The Geology of Mars
Evidence from Earth-Based Analogs

With the prospect of a manned mission to Mars still a long way in the future, research into the geological processes operating there continues to rely on interpretation of images and other data returned by unmanned orbiters, probes, and landers. Such interpretations are necessarily based on our knowledge of processes occurring on Earth. Terrestrial analog studies therefore play an important role in understanding the origin of geological features observed on Mars.

This book presents contributions from leading planetary geologists to demonstrate the parallels and differences between these two neighboring planets, and to provide a deeper understanding of the evolution of the Solar System. Mars is characterized by a wide range of geological phenomena that also occur on Earth, including tectonic, volcanic, impact cratering, aeolian, fluvial, glacial, and possibly lacustrine and marine processes. This is the first book to present direct comparisons between locales on Earth and Mars and to provide terrestrial analogs for newly acquired data sets from Mars Global Surveyor, Mars Odyssey, Mars Exploration Rovers, and Mars Express.

The results of these analog studies provide new insights into the role of different processes in the geological evolution of Mars. This book will therefore be a key reference for students and researchers of planetary science.

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THE GEOLOGY OF MARS

Evidence from Earth-Based Analogs

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Preface: the rationale for planetary analog studies

Just before I left to attend the June 2001 Geologic Society of London/Geologic Society of America Meeting in Edinburgh, Scotland, I received two e-mail messages. The first was from a UK-based freelance science writer, who was producing a proposal for a six-part television series on various ways that studies of the Earth produce clues about Mars. He requested locations where he might film, other than Hawaii. I was amazed that he seemed not to be aware of all of the locations on Earth where planetary researchers have been studying geologic processes and surfaces that they believe are analogous to those on Mars. In retrospect, his lack of knowledge is understandable, as no books were in existence on the topic of collective Earth locales for Martian studies and no planetary field guides had been published that included terrestrial analogs of the newly acquired data sets: Mars Global Surveyor, Mars Odyssey, Mars Exploration Rovers, and Mars Express. [Historically, NASA published a series of four Comparative Planetary Geology Field Guides with four locales having analog features for comparison with Mars, each book on a different subject and area (volcanic features of Hawaii, volcanism of the eastern Snake River Plain, aeolian features of southern California, and sapping features of the Colorado Plateau). However, all of these books were based on Viking data, intended for researchers in the field, were not widely distributed, and are now out of print (NASA has not published any more field guides).] The second e-mail was from Science Editor Susan Francis of Cambridge University Press, requesting that I stop by their booth at the Edinburgh meeting to discuss a possible topic for a new book on the geology of Mars. Following this e-mail correspondence, I came up with a topic that highlights the current research of geologists who study various environments on Mars using Earth-based analogs.

Planetary geologists commonly perform terrestrial analog studies in order to better understand the geology of extraterrestrial worlds, in order to know more about our solar system. Especially Mars, because although the radius of Mars is about half that of the Earth, its gravity is about a third of our own, and the current Martian atmosphere is very thin, dry, and cold – it is the one planet in the solar system whose surface is most similar to our own. The geology of Mars is characterized by a wide range of geological processes including tectonic, volcanic, impact cratering, aeolian, fluvial, glacial and possibly lacustrine and marine. However, other than the ongoing processes of wind, annual carbon dioxide frosts, and impact cratering, most active geologic processes on Mars shut down millennia ago, leaving a red planet frozen in time. Many of the almost perfectly preserved surface features and deposits of Mars appear visually very similar to analogous terrestrial locales, leading researchers to propose similar processes and origins for deposits on both planets. In order to test their hypotheses, logically researchers visit and study these analog areas on Earth to determine characteristics that (1) provide evidence for the origin of surfaces on Mars and (2) can be detected by instruments and astronauts on current and future missions. Currently, the Mars Global Surveyor, Mars Odyssey, and Mars Express spacecraft and onboard instruments continue to orbit the planet and acquire data, while the active Mars Exploration Rovers explore the surface of Gusev Crater and the Meridiani plains. Recent data from these missions show that our earlier interpretations of Mars geology need to undergo expansion and revision. In this book, examples of new insights into these processes on Mars underline the need for study of Earth processes and analogs and the application of these results to a better understanding of the geological evolution of Mars. In addition, future rover and spacecraft missions are also being planned for upcoming launch opportunities. Within the next 20 years, perhaps astronauts may be sent to Mars. Missions to Mars are expensive. It is necessary and cost effective to attempt to be certain that our mission instruments and personnel are equipped and trained to detect and discern the nature of Martian terrains before they are deployed on that planet. Therefore, research geologists investigate terrestrial analog environments to develop criteria to better identify the nature of planetary deposits from remote surface measurements and orbiting spacecraft data.

The first chapter in this book by Jim Head discusses how our Viking-based view of Mars has changed based on the new data we are receiving from the current Mars missions. The rest of the chapters detail how specific rocks and environments on Earth are studied in order to better interpret data from Mars. I would like to thank all the authors that participated in this long-overdue book. The chapters in this book were improved by helpful comments and suggestions from our peer reviewers and I appreciate and want to thank for their time and efforts Devon Burr, Nathalie Cabrol, Bill Cassidy, Dean Eppler, Sarah Fagents, Paul Geissler, Trent Hare, Jeff Kargel, Lazlo Keszthelyi, Goro Komatsu, Nick Lancaster, John McHone, Dan Milton, Bill Muehlburger, Kevin Mullins, Horton Newsom, Tom Pierson, Jeff Plescia, Sue Priest, Susan Sakimoto, Ian Skilling, Jim Skinner, Ken Tanaka, Tim Titus, Wes Ward, Lionel Wilson and Jim Zimbelman.

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