



Calcining bauxite at the Pocas de Caldas, Brazil operation of Mineração Curimbaba.

Quest for calcined bauxite

For over a decade the world has depended on China as a cheap feedstock source of calcined bauxite. With availability of quality material on the decline and a steady reduction in exports inevitable, world consumers are looking elsewhere to secure supplies

by Alison Tran, *Asia Correspondent*

Calcined bauxite is an important raw material for two main markets: refractories and abrasives. Smaller volumes are consumed in other applications including proppants, welding fluxes, and antiskid surfaces. While the process of calcining bauxite for each of these applications is fundamentally the same (ie. it involves the same basic burning process), the physical and chemical characteristics of each grade vary.

Only a handful of countries produce

non-metallurgical grade bauxite and not all these sources produce material suitable for certain calcined bauxite applications. Total world reserves of bauxite are estimated at 25m. tonnes. In terms of annual output, non-metallurgical bauxite accounts for only 15% of world bauxite mine production capacity, an estimated 177m. tonnes in 2006. Of total raw non-metallurgical production, calcined bauxite accounts for about 70% (*see table of principal calcined bauxite producers*).

For refractory grade, there are

essentially only two commercial world sources: China and Guyana. Consumers have a wider choice when it comes to sourcing raw non-metallurgical bauxite for abrasive and proppant applications: Guinea, Australia, China, Guyana, and Brazil. For welding grade, consumers can choose between Brazil, Guyana and China.

China leads refractory supply

For over a decade, China has maintained an anchoring position as the world's major supply source of calcined

up-draft shaft kilns and down-draft beehive kilns) owing to environmental restrictions wiped out a significant portion of supply almost overnight.

To place this in perspective, before the measures were introduced, almost 60% of China's calcined refractory grade bauxite was produced in rudimentary unpressurised vertical shaft kilns, and 30% in rudimentary "round kilns". Effectively the whole industry has had to convert to more costly rotary kilns or simply go out of business.

Unsurprisingly, the number of producers has dropped dramatically from over 60 a couple of years ago to around 15-20 today, the largest of which is Bosai Minerals Group Co. Ltd (formally Nanchuan Minerals). The Chongqing based privately owned group claims to be the leading producer of calcined bauxite in China, and the

number one producer of fused alumina in Asia in terms of output and export volumes.

Bill Holroyd, Bosai Minerals, confirmed: "In terms of bauxite producers, the number has significantly decreased and especially for abrasive grade bauxite from Henan province due to the dramatic increase for metallurgical use. China increased their alumina production 50% over the past two years".

Export markets at tipping point

For consumers outside China, this "perfect storm" of negative factors has translated into higher export prices for overseas consumers. Since 2004, prices have increased over 70%.

Today, Chinese bauxite pricing stands at about \$150/tonne FOB Xingang, compared to \$90/tonne in 2004. The

bauxite. It is estimated the country produces over 3m. tpa for refractory, abrasive, and welding applications. It also leads in the supply of high alumina refractory materials.

The difficulty of sourcing cheap, good quality material from China lately has been well documented in **IM**. Owing largely to China's voracious appetite for bauxite to feed its aluminium metal refineries, the amount of both metallurgical and non-metallurgical bauxite nationwide available for export has steadily declined. Although diaspora bauxite is not the preferred material for making Bayer alumina, Chinese metal producers have learnt to use it.

Government influence

Taking direct action to conserve material for domestic needs, the Chinese government has implemented a number of measures in an effort to control supply. This has taken the form of a string of export rebate cuts beginning in 2002. The quantity of non-metallurgical bauxite available for export has gone from 1.3m. in 2004 to around 950,000 tonnes in 2007 out of a total annual production of around 1.4-1.5m. tonnes.

In 2006, the Chinese government's closure of primary bauxite calcining facilities (which involved traditional rudimentary calcination processes, eg.

High quality requirements

Part of the reason that sources of 'calcinal' bauxite are so limited stems from the rigorous quality requirements (pertaining to alumina content, impurity levels, and bulk density) that material for refractory and abrasive applications must meet.

Bauxite for refractory applications has premium chemical characteristics and typically fetches a higher price over other grades (*see table*). Material must have less than 3% iron compared to 20-30% for metallurgical grade. Only trace amounts of alkaline earth should be present in the raw ore as it tends to flux/melt at lower temperatures than Al_2O_3 , thereby reducing the refractoriness of the bauxitic material.

The requirements to produce

abrasive grade are slightly less stringent. Abrasive grade material has an Al_2O_3 content of 80-88% and a maximum silica content of 5%. The ratio of iron to silica should not exceed 3:1. The titania content, important in controlling the crystal structure and the hardness of the alumina grain, must be in the range of 2-4%. When it comes to calcining, refractory grade bauxite is usually fired at temperatures in the range of 1,400-1,800°C and abrasive grade at 1,100°C.

Bauxite used for proppants is more or less the same as that used for abrasive applications although the individual grains must have a high degree of roundness.

Welding rod grade bauxite requires a very low Fe_2O_3 content, compared to refractory grade.

Chemical analysis of typical raw bauxites by grade

Grade	Major Oxides (%)			
	Al_2O_3	SiO_2	Fe_2O_3	TiO_2
Metallurgical	40-52	1.5-15	5-30	1-6
Cement	45-55	max.6	20-30	3
Abrasive	min.55	max.5	max.6	min.2.5
Chemical	min.55-58	max.5-12	max.2	0-6
Refractory	min.55	max.1.5-5.5	max.2	max.2.5
Proppants	min.55	max.6	max.6	max.8

Principal producers of calcined bauxite

Country	Company	Estimated capacity (tpa)	Grade
Australia	Comalco	200,000	abrasive
	Alcan Gove	300,000	abrasive
Brazil	Mineracao Curimbaba Ltda	225,000	abrasive, proppant, slag adjuster
China	Bosai Minerals	200,000	abrasive
	Gongyi Refractories	40,000	abrasive
	Guizhou Star Minerals (C-E Minerals)	50,000	refractory
	Guizhou Yindu Refractories	25,000	refractories
	Henan Mines and Refractories	80,000	abrasive
	Jie Xiu Bauxite plant	80,000	refractory
	Shanxi Fangshan Bauxite	150,000	refractory
	Shanxi Xiaoyi Fengmao	50,000	refractory
	Shanxi Xiaoyi Jincai	50,000	refractory
	Shanxi Xiaoyi Jinlong	100,000	refractory
	Shanxi Xiaoyi Xinsheng	80,000	refractory
Shanxi Yangquan (combined)	150,000	refractory, abrasive	
	Xiaoyi Ducun	50,000	refractory
	Xiaoyi Dongxing	40,000	refractory
	Other small producers	300-400,000	refractory
Guyana	OBMI	200,000	refractory, abrasive
Guinea	Compagnie des Bauxite de Guinee	60-100,000	abrasive
India	Ashapura MineChem Ltd	500,000	abrasive
	Gujarat Minerals	500,000	abrasive, refractory
USA	C-E Minerals	500,000	refractory (bauxitic clay)



One of the many round, or down draught beehive bauxite kilns of Shanxi province which have faced enforced government closure for environmental reasons. The impact of which has been a shortage in supply of certain calcined bauxite grades.

to the International Iron and Steel Institute, world crude steel production for the first eight months of 2006 was about 9% higher than in the comparable period of 2005. China, with about 34%, led production, followed by Japan at 9% and the USA at 8%.

China is now also the leading producer of refractories. Output stands at about 23m. tonnes, which is approaching a level four times greater than the highest US production in 1979. According to an estimation by the China Refractory Industry Association (in 2005) the unit refractory consumption in China is about twice that of other regions.

As China develops, not to mention other developing countries, its per capita consumption of refractories will gradually increase towards an expected 20kg per capita in line with North American currently. McCracken summed up: "Those additional refractories must come from somewhere, local or imported, and the increased consumption of raw materials like bauxite to make those additional refractories must also enter into the projected changing world demand supply/equation".

Demand is also picking up in North America. A recent report by the Freedonia Group on the US refractory market forecasts a brighter outlook in the industry, "...better than has been experienced in recent history". US refractory demand is forecast to increase 1% annually to \$2,300m. in 2009. Chief drivers identified were improved economic fundamentals and recent stability in the iron and steel market.

situation has latterly been compounded by revaluation of the remimbi, and rising freight and energy rates. For example, power prices for south-east China were RMB0.36(\$0.04)/KWH in January 2006; up 8% to RMB0.39(\$0.05)/KWH from 1 May 2006; up a further 5% from 1 July 2006 to RMB0.25-0.415(\$0.03-0.05)/KWH.

Longer term, prices are expected to continue rising, and critically, the availability of uniform quality low priced material, will become more scarce. William McCracken, formerly with Harbison-Walker Refractories Co. and F&S Alloys and Minerals Corp., said: "Up till now, by a special fine-tuning of the burn cycle, the Chinese have been able to achieve higher bauxite densities in their unsophisticated round kilns than is normally secured in rotary or ordinary shaft kilns".

For now, specific export cargos

may meet overall specifications, but shipments are made up of composite materials, sourced from multiple mines and then blended to maintain specification for Al_2O_3 and Fe_2O_3 .

Cracken forewarned: "As the supply quality of any refractory material deteriorates or changes, the producer must make immediate adjustments, but only within limits that cannot be surpassed. Once critical standards have been breached, the raw material is declared unacceptable, and a substitute must take its place".

Market demand drivers

Meanwhile, demand for calcined bauxite-based refractories used principally in steel production continues unabated. The majority of standard refractory products incorporate a calcined or fire-treated form of bauxite for their raw material base. According

Guyana bauxite history in brief

- Until 1971, the Guyana bauxite industry was owned entirely by Alcan Inc. and Reynolds. In 1971 Alcan (Linden) was nationalised into “Guybau”. In 1975, Reynolds (Bermice) was nationalised into Bermine. BIDCO was the holding entity of these two entities. In 1977, they merged to form “Guymine”.
- Following its nationalisation, the industry experienced a 10 year period of reasonable success, until the global recession of the early 1980s and the impact of low cost bauxite from China.
- By 1992, production hit major problems and was declared technically bankrupt. The government stepped in with a major restructuring program and the formalised privatisation plans.
- In 1998, the government decided to publicise the potential for privatisation in September 1998, with the intent of completing the privatisation process by the end of 1999. After achieving no success, the Government of Guyana solicited Cambior’s involvement in 2000.
- Cambior conducted a period of contract mining from 1999-2004 to test the feasibility of the project. In December 2004, the company co-created a new company, OMAI Bauxite Mining Inc.
- Rehabilitation efforts resulted in the production of 212,000 tonnes of RASC and the operation essentially broke even with sales for 2005 amounting to \$36.9m in 2005
- In 2006, monthly sales of RASC at OBMI began to dwindle. In June, Cambior announced its intention to sell, in total or in part, its 70% interest in the operation in order to focus on its core gold business “rather than make significant new investments in the bauxite business.”
- October 2006: Cambior merged with Iamgold Corp, a Toronto-based gold mining and exploration company.
- December 2006: leading Chinese alumina producer, Bosai Minerals Group., announces intention to acquire OBMI from Iamgold Corp., in a \$46m. Deal.
- February 2007: Agreement reached to permit Bosai takeover.

Calcined bauxite prices

Bauxite type	Grade	Description	Q4 2006 (\$/tonne)	Q1 2007 (\$/tonne)
Refractory Bauxite: Chinese, Al ₂ O ₃ /Fe ₂ O ₃ /BD,(lumps, 0-25mm)	Shanxi, FOB Xingang	Round kiln 88/1.6/3.25+	\$150-160	\$150-160
		Round kiln 87/2.0/3.20	\$135-145	\$140-145
		Round kiln 86/2.0/3.15	\$125-135	\$130-135
	Guizhou, FOB Zhanjiang/ Fangcheng	Rotary kiln 88/1.8/3.25+	\$150-160	\$150-160
		Rotary kiln 87/1.8/3.20	\$140-150	\$145-150
		Rotary kiln 86/1.8/3.20	\$135-145	\$140-145
Guyana refractory bauxite		Bulk FOB Linden		\$165 – 175
		Bulk CIF US Gulf	\$205-210	\$215 - 220
		Bulk, CIF Rotterdam	\$205-210	\$220 - 225
		Bulk, CIF Japan	\$205-210	\$230 - 235
Abrasive grade bauxite	Australian & Guinean, CIF North Europe		\$112-124	\$112-124
	Chinese, CIF North Europe and USA		\$155-160	\$155-160
	FOB China		\$120-125	\$125 - 130

Source: Mineral PriceWatch

Supply constraint fuels Guyana showdown

With supply the only constraint to such tremendous market opportunity, it should come as no surprise that China’s leading calcined bauxite producer, Bosai Minerals, made moves to acquire Guyana’s refractory bauxite producer, Omai Bauxite Mining Inc. (OBMI), the only viable source of refractory grade bauxite outside China (*see p.9*).

Canada’s Iamgold had agreed to sell OBMI to Bosai in a \$47m. deal late last year. In January 2007, closure of the deal had been stalled owing to disagreement between Bosai and the government on certain issues, not to mention the threat and influence of Russia’s aluminium major Rusal, already in possession of other Guyana bauxite interests, hovering in the wings. However, Bosai prevailed on 12 February 2007.

Bill Holroyd, director of international development at Bosai, stated the company’s purpose plainly: “As an alumina producer, Bosai wants to have control of resources and Guyana gives us 23 years of reserves”.

The OBMI operation is renowned for its deposits of high quality refractory grade bauxite, branded Refractory “A” Grade Super Calcined Bauxite (RASC). Reserves are known to be extensive in Guyana (in the order to 125m. tonnes of which 60m. is premium grade).

McCracken, who has visited the deposits many times, told **IM**: “Guyanese bauxite, primarily with a gibbsitic mineralogy, has always been the benchmark for global refractory grade bauxite.” Critically, Guyanese gibbsitic bauxite, of lesser hardness than diasporitic Chinese bauxite making it easier to crush and grind, is essentially from a single mine source which means it can be processed at lower temperatures, so producers can save on the energy costs.

Guyana would have an added advantage in the world high alumina refractory raw material export market if it would decide to also mine and process the associated 50-70% Al₂O₃ mullite-grade material at the same location, usually from the same mining pit, according to McCracken.

While OBMI’s output is still far from what the operation enjoyed during the



A rotary kiln undergoing maintenance and repair at Omai Bauxite Mining Inc., Guyana. The operation is in the market spotlight owing to it being the only source of refractory grade bauxite outside China, and the subject of a change of ownership to Bosai Minerals of China.

boom years before China emerged on the world market in the 1980s, its recent rehabilitation thanks to Cambior is a major reversal.

To recap, Cambior acquired 70% of the operation in December 2004 through a joint venture with the Guyanese government. The operation has gone from producing 60,000 tpa at its lowest point to a steady 200,000 tpa, and, critically, rediscovered a core customer base. Planned production for 2007 will be approximately: 150,000 tpa RASC refractory grade; 25,000 tpa welding grade; 80,000 tpa chemical grade; 80,000 tpa cement grade.

Although the prior deteriorated state of the refractory grade bauxite production facilities in Guyana will take time to properly repair and upgrade completely, there is now major market incentive. As McCracken put it: "While Guyana is faced with a dredging, low river tidal draft, and an ocean transfer shipping cost aspect, this can be reduced, including by an increased overall high alumina shipment volume. At the same time, the Chinese are faced with not only higher calcining costs, particularly if they must go completely to rotary kilns, but with a significant ongoing inland freight problem in moving their bauxite to a distant ocean shipping port".

Pricing gap narrows

Until now, consumers have opted to use Chinese material on the basis of delivered prices that have frequently been 25-40% lower than Guyanese material. Economy of scale and highly-developed infrastructure are prime factors in achieving lower operating costs. The current world-wide refractory

plant consumers of approximately 200,000 tpa. of Guyanese material continue to pay a higher premium.

However, the gap between Chinese and Guyanese bauxite is narrowing. Exporters report that Guyanese RASC bauxite list pricing currently stands at approximately FOB \$160/tonne, up from \$150/tonne in mid-2006. This roughly compares to \$150/tonne FOB Xingang for Chinese bauxite.

In recent communication with local press in Guyana, Bill Holroyd summed up Bosai's position on pricing: "Bosai believes that the local [ie. Guyana] bauxite cannot presently compete against Chinese bauxite on price, but it will someday when Chinese prices increase to RASC levels. Chinese bauxite cannot compete technically against local RASC bauxite for special refractory brick applications and this provides a minimum production tonnage base".

Added to this, all cost/pricing in Guyana will certainly continue to move upwards at a relatively slower pace in Guyana, particularly those costs related to personnel and local input as McCracken pointed out.

In the short term, consumers can expect more upward pressure on world refractory grade bauxite pricing at least until Guyana can significantly increase production and lower processing/shipping costs, and until China can make available increasing export amounts of homogeneous competitive quality material.

Pricing of refractory grade bauxite could also be influenced to some extent by any new developments in world production and supply of 50-70% Al_2O_3 raw materials, based on mullite and andalusite.

Long term market outlook

Whilst there is a sentiment that a tighter world bauxite supply situation could develop if China's export capability were significantly reduced because of ongoing environmental problems, longer term, the market for bauxite-based refractories is considered on a downwards trajectory.

This is because technological shifts over the last decade have resulted in the expanded use of higher performance refractories, bringing about a market

decline in the consumption of refractories per tonne of steel produced.

A source at Almatris, the leading producer of non-metallurgical alumina, explained: "The development and improvement of the steel producing technology in combination with much higher process demands on the refractory linings have resulted in a constant decrease of specific refractory consumption from about 50kg/t in the 1960s to a level of 8-10 kg/t today for modern steel making".

At the same time, this decrease has been accompanied by an increasing use of higher quality refractories, ie. those based on synthetic raw materials, which are technically required by the much more severe conditions of the new steelmaking technologies.

Given this, the current world supply and known reserves of natural refractory grade bauxite is considered essentially adequate despite China's frenetic ongoing industrialisation. Both China's and Guyana's in-the-ground reserves of crude bauxite ore are substantial.

That said, the geological mapping of Chinese bauxite reserves outside the already established large open pits, has not been extensive. It is not entirely clear as to what extent the reported reserves are under- or overstated.

A number of research programs are underway in China to make better use of bauxite ores and develop bauxite-based synthetic raw materials (see *IM January '06, Refractory Raw Materials Supplement*).

Abrasive grade bauxite

Unlike refractory grade bauxite, abrasive grades are available from a number of countries besides China including Australia, Brazil, India and Guinea. OBMI in Guyana does not produce an abrasive grade right now, although the operation did in the past. Bosai, if successful in the acquisition of OBMI, will consider restarting production.

Total world demand for abrasive grade is put at 1m. tpa. Some of this calcined bauxite is used directly as a fairly cheap abrasive product, but by far the largest amount is used as feedstock for the manufacture of brown fused alumina (BFA) used in refractories.

Calcined bauxite and India

A possible new supplier to the international calcined bauxite markets may be India. India currently imports 40-60% (about 100,000 tpa) of its calcined bauxite requirements from China. Spurred by expansion of domestic steel production, a scarcity of acceptable quality of bauxite from China, and rising import costs, drives are now underway in India to produce high grade bauxite from domestic bauxite sources.

At present, India is a very minor producer of non-metallurgical bauxite, despite having occurrences of high grade bauxite in west coast and central India. This is attributed to limited efforts to test high grade bauxite occurrences in regions outside the main bauxite producing area around Gujarat, and limited R&D and technology for calcining bauxite.

In a recently published paper entitled "Indian calcined bauxite and future prospects", A.K. Nandi, RL Bhatia, and P.Sahni of the Mineral Information and Development Centre, Nagpur, put forward the case that high grade bauxite suitable for refractory, abrasive and proppant industries can be produced with further investments in beneficiation technology.

Non-metallurgical bauxite from India comes in two main types: from Gujarat and Maharashtra. Gujarat calcined bauxite is known to have a significant amount of alumina, calcia, iron, and titania, which reduces its value for refractory and abrasive markets, and makes investing in beneficiation

economically unviable.

This calcined ore is apparently easy to grind and has fairly high bulk density. Until now, this type of calcined bauxite has been used by several Indian abrasive/refractory producers, notably Carborundum Universal Ltd, Cutfast Abrasive Ltd, and VRW Refractory Ltd. Also, another major problem in developing bauxite in the region is that high grade deposits are reserved for the local alumina industry.

For these reasons, further development of high grade ore deposits from west coast deposits is proposed, particularly those of coastal Maharashtra. Total reserves in the region are estimated to be in the range of 0.5-2m. tonnes. "Since the requirement for non-metallurgical grade bauxite is limited, even the production of 50,000 tonnes of high grade bauxite per annum can make the proposal feasible".

In terms of costs and availability, bauxite in the region is well placed compared to other types of bauxite. The pit head cost of typical bauxite in the mine here works out to be less than \$5/tonne.

Already, an attempt has been made to produce value added non-metallurgical bauxite by "de-ironing" the bauxite by acid leaching. Salient results are "encouraging". At Gujarat/Bhuj in western India, among the larger alumina grade reserves, there is a small quantity (2-3m. tonnes) of a marginal grade of 85% Al_2O_3 refractory grade bauxite..

China dominates supply

Despite the wider supply choices, consumers of abrasive grade bauxite often compete with consumers of refractory grade bauxite for the same supply sources in China. Historically, abrasive grade has come from the provinces of Henan, Guizhou, Shanxi, Guangxi, and Sichuan. In recent years, most of China's abrasive grade bauxite has been used to produce BFA domestically owing to favourable electricity costs. As a result, demand for abrasive grade in other regions has decreased because of cheaper Chinese exports.

China's well known energy deficit and rising electricity prices has not been good news for BFA producers in China. Going forward, Chinese BFA exports will inevitably come under increasing pressure from both governmental policy and rising costs with talk of a complete ban on BFA exports imminent. One exporter said: "It is logical that China should cease exports of electrical energy intensive products; both aluminium metal and BFA are highly energy intensive, in both cases more than 50% of their production cost is electricity."

Producers in other parts of the world can only hope that customers resistant

to paying higher prices defer business elsewhere. Major producers of BFA outside China include: Elfusa General de Eletrofusao, Brazil; Alcan Specialty Aluminas, France; Saint-Gobain, France; Treibacher Schleifmittel AG, Austria; Washington Mills Electro Minerals Corp., USA.

While China dominates the export market for abrasive grade bauxites, the tightening supply situation is opening the doors for producers of calcined bauxite feedstock in other parts of the world.

Guinea

Compagnie des Bauxite de Guinée (CBG) produces some 210,000 tonnes of abrasive grade bauxite, out of a total bauxite production of 13.5m. tonnes. The company operates one of the world's largest bauxite facilities – the Boké project located in north-west of the country.

CBG is operated by Alcoa World Alumina through its Halco venture with Canada's Alcan and privately owned Dadco. Halco owns 51% of CBG and Guinea's government holds the remaining stake.

At the beginning of the year, export was severely disrupted by violent strikes at the company's mines. Guinea's unions launched a general strike on 10 January 2007, demanding an end to the rule of President Lansana Conte.

Brazil

Mineração Curimbaba mines around 260,000 tpa of non-metallurgical grade bauxite from its 40 mining concessions containing around 22m. tonnes ore around Pocas de Caldas in Minas Gerais. A significant amount feeds the proppant market, followed by sintered bauxite for BFA production.

The Curimbaba Group is the major supplier of raw material for Elfusa's BFA production, and has been for over 40 years. Supply is in the region of 70,000 tpa.

Elfusa uses sintered rather than calcined bauxite for fused alumina production, which offers better permeability in the furnace and higher conductivity to the furnace charge. The company proppants are supplied to Brazil's state oil company, Petrobras.

Australia

In Weipa, northern Queensland, Comalco, is major metallurgical bauxite producer, which produces some 300,000 tonnes of abrasive and cement grade bauxite of a total annual production of 11m. tonnes.

Comalco's bauxite mine at Weipa has adopted a process for an efficient utilisation of existing reserves and produces different grades of bauxite from the same source for various industries. Calcined abrasive grade bauxite is exported to Europe and North America. Approximately one third is used in the production of proppants, and the remainder to produce BFA for industrial abrasives. The typical specification for calcined grade bauxite supplied from Weipa is consistent with the following:

Chemical analysis	
Al ₂ O ₃	82-85%
SiO ₂	6.5-7.3%
Fe ₂ O ₃	5.5-7.0%
TiO ₂	3.1-3.7%
Loss on ignition	0.2-0.9%

Greece

S&B Industrial Minerals SA produces a raw bauxite grade used in abrasives. The company does not produce calcined bauxite but its raw bauxite is in competition with Chinese calcined bauxite imports from China.

A source at the company said: "Our raw bauxite, due to its lower logistics has a price advantage, while Chinese calcined bauxite has a quality advantage. Our major markets are in Europe, where we see an upward trend."

Long term market outlook

Trends in supply of abrasive grade bauxite tend to track those of BFA. This market is in decline in North America and western Europe. In a recent US Geological Survey report on bauxite, Errol Sehnke wrote: "The consensus is that the future for bauxite-based abrasives is not particularly bright. It is a market in broad decline and demand for brown fused alumina in the abrasives sector has slowly declined but is now expected to remain static or drop at a

reduced rate in the future".

On the upside, demand is growing steadily in eastern Europe and South America, and is strong in Asia.

Proppants: a bright spot

Proppants, on the other hand, are one of the bright spots for calcined bauxite. These small ceramic beads, about the size of a grain, are pumped into hydrocarbon-bearing rock formations to "prop" open the fractures and stimulate oil or gas production. Bauxite-based high strength proppants are required in deep, high temperature and pressure hydrocarbon wells, which are often gas-bearing.

The market for proppants has experienced something of a boom of late given the higher oil and gas prices which have led to record levels of drilling activity. Gas drilling is the biggest consumer of proppants, and particularly those based on bauxite, since the formations tend to be deeper, but oil fields are generating new demand. Proppants will stimulate wells and hold open fissures, and though most oil wells will produce naturally, they will produce faster if stimulated.

The world's top three proppant producers are: Saint-Gobain Proppants (formerly Norton Proppants), USA; Carbo Ceramics Inc., USA; and Mineração Curimbaba, Brazil

Saint-Gobain expanding

Saint-Gobain Proppants recently completed a production expansion project at the company's site in Fort Smith, Arkansas to meet rising demand for its proppant products-Versaprop® and Ultraprop®. The project has added 60m. pounds of annual capacity to the facility.

This expansion is part of an overall strategy to increase the company's capacity globally. In addition to the Fort Smith projects, Saint-Gobain Proppants completed an expansion to its Guanghan, China facility in 2006, and will further increase capacity in China by 2008. The company is also constructing a new 50,000 tpa facility in Puerto Ordaz, Venezuela.

Sales up at Carbo

Carbo Ceramics Inc. is also on an

expansion drive. In 2007, the company expects to complete the construction of its manufacturing facility in Kopyesk, Russia, and the expansion of its facility in Toombsboro, Georgia. By the end of 2007, the company expects to have expanded its proppant manufacturing capacity by 80% in a two-year period.

Higher sales revenues will help pay for the expansions. For the year ended 31 December 2006, revenues increased 24% compared to 2005. The company said the improvement was the result of a 13% increase in proppant sales volume, a 9% increase in the average selling price of proppant. The volume of ceramic proppant sold in North America increased 18% from 2005 owing to proppant sales that increased in greater proportion than North American drilling activity.

Welding grade bauxite

Welding fluxes are a small but valuable market for calcined bauxite. Here, calcined bauxite is used in submerged arc welding to shield the molten weld pool from the atmosphere during the weld's application or placement. Calcined bauxite may make up to 25% of the welding flux.

For welding fluxes, it is critical that the residual moisture content of the bauxite should not exceed 0.5%. Any moisture present in the flux can potentially reduce to hydrogen when exposed to the welding arc which can cause brittleness. Strict limits are also imposed on the sulphur and phosphorus content of the bauxite because presence of these elements can cause cracking.

Most bauxite producers do not sell welding grade exclusively, but alongside other grades. There is now only one mine in China producing welding grade and that is in Guizhou province, with production of about 25,000 tpa. Other mines have closed owing to shortages of good material. Bosai sells one half of the tonnage.

Bosai is the largest supplier to this market in China. Bill Holroyd recently commented: "Bosai expects that the quality of Guyana bauxite will replace Chinese bauxite for welding rod applications, since the Chinese resources are depleting and mines have been closed".

