

ENCYCLOPEDIA *of*
SCIENTIFIC DATING
METHODS

Encyclopedia of Earth Sciences Series

ENCYCLOPEDIA OF SCIENTIFIC DATING METHODS

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ENCYCLOPEDIA OF EARTH SCIENCES SERIES

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Preface

Scientific dating methods provide the timing, sequence, and rates of geological, archaeological, and biological events and processes. It is no exaggeration to say that quantitative measurements of age (geochronology) provide the foundations for scientific understanding for many disciplines within the earth and archaeological sciences.

The field of geochronology began with early applications of biostratigraphy and a basic understanding of sedimentary processes. The ages and sequences fossils provided the foundation for the geological time scale. At the turn of the twentieth century, our understanding of radioactivity revolutionized geochronology. This led to the flourishing of numerous radiogenic isotopic dating methods. In addition, of particular importance, was the development of radiocarbon dating in 1949, which has since yielded hundreds of thousands of age estimates for earth scientists and archaeologists. Radiation exposure methods, which utilize the effects of background radiation on defects in minerals and biological materials, were developed through the 1960s and the 1990s. More recently, the development of molecular clock techniques has resulted in a new approach to determine ages of events in the history of biological evolution.

This volume is a comprehensive synthesis of the applications and physical basis for scientific dating methods in use in the earth sciences, archaeology, and biology. All widely-accepted scientific dating techniques – physical, chemical, and biological – have been included, as well as the most important materials which are amenable to the application of scientific dating methods.

We trust that this volume will be of use to researchers and students in the earth sciences and archaeology, who wish to understand the scientific basis that underlies our understanding of geological and archaeological chronology. In addition, this volume may be useful to geologists involved in exploration and exploitation of natural resources, natural resource managers, and environmental and archaeological consultants.

Each of the major dating methods is described in a main entry that provides an in-depth review of the underlying scientific principles of that method, including methods, applications, uncertainties, applications, and limitations. If appropriate, the most recent development in each field is discussed. Each of these main entries was authored by a leading expert in that field.

The majority of the entries in this volume are focused on applications of scientific dating methods, and are usually titled according to the material to be dated (e.g., “Carbonates, marine”), with the method in parenthesis. We have attempted to provide comprehensive coverage of organic and inorganic materials, including minerals, rocks, archaeological materials, biominerals, plants, art objects, water, and many more. Some entries focus on rates of geological processes, such as sedimentation, fluid flow, tectonics, cooling rates, and many more. By organizing entries by the application, rather than the methodology, we hope that readers will be able to quickly locate information most relevant for their interests and specific needs.

Finally, this volume includes shorter, mini-entries with key definitions, important materials, or notes on instrumentation.

This volume was only possible through the extensive contributions of the three associate editors and the large editorial board who worked together to establish the range of authors from 18 different countries who agreed to contribute. The online version, which can be updated by the authors as new information becomes available, provides a dynamic dimension in the rapidly changing field of geo-, bio-, and archaeo-chronology.

The field of dating methods continues to grow rapidly through research scientists thinking of new ways to apply the methods. Though it cannot be said that every single application of dating methods is included, this volume significantly expands the availability of knowledge through its broad scope in each area in the field of dating.

Acknowledgments

First of all we want to thank all of the authors for their long hours composing the text and graphics of the entries, and for answering our correspondence. Without their contributions, the encyclopedia could not have become a reality.

There are a large number of individuals who contributed to both the design and fulfillment of the aims of this volume. Our section editors made great contributions in this area and in finalizing the author list. The person who made the biggest impact is Larry Heaman who stepped in to handle much of the creation and editing of the radiogenic isotope side of the volume. He has given of his time extensively as decisions were made in all of the stages of development, and we are both very grateful for this contribution. Jim Paces also shouldered a large amount of the creation and editing of the encyclopedia, and we thank him for his contribution, especially in regard to the creation of the uranium series dating articles. Tim Jull also created an entire section of the encyclopedia with a large range of articles on radiocarbon applications, and without him, we would not have achieved the great depth of the entries we have. Many thanks to you Tim, from both of us.

The editorial board was seminal in creating the authorship of the encyclopedia. Our great thanks to Robert A. Creaser, Don Davis, Geoff Duller, John Gosse, Simon Ho, James K.W. Lee, Josep M. Pares, Peter W. Reiners, and John F. Wehmiller, who were seminal in the early stages in establishing the breadth of this volume. The editorial board made decisions regarding how to “boil down” which applications articles were the most relevant to current developments in the fields of geochronology, and made suggestions that led to the creation of synthesized articles which encompassed more than one of the

original topics. Each of you made a great contribution, and we are indebted to you for helping us condense our early ideas into the most relevant entries that could be created.

Our most sincere thanks go to the Springer personnel who worked painstakingly throughout the process to smooth our path. Petra van Steenberg provided inspiration, encouragement, and opportunity, while Sylvia Blago, Simone Giesler, and Hermine Vloemans gave countless hours regarding the correspondence and organization of entries and scheduling.

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W. Jack Rink
Jeroen W. Thompson