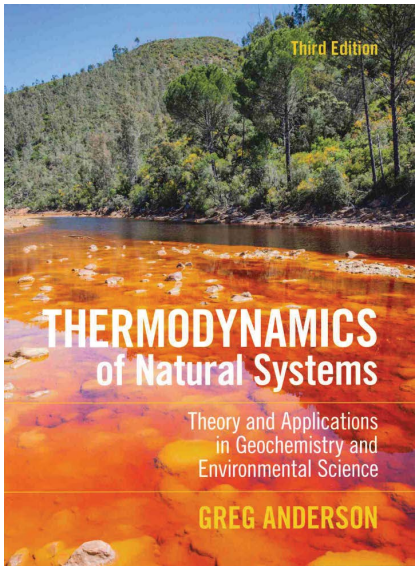
Book Review

Book Review: Thermodynamics of Natural Systems: Theory and Applications in Geochemistry and Environmental Science, 3rd edition. (2017) By Greg Anderson. Cambridge University Press. ISBN 9781107175211, 428 p. $74.99.

This is the third yet distinctive edition of *Thermodynamics of Natural Systems* written by Greg Anderson. The goal of this edition was to make it shorter and more concise to be suitable as an introduction to thermodynamics book. The first edition was written because his other book, *Thermodynamics in Geochemistry* (Anderson and Crerar, 1993), was not practical for teaching. The second edition was more suitable for graduate students but still was seen more as a reference book. I have personally used the second edition as a reference for many years, but also used some of the sections included in different chapters for teaching my junior level undergraduate thermodynamics classes. This third edition is definitely an improvement for students in an introductory thermodynamics class, where less information at the beginning avoids confusion commonly encountered in this discipline.

This book covers the fundamental equations in thermodynamics, including the three laws of thermodynamics, how to measure thermodynamic properties of minerals, water-gas-mineral equilibria, equilibrium constants and activities. The approach is a little bit different from many other textbooks on thermodynamics, which commonly introduce the subject by starting with heat, work, and entropy using classical thermodynamic developments from concepts used in mechanical engineering such as the Otto/Carnot cycles and efficiency of steam engines. Greg Anderson explains his rationale: "The connection between thermodynamics and reality is made, not by explaining entropy with statistical mechanics, but by using thermodynamics to elucidate the countless number of practical real-world problems in all aspects of Earth sciences...". Although shifting the introduction away from these examples makes sense for students focusing on applying this knowledge in geosciences, students who need a degree in geological engineering might need to seek additional references.

I really enjoyed how Greg Anderson introduced some basic thermodynamics concepts including equilibrium, metastability, entropy, and spontaneity of reactions, with examples such as graphite/diamond stability, the cooling of a coffee cup, or the melting of an ice cube out of the freezer. The book also features exercises and solutions at the end of each chapter, which will be very valuable for undergraduate students who wish to solve additional problems. Some of the solutions can only be accessed online by teachers, which will also permit to use some of the exercises in classes and/or exams. Certain concepts are explained in more detail in very useful boxes that contain definitions, calculations, chemical reactions, and real examples that one may encounter. Hence this new edition is an ideal textbook for teaching undergraduate classes that cover thermodynamics applied to geosciences. I also particularly appreciated some of the reorganization in the new version, which makes more sense to me in comparison to the second edition. This includes for example starting with equilibrium constants in chapter 9, followed by rock-water systems in chapter 10 and finally redox reactions in chapter 11.



For researchers and graduate students looking into a reference book, I would say that the second edition in their library does not need to be replaced, since both editions cover very similar topics and examples. More in-depth chapters from the second edition not printed in this third edition can be downloaded online. Nevertheless, if someone is looking for a more portable version of this book, the new edition is definitely more travel friendly and the cover picture more inviting, which will also help motivate students to learn from this book. Overall, I recommend this book for anyone interested in thermodynamics applied to geosciences and as teaching textbook. The author gives instructors other options to include particular and more advanced topics from the second edition on the Cambridge University Press website. These include more in depth topics such as equations of state and the theory behind real solutions.

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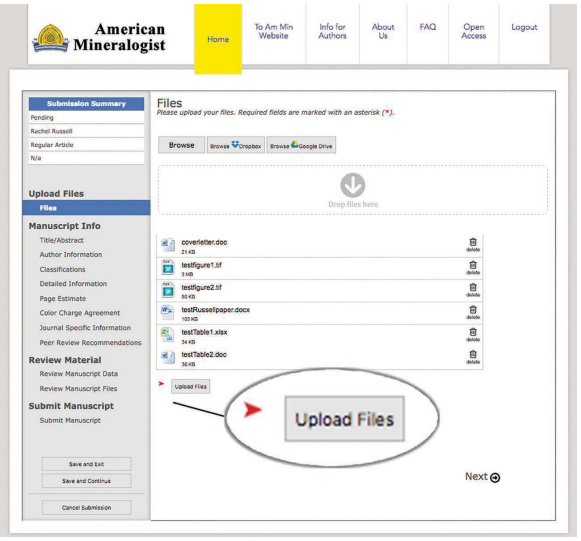

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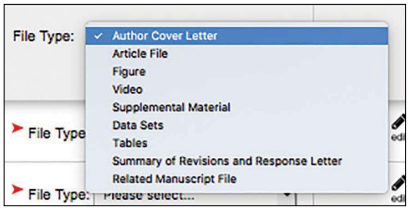

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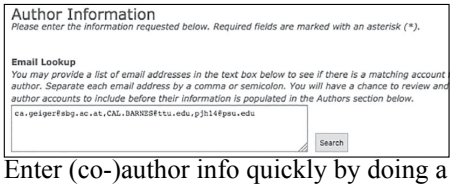

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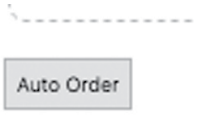

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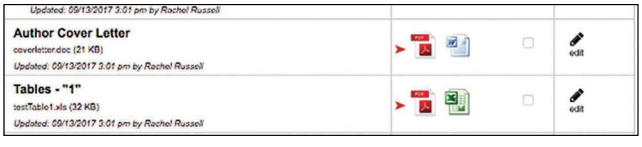

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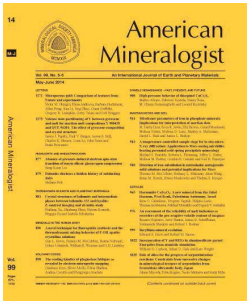

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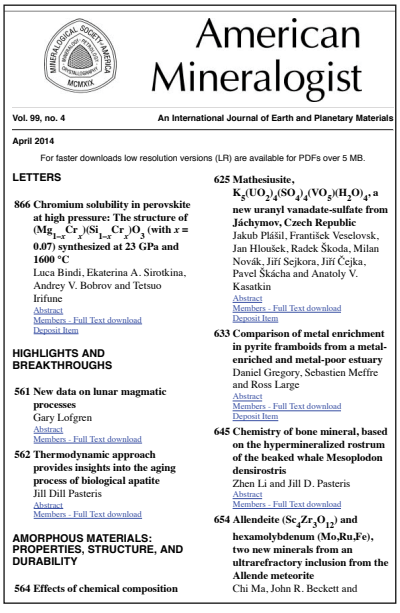

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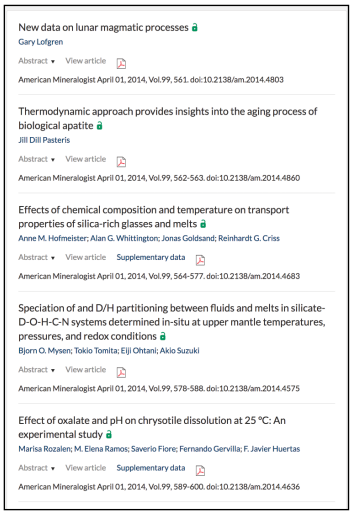

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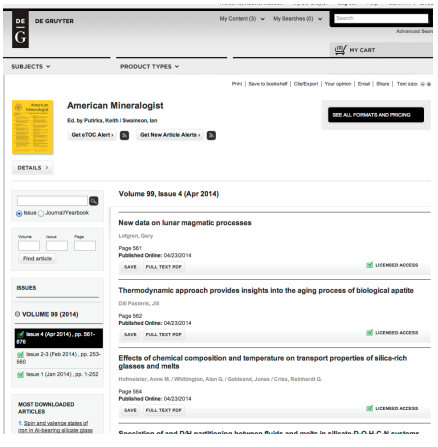

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