

CLAY AND SHALE

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Six types of clays are mined in the United States—ball clay, bentonite, common clay, fire clay, fuller's earth, and kaolin. Ball clays consist primarily of kaolinite with minor to major amounts of illite, chlorite, smectite minerals, quartz, and organic materials. Bentonites comprise smectite minerals (usually montmorillonite) with minor amounts of feldspars, biotite, and quartz. Common clays contain illite and chlorite as major components. Fire clay comprises mainly kaolinite, halloysite, and/or diasporite. Fuller's earth consists primarily of attapulgite or montmorillonite clays with quartz. Kaolin comprises primarily kaolinite or kaolin-group minerals. Color, plasticity, mineral composition, absorption qualities, firing characteristics, and clarification properties are a few of the characteristics used to distinguish between the different clay types.

The amount of clay sold or used by domestic producers in 2001 was 40.0 million metric tons (Mt) valued at \$1.47 billion, a decrease of 2% in tonnage and 3% in value from those of 2000. Production of bentonite increased, but production of ball clay, common clay and shale, fire clay, fuller's earth, and kaolin decreased. Of the clay and shale produced in 2001, common clay and shale accounted for 58% of the tonnage, and kaolin accounted for 59% of the value. Imports of clays increased to 148,000 metric tons (t) valued at \$33.9 million. Exports increased to 4.97 Mt valued at \$836 million (table 1).

Major markets for the individual clays were pottery and miscellaneous ceramics (14%), sanitaryware (22%), and floor and wall tile (35%) for ball clay; absorbents (25%), drilling mud (17%), foundry sand bond (20%), and iron ore pelletizing (14%) for bentonite; brick (55%), cement (18%), and lightweight aggregate (17%) for common clay and shale; refractories (72%) for fire clay; absorbents (75%) for fuller's earth; and paper coating and filling (60%) for kaolin.

Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) continued its work on the maximum achievable control technology (MACT) requirements for the clay processing and manufacturing industries. The MACT is required under the National Emissions Standards for Hazardous Air Pollutants Program, which was established by the 1990 Amendments to the Clean Air Act. The MACT covers clay processors and manufacturers of lightweight aggregate, brick and structural clay products, and ceramics. The EPA was developing a standard to require the affected industries to achieve 99.8% combustion efficiency for organic emissions. Another option is to limit emissions of total hydrocarbon to 20 parts per million. Since no data have been obtained from kilns operating under the conditions specified by the EPA during its standards development, there is some question as to whether these emission limits are achievable (Refractory News, 2001).

Clay mining has an environmental impact because of the disturbance to the land. Overburden is moved, and clays are removed, leaving a depression or pit. State laws usually require

leveling or contouring of the disturbed area and planting trees or grasses to prevent or minimize erosion. For processing, the impoundment of slimes and dust control is usually required. The rules for disposal of coarse tailings are similar to or included within those laws governing reclamation of the mined area.

Production

In 2001, 237 companies operated approximately 633 clay and shale pits or quarries. The largest 20 companies, many with multiple operations, accounted for 50% of the tonnage and 79% of the value for all types of clay produced and sold or used. Clay production was reported in all States except Alaska, Delaware, Hawaii, Idaho, New Hampshire, Rhode Island, Vermont, Wisconsin, and the District of Columbia (table 2). For States not reporting production, clay probably was extracted for construction uses by companies not participating in the U.S. Geological Survey (USGS) canvass of the clay and shale industry.

The 10 leading producer States, in decreasing order by tonnage, were Georgia, Wyoming, Alabama, Texas, North Carolina, Missouri, South Carolina, Ohio, California, and Virginia. The 10 leading producing companies, in alphabetical order, were American Colloid Co. (bentonite), Bentonite Performance Minerals (a division of Halliburton Energy Services, Inc.) (bentonite), Engelhard Corp. (bentonite, fuller's earth, and kaolin), General Shale Products Corp. (common clay and shale), Holnam, Inc. (common clay and shale), J.M. Huber Corp. (kaolin), IMERYS (ball clay and kaolin), Oil-Dri Corp. (fuller's earth), Solite Corp. (common clay and shale), and Thiele Kaolin Co. (kaolin).

Most clay mining in the United States was by open pit methods; less than 1% of U.S. clay output was from underground mines. All underground production was in Ohio where the clays are mainly underclays associated with coal.

Domestic production data for clays were developed by the USGS from a voluntary survey of U.S. operations. Responses to the survey (354 of 544 sent) account for approximately 85% of the total clay and shale production sold or used shown in table 1. The bulk of the nonrespondents were producers of common clay and shale. Production data for the nonrespondents were estimated from reported prior-year production levels adjusted by trends in the industry and other guidelines.

Ball Clay.—In 2001, 4 companies mined ball clay from 38 quarries in 4 States. Production of domestic ball clay was reported to be 1.10 Mt valued at \$45.2 million in 2001, a decrease from 1.14 Mt valued at \$48.4 million in 2000 (table 3). Tennessee supplied 62% of the Nation's output, followed by Texas, Kentucky, and Mississippi. Production decreased in all States. Water-slurried ball clay was produced in Kentucky and Tennessee. Airfloat and shredded (unprocessed) ball clay was produced in Kentucky, Mississippi, Tennessee, and Texas.

Hecla Mining Co. finalized its sale of Kentucky-Tennessee Clay Co. (K-T Clay) and K-T Feldspar Corp. to IMERYS, a French investment group, for \$62.5 million. The sale consisted of K-T Clay's ball clay operations in Kentucky, Mississippi, and Tennessee, kaolin operations in Georgia and South Carolina, a feldspar operation in North Carolina, and K-T Mexico, which produces clay slurries for the sanitaryware industry. The sale permits Hecla to focus on its metal mining operations and IMERYS to increase its presence as a supplier of raw materials for the ceramic industry (Hecla Mining Co., 2001; Industrial Minerals, 2001b).

Bentonite.—In 2001, 21 companies produced bentonite from approximately 86 pits in 12 States. The quantity and value of all varieties of bentonite sold or used were reported by producers to have increased to 4.29 Mt valued at \$187 million in 2001 from 3.76 Mt valued at \$155 million in 2000 (table 5). The 4.29 Mt reported in 2001 is believed to be excessive based on industry trends. U.S. production of bentonite probably was about 3.82 Mt valued at \$167 million (see discussion of swelling bentonite production). Production of nonswelling bentonite decreased to 357,000 t valued at \$11.5 million in 2001 from 400,000 t valued at \$14.0 million in 2000. Alabama led all States in the production of nonswelling bentonite, followed by Mississippi, Georgia, Arizona, Nevada, California, and Colorado. Production increased in Arizona, Colorado, decreased in Alabama, California, Mississippi, and Texas, and was unchanged in Nevada.

Production of swelling bentonite reported by producers increased to 3.94 Mt valued at \$175 million in 2001 from 3.36 Mt valued at \$141 million in 2000. It is believed, however, that production in Wyoming was actually lower than reported based on industry trends. The actual sales from production in Wyoming probably were closer to 3.1 Mt valued at \$133 million, giving a U.S. production of 3.46 Mt valued at \$155 million for swelling bentonite. Despite this, Wyoming still led all States in the production of swelling bentonite, followed by Montana, Utah, California, Texas, Oregon, and Mississippi. Production increased in California, Mississippi, Montana, Texas, and Wyoming and decreased in Oregon and Utah.

American Colloid opened its blending plant in Butler, GA. The plant will produce a preblended bentonite-based foundry sand additive for use by the metal-casting industry. The plant in Georgia is the company's 13th blending plant in the United States (Ceramic Bulletin, 2001a).

AMCOL International Corp. is increasing its presence in the nanocomposite field through its subsidiary Nanocor, Inc. Nanocor has licensed Honeywell Co. to use its ultrafine montmorillonite products in Honeywell's nylon packaging and engineering resins products. The packaging products act as a barrier film for oxygen and carbon dioxide. Composites made using nanocomposite technology have higher tensile modulus, flexural modulus, and flexural strength, allowing for lighter and thinner parts (AMCOL International Corp., 2001b; North American Minerals News, 2001d). Nanocor also worked with New Castle Industries to develop a mixing screw for extrusion and injection molding equipment. The new screw simplifies dispersal of nanocomposite particles in polymer resins (AMCOL International Corp., 2001a).

Common Clay and Shale.—In 2001, 163 companies produced common clay and shale from approximately 360 pits in 41 States and Puerto Rico. For States not reporting production, common clay and shale probably was mined and

sold for construction uses by companies not participating in the USGS canvass of the clay and shale industry. Most of these companies were manufacturers of structural clay products, such as brick, cement, clay pipe, drain tile, lightweight aggregates, and sewer pipe. About 90% of production was used to manufacture brick, lightweight aggregate, and cement.

Domestic sales or use of common clay and shale decreased to 23.2 Mt valued at \$129 million in 2001 from 23.7 Mt valued at \$135 million in 2000 (table 7). The major producing States, in decreasing order by tonnage, were North Carolina, Texas, Alabama, Georgia, Ohio, South Carolina, Missouri, Kentucky, Arkansas, Virginia, and California.

Fire Clay.—Fire clay producers were mostly refractories manufacturers that used the clays in firebrick and other refractories. In 2001, 35 pits were operated by 9 firms in 4 States.

Fire clay sold or used by domestic producers decreased to 383,000 t valued at \$5.97 million in 2001 from 476,000 t valued at \$7.56 million in 2000 (table 9). Missouri was the leading producing State, followed by Ohio, South Carolina, and California. Production increased in South Carolina and decreased in California, Colorado, Kentucky, Missouri, and Ohio. Colorado and Kentucky did not report production in 2001.

RHI Refractories Holding Co. (the parent company of Harbison-Walker Refractories Co., A.P. Green Refractories Co., and North American Refractories Co.) announced that it was restructuring its U.S. refractories operations because of the downturn in the U.S. steel industry. The company operated 24 manufacturing facilities in Canada and the United States. Several of these operations will be closed during the restructuring to reduce production capacity. Also, Harbison-Walker Refractories and A.P. Green Refractories are facing liability issues related to asbestos law suits. Both companies used asbestos in some refractory products in the 1950s, 1960s, and 1970s (Industrial Minerals, 2001f; RHI Refractories Holding Co., 2001).

Fuller's Earth.—In 2001, 16 companies produced fuller's earth (attapulgite and montmorillonite varieties) from 31 pits in 11 States. Production of fuller's earth decreased to 2.89 Mt valued at \$233 million in 2001 from 2.91 Mt valued at \$254 million in 2000. Owing to undervaluing of the attapulgite production by one producer, the actual value of production is believed to be about \$20 million greater than reported in both years (table 11; "Prices"). The fuller's earth deposits grade from attapulgite-rich in Florida to montmorillonite-rich further northward into Georgia. Only those clays for which attapulgite is the major clay component are classified as attapulgite. These basically are the gellant-grade fuller's earths in Florida and the southernmost part of Georgia. Going northward into Georgia, the attapulgite content of the fuller's earth declines, and montmorillonite becomes the dominant clay present. This is classified under montmorillonite although it contains minor to trace amounts of attapulgite.

The attapulgite variety of fuller's earth was mined from 8 pits in the Florida panhandle and southwestern Georgia. Although only Engelhard and Milwhite Co. mined attapulgite in 2001, a portion of the production was sold by ITC Inc. under the terms of a U.S. Department of Justice-directed purchase agreement of Floridin Co. by Engelhard in 1997, making, in essence, three producers of attapulgite. Attapulgite production was reported as essentially unchanged at 292,000 t valued at \$13.5 million by

producers in 2001. However, attapulgite production was believed to be greatly undervalued by one producer in 2001; the actual value of U.S. production was estimated to be about \$33 million. Florida led in the production of attapulgite followed by Georgia. Production of the montmorillonite variety of fuller's earth was 2.59 Mt valued at \$220 million in 2001, a slight decrease from 2.62 Mt valued at \$240 million in 2000. Montmorillonite was produced, in decreasing order by tonnage, in Georgia, Mississippi, Missouri, Illinois, Virginia, California, Florida, Tennessee, Kansas, and Texas.

Oil-Dri announced that it would supply A&M Products Manufacturing Co. (a subsidiary of The Clorox Co.) with two calcium bentonite cat litter products. The products will be produced at Oil-Dri's Ocklocknee, GA, facility. Clorox will then close its Wrens, GA, facility. That facility opened in 1991. A&M Products will continue to operate its facility for cat litter products in Taft, CA (Industrial Minerals, 2001d).

Oil-Dri completed its environmental impact statement and continued with the permitting process for its mill facility near Reno, NV. The mines will be located on Federal land. The mill was to be built off-site to minimize the visual impact and to benefit the local residents. In December, the Washoe County Planning Commissioners denied issuance of a special use permit for the facility. Oil-Dri has appealed that decision but indicated that, if necessary, the company can build the facility at the mine (Oil-Dri Corp., 2001).

Sepiolite clay, produced in Nevada, is included with the attapulgite variety of fuller's earth to avoid disclosing company proprietary data. Production in Kansas is a saprolitic clay but is included with montmorillonite for the same reason.

Kaolin.—In 2000, 24 firms mined kaolin from approximately 83 pits in 10 States. Domestic production decreased to 8.11 Mt valued at \$867 million in 2001 from 8.80 Mt valued at \$929 million in 2000 (table 13). The leading producer State was Georgia, followed by Alabama, South Carolina, California, North Carolina, Nevada, Texas, Arkansas, Florida, and Tennessee.

Approximately 56% of the kaolin produced was water washed; 17%, calcined; 13%, delaminated; 11%, airfloat; and 3%, unprocessed (table 14). A total of 1.37 Mt valued at \$238 million of calcined kaolin was reported. Of this amount, 769,000 t valued at \$224 million was pigment-grade (low-temperature). The remainder was refractory-grade (high-temperature) calcined kaolin (table 15). As has occurred in each of the past 2 years, it is believed that production of refractory-grade calcined kaolin production was greater than reported by producers in 2001. Actual U.S. production is estimated to be in the 850,000-t-to-950,000-t range rather than 602,000 t as reported by producers, based on industry trends.

Kaolin production in Georgia decreased to 7.02 Mt valued at \$816 million in 2001 from 7.66 Mt valued at \$877 million in 2000. Approximately 64% of the production was sold as water washed; 16%, delaminated; 12%, calcined; 8%, air float; and less than 1%, unprocessed (table 16). Production of calcined kaolin in Georgia probably was between 1.0 Mt and 1.10 Mt rather than 812,000 t in 2001 due to underreporting by refractory kaolin producers. Production in South Carolina decreased to 377,000 t valued at \$22.8 million in 2001 from 397,000 t valued at \$21.9 million in 2000. Approximately 83% of the production was airfloat kaolin with the remainder being unprocessed (table 18).

Engelhard announced plans to shift the focus of some of its

production from paper to the more profitable petroleum catalyst lines. The company planned to reduce production of paper-filler grades of kaolin at its Gordon, GA, facility and to increase production of kaolin grades that are used in the production of some of Engelhard's petroleum catalysts. The company will continue to produce about 2.2 million metric tons per year (Mt/yr) of kaolin in Georgia (North American Minerals News, 2001b).

Imerys announced a reduction of 726,000 t of capacity for papergrade products at its Georgia operations. The cut-back is in response to declining markets and prices. Before the reduction, Imerys' Deepstep operation produced about 907,000 tons per year (t/yr) of hydrous kaolin product, and the Dry Branch and Jefferson operations produced about 1.09 Mt/yr. In 1999, Imerys had transferred plants at Sandersville and Wrens, GA, to J.M. Huber Co. in return for full ownership in Huber's precipitated calcium carbonate venture Faxe Paper Pigments-USA. The Sandersville plant had calcined- and hydrous-kaolin capacities of 36,000 t/yr and 771,000 t/yr, respectively. The Wrens plant had calcined- and hydrous-kaolin capacities of 45,000 t/yr and 227,000 t/yr, respectively (Industrial Minerals, 2001a).

Alchemy Ventures Ltd. continued its investigation of the Helmer Bovill kaolin deposit in Idaho. The company announced plans to open several pits to obtain kaolin ore for pilot plant testing. The company plans to produce about 18,100 t of product of various grades for testing. Byproducts will include potassium feldspar and silica sand. The company also plans to begin an assessment of halloysite resources in its Corral Creek deposit (Alchemy Ventures Ltd., 2001; North American Minerals News, 2001e).

Kaoclay Resources Inc. (the parent company of Sparta Kaolin Corp.) indicated that it has identified 21 kaolin deposits in Georgia and South Carolina. Resources in 10 of the deposits were estimated to be 63.5 Mt (Kaoclay Resources Inc., 2001).

Atlas Mining Co. announced its intent to acquire a halloysite mine in north-central Utah, subject to due diligence. About 1.2 Mt of halloysite was produced from the mine between 1950 to 1973. There is an estimated 300,000 t of reserves consisting of greater than 98% halloysite. A large volume of reserves containing less than 98% halloysite also has been identified on the site. The company will evaluate the feasibility of upgrading that material. Halloysite is used in the manufacture of petroleum cracking catalysts, specialty cements, china, and porcelain (Atlas Mining Co., 2001).

Consumption

Ball Clay.—The principal domestic ball clay markets, in decreasing order, were floor and wall tile, sanitaryware, and refractories (table 4). Consumption decreased to 1.10 Mt in 2001 from 1.14 Mt in 2000. Sales decreased slightly in all end-use categories. In general, sales and use of ball clay have increased since 1990 because growth in commercial and residential building construction and home renovations has increased demand for sanitaryware, tile, and whiteware. Despite the continued growth in these markets, domestic sales of ball clay have declined slightly in the past 2 years owing partially to competition from imports of sanitaryware and tile.

Bentonite.—Major markets for bentonite were drilling mud, foundry sand, iron ore pelletizing, and pet waste absorbents. While sales by producers were reported to be 4.29 Mt, it is

likely that they were closer to 3.32 Mt in 2001. Consequently, data in table 6 must be adjusted. Estimated sales, based on industry trends, for pet waste absorbents were 900,000 t; for foundry sand bond, 756,000 t; for pelletizing iron ore, 507,000 t; and for miscellaneous applications, 21,800 t. This gives a total of 3.39 Mt for domestic sales of bentonite. Sales to other markets and exports remained unadjusted. Based on these estimates, drilling mud, foundry sand, iron ore pelletizing, and pet waste absorbents accounted for about 85% of the domestic sales (table 6). Total sales (domestic and exports) of bentonite were approximately 799,000 t for drilling mud (more than 99% was swelling bentonite), 994,000 t for foundry sand bond (795,000 t was swelling bentonite), 565,000 t for pelletizing iron ore (all swelling bentonite), 904,000 t for pet waste absorbent (more than 99% was swelling bentonite), and 305,000 t for waterproofing and sealing (more than 99% was swelling bentonite). These five markets accounted for 93% of total bentonite sales.

Data for other bentonite markets were concealed to avoid disclosing company proprietary data. However, more than 90% of the bentonite sold for absorbents, animal feed, civil engineering, oil drilling mud, pelletizing iron ore, pharmaceutical, waterproofing, and water treatment; slightly more than 70% of bentonite sold for foundry sand and miscellaneous chemical manufacture applications, and more than 50% of sales for paint and water treatment was swelling bentonite. Bentonite sold for desiccant, for filtering, clarifying, and decolorizing of oils and greases, and for miscellaneous filler and extender applications was largely the nonswelling variety of bentonite.

The major domestic markets for swelling bentonite, in decreasing order, were pet waste absorbents, drilling mud, foundry sand, iron ore pelletizing, and waterproofing and sealing. Major export markets for swelling bentonite, in decreasing order, were foundry sand, drilling mud, and iron ore pelletizing applications. The major domestic uses for nonswelling bentonite, in decreasing order, were in foundry sand; clarifying, decolorizing, and filtering of oils and greases; miscellaneous absorbents; chemical manufacture; animal feed; and desiccants. Very little nonswelling bentonite was exported.

Common Clay and Shale.—Common clay was used most frequently in the manufacture of heavy clay products, such as building brick, drain tile, flue linings, lightweight aggregate, portland cement, sewer pipe, structural tile, and terra cotta (table 8). Consumption of common clay and shale decreased slightly to 23.2 Mt in 2001 from 23.7 Mt in 2000. Despite the slight decline, the strong housing and commercial building market has helped maintain sales of common clay and shale for brick and lightweight aggregate manufacture for the past several years. Privately owned housing starts increased to 1.6 million units in 2001 from 1.57 million units in 2000 (U.S. Department of Commerce, 2002a).

Fire Clay.—Fire clays were used in refractory products, such as firebrick and block, grogs and calcines, high-alumina brick and specialties, saggars, refractory mortars and mixes, and ramming and gunning mixes. Fire clays also were used to produce such items as brick and pottery.

Consumption of fire clay decreased to 383,000 t in 2001 from 476,000 t in 2000 (table 10). Major markets for fire clay, in decreasing order, were firebrick, refractory mortar and cement, common brick, grogs and calcines, portland cement, miscellaneous refractories, pottery, and foundry sand. Sales for

brick under “Heavy clay products and lightweight aggregates” and unspecified refractory applications under “Other refractories” accounted for the bulk of the sales decline for fire clay. Fire clay, like many refractory raw materials, has been affected by changing refractory technology and more lately, a declining steel industry.

Fuller’s Earth.—The major domestic uses for attapulgite and montmorillonite varieties of fuller’s earth, in decreasing order, were pet waste absorbents; oil and grease absorbents; portland cement manufacture; fertilizer carriers; animal feed; filtering, clarifying, and decolorizing of oils and greases; pesticide carrier; paint; adhesive; drilling mud; and desiccant (table 12). Consumption of fuller’s earth decreased to 2.89 Mt in 2001 from 2.91 Mt in 2000.

Sales of montmorillonite decreased to 2.59 Mt in 2001 from 2.62 Mt in 2000. Major domestic markets for montmorillonite, in decreasing order, were pet waste absorbents; oil and grease absorbents; portland cement; fertilizer carrier; clarifying, decolorizing, and filtering of oils and greases; animal feed; desiccant; and pesticide carrier.

Sales of attapulgite remained unchanged at 292,000 t in 2001. Most of the sales data were concealed to avoid disclosing company proprietary data. Major markets, in decreasing order, were fertilizer carrier; oil and grease absorbents; paint; pet waste absorbents; drilling mud; adhesives; pesticide carriers; and animal feed.

Sales of montmorillonite variety of fuller’s earth accounted for more than 70% of sales of fuller’s earth for animal feed; portland cement manufacture; clarifying, decolorizing, and filtering oils and greases; desiccant; oil and grease absorbents; and pet waste absorbents. Attapulgite accounted for more than 60% of the sales for adhesive and pesticide carriers and all of the sales for asphalt tile, drilling mud, gypsum products, paint, pharmaceuticals, roofing granules, and textiles. The largest increase in sales for an end-use market was for fertilizer carriers. A decline occurred in sales for pet waste absorbents and pesticide carriers. The decrease in sales for pet waste absorbents was distributed among many producers. The change in sales for fertilizer and pesticide carriers involved only one company, so it probably represented a shift in its classification of the product.

Kaolin.—Consumption of kaolin decreased to 8.11 Mt in 2001 from 8.80 Mt in 2000. The major domestic markets for kaolin, in decreasing order, were paper coating and filler, refractories, fiber glass, paint, catalyst, and rubber (table 20). Most categories remained relatively unchanged or declined. The largest decreases in domestic sales again were for paper coating (340,000 t or 12%) and paper filler applications (92,000 t or 18%). Paper coating and filler markets have been affected in recent years by a stagnating paper market and competition from calcium carbonate, respectively. Sales of kaolin for refractories were reported by producers to be 637,000 t in 2001 and 424,000 t in 2000. These data are believed to be considerably less than actual sales to the refractories market. Estimated sales of refractory-grade kaolin probably were between 850,000 t and 950,000 t in 2001 and about 1.0 Mt in 2000. This corresponds more closely with recent sales patterns for clay refractories. Major domestic markets for kaolin from Georgia, in decreasing order, were paper coating, paper filling, paint, fiberglass, catalyst manufacture, and refractories (table 17).

Absorbent Uses.—Sales reported by producers for absorbent

uses were about 3.33 Mt, an increase of 8% compared with that of 2000. As mentioned earlier, reported sales of bentonite for pet waste absorbents were considerably greater than expected based on industry trends. Actual sales of clay for absorbents were estimated to be 3.13 Mt in 2001 compared with 3.07 Mt in 2000. Fuller's earth accounted for 66% of the clay used for absorbents, followed by bentonite and kaolin. Pet waste absorbents accounted for 89% of absorbent consumption, followed by oil and grease absorbents and miscellaneous absorbent applications.

Ceramics.—All varieties of clays were used in ceramics. Demand for clay in the manufacture of ceramics, ranging from china to sanitaryware to roofing granules, was 1.81 Mt, a decrease from 2.00 Mt in 2000. The largest ceramics market was ceramic floor and wall tile (46%), followed by sanitaryware (18%), catalyst (12%), roofing granules (10%), quarry tile (4%), fine china (3%), and pottery (3%). Ball clay accounted for 41% of the clay used in ceramics, followed by common clay and shale (35%) and kaolin (23%). Small amounts of bentonite, fire clay, and fuller's earth also were used in the manufacture of ceramics. Ball clay dominated the crockery, electrical porcelain, glazing, and sanitaryware markets. Common clay and shale was the predominant clay used in quarry tile and roofing granules. Kaolin dominated the catalyst market. Ball clay and common clay and shale were the predominant clays used in floor and wall tile manufacture, and ball clay and kaolin dominated the fine china markets.

Production and shipments of clay tile decreased by 12% and 9%, respectively. Apparent consumption of clay floor and wall tile was 211 million square meters valued at \$2.11 billion in 2001, a decrease from 214 million square meters valued at \$1.96 billion in 2000. Domestic manufacturers shipped 54.9 million square meters of clay floor and wall tile valued at \$776 million in 2001 compared with 60.4 million square meters valued at \$867 million in 2000. Imports were 159 million square meters valued at \$1.36 billion in 2001 and 155 million square meters valued at \$1.12 billion in 2000 (U.S. Census Bureau, 2002a).

Approximately 2.04 million square meters of tile valued at \$17.8 million was imported in 2001 compared with 2.05 million square meters valued at \$18.6 million in 2000, according to the U.S. Census Bureau.

Data on sales of vitreous sanitaryware used in the United States were not available for 2001 or 2000. In 1999, apparent consumption was valued at \$976 million compared with \$886 million in 1998. The value of manufacturer shipments was \$932 million in 1999 versus \$883 million in 1998. The value of imports increased to \$101 million in 1999 from \$68 million in 1998. Shipments of vitreous china lavatories were 3.27 million units in 1999 compared with 3.26 million units in 1998, 7.89 million units of vitreous china water closet bowls in 1999 compared with 8.22 million units in 1998, and 7.31 million units of vitreous china flush tanks in 1999 compared with 7.17 million units in 1998 (U.S. Census Bureau, 2000). Imports of sanitaryware continued to increase in 2001. The U.S. Census Bureau source reported 17.5 million units of sanitaryware imported in 2001 compared with 16.2 million units in 2000 and 14.9 million units in 1999.

Construction.—Common clays and shales were used to manufacture a wide variety of construction materials, including expanded aggregates, hydraulic cement, and structural clay products.

Expanded Clay and Shale.—Approximately 3.87 Mt of clay and shale was used in the production of lightweight aggregates (table 21). Nearly all the clay used to manufacture lightweight aggregates was common clay and shale. Lightweight aggregates were used in concrete block, structural concrete, and highway surfacing, in decreasing order of consumption.

Hydraulic Cement.—Clays provide the alumina and silica required to manufacture hydraulic cements. In 2001, approximately 4.57 Mt of clays was consumed, an increase from 4.19 Mt in 2000. In decreasing order, common clay and shale, fuller's earth, kaolin, fire clay, and bentonite were used in the manufacture of portland cement clinker. More than 92% of the clay consumed by the cement industry was common clay and shale.

Structural Clay Products.—Approximately 13.4 Mt of clays was used in the manufacture of structural clay products, such as building brick, roofing tile, and sewer pipe. Common and face brick accounted for 95% of this total. Other markets, in decreasing order by tonnage, were flue linings, sewer pipe, flower pots, structural tile, terra cotta, drain tile, and roofing. About 98% of the clay used to manufacture structural clay products was common clay and shale. Small amounts of bentonite, fire clay, fuller's earth, and kaolin also were used.

In 2001, 7.95 billion building and face bricks valued at \$1.69 billion was shipped compared with 8.62 billion bricks valued at \$1.69 billion in 2000. Structural facing tile and ceramic glazed brick shipments totaled 25,800 units valued at \$13.7 million in 2001 compared with 28,100 units valued at \$13.2 million in 2000. About 44,900 t of structural clay tile valued at \$10.6 million was shipped in 2001 compared with 42,600 t valued at \$9.07 million in 2000. Shipments of vitrified clay and sewer pipe fittings were 142,000 t valued at \$44.1 million compared with 146,000 t valued at \$55.7 million in 1999 (U.S. Census Bureau, 2002a).

Drilling Mud.—Sales (domestic and exports) for drilling mud applications were 800,000 t (733,000 t sold domestically and 66,700 t exported). Swelling-type bentonite accounted for approximately 99% of the clay used in drilling mud. Fuller's earth also was used in drilling mud applications.

Drilling activity in North America decreased in 2001. The number of rotary rigs operating as of December 24, 2001, was 1,196 in Canada and the United States compared with 1,563 in 2000 (Oil & Gas Journal, 2001a). By midyear, worldwide drilling increased in 2001 to an average 739 active rigs per month from 591 in 2000, excluding Canada and the United States (Oil & Gas Journal, 2001b).

Fillers, Extenders, and Binders.—Clays are used as fillers, extenders, and binders in a wide variety of products, such as adhesives, flooring products, paint, paper, and rubber. About 4.26 Mt of clays was sold for use as fillers, extenders, and binders in 2001 compared with 4.61 Mt in 2000. The bulk of the decline was in sales of kaolin to the paper industry. Paper coating and filling accounted for 68% of domestic sales, followed by paint (8%), rubber (5%), fertilizer carrier (3%), wallboard (3%), and animal feed (3%). Adhesive, asphalt tile, fertilizer carrier, gypsum products, ink, medical (and cosmetic and pharmaceutical), pesticide carrier, plastic, textile, and wallboard applications each accounted for less than 2% of the fillers and extenders markets.

Kaolin accounted for approximately 87% of the clay used in filler and extender applications, followed by fuller's earth (7%), common clay and shale (4%), bentonite (2%), and ball clay and

fire clay (less than 1%). Bentonite was the predominant clay used for ink applications; common clay and shale, for wallboard production; fuller's earth, for fertilizer and pesticide applications; and kaolin, for gypsum products, paint, paper, plastics, rubber, and textile markets. Fuller's earth and kaolin were the major type of clay used in adhesives; ball clay and fuller's earth, in animal feed; and bentonite and fuller's earth, in pharmaceuticals.

The U.S. Census Bureau reported shipments of paints and coatings through the second quarter of 2002 to be 633,000 gallons valued at \$8.34 billion compared with 1.19 billion gallons valued at \$15.7 billion for the entire year in 2001. Architectural paints accounted for 350 million gallons, product coatings for 203 million gallons, and special purpose coatings for 80 million gallons in the first two quarters of 2002 compared with 618 million gallons, 407 million gallons, and 162 million gallons, respectively, for all of 2001 (U.S. Census Bureau, 2002c). Architectural paints are the major market for industrial mineral fillers among the paint types.

Fiberglass.—Domestic sales to the fiberglass industry were reported by producers to be 322,000 t in 2001 compared with 304,000 t in 2000. Although 288,000 t of kaolin sales for fiberglass was reported in table 20, it is likely that 34,000 t reported under ball clay should have been reported as kaolin.

Iron Ore Pelletizing.—Sales (domestic and exports) reported by producers were 669,000 t in 2001 compared with 558,000 t in 2000. As discussed earlier, sales reported by bentonite producers were greater than expected based on industry trends. Actual sales of clays for pelletizing were estimated to be 565,000 t. Domestic use accounted for 507,000 t in 2001 compared with 500,000 t in 2000. Swelling bentonite was the only type of clay used for this application.

Paper Products.—Kaolin accounted for almost all the clay sales used for paper coating (2.48 Mt sold domestically and 1.86 Mt exported) and essentially all the clay used for paper filling (414,000 t sold domestically and 85,200 t exported). A small amount of bentonite also was sold for paper applications.

The U.S. paper industry experienced a downturn in 2001, resulting in a reduction of capacity within the industry. Contributing to the downturn in U.S. paper demand was the strong U.S. dollar, which hurt U.S. paper competitiveness both domestically and overseas. Capacity decreases were anticipated in all sectors of the paper industry (Walden's North American Pulp and Paper Report, 2001§¹). This downward trend in U.S. paper production has resulted in declining return on investment for the domestic paper-grade kaolin producers for the past few years through declining sales, increased competition from calcium carbonate, declining prices, and increased energy costs. The kaolin industry has reduced capacity to counter this trend and introduced several new engineered kaolin products to enhance paper characteristics and combat market losses. Use of kaolin in paper is expected to remain flat or turn slightly downward during the next 5 years (Director, 2001§).

Refractories.—Producers reported that 2.60 Mt of clays was used for the domestic manufacture of refractories in 2001 compared with an estimated 2.80 Mt in 2000. As mentioned earlier, it is believed that underreporting occurred in 2001. It is estimated that the reported tonnage should be increased by about 200,000 t to 300,000 t, bringing sales for refractory usage

¹References that include a section twist (§) are found in the Internet References Cited section.

to about 2.90 Mt compared with 2.80 Mt in 2000 and 3.06 Mt in 1999. The largest domestic markets, as reported by producers, were foundry sand (34%), firebrick (28%), refractory mortar and cement (13%), grogs and calcines (5%), high alumina brick and kiln furniture (1%). The market percentages for refractories must be used with caution for all but the foundry sand and the refractory mortar and cement categories because of the uncertainty in the data for specific market destinations.

Bentonite accounted for 34% of domestic refractory sales, followed by common clay and shale, 29%; kaolin, 25%; fire clay, 11%; ball clay, 1%; and fuller's earth, less than 1%. Fire clay and kaolin were the predominate clays used in firebrick and grogs; bentonite, in foundry sand; common clay, in refractory mortar and cement; and kaolin, in high aluminum brick.

Data on U.S. refractories production and shipments were not available for 2001. The U.S. Census Bureau reported shipments of clay refractories to be \$771 million in 2000 compared with \$919 million in 1999. In 2000, 775,000 t (262 million bricks) valued at \$365 million of clay refractory brick and shapes was shipped by manufacturers. This can be subdivided into fire clay brick and shapes, 372,000 t (108 million bricks) valued at \$146 million; high alumina brick and shapes, 369,000 t (127 million bricks) valued at \$173 million; and insulating brick and shapes, 33,800 t (27.8 million bricks) valued at \$44.8 million. Shipments of unshaped clay refractories were 680,000 t valued at \$363 million. This can be broken out into refractory mortars, 111,000 t valued at \$57.4 million; plastic refractories, 138,000 t valued at \$79.6 million; castable refractories, 305,000 t valued at \$178 million; and fire clay gunning mixes, 125,000 t valued at \$47.7 million. Approximately 143,000 t of miscellaneous refractories valued at \$23.3 million and \$19.9 million of other unknown types of clay refractories also was sold in 2000 (U.S. Census Bureau, 2001).

Refractories sales have declined sharply in recent years because of declining steel production. Steel production in November 2001 was at a rate of 1.6 million metric tons per week (Mt/wk) compared with a rate of 2.1 Mt/wk in November 2000. Contributing factors for the downturn in the steel industry are competition from imported steel, worldwide overcapacity, a strong U.S. dollar, increased energy costs, and a slower U.S. economy. The result is an oversupply of refractories that has caused prices to decline, worsening the situation (North American Minerals News, 2001a). Despite the decline through 2001, it is predicted that the industry will improve and provide modest growth by 2005. Sales of nonclay refractories are predicted to grow by 1.3% between 2000 and 2005; for clay refractories, growth is predicted to be 1.8% (Ceramic Bulletin, 2001b).

Prices

Ball Clay.—The average value for ball clay reported by domestic producers was \$41.09 per metric ton. The average values for imported and exported ball clay were \$270.31 per ton and \$54.89 per ton, respectively.

Bentonite.—The average value reported by domestic producers for nonswelling bentonite was \$32.21 per ton. The average value for swelling bentonite was \$44.42 per ton. The average value for all bentonite was \$43.59 per ton. The average value of imported bentonite was \$549.07 per ton. The average value of exported bentonite was \$124.52 per ton.

The price, ex-works, Wyoming, crude, bulk, rail cars, was \$28 per ton to \$69 per ton; foundry grade, bagged, rail cars, \$57

per ton to \$84 per ton; API-grade, bagged, rail cars, \$50 per ton to \$58 per ton (Industrial Minerals, 2001e).

Common Clay and Shale.—The average value for all common clay and shale produced in the United States and Puerto Rico was \$5.56 per ton. The average value of clay and shale used in lightweight aggregate was \$13.62 per ton. The value for lightweight aggregate is an estimate of the clay value. Average prices for lightweight aggregate produced from clay and shale range from \$30 per ton to \$50 per ton for most applications.

Fire Clay.—The average value for fire clay reported by domestic producers was \$15.58 per ton. The average of imported fire clay was \$587.84 per ton. The average value of exported fire clay was \$90.34 per ton.

Fuller's Earth.—The average value of attapulgite-type fuller's earth was estimated to be \$113.28 per ton. The value reported by producers on the USGS canvass and given in table 11 was believed to be greatly undervalued based on available pricing on attapulgite. The average value of montmorillonite-type fuller's earth was \$84.66 per ton. The average value of all fuller's earth was estimated to be \$87.56 per ton. The average value of imported fuller's earth was \$451.61 per ton. The average value of exported fuller's earth was \$161.64 per ton.

The price, ex-plant, Georgia, 40% to 100% less than 325 mesh, truck load, was \$220 per ton to \$551 per ton; granular processed, 40% to 100% less than 4/8 mesh, truck load, \$193 per ton to \$551 per ton; granular, 6/30 mesh, truck load, \$132 per ton to \$220 per ton; and granular, 6/30 mesh, gel grade, bagged, \$358 per ton to \$772 per ton (Industrial Minerals, 2001e).

Kaolin.—The average value of kaolin was \$106.91 per ton for all kaolin grades. The average value for airfloat was \$54.64 per ton; refractory grade (high-temperature calcined), \$24.25 per ton; pigment grade (low-temperature calcined), \$291.28 per ton; all types of calcined, \$173.72 per ton; delaminated, \$102.72 per ton; water washed, \$101.98 per ton; and unprocessed, \$16.88 per ton. The average value of the imported kaolin was \$164.04 per ton. The average value of exported kaolin was \$164.83 per ton.

The price, ex-works, Georgia, filler, bulk, was \$88 per ton to \$110 per ton; coating, bulk, \$94 per ton to \$204 per ton; sanitaryware-grade, bagged, \$71 per ton to \$82 per ton; tableware-grade, bagged, \$138 per ton; and calcined, bulk, \$369 per ton to \$435 per ton (Industrial Minerals, 2001e).

Energy costs continued to hamper profitability for major kaolin producers. Engelhard, Huber, Imerys, and Thiele Kaolin Co. instituted price increases in 2001. The China Clay Producers Association estimated that energy costs for natural gas had increased to \$72 million in 2000 from \$50 million in 1999 despite energy conservation measures reducing consumption by 14%. Energy costs were estimated to represent 25% of all production costs, being higher for the more energy-consuming calcined products (North American Minerals News, 2001e).

Foreign Trade

Ball Clay.—Ball clay exports increased to 174,000 t valued at \$9.55 million, according to the U.S. Census Bureau (table 23). Domestic ball clay producers reported that 181,000 t of ball clay was exported in 2001 (table 4). Imports were 3,570 t of ball clay valued at \$965,000 (table 24).

Bentonite.—Bentonite exports decreased to 628,000 t valued

at \$78.2 million (table 23). Domestic bentonite producers reported exports of 428,000 t (table 6). The discrepancy between producers and the U.S. Census Bureau may result from producers including most of the exports destined for Canadian markets (193,000 t) under domestic sales. Sales through U.S. mineral brokers, where producers do not know if the bentonite is used domestically or exported, could also explain part of the discrepancy.

Bentonite imports consisted mainly of untreated bentonite clay and chemically or artificially activated materials. Imports of untreated bentonite were 4,280 t valued at \$2.35 million. Imports of chemically activated material were 21,400 t valued at \$9.33 million (table 24).

Fire Clay.—Approximately 238,000 t of fire clay valued at \$21.5 million was exported (table 23). In 2001, 148 t of fire clay valued at \$87,000 was imported (table 24).

Fuller's Earth.—Approximately 146,000 t of fuller's earth valued at \$23.6 million was exported (table 23). Approximately 31 t of decolorizing earth and fuller's earth valued at \$14,000 was imported in 2001 (table 24).

Kaolin.—The U.S. Census Bureau reported that 3.44 Mt of kaolin valued at \$567 million was exported in 2001 compared with 3.69 Mt valued at \$621 million in 2000 (table 23). Producers reported exports of 2.70 Mt (table 20). Much of the 848,000 t of kaolin destined for Canada, particularly for its paper markets, probably was reported under domestic consumption.

Kaolin imports increased to 114,000 t valued at \$18.7 million in 2001 compared with 62,500 t valued at \$19.5 million in 2000 (table 24). Approximately 90% of the imports was from Brazil, followed by the United Kingdom with 7%.

World Review

World production of bentonite was approximately 10.4 Mt, fuller's earth production was estimated to be 3.89 Mt, and kaolin production was 42.0 Mt (tables 25-27). The world production data for kaolin also contain common clay for Colombia, ball clay for Australia, and crude kaolin ore for many other countries. Sales of processed kaolin were estimated to be about 24.8 Mt, after excluding 100,000 t for Australia, 7.5 Mt for Colombia, 4 Mt for the Czech Republic, 200,000 t for Egypt, 600,000 t for Iran, and 4 Mt for Uzbekistan. The United States continued to be the leading producer of all three varieties of clays, followed by Greece and countries of the former Soviet Union for bentonite; Germany for fuller's earth; and Uzbekistan, the Czech Republic, and the United Kingdom for crude kaolin production. Spain led all countries in the production of sepiolite.

Australia.—Eaglehawk Kaolin Pty. continued its environmental and title issues on a 36 Mt kaolin deposit in the Thangoo region in Western Australia. The deposit is a secondary kaolin. The company patented a process for synthesizing zeolites from the kaolin, which it hopes to sell to the Australian wine industry.

WA Kaolin Holdings Pty. Ltd. began conducting a feasibility study of a kaolin deposit near Wickepin, assuming an production of 250,000 t/yr of coating and filler grades of kaolin (Industrial Minerals, 2001c).

Brazil.—Rio Capim Caulim SA (RCC) (partially owned by Imerys) increased its capacity to 600,000 t/yr from 400,000 t/yr and began construction of a 160-kilometer pipeline to its processing plant at the port of Barcarena (Industrial Minerals,

2001h). Parà Pigmentos SA (PPSA), another of the three major Brazilian producers, increased its production capacity to 600,000 t/yr. PPSA sold 318,000 t in 1999 with 78% to the European market, 13% to Asia, and 9% consumed domestically (Companhia Vale do Rio Doce, 2001).

Canada.—Exploration Tom Inc., Rouyn-Noranda, Quebec, acquired a bentonite deposit in Gaspésie, Quebec. Reserves are about 300,000 t. The bentonite, in combination with perlite from another deposit of Exploration Tom, will be tested for the manufacture of lightweight concrete products. Testing will be done by Laval University and is cosponsored by the Canadian Government (North American Minerals News, 2001c).

Greece.—Silver & Baryte Ores Mining Co. Ltd. (S&B) obtained full ownership of IKO-Erbsloeh GmbH & Co. GD, a specialty bentonite product supplier. S&B had controlled about 75% of IKO shares prior to the acquisition. This purchase eliminates some of the intermediaries between the producer and consumers of bentonite products (Industrial Minerals, 2001g).

Outlook

The outlook for the clay industry will be mixed for the next few years. Construction-oriented markets still are growing slowly despite the slowdown in the U.S. economy. Still, sales of clays for adhesives, brick, ceramics, fiber glass, lightweight aggregate, paint, and other construction-oriented markets have slowed and even declined slightly. Very low growth in sales of clays to these markets probably will persist as long as the U.S. economy continues to stagnate. Similarly, the slow economy affects sales of clays for such industrial manufacturing applications as foundry sand bond, iron ore pelletizing, oil and grease absorbents, and refractories. Interest in oil exploration and processing should continue to provide a slight boost in sales for catalysts and drilling muds. Pet litter markets should remain strong but growth will be low. Competition in the paper-filler and coating markets as well as increased fuel costs will continue to hamper the kaolin industry.

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TABLE 1
SALIENT U.S. CLAY STATISTICS 1/ 2/

(Thousand metric tons and thousand dollars)

	1997	1998	1999	2000	2001
<u>Domestic clays sold or used by producers:</u>					
Quantity	42,000	41,900	42,200	40,800	40,000
Value	\$1,670,000	\$1,670,000	\$1,570,000	\$1,520,000	\$1,470,000
<u>Exports:</u>					
Quantity	5,080	5,230	4,800	5,260	4,970
Value	\$860,000	\$843,000	\$823,000	\$896,000	\$836,000
<u>Imports for consumption:</u>					
Quantity	64	86	90	96	148
Value	\$23,200	\$27,700	\$23,000	\$34,900	\$33,900

1/ Excludes Puerto Rico.

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

TABLE 2
CLAYS SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 2001, BY STATE 1/ 2/

(Thousand metric tons and thousand dollars)

State	Ball clay	Bentonite	Common clay and shale	Fire clay	Fuller's earth	Kaolin	Total	Total value
Alabama	--	132	2,050	--	--	W	2,180	28,800
Arizona	--	W	W	--	--	--	W	W
Arkansas	--	--	989	--	--	W	989	1,440
California	--	W	885	W	W	W	885	18,300
Colorado	--	W	254	--	--	--	254	1,500
Connecticut	--	--	55	--	--	--	55	183
Florida	--	--	94	--	334	32	460	26,800
Georgia	--	W	1,360	--	879	7,020	9,250	901,000
Illinois	--	--	198	--	367	--	565	35,100
Indiana	--	--	575	--	--	--	575	1,470
Iowa	--	--	274	--	--	--	274	836
Kansas	--	--	635	--	W	--	635	4,280
Kentucky	W	--	1,010	--	--	--	1,010	4,230
Louisiana	--	--	663	--	--	--	663	1,670
Maine	--	--	49	--	--	--	49	125
Maryland	--	--	266	--	--	--	266	560
Massachusetts	--	--	36	--	--	--	36	321
Michigan	--	--	595	--	--	--	595	2,280
Minnesota	--	--	14	--	--	--	14	15
Mississippi	W	155	461	--	385	--	1,000	39,000
Missouri	--	--	1,030	289	W	--	1,310	7,020
Montana	--	252	W	--	--	--	252	16,200
Nebraska	--	--	133	--	--	--	133	338
Nevada	--	5	--	--	28	W	33	4,630
New Jersey	--	--	W	--	--	--	W	W
New Mexico	--	--	35	--	--	--	35	205
New York	--	--	647	--	--	--	647	7,960
North Carolina	--	--	2,340	--	--	47	2,390	11,600
North Dakota	--	--	68	--	--	--	68	W
Ohio	--	--	1,320	W	--	--	1,320	7,410
Oklahoma	--	--	783	--	--	--	783	1,910
Oregon	--	W	237	--	--	--	237	662
Pennsylvania	--	--	758	--	--	--	758	2,320
South Carolina	--	--	1,050	42	--	377	1,460	27,000
South Dakota	--	--	200	--	--	--	200	W
Tennessee	680	--	304	--	W	W	984	29,000
Texas	W	W	2,120	--	29	W	2,150	11,000
Utah	--	51	360	--	--	--	411	5,490
Virginia	--	--	937	--	W	--	937	1,840
Washington	--	--	89	--	--	--	89	258
West Virginia	--	--	167	--	--	--	167	462
Wyoming	--	3,570	11	--	--	--	3,590	153,000
Total	1,100	4,290	23,200	383	2,890	8,110	40,000	1,470,000

See footnotes at end of table.

TABLE 2--Continued
 CLAYS SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 2001, BY STATE 1/ 2/

W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.
 1/ Excludes Puerto Rico.
 2/ Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 3
 BALL CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Airfloat		Water-slurried		Unprocessed		Grand total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2000:								
Tennessee	287	14,400	180	7,660	218	7,160	685	29,300
Other 2/	212	11,500	W	W	W	W	456	19,100
Total	499	26,000	180	7,660	218	7,160	1,140	48,400
2001:								
Tennessee	254	12,700	195	8,400	230	7,670	680	28,800
Other 2/	186	9,580	W	W	W	W	425	16,400
Total	440	22,300	195	8,400	230	7,670	1,100	45,200

W Withheld to avoid disclosing company proprietary data; included in "Grand total."
 1/ Data are rounded to no more than three significant digits; may not add to totals shown.
 2/ Includes Kentucky, Mississippi, and Texas.

TABLE 4
 BALL CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE
 IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	2000	2001
Fillers, extenders, binders 2/	W	W
Floor and wall tile	400,000	387,000
Miscellaneous ceramics 3/	151,000	135,000
Pottery	22,700	20,500
Refractories 4/	68,500	62,200
Sanitaryware	256,000	247,000
Miscellaneous 5/	78,600	71,900
Exports 6/	164,000	181,000
Total	1,140,000	1,100,000

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."
 1/ Data are rounded to no more than three significant digits; may not add to totals shown.
 2/ Includes rubber and other fillers, extenders and binders.
 3/ Includes catalysts, electrical porcelain, fiber glass, fine china/dinnerware, glazes, mineral wool, and miscellaneous ceramics.
 4/ Includes firebrick, blocks, shapes, and kiln furniture.
 5/ Includes fillers, extenders, binder, and waterproofing seals.
 6/ Includes ceramics and glass, fillers, extenders and binders, and floor and wall tile.

TABLE 5
BENTONITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Nonswelling		Swelling		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2000:						
California	W	W	W	W	21	2,160
Mississippi	W	W	--	--	W	W
Nevada	W	W	W	W	6	W
Wyoming	--	--	3,080	126,000	3,080	126,000
Other 2/	400	14,000	285	14,400	658	26,200
Total	400	14,000	3,360	141,000	3,760	155,000
2001:						
California	W	W	W	W	W	W
Mississippi	W	W	W	W	155	4,900
Nevada	5	758	W	W	5	758
Wyoming	--	--	3,570	153,000	3,570	153,000
Other 2/	352	10,700	362	22,200	559	28,000
Total	357	11,500	3,940	175,000	4,290	187,000

W Withheld to avoid disclosing company proprietary data; included with "Other" or "Total." -- Zero.

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

2/ Includes Alabama, Arizona, California (2001), Colorado, Georgia (2001), Montana, Oregon, Texas, and Utah.

TABLE 6
BENTONITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	2000	2001
Domestic:		
Absorbents:		
Pet waste absorbents	862,000	1,100,000
Other absorbents	W	W
Adhesives	5,680	2,170
Animal feed	46,800	49,900
Ceramics (except refractories) 2/	W	W
Drilling mud	654,000	733,000
Filler and extender applications 3/	35,400	47,100
Filtering, clarifying, decolorizing, mineral oils and greases, vegetable oils, desiccants	93,800	91,600
Foundry sand	835,000	876,000
Pelletizing (iron ore) 4/	500,000	611,000
Miscellaneous refractories 5/	4,050	W
Miscellaneous 6/	66,800	81,800
Waterproofing and sealing	254,000	270,000
Total	3,360,000	3,870,000
Exports:		
Drilling mud	56,400	66,700
Foundry sand	233,000	238,000
Other 7/	115,000	124,000
Total	404,000	428,000
Grand total	3,760,000	4,290,000

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

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

2/ Includes catalysts and pottery.

3/ Includes asphalt tiles, cosmetics, ink, medical, miscellaneous fillers and extenders applications, paint, paperfilling (2000), pesticides and related products (2001), pharmaceutical, and plastics.

4/ Excludes shipments to Canada. Total sales in North America were 558,000 metric tons in 2000 and 669,000 metric tons in 2001.

5/ Includes kiln furniture (2000) and miscellaneous refractories.

6/ Includes chemical manufacturing, heavy clay products, and other unknown uses.

7/ Includes absorbents, fillers and extender, miscellaneous refractories, pelletizing, and other unknown uses.

TABLE 7
COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY STATE 1/ 2/

(Thousand metric tons and thousand dollars)

State	2000		2001	
	Quantity	Value	Quantity	Value
Alabama	2,090	23,200	2,050	24,800
Arkansas	958	1,170	989	1,440
California	969	16,800	885	18,300
Georgia	1,500	5,200	1,360	4,580
Indiana	639	1,560	575	1,470
Kansas	594	3,970	635	4,280
Kentucky	1,000	4,190	1,010	4,230
Michigan	594	3,210	595	2,280
Mississippi	484	2,200	461	2,040
Missouri	1,050	3,240	1,030	3,420
New York	630	7,820	647	7,960
North Carolina	2,430	18,600	2,340	11,100
Ohio	1,370	7,380	1,320	7,410
Oklahoma	757	2,060	783	1,910
Pennsylvania	840	1,870	758	2,320
South Carolina	890	2,790	1,050	4,150
Texas	2,210	9,460	2,120	8,750
Virginia	1,010	2,380	937	1,840
Other 3/	3,730	17,400	3,630	16,300
Total	23,700	135,000	23,200	129,000

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

2/ Excludes Puerto Rico.

3/ Includes all other States except Alaska, Delaware, Hawaii, Idaho, Nevada, New Hampshire, Rhode Island, Vermont, and Wisconsin.

TABLE 8
COMMON CLAY AND SHALE SOLD OR USED BY
PRODUCERS IN THE UNITED STATES, BY USE 1/ 2/

(Metric tons)

Use	2000	2001
Ceramics and glass 3/	W	W
Civil engineering and sealing	28,000	W
Floor and wall tile:		
Ceramic	517,000	409,000
Other 4/	W	68,600
Heavy clay products:		
Brick, extruded	11,600,000	11,100,000
Brick, other	1,730,000	1,680,000
Drain tile and sewer pipe	71,900	79,900
Flowerpots	W	W
Flue linings	259,000	256,000
Structural tile	W	W
Other 5/	108,000	71,400
Lightweight aggregate:		
Concrete block	2,330,000	2,370,000
Highway surfacing	239,000	284,000
Structural concrete	941,000	857,000
Miscellaneous 6/	344,000	358,000
Portland and other cements	4,030,000	4,110,000
Refractories 7/	472,000	741,000
Miscellaneous 8/	1,060,000	808,000
Total	23,700,000	23,200,000

See footnotes at end of table.

TABLE 8--Continued
COMMON CLAY AND SHALE SOLD OR USED BY
PRODUCERS IN THE UNITED STATES, BY USE 1/ 2/

W Withheld to avoid disclosing company proprietary data; included with "Other" or "Miscellaneous."
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes Puerto Rico.
3/ Includes pottery and roofing granules.
4/ Includes quarry tile and miscellaneous floor and wall tiles.
5/ Includes flower pots, roofing tile, terra cotta, and miscellaneous clay products.
6/ Includes miscellaneous lightweight aggregates.
7/ Includes firebrick, block and shapes, mortar and cement, and miscellaneous refractories.
8/ Includes asphalt emulsion, asphalt tile (2000), exports, miscellaneous fillers and extenders, wall board, and other unknown uses.

TABLE 9
FIRE CLAY SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY STATE 1/ 2/

(Thousand metric tons and thousand dollars)

State	2000		2001	
	Quantity	Value	Quantity	Value
Missouri	351	4,630	289	3,610
Other 3/	125	2,940	94	2,370
Total	476	7,560	383	5,970

1/ Refractory uses only.

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

3/ Includes California, Colorado (2000), Kentucky (2000), Ohio, and South Carolina.

TABLE 10
FIRE CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	2000	2001
Heavy clay products and lightweight aggregates 2/	101,000	88,200
Refractories:		
Firebrick, block, shapes	140,000	146,000
Other refractories 3/	208,000	131,000
Miscellaneous 4/	26,900	18,300
Total	476,000	383,000

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

2/ Includes common brick, portland cement, and terra cotta.

3/ Includes foundry sand, grogs and calcines, mortar and cement, and miscellaneous refractories.

4/ Includes animal feed, ceramics and glass, pottery, quarry tile (2000), and other unknown uses.

TABLE 11
FULLER'S EARTH SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Attapulgate 2/		Montmorillonite		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2000:						
Georgia	W	W	W	W	919	81,400
Southern States 3/	--	--	996	79,400	996	79,400
Western States 4/	W	W	W	W	995	93,100
Total	292	13,500 5/	2,620	240,000	2,910	254,000

See footnotes at end of table.

TABLE 11--Continued
FULLER'S EARTH SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Attapulgite 2/		Montmorillonite		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2001:						
Georgia	W	W	W	W	879	80,600
Southern States 3/	--	--	991	81,900	991	81,900
Western States 4/	W	W	W	W	1,020	70,700
Total	292	13,500	2,590	220,000	2,890	233,000

W Withheld to avoid disclosing company proprietary data; included with "Southern States" or "Total." -- Zero.

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

2/ Primarily gellant-grade fuller's earth; information in the discussion under "Production: Fuller's Earth."

3/ Includes Florida, Mississippi, Tennessee, and Virginia.

4/ Includes California, Illinois, Kansas, Missouri, Nevada, and Texas.

5/ Information can be found in the discussion of fuller's earth under "Prices."

TABLE 12
FULLER'S EARTH SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	2000	2001
Absorbents:		
Oil and grease absorbent	276,000	296,000
Pet waste absorbent	1,920,000	1,870,000
Animal feed	83,100	W
Fertilizers	62,500	135,000
Fillers, extenders, binders 2/	70,200	70,200
Filtering, clarifying, decolorizing, animal, mineral, vegetable oils, greases	72,300	67,800
Pesticides and related products	79,500	29,400
Miscellaneous 3/	347,000	338,000
Exports 4/	W	79,100
Total	2,910,000	2,890,000

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

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

2/ Includes adhesives, asphalt emulsions and tiles, gypsum products, medical, pharmaceutical and cosmetics, paint, textiles, and other unknown uses.

3/ Includes animal feed (2001), drilling mud, portland cement, refractories, roofing granules, and other unknown uses.

4/ Includes absorbents, drilling mud, fillers, extenders and binders, floor and wall tiles, heavy clay products (2001), mineral oils and greases (2001), and other unknown uses (2000).

TABLE 13
KAOLIN SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	2000		2001	
	Quantity	Value	Quantity	Value
Georgia	7,660	877,000	7,020	816,000
South Carolina	397	21,900	377	22,800
Other 2/	742	30,400	715	28,100
Total	8,800	929,000	8,110	867,000

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

2/ Includes Alabama, Arkansas, California, Florida, Nevada, North Carolina, Tennessee, and Texas.

TABLE 14
KAOLIN SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY KIND 1/

(Thousand metric tons and thousand dollars)

Kind	2000		2001	
	Quantity	Value	Quantity	Value
Airfloat	1,420	65,300	915	50,000
Calcined 2/	1,190	261,000	1,370	238,000
Delaminated	1,160	119,000	1,100	113,000
Unprocessed	210	2,640	192	3,240
Water washed	4,820	482,000	4,540	463,000
Total	8,800	929,000	8,110	867,000

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

2/ Includes pigment- and refractory-grade calcined kaolin; information can be found in the discussion under "Production: Kaolin."

TABLE 15
CALCINED KAOLIN SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Refractory-grade		Pigment-grade	
	Quantity	Value	Quantity	Value
2000:				
Alabama and Georgia	W	W	839	247,000
Other 2/	W	W	(3/)	(3/)
Total	354 4/	9,760	839	247,000
2001:				
Alabama and Georgia	W	W	730	215,000
Other 2/	W	W	39	8,350
Total	602	14,600	769	224,000

W Withheld to avoid disclosing company proprietary data; included in "Total."

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

2/ Includes Arkansas, California, South Carolina (2001), and Texas.

3/ Included with "Refractory-grade" to avoid disclosing company proprietary data

4/ Information can be found in the discussion under "Production: Kaolin."

TABLE 16
GEORGIA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND 1/

(Thousand metric tons and thousand dollars)

Kind	2000		2001	
	Quantity	Value	Quantity	Value
Airfloat	616	29,200	593	28,000
Calcined 2/	1,070	248,000	812	216,000
Delaminated	1,160	119,000	1,100	113,000
Unprocessed	61	655	59	609
Water washed	4,760	480,000	4,460	459,000
Total	7,660	877,000	7,020	816,000

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

2/ Includes pigment- and refractory-grade calcined kaolin; information can be found in the discussion under "Production: Kaolin."

TABLE 17
 GEORGIA KAOLIN SOLD OR USED BY PRODUCERS, BY USE 1/ 2/

(Metric tons)

Use	2000	2001
Domestic:		
Ceramics and glass:		
Catalysts (oil-refining)	W	155,000
Electrical porcelain	W	W
Fiber glass	277,000	265,000
Roofing granules	22,200	20,100
Sanitaryware	82,900	77,200
Other 3/	218,000	38,500
Fillers, extenders, binders:		
Adhesives	55,600	43,400
Paint	290,000	256,000
Paper coating	2,810,000	2,470,000
Paper filling	505,000	413,000
Plastic	49,600	46,200
Rubber	64,400	60,400
Other 4/	100,000	213,000
Heavy clay products 5/	17,400	17,400
Refractories 6/	278,000	132,000
Undistributed 7/	182,000	158,000
Total	4,960,000	4,370,000
Exports:		
Paint	400,000	353,000
Paper coating 8/	1,930,000	1,860,000
Paper filling 8/	100,000	85,200
Rubber	7,670	7,270
Undistributed 9/	263,000	340,000
Total	2,700,000	2,650,000
Grand total	7,660,000	7,020,000

W Withheld to avoid disclosing company proprietary data; included with "Other" or "Undistributed."

1/ Includes airfloat, high- and low-temperature calcined and delaminated, water washed, and unprocessed kaolin.

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

3/ Includes fine china/dinnerware, pottery, and miscellaneous ceramics.

4/ Includes animal feed (2000), asphalt tile, fertilizers, gypsum products, medical, pharmaceutical and cosmetics, pesticides and related products, textiles and miscellaneous fillers, extenders and binders.

5/ Includes brick (common and face) and miscellaneous clay products.

6/ Includes firebricks, blocks and shapes, grogs and calcines, high-alumina specialties, kiln furniture, and miscellaneous refractories; also information can be found in the discussion under "Production: Kaolin."

7/ Includes chemical manufacturing, floor and wall tiles, and other unknown uses.

8/ Some export sales may be included under domestic sales.

9/ Includes adhesives, catalyst (oil-refining), fiber glass, sanitaryware, miscellaneous fillers, extenders and binders, portland cement, and miscellaneous refractories.

TABLE 18
SOUTH CAROLINA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND 1/

(Thousand metric tons and thousand dollars)

Kind	2000		2001	
	Quantity	Value	Quantity	Value
Airfloat	337	21,400	313	21,400
Unprocessed	61	485	63 2/	1,400 2/
Total	397	21,900	377	22,800

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

2/ Includes calcined kaolin.

TABLE 19
SOUTH CAROLINA KAOLIN SOLD OR USED
BY PRODUCERS, BY KIND AND USE 1/

(Metric tons)

Kind and use	2000	2001
Adhesives	12,700	126,000
Ceramics 2/	W	102,000
Rubber	161,000	140,000
Refractories 3/	W	7,350
Other uses 4/	224,000	81,700
Exports 5/	W	32,700
Total	397,000	377,000

W Withheld to avoid disclosing company proprietary data; included with "Other uses."

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

2/ Includes catalysts (oil-refining), fine china/dinnerware; glazes, glass, and enamels; pottery; roofing granules; sanitaryware; and miscellaneous ceramics.

3/ Includes firebrick, blocks and shapes, and miscellaneous refractories.

4/ Includes asphalt tile, brick (common and face), catalysts (oil refining), chemical manufacturing, civil engineering and sealings, drilling mud (2001), fillers, extenders and binders, heavy clay products, lightweight aggregates (2001), paints, and plastics.

5/ Includes refractories (2001) and fillers, extenders, and binders.

TABLE 20
KAOLIN SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	2000	2001
Domestic:		
Ceramics:		
Catalyst (oil and gas refining)	219,000	212,000
Electrical porcelain	7,890	6,940
Fine china and dinnerware	28,700	26,300
Floor and wall tile	49,400	39,900
Pottery	13,500	4,590
Roofing granules	38,700	37,400
Sanitaryware	90,600	81,100
Miscellaneous	8,420	W
Chemical manufacture	31,200	31,600
Civil engineering	W	W
Fiber glass, mineral wool	304,000	288,000
Fillers, extenders, binders:		
Adhesive	68,300	56,000
Fertilizer	4,050	3,580
Medical, pharmaceutical, cosmetic	W	738
Paint	326,000	274,000
Paper coating	2,820,000	2,480,000
Paper filling	506,000	414,000
Pesticide	W	W
Plastic	53,100	50,800
Rubber	226,000	201,000
Miscellaneous	115,000	225,000
Heavy clay products:		
Brick, common and face	126,000	122,000
Portland cement	81,100	W
Refractories: 2/		
Firebrick, block and shapes	13,600	W
Groggs and calcines	153,000	W
High-alumina brick, specialties, kiln furniture	W	W
Foundry sand, mortar, cement, miscellaneous refractories	257,000	637,000
Miscellaneous applications	514,000	225,000
Total	<u>6,050,000</u>	<u>5,410,000</u>
Exports:		
Ceramics	228,000	219,000
Paint	412,000	365,000
Paper coating	1,930,000	1,860,000
Paper filling	100,000	85,200
Rubber	33,700	39,600
Miscellaneous	38,100	125,000
Total	<u>2,740,000</u>	<u>2,700,000</u>
Grand total	<u>8,800,000</u>	<u>8,110,000</u>

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous" or "Miscellaneous applications."

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

2/ Information can be found in the discussion under "Consumption: Kaolin" and "Consumption: Refractories."

TABLE 21
COMMON CLAY AND SHALE USED IN LIGHTWEIGHT AGGREGATE PRODUCTION IN THE UNITED STATES BY STATE 1/

(Thousand metric tons and thousand dollars)

State	Concrete block	Structural concrete	Highway surfacing	Other	Total	Total value e/
2000:						
Alabama and Arkansas	848	131	8	--	987	15,300
California e/	53	220	--	--	272	10,600
Florida and Indiana	205	34	--	--	236	1,570
Kansas, Kentucky, Louisiana	409	227	9	91	735	2,830
Missouri	--	--	--	122	122	1,820
New York	82	54	--	--	136	5,600
North Carolina e/	301	52	--	--	353	4,050
Ohio and Oklahoma	170	11	--	--	182	1,420
Texas e/	49	157	222	31	459	2,520
Utah and Virginia	209	59	--	100	367	5,860
Total	2,330	941	239	344	3,850	51,600
2001:						
Alabama and Arkansas	885	133	8	--	1,030	16,800
California e/	46	164	--	--	210	9,880
Florida and Indiana e/	205	34	--	--	236	1,570
Kansas, Kentucky, Louisiana	427	196	53	93	769	3,010
Missouri	--	--	--	134	134	2,000
New York e/	82	54	--	--	136	5,600
North Carolina e/	301	52	--	--	353	4,050
Ohio and Oklahoma	170	12	--	--	182	1,420
Texas e/	49	157	222	31	459	2,520
Utah and Virginia e/	209	59	--	100	367	5,860
Total	2,370	857	284	358	3,870	52,700

e/ Estimated. -- Zero.

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

TABLE 22
COMMON CLAY AND SHALE USED IN BUILDING BRICK PRODUCTION IN THE UNITED STATES, BY STATE 1/ 2/

(Thousand metric tons and thousand dollars)

State	2000		2001	
	Quantity	Value	Quantity	Value
Alabama	910	2,310 r/	815	2,170
Arkansas	479	366	478	540
California	251	734	243	409
Colorado	224	1,790	202	1,320
Connecticut, New Jersey 3/, New York 3/	358	1,640	368	1,760
Georgia	1,150	3,140	1,160	3,180
Illinois	188	804	188	874
Indiana and Iowa	395	1,250	394	1,170
Kentucky 3/ and Tennessee 3/	789	2,100	787	2,100
Maryland and West Virginia 4/	317	1,060	294	582
Mississippi and Missouri	531	2,240	491	2,060
North Carolina	1,990	6,100 r/	1,890	5,770
Ohio	845	4,370	837	4,450
Oklahoma	455	975	481	829
Pennsylvania	743	1,470	655	1,910
South Carolina	876	2,720	778	2,600
Texas	1,110	3,950 r/	1,040	6,960
Virginia	687	2,240 r/	W	W
Other 5/	1,050	3,250 r/	1,650	4,050
Total	13,300	42,500 r/	12,800	43,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Other."

1/ Includes extruded and other brick.

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

3/ Extruded brick only.

4/ Includes other brick only.

5/ Includes Arizona, Kansas, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Nebraska, New Mexico, North Dakota, Utah, Washington, and State indicated by the symbol W.

TABLE 23
U.S. EXPORTS OF CLAYS IN 2001, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	Ball clay		Bentonite		Fire clay		Fuller's earth	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	(2/)	3	(2/)	155	(2/)	22	1	641
Australia	--	--	1	608	11	913	(2/)	6
Belgium	--	--	1	1,140	(2/)	11	2	359
Brazil	(2/)	46	12	2,240	(2/)	10	(2/)	32
Canada	19	1,880	193	14,400	6	1,120	88	13,800
Finland	--	--	--	--	--	--	(2/)	14
France	(2/)	5	10	793	(2/)	117	(2/)	35
Germany	(2/)	97	(2/)	99	(2/)	56	(2/)	35
Indonesia	--	--	5	1,040	(2/)	60	7	1,490
Italy	--	--	5	442	(2/)	5	3	999
Japan	(2/)	96	136	13,700	41	3,580	(2/)	96
Korea, Republic of	(2/)	113	18	2,410	5	967	(2/)	5
Malaysia	--	--	30	2,150	(2/)	8	2	217
Mexico	95	3,470	19	2,440	68	4,740	1	142
Netherlands	(2/)	39	41	2,960	15	1,300	23	2,030
Singapore	(2/)	49	4	1,300	--	--	(2/)	124
South Africa	(2/)	11	(2/)	228	--	--	--	--
Taiwan	16	402	23	3,050	16	1,040	(2/)	75
Thailand	--	--	19	1,810	(2/)	3	(2/)	73
United Kingdom	4	110	47	13,200	(2/)	82	2	310
Venezuela	24	2,010	14	2,010	1	182	(2/)	62
Other	16	1,220	50	11,000	75	7,270	17	3,060
Total	174	9,550	628	78,200	238	21,500	146	23,600

	Kaolin		Clays, n.e.c. 3/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	4	990	3	4,060	8	5,870
Australia	22	11,800	5	4,550	39	17,800
Belgium	51	10,500	(2/)	967	55	13,000
Brazil	3	1,410	3	1,530	18	5,260
Canada	848	88,100	144	32,300	1,300	152,000
Finland	282	49,600	1	1,980	283	51,600
France	9	2,230	2	1,420	23	4,600
Germany	35	10,700	5	2,580	41	13,600
Indonesia	48	10,500	2	1,020	61	14,100
Italy	131	21,200	2	1,370	142	24,000
Japan	880	153,000	15	7,370	1,070	177,000
Korea, Republic of	162	33,400	9	6,320	194	43,300
Malaysia	3	906	3	1,090	37	4,370
Mexico	225	22,600	26	6,430	434	39,800
Netherlands	173	27,500	23	17,500	275	52,300
Singapore	2	737	6	4,230	13	6,450
South Africa	6	2,450	2	869	9	3,560
Taiwan	169	21,900	7	2,880	230	29,400
Thailand	29	6,600	4	1,580	52	10,100
United Kingdom	29	10,500	10	9,150	93	33,300
Venezuela	16	1,930	5	2,370	60	8,560
Other	317	78,900	60	24,900	530	126,000
Total	3,440	567,000	337	137,000	4,970	836,000

-- Zero.

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

2/ Less than 1/2 unit.

3/ Also includes chamotte or dina's earth, activated clays and earths, and artificially activated clays.

Source: U.S. Census Bureau.

TABLE 24
U.S. IMPORTS FOR CONSUMPTION OF CLAY IN 2001, BY KIND 1/

Kind	Quantity (metric tons)	Value 2/ (thousands)
China clay or kaolin:		
Brazil	103,000	\$14,800
Canada	726	384
France	593	175
Germany	142	159
Japan	95	140
Mexico	88	36
United Kingdom	8,350	2,760
Other	482	239
Total	114,000	18,700
Fire clay:		
Canada	132	59
Germany	5	17
Korea, Republic of	11	12
Total	148	87
Decolorizing earths and fuller's earth:		
Canada	15	5
Malaysia	16	9
Total	31	14
Bentonite:		
Canada	483	282
Germany	61	43
Israel	85	60
Italy	12	51
Japan	52	98
Mexico	109	46
Spain	106	96
Turkey	2,040	1,050
United Kingdom	1,310	599
Other	15	19
Total	4,280	2,350
Common blue clay and other ball clay:		
Canada	9	5
China	41	42
Italy	11	10
United Kingdom	3,510	908
Total	3,570	965
Other clay:		
Canada	2,810	901
China	234	138
Germany	80	241
Mexico	222	91
Netherlands	124	54
Spain	489	348
United Kingdom	559	340
Other	219	383
Total	4,740	2,480
Artificially activated clay and activated earth:		
Austria	282	403
Canada	2,440	1,270
Denmark	186	209
Germany	2,860	2,410
Mexico	14,600	4,330
Netherlands	105	55
United Kingdom	103	281
Other	859	366
Total	21,400	9,330
Grand total	148,000	33,900

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

2/ U.S. customs declared value.

Source: U.S. Census Bureau.

TABLE 25
BENTONITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Algeria 4/	17,657	15,655	15,491	22,708	23,000
Argentina	104,880 r/	131,320	128,809 r/	122,000 r/ e/	120,000
Armenia	2,750 e/	3,000 e/	3,493 r/	2,807	3,000
Australia e/ 4/	73,100	104,000	180,000	180,000	180,000
Bosnia and Herzegovina e/	800	800	800	800	800
Brazil (beneficiated)	230,000	220,000	274,623	273,975 r/	275,000
Bulgaria	171,000 e/	176,110 r/	242,725 r/	295,000 r/	250,000
Burma	4,908	3,871	1,066 r/	998 r/	900
Chile	717	721	1,104	1,314	1,675 5/
Croatia	7,331	7,581	8,441	10,013	10,000
Cyprus	98,700	121,850	138,853	167,500 r/	126,600 5/
Czech Republic	110,000	125,000	160,000	280,000 r/	250,000
Egypt e/	50,000	33,000 r/	50,000	50,000	50,000
Georgia	12,000	11,000 e/	9,891 r/	7,084 r/	7,000
Germany e/	510,000	500,000	500,000 5/	500,000	500,000
Greece e/	950,000	950,000	950,000 5/	950,000	950,000
Guatemala	4,000 r/ e/	2,278 r/	4,301 r/	3,317 r/	3,000
Hungary	14,848	17,000	16,000	15,000	15,000
Indonesia	653,623	840	5,213	5,000 r/	5,000
Iran 6/	105,300	83,279	64,957	70,000 e/	70,000
Italy	513,000	592,000	500,000	500,000 e/	500,000
Kenya	NA	NA	--	64	65
Japan	495,646	443,566	428,247	415,115 r/	410,000
Macedonia e/	30,000	30,000	30,000	30,000	30,000
Mexico	111,503	185,729	208,611	269,730	250,000
Morocco	49,633	47,881	36,528	21,352	20,000
Mozambique	13,799	14,000 e/	10,828	16,144	17,700
New Zealand (processed)	12,802	14,000 e/	15,000	10,000 e/	10,000
Pakistan	16,450	14,196	15,349	27,700	27,000
Peru	20,171	19,563 r/	19,659	21,059	18,217 5/
Philippines	8,000 e/	3,900	1,844	2,000 e/	2,000
Poland 7/	6,100	5,400	5,000 r/	6,000 e/	6,000
Romania	27,133	25,434	19,577	35,789	35,000
Serbia and Montenegro	100 e/	68	77	75	75
South Africa 8/	33,326	48,382	50,363	85,187	116,384 5/
Spain e/	150,000	150,000	150,000 5/	150,000	150,000
Tanzania e/	85 r/	115 r/	125 r/	140 r/	145
Turkey	521,158	565,708	899,614 r/	636,273 r/	600,000
Turkmenistan e/	50,000	50,000	50,000	50,000	50,000
Ukraine e/	300,000	300,000	300,000	300,000	300,000
U.S.S.R., former e/ 9/	800,000	600,000	700,000	750,000	750,000
United States	4,020,000	3,820,000	4,070,000	3,760,000	4,290,000 5/
Zimbabwe 8/	186,000 e/	135,785	140,000	140,000	--
Total	10,500,000	10,600,000 r/	10,400,000 r/	10,200,000 r/	10,400,000

e/ Estimated. r/ Revised. NA Not available. -- 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.

2/ Table includes data available through August 21, 2002.

3/ In addition to the countries listed, Canada and China are believed to produce bentonite, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

4/ Includes bentonitic clays.

5/ Reported figure.

6/ Year beginning March 21 of that stated.

7/ Montmorillite type bleaching clay.

8/ May include other clays.

9/ Dissolved in December 1991; however, information is inadequate to formulate reliable estimates for individual countries, except Armenia, Georgia, Turkmenistan, and Ukraine.

TABLE 26
FULLER'S EARTH: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Algeria	3,960 r/	3,942 r/	2,489	3,431	3,200
Argentina e/	1,500	1,500	1,500	1,500	1,500
Australia (attapulgitite)	28,262	15,670	5,639	5,000 e/	5,000
Germany (unprocessed) e/	511,000 4/	500,000	500,000	500,000	500,000
Italy e/	30,000 4/	30,000	30,000	30,000	30,000
Mexico	51,430	48,016	47,522	51,685	50,000
Morocco (smectite)	24,425	27,650	21,956	30,665	32,000
Pakistan	12,307	14,659	15,565	15,288	15,000
Senegal (attapulgitite) e/	80,000	80,000	136,000 r/ 4/	131,000 r/ 4/	130,000
South Africa (attapulgitite)	9,349	7,830	7,067	7,337	9,229 4/
Spain (attapulgitite) e/	90,000	90,000	90,000	90,000	90,000
United Kingdom e/ 5/	140,000	140,000	140,000	140,000	140,000
United States 6/	2,370,000	2,420,000	2,560,000	2,910,000	2,890,000 4/
Total	3,350,000	3,380,000	3,560,000 r/	3,920,000 r/	3,890,000

e/ Estimated. r/ Revised.

1/ World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

2/ Excludes centrally planned economy countries and former such countries, some of which presumably produce fuller's earth but for which no information is available. Table includes data available through August 21, 2002.

3/ In addition to the market economy countries listed, France, India, Iran, Japan, and Turkey have reportedly produced fuller's earth in the past and may continue to do so, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

4/ Reported figure.

5/ Salable product.

6/ Sold or used by producers.

TABLE 27
KAOLIN: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Algeria	18,533	13,640	16,833	11,616	12,000
Argentina	47,365	46,832	52,665 r/	50,000 r/ e/	50,000
Australia (includes ball clay) e/	220,000	180,000	200,000	220,000	220,000
Austria (marketable) e/	60,000	60,000	50,000	50,000	50,000
Bangladesh e/ 5/	7,200	7,500	7,700	7,900	8,000
Belgium e/	300,000	300,000	300,000	300,000	300,000
Bosnia and Herzegovina e/	3,000	3,000	3,000	3,000	3,000
Brazil (beneficiated)	1,165,047	1,373,892	1,516,700	1,734,707 r/	1,700,000
Bulgaria	110,954 r/	73,700 r/	97,500 r/	108,000 r/	100,000
Burundi	3,539 r/	3,500 r/	1,597 r/	1,500 r/	-- 4/
Chile	14,238	11,530	4,361	6,445	5,300 4/
Colombia (includes common clay)	8,040,000	8,000,000 e/	8,000,000	8,400,000 r/ e/	8,500,000
Czech Republic	2,982,000	3,049,000	5,183,000	5,573,000 r/	5,500,000
Denmark (sales) e/	3,000	2,500	2,500	2,500	2,000
Ecuador	7,345	7,000 e/	20,652 r/	11,022 r/	8,818 4/
Egypt	258,869	285,497	290,000	290,000	300,000
Eritrea	4,670	3,809	1,138 r/	943 r/	990
Ethiopia	3,512	378	681	1,654	1,790
France (marketable)	332,000	330,000 e/	325,000	300,000	300,000
Germany	1,800,000 e/	1,800,000 e/	1,800,000	1,800,000	1,800,000
Greece	60,000	60,000 e/	60,000	60,000	60,000
Guatemala e/	130 r/	7,150 r/	61 r/	77 r/	100
Hungary (processed) e/	6,000	7,000	7,000	7,000	7,000
India:					
Processed	175,000	148,000	150,000	160,000	170,000
Salable crude	402,000	540,000	520,000	530,000	540,000
Indonesia	1,956	8,567	21,389	15,000 r/	15,000
Iran	478,964 r/	582,485	837,277	800,000	800,000
Israel	16,000	27,000	20,000 r/	13,000 r/	13,300
Italy, kaolinitic earth e/	9,000	9,000	9,000	10,000	10,000

See footnotes at end of table.

TABLE 27--Continued
KAOLIN: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Japan	110,915	83,257	53,092	25,739 r/	20,000
Jordan	57,255	78,000	34,040	36,795	38,000
Kazakhstan e/	50,000	60,000	70,000	70,000	70,000
Kenya	500 e/	500 e/	192 r/	793 r/	790
Korea, Republic of	2,688,489	2,259,809	1,858,359 r/	2,097,450 r/	2,383,833 4/
Madagascar e/	166 4/	160	110	115	120
Malaysia	221,769	198,930	213,973 r/	233,885 r/	286,648 4/
Mexico	235,278	339,013	489,993	532,268	530,000
New Zealand	21,874	26,000	25,000	25,000	25,000
Nigeria e/	100,000	110,000	110,000 4/	110,000	110,000
Pakistan	66,235	70,777	64,692	49,574	50,000
Paraguay	66,700	66,700 r/	66,600	66,500	66,500
Peru	7,875	4,968	1,332	6,165	5,532 4/
Poland (washed)	83,600	82,450 e/	88,792	100,756 r/	129,123 4/
Portugal e/	180,000	180,000	175,000	175,000	175,000
Romania	29,169	24,724	25,456	19,007	20,000
Russia (concentrate)	50,000	50,000	40,600	45,000	45,000
Serbia and Montenegro:					
Crude	65,724 r/	75,092	40,321	39,475 r/	40,000
Washed e/	5,000	7,000	3,000	4,000	4,000
Slovakia	24,000 e/	28,000	22,000	32,000 r/	30,000
Slovenia: e/					
Crude	10,000	10,000	10,000	10,000	10,000
Washed	7,000	4,000	4,000	4,000	4,000
South Africa	164,400	138,300	122,400	98,897	85,556 4/
Spain (marketable), crude and washed e/ 6/	315,000	300,000	320,000	365,000 4/	350,000
Sri Lanka	15,800	11,110	12,573	12,230	12,000
Sweden e/	450	450	450	440	400
Tanzania	1,000	1,000	1,500	1,700 e/	1,800
Taiwan e/	-- r/	-- r/	171 r/	409 r/	147 4/
Thailand (beneficiated)	296,510 r/	248,461 r/	113,005	201,226	220,000 4/
Turkey	472,646	403,733	449,954 r/	400,000	600,000
Uganda	NA	NA	198	14	90 4/
Ukraine	250,000 e/	201,670	221,526	225,000 e/	225,000
United Kingdom (sales) 7/	2,400,000 e/	2,391,595	2,303,607	2,420,000	2,400,000
United States 8/	9,280,000	9,640,000	9,160,000	8,800,000	8,110,000 4/
Uzbekistan e/	5,500,000	5,500,000	5,500,000	5,300,000 r/	5,500,000
Venezuela	5,000	4,000	12,000	--	--
Vietnam e/	1,100	1,100	1,100	1,200	13,000
Total	39,300,000 r/	39,500,000 r/	41,100,000	42,400,000 r/	42,000,000

e/ Estimated. r/ Revised. NA Not available. -- 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.

2/ Table includes data available through August 21, 2002.

3/ In addition to the countries listed, China, Morocco, and Suriname may also have produced kaolin, but information is inadequate to make reliable estimates of output levels.

4/ Reported figure.

5/ Data for year ending June 30 of that stated.

6/ Includes crude and washed kaolin and refractory clays not further described.

7/ Dry weight.

8/ Kaolin sold or used by producers.