

The Origin Of Clay Minerals In Soils And Weathere

Clay minerals are one of the most important groups of minerals thatdestroy permeability in sandstones. However, they also react withdrilling and completion fluids and induce fines migration duringhydrocarbon production. They are a very complex family of mineralsthat are routinely intergrown with each other, contain a wide rangeof solid solutions and form by a variety of processes under a widerange temperatures and rock and fluid compositions. In this volume, clay minerals in sandstones are reviewed interms of their mineralogy and general occurrence, their stable andradiogenic isotope geochemistry, XRD quantification, their effectson the petrophysical properties of sandstones and theirrelationships to sequence stratigraphy and palaeoclimate. Thecontrols on various clay minerals are addressed and a variety ofgeochemical issues, including the importance of mass flux, links tocarbonate mineral diagenesis and linked clay mineral diagenesis ininterbedded mudstone-sandstone are explored. A number of case studies are included for kaolin, illite and chlorite cements, andthe occurrence of smectite in sandstone is reviewed. Experimentalrate data for clay cements in sandstones are reviewed and there aretwo model-based case studies that address the rates of growth ofkaolinite and illite. The readership of this volume will include sedimentologists andpetrographers who deal with the occurrence, spatial and temporaldistribution patterns and importance of clay mineral cements insandstones, geochemists involved in unravelling the factors thatcontrol clay mineral cement formation in sandstones and petroleumgeoscientists involved in predicting clay mineral distribution insandstones. The book will also be of interest to geologistsinvolved in palaeoclimate studies basin analysis. Latest geochemical data on clays in sandstones Provides important information for geologists involved inbasin analysis, sandstone petrology and petroleum geology If you are a member of the International Association ofSedimentologists (IAS), for purchasing details, please see:http://www.iasnet.org/publications/details.asp?code=SP34

Introduction to Clay Minerals is designed to give a detailed, concise and clear introduction to clay mineralogy. Using the information presented here, one should be able to understand clays and their mineralogy, their uses and importance in modern life.

Origin and Mineralogy of Clays, the first of two volumes, lays the groundwork for a thorough study of clays in the environment. The second volume will deal with environmental interaction. Going from soils to sediments to diagenesis and hydrothermal alteration, the book covers the whole spectrum of clays. The chapters on surface environments are of great relevance in regard to environmental problems in soils, rivers and lake-ocean situations, showing the greatest interaction between living species and the chemicals in their habitat. The book is of interest to scientists and students working on environmental issues.

Origin and Mineralogy of Clays

Clays: Their Nature, Origin and General Properties

Clay Mineral Origin and Distribution on Astoria Fan

Clay Mineralogy

Interstratified Clay Minerals

Clay Minerals 27(3) 1992 P398-392

Explores soil as a nexus for water, chemicals, and biologically coupled nutrient cycling Soil is a narrow but critically important zone on Earth's surface. It is the interface for water and carbon recycling from above and part of the cycling of sediment and rock from below. Hydrogeology, Chemical Weathering, and Soil Formation places chemical weathering and soil formation in its geological, climatological, biological and hydrological perspective. Volume highlights include: The evolution of soils over 3.25 billion years Basic processes contributing to soil formation How chemical weathering and soil formation relate to water and energy fluxes The role of pedogenesis in geomorphology Relationships between climate soils and biota Soils, aeolian deposits, and crusts as geologic dating tools Impacts of land-use change on soils 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. Find out more about this book from this Q&A with the Editors

Clay is an abundant raw material which has a variety of uses and properties depending on their structure and composition. Clay minerals are inexpensive and environmentally friendly naturally occurring nanomaterials, thanks to their 1 nm thick silicate layers, in all types of sediments and sedimentary rocks. The book chapters have been classified according to their characteristics in topics and applications. Therefore, in the first section five chapters is dedicated to the characterization and utilization of clay minerals in deposits. The second section includes four chapters about the significance of clay minerals in soils. Third section is devoted to different aspects of clay minerals research, especially to the characterization of structure and modifications for their application.

*This book on Applied Clay Mineralogy is comprehensive. It covers the structure, composition, and physical and chemical properties of kaolinite, halloysite, ball clays; bentonites including sodium montmorillonite, calcium montmorillonite, and hectorite; and polygorskite and sepiolite. There is also a short chapter on common clays which are used for making structural clay products and lightweight aggregate. The location and geology of the major clay deposits that are marketed worldwide and regionally include kaolins from the United States, Southwest England, Brazil, and the Czech Republic along with halloysite from New Zealand and ball clays from the US, England, Germany, and Ukraine. Bentonites from the U.S. and Europe are included along with polygorskite and sepiolite from the U.S., China, Senegal, and Spain. The mining and processing of the various clays are described. Extensive discussions of the many applications of the clays are included. The appendices cover the important laboratory tests that are used to identify and evaluate the various types of clay. Many figures are included covering electron micrographs, processing flow sheets, stratigraphy, and location maps. * Provides the structure and composition of clay minerals, as well as their physical and chemical properties * Discusses applications for Kaolin, Bentonite, Polygorskite and Sepiolite * Contains appendices of laboratory tests and procedures, as well as a test for common clays*

Clays in the Minerals Processing Value Chain

Nanomaterials from Clay Minerals

Advances in the Characterization of Industrial Minerals

Linking Geology, Biology, Agriculture, and the Environment

Surface and Interface Chemistry of Clay Minerals

Geological Origin, Mechanical Properties and Industrial Applications

The large lakes of the East African Rift Valley are among the oldest on Earth, and are vital resources for the people of their basins. They are unique among the large lakes of the world in terms of their sensitivity to climatic change, rich and diverse populations of endemic species, circulation dynamics and water-column chemistry, and long, continuous records of past climatic change. A comprehensive study of the large African lakes is long overdue. The scientific justification for such an effort is noted in the previous paragraph and is illustrated in great detail in this volume. Societal need for the sustainable utilization of these lakes offers an even more compelling reason for examination of biological food webs, water quality, and past climate variability in East Africa. The lakes provide the most important source of protein for the people of the African Rift Valley, and fish populations are shifting dramatically in response to fishing pressure, introduction of exotic species, land use impact on water quality, and perhaps climatic change. Current estimates of primary productivity, the underpinning of the food resource, are extremely crude and based on only a few spot measurements.

Bringing together information widely distributed throughout scientific and industrial journals, here is an overview of the chemical constitution and properties of clay minerals and the environmental conditions that lead to their formation. Provides a detailed picture of the chemical constitution of the eight main groups of clay minerals containing silica and the non-siliceous oxide clays. The central section of the book deals with the properties of clays: their colloidal behavior, cation exchange, interaction with water, reactions on heating, catalytic properties, and reactions with organic compounds. Also discusses the chemical conditions that favor the formation of clays and their evolution or decomposition into other materials.

The Encyclopedia is a complete and authoritative reference work for this rapidly evolving field. Over 200 international scientists, each experts in their specialties, have written over 330 separate topics on different aspects of geochemistry including geochemical thermodynamics and kinetics, isotope and organic geochemistry, meteorites and cosmochemistry, the carbon cycle and climate, trace elements, geochemistry of high and low temperature processes, and ore deposition, to name just a few. The geochemical behavior of the elements is described as is the state of the art in analytical geochemistry. Each topic incorporates cross-referencing to related articles, and also has its own reference list to lead the reader to the essential articles within the published literature. The entries are arranged alphabetically, for easy access, and the subject and citation indices are comprehensive and extensive. Geochemistry applies chemical techniques and approaches to understanding the Earth and how it works. It touches upon almost every aspect of earth science, ranging from applied topics such as the search for energy and mineral resources, environmental pollution, and climate change to more basic questions such as the Earth's origin and composition, the origin and evolution of life, rock weathering and metamorphism, and the pattern of ocean and mantle circulation. Geochemistry allows us to assign absolute ages to events in Earth's history, to trace the flow of ocean water both now and in the past, trace sediments into subduction zones and are volcanoes, and trace petroleum to its source rock and ultimately the environment in which it formed. The earliest evidence of life is chemical and isotopic traces, not fossils, preserved in rocks. Geochemistry has allowed us to unravel the history of the ice ages and thereby deduce their cause. Geochemistry allows us to determine the swings in Earth's surface temperatures during the ice ages, determine the temperatures and pressures at which rocks have been metamorphosed, and the rates at which ancient magma chambers cooled and crystallized. The field has grown rapidly more sophisticated, in both analytical techniques that can determine elemental concentrations or isotope ratios with exquisite precision and in computational modeling on scales ranging from atomic to planetary.

Invitation Address (73.)

Occurrences, Processing and Applications of Kaolins, Bentonites, Polygorskitesepiolite, and Common Clays

A Comprehensive Reference Source on the Chemistry of the Earth

Clay Minerals in Nature

Index to the Proceedings of the First to the Tenth National Conferences on Clays and Clay Minerals

Clays and Clay Minerals

The first edition of the Handbook of Clay Science published in 2006 assembled the scattered literature on the varied and diverse aspects that make up the discipline of clay science. The topics covered range from the fundamental structures (including textures) and properties of clays and clay minerals, through their environmental, health and industrial applications, to their analysis and characterization by modern instrumental techniques. Also included are the clay-microbe interaction, layered double hydroxides, zeolites, cement hydrates, and genesis of clay minerals as well as the history and teaching of clay science. The 2e adds new information from the intervening 6 years and adds some important subjects to make this the most comprehensive and wide-ranging coverage of clay science in one source in the English language. Provides up-to-date, comprehensive information in a single source Covers applications of clays, as well as the instrumental analytical techniques Provides a truly multidisciplinary approach to clay science

Clay minerals from sediment samples obtained on Astoria Fan were analyzed by X-ray diffraction. Clay minerals are defined for the purpose of this study as crystalline phyllosilicates less than two microns in equivalent settling diameter. The clay minerals are subdivided into the five common families: montmorillonite, chlorite, vermiculite, illite, and kaolinite. One X-ray scan of a magnesium ion saturated, ethylene glycol treated sample was sufficient for the identification of all the clay minerals. A typical Recent hemipelagic sediment contains about 40 percent montmorillonite, 30 percent illite, and 30 percent chlorite. Neither kaolinite nor vermiculite is detectable in these samples. These concentrations are similar to those reported for Columbia River sediments. The surface sediments have an identical clay mineral assemblage from the head of Astoria Canyon to the outer edge of the fan approximately 250 kilometers offshore. All of the Recent sediments in piston cores from Astoria Fan are the same as the surface sediments on the fan. This similarity indicates an unchanging source during Recent time and a lack of any visible marine diagenesis after burial. X-ray traces of Pleistocene clay minerals are distinctly different from those of the Recent. One can use this change in clay mineralogy as a time marker across the fan. Presumably the Pleistocene clays were formed under different weathering conditions caused by different climatic conditions.

Of huge relevance in a number of fields, this is a survey of the different processes of soil clay mineral formation and the consequences of these processes concerning the soil ecosystem, especially plant and mineral. Two independent systems form soil materials. The first is the interaction of rocks and water, unstable minerals adjusting to surface conditions. The second is the interaction of the biosphere with clays in the upper parts of alteration profiles.

Applied Clay Mineralogy

Chemistry, origins, uses and environmental significance

Origin, Characterization & Geochemical Significance

Their Origin and Relation to Soils and Clays

Distribution and Origin of Clay Minerals in the Deep Bering Sea

Clays

To a geologist, clay minerals are fine particles (

As the human population grows from seven billion toward an inevitable nine or 10 billion, the demands on the limited supply of soils will grow and intensify. Soils are essential for the sustenance of almost all plants and animals, including humans, but soils are virtually infinitely variable. Clays are the most reactive and interactive inorganic compounds in soils. Clays in soils often differ from pure clay minerals of geological origin. They provide a template for most of the reactive organic matter in soils. They directly affect plant nutrients, soil temperature and pH, aggregate sizes and strength, porosity and water-holding capacities. This book aims to help improve predictions of important properties of soils through a modern understanding of their highly reactive clay minerals as they are formed and occur in soils worldwide. It examines how clays occur in soils and the role of soil clays in disparate applications including plant nutrition, soil structure, and water-holding capacity, soil quality, soil shrinkage and swelling, carbon sequestration, pollution control and remediation, medicine, forensic investigation, and deciphering human and environmental histories. Features: Provides information on the conditions that lead to the formation of clay minerals in soils Distinguishes soil clays and types of clay minerals Describes clay mineral structures and their origins Describes occurrences and associations of clays in soil Details roles of clays in applications of soils Heavily illustrated with photos, diagrams, and electron micrographs Includes user-friendly description of a new method of identification To know soil clays is to enable their use toward achieving improvements in the management of soils for enhancing their performance in one or more of their three main functions of enabling plant growth, regulating water flow to plants, and buffering environmental changes. This book provides an easily-read and extensively-illustrated description of the nature, formation, identification, occurrence and associations, measurement, reactivities, and applications of clays in soils.

The advancement of human civilization has been intimately associated with the exploitation of raw materials. In fact the distinction of the main historical eras is based on the type of raw materials used. Hence, passage from the Paleolithic and Neolithic Age to the Bronze Age is characterized by the introduction of basic metals mainly copper, zinc and tin in human activities; the Iron Age is marked by the use of iron as the predominant metal. The use of metals has increased and culminated with the industrial revolution in the mid-eighteenth century, which marked the onset of the industrial age in the western world. Since then the importance of metals has gradually been surpassed by industrial minerals in the industrialized countries. Industrial minerals are raw materials used by industry for their physical and/or chemical properties. Characterization of industrial minerals is important for their assessment and can be demanding and often complicated. This new volume, co-published by the European Mineralogical Union and the Mineralogical Society of Great Britain & Ireland, is based on papers presented at an EMU-Erasmus IP School which was held in the Technical University of Crete, Chania, Greece. The aim of the School was to describe advances in some of the analytical methods used to characterize industrial minerals and to propose additional methods which are currently not used for this purpose.

Encyclopedia of Geochemistry

Clays and the Environment

Chemistry, Origins, Uses and Environmental Significance

Clay Minerals and the Origin of Life

Clay Sedimentology

Soil Clays

Clay Sedimentology is a comprehensive textbook divided into six parts: - clay minerals and weathering - clay sedimentation on land - origin and behaviour of clay minerals and associated minerals in transitional environments (estuaries, deltas) and shallow-sea environments - diverse origins of clay in the marine environment - post-sedimentary processes intervening during early and late diagenesis - use of clay stratigraphic data for the reconstruction of past climate, marine circulation, tectonics, and other paleogeographical aspects. A basic idea on most topics dealing with sedimentary clays is presented and controversial data and uncertainties from the frontiers of knowledge are discussed.

Surface and Interface Chemistry of Clay Minerals, Volume 9, delivers a fundamental understanding of the surface and interface chemistry of clay minerals, thus serving as a valuable resource for researchers active in the fields of materials chemistry and sustainable chemistry. Clay minerals, with surfaces ranging from hydrophilic, to hydrophobic, are widely studied and used as adsorbents. Adsorption can occur at the edges and surfaces of clay mineral layers and particles, and in the interlayer region. This diversity in properties and the possibility to tune the surface properties of clay minerals to match the properties of adsorbed molecules is the basis for study. This book requires a fundamental understanding of the surface and interface chemistry of clay minerals, and of the interaction between adsorbate and adsorbent. It is an essential resource for clay scientists, geologists, chemists, physicists, material scientists, researchers, and students. Presents scientists and engineers with a resource they can rely on for their own research and work involving clay minerals Includes an in-depth look at ion exchange, adsorption of inorganic and organic molecules, including polymers and proteins, and catalysis occurring at the surfaces of clay minerals Includes materials chemistry of clay minerals with chiral clay minerals, optical materials and functional films

The clay perspective; Tools; Clays as minerals; Origin of clays; uses of clays; Clays in the environment. .

A New Approach to Green Functional Materials

The Origin of Clay Minerals in the Coniacian Chalk of London

Clays, Clay Minerals and Ceramic Materials Based on Clay Minerals

The origin of clay minerals in soils of King George Island, South Shetland Islands, West Antarctica, and its implications for the clay-mineral compositions of marine sediments

Limnology, Climatology and Paleoclimatology of the East African Lakes

On the Origin of Some Minerals in Soils

*The first general texts on clay mineralogy and the practical applications of clay, written by R.E. Grim, were published some 40-50 years ago. Since then, a vast literature has accumulated but this information is scattered and not always accessible. The Handbook of Clay Science aims at assembling the scattered literature on the varied and diverse aspects that make up the discipline of clay science. The topics covered range from the fundamental structures (including textures) and properties of clays and clay minerals, through their environmental, health and industrial applications, to their analysis and characterization by modern instrumental techniques. Also included are the clay-microbe interaction, layered double hydroxides, zeolites, cement hydrates, genesis of clay minerals as well as the history and teaching of clay science. No modern book in the English language is available that is as comprehensive and wide-ranging in coverage as the Handbook of Clay Science. In providing a critical and up-to-date assessment of the accumulated information, this will serve as the first point of entry into the literature for both newcomers and graduate students, while for research scientists, university teachers, industrial chemists, and environmental engineers the book will become a standard reference text. * Presents contributions from 66 authors from 18 different countries who have come together to produce the most comprehensive modern handbook on clay science * Provides up-to-date concepts, properties, and reactivity of clays and clay minerals in a one-stop source of information * Covers classical and new environmental, industrial, and health applications of clays, as well as the instrumental techniques for clay mineral analysis * Combines geology, mineralogy, crystallography with physics, geotechnology, and soil mechanics together with inorganic, organic, physical, and colloid chemistry for a truly multidisciplinary approach*

The peculiar characteristics of clays provide it with very interesting adsorption qualities, especially for polar or ionizable molecules. Some of these characteristics include the silicates' sheet structure that makes a large surface area accessible for adsorption; the usually significant surface charge that can be responsible for strong electrostatic interactions; and clays' swelling properties and presence of exchangeable surface cations that facilitate ion-exchange mechanisms. Added to their wide availability and associated low cost, these characteristics have motivated in recent years an increasing interest in utilizing natural, processed or chemically-modified clays for the removal of organic contaminants from aqueous solutions. This book discusses the application of clay materials for the removal of organic compounds from contaminated waters. It also discusses several other topics that include time and temperature related behavior of clays; mechanical treatment of clay minerals; the workability of natural clays and clays in the ceramics industry; recent advances in hydraulic performance of clay liners; and the genesis, properties and industrial applications of bauxitic lithomargic clay.

Here is a comprehensive and up to do-date presentation of the origins, and properties of clay minerals at the Earth's surface. The text reviews the relatively simple laws that govern the chemical or isotopic composition and the crystalline structure of clays, and then discusses their genesis and alteration. Concluding chapters show that clay minerals can form in variety of different environments: meteorites, lavas, subduction zones, among others.

Chemical and Isotopic Investigations Into the Origin of Clay Minerals from the TAG Hydrothermal Mound, Mid-Atlantic Ridge

Clay Minerals

Chemistry of Clays and Clay Minerals

The Origin of Clay Minerals in Soils and Weathered Rocks

Properties, Occurrence, and Uses

Introduction to Clay Minerals

This volume is the edited proceedings of a conference seeking to clarify the possible role of clays in the origin of life on Earth. At the heart of the problem of the origin of life lie fundamental questions such as: What kind of properties is a model of a primitive living system required to exhibit and what would its most plausible chemical and molecular makeup be? Answers to these questions have traditionally been sought in terms of properties that are held to be common to all contemporary organisms. However, there are a number of different ideas both on the nature and on the evolutionary priority of 'common vital properties', notably those based on protoplasmic, biochemical and genetic theories of life. This is therefore the first area for consideration in this volume and the contributors then examine to what extent the properties of clay match those required by the substance which acted as the template for life. Nanomaterials from Clay Minerals: A New Approach to Green Functional Materials details the structure, properties and modification of natural nanoscale clay minerals and their application as the green constituent of functional materials. Natural nanomaterials from clay minerals have diverse morphologies, from 1D to 3D, including nanorods, nanofibers, nanotubes, nanosheets and nanopores. These structures show excellent adsorption, reinforcing, supporter, electronic, catalytic and biocompatible properties and are great as sustainable alternatives for toxic or expensive artificial materials. This book provides systematic coverage of clay nanomaterials as eco-friendly resources, emphasizing the importance of such materials in a range of industries, including biomedicine, energy and electronics. This book will provide an important reference for materials scientists and engineers who have an interest in sustainable material development. Presents systematic coverage of a broad range of nanomaterials from clay minerals, including Kaolinite, Smectite and Halloysite Depicts use cases for each mineral in a variety of applications, such as drug delivery, agriculture, and in the reinforcement of polymer materials Provides an overview on the advantages and limitations of nanomaterials from clay minerals, as well as chapters on the future potential of such materials

This book presents the state-of-the-art results of characterization of clays, clay minerals and ceramic materials based on clay minerals. The main goal of this work is to contribute to the rationalization of some important results obtained in the open area of clays and clay materials characterization. Moreover, this book also provides a comprehensive account on polymer and biopolymer-clay nanocomposites, use of clay as adsorption materials for industrial pollutants, ceramic materials in cultural heritage and physical-chemistry aspects of clay and clay minerals aqueous dispersions. This book will be beneficial for students, teachers and researchers of many areas who are interested to expand their knowledge about clays and its derivatives in the fields of Nanotechnology, Biotechnology, Environmental Science, Industrial Remediation, Cultural Heritage, etc.

Handbook of Clay Science

Clay in Engineering Geology

Clay Mineral Cements in Sandstones

Hydrogeology, Chemical Weathering, and Soil Formation

The Origin of Clay Minerals in Soils

Properties, Occurrence and Uses

Clays are increasingly becoming a major problem in the mining, extraction and value-adding processes for a wide range of commodity raw materials. Clays can impact negatively on virtually every unit process within the mining and minerals processing sector, having long-term environmental implications that go well beyond the lifetime of the mining operation. This book is the first to compile, explain and evaluate the effects of clays in the mineral processing value chain, from mining to minerals processing, and finally, tailings disposal. Focusing on topics from the chemistry and rheology of clays to their detection and dissolution behaviour, this book provides comprehensive coverage of the effects on processes such as settling, preg-robing, flotation and comminution. It is an excellent reference for professional mineralogists and geologists, industrial engineers, and researchers interested in clays and clay minerals.

Engineering geology is an interdisciplinary subject concerned with the application of geological science to engineering practice, and it is therefore important for the engineering geologist to recognize the boundary between engineering application and purely scientific enquiry. Much research in applied clay science results from imperfectly understood engineering behaviour. Engineering geology is most closely allied to the geotechnical and materials areas of civil engineering. The scope of the present book is limited to the influence of clay but because clay is almost ubiquitous in earth materials the subject still remains broad. In soil and rock, clay is the smallest size fraction, but it is that very fact which often determines its major influence on engineering behaviour. In this book the author reviews the importance of clay in engineering geology and summarizes present knowledge in this field. The plan of the book has remained unchanged since the first edition was published in 1968 but the text, diagrams and reference lists have all been extensively updated. The first 5 chapters review the classification, origin, composition, fabric and physical chemistry of clays. Behavioural aspects, covered in the following 4 chapters, include moisture interaction, strength and rheology, soil stabilization and the use of clays as materials. The final 3 chapters describe methods of analysis of clays and soils. Clay in Engineering Geology contains material drawn from a wide variety of sources and, together with its literature review and indexes, will provide much of value to geologists, mineralogists, civil and geotechnical engineers concerned with applied clay science.

To a geologist, clay minerals are fine particles (2 and micron in size) and are also major constituents of rocks, sediment and soils. To an engineer, ceramicist or mineralogist, clay minerals belong to the family of phyllosilicate (or sheet silicate) of minerals, which shows properties of plasticity, shrinkage, and hardening upon drying or firing. The types and characteristics of clay minerals depends on their origin of occurrences. Commonly clay minerals are formed over a long period of time by gradual chemical decomposition of feldspar, usually silicate-bearing by low concentration of carbonic acid and other diluted acidic or alkaline solvents. Clay minerals can be grouped into four main groups: kaolinite, illite, smectite and vermiculite. Clay and clay minerals have been used since the very beginning of civilization, and are also very important industrially. This is because of their abundant availability, inexpensiveness and unique properties. Considering its unique properties and vast applications, this book was written in order to provide various research results and compile up-to-date development on the current states of knowledge concerning clay mineral occurrences, types, properties and various uses. There are a total of eight chapters contributions by a significant number of expert authors around the world, covering topics such as the occurrence of clay in pore space of impure chalk, imparting functionality to clays, metakaolin based composite zeolite synthesis, rheological transport properties of kaolin-bentonite slurry solutions, clay minerals as adsorbents in water treatment, and metakaolin in building materials. This book will be useful to practicing engineers, scientists, researchers, academics, and undergraduate and post-graduate students interested in this specific area.

Their Characterization, Modification and Application

Minerals of the Montmorillonite Group