

Igneous Petrology

A concise introduction to the mineralogy and petrology of igneous and metamorphic rocks for all Earth Science students.

Igneous and metamorphic petrology has over the last twenty years expanded rapidly into a broad, multifaceted and increasingly quantitative science. Advances in geochemistry, geochronology, and geophysics, as well as the appearance of new analytical tools, have all contributed to new ways of thinking about the origin and evolution of magmas, and the processes driving metamorphism. This book is designed to give students a balanced and comprehensive coverage of these new advances, as well as a firm grounding in the classical aspects of igneous and metamorphic petrology. The emphasis throughout is on the processes controlling petrogenesis, but care is taken to present the important descriptive information so crucial to interpretation. One of the most up-to-date synthesis of igneous and metamorphic petrology available. Emphasis throughout on latest experimental and field data. Igneous and metamorphic sections can be used independently if necessary.

courses more petrogenesis-orientated are im My main objective in writing this book has been to mediate confronted with a basic problem; the review the processes involved in present-day mag ma generation and their relationship to global average student does not have a strong enough tectonic processes. Clearly, these are fundamental background in geochemistry to understand the to our understanding of the petrogenesis of ancient finer points of most of the relevant publications in volcanic and plutonic sequences, the original tec scientific journals. It is virtually impossible to fmd tonic setting of which may have been obscured by suitable reading material for such students, as most subsequent deformation and metamorphism. authors of igneous petrology textbooks have de Until fairly recently, undergraduate courses in liberately steered clear of potentially controversial igneous petrology tended to follow rather classical petrogenetic models. Even the most recent texts lines, based on the classification of igneous rocks, place very little emphasis on the geochemistry of descriptive petrography, volcanic landforms, types magmas erupted in different tectonic settings, of igneous intrusions and regional petrology . despite extensive discussions of the processes re However, the geologist of the late 1980s requires, in sponsible for the chemical diversity of magmas.

This is the eBook of the printed book and may not include any media, website access codes, or print supplements that may come packaged with the bound book. For a combined, one-semester, junior/senior-level course in Igneous and Metamorphic Petrology. Also useful for programs that teach Igneous Petrology and Metamorphic Petrology. Typical texts on igneous and metamorphic petrology are geared to either advanced or novice petrology students. This unique text offers comprehensive, up-to-date coverage of both igneous and metamorphic petrology in a single volume—and provides the quantitative and technical background required to critically evaluate igneous and metamorphic phenomena in a way that students at all levels can understand. The goal throughout is for students to be able to apply the techniques—and enjoy the insights of the results—rather than tinker with theory and develop everything from first principles.

Our aim in writing this book is to try to show how igneous rocks can be persuaded to reveal some of the secrets of their origins. The data of igneous rocks consist of field relations, texture, mineralogy, and geochemistry. Additionally, experimental petrology tells us how igneous systems might be expected to behave. Working on this material we attempt to show how hypotheses concerning the origins and evolution of magmas are proposed and tested, and thus illuminate the interesting and fundamental problems of petrogenesis. The book assumes a modest knowledge of basic petro graphy, mineralogy, classification, and regional igneous geology. It has a role complementary to various established texts, several of which are descriptively good and give wide coverage and evaluation of petrogenetic ideas in various degrees of detail. Existing texts do not on the whole, however, deal with methodology, though this is one of the more important aspects of the subject. At first sight it may appear that the current work is a guidebook for the prospective research worker and thus has little relevance for the non-specialist student of geology. We hope this will prove to be far from the case. The methodological approach has an inherent interest because it can provide the reader with problems he can solve for himself, and as an almost incidental consequence he will acquire a satisfying understanding.

This book is for geoscience students taking introductory or intermediate-level courses in igneous petrology, to help develop key skills (and confidence) in identifying igneous minerals, interpreting and allocating appropriate names to unknown rocks presented to them. The book thus serves, uniquely, both as a conventional course text and as a practical laboratory manual. Following an introduction reviewing igneous nomenclature, each chapter addresses a specific compositional category of magmatic rocks, covering definition, mineralogy, eruption/ emplacement processes, textures and crystallization processes, geotectonic distribution, geochemistry, and aspects of magma genesis. One chapter is devoted to phase equilibrium experiments and magma evolution; another introduces pyroclastic volcanology. Each chapter concludes with exercises, with the answers being provided at the end of the book. Appendices provide a summary of techniques and optical data for microscope mineral identification, an introduction to petrographic calculations, a glossary of petrological terms, and a list of symbols and units. The book is richly illustrated with line drawings, monochrome pictures and colour plates. Additional resources for this book can be found at: <http://www.wiley.com/go/gill/igneous>.

Featuring over 250 contributions from more than 100 earth scientists from 18 countries, The Encyclopedia of Igneous and Metamorphic Petrology deals with the nature and genesis of igneous rocks that have crystallized from molten magma, and of metamorphic rocks that are the products of re-crystallization associated with increases in temperature and pressure, mainly at considerable depths in the Earth's crust. Entries range from alkaline rocks to zeolite facies - providing information on the mineralogical, chemical and textural characters of rock types, the development of concepts and the present state of knowledge across the spectrum of igneous and metamorphic petrology, together with extensive lists of both commonly used and little used terms and bibliographies.

This textbook provides a basic understanding of the formative processes of igneous and metamorphic rock through quantitative applications of simple physical and chemical principles. The book encourages a deeper comprehension of the subject by explaining the petrologic principles rather than simply presenting the student with petrologic facts and terminology. Assuming knowledge of only introductory college-level courses in physics, chemistry, and calculus, it lucidly outlines mathematical derivations fully and at an elementary level, and is ideal for

intermediate and advanced courses in igneous and metamorphic petrology. The end-of-chapter quantitative problem sets facilitate student learning by working through simple applications. They also introduce several widely-used thermodynamic software programs for calculating igneous and metamorphic phase equilibria and image analysis software. With over 350 illustrations, this revised edition contains valuable new material on the structure of the Earth's mantle and core, the properties and behaviour of magmas, recent results from satellite imaging, and more. The field of Igneous Petrology has evolved greatly in the past years. McBirney's new Third Edition, completely revised and updated, presents a modern and integrated survey of the geological and genetic relations of igneous rocks. It illustrates how modern geochemical and geophysical methods can be combined with field relations to understand the generational and compositional evolution of magmas.

Trace Elements in Igneous Petrology, 5: Developments in Petrology: A Volume in Memory of Paul W. Gast focuses on the contributions and influence of Gast in petrology, including crystallization, magmatic processes, isotopic composition, and ocean ridge basalt chemistry. The selection first takes a look at quantitative models of trace element behavior in magmatic processes; application of trace elements to the petrogenesis of igneous rocks of granitic composition; and an assessment of local and regional isotopic equilibrium in the mantle. Discussions focus on evidence derived from time constraints, scale of isotopic disequilibrium, fractional crystallization, trace element modeling, geodynamics and tectonic setting, partition coefficients, quantitative models for trace elements, and parameter determination and inverse-problem solution. The publication then examines the isotopic composition of lead in oceanic basalt and its implication to mantle evolution; strontium isotopes in basalts from the Pacific Ocean basin; and trace elements in ocean ridge basalts. Concerns cover variations in ocean ridge basalt chemistry, trace elements in ocean ridge basalts, disequilibrium partial melting, seawater alteration, background for lead isotope tracer studies, and uranium, thorium, and lead concentrations in basalts. The book examines trace elements and anorthosite genesis, lead isotopes in Archaean plutonic rocks, early Archaean rocks and geochemical evolution of the earth's crust, and factors controlling the noble gas abundance patterns of deep-sea basalts. The selection is a valuable source of data for researchers interested in petrology.

Concise introductory textbook on the petrology of igneous and metamorphic rocks for one-semester courses. Topics are organized around the types of rocks to expect in tectonic environments, rather than around rock classifications. Application boxes engage students by showing how petrology connects to wider aspects of geology. Includes end-of-chapter exercises. Hawaiian Volcanoes, From Source to Surface is the outcome of an AGU Chapman Conference held on the Island of Hawai'i in August 2012. As such, this monograph contains a diversity of research results that highlight the current understanding of how Hawaiian volcanoes work and point out fundamental questions requiring additional exploration. Volume highlights include: Studies that span a range of depths within Earth, from the deep mantle to the atmosphere Methods that cross the disciplines of geochemistry, geology, and geophysics to address issues of fundamental importance to Hawai'i's volcanoes Data for use in comparisons with other volcanoes, which can benefit from, and contribute to, a better understanding of Hawai'i Discussions of the current issues that need to be addressed for a better understanding of Hawaiian volcanism Hawaiian Volcanoes, From Source to Surface will be a valuable resource not only for researchers studying basaltic volcanism and scientists generally interested in volcanoes, but also students beginning their careers in geosciences. This volume will also be of great interest to igneous petrologists, geochemists, and geophysicists.

A balanced text that bridges the gap between introductory petrography-oriented texts and the more advanced texts that have a thermodynamic and/or chemical approach. Well-indexed, well-referenced and written in a particularly readable style, it leads the reader from classical to modern concepts in igneous petrology.

All geoscience students need to understand the origins, environments and basic processes that produce igneous and metamorphic rocks. This concise textbook, written specifically for one-semester undergraduate courses, provides students with the key information they need to understand these processes. Topics are organized around the types of rocks to expect in a given tectonic environment, rather than around rock classifications: this is much more interesting and engaging for students, as it applies petrology to real geologic environments. This textbook includes over 250 illustrations and photos, and is supplemented by additional color photomicrographs made freely available online. Application boxes throughout the text encourage students to consider how petrology connects to wider aspects of geology, including economic geology, geologic hazards and geophysics. End-of-chapter exercises allow students to apply the concepts they have learnt and practice interpreting petrologic data.

Exploring the links between Large Igneous Provinces and dramatic environmental impact An emerging consensus suggests that Large Igneous Provinces (LIPs) and Silicic LIPs (SLIPs) are a significant driver of dramatic global environmental and biological changes, including mass extinctions. Environmental changes caused by LIPs and SLIPs include rapid global warming, global cooling ('Snowball Earth'), oceanic anoxia events, mercury poisoning, atmospheric and oceanic acidification, and sea level changes. Continued research to characterize the effects of these extremely large and typically short duration igneous events on atmospheric and oceanic chemistry through Earth history can provide lessons for understanding and mitigating modern climate change. Large Igneous Provinces: A Driver of Global Environmental and Biotic Changes describes the interactions between the effects of LIPs and other drivers of climatic change, the limits of the LIP effect, and the atmospheric and oceanic consequences of LIPs in significant environmental events. Volume highlights include: Temporal record of large igneous provinces (LIPs) Environmental impacts of LIP emplacement Precambrian, Proterozoic, and Phanerozoic case histories Links between geochemical proxies and the LIP record Alternative causes for environmental change Key parameters related to LIPs and SLIPs for use in environmental change modelling Role of LIPs in Permo-Triassic, Triassic-Jurassic, and other mass extinction events The American Geophysical Union promotes discovery in Earth and space science for the benefit of humanity. Its publications disseminate scientific knowledge and provide resources for researchers, students, and professionals.

Petrology and Genesis of Igneous Rocks comprises of two parts - the first part (Chapters 1 to 8) deals with constituent minerals, texture, thermodynamic principles, phase relations in natural rock systems and causes of diversity in a single petrographic province. Petrology of the crust, mantle and core, the convective cycle patterns in the mantle and their relation to magma genesis and physicochemical properties of magma are also discussed in this part. Use of Isotope geology in determination of age and degree of magma

mixing is included towards the end of the first part. The second part (Chapters 9-13) describes individual rock types, from various countries including their geochemistry, petrology and genesis.

Igneous Petrology provides up-to-date, integrated, comprehensive coverage of physical and chemical facets of magmatic rocks and magma systems. Field relations and fabrics of rocks together with their mineralogical, chemical and isotopic compositions facilitate interpretation of rock origin. The dynamic evolution of magma systems is considered from thermodynamics and from their chemical, physical and kinetic properties. Sources of magmas and how they are generated and subsequently evolve are considered in the context of global tectonics. The textbook stresses petrologic processes while also providing thorough descriptions of rock products suitable for the undergraduate student. Organized in terms of chemical and physical phenomena. Includes new insights into intrusive and volcanic processes-especially, explosive volcanism in field petrology. Contains new data in physical petrology. Focuses on the latest research of magma properties and experimental and theoretical modeling. Consists of new coverage of trace element characterization of rock associations and modeling. Well illustrated text with a 6-page, 4-color insert. For ease of use, the quantitative material is set aside in boxes and in certain chapters.

Features "Fundamental questions considered in the chapter" which provide a brief, chapter preview. "Critical thinking questions" allow the students to expand their command of the subject. Contains a comprehensive glossary along with a list of cited references. Additional problem sets will be available on the web.

The second half of the past century witnessed a remarkable paradigm shift in approach to the understanding of igneous rocks. Global literature records a change from a classical petrographic approach to emphasis on mineral chemistry, trace element characteristics, tectonic setting, phase relations, and theoretical simulation of magma generation and evolution processes. This book contains contributions by international experts in different fields of igneous petrology and presents an overview of recent developments. This book is dedicated to the late Dr Mihir K. Bose, former professor of the Department of Geology, Presidency College, Calcutta, India, who actively participated in the development of this new global view of igneous petrology.

Igneous Petrology Elsevier

This volume, based on Symposium on Igneous Petrology held during the 30th International Geological Congress, focuses on intraplate magmatism and diversity and complexity of mechanisms of magma formation.

Volume 24 of Reviews in Mineralogy attempted to bring together the basic data and fundamental theoretical constraints on magmatic processes with applications to specific problems in igneous petrology. The Mineralogical Society of America (MSA) sponsored the short course on "Modern Methods of Igneous Petrology: Understanding Magmatic Processes" at the Cathedral Hill Hotel in San Francisco, California in December 1990. It was organized by the editors, Jim Nicholls and Kelly Russell, and presented by the authors of this volume to about 80 participants in conjunction with the Fall Meeting of the American Geophysical Union.

Processes involved in the development of igneous and metamorphic rocks involve some combination of crystal growth, solution, movement and deformation, which is expressed as changes in texture (microstructure). Advances in the quantification of aspects of crystalline rock textures, such as crystal size, shape, orientation and position, have opened fresh avenues of research that extend and complement the more dominant chemical and isotopic studies. This book discusses the aspects of petrological theory necessary to understand the development of crystalline rock texture. It develops the methodological basis of quantitative textural measurements and shows how much can be achieved with limited resources. Typical applications to petrological problems are discussed for each type of measurement. This book will be of great interest to all researchers and graduate students in petrology.

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Introduction to Mineralogy and Petrology presents the essentials of both disciplines through an approach accessible to industry professionals, academic researchers, and students. Mineralogy and petrology stand as the backbone of the geosciences. Detailed knowledge of minerals and rocks and the process of formation and association are essential for practicing professionals and advanced students. This book is designed as an accessible, step-by-step guide to exploring, retaining, and implementing the core concepts of mineral and hydrocarbon exploration, mining, and extraction. Each topic is fully supported by working examples, diagrams and full-color images. The inclusion of petroleum, gas, metallic deposits and economic aspects enhance the book's value as a practical reference for mineralogy and petrology. Authored by two of the world's premier experts, this book is a must for any young professional, researcher, or student looking for a thorough and inclusive guide to mineralogy and petrology in a single source. Authored by two of the world's experts in mineralogy and petrology, who have more than 70 years of experience in research and instruction combined Addresses the full scope of the core concepts of mineralogy and petrology, including crystal structure, formation and grouping of minerals and soils, definition, origin, structure and classification of igneous, sedimentary and metamorphic rocks Features more than 150 figures, illustrations, and color photographs to vividly explore the fundamental principles of mineralogy and petrology Offers a holistic approach to both subjects, beginning with the formation of geologic structures followed by the hosting of mineral deposits and concluding with the exploration and extraction of lucrative, usable products to improve the health of global economies

Mind over Magma chronicles the scientific effort to unravel the mysteries of rocks that solidified on or beneath Earth's surface from the intensely hot, molten material called magma. The first-ever comprehensive history of the study of such igneous rocks, it traces the development of igneous petrology from ancient descriptions of volcanic eruptions to recent work incorporating insights from physical chemistry, isotope studies, and fluid dynamics. Intellectual developments in the field--from the application of scientific methods to the study of rocks to the discovery of critical data and the development of the field's major theories--are considered within their broader geographical, social, and technological contexts. Mind over Magma examines the spread of igneous petrology from western Europe to North

