tle by a supercontinent assembled at about 1.8 billion years ago should be considered. R. C. Newton and E. C. Hansen, in a welcome marriage of experimental petrology, field geology, and comparative tectonics, conclude that 1.0- to 2.7-billion-year-old charnokitic granulites are best explained as products of continental collisions. The section on mineral deposits contains papers on tectonic controls (F. J. Sawkins), massive sulfide deposits (G. H. Gale), stratiform lead-zinc deposits (I. B. Lambert), sedimentary iron formations (M. M. Kimberley), and uranium deposits (F. F. Langford). Three rewarding papers make up the section on life and the oceans: a poetical overview by P. Cloud, a status report on the puzzling oxygen isotope data for Proterozoic sediments by E. C. Perry and S. N. Ahmad, and an informative summary of Proterozoic plankton by G. Vidal and A. H. Knoll. Two of the four papers on glaciation do not directly concern the Proterozoic, but one of them, by J. C. Crowell, concludes with the apt warning that globally dispersed Late Proterozoic glacial deposits are probably diachronous and that paleomagnetic evidence for low latitudes may result from rapid continental drift, possibly related to the breakup of a Late Proterozoic supercontinent.

In sum, Memoir 160 will be of interest to Great Lakes geologists and those wishing to follow progress in a "classic" field area. Memoir 161, although it contains some good material, lacks sufficient originality and foresight to impress as a research document and lacks the coherence and focus desirable in a textbook.

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Self-Revelations

A Slot Machine, a Broken Test Tube. An Autobiography. S. E. LURIA. Harper and Row, New York, 1984. x, 229 pp. $17.95. Alfred P. Sloan Foundation Series.

Among literary art forms, I suspect the autobiography is the most difficult to write. The novelist is free to create as vivid and memorable a personality as his or her imagination and talent will allow. A biography can describe, dissect, and analyze the anatomy of a life. However, an autobiography presents the reader not only with the story of a life but with the autobiographer as storyteller as well. I have found most autobiographies unsatisfying. Too often the story is not whole; the author seems intent on justifying some aspect of his or her life, or, in the case of many scientists, deals only with the science and leaves the scientist as person seemingly narrowly restricted, uninteresting, and unrevealed.

Salvador Luria, in the introduction of his autobiography, *A Slot Machine, a Broken Test Tube*, informs the reader that he is aware of this problem. In Luria's view, "An autobiography is valuable if it shares with the reader even those budding insights of which the writer is still uncertain. In fact, it ought to reveal the effort of self-creation through self exploration." In a word, the autobiographer should be immanent in the story. Given this objective (with which I agree), Luria has written a successful, and unusual, autobiography.

Luria, together with Max Delbruck and Alfred Hershey, was a founder of "the phage group" in the 1940's. Their research and, more important, their intellectual influence contributed greatly to the emergence of molecular genetics, a methodology, a paradigm really, that is now invading virtually every biological nook and cranny.

I was a latecomer to the phage group, and though I was close to Delbruck I do not know Luria, although I have met him on many occasions. Thus I approached his autobiography with interest and innocence. I left it with a sense of coming to know him in the same way I grow to know my close personal friends. Indeed, the form of the book itself resembles a developing friendship.

At first rather distant and guarded, Luria recounts the major events of his life. A lower-middle-class Jew who grew up in Fascist Italy, he became a physician, but his dissatisfaction with the practice of medicine turned him to research. The rise of anti-Semitism in Italy before World War II led him to leave Italy for Paris. Before the advancing German armies, he fled Paris on a bicycle. In the south of France, he managed to obtain a visa, ending up in the United States, one of the numerous Jewish scientists rescued from the clutches of Fascism who contributed to the postwar development of American science.

In a more personal vein, Luria then describes what he perceives to be his most satisfying scientific accomplishments. I found especially fascinating his account of the role of metaphor (a slot machine) and serendipity (a broken test tube) in shaping his major discoveries, the mode of mutant formation in bacterial populations and the phenomenon of host-induced modification. The former discovery marked the beginnings of bacterial genetics, the latter led to the discovery of restriction enzymes and thus to genetic engineering.

The second half of the book increasingly reveals the "inner Luria"—his attitudes and opinions about science and the academic life, the importance of politics and political action to his life, his conscious efforts to expand his appreciation and understanding of the arts. In the last chapter he describes his long ordeal with bouts of depression and his bitterness with what he experienced as the ineffectuality of psychotherapy.

Luria writes well, and with wry humor. His personal approach allows the reader to learn, without judgment, of his opinions and attitudes about science, politics, philosophy, and art. They are presented as aspects of a man, a man whose formative years occurred in a time and place of great social evil. He reveals himself as a discerning immigrant who actively and consciously embraced many of the American ideals. Yet he is an avowed existentialist and socialist. This book helped me to appreciate how these philosophies could allow one who lived through that bitter time to grasp the present and, through the efforts of self-creation, move toward wholeness and affirmation.

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Pioneering Space Research

Origins of Magnetospheric Physics. JAMES A. VAN ALLEN. Smithsonian Institution Press, Washington, D.C., 1983. 144 pp., illus. $19.95.

The last three decades have witnessed dramatic advances in our knowledge of physical phenomena throughout the universe. Especially significant has been the radical transformation of physical understanding—and, indeed, the dramatic extension of concepts—in the geophysical sciences. From global plate tectonics, with its vast implications regarding the structure of the earth (and other planets), to the earth's radiation belts, which would not exist if there were no geophysical magnetic dynamo, many basic ideas have undergone complete revolutions. The discovery of the radiation belts at once linked concepts of plasma physics to those of terrestrial geophysics; the linkage is now found in many other aspects of the solar system, as in the case of the close coupling of the volcanos of Io to the dynamics of Jupiter's radiation environment.

After the Second World War, with the availability, first, of captured German V-2 rockets and, later, of domestically produced launch vehicles, scientists of vision recognized that it was only a matter of time until sophisticated instrumentation could be lifted high into and above the confining atmosphere to obtain measurements of the space environment of the earth. The author of this slim volume on the origins of the research that led to the discovery of the earth's radiation belts and of the magnetosphere was present "at the beginning." He dominated the early discoveries and has continued to be a guiding force in the use of rockets and spacecraft in scientific research. His early principal scientific purpose for propulsion of an instrument above the atmosphere was to measure the primary fluxes of cosmic rays (high-energy particles from the galaxy), which are shielded by the thick atmosphere from direct detection on the earth's surface. Indeed, in order to achieve greater altitudes with the vehicles existing in the 1950's, he launched his rocket payloads after first lifting them by balloons to high altitudes—thus the term "rockoon." Other American scientists in that era were motivated by the desire to study equally intriguing scientific phenomena—to measure cosmic dust, the atmospheric density at great altitudes, the ultraviolet spectrum of the sun, and the nature of the radiation producing the auroral displays. A pleasant surprise contained in this volume is the preface and table of contents of the proceedings of a workshop on the scientific uses of earth-orbiting satellites, which was held in 1955 at the University of Michigan. The volume (difficult to find today in the used book market) was edited by Van Allen and attests to the visions of early American pioneers in space research.

The volume under review, which was written during a sabbatical stay at the Smithsonian Institution's Air and Space Museum, contains a very personalized account of how the author, together with his Iowa students and associates, flew a Geiger counter on the Explorer I spacecraft during the International Geophysical Year and discovered the earth's trapped radiation. As recounted in the volume, a reporter asked after a lecture on the discovery if the radiation looked "like a belt" around the earth. Van Allen answered yes, and "Van Allen radiation belt" it has been ever since.

Much of the material included in the book is the stuff by which scientific research is accomplished. Copies of notebook entries and chart recordings attest to the excitement aroused by the author's radio detection of Sputnik 1 on shipboard, en route to a rockoon campaign in the Antarctic. Block diagrams of experiment electronics on Explorer I and Explorer II are included from papers written by Van Allen's student George Ludwig and illustrate the sophistication of space instrumentation possible at the time. Copies of original data plots, chart recordings, and instrumentation response characteristics illustrate the materials used for the leap of understanding that led to the idea of the earth's trapped radiation.

The author was a central figure in the research activities devoted to the detection and understanding of artificial radiation belts produced by high-altitude nuclear explosions, an idea originally suggested by N. Christofolis. Van Allen conveys the personal excitement associated with those times, when he and his associates provided, within 14 months, "the principal scientific instrumentation" for some nine space flight missions, "seven [of which] yielded valuable radiation data."

Finally, the International Geophysical Year and the onset of U.S. scientific research using spacecraft was a part of a larger mosaic in international geophysics, a mosaic in which artificial earth satellites represented not only scientific advances but also political rivalries between two great powers. The work of the late S. N. Vernov and his colleagues at Moscow State University is well represented in the book. These scientists made the observational discovery of the outer radiation belt and subsequent considerable contributions to defining the earth's total radiation environment.

From the discoveries of 1958–1960 have evolved extensive space research programs, not only in the United States and the Soviet Union but also in European nations and Japan. The search for understanding of the radiation belts has developed into the discipline of space plasma physics, a discipline that has deftly combined measurements of plasmas in situ throughout the solar system and extensive theoretical work in basic plasma physics. The discoveries and concepts developed in space plasma physics have now become well recognized as fundamental to the understanding of many remote astrophysical systems that are inaccessible to in situ space probe measurements. Van Allen has provided a most readable account of the beginnings of the revolution in using space vehicles to study the solar system and the cosmos.

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"William H. Pickering, James A. Van Allen, and Wernher von Braun hold aloft a full-scale model of *Explorer I* at a press conference in the Great Hall of the National Academy of Sciences in the early hours of February 1, 1958, following confirmation that *Explorer I* had completed its first orbit of the earth." [From *Origins of Magnetospheric Physics*]