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# 2006 Minerals Yearbook

## DIATOMITE

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# Diatomite

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Production of diatomite in the United States increased by 22% to 799,000 metric tons (t), and its value decreased slightly to $176 million free on board (f.o.b.) plant in 2006 compared with 653,000 t valued at $179 million f.o.b. plant in 2005 (table 1). The United States remained the world's leading producer and consumer of diatomite.

Diatomite used for filtration represented 59% of consumption, with use as a cement additive next at 22%, followed by use as a filler at 9%, use as absorbent at 5%, and insulation at 2%. Other uses, including abrasives, insecticide and soil conditioner, accounted for the remainder (table 2). Major diatomite products were sold as various grades of calcined powders.

Encroachment into diatomite markets by natural and synthetic substitute material remained minimal, particularly in the beverage filter segment. Use for biological filtration, including filtering human blood plasma, continued to grow. Use as filler dropped in 2006 as concerns about free-crystalline silica continued. Diatomaceous material that contains abundant clay had considerable use in 2006, and so this relatively low value material was listed as a separate entry in table 2.

## Domestic Data Coverage

Domestic production data for diatomite were developed by the U.S. Geological Survey (USGS) from an annual voluntary survey of U.S. diatomite-producing sites and company operations. The canvass for 2006 covered 9 diatomite-producing companies with 11 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Sales and use data for companies that did not respond were estimated based on past production figures and man-hours worked as reported to the Mine Safety and Health Administration. Data are rounded to no more than three significant figures. All percentages in this report were computed based on unrounded data.

## Production

Recovery of diatomite from most deposits is by low-cost open pit mining because many occurrences are at or near the surface and the topography allows for open pit mining. Outside the United States, however, underground mining is fairly common owing to deposit form and depth as well as topography and other constraints. Explosives are not normally needed either in surface or underground mining of diatomite because of the soft, friable nature of the rock. In Iceland, dredging is used to recover diatomaceous mud from the bottom of a lake.

Diatomite usually is processed near the mine to reduce the cost of hauling the crude ore, which can contain up to 65% water. Processing typically involves a series of crushing, drying, size reduction, and calcining operations, using heated air for conveying and classifying within the plant. Fines, especially from baghouses, are used mostly for filler-grade products, and coarser particles are used for filter grades. In the latter stages of processing, calcining is normally done in rotary kilns to effect physical and chemical changes.

Industry production cost allocations for the United States average 10% for mining, 60% to 70% for processing, and 20% to 30% for packing and shipping. Energy costs compose a large portion (25% to 30%) of direct costs, and the proportion of the product that is calcined directly affects energy consumption. Diatomite used for cement production does not normally require calcining so the unit value reported is much lower.

In 2006, 799,000 t of diatomite was produced from 11 separate mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Major producers were Celite Corporation (a subsidiary of Imerys, USA) with mines and facilities in California, Nevada, and Washington, and EP Minerals, LLC (a subsidiary of EaglePicher Incorporated) with operations in Nevada and Oregon. California was the leading producing State, followed closely by Nevada. The combined output of these two States accounted for about 76% of the U.S. production in 2006.

## Consumption

Apparent domestic consumption (excluding stocks for which data were not available) of diatomite in 2006 was about 649,000 t, up by about 26% from 515,000 t in 2005. The total domestic and export quantity of filter-grade diatomite sold or used by U.S. producers was 474,000 t in 2006, down by 3% from 489,000 t in 2005, accounting for 59% of total diatomite consumption. Use of diatomite as a filler was 75,000 t in 2006, up slightly from 73,000 t in 2005, accounting for 9% of total diatomite consumption. For absorbents, 36,000 t of diatomite was consumed, down by 22% from 46,000 t in 2005, accounting for 5% of total diatomite consumption. Diatomite use for insulation rose by 30% to 16,500 t in 2006 from 12,700 t in 2005, accounting for 2% of total diatomite consumption. Diatomite used as an additive for cement was not reported as a separate category in 2005. A cement manufacturer in California began using diatomaceous earth; and thus, diatomaceous earth used in cement manufacture accounted for 22% of total consumption in 2006.

Commercial diatomite products provide fine-sized, irregular-shaped porous noncaking particles that have a large surface area and high liquid absorption capacity. They are relatively inert chemically, have a low refractive index, are mildly abrasive, have low thermal conductivity with a reasonably high fusion point, can be slightly pozzolanic, are very high in silica, and can be produced and delivered at a cost consistent with customer applications. Sawn shapes, which continue to account for a significant part of world diatomite production, have long been used as lightweight building material, especially in China, and primarily for thermal insulation (especially the high-clay-content Danish moler). Dried natural products and calcined products are used in the aforementioned building applications. The major use of diatomite is as a filtration medium for beverages (especially beer and wine), sugar and sweetener liquors, oils and fats, petroleum and chemical processing (including reprocessing waste dry cleaning fluids), pharmaceuticals, and water (industrial process, potable, swimming pool, and waste). Another leading use is as an absorbent for industrial spills (oil and toxic liquids) and for pet litter.

Another important broad category of use is as filler, often serving a dual purpose, such as an extender and flatting agent in paints and coatings; a bulking and anticaking agent in granular materials; and as a multieffect component in plastics (including preventing films from sticking). Other filler uses are as an extender and absorbent carrier for dry pesticides, pharmaceuticals, catalysts, and other chemicals. Other significant uses are as an insulation material in bulk (loose) and molded forms, other insulation products that include calcium silicate as a component, and as a silica additive in various compounds, including mortar and portland cement, where it is used also for its pozzolanic properties.

Commercial diatomite products are offered in a great variety of grades. Principal grading factors are the size, shape, overall arrangement, and proportions of the various types of frustules (factors that affect filtration rate, product clarity, and absorption capacity), the content of silica, and various impurities, such as certain minerals and chemicals, especially iron, a major impurity, as well as clay, sand, and organics. Additional specialized application specifications are brightness/whiteness and abrasive hardness. Reduced free-crystalline silica content, although normally low, also is required by some environmental regulations, particularly for calcined products. Calcining removes organics, increases filtration rate, oxidizes iron, increases specific gravity, increases particle hardness, and can lighten the color. Flux-calcining significantly affects the physical and chemical properties and makes a white product. Most filter grades are calcined.

## Prices

The calculated weighted average unit value of diatomite sold or used by U.S. producers during 2006, using USGS survey data and estimates, was $220 per metric ton f.o.b. plant, a decrease of about 20% compared with about $274 per ton in 2005 (table 3). The average values for filtration uses rose slightly in 2006 to about $264.00 per ton from the 2005 values. The value for diatomite used for absorbents rose by 19% to $37 per ton. The unit value for diatomite used as fillers increased by 3% to $395 per ton in 2006, and the value for diatomite used in insulation remained about the same at $44 per ton in 2006 compared with that of 2005. The average value for specialized or other uses in 2006 increased by about 43% to $932 per ton, up from $652 per ton in 2005. The decreases in the unit value of use categories in 2005 probably resulted from competition from less expensive substitutes in many uses. Diatomite used in cement manufacture commands a much lower price than some specialty uses, which most likely caused the value per ton of the other use category to drop.

## Foreign Trade

Export and import data presented here, which are from the U.S. Census Bureau, are of limited accuracy owing to inconsistencies in producer reporting and because there is a lack of detail for the various materials specified in the 2006 Harmonized Tariff Schedule of the United States (HTS) issued by the U.S. International Trade Commission. Exports of diatomite from the United States in 2006 were about 150,000 t, about 8,000 t more than in 2005 (table 4). Exports accounted for about 19% of total domestic production sold or used. The trade data were issued under heading 2512 of the HTS, described as applying to natural and straight-calcined diatomite. Industry sources, however, indicated that exports also included some flux-calcined material, which is included under code 3802.90.2000, where it is not differentiated from activated clays. Similarly, heat-insulating mixtures and sawn and molded unfired shapes of diatomite are collected under data classification code 6806.90.0090 and are not exclusively identified as diatomite. Also, fired, sawn, and molded shapes of diatomite are covered under heading 6901 that is not exclusively used for diatomite data.

According to the U.S. Census Bureau data, diatomite and diatomite products were exported to 88 countries in 2006, with 26 countries accounting for 91% of the total. The main export markets were Germany (18,800 t), Belgium (16,700 t), Japan (10,300 t), Australia (8,950 t), China (7,780 t), Thailand 7,410 t, Russia (7,300 t), the Republic of Korea (6,310 t), the Netherlands (6,220 t), and the United Kingdom (5,870 t). These 10 countries accounted for 65% of the total exports reported. Based on the available data, the average unit value free alongside ship of exported diatomite was $1,050 per ton in 2006 compared with $426 per ton in 2005, an increase of 147% (table 4). This large increase may be because not only were exports of higher value in 2006, but the 2005 data may not have included all the higher value material, as discussed above. Import data available for diatomite show that 4,480 t came from 11 countries in 2006. Mexico provided 2,670 t (60%), Germany 925 t (21%), Spain 356 t (8%), Italy 154 t (4%), Australia 140 t (3%) and the remainder came from Brazil, China, France, Japan, New Zealand, and United Kingdom.

## World Review

For 2006, world output of 2.16 Mt was about 7% higher than that of 2005 (table 5). Chinese diatomite production was up by 2% to 420,000 t in 2006, while Japanese production remained the same as in 2005. Mexican diatomite production was about 59,000 t in 2006, a decrease of 5% compared with that of 2005. The United States was the leading producer, consumer, and exporter of diatomite and accounted for 37% of total world production, followed by China with 19%, Denmark with 11% (all moler products), Japan with 6%, the Commonwealth of

Independent States with 4%, and France and Mexico each with 3%. Small amounts of diatomite were produced in 24 other countries to account for the remainder.

World reserves are estimated to be almost 1 billion metric tons (Gt), which is more than 500 times the current annual estimated world production rate of 2.01 Mt (the average world production of the past 5 years). About 250 Mt, or 25%, of the estimated 1 Gt world reserve is in the United States (Founie, 2007). The world reserve base was estimated by the U.S. Bureau of Mines in 1985 to be almost 2 Gt (Meisinger, 1985). The world's reputed largest producing district in terms of volume is near Lompoc, CA. A resource estimate based just on the dimensions of those deposits, suggests that diatomite from those deposits alone could meet the world's needs for centuries at current rates of production. Information on reserves is difficult to calculate because some companies are reluctant to release proprietary data, and data from some nations is inadequate. Huge deposits with at least 110 Mt of reserves occur in China (Lu, 1998, p. 53; Founie, 2007).

## Outlook

While diatomite production increased by 22% in 2006, much of the increase was owing to a growing use of diatomite as a lightweight component and as a pozzolan in the cement industry. Only a limited number of cement companies did this, and it remains to be seen if this is a trend.

The diatomite market is expected to be stable for the next several years, with the export market continuing to remain strong. A change in the amount of diatomite used as a filtration medium would be linked to changes in the markets of products that use diatomite in their filtering process. Diatomite use in filtration of human blood plasma and other biotechnical applications is expected to continue expanding. Increased energy costs and possible global overcapacity, however, may be impediments to future expansion. The past concerns of encroachments into filter applications by more advanced technologies using carbon membranes, ceramics, and polymers were still not a major concern to diatomite producers in 2006 because cost factors and tradition, particularly in the brewing and wine industries, precluded changing to substitutes. Disposal of diatomite waste, however, continued as a problem not fully resolved by recycling. The problem of association of free-crystalline silica with diatomite, particularly when calcined, was expected to continue to be a concern, especially in the filler and absorbent markets in which diatomite use steadily decreased in recent years. The use of uncalcined diatomite has replaced calcined in some markets, and more recycling has occurred. Finally, with the large domestic and world reserve bases and small change in demand, it appears that there will be adequate supplies of diatomite for the foreseeable future.

Indications are that diatomite use will remain steady or expand slightly in the near future.

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TABLE 1
DIATOMITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES[1]

(Thousand metric tons and thousand dollars)

| | 2005 | 2006 |
|---|---|---|
| Domestic production, sales: | | |
| Quantity | 653 | 799 |
| Value | 179,000 | 176,000 |

[1]Data are rounded to no more than three significant digits.

TABLE 2
DIATOMITE SOLD OR USED, BY MAJOR USE[1]

(Percentage of U.S. production)

| | 2005 | 2006 |
|---|---|---|
| Absorbents | 7 | 5 |
| Cement | NA | 22 [2] |
| Fillers | 11 | 9 |
| Filtration | 75 | 59 |
| Insulation | 2 | 2 |
| Other[3] | 5 | 3 |

NA not available.

[1]Includes exports.

[2]As ingredients in portland cement, not reported as a separate use in 2005.

[3]Includes abrasives, lightweight aggregates, and unspecified uses.

TABLE 3
AVERAGE VALUE PER METRIC TON OF DIATOMITE, BY MAJOR USE[1]

| | 2005 | 2006 |
|---|---|---|
| Absorbents | $31.00 | $37.00 |
| Cement | NA | 3.00 [2] |
| Fillers | 382.00 | 395.00 |
| Filtration | 262.00 | 264.00 |
| Insulation | 44.00 | 44.00 |
| Other[3] | 652.00 | 932.00 |
| Weighted average | 274.00 | 220.00 |

NA not available.

[1]Rounded estimates.

[2]As ingredients in portland cement, not reported as a separate use in 2005.

[3]Includes abrasives, lightweight aggregates and unspecified uses.

TABLE 4
U.S. EXPORTS OF DIATOMITE[1, 2]

(Thousand metric tons and thousand dollars)

| Year | Quantity | Value[3] |
|---|---|---|
| 2005 | 142 | 60,400 |
| 2006 | 150 | 158,000 |

[1]Harmonized Tariff System (HTS) heading 2512.00.0000, natural and straight-calcined grades, but in practice probably includes an undetermined quantity of flux-calcined product HTS heading 3806.90.2000.

[2]Data are rounded to no more than three significant digits.

[3]Free alongside ship U.S. customs value.

Source: U.S. Census Bureau.

TABLE 5
DIATOMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

| Country | 2002 | 2003 | 2004 | 2005[e] | 2006[e] |
|---|---|---|---|---|---|
| Algeria | 3 | 3 | 3 [r] | 2 [r, 3] | 3 |
| Argentina | 23 | 36 | 8 [e] | 29 [r, 3] | 10 |
| Australia[e] | 20 | 20 | 20 | 20 | 20 |
| Brazil, marketable[e] | 6 [3] | 7 | 7 | 8 | 8 [p] |
| Chile | 30 | 26 | 30 | 27 [r, 3] | 30 |
| China[e] | 370 | 380 | 390 | 410 | 420 |
| Colombia[e] | 4 | 4 | 4 | 4 | 4 |
| Commonwealth of Independent States[e, 4] | 80 | 80 | 80 | 80 | 80 |
| Costa Rica | 26 [e] | 26 | 27 [e] | 26 [r] | 26 |
| Czech Republic[e] | 28 [3] | 41 | 33 | 38 [r] | 40 |
| Denmark[e, 5] | 230 [3] | 232 | 233 | 234 | 235 |
| Ethiopia[6] | 1 [e] | 1 | 2 | (8) [r] | (8) |
| France[e] | 80 | 80 [3] | 75 | 75 | 75 |
| Germany | 54 | 55 | 54 [e] | 54 [r] | 54 |
| Iceland | 26 | 28 | 28 | 29 | 28 |
| Iran[7] | 2 | 10 | 8 | 8 | 8 |
| Italy[e] | 25 | 25 | 25 | 25 | 25 |
| Japan | 124 | 112 | 125 | 130 | 130 |
| Kenya | 1 | (8) [r] | (8) | (8) [r, 3] | (8) |
| Korea, Republic of | 21 | 16 | 2 | 2 [r, 3] | 2 |
| Macedonia[e] | 5 | 5 | 5 | 5 | 5 |
| Mexico | 62 | 53 | 59 | 62 [3] | 60 [3] |
| Mozambique | -- | -- | 3 [e] | 5 | 6 |
| Peru[e] | 35 | 35 | 35 | 35 | 35 |
| Poland | 1 | 1 [r, e] | 1 [e] | 1 | 1 |
| Portugal[e] | (8) | (8) [r] | (8) [r] | (8) | (8) |
| Romania | 20 | 31 | 21 [r] | 1 [r, 3] | 10 |
| Spain[e, 9] | 54 [r] | 58 [r] | 34 [r] | 34 [r] | 35 |
| Thailand | 1 | 1 | 1 | 1 | 1 |
| Turkey[e] | 10 | 10 | 10 | 10 | 10 |
| United States[10] | 624 | 599 | 620 | 653 [3] | 799 [3] |
| Total | 1,970 [r] | 1,970 [r] | 1,940 [r] | 2,010 [r] | 2,160 |

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown. Purity and moisture content are generally not reported or estimated.

[2]Table includes data available through April 4, 2007.

[3]Reported figure.

[4]Information is inadequate for formulation of reliable estimates for individual countries.

[5]Data represent "extracted moler" (reported cubic meters times 1.5). Contains about 30% clay.

[6]Year ending July 7 of that stated.

[7]Data are for year beginning March 21 of that stated.

[8]Less than ½ unit.

[9]Includes tripoli.

[10]Sold or used by producers.