

## Meteorites Earth

Proceedings of IAU Symposium 229 on minor bodies of the solar system, for researchers and graduate students of planetary sciences.

Looks at asteroids, comets and meteorites, including what they are, how they are formed, how they have affected the history of Earth, and definitions of related terms.

As end-of-the-world scenarios go, an apocalyptic collision with an asteroid or comet is the new kid on the block, gaining respectability only in the last decade of the 20th century with the realisation that the dinosaurs had been wiped out by just such an impact. Now the science community is making up for lost time, with worldwide efforts to track the thousands of potentially hazardous near-Earth objects, and plans for high-tech hardware that could deflect an incoming object from a collision course – a procedure depicted, with little regard for scientific accuracy, in several Hollywood movies. Astrophysicist and science writer Andrew May disentangles fact from fiction in this fast-moving and entertaining account, covering the nature and history of comets and asteroids, the reason why some orbits are more hazardous than others, the devastating local and global effects that an impact event would produce, and – more optimistically – the way future space missions could avert a catastrophe.

Among the rarest things on earth, meteorites carry an air of mystery and drama while having left a pervasive, outsized mark on our planet and civilization. In Meteorite, Maria Golia tells the long history of our engagement with these sky-born space rocks. Arriving amid thunderous blasts and flame-streaked skies, meteorites were once thought to be messengers from the gods. Worshipped in the past, now scrutinized with equal zeal by scientists, meteorites helped sculpt Earth's features and have shaped our understanding of the planet's origins. Prized for their outlandish qualities, meteorites are a collectible and a commodity, objects of art and artists' desires and a literary muse; and 'meteorite hunting' is an adventurous, lucrative profession for some and an addictive hobby for thousands of others. A richly illustrated, remarkably wide-ranging account of the culture and science surrounding meteorites, Golia's book explores the ancient, lasting power of the meteorite to inspire and awe.

A Petrologic, Chemical Synthesis

Nature and Culture

Could an Asteroid Hit the Earth?

A Pictorial Guide To The Collection

Cosmic Invaders of the Earth

Impact Hazard from Asteroids and Comets

This definitive guide provides advanced students and researchers with a detailed yet accessible overview of all of the central topics of meteor science. Leading figures from the field summarise their active research on themes ranging from the physical composition of meteoroids to the most recent optical and radar observations and ongoing theoretical developments. Crucial practical issues are also considered, such as the risk posed by meteoroids - to spacecraft, and on the ground - and future avenues of research are explored. Taking advantage of the latest dynamical models, insights are offered into meteor flight phenomena and the evolution of meteoroid streams and complexes, as well as describing the in-depth laboratory analysis of recovered material. The rapid rate of progress in twenty-first-century research makes this volume essential reading for anyone who wishes to understand how recent developments broaden our understanding of meteors, meteoroids and their origins.

Describes what meteors and micrometeors are, and describes the different types of meteorites, including lunar and martian meteorites, and how meteorites form craters.

The impact of extraterrestrial material on Earth can lead to effects traceable in both the geological and biological record. This study describes meteorite flux with time, covering small and large bodies capable of producing craters. The effects of impacts on the environment is also covered focusing specifically on the Cretaceous-Tertiary mass extinction event.

Describes the role that collisions with meteors, comets, and asteroids have played in the history of Earth and other planets in the solar system and examines what is being done to protect Earth from future collisions.

Gold in Meteorites and in the Earth's Crust

Meteoroids and Cosmic Dust and Their Interactions with the Earth's Upper Atmosphere

a southern African perspective

Meteorites

The Science and History of Meteorites and Why We Should Learn to Love Them

Classification and Properties

Principles of Meteoritics examines the significance of meteorites in relation to cosmogony and to the origin of the planetary system. The book discusses the science of meteoritics and the sources of meteorites. Scientists study the morphology of meteorites to determine their motion in the atmosphere. The scope of such study includes all forms of meteorites, the circumstances of their fall to earth, their motion in the atmosphere, and their orbits in space. Meteoric bodies vary in size; in calculating their motion in interplanetary space, astronomers apply the laws of Kepler. In the region of retardation, the direction of motion of the meteoric body changes, and a break in the visible and real trajectories follows. The angle of fall of meteorites at a vertical line on the surface of the Earth measures between 20 degrees to 30 degrees. The text also discusses the Tunguska and Sikhote-alin meteorites, two gigantic meteorites that fell in the U.S.S.R. The text also discusses the chemistry, the mineralogy, the petrography, and the physical properties of meteorites. The book is suitable for astronomers, geologists, and general readers who have an interest in sky watching.

A study of meteors, by a Soviet scientist, with interesting information on the history of the study of meteors from a Russian viewpoint, collisions of meteors with the earth, meteor streams, other small bodies of the solar system, and processes of evolution in the system of small bodies of the solar system.

Volume 1 provides a broad overview of the chemistry of the solar system. It includes chapters on the origin of the elements and solar system abundances, the solar nebula and planet formation, meteorite classification, the major types of meteorites, important processes in early solar system history, geochemistry of the terrestrial planets, the giant planets and their satellite, comets, and the formation and early differentiation of the Earth. This volume is intended to be the first reference work one would consult to learn about the chemistry of the solar system. Reprinted individual volume from the acclaimed Treatise on Geochemistry (10 Volume Set, ISBN 0-08-043751-6, published in 2003)

Looks at the properties and characteristics of such objects found in Outer Space as asteroids, comets, and meteors.

Collision Earth!

Meteorite

Asteroids and Meteorites

Meteors and Meteorites

Sources of Meteors on Earth and Beyond

Asteroids III

What's the likelihood of the impact on earth of debris from outer space? Even near misses can change our climate, while a major impact could be catastrophic, equivalent to that which caused the disappearance of the dinosaurs and the rise of mammalian mastery of the planet. In this fascinating survey of the great collisions and the dangerous close passes of recent and prehistoric times, you'll find detailed chronicles of the effect on our earth of comets, meteors, meteorites, meteor storms, shooting stars, cosmic famous fireballs, UFOs, and other phenomena.

They range in size from microscopic particles to masses of many tons. The geologic diversity of asteroids and other rocky bodies of the solar system are displayed in the enormous variety of textures and mineralogies observed in meteorites. The composition, chemistry, and mineralogy of primitive meteorites collectively provide evidence for a wide variety of chemical and physical processes. This book synthesizes our current understanding of the early solar system, summarizing information about processes that occurred before its formation. It will be valuable as a textbook for graduate education in planetary science and as a reference for meteoriticists and researchers in allied fields worldwide.

Part of an eight-volume set for students, this book examines asteroids, comets, and meteorites and the various consequences of their impact on Earth.

Describes meteorites, where they come from, how they are found, and how they are different from rocks formed on earth

A Petrologic, Chemical and Isotopic Synthesis

Meteorite Craters and Impact Structures of the Earth

Asteroid Impact Risk

The Search for the Million Megaton Menace That Threatens Life on Earth

Flux with Time and Impact Effects

The Falling Sky

Over 150 crater-producing events have been identified, and this book describes all 139 sites worldwide at which evidence of the impacts can be seen. They range in age from recent craters formed this century to highly eroded billion-year-old craters. Some are spectacular to visit, such as the Barringer Crater in Arizona, the ring-shaped mountains of Gosses Bluff, Australia, and the huge crater at Ries in Germany. The author has visited many of the sites and his photographs enrich this thorough survey. For each site there is a summary table giving location, size, age and present condition. Maps are included where necessary. Meteorite craters are fascinating to visit, so the descriptions include guidance about access and suggested itineraries for the large structures.

Describes what are meteorites, and where do they come from?

A comprehensive overview of the extraterrestrial matter that falls to Earth from space.

Meteorites are the remnants of meteors from outer space that have survived the corridor of fire through Earth's atmosphere and landed on our planet. Rare, and bearing secrets about the formation of our Universe, these 'treasures from space' have fascinated people ever since they were first identified in the late 18th century as extraterrestrial arrivals. This jam-packed book by enthusiast and collector Ronnie McKenzie introduces the topic in straightforward language and is richly illustrated with some 200 photographs and diagrams. It discusses how to identify meteorites, where they come from and where they have landed on Earth, the many different types, and how to set about collecting them. It also dispels some of the myths about these stones, and presents some infamous meteorite scams. A handy basic guide for those new to the topic, and for anyone interested in entering the field of meteorite collecting.

Messengers from Space

Meteoroids

Meteorites, Comets, and Planets

Killer Rocks from Outer Space

Asteroids, Comets, and Meteorites

Meteors in the Earth's Atmosphere

A history of massive comet and asteroid impacts with Earth speculates on the possibility of a devastating future collision, and tells what actions should be taken to safeguard humankind

Did an enormous collision in the Asteroid Belt, orbiting the sun between Mars and Jupiter, bombard Earth with meteorites 470 million years ago? Astonishing new research suggests it did, and a revolutionary theory is emerging that this bombardment resulted in the single greatest increase in biological diversity on the planet since the origin of life. Introducing these discoveries to the general public for the first time, Ted Nield challenges the view that meteorites are bad news. Tracing the history of meteorites from the first recorded strike to the videos made routinely today, he reveals the fascinating ways in which meteorites have transformed from omens of doom to a stepping stone to Mars in twenty-first-century space exploration. The Falling Sky will shatter everything you thought you knew about one of the most terrifying forces in the universe.

An account of the present knowledge about meteorites, and a discussion of what they tell us about the evolution of the solar system and life on Earth. The book is aimed at a wide readership - including secondary students, beginning geologists and general readers.

What is unique about Richard Norton's book is that it is both a field guide to observing meteors, and also a field guide to locating, preparing and analysing meteorites. In addition to giving the reader information about observing techniques for meteors, this book also provides a fully detailed account of the types of meteorites, how and where to find them, how to prepare and analyse them. The book provides everything the amateur astronomer (or geologist!) needs to know about meteors and meteorites. It is thus the only complete book on the subject available at present.

New View of Earth, Planets and Humans

Introduction to Earth and Planetary System Science

Asteroids, Comets, Meteors, and More

Meteors

Accretion of Extraterrestrial Matter Throughout Earth ' s History

Asteroids IV

My goal in writing this book was to provide an introduction to meteorite science and a handbook on meteorite classification. Insofar as I succeeded it should prove useful both to the practicing professional and to university students at the upper-division and graduate levels. I originally intended the book to be nearly twice as long. The second half was to be a review of properties relating to the origin of each group of meteorites. Chapter XVIII is an example of how these later chapters would have looked, although most would not have been as interpretative. These chapters would have been useful chiefly to meteorite researchers looking for a quick summary of group properties; they were not written because of lack of time. Perhaps I will start to prepare this "second volume" in a year or so when my family and I have recovered from the preparation of the present volume. Although some parts of the classification portion are mildly icono-elastic, I have attempted either to avoid the inclusion of speculative interpretations or to flag them with a caveat to the reader. I have relaxed these principles somewhat in Chapter XVIII to conserve space, but even there the discussion of alternative speculations should give the reader a feeling for the degree of uncertainty attached.

When many young readers think of space, they just think of the planets, and perhaps the sun and moon. But there's much more to space than just those things. Asteroids, meteors, and comets are just a few of the other things that exist in what we know as space. Readers of this delightful book will learn all about these amazing, often rocky or icy, objects. Fact boxes emphasizing key numbers are included throughout the book, while colorful photographs and diagrams also help visual learners understand many of these figures.

This book presents basic information on material science (geochemistry, geophysics, geology, mineralogy, etc.), interaction between subsystem consisting earth system (atmosphere, hydrosphere, litho (geo) sphere, biosphere, humans) and in earth-planet system and evolution of earth-planetary system. The nature-humans interactions are described and new view on earth, planets and humans (integration of anthropocentrism and naturecentrism) are presented.

Two hundred years after the first asteroid was discovered, asteroids can no longer be considered mere points of light in the sky. Spacecraft missions, advanced Earth-based observation techniques, and state-of-the-art numerical models are continually revealing the detailed shapes, structures, geological properties, and orbital characteristics of these smaller denizens of our solar system. This volume brings together the latest information obtained by spacecraft combined with astronomical observations and theoretical modeling, to present our best current understanding of asteroids and the clues they reveal for the origin and evolution of the solar system. This collective knowledge, prepared by a team of more than one hundred international authorities on asteroids, includes new insights into asteroid-meteorite connections, possible relationships with comets, and the hazards posed by asteroids colliding with Earth. The book's contents include reports on surveys based on remote observation and summaries of physical properties; results of in situ exploration; studies of dynamical, collisional, cosmochemical, and weathering evolutionary processes; and discussions of asteroid families and the relationships between asteroids and other solar system bodies. Two previous Space Science Series volumes have established standards for research into asteroids. Asteroids III carries that tradition forward in a book that will stand as the definitive source on its subject for the next decade.

Asteroids, Comets, and Meteors (IAU S229)

Understanding the Threat to Earth from Asteroids and Comets

Asteroids, Meteors, and Comets

International Series of Monographs on Earth Sciences

Field Guide to Meteors and Meteorites

The Threat from Outer Space : Meteorite and Comet Impacts

Every year Earth is bombarded with about 40,000 tons of extraterrestrial material. This includes microscopic cosmic dust particles shed by comets and asteroids in outer space, meteorites, as well as large comets and asteroids that have led to catastrophic events in the geologic past. Originally considered only a curiosity, extraterrestrial matter found on Earth provides the only samples we have from comets, asteroids and other planets. Only recently mankind has started to actively collect extraterrestrial matter in space (Apollo program, Stardust mission) rather than to wait for its delivery to Earth. Still, most of our knowledge of the origin and evolution of our solar system is based on careful studies of meteorites, cosmic dust, and traces of large impact events in the geologic record such as the mass extinction that terminated the Cretaceous Period and led to the extinction of the dinosaurs. This book summarizes our current knowledge of the properties, origin, orbital evolution and accretion mechanism of extraterrestrial matter accreted on Earth and sheds light on accretion processes and fluxes in the geologic past. The chapters in the first part of the book are arranged in order to follow extraterrestrial matter from its origin in space, its orbital evolution on its way to Earth, its interaction with the Earth magnetosphere and atmosphere to its more or less violent collision with the Earth's surface. In the second part of the book several chapters deal with the present/day flux of cosmic dust and meteorites to Earth. Finally, several chapters deal with the reconstruction of the accretion history of extraterrestrial matter on Earth, starting with the most recent geologic past and ending with the very early, violent accretion period shortly after the formation of Earth, Moon and other solid planets in our solar system.

Meteorite science is fundamental to our understanding of the origin and early history of the Solar System. Some meteorites were produced by melting on asteroids, a few are from the Moon and others are martian. Their study yields a chronology of the first 100 million years of Solar System history and provides evidence that our Sun went through a highly radiative, T Tauri stage. This book considers the mechanism and timing of core formation and basaltic volcanism on asteroids and the effects of heating water-rich bodies. Results from meteorite research are placed in a galactic setting, and a theory is proposed for the origin of the planets of our Solar System. This advanced yet succinct introduction provides a classification of meteorites and discusses their ages and origin. It will be valuable to graduate students and scientists in astrophysics, space research, cosmochemistry, geochemistry, isotope geology and earth and planetary sciences.

The definitive guide to modern meteor science, destined to be the standard resource for advanced students and researchers.

"More than forty chapters detail our current astronomical, compositional, geological, and geophysical knowledge of asteroids, as well as their unique physical processes and interrelationships with comets and meteorites"--Provided by publisher.

Principles of Meteoritics

Treatise on Geochemistry, Second Edition

Catastrophic Collisions with Earth

35 Seasons of U.S. Antarctic Meteorites (1976-2010)

Meteorites and the Early Solar System II

Falling Sky

The US Antarctic meteorite collection exists due to a cooperative program involving the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Smithsonian Institution. Since 1976, meteorites have been collected by a NSF-funded field team, shipped for curation, characterization, distribution, and storage at NASA, and classified and stored for long term at the Smithsonian. It is the largest collection in the world with many significant samples including lunar, martian, many interesting chondrites and achondrites, and even several unusual one-of-a-kind meteorites from as yet unidentified parent bodies. Many Antarctic meteorites have helped to define new meteorite groups. No previous formal publication has covered the entire collection, and an overall summary of its impact and significant samples has been lacking. In addition, available statistics for the collection are out of date and need to be updated for the use of the community. 35 seasons of U.S. Antarctic Meteorites (1976-2011): A Pictorial Guide to the Collection is the first comprehensive volume that portrays the most updated key significant meteoritic samples from Antarctica. 35 seasons of U.S. Antarctic Meteorites presents a broad overview of the program and collection nearly four decades after its beginnings. The collection has been a consistent and reliable source of astromaterials for a large, diverse, and active scientific community. Volume highlights include: Overview of the history, field practices, curation approaches Special focus on specific meteorite types and the impact of the collection on understanding these groups (primitive chondrites, differentiated meteorites, lunar and martian meteorites) Role of Antarctic meteorites in influencing the determination of space and terrestrial exposure ages for meteorites Statistical summary of the collection by year, region, meteorite type, as well as a comparison to modern falls and hot desert finds The central portion of the book features 80 color plates each of which highlights more influential and interesting samples from the collection. 35 seasons of U.S. Antarctic Meteorites would be of special interest to a multidisciplinary audience in meteoritics, including advanced graduate students and geoscientists specializing in mineralogy, petrology, geochemistry, astronomy, near-earth object science, astrophysics, and astrobiology.

Thoroughly revised second edition of a highly successful book describing all aspects of meteorites.

Astonishing new research suggests that 470 million years ago, an enormous collision in the Asteroid Belt, which orbits the sun between Mars and Jupiter, bombarded the Earth with meteorites. That bombardment may have resulted in the single greatest increase in biological diversity on the planet since life began. Introducing these revolutionary discoveries to the general public for the first time, Nield challenges the view that meteorites are bad news for life on Earth while tracing their history from the first recorded strike to the videos made routinely today. Here is the perfect introduction to the science and history of the falling sky.

This is an easy-to-read introduction to, and overview of, current knowledge about meteorites. With information on fall phenomena, chemical and mineral composition, and classification, the book also provides current information on meteorite falls for planning observations. Accessible to the layperson and student, this concise book is thorough enough to serve as an introduction for scientists.

Cosmic Impact

Rogue Asteroids and Doomsday Comets

Exploring meteorite mysteries: a teacher's guide with activities for earth and space sciences.

Meteorites and Their Parent Planets

The Key to Our Existence