# STRATEGY FOR CLAY MINERAL CHARACTERISATION

**M.P. Gómez-Tena(1), J. Gilabert(1), E. Zumaquero(1), E.M. Díaz-Canales(1), M.F. Gazulla(1), M.J. Ventura(1)**

(1) **Instituto de Tecnología Cerámica (ITC). Asociación de Investigación de las Industrias Cerámicas (AICE)**

**Universitat Jaume I. Castellón. Spain.**

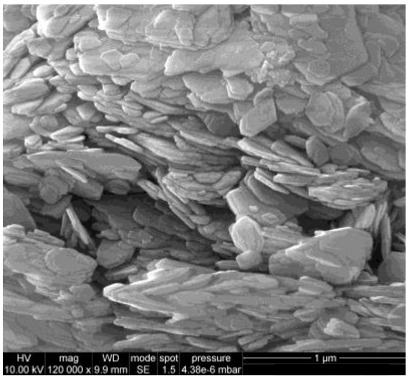
## 1. INTRODUCTION

The European industrial sector is currently evolving towards industry 4.0 and an integrated resources and materials management system.

In this frame, raw materials must meet an increasing number of technical specifications and regulations, depending on the end-user sector, giving rise to new, only partly solved, analytical challenges [1].

The QUANTIROCK project has emerged in this context to respond to the needs of the ceramic sector and other ancillary sectors. The project's main aim is to define new product quantification and speciation strategies, as well as to obtain specific procedures for controlling and characterising rocks and materials of a wholly or partially clayey nature [2, 3].

No specific, well-defined protocols are at present available on an industrial level for speciating and fully quantifying a ceramic product and, given how costly and poorly standardised such tests are, companies only perform general estimations by product type. Achieving a better understanding of each product type would enable the properties of the end product to be much more effectively established and would allow clay characteristics to be determined at hitherto unknown levels [4, 5].




## 2. OBJECTIVE

Within the frame of the project, this study focuses on optimising the strategy for speciating minerals pertaining to the smectite group, a group of great interest in the ceramic industry.

## 3. EXPERIMENTAL PROCEDURE

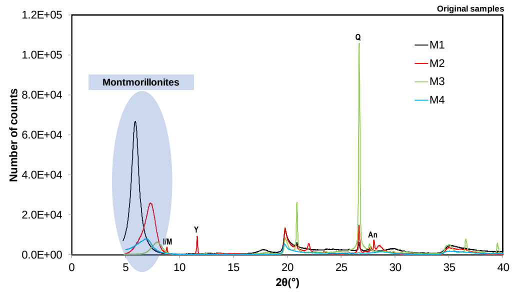
Four industrial raw materials classified as smectite/montmorillonite (referenced M1, M2, M3, and M4) were selected owing to their interest for the industrial tile sector.

To characterise each raw material in detail, a sequential work protocol of different specialised analytical techniques was drawn up: X-ray diffraction (XRD) of the original samples and, after applying the oriented aggregates (Or. Agg.) method, X-ray fluorescence (XRF), simultaneous thermogravimetric analysis (DTA–TG), and scanning electron microscopy (SEM).

## 4. RESULTS

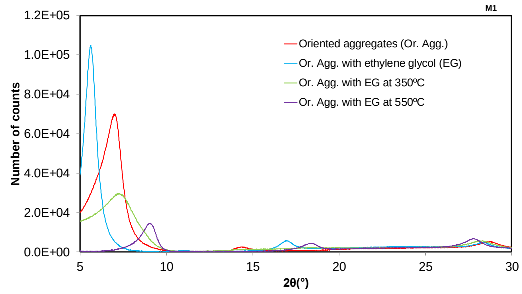
### Identification of crystalline phases

#### Crystal powder method




*I/M Illite/Mica, Y Gypsum, Q Quartz, An Anorthite*

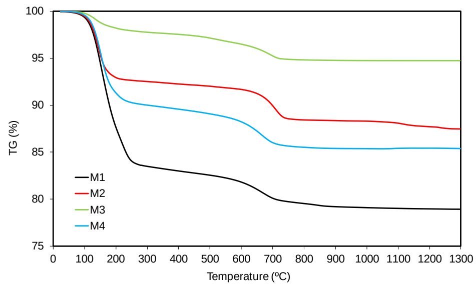
#### Oriented aggregates method




#### Chemical analysis

| Oxide | M1 | M2 | M3 | M4 |
|---|---|---|---|---|
| $SiO_2$ | 53.0 | 57.9 | 65.7 | 55.0 |
| $Al_2O_3$ | 15.1 | 17.9 | 15.8 | 16.6 |
| $Fe_2O_3$ | 1.5 | 3.7 | 1.1 | 3.3 |
| CaO | 2.6 | 1.4 | 0.2 | 1.7 |
| MgO | 5.2 | 2.4 | 1.4 | 4.9 |
| $Na_2O$ | 0.1 | 1.8 | <0.1 | 2.2 |
| $K_2O$ | <0.1 | 0.5 | 3.6 | 0.1 |

#### Simultaneous thermal analysis




## 5. CONCLUSIONS

Analysis of all the results, upon following a proposed work protocol, enabled classification and speciation of each studied material, determining its approximate molecular formula.

| Reference | Classification | Content (%) | Proposed formula |
|---|---|---|---|
| M1 | Calcium montmorillonite | 96 | $Ca_{0.3}Al_{1.3}Fe_{0.1}Mg_{0.6}Si_4O_{10}(OH)_2{\cdot}5H_2O$ |
| M2 | Sodium montmorillonite | 82 | $Na_{0.2}Al_{1.4}Fe_{0.2}Mg_{0.3}Si_4O_{10}(OH)_2{\cdot}2H_2O$ |
| M3 | Regular interbedded illite–vermiculite | 20 | $Mg_xAl_{1.2}Fe_{0.2}Mg_{0.6-x}Si_4O_{10}(OH)_2{\cdot}2H_2O$ |
| M4 | Sodium–calcium montmorillonite of low crystallinity | 100 | $Na_{0.3}Ca_{0.1}Al_{1.4}Fe_{0.1}Mg_{0.5}Si_4O_{10}(OH)_2{\cdot}3H_2O$ |

## 6. ACKNOWLEDGEMENTS

This project has been co-funded by the Valencian Institute for Business Competitiveness (IVACE) and the European Regional Development Fund (ERDF), under the 2014–2020 ERDF Operational Programme of the Valencia Region in the 2019–2020 call for aid for Technology Centres in the Valencia Region for R&D projects in cooperation with companies (IMDEEA/2019/28_QuantiROCK).


## 7. REFERENCES


[1] J. Bastida Cuairan, Mineralogía aplicada de las arcillas cerámicas de la provincia de Castellón. Bellaterra: Universitat Autònoma de Barcelona, [198-]

[2] M.I. Carretero, M.I. Pozo, Mineralogía aplicada: salud y medio ambiente. Madrid: Thomson, 2007

[3] E. Galan huertos (ed.) Mineralogía aplicada. Madrid: Síntesis, 2003

[4] C.S. Hurlbut, Manual de mineralogía de Dana. Barcelona [etc.]: Reverté, 1976.

[5] Crystal structures of clay minerals and X-ray identification. London: Mineralogical Society, 1980