effects of radioisotopes on the environment and humans are treated in two chapters, and a chapter is spent on the uses of radiation and radioisotopes in medicine, scientific research, industry and consumer products. Next, the author discusses the use of nuclear fuel for generating electricity. Her treatment is comprehensive but sketchy: engineering performance, monitoring and surveillance of radioactive emissions, transportation and storage of wastes, analysis of reactor-safety systems, the breeder-reactor concept and non-nuclear energy alternatives are all treated in 28 pages. The book ends with a chapter on nuclear weapons.

Stylistically and technically, the book is well done. Brodine has a definite journalistic style, which makes for easy reading. The book is well illustrated with interesting photographs and useful tables. There are 225 footnotes, most of them to original source material, and an index. The book has several useful appendices, one of which includes an extensive tabulation of the physical characteristics, biological characteristics and sources of selected radioisotopes.