First Latin - American Clay Conference

PROCEEDINGS

VOLUME 2

Extended Abstracts

[redacted]

YOU CAN FEEL NATURE ALL AROUND YOU

Madeira

[redacted]

17-22 September 2000

Funchal – Madeira

FIBROUS CLAY MINERALS FROM A TERTIARY CONTINENTAL DEPOSIT (MALPICA DO TEJO, PORTUGAL) - MINERALOGICAL AND STATISTICAL ANALYSIS

Isabel Dias, M.[(1)]; Rocha, F.[(2)] & Prates, S.[(3)]

[(1)]Instituto Tecnológico e Nuclear, Estrada Nacional 10, 2686-953, Sacavém, Portugal
[(2)]Dep. Geociências, Univ. de Aveiro, Campo Santiago, 3810-193 Aveiro, Portugal
[(3)]Centro e Dep. Geologia, Fac. Ciências Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Introduction

Fibrous clays are very common in the Iberian Peninsula, especially in the Tagus Tertiary Basin (Galan & Castillo, 1984; Dias *et al*, 1997). Concerning the Portuguese Tagus Tertiary basin, the first important contributions were those of Carvalho (1967, 1968, 1969) that have enhanced the presence of palygorskite, in general joined to smectite, in several stratigraphic levels of deposits attributed to the Paleogene. Further work has been done by diverse authors concerning the presence of palygorskite in several deposits all over Portugal, almost always in a Tertiary context and always remarking that palygorskite is mainly associated to montmorillonite and more rarely to illite and traces of kaolinite. Dias (1998) presented a review of the "state of the art" concerning the Portuguese deposits of fibrous clay minerals.

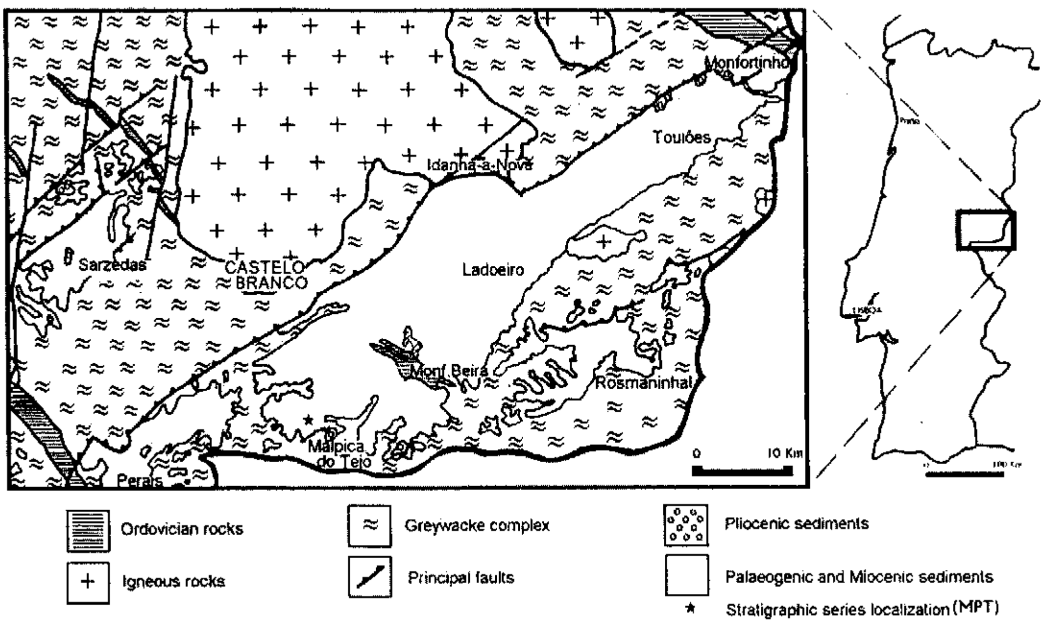

Fig.1 – Geological setting of the studied area.

In this paper we studied a sedimentary profile, located in the Beira Baixa Tertiary deposits, near Castelo Branco (Fig. 1), where the presence of palygorskite is important in several levels (Dias, 1998; Dias & Prates, 1997). These deposits fill two small tectonic basins: Sarzedas and Castelo Branco and are mainly detrital, rich in feldspar and quartz. The studied profile is located in the Castelo Branco basin. The basement is a "schist-greywacke complex" dated from Precambrian-Cambrian, intruded in some places by the granite plutons of Castelo Branco and Penamacor, by the Pre-Hercynian of Salvaterra do Extremo, Zebreira and Segura, and also by veins of quartz, pegmatite, aplite, microgranite and basic rocks. Some higher upper units are covered with a "raña" deposit (Plio-Quaternary), which consists of a red fanglomerate of quartzite pebbles.

The lithostratigraphic scheme proposed for the region is synthesised in Table 1. It's important to enhance that units proposed by Carvalho (1968) and Dias (1998) have mainly a clay mineral composition support.

Table 1 – Proposed Units in the Castelo Branco depression

<table>
<tr><th colspan="2">Units and associated clays (DIAS, 1998)</th><th colspan="2">Lithostratigraphic units (CUNHA, 1992)</th><th>"Complexes" (CARVALHO, 1968)</th></tr>
<tr><td>A</td><td>K (+I)</td><td>CFA</td><td>Upper Pliocene</td><td rowspan="2">"Kaolinitic complex "</td></tr>
<tr><td>A-1</td><td>I (+K)</td><td>CMO</td><td>Lower Pliocene</td></tr>
<tr><td>A-2</td><td>Sm (+I)</td><td>ATO</td><td>Mio-Pliocene</td><td rowspan="3">"Montmorilonitic Complex"</td></tr>
<tr><td rowspan="2">B</td><td rowspan="2">Sm (+I+K)</td><td>USF</td><td>Miocene (Medium to Upper)</td></tr>
<tr><td>UCI upper</td><td rowspan="3">Paleogene (Lower Oligocene to Upper Eocene)</td></tr>
<tr><td>C</td><td>Pa + I</td><td rowspan="2">UCI lower</td><td rowspan="2">"Attapulgite Complex "</td></tr>
<tr><td>D</td><td>Sm (+Pa+I)</td></tr>
</table>

The main purposes of this paper is to increase the knowledge of the described units in the Tertiary deposits of Castelo Branco and to test a statistical analysis of the mineralogical parameters.

Materials and Methods

Thirty six samples have been collected in order to be representative of the different beds of the tertiary sediments of the studied profile, in Malpica do Tejo, south of Castelo Branco (Fig.1).

Powdered samples were examined by X-ray diffraction using the bulk rock prepared as unoriented aggregates, as well as the <2μm fractions prepared as oriented aggregates under ambient conditions, after solvation with ethylene-glycol and after heating to 550°C. The apparatus used was a Phillips PW 1080 with a Ni-filtered Cu-Kα radiation. Semi-quantitative mineralogical contents were obtained by using data from Schultz (1964), Barahona (1974) and Galan (unpublished, for fibrous clay minerals).

Multivariate data analysis (cluster analysis and R-mode factor analysis) of the mineralogical data has been carried out using the *Statistica* program.

Results and Discussion

The mineralogical results for the bulk sample and for the clay fractions had been presented by Dias (1998). In the studied profile, the mineralogical composition of the bulk sample allowed the definition of two patterns (Table 2), one associated to the upper levels (with quartz, phyllosilicates and goethite), and another one corresponding to the other levels (with quartz, phyllosilicates, feldspars, dolomite and sometimes calcite). Four units could be defined by Dias (1998) according to the clay mineralogy: 1) an upper unit in which kaolinite is associated to illite; 2) downwards, one unit in which smectite is associated to illite and kaolinite; 3) other unit with palygorskite associated to illite; and 4) in the basement, closer to the schists, a clay mineralogical association of smectites, palygorskites and illite (Table 2).

Table 2 – Lithostratigraphic units defined in the Malpica do Tejo region according to the analysed mineralogical parameters (Dias, 1998).

Unit	Clay Mineralogical Association	Bulk Sample Mineralogical Association
A	K (+ I)	Qz (+Phyllosilicates + Goethite)
B	Sm (+ I + K)	Qz (+Phyllos. + Felds ± Calc ± Dol)
C	Pa + I	Qz (+Phyllos. + Felds ± Calc ± Dol)
D	Sm (+ Pa + I)	Qz (+Phyllos. + Felds ± Calc ± Dol)

The application of R-mode factor analysis (Fig. 2) to the mineralogical composition of the bulk samples, with redistribution of phyllosilicates contents by kaolinite, illite, palygorskite and smectite, allows some interesting observations to be made:

- Factor 1 shows kaolinite, goethite and quartz in front of dolomite, smectite, feldspars, palygorskite and illite;
- Factor 2 shows illite and palygorskite in front of feldspars;
- Factor 3 shows calcite in front of quartz.

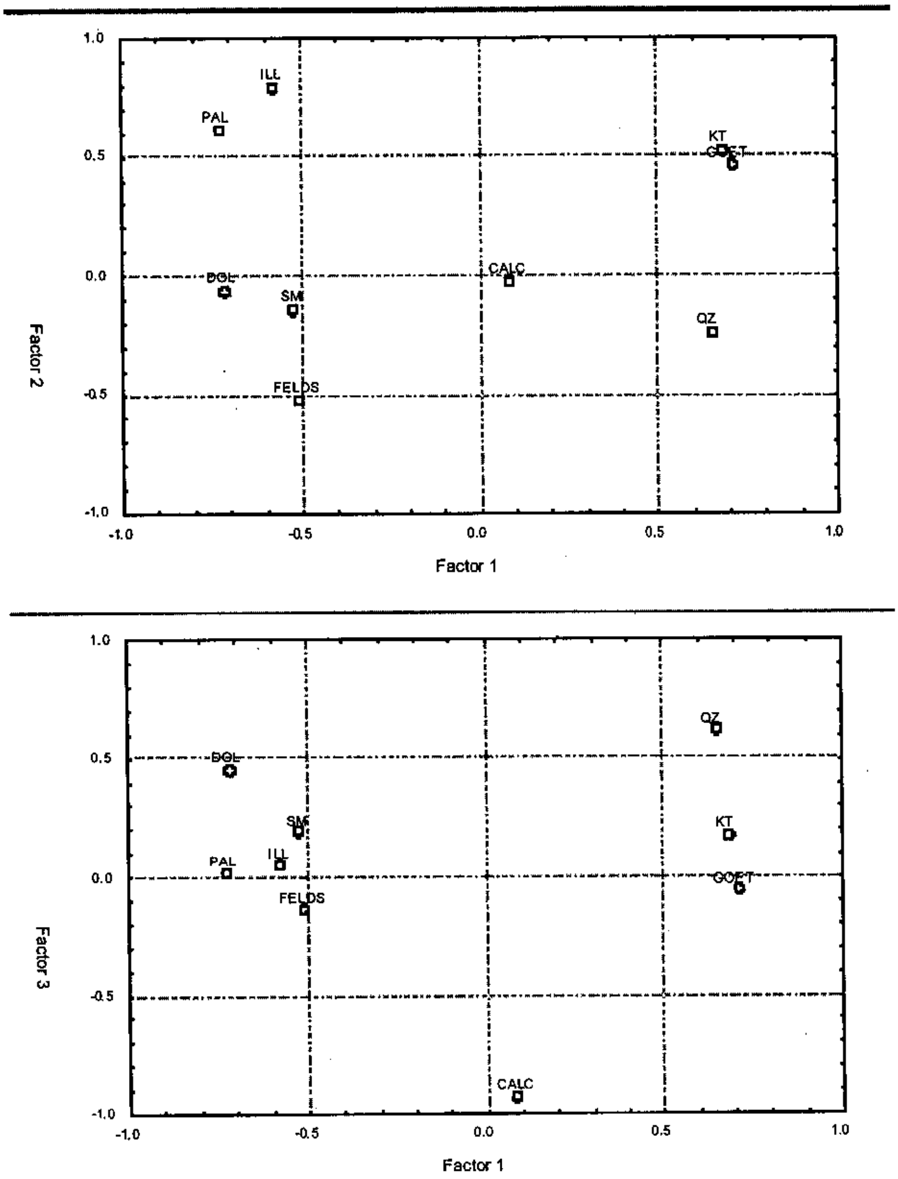

Figure 2 - R-mode factor analysis of the mineralogical composition of the bulk samples (with redistribution of phyllosilicates contents by kaolinite, illite, palygorskite and smectite).

The cluster analysis of the same data (Fig. 3) confirms the associations observed in the R-mode factor analysis. Actually, we can see four clusters: 1) kaolinite and goethite is linked with quartz, well separated from all the other analysed minerals; 2) dolomite and smectite are linked with feldspars; 3) illite is linked with palygorskite; and 4) calcite is linked with these later two clusters.

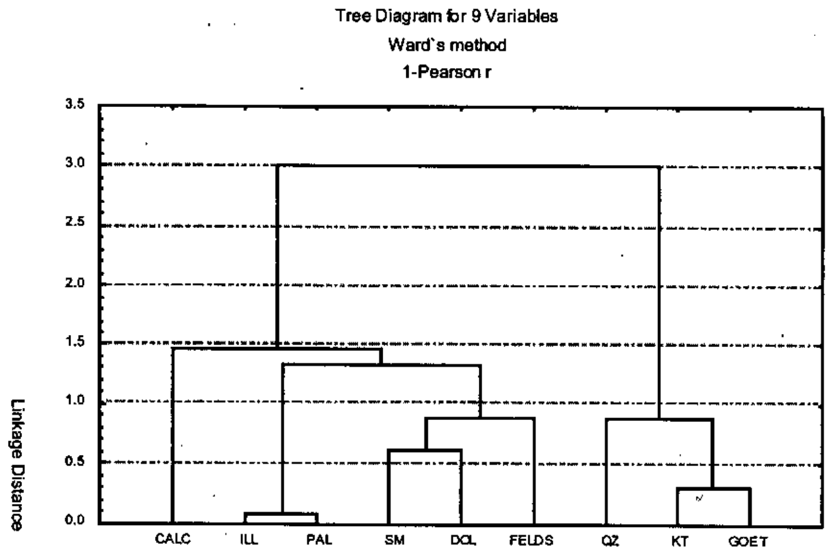

Figure 3 - Cluster analysis of the mineralogical composition of the bulk samples.

The application of R-mode factor analysis (Fig. 4) to the mineralogical composition of the clay fractions allows some interesting observations to be made:

- Factor 1 shows smectite in front of palygorskite and illite;
- Factor 2 explains kaolinite.

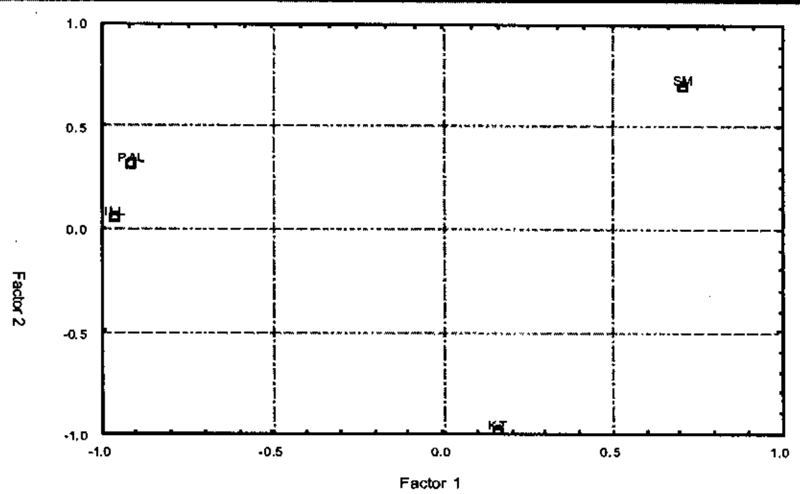

Figure 4 - R-mode factor analysis of the mineralogical composition of the clay fractions.

Therefore, it is clear that these statistical analysis allow the definition of five mineralogical associations: 1) kaolinite + goethite + quartz; 2) dolomite + smectite + feldspars (+ palygorskite + illite); 3) illite + palygorskite; 4) feldspars (+ dolomite + smectite); and 5) calcite.

The vertical evolution of the Factor scores (Fig. 5) shows the impact of each Factor (or, each mineralogical association), in the different units defined by Dias (1998). Association 1, kaolinite + goethite + quartz, is clearly predominant along unit A, the upper one of the studied profile; association 2, dolomite + smectite + feldspars (+ palygorskite + illite), is present essentially at the bottom of the profile, along units C and D; association 3, illite + palygorskite, predominates along unit C and also in some layers of the intermediate section of unit D; association 4, feldspars (+ dolomite + smectite), characterises unit B; finally, association 5, formed just by calcite, is present only in two samples of the bottom of unit D, in one sample of unit C (at its bottom) and in another sample of unit B.

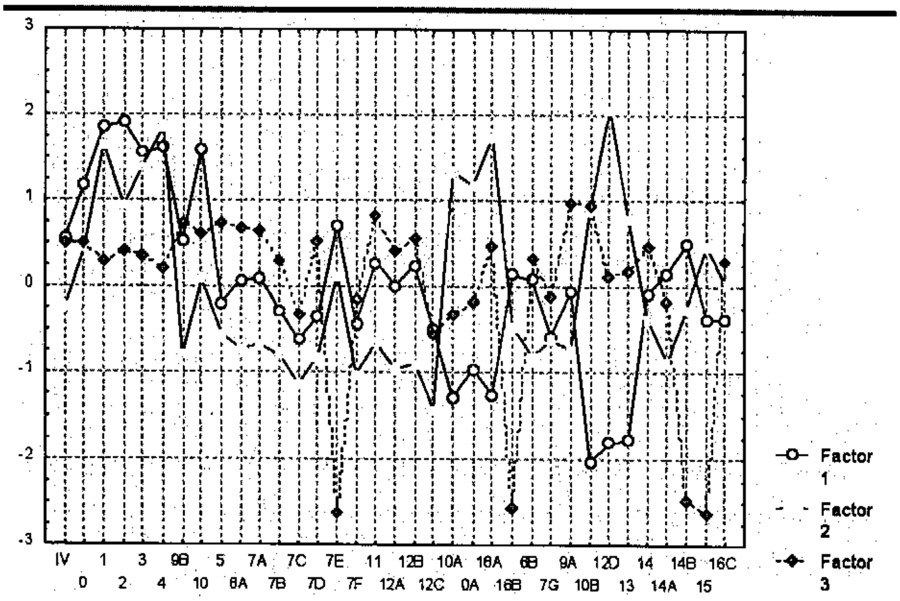

Figure 5 - Vertical evolution of the Factor scores (bulk samples).

Conclusions

The tertiary deposits of Beira Baixa are detrital, rich in feldspars and fill two tectonic basins, the Sarzedas and the Castelo de Branco ones. The basement is a schist-greywacke complex intruded by granites and several kinds of veins; in some higher places the tertiary is covered with raña deposits. In the Castelo Branco region the main lithologies are conglomerates rich in quartz and feldspars, sandstones or silty-sandstones.

Palygorskite appears associated to smectite or illite (when prevails) in the basal terms. Smectites predominates in the middle units, and kaolinite increase towards the top. In general carbonates are absent, despite the presence of some rich levels of calcite or dolomite. The main global mineralogical association in the basement is quartz > palygorskite > smectite > illite > feldspars, with traces of other phyllosilicates, like vermiculite, pyrophyllite and chlorite. The more palygorskite rich conglomerates are directly laying in the schists, which several times are also weathered to palygorskite.

Considering the geological setting of the area and the mineralogy and texture of the main occurrences of palygorskite in the studied region, this fibrous clay must have had similar genesis conditions like the palygorskite deposit of Torrejon (Spain) according to the process described by Galan and Castillo (1984), by the degradation of illite and chlorite of the schists, under acid conditions, and subsequent fixation of Mg in the basin in an alkaline environment.

It's also interesting to enhance how the statistical analysis carried out shows a complete accordance with those statements, as cluster analysis and each factor of the application of R-mode factor analysis, points to the same mineralogical association along the studied profile. Also one important remark is the clear association between palygorskite and illite.

References

Barahona (1974) – *Arcillas de ladrilleria de la provincia de Granada. Evaluacion de algunos ensayos de materias primas.* Tesis Doctoral. Univ. Granada, Spain.

Biscaye, P. E. (1965) - Mineralogy and sedimentation of recent deep-sea clays in the Atlantic Ocean and adjacent seas and oceans. *Geol. Soc. Am. Bull.* **76**: 803-932.

Carvalho, A. M. G. (1967) - Atapulgite em alguns depósitos sedimentares portugueses. Considerações estratigráficas e morfoclimáticas. *Finisterra* **II**, Lisboa, 174-200.

Carvalho, A. M. G. (1968) - Contribuição para o conhecimento geológico da Bacia Terciária do Tejo. *Memórias Serviços Geológicos de Portugal,* nº 15 (N.S.) Serv. Geol. Portugal.

Carvalho, A. M. G. (1969) - Sobre a existência de Atapulgite em Portugal. Sua utilização como matéria-prima. *Estudos, Notas e Trabalhos,* **XVII (3/4)**, 297-307.

Cunha, P. M. (1992) - *Estratigrafia e sedimentologia dos depósitos do Cretácico superior e Terciário de Portugal Central, a leste de Coimbra.* Unpubl. PhD thesis, Univ. Coimbra, 262 p.

Dias, M. I. (1998) - *Caracterização Mineralógica e Tecnológica de Argilas Especiais de Bacias Terciárias Portuguesas*. Unpubl. PhD thesis, Univ. Lisboa, 333 p.

Dias, M. I. & Prates, S. (1997) - Clay mineralogy, texture and chemism of the North sector Tagus basin Tertiary sediments, Castelo Branco, Portugal. *Proc. of The 11th International Clay Conference*. Canada, pp.631-638.

Dias, M. I.; Gonzalez, I.; Prates, S.; Galan, E. (1997) - Palygorskite occurrences in the portuguese sector of the Tagus basin. A preliminary report. *Clay Minerals*, **32**: pp. 323-328.

Galan, E. (1986) - Las arcillas como indicadores paleoambientales. *Bol. Soc. Esp. Miner.* **9**: 11-22.

Galan, E. & Castillo, A. (1984) - Sepiolite-palygorskite in Spanish Tertiary basins: Genetical patterns in continental environments. *In* A.Singer & E. Galan eds. Palygorskite-Sepiolite, Occurrences, Genesis and Uses. *Developments in Sedimentology* **37**: 87-124.

Schultz, L. G. (1964) - Quantitative interpretation of mineralogical composition from x-ray and chemical data for the Pierre shale. *Geol. Survey Prof. Paper* **391 - C**, 31 pp.