2018 Minerals Yearbook

DIATOMITE [ADVANCE RELEASE]

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Diatomite

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Production of diatomite in the United States increased 25% to 957,000 metric tons (t) with a corresponding value of $319 million free on board (f.o.b.) plant compared with 768,000 t valued at $278 million f.o.b. plant in 2017 (table 1). The large production increase was caused by a single mine in Nevada operated by EP Minerals, LLC, which was purchased by U.S. Silica Holdings, Inc. on May 1, 2018. The United States was the world's leading producer of diatomite in 2018, accounting for 34% of the estimated world production total of 2.84 million metric tons (Mt) (table 5). Other leading producers included Denmark with 15%, China with 15%, Turkey with 6%, and the Republic of Korea with 5%. Diatomite was produced in 27 countries in 2018.

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 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 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 present in three distinct sizes, from micron to submicron diameters. The number and sizes of holes vary with the species (Imerys Minerals Ltd., 2018).

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 2018 was sent to six diatomite-producing companies with 13 mining areas. Responses were received from all companies either through returned surveys or through the disclosure of production information as published in company annual reports filed with the U.S. Securities and Exchange Commission. All percentages in this report were calculated on the basis of unrounded data.

In 2018, 957,000 t of diatomite was produced from 13 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 U.S. Silica) with operations in Nevada and Oregon. Nevada was the leading producing State, followed by California.

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 898,000 t in 2018, a 30% increase from 690,000 t in 2017. The total quantity of filter-grade diatomite sold or used by U.S. producers was 560,000 t in 2018, a 24% increase from 450,000 t in 2017, accounting for 59% of total diatomite sold or used. The remaining amount, which totaled 397,000 t, was primarily used for absorbent and filler purposes, which represented an increase of 25% from 318,000 t in 2017 (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 largest consumers for these products typically include the agriculture, automotive, biofuel, chemical, food and beverage, oil and gas, paint and coatings, pharmaceuticals, plastics, rubber, and spirits industries (U.S. Silica Holdings, Inc., 2019, p. 8). 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 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 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 2018, using USGS survey data and estimates, was $330 per metric ton f.o.b. plant, a 7% decrease compared with about $360 per ton in 2017 (table 3). The average unit value for diatomite used in filtration decreased by 4% in 2018 to $490 per ton from $510 per ton in 2017. The value for diatomite used for absorbent purposes was $70 per ton, a sevenfold increase from the reported $10 per ton value of 2017. The large increase was amplified as a result of a relatively small amount of produced absorbent material. The unit value for material used as fillers increased by 6% to $430 per ton in 2018 compared with $400 per ton in 2017. The average value for diatomite used in other applications in 2018 increased by 80% to an estimated $20 per ton. As with the absorbents end use, the large increase was likely a result of relatively small amounts of sold material.

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 77 countries in 2018. Exports of diatomite from the United States in 2018 were approximately 68,000 t, a decrease of 22% from 87,000 t in 2017 (tables 1, 4). Exports accounted for about 7% of total domestic production sold or used. The main export markets were Canada (15,000 t), Germany (12,000 t), China (5,400 t), Brazil (3,400 t), and South Africa (3,000 t). These five countries accounted for 57% of total reported exports. Based on available U.S. Census Bureau data, the average unit value free alongside ship of exported diatomite was $600 per ton in 2018 compared with $511 per ton in 2017 (table 4). Import data for diatomite indicate that 9,000 t came from 14 countries in 2018. Canada was the leading source with 4,000 t (62%), followed by Mexico with 1,000 t (15%), Germany with 970 t (15%), Japan with 180 t (3%), and China with 80 t (1%). These five countries provided 96% of the imports to the United States in 2018.

World Review

Estimated world production of diatomite in 2018 was 2.84 Mt (table 5), a 7% increase from that of the revised 2017 world production tonnage. World reserves are thought to be almost 1 billion metric tons (Gt), which represents approximately 350 times current annual world production. About 250 Mt, or 25% of the estimated 1 Gt of world reserves, is in the United States (Crangle, 2019). The world's leading producing district in terms of reserves and capacity 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 2018, the United States was the leading producer of diatomite, accounting for 34% of total world production, followed by China and Denmark, each with 15%; Turkey with 6%; and the Republic of Korea with 5%. Smaller quantities of diatomite were mined in 22 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 and 2018. Adequate supplies of diatomite are likely to remain available for the foreseeable future. The economic stability of the diatomite industry was largely due 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 2018. 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 STATISTICS[1]

(Thousand metric tons and thousand dollars)

	2014	2015	2016	2017	2018
United States:					
Sold or used, by producers:					
Quantity	901	832	686	768	957
Value	269,000	242,000	195,000	278,000	319,000
Exports[2]	82	74	66	87	68
Imports for consumption[2]	4	7	8	9	9
Apparent consumption[3]	823	765	628	690	898
World, production[e]	2,620 r	2,440 r	2,330 r	2,650 r	2,840

[e]Estimated. [r]Revised.
[1]Table includes data available through June 10, 2019. Data are rounded to no more than three significant digits.
[2]Source: U.S. Census Bureau.
[3]Production plus imports minus exports.

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

(Thousand metric tons)

Use	2017	2018
Filtration	450	560
Other[3]	318	397
Total	768	957

[1]Table includes data available through June 10, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes exports.
[3]Includes 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)

Use	2017	2018
Absorbents	10	72
Fillers	401	426
Filtration	511	489
Insulation	NA	NA
Other[3]	10	18
Weighted average	361	334

NA Not available.
[1]Table includes data available through June 10, 2019. Data are rounded to no more than three significant digits.
[2]Rounded estimates.
[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]	Principal destinations based on quantity
2017	87	44,100	Mexico, 22%; Canada, 18%; Germany, 14%; China, 5%; South Africa, 4%.
2018	68	40,800	Canada, 22%; Germany, 18%; China, 8%; Brazil, 5%; South Africa, 4%.

[1]Table includes data available through June 10, 2019. Data are rounded to no more than three significant digits.
[2]Harmonized Tariff Schedule (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.
[3]Free alongside ship value.

Source: U.S. Census Bureau.

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

(Thousand metric tons)

Country or locality	2014	2015	2016	2017	2018
Algeria	2	2	3 r	3 r	3 e
Argentina	52 r	61 r	57 r	70 r	70 e
Armenia	18 r	16 r	22 r	20 r	20 e
Australia[e]	15 r	14 r	12 r	12 r	12
Brazil, beneficiated	3 r	3	3	3	3 e
Chile	31	26	27 r	28 r	28 e
China	379	350	420	420	420 e
Costa Rica[e]	18 r	20 r	20 r	20 r	20
Czechia	34 r	15 r	26	34 r	34 e
Denmark[2]	440 r, e	440 r, e	440	440	440 e
Ethiopia	5 e	5 e	5 e	5	5 e
France[e]	75	75	75	75	75
Germany, siliceous earth	50 e	50	52 e	52	52 e
Guatemala, siliceous earth[e]	-- r	-- r	--	--	--
Hungary	1	1	1	1	1 e
Iran	10	10	10 e	10	10 e
Italy	-- r	-- r	-- r	--	-- e
Japan	50 r, e	50 r, e	41 r	40 r, e	40 e
Kenya	1	1	(3)	(3)	-- e
Korea, Republic of, diatomaceous earth	66 r	15	21 r	134 r	134 e
Mexico	88 r	90 r, e	97 r	96 r	96 e
Mozambique	(3)	(3) e	1 r	5 r	5 e
New Zealand, diatomaceous earth	44	40 e	40 e	40 e	40 e
Peru	151	121	107	110	110 e
Poland	1	1	1	1	1 e
Russia	72 e	66	47	47	47 e
Spain[4]	54	50	50 e	50	50 e
Thailand	--	--	1 r	1 r, e	1 e
Turkey	62	87	62	170 r	170 e
United States[5]	901	832	686	768	957
Total	2,620 r	2,440 r	2,330 r	2,650 r	2,840

[e]Estimated. [r]Revised. -- Zero.
[1]Table includes data available through April 30, 2019. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Data represent “extracted moler” (reported cubic meters times 2.3). Danish extracted moler figures, in thousand cubic meters, are as follows: 2014—190; and 2015, 2016, 2017, and 2018—192 (estimated). Contains about 30% clay.
[3]Less than ½ unit.
[4]Includes tripoli.
[5]Sold or used by producers.