CLAY AND SHALE

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The amount of clay sold or used by domestic producers in 1999 was 42.2 million metric tons (Mt) valued at $1.57 billion, a slight increase in tonnage from that of 1998. Production of ball clay, bentonite, common clay and shale, and fuller's earth increased, and production of fire clay and kaolin decreased. Of the clay and shale produced in 1999, common clay and shale accounted for 59% of the tonnage, and kaolin accounted for 60% of the value. Imports of clays increased to 90,400 metric tons (t) valued at $23.0 million. Exports decreased to 4.80 Mt valued at $823 million (table 1).

Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) continued its work on the Maximum Achievable Control Technology (MACT) for the clay-products-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. Clay processors and manufacturers of lightweight aggregate, brick, tile, and whiteware are covered under the MACT. As a result of a survey of 414 plants, the EPA concluded that those in the pottery and dinnerware manufacturing categories did not represent a major source of hazardous air pollutants. The agency further concluded that there were approximately 20 major sources of pollutants in the ceramic tile, sanitaryware, and technical ceramics manufacturing categories. EPA is concerned mainly about the hydrogen fluoride, hydrogen chloride, and trace metal emissions for ceramic tile and sanitaryware producers. For technical ceramic producers, the concern is with emissions of hydrogen fluoride, hydrogen chloride, trace metals, and organics. A proposed MACT ruling will not be issued until May 2001 (American Ceramic Society Bulletin, 1999b).

The Food and Drug Administration issued a guidance document discussing the presence of dioxins in some anticaking agents, including clay, used in animal feeds. The document reviewed the history of the investigation and the dioxin congeners detected and gave advice on analysis (Food and Drug Administration, 1999).

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 recontouring of the disturbed area and planting trees or grasses to prevent or minimize erosion. For processing, the impoundment of slimes and dust control are 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 1999, 233 companies operated approximately 650 clay pits or quarries; of these, 20 companies, many with multiple operations, accounted for 50% of the tonnage and 77% 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, and Wisconsin, and the District of Columbia (table 2).

The 10 leading producer States, in decreasing order by tonnage, were Georgia, Wyoming, Alabama, North Carolina, Texas, Ohio, Missouri, South Carolina, Tennessee, and California. The 10 leading producing companies, in alphabetical order, were American Colloid Co. (bentonite), Engelhard Corp. (fuller's earth and kaolin), General Shale Products Corp. (common clay and shale), Glen Gery Corp. (common clay and shale), Holnam, Inc. (common clay and shale), J.M. Huber Corp. (kaolin), IMERYS (composed of Dry Branch Kaolin Co. and ECC International LTD [ECCI], kaolin), Radex Heraklith Industriesbeteilgungs AG (RHI, including the former A.P. Green Industries, Inc. and Harbison Walker Refractories Co., fire clay and kaolin), Solite Division, Big River Industries, Inc. (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 the underground production was in Ohio where the clays are mainly underclays associated with coal.

Domestic production data for clays were developed by the U.S. Geological Survey from a voluntary survey of U.S. operations. Of the 552 survey forms issued, 366 were completed, representing approximately 70% 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 1999, 5 companies mined ball clay from 32 quarries in 4 States. Two of the producers were large, diversified firms with widespread foreign and domestic mineral interests.

Production of domestic ball clay increased to 1.20 Mt valued at $48.0 million in 1999 from 1.13 Mt valued at $51.1 million in 1998 (table 3). Tennessee supplied 60% of the Nation's output, followed by Texas, Kentucky, and Mississippi.

Production increased in Kentucky, Tennessee, and Texas and was unchanged in Mississippi. Water-slurried ball clay was produced in Kentucky and Tennessee. Airfloat ball clay was produced in Kentucky, Mississippi, Tennessee, and Texas. Shredded and (or) unprocessed clay was mined and then sold or used from mines in all four ball-clay-producing States.

Unimin Corp. purchased the United Clays Inc., a division of Watts Blake Bearne & Co. PLC (WBB). The purchase included the ball clay operations in Mississippi, Tennessee, and Texas and a talc operation in Texas. Unimin Corp. is owned by SCR Sibelco SA, which controls more than 90% of the ordinary and preferred share capital of WBB. Unimin already was a supplier of ceramic flint, feldspar, and nepheline syenite to the ceramics markets (Ceramic Industry, 2000; Watts Blake Bearne & Co. PLC, [undated], WBB now, press release, accessed August 9, 2000, at URL http://www.wbb.co.uk/wbbhtm/welcome/wbb_ now.htm).

Bentonite.—In 1999, 21 companies produced bentonite from approximately 70 quarries in 11 States. Six producers were large, diversified firms with international mineral operations or interests in other types of clay in the United States.

The quantity and value of all varieties of bentonite sold or used increased to 4.07 Mt valued at $176 million in 1999 from 3.82 Mt valued at $176 million in 1998 (table 5). Production of nonswelling bentonite decreased to 392,000 t valued at $13.2 million in 1999 from 410,000 t valued at $15.5 million in 1998. Alabama led all States in the production of nonswelling bentonite, followed by Mississippi, Arizona, Texas, Nevada, California, and Colorado.

Production of swelling bentonite increased to 3.68 Mt valued at $163 million in 1999 from 3.41 Mt valued at $160 million in 1998. Wyoming led all States in the production of swelling bentonite, followed by Montana, Utah, Texas, California, Oregon, and Nevada.

American Colloid announced plans for the construction of a new foundry compounds blending plant in the southeastern United States. This will be the company's 10th blending plant in the United States. The plant will cost between $3 million and $4 million to construct, with construction beginning in 2000. The site selection is still pending (AMCOL International Corp., December 17, 1999, press release, accessed August 10, 2000, at URL http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=105&STORY=www/story/12-17-1999/0001099287).

Bentonite Performance Minerals (BPM), a division of Halliburton Co., purchased the foundry compounds production facility of M.A. Bell Co. in St. Louis, MO. BPM will produce blends of bentonite, coal, and other additives for use as sand binders in the cast metal industry (Halliburton Co., 1999).

US Clay LP began mining bentonite near Alpine, TX. The deposit contains proven reserves of 5 Mt of sodium bentonite. One market served by US Clay is pet litter, with sales in California, Florida, Texas, Virginia, and Wisconsin. The company was seeking partners to expand the operation (North American Minerals News, 1999b).

Common Clay and Shale.—In 1999, 176 firms produced common clay and shale from approximately 380 pits in 40 States and Puerto Rico. Most of these companies also were manufacturers of structural clay products, such as clay pipe, drain tile, and sewer pipe, lightweight aggregates, and cement. More than 90% of the production was used by producers to manufacture structural clay products, aggregate, and cement or for civil engineering applications.

Domestic sales or use of common clay and shale increased to 24.8 Mt valued at $155 million in 1999 from 24.5 Mt valued at $145 million in 1998 (table 7). The major producing States, in decreasing order by tonnage, were North Carolina, Alabama, Texas, Ohio, Georgia, South Carolina, Missouri, Arkansas, Kentucky, Virginia, California, and Pennsylvania.

Acme Brick Co. announced an agreement to purchase Texas Clay Industries, a division of Temtex Industries Inc. (American Ceramic Society Bulletin, 1999a).

Fire Clay.—Fire clay producers were mostly refractories manufacturers that used the clays in firebrick and other refractories. In 1999, 36 quarries were operated by 10 firms in 6 States.

Fire clay sold or used by domestic producers decreased slightly to 402,000 t valued at $6.77 million in 1999 from 410,000 t valued at $7.52 million in 1998 (table 9). Missouri was the leading producing State, followed by Ohio, South Carolina, California, Kentucky, and New Mexico.

RHI completed its acquisition of Global Industrial Technologies Inc. (GIT) in January 2000. RHI owns Veitsch-Radex-Didier Group, which is the parent company of North American Refractories Co. GIT owns A.P. Green Industries, Inc. and Harbison Walker Refractories Co., both major refractory manufacturers. The combined companies will operate as RHI America, following divestiture of some of its assets (RHI, January 7, 2000, RHI AG completes acquisition of Global Industrial Technologies, accessed February 18, 2000, at URL http://www.hwr.com/news/index.asp?54; Industrial Minerals, 1999i).

Fuller's Earth.—In 1999, 17 companies produced fuller's earth (attapulgite and montmorillonite varieties) from 26 quarries in 11 States. Attapulgite was mined from approximately 10 mines in the Florida panhandle and southwestern Georgia; these two States accounted for all the domestic attapulgite production. Most of the fuller's earth producers were small, independent firms, but six were large, diversified corporations with international mineral interests.

Production of fuller's earth increased to 2.56 Mt valued at $231 million in 1999 from 2.42 Mt valued at $233 million in 1998 (table 11). Production of attapulgite was estimated to be 725,000 t in 1999, a decrease from 793,000 t in 1998. Georgia was the major producing State, followed by Florida. Sepiolite clay, which is included under fuller's earth, was produced in Nevada. Production of montmorillonite was estimated to be 1.84 Mt in 1999, an increase from 1.56 Mt in 1998. Montmorillonite was produced, in decreasing order by tonnage, in Mississippi, Missouri, California, Virginia, Illinois, Tennessee, Florida, Georgia, Kansas, and Texas.

Kaolin.—In 1999, 25 firms mined kaolin from approximately 75 quarries in 10 States. Domestic production decreased to 9.16 Mt valued at $948 million in 1999 from 9.64 Mt valued at $1.06 billion in 1998 (table 13). Georgia was the largest kaolin producer, followed by South Carolina, Alabama,

California, Texas, North Carolina, Florida, Nevada, Arkansas, and Tennessee.

Approximately 50% of the kaolin produced was water washed; 20%, calcined; 15%, delaminated; 11%, airfloat; and 4%, unprocessed (table 14). A total of 1.83 Mt valued at $272 million of calcined kaolin was produced. Of this amount, 799,000 t valued at $250 million was pigment-grade (low-temperature) and 1.03 Mt valued at $22.4 million was refractory-grade (high-temperature) calcined kaolin (table 15).

Kaolin production in Georgia decreased to 8.16 Mt valued at $907 million in 1999 from 8.55 Mt valued at $1.01 billion in 1998. Approximately 56% of the production was sold as water washed; 10%, pigment-grade calcined; 17%, delaminated; 8%, airfloat; and 9%, refractory-grade calcined and unprocessed (table 16). Production in South Carolina increased to 408,000 t valued at $15.7 million in 1999 from 395,000 t valued at $22 million in 1998. Approximately 83% of the production was airfloat kaolin with the remainder being unprocessed (table 18).

The purchase of ECCI by IMERYS, a French investment group (formerly called IMETAL), was finalized in April 1999. The purchase required the divestiture of some production capacity. An agreement for J.M. Huber to acquire some of IMERYS' production capacity was awaiting Department of Justice approval. The deal would include IMERYS' No. 1 plant in Sandersville, GA, and its plant in Wrens, GA. The Sandersville No. 1 plant has a production capacity of 770,000 tons per year (t/yr) of hydrous kaolin products and approximately 35,000 t/yr of calcined kaolin. The Wrens plant has a production capacity of approximately 225,000 t/yr of hydrous kaolin products and 45,000 t/yr of calcined kaolin. J.M. Huber has a total production capacity of approximately 2.4 million tons per year (Mt/yr) when its newly acquired capacity is combined with that of its plants in Huber and Wrens, GA. Production capacity for IMERYS will be approximately 1.9 Mt/yr. Under the acquisition agreement, IMERYS will acquire Huber's share of precipitated calcium carbonate facilities in Maine and Michigan. These were operated as a joint venture by Faxe Paper Pigments-USA, an affiliate of J.M. Huber, and ECCI. This deal will consolidate ownership under IMERYS (Industrial Minerals, 1999d).

American Borate will process kaolin for Utah Clay Technology, Inc. at its Baker, CA, plant; while Utah Clay Technology builds its $15 processing plant in Milford, UT (Chemical Week, 1999b).

Consumption

Ball Clay.—The principal domestic ball clay markets, in decreasing order, were floor and wall tile, sanitaryware, and pottery (table 4). Consumption increased to 1.20 Mt in 1999 from 1.13 Mt in 1998. The largest increase was for sanitaryware. Sales and use of ball clay increased in recent years because growth in commercial and residential building construction and home renovations has increased demand for sanitaryware, tile, and whiteware.

Bentonite.—Major markets for bentonite were drilling mud, foundry sand, iron ore pelletizing, and pet waste absorbents. Domestic consumption increased by 7% in 1999. Domestic sales of bentonite for major markets were 888,000 t for foundry sand bond; 788,000 t for pet waste absorbent; 667,000 t for drilling mud; 540,000 t for iron ore pelletizing; and 268,000 t for sealant applications (table 6).

Total sales (domestic and exports) of bentonite were approximately 736,000 t for drilling mud (more than 99% was swelling bentonite), 1.14 Mt for foundry sand bond (894,000 t was swelling bentonite), 598,000 t for pelletizing iron ore (all swelling bentonite), 790,000 t for pet waste absorbent (more than 99% was swelling bentonite), and 280,000 t for waterproofing and sealing (more than 99% was swelling bentonite). These five markets accounted for 87% of swelling bentonite sales and 79% of total bentonite sales.

Much of the data on other sales of swelling and nonswelling bentonite were concealed to avoid disclosing company proprietary data. More than 90% of sales for absorbents, adhesive, animal feed, drilling, pelletizing iron ore, waterproofing, and water treatment; almost 90% of sales for other filler and extenders; and slightly more than 70% of sales for foundry sand were swelling bentonite. Nonswelling bentonite dominated sales for catalyst, desiccant, filtering, clarifying, and decolorizing of oils and greases, and miscellaneous chemical manufacture applications.

The major domestic uses for swelling bentonite, in decreasing order, were pet waste absorbents, drilling mud, foundry sand, iron ore pelletizing, and waterproofing and sealing. Major export markets were in 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; catalyst; miscellaneous absorbents; animal feed; and chemical manufacture. Exports were limited to foundry sand and miscellaneous unknown applications.

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 increased slightly to 24.8 Mt in 1999. The strong housing and commercial building market has helped maintain sales of common clay and shale for brick and lightweight aggregate manufacture.

Fire Clay.—Fire clays were used in refractory products, such as firebrick and block, grogs and calcines, high-alumina brick and specialties, saggers, 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 slightly to 402,000 t in 1999 from 410,000 t in 1998 (table 10). Major markets for fire clay, in decreasing order, were firebrick, refractory mortar and cement, common brick, miscellaneous refractories, grogs and calcines, quarry tile, and pottery.

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, fertilizer carriers, cement manufacture, animal feed, and pesticide carriers (table 12). Consumption of fuller's earth increased 6% to 2.56 Mt in 1999.

Sales of montmorillonite increased by 18% to 1.84 Mt in 1999 compared with 1.56 Mt in 1998. Major domestic markets for montmorillonite, in decreasing order, were pet waste absorbents; oil and grease absorbents; fertilizer carrier; animal feed; desiccant; pesticide carrier; and clarifying, decolorizing, and filtering of oils and greases.

Sales of attapulgite decreased 9% to 725,000 t in 1999 compared with 793,000 t in 1998. Most of the sales data were concealed to avoid disclosing company proprietary data; major markets, in decreasing order, were pet waste absorbents; oil and grease absorbents; pesticide carriers; clarifying, decolorizing, and filtering of oils and greases; fertilizer carriers; paint; drilling mud; adhesives; animal feed; asphalt tile; desiccants; pharmaceuticals; roofing; and textile.

Sales of montmorillonite-variety of fuller's earth accounted for more than 80% of total sales for animal feed and pet waste absorbents. More than 70% of the fuller's earth sold for desiccant, fertilizer and pesticide carriers, and oil and grease absorbents was the montmorillonite-variety of fuller's earth. Attapulgite accounted for all of the sales for adhesive, asphalt tile, drilling mud, gypsum products, paint, pharmaceuticals, and textiles and most of the sales for filtering, clarifying, and decolorizing oils and greases.

Kaolin.—The major domestic markets for kaolin, in decreasing order, were paper coating and filler, refractories, fiberglass, paint, rubber, catalyst, and brick (table 20). Consumption decreased 6% in 1999; the largest decreases were in refractories (437,000 t), paper coating (90,000 t), and paper fillers (75,000 t). Although sales of kaolin for refractories were reported to be 1.21 Mt by domestic producers in 1998, actual demand is believed to have been less than 1.00 Mt, reducing the difference between sales in 1998 and 1999 to about 200,000 t rather than 437,000 t. This corresponds more closely with the pattern of sales observed over the past 10 years. Another factor for the smaller tonnage in refractory sales was the closure of several mines and plants resulting from consolidation within the refractories industry. Sales of kaolin to the paper industry also declined. Two factors were competition from calcium carbonate and lower demand by the paper industry. Overcapacity in the paper industry resulted in excess paper inventories and a need to reduce paper inventories before resuming increased levels of paper production. Major domestic markets for kaolin from Georgia, in decreasing order, were paper coating, paper filling, refractories, fiberglass, and paint (table 17).

The major domestic market for kaolin from South Carolina was rubber, followed by common and face brick, catalyst, fiber glass, roofing granules, adhesives, paper coating and filler, pesticide carriers, sanitaryware, plastics, gypsum products, fertilizer carriers, firebrick, and asphalt tile (table 19).

Absorbent Uses.—Sales for absorbent uses were about 2.65 Mt, an increase of 3% compared with that of 1998. Fuller's earth accounted for 70% of the clay used for absorbents, followed by bentonite. Pet waste absorbents accounted for approximately 89% of absorbent consumption, followed by oil and grease absorbents and miscellaneous absorbent applications.

Pet litter has become one of the major bentonite markets in recent years. It is one that is continually changing to meet the customer needs. The market is split into scoopable pet litter, of which sodium bentonite is the most common ingredient, and traditional pet litters, consisting mainly of calcium bentonite and attapulgite. These two types of pet litter account for more than 90% of the total pet litter market, which includes litters based on straw, wood, paper, crop byproduct, and inorganic salts. The traditional clay litters account for approximately 65% of the clay-based litter market nationwide. On a regional basis, traditional litters account for about 68% of the market on the east coast and 35% of the market on the west coast. On a dollar basis, these percentages are reversed. The difference in market share occurs because Wyoming is the largest producing State for sodium bentonite, and Florida and Georgia are the largest producing States of calcium bentonite and attapulgite (Landis and Gaylord, 1999).

Oil-Dri Corp. entered into an agreement to be the exclusive clay supplier for Church & Dwight Co. Inc.'s (C&D) traditional pet litters. C&D is the maker of Arm & Hammer products. Its experience in the odor control field will be complemented by Oil-Dri's research and development program and manufacturing and logistical capabilities (North American Minerals News, 1999a).

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 approximately 1.95 Mt, an increase of 13% compared with that of 1998. The largest ceramics market was ceramic floor and wall tile (41%), followed by sanitaryware (19%), catalyst (12%), roofing granules (11%), and pottery (8%). Ball clay accounted for 43% of the clay used in ceramics, followed by common clay and shale (32%) 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 electrical porcelain, glazing, pottery, and sanitaryware markets. Common clay and shale was the predominant clay used in 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 fine china markets.

Sales of ceramic tile continued to increase with the continued growth in housing and commercial building construction. Apparent consumption of clay floor and wall tile was 195 million square meters (Mm^2) valued at $2.02 billion in 1999, an increase from 170 Mm^2 valued at $1.81 billion in 1998. Much of the increase in sales, however, was from increased imports rather than domestic production. Domestic manufacturers shipped 59.1 Mm^2 of clay floor and wall tile valued at $843 million in 1999 compared with 59.2 Mm^2 valued at $837 million in 1998. Imports were 139 Mm^2 valued at $1.2 billion in 1999 and 115 Mm^2 valued at $999 million in 1998 (U.S. Department of Commerce, 2000a).

Sales of vitreous sanitaryware used in the United States also increased in 1999. Apparent consumption was valued at $935 million in 1999 compared with $879 million in 1998, based on fourth quarter reporting by the U.S. Census Bureau. Manufacturers shipments were $891 million in 1999 versus $877 million in 1998. Imports increased to $102 million in

1999 from $68 million in 1998 (U.S. Department of Commerce, 2000c).

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 3.93 Mt of clay and shale was used in the production of lightweight aggregate. Nearly all the clay used to manufacture lightweight aggregate 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 1999, approximately 5.32 Mt of clays was consumed, a 2% decrease compared with that of 1998. In decreasing order, common clay and shale, fuller's earth, kaolin, and fire clay were used in the manufacture of portland cement clinker. More than 97% of the clay consumed by the cement industry was common clay and shale.

Structural Clay Products.—Approximately 14.2 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 98% of this total. Other markets, in decreasing order by tonnage, were roofing tile, flue linings, flower pots, sewer pipe, structural tile, drain tile, and terra cotta. Small amounts of ball clay, bentonite, fire clay, and kaolin also were used.

In 1999, 8.93 billion building and face bricks valued at $1.63 billion were shipped within the United States; this was an increase from 8.24 billion bricks valued at $1.45 billion in 1998. Structural facing tile and ceramic glazed brick shipments totaled 26.7 million units valued at $14.6 million in 1999 compared with 25.8 million units valued at $15.1 million in 1998. Approximately 42,800 t of structural clay tile valued at $8.49 million was shipped in 1999, a decrease from 44,500 t valued at $8.64 million in 1998. Shipments of vitrified clay and sewer pipe fittings were 162,000 t valued at $53.6 million, an increase from 141,000 t valued at $48.1 million in 1998 (U.S. Department of Commerce, 2000a).

Drilling Mud.—Sales (domestic and exports) for drilling mud applications were 811,000 t (711,000 t sold domestically and 101,000 t exported), a 5% increase from that of 1998. Swelling-type bentonite accounted for approximately 91% of the clay used in drilling mud. Ball clay, fuller's earth, and kaolin also were used in drilling mud applications.

Drilling activity again declined due to lower gas and oil prices in 1999. There were an estimated 18,600 wells completed compared with 23,900 wells in 1998. The number of exploratory wells declined to 1,998 from 4,000 in 1998. The average count of active drilling rigs was 580 per week in 1999, compared with 860 per week in 1998 (Oil & Gas Journal, 1999).

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 5.18 Mt of clays was sold for use as fillers, extenders, and binders in 1999, a decrease of 6% compared with that of 1998. Paper coating and filling accounted for 73% of domestic sales, followed by paint (6%), rubber (4%), animal feed (3%), and fertilizer carrier (3%). Adhesive, asphalt emulsion, asphalt tile, gypsum products, ink, medical (and cosmetic and pharmaceutical), pesticide carrier, plastic, textile, and wallboard applications each accounted for less than 1% of the fillers and extenders markets.

Kaolin accounted for approximately 88% of the clay used in filler and extender applications, followed by fuller's earth (7%), bentonite (2%), common clay and shale (2%), ball clay (1%), and trace amounts of fire clay. Ball clay was the predominate clay used in asphalt emulsions; bentonite in ink applications; common clay and shale in wallboard production; fuller's earth in fertilizer and pesticide applications; and kaolin in adhesive, gypsum products, paint, paper, plastics, rubber, and textile markets. Bentonite, fuller's earth, and kaolin were the predominant clays used in asphalt tile, and bentonite and fuller's earth were the predominant clays used in animal feeds and pharmaceuticals.

The U.S. Census Bureau reported shipments of paints and coatings to be 1.31 billion gallons valued at $16.3 billion in 1999 compared with 1.28 billion gallons valued at $15.6 billion in 1998. Architectural paints accounted for 659 million gallons, product coatings for 487 million gallons, and special purpose coatings for 165 million gallons (U.S. Department of Commerce, 2000b). Architectural paints are the major market for industrial mineral fillers among the paint types.

Fiberglass.—Sales to the fiberglass industry declined to 329,000 t in 1999. Kaolin was the only clay type used for this application.

Iron Ore Pelletizing.—Sales (domestic and exports) increased slightly to 598,000 t in 1999. Swelling bentonite was the only type of clay used for this application.

Paper Products.—Kaolin accounted for all the sales used for paper coating (3.00 Mt sold domestically and 1.97 Mt exported), and all the clay used for paper filling (791,000 t sold domestically and 110,000 t exported).

Approximately 86.8 Mt of paper and paperboard was produced in 1999. Paperboard accounted for 46.2 Mt of this amount and paper accounted for 40.6 Mt. Paper accounted for 62% of the value of these shipments. Reduction of inventories and increased demand for certain grades of printing and writing paper resulted in better performance by domestic producers. The U.S. Department of Commerce forecasts growth of 1.5% in 2000 (McGraw-Hill Companies and U.S. Department of Commerce, 2000). The slow growth in the paper industry and overcapacity in the kaolin industry have contributed to lower prices for paper-grade kaolin products. In 1998, the price remained fixed and no increase was anticipated in 1999. This caused kaolin producers to focus on cutting production costs and to begin seeking alternative markets (Chemical Week, 1999c).

Demand for mineral fillers is expected to increase to 7.85 Mt in 2005 from 5.73 Mt in 1996. Calcium carbonate use will continue to increase because of the shift to alkaline papermaking processes. For coatings, clay will continue to dominate although calcium carbonate's share of the market has been increasing (Industrial Minerals, 1999h).

Refractories.—Approximately 3.06 Mt of clays was used for the domestic manufacture of refractories, a slight decrease compared with that of 1998. The largest domestic markets were grogs and calcines (29%), foundry sand (29%), refractory mortar and cement (18%), firebrick (8%), high alumina brick (1%), and high alumina specialties (less than 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 35% of domestic refractory sales, followed by common clay and shale, 27%; kaolin, 25%; fire clay, 11%; ball clay, 1%; and fuller's earth, less than 1%. Fire clay was the predominate clay used in firebrick; bentonite, in foundry sand; common clay, in refractory mortar and cement; and kaolin, in calcine, grog, high alumina brick, and kiln furniture.

The U.S. Census Bureau reported shipments of clay refractories at $965 million, a decrease from $1.02 billion in 1998. In 1999, 861,000 t (292 million bricks) valued at $518 million of clay refractory brick and shapes was shipped by manufacturers. This can be subdivided into fire clay brick and shapes, 384,000 t (118 million bricks) valued at $160 million; high alumina brick and shapes, 435,000 t (139 million bricks) valued at $301 million; and insulating brick and shapes, 41,800 t (36.0 million bricks) valued at $56.6 million. Shipments of unshaped clay refractories were 759,000 t valued at $393 million. This can be broken out into refractory mortars, 121,000 t valued at $60.6 million; plastic refractories, 144,000 t valued at $79.1 million; castable refractories, 325,000 t valued at $190 million; and fire clay gunning mixes, 169,000 t valued at $64.2 million. Approximately 150,000 t of miscellaneous refractories valued at $54.0 million also was sold in 1999 (U.S. Department of Commerce, 2000d). Shipments of fire clay and high-alumina brick are expected to decline 1.5% per year through 2003 because of the increased use of monolithic refractories domestically. This trend toward monolithic refractories has proceeded at a faster rate in Europe and Japan (American Ceramic Society Bulletin, 1999c). Despite this trend, fire clay bricks are still used for blast furnace checker brick, reheat-furnace walls, soaking pit walls, roofs, and sub-hearths. High-alumina bricks are used in backup linings in several furnace types. Fire clay and high-alumina monoliths are used in linings of heating furnaces, boilers, forging furnaces, iron ladles, and reheat furnaces (Banerjee and Abraham, 1999).

Prices

Ball Clay.—The average value for ball clay reported by domestic producers was $40.00 per metric ton. The average values for imported and exported ball clay were $240.63 and $56.82 per ton, respectively.

Bentonite.—The average value reported by domestic producers for nonswelling bentonite was $33.67 per ton. The average value for swelling bentonite was $44.29 per ton. The average value for all bentonite was $43.24 per ton. The average value of imported bentonite was $334.83 per ton. The average value of exported bentonite was $104.73 per ton.

Common Clay and Shale.—The average value for all common clay and shale produced in the United States and Puerto Rico was $6.25 per ton. The average value of clay and shale used in lightweight aggregate was $16.59 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 $40 per ton for most applications.

Fire Clay.—The average value for fire clay reported by domestic producers was $16.84 per ton. The average of imported fire clay was $357.69 per ton. The average value of exported fire clay was $87.30 per ton.

Fuller's Earth.—The average value of attapulgite-fuller's earth was estimated to be $110 per ton. The average value of montmorillonite-fuller's earth was $90.00 per ton. The average value of all fuller's earth was estimated to be $90.23 per ton. The average value of imported fuller's earth was $47.74 per ton. The average value of exported fuller's earth was $161.84 per ton.

Kaolin.—The average value of kaolin was $103.49 per ton for all kaolin grades. The average value for airfloat was $44.76 per ton; refractory grade (high-temperature calcined), $21.75; pigment grade (low-temperature calcined), $312.89; all types of calcined, $148.63 per ton; delaminated, $97.78 per ton; water washed, $107.84 per ton; and unprocessed, $8.95 per ton. The average value of the imported kaolin was $185.31 per ton. The average value of exported kaolin was $171.54 per ton.

Foreign Trade

Ball Clay.—Ball clay exports decreased to 107,000 t valued at $6.08 million, according to the U.S. Census Bureau (table 23). Domestic ball clay producers reported that 161,000 t of ball clay was exported in 1999 (table 4). Imports were 827 t of ball clay valued at $199,000 (table 24).

Bentonite.—Bentonite exports decreased to 719,000 t valued at $75.3 million (table 23). Domestic bentonite producers reported exports of 440,000 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 and Mexican markets (approximately 225,000 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 8,930 t valued at $2.99 million. Imports of chemically activated material were 17,500 t valued at $7.53 million (table 24).

Fire Clay.—Approximately 189,000 t of fire clay valued at $16.5 million was exported (table 23). In 1999, 260 t of fire clay valued at $93,400 was imported (table 24).

Fuller's Earth.—Approximately 152,000 t of fuller's earth valued at $24.6 million was exported (table 23). Domestic producers reported 114,000 t of exports in 1999 (table 12). The discrepancy between producer and U.S. Census Bureau data is partially explained by the fact that producers may include some

of the exports destined for Canada (approximately 89,000 t) under domestic sales. Several producers manufacture commercial products, such as pet waste absorbent and commercial absorbents, that may have been reported under export classifications other than fuller's earth.

Approximately 398 t of decolorizing and fuller's earth valued at $19,300 was imported in 1999 (table 24).

Kaolin.—The U.S. Census Bureau reported that 3.31 Mt of kaolin valued at $567 million was exported in 1999 (table 23). Producers reported exports of 2.44 Mt (table 20). Much of the kaolin destined for Canadian paper markets (746,000 t) and for various Mexican markets (204,000 t) probably was reported under domestic consumption.

Kaolin imports increased to 57,200 t valued at $10.6 million (table 24). Approximately 77% of the imports was from Brazil, followed by the United Kingdom with 18%.

World Review

World production of bentonite was approximately 9.82 Mt (table 25), fuller's earth production was estimated to be 3.52 Mt (table 26), and kaolin production was 41.6 Mt (table 27). 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 for kaolin. Spain led all countries in the production of sepiolite.

In Europe, 10 bentonite producers have formed the European Bentonite Producers Association (EUBA). The participating companies are Ceca SA, Dykerhoff Wopfinger Umweltbaustoffe GmbH, Laporte Industries Spain SL, Laviosa Chimica Mineraria SpA, Mykobar Mining Co. SA, Peletico Ltd., Silver & Baryte Ores Mining Co. SA, Steetley Bentonite & Absorbents Ltd., Sud Chemie AF, and Volclay Ltd. EUBA is part of Industrial Minerals Association-Europe, which represents the minerals interests of approximately 120 European companies (Industrial Minerals, 1999e).

The European Commission (EC) proposed a standard setting maximum dioxin concentrations of 5 nanograms per kilogram in kaolinitic clay products. This standard was proposed because some of the kaolinitic clay from the Westerwald region in Germany contained above average levels of dioxin. Sales of the German clay for animal feed applications were discontinued (Mining Journal, 1999b; Industrial Minerals, 1999b).

Brazil.—IMETAL (now IMERYS) acquired a 10% share of Rio Capim Caulim SA (RCC) from Amberger Kaolinwerke AG (AKW). The sale of the shares of RCC by AKW occurred after the EC required a separation of AKW's and IMERYS' paper-grade kaolin business to avoid having AKW and IMERYS controlling 90% of the paper-grade kaolin market in Europe. With this and other recent acquisitions, IMERYS controls approximately 80% of RCC (Chemical Week, 1999a; Industrial Minerals, 1999f).

China.—English China Clay Ltd. (ECC), a member of the IMERYS group, signed a conditional agreement to form a joint venture with Fujian Jiuzhou Longyan Kaolin Co. If finalized, the joint venture will process kaolin from Longyan for the ceramics markets. The focus will be on high-quality tableware (Industrial Minerals, 1999c).

Germany.—IMERYS purchased 50% of AKW's share in Euroclay BV. Euroclay handled sales of kaolin for Dry Branch Kaolin Co. and RCC. The sale occurred because the EC required IMERYS and AKW to separate their paper-grade kaolin business following IMERYS purchase of ECC (Industrial Minerals, 1999f).

India.—Volclay International, a subsidiary of Amcol International Corp., acquired a 20% share of Ashapura Minechem Ltd. (Chemical Market Reporter, 1999).

20 Micron Ltd. began production of calcined kaolin in a 10,000-t/yr plant in Gujarat, western India. The addition of the calciner was the second stage of an effort to developing the company's kaolin production. The first stage occurred in 1998 with the construction of a 40,000-t/yr hydrous kaolin plant. Markets for the kaolin products will be paint, paper, and plastics. The Indian Aluminum Co. Ltd. also added a 3,500-t/yr calcined kaolin plant to its operations in late 1998, in response to increasing Indian markets (Industrial Minerals, 1999a).

Italy.—Laviosa Chimica Minerais SpA acquired complete control of Bentec SpA, a joint venture between Laviosa and Sud Chemie AG. Bentec specializes in the production of rheological additives, selling bentonite clay modified with quaternary ammonium compounds as gelling agents in paint, ink, adhesives, and lubricating grease (Industrial Minerals, 1999g).

One of the faster growing product lines in Italy is porcelain stoneware tiles. These are composed of clays, quartz, and feldspar that are dry pressed and fired to 677° C. This process produces a tile that has low permeability, high hardness, and resistance to wear and chemical attack. Production increased from 95 Mm^2 in 1996 to an anticipated 200 Mm^2 in 2000. Porcelain tile accounted for 13% of production in 1994 and 22% in 1997. It is used in commercial and residential applications (Saller, 1999).

Japan.—With the decline in Japan's economy, the minerals sector has been hurt by lower domestic demand and decreased exports in recent years. This is true of bentonite, where sales for civil engineering applications and the foundry industry, the two largest bentonite markets, have declined over the past 6 to 8 years. The decline in construction activity resulted in lower sales for civil engineering applications (220,000 t in 1994 and 180,000 t in 1998). Declining car sales were a major factor in the decline of sales for foundry applications (200,000 t in 1992 and 160,000 t in 1998). Pet litter applications increased since 1991 but its growth has slowed because of maturation of the market (56,000 t in 1991 and 90,000 t in 1998). With the gradual improvement in the economy, sales for civil engineering should improve, particularly for landfill applications. Domestic car sales and decreased exports, coupled with increasing imports of automobiles due to the strengthening yen, probably will continue to affect the foundry markets (Pearson, 1999).

Kazakhstan.—Iran Industrial Design Co. will invest $13.5 million in a kaolin processing plant in western Kazakhstan. The plant will process kaolin from the Yarovslavskoye deposit in Aktyubinsh. The plant should be completed approximately

36 months after financing is arranged (Mining Journal, 1999a).

Spain.—WBB acquired Arcitras, SL, Arcillas Galve, SL, and Arevi, SL. All are producers of plastic red clay used in ceramics and have been serving the ceramics tile industry for 30 years. The three companies will operate as WBB Espana (Industrial Minerals, 1999j).

Outlook

The outlook for most of the domestic clay industry looks promising with modest growth expected for the next few years. The strength of the U.S. economy (particularly in the housing, industrial manufacturing, and other industries) will benefit the ball clay, bentonite, common clay, and segments of the fire clay and kaolin industry for several years. Strong absorbent markets should ensure growth in bentonite and fuller's earth absorbent sales, but sales of kaolin to the paper market, which is the mainstay of the kaolin industry, probably will remain unchanged or decline slightly for the next 1 to 2 years.

References Cited

American Ceramic Society Bulletin, 1999a, Acme Brick to acquire Texas Clay: American Ceramic Society Bulletin, v. 78, no. 1, January, p. 25.

———1999b, LPAC makes progress with ceramics MACT: American Ceramic Society Bulletin, v. 78, no. 9, September, p. 26-27.

———1999c, Refractories market, $18.5B by 2003: American Ceramic Society Bulletin, v. 78, no. 3, March, p. 20.

Banerjee, Subrata and Abraham, Thomas, 1999, Changing the face of the global refractories industry: American Ceramic Society Bulletin, v. 78, no. 5, May, p. 55-58.

Ceramic Industry, 2000, Unimin as clay supplier: Ceramic Industry, v. 150, no. 3, March, p. 39.

Chemical Market Reporter, 1999, Volclay acquires stake in Ashapura Minechem: Chemical Market Reporter, v. 255, no. 21, May 24, p. 28.

Chemical Week, 1999a, Imetal takes control in Brazil: Chemical Week, v. 161, no. 19, May 19, p. 7.

———1999b, Kaolin deal: Chemical Week, v. 161, no. 39, October 20, p. 53.

———1999c, PCC demand improves, but others feel the pinch: Chemical Week, v. 161, no. 6, February 17, p. 48.

Food and Drug Administration, 1999, Guidance for industry—Dioxin in anti-caking agents used in animal feed and feed ingredients—Availability: Federal Register, v. 64, no. 199, October 15, p. 55948.

Halliburton Co., 1999, Bentonite acquires M.A. Bell Company: Dallas, press release, February 1, 1 p.

Industrial Minerals, 1999a, 20 Micron starts calcined kaolin production: Industrial Minerals, no. 382, July, p. 13.

———1999b, Dioxin fear in Westerwald clays: Industrial Minerals, no. 384, September, p. 117.

———1999c, ECC's Chinese j-v back on track: Industrial Minerals, no. 384, September, p. 126.

———1999d, Huber/ECC deal to be approved: Industrial Minerals, no. 387, December, p. 15.

———1999e, IMA Bentonite Association formed: Industrial Minerals, no. 377, February, p. 85.

———1999f, Imetal buys AKW's 50% in Euroclay: Industrial Minerals, no. 382, July, p. 19.

———1999g, Laviosa buys remainder of Bentec: Industrial Minerals, no. 382, July, p. 86.

———1999h, Paper for the population: Industrial Minerals, no. 377, February, p. 69-77.

———1999i, RHI to buy Global in $500 m. refractories merger: Industrial Minerals, no. 383, August, p. 8-9.

———1999j, WBB acquires red-firing clay sources: Industrial Minerals, no. 387, December, p. 11.

Landis, Charles, and Gaylord, Brett, 1999, Absorbent pet litters: North American Minerals News, no. 48, May, p. 9-12.

McGraw-Hill Companies and U.S. Department of Commerce, 2000, Paper and allied products, chap. 10 *of* U.S. Industry & Trade Outlook 2000: New York, McGraw-Hill, p. 10-1–10-12.

Mining Journal, 1999a, Alga china clay development: Mining Journal, v. 332, no. 8534, June 4, p. 420.

———1999b, Kaolinite standard proposed: Mining Journal, v. 333, no. 8562, December 17, p. 483.

North American Minerals News, 1999a, Church & Dwight enters traditional clay cat litter market: North American Minerals News, no. 55, December, p. 6.

———1999b, US Clay seeks partner to grow "Texas tea" bentonite business: North American Minerals News, no. 52, September, p. 6.

Oil & Gas Journal, 1999, U.S. drilling at historic low, Canada's drop not so severe: Oil & Gas Journal, v. 97, no. 30, July 26, p. 65-66.

Pearson, Karine, 1999, Bowed down with imports: Industrial Minerals, no. 387, December, p. 49-59.

Saller, Marcus, 1999, It's all tiled up for Italy and Spain: Industrial Minerals, no. 377, February, p. 43-51.

U.S. Department of Commerce, 2000a, Clay construction products—Summary 1999: U.S. Department of Commerce, MQ32D(99)-5, March, 13 p.

———2000b, Paint, varnish, and lacquer—Fourth quarter 1999: U.S. Department of Commerce, MQ325F(99)-4, March, 3 p.

———2000c, Plumbing fixtures—Fourth quarter 1999: U.S. Department of Commerce, MQ332E(99)-4, April, 9 p.

———2000d, Refractories—1999: U.S. Department of Commerce, MA327C(99)-1, September, 10 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Clays. Ch. in Mineral Commodity Summaries, annual.

Clays. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

American Forest and Paper Association.

China Clay Producers Association.

Clays. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

Cosmetic, Toiletry, and Fragrance Association.

Engineering and Mining Journal.

Mining Engineering.

Mining Magazine.

National Paint and Coatings Association.

Society of the Plastics Industry.

World Mining.

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

(Thousand metric tons and thousand dollars)

	1995	1996	1997	1998	1999
Domestic clays sold or used by producers:					
Quantity	43,000	43,100	42,000 r/	41,900 r/	42,200
Value	$1,730,000	$1,710,000	$1,670,000	$1,670,000 r/	$1,570,000
Exports:					
Quantity	4,680	4,830	5,080	5,230	4,800
Value	$812,000	$825,000	$860,000	$843,000	$823,000
Imports for consumption:					
Quantity	35	45	64	86	90
Value	$16,000	$21,000	$23,200	$27,700	$23,000

r/ Revised.
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 1999, 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	--	W	2,320	--	--	W	2,320	23,700
Arizona	--	W	W	--	--	--	W	W
Arkansas	--	--	1,010	--	--	W	1,010	1,510
California	--	23	829	W	W	W	852	15,200
Colorado	--	1	373	--	--	--	374	2,530
Connecticut	--	--	55	--	--	--	55	183
Florida	--	--	W	--	W	35	35	3,830
Georgia	--	--	1,600	--	725	8,160	10,500	986,000
Illinois	--	--	134	--	W	--	134	616
Indiana	--	--	752	--	--	--	752	1,480
Iowa	--	--	302	--	--	--	302	1,040
Kansas	--	--	592	--	W	--	592	2,770
Kentucky	W	--	892	10	--	--	901	3,790
Louisiana	--	--	626	--	--	--	626	11,700
Maine	--	--	49	--	--	--	49	W
Maryland	--	--	335	--	--	--	335	1,380
Massachusetts	--	--	36	--	--	--	36	W
Michigan	--	--	615	--	--	--	615	3,550
Minnesota	--	--	W	--	--	--	W	W
Mississippi	W	W	497	--	377	--	874	32,800
Missouri	--	--	1,080	293	W	--	1,370	8,160
Montana	--	W	W	--	--	--	W	W
Nebraska	--	--	133	--	--	--	133	W
Nevada	--	6	--	--	25	W	31	3,580
New Jersey	--	--	W	--	--	--	W	W
New Mexico	--	--	W	1	--	--	1	W
New York	--	--	W	--	--	--	W	W
North Carolina	--	--	2,430	--	--	W	2,430	18,700
North Dakota	--	--	54	--	--	--	54	W
Ohio	--	--	1,710	W	--	--	1,710	8,170
Oklahoma	--	--	757	--	--	--	757	2,050
Oregon	--	W	240	--	--	--	240	77
Pennsylvania	--	--	816	--	--	--	816	1,760
South Carolina	--	--	1,130	35	--	408	1,570	20,700
South Dakota	--	--	183	--	--	--	183	W
Tennessee	725	--	W	--	W	W	725	30,100
Texas	W	W	2,100	--	W	W	2,100	9,890
Utah	--	W	327	--	--	--	327	4,600
Virginia	--	--	881	--	W	--	881	3,240
Washington	--	--	110	--	--	--	110	W
West Virginia	--	--	336	--	--	--	336	813
Wyoming	--	3,370	34	--	--	--	3,410	146,000
Total	1,200	4,070	24,800	402	2,560	9,160	42,200	1,570,000

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)

	Airfloat		Water-slurried		Unprocessed		Total	
State	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1998:								
Tennessee	299	15,900	162	7,140	250	7,060	712	30,100
Other 2/	173	12,800	--	--	244	8,150	417	21,000
Total	473	28,700	162	7,140	494	15,200	1,130	51,100
1999:								
Tennessee	323	15,700	184	7,410	218	7,000	725	30,100
Other 2/	194	9,230	9	400	270	8,330	472	18,000
Total	517	24,900	193	7,810	488	15,300	1,200	48,000

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Includes Indiana (1998), Kentucky, Mississippi, and Texas.

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

(Metric tons)

Use	1998	1999
Fillers, extenders, binders 2/	82,900	W
Floor and wall tile	325,000	353,000
Miscellaneous ceramics 3/	76,000	72,900
Pottery	108,000	121,000
Refractories 4/	50,600	42,200
Sanitaryware	239,000	292,000
Miscellaneous 5/	107,000	155,000
Exports 6/	142,000	161,000
Total	1,130,000	1,200,000

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 animal feed, asphalt emulsions, pesticides, and other fillers, extenders and binders.
3/ Includes catalysts, electrical porcelain, fiber glass (1998), fine china/dinnerware, glazes, and miscellaneous ceramics.
4/ Includes firebrick, blocks, shapes, high-alumina brick and specialties, and miscellaneous refractories.
5/ Includes absorbents (1998), brick (common), waterproofing seals, drilling mud, and other unknown uses.
6/ Includes ceramics and glass, fillers, extenders and binders, floor and wall tile, and other unknown uses.

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
1998:						
California	W	W	W	W	29	2,700
Mississippi	W	W	--	--	W	W
Nevada	W	W	W	W	W	W
Oregon	--	--	W	W	W	W
Wyoming	--	--	3,150	145,000	3,150	145,000
Other 2/	410	15,500	260	15,100	641	27,900
Total	410	15,500	3,410	160,000	3,820	176,000
1999:						
California	W	W	W	W	23	2,110
Mississippi	W	W	--	--	W	W
Nevada	W	W	W	W	6	W
Oregon	--	--	W	W	W	W
Wyoming	--	--	3,370	146,000	3,370	146,000
Other 2/	392	13,200	305	16,400	668	27,500
Total	392	13,200	3,680	163,000	4,070	176,000

W Withheld to avoid disclosing company proprietary data; included with "Other" or in "Total." -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Includes Alabama, Arizona, Colorado, Montana, Texas, and Utah.

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

(Metric tons)

Use	1998	1999
Domestic:		
Absorbents:		
Pet waste absorbents	773,000	788,000
Other absorbents	W	W
Adhesives	12,900	14,200
Animal feed	77,400	74,200
Ceramics (except refractories) 2/	W	W
Drilling mud	665,000	667,000
Filler and extender applications 3/	48,700	24,700
Filtering, clarifying, decolorizing, mineral oils and greases, vegetable oils, dessicants	104,000	81,400
Foundry sand	869,000	888,000
Pelletizing (iron ore) 4/	529,000	540,000
Miscellaneous refractories 5/	2,530	201,000
Miscellaneous 6/	79,800	83,300
Waterproofing and sealing	236,000	268,000
Total	3,400,000	3,630,000
Exports:		
Drilling mud	64,800	68,800
Foundry sand	239,000	251,000
Other 7/	123,000	121,000
Total	427,000	440,000
Grand total	3,820,000	4,070,000

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 (1999) and pottery.
3/ Includes medical, pharmaceutical, cosmetics, paint, pesticides and related products, plastics, asphalt tiles, ink, and miscellaneous fillers and extenders applications.
4/ Excludes shipments to Canada. Total sales in North America were 588,000 tons in 1998 and 598,000 tons in 1999.
5/ Includes kiln furniture and miscellaneous refractories.
6/ Includes chemical manufacturing, heavy clay products, and other unknown uses.
7/ Includes absorbents, waterproofing and sealing, fillers and extenders, filtering and clarifying oils (1998), pelletizing, miscellaneous refractories, 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	1998		1999	
	Quantity	Value	Quantity	Value
Alabama	2,400	23,100	2,320	23,700
Arkansas	995	1,370	1,010	1,510
California	918	9,610	829	13,100
Georgia	1,650	5,470	1,600	5,130
Indiana	681	1,330	752	1,480
Kansas	585	2,510	592	2,770
Kentucky	872	3,930	892	3,790
Michigan	644	2,920 r/	615	3,550
Mississippi	502	3,410	497	3,390
Missouri	1,030	4,440	1,080	4,180
New York	622	7,560	W	W
North Carolina	2,380	11,600	2,430	18,700
Ohio	1,530	7,290	1,710	8,170
Oklahoma	658	4,450	757	2,050
Pennsylvania	886	2,270	816	1,760
South Carolina	1,220	3,950	1,130	4,930
Texas	2,120	10,100	2,100	9,890
Virginia	872	3,310 r/	881	3,240
Other 3/	3,940	36,200 r/	4,820	44,100
Total	24,500	145,000 r/	24,800	155,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
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	1998	1999
Ceramics and glass 3/	182,000	181,000
Civil engineering and sealing	W	34,800
Floor and wall tile:		
Ceramic	349,000	400,000
Other 4/	W	W
Heavy clay products:		
Brick, extruded	11,100,000	12,000,000
Brick, other	2,130,000	1,800,000
Drain tile and sewer pipe	25,400	27,000
Flowerpots	35,300	W
Flue linings	55,600	58,900
Structural tile	16,300	22,700
Other 5/	85,900	160,000
Lightweight aggregate:		
Concrete block	2,540,000	2,430,000
Highway surfacing	311,000	317,000
Structural concrete	871,000	929,000
Miscellaneous 6/	441,000	259,000
Portland and other cements	5,140,000	5,010,000
Refractories 7/	632,000	785,000
Miscellaneous 8/	520,000	429,000
Total	24,500,000	24,800,000

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 (1999), roofing tile, and miscellaneous clay products.
6/ Includes miscellaneous lightweight aggregates.
7/ Includes firebrick, block and shapes, mortar and cement, and miscellaneous refractories.
8/ Includes civil engineering and sealing (1998), exports, miscellaneous fillers and extenders, asphalt emulsion, 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)

	1998		1999	
State	Quantity	Value	Quantity	Value
Missouri	288	4,220	293	3,980
Ohio	62	2,810	W	W
Other 3/	59	487	109	2,790
Total	410	7,520	402	6,770

W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Refractory uses only.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.
3/ Includes Alabama (1998), California, Kentucky, New Mexico, Ohio (1999), and South Carolina.

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

(Metric tons)

Use	1998	1999
Ceramics and glass 2/	W	W
Heavy clay products and lightweight aggregates 3/	W	46,700
Refractories:		
Firebrick, block, shapes	166,000	154,000
Other refractories 4/	165,000	172,000
Miscellaneous 5/	78,900	29,400
Total	410,000	402,000

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 pottery and miscellaneous ceramics.
3/ Includes common brick, portland cement, terra cotta.
4/ Includes foundry sand, grogs and calcines, high alumina brick and specialties, mortar and cement, plug, tap and wad (1998), and other unknown uses.
5/ Includes animal feed, quarry tile, lightweight aggregate, 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)

	Attapulgite		Montmorillonite		Total	
State	Quantity	Value	Quantity	Value	Quantity	Value
1998:						
Florida	(2/)	(2/)	W	W	W	W
Georgia	686	74,800	(3/)	(3/)	686	74,800
Southern States 4/	--	--	913	74,600	913	74,600
Western States 5/	(6/)	(6/)	820	83,400	820	83,400
Total	686	74,800	1,730 r/	158,000 r/	2,420 r/	233,000 r/
1999:						
Florida	(2/)	(2/)	W	W	W	W
Georgia	725	73,800	(3/)	(3/)	725	73,800
Southern States 4/	--	--	1,030	79,000	1,030	79,000
Western States 5/	(6/)	(6/)	808	78,600	808	78,600
Total	725	73,800	1,840	158,000	2,560	231,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Southern States."
-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Included with "Montmorillonite: Southern States."
3/ Included with "Attapulgite: Georgia."
4/ Includes Florida, Mississippi, Tennessee, and Virginia.
5/ Includes California, Illinois, Kansas, Missouri, Nevada, and Texas.
6/ Included with "Montmorillonite: Western States."

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

(Metric tons)

Use	1998	1999
Absorbents:		
Oil and grease absorbent	286,000 r/	275,000
Pet waste absorbent	1,470,000 r/	1,580,000
Miscellaneous absorbent	W	W
Animal feed	108,000	82,900
Drilling mud	W	W
Fertilizers	53,200	137,000
Fillers, extenders, binders 2/	77,600	63,900
Filtering, clarifying, decolorizing, of animal, mineral, vegetable oils, and greases	W	W
Pesticides and related products	136,000	67,800
Miscellaneous 3/	222,000	245,000
Exports 4/	67,800	114,000
Total	2,420,000 r/	2,560,000

r/ Revised. 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 crockery and earthware (1998), portland cement, refractories, roofing granules (1999), and other unknown uses.
4/ Includes absorbents, drilling mud, fillers, extenders and binders, floor and wall tiles, and other unknown uses.

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

(Thousand metric tons and thousand dollars)

	1998		1999	
State	Quantity	Value	Quantity	Value
Georgia	8,550 r/	1,010,000 r/	8,160	907,000
South Carolina	395	22,000	408	15,700
Other 2/	701	29,100	588	25,800
Total	9,640 r/	1,060,000 r/	9,160	948,000

r/ Revised.
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, Pennsylvania (1998), Tennessee, and Texas.

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

(Thousand metric tons and thousand dollars)

	1998		1999	
Kind	Quantity	Value	Quantity	Value
Airfloat	1,180 r/	60,200 r/	1,030	46,100
Calcined 2/	1,970	286,000	1,830	272,000
Delaminated	1,400	142,000	1,350	132,000
Unprocessed	380	2,720	363	3,250
Water washed	4,720	565,000	4,590	495,000
Total	9,640 r/	1,060,000 r/	9,160	948,000

r/ Revised.
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.

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
1998:				
Alabama and Georgia	W	W	790	261,000
Other 2/	W	W	29	6,790
Total	1,150	18,700	819	267,000
1999:				
Alabama and Georgia	W	W	799	250,000
Other 2/	W	W	(3/)	(3/)
Total	1,030	22,400	799	250,000

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, Colorado (1998), and Texas.
3/ Included with refractory-grade kaolin to avoid disclosing company proprietary data.

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

(Thousand metric tons and thousand dollars)

Kind	1998		1999	
	Quantity	Value	Quantity	Value
Airfloat	809 r/	34,200 r/	654	26,800
Calcined 2/	1,430	261,000 3/	799	250,000 3/
Delaminated	1,400	142,000	1,350	132,000
Unprocessed	232	W	W	W
Water washed	4,680	564,000	4,540	494,000
Total	8,550 r/	1,010,000 r/	8,160	907,000

r/ Revised. 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 pigment-and refractory-grade calcined kaolin.
3/Excludes values for refractory-grade kaolin; included in "Total."

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

(Metric tons)

Use	1998	1999
Domestic:		
Ceramics and glass:		
Catalysts (oil-refining)	W	W
Electrical porcelain	W	8,550
Fiber glass	362,000 r/	301,000
Roofing granules	W	25,000
Sanitaryware	W	67,000
Other 3/	323,000 r/	212,000
Fillers, extenders, binders:		
Adhesives	63,300 r/	66,500
Paint	270,000 r/	263,000
Paper coating	3,080,000	2,990,000
Paper filling	857,000 r/	784,000
Plastic	36,000 r/	34,600
Rubber	70,200 r/	85,200
Other 4/	102,000 r/	104,000
Heavy clay products 5/	W	W
Refractories 6/	726,000 r/	650,000
Undistributed 7/	227,000 r/	179,000
Total	6,120,000 r/	5,770,000
Exports:		
Paint	70,700	81,500
Paper coating 8/	2,020,000	1,970,000
Paper filling 8/	111,000 r/	110,000
Rubber	4,730	4,670
Undistributed 9/	225,000 r/	234,000
Total	2,430,000 r/	2,400,000
Grand total	8,550,000 r/	8,160,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other" or "Undistributed."
1/ Includes high-temperature and low-temperature calcined and delaminated.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.
3/ Includes crockery/earthenware, fine china/dinnerware, pottery, and miscellaneous ceramics.
4/ Includes animal feed, 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), portland cement, and miscellaneous clay products.
6/ Includes firebricks, blocks and shapes, grogs and calcines, high-alumina specialties, and miscellaneous refractories.
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, ink (1998), miscellaneous fillers, extenders and binders, portland cement, miscellaneous refractories, and other unknown uses.

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

(Thousand metric tons and thousand dollars)

	1998		1999	
Kind	Quantity	Value	Quantity	Value
Airfloat	319	21,500	338	15,100
Unprocessed	76	491	70	554
Total	395	22,000	408	15,700

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

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

(Metric tons)

Kind and use	1998	1999
Adhesives	12,300	15,000
Ceramics 2/	W	W
Fertilizers, pesticides, related products	W	W
Fiber glass	W	W
Paper coating and filling	W	W
Plastics	W	W
Rubber	146,000	137,000
Refractories 3/	W	W
Other uses 4/	199,000	215,000
Exports 5/	37,000	41,100
Total	395,000	408,000

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 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), civil engineering and sealings, gypsum products (1999), paint, miscellaneous fillers, extenders, and binders, and other unknown uses.
5/ Includes fillers, extenders, and binders.

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

(Metric tons)

Use	1998	1999
Domestic:		
Ceramics:		
Catalyst (oil and gas refining)	W	208,000
Electrical porcelain	W	12,700
Fine china and dinnerware	20,000 r/	23,500
Floor and wall tile	34,100	39,800
Pottery	27,000	11,200
Roofing granules	8,270 r/	43,200
Sanitaryware	59,400	75,600
Miscellaneous	231,000 r/	26,300
Chemical manufacture	W	23,200
Civil engineering	W	W
Fiber glass, mineral wool	385,000 r/	329,000
Fillers, extenders, binders:		
Adhesive	75,600 r/	81,500
Fertilizer	3,640	W
Medical, pharmaceutical, cosmetic	23,100	W
Paint	271,000 r/	288,000
Paper coating	3,090,000	3,000,000
Paper filling	866,000 r/	791,000
Pesticide	18,300 r/	13,100
Plastic	39,600 r/	39,700
Rubber	216,000 r/	222,000
Miscellaneous	176,000 r/	115,000
Heavy clay products:		
Brick, common and face	135,000 r/	126,000
Portland cement	60,800 r/	54,200
Refractories:		
Firebrick, block and shapes	4,040 r/	13,800
Grogs and calcines	1,120,000	135,000
High-alumina brick, specialties, kiln furniture	W	W
Foundry sand, mortar, cement, miscellaneous refractories	82,600	621,000
Miscellaneous applications	227,000 r/	430,000
Total	7,170,000 r/	6,720,000
Exports:		
Ceramics	201,000 r/	210,000
Foundry sand, grogs and calcines; other refractories	W	W
Paint	78,100	88,100
Paper coating	2,020,000	1,970,000
Paper filling	111,000 r/	110,000
Rubber	41,800	45,700
Miscellaneous	24,400 r/	23,800
Total	2,470,000 r/	2,440,000
Grand total	9,640,000 r/	9,160,000

r/ Revised. 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.

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/
1998:						
Alabama and Arkansas	851	106	22	--	978	14,300 r/
California e/	141	104	--	76	321	7,540
Florida and Indiana	202	44	--	--	246 r/	1,500
Kansas, Kentucky, Louisiana	300	138	56	145	638	9,540
Missouri	--	--	--	133	133	1,770
New York	284	220	--	--	503	15,300
North Carolina e/	300	52	--	--	353	4,050
Ohio and Oklahoma	228	3	12	--	242	1,470
Texas e/	49	157	222	31	459	2,520
Utah and Virginia	191	48	--	54	293	5,120
Total	2,540	871	311	441	4,170	63,400
1999:						
Alabama and Arkansas	713	8	8	--	729	15,000
California	41	160	--	--	201	7,990
Florida and Indiana	229	48	--	--	277	1,520
Kansas, Kentucky, Louisiana	358	219	86	76	740	12,000
Missouri	--	--	--	135	135	1,780
New York e/	284	220	--	--	503	15,300
North Carolina e/	300	52	--	--	352	4,050
Ohio and Oklahoma	258	16	--	--	274	1,620
Texas e/	49	157	222	31	459	2,520
Utah and Virginia	193	48	--	16	259	3,520
Total	2,430	929	317	259	3,930	65,200

e/ Estimated. r/ Revised. -- 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	1998		1999	
	Quantity	Value	Quantity	Value
Alabama	930	1,970	877	215
Arkansas	446	357	739	734
California	190	629	249	1,030
Colorado	222	1,480 r/	286	2,240
Connecticut, New Jersey, 3/ New York 3/	252	993	247	1,070
Georgia	1,340	3,690	1,300	3,540
Illinois	121	553 r/	134	616
Indiana and Iowa	391	1,180	389	949
Kentucky 3/ and Tennessee 3/	831	2,240 r/	907	2,300
Maryland and West Virginia 4/	336	1,300	385	1,480
Mississippi and Missouri	509	2,560	508	2,190
North Carolina	1,950	6,340 r/	1,980	13,300
Ohio	843	4,030	929	4,500
Oklahoma	410	3,050 r/	476	1,110
Pennsylvania	790	1,870 r/	718	1,360
South Carolina	962	2,640 r/	919	4,420
Texas	1,010	5,370	1,000	5,220
Virginia	731	2,330 r/	740	2,260
Other 5/	1,010	3,430 r/	999	5,550
Total	13,300	46,000 r/	13,800	54,100

r/ Revised.

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 Wyoming.

TABLE 23
U.S. EXPORTS OF CLAYS IN 1999, 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	11	266	(2/)	204	(2/)	52	1	132
Australia	2	44	12	3,470	20	981	--	--
Belgium	--	--	6	597	--	--	1	69
Brazil	3	497	11	2,130	1	152	1	237
Canada	34	2,120	208	14,100	6	1,130	89	13,000
Finland	--	--	--	--	--	--	(2/)	10
France	--	--	41	1,830	(2/)	10	(2/)	28
Germany	--	--	4	609	(2/)	75	4	844
Indonesia	--	--	6	1,620	(2/)	66	3	316
Italy	--	--	(2/)	347	--	--	4	1,450
Japan	17	430	152	12,700	34	2,040	2	319
Korea, Republic of	(2/)	29	21	4,910	4	611	(2/)	6
Malaysia	--	--	14	1,300	--	--	1	132
Mexico	17	653	17	1,470	48	3,890	1	196
Netherlands	(2/)	28	47	4,920	44	4,840	23	2,450
Singapore	(2/)	26	8	2,180	--	--	1	91
South Africa	(2/)	29	(2/)	249	(2/)	35	(2/)	85
Taiwan	2	186	27	4,450	12	953	(2/)	54
Thailand	(2/)	16	18	1,440	1	88	1	138
United Kingdom	(2/)	8	37	3,590	(2/)	59	5	1,040
Venezuela	8	671	14	2,190	(2/)	68	2	451
Other	13	1,080	76	11,000	19	1,470	13	3,610
Total	107	6,080	719	75,300	189	16,500	152	24,600

	Kaolin		Clays, n.e.c. 3/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	4	1,100	8	2,300	24	4,060
Australia	16	8,690	7	3,420	57	16,600
Belgium	26	7,710	4	1,530	37	9,910
Brazil	1	623	4	2,590	20	6,230
Canada	746	82,900	144	32,300	1,230	145,000
Finland	354	63,200	1	1,280	355	64,500
France	7	1,940	1	1,340	50	5,140
Germany	13	5,260	6	3,700	27	10,500
Indonesia	65	14,500	5	1,850	79	18,400
Italy	132	26,300	1	596	137	28,700
Japan	877	164,000	10	7,690	1,090	187,000
Korea, Republic of	134	24,500	5	4,090	165	34,100
Malaysia	2	753	2	1,150	19	3,340
Mexico	204	22,100	19	4,160	305	32,400
Netherlands	220	37,000	15	11,100	348	60,300
Singapore	2	546	4	3,180	14	6,020
South Africa	10	3,070	4	1,740	15	5,220
Taiwan	136	21,000	9	3,460	187	30,100
Thailand	19	4,860	2	1,530	41	8,080
United Kingdom	37	8,110	18	15,600	97	28,400
Venezuela	22	2,500	4	1,400	50	7,290
Other	279	66,300	56	27,400	455	111,000
Total	3,310	567,000	329	133,000	4,800	823,000

-- 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 1999, BY KIND 1/

Kind	Quantity (metric tons)	Value 2/ (thousands)
China clay or kaolin:		
Brazil	44,300	$6,550
China	1,380	221
France	484	110
Mexico	216	82
United Kingdom	10,600	3,370
Other	254	267
Total	57,200	10,600
Fire clay:		
Canada	27	12
Germany	107	45
Mexico	5	7
Taiwan	121	30
Total	260	93
Decolorizing earths and fuller's earth:		
Ireland	398	19
Bentonite:		
Canada	1,680	534
Germany	206	112
Japan	455	144
Mexico	462	115
Netherlands	279	83
Turkey	2,320	737
United Kingdom	3,510	1,250
Other	22	15
Total	8,930	2,990
Common blue clay and other ball clay:		
Canada	29	17
China	2	3
United Kingdom	796	179
Total	827	199
Other clay:		
Canada	1,840	456
China	122	187
Guyana	1,760	32
Haiti	200	5
United Kingdom	1,040	295
Other	285	585
Total	5,250	1,560
Artificially activated clay and activated earth:		
Austria	391	486
Canada	1,620	904
Germany	1,100	739
Mexico	13,200	4,010
Netherlands	187	60
Norway	165	85
Switzerland	254	369
Venezuela	215	36
Other	338	841
Total	17,500	7,530
Grand total	90,400	23,000

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/	1995	1996	1997	1998	1999 e/
Algeria 4/	17,088	17,200	17,657 r/	15,655 r/	15,000
Argentina	111,011	134,588	113,572 r/	131,320 r/	130,000
Armenia	110	2,750	2,750 e/	3,000 e/	3,000
Australia e/ 4/	35,000	35,000	35,000	35,000	35,000
Bosnia and Herzegovina e/	800	800	800	800	800
Brazil (beneficiated)	150,000	186,000	224,055	210,214 r/	210,000
Bulgaria	125,800	202,000	171,000 e/	175,000 e/	175,000
Burma	1,081 r/	4,769 r/	4,908 r/	3,871 r/	3,700
Chile	684	1,191	717	721	725
Croatia	7,327	9,728	7,331	7,581 r/	8,440 5/
Cyprus	71,773 r/	70,927	101,000	140,000	140,000
Czech Republic	54,000	59,000	110,000	125,000 r/	160,000
Egypt	1,930	1,136	1,200 e/	1,545 r/	1,500
Georgia	13,000	13,000	12,000	11,000 e/	12,000
Germany	529,000	491,000	510,000 e/	500,000 e/	500,000
Greece	1,115,119	973,517	950,000 e/	950,000 e/	950,000
Guatemala	5,839 r/	3,755 r/	3,750 r/	3,800 e/	3,800
Hungary	22,792	15,376	14,848	17,000 r/	16,000
Indonesia	26,057	26,000 e/	653,623 r/	840 r/	5,213 5/
Iran 6/	54,798	85,000 e/	105,300	115,000 r/	115,000 5/
Italy	591,000	475,000	513,000	592,000 r/	500,000
Japan	478,056	468,728	495,646	443,566 r/	426,455 5/
Macedonia e/	30,000	30,000	30,000	30,000	30,000
Mexico	72,599	69,810	111,503	185,729	208,611 5/
Morocco	29,308	39,680	49,633	47,881 r/	48,000
Mozambique	3,500 e/	11,051	13,799	14,000 e/	14,000
New Zealand (processed)	3,699	13,734	12,802	14,000 e/	15,000
Pakistan	5,759	15,290	16,450 r/	14,196	15,349 5/
Peru	26,961	18,592	22,285	22,300 r/	22,300
Philippines	7,636	8,000 e/	8,000 e/	3,900 r/	1,844 5/
Poland	6,300	8,000	10,000 e/	24,000 r/	25,000
Romania	42,277	43,543	27,133	25,434 r/	19,609 5/
Serbia and Montenegro	192	95	100 e/	68 r/	77
South Africa 7/	70,927	48,076	33,326	48,382 r/	40,000
Spain	172,265	151,155	150,000 e/	150,000 e/	150,000
Tanzania e/	70	75	75	75	75
Turkey	602,499	515,452 r/	521,158 r/	565,708 r/	560,000
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/ 8/	1,000,000 r/	900,000 r/	800,000 r/	600,000 r/	700,000
United States	3,820,000	3,740,000	4,020,000	3,820,000	4,070,000
Zimbabwe 7/	169,823	185,953	186,000 e/	135,785 r/	140,000
Total	9,820,000 r/	9,420,000	10,400,000 r/	9,540,000 r/	9,820,000

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/ Table includes data available through Auagust 11, 2000.

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/ May include other clays.

8/ 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/	1995	1996	1997	1998	1999 e/
Algeria e/	4,500	4,500	4,500	4,500	4,000
Argentina e/	1,600	1,500	1,500	1,500	1,500
Australia (attapulgite) e/	15,000	15,000	15,000	15,000	15,000
Germany (unprocessed)	529,000	491,000	511,000	500,000 e/	500,000
Italy	34,000	26,000	30,000	30,000 e/	30,000
Mexico	15,755	41,800	51,430	48,016	47,522 4/
Morocco (smectite)	15,027	17,223 r/	24,425 r/	27,650 r/	28,000
Pakistan	12,862	13,415	12,307 r/	14,659 r/	15,565 4/
Senegal (attapulgite) e/	120,000	100,000 r/	80,000 r/	80,000 r/	80,000
South Africa (attapulgite)	8,049	14,318	9,349	7,671 r/	7,000
Spain (attapulgite) e/	94,266 4/	94,000	90,000	90,000	90,000
United Kingdom 5/	132,300	143,000	140,000	140,000 e/	140,000
United States 6/	2,640,000	2,600,000	2,370,000	2,420,000 r/	2,560,000 4/
Total	3,620,000	3,560,000 r/	3,340,000 r/	3,380,000 r/	3,520,000

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 11, 2000.

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/	1995	1996	1997	1998	1999 e/
Algeria	24,068	25,000 r/ e/	18,533 r/	13,640 r/	10,000
Argentina	39,860	64,241	47,365 r/	46,832 r/	45,000
Australia (includes ball clay) e/	210,000	210,000	220,000	220,000	250,000
Austria (marketable)	57,000 4/	60,000	60,000	60,000	60,000
Bangladesh 5/	6,541 4/	7,000	7,200	7,500	7,700
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)	1,067,109	1,057,671	1,280,000	1,381,000 r/	1,381,000
Bulgaria e/	115,000	115,000	115,000	110,000	110,000
Burundi e/	1,000	1,000	1,000	1,000	800
Chile	10,845	13,452	14,238	11,530	11,600
Colombia (includes common clay)	7,300,000	3,957,000	8,040,000	8,000,000 e/	8,000,000
Czech Republic	2,800,000	2,798,000	2,982,000	3,049,000 r/	5,183,000 4/
Denmark (sales) e/	3,500	3,000	3,000	2,500	2,500
Ecuador	45,054	86,541	7,345 r/	7,000 r/ e/	7,000
Egypt	293,381	258,725	258,869 r/	285,497 r/	290,000
Eritrea	3,200 e/	2,620	4,670 r/ e/	3,809 r/	3,000
Ethiopia e/	15	15	16	15 r/	15
France (marketable)	345,000	326,000	332,000	330,000 e/	325,000
Germany	1,925,000	1,794,000	1,800,000 e/	1,800,000 e/	1,800,000
Greece	68,682	60,453	60,000	60,000 e/	60,000
Guatemala e/	76	109	110	110	110
Hungary (processed)	4,847 4/	5,000	6,000 r/	7,000 r/	7,000
India:					
Processed	160,689	183,268	175,000 r/	148,000 r/	150,000
Salable crude	552,128	557,778	575,000 r/	402,000 r/	520,000
Indonesia	14,373	15,000 e/	1,956 r/	8,567 r/	21,389 4/
Iran	250,000 r/ e/	350,000	510,000	600,000 r/ e/	600,000
Israel e/	40,000	40,000	40,000	40,000	40,000
Italy: Kaolinitic earth e/	10,000	10,000	9,000	9,000	9,000
Japan	182,122	141,230	110,915	83,257 r/	53,092 4/
Kazakhstan e/	30,000	40,000	50,000	60,000	70,000
Korea, Republic of	2,792,139	2,501,600	2,688,489	2,259,809	1,858,359 4/
Madagascar e/	1,545 4/	1,500	1,500	1,500	1,500
Malaysia	211,182	209,562	187,411	176,500 r/	209,125 4/
Mexico	221,685	253,602 r/	235,278	339,013	489,993 4/
New Zealand	13,662	26,325	21,874	26,000	25,000
Nigeria	11,950	102,078	100,000 e/	110,000 r/ e/	110,000
Pakistan	30,746	54,860	66,235 r/	70,777 r/	64,692 4/
Paraguay e/	66,300 4/	66,500 r/	66,700	66,700 e/	66,500
Peru	8,445	14,295	7,875	7,900 e/	7,900
Poland (washed)	53,000	71,700	83,600	82,450 e/	80,000
Portugal	180,000	177,423 4/	180,000	180,000	180,000
Romania	49,024	45,199	29,169	24,724 r/	23,586
Russia (concentrate)	50,000	50,000	50,000	50,000 4/	40,000
Serbia and Montenegro:					
Crude	56,926 4/	55,000	55,000	75,092 r/ 4/	40,321 4/
Washed	4,900 4/	5,000	5,000	7,000 r/	3,000
Slovakia	13,300	23,240	24,000 e/	28,000 r/	25,000
Slovenia: e/					
Crude	10,000	10,000	10,000	10,000	10,000
Washed	4,000	7,000	7,000	4,000	4,000
South Africa	146,587	146,496	122,800 r/	101,300 r/	120,000
Spain (marketable): Crude and washed 6/	316,074 4/	315,000	315,000	300,000	300,000
Sri Lanka	16,000	7,700	20,100 r/	24,478 r/	25,000
Sweden e/	460	460	450	450	450
Taiwan e/	100,000	100,000	100,000	70,000	70,000
Thailand (beneficiated)	460,629	553,770	366,563	255,152 r/	250,000
Turkey	489,635	449,561	472,646 r/	403,733 r/	400,000
Ukraine	950,000 4/	900,000	850,000	850,000	850,000
United Kingdom (sales) 7/	2,585,881	2,281,000	2,400,000 e/	2,391,595 r/	2,303,607 4/
United States 8/	9,480,000	9,120,000	9,280,000 r/	9,640,000 r/	9,160,000
Uzbekistan e/	5,500,000	5,500,000	5,500,000	5,500,000	5,500,000

See footnotes at end of table.

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

(Metric tons)

Country 3/	1995	1996	1997	1998	1999 e/
Venezuela	3,020	7,542	5,000 r/	16,900 r/	8,000 4/
Vietnam e/	1,000	1,000	1,100	1,100	1,100
Zimbabwe	57	--	-- e/	--	--
Total	39,700,000 r/	35,500,000 r/	40,300,000 r/	40,100,000 r/	41,500,000

e/ Estimated. 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.

2/ Table includes data available through August 11, 2000.

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.