

GYPSUM

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Although there are some other uses for gypsum, by far the greatest proportion of consumption is in the construction industry. Its use in the production of plaster and plasterboard and as a setting retarder for Portland cement accounts for all but a small proportion of world demand. Its use in cement is on a worldwide basis and as such is probably still the largest single application for gypsum. However, in regions such as North America, Western Europe and Japan, there is large consumption of plasterboard. The US is by far the largest consumer of plasterboard because of the prevalence of wood frame construction with plasterboard panels in housing. The use of plasterboard has been spreading to other regions, but is still limited in many areas.

Gypsum and anhydrite are two naturally occurring forms of the compound calcium sulphate but it is gypsum that is by far the most important commercially. 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 relative density of 2.3, and this is considerably less dense than anhydrite, which has a relative density of 2.93.

While anhydrite is the more common mineral, gypsum is of greater economic significance 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 methods, 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 (eg flue gas desulphurisation (FGD) at coal-fired power plants, production of phosphate fertilisers, and titanium dioxide production using the sulphate route).

Production

Figures from the United States Geological Survey (USGS) (Table 1) indicate that production of gypsum in 2002 remained steady on a worldwide basis with some small gains in the US, Thailand, and 'other countries' but declines in countries such as Mexico, Egypt and Poland. This follows revisions to figures originally published for 2001 resulting in a decrease of about 5 Mt. However, this does not give the full picture. The table of world mine production of gypsum published by the USGS lists provisional US production as only 16.1 Mt, excluding 7.7 Mt of by-product gypsum production used. There are also considerable amounts of by-product gypsum used in other countries. For example, the UK production of 1.5 Mt is supplemented by over 1 Mt of gypsum supplied from FGD at power plants and from a titanium dioxide plant. In contrast, there is very little gypsum mined in Japan now and virtually all of the 5.8 Mt listed as production is by-product from FGD, phosphate fertiliser plants or titanium dioxide plants.

German production of gypsum is not included separately, and much of its demand is supplied by FGD gypsum resulting in the country's relegation to the 'others' category. Another factor is that, in many instances, the industry is vertically integrated with cement or plaster/plasterboard manufacturers producing their own gypsum and only the end products are recorded in production statistics. These factors, combined with the fact that many small operations in some of the smaller consuming countries that may not be recorded, mean that total consumption of gypsum is generally underestimated. Total usage of both natural mined gypsum and by-product gypsum is thought to be of the order of 150 Mt/y.

North America

Total consumption of domestically produced gypsum in the US rose to 23.8 Mt in 2002 made up of 16.1 Mt of mined gypsum and 7.7 Mt of by-product gypsum. However the figures for 2001 had been revised downwards from 24.9 Mt to 23.1 Mt. Revisions from the preliminary figures issued are a common occurrence. In addition, 8.33 Mt of gypsum was imported with only 380,000 t exported giving a total apparent consumption of 31.75 Mt. Imports were marginally higher in 2002, but the general trend since the peak of 1999 is for a decline in imports, which are now about 1 Mt less than in 1999. This is almost certainly due to replacement by FGD gypsum. Traditionally, imports of gypsum from coastal locations in Canada, Mexico and to a lesser extent Spain fed wallboard plants near US coastal waters that were distant from sources of domestically-produced mined gypsum. Power plants that can produce FGD gypsum, are often much more conveniently located, with concentrations in areas of high population density, and this has resulted in a

significant change in the geography of supply. The use of mined gypsum is declining after reaching a peak in 1999 but the use of by-product gypsum, specifically FGD gypsum, has been increasing rapidly from only 3 Mt in 1998 to the present situation. This trend is likely to continue, with the majority of new plants based on FGD gypsum and conversions of some older plants to at least partially replace mined gypsum.

Wallboard shipments rose to record levels in the US during 2002 to a level of 29.87 billion ft² (2.68 billion m²). This does not directly correlate with gypsum consumption. According to the USGS, consumption of gypsum peaked in 1999, which does correspond with a previous peak in wallboard production. However, current wallboard production reported by the Gypsum Association is about 800 Mft² (74 Mm²) more than in 1999 with gypsum consumption 5 Mt lower, whereas the increased wallboard production would suggest that consumption has actually increased by 5-600,000 t. This is difficult to reconcile as there has been no real change in the type of gypsum board produced; if anything boards are actually thicker. There has also been an increase in apparent consumption of cement clinker over the period, which would have required greater amounts of gypsum. It may well be that the extent of the growth in FGD gypsum usage has been under-reported and it appears that actual consumption may be considerably higher.

The residential market has been strong in the US both for new housing and renovation, although the commercial market has not been performing so well. Volume sales of plasterboard and plaster have increased and prices for plasterboard have strengthened. Average plasterboard prices were about US\$90/1,000 ft² (93 m²), although they had fallen to about US\$86 at the end of the year during the quiet winter period. However, there were indications from suppliers that prices would be increased by about 10% in the second quarter of 2003 as the market picks up after the winter.

The surge in new wallboard capacity in the US has largely been completed now. A number of these additions were designed to replace older plants and, in November 2002, Lafarge announced the closure of its Wilmington, plant in Delaware. This is part of the company's continuing strategy to supply customers predominantly from newer, more efficient plants, and the company has added considerably to its capacity in recent years. The Wilmington plant had been in operation since 1959 and produced 325 Mft² (30 Mm²) of wallboard in 2001. This is relatively small compared with Lafarge's two new plants in Kentucky and Florida, each of which has a capacity of 900 Mft² (83.6 Mm²). Rationalisation of the industry also seems to have paused after the acquisition of James Hardie by BPB of the UK in March 2002, and Lafarge's acquisition of Continental Gypsum in January 2002. BPB has announced that it is to operate all of its North American operations under the BPB identity. Previously, the four companies that made up its North American activities had traded as BPB Celotex, BPB Marco, BPB Westroc and BPB Gypsum, the last of these being the operations obtained from the acquisition of James Hardie. One new development in the US was the opening of a new plaster plant in March 2002, at Las Vegas, Nevada, by Georgia-Pacific, which will supply industrial plasters, primarily to the West Coast.

Canadian production of gypsum is recorded as 8.85 Mt in 2002 by the Energy Mines and Resources Ministry in its preliminary figures, almost 250,000 t more than the USGS figure. This, however, only includes mined gypsum and FGD gypsum, which is recorded along with other coal combustion products in the cement section of the Canadian commodity reviews, is estimated to be of the order of 600,000 t. Much of this is exported to the US, of the order of 5.6 Mt. However, housing starts in Canada were strong in 2002 and remain strong into 2003, boosting domestic demand.

Mexican production is estimated to have fallen considerably from 7.5 Mt in 2001 to only 6.3 Mt in 2002. Much of the Mexican industry is geared to serving the US market with either gypsum or wallboard. The fall in production probably reflects decreased exports to the US with the closure of some older plants on the West Coast and the replacement of some of the mined gypsum consumed by FGD gypsum. Both USG and Georgia Pacific have major operations in Mexico and USG also produces significant quantities of wallboard in the country, as does local company Panel Rey SA.

Europe

The European industry is still dominated by three major companies, BPB, Lafarge and Knauf. During 2002 there was some further concentration of the industry with BPB gaining full control of Gyproc Benelux, increasing its shareholding from 46% to 99% with the acquisition of the shareholding of Etex. At the same time, BPB sold Gyproc's plasterboard businesses in Germany and Poland to Lafarge. After disposal proceeds of €54.9 million, the acquisition involved a net cash payment of €28.6 million and BPB assumed a further €24.8 million in debt. Apart from that, there was little change in the structure of the industry during 2002.

Production of gypsum in Europe is second only to that of North America. USGS preliminary figures show no changes in production in major producing countries during the year, although they do not account for FGD gypsum usage, which will add about 1 Mt to the UK figures and accounts for the majority of Germany consumption. However, the USGS estimates French production at only 4.5 Mt, whereas French sources indicate production of around 5.3 Mt. French usage of by-product gypsum is quite small, and since a large portion of its energy requirements are based on nuclear power, there has been little use of FGD gypsum.

There has been growth in some markets such as the UK, where housing is still defying predictions of a fall, and in Mediterranean countries notably Spain. Indeed at one point there was a shortage of plaster in the UK, although that has now been eliminated with additional capacity brought on line by BPB. There has also been growth in much of Eastern Europe. In contrast, markets in Germany and Poland have been far from strong. It must be remembered, however, that the market in Poland has grown dramatically in recent years. Until 1997, there was only a single plasterboard plant in Poland with modest production of only 10 Mm². Since that time five new plants have been built with all the major Western European producers involved, resulting in an increase in capacity to around 160 Mm².

The USGS noted a significant fall in gypsum production from 2 Mt to 1.2 Mt from 2001 to 2002. However, it is not expected that there has been such a reduction in total consumption. In fact, the 2002 figure probably accurately reflects the production of mined gypsum, but FGD gypsum consumption is now about the same size and is used as feedstock for some of the new gypsum board capacity. Poland has also become a significant exporter of gypsum board, to Central and Eastern Europe. There has also been growth in Turkey, again led by the entrance of major European producers. Significant advances have also been made with the use of FGD gypsum, and there is significant further potential in a country where the use of plasterboard has not been a traditional method of construction.

One important event during the year was the imposition of large fines by the European Competition authorities on the European wallboard manufacturers for allegedly fixing the prices of some of their products. Lafarge was fined €249.6 million, BPB €138.6 million, Knauf €85.6 million and Gyproc Benelux (now controlled by BPB) €4.32 million. BPB and Lafarge have announced that they are to appeal against the fines, and it is likely that Knauf will follow. In general, the companies believe that the Commission lacks the evidence to substantiate its case, and point out that prices for plasterboard are lower now than they were in 1990, before the price fixing was alleged to have started.

On a much smaller scale than the plasterboard producers, Kemira Chemicals of Finland produces gypsum pigments for filling and coating paper. It recently announced the expansion of its plant in Finland from 80,000 t to 100,000 t annually, with completion of the €5 million project by the end of 2003. The gypsum is obtained as a by-product of the company's own phosphoric acid plant and is used as a coating pigment particularly in lightweight paper. The company has another plant in Spain producing gypsum fillers from natural mined gypsum, again mainly for use in the paper industry. The 100,000 t capacity plant was acquired from Casgas Blancas Inorganica in 2001. Although volumes are tiny compared with overall gypsum production these are added value products commanding significantly higher prices than would be expected for construction grades.

Asia

The third largest consuming area for gypsum and plasterboard is in Asia, an area that still has considerable potential for further growth. Markets in Japan are large, long-established and fairly mature. The country makes extensive use of by-product gypsum from a variety of sources and supplements this with imports from countries such as Thailand and Australia. Its production of mined gypsum is now very small. China has overtaken Japan as the largest producer and consumer of gypsum, still mainly for use in its huge cement industry. However, there has been increasing use in plasterboard as new plants have been built in recent years, mainly in conjunction with the large European based producers. Growth has perhaps been less than some might have predicted and the rapid growth in production capacity seems to have outpaced demand. The joint venture between Lafarge and Boral of Australia relocated some under utilised plant from its Shanghai operations to the joint

venture's new production site in Seoul, South Korea, where sales volumes are strong, although still relatively small for a country the size of Korea. The markets in other countries such as Thailand, and Australia seem to be recovering after downturns and markets also remain strong in India, Malaysia and Indonesia.

Given the current situation in the Middle East, the market conditions for gypsum are very uncertain. It was mentioned in the European section that the market in Turkey has been growing strongly from relatively low levels as gypsum board usage becomes more common. Production and usage of gypsum in Iran is very large, the second largest in the world according to the USGS and there has been a long tradition of gypsum plaster usage in construction. The situation is unlikely to have changed significantly despite the current events in the region. Iraq was at one time a very large producer of gypsum also and may return to that position once hostilities cease and reconstruction starts.

South America offered the prospects of considerable growth in gypsum usage from a relatively small initial base. Companies such as Knauf, BPB and Lafarge targeted large potential markets for wallboard including Brazil, Argentina and Chile, with the construction of new plants in countries where this was not a conventional building material. Brazilian markets have continued to grow, but the well-reported financial problems in Argentina have resulted in a collapse in construction activity.

Africa has not traditionally been known as a large user of gypsum, although there are possibly a considerable number of relatively small gypsum operations, supplying local cement industries. Plaster and plasterboard production tends to be concentrated in South Africa, and in North African countries such as Egypt, where plaster sales have been strong.

Table next page.

Table 1

World Gypsum Production (t)	2001	2002
US	23,120	23,800
Iran	11,000	11,000
Canada	8,560	8,600
Mexico	7,500	6,300
Spain	7,500	7,500
China	6,800	6,800
Japan	5,900	5,800
Thailand	5,900	6,100
France	4,500	4,500
Australia	3,800	3,800
India	2,250	2,300
Egypt	2,000	1,900
UK	1,500	1,500
Italy	1,300	1,300
Poland	2,000	1,200
Other countries	17,200	18,300
World total (rounded)	111,000	111,000

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