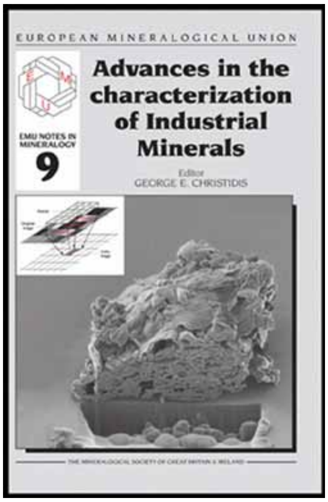
ADVANCES IN THE CHARACTERIZATION OF INDUSTRIAL MINERALS[1]

Industrial minerals are geological materials mined for their commercial value. The term does not include gemstones or materials used as fuels or as sources of metals. Industrial minerals are generally used after beneficiation and/or comminution as raw materials or as additives in a multitude of applications in the ceramic, construction, paint, polymer, adhesive, paper and packaging industries, among others. Industrial minerals are used in large quantities – for example, over 25 Mt of kaolin, 37 Mt of gypsum and 75 Mt of calcium carbonate are consumed annually – and most applications depend critically on specific physical and/or chemical properties. Hence, characterization of these materials is of fundamental importance for determining the overall economic potential of a deposit/business or the applicability and value of a sample for a specific use.

In July 2009, the EMU-Erasmus IP School "Advances in the Characterization of Industrial Minerals" was held in the Technical University of Crete, Greece. The chapters in the volume reviewed here were the main topics addressed in the School. The book, edited by George Christidis, is organised into three parts. After an introductory section, the bulk of the text deals with a range of experimental techniques used to characterise physical and chemical properties, while the final section deals with some selected industrial minerals and synthetic materials.



The Introduction, by George Christidis, is rather short (10 pages). It sets the scene, covering definitions, value, competition/substitution, specifications and standards, environmental constraints and economic aspects.

Each of the seven chapters of the Experimental Techniques section is highly readable and authoritative, though not always comprehensive. I did also wonder whether the first of these chapters ("The Geological Setting for Industrial Mineral Resources") might have been better placed in the Introduction. Peter Scott's way of classifying minerals by market characteristics (value, scale, etc.) would be a real eye-opener for many, I expect. The XRD chapter (Bish and Plötze) is extremely realistic about what can be achieved. For example, quantification using the Rietveld method is described well, but the authors note that "the ability to consider 2D diffraction effects would considerably enhance the ability of this powerful method to analyse complex mixtures containing clay minerals." The particle size and shape chapter (Hart, Zhu and Pirard) is comprehensive, covering theoretical and practical matters well. However, we might have benefited from even more information on particle shape, as it controls performance in many applications. The chapter on vibrational spectroscopy (Madejová, Balan and Petit) is excellent, particularly when describing IR applications to clay minerals. A minor criticism is that other minerals are not covered in the same depth. The electron microbeam chapter is also exceptional in what it covers, although, as the authors (Pownceby and Macrae) acknowledge, TEM methods are not covered in detail. Almost all large-volume and high-value applications of industrial minerals involve composites with particles dispersed in other continuous phases. Imaging and imaging analysis have become absolutely key for generating useful information in realistic time frames so that understanding the performance of the composite can be achieved. The chapter by Pirard and Sardini covers both aspects really well. Every reader will learn something new.

The third section, Selected Industrial Minerals and Synthetic Materials, is very selective and contains three chapters. The chapter on industrial clays, 73 pages long, is an excellent and comprehensive summary by George Christidis of the structures, locations, properties and applications of kaolins, bentonites and other clay minerals. The second chapter, on clays as nanomaterials (Schoonheydt and Bergaya), again covers clay structures but then moves on to particle dispersion in polymer phases (homo- versus heterogeneous, exfoliated versus intercalated, etc.), categorizing preparation methods and considering factors influencing performance. All this is done well but, considering the economic performance of such composites, it would have been nice to see details of some applications in the structural, automotive and packaging industries. Finally, in the chapter on Portland cement (2550 million tonnes used worldwide in 2007), Elsen, Mertens and Snellings cover history, cement types and the rapid recent evolution in understanding hydration mechanisms and products, and finish with the identification of low–carbon dioxide cements as being the biggest constraint and opportunity driving change in the industry.

Overall, the text is remarkably free of typographical errors. The figures are almost all of good quality and the reference lists at the end of each chapter are wide ranging and useful. The original aim was to produce a reference textbook for university-level courses. The book will meet this target and will also be extremely valuable for postgraduates and scholars interested in these materials and their uses. Not only will the text be valuable to those starting industrial careers, it will also stimulate thought and action by those with years of industrial experience. I recommend the book highly for its authority, clarity, and practicality, and as a stimulus for future work.

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1 Christidis GE (2011) Advances in the Characterization of Industrial Minerals. EMU Notes in Mineralogy 9, European Mineralogical Union and the Mineralogical Society of Great Britain and Ireland, London