

# SALT

By Dennis S. Kostick

Salt, also known as sodium chloride, an important commodity, has many end uses. Virtually every person in the world has some daily contact with salt either directly or indirectly. 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 and these two important inorganic chemicals are used to make a multitude of consumer-related end-use products, such as polyvinyl chloride (PVC) plastic made from chlorine, and paper pulping chemicals manufactured from caustic soda.

## Production

U.S. production data for salt are developed by the U.S. Geological Survey (USGS) from an annual voluntary survey of U.S. salt-producing sites and of company operations. Of the 27 companies to which a survey request was sent, all but two responded, representing 97% of the total production shown in this report. Data for the two companies were estimated on the basis of their prior responses to previous annual surveys, the 1997 production estimate survey, or brine production capabilities for chloralkali manufacture based upon chlorine production capacities.

Total U.S. salt production decreased slightly in 1997 compared with that of 1996. Although rock salt production decreased only 5%, rock salt for highway deicing declined 12% because of the extremely mild winter caused by the El Niño weather phenomena. According to the USGS canvass for 1997, 27 companies operated 66 salt-producing plants in 14 States. Six of the companies and 11 of the plants produced more than 1 million tons each and accounted for 86% and 58%, respectively, of the U.S. total production and 92% and 26%, respectively, of total value. Several companies and plants produced more than one type of salt. In 1997, 11 companies (16 operations) produced solar-evaporated salt; 4 companies (15 operations), vacuum pan salt; 9 companies (13 operations), rock salt; and 13 companies (28 operations), salt brine. (*See tables 1, 2, and 3.*)

The five leading States in terms of total salt sold or used were Louisiana, 38%; Texas, 24%; New York, 9%; Kansas, 8%; and Utah, 4%. Other Eastern States (Alabama, Michigan, Ohio, and West Virginia) accounted for 13% of the domestic total salt sold or used. Other Western States (Arizona, California, Nevada, New Mexico, and Oklahoma) represented 4%. (*See table 4.*)

U.S. salt production accounted for about 21% of total world production. Total world production of all types of salt remained virtually unchanged compared with that of 1996. Although the economy in Asia began to decline in late 1997, the market for chlorine and exports of polyvinyl chloride and ethylene dichloride were stable by yearend. Some environmental problems associated with emissions of chlorinated compounds may affect the short-

term status of the world chloralkali industry, which is the largest single consumer of salt.

The purchase of Akzo Nobel Salt Inc. from Akzo Nobel NV of the Netherlands by Cargill Inc.'s salt division was completed in April following an investigation by the U.S. Department of Justice, which ruled that Cargill had to sell the former Akzo vacuum pan salt plant at Watkins Glen, NY (Chemical Market Reporter, 1997b). In November, this salt plant was acquired by U.S. Salt Corp., a newly formed salt company based in Jacksonville, FL. The company, which employed 140 people, was formed by former executives of North American Salt Co. (a subsidiary of the Harris Chemical Group, Inc.), First Union Capital Partners, Inc. (a subsidiary of the First Union Bank Corp.), and other investors (U.S. Salt Corp., 1997).

When Akzo Nobel NV decided in 1996 to abandon plans to construct a new rock salt mine at Hampton Corner, NY, and to replace the Retsof Mine that was lost to flooding, a new salt company—American Rock Salt Corp.—was formed to continue efforts to construct the new mine. As part of the U.S. Department of Justice's consent order from the Cargill-Akzo agreement, American Rock Salt was given the remaining 800,000 metric tons of rock salt in inventory on the surface at the Retsof facility and allowed to purchase the real estate, mineral rights, and the State mining permits for the new mine from Akzo. The capacity of the proposed rock salt mine was estimated at 2.5 million tons per year (Chemical Market Reporter, 1997d).

Plans for another new rock salt mine in Grand Saline, TX, were announced in October. U.S. Salt International, Inc. (no relation to the previously mentioned U.S. Salt, Inc.) and a group of Chinese business partners obtained the mineral rights to 19 hectares (47 acres) on the Grand Saline salt dome. Although there was no information regarding the timetable for construction or the size of the operation, the company was contemplating opening the mine and conducting underground tours for the public (Van Zandt News, 1997).

Texas Brine Corp., which is the sister company of United Salt Corp. under Texas United Corp., selected U.S. Filter Corp. to design, supply, and install a brine purification and salt crystallization facility near Baytown, TX. The project is associated with Bayer Corp.'s new chloralkali plant that is expected to be on-line by yearend 1998 (Chemical Market Reporter, 1997c).

Market Hub Partners L.P. announced in March that its subsidiary, NE Hub Partners, L.P., signed a brine supply agreement with United Salt Northeast, L.L.C., which is owned by Texas United Corp. of Houston, TX. Market Hub is a Delaware-base limited partnership owned by TPC Gas Storage Services, L.P., (an affiliate of TPC Corp); Miami Valley Leasing, Inc.; NIPSCO Energy Services, Inc.; NJR Storage Corp. (an affiliate of New Jersey Resources Corp.); and PSRC Delaware Inc. (an

affiliate of Public Service Enterprise Group, Inc.). The joint venture will solution-mine a large salt deposit near Tioga, PA. United planned to construct an evaporated salt facility that would have an annual capacity of about 750,000 tons, the majority of which would be marketed in the region in 1998. Market Hub Partners planned to use the resulting caverns to store up to 10 billion cubic feet of gas to serve the northeastern U.S. gas markets. Aside from Pennsylvania, Market Hub also is constructing a system of natural gas market centers in Louisiana, Mississippi, and Texas (Market Hub Partners, L.P.1997).

In August, IMC Global, Inc. announced that its potash subsidiary, IMC Kalium Corp., began manufacturing coproduct food-grade salt at its potash plant at Hersey, MI. The total annual capacity of the salt operation is 376,000 tons (415,000 short tons) but is expected to produce about 272,000 tons (300,000 short tons) per year (Chemical Week, 1997b). The operation was designed to eventually produce 544,000 tons (600,000 short tons), and the facility has expansion capabilities to ultimately achieve an annual capacity of 1.09 million tons (1.2 million short tons).

In addition to the Hersey, MI, venture, IMC Global, Inc. announced in December that it would purchase the salt and chemical businesses of the Harris Chemical Group Inc. The companies are North American Salt Co. (with vacuum pan salt plants in Kansas and rock salt plants in Canada and Louisiana), North American Chemical Co., Great Salt Lake Minerals (produces solar salt in Utah for sale by North American Salt), Penrice Soda Products Pty. Ltd. of Australia, and Salt Union in England for \$450 million in cash and assume about \$950 million of debt. Harris Chemical, with annual sales of \$850 million, has operations in Australia, Canada, Europe, and the United States and produces boron chemicals, magnesium chloride, potash, salt, soda ash, sodium bicarbonate, and sodium sulfate. IMC Global, which produces phosphate, potash, and salt, has annual sales of about \$3 billion (IMC Global, 1997).

## Consumption

Approximately 49.5 million metric tons of domestic and imported salt was consumed in the United States in 1997, based on the annual survey of the U.S. salt producers. This represented a decrease of 6% compared with that of 1996, primarily because of reduced salt sales for highway deicing. The 1997 reported percent distribution of salt by major end uses were chemicals, 45%; ice control, 30%; distributors, 8%; general industrial, 7%; agricultural, 4%; food, 3%; other combined with exports, 2% and primary water treatment, 1%. Distributors represent a substantial share of salt sales by the salt industry; however, all the salt ultimately is resold to many end users. Some customers have specific uses. For a more complete analysis of end-use markets, specific sectors of distribution in table 5 can be combined, such as agricultural and water conditioning with agricultural and water conditioning distribution, respectively.

The chemical industry consumes the majority of the salt produced, primarily salt brine. Although most salt brine is captively produced by chemical producers, many chloralkali manufacturers now purchase brine from independent brine supply companies. In certain cases, brine is captively produced by one chemical company, and any excess brine is sold to neighboring

competitors. According to a survey of domestic salt-based chlorine facilities, about 48% of the salt used to manufacture chlorine was captive and 31% was purchased brine. Solar salt, rock salt, and vacuum pan salt are also used to manufacture many chemicals. (See tables 5 and 6.)

According to the Bureau of the Census data, 11.8 million tons of chlorine and 10.3 million tons of sodium hydroxide were produced in 1997. Based on the industry average ratio of 1.75 tons of salt required to produce 1 ton of chlorine and 1.1 tons of coproduct sodium hydroxide, the chlorine and caustic soda industry consumed about 20 million tons of salt for feedstock. Reported consumption of total domestic and imported salt for chlorine manufacture was 19.7 million tons, as shown in table 5. The difference between the calculated and reported quantities was the amount of salt unreported to the USGS from imports or captively brine production of chloralkali producers.

The quantity of salt consumed for road deicing each year is directly related to the severity or mildness 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. However, meteorologists 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, which is now believed to be the largest single weather influence on Earth. El Niño is characterized by unusually warm temperatures in the equatorial Pacific Ocean which influence global variations in ocean and atmospheric temperatures, precipitation, and biologic activity. As the warm ocean water interacts with the colder surface water, changes in atmospheric pressures alter the normal patterns of tropical precipitation and atmospheric circulation features, such as jet streams in the subtropics and in the temperate latitudes of the northern hemisphere. As a result, midlatitude low pressure systems in the winter tend to be stronger in the Gulf of Alaska region, pumping abnormally warm air into Alaska, western Canada, and the northern portions of the United States. This causes fewer ice and snow storms that reduce the demand for deicing salt. Also, storms tend to be more severe in the Gulf of Mexico and along the southeast coast of the United States resulting in wetter than normal conditions (National Oceanic and Atmospheric Administration, El Niño and climate prediction, accessed July 15, 1998, at URL <http://www.pmel.noaa.gov/toga-tao/el-nino-report.html#part5>).

Formally known as the El Niño Southern Oscillation, the phenomenon has been observed as early as 1567, but with the advent of weather satellites and high-speed computers to process weather information to study the history of past El Niño events, more information about its frequency and effects is becoming known during the past 30 years. Prior to 1997, the six strongest recorded El Niño patterns were for the winters of 1957-58, 1965-66, 1972-73, 1982-83, 1986-87, and 1991-92 (National Broadcast Company, El Niño facts accessed July 15, 1998, at URL [http://wxnet4.nbcr.com/el\\_nino.html](http://wxnet4.nbcr.com/el_nino.html)). The El Niño of 1997-98 was reported to be the first one that was predicted so early by weather experts and that it was to be perhaps the worst El Niño of the century. By detecting the early signs associated with the beginning of El Niño events, weather forecasters may provide some indication of forthcoming winter weather to assist salt

companies in estimating salt use for highway deicing. Total salt consumption for highway deicing in 1997 declined 15% primarily because of the El Niño phenomenon. Figure 1 shows U.S. salt consumption for highway deicing relative to several of the major El Niño events. The majority of the declines in salt consumption tend to occur during these climatic episodes. (See figure 1).

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 that provides a source of iodine that is essential to the oxidation processes in the body. Kosher salt, seasalt, 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 missing nutrients not found naturally in the diet of certain livestock. Salt is also compressed into pellets and used for water conditioning.

There are reportedly about 14,000 different direct and indirect uses of salt. The USGS annually surveys 8 major categories comprising 29 separate end uses.

**Chemical.**—The greatest quantity of salt used in the chemical industry is by the chloralkali sector. Traditionally, the chloralkali sector included salt consumed for chlorine, coproduct sodium hydroxide (also known as caustic soda and lye), 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; however, many countries 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 using three different cell technologies. The types of cells and percent 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 tons of salt to make 1 ton of chlorine and 1.1 tons 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 second generation products from salt. 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). In powdered soaps and detergents, salt is

used as a bulking agent and as 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 as a cofeedstock 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 over the past several years. Since the 1970's, the number of producers has decreased from three to one; Ethyl Corp. and RMI Titanium Corp. exited the market in about 1985 and 1992, respectively, leaving E.I. du Pont de Nemours & Co. as the sole manufacturer of metallic sodium in the United States. The domestic market was about 126,000 tons in 1978 whereas in 1992 it shrunk to only 30,000 tons. The phasing out of tetraethyl lead and tetramethyl lead gasoline additives were the main reasons for the decline in consumption. Sodium usage in gasoline represented about 80% of the domestic market in 1978. The largest use of sodium in 1992 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 accounts for about 33% of metallic sodium consumption.

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

In meatpacking, salt is added to processed meats to promote the 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 used to store their perishables in salt barrels for protection and preservation. Salt acts as a binder in sausages to form a binding gel comprised of meat, fat, and moisture. Salt also acts as a flavor enhancer and a tenderizer.

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

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 (i.e., potato chips, pretzels) and for domestic pet consumption (i.e., dog and cat food). 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 is grain mill products, which consists of milling flour and rice, and manufacturing cereal breakfast food and blended or prepared flour.

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.

**General Industrial.**—The industrial uses of salt are diverse. They include, in descending order of salt usage, oil and gas exploration; other industrial uses; 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 well drilling fluids. It is used to flocculate and to increase the density of the drilling fluid in order to overcome high down-well gas pressures. Whenever drilling activities encounter salt formations, salt is added to the drilling fluid to saturate the solution and minimize the dissolution within the salt strata. Salt is also used to increase the set rate of concrete in cemented casings. 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 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 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-base bleaching chemical. Although the chlorine dioxide process originated in Germany after World War I, it 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 neoprene rubber, white rubber, and buna rubber. 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. Salt also acts as an excellent carrier for trace elements not found in the vegetation consumed by grazing livestock. Sulfur, selenium, and other essential elements are commonly added to salt licks, or salt blocks, for free-choice feeding.

**Water Treatment.**—Approximately 1.2 trillion liters (325 billion gallons) of water is used daily in the United States for residential and commercial uses. 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 water 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.

**Ice Control and Road Stabilization.**—The second largest end use of salt is for highway deicing. The developer of the Fahrenheit temperature scale (°F), discovered that salt mixed with ice (at a

temperature below the freezing point) creates a solution with a lower freezing point than water by itself. 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. Therefore, salt causes 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 -9.4° C to -6.7° C (15° F to 20° 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 from -3.9° C to 0° C (25° F and 32° F), a 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 Federal Food and Drug Administration.

In highway deicing, salt has been associated with corrosion to 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 there is evidence of environmental loading of salt during peak usage, the spring rains and thaws usually dilute the concentrations of sodium in the area.

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 by changes in humidity and traffic load in the subsurface.

**Distributors.**—A tremendous amount of salt is marketed through various distributors, some of which specialize in certain markets such as agricultural and water treatment services. In addition to these two categories, distributor sales include grocery wholesalers and/or retailers, institutional wholesalers, U.S. Government resale, and other wholesalers and retailers.

## 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 1 million tons. 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 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

The locations of the salt supplies often are not in proximity of the location of consumers, and 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 are increased and are reflected in higher selling prices.

Ocean-borne imports of salt have been increasing in some areas of the United States because they are less expensive with respect to transportation costs than what could be purchased from domestic suppliers using rail transportation.

## Prices

The four types of salt that are produced each 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 occurred, nor do they represent bid and asked prices. They are quoted here to serve only as a reference to yearend price levels. Except for 1997, for which information was not available, yearend prices were quoted in *Chemical Market Reporter*, as shown in table 7. The average annual values, as collected by the USGS in table 8 represent a national average value for each of the types of salt and the various product forms. (*See tables 7 and 8.*)

## Foreign Trade

Under the Harmonized Tariff Schedule (HTS) nomenclature, imports are aggregated under one category known as "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 2501.000000. The trade tables in this report list the previous and current identification codes for salt. Although there are several other HTS codes that pertain to various salt classifications, the United States aggregates the shipments under one code because the total of individual subclassifications fail to meet the minimum dollar requirements necessary for individual listings.

Based on Bureau of the Census statistics, the United States exported 748,000 tons in 1997, a 14% decrease compared with 1996. Salt was shipped to 72 countries through 33 U.S. customs districts; Cleveland, OH, district exported the most and represented 49% of the U.S. total. In 1997, the majority of exports, or 83% of the total, was to Canada. The *Journal of Commerce's* Port Import/Export Reporting Service (PIERS), which reports only ocean commerce (no rail or truck traffic between borders with Canada and Mexico; therefore, actual shipments to and from these countries are understated as compared with Bureau of the Census data) reported that seven domestic salt producing companies exported 93% of the 280,000

metric tons exported in 1997 (Bureau of the Census reported 748,000 tons, or 468,000 tons more than PIERS). The companies, in descending order of shipments, were Cargill, Inc., Morton Salt Co., Akzo Nobel Salt Inc., Western Salt Co., United Salt Co., U.S. Salt Corp. (began exporting in November after it acquired Akzo's Watkins Glen, NY, plant from Cargill), and North American Salt Co. Therefore, the remaining 7% of exports was by companies that do not produce salt.

Based on Bureau of the Census statistics, the United States imported 9.16 million tons of salt from 39 countries in 1997, which was 14% less than was imported during 1996. The extremely mild winter reduced the demand for imported rock salt. The quantity of imports was 12 times more than the quantity of salt that was exported. Although this would indicate that the United States is import reliant to meet its salt requirements, 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.

The PIERS service reported that 7.91 million tons was imported in 1997 whereas the Bureau of the Census import statistics showed 9.16 million tons; most of the difference was attributed to imports from Canada and Mexico that are not reported by PIERS. Based on PIERS data, Akzo Nobel Salt, Inc., Cargill, Inc., Morton International, and North American Salt Co. imported 54% of the total salt. Four chloralkali companies—Atochem North America, Occidental Chemical Corp., Pioneer Chemical, and Weyerhaeuser Co.—imported 7% of the total salt. Several major salt distributors, including Continental Salt Co., Eastern Minerals, Granite State Minerals, International Salt Co. LLC, and Rochez Brothers, imported 30% of all salt. The domestic salt industry, salt distributors, and chloralkali manufacturers imported 91% of total PIERS imports; the remainder was by many small direct buyers. Tables 9 through 12 list the import and export statistics reported by the Bureau of the Census for 1996-97. (*See tables 9, 10, 11, and 12.*)

## World Review

Table 13 lists world salt production statistics for 111 nations based on reported and estimated information. Total world production in 1997 was virtually identical with that of 1996. The United States remained the world's leading salt-producing country, representing 21% of total world output. 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 mergers and acquisitions that reduced the size of the industry to 27 companies and 66 plants by 1997.

Most countries possess some form of salt production capability with production levels set to meet their own domestic demand requirements with additional quantities available for export. Many developing nations tend to develop their agricultural resources first to feed their population. Development of easily extractable

mineral resources follows with salt being 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.

**Australia.**—Akzo Nobel NV of the Netherlands announced plans to construct a \$50 million solar salt plant in Onslow, Western Australia, with Gulf Holdings of Australia and Hanwha Corp. of the Republic of Korea as partners. Once approval is granted by the Government, the facility was scheduled to begin construction and be on-stream in 1999. The planned annual capacity is 2.5 million tons of solar salt (Chemical Market Reporter, 1997a).

Dampier Salt Ltd., which is the largest solar salt producer in Australia, began expanding production capacity in July from 3 million tons per year to 4 million tons per year. The expansion, the latest since 1992, will provide salt to the expanding chemical markets in Asia. Three additional brine concentration ponds, new salt production crystallizers, and six bitterns crystallizers will be added to the existing saltworks (Industrial Minerals, 1997).

**Canada.**—The first phase of a two-step plant expansion of the Goderich rock salt mine in Ontario was completed by the Harris Chemical Group, Inc. in late 1997. The first phase raised the operation's annual capacity from 4.5 million tons to 5.5 million tons and cost \$5.5 million. The second phase of the expansion, which will raise the total annual capacity to 6.5 million tons, was scheduled for completion by April 1998, at an estimated cost of \$9 million (Harris Chemical Group, Inc., 1997).

**France.**—Morton International finished its acquisition of two-thirds of the solar salt facility operated by Compaigne des Salins du Mide et des Salines de l'Est. Morton paid about \$180 million to the owners, which were Suez Industrie, the Credit Agricole Group, and the Rougie family, and will make a bid to purchase the remaining shares later, resulting in a total acquisition price of \$290 million. This was Morton's first salt acquisition outside of North America. The transaction raised Morton's worldwide salt sales by 45% to \$870 million per year. The solar salt plant produces nearly all of France's solar salt and about one-half of vacuum pan salt output. It also is the only producer of rock salt in the country (Chemical Week, 1997a).

## Outlook

The loss of the Retsof Mine that occurred in late 1995 caused several rock salt companies to expand their production facilities and rely on imported rock salt to satisfy any anticipated demand requirements. Although the United States will continue to have adequate sources of salt to fulfill these requirements, a potential excess of supply will probably occur if all the new projects scheduled for development, and those under consideration, are constructed.

Salt consumption for chlorine production will probably remain stable for the near future despite efforts to reduce chlorine usage in the United States because of environmental concerns regarding chlorinated paper bleaching chemicals. As some countries close some of the small and inefficient synthetic soda ash plants, such as those that closed in Europe and Japan, consumption of salt feedstock will decline. Japan closed two of its synthetic soda ash plants in 1996 and 1997 that used imported solar salt from

Australia and Mexico. Salt producers in these countries will evaluate alternative markets to sell into to offset sales to the soda ash industry.

## References Cited

- Chemical Market Reporter, 1997a, Akzo builds Aussie salt plant: Chemical Market Reporter, v. 251, no. 11, p. 6  
———1997b, Cargill completes acquisition of Akzo Nobel's salt business: Chemical Market Reporter, v. 251, no. 18, p. 7.  
———1997c, Market briefs—Salt: Chemical Market Reporter, v. 252, no. 23, p. 21.  
———1997d, Salt market consolidation is creating opportunities: Chemical Market Reporter, v. 252, no. 22, p. 7.  
Chemical Week, 1997a, Morton expands in Europe, plans more acquisitions: Chemical Week, v. 159, no. 2, p. 8.  
———1997b, Wrap-up: Chemical Week, v. 159, no. 32, p. 10.  
Harris Chemical Group, Inc., 1997, Harris Chemical Group completes first phase of 2 million-ton Canadian salt mine expansion: New York, NY, Harris Chemical Group press release, November 4, 2 p.  
IMC Global, 1997, IMC Global to acquire Harris Chemical Group, Inc., in accretive cash transaction: Northbrook, IL, IMC Global press release, December 12, 1 p.  
Industrial Minerals, 1997, Dampier Salt expands salt capacity: Industrial Minerals, no. 362, p. 9.  
Market Hub Partners L.P., 1997, Market Hub Partners reaches agreement with United Salt Corp. for disposal of brine at Tioga gas storage project: Leesburg, VA, Market Hub Partners L.P. press release, March 4, 2 p.  
U.S. Salt Corp., 1997, U.S. Salt Corporation acquires Cargill salt evaporation plant: Jacksonville, FL, U.S. Salt Corp., press release, November 3, 1997, 1 p.  
Van Zandt News, 1997, Plans announced for new salt mine in GS: Van Zandt News, v. 17, no. 20, p. 1.

## SOURCES OF INFORMATION

### U.S. Geological Survey Publications

- Evaporites and brines. Ch. in United States mineral resources, U.S. Geological Survey Professional Paper 820, 1973.  
Salt. Ch. in Mineral Commodity Summaries, annual.<sup>1</sup>  
Salt. Ch. in Mineral Yearbook, annual.<sup>1</sup>  
Directory of companies producing salt in the United States, Mineral Industry Surveys, annual.

### Other

- Salt. Ch. in Mineral facts and problems, U.S. Bureau of Mines Bulletin 675, 1985.  
The material flow of salt, U.S. Bureau of Mines, Information Circular 9343, 1993.  
Salt. Ch. in Canadian Minerals Yearbook, annual.  
The Chlorine Institute.  
Handbook of world salt resources. Stanley J. Lefond, 1969, 384 p.  
Salt. Ch. in Industrial minerals and rocks. Society of Mining, Metallurgy, and Exploration, 6th ed., 1994.  
Salt in Mining Engineering, annual commodity review.  
The Salt Institute.  
Sodium chloride. American Chemical Society Monograph. No. 145, Reinhold Pub. Corp., 1960, 743 p.  
Solution Mining Research Institute.

<sup>1</sup>Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1  
SALIENT SALT STATISTICS 1/

(Thousand metric tons and thousand dollars)

	1993	1994	1995	1996	1997
<b>United States:</b>					
Production total: 2/	39,200	40,100	42,100	42,200	41,400
Brine	18,100	18,000	20,600	21,500	21,400
Rock	14,300	15,100	14,000	13,500	12,900
Solar	2,960	3,020	3,540	3,270	3,170
Vacuum pan and open pan	3,860	3,960	3,950	3,920	3,980
Sold or used by producers	38,200	39,700	40,800	42,900	40,600
Value	\$904,000	\$990,000	\$1,000,000	\$1,060,000	\$993,000
Exports	688	742	670	869	748
Value	\$34,800	\$30,200	\$34,400	\$39,300	\$38,000
Imports for consumption	5,870	9,630	7,090	10,600	9,160
Value	\$100,000	\$151,000	\$114,000	\$167,000	\$148,000
Consumption, apparent 3/	43,400	48,600	47,200	52,600 r/	49,000
Consumption, reported	44,400	47,200	46,500	52,800	49,500
World Production	187,000	191,000	199,000 r/	201,000 r/	201,000 e/

e/ Estimated. r/ Revised.

1/ Data are rounded to 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 pans and open pans	Solar	Rock	Brine	Total
<b>1996</b>					
Bulk	738	1,920	12,900	21,500	37,100
Compressed pellets	1,020	284	XX	XX	1,300
Packaged	1,920	928	555	XX	3,410
Pressed blocks	246	134	67	XX	447
Total	3,920	3,270	13,500	21,500	42,200
<b>1997</b>					
Bulk	768	1,930	12,500	21,400	36,600
Compressed pellets	1,110	268	XX	XX	1,380
Packaged	1,850	843	311	XX	3,010
Pressed blocks	246	126	76	XX	448
Total	3,980	3,170	12,900	21,400	41,400

XX Not applicable.

1/ Data are rounded to 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)

Product form	Vacuum pans and open pans		Solar		Rock		Brine		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1996:										
Bulk	723	38,500	1,690	31,400	13,800	278,000	21,500	145,000	37,700	492,000
Compressed pellets	1,020	138,000	285	29,200	XX	XX	XX	XX	1,300	167,000
Packaged:										
Less-than-5-pound units	112	NA	(3/)	NA	--	NA	XX	XX	112	XX
More-than-5-pound units	1,800	NA	860	NA	587	NA	XX	XX	3,250	XX
Total	1,910	264,000	860	52,800	587	41,400	XX	XX	3,360	358,000
Pressed blocks:										
For livestock	102	NA	100	NA	66	NA	XX	XX	269	XX
For water treatment	147	NA	34	NA	--	NA	XX	XX	180	XX
Total	249	25,400	134	11,500	66	6,440	XX	XX	449	43,300
Grand total	3,900	466,000	2,970	125,000	14,500	325,000	21,500	145,000	42,900	1,060,000
1997:										
Bulk	763	39,900	1,780	31,600	11,800	226,000	21,400	143,000	35,800	440,000
Compressed pellets	1,130	152,000	267	29,600	XX	XX	XX	XX	1,400	182,000
Packaged:										
Less-than-5-pound units	130	NA	(3/)	NA	--	NA	XX	XX	130	XX
More-than-5-pound units	1,720	NA	802	NA	313	NA	XX	XX	2,840	XX
Total	1,850	256,000	803	49,200	313	23,100	XX	XX	2,970	328,000
Pressed blocks:										
For livestock	99	NA	70	NA	64	NA	XX	XX	233	XX
For water treatment	141	NA	52	NA	10	NA	XX	XX	203	XX
Total	240	25,000	122	10,700	75	7,140	XX	XX	437	42,800
Grand total	3,990	473,000	2,970	121,000	12,200	256,000	21,400	143,000	40,600	993,000

NA Not available. XX Not applicable.

1/ Data are rounded to 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.

3/ Less than 1/2 unit.



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

(Thousand metric tons and thousand dollars)

State	1996		1997	
	Quantity	Value	Quantity	Value
Kansas	2,950	118,000	3,210	120,000
Louisiana	15,500	175,000	15,300	169,000
New York	4,420	203,000	3,590	183,000
Texas	9,700	88,900	9,780	91,000
Utah	1,720	70,400	1,670	69,000
Other Eastern States 3/	7,040	332,000	5,440	289,000
Other Western States 4/	1,490	73,400	1,580	72,800
Total	42,900	1,060,000	40,600	993,000
Puerto Rico e/	45	1,500	45	1,500

e/ Estimated.

1/ Data are rounded to 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, 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 pans and open pans		Solar		Rock		Salt in brine		Grand total 3/	
		1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
<b>Chemical:</b>											
Chloralkali producers	2812	34	25	684	764	906	913	19,700	19,700	21,300	21,400
Other chemical	28 (excludes 2812, 2899)	378	396	178	211	458	370	91	94	1,110	1,070
<b>Total</b>		<b>412</b>	<b>420</b>	<b>862</b>	<b>975</b>	<b>1,360</b>	<b>1,280</b>	<b>19,800</b>	<b>19,800</b>	<b>22,400</b>	<b>22,400</b>
<b>Food processing industry:</b>											
Meat packers	201	238	249	44	44	125	123	--	--	407	416
Dairy	202	116	122	5	5	4	3	--	--	126	130
Canning	2091, 203	202	202	86	84	49	46	--	2	336	334
Baking	205	157	152	1	1	11	13	--	--	169	167
Grain mill products	204 (excludes 2047)	105	103	3	15	50	47	--	--	158	164
Other food processing	206-208, 2047, 2099	210	229	30	28	48	46	1	1	288	304
<b>Total</b>		<b>1,030</b>	<b>1,060</b>	<b>169</b>	<b>177</b>	<b>287</b>	<b>278</b>	<b>1</b>	<b>2</b>	<b>1,490</b>	<b>1,510</b>
<b>General industrial:</b>											
Textiles and dyeing	22	210	198	53	55	18	14	7	6	288	273
Metal processing	33, 34, 35, 37	11	8	27	26	161	143	--	--	199	177
Rubber	2822, 30 (excludes 3079)	4	4	1	1	4	3	63	61	71	68
Oil	13, 29	35	35	214	219	66	61	2,120	2,130	2,430	2,440
Pulp and paper	26	10	10	65	52	30	27	17	17	122	107
Tanning and/or leather	311	9	11	31	25	42	42	--	--	83	78
Other industrial	--	30	50	170	182	74	135	(4/)	(4/)	275	367
<b>Total</b>		<b>309</b>	<b>317</b>	<b>567</b>	<b>560</b>	<b>395</b>	<b>424</b>	<b>2,200</b>	<b>2,210</b>	<b>3,480</b>	<b>3,510</b>
<b>Agricultural:</b>											
Feed retailers and/or dealers mixers	5159	273	367	387	435	491	303	--	--	1,150	1,110
Feed manufacturers	2048	62	69	102	108	239	506	--	--	403	683
Direct-buying end user	02	6	5	12	12	47	46	--	--	65	63
<b>Total</b>		<b>340</b>	<b>442</b>	<b>502</b>	<b>502</b>	<b>777</b>	<b>854</b>	<b>--</b>	<b>--</b>	<b>1,620</b>	<b>1,850</b>
<b>Water Treatment:</b>											
Government (Federal, State, local)	2899	18	12	75	75	131	89	4	3	229	179
Commercial or other	2899	31	29	108	154	162	106	4	3	304	292
<b>Total</b>		<b>49</b>	<b>40</b>	<b>183</b>	<b>228</b>	<b>293</b>	<b>195</b>	<b>8</b>	<b>6</b>	<b>534</b>	<b>471</b>
<b>Ice control and/or stabilization:</b>											
Government (Federal, State, local)	9621	9	11	1,300	499	14,000	12,600	10	9	15,300	13,100
Commercial or other	--	11	78	173	137	2,220	1,680	--	--	2,400	1,900
<b>Total</b>		<b>20</b>	<b>88</b>	<b>1,470</b>	<b>637</b>	<b>16,200</b>	<b>14,200</b>	<b>10</b>	<b>9</b>	<b>17,700</b>	<b>15,000</b>

See footnotes at end of table.

TABLE 5--Continued  
DISTRIBUTION OF DOMESTIC AND IMPORTED DATA BY PRODUCERS IN THE UNITED STATES  
BY END USE AND TYPE 1/ 2/

(Thousand metric tons)

End use	Standard industrial classification	Vacuum pans and open pans		Solar		Rock		Salt in brine		Grand total 3/	
		1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
<b>Distributors:</b>											
Agricultural distribution	5191	216	109	192	126	252	73	--	--	661	307
Grocery wholesalers and/or retailers	514, 54	535	511	221	227	99	62	--	--	855	800
Institutional wholesalers and end users	58, 70	118	121	36	39	30	24	(4/)	(4/)	184	185
Water-conditioning distribution	7399	163	150	485	417	72	53	--	4	719	624
U.S. Government resale	9199	(4/)	(4/)	1	1	1	1	--	--	2	2
Other wholesalers and/or retailers	5251	724	554	694	621	807	784	(4/)	(4/)	2,230	1,960
Total		1,760	1,440	1,630	1,430	1,260	997	1	(4/)	4,650	3,880
Other n.e.s. 5/		139	281	169	241	463	278	118	29	889	829
Grand total		4,060	4,090	5,550	4,810	21,100	18,500	22,100	22,000	52,800	49,500

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ The quantity 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. Bureau of the Census 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)

Destination	1996				1997			
	Evaporated			Total	Evaporated			Total
	Vacuum pans and open pans	Solar	Rock		Vacuum pans and open pans	Solar	Rock	
Alabama	58	1	74	133	61	1	76	138
Alaska	(3/)	4	(3/)	4	(3/)	4	(3/)	4
Arizona	49	101	2	151	52	101	2	155
Arkansas	46	2	91	140	47	2	90	139
California	148	761	2	911	153	763	2	918
Colorado	15	85	119	218	14	88	106	208
Connecticut	10	89	120	220	9	59	58	126
Delaware	3	6	30	39	2	9	2	13
District of Columbia	(3/)	2	10	13	(3/)	1	9	11
Florida	68	167	22	257	67	201	8	276
Georgia	69	80	65	215	70	100	55	225
Hawaii	1	3	(3/)	4	1	2	--	3
Idaho	10	99	3	112	13	100	9	122
Illinois	307	176	1,370	1,860	323	192	2,000	2,510
Indiana	219	68	728	1,020	220	98	756	1,070
Iowa	195	73	499	767	199	77	579	855
Kansas	78	40	377	494	79	29	478	586
Kentucky	61	9	727	797	72	6	415	493
Louisiana	46	2	580	628	46	2	600	649
Maine	9	11	654	674	11	4	162	177
Maryland	69	293	199	561	61	62	266	389
Massachusetts	34	39	226	299	33	66	193	292
Michigan	230	35	1,790	2,060	244	28	1,880	2,150
Minnesota	149	199	757	1,100	148	213	699	1,060
Mississippi	22	1	219	242	31	1	224	255
Missouri	103	45	630	778	98	39	526	662
Montana	1	48	3	52	1	44	2	47
Nebraska	72	38	169	280	74	41	214	329
Nevada	2	269	12	283	2	261	15	278
New Hampshire	6	95	98	200	10	66	45	121
New Jersey	129	400	300	829	127	82	272	481
New Mexico	11	53	(3/)	65	11	103	1	115
New York	213	111	2,930	3,250	205	78	2,780	3,060
North Carolina	190	137	109	436	174	76	80	330
North Dakota	6	20	5	30	7	32	9	47
Ohio	380	42	2,390	2,810	382	47	1,560	1,990
Oklahoma	34	19	96	150	38	17	98	153
Oregon	14	129	1	143	15	139	1	155
Pennsylvania	194	138	1,990	2,320	186	98	1,170	1,460
Rhode Island	8	169	23	200	9	86	5	100
South Carolina	58	12	9	79	41	14	4	58
South Dakota	27	59	37	122	25	51	42	117
Tennessee	64	4	690	758	84	4	615	703
Texas	207	155	211	572	210	148	199	557
Utah	8	433	27	468	9	344	85	438
Vermont	4	1	67	72	4	3	267	274
Virginia	81	91	404	576	84	43	203	331
Washington	29	451	1	481	31	532	2	566
West Virginia	13	2	289	305	13	2	128	144
Wisconsin	196	143	1,290	1,630	200	134	1,360	1,700
Wyoming	(3/)	23	2	25	(3/)	23	2	25
Other 4/	109	92	363	564	94	93	188	375
Total 5/	4,060	5,550	21,100	30,700	4,090	4,810	18,500	27,400

See footnotes at end of table.

TABLE 6--Continued  
 DISTRIBUTION OF DOMESTIC AND IMPORTED EVAPORATED AND ROCK SALT  
 IN THE UNITED STATES, BY DESTINATION 1/ 2/

1/ Data are rounded to 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  
 SALT YEAREND PRICES

	1996	1997
Salt, evaporated, common: 80-pound bags, carlots or truckloads:		
North, works, 80 pounds	\$4.02	NA
Bulk, same basis, per ton	60.00-61.20	NA
Salt, chemical grade, same basis: North, works, 80 pounds	4.30	NA
Salt, rock, medium, coarse:		
Same basis, 80 pounds	2.70	NA
Bulk, same basis, per ton	18.00-25.00	NA
Sodium chloride, U.S.P.: Granular bags, per pound	.29	NA

NA Not available.

Sources: Chemical Market Reporter. Current Prices of Chemicals and Related Materials. v. 251, no. 1, January 1997. p. 28.

TABLE 8  
AVERAGE VALUE OF SALT, BY PRODUCT FORM AND TYPE 1/

(Dollars per metric ton)

Product form	Vacuum pans and open pans	Solar	Rock	Brine
1996:				
Bulk	\$53.26	\$18.56	\$20.09	\$6.72
Compressed pellets	135.14	102.45	XX	XX
Packaged	138.22	61.38	70.47	XX
Average 2/	120.54	39.97	22.14	6.72
Pressed blocks	101.89	85.57	97.03	XX
1997:				
Bulk	52.29	17.83	19.09	6.67
Compressed pellets	134.57	110.88	XX	XX
Packaged	138.21	61.27	73.66	XX
Average 2/	119.61	38.81	20.50	6.67
Pressed blocks	103.84	87.79	95.63	XX

XX Not applicable.

1/ Net selling value, f.o.b. plant, excluding container costs.

2/ Salt value data previously reported 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 shown in table 3.

TABLE 9  
U.S. EXPORTS OF SALT, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1996		1997	
	Quantity	Value	Quantity	Value
Australia	(2/)	336	1	92
Bahamas, The	1	239	1	247
Bahrain	1	331	(2/)	180
Benin	--	--	2	63
Brazil	2	386	(2/)	283
Canada	710	23,300	624	23,300
Chile	(2/)	88	1	113
Colombia	1	242	1	193
Dominican Republic	1	385	1	140
El Salvador	1	126	1	131
Finland	1	65	--	--
France	2	163	(2/)	163
Honduras	3	452	2	229
Hong Kong	2	81	(2/)	107
India	2	64	(2/)	3
Indonesia	25	1,220	(2/)	33
Japan	3	546	8	709
Kuwait	1	136	(2/)	76
Malaysia	2	77	2	152
Mexico	64	2,770	61	3,160
Netherlands	2	868	2	707
Nigeria	(2/)	41	1	114
Pakistan	1	34	--	--
Panama	1	112	1	229
Peru	1	87	1	46
Saudi Arabia	17	1,790	16	1,610
Singapore	7	662	(2/)	36
Suriname	1	127	(2/)	20
Sweden	1	135	--	--
Taiwan	1	253	3	272
United Arab Emirates	1	200	1	335
United Kingdom	1	337	2	863
Venezuela	9	1,780	7	2,620
Other	4	1,840 r/	9	1,690
Total	869	39,300	748	38,000

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 10  
U.S. EXPORTS OF SALT, BY CUSTOMS DISTRICT 1/

(Thousand metric tons and thousand dollars)

District	1996		1997	
	Quantity	Value	Quantity	Value
Anchorage, AK	(2/)	51	(2/)	4
Baltimore, MD	1	197	1	219
Boston, MA	--	--	(2/)	9
Buffalo, NY	54	4,770	65	4,200
Charleston, SC	1	190	2	201
Chicago, IL	(2/)	39	(2/)	10
Cleveland, OH	480	8,740	363	8,050
Columbia-Snake, OR	(2/)	36	3	97
Detroit, MI	37	3,440	40	3,310
Duluth, MN	1	58	(2/)	6
El Paso, TX	5	228	1	89
Great Falls, MT	9	658	8	490
Houston, TX	18	3,240	15	3,850
Laredo, TX	53	2,340	32	2,290
Los Angeles, CA	35	3,200	8	1,310
Miami, FL	3	654	4	689
Minneapolis, MN	(2/)	4	--	--
Mobile, AL	1	223	1	116
New Orleans, LA	4	641	8	572
New York, NY	7	1,230	8	1,180
Nogales, AZ	1	58	1	87
Norfolk, VA	1	170	5	271
Ogdensburg, NY	5	698	7	933
Pembina, ND	3	286	3	278
Philadelphia, PA	(2/)	25	(2/)	39
Portland, ME	(2/)	6	(2/)	21
St. Albans, VT	(2/)	22	26	690
St. Louis, MO	(2/)	51	21	1,100
San Diego, CA	5	148	(2/)	75
San Francisco, CA	34	874	3	911
San Juan, PR	1	141	43	1,360
Savannah, GA	8	1,480	1	87
Seattle, WA	24	762	(2/)	30
Tampa, FL	1	129	(2/)	114
Other 3/	78	4,480	80	5,280
Total	869	39,300	748	38,000

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

3/ Unknown, but assumed to be rail and/or truck shipments to Canada through various points of departure.

Source: Bureau of the Census.



TABLE 11  
U.S. IMPORTS FOR CONSUMPTION OF SALT, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1996		1997	
	Quantity	Value	Quantity	Value
Australia	(2/)	45	67	527
Bahamas, The	1,240	16,400	1,070	14,600
Brazil	161	1,900	170	1,980
Canada	3,810	78,100	3,630	72,200
Chile	2,650	30,100	1,920	22,800
China	--	--	1	285
Dominican Republic	39	256	69	581
Egypt	69	722	36	911
France	15	1,010	18	825
Germany	--	--	4	545
Hong Kong	--	--	1	115
Ireland	47	561	44	437
Israel	1	146	(2/)	126
Italy	(2/)	143	1	125
Japan	2	120	(2/)	158
Korea, Republic of	1	769	1	709
Mexico	2,170	30,600	1,410	21,900
Netherlands	48	1,440	63	2,170
Netherlands Antilles	80	1,500	98	1,770
Peru	96	859	426	3,400
Spain	136	1,130	1	138
Switzerland	38	389	(2/)	7
United Kingdom	33	497	75	714
Venezuela	--	--	51	381
Other	1	691	2	281
Total	10,600	167,000	9,160	148,000

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 12  
U.S. IMPORTS OF SALT, BY CUSTOM DISTRICTS 1/

(Thousand metric tons and thousand dollars)

District	1996		1997	
	Quantity	Value	Quantity	Value
Anchorage, AK	17	218	8	173
Baltimore, MD	1,130	17,600	791	11,100
Boston, MA	854	10,900	611	8,110
Buffalo, NY	227	6,400	339	7,170
Charleston, SC	49	1,430	95	2,200
Chicago, IL	518	11,400	336	7,520
Cleveland, OH	268	5,440	203	4,420
Columbia-Snake, OR	425	5,670	276	3,530
Dallas-Fort Worth, TX	(2/)	9	(2/)	2
Detroit, MI	1,080	20,300	1,210	23,100
Duluth, MN	224	3,990	67	927
El Paso, TX	(2/)	2	--	--
Great Falls, MT	1	86	1	62
Honolulu, HI	--	--	(2/)	5
Houston-Galveston, TX	1	380	(2/)	164
Laredo, TX	1	129	1	216
Los Angeles, CA	115	2,350	115	2,490
Miami, FL	(2/)	20	(2/)	30
Milwaukee, WI	1,000	20,300	1,150	23,100
Minneapolis, MN	1	9	--	--
New Orleans, LA	283	3,910	319	6,240
New York, NY	1,680	18,900	829	10,100
Norfolk, VA	222	2,960	132	1,940
Ogdensburg, NY	94	2,950	94	2,140
Pembina, ND	28	645	23	1,020
Philadelphia, PA	761	9,130	672	7,580
Portland, ME	662	8,270	900	9,970
Providence, RI	227	2,730	221	2,570
St. Albans, VT	53	1,450	(2/)	131
St. Louis, MO	(2/)	25	(2/)	69
San Diego, CA	1	168	11	572
San Francisco, CA	(2/)	123	108	1,540
San Juan, PR	9	442	315	4,180
Savannah, GA	90	1,180	8	508
Seattle, WA	312	4,120	(2/)	20
Tampa, FL	193	2,740	261	3,600
Wilmington, NC	106	1,170	73	1,140
Total	10,600	167,000	9,160	148,000

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 13  
SALT: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1993	1994	1995	1996	1997 e/
Afghanistan (rock salt) e/	13	13	13	13	13
Albania e/	10	10	10	10	10
Algeria (brine and sea salt)	179	178	250 r/	250 r/ e/	250
Angola e/	30	30	30	30	30
Argentina:					
Rock salt	1 e/	3	(4/) r/	-- r/	--
Other salt	1,033	834 r/	1,009 r/	1,096 r/	1,100
Total	1,034 e/	837 r/	1,009 r/	1,096 r/	1,100
Armenia	30 e/	30 e/	33	26	26
Australia (brine salt and marine salt)	7,737	7,685	8,148	7,905	8,722 5/
Austria:					
Brine salt	695	701	523	600 e/	600
Rock salt e/	1	1	1	1	1
Total e/	696	702	524	601	601
Azerbaijan e/	40	30	20	15	15
Bahamas, The e/	850	900	900	900	900
Bangladesh (marine salt) e/ 6/	340	350	350	350	350
Belarus	300 e/	263	1	1	1 5/
Benin (marine salt) e/	(4/)	(4/)	(4/)	(4/)	--
Bolivia	(4/) e/	e/	5	(4/)	(4/)
Bosnia and Herzegovina e/	50	50	50	50	50
Botswana 7/	98	186	208	94 r/	150
Brazil:					
Marine salt	4,780	4,670	4,460	3,870 r/	4,000
Rock salt	1,400	1,373	1,340	1,514 r/	1,520
Total	6,180	6,043	5,800	5,384 r/	5,520
Bulgaria	650	1,300	1,500	1,600	1,500
Burkina Faso e/	7	7	7	7	5
Burma e/ 8/	30 r/	30 r/	35 r/	35 r/	35
Cambodia e/	40	40	40	40	40
Canada	10,900	11,700	10,957	12,248 r/	13,264 p/
Cape Verde e/	4	4	4	1	1
Chile	1,443	3,178	3,494 r/	4,043 r/	5,488 5/
China e/	29,500	29,700	29,800	29,000 r/	29,300
Colombia:					
Marine salt	199	358	282 e/	424	182 p/
Rock salt	201	207	268	153	144 p/
Total	400	565	550 e/	576	326 p/
Costa Rica (marine salt) e/	31	32	32	37	37
Croatia	30	22	22	19	17 5/
Cuba e/	185	175	180	180	180
Czech Republic e/	180	180	-- r/	-- r/	--
Denmark (sales)	591	634	603	600 e/	600
Dominican Republic:					
Marine salt	53	47	42	50	50
Rock salt	8 r/	10	11 r/	11 r/	12
Total	62	58	53	61	62
Egypt	986	1,008	1,990 r/	2,000 r/ e/	2,000
El Salvador (marine salt) e/	30	30	30	31 r/	32
Eritrea: 9/					
Marine salt e/	25	206	253	198	200
Rock salt e/	1	2	2	2	--
Total	26	208	255	200	200
Ethiopia: e/ 6/					
Marine salt	45	--	--	--	--
Rock salt	8	5	5	5	1
Total	53	5	5	5	1
France:					
Brine salt	1,310	1,658	1,491	1,460 r/	1,500
Marine salt	1,200 e/	1,123	1,473	1,970 r/	1,000
Rock salt	116 e/	143	165	160 e/	160

See footnotes at end of table.

TABLE 13--Continued  
SALT: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1993	1994	1995	1996	1997 e/
France--Continued:					
Salt in solution	4,355	4,612	4,410	4,273 r/	4,500
Total	6,980 e/	7,536	7,539	7,860 r/ e/	7,160
Germany:					
Marine salt	558	542 r/	617 r/	731 r/	700
Rock salt and other	12,130	9,731	14,607 r/	15,176 r/	15,000
Total	12,688	10,273 r/	15,224 r/	15,907 r/	15,700
Ghana e/	50	50	50 r/	50 r/	50
Greece	175	192	200 e/	200 e/	200
Guatemala e/	47	48	48	48	48
Honduras e/	30	25	25	25	25
Iceland e/	5	5	4	4	4
India:					
Marine salt e/	9,500	9,500	9,500	9,500	9,500
Rock salt	3	3	2 r/	2 r/	3
Total e/	9,500	9,500	9,500	9,500	9,500
Indonesia e/	650	650	670	670	680
Iran 10/	720	1,050	936	450 e/	500
Iraq e/	300	300	250	250	250
Israel e/	1,122 5/	1,120	900 r/	800 r/	800
Italy:					
Brine salt and rock salt	3,150	3,353	2,952	3,000 e/	3,000
Marine salt, crude e/ 11/	580	600	600	600	600
Total	3,730	3,953	3,552	3,600 e/	3,600
Jamaica	18	18	20 r/	18 r/	18
Japan	1,378	1,387	1,351 r/	1,390 r/	1,400
Jordan e/	26 5/	26	25	25	25
Kenya (crude salt)	75	71	71 e/	41 r/ e/	40
Korea, North e/	590	600	600	590 r/	590
Korea, Republic of e/	750	760	770	770	770
Kuwait e/	41 5/	45	100 r/	100 r/	100
Laos (rock salt) e/	8	8	8	8	8
Lebanon e/	3	3	3	4	4
Leeward and Windward Islands e/	1	1	1	1	1
Libya e/	15 r/	15 r/	30 r/	30 r/	30
Madagascar	64 r/	76 r/	51 r/	50 r/ e/	50
Mali e/	5	5	5	6	5
Malta (marine salt) e/	(4/)	(4/)	(4/)	(4/)	(4/)
Martinique e/	200	200	200	200	200
Mauritania e/	6	6	6	6	6
Mauritius e/	6	6	6	6	6
Mexico	7,490	7,458	7,670	8,508	7,933 5/
Mongolia	1	(4/)	(4/)	(4/)	(4/)
Morocco (marine salt and rock salt)	170	177	173	168	170
Mozambique (marine salt) e/	40	40	40	60	60
Namibia (marine salt) 12/	133 r/	357 r/	304 r/	382 r/	490 5/
Nepal e/ 13/	7 5/	7	7	7	7
Netherlands	3,500 e/	3,500 e/	4,976 r/	5,530 r/	5,000
Netherlands Antilles	300 e/	420	424	366	432 5/
New Zealand e/	80	80	50	67 r/	67
Nicaragua (marine salt) e/	15	15	15	15	15
Niger e/	3	3	3	3	3
Pakistan: 6/					
Marine salt	14	13	17	18 e/	17
Rock salt	895	847	935	940 e/	935
Total	909	860	952	958 e/	952
Panama (marine salt) e/	20	20	22	22	22
Peru	238	238 e/	140 r/	236 r/	240
Philippines (marine salt)	535	562 r/	540 e/	550 e/	550
Poland:					
Rock salt	718	750	812	923 r/	900

See footnotes at end of table.

TABLE 13--Continued  
SALT: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1993	1994	1995	1996	1997 e/
<b>Poland--Continued:</b>					
Other salt	3,099	3,324	3,402	3,240 r/	3,070
Total	3,817	4,074	4,214	4,163	3,968 5/
<b>Portugal:</b>					
Marine salt e/	125	125	--	--	--
Rock salt	525	519	545	610 r/	600
Total	650 e/	644 e/	545	610 r/	600
<b>Romania:</b>					
Rock salt	808	892	669	350	350
Other salt	1,380	1,310	1,820	2,339	2,300
Total	2,188	2,202	2,489	2,689	2,650
Russia e/	2,200	2,000	2,000	1,600	1,400
Senegal e/	117 5/	117	120	120	120
Serbia and Montenegro	39	32	14	22	28 5/
Sierra Leone e/	200	200	--	50 r/	--
Slovakia	70 e/	100	100	107	100
Slovenia	7	8	3 r/	5 r/ e/	5
Somalia e/	1	1	1	2	1
South Africa 12/	613	414	313	253	319 5/
<b>Spain:</b>					
Marine salt and other evaporated salt	900 e/	1,422	1,282	1,500 e/	1,500
Rock salt	2,505	3,510	3,494	2,500 e/	2,500
Total	3,410 e/	4,932	4,776	4,000 e/	4,000
Sri Lanka	43	56	60 e/	65 r/ e/	65
Sudan e/	75	75	75	50	50
Switzerland	221	259	300 r/ e/	300 e/	300
Syria	113	127	111	112 r/	115
Taiwan (marine salt)	176	186	221	233	230
Tanzania	18	84 r/	105 r/	87 r/	90
<b>Thailand:</b>					
Rock salt	262	288	381	530 r/	550
Other e/	100	100	100	100	100
Total e/	362	388	481	630 r/	650
Tunisia (marine salt)	435	414 r/	481 r/	478	393 5/
Turkey	1,526 r/	1,353	1,444	1,400 e/	1,400
Turkmenistan	300 e/	300 e/	277	256 r/	217 5/
Uganda e/	10 r/	10 r/	10 r/	10 r/	10
Ukraine e/	4,000	3,500	3,000	2,800	2,500
<b>United Kingdom:</b>					
Brine salt e/ 14/	1,200	1,300	1,300	1,300	1,300
Rock salt e/	1,500	1,700 5/	1,800	1,800	1,800
Other salt 14/	4,086	4,004	3,548	3,512 r/	3,500
Total e/	6,790	7,000	6,650	6,610 r/	6,600
<b>United States including Puerto Rico:</b>					
<b>United States:</b>					
Brine	18,100	18,000	20,600	21,500	21,400 5/
Rock salt	14,300	15,100	14,000	13,500	12,900 5/
Solar salt	2,960	3,020	3,540	3,270	3,170 5/
Vacuum pan salt	3,860	3,960 r/	3,950	3,920	3,980 5/
Puerto Rico e/	45	45	45	45	45
Total e/	39,300	40,100 r/	42,200	42,300	41,500
Venezuela e/	370	400	350	350	350
Vietnam e/	350	375	375	375	390
Yemen	110	110	110 e/	110 e/	110
Grand total	187,000	191,000	199,000 r/	201,000 r/	201,000

See footnotes at end of table.

TABLE 13--Continued  
SALT: WORLD PRODUCTION, BY COUNTRY 1/ 2/

---

e/ Estimated. p/ Preliminary. r/ Revised.

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through July 10, 1998.

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/ Less than 1/2 unit.

5/ Reported figure.

6/ Year ending June 30 of that stated.

7/ From natural soda ash production.

8/ Brine salt production as reported by the Burmese Government in metric tons, was as follows: 1993--58,915; 1994--58,612; 1995--81,156; 1996--71,350 (revised); 1997--70,000 (estimated).

9/ Eritrea production was included in Ethiopia until independence in May 1993.

10/ Year beginning March 21 of that stated.

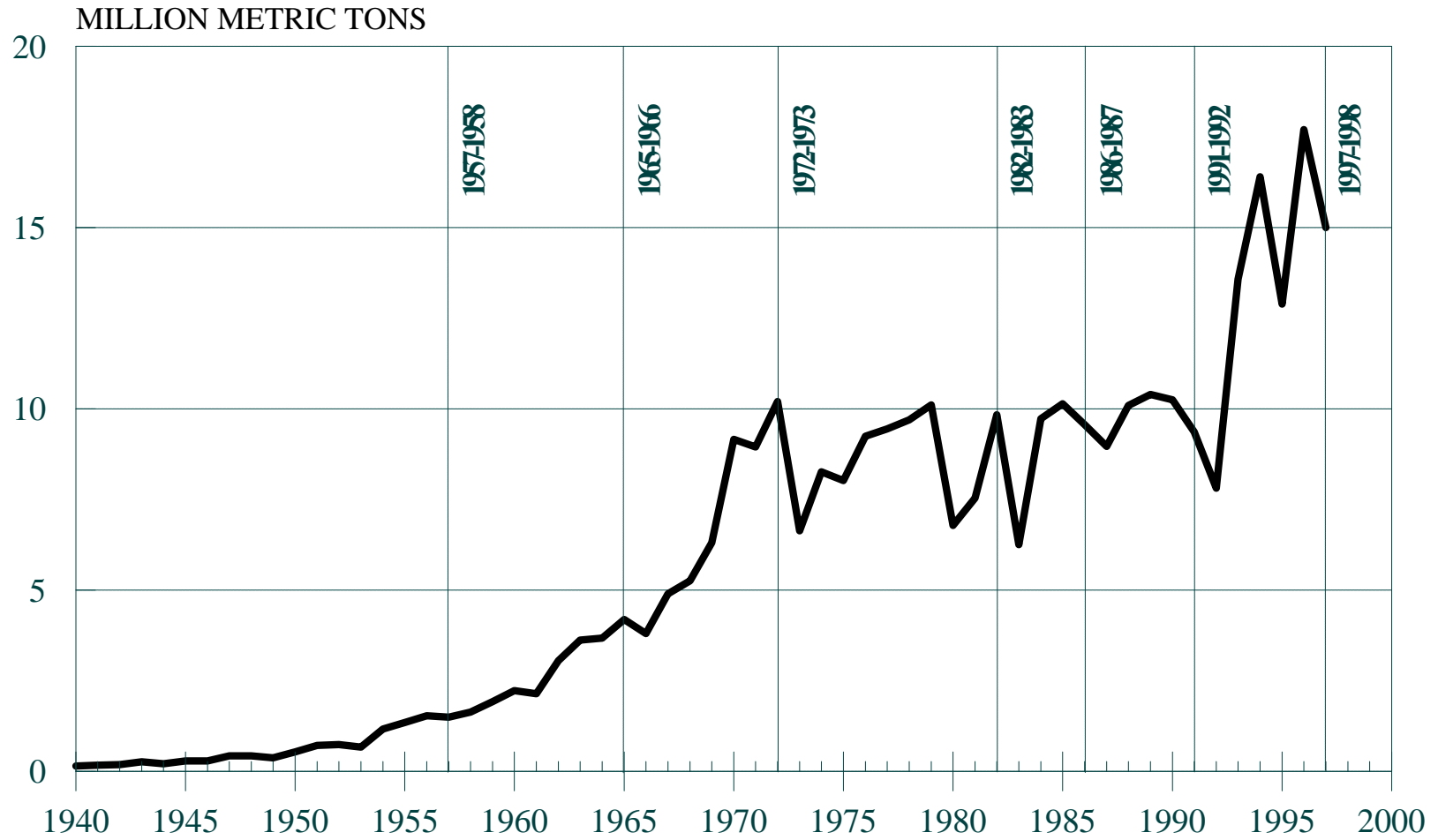
11/ Does not include production from Sardinia and Sicily, estimated at 200,000 metric tons annually.

12/ South Africa's decline and Namibia's increase in 1994 were due to production from Walvis Bay now included under Namibia.

13/ Year ending July 15 of that stated.

14/ Data captioned "Brine salt" for the United Kingdom are the quantities of salt obtained from the evaporation of brines; that captioned "Other salt" is the salt content of brines used for purposes other than production of salt.

FIGURE 1  
CONSUMPTION OF SALT FOR HIGHWAY DEICING  
RELATIVE TO THE SEVEN MAJOR EL NIÑO EVENTS



Source: U.S. Geological Survey.