



# 2011 Minerals Yearbook

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## DIATOMITE

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Production of diatomite in the United States increased by 37% to 813,000 metric tons (t), with a corresponding value of \$219 million free on board (f.o.b.) plant in 2011 compared with 595,000 t valued at \$178 million f.o.b. plant in 2010 (table 1). The large production increase reflected a return to levels observed prior to the economic downturn. The United States was the leading producer of diatomite in 2011. Estimated world production was 2.1 million metric tons (Mt), an increase of 12% from 2010. Of the 26 countries that reported the production of diatomite in 2011, the United States accounted for 39% of total world production.

Diatomite used for filtration represented 61% of consumption, followed by its use as a cement additive (13%), as an absorbent (12%), and as a filler (12%). Other diatomite applications, including abrasives, insecticides, insulation, 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 for beverage filtration. Use as a biological filter for human blood plasma continued to increase.

Diatomite is a chalk-like, soft, friable, earthy, very fine-grained, siliceous sedimentary rock comprised of fossilized diatom remains. Diatomite often has a light color (white if pure, commonly buff to gray in-situ, and rarely black). It is extremely lightweight because of its low density and high porosity, and essentially chemically inert. Diatomaceous earth (often abbreviated as D.E.) is a common alternate name but is more appropriate for the unconsolidated or less lithified sediment. Diatomite is also known as kieselguhr (Germany), tripolite (after an occurrence near Tripoli, Libya), and moler (an impure Danish form). Alfred Nobel named his explosive invention “dynamite” following his discovery that nitroglycerin could be stabilized if first absorbed in diatomite (Nobel, 1868).

Diatomite deposits form from an accumulation of amorphous hydrous silica cell walls of dead diatoms in both oceanic and fresh waters. These microscopic single-cell aquatic plants (algae) contain an internal, elaborate siliceous skeleton consisting of two frustules (valves) that vary in size from less than 1 micrometer ( $\mu\text{m}$ ) to more than 1 millimeter in diameter but are typically 10 to 200  $\mu\text{m}$  in diameter. The frustules have a broad variety of delicate, lacy, perforated shapes, including cylinders, discs, feathers, ladders, needles, and spheres. Additional information on the environmental and physical properties of diatoms can be found in Dolley and Moyle (2003) and Moyle and Dolley (2003). The oldest occurrences of diatomite are thought to be of Cretaceous age, deposited about 66 million to 138 million years ago. Older diatomite occurrences may have been altered into other forms of silica, particularly chert, owing to diagenesis, burial, and exposure. Detailed

information on the geology of diatomite can be found in Wallace (2003) and Moyle and Dolley (2003).

## Production

Domestic production data for diatomite were developed by the U.S. Geological Survey (USGS) from a voluntary annual survey of U.S. diatomite-producing sites and company operations. The USGS canvass for 2011 was sent to 7 diatomite-producing companies with 10 mining areas and 9 processing facilities. All companies responded, accounting for 100% of the production listed in table 1. Some company data were not complete and were estimated on the basis of annual hours worked, as reported by the Mine Safety and Health Administration. Data were rounded to no more than three significant figures. All percentages in this report were computed based on unrounded data.

In 2011, 813,000 t of diatomite were produced from 10 separate mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. This amount reflected an alltime production high for the United States. Major producers were Celite Corp. (a subsidiary of Imerys USA, Inc.) with mines and facilities in California, Nevada, and Washington; and EP Minerals, LLC (a subsidiary of EaglePicher Corp.) with operations in Nevada and Oregon. California was the leading producing State, followed by Nevada. The combined output of these two States accounted for about 79% of U.S. production in 2011.

Because diatomite occurrences are at or near the earth's surface, recovery from most deposits is achieved through low-cost, open pit mining. Outside the United States, however, underground mining is fairly common owing to deposit location and topographic constraints. Explosives are generally not required for surficial or subsurface mining because of the soft, friable nature of the deposits. In Iceland, dredging is used to recover lake-bottom diatomaceous mud deposits.

Diatomite is often processed near the mine to reduce transportation costs associated with 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. Fine-sized diatomite grains, especially from baghouses, are used most often for filler-grade products, while coarser particles are employed for filtration purposes. In the latter processing stages, calcining is performed in rotary kilns to effect chemical and physical changes.

Diatomite production costs for the United States average 60% to 70% for processing, 20% to 30% for packing and shipping, and 10% for mining. Energy costs compose a large and growing portion (25% to 30%) of diatomite production costs, both in the direct costs of mining and transportation,

as well as within the energy-intensive calcining process. Diatomite used for cement production does not normally require calcining, and thus, processing costs are lower. For 2011, overall diatomite production was much higher than that in 2010, which represented a rebound in the marketplace to levels observed in 2008 when U.S. production was 764,000 t. In 2009–10, production from the larger U.S. diatomite producers was lower as some operations were idled during that period as a result of the 2008 economic downturn and the resulting decrease in demand.

## Consumption

Apparent domestic consumption of diatomite was approximately 707,000 t in 2011, an increase of approximately 39% from 509,000 t in 2010. The total domestic and export quantity of filter-grade diatomite sold or used by U.S. producers was 500,000 t in 2011, an increase of 25% from 400,000 t in 2010, accounting for 61% of total diatomite sold or used. For absorbents, 95,000 t of diatomite was reported, an increase of 48% from 64,000 t in 2010. Use of diatomite as a filler was 99,000 t in 2011, an increase of 148% from the 40,000 t in 2010.

In antiquity, diatomite was used by the Greeks as an abrasive and in the production of lightweight building bricks and blocks. In the late 1800s, diatomite became of industrial interest in Western Europe when pulverized diatomite was the preferred absorbent and stabilizer of nitroglycerine used to make dynamite. Maryland was the site of the first U.S. production of diatomite in 1884. By the late 1880s, very pure, large deposits near Lompoc, CA, became the focus of interest and have continued to dominate world markets (Dolley and Moyle, 2003). Although diatomite is principally used as a filtration medium, it is also used as a silica additive in cement and various other compounds, a filler in a variety of products, an absorbent, an insulation medium, a mild abrasive, and an agent in the purification and extraction of DNA.

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 chemically inert, have a low refractive index, are mildly abrasive, have a 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 building applications. The major use of diatomite continues to be 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 a filler, often serving a dual purpose, such as an extender and flattening 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 catalysts, nontoxic pesticides (as a desiccating agent), pharmaceuticals, and other chemicals.

Brightness, whiteness, and abrasive hardness are considered for specialized diatomite applications. Free-crystalline silica content, although normally low, is required to be identified, particularly for calcined products. Calcining removes organics, increases filtration rate, oxidizes iron, increases specific gravity, increases particle hardness, and can lighten 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 2011, using USGS survey data and estimates, was \$269 per metric ton f.o.b. plant, a decrease of about 10% compared with about \$299 per ton in 2010 (table 3). The average values for filtration decreased by 30% in 2011 to \$274 per ton from \$394 per ton reported in 2010. The value for diatomite used for absorbent purposes was \$101 per ton, a 148% increase from \$41 per ton reported in 2010. The unit value for material used as fillers decreased slightly to \$410 per ton in 2011. The average value for specialized or other uses in 2011 decreased by 38% to \$446 per ton from \$705 per ton in 2010. This decrease was derived from a specialty-grade form of diatomite, which is subject to large price fluctuations, and represented less than 1% of total U.S. production in 2011.

## Foreign Trade

Export and import data presented here from the U.S. Census Bureau may be of limited accuracy. This is a result of a lack of detail caused by the inclusion of diatomite with other mineral commodities within several categories in the Harmonized Tariff Schedule of the United States (HTS) issued by the U.S. International Trade Commission. Exports of diatomite from the United States in 2011 were approximately 106,000 t, about 20,000 t more than those in 2010 (table 4). Exports accounted for about 13% of total domestic production sold or used. Trade data were issued under heading 2512 of the HTS, described as applying to siliceous fossils, including kieselguhr, tripolite, diatomite, and similar siliceous earths of an apparent specific gravity of 1 or less. Industry sources, however, indicated that exports also included some flux-calcined material, which is included under HTS 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 HTS code 6806.90.0090 and are not exclusively identified as diatomite. Lastly, fired, sawn, and molded shapes of diatomite are covered under heading 6901, which is not exclusively used for diatomite data.

According to U.S. Census Bureau data, diatomite and diatomite products were exported to 94 countries in 2011. The main export markets were Canada (18,900 t), Germany (12,900 t), Belgium (7,600 t), Russia (4,500 t), and South Africa (4,500 t). These five countries accounted for 46% of the total

reported exports. Based on available ITC trade data, the average unit value free alongside ship of exported diatomite was \$527 per ton in 2011 compared with \$517 per ton in 2010 (table 4). Import data for diatomite show that 1,880 t came from 10 countries in 2011. Mexico was the leading source with 1,250 t (66%); followed by the Netherlands with 136 t (7%), China with 129 t (7%), Italy with 126 t (7%), and the United Kingdom with 63 t (4%). These five countries provided 91% of the imports to the United States in 2011.

## World Review

Estimated world production of diatomite in 2011 was 2.1 million metric tons (Mt) (table 5). World reserves are thought to be almost 1 billion metric tons (Gt), which represents approximately 500 times the annual estimated world production rate. About 250 Mt, or 25% of the estimated 1 Gt of world reserves, is in the United States (Crangle, 2010). The world's largest producing district in terms of volume is near Lompoc, CA. A resource assessment of this location suggested these deposits could meet all of the world's current diatomite consumption for hundreds of years. Compiling data regarding reserve estimates can be challenging because some data are proprietary and not released by companies nor by countries. Huge deposits, on the order of at least 110 Mt of reserves, have been reported to occur in China (Lu, 1998, p. 53).

The United States was the leading producer of diatomite, accounting for 39% of total world production, followed by China with 21%, Denmark with 11% (all molar products), and Japan with 5%. Smaller amounts of diatomite were mined in 26 additional countries.

## Outlook

Despite challenging market conditions for many industrial commodities, domestic diatomite production increased in 2011. The economic stability of the mineral commodity was largely owing to its use as a filtration medium, where its demand remains strong, particularly in the filtration of spirits as well as human blood plasma and other biotechnical applications. Likewise, the encroachment of more advanced filter applications, including carbon membranes, ceramics, and polymers, were not a concern in 2011. The high costs associated with these alternatives and a cultural preference toward the use of diatomite in the brewing and wine industries indicate a strong likelihood for the continued widespread use of diatomite in filtration.

The associated issue of free-crystalline silica, particularly after diatomite is calcined, was expected to continue to be

a concern, especially in the filler and absorbent markets. Although some diatomite deposits were reported to be low in free-crystalline silica, an effort to classify diatomite and related absorbent products as free of this material remains contentious, litigious, and, to date, unsuccessful. Adequate supplies of diatomite, owing to the large domestic and world reserves, coupled with small or no changes in demand, probably will remain available for the foreseeable future.

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## GENERAL SOURCES OF INFORMATION

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TABLE 1  
DIATOMITE SOLD OR USED BY PRODUCERS IN THE  
UNITED STATES<sup>1</sup>

(Thousand metric tons and thousand dollars)

	2010	2011
Domestic production, sales:		
Quantity	595	813
Value	178,000	219,000

<sup>1</sup>Data are rounded to no more than three significant digits.

TABLE 2  
DIATOMITE SOLD OR USED, BY MAJOR USE<sup>1</sup>

(Percentage of U.S. production)

	2010	2011
Absorbents	11	12
Cement <sup>2</sup>	15	13
Fillers	7	12
Filtration	67	61
Other <sup>3</sup>	(4)	1

<sup>1</sup>Includes exports.

<sup>2</sup>As ingredient in portland cement.

<sup>3</sup>Includes abrasives, lightweight aggregates, insulation and unspecified uses.

<sup>4</sup>Less than ½ unit.

TABLE 3  
AVERAGE VALUE PER METRIC TON OF DIATOMITE,  
BY MAJOR USE<sup>1</sup>

	2010	2011
Absorbents	41	101
Cement <sup>2</sup>	9	XX
Fillers	412	410
Filtration	394	274
Insulation	XX	XX
Other <sup>3</sup>	705	446
Weighted average	299	269

XX Not applicable.

<sup>1</sup>Rounded estimates.

<sup>2</sup>As ingredient in portland cement.

<sup>3</sup>Includes abrasives, lightweight aggregates, and unspecified uses.

TABLE 4  
U.S. EXPORTS OF DIATOMITE<sup>1, 2</sup>

(Thousand metric tons and thousand dollars)

Year	Quantity	Value <sup>3</sup>
2010	86	44,500
2011	106	55,800

<sup>1</sup>Harmonized Tariff Schedule (HTS) number 2512.00.0000, natural and straight-calcined grades, but in practice probably includes an undetermined quantity of flux-calcined product HTS number 3806.90.2000.

<sup>2</sup>Data are rounded to no more than three significant digits.

<sup>3</sup>Free alongside ship value.

Source: U.S. Census Bureau.

TABLE 5  
DIATOMITE: ESTIMATED WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Thousand metric tons)

Country	2007	2008	2009	2010	2011
Algeria	2 <sup>3</sup>	2 <sup>3</sup>	2 <sup>3</sup>	2 <sup>r,3</sup>	2
Argentina	50 <sup>3</sup>	37 <sup>3</sup>	62 <sup>3</sup>	62 <sup>r</sup>	62
Armenia	(4)	(4)	(4)	(4)	(4)
Australia	20	20	20	20	20
Brazil, marketable	6 <sup>3</sup>	4 <sup>r,3</sup>	4 <sup>r,3</sup>	4 <sup>r,3</sup>	4 <sup>p</sup>
Chile	25 <sup>3</sup>	25 <sup>3</sup>	23 <sup>3</sup>	31 <sup>r,3</sup>	31
China	420	440	440	400	440
Commonwealth of Independent States <sup>5</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Costa Rica	2 <sup>3</sup>	1 <sup>3</sup>	1	1	1
Czech Republic <sup>6</sup>	19	31	--	32 <sup>r</sup>	3
Denmark <sup>6</sup>	230	230	225	225	225
France	75	75	75	75	75
Germany	NA <sup>r</sup>	NA <sup>r</sup>	NA <sup>r</sup>	NA <sup>r</sup>	NA
Iceland	28	28	26	25	25
Iran <sup>7</sup>	(5)	2	-- <sup>r</sup>	-- <sup>r</sup>	--
Italy	25	25	25	25	25
Japan	120	115	110	110	100
Kenya <sup>3</sup>	(4)	(4)	(4)	(4)	(4)
Korea, Republic of	2 <sup>3</sup>	3	2	2 <sup>r</sup>	3
Macedonia	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Mexico	63 <sup>3</sup>	129 <sup>3</sup>	81 <sup>3</sup>	92 <sup>r,3</sup>	90
Mozambique	1 <sup>3</sup>	(4) <sup>3</sup>	(4)	(4)	(4)
Peru	22 <sup>3</sup>	12 <sup>3</sup>	10 <sup>3</sup>	11 <sup>r</sup>	11 <sup>p</sup>
Poland	1	1	1	1	1
Portugal	(4)	(4)	(4)	(4)	(4)
Romania	2	--	--	--	--
Russia <sup>6</sup>	28	30	28	30	32
Spain <sup>8</sup>	50	50	50	50	50
Thailand	1 <sup>3</sup>	4 <sup>3</sup>	4	4	4
Turkey	33 <sup>3</sup>	63 <sup>3</sup>	28 <sup>3</sup>	40 <sup>r</sup>	45
United States <sup>3,9</sup>	687	764	575	595	813
Total	1,910 <sup>r</sup>	2,090 <sup>r</sup>	1,790 <sup>r</sup>	1,840 <sup>r</sup>	2,060

<sup>p</sup>Preliminary. <sup>r</sup>Revised. NA Not available. -- Zero.

<sup>1</sup>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.

<sup>2</sup>Table includes data available through March 29, 2012.

<sup>3</sup>Reported figure.

<sup>4</sup>Less than ½ unit.

<sup>5</sup>Information is inadequate for formulation of reliable estimates for individual countries.

<sup>6</sup>Data represent "extracted moler" (reported cubic meters times 1.5). Contains about 30% clay.

<sup>7</sup>Data are for Iranian years beginning March 21 of that stated.

<sup>8</sup>Includes tripoli.

<sup>9</sup>Sold or used by producers.