

Criticality of Raw Materials: Gypsum Data

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I. The European Gypsum Industry: Background

With a turnover of over 10 billion EURO, the **European Gypsum Industry** operates 160 quarries and some 200 factories (plaster powder plants, plaster block plants and plasterboard plants) and generates employment directly to 28,000 people and indirectly to 85,000 people (plasterers and plasterboard erectors). **It is one of the few fully integrated industries within the construction products field.**

The Gypsum Industry covers the **whole life-cycle of the product**. Indeed, the companies which extract the mineral "Gypsum" also process it and manufacture the value-added products and systems mainly used in construction. Gypsum products are indefinitely and fully recyclable as they always keep their natural properties during use.

Gypsum products and systems, which are used extensively in **construction** and more particularly in interior applications such as ceilings, walls, partitions and floors, contribute to the safety and well-being of the users of these buildings.

II. The European Gypsum Industry in Figures

- ❖ The European Gypsum Industry's growth is around 5% a year (without recession)
- ❖ It has an annual turnover of around 10 billion Euro.
- ❖ Recycled content of Gypsum Boards (with FGD Gypsum): 42% across Europe. In Europe, the production of FGD Gypsum was 15 million tons in 2006.
- ❖ In the EU, The Gypsum Industry represents around:
 - 160 quarries
 - 65 plaster powder plants
 - 28 plaster blocks and ceiling tiles plants
 - 100 plasterboard plants
 - 8 gypsum fibreboard plants
 - 30 gypsum ceiling tiles plants
- ❖ More than 1,600 million m² of European interior surfaces are covered with plasterboards every year.
- ❖ More than 5 million tons of plaster are used in Europe for interior lining
- ❖ More than 20 million m² of European interior walls are separated using plaster blocks

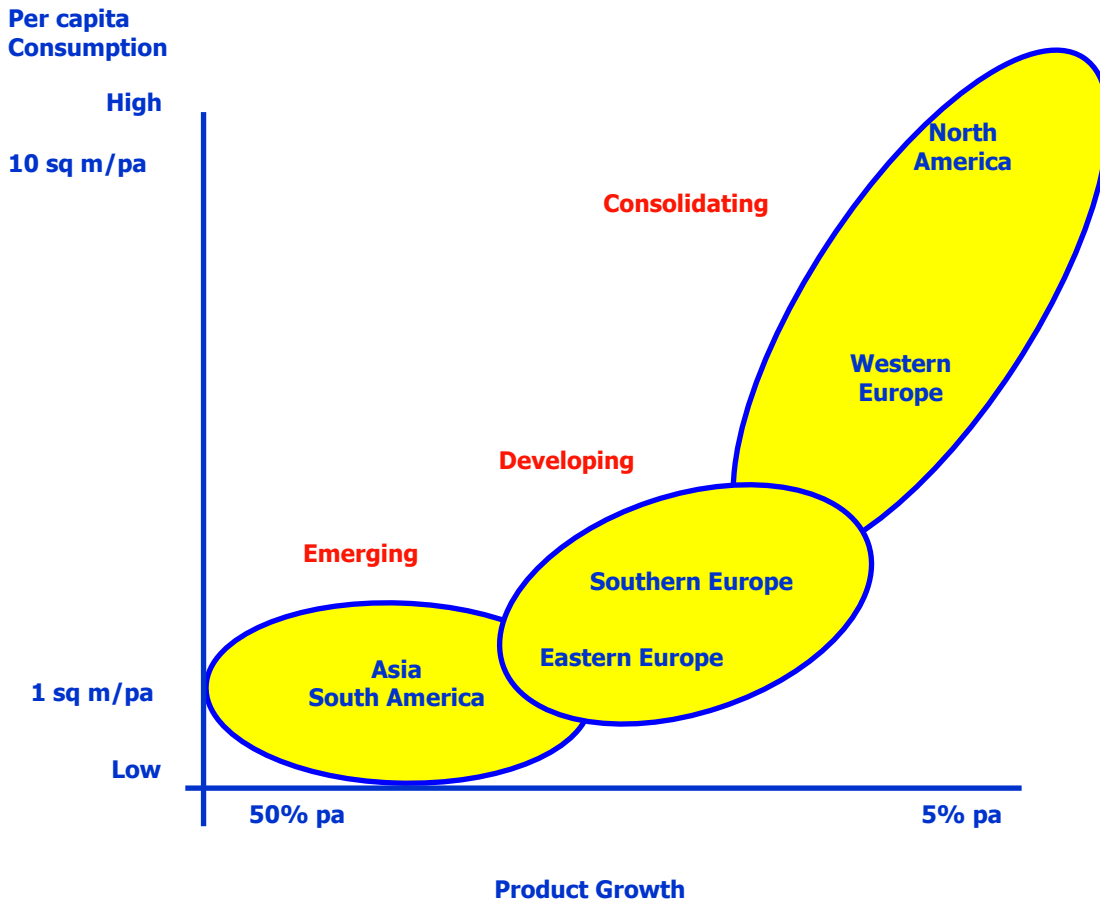
III. Overall Market Size and Growth Potential for Gypsum Board Products

Gypsum products, and in particular gypsum board, represent one of the few opportunities for fundamental growth in the building products sector today. Although gypsum sales for plasters and cement are significant, the future growth in the industry is driven primarily by sales of gypsum board systems. Japan and Scandinavia use about 5-6 square meters per person. Germany, France and the UK use between 3 and 4 square meters per person. While this figure describes the usage rate of gypsum board in these more well developed economies, it should be remembered that about 85 percent of the world population has only been recently been introduced to gypsum board (or indeed still has no local access).

IV. Emerging, Developing and Consolidating Market for Gypsum Board

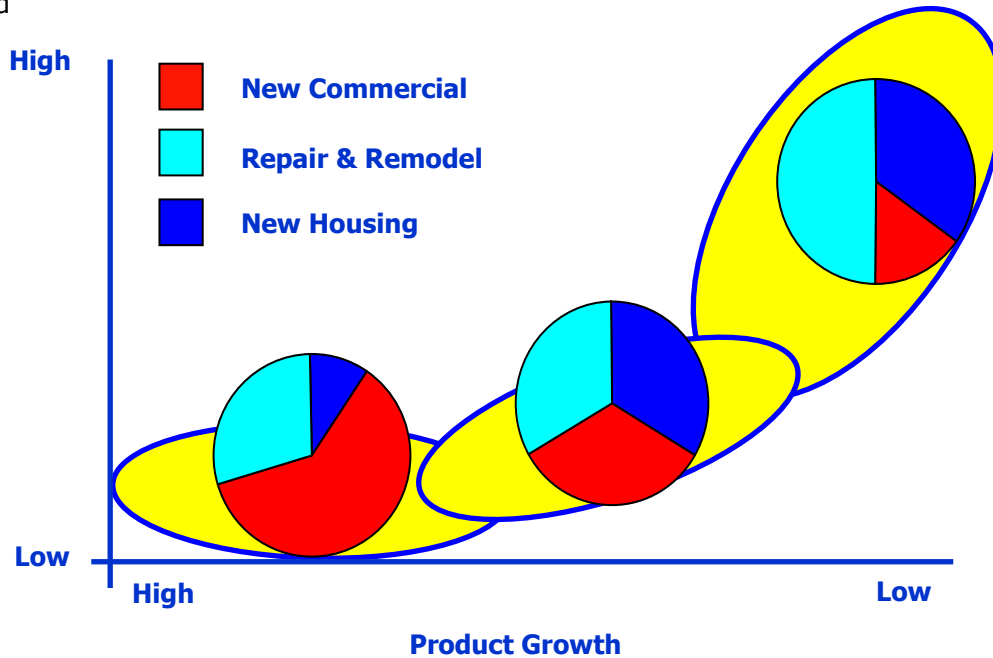
Around the world today there are three types of markets for gypsum products. In North America, Australia, Japan, North West Europe and Scandinavia, gypsum board systems have taken over as the dominant building product for interior lining of residential and commercial construction. In Southern and Eastern Europe, gypsum board is gradually replacing gypsum (or cement) plaster as the preferred interior lining system. For the remainder of the global market, gypsum board has only recently been introduced as a new building material, in many cases replacing ancient materials such as mud bricks. These represent an evolving global marketplace, with the three stages called Emerging, Developing and Consolidating. In terms of penetration rate, Figure 1 illustrates these three stages and the areas of the world that fall into each stage.

Figure 1 Emerging, Developing and Consolidating Markets for Gypsum Board



The market use of the gypsum board products differs in each of these types of markets as shown below in Figure 2.

Figure 2 Per Capita Consumption of Gypsum Board



As gypsum board is introduced into new markets, the first application is primarily in new non-residential construction. New office construction and resort hotels built using western building techniques are often the first major consumers. As the market becomes more developed, both residential construction and the renovation market grow in importance. In a well-developed market such as North America, the renovation market will approach 50 percent of the overall market.

V. Gypsum Board Market in Europe

To provide some detail for the overall usage patterns for gypsum boards in the major countries (UK, France, and Germany) consider the following below Figures 6 and 7. Figure 6 illustrates the percentage of interior walls in which gypsum board is used for each type of construction for these three countries.

Figure 6
Usage Patterns for Gypsum Board

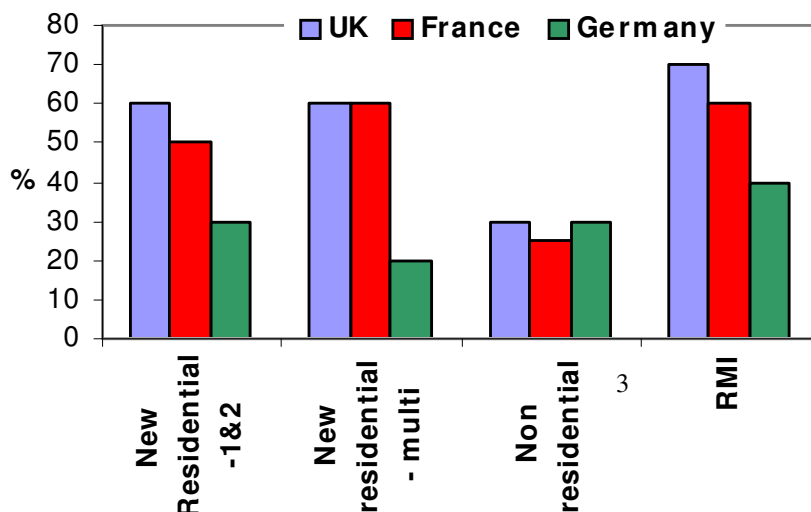
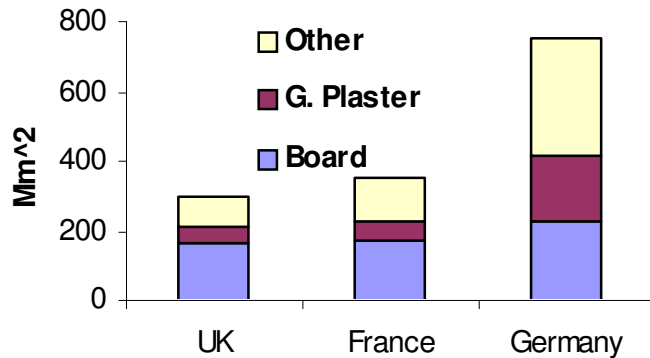


Figure 7 shows the overall market size in terms of interior lining area available (for an average construction year) and shows what proportion would be normally covered by gypsum board as opposed to gypsum plaster or other materials (cement mostly).

Figure 7
Interior Linings Market - Europe



VI. Natural Gypsum Production ¹

Global output of gypsum rose from about 42Mt in 1960 to a peak of around 112Mt in 1999, an average annual growth rate of around 2.6%. World output then declined to around 108Mt in 2001 before rising to 111Mt in 2003.

World production of gypsum and anhydrite is concentrated in North America, Western Europe and Asia. Please see Annex I for more details

Production of natural Gypsum in Western Europe

Regional output of natural gypsum is concentrated in France, Germany, Italy, Spain and the UK. Rising demand for plasterboard and cement over the last twenty years has led to an increase in Western European natural gypsum production. Production varied between 20.7Mt in 1993 and 25.7Mt in 2001 but remained flat between 1998-2003. One reason for the very low growth in output was that much of the increase in demand for gypsum after 1998 was met by increasing use of synthetic material.

Natural gypsum output may decline in some Western European countries as use of synthetic material increases, especially in Germany and the UK. A further factor that may reduce production of natural gypsum in the region could be an increase in the amount of plasterboard recycled in the future.

Production of natural Gypsum in Eastern Europe

Regional production declined from 4.3Mt in 1993 to less than 3.2Mt in 1998 before recovering to 4.3Mt by 2003. The decline in output was caused by economic recession and the break-up of the USSR into sovereign republics.

Eastern European production of natural gypsum is concentrated in Poland, Russia and the Ukraine. Production recovered strongly in Russia and the Ukraine in the late 1990s. This growth was partially offset by a rapid fall in output in the Czech Republic where the mining of natural gypsum suffered from competition with FGD material.

¹ Roskill report 2004

VII. World Synthetic Gypsum Production²

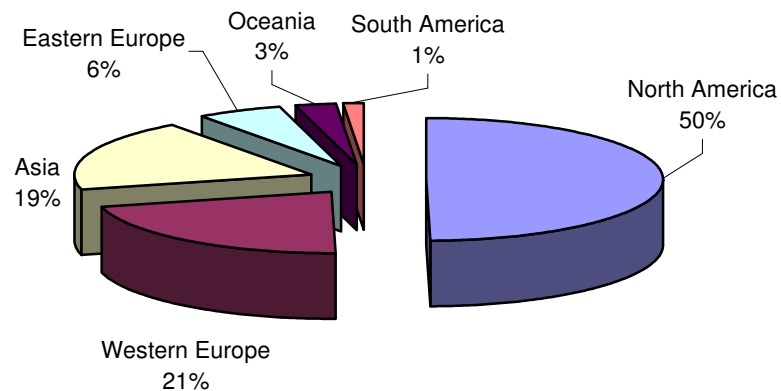
Potential world production of synthetic gypsum exceeds that of natural material at 200-225Mtpy but the proportion consumed commercially is much smaller. The majority of potential synthetic gypsum production is accounted for by phosphogypsum, possibly up to 150Mtpy, followed by FGD gypsum (40-50Mtpy), titanogypsum (4-7Mtpy) and other sources (up to 20Mtpy). FGD gypsum is the most valuable form of synthetic material because of its purity, availability and the ease by which its particle size and shape can be changed.

In Europe and North America, the most important form in terms of the amount used commercially is FGD gypsum, probably followed by titanogypsum then fluorogypsum. In Asia, phosphogypsum is the most commonly used form and Chinese consumption could be similar in size to world use of FGD material.

VIII. Gypsum Products Consumption

Roskill³ estimates world consumption of gypsum in plaster and plasterboard at 60Mt in 2003. World plasterboard capacity has been traditionally concentrated in the USA and Europe. However, a number of plasterboard plants have been built in other regions over the last decade, particularly in Eastern Europe and Asia. In addition to natural gypsum, increasing quantities of FGD gypsum are used in plasterboard manufacture, especially in North America and Europe.

World plasterboard capacity 2004 (%)⁴



The world plaster and plasterboard industry is dominated by a small number of vertically integrated US and Western European companies. These companies control the production

² Roskill report 2004

³ Roskill report 2004

⁴ Source: Global Gypsum Directory, 2003, Knauf and Temple-Inland

process from the initial mining of crude gypsum, through calcining, to the manufacture of plaster and plasterboard products. The five leading companies controlled around 68% of global capacity in 2004.

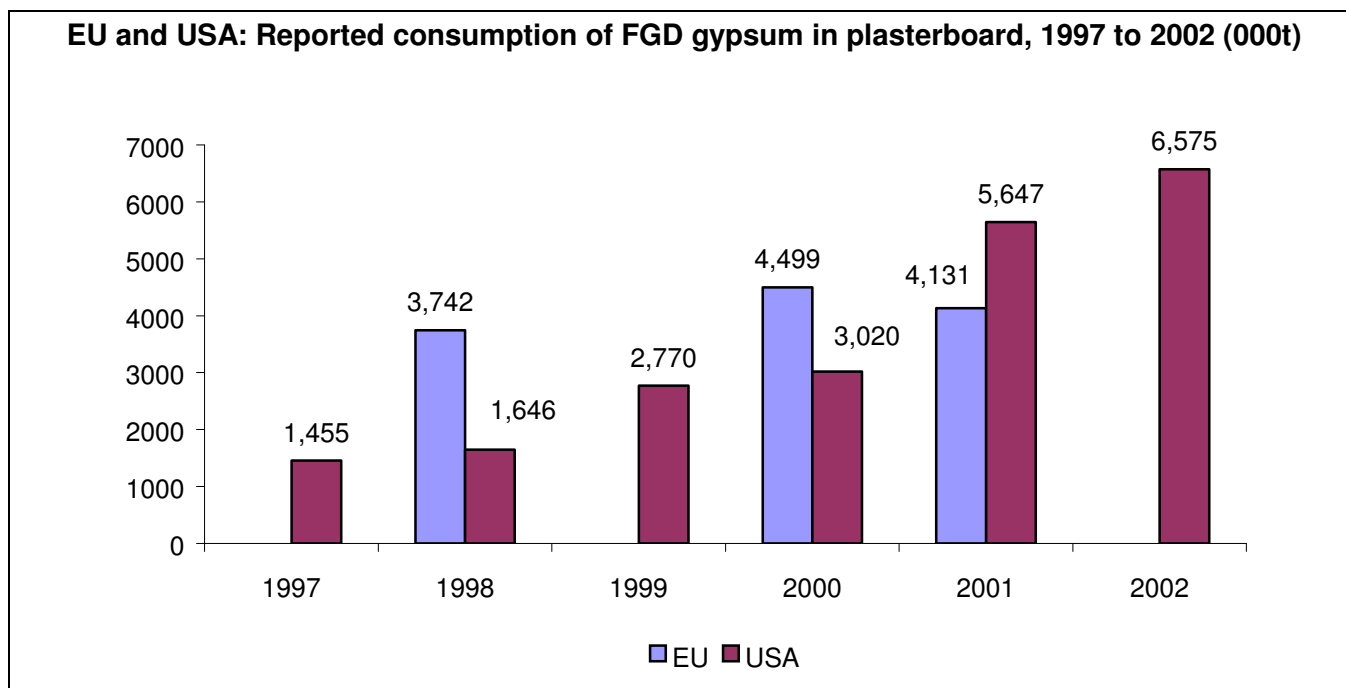
Plasterboard Consumption M2 per capita in 2005 in Europe⁵

Country	M2 per capita
Belgium	2,7
Denmark	3,6
Germany	2,3
Greece	1,1
Spain	2,0
France	4,7
Ireland	4,6
Italy	1,1
Luxembourg	2,5
Netherlands	2,2
Austria	3,3
Finland	4,8
Sweden	3,9
United Kingdom	4,6
Portugal	2,0
Norway	3,7
Switzerland	1,4
Poland	1,9

⁵ Bid Defense BPB Plc- Saint-Gobain 2005

IX. Consumption of FGD Gypsum in plaster and plasterboard⁶

Around 7.5kg to 8kg of gypsum is required for each square metre of plasterboard produced. A significant proportion of the gypsum consumed in this market in the USA and EU was FGD gypsum, as shown below.



Sources: ECOBA and ACAA

Over 10Mt of FGD gypsum was used in plasterboard in the EU and USA during 2001. Of this total, 5.6Mt was used in plasterboard manufacture in the USA, 4.1Mt in the European Union to which must be added an unknown quantity in the Czech Republic, Japan, Finland and Poland. The amount of FGD material consumed in plasterboard in the USA rose substantially from under 1.5Mt in 1997 to almost 6.6Mt in 2002. The use of FGD gypsum in the EU started earlier than in the USA and until 2001 was higher

X. Specific Applications⁷

1. Markets for Gypsum in Filler and Pigments

Gypsum is used as a filler or pigment mineral in a variety of applications, including paper, plastics, fertilisers, pharmaceuticals, food, adhesives and paint manufacture. The total amount of natural gypsum used in these applications is small, probably less 250,000t in 2003. Synthetic gypsum is also used in these markets, accounting for around 150,000tpy in this sector.

Paper

Gypsum can be used in paper manufacture to add gloss and opacity, especially to lightweight coated grades.

Plastics

⁶ Roskill report 2004

⁷ Roskill report 2004

Filler grade gypsum is used in small quantities in the plastics industry. Dihydrate gypsum is used as a filler in flame retardants for polyester spray-up and room temperature curable systems. Anhydrous gypsum can be used as a filler in thermoplastics and thermosets. Fibrous filler grade gypsum is produced in both hemihydrate and anhydrous forms. The hydrous type is used as a strengthening filler in thermoset resins, and the anhydrous type is used in a similar way in thermoplastics.

Food and pharmaceuticals

The highest purity grades of gypsum filler, with minimum purity levels of 98% calcium sulphate, are used in food and pharmaceutical manufacture. In food production, gypsum is used as a firming agent in canned vegetables, and also as a processing aid in the brewing, flour and sugar industries. In the pharmaceutical industry, gypsum is one of a number of minerals used as a diluent in compressed tablets and capsules. This application uses the highest grade gypsum filler, containing a minimum of 99% calcium sulphate. The quantity of gypsum consumed in this end-use is small but the quality required means that its unit value is high.

Pesticides

Gypsum can be used as a carriers and diluents in insecticides, herbicides and fungicides. Materials used in this application must have a high absorbency, solubility in liquids, be chemically inert and also be compatible with the active ingredient. Many minerals meet these criteria including attapulgite, diatomite, fullers earth, gypsum, kaolin, lime, perlite, pyrophyllite, sepiolite and talc. Gypsum is suitable for the production of pesticides in granule and wettable powder forms, but not for liquid formulations

2. Markets for Gypsum in Glass production

Uncalcined gypsum, ground to sand sized particles, can be used as an oxidizing and fining agent in the manufacture of container glass. Barium sulphate and sodium sulphate have similar properties to gypsum in this end-use and are more widely-used in some countries, but locally produced gypsum often has a cost advantage. Gypsum can also be used as a bedding agent to hold glass during cutting, grinding and polishing.

3. Markets for Gypsum in chemicals

Gypsum and anhydrite can be used as feedstock for the manufacture of ammonium sulphate and sulphuric acid. Ammonium sulphate is produced by reacting gypsum or anhydrite with a concentrated solution of ammonium carbonate, formed by introducing carbon dioxide (CO₂) and ammonia into the aqueous medium.

XI. Recycling of Gypsum⁸

Until recently, the majority of gypsum discarded as scrap during the plasterboard production process, or generated during construction or demolition work, was simply dumped in landfill. This material can generate hydrogen sulphide gas and pollute water supplies.

Sources within the plasterboard industry have estimated that 3-5% of production is lost as waste. In new construction and renovation, 5-10% is lost as "cut off" scrap when plasterboard is installed. In total, an estimated 8-15% of annual plasterboard production is lost as scrap, which could be recycled and fed back into the production process. In addition, an unknown amount of plasterboard scrap is produced during the demolition of property and offices.

The amount of gypsum that could be recycled as a result of these activities is substantial.

⁸ Roskill report 2004

XII. Price of Natural Gypsum

Prices for gypsum are not published in any detail. Producers of natural gypsum tend to be vertically integrated with cement and/or plasterboard operations so there is no recognised open market for gypsum.

XIII. Price of synthetic Gypsum

Synthetic gypsum tends to be cheaper than natural gypsum for a number of reasons. The most important factor in North America and Western Europe is that producers cannot use simply dump synthetic gypsum without paying a tax. This has encouraged producers to find markets for synthetic gypsum and to sell it at a price attractive to consumers. Some synthetic gypsum, notably phosphogypsum, contains impurities and requires further processing before sale, which increases the cost and decreases economic viability. The most commercially viable synthetic gypsum in developed economies is generally produced by FGD equipment and is of very high purity.

XIV. World reserve of Gypsum

World reserves of natural gypsum probably exceed trillions of tons, sufficient to meet demand in the immediate future. Identified reserves are capable of sustaining decades of output at current rates of extraction. The rise in consumption of synthetic material in Europe and North America is slowing the rate at which natural gypsum reserves are mined. Limited information is available on the size of gypsum deposits in Brazil, the CIS, India, Poland and the USA.

ANNEX 1⁹

World: Mine production of gypsum and anhydrite by region and country, 1997 to 2003 (000t)							
<u>Western Europe</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
Austria ^{1,2}	¹ 1,000	1,000	1,000	1,000	1,000	1,000	1,000
Cyprus	234	297	182	260	250	¹ 260	260
France ^{1,2}	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Germany ^{1,2}	³ 4,800	³ 4,740	4,750	4,750	4,750	4,750	4,750
Greece ²	641	758	600	¹ 600	¹ 600	¹ 500	500
Ireland	477	450	450	450	450	450	450
Italy ¹	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Portugal ²	567	562	570	¹ 500	¹ 500	¹ 500	500
Spain ²	7,742	9,058	9,214	9,929	10,000	10,000	10,000
Switzerland ¹	300	300	300	300	300	250	250
Turkey	414	352	243	303	¹ 300	¹ 300	300
UK ^{1,2}	2,000	2,000	1,800	1,500	1700	1,700	1,700
<i>Subtotal</i>	<i>23,975</i>	<i>25,317</i>	<i>24,909</i>	<i>25,392</i>	<i>25,650</i>	<i>25,510</i>	<i>25,510</i>
<u>Eastern Europe</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
Azerbaijan ¹	60	60	60	60	60	60	60
Bosnia-Herzegovina ¹	30	30	30	30	30	30	30
Bulgaria ²	156	184	169	170	¹ 170	¹ 170	170
Croatia	102	108	138	151	131	¹ 135	135
Czech Republic	241	222	136	82	24	¹ 25	25
Georgia	5	6	10	14	14	¹ 14	14
Hungary	192	185	203	251	250	¹ 250	250
Kazakhstan ¹	25	25	25	25	25	25	25
Latvia	117	119	97	122	125	¹ 120	120
Macedonia ¹	25	30	30	30	30	30	30
Moldova	15	19	19	32	55	91	100
Poland ^{3,4}	1,035	1,029	1,163	1,184	1,094	¹ 1,100	1,100
Romania ¹	79	75	75	75	75	75	75
Russia	559	609	867	1,013	1,180	1,390	1,500
Slovakia ²	102	128	118	123	130	¹ 130	130
Slovenia ¹	10	10	10	10	10	10	10
Tajikistan ¹	26	32	35	35	35	35	35
Turkmenistan ¹	85	100	100	100	100	100	100
Ukraine	70	70	110	117	151	207	250
Uzbekistan ¹	80	80	80	80	100	100	100
Yugoslav Republic	32	28	34	47	50	¹ 50	50
<i>Subtotal</i>	<i>3,046</i>	<i>3,149</i>	<i>3,509</i>	<i>3,751</i>	<i>3,839</i>	<i>4,147</i>	<i>4,309</i>
<u>North America</u>							
Canada ²	8,628	8,967	9,345	8572	7821	8906	9000
Mexico ²	5,869	7,045	6,954	5654	6237	6500	6500
USA ⁴	18,612	19,027	22,400	19,500	16300	15700	16000
<i>Subtotal</i>	<i>33,109</i>	<i>35,039</i>	<i>38,699</i>	<i>33726</i>	<i>30358</i>	<i>31106</i>	<i>31500</i>
<u>South/Central America</u>							
Argentina	729	650	647	¹ 514	524	455	450
Brazil ²	1,396	1,632	1,456	1,541	1,507	1,633	1,650

⁹ Roskill report 2004

Chile	398	781	880	376	519	610	650
Colombia	565	¹ 560	¹ 560	¹ 560	¹ 560	¹ 560	560
Cuba ¹	130	130	130	130	130	130	130
Dominican Republic	115	80	81	110	176	18	20
Ecuador	2	2	1	1	1	1	1
El Salvador ¹	6	6	6	6	6	6	6
Guatemala	3	52	110	212	100	¹ 100	100
Honduras ¹	28	30	56	59	60	59	60
Jamaica	264	154	236	330	¹ 330	¹ 330	330
Nicaragua ²	16	23	27	28	28	28	28
Paraguay ¹	5	5	4	4	4	4	4
Peru	64	79	76	52	41	30	30
Uruguay	943	1,123	1,050	1,076	1,127	1,130	1,150
Venezuela	30	80	42	25	5	10	10
<i>Subtotal</i>	<i>4,694</i>	<i>5,387</i>	<i>5,362</i>	<i>5,024</i>	<i>5,118</i>	<i>5,104</i>	<i>5,179</i>
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<u>Africa</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>¹2003</u>
Algeria	¹ 275	¹ 275	1,316	1,341	868	322	350
Egypt ²	2,423	1,338	¹ 2,000	¹ 2,000	¹ 2,000	¹ 2,000	2,000
Ethiopia ²	120	120	36	47	51	51	50
Kenya ²	12	11	10	8	8	8	8
Libya ¹	125	150	150	175	150	150	150
Mali ¹	1	1	1	1	1	1	1
Mauritania ¹	80	100	100	100	100	100	100
Morocco ¹	450	450	450	450	450	450	450
Niger ¹	2	2	2	2	2	2	2
Nigeria ¹	300	300	200	200	200	200	200
Somalia ¹	1	2	2	2	2	2	2
South Africa	366	488	505	413	383	415	450
Sudan ^{1,2}	4	3	4	4	4	4	4
Tanzania ²	46	59	40	60	72	72	72
Tunisia ¹	100	100	110	125	125	125	125
Zambia ^{1,5,6}	11	11	11	10	10	10	10
<i>Subtotal</i>	<i>4,316</i>	<i>3,410</i>	<i>4,937</i>	<i>4,938</i>	<i>4,426</i>	<i>3,912</i>	<i>3,974</i>
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<u>Middle East</u>							
Iran ²	9,966	11,843	10,834	¹ 11,000	¹ 11,000	¹ 11,500	11,500
Iraq ^{1,3}	85	100	100	80	100	80	100
Israel	121	56	140	130	133	131	131
Jordan	194	176	245	158	163	176	175
Lebanon ¹	2	2	2	2	2	2	2
Oman	200	190	180	132	30	60	75
Saudi Arabia ¹	365	330	380	400	450	450	450
Syria	330	325	394	333	345	¹ 345	350
UAE ¹	90	90	90	90	90	90	100
Yeman ¹	101	102	103	100	100	100	100
<i>Subtotal</i>	<i>11,454</i>	<i>13,214</i>	<i>12,468</i>	<i>12,425</i>	<i>12,413</i>	<i>12,934</i>	<i>12,983</i>
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<u>Asia</u>							
Afghanistan ¹	3	3	3	3	3	3	3
Bhutan	50	53	54	54	55	55	55
Burma	38	36	45	48	65	66	65
China ¹	9,100	6,800	6,700	6,800	6,800	6,850	6,850
India	2,210	2,192	2,267	3247	2,707	¹ 2,700	2,700
Indonesia	6	6	6	5	6	6	6
Japan ^{2,7}	5,371	5,305	5,549	5,917	5,874	5,900	5,900
Laos	114	130	135	132	108	130	130

Mongolia ¹	25	25	25	25	25	25	25
Pakistan	465	244	245	377	350	360	360
Taiwan	2	2	2	2	1	-	-
Thailand	8,558	4,334	5,005	5,830	6,533	6,337	7,000
<i>Subtotal</i>	<i>25,942</i>	<i>19,130</i>	<i>20,036</i>	<i>22,440</i>	<i>22,527</i>	<i>22,432</i>	<i>23,094</i>
Oceania							
Australia ¹	1,916	2,393	3,052	3,466	3,800	4,000	4,000
World total	108,452	107,039	112,972	111,162	108,131	109,145	110,549

Source: USGS

- Notes:
- 1-Estimate
 - 2-Includes anhydrite
 - 3-National statistics
 - 4-Gypsum rock and anhydrite
 - 5-For cement production only
 - 6-Data for years beginning March 1st of that stated
 - 7-All Japanese production is of synthetic material