

Introduction To Planetary Geomorphology

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nearly all major planets and moons in our solar system have been visited by spacecraft and the data they have returned has revealed the incredible diversity of planetary surfaces featuring a wealth of images this textbook explores the geological evolution of the planets and moons introductory chapters discuss how information gathered from spacecraft is used to unravel the geological complexities of our solar system subsequent chapters focus on current understandings of planetary systems the textbook shows how planetary images and remote sensing data are analyzed through the application of fundamental geological principles it draws on results from spacecraft sent throughout the solar system by nasa and other space agencies aimed at undergraduate students in planetary geology geoscience astronomy and solar system science it highlights the differences and similarities of the surfaces at a level that can be readily understood by non specialists

featuring hundreds of images this textbook explores the geological evolution of planets and moons for undergraduate students in planetary science

the latest mars missions are returning data of unprecedented fidelity in their representation of the martian surface new data include images with spatial resolution better than 30 cm per pixel stereo imaging derived terrain models with one meter postings high resolution imaging spectroscopy and radar data that reveal subsurface structure this book reveals how this information is being used to understand the evolution of martian landscapes and includes topics such as fluvial flooding permafrost and periglacial landforms debris flows deposition and erosion of sedimentary material and the origin of lineaments on phobos the larger martian moon contemporary remote sensing data of mars on a par with those of earth reveal landscapes strikingly similar to regions of our own planet so this book will be of interest to earth scientists and planetary scientists alike an overview chapter summarising mars climate geology and exploration is included for the benefit of those new to mars

the plate tectonics revolution in the earth sciences has provided a valuable new framework for understanding long term landform development this innovative text provides a comprehensive introduction to the subject of global geomorphology with the emphasis placed on large scale processes and phenomena integrating global tectonics into the study of landforms and incorporating planetary geomorphology as a major component the author discusses the impact of climatic change and the role of catastrophic events on landform genesis and includes a comprehensive study of surface geomorphic processes

the objective of this book is to introduce the surface of the objects in the solar system the individual treatment features of the planets and satellites in the context of varies among the chapters for example it was difficult geomorphic processes introductory chapters include the to decide what to leave out of the chapter on mars because bows and whys of solar system exploration and a so much is known about the surface whereas data are review of the primary processes that shape our planet rather limited for mercury earth and which appear to be important to planetary in addition to introducing the geomorphology of plane sciences the remaining chapters describe the geomor tary objects this book is intended to be a source for phology of the planets and satellites for which data are obtaining supplemental information references are cited available for most of these objects the general physiog throughout the text however these citations are not raphy and terrain units for each are introduced then the intended to be exhaustive but rather are given to provide geomorphic processes that are inferred for the develop a springboard for additional literature surveys

a note to the readers dear readers this book emerges from a profound fascination with the forces that shape worlds forces both familiar and alien from the gentle flow of rivers carving through earth s landscapes to the harsh winds sculpting the dunes of mars planetary geomorphology comparative landforms on earth and mars aims to bridge the gap between terrestrial and planetary science guiding you through the intricate dialogues between these two worlds and enriching your understanding of both within these pages you will encounter detailed examinations of diverse geomorphic processes volcanic fluvial glacial aeolian tectonic and hydrothermal accompanied by comparisons that highlight both striking similarities and profound differences between earth and mars through integrated insights from remote sensing data field analog studies and computational modeling i invite you to explore these planets not only as distinct entities but as interconnected bodies within the broader context of planetary evolution throughout the text my intent has been to weave complex scientific findings into a narrative that is rigorous yet accessible aiming for a style that appeals equally to researchers advanced students and scientifically curious readers figures maps and detailed descriptions are abundantly provided not merely as supplemental materials but as central elements of the storytelling allowing you to visualize and appreciate the remarkable beauty and complexity of planetary surfaces i encourage you to approach this work not only as a scholarly resource but also as a starting point for your own exploration an invitation to engage critically and imaginatively with the profound mysteries and captivating landscapes of our planetary neighbors this book aims to serve not as an endpoint but as a catalyst for deeper inquiry and reflection about our place in the cosmos thank you for joining me on this intellectual journey may it inspire further curiosity exploration and wonder

perspectives on the future directions of research in geomorphology form the major theme of this volume ten geomorphologists were asked to star gaze that is provide opinions about the future direction of their specialty each paper is supported by the literature that currently defines the research frontier

this text explores from a geological perspective the volcanic processes on the planets and moons of our solar system its comprehensive coverage probes the nature of volcanic activity among the planets and their satellites the work is designed as an introduction to volcanic phenomena in departments of geology geophysics and earth science and is intended primarily for beginning students with no previous geological experience

the technique of the mapping of planetary surfaces and the methods used for the identification of various planetary landforms improved much in the last 400 years until the 20th century telescopic observers could

interpret planetary landforms solely based on their appearance while today various data sets acquired by space probes can be used for a more detailed analysis on the composition and origin of the surface features before the greeks the earth and the heavens were indisputably of different origin and nature it was a major philosophical breakthrough first appeared as an a priori theory later based on observations that the heavens planetary bodies and the earth share common features gravity composition and solar distance may be different but the nature of the physical processes shaping the landforms are essentially the same it has been a long way since we have arrived from the first telescopic description of lunar craters to the identification of various geological formations on mars or on minor planets relief features of the moon have first been observed by galileo galilee via his telescope during the next centuries a multitude of lunar landforms have been identified theories based on observations have been connected together by a scientific paradigm which explained their origin in a logical and seemingly undisputable manner telescopes showed a lunar surface full of circular landforms called craters a landscape with no parallel on earth but the individual landforms had a morphological equivalent volcanoes which naturally led to the conclusion that craters had been created by volcanic processes maria seas served as natural basins for water bodies observations clearly showed that water and air are hardly found on the moon the lack of clouds indicated the lack of precipitation but the flat surface of the maria obviously composed of marine sediments and the meandering valleys suggested the presence of liquid water and a higher atmospheric pressure in the past during the age of active volcanism and degassing there were no observable active volcanic processes but some craters though to be volcanoes have been observed as being active flashes of light interpreted as eruptions have been reported by several observers the presence of pyroclasts thrown out from the volcanic vents of craters provided an independent evidence meteor showers and individual meteorites falling from the sky originating from lunar craters the logical and interconnected set of explanations based on observations proved to be completely false by the second half of the 20th century the new paradigm interpreted the very same features in a new context the case of mars was different there were no telescopes capable of observing relief forms no shadows on mars are visible from the earth because mars always shows a nearly full mars phase so only albedo features could be seen and used for interpretation the lack of visible relief features were interpreted as a lack of considerable topography an unnoticed distortion in the observational data the hue and contrast of dark and bright orange grey and white spots have changed seasonally the polar areas clearly showed a polar cap made of ice and snow but clouds have not been observed since mars is farther away from the sun than the earth it was evident that temperature values are lower there scientists concluded that mars is an ancient arid world then contemporary geology taught the theory according to which waters on the earth are going to infiltrate underground in time making the surface dry observations showed that this had already happened on mars the last surface reservoirs of water were the polar caps some observers reported seeing a global network of linear features but other have only seen very few of such albedo markings these features were interpreted as canals made by a civilization for irrigation carrying water from the poles to all around the flat plains of mars what was observable from the earth were the broad stripes of irrigated vegetation like those along the Nile the canals themselves were too narrow to be visible from here all theories converged supposing that the features seen by some but not seen by others were real there was no chance for verification until spacecrafts have been developed which were able to make local observations instead of canals the first pictures returned revealed a surface full of craters a landform not expected by anyone a paradigm shift was needed to explain the features of the new mars on the moon features were observable but the interpretation was wrong on mars only blurred albedo markings could be observed along with sharp lines of imagination which again were interpreted falsely in the case of venus there was no data on surface features only its bright cloud top could be observed from the earth but this fact along with the planet's orbital parameters provided enough information for a popular view on its surface conditions a hot world inferred from its proximity to the sun and also a rainy one from its complete cloud cover the conclusion venus is a global jungle possibly with dinosaurs like the hot and wet world of the then discovered mesozoic era our current knowledge originated from these early attempts of interpreting surface conditions and geological origin of landforms from a very little set of available data today we have a huge set of images and other physical data which makes it possible to create models on the inner structure and thermal history of planetary bodies combined data sets lead to better supported models on the formation of surface features today we believe that most models

give reliable explanation for the origin of planetary landforms new higher resolution images reveal new sets of meso and microscale landforms while images from previously not imaged dwarf planets satellites asteroids and cometary nuclei show landforms never seen before in the future exoplanets are expected to provide brand new types of relief features no predictable by our earth and solar system bound imagination there are so many different landforms on planetary surfaces that it is nearly impossible for anybody to overview all of them who does not work exactly with that certain feature type the encyclopedia helps with presenting the landforms in searchable alphabetical order the book contains more than a simple list of various features it provides context and connections between them and point to their origin for example sand dunes were found on venus mars and titan fluvial valleys and shorelines are present on mars and titan impact craters have many different types all are presented and explained here beyond the texts references schematic figures images and planetary maps accompany the description of landforms providing a wide background for detailed analyses even for geomorphologists working in planetary science this book is to help the reader to discover the great variety of planetary landforms

this comprehensive compendium provides information on nearly every u s doctoral program in physics and astronomy plus data on most major master s programs in these fields information on many major canadian programs is also included in addition the graduate programs directory lists a substantial number of related field departments including materials science electrical and nuclear engineering meteorology medical and chemical physics geophysics and oceanography this twenty eighth annual edition contains information valuable to students planning graduate study and faculty advisors including each program s research expenditures and sources of support a number of helpful appendices make navigating the directory a simple task

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Introduction

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