GYPSUM

By Ted Dickson
TAK Industrial Mineral Consultancy

Gypsum and anhydrite are two naturally occurring forms of the compound calcium sulphate. Gypsum is the hydrated form ($CaSO_4.2H_20$) and anhydrite, as its name implies, is the anhydrous form ($CaSO_4$). Gypsum is a monoclinic mineral, whereas anhydrite is orthorhombic. Crystals are commonly colourless, although the rocks generally appear white or grey. The hardness of gypsum is 1.5-2 and it can be scratched easily with a fingernail. Anhydrite is about twice as hard at 3-3.5. Gypsum has a specific gravity of 2.3, considerably less dense than anhydrite, which has a specific gravity of 2.9.

While anhydrite is the more common mineral, gypsum is of greater economic interest because of its importance in making plaster products. In addition, reserves of gypsum normally overlie associated anhydrite making them more amenable to surface mining methods. Anhydrite will rapidly convert to gypsum in regions where there is even reasonable rainfall, although it may be found in outcrops in more arid regions.

Calcium sulphate does occur in other less common forms, including alabaster, a fine grained and compact variety; selenite, found as large transparent euhedral crystals; and satin spar, a fibrous variety possessing a silky lustre.

Owing to the widespread nature of the occurrence of gypsum, only the most accessible and highest quality deposits are generally exploited. There is much geological similarity between commercial deposits and the geology and extractive technology is relatively simple. Since gypsum is such a low-cost material, it must be mined very economically, preferably by open-pit methods, although there are also many underground mines. Little or no processing is carried out beyond crushing and grinding.

Mines are located throughout the world and there are few countries where there are no actual or potential commercial deposits. However, the major producing regions are the industrialised nations of North America, Western Europe and the Far East. This is because gypsum is a low-cost commodity and as such, production is only economical close to the main markets unless very cheap ocean transport is possible.

Gypsum is also produced as a by-product from a number of industrial processes (e.g. flue gas desulphurisation (FGD) at coal-fired power plants, production of phosphate fertilisers, and titanium dioxide production using the sulphate route).

The gypsum industry is dominated by its consumption in construction either as an additive to cement clinker to make Portland cement or as gypsum plaster or wallboard. Because of different building practices, regional consumption varies considerably.

The US consumes about a third of gypsum production because wood frame housing with gypsum cladding, both inside and out is commonly used for housing construction. Northern and Central Europe and Japan are the other main consuming areas, but gypsum wallboard production and consumption is growing rapidly in areas where its use has until now been less common. Despite this, gypsum's use as a setting retarder in the production of Portland cement is still the largest single application for the mineral.

Production

World production of gypsum can be difficult to estimate for a number of reasons. The way that by-product gypsum use is recorded is one of the main sources of discrepancies in statistics. The United States Geological Survey (USGS) figures actually refer to mine

production in their headings. However, the use of FGD gypsum has been growing fast, with virtually all new production of wallboard based on this product. In addition to the mined gypsum listed in the table, a further 6.3 Mt of by-product gypsum were sold or used in the US alone. In contrast, virtually all of the gypsum listed as production in Japan is by-product from a number of sources. In the UK, production of gypsum from all sources is about 40% higher than listed by the USGS.

Another significant factor is that a considerable amount of gypsum production is captively held by producers of either wallboard or cement, and in some countries, only the end products are reported. There are also many small operations in lesser developed countries that may not be recorded and in aggregate may amount to considerable tonnages. The 'other countries' total, including by-product usage may be considerably under reported. Total production of gypsum including usage of by-product gypsum may be as high as 150 Mt. This excludes production of by-product gypsum that is disposed of as waste either because there is no local or regional market or because the material is unsuitable for use in wallboard or cement. It should also be stressed that these figures are estimates and that actual figures can vary when individual countries report detailed figures, sometimes much later in the year.

North America

US production of mined gypsum was estimated to have risen to 25 Mt in 2000, after production in 1999 was revised upwards from 19.4 to 22.4 Mt. By-product gypsum usage continued to rise rapidly to 6.3 Mt in 2000 compared with 5.2 Mt in 1999, which was an upward revision from the original estimate of only 3.3 Mt. However, imports fell from 9.3 Mt in 1999 to 8.7 Mt in 2000, approximately 6 Mt from Canada, 2 Mt from Mexico and most of the balance from Spain. This resulted in yet another record high demand of 39.9 Mt, the ninth consecutive year of increased consumption.

The market for gypsum was still buoyant early in 2000 although it slowed later and there are now signs that lower levels of economic growth are having an impact on construction levels. Total production of wallboard in the US from the ten manufacturers announced by the Gypsum Association actually fell in 2000 to 28.2 billion square feet (2.6 billion m^2) a drop of about 900 million square feet (83 million m^2) over 1999, which was a record high year. This would indicate an estimated fall of about 600,000 t in the demand for gypsum and it would be no surprise if total preliminary consumption figures were revised downwards. New housing starts are beginning to decline after a period when housing construction had been one of the bright spots in the economy. However, the decline has been relatively modest from what were high levels and it has been pointed out by a number of sources that the fundamentals of the construction industry are still firm despite fears of a slowing economy.

Many new wallboard plants have been built in the US over the past two years as well as expansions at a number of existing plants.

World Gypsum Production ('000 t)		
	1999	**2000**
US	22,400	25,000
Iran	9,750	9,750
Canada	9,470	9,500
China	9,000	9,000
Spain	7,500	7,500
Mexico	7,000	7,100
Japan	5,500	5,500
Thailand	5,000	5,000
France	4,500	4,500
India	2,200	2,200
Australia	2,100	2,100
UK	1,800	1,800
Egypt	1,500	1,500
Italy	1,300	1,300
Poland	1,000	1,000
Other countries	16,980	17,000
World total (rounded)	**107,000**	**110,000**

Source USGS

This represented total new capacity of 840 million m^2 (9 billion ft^2). Existing plants had been operating at very high levels of capacity to supply the growing demand and there were unusually high levels of wallboard imports from as far as South America, Asia and Europe.

With many of the new plants now in operation, the capacity constraints have disappeared and the market for wallboard went from shortages in early 2000 to excess supply by the end of the year.

It should be remembered that some of the new wallboard capacity introduced is designed as replacement for older high cost operations. For example, US Gypsum, the largest producer with about a third of the market, added more than 3 billion ft^2 of plasterboard capacity at three new operations and two expanded operations during 1999 and 2000. However, it closed its Plasterco, Virginia plant, and some production lines at its East Chicago, Illinois, plant in 1999, its Plaster City, California, and Gypsum, Ohio, plants in 2000, and in February 2001 it closed the Oakfield, New York, plant and all but one line at its Fort Dodge, Iowa, plant. With demand outstripping supply in early 2000, some of these plants may have been kept in operation longer than initially planned. With the change from shortage to oversupply, prices for wallboard fell from their highs to almost half the levels at the peak, a drop to around US$75 per thousand square feet.

During the year, BPB of the UK purchased Celotex, which broadens its North American wallboard production coverage, as it already owns Westroc in Canada. With the opening of its new plant in Kentucky, it now claims to be the fourth largest US producer of wallboard.

Lafarge has two new large wallboard plants in Florida and Kentucky, and the third of the European producers, Knauf, has gained a stake in the US industry with the purchase of 10% of USG. The investor Warren Buffett has also acquired a shareholding of 15% of USG through his investment vehicle Berkshire Hathaway.

James Hardie purchased Western Gypsum, a Utah-based gypsum-mining company. Western Gypsum supplies gypsum to the plaster and cement industries in southwestern US from its Blackrock, Arizona, mine as well as ground gypsum for agricultural and filler applications from a mine at Apex Nevada. It has extensive reserves of gypsum near the borders of Utah, Nevada and Arizona and will significantly expand the gypsum reserves available to James Hardie's Las Vegas, Nevada wallboard plant.

It is very significant that virtually all of the new capacity that has been built is based on by-product, mainly FGD, gypsum. Although this is seen as a low cost and environmentally sound option, an added factor is that plants can be built in areas where there is no locally available natural gypsum and away from coastlines that can be supplied with imports by large bulk ships. Because of this, there is scope for expansion of regional markets where transport costs have influenced the competitive position of wallboard.

Canadian production of gypsum appeared to have been stable according to preliminary estimates from the USGS. However, final figures from Canada indicate that production actually fell from 9.3 Mt in 1999 to 8.5 Mt in 2000. The Canadian industry had benefited from the strength of the US market, but as new plants came on stream in the US, based on by-product gypsum, exports of both gypsum and plasterboard declined. Figures from the Gypsum Association indicate that wallboard production fell from almost 3.9 billion square feet (360 million m^2) to just over 3 billion square feet (280 million m^2), a fall of more than 20%. Another factor was that there was a strike at Westroc's Montreal wallboard plant, which has since been resolved. The growth in wallboard capacity in the US and increasing use of by-product gypsum may have a long-lasting effect on the Canadian industry.

Mexico, like Canada, is heavily influenced by markets in the US. Significant quantities of both crude gypsum and wallboard are exported, mainly to southern and western US states. Because of this, Mexican production of over 7 Mt is much higher than might be expected for its size. It may be set to increase further when USG opens its new wallboard plant in Monterrey, expected to be on stream in the September quarter of 2001. USG is already the market leader in Mexico and its new plant in the north of the country supplements plants in other regions.

Europe

Consumption of gypsum in Europe as a whole is second only to that of the US. While the industry is very much organised on a Europe-wide basis, with three major companies BPB, Knauf and Lafarge dominating, the strength of markets in various countries can vary considerably. The European industry did not experience the same levels of growth as in the US during 1999 and early 2000 and it has yet to show signs of any real downturn in demand. Overall there has been growth of about 2% in plasterboard sales, although Germany is seen as an exception to this trend with a recession in the German construction market, particularly in the east of the country. During 1999, there were some exports of wallboard to the US because of shortages there, but with capacity limitations easing in North America, this unusual export volume has now disappeared.

Markets were strong in France, UK, Ireland, Italy and particularly Spain. Levels of usage of plasterboard are still relatively low in Mediterranean countries compared with Northern Europe and there is room for considerably more growth as the markets develop further. Although there has been expansion of capacity in Southern Europe, with BPB opening a second plasterboard (and plaster) plant in Italy, east of Rome, the company closed one of its plants in Germany, at Gulstein. In contrast, Lafarge has announced plans to build a new 20 million m^2 plasterboard plant in Germany at Lippendorf with an expected completion in 2002.

All of the major producers are looking towards Central and Eastern Europe as potential growth areas because *per capita* consumption is currently very low. Despite good long-term growth prospects in the region, growth in Poland has slowed recently. In Romania, Lafarge announced in March 2001 that it had signed a memorandum of understanding to form a joint venture with Arcom, one of the largest Romanian construction companies, to merge their gypsum businesses into a joint venture to be known as Lafarge Arcom Gips. Lafarge is the only producer of wallboard in Romania, with a recently completed near Bucharest.

The company pointed out that consumption in Romania is currently only 0.3 m^2 *per capita*. Consumption p*er capita* in Poland, has risen to 1.5 m^2 in recent years, but this is still well behind Western European countries where *per capita* consumption is generally 3-5 m^2 and there is considerable scope for further market development in both Eastern and Southern Europe.

The European Commission is still investigating alleged anti-competitive practices in the markets for plasterboard and other gypsum-based products. The companies in question were sent a statement of objections (a document outlining the concerns about a practice) by the EC in April 2001. However, it may be some time before the EC makes a final decision.

In the 1980s and 1990s the industry in Europe became truly pan European with the three dominant producers expanding outside their home countries through acquisition or the construction of new plants. The focus has now shifted and BPB, Lafarge and Knauf have growing interests thoughout the world and they have become leading players on a global basis, including the very large US market, where all three have gained a position in the past year.

Rest of the World

The Asian market for gypsum continues to show strong activity, despite periods of financial instability in recent years.

Japan had traditionally been the largest user in the region with a long-established wallboard industry. Thailand has emerged as a major producer and exporter of gypsum as well as a growing producer of wallboard. China is a large producer of gypsum, mainly for use in its very large cement industry. However, in recent years a number of wallboard plants have been built in China, where all three of the large European-based companies have interests.

One recent development is that Lafarge and Boral announced in February 2001 that they are to acquire 71% of Siam Gypsum from Siam Cement for US$50 million in cash (Siam Gypsum also had debt of US$35 million). A year earlier, Lafarge and Boral had combined their Asian gypsum and wallboard assets to form Lafarge Boral Gypsum (Lafarge 73%, Boral 27%) with manufacturing operations in Thailand, China, Indonesia, Korea and Australia. Boral has the right to increase its shareholding in Lafarge Boral Gypsum to 50% over the next two years and by funding the cash payment for the purchase of Siam Gypsum. Boral will increase its shareholding in the joint venture to approximately 43%.

Boral announced at the end of 2000 that it was closing its wallboard plant at Gillman, in South Australia, in response to a severe downturn in the Australian housing market. It was one of the smallest wallboard plants in Australia and the company will continue to supply the area from its plant in Port Melbourne. In contrast, Lafarge Boral Gypsum announced in February 2001 that it is to build a new 54 million m^2 wallboard plant in South Korea, 90 km south of Seoul, to cater for strong demand after the recession of 1998. The first part of the plant, which is based on FGD gypsum, is expected to be in production in the second half of 2002. BPB increased its interest in shareholding in India Gypsum from 40% to 80% during 2000 and the company commissioned a new wallboard plant at Chennai to add to its existing plant near Delhi.

In the Middle East, Iran is the largest producer and consumer, but there has been little change in what is a well developed industry. Production of wallboard in Turkey looks set to grow in the longer term as local production is increased, largely based on FGD gypsum.

In Africa, much of the gypsum is destined for use in cement. Only South Africa and Egypt have significant wallboard production capacity. One recent development is that BPB of the UK, the leading supplier of wallboard in South Africa announced in February 2001 that it is has formed a 50:50 joint venture with Orascom, an established Egyptian construction group, to acquire 90% of Egyptian Gypsum. BPB will have management control of the company, which is the leading supplier of building plasters in Egypt. It has two plaster plants and two quarries supplying around 350,000 t/y of plaster to the growing Egyptian construction industry.

In South America, the Brazilian market is benefiting from having domestically produced wallboard following the commissioning of BPB's new plant. There has been growth in the underdeveloped wallboard market in South America with Lafarge, Knauf and BPB all building plants, but the market is still small compared with Europe and North America.