

Phosphate Rock

Stephen M. Jasinski, the phosphate rock commodity specialist for the U.S. Geological Survey, has prepared the following information on phosphate rock, which is the source of phosphorus in fertilizers and industrial chemicals.

Phosphate rock minerals provide the only significant global resources of phosphorus, which is an essential element for plant and animal nutrition. Phosphate rock is used primarily as a principal component of nitrogen-phosphorus-potassium fertilizers, but also to produce elemental phosphorus and animal feed.

The grade of the rock ore is expressed as the percent phosphorus pentoxide or tricalcium phosphate, which is commonly referred to as bone phosphate of lime. The phrase came about at a time when animal bones were the principal source of tricalcium phosphate fertilizer. Today, phosphate rock is used as a concentrated product, known as marketable phosphate rock, which has phosphorus pentoxide content greater than 28 percent for use in phosphoric acid production plants. Elemental phosphorus production plants can use lower grade ores.

The untreated form of phosphate rock is not very soluble and provides little available phosphorus to plants, except in moist, acidic soils. Treating ground phosphate rock with sulfuric acid creates wet-process phosphoric acid, the basic material for producing most phosphoric fertilizers. The primary fertilizer products are diammonium phosphate and monoammonium phosphate, which are manufactured by reacting phosphoric acid with ammonia and triple superphosphate, produced by treating phosphate rock with phosphoric acid.

More than 95 percent of the phosphate rock mined in the United States is used to produce phosphoric acid. In the United States, phosphate rock is mined by open pit methods, and processed by washing and milling the phosphate rock ore zone (matrix), then separating the rock particles and grinding them to a uniform size. The process produces marketable phosphate rock.

Manufacturers can also produce phosphorus in its elemental form by smelting phosphate rock, coke and silica in an electric furnace. The phosphorus is then liberated as a gas, collected by condensation and stored underwater to prevent combustion. Elemental phosphorus is used to produce phosphorus chemical compounds that are used in applications such as cleaners, food additives and herbicides. Elemental phosphate is slowly being replaced by high-purity, wet-process phosphoric acid as a feedstock for phosphorus chemicals because of its lower production cost and cleaner technology.

Most phosphate rock deposits are of sedimentary origin, with phosphorus found in the form of hydroxy fluorapatite, or as carboxyapatite. Active U.S. phosphate rock mines exist in Florida, Idaho, North Carolina and Utah. Florida and North Carolina alone account for 85 percent of U.S. production. Worldwide, large deposits are found in northern Africa, Australia, China and the Middle East. Phosphate rock also occurs in igneous deposits, in the form of apatite, generally as fluorapatite. Significant igneous deposits are located in Brazil, Canada, Finland, Russia and South Africa. Morocco, China, South Africa, Jordan, and the United States have the largest reserves, in descending order.

In 2006, world phosphate rock production was about 145 million metric tons. China, the United States and Morocco, in descending order, were the leading producers, accounting for approximately 65 percent of the total. The United States was once the biggest producer and consumer of phosphate rock, but China's production surpassed the United States in 2006, when U.S. phosphate rock production and consumption fell to the lowest levels in nearly 40 years, owing to mine and plant closures and lower export sales of phosphate fertilizers.

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Samples of phosphate rock with penny for scale. Image from *Minerals in Your World*.