
GROUND CALCIUM CARBONATE

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Ground calcium carbonate (GCC) is a large market of 53 Mt/y and includes fine-grained products mainly used in paper, plastics and paint, and a large volume of coarser grades for consumer use (carpet backing, cultured marble and landscaping). World capacity has increased significantly over the past decade with much of the increase being used as a coating pigment for paper.

Types of calcium carbonate

The main types of calcium carbonate used in GCC production are marble (crystalline limestone), limestone and chalk. The characterisation of calcium carbonate used in GCC is mainly based on its physical (particle size distribution and brightness) and chemical properties. The chemical composition is a good guide to the mineralogy (whether calcite or dolomite based on the CaO and MgO levels) and often a good guide to the abrasion (high acid insoluble residues such as silicates will give higher abrasion). Brightness is mainly determined by the degree of crystallinity and levels of iron and manganese, lower levels being associated with higher brightness (reflectance).

The presence of graphite and finely divided iron pyrites can also be deleterious to the brightness, especially at the finer grinding stages of processing. GCC, based on the different sources such as marble, limestone and chalk shows a wide range of brightness.

The grey limestone found in many parts of the world has a poor brightness, even though it is often chemically pure and suitable as a feed to make lime, and hence precipitated calcium carbonate (PCC). Only small amounts of GCC, based on grey limestone, are produced because of the poor brightness. Chalk gives a better brightness than grey limestone and, unless bleached, rarely has brightness above 85 ISO. The higher brightness limestone deposits of Indonesia, Italy and Jamaica can attain a brightness of 94 ISO with fine grinding. This leaves GCC, based on marble, to give the high brightness figures up to 96 ISO.

Deposits of calcium carbonate

Deposits of calcium carbonate are widespread throughout the world and resources are large. It is estimated that the use of calcium carbonate types in GCC manufacture are dominated by marble (72%), limestone (19%) and chalk (9%). Official statistics published by various organisations often do not identify those resources that are suitable for GCC as calcium carbonate is often included under limestone or aggregates. Some major calcium carbonate deposits of the world used in GCC production are shown in Table 1.

Major uses of GCC

The utilisation of GCC, its function and some quality characteristics are summarised in Table 2, with a split of the markets in Table 3. GCC has become the primary coating pigment in coated paper. The GCC coating products impart high brightness, low binder demand, good runnability, low drying energy and good printability.

GCC is a primary extender for paint and important properties are its non-toxicity, weather resistance and low abrasiveness. Fineness and particle size distribution determine the opacity. GCC is used in both interior and exterior paint, primers and high solid coatings.

Plastics is an important market for GCC, the main benefits being improved colour characteristics because of their high whiteness, increased rigidity and thermal conductivity, controlling the rheological properties of PVC plastisols, improved anti-block, slip and printing properties of PE films. GCC has for long been used in a variety of polyolefin markets and recent product developments by Omya, Imerys and Huber (in the US), has been in the diaper (nappy) market. LLDPE (linear low density polyethylene) and GCC are mixed into a compound. The concept is to provide voids in the diaper film for vapour to escape but prevent liquid from passing through the membrane. The so-called 'breathable' film will have applications in the diaper films for infants, and sanitary napkins for adult incontinence, which is considered a growth market with an ageing population.

GCC is the main filler used in adhesives and sealants and in a number of rubber applications. Other markets are in pharmaceuticals and food, toothpaste, chewing gum, and in cultured marble – this is where a coarse GCC is mixed with a polymer to produce a range of artificial marble for work or decorative surfaces, such as in the kitchen. GCC is also used in carpet backing where the role is to increase the solids and improve the drying characteristics of the compound. There is also a large market in landscaping where chippings of various sizes are used in golf-course bunkers and in gardens.

Production of GCC

World production of GCC in 2003 was approximately 53 Mt, with a regional split in Table 4 and country details in Table 5. The top 11 producing countries in the world account for 75% of the output with just one company, Omya, accounting for 40% of the world's total (Table 6).

Europe

The market for GCC in Europe was 20.5 Mt in 2003, with six countries (Austria, France, Germany, Norway, Italy and Spain) accounting for 68% of production. Omya, a Swiss-based company, dominates the market with 70%, followed by Imerys with 8%, leaving just 22% for the remaining companies. The market for GCC in Europe is dominated by paper (61%), plastics (15%), paint (8%), carpets (5%) and others, including rubber, sealants and adhesives (16%).

Major growth in the GCC sector in Europe has been in the paper sector, with the continuing and increasing use of GCC as a pre-coat and coating pigment in paper. Omya continues to dominate the market, based on the acquisition of high-quality calcium carbonate deposits and operations throughout Western and Eastern Europe.

Omya Gummern in Austria is one of Omya's largest plants with a capacity of 2.5 Mt/y. The marble is mined underground and following crushing goes into either a wet ground or dry ground-processing route. In Belgium, Imerys has a plant at Lixhe, near Vise, which imports marble chippings from Carrara, Italy for processing for a range of products for the paper sector. It also manufactures a GCC product for the polyolefin film industry in Europe, particularly for the diaper/nappy sector.

Omya has a plant at Stevns, Denmark, where chalk is mined to give a range of products mainly for the paper industry. The range of brightness is from 82 to 89 ISO. Finland relied on the import of kaolin for its filler and coating applications up to the mid-1970s and local talc was used as filler. Since then, the use of calcium carbonate has increased significantly, both for coating and to a lesser extent filler, with consumption of GCC in Finland increasing from 0.47 Mt in 1992 to 1.3 Mt in 2003. Omya Oy has two operations at Förby and Lappeenranta. There is also a large tank farm at Förby that imports GCC slurry from its Molde plant in Norway.

France has a wide range of calcium carbonate resources ranging from chalk, limestone, semi-crystalline limestone and marble. Chalk is mined and processed in the Paris Basin and limestone occurs over wide areas of southern France. Omya has important operations at Orgon in the Cretaceous Urgonian limestone. The marble deposits of France are situated in the Pyrenees with Provencale and Omya having quarries and operations in the Salses area.

In Germany, Omya dominates the market with a 90% share. The majority of the production is based on local deposits of chalk and high-brightness limestone. In the north, deposits of chalk are worked at Lagerdorf (Omya), near Hamburg and at Sohlde (Omya) east of Hanover. In the south, a cream-coloured, fine-grained Jurassic limestone is processed by Omya at Burgberg. If high-brightness material is required, marble is often imported from Spain and Greece.

Microfill K Zafranias SA is the major GCC Company in Greece, with a range of products and a capacity of 100,000 t/y. Italy is an important country for GCC based on its diverse range of resources, the most famous being Carrara (where Michelangelo obtained the marble for his sculptures). There is also high-brightness limestone in the south at Avezzano.

Apart from Omya and Imerys, which produce GCC in slurry form, all other operations are by dry grinding, dry milling and classification. It was announced by Omya on March 31, 2004 that Omya Baheer BV is to build a new GCC plant in Moerdijk, near Rotterdam.

The plant is expected to begin production in mid-2005 with an initial capacity of 500,000 t/y. The marble for the plant will be imported from Omya's mines in Turkey.

Hustadmarmor AS is a joint venture between Omya and a local family in Norway with a capacity of 5.0 Mt and an output of 3.0 Mt/y – this makes it the largest GCC plant in the world. The operation is based on marble deposits in the Molde area and nearby. Slurry products, mainly for the paper industry, are exported in vessels up to 16,000 t at 75 wt% solids to the Omya's tank farms in Finland, Holland and Scotland.

The main GCC operations in Spain are based in the Barcelona and Almeria areas. Almeria is the second most important marble region in Europe, after Carrara in Italy, for block cutting. The Macael Raw Stone Suppliers Association established Triturados Blanco Macael based in Almeria in 1994. The waste from the block cutting operations is to supply Omya and Reverté with their marble chippings for GCC production. Clariancal SA (Omya) has a plant at Arbos in Tarragona and utilises the local limestone, which has a brightness of 91-92 ISO. The new Omya plant at Purchena, Almeria has a planned capacity of 250,000 t/y for the first phase and utilises the local waste marble which has a brightness of >94 ISO Brightness.

SA Reverté has two plants in Castellet i La Gomal (near Barcelona), with a recently commissioned plant in Albox, near Macael in Almeria. The new plant was built in Almeria, in line with the trend toward higher brightness GCC products. In 1998, the French company Provencale, acquired Marcael, part of Valenciana de Cementos, situated in Arboleas, Almeria. The plant utilises local marble that formerly was mined by the cement company and produces a range of products for the paper industry and paint, rubber and plastics.

In Sweden, Imerys Minerals AB has two plants at Tunadal and Köping. The Tunadal GCC plant receives marble chippings from Carrara for processing to supply local paper mills. The current capacity is being increased to supply the M-real paper mill with GCC and well as building a new satellite PCC plant at the Husum paper mill. The Köping plant capacity is 120,000 t/y, with marble imported from Carrara and Hestivika in Norway as the local marble brightness is not good enough. Omya AB has a slurry plant at Persberg and also imports slurry from its plant in Norway for distribution to paper customers.

Omya now control three plants in Turkey and over 70% of the GCC market. The three plants are at Gebze, Örtuluçe and the former operations of Akmaden at Yatagan, near Izmir. Omya plans to ship up to 1 Mt/y of marble to a new GCC plant in the Netherlands at Moerdijk. The Örtuluçe plant was built by Omya Madecilik AS and has a capacity of 300,000 t/y, producing both dry and wet ground products. The majority of products are for the paint, rubber and plastics industries with some for paper. Some GCC is exported. The Omya Akmaden plant was formerly a subsidiary of Yasar, producing GCC for its own paint factories and other industries. Omya purchased the shares of Yasar Holdings, the paint group, and acquired its quarries and plant

inland from Izmir on the west coast of Turkey. Omya now hold large reserves of marble in the Yatagan area and a GCC plant with a capacity of 250,000 t/y. There are other marble resources in the area and Omya has recently acquired additional reserves of high-quality marble. The markets for the products from Akmaden are mainly for paint, plastics and a lesser amount for the paper industry. Some GCC is exported.

Both Omya and Imerys have GCC operations in the UK, along with Minelco Specialities Ltd (former Veba Group). Imerys Minerals has two operations in Beverley, Humberside and Salisbury, Wiltshire, both based on chalk deposits. The Beverley plant products are mainly destined for the paint and plastics industries, with little for paper. Minelco, part of the Swedish company LKAB, took over the operations of the Veba Group and includes Fordamin and Microfine. Omya UK has a number of operations in the UK based on chalk and limestone deposits in Humberside and Derbyshire.

Eastern European GCC production is small compared with Western Europe. Existing capacity for GCC is estimated at 1.92 Mt/y, with 50% of the capacity utilising Russian chalk deposits, and 16% from the Omya operation at Vapenna in the Czech Republic, based on marble. Omya have been the most active company investing in GCC resources in the region and has established operations in many countries, with plans for most others.

North America

The US is the largest GCC producer in the world with 16.2 Mt of production and is dominated by Omya, Imerys, Huber, Franklin, Global Stone and SMI. Imerys is the largest producer, with operations in Sylacauga, Alabama, Marble Hill, Georgia, Cockeysville, Maryland and Kimberly, Wisconsin. These four operations produce high quality fine-grained products for paper, paint, rubber and plastics based on marble deposits. The Sylacauga operation has increased its capacity to 2.0 Mt/y and also supplies the Kimberly plant, with an increased capacity of 200,000 t/y, with marble chippings. Omya has large operations at Florence Virginia, Lucerne Valley in California and at Sylacauga, Alabama. Omya recently sold its Quincy plant in Illinois to Huber. Huber has a GCC capacity in excess of 2.0 Mt/y, with operations at Marble Hill and Fairmount in Georgia, at Quincy in Illinois and at Marble Falls and Seattle in Washington. Speciality Minerals (SMI) has GCC plants at Lucerne Valley and Adams in Missouri.

Asia and Oceania

The market for ground calcium carbonate (GCC) in the Asia-Pacific region was 11.6 Mt in 2003 with production dominated by China (29%) and Japan (21%). Major growth in the GCC sector is mainly being driven by increasing use of GCC as a pre-coat and coating pigment for paper. A major trend in the region is for medium- and large-sized paper companies to install their own in-house satellite GCC plants rather than buy from outside. GCC is mainly produced from marble deposits (95% of total) and the search and exploitation of new high quality deposits is a priority for continuing growth and

development. The GCC market is dominated by paper (41%), plastics (38%), paint (7%) and others (14%).

The top ten GCC producing companies in the region account for 56% of the total production of 11.6 Mt, with Omya and Imerys sharing 27% between them. Asia Pulp & Paper is third with 7% and Fimatec fourth (5%) with GCC plants in Japan, Thailand, South Korea, Indonesia and India.

Worldwide production of paper and paperboard in 2001 was 318 Mt, with Asia-Oceania producing a similar amount to the US and Europe. The top ten producing countries in the world now account for 74% of production, with the US leading the way with 25%, followed by China (11%) and Japan (10%). Asia-Oceania now accounts for 32% of the world's paper production and China is now the largest producer in the region, and second only to the US in world terms, having overtaken Japan.

It was announced in December 2003 that Imerys has been selected by UPM Kymmene, one of the major worldwide paper producers, as the exclusive ground calcium carbonate (GCC) supplier for its new paper machine to be installed in its Changshu production complex, Jiangsu Province, China. Imerys will build a new GCC processing plant close to the paper plant, with initial capacity of approximately 120,000 t/y, and will use the group's locally-owned sources of marble in Qing Yang County, Anhui Province. The plant will commence in the summer of 2005 simultaneously with the expected start-up date of UPM's paper machine. Imerys (100% ownership) already has a GCC slurry plant in Nanling, Anhui Province, which has been expanded to 180,000 t/y from the initial capacity of 100,000 t. Imerys Pigments (Qingyang) Co Ltd has been formed to mine marble underground from the Nanyang area, Qing Yang County, Anhui Province.

With the large demand forecast for GCC in China there is an urgent search for high-quality marble deposits throughout China. Current GCC in paper is estimated at 1.2 Mt/y and will increase to 2.5 Mt in 2005. However, in March 2004, it was announced that Omya AG has sealed a contract to supply all of the filler and coating GCC needs of the existing paper machine at UPM-Kymmene's Changshu paper mill. There will ultimately be two paper machines at Changshu – the existing but expanded PM2 and the new PM3, which will be supplied by Imerys and the new Omya plant, with a capacity of 200,000 t/y. Many other paper mills in China are planning satellite GCC plants.

APP (Asia Pulp & Paper) is the largest paper group in China and already has Satellite GCC plants at Ningbo (built with FMT Japan's technology) and in 1997 at Dagang, a turnkey facility built by ECC International (now Imerys) with a capacity of 250,000 t/y. Plans are currently being discussed for expansion of the Dagang GCC plant to 600,000 t/y (and even to 800,000 t/y for a subsequent phase). There are plans to build a pulp mill on Hainan Island and perhaps a paper mill to follow, which will probably require GCC.

Omya Australia was formed in 2000 following the decision of Normandy Mining Ltd to sell its industrial minerals business. Normandy's industrial minerals business consisted of Commercial Minerals, Omya Southern (a 50% share) and Larvik Pigment International. In July 2000, Normandy Mining sold its 50% share to Omya for an undisclosed price. Omya has a high-quality marble deposit in Bajool, Queensland, which has a high brightness helped by an optical sorting device to remove black amphibolitic dyke material. The Bathurst plant takes a whitish marble from McGills quarry and is processed for a range of dry products from 1-45 µm, and also a range of chippings for landscaping. At Moss Vale, marble is mined from the Wombeyan quarry, which supplies much of Sydney's cut and polished marble. The marble is a coarse-grained whitish to light-greyish calcitic type. The plant produces dry GCC for paper, plastic, paint and rubber. Geelong is a new plant, which receives marble from the Bajool deposit in Queensland. Plant capacity is divided between WGCC (40%) and DGCC (60%). Imerys Minerals Australia established a 70,000 t/y capacity GCC plant adjacent to the paper mill at Burnie, Tasmania following the award of a supply contract for paper filler and coating grades. Marble is shipped from Ipoh, Malaysia for processing at Burnie.

In India, the production of high-quality GCC is limited to two companies, namely 20 Microns Ltd and Wolkem India. Although India is a large country there is a scarcity of high quality calcitic marbles. Many of the marbles in Rajasthan are dolomitic in nature and too abrasive to be utilised in GCC. 20 Microns Ltd was established in 1988 and processes calcium carbonate, diatomite, iron oxide, kaolin, mica and quartz. The Swarupgunj GCC operation, near Baroda in Gujarat, has a capacity of 30,000 t/y with four ball mills for dry grinding a calcite from Mount Abu, 25 km from the plant. The other GCC plant is at Hosur, near Bangalore, and 20,000 t/y of calcite for the dry grinding process is taken from a mine at Dirneveli. Speciality Minerals, a division of 20 Microns offers many grades of calcium carbonate for paper, paint and plastics.

Wolkem India Ltd is well known for its production of wollastonite found within a whitish coarse-grained calcite marble at Kelka Pahar, Sirohi. Crude output of wollastonite from the mine is 65,000 t/y with 80,000 t/y of calcitic marble. There is a 60,000 t/y capacity processing plant in Udaipur that produces the GCC Calstar range of products. In 1998, Wolkem formed a joint venture with the Japanese GCC producer Fimatec. The new company is called Fimaken India and operates a wet ground GCC plant at Bhadrachalam in Andhra Pradesh, which supplies filler and coating grades to the paper industry.

Imerys signed an agreement in August 2003 for the creation of a joint venture (74% owned by Imerys) for the production of GCC in India with the largest paper maker in the country, Ballapur Industries Ltd (Bilt). The agreement provides for the construction of a calcium carbonate plant with annual capacity of 60,000 t. The plant is scheduled to come on stream in late 2004 and is located near Bilt's main production site in Bhigwhan, western India. It will use high-purity calcium carbonate from the Imerys marble deposit in Ipoh, Malaysia.

In Indonesia, Camco Omya, a JV between Omya, PT Inkalko Agung and PT ICCI of Indonesia, was established in 1992. Inkalko Agung, established 1975, and ICCI, established in 1980 were the biggest high-grade calcium carbonate producers, supplying most of the GCC requirements in Indonesia. Camco Omya controls reserves of 25 Mt of high-brightness limestone. PT Supersonic Chemical Industries has a mine and plant at Wonosari, east of Yogyakarta in southern Java. The mine is based on the chalky-limestone found widely in the Wonosari area and the plant has a capacity of 120,000 t/y destined for use in plastics (60% of total sales), paint (25%) and rubber (15%). Stearate-coated grades have been introduced, enabling the company to compete more in the plastics market. Some product is exported to Australia for use in plastic garden furniture.

Asia Pacific Resources International Holdings Ltd has a 98.5% ownership of Riaupulp of Indonesia, which operates an 850,000 t/y BHK pulp mill in Kerinci, Riau Province in southern Sumatra. Riaupaper has a 350,000 t/y uncoated wood-free paper machine integrated with Riaupulp and is constructing a second identical machine on the same site. A Satellite GCC facility has been built on-site to supply 80,000 t/y of GCC slurry for the plant and is a JV between Imerys Minerals Indonesia and Riaupaper. Marble chippings from the Imerys crushing operation at Ipoh, Malaysia are delivered to Kerinci from the port of Lumut.

Japan is the second largest producer in the Asia/Pacific region after China, with a capacity of 2.5 Mt/y. The largest market for GCC in Japan is paper with 47%. The current wet ground capacity is 0.9 Mt, a significant increase over the 1997 total of 0.5 Mt. The split between GCC producers and satellite plant facilities is about 60:40. Fimatec is the leader, with four GCC plants in Akita, Fuji, Soma and Tomanto, and two satellite plants – Daishowa Paper at Shiraioi and Nippon Paper at Ishinomaki. Imerys Minerals Japan KK (formerly ECC International) was the first producer of GCC for slurry in Japan, with the purchase of Fuji Kaolin in a joint venture with ITC. Today, Imerys has 100% ownership and two GCC plants at Fuji and Miyagi with a combined capacity of 200,000 t/y. Ten years ago 70% of the marble was from Japanese sources but today most of the marble is imported from Imerys (Malaysia), Vietnam (Mongson deposit) and some previously from China. The two plants produce slurry at 75% solids for the local paper industry.

Malaysia has large resources of high-quality marble, particularly in the Pulai area of Ipoh where most of the GCC operations are located. The largest GCC company in Malaysia is Imerys, which, in October 2000, acquired Honaik Sdn Bhd, a leading Asian producer of GCC products for the paper, plastics, paints and a wide variety of other industrial applications. In 2002, Imerys increased its stake in the company to 100%. The operation has a high quality marble deposit with reported resources of 100 Mt and a plant with a capacity of 0.4 Mt/y. The quarry has a crushing capacity of 1.0 Mt/y and marble chippings from this operation are sent to other Imerys GCC plants in Japan (Miyagi and Fuji), Australia (Burnie), Indonesia (Kerinci), Taiwan (Kaohsiung) and will also be the source material for a proposed GCC satellite plant in India.

GCC production in South Korea is dominated by Omya Korea Inc, with 64% of the market, the main markets being for paper (52%) and plastics (32%).

In Taiwan, the marble of the Ho Ping area, 60 km north of Hualien, is mainly whitish-greyish, fine-grained and banded and has been quarried for many years for building stone and GCC. Formosa Plastics, established in 1994, has become one of the largest companies in Taiwan and one of the largest producers in the world of a wide range of plastics. It produces a full range of GCC products under the NCC Series for use in PVC and other plastics. Imerys Minerals (Taiwan) Ltd has a wet-ground GCC plant at the Ta Fa Industrial Park in Ta Liao, Kaohsiung. The plant receives marble chippings, greater than 1-15 mm in size, from Jwa Hwa and An Rong, two powder producers in the Su Ao area. In recent years some marble chippings have also been imported from Imerys Malaysia. The plant produces Carbital products for the local paper mills, one of which, YFYU at Chiu Tang, is the largest in Taiwan.

In Thailand, the best quality is from the Khoktum area, 10-30 km east of Lopburi. The main plants operated by Omya, Calcium Products, Quality Minerals, Lime Quality and Imerys Minerals are all located here and use marble from the Khoktum deposits. Marble is also delivered to Fimatec at its Sing Buri slurry plant. The Khoktum marble deposits cover a wide area stretching over a distance of 20-30 km with a width of some 5-10 km. All of the deposits are in flat-lying land are mined near the surface. The marble is generally a fine-grained calcitic marble with low iron, magnesia and acid insolubles, with brightness greater than 94 ISO.

Calcium Products was founded in 1996 to produce GCC powder and slurry with Japanese technology. Investment promotion privileges from the Board of Investment enable finished products to be widely exported in the region.

Imerys Thailand was originally established as Alpha Thai Minerals Co Ltd, part of Honaik Sdn Malaysia. Following a JV agreement between Imerys and Honaik in 2000, 72.1% of the shares of Alpha Thai were acquired under the name Imerys Honaik (Thailand) Co Ltd. The remaining shares of the company were acquired in 2002 giving Imerys 100% control. A deposit of marble in the Khoktum area is operated by KK Silaon Co Ltd, now owned 100% by Imerys. The capacity of the dry grinding GCC plant is 20,000 t/y and is mainly geared to the plastics market in both Thailand and other countries in the region.

FMT's plant at Sing Buri produces slurry for the paper industry with a capacity of 100,000 t/y. Surint Omya Chemicals Co Ltd originally operated its JV with Surint Omya in Napralaan. However, when it was realised that the Lopburi marble was the best source, a new plant was built just 20 km east of Lopburi, near to the Khoktum marble deposits. Omya has good supply agreements with several quarry owners and has ownership of some areas of the Khoktum marble deposit. Omya exports GCC from its Lopburi operation to many other countries in the region.

Vietnam has a number of high-quality marble deposits of which Mongson, situated in Yen Binh District, Yen Bai Province, 170 km northwest of Hanoi and 300 km from the port of Haiphong, is the best known. Yen Bai Banpu YBB Co Ltd (YBB) operates the mine and is a JV between Yen Bai Mineral Co and Banpu plc of Thailand. The company was established in 1997 to develop the Mongson marble deposit with reported reserves of 75 Mt. The deposit is a very high brightness coarse-grained crystalline marble and, if graphitic zones can be avoided, can yield a >96 ISO brightness material, especially when fine-ground. The high brightness of the marble was realised by many GCC producers in the region and shipments of marble chippings (5-40 mm and 40-80 mm size) to Japan were established in 1998-1999. The marble is hand-selected at the Mongson quarry, adjacent to a large lake and taken in barges to a crushing facility. The marble chippings are then delivered by barge and rail to Haiphong port where they are loaded on vessels for Japan and elsewhere.

Prices

There is a tremendous variation in the price of GCC products. Coarse-grained GCC can be in the range of US\$50-100/t, whilst the fine-ground products, especially when stearate-coated and utilised in plastics, can be sold for up to US\$350/t. Fine-ground GCC coating products for the paper industry can be in the range of US\$100-270/t depending on the location. There are regional variations depending on the availability of high-quality marble and proximity to the paper mills.

Tables 1–6 following pages.

Table 1.

Some major calcium carbonate deposits of the world

Type of deposit	Country	Location
Marble	Italy	Carrara – waste from block cutting used
	US	Sylacauga, Alabama
	US	Florence, Vermont
	Malaysia	Ipoh, Perak State
	Vietnam	Mongson, Yenbai
	Thailand	Lopburi
	China	Nanyang and Qing Yang, Anhui Province
	China	Fuyang, Zhejiang Province
	China	Panshi, Jilin Province
	Taiwan	Ho Ping, Eastern Taiwan
Limestone	Jamaica	Ocho Rios, Northern Jamaica
	Italy	Avezzano
	Wonosari	Java
	Germany	Bergberg
Chalk	France	Precy-sure-Oise, Paris Basin
	Germany	Northern Germany
	Russia	Belograd Region
	UK	Salisbury and Beverley

Table 2.

Main GCC applications, utilisation and main quality characteristics

Application	Utilisation and function	Main quality characteristics
Adhesives	Improve physical properties, reduce resin demand	Consistent colour, brightness and psd
Food Grade	As an additive in food	Tight control of particles from 4-16 µm mps. Trace element limits for heavy metals
Paint/coatings	Provides non-toxic, low abrasion, weather resistance, consistent colour to various paints	Good brightness, fine psd and low abrasion. Good dispersion and flow properties
Paper Coating	Provides high brightness, high solids in coating formulations, good runnability, good coverage for precoating and acceptable gloss in top coats	High Brightness >94 ISO @ 90 wt.%. <2µm and >92.5 ISO @ 95 wt.% <2 µm. Low iron and MgO levels, low abrasion
Paper Filler	High brightness, imparts strength to sheet, high loading, easy drainage and drying	Good brightness (>90-95 ISO). Particle size between 50-75 wt.% <2µm. Low abrasion
Pharmaceutical	Pharma grades for pills. Functional filler for medical pills, non-toxic	As with Food tight control of particles from 4-16 µm mps. Trace element control
Plastics	Properties such as stiffness, impact strength And dimensional stability are all improved by use of GCC. Used in thermoplastics such as PVC	Wide range of fine psd, good brightness and colour (shade of colour important). Both coated and uncoated grades. Low abrasion
Polyolefin	Diaper/nappy film (breathable) market growing. Allows diaper to absorb moisture	Fine particle size distribution carefully controlled during processing. Chemically treated
Rubber	Functional cheap filler to reduce costs	Controlled psd with colour not so critical

Table 3
Consumption of coarse and fine GCC by end use – 53 Mt

Industry	Share (%)
Paper	31
Consumer	27
Plastics	15
Paint	10
Carpet	5
Rubber	4
Others - includes adhesives and sealants	8
Total	100

Table 4
World GCC production by region (2003)

Region	'000 t/y	%
Europe	20,500	38.5
North America	18,430	35
Asia/Oceania	11,600	22
South/Central America and Caribbean	1,360	2.5
Africa and Middle East	1,150	2
Total	53,040	100

Table 5**World production ground calcium carbonate (2003)**

	'000 t		'000 t
Europe		Asia/Oceania	
Austria	2,750	Australia	415
Belgium	500	China	3,368
Denmark	550	India	188
Finland	930	Indonesia	808
France	2,130	Japan	2,500
Germany	2,490	Malaysia	452
Greece	165	New Zealand	65
Italy	1,825	South Korea	994
Netherlands	25	Taiwan	1,300
Norway	3,000	Thailand	1,210
Portugal	155	Vietnam	200
Spain	2,040	Others Asia	100
Sweden	370	<i>Sub-Total (22%)</i>	<i>11,600</i>
Turkey	940	Africa/Middle East	
UK	750	Africa	
Bulgaria	50	Algeria	90
Czech Republic	320	Egypt	80
Hungary	100	South Africa	150
Poland	50	Tunisia	20
Romania	70	Uganda	50
Russia	1,110	Middle East	
Serbia	50	Iran	80
Slovakia	50	Israel	100
Slovenia	50	Jordan	400
Ukraine	30	Saudi Arabia	140
<i>Sub-Total (38.5%)</i>	<i>20,500</i>	Syria	40
South/Central America/Caribbean		<i>Sub-Total (2%)</i>	<i>1,150</i>
Argentina	180	North America	
Brazil	598	Canada	1,630
Chile	50	Mexico	600
Colombia	200	US	16,200
Ecuador	22	<i>Sub-Total (35%)</i>	<i>18430</i>
Peru	150		
Jamaica	100	World Total	53,000
<i>Sub-Total (2.5%)</i>	<i>1,300</i>	(rounded)	

Source: Ian Wilson Consultancy and industry comments

Table 6
Leading producers (2003)

Company	'000 t/y	%
Omya, Switzerland	20,795	40
Imerys, France	7,325	14
Global Stone, US	2,450	5
Franklin Minerals, US	2,300	4
Huber Engineered Minerals, US	1,800	3
Specialty Minerals, US	1,200	2
Reverté, Spain	1,120	2
APP, Indonesia and China	850	2
Provencale, France	600	1
Formosa Plastics, Taiwan	580	1
Fimatec, Japan	580	1
Others	13,440	25
Total	53,040	100