current compendium of the application of theoretical techniques to complex solid-state materials. Neither book will answer a colleagues' perennial lament for a new book that covers all the latest hot topics, but both books enrich the field in their own ways.

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The Dating Game: One Man's Search for the Age of the Earth

Cherry Lewis
Cambridge U. Press, 2000. $24.95 (253 pp.). ISBN 0-521-79051-4

The beginning of the 20th century was a time of ferment in geology as it was in physics. Lord Kelvin had weighed in on the centuries-old debate about the age of Earth, and his estimates of 10 million to 100 million years were highly influential in educated secular society. The discovery of radioactivity abruptly revealed a flaw in Lord Kelvin's assumptions; it also provided the means to date rocks directly and thereby confront the problem empirically.

Arthur Holmes (1890–1965) played a leading role in these efforts over the first half of the 20th century. As early as 1910, Holmes's work suggested that Lord Kelvin was wrong by at least an order of magnitude, placing the young Holmes in the daunting position of challenging perhaps the most influential scientist of his time. By the time of his death, Holmes had added another order of magnitude to Lord Kelvin's error. In *The Dating Game*, Cherry Lewis chronicles Holmes's dogged pursuit, over five decades, of a quantitative geologic time scale. In the process, she provides unique insight into some intriguing digressions from this pursuit.

Holmes's early work was remarkable in that much of it was done before the theory of isotopes. Shortly after Bertram B. Boltwood's discovery in 1907 that uranium decayed slowly to stable lead, Holmes was smitten by the geological implications: they drove him to switch from physics to geology as a student at University College of London. By 1911, using only analytical chemistry applied to a few mineral samples, Holmes established a framework for the geologic time scale that turns out to have been uncannily accurate, considering the deficiencies of his approach. Without belaboring details of his experimental and theoretical approaches, Lewis reveals Holmes's continual updating of his methodology to match the blistering pace of discoveries in the new physics. After the discovery of the neutron and the recognition of isotopes, Holmes refined his computational approach. But he was no longer able to make the relevant laboratory measurements himself; he relied instead on collaborators at the Vienna Radium Institute and, eventually, on others. His reliance on better-funded colleagues abroad to provide data is well illustrated by his correspondence, notably with the eminent American experimentalist Alfred Nier. Holmes's nearly lifelong financial struggles, exemplified by his storied plea for funds to buy a calculating machine, are a continuous theme.

Lewis deftly highlights some of Holmes's significant contributions to Earth science, such as his precocious advocacy of continental drift, including a proposal for mantle convection, and some of his ideas about using isotopes as tracers of geologic processes. Holmes's work in these areas is less widely known than his seminal work in geochronology, and Lewis thus makes an important contribution by documenting them. Holmes's impact as an educator is also given just acclaim; his textbook, *Principles of Physical Geology* (Thomas Nelson and Sons, 1944), was perhaps the most popular introductory text on Earth science ever published.

The picture of Holmes that emerges is curiously schizophrenic: on the one hand a scientific visionary and pedagogical leader, on the other a daring adventurer making extended forays to exotic lands (Mozambique and Burma, in mineral exploration and petroleum production respectively) to ease chronic financial need. These diverse dimensions of Holmes's personality and their interplay with events of his times are the distinctive emphases of this biography. For example, Holmes's extramarital romance with the irascible Doris Reynolds (also a geologist, and leading proponent of the ill-fated theory of "granitisation"), and the disapproving reception this relationship received at the staid University of Durham, emerge among the factors that led to his acceptance of the Regius Professorship that took him to the University of Edinburgh.

Lewis's book is accessible to anyone with a high-school physics and chemistry background. It provides unique insight into the life and times of a man who was indisputably one of the three most important figures in Earth science of the last century. The book may disappoint those who seek much depth in the evolving physics employed by Holmes and his contemporaries, but this was clearly not Lewis's aim in writing it. It makes lively reading and is recommended as an absorbing historical biography.

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Small Scale Processes in Geophysical Fluid Flows

Lakshmi H. Kantha
and Carol Anne Clayson
Academic Press, San Diego, Calif., 2000. $115.00 (888 pp.). ISBN 0-12-434070-9

The complexity in the motions of fluids flowing over Earth's surface (in both atmosphere and ocean) is the result in large part of the great range of physical scales at play. The largest length scales are planetary, and the largest time scales are unknown (but certainly many tens of years). The smallest scales (millimeters-to-centimeters, and seconds) are those dominated by three-dimensional turbulence and at which irreversible thermodynamic transfers occur. Although the highly nonlinear equations governing fluid flow (the Navier–Stokes equations) have been well known for over a century, and can be solved numerically, they cannot be solved simultaneously at all geophysical scales. This means that any attempt to model geophysical flows on the scales important for weather patterns or climatic variations requires parameterization of processes occurring at smaller scales. These processes are the focus of *Small Scale Processes in Geophysical Fluid Flows*, by Lakshmi H. Kantha and Carol Anne Clayson.

The authors discuss a range of phenomena involving small-scale processes in geophysical flows. These include 3D turbulence and the various instability mechanisms leading to turbulence. One example is convective instability, caused by heating the fluid from below (as in the lower atmosphere during the day), or by cooling from above (as in the upper ocean at night). Another example is the breaking of gravity waves either at the surface of the ocean or in the interior of the ocean or atmosphere. While all are governed by the same set of equations, some understanding of the physics of each process can be gained by simplification, leading to a categorization of small scale motions.