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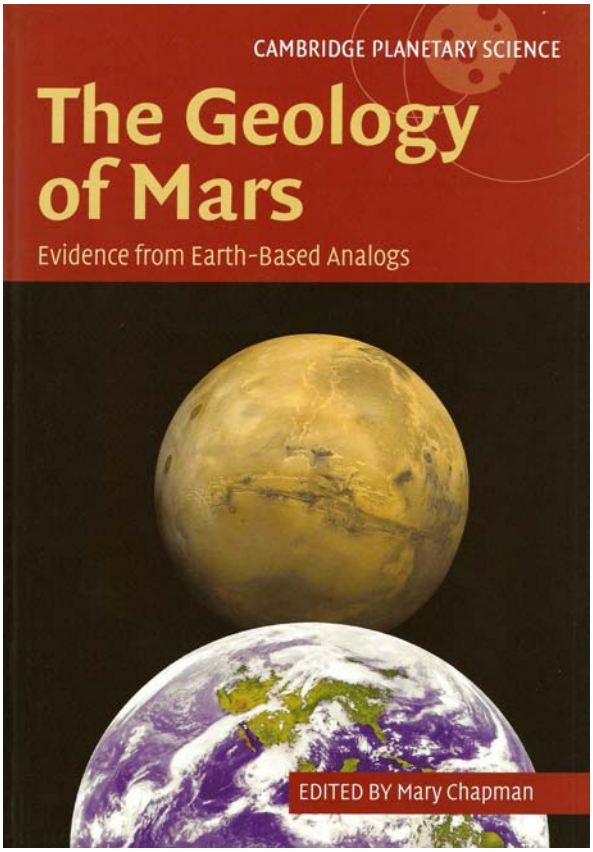
Book Review

The geology of Mars: Evidence from Earth-based analogs, edited by M. G. Chapman. New York: Cambridge University Press, 2007, 460 p., $145.00, hardcover (ISBN 978-0-521-83292-2)



These are exciting times in planetary exploration. Although the near-term focus for human exploration is the Moon, Mars remains a high-priority focus for planetary scientists around the world. Comparative planetology and the study of terrestrial analogues are driven by the need to interpret and ground-truth data sent back from Mars by unmanned orbiters and rovers. In essence, by understanding geological processes on Earth, we hope to further our understanding of geological processes on Mars. One can think of terrestrial analogue research as falling into three broad areas: comparative planetary geology, astrobiology, and exploration-related activities, such as technology testing and validation. This book discusses all of these topics, although the latter two to a lesser extent. As noted by Mary Chapman in her preface, until now there has been no book that draws together research conducted on the comparative study of Mars and Earth-based analogues.

This is an edited book comprising 17 chapters on various topics and represents the latest in a new Planetary Science series being published by Cambridge University Press. As with any edited volume, the chapters are variable in terms of length, style and approach to this subject, reflecting the individual authors' writing style(s). As such, the target audience is also broad and this book should be of interest to students and more experienced researchers alike. This book is particularly relevant for those interested in volcanic processes, with several chapters to compare and contrast different aspects of volcanism on Earth and Mars. One particularly useful aspect of this book is the emphasis on describing outstanding issues, which should prove valuable for directing and stimulating future work.

This book begins with an excellent overview chapter by J. W. Head summarizing the various geological processes that have acted to shape the Martian surface. This is a thorough and excellent summary of Martian surface processes and what we have learned from terrestrial analogues. I particularly like the attention to highlighting what we don't know as well as what we do know. This introduction is followed by a series of chapters on various planetary surface processes. N. G. Barlow and co-authors provide a summary of impact structures on Earth and Mars. They begin with a nice summary of impact processes and then devote the bulk of the chapter to discussing the effect of volatiles on the formation of impact structures on Mars and Earth. The only shortcoming of this and many of the chapters is that most of the referenced literature is pre-2001, so that the more recent findings from Mars Express, the Mars Exploration Rovers, and Mars Reconnaissance Orbiter are not included.

The next six chapters deal with various aspects of volcanism and volcanic deposits. P. J. Mouginis-Mark and co-authors focus on terrestrial analogues to the calderas of the Tharsis volcanoes on Mars. They provide an excellent introduction to calderas, which is detailed but concise. I like the organization of this chapter in that it draws attention to how particular terrestrial analogues are instructive for understanding different aspects of Martian calderas. Chapter 4 takes a different approach to the previous chapter, focusing specifically on the New Mexico volcanic region. L. S. Crumpler and co-authors first provide an excellent overview and then highlight various aspects of this field that may be useful analogues for Mars. In Chapter 5, L. Keszthelyi

and A. McEwen provide a detailed overview of Martian flood lava occurrences and note specific similarities and differences to terrestrial Large Igneous Province flood basalts. There is a nice summary of unanswered questions to stimulate further work.

S. A. Fagents and T. Thordarson (Chapter 6) draw comparisons between rootless volcanic cones on Iceland and on Mars. The authors note that lava-rock interactions are poorly understood in general. This introduces an interesting by-product of terrestrial analogue studies, namely, that many geological processes and features on Earth are still poorly understood, so by studying the geology of these terrestrial analogues, we not only increase our understanding of Mars but also our understanding of fundamental scientific problems here on Earth. These authors also do a good job of describing the limitation of terrestrial analogues, which is a very good point that is often overlooked—differences in scale, weathering rates, and the overall environment (e.g., pressure, temperature, precipitation) must be considered. In Chapter 7, M. G. Chapman and J. L. Smellie note similarities between Mars' interior layered deposits and terrestrial sub-ice volcanoes. There is a lengthy and very useful discussion section. As with the previous chapter, the authors note the paucity of terrestrial data available. T. Gregg continues in a similar vein in Chapter 8 by exploring the evidence for lava-sediment interaction on Mars, drawing on terrestrial analogue studies involving the emplacement of lava into wet and dry sediments.

J. R. Zimbelman and S. H. Williams focus on comparing aeolian features on Earth and Mars. This is the only chapter on aeolian processes. The authors manage to do a concise but detailed job of describing 22 sites in the western United States; they then go on to describe evidence for aeolian processes and dunes on Mars. As noted by the authors, the effects of the thin atmosphere and lack of a hydrological cycle on Mars—which effects mobility and boundary conditions required to initiate aeolian transport—complicates the use of terrestrial analogues.

Chapter 10 is the only chapter on Martian gullies, which is perhaps surprising given the current interest in such landforms and the evidence for very recent gully formation on Mars. F. Costard and co-authors focus on gullies in Greenland and the importance of ground-ice in gully formation on Earth and, by analogy, possibly Mars. The following two chapters continue on a similar aqueous theme but on a much larger scale, focusing on the origin of channels and valleys on Mars. F. Costard and E. Gautier suggest that periglacial regions of Earth are perhaps the best analogues for Mars and draw comparisons between Siberian rivers and Martian outflow channels. In Chapter 12, G. Komatsu and V. R. Baker note the distinction between valleys and channels and the differences and similarities between such landforms on Earth and Mars. As these authors note, our knowledge of Martian outflow channels would not have been possible without the study of terrestrial analogues, such as the Channeled Scabland in the United States.

In Chapter 13, G. Komatsu and co-authors present a summary of their investigation of terrestrial playa environments and present a convincing case why such features should also be present on Mars. This chapter has a nice section on the remote sensing identification of terrestrial evaporite deposits, which draws attention to the difficulties in interpreting similar data from Mars and the important factor of spatial resolution.

Chapter 14 is the sole chapter dedicated to the use of terrestrial analogues in astrobiology. N. A. Cabrol and co-authors focus on the astrobiological potential of high-altitude lakes in South America. Studies such as these are important for understanding the limits of life on Earth, which is important in identifying potential habitats for life on Mars. In Chapter 15, R. A. Schultz revisit the "canyonlands model" for simple planetary grabens. The authors provide examples from the Moon and Venus and then finish up with a short section on Mars. The penultimate chapter, by H. E. Newsom, is on geochemical analogues and Martian meteorites and introduces another aspect of terrestrial analogues: the characterization of analogue materials. The physical properties (e.g., strength, density, thermal conductivity, etc.) of rocks and minerals affect the efficiency, rate, and outcome of many geological processes.

The final chapter introduces the use of terrestrial analogue studies for exploration. K. Snook and co-authors present a case for carrying out simulated missions in analogue environments on Earth in preparation for human missions to the Moon and Mars. With the current emphasis on the return of humans to the Moon, the use of terrestrial analogues for instrument testing and development, astronaut training, and other exploration-related activities will become increasingly important. In summary, this book provides an excellent introduction to the field of comparative planetology and should be a welcome addition to the bookshelf of planetary scientists.

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