



2017 Minerals Yearbook

DIATOMITE [ADVANCE RELEASE]

DIATOMITE

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Production of diatomite in the United States increased by 12% to 768,000 metric tons (t) with a corresponding 42% increase in value to \$278 million free on board (f.o.b.) plant. That compared with 686,000 t valued at \$195 million f.o.b. plant in 2016 (table 1). The United States was the world's leading producer of diatomite in 2017, providing 31% of the estimated world production total of 2.46 million metric tons (Mt) (table 5). Other leading producers included Denmark, with 18%; China, 17%; and Peru and Japan, 4% each. Diatomite was produced in 28 countries in 2017.

Diatomite used for filtration represented 59% of domestic consumption. Its use as a cement additive, as a filler, and as an absorbent represented 41% of consumption. Other diatomite applications, including abrasives, insecticides, and soil conditioner, accounted for the remainder, which totaled less than 1% (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 composed 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 present in three distinct sizes, from micron to submicron diameters. The number and sizes of holes vary with the species (Imerys Minerals Ltd., 2017).

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), also known as diatoms, contain an internal, elaborate siliceous skeleton consisting of two frustules (valves) that vary in size from less than 1 micrometer (μm) to more than 1 millimeter in diameter but are typically 10 to 200 μm 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). Given their unique structure and large species variety, diatoms are frequently used in the interpretation of geologic paleoenvironmental

studies, including a study of tidal environments in Oregon and Washington (Sawai and others, 2016). The oldest diatomite occurrences 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 2017 was sent to six diatomite-producing companies with 12 mining areas. All companies responded. All percentages in this report were calculated on the basis of unrounded data.

In 2017, 768,000 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. California was the leading producing State, followed by Nevada.

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 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, 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 are estimated to 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, such as 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; thus, processing costs are lower (Yilmaz and Ediz, 2008).

Consumption

Domestic apparent consumption of diatomite was approximately 690,000 t in 2017, a 10% increase from 628,000 t in 2016. The total quantity of filter-grade diatomite sold or used by U.S. producers was 450,000 t in 2017, a 35% increase from 333,000 t in 2016, accounting for 59% of total diatomite sold or used. The remaining amount, which totaled 318,000 t, a 10% decrease from 353,000 t in 2016, was primarily used for absorbent and filler purposes (table 2).

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-sized, irregular-shaped, porous noncaking particles that have a large surface area and high liquid-absorption capacity. The products are chemically inert, have a low refractive index, are mildly abrasive, have a low thermal conductivity with a relatively high fusion point, can be slightly pozzolanic, are very high in silica, and can be produced and delivered cost effectively for many 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 construction 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). Other uses are as an absorbent for industrial spills (oil and toxic liquids) as well as an absorbent in 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 important 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 2017, using USGS survey

data and estimates, was \$361 per metric ton f.o.b. plant, a 27% increase compared with about \$284 per ton in 2016 (table 3). The average unit value for diatomite used in filtration increased by 15% in 2017 to \$511 per ton from \$443 per ton in 2016. The value for diatomite used for absorbent purposes was \$10 per ton, a decrease of 74% from that of 2016. The large decrease was amplified as a result of a relatively small amount of produced absorbent material. The unit value for material used as fillers decreased slightly to \$401 in 2017 compared with \$407 per ton in 2016. The average value for diatomite used in other applications in 2017 decreased by 17% to \$10 per ton.

Foreign Trade

Export and import data presented here from the U.S. Census Bureau may be of limited accuracy with regard to diatomite because diatomite is included with other mineral commodities within several categories in the Harmonized Tariff Schedule of the United States (HTS). 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 included 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 75 countries in 2017. Exports of diatomite from the United States in 2017 were approximately 87,000 t, an increase of 32% from 66,000 t in 2016 (tables 1, 4). Exports accounted for about 11% of total domestic production sold or used. The main export markets were Mexico (19,000 t), Canada (16,000 t), Germany (12,000 t), China (4,400 t), and South Africa (3,500 t). These five countries accounted for 62% of total reported exports. Based on available U.S. Census Bureau data, the average unit value free alongside ship of exported diatomite was \$506 per ton in 2017 compared with \$570 per ton in 2016 (table 4). Import data for diatomite indicate that 9,370 t came from 12 countries in 2017. Canada was the leading source with 6,990 t (75%), followed by Mexico with 1,030 t (11%), Germany with 937 t (10%), Japan with 104 t (1%), and France with 100 t (1%). These five countries provided 98% of the imports to the United States in 2017.

World Review

Estimated world production of diatomite in 2017 was 2.46 Mt (table 5), a slight decrease from that of 2016. World reserves are thought to be almost 1 billion metric tons (Gt), which represents approximately 500 times current annual world production. About 250 Mt, or 25% of the estimated 1 Gt of world reserves, is in the United States (Crangle, 2018). The world's leading producing district in terms of quantity is near Lompoc, CA. A resource assessment of this location indicated that these deposits could supply all of the world's diatomite needs at current

rates of consumption for hundreds of years. Compilations of reserve estimates are not comprehensive because some data are proprietary and not released by companies or countries. Very large deposits, on the order of at least 110 Mt of reserves, have been reported in China (Lu, 1998, p. 53).

In 2017, the United States was the leading producer of diatomite, accounting for 31% of total world production, followed by Denmark with 18%, China with 17%, and Peru and Japan with 4% each. Smaller quantities of diatomite were mined in 23 additional countries (table 5).

Outlook

With the exception of decreased production while the world was recovering from an economic downturn, annual U.S. production has been more than 600,000 t since 1994 with production exceeding 900,000 t in 2014. Adequate supplies of diatomite are likely to remain available for the foreseeable future. The economic stability of the diatomite industry was largely owing to its use as a filtration medium, where demand remains strong, particularly in the filtration of spirits, as well as human blood plasma and other biotechnical applications. Likewise, the substitution for diatomite by more advanced filtration products, including carbon membranes, ceramics, and polymers, was not a concern in 2017. 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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TABLE 1
SALIENT DIATOMITE STATISTICS¹

(Thousand metric tons and thousand dollars)

	2013	2014	2015	2016	2017
United States:					
Sold or used, by producers:					
Quantity	782	901	832	686	768
Value	229,000	269,000	242,000	195,000	278,000
Exports ²	92	82	74	66	87
Imports for consumption ²	1	4	7	8	9
Apparent consumption ³	691	823	765	628	690
World, production ^e	2,930 ^r	3,190 ^r	3,090 ^r	2,530 ^r	2,460

^eEstimated. ^rRevised.

¹Table includes data available through June 20, 2018. Data are rounded to no more than three significant digits.

²Source: U.S. Census Bureau.

³Production plus imports minus exports.

TABLE 2
DIATOMITE SOLD OR USED, BY MAJOR USE^{1,2}

(Thousand metric tons)

	2016	2017
Filtration	333	450
Other ³	353	318
Total	686	768

¹Table includes data available through June 20, 2018.

Data are rounded to no more than three significant digits, may not add to totals shown.

²Includes exports.

³Includes abrasives, absorbents, cement, fillers, insulation, and unspecified uses.

TABLE 3
AVERAGE VALUE PER METRIC TON OF DIATOMITE,
BY MAJOR USE^{1,2}

(Dollars per metric ton)

	2016	2017
Absorbents	38	10
Fillers	407	401
Filtration	443	511
Insulation	NA	NA
Other ³	12	10
Weighted average	284	361

NA Not available.

¹Table includes data available through June 20, 2018. Data are rounded to no more than three significant digits.

²Rounded estimates.

³Includes 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	Principal destinations
2016	66	37,600 ^r	Canada, 24%; Germany, 18%; China, 6%; South Africa, 4%; Vietnam 4%.
2017	87	44,100	Mexico, 22%; Canada, 18%; Germany, 14%; China, 5%; South Africa, 4%.

¹Revised.

²Table includes data available through June 20, 2018. Data are rounded to no more than three significant digits.

³Harmonized Tariff Schedule of the United States (HTS) code 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 code 3802.90.2000.

⁴Free alongside ship value.

Source: U.S. Census Bureau.

TABLE 5
DIATOMITE: WORLD PRODUCTION, BY COUNTRY OR LOCALITY¹

(Thousand metric tons)

Country or locality	2013	2014	2015	2016	2017
Algeria	2	2	2	2 ^e	2
Argentina	209	189 ^r	189 ^r	200	57
Armenia	6 ^e	7 ^e	6 ^e	8	8
Australia	20 ^e	20 ^e	20 ^e	20 ^e	20
Brazil, marketable	2	2 ^r	3	3	3
Chile	27	31	26	26	27
China	310 ^r	379 ^r	350 ^r	420	420
Costa Rica	4 ^e	4 ^e	4 ^e	4 ^e	4
Czechia	392	449	451	26 ^r	26
Denmark ^{e,2}	460	410	470	440	440
Ethiopia	4 ^{r,e}	5 ^e	5 ^e	5 ^e	5
France ^e	75	75	75	75	75
Germany, siliceous earth	50 ^e	50 ^e	50	52 ^e	52
Guatemala, siliceous earth	(3)	(3)	(3)	--	--
Hungary	(3)	1	1	1	1
Iran	10	10	10	10 ^e	10
Italy ^e	25	25	25	25	--
Japan ^e	90	90	100	100	100
Kenya	1	1 ^r	1 ^r	(3)	(3)
Korea, Republic of, diatomaceous earth	34 ^e	65 ^r	15 ^r	20 ^r	21
Mexico	87	87 ^r	89 ^{r,e}	96 ^r	97
Mozambique	1	(3) ^r	(3) ^r	(3) ^r	(3)
New Zealand, diatomaceous earth	(3) ^r	44	40 ^r	40 ^r	40
Peru	125 ^e	151	121	107 ^r	110
Poland	1	1	1	1	1
Russia	70 ^e	72 ^e	66 ^r	47 ^r	47
Spain ⁴	54	54	50	50 ^e	50
Thailand	-- ^{r,e}	-- ^{r,e}	-- ^{r,e}	-- ^r	9
Turkey	85 ^r	62	87 ^r	62 ^r	62
United States ⁵	782	901	832	686	768
Total ^e	2,930 ^r	3,190 ^r	3,090 ^r	2,530 ^r	2,460

^eEstimated. ^rRevised. -- Zero.

¹Table includes data available through May 14, 2018. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

²Data represent "extracted moler" (reported cubic meters times 2.3). Danish extracted moler figures, in thousand cubic meters, are as follows: 2013—205; 2014—190; and 2015—192 (estimated). Contains about 30% clay.

³Less than ½ unit.

⁴Includes tripolite.

⁵Sold or used by producers.