VOLCANISM ON IO

A Comparison with Earth

The most powerful volcanoes in the Solar System are found not on Earth but on Io, a tiny moon of Jupiter. Earth and Io are the only bodies in the Solar System with active, high-temperature volcanoes, but volcanoes on Io are larger and hotter – as well as more violent.

This book, the first dedicated to volcanism on Io, contains the latest results from the *Galileo* mission. In addition to investigating the different styles and scales of volcanic activity on Io, it compares those volcanoes to their contemporaries on Earth. The book also provides background on how volcanoes form and how they erupt, and explains quantitatively how remote-sensing data from spacecraft and telescopes are analyzed to reveal underlying volcanic processes.

This richly illustrated book will be a fascinating reference for advanced undergraduate and graduate students, as well as researchers in planetary sciences, volcanology, remote sensing, and geology.

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Preface

I have always been fascinated by volcanoes, and especially by Io, a tiny moon that beyond any expectation turned out to be the most volcanically active body in the Solar System. Now that the NASA *Galileo* mission is over and initial data analyses have been completed, this is an appropriate time to assess the "state of the satellite" and review what has been learned about Io over the past few decades.

A fascination with volcanoes is understandable, but I am also inspired to understand, through modeling of volcanic processes, how volcanoes *work*. Such motivation was instilled in me as a post-graduate student by Lionel Wilson and Harry Pinkerton at Lancaster University in the UK.

In this book, therefore, I have endeavored not only to describe what *Galileo* saw, but also to provide the necessary background for understanding the physical, volcanological processes taking place on Io, and to demonstrate how remote-sensing data of volcanic activity can be used to peel back the layers of a planet to reveal interior processes and structure. To put the majestic scale of volcanism on Io into proper context, comparison is made wherever possible with volcanic activity on Earth.

It has taken nearly two years to write this book. Along the way, I have had a great deal of help from friends, family, and colleagues. I thank Simon Mitton of Cambridge University Press, who originally suggested that I write this book and helped me prepare the proposal for Cambridge University Press; Diana Blaney, Nathan Bridges, Julie Castillo-Rogez, Torrence Johnson, Dennis Matson, Dave Pieri, and Glenn Veeder at the Jet Propulsion Laboratory, California Institute of Technology (JPL); Giovanni Leone and Lionel Wilson (Lancaster University); Laszlo Keszthelyi (U.S. Geological Survey [USGS] Astrogeology Branch), Jani Radebaugh (Brigham Young University), and Alison Canning Davies, all of whom reviewed chapters (multiple chapters in some cases); Tammy Becker (USGS) for supplying me with *Voyager* imagery; Paul Geissler (USGS) for a cylindrical projection of the magnificent Io global mosaic he helped create; Ju Zhang for

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Abbreviations

AIDA	Adaptive Image Deconvolution Algorithm
ALI	Advanced Land Imager (*EO-1*)
AO	Adaptive optics
ASE	Autonomous Sciencecraft Experiment (*EO-1*)
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer (*Terra*)
CAI	Calcium-aluminum-rich inclusion
CRB	Columbia River Flood Basalts
CRISM	Compact Reconnaissance Imaging Spectrometers for Mars (*MRO*)
ELT	Extremely Large Telescope
EOS	Earth Observing System
EO-1	*Earth Observing 1*
ESA	European Space Agency
ESO	European Southern Observatory
FLIR	Forward-looking infrared camera, built by FLIR Systems, Inc.
GEM	*Galileo* Europa Mission
GMM	*Galileo* Millennium Mission
GOES	*Geostationary Operational Environmental Satellite*
HGA	High Gain Antenna (*Galileo*)
HiRise	High-Resolution Imaging Science Experiment (*MRO*)
HRIR	High-Resolution Infrared Radiometer (*Nimbus 1*)
HST	Hubble Space Telescope
IRIS	Infrared Radiometer Interferometer and Spectrometer (*Voyager*)
IRTF	Infrared Telescope Facility
ISS	Imaging Sub-System (*Cassini*)
ISS	Imaging Sub-System (*Voyager*)
JPL	Jet Propulsion Laboratory, California Institute of Technology
LGA	Low Gain Antenna (*Galileo*)

LLRI	Long-lived radioisotope
MODIS	Moderate-Resolution Imaging Spectroradiometer (*Aqua* and *Terra*)
MRO	*Mars Reconnaissance Orbiter*
NASA	National Aeronautics and Space Administration
NGAO	Next Generation Adaptive Optics
NIMS	Near-Infrared Mapping Spectrometer (*Galileo*)
OWL	OverWhelmingly Large telescope
PPR	Photo-Polarimeter Radiometer (*Galileo*)
PPS	Photo-Polarimeter (*Voyager*)
SLRI	Short-lived radioisotope
SSI	Solid State Imaging experiment (*Galileo*)
SWIR	Short-wavelength infrared
TM	Thematic Mapper (*Landsat*)
TMT	Thirty-Meter Telescope
UVS	Ultra-Violet Spectrometer (*Voyager*)
UVS-EUVS	Ultra-Violet/Extreme Ultra-violet Spectrometer (*Galileo*)
VLT	Very Large Telescope
WFPC2	Wide-Field Planetary Camera 2 (Hubble)

Note: Spacecraft names are in italic.

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