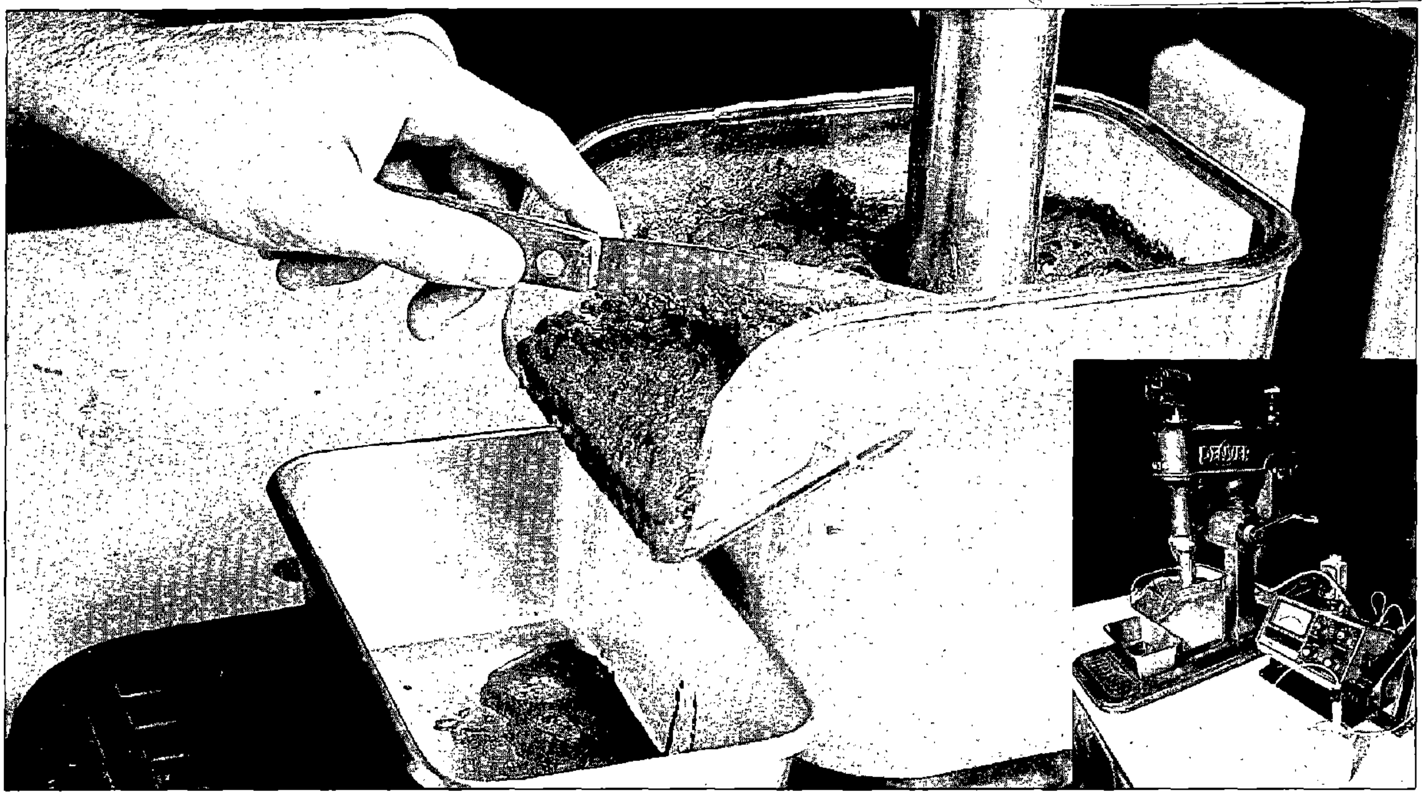
ANNUAL REPORT



PHOSPHATE ROCK

By Thomas O. Llewellyn

1993

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

ANNUAL REPORT

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U.S.
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Bruce Babbitt
Secretary

BUREAU
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Contents

Tables

COVER PHOTO:
Phosphate batch flotation test. (Photo courtesy of Mr. Chip Cooper, University of Alabama, Tuscaloosa, AL; and Mr. Broderick. E. Davis, Tuscaloosa Research Center, U.S. Bureau of Mines, Tuscaloosa, AL.)

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PHOSPHATE ROCK

By Thomas O. Llewellyn

Mr. Llewellyn, a physical scientist with more than 30 years of industry and U.S. Bureau of Mines experience, has been a commodity specialist since 1987. Domestic survey data were prepared by Christopher Lindsay, statistical assistant; and the international data table was prepared by Jeremy Tidwell, international data coordinator.

Phosphate rock, the only significant commercial source of the element phosphorus, is vital to the agricultural sector worldwide. Phosphorus is a basic element that is essential to life. Phosphorus is not usually very abundant in soils because it is removed by crop and natural losses. To maintain high crop yields, fertilizers containing the major plant nutrients phosphorus, nitrogen, and potassium must be applied to the soil. The world requires that agriculture be highly productive to feed its expanding population. In the United States, nearly 90% of the phosphate rock consumed is for the production of fertilizers with the remainder consumed in a variety of phosphate chemicals used by industry and the general public.

U.S. production of phosphate rock dramatically decreased in 1993 compared with that of 1992 as sales of phosphate fertilizer products declined. The phosphate industry, faced with lower demand and prices for fertilizer products, was forced to idle and/or close some mines and fertilizer plants in an effort to control production to ensure competitive selling prices. Domestic and world production of phosphate rock decreased 24% and 10%, respectively, compared with output in 1992. Preliminary estimates showed that world phosphate rock trade decreased again in 1993 by about 7%, reaching only 27 million metric tons, from the almost 29 million tons traded in 1992; U.S. phosphate rock exports decreased from 3.7 million tons to 3.2 million tons primarily because of reduced consumption in Western Europe and the loss of exports to India.

The historical breakup of the former U.S.S.R. and the significant changes in the socioeconomic structures of countries in Eastern Europe is expected to continue affecting the demand for phosphate fertilizers in that region and across the world markets for the near future. Producers of phosphate products from the former U.S.S.R. and the Eastern Europe countries have been dumping phosphate fertilizer inventories on the world market to obtain needed hard currency.

The year 1993 produced significant changes in international trade. The North American Free Trade Agreement (NAFTA) was approved by the Governments of Canada, Mexico, and the United States. After 7 years, the Uruguay Round of multilateral trade negotiations were closer to reality. The United States intended to enter into the trade agreements by April 15, 1994. These agreements will not have domestic legal force until the U.S. Congress has approved them. *(See table 1.)*

DOMESTIC DATA COVERAGE

Domestic production data for phosphate rock were developed by the U.S. Bureau of Mines from two separate voluntary surveys of U.S. operations. Of the 14 operations to which a survey request was sent, all responded, representing 100% of the U.S. production data shown in table 1.

BACKGROUND

Phosphate rock deposits occur as marine phosphorites, apatite-rich igneous rock, and guano. Guano deposits are a result of animal waste accumulation, mainly sea birds. Current world phosphate production from guano deposits is insignificant. *(See table 20.)* All U.S. production was from marine phosphorites. The U.S. industry reports production in terms of a beneficiated phosphate rock concentrate and reserves in terms of an economically recoverable phosphate rock concentrate product. The grade of phosphate rock may be reported as percent of phosphorus pentoxide (P_2O_5) or as tricalcium phosphate, $Ca_3(PO_4)_2$, which also is referred to as percent bone phosphate of lime (BPL). Conversion factors are: $P_2O_5 = \%BPL \times 0.4576$; $\%BPL = P_2O_5 \times 2.1853$; and $P = P_2O_5 \times 0.436$. The phosphate ore bed or the zone of phosphorus-bearing material is known as matrix in Florida and North Carolina.

Marketable phosphate rock was produced by 14 companies in the United States. Six companies in Florida and one in North Carolina produced about 85% of the phosphate rock. The balance of 15% was produced in Idaho, Montana, and Utah. Approximately 82% of the phosphate rock sold or used by U.S. producers was consumed domestically to produce fertilizers and feed supplements; about 8% was exported and 10% was used to produce a variety of industrial chemicals.

Sedimentary apatite has a range of chemical compositions. The general formula for marine carbonate-apatite is $Ca_{10}(PO_4CO_3)_6F_{2-3}$. Apatite is host to many cation, anion, and anionic radical substitutions for PO_4. Accessory elements may be associated minerals or those that are chemical substitutions in the phosphate mineral.

The part of phosphate resources that can be economically recovered is called reserves. Reserves may increase as new deposits are discovered and as technology is improved. Estimates of phosphate rock reserves are made for a specific date and are subject to changing economic or environmental conditions. Operating companies and companies holding phosphate lands estimate the recoverable tonnages based on current and future economics. Estimated reserves for Florida and North Carolina deposits are about 1 billion tons for each State.

The phosphate rock bed of the Pungo River Formation in North Carolina is a primary marine phosphate 6 to 12 meters (20 to 40 feet) thick, overlain with 27 to 40 meters (90 to 130 feet) of sand, clay, and marl overburden. The underlying aquifer was depressurized by pumping water to the surface to ensure a dry pit. Currently, bucket wheel excavators have replaced dredges to strip the top 12 meters (40 feet) of overburden. Large-capacity draglines with buckets as large as 55 cubic meters (72 cubic yards) were used to strip the remaining overburden and mine the matrix. The matrix was slurried with high-pressure waterjets, pumped to the beneficiation plant, washed, and classified to produce a minus 16-mesh, plus 200-mesh flotation feed. Flotation concentrate was either calcined or dried.

Most of the phosphate mines in central Florida recover phosphate rock from the Bone Valley Formation. Overburden averages about 6 meters (20 feet). The overburden consists of a clay sand and a leach-zone material that overlays the matrix. The materials were selectively strip-mined with large electric draglines. The matrix was slurried in a sump and pumped to the washing plant. Cleaned, screened material from the washer that was plus 14 or 16 mesh was separated and may be a salable pebble product. The minus 16-mesh fraction was deslimed at a 150-mesh, and the plus 16- minus 150-mesh fraction was floated to produce a phosphate concentrate. The minus 150-mesh fraction, called slimes, is discarded by pumping into impoundment areas. Phosphate slimes contain 6% to 17% P_2O_5, which in some cases amount to almost one-third of the phosphate content in the matrix. Over the years, many unsuccessful attempts have been made to economically recover phosphate values from the slimes. Recovery of phosphate values from this waste product would lengthen the life of domestic phosphate reserves.

Improved recovery of phosphate rock concentrate from deposits in the United States was accomplished with the introduction of the flotation process in 1927 and 1928. Values in the 14 mesh by 150 mesh became recoverable, adding to the coarser plus 14-mesh pebble fraction. Conversion of phosphate rock with controlled quantities of sulfuric acid to single superphosphate, which contains about 20% P_2O_5, was the major phosphate fertilizer through the 1950's and into the 1960's. High analysis triple superphosphate, which contains more than 40% P_2O_5, is manufactured by acidulating phosphate rock with phosphoric acid. Ammonium phosphates, which contain 46% to 54% P_2O_5, are produced by reacting phosphoric acid with anhydrous ammonia. The ammonium phosphates and triple superphosphate have become the preferred fertilizers for domestic consumption and international trade. The intermediate chemical for these preferred fertilizers, phosphoric acid, is produced by acidulating phosphate rock with sulfuric acid. Phosphoric acid itself may be used as a fertilizer and is traded internationally; importers of phosphoric acid may manufacture fertilizers from the acid or use it to produce other phosphate chemicals.

In the past few years, experimental farming has determined more efficient use of mineral-based fertilizers. Farmers have learned to follow recommended application rates, timing, and use of efficient spreaders. These advances in the use of fertilizers significantly increased crop yields and decreased fertilizer consumption per planted acre.

ANNUAL REVIEW

Legislation and Government Programs

On September 30, 1993, the U.S. Department of Commerce notified the public of its determination not to revoke the antidumping duty on industrial phosphoric acid from Belgium, as was proposed the month before. Special dumping duties were established on August 20, 1987.[1] In Florida, new phosphogypsum stacks are required to be lined to prevent ground water from becoming contaminated with heavy metals. Heavy metals such as arsenic, cadmium, chromium, and phosphorus are found in waste phosphogypsum. New stacks must be constructed using a thick plastic sheet. The cost to build a 160-hectare (400 acre) lined stack site was estimated at more than $80 million.

The U.S. Environmental Protection Agency (EPA) announced the establishment of the Dialogue Committee on Phosphoric Acid Production Wastes (DCPAPW) in November 1992. The committee included the EPA, various State agencies, industry representatives, the Fertilizer Institute, and public interest groups. As required by the Federal Advisory Committee, the DCPAPW held two meetings in Arlington, VA, one in March and the other in November 1993, to continue reviewing information regarding existing or potential risks to human health or the environment from generated phosphoric acid wastes by identifying technically and economically feasible changes to the current production process of phosphoric acid.[2] The committee plans to publish a report on its findings in 1994.

The U.S. President, by Executive Order 12850 of May 28, 1993, announced the renewal of China's most-favored-nation (MFN) trading status without conditions. Each year MFN trading status for all nations expires. Therefore, the President recommended renewal of China's MFN status for an additional 12-month period beginning July 3, 1994, but future renewal would be subjected to its progress in human rights and weapons proliferation improvements.[3] U.S. exports of phosphate fertilizers are among the Nation's principal sales to China.

The North America Free Trade Agreement (NAFTA), between Canada, Mexico, and the United States, becomes effective January 1, 1994. Under this agreement most fertilizer products tariffs were eliminated, except for the following: phosphoric acid and anhydrous ammonia were assigned a 10-year phaseout and diammonium phosphate (DAP) and ammonium sulfate were assigned a 5-year phaseout.[4] The fertilizer industry is expected to benefit directly and indirectly from this agreement. The United States has no duties or tariffs on fertilizer imports. As Mexico eliminates duties under NAFTA, the U.S. industry is expected to directly benefit from an increase on fertilizer sales and, indirectly, from a potential increase in U.S. grain export.

On December 15, 1993, the President notified the U.S. House of Representatives and the U.S. Senate of his intention to enter into the trade agreement resulting from the Uruguay Round of multilateral negotiations under the auspices of the General Agreement of Tariffs and Trade (GATT). The Administration planned to enter into the GATT by April 15, 1994. Signed agreements will be submitted for congressional approval together with legislation and administrative actions required to implement the agreements in the United States. Fertilizer products are included in a chemical harmonized tariff system adopted in the market access of the GATT agreement.[5]

Issues

Phosphate rock mining and beneficiation processes require huge volumes of water. Transporting the matrix to the beneficiation plant, desliming it, and producing a high-grade phosphate concentrate by flotation consumes large volumes of water. The matrix is slurried with high-pressure hydraulic jets and pumped via a pipeline to the beneficiation plant. During beneficiation the minus 150-mesh slimes, mainly clays, are removed from the matrix by hydrocyclones and discarded by pumping into settling areas, called slime ponds. The Florida Department of Natural Resources, Bureau of Mine Reclamation, indicated that as of December 1991 there were about 40,000 hectares of active and inactive slime settling areas. Slime pond reclamation was a long-term operation requiring about 15 years for the clays to settle from an original 5% solids content to about 20% solids. Now reclamation time, after the slime pond becomes inactive, has been reduced to about 4 years by dewatering the pond using flotation tractors to dig the drainage ditches. For the past 30 years the phosphate industry, government institutions, and private research organizations have investigated methods of dewatering slimes instantaneously using flocculants. To date, an economic process to dewater slimes has not been discovered.

In the wet phosphoric acid process, phosphate rock is digested with sulfuric acid to produce dilute phosphoric acid. The process generates a solid waste of mainly calcium sulfate, called phosphogypsum. This waste also contains quartz, phosphates, fluoride, and radioactive minerals as well as minor amounts of heavy minerals, such as cadmium and cobalt. The water-slurried phosphogypsum is pumped to impoundments where the solids settle and the water is recycled to the process. The use of phosphogypsum is restricted because its radium content emits the radioactive gas radon. The National Emissions Standards for hazardous air pollutants of the Clean Air Act Amendments of March 15, 1990, requires that phosphogypsum be disposed of in stacks or mined-out areas. It is estimated that the Florida phosphate industry generates about 30 million tons of phosphogypsum per year at the present operating rates and there are about 600 million tons of this material in the existing stacks. It is technologically feasible to remove the harmful impurities from phosphogypsum, but the purified phosphogypsum is not economically competitive with natural gypsum.

Runoff from excessive application of fertilizer can contaminate ground water and receiving waters. The concern over negative environmental impacts frequently dismisses the importance of mineral fertilizers. Without providing and replenishing soil nutrients by increased use of fertilizers, production of food to satisfy an increasing world population will not be possible. The World Bank estimates that by the year 2025 the world population will reach 8.3 billion compared with the current population of about 5.4 billion, a 54% increase in a period of only 31 years.

Production

Production of marketable phosphate rock in the United States dramatically decreased from about 47 million tons in 1992 to about 35 million tons in 1993. Some mines and fertilizer plants were either closed or temporarily idled because of a low demand for phosphate rock and phosphate fertilizer products.

Florida and North Carolina.—Phosphate rock was produced in central Florida by Cargill Fertilizer, Inc. (CFI); CF Industries, Inc.; IMC-Agrico Co.; Mobil Mining and Minerals Corp.; and U.S. Agri-Chemicals Corp., owned by Sinochem (USA) Inc.

CFI closed its North Pasture Mine in June 30, 1993. CFI was buying phosphate rock from IMC-Agrico as feedstock for its phosphoric acid production through a contract expiring by the end of 1995. CFI also hired Jacobs Engineering Group Inc. to provide all engineering services related with the expansion and relocation of its beneficiation plant from the closed North Pasture Mine to a site near the new South Pasture Mine in Hardee County, FL. Startup for both the new South Pasture Mine and the expanded beneficiation plant was scheduled for late 1995.

IMC-Agrico Co. closed its Kingsford Mine in June and the Payne Creek Mine in October 1993. Both mines are in Polk County, FL. In July, the company also was forced to make additional adjustments in production of both fertilizers and phosphate rock concentrate as a result of large inventories in relation to low demand for fertilizers. DAP production was shut down at the Taft, LA, plant and production was reduced at one of the New Wales, FL, plants. To accommodate this lower fertilizer production level, the Four Corners Mine operation in Polk County, FL, was reduced from a 7-day to a 5-day week schedule. The closures and cutbacks in phosphate rock production were generally attributed to continued low prices for chemical fertilizers in the world market. The mines were expected to remain idle until market conditions improve. However, Clear Springs Mine, closed since November 1991, was reopened in October 1993. Company officials indicated that despite the sustained decline in phosphate prices the high-grade phosphate concentrate produced from Clear Springs had higher demand.

On December 2, 1993, IMC-Agrico announced the reopening of the DAP Taft fertilizer plant before the end of the month and returned the Four Corners Mine to a 7-day, three-shifts-per-day scheduled operation by January 1994, in response to the increased demand and higher prices for fertilizer products from domestic and international consumers. According to the company, this action was taken in anticipation of an expected increase in fertilizer demand for the coming spring season and to offset their lower fertilizer stocks.

Mobil Mining and Minerals Co. of Florida was told to go ahead with its projected mine development at South Fort Meade property. Mobil Corp., the parent company, agreed to fund the project cost of $200 to $300 million. Startup production of about 3 million tons per year was scheduled for 1995.

In northern Florida, Occidental Chemical Agricultural Products Inc. (Oxy) produced phosphate rock for production of phosphoric acid, superphosphoric acid, and diammonium phosphate. Oxy operated two mines north of Lake City, FL. As a result of the prevailing economic conditions affecting the phosphate fertilizer business, the company's Swift Creek phosphate mine was temporarily closed in May and remained closed through the end of 1993. In north-central Florida, low-fluorine soft phosphate rock was recovered from hard phosphate rock tailing ponds.

Texasgulf Chemical Co. (TG), a division of Texasgulf Inc., a subsidiary of Elf Aquitaine Inc., produced phosphate rock from the Aurora Mine in eastern North Carolina. TG employed bucket wheel excavating systems to remove the top 12 meters of overburden. Draglines were used to remove the remaining overburden and mine the 10 to 12 meters of matrix.

During 1993, the phosphate industry was affected by lower demand and prices for fertilizer products, and an important way to remain in business was through consolidation or joint ventures. Thus, in May 1993, Cargill Fertilizer, Inc., a subsidiary of Cargill Inc. of Minneapolis, MN, bought the assets of Seminole Fertilizer Corp., which was formerly owned by Tosco Corp. of Stanford, CT. The transaction included Seminole's Bartow phosphate fertilizer production plant, the phosphate mine Hookers Prairie, and two ammonia-storage tanks at Port Sutton, FL. Seminole's DAP plant in Fort Meade, FL, which is jointly owned (50%) by Agri-Chemicals, was not included in the deal.

On July 1, 1993, IMC Fertilizer Inc. and Freeport-McMoRan Resources Partners L.P., two of the largest domestic phosphate producers, finalized a joint agreement that combined both companies' phosphate rock mining and phosphate fertilizer businesses, as well as their uranium extraction operations. The new company name, IMC-Agrico Co., was expected to generate an overall operational cost savings of about $95 million in 1993.

Western States.—Phosphate rock was mined in Idaho by J. R. Simplot Co., Monsanto, and Rhône-Poulenc Basic Chemicals Co. Simplot produced phosphate rock from the Gay Mine on the Fort Hall Indian Reservation; however, the Gay Mine was closed in July 1993 because of phosphate rock depletion. Mainbed ore was used by Simplot to manufacture phosphoric acid, and the lower grade shale was used in FMC Corp. electric furnaces in Pocatello, ID. Simplot also produced phosphate rock from the Smoky Canyon Mine in the Caribou National Forest. The concentrate was pumped from the mine to Simplot's fertilizer plant west of Pocatello, ID. FMC produced phosphate rock from the Dry Valley facility for its Pocatello plant; Dry Valley material replaced shale from the Gay Mine, which closed during 1993. Monsanto supplied its electric furnaces in Soda Springs, ID, with phosphate rock from its Enoch Valley Mine in the Caribou National Forest. Rhône-Poulenc produced phosphate rock from the Wooley Valley Mine, Caribou National Forest, ID, and shipped to its electric furnace plant in Silver Bow, MT. Conda Partnership produced phosphate rock from the Mountain Fuel Mine and Maybe Canyon Mine, Caribou National Forest, ID. The Mountain Fuel Mine closed at the end of December 1993. The phosphate rock was shipped by rail to Conda, ID, beneficiated, calcined, and used to produce phosphoric acid. In March 1993, Cominco American closed its Warm Springs Mine near Garrison, MT. This was the only operating underground phosphate rock mine in the United States. The Cominco announcement stated that with scaled down production at its smelter complex at Trail, British Columbia, Canada, owing to environmental problems, the need for phosphate rock from the Warm Springs Mine was substantially reduced. SF Phosphates Ltd., formed in April 1992 by Simplot and Farmland Industries, produced phosphate rock from a mine near Vernal, UT. *(See tables 2 and 3.)*

Consumption and Uses

The demand pattern for phosphate rock was similar to that of 1992. In 1993, nearly 89% of the phosphate rock sold or used by U.S. producers was for the manufacture of wet-process phosphoric acid, single superphosphate, triple superphosphate, and deflourinated rock;

the balance was used to produce elemental phosphorus. Most of the phosphate rock imported was used to produce wet-process phosphoric acid. *(See tables 4 and 5.)*

Stocks

Phosphate rock stocks were maintained in wet rock piles in Florida and North Carolina and, after drying or calcining, were stored in silos. In the Western States, phosphate rock was stockpiled during the nonfreezing months of the year near electric furnaces or wet-process phosphoric acid plants to avoid railroad car or truck unloading problems in the wintertime. Phosphate rock inventory levels are of interest to analysts who follow inventory levels to indicate the strength of the demand for phosphate rock. In the United States, ending stocks in 1992 were 12.6 million tons. In 1993, phosphate rock ending stocks were 9.2 million tons, indicating a decrease of 3.4 million tons. *(See table 6.)*

Transportation

From production centers in central and north Florida, phosphate rock was moved by rail to terminals on Hillsborough Bay, FL, and Jacksonville, FL. In central Florida, CSX Transportation Railroad moved phosphate rock to terminals on Hillsborough Bay. The Rockport terminal was owned and operated by the CSX Railroad. Big Bend terminals and Port Sutton were owned and operated by IMC-Agrico Co. Eastern Associated Terminal (E.A.T.) was owned and operated by E.A.T.

In North Carolina, barges were used to transport phosphate rock from the Aurora Mine to the port at Morehead City for export. Railroad facilities were also available at the Aurora Mine to move phosphate rock to the port or domestic markets. Both railroads and trucks were used in the Western States to move phosphate rock from mines to plants. Two pipelines were used to move slurried phosphate rock from mines to plants. One pipeline was used to pump slurried concentrate from Vernal, UT, to Rock Springs, WY, and another was used to pump phosphate rock from the Smoky Canyon Mine in the Caribou National Forest to Pocatello, ID.

Markets and Prices

The price or value of phosphate rock, f.o.b. mine, was obtained from a semiannual survey of producing companies. The data from the survey were used to develop the weighted average price or value for each grade of phosphate rock sold or used in the domestic market or exported. The average annual price for phosphate rock in 1950 was $5.67 per ton and gradually increased to $7.42 per ton by 1966. In 1967, the average price started to decline progressively and, by 1972, bottomed out at $5.62 per ton. In 1973, the average price of phosphate rock followed a slight upward trend, reflecting the variation in supply and demand. In 1974, the price of phosphate rock continued a 2-year trend of sharp increases and averaged four times greater than the 1973 level, reaching the $25-per-ton mark for 1975. The dramatic increase in price was attributed to an arbitrary price increase by Morocco's Office Cherifien des Phosphate for exported phosphate rock. Although the price declined to $17.39 per ton in 1977, cost increases caused the price to level off at more than $20 per ton in 1979; the price peaked again in 1981 to $26.63 per ton, reaching a record-high level due to a strong demand. The price gradually declined to $19.37 per ton in 1987 and increased to $23.20 per ton in 1990. The price for phosphate rock followed a slight downward trend throughout 1991 and 1992 and for 1993 was $21.38 per ton. *(See tables 7, 8, and 9.)*

In 1993, prices of phosphate-based fertilizer products were low. DAP, the main phosphate fertilizer traded commodity, was selling at about $120 per ton in central Florida compared with about $150 per ton in January 1992. By mid-April, the price reached $110 per ton, the lowest in two decades. Low prices were attributed to lower demand for fertilizer products, an international market flooded with fertilizer products from the former U.S.S.R. in search of hard currency, and a compounded effect resulting from fewer fertilizer products bought by China and India.

Low prices and demand forced the phosphate industry to consolidate operations, close plants, and/or cutback on fertilizer products. Production cuts were necessary to turn depressed prices around. Since July, prices followed an upward trend, and at the end of December, DAP was quoted at more than $150 per ton in central Florida. The rise in fertilizer products prices did not trickle down to the phosphate rock prices. It usually takes more than 6 months of firm prices for the end products before the prices for raw materials gain ground.

Foreign Trade

Total exports of phosphate rock decreased about 14% from those in 1992. The major factor on exports of phosphate rock continued to be a lower demand for raw material, mainly triggered by closures of a number of phosphoric acid plants in Western Europe during 1992. These closures continued to affect the phosphate rock market in 1993. Exports of DAP, phosphoric acid, triple superphosphate, and elemental phosphorus decreased. Exports of monoammonium phosphate, however, increased by about 23% compared to those of 1992.

Imports of phosphate rock into the United States remained at about the same level in 1993 compared with those of 1992. The Bureau of the Census, however, supressed data on imports from Morocco into one U.S. customs district, which resulted in the artificially low import data shown in tables 1 and 17. The Moroccan Office Cherfien des Phospahtes reported exports of 1.46 million tons to the United States in 1993. *(See tables 10, 11, 12, 13, 14, 15, 16, and 17)*

World Review

World phosphate rock production decreased again in 1993 and was 20%

less than ouput in the peak year 1989. The decline in rock production was a consequence of lower phosphate fertilizer consumption worldwide. Morocco's phosphate rock exports were down by 8% compared to the level of 1992. However, Morocco's lower level of phosphate rock exports was probably due more to its built-up capacity for conversion of phosphate rock into other chemical products, rather than only a low international demand for raw materials. Preliminary estimated world phosphate fertilizer consumption showed a decline of about 6% in 1993 compared to that of the previous year. This was principally caused by reduced consumption in China and the former U.S.S.R. In Western Europe, during 1991, 1992, and 1993, phosphate rock imports decreased as a reflection of the closure or idling of various phosphoric acid plants with an annual capacity of more than 1.3 million tons P_2O_5. The acid plants were closed or idled for environmental and/or economic reasons. Closures of phosphoric acid plants during the previous 2 years had their final impact felt on phosphate rock production and trade in 1993.

Israel.—Fertilizers and Chemicals, a subsidiary of Israel Chemicals Ltd., formed a joint venture with Turkey's Trans Turk. The partners intended to build a plant in southern Turkey to produce liquid fertilizers. Fertilizers and Chemicals expected to have sales of more than $5 million in 1993.

Pakistan.—Fauji Fertilizer Co. (FFC), Pakistan, and Jordan Phosphate Mines Co. (JPMC), Jordan, have signed a memorandum of agreement to build a 200,000-ton-per-year phosphoric acid plant in Jordan and an ammonia, urea, and DAP facility at Port Qasim, Pakistan, with a capacity of 450,000 tons per year of DAP. The project cost was estimated at about $400 million. FFC was to own 65% of the phosphoric plant in Jordan and 75% of the facility in Pakistan, with the remaining 35% and 25%, respectively, to be owned by JPMC. The project cost was estimated at about $400 millon; plants in both countries were expected to start production by 1996.

Russia.—Phosphate concentrate production capacity of Production Association Apatit (P.O. Apatit) decreased by about 20% owing to the closure of the company's apatite-nepheline beneficiation plant No. 1, in January 1993. P.O. Apatit is Russia's largest producer of high-quality phosphate rock concentrates.

The U.S. Bureau of Mines estimates of world phosphate rock reserves and the reserve base are shown in table 19. Included are reserves and reserve base estimates with costs of less than $40 and $100 per ton, respectively. *(See tables 18, 19, and 20.)*

Current Research

The U.S. Bureau of Mines, research center in Tuscaloosa, AL, conducted research in an attempt to prevent loss of coarse phosphate in a flotation circuit. The results of this study to reexamine the conditioning of coarse Florida phosphate has determined that the mixing intensity of the conditioner affects the P_2O_5 rougher concentrate grade and recovery. The study also showed that removal of the residual clay or fine particles from the coarse flotation feed material resulted in a lower reagent consumption that could offset the added cost of scrubbing and/or elutriation. Optimizing the conditioning time, mixing intensity, and other conditioning parameters resulted in a rough phosphate concentrate grading 30% P_2O_5 with a total recovery of 95%.[6]

OUTLOOK

World production and consumption has declined steadily since 1989, primarily as a result of the sociopolitical restructuring of the economies of Eastern Europe and the former U.S.S.R. In addition, Western European imports were affected by the closure of a number of phosphoric acid plants the previous year that continued affecting the demand for phosphate rock. North American consumption of phosphate fertilizers has followed a downward trend in recent years as farmers learned to apply fertilizers following recommended procedures to optimize crop yield.

Significant dislocations worldwide have contributed to the decline in phosphate production, consumption, and trade. Despite all the negatives mentioned, the balance between supply and demand shifted in favor of the fertilizer producers during the last quarter of 1993. China resumed its levels of acquisition after almost a year of backcuts, and India, the second largest importer, increased fertilizer imports during the last part of 1993. The importance of having these two countries back into the international market cannot be ignored; these countries are recipients of about one-half the U.S. phosphate exports.

Based on the market recovery for phosphate fertilizer products that occurred during the last quarter of 1993, the outlook for domestic phosphate-based fertilizers within the next 2 to 3 years can be seen as optimistic. Farmers from the Midwestern States will need fertilizer to replace nutrients washed out by the worst flood in 100 years that took place in 1993. A modest increase in phosphate rock trade for 1994 is forecast. However, in the long term, phosphate rock trade will probably continue to decline. The continuing growth in world population will require increased use of fertilizer for food production. The long-term growth in phosphate-based fertilizers production should average between 1.5% to 2.0% annually beginning in 1996.

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[1]Federal Register. Department of Commerce. Industrial Phosphoric Acid From Belgium Determination Not To Revoke Antidumping Duty Order. V. 58, No. 188, Sept. 30, 1993, p. 51058.

[2]———. Environmental Protection Agency. Phosphoric Acid Production Waste Dialogue Committee; Public Meeting. V. 58, No. 39, Mar. 2, 1993, p. 12035.

———. Environmental Protection Agency. Public Meeting of the Phosphoric Acid Production Waste Dialogue Committee. V. 58, No. 203, Oct. 22, 1993, pp. 54590-54591.

[5]———. Presidential Documents. Conditions for Renewal of Most-Favored-Nation Status for the People's Republic of China in 1994. V. 58, No. 103, June 1, 1993,

pp. 31327-31329.

[4]———. Presidential Documents. To Implement the North American Free Trade Agreement and for Other Purposes. V. 58, No. 242, Dec. 20, 1993, pp. 66867-67259.

[5]———. Presidential Documents. Trade Agreement Resulting From the Uruguay Round of Multilateral Trade Negotiations. V. 58, No. 242, Dec. 20, 1993, pp. 67263-67302.

[6]Davis, B. E., and G. D. Hood. A Re-examination of the Conditioning of Coarse Florida Phosphate. Ch. 39 in Proceedings of the Engineering Foundation Conference, Beneficiation of Phosphates: Theory and Practice. Palm Coast, FL, Dec. 5-10, 1993, pp. 283-398.

OTHER SOURCES OF INFORMATION

Chemical Marketing Reporter, weekly.
Chemical Week, weekly.
European Chemical News (London), monthly.
Fertilizer Focus, bimonthly
Fertilizer International, monthly.
Fertilizer Market, weekly.
Green Markets, weekly.
Industrial Minerals, monthly.
International Fertilizer Industry Association Ltd.
The British Sulphur Corp. Ltd., Phosphorus and Potassium, bimonthly.
The Fertilizer Institute, Dealer Progress.
The Moroccan Office Cherifien des Phosphates.
The Phosphate Rock Export Association.

TABLE 1
SALIENT PHOSPHATE ROCK STATISTICS

(Thousand metric tons and thousand dollars unless otherwise specified)

	1989	1990	1991	1992	1993
United States:					
Mine production (crude ore)	170,268	151,277	154,485	154,936	106,790
Marketable production	49,817	46,343	48,096	46,965	35,494
P_2O_5 content	15,116	14,172	14,510	14,063	10,816
Value[1]	$1,084,022	$1,075,093	$1,109,094	$1,058,393	$758,983
Average per metric ton[2]	$21.76	$23.20	$23.06	$22.53	$21.38
Sold or used by producers[3]	49,280	49,754	44,707	45,113	40,051
P_2O_5 content	14,935	15,098	13,467	13,529	11,940
Value[1]	$1,072,454	$1,154,422	$1,030,913	$1,016,271	$856,414
Average per metric ton[2 4]	$21.76	$23.20	$23.06	$22.53	$21.38
Exports[5]	7,842	6,238	5,082	3,723	3,198
P_2O_5 content	2,522	2,019	1,643	1,200	1,018
Value[1]	$227,272	$191,233	$162,624	$120,216	$91,175
Average per metric ton[2]	$28.98	$30.66	$32.00	$32.29	$28.51
Imports for consumption	705	451	552	1,530	[6]534
C.i.f. value	$29,878	$21,905	$28,001	$56,159	$32,279
Average per metric ton[7]	$42.44	$48.57	$50.73	$36.71	$60.45
Consumption[8]	42,143	43,967	40,177	42,920	[e]38,287
Stocks, Dec. 31: Producers	11,027	8,912	10,168	12,612	9,215
World: Production	[r]165,788	[r]161,554	[r]149,494	[r]146,004	[e]131,941

[e]Estimated. [r]Revised.

[1]The total value is based on a weighted value.

[2]Computer-calculated average value based on the weighted sold or used values.

[3]Includes domestic sales and exports.

[4]Weighted average of sold or used values.

[5]Exports reported to the U.S. Bureau of Mines by companies.

[6]Some phosphate rock import tonnage and value were supressed by the Bureau of the Census.

[7]Average unit value obtained from unrounded data.

[8]Expressed as sold or used plus imports minus exports. Includes an estimated 900,000 tons of phosphate rock imported from Morocco not reported by the Bureau of the Census.

TABLE 2
PRODUCTION OF PHOSPHATE ROCK IN THE UNITED STATES, BY REGION

(Thousand metric tons and thousand dollars)

Region	Mine production		Marketable production			Ending stocks
			Beneficiated			
	Rock	P_2O_5 content	Rock	P_2O_5 content	Value[1]	
1992	154,936	20,485	46,965	14,063	1,058,393	12,612
1993:						
January-June:						
Florida and North Carolina	56,433	7,964	15,857	4,775	347,110	8,900
Idaho, Montana, Utah	3,721	969	2,204	900	40,620	1,374
Total	60,154	8,933	18,061	5,675	387,730	10,274
July-December:						
Florida and North Carolina	42,073	8,323	14,440	4,305	316,092	7,668
Idaho, Montana, Utah	4,563	1,119	2,993	836	55,161	1,547
Total	46,636	9,442	17,433	5,141	371,253	9,215
Grand total	106,790	18,375	35,494	10,816	758,983	XX

XX Not applicable.
[1]Computer-calculated value based on the weighted sold or used value.

TABLE 3
PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY GRADE AND REGION

(Thousand metric tons and thousand dollars)

Grade (percent BPL[1] content)	Florida and North Carolina			Idaho, Montana, Utah			Total		
	Rock	P_2O_5 content	Value[2]	Rock	P_2O_5 content	Value[2]	Rock	P_2O_5 content	Value[2]
January-June 1992	20,330	6,151	477,230	2,762	783	49,968	23,092	6,934	527,198
July-December 1992	18,749	5,676	434,204	3,272	918	54,869	22,021	[3]6,595	489,073
January-June 1993:									
74 or more[4]	—	—	—	—	—	—	—	—	—
72 to less than 74	745	249	21,629	—	—	—	745	249	21,629
70 to less than 72	671	217	21,088	430	141	16,110	1,101	358	37,198
66 to less than 70	9,935	3,034	197,992	466	145	8,879	10,401	3,179	206,871
60 to less than 66	5,663	1,627	137,619	624	174	6,346	6,287	1,801	143,965
Below 60	—	—	—	1,381	353	18,362	1,381	353	18,362
Total	17,014	5,127	378,328	2,901	813	49,697	19,915	5,940	428,025
July-December 1993:									
74 or more[4]	—	—	—	—	—	—	—	—	—
72 to less than 74	832	277	22,609	414	139	15,516	1,246	416	38,125
70 to less than 72	215	72	5,882	—	—	—	215	72	5,882
66 to less than 70	10,506	3,218	207,276	402	127	7,521	10,908	3,345	214,797
60 to less than 66	4,855	1,404	115,885	638	179	6,582	5,493	1,583	122,467
Below 60	752	195	18,069	1,522	389	29,049	2,274	584	47,118
Total	17,160	5,166	369,721	2,976	834	58,668	20,136	6,000	428,389

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.
[2]F.o.b. mine.
[3]Data do not add to total shown because of independent rounding.
[4]No reported sold or used for 1993.

TABLE 4
PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE

(Thousand metric tons)

Use	1992 total		1993					
			January-June		July-December		Total	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
Domestic:[1]								
Wet-process phosphoric acid	37,790	11,349	16,136	4,843	16,242	4,881	32,378	9,724
Normal superphosphate	23	8	11	3	8	3	19	6
Triple superphosphate	501	164	167	56	26	8	193	64
Deflourinated rock	—	—	42	14	43	14	85	28
Direct applications	(2)	(2)	24	7	4	1	28	8
Elemental phosphorus	3,076	808	2,033	537	2,117	555	4,150	1,092
Total	41,390	12,329	18,413	5,460	18,440	5,462	36,853	10,922
Exports[3]	3,723	1,200	1,502	480	1,696	538	3,198	1,018
Grand total	45,113	13,529	19,915	5,940	20,136	6,000	40,051	11,940

[1]Includes rock converted to products and exported.
[2]Less than 1/2 unit.
[3]Exports reported to the U.S. Bureau of Mines by companies.

TABLE 5
PHOSPHATE ROCK SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE AND REGION

(Thousand metric tons)

Use	Florida and North Carolina		Idaho, Montana, Utah		Total	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1992	39,079	11,828	6,034	1,701	45,113	13,529
1993:						
January-June:						
Domestic:[1]						
Agricultural	15,300	4,576	836	267	16,136	4,843
Industrial	244	80	2,033	537	2,277	617
Subtotal	15,544	4,656	2,869	804	18,413	5,460
Exports[2]	1,471	471	31	9	1,502	480
Total	17,015	5,127	2,900	813	19,915	5,940
July-December:						
Domestic:[1]						
Agricultural	15,426	4,615	816	266	16,242	4,881
Industrial	81	26	2,117	555	2,198	581
Subtotal	15,507	4,641	2,933	821	18,440	5,462
Exports[2]	1,652	525	44	13	1,696	538
Total	17,159	5,166	2,977	834	20,136	6,000
Grand total	34,174	10,293	5,877	1,647	40,051	11,940

[1]Includes rock converted to products and exported.
[2]Exports reported to the U.S. Bureau of Mines by companies.

TABLE 6

MARKETABLE PHOSPHATE ROCK YEAREND STOCKS[1]

(Million metric tons)

Year	Quantity
1984	11.9
1985	15.5
1986	13.3
1987	10.9
1988	9.3
1989	11.0
1990	8.9
1991	10.2
1992	12.6
1993	9.2

[1]Includes inventory adjustments.

TABLE 7

PRICE OR VALUE OF FLORIDA AND NORTH CAROLINA PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1992			1993		
	Domestic	Export	Average	Domestic	Export	Average
74 or more	—	—	—	—	—	—
72 to less than 74	29.57	34.13	32.13	26.93	29.20	28.04
70 to less than 72	25.03	30.14	29.28	20.31	31.57	30.43
66 to less than 70	20.55	30.60	21.00	19.33	25.80	19.83
60 to less than 66	25.56	—	25.56	24.11	26.45	24.11
Less than 60	—	—	—	24.03	—	24.03
Weighted average	22.47	31.69	23.32	21.26	28.11	21.89

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 8

PRICE OR VALUE OF IDAHO, MONTANA, AND UTAH PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1992			1993		
	Domestic	Export	Average	Domestic	Export	Average
70 to less than 72	36.82	—	36.82	37.48	—	37.48
66 to less than 70	18.49	50.76	22.02	18.90	—	18.90
60 to less than 66	14.60	—	14.60	8.04	45.23	10.24
Less than 60	9.33	—	9.33	16.32	—	16.32
Weighted average	16.72	50.76	17.38	18.09	45.23	18.43

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 9
PRICE OR VALUE OF U.S. PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade (percent BPL[1] content)	1992 Domestic	1992 Export	1992 Average	1993 Domestic	1993 Export	1993 Average
74 or more	—	—	—	—	—	—
72 to less than 74	29.57	34.13	32.13	30.51	29.20	30.00
70 to less than 72	34.11	30.14	31.99	34.51	31.57	32.73
66 to less than 70	20.46	32.57	21.04	19.31	25.80	19.79
60 to less than 66	23.77	—	23.77	22.48	45.02	22.62
Less than 60	9.33	—	9.33	17.91	—	17.91
Weighted average	21.65	32.29	22.53	20.76	28.51	21.38

[1]1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

TABLE 10
U.S. EXPORTS OF GROUND PHOSPHATE ROCK, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 2510.20.0000)

Country	1992 Quantity	1992 Value	1993 Quantity	1993 Value
Canada	128		93	
France	122		(1)	
India	21	NA	—	NA
Mexico	2		1	
Other	15		13	
Total	288	NA	107	NA

NA Not available.
[1]Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 11

U.S. EXPORTS OF UNGROUND PHOSPHATE ROCK, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 2510.10.0000)

Country	1992		1993	
	Quantity	Value	Quantity	Value
Australia	118		188	
Belgium	([1])		206	
Brazil	4		20	
Canada	153		170	
France	236		14	
Germany	312		194	
India	450		272	
Italy	24	NA	—	NA
Japan	603		554	
Korea, Republic of	1,147		1,053	
Mexico	5		2	
Netherlands	346		315	
New Zealand	161		204	
Romania	32		31	
Other	98		241	
Total	3,689	NA	3,464	NA

NA Not available.
[1]Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 12

U.S. EXPORTS OF SUPERPHOSPHATES, MORE THAN 40% P_2O_5, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 3103.10.0020)

Country	1992		1992	
	Quantity	Value	Quantity	Value
Argentina	27		14	
Australia	227		228	
Bangladesh	108		16	
Brazil	186		99	
Canada	11		53	
Chile	175		148	
Colombia	10		13	
Costa Rica	2		2	
Dominican Republic	10		—	
Equador	15	NA	—	NA
Indonesia	182		—	
Japan	52		50	
Mexico	4		—	
Peru	4		14	
South Africa, Republic of	6		—	
Spain	4		—	
United Kingdom	25		—	
Uruguay	29		4	
Venezuela	18		—	
Other	19		121	
Total	1,114	NA	762	NA

NA Not available.

Source: Bureau of the Census.

TABLE 13

U.S. EXPORTS OF DIAMMONIUM PHOSPHATES, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 3105.30.0000)

Country	1992		1993	
	Quantity	Value	Quantity	Value
Albania	10		—	
Argentina	191		190	
Australia	286		436	
Bangladesh	17		—	
Belgium	35		—	
Brazil	41		77	
Canada	175		175	
Chile	69		108	
China	3,582		2,109	
Colombia	98		135	
Costa Rica	7		10	
Cote d'Ivoire	34		—	
Dominican Republic	49		33	
Ecuador	44		38	
El Salvador	16		—	
France	61		34	
Germany	94		91	
Guatemala	21		5	
Honduras	15		—	
India	1,187		1,189	
Iran	281	NA	32	NA
Ireland	16		37	
Italy	26		—	
Japan	431		512	
Jordan	27		—	
Kenya	31		62	
Korea, Republic of	54		—	
Mexico	58		247	
Netherlands	30		—	
New Zealand	55		159	
Pakistan	713		732	
Panama	17		—	
Peru	14		24	
Philippines	33		—	
Spain	42		11	
Taiwan	55		—	
Thailand	111		87	
Turkey	74		131	
United Kingdom	25		—	
Uruguay	66		40	
Venezuela	45		10	
Other	36		652	
Total	8,272	NA	7,366	NA

NA Not available.

Source: Bureau of the Census.

TABLE 14

U.S. EXPORTS OF MONOAMMONIUM PHOSPHATES, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 3105.40.0000)

Country	1992 Quantity	1992 Value	1993 Quantity	1993 Value
Argentina	5		2	
Australia	216		188	
Brazil	8		132	
Canada	298		395	
Chile	33		34	
China	5		2	
Colombia	40		91	
Costa Rica	26		20	
Dominican Republic	1		([1])	
Ecuador	—	NA	5	NA
Guatemala	37		22	
Japan	157		111	
Mexico	22		38	
New Zealand	—		20	
Peru	([1])		([1])	
Saudi Arabia	—		10	
Thailand	17		([1])	
Venezuela	([1])		([1])	
Other	24		23	
Total	889	NA	1,093	NA

NA Not available.
[1]Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 15

U.S. EXPORTS OF PHOSPHORIC ACID, LESS THAN 65% P_2O_5, BY COUNTRY

(Thousand metric tons and thousand dollars)
(HTS No. 2809.20.0010)

Country	1992 Quantity	1992 Value	1993 Quantity	1993 Value
Australia	60		46	
Canada	6		13	
Colombia	8		6	
India	279	NA	138	NA
Indonesia	69		61	
Japan	—		([1])	
Venezuela	56		37	
Other	124		197	
Total	602	NA	498	NA

NA Not available.
[1]Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 16
U.S. EXPORTS OF ELEMENTAL PHOSPHORUS, BY COUNTRY

(HTS No. 2804.70.0000)

Country	1992 Quantity (metric tons)	1992 Value[1] (thousands)	1993 Quantity (metric tons)	1993 Value[1] (thousands)
Brazil	507	$1,060	748	$1,500
Canada	1,726	2,571	1,489	2,509
Japan	9,334	16,988	9,378	17,632
Korea, Republic of	134	596	24	101
Mexico	5,314	8,329	6,358	9,695
Netherlands	21	137	23	60
Taiwan	38	48	—	—
Other	806	3,055	333	691
Total	17,880	32,784	18,353	32,188

[1]All values f.a.s.

Source: Bureau of the Census.

TABLE 17
U.S. IMPORTS FOR CONSUMPTION OF PHOSPHATE ROCK AND PHOSPHATIC MATERIALS

(Thousand metric tons and thousand dollars)

Phosphatic materials	HTS No.[1]	1992 Quantity	1992 Value[2]	1993 Quantity	1993 Value[2]
Natural calcium[3] phosphates unground	2510.10.0000	1,528	55,986	532	32,028
Natural calcium[3] phosphates ground	2510.20.0000	2	173	2	251
Dicalcium phosphate	2835.25.0000	2	2,746	3	3,783
Phosphorus	2804.70.0000	4	10,330	1	7,257
Normal superphosphate	3103.10.0010	([4])	71	([4])	5
Triple superphosphate	3103.10.0020	([4])	5	([4])	8
Diammonium phosphate	3105.30.0000	22	4,907	38	7,096
Fertilizer containing nitrates and phosphates	3105.51.0000	1	150	56	5,604
Phosphoric acid	2809.20.0010	1	214	([4])	12

[1]Harmonized tariff schedule of the United States.
[2]Declared c.i.f values.
[3]Excludes reported imports from Canada and Israel.
[4]Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 18

WORLD PHOSPHATE ROCK ANNUAL PRODUCTION CAPACITY, DECEMBER 31, 1993, RATED CAPACITY[1]

(Million metric tons per year)

Country	Capacity
North America:	
Mexico	1.0
United States	50.0
Total	51.0
South America	10.0
Europe:	
Russia	18.0
Other	1.0
Total	19.0
Africa:	
Algeria	2.3
Morocco[2]	32.0
Senegal	2.0
South Africa, Republic of	4.5
Togo	3.2
Tunisia	8.0
Other	1.2
Total	53.2
Asia:	
China	25.0
Israel	4.0
Jordan	8.0
Kazakhstan	8.0
Korea, North	1.0
Vietnam	1.0
Other	1.0
Total	48.0
Oceania:	
Australia	1.0
Nauru	2.0
Total	3.0
World total	184.2

[1]Includes capacities of operating plants as well as plants on standby basis.
[2]Includes former Western Sahara.

TABLE 19

WORLD PHOSPHATE ROCK RESERVES AND RESERVE BASE

(Million metric tons)

	Number of deposits	Reserves[1]	Reserve base[2]
North America:			
Canada	1	50	50
Mexico	2	10	110
United States	94	1,200	4,440
Total	97	1,260	4,600
South America:			
Brazil	11	330	370
Colombia	1	—	100
Peru	1	310	310
Venezuela	1	—	10
Total	14	640	790
Europe:			
Finland	1	—	70
Russia	8	—	1,000
Turkey	1	30	30
Total	10	30	1,100
Africa:			
Algeria	1	240	240
Egypt	5	—	760
Morocco[3]	11	5,900	21,440
Senegal	2	—	160
South Africa, Republic of	1	2,530	2,530
Togo	12	—	60
Tunisia	11	—	270
Total	43	8,670	25,460
Asia:			
China	6	210	210
Christmas Island	1	10	10
Israel	4	—	180
Jordan	3	90	480
Kazakhstan	3	—	100
Syria	2	190	190
Other	6	30	330
Total	25	530	1,500
Oceania:			
Australia	5	90	590
Nauru	1	5	5
Total	6	95	595
World total	195	11,225	34,045

[1]Phosphate rock reserves at a cost less than $40 per ton f.o.b. mine. Costs include capital, operating taxes, royalties (if applicable), miscellaneous costs and a 15% rate of return on investment. Costs and resources are as of Jan. 1993, f.o.b. mine.
[2]Reserve base at a cost less than $100 per ton. Costs are as defined in footnote 1.
[3]Includes former Western Sahara.

TABLE 20

PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Commodity and country[2]	Gross weight					P_2O_5 content				
	1989	1990	1991	1992	1993[e]	1989	1990	1991	1992	1993[e]
Phosphate rock:										
Albania[e]	25	10	9	2	2	3	1	1	([3])	([3])
Algeria	1,124	1,128	1,090	1,136	1,136	[e]371	[e]333	[e]322	[r][e]340	340
Australia	8	16	[e]4	[e]4	5	1	4	1	1	1
Brazil	3,655	2,968	3,280	[r]2,825	3,000	[r]1,279	[r]1,039	[r]1,148	[r]989	1,050
Burkina Faso[e]	3	3	3	3	3	1	1	1	1	1
Chile	14	14	13	[r]17	14	[e]1	[e]1	[e]1	[e]1	1
China[e]	20,000	21,550	22,000	23,000	24,000	6,000	6,400	6,500	6,800	7,000
Colombia	31	[r]31	32	32	32	[e]8	[e]8	[e]8	[e]8	8
Egypt	1,347	1,143	1,652	[r]2,000	2,000	[e]337	[e]286	[e]413	[r][e]500	500
Finland	580	546	472	[r]555	600	214	201	[e]170	[r]201	215
India	704	674	563	[e]600	635	235	[e]220	[e]195	[e]200	210
Indonesia	11	2	6	[e]8	7	4	1	2	3	2
Iraq[e] [4]	1,140	900	400	900	1,000	342	270	120	270	300
Israel[4]	3,922	3,516	[e]3,370	3,595	3,590	[e]1,231	[e]1,104	[e]1,070	[e]1,125	1,120
Jordan	6,900	6,082	4,433	4,296	4,200	[e]2,277	[e]2,007	[e]1,458	[r][e]1,409	1,300
Kazakhstan[e]	—	—	—	[r]12,000	10,000	—	—	—	[r]3,000	2,500
Korea, North[e]	500	500	[r]500	[r]500	510	160	160	[r]160	[r]160	163
Mali[e]	10	10	[r]—	[r]—	—	2	2	[r]—	[r]—	—
Mexico[5]	655	623	596	[r]452	350	197	[e]174	[e]180	[r][e]135	105
Morocco[6]	18,067	21,396	17,900	[r]19,145	[7]18,305	[e]5,781	[e]6,906	[e]5,700	[r][e]6,178	5,919
Nauru	1,181	926	530	747	600	[e]455	[e]355	[e]200	[e]285	228
Netherlands Antilles[e]	15	15	15	15	10	5	5	5	5	4
Pakistan	[e]40	[e]42	19	20	20	[e]13	[e]13	6	[e]6	6
Peru	15	47	18	[r][e]18	18	[r][e]5	[r][e]16	[e]6	[e]6	6
Philippines	4	3	21	[e]20	20	[e]2	[e]1	[e]5	[e]5	5
Russia[e]	—	—	—	[r]11,500	10,400	—	—	—	[r]4,336	3,928
Senegal[8]	2,273	2,147	1,741	[r]2,284	2,200	823	777	[e]630	[e]830	790
South Africa, Republic of	2,963	3,165	3,050	3,051	3,100	1,111	1,190	[e]1,150	[e]1,150	1,200
Sri Lanka	24	33	20	[r]26	25	[e]8	[e]11	[e]6	[e]6	8
Sweden	71	[r]7	—	—	—	26	[r]3	—	—	—
Syria	2,256	1,633	1,359	1,266	1,275	[e]690	[e]511	[e]425	[e]395	400
Tanzania	5	25	22	22	22	[e]1	[e]8	[e]7	[e]7	7
Thailand	7	10	6	[r]8	8	2	[e]3	2	2	2
Togo	3,355	2,314	2,965	[r]2,100	2,100	[e]1,270	[e]840	[e]1,076	[r][e]760	760
Tunisia	6,610	6,258	[r]6,352	6,400	6,400	[e]1,963	[e]1,858	[r][e]1,880	[e]1,900	1,900
Turkey	85	87	[r]4	[r]65	65	26	27	[r]1	[r]20	20
Uganda	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])
U.S.S.R.[e] [9]	37,500	36,800	28,400	—	—	12,200	11,800	9,250	—	—
United States	49,817	46,343	48,096	46,965	[7]35,494	15,116	14,172	14,501	14,063	[7]10,816
Venezuela	237	165	162	[r]10	100	57	34	[e]34	[r]3	33
Vietnam[e]	500	[7]274	[r]274	275	250	175	96	96	95	90
Zimbabwe, concentrate	134	148	117	[r]142	145	47	52	41	42	45
Total	[r]165,788	[r]161,554	[r]149,494	[r]146,004	[r]131,641	[r]52,439	[r]50,890	[r]46,771	[r]45,237	40,983
Basic (Thomas converter) slag:										
Argentina[e]	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])
Egypt[e]	8	8	8	8	8	2	2	2	2	2

See footnotes at end of table.

TABLE 20—Continued

PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Commodity and country[2]	Gross weight					P_2O_5 content				
	1989	1990	1991	1992	1993[e]	1989	1990	1991	1992	1993[e]
Basic (Thomas converter) slag:										
France	701	488	538	[r]356	350	126	88	97	90	90
Germany	122	128	[r]142	[r]120	100	18	19	[r]21	18	15
Luxembourg	672	603	[r]536	[r]519	520	[r]121	109	[r e]95	[r e]93	93
Total	1,503	1,227	[r]1,224	[r]1,003	978	[r]267	218	[r]215	[r]203	200
Guano:										
Chile	3	[r]1	1	[r]([3])	—	[e]([3])	[e]([3])	[e]([3])	[e]([3])	—
Philippines	48	1	[e]12	[e]10	10	16	[e]([3])	[e]4	[e]3	3
Total	51	[r]2	13	[r]10	10	16	([3])	4	3	3

[e]Estimated. [r]Revised.

[1]Table includes data available through May 13, 1994. Data for major phosphate rock-producing countries derived in part from the International Fertilizer Industry Association; other figures are from official country sources where available.

[2]In addition to the countries listed, Belgium may have produced small quantities of phosphate rock and Namibia may have produced small quantities of guano, but output is not officially reported, and available information is inadequate for formulation of reliable estimates of output levels.

[3]Less than 1/2 unit.

[4]Beneficiated.

[5]Includes only output used to manufacture fertilizers.

[6]Production from Western Sahara area is included.

[7]Reported figure.

[8]Does not include aluminum phosphate production, gross weight estimated as follows in thousand metric tons: 1989—140; 1990—127; 1991—92; 1992—75 (revised); and 1993—75.

[9]Dissolved in Dec. 1991.