

GYPSUM

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Gypsum and anhydrite are two naturally occurring forms of the compound calcium sulphate. Gypsum is the hydrated form ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) 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 2.93.

While anhydrite is the more common mineral, gypsum is of greater economic importance 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 with a silky lustre.

Due 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 in a very economical method, preferably by open-pit operation, although there are also many underground mines. Little or no processing is carried out beyond mining, 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, for example, 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

It is estimated by the USGS that total production of gypsum in 2001 amounted to 116 Mt. However, these figures tend to underestimate total world consumption, which is thought to be as high as 150 Mt. There are various reasons why it is difficult to estimate world production accurately. One of the largest sources of discrepancy is the usage of by-product gypsum, which is often not

recorded in production statistics. In the US, over 6 Mt of by-product gypsum, mainly from flue gas desulphurisation (FGD) units at coal-fired power plants, is now used and this has been added to the total production figure in the table above.

In Japan, virtually all of the production recorded is by-product gypsum from a number of industrial processes. However, in some other countries the consumption of by product gypsum is not included. UK production is estimated to be about 1.4 Mt, but about 1 Mt of FGD gypsum and some gypsum produced as a by product of a titanium dioxide plant are used in addition to the figure quoted, which only represents mined gypsum. There are a number of other countries where usage of by product gypsum is considerable. Germany is now included amongst the 'Other countries' category, probably because its production of mined gypsum has fallen to quite low levels, although its usage of by product gypsum amounts to several million tonnes.

Another factor that can influence accurate gathering of statistics in some countries is that the industry is often vertically integrated with wallboard or cement manufacturers that are producing gypsum on a 'captive' basis, and only the end products are recorded in production figures. There are also many small operations, especially in lesser-developed countries that may not be recorded, which in aggregate amount to considerable tonnages.

It must also be remembered that the figures compiled by the USGS in their Mineral Commodity Profiles are preliminary statistics. These are often amended the following year to reflect the receipt of more accurate statistics. For example, for 2000 production figures, Chinese production has been revised downwards from 9 Mt to 6.8 Mt, reflecting a better source of information rather than an actual reduction in production. In contrast, production in Iran has been increased from 9.75 Mt to 11 Mt. It is notable that in the case of both of these countries it can be difficult to get accurate production figures at the best of times.

Even in countries where there is a wealth of production statistics available, preliminary estimates can vary from actual production figures. The USGS estimate for Canadian production is 9 Mt, but production figures released by Natural Resources Canada indicate that 'shipments' in 2001 were just over 8 Mt. It is notable that shipments in December 2001 were particularly low but shipments in January 2002 were particularly high, which can be a result of timing of large shipments at the beginning or end of the month in question.

Production

World Gypsum Production

	2000	2001
US	24,700	24,900
Iran	11,000	11,000
Canada	8,550	9,000
Mexico	7,000	7,600
Spain	7,500	7,500
China	6,800	6,800
Japan	5,600	6,000
Thailand	5,830	6,000
France	4,500	4,500
Australia	3,800	4,000
India	2,210	2,220
Egypt	2,000	2,200
UK	1,500	1,400
Italy	1,300	1,300
Poland	1,700	1,300
Other countries	17,200	20,100
World total (rounded)	111,000	116,000

Source USGS (Note: figures do not add to total due to independent rounding)

North America

Production of mined gypsum in the US amounted to 18.8 Mt in 2001, a decline of 700,000 t from the previous year. In contrast, the use of by-product gypsum from industrial processes such as FGD, titanium dioxide or phosphate fertiliser manufacture increased by 900,000 t to 6.1 Mt. Imports, mainly from Canada and Mexico but also from Spain

amounted to 8.5 Mt compared with 9.2 Mt in the previous year. With very small exports of only 200,000 t, this gave apparent consumption of about 33.2 Mt a decline of 0.5 Mt.

Most of the gypsum consumed in the US is used in the production of plasterboard and other plaster products. Of the total consumption only 3.8 Mt was used as a setting retarder in cement and 2 Mt was used in agricultural applications. Other uses consume very minor tonnages. Sales of gypsum wallboard in the US recovered slightly in 2001 to 29.34 billion ft² (2.73 billion m²) compared with 28.16 billion ft² in 2000 (2.62 billion m²). Housing starts remained fairly stable through the period but there was an increase in new office and commercial buildings, which stimulated demand.

A considerable amount of wallboard capacity has been added over the past three years, all of which was on line by the end of 2001. This has relieved shortages that occurred in the late 1990s, necessitating imports from as far afield as Europe and South America. Now that the new capacity is on stream, some older plants have been closed down, bringing supply and demand closer to balance, although operating rates are still lower than they were throughout much of the 1990s. However, there are still considerable imports from Canada and Mexico, mainly from plants owned by US producers, that supply regional markets near the borders or along the coastline from conveniently located plants.

Prices for wallboard had plummeted to about US\$70 per 1,000 ft² in 2001, about half their levels at their peak, but have since recovered to US\$90-95 per 1,000 ft² still at a level considered to be uneconomic by some observers.

During the year, USG, the largest of the wallboard manufacturers, filed for protection under the Chapter 11 bankruptcy laws. This was a result of growing pressure of asbestos litigation on the company rather than a result of

financial difficulties with its present operations. The company has also announced plans permanently to close one of its older plants at Fremont, California, bringing its total closures to 2 billion ft² as it has added new state of the art facilities giving it a net increase in capacity. In addition, it has announced that it is prepared to idle a production line in Jacksonville, Florida, and reduce operating rate at other facilities depending on market demand.

BPB of the UK increased its North American interests further with the announcement in March 2000 of the acquisition of James Hardie's gypsum and wallboard operations in the US for US\$345 million subject to regulatory approval. In 1999, BPB had acquired Celotex, and the combined group will have a market share of about 16% (putting it in third place behind USG and National Gypsum). The company has seven wallboard plants in the US following the closure of the Port Clinton, Ohio, plant acquired from Celotex, which was replaced by a new plant opened in October 2000 at Carrolton, Kentucky.

Lafarge, which has increased its production capacity substantially in North America in recent years with the construction of new plants, added to this with the acquisition of Continental Gypsum in January 2002. This gives it a greater presence in the large northeast US market. Continental Gypsum has its base in New Jersey with 300 million ft² (28 million m²) of capacity.

Canadian production of gypsum amounted to just over 8 Mt in 2001, according to Natural Resources Canada, about 1.0 Mt less than the estimates from the USGS and a decline of 500,000 t from the previous year. Despite this decline, there was a slight increase in wallboard production to 3.16 billion ft² (294 million m²). This compares with a decline of 22% in 2000 from the record high levels of 1999. The fall in gypsum production tends to reflect a decrease in exports to the US. Total US imports of gypsum fell by a total of 700,000 t in 2001 and Canada is the principal source of these imports.

It should be noted that virtually all of the new production that has come onstream in the US is based on by-product gypsum, mainly from FGD. Older plants that have been closed in the modernisation process were almost all based on natural mined gypsum. The increase in production of wallboard in Canada reflects increased exports to the US, which traditionally takes about one-third of production, while demand in Canada remained fairly flat.

Mexico is also very reliant on the US market, with many of its operations being subsidiaries of US companies. Production of gypsum is estimated by the USGS to have increased in 2001. Exports of raw gypsum to the US will have declined, but there have been significant increases in wallboard capacity in the country, much of it aimed at export to the US.

Europe

The European market is still dominated by the three large producers, BPB of the UK, Lafarge of France and Knauf of Germany. Of these three, the first two are publicly held but Knauf is a privately-owned company. With the consolidation of the industry in Europe, virtually complete, all three companies have been expanding in other regions, both through acquisition and through construction of new plants.

The market in Europe is often quite variable from country to country. On the whole, the market in 2001 was reasonably steady, with the notable exception of Germany where there has been a significant reduction in plasterboard demand and a decline in prices. As a result of the weakness in Germany, BPB completed a restructuring of its operations during the year, removing surplus plasterboard capacity and reducing its workforce by 20%. In France and the UK, markets were still reasonably strong. Although new housing starts were weaker, the renovation markets remained strong. In Southern Europe, the Italian and Spanish markets continued to show strong growth. Plasterboard consumption in Spain is

particularly strong, but it must be remembered that in both Italy and Spain, consumption levels are relatively low and plasterboard is still making inroads into a market where it has not traditionally been the construction material of choice. As recently as ten years ago, Italy had no production of plasterboard. Now, BPB has two plants there and Knauf one.

While all the companies have looked towards Eastern Europe for expansion and acquisition opportunities in recent years, the focus seems to be extending further south. All three of the leading companies now have operations in Turkey. Knauf has two plants, one in Ankara and the other at Izmit near Istanbul, and it is building a third near Adana, aimed at servicing Eastern Mediterranean countries. Much of the production is based on FGD gypsum from power plants. Lafarge built a new plasterboard plant in Ankara (opened in 2000) through its joint venture with Dalsan an existing producer of plaster in Turkey. BPB gained local production capacity, having previously supplied from operations outside Turkey, with the acquisition of Dogan Alçi A.S. announced in September 2001. The company supplies over 200,000 t of plaster to the rapidly growing Turkish construction market, representing about 20% of demand.

Earlier in 2001, BPB had also acquired a plaster company in Egypt, and there seems to be a strong focus on development of Eastern Mediterranean markets. Elsewhere in the Mediterranean, Knauf signed a partnership agreement in October 2001 with the Safari Group in Morocco. The group includes Compagnie Marocaine de Production et d'Exportation (CMPE) in which Knauf will now have a 40% share.

Rest of the World

Asia has been one of the main areas of expansion in the gypsum and plasterboard markets in recent years, with significant growth rates in many countries, despite periods of financial instability. Japan has traditionally been a large producer and consumer of plasterboard, primarily from the largest

company, Yoshino Gypsum, although there are a number of smaller producers. All three of the large European manufacturers have invested heavily in the region, especially in China, Korea, Thailand, Indonesia and India.

During 2001, Lafarge Boral Gypsum, a joint venture of Lafarge and the largest plasterboard producer in Australia, Boral, finalised its acquisition of Siam Gypsum from Siam Cement. Also on the acquisition trail was Knauf, which announced the purchase in July 2001 of all the shares of gypsum combine Kapschagaj near Almaty in the Central Asian republic of Kazakhstan. This included a recently modernised gypsum board line with a capacity of 18 million m². The company already has extensive interests in the republics of the Former Soviet Union with 12 operations in Russia and further operation in the Ukraine. The Kazakh operations will supply local markets as well as markets in Western China.

Knauf also opened a new plasterboard plant at Machong in China during the 2001, its third plant in the country. The market in China is still very competitive, with significant new capacity still developing markets. Other countries with high growth rates in 2001 included Malaysia, Thailand and Indonesia. Some of the new production is based on by-product gypsum, which is the main raw material source in Japan. However, there is significant trade in natural gypsum, primarily from operations in Western Australia and Thailand. One weak point in the region was the heavy fall in demand for plasterboard in Australia due to a downturn in residential building.

The Middle East market seems to be an area of considerable growth (as mentioned in the European section). New developments in Turkey and Egypt by the major European producers indicate a strong push to develop sales in the region. The USGS also increased its estimates for production in Iran from 9.75 Mt to 11 Mt. Iran has traditionally been a large user of gypsum and gypsum products, as was Iraq, although little is known about the current situation in Iraq. However, it would appear that the plasterboard market is expected to grow in the region, possibly with initial supply from Iran, Turkey and Egypt, but with developments in other countries as the markets reach sufficiently high levels of demand.

South America has been experiencing large growth rates for both gypsum and plasterboard. However, this has been from very low initial consumption levels. In some countries, most notably Argentina, growth declined because of the financial problems of the country. Knauf has opened a new plant at Mendoza, which will enable it to supply both Argentina and Chile with plasterboard. There have also been new plasterboard plants built in Brazil, by both Knauf and BPB in recent years, with expectations of very high growth rates with booming construction rates in a country where dry wall construction techniques were largely unknown.

African production of gypsum and plasterboard tends to be concentrated in South Africa (where BPB is the largest producer) and in North Africa (most notably Egypt) but Knauf's partnership agreement with a Moroccan company may be expected to lead to further developments there.