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2015 Minerals Yearbook

DIATOMITE [ADVANCE RELEASE]

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Diatomite

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Production of diatomite in the United States decreased by 8% to 832,000 metric tons (t), with a corresponding value of $242 million free on board (f.o.b.) plant in 2015 compared with 901,000 t valued at $269 million f.o.b. plant in 2014 (table 1). The United States was the world's leading producer of diatomite in 2015, providing 31% of the estimated world production total of 2.67 million metric tons (Mt) (table 5). Other leading producers included Denmark with 16%, China with 16%, Argentina with 7%, Peru with 6%, and Japan with 4%. Diatomite was produced in 23 countries in 2015.

Diatomite used for filtration represented 59% of consumption, followed by its use as a cement additive (25%), as a filler (12%), and as an absorbent (4%). 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 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., 2013).

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).

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 (Centers for Disease Control, 1978; Oregon Occupational Safety and Health Division, Department of Consumer and Business Services, 2016). 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.

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 2015 was sent to 6 diatomite-producing companies with 12 mining areas. All companies responded. For those companies that provided incomplete information, estimates were made on the basis of prior-year data coupled with employment hours reported to the Mine Safety and Health Administration. All percentages in this report were calculated based on unrounded data.

In 2015, 832,000 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. The combined output of these two States accounted for 79% 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 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 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 and, thus, processing costs are lower (Yilmaz and Ediz, 2008).

Consumption

Domestic apparent consumption of diatomite was approximately 764,000 t in 2015, a 7% decrease from 823,000 t in 2014. The total quantity of filter-grade diatomite sold or used by U.S. producers was 490,000 t in 2015, a slight decrease from 493,000 t in 2014, accounting for 59% of total diatomite sold or used. For use in absorbents, 33,000 t of diatomite was reported, a decrease of 59% from 81,000 t in 2014. Use of diatomite as a filler was 97,000 t in 2015, a decrease of 23% from 126,000 t in 2014 (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). 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 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 2015, using USGS survey data and estimates, was $291 per metric ton f.o.b. plant, a slight decrease compared with about $298 per ton in 2014 (table 3). The average unit value for diatomite used in filtration increased slightly in 2015 to $416 per ton from $409 per ton in 2014. The value for diatomite used for absorbent purposes was $40 per ton, a decrease of 62% from that of 2014. The unit value for material used as fillers increased to $433 per ton in 2015, an increase of 10% from $394 per ton in 2014. The average value for specialized or other uses in 2015 increased to $551 per ton, an increase of 36% from $404 per ton in 2014.

Foreign Trade

Export and import data presented here from the U.S. Census Bureau may be of limited accuracy with regard to diatomite because it 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 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 88 countries in 2015. Exports of diatomite from the United States in 2015 were approximately 75,000 t, a decrease of 9% from 82,000 t in 2014 (table 4). Exports accounted for about 9% of total domestic production sold or used. The main export markets were Canada

(16,100 t), Germany (12,500 t), South Africa (3,550 t), China (3,460 t), and Belgium (3,300 t). These five countries accounted for 52% of the total reported exports. Based on available U.S. Census Bureau data, the average unit value free alongside ship of exported diatomite was $550 per ton in 2015 compared with $540 per ton in 2014 (table 4). Import data for diatomite indicate that 6,500 t came from eight countries in 2015. Canada was the leading source with 4,990 t (77%), followed by Mexico with 540 t (8%), Germany with 351 t (5%), China with 240 t (4%), and Switzerland with 172 t (3%). These five countries provided 97% of the imports to the United States in 2015.

World Review

Estimated world production of diatomite in 2015 was 2.67 Mt (table 5), a 3% decrease from 2.74 Mt in 2014. 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, 2016). 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 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. Very large deposits, on the order of at least 110 Mt of reserves, have been reported in China (Lu, 1998, p. 53).

In 2015, the United States was the leading producer of diatomite, accounting for 31% of total world production, followed by Denmark with 16%, China with 16%, Argentina with 7%, Peru with 6%, and Japan with 4%. Smaller quantities of diatomite were mined in 17 additional countries (table 5).

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 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, were not a concern in 2015. 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
DIATOMITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES[1]

(Thousand metric tons and thousand dollars)

	2014	2015
Domestic production, sales:		
Quantity	901	832
Value	269,000	242,000

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

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

(Thousand metric tons)

	2014	2015
Absorbents	81	33
Cement[2]	189	212
Fillers	126	97
Filtration	493	490
Other[3]	2	(4)

[1]Includes exports.
[2]As ingredient in portland cement; includes lightweight aggregates.
[3]Includes abrasives, insulation, and unspecified uses.
[4]Less than ½ unit.

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

(Dollars per metric ton)

	2014	2015
Absorbents	106	40
Cement[2]	10	10
Fillers	394	433
Filtration	409	416
Insulation	54	NA
Other[3]	404	551
Weighted average	298	291

NA Not available.
[1]Rounded estimates.
[2]As ingredient in portland cement.
[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]
2014	82	44,300 r
2015	75	41,300

[r]Revised.
[1]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.
[2]Data are rounded to no more than three significant digits.
[3]Free alongside ship value.

Source: U.S. Census Bureau.

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

(Thousand metric tons)

Country	2011	2012	2013	2014	2015
Algeria[3]	2	2	2	2	2
Argentina	61 [3]	278 [3]	209 r, 3	200 r	200
Armenia	(4)	(4)	(4) r	--	--
Australia	20	20	20	20	20
Brazil, marketable	4 [3]	2 [3]	2 [3]	2 [3]	2
Chile	23 [3]	23 [3]	27 [3]	31 r, 3	30
China	440	420	420	420	420
Costa Rica	4 [3]	4	4	4	4
Czech Republic	46 [3]	43 [3]	49 [3]	34 r, 3	30
Denmark[5]	460 r	410 r	470 r	440 r	440
Ethiopia	4	5	5	5	5
France	75	75	75	75	75
Italy	25	25	25	25	25
Japan	100	100	90	90	100
Kenya	1 [3]	2	1	1	1
Korea, Republic of, diatomaceous earth	5 [3]	6	34	66 r	70
Mexico	84 [3]	85	87 [3]	88 [3]	80
Mozambique	(4) [3]	1 [3]	1	1	1
Peru	10	94 [3]	125	151 r, 3	150
Poland	1	1	1	1	1
Russia	33 [3]	70	70	72 r	70
Spain[6]	54 [3]	61 [3]	54 r, 3	54 r	50
Thailand	38 [3]	9 [3]	--	--	--
Turkey	45 [3]	86 [3]	85 [3]	62 r, 3	60
United States[3, 7]	813	735	782	901	832
Total	2,350 r	2,550 r	2,640 r	2,740 r	2,670

[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]Includes data available through August 30, 2016.
[3]Reported figure.
[4]Less than ½ unit.
[5]Data represent "extracted moler" (reported cubic meters times 2.3). Danish extracted moler figures, in thousand cubic meters, are as follows: 2011—201; 2012—177; 2013—205; 2014—190; and 2015—192 (estimated). Contains about 30% clay.
[6]Includes tripoli.
[7]Sold or used by producers.