

# CLAY AND SHALE

By Robert L. Virta

**Domestic survey data and tables were prepared by Maria Arguelles, statistical assistant, and the world production tables were prepared by Linder Roberts, international data coordinator.**

Companies in the United States mined six types of clays: ball clay, bentonite, common clay and shale, 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 clay and shale contain illite and chlorite as major components. Fire clay comprises mainly kaolinite, halloysite, and/or diaspore. Fuller's earth consists primarily of attapulgite, calcium-rich montmorillonite with quartz. In many countries all calcium-rich montmorillonite clays including calcium-rich bentonite are called fuller's earth and attapulgite is grouped under specialty clays. Kaolin comprises primarily kaolinite or kaolin-group minerals. Smectite minerals, mica, quartz, and rutile are a few other components of kaolin deposits. Mineral composition, plasticity, color, 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 2002 was 39.3 million metric tons (Mt) valued at \$1.58 billion, a decrease in tonnage but an increase in value from those of 2001. Production of ball clay and fire clay increased while production of bentonite, common clay and shale, fuller's earth, and kaolin decreased. Of the clay and shale produced in 2002, common clay and shale accounted for 59% of the tonnage, and kaolin accounted for 60% of the value. Imports of clays increased to 217,000 metric tons (t) valued at \$39.4 million. Exports decreased to 4.96 Mt valued at \$817 million (table 1).

Major markets, including exports, for ball clay were floor and wall tile (38%), sanitary ware (32%), pottery and miscellaneous ceramics (17%); for bentonite, foundry sand bond (25%), absorbents (23%), drilling mud (21%), and iron ore pelletizing (15%); for common clay and shale, brick (56%), cement (17%), and lightweight aggregate (17%); for fire clay, refractory products (75%), for fuller's earth, absorbents (74%); and for kaolin, paper coating and filling (64%).

The Industrial Minerals Association-North America was established as a complement to the Industrial Minerals Association-Europe. The organization will represent the interests of the North American industrial minerals producers. There currently are 38 member companies from a variety of mineral industries, including ball clay, feldspar, industrial sand, mica, soda ash, and talc producers (Industrial Minerals, 2002h).

## Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) issued proposed emission standards as the agency continued developing its maximum achievable control technology

(MACT) regulation. The proposed standards would require the refractory industry to achieve a 99.8% combustion efficiency for hydrocarbons or alternatively limiting emissions of total hydrocarbons to 20 parts per million. The EPA also was studying emission of hydrocarbon, hydrogen fluoride, hydrogen chloride, and trace metal emissions from clay processors and manufacturers of lightweight aggregate, brick, and other ceramic products. Final specifications for the MACT regulation were under consideration at yearend 2002 (U.S. Environmental Protection Agency, 2002a, b).

Clay mining has an environmental impact because of the disturbance to the land through open pit or cut-and-fill mining methods. 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. Ponds for recreational purposes often are created when ground water levels permit. For processing, the impoundment of slimes and dust control is required. The rules for disposal of coarse tailings are similar to or included within those laws governing reclamation of the mined area.

## Production

In 2002, 237 companies operated approximately 760 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, and Wisconsin (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 of tonnage, were Georgia, Wyoming, Alabama, Texas, North Carolina, Missouri, South Carolina, Ohio, California, and Mississippi. The 10 leading producer companies, in alphabetical order, were American Colloid Co. (bentonite), Big River Industries, Inc. (common clay and shale), 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 the 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 and company data available from other sources account for approximately 70% of the total clay and shale sold or used quantity 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 2002, 4 companies mined ball clay from 46 pits in 4 States. Production of domestic ball clay was estimated to be 1.12 Mt valued at \$47 million, a slight increase from 1.11 Mt valued at \$46.7 million in 2001 (table 3). Tennessee supplied 59% of the Nation's output, followed by, in descending order of tonnage, Texas, Kentucky, and Mississippi. One producer reported a small amount of production in Indiana, but this was fire clay rather than ball clay. Water-slurried ball clay was produced in Kentucky and Tennessee. Airfloat and shredded (unprocessed) ball clay was produced in all four producer States.

**Bentonite.**—In 2002, 21 companies produced bentonite from approximately 93 pits in 12 States. The quantity of all varieties of bentonite sold or used, 3.97 Mt valued at \$180 million, was essentially unchanged from that of 2001 and the value decreased by about 5% (table 5). Production of nonswelling bentonite decreased to 354,000 t valued at \$14 million from 357,000 t valued at \$13.7 million in 2001. Alabama led all States in the production of nonswelling bentonite, followed by, in descending order of tonnage, Mississippi, Georgia, Arizona, Nevada, California, Utah, and Colorado.

Production of swelling bentonite increased slightly to 3.62 Mt valued at \$166 million from 3.61 Mt valued at \$176 million in 2001. Wyoming still led all States in the production of swelling bentonite, followed by Montana, Utah, Texas, California, Oregon, and Nevada.

Süd-Chemie Inc. won its appeal of a judgment of \$78 million against Southern Clay Products, Inc. for patent infringement. The U.S. District Court for the Southern District of Texas invalidated one of the patent infringement claims made by Southern Clay Products and remanded the other claim to a federal court for retrial (Chemical Week, 2002).

AMCOL International Corp. purchased FNG Industries Inc., New Haven, WV. FNG is a producer of ferrosilicon and carbon-silicon foundry brick and fluxes for iron foundries. The acquisition permitted AMCOL to expand its services to its foundry customers by providing products used for metal melting as well as for molding operations (Industrial Minerals, 2002d). Nanocor, Inc. (a subsidiary of AMCOL International Corp.) announced that it was expanding its research efforts with Gitto Global Corp., Lunenburg, MA, on flame-resistant polyolefin plastics using nanocomposites. Products developed thus far had greater strength, lower weight, and used less of the traditional flame retardant additives (AMCOL International Corp., 2002b).

**Common Clay and Shale.**—In 2002, 162 companies produced common clay and shale from approximately 450 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 the common clay and shale producers 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 23.0 Mt valued at \$148 million from 23.2 Mt valued at \$129 million in 2001 (table 7). The major producing States, in descending order of tonnage, were North Carolina, Texas, Alabama, Georgia, Ohio, Missouri, Oklahoma, California, South Carolina, Kentucky, Arkansas, Virginia, and Pennsylvania.

Mohawk Industries, Inc. purchased Dal-Tile International Inc. for approximately \$1.8 billion. The purchase made Mohawk Industries the largest floor covering manufacturer and distributor in the world. Dal-Tile had about \$1 billion in annual sales of ceramic tile and stone (Mohawk Industries, Inc., 2002; Tile and Decorative Surfaces, 2002).

Gladding McBean (a division of Pacific Coast Building Products, Inc.) purchased Lincoln Clay Products Co. Lincoln Clay produced mortar, fire, and ceramic clays for domestic and Mexican markets. Gladding McBean produced clay for architectural terra cotta, clay roof tiles, sewer pipe, and pottery (Ceramic Bulletin, 2002a).

**Fire Clay.**—Fire clay producers were mostly refractory product manufacturers that used the clays in firebrick and other refractory products. In 2002, 7 firms in 4 States operated 44 pits. Fire clay sold or used by domestic producers increased to 446,000 t valued at \$10.5 million from 383,000 t valued at \$7.57 million in 2001 (table 9). Missouri was the leading producing State, followed by, in descending order of tonnage, South Carolina, Ohio, and California.

RHI Refractories America (a subsidiary of RHI AG) filed for bankruptcy protection following increasing asbestos-related liabilities. Included in the filing are its U.S. subsidiaries, Global Industrial Technologies, Inc.; Harbison-Walker Refractories Co.; and A.P. Green Industries, Inc. North American Refractories Co. Inc. (another RHI Refractories subsidiary) filed for bankruptcy protection earlier in the year due to asbestos-related liabilities (Industrial Minerals, 2002m; North American Minerals News, 2002c). RHI America will close some operations and restructure to improve efficiency. RHI AG will focus its efforts on its Veitsch-Radex America operation in Canada and RHI-Refmex SA operation in Mexico (Industrial Minerals, 2002p; Refractory News, 2002).

**Fuller's Earth.**—In 2002, 16 companies produced fuller's earth (attapulgitite and montmorillonite varieties) from 31 pits in 10 States. Production of fuller's earth decreased to 2.73 Mt valued at \$246 million from 2.89 Mt valued at \$267 million in 2001 (table 11). The fuller's earth deposits grade from attapulgitite-rich in Florida to montmorillonite-rich further northward into Georgia. Only those clays with attapulgitite as the major clay component are classified as attapulgitite. These basically are the gellant-grade fuller's earths in Florida and the southernmost part of Georgia. Going northward into Georgia, the attapulgitite 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 attapulgitite.

The attapulgitite variety of fuller's earth was mined from eight pits in the Florida Panhandle and Southwestern Georgia.

Only Engelhard and Zemex Corp. mined attapulgite at yearend 2002 but an unspecified portion of the production was sold by ITC, Inc., making, in essence, three producers of attapulgite. Attapulgite production was reported by producers to have declined to 218,000 t valued at \$26.8 million from 292,000 t valued at \$35.8 million in 2001. Sales to oil and grease absorbent, adhesives, and paint markets showed moderate declines. The largest decrease in sales was in attapulgite exported for drilling mud applications and the processing of oils and greases. This decline in exports does not follow industry trends and it is believed that one company underreported exports by approximately 35,000 t; total sales in 2002 were probably closer to 255,000 t than the reported 218,000 t. Florida led in the production of attapulgite followed by Georgia. Production of the montmorillonite variety of fuller's earth was 2.51 Mt valued at \$219 million, a decrease from 2.60 Mt valued at \$231 million in 2001. Montmorillonite was produced, in decreasing order of tonnage, in Georgia, Mississippi, Missouri, Virginia, California, Illinois, Florida, Tennessee, Kansas, and Texas.

Nestlé SA purchased Ralston Purina Co. for \$10.3 billion. The purchase includes the pet litter products and pet food division. Ralston Purina had clay mining operations in California, Illinois, and Missouri. The purchase provided Nestlé with products that complement its current product line and provides additional access to pet care markets (North American Minerals News, 2002b).

Zemex purchased the attapulgite operations of Milwhite Inc. in Georgia for \$12 million. Milwhite mined and processed attapulgite near Attapulcus, GA. The company produced about 50,000 tons per year (t/yr) of attapulgite for absorbent, coating, construction, oil well drilling applications and accounts for about 12% of the domestic supply. Zemex will spend \$2.5 million to increase the efficiency of the facility, including \$1.5 million for a new pneumatic conveyance system and bagging upgrades and \$1 million for optimizing ore reserves (North American Minerals News, 2002d).

Oil-Dri completed its acquisition of specific assets from A&M Products Manufacturing Co. (a subsidiary of Clorox Co.). The purchase includes the inventories, mineral reserves of fuller's earth, a manufacturing plant in Taft, CA, and rights to trademarks. The assets acquired include Jonny Cat litter, Jonny Cat liners, industrial absorbents, and agricultural carriers, producing annual revenues of about \$18 million. The purchase expanded Oil-Dri's distribution network for absorbents. Oil-Dri operates 12 domestic and international manufacturing facilities (Oil-Dri Corp. of America, 2002a).

Oil-Dri decided not to proceed with its plans to develop a fuller's earth deposit and construct a mill facility in Hungary Valley, near Reno, NV, after the Washoe County Commission refused to issue a special use permit for the operation. Oil-Dri had received permits from the U.S. Department of the Interior's Bureau of Land Management to develop a fuller's earth deposit on Federal land. The company filed suit against the Commission to recoup damages (Oil-Dri Corp. of America, 2002b).

**Kaolin.**—In 2002, 24 firms mined kaolin from approximately 78 pits in 10 States. Domestic production decreased to 8.01 Mt valued at \$951 million from 8.11 Mt valued at \$875 million in 2001 (table 13). Nearly all of the increase in value was accounted for by a higher proportion of high-value low-

temperature calcined (pigment grade) kaolin being sold and 5% to 7% energy surcharges implemented by major producers in 2002. The leading producer State was Georgia, followed by, in descending order of tonnage, Alabama, South Carolina, California, Arkansas, Texas, North Carolina, Florida, Nevada, and Tennessee.

Of the 8.01 Mt mined, 4.26 Mt was water washed, 1.55 Mt was calcined, 1.07 Mt was delaminated, 943,000 t was airfloat, and 185,000 t was unprocessed (table 14). Of the calcined kaolin, 826,000 t valued at \$264 million was pigment-grade (low-temperature calcined kaolin). The remainder was refractory-grade (high-temperature calcined kaolin) (table 15).

Kaolin production in Georgia decreased to 6.83 Mt valued at \$893 million from 7.02 Mt valued at \$818 million in 2001. Again, the increased value resulted from increased sales of high-value low-temperature calcined kaolin and energy surcharges placed on products in 2002. Approximately 4.22 Mt of Georgia kaolin production was sold as water washed, 1.07 Mt was delaminated, 888,000 t was calcined (high- and low-temperature calcined kaolin), 593,000 t was airfloat, and less than 59,000 t was unprocessed (table 16). Production in South Carolina was 374,000 t valued at \$21.4 million compared with 377,000 t valued at \$22.8 million in 2001. Approximately 307,000 t of production was airfloat kaolin with the remainder being calcined or unprocessed (table 18).

Alchemy Kaolin, Inc. (a subsidiary of Alchemy Ventures Ltd.) continued work on its deposit in Latah County, ID. Detailed mapping and sampling were completed, further defining the boundaries of the feldspar, kaolin, and quartz deposit. Preliminary work indicated that, at a minimum, feldspar could be economically recovered from the deposit. The company is continuing to characterize the kaolin that is present (Alchemy Ventures Ltd., 2002). Alchemy Ventures also has agreed with Idaho Industrial Minerals (IIM) to issue 1.75 million shares of stock to IIM in exchange for 100% interest in the lease applications for the Helmer Bovill property, subject to approval by the Toronto Stock Exchange (Industrial Minerals, 2002b).

J.M. Huber Corp. began working with Sparta Kaolin Corp. (a subsidiary of Kaoclay Resources Inc., Halifax, Nova Scotia) on a kaolin deposit near Sparta, GA, on the border of Georgia and South Carolina. Huber will make a market assessment of the kaolin from the deposit, conducting bench test and full-scale production runs. The agreement allows Sparta Kaolin to tap into Huber's experience in the industry and is expected to give Huber first rights if the testing is successful. The deposit, 75% in Georgia and 25% in South Carolina, is expected to yield about 17.7 Mt of finished product (Industrial Minerals, 2002g).

Engelhard announced that it would consolidate some of its resources in its kaolin operations in Georgia and its petroleum refining catalyst facility in Savannah, GA. The shift of some resources from paper market applications to catalyst technologies was made to better leverage the assets of the company (Engelhard Corp., 2002a). The company announced that it would idle additional capacity and reduce staffing at its Gordon and McIntyre plants in Georgia by midyear. This action was partially in response to the continued downturn in the paper market (North American Minerals News, 2002a).

Atlas Mining Co. has contracted with Lintech International Inc., Macon, GA, to distribute halloysite mined from Atlas

Mining's Dragon mine in Juab County, Utah. Atlas Mining will market only one product initially for porcelain, synthetic zeolite-based molecular sieve, catalyst support, and catalyst absorption, and filtration applications (Industrial Minerals, 2002l).

Imerys announced that it had further restructured its operations in Georgia. Production of kaolin for paper applications will be undertaken in its Sandersville, GA, operation. Kaolin for other applications will be the focus of Imerys' Dry Branch plant (Mining Journal, 2002).

The Society for Mining, Metallurgy, and Exploration, Inc. held a conference on global kaolin resources, exploration, and development in Savannah, GA, in September. Reviews were presented on the world kaolin resources, the current state of the kaolin industries in various major source countries, a history of technological developments in the kaolin industry and their impact, trends in the paper industry with regard to kaolin consumption in Europe and the United States, potential for new deposits, and a general overview of consumption trends of mineral fillers that compete with kaolin. Worldwide sales of processed kaolin are approximately 25 Mt, with crude production of about 42 Mt. Approximately 42% of world sales were for paper applications in 2000. The United States is still the leading world source for paper-grade kaolin, but the share of the market held by Brazil has been increasing in recent years. Consumption of standard grades of kaolin has been decreasing in favor of specialty grades in North America. In the paper industry, the transition from acid to alkaline processing has enabled consumers to increase their use of calcium carbonate at the expense of kaolin. The impact was felt more strongly in the paper filler markets than in the coating markets. Kaolin producers have responded by manufacturing engineered kaolin products with unique size, shape, size distribution, and brightness characteristics and composite blends of kaolin and other mineral fillers. These actions have brought some of the emphasis back to print quality versus print brightness, which gave calcium carbonate an advantage. Standard ground wood grades of paper products were predicted to remain the mainstay of the kaolin industry although there was potential for growth in the short-term ground wood grades (Freas and others, 2002).

North American Refractories Co. Inc. closed its Indian Hills and Ione facilities in California. These facilities produced kaolin, refractory clay, and refractory products through its subsidiary, Ione Minerals & Refractories (Industrial Minerals, 2002k).

## Consumption

**Ball Clay.**—The principal domestic ball clay markets, in decreasing order, were floor and wall tile, sanitaryware, and miscellaneous ceramics (table 4). Sales and use, including exports, increased to 1.12 Mt from 1.10 Mt in 2001. Exports declined but sales for miscellaneous ceramics increased. Sales to other end use categories were essentially unchanged. Sales and use of ball clay increased from 1990 to 1998 because increased commercial and residential building construction and home renovations resulted in greater demand for sanitaryware, tile, and whiteware. Although construction activity has continued at record levels since 1998, domestic sales of ball clay have leveled off. A contributing factor is competition from

imports of clay-based ceramic products such as sanitaryware and tile (see discussion under Ceramics) and the movement of whiteware manufacturing operations out of the United States.

**Bentonite.**—Domestic sales and use were estimated to be 3.56 Mt compared with 3.52 Mt in 2001 (table 6). Major domestic markets for bentonite were pet waste (899,000 t), drilling mud (762,000 t), foundry sand (762,000 t), and iron ore pelletizing (536,000 t). Total sales (domestic and exports) of bentonite were approximately 1.01 Mt for foundry sand bond (812,000 t was swelling bentonite), 903,000 t for pet waste absorbent (more than 99% was swelling bentonite), 821,000 t for drilling mud (essentially all swelling bentonite), 603,000 t for pelletizing iron ore (all swelling bentonite), and 243,000 t for waterproofing and sealing, water treatment and filtering, and miscellaneous civil engineering applications (more than 99% was swelling bentonite).

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, drilling mud, ink, miscellaneous chemical manufacture applications, paint, pelletizing iron ore, pharmaceutical, plastics, waterproofing, and water treatment; and more than 70% of bentonite sold for foundry sand and miscellaneous filler and extender applications was swelling bentonite. More than 60% of the bentonite sold for clarifying, decolorizing, and filtering of oils and greases was the nonswelling variety. Mainly nonswelling bentonite was for desiccant and pesticides applications.

The major domestic markets for swelling bentonite, in decreasing order, were pet waste absorbents, drilling mud, foundry sand, iron ore pelletizing, and sealing and waterproofing. Major export markets for swelling bentonite, in decreasing order, were foundry sand, iron ore pelletizing, and drilling mud applications. The major domestic uses for nonswelling bentonite, in descending order of tonnage, were foundry sand bond; clarifying, decolorizing, and filtering of oils and greases; sealing and waterproofing; miscellaneous absorbents; pesticides; portland cement, animal feed, desiccants, and pet waste absorbent. Little nonswelling bentonite was exported.

**Common Clay and Shale.**—Common clay and shale 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 23.0 Mt from 23.2 Mt in 2001. Brick manufacture remained the largest market for common clay and shale, followed by, in descending order of tonnage, lightweight aggregate and portland cement. 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, not seasonally adjusted, increased to 1.70 million units from 1.60 million units in 2001 (U.S. Department of Commerce, 2002).

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

Consumption of fire clay increased to 446,000 t from 383,000 t in 2001 (table 10). Major markets for fire clay, in descending order of tonnage, were kiln furniture, refractory mortar and cement, miscellaneous refractory products, common brick, portland cement, grogs and calcines, firebrick, pottery, foundry sand, lightweight aggregate, terra cotta, and animal feed. Increased sales for refractory products along with a smaller increase in sales for brick manufacture under “Heavy clay products and lightweight aggregates” accounted for the bulk of the sales increase for fire clay.

**Fuller’s Earth.**—The major domestic uses for attapulgite and montmorillonite varieties of fuller’s earth, in descending order of tonnage, were pet waste absorbents; oil and grease absorbents; portland cement manufacture; fertilizer carriers; pesticides; animal feed; clarifying, decolorizing, and filtering of oils and greases; miscellaneous absorbents; miscellaneous heavy clay products; gypsum products; drilling mud; paint; desiccant; adhesives; and textiles (table 12). Consumption of fuller’s earth decreased to 2.73 Mt from 2.89 Mt in 2001.

Sales of montmorillonite decreased to 2.51 Mt from 2.60 Mt in 2001. Major domestic markets for montmorillonite, in descending order of tonnage, were pet waste absorbents, oil and grease absorbents, portland cement, fertilizer carrier, pesticide carrier, animal feed, clarifying, decolorizing, and filtering of oils and greases, miscellaneous heavy clay products, and miscellaneous absorbents. The largest export market was pet waste absorbent.

Sales of attapulgite reported by producers declined to 218,000 t from 292,000 t in 2001. The largest declines were in sales for pet waste absorbents, adhesives, paint, and exports for drilling mud and clarifying, decolorizing, and filtering of oils and greases. It is believed that one producer underreported exports by about 35,000 t, bringing U.S. sales to about 253,000 t rather than 218,000 t. Most of the sales data were concealed to avoid disclosing company proprietary data. Major markets for attapulgite, in decreasing order, were fertilizer carrier; oil and grease absorbents; pesticide carrier; gypsum products; drilling mud; paint; animal feed; miscellaneous filler and extender applications; miscellaneous absorbents; miscellaneous refractory; textile; miscellaneous clarifying, decolorizing, and filtering of oils and greases; ceramic floor tile; cosmetic, medical, pharmaceutical applications; asphalt tile; and adhesives.

Sales of the montmorillonite variety of fuller’s earth accounted for more than 80% of sales of fuller’s earth for adhesives; animal feed; portland cement manufacture; clarifying, decolorizing, filtering oils and greases; desiccant; oil and grease absorbents; pet waste absorbents; and exported products. Montmorillonite also accounted for more than 60% of sales for fertilizer carriers and pesticide carriers. Attapulgite accounted for all of the sales for asphalt tile; cosmetic, medical, pharmaceutical applications; drilling mud; gypsum products; paint; textiles; miscellaneous filler and extender applications; miscellaneous ceramic floor tile; and miscellaneous refractory products.

**Kaolin.**—Consumption of kaolin decreased to 8.01 Mt from 8.11 Mt in 2001. The major domestic markets for kaolin, in descending order of tonnage, were paper coating and filler, refractory products, paint, fiberglass, catalyst, and rubber

(table 20). The largest increase in domestic sales was for refractory applications and the largest decrease was for paper coating applications. Paper coating and filler markets have been affected in recent years by a stagnating paper market and competition from calcium carbonate. Major domestic markets for kaolin from Georgia, in descending order by tonnage, were paper coating, paper filling, fiberglass, paint, refractory products, and catalyst manufacture (table 17). Major domestic markets for kaolin from South Carolina, in descending order of tonnage, were rubber, roofing granules, catalyst, brick, fiberglass, and adhesives. The major export market for kaolin from South Carolina was rubber applications.

**Absorbent Uses.**—Sales reported by producers for absorbent uses were about 2.95 Mt, a decrease from 3.13 Mt in 2001. Fuller’s earth accounted for about 69% of the clay used for absorbents, followed by bentonite and kaolin. Pet waste absorbents accounted for 85% 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 2.16 Mt, an increase from 1.81 Mt in 2001. The largest ceramics market was ceramic floor and wall tile (43%), followed by sanitaryware (23%), catalyst (12%), roofing granules (9%), fine china (3%), pottery (3%), and quarry tile (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.

Apparent consumption of clay floor and wall tile in the United States was 245 million square meters valued at \$2.37 billion compared with 211 million square meters valued at \$2.11 billion in 2001. Domestic producers shipped 60.3 million square meters of clay floor and wall tile valued at \$825 million compared with 54.9 million square meters valued at \$776 million in 2001. Exports were 3.87 million square meters valued at \$27.9 million compared with 3.09 million square meters valued at \$26.5 million in 2001. Imports of clay floor and wall tile were 189 million square meters valued at \$1.57 billion compared with 159 million square meters valued at \$1.36 billion in 2001 (U.S. Census Bureau, 2003a).

The International Trade Administration reported that approximately 24.5 million square meters of glazed and unglazed ceramic tile with sides under 7 centimeters valued at \$171 million was imported compared with 21.1 million square meters valued at \$149 million in 2001.

Domestic tile consumption remained essentially unchanged for 2000 and 2001 despite the slow U.S. economy. The United States is the ninth largest producer of ceramic tile, the largest importer, and the fourth largest consumer. With imports accounting for much of the domestic growth in the tile market, some domestic producers have closed factories. Other

manufacturers, however, have opened new factories to improve overall company production efficiency. Large-form tile (30.5 centimeters (cm) by 30.5 cm) was the largest domestic market with the greatest growth being in low water-absorption floor tile such as glazed and unglazed porcelain tiles (Daniels, 2002a, b).

Continued record levels of new home construction have increased demand for sanitaryware in the United States in 2001 and early 2002. Spending for bathroom construction and remodeling has grown by double digits in Europe and the United States. In some cases, an increased sales value for individual products compensated for an overall decline in unit sales (Grahl, 2002a).

Government statistics on sales of vitreous sanitaryware including drinking fountains, flush tanks, lavatory bowls, urinals, wash sinks, and water closet bowls used in the United States were not available after 1999. In 1999, shipments from domestic producers were valued at \$932 million, imports were valued at \$102 million, exports were valued at \$57.5 million, and apparent consumption was valued at \$976 million (U.S. Census Bureau, 2000). Imports of sanitaryware continued to increase in 2002 with the U.S. Census Bureau reporting imports of 21.1 million units compared with 17.5 million units in 2001 and 16.2 million units in 2000.

**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 4.01 Mt of clay and shale was used in the production of lightweight aggregates, an increase from 3.87 Mt in 2001 (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 2002, approximately 4.28 Mt of clays was consumed, a decrease from 4.57 Mt in 2001. In descending order of tonnage, common clay and shale, fuller's earth, kaolin, fire clay, bentonite, and ball clay 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 13.3 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 about 97% of this total. Other markets, in descending order of tonnage, were flue linings, flower pots, sewer pipe, roofing tile, structural tile, drain tile, and terra cotta. 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 2002, domestic producers shipped 8.04 billion building and face bricks valued at \$1.71 billion compared with 7.94 billion building and face bricks valued at \$1.9 billion in 2001. Structural facing tile and ceramic glazed brick shipments were 19,200 units valued at \$10.9 million compared with 25,800 units valued at \$13.7 million in 2001. Shipments of structural clay tile were 49,600 units valued at \$11.2 million compared with 49,500 units valued at \$10.6 million in 2001. About 139,000

units of vitrified clay sewer pipe and fittings valued at \$54 million were shipped compared with 165,000 units valued at \$53.3 million in 2001 (U.S. Census Bureau, 2003a).

Brick markets remained strong in the United States and Canada in 2001 because of the strong housing market. Several major domestic producers of bricks reported unchanged or slightly lower shipments that were offset by increased unit values. International markets varied with housing markets declining in Germany and nearby countries and Australia while increasing in Slovakia. In North America, manufacturers believe that markets will increase modestly in the long term because population growth should bolster housing demand (Grahl, 2002b).

**Drilling Mud.**—Sales (domestic and exports) for drilling mud applications were 841,000 t (782,000 t sold domestically and 59,200 t exported). Swelling-type bentonite accounted for more than 95% of the clay used in drilling mud. Fuller's earth and a small tonnage of kaolin also were used in drilling mud applications.

Drilling activity in North America continued at relatively low levels in 2002 with predictions for a 20% or greater decline. Drilling through April 2002 in other parts of the world was essentially unchanged from 2001. The rig count through May 2002 was 673 for land-based rigs compared with 985 in 2001. For Canada, the count through May 2002 was 273 for all rigs compared with 397 for all rigs through May 2001 (Petzet, 2002). The number of rotary rigs operating as of December 23, 2002, was 829 in Canada and the United States compared with 1,167 in 2001 (Oil & Gas Journal, 2002).

**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 4.21 Mt of clays was sold for use as fillers, extenders, and binders in the United States compared with 4.34 Mt in 2001. The decline was distributed throughout several end use categories so there were no significant losses in any one particular category. An additional 2.29 Mt of clays was exported for filler and extender applications compared with 2.35 Mt in 2001. Paper coating and filling accounted for 71% of domestic sales, followed by paint (8%), rubber (4%), fertilizer carrier (3%), pesticide carrier (3%), and animal feed (3%). Adhesive, asphalt emulsion, asphalt tile, gypsum products, ink, cosmetic, medical, and pharmaceutical, plastic, textile, and wallboard applications each accounted for less than 2% 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 (9%), bentonite (2%), ball clay, common clay and shale, and fire clay (less than 1% each). Bentonite was the predominant clay used for ink, and cosmetic, medical, and pharmaceutical applications; Fuller's earth dominated in animal feed, fertilizer and pesticide applications, and pet waste absorbents. Kaolin was the predominant clay used for adhesives, gypsum products, paint, paper, plastics, rubber, and textile markets.

Markets for mineral fillers in plastics continue to increase. In 2001, world consumption of fillers in plastics was 11 Mt. Calcium carbonate accounted for 66% of this total. The next most widely used mineral fillers were kaolin and talc (6% each), wollastonite (3%), and mica (1%). Unspecified mineral

fillers accounted for 18% of world consumption (Hohenberger, Holzinger, and Bernhart, 2002).

The U.S. Census Bureau reported shipment of paint and coatings for 2002 to be 1.46 billion gallons (5.53 billion liters) valued at \$17.2 billion compared with 1.39 billion gallons (5.26 billion liters) valued at \$17.3 billion in 2001. Of this amount, architectural paints, the major market for paint-grade fillers, was 719 million gallons (2.72 billion liters) valued at \$7.12 billion compared with 667 million gallons (2.52 billion liters) valued at \$7.04 billion in 2001 (U.S. Census Bureau, 2003b).

**Fiberglass.**—Sales, including exports, to the fiberglass and mineral wool industry were 409,000 t, an 8% increase from that of 2001.

While industry statistics are not available on fiberglass production, industrial sand used for the production of fiberglass was 1.43 Mt compared to 1.15 Mt in 2001, 953,000 t in 2000, and 1.00 Mt in 1999 (Dolley, 2004).

**Iron Ore Pelletizing.**—Sales (domestic and exports) reported by producers were 603,000 t compared with 570,000 t in 2001. Swelling bentonite was the only type of clay used for this application.

**Paper Products.**—Sales of kaolin for paper applications increased slightly for the first time in several years. The industry had lost sales to ground and precipitated calcium carbonate for paper applications. Kaolin accounted for almost all the clay sales used for paper coating (2.54 Mt sold domestically and 2.04 Mt exported) and essentially all the clay used for paper filling (450,000 t sold domestically and 93,900 t exported). A small amount of bentonite also was sold for paper applications.

Slow economic growth in North America with its reduced paper demand and competition from calcium carbonate for paper applications has affected sales of kaolin for paper applications for the past several years. Reduced paper demand, however, also affected calcium carbonate sales for paper applications in 2001. Producers of kaolin and precipitated calcium carbonate were researching ways for their products to satisfy the trend by the paper industry to produce whiter, more opaque, and lighter paper products. Major kaolin producers indicated that they would like 25% to 30% of their sales to paper applications from products developed within the past 5 years. The trend toward multipigment combinations to enhance performance and a tendency for paper manufacturers to look to single source suppliers has already resulted in alliances among suppliers or product diversification by former single commodity producers. Estimated world consumption for paper fillers was 1.3 Mt for ground calcium carbonate, 2.1 Mt for precipitated calcium carbonate, 3.1 Mt for kaolin, 136,000 t for talc, and 204 t for titanium dioxide in 2001 (Harris, 2002; Seewald, 2002).

**Refractory Products.**—Producers reported that 2.09 Mt of clays was used for the domestic manufacture of refractory products in 2002 (2.86 Mt with foundry sand included) compared with an estimated 1.72 Mt in 2001 (2.47 Mt with foundry sand included). Domestic and export sales were 2.33 Mt. At about 769,000 t, foundry sand was the largest domestic market. Other markets were firebrick, refractory mortar and cement, grogs and calcines, high alumina brick and kiln furniture, and plug, tap and wad.

Bentonite accounted for 1.01 Mt of refractory sales (753,000 t domestic and 244,000 t exported), followed by kaolin (904,000

t domestic and exports), common clay and shale (795,000 t domestic with no exports), fire clay (333,000 t domestic with no exports), ball clay, and fuller's earth. Data on U.S. refractory production and shipments were not available for 2002. The U.S. Census Bureau reported shipments of clay refractory products to be \$757 million in 2001 compared with \$878 million in 2000. In 2001, 715,000 t (238 million bricks) valued at \$396 million of clay refractory brick and shapes were shipped by U.S. manufacturers. This is subdivided into fire clay brick and shapes, 362,000 t (107 million bricks) valued at \$137 million; high alumina brick and shapes, 324,000 t (107 million bricks) valued at \$219 million; and insulating brick and shapes, 29,000 t (23.8 million bricks) valued at \$40.3 million. Shipments of unshaped clay refractory products were 581,000 t valued at \$297 million. This is subdivided into refractory bonding mortar valued at \$44.5 million (tonnage concealed); plastic refractory products, 115,000 t valued at \$62.7 million; castable refractory products, 275,000 t valued at \$159 million; and fire gunning mixes, 96,800 t valued at \$30.6 million. Approximately 163,000 t of miscellaneous refractory products valued at \$44 million and \$19.5 million of other unknown types of clay refractory products also were sold in 2001 (U.S. Census Bureau, 2002).

## Prices

Many of the clay producers instituted price increases of 3% to 8% for the past 2 to 3 years because of increased energy costs, particularly for natural gas users, and increased costs of production. Imerys announced that it would raise the price of all grades of paper-grade kaolin and calcium carbonate products by 2% to 7% (Imerys, 2002).

**Ball Clay.**—The average value for ball clay reported by domestic producers was \$41.96 per metric ton. The average values for imported and exported ball clay were \$348.89 and \$55.51 per ton, respectively.

Average prices for ball clay, United Kingdom, free on board (f.o.b.), air-dried, shredded, bulk, were \$40 per ton to \$105 per ton; refined, noodled, bulk, \$88 per ton to \$112 per ton; pulverized, bagged, \$129 per ton to \$209 per ton. Average prices for ball clay, Germany, f.o.b., dried and ground, bulk, were \$52 per ton to \$141 per ton; and shredded, bulk, \$15 per ton to \$61 per ton (Industrial Minerals, 2002n).

**Bentonite.**—The average value reported by domestic producers for nonswelling bentonite was \$39.55 per ton. The average value for swelling bentonite was \$45.85 per ton. The average value for all bentonite was \$45.34 per ton. The average value of imported bentonite was \$115.12 per ton. The average value of exported bentonite was \$121.33 per ton.

The price, ex-works, Wyoming, crude, bulk, rail cars, was \$26 per ton to \$63 per ton; foundry grade, bagged, rail cars, \$50 per ton to \$76 per ton; API-grade, bagged, rail cars, \$43 per ton to \$53 per ton. The price for bentonite, India, crushed, dried, loose in bulk, was \$30 per ton to \$40 per ton for API grade; \$32 per ton to \$40 per ton for cat litter grade; and \$40 to \$45 per ton for foundry grade (Industrial Minerals, 2002o).

**Common Clay and Shale.**—The average value for all common clay and shale produced in the United States and Puerto Rico was \$6.43 per ton. The average value of clay and shale used in lightweight aggregate was \$13.69 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 \$23.54 per ton. The average of imported fire clay was \$532.11 per ton. The average value of exported fire clay was \$90.84 per ton.

**Fuller's Earth.**—The average value of attapulgitic-type fuller's earth was \$122.94 per ton. The average value of montmorillonite-type fuller's earth was \$87.25 per ton. The average value of all fuller's earth was estimated to be \$90.11 per ton. The average value of imported fuller's earth was \$234.15 per ton. The average value of exported fuller's earth was \$144.50 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, 2002n).

The price of filler-grade attapulgitic from Asia ranged from \$158 per ton to \$315 per ton (Geo.net Commodities GmbH, 2003<sup>1</sup>).

**Kaolin.**—The average value of kaolin was \$118.73 per ton for all kaolin grades. The average value for airfloat was \$55.64 per ton; refractory-grade (high-temperature calcined), \$28.57 per ton; pigment-grade (low-temperature calcined), \$319.61 per ton; all types of calcined, \$183.22 per ton; delaminated, \$115.89 per ton; water washed, \$114.79 per ton; and unprocessed, \$9.57 per ton. The average value of the imported kaolin was \$141.77 per ton. The average value of exported kaolin was \$160.00 per ton.

The price, ex-works, Georgia, filler, bulk, was \$80 per ton to \$100 per ton; coating, bulk, \$85 per ton to \$185 per ton; sanitaryware-grade, bagged, \$65 per ton to \$75 per ton; tableware-grade, bagged, \$125 per ton; and calcined, bulk, \$320 per ton to \$375 per ton (Industrial Minerals, 2002o).

## Foreign Trade

**Ball Clay.**—Ball clay exports decreased to 127,000 t valued at \$7.05 million, according to the U.S. Census Bureau (table 23). Domestic ball clay producers reported that 146,000 t of ball clay was exported in 2002 (table 4). Imports were 407 t of ball clay valued at \$142,000 (table 24).

**Bentonite.**—Bentonite exports increased to 722,000 t valued at \$87.6 million (table 23). Domestic bentonite producers reported exports of 408,000 t (table 6). The large discrepancy between producers and the U.S. Census Bureau may result from producers including most of the exports destined for Canadian markets (219,000 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 29,100 t valued at \$3.35 million. Imports of chemically activated material were 26,800 t valued at \$11.3 million (table 24).

**Fire Clay.**—Approximately 251,000 t of fire clay valued at \$22.8 million was exported (table 23). In 2002, 218 t of fire clay valued at \$116,000 was imported (table 24).

**Fuller's Earth.**—Approximately 60,000 t of fuller's earth valued at \$8.67 million was exported (table 23). Approximately 205 t of decolorizing earth and fuller's earth valued at \$48,000 was imported in 2002 (table 24).

**Kaolin.**—The U.S. Census Bureau reported that 3.35 Mt valued at \$536 million was exported compared with 3.44 Mt of kaolin valued at \$567 million in 2001 (table 23). Producers reported exports of 2.49 Mt (table 20). Much of the 783,000 t of kaolin destined for Canada, particularly for its paper markets, probably was reported under domestic consumption.

Kaolin imports increased to 158,000 t valued at \$22.4 million compared with 114,000 t valued at \$18.7 million in 2001 (table 24). Approximately 90% was imported from Brazil, followed by the United Kingdom with 9%.

## World Review

World production of bentonite was approximately 10.3 Mt, fuller's earth production was estimated to be 3.89 Mt, and kaolin production was 43.2 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 25.9 Mt, after excluding 8.4 Mt for Colombia, 4 Mt for the Czech Republic, 4 Mt for Uzbekistan, 600,000 t for Iran, 200,000 t for Egypt, and 100,000 t for Australia. The United States continued to be the leading producer of all three varieties of clays, followed by Greece and countries of the Commonwealth of Independent States for bentonite; Germany for fuller's earth; and the Republic of Korea (likely crude ore tonnage), the United Kingdom (processed sales), Brazil (processed sales), Germany (processed ore), Uzbekistan (processed ore), and the Czech Republic (processed ore). Spain led all countries in the production of sepiolite.

**Australia.**—Minerals Corp. announced that it had almost completed renovations at the Skardon River kaolin project. Equipment was overhauled in 2001 and the wet plant, dry plant circuit, spray drier, and bagging lines were commissioned in 2002. The company produced some ceramic-grade hydrous kaolin products and had plans to produce hydrous kaolin products for other markets later in the year. Initial plans were to produce 25,000 t/yr for nonpaper Asian markets (Industrial Minerals, 2002t). The company also completed renovations of its calciner circuit, producing a product with a brightness of 90 on the initial run. Several calcined paint-grade products and metakaolin for cement applications were produced (Industrial Minerals, 2002u; Minerals Corp. Ltd., 2002).

Unimin Australia Ltd. (a subsidiary of Unimin Corp.) acquired Kingaroy Kaolin Pty. Ltd. Kingaroy Kaolin is the largest of Queensland's kaolin producers. The purchase included the plant and mineral leases. Kingaroy Kaolin sold kaolin for adhesive, ceramic, fiberglass, insecticide, paint, paper, and rubber applications (Industrial Minerals, 2002w).

<sup>1</sup>A reference that include a section mark (§) is found in the Internet Reference Cited section.



**Belgium.**—Engelhard Corp. opened a slurry facility in Ghent. The facility will process kaolin for paper markets in northern Europe. The facility has two 5.2 cubic meter slurry mixers, four 100 cubic meter holding tanks, and four 60 cubic meter holding tanks. The facility can store up to 36,000 t of dry kaolin and ship by barge, rail, or truck (Engelhard Corp., 2002c).

**Brazil.**—WBB Minerals (a subsidiary of Watts Blake Bearne & Co. PLC) acquired a 51% share of Caulim do Nordeste. Nordeste has its operations near Recife in Northeastern Brazil and supplies refined clay and ceramic body products to the Brazilian sanitaryware industry. The purchase will provide WBB with an opportunity to become a major supplier of specialty ceramic raw materials to Brazilian markets (Ceramic Bulletin, 2002b).

Rio Capim Caulim (a subsidiary of Imerys) commissioned a 160-kilometer pipeline used to transport kaolin from its quarry to its plant. The company also continued expanding its production capacity to 850,000 t/yr from 600,000 t/yr (Imerys, 2003).

**Canada.**—RHI AG announced that it would modernize its RHI Canada operations in Becancour, Quebec, and Burlington, Ontario. The modernization, to occur during an 18-month period, would involve downsizing the workforce and upgrading machinery such as crushers. The operations manufacture basic refractory brick for the steel, nonferrous metals, and cement industries (Industrial Minerals, 2002q).

Black Bull Resources Inc. withdrew its application to mine a deposit near Yarmouth County, Nova Scotia, for its kaolin, mica, and quartz content. The decision was made after the Minister of Environment and Labour in Nova Scotia requested an environmental assessment report and the company did not have all of the required data available at the time of the request. The company was considering submitting a proposal to mine quartz present in the deposit (Black Bull Resources Inc., 2002).

**China.**—Engelhard Corp. acquired certain operating aspects of Shuozhou Anpeak Kaolin Co., Ltd., a producer of calcined kaolin products. Shuozhou Anpeak Kaolin had operations in Pinglu District, Shuozhou City, Shanxi Province and processed kaolin for coatings, paints, paper, plastics, and rubber applications. The purchase provided Engelhard with more direct access to a growing Asian market (Engelhard Corp., 2002b).

The Absorbents Division of Süd-Chemie Ag acquired 100% ownership of Liaoning Redhill Volclay Co. Ltd., which was a joint venture between Volclay International and Beijing Prosperity Clay & Construction Materials Co. Ltd. Liaoning Redhill was China's largest producer of bentonite for foundry applications, operating a surface and underground mine with a capacity of 120,000 t/yr for foundry and engineering applications. About 50,000 t/yr is sold as sodium exchanged bentonite and 70,000 t/yr is sold as calcium bentonite. Süd-Chemie also planned to market the bentonite to China's growing construction and paper markets. The company will operate as Süd-Chemie Redhill Bentonite Co. Ltd. (Industrial Minerals, 2003; Süd-Chemie Co., 2003).

Nanocor, Inc. (a subsidiary of AMCOL International Corp.) announced that Beijing Nano Sunshine Technology Co., Ltd. would sell and distribute Nanocor products to automotive and food packaging (plastics) markets. The company will focus on the use of nanoclays in nylon and polyolefin plastics (AMCOL International Corp., 2002a).

**Hungary.**—Silver & Baryte Ores Mining Co. SA acquired 100% of the shares of Bentonit Hungaria Kft (BEH) (a subsidiary of Dyckerhoff Wopfinger Umweltstoffe GmbH). BEH mines and sells bentonite from its operation in Egyhazakeszo in western Hungary. Sales are primarily for civil engineering applications. The mill facilities have a capacity of 40,000 t/yr. The purchase provides Silver & Baryte Ores Mining with better access to the eastern European markets (Industrial Minerals, 2002s).

**Namibia.**—Afhold Ltd. announced plans to begin production of sepiolite from a deposit south of Gobabis. The company plans to market the sepiolite to the European cat litter industry. Export sales were expected to account for about 95% of sales. The open pit mine will have an initial capacity of 40,000 t/yr with three grades being produced (Industrial Minerals, 2002a).

**Russia.**—Joint Stock Company (JSC) Gai GOK began preparing feasibility reports on a bentonite deposit in the Kuvandyk District, Orenburg oblast. The deposit had estimated reserves of 27 Mt, averaging 50% to 60% montmorillonite at a depth of 10 meters. Kachkanar GOK Vanadii will use the bentonite primarily for pelletizing iron ore (Industrial Minerals, 2002f).

**Sweden.**—Tricorona Mineral AB announced that it would sell its graphite operations and focus strictly on kaolin through its subsidiary, Svenska Kaolin AB. Svenska holds reserves in Billinge and feasibility studies indicated the kaolin could be produced at a rate of 40,000 t/yr, along with 15,000 t/yr feldspar and 10,000 t/yr quartz. The kaolin will be marketed to the Scandinavian paper industry (Industrial Minerals, 2002v).

**Thailand.**—Imerys acquired a majority share of MRD-ECC Co. Ltd. from Banpu PLC, a Thailand energy producer. MRD-ECC mines a kaolin deposit in Ranong province. The kaolin is used for fiberglass, sanitaryware, tableware, and tile applications. MRD-ECC also processed ball clay that was a byproduct of Banpu's coal extraction. The purchase enhanced Imerys' access to the growing ceramics market in southeast Asia (Ceramic Industry Cybernews, 2002; Industrial Minerals, 2002i).

**Ukraine.**—A 25% share stake in JSC Dashukovsky Bentonites was offered by sale by the Fund of State Property of Ukraine. Dashukovsky Bentonites' facility had a capacity of 220,000 t/yr of crude and 180,000 t/yr of processed bentonite. The conditions of the purchase were that the buyer would have to upgrade the facilities and maintain existing production (Industrial Minerals, 2002r).

Engelhard Corp. divested itself of its 50% share of Dnipro Kaolin due to losses generated through the joint venture (Engelhard Corp., 2003).

**United Kingdom.**—Imerys announced that it would transfer a portion of paper-grade kaolin production from its Cornwall facility to its Brazilian facilities. The Brazilian operations include Rio Capim Caulim and ECC do Brazil Mineracao Ltda. Imerys cited increased expenses of production of paper-grade products from the Cornwall operations. The move will shift 150,000 t of production, or 10% of the Cornwall production, to Brazil. Imerys' kaolin reserves in Brazil are more suited for the production of paper-grade products than that mined in Cornwall (Industrial Minerals, 2002j).

Minsol Ltd. purchased the foundry business and some refractory assets from Volclay Ltd., a subsidiary of AMCOL

International. The purchase included the manufacturing facilities in Wallasey, Merseyside, and license to some existing trademarks. The plant obtained its bentonite from non-AMCOL sources in Europe and had a capacity of 80,000 t/yr. Some bentonite will be obtained from Cetco Europe Ltd., an AMCOL International subsidiary that operates in Merseyside. Minsol will continue selling the bentonite for greensand molding sands. AMCOL cited inadequate returns as part of the reason for the divestiture (Industrial Minerals, 2002c).

**Uzbekistan.**—JSC Bentonit, a joint venture to produce bentonite in Uzbekistan, announced plans to commission its facilities in 2002. The facilities are in the Novbakhor District of Navoi Oblast. Bentonite will be produced from the Karatau deposit, estimated to have 160 years of reserves. The plant has a capacity of 40,000 t/yr. The bentonite will be used primarily as a soil amendment in agriculture and for water treatment (Industrial Minerals, 2002e).

## Outlook

Although the economy remains sluggish, it has shown signs of recovery in the past year, brightening the prospects for several segments of the clay industry. Construction-oriented markets for clay-based products such as adhesives, brick, ceramics, fiber glass, lightweight aggregate, paint, and other construction-oriented markets remain fairly strong. Domestic sales to these markets probably will maintain their current levels for the near future. One stumbling block could be the continued increase in the use of imported clay-based products such as tile and whiteware. These imports already have affected domestic ball clay sales and probably will continue to do so in the near future. If the economic recovery continues and industrial manufacturing begins to increase, that bodes well for clays sold for foundry sand bond (bentonite), pelletizing iron ore (bentonite), and oil and grease absorbent (bentonite and fuller's earth). These markets declined in the past several years in response to a decline in heavy industrial manufacturing. Based on the rate of the current recovery, growth in these markets probably will be slow in the near future. Prospects for domestic sales of bentonite for drilling mud applications are not favorable owing to a continued decline in drilling activity in Canada and the United States. Foreign drilling mud markets may help offset this decline. Sales for pet litter markets probably will remain at current levels based on recent trends. A continuing decline in the paper industry and competition in the paper-filler and coating markets will hamper sales in the kaolin industry with sales likely to remain at current levels for the near term.

## References Cited

Alchemy Ventures Ltd., 2002, Corporate update: Vancouver, British Columbia, Canada, Alchemy Ventures Ltd. press release, December 17, 1 p.  
AMCOL International Corp., 2002a, AMCOL International Corp. Nanocor subsidiary announces Chinese distributor: Arlington Heights, IL, AMCOL International Corp. press release, February 1, 1 p.  
AMCOL International Corp., 2002b, Nanocor subsidiary announces expansion of joint development program with Gitto Global Corp.: Arlington Heights, IL, AMCOL International Corp. press release, June 18, 1 p.  
Black Bull Resources Inc., 2002, Environmental assessment update: Vancouver, British Columbia, Canada, Black Bull Resources Inc. press release, February 28, 1 p.

Ceramic Bulletin, 2002a, Gladding McBean buys clay plant: Ceramic Bulletin, v. 81, no. 3, March, p. 13.  
Ceramic Bulletin, 2002b, WBB Minerals increases holdings in Brazil: Ceramic Bulletin, v. 81, no. 1, January, p. 11.  
Chemical Industry Cybernews, 2002, Imerys announces acquisition in Thailand: Ceramic Industry Cybernews, v. 3, no. 29, July, 1 p.  
Chemical Week, 2002, Court overturns \$78 million verdict against Süd-Chemie: Chemical Week, v. 164, no. 43, October 30, p. 7.  
Daniels, R.E., 2002a, The United States ceramic tile industry: Tile & Decorative Surfaces, v. 52, no. 7, July, p. 38-40.  
Daniels, R.E., 2002b, U.S. tile sales hold steady; imports continue fueling growth: Ceramic Industry, v. 152, no. 9, August, p. 21-23.  
Dolley, T.P., 2004, Silica, in Metals and minerals: U.S. Geological Survey Minerals Yearbook 2002, v. I, p. 67.1-67.18.  
Engelhard Corp., 2002a, Engelhard announces market-driven actions to redeploy certain assets: Iselin, NJ, Engelhard Corp. press release, July 31, 1 p.  
Engelhard Corp., 2002b, Engelhard expands presence in China, acquires specialty mineral company: Iselin, NJ, Engelhard Corp. press release, December 3, 1 p.  
Engelhard Corp., 2002c, Engelhard opens kaolin pigment slurry facility in Ghent to serve papermakers in northern Europe: Iselin, NJ, Engelhard Corp. press release, April 12, 1 p.  
Engelhard Corp., 2003, Annual report 2002: Iselin, NJ, Engelhard Corp., March 31, 86 p.  
Freas, R.C., Alsobrook, A.F., Kogel, J.E., Pickering, S.M., Jr., and Murray, H.H., eds., 2002, Proceedings of the Conference on Global Kaolin Resources, Exploration, and Development, Savannah, GA, September 9-11, 2002: Littleton, CO, Society for Mining, Metallurgy, and Exploration, Inc., CD-ROM.  
Grah, C.L., 2002a, Remodeling, new construction drive U.S. sanitaryware sales higher: Ceramic Industry, v. 152, no. 9, August, p. 28.  
Grah, C.L., 2002b, U.S. brick sales remain steady in 2001; near-term outlook is uncertain: Ceramic Industry, v. 152, no. 9, August, p. 42.  
Harris, Paul, 2002, A coat for any occasion: Industrial Minerals, no. 414, March, p. 38-43.  
Hohenberger, Walter, Holzinger, Thomas, and Bernhart, Wolfram, 2002, Mineral aspect ratio: Industrial Minerals, no. 422, November, p. 64-69.  
Imerys, 2002, Imerys to raise prices of paper-grade kaolin and calcium carbonate products: Atlanta, GA, Imerys press release, December 11, 1 p.  
Imerys, 2003, Results 2002: Paris, France, Imerys press release, March 11, 11 p.  
Industrial Minerals, 2002a, Afhold to sell sepiolite cat litter: Industrial Minerals, no. 416, May, p. 14-15.  
Industrial Minerals, 2002b, Alchemy completes kaolin agreement: Industrial Minerals, no. 420, September, p. 12.  
Industrial Minerals, 2002c, Amcol sells UK foundry bentonite business to Minsol: Industrial Minerals, no. 414, March, p. 15-16.  
Industrial Minerals, 2002d, Amcol strengthens foundry business with FNG buy: Industrial Minerals, no. 419, August, p. 19.  
Industrial Minerals, 2002e, Bentonit joint venture commissioned: Industrial Minerals, no. 417, June, p. 19.  
Industrial Minerals, 2002f, Gai GOK to mine bentonite: Industrial Minerals, no. 414, March, p. 21.  
Industrial Minerals, 2002g, Huber interest in Kaoclay kaolin: Industrial Minerals, no. 415, April, p. 23.  
Industrial Minerals, 2002h, IMA to represent North American minerals industry: Industrial Minerals, no. 417, June, p. 15-16.  
Industrial Minerals, 2002i, Imerys acquires majority stake in kaolin/ball clay j-v: Industrial Minerals, no. 419, August, p. 15.  
Industrial Minerals, 2002j, Imerys shifts kaolin output from UK to Brazil: Industrial Minerals, no. 415, April, p. 27.  
Industrial Minerals, 2002k, Ione Minerals & Refractories plant auction: Industrial Minerals, no. 421, October, p. 21.  
Industrial Minerals, 2002l, Lintech to market Atlas halloysite: Industrial Minerals, no. 422, November, p. 6.  
Industrial Minerals, 2002m, NARCO files Ch. 11 as RHI faces asbestos battle: Industrial Minerals, no. 413, February, p. 21.  
Industrial Minerals, 2002n, Prices: Industrial Minerals, no. 420, September, p. 66.  
Industrial Minerals, 2002o, Prices: Industrial Minerals, no. 423, December, p. 70.  
Industrial Minerals, 2002p, RHI clarification: Industrial Minerals, no. 420, September, p. 70.  
Industrial Minerals, 2002q, RHI focuses on Canada: Industrial Minerals, no. 417, June, p. 26.  
Industrial Minerals, 2002r, Sale of stake in Dashukovsky Bentonites: Industrial Minerals, no. 414, March, p. 22.

- Industrial Minerals, 2002s, Silver & Baryte buys Bentonit Hungaria: Industrial Minerals, no. 412, January, p. 11.
- Industrial Minerals, 2002t, Skardon kaolin approaches all systems go: Industrial Minerals, no. 415, April, p. 114.
- Industrial Minerals, 2002u, Skardon kaolin recommissions dry calciner: Industrial Minerals, no. 417, June, p. 74.
- Industrial Minerals, 2002v, Tricorona to sell Woxna Graphite to focus on kaolin: Industrial Minerals, no. 413, February, p. 14-15.
- Industrial Minerals, 2002w, Unimin acquires Kingaroy Kaolin: Industrial Minerals, no. 416, May, p. 10.
- Industrial Minerals, 2003, Süd-Chemie expands rapidly in China with Redhill Volclay buy: Industrial Minerals, no. 424, January, p. 10.
- Minerals Corp. Ltd., 2002, Minerals Corp. seeks \$3.7 million for Skardon River kaolin project: Sydney, Australia, Minerals Corp. Ltd. press release, May 22, 3 p.
- Mining Journal, 2002, Imerys to restructure Cornish operations: Mining Journal, v. 338, no. 8677, March 22, p. 219.
- Mohawk Industries, Inc., 2002, Mohawk Industries, Inc. completes acquisition of Dal-Tile International Inc.: Calhoun, GA, Mohawk Industries Inc. press release, March 20, 2 p.
- North American Minerals News, 2002a, Engelhard to cut kaolin jobs in Georgia: North American Minerals News, no. 82, March, p. 3.
- North American Minerals News, 2002b, Nestlé buys Ralston Purina: North American Minerals News, no. 81, February, p. 8.
- North American Minerals News, 2002c, RHI files for ch 11 protection for all U.S. subsidiaries: North American Minerals News, no. 83, April, p. 6.
- North American Minerals News, 2002d, Zemex buys Milwhite attapulgite: North American Minerals News, no. 82, March, p. 5.
- Oil & Gas Journal, 2002, Statistics: Oil & Gas Journal, v. 100, no. 52, December 23, p. 149.
- Oil-Dri Corp. of America, 2002a, Oil-Dri completes acquisition strengthening its position as the world's largest cat litter producer and expanding its ability to service customers worldwide: Chicago, IL, Oil-Dri Corp. of America press release, December 13, 1 p.
- Oil-Dri Corp. of America, 2002b, Oil-Dri reports fourth quarter and year end results: Chicago, IL, Oil-Dri Corp. of America press release, September 25, 5 p.
- Petzet, Alan, 2002, Drilling declines of more than 20% forecast in U.S., Canada: Oil & Gas Journal, v. 100, no. 26, July 1, p. 80-82.
- Refractory News, 2002, RHI update and clarification: Refractory News, v. 3-02, March, p. 1.
- Seewald, Nancy, 2002, PCC fillers grab share from kaolin: Chemical Week, v. 164, no. 4, January 30, p. 21.
- Süd-Chemie Co., 2003, Annual report-2002: Munich, Germany, Süd-Chemie Ag, 52 p.
- Tile and Decorative Surfaces, 2002, Mohawk Industries completes acquisition of Dal-Tile: Tile and Decorative Surfaces, v. 52, no. 1, January, p. 21-22, 61.
- U.S. Census Bureau, 2000, Plumbing fixtures—1999: U.S. Census Bureau MQ332E(99)-5, October, 24 p.
- U.S. Census Bureau, 2002, Refractories—2001: U.S. Census Bureau MA327C(01)-1, October, 11 p.
- U.S. Census Bureau, 2003a, Clay construction products—Summary: U.S. Census Bureau MQ327D(02)-5, July, 16 p.
- U.S. Census Bureau, 2003b, Paint and allied products—2002: U.S. Census Bureau MA325F(02)-1, July, 10 p.
- U.S. Department of Commerce, 2002, New residential construction in June 2003: U.S. Department of Commerce CB03-113, June 17, 6 p.
- U.S. Environmental Protection Agency, 2002a, National emission standards for hazardous air pollutants for brick and structural clay products manufacturing; and national emission standards for hazardous air pollutants for clay ceramics manufacturing: Federal Register, v. 67, no. 140, July 22, p. 47894-47949.
- U.S. Environmental Protection Agency, 2002b, National emission standards for hazardous air pollutants for refractory products manufacturing: Federal Register, v. 67, no. 119, June 20, p. 42108-42170.

## Internet Reference Cited

Geo.net Commodities GmbH, 2003, Offers—Bentonite, accessed August 14, 2003, via URL <http://geo.net>.

## 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<sup>1,2</sup>

(Thousand metric tons and thousand dollars)

	1998	1999	2000	2001	2002
<b>Domestic clays sold or used by producers:</b>					
Quantity	41,900	42,200	40,800	39,600 <sup>r</sup>	39,300
Value	1,670,000	1,570,000	1,520,000	1,510,000 <sup>r</sup>	1,580,000
<b>Exports:</b>					
Quantity	5,230	4,800	5,260	4,970	4,960
Value	843,000	823,000	896,000	836,000	817,000
<b>Imports for consumption:</b>					
Quantity	86	90	96	148	217
Value	27,700	23,000	34,900	33,900	39,400

<sup>r</sup>Revised.

<sup>1</sup>Excludes Puerto Rico.

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

TABLE 2  
CLAYS SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 2002, BY STATE<sup>1,2</sup>

(Thousand metric tons and thousand dollars)

State	Ball clay	Bentonite	Common clay and shale	Fire clay	Fuller's earth	Kaolin	Total	
							Quantity	Value
Alabama	--	125	2,020	--	--	531	2,680	43,100
Arizona	--	W	W	--	--	--	W	W
Arkansas	--	--	922	--	--	W	922	2,280
California	--	W	1,030	W	W	W	1,030	24,200
Colorado	--	W	214	--	--	--	214	1,260
Connecticut	--	--	55	--	--	--	55	183
Florida	--	--	W	--	260	32	292	3,370
Georgia	--	W	1,310	--	979	6,830	9,110	993,000
Illinois	--	--	181	--	118	--	299	856
Indiana	W	--	429	--	--	--	429	1,240
Iowa	--	--	256	--	--	--	256	763
Kansas	--	--	642	--	W	--	642	4,280
Kentucky	W	--	925	--	--	--	925	4,740
Louisiana	--	--	667	--	--	--	667	1,680
Maine	--	--	49	--	--	--	49	125
Maryland	--	--	268	--	--	--	268	550
Massachusetts	--	--	36	--	--	--	36	321
Michigan	--	--	499	--	--	--	499	884
Minnesota	--	--	14	--	--	--	14	15
Mississippi	W	W	496	--	411	--	907	32,100
Missouri	--	--	1,050	340	W	--	1,390	11,300
Montana	--	181	W	--	--	--	181	14,900
Nebraska	--	--	133	--	--	--	133	338
Nevada	--	6	--	--	28	W	34	3,870
New Jersey	--	--	W	--	--	--	W	W
New Mexico	--	--	33	--	--	--	33	175
New York	--	--	641	--	--	--	641	7,990
North Carolina	--	--	2,420	--	--	W	2,420	11,900
North Dakota	--	--	57	--	--	--	57	W
Ohio	--	--	1,310	W	--	--	1,310	7,820
Oklahoma	--	--	1,030	--	--	--	1,030	2,250
Oregon	--	W	237	--	--	--	237	662
Pennsylvania	--	--	779	--	--	--	779	2,560
South Carolina	--	--	1,020	53	--	374	1,450	25,500
South Dakota	--	--	208	--	--	--	208	W
Tennessee	660	--	262	--	W	W	922	29,700
Texas	W	W	2,160	--	W	39	2,200	29,600
Utah	--	W	349	--	--	--	349	5,010
Virginia	--	--	827	--	W	--	827	3,320
Washington	--	--	89	--	--	--	89	169
West Virginia	--	--	151	--	--	--	151	407
Wyoming	--	3,340	33	--	--	--	3,380	145,000
Total	1,120	3,970	23,000	446	2,730	8,010	39,300	1,580,000

W Withheld to avoid disclosing company proprietary data, included in "Total." -- Zero.

<sup>1</sup>Excludes Puerto Rico.

<sup>2</sup>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<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Airfloat		Water-slurried		Unprocessed		Grand total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2001:								
Tennessee	254	12,700	196 <sup>r</sup>	8,400	230	7,670	680	28,800
Other <sup>2</sup>	186	11,100 <sup>r</sup>	W	W	W	W	425	17,900 <sup>r</sup>
Total	440	23,800	196 <sup>r</sup>	8,400	230	7,670	1,110	46,700
2002:								
Tennessee	248	12,400	194	8,350	217	7,320	660	28,100
Other <sup>2</sup>	196	11,500	W	W	W	W	459	11,500
Total	444	24,000	194	8,350	217	7,320	1,120	47,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Grand total."

<sup>1</sup>Data are rounded to no more than three significant digits, may not add to totals shown.

<sup>2</sup>Includes Indiana (2002), Kentucky, Mississippi, and Texas.

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

(Metric tons)

Use	2001	2002
Fillers, extenders, binders <sup>2</sup>	W	25,100
Floor and wall tile	387,000	395,000
Miscellaneous ceramics <sup>3</sup>	135,000	169,000
Pottery	20,500	23,100
Refractories <sup>4</sup>	62,200	63,100
Sanitaryware	247,000	246,000
Miscellaneous <sup>5</sup>	70,900 <sup>r</sup>	52,200
Exports <sup>6</sup>	182,000 <sup>r</sup>	146,000
Total	1,100,000	1,120,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

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

<sup>2</sup>Includes animal feed (2002), asphalt tile (2002), asphalt emulsions (2002), rubber and other fillers, extenders and binders.

<sup>3</sup>Includes catalysts, electrical porcelain, fiber glass, fine china/dinnerware, glass, mineral wool, and miscellaneous ceramics.

<sup>4</sup>Includes firebrick, blocks, shapes, and kiln furniture.

<sup>5</sup>Includes fillers, extenders, binder, and waterproofing seals.

<sup>6</sup>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<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Nonswelling		Swelling		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2001:						
Nevada	5	758	-- <sup>r</sup>	-- <sup>r</sup>	5	758
Wyoming	--	--	3,330 <sup>r</sup>	153,000	3,330 <sup>r</sup>	153,000
Other <sup>2</sup>	352	13,000 <sup>r</sup>	282 <sup>r</sup>	22,500 <sup>r</sup>	635 <sup>r</sup>	35,500 <sup>r</sup>
Total	357	13,700 <sup>r</sup>	3,610 <sup>r</sup>	176,000 <sup>r</sup>	3,970 <sup>r</sup>	189,000 <sup>r</sup>
2002:						
Nevada	W	W	W	W	W	W
Wyoming	--	--	3,340	145,000	3,340	145,000
Other <sup>2</sup>	354	14,000	273	20,800	627	34,800
Total	354	14,000	3,620	166,000	3,970	180,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

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

<sup>2</sup>Includes Alabama, Arizona, California, Colorado, Georgia, Mississippi, Montana, Oregon, Texas, and Utah.

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

(Metric tons)

Use	2001	2002
Domestic:		
Absorbents:		
Pet waste absorbents	902,000 <sup>r</sup>	899,000
Other absorbents	W	W
Adhesives	2,170	2,100
Animal feed	52,200 <sup>r</sup>	42,400
Ceramics (except refractories) <sup>2</sup>	W	W
Drilling mud	787,000 <sup>r</sup>	762,000
Filler and extender applications <sup>3</sup>	49,300 <sup>r</sup>	45,700
Filtering, clarifying, decolorizing	91,600 <sup>r</sup>	127,000
Foundry sand	746,000 <sup>r</sup>	762,000
Pelletizing (iron ore) <sup>4</sup>	522,000 <sup>r</sup>	536,000
Miscellaneous refractories	W	W
Miscellaneous <sup>5</sup>	90,700 <sup>r</sup>	117,000
Waterproofing and sealing	283,000 <sup>r</sup>	269,000
Total	3,520,000 <sup>r</sup>	3,560,000
Exports:		
Drilling mud	73,300 <sup>r</sup>	59,200
Foundry sand	244,000 <sup>r</sup>	244,000
Other <sup>6</sup>	129,000	106,000
Total	446,000 <sup>r</sup>	408,000
Grand total	3,970,000 <sup>r</sup>	3,970,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

<sup>1</sup>Data are rounded to no more than three significant digits, may not add to totals shown.

<sup>2</sup>Includes catalysts and pottery.

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

<sup>4</sup>Excludes shipments to Canada. Total sales in North America were 570,000 metric tons in 2001 and 603,000 metric tons in 2002.

<sup>5</sup>Includes chemical manufacturing, heavy clay products, and other unknown uses.

<sup>6</sup>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<sup>1,2</sup>

(Thousand metric tons and thousand dollars)

State	2001		2002	
	Quantity	Value	Quantity	Value
Alabama	2,050	24,800	2,020	24,600
Arkansas	989	1,440	921	2,280
California	885	18,800 <sup>r</sup>	1,030	21,400
Georgia	1,360	4,580	1,310	5,500
Indiana	575	1,470	429	1,240
Kansas	635	4,280	642	4,280
Kentucky	1,010	4,230	925	4,740
Michigan	595	2,280	499	884
Mississippi	461	2,040	496	2,210
Missouri	1,030	3,420	1,050	3,930
New York	647	7,960	641	7,990
North Carolina	2,340	11,100	2,420	11,900
Ohio	1,320	7,410	1,310	7,820
Oklahoma	783	1,910	1,030	2,250
Pennsylvania	758	2,320	779	2,560

See footnotes at end of table.

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

(Thousand metric tons and thousand dollars)

State	2001		2002	
	Quantity	Value	Quantity	Value
South Carolina	1,050	4,150	1,020	3,360
Texas	2,120	8,750	2,160	21,200
Virginia	937	1,840	827	3,320
Other <sup>3</sup>	3,630	16,400 <sup>r</sup>	3,510	16,900
Total	23,200	129,000	23,000	148,000

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

<sup>2</sup>Excludes Puerto Rico.

<sup>3</sup>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<sup>1,2</sup>

(Metric tons)

Use	2001	2002
Ceramics and glass <sup>3</sup>	W	174,000
Civil engineering and sealing	W	W
Floor and wall tile:		
Ceramic	409,000	387,000
Other <sup>4</sup>	68,600	115,000
Heavy clay products:		
Brick, extruded	11,100,000	11,300,000
Brick, other	1,680,000	1,500,000
Drain tile and sewer pipe	79,900	39,000
Flowerpots	W	46,000
Flue linings	256,000	47,700
Structural tile	W	W
Other <sup>5</sup>	71,400	110,000
Lightweight aggregate:		
Concrete block	2,370,000	2,370,000
Highway surfacing	284,000	364,000
Structural concrete	857,000	908,000
Miscellaneous <sup>6</sup>	358,000	361,000
Portland and other cements	4,110,000	3,950,000
Refractories <sup>7</sup>	741,000	795,000
Miscellaneous <sup>8</sup>	807,000 <sup>r</sup>	556,000
Total	23,200,000	23,000,000

<sup>1</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Other" or "Miscellaneous."

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

<sup>3</sup>Excludes Puerto Rico.

<sup>4</sup>Includes pottery and roofing granules.

<sup>5</sup>Includes quarry tile (2001) and miscellaneous floor and wall tiles (2002).

<sup>6</sup>Includes flower pots, roofing tile, structural tile, terra cotta, and miscellaneous clay products.

<sup>7</sup>Includes miscellaneous lightweight aggregates.

<sup>8</sup>Includes firebrick, block and shapes, mortar and cement, plugs, taps, wads, and miscellaneous refractories.

<sup>8</sup>Includes exports; miscellaneous civil engineering and sealings; miscellaneous fillers, extenders, and binders; wallboard; and other unknown uses.

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

(Thousand metric tons and thousand dollars)

State	2001		2002	
	Quantity	Value	Quantity	Value
Missouri	289	4,650 <sup>r</sup>	340	7,360
Other <sup>2</sup>	94	2,920 <sup>r</sup>	106	3,110
Total	383	7,570 <sup>r</sup>	446	10,500

<sup>r</sup>Revised.

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

<sup>2</sup>Includes California, Ohio, and South Carolina.

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

(Metric tons)

Use	2001	2002
Heavy clay products and lightweight aggregates <sup>2</sup>	88,200	W
Refractories:		
Firebrick, block, shapes	146,000	20,400
Other refractories <sup>3</sup>	131,000	312,000
Miscellaneous <sup>4</sup>	18,300	114,000
Total	383,000	446,000

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

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

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

<sup>3</sup>Includes foundry sand, grogs and calcines, kiln furniture (2002), mortar and cement, and miscellaneous refractories.

<sup>4</sup>Includes animal feed, ceramics and glass, pottery, miscellaneous lightweight aggregates, and other unknown uses.

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

(Thousand metric tons and thousand dollars)

State	Attapulgit <sup>2</sup>		Montmorillonite		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2001:						
Georgia	W	W	W	W	879	82,500 <sup>r</sup>
Southern States <sup>3</sup>	W	W	764 <sup>r</sup>	75,400 <sup>r</sup>	764 <sup>r</sup>	75,400 <sup>r</sup>
Western States <sup>4</sup>	W	W	W	W	989 <sup>r</sup>	77,300 <sup>r</sup>
Total	292	35,800 <sup>r</sup>	2,600 <sup>r</sup>	231,000 <sup>r</sup>	2,890	267,000 <sup>r</sup>
2002:						
Georgia	W	W	W	W	979	93,800
Southern States <sup>3</sup>	W	W	835	75,300	835	75,300
Western States <sup>4</sup>	W	W	W	W	736	54,800
Total	218	26,800	2,510	219,000	2,730	246,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Southern States" or "Total."

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

<sup>2</sup>Primarily gellant-grade fuller's earth. See discussion under "Production: Fuller's Earth."

<sup>3</sup>Includes Florida, Mississippi, Tennessee, and Virginia.

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



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

(Metric tons)

Use	2001	2002
Absorbents:		
Oil and grease absorbent	296,000	409,000
Pet waste absorbent	1,870,000	1,580,000
Animal feed	W	81,500
Fertilizers	135,000	139,000
Fillers, extenders, binders <sup>2</sup>	70,200	58,800
Filtering, clarifying, decolorizing, animal, mineral, vegetable oils, greases	67,800	63,300
Pesticides and related products	29,400	102,000
Miscellaneous <sup>3</sup>	338,000	264,000
Exports <sup>4</sup>	79,100	30,900
Total	2,890,000	2,730,000

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

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

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

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

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

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

(Thousand metric tons and thousand dollars)

Use	2001		2002	
	Quantity	Value	Quantity	Value
Georgia	7,020	818,000 <sup>r</sup>	6,830	893,000
South Carolina	377	22,800	374	21,400
Other <sup>2</sup>	716 <sup>r</sup>	34,400 <sup>r</sup>	806	36,600
Total	8,110	875,000 <sup>r</sup>	8,010	951,000

<sup>r</sup>Revised.

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

<sup>2</sup>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<sup>1</sup>

(Thousand metric tons and thousand dollars)

Kind	2001		2002	
	Quantity	Value	Quantity	Value
Airfloat	925 <sup>r</sup>	51,400 <sup>r</sup>	943	52,500
Calcined <sup>2</sup>	1,370	240,000 <sup>r</sup>	1,550	284,000
Delaminated	1,100	113,000	1,070	124,000
Unprocessed	182 <sup>r</sup>	1,830 <sup>r</sup>	185	1,770
Water washed	4,540	469,000 <sup>r</sup>	4,260	489,000
Total	8,110	875,000 <sup>r</sup>	8,010	951,000

<sup>r</sup>Revised.

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

<sup>2</sup>Includes pigment- and refractory-grade calcined kaolin.

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

(Thousand metric tons and thousand dollars)

State	Refractory-grade		Pigment-grade	
	Quantity	Value	Quantity	Value
2001:				
Georgia	W	W	730	215,000
Other <sup>2</sup>	W	W	39	8,350
Total	602	16,400 <sup>r</sup>	769	224,000
2002:				
Georgia	W	W	786	255,000
Other <sup>2</sup>	W	W	40	8,850
Total	721	20,600	826	264,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."

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

<sup>2</sup>Includes Alabama, Arkansas, California, South Carolina, and Texas.

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

(Thousand metric tons and thousand dollars)

Kind	2001		2002	
	Quantity	Value	Quantity	Value
Airfloat	593	28,000	593	28,000
Calcined <sup>2</sup>	812	217,000 <sup>r</sup>	888	258,000
Delaminated	1,100	113,000	1,070	124,000
Unprocessed	59	609	59	609
Water washed	4,460	459,000	4,220	483,000
Total	7,020	818,000 <sup>r</sup>	6,830	893,000

<sup>r</sup>Revised.

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

<sup>2</sup>Includes pigment- and refractory-grade calcined kaolin.

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

(Metric tons)

Use	2001	2002
Domestic:		
Ceramics and glass:		
Catalysts (oil-refining)	155,000	152,000
Fiber glass	265,000	265,000
Roofing granules	20,100	20,100
Sanitaryware	77,200	77,000
Other <sup>3</sup>	38,500	46,200
Fillers, extenders, binders:		
Adhesives	43,400	52,700
Paint	256,000	261,000
Paper coating	2,470,000	2,530,000
Paper filling	413,000	449,000
Plastic	46,200	45,400
Rubber	60,400	61,000
Other <sup>4</sup>	213,000	92,400
Heavy clay products <sup>5</sup>	17,400	17,400
Refractories <sup>6</sup>	132,000	258,000
Undistributed <sup>7</sup>	158,000	54,700
Total	4,370,000	4,380,000

See footnotes at end of table.

TABLE 17--Continued  
 GEORGIA KAOLIN SOLD OR USED BY PRODUCERS, BY USE<sup>1,2</sup>

(Metric tons)

Use	2001	2002
Exports:		
Paint	353,000	85,000
Paper coating <sup>8</sup>	1,860,000	2,040,000
Paper filling <sup>8</sup>	85,200	93,900
Rubber	7,270	6,970
Undistributed <sup>9</sup>	340,000	221,000
Total	2,650,000	2,450,000
Grand total	7,020,000	6,830,000

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

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

<sup>3</sup>Includes electrical porcelain, fine china/dinnerware, pottery, and miscellaneous ceramics.

<sup>4</sup>Includes animal feed, asphalt tile, fertilizers, gypsum products, medical, pharmaceutical and cosmetics, pesticides and related products, textiles and miscellaneous fillers, extenders and binders.

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

<sup>6</sup>Includes firebricks, blocks and shapes, grogs and calcines, high-alumina specialties, kiln furniture, and miscellaneous refractories.

<sup>7</sup>Includes absorbents (2002), chemical manufacturing, floor and wall tiles, and other unknown uses.

<sup>8</sup>Some export sales may be included under domestic sales.

<sup>9</sup>Includes adhesives, catalyst (oil-refining), fiber glass, sanitaryware, miscellaneous fillers, extenders and binders, portland cement, miscellaneous refractories (2001).

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

(Thousand metric tons and thousand dollars)

Kind	2001		2002	
	Quantity	Value	Quantity	Value
Airfloat	313	21,400	307	20,000
Unprocessed <sup>2</sup>	63	1,400	68	1,350
Total	377	22,800	374	21,400

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

<sup>2</sup>Includes calcined kaolin.

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

(Metric tons)

Kind and use	2001	2002
Adhesives	12,600 <sup>r</sup>	14,700
Ceramics <sup>2</sup>	102,000	104,000
Rubber	140,000	116,000
Refractories <sup>3</sup>	7,350	7,030
Other uses <sup>4</sup>	81,700	88,900
Exports <sup>5</sup>	32,700	44,200
Total	377,000	374,000

<sup>r</sup>Revised.

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

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

<sup>3</sup>Includes firebrick, blocks and shapes, and miscellaneous refractories.

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

<sup>5</sup>Includes fillers, extenders, and binders, and refractories.

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

(Metric tons)

Use	2001	2002
<b>Domestic:</b>		
<b>Ceramics:</b>		
Catalyst (oil and gas refining)	212,000	210,000
Electrical porcelain	6,940	8,300
Fine china and dinnerware	26,300	27,400
Floor and wall tile	39,900	63,100
Pottery	4,590	13,400
Roofing granules	37,400	36,500
Sanitaryware	81,100	85,200
Miscellaneous	W	W
Chemical manufacture	31,600	31,600
Civil engineering	W	W
Fiber glass, mineral wool	288,000	288,000
<b>Fillers, extenders, binders:</b>		
Adhesive	56,000	67,400
Fertilizer	3,580	3,550
Medical, pharmaceutical, cosmetic	738	754
Paint	274,000	298,000
Paper coating	2,480,000	2,540,000
Paper filling	414,000	450,000
Pesticide	W	W
Plastic	50,800	49,700
Rubber	201,000	177,000
Miscellaneous	225,000	107,000
<b>Heavy clay products:</b>		
Brick, common and face	122,000	70,900
Portland cement	W	W
<b>Refractories:<sup>2</sup></b>	637,000	904,000
Miscellaneous applications	225,000	91,600
<b>Total</b>	<b>5,410,000</b>	<b>5,520,000</b>
<b>Exports:</b>		
Ceramics	219,000	203,000
Paint	365,000	85,000
Paper coating	1,860,000	2,040,000
Paper filling	85,200	93,900
Rubber	39,600	50,700
Miscellaneous	125,000	19,000
<b>Total</b>	<b>2,700,000</b>	<b>2,490,000</b>
<b>Grand total</b>	<b>8,110,000</b>	<b>8,010,000</b>

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

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

<sup>2</sup>Includes firebrick (blocks and shapes), grogs and calcines, high-alumina (brick and specialties), kiln furniture, and miscellaneous refractories.

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

(Thousand metric tons and thousand dollars)

State	Concrete block	Structural concrete	Other <sup>2</sup>	Total	Total value <sup>c</sup>
2001:					
Alabama	703	42	8	754	16,600
Arkansas	182	91	--	273	225
California <sup>c</sup>	46	164	--	211 <sup>r</sup>	9,880
Florida	68	23	--	91	1,280
Indiana	137	8	--	145	295
Kansas	--	--	93	93	1,280
Kentucky	109	36	--	145	557
Louisiana	319	159	53	531	1,170
Missouri	--	--	134	134	2,000
New York	82	54	--	136	5,600
North Carolina <sup>c</sup>	301	52	--	353	4,050
Ohio <sup>c</sup>	149	8	--	157	764
Oklahoma	22	3	--	25	659
Texas <sup>c</sup>	49	157	253	459	2,520
Utah	68	59	100	227	4,880
Virginia	141	--	--	141	980
Total	2,370	857	641	3,870	52,700
2002:					
Alabama	749	53	89	891	18,200
Arkansas	203	102	--	305	1,340
California	47	181	--	228	11,200
Florida <sup>c</sup>	68	23	--	91	1,280
Indiana <sup>c</sup>	137	8	--	145	295
Kansas	--	--	73	73	1,010
Kentucky <sup>c</sup>	109	36	--	145	557
Louisiana <sup>c</sup>	319	159	53	531	1,170
Missouri	--	--	125	125	1,860
New York <sup>c</sup>	82	54	--	136	5,600
North Carolina <sup>c</sup>	301	52	--	353	4,050
Ohio <sup>c</sup>	149	8	--	157	764
Oklahoma <sup>c</sup>	22	3	--	25	659
Texas <sup>c</sup>	49	157	253	459	2,520
Utah	--	71	133	204	3,450
Virginia <sup>c</sup>	141	--	--	141	980
Total	2,370	908	726	4,010	54,900

<sup>c</sup>Estimated. -- Zero.

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

<sup>2</sup>Includes highway surfacing.

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

(Thousand metric tons and thousand dollars)

State	2001		2002	
	Quantity	Value <sup>c</sup>	Quantity	Value <sup>c</sup>
Alabama	815	2,070 <sup>r</sup>	642	2,050
Arkansas	478	540	464	504
California	243	1,170	243 <sup>e</sup>	1,170 <sup>e</sup>
Colorado	202	1,320	176	1,130
Georgia	1,160	3,180	1,110	4,100
Illinois	188	874	172	763
Kentucky <sup>3</sup>	483	1,840	400	2,360
Maryland	198	253	200	243
Mississippi	384	1,910	420	2,080
North Carolina	1,890	5,290 <sup>r</sup>	1,960	6,540
Ohio	837	4,450	817	4,840
Oklahoma	481	829	731	1,170
Pennsylvania	655	1,910	674	2,160
South Carolina	778	2,600	814	2,150
Texas	1,040	3,990 <sup>r</sup>	1,010	16,200
Other <sup>4</sup>	2,920	7,740 <sup>r</sup>	2,950	11,600
Total	12,800	40,000 <sup>r</sup>	12,800	59,000

<sup>c</sup>Estimated.

<sup>1</sup>Includes extruded and other brick.

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

<sup>3</sup>Extruded brick only.

<sup>4</sup>Includes all other States except Alaska, Delaware, Hawaii, Idaho, Nevada, New Hampshire, Rhode Island, Vermont, and Wisconsin.

TABLE 23  
U.S. EXPORTS OF CLAYS IN 2002, BY COUNTRY<sup>1</sup>

(Thousand metric tons and thousand dollars)

Country	Ball clay		Bentonite		Fire clay		Fuller's earth	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	4	99	(2)	107	(2)	76	(2)	89
Australia	1	21	12	1,080	16	1,230	--	--
Belgium	(2)	4	4	5,290	(2)	49	(2)	50
Brazil	(2)	32	10	1,650	(2)	69	(2)	9
Canada	51	1,820	219	13,300	32	1,520	15	1,670
Finland	--	--	(2)	11	--	--	--	--
France	--	--	(2)	520	(2)	46	(2)	34
Germany	(2)	3	12	950	(2)	40	(2)	81
Indonesia	--	--	11	1,770	2	414	--	--
Italy	--	--	1	602	--	--	1	271
Japan	1	177	174	16,900	22	2,010	--	--
Korea, Republic of	(2)	130	23	2,390	1	380	--	--
Malaysia	--	--	15	1,420	(2)	12	2	228
Mexico	3	105	20	2,050	84	7,990	1	100
Netherlands	(2)	25	24	10,200	55	5,770	22	1,970
Singapore	(2)	11	3	721	--	--	(2)	5
South Africa	--	--	1	620	(2)	33	(2)	16
Taiwan	16	407	28	3,940	12	774	(2)	32
Thailand	--	--	12	1,290	--	--	(2)	73
United Kingdom	1	64	75	7,880	(2)	67	2	300
Venezuela	27	2,270	4	1,080	(2)	25	1	261
Other	23	1,880	74	13,800	27	2,350	16	3,480
Total	127	7,050	722	87,600	251	22,800	60	8,670
	Kaolin		Clays, n.e.c. <sup>3</sup>		Total			
	Quantity	Value	Quantity	Value	Quantity	Value		
Argentina	11	1,310	1	927	16	2,610		
Australia	15	4,340	5	4,340	49	16,200		
Belgium	32	8,240	1	639	38	14,300		
Brazil	5	1,820	4	3,530	19	7,100		
Canada	783	74,500	244	42,600	1,340	135,000		
Finland	259	50,400	1	1,740	260	52,200		
France	7	1,530	2	1,600	10	3,730		
Germany	36	12,000	4	2,120	52	15,200		
Indonesia	71	15,800	3	1,270	87	19,200		
Italy	91	15,800	5	2,630	97	19,300		
Japan	866	138,000	18	8,900	1,080	166,000		
Korea, Republic of	175	32,500	8	6,830	207	42,300		
Malaysia	3	902	2	1,200	22	3,770		
Mexico	213	18,600	28	6,510	348	35,300		
Netherlands	175	28,600	20	17,400	297	64,000		
Singapore	3	776	3	3,810	9	4,330		
South Africa	4	1,830	4	1,740	9	4,240		
Taiwan	176	24,900	8	3,760	240	33,800		
Thailand	39	8,110	4	1,930	55	11,400		
United Kingdom	20	7,880	10	12,300	108	28,500		
Venezuela	23	10,000	5	1,180	60	14,800		
Other	339	77,500	69	28,600	546	123,000		
Total	3,350	536,000	449	156,000	4,960	817,000		

-- Zero.

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

<sup>2</sup>Less than 1/2 unit.

<sup>3</sup>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 2002, BY KIND<sup>1</sup>

Kind	Quantity (metric tons)	Value <sup>2</sup> (thousands)
China clay or kaolin:		
Brazil	142,000	16,700
Canada	488	216
France	645	208
Germany	244	273
Japan	130	184
Mexico	96	96
United Kingdom	13,700	4,340
Other	694	289
Total	158,000	22,400
Fire clay:		
Canada	210	88
Germany	8	27
Total	218	116
Decolorizing earths and fuller's earth:		
China	189	41
Malaysia	16	7
Total	205	48
Bentonite:		
Canada	1,380	619
Germany	24	29
Greece	24,400	980
Italy	21	64
Japan	49	86
Mexico	329	85
Netherlands	156	62
Spain	305	315
Turkey	2,080	943
United Kingdom	316	152
Other	39	19
Total	29,100	3,350
Common blue clay and other ball clay:		
Canada	29	12
China	14	18
Germany	18	8
United Kingdom	346	104
Total	407	142
Other clay:		
Canada	1,260	305
China	305	278
Germany	101	131
Mexico	192	232
Netherlands	32	23
Spain	598	406
United Kingdom	387	232
Other	193	521
Total	3,070	2,130
Artificially activated clay and activated earth:		
Austria	53	73
Canada	1,990	1,150
Denmark	464	694
Germany	2,880	1,930
Mexico	20,000	6,230
Netherlands	199	110
Peru	203	102
United Kingdom	336	436
Other	732	536
Total	26,800	11,300
Grand total	217,000	39,400

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

<sup>2</sup>U.S. Customs declared value.

Source: U.S. Census Bureau.



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

(Metric tons)

Country <sup>3</sup>	1998	1999	2000	2001	2002 <sup>e</sup>
Algeria <sup>4</sup>	15,655	15,491	22,708	21,286 <sup>r</sup>	27,178 <sup>5</sup>
Argentina	131,320	128,809	123,092 <sup>r</sup>	104,335 <sup>r</sup>	88,685 <sup>5</sup>
Armenia	3,000 <sup>e</sup>	3,493	2,807	3,000 <sup>e</sup>	3,000
Australia <sup>e,4</sup>	104,000	180,000	180,000	180,000	200,000
Bosnia and Herzegovina <sup>e</sup>	800	800	800	800	800
Brazil, beneficiated	220,000	274,623	273,975	160,381 <sup>r</sup>	165,000
Bulgaria	1,176,110	242,725	295,000	250,000 <sup>e</sup>	250,000
Burma	1,066 <sup>r</sup>	998 <sup>r</sup>	978 <sup>r</sup>	900 <sup>e</sup>	900
Chile	721	1,104	1,314	1,695 <sup>r</sup>	632
Commonwealth of Independent States <sup>e,6</sup>	600,000	700,000	750,000	750,000	750,000
Croatia	7,581	8,441	10,013	10,580 <sup>r</sup>	11,000
Cyprus	121,850	138,853	167,500	126,600	125,000
Czech Republic	125,000	160,000	280,000	250,000 <sup>e</sup>	250,000
Egypt <sup>e</sup>	33,000	50,000	50,000	50,000	50,000
Georgia <sup>e</sup>	11,000	9,891	7,084	7,000	7,000
Germany <sup>e</sup>	500,000	500,000 <sup>5</sup>	500,000	500,000	500,000
Greece <sup>e</sup>	950,000	950,000 <sup>5</sup>	950,000	950,000	950,000
Guatemala	2,278	4,301	3,317	3,000 <sup>e</sup>	3,100
Hungary	17,000	16,000	15,000	30,400 <sup>r</sup>	30,000
Indonesia <sup>e</sup>	840 <sup>5</sup>	5,213 <sup>5</sup>	5,000	5,000	5,000
Iran <sup>7</sup>	83,279	64,957	70,000	80,000 <sup>r</sup>	80,000
Italy	592,000	500,000	500,000 <sup>e</sup>	500,000 <sup>e</sup>	500,000
Kenya	NA	--	64	50 <sup>r</sup>	50
Japan	443,566	428,247	415,115	405,738 <sup>r</sup>	400,000
Macedonia <sup>e</sup>	30,000	30,000	30,000	30,000	30,000
Mexico	185,729	208,611	269,730	415,133 <sup>r</sup>	400,000
Morocco	33,311 <sup>r</sup>	36,528	43,152 <sup>r</sup>	71,741 <sup>r</sup>	65,754 <sup>5</sup>
Mozambique	10,448 <sup>r</sup>	10,828	16,144	1,611 <sup>r</sup>	1,600
New Zealand, processed <sup>e</sup>	14,000	15,000 <sup>5</sup>	10,000	10,000	7,800 <sup>5</sup>
Pakistan	14,196	15,349	27,700	27,000 <sup>e</sup>	28,000
Peru	19,563	19,659	21,059	18,217	18,200
Philippines	3,900	1,844	2,800 <sup>r</sup>	5,128 <sup>r</sup>	5,500
Poland <sup>8</sup>	5,400	5,000	29,700 <sup>r</sup>	29,000 <sup>r</sup>	30,000
Romania	25,434	19,577	35,789	24,779 <sup>r</sup>	15,402 <sup>5</sup>
Serbia and Montenegro	68	77	75 <sup>e</sup>	75 <sup>e</sup>	75
South Africa <sup>9</sup>	48,382	50,363	85,187	116,384	218,512 <sup>5</sup>
Spain <sup>e</sup>	150,000	150,000 <sup>5</sup>	150,000	150,000	150,000
Tanzania <sup>e</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Turkey	565,708	899,614	636,273	600,000	600,000
Turkmenistan <sup>e</sup>	50,000	50,000	50,000	50,000	50,000
Ukraine <sup>e</sup>	300,000	300,000	300,000	300,000	300,000
United States	3,820,000	4,070,000	3,760,000	3,970,000 <sup>r</sup>	3,970,000 <sup>5</sup>
Zimbabwe <sup>9</sup>	135,785	140,000	140,000 <sup>e</sup>	--	--
Total	10,600,000	10,400,000	10,200,000	10,200,000 <sup>r</sup>	10,300,000

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. -- Zero.

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

<sup>2</sup>Table includes data available through August 21, 2003.

<sup>3</sup>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.

<sup>4</sup>Includes bentonitic clays.

<sup>5</sup>Reported figure.

<sup>6</sup>Does not include Armenia, Georgia, Turkmenistan, and Ukraine, for which data are available and reported separately in this table.

<sup>7</sup>Year beginning March 21 of that stated.

<sup>8</sup>Montmorillite type bleaching clay.

<sup>9</sup>May include other clays.

TABLE 26  
FULLER'S EARTH: WORLD PRODUCTION, BY COUNTRY<sup>1</sup>

(Metric tons)

Country <sup>2</sup>	1998	1999	2000	2001	2002 <sup>c</sup>
Algeria	3,942	2,489	3,431	3,254 <sup>r</sup>	3,521 <sup>3</sup>
Argentina <sup>c</sup>	1,500	1,500	1,500	1,500	1,500
Australia, attapulгите	15,670	5,639	5,600 <sup>r</sup>	5,600 <sup>r</sup>	6,000
Germany, unprocessed <sup>c</sup>	500,000	500,000	500,000	500,000	500,000
Italy <sup>c</sup>	30,000	30,000	30,000	30,000	30,000
Mexico	48,016	47,522	51,685	148,194 <sup>r</sup>	150,000
Morocco, smectite	27,650	21,956	30,665	40,664 <sup>r</sup>	42,243 <sup>3</sup>
Pakistan	14,659	15,565	15,288	15,000 <sup>e</sup>	15,000
Senegal, attapulгите	80,000 <sup>e</sup>	136,000	131,000	130,000 <sup>e</sup>	176,454 <sup>3</sup>
South Africa, attapulгите	7,830 <sup>e</sup>	7,067	7,337	9,229	7,990
Spain, attapulгите <sup>c</sup>	90,000	90,000	90,000	90,000	90,000
United Kingdom <sup>e, 4</sup>	140,000	140,000	140,000	140,000	140,000
United States <sup>5</sup>	2,420,000	2,560,000	2,910,000	2,890,000	2,730,000 <sup>3</sup>
Total	3,380,000	3,560,000	3,920,000	4,000,000 <sup>r</sup>	3,890,000

<sup>c</sup>Estimated. <sup>r</sup>Revised.

<sup>1</sup>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, 2003.

<sup>2</sup>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.

<sup>3</sup>Reported figure.

<sup>4</sup>Salable product.

<sup>5</sup>Sold or used by producers.

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

(Metric tons)

Country <sup>3</sup>	1998	1999	2000	2001	2002 <sup>c</sup>
Algeria	13,640	16,833	11,616	13,356 <sup>r</sup>	9,505 <sup>4</sup>
Argentina	46,832	52,665	34,023 <sup>r</sup>	42,659 <sup>r</sup>	36,259 <sup>4</sup>
Australia, includes ball clay <sup>c</sup>	180,000	200,000	220,000	220,000	230,000
Austria, marketable <sup>c</sup>	60,000	50,000	50,000	50,000	50,000
Bangladesh <sup>e, 5</sup>	7,500	7,700	7,900	8,000	8,100
Belgium <sup>c</sup>	300,000	300,000	300,000	300,000	300,000
Bosnia and Herzegovina <sup>c</sup>	3,000	3,000	3,000	3,000	3,000
Brazil, beneficiated	1,373,892	1,516,700	1,639,673 <sup>r</sup>	1,817,419 <sup>r</sup>	1,820,000
Bulgaria	73,700	97,500	108,000	100,000 <sup>e</sup>	100,000
Burundi	3,500	1,597	1,500	--	--
Chile	11,530	4,361	6,445	5,300	6,164 <sup>4</sup>
Colombia, includes common clay <sup>c</sup>	8,000,000	8,000,000 <sup>4</sup>	8,400,000	8,500,000	8,500,000
Czech Republic	3,049,000	5,183,000	5,573,000	5,500,000 <sup>e</sup>	5,500,000
Denmark, sales <sup>c</sup>	2,500	2,500	2,500	2,500 <sup>r</sup>	2,500
Ecuador	7,000 <sup>e</sup>	20,652	11,022	8,818	9,000
Egypt	285,497	290,000	290,000	300,000 <sup>e</sup>	300,000
Eritrea	3,809	1,138	943	588 <sup>r</sup>	250 <sup>4</sup>
Ethiopia	378	681	1,654	1,790 <sup>e</sup>	1,800
France, marketable	330,000 <sup>e</sup>	325,000	300,000	300,000 <sup>e</sup>	300,000
Germany	1,800,000 <sup>e</sup>	1,800,000	1,800,000	1,800,000 <sup>e</sup>	1,800,000
Greece	60,000 <sup>e</sup>	60,000	60,000	60,000 <sup>e</sup>	60,000
Guatemala <sup>c</sup>	7,150	61	77	100	100
Hungary, processed <sup>c</sup>	7,000	7,000	7,000	7,000	7,000
India:					
Processed	148,000	150,000	160,000	170,000 <sup>e</sup>	170,000
Salable crude	540,000	520,000	530,000	540,000 <sup>e</sup>	540,000

See footnotes at end of table.

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

(Metric tons)

Country <sup>3</sup>	1998	1999	2000	2001	2002 <sup>e</sup>
Indonesia	8,567	21,389	15,000 <sup>e</sup>	15,000 <sup>e</sup>	15,000
Iran	582,485	837,277	850,000 <sup>r</sup>	800,000 <sup>e</sup>	800,000
Israel <sup>c</sup>	27,000	20,000	13,000	-- <sup>r</sup>	--
Italy, kaolinitic earth <sup>c</sup>	9,000	9,000	10,000	10,000	10,000
Japan	83,257	53,092	25,739	19,976 <sup>r</sup>	19,000
Jordan	78,000	34,040	36,795	38,000 <sup>e</sup>	41,000
Kazakhstan <sup>e</sup>	60,000	70,000	70,000	70,000	70,000
Kenya	500 <sup>e</sup>	192	793	700 <sup>r</sup>	700
Korea, Republic of	2,259,809	1,858,359	2,097,450	2,383,833	2,831,027 <sup>4</sup>
Madagascar <sup>e</sup>	200 <sup>r</sup>	120 <sup>r</sup>	170 <sup>r</sup>	170 <sup>r</sup>	50
Malaysia	198,930	213,973	233,885	364,458 <sup>r</sup>	258,273 <sup>4</sup>
Mexico	339,013	489,993	532,268	681,709 <sup>r</sup>	680,000
New Zealand	26,000	16,700 <sup>r</sup>	16,300 <sup>r</sup>	15,000 <sup>r</sup>	16,000
Nigeria <sup>c</sup>	110,000	110,000 <sup>4</sup>	110,000	110,000	110,000
Pakistan	70,777	64,692	49,574	50,000 <sup>e</sup>	50,000
Paraguay	66,700	66,600	66,500	66,500 <sup>e</sup>	66,700
Peru	4,968	1,332	6,165	5,532	5,500
Poland, washed	82,450 <sup>e</sup>	88,792	100,756	129,123	142,000
Portugal <sup>c</sup>	180,000	175,000	175,000	175,000	175,000
Romania	24,724	25,456	19,007	21,867 <sup>r</sup>	22,514 <sup>4</sup>
Russia, concentrate	50,000	40,600	45,000	45,000 <sup>e</sup>	45,000
Serbia and Montenegro:					
Crude	75,092	40,321	39,475	60,900 <sup>r</sup>	60,000
Washed <sup>e</sup>	7,000	3,000	4,000	10,000 <sup>r</sup>	10,000
Slovakia	28,000	22,000	32,000	30,000 <sup>e</sup>	30,000
Slovenia: <sup>e</sup>					
Crude	10,000	10,000	10,000	10,000	10,000
Washed	4,000	4,000	4,000	4,000	4,000
South Africa	138,300	122,400	98,897	85,556	91,380 <sup>4</sup>
Spain, marketable, crude and washed <sup>e,6</sup>	300,000	320,000	365,000 <sup>4</sup>	350,000	350,000
Sri Lanka	11,110	12,573	12,230	9,403 <sup>r</sup>	8,613 <sup>4</sup>
Sweden <sup>e</sup>	450	450	-- <sup>r</sup>	-- <sup>r</sup>	--
Tanzania	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Taiwan	--	171	409	147	--
Thailand, beneficiated	248,461	113,005	201,226	168,063 <sup>r</sup>	165,000
Turkey	403,733	449,954 <sup>r</sup>	400,000	600,000 <sup>e</sup>	600,000
Uganda	NA	198	14	90	90
Ukraine	201,670	221,526	225,000 <sup>e</sup>	225,000 <sup>e</sup>	225,000
United Kingdom, sales <sup>7</sup>	2,391,595	2,303,607	2,420,000	2,400,000 <sup>e</sup>	2,400,000
United States <sup>8</sup>	9,640,000	9,160,000	8,800,000	8,110,000	8,010,000 <sup>4</sup>
Uzbekistan <sup>c</sup>	5,500,000	5,500,000	5,300,000	5,500,000	5,500,000
Venezuela	4,000	12,000	--	--	--
Vietnam <sup>e</sup>	350,000 <sup>r</sup>	398,000 <sup>r</sup>	520,000 <sup>r</sup>	600,000 <sup>r</sup>	600,000
Total	39,900,000 <sup>r</sup>	41,500,000 <sup>r</sup>	42,800,000 <sup>r</sup>	42,900,000 <sup>r</sup>	43,200,000

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. -- Zero.

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

<sup>2</sup>Table includes data available through August 21, 2003.

<sup>3</sup>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.

<sup>4</sup>Reported figure.

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

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

<sup>7</sup>Dry weight.

<sup>8</sup>Kaolin sold or used by producers.