

DUNE WORLDS

How Windblown Sand
Shapes Planetary Landscapes

Ralph D. Lorenz
James R. Zimbelman



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Landscapes

 Springer

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Preface

This book arose from the evident need to sum up the breathtaking progress made in the last 25 years in the study of dunes and ripples on Earth and the other worlds of the solar system. Not only observations by orbiting spacecraft, but the close-up views and physical interaction with landers and rovers, have transformed our views of the other planets (and we count Titan in that category, however politically incorrect that may be!). Our knowledge of the Earth, too, has dramatically improved, with global satellite data able to reveal the topography of dunes and measure their motion, and ground-penetrating radar able to profile the internal structure of dunes and diagnose their history. New instrumentation and data acquisition equipment, both in the laboratory and in the field, exposes the turbulent variations in wind and sand's response with high time resolution, freeing us from the tyranny of the average and showing ripples moving in timelapse. And all these data are being synthesized into a better understanding with ever-more sophisticated computer models. All this has left the "classic" books—Bagnold, McKee, Greeley, and Lancaster—behind.

Bagnold's *Physics of Wind-Blown Sand and Desert Dunes* (1941) has been long considered the bible of aeolian studies, although 70 years on it must be considered, perhaps, the Old Testament. That said, we pay homage throughout this book to its pioneering approaches. McKee's formidable space-age survey of Earth, *Global Sand Seas* (1979), remains a tremendous resource, but much superior satellite datasets now exist in the age of Google Earth. Greeley and Iverson's *Wind as a Geological Process* (1984) is perhaps most comparable in scope to what we have attempted, insofar as it considers other planets in some detail. However, planetary science is a field that moves quickly, and Mars has now been much better explored, Venus's few dunefields were discovered, and Titan opened up a whole new arena for planetary dunes. We have aimed for the breezy clarity of exposition exemplified by Nick Lancaster's (sadly earthbound) *Geomorphology of Desert Dunes* (1995). We draw inspiration from all these sources.

This book is not intended as a textbook; a textbook explains how to do something, whereas we see this book as more useful in suggesting what might be worth doing, and where to start—a travel guide to the research landscape, if you will. We have attempted to be reasonably comprehensive in providing references to allow the reader to follow up details close to the frontiers of present research in the various topics, but this book is not intended to be a complete review of each—that would entail far more work for us and far more pages from our publisher than either party can afford. We have tried to be fairly rigorous in covering the planetary dune literature, at least, such that this book can complement texts on (terrestrial) aeolian geomorphology, of which there are many examples such as Pye and Tsoar's *Aeolian Sand and Sand Dunes* (1990) and Cooke and Warren's *Geomorphology in Deserts* (1973). Even so, we crave the indulgence of our many colleagues, some of whose vast body of work we have inevitably failed to acknowledge.

On the subject of indulgence, one of the few pleasures available to the author is the ability to decide what to write about. We have included some more quirky topics that just seemed fun and worth discussing in a scientific manner, such as booming dunes, locomotion on dunes, and dunes portrayed in other worlds in science fiction. We hope our readers enjoy these diversions but find them instructive nonetheless.

We have pursued our research into dunes with the support of NASA, via the Cassini mission (RL) and through various Mars-related research and analysis programs (JZ). The compilation of this book, however, was very much a “spare time” affair, although RL acknowledges a Janney Publication Fellowship from the Johns Hopkins University Applied Physics Laboratory, and JZ the support of the Smithsonian Institution.

We thank Clive Horwood of Praxis Publishing who has been a patient supporter of this project from the beginning, and Mary Bourke who helped us shape the idea. We are deeply indebted to our many colleagues who unhesitatingly gave us permission to use various graphics, and indeed for finding photos for us: we have acknowledged their contributions where they occur. Prof. Jani Radebaugh of Brigham Young University deserves special mention, however, for also participating in a number of our desert adventures, and for giving us critical feedback on an early draft of the book.

Last, but by no means least, we note our appreciation of the patience and love of our respective spouses, Zibi Turtle and Cheryl Zimbelman, who have tolerated our physical absences off in desert places, and our mental absences over many weekends and evenings spent at home but hunched over our laptops working on the text you have before you.

Columbia, May 2013
Manassas

Ralph D. Lorenz
Jim R. Zimbelman

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