



# 2013 Minerals Yearbook

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**DIATOMITE [ADVANCE RELEASE]**

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# DIATOMITE

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Production of diatomite in the United States increased by 6% to 782,000 metric tons (t), with a corresponding value of \$229 million free on board (f.o.b.) plant in 2013 compared with 735,000 t valued at \$210 million f.o.b. plant in 2012 (table 1). The United States was the world's leading producer of diatomite in 2013, providing 33% of the estimated world production total of 2.3 million metric tons (Mt) (table 5). Other leading producers, China and Denmark, produced 18% and 14% of diatomite production, respectively. Diatomite was produced in 24 countries in 2013.

Diatomite used for filtration represented 59% of consumption, followed by its use as an absorbent (14%), as a cement additive (14%), and as a filler (13%). 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.

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 is 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). A unique attribute of diatomite is found within its microstructure, which often contains thousands of individual holes. These hollows are typically found in three distinct sizes, from micrometer ( $\mu\text{m}$ ) to submicrometer diameters. The number and sizes of holes vary with the species (Imerys Minerals, Ltd., 2012).

Diatomite deposits form from an accumulation of amorphous hydrous silica cell walls of dead diatoms in 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  $\mu\text{m}$  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 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).

## Legislation and Government Programs

In uncommon instances of extreme heat coupled with slow cooling conditions, amorphous silica, the primary constituent of diatomite, may be altered to crystalline silica (Oregon Department of Consumer and Business Services, 2007). 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.

## 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 2013 was sent to six diatomite-producing companies with 12 mining areas and 9 processing facilities. Although all companies responded, some data were not complete, and in those instances, production was estimated on the basis of Mine Safety Health Administration reported hours worked, coupled with previous-year production information. All percentages in this report were computed based on unrounded data.

In 2013, 782,000 t of diatomite was produced from 12 separate mining areas in California, Nevada, Oregon, and Washington. 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. Nevada was the leading producing State, followed by California. The combined output of these two States accounted for about 77% of U.S. production.

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). Because U.S. 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 diatomite grains, especially from baghouses, are used most often for filler-grade products, and 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 account for a large and growing portion (25% to 30%) of diatomite production costs, 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 (Yilmaz and Ediz, 2008).

### Consumption

Apparent domestic consumption of diatomite was approximately 691,000 t in 2013, an increase of approximately 8% from 642,000 t in 2012. The total domestic and export quantity of filter-grade diatomite sold or used by U.S. producers was 453,000 t in 2013, an increase of 10% from 412,000 t in 2012, accounting for 58% of total diatomite sold or used. For use in absorbents, 109,000 t of diatomite was reported, an increase of 14% from 96,000 t in 2012. Use of diatomite as a filler was 102,000 t in 2013, a slight decrease from 103,000 t in 2012.

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.

Commercial diatomite products provide fine, irregular-shaped, porous noncaking particles that have a large surface area and high liquid-absorption capacity. The products 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 2013, using USGS survey data and estimates, was \$293 per metric ton f.o.b. plant, a slight increase compared with about \$286 per ton in 2012 (table 3). The average values for filtration decreased slightly in 2013 to \$379 per ton from \$381 per ton reported in 2012. The value for diatomite used for absorbent purposes was \$91 per ton, a decrease of 10% from 2012. The unit value for material used as fillers decreased slightly to \$398 per ton in 2013. The average value for specialized or other uses in 2013 increased by 9% to \$464 per ton from \$424 per ton in 2012.

### Foreign Trade

Export and import data presented here from the U.S. Census Bureau may be of limited accuracy, which 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. 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 96 countries in 2013. Exports of diatomite from the United States in 2013 were approximately 92,000 t, about 4,000 t less than those in 2012 (table 4). Exports accounted for about 12% of total domestic production sold or used. The main export markets were Canada (16,300 t), Germany (10,100 t), Belgium (7,000 t), Russia (5,300), and South Africa (4,100 t). These five countries

accounted for 47% of the total reported exports. Based on available Census trade data, the average unit value free alongside ship of exported diatomite was \$529 per ton in 2013 compared with \$528 per ton in 2012 (table 4). Import data for diatomite show that 914 t came from 18 countries in 2013. Mexico was the leading source with 374 t (41%); followed by China with 239 t (26%), Japan with 107 t (12%), Italy with 84 t (9%), and France with 72 t (8%). These five countries provided 96% of the imports to the United States in 2013.

## World Review

Estimated world production of diatomite in 2013 was 2.3 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, 2014). The world's largest producing district in terms of volume is near Lompoc, CA. A resource assessment of this location suggested that these deposits could supply all of the world's current diatomite consumption for hundreds of years. Compilations of reserve estimates are not comprehensive because some data are proprietary and not released by companies or countries. Huge deposits, on the order of at least 110 Mt of reserves, have been reported in China (Lu, 1998, p. 53).

In 2013, the United States was the leading producer of diatomite, accounting for 33% of total world production, followed by China with 18%, Denmark with 14% (all molar products), and Japan with 4%. Smaller quantities of diatomite were mined in 20 additional countries.

## Outlook

With the exception of depressed production while the world was recovering from an economic downturn, annual U.S. production has been more than 600,000 t for more than 20 years, with production exceeding 800,000 t 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 2013. 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.

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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)

	2012	2013
Domestic production, sales:		
Quantity	735	782
Value	210,000	229,000

<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)

	2012	2013
Absorbents	13	14
Cement <sup>2</sup>	13	14
Fillers	14	13
Filtration	56	58
Other <sup>3</sup>	(4)	(4)

<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>

(Dollars per metric ton)

	2012	2013
Absorbents	101	91
Cement <sup>2</sup>	7	10
Fillers	399	398
Filtration	381	379
Insulation	58	54
Other <sup>3</sup>	424	464
Weighted average	286	293

<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>
2012	96	50,700
2013	92	48,700

<sup>1</sup>Harmonized Tariff Schedule (HTS) number 2512.00.0000, natural and straight-calcined grades, but in practice may include an undetermined quantity of flux-calcined product, which should be reported as 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	2009	2010	2011	2012	2013 <sup>e</sup>
Algeria	2	2 <sup>3</sup>	2	2	2
Argentina	62 <sup>3</sup>	54 <sup>3</sup>	61 <sup>3</sup>	278 <sup>r</sup>	100
Armenia	(4)	(4)	(4)	(4)	(4)
Australia	20	20	20	20 <sup>r</sup>	20
Brazil, marketable	4 <sup>3</sup>	4 <sup>3</sup>	4 <sup>3</sup>	2 <sup>r</sup>	2
Chile	23 <sup>3</sup>	31 <sup>3</sup>	23 <sup>3</sup>	23 <sup>r</sup>	27
China	440	400	440	420	420
Costa Rica	1	14 <sup>r,3</sup>	4 <sup>r,3</sup>	4 <sup>r</sup>	4
Czech Republic	--	32	46	43 <sup>r</sup>	49
Denmark <sup>5</sup>	303	338	338	338	335
Ethiopia	4 <sup>3</sup>	4	4	5 <sup>r</sup>	5
France	75	75	75	75	75
Italy	25	25	25	25	25
Japan	110	110	100	100	90
Kenya	(4) <sup>3</sup>	(4) <sup>3</sup>	1 <sup>3</sup>	2 <sup>r</sup>	1
Korea, Republic of, diatomaceous earth	2 <sup>3</sup>	2 <sup>3</sup>	5 <sup>3</sup>	6 <sup>r</sup>	34
Mexico	81 <sup>3</sup>	92 <sup>3</sup>	84 <sup>3</sup>	85	87
Mozambique	(4) <sup>3</sup>	(4) <sup>3</sup>	(4) <sup>3</sup>	85 <sup>r,3</sup>	87
Peru	10 <sup>3</sup>	11	10 <sup>r</sup>	94 <sup>r,3</sup>	125
Poland	1	1	1	1	1
Russia	30 <sup>r</sup>	32 <sup>r</sup>	33 <sup>r</sup>	70 <sup>r</sup>	70
Spain <sup>6</sup>	29 <sup>r</sup>	64 <sup>r</sup>	54 <sup>r</sup>	36 <sup>r</sup>	36
Thailand	6 <sup>r</sup>	7 <sup>r</sup>	38 <sup>r</sup>	9 <sup>r</sup>	8
Turkey	28	18 <sup>3</sup>	45 <sup>3</sup>	86 <sup>r</sup>	85
United States <sup>3,7</sup>	575	595	813	735	782
Total	1,830 <sup>r</sup>	1,930 <sup>r</sup>	2,230 <sup>r</sup>	2,460 <sup>r</sup>	2,380

<sup>e</sup>Estimated. <sup>r</sup>Revised. -- 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>Includes data available through April 22, 2014.

<sup>3</sup>Reported figure.

<sup>4</sup>Less than ½ unit.

<sup>5</sup>Data represent “extracted moler” (reported cubic meters times 1.5). Danish extracted moler figures, in thousand cubic meters, are as follows: 2009—202 (estimated); 2010—225 (estimated); 2011—225 (estimated); 2012—225 (estimated); and 2013—225 (estimated). Contains about 30% clay.

<sup>6</sup>Includes tripoli.

<sup>7</sup>Sold or used by producers.