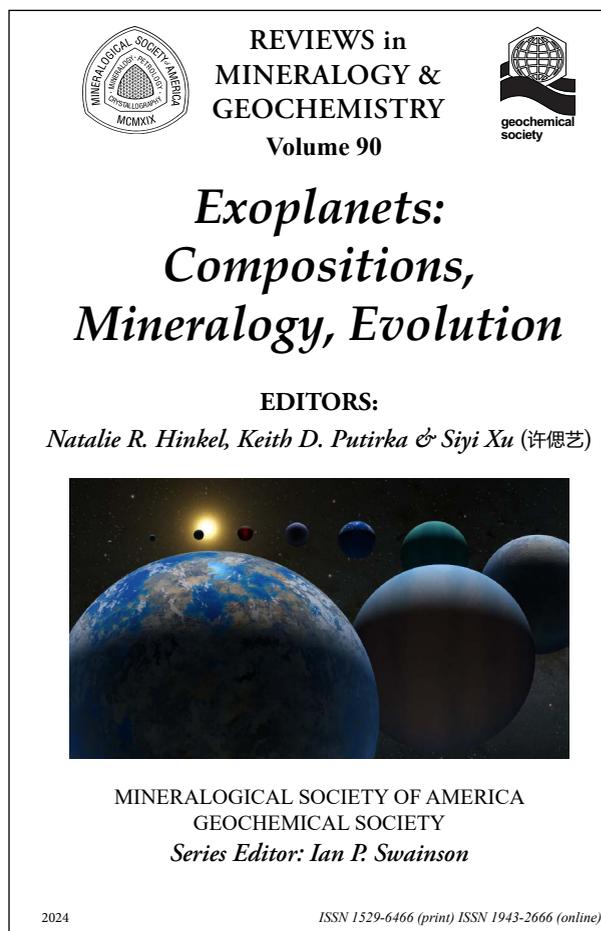


## BOOK REVIEW

**Book Review: Exoplanets: Compositions, Mineralogy, Evolution.** (2024) Edited by Natalie R. Hinkel, Keith D. Putirka, and Siyi Xu. Reviews in Mineralogy and Geochemistry, Volume 90, Mineralogical Society of America/Geochemical Society. ISBN 978-1-946850-12-6, i-xvii + 594 p. \$65.

The desire for exploration and to understand our own origins has driven humanity to study the diverse planets, moons, asteroids, and comets in the farthest reaches of our Solar System. As captivating as our closest celestial neighbors are, the first images of deep space from the Hubble Space Telescope revealed thousands of galaxies beyond our own, which revolutionized our knowledge of what exists beyond our Solar System. The advancement of technology and new missions, such as the James Webb Space Telescope, has allowed the field of exoplanet research to flourish, with over 5,000 exoplanets identified at the point of writing, providing an ever-growing dataset to study various stages of planetary evolution. *Exoplanets: Compositions, Mineralogy, Evolution* serves as a guide to our current knowledge of exoplanets from the unique combined perspective of astronomers and geologists, creating a roadmap from early stellar evolution to planetary formation and, eventually, the decay of planetary systems at the end of a star's life.

This book covers both the basic concepts of astronomy that geologists may need and, conversely, the basic concepts of geology that astronomers may need to understand exoplanets thoroughly. Each chapter builds upon and references previous chapters, providing a synergistic flow of concepts throughout the text to bridge the two fields of science, enhanced by informative and detailed figures and tables to illustrate the concepts. Throughout this book, relevant and pivotal examples of data collected from space telescopes (e.g., Hubble, Spitzer, James Webb) and ground-based observational techniques (e.g., Atacama Large Millimeter/Submillimeter Array) are described to show the diverse data used by astronomers to study exoplanets and their star systems. Techniques used by geologists to interpret planetary bodies in our Solar System and beyond are covered to provide insight into how interpretations of the composition and structure of planetary surfaces and interiors are made, which include: high-pressure, high-temperature experiments on synthetic analogs of planetary materials, theoretical modeling, and analytical analysis used to assess the geochemistry of meteorites. Each chapter contains an extensive reference list of astronomy- and geology-based studies that have moved the field of exoplanet



science forward. On a broader scale, this book can be broken into four basic sections: (1) Stellar and planetary disk evolution, (2) Chemistry of planetary materials, (3) Geology fundamentals related to rocky planet processes, and (4) Light/volatile element evolution from planetary interiors to atmospheres, and thus, the potential for life.

The observational portion of this book provides valuable insight into how astronomers detect and measure stars, proto-planetary disks, planets, and planetary atmospheres. Chapters 1–3 and 5–6 are a thorough analysis of how astronomers assess

various star systems at different points in their lifetimes, providing a window into the different stages of stellar and planetary evolutions, from birth to destruction. From the perspective of a geologist, these astronomy-based chapters are helpful and insightful in understanding how chemical measurements are obtained and the process that goes into searching for and analyzing exoplanets. This detailed background information is necessary, as geologists use the chemical information obtained from telescopes to make predictions about the evolution of rocky planets in our Solar System and beyond.

The geology section in this book is a broad overview of the knowledge we have on the physical samples of rocky objects in the Solar System (e.g., meteorites) that show the diverse chemistry and thermal and physical evolution of our Solar System objects, as well as an overview of fundamental geologic processes based on knowledge gained from how Earth works. Chapters 4 and 7–9 provide a good overview of how geologists approach the formation and evolution of our rocky planets, beginning with the fundamental concepts of physical and thermodynamic processes that are the foundation of terrestrial-based geology. These chapters explore how we employ these concepts, such as applying tectonic processes here on Earth to other rocky bodies in our Solar System, along with information gathered from astronomers that is used in experimental geoscience and modeling to study rocky exoplanets.

The quest to understand life beyond Earth is perhaps one of the most compelling and rapidly growing branches of planetary science. Earth is our point of comprehending life as we know it; thus, our knowledge of organic evolution and survivability

based on temperature, atmospheric composition, presence of liquid water, and energy sources guides initial observations on potentially habitable exoplanet candidates. Presently, detecting molecules that are known to be associated with life in exoplanet atmospheres is a primary focus in evaluating these candidate planets, which this book examines in later chapters. Specifically, *Exoplanets* includes a detailed discussion on the evolution of volatile elements, from their inclusion in bulk planetary compositions and magmatic influences (chapter 10) to atmospheric evolution and what mechanisms we have to detect organic compounds that are essential to life (chapters 12–13). While assessing exoplanetary compositions and their atmospheres with any level of precision is a challenge with current technology, this book allows us to appreciate the current state of astrobiology science and look forward to future advancements.

*Exoplanets* takes on the challenging role of combining two different fields of study and making the subjects appropriate and relevant to a broad scientific audience. While some concepts may be an introductory overview for those who are experts in either the geoscience or astronomy fields, this book provides a foundation for any researcher to understand the basics of planetary evolution and the current state of knowledge of exoplanets. I recommend this book for any scholar, graduate student and beyond, as it will serve as an important reference as we embark on exoplanet research in the years to come.

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