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Book Review

Review of Cosmogenic Nuclides: Principles, Concepts, and Applications in the Earth Sciences, Tibor Dunai

My first feeling upon learning of the publication of the first hardcover book on cosmogenic-nuclide geochemistry was one of dread. This is because the field of cosmogenic-nuclide applications in Earth sciences is still half-baked: we have figured out how to measure the concentrations of these nuclides pretty well, and we have come up with a wide variety of important and interesting applications to problems that can't be solved in any other way, but how best to estimate nuclide production rates – which is the core of making these applications actually work in a precise and accurate fashion – remains an area of hot debate and rapid obsolescence of ideas. I envisioned a massive tome, priced at $149.95 and filled with scaling formulae that would already be obsolete by the time the book went to press, and saw myself spending the rest of my scientific career explaining why the beryllium-10 production rate clearly printed on page 378 was actually incorrect. Fortunately, I am happy to report here that the book I eventually received from Cambridge University Press is nothing like this. It is a short book, it is clearly written, it is neither prescriptive or didactic, it makes a serious and credible effort to resist obsolescence, and at the time of this writing it is priced at a reasonable $48 through online sellers. I am pleased to recommend its purchase to a wide variety of Earth scientists and students.

This book does a number of worthwhile things very well. If read in an as-needed fashion, it serves as a valuable glossary of terms and concepts used in cosmogenic-nuclide geochemistry. If, for example, one wants general information about how solar modulation affects nuclide production rates, this information is consolidated into a single section with an easily recognizable entry in the table of contents. If read in sequential fashion from the beginning, it provides a clear and concise introduction to the origin and development of the important concepts in measurement and production rate estimation. It is particularly strong in explaining how and why only a few cosmic-ray-produced nuclides, out of the enormous number of potential candidates, are geologically useful and thus widely used. It successfully avoids the trap that many publications about cosmogenic-nuclides fall into in which processes relevant to only a small minority of Earth science applications (muons, thermal neutrons, and topographic and geometric shielding, for example) tend to take up wildly disproportionate amounts of text.

The book also wisely avoids doing a number of things that would likely detract from its main purpose. It does not include full sets of equations for production rate calculations, or tables of things like production rate measurements, effective attenuation lengths, or neutron interaction cross-sections. Thus, in contrast to the previous comprehensive review of cosmogenic-nuclide geochemistry by Gosse and Phillips, this book is neither a technical reference for specialists or a one-stop cookbook for turning cosmogenic-nuclide measurements into exposure ages. The focus is very firmly on providing a general introduction to concepts and a broad survey of applications.

On the other hand, this book is lacking in a few areas. A minor example is that it gives only cursory attention to the currently very popular procedure of trying to infer both the exposure age and the erosion rate of a surface by collecting a cosmogenic-nuclide depth profile that is deep enough to sample both spallogenic and muon-produced nuclide inventories. This idea has some serious weaknesses, and it is certainly possible that it will not survive as a major application over the long term. However, this book does not explain the idea and its implementation in enough detail for a reader to critically evaluate the rapidly proliferating studies that use it. A broader but more subtle weakness relates to the book's overall presentation of applications as distinct and relatively unrelated geological situations, each with their own set of equations, type of data plot, and sampling strategy. If I had written this book I would have tried harder to make the point that all applications of cosmogenic-nuclide geochemistry to Earth surface processes are at root very similar model-fitting exercises. If you can quantitatively describe how a process works, you can predict the cosmogenic-nuclide concentrations in rock or sediment affected by that process, and you can use these predictions to design a sampling scheme that will ensure that the nuclide concentrations are sensitive to the rates or times you seek to measure. Emphasizing the similarity in this regard, rather than the differences between, all the applications that are covered in the book would help to give readers the tools needed to come up with applications that have not yet been invented.

To summarize, this is a short, clear, and concise book that provides an sensible and understandable introduction to how cosmogenic-nuclide geochemistry and its applications work. It is moderately useful as a reference for specialists, but has much greater value in providing a wide variety of Earth scientists and students, who are not already experts in this field, a clear idea of what the field is all about and a basis for determining whether they can use these techniques in their own work.

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