Earth

Evolution of a Habitable World

Second edition

Fully updated throughout, including revised illustrations and new images from NASA missions, this new edition provides an overview of Earth's history from a planetary science perspective, for undergraduates in earth science, planetary science, and astronomy. The evolution of the Earth is described in the context of what we know about other planets and the cosmos at large, from the origin of the cosmos to the processes that shape planetary environments, and from the origins of life to the inner workings of cells.

Key features

- Integrates astronomy, earth science, planetary science, and astrobiology to give students the whole picture of how the Earth has come to its present state
- Presents concepts in nontechnical language and avoids mathematical treatments where possible, allowing students to grasp concepts without wading through complex maths
- New end-of-chapter summaries and questions allow students to check their understanding and critical thinking is emphasized to encourage students to explore ideas scientifically for themselves

Jonathan I. Lunine is the David C. Duncan Professor in the Physical Sciences at Cornell University. His research interests center broadly on planetary origin and evolution, in our solar system and around other stars. He works as an interdisciplinary scientist on the *Cassini* mission to Saturn, and on the James Webb Space Telescope, and is also a co-investigator on the *Juno* mission, which launched for Jupiter in August 2011. Dr. Lunine is the author of over 230 scientific papers and besides the first edition of this book (Cambridge University Press, 1999), he has also written *Astrobiology: A Multidisciplinary Approach* (Pearson Addison-Wesley, 2005). He is a member of the US National Academy of Sciences, and a fellow of the American Association for the Advancement of Science and the American Geophysical Union.

Praise for this book:

"The keenly awaited second edition of Lunine's book does not disappoint. The clarity of writing and level of scholarship remain high, and there is no other treatment of our planet with this interdisciplinary breadth. As we home in on Earth-like worlds far from home, this book is a perfect component for an undergraduate astronomy or astrobiology course."
- Professor Chris Impey *University Distinguished Professor and Deputy Dept. Head, Astronomy, University of Arizona*

"Lunine focusses on the Earth as a system, and sets it in context in comparison with other Solar System bodies. This is how a geoscience text should be done these days."
- Dr. David A. Rothery *The Open University*

"*Earth: Evolution of a Habitable World* brings the knowledge gained by 50 years of Solar System exploration back to Earth and infuses the often hazy first half of Earth history with new energy and insight, providing a unique perspective on the entire history of our home planet."
- Professor James Head *Louis and Elizabeth Scherck Distinguished Professor of Geological Sciences, Brown University*

"Lunine's astrobiological perspective on Earth history is a breath of fresh air, drawing on the entire breadth of science to address fundamental questions about the origins of life, and the development of the systems that sustain it here on Earth, in a manner that quickly and directly connects to students."
- Dr. Marshall Bartlett *Assistant Professor and Chair of Physics, Hollins University*

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PREFACE

When the first edition of this book was published some 15 years ago, astrobiology was not recognized as a separate academic discipline, and few universities and colleges offered courses in the subject per se. But the question of what makes a planet capable of sustaining life, and whether inhabited planets exist in large numbers in the cosmos, was long a popular draw for courses in planetary science, geology, and astronomy. I wrote *Earth: Evolution of a Habitable World* so as to encourage instructors of freshmen and sophomore non science majors to take a consciously planetary bent in covering how our home planet came to be, its place in the overall evolution of the cosmos, how it became habitable *and* inhabited, and how life and the environment evolved together (sometimes coupled, sometimes not) to the present day. And in closing with chapters on human-induced global warming and depletion of resources, I wished to provide a "cosmic perspective" via the rest of the book to some very down-to-Earth problems. In the breadth of topics and perspective I took in writing it, *Earth* was alone in its chosen subject area, with only a few notable exceptions.

Today astrobiology is a thriving academic field with a daunting number and variety of textbooks on the subject. In preparing a revised edition I considered making the book more consciously astrobiological, either by aligning the contents more closely with the typical survey treatment – or by simply adding the word "Astrobiology" to the title. But neither option seemed to me to do justice to the main theme of the text, which remains the story of our planet Earth from its cosmic beginnings to the present-day practical dilemmas our success as a technological species has brought us. The astute instructor or student will be able to figure out that the book is suitable for a course in an astrobiology program, just as one might understand that a textbook entitled *Classical Mechanics* is suitable for covering part of a physics curriculum. The level remains the same, parts have been updated or rewritten, new figures included, and quiz questions expanded. As before, the book also will be useful to those who are not enrolled in courses but want to learn something of Earth's history from a planetary perspective. However, I am well aware that there is much more competition today for both the student and interested layman, and I can only hope that this particular narrative finds its niche within the plethora of astrobiology books.

The first edition of the book was prepared when I was on the faculty of the Lunar and Planetary Laboratory, Department of Planetary Sciences, The University of Arizona. I remain forever in debt for the help, encouragement, and contributions of my colleagues there. The second edition was prepared while I was on leave of absence to the University of Rome Tor Vergata, Rome, Italy, and completed here at Cornell University where I now teach; both of these institutions provided assistance and encouragement. Likewise I thank Phil Eklund, who as with the first edition provided stimulating comments, suggestions, and figure ideas. My wife Cynthia Lunine illustrated the first edition but other commitments prevented her from preparing new figures for the revised edition. Nonetheless the clarity and attractiveness of style are the direct result of her work, for which I am deeply grateful.