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BOOK REVIEW

NOBLE GASES IN GEOCHEMISTRY AND COSMOCHEMISTRY by D. Porcelli, C. J. Ballentine, and R. Wieler (eds.). Mineralogical Society of America Reviews in Mineralogy and Geochemistry, Vol. 47, 2002, 844 p. $40 ($30 for MSA members)

This is an enormous book, containing 17 sections (each section approximately 50 pages, with densely spaced lines and narrow margins) with numerous references (some sections have more than 400 references, including a few published in 2002). The authors include many world-class experts in their fields. The book covers essentially all aspects of current noble gas geo- and cosmochemistry. I congratulate the editors on this very prompt, timely, and comprehensive reference book. This book is a treasure house of up-to-date information on noble gas geo- and cosmochemistry for researchers working in this field. Every library concerned with Earth and Planetary Sciences should have a copy. However, students and non-specialists may find the book difficult to use, because it does not have an index and the level of discussion is generally advanced and detailed.

The book covers two major subjects, cosmochemistry (7 sections) and geochemistry (10 sections). In spite of their obvious common ground, these two disciplines hitherto have been treated almost independently. For example, the term "solar noble gas" is often used in different contexts by cosmochemists working on meteorites and geochemists whose major concern is geological applications. Hence, it is very welcome that both subjects are integrated in a single book with editorial effort at cross-referencing.

Following a short introductory overview on noble gas geo- and cosmochemistry by D. Porcelli, C. Ballentine, and R. Wieler that contains concise tables for fundamental properties of noble gases, R. Wieler discusses various noble gas components in the solar system. I found that this 42-pages article gives an admirably lucid account of formidably complicated issues, illuminating distinctive characteristics of various noble gas components in the solar system. U. Ott reviews noble gases in meteorites, and provides a critical discussion of genetic relationships among noble gas components of the solar system, one of the fundamental issues in noble gas cosmochemistry. T. Swindle gives a useful overview of solar system impact history deduced from ^{40}Ar-^{39}Ar and I-Xe systematics in lunar and meteorite samples. In a subsequent section, Swindle discusses Martian noble gases; it is intriguing to learn how noble gas studies of only 20 Martian meteorite samples have yielded unparalleled insight into the evolution of Mars and the Martian atmosphere. This is an outstanding example of the strength of noble gas studies as a geochemical tool. R. Wieler reviews cosmic-ray-produced noble gases in meteorites, and their use as exposure age chronometers, with a neat account of fundamental physical processes in cosmic-ray-induced nuclear reactions. This section should be read as complementary to a later section wherein S. Niedermann discusses cosmic-ray-produced noble gases in terrestrial samples. The above six sections review the state of the art in their respective areas, with abundant presentation of the latest empirical data in figures and tables. In the last section on Cosmochemistry, R. Pepin and D. Porcelli extensively discuss theories on the origin of noble gases in terrestrial planets, emphasizing their preferred view of the importance of giant impacts in terrestrial noble gas systematics. It seems to this reviewer that the feasibility of giant-impact-induced-fractionation of terrestrial Xe remains to be proven.

In the first section on geological aspects, D. Graham gives an extensive survey of noble gas studies in mid-ocean-ridge basalts (MORB) and oceanic island basalts (OIB), with a discussion of implications for the noble gas state of the mantle and with references to mantle evolution. Basic concepts that are needed to interpret noble gas systematics are carefully explained, so this will be useful for beginners in this field. D. Hilton, T. Fischer, and B. Marty discuss noble gas and volatile recycling at subduction zones. This subject has important relevance to arc volcanology. Following the above two sections dealing with oceanic basalt noble gases, T. Dunai, and D. Porcelli discuss noble gas storage and transport in the continental lithosphere. I enjoyed this well-thought-out, well-balanced review of this complicated subject. D. Porcelli and C. Ballentine present models for the distribution of terrestrial noble gases and the evolution of the atmosphere, the outstanding problem in noble gas geochemistry. The essential materials in this article have been published as original papers in several journals by Porcelli et al. While I appreciate their very careful and stimulating modeling, I feel that close examination of some of the underlying fundamental assumptions is needed. For example, I would have liked to know why the authors assumed that the initial $^{129}I/^{130}I$ ratio in the Earth was the same as the common meteorite value of 10^{-4}. To many noble gas cosmochemists, including this reviewer, this still is not an assumption to take for granted.

In subsequent sections on geochemistry, C. Ballentine and P. Burnard discuss production, release and transport of noble gases in the continental crust. Their section contains careful discussions of basic physico-chemical processes including noble gas diffusion and the production of nucleogenic noble gases. The authors point out the importance of mineral-fluid partitioning in noble gas diffusion, an issue that is rarely discussed in noble gas diffusion papers, but important in diffusion not only of noble gases but also of other trace elements. C. Ballentine, R. Burges, and B. Marty discuss the use of noble gases as tracers of crustal fluid movements. This issue has im-

portant relevance in exploitation of oil and water as well as in the study of surface and ground water systems. This subject is likely to become a major branch in future studies of noble gas geochemistry. They also gave detailed accounts of basic processes of noble gas transport that would be useful for newcomers in this field. R. Kipfer, W. Aeschbach-Hertig, F. Peeters, and M. Stute discuss noble gas behavior in lakes and ground waters with numerous case studies in a section that may be too detailed for general readers, although specialists in this field will find the details useful. In this and the following section by P. Schlosser and G. Winckler, we see the important effects of anthropogenic noble gases, especially of ^{3}H-derived ^{3}He due to nuclear tests in hydrothermal systems. Surprisingly, no account on the effects of the ^{3}H-derived ^{3}He in terrestrial environments is found in other sections of the book, only in these two. Considering the enormous amount of ^{3}H released to the atmosphere in the sixties, it seems that the fate of ^{3}H (half life = 12.26a) that must have penetrated into rock fabric via rainfall would be worth close examination.

In the final sections on geochemistry I enjoyed the succinct and informative accounts of a rapidly developing field in the use of noble gases for oceanographic studies such as ocean circulation, paleo-oceanography, and ocean/atmosphere gas exchange by P. Schlosser and G. Winckler. S. Niedermann discusses cosmic-ray-produced noble gases in rocks and their use as chronometric tracers in some surface processes, including the estimation of surface erosion rates that is a central issue in current geomorphology. In addition to a basic discussion of cosmic-ray-induced nuclear reactions in the surface of the Earth, this section addresses in some detail the shielding effects of the geomagnetic field on impinging cosmic ray flux, a subject that generally fails to attract due attention in noble gas geochemistry papers. As an aside, the author of this section may wish to reconsider his comments on noble gases in diamonds in the light of a paper by M. Ozima (EPSL Vol.101, p. 107-109, 1990). The last two sections of the book are short comments on K-Ar and Ar-Ar dating by S. Kelley and on (U-Th)-He dating by K. Farley with special relevance to noble gas geochemistry.

Because this book is likely to be used as a reference, it is a pity that it does not have an index. Although some effort was made to cross-reference among sections, this is hardly sufficient. Even noble gas specialists would have difficulty in finding items that they want to refer to, perhaps feeling as if standing in front of a treasure vault unable to recall the words "*open sesame*." I hope that the editors would consider adding an index in the second printing (or even as a supplement to the first printing); this remarkable book certainly well deserves the effort.

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