interesting to note that Grøn proposed in his chapter that adsorbable organic halogens may be attributed to naturally halogenated humic substances rather than manmade pollutants.

This book was written for the specialists, as evidenced by numerous acronyms and lack of definition of terms known only to investigators working with humic substances. A subject index would have also been useful. Because of these reasons, non-specialists will find parts of this book difficult reading. Still, because of the rapidly growing importance of humic matter in both basic and applied science, this book is highly recommended to geochemists and other earth scientists. The editors and authors should be commended for making all this significant information available both to the specialists and to geochemists.

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The Sun in Time edited by C. P. Sonett et al. University of Arizona Press, 1991, 990p., US $60.00 (ISBN 0-8165-1297-3).

THE THEME OF this book, as implied by the title, is the variation of the Sun over time, revealed by a surprisingly wide variety of techniques. It is covered in thirty-six chapters by eighty-three authors from astronomy, physics, meteorology, and geology. The current Sun and its environs are discussed extensively to provide a context for the variations; topics include solar interior models and the solar neutrino problem, the solar wind (especially imbedded magnetic fields and their interaction with cosmic rays), particle acceleration by flares, and effects of solar variations on the Earth's atmosphere. While most chapters emphasize observations, purely theoretical treatments are not neglected.

Solar variations shorter than an eleven-year solar cycle are generally considered only briefly, mostly in sunspot variations over weeks and months. The five-minute oscillations are presumably covered in a companion book, *Solar Interior and Atmosphere.* Discussions of the sunspot cycle involve irradiance variability measured from space, effects of magnetic variations on solar structure, and modulation of galactic cosmic rays. Two chapters discuss similar activity cycles on other stars, revealing among other things that about one third of solar-type stars show little such variation, reminiscent of the Sun during the Maunder Minimum. One hopes the long-term monitoring on Mount Wilson continues to be supported.

On historical time scales, evidence is considered that the Sun's radius varied (the conclusion is that the apparent radius certainly has, but it is not proven that the Sun should be held responsible). The effects of the solar wind on the geomagnetic field are compared for "normal" times and the Maunder minimum. The record of solar variations over longer times is displayed in such terrestrial sources as ^{14}C in tree rings and ^{10}Be in polar ice cores; fallout from the Chernobyl accident provides one calibration. Other terrestrial variations are documented but are harder to ascribe to the Sun, such as the extent of glaciers or the composition of deep-sea sediments. The evidence for Sun–climate connections is still statistical, with no understanding of how solar variations containing so little energy at the Earth could control much more energetic atmospheric processes. The influence of Milankovitch cycles is much more convincing.

On time scales up to the age of the Sun, variations are recorded from solar wind particles implanted in lunar rocks and meteorites. The creation of the Sun's magnetic field in a primordial cloud and its subsequent history, rapidly slowing the Sun's rotation and generally weakening with age, are followed theoretically. Observations of solar-type stars of differing ages give confirmation.

A monotonic increase in solar luminosity since it reached the main sequence is a rare example of a variation not resulting from magnetic fields. The ability of the Earth to avoid freezing over during the Sun's fainter youth is convincingly ascribed to a terrestrial feedback, enhancing atmospheric carbon dioxide and the resulting greenhouse effect. The young Earth may have been hot, with 10 bars of CO_2 partial pressure.

A major emphasis in the book is a study of the very early sun, based on theoretical arguments, observations of other forming stars, and analysis of primitive meteorites. Studies of T Tauri stars are extensively presented, although applications to the young Sun are controversial. Two chapters give arguments for and against a T Tauri-type equatorial wind as the primary heat source for planetesimals through electromagnetic induction. Much has been learned in recent decades about T Tauri stars, but some crucial observations lie in the future.

The broad interdisciplinary nature of the volume is impressive. Some areas are well developed; the slowing of stellar rotation due to angular momentum transfer to stellar winds via magnetic fields is based on both theory and observations. Some topics are highly speculative, such as interpreting the remnant magnetization of a meteoritic chondrule. Some issues are unresolved, such as tree ring growth vs. solar cycles.

The bibliography runs nearly one hundred pages of fine type. The book's encyclopedic function is obvious. There were some detailed problems. I found the index skimpy, and I added many notations for my own future benefit. The glossary is useful, but I would have preferred more entries for abundant abbreviations (e.g., CAI, CME, CTT, GCR, PSI, and TL), and I doubt that the glossary definitions are necessary for meteorite, alpha particle, Boltzmann's constant, or greenhouse effect. I spotted a few misprints, and nearly a dozen sentences were grammatically undecipherable. The misuse of a comma to separate the subject and predicate of a sentence was not unusual. However, as with other members of the Arizona Space Science Series, this book will be a valuable basic reference for many years to come.

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Metallogeny of Tin by B. Lehmann. *Lecture Notes in Earth Sciences 32* edited by S. Battacharji et al. Springer-Verlag, 1990, viii + 211p., US $29.00 (ISBN 0-387-52806-7).

THE MANY BOOKS that have been written on tin are a clear testimony to the fascination it holds for geologists and geochemists. It is the most provincial of the major ore metals and exhibits a clearer affinity for specific geologic and geochemical environments than any of the others. As a result, tin has been at the center of the continuing debate over metallogenic provinces, which are zones of Earth in which deposits of an element are unusually abundant. The focus of this debate is the question of whether metallogenic provinces form because the host rocks in that area are enriched in the element of interest, or because the element was simply concentrated more effectively from normal background levels. This book is an excellent statement of progress on the metallogenesis problem.

The book is divided into six chapters. The introduction deals with metallogenic provinces and concepts and their relation to tin, and the second chapter concerns the geochemistry of tin in magmatic and aqueous environments. These form the basis for a discussion of selected tin deposits and their magmatic affiliations, which is presented in three chapters. The first of these chapters deals with igneous rock series that are associated with tin deposits. The second deals with deposits in which tin in igneous rock suites has been redistributed by hydrothermal processes, and the final one deals with the problem of premagmatic concentrations of tin. Lehmann comes down hard on the side of normal magmatic processes as the agent for forming metallogenic provinces of tin. He notes that ". . . the assumption that the source material for tin granite suites may already be enriched in tin beyond average crustal abundances is . . . not justified." In order to reach this conclusion, Lehmann has to deal with the possibility that major tin concentrations formed by magmatic or sedimentary processes, both of which are reviewed in some detail and rejected.

In general, this book is very convincing. It musters a wide range

of geochemical and geological data in support of its basic thesis. In fact, it contains an excellent compilation of geochemical data on tin, as well as comparative data on related metals such as tungsten and molybdenum. It is less complete as a reference on tin deposits, completely ignoring important deposits such as those in the Bushveld Complex. The chapters themselves read well, although the limited amount of bridging discussion from chapter to chapter makes it hard to follow the author's basic argument in all places. The book is much more geochemically oriented than other recently published books on tin and tin deposits and would be the obvious choice of anyone wishing to have a timely reference work on tin and its deposits. Although the book and its topic would not support a single course, it could be used as the basis for an advanced seminar on tin deposits, metallogenic provinces, or specialized magmatic processes. It is also just the sort of book to attract the conventional chemical petrologist who is finally tiring of a lifetime spent worrying about major elements into something really interesting, an element that shows amazing petrologic specialization and sells for $3/pound!

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Victor Moritz Goldschmidt: Father of Modern Geochemistry by Brian Mason. Special Publication No. 4, The Geochemical Society, 1992, 184p., (members) US $30.00, (nonmembers) US $40.00 (ISBN 0-941809-03-X).

AN IN-DEPTH BIOGRAPHY of V. M. Goldschmidt has long been needed, and Brian Mason has filled this need brilliantly. Goldschmidt was indeed the "father of modern geochemistry," as Mason labels him: the first to essay, with modern methods, a solution to the basic problem of geochemistry—"to determine the quantitative chemical composition of the earth and to find the laws which underlie the frequency and distribution of the various elements in nature," as he expressed it. For his success in this gigantic undertaking he is known and revered among modern geochemists, but less known than he should be among chemists and even among other earth scientists. Mason's biography should go far toward giving him his rightful place among the great physical scientists of the first half of this century.

Compiling material for the biography was not easy, because Goldschmidt never married and had no siblings or other surviving close relatives who could have supplied details of his personal life. He was a prolific correspondent, and fortunately copies of many of his letters, memoranda, and unpublished manuscripts were available to Mason at the Goldschmidt Archives maintained by the Norwegian Geological Survey in Trondheim. This background material was supplemented by much additional correspondence, personal recollections, and photographs that Mason solicited from former colleagues and acquaintances of his subject. Mason himself was associated with Goldschmidt only briefly, for a few weeks in 1940 before the German invaders descended on Oslo.

In his preface, Mason notes that he has in mind three possible groups of readers: scientists (geologists, chemists, and geochemists), historians of science, and laymen with an interest but only modest background in science. That he has succeeded in making the book interesting and understanding to all three is no mean achievement.

Chapters in the book describe the four major periods of Goldschmidt's scientific career: (1) the early years (1907–21) devoted to the petrology of metamorphic and igneous rocks in southern Norway, notable especially for the famous monograph on contact metamorphism in the region near Oslo (at age 23); (2) the years at Oslo (1922–29) when the rules of crystal chemistry were developed, with emphasis on the substitution of minor elements in crystal structures according to ionic size and polarization; (3) the six years at Göttingen (1929–35), when the introduction of carbon-arc spectrography made possible rapid analysis of a myriad of rocks, ores, and meteorites for small concentrations of trace elements, and estimates of the Earth's overall composition; and (4) the second period at Oslo (1935–42), with a culmination of the work on distribution of the elements in terrestrial and cosmic materials and some prescient guesses about the existence and properties of transuranic elements. Mason describes also Goldschmidt's more practical accomplishments as long-time director of Norway's State Raw Materials Laboratory—a position he assumed in 1917, when German submarines cut off Norway's usual imports and a search for raw materials within the country became urgent. In all these chapters Mason's concern for his three groups of readers is manifest: for the scientists, he gives a brief but thoroughgoing treatment of Goldschmidt's major contributions; for the historians, a penetrating analysis of the interplay between Goldschmidt's developing ideas and concepts being formulated elsewhere in the scientific world; and for the laymen, a remarkably clear presentation of the basic chemical and geological background—complete with a periodic table, a geologic time table, a table of ionic radii, many informative diagrams, and a glossary of scientific terms.

Because of his Jewish ancestry, Goldschmidt had lost his position at Göttingen in 1935; then in 1942, after the German invasion of Norway, troubles multiplied and he was barely saved from deportation to a concentration camp in Poland. A chapter at the end of the book describes the last sad years: his escape to Sweden and England, the increasing bouts of ill health, and the final return to Oslo a few months before his death in early 1947.

It is a fascinating and in part tragic story of an eminent scientist who with his many devoted students and co-workers made discoveries that have shaped the course of much of more recent geochemistry, then fell victim to the political troubles of the mid-century. Mason tells the story with understanding and gusto, and tries to reconstruct a picture of his subject's personality by generous quotations from his correspondence and from comments by those who knew him. He grants that there was "a dark side to Goldschmidt's personality," traits that made him unpopular among some of his faculty colleagues at Oslo—a fact of which this reviewer became acutely aware during a sabbatical year at Oslo in 1952, five years after Goldschmidt's death. It is a pleasure to acknowledge my indebtedness to Mason for correcting the somewhat warped view I had gained, and for giving me an appreciation of how truly Goldschmidt "inspired lifelong devotion in most of his students and research assistants."

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Characterization of Oil Shales and Shale-Like Rocks of Well-Known Deposits and Occurrences by K. Urov and A. Sumberg. Valgus, Tallinn, 1992, 61p (in Russian).

THE BOOK UNDER review contains information about oil shales of a hundred well-known deposits and occurrences from all over the world. Most of them are located in the territory of the former USSR. In fact, it is a short handbook that comprises an introduction, three chapters, and the list of 226 references.

In the introduction the authors consider in detail the diagnostic properties of oil shales and define them as ". . . sedimentary rocks containing principally aquagene organic matter that was transformed under mesocatagenetic or less intensive conditions. This matter is slightly soluble in low-boiling organic solvents, yet, with thermal destruction, it generates a great many liquid organic products."

The peculiar feature of the book is that all three chapters include no text at all. Their content is presented in the form of fourteen tables with references, but without any comments. Chapter 1 covers the compositions and properties of oil shales and shale-like rocks. It presents locations and geological ages of the deposits and occurrences, proportions of organic and inorganic constituents in oil shales, contents of common, pyritic and sulfate sulfur in these shales, and the elementary composition of kerogen. Mineralogical and chemical compositions (including some trace elements) of inorganic constituents are given as well. Chapter 2 gives information about "bitu-