SALT

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Salt, also known as sodium chloride, comprises the elements sodium and chlorine. Sodium is a silver-colored metal that is so unstable that it reacts violently in the presence of water, and chlorine is a greenish-colored gas that is dangerous and may be lethal. Yet the combination of these two elements forms sodium chloride that is a white-colored compound essential to life itself. Virtually every person in the world has some direct or indirect contact with salt daily. People routinely add salt to their food as a flavor enhancer or apply rock salt to walkways to remove ice in the winter. Salt is used as feedstock for chlorine and caustic soda manufacture. These two inorganic chemicals are used to make many consumer-related end-use products, such as polyvinyl chloride (PVC), a plastic made from chlorine and paper-pulping chemicals manufactured from sodium hydroxide (caustic soda). With the heightened domestic awareness regarding terrorism, a PVC suit that shields against nuclear radiation has been developed for military and civilian uses (Chemical Week, 2002).

Domestic Data Coverage

U.S. production and sales data for salt are developed by the U.S. Geological Survey (USGS) from an annual voluntary canvass of U.S. salt-producing sites and company operations. Production refers to the quantity of salt mined or manufactured that is available for sale. Salt sold or used is the quantity of salt that was sold directly to customers or used captively by the salt producer, which usually is a chloralkali manufacturer.

Of the 29 companies to which a canvass form was sent, all but 3 responded (Dow Chemical Co., Texas Brine Corp., and United Salt Co.), representing 76% of the total production shown in this report. Data for nonrespondents were estimated based on their responses to previous annual surveys, the 2002 production estimate survey, or brine production capabilities for chloralkali manufacture based upon published chlorine production capacities [1.75 metric tons (t) of salt required per ton of chlorine capacity].

The information and data collected from these facilities are fundamental resources for analysis both within and outside the Government. The salt data and information are needed by the public and private sectors to better understand minerals and materials use and the ultimate disposition of materials in the economy and in the environment. The data are also used to develop public and private sector policies and practices that better use our mineral and material resources. The salt data and information are used by financial institutions, State and Federal agencies, salt-consuming industries (e.g., agricultural, chemical, and food processing), educational institutions, consultants, and the general public.

Production

The structure of the U.S. salt industry has changed throughout the years. In 1970, 50 companies operated 95 salt-producing plants in the United States. Market competition, energy and labor costs, less expensive imports, currency exchange rates, and an excess of production capacity (resulting in the downsizing of the industry through mergers and acquisitions) reduced the number of operations in the industry to 29 companies and 66 plants by 2002.

The four types of salt that are surveyed are classified according to the method of recovery as follows: rock salt, from the surface or underground mining of halite deposits; solar salt, from the solar evaporation of seawater, landlocked bodies of saline water, or primary or byproduct brines; vacuum pan salt, from the mechanical evaporation of a purified brine feedstock; and brine, from the solution mining of underground halite deposits. Data for brine production and consumption represent the anhydrous salt content only and not the weight of the water.

***Mining.*—Rock Salt.**—Rock salt is mined by the room-and-pillar method, which is similar to that used in coal and trona mining. The pillar widths are controlled by the percentage of extraction permissible at the various depths and room widths. Most room-and-pillar operations recover about 45% to 65% of the resource, with the remainder left behind as pillar supports for structural integrity of the mine. The salt is drilled, cut, blasted, mucked, crushed, and transported to the surface for processing, which usually involves removing the impurities and screening the material to finer size fractions.

Underground mining practices of bedded halite (commonly referred to as “rock salt”) and domal salt formations are similar except for the height differences within the mines of the two types of operations. For example, bedded formations usually are laterally extensive but are vertically restricted. Salt domes are laterally restrictive but are vertically extensive. Many salt domes have depths in excess of 6,100 meters (m) (20,000 feet), yet many outcrop at the surface. Most Gulf Coast salt mining operations are generally less than 300 m (1,000 feet) below the surface. Working at deeper depths is difficult because of higher temperatures and denser rock.

Solar Evaporation.—Solar evaporation uses the wind and the sun to evaporate the water and is an effective method of producing solar salt in areas of high evaporation and low precipitation. Along coastal margins in many parts of the world, seawater is collected and allowed to evaporate in specially constructed concentrating and evaporating ponds. Seawater contains various dissolved salts that will separate depending on their relative solubilities. Calcium carbonate, which is the least soluble, will separate out first. Highly soluble magnesium

salts tend to separate last. The order of separation of mineral salts from seawater from first to last are: calcite, gypsum, halite, astrakainite, epsomite, kainite, hexahydrite, kieserite, carnallite, and bishofite. Saline lakewater is also processed using solar evaporation. The ponds are separated by levees that isolate the brine during different stages of fractional crystallization.

The brine is circulated among a network of interconnecting ponds, with salinity increasing with each transfer. The brine is then treated with lime to remove excess calcium sulfate, pumped to evaporation ponds, and then transferred to harvesting ponds to permit the salt to crystallize. After about 85% of the salt is precipitated, the remaining supernatant liquid, called "bitterns," can be pumped to adjacent ponds for subsequent extraction of magnesium, potassium, bromine, and sodium compounds. The harvesting pond is flooded again with new brine from the lime pond to repeat the cycle. It takes about 5 years once seawater is first introduced into the system for the completion of the crystallization process. The salt is harvested by special tractors equipped with scrapers and is ready for processing.

Solution Mining.—The first reported use of solution mining was about 250 B.C. in China when holes were drilled into deep salt deposits. The brine was brought to the surface by pipes made of bamboo. The brine was evaporated over fires fueled with wood, coal, or unprocessed natural gas. The basis of current technology began in France around A.D. 858. Today, an injection well is sunk, and pressurized freshwater is introduced to hydraulically fracture the bedded salt. Once communication with the production well is established, the brine is pumped to the surface for treatment. Solution mining can also use annulus injection that uses a pair of concentric pipes (one carries the solvent downward and the other containing the brine upward) or tubing injection that introduces the solvent at the bottom of the tube.

Solution mining is used to obtain a sodium chloride feedstock for vacuum pan salt production and for chlorine, caustic soda, and synthetic soda ash (excluding the United States) manufacture. The quantity of underground salt dissolved and recovered as brine to make vacuum pan salt usually is not. Only the quantity of vacuum pan salt manufactured is reported as primary salt production. The quantity of brine used to make chloralkali chemicals is reported as either the amount of captive brine used or brine sold. The chemical industry is the largest consumer of salt brine in the world.

***Processing.*—Rock Salt.**—About 78% of total rock salt produced and imported is for highway deicing. Crushing and screening to the proper physical size is usually the only processing that road salt undergoes. In many operations, these steps are done underground in the mine to minimize haulage and storage costs. In addition, the extremely fine fraction, which often is unusable and would represent a waste product if brought to the surface, remains underground.

Solar Salt.—After harvesting, the salt crystals are washed with dilute brine to remove residual bitterns and impurities. The salt is transferred to processing facilities where it is washed with saline water, dried for about 8 minutes at approximately 160º C (300º F), and screened into fine to coarse sizes, depending on the end use of the salt to be sold. Most operations ship solar salt in bags and in bulk, using barges, truck, and rail transportation.

Mechanical Evaporation.—Vacuum pan salt is not mined but is a type of salt produced using mechanical evaporation technology. Although rock salt, solar salt, and salt brine may be used to make vacuum pan salt, virtually all domestic vacuum pan salt is obtained from solution mining underground salt formations. Vacuum pan salt is obtained by dehydrating brine using heat alone or in combination with a vacuum. The vacuum pan process conserves energy by utilizing multiple-effect evaporators connected to vacuum pumps. A saturated salt solution will boil at a higher temperature than pure water. When a vacuum is applied, the brine boils at a lower temperature, enabling the superheated vapor that is generated to act as the heating medium for the next evaporator.

The grainer or open pan process uses open, rectangular pans with steam-heated immersion coils to evaporate the water in the brine. Rotating rakes scrape the salt precipitate into a sump or up a ramp, depending on the method, and onto conveyors for debrining and drying treatment. The final product is usually flake shaped rather than the typical cubic form. Flake salt is preferred for production of cheese, butter, and baked goods.

The Alberger process is a modified grainer operation that produces cubic salt with some flake salt. The pans are shallow, circular units with external heating units, rather than heating coils. The open pan process cannot be operated successfully in regions with high humidities because the evaporation rate is too slow and more energy is required to evaporate the brine.

Production in 2002.—Total U.S. salt production decreased by about 10% in 2002 to 40.3 million metric tons (Mt) compared with that of 2001. According to the USGS canvass for 2002, 29 companies operated 66 salt-producing plants in 15 States. Of these, 9 companies and 15 plants produced more than 1 Mt each and accounted for 90% and 63%, respectively, of total U.S. production and 89% and 28%, respectively, of total value. Several companies and plants produced more than one type of salt. In 2002, 10 companies (13 operations) produced solar-evaporated salt; 6 companies (18 operations), vacuum pan salt; 11 companies (15 operations), rock salt; and 13 companies (31 operations), salt brine (tables 1-3).

The five leading States, in terms of total salt sold or used, were Louisiana, 32%; Texas, 24%; New York, 12%; Kansas, 7%; and Utah, 6% (table 4). Other Eastern States (Alabama, Michigan, Ohio, Tennessee, and West Virginia) accounted for 16% of the domestic total salt sold or used. Other Western States (Arizona, California, Nevada, New Mexico, and Oklahoma) represented 3%.

In May, Cargill, Inc. announced it would sell 6,680 hectares (16,500 acres) of its San Francisco Bay area property to the State and Federal Governments for wildlife habitat restoration. The Bay area has lost about 80% of its original 76,900 hectares (190,000 acres) of tidal marshes to solar salt pond construction and production activities during the past 150 years (Kay, 2002§[1]). For about 40 years, local environmental groups have wanted to secure the area for wildlife and wetlands preservation. Cargill will receive $100 million ($53 million paid in November 2002, and the balance due during a period of 5 years) from the State ($72 million), the U.S. Department of the Interior's U.S. Fish and Wildlife Service ($8 million), and private philanthropic foundations ($20 million). An additional $35 million will

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

be spent during the first 5 years for initial stewardship and restoration planning—$20 million of which will be from the State and Federal Governments, and $15 million, from private foundations (Cargill, Inc., 2002§). Cargill will retain 4,450 hectares (11,000 acres) of land that it owns or has salt extraction rights around the bay for continued solar salt production.

Consumption

In 2002, apparent consumption (salt sold or used, plus imports, minus exports) was 45.1 Mt, whereas reported consumption (sales or use as reported by the salt companies, including their imports and exports) was 43.6 Mt. Although these two measures of consumption are not necessarily expected to be identical, they normally are similar. Apparent consumption normally is greater than reported consumption because apparent consumption includes additional quantities of salt imported and exported by non-salt-producing companies, such as some chloralkali operations and salt distributors. Reported consumption statistics are reported only by the domestic salt producing companies.

The direct and indirect uses of salt number about 14,000 according to industry sources. The USGS annually surveys 8 major categories comprising 29 end uses. The 2002 reported percentage distribution of salt by major end use was chemicals, 45%; ice control, 31%; distributors (grocery and other wholesalers and retailers, etc.), 8%; general industrial, 6%; food processing, 4%; agricultural, 4%; primary water treatment, 2%; and other uses combined with exports, less than 1%. Distributors represented a substantial share of salt sales by the salt industry; all this salt is ultimately resold to many different end users. For a more complete analysis of end-use markets, specific sectors of distribution in table 5 can be combined, such as agricultural and water treatment with agricultural and water conditioning distribution, respectively.

Aside from the different types of salt, there are various distinctions in the packaging and applications of salt. Salt for human consumption is packaged in different sized containers for several specialized purposes. Table salt may contain 0.01% potassium iodide as an additive, which provides a source of iodine that is essential to the oxidation processes in the body. Kosher salt, sea salt, condiment salt, and salt tablets are special varieties of salt.

Water conditioning and animal feed salt are made into 22.7-kilogram (50-pound) pressed blocks. Sulfur, iodine, trace elements, and vitamins are occasionally added to salt blocks to provide nutrients not found naturally in the diet of certain livestock. Salt is also compressed into pellets that are used for water conditioning.

Chemical.—The largest consumer of salt, primarily salt brine, is the chemical industry. Salt brine is obtained from extraction of natural underground saline sources, solution-mined halite deposits (salt beds or salt domes), or the dissolution of solar salt supplies. Within this industry, the chloralkali sector remains the major consumer of salt for manufacturing chlorine, coproduct sodium hydroxide, and synthetic soda ash. Since 1986, when the last synthetic soda ash plant closed because of high production costs and competition with less expensive natural soda ash, no synthetic soda ash has been manufactured in the United States; many countries, however, still produce synthetic soda ash and use vast quantities of salt brine as feedstock.

Salt is used as the primary raw material in chlorine manufacture because it is an inexpensive and widely available source of chlorine ions. For sodium hydroxide production, salt is the main source of the sodium ions. About 98% of the domestic chlorine and sodium hydroxide produced is obtained from the electrolysis of salt brine feedstock by using three-cell technologies. The types of cells and the percentages of chlorine manufactured by them are diaphragm, 78%; mercury, 14%; and membrane, 6%. The remaining 2% of chlorine and caustic soda production is recovered as a byproduct from magnesium and sodium metal manufacture.

It takes about 1.75 t of salt to make 1.0 t of chlorine and 1.1 t of coproduct caustic soda. The electrolytic process ionizes the sodium chloride compound and selectively allows the ions to migrate through special membranes. Chlorine gas forms at the anode while sodium ions bond with water molecules at the cathode to form sodium hydroxide with hydrogen gas evolving.

Chlorine and caustic soda are considered to be the first generation of products made from salt. These two chemicals are further used to manufacture other materials, which are considered to be the second generation of products from salt. Although most salt brine is produced by the same companies that use it, many chloralkali manufacturers now purchase brine from independent brine supply companies. In certain cases, brine is produced by a chemical company that uses some of it and sells the excess to neighboring competitors. According to a survey of domestic salt-based chlorine facilities, about 48% of the salt used to manufacture chlorine was captive (produced by manufacturing companies), and 31% was purchased brine. Purchased solar salt and rock salt comprised 12%, and imported rock, solar, and vacuum pan salt was 9% (tables 5, 6).

In 2002, according to the U.S. Census Bureau, 11.4 Mt of chlorine and 8.99 Mt of sodium hydroxide (caustic soda or lye) were produced. Based on the industry average ratio of 1.75 t of salt required to produce 1.0 t of chlorine and 1.1 t of coproduct sodium hydroxide, the chlorine and caustic soda industry consumed about 20 Mt of salt for feedstock. Reported consumption of total domestic and imported salt for chlorine manufacture was 18.3 Mt (table 5). The difference between the calculated and reported quantities was the amount of salt not reported to the USGS from imports or captive brine production of chloralkali producers.

Salt is also used as a feedstock in chemical establishments that make sodium chlorate (by the electrolysis of an acidified salt brine using hydrochloric acid adjusted to a pH of 6.5), metallic sodium (by the electrolysis of a molten salt mixture containing 33.2% sodium chloride and 66.8% calcium chloride, which is added to reduce the melting temperature of salt), and other downstream chemical operations. In powdered soaps and detergents, salt is used as a bulking agent and a coagulant for colloidal dispersion after saponification. In pharmaceuticals, salt is a chemical reagent and is used as the electrolyte in saline solutions. It is also used with sulfuric acid to produce sodium sulfate and hydrochloric acid. This subsector is relatively small, representing only 5% of domestic salt sales for the entire chemical sector and only 2% of total domestic salt consumption.

The consumption of salt for metallic sodium has declined during the past several years. Since the 1970s, the number

of producers has decreased from three to one; Ethyl Corp. and RMI Titanium Corp. exited the market in 1985 and 1992, respectively, leaving E.I. du Pont de Nemours & Co., Inc., as the sole manufacturer of metallic sodium in the United States. In 1998, the domestic market was less than 30,000 t, having decreased from about 126,000 t in 1978. The phasingout of tetraethyl lead and tetramethyl lead gasoline additives was the main reason for the decline in consumption. In 1978, sodium usage in gasoline represented about 80% of the domestic market. Although there is no information about sodium consumption in 2002, the largest use of sodium in 1998 was for sodium borohydride production, which is the feedstock for sodium dithionite that is used as a reductive bleaching agent by the pulp and paper industry. Sodium for sodium borohydride manufacture accounted for about 38% of metallic sodium consumption. Sodium metal also is used to manufacture sodium azide, which is used in automotive air bags. Other promising uses of sodium metal are in the remediation of chemical weapons, pesticides, polychlorinated biphenyls, and chlorofluorocarbons.

Ice Control and Road Stabilization.—The second largest end use of salt is for highway deicing. The developer of the Fahrenheit temperature scale discovered that salt mixed with ice at a temperature below the freezing point of water creates a solution (brine) with a lower freezing point than water alone. The brine forms below the surface of the ice and snow and prevents the water from freezing into ice and bonding with the road surface, thus causing the snow and ice to melt. Salt is an inexpensive, widely available, and effective ice control agent. It does, however, become less effective as the temperature decreases below about 9.5º C to 6.5º C (15º F to 20º F). At lower temperatures, more salt would have to be applied to maintain higher brine concentrations to provide the same degree of melting. Most winter snowstorms and ice storms occur when temperatures are between 4º C and 0º C (25º F and 32º F), the range in which salt is most effective. An anticaking agent, such as ferric ferrocyanide (Prussian Blue) or sodium ferrocyanide (Yellow Prussiate of Soda), is used to prevent the salt from agglomerating. Both additives are nontoxic and harmless to humans. In fact, sodium ferrocyanide is approved for use in food-grade salt by the U.S. Food and Drug Administration (U.S. Food and Drug Administration, Food and Nutrition Board, 1966).

In highway deicing, salt has been associated with corrosion of motor vehicles, bridge decks, unprotected steel structures, and reinforcement bar and wire used in road construction. Surface runoff, vehicle spraying, and windblown actions also affect roadside vegetation, soil, and local surface- and ground-water supplies. Although evidence of environmental loading of salt has been found during peak usage, the spring rains and thaws usually dilute the concentrations of sodium in the area where salt was applied.

Salt is also added to stabilize the soil and to provide firmness to the foundation on which highways are built. The salt acts to minimize the effects of shifting caused in the subsurface by changes in humidity and traffic load.

The quantity of salt consumed for road deicing each year is directly related to the severity of the winter weather conditions. Long-range forecasting of salt consumption in this application is extremely difficult because of the complexities in long-range forecasting of the weather. Meteorologists, however, are becoming more aware of the dynamics of certain weather phenomena that influence the climate in various parts of the world. One of these phenomena is El Niño, an increase in sea-surface temperatures in the equatorial Pacific Ocean, which is now believed to be the largest single weather influence on Earth. The mild winters of 1997 and 1998 were attributed to El Niño effects. In 1998, highway deicing salt sales were the lowest since about 1992, which also was an El Niño year (National Broadcast Company, 1998§). The winters of 1999 and 2000 were colder and produced more precipitation that required more salt for road deicing. In 2001, there was not as much cold weather and precipitation as in the winter of 2000, resulting in a 3 Mt decrease in salt consumption for highway deicing. The winter of late 2002 to early 2003 was more severe than in past years. Although the increase in ice storms and snowfall used more rock salt than in previous years, salt sales by producers was actually less in 2002, indicating that there was a large decrease in salt inventories at the municipal and State stockpiles in early 2003.

Distributors.—A tremendous amount of salt is marketed through various distributors, some of which specialize in markets such as agricultural and water treatment services, two sectors where the salt companies also have direct sales (table 5). Distributor sales also include grocery wholesalers and/or retailers, institutional wholesalers, U.S. Government resale, and other wholesalers and retailers.

General Industrial.—The industrial uses of salt are diverse. They include, in descending order, oil and gas exploration, other industrial applications, textiles and dyeing, metal processing, pulp and paper, tanning and leather treatment, and rubber manufacture.

In oil and gas exploration, salt is an important component of drilling fluids in well drilling. It is used to flocculate and increase the density of the drilling fluid to overcome high down-well gas pressures. Whenever a drill hits a salt formation, salt is added to the drilling fluid to saturate the solution and to minimize the dissolution within the salt stratum. Salt is also used to increase the set rate of concrete in cemented casings.

In textiles and dyeing, salt is used as a brine rinse to separate organic contaminants, to promote "salting out" of dyestuff precipitates, and to blend with concentrated dyes to standardize them. One of its main roles is to provide the positive ion charge to promote the absorption of negatively charged ions of dyes.

In metal processing, salt is used in concentrating uranium ore into uranium oxide (yellow cake). It is also used in processing aluminum, beryllium, copper, steel, and vanadium.

In the pulp and paper industry, salt is used to bleach wood pulp. It also is used to make sodium chlorate, which is added along with sulfuric acid and water to manufacture chlorine dioxide, an excellent oxygen-based bleaching chemical. The chlorine dioxide process, which originated in Germany after World War I, is becoming more popular because of environmental pressures to reduce or eliminate chlorinated bleaching compounds.

In tanning and leather treatment, salt is added to animal hides to inhibit microbial activity on the underside of the hides and to replace some of the moisture in the hides. In rubber manufacture, salt is used to make buna, neoprene, and white

types. Salt brine and sulfuric acid are used to coagulate an emulsified latex made from chlorinated butadiene.

Agricultural Industry.—Since prehistoric times, humankind has noticed that animals satisfied their salt hunger by locating salt springs, salt licks, or playa lake salt crusts. Barnyard and grazing livestock need supplementary salt rations to maintain proper nutrition. Veterinarians advocate adding loose salt in commercially mixed feeds or in block forms sold to farmers and ranchers because salt acts as an excellent carrier for trace elements not found in the vegetation consumed by grazing livestock; selenium, sulfur, and other essential elements are commonly added to salt licks, or salt blocks, for free-choice feeding.

Food Processing.—Every person uses some quantity of salt in their food. The salt is added to the food by the food processor or by the consumer through free choice, as a flavor enhancer, preservative, binder, fermentation-control additive, texture-control agent, and color developer. This major category is subdivided, in descending order of salt consumption, into other food processing, meat packers, canning, baking, dairy, and grain mill products.

In meat packing, salt is added to processed meats to promote color development in bacon, ham, and other processed meat products. As a preservative, salt inhibits the growth of bacteria, which would lead to spoilage of the product. Early pioneers stored their perishable food in salt barrels for protection and preservation. Salt acts as a binder in sausages to form a binding gel composed of meat, fat, and moisture. Salt also acts as a flavor enhancer and a tenderizer.

In the dairy industry, salt is added to cheese as a fermentation-control agent and as a color- and texture-control agent. The dairy subsector includes companies that manufacture creamery butter, natural and processed cheese, condensed and evaporated milk, ice cream, frozen desserts, and specialty dairy products.

In canning, salt is primarily added as a flavor enhancer and preservative. It also is used as a dehydrating agent, tenderizer, enzyme inhibitor, and carrier for other ingredients.

In baking, salt is added to control the rate of fermentation in bread dough. It also is used to strengthen the gluten (the elastic protein-water complex in certain doughs) and as a flavor enhancer, such as a topping on baked goods.

The food-processing category also contains grain mill products, which consist of milling flour and rice and manufacturing cereal breakfast food and blended or prepared flour.

In the "other food processing" category, salt is used mainly as a seasoning agent. Other food processing includes miscellaneous establishments that make food for human consumption (such as potato chips and pretzels) and for domestic pet consumption (such as cat and dog food).

Water Treatment.—Many areas of the United States have hard water, which contains excessive calcium and magnesium ions that contribute to the buildup of a scale or film of alkaline mineral deposits in household and industrial equipment. Commercial and residential water-softening units use salt to remove the ions causing the hardness. The sodium ions captured on a resin bed are exchanged for the calcium and magnesium ions. Periodically, the water-softening units must be recharged because the sodium ions become depleted. Salt is added and dissolved, and the brine replenishes the lost sodium ions.

Stocks

Because bulk salt is stored at many different locations, such as at the plants, warehouses, ports, and terminals, data on the quantity of salt stockpiled by the salt industry are not reliable enough to formulate accurate inventory totals; however, yearend stocks of producers were estimated to be 2 Mt, and consumer inventories also were estimated to be high. Most of these inventories were imported rock salt and solar salt. Many salt producers, States, municipalities, distributors, and road deicing contractors stockpiled additional quantities of salt in anticipation of adverse weather conditions. Deicing salt inventories were extremely large by yearend 2002 because the mild winter in the domestic snow belt did not require as much salt as had been stockpiled. For the reasons discussed above, salt stocks are assumed to be the difference between salt production and salt sold or used in calculating apparent consumption.

Transportation

Because the locations of the salt supplies are not often near consumers, transportation can become an important cost. Pumping salt brine through pipelines is an economic means of transportation but cannot be used for dry salt. Large bulk shipments of dry salt in ocean freighters or river barges are low in cost but are restricted in points of origin and consumption. River and lake movement of salt in winter is often severely curtailed because of frozen waterways. As salt is packaged, handled, and shipped in smaller units, the costs increase and are reflected in higher selling prices.

Transportation costs significantly add to the price of salt. In some cases, shipping costs are higher than the actual value of the salt. Ocean vessels can transport greater quantities of salt than barge, rail, or truck shipments. Transoceanic imports of salt have been increasing in some areas of the United States because they are more cost competitive than salt purchased from domestic suppliers using barge, rail, or truck transportation. One important factor that often determines the quantity of imported salt that can be delivered is the depth of the channels and the ports; many ports are not deep enough to accommodate the larger ships.

Prices

The four types of salt that are produced have unique production, processing, and packaging factors that determine the selling prices. Generally, salt sold in bulk is less expensive than salt that has been packaged, pelletized, or pressed into blocks. Salt in brine is the least expensive salt sold because mining and processing costs are less. Vacuum pan salt is the most expensive because of the higher energy costs involved in processing and the purity of the product.

Price quotations are not synonymous with average values reported to the USGS. The quotations do not necessarily represent prices at which transactions actually took place or bid and asked prices. Yearend prices for salt are no longer quoted in

Chemical Market Reporter; this information was last available for 1997. The average annual values, as collected by the USGS and listed in table 7, represent a national average value for each of the types of salt and the various product forms.

Foreign Trade

Under Harmonized Tariff Schedule of the United States (HTS) nomenclature, imports are aggregated under one category named "Salt (including table and denatured salt) and pure sodium chloride, whether or not in aqueous solution, seawater." The same classification also applies to exports. The HTS code for salt is 2501.00.0000. The trade tables in this report list previous and current identification codes for salt. Although several other HTS codes pertain to various salt classifications, the United States aggregates shipments under one code because the sums of individual subclassifications fail to meet the minimum dollar requirements necessary for individual listings.

Based on U.S. Census Bureau data for 2002, the United States exported 689,000 t; this was a 38% decrease compared with that of 2001 (table 8). Salt was shipped to 69 countries through 33 U.S. customs districts; the Cleveland, OH, district exported the most and represented 28% of the U.S. total (table 9). In 2002, the majority of exports, or 85% of the total, was to Canada.

Based on U.S. Census Bureau statistics, the United States imported 8.16 Mt of salt from 40 countries in 2002, which was 37% less than was imported during 2001 (table 10). Table 11 lists the imports of salt by customs districts. Of the 38 customs districts that imported salt in 2002, the Detroit, MI, customs district was the largest in terms of tonnage accounting for about 15% of the total. Canada was the largest source of imports, representing about 45% of total imports. The quantity of imported salt was about 12 times more than that of exports. This indicates the magnitude of the United States' reliance on salt imports. The majority of imported salt was brought into the country by foreign subsidiaries of major U.S. salt producers. Generally, imported salt can be purchased and delivered to many customers at costs lower than the comparable domestic product because production costs are lower abroad, currency exchange rates are more favorable, and ocean freight rates are less expensive than overland rail or truck rates.

World Review

In June, a new joint venture was formed between two of Europe's largest salt producers. The European Salt Company (ESCO) is a merger between Kali und Salz Aktiengesellschaft (holding 62% of the shares) and Solvay S.A. (38% of the shares). ESCO will operate 15 plants and 40 salt warehouses in 6 European countries. The joint venture represents a combined capacity of 6.2 million metric tons per year (Mt/yr) of rock salt, 2.22 Mt/yr of vacuum pan salt, and 1.4 Mt/yr of salt brine. Of these capacities, Germany accounts for all the rock salt, 530,000 metric tons per year (t/yr) of vacuum pan salt, and all the 1.4 Mt/yr of salt brine; Belgium, 70,000 t/yr of vacuum pan salt; France, 260,000 t/yr of vacuum pan salt; the Netherlands, 1.2 Mt/yr of vacuum pan salt; Portugal, 60,000 t/yr of vacuum pan salt; and Spain, 100,000 t/yr of vacuum pan salt. ESCO will produce and sell the various types of salt for road deicing, chemical manufacture, and food-grade and industrial applications (European Salt Company, 2002§).

Table 12 lists world salt production statistics for 115 nations based on reported and estimated information. In 2002, the total estimated world production declined to about 210 Mt. The United States remained the world's leading salt-producing country, representing 19% of total world output.

Most countries possess some form of salt production capability with production levels set to meet their own domestic demand requirements and with additional quantities available for export. Many developing nations tend to develop their agricultural resources to feed their population first. Development of easily extractable mineral resources follows, and salt is one of the first commodities to be mined. Some countries, such as the United States, import a substantial amount of salt to meet total demand requirements because of economic factors.

Outlook

Although the severity of winter weather is virtually impossible to forecast far in advance, the supplies of salt, from either domestic or imported sources, are more than adequate to meet any anticipated increase in demand. The severe winter season of early 2003 depleted a lot of salt inventories that had built up during the past 3 years. If the next few winters bring abundant ice storms and snow, imports of deicing salt may increase. However, the growing reliance on imports does not necessarily indicate that domestic production capacity cannot meet demand requirements. The majority of salt imports are under the direct control of the primary U.S. salt companies that operate subsidiaries near the United States.

The outlook for balancing salt supplies (from domestic production and imports) with salt demand is very favorable for the foreseeable future. Excluding deicing salt, domestic salt consumption may fluctuate but will continue to grow parallel to population growth trends. U.S. total salt production in 2003 is estimated to be 42 Mt.

References Cited

Chemical Week, 2002, Using PVC and PE as a radiation shield: Chemical Week, v. 164, no. 47, December 4, p. 44.

U.S. Food and Drug Administration, Food and Nutrition Board, 1966, Sodium chloride, *in* Food chemicals codex: Washington, DC, National Academy of Sciences, p. 613-614.

Internet References Cited

Cargill, Inc., 2002 (May 29), Cargill announces historic agreement to help restore thousands of acres in San Francisco Bay shoreline, accessed July 21, 2003, at URL http://www.Cargill.com/today/releases/02_05_29salt.htm.

European Salt Company, 2002, K+S gruppe-history, accessed April 29, 2003, at URL http://www.k-plus-s.com/gruppe/historie_en.cfm?.

Kay, Jane, 2002 (May 29), Salt ponds on way to becoming wetlands—Cargill agrees to sell 16,500 acres in bay, San Francisco Chronicle, accessed July 21, 2003, at URL http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2002/05/29/MN190127.DTL.

National Broadcast Company, 1998, El Niño facts, accessed July 15, 1998, at URL http://wxnet4.nbcr.com/elnino.html.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Evaporites and Brines. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Salt. Ch. in Mineral Commodity Summaries, annual.

Other

Chlorine Institute, The.
Handbook of World Salt Resources. S.J. Lefond, Plenum Press, 1969.
Material Flow of Salt, The. U.S. Bureau of Mines Information Circular 9343, 1993.
Salt. Ch. in Canadian Minerals Yearbook, annual.
Salt. Ch. in Industrial Minerals and Rocks, Society for Mining, Metallurgy, and Exploration, Inc., 6th ed., Carr, D.D., ed., 1994.
Salt. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Salt. Mining Engineering, annual review of industrial minerals.
Salt Institute.
Sodium Chloride. American Chemical Society Monograph No. 145, Reinhold Publishing Corp., 1960.
Solution Mining Research Institute.

TABLE 1
SALIENT SALT STATISTICS[1]

(Thousand metric tons and thousand dollars)

	1998	1999	2000	2001	2002
United States:					
Production total:[2]	41,200	44,900	45,600	44,800	40,300
Brine	21,100	22,700	22,500	20,400	19,300
Rock	12,900	14,400	15,000	17,000	13,500
Solar	3,190	3,580	3,810	3,310	3,390
Vacuum and open pans	4,040	4,190	4,200	4,120	4,100
Sold or used by producers	40,800	44,400	43,300	42,200	37,700
Value	$986,000	$1,110,000	$1,040,000	$1,110,000	$1,010,000
Exports	731	892	642	1,120	689
Value	$35,200	$37,000	$37,800	$48,000	$31,600
Imports for consumption	8,770	8,870	8,960	12,900	8,160
Value	$145,000	$137,000	$127,000	$179,000	$129,000
Consumption, apparent[3]	48,800	52,400	51,600	54,000	45,100
Consumption, reported	44,200	50,000	54,000	48,700	43,600
World, production	200,000 r	210,000 r	212,000 r	217,000 r	210,000 e

eEstimated. rRevised.
[1]Data are rounded to no more than three significant digits.
[2]Excludes Puerto Rico.
[3]Sold or used plus imports minus exports.

TABLE 2
SALT PRODUCED IN THE UNITED STATES, BY TYPE AND PRODUCT FORM[1]

(Thousand metric tons)

Product form	Vacuum and open pans	Solar	Rock	Brine	Total
2001:					
Bulk	742	1,930	16,500	20,400	39,600
Compressed pellets	1,200	358	XX	XX	1,560
Packaged	1,980	894	401	XX	3,270
Pressed blocks	197	132	68	XX	397
Total	4,120	3,310	17,000	20,400	44,800
2002:					
Bulk	770	2,080	13,200	19,300	35,300
Compressed pellets	1,290	383	XX	XX	1,670
Packaged	1,850	793	293	XX	2,940
Pressed blocks	183	135	68	XX	386
Total	4,100	3,390	13,500	19,300	40,300

XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 3
SALT SOLD OR USED IN THE UNITED STATES, BY TYPE AND PRODUCT FORM[1, 2]

(Thousand metric tons and thousand dollars)

	Vacuum and open pans		Solar		Rock		Brine		Total	
Product form	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2001:										
Bulk	732	40,200	1,570	37,200	14,100	288,000	20,400	128,000	36,800	493,000
Compressed pellets	1,250	167,000	340	39,100	XX	XX	XX	XX	1,590	206,000
Packaged:										
Less-than-5-pound units	232	NA	13	NA	1	NA	XX	XX	246	XX
More-than-5-pound units	1,680	NA	1,070	NA	433	NA	XX	XX	3,180	XX
Total	1,910	260,000	1,090	80,700	434	29,600	XX	XX	3,430	371,000
Pressed blocks:										
For livestock	126	NA	113	NA	79	NA	XX	XX	318	XX
For water treatment	69	NA	7	NA	5	NA	XX	XX	81	XX
Total	195	20,600	120	11,500	84	8,770	XX	XX	398	40,900
Grand total	4,090	488,000	3,120	168,000	14,600	326,000	20,400	128,000	42,200	1,110,000
2002:										
Bulk	759	44,100	1,460	34,500	11,000	221,000	19,300	114,000	32,500	413,000
Compressed pellets	1,280	173,000	353	41,600	XX	XX	XX	XX	1,640	214,000
Packaged:										
Less-than-5-pound units	224	NA	12	NA	1	NA	XX	XX	237	XX
More-than-5-pound units	1,620	NA	952	NA	342	NA	XX	XX	2,910	XX
Total	1,840	249,000	964	73,400	342	24,200	XX	XX	3,150	347,000
Pressed blocks:										
For livestock	116	NA	115	NA	77	NA	XX	XX	308	XX
For water treatment	69	NA	6	NA	5	NA	XX	XX	81	XX
Total	185	19,900	121	11,800	82	8,380	XX	XX	388	40,100
Grand total	4,070	486,000	2,890	161,000	11,400	254,000	19,300	114,000	37,700	1,010,000

NA Not available. XX Not applicable.

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

[2]As reported at salt production locations, the term "sold or used" indicates that some salt, usually salt brine, is not sold but is used for captive purposes by plant or company. Because data do not include salt imported, purchased, and/or sold from inventory from regional distribution centers, salt sold or used by type may differ from totals shown in tables 5 and 6, which are derived from company totals.

TABLE 4
SALT SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1, 2]

(Thousand metric tons and thousand dollars)

	2001		2002	
State	Quantity	Value	Quantity	Value
Kansas	3,130	122,000	2,630	119,000
Louisiana	13,100	139,000	12,000	129,000
New York	5,570	215,000	4,610	185,000
Texas	9,370	104,000	9,100	103,000
Utah	2,300	121,000	2,090	113,000
Other Eastern States[3]	7,360	341,000	6,120	299,000
Other Western States[4]	1,390	68,000	1,100	66,900
Total	42,200	1,110,000	37,700	1,010,000
Puerto Rico[e]	45	1,500	45	1,500

[e]Estimated.

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

[2]The term "sold or used" indicates that some salt, usually salt brine, is not sold but is used for captive purposes by plant or company.

[3]Includes Alabama, Michigan, Ohio, Tennessee, and West Virginia.

[4]Includes Arizona, California, Nevada, New Mexico, and Oklahoma.

TABLE 5

DISTRIBUTION OF DOMESTIC AND IMPORTED SALT BY PRODUCERS IN THE UNITED STATES BY END USE AND TYPE[1, 2]

(Thousand metric tons)

End use	Standard industrial classification	Vacuum and open pans		Solar		Rock		Brine		Total[3]	
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Chemical:											
Chloralkali producers	2812	29	23	313	324	511	634	18,100	17,400	18,900	18,300
Other chemical	28 (excludes 2812, 2899)	253	240	183	172	722	716	2	2	1,160	1,130
Total		282	263	496	496	1,230	1,350	18,100	17,400	20,100	19,500
Food-processing industry:											
Meat packers	201	261	262	53	56	97	76	--	(4)	411	395
Dairy	202	118	125	7	8	3	3	--	--	128	136
Canning	2091, 203	135	143	40	43	38	42	1	1	213	229
Baking	205	223	197	6	5	13	13	--	--	242	215
Grain mill products	204 (excludes 2047)	92	89	9	8	24	23	--	--	125	120
Other food processing	206-208, 2047, 2099	521	537	75	70	65	82	1	1	663	690
Total		1,350	1,350	192	190	241	239	2	2	1,780	1,780
General industrial:											
Textiles and dyeing	22	114	105	44	38	10	11	4	(4)	172	155
Metal processing	33, 34, 35, 37	5	7	30	27	89	84	--	--	124	118
Rubber	2822, 30 (excludes 3079)	3	3	1	1	1	1	56	56	61	61
Oil	13, 29	32	34	184	100	50	54	2,000	1,820	2,260	2,010
Pulp and paper	26	13	11	45	45	26	21	16	16	100	93
Tanning and/or leather	311	17	18	27	20	43	41	--	--	87	79
Other industrial	XX	94	117	66	81	81	80	1	1	242	279
Total		278	294	397	312	300	293	2,080	1,890	3,050	2,790
Agricultural:											
Feed retailers and/or dealers mixers	5159	356	330	363	330	454	381	(4)	--	1,170	1,040
Feed manufacturers	2048	52	55	129	130	352	322	--	--	533	507
Direct-buying end user	02	5	5	17	14	63	51	--	--	85	70
Total		413	390	510	474	869	753	(4)	--	1,790	1,620
Water treatment:											
Government (Federal, State, local)	2899	17	17	74	95	73	123	3	3	168	238
Commercial or other	2899	134	130	140	163	68	128	2	2	344	424
Total		151	147	215	258	141	252	5	5	512	662
Ice control and/or stabilization:											
Government (Federal, State, local)	9621	2	2	818	708	13,900	10,800	--	--	14,800	11,600
Commercial or other	XX	7	2	226	146	1,790	1,590	--	--	2,030	1,730
Total		8	4	1,040	854	15,700	12,400	--	--	16,800	13,300
Distributors:											
Agricultural distribution	5191	95	88	126	111	60	46	--	--	280	245
Grocery wholesalers and/or retailers	514, 54	531	515	240	220	53	45	--	--	824	781
Institutional wholesalers and end users	58, 70	107	106	51	49	37	32	(4)	(4)	195	187
Water-conditioning distribution	7399	150	123	388	385	22	16	1	1	560	525
U.S. Government resale	9199	(4)	(4)	(4)	(4)	1	1	--	--	2	1
Other wholesalers and/or retailers	5251	795	849	831	847	388	231	1	(4)	2,020	1,930
Total		1,680	1,680	1,640	1,610	561	371	2	2	3,880	3,670
Other[5]		77	110	75	52	539	67	151	110	842	339
Grand total		4,230	4,240	4,570	4,250	19,600	15,800	20,300	19,400	48,700	43,600

XX Not applicable. -- Zero.

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

[2]The quality of imports included in the total for each type of salt is the amount reported by the U.S. salt industry, not the quantity reported by the U.S. Census Bureau that appears in tables 1, 11, and 12.

[3]Because data include salt imported, produced, and/or sold from inventory from regional distribution centers, salt sold or used by type may differ from totals shown in tables 1, 3, and 4, which are derived from plant reports at salt production locations. Data may differ from totals shown in table 6 because of changes in inventory and/or incomplete data reporting.

[4]Less than 1/2 unit.

[5]Includes exports.

TABLE 6
DISTRIBUTION OF DOMESTIC AND IMPORTED EVAPORATED AND ROCK SALT IN THE UNITED STATES, BY DESTINATION[1, 2]

(Thousand metric tons)

	2001				2002			
	Evaporated				Evaporated			
Destination	Vacuum/open pans	Solar	Rock	Total	Vacuum/open pans	Solar	Rock	Total
Alabama	73	2	73	147	72	2	71	144
Alaska	5	4	(3)	9	4	3	(3)	7
Arizona	13	96	14	123	13	95	8	116
Arkansas	45	2	69	116	44	2	54	100
California	201	685	3	888	216	584	2	802
Colorado	13	93	142	248	13	79	85	177
Connecticut	17	170	118	304	17	88	114	219
Delaware	4	9	2	15	4	9	1	15
District of Columbia	1	7	(3)	8	1	7	(3)	8
Florida	76	204	7	288	81	208	6	294
Georgia	81	56	58	195	79	59	57	195
Hawaii	(3)	1	(3)	1	(3)	1	(3)	2
Idaho	16	109	3	129	17	114	1	133
Illinois	345	113	1,820	2,280	355	111	1,480	1,950
Indiana	247	113	754	1,110	249	114	588	952
Iowa	146	104	600	850	142	100	461	703
Kansas	92	42	346	480	95	44	234	374
Kentucky	66	5	517	589	66	7	525	598
Louisiana	56	2	326	384	62	2	562	626
Maine	13	10	319	342	13	14	228	255
Maryland	65	82	54	201	65	70	12	147
Massachusetts	32	98	357	486	32	187	162	382
Michigan	303	36	2,030	2,370	290	39	1,770	2,100
Minnesota	129	227	734	1,090	134	227	504	865
Mississippi	28	(3)	252	281	26	(3)	249	275
Missouri	143	48	513	703	147	57	386	590
Montana	1	35	2	38	1	32	1	34
Nebraska	77	44	237	359	73	44	151	269
Nevada	3	290	15	309	5	275	14	294
New Hampshire	15	79	114	207	16	85	42	142
New Jersey	116	87	50	253	117	71	36	225
New Mexico	15	73	6	94	14	71	3	88
New York	206	125	2,830	3,160	196	59	2,050	2,300
North Carolina	105	68	57	231	110	76	43	229
North Dakota	5	18	5	28	4	17	5	25
Ohio	415	51	2,470	2,940	412	46	1,790	2,250
Oklahoma	36	19	77	133	36	20	57	113
Oregon	19	109	1	129	19	104	1	124
Pennsylvania	166	125	1,520	1,810	170	92	1,520	1,780
Rhode Island	5	55	118	178	4	69	48	121
South Carolina	32	13	6	51	34	17	6	57
South Dakota	20	44	39	103	20	46	32	97
Tennessee	104	19	480	603	96	26	481	603
Texas	222	135	197	553	222	137	193	552
Utah	13	461	121	595	14	350	64	428
Vermont	6	5	319	330	6	5	380	391
Virginia	71	58	76	206	66	84	55	204
Washington	24	111	9	144	24	108	8	140
West Virginia	12	6	159	178	12	5	131	148
Wisconsin	217	144	1,310	1,670	213	140	1,010	1,370
Wyoming	(3)	22	11	33	(3)	21	6	27
Other[4]	119	51	271	441	123	25	66	214
Total[5]	4,230	4,570	19,600	28,400	4,240	4,250	15,800	24,200

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

[2]Each salt type includes domestic and imported quantities. Brine is excluded because brine is not shipped out of State.

[3]Less than 1/2 unit.

[4]Includes shipments to overseas areas administered by the United States, Puerto Rico, exports, and some shipments to unspecified destinations.

[5]Because data include salt imported, purchased, and/or sold from inventory from regional distribution centers, evaporated and rock salt distributed by State may differ from totals shown in tables 1 and 3, which are derived from plant reports at salt production locations. Data may differ from totals shown in table 5 because of changes in inventory and/or incomplete data reporting.

TABLE 7
AVERAGE VALUE OF SALT, BY PRODUCT FORM AND TYPE[1]

(Dollars per metric ton)

Product form	Vacuum and open pans	Solar	Rock	Brine
2001:				
Bulk	54.87	23.62	20.41	6.26
Compressed pellets	133.30	115.13	XX	XX
Packaged	136.30	74.32	68.29	XX
Average[2]	120.02	52.33	21.84	6.26
Pressed blocks	105.66	96.33	104.81	XX
2002:				
Bulk	58.12	23.73	20.10	5.89
Compressed pellets	134.61	117.62	XX	XX
Packaged	135.39	76.17	70.62	XX
Average[2]	120.02	53.93	21.62	5.89
Pressed blocks	107.18	98.14	101.81	XX

XX Not applicable.
[1]Net selling value, free on board plant, excluding container costs.
[2]Salt value data reported prior to 1984 were an aggregate value per ton of bulk, compressed pellets, and packaged salt. For time series continuity, an average of these three types of product forms is presented that is based on the aggregated values and quantities of the product form for each type of salt listed in table 3.

TABLE 8
U.S. EXPORTS OF SALT, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

Country	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Bahamas, The	1	150	1	208
Bahrain	1	412	1	214
Belgium	2	48	(3)	33
Canada	984	31,400	585	21,000
Chile	1	189	1	210
China	1	135	(3)	91
Colombia	2	388	1	147
Costa Rica	1	107	1	140
Dominican Republic	1	132	1	130
El Salvador	1	156	1	163
France	3	127	(3)	31
Haiti	6	1,690	(3)	126
Honduras	3	404	5	613
Hong Kong	(3)	110	1	173
Israel	1	38	(3)	37
Jamaica	1	42	2	141
Japan	2	575	2	550
Kuwait	1	190	(3)	41
Lebanon	1	153	1	143
Malaysia	(3)	23	4	147
Mexico	68	3,870	59	2,880
Netherlands	1	180	(3)	35
Oman	1	157	(3)	19
Panama	3	325	3	430
Philippines	1	59	(3)	15
Saudi Arabia	24	2,290	12	1,560

See footnotes at end of table.

TABLE 8--Continued
U.S. EXPORTS OF SALT, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

Country	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Taiwan	1	192	(3)	248
Trinidad and Tobago	(3)	16	1	25
United Arab Emirates	2	456	1	445
United Kingdom	6	587	2	548
Venezuela	1	533	(3)	72
Other	1	2,920 r	4	1,000
Total	1,120	48,000	689	31,600

rRevised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Free alongside ship value at U.S. ports.
[3]Less than 1/2 unit; included with "Other."

Source: U.S. Census Bureau.

TABLE 9
U.S. EXPORTS OF SALT, BY CUSTOMS DISTRICT[1]

(Thousand metric tons and thousand dollars)

District	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Anchorage, AK	16	368	--	--
Baltimore, MD	1	141	3	518
Boston, MA	(3)	3	--	--
Buffalo, NY	33	2,840	24	2,040
Charleston, SC	(3)	39	(3)	24
Chicago, IL	1	47	108	2,100
Cleveland, OH	592	12,900	196	3,660
Columbia-Snake River, OR	1	77	--	--
Dallas-Fort Worth, TX	(3)	5	(3)	14
Detroit, MI	148	5,540	25	2,720
Duluth, MN	(3)	7	(3)	8
El Paso, TX	6	305	10	413
Great Falls, MT	8	504	10	411
Honolulu, HI	(3)	21	--	--
Houston, TX	31	4,150	16	2,570
Laredo, TX	55	2,830	41	1,760
Los Angeles, CA	3	898	7	910
Miami, FL	2	1,630	4	692
Mobile, AL	1	138	1	128
New Orleans, LA	3	646	5	479
New York, NY	10	1,430	7	1,160
Nogales, AZ	5	232	6	321
Norfolk, VA	5	703	1	357
Ogdensburg, NY	8	512	30	961
Pembina, ND	4	369	3	363
Philadelphia, PA	3	134	(3)	117
Port Arthur, TX	7	1,910	(3)	24
Portland, ME	2	172	3	188
St. Albans, VT	(3)	9	(3)	13
St. Louis, MO	(3)	74	(3)	154
San Diego, CA	2	495	3	390
San Francisco, CA	1	371	1	230
San Juan, PR	(3)	4	--	--

See footnotes at end of table.

TABLE 9--Continued
U.S. EXPORTS OF SALT, BY CUSTOMS DISTRICT[1]

(Thousand metric tons and thousand dollars)

District	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Savannah, GA	1	53	(3)	39
Seattle, WA	44	1,320	9	616
Tampa, FL	(3)	19	(3)	24
Washington, DC	(3)	144	--	--
Wilmington, NC	(3)	24	(3)	5
Other[4]	129	6,950	178	8,230
Total	1,120	48,000	689	31,600

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Free alongside ship value at U.S. ports.
[3]Less than 1/2 unit.
[4]Unknown but assumed to be rail and/or truck shipments to Canada through various points of departure.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF SALT, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

Country	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Australia	67	599	125	1,080
Bahamas, The	1,010	11,600	499	6,880
Brazil	308	3,030	92	1,260
Canada	4,610	74,300	3,660	60,800
Chile	3,480	37,300	1,990	24,700
China	1	709	2	920
Dominican Republic	162	1,750	--	--
Egypt	332	3,040	107	870
France	5	1,370	22	2,600
Germany	1	766	1	739
Ireland	32	224	25	201
Israel	1	530	1	484
Italy	4	482	4	771
Jordan	168	2,020	218	1,720
Korea, Republic of	1	579	1	478
Mexico	1,460	22,900	738	13,600
Netherlands	135	4,250	144	4,640
Netherlands Antilles	239	4,050	124	2,360
Peru	709	5,160	347	2,510
Spain	2	624	(3)	148
Tunisia	147	3,170	35	803
United Kingdom	16	224	11	354
Other	3	567 [r]	3	847
Total	12,900	179,000	8,160	129,000

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value only.
[3]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 11
U.S. IMPORTS OF SALT, BY CUSTOMS DISTRICT[1]

(Thousand metric tons and thousand dollars)

District	2001		2002	
	Quantity	Value[2]	Quantity	Value[2]
Anchorage, AK	16	407	3	118
Baltimore, MD	1,190	14,600	668	9,840
Boston, MA	815	9,630	568	5,600
Buffalo, NY	232	4,940	204	4,390
Charleston, SC	176	4,530	150	4,470
Chicago, IL	822	10,500	488	7,460
Cleveland, OH	247	4,500	388	6,640
Columbia-Snake, OR	33	419	(3)	91
Dallas-Fort Worth, TX	(3)	39	(3)	34
Detroit, MI	1,280	22,700	1,200	19,600
Duluth, MN	306	5,100	112	1,410
El Paso, TX	(3)	17	(3)	3
Great Falls, MT	1	160	2	338
Houston-Galveston, TX	5	431	1	394
Laredo, TX	3	320	2	340
Los Angeles, CA	115	2,520	109	2,660
Miami, FL	(3)	229	(3)	171
Milwaukee, WI	1,260	18,500	878	15,300
Minneapolis, MN	(3)	3	(3)	9
Mobile, AL	--	--	(3)	25
New Orleans, LA	374	5,270	109	1,210
New York, NY	2,570	30,600	1,080	16,100
Nogales, AZ	--	--	(3)	42
Norfolk, VA	38	384	121	1,740
Ogdensburg, NY	168	3,330	99	1,810
Pembina, ND	4	386	1	601
Philadelphia, PA	1,100	13,100	487	7,260
Portland, ME	1,080	10,500	778	8,440
Providence, RI	459	6,860	298	5,310
St. Albans, VT	4	444	2	223
St. Louis, MO	(3)	17	(3)	32
San Diego, CA	(3)	5	(3)	59
San Francisco, CA	(3)	84	(3)	131
San Juan, PR	7	188	4	93
Savannah, GA	41	702	47	697
Seattle, WA	146	2,150	15	816
Tampa, FL	325	4,650	265	4,130
Wilmington, NC	80	1,190	79	1,240
Total	12,900	179,000	8,160	129,000

-- Zero.

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

[2]Customs value only.

[3]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 12
SALT: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	1998	1999	2000	2001	2002[e]
Afghanistan, rock salt[e]	13	13	13	13	13
Albania[e]	10	10	10	10	10
Algeria, brine and sea salt	172	164	182 [e]	190 [r]	185
Angola[e]	30	30	30	30	30

See footnotes at end of table.

TABLE 12--Continued
SALT: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	1998	1999	2000	2001	2002[e]
Argentina	872	1,263	1,000 [e]	1,000 [e]	1,000
Armenia	25	27	30 [e]	30 [e]	30
Australia, salt and marine salt	9,033	9,888	8,778	9,536	9,887 [4]
Austria:[e]					
Brine salt	500	400	400	400	400
Rock salt	1	1	1	1	1
Total	501	401	401	401	401
Azerbaijan	4	3	4	4 [e]	4
Bahamas, The[e]	900	900	900	900	900
Bangladesh, marine salt[e, 5]	350	350	350	350	350
Belarus	355	344	311	300 [e]	300
Benin, marine salt[e]	--	15	15	15	15
Bolivia	1	1	(6)	(6) [r]	1 [4]
Bosnia and Herzegovina[e]	50	50	50	50	50
Botswana[7]	215	233	185	179 [r]	190
Brazil:					
Brine salt	5,353	4,528	4,626	4,370 [r]	4,400
Rock salt	1,484	1,430	1,448	1,208 [r]	1,200
Total	6,837	5,958	6,074	5,578 [r]	5,600
Bulgaria	2,400	1,300 [e]	1,700 [e]	1,931 [r]	1,900
Burkina Faso[e]	6 [r]	6 [r]	6 [r]	6 [r]	6
Burma[e, 8]	35	35	35	35	35
Cambodia[e]	40	40	40	40	40
Canada	13,296	12,686	12,164	13,725 [r]	12,313 [p]
Cape Verde[e]	7	2	2	2	2
Chile	6,207	6,074	5,083	5,989 [r]	5,990
China	22,420	28,124	31,280	34,105 [r]	32,835 [4]
Colombia:					
Marine salt	166	157	178	110 [r]	120
Rock salt	330	304	282	285 [r]	300
Total	496	461	460	395 [r]	420
Costa Rica, marine salt[e]	37	37	37	37 [r]	37
Croatia	24	18	34	33 [r]	37 [4]
Cuba	135	159	177 [r]	180 [r]	180
Denmark, sales[e]	600	600	605	605	610
Djibouti	83	127	136	173 [r]	175
Dominican Republic:					
Marine salt[e]	50	50	50	50	50
Rock salt	6	5	12	12	12
Total	56	55	62	62	62
Ecuador[e]	100	95	90	90	90
Egypt[e]	2,387 [4]	2,400	2,400	2,400	2,400
El Salvador, marine salt	89	742 [r]	715 [r]	710 [r]	715
Eritirea, marine salt	114	10	47	50 [e]	50
Ethiopia, rock salt[e, 5]	1	56 [4]	56	61	61
France:[e]					
Brine salt	1,500	1,500	1,500	1,500	1,500
Marine salt	1,200	1,200	1,200	1,200	1,200
Rock salt	300	300	300	300	300
Salt in solution	4,000	4,000	4,000	4,000	4,000
Total	7,000	7,000	7,000	7,000	7,000
Germany:[e]					
Marine salt	700	700	700	700	700
Rock salt and other	15,000	15,000	15,000	15,000	15,000
Total	15,700	15,700	15,700	15,700	15,700
Ghana[e]	125 [r]	125 [r]	150 [r]	200 [r]	200
Greece[e]	150	150	150	150	150
Guadeloupe[e]	48 [r]	50 [r]	49 [r]	49 [r]	49
Guatemala[e]	48	50	50	50	50
Guinea[e]	-- [4]	15	15	15	15

See footnotes at end of table.

TABLE 12--Continued
SALT: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	1998	1999	2000	2001	2002[e]
Honduras[e]	25	25	25	25	25
Iceland[e]	4	4	4	5 [r]	5
India:					
Marine salt	11,962	14,450	14,450	14,500	14,500
Rock salt	2	3	3	3	3
Total	11,964	14,453	14,453	14,503	14,503 [4]
Indonesia[e]	650	680	680	680	680
Iran[9]	1,912	1,600	1,600 [e]	2,000 [r, e]	2,000
Iraq[e]	250	300 [r]	300 [r]	300 [r, e]	300
Israel	874	538	526	537 [e]	527
Italy:[e]					
Brine and rock salt	3,000	3,000	3,000	3,000	3,000
Marine salt, crude[10]	600	600	600	600	600
Total	3,600	3,600	3,600	3,600	3,600
Jamaica	16	19 [r]	19 [r]	19 [r]	19
Japan	1,293	1,327	1,374	1,358 [r]	1,360
Jordan	263	279	311	321 [e]	347
Kenya, crude salt	22	45	16	6 [r]	6
Korea, North[e]	550	500	500	500	500
Korea, Republic of[e]	780	800	800	800	800
Kuwait[e]	100	100	100	100	100
Laos, rock salt	4 [r]	2	2	2	2
Lebanon[e]	4	4	4	4	4
Libya[e]	30	30	40	40	40
Madagascar	27	26	26 [r]	26	13
Mali[e]	6	6	6	6	6
Malta, marine salt[e]	(6)	(6)	(6)	(6)	(6)
Martinique[e]	200	200	200	200	200
Mauritania[e]	6	6	6	6	6
Mauritius	7 [e]	7	6	6 [e]	6
Mexico	8,412	8,236	8,884	8,501 [r]	8,500
Mongolia, mine output	1 [e]	2	1	2 [r]	1 [4]
Morocco, marine and rock salt[e]	148 [4]	196 [r]	188 [r]	190 [r]	190
Mozambique, marine salt[e]	88 [r]	82 [r]	7 [r]	10 [r]	80
Namibia, marine salt	507	503	576 [r]	523 [r]	550
Nepal[e, 11]	6	1 [r]	2 [r, 4]	2 [r]	2
Netherlands[e]	5,500 [4]	5,000	5,000	5,000	5,000
Netherlands Antilles[e]	487 [4]	500	500	500	500
New Zealand[e]	65	65	60	70	70
Nicaragua, marine salt	15	27	28	28 [e]	28
Niger[e]	2	2	2	2	2
Pakistan:[5]					
Marine salt	15	16	20 [e]	20 [e]	20
Rock salt	1,038	1,019	1,313	1,300 [e]	1,300
Total	1,053	1,035	1,333	1,320 [e]	1,320
Panama, marine salt[e]	23	23	23	23	23
Peru[e]	80	80	80	80	80
Philippines, marine salt	728	704	590	600 [e]	600
Poland:					
Rock salt	748	923	841	787 [r]	800
Other	3,257	3,289	3,466	3,413 [r]	3,400 [4]
Total	4,005	4,212	4,307 [r]	4,200	4,200 [4]
Portugal, rock salt[e]	600	600	600	600	600
Romania:					
Rock salt	68	64	52	48 [r]	50
Other	2,152	2,133	2,215	2,176 [r]	2,200
Total	2,220	2,197	2,267	2,224 [r]	2,250
Russia	2,200	3,200	3,200 [e]	2,800 [e]	2,800
Saudi Arabia	140 [e]	200	200	200	200
Senegal[e]	139 [r]	130 [4]	130 [4]	130	130

See footnotes at end of table.

TABLE 12--Continued
SALT: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	1998	1999	2000	2001	2002[e]
Serbia and Montenegro	78	64	78	62	42 [4]
Slovakia[e]	100	100	99	100	100
Slovenia[e]	5	5	2	2	2
Somalia[e]	1	1	1	1	1
South Africa	352 [r]	358 [r]	346	356 [r]	431 [4]
Spain:[e]					
Marine and other evaporated salt	1,500	1,200	1,200	1,200	1,200
Rock salt	2,000	2,000	2,000	2,000	2,000
Total	3,500	3,200	3,200	3,200	3,200
Sri Lanka	82	107	70 [r]	130 [r]	120
Sudan	72	117	120 [e]	120 [e]	120
Switzerland[e]	300	300	300	300	300
Syria	178	104	106	106 [e]	106
Taiwan, marine salt	7	77	70	66	57 [4]
Tanzania	75	36 [r]	70	65 [r]	65
Thailand:					
Rock salt	546	740	792	853 [r]	850
Other[e]	100	100	100	100	100
Total	646	840	892	953 [r]	950
Tunisia, marine salt	473	447 [e]	620 [r]	653 [r]	616 [4]
Turkey	2,170	2,146	2,126	2,100 [r]	2,100
Turkmenistan[e]	215	215	215	215	215
Uganda[e]	5	5	5	5	5
Ukraine	2,500 [e]	2,185	2,287	2,300 [e]	2,300
United Kingdom:[e]					
Brine salt[12]	1,300	1,300	1,300	1,300	1,300
Rock salt	1,800	1,500	1,500	1,500	1,500
Other salt[12]	3,500	3,000	3,000	3,000	3,000
Total	6,600	5,800	5,800	5,800	5,800
United States including Puerto Rico:					
United States:					
Brine	21,100	22,700	22,500	20,400	19,300 [4]
Rock salt	12,900	14,400	15,000	17,000	13,500 [4]
Solar salt	3,190	3,580	3,810	3,330	3,390 [4]
Vacuum and open pan	4,040	4,190	4,200	4,120	4,100 [4]
Puerto Rico[e]	45	45	45	45	45
Total	41,300	45,000	45,600	44,800	40,300 [4]
Venezuela[e]	350	350	350	350	350
Vietnam	867	653	590 [r]	575 [r]	580
Yemen	147	149	150 [e]	150 [e]	150
Grand total	200,000 [r]	210,000 [r]	212,000 [r]	217,000 [r]	210,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

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

[2]Table includes data available through July 10, 2003.

[3]Salt is produced in many other countries, but quantities are relatively insignificant and reliable production data are not available. Some salt brine production data for manufacture of chlorine, caustic soda, and soda ash are not reported because of incomplete data reporting by many countries.

[4]Reported figure.

[5]Year ending June 30 of that stated.

[6]Less than 1/2 unit.

[7]From natural soda ash production.

[8]Brine salt produced, as reported by the Burmese Government in metric tons, was as follows: 1998--91,992; 1999--61,674; 2000--69,245; 2001--59,519 (revised); and 2002--62,000 (estimated).

[9]Year beginning March 21 of that stated.

[10]Does not include production from Sardinia and Sicily, which is estimated to be 200,000 metric tons per year.

[11]Year ending July 15 of that stated.

[12]Data captioned "Brine salt" for the United Kingdom are the quantities of salt obtained from the evaporation of brine; that captioned "Other salt" are for salt content of brines used for purposes other than production of salt.