KAOLIN DEPOSITS OF WESTERN IBERIA

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A brief review of the main kaolin deposits of Western Iberia is presented covering the distribution, geological environment and main markets for the various types of products. In north-west Spain there are two major producers of kaolin. The altered felsite dyke at Burela is exploited for high quality ceramic kaolin by *Explotaciones Ceramicas Espanolas SA (ECESA)* and *Rosenthal AG.* The clay is characterised by low iron and high strength which makes it suitable for use in porcelain and high-grade tableware. Much of the production is exported to Germany for use in porcelain. The other main producer is in Galicia at Vimianzo - *Caolines de Vimianzo SA (CAVISA)* - produces about 100,000 tpa of kaolin from its primary deposit at Vimianzo. *CAVISA* produces a filler grade for the paper industry with a brightness of 82.5 ISO and averages 45 wt% -2 microns. The kaolin is formed by the alteration of a granite. In Portugal there are many areas where kaolin is quarried but none are on a large scale. *Anglo-Portuguesa de Caolines de Viana (APCV)* produces kaolin for the paper and ceramic industries. The geology of the kaolin deposits in the Viana area is interesting in that much of the kaolinised material appears to have been re-worked, being derived from the underlying kaolinised granite. The depth of kaolinisation rarely reaches more than 20 m in depth and is probably of a weathering origin. *Groupe Mineral Harwanne (GMH)* is a more recent producer of kaolin for ceramics as a by-product from its sand operations at Mosteiros and Bracais in Central Portugal. Other deposits in the Mondego Basin, Central Portugal, are mainly worked for their sand. Local kaolin production in north-west Spain and Portugal will continue to supply the local markets (mainly ceramics). No large scale development of kaolin for paper coating is foreseen due to the small size of the deposits and inferior quality, in some cases, to existing suppliers.

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INTRODUCTION

The kaolin deposits of Western Iberia are exploited by many companies mainly for utilisation in the ceramics and paper industries. They are found in differing geological environments:

I. From the alteration of granites

II. In sedimentary sequences - mainly kaolinitic sands

III. The alteration of a fine-grained felsite dyke

The paper will consider the two major producers of kaolin in north-west Spain, *Explotaciones Ceramicas Espanolas SA (ECESA)* at Burela and *Caolines de Vimianzo SA (CAVISA)* at Vimianzo. A brief description will be given of some of the kaolin deposits derived from granites and sedimentary sequences in Portugal exploited by *Anglo-Portuguesa de Caolines de Viana (APCV)* and *Groupe Minerale Harwanne (GMH).*

The location of some of the kaolin deposits in Western Iberia is shown in Figure 1.

KAOLIN DEPOSITS OF NORTH-WEST SPAIN

CAVISA, VIMIANZO - Altered Granite

The parent rock of the *CAVISA* kaolin is a basement metamorphic type granite. The kaolinisation process is probably attributable to a weathering process with the degree of kaolinisation more intense near the surface and decreasing with depth. The variable nature of the parent rock and the weathering process combine to give irregular, scattered deposits of variable quality with varying iron contents a major factor in the exploitation for use as a paper filler grade. The various deposits are found straddling the road between La Coruna to Corcubio immediately south of the town of Vimianzo. The production from *CAVISA* is estimated at 100,000 tpa of kaolin and also some mica. The filler kaolin product is known at *P-30* and is the only kaolin grade available with an ISO Brightness/Yellowness of 83.7/6.7 at a particle size distribution of 46 wt% -2 microns and 11 wt% +10 microns (detailed results of quality in Table 1). No coating kaolin in produced from the area due to poor rheology and brightness. The morphology of the kaolin is pseudo-hexagonal platelets.

Product Name	P-30 Filler Kaolin
Particle Size Distribution	
wt.% +10	11
wt.% -2 microns	46
wt.% -1 micron	29
ISO Brightness/ Yellowness	83.7/6.7
Chemistry (wt.%)	
SiO_2	48
Al_2O_3	37
Fe_2O_3	1.1
TiO_2	0.03
MgO	0.19
CaO	0.03
K_2O	1.8
Na_2O	0.11
LOI	11.9
Mineralogy (wt.%)	
Kaolinite	87
Mica	12
Quartz	1

Table 1. Particle size distribution, brightness, chemistry and mineralogy of the P-30 CAVISA filler clay product, Vimianzo

ECESA, BURELA - Altered felsite

Explotaciones Ceramicas Espanolas SA (ECESA) is a subsidiary of *Minerales y Productos Ceramicas SA* and *Rosenthal AG* (German ceramic manufacturer) and produce kaolin from Burela de Cabo. The production of kaolin for ceramics is 50,000 tpa and the associated silica sand production is 38,000 tpa for various industries. Geologically the kaolin has been formed by the alteration of a felsitic sill. The morphology of the clay is dominantly tubular (halloysitic) with some pseudo-hexagonal kaolinite stacks. This combination of stacky kaolinite and tubular halloysite has been reported from the Longyan deposit in Fujian Province in China by Wilson *et al.* (1997). The majority of the processed kaolin is exported for use by *Rosenthal AG* in Germany who produce high grade tableware and porcelain. The presence of halloysite associated with low iron and titania levels (giving good fired properties) and, with a fine particle size distribution (giving high strength as measured by modulus of rupture), combines to give a kaolin of high strength and low iron suitable for use in porcelain. The low iron levels often found associated with halloysite contribute to a porcelain of high quality with good fired brightness and translucency (Harvey and Murray, 1993). The felsite dykes have probably been altered by a combination of weathering and some hydrothermal activity. The main ore body is almost exhausted and smaller altered felsite dykes are being worked. The ceramic properties of the *Burela 201* product is shown in Table 2 and is characterised by a high strength (modulus of rupture of 1.14 MNm^{-2} at 80% Relative Humidity) and a fired brightness of 92% at 1280°C. The iron levels at 0.60 wt% Fe_2O_3 and low titania at 0.02 wt% TiO_2 give rise to the good fired brightness. Mineralogically the clay is dominantly a mixture of halloysite and kaolinite with some mica and quartz.

Product Name	Burela 201
Particle size distribution	
wt.% +10 microns	20
wt.% -2 microns	45
Modulus of Rupture (MNm^{-2} @ 80% RH)	1.15
Casting Concentration (% solids)	63
Casting Rate ($mm^2\ min^{-1}$)	2.2
Fired Properties 1180°C	
% Fired Brightness	92
% Absorption	20.5
% Contraction	6.2
Fired Properties 1280°C	
% Fired brightness	93
% Absorption	15
% Contraction	7.5
Chemistry (wt.%)	
SiO_2	51
Al_2O_3	36
Fe_2O_3	0.6
TiO_2	0.03
MgO	0.29
CaO	0.04
K_2O	1.2
Na_2O	0.04
LOI	11.3
Mineralogy (wt.%)	
Kaolinite/halloysite	82
Mica	13
Quartz	5

Table 2. Ceramic properties, chemistry and mineralogy of Burela 201

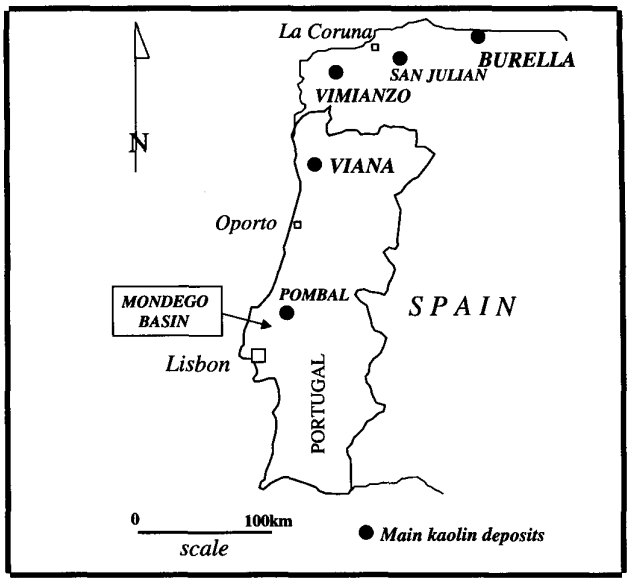

Figure 1. *Location of the main kaolin deposits of Western Iberia*

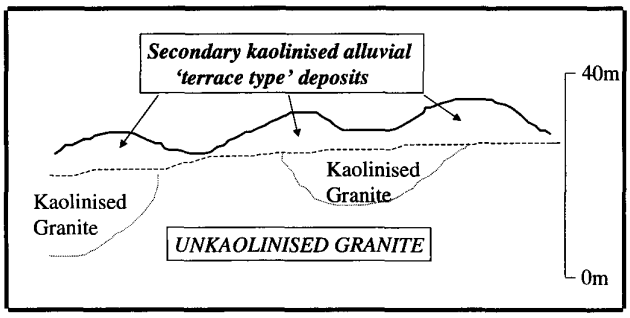

Figure 2. *Sketch of the secondary kaolinised alluvial 'terrace type' deposits, of the Viana area Portugal*

Other deposits in north-west Spain

Galicia is an area of geological complexity and is made up of a variety of ancient crystalline metamorphic and igneous rocks . A series of five different rock groups have been defined in the crystalline Hercynian basement of western Galicia by Parga-Pondal (1963). These five groups of rocks are as follows;

1. An ancient complex of highly metamorphosed and migmatised rocks of Archean age.
2. The Lage group of migmatite, granites, gneisses and metamorphosed sediments.
3. A group of basic rocks including gabbros, pyroxenites and amphibolites.
4. A group of intrusive granitic rocks of early to late Hercynian age.
5. A group of younger post-Hercynian rocks, including granites and dolerite dykes.

The primary kaolin deposits of Galicia were formed during the Tertiary (Galan and Martin, 1973) and are often associated with quartz veins, aplite dykes and pegmatites of the Lage group. Kaolinisation is typified by locations in the vicinity of San Julian (Figure 1), south west of La Coruna, where a biotite-rich granite is the host. Kaolinisation is closely associated with major zones of east-west quartz veining in the San Julian area within the same biotite-muscovite-granite. The iron content of the kaolin is generally high as a result of the release of ferric iron during alteration which gives rise to

patchy yellowish-brown staining. The high iron levels (often >1 wt.% Fe_2O_3) restrict the use of the kaolins in paper filler and higher grade ceramic applications.. However, selective mining of some areas could yield some kaolin for use in those applications but not on a large scale.

There are many other smaller deposits in the area, mainly formed by the weathering and alteration of granitic rocks. Generally the depth of alteration is rarely more than 15-20 m and they are worked for local ceramic use, mainly for tiles. None of the deposits show potential for coating clay production due to poor rheology and often low brightness.

KAOLIN DEPOSITS OF PORTUGAL

APCV, VIANA - Kaolinised granites

Anglo-Portuguesa de Caolines de Viana is part of *ECC International Ltd* and now has an operation near Viana in Northern Portugal (Figure 1). The old APCVoperations produced ceramic and filler grades at Oporto but as these local reserves were exhausted the whole operation is now based in Viana. The kaolinisation in the Viana area is complex and several types of granite have been altered. There is also the unusual presence of an apparently kaolinised granite that has been transported over short distances incorporating gravels in the process. An idealised cross-section of this relationship between the underlying kaolinised and parent granite and the overlying "secondary" kaolinisation is shown in Figure 2. These secondary sequences can be considered as kaolinitic terrace type deposits of Plio-Pleistocene age overlying primary kaolinised medium-coarse grained granites and unaltered granites. The granites north of Oporto are of Hercynian age and are medium-coarse grained, two mica and alkaline. There has been a very detailed exploration programme carried out in the 1980's and reserves of coating and filler clay have been identified. However, the reserves are localised and patchy with no large deposits as found in Cornwall, south-west England (Bristow, 1993). The depth of kaolinisation is rarely more than 20 m and the overlying re-worked kaolinised granites rarely exceed 5-10 m in thickness. Both filler and coating grade kaolins are produced with the following properties:

Filler Grade - Vianafil

ISO Brightness/Yellowness (%)	81.0/5.5
% -2 microns	65
% +10 microns	6 (maximum)

Coating Grade - VCC

ISO Brightness/Yellowness (%)	84.5/5.5
% -2 microns	S80
Viscosity	69 wt.% at 500 cps

Some ceramic kaolins are also produced for use in local tile manufacture and are classified on the basis of their strength (Modulus of Rupture), fired brightness, iron and potassium levels.

GMH, MONDEGO BASIN - Kaolinitic sands

Groupe Mineral Harawanne (GMH) was created in 1992 and now produces kaolin from two areas in France *(Kaolins du Morbihan and Kaolins du Finistere in Brittany, France)* and two areas in Portugal *(SAIBRAIS, near Mosteiros and SAIBRAIS, near Bracais). SAIBRAIS* was formed in 1982 solely to sell sand for construction and public works. In 1990 an investment programme aimed at recovering kaolin from the sand was started. GMH became involved in 1992 and now the production capacity of kaolin is 20,000 tpa and 200,000 tpa of sand. Much of the kaolin is sold to ceramic producers for use in tiles, sanitaryware and some tableware. The Mondego Basin (Figure 1) is a geological depression containing sediments of post-Cretaceous age which dip towards the basin's centre to the west, under the sea. On the eastern side of the basin is a sequence of kaolinitic sands up to 15-20 m thick which are found over a large area. They are overlain by coloured sands including seams of ball clays, some of which are badly iron stained. Unfortunately the good quality kaolin is overlain by up to 20 m of overburden which will make large scale exploitation uneconomic. It is possible to produce a coating clay product with good brightness and viscosity from the kaolin fraction in the sands but the main problem is the low yield of only 5 wt% or below. At Mosteiros, *Saibrais* extract kaolin, sand and red clay. The kaolin is washed, de-sanded and thickened after which it undergoes cyclone refining, decantation, homogenisation, filtering pressing and drying. The products are sold dominantly to the ceramics sector. Originally opened in 1987 under the company name of *CAULIMINAS, GMH* became involved as a partner in the operation in 1989. In 1997 the Mosteiros site was integrated into the operations of *SAIBRAIS* under the control of *GMH.* Much attention has been paid over the last 5 years to characterising the reserves (quantity and quality) together with an improvement in the production technology. The installation of a dryer in September 1992 has allowed the Mosteiros plant to enter markets further afield. The current production capacity is given as 15,000 tpa of kaolin, 35,000 tpa of sand and 50,000 tpa of red clay *(GMH Pamphlet, 1997 -unpublished).* The kaolin from the sands exhibits a wide range of properties but generally the iron and titania levels are low (0.60-0.80 wt.% Fe_2O_3, 0.05-0.09 wt.% TiO_2) which is suitable for ceramics (sanitaryware and tableware). The mineralogy is mainly 92 wt.% kaolinite, 7 wt.% mica and 1 wt% quartz on the refined kaolin fraction at approximately 70 wt.% -2 microns. Whilst, as mentioned, they show some potential for coating clay the yield is very low and there are other deposits of a better quality in Central Spain in Guadalajara (Poveda de la Sierra and Penalen). However, the concept of utilising the sand as the main product and developing the kaolin as a by-product is a good one - just to develop the kaolin alone would unlikely to be economic.

POMBAL AREA, MONDEGO BASIN - Kaolinitic sands

Detailed exploration work carried out in the 1970's by many companies within the Mondego Basin identified the Pombal area (Figure 1) as containing kaolin within sands. Two matrix types were identified:

Netos Type A hard kaolinitic pebble bed of little commercial value.

Pinto Type An unconsolidated loose quartz sand containing about 5% kaolin with good brightness and of some commercial interest for paper and ceramics. Unlikely to be developed commercially just for kaolin but as a by-product of sand production.

SUMMARY

On the basis of existing information no large scale development of kaolin for coating clay is foreseen due to the small size of the deposits in Western Iberia and inferior quality, in some cases, to existing suppliers. The local kaolin production in northwest Spain and Portugal will continue to supply the local markets mainly for ceramics. In the case of Burela it will continue to produce kaolin for ceramics, much of which will continue to be exported.

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