

KAOLIN

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Kaolin, also known as china clay, is a white commercial clay consisting predominantly of the mineral kaolinite, a hydrated aluminosilicate. The name 'kaolin' is derived from the village of Gaoling in Jiangxi province, China, where the white clay was mined. The nearby Jingdezhen potteries used the kaolin to create their fine white porcelain. The composition of Chinese porcelain was identified by Europeans in the eighteenth century and deposits of kaolin were sought in Europe. This led to the discovery of the kaolin deposits in Cornwall, south-west England, which were named china clay.

Deposits

Kaolin deposits have now been found throughout the world and new deposits are still being discovered. Kaolin deposits may be classified as primary or sedimentary. Primary, or residual deposits, were formed by the alteration in situ of the parent rocks, which may have been igneous, metamorphic or volcanic in origin, by hydrothermal and weathering processes. Sedimentary, or secondary, kaolin is derived from the erosion of pre-existing rocks and the subsequent transport and deposition of the clay.

In Cornwall and Devon, the kaolinite is derived from the late-stage magmatic or hydrothermal decomposition of feldspar within granite. It is separated from the host granite by washing it out with high-pressure water hoses, a process known as monitoring. The kaolin content rarely exceeds 20% of the altered granite, but the depth of kaolinisation extends in many places down to 300 m. The best known sedimentary kaolin deposits are from Georgia in the US and the Amazon Basin in Brazil. Here the deposits of kaolin were formed from the erosion of deeply weathered crystalline rocks in the plateau areas, which were then transported and deposited as sedimentary sequences. Here, the kaolin is found in

lenses, often between 5-20 m thick, and with a high percentage of kaolinite, around 80-95%, which are dry mined.

Production

Kaolin is found in many countries but it is just the beneficiated, or refined clays that will be considered in this report. The worldwide production is estimated by the US Geological Survey (USGS) to be in excess of 40 Mt/y. However, this value includes 13.5 Mt/y from Colombia and Uzbekistan, which distort the figures, as the majority of these clays are low grade, and not processed. The estimated production figures of beneficiated kaolin from 30 countries are shown in Table 1 for 1999-2001.

North America is still the most important area with 37% of production, followed by Europe with 25%. However, both the US and UK are decreasing their production mainly as a result of Brazilian competition. The share of South America has risen from 4% to 9% in the past five years, solely as a result of the high quality of coating clay being achieved by the Capim kaolin deposits.

The leading producing kaolin companies are shown in Table 2 with estimated production levels for 2001. The 11 leading producing companies account for 57% of the total. Comparisons with previous years are not relevant as there has been so much restructuring of the industry by a combination of acquisitions, closure of some unprofitable plants and switching of grades from one operation to another.

Imerys

Imerys, with headquarters in France, is the only truly international company, with kaolin operations in the US, Brazil, UK, Portugal, Thailand, Australia and New Zealand, and accounts for almost one-quarter of the world's production. Imerys started as a major

producer in Brazilian kaolin through the stake of its US subsidiary, Dry Branch Kaolin in Rio Capim Caulim (RCC). Since the acquisition of ECC in 1999, it increased its share in RCC to 99% and also acquired ECC do Brasil. At present, RCC has a capacity of 0.6 Mt/y with 95% of production being exported to papermakers in Asia, Europe and more recently the US. A 175 km pipeline is being constructed from the Capim deposits to the plant at Baracena. Capacity from the RCC operation is forecast to be around 1.0 Mt/y within the next few years.

Due to the unprofitable nature of some of its grades of kaolin from Georgia, US, Imerys reduced capacity by 800,000 t/y in 2001. It also announced in February 2002 that, following a review of its worldwide kaolin business, 290 people in the UK would be made redundant and 150,000 t/y of coating kaolin would in future be supplied from its Brazilian operations. The UK operations will focus on the 50 kaolin grades that can be economically produced. In 2001, Imerys invested £10 million into its UK kaolin operations, for pit development, refining improvements, a new calcining plant and the replacement of a ceramic plant dryer. Of the investment, £6 million went into the development of the Karslake and Blackpool kaolin pits. Kaolin from the Brazilian deposits has a higher brightness than Cornish kaolin and can be produced at a cheaper rate, as less processing is necessary for the engineered kaolins.

Imerys is reducing its exposure to the cyclical paper industry by investing in the ceramic sector. Following the acquisition of New Zealand China Clays in 2000, it has recently acquired ceramic body plants and operations in Germany and has announced potential investments in Thailand. This increases its dominance in the supply of clays and ceramic bodies to the porcelain manufacturers in Europe and Asia. Imerys is also increasing its capacity for high value added calcined products. A new plant in Cornwall has been commissioned which will produce Opacilite, a

World Production of Kaolin ('000 t)¹

	1999	2000	2001 ^e
Europe			
Austria	50	50	50
Bulgaria	110	110	110
Czech Republic	700	750	750
France	325	325	325
Germany	1,800	1,800	1,800
Poland	50	50	50
Portugal	90	100	100
Spain	300	300	300
Ukraine	200	250	300
UK ²	2,304	2,376	2,400
Uzbekistan	200	200	200
Europe			(25%)
Asia/Oceania			
Australia	100	100	100
China	1,900	1,900	2,000
India	450	500	500
Indonesia	300	400	500
Pakistan	70	70	70
South Korea	1,858	1,858	1,800
Malaysia	209	209	210
New Zealand	15	15	15
Thailand	250	350	250
Asia/Oceania			(21%)
South America			
Argentina	100	100	100
Brazil	1,400	1,500	2,000
Colombia	100	100	100
South America			(9%)
North America			
Mexico	490	490	400
US	9,160	9,000	9,000
North America			(37%)
Africa/Middle East			
Egypt	260	260	260
Iran	500	500	500
Nigeria	100	100	100
South Africa	120	120	140
Turkey	400	400	400
Africa/Middle East			(5%)
Others	800	850	870
Total	24,711	25,233	25,700

^e Estimated

¹ Sources: US Geological Survey and industry comments.

² UK production figures, NERC, 2001, section 1-7.

new flash calcined clay for use in the paint industry in Europe. Whilst Imerys will no doubt continually review capacity of unprofitable grades, there will be a concentration on higher value added products where smaller volumes can attract premium prices. This is the future of such operations as in Devon and Cornwall.

North America

The shake-out in the kaolin industry of mid-Georgia continues, following the acquisition of ECC by Imerys and the subsequent decision to shut down 0.8 Mt/y of capacity. This has been followed by announcements by Engelhard that it will concentrate on its higher value added calcined clays and not invest more in the lower quality commodity grades. All producers, owing to the unprofitable nature of the kaolin business, have been following this trend over the past few years.

The China Clay Producers Association (CCPA) of Mid-Georgia, whose members include Engelhard, Huber, Imerys and Thiele, announced in June 2001 that the composite earnings for the four major kaolin producers for 2000 was an after tax loss of US\$17.9 million, which represents a negative return of 1.78%. In 1999, the industry posted a profit of US\$33.2 million, a return of just 2.7%. "Despite volume gains and productivity improvements, dramatic increases in energy costs and other related cost increases have had a negative impact on our profitability picture," said Lee Lemke, executive vice president of the CCPA. Another major factor for the poor profitability within the industry has been the increased pressure on US kaolin producers by the stiff overseas competition from Brazil. In addition, worldwide kaolin growth is estimated to be approximately 1% per year. Alternative minerals, most notably PCC (precipitated calcium carbonate) and GCC (ground calcium carbonate), are also causing loss of market share for Georgia producers.

Thiele is becoming more involved with the Para Pigmentos operation in the Capim area of the Amazon basin and the capacity there will be increased to 1.0 Mt/y over the next few

years. Huber acquired the Sandersville No.1 plant of Imerys following the Department of Justice ruling that it must divest some capacity. This deal came with reserves of high quality kaolin as well. Huber has just announced in March 2002 that it will carry out a detailed investigation of Kaoclay's Sparta kaolin resources, recently drilled in kaolinised granite northeast of the sedimentary deposits. This study amounts to an extended due-diligence as Kaoclay has no intention of developing the resource itself.

Leading Producers (2001)

Company	'000 t/y	%
Imerys, France	6,100	24.0
Engelhard, US	2,000	8.0
Huber, US	1,500	6.0
Thiele US	1,300	5.0
Caulim de Amazonia, Brazil	1,000	4.0
AKW, Germany	900	3.5
Para Pigmentos, Capim, Brazil	600	2.0
Horní Brza, Czech Republic	400	1.5
Alter Abadi, Indonesia	300	1.0
DAM, France	270	1.0
Goonvean, UK	250	1.0
Others	11,080	43.0
Total	25,700	100

The Georgia kaolin belt continues to be an important supplier to the paper industry in the US with supplies mainly being by rail in slurry form. The calcined clay capacity is also 1.1 Mt/y; it is sold to the paper industry as a partial replacement for the more expensive titania dioxide in paper and paint. Some of the kaolin can also be processed dry by air flotation and various grades of kaolin are sold for the ceramics, paint, rubber and adhesives sectors.

In Canada, where up to 1.0 Mt/y of kaolin is imported from the US and UK, investigations continue by Black Bull Resources Inc. on the kaolinised granite of the Yarmouth area, Nova Scotia. Here the kaolin shows the potential to

be delaminated and is considered suitable for supercalendered (SC) paper. Port Hawkesbury at present produces SC paper and imports up to 150,000 t/y from Cornwall.

Europe

The main producing country in Europe remains the UK with Imerys now controlling the deposits in Cornwall and Devon. Production has remained fairly static for the past few years at 2.3 Mt/y, way below the heights reached in the late 1980s when up to 3.3 Mt/y was produced. Apart from Imerys other producers are Goonvean, a privately owned company with a capacity of 250,000 t/y based on the St Austell granite and WBB (Watts Blake & Bearne, now fully owned by Sibelco, the Belgium Group) with 150,000 t/y. Goonvean, is thus the only remaining English china clay producer and specialises in the filler and ceramic markets. The Cornish and Devon kaolins are characterised by very low titania which makes it suitable for high quality ceramics, particularly porcelain and tableware. The iron level is also of importance and this can be controlled by selective mining and in the St Austell and Dartmoor granite areas, and by using superconducting magnets. Over 87% of the kaolin from Devon and Cornwall is exported.

The Czech Republic is an important kaolin producer based on the kaolinitic sands of Horni Briza (formerly ZKZ) which is now controlled by the Austrian group, Lasselberger. These clays are naturally platy and some are exported to Germany where they are blended with local clays for use on lightweight coated paper (magazine paper). The kaolinised granites of the Karlovy Vary area produce the famous Zettlitz range of products for use in porcelain and tableware. Huttenrusher sold its interest in its Hlubany operation to WBB.

In France, Denain Anzin Minéraux (DAM), a subsidiary of the Swiss based group Harwanne, controls all of the kaolin deposits, apart from Société Kaolinère Américaine (SOKA). AGS, the Dordogne based chamotte

producer used to be owned 40% by Imetal (now Imerys). As part of the acquisition of ECC it was necessary for Imerys to divest its share in AGS and they have now formed a partnership with SOKA, leaving DAM and AGS/SOKA as the sole kaolin producers in France. Ironically, Imerys, the largest kaolin-producing company in the world has no kaolin operations in France, but has plastic ball clays, ceramics clays and a body plant in Limoges.

In Germany, the main producer is AKW with an estimated 900,000 t/y of capacity. Imerys Tableware has recently acquired the body preparation plant in Kirchenlamitz, Germany from German ceramics producer Winterling. The ten-year-old plant is a modern facility with capacity to produce 10,000 t/y.

Production from Ukraine remains low at 300,000 t/y, compared with 750,000 t/y prior to the breakdown of the former Soviet Union. High quality kaolin exists in many areas but investment has not been forthcoming. The joint venture between Prosianaya and Engelhard, Dnipro Kaolin, to produce coating clays has now been discontinued following difficulties. The plant in the Glukhiv area, near Kiev is undergoing some modernisation but production is still way down.

Asia

Production of processed kaolin is growing in Asia, particularly in China where the major use is in ceramics. With the fast growing paper industry in China there is also the need to develop local resources for paper coating to cut down on imports from the US. Several deposits have been identified at Maoming, Guangdong Province for coating clay and a high-quality kaolin at Longyan in Fujian Province for high quality tableware. Several coal-mining companies are also calcining a flint type clay found interbedded within the coal measures for use in paper and paint.

In Thailand, Imerys has announced that it is considering three investments in kaolin for tableware, sanitaryware and technical ceramics, representing approximately 20

million. At present Imerys has a joint venture on some ball clay deposits with Banpu Mining and also offers technical assistance to Banpu's kaolin operation in Ranong.

Australian Kaolin Ltd expect its Skardon River project finally to go ahead in mid-2002 following changes made in the process and successful trials with customers of certain grades. The company has been restructured under the ownership of Minerals Corp. but the project slowed during 2001 in order to conserve cash as the company sought to raise A\$15 million to complete the work. Initial production of 25,000 t/y will mainly be exported to non-paper markets with an anticipated increase to 175,000 t/y for hydrous and calcined grades. Minerals Corp. acquired Skardon for A\$6.5 million from the receivers.

Market

The consumption of kaolin is mainly for paper filler and coating, with paint, rubber, plastics, sealants, ceramics, refractories and fibreglass being of importance as shown in Table 3.

Consumption of Kaolin

Industry	Share (%)
Paper	45
Paint, rubber, plastics, sealants	10
Ceramics	16
Refractories	15
Fibreglass	6
Others	8
Total	100

Kaolin competes with ground and precipitated calcium carbonate and talc in the paper, paint and plastics industries. In 1980, approximately 87% of the pigment use in paper was kaolin and this has reduced to 44% by 2000. Ground calcium carbonate (GCC) which was 9% of the market in 1980 has increased its share to 37%, and precipitated calcium carbonate (PCC), virtually unused in 1980, now has a 15% market share. This trend towards calcium

carbonate has mainly been as a result of an alkaline paper-making system being introduced, and also because of the requirements of higher brightness pigments for woodfree pulp. Kaolin brightness for coating grades is between 86-90 ISO, whilst GCC and PCC can achieve >95 ISO brightness.

However, kaolin has a platy morphology that is still required for a large number of paper applications, particularly in LWC (light-weight coated) papers. The trend in recent years has been for a combination of different minerals being used in the same coating formulation. GCC can be mixed with kaolin, GCC with PCC and more recently talc with GCC to obtain improved performance. Kaolin is widely used in paint as an extender and the calcined grades give higher opacity than a hydrous type. There are regional trends, with the US still relying dominantly on kaolin for coating, followed by PCC and GCC. In Europe and Asia the trend has been more towards the use of GCC, no doubt due to the proximity of high-quality marble deposits. It is necessary to use a crystalline limestone (marble) for high brightness as chalk and limestone rarely achieve brightness greater than 85-90 ISO.

Ceramics remains an important market for kaolin, with various grades for porcelain (low iron and titania), sanitaryware (good casting properties) and in refractories (controlled alkali levels).

Prices

List prices for various grades of kaolin produced in the US and UK are regularly quoted in Industrial Minerals, with Chemical Marketing Reporter quoting prices for US grades. The price of kaolin varies tremendously, depending on the degree of processing and in some cases the scarcity of a particular grade. The price of one grade can vary tremendously depending on the size of the order. Large papermakers taking bulk-delivery of 15,000 t in one shipment can expect to receive the same grade much more cheaply than a smaller customer.

Throughout the 1990s there was price stagnation, mainly due to the negotiating strength of the papermakers and the competition from GCC and PCC. As mentioned, the Georgia producers show little financial return on their vast production capacities that led them to cutting capacities of unprofitable grades and attempting to get realistic price increases to remain viable. Following some increases in 2000, further price increases were announced at the end of 2001. Imerys, in North America raised its prices for all paper grades of kaolin and calcium carbonate by 6-8%, and Engelhard Corp. and Thiele followed by raising their prices by an average 5-7%. The Thiele price increase on selected kaolin products to the paper industry has been set at 5% to offset higher mining and processing costs, due to increases in energy, chemical and transportation costs. Both Imerys and Thiele

Kaolin Co. also stated that they intend to continue with a policy of energy surcharges if natural gas prices in the region rise above the level of US\$3.50 million Btu.

The prices quoted by Mineral Price Watch in February 2002 for kaolin, ex-Georgia plant per short ton was US\$80-100 for bulk filler, US\$85-185 for paper coating grade, US\$335-395 for calcined bulk, US\$64-74 for sanitaryware grade (bagged) and US\$125 for tableware grade (bagged).

For Cornwall, UK, free-on-truck prices quoted in February 2002 (per tonne), were £47-58 for filler, £63-90 for paper coating, £35-90 for ceramic grade and £70-130 for porcelain grade. In New Zealand the ex-works price of Premium, the high quality clay for use in porcelain was around US\$400/t ex-works.