

Ceramic clays in the pan

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As the lag in construction catches up with the ceramic markets of tableware, tiles and sanitaryware, ceramic clay producers will have to cling to value-added products to avoid getting flushed away by Jessica Roberts, Assistant Editor

Have a flick through the latest pages of **IM**'s weekly bulletin, or its monthly magazine, and several headlines related to the ceramic clays industry jump out, such as; **Italian tile production falls** (23 December 2008), **UK port clay exports down** (3 February 2009), **European ceramics demand drops** (*IM February '09, p.24*), **Construction hit in CIS countries** (12 May 2009), **Eastern Europe's building slump** (13 May 2009).

Unfortunately for ceramic clay producers – which between them mined around 20m. tonnes of ball clay and 22m. tonnes of kaolin in 2007 – the demand for sanitaryware and tile products (two of the biggest end uses for ceramic clays) is directly linked to the fortunes of the construction and housing sector.

The health of a country's ceramics market (and construction industry) is generally in line with its GDP. It is interesting to note that although trends in the ceramics market often mirror those seen in construction, there tends to be a lag period of around 3-6 months. So while construction has been depressed in many western countries since Q3-Q4 2008 (*see figure 2*), the full effect of this is only now filtering through to ceramics producers.

Keith Savage, sales director for UK-based ceramics distributor Whitfield and Son Ltd, told **IM**: “The impact of the global downturn has been severe on the ceramic industry, with reductions in the requirements for sanitaryware, tableware and wall/floor tiles.”

“Talking in Europe recently I was informed that reduced levels, up to 50%, have been seen since the beginning of the year, and it is a case of everyone really controlling cost and expenditures while we move through this period of difficulty,” Savage revealed.

This difficult period has even eaten into the operations of the world's largest industrial minerals group, Imerys SA, which told **IM**: “The group's turnover dropped 21% in Q1 2009 versus Q1 2008, as a result of the downturn.”

Putting this drop into context, Imerys' annual turnover for 2008 was €3,449m. (\$4,680m.) – with ceramics accounting for around 10% of the overall figure. The group's portfolio includes 29 minerals which together accounted for 16m. tonnes in 2008. Production of kaolin (for paper, performance minerals, and ceramics) was 25% of this total (ie. 4m. tonnes), with ceramic kaolin representing not more than 15% of this.

The story is the same for public and private companies alike. Goonvean Ltd, Europe's largest kaolin, china clay and speciality minerals producer, explained to **IM** that the downturn had contributed to a significant over-capacity of ceramic kaolin within the European producing region.

Robert Canning, Goonvean's technical service manager, said: "Plant closures and short-time working, particularly in Europe, have decreased demand for ceramic kaolin and other raw materials."

"Some kaolin producers have been moved to cut prices to maintain sales volumes and have also reduced the number of employees. At Goonvean we have changed working practices to reduce capacity, whilst retaining the skill pool and production capability, so we are prepared to increase output when the market improves," Canning revealed.

While it may be true that traditional producers of ceramic clay – for example those based in south-west UK, the Westerwald of Germany, or even the kaolin deposits of Georgia, USA – have felt the definite pinch of falling sales from the construction sector, this is not the case world over.

In fact, for Asian ceramic clay producers, particularly those in China and India, the situation is fairly positive. Atil Parikh, joint managing director of Indian industrial minerals company 20 Microns Ltd, told **IM**: "The Indian ceramic industry has been growing across all segments driven by India's booming construction sectors... with vitrified tiles, glaze tiles, sanitaryware, bone china, agglomerated marble, industrial ceramics and other applications recording the fastest growth."

Although India's ceramics producers have been "marginally" affected by the downturn, Parikh believes that reducing high energy costs is the primary requirement for the sector: "The ceramics sector is highly energy intensive and uses both oil and electricity to operate. Therefore, cutting energy costs [will help us] to remain competitive during the global downturn."

Figure 1: Main ceramic clay end uses, USA, 2007

Source: US Geological Survey: Clay and shale, 2007 minerals yearbook

Constructing the market

Although this article focuses on *traditional ceramics* (see panel for definition), the main end uses for ceramic clays come from: floor and wall tiles, sanitaryware, tableware, roofing granules, pottery and electrical porcelain (*see figure 1*). In other words – ceramic end uses are directly linked to construction and housing.

Using the UK as a western example, the Office for National Statistics last month released its preliminary estimate of the UK's GDP for Q1 2009. All in all, the UK's GDP fell 1.9% compared to the previous quarter, while construction in the UK was down 2.4%. Compared to Q1 2008, however, construction has fallen 8.6%.

Further, the Key Purchasing Managers Index for construction from the Chartered Institute of Purchasing and Supply (CIPS) rose from 30.9 in March 2009 to 38.1 in April. This index essentially illustrates that anything with a value below 50 is falling, and anything below 40 is falling very fast indeed. So although the rate of decline in UK construction slowed somewhat in April, it is certainly nowhere near a stabilisation. What does this mean for ceramics markets?

Floor and wall tiles

Clays and kaolins are integral constituents of a tile's body, engobe and glaze, and the tile market demands properties such as: high dry strength and plasticity, a light fired colour, absence of dark specks, good vitrification properties and consistent quality.

In practice, however, modern processing methods and tile manufacturing plants have been developed to ensure that lower quality, *local clays*, can be used to produce good quality tiles from an economically attractive clay deposit.

This in part has contributed to a trend seen over the past decade, where ceramic producers have begun to move away from established sites (ie. Devon and Dorset, UK) to more low cost base locations. Once there, producers have made significant increases in capacity.

Goonvean's Robert Canning concurred: "This has driven kaolin demand in Egypt, while the Middle East and Gulf states continue to grow."

Sanitaryware

The majority of commercial sanitaryware production is done via the slip casting process, which is most successful when the rheological properties of the slip are controlled within set limits. Rheological properties are dependent on the source clay and kaolin, and in this sense there are only a few deposits worldwide that meet the quality criteria for sanitaryware.

These criteria include: control of rheology, casting performance, wet and dry strength, ease of dispersion, deflocculation, particle size distribution, plasticity and workability, purity, and consistency.

Thus despite the trend of established ceramic centres moving to lower cost bases – as seen in tile production – the higher quality clays found in Germany and the Ukraine, for example, cannot be replaced by local clays.

Unfortunately for producers, demand for these higher quality clays (and sanitaryware overall) has been offset recently owing to the rapid decline in new construction projects.

Consultant Georg Fiederling, part of ceramic raw materials consultancy Hans-Georg Fiederling-Kapteinat, told **IM**: "The clay miners of the Westerwald are facing a reduction of 20-40% in sales, and for the first time since WWII some of them are applying short-time working."

Tableware

Frequently, kaolin is the only plastic material present in porcelain and high quality tableware, and is always the most predominant. In this sense, the source kaolin is largely responsible for wet and dry strength of the body, plus its plasticity and workability.

Tableware demands that the final product be very clean after firing, contain no dark specks, and exhibit good translucency. Desired criteria include: white fired colour, good translucency, high dry strength (fine particle size), good plasticity (also fine particle size), and consistency.

With regards to the evolution of the tableware market, Goonvean's Canning said: "In tableware we have seen a continued move away from formal tableware towards cheaper, expendable – almost disposable – ware. In the ceramic industry, as everywhere, the buzz words are *low-cost and energy saving.*"

Eastern sunrise

In terms of overall market dominance, China is by far the largest consumer of ceramic clays and the biggest manufacturer of ceramic products. It led world sanitaryware production in 2007 with 28% of the market (approximately 311m. pieces produced globally), produced 38% of all tiles (world total was 7,695m.m²), and surely held the most dinner parties in 2007 with 49% of the tableware market (world total was 1,431m. tonnes, including porcelain and bone china – *see panel*).

Whitfield & Son's Keith Savage remarked: "The country that has emerged as the biggest consumer of ceramic clays without doubt is China. This is closely followed by India and the Middle East, where there has been substantial growth in the ceramics markets, specifically for sanitaryware, wall and floor tile, and to a certain extent tableware."

Atil Parikh of 20 Microns agreed, commenting: "The Indian sanitaryware industry reflected an appreciable growth in the last few years with leading global players like Duravit and Kohler, for example, increasing their production capacities."

"The total demand for organised manufacturers is estimated at 9m. pieces and the unorganized sector at 13m. pieces, growing at 12-15% pa," Parikh said. He estimated that the Indian ceramic tiles industry, meanwhile, is worth around Rs 60,000m. (\$1,260m.), while the Compound Annual Growth Rate of the industry has been around 14% over the past eight to nine years.

Although India's ceramics market is perhaps one of the healthiest globally, it too has not been able to deflect the economic downturn entirely. Parikh said: "The majority of manufacturers saw some decline in production and sales. About 80% of building ceramic manufacturers have temporarily restricted operations as half of their products are not finding buyers in the domestic market."

The main concern for India's ceramic miners and producers at present appears to be high energy costs. Parikh confirmed that ceramics manufacturers were looking for concessions to bring down the cost of other, more efficient energy types, such as electricity and diesel.

Figure 2: UK construction growth, 2006-2009

The view from the West

When it comes to the manufacture of ceramic goods, western countries are lagging behind the rest of the world: they hold 23% of the sanitaryware market and 30% of the tableware market. For tile production, meanwhile, only Italy (8%) and Spain (9%) have made a significant dent in China's market share (*see panel*).

This appears to have encouraged many western companies to focus on value-added ceramic grades and move away from a commodity-centred mentality. For western producers, it is quality rather than quantity.

Whitfield & Son's Keith Savage commented: "The ceramic market is being driven at present, in my opinion, by special ceramics. This would be items manufactured to very tight tolerances with the ability for use in very special areas."

Consultant Georg Fiederling revealed: "This situation has inspired a few people to develop new ideas for production and products. A different and creative method to utilise the Westerwald clays is being evaluated at the moment – but it's too early to give more information."

Future developments

The consensus between western ceramics companies is that advanced ceramics will become increasingly important. This is the utilisation of composite materials coupled with the need for high temperature ceramic parts for use in friction and other arduous conditions (*see IM December '08, p.66: Technical ceramics take off*).

Advanced ceramics (also referred to as *technical* or *engineering ceramics*) are considered non-traditional as they utilise highly refined materials and new forming techniques.

Typical uses include: in processing and manufacturing industries, where they may extend equipment life, decrease emissions, increase energy efficiency; in power generation, aerospace and transportation, where they increase specific power, reduce weight, and decrease fuel use; and in military applications, where they may expand the capabilities of weapons, decrease equipment costs, and increase reliability.

The long-term future of traditional ceramics and ceramic clays, for western producers at least, appears to lie in the development of value-added products and speciality grades.

Canning revealed that Goonvean is currently developing its product portfolio: "We are looking further at adding value to our kaolins by blending other minerals that would give special properties."

Indian producer 20 Microns, meanwhile, is in the process of developing artificial ball clay to replace high quality, expensive Ukrainian clay. "We are also in the process of developing low

cost, super white clay, to reduce zircon consumption. Lots of work is being done in this area and we are hopeful to get a breakthrough soon,” Parikh said.

Until the construction market picks up again, the near future of traditional ceramics lies in cost reduction and plant utilisation, while low fired temperature sanitaryware (1,050-1,100°C) may gain popularity with those producers conscious of energy conservation.

Selected world ball clay and ceramic kaolin producers

Company	Location (where known)	Production/capacity tpa (where known)	Mineral
Adolf Gottfried Tonwerke	Grossheirath, Bavaria, Germany	100,000	Ball and ceramic clays
Ashapura Minechem	Trivandrum, Kerala, India	180,000	Kaolin
Ceské Lupkové Závody	Rakovnik, Czech Republic	120,000	Ball and ceramic clays
Donbas Clays JSC	Octyabrskoe and Dorozhnoe, Dobropolye District, Ukraine	1m.	Ball clay, ceramic clay
Esan Eczacibasi Endustriyel	Bozuyuk and Esan, Turkey	380,000 overall	Ball clay: clay beneficiation, blending
Kaolin: blending			
Franklin Industrial Minerals (H.C. Spinks Clay Co.)	Paris and Gleason, Tennessee, USA	N/A	Ball clay

Goerg & Schneider	Aarbergen, Tanus; Altendorf, Leuterod; Eisbach, Girod; Guterborn, Boden; Gute Hoffnung, Siersahn; Hahnenberg; Hub, Vielsbach; Zimmermann, Germany	N/A	Ball clay and china clay	
Goonvean Ltd	Goonvean; Greensplat; Prosper; Rostowrack; Trelavour, Cornwall, UK	200,000 overall	Kaolin	
Imerys SA	Crenshaw, Mississippi, USA	200,000	1m. tpa overall	Ball clay
	Gleason, Tennessee, USA	400,000		
	Heathfield (Bovey Tracy), South Devon Ball Clays, UK	N/A		
	Mayfield, Kentucky, USA	200,000		
	Wareham, Dorset, UK	N/A		
	Ploemeur and Berrien, France	~260,000	Kaolin	
	St Austell, Cornwall, UK			
	Sandersville, Georgia, USA			
	Langley, South Carolina, USA			
Kalemaden	Arpatarla, Sindirgi, Balikesir Province; Tepekoy, Buyuktepe, Can; Duman, Can; Kizildam, Yenice, Turkey	363,000	Kaolin	
Kaolin AD	Serbia: Devnya, Dmitrovgrad, Gorna Oriahovica, Kaolinovo, Rgotina, Topolovgrad, Ub, Vetovo	44,000	Ball and ceramic clays	

	Ukraine: Buriakovsko Mestorozhdenie, Papernianskoe Mestorozhdenie		
Lasselsberger GmbH	Chlumzany, Czech Republic	50,000	Kaolin
	Horní Bziza, Czech Republic	100,000	
	Kaznzjov, Czech Republic	240,000	
	Nová Ves, Slovakia	200,000 overall	Ball and ceramic clays
	ema, Slovakia		
	Suchá, Slovakia		
Old Hickory Clay	Gleason, Tennessee; Hickory, Kentucky, USA	450,000	Ball clay
Rohstoff GmbH	Auhofweiher and Maxhutte-Haidof, Bavaria, Germany	100,000	Ball and ceramic clays
Samca Group (Euroarce)	Ariño, Spain	N/A	Ball clay
SCR Sibelco	Xinhui, China	N/A	Ball clay, plastic clays
	Kalimantau, Indonesia		
	Bangleu, Thailand		
	Lampang, Thailand		
	Impoh, Malaysia	N/A	Kaolin, clays
	Cornwood, Devon, UK		
	Petrockstowe, Devon, UK		
	Sibelco Gilfair, Hong Kong	700,000	Ball clay, kaolin

Soka	Quessoy, France; and Pervomiansk, Ukraine	N/A	Kaolin
Stephan Schmidt Gruppe	Group includes: Ceramat s.r.l., Cerargillum S.L., Marx Bergbau GmbH, Müllenbach & Thewald, MTG Mittelhessische Tonbergbau, Progind International s.r.l., Stephan Schmidt KG, and Stephan Schmidt meißer	1.6m.	Kaolin, ceramic clay
Vesco JSC	Novoandreyevskoye, Ukraine	1.3m.	Ball clay

Source: Industry sources

Ceramic clays: types and uses

For the purpose of this article, the term *ceramic clays* refers to ball clay and kaolin products when used in traditional ceramic applications; for example, porcelain, sanitaryware, tableware and tiles. Heavy clay products – which comprise bricks, drainage pipes, roofing tiles – plus special clays, are beyond the scope of this article.

Industry sources estimate that around 75% of ceramic clays production comprises lower grade, red- or pink-burning material, commonly used in tile bodies, while the remaining 25% consists of geologically rarer, light-burning plastic clays.

Ball clays

The name *ball clay* is derived from the original method in the UK for extracting clay by cutting it into 1ft³ blocks that became rounded during transportation to form balls. Globally, around 20m. tonnes of ball clay were produced in 2008.

Composition: Ball clay is a fine-grained and primarily kaolinitic sedimentary clay, which has high plasticity; the higher grades of this material may be fired to a white or near-white colour. Typically ball clay is a fine-grained mixture of 70% disordered kaolinite plus illite, quartz, montmorillonite, chlorite and small amounts of carbonaceous material.

Contaminants may include dolomite, gypsum, iron/titanium oxides, pyrite and siderite.

Properties: Ball clay is used in ceramic bodies to provide plasticity and strength, while the higher grades may also impart a light cream to white fired colour. Ball clays can increase the workability and strength of a ceramic body.

Mining: The majority of ball clay deposits are mined by digger and undergo minimal processing, such as shredding and blending, although for some applications (such as sanitaryware) the ball clay is wet-refined.

Locations: Ball clay deposits are found throughout the world, in Argentina, Brazil, Chile, China, Czech Republic, France, Germany, India, Italy, Malaysia, Thailand, Turkey, UK, Ukraine, USA, and Vietnam.

Kaolin

Kaolin is a corruption of the Chinese word Kau-ling, or Geo-ling, referring to the *high ridge* close to the town of Jaucha Fu, Jiangxi Province, where kaolin is thought to have been extracted during the third century BC. Globally, around 7m. tonnes of high grade, ceramic kaolin were produced in 2008, while lower grade kaolin production was 15m. tonnes.

Composition: The average composition of kaolin is $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$: or around 46% silica, 40% alumina and 14% water. Kaolin is a soft white, plastic clay, comprising ordered kaolinite and a low iron content. When washed it is made up of a loose aggregation of randomly oriented stacks and micron-sized kaolinite flakes.

Properties: Coarse kaolin, containing little or no smectite, has good casting properties for the production of sanitaryware (ie. high casting rate and casting concentration). Kaolin with low iron and titania, but some smectite (for strength), is suitable for tableware – particularly where fired properties are important. Kaolin intended for firing as a ceramic must have a high alumina content, as well as a low amount of fluxing and colouring agents.

The main applications of ceramic kaolin include sanitaryware, tableware, porcelain, bone china, and tiles.

Mining: The majority of kaolin is processed via wet refining to remove quartz and other coarse particles, while particle size reduction can be achieved by processing in cyclones and centrifuges. After processing, kaolin is pressed and dried.

Locations: Kaolin deposits are found throughout the world, in Argentina, Australia, Brazil, China, Czech Republic, France, Germany, Indonesia, Iran, Malaysia, Portugal, Spain, Thailand, Turkey, UK, Ukraine, and USA.

Main ceramic uses

World sanitaryware production, 311m. pieces, 2008*

World sanitaryware production, 311m. pieces, 2008*

World tableware production, 1,431m. tonnes, 2008*

Source: Industry sources

World tile production, 7.695m.m², 2008*

Source: Industry sources

*estimated